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Precision Agriculture for Sustainable Agriculture Production Systems

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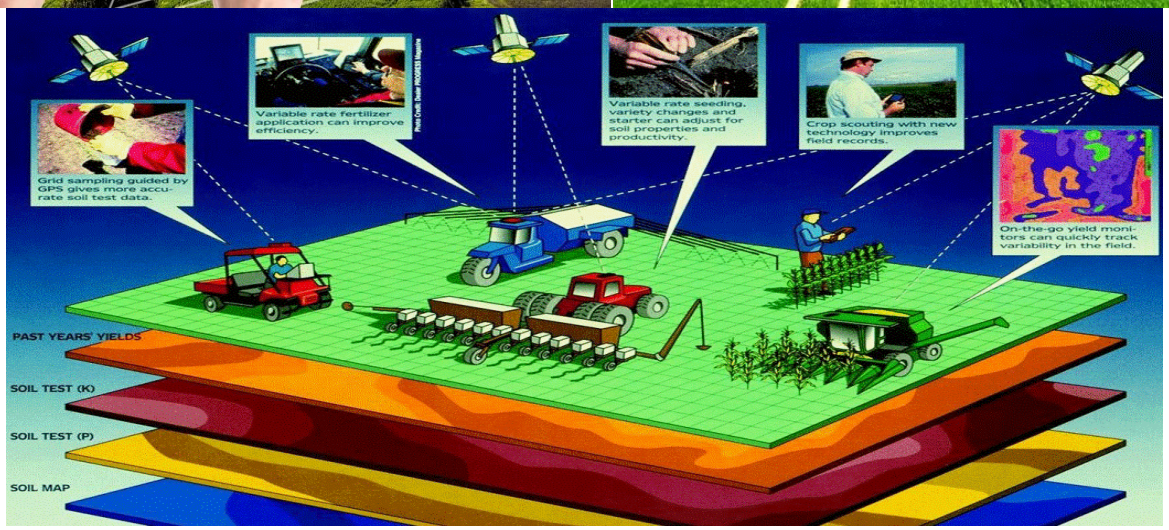
SUMMARY

The human population continues to grow steadily with the shrinking resources being used for agricultural production situates great challenge against Indian agricultural system to attain food and environmental security. Precision agriculture is changing agriculture, and providing opportunities to reduce the impact of agriculture on the environment. Precision agriculture is based on the use of information and science-based decision tools to improve productivity and profitability. Moreover, it optimizes the use of traditional resources. Therefore, this agricultural management system contributes to the development of sustainable agriculture, allowing to solve both economic and ecological problems, which are becoming more acute. It has a lot of potential for enhancing crop yield and input use efficiency under field conditions while reducing the cost of production and deleterious impacts on environmental.

INTRODUCTION

Nowadays, there have been important concerns regarding the long-term impact of soil and water supplies, because they are no longer considered inexhaustible or plentiful resources. Agriculture production highly depends on water and soil factors which increasingly need to be utilized efficiently. The traditional practice for application of production inputs is uniform blanket recommendation across the fields (Gaston *et al.*, 2001). Input management using traditional practices wherein application of agricultural inputs for farming are being made irrespective of the resource characteristics have led to low input use efficiency, high cost of production and degradation of natural resources (Kumar *et al.*, 2017). Here, it has been observed that Precision Agriculture (PA) can often help to maximize these and other resources with the objective of minimizing losses and waste. In addition, PA can increase the yield of crops, as well as reduce the variability and input costs.



The Precision Farming is based on the concept of determination of spatial and temporal variability in the crop production which in turn aimed for increasing crop productivity and reducing environmental menaces. PA describes a suite of Information Technologies (IT) and is focused on producing immediate benefits by being conscious of the environment (Yost *et al.*, 2017). IT used in precision agriculture allow to collect different data of the land which permits farmers to recognize temporal and spatial variations in the production resources, facilitating the application of the necessary treatments with a greater precision (Aubert *et al.*, 2012). Future agricultural systems will evolve through development and adoption of new technologies that address environmental sustainability issues and support further increase in system productivity.

Figure 1.: Precision agriculture for sustainable soil and crop management

Precision agriculture is a management strategy that applies a wide range of technologies to collect, process and examine data to guide targeted actions that progress the efficiency, productivity and sustainability of agricultural procedures. Enabling technologies in PA include the global positioning system (GPS), geographical information systems (GIS) and a multitude of different sensors for assessing site and crop variability, providing information to assist growers in more precise management of agricultural system.

Farmers can control all the processes remotely with a precision agriculture system. Even small farms can manage large fields or a group of small areas. It dramatically improves the efficiency of crops and saves financial costs while increasing production. The last aspect is essential since it seems that precision agriculture technologies are costly at first glance. However, the savings are significantly higher than with traditional agricultural methods in the long run. So, growers can accurately sum the required fertilizer amount, determine effective fertilizer types for a particular area. Moreover, the importance of precision farming technologies is that they improve the planning of agricultural operations for an extended period, adjusting the real-time strategy during force majeure. Therefore, precision farming in agriculture plays an essential part in solving the global problem of hunger.

Need for precision farming

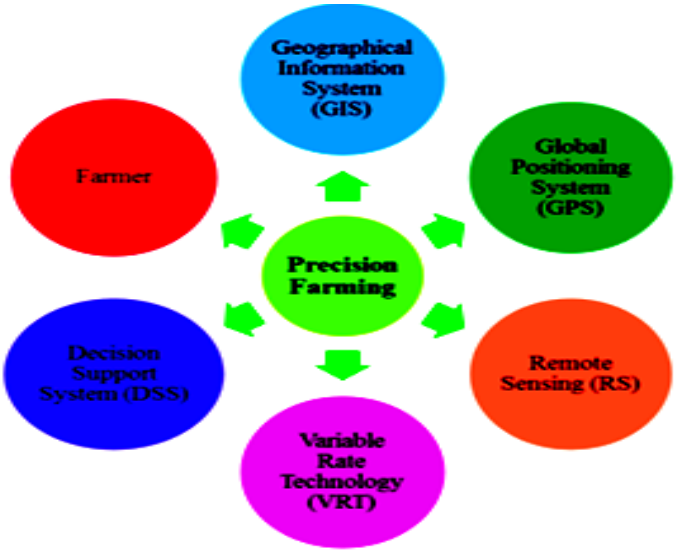
To meet the huge food grain requirement of 480 million tonnes (Mt) by the year 2050, with the increasing challenges of biotic and abiotic stresses experienced by crops, introduction and adoption of modern technology in Indian agriculture is inevitable.

The global food system faces formidable challenges and that will increase over the next 40 years. More radical changes to the food system and investment in research are required to cope up with future challenges and their solutions. The decline in the total productivity, diminishing and degrading natural resources, stagnating farm incomes, lack of eco-regional approach, declining and fragmented land holdings, trade liberalization on agriculture, limited employment opportunities in non-farm sector, and global climatic variation have become major concerns in agricultural growth and development. Therefore, the use of newly emerged technology adoption is seen as one key to increase agriculture productivity in the future.

Components of precision farming

Geographical information system (GIS), Global positioning system (GPS), Remote sensing (RS) and the farmer are the major components of precision farming.

1. Global Positioning System (GPS): It is a set of 24 satellites in the Earth orbit. It sends out radio signals that can be processed by a ground receiver to determine the geographic position on earth. It has a 95% probability that the given position on the earth will be within 10-15 meters of the actual position. GPS allows precise mapping of the farms and together with appropriate software informs the farmer about the status of his crop and which part of the farm requires what input such as water or fertilizer and/or pesticides etc.



2. Geographic Information System (GIS): It is software that imports, exports and processes spatially and temporally geographically distributed data.

3. Variable Rate Technology (VRT): The existing field machinery with added Electronic Control Unit (ECU) and onboard GPS can fulfil the variable rate requirement of input. Spray booms, the Spinning disc applicator with ECU and GPS have been used effectively for patch spraying. During the creation of nutrient requirement map for VRT, profit maximizing fertilizer rate should be considered more rather than yield maximizing fertilizer rate.

4. Remote Sensors: These are generally categories of aerial or satellite sensors. They can indicate variations in the colours of the field that corresponds to changes in soil type, crop development, field boundaries, roads, water, etc. Arial and satellite imagery can be processed to provide vegetative indices, which reflect the health of the plant.

5. Farmer: As farming cannot be imagined without farmer, the latter must be considered as an essential component of precision farming too. For assessing and managing the variability, decision-making is the key factor, and it is to be done in consultation with the farmer.

5. Yield Maps: Yield maps are produced by processing data from adapted combine harvester that is equipped with a GPS, i.e., integrated with a yield recording system. Yield mapping involves the recording of the grain flow through the combine harvester, while recording the actual location in the field at the same time.

Advantages

- It will enhance agricultural productivity and prevent soil degradation in cultivable land resulting in sustained agricultural development.
- It will reduce excessive chemical usage in crop production.
- Water resources will be utilized efficiently under the precision farming.
- GPS allows agricultural fields to be surveyed with ease. Moreover, the yield and soil characteristics can also be mapped.
- Dissemination of information about agricultural practices to improve quality, quantity and reduced cost of production in agricultural crops.
- It will minimize the risk to the environment particularly with respect to the nitrate leaching and groundwater contamination by means of the optimization of Agro-chemical products.
- Non-uniform fields can be sub-divided into smaller plots based on their unique requirements.
- It provides opportunities for better resource management and hence reduce wastage of resources

Disadvantages

- High capital costs may discourage farmers to not adopt this method of farming.
- Precision agriculture techniques are still under development and requires expert advice before actual implementation.
- It may take several years before the actual collection of sufficient data to fully implement the system.
- It is an extremely difficult task particularly the collection and analysis of data.

CONCLUSION

Refinement and wider application of precision agriculture technologies can help in reducing production costs, increasing productivity and better utilization of natural resources. It has the ability to revolutionize modern farm management through improvement in profitability, productivity, sustainability, crop quality, environmental protection, on-farm quality of life, food safety and rural economic development. Site-specific application of irrigation and fertilizers applications can highly reduce production costs and also reduce environmental loading of chemicals. It can increase the efficiency of irrigation efficiency when water resources are low. Farmers can use forecast and mitigate problems like water stress, nutrient deficiency, and pests/diseases. It also increases opportunities for skilled employment in the agriculture sector and also provides new tools for evaluating multifunctional aspects including non-market functions. It has the essential role in the monitoring of greenhouse conditions in agricultural fields.

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