

Technologies for Sustainable Agriculture Development



Farmers can develop sustainable farming systems that promote environmental, social, and economic sustainability by adopting advanced technologies. However, it is essential to note that technology is not a silver bullet and must be implemented with other sustainable farming practices, such as soil conservation, crop rotation, and integrated pest management, to achieve sustainable farming systems.

**Dr Neeraj Sinha
Naman Agrawal
Rajeev Kumar**

Agriculture is the backbone of the Indian economy, employing more than half of the country's population. On the other hand, traditional agricultural practices in India are frequently unsustainable and can negatively affect the environment and human health. Sustainable agricultural practices are required to ensure the long-term viability of agriculture in India.

According to the World Bank, as of 2020, 42.1% of the Indian population was employed in agriculture.

While the industry and services sectors contribute more than 80% of the gross value added in the country, they employ 54.4% of the workforce. Agriculture, which accounted for 18.29% of GVA in 2019–20, still employs 45.6% of the workforce, indicating that a significant portion of the Indian population relies on agriculture for their livelihoods. However, over the years, the percentage of the population employed in agriculture has gradually declined as the country has diversified its economy and developed other sectors, such as

services and manufacturing. In 2000, the percentage of the population employed in agriculture was 60.5%, showing a significant shift away from agriculture in recent years.

Gross Domestic Product (GDP) Growth Rate in India

Per capita GDP measures the average economic output per person in a given country or region. The agriculture sector's contribution to per capita GDP in India has declined over the years as the country has diversified its economy and developed other sectors such as services and manufacturing. The Ministry of Statistics & Programme Implementation (MoSPI) estimates that the GVA of agriculture and related sectors was 20.2% in 2020–21, 19.8% in 2021–22, and again decreased to 18.3% in 2022–23.

In recent years, there has been a shift in economic power and focus on the growing economies of the BRIC countries: Brazil, Russia, India, and China. The BRIC countries' GDP growth rate is far greater than that of traditionally strong economies such as the United States and Germany. While the United States has the world's largest economy by almost any measure, China has the second-largest share of global GDP, with India racing Japan for third place. Despite the global recession in 2008 and 2009, India managed to maintain impressive GDP growth rates, especially given that most of the world experienced negative growth in at least one of those years.

While the agriculture sector's contribution to India's per capita GDP has declined over time, it remains an essential sector of the economy, particularly regarding employment and livelihoods. Several initiatives, including the Pradhan Mantri Fasal Bima Yojana, the Pradhan Mantri Krishi Sinchayee Yojana, and the National Agriculture Market (e-NAM) platform, have been launched by the Government to promote the development of the agriculture sector. These initiatives aim to increase farmer productivity, reduce risks, and increase income in India. According to the survey, the Pradhan Mantri Fasal Bima Yojana (PMFBY) is a watershed initiative that provides farmers with a comprehensive risk solution at the lowest uniform premium across the country. Year after year, the PMFBY receives around 5.5 crore farmer applications.

Sustainable agriculture is a farming method that considers the soil, the environment, and the community's long-term health. It is critical to meet rising food demand while protecting natural resources for future generations. As the world has become more aware of the importance of environmental preservation, sustainable agriculture has received significant attention in recent years. Sustainable agriculture produces food, fibre, or other plant or animal products while preserving the environment, public health, human communities, and animal welfare. Natural resources such as soil, water, and air are conserved and regenerated for future generations through these practices.

As a developing country, India is vital in achieving sustainable agriculture globally. Agriculture provides a living for more than 58% of India's population. The country has made significant strides in increasing agricultural output, but much more work remains to achieve sustainable agricultural practices. One of the most significant challenges confronting Indian farmers is declining soil fertility due to the excessive use of chemical fertilisers, pesticides, and intensive farming practices.

Adopting sustainable agriculture practices in India is critical for the long-term sustainability of the agriculture sector. The Indian Government and various organisations have launched several initiatives to promote sustainable agriculture practices. For example, the government launched the National Food Security Mission, the Pradhan Mantri Fasal Bima Yojana, and the Soil Health Card Scheme to improve agricultural practices and financially assist farmers.

Adopting technologies can be crucial in developing sustainable farming systems that promote environmental, social, and economic sustainability.

Here are some ways in which technology can help in sustainable farming:

Precision Farming: It involves sensors, GPS mapping, and data analytics to monitor and optimise crop performance. By using precision farming techniques, farmers can reduce the use of fertilisers and pesticides, improve water management, and increase yields. Precision farming is a relatively new concept in India, and its adoption varies by state depending on various factors such as the availability of technology, agricultural practices, and Government policies.

Agroforestry: Agroforestry is a land-use integrated management system that combines trees and shrubs with crops and livestock to create a more sustainable and productive farming system. This approach can provide various benefits, including soil conservation, biodiversity conservation, and carbon sequestration.

Vertical Farming: It cultivates crops in stacked layers, usually under controlled conditions. Vertical farming can potentially increase local food production while reducing water consumption and optimising resource utilisation, making it an appealing option for Indian urban agriculture. This method can reduce the need for pesticides and herbicides while increasing crop yields and lowering transportation costs.

Hydroponics: Hydroponics is gaining traction in various Indian states as a sustainable farming method that allows for efficient water and nutrient use, year-round cultivation, and reduced dependence on traditional agricultural practices. Hydroponics involves growing plants in nutrient-rich water without soil. This approach can reduce water use, increase yields, and allow for year-round crop production. It can potentially revolutionise how we grow food in India, especially in urban areas with limited space and resources.

Renewable Energy-based: Renewable energy technologies, such as solar and wind power, can be used to power farming operations. This approach can reduce greenhouse gas emissions and dependence on fossil fuels.

Robotics and Automation-based: Robotics and automation technologies can help reduce labour costs, improve crop yields, and reduce the use of fertilisers and pesticides.

Gaps Identified in Adopting Sustainable Agriculture Development

Adopting sustainable agriculture development practices is critical to the long-term viability of the agriculture sector in India. However, several gaps have been identified in adopting sustainable agriculture practices in the country. Here are some of the significant gaps:

- 1. Lack of Awareness and Knowledge:** One of the main barriers to adopting sustainable agriculture practices is farmers' lack of awareness and knowledge. Many farmers must know the benefits of sustainable agriculture practices or how to implement them effectively.
- 2. Limited Access to Finance:** Sustainable agriculture practices often require significant infrastructure and technology investments. However, many tiny and marginal farmers need more access to finance to make these investments.
- 3. Inadequate Policy and Regulatory Framework:** Adopting sustainable agriculture practices is not always supported by India's policy, and the regulatory framework does not always support adopting sustainable agriculture practices. For example, farmers may need more incentives to adopt sustainable practices, or regulations may prohibit certain sustainable practices. The National Mission for Sustainable Agriculture receives only 0.8% of the Ministry of Agriculture and Farmers Welfare (MoAFW) budget, indicating a significant opportunity to support sustainable agriculture further.

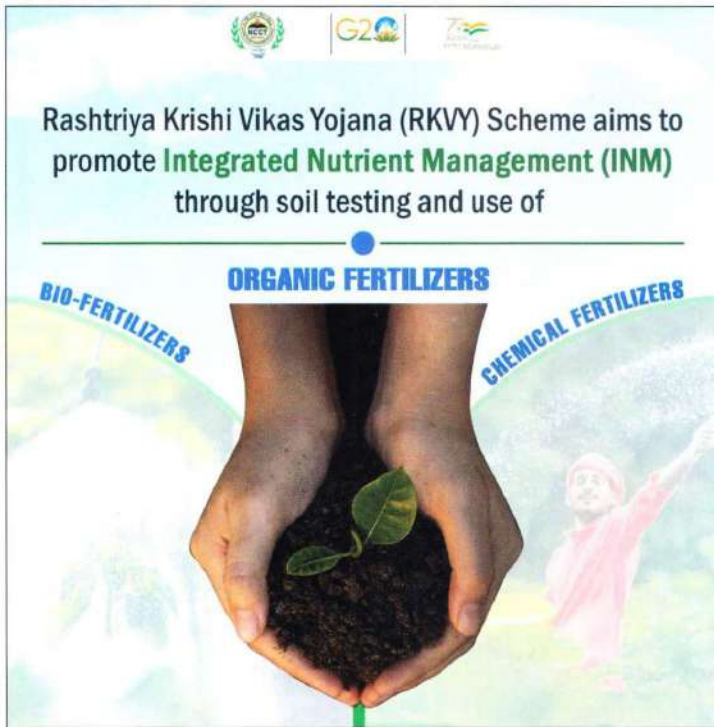
4. **Limited Research and Development:** There is a need for more research and development in sustainable agriculture practices that are appropriate for the Indian context. There is also a need for more investment in disseminating research findings and developing extension services to help farmers adopt these practices.
5. **Lack of Infrastructure and Technical Support:** Adopting sustainable agriculture practices often requires significant infrastructure and technical support. However, many farmers need access to these resources, particularly in remote rural areas.
6. **Low Productivity:** Agriculture in India is characterised by low productivity, a significant impediment to its growth and development. The yield per hectare for most crops in India is significantly lower than the global average, and several factors contribute to this, such as low levels of mechanisation, inadequate irrigation facilities, and poor soil health.
7. **Fragmented Landholdings:** The average landholding size in India is small, which makes it difficult for farmers to adopt modern farming techniques and technologies. Fragmented landholdings also make it difficult for farmers to access credit and other support services.
8. **Lack of Market Access:** The lack of access to markets is a significant challenge for farmers in India, tiny and marginal farmers. Many farmers are forced to sell their produce to intermediaries at low prices, as they cannot access direct markets. This results in lower incomes for farmers and higher food prices for consumers.
9. **Inadequate Infrastructure:** Inadequate infrastructure, such as rural roads, storage facilities, and cold chains, is a significant challenge for the agriculture sector in India. This makes it difficult for farmers to transport their produce to markets, store it safely, and sell it later.
10. **Climate Change:** Climate change poses significant challenges to the agriculture sector in India, particularly in terms of water availability, pest and disease management, and crop yields. The changing weather patterns, including erratic rainfall and rising temperatures, affect crop productivity and increase farmers' vulnerability.

Women are particularly susceptible. The Global Food Security Index (GFSI) score for sustainability and adaptation decreases as gender inequality increases. The GFSI demonstrates that a lack of access to fresh, clean water and land resources and a lack of political commitment to adaptation and sustainable agricultural practices are all factors associated with gender inequality. Identifying numerous additional gaps in India's agricultural sector presents severe obstacles to developing a resilient and sustainable agriculture sector. A multifaceted approach will be necessary to close these gaps, necessitating investments in R&D, regulatory and policy reforms, and creating infrastructure and extension services to encourage adopting sustainable agricultural practices. The Indian government has launched several programmes to support sustainable agricultural practices, including the Paramparagat Krishi Vikas Yojana, the Soil Health Card Scheme, the Rashtriya Krishi Vikas Yojana, the Pradhan Mantri Fasal Bima Yojana, the Pradhan Mantri Krishi Sinchayee Yojana, and the National Agriculture Market (e-NAM) platform.

Improving Dissemination of Technological Information to Farmers

Improving the dissemination of technical information to farmers is critical for adopting modern farming techniques and practices in India. According to a survey conducted by the National Sample Survey Organisation, only 6% of farmers in India have access to information on modern agricultural practices. To address this issue, the Government of India has

Farmers benefit from sustainable agriculture by preserving the environment, ensuring food security, and improving their livelihoods. Sustainable agriculture practices have the potential to boost agricultural productivity, reduce production costs, and enhance the quality of crops. It may also promote the production of healthier and safer foods, which is beneficial to public health.



launched several initiatives, such as the Kisan Call Centre and the mKisan portal, which provide farmers with information on a wide range of agricultural topics, including weather forecasting, market prices, and pest and disease management. The Kisan Call Centre had received over 21 million calls from farmers across India, indicating the importance of such initiatives in improving the dissemination of technological information to farmers.

India has had a National Mission for Sustainable Agriculture (NMSA) to promote sustainable agriculture since 2014-15. It is divided into several programmes focusing on agroforestry, rainfed areas, water and soil health management, climate impacts, and adaptation. Aside from NMSA, the Pradhan Mantri Krishi Sinchayee Yojana encourages precision farming techniques like micro-irrigation, and the Integrated Watershed Management Programme encourages rainwater harvesting.

Some Agri Tech Startup Case Studies

Sustainable agriculture is critical to agriculture's long-term viability in India. While the country has made strides towards adopting sustainable agricultural practices, there is still room for advancement. The Government, farmers, and other stakeholders must

work together to promote and implement sustainable agricultural practices in the country. Finally, sustainable agriculture is critical for the agriculture sector's and the environment's long-term viability. While India has made some progress towards adopting sustainable agricultural practices, much work still needs to be done. The Government and various organisations must collaborate to promote and implement sustainable agriculture practices in the country. India can ensure food security while improving farmer livelihoods and contributing to global efforts to create a more sustainable future by implementing sustainable agriculture practices.

AgriApp Technologies Pvt. Ltd. is an IT, ICT, and IoT-enabled technology company intending to bring technology to the agriculture and food sector. We work on precision and predictive agriculture while building a strong Agri-Ecosystem to benefit farmers, the economy and ecology. AgriApp works to fill the gap between farmers and the right kind of strategic information, thus making the farmers ready for high-efficiency technology-enabled agriculture production and marketing.

Khetee promotes agroecological farming through the agroforestry model, which first sets a farmer's prosperity and the environment. Khetee has created a one-of-a-kind fellowship programme for farmers and aspiring farmers to help them build agroecological model farms. Khetee is constructing a model farm in Lakhisarai's Durdih village. Farmers from all over the state come to our farm to gain experience and knowledge. Khetee organises training programmes for farmers regularly to help them build their capacity in regenerative farming. Khetee is aiming for systemic change in how agriculture is practised, its relationship with the market, and the policies surrounding it.

Instinct Earth Aqua-Scaping Private Limited is a Private Limited Company based firm engaged as the foremost Manufacturer of Clay Ball, Indoor Vertical Plant, Artificial Potted Plant, Artificial Vertical Garden Wall, Vermicompost Fertilisers, Hydroponic Machine, etc. They are also a Service Provider of Green Wall Installation Services, Gardening Services, and Vertical Garden Landscaping Services.

Aumsat provides precision-driven, satellite-based, AI-enabled hydrological analysis for locating, predicting, and forecasting groundwater resources. Unlike conventional costly and time-consuming methods

used in groundwater exploration, Startup services can help detect groundwater zones at a high precision rate without physically being present on the field, thereby saving cost economically and logistically by 75%.

Pudhuvai Green Gas Chemicals Fertilisers Private Limited is a clean & renewable Bioenergy startup producing organic waste agri-raw materials. Methane and Hydrogen will be produced as a by-product of the process, utilised commercially to provide a green fuel. Many by-products will also be produced, namely solid and liquid Bio-fertilisers, CO₂, Sodium Silicate, Precipitated Silica & CaCO₃, and Monosulfur, which will be used commercially.

Sense it Out is a deep-tech startup that brings technology solutions to specific climate change problems in Agriculture. Their product SICCA (Sensor-based Intelligent Crop Centric Automation), uses indigenously developed sensor technology that makes irrigation management more competent, reliable, and efficient. It is an IoT-based solution that optimises water usage using innovative soil sensor technology and scalable LoRa technology, making it suitable for small and large farms.

Conclusion

Farmers can develop sustainable farming systems that promote environmental, social, and economic sustainability by adopting advanced technologies. However, it is essential to note that technology is not a silver bullet and must be implemented with other sustainable farming practices, such as soil conservation, crop rotation, and integrated pest management, to achieve sustainable farming systems. Farmers in India have adopted various sustainable agricultural practices to ensure agriculture's long-term sustainability. Crop rotation involves alternating crops in a specific field over time. This practice promotes soil health and fertility while decreasing the likelihood of pest infestations and diseases.

Organic farming methods are another sustainable agricultural practice. To produce crops without synthetic chemicals, organic farming relies on natural processes and techniques such as crop rotation, intercropping, and natural fertilisers. Organic farming has numerous advantages, including producing healthy and nutritious food, reducing soil erosion, and water resource conservation. When comparing

India to global data, sustainable agriculture has gained much traction. According to the Food and Agriculture Organization (FAO) report, sustainable agriculture practices have increased in developed countries such as Australia, Canada, the United States, and several European nations. Furthermore, the report highlights the increasing popularity of sustainable agriculture practices in developing countries such as China, Brazil, and South Africa.

Furthermore, improved crop varieties, rainwater harvesting, and drip irrigation systems are examples of sustainable agricultural practices in India. These practices not only increase crop yields but also ensure the efficient use of natural resources. Despite adopting sustainable farming practices in India, the country faces numerous challenges in ensuring long-term sustainability. For example, indiscriminate pesticide and fertiliser use persists in many parts of the country, resulting in soil degradation and water pollution. Furthermore, climate change poses a significant threat to India's agricultural sustainability. Numerous climate-related disasters, such as floods and droughts, have occurred in the country, resulting in crop failures and the loss of livelihoods for many farmers.

Farmers benefit from sustainable agriculture by preserving the environment, ensuring food security, and improving their livelihoods. Sustainable agriculture practices have the potential to boost agricultural productivity, reduce production costs, and enhance the quality of crops. It may also promote the production of healthier and safer foods, which is beneficial to public health. □

References

1. <https://www.niti.gov.in/indian-agriculture-towards-2030>
2. https://impact.economist.com/sustainability/project/food-security-index/reports/Economist_Impact_GFSI_2022_Global_Report_Sep_2022.pdf
3. <https://www.ceew.in/sites/default/files/CEEW-FOLU-Sustainable-Agriculture-in-India-2021-20Apr21.pdf>
4. <https://www.fao.org/india/fao-in-india/india-at-a-glance/en/>
5. https://www.indiabudget.gov.in/economicsurvey/ebook_es2022/index.html#p=262
6. https://www.niti.gov.in/sites/default/files/2022-04/Discussion_Paper_on_Workforce_05042022.pdf