

## Role of Satellites and Remote Sensing in Agrometeorology

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### INTRODUCTION

Agrometeorology - The science of weather and climate applications in agriculture has evolved dramatically with the advent of satellite technology and remote sensing. Traditionally dependent on ground based weather stations and field observations, agricultural weather monitoring was often limited in spatial coverage and timeliness. Today, Earth observation systems provide continuous, large-scale, and near real time data that have transformed how we understand and manage agricultural environments. In India, organizations such as the Indian Space Research Organisation (ISRO) and the India Meteorological Department (IMD) play a vital role in providing satellite-based weather and agricultural advisories. Satellites such as Landsat 8, Sentinel-2, and NOAA-20 deliver critical information on land surface temperature, soil moisture, vegetation health, rainfall patterns, and evapotranspiration. These observations enable scientists and farmers to monitor crop conditions, assess drought severity, forecast yields, and manage water resources more efficiently. Unlike conventional methods, satellite based remote sensing offers synoptic coverage over vast and inaccessible regions, ensuring consistent and objective data collection. Remote sensing integrates data from optical, thermal, and microwave sensors to derive key agrometeorological parameters. Vegetation indices such as the Normalized Difference Vegetation Index (NDVI), surface energy balance measurements, and precipitation estimates from satellite platforms support early warning systems for droughts, floods, and pest outbreaks. By linking atmospheric processes with crop growth models, satellite observations strengthen climate risk management and decision-making in agriculture. In an era of increasing climate variability and food security challenges, the role of satellite remote sensing in agrometeorology is more critical than ever. It not only enhances scientific understanding of crop weather interactions but also supports sustainable agricultural planning, precision farming, and policy formulation at regional and global scales.

## **Key Roles of Satellites and Remote Sensing in Agrometeorology**

### **1. Weather Monitoring and Forecasting -**

Satellites continuously monitor cloud formation, rainfall systems, cyclones, and temperature patterns, air pressure, wind speed. Indian meteorological satellites like INSAT-3D provide these real time weather data and this data along with computer models was used to predict future weather conditions that in form of short range and medium range weather forecasts. This information helps farmers to plan sowing and harvesting operations, Avoid losses from heavy rainfall or frost, prepare for extreme events like heat waves or cyclones

### **2. Drought Monitoring and Early Warning –**

Satellite based rainfall estimates, soil moisture observations, land surface temperature and water bodies images help in early detection of drought conditions before visible symptoms appear in crops. Early warning systems analyze satellite data and issue alerts. This helps government and farmers to take timely actions such as water conservation, crop planning and relief preparations. By analyzing vegetation stress patterns, agrometeorologists can identify affected regions and advise farmers on contingency crop planning. Remote sensing also helps detect drought conditions by analyzing vegetation indices such as NDVI (Normalized Difference Vegetation Index). Programs such as the National Agricultural Drought Assessment and Monitoring System (NADAMS) use satellite imagery to assess drought severity and guide relief planning.

### **3. Crop Acreage and Yield Estimation -**

Satellite imagery enables estimation of area under different crops, crop growth stages, biomass production, yield forecasting. Different crops are identified based on their spectral signatures. The Mahalanobis National Crop Forecast Centre (MNCFC) uses remote sensing data along with weather parameters to provide pre-harvest crop production estimates. The Indian Space Research Organisation (ISRO) uses satellite data under programs such as FASAL (Forecasting Agricultural output using Space,

Agro-meteorology and Land-based observations) to estimate crop acreage and production. This information is crucial for food security planning and market regulation.

### **4. Crop Monitoring, Health Assessment and Pest Incidence -**

Remote sensing allows continuous observation of crop growth and health over large areas. Vegetation indices like NDVI (Normalized Difference Vegetation Index) are derived from satellite imagery to assess crop vigour, biomass, and stress conditions. Variations in leaf colour, canopy temperature, and reflectance patterns indicate crop stress caused by nutrient deficiency, pests or diseases. Thermal sensors help identify abnormal canopy temperature linked to water stress and abnormal patches in field shows early sign of infestation and monitor spread of pests and diseases. Early detection enables timely intervention, reducing pesticide use and improving sustainability and production costs.

### **5. Soil Moisture and Water Resource Assessment -**

Microwave remote sensing satellites can estimate surface soil moisture even under cloudy conditions. This information assists in irrigation scheduling, drought preparedness, watershed management. Satellite-based evapotranspiration models also help determine crop water requirements, reducing over irrigation and conserving groundwater resources.

### **6. Support to Agromet Advisory Services –**

Satellite derived weather data strengthens district level advisories under schemes like the Gramin Krishi Mausam Sewa (GKMS). These advisories guide farmers on sowing windows, fertilizer application timing, irrigation planning, pest and disease management. Timely advisories reduce climatic risks and enhance farm profitability.

### **7. Climate Change Studies and Risk Assessment -**

Long-term satellite records provide valuable insights into changing rainfall patterns, temperature trends, and frequency of extreme events. These datasets help researchers assess climate risks related to crop yield variability, soil moisture decline, water availability changes, shifts in growing seasons and helps to develop climate resilient cropping systems suited to different agro-climatic zones.

## 8. Precision Agriculture and Decision

**Support-** Integration of satellite imagery with GIS (Geographic Information Systems) enables site-specific crop management. Farmers can identify nutrient deficiencies, water stress, and yield variability within fields. This promotes precision farming, optimizing input use and increasing productivity.

### CONCLUSION

With advancements in high-resolution satellites, artificial intelligence, and GIS integration, agrometeorology is becoming more precise and farmer centric. The integration of satellite data

with mobile based advisory apps is bridging the gap between scientific forecasting and farm level decision making. In the era of climate change, satellites and remote sensing are indispensable tools for climate resilient agriculture. In the Indian context, the combined efforts of organizations like IMD and ISRO have strengthened agrometeorological advisory services, empowering farmers to mitigate climate risks and enhance sustainable agricultural production. By providing accurate weather intelligence and crop monitoring, they ensure sustainable production, risk reduction, and improved livelihoods for farmers.