Artificial Intelligence

Intelligent Inputs Revolutionising Agriculture

Naman Agrawal & Himanshu Agrawal

AUTOMATION in agriculture is an emerging subject across the world. In recent time, Artificial Intelligence has been seeing a lot of direct application in farming 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.

Advances in computer vision, mechatronics, artificial intelligence, and machine learning are enabling the development and deployment of remote sensing technologies to identify and manage plants, weeds, pests and diseases. This also provides a unique opportunity to develop intelligent seeding methods for precise fertilization. Artificial intelligence solutions can enable farmers not to only reduce wastage, but also improve quality and ensure faster market access for the produce.

Cognitive computing has become the most disruptive technology in agricultural services as it can learn, understand, and interact with different environments to maximize productivity. Microsoft is currently working with 175 farmers in Andhra Pradesh to provide agricultural, land and fertilizer advisory services. This initiative has already resulted in 30% higher average yield per hectare last year.

Proximity sensing, remote sensing, Internet of Things (IoT) and image based Precision Farming are being used for intelligent data integration related to historical meteorology, soil reports, recent research, rainfall, insect infections and along with drone imagery is being used for in-depth field analysis, crop monitoring and field surveys.

Analysing Farm Data using AI

Thousands of field data points are captured on the ground every day. With the help of artificial intelligence, farmers can now extract and analyse information such as weather, temperature, water consumption or soil conditions collected from their field which can also be collected in real-time.

Artificial intelligence technology is already helping farmers achieve higher yields through better crop selection, hybrid seed selection and resource utilization and also to improve the quality and accuracy of crops – something called precision farming. Precision farming uses artificial intelligence techniques to detect disease, pests, and malnutrition in the field. AI sensors can detect and target weeds and then determine the pesticides and weedicides to be used in the identified buffer zone. This helps in optimising the amount of pesticides and weedicides to be used by the farmers.

AI is also aiding farmers to develop seasonal forecast models to improve farming accuracy and improve productivity. This can also help farmers to make better decisions using technologies to predict future weather trends over the next several months. Seasonal forecasts are mainly targeted at small farms in developing countries as data and knowledge may be limited. Since these small farms produce 70% of the world's harvest, it is important that these small farmers produce the highest yields.

In addition to topographic data, farmers are also using drone-based AI-enabled cameras to take pictures in the field and analyse images in real time to identify potential problems and improvements. Drones can cover a much wider area than humans and monitor the produce more efficiently.

The use of image recognition using artificial intelligence approaches for plant identification, pest infestation and disease diagnosis is also becoming prevalent. Cruz *et al*. (2017) developed the X-Phyto insight-based program to detect the symptoms of Olive Quick Decline Syndrome (OQDS). The system uses a transform intensive neural network (DP-CNN) and a new aggregation algorithm at the summary level to improve diagnostic accuracy. Similarly, an industrial Principal Component Analysis (PCA) detection system is being used to help farmers make timely management decisions and control the spread of disease.

Yield Management using AI

AI, cloud computing, satellite imagery and advanced analytics have today created an ecosystem for smart agriculture. The combination of these technologies allows farmers to achieve higher average yields and better control over prices.

Microsoft is currently working with farmers in Andhra Pradesh to provide consulting services, including machine learning and Power Business Intelligence using the Cortana Intelligence Suite. The pilot project was completed using agricultural AI applications to communicate dates, soil preparation, fertilization based on soil tests, seed treatment, optimal spreading depth, and more. Mobile robots and field

sensors support digital agricultural robots, multidisciplinary cameras and laser scanners for facilities and areas of radiation that cannot be measured.

Tackling the Labour Challenge

Farm operations are getting hampered today due to mass migration of labour to the cities. Robots employing AI are increasing the efficiency of labour in many ways. These robots can harvest faster, locate and remove weeds more accurately, and thus reduce operating costs and dependence on labour.

In the meantime, farmers are already turning towards chatbots for help. Chatbots help farmers by answering their questions and provide advice and guidance on specific agricultural issues.

AI Startups in Agriculture

Throughout the world efforts are being directed at automation of farm operations and use of AI and associated technologies to streamline agriculture based on data inputs. This has given rise to the establishment of innumerable start-ups.

1. **Prospera:** This startup has built a cloud-based solution that collects all data available to farmers, such as land/water sensors, air images, etc. It then connects to a device in the field that analyses the data and suggests desired results. Prospera can be used both in greenhouses and in the field; it works with a variety of sensors and technologies such as computer vision. The input from these sensors is used to determine the correlation between the various data labels and their predictions.
2. **Blue River Technology** combines AI, computer vision and robotics to save costs and reduce the amount of pesticides. The computer vision defines each plant separately, machine learning determines how the characteristics of each should be observed and allows the robot to intelligently control the farm machinery and takes suitable actions.
3. **Formbot** founded in 2011 has taken precision research to the next level by reaching out to the community by using precision farming techniques for home farmers. It allows the farmers to perform a range of activities from planting seeds to weed detection, and testing of soil to watering plants through robots that work with an open source software system.
4. **Harvest CROO Robotics** is a robotic strawberry harvesting system that allows the detection and identification of ripe berries for picking strawberries using machine vision and artificial intelligence. Strawberry growers face acute labour shortage, which increases crop costs and the risk of incomplete harvests. The development of mechanical harvesting methods and the use of other artificial intelligence will reduce the manufacturer's manual labour, lower harvesting costs and increase overall competitiveness.
5. **Gramophone (Agstack Technologies):** They use image recognition skills to help farmers get the right information, methods and materials at the right time to get the best harvest possible. The company uses artificial intelligence and machine learning to predict pests and diseases, predict food prices to maximize productivity, and recommend products to farmers.
6. **Jivabhumi** is creating a "Smart" Agriculture Marketplace for optimising the supply and demand for agricultural products, which is often inadequate. It is an innovative food aggregation solution that integrates agricultural products, e-marketplace services and innovation. It uses technologies such as blockchain to collect information about products at various stages of the supply chain.

Challenges in Adoption of AI

While AI has huge potential for agricultural applications, farms in many parts of the world still lack the use of high-tech machine learning solutions. Agriculture's exposure to external factors such as climate, soil conditions and pests is also important. So, what would look like a good decision in the planning stage might not prove to be the best one because of changes in external factors.

Artificial Intelligence systems require a lot of data to train machines and make accurate predictions. It is difficult to find temporal data for large agricultural areas, although spatial data are easy to collect. Because data infrastructure requires maturity, it takes time to develop a powerful machine learning model. This is one of the reasons why AI is used in agricultural products like seeds, fertilizers, and pesticides, rather than in field solutions. Agriculture is still at an incredibly early stage when it comes to managing farmers' decision making and making independent decisions and predictions to cope with the situation.

To explore a wide range of AI in agricultural applications, the applications must be robust. They should be capable of handling changes in external circumstances, facilitate real-time decision-making and use the appropriate structure/platform to retrieve relevant data.

Another important disadvantage is the inflated cost of the many different solutions available in the agricultural market. Solutions need to be more affordable so that technology can be accessed even at the farm level. The open source platform creates a more structured solution that enables faster and better adoption by the farmers.

The development of artificial intelligence technology based on computer vision involves a learning (training) process that requires the collection and analysis of several examples in a natural and dynamic environment that accurately reproduces the conditions of the field.

AI technology usually improves by increasing the amount of quality data that allows the processors to solve various visualization problems, such as lighting conditions, improper cropping and poor alignment. These algorithms and artificial intelligence technologies can be integrated with mobile devices to provide an efficient platform for pest and disease detection and pesticide mapping. The use of agrochemicals in specified doses and use of pesticides only where necessary help greatly in reducing the use and cost of pesticides, subsequently reducing their impact on the environment.

Mr Naman Agrawal is Senior Associate (naman.agrawal@nic.in) and Mr Himanshu Agrawal (himanshu.agrawal@nic.in) is Young Professional at the NITI Aayog, Government of India