SUPREME AUDIT INSTITUTION OF INDIA
लोकहितार्थ सत्यनिष्ठा
Dedicated to Truth in Public Interest

Precision Agriculture

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AGENDA

- Introduction
- Precision Agriculture & related Technology
- India’s Initiatives and Status of Precision Agriculture
- Importance of Audit
- Key Audit Questions and Probable Outcomes
- Way Forward

INTRODUCTION

- Agriculture - critical to India's economy, livelihoods, and food security
- Growing need for data-driven and sustainable practices
- Precision Agriculture: Integrates technology to optimize productivity and sustainability
- SAI India audits aligned with national missions on Agriculture

PRECISION AGRICULTURE

- Technology-enabled approach for site-specific crop management
- Integrates Remote Sensing, Internet of Things sensors, Artificial Intelligence/Machine Learning, and data analytics for decision making
- Focus: efficient input use (water, fertilizers, seeds) and yield maximization
- Strengthens resilience through data-driven decision-making
- Reduces environmental footprint and supports SDG 2 (Zero Hunger)

Technology in Precision Agriculture

- GPS/GNSS: Accurate geospatial referencing for site-specific operations.
- GIS: Integrates spatial data (soil, topography, weather, crops) for interventions.
- Remote Sensing: Satellite/drones data for crop health, vegetation indices etc.
- Optical/Soil Sensors: Real-time nutrient/soil moisture/plant health.
- Grid/Zone Soil Sampling: Develops fertility maps for nutrient recommendations
- Laser Land Levelling (LLL): Uniform slopes for water efficiency.
- Automated Irrigation: Drip/sprinkler with sensors/timers.
- Yield Monitors/Mapping: Records spatial yield variations for planning.

India's Initiatives in Precision Agriculture

- National Mission on Sustainable Agriculture (NMSA) – promotes technology adoption
- Digital Agriculture Mission 2021–25 – data-driven decision support system
- PM Gati Shakti & AgriStack – integrated Geographic Information System-based agricultural data layers
- Collaboration with space and agriculture research organisations for satellite-based crop monitoring
- Primary focus on improving Nutrient-Use Efficiency (NUE) and Water-Use Efficiency (WUE) through technology adoption

Precision Agriculture in India

- National Mission on Micro Irrigation (NMMI) and the “Per Drop More Crop” component under the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)
- 95.58 Lakh Hectare area covered from 2016 to 2025
- Bringing Green Revolution to Eastern India (BGREI) Programme under the Rashtriya Krishi Vikas Yojana (RKVY)
- Establishment of 22 Precision Farming Development Centres (PFDCs) for high-value horticultural crops
- ICAR–National Rice Research Institute (NRRI) developed a Customised Leaf Colour Chart (CLCC) for nitrogen management in rice.

4E Approach to audit of Precision Agriculture

- **Economy** – Cost-efficiency in technology procurement.
- **Efficiency** – Optimal utilisation of tools (e.g., micro-irrigation, sensors).
- **Effectiveness** – Measurable improvements in yield, Water use efficiency, Nutrient use efficiency, energy use.
- **Equity** – Benefits reaching smallholders and women farmers.

Importance of Audit of Precision Agriculture

- Ensuring technology procurement and implementation adhere to transparency, competitiveness, and value for money.
- Verifying the functionality, utilisation, and sustainability of installed systems through field verification and data analytics.
- Assessing effectiveness of policy design and targeting, adequacy of monitoring and impact evaluation mechanisms.
- Evaluating inclusiveness and accessibility for equitable dissemination.

Institutions & Data Sources in India

- National Remote Sensing Centre (NRSC), Indian Space Research Organisation (ISRO) – Central node for satellite data acquisition and dissemination.
- Bhuvan Geoportal – Provides thematic agricultural layers accessible to government and researchers.
- State Remote Sensing Centres (e.g., PRSC, HARSAC) – Regional monitoring and data services.
- Bhaskaracharya National Institute for Space Applications and Geo-informatics – Partnering with SAI India to integrate geospatial tools and AI into audits.
- Mahalanobis National Crop Forecast Centre (MNCFC) – Uses remote sensing for crop yield estimation and early warnings.

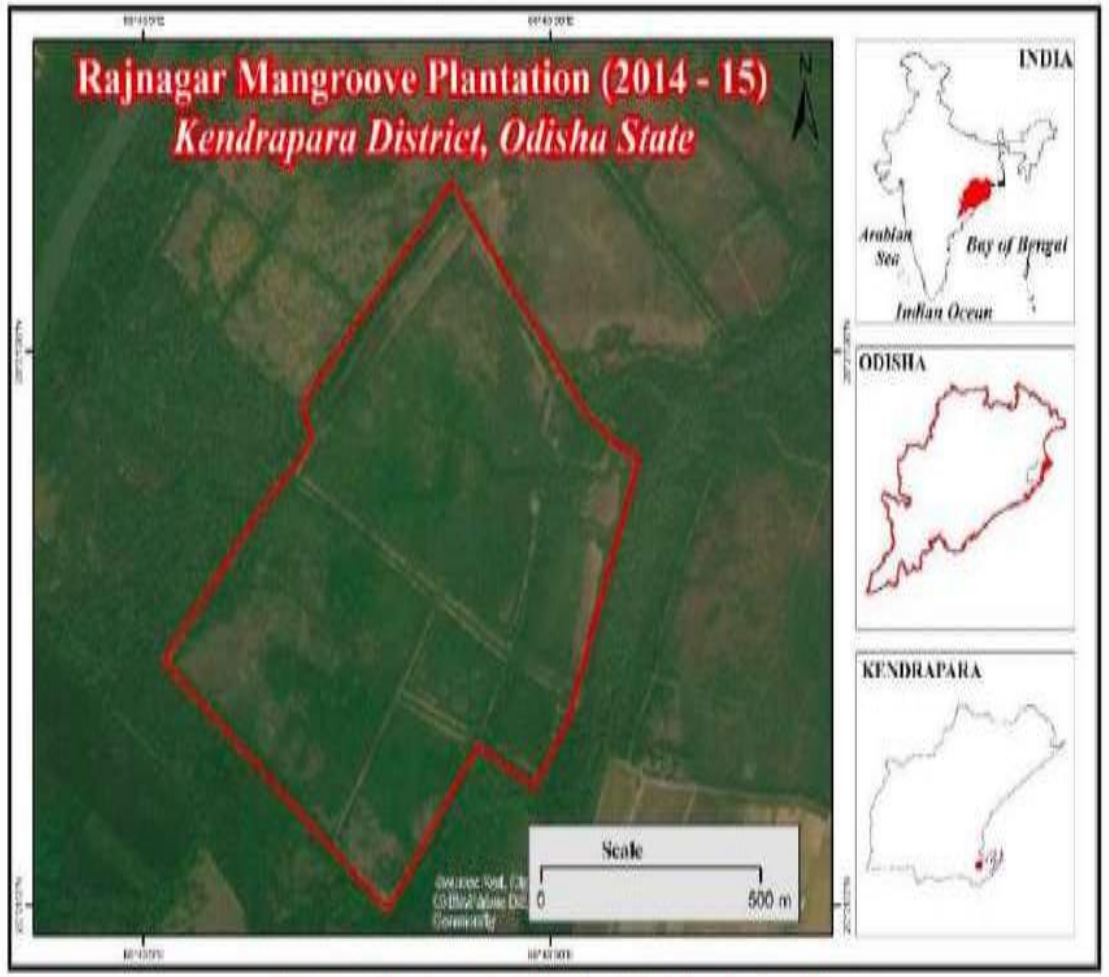
Case Example – Afforestation & Plantation Activities

- **Enhanced monitoring** of afforestation programs for transparency & effectiveness.
- **Key Findings:**
  - **Plantation Verification:** Identified ghost plantations where trees existed only on paper.
  - **Survival Rate Analysis:** Tracked tree growth and mortality, revealing gaps in care and environmental challenges.
  - **Infrastructure Audit:** Evaluated sustainability measures like water trenches & irrigation facilities to support plantations.
  - **Impact Assessment:** Assessed afforestation efforts in combating deforestation, improving biodiversity & mitigating climate change.

(CAG Report: Odisha 2022)

Survival of Plantations

Photograph No.19



Mangrove plantation at Santubi under Mahakalapada Forest Range

The evaluation of the site was done using UAV as detailed in Table 2.17.

Table 2.17: Results of evaluation of mangrove plantation by UAV

Forest Division	Range/ plantation site	Scheme/ year of plantation/ area in ha	Type of trees	Tree as per Plantation journal	Trees as per UAV	Plantation expenditure (in ₹)	Survival percentage
Rajnagar	Mahakalpada/ Santubi	ICZMP/ 2014-15/ 65	*Sindhuca* and *Rai*	2,88,925	1,05,333	23,98,500	36.46
Total				**2,88,925**	**1,05,333**	**23,98,500**	**36.46**

The survival percentage of the plantation was 36.46 at Santubi, which should be treated as a failed plantation.

Key Audit Questions on Precision Agriculture

- **Targeting & Planning:**
  Were scheme objectives aligned with agro-climatic needs, and was beneficiary selection transparent and inclusive of small/marginal farmers?
- **Procurement & Economy:**
  Were procurements competitive, transparent, and free from vendor concentration or unjustified cost variations?
- **Implementation & Utilisation:**
  Are precision systems (micro-irrigation, sensors, levellers) installed, functional, and actively used by farmers?
- **Effectiveness & Outcomes:**
  Have interventions improved key indicators — yield, WUE, NUE, profitability, and GHG reduction — based on credible baselines?
- **Monitoring & Inclusiveness:**
  Is data reliable, geo-tagged, and updated? Are training, capacity-building, and benefits inclusive of women and smallholders?

Probable Audit Outcomes & Policy Insights

Key Outcomes

- Identify inefficiencies, procurement gaps, and under-utilized assets.
- Assess if expenditure translated into measurable improvements in yield, WUE & NUE.

Recommendations

- Strengthen monitoring through integrated data systems & third-party evaluations.
- Link subsidies to verified performance.
- Encourage open, interoperable technologies and inclusive training modules.

Policy Inputs

- Align agricultural technology investments with climate resilience & sustainability goals.
- Promote service-based local ecosystems and performance-linked support.
- Build a “measurement culture” through geo-tagging, digital logs, and data transparency.

WAY FORWARD

- Build auditor capacity in data analytics, GIS & remote sensing.
- Strengthen collaboration with research and agri-tech institutions.
- Focus on inclusiveness — smallholders & women farmers.
- Link subsidies and outcomes to verified performance metrics
- Promote open, interoperable, and sustainable technology adoption.

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THANK YOU