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Applications of Remote Sensing in Agriculture

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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 (Shanmugapriya *et al.*, 2019). In remote sensing, the sensors are not in direct contact with the object or the event being observed. The information need a carrier to travel from the object to the sensor through an intervening medium. The electromagnetic radiations are generally used as a carrier of information in remote sensing. When farmers or ranchers observe their fields or pastures to assess their condition without physically touching them, it is a form of remote sensing. Observing the colors of leaves or the overall appearances of plants can determine the plant's condition. Remotely sensed images taken from satellites and aircraft provide a means to assess field conditions without physically touching them from a point of view high above the field. It is a phenomenon that has numerous applications including photography, surveying, geology, forestry and many more. But it is in the field of agriculture that remote sensing has found significant use.

Principle of Remote Sensing

The principle behind remote sensing is the use of electromagnetic spectrum (visible, infrared and microwaves) for assessing the earth's features. A number of interactions are possible when electromagnetic energy encounters matter depending on its properties, whether solid, liquid or gas. This energy may be transmitted, through the substance, absorbed by the substance, emitted by the substance, scattered and ultimately reflected from the substance. The sensors used in remote sensing detect and record changes in electromagnetic radiations by magnitude, direction, wavelength, polarization and phase. The resulting images and data are interpreted to identify the characteristics of matter that produced the changes in recorded electromagnetic radiations.

Basic processes of remote sensing: -

- ✓ Energy source (Sun or transmitter)
- ✓ Transmission of energy from source to object
- ✓ Energy interaction with the object surface
- ✓ Transmission of energy to sensor
- ✓ Scattering and absorption by atmosphere
- ✓ Detection, measurement and output by sensor
- ✓ Data acquisition, recording, pre-processing and interpretation

Remote Sensing in Agriculture

Generally, the passive type of remote sensing system is used in agriculture that senses the electromagnetic energy reflected from soil and plants. Passive system sensors can be mounted on satellites, unmanned or manned aircraft, or directly on farm equipment. There are many applications of remote sensing in the agricultural sector (Sishodia *et al.*, 2020). Below is a summary of these applications.

1. Crop yield forecasting: Remote sensing technology can give accurate estimates of the expected crop yield in a planting season using various crop information such as the crop quality, the moisture level in the soil and in the crop and the crop cover of the land.

2. Assessment of crop damage and progress: In the event of crop damage or crop progress, remote sensing 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.

3. Identification of Crop: Remote sensing has an important role in crop identification especially in cases where the crop under observation is mysterious or shows some mysterious characteristics.

4. Crop acreage estimation: Remote sensing is used in the estimation of the farmland on which a crop has been planted.

5. Crop condition assessment and stress detection: In the assessment of the health condition of plants and quality of the crop.

6. 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.

7. Identification of pests and disease infestation: Remote sensing can be used in the identification of pests in farmland and gives data on the right pests control mechanism to be used.

8. Soil moisture estimation: 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.

9. Irrigation management: Remote sensing gives information on the moisture quantity of soils. This information is used to determine irrigation needs of the soil.

10. Soil mapping: 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. This information helps in precision agriculture.

11. Land cover and land degradation mapping: 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.

12. Identification of problematic soils: Remote sensing has important role in the identification of problematic soils that have a problem in sustaining optimum crop yield throughout a planting season.

13. 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.

14. Crop reflectance modeling: 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.

15. Determination of water content of crops: Apart from determining the soil moisture content, remote sensing can also estimate water content in the field crops.

16. Flood mapping and monitoring: Using remote sensing technology, areas can be map out that are likely to be hit by floods and the areas that lack proper drainage.

17. Water resources mapping: Through remote sensing, farmers can tell what water resources are available for use over a given land and whether the resources are adequate.

18. 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.

19. Crop health analysis: Remote sensing technology plays an important role in the analysis of crop health which determines the overall crop yield.

20. 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.

Limitations in application of remote sensing in agriculture:

- ✓ Remote sensing is a fairly expensive method of analysis.
- ✓ Remote sensing requires a special expertise and training to analyze the images.
- ✓ Large scale engineering maps cannot be prepared with remote sensing.
- ✓ Remote sensing mainly deals with surface phenomena, limited capability to deal with parameters related with soil depth.

Conclusions

Remote sensing systems, using information and communication technologies, generate a large volume of spectral data 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. 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 physio-chemical changes. 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.

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