

Precision Farming : A Modern Approach

CHANDNI NEGI*, RANA H AND RATURI G

Department of Horticulture, School of Agriculture and Allied Science, Hemvati Nandan Bahuguna
Garhwal University (A Central University), Srinagar (Garhwal), Uttarakhand- 246174, India

*Corresponding email id: negichandni48@gmail.com

INTRODUCTION

Precision agriculture is a modern farming approach that leverages advanced technologies to enhance productivity and optimize resource use. Unlike traditional farming methods, it focuses on using precision tools and data-driven techniques to maximize crop yields while minimizing waste. This approach involves investments in technologies such as GPS, Geographic Information Systems (GIS), and sensors to make farming more efficient and sustainable. In India, precision agriculture faces unique challenges due to the fragmented nature of landholdings, with 58% of farms being smaller than one hectare. Small land sizes limit economies of scale and make it harder for farmers to adopt expensive technologies. However, precision farming can significantly benefit even small holder farmers by providing accurate insights into soil health, water requirements,

and crop conditions. It helps farmers make better decisions, reduce input costs, and improve yields. This approach is crucial for India, where agriculture forms the backbone of the economy and supports millions of livelihoods. By adopting precision agriculture, small-scale farmers can overcome productivity barriers and contribute to sustainable agricultural growth. Despite its potential, the widespread adoption of precision agriculture requires supportive policies, affordable technology, and awareness among farmers.

The Need for Precision Agriculture

The popularity of precision agriculture is growing rapidly in developed countries as it leads to maximum growth in agricultural productivity by utilizing various technologies such as satellites and Geographic Information Systems (GIS). Farmers require reliable resources and

timely information about input supplies directly related to agricultural production. Farmers also need knowledge about agricultural technology, better farming methods, pricing strategies, market improvements, and new policies. This knowledge enables farmers to manage the costs, stock, supply, and markets for their produce effectively. When farmers have access to timely and accurate information, they can sell their produce at the right price without delays. Through mobile technology, various agriculture-based companies and administrative bodies can provide services to farmers, helping them understand prices, stock levels, and market demands. This helps reduce the risks of under-selling or over-supply in the market. Additionally, it aids in mitigating risks related to extreme weather conditions or disasters by employing early warning systems and measures for controlling pest outbreaks.

Modern Technologies

Autonomous Driving Machinery

This technology has revolutionized the way farming operations are conducted. These self-operating machines are equipped with GPS systems, enabling them to

navigate and cover entire plots of land with precision. They can perform tasks such as plowing, sowing, or harvesting without human intervention, ensuring efficiency and accuracy in the field. Farmers only need to oversee the telemetry data of the machinery, which provides real-time updates on its operations. This technology reduces labor requirements, minimizes human error, and optimizes resource usage, making farming more sustainable and cost-effective. Autonomous machinery is particularly valuable in large-scale farming, where consistent and uniform operations are essential for better yields.

Satellite Images

Satellite images play a pivotal role in precision farming by offering comprehensive insights into crop health, soil conditions, and field variability over large areas. These images enable farmers to monitor agricultural activities remotely, identifying issues like nutrient deficiencies, pest infestations, or water stress. By analyzing vegetation indices such as NDVI, satellite data helps detect plant health and growth patterns accurately. This technology ensures efficient resource utilization by

guiding decisions on irrigation, fertilization, and pest control.

Drones

Drones are becoming increasingly prominent worldwide due to their versatility and utility in various domains, particularly in agriculture. They are equipped with advanced features such as multispectral and thermal cameras, which enable a level of precision currently unattainable with satellites. Unlike satellites, drones are not hindered by cloud cover and require far fewer adjustments in their imagery. This advantage stems from the significant distance satellites operate from, which also leads to atmospheric interference. Moreover, drones are far more affordable than private satellites, making them an economical and effective alternative.

Weather Stations

Weather stations are tools that offer vital information, including temperature, wind direction and speed, soil moisture, environmental heat, rainfall, and more. Equipped with sensors, they collect diverse data such as barometric pressure, dew point, wind velocity, and UV radiation. This data

enables precise monitoring and forecasting of changes in environmental conditions, aiding in better decision-making and resource management.

Soil mapping

Soil mapping focuses on assessing and monitoring soil health. It utilizes advanced equipment to observe and evaluate the condition of the soil. By analyzing soil health indicators, this system aids in optimizing farming practices. It provides crucial data such as pH levels, electrical conductivity, salinity, and other essential parameters, contributing to improved agricultural productivity and sustainability.

Cloud computing

It enables real-time data storage, analysis, and access, facilitating better decision-making, efficient resource management, and improved agricultural productivity.

Yield Monitor

It is an electronic device which collects data on crop performance for a certain period. It provides an accurate assessment of how yields vary within a region. It measures and records information such as grain flow, grain

moisture, area coverage. It also helps in comparison between hybrids and regular varieties.

Global Positioning System (GPS)

GPS technology offers precise, automated position tracking and data recording, enabling variable rate input applications across specific sections within large farm plots. It delivers real-time information, facilitating accurate soil and crop measurements, optimizing resource usage, and enhancing farm management efficiency.

Geographic Information System (GIS):

GIS technology allows for the storage and management of various types of agricultural data on a computer, such as yield records, soil survey maps, crop scouting reports, and soil nutrient levels. This information can be easily exchanged and visualized in a user-friendly format, helping farmers and experts develop effective strategies for improved decision-making and farm management.

Remote sensing

It provide valuable data from a distance, typically through satellites, drones, or airborne sensors. It helps farmers monitor

and assess various factors such as soil health, crop conditions, water usage, and pest infestations. Through the use of multispectral and thermal imaging, remote sensing allows for real-time, detailed insights into crop health, enabling farmers to make precise, data-driven decisions on irrigation, fertilization, and pest control. This leads to optimized resource use, improved crop yields, and sustainable farming practices.

Variable Rate Technology: It includes the following specific technologies

- **Precision Irrigation:** A precision irrigation system will help you apply the right amount of water directly where it is needed, therefore saving water by avoiding overwatering or leaching.
- **Precision Fertilizer Application:** Precision Fertilizer will help you improve the application of nutrients to the root zones in the soil and the rate that matches the crop's requirements.
- **Bio-Control Agents Application:** Effective management and application of bio-control agents

depending on the presence of pests/weeds/fungi will help you reduce the losses to your crop.

Key benefits

Improvement in decision making

Information technology greatly aids farmers, researchers, and others in making informed decisions about the future. By providing access to essential data, farmers can make well-informed decisions related to agricultural activities, such as crop selection, irrigation, pest control, and resource management, ultimately improving productivity and sustainability.

Agricultural success

Precision farming boosts agricultural success by optimizing resources and increasing crop yields. Using technologies like GPS, drones, and data analytics, farmers can monitor soil health, track crop performance, and apply inputs accurately, reducing costs and environmental impact. It improves pest management, enhances productivity, and promotes sustainability.

Appropriate planning

Appropriate planning involves using data-driven insights to optimize resources and farming practices. By analyzing soil conditions, weather patterns, and crop health, farmers can make informed decisions on irrigation, fertilization, and pest control. This proactive approach ensures efficient use of inputs, maximizes yields, reduces costs, and supports sustainable farming, ultimately improving farm productivity and profitability.

Weather forecast

In precision farming, weather forecasting uses real-time data to enhance planting, irrigation, and pest management decisions. By predicting weather patterns, farmers can lower risks, boost yields, and reduce resource wastage, leading to more efficient and sustainable farming practices.

Better selling opportunities

Information technology enhances selling opportunities by providing insights into what products are in demand and identifying suitable markets for better sales potential. It enables businesses to determine where to

sell their products at competitive and reasonable prices.

Challenges

Precision farming faces several challenges despite its potential to revolutionize agriculture. High initial costs for equipment and technology, such as GPS-guided machinery and IoT sensors, can deter small-scale farmers. Limited access to reliable internet and electricity in rural areas hampers the implementation of data-driven solutions. Additionally, the need for specialized knowledge and training to operate advanced tools poses a significant barrier. Farmers may also face difficulty in interpreting complex data and integrating it into practical decision-making. Lastly, concerns about data security and privacy add to the complexities of adopting precision farming technologies on a broader scale.