

THE PERSPECTIVE OF ADVANCED TECHNOLOGY IN AGRICULTURE: AN INITIATIVE TO HELP INDIAN FARMERS

Abstract

The concerns over food insecurities, increasing population growth, effect of global warming, and lack of knowledge and resources in agriculture demand widespread applicability of new advanced technology. All emerging advanced technologies are built on the concept of AI or branches of AI. Agriculture is the primary source of income, and more than half of families living in India depend on it; hence both the private and Government sector need to take appropriate steps to increase the productivity of agriculture by using AI or AI-based technology. In addition, based on a literature review, it is proved that the recent advancement made in AI is more environmentally friendly and helps farmers through increased productivity, reducing waste and providing an opportunity to earn an enormous margin in profit. This article explains the existing challenges being faced by farmers, the necessity to apply advanced technology in agriculture with benefits, and how it helps India to accomplish sustainable development goals.



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INTRODUCTION

Looking at the several initiatives taken by both Government and private sector towards the development of technology based on artificial intelligence (AI) in India, one can conclude that most of the research about advancement concerning AI and other cutting-edge technology is carried out by

prestigious technical institutions such as the Indian Institute of Technology (IITs). Deepak Khemani, Professor of Computer Science and Engineering at IIT Madras, wrote a book titled "A First Course in Artificial Intelligence" in the year 2013. This work shows that the research and development initiative in AI and machine learning (ML) was already there before the recent efforts and initiatives taken

by the government (Vempati, 2016).

In India, to recognise and acknowledge the potentiality and large scale adaptability of AI, *Niti Aayog* released a discussion paper to introduce National Strategy for AI in June 2018. This effort was likewise the outcome of a response to significant research and development accomplished in the field of AI in the countries like USA and China.

Additionally, it was also the result of a speech given by the Prime Minister in *Mann Ki Baat* aired in February 2018, which talks about the launching of the Institute for the development of AI (i.e. Wadhvani Institute of Artificial Intelligence) (*Vempati, 2018*). According to National Strategy for AI (NSAI), the Central Government needs to play a vital role in the widespread application of AI in sectors such as agriculture, health, smart cities and mobility, and education. In addition, NSAI also recommends how both the public and private sectors contribute to nurturing and developing an ecosystem for AI in India. The recommendation is directed towards promoting research continuously, introducing effective skill-related programmes, reskilling the existing workforce, and making efforts to widely spread the idea concerning the adoption of AI while strictly following every guideline of responsible AI. The central theme of the NSAI recommendation was to balance both protecting society's interest and continuous research and development in the field of AI.

All these research and development in AI, ML, and other branches of computer science can help the Government to succeed in their plan and make a significant improvement in sectors including education, health care and agriculture. Further, the state of AI and its feature has the potential to improve the agriculture sector by adopting an approach such as precision farming. In addition, it can help farmers in accessing various Government welfare schemes and thereupon make digital India programme successful.

IMPACT OF GLOBAL WARMING ON FOOD SECURITY

The change in climate across the globe is the result of increasing global warming, which in turn leads to low food production and availability. It has a devastating effect on the world,

especially on developing countries. The average reduction of one per cent in consumable food calories in Asia raises the inquiry of how poor and food-insecure countries overcome this challenge and have required money to import food (*Ray et al., 2019*). This will result in increased food insecurities that affect the agricultural ecosystem. In addition to this, the rising sea level has also become a significant concern in the last few years. It is expected that the sea level will rise about 1 meter by the year 2100 (*Rahmstorf, 2007*). It has a detrimental impact on farmers living and doing agricultural activities around the coastal area as the water becomes too salty which is not suitable for growing crops. However, it is essential to understand how several processes involved in agricultural activities (e.g. land clearing) create situations and are responsible for global warming and climate change. It is estimated that 40 per cent of global methane is from deforestation. All of these resulted in a substantial reduction in agricultural production.

Therefore, to achieve the goal of sustainable development, there is an urgent need to implement reformative policy and an effective action plan on two issues; (1) Reforestation and (2) creating environmentally conscious farming behaviour. The recent advancement in technology (e.g. AI, the Internet of Things (IoT), etc.) plays a vital role in doing smart farming (*Das et al., 2018*). It ensures minimizing global warming and climate change and providing food security for poor and developing countries.

WHAT'S WRONG WITH TRADITIONAL FARMING

- ⊙ The average daily wages paid to agricultural workers are comparatively much lower than what is paid to workers in other professions or services. That is why many workers

nowadays choose to work in construction or manufacturing fields and leave farmland.

- ⊙ In India, a considerable workforce is deployed in agriculture (*Nair, 2021*). However, there is a significant increase in farmers' suicide reported in 2020 compared to 2019, as per the report published by NCRB. Due to this, the total contribution of agriculture to the GDP is also decreasing year after year. Another reason behind the farmers' suicide in India is that farming policies are formulated and implemented by the Government without any dialogue or consultation with the farmers, researchers and experts working in the field of agriculture.
- ⊙ Farmers must have knowledge about how much of fertilizers need to be used for increasing productivity and provide an adequate amount of nutrition to the soil. Lack of adequate knowledge or less expertise of farmers in the usage of fertilizers sometimes damages the crops. In addition to this, there have been a number of cases in which it is stated that farmers died due to drinking the water contaminated with fertilizers.

APPLICATION OF AI OR AI-BASED TECHNOLOGIES IN AGRICULTURE

There are several ways through which AI help farmers in take up smart farming. As information is crucial and is central to smart farming, it is very important to look how the use of advance technologies improve the overall production and reduce wastage keeping in mind significant improvement both economically and ecologically. It addresses the new approach to farming that remotely monitor the condition of

The primary function of a robot-driven tractor is to decide the area for plantation, time for the harvesting process and doing crisscrossing for farmland more effective and efficient than a human has ever done

crop and soil, measure and alert the temperature for plant growth, use drones to analysing crop health, provide scientific knowledge and skill to farmer, detect pest through smart technology and application of robotic technology in agricultural activities. In addition, recent advancement in scientific knowledge and technology in the field of agriculture provide opportunities to urban citizen to do urban farming (e.g. terrace farming). By doing so, these will also help in reducing deforestation and reforestation process. The key methods used as a part of smart agriculture (i.e. based on using latest advancement made in technology) by farmers and researchers are explained in the following paragraphs.

A. New Approach to Traditional Farming - A Precision Farming

Precision farming is a new approach to adding scientific knowledge and using technology for agricultural activities, which in turn replaces to some extent the century-old cultivation techniques adopted by the farmers for planting and harvesting crops. The major problem in India is that majority of farmers have small piece of agricultural land (e.g. less than one hectare). The

main benefit of the application of precision farming is that it can help farmers to increase their production capacity even within the small size of land by providing a wide range of appropriate data.

B. Applying Sensor based Technology

Using AI-based technology, a farmer can remotely control and operate a crop watering system with the use of a laptop and mobile. There is a wide range of sensors used in precision farming. The main benefit of sensors is that they are small in size but can store a gigantic collection of data concerning the temperature of soil and air, information about the health and growing pattern of the crop, detect unhealthy plants, and also provide facility to get adequate feedback (Levy, 2017). The approach to adopting precision farming by farmers includes the installation of a device on land where farmers want to do agricultural activities or collect data by using high resolution based drones. These steps enable the farmers to gather vast and specific data efficiently. A farmer can save money that was earlier wasted because of the unavailability of real-time information. As a result of doing this, the ecosystem of farming will change and make agricultural activities more cost-effective which in turn can increase the overall profit of farming that support the livelihood of farmers.

C. Drones - A futuristic approach to smart farming

Recently, the use of drones is increasing in farming. There are many countries in the world including USA and Europe where one can

see drones flying over their head. In 2022, Prime Minister of India, Narendra Modi launched one hundred drones (i.e. Kishan Drones) across the country as a new direction towards smart farming. In addition to this, in the 2022 budget speech, Finance Minister Nirmala Sitharaman addressed the nation about upcoming major reforms in the agricultural sector. According to it, the Central Government of India will be promoting Kishan Drones, Organic and chemical-free farming, and smart farming using advanced technology so that it will help farmers across the country in crop and soil management, store and access land records digitally and spray insecticide over agricultural lands through drones. The main aim to use drones in farming is to collect data for farmers and researchers so that they are well informed about crop and soil conditions before taking any decision. It will help farmers, researchers and agronomists, too.

D. Application of Robotics technology in Agriculture

An increasing number of the world population and shrinking cultivable land became concern issues across the globe including in India. It will lead researchers and innovators to do research or innovation towards the application of AI, ML, IoT and robotics in agricultural activities that would meet required demand and ensure food security. Further, advancements in technologies proved to be more cost-effective and environment friendly. It can help to achieve the goal of sustainable agriculture. There is enough data available

regarding the application of robots or robotic technology in a sector like manufacturing, service, transport, etc. However, very few attempts have been made in India towards the use of robotics technology in agriculture.

There are many activities involved in farming from sowing the seeds to examining the condition of soil and harvesting carried out by humans that required accuracy, efficiency, reliability and continuous labour efforts. Robotics technology is used to replace all such work involved in farming with less human intervention.

John Solie from Oklahoma State University made a machine (green seeker sensor) to read and collect information from the plant through sensors. The main purpose of the machine is to inform the farmers regarding the accurate quantity of fertilizer required for a plant to grow. The result came out from the study of one farm showing that the total quantity of fertilizers used decreased to 75 per cent which is time-saving

and cost-effective for the farmer. A robot drone tractor is another example of the revolutionizing machine introduced for farming. The primary function of a robot-driven tractor is to decide the area for plantation, time for the harvesting process and doing crisscrossing for farmland more effective and efficient than a human has ever done. Concerning the wastage of seasonal fruit, much research has been done and has also been in progress to pick the fruit at the right time with the use of AI-enabled robots. It helps farmers across the globe to save money and reduce wastage. The Automation Centre for Research and Education (ACRO) developed a machine that works with the vision system to help the farmers in fruit harvesting. However, the research institutes that have been working on automated fruit harvesting machines are less in number and very few out of this are used by farmers.

AGRITECH STARTUPS IN INDIA

Since 2010, many startups and

research institutes in the agriculture field have been taking steps to develop innovative ideas, AI-based technology, and create web/mobile-based platforms. The aim is to increase the quality and productivity of crops, boost profitability, connect farmers with distributors through an efficient supply chain, and provide quality food to the people of India. According to the National Association of Software and Service Companies (NASSCOM, 2018), India hosts more than 450 agritech startups. The growing rate of agritech startups is more than 25 per cent. The report also stated that more than 50 per cent of startups aim to improve the supply chain in order to deliver good quality products to the customer. Another focus area is developing advanced machinery and value systems for the farmers that can help to increase productivity and reduce wastage. As a result, farmers can earn more profit than through the traditional practice. The key objective, beneficial group and technology used in agriculture can be understood by referring Table 1.

TABLE 1

Name	Started in	Technology used in agriculture	Key objective	Beneficiary
Ninjacart	2015	Platform such as E-commerce and Mobile	<ul style="list-style-type: none"> Connect farmers to Businesses Increase farmers' income Solve supply chain problem 	Connect 3000 farmers to 4000 distributors
Fasal	2018	AI, IoT and AI driven tool such as data analytics	<ul style="list-style-type: none"> Increase productivity Increase quality of yield Creating farmers network 	Provide service to 20 independent farmers and some B2B farmers
Kamal Kisan	2013	Engineering innovation	<ul style="list-style-type: none"> Develop innovative equipment for farmers Reduce labour Increase profitability 	3000 farmers save more than INR 300,000 per year
FlyBird Farm Innovations	2013	IoT, Mobile App, and Micro irrigation system	<ul style="list-style-type: none"> Save water and energy by adopting smart irrigation system Provide affordable technology to farmers 	Installed 400 controllers (sensor based irrigation controller)
KrishiHub	2016	AI	<ul style="list-style-type: none"> Reduce wastage through better supply chain Increase profit Provide crop information Price forecasting 	Covers more than 600 farmers

Farmizen	2017	Mobile Application	<ul style="list-style-type: none"> • Provide opportunity to individual to produce organic food • Develop mini farm • Provide alternative source of income to the farmers 	More than 750 customers
Drone	2017	Robotics and mapping technology	<ul style="list-style-type: none"> • Provide data about weather, condition of seeds and soil, health of crop to the farmers • Help farmers to improve productivity and quality of crop 	More than 500 farmers used this drone

Source: Anand, et al. (2019). (Compilation of the data)

CONCLUSION

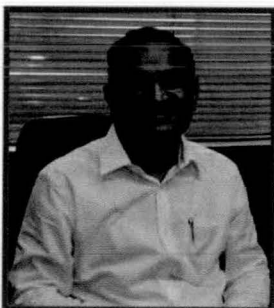
Considering the challenge faced by farmers to meet the increasing demand for agricultural production, one can argue that technological interference proved to be beneficial and effective. The recent advancement made in technology based on AI and its branches proved to be efficient and effective in increasing the overall productivity of farming with less wastage. In India, both Government and private sector play a vital role in developing AI-driven tools and machinery for agriculture. However, the outreach of AI-based technology to the farmers is significantly nominal in numbers. Very few farmers have knowledge about this advanced technology and are benefiting from it. The Government of India should establish some local bodies or institutions all over India, whose primary goal would be to make the

farmers aware of such technology and how to use it in farmland. **MA**

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At the Helm



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We wish CMA (CS) Rajesh Kedia all the best in his future endeavours.