



# Review of Remote Sensing Technology and It's Applications in Agriculture

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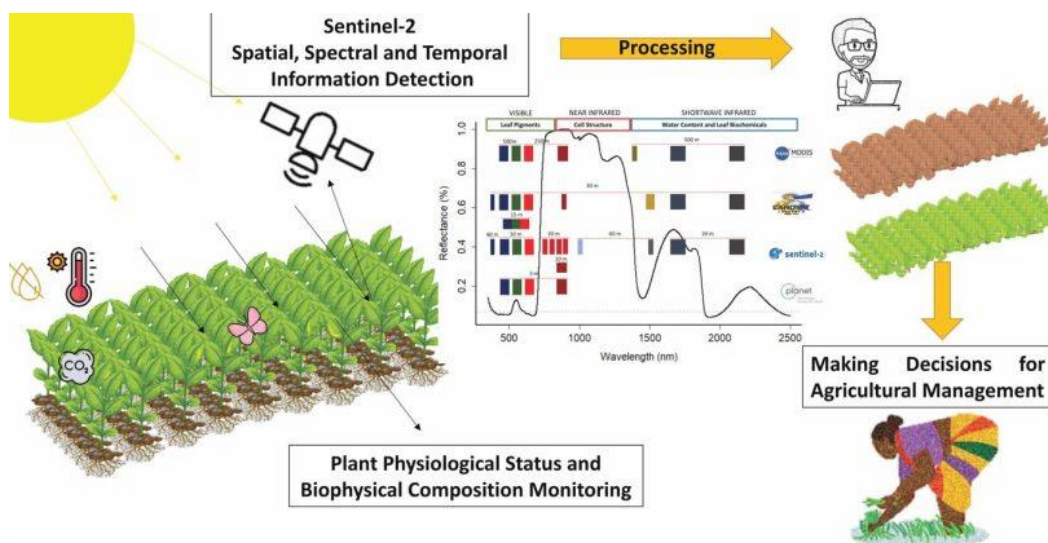
**Abstract:** Remote sensing is an advanced technology used to collect information about the Earth's surface without direct physical contact. In agriculture, it has become an essential tool for monitoring crop health, soil conditions, water resources, and land use patterns. With the integration of satellite systems, drones (UAVs), Geographic Information Systems (GIS), and machine learning, remote sensing has significantly improved precision agriculture practices. This review paper presents a comprehensive study of remote sensing technology, its types, methodologies, and wide-ranging applications in agriculture. It also discusses challenges, limitations, and future trends for sustainable agricultural development [1].

**Keywords:** Remote sensing, GIS, Drone, Agriculture.

## I. INTRODUCTION

Agriculture plays a vital role in global food security and economic development. Increasing population, climate change, and resource limitations demand efficient agricultural monitoring systems. Traditional field-based observation methods are often time-consuming, expensive, and limited in spatial coverage.

Remote sensing provides a modern solution by collecting agricultural data using satellite, aerial, and drone-based sensors. These systems capture reflected or emitted electromagnetic radiation from the Earth's surface and convert it into useful information for analysis[1][2].



Remote sensing for agriculture monitoring: Sentinel-2 features and precision agriculture

## II. CONCEPT OF REMOTE SENSING

Remote sensing is the science of obtaining information about objects or areas from a distance without physical contact. It relies on electromagnetic radiation reflected or emitted from surfaces.

Basic Principle

- Energy source (sun or artificial sensor)



- Interaction with atmosphere
- Reflection from target (soil/crop)
- Sensor detection
- Data processing and interpretation

Remote sensing is widely used in agriculture due to its ability to monitor large areas continuously and accurately[1].

### III. TYPES OF REMOTE SENSING

#### 1 Passive Remote Sensing

- Uses natural sunlight
- Records reflected energy from crops and soil
- Example: satellite imagery (Sentinel, Landsat)

#### 2 Active Remote Sensing

- Sensor emits its own signal (laser or microwave)
- Measures reflected signals
- Example: RADAR, LiDAR systems

### IV. PLATFORMS USED IN AGRICULTURAL REMOTE SENSING

#### 1. Satellite-Based Systems:

Provide large-scale, repetitive data useful for regional crop monitoring. Satellite-based systems are one of the most important components of remote sensing technology used in agriculture. These systems collect large-scale data about the Earth's surface using sensors mounted on satellites orbiting the Earth. The data obtained is used for monitoring crops, soil conditions, water resources, and land use patterns.

#### 2. Concept of Satellite-Based Remote Sensing

Satellite-based remote sensing works by capturing reflected or emitted electromagnetic radiation from the Earth's surface. The sensors on satellites detect different wavelengths of energy and convert them into digital images for analysis.

These images help in understanding:

- Crop health
- Vegetation growth
- Soil moisture levels
- Weather conditions
- Land use changes

#### 3. UAV (Drone) Systems

Provide high-resolution images for field-level analysis: UAV-based remote sensing involves the use of drones equipped with cameras and sensors to capture images and data of agricultural fields from low altitudes. These systems collect detailed spatial and temporal information about crops, soil, and irrigation conditions.

Drones can fly over specific fields and capture data on demand, making them highly flexible compared to satellite systems.

#### 4. Ground Sensors in Remote Sensing for Agriculture

Used for calibration and validation of satellite data. Ground sensors are an important part of modern agricultural monitoring systems. Unlike satellite and UAV-based remote sensing, ground sensors collect data directly from the field by being placed in or near the soil. They provide highly accurate, real-time, and localized information about soil and crop conditions.

##### 4. 1. Concept of Ground Sensors

Ground sensors are electronic devices installed in agricultural fields to continuously measure environmental and soil parameters such as moisture, temperature, humidity, salinity, and nutrient levels.

These sensors play a key role in precision agriculture by providing real-time data that helps farmers make informed decisions about irrigation, fertilization, and crop management.[3]



## 5. Key Vegetation Indices Used

Vegetation indices are mathematical combinations of spectral bands used to assess crop health.

Normalized Difference Vegetation Index (NDVI)

$NDVI = (NIR - Red) / (NIR + Red)$

NDVI is widely used to:

- Measure plant health
- Detect crop stress
- Estimate biomass[1][2]

## 6. Applications of Remote Sensing in Agriculture

- **Crop Monitoring** : Remote sensing helps track crop growth stages, detect stress, and monitor crop conditions throughout the season. Satellite images enable continuous observation of agricultural fields.
- **Crop Health Assessment**: Spectral data helps identify nutrient deficiencies, pest attacks, and diseases early. Healthy crops reflect more near-infrared light, while stressed crops show lower reflectance.
- **Soil Moisture Estimation**: Remote sensing techniques estimate soil moisture content, which is crucial for irrigation planning and water management.
- **Drought Monitoring**: Satellite data is used to detect drought conditions by analyzing vegetation stress and rainfall variability.
- **Yield Prediction**: Machine learning models combined with remote sensing data help predict crop yield before harvest, improving food supply planning.
- **Precision Agriculture**: Remote sensing supports site-specific farming by providing detailed spatial variability in fields, enabling targeted fertilizer and irrigation applications.
- **Land Use and Land Cover Mapping**: It helps classify agricultural land, forest, and urban areas, supporting agricultural planning and policy-making.
- **Pest and Disease Detection**: Early detection of pest infestation and disease outbreaks helps reduce crop losses through timely intervention [2].

## 7. Data Analysis Techniques in Remote Sensing

Image classification (supervised and unsupervised)

- Machine learning algorithms
- Deep learning models
- GIS spatial analysis
- Time-series analysis

Recent studies show that deep learning improves classification accuracy in agricultural monitoring compared to traditional methods.

## 8. Advantages of Remote Sensing in Agriculture

- Covers large agricultural areas efficiently
- Reduces field survey costs
- Provides real-time monitoring
- Helps in early warning of crop stress
- Improves irrigation and fertilizer management
- Supports sustainable agriculture practices

**9. Limitations and Challenges:** Despite its advantages, remote sensing faces some limitations:

- Cloud cover affects satellite image quality
- High cost of advanced sensors and UAVs
- Need for technical expertise
- Data processing complexity
- Limited accuracy in heterogeneous crop fields

## 10. Future Scope

The future of remote sensing in agriculture is promising with advancements in:

- Artificial Intelligence and Machine Learning integration
- High-resolution satellite systems
- IoT-based smart farming systems



- Real-time cloud computing platforms
- Automated crop monitoring systems
- Integration with mobile applications for farmers

These developments will further enhance precision agriculture and sustainable food production systems.

## **V. CONCLUSION**

Remote sensing has become a powerful tool in modern agriculture. It enables efficient monitoring of crops, soil, and water resources while supporting decision-making in farming practices. The integration of satellite technology, drones, GIS, and artificial intelligence is transforming traditional agriculture into precision agriculture. In the future, remote sensing will play a critical role in achieving sustainable agricultural productivity and global food security.

## **REFERENCES**

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