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The Future of Indian Agriculture may lie on Precision Farming

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Precision agriculture (PA) uses modern sensor and analysis capabilities to increase crop yields and support management decisions. A novel idea called PA has been widely adopted in order to boost output, shorten labour hours, and guarantee efficient fertilizer and irrigation management. It makes extensive use of data and information to boost crop quality, yields, and utilization of agricultural resources. PA is a cutting-edge innovation and field-level management method used in agriculture with the goal of increasing resource production. In order to increase productivity, quality, and yield, farmers use PA, a novel advanced strategy, which involves providing optimized inputs like water, pesticide and fertilizer. High spatial resolution data about the crop condition or crop health during the growing season are essential. The most important goal of PA, regardless of the data source, is to assist farmers in running their businesses. Although there are many different forms of this support, the end result is typically a reduction in the resources required. Such support comes in diverse ways, but the end result is typically a decrease of the necessary resources

Scope of Precision Farming in India

The food system around the world is currently facing major challenges that will only get worse over the next 40 years. With today's knowledge and technologies, a lot can be done right away with enough effort and money. The food system will need to undergo more significant changes in order to meet future challenges, and investment for research to provide novel solutions for brand-new issues will be necessary. Major issues in agricultural growth and development now include the decline in total productivity, diminishing and depleting natural resources, stagnating farm incomes, lack of an eco-regional approach, decreasing and fragmented land holdings, trade liberalization's effect on agriculture, limited employment opportunities in non-farm sectors, and global climatic variation. Therefore, one way to boost agriculture productivity in the future is through the adoption of recently developed technology. A precision farming technique takes into account site-specific differences within fields and optimises management measures accordingly, as opposed to managing an entire field based on some hypothetical average condition that may not exist anywhere in the field. The majority of farmers are aware of the unequal yields that occur throughout their crops.

These variations can be traced to management practices, soil properties and/or environmental characteristics. The level of knowledge of field conditions is difficult to maintain because of the large sizes and changes due to annual shifts in leasing arrangements in the farm area. So the entire farm area has to be divided into small farm units of 50 cents or less. Precision agriculture offers the potential to automate and simplify the collection and analysis of information. It allows management decisions to be made and quickly implemented on small areas within larger fields.

What difficulties does precision farming face?

High Cost: Precision farming is dependent on technologies like GPS, drones, and sensors. All these technologies are capital intensive and require large investments in the beginning. Spending the requisite amounts is beyond the capacity of small and marginal farmers.

Lack of technical expertise knowledge and technology: Deploying and using the technologies, interpreting the captured data require high level of awareness and skills.

Inadequate technological knowledge Technology and knowledge: Using the tools, deploying them, and understanding the data they acquire demand for a high level of understanding and expertise.

Not viable for small land holdings: Precision farming require high investments. Moreover, proximate sensors (say to capture information/samples of soils) are generally deployed on farm machinery like tractors. Thus precision farming is more conducive with mechanized farming.

High investments and mechanized farming are viable only in large holdings. Return in small landholding are too little (due to low absolute output even though yield may be high) to justify high investments required in precision farming.

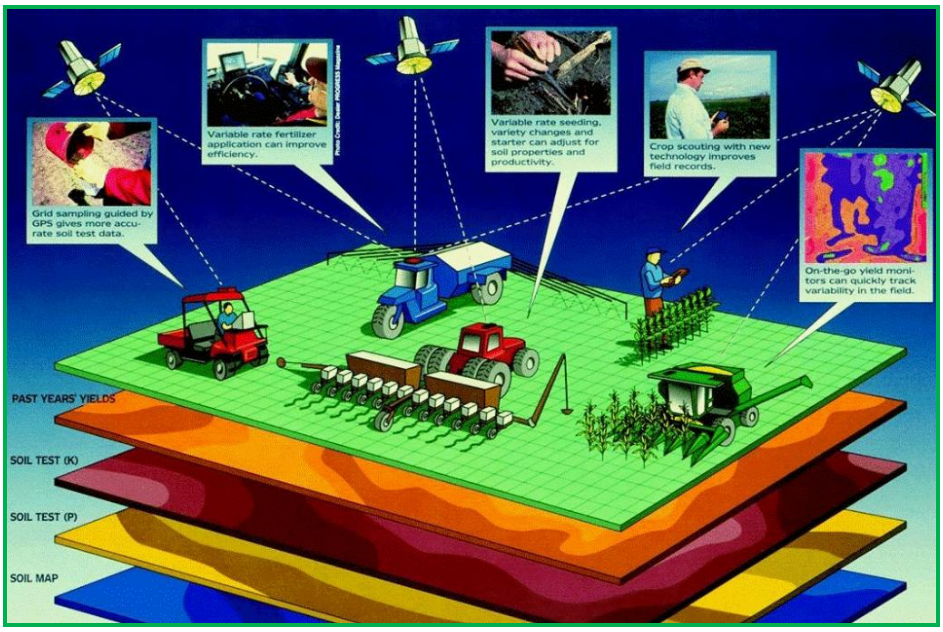
Tools and Technology

It is an innovative approach to farming that use a variety of technologies to improve agriculture practices. Rather than relying on a single technology to improve a single practice precision agriculture combines multiples technologies to increase efficiency and reduce waste. This multifaceted approach allows for great accuracy.

There are many different types of crops and practices in all crop and practices, and not all of them require the same level of technology. For example, some crops may require more advanced technology for certain practices, while other may not need any technology at all. It is very important to assess the need of each crop and practices.

Precision agriculture is an area of research and development that focuses on the use of many different technologies to improve agriculture practices this include the use of

1. GPS
2. Remote Sensors
3. Drones
4. GIS



Various technologies used in precision Agriculture (source AFGRI)

Global Positioning System (GPS): The development and implementation of precision agriculture or site-specific farming has been made possible by combining the Global Positioning System (GPS)

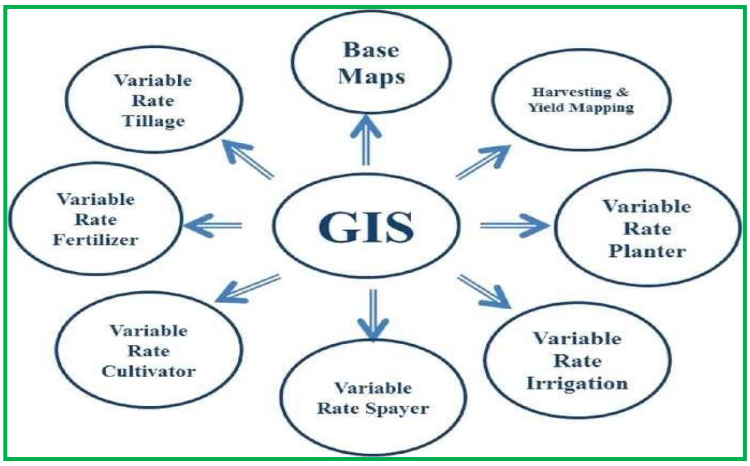
The importance of being well informed about a precision location with in inches is that

- GPS – based application in precision farming are being used for farm planning, field mapping, soil sampling and crop scouting and yield mapping.
- Accurate field navigation minimizes redundant application and skipped areas and enables maximum ground coverage in the shortest possible time.
- Ability to work through low visibility field conditions such as rain, dust fog and darkness increase productivity.
- Accurately monitored yield data enables future sites – specific field preparation

GPS use in Agriculture

- *Tractor Guidance*
- *Crop-duster Targeting*
- *Tracking Livestock*
- *Yield Monitoring*

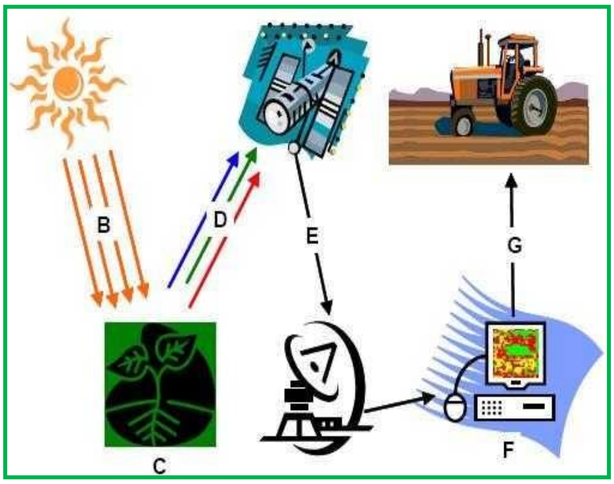
Geographical information system (GIS): A geographical information system (GIS) comprises computer software database system used to input, store, retrieve, analyze and display in a map like form, spatially referenced geographical information. It is a computer base management system used for computation, storage, analysis and display of spatial data in the form of a map. It is correctly called as brain of precision farming



It helps in agriculture in two ways:

- One is in linking and integrating GIS data (soil, crop, weather, Field history, etc.) with simulation models.
- Another is to support the engineering component for designing implement and GPS guided machine.

Remote Sensors: Remote sensing is a term utilized for the identification and collection of data without having a physical contact with the object of the study. In agriculture, remote sensing can be used to measure a variety of factors such as air and soil temperature. This technology can provide valuable information to farmer and agriculture scientist, allowing them to better understand and manage their crops. Remote sensing can also be used to monitor change in the environment such as change in precipitation or soil quality which have significant impact on crop yield. Remote sensing equipment is usually installed on equipment such as global positioning satellites, UAVs (unmanned aerial vehicles- also known as drones.



Illustrate a satellite remote sensing process as applies to agriculture monitoring process

A. The sun emits electromagnetic energy
B. To plants
C. A portion of the electromagnetic energy is transmitted through the leaves.
D. The sensor on the satellite detects the reflected energy than transmitted to the ground station
F. And display on the field map.
(Source: Agriculture remote sensing basics, 2011)

Grid sampling of soil and application of variable-rate fertiliser (VRT): Automatic variable-rate technology (VRT) can be used in a variety of farming operations. Based on the soil type identified on a soil map, VRT systems determine the rate of delivery of agricultural inputs. Calculating data from the GIS can be used to control activities like planting, fertiliser and pesticide application, herbicide selection, and application at the proper time and place with a variable rate. Perhaps the most popular PFS technology in the US is VRT [4]. The same concepts of soil sampling are applied in grid soil sampling, however sampling intensity is increased. The geographic location of soil samples gathered in a systematic grid also provides the ability to plot the data. A map of nutrient requirements known as an application map is the end result of grid soil sampling. Samples may be taken from multiple fields within a single zone that fall within the same yield range, soil colour range, etc. Grid soil samples are tested in the lab, and for each soil sample, crop nutrient requirements are interpreted. The whole collection of soil samples are then used to plot the map for applying fertiliser. A computer that is mounted on a variable-rate fertiliser spreader has the application map loaded into it. The computer instructs a product-delivery controller to alter the quantity and/or type of fertiliser product in accordance with the application map by using the application map and a GPS receiver.

Management of Crop: Farmers are able to understand the variations in topography and soil characteristics that affect crop performance in a field thanks to satellite data. In order to maximise output and efficiency, farmers can precisely manage production parameters such seeds, fertilisers, pesticides, herbicides, and water control.

Soil and plant sensors: It has been extensively reported that sensors are used to provide data on soil characteristics, plant fertility, and water status. Sensor technology is a key component of precision agriculture technology. A thorough list of available sensors as well as attributes that might make new sensors attractive in the future.

Surveying the field with soil apparent electrical conductivity (ECa) sensors, which continually capture data when moved over the field surface, is one of the most common methods for describing soil variability. Since ECa is sensitive to changes in salinity and soil texture, these sensors offer a great starting point for site-specific management.

Precision irrigation in pressurized systems: Recent innovations in sprinkler irrigation are now being made available for commercial usage by regulating the motion of the irrigation equipment with GPS-based controls. In addition to motion control, wireless communication and sensor technologies are being developed to keep track of soil and environmental variables as well as operational irrigation machine characteristics (such as flow and pressure) to increase the effectiveness of water application and crop utilisation. These technologies have amazing potential, but more work must be done before they can be bought on the open market.

Precision farming on arable land: The most common and advanced PA approach among farmers is its application to arable land. CTF is a whole-farm strategy that tries to reduce the costs associated with traditional methods by preventing unneeded crop damage and soil compaction by heavy machinery. Controlled traffic approaches use GNSS technology and decision support systems to restrict all field vehicles to the smallest possible area of permanent traffic lanes.

Optimising the usage of fertilizers, starting with the three primary nutrients nitrogen, phosphorus, and potassium, is a significant application of precision agriculture in arable land. These fertilisers are administered consistently over fields at specific periods of the year in conventional farming. This results in inconsistent application across different locations. The environmental cost is directly tied to over application, which permits nitrogen and phosphorus to leach from the field into surface and ground waters as well as other parts of the field where they are not wanted.

Precision farming within the fruits & vegetables and viticulture sectors: With automation systems recording characteristics important to product quality, producers can now evaluate products and monitor food quality and safety in the fruit and vegetable industry due to the recent rapid adoption of machine vision techniques. These consist of internal characteristics such as sugar content, acidity, size, shape, colour, and other external flaws. To give complete fruit and vegetable processing procedures, it might be possible to perform field operations like pesticide spraying and fertiliser use.

What steps have been taken to promote the use of Technology in agriculture?

Digital Agriculture Mission 2021-2025. The initiative aims to leverage a wide range of technologies such as AI, block chain and drone technology to improve the overall performance of the sector. Currently, ICRISAT (International Crop Research Institute for Semi-Arid Tropics) is working with Microsoft to develop an AI app for sowing that will provide farmers with recommendations on the optimal date to sow. Sowing date is very important when it comes to getting the best yield, and this app aims to take the guesswork out of the process.

Crop yield prediction model using AI: In May 2018, NITI Aayog partnered with IBM to develop a crop yield prediction model using AI to provide real-time advisory to farmers. The partnership aims to provide insights to improve crop productivity, increase soil yield and manage farm inputs to improve farmers' income. It aims to develop crop monitoringand early warning systems for pest and disease outbreak based on advanced AI innovations. It also includes the use of weather advisory services using satellites and enhanced weather forecast information, along with IT and mobile applications with the aim of increasing crop yields and cost savings through better farm management.

AI sensors for smart agriculture: The Government of India, in collaboration with Microsoft, has begun empowering small-holder farmers in India to increase income through higher crop yield and greater price control using AI sensors. Microsoft is engaging with multiple stakeholders, including farmers, State Governments, the Ministry of Electronics and Information Technology (MeitY), and the Ministry of Agriculture and Farmers Welfare, to create an ecosystem for AI in agriculture. Microsoft is also engaging with Escorts (agricultural equipment manufacturers) to enable precision agriculture.

Drones to monitor crop and soil health: The project, entitled 'SENSAGRI: Sensor-based Smart Agriculture is being undertaken by the Indian Council of Agricultural Research (ICAR) along with six partner institutes. Its objective is to develop an indigenous prototype for a drone-based system to monitor crop and soil health using remote sensors. This technology could also be integrated with satellite-based technologies for large-scale applications.

Conclusion

In many developing nations, precision farming is still merely an idea, therefore it requires significant assistance from both the public and business sectors to encourage its rapid adoption. However, exploration, analysis, and execution are the first three phases of successful adoption. Environmental and economic concerns that surround agricultural production today can be addressed with precision agriculture. The idea of "doing the right thing in the right place at the right time" has a strong intuitive appeal, but there are still questions regarding cost-effectiveness and how best uses of the technological tools we now have continue to exist. An all-out attempt should be made to leverage new technical inputs to transform the "Green Revolution" into an "Evergreen Revolution" that meets the pressing needs of the times. In the success of precision agriculture will depend in large part on how quickly and speed with which the information required to direct the new technologies can be discovered will greatly influence the success of precision agriculture.

With its systems approach, precision agriculture offers an innovative solution to current agricultural problems such as the need to balance productivity and environmental considerations. Advanced information technology serves as the foundation. It involves sensing and simulating variability in soils and crop species, and integrating agricultural practices to satisfy site-specific needs. It tries to maximize economic returns while decreasing agricultural energy use and environmental impact.