Using and Applications of Remote Sensing in Trend Agriculture

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Abstract

Remote sensing has the capacity to assist the adaptive evolution of agricultural practices in order to face this major challenge, by providing repetitive information on crop status throughout the season at different scales and for different actors. The monitoring of agricultural production system follows strong seasonal patterns in relation to the biological life cycle of crops. We start this article by making an overview of the current remote sensing techniques relevant for the agricultural context. By delivering consistent crop condition data throughout the season at various scales and for various players, remote sensing can help agricultural methods adapt and evolve to meet this significant challenge. When it comes to the biological life cycle of crops, the agricultural production system is monitored according to significant seasonal trends.

Introduction

The art and science of gathering data about actual items or regions at a distance without making direct or physical touch with them is known as remote sensing. In order to monitor the earth's resources with greater precision and accuracy, remote sensing integrates satellite technology with surface observations. Climate change, irrigation sources, crop monitoring, resource management are challenges to agriculture production system across the world. The number of agricultural workers has significantly decreased over the past several years, and the agriculture industry is experiencing a scarcity of human resources. The development of remote sensing in conjunction with notable breakthroughs in GPS receivers, microcomputers, and geographic information systems (GIS) can help the agriculture industry overcome these obstacles by enhancing crop monitoring, improving crop simulation models, and enabling remote access (Bhattacharyay *et al.*, 2020 a, b).

Application of remote sensing in agriculture can have many advantages like precision nutrient management, drought stress management, efficient water use models, yield mapping, and yield estimation and crop phonological stages (Huang *et al.*, 2018). The soil and crop mapping may be accomplished by image processing using the hyperspectral and multispectral pictures obtained from earth-orbiting satellites or aerial vehicles, which can offer the variability of the fields. A geographic information system (GIS) may be used to monitor crops in a given area and to track individual crops. Precision farming, a management approach that incorporates a variety of cutting-edge information, communication, and data analysis techniques into the decision-making process to improve crop production while lowering water and nutrient losses and increasing nutrient use efficiency, is also where remote sensing got its start. The application of remote sensing for sustainable agriculture development and resource conservation measures are described briefly in this article.

Types of remote sensing

1. Passive remote sensing: It makes use of seasons that detects the reflected/emitted electromagnetic radiation natural sources.

2. Active remote sensing: It makes the use of seasons that detects reflected responses from object that are irradiated from artificially generated energy sources, such as radar.

Remote sensing platforms:

1. Ground based: Infrared thermometer, spectral radiometer, pilot balloons and radars are some of the grounds based remote sensing tools.

2. Air based: Aircrafts are air based remote sensing tools.

3. Satellite based: Satellite technology has become handy for wider application of remote sensing techniques. The satellites are subdivided into two classes. These are-

i) Polar orbiting satellites: These satellites operate at an altitude between 550 and 1600 km along an inclined circular place over poles. LANDSAT (USA), SPOT (France) and IRS (India) series are some of the remote sensing satellites.

ii) Geostationary satellites: These have orbit around the equator at an altitude of 36000 km and move with the same speed as the earth, so as to view the same area on the earth continuously. The INSAT series satellites are launched from India for the above purpose.

Role of remote sensing in agriculture

A recent report by the FAO projects that an increase in world population to 9.15 billion by 2050, which may need the current food production to increase by 60%. Many efforts are underway to increase overall production to feed the burgeoning population by increasing efficiency in production such as high intensity agriculture, efficient water use, and high yield varieties. Strong seasonal trends in agricultural productivity are associated with the biological lifespan of crops. Aside from climate driving factors and agricultural management techniques, the physical topography (such as soil type) also affects productivity. All these variables are highly variable in space and time. Moreover, as productivity can change within short time periods, due to unfavorable growing conditions, agricultural monitoring systems need to be real time for higher productivity. In order to monitor agricultural fields, crop and soil health, water management and quality, and atmospheric conditions with a focus on yield, remote sensing is therefore essential. Agricultural applications like crop discrimination, crop acreage estimation, crop condition assessment, soil moisture estimation, yield estimation, precision agriculture, soil survey, agriculture water management, and agrometeorological and agro advisories have all been investigated over the past 20 years using remote sensing techniques. The application of remote sensing in agriculture, *i.e*. in crops and soils is extremely complex because of highly dynamic and inherent complexity of biological materials and soils. However, remote-sensing technology provides many advantages over the traditional methods in agricultural resources survey.

The advantages include

(a) capability of synoptic view

(b) potential for fast survey,

(c) capability of repetitive coverage to detect the changes,

(d) low cost involvement

(e) higher accuracy,

(f) use of hyper spectral data for increased information.

applications of remote sensing in agricultural sector

Monitoring of vegetation cover: Remote sensing is essential for agricultural categorization, crop acreage, and yield calculation. Numerous study inquiry strategies made advantage of digital image processing and aerial photography. Nonetheless, the technological field of remote sensing improves the accuracy of a set of estimations while lowering the amount of human labor required (Kingra *et al*., 2016). Hyperspectral data has a great capacity to improve the characterization, classification, and modelling when it comes to crop and vegetation mapping as compared to multispectral broadband the term "remote sensing" is well-known. (Thenkabail *et al*., 2011). The most used metric for evaluating the status of vegetation is the Normalized Difference. The most popular statistic nowadays is the NDVI. (Calvao and Palmeirim, 2004) initiatives have been made to develop additional Indicators that can lessen the soil's influence on the impact of context and atmosphere on the outcomes of observations in the spectral range. Soil Adjusted Vegetation Index (SAVI) is an example of a vegetation index that reduces the impact of soil on remotely sensed vegetation data (Bernardes *et al*., 2012).

Crop condition assessment: Crop health may be analyzed using timely spectral data from remote sensing. Stress may alter the spectral properties of plants due to physiological changes and biophysical plant health markers. Because of the reflectance and emission characteristics, stress can be detectable remotely for sensing (Prasad *et al*., 2006). In order to take appropriate action and be aware of the possibility of output losses due to any stressor, crop monitoring is necessary at regular intervals during the growing season. A number of factors, including soil moisture availability, planting date, air temperature, and soil conditions, influence the stages of crop growth and their progressions. These components are in charge of the environment and productivity of the plant. For instance, excessive heat during pollination might reduce corn crop yields. Therefore, knowing the temperature during the corn pollination time might help corn forecasters make more precise forecasts (Nellis *et al*., 2009). Drought renders the land unusable for agriculture and makes it uninhabitable for human environment, livestock population, biomass potential and plant diversity species (Sankaran *et al.,* 2010). Drought monitoring using satellite data has gained popularity in recent years, particularly the usage Vegetation Condition Index (VCI) and Normalized Difference Vegetation Value Index (NDVI) has been widely acknowledged around the world. highlighting drought in agriculture in a variety of global ecoregions with diverse climatic circumstances (Anyamba *et al*., 2001; Ji and Peters, 2003).

Irrigation water management: Remote sensing data can be used to identify field fluctuations and efficiently apply water when utilizing variable rate irrigation equipment, such as the center pivot system. In order to achieve consistently high yields throughout the field while reducing water and nutrient use losses, variable rate application conditions can be employed to counteract water stress brought on by excessively wet and dry conditions (Evans *et al*, 2013). Using remote sensing in the optical, thermal, and microwave bands, several indices and methods for precise water management have been created and evaluated. In order to provide soil moisture and soil temperature at 1 km spatial resolution in real-time at four soil depths and vegetation root zones, a high-resolution land data assimilation system was used as a computing tool to create a soil moisture and temperature map. Remote sensing has become increasingly important in understanding crop soil properties as a result of the rise in the production of hyperspectral bands in the thermal zone. When combined with GPS, this data will yield encouraging outcomes that are more beneficial for precision farming.

Monitoring of pest management: The way electromagnetic radiation interacts with plants depends on its wavelength. Measured reflectance of the leaves can vary greatly depending on the health and vigor of the plant. Due to significant absorption by photoactive pigments, healthy and aggressively developing plant leaves can be measured and analysed to find the diseased leaf. Insect defoliation has been assessed and monitored using a remote sensing method. Comparing the different spectral responses to chlorosis (leaf and foliage yellowing) decreases over some time, assuming that these differences can be correlated, classified, and interpreted (Franklin, 2001). Detecting and mapping defoliation, characterization of pattern disruptions, and other remote sensing applications have been used as well as giving information to pest management mechanisms that aid in making decisions (Lee *et al*., 2010).

Soil Mapping: One of the most popular and significant applications of remote sensing is soil mapping. Farmers may determine which soils are best for specific crops, which ones need irrigation, and which ones don't by using soil mapping. This information helps in precision agriculture.

Cropping system analysis*:* Details on a region's current agricultural system in relation to Finding agricultural areas with low to medium crop productivity where appropriate agronomic management packages, including the introduction of new crops, can lead to a sustainable increase in crop production requires knowledge of the area extent of crops, crop yield, and annual crop rotation/sequence practices etc. Remote sensing can play a vital role in cropping system analysis of an area by spatial integrating temporal crop inventory information of various crop seasons of that area. The cropping system analysis was carried out by GIS aided integration of multi-temporal digital satellite (IRS-1B LISSII) data-based classification crop inventory information of the *kharif* season (rainy season), *rabi* season (winter season) and summer crop season in 1995 in Madnur Watershed, Nizamabad district, Andhra Pradesh.

Precision farming*:* The entire farm receives the same amount of fertilizer, water, and other inputs in standard cropping practices. In the entire area, the input need could differ, nevertheless. In order to maximize crop input efficiency based on site-specific requirements within a farm, precision farming aims to collect and analyze data regarding the spatial variability of soil and crop condition. Thus precision farming can be considered as site specific farming, which has a potential to reduce cost through more efficient and effective application of agronomic inputs. Because inputs are applied where and in the necessary quantity, this also lessens the impact on the environment. An application map that specifies the location, spatial extent, and level of input to be used is necessary before we can realize variable rate of input. For variable rate of application, precision farming necessitates the integration of multiple technologies, including field equipment, GPS, GIS and remote sensing. Information can now be provided at the field or within the field level thanks to next-generation satellites that provide high resolution multispectral data.

Water stress: Several indices and methods for precision water management have been developed and tested using remote sensing products in the optical, thermal, and microwave bands. For instance, the normalized difference vegetation index (NDVI) and soil adjusted vegetation index (SAVI), which are created from optical images, can be used to diagnose soil moisture conditions and water stress in a variety of crops (Amani, M. *et al*, 2016).

Evapotranspiration (ET): The hydrologic cycle and water balance depend heavily on evapotranspiration (ET), the greatest water flux from the Earth's surface to the atmosphere. Traditional techniques for measuring ET, such as weighing lysimeters and eddy covariance, are typically costly and do not offer estimates of ET that vary spatially due to variations in topography, soils, land use, and other hydrologic processes (Liou, Y. *et al*, 2014 and Verstraeten, W.W. *et al*, 2008). Remote sensing data is widely used to estimate ET, which is needed to determine crop water requirements to schedule irrigation (Mendes, R.W. *et al*, 2019: Barker, J. B. *et al,* 2018).

Crop Yield Modelling and Estimation: Remote sensing also allows farmers and experts to predict 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.

Crop Production Forecasting: 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 in a given farmland over a given period (Sinha, N. K *et al*, 2018).

Advantages of remote sensing

1. **Extent of coverage:** By using satellite technology information from a large area can be covered with short time much accuracy as compared to traditional methods.
2. **Permanence of record:** Areal and satellite data are the permanent record; these are use in future purpose.
3. **Spectral and spatial resolution:** Greater fineness of the image and the details of the object can be obtained by using spatial resolution of any sensor
4. **Speed and consistency of interpretation:** With the use of digital image processing system we can analyse the data consistently and speedily
5. **Cost effective and reliable:** Remote sensing offers cost effective and reliable monitoring system.

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