AI in agriculture

Using satellite imagery, weather sensors, and data-based algorithms, farmers can track crop progress over the entire crop cycle

By Khalid Saeed Wattoo and Dr Waqar Ahmad

PAKISTAN desperately needs to enhance the production and supply of quality food at affordable prices to meet the growing food demand driven by the country's exponential population growth.

The country also requires an export surplus to generate much-needed foreign exchange. However, achieving these objectives is contingent upon increasing crop yields and improving the efficiency of agricultural inputs, including land, water, fertiliser, pesticide, and labour.

The crop production data from the past two decades reveals that farmers' conventional methods and technologies have fallen short in addressing the escalating challenges of food security and high production costs.

The current situation necessitates embracing new technologies, including artificial intelligence (AI), which is ushering in an agricultural revolution in both developed and developing countries.

Using satellite imagery, weather sensors, and data-based algorithms, AI has empowered farmers to track crop progress over the entire crop cycle (from planting to harvesting) and make informed decisions regarding various agricultural practices.

AI facilitates the optimisation of tillage and irrigation and allows precise application of fertilisers based on mapping of soil contents (soil type, nutrients, pH level, moisture contents), insights from field trials, and remote sensing.

AI-enabled automated irrigation systems save water by adjusting water quantities and timings based on the data collected through field sensors and weather forecasts. Likewise, AI-powered apps, sensors, and GPS modules embedded in robots, agricultural drones, and unmanned ground vehicles are now used for crop mapping, real-time crop monitoring, early detection of crop diseases or nutritional deficiencies, yield analysis, and the precise application of pesticides and herbicides.

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Precision farming has become a reality with AI-enabled decision support systems and automation. It is a transformative approach that markedly enhances the efficiency and effectiveness of various agricultural operations, reduces associated risks, and decreases farmers' workload.

This not only results in increased crop yields while mitigating the impacts of climate change but also prevents the inefficient use of valuable resources such as water, fertiliser, pesticides, and herbicides. Across the world, the land area of such resource-efficient agriculture is expanding.

While there is a long list of benefits of AI and its increasing applications in the agriculture sector, the key question is whether Pakistan's agriculture sector has attained the social, technological, and financial readiness level where it can use AI effectively. This question echoes the inquiries made whenever a new technology makes a breakthrough in the agricultural domain.

Unfortunately, Pakistan's agriculture sector is plagued with numerous constraints hampering the sector's ability to leverage technological advancements effectively. Key constraints include low-educated farmers, small farm sizes, and subsistence farming, which are contributing to a lag behind comparable countries by at least two decades.

Specifically, in the realm of AI use in agriculture, significant constraints include the scarcity of skilled professionals, farmers' poor financial condition and their risk-averse approach, and limitations in data availability and its authenticity and quality. In addition, rural areas are grappling with infrastructure constraints such as poor internet connectivity and irregular power supply.

Despite all these odds, the country is home to a substantial number of progressive and educated farmers who have been early adopters of new technologies. Luckily, their numbers have notably increased over the past decade.

On the other hand, AI offers a comprehensive range of solutions, spanning from decision support systems for farmers to highly automated and complex AI-enabled machines.

Therefore, in the first phase, the government can effectively promote relatively simple AI applications that offer cost-effective solutions to the major challenges facing Pakistan's agriculture.

In this respect, it is worth noting that the federal government has already formed a national task force on AI in April 2023 to develop a 10-year roadmap (policy) for the accelerated adoption of AI across various sectors. Given that the agriculture sector serves as the backbone of Pakistan's economy, employing around 40 per cent of the country's workforce, it is imperative that due importance be accorded to this sector in the national AI policy.

The draft AI policy (accessible on the website of the Ministry of Information Technology and Telecommunication) has only briefly touched upon two aspects of the agriculture: a) "agriculture supply chain optimisation" and b) "weather prediction and analysis system." However, we should not ignore the fact that AI applications in agriculture are extensive and cross-functional.

Worldwide, AI is increasingly utilised in precision farming, agricultural inputs optimisation, automation of farming, and farmers' decision support systems by leveraging data analytics, machine learning, and predictive modelling.

The policy could benefit from an expanded scope to fully encompass the broad and multifaceted applications of AI in agriculture. In turn, provincial governments should devise strategies and programmes to promote AI adoption among the farmers.

Given the complexity and expanse of crop management systems and recognising the inherent risk aversion among common farmers, often labelled as slow adopters of new technology, it becomes imperative for the government(s) to promote AI strategically.

This entails shortlisting the top challenges that impede the improvement of crop yields and resource-efficient farming, where AI can make a significant impact. The most commonly cited challenges are climate change with erratic weather patterns, lack of climate-resilient practices, inefficient irrigation methods, ineffective application of fertilisers, inadequate control of pests and diseases, high food loss, and escalating energy costs.

Following this, tailored grant-based programmes should be rolled out for both farmers and private sector service providers, initially on a limited scale, with the objective of establishing a "proof-of-concept" in a local context.

In conclusion, as we transition into an increasingly digital future, Pakistan's agriculture sector demands a strategic approach and collaborative efforts from all stakeholders, including the government(s), private sector, and international development agencies.

Without such concerted endeavours, harnessing the transformative potential of AI would remain only a dream for another decade. ■

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