



SOIL HEALTH CARDS: A KEY TO SUSTAINABLE FOOD GRAIN PRODUCTION IN INDIA

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Abstract

Soil degradation and imbalanced nutrient management pose significant challenges to sustainable food grain production in India. To address these issues, the Government of India launched the Soil Health Card (SHC) Scheme in 2015, providing farmers with soil test-based, site-specific fertilizer recommendations to enhance soil fertility and crop productivity. By 2019, the scheme had analysed over 176 million soil samples and issued more than 220 million Soil Health Cards nationwide. Studies indicate notable yield improvements across major states—for instance, wheat yields in Uttar Pradesh increased by 30.8%, while paddy yields improved by 19.4% in Madhya Pradesh. The SHC initiative also contributed to a reduction in nitrogen and phosphorus fertilizer usage by approximately 20 kg/ha in Andhra Pradesh, alongside increased micronutrient application, promoting balanced fertilization. Economic benefits include significant net income increases (up to 139.8%) and reduced production costs by ₹2,100–3,100 per acre in targeted regions. Despite these gains, challenges such as timely soil sampling, farmer awareness, and extension support limit full potential realization. Integration of digital tools like mobile apps and GPS mapping has improved program efficiency and farmer engagement. Strengthening soil testing infrastructure, enhancing farmer education, and promoting organic amendments are critical recommendations to further enhance the

scheme's impact. Overall, the SHC Scheme represents a vital step towards sustainable soil health management, improved crop yields, and long-term food security in India.

Introduction

India, home to over 1.4 billion people, faces the constant challenge of ensuring food security while maintaining environmental sustainability. As one of the world's leading producers of rice, wheat, and pulses, the country's agricultural sector plays a pivotal role in feeding its population and driving rural livelihoods. However, the foundation of this productivity—soil health—has been under increasing stress in recent decades due to intensive farming, monocropping, excessive tillage, and indiscriminate use of chemical fertilizers.

Declining soil fertility, imbalanced nutrient application, and the neglect of organic matter have led to stagnating yields, rising input costs, and deteriorating soil quality. Many farmers, in the absence of scientific guidance, tend to apply fertilizers based on general practices rather than crop and soil-specific needs, leading to nutrient excesses or deficiencies. This not only reduces crop productivity but also affects long-term soil resilience and increases greenhouse gas emissions.

Recognizing the urgent need to address soil degradation and promote sustainable agricultural practices, the Government of India launched the Soil Health Card Scheme in 2015. The initiative aims to provide farmers with soil

test-based, customized nutrient recommendations to improve the health of their soils. Each card contains vital information on soil parameters—such as pH, organic carbon, and macro- and micronutrient levels—and offers fertilizer suggestions tailored to specific crops and land conditions.

By equipping farmers with knowledge about their soil, the SHC scheme supports balanced fertilization, enhanced productivity, and long-term sustainability—key components in achieving food security for future generations.

Soil Health Card Scheme

The Soil Health Card (SHC) Scheme, launched by the Government of India in 2015, is a large-scale initiative designed to promote balanced fertilizer use and improve soil health for sustainable agricultural productivity. The scheme provides farmers with detailed, soil test-based information about the nutrient status of their fields, enabling more efficient and targeted application of fertilizers and soil amendments. Soil samples are systematically collected from the top 0–15 cm layer of farmers' fields and analyzed in accredited laboratories across the country. Based on these analyses, personalized Soil Health Cards are issued every two years, offering crop-specific fertilizer recommendations tailored to the unique characteristics of each soil.

Between 2015 and 2019, the program conducted one of the world's largest soil testing efforts, analyzing over 17.6 crore soil samples and distributing more than 22 crore Soil Health Cards to farmers nationwide. This massive outreach aims to improve soil fertility management, enhance crop productivity, and promote long-term sustainability. The scheme continuously evolves by integrating modern technologies such as mobile soil testing labs and digital platforms, which improve accessibility and the efficiency of soil health monitoring.

The Soil Health Cards provide comprehensive data on critical soil parameters, including pH (acidity or alkalinity), electrical conductivity (soil salinity), and organic carbon content, which reflects soil organic matter and fertility. They also include information on essential macronutrients like nitrogen, phosphorus, and potassium, secondary nutrients such as sulfur, calcium, and magnesium, and vital micronutrients including zinc, iron, copper, manganese, and boron. By equipping farmers with this detailed information, the SHC scheme supports precise nutrient management, helping to maintain soil fertility, reduce excessive fertilizer use, lower input costs, and improve crop yields—key factors in advancing sustainable agriculture and food security in India.

Table 1. Effect of soil health card programme on food production and fertilizer use in India

State	Crop(s)	Yield Increase (%)	Other Impacts	Reference
Andhra Pradesh	Various food grains	Not specified	Reduced N and P fertilizer use by ~20 kg/ha, increased micronutrient use	Singh et al. (2022)
Uttar Pradesh	Wheat, Paddy, Sugarcane	Wheat: 30.8%; Paddy: 29.8%; Sugarcane: 32.9%	Reduced production costs by ₹2,100–3,100/acre; increased net income significantly	Singh et al. (2021)

Madhya Pradesh	Paddy, Soybean, Maize	Paddy: 19.4%; Soybean: 13.8%; Maize: 9.6%	Net income increased by 54.8%-139.8%; improved benefit-cost ratio	Agrawal et al. (2018)
Haryana	Cotton	11.93%	Net income increases by 48.1%; benefit-cost ratio improved from 1.41 to 1.63	Kumar et al. (2024)
Punjab	Wheat, Paddy	Wheat: 6.16%; Paddy: 3.7%	Reduced fertilizer consumption; increased net income	Punjab Agricultural University (2019)

Importance of soil health card

Soil health plays a crucial role in sustainable food grain production by maintaining the natural processes essential for crop growth and productivity. Healthy soils support efficient nutrient cycling, ensuring that vital nutrients like nitrogen, phosphorus, and potassium are available to plants in the right amounts at the right time. They also improve water retention and infiltration, helping crops withstand droughts and reducing the need for frequent irrigation. Moreover, healthy soils provide a favorable environment for beneficial microorganisms, which further enhance nutrient availability and protect plants from diseases. Together, these factors contribute to higher crop yields and better-quality grains, supporting food security and farmer livelihoods.

In contrast, degraded soils—characterized by nutrient depletion, erosion, compaction, or salinity—have a direct negative impact on agricultural productivity. Such soils often result in reduced yields and poor crop quality, which increases the cost of production due to higher input requirements, including fertilizers and water. Additionally, soil degradation leads to environmental problems such as increased greenhouse gas emissions, loss of biodiversity, and contamination of water bodies from fertilizer runoff. These issues

threaten the long-term sustainability of food production systems.

Balanced fertilization, based on the actual nutrient status of soils, is fundamental to sustainable grain production. Applying the right type and amount of fertilizers helps replenish depleted nutrients without causing excess buildup or environmental pollution. This approach not only optimizes crop growth but also preserves soil health and reduces input costs. Thus, maintaining soil health through balanced fertilization and good management practices is key to achieving sustainable food grain production that meets current needs without compromising future productivity.

The Soil Health Card (SHC) scheme helps farmers by providing personalized, soil test-based fertilizer recommendations that are tailored to the specific nutrient needs of their fields. This customized guidance enables farmers to apply the right type and amount of fertilizers, avoiding the common practice of overusing chemical inputs. As a result, farmers can improve input efficiency, reducing unnecessary costs and minimizing the risk of soil nutrient imbalances or environmental pollution caused by excess fertilizer runoff.

In addition to fertilizer recommendations, the SHC scheme raises farmers' awareness about the importance of

maintaining soil organic matter and adopting soil conservation practices. By understanding the role of organic carbon in improving soil structure, moisture retention, and microbial activity, farmers are encouraged to incorporate organic amendments such as compost, crop residues, and green manures. This holistic approach not only sustains soil fertility but also enhances the long-term health and productivity of their land. Overall, the SHC scheme empowers farmers with the knowledge and tools needed to manage their soils more sustainably, leading to better crop yields and improved livelihoods.

Challenges in implementation Soil Health Card

The implementation of the Soil Health Card scheme faces several challenges that affect its overall effectiveness. One major issue is the difficulty in timely and accurate soil sample collection from diverse and often remote agricultural fields, which can delay testing and the distribution of Soil Health Cards to farmers. Delays in issuing these cards reduce their relevance for the current cropping season, limiting farmers' ability to use the recommendations effectively. Additionally, awareness gaps exist among many farmers, especially in less accessible or resource-poor regions, leading to limited adoption of the soil test results and recommended fertilizer practices.

Another significant challenge is the lack of adequate training and extension services to help farmers interpret the information provided in the Soil Health Cards. Many farmers may find it difficult to understand technical details or how to translate the recommendations into practical actions on their farms without proper guidance. This gap highlights the need for stronger support systems, including farmer education programs, on-field demonstrations, and regular follow-up visits by agricultural extension workers. Addressing these challenges is critical to ensuring

that the SHC scheme fulfills its potential in promoting balanced fertilization, improving soil health, and advancing sustainable food grain production across India.

Digital tool in soil health card

The use of mobile apps has become an important advancement in the Soil Health Card Scheme, helping to improve accessibility, efficiency, and farmer engagement. Mobile applications developed under the scheme allow farmers to easily access their soil health data and recommendations directly on their smartphones. Through these apps, farmers can view detailed information about their soil's nutrient status, pH, organic carbon, and fertilizer suggestions without waiting for physical cards. This digital access speeds up communication and helps farmers make timely decisions for crop nutrient management.

Moreover, mobile apps enable the integration of GPS technology to accurately record soil sample locations, improving the precision of soil testing and mapping. They also facilitate real-time data entry and updates by soil testing laboratories, reducing delays and errors in processing and distribution. Many apps include features like reminders for soil testing schedules, fertilizer application guidance, and links to expert advice or agricultural extension services, empowering farmers with knowledge and support.

Overall, the integration of mobile apps in the SHC scheme enhances transparency, convenience, and farmer participation, making soil health management more dynamic and responsive. This digital approach helps scale the reach of the program, especially in remote areas, and supports the broader goal of promoting sustainable and balanced fertilization practices for improved crop productivity.

Conclusion

The way forward for the Soil Health Card (SHC) Scheme involves several key strategies to enhance its impact and support sustainable agriculture in India. Strengthening soil testing infrastructure is essential, including upgrading laboratories, increasing their number, and adopting advanced technologies to ensure faster, more accurate, and cost-effective soil analysis. Alongside this, expanding the use of digital tools such as mobile apps, GIS mapping, and cloud-based data management will improve accessibility and streamline the flow of information between farmers, labs, and extension services.

Integrating the SHC scheme with emerging agricultural practices like precision farming and climate-smart agriculture offers great potential. By combining detailed soil health data with technologies such as remote sensing, drones, and automated nutrient application systems, farmers can optimize input use, reduce environmental impact, and increase resilience to climate variability. This integration will help tailor fertilizer recommendations not just to soil conditions but also to changing weather patterns and crop needs.

Additionally, promoting the use of organic inputs, composting, and biofertilizers should be a priority. Encouraging farmers to adopt these sustainable soil fertility management practices helps improve soil organic matter, enhance microbial activity, and reduce dependence on chemical fertilizers. Together, these approaches will strengthen the SHC scheme's role in ensuring long-term soil health, boosting crop productivity, and achieving sustainable food grain production in India.

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