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Precision Farming

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ABSTRACT: -

India's population growth is accelerating, but food production is decreasing, leading to a decrease in per capita food availability. To improve agriculture quality and quantity, a global shift towards scientific and sustainable practices is needed. Precision farming, also known as precision agriculture (PA), is a key component of this paradigm shift. PA optimizes agricultural practices by using technology to improve crop yields and management decisions. It involves site-specific management practices tailored to specific areas within a field, aiming for maximum production and minimal inputs while minimizing environmental damage. Precision farming uses large amounts of data to improve agricultural resource use, yield, and crop quality. Farmers use scientific tools like GPS, VRA, drones, sensors, and data analytics to assess and manage variability within fields. This allows farmers to make informed decisions about planting, pest control, irrigation, and fertilization, leading to more efficient resource utilization, increased crop yield, improved farm management, and less environmental impact.

Importance of Precision Farming

Precision agricultural technology and maintaining the condition of the soil through optimal use allows the farmers to remotely manage every aspect of operation and also for a steady supply of food. Precision farming can raises the productivity of the crops significantly while saving money and enhances

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crop efficiency. It has many advantages such as preserving the health of the soil by using fewer pesticides as a result the degradation of the soil is less, limiting the prices of supplies and resources (fuel, water, seeds), long-term agricultural operation planning and enabling real time strategy adjustments and increased attention to management, lowers the dependence of agriculture on weather conditions. It also empowers farmers with data-driven insights, innovative technologies and tailored recommendations to make informed decisions, maximize output and ensure sustainable agricultural practices and as a result change the socio-economic status of the farmers.

There is a need for Indian farmers to take precision farming to meet the huge food grain requirement of 480 Mt by the year 2050, since the population of our country is increasing and land production of food grains is decreasing due to biotic and abiotic stresses experienced by the crops, natural resources are diminishing and degrading, variation in global climate so introduction and adoption of modern technology in Indian agriculture is inevitable.

Constraints of Precision Farming

Precision farming involves leveraging technology to enhance agricultural practices, yet several challenges hinder its widespread adoption. Financial constraints like the utilization of advanced technologies such as GPS-guided tractors and drones incurs substantial costs. The initial investment, coupled with on going expenses for maintenance and upgrades, poses a significant financial barrier. This economic burden particularly affects smaller-scale farmers with limited budgets. Limited technology access like uneven accessibility to modern agricultural technologies creates a digital divide among farmers. Geographical isolation and insufficient infrastructure can prevent some farmers from incorporating these advanced tools, impeding the universal adoption of precision farming practices. Effectively utilizing precision farming tools requires a certain level of technological literacy. The absence of comprehensive education and training programs prevents farmers from acquiring the necessary skills to operate and interpret data from these technologies, hindering successful implementation. Precision farming generates vast data sets through sensors and GPS devices. The ability to manage, analyse, and derive actionable insights from this data is crucial. Insufficient data management skills can lead to information overload, hindering farmer’s ability to make well-informed decisions. Robust infrastructure, particularly reliable internet connectivity, is essential for the seamless operation of precision farming technologies. In regions lacking such infrastructure, real-time data transmission and communication with smart devices become challenging, limiting the effectiveness of precision farming practices. Precision farming is often tailored for larger agricultural operations, and the associated investment and technology deployment may not be practical for smaller farms. Smaller-scale farmers may struggle to justify the costs of precision farming, as the benefits may not align with their operational scale. Precision farming technologies are sensitive to environmental conditions, especially weather patterns. Adverse weather events, such as heavy rainfall or extreme temperatures, can impact the performance of GPS systems, drones, and other precision tools, introducing risk and uncertainty.

REMOTE SENSING:

Definition:

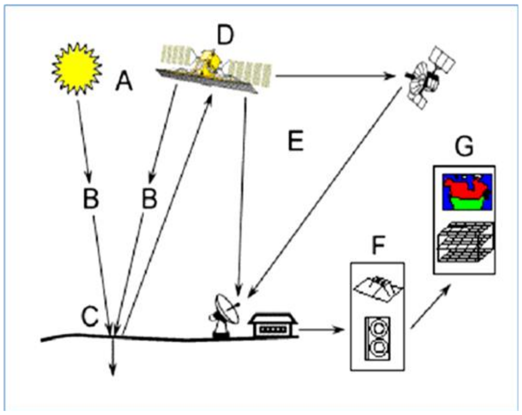
It is the gathering of data about objects and the earth's surface without making direct physical contact with them. It involves the utilization of electromagnetic radiation emitted by the targets of interest to acquire input from the sensor to obtain data or information about objects or substances that are not in direct touch with it. The definition of remote sensing is the science and technology that allows one to identify, measure, or evaluate an object's features without having to come into direct touch with it.

"Remote sensor" or "sensor" is the device which is used detection of electromagnetic radiation reflected or emitted from an object. One common example of a remotely sensed (by camera and film, or now digital) product is an aerial photograph.

The sun is a source of radiation and energy, making it an ideal energy source for remote sensing. When it comes to visible wavelengths, the sun's energy is reflected; when it comes to thermal infrared wavelengths, it is absorbed and then reemitted. Crop identification, crop area production estimation, disease and stress detection, and soil and water resource management are all impacted by remote sensing techniques. Applications of remote sensing have grown in significance for macroeconomic decision-making concerning the nation's food security, poverty, and sustainable development. In India, Pisharoth Rama Pisharoty is credited as founding the field of remote sensing.

BASIC CONCEPT OF REMOTE SENSING:

The interaction between incident radiation and the targets of interest is a common phenomenon in remote sensing. The installation of imaging systems involves the following seven elements as follows



I. **Energy Source or Illumination (A):** A power source that can illuminate the target of interest or supply electromagnetic energy to it is the primary prerequisite for remote sensing.

II. **Radiation and the Atmosphere (B):** The energy will encounter and interact with the atmosphere it passes through on its way from its source to the target. The energy may interact with the target again throughout its journey to the sensor.

III. **Interaction with the Target (C):** Depending on the characteristics of the target and the radiation, the energy interacts with the target after passing through the atmosphere.

IV. **Recording of Energy by the Sensor (D):** A remote sensor which is not in contact with the target is required for collecting and recording the electromagnetic radiation that has been scattered by or emitted from the target.

V. **Transmission, Reception, and Processing (E):** A receiving and processing station where the data are processed must receive the energy that the sensor recorded, usually in the form of an electronic transmission.

VI. **Interpretation and Analysis (F):** To extract information about the illuminated target, the processed image is analyzed visually, digitally, or electronically.

VII. **Application (G):** The last step in the remote sensing process is applying the knowledge we were able to gather from the imagery about the target to help solve a specific problem, gain new perspectives, or gain a better understanding of it.

TYPES OF REMOTE SENSING/SENSORS:-

There are two main types of remote sensing: Passive remote sensing and Active remote sensing.

- **Passive remote sensors/sensing:** Identification any natural radiation that the object or the area is reflecting or emitting. The most frequent source of radiation detected by passive sensors is sunlight that has been reflected. Radiometers, infrared cameras, and film photography are a few types of passive remote sensors.

- **<u>Active remote sensors/sensing</u>:** The radiation that is reflected or backscattered from the target is then detected and measured by a sensor after the source of energy has been released to scan the area and objects. Using active remote sensing, such as RADAR, one can determine an object's location, height, speed, and direction by measuring the time interval between emission and return.

Applications of Remote Sensing in Agriculture:

1. **Forecasting of crop production:** Through remote sensing, one may predict how much crop will be harvested under particular circumstances and estimate agricultural production and yield across a specified area. Researchers can forecast how much crop will be produced in a specific acreage over a specific amount of time.
2. **Evaluation of crop development and damage:** Remote sensing technology can be used for assessment of agricultural damage or progress, allowing farmers to precisely assess the amount of crop damage and the state of the remaining crop
3. **Analysis of Cropping and Horticultural Systems:** The study of different crop planting strategies has also benefited greatly from the use of remote sensing technology. The horticultural sector, where flower growth patterns may be examined and predictions made based on the study, has been the primary application for this technology.
4. **Identification of Crop:** In circumstances in which the crop being observed is intriguing or exhibits other strange features, remote sensing has also shown to be very helpful in crop identification. Crop data is gathered and brought to the Jabs for study of the crop's different features, including crop culture.
5. **Forecasting crop acreage:** Another significant application of remote sensing has been in the assessment of the amount of farmland used for crop planting. Since the areas to be estimated are so large, measurement done manually is typically a laborious process.
6. **Evaluation of crop quality and identification of stress:** The evaluation of all the crop's health and resistance to stress is assisted by the use of remote sensing technologies. The crop's quality is then determined using this data.

7. **Determining the dates for planting and harvesting:** According to the predictive abilities of remote sensing technology, farmers can now use it to study a range of elements, such as soil types and weather patterns, to estimate when each crop will be planted and harvested.

Conclusion

The true potential of precision agriculture primarily hinges on the disparity between scientific understanding and technological capabilities between technological advancements and human cognitive processes. The key objective of precision farming is to minimize environmental damage while gaining optimum output with the least amount of input. Precision farming helps to provide benefit to both farmers and society through increasing production efficiency. At the same time there are several constraints in precision farming also so necessitates comprehensive solutions are necessary that consider financial, technological, educational, infrastructural, and environmental aspects to promote the successful integration of precision farming across diverse agricultural settings.

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