Mindtree

Welcome to possible

Artificial Intelligence in Agriculture

"To eradicate extreme poverty and hunger"

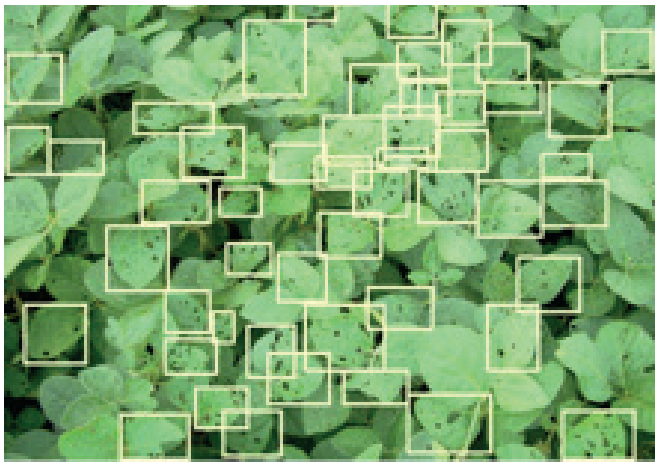
- Millennium Development Goal, UN Summit 2000

Abstract

According to UN Food and Agriculture Organization, the population will increase by 2 billion by 2050. However, only 4% additional land will come under cultivation by then.

In this context, use of latest technological solutions to make farming more efficient, remains one of the greatest imperatives. While Artificial Intelligence (AI) sees a lot of direct application across sectors, it can also bring a paradigm shift in how we see farming today. AI-powered solutions will not only enable farmers to do more with less, it will also improve quality and ensure faster go-to-market for crops.

In this article, we will discuss how AI can change the agriculture landscape, the application of drone-based image processing techniques, precision farming landscape, the future of agriculture and the challenges ahead.



Scope of AI in Agriculture

Agriculture is seeing rapid adoption of Artificial Intelligence (AI) and Machine Learning (ML) both in terms of agricultural products and in-field farming techniques. Cognitive computing in particular, is all set to become the most disruptive technology in agriculture services as it can understand, learn, and respond to different situations (based on learning) to increase efficiency.

Providing some of these solutions as a service like chatbot or other conversational platform to all the farmers will help them keep pace with technological advancements as well as apply the same in their daily farming to reap the benefits of this service.

Currently, Microsoft is working with 175 farmers in Andhra Pradesh, India to provide advisory services for sowing, land, fertilizer and so on. This initiative has already resulted in 30% higher yield per hectare on an average compared to last year.

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

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. 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

Companies like **Aerialtronics** have implemented IBM Watson IoT Platform and the Visual Recognition APIs in commercial drones for image analysis in real time. Given below are some areas where computer vision technology can be put to use:

- **Disease detection:**

  Capture of image → Preprocessing → Transmission to remote labs

  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 send to remote labs for further diagnosis. It also helps in pest identification, nutrient deficiency recognition and more.

- **Crop readiness identification:**

  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.

- **Field management:**

  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.

3. Identification of optimal mix for agronomic products

   Based on multiple parameters like soil condition, weather forecast, type of seeds, 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.

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 anomalies.

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.

Importance of Drone

As per a recent **PWC Study**, the total addressable market for Drone-based solutions across the globe is $127.3 billion and for agriculture it is at $32.4 billion.

Drone-based solutions in agriculture have a lot of significance in terms of managing adverse weather conditions, productivity gains, precision farming and yield management.

- Before the crop cycle, drone can be used to produce a **3-D field map** of detailed terrain, drainage, soil viability and irrigation. Nitrogen-level management can also be done by drone solutions
- **Aerial spraying** of pods with seeds and plant nutrients into the soil provides necessary supplements for plants. Apart from that, Drones can be programmed to spray liquids by modulating distance from the ground depending on the terrain
- **Crop Monitoring** and **Health assessment** remains one of the most significant areas in agriculture to provide drone-based solutions in collaboration with Artificial Intelligence and computer vision technology. High-resolution cameras indrones collect precision field images which can be passed through convolution neural network to identify areas with weeds, which crops need water, plant stress level in mid-growth stage. In terms of infected plants, by scanning crops in both RGB and near-infra red light, it is possible to generate multispectral images using drone devices. With this, it is possible to specify which plants have been infected including their location in a vast field to apply remedies, instantly. The multi spectral images combinehyper spectral images with 3D scanning techniques to define the spatial information system that is used for acres of land. The temporal component provides the guidance for the entire lifecycle of the plant.

Precision Farming

The phrase "Right Place, Right Time, Right Product" sums up precision farming. This is a more accurate and controlled technique that replaces the repetitive and labor-intensive part of farming. It also provides guidance about crop rotation, optimum planting and harvesting time, water management, nutrient management, pest attacks and so on.

Key technologies that enable precision farming are give below:

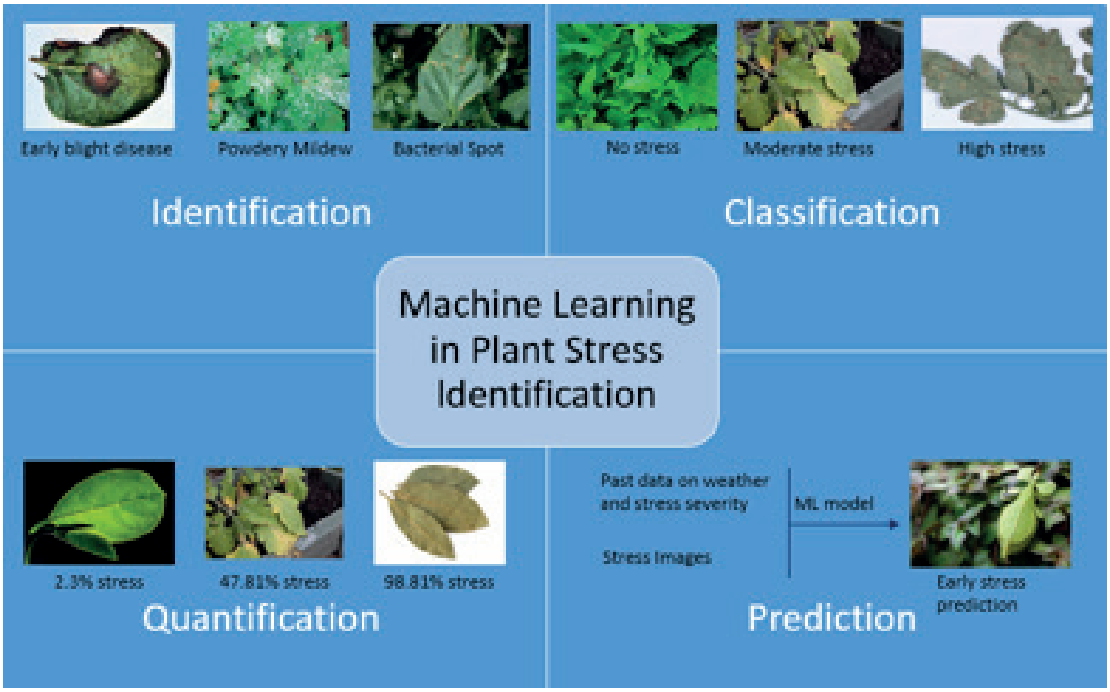
- High precision positioning system
- Automated steering system
- Geo mapping
- Sensor and remote sensing
- Integrated electronic communication
- Variable rate technology

Goals for precision farming:

- Profitability: Identifying crops and market strategically as well as predicting ROI based on cost and margin.
- Efficiency: By investing in precision algorithm, better, faster and cheaper farming opportunities can be utilized. This enables overall accuracy and efficient use of resource
- Sustainability: Improved social, environmental and economic performance ensures incremental improvements each season for all the performance indicators

Examples of precision farming management:

- Identification of stress level in a plant is obtained from high-resolution images and multiple sensor data on plants. This large set of data from multiple sources needs to be used as an input for Machine Learning to enable data fusion and feature identification for stress recognition.
- Machine learning models trained on plant images can be used to recognize stress levels in plants. The entire approach can be classified into four stages of identification, classification, quantification and prediction to make better decisions.



Yield Management using AI

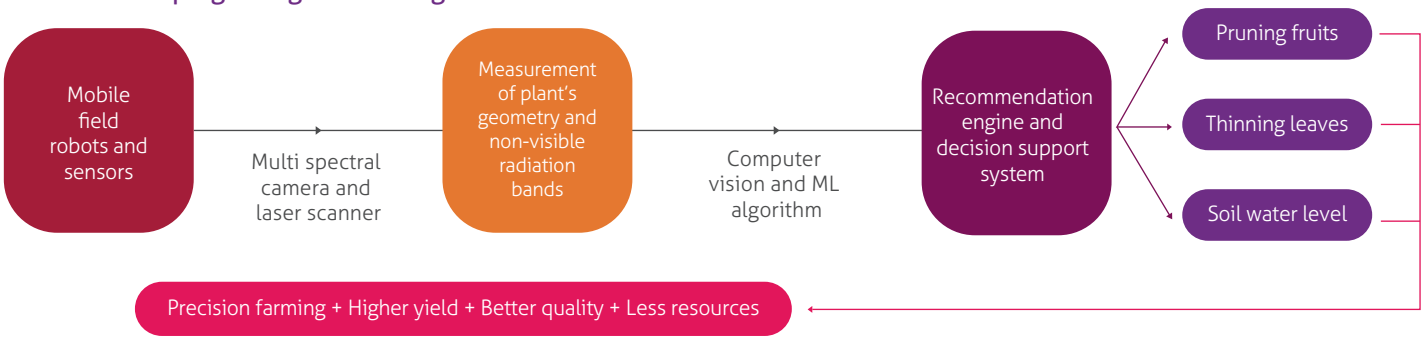
The emergence of new age technologies like Artificial Intelligence (AI), Cloud Machine Learning, Satellite Imagery and advanced analytics are creating an ecosystem for smart farming. Fusion of all this technology is enabling farmers achieve higher average yield and better price control.

Microsoft is currently working with farmers from Andhra Pradesh to provide advisory services using Cortana Intelligence Suite including Machine Learning and Power BI. The pilot project uses an AI sowing app to recommend sowing date, land preparation, soil test-based fertilization, farm yard manure application, seed treatment, optimum sowing depth and more to farmers which has resulted in 30% increase in average crop yield per hectare.

Technology can also be used to identify optimal sowing period, historic climate data, real time Moisture Adequacy Data (MAI) from daily rainfall and soil moisture to build predictability and provide inputs to farmers on ideal sowing time.

To identify potential pest attacks, Microsoft in collaboration with United Phosphorus Limited is building a Pest Risk Prediction API that leverages AI and machine learning to indicate in advance, the risk of pest attack. Based on the weather condition and crop growth stage, pest attacks are predicted as High, Medium or Low.

How Robotics helping in Digital Farming



AI 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.

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.

Challenges in AI Adoption in Agriculture

Though Artificial Intelligence offers vast opportunities for application in agriculture, there 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.

Summary

The future of farming depends largely on adoption of cognitive solutions. While large scale research is still in progress and some applications are already available in the market, the industry is still highly underserved. When it comes to handling realistic challenges faced by farmers and using autonomous decision making and predictive solutions to solve them, farming is still at a nascent stage.

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.

Another important aspect is the exorbitant cost of different cognitive solutions available in the market for farming. The solutions need to become more affordable to ensure the technology reaches the masses. An open source platform would make the solutions more affordable, resulting in rapid adoption and higher penetration among the farmers.

About the author

Arka Bagchi
Associate Consultant, Mindtree

Working as an Artificial Intelligent-Deep Learning Consultant for Mindtree AI COE. Consulted clients on digital transformation and innovation. Apart from work, travelling and exploring new places is my passion.

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