Remote Sensing: An Application in Agriculture

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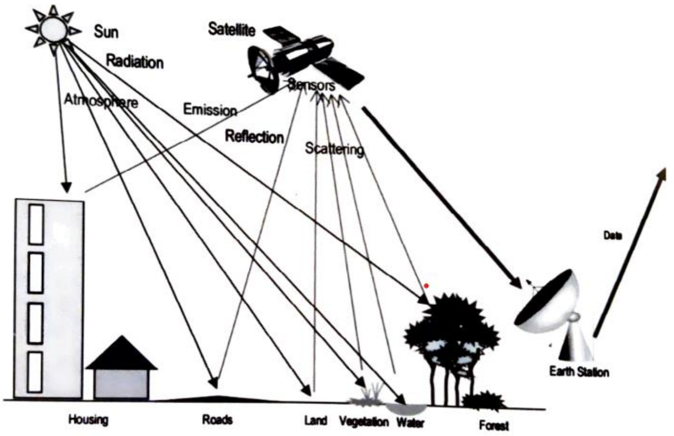
Remote sensing is the art and science of obtaining information about an object without coming in physical contact with it. According to Nicholas Short, remote sensing is a technology that uses electromagnetic radiation sampling to collect and read non-immediate geographical data that can be used to gather information about features, objects and the earth's surface, oceans, and atmosphere. The information can be gathered in a variety of ways, including differences in electromagnetic energy, variations in wave dispersion, and variations in acoustic force distribution. EMR remote sensing is primarily utilized in agriculture that is based on electromagnetic radiation.

Remote sensing works on the principle that electromagnetic radiation emitted from an item is measured in remote sensing and converted into data about the object or processes connected to the object. Different objects reflect or emit different amounts of energy in different bands of the electromagnetic spectrum. The amount of energy reflected or emitted depends on the properties of both the material and the incident energy (angle of incidence, intensity and wavelength). Detection and discrimination of objects or surface features is done through the uniqueness of the reflected or emitted electromagnetic radiation from the object.

Along with field observations, it can also be used for crop growth monitoring, land use pattern and land cover changes, water resource mapping and water status in the field, disease and pest monitoring, yield estimation, harvest date forecasting, precision farming, and weather forecasting. In essence, the detecting of earth's resources is done through remote sensing techniques. By providing fast, synoptic, cost-effective, and repeatable information on the earth's surface, remote sensing data can significantly contribute to the monitoring of earth's surface features (Justice *et al.*, 2002). Remote sensing inputs combined with crop simulation models are very useful in crop yield forecasting.

Agricultural application of remote sensing

In recent years, the research of agricultural remote sensing has focused increasingly on describing the biophysical traits of plants. Agriculture-related activity analysis and monitoring have long been done using remote sensing. Agronomic characteristics can be better understood thanks to remote sensing of crop



canopies. Remote sensing's advantage is its capacity to deliver consistent data without harmful crop sampling, which can be used to deliver important data for precision agricultural applications. Remote sensing provides a cheap alternative for data acquisition over large geographical areas (De-beurs and Townsend, 2008).

The main applications of satellite remote sensing in India are for estimating crop production and crop acreage. Based on the biophysical characteristics of crops and/or soils, remote sensing technology has the potential to revolutionize the detection and characterization of agricultural productivity (Liaghat & Balasundram, 2010).Remote sensing along with GIS is highly beneficial for creating spatio-temporal basic informative layers which can be successfully applied to diverse fields including flood plain mapping, hydrological modelling, surface energy flux, urban development, land use changes, crop growth monitoring and stress detection (Kingra *et al.*, 2016). The advances in the use of remote sensing methods are due to the introduction of narrow band or hyperspectral sensors and increased spatial resolution of aircraft or satellite mounted sensors. Hyperspectral remote sensing has also helped to enhance more detailed analysis of crop classification.

Crop condition assessment

Remote sensing can play an important role in agriculture by providing timely spectral information which can be used for assessing the Bio-physical indicators of plant health. The physiological changes that occur in a plant due to stress may change the spectral reflectance/ emission characteristics resulting in the detection of stress amenable to remote sensing techniques (Menon, 2012).

Crop monitoring is required at regular intervals throughout crop growth in order to take the proper action and to determine the likelihood of output loss due to any stressor. A number of variables, including the amount of soil moisture present, the date of planting, the air temperature, the length of the day, and the soil condition, affect the crop's development and growth phases. These elements are in charge of the health and productivity of the plants. For example, corn crop yields can be negatively impacted if temperatures are too high at the time of pollination. For this reason, knowing the temperature at the time of corn pollination could help forecasters better predict corn yields (Nellis *et al.*, 2009).

Nutrient and water status

Nutrient and water stress management are the most significant domains where we can choose to apply remote sensing and GIS through the implementation of precision farming. The use of precision agricultural technologies can enable the wise use of water in semi-arid and arid locations. 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 (Das and Singh, 1989).

Crop evapotranspiration

Crop production is declining as a result of rainfall inconsistencies, temperature increases, and other factors that lead to a reduction in soil moisture. A long-term average condition of the balance between precipitation and evapo-transpiration in a specific location is known as a "drought," which also depends on the monsoon's timely arrival and strength Glantz and Wilhite, (1985). Sruthi *et al*., (2015) analyzed the vegetation stress in the Raichur district of Karnataka by using the MODIS data for calculating NDVI values of the particular study area and its correlation with the land surface temperatures (LST). Estimation of evapotranspiration is essential for assessing the irrigation scheduling, water and energy balance computations, determining crop water stress index (CWSI), climatological and meteorological purposes. The energy emitted from cropped area has been useful in assessing the crop water stress as the temperature of the plants are mediated by the soil water availability and crop evapotranspiration.

Weed identification and management

Precision weed management technique helps in carrying out the better weed management practices. Remote sensing coupled with precision agriculture is a promising technology in nowadays. Though, ground surveying methods for mapping site–specific information about weeds are very time– consuming and labor–intensive. However, image–based remote sensing has potential applications in weed detection for site– specific weed management (Johnson *et al.*, 1997; Moran *et al.*, 1997; Lamb *et al.*, 1999). Remote sensing technology offers a way to identify weeds in crop stands and further aids in the creation of weed maps in the field so that site-specific and need-based herbicides can be applied for the management of weeds. This is based on the difference in the spectral reflectance properties between weeds and crop. In solid stands or pure wheat plots, Kaur et al. (2013) reported higher radiance ratio and NDVI values, and lowest values under solid weed plots. Beyond 30 DAS, it was found that pure populations of *Rumexspinosus* and pure populations of wheat could be discriminated using radiance ratio and NDVI.

Pest and disease infestation

For measuring agricultural stress brought on by biotic and abiotic variables, remote sensing has become a crucial technique. For establishing plans to prevent their expansion and implementing efficient control measures, it is necessary to perfect remote sensing approaches for identifying insect breeding areas. With the assumption that these differences can be correlated, categorized, and interpreted, the remote sensing approach to 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 (Franklin, 2001).

Detecting and mapping defoliation, characterizing pattern disruptions, and supplying data to pest management decision support systems are just a few of the uses for remote sensing that have been used (Lee *et al.*, 2010). In order to distinguish between good and unhealthy vegetation cover, William et al. (1979) analyzed various types of vegetation indices on Landsat imagery obtained before and after defoliation.

Crop yield and production forecasting

Based mostly on statistical-empirical correlations between agricultural production and vegetation indices, remote sensing has been utilized to anticipate crop yields (Thenkabail *et al.*, 2002; Casa and Jones, 2005). Planning national food policy requires knowledge on crop productivity prior to harvest. An essential element of agricultural output forecasting is a reliable crop yield.

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 (Liaghat and Balasundram, 2010). 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 (NRC, 1997). 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 information. Bagheri*et al*., (2013) used multispectral remote sensing for site- specific nitrogen fertilizer management.

Future prospects

Even at small farm holdings, remote sensing is quite helpful in identifying and managing a variety of crop difficulties. It is also very helpful in analyzing various abiotic and biotic stresses in different crops. It is necessary to establish a state- or district-level information system based on the information that is now available on different crops gathered through remote sensing and GIS techniques in order to properly use the information on crops for improving the economy. 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 nanochips 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.

References

Bagheri, N., Ahmadi, H., Alavipanah, S. K. and Omid, M. 2013. Multispectral remote sensing for site-specific nitrogen fertilizer management, *Int. Agrophy.*, 26: 103- 108.

Casa, R. and Jones, H.G. 2005. LAI retrieval from multi-angular image classification and inversion of a ray tracing model. *Remote Sens Environ.*, 98: 414–428.

Lamb, D. W., M. M. Weedon, and L. J. Rew. 1999. Evaluating the accuracy of mapping weeds in seeding crops using airborne digital imaging: Avena spp. in seeding triticale. *Weed Res.*, 39(6): 481–492.

Lee, W., Alchanatis, V., Yang, C., Hirafuji, M., Moshou, D. and Li, C. 2010. Sensing technologies for precision specialty crop production. Computer and Electronic in Agriculture, 74: 2-33.

Liaghat, S. and Balasundram, S. K. 2010. A Review: The Role of Remote Sensing in Precision Agriculture. *American J. of Agri. and Biol. Sci.*, 5 (1): 50-55.

NRC. 1997. Precision Agriculture in the 21st Century Geospatial and information techniques in crop management. National Academy Press, Washington DC, pp.149.

Sruthi, S. and Mohammed Aslam., M.A. 2015. Agricultural Drought Analysis Using the NDVI and Land Surface Temperature Data; a Case Study of Raichur District. International Conference on Water Resources, Coastal And Ocean Engineering, 4: 1252-1264.

Thenkabail, P.S., Smith, R.B. and De-Pauw, E. 2002. Evaluation of narrowband and broadband vegetation indices for determining optimal hyperspectral wavebands for agricultural crop characterization. *Photogramm. Eng.*, 68: 607–621.

Wilhite, D. A. and Glantz, M. H. 1985. Understanding the drought phenomenon: The role of definitions. Water International, 10: 111-120.

Williams, D., Stauffer, M. and Leung, K. 1979 A forester's look at the application of image manipulation techniques to Landsat data. In: Symposium on Remote Sensing for Vegetation Damage Assessment, February 14-16, Washington, The Society, Falls Church, VA, pp. 221-29.

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