

# THE ROLE OF REMOTE SENSING IN HIGH-TECH AGRICULTURE

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*Vietnam's history has always been closely linked to agricultural production. Today, the Party and State's orientation is to fundamentally transform Vietnam into an industrialized nation. However, the role of agriculture remains indispensable. We are gradually transforming a traditional agricultural system into a high-tech one with the assistance of many advanced scientific and technical fields, including the role of remote sensing technology. This article addresses the general concept of high-tech agriculture and the role of remote sensing in this field.*

*Keywords:* *High-tech agriculture; Remote sensing.*

## 1. **High-tech agriculture**

High-tech agriculture is an agricultural system that aims to achieve the following goals: minimal production costs; high productivity and product quality; reduced negative environmental impacts; improved soil quality; and the application of advanced technologies in agricultural management.

The system integrates high technologies in agricultural management, including: Global Positioning System (GPS); Geographic Information System (GIS), yield monitor technologies and variable rate technology and Remote Sensing (RS) [1], [2].

The main components of a high-tech agricultural management system are:

- Space data collection systems: Remote sensing; space control systems: GPS; information technology for controlling agricultural machinery and equipment;
- Database system: GIS;
- A system for assessing the impact of agricultural production on the environment;
- A system for evaluating agronomic and economic efficiency.

High-tech agricultural techniques are implemented through several steps:

- Step 1: Collect and accumulate spatial data, including remote sensing data monitoring vegetation status and data analyzing soil samples. At this stage, GPS and GIS technologies are used to create the database.
- Step 2: Analyzing and interpreting the thematic spatial information. In this stage, thematic maps are created for each field and each crop type to make decisions about using appropriate agricultural techniques.
- Step 3: Implement agricultural techniques, such as determining crop yields, along with fertilizer or pesticide types, adjusting cropping schedules, etc. During this stage, variable rate technology is used, which allows for the precise determination of agricultural input standards.
- Step 4: Evaluate and determine food production on each field. This includes collecting factual information during harvesting or forecasting information based on the results of determining crop growth stages using remote sensing technology.
- Step 5: Evaluate the effectiveness of applying high-tech agricultural techniques, including three main aspects: agronomy (increased productivity), economics (reduced costs), and environment (minimizing environmental impact).

## 2. **Applications of remote sensing in high-tech agriculture.**

Remote sensing is widely applied in many fields today, including applications to assess the state of vegetation cover. Surface cover remote sensing allows assessment of the development process and state of the cover at levels such as within the framework of individual countries, regions and continents to individual vegetation cover areas. In high-tech agriculture, remote sensing is applied to create agricultural maps, determine agricultural land funds and assess the level of destruction of cultivated land; monitor the area of different crops and assess land use; monitor the growth of agricultural crops; monitor plant pests and diseases; monitor soil pH, salinity, drought or excess water; determine food production, etc.[3].

Traditionally, agricultural yields have been assessed based on the average value of large fields or regions. In reality, yields are not uniform across large fields, or even individual plots. The condition of individual crops and plant populations as a whole is affected by a range of factors such as:

- Weather factors: Frequency and amount of rainfall; number of sunny days; temperature;...
- Soil factors: Physical and mechanical properties, structure and density of the soil; humus content, soil fertility; water supply and drainage; soil metabolic capacity; pH;...
- Factors contributing to agricultural investment include: initial seeds; planting quotas; uniformity of growth; crop rotation; soil improvement methods; lessons learned from previous seasons; insufficient irrigation; lack of plant protection equipment; lack of basic nutrients; errors related to farming techniques; incorrect planting seasons; etc.
- Geographical factors: Slope of the terrain; correlation between illuminated locations;...
- Biological factors: Damage caused by pests (insects, rodents); by weeds; plant diseases caused by other factors (viruses, fungi, etc.).

Under the complex influence of the aforementioned factors, changes occur in the physiology and morphology of individual plant species (at the micro level), as well as of the entire plant population (at the macro level).

At the microscopic level, plants respond by altering both the quantity and quality of pigments and chlorophyll structure, and by changing the surface properties and moisture content of the leaves. These responses are reflected in the plant's spectral reflectance, particularly pronounced when the plant is in an abnormal state.

At the macro level, spectral reflectance indicates fundamental parameters of vegetation such as pigment suppression, chlorophyll reduction leading to slowed growth, reduced biomass, and ultimately reduced crop yield. These changes inevitably disrupt the structure of the vegetation: altering ground cover

levels and reducing leaf area index. Under the influence of this overall process, the spectral reflectance characteristics of the vegetation cover change, and this is key to applying remote sensing technology to assess crop status and yield.

Most remote sensing methods rely on electromagnetic radiation parameters, obtained during interaction with the objects under study. The interaction of electromagnetic radiation with the ground cover is quite complex because this process involves not only reflection, but also absorption and passage through the vegetation cover of incoming energy (such as solar energy), thus the object under study is considered a "ground-vegetation" system. The electromagnetic radiation and reflection (or back-radiation) properties of the aforementioned system are determined primarily by the following factors:

- The optical properties of plants change continuously during growth, depending on the surrounding environment;
- The structure of the vegetation cover is constantly changing over time (crop density, leaf surface area, leaf orientation, degree of soil cover by plants);
- Reflections of each soil type (particle size, humus content), moisture content, mulch (dead plant matter), soil treatment methods, and other factors;
- Conditions for acquiring remote sensing images include: flight altitude, shooting angle, sun elevation angle, relationship between direct and scattered radiation, etc.
- State of the atmosphere: scattering characteristics caused by gas molecules, dust particles, aerosols, water vapor, etc.

Furthermore, changes in surface cover reflectance parameters are also caused by other factors such as nutrient deficiencies or excesses, soil pollution levels, drought, or pests and diseases. This makes it difficult to classify crop problems through spectral measurements, thus requiring additional investigations in the photographed area regarding factors such as the physiology and biochemistry of the crops.

To determine the role of remote sensing in high-tech agriculture, as well as the most economically viable application methods, several questions need to

be answered. First, and most fundamentally, does remote sensing technology meet the needs of users? It's important to understand that information received from remote sensing imagery, like any other information, is presented in a highly detailed and reliable manner. Remote sensing images are captured from space using receivers placed on remote sensing satellites.**wide coverage**Each remote sensing image covers an area of hundreds of square kilometers.<sup>2</sup>Images from VNREDSat, IKONOS, and QUICKBIRD can reach thousands of kilometers.<sup>2</sup>like SPOT images, Landsat, or images from tens of thousands of kilometers.<sup>2</sup>such as MODIS images,... Remote sensing images include**Multi spatial resolution**From centimeters to kilometers. The objects captured and their attribute information extracted from the images are completely objective and accurate.

Secondly, how is information received using remote sensing technology integrated into a database for further processing and analysis? Remote sensing technology is closely linked to the spectral characteristics of the objects being captured. There are different types of remote sensing imagery.**multiple spectral channels**It allows for the classification of objects and the identification of information about their physical state, structure, and properties. Image processing technology is a digital technology that facilitates the storage and analysis of data using GIS (Geographic Information System).

Third, what is the fastest time for users to receive remote sensing data? Remote sensing imagery data is available.**repeat shooting cycle**Daily, weekly, and monthly monitoring of the same object allows for the identification of changes and developments in those objects. Vietnam's VNREDSat imagery has a 23-day repeat cycle. Ordering imagery from foreign satellite companies with shorter cycles, meeting practical needs, is entirely easy and poses no obstacles.

There are many approaches to applying remote sensing technology in high-tech agriculture. Initially, remote sensing technology was only applied to detect and pinpoint abnormal plant growth, manifested in factors such as crop failure, pests and diseases, weeds, nutrient deficiencies, irrigation problems, etc.

The second approach is based on discovering quantitative relationships between physiological parameters of vegetation state and their spectral reflectance due to the influence of exogenous factors and applied agricultural techniques.

The third approach is to integrate several physiological parameters of vegetation (biomass, cover, leaf index) or radiation parameters of plants (evaporation, active radiation levels), through remote sensing data and mathematical and physiological models, to estimate crop yields, thereby making decisions within the framework of high-tech agricultural applications.

### **3. Prospects in the near future**

Currently, the application of remote sensing technology in Vietnam to solve practical problems in high-tech agriculture is still in its early stages. This is mainly due to the high cost of remote sensing data and some technical limitations. There is every reason to believe that with a new generation of satellite systems (with high spatial and temporal resolution) and a large number of companies in the remote sensing service market, including small Vietnamese satellites, the role of remote sensing will increasingly be demonstrated and widely applied in the emerging high-tech agriculture in our country.

### **References**

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