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Remote Sensing in Precision Farming for Monitoring Agricultural Activities

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SUMMARY

Precision agriculture (P.A.) utilizes tools and tecnologies to identify in field crop and soil variablity for improving farming practices, optimizing inputs and better managemnt of insects –pests. India is an agricultural country, indian farmers are searching for ways to maximize their income. The use of remote sensing (R.S.), farmers can more precisely determine what inputs to place exactly where and in what quantities. This information help farmers to effectively use expensive resources such as agrochemicals, organic manures and chemcial fertilisers. Agricultural produaction and productivity will be severly constrained by lack of additional arable land. Moreever, the agricultural productivity can change within short time period, due to unfavourable crop growing conditions. The remote sensing applications in the field of agriculture such as soil fertility evaluation, detection of disesases and pests infestation, drought, soil moisture estimation, crop growth monitoring and weather forcasting, precision agricultue for maintainig the sustanabilty of the agricultural and improving economic growth of the country.

INTRODUCTION

Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance from the targeted area. Special cameras collect remotely sensed imagesof the Earth, which help researchers "sense" things about the Earth. Remote sensing obviously implies from distance. It is nothing but an extension of an eye. It is generally understood to imply the acquisition of information about object/phenomena by scientific means or devices called sensors without there being any physical contact between any sensor and object. The different objects emit different amount of energy in different wavelengths from the range of EMW (Electromagnetic wavelength) spectrum. The remote sensing satellites have sensors that measure the amount of energy reflected from the ground objects. The term remote sensing was given by Ewlyn L. in 1960. He was a geographer. The first aerial photograph in the history was given by FellinTournachone nick named Nadar, when he used a balloon to photograph the Paris suburb Prtit, on a sunny autumn day 1858. Satellite based optical and radar imagery plays important role in monitoring agricultural activities. On time availability of information about the crops and affective parameters helps in taking decisions on issues like pest attacks, crop diseases, crop production, food security, drought assessment, weather forecast, crop related statistics and other observations to achieve sustainable agriculture.

The remote sensing data analysis helps in:

Identification, area estimation & monitoring:

The specific requirement of climate and soil conditions coupled with the specialised management practices make the distribution of plantation crops rather more localised in comparison to other agricultural crops. The identification, estimation of growing stock, analysis of distribution and monitoring at regular intervals are major aspects in plantation crops.

Crop Nutrient Deficiency Detection:

The nutrient deficiency in plants affects the colours, moisture content and internal structures of leaves and that result in change of reflecting power of plants.

Soil Mapping:

Soil properties can also be inferred from microwave data using various different monitoring methods. Soil properties like mineralogy, texture, soil iron, soil moisture, soil organic carbon, soil salinity and carbonate contents can be measured using remote or proximal sensing approaches.

Crop Condition Assessment:

The physiological changes that occur in plant due to stress results in change of spectral reflectance characteristics. This shows the detection of stress using remote sensing techniques. Periodically monitoring of crops during their growth cycle is essential to take appropriate measures and assess information on loss of production.

Agricultural Draught Assessment:

The remote sensing make use of NDVI (Normalized Difference Vegetation Index) to take timely preventive and corrective measures at operational level to deal with drought conditions. The purpose the NDVI is to analyse the vegetation stress and land surface temperature (LST). this information is useful for agricultural drought monitoring and early warning system for the farmers. remote sensing helps detecting photo synthetically active radiation that is absorbed by vegetation. Since green vegetation had strong absorption of spectrum in red region and high reflectance in infrared region, vegetation index was thus generally formulated as various combinations of red and infrared bands.

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

Where, λNIR and λRED are the reflectance in the near infrared (NIR) and red bands respectively.

Reflectance modelling:

Reliable growth production models helps in describing relation between physiological process in plants and environmental factors such as solar radiation, temperature, water and nutrient availability.

Crop yield modelling and production forecasting:

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

There are various essential components involved in remote sensing process:-

- Signals from a light source.
- Sensors on remote sensing platform.
- Signal reception, storage, processing, information extraction and decision making.

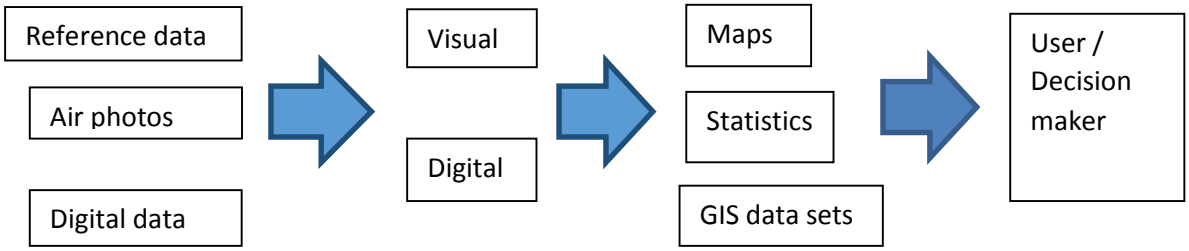

Figure 1. Remote Sensing Process

The above photographs is remotely sensed from Remote Sensing satellite
Some examples are:

- Cameras on satellites and airplanes take images of large areas on the Earth's surface, allowing us to see much more than we can standing on the ground.
- Sonar systems on ships can be used to create images of the ocean floor without needing to travel to the bottom of the ocean.
- Cameras on satellites can be used to make images of temperature changes in the oceans.
- Some specific uses of remotely sensed images of the Earth include:

- Large forest fires can be mapped from space, allowing rangers to see a much larger area than from the ground.
- Tracking clouds to help predict the weather or watch erupting volcanos, and help watch for dust storms.
- Tracking the growth of a city and changes in farmland or forests over several years or even decades.
- Mapping the ocean bottom - Discovery and mapping of the rugged topography of the ocean floor (e.g., huge mountain ranges, deep canyons, and the "magnetic striping" on the ocean floor).

Types of Remote Sensing

There are major two types of remote sensing based on the energy sources.

Figure 2. Process of Remote Sensing

Passive Remote Sensing

Passive Remote Sensing measures reflected sunlight emitted from the sun. When the sun shines, passive sensors measure this energy.

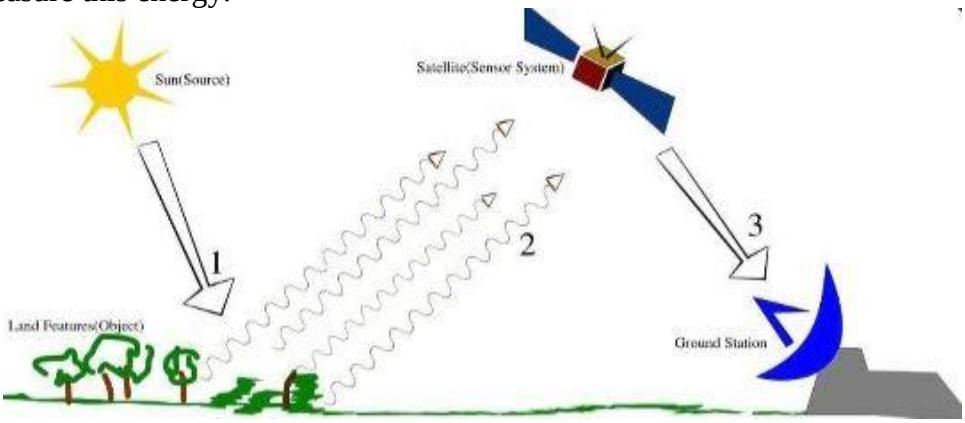

Figure 3. Passive Remote Sensing

Active Remote Sensing

Active sensors have its own source of light or illumination. In particular, it actively sends a wave and measures that backscatter reflected back to it. The two main advantages of active remote sensing are the capability to collect imagery night and day and it is unfazed by clouds and poor weather conditions.

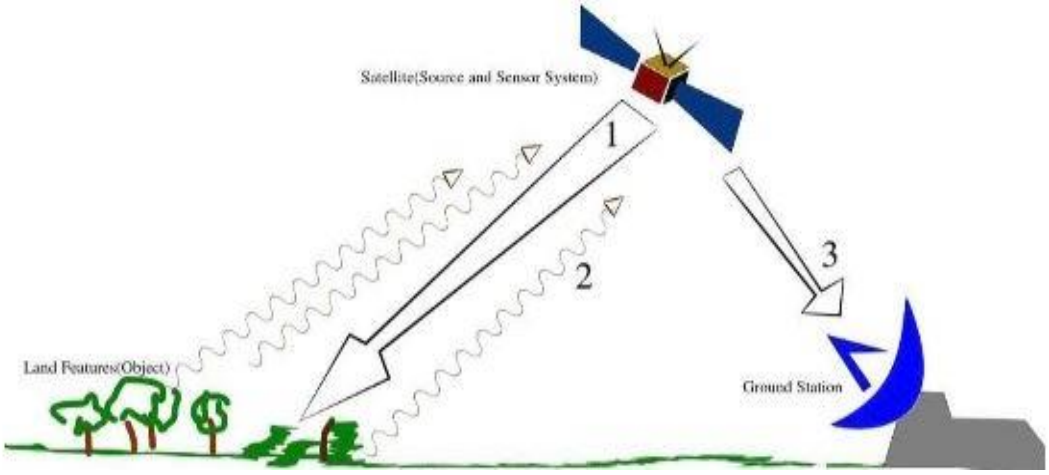

Figure 4. Active Remote Sensing

Remote Sensing Platforms in Active Remote Sensing

Air Borne Remote Sensing –In this art of science a camera held on an airplane takes photograph. The successive photographs of the terrain are taken in such a way direction & that a 60% overlap in forward 30%

overlap in lateral direction of flight line are taken so as to have stereoscopic view(3 D) & full coverage. The height of the plane depends upon scale of photography required.

$$S = F/H$$

Where

S = Scale of photograph
F = Focal length of lens
H =Flying height

Space Borne Remote Sensing - In this type of remote sensing objects are sensed from space by a satellite through various types of sensors. It is concerned with the measurement of sun's energy which is reflected, emitted by object receiving &returning energy from the sun. The suns energy is commonly referred to as E.M spectrum. It is an array of E.M radiation that moves with constant velocity,which is characterized by wavelength or frequency. Thus in 7remote sensing program the physical basis of remote sensing is composed of :-

- Source of energy (Sun)
- Target (Earth)
- Sensor (photographic film detection in scanners)

They make use of remote sensing satellites that communicate with each other to sense earth objects. This data is then sends to processing station on the ground to analyse and find out resultants over the crude data collected from the space.

Ground Borne Remote Sensing –Ground borne remote sensing system for earth resources study is mainly used for collecting the ground truth or arbitrary simulation studies. Platforms may be divided into 2 categories:-

- Geostationary
- Polar orbiting or Synchronous

Application of Remote Sensing in Agriculture

The remote sensing has evolved in many domains of agriculture. Agriculture is a vast field which is highly dependent on various disciplines like crop monitoring, soil analysis, weather forecasting, pest management, crop disease identification, water usage etc. for successful production of crops. These various paramters must be monitored for increased crop production and performance analysis of crop and land. The various application areas of remote sensing in agriculture are discussed as under:

Production Forecasting and Crop Assessment: Remote sensing is used to forecast the expected crop production and yield over a given area and determine how much of the crop will be harvested under specific conditions. Researchers can be able to predict the quantity of crop that will be produced in a given farmland over a given period of time. In the event of crop damage or crop progress, remote sensing technology can be used to penetrate the farmland and determine exactly how much of a given crop has been damaged and the progress of the remaining crop in the farm.

Horticulture Systems Analysis and Crop Identification: Remote sensing technology has also been instrumental in the analysis of various crop planting systems. This technology has mainly been in use in the horticulture industry where flower growth patterns can be analysedand a prediction made out of the analysis. Remote sensing has also played an important role in crop identification especially in cases where the crop under observation is mysterious or shows some mysterious characteristics. The data from the crop is collected and taken to the labs where various aspects of the crop including the crop culture are studied.

Crop acreage estimation and Stress Detection: Remote sensing has also played a very important role in the estimation of the farmland on which a crop has been planted. This is usually a cumbersome procedure if it is carried out manually because of the vast sizes of the lands being estimated.Remote sensing technology plays an

important role in the assessment of the health condition of each crop and the extent to which the crop has withstood stress. This data is then used to determine the quality of the crop.

Identification of planting and harvesting dates: Because of the predictive nature of the remote sensing technology, farmers can now use remote sensing to observe a variety of factors including the weather patterns and the soil types to predict the planting and harvesting seasons of each crop.Remote sensing also allows farmers and experts topredict the expected crop yield from a given farmland by estimating the quality of the crop and the extent of the farmland. This is then used to determine the overall expected yield of the crop.

Identification of pests and disease infestation: Remote sensing technology also plays a significant role in the identification of pests in farmland and gives data on the right pests control mechanism to be used to get rid of the pests and diseases on the farm.

Soil moisture estimation, Soil mapping and Irrigation Management: Soil moisture can be difficult to measure without the help of remote sensing technology. Remote sensing gives the soil moisture data and helps in determining the quantity of moisture in the soil and hence the type of crop that can be grown in the soil. Remote sensing gives information on the moisture quantity of soils. This information is used to determine whether a particular soil is moisture deficient or not and helps in planning the irrigation needs of the soil. Soil mapping is one of the most common yet most important uses of remote sensing. Through soil mapping, farmers are able to tell what soils are ideal for which crops and what soil require irrigation and which ones do not. This information helps in precision agriculture.Apart from determining the soil moisture content, remote sensing also plays an important role in the estimation of the water content in the field crops.Remote sensing technology is just about the only technology that can provide data on crop reflectance. Crop reflectance will depend on the amount of moisture in the soil and the nutrients in the crop which may also have a significant impact on the overall crop yield.

Monitoring of droughtsand land degradation mapping:: Remote sensing technology is used to monitor the weather patterns including the drought patterns over a given area. The information can be used to predict the rainfall patterns of an area and also tell the time difference between the current rainfall and the next rainfall which helps to keep track of the drought. Remote sensing has been used by experts to map out the land cover of a given area. Experts can now tell what areas of the land have been degraded and which areas are still intact. This also helps them in implementing measures to curb land degradation.

Crop health analysis and crop nutrient deficiency detection: Remote sensing technology has also helped farmers and other agricultural experts to determine the extent of crop nutrients deficiency and come up with remedies that would increase the nutrients level in crops hence increasing the overall crop yield.Remote sensing can be used for crop intensification that includes collection of important crop data such as the cropping pattern, crop rotation needs and crop diversity over a given soil.

Flood mapping and monitoring: Using remote sensing technology, farmers and agricultural experts can be able to map out the areas that are likely to be hit by floods and the areas that lack proper drainage. This data can then be used to avert any flood disaster in future.Remote sensing technology is ideal for collection and storing of past and current weather data which can be used for future decision making and prediction.

Water resources mapping: Remote sensing is instrumental in the mapping of water resources that can be used for agriculture over a given farmland. Through remote sensing, farmers can tell what water resources are available for use over a given land and whether the resources are adequate.

Precision farming: Remote sensing has played a very vital role in precision agriculture. Precision agriculture has resulted in the cultivation of healthy crops that guarantees farmers optimum harvests over a given period of

time.Remote sensing technology is used in the estimation of air moisture which determines the humidity of the area. The level of humidity determines the type of crops to be grown within the area.

Climate change monitoring: Remote sensing technology is important in monitoring of climate change and keeping track of the climatic conditions which play an important role in the determination of what crops can be grown where.For the agricultural experts and other farmers, remote sensing is important in keeping track of the farming practices by all farmers and ensuring compliance by all farmers. This helps in ensuring that all farmers follow the correct procedures when planting and when harvesting crops.

Land mapping: Remote sensing helps in mapping land for use for various purposes such as crop growing and landscaping. The mapping technology used helps in precision agriculture where specific land soils are used for specific purposes.

CONCLUSION

Remote sensing is one of the precision agriculture technologies that allows growers to collect, visualize and evaluate crop and soil health conditions at various stages of crop production in a cost effective manner. Remote sensing technologies can be used to support site specific management decisions at various stages of production, mappingsoil properties, monitoring of pests and diseases in crops, classification of crop species, detection of crop water stress, mapping of crop yield and helping to optimize crop production.

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