

PRECISION FARMING: THE FUTURE OF AGRICULTURE AND NATURAL RESOURCE MANAGEMENT UNDER CHANGING CLIMATIC CONDITIONS

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ABSTRACT

Agricultural production frameworks are profoundly powerless against variability in environment, soil and geography of various areas. For future agricultural production, every one of these variables should be dissected on spatio-temporal premise. The modern technologies like GIS, GPS and remote sensing, could bring about a great use for their evaluation and management. Precision farming is data and innovation based agricultural administration framework to distinguish, dissect and oversee site-soil, spatial and temporal inconstancy inside fields for ideal benefit, supportability and insurance of the climate. Remote sensing innovation assumes a significant part in precision agriculture, its applications are most definitely going to bring enhancement in agricultural practices. With assistance of global positioning system (GPS), it is feasible to record field information as geographically latitude and longitude information. It has ability to decide and record the right position constantly, so consequently, it can make a bigger information base for the users. For further analysis geographic information system (GIS) is required, that can help in storage and handling of these information. This writing features about remote sensing innovation, GIS, GPS and give you a thought regarding, how it tends to be important in precision agriculture.

Key Words: Precision farming, GIS, GPS, Remote Sensing

INTRODUCTION

Since early period, people are utilizing land for significant purposes. Food and water are essential assets which we need for our lives and are our extreme concern when we are making a sustainable world. Improvement in annual yield is a significant concern in agriculture. All the components such as farming, or dairy, or fishery, everything should

maintain an equilibrium. Such areas should be selected, where crops can be grown at its maximum potential. Those soils need particular treatment and balanced nutrients for growing best crop. Hence the interest of site-specific agriculture emerged (Hartkamp et al., 2000).

Today, new digital technologies have been made in agriculture sector to utilize soil fertility, soil survey, crop production, crop protection and fertilizer application. Computer applications like geographical information system (GIS), global positioning system (GPS) and remote sensing add to the speed and productivity of overall agronomic practices. Hence, precision agriculture which depends on data and information is a combined strategy of modern agribusiness. It is a complete framework that exploits available agricultural assets, diminishes environment pollution and boosts sustainable agriculture.

Agricultural productivity these days may arrive at highest point due to worldwide accessibility of synthetic fertilizers, pesticides and herbicides. However, maximum use of these products and lack of consciousness can diminish our agricultural productivity and endanger the ecological equilibrium.

Agriculture is turning out to be more modern by the use of remote sensing, GPS, GIS and data analytics. A huge number of farmers are adapting new technologies to make their cultivation more exact. Farm equipment can map fields, drive themselves and check its own movement inside inches so it can minimize the loss of fertilizer, seed and fuel.

Precision agriculture can be characterized as the principle of spatial and temporal irregularity that is related with all agricultural practices to improve crop and environment quality (Pierce et al. 1999). Precision agriculture is about controlling variation in the field precisely to develop more food production by utilizing less inputs and decrease cost of cultivation.

All part of climate such as soil, vegetation, weather, water changes from one place to another. Each factor of these variables decides crop growth and its success rate. Farmers have always known about this, yet they came up short on the device to quantify, plan and deal with these variations. Subsequently, precision farming can have an effect to food production facing the challenge of increasing population and can help farmers to get (Venkataratnam et al.,2001):

- Crop details such as growth stage, crop health, nutrient requirements of the crop

- Soil physiochemical parameters such as electrical conductivity, soil temperature, soil moisture content, evapotranspiration
- Microclimatic data such as humidity, wind direction and speed, canopy temperature
- Surface and sub surface drainage conditions

Geographical information system (GIS)

A geographical information system (GIS) is a combined structure that gathers, manages and analyses the data. Established in the study of geography, GIS coordinates many types of information. It analyses a particular area and coordinates layers of data into visualization by utilizing map and 3D scenes. With this extraordinary capacity GIS converts deeper insights into data like relationships, patterns and circumstances which helps people to take smarter decisions.

GIS is a piece of a setup of technology that helps to make a research more appropriate. The framework requires fundamental essential data that is relevant to specific project. This importation of data into a GIS would require time and consideration, because this data will give the essential information on the domain and individual parameters and it is hard to modify latter (Basso et al., 2005). According to Basso et al., all the data in a GIS can be interconnected with each other and processed simultaneously, acquiring a syntactical articulation of the progression induced in the system by the varieties of parameters.

GIS offers valuable support to handle out voluminous information that are created through general and spatial format and for the incorporation of these data indexes (Vadivelu et al., 2007). GIS producers utilizes a computerized map that permits the user to see, update, question, analyse and control the spatial and tabular information either alone or together, in a quick time. Unlike paper map, GIS can plan and analyse huge agricultural data necessary for crop production (Senthurpandian et al., 2007).

Use of GIS in Agriculture

In agricultural production around the world, GIS has played a very beneficial role, providing farmers with the most suitable solutions to increase crop yields, reduce costs by applying fertilizers in a balanced way, and managing their land more effectively (A.Fourie 2009).

All sectors that are related to agricultural industries use Geographic Information System (GIS) technology to share data, increase production, predict results, and enhance business opportunities. With addition of GIS technology to their operations, farm operators can co-list resources and responsibilities more effectively, can design data portals that gets large amounts of farm data published, form interactive maps, and support farming communities. One layer on the agricultural area map can represent the boundary of a particular land part, while the second layer represents the type of soil and the third layer represents the crop yield or specific soil management (ESRI, 2007)

In this age of computer and information technology, it is very important to elevate farm management to a new level. In developed countries, for information technology reasons, the solution to every problem can be achieved with a single click on the Internet. For a long time, GIS has been providing spatial solutions and suggestions for different agricultural problems through remote sensing, statistical analysis of spatial data, and delineation of sustainable agriculture fields. With the help of Web-GIS, all aspects of any agricultural problem can be solved at any time through maps, graphs and user interaction functions in the area. In this way, farmers can complete their work more efficiently without wasting time and money. In underdeveloped countries, information technology is an emerging platform through which relevant information can be transmitted to farmers, educational institutions, researchers and any other interested party.

Use of GIS in regional levels

The combination of these technologies and remote sensing data has been used to assess land capacity (Corbett et al., 1996), crop conditions and yields (Carbone et al., 2005), grassland conditions, floods and droughts, soil erosion, soil compaction and the impact of climate change at the regional level (Kern et al.).

In particular field and subfield scale applications are tied to precise or site-specific agriculture, helping to target seeds, fertilizers, pesticides, and pesticides in a way that optimizes agricultural yields, minimizes chemical inputs, and hazards. environmental Water application in the field (Carr et al., 2011). GIS can be used to produce production-based production systems in precision farming, which can be designed to promote long-term, special-on-site along with total production efficiency, elaborate productivity and profitability. The majority of sites-specific agricultural systems employ some merger of GPS

receivers, that continuous to yield sensors, remote sensors, and changable rate processing implementations.

Use of GIS in Agrometeorology

Due to the increasing pressure on land and water resources for agriculture, the management and forecasting of land use (crops, climate, fires, etc.) are becoming more important day by day. Therefore, GIS is an important tool that decision-makers can use. For example, precipitation and solar radiation are meteorological conditions that can be mapped and monitored to directly aid agronomic processes and provide suggestions for the occurrence of droughts (McVicar et al., 2008). It is reported that developed countries use geographic information systems for drought monitoring. Planning the time and type of agricultural practice requires certain information, such as soil type, land cover, climatic data, and geological information when describing the specific situation in a given place. Each layer of information gives the operator the possibility to consider its impact on the final result (Basso et al., 2005).

Use of GIS in Soil Survey

GIS uses advanced sensors and smart target positioning and geoprocessing algorithms to generate accurate, high-resolution information about the ground and terrain. By better understanding the physical and chemical properties of the soil, including the way inputs move through the soil, GIS enables trusted consultants of farmers to implement more effective solutions to the unique challenges faced by each area of their fields. Soil maps can be used to make key agricultural management decisions regarding irrigation, drainage and fertility.

Use of GIS as Agronomic Land-Use Planning Tool

The GIS is used for land use planning. Coleman AL and Galbraith JM noted that soil survey data and geographic information systems (GIS) are important tools in land use planning. They report that after adding soil data to other data and image layers, explanatory records from map units are used to create explanatory maps, flood frequency maps, and runoff maps.

GPS

The Global positioning system (GPS); is a combination of around 30 satellites circling the Earth at a height of 20,000 km, which sends and gets continuous information. This continuous information assortment gives precise position data, which prompts productive examination and control of a lot of geospatial information. Accuracy agribusiness is about assembling ideal geospatial data on soil and plant necessity and endorsing site-explicit activities to secure the harvests and to increase agricultural production. GPS is a significant device of precision farming which is utilized in various agricultural cycles (Reshma et al., 2020).

Role of GPS in Agriculture

In this present case, GPS has become an fundamental part of precision agriculture. In order to inspect and process remote sensing images, it is absolutely required to gather factual information on the ground in the experimental field at several locations all-round the crop production season, generally at various times. Conventionally, this collected data is manually been recorded on field worksheets, aerial photographs, or paper maps, and which requires a lot of time and effort to be translated into a digital format for remote sensing or GIS. In order to perform image survey, the ground data collected are necessary to be digitized as it requires to create a mask to train the software which recognizes different situations and classify remote sensing images. We have grown an interactive portable system that records field data directly into a digital database that incorporates yield, soil, road, water and contour maps superimposed on aerial photographs or remote sensing images. The GPS receiver is associated with a laptop that shows the suitable preloaded information layer, and the software package blends the input GPS signal with the presented data to authorize the user to view their position relative to the map component. Multiple layers of facts and figures can be easily improved and modified on site, and recently developed data such as a point or surface layers and credit table can be added. (Ravi et al., 2002).

Use of GPS for Yield Monitoring and Mapping:

The majorly recognized utilization of the GPS in agribusiness is to plan yield and varying rate of fertilizer or pesticide tool for the yield planning collector travel speed and flow rate of matter are estimated (Dong et al., 2019).

The control computer facilitates the infield activity. It has the guide of movement as an element of a given geographic area. It gets the hardware's present area from the finder, which has a GPS in it, and chooses what to do in view of the guide in its memory or

information stockpiling. It at that point gives the order to the actuator, which makes the information application (Ravi and Jagadeesha, 2002).

Remote Sensing

Remote Sensing gives a wellspring of information just as the limit with respect to information handling and investigation, appraisal, observing and forecasting. Satellite Remote sensing addresses an innovation for succinct obtaining of spatial information and the extraction of scene utilizing satellites (Pierpaolia et al., 2013). A conversation of the Remote Sensing innovation would not be completed without the notice of GIS. Remote Sensing in India is sensibly well grown however not so are GIS applications. GIS is a developing innovation that has now arrived at certain development in the application regions. The native specialized information with the assistance of Remote Sensing also, GIS gives significant understanding into practical agribusiness. A precise spatial information base empowers the portrayal of agro-frameworks (Gebbers et al., 2010).

Use of Remote Sensing in Agriculture

Today, RS is possibly a practical management apparatus for site-explicit harvest the board. Presently, there is a wide scope of satellite information that differs in (i) method (dynamic/detached, radiometer/scatter meter), (ii) spatial goal from centimetres to kilometres (iii) spectral reach, also, (iv) geometry (Hedley et al., 2014). The full business accessibility of high goal satellite information has opened up various new opportunity for the utilization of Earth Observation (EO) information. Today, we can perform numerous applications with EO information that in just the new past were selective to human examination and in situ reviews, which was taking longer time and hard-sledding, regardless of the geographic impediments of such information and strategies (Jha et al., 2019). Satellite symbolism can be procured over any space internationally, in a time period and at a given cost. As of now, higher goal satellite symbolism defeats past imperatives and licenses the utilization of such information as a speedy and simple apparatus for regional administration, including farming investigation, measurements and sponsorship control (Elijah et al., 2018).

Use of RS in Irrigation Water Management

Application time and flow of irrigation system assume a significant part in relieving crop water stress and accomplishing ideal harvest and yield (Uphoff et al., 2018). Different

types of water management practices are utilized by farmers relying upon numerous components including water accessibility, existing water availability framework at the field (e.g., capacity and movement framework, kind of water system framework), nearby/territorial water laws, financial status, size of the homestead, skill and knowledge of farmer, and others (Pardossi et al., 2009).

Numerous farmers apply uniform water at standard spans dependent on their prior information or experience of cultivation, soils, and environment at the area (Boland et al., 2006). Large scale commercial farmers deploy soil moisture monitoring systems (wired or wireless moisture sensors) to irrigate (automatically or manually operation mode) based on the measured soil moisture data and crop/plant water requirements (Holt et al., 2019).

Practically these conventional cultivation practices don't take the variability inside a field and utilize a uniform water flow for the whole field. Remote sensing information can help observe the inconstancy inside the field and apply variable rate water system with usually utilized water system frameworks like a focus rotate. Variable rate application can help relieve water pressure emerging from outrageous wet and dry conditions to accomplish consistently exceptional returns in all parts in the field while decreasing water and nutrient loss (Evans et al., 2013).

Use of RS in Water Stress Management

Remote sensing items, either in optical, thermal, and microwave groups, have been utilized to create and test various indices and methods for exactness water the board. For instance, normalized difference vegetation index (NDVI) and soil adjusted vegetation index (SAVI), created from optical pictures, can be utilized to analyse water pressure and soil dampness conditions for numerous yields. These indices, joined with anticipated climate information, could be utilized for water system booking. Thermal remote sensing-based crop water stress index (CWSI) is a famous sign used to evaluate irrigation supply and planning (Khanal et al., 2017).

Use of RS in Determining Evapotranspiration

Evapotranspiration (ET), the largest water flux from the Earth's surface to the atmosphere, is a critical component of the hydrologic cycle and water balance. Conventional methods of ET measurement (e.g., weighing lysimeter and eddy covariance) are generally

expensive and do not provide spatially variable ET estimates resulting from differences in land use, soils, topography and other hydrologic processes (Liou et al., 2014).

Remote sensing information is broadly used to determine ET, which is expected to decide crop water prerequisites to plan water system (Mendes et al., 2019). ET assessment draws near, in view of the far-off detecting information, can be assembled into three classifications: (I) surface energy balance, (ii) crop coefficient, and (iii) the Penman–Monteith technique (Barker et al., 2018). Numerous examinations in the past have given a survey of far off detecting based ET assessment methods.

Use of RS in Determining Soil Moisture Data

Remote sensing information gained in different groups, including optical, thermal and microwave, have been utilized to gauge soil moisture universally (Zhou et al., 2016). Optical and thermal remote sensing information has been broadly utilized for soil dampness and ET assessments in a methodology known to as "triangle" or "trapezoid" or land surface temperature-vegetation index (LST-VI) technique. The triangle or LST-VI strategy depends on the actual connection between the surface temperature and vegetative cover attributes (Zhang et al., 2016).

Use of RS in Nutrient Management

Convenient and proper use of fertilizers is the key to enhance crop development and yields while limiting ecological harm through nutrient loss to groundwater and surface water. Normally, RDF is consistently applied during planting and later harvest development stages. But, the manure necessity of yields changes spatially and temporally because of contrasts in soils, its management, geography, climate, and hydrology (Hendricks et al., 2019). Planning of such fluctuation in crop nutrient status/necessity for PA applications could be challenging with conventionally utilized apparatuses.

A few vegetation indices (e.g., NDVI, SAVI), got from remote sensing information, have been demonstrated to be essentially corresponded with plant chlorophyll content, photosynthetic action, and plant productivity (Marino et al., 2015). Planning of these indices would thus be able to help comprehend the spatial changeability in crop nutrient status, which is significant for PA. Recently, a few work vehicles mounted remote sensors have become accessible that can gauge plant and soil nutrient status for constant use of spatially-factor fertilizer rates. Green Seeker, Yara N-sensor, and Crop Circle are a few instances of

commercially accessible hand-held and farm vehicle mounted remote sensors that utilize crop reflectance information to decide also, apply spatially variable fertilizer rates progressively (Ali et al., 2017).

Use of RS in Disease Management

Disease can cause a huge loss in yield and can lower B:C ratio. Timely detection of plant disease and its spatial degree can help contain the spread of disease and diminish yield loss. Manual method of disease detection is tedious, work concentrated, inclined to human mistakes (Ehsan et al., 2013). Also, with field exploring, it very well might be hard to distinguish the infection during the beginning phases when the side effects are not completely apparent. Moreover, a few infections don't show any apparent manifestations, or the impact may not be perceptible until it is past the point where it is possible to act. It is too hard to plan the spatial degree and seriousness of the illness spread with the customary technique for field exploring (Sladojevic et al., 2016).

Remote sensing could be utilized to screen the disease infection effectively, particularly in the beginning phases of infection improvement, when it might be hard to recognize the indications of infection with field exploring. Various strategies utilizing RGB, multi-gastly, hyperspectral, thermal, and fluorescence imaging have been utilized to recognize illnesses in different crops (Mahlein et al., 2016).

CONCLUSION

Precision farming permits the exact following and tuning of agricultural production. Precision agriculture makes farmers arranging both simpler and more composite. There is considerably more guide information to use in deciding long haul editing plans, disintegration controls, salinity controls and evaluation of cultivation systems. If the number of information grows, more work is expected to decipher the information and this builds the danger of distortion. Farmers executing precision agriculture will probably work nearer with a few experts in the agricultural, GPS and computer sciences. Thus, the establishment advancements in precision agriculture are GIS, GPS and remote sensing.

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