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Application of Remote Sensing Technology for Soil Fertility and Sustainable Crop Production

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The role of remote sensing facts has reached a great importance in the sphere of soil fertility assessment, crop monitoring, and ensuring sustainability in agriculture. Besides, remote sensing may be understood as a way of gathering data on soil characteristics, crops and vegetation without their physical impact by means of satellites, drones or aircraft. For example, the usage of the remote sensing indices, for example, NDVI, allows to monitor different aspects of plant's physiology from the point of view of deteriorated nutrients or moisture level. Remote sensing provides precision agriculture along with the usage of GIS, soil tests and field observations. The system makes it possible to make higher efficiency of resources usage and diminish over-fertilization and achieve environmental protection. The manuscript contains a thorough overview of the main aspects of remote sensing usage as well as its advantages, disadvantages and perspectives for further implementation in the field of soil fertility management and sustainable agriculture in India.

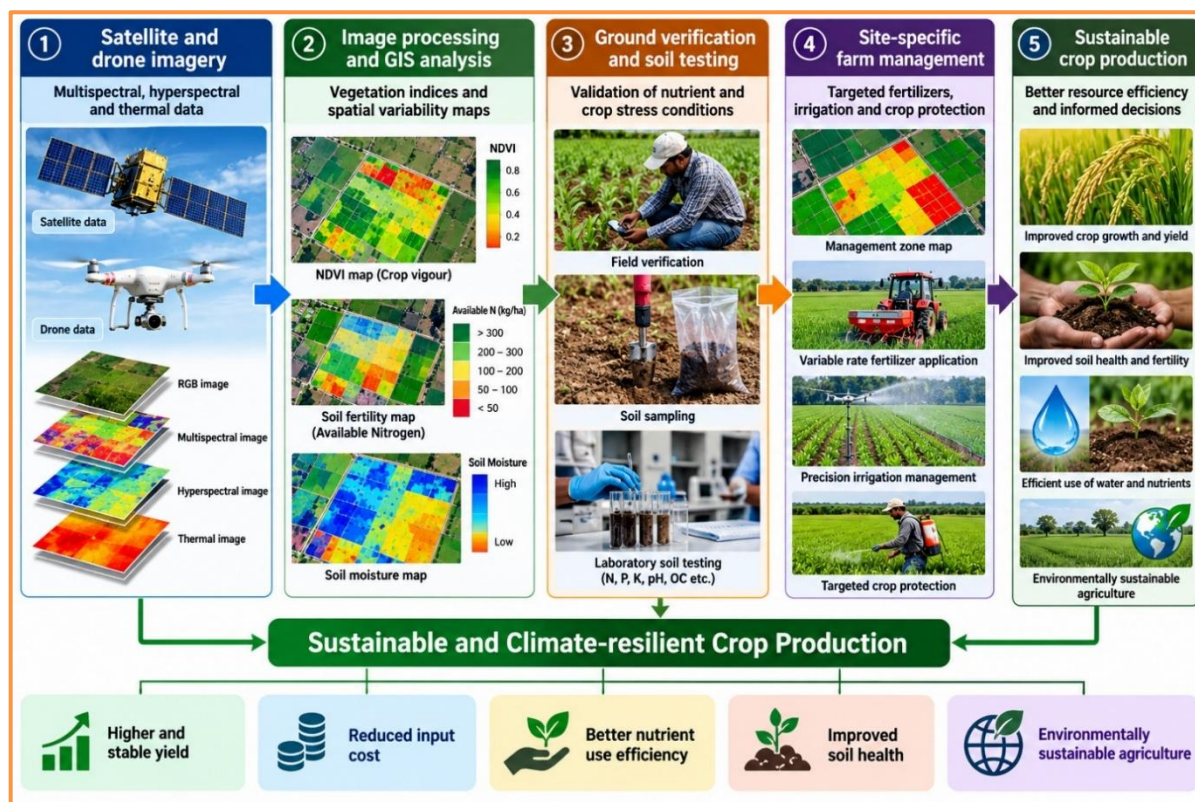
Keywords: remote sensing, soil fertility, precision agriculture, NDVI, sustainable agriculture, GIS, nutrition management.

Introduction

Agricultural enterprises are experiencing challenges in relation to matters such as soil degradation, absence of nutrients, and deficiency of water along with unpredictable weather situation and rising cost of ensuring the process's economic sustainability. Classical sampling methods and management of soil provide certain information about soil; however, they might not be accurate enough for making decisions.

Remote sensing can be a good solution for monitoring agricultural resources over extensive areas. For instance, satellites like Sentinel-2 and Landsat could provide multispectral information for studying plants, assessing the area of crops, tracking the humidity of soil, etc. Using remotely piloted aircrafts can improve the accuracy of data collection for smaller farms.

Although remote sensing technologies do not substitute some soil tests conducted in laboratories in terms of accuracy of providing information about the nutrients of a particular soil type, they can be beneficial for the determination of the regions with problems.



Methods and Materials

The article is written based on the review of existing scientific literature, remote sensing and agricultural monitoring techniques. The important methods of conducting agricultural remote sensing are described below.

Technologies of remote sensing

- Satellite remote sensing: Satellite images obtained from Sentinel-2 and Landsat satellites can be utilized in the measurement of vegetation, crop growth, and distribution.
- Drone remote sensing: Unmanned Aerial Vehicles equipped with RGB, multispectral, or thermal sensors are used to gather information concerning fields and crops.
- Vegetation indices: Vegetation indices such as NDVI are used to determine plants' condition.
- GIS technology: Geographic information system processes a number of images as well as soil testing data.

Uses of Technology in Soil Fertility and Crop Production

Evaluations of soil fertility

Remote sensing technology shows the potential of finding the variations in the soil features like organic matter characteristics, surface moisture, salinity and variability. These estimates depend on the soil type, the condition of the field, the sensor's characteristics and calibration. There isn't any telling here that satellite imagery may provide significant information regarding nitrogen, phosphorus and potassium in the soil; however, this cannot replace laboratory testing.

Determining lack of nutrients

Leaf color, canopy structure as well as chlorophyll content are affected by nutrient stress. In many cases, variations in nutrient stress levels can be revealed by using multispectral and hyperspectral sensors but such technologies can be also responsible for disturbance caused by drought, pests and disease. Thus, soil testing and ground truthing are needed.

Precision nutrient management

Remote sensing can be used for dividing fields in terms of crop health and spatial variability. This allows for combining maps of the fields and soil test results, crop nutrition requirements and data on crop yields. Thus, farmers have an opportunity to use fertilizers more precisely and increase the efficiency of nutrient use.

Monitoring crop health and irrigation

By utilizing images taken from satellites and drones, it is possible to observe regions where crops germinate unequally and where there is a lack of water among other locations where problems might occur. In addition to this, it is also possible to utilize heat images and climate data in order to make irrigation decisions. Early detection of an issue helps farmers to conduct further inquiries.

There is no doubt that satellite imagery can offer important information about the concentration of nitrogen, phosphorus, and potassium in soil, but it should not be regarded as a substitute for lab studies.

Identifying nutrient deficiency

The basic fact of nutrient deficiency is that it will affect the color of the leaves, leaf canopy structure and amount of chlorophyll.

Application	Technology or indicator	Major benefit
Crop vigour monitoring	NDVI, Sentinel-2	Identifies variation in crop growth
Nutrient stress detection	Multispectral and hyperspectral sensors	Locates areas requiring investigation
Soil variability mapping	Satellite imagery and GIS	Supports management-zone delineation
Irrigation management	Uses thermal imaging and vegetation indices	identifying crops experiencing drought stress
Precision fertilization	Uses remote sensing with soil analysis for	fertilizer application
Yield estimation	Vegetation indices and crop models	Supports production planning

Illustrative Workflow

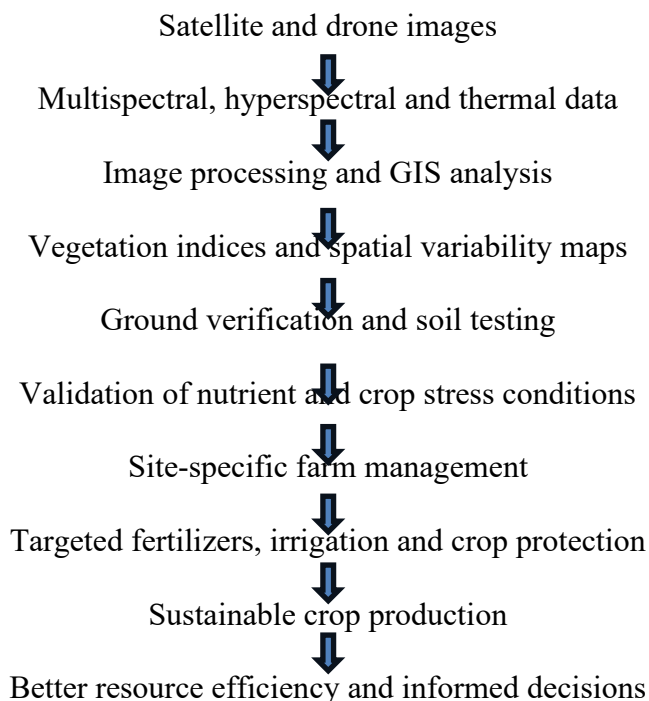


Figure 1: Processes involved in the use of remote sensor in managing soil fertility and crop production sustainability.

Difficulties and Future Opportunities

Remote sensing has a lot of potential but it still has numerous limitations. For example, the presence of clouds may hinder the user from obtaining useful satellite images. Further, agriculture can be performed on small and fragmented farms that may require data of a much

greater resolution. There are other limitations, such as sensor calibration, technical knowledge, costs of data processing, and restricted availability of digital technologies. Modern innovations including artificial intelligence, machine learning, and cheap drones have the potential to improve agricultural monitoring in rural areas. These technologies will allow farmers to implement precision farming thanks to the use of remote sensing technologies as well as other services such as soil health card, laboratory testing of soil samples, and the provision of farming advice.

Conclusion

Remote sensing refers to the use of sensors in assessing crop health or checking how the soils vary in terms of condition and controlling agricultural inputs. However, the use of remote sensing can be considered a successful method in terms of effective management of nutrients and sustainability only with the help of GIS, soil investigation, and the collection of data from the field. Moreover, it is necessary to outline that the role of spectral index is complementary in the majority of cases rather than replacing traditional agricultural practices. Furthermore, it is necessary to stress the significance of the dissemination of the data, accessibility of technology, and training farmers on how to adopt remote sensing in the sustainable agriculture.

References

1. Basso, B., and Antle, J. (2020). The application of digital technologies in agriculture for sustainable agricultural systems, *Nature Sustainability*, 3, 254-256.
2. Hatfield, J. L., Gitelson, A., Schepers, J. S., and Walthall, C. L. (2008). The role of spectral remote sensing in agricultural decision-making, *Agronomy Journal*, 100(Suppl. 3), S-117-S-131.
3. Mulla, D. J. (2013). The journey of remote sensing in precision agriculture for the last 25 years: successes and knowledge gaps, *Biosystems Engineering*, 114(4), 358-371.
4. Thenkabail, P. S., Smith, R. B., and De Pauw, E. (2000). The link between hyperspectral indices and crop attributes, *Remote Sensing of Environment*, 71(2), 158-182.
5. European Space Agency, Sentinel-2 Project.
6. U.S. Geological Survey, Landsat Project.