

**Precision Farming in India: Challenges and Solutions**

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**Abstract: -**

Precision agriculture offers a targeted, data-driven approach to improve farm productivity, reduce input costs, and protect natural resources. In India, however, its adoption remains limited due to small landholdings, high initial costs, low awareness, and infrastructural gaps. This article explores the relevance of precision farming in the Indian context, highlights the ground-level challenges, and proposes practical, low-cost strategies for smallholders. Emphasizing affordable tools, farmer-centric training, and soil-health-focused practices, it also outlines the role of agri-tech startups and government schemes in driving wider adoption. A phased, localized approach to precision agriculture can significantly enhance sustainability, profitability, and climate resilience in Indian agriculture.

**Introduction:**

Indian agriculture today stands at a turning point. While food grain production has increased considerably over the years, farm profitability and soil health continue to decline due to rising input costs, unpredictable monsoons, and conventional blanket-approach farming practices. Most farmers still base crucial decisions like fertilizer doses, irrigation, and pest control on experience or

guesswork, which often leads to soil degradation, wasted resources, and lower yields.

In this situation, **precision agriculture** offers a practical, modern approach to improve crop productivity, optimize resource use, protect soil health, and reduce environmental risks. Though globally popular, precision farming's adoption in India remains limited due to specific local challenges, which this

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article aims to highlight, while also suggesting farmer-friendly solutions and policy opportunities.

### Understanding Precision Agriculture in the Indian Context

Precision agriculture is a need-based, scientific farming approach where inputs like water, fertilizers, and crop protection measures are applied in precise amounts, at the right time, and at specific field locations based on data-driven decisions. It uses tools like soil testing kits, GPS mapping, drones, soil moisture sensors, and crop advisory apps to support timely, localized decisions.

In India's small and fragmented fields, this approach is especially valuable, as it helps reduce input costs, increase yield per unit area, protect soil quality, and improve the overall resilience of farm production systems.

### Potential Opportunities for Precision Agriculture in India

Despite challenges, India presents numerous opportunities for integrating precision farming techniques. Rising input costs, depleting water tables, degrading soil fertility, and unpredictable climate events make it necessary to move towards site-specific, resource-efficient practices.

#### Precision agriculture can help:

- ✓ Save water through soil moisture sensors and drip irrigation.

- ✓ Improve fertilizer use efficiency via soil health mapping.
- ✓ Grow high-value crops with protected structures and controlled fertigation.
- ✓ Monitor pest outbreaks with drone surveillance.
- ✓ Manage weather risks with real-time advisory apps.
- ✓ Access premium markets by producing high-quality, residue-free produce.

The growth of India's agri-tech startups and increased awareness about organic and sustainable farming also open new avenues for its adoption.

### Challenges to Adoption by Indian Farmers

The practical adoption of precision agriculture in India faces several real-world challenges:

**Small and Fragmented Landholdings:** With over 86% of Indian farmers owning less than 2 hectares, using high-end tools like drones or VRT sprayers individually isn't feasible.

**High Initial Investment:** Soil sensors, drones, and management software involve upfront costs unaffordable for most smallholders.

**Limited Awareness and Digital Literacy:** Many farmers are unaware of precision tools or how to use and interpret farm data.

**Poor Rural Infrastructure:** Inconsistent internet, electricity, and equipment availability restrict adoption.

**Lack of Customized, Multi-Crop Solutions:** Most tools are designed for large monoculture farms, unlike India's mixed cropping systems.

**Weak Market Linkages:** Without assured premium pricing or procurement networks, farmers hesitate to invest in precision technologies.

### **Socio-Economic and Institutional Constraints Impacting Adoption**

Apart from technical hurdles, several socio-economic and institutional factors hinder adoption:

1. Low education and digital literacy rates.
2. Skepticism toward new, unfamiliar techniques.
3. Bureaucratic delays in availing government schemes.
4. Lack of mobile-based advisories in regional languages.
5. Resistance in conservative farming communities toward tech-driven practices.

Such constraints can only be addressed through proactive policy support and sustained field-level interventions.

### **Precision Soil Health Management: The Practical Starting Point**

For most small farmers, soil and water management is the easiest and most beneficial entry point into precision farming. The following practices are simple, affordable, and field-tested:

1. Regular soil testing using Soil Health Cards.
2. Balanced, need-based fertilizer application based on soil test results.
3. Use of bio-fertilizers, organic manures, and neem cake for soil enrichment.
4. Moisture conservation through mulching and improved drainage.

These steps help revive soil fertility, improve input-use efficiency, and gradually prepare farmers for advanced precision techniques.

### **Affordable Precision Tools and Technologies for Indian Farms**

Several practical, low-cost tools suitable for smallholders include:

1. Portable soil testing kits.
2. Soil moisture meters.
3. Mobile-based agri-advisory apps in local languages.
4. Handheld GPS units for farm boundary mapping.
5. Drones and laser levellers available through Custom Hiring Centres (CHCs).

By starting with these simple tools, farmers can slowly integrate advanced precision practices without heavy investments.

## Available Government Schemes Supporting Precision Agriculture

Many government programs currently support precision farming components:

1. **Mission for Integrated Development of Horticulture (MIDH)** for protected farming and micro-irrigation.
2. **Sub-Mission on Agricultural Mechanization (SMAM)** for equipment subsidies.
3. **Soil Health Card Scheme** for precision nutrient management.
4. **Paramparagat Krishi Vikas Yojana (PKVY)** for organic farming and precision input use.
5. **Rashtriya Krishi Vikas Yojana (RKVY)** for innovative precision projects.
6. **Pradhan Mantri Krishi Sinchai Yojana (PMKSY)** for efficient irrigation systems.

Farmers can apply for these through their local KVKs, District Agriculture Offices, or Panchayat portals.

## Practical, Farmer-Centric Strategies for Precision Farming Adoption

For broader adoption of precision farming in India, the following grassroots strategies are essential:

1. Encourage **cluster-based adoption** through Farmer Producer Organizations (FPOs).

2. Establish **Custom Hiring Centres (CHCs)** for shared use of expensive tools.

3. Promote **mobile-based, localized advisory services**.

4. Conduct **field demonstrations and exposure visits** by KVKs.

5. Foster **public-private partnerships** for affordable, tailored precision tools.

6. Focus first on **soil health and water management practices**, before advancing to high-end tools.

## Role of Agri-Tech Startups and Cooperative Models

India's growing agri-tech startup ecosystem plays a crucial role in customizing precision solutions for Indian fields. Many startups now offer services like drone surveillance, remote soil mapping, and decision-support mobile apps at affordable rates. Farmer cooperatives and FPOs can collaborate with such startups to jointly access advanced technologies and reduce per-head costs.

## Climate Resilience and Environmental Benefits of Precision Agriculture

Precision agriculture helps farms become more climate-resilient by minimizing resource waste, optimizing soil moisture use, reducing chemical pesticide reliance, and improving biodiversity. It aids in producing high-quality, eco-friendly food while

protecting long-term soil and water health — essential for future generations of Indian farmers.

### **Need for Capacity Building and Farmer Training Programs**

No technology can succeed without human capacity to use it effectively. Regular training programs, field demonstrations, awareness campaigns, and mobile-based advisory services are critical for farmers to adopt and benefit from precision agriculture. These programs should be designed in local languages, with simple, step-by-step instruction modules.

Krishi Vigyan Kendras (KVKs), agricultural universities, and state departments must invest in regular capacity-building initiatives to ensure technology reaches and benefits grassroots farmers.

### **Conclusion and Way Forward**

Precision agriculture offers a practical, field-proven pathway to improve farm productivity, soil health, and farmer incomes in India. While challenges remain, a phased, localized, and farmer-friendly approach can gradually integrate smart farming practices into smallholder systems.

By focusing first on precision soil and water management, promoting affordable tools, strengthening agri-startup collaborations, and ensuring strong government policy support, India can transform its traditional

farming sector into a climate-smart, resource-efficient, and profitable enterprise.

