PRECISION FARMING FOR SUSTAINABLE AGRICULTURE DEVELOPMENT

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ABSTRACT

Precision agriculture is an innovative approach that enhances farming efficiency, productivity, and sustainability. The method currently used is based on recommendations derived from the composition or symptoms of crops and does not take into account changes in the field. Leveraging advanced technologies, precision agriculture optimizes farming practices and improves crop yields. This article explores precision agriculture's applications, benefits, challenges, and future directions. Key applications include crop monitoring, soil mapping, weather forecasting, irrigation management, and yield prediction. Additionally, this article discusses precision agriculture's benefits, such as increased efficiency, reduced environmental impact, and improved crop quality.

Keywords: precision farming, components, applications, sustainable agriculture, challenges and limitations, and future of precision agriculture.

INTRODUCTION

By 2050, India's agriculture sector will face the daunting task of feeding nearly 1.7 billion people using scarce land, water, and energy. Our cropland is barely 140 million hectares, leaving little room for improvement. Agricultural intensification is leading to degradation of natural resources, especially soil and water. Our current implementation strategy is based on recommendations derived from mixed models or observed crop symptoms and does not take into account regional variations. This means that ideas are under or over-used because the average use of recommendations is rarely found in a single location. It reduces input efficiency and also causes environmental degradation. Therefore, intensive farming using modern equipment is very important. Precision agriculture is a solution for the development of sustainable agriculture. It supports the implementation of the right ideas, at the right time and place, where the right equipment or methods are used. It is an achievement that uses the basic elements of information technology and management to increase productivity,

improve product quality, improve the performance of medical products and improve production to save energy and the environment. Precision agriculture is therefore a beautiful concept and its content always gives rise to the hope that there can be an environment where agricultural products can be used more, thus increasing profits and making production less difficult. Today's developments in precision agriculture can provide technology for tomorrow's green agriculture. For smallholder farmers in developing countries, precision agriculture supports and increases productivity with reduced use of external inputs.

Precision agriculture uses a method that offers new solutions to current agricultural problems, such as the need to expand production, even if there is a concern. It is based on the advancement of information technology. It adds the description and modeling of soil and vegetation changes and integrated agriculture to meet a specific environment. It aims to increase financial returns, as well as reduce energy consumption and the environmental impact of agriculture. The tools include a variety of technologies, including information technology, sensor and application technology, agricultural management, and marketing. It is important to look at PA as a method and value of additional information for performance management.

NEED OF PRECISION AGRICULTURE

"The world food system is currently facing many challenges, which will only worsen over the next forty years. With today's knowledge and techniques, a lot can, be accomplished quickly with enough effort and money".

However, future challenges will require further changes in food supply and funding of research to find new answers to old questions. Current major challenges to the growth and development of agriculture include loss of total production, depletion of natural resources, energy deficit in agricultural income, lack of eco-regional approach, reduction and fragmentation of land holdings, liberalization of agricultural industry, and prohibition of agricultural work. Climate change is a major challenge for agriculture and development. Therefore, it is believed that the use of the latest technologies will be important for the development of agriculture in the future. Precision agriculture methods take into account the location differences in the region and change the management behavior accordingly, instead of managing the entire field, as expected, where no field is located.

CONCEPT OF PRECISION FARMING, COMPONENTS AND REQUIREMENT

The concept of precision agriculture Dr. Pierre Roberts, speaking about the food quality problem in large farms in the United States. The main goal is to improve production, save input costs and reduce the negative impact on the environment. The main components of precision agriculture are knowledge, technology and management.

The following are specific farming techniques commonly used by precision farmers.

Global Positioning System (GPS)

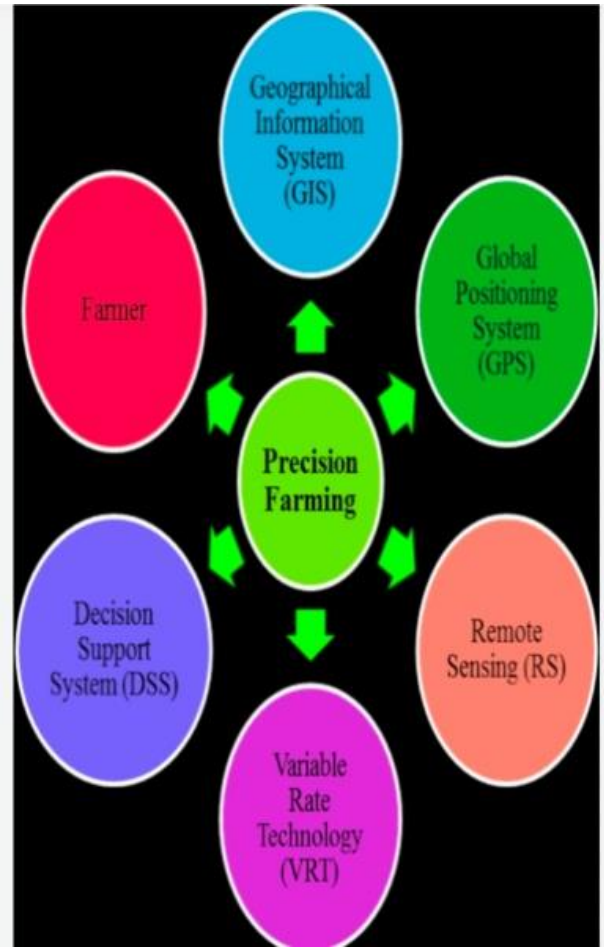
It is a satellite network-based navigation system that helps users collect location information (latitude, longitude, and altitude) with an accuracy of 100 to 0.01 m. GPS helps farmers find accurate information about the area, such as soil type, pests, water availability, boundaries, pests, and problems. GPS satellites broadcast signals that allow GPS receivers to calculate their location. The system allows farmers to map out their work areas, ensuring that inputs (seed, fertilizer, pesticides, and irrigation water) are available in one place based on historical performance standards and historical transcripts.

Geographic Information System (GIS)

This includes hardware, software, and systems designed to support the compilation, storage, retrieval, and analysis of characteristics and data sources for document preparation demonstration. GIS puts information in a place where it can be used when needed. Computerized GIS maps differ from traditional maps in that they contain information at different levels (such as yields, soil survey maps, soil nutrient levels, precipitation, crops, and pests). GIS is a form of computer science, but its primary function is to use statistical and geographic methods to describe people and places. Agricultural GIS databases provide information on topography, soil testing, irrigation, soil types, water flow, subsurface drainage, chemical use rates, and crop yields. After analysis, this information can be used to understand the relationship between traits that affect crops in a given field.

Sensor technologies

Using electromagnetic, conductivity, photoelectric, ultrasonic and other technologies to measure humidity, vegetation, temperature, texture, structure, physical strength, moisture, grain level, water vapor, air, etc., to prevent and control diseases, pests and weeds, and to monitor drought, soil and soil conditions. . Sensors can collect a lot of information without the need for control. A complete list of current sensors and features needed to develop new sensors in the future. One of the most popular ways to show the difference in soil is to measure the area using apparent electrical conductivity (ECa), which continuously collects information about the soil.



Grid soil sampling and variable-rate fertilizer (VRT) application

Variable rate technology (VRT) is automated and can be used in many agricultural applications. The VRT system determines the value of farm gates based on the type of land indicated on the map. Information obtained from GIS can control processes such as the use of seed, fertilizer, and pesticides at the right time, in the right place, and at different prices. VRT is probably the most widely used PFS technique in the United States. Grid soil sampling is based on the same principles as soil sampling, but with an increased sampling rate. The soil model written on the grid also contains location information that can be used to draw the profile. The purpose of the site program is to create a menu called the request menu. Samples can be taken from different areas of the field, such as brownfields that give the same yield, and therefore from the same area. Soil samples are analyzed in the laboratory and the results of each soil sample must be interpreted. All soil samples are used to create fertilizer tables. Fertilization data is sent to computers installed at various locations in the fertilizer plant. The computer uses a mapping application and a GPS receiver to control distribution and change the amount and/or type of fertilizer according to the mapping application.

Crop management

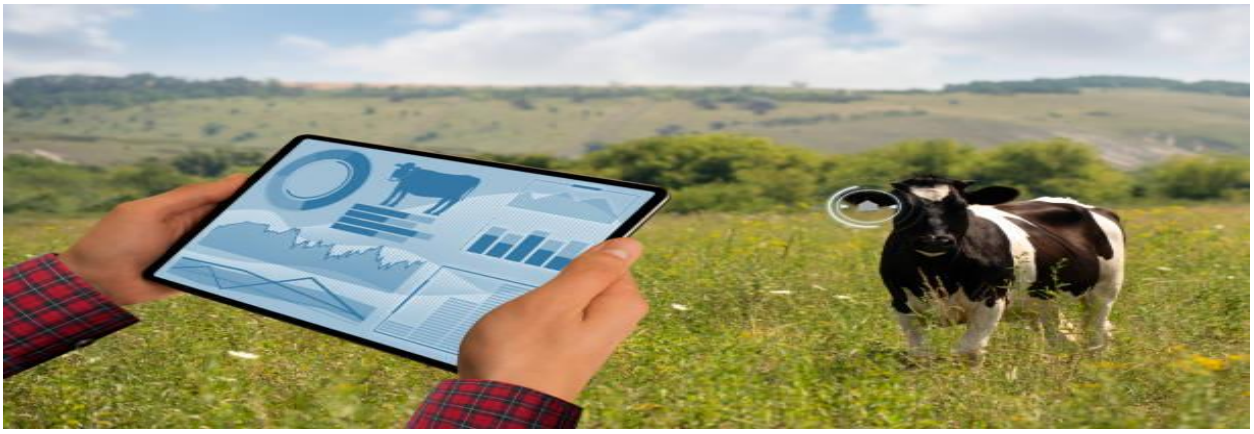
Satellite data allows farmers to better understand soil and soil changes that affect crop growth. As a result, farmers can manage inputs such as seeds, fertilizers, pesticides and water management to increase yields and productivity.

Rate controllers

A price controller is a tool designed to control the price of chemical products such as liquid or granular fertilizers and pesticides. This price controller monitors the speed of the tractor/sprayer as well as the flow rate and pressure of the product (if liquid) and instantly adjusts the volume according to the target price. Speed controllers have been used for some time, usually as standalone devices.

Precision irrigation in pressurized systems

The latest innovation in the irrigation industry is the use of GPS-based controllers to control the movement of irrigation systems. Wireless communication and sensor technology has been developed to monitor soil, media and water using mechanical systems such as flow and pressure to maximize the efficiency and use of water as well as control movement. This technology has great potential but requires further development before it can be commercialized.



Yield monitor

Yield monitors are integrated products. They usually contain a variety of sensors and other devices, including data storage, user interfaces (monitors and keyboards), and in-cab computers that control the system combination and interaction of these products. The sensor measures the size or volume of the particle flow (particle flow sensor), the separate velocity, the ground speed, and the particles. For rice, the results were recorded continuously by measuring the force of the water stream hitting the sensitive plate while agitating the clean rice. Recently developed sensors are large enough to work by emitting a beam of microwave energy and measure some of the energy returned after the flow of seeds is cut off from the chute.

Precision farming in cropland

Precision farming technology for farmland is the most common and advanced technology used by farmers. CTF is an integrated farming system designed to prevent unnecessary planting and heavy machinery cultivation, thus reducing the costs associated with traditional methods. The traffic control system will include closing all vehicles in the home to the minimum safety lane with the help of GNSS technology and decision support. Another important aspect of agriculture in agriculture is the development of the use of chemical fertilizers, starting with the three main nutrients: nitrogen, phosphorus and potassium. In traditional agriculture, this fertilizer is applied to the fields in equal amounts at certain times of the year. This results in oversupply in some areas and undersupply in others. Environmental costs are directly related to overuse, which releases nitrogen and phosphorus from farmland into soil, surface water, or other undesirable resources. With precision farming technology, families and equipment can be more efficient in their use of fertilizer. Variable Rate Application (VRA) is a way for farmers to manage inputs by combining variable rate (VR) management with real-time and/or on-site management. Enter to request a quote on the website. VR is determined based on previous measurements such as remote sensing or machine-mounted sensors. Precision agriculture in fruit, vegetables and viticulture. The development and adoption of PA technologies and methods (so-called precision viticulture, PV) in viticulture is the real development in arable land. However, due to the high value of the crop and the importance of its quality, many studies are carried out in wine-producing regions around the world. Grape quality and yield maps are very important during harvest to avoid mixing grapes with many other grapes that have the potential to be good.

Precision livestock farming (PLF)

Precision farming (PLF) refers to the use of agricultural methods and technologies to manage livestock. Potential applications include livestock production, milk and egg production, disease detection and monitoring, and behavioral and physical environments such as thermal microenvironments and emissions of gaseous pollutants. The system includes milk fat and microbiological analysis to help identify potential pathogens, as well as additional cleaning services such as milking machines, weighing machines, washing machines, feed pushers and animal contact to prevent problems. Monitoring existing feed and water usage data can be used to detect disease early. Other improvements include cattle growth monitoring, which requires immediate measurement of growth, providing producers with flexibility and growth.

Acoustic sensors detect increased coughing in pigs as an indicator of respiratory disease. Additional sensors are now used to report activity. Thermometers measure temperature, gauge work and water taps, and communicate with farmers via text message. Sensors placed on the animal's collar also collect data to detect signs of heat and prepare them for insemination. Farmers can make planting plans in newspapers.

On-line resources for precision agriculture

There is a wealth of information on the Internet about modern agriculture. Many manufacturers of agricultural equipment, GPS receivers, sensors, and other PA technology use this medium to inform growers about new products, features, information solution issues, software updates, and many other services.

Here are some key reasons why precision farming is becoming increasingly important in India

Limited land and resources: As the population grows and land and resources are limited, the need to maximize yields and minimize waste is essential to ensure the country's food security.

Climate change: Climate change and climate change is increasing in India due to climate change affecting agriculture, better and sustainable agriculture needs to be adopted.

High input costs: The way farming is done is increasing, along with the price sensitivity of fertilizers, seeds and pesticides, so it is important to improve their use and reduce waste.

Market competition: With the globalization of the agricultural market, Indian farmers are facing increasing competition, hence improving the quality and quantity of produce is very important.

Technology adoption: With the rapid increase in the utilization of technology in India, farmers are looking for new ways and information to use in agriculture to help them achieve good advertising and results. Overall, precision agriculture offers Indian farmers a way to overcome these challenges and rapidly increase productivity, profitability and sustainability in a changing world.

Applications:

Precision agriculture has numerous applications that make farming more efficient, productive, and sustainable.

Some key applications include:

1. Crop Monitoring and Management:

- Crop health monitoring.
- Yield prediction.
- Pest and disease management.
- Fertilizer application optimization.
- Irrigation management.

2. Soil Mapping and Analysis:

- Soil type identification.
- Soil moisture monitoring.
- Nutrient analysis.
- pH level monitoring.
- Soil erosion control.

3. Weather Forecasting and Climate Management:

- Weather forecasting.
- Climate modelling.
- Temperature monitoring.
- Humidity monitoring.
- Wind speed monitoring.

4. Irrigation Management:

- Water usage optimization.
- Irrigation scheduling.
- Soil moisture monitoring.
- Water quality monitoring.
- Drainage management.

5. Yield Prediction and Optimization:

- Yield forecasting.
- Crop growth modeling.
- Harvest planning.
- Yield optimization.
- Post-harvest management.

6. Farm Equipment Automation:

- Tractor automation.
- Drone-based farming.
- Robotic farming.
- Precision planting.
- Precision spraying.

7. Livestock Monitoring:

- Animal health monitoring.
- Feed optimization.
- Breeding management.
- Animal tracking.
- Behavior monitoring.

8. Supply Chain Management:

- Inventory management.
- Logistics optimization.
- Market analysis.
- Price forecasting.
- Quality control.

9. Decision Support System:

- Data analysis.
- Decision-making tools.
- Risk management.
- Economic analysis.
- Environmental impact assessment.

10. Education and Training:

- Farmer education.
- Training programs.
- Workshops.
- Webinars.
- Online courses.

Benefits:

1. Increased Efficiency and Productivity.
2. Reduced Environmental Impact.
3. Improved Crop Quality and Yield.
4. Enhanced Decision-Making Capabilities.
5. Economic Benefits.

Challenges and Limitations:

1. High Initial Investment Costs.
2. Limited Internet Connectivity and Infrastructure.
3. Data Analysis and Interpretation Challenges.
4. Training and Capacity Building Requirements.

Here are the government and organizational initiatives promoting precision agriculture in India:

Government Initiatives:

1. *Digital Agriculture Mission:* To promote digital technologies in agriculture.
2. *Precision Technology for Agriculture (PRIYA):* A pilot study by Centre for Development of Advanced Computing (C-DAC) and Government of Andhra Pradesh.
3. *National Mission on Sustainable Agriculture (NMSA):* To promote sustainable agriculture practices.
4. *Rashtriya Krishi Vikas Yojana (RKVY):* To strengthen agricultural infrastructure.
5. *Soil Health Card Scheme:* To promote soil testing and nutrient management.

Organizational Efforts:

1. *Indian Council of Agricultural Research (ICAR):* Conducts research on precision agriculture.
2. *National Academy of Agricultural Sciences (NAAS):* Provides training and support to farmers.
3. *Indian Agricultural Research Institute (IARI):* Develops precision agriculture technologies.
4. *Agricultural Technology Management Agency (ATMA):* Promotes agricultural extension services.
5. *National Centre for Sustainable Aquaculture (NaCSA):* Supports precision aquaculture.

International Organizations:

1. Food and Agriculture Organization (FAO) of the United Nations.
2. International Fund for Agricultural Development (IFAD).
3. World Bank.
4. These initiatives aim to promote precision agriculture in India, enhancing farmers' productivity, efficiency, and profitability.

FUTURE OF PRECISION AGRICULTURE

- Integration of Artificial intelligence (AI) in farming.
- Expansion Internet of things (IoT).
- Autonomous farming.
- Block chain technology.
- Next generation sensors and drones.

THE FUTURE OF PRECISION AGRICULTURE

Recent advances in the application of technology now allow for small-scale operations from paper to field-specific needs. Future automated systems will be equipped with sensors and computer technology before classifying each plant in a field as a plant or crop and then determining the type of plant. Artificial Intelligence (AI) is recently being used to complete prediction, control and/or recognition tasks in various sensing environments.

CONCLUSION

Precision agriculture makes agriculture efficient, productive and profitable. The use of efficient farming methods has benefited farmers and solved problems such as balancing production and environmental concerns. It is based on advanced information technology. It involves identifying and modeling changes in soil, vegetation and agricultural mix to meet specific conditions. Its aim is to improve the economic outcomes of agriculture and reduce energy consumption and environmental impact.

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