



## Remote sensing application in precision agriculture: A review

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### Abstract

Precision Agriculture or Precision Farming is a concept of using the new technologies and collected field information doing the right thing, in the right place, at right time. It is a production system that promotes variable management practices within a field, according to site conditions. This system is based on new tools and sources of information provided by modern technologies. These include the global positioning system (GPS), geographic information systems (GIS), yield monitoring devices, soil, plant and pest sensors, remote sensing (RS), and variable rate technologies for applicators of inputs (Santosh *et al.* 2003). RS techniques play an important role in assessing crop condition and yield forecasting, acreage estimates of specific crops, detection of crop pests and diseases, disaster location and mapping, wild life management, water supply information and management, weather forecasting, range land management, and livestock surveys (Patil and Chetan 2017). Remote sensing technologies can provide an automatic and objective alternative to visual disease assessment of plant diseases (Mahlein *et al.* 2012). Production losses have been recorded in agricultural industries worldwide due to various diseases in plants, According to a study by (Huang *et al.* 2012). The Normalized Difference Vegetation Index (NDVI) is the most popular vegetation index that is extensively used to find the content of green in PA applications. It uses Red (R) and Near Infrared (NIR) channels to compute the NDVI index. More NIR light is absorbed by healthy vegetation; however, absorption ratio is very small for red light (Shafi *et al.* 2019). It is concluded that remote sensing can provide accurate information to guide agronomic and economic decision making. Precision agriculture is mainly drawn from developed countries, but in India there is still lack of adoption of the technology because of lack of knowledge and awareness among the farmers.

**Keywords:** Precision, Agriculture, application, farmers

### Introduction

With increasing population of the world nearly about six billion mark and expected to increase by another three billion over the next five decades, the world's food scenario is changing fast. Being the arable land resource very limited, the pressure on presently productive land is greater than ever before. In 2000, per capita arable land was projected 0.23 ha which reduced to about 0.15 ha by 2050 (Lal, 1991)<sup>[10]</sup>. The global demand for food is projected to increase by 1.5–2 times (Daily *et al.*, 1998)<sup>[3]</sup> due to the combined effects of a larger population and richer diet for those ascending the economic ladder. Therefore, to feed the increasing population there is an urgent need to introduce some modern technologies to improve crop yield, provide information to enable better in-field management decisions, reduce chemical and fertilizer costs through more efficient application, permit more accurate farm records, increase profit margin and reduce pollution. In this regard remote sensing may be a better option. Agriculture sector is most affected by the onset of drought as it is highly reliable on the weather, climate, soil moisture etc. Agricultural drought is nothing but the decline in the productivity of crops due to irregularities in rainfall, increase in the temperature rate etc., which causes a decrease in the soil moisture. The role of remote sensing and GIS in agricultural drought detection, assessment and management is becoming crucial these days as they provide up to date information in different range of spatial and temporal scales which is hectic and time

consuming when done by traditional methods such as Field Survey, and sampling questionnaires, Thenkabail *et al.* (2004)<sup>[17]</sup>, Arshad *et al.* (2008)<sup>[2]</sup>, Hasan and Saiful, (2011)<sup>[5]</sup>, Brian *et al.* (2012).

### Blueprint of Precision Agriculture

- 1. Soil sampling:** The grid soil sampling uses the same principles of soil sampling but increases the intensity of sampling compared to the traditional sampling. Soil samples collected in a systematic grid also have location information that allows the data to be mapped.
- 2. Site-specific crop management:** An information and technology based agricultural management system to identify, analyze and manage site soil spatial and temporal variability within fields for optimum profitability, sustainability, and protection of the environment.
- 3. Proximal soil sensing:** Proximal sensing systems rely on gathering signals from transducers placed in contact, or less than 2 m away, from the target. Knowing and understanding the heterogeneity of soil properties helps farmers and other land managers optimize their decision-making process to develop profitable, sustainable, and environmentally friendly operation. Can be viewed as a stand-alone or integrated with a traditional field machine (e.g., planter, sprayer, or combine) measurement system providing readouts of soil properties of interest when moving across the field.

**4. Satellite remote sensing:** Remote sensing provides spatial coverage by measurement of reflected and emitted electromagnetic radiation, across a wide range of wavebands, from the earth's surface and surrounding atmosphere. The improvement in technical tools of meteorological observation, during the last twenty years, has created a favorable substratum for research and monitoring in many applications of sciences of great economic relevance, such as agriculture and forest.

**Need of precision agriculture**

- **For assessing and managing field variability**  
Our fields have variable yields across the landscape because of variations to management practices, soil properties and/or environmental characteristics. One's mental information database about how to treat different areas in a field requires years of observation and implementation through trial-and-error.
- **For doing the right thing in the right place at the right time:** After assessing the variability precision agriculture allows management decisions to be made and implemented in right time in right places on small areas within larger fields.
- **For higher productivity:** Proposes to prescribe tailor made management practices, it will definitely increase the yield per unit of land.
- **For increasing the effectiveness of inputs:** Increased productivity per unit of input used indicates increased efficiency of the inputs. The analyze the low input and high output
- **For maximum use of minimum land unit:** After knowing the land status, a farmer tries to improve each and every part of land and uses it for the production purpose.

**Components of Precision Agriculture**

1. **Geographic information systems (GIS):** This system comprises hardware, software and procedures designed to support the compilation, storage, retrieval and analysis of feature attributes and location data to produce maps. Computerized GIS maps are different from conventional maps and contain various layers of information (e.g. yield, soil survey maps, rainfall, crops, soil nutrient levels and pests). GIS is a kind of computerized map, but its real role is using statistics and spatial methods to analyze characters and geography. A farming GIS database can provide information on filed topography, soil types, surface drainage, subsurface drainage, soil testing, irrigation, chemical application rates and crop yield.
2. **Global Positioning System (GPS):** Global Positioning System is a network of satellite that continuously transmits coded information. It measure latitude, longitude and elevation anywhere of the earth. Having precise location information at any time allows soil and crop measurements to be mapped. GPS receivers, either carried to the field or mounted on implements allow users to return to specific locations to sample or treat those areas. Uncorrected GPS signals have an accuracy of about 300 feet. ss
3. **Variable Rate Technology (VRT):** The instrumentation used for regulating application rates of

4. fertilizer, lime, pesticides and seed as an applicator travels across a field, based on a decision support system and management plan.



**Fig 1:** Variable rate technology

The way in which the materials are applied is based on data that is collected by sensors, maps, and GPS. These materials include things like fertilizers, chemicals, and seeds, and they all help optimize one's crop production.

1. **Yield Monitoring (YM):** Yield monitoring is an aspect of precision agriculture that helps to provide farmers with adequate information to make educated decisions about their fields. Yield monitors are a rather recent development and allow farm equipment such as combine harvesters or tractors to gather a huge amount of information, including grain yield, moisture levels, soil properties, and much more. Due to the fact that yield monitors provide farmers with so much information, they are much more able to assess things such as when to harvest, fertilize or sow seeds, the effects of weather, and much more. Yield monitors work in three very simple steps: the grain is harvested and fed into the grain elevator which has sensors that read moisture content of the grain.
2. **Remote Sensing (RS):** Remote sensing is the art and science of gathering information about the objects or area of the real world at a distance without coming into direct physical contact with the object under study. The principle behind remote sensing is the use of electromagnetic spectrum (visible, infrared and microwaves) for assessing the earth's features.

**Component of remote sensing:**

1. **Energy source**
  - Natural e.g. Sunlight
  - Artificial e.g. Laser, RADAR
2. **Sensor:** Device to detect EMR E.g. Camera, Scanner
3. **Platform:** Vehicle to carry sensors E.g. Aircraft, Satellite
4. **Sensing:** Sensor should be able to detect EMR
5. **Processing:** Handling signal data and preparing products E.g. Photographic product FCC, Digital camera
6. **Institutionizations:** Organization to execute at all stage of remote sensing technology E.g. International and National organization ISRO, NRSC
7. **Photographic Products: E.g.**
  - Fabe colour composite (FCC)
  - True colour composite (TCC)

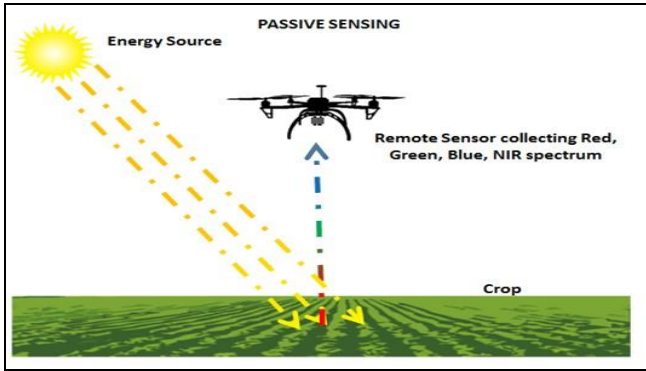


Fig 2: Passive remote sensing

**Type of Remote Sensing**

**1. Passive remote sensing**

- Uses of sun energy as the source of illumination
- Fine resolution
- Day time information
- Weather dependent

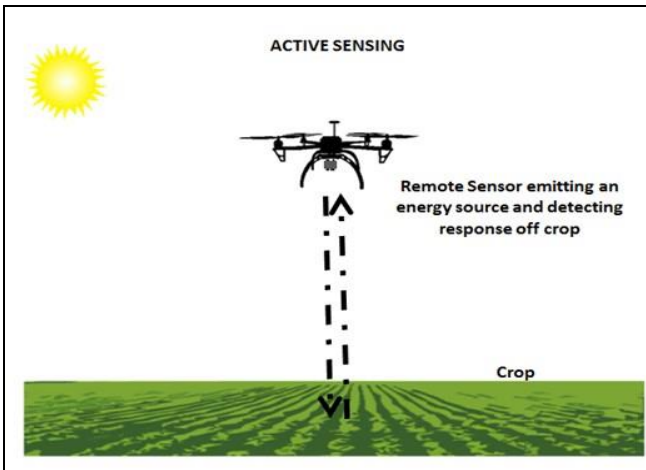


Fig 3: Active remote sensing

**2. Active remote sensing**

- Uses of artificial energy as the source of illumination  
E.g. Synthetic aperture radar (SAR)
- More costly
- Day and night time information
- Weather independent

**Principle of remote sensing**

Detection and discrimination of objects or surface features means detecting and recording of radiant energy reflected or emitted by objects or surface material. Different objects return different amount of energy in different bands of the electromagnetic spectrum, incident upon it. This depends on the property of material (structural, chemical, and physical), surface roughness, angle of incidence, intensity, and wavelength of radiant energy.

**Process of remote sensing**

1. Energy source
2. Interaction with atmosphere and earth's surface

**Three type of interaction takes place viz**

- Absorption
- Transmission
- Reflection

1. Recording of energy by sensor
2. Transmission, Reception and Processing
3. Interpretation and analysis
4. Application

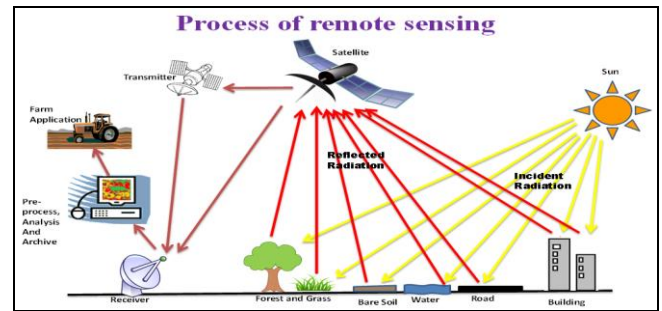


Fig 4: Process of remote sensing

**Electromagnetic Spectrum**

The wavelengths used in most agricultural remote sensing applications cover only a small region of the electromagnetic spectrum. The infrared region nearest to that of the visible region is the near infrared (NIR) region. Both the visible and infrared regions are used in agricultural remote sensing.

**Interaction of EMR with Atmosphere**

Particles and gases in the atmosphere can affect the incoming light and radiation. These effects are caused by the mechanisms of scattering and absorption. Ozone, carbon dioxide, and water vapor are the three main atmospheric constituents which absorb radiation. Those areas of the spectrum which are not severely influenced by atmospheric absorption and thus are useful to remote sensors are called atmospheric windows (in green).

**Interaction of EMR with earth surface**

- Reflection
- Transmission
- Absorption

**Spectral signature**

Spectral Signature  $\rho(\lambda)$  is ratio of reflected energy to incident energy as a function of wavelength. The relationship between reflected, absorbed and transmitted energy is used to determine the spectral signature of plants. Spectral signature is a term used for unique spectral response. It is unique for plant species.

**Resolution**

Ability of an entire remote sensing system including lance antennae camera etc to provide a sharply defined image

**Type of Resolution:** there are four type of remote sensing

1. **Spatial Resolution:** Minimum distance between two objects that a sensor can distinctly depends on instantaneous field of view (IFOV) is the angular cone of visibility of sensor which determined that area on the earth surface seen from a given altitude at one. E.g. 10 x10 m.
2. **Radiometric Resolution:** Describe the ability of sensor to measure signal strength or brightness called contrast.
3. **Temporal Resolution:** Period of time taken to acquire the image of the same object at same location.

- 4. Spectral Resolution:** Describe the ability of sensor to define fine wavelength intervals

#### **Indian Remote Sensing Satellites**

ISRO has launched 32 Indian remote sensing satellites starting with IRS- 1A in March 1988.

- IRS-1B in August 1991
- Cartosat-1 in May 2005
- Cartosat-2 in June 2007
- Indian Mini satellite (IMS-1) in April 2008
- RESOURCESAT-1 (IRS-P6) is the tenth satellite in IRS series
- SARAL in Feb 2013
- RISAT-2B May in 2019
- Cartography satellite Cartosat-3 in Nov 2019

#### **Advantages of remote sensing**

- Nondestructive method to collect information about earth features
- Data may be obtained systematically over very large geographical areas rather than just single point observations
- Inaccessible areas such as oceans and deep valleys can be easily mapped using remote sensing.
- Remote sensing data recording is completely unbiased
- Remote sensing is not weather dependent unlike traditional surveying and can be performed in all weather conditions
- Provide geo-referenced digital data
- Synoptic view is obtained in remote sensing
- Systematic (raster) data collection in RS can remove sampling bias
- Provide fundamental biophysical information that can be used in other sciences

#### **Disadvantage of remote sensing**

- Remote sensing is expensive and not cost-effective for collecting details for a small area.
- Data collection for unit area, specialist training, equipment and maintenance becomes costly for a small area compared with larger areas.
- Requires specialist/skilled persons for analyzing and interpreting remote sensing data.
- It is difficult or sometimes not possible to prepare maps at higher scale from remote sensing or satellite data. However, this data is getting improved with time as technology is getting advanced.
- Some of the satellite imagery is costly.
- Repetitive coverage is required for studying dynamic features.
- Remote sensing satellites are difficult to control and maintain if any problem arises once after the launch.
- Improper selection of bands, lack of experience may result in unwanted errors or mistakes in the information.
- Though remote sensing is widely used in many fields and applications, it is not an universal solution and in many areas it cannot be used.
- Depending on spatial resolution data storage may become big problem.
- Poor temporal resolution and spatial resolution may

cause problems often in certain analysis.

#### **Application of RS in Precision Agriculture**

- Remote sensing has played a vital role in the field of agriculture
- Remote sensing in association with GIS and GPS has found a number of myriad application in field of agriculture
- Satellite and airborne images are used as mapping tools to classify crops, examine their health and viability, and monitor farming practices

#### **1. Soil mapping, climate and land characteristics**

- preparing soil maps in various themes.  
Used in soil survey
- A database on soil, climatic, environmental as well as present land use can be prepared which can act as a decision support system in formulating new and effective land use plan

#### **2. Crop nutrient deficiency detection:**

Affects the color, moisture content, and internal structure of the leaves and as a result their reflecting power changes. Nitrogen deficiency yellows down the midvein starting at the tip and moving back towards the stem Phosphorus deficiency turns red purple along the leaf margins. Potassium deprived plant features firing and yellowing along the leaf margin

#### **3. Vegetative analysis:**

Crop models are used to analyze the condition of the crops based on provided direct remote sensing indices such as Normalized Difference Vegetation Index (NDVI).

#### **4. Crop yield estimation and production forecasting:**

The information about crop yield before the harvest is very vital to the national food policy planning and economy of the country. Reliable crop yield estimate is one of the most important components of crop production forecasting

#### **5. Crop yield forecasting in India:**

In India, Crop acreage and production estimation project was formulated under the Remote Sensing Application Mission 1986. CAPE project provide district level crop production forecast for all major crops (wheat, rice, maize etc.)

#### **Forecasting Agricultural output using Space, Agro meteorology and Land based observations (FASAL)**

- The programme is sponsored by Ministry of agriculture.
- Launched in August 2006.
- The main aim was to collect monsoon data through remote sensing.
- Provides information related to crop condition and crop production any time of the season.

#### **6. Satellite-based Agro-advisory Service:**

Data sets available from a variety of satellites have opened up tremendous possibilities of extracting a variety of information. This information are delivered or made accessible in sufficient time for the user to make professional sense and use these advisories appropriately in the management process

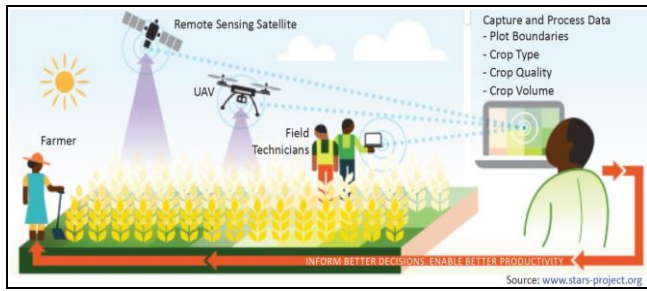


Fig 5: Satellite based Agro-advisory service

7. **Pest Management:** Integrated pest management is an important component of sustainable agriculture. Methodologies needs to be perfect for identification of locust breeding ground based on vegetation or moisture status thereby. Developing strategies or preventing their spread and effective control measures.
8. **Assessment and Monitoring Drought:** Combination of NDVI and LST provides very useful information for drought monitoring and early warning system for the farmers. The district level drought assessment and monitoring using NDVI generated from NOAA-AVHRR data helps in taking timely preventive and corrective measures for combating drought.
9. **Soil site suitability assessment:** ISRO is offering GIS and Remote Sensing services for tea garden in Assam and West Bengal. It will enable the availability of accurate and timely information required by tea garden for pest control and other activities to increase the yield. ISRO in partnering with Tea Board has launched a pilot project titled “Tea area development and management using RS and GIS” in 2010.
10. **Soil Moisture Estimation:** The sensor recording signal in wavebands of 8-14  $\mu\text{m}$ , directly measures the surface temperature. Which is a function of energy balance, evaporation and transpiration? The moisture content detected in this way refers to a very thin layer of soil.
11. **Assessment and Monitoring Flood:** Hydrodynamic model is mostly use for flood monitoring. It monitors the intensity, movement, and propagation of the precipitation system to determine how much, when, and where the heavy precipitation is going to move during the next zero to three hours (called NOWCASTING).

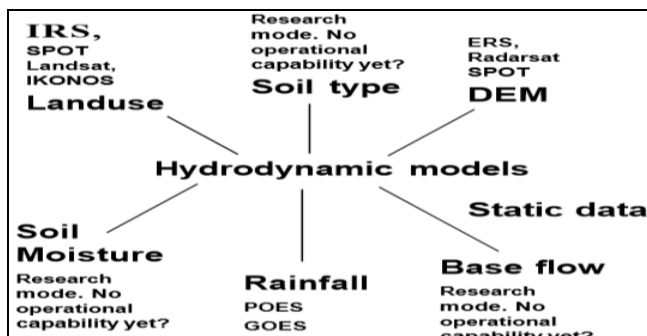


Fig 6: Remote sensing capabilities in Hydrodynamic models of flood

**Case Studies**

**Stress Monitoring**

Santhosh *et al.* in 2003 [14] studies Stress detection and monitoring field conditions. To use high-resolution imagery data collected from two positive Systems flights in 1999

using the ADAR 5500 digital aerial camera at 70 cm ground resolution in blue, green, red and near infrared spectral channels.

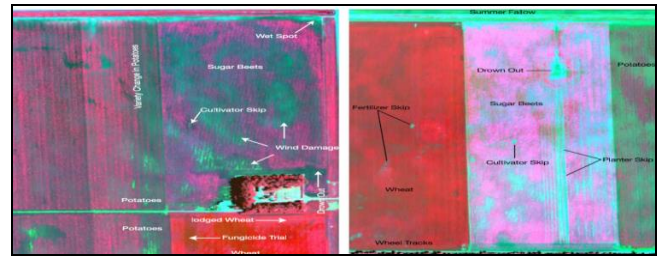


Fig 7: Stress detection and monitoring field condition (Santhosh *et al.* 2003) [14]

They were able to identify stressed areas caused by wind damage, crops damaged due to inundation, fertilizer skips, cultivator blights, planter skips, disease, and lodging. The information from high-resolution imagery was used to identify where ground investigation was needed, and to draw boundaries around problem areas. The smaller anomalies that could not be noticed on the ground could be easily identified on the imagery. For example, the planter’s skips observed in occurred as a result of the planter turning too close to the wet area (shown as drown out). This happened because the planter was plugged with mud, of which the operator was not aware. The imagery showed the extent of the problem and allowed the farmer to avoid the wet area in the subsequent year. The image showing wind damage reinforced the importance of planting cover crop to alleviate sugar beet stand loss due to wind.

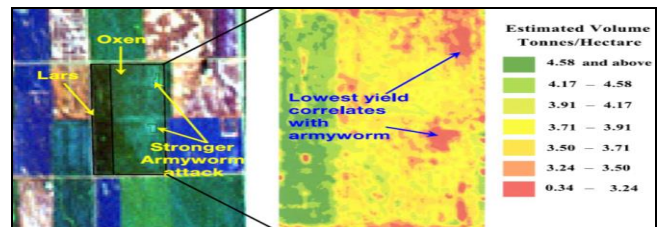
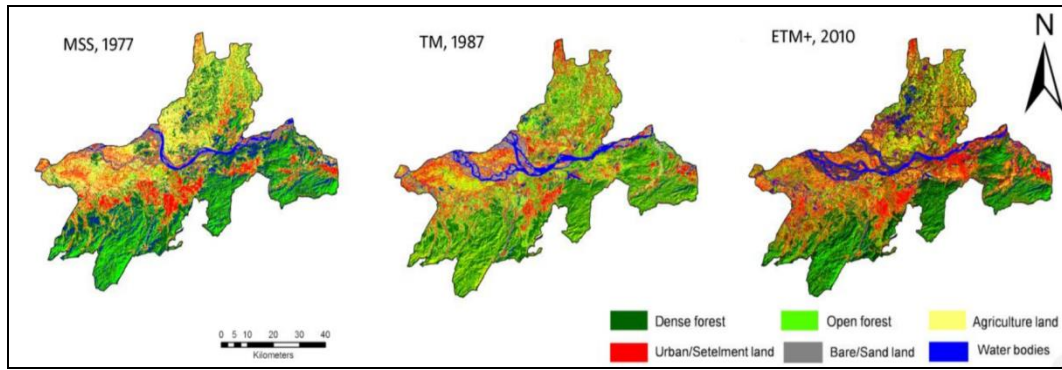


Fig 8: Detection of insect infestation (Santhosh *et al.* 2003) [14]

Used Landsat imagery to confirm damage caused by armyworms in two varieties of wheat, Oxen and Lars. The farmer noticed the armyworm infestation in parts of his field during a routine investigation. Since it was difficult to pinpoint the areas of attack, he then sprayed pesticide over the whole field. After harvest, the final yield map was compared with two Landsat scenes, one taken in June before the insect attack was noticed, and the other taken in late July, a few weeks after the spray was done. The abnormally low reflectance areas on the July image indicated areas of armyworm attack.

**Land use planning**

Kumar D., 2017 [9], carried out study on monitoring and assessment of land use and land cover changes of north-eastern region of India using Landsat MSS, TM and ETM+ remotely sensed images to focus on spatial and temporal changes in between 1977-2010. The LULC maps with six major categories viz., dense forest, open forest, agriculture land, urban settlement, water body and sand of the study site were generated using supervised classification approach



**Fig 9:** Class map of Vegetation and land cover of the study area in 1977 to 2010

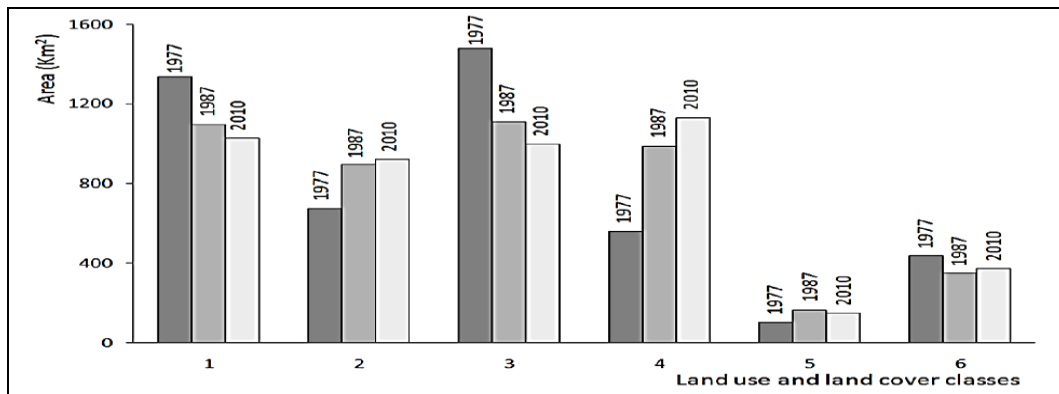
**Table 1:** Percentage area covered in different land use categories and SHDI during 1977-2010

Year	Area covered (%)					
	Dense Forest	Open Forest	Agriculture Land	Urban Settlement	Sand	Water bodies
1977	29.08	14.75	32.23	12.18	2.22	9.54
1987	23.83	19.42	24.13	21.48	3.54	8.37
2010	22.34	20.06	21.68	24.57	3.23	8.11

(Kumar, D. 2017)<sup>[9]</sup>

1977 was approximately 29.08% (1335.42 km<sup>2</sup>) of the total mapped area which has been decreased up to 23.83% (1094.16 km<sup>2</sup>) in 1987 and 22.34% (1025.81 km<sup>2</sup>) in 2010. Normalized Difference Vegetation Index (NDVI) of non-vegetative area is in increasing similarly with urban settlement and open forest. The overall classification accuracy reached 76.34% in 1977, 89.56% in 1987 and 92.34 % in 2010. Normalized Difference Vegetation Index (NDVI) of non-vegetative area is in increasing similarly with urban settlement and open forest.

The result interpreted that the initial dense forest cover in



**Fig 10:** Changes in LULC (1977 to 2010) in different land use (1: Dense forest, 2: Open forest, 3: Agriculture land, 4: Urban settlement, 5: Sand, 6: Water bodies). (Kumar, D. 2017)<sup>[9]</sup>

**Crop Acreage Estimation**

1. Maurya, 2008<sup>[12]</sup>, carried a study on estimation of acreage & crop production through remote sensing & GIS technique. He found that total production of soybean in the 11 districts of Madhya Pradesh has been predicted to be 22.58 tones (Table 3). Ujjain with

acreage of 4.21 lakh ha and yield of 943 kg/ha is the largest producer of soybean in the state (Table 2). The total production of soybean in Ujjain has been estimated to be 3.97 lakh tones. The lowest production of soybean has been estimated to be 0.69 lakh tones in Bhopal district.

**Table 2:** Comparison of Satellite Estimated yield of year 2007 with that of field derived yield in the years in 2005 & 2006

Districts	Yield (kg/ha) 2005	Yield(kg/ha) 2006	Yield(kg/ha) 2007
Ujjain	920	930	943
Dewas	910	830	842
Sahajahanpur	930	890	903
Bhopal	650	730	740
Sehore	770	720	730
Raisen	850	810	822
Vidisha	830	670	680
Rajgarh	850	870	883
Indore	780	950	964
Sagar	790	890	903
Guna	850	870	883
Average yield	830	832	844

(Maurya 2008)<sup>[12]</sup>

**Table 3:** Total Soybean Production in Parts of MP

Districts	Area Shown (2007)	Yield (2007)	Total Production
Ujjain	4.21	943	3.97
Dewas	2.83	842	2.38
Sahjahanpur	3.08	903	2.78
Bhopal	0.94	74	0.69
Sehore	2.55	730	1.86
Raisen	1.17	822	0.96
Vidisha	1.56	680	1.06
Rajgarh	2.91	883	2.56
Indore	2.15	964	2.07
Sagar	3.07	903	2.77
Guna	1.68	883	1.48
<b>Total</b>	<b>26.15</b>	<b>8627</b>	<b>22.58</b>

(Maurya 2008) <sup>[12]</sup>

2. Another experiment carried out by Yedage et al., in 2013 <sup>[18]</sup>, to estimate the crop acreage using remote sensing application in Solapur District, Maharashtra. He used location quotient method i.e. crop concentration index (Bhatia 1965) is expressed as below to estimate the crop acreage.

$\frac{\text{Area of x crop in the component}}{\text{Area of all crops in the component}}$ Areal unit (Tahshil)	$\frac{\text{Area of x crop in the entire region (State)}}{\text{Area of all crops in the entire region State}}$ region (State)
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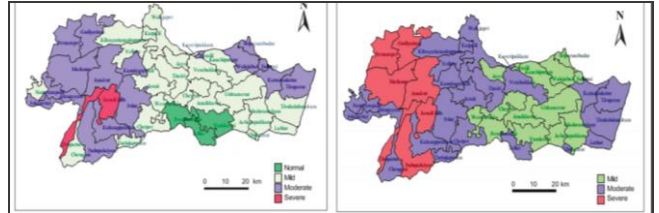
**Drought Assessment**

1. Krishna et al. 1998-99 <sup>[8]</sup>, conducted a study on remote sensing based agricultural drought assessment in Palar basin of Tamilnadu, India. The result showed that 60% of the total basin is affected by reduction in Paddy area in Samba season and 75% in Navarai season as indicators of drought condition in 1999 (Fig. 21).

**Table 4:** Range of NDVI

SI no.	NDVI (%)	Crop condition	Weightage
1	>+10	Excess	1
2	-10 to +10	Normal	2
3	-10 to -20	Mild	3
4	-20 to -40	Moderate	4
5	<-40	Severe	5

Krishna et al. (2008) <sup>[8]</sup>



**Fig 11:** Map of study area. (Krishna et al.2008) <sup>[8]</sup>

2. Sruthi et al. in 2012 <sup>[16]</sup> conducted a study on Agricultural Drought Analysis using the NDVI and Land Surface Temperature Data at Raichur district of Karnataka

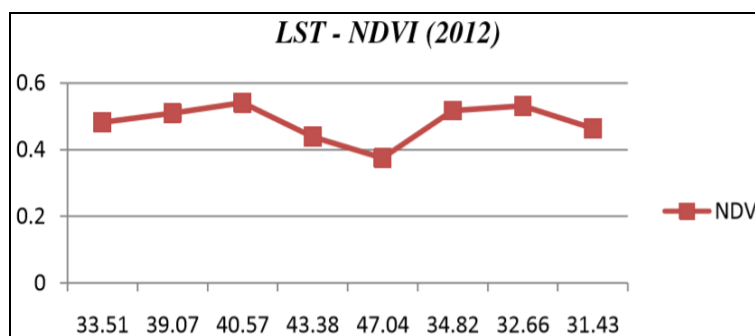
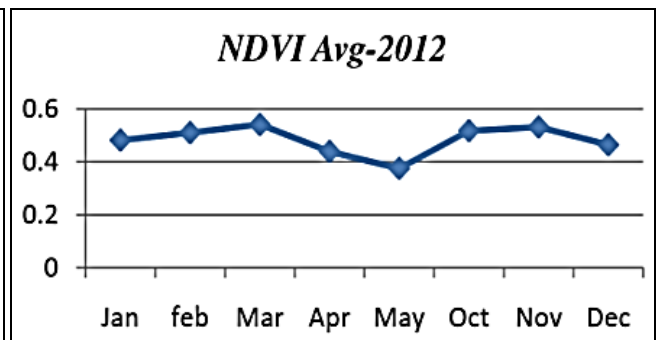
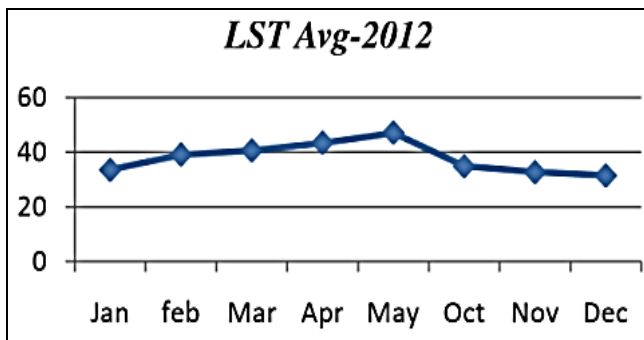
$$NDVI = (\lambda NIR - \lambda RED) / (\lambda NIR + \lambda RED)$$

Where,

$\lambda NIR$  and  $\lambda RED$  are the reflectance in the near infrared (NIR) and Red bands respectively.

The monthly average temperature of the region is calculated by the given formula:

$$\text{Temperature} = (DN * 0.02) - 273.15 \text{ } ^\circ\text{C}$$



(Sruthiet al. 2012) <sup>[16]</sup>

**Fig 12:** Line Graph showing NDVI change w.r.t. LST for the year 2012

From the graph it can be clearly noticed that both the parameters are inversely proportional to each other and shows a high negative correlation. Temperature is greater; the NDVI value is lesser which points out the decrease in the vegetation density. The decrease in soil moisture due to

lack or untimely onset of rainfall along with the increased temperature causes the agricultural drought to be severe

**Disease infestation monitoring**

Huang et al., 2002-2003 <sup>[6]</sup>, carried out a study to detect

yellow rust disease in wheat using field and airborne hyperspectral data In Beijing, China. Their results confirmed that PRI (photochemical reflectance index) is a potential candidate for monitoring of yellow rust in wheat and its remote detection and mapping process.

**They used the following formula to calculate Disease Incidence (DI)**

$$DI(\%) = \frac{\sum(x \times f)}{n \times \sum f} \times 100$$

**Where,**

**X:** Disease incidence

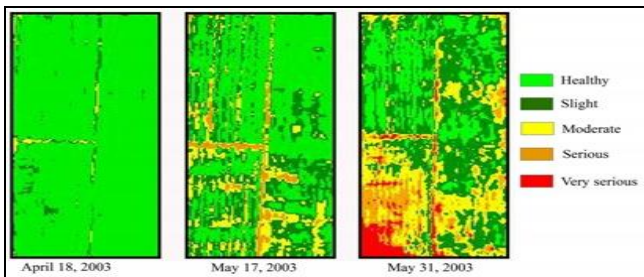
**F:** Total number of leaves of each degree of disease severity

**N:** Degree of disease severity observed

**Table 4:** They classify the disease severity as follows

DI (Range)	Class
DI > 80%	Very Serious
45% < DI ≤ 80%	Serious
10% < DI ≤ 45%	Moderate
1% < DI ≤ 10%	Slight
(0 < DI ≤ 1%)	None

(Huang *et al.*2012)<sup>[6]</sup>



(Huang *et al.*2012)<sup>[6]</sup>

**Fig 13:** DI images derived from PHI airborne images of the trial site in 2003

**Soil Fertility**

Dhayalan *et al.*, 2012<sup>[4]</sup>, conducted a study in Tharangambadi taluk area which is under threat due to the critical issues of environmental pollution and salinity problem. The soil quality in tharangambadi taluk has been reduced due to pollution. Hence the researcher conducted a study to monitor the quality of the soil using remote sensing. With the help of remote sensing he estimated soil nutrient index Table 5.

**Estimation of Soil Nutrient Index (SNI)**

Parker's (1951) method of calculating Nutrient Index (NI) values to indicate fertility status of soils for the purpose of mapping. The following equation is used to calculate Nutrient Index Value:-

$$\text{Nutrient Index} = (NI \times 1) + (Nm \times 2) + (Nh \times 3) / Nt$$

NH = Number of samples falling in high category of nutrient Status.

NT = Total number of samples analyzed for a nutrient in any given area.

NL = Number of samples falling in low category of nutrient status.

Nm = Number of samples falling in medium category of nutrient status.

**Table 5:** soil nutrient index for the study area

Nutrient	Soil nutrient index	Description
Nitrate (N)	1.6	Optimum nutrients
Potassium (K)	2.36	Optimum nutrients
Phosphorus (P)	2.62	High nutrient status
Iron (Fe)	2	Optimum nutrients
Manganese (Mg)	2	Optimum nutrients

**Conclusions**

- It is concluded that remote sensing can provide accurate information to guide agronomic and economic decision making.
- Remote sensing plays an important role in detecting and management of various crop issues even at a small land holding with high resolution.
- Crop yield forecast is also an important factor in decision making and therefore can be accomplished by ground and satellite based remote sensing.
- Precision agriculture is mainly drawn from developed countries, but in India there is still lack of adoption of the technology because of lack of knowledge and awareness among the farmers.
- Remote sensing is a powerful technique for surveying, mapping monitoring and can be put to best use if it is incorporated with GIS. Crop discrimination and area estimation can be possible by Digital Image Processing Classification Algorithms.

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