Vol. 4 Issue- 5, January 2024 (e-ISSN: 2582-8223)

Precision Agriculture and Emerging Technologies to Smart Farming

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ARTICLE ID: 43

Introduction

Precision agriculture can be defined as the application of principles and technologies to manage spatial and temporal variability associated with all the aspects of agricultural production for the purpose of improving crop performance and environmental quality, according to Pierce and Nowak, 1999. Precision agriculture is also known as precision farming in which in-field variability is taken into account and according to the local circumstances of a given field, seeding, nutrient management, plant protection measures etc. are taken up.

Thus, precision farming which is based on information and knowledge is a new combined technique for the scientific management of modern agriculture. It is a complete system that takes full advantage of available agricultural resources, reduces pollution to protect environment and promotes sustainable agriculture. The main objective of precision farming is to optimal use of inputs, resulting in increased gross margins with reduced impact on the environment. This can be done by new emerging information technologies such as Global Positioning System (GPS), Geographical Information System (GIS), remote sensing, yield monitors, Variable-Rate Technology (VRT), SSNM and Laser Land Leveller.

Technologies involved

Global Positioning System (GPS)

It is navigation system based on a network of satellite that helps users to record positional information (latitude, longitude and elevation) with an accuracy of between 100 and 0.01 m. GPS allows farmers to locate the exact position of field features such as soil type, pest occurrence, weed invasion etc. GPS receivers, either carried to the field or mounted on implements allows users to return to specific location to sample or treat those areas. The system enables farmers to accurately identify field location, facilitating the targeted application of

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inputs such as seeds, fertilizers, herbicides, pesticides and water. This process is guided by performance criteria and previous input application for each individual field.

Geographical Information System (GIS)

GIS consists hardware, software and procedure designed to support the compilation, storage, retrieval and analysis of feature attributes and location data to produce maps. An impotant function of an agricultural GIS is to store layers of information such as yields, soil survey maps, remotely sensed data, crop scouting reports and soil nutrient levels. It helps to convert the digital information to a form that can be recognized and used. It is computerized map, but the primary of GIS is using statistical and spatial methods to analyze both characteristics and geography. A GIS can provide information on field topography, soil types, irrigation, surface and subsurface drainage, chemical application and crop yield. After analysis, this information is utilized to understand the relationship among the various elements influencing a crop in specific location.

Importance of GIS

1. Perform geographic queries and analysis
2. Improve organizational integration
3. Making maps
4. Make better decisions

Remote Sensing (RS)

Remote sensing is an art and science of obtaining information about an object or feature without physically coming in contact with that object or feature. Human apply remote sensing in their day-to-day business, through vision, hearing and sense of smell. Data sensors can simply be hand held devices, mounted on aircraft or satellite based. Remotely sensed data provide a tool for evaluating crop health. Plant stress related to moisture, nutrient, compaction, crop diseases and other plant health concerns are often easily detected in overhead images. Remote sensing can reveal in season variability that affects crop yield and can be timely enough to make management decisions that improve profitability for the current crop.

Main stages in remote sensing are the following:

A. Emission of electromagnetic radiation
   - ➢ The Sun or EMR source located on the platform

B. Transmission of energy from the source to the object

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- Absorption and scattering of the EMR while transmission

C. Interaction of EMR with the object and subsequent reflection and emission

D. Transmission of energy from the object to the sensor

E. Recording of energy by the sensor

- Photographic or non-photographic sensors

F. Transmission of the recorded information to the ground station

G. Processing of the data into digital or hard copy image

H. Analysis of data

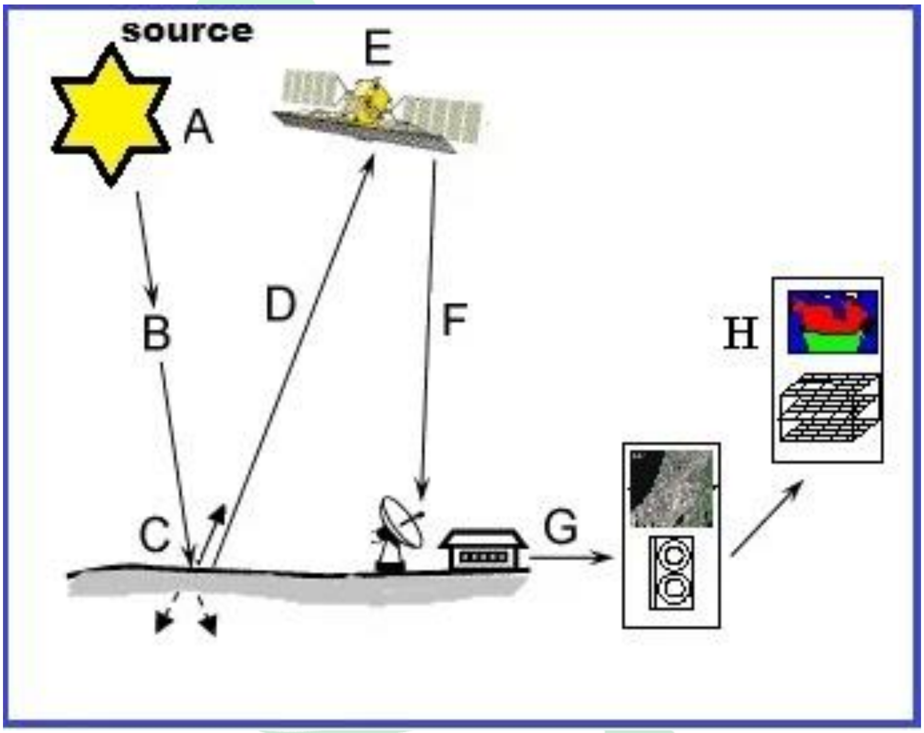

Fig 1. Stages of Remote Sensing

Yield Monitoring and Mapping

It consists several different types of sensors and other components, including a data storage device, user interface (display and key pad) and a task computer located in the combine cab, which control these components. The sensors measure the mass of grain flow, separator speed, ground speed, grain. The yield is continuously recorded by measuring the force of the grain floe as it impacts a sensible plate in the clean grain elevator of the combine. It works on the principle of transmitting beam of microwave energy and measuring the portion of that energy that bounces back after hitting the stream of seeds flowing through the chutes. GPS receivers also mounted to record the location of yield data and create yield maps.

Variable-Rate Technologies (VRT) or Variable-Rate Applicator (VRA)

It is automatic and may be applied to numerous farming operations. The VRT systems set the rate of delivery of farm inputs depending on the soil type noted in a soil map. Information extrapolated from the GIS can control processes such as seeding, fertilizer, herbicide and pesticide application, at a variable rate in the right place and at the right time.

Site-Specific Nutrient Management

Site-specific nutrient management (SSNM) is an approach of supplying plants with nutrients to optimally match their inherent spatial and temporal needs for supplemental nutrients. The SSNM provide an approach for supplying nutrient to crops based on their specific needs. The main aim of SSNM is to increasing farmer’s profit by achieving the goal of maximum economic yield of crops.

The main features of SSNM are:

1. Nitrogen, Phosphorus, potassium, other secondary and micronutrients are applied specifically to sites based on soil test results.
2. Efficient utilization of available nutrients, including those from the soil, residues and manures.
3. SSNM offers guidance for choosing the most cost-effective combination of nutrients.
4. Encourages the judicious and efficient utilization of indigenous nutrient sources such as crop residues and manures.

Laser Land Leveler (LLL)

Farmers traditionally have been practicing land levelling in their fields by using animal drawn levelers. Traditionally leveled lands lead to water logging conditions at low areas and less soil moisture in higher levels. About 10-25% of irrigation water is lost during application at the farm due to poor management and uneven fields.

Precision land levelling helps in controlling the emergence of salt affected patches, increasing cropping intensity and crop productivity in cultivable land area by 3-5%, improving the crop establishment, reducing the weed intensity and saving the irrigation water. Laser levelling involves altering the field in such a way as to create a constant slope of 0-0.2%. this practice makes use of large horsepower tractors and soil movers that are equipped with GPS and laser guided instrumentation so that the soil can be moved either by cutting or filling to create the desired slope.

Major components of Laser Land Levelling:

1. Drag bucket
2. Laser transmitter
3. Laser receiver
4. Control box
5. Hydraulic system

Benefits of LLL:

1. Improving uniformity of crop maturity
2. Increasing approximately 3 to 5% of cultivable land area
3. Increasing water application efficiency potential upto 50%
4. Saving irrigation water by approximately 35-45%
5. Reducing weed problems