

Smart Agriculture: AI-Powered Farming

Emerging agriculture farming has established the use of AI technology, particularly in developed countries. However, this is not the case in all [developing countries](#) (Singh & Kaur 2022). The United Nations estimates that there will be 9.7 billion people on earth by 2050, significantly increasing the demand for food (Putterill, 2023). Hence, policymakers in both developed and developing countries are on the quest to adopt and implement [smart agriculture](#). This empowers AI-powered farming for sustainable food production in various geographical locations. This equity has propelled the need to reorientate the use of high-tech AI in sustainable food production. This article centres on how smart agriculture via [AI technology](#) stands a chance to enhance sustainable food production.



AI in Agriculture.

Source: [Technosanta.com](https://www.technosanta.com)

what is SMART-AI Agriculture?

SMART-AI agriculture involves the integration of modern [technological agriculture devices](#) such as digital soil maps, global positioning systems, robots, smart sprayers, and monocular visual odometry systems to optimise food

production ([Brenya et al., 2023](#)) [The Internet of Things \(IoT\)](#), Big Data, Artificial Intelligence (AI), [geo-positioning systems](#), and drones are [some of the technologies that are being applied to agriculture, in combination with ICT](#). Revolutionised SMART-AI technology has provided the foundation for mitigating crop and livestock cultivation failures, protecting biodiversity and ecosystems, enhancing planetary health, and promoting household farms to a farm-to-fork agenda ([Qazi et al., 2022](#)).



A Concept of Technology-Enabled Smart Farm.

Source: [freepik.com](https://www.freepik.com)

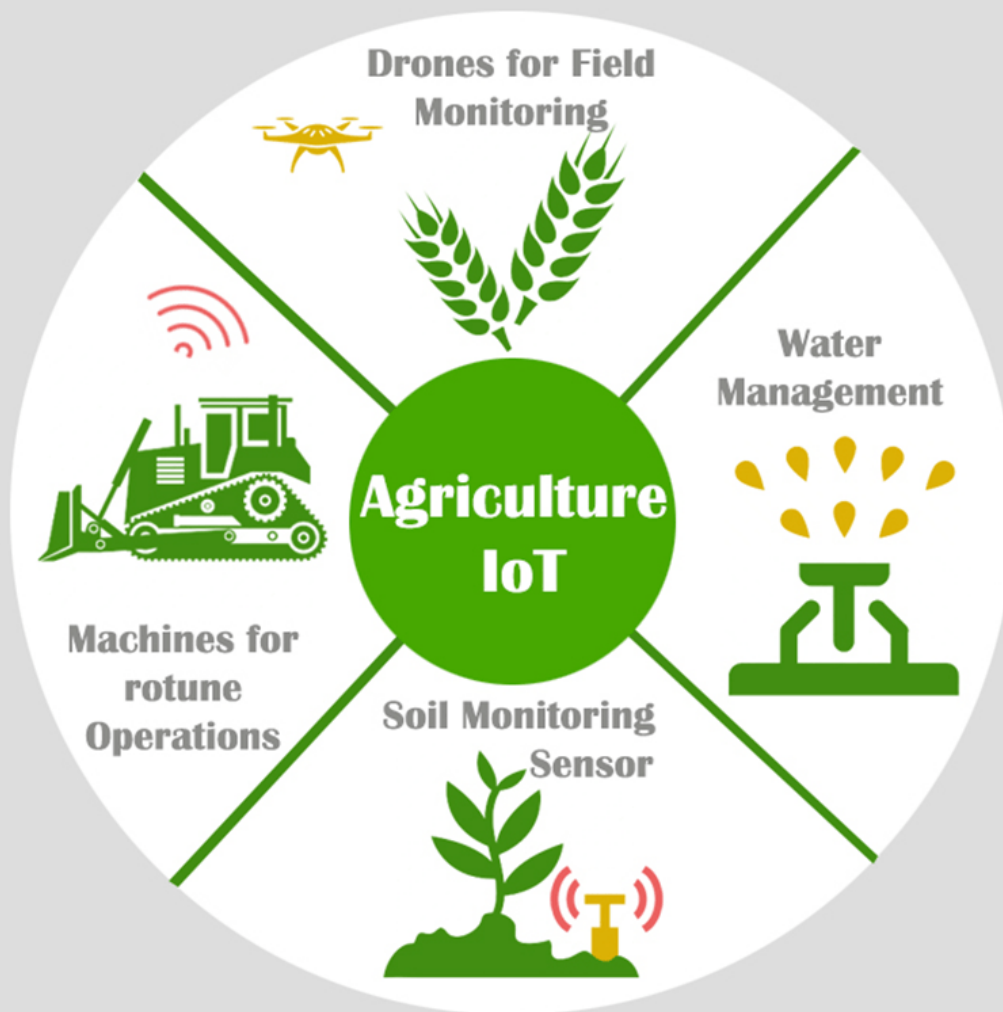
What Are the benefits and constraints of AI-powered Farming?

Possible Benefits

Global modern agricultural farming is subject to data-driven insights, and AI-powered farming enables farmers and other agricultural stakeholders to analyse

and make constructive decisions ([Chukwuma et al., 2024](#)). This improves sustainable food production and determines the measures to ensure nutrient balance and resilience to pests and diseases, among others ([Singh & Kaur, 2022](#); [Brenya et al., 2023](#)). More so, mammoth benefits such as AI facilitation of precision agriculture via [sensors monitoring](#) plant's health have been a reliable panacea to curtail plant losses and equitable distribution of fertilisers on the field to increase food production ([Shaikh et al., 2022](#)). AI-powered farming for sustainable production enables farmers to prepare and resist weather patterns, drought, and the like.

How IoT technology is benefiting today's modern farming industry



Agriculture IoT.

Source: infiniteinformationtechnology.com

Possible Constraints

The unprecedented accuracy of AI technology in agriculture farming comes with its demerited characteristics. Below are highlighted challenges that are encountered in the application of SMART-AI Technology in agriculture:

Attaining and Maintaining AI Technology:

Purchasing agriculture AI technology is not only expensive for farmers but the cost of maintaining it also drains their resources and income, hence reducing farmers' ability to maintain sustainable food production. As postulated by the [Harvard International Review article](#), AI technology acquisition can lead household farmers into debt as well as the increased level of wear-and-tear of these technologies.

Data Privacy and Security:

The consistent use of [precision agriculture](#) tools such as sensors, robots, and data analysis tools, raises concerns about the privacy and security of the households. A study conducted by [Kaur et al., \(2022\)](#) asserted that farmers are uncertain about data privacy as they are concerned about unauthorised access to data and data sharing. This is a key factor that makes farmers hesitant to adopt SMART-AI technology.

Technical Know-How:

Securing AI technology for sustainable food production has the potential to meet food demand. However, experts capable of implementing these technologies can be difficult to find, especially in developing countries. Most household farmers lack expertise in technologies like sensors and robots, let alone the implementation of AI algorithms that improve the conditions of crops and animals. A study conducted in an American work environment indicated that often new skills are required to operate the AI technology ([Mateescu & Elish, 2019](#)).

Negative Environment Effect:

There is no doubt that SMART-AI agricultural practices are an essential component that can increase agriculture production to meet the predicted food demand of 2050 ([Putterill, 2023](#)). However, it is not perfect and brings its own potentially negative effects on human health and the environment. National

Geographic postulated that agricultural technology application depletes via irrigating river systems, aquifers, and the like. Agricultural irrigation can significantly impact river systems by [altering water quality and quantity](#). For instance, diverting water for irrigation can reduce downstream flow, affecting ecosystems and human communities. Additionally, irrigation can lead to increased groundwater levels in irrigated areas and higher evaporation rates. These changes can have various environmental consequences, including habitat disruption and altered hydrological cycles (ICID.CIID, n.d). This report from THRIVE indicates that negative effects on the environment not only have grave consequences on the ecosystem and biodiversity but also on human health.

Moving Forward

This article looked at the future agenda of SMART-AI sustainable food production from social, economic, and environmental angles.

Social Sustainability Towards Food Production

Societal elements, such as the local communities' lives, health, and values, can affect their adoption of SMART-AI sustainable [food production](#), food choice, and nutrient consumption. Farmers from lower economic backgrounds are susceptible to consuming unbalanced diets owing to their inability to practice sustainable agriculture using AI-empowered technology. Hence, Policymakers must institute policies that improve resource availability in developing countries to support the use of AI in sustainable food production.

Economic Sustainability Towards Food Production

The economic sustainability of food production denotes the need for households' fiscal status to cover the needs of present members as well as future generations. AI technology enables smart sustainable agricultural practices that increase food production yield, expedite market access, and generate income. Thus, international donor institutions must do their best to support countries economically.

Environment Sustainability Towards Food Production

Environmental sustainability promotes households' agricultural food production while ensuring intergenerational equity by using AI technology to balance biodiversity and the ecosystem ([Qazi et al., 2022](#)). AI algorithms have a superior accuracy in analysing agriculture climate data, which can help improve farmers' understanding of temperature ([Bhat & Huang, 2021](#)). For instance, precipitation measures such as soil moisture sensors and irrigation, to counter drought-prone areas and determine the best time to harvest crops to increase the probability of avoiding environmental pollution ([Kikon & Deka, 2022](#)). Hence, governments must support and implement strategies that improve environmentally sustainable agricultural practices.

achieving the United Nations Sustainable Development Goals (SDGs) and how they link to Smart Agriculture

Smart Agriculture: AI-powered farming for sustainable food production is a key component in achieving the United Nations Sustainable Development Goals (SDGs). AI plays a crucial role in Global Goals, SDG1: No Poverty, SDG2: Zero Hunger, and SDG13: Climate Action. Thus, AI-powered farming [enhances agricultural productivity](#) to meet the demand for food by households, generating income opportunities to counter poverty and increasing funds to spend on food. More so, AI-powered sustainable agricultural practice ensures [resilience](#) to the constraints resulting from climate change such as drought and excessive rainfall, working towards climate action. By promoting an AI farming methodology, households can integrate measures to achieve some of the SDGs. According to the Food and Agriculture Organization, households that use digital technology to support [sustainable farming practices](#) enhance their livelihoods and standard of living whilst protecting the environment.

Conclusion and Call to Action

AI is transforming agriculture by making farming more efficient. With AI tools,

farmers can monitor crops, predict weather, and optimise the use of resources like water and fertilisers. This helps reduce waste, increase yields, and support thrivable practices. AI-powered farming is essential for food security and environmental protection, especially as climate change and population growth challenge traditional farming methods ([Dara et al., 2022](#)).

Smart agriculture and AI-powered farming achieve [THRIVE's 12 Foundational Focus Factors](#) (FFF). Specifically, [Values-Based Innovation](#) and [Science Based Targets](#).

To ensure a thrivable and food-secure future, we must embrace AI in agriculture. Farmers, researchers, policymakers, and the tech industry all play important roles in this transformation. Farmers should begin by learning about AI tools that can improve their farming practices. By using precision farming techniques, farmers can reduce waste, use water and fertilisers efficiently, and increase yields. These changes will help make agriculture more thrivable and productive ([Umar, 2023](#)). Researchers should focus on making AI technology more affordable and accessible for farmers. They should work on creating solutions that are tailored to different farming needs, whether for small or large-scale operations. Additionally, training programs should be developed to help farmers understand and use AI effectively ([Kasan, 2024](#)).

Policymakers must create policies that support the adoption of AI. This can include offering financial incentives for farmers to invest in smart technologies and improving access to digital tools. Governments should also invest in education and infrastructure to ensure that all farmers, regardless of location, can benefit from AI-powered farming ([Bhat & Huang, 2021](#)). Tech companies must make AI tools user-friendly and affordable. By collaborating with farmers, they can help reduce costs and increase accessibility. By working together, we can build a future where AI helps create a resilient, efficient, and thrivable agricultural system.

A Thrivable Framework

[The THRIVE Framework](#) examines issues and evaluates potential solutions in relation to the overarching goal of [thrivability](#). It is about making predictive analyses using modern [technology](#) that supports environmental and social

sustainability transformations. The international community faces unparalleled threats such as climate change, deforestation, deep-sea depletion, and resource misuse. Governments and organisations must adopt innovative strategies including AI smart agriculture to ensure human existence continues. The [THRIVE Framework](#) highlights the need to [shift](#) to a transdisciplinary approach and embrace [Values-Based Innovation](#), which is a step towards a thriving future.

The [THRIVE Framework](#) is a Holistic Regenerative Innovative Value Entity Framework that integrates distinct approaches adopted by institutions concerned with going beyond sustainability to thriving. It provides a clear template for evaluating sustainability by integrating the [12 Foundational Focus Factors](#). Contrasting mere sustainability, the concept of [thrivability](#) looks beyond environmental and social issues. THRIVE aims for humanity to overcome planetary devastation and build foundations for a world that thrives.

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