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Original Article

Sustainable Agriculture and Food Security in India

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Abstract

Sustainable agriculture is central to India's capacity to feed a growing population while conserving natural resources and improving rural livelihoods. This paper reviews the state of sustainable agriculture in India, assesses links between agricultural sustainability and food security, and analyses recent national data on production, irrigation, soil/groundwater pressures, and policy interventions. Over the past few decades India transitioned from chronic food deficit to sustained cereal surpluses and record production in food grains. Sustainable agriculture enhances food security, availability, access, utilization, and stability by promoting resource efficiency, resilience, and inclusivity. India continues to register record food grain production but faces serious environmental stresses (groundwater depletion, soil health challenges, overuse of chemical inputs) that threaten long-term food security; national missions and programmes show promise but require deeper adoption, stronger incentives, and market linkages. Heavy reliance on groundwater for irrigation links agricultural productivity directly to aquifer health. In order to protect the right to food for future generations, India can make sure that agricultural growth stays productive and strong by promoting sustainable farming practices, improving rural infrastructure, and incorporating sustainability into national food policies. To achieving large-scale sustainability requires stronger farmer participation, better incentives, and institutional coordination.

Keywords: *Sustainable agriculture, food security, groundwater, organic farming, climate resilience*

Introduction

India is simultaneously a global agricultural success story and a country confronting severe natural resource constraints. Over the past three decades India transitioned from chronic food deficit to sustained cereal surpluses and record production years in the early 2020s. Sustainable agriculture follows production systems that meet present food and income needs without compromising future generations' ability to do so through prudent management of soil, water, biodiversity, and inputs while ensuring livelihoods. However, the environmental footprint of intensive, input heavy practices particularly groundwater extraction, soil nutrient imbalance, and fertilizer overuse-has raised alarms about the long-term sustainability of India's food systems. Agriculture is the backbone of India's economy, employing more than 45% of the workforce and contributing nearly 18% to the national Gross Value Added (GVA) As the world's most populous nation,

India faces the dual challenge of producing enough food for its population while conserving natural resources. Sustainable agriculture, which emphasizes environmental stewardship, economic viability, and social equity, has therefore become central to India's development agenda.Sustainable agriculture follows FAO and national definitions: production systems that meet present food and income needs without compromising future generations' ability to do so through prudent management of soil, water, biodiversity, and inputs while ensuring livelihoods (FAO, 2023). Food security is multidimensional (availability, access, utilization, stability).Sustainable agricultural practices affect availability (production levels and stability), access (farm incomes, affordability), utilization (nutrition through crop diversification), and stability (resilience to shocks). Hence, sustainability and food security are tightly interdependent (FAO, 2023; NITI Aayog, 2023).

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Objectives

To examine the status of Indian agriculture
To review India's stand in achieving the twin goals of sustainable agriculture and food security
To discuss the challenges faced and way ahead in achieving food security

Data sources and Methodology

This is a synthesis paper using secondary data and literature. Primary data sources include: Agricultural Statistics at a Glance (Ministry of Agriculture & Farmers Welfare), Ministry of Agriculture and press releases and annual reports, Central Ground Water Board reports, FAO/UN flagship reports, programme documents for national missions (NMSA, PKVY), and peer-reviewed studies on groundwater/soil. Where possible the most recent official estimates (2022-24) and highlight year(s) are used explicitly. In addition this paper synthesises recent official statistics, programme documentation, and academic studies to provide a grounded assessment and a set of actionable recommendations.

The Evolution of Indian Agriculture

India's agricultural transformation began with the Green Revolution in the 1960s, which introduced high-yielding varieties (HYVs), chemical fertilizers, and irrigation expansion. This led to dramatic increases in food grain production and helped India to achieve food self-sufficiency. However, the intensive use of inputs also led to soil degradation, groundwater depletion, and declining biodiversity (Food and Agriculture Organization [FAO], 2023). The long-term sustainability of India's agricultural growth now depends on balancing productivity with ecological health. Policy documents and annual reports emphasize that while aggregate production has risen, structural issues remain: small average farm size, large numbers of marginal holdings, and spatial heterogeneity in access to technology, credit, and markets. These structural characteristics shape both productivity growth potential and the capacity to adopt sustainable practices.

Current Status of Food Production in India

India is the second-largest producer of food grains globally, recording an estimated 332.3 million tonnes of food grain output in 2023-24 (MoAFW, 2024). The gross cropped area in the country is about 219 million hectares**,** of which approximately 77.9 million hectares are irrigated (Directorate of Economics and Statistics, 2023). The share of tube wells in irrigation exceeds 47%, revealing the country's heavy dependence on groundwater (Central Ground Water Board, 2020). While production levels are rising, sustainability concerns persist. Over 60% of Indian agriculture remains rain fed and thus vulnerable to monsoon variability. Regions like Punjab, Haryana, and parts of Gujarat have reported significant groundwater depletion due to intensive rice–wheat cultivation systems (CGWB, 2020). Additionally, the excessive use of fertilizers-estimated at over 27 million tonnes annually-has caused soil nutrient imbalances and reduced soil fertility (Indian Council of Agricultural Research [ICAR], 2024).

The net irrigated area during 2021-22 was 77.9 million hectares**,** with tube wells (groundwater) accounting for a substantial share (47.3% of irrigation), canal systems 24.7%, and tanks 2.8%. Heavy reliance on groundwater for irrigation links agricultural productivity directly to aquifer health. Groundwater assessments underscore the concern: national groundwater resource compilations and state assessments indicate that a non-trivial share of assessment units are classified as 'over-exploited' or 'critical' the 2023/2024 dynamic groundwater assessments noted a measurable portion of assessment units under stress (the precise percentage varies by assessment year and methodology). This has direct implications for future irrigation reliability, cropping choices (e.g., water-intensive rice and sugarcane), and the need for basin-level water governance and recharge investment.

Practices for Sustainable Agriculture

Sustainable agriculture in India integrates ecological, economic, and technological dimensions to maintain long-term productivity and food security.

- **Organic and Natural Farming:** Organic and natural farming aim to eliminate synthetic inputs and promote soil biodiversity. Under the *Paramparagat Krishi Vikas Yojana (PKVY)*, about 1.5 million hectares have been brought under organic clusters since 2015 (MoAFW, 2025). Studies indicate that organic farming enhances soil organic matter and reduces input costs, though yields may be lower initially (FAO, 2023).
- **Efficient Water Management**: India's *Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)* promotes water-use efficiency through micro-irrigation technologies such as drip and sprinkler systems. These techniques improve water productivity by 30-50% compared with conventional flood irrigation (ICAR, 2024). In addition, the *Atal Bhujal Yojana* focuses on community-based groundwater management in critical regions.
- **Integrated Nutrient and Pest Management:** Sustainable nutrient management combines organic manures, crop residues, and bio-fertilizers with judicious chemical use. The *Soil Health Card Scheme* launched in 2015 provides farmers with soil-specific fertilizer recommendations to prevent nutrient imbalance. Integrated Pest Management (IPM) also reduces dependence on chemical pesticides, protecting beneficial species and reducing costs (NITI Aayog, 2023).
- **Crop Diversification and Agroforestry:** Diversifying from water-intensive crops (rice and sugarcane) to pulses, oilseeds, and millets improves resilience and nutrition. The Government of India declared 2023 as the

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International Year of Millets to promote climate-resilient crops. Agroforestry systems under the *National Agroforestry Policy (2014)* integrate trees with crops, enhancing soil carbon and providing additional income sources.

How Sustainable Agriculture Strengthens Food Security

Sustainable agriculture enhances all four dimensions of food security, availability, access, utilization, and stability by promoting resource efficiency, resilience, and inclusivity (NITI Aayog, 2023).

- **Food Availability:** Sustainable agricultural practices such as crop diversification, integrated nutrient management, and organic farming improve soil fertility and ensure stable yields over time. For instance, organic and natural farming programs under the *Paramparagat Krishi Vikas Yojana (PKVY)* have covered about **1.5 million hectares** as of 2025, promoting chemical-free cultivation and improving soil organic matter (MoAFW, 2025). Additionally, efficient irrigation under the *Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)* increases water-use efficiency by up to 50% through drip and sprinkler systems (Indian Council of Agricultural Research [ICAR], 2024).
- **Food Access:** Sustainability oriented programs increase rural incomes by reducing input costs and diversifying crops toward high-value produce such as pulses, fruits, and vegetables. Farmer Producer Organizations (FPOs) and value-chain initiatives under the *National Mission for Sustainable Agriculture (NMSA)* strengthen smallholder participation in markets, improving both economic accesses to food and livelihood security (NITI Aayog, 2023).
- **Food Utilization:** Diversified farming systems that include pulses, millets, and horticultural crops contribute to improved nutritional outcomes. India's focus on promoting millets during the *International Year of Millets 2023* emphasizes their role in sustainable diets that are both climate resilient and nutrient-rich (FAO, 2023).
- **Stability and Resilience:** Climate change poses serious risks to India's food systems through irregular monsoons, droughts, and floods. Sustainable practices such as conservation agriculture, integrated farming systems, and agroforestry enhance resilience by improving soil moisture retention and reducing dependence on external inputs (ICAR, 2024). These strategies help stabilize production and reduce vulnerability to climatic and market shocks.

Barriers to scaling sustainable practice adoption

- **Short-term income trade off:** Transition to organic or diversified systems can reduce yields or incomes initially without adequate price premiums or transitional support (market failures).
- **Fragmented landholdings and capita constraints:** Small and marginal farmers often lack capital for micro-irrigation, soil amendments, or soil testing.
- **Weak value chains and certification costs:** Smallholders face high transaction costs for organic certification and limited access to premium markets. PKVY and MOVCDNER try to address this but scale remains limited.
- **Spatially uneven public goods:** Irrigation infrastructure, extension, and research availability are unevenly distributed across states, producing regional gaps in adoption.

Policy Framework

The **National Mission for Sustainable Agriculture (NMSA),** part of India's National Action Plan on Climate Change, promotes climate-resilient practices such as soil health management, efficient irrigation, and rain fed area development (MoAFW, 2024). Similarly, programs like the *National Food Security Mission (NFSM)* and *Mission Organic Value Chain Development for North Eastern Region (MOVCDNER)* support sustainable intensification and organic value chains. Collectively, these initiatives seek to enhance productivity while reducing environmental pressures.

Challenges and the Way Forward

Despite these efforts, several barriers hinder widespread adoption. Small landholdings, limited access to credit, and inadequate extension services restrict farmers from transitioning to sustainable methods. Organic produce often faces certification challenges and weak market linkages. Moreover, climate change manifested through irregular rainfall, droughts, and heat stress pose a severe threat to India's agricultural productivity (FAO, 2023).

To address these challenges, India must strengthen research and development on sustainable technologies, incentivize water-efficient crops, and integrate sustainability goals into procurement and public distribution systems. In order to protect the right to food for future generations, India can make sure that agricultural growth stays productive and strong by promoting sustainable farming practices, improving rural infrastructure, and incorporating sustainability into national food policies. Promoting Farmer Producer Organizations (FPOs) can help small holders' access inputs, technology, and markets. Furthermore, digital platforms and precision agriculture tools can assist in optimizing resource use and minimizing waste.

Conclusion

Sustainable agriculture is not merely an environmental necessity it is the foundation of long-term food security. Sustainable agriculture is critical to India's goal of ensuring long-term food and nutritional security. While the country has achieved remarkable growth in production, the environmental costs threaten the resilience of its food systems. Policies like NMSA, PMKSY, and PKVY have laid a strong foundation, but achieving large-scale sustainability requires stronger farmer participation, better incentives, and institutional coordination. However, balance between

productivity and ecological conservation will determine India's agricultural future ensuring that the nation continues to feed its people without exhausting its natural resource base.

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