Artificial Intelligence and Integrated Farming System

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ABSTRACT

Agriculture plays a significant role in the economic sector. The automation in agriculture is the main concern and the emerging subject across the world. With the increasing population, demand of food and employment is also increasing. The traditional methods which were used by the farmers, were not sufficient enough to fulfill these requirements. Thus, new automated methods were introduced. These new methods satisfied the food requirements and also provided employment opportunities to billions of people. Artificial Intelligence in agriculture has brought an agriculture revolution. This technology has protected the crop yield from various factors like the climate changes, population growth, employment issues and the food security problems. The main concern of this paper is to highlight the various applications of Artificial intelligence in agriculture such as for irrigation, weeding, spraying with the help of sensors and other means embedded in robots and drones (Talaviya *et al.*, 2020). These technologies saves the excess use of water, pesticides, herbicides, maintains the fertility of the soil, also helps in the efficient use of man power and elevate the productivity and improve the quality.

INTRODUCTION

The global population is increasing at an alarming rate, which is projected to reach 10 billion by 2050, puts pressure on the agricultural sector to increase crop production and maximize yields. To address looming food shortages, two potential

approaches have emerged: expanding land use and adopting large-scale farming, or embracing innovative practices and leveraging technological advancements to enhance productivity on existing farmland (Talaviya *et al*., 2020).

Pushed by many obstacles to achieving desired farming productivity — limited land holdings, labor shortages, climate change, environmental issues, and diminishing soil fertility, to name a few, — the modern agricultural landscape is evolving, branching out in various innovative directions. Farming has certainly come a long way since hand plows or horse-drawn machinery. Each season brings new technologies designed to improve efficiency and capitalize on the harvest. However, both individual farmers and global agribusinesses often miss out on the opportunities that artificial intelligence in agriculture can offer to their farming methods.

Benefits of AI in agriculture

Until recently, using the words AI and agriculture in the same sentence may have seemed like a strange combination. After all, agriculture has been the backbone of human civilization for millennia, providing sustenance as well as contributing to economic development, while even the most primitive AI only emerged several decades ago. Nevertheless, innovative ideas are being introduced in every industry, and agriculture is no exception. In recent years, the world has witnessed rapid advancements in agricultural technology, revolutionizing farming practices (Elijah *et al*., 2018). These innovations are becoming increasingly essential as global challenges such as climate change, population growth together with resource scarcity threaten the sustainability of our food system. Introducing AI solves many challenges and helps to diminish many disadvantages of traditional farming.

Integrating AI into integrated farming systems

Integrating AI into integrated farming systems (IFS) enhances efficiency and sustainability by using technologies like machine learning, computer vision, and data analytics to optimize resource management, monitor crop health, and automate tasks, ultimately leading to higher yields and reduced waste (Ahmed & De Hussain., 2018).

Integrated Farming Systems (IFS)

- IFS is a sustainable agricultural approach that combines various farming components (livestock, crop production, fish, poultry, tree crops, etc.) to create a self-sustaining and efficient system.
- The core principle is that "there is no waste" and "waste from one component becomes a resource for another".

AI Improves Integrated Farming Systems:

- **Precision Farming:** AI algorithms analyze data from sensors, drones, and other technologies to optimize irrigation, fertilization, and pest control, leading to resource efficiency and reduced environmental impact.
- **Crop Monitoring and Disease Detection:** AI-powered systems can monitor crop health, detect diseases early, and predict yields, allowing farmers to take timely action.
- **Livestock Health Monitoring:** AI can track livestock health, detect diseases, and optimize feeding and management practices.
- **Automated Weed Control:** AI-equipped robots can identify and eliminate weeds without harming crops, reducing labor costs and the need for herbicides.

- **Supply Chain and Demand Forecasting:** AI can analyze market trends and predict demand, helping farmers plan production and optimize distribution (Stočes *et al*., 2016).

- **Smart Irrigation Systems:** AI can optimize irrigation based on real-time data, ensuring efficient water usage and maximizing crop yields.

- **Data-Driven Decision Making:** AI provides farmers with data-driven insights, enabling them to make informed decisions about planting, harvesting, and other farming operations.

- **Optimizing Climate Control in Vertical Farms:** AI can monitor and adjust environmental factors such as temperature, humidity, and CO2 levels to ensure consistent crop growth and quality.

- **Guiding Automated Harvest Systems:** AI-powered drones provide crucial information for automated harvest systems, including ripeness maps, obstacle detection, and yield estimations.

3. **Benefits of AI in Integrated Farming**

- **Increased Efficiency:** AI helps farmers optimize resource use, reduce waste, and improve productivity.

- **Enhanced Sustainability:** AI promotes sustainable farming practices by reducing reliance on chemicals, conserving water, and minimizing environmental impact.

- **Improved Crop Quality and Yields:** AI-driven precision farming techniques lead to higher quality crops and increased yields.

- **Reduced Labor Costs:** AI-powered automation can reduce the need for manual labor, saving time and resources.

- **Better Decision-Making:** AI provides farmers with data-driven insights, enabling them to make informed decisions about planting, harvesting, and other farming operations.

Challenges of AI in agriculture

Many people perceive AI as something that applies only to the digital world, with no relevance to physical farming tasks. This assumption is usually based on a lack of understanding of AI tools. Most people don't fully understand how AI in agricultural biotechnology works, especially those in non-tech-related sectors, leading to slow AI adoption across the agricultural sector. Although agriculture has seen countless developments in its long history, many farmers are more familiar with traditional methods (Alreshidi., 2019). A vast majority of farmers are unlikely to have worked on projects that involved AI technology.

A huge amount of work must be done by technology providers to help people understand the application of AI in agriculture. Considering the benefits of artificial intelligence for sustainable farming, implementing this technology may look like a logical step for every farmer. However, there are still some challenges to overcome (Stoces *et al*., 2016).

Large upfront costs

While AI solutions can be cost-effective in the medium-to-long-term, there's no escaping the fact that the initial investment can be very expensive. With many farms and agribusinesses struggling financially, adopting AI may be impossible for the time being,

especially in the cases of small-scale farmers and those in developing countries (Talaviya *et al*., 2020).

Reluctance to embrace new technologies and processes

Unfamiliarity often makes people hesitant to adopt new technologies creating difficulties farmers to fully embrace AI, even when it offers undeniable benefits. Resistance to innovation alongside some reluctance to take a chance on new processes hold back the farming methods development as well as the sector's profitability in general. Governments must also develop the regulations needed to assure workers that the technology is not a threat.

Lack of practical experience with new technologies

Technology companies hoping to do business in regions with emerging agricultural economies may need to take a proactive approach. In addition to providing their products, they must offer training and ongoing support for farmers and agribusiness owners who are ready to take on innovative solutions.

A lengthy technology adoption process

In addition to a lack of understanding and experience, the agricultural sector generally lacks the infrastructure needed for AI to work. Even farms that already have some technology in place may find it difficult to move forward. Infrastructure is also a challenge for AgTech providers and software companies.

Technological limitations

As AI is still developing, the technology will have constraints. Accurate models depend on diverse, high-quality data, which can be scarce in agriculture. For robots with sensors, limitations can make adapting to changing farming environments difficult.

Privacy and security issues

There is still a general lack of regulations relating to the use of AI across all industries. Particularly, implementing AI in precision agriculture and smart farming raises various legal questions.

Future of AI in agriculture

AI is sure to play an increasingly large role in agriculture and food sustainability over the coming years. Technology has always been at the forefront of agriculture, from primitive tools to irrigation to tractors to AI. Each development has increased efficiency while reducing the challenges of farming (Ahmed & De Hussain., 2018).

More importantly, the benefits of AI in agriculture are undeniable. Smart farming tools, intelligent automation, and AI-powered products perform repetitive time-consuming tasks so workers can use their time for more strategic operations that require human judgment. Increasingly affordable computer vision alongside agricultural robotics have the potential to accelerate AI advancement in farming.

AI has the tools to address the challenges posed by climate change, environmental concerns, and an increasing demand for food. It will revolutionize modern agriculture by improving efficiency, sustainability, resource allocation on top of real-time monitoring for healthier and higher-quality produce. Farmers need to be educated and trained in how to use AI-powered solutions (Alreshidi, 2019).

AI is likely to change the role of farmers from manual workers to the planners and overseers of smart agricultural systems. An

understanding of IT solutions and agribusiness intelligence will potentially become more useful than the ability to use conventional tools or carry out physical labor.

Despite AI and machine learning together with MLOps services having the potential to radically transform farming, they need other technologies to work in sync. To reap all the benefits of AI, farmers first need a technology infrastructure. It could take years to develop that infrastructure, but doing so could result in a robust, future proof technology ecosystem. Understanding how AI works and how best to integrate technical knowledge into real-life processes is vital for maximizing its benefits. That's why partnering with an expert software development team is an excellent first step (Elijah *et al*., 2018).

The success of human society is essentially dependent on the optimization of its agricultural systems. Traditional farming methods are becoming outdated, need for advanced technological solutions. Worldwide, the impact of automation on industries has always been considerable. Digital technology is now playing a huge role in transforming agriculture, and the impact of artificial intelligence in agriculture is set to be vast.

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