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Relevance of Precision Farming to Indian Agriculture

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The concept of precision farming first originated in the United States of America during 1980s. Precision farming or precision agriculture is a farming management concept based on modern information technologies such as GPS (Global Positioning System), Remote Sensing Technology and GIS (Geographic Information Systems). In Indian context, precision farming may be defined as an accurate application of agricultural inputs for crop growth considering relevant factors such as soil, weather and crop management practices. It is actually information and technology based farming system where inputs are managed and distributed on a site-specific basis for long term benefit. In precision farming, application of same quantities of crop inputs throughout the field is considered as an enormous waste of resources. First of all, variables existing in a field is studied and then based on these variables the entire field is divided into small units. That is, small areas of a big field is taken as single units rather than taking the entire field as a single unit. Thereafter, management is customized for these small units. Since accurate quantities of inputs are used, resource efficiency is highest in precision farming which in turn increases crop yields and productivity per unit area.

Some of the **Advantages** of precision farming include:

- Reduce fertilizer costs
- Reduce chemical application costs
- Reduce pollution through poor use of chemicals.
- Improve crop yields
- Provide better information for management decisions
- Provide better farm records essential for sale and succession

Disadvantages

Techniques are still under development and so it is important to take specialist advice before making expensive decisions.

- Initial capital costs may be high and so it should be seen as a long-term investment.
- It may take several years before you have sufficient data to fully implement the system.
- Extremely demanding work particularly collecting and then analysing the data.

Methods of Precision Farming

There are two methodologies for implementing precision farming. Each method has unique benefits and can even be used in a complementary or combined fashion.

1. Map based

It includes grid sampling a field, performing laboratory analyses of the soil samples, generating a site specific map of the properties and finally using this map to control a variable

rate applicator. During both the sampling and application steps, a positioning system GPS/DGPS is used to identify the current location with higher accuracy in the field. This method is most popular due to lack of sufficient sensors for monitoring the soil conditions and also truth in a laboratory analyses and the reliability of the data. However, the cost of soil testing limits the number of samples that a farmer can afford to test. Thus, the usual practice is to grid sample a field every 2 to 2.5 acres. Sitespecific maps may also be used for grid wise site specific input management. This methodology is most relevant for Indian agriculture at present.

2. Sensor based

It utilizes real time sensors and feed-back control to major the desired properties on-the-go, usually soil properties or crop characteristics and immediately use this signal to control the variable rate applicator. Sensors developed for on-the-go real time measurement of soil properties have the potential to provide benefits from increased density of measurements at a relatively low cost. A GPS receiver and a data logger are used to record the position of each soil sample or measurement, to generate a map which can be processed along with other layers of spatially variable information to control the variable rate applicator (Adamchuk *et. al.,* 2004). The major differences between map based and sensor based precision farming systems are given in table 1.

Table 1: Major differences between Map based and Sensor based Precision farming systems.

S.No.	Parameter	Map based	Sensor based
1.	Methodology	Grid Sampling - lab analyses - site specific maps and use of variable rate applicator	Real time sensors – Feedback control measures and use of variable rate applicator
2.	GPS/DGPS	Very Much Required	Not necessary
3.	Laboratory analysis (Plant & Soil)	Required	Not required
4.	Mapping	Required	May not required
5.	Time consumption	More	Less
6.	Limitations	Cost of soil testing and analyses limits the usage	Lack of sufficient sensors for getting crop and soil information
8.	Skills	Required	Required
9.	Sampling unit	2 to 3 acres	Individual spot
10.	Relevance	Popular in Developing countries	Popular in Developed countries

Interventions

The PF technique can be employed for working on drip irrigation, sprinkler irrigation, fertigation, in-situ moisture conservation, anti-hail nets, anti-bird nets, shade nets, protected cultivation of fruits, vegetables and floricultural crops and LDPE lined water storage tanks. Drip irrigation studies can be undertaken on various commercially important fruits, vegetables and floricultural crops including crop geometry studies in vegetables with a view to minimize the cost of installation of drip irrigation. Under protected cultivation, studies on cultivation, mulching and propagation of fruit and vegetable crops under polyhouse condition, shading in ornamental crops and hail protection in fruit crops can be undertaken.

These interventions can come out with specific recommendations on drip irrigation, plastic mulching, crop geometry, fertigation, etc in fruits, vegetables and high value cut flowers, which will definitely increase the earnings of the farmers many times.

1. Rice, wheat, cotton, sugar beet, onion, potato, etc are the important field crops where PF can be adopted. Some of these are having very high value per acre, making excellent causes for SSM. For all these crops yield mapping is the first step to determine precise locations of highest and lowest yield areas of the field, and to analyze the factors causing yield variations.
2. Nutrient and water management is another area where PF can help Indian farmers. Detecting nutrient stress using remote sensing and combining data in GIS can help in SS applications of fertilizers and organic amendments like lime, manure, compost, sulphur, etc which in turn would increase nutrient use efficiency and reduce nutrient losses.
3. In semi-arid and arid tropics, PF can help growers in scheduling irrigation more profitably by varying the amounts, timing and application of water, e.g. in drip irrigation using information coupled with remotely sensed stress conditions (canopy-air-temperature difference) can increase WUE thereby reducing runoff and deep percolation losses.
4. Some disease and insect pests of crops may be monitored by remote sensing. Remote sensing techniques are used to detect specific insect pests and to distinguish between insect and disease damage on crops. Results of various studies suggested that canopy characteristics and spectral reflectance differences between insect infestation damage and disease infection damage can be measured in crop canopies by remote sensing but that these differences may not be consistent from one growing season to the next.
5. Multi-temporal Landsat imagery are used to classify land cover types and grazing intensity. Grazing intensity categories are defined based on percentage of bare soil, sward height and standing dead material Correlation analysis between spectral ratio, i.e. Normalized Difference Vegetation Index (NDVI), and above ground biomass, is to be done.

Economic feasibility of precision farming

The profitability potential for variable-rate management is significantly enhanced, if the initial means of forming application maps are inexpensive. Recent research in precision farming has focused on site-specific management zones (SSMZ) as a means to generate application maps and improve nutrient management in cropping systems

Priority areas for the immediate implementation of precision farming technologies are
(i) Horticultural, plantation crops and other high profit making crops
(ii) Precision management of nutrients, water and other inputs in irrigated agriculture and
(iii) Forecasting incidence of pests and diseases and management in commercial crops and in crops such as paddy, cotton, pigeon pea, chickpea etc, where huge quantities of pesticides are used.

Some of the areas in agriculture where precision farming is taking hold with implications for the economics of farming are listed below.

1. Soil Fertility Management

a) This involves dividing a field into several small and equal divisions using the sub-inch accuracy of GPS. To do this, the tractor is fitted with a dish antenna to receive signals from satellites, which are recorded on a tractor-mounted computer. Soil samples are mechanically taken from each sub-division and this process is technically known as “Grid Sampling.”
b) Samples are tested in a modern soil testing laboratory for about 17 parameters including physical and chemical characteristics of the soil and recorded.

c) Using the test results of this grid samples, composite colour–grams are created through computer simulation on each of the17 parameters for the entire field .
d) The colour-grams are stored as stencils in the computer for various functions. One of the chief among the functions is balancing soil fertility of the field with respect to all major, secondary, and micro- nutrients. This is achieved through tractor-mounted computer guided spreader equipment capable of reading the variability of fertility from colour-grams. Fertilizers are then automatically applied at variable rates only to where they are needed as indicated by the colour-grams.

In practical experience, the savings in fertilizer cost from this variable rate application alone will more than offset the cost involved in the programme. Besides, use of this method brings about greater uniformity of soil fertility in the field, leading to maximum economic yields of crops, which could not be achieved through other methods.

2. Other applications of the GPS-generated grid method

The grid generated by GPS is stored in the computer and used for site-specific evaluation and monitoring of numerous functions involved in crop production to achieve peak efficiency in farm management. Some of these areas are listed below:
a) Planting variable rates of seed to maximize crop yields from the specific fertility of each grid section.
b) The GPS-guided grid system helps to apply variable rates of herbicides and pesticides to achieve maximum control of weeds and pests. This not only reduces the cost of chemicals used, but also improves efficiency of pest control and protects environment.
c) This enables the farmer to side dress application of fertilizers at variable rates to meet the specific requirement of each grid section, thus improving fertilizer use efficiency.
d) Irrigation rates are tailored to the requirement of each grid area improving water use efficiency.
f) Scouting for pest information and pest control are achieved on a site-specific basis.
g) At harvest, crop yield information is recorded on a grid section basis. Solutions for differences of yield between grid sections are sought through computer analysis of all variables controlling yield of crops that are stored in the computer. Based on this, the farmer fine-tunes his or her variable rates of application of fertilizers and other impacting parameters for use in future cropping programmes.
h) One other great advantage of the GPS system of farming involves the ability of the farmer to achieve greater efficiency in time control of his farm operations. This is because the GPS system enables him to operate his equipment round the clock irrespective of factors restricting visibility such as fog, darkness, or even showers. The sub-inch accuracy of GPS-based operations provides the farmer maximum efficiency with equipment operations.

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