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AI in Agriculture — The Future of Farming

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The growth of the global population, which is projected to reach 10 billion by 2050, is placing significant 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 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 (Dharmaraj and Vijayanand, 2018). 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. At Intellias, we've worked with the agricultural sector for over 20 years, successfully implementing real-life technological solutions. Our focus has been on developing innovative systems for quality control, traceability, compliance practices, and more. Now, we will dive deeper into how new technologies can help your farming business move forward (Malo, 2020)

Benefits of AI in agriculture

1. Data-based decisions

The modern world is all about data. Organizations in the agricultural sector use data to obtain meticulous insights into every detail of the farming process, from understanding each acre of a field to monitoring the entire produce supply chain to gaining deep inputs on yields generation process. AI-powered predictive analytics is already paving the way into agribusinesses. Farmers can gather, then process more data in less time with AI. Additionally, AI can analyze market demand, forecast prices as well as determine optimal times for sowing and harvesting. Artificial intelligence in agriculture can help explore the soil health to collect insights, monitor weather conditions, and recommend the application of fertilizer and pesticides.

2. Cost savings

Improving farm yields is a constant goal for farmers. Combined with AI, precision agriculture can help farmers grow more crops with fewer resources. AI in farming combines the best soil management practices, variable rate technology, and the most effective data management practices to maximize yields while minimizing minimize spending. Application of AI in agriculture provides farmers with real-time crop insights, helping them to identify

which areas need irrigation, fertilization, or pesticide treatment. Innovative farming practices such as vertical agriculture can also increase food production while minimizing resource usage. Resulting in reduced use of herbicides, better harvest quality, higher profits alongside significant cost savings.

3. Automation impact

Automated farm machinery like driverless tractors, smart irrigation, fertilization systems, IoT-powered agricultural drones, smart spraying, vertical farming software, and AI-based greenhouse robots for harvesting are just some examples. Compared with any human farm worker, AI-driven tools are far more efficient and accurate.

Applications of artificial intelligence in agriculture

Traditional farming involves various manual processes. Implementing AI models can have many advantages in this respect. By complementing already adopted technologies, an intelligent agriculture system can facilitate many tasks. AI can collect and process big data, while determining and initiating the best course of action. Here are some common use cases for AI in agriculture (Eli-Chukwu, 2019):

1. **Optimizing automated irrigation systems:** AI algorithms enable autonomous crop management. When combined with IoT (Internet of Things) sensors that monitor soil moisture levels and weather conditions, algorithms can decide in real-time how much water to provide to crops. An autonomous crop irrigation system is designed to conserve water while promoting sustainable farming practices.

2. **Detecting leaks or damage to irrigation systems:** AI plays a crucial role in detecting leaks in irrigation systems. By analyzing data, algorithms can identify patterns and anomalies that indicate potential leaks. Machine learning (ML) models can be trained to recognize specific signatures of leaks, such as changes in water flow or pressure. Real-time monitoring and analysis enable early detection, preventing water waste together with potential crop damage. AI also incorporates weather data alongside crop water requirements to identify areas with excessive water usage. By automating leak detection and providing alerts, AI technology enhances water efficiency helping farmers conserve resources.
3. **Crop and soil monitoring:** The wrong combination of nutrients in soil can seriously affect the health and growth of crops. Identifying these nutrients and determining their effects on crop yield with AI allows farmers to easily make the necessary adjustments. While human observation is limited in its accuracy, computer vision models can monitor soil conditions to gather accurate data. This plant science data is then used to determine crop health, predict yields while flagging flag any particular issues. In practice, AI has been able to accurately track the stages of wheat growth and the ripeness of tomatoes with a degree of speed and accuracy no human can match.

4. **Detecting disease and pests:** As well as detecting soil quality and crop growth, computer vision can detect the presence of pests or diseases. This works by using AI to scan images to find mold, rot, insects, or other threats to crop health. In conjunction with alert systems, this helps farmers to act quickly in order to exterminate pests or isolate crops to prevent the spread of disease. AI has been used to detect apple black rot with an accuracy of over 90%. It can also identify insects like flies, bees, moths, etc., with the same degree of accuracy. However, researchers first needed to collect images of these insects to have the necessary size of the training data set to train the algorithm with.
5. **Intelligent pesticide application:** By now, farmers are well aware that the application of pesticides is ripe for optimization. Unfortunately, both manual and automated application processes have notable limitations. Applying pesticides manually offers increased precision in targeting specific areas, though it might be slow and difficult work. Automated pesticide spraying is quicker and less labor-intensive, but often lacks accuracy leading to environment contamination. AI-powered drones provide the best advantages of each approach while avoiding their drawbacks. Drones use computer vision to determine the amount of pesticide to be sprayed on each area. While still in infancy, this technology is rapidly becoming more precise.

Challenges of AI in agriculture

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. However, the cost of implementing AI may drop as technologies develop. Businesses also have the opportunity to explore funding resources such as government grants or private investment.

Lack of practical experience with new technologies

Aspects of the agricultural industry differ in their technological advancement around the world. Some regions could leverage all the benefits AI, though there are some hurdles in countries where next-gen agricultural technology is uncommon. 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. One of the main ways to overcome this is by approaching farmers gradually: for instance, offering the use of simpler technology first, such as an

agricultural trading platform. Once farmers get used to a less complicated solution, providers can add additional tools and features.

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. Overcoming these limitations requires ongoing research and analysis of data. Farmers should also remain involved with decision-making rather than entirely handing control over to AI. Monitoring AI decisions manually is likely to be useful during the early stages of adoption.

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. For example, security threats like cyber attacks and data leaks may cause farmers serious problems. It's even conceivable that AI-based farming systems could be targeted by hackers with the aim of disrupting food supplies.

Role of AI in the agriculture information management cycle

Managing agricultural data with AI can be beneficial in many ways:

- **Risk management**: Predictive analytics reduces errors in farming processes.
- **Plant breeding:** AI utilized plant growth data to further advise on crops that are more resilient to extreme weather, disease or harmful pests.
- **Soil and crop health analysis:** AI algorithms can analyze the chemical composition of soil samples to determine which nutrients may be lacking. AI can also identify or even predict crop diseases.
- **Crop feeding:** AI in irrigation is useful for identifying optimal patterns and nutrient application times, while predicting the optimal mix of agronomic products.
- **Harvesting:** AI is useful for enhancing crop yields and can even predict the best time to harvest crops.

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