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Precision Agriculture and Its Future Innovative Approaches for Crop Improvement by Integrated Nutrient Management

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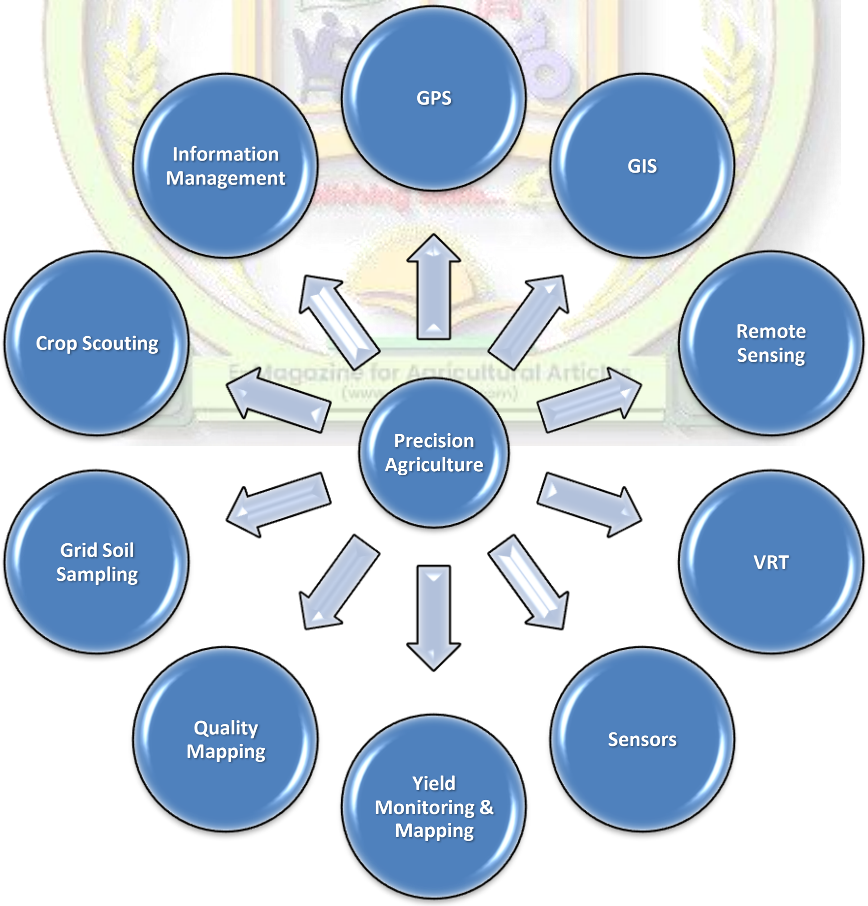
Precision farming (PF) is a technique that combines information and technology in a farm management system to identify, analyze and manage variability within fields for optimum profitability, sustainability and protection of the land resources. It is based on the ability to measure spatial variation in soil and assess the influence on crop variability in order to apply appropriate management strategies. Increasing environmental consciousness of the general public is necessitating us to modify agricultural management practices for sustainable conservation of natural resources while staying economically profitable. It is a Site-Specific Management system with the use of inputs in the right quantity, at the right time, and in the right place. Market-based global competition in agricultural products is challenging the economic viability of traditional agricultural systems, and requires the development of new and dynamic production systems.

Tools and components of Precision Agriculture



Precision Nutrient Management

Precision nutrient management is a key component of precision agriculture and governs all the major issues of improving productivity, sustainability, profitability and climate change related turbulences. It is a science of using advanced, innovative, cutting edge technologies to manage spatial and temporal variability in inherent nutrient supply from soil to the plant. Soil test based nutrient management recommendations have served the purpose of improving food grain production, but have not improved nutrient use efficiency beyond a certain limit. Researchers have shifted to an approach of feeding the crops rather than feeding the soil. The availability of quick and non-destructive measures (optical sensors, chlorophyll meter and leaf colour chart) to quantify spectral characteristics of leaves has facilitated the task of making in-season need-based nitrogen application in crops. The research and adoption of precision management of nutrients other than nitrogen is progressively growing in developed countries, but developing countries have yet to strengthen the subject for establishing precision nutrient management recommendations based on omission plot technique or nutrient management models.

Studies have highlighted the benefits of precision nutrient management in reducing nutrient losses. The precision nutrient management plan is a dynamic tool and should be monitored and adjusted on a regular basis. Soil properties vary greatly across space and time, and the spatial availability of nutrients in soil is the integrated effect of chemical, physical and biological properties, landscape attributes, environmental factors, as well as management practices. The soil variability can occur on any scale, including area, field and regions within the field and even between a few millimetres spacing. This makes the science of synchronizing nutrients supply from the soil with the plant demand a complex task. The most important details in this text are geo-spatial technologies such as GPS, GIS, remote sensing, real time and/or variable rate applications (VRA) can be used to ensure need-based nutrient management in crop fields. Nitrogen is the most widely and indiscriminately used nutrient in crop production, and spectral properties of plant leaves can be used as an index to coin precision nitrogen management strategies. Other techniques are being employed for making precision nutrient management decisions while considering spatial and temporal variability in nutrient supply from the inherent sources.

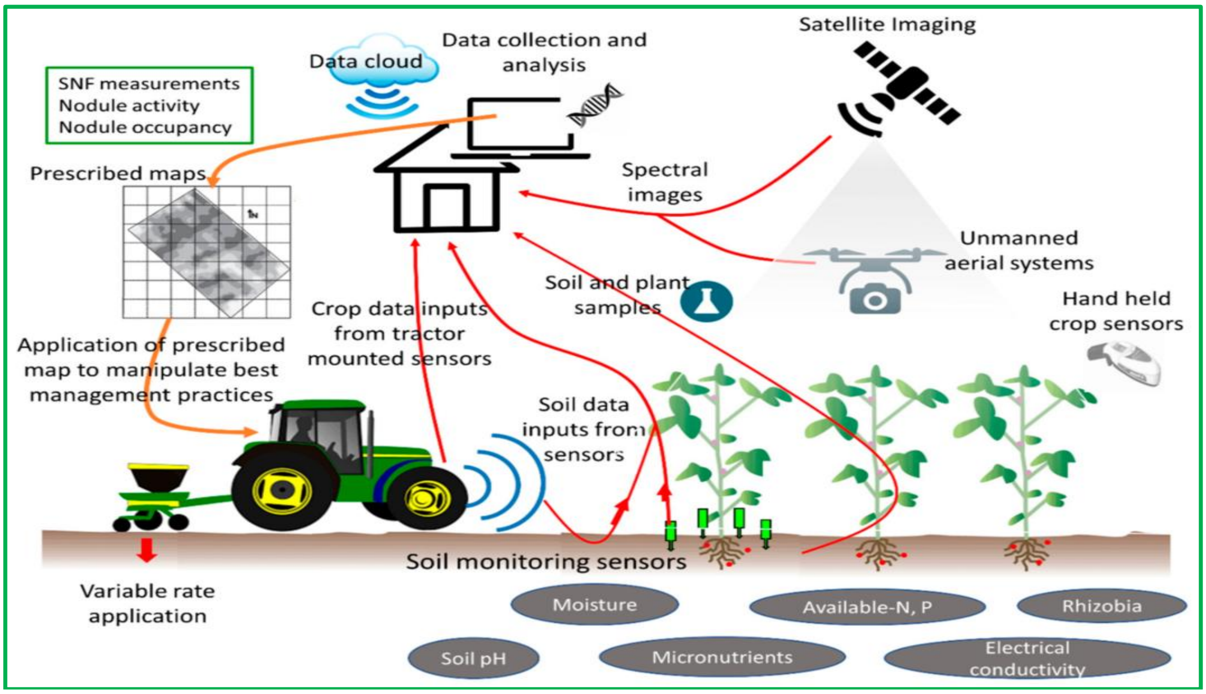


Figure 2: Mechanised Precision Farming (Thilakarathna & Raizada, 2018)

Applications of Precision Agriculture

Soil analysis and sampling: Data on soil type, fertility, moisture content, and other aspects may be gathered via mobile applications. Using this information, crop management decisions may be made about fertilisation, irrigation, and other factors.

Weather observation: Users may utilise hyperlocal meteorological information to determine when to plant, how much water to provide crops, and when to harvest.

Labour administration: Mobile apps with GPS functionality can monitor the whereabouts and activity of field employees. By using this information, processes may be improved and activities can be carried out effectively.

Equipment administration: The cost of agricultural equipment makes it important for farmers to keep track of it, schedule maintenance, and prepare for repairs.

Challenges involved in Precision Agriculture

There are difficulties with precision agriculture. The most problematic issue is data management. It might be difficult to make sense of the enormous amount of data that precision agricultural sensors capture. Integrating all the numerous data sources to interpret a meaningful result is another great task. Precision agriculture involves a variety of distinct data sources, and it might be challenging to integrate them all.

Precision agriculture necessitates a substantial technological investment. It may be expensive to purchase the hardware and software needed for precision agriculture, and it takes time to become proficient with it all. Despite these difficulties, farmers are increasingly embracing precision agriculture in an effort to maximise productivity and crop yields.

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