

Space Technology in Agricultural Resources Development in India

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Agriculture is the main stay of our country which contribute about 54 percent of GDP directly or indirectly. It is our culture more than profession without farming nothing can be perishable. In recent years our government has taken several steps to improves the livelihood of farmers like DBT (Direct Benefit Transfer), RKVY (Rashtriya Kishan Vikash Yojana) , Pradhan Mantri Fasal Bima Yojana (PMFBY), Digital Mission etc. Due to launching of several satellite's for soil and water resource management by ISRO things goes easy and running in positive directions since 19 April 1975 Aryabhata then the latest satellite of ISRO is EOS-08 launched on 16 August 2024 . It was an Earth Observation satellite. Space technology has been instrumental in advancing rural development in India by addressing key challenges in agriculture, natural resource management, disaster management, and rural infrastructure. Here's a comprehensive overview:

Agriculture and Crop Monitoring: Space technology plays a transformative role in agriculture and crop monitoring by providing accurate, timely, and large-scale data that empowers farmers, policymakers, and researchers. Here's an in-depth overview:

Crop Monitoring and Health Assessment: Satellite Imagery: Satellites like Carto- sat, Resource -sat, and Sentinel provide high-resolution images to assess crop conditions. **Vegetation Indices:** Tools like the Normalized Difference Vegetation Index (NDVI) help monitor crop health, stress levels, and growth stages. **Pest and Disease Surveillance:** Space-based data detects early signs of pest infestations and diseases, enabling timely intervention.

Precision Farming: Field-Level Insights: Remote sensing aids in precision farming by mapping soil fertility, crop nutrient needs, and water requirements. **Site-Specific Management:** Data enables variable-rate applications of fertilizers, pesticides, and water, reducing costs and environmental impact. **Yield Estimation:** Satellite data helps predict yields, assisting farmers in market planning and ensuring food security.

Soil Health and Land Management: Soil Moisture Monitoring: Satellites like SMAP (Soil Moisture Active Passive) track moisture levels, crucial for irrigation planning. **Soil Mapping:** Remote sensing identifies soil types, salinity, erosion risks, and nutrient deficiencies. **Land Use Classification:** Space technology helps determine suitable land for various crops based on soil and climatic conditions.

Irrigation and Water Resource Management; Irrigation Scheduling: Satellites provide data on evapotranspiration rates, guiding efficient irrigation practices. **Water Body Mapping:** Identification of reservoirs, rivers, and potential groundwater zones supports irrigation projects. **Drought Monitoring:** Remote sensing detects early drought conditions, facilitating proactive measures.

Weather Forecasting and Risk Management: Agro-Meteorological Services: Satellites like INSAT provide weather forecasts, helping farmers plan activities like sowing, irrigation, and harvesting. **Extreme Weather Alerts:** Real-time satellite data predicts storms, hail, and other adverse weather, reducing crop losses. **Climate Resilience:** Long-term climate data helps develop resilient cropping patterns and stress-tolerant crop varieties.

Disaster Management: Flood Mapping: Satellites like RISAT detect flood-prone areas, minimizing crop losses. **Cyclone Monitoring:** Satellite data predicts cyclones, enabling farmers to safeguard crops and equipment. **Post-Disaster Assessment:** Space technology helps evaluate agricultural losses and guides relief measures.

Crop Forecasting and Policy Support: Food Security: Accurate yield predictions guide national food storage and distribution policies. **Market Insights:** Data supports decision-making on crop pricing, exports, and imports. **Insurance Support:** Satellite imagery is used for crop damage assessment under schemes like the Pradhan Mantri Fasal Bima Yojana (PMFBY).

Sustainable Agricultural Practices: Green Agriculture: Space technology encourages reduced input usage and promotes organic farming by providing precise field data. **Carbon Sequestration:** Monitoring vegetation cover helps track carbon storage and implement sustainable farming techniques. **Conservation Agriculture:** Data supports conservation practices like crop rotation and cover cropping.

Natural Resource Management: Space technology is a cornerstone of modern natural resource management, enabling efficient monitoring, assessment, and sustainable utilization of Earth's resources. By leveraging satellite data and remote sensing, it provides precise, large-scale, and real-time information critical for managing land, water, forests, minerals, and biodiversity. Below is a detailed explanation of its role:

Land Resource Management: Land Use and Land Cover Mapping: Satellites like Cartosat and Resource sat provide data to classify land for agriculture, forestry, urbanization, and conservation. **Soil Erosion and Degradation:** Space technology identifies areas prone to erosion, salinity, and desertification, guiding soil conservation efforts. **Urban Planning:** Remote sensing data supports sustainable urban development by monitoring land encroachment and managing peri-urban growth.

Water Resource Management: Surface Water Monitoring: Satellites track rivers, lakes, and reservoirs, aiding in the management of water bodies for agriculture, drinking water, and hydropower. **Groundwater Mapping:** Remote sensing helps identify aquifer locations and monitor groundwater depletion levels. **Flood and Drought Management:** Real-time data from satellites like RISAT assists in predicting floods and droughts, facilitating proactive measures. **Irrigation Planning:** Evapotranspiration and soil moisture data guide efficient irrigation strategies, ensuring optimal water use.

Forest and Biodiversity Management: Forest Cover Monitoring: Satellites like Landsat and Sentinel monitor deforestation, afforestation, and changes in forest cover over time. **Wildlife Habitat Mapping:** Remote sensing identifies critical habitats, aiding in biodiversity conservation and planning wildlife corridors. **Illegal Logging Detection:** Space technology helps track and curb illegal logging and forest encroachments. **Carbon Sequestration:** Monitoring vegetation biomass helps quantify carbon sequestration, essential for climate change mitigation strategies.

Mineral and Energy Resource Exploration: Mineral Mapping: Satellites provide data on surface mineralogy and geological structures, aiding in exploration. **Renewable Energy Planning:** Space-based data identifies potential sites for solar, wind, and hydroelectric power generation. **Oil and Gas Exploration:** Remote sensing techniques are used for mapping geological formations favourable for hydrocarbon deposits.

Coastal and Marine Resource Management: Coastal Zone Monitoring: Satellites monitor shoreline changes, erosion, and sedimentation, aiding in sustainable coastal development. **Fisheries Management:** Remote sensing tracks ocean temperature and chlorophyll concentration to identify fishing zones. **Marine Pollution Monitoring:** Space technology detects oil spills, plastic pollution, and algal

blooms, ensuring marine ecosystem health.

Climate Change and Environmental Monitoring: Climate Data Collection: Satellites like Megha-Tropiques monitor atmospheric parameters such as temperature, humidity, and greenhouse gas concentrations. **Desertification Monitoring:** Remote sensing identifies regions undergoing desertification, aiding in restoration efforts. **Air and Water Quality Assessment:** Space-based sensors track pollutants in the air and water, providing data for environmental regulations.

Disaster Management and Risk Mitigation: **Natural Disaster Forecasting:** Satellites provide early warnings for floods, droughts, cyclones, and landslides. **Post-Disaster Assessment:** Remote sensing evaluates damage to natural resources, aiding in recovery and rehabilitation. **Forest Fire Monitoring:** Satellites like MODIS detect and monitor wildfires, reducing the impact on forests and biodiversity.

Agriculture and Food Security: **Crop Yield Prediction:** Satellite data supports food security by assessing agricultural productivity and identifying resource stress. **Soil and Water Conservation:** Space technology aids in designing watershed programs and soil fertility management.

Disaster Prediction and Early Warning: **Weather Monitoring:** Satellites like INSAT and Megha-Tropiques track weather patterns, enabling predictions of cyclones, storms, and heavy rainfall. **Earthquake Analysis:** GPS and InSAR (Interferometry Synthetic Aperture Radar) data monitor tectonic movements, identifying seismic hotspots. **Flood Forecasting:** Remote sensing provides information on river flow, snowmelt, and precipitation, predicting flood risks. **Landslide Prediction:** Satellite data identifies areas prone to landslides by analyzing slope stability, vegetation, and rainfall.

Real-Time Monitoring of Disasters: **Cyclones and Storms:** Satellites offer real-time data on cyclone intensity, trajectory, and land-fall points, aiding timely evacuation. **Flood Inundation Mapping:** Remote sensing identifies affected regions, guiding rescue and relief operations. **Forest Fire Detection:** Satellites like MODIS detect hotspots and smoke, enabling quick fire fighting responses. **Drought Monitoring:** Vegetation indices like NDVI track soil moisture and crop stress, providing insights into drought conditions.

Climate Change and Environmental Monitoring: **Climate Data Collection:** Satellites like Megha-Tropiques monitor atmospheric parameters such as temperature, humidity, and greenhouse gas concentrations. **Desertification Monitoring:** Remote sensing identifies regions undergoing desertification, aiding in restoration efforts. **Air and Water Quality Assessment:** Space-based sensors track pollutants in the air and water, providing data for environmental regulations.

Poverty Alleviation through Enhanced Livelihood Opportunities: **Improved Agricultural Productivity:** Remote sensing satellites like Resourcesat provide data on soil health, crop conditions, and water resources, enabling precision farming and higher yields. Early warning systems for droughts, floods, and pest outbreaks protect farmers' incomes and ensure food security. Satellite data supports programs like the Pradhan Mantri Fasal Bima Yojana (PMFBY) by improving the efficiency of crop insurance schemes. **Fisheries Development:** Satellite-based identification of Potential Fishing Zones (PFZ) improves catch efficiency, benefiting coastal communities. **Forest-Based Livelihoods:** Space technology aids in sustainable forest management, ensuring resources for tribal communities dependent on forest products.

Employment Generation: **Skill Development and Training:** Space-enabled tele-education programs provide vocational training to rural youth, enhancing their employability. Digital platforms supported by satellite connectivity promote e-learning, preparing individuals for jobs in IT, manufacturing, and service sectors. **Industrial Development:** Space technology drives growth in sectors like satellite manufacturing, data analytics, and geospatial services, creating high-skilled jobs. **Tourism Promotion:** Remote sensing identifies and promotes natural and cultural heritage sites, supporting eco-tourism and generating employment in the hospitality industry.

Indian Initiatives in Space Technology for Natural Resource Management

- **BHUVAN**: ISRO's geo-platform for resource mapping, disaster management, and monitoring of government programs like MGN-REGA.
- **NRSC (National Remote Sensing Centre)**: Provides data for environmental monitoring, resource assessment, and sustainable development.
- **FASAL (Forecasting Agricultural output using Space, Agro-meteorology, and Land-based observations)**: Helps predict crop production and assess drought impacts.
- **NADAMS (National Agricultural Drought Assessment and Monitoring System)**: Monitors drought conditions and supports mitigation planning.
- **NavIC (Navigation with Indian Constellation)**: Facilitates navigation and precision agriculture applications.
- **RISAT (Radar Imaging Satellite)**: Monitors weather and disasters like floods and cyclones.
- **DISHA (Disaster Management Support Programme)**: ISRO provides satellite data for disaster management.

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