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Precision Agriculture in India: Opportunities and Challenges

Komal Tanaji Dige*
M.Sc. Biochemistry, Department of Biochemistry, Shivaji University, Kolhapur, India
*Corresponding author: komaldige0123@gmail.com

***Abstract*: Agriculture is the backbone of our country which accounts for almost 30% of GDP and employs 70% of the population. Though this is a rosy picture of our agriculture, how long will it meet the growing demands of ever-increasing population? This is a difficult question to be answered, if we depend only on traditional farming. To meet the forthcoming demands and challenge we have to divert towards new technologies for revolutionizing our agricultural productivity. Over the lost decade's technical methods have been developed to utilize modern electronic to respond to field variability such methods are known as specially variable crop production, geographic positioning system (GPS) based agriculture, site-specific and precision farming.**

***Keywords*: GIS, GPS, Precision Agriculture, Remote sensing, Senser's, Mapping.**

1. Introduction

Precision agriculture is an approach where inputs are utilized in precise amounts to get increased yields compared to traditional cultivation techniques. Hence it is a comprehensive system designed to optimize production by using a key elements of information technology and management so as to increase production efficiency, improve production quality, improve the efficiency of crop chemical use, conserve energy and protect environment. Thus, precision farming is an appealing concept and its principles quite naturally lead to the expectation that farming inputs can be used more effectivity with subsequent improvement in profit and environmentally less burdensome production.

The precision farming developments of today can provide the technology for the environment friendly agriculture of tomorrow. Especially in the case of small farmers in developing countries, precision farming holds the promise of substantial yield improvement with minimal external input use.

2. Need of Precision Agriculture

The global food system faces challenges today that will increase markedly over the next 40 years. Much can be achieved immediately with current technologies and knowledge, given sufficient will and investment. But coping with future challenges will require more radical change to the food system and investment in research to provide new solutions to novel problems. The decline in the total productivity, diminishing and degrading natural resource, stagnating farm income, lack of Eco regional approach, declining and fragmented land holdings trade liberalization or agriculture limited employment opportunities in non-farm sector and global climatic variation have become major concerns in agricultural growth and development. A precision farming approach recognizes site-specific differences within fields and adjust management actions. Precision agriculture offers the potential to automate and simplify the collection and analysis of information. It allows management decisions to be made and quickly implemented on small areas within large fields.

3. Technologies Used in Precision Agriculture

In order to collect and utilize information effectively, it is important for anyone considering precision farming to familiar with the modern technological tools available.

A. Mapping

The generation of maps for crops and soil properties is the most important and first step in precision agriculture. These maps will measure special variability and provide the basis for controlling spatial variability. Data collection occur both before and during crop production and is enhanced by collecting precise location coordinates using the GPS. During crop production the data are collected through sensing instruments such as soil probes, electrical conductivity and soil nutrient status. Mapping can be done by RS, GIS and manually during field operations.

B. Global Positioning System(GPS)

GPS is navigation system based on a network of satellite that helps users to record positional information with an accuracy of between 100 and 0.01m. GPS allows farmers to locate the exact position of field information such as soil type, post occurrence, weed invasion, water holes, boundaries and obstructions. There is an automatic controlling system with light or sound guiding panel (DGPs), antenna and receiver. GPS satellites broadcast signals that allow GPS receivers to calculate their position. The system allow farmers to reliably identify field locations so that inputs (seeds, fertilizers, pesticides, herbicides and irrigation water) can be applied to individual field based on performance criteria and previous input applications.

C. Sensor technologies

Various technologies such as electromagnetic conductivity, photo electrical and ultra sound are used to measure humidity, vegetation, temperature, texture, structure, physical character, humidity, nutrient level, vapor, air etc. Remote sensing data are used to distinguish crop species, locate stress condition, identify pests and weeds and monitor drought, soil and plant conditions. Sensors enable the collection of immense quantities of data without laboratory analysis.

D. Geographic Information System(GIS)

This system comprises hardware, software and procedure designed to support the completion, storage and location data to produce maps. GIS links information in one place so that it can be extrapolated when needed. A farming GIS database can provide information on field topography, soil types, surface drainage, subsurface drainage, soil testing, irrigation, chemical application rates and crop yield. In addition to data storage and display the GIS can be used to evaluate present and alternative management by combining and manipulating data layers to produce on analysis of management scenarios.

E. Global Positioning System(GPS)

GPS satellite broadcast signals that allow GPS receivers to calculate their position. This information is provided in real time meaning that continuous position information is provided while in motion. Having precise location information at any time allows soil and crop measurements to be mapped. GPS receivers either carried to the field or mounted on implements allow users to return to specific locations to sample or treat those areas. Uncorrected GPS signals have an accuracy of about 300 feet.

F. Quantifying on farm variability

Every farm presents a unique management puzzle. Not all the tools described above will help determine the Couse of variability in a field and it would be cost and prohibitive to implement all of them immediately. An incremental approach is a wiser strategy using one or two of the tools at a time and carefully evaluating the results.

G. Variability of soil water content

It is well established fact that soil water content in a field varies over time and location and this temporal and spatial variability in soil water content patterns may have profound implications for precision agriculture in general and water management in particular knowledge of the underlying stable soil water distribution could provide on useful basis for precision water management and lead to saving in energy, water, equipment cost, labor and improved production.

4. Opportunities in Precision Agriculture

1. Prioritization of macro/ micro watersheds for implementation and impact assessment of watershed projects at national, state, district, taluka and hobli levels.
2. Forecasting of outbreak of pests and disease based on soil water status and plant stress indicators in crops such as paddy, wheat, sugarcane, cotton, chili and pigeon pea etc.
3. Development of decision support system for precise management of resources at farm level at least in commercial/ fruit/flower crops to begin with.
4. Airborne SAR data utilization for identification of kharif crops and development of procedure for canopy backscatter models for identification and yield prediction.
5. Soil mapping at cadastral scale using high resolution spatial, spectral and radiometric resolutions.
6. Quantification of soil loss.
7. Detection of water logging due to rising ground water table.
8. Delineation of salt-affected soils in black soil and sandy regions.
9. Soil moisture estimation and mapping using micro wave remote sensing techniques in surface and root zone depth.
10. Land surface temperature estimation using thermal and microwave remote sensing techniques.
11. Development at digital technique for a variety of applications using GIS techniques. E.g. Soil suitability to crops, land irrigabillity assessment etc.
12. Improved yield models by integration of biophysical simulation and regional level crop models.
13. Preparatory activities towards hyper spectral data utilization for understanding the plant processes and development of spectral response models for stress detection.

5. Challenges in Precision Agriculture

1. Identification of crops and estimation of area and production of short duration crops grown in fragmented land holding in particular during kharif season.
2. Forecasting of droughts and floods.
3. Detection of crop stress due to nutrients, pests and diseases and quantification of their effects on crop yield.
4. Automation of land evaluation procedure for a variety of applications using GIS techniques.
5. Information of sub-surface soil horizons.
6. Extending precision farming database to smaller farm size and diverse cropping systems.
7. Developing decision support system for management of biotic and abiotic stresses at the farm level.
8. Use of remote sensing and precision farming technologies in intercropping situation.
9. Convincing evidence to prove utility and economic variability of these technologies so as to mobilize

support for R&D work.

10. Human resource development to hasten the process of large scale use of unexplained and cutting edge technologies that have tremendous scope and potential.

6. Conclusion

- Precision farming provides a new solution using a system approach for today's agricultural issue such as the need to balance productivity with environmental concerns.
- It is based on advanced information technology.
- It includes describing and modeling variation in soil and plant species and integrating agricultural practices to meet site-specific requirements.
- It aims at increased economic return as well as at reducing the energy input and the environmental impact of agriculture.

7. The future of Precision Agriculture

1. Opportunities will continue for precision agriculture studies.
2. Tools will become available to apply chemicals, fertilizers, tillage and seed differentially to a field and collect the yield or plant biomass by position across the field.
3. Remote sensing technology will allow us to observe variation within a field throughout the growing season relative to the imposed management changes.
4. Monitoring equipment exists for capturing the surface water and groundwater samples needed to quantify the environmental impact trough surface runoff or leaking.
5. The future direction of agriculture will depend upon the research community's ability to conduct this type of study. With confidence from the environmental and producer communities that changes will benefit the environment and increase the efficiency of agricultural production.

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