



AGRI MAGAZINE

(International E-Magazine for Agricultural Articles)

Volume: 02, Issue: 10 (October, 2025)

Available online at <http://www.agrimagazine.in>

© Agri Magazine, ISSN: 3048-8656

Reviving Punjab's Soil Health: The Need to Shift from Paddy to Diversified Crops

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Punjab, once known as India's "Granary," now faces an ecological crisis due to decades of paddy-wheat monoculture that has degraded soil health, depleted groundwater, and damaged the environment. This paper examines the urgent need to transition from paddy dominance to a diversified cropping system as a sustainable solution. The continuous cultivation of rice has led to soil nutrient depletion, structural degradation, and water overuse, while stubble burning contributes to severe air pollution. Crop diversification through the inclusion of legumes, maize, millets, oilseeds, vegetables, fruits, and agro forestry can restore soil fertility, conserve water, and enhance farmers' resilience. The study emphasizes that policy and institutional support, such as expanding MSP coverage, improving market infrastructure, and promoting farmer training, are critical to achieving this transition. Successful field examples from districts like Moga, Ludhiana, and Hoshiarpur demonstrate the potential of diversified systems to improve soil health and farm income. The paper concludes that shifting toward a balanced, ecologically sustainable agricultural model is essential for revitalizing Punjab's soils and ensuring long-term food and livelihood security.

Introduction

Punjab, once celebrated as India's "Granary," is now confronting a grave ecological challenge. The state's soil the very foundation of its prosperity is showing signs of exhaustion. Decades of intensive paddy-wheat cultivation have drained its nutrients, depleted groundwater, and destabilized the environment. What began as an agricultural success story during the Green Revolution has evolved into a sustainability crisis. To restore Punjab's soil health and ensure long-term food and livelihood security, a decisive shift from paddy monoculture to diversified cropping is essential.

The Ecological Cost of Paddy Dominance

The rapid spread of paddy cultivation in Punjab was driven largely by the Green Revolution of the 1960s and 70s. Government incentives, assured procurement under the Minimum Support Price (MSP) system, and high-yielding rice varieties encouraged farmers to replace traditional crops with paddy. However, this transformation came with unintended consequences.

1. Soil Nutrient Depletion

Continuous rice cultivation has stripped Punjab's soils of vital nutrients. Studies show declining levels of nitrogen, phosphorus, potassium, and micronutrients like zinc and iron. The heavy use of urea and chemical fertilizers has further disturbed the soil's natural microbial balance, leading to reduced fertility and lower productivity over time.

2. Water Overuse and Groundwater Crisis

Paddy is a water-intensive crop, consuming nearly 4,000–5,000 liters of water per kilogram of rice produced. Punjab's semi-arid climate and limited rainfall make such irrigation demands unsustainable. As a result, the water table in many districts is falling by more than

one meter annually, with some areas already facing acute water scarcity. Over-irrigation has also led to salinity and water logging, rendering parts of the soil unfit for cultivation.

3. Soil Structure Degradation

Repeated puddling for paddy transplanting alters soil structure, making it compact and less aerated. This impedes root growth and reduces the soil's capacity to retain organic matter, creating a vicious cycle of declining productivity and increasing input costs.

4. Environmental Impact

The practice of burning paddy stubble to clear fields before wheat sowing releases massive amounts of carbon dioxide, methane, and particulate matter into the atmosphere, contributing to air pollution and greenhouse gas emissions.

Why Crop Diversification Is the Solution

Crop diversification shifting from a rice-wheat monoculture to a more varied cropping system offers multiple benefits: improved soil fertility, reduced water stress, and enhanced farmer resilience.

1. Soil Restoration through Legumes

Leguminous crops such as moong, masoor, and chickpea naturally fix atmospheric nitrogen, enriching the soil without external fertilizers. Including pulses in crop rotations helps restore soil fertility, improves texture, and enhances microbial activity.

2. Water Conservation with Maize and Millets

Maize and millets consume only a fraction of the water required for paddy and can thrive in Punjab's agro-climatic conditions. These crops not only conserve groundwater but also diversify farmers' income streams. Millets, in particular, have gained national attention as "nutri-cereals," rich in micronutrients and resilient to climate variability.

3. Oilseeds, Vegetables, and Fruits

Crops such as mustard, sunflower, and groundnut, along with vegetables and fruits, can rejuvenate soil health through varied root structures and organic residues. Horticulture, when integrated with field crops, can boost farm profitability and promote ecological stability.

4. Agro forestry and Integrated Farming

Agro forestry growing trees alongside crops improves soil organic matter, prevents erosion, and enhances biodiversity. Integrated farming systems that combine crops, livestock, and fisheries can also recycle nutrients and reduce dependence on chemical inputs.

Policy and Institutional Support: The Missing Link

1. Expanding Market Support beyond Paddy and Wheat

Currently, assured procurement through MSP is largely limited to paddy and wheat. Expanding procurement mechanisms to include pulses, maize, and oilseeds would encourage farmers to diversify. Price assurance and risk coverage for these crops can make them economically viable alternatives.

2. Strengthening Supply Chains and Processing Infrastructure

A major obstacle to diversification is the absence of robust market linkages. The establishment of cold storage facilities, agro-processing units, and value-addition centers for maize, fruits, and vegetables can make non-paddy crops more profitable and marketable.

3. Research, Extension, and Training

Punjab's agricultural universities and Krishi Vigyan Kendras (KVKs) should play a greater role in promoting region-specific diversification models. Training programs can equip farmers with knowledge of soil health management, crop rotations, and sustainable irrigation practices.

4. Incentives for Soil and Water Conservation

Government schemes that reward farmers for adopting soil-friendly practices such as zero tillage, drip irrigation, and organic farming can accelerate the transition. Soil health cards, which track nutrient levels, should be actively used to guide fertilizer and crop decisions.

Learning from Ground-Level Success

Several districts in Punjab have already demonstrated that diversification is both feasible and profitable.

- Moga and Ludhiana have seen encouraging results from maize-pulse rotations, which improved soil health and reduced input costs.
- Farmer producer organizations (FPOs) in Hoshiarpur and Kapurthala have promoted vegetable and fruit cultivation, creating local value chains.
- NGO-led initiatives focusing on organic basmati rice, integrated with pulses and vegetables, have shown that soil restoration can go hand-in-hand with higher farmer incomes.

These examples illustrate that with proper support, Punjab can move towards a more balanced and sustainable agricultural model.

Socio-Economic and Environmental Benefits

The transition away from paddy monoculture will not only rejuvenate soil health but also generate wide-ranging benefits:

- **Improved Soil Fertility:** Crop rotation restores nutrient cycles and enhances microbial life.
- **Water Security:** Less water-intensive crops reduce pressure on the state's depleting aquifers.
- **Reduced Pollution:** Eliminating stubble burning and excessive fertilizer use cuts air and water contamination.
- **Higher Farm Income:** Diverse crops provide resilience against market and climate shocks.
- **Climate Resilience:** Agro-ecologically balanced systems increase adaptability to droughts and erratic rainfall.

Challenges Ahead

Despite the clear advantages, several challenges remain:

- **Economic Inertia:** Farmers are hesitant to shift due to the assured income from MSP-backed paddy.
- **Infrastructure Deficits:** Lack of procurement facilities and storage for alternative crops limits diversification.
- **Policy Gaps:** Subsidies and support continue to favor paddy, discouraging experimentation.
- **Climate Uncertainty:** Weather variability makes crop diversification risky without insurance coverage.

Addressing these issues requires a holistic, multi-stakeholder approach involving the government, research institutions, private sector, and farming communities.

The Way Forward

1. **Redesign Agricultural Subsidies:** Link input subsidies (for fertilizers, power, and irrigation) to sustainable practices and crop diversification targets.
2. **Promote Crop-Specific Zones:** Identify agro-climatic regions within Punjab for maize, pulses, oilseeds, and horticulture to optimize resource use.
3. **Public Awareness Campaigns:** Launch state-wide programs emphasizing the long-term ecological and economic benefits of soil restoration.
4. **Leverage Technology:** Use soil health data, remote sensing, and AI-driven advisories to guide farmers' crop choices.
5. **Encourage Youth Participation:** Attract young entrepreneurs into agri-businesses related to processing, marketing, and value addition of diversified crops.

Conclusion

Punjab's agricultural success once fed the nation but that success has come at a heavy ecological price. The state's soils, water, and environment are now under severe stress due to

decades of paddy monoculture. Reviving soil health through crop diversification is not merely an environmental choice it is a socio-economic necessity. A diversified, soil-friendly farming system can restore ecological balance, secure livelihoods, and safeguard Punjab's agricultural future. By moving from short-term gains to long-term sustainability, Punjab can once again lead the nation this time, in the revolution to heal the land that feeds us.

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