International Journal of Agricultural Sciences ☞DOI:10.15740/HAS/IJAS/17.1/114-120
Volume 17 | Issue 1 | January, 2021 | 114-120 ■ ISSN : 0973-130X Visit us : *www.researchjournal.co.in*

*A REVIEW*

# Artificial intelligence: A cutting edge technology in agriculture

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**Abstract :** Attention is currently being paid to the use of smart technologies. Agriculture has provided an important source of food for humans over thousands of years, including the development of appropriate farming methods for the cultivation of different crops. The emergence of new advanced technologies has the potential to monitor the agricultural environment to ensure high-quality produce. In this context, a systematic review that aimsto study the application of various technologies and algorithms in Artificial Intelligence (AI) with the latest solutions to make the farming more efficient remains one of the greatest imperatives. Artificial intelligence can be applied directly in the field of agriculture for various operations. Amid high expectations about how AI will help the common personand transform his mindset, thoughts and attitude towards the benefits that it may bring. There are certain concerns about the ill effects of such sophisticated technologies as well.This review also focuses on the activation of perceptive technologies and application of computer vision and machine learning in agriculture.

**Key Words :** Artificial intelligence, Computer vision, Deep learning, Machine learning

**View Point Article :** Allawadi, Sidhant, Jayaty, Sharma, Parmod, Rohilla, Kapil and Deokar, Gopal (2021). Artificial intelligence: A cutting edge technology in agriculture. *Internat. J. agric. Sci.*, **17** (1) : 114-120, **DOI:10.15740/HAS/IJAS/17.1/114-120**. 

**Article History : Received :** 28.10.2020**; Accepted :** 24.12.2020

## INTRODUCTION

Computer science that accentuates the calibration of realizable or non-realizable systems, which behave intelligently as human beings thinking, act even better and achieve human-like exposure to all mentally under standing course work, avoiding strictly discursive anticipation /argumentation. Artificial means not happing or existing naturally and intelligenceis the ability to acquireand apply knowledge and skill. Thus, Artificial Intelligence (AI) relates to the mental process of perception, judgment, memory and reasoning that anyone can companion with human abilities such asquality of being recognized or acknowledge, general annunciation of cognate and compounding, cognition demobilization, processing of image developing, instant responding, knowledge acquisition, etc., which give effective and functional data structure.

Artificial intelligence is mutelygrowing in agriculture, and due to its interference, it has greater impact on our organization. Machine learning has also been used for the prediction, classification, yield forecasting and food

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grading. Deep learning algorithms and AI applications have possibilities of taking this kind of research to much higher levels with more accuracy. AI is also able to enhance farmers in terms of their social and economic wellbeing.

In the decade of industrial revolution, the machines were developed for alteration and change to get better result than human power. AI as progressing sector with the advancements and information technology in the 20th century, post-arrival of computers initiated the vision for AI powered machines. In the present scenario, it is fact that AI is taking over the human labour.

By 2050, the world needs to produce 50 per cent more food but only 4 per cent additional land can bring under cultivation to meet this demand (Bagchi, 2018). For making the agriculture supplementary-resourceful, leftover of the supreme essentials adoption of latest technological resolutions is necessary. How can farming be done in present days by the efficient application of AI? It can likewise convey a model modification, requiring lot of direct application across the various sectors. According to the concept of future farming and for overcoming challenges in future farming, one will deliberate based on the performance of AI. Like Pascal's Law in case of pressure, AI-powered resolutions can also enable farmers to do more with fewer resources in all cases of applications.

In agriculture, it is remarkable that developing image and applications of computer vision have increased due to the availability of equipments at affourdable prices and increased computational power and development in constructive food acquiring algorithms (Mahajan *et al*., 2015). The adoption of these techniques is benefited when compared with traditional methods based on human power, nevertheless, there are many demands to explain and overtake them (Barbedo, 2016). The applications of machine learning and computer vision have been increasing gradually to overcome the need of increasing population and accurate methods in monitoring grain production. Such methods are also used in rice production to raise the quality of final produce and to fit food security criteria in an automated, economically efficient and constructive manner (Zareiforoush *et al*., 2015). Manual methods for grain assessment are challenging even for trained people particularly to perform these tasks. To overcome these limitations, some practices such as use of computer vision and near infrared can be followed (Vithu and Moses, 2016). Techniques in combination with pattern recognition methods and tools for automation have been used to contract with the challenge of monitor cultures and analyse food quality. Machine learning algorithms are already common in many areas such as fraud detection, credit analysis, fault prediction models, image recognition patterns, intelligent spam filters and product quality analysis.

Artificial narrow intelligence (ANI), Artificial general intelligence (AGI), Artificial super intelligence (ASI) are analyzed with the help of AI (Bhar *et al*., 2016). Artificial narrow intelligence is related to place like Google map, which is an impressive way to recognize places while riding a car or a chess-playing programme. Artificial general intelligence is like a computer, which is as smart as a human in all aspects is. Therefore, anything that we can do with our brain can be done, including acquisition of knowledge. Artificial intelligence is getting power day by day with its applications leading to machines and systems to more advanced AI. Artificial super intelligence is a system, which works better than a human being-more wiser, creative and socially adopted and it ranges from being a little bit better to being smarter than human working abilities.

**An overview on applications of AI in agriculture:**

There are some areas of AI, which are having great ability to compete for solving agriculture problems such as Natural language processing (NLP), Robotics, Machine learning (ML), Automated reasoning, Knowledge representation, Expert systems, Computer vision, Speech recognition, Automated data analytics, Virtual reality, Augmented reality, Internet of things (IoT), Cloud computing, Statistical computing, Deep learning, etc. (Bhar *et al*., 2016). Artificial intelligence envisages on the problems occurred in the Agriculture and can resolve them and enables the farmers, *e.g.*, impart knowledge to the farmers based on the characteristics of soil, appropriate time of seed drilling, diseased area and fertigation. In addition, motivated technologies by AI are evolving to help the farmers in improving the efficiency with respect to crop and soil monitoring, weather forecasting and predictive agricultural analysis.

Agriculture will certainly get benefit from the application of AI. It should be used to form clever data structure, which are integrated with machines that can work more precisely as well as alacrity than humans can and at the same time, it may be more responsive like humans. AI unneurotic with Internet of Things (IoT) and

sensor technology can be the large commute of precision farming. AI is crucial part of remote sensing technology in wide scale adoption of climate smart agriculture.

Mobile based systems and skilful systems are some of the AI techniques in agriculture, which make the various machines user friendly. Automation, sensors, drones, IoT and solar power assisted with AI provide new achievability for business and entrepreneurs to bear progressive solutions as service at inexpensive prices to the farmers. The most beneficial thing in agriculture by the application of AI is to get rid of frustrating efforts and disappointment from many agricultural operations so that one can use his time and make efforts in most efficient ways of finding an array of creative AI innovations to surpass human capabilities or defensibilities.

In computer science, ontology is a formal representation of the knowledge by a set of concepts within a domain and their relationship. It is the current AI acknowledgement expertise but can play important role in creating scientific repositories of actualize knowledge and allegorise different applications to use this knowledge for making intelligent decisions.

Artificial intelligence supported involuntary categorisation and grading are already being done for fruits and vegetables with an opportunity for adopting an international agri-commodity standard aiding reliable business enterprise. Deep learning and advanced image developing techniques are used for viewing images and pictures thus, digitizing quality and categorisation of food. For raising the inferior utility of more products and at geographical locations, there must be a very large amount of such images. It is a fact that the highest agricultural data lies with the government and hence, burdenis totally upto them to adopt it and make it usable or applicable.

Consulting firm of Microsoft is employed in the state of Andhra Pradesh with 175 farmers and is rendering services and solutions for land preparation, sowing, addition of fertilizers and other nutrient supplements for crop (Dharmaraj and Vijayanand, 2018). In comparison to previous harvest, they found 30 per cent increase in crop yield per hectare. There are large areas for improving agriculture such as Internet of Things (IoT) driven development, image-based insight generation, disease detection, identifying the readiness of the crop, field management, identification of optimal mix for agronomic products and crop health monitoring. Automation techniques in irrigation and water conservation can benefit farmers in managing their water problems since onlyone fourth of the world's good quality water resource is utilized for irrigation. Significance of drone and precision farming care meticulously for water resource management, plant and soil nutrients management, insect-pest management, geological mapping, remote sensing, integrated electronic communication, variable rate technology and optimum planting and harvesting time estimator. The goals achieved in precision farming by application of AI are highly profitable and efficient. Various scientists in world developed application of AI through machine learning and computer vision in the field of agriculture and some of these techniques are discussed in this review article.

**Study sectors in application of AI in agriculture:**

*Activation of perceptive technologies*:

Intelligent data fusion:

Remote sensing and scenery sensing are two technologies, which are primarily used for intelligent data fusion like soil testing. Remote sensings cans the earth by satellite or high-flying aircraft in order to obtain information about it and scenery 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 at a particular place. Robots are used for aggregation of other activities such as data-collecting software with robotics to prepare the best fertilizer application plan for increasing production.

**Discernment issue from image:**

Now-a-day, one of the most focussing sectors in application of AI in agriculture is precision farming. Deep analysis of field, crop inspection, scanning of fields and so on is done by drone-based images. To guarantee quick activities by farmers, union of computer vision technology, IoT and drone data are necessary. Disease detection, crop readiness identification, field management, etc. are the some areas where computer vision technology is applicable.

**Identification of best agronomic recommendation:**

According to soil conditions, weather forecast, types of seed, infestation in a certain area and so on, intelligent assurance gives suggestion to farmers for the best choice of crops and hybrid seeds. Based on farm's requirement, local conditions and according to experience regarding pervious farming, the suggestions can be

further personalized.

**Inspection of crop and their comfort:**

To provide drone-based solutions in allegiance with Artificial intelligence and computer vision technology, the crop inspection and its comfort detection are most significant area in agriculture. High-resolution cameras in drones collect acceptable or required field images, which can be passed through corrugation neural network for detection of region having unwanted plant growth, water requirement of particular plant, which faces water stress and the region, which is affected due to the disease, or deficiency or excess of nutrients. The other technique used for large area at a time is hyper-spectral images. These are short-term agents but give knowledge about the whole plant life.

**Precise use of water by automation:**

Automated Irrigation is an artificial application of water to the soil using wireless system. Proposed system has developed based on information sent from the sensors and estimated the quantity of water needed. Two sensors are used to get the data at the base station humidity, temperature of the soil and the duration of sunshine per day. Based on these values, the proposed systems calculate the water quantity required for irrigation. The major advantage of the system is implementation of Precision agriculture (PA) with cloud computing to optimize the usage of water and fertilizers while maximizing the crop yield and it will also help in analyzing the weather conditions of the field. Precision irrigation is the requirement of all water dependent sectors including agriculture and this technique is one of the best solutions on precise use of water and saving of water without wasting it.

**Managing yield by application of AI:**

The conception of recent technologiesis generating bio network forthe adoption of smart farming. For empowering farmers, the realization of higher average yield and better price control union of all this expertise, *i.e.*, Innovative analytics, Cloud machine learning, Satellite imagery and Artificial intelligence (AI), is necessary. Using cortana intelligence collection along with Machine learning microsoft is currently working with farmers in Andhra Pradesh to provide recommended services. In addition, for the determination of pest attacks, the Microsoft in association with United phosphorus Limited is building a pest risk prediction (API) that powers AI and machine learning to specify the risk of pest attack. Prediction of pest attack is done based on stage of crop development and weather conditions. The experimental plan has shown near about one-third increase in average crop yield per hectare than previous due to the uses of AI sowing app to recommend sowing date, land preparation, soil test-based fertilization, farmyard manure application, seed treatment and optimum sowing depth.

**Application of computer vision and machine learning:**

*Application of computer vision* :

It includes techniques through which artificial vision systems can be adopted for implementation of particular application in agriculture. It comprises the software, hardware and image processing (Davies, 2005). Primarily, computer vision system consists of learning and developing images.

**Learning of image:**

In this system, electronic signals obtained by sensor through a device like camera are transferred to numerical representation (Zareiforoush *et al*., 2015). Scanning of images from the field is done by cameras in two ways such as line and area scanning. In line scanning, camera captures only one line of pixels at a time, whereas, in area scanning, camera generates an image in each exposure cycle. For the generation of two-dimensional images, it is essential to move the object to be captured using a conveyor or move the camera along a motionless body. The quality of the image learned by a computer vision system is directly affected by the illumination used during the acquisition phase.

**Image developing:**

It includes handling digital images for modifying lighting problems, improving their quality and reducing noise. For the assessment and study of particular images deeply, the image is divided into different areas and the study area is detected. From that area, the information or knowledge is collected. It can be divided in pre-level, intermediate-level and high-level developing. Pre-level developing comprises of focus correction, divergence or perceptiveness augmentation and clatter lessening by geometric transformations. These operations can develop a new image and improve its quality (Hornberg, 2017)

Intermediate-level progression in volves subdividing of images in sections, explanation and grouping of things present in the image (Hornberg, 2017). In high-level progression, the recognition and sorting of sections of interest are usually performed by using neural networks along with statistical classifiers.

**Application of machine learning:**

For computational applications, machine-learning techniques are able to transform and take best and appropriate decision. Some learning algorithms like supervised learning, unsupervised learning, reinforcement learning and evolutionary learning are the components of machine learning. In supervised learning algorithms, there is set of trained answers for particular set of possible inputs, hence, it is restricted for giving response for a particular inputs with a most possible correct answers, but in unsupervised learning algorithms, firstly it compares the inputs to each other and distributes it according to their similarities in between them and gives response in a particular way. Reinforcement learning algorithms can be classified as an intermediary stage between supervised and unsupervised learning. This algorithm is advised when it responds with incorrect answers to a question but this does not happen when it responds with correct answers.We have to examine the different answers until the response is not given with required correct answers. Evolutionary learning consists of adapting to increase the chances of surviving and reproducing in the environment in which they live. Mutually, reversion and sorting difficulties can be analyzed with machine learning (Marsland, 2014). Process of machine learning also includes formation and acquiring knowledge regarding collecting information, addressing problems occurred, selection of algorithm, parameters selection, training, rating, monitoring, etc.

**Adoption of computer vision in agriculture:**

*For diseased grain and insect infestations*:

Due to diseases or infestation by insect-pests, grain production is susceptible to a number of adverse factors such asitrestricts inconvenient effects and reduces increment in crop production as well as harms the grain quality, thus, results indecreasing selling price and thereby storage co-efficient. For effective management of crop disease and assure productivity for sustainable agriculture, the primary function is to recommend, identify and detect the diseases in crops.

While analysing the images obtained in the field, presence of complex backgrounds and interferences in the scene like occlusion, soil, plants of other species and specular reflections are the challenges. Traps can be used to improve the quality of image segmentation and accurate the process to count the insects being in the scene. It is important to highlight the variability in size and shape of these insects due to their species or stage of development.

For detection of disease in crops, some other techniques were also used by different scientists such as Bakanae detection in rice crops (Chung *et al*., 2016), leaf diseases in soybean (Shrivastava *et al*., 2016), local descriptors to detect soybean diseases (Pires *et al*., 2016), aphids detection in wheat (Liu *et al*., 2016), detection and evaluation of leaf spot severity in wheat (Han *et al*., 2015) and *Sitophilus granarius* detection in stored wheat seeds (Boniecki *et al*., 2014).

**Detection of grain quality:**

The implementation of machine learning skills for detection, identification, distribution and calibration of image has gradually given more importance since it creates proper, adequate, precise and cognitive organization. The defining characteristics of agriculture products such as size, colour, roundness, flavour and texture of agricultural products is difficult task even for computer vision too. Computer vision techniques are an alternative to manually inspecting grain samples. Information on grain type and quality are required at various stages during the grain processing action, however, inspection of these products by vision is boring and it takes more time. The inspector cannot give more attention even adequate attention for a total period safely. Hence, the detection of grain quality by automatic grain detection techniques in comparison to manual inspection can prevent human errors in the quality assessment process (Singh and Chaudhury, 2016). Some other grain characteristics are also detected by different techniques such as classification of wheat seeds by using Artificial Neural Network (Sabanci *et al*., 2017), recognition of fungal colonies by using computer vision and machine learning techniques (Sun *et al*., 2016), shadow-based method to quantify the percentage of filled rice seeds (Liu *et al*., 2016), computer vision approach by using two cameras to identify germinated seeds (Shrestha *et al*., 2016), identification of diseases in soybean seeds by using BPNN (Kezhu *et al*., 2014), classification of milled

rice seeds based on maturity and moisture content by using SVM (Sun *et al*., 2014), automatic wheat purity measurement system (Ebrahimi *et al*., 2014) and detection of wheat seeds damaged by *Fusarium*, mottled and vitreous by using hyper spectral images (Serranti *et al*., 2013).

**Application in phenology and phenotyping:**

Phenology is a branch of science dealing with the relations between climate and periodic phenomena such as bird migration, plant flowering or it is a periodic biological phenomena, which are correlated with climatic conditions. Some eco-friendly circumstances can activateres ponses such as flowering and fruiting in plants according to temperature, light and humidity. The application of a computer vision scheme would offer a productive and non-invasive alternative to the manual investigation required in plant phenotyping. Plant development phase is also one of the features among them. Some other applications of phenology and phenotyping are to evaluate the severity of stress in soybean plants to determine emergence, flowering and development stages in wheat, characterize the corn tassel, maize tassel segmentation depending upon the region-based colour modelling method, automatic characterization of rice flowering, corn tassel detection by using computer vision and SVM, diagnosis of nutritional status relative to nitrogen in corn leaves, etc.

**Conclusion:**

With continuously increasing demand for food supplies, artificial intelligence can play an important part in supporting the agriculture production to maintain the pace with the growing demands. Agriculture industry is increasing its efficiency and production rates with the application of agricultural robots, aerial data collection and mobile apps, often powered with computer vision. As compared to human power, AI is more precise in classification, prediction, soil and water management, nutrients deficiency, insect-pest and disease attack, crop yield and food grading. Various procedure and techniques have been developed by scientists for the identification and their remedial measures for different crops. The challenges for food production based on qualitative, quantitative and economic analysis can be met out with the application of AI in agriculture. Human can handle each condition within certain limit of its strength but work done requires power or energy, which is available in the nature and can be gathered by human brain.

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