National Experts Program

برنامج خبراء الإمارات

AI Report

The Impact of AI in the Food & Agriculture Industry

Hamad Al Shehhi

Food and Water Security

Hamad Al Shehhi

Investment Manager
ADQ

Hamad Al Shehhi currently is an investment manager in the Food & Agriculture Division at ADQ, leading some of the space's key greenfield developments and investments. Al Shehhi also serves as a member of the management board of one of the largest agricultural commodity traders globally, Louis Dreyfus Company.

He previously held various positions in Metal & Mining and Agribusiness Divisions at Mubadala Investment Company. Prior to that, he worked as an engineer for several years in the first nuclear power plant in the UAE during its development stage. Al Shehhi is a CFA Charterholder, and holds a Bachelor of Science degree in Electrical Engineering from Purdue University.

The journey toward sustainable agriculture

Humanity is facing a critical moment in its history. It is nearing a potential point of no return on the road to a climate and ecological catastrophe. This means business as usual is no longer a viable option.

The food and agriculture industry is inextricably linked to climate change. It is one of the key sources of greenhouse gas emissions, estimated to produce around **25%** of total emissions as a result of livestock production, fertilizer use, soil management practices, and other activities. However, agriculture is also affected severely by climate change due to the impact on available arable lands, weather conditions, water sources, and other factors linked to crop production.

As populations continue to grow, food sources are coming under significant stress. Existing agricultural practices and techniques deplete the availability of resources like water at a rate that is unsustainable given the pace of population growth. A combination of water depletion and high temperatures will result in significant yield reductions, which in turn could drive record numbers of people toward starvation.

Technological advances and applied artificial intelligence (AI) can mark a turning point. The impact of climate change on agriculture can be managed through appropriate data-driven decision-making processes that automate and manage the use of natural resources. Data gathered from AI can create a vertically integrated ecosystem ready to transform the industry. However, government support is required to incentivize people to invest in AI technologies, while providing suitable environments and infrastructure to learn and exchange best practices.

Ignoring food system challenges is not an option

The world has gone through unprecedented challenges in recent years. The COVID-19 pandemic and the Russia-Ukraine war shifted perceptions of globalization and interdependency. Countries have started paying increased attention to their sources of food, and have implemented policies to ensure food security, including banning exports of some key agricultural commodities such as wheat and rice. Some states have struggled to source some of their key requirements, while others have had to pay significant premiums to access food products that were previously considered easily attainable.

While the pandemic amplified the preexisting food inequality among countries—making many of them prioritize their own needs over wider global requirements—it has also accelerated the notion of digital transformation and the need to embrace new business models. It has focused the spotlight on the importance of sustainable food and agriculture security, especially for countries that rely heavily on imports.

The world's population is expected to reach **9.8 billion** by 2050. Demand for food and resources will therefore escalate significantly. Ensuring availability of arable land for agricultural production will be essential to keep pace with this projected demand. However, the amount of arable land suitable for agricultural production is limited and shrinking. The UN Food and Agriculture Organization says that only around **11%** of the world's land area can be considered arable. In addition, it estimates that **12 million** hectares of arable land are lost each year due to desertification, with an additional **1.5 billion** hectares of land considered degraded.

Given the limited amount of land available, it will be necessary to improve crop yields to meet future levels of food demand. However, this will be difficult. Increasing demand means farmers are more likely to overuse the soil, leading to soil degradation and loss of fertility. Increased use of chemicals, such as fertilizers and pesticides, might boost yields in the short term but will damage the soil and the environment in the longer term and is likely to have negative health implications for humans.

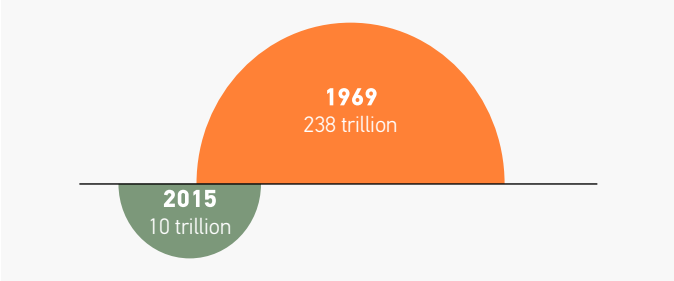
Climate conditions and water availability are other core factors in ensuring the availability of food and securing human survival. Agriculture will be one of the biggest victims of climate change—a **1°C** rise in average global temperatures will mean a significant decrease in yields and production, especially in key producing countries where conditions for crop production are currently considered optimal. The Intergovernmental Panel on Climate Change has projected that climate change will lead to an increase in extreme weather events, including droughts and floods that can reduce the productivity of farmland and lead to soil erosion.

The threat of water scarcity

Water security has become a central point of discussion in recent years, particularly for countries in the Arab world, many of which have limited sources of water. Of the **17** most water-stressed countries, **12** are situated in West Asia and North Africa, which have experienced continuous drought since 1990 and a significant increase in average temperatures. Water scarcity is among the top environmental issues that threaten the world's economic growth trajectory in the near term.

Several countries have sounded the alarm on water scarcity. In the UAE, a team of experts from different ministries and agencies has taken measurements at the quaternary aquifer east of Jebel Hafit in Al Ain, one of the country's main water reserves, where groundwater decreased from **238 trillion**

liters in 1969 to **10 trillion** liters in 2015. With a growing population in the UAE and very limited rainfall, the water table has dropped by around one meter per year over the last **30 years**.



Egypt is experiencing a sharp increase in its population, which is expected to grow by **10%** by 2027—an additional **10.8 million** people. Agriculture is a key sector in the country, accounting for around **55%** of employment. Because of the growing population and agriculture sector activities, groundwater sources have been overused for many years, taking them to the point of collapse. Methods of irrigation are inefficient, with most water being lost to evaporation in the region. At the COP27 UN Climate Change Conference in Sharm El-Sheikh last November, water-related issues were a key focus of the Egyptian Presidency, and coordinating parties were urged to ensure equitable access to water across various geographies.

In the GCC region, it is projected that water needs will exceed **33,700 cubic meters** per year by 2050, but expected future storage capacity falls short of this at under **26,000 cubic meters**. Therefore, there is a need to boost future water storage capacity by **30%** to meet demand.

These are just a few examples of issues that are likely to become more severe if current practices continue. Volatile climate conditions coupled with inefficient water-use practices will hinder agriculture and food production and increase starvation levels globally. It is worth bearing in mind that at present, the world still produces enough food to feed everyone, yet over **690 million** people go hungry every day. Leveraging technological advances will be pivotal in preserving resources and, in turn, human life.

How AI can transform agriculture

Digital transformation has accelerated in recent years, partly as a result of the pandemic. Several industries have started identifying digital solutions to key challenges in an attempt to become more efficient, resilient, and sustainable.

> **However, the extent of technological adoption in agriculture is fairly limited compared to the size of the industry, and this is down to multiple factors.**

The main challenges facing agritech companies are:

- Fragmentation of the industry, with the average size of farms worldwide below one hectare
- The majority of farms are family-owned businesses that lack know-how and expertise in existing technologies
- A lack of accessible data from equipment and instruments in the field, while many farms are in rural areas that lack internet accessibility
- The long cycle of experiments and the high cost of mistakes
- Investments can take a long time to produce returns and prove their value
- The complexity of indirect factors such as weather and climate change

AI has the potential to transform the agriculture industry into a much more resilient and sustainable operation, enabling informed and data-driven decisions that will likely improve crop yields, reduce water consumption, and increase efficiencies. Although the implementation of such technologies might not directly impact climate conditions, it will ensure that we are able to use the available resources more efficiently, while minimizing the impact on the environment.

Some of the ways in which AI can transform and drive growth in the agriculture industry are:

- **Precision agriculture:** AI can help farmers analyze data on soil conditions, weather patterns, and crop health to make informed decisions about planting, fertilization, and irrigation. This can result in more precise and efficient use of resources, improved crop yields, and reduced water consumption.
- **Crop monitoring:** AI-powered sensors and drones can monitor crops and provide real-time data on crop health, soil moisture levels, and weather conditions. This can help farmers detect potential issues early on and take corrective action, leading to improved crop yields and reduced crop losses.
- **Smart irrigation:** AI-powered sensors can also monitor soil moisture levels and adjust irrigation schedules accordingly. This can reduce water consumption, lower energy costs, and improve crop yields.
- **Predictive analytics:** AI can analyze historical data on weather patterns, crop yields, and market trends

to make predictions about future crop yields and prices. This can help farmers plan their production and marketing strategies more effectively.

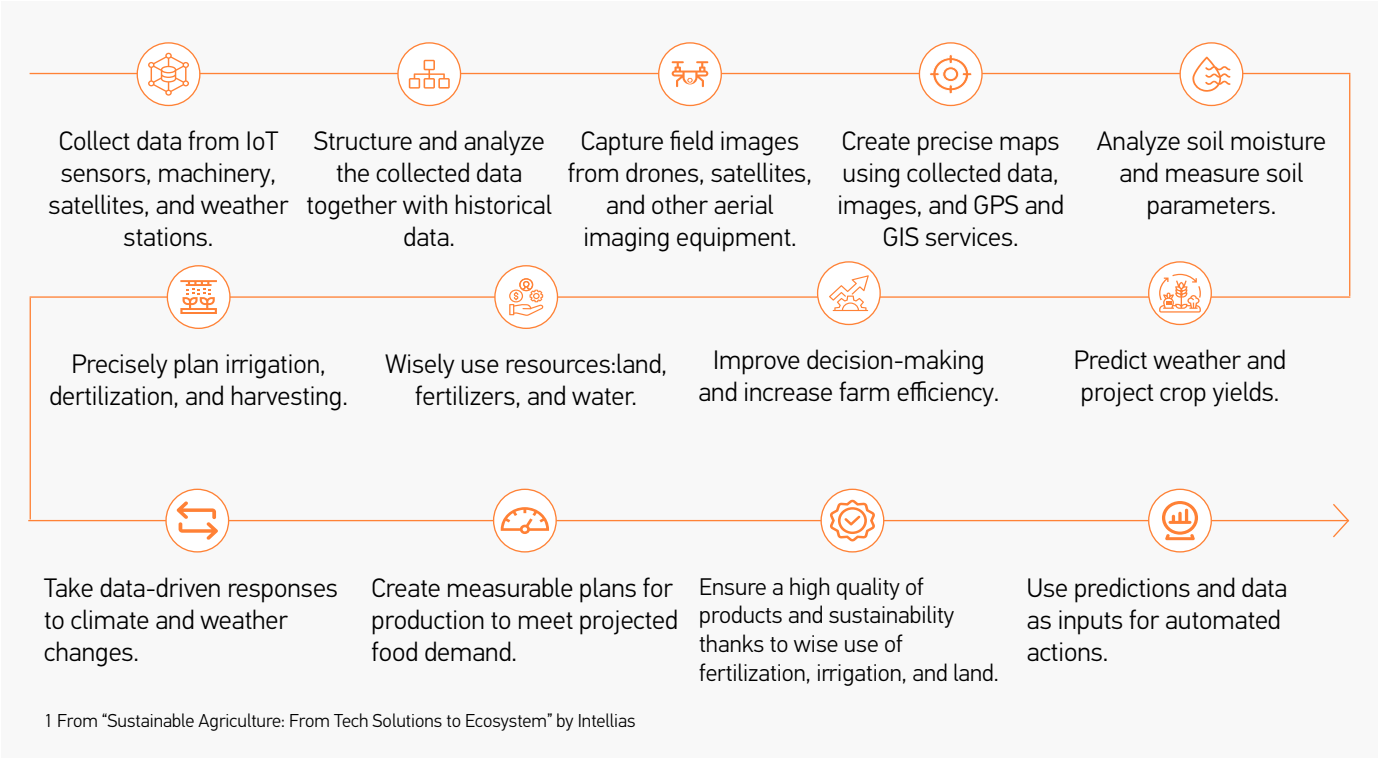
Food waste management: AI can provide real-time data on expected yields on a daily, weekly, and monthly basis. This will help both farmers and retailers to plan their production and selling strategies, as well as enable them to minimize the amount of time lost between the farm and the shop shelf.

Pest management: AI can be used to identify and monitor pest infestations in crops, enabling farmers to take timely and targeted action. This can reduce the use of chemical pesticides and improve the quality of crops, the soil, and the ecosystem.

> **In the past, agriculture data has allowed farmers to look in the rear-view mirror. Today, the rise of predictive tools can allow them to look to the road ahead.**

Advanced technologies such as machine learning can build models that would normally take decades to produce.

A fully AI-driven agriculture value chain could look like this:



1 From "Sustainable Agriculture: From Tech Solutions to Ecosystem" by Intellias

Although some of these technologies might have limited impact in the short run, the objective is to phase in the implementation, focusing first on those that could play a significant role in driving overall industry improvements. Smart irrigation and water optimization have been identified as crucial areas to address, given that water is the backbone of agriculture and has faced significant depletion and misuse over the years.

Using AI to optimize water consumption

Water optimization in agriculture refers to the process of maximizing the efficiency of water use in crop production while minimizing waste and maintaining crop yields. AI tools will allow farmers to do this by enabling data-driven decisions about irrigation scheduling, crop selection, and other water management strategies.

Specific ways in which AI can be used for water optimization in agriculture include:

Precision irrigation: AI algorithms can analyze real-time data on soil moisture levels and weather patterns to optimize irrigation schedules and minimize water waste. This can be done by precision irrigation systems such as drip irrigation, which deliver water directly to the root, or through the use of smart controllers that adjust irrigation schedules based on real-time data.

Predictive analytics: AI algorithms can use historical data on weather patterns, soil moisture, and crop growth to make predictions about future crop yields and water needs. This can help farmers make informed decisions about irrigation scheduling and other water management strategies.

Crop selection: AI algorithms can analyze data on crop performance and water requirements to help farmers choose crop varieties that are well-suited to local climatic and soil conditions, and that require less water to grow.

Water reuse: AI algorithms can help optimize the treatment and reuse of wastewater for irrigation purposes by analyzing data on water quality and irrigation requirements.

Soil management: AI algorithms can analyze data on soil conditions to suggest specific techniques to improve soil structure and fertility, such as cover cropping and the use of organic amendments, which can improve water retention and reduce runoff.

Smart irrigation can use a combination of these technologies and systems to create a more efficient and sustainable irrigation cycle and value chain. By reducing water consumption, lowering energy costs, and improving crop yields, smart irrigation can help promote sustainable agriculture practices and ensure a secure water supply for future generations.

Proven results with AI in water optimization

Several institutions have run experiments to validate and quantify the impact of AI in agriculture, primarily in water optimization, crop management, and crop yields:

Artificial neural networks: Artificial neural networks have been used to develop a new watering system for a **1,000m² strawberry orchard** in Antalya, Turkey. The AI model took into account factors such as soil moisture data, soil type, and crop type to determine optimal watering requirements and timings. It increased the amount of watering done at night and cut overall water consumption by around **21%** while reducing energy use by **24%**.

Drip irrigation: Drip irrigation is a precision agricultural technology that calculates the amount of fertilizer and water that crops require at different times, based on soil nutrient levels and water balance. Advanced drip irrigation technologies powered by AI have been trialed on wheat crops in China. They boosted yields by **15-20%** and made water resource management much more efficient, raising crop water productivity by **27-30%** and boosting the productivity of irrigation water by **37-42%**.

Reuse of wastewater: Researchers from the University of Jordan have explored the use of AI to optimize the treatment and reuse of wastewater for irrigation systems. Treated wastewater is becoming increasingly important in countries with substantial arid and water-stressed regions, such as Jordan. Tests performed on tomato crops compared performance between traditional and conventional methods of water use, finding a comparable yield with a **50%** reduction in water consumption.

These are just some of the case studies that have proven the applicability of AI-driven technologies in optimizing water consumption. The potential impact of AI extends to the full agriculture ecosystem.

Stakeholders incentivizing industry transformation

Large-scale deployment of AI-driven technologies is required to secure the sustainable transformation the agriculture industry needs. This will require collaboration between different stakeholders and the right incentive schemes from governments.

Some countries provide subsidies toward the water and electricity costs of participants in the agriculture industry. However, such subsidies are not a long-term solution and are likely to promote unsustainable behavior by some beneficiaries. When they are linked to key deliverables and milestones, subsidies are a good incentive. For example, they could be offered when the beneficiary is investing in AI technologies that will help reduce and optimize their use of water and other resources, while penalties could be applied for mismanagement.

Farmers' lack of knowledge about available technologies and their potential benefits has been highlighted as a key obstacle. The authorities therefore need to establish channels to share this knowledge. Training and education programs on the benefits and applications of AI in agriculture need to be developed for farmers and agricultural workers. This can help to build capacity and promote awareness of the potential for AI to improve agricultural productivity and sustainability.
Given that the expected financial returns on agriculture projects and developments will only emerge in the long term, many people are likely to avoid such investments. However, promoting attractive funding schemes and grants related to AI technologies is likely to accelerate technology adaptation. These funding regimes could be based on pre-determined criteria and linked to output.

Investment in the development of shared infrastructure can reduce operating costs for the beneficiaries. Examples include water treatment plants, CO2 capture facilities, and solar power plants. These can be complemented by sharing post-harvest processing facilities and using digital platforms and a digital marketplace to help collect data and optimize operations.

> **"Data is the new gold for many industries, and AI has been developed to make use of such information to drive optimization and growth."**

This will result in a significant amount of data being collected and analyzed on a real-time basis. To make best use of such data, establishing a national data center for agriculture could be a key step in incentivizing the use of AI in the sector.

A national data center could provide a centralized platform for collecting, storing, analyzing, and sharing agricultural data, and this could in turn help farmers and other stakeholders make better-informed decisions, improving agricultural productivity and sustainability. Such centers would receive data from various technologies at different farms and would provide a holistic view of what is happening in different regions on a real-time basis. It would enhance sustainability by providing data on key environmental factors, such as water quality and soil health. It would also improve competitiveness by enabling comparison with the results of different practices in other regions. As an extension, it could act as a platform to exchange views and industry best practices with other countries.

Conclusion and recommendations

Sustainable agricultural practices require not only cooperation between countries on knowledge and expertise, but also investment in the development of sustainable ecosystems. Resources and funds are needed to support the integration of AI and digital transformations. Securing the understanding and cooperation of citizens will be just as important and can be achieved by providing a framework and incentives to promote such sustainable practices.

Water, the backbone of agriculture, will remain under pressure in the near term, but with the right cooperation between parties and awareness of what needs to be done, suitable solutions will emerge to address the current crisis and move closer to a complete solution.
A thorough strategy is required. Dedicated teams need to start analyzing the key strengths of the agriculture industry and putting together a roadmap to implement new technologies and improvements. These need to target the creation of a data-driven economy that monitors key inputs and enables more informed decision making. Fully integrating a system such as this will put the food and agriculture sector in a better place to address future challenges.

The impact of the decisions taken and policies implemented today might not be seen in the short and medium term, but these decisions will facilitate the production of food supplies in the long term and, ultimately, the survival of future generations.