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Applications of Remote Sensing in Agriculture

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Remote sensing has several advantages in the field of agronomical research purpose. The assessment of agricultural crop canopies has provided valuable insights in the agronomic parameters. Remote sensing plays a significant role in crop classification, crop monitoring and yield assessment. The use of remote sensing is necessary in the field of agronomical research purpose because they are highly vulnerable to variation in soil, climate and other physico- chemical changes. The monitoring of agricultural production system follows strong seasonal patterns in relation to the biological life cycle of crops. All these factors are highly variable in space and time dimensions. Moreover, the agricultural productivity can change within short time periods, due to unfavourable growing conditions. Monitoring of agricultural systems should be followed in timely. Remote sensing are important tools in timely monitoring and giving an accurate picture of the agricultural sector with high revisit frequency and high accuracy. These technologies have many fold applications in the field of agriculture such as crop acreage estimation, crop growth monitoring, soil moisture estimation, soil fertility evaluation, crop stress detection, detection of diseases and pest infestation, drought and flood condition monitoring, yield estimation, weather forecasting, precision agriculture for maintaining the sustainability of the agricultural systems and improving the economic growth of the country.

Introduction

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. Remote sensing is a tool to monitor the earth's resources using space technologies in addition to ground observations for higher precision and accuracy. The principle behind remote sensing is the use of electromagnetic spectrum (visible, infrared and microwaves) for assessing the earth's features. The typical responses of the targets to these wavelength regions are different, so that they are used for distinguishing the vegetation, bare soil, water and other similar features. It can also be used in crop growth monitoring, land use pattern and land cover changes, water resources mapping and water status under field condition, monitoring of diseases and pest infestation, forecasting of harvest date and yield estimation, precision farming and weather forecasting purposes along with field observations. In essence, remote sensing techniques are used for earth's resources sensing. Remote sensing data can greatly contribute to the monitoring of earth's surface features by providing timely, synoptic, costefficient and repetitive information about the earth's surface (Justice *et al.,* 2002). It also has several applications in the field of agrometeorological purpose. Remote sensing inputs combined with crop simulation models are very useful in crop yield forecasting. Since the ground based and air-based platforms are time consuming and have limited use, these space-

based satellite technologies are gaining more importance for acquiring spatio-temporal meteorological and crop status information for complementing the traditional methods.

Agricultural applications – Basic aspects

During the early stages of the satellite remote sensing, most researchers are focused on the use of data for classification of land cover types with crop types being a major focus among those interested in agricultural applications. In recent years, the work in agricultural remote sensing has focused more on characterization of plant biophysical properties. Remote sensing has long been used in monitoring and analyzing of agricultural activities. Remote sensing of agricultural canopies has provided valuable insights into various agronomic parameters. The advantage of remote sensing is its ability to provide repeated information without destructive sampling of the crop, which can be used for providing valuable information for precision agricultural applications.

1. Monitoring of vegetation cover: The science of remote sensing play a vital role in the area of crop classification, crop acreage estimation and yield assessment. Many research experiments were done using aerial photographs and digital image processing techniques. But the field of remote sensing helps in reducing the amount of field data to be collected and improves the higher precision of estimates (Kingra *et al.*, 2016). The ability of hyper spectral data to significantly improve the characterization, discrimination, modeling, and mapping of crops and vegetation, when compared with broadband multispectral remote sensing, is well known.

2. Nutrient and water status: The most important fields where we can opt for application of remote sensing and GIS through the application of precision farming are nutrient and water stress management. Detecting nutrient stresses by using remote sensing and GIS helps us in site specific nutrient management through which we can reduce the cost of cultivation as well as increase the fertilizer use efficiency for the crops. In semi-arid and arid regions judicious use of water can be made possible through the application of precision farming technologies. For example, drip irrigation coupled with information from remotely sensed data such as canopy air temperature difference can be used to increase the water use efficiency by reducing the runoff and percolation losses

3. Crop evapo-transpiration: The decline in the productivity of crops is due to irregularities in rainfall, increase in the temperature rate etc., which causes a decrease in the soil moisture. Drought is a situation which can be defined as a long-term average condition of the balance between precipitation and evapo-transpiration in a particular area, which also depends on the timely onset of monsoon as well as its potency. Most of the approaches use simple direct correlations between remote sensed digital data and evapo-transpiration, but some combine various forms of remotely sensed data types. Remote sensing is playing a major role in the water management for agricultural system. And this can be further enhanced by the development of hyper spectral sensors and linking the remote sensing data with other spatial data through GIS and GPS technologies.

4. Pest and disease infestation: Remote sensing has become an essential tool for monitoring and quantifying crop stress due to biotic and abiotic factors. Remote sensing methodologies need to be perfected for identification of insect breeding grounds for developing strategies to prevent their spread and taking effective control measures. The remote sensing approach in assessing and monitoring insect defoliation has been used to relate differences in spectral responses to chlorosis, yellowing of leaves and foliage reduction over a given time period assuming that these differences can be correlated, classified and interpreted (Franklin, 2001). The range of remote sensing applications has included detecting and mapping defoliation, characterization of pattern disturbances etc. and providing data to pest management decision support system

5. Precision agriculture: Remote sensing technology is a key component of precision farming and is being used by an increasing number of scientists, engineers and large-scale crop growers. The main aim of precision farming is reduced cost of cultivation, improved control and improved resource use efficiency with the help of information received by the sensors fitted in the farm machineries. Variable rate technology (VRT) is the most advanced component of precision farming. Sensors are mounted on the moving farm machineries containing a computer which provides input recommendation maps and thereby controls the application of inputs based on the information received from GPS receiver. The advantage of precision farming is the acquisition of information on crops at temporal frequency and spatial resolution required for making management decisions. Remote sensing is a no doubt valuable tool for providing such informations.

Future prospects

Remote sensing is highly useful in assessing various abiotic and biotic stresses in different crop and also very useful in detecting and management of various crop issues even at small farm holdings. To effectively utilize the information on crops for improvement of economy there is a need to develop state or district level information system based on available information on various crops. derived from remote sensing and GIS approaches. The governments can use remote sensing data in order to make important decisions about the policies they will adopt or how to tackle national issues regarding agriculture. A new and nontraditional remote sensing application involves the implanting of nano-chips in plant and seed tissue that can be used in near-real time to monitor crop. Clearly, these and other new approaches will reinforce the importance of remote sensing in future analysis of agricultural sciences

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