

Growth of Artificial intelligence (AI) in Agriculture

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With the help of artificial intelligence, farmers are now able to grow better crops and look after their animals while saving time and energy. The combination of artificial intelligence and big data will move this industry towards digitalization and making every economy an agri-focused one. The data collected is used to predict the perfect time to harvest or to estimate total milk production in long-term. The acquisition of this information helps farmers to not only save out on costs but also optimize the production process and reduce wastage of produce. The digitalization of agriculture sector as a big step to overcome challenges it faces in present times. It also studied farmers' awareness of Artificial Intelligence (AI) and their perception of major problems they face. Majority of the respondent farmers were found unaware of Artificial Intelligence. Only few farmers were found to have read about Artificial Intelligence (AI) aspects like drones and robotics etc or browsed online. It implies need to generate awareness and create infrastructure to meet this imperative technological need to revamp Indian agricultural sector.

Key words: Agriculture, Digitization

INDIA has an agriculture-based mixed economy. Agricultural sector in India is considered to be the backbone of its economy. Its share in GDP has declined from 29% of 1991 to 18% in 2014 (*Statistics Times*). Based on 2016-17 values, agriculture constitutes of 17.32% of the overall GDP of India while services sector constitutes for about 53.66% and Industry sector constitutes for about 29.02%. Contribution of Agriculture sector in Indian economy is higher than world's average (6.1%). However, we still have a long way to go as most of the Indians are directly or indirectly depending on the agriculture.

Major challenges faced by Indian agriculture

The issues with Indian agriculture are majorly due to knowledge deficit and infrastructure deficit, especially in the rural areas.

Irrigation: Agricultural production and productivity depends, to a large

extent, on the availability of water. India faces an irregularity in the distribution of rainfall throughout the year. Monsoon is irregular and erratic in nature, sometimes there is heavy rainfall whereas sometimes inadequate rainfall. The irrigation system helps the farmers during inadequate rainfall. Despite the investment in irrigation facilities, the lack of adequate irrigation facilities and no effective system management for how much water is stored, how much water is used for irrigation has led to farmers' dependence on rainfall specifically during monsoon. Also there is significant cultivable area under rainfed conditions. The Maharashtra, Rajasthan, Karnataka, Telangana and Odisha took up some measures of water harvesting and budgeting based on the concept of watershed development. Nevertheless, climatic vagaries, no or minimal rainfall and not much of irrigation facilities at ground level form a vicious circle for the farmers

resulting in agrarian distress and unrest.

Climate change and agriculture: Due to climate change, the normal practices of the farmer get disturbed resulting in high input cost to the farmer. This indirectly affects the final consumer, as he/she gets a low quality fruit, less nutritive fruit and the cost to the consumer also goes up. Rising temperatures, unexpected floods and drought conditions create precarious situations for agricultural production. The conditions resulted in vulnerabilities among farmers so much so that many cases of farmers' suicides have been reported from Maharashtra, Karnataka and Andhra Pradesh.

Poor socio-economic conditions of the farmers: The poor socio-economic conditions among farmers is majorly due to restricted access to proper education amongst their community and exploitation by middlemen.

Since the days of British rule, the central government has been striving

to expand institutional lending to the rural agricultural sector. In recent decades, efforts in this direction were intensified and, there is a vast network of institutions providing credit for agriculture.

Major sources of rural credit in India are: Co-operative Credit Societies, Land Development Banks, Commercial Banks, Regional Rural Banks, and the governments of states and central.

The main causes of rural indebtedness include low earning power of the borrowers, very high rate of interest charged by the village moneylender and the manipulation of accounts by the lenders. Less availability of credit influences adversely the adoption of modern technology, which in turn lowers the productive capacity of the agricultural sector and results in lower productivity and production and also pushes the farmers to borrow from non-institutional sources. This vicious cycle leads to poor socio-economic conditions amongst farmers.

Inadequate uses of farm equipment: In most areas of India, primitive methods of cultivation are still practised. Most farmers continue to use native plough and other accessories. Mechanization helps in raising farm income by increasing productivity. However, the problem is not the lack of access of appropriate farm equipment. The real problem is that the farmers lack the knowledge of using the equipment efficiently.

The government has set up a number of Farm Machinery Training and Testing Institutes to train farmers on the operation and maintenance of agricultural equipment. The Government also released a new subsidy for the establishment of 988 Farm Machinery Banks and distribution of farm machinery and tools to farmers in various states.

Small-land holdings: Indian agriculture consists of majorly small-and marginal-farmers. These small-and marginal-farmers own small land-holdings due to their poor financial condition. Besides, farmers use traditional technology which enhances their problem. Hence, they

produce low yield and are not able to profit. Any advanced or new technology requires less fragmented land to make significant difference in the economy.

Lack of marketing channels: Marketing information is critical to farm profitability. To receive regular profits from the land, resources must be utilized to the fullest. Farmers fall in the lowest bracket of the pyramid of target audience for the latest technology producers. Hence, the farmers are unaware of new technological methods of increasing productivity.

Digitalization and its impact on agriculture, how it solves the problems

Innovative and technological solutions to the above listed challenges faced by Indian agriculture are imperatives in the present scenario. Artificial intelligence is taking over all industries these days. The industries are curious to know how the technology can help businesses become more efficient. Modern agriculture is also one of them. As defined by Gartner, “Artificial intelligence (AI) is technology that appears to emulate human performance typically by learning, coming to its own conclusions, appearing to understand complex content, engaging in natural dialogs with people, enhancing human cognitive performance (also known as cognitive computing) or replacing people on execution of non-routine tasks. Applications include autonomous vehicles, automatic speech recognition and generation and detecting novel concepts and abstractions (useful for detecting potential new risks and aiding humans quickly understand very large bodies of ever changing information).”

AI works on the principle where a machine can perceive its environment and take a specific action with rationality. Machine learning is when this same machine, according to a specified set of protocols, improves in its ability to address problems and goals related to the environment as the statistical nature of the data it receives increases. Put more plainly, as the system receives an increasing

amount of similar sets of data that can be categorized into specified protocols, its ability to rationalize increases, allowing it to better “predict” on a range of outcomes.

According to the United Nations Food and Agricultural Organisation (FAO), the global population is set to reach 9.2 billion by 2050. With available acreage estimated at just an additional 4%, it seems it is no longer an option to simply plant more crop fields or breed more cattle. What is needed, therefore, is a greater efficiency within current farming methods as farmers will be required to ‘do more with less’.

The growth of artificial intelligence in agriculture is primarily driven by the increasing demand for agricultural production due to the increasing population, rising adoption of information management systems and new technologies for improving crop productivity, and increasing by implementing deep learning techniques, and growing initiatives by governments worldwide supporting the adoption of modern agricultural techniques. The only restraint in the growth of artificial intelligence in agriculture market is the high cost of gathering precise field data.

Artificial intelligence in agriculture is emerging in three major categories: Agricultural robotics, Soil and crop monitoring, and Predictive analytics. Digitalization in agriculture has opened up new dimensions for growth. Remote sensors, satellites, and drones can gather information throughout the day over an entire field. They monitor temperature, humidity along with plant and soil health. These sensors can generate an avalanche of data which is then used for cultivation of significantly better produce.

Artificial intelligence can boost the efficiency of daily operations in a traditional farm and maximize production volume and minimize the possibility of failure due to natural disasters, system errors, and other factors by acquiring data on growth, the weather, and agricultural equipment.

Use of drones: Drones can facilitate irrigation and assess the health of the

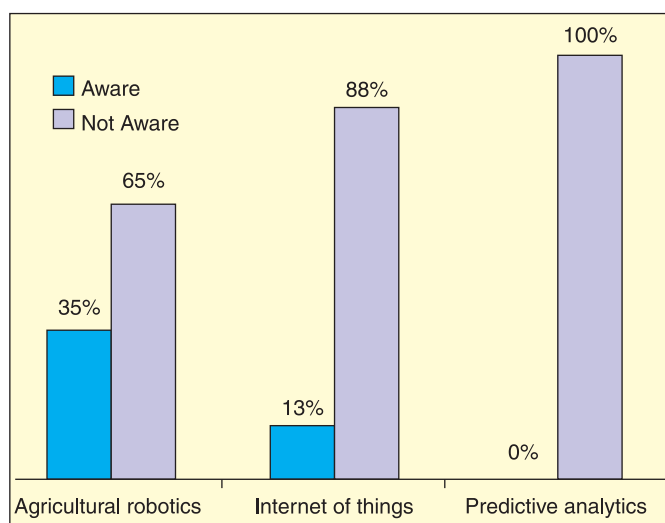


Fig. 1. Awareness of Haryana farmers about digitalization (N=80)

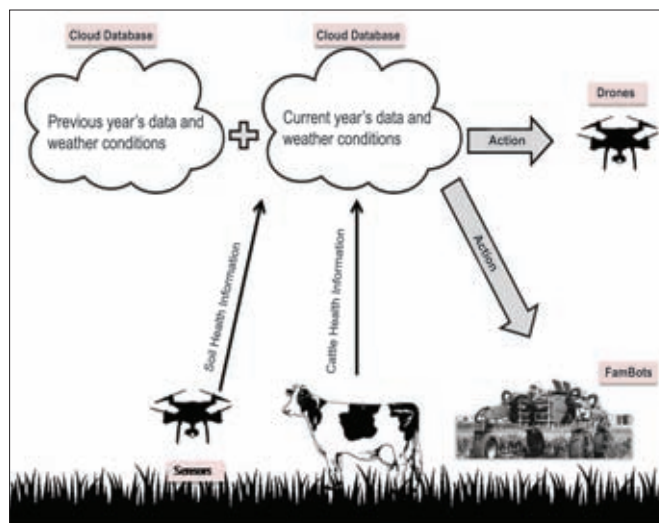


Fig. 2. The Way Ahead

crops. Drones can also help with soil and field analysis by creating precise 3-D maps for early soil examination and post-plantation soil examination can help in managing nitrogen levels in soil. They assist modulation of liquid while crop spraying by altering the distance from the ground. This process is indeed a boon in terms of efficiency. In fact, experts estimate that aerial spraying can be completed up to five-fold faster with drones than with traditional machinery.

Image/ Facial recognition: Devices were developed that can eliminate the need of fitting devices and allow easy monitoring of plants with minimal interaction. Facial recognition has climbed beyond the spectrum of humans and into the world of domestic cattle. Cattle, like humans, have their own set of unique facial features and these characteristics can be used as data by the technology to identify that specific animal. The existing systems require the use of physical tracking devices. Adaptation of facial recognition technology will eliminate the stress of fitting these devices, allowing easy monitoring of an entire herd with minimal interaction. It also helps in monitoring group behaviour and recording their feeding habits. An artificial intelligence-based algorithm derives information about food and water intake, body temperature and environmental conditions, and sends alerts directly to farmers. This help provides farmers the opportunity to meet health challenges pre-emptively and also to adjust feeding and water

quickly. Few Agritech companies are making this technology more accessible as they turn visual information into actionable data. They provide data driven solutions that help reduce inefficiencies in food production and facilitate the more effective, environmentally sustainable use of land.

Automated irrigation system: They need to create strategies based on science and technology for sustainable use of water is mainly due to the lack of rains and scarcity of land reservoir water. Automated irrigation systems are designed to utilise real-time machine learning to constantly maintain desired soil conditions to increase average yields. The use of automated irrigation systems results in lesser costs and labour involved.

Crop health monitoring: Farmers are implementing technologies which allow them to gain a better understanding of the situation on the ground through advanced technology and can tell them more about their situation than they can see with the naked eye. Monitoring crop health is being made easier by automated detection and analysis technologies such as hyper-spectral imaging and 3D laser scanning. In this process, remote sensors are used which enable algorithms to interpret a field's environment as statistical data. This data can be used by the farmer for decision making. Algorithms process the data, adapting and learning based on the data received. The more inputs and statistical information

collected, the better the algorithm will be at predicting a range of outcomes. These technologies are expected to increase the precision and volume of data collected. And the aim is that farmers can use this artificial intelligence to achieve their goal of a better harvest through making better decisions in the field.

The challenge with deploying machine learning and artificial intelligence in agriculture is not that scientists lack capacity to develop such technologies, the problem is that in most cases, no two environments are alike which makes the testing, validation and successful rollout of such technologies more difficult than other industries.

With help of big data analytics artificial intelligence can help open-field agriculture in three ways by monitoring crop growth, analysing data in the decision-making stage and carrying out variable rate application using smart farm machinery.

Agricultural transformation by merging with Internet of things

While digital transformation is disrupting the agricultural world and more data comes to feed the systems, solutions like the Watson internet of things (IoT) platform enhance value by applying machine learning abilities to sensor or drone data, transforming management systems in real artificial intelligence systems. Cognitive IoT technologies allow many types of correlations of large amount of structured and unstructured data from multiple sources like historic

weather data, research notes, soil information, market place information, images etc. The data thus is utilized by IoT to extract knowledge and provide organizations with richer insights and recommendations to take suitable actions, improve crop yields and market the produce efficiently without much post-harvest losses.

Awareness of farmers about digitalization

A survey was conducted to find out how many of the farmers were aware of the application of different technologies in farming sector among the 80 farmers selected for the study from two villages of Faridabad district of Haryana. The results showed that majority of farmers were found not aware of different technologies (Fig. 1).

Case studies

The Government of Karnataka has signed a Memorandum of Understanding (MoU) with Micro-soft to empower small-holder farmers with solutions that will help them increase their income using cloud-based technologies, machine learning and advanced analytics. These solutions are built on Microsoft Cortana Intelligence Suite including machine learning and power BI(business intelligence). They aim at promoting digital farming practices in the state.

Microsoft has collaborated with International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Microsoft and the Andhra Pradesh government, developed an artificial intelligence sowing application powered by Microsoft Cortana Intelligence Suite including machine learning and power BI. The application sends sowing advisories to participating farmers on the optimal date to sow. This saves the farmers the effort of installing sensors in their fields and helps reduce the expenditure.

Blue River technology which specializes in developing smart farming technologies, has designed a smart attachment to a tractor. This attachment determines different treatment for each plant depending on its health. It can also differentiate

between plants and weeds by leveraging big data, and actively sprays pesticide on the weeds, ignoring the plants. Increased usage of their smart tractor shall aid in collecting more data to make better farming decisions in future. Every plant that is analysed by the Blue River Smart Tractors is an opportunity to make their machines more efficient.

Prospero, invented by Dave Dorhout is the working prototype of an Autonomous Micro-Planter. It intends to make farms have maximum crop yield through full optimization. Dan's idea behind Prospero was to make robots maintain the farms. Prospero's farmbots are equipped with a seed hopper and fertilizer.

Prospero's body is designed by Lynxmotion and allows it to walk autonomously in any direction while avoiding objects without turning its body. Sensors are deployed under the robot body to detect, if a seed was planted in the area at the optimal spacing and depth. The farmbots can dig and plant seeds along with applying fertilizers or herbicides.

Niti Aayog, erstwhile Planning Commission of India, has constituted a committee of six people to work on catalysing artificial intelligence across sectors. They have also partnered with a technology company to provide real-time advice to the farmers. The government plans to implement artificial intelligence-based farming predictions.

Way ahead: suggestion

Digital transformation in agriculture would take place in stages. The first stage would include gathering information of environment, soil fertility, moisture content in the soil, crop growth and their health status and occurrences of weeds. Acquisition of this real-time information would occur through the use of artificial intelligence and big data analytics and the data would be stored in a cloud database.

Drones monitor the condition of the soil and determine whether it needs watering or seeding, while sensors in and around the cattle check their health and nutrition. Cameras

monitor vegetables and fruits are being taught to recognize irregularities or problems such as dehydration and unwelcome insects.

The second stage would be predicting future action for farming and management. It forecasts future conditions/problems by taking into account previous year's data and current weather conditions which are already stored in the cloud database. This helps the farmbots take necessary action towards crop management.

Simultaneously, there would be a cloud database storing historical demand pattern of certain crops. As the production of any crop would take months, the demand of the same might fluctuate. The database would take these fluctuations into account and predict the total demand in the economy for a certain crop. There would also be a database storing the records of information such as number and type of seeds purchased by each farmer. It would also record the sowing of those seeds. The farmers would purchase the total seeds according to the forecast demand of that crop. The supply of the number of seeds would be regulated by the Government.

SUMMARY

Digitalization has immense scope to transform the agricultural sector. It assumes importance as feeding the entire population is a challenge facing us. With the help of artificial intelligence, farmers are now able to grow better crops and look after their animals while saving time and energy. The combination of artificial intelligence and big data will move this industry towards digitalization. But our farmers' awareness of artificial intelligence was found to be almost nil. Only few farmers were found to have read about artificial intelligence aspects like drones and robotics etc or browsed online. It implies need to generate awareness and create infrastructure to meet this imperative technological need to revamp Indian agricultural sector.

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