

Growing Smarter: A Look Inside the World of Precision Farming

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ABSTRACT

The goal of precision farming, also referred to as site-specific management, is to maximize output and profitability while maintaining environmental sustainability by carefully controlling inputs such as pesticides and fertilizers that must be applied in the proper quantity, at the appropriate time, and at the appropriate location. Precision agriculture provides a route towards dynamic and financially feasible production systems, which are further required by global market competition that challenges traditional farming, growing environmental consciousness, and the need for sustainable resource management (soil, water, and air).

INTRODUCTION

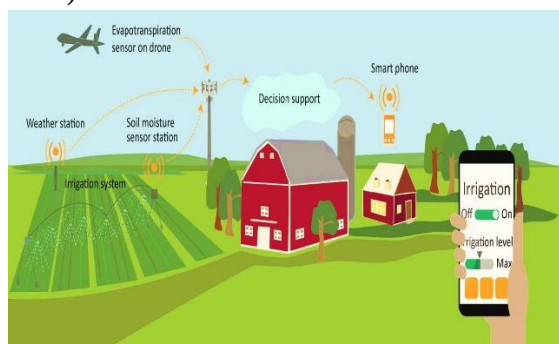
Imagine a farmer who knows exactly what each plant in their field needs, almost like they have a personal connection with every single plant. They will know when to water, how much fertilizer to give at what stage precisely, and can spot a problem before it even becomes serious. This isn't just science fiction; it's the reality of precision farming, a revolutionary approach that's changing how

we grow our food. Instead of treating an entire field the same way, precision farming uses technology to understand the unique needs of different areas within the field, even individual plants. It's like giving each part of the farm the care and requirement it needs, leading to healthier crops, less waste, and a more sustainable way to feed the world (Verma, 2025).

What is precision farming?

Precision farming, also known as site-specific crop management (SSCM), is a modern farming strategy that's all about treating different parts of a field, or even individual plants, in a way that caters to their specific needs. Instead of applying the same amount of water, fertilizer, or pest control across an entire field, precision agriculture uses technology to carefully monitor and measure the variability that naturally exists within and between fields.

By understanding these differences in things like soil type, nutrient levels, moisture content, and pest infestations, the farmers can then precisely adjust their inputs. This might involve using machinery that is guided by GPS to apply fertilizer only where it's needed, variable rate irrigation systems to deliver the exact amount of water to different zones of soil, or drone technology to identify areas with specific problems within the field (Verma, 2025).



(Image source: <https://geopard.tech/What-are-The-Major-Components-of-Precision-Farming>
Retrieved on 05.05.2025 at 11:32pm)

Need for Precision Farming in India

- **Optimize production efficiency:** Increasing population means an increase in demand for food in the future. By just relying on traditional approaches, it is difficult to meet the increasing demands. Site-specific technology is essential to increase agricultural productivity. The best combination of inputs should be determined, and through their application,

cost can be minimized along with an increase in productivity.

- **Optimize production quality:** excessive usage of pesticides and insecticides damages the quality of agricultural produce (Katke, 2019). Precision farming involves the application of only the required quantity of pesticides and insecticides, thereby improving the quality of produce.
- **Difficult to maintain:** Large sizes of farms make it difficult to maintain and keep track, and therefore precision farming helps in dividing the large farms into small plots and giving importance to each plot.

Advantages of Precision Farming

- It helps in increasing overall agricultural productivity.
- Excessive use of fertilizer can be reduced due to its precise usage in different parts of a field, thereby saving the money of farmers.
- Water resources are utilized efficiently, thereby reducing the excessive usage of water where it is not required.
- GPS technology helps in surveying the fields in an easier way.
- The optimum usage of agrochemicals in turn reduces the environmental pollution due to leaching.
- It reduces the wastage of resources.
- Dividing non-uniform fields into small homogenous plots based on their requirements helps in optimizing the yield from each plant.

Disadvantages of Precision Farming

- High initial investment



- It requires specialized skills.
- Farmers may find it difficult to interpret the large amount of data in an effective manner.
- There can be issues related to network connection in rural areas.

Tools and Equipment

1. Global Positioning System (GPS)

Satellite-based navigation system, GPS offers extremely accurate location information. Farmers use this to pinpoint exactly where different things are in their fields, like soil types, pests, weeds, water spots, and boundaries. With special tools that use GPS, they can then apply seeds, fertilizers, and water specifically where needed, based on what each part of the field requires (Hakkim *et al.*, 2016).

2. Sensor technologies

Various sensors employing technologies like electromagnetism, conductivity, light, and ultrasound can measure crucial field parameters such as moisture, vegetation health, temperature, soil texture and structure, physical properties, nutrient levels, and air conditions. Remote sensing provides valuable data for identifying crop types, detecting stress, locating pests and weeds, and monitoring drought and overall soil and plant health. These sensor technologies allow for the rapid collection of large datasets, reducing the need for extensive lab work (Hakkim *et al.*, 2016).

3. Geographic Information System (GIS)

These are powerful tools that combine hardware, software, and methods to collect, store, analyze, and display location-based information, creating intelligent maps. Unlike regular maps, GIS maps contain multiple layers of data (like yield, soil, rainfall, and

nutrients) linked to specific locations. By analyzing this spatial data using statistics, GIS helps understand how different factors influence crops in particular areas. Farmers can use GIS databases to access information on field conditions like topography, soil types, drainage, soil tests, irrigation, chemical use, and yields. This analysis helps in understanding the relationships between these factors and allows for evaluating current and alternative management strategies by combining and manipulating data layers (Hakkim *et al.*, 2016).

4. Variable-rate fertilizer application (VRT)

Variable-Rate Technologies (VRT) automate the precise application of farm inputs like seeds, fertilizers, and pesticides based on soil maps derived from GIS. This ensures the right input amount is applied at the right place and time. Lab analysis of these samples creates detailed nutrient maps, which are then loaded into VRT-equipped machinery. Guided by GPS, these machines automatically adjust the fertilizer type and amount as they move across the field, according to the application map (Hakkim *et al.*, 2016).

CONCLUSION

Precision farming is gaining importance in most of the developing nations. The main principle of precision farming is "right input, right place, right time." There are challenges in adopting this technique regarding cost-effectiveness and optimal technology use. Precision farming offers a great solution to balance productivity with responsibility to our environment by understanding and responding to site-specific variations in soils and plants, which ultimately aims at increased profitability, reduced energy use, and minimized impact on the environment.

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