BENEFITS OF PRECISION FARMING :-

a) Precision fanning not only is potentially more economical, but it also reduces the amounts of chemicals released into the environment.

b) Improves crop yield and profit

c) Provides better information for making management decision.

d) Provides more details and useful farm records.

e) Reduces fertilizer costs.

I) Reduces pesticide costs.

g) Reduces pollution.

COMPONENTS OF PRECISION FARMING :-

1. Remote sensing (RS)
2. Geographical information system (GIS)
3. Global Positioning System (GPS)
4. Soil testing
5. Yield monitors
6. Variable Rate technology (VRT)

ADVANTAGES OF PRECISION FARMING SYSTEM (PFS) TO FARMERS :-

Overall yield increase :- Precise selection of crop varieties, application of exact types and doses of fertilizers, pesticides and herbicides and appropriate irrigation meet the demands of crops for optimum growth and development.

Efficiency improvement :- Advanced technologies, including machinery, tools and information, help farmers to increase the efficiency of labour, land and time in farming.

Reduced production cost :- Application of exact quantities at the appropriate time reduces the cost of agrochemical inputs in crop production.

Better decision making in agricultural management :- Agricultural machinery, equipment and tools help farmers acquire accurate information which is processes and analysed for appropriate decision making.

Reduced environmental impact :- Timely application of agrochemicals at an accurate rate avoids excessive residues in soils and water and thus reduces environmental pollution.

Accumulation of farmers knowledge for better management with time :- All PFS field activities produce valuable field and management information and data are stored in tools and computers. Farmers can thus accumulate knowledge about their farms and production systems to achieve better management.

STEPS IN PRECISION FARMING :-

- There are **two basic steps** in precision agriculture.

1. Identification and Assessment of Variability :-

a) Grid soil sampling :-

- Grid soil sampling uses the same principles of soil sampling but increases the intensity of sampling compared to the traditional sampling.
- Soil samples collected in a systematic grid also have location information that allows the data to be mapped.
- The goal of grid soil sampling is to generate a map of nutrient/water requirement called an **application map**

b.) Yield map:-

- Yield mapping is the first step to determine the precise locations of the highest and lowest yield areas of the field and to analyse the factors causing yield variation.
- One way to determine yields map is to take samples from the land in a 100 x 100 m grid pattern to test for nutrient levels, acidity and other factors.

c) Crop Scouting: - In season observations of crop conditions like weed patches (weed type and intensity), insect or fungal infestation (species and intensity) and crop tissue nutrient status can be helpful for explaining the variations in yield maps.

d) Use of precision technologies for assessing variability: - Faster and real time assessment of variability is possible only through advanced tools of precision agriculture.

2. Management of Variability:-

a) **Variable rate application** :-

Grid soil samples are analyzed in the laboratory and an interpretation of crop input (nutrient/water) needs is made for each soil sample.

- Then the input application map is plotted using the entire set of soil samples.
- The input application map is loaded into a computer mounted on a variable rate input applicator.
- The computer uses the input application map and GPS receiver to direct a product delivery controller that changes the amount and kind of input according to the application map.

b) Yield monitoring and mapping :-

- Yield measurements are essential for making sound management decisions.
- However, soil landscape and other environmental factors should also be weighed when interpreting a yield map.
- Yield information provides important feedback in determining the effects of managed inputs such as fertilizer amendments, seed, pesticides and cultural practices.

c) Quantifying farm variability: Every farm presents a unique management. Not all the tools described above will help determine the causes of variability in a field and it would be cost prohibitive to implement all of them immediately.

d) Flexibility: - All farms can be managed precisely. Small scale farmers often have highly detailed knowledge of their lands based on personal observations and could already be modifying their management accordingly. Appropriate technologies here might make this task easier or more efficient.

SCOPE AND ADOPTION OF PRECISION FARMING IN INDIA:

PA for small farms can use small farm machinery and robots which will not compact the soil and may also run on renewable fuels like bio oil, compressed biogas and electricity produced on farms by agricultural residues. For small farms, precision agriculture may include sub-surface drip irrigation for precise water and fertilizer application, weed removal, harvesting and other cultural operations. Some of these robots are already being used on small farms in the US and Europe and it is expected that they may be deployed in large scale in the near future. For small farms, precision agriculture may help in sub-surface drip irrigation for precise water and fertilizer application and robots for weed control, harvesting and other operations. Similarly, drones have also been introduced in Japan and the U.S. for mapping the farms, identifying diseases and so on. Most robotic machines and drones are compact and thus suitable for small farms. India's small farms, therefore, are ideal for the large-scale application of precision agriculture.

SCOPE AND LIMITATION IN ADOPTION OF PRECISION FARMING IN INDIA

1. Precision Farming concepts are applicable to all agricultural sectors like animal farming, fisheries and forestry. Precision Agriculture (PA) can be classified into two categories namely 'Soft' PA and 'Hard' PA.
2. 'Soft' Precision Agriculture mainly depends on visual observation of crop and soil and management decision based on experience and intuition, rather than statistical and scientific analysis.
3. Whereas, 'Hard' PA utilizes all modern technologies like GPS, GIS, VRT, etc.
4. In India 96 million farms out of a total 105.3 million farms have less than 4 hectares (ha) area.
5. Though only fragmented lands are cultivated, the present food grain production in India is nearly 200 Million Tone, which has made India self sufficient in food production.
6. To compete with the world production, the crop yield per hectare must be economic and without environment degradation.
7. In India, overall fertilizer consume-tion rate is 84.3 Kg/ha, which must be reduced by systematic soil testing and creating nutrient maps along with fertilizer recommendations.
8. Along with nutrient zones pest control, disease and weed management also plays an important role in high yield of crop. Using advance technology, it is possible to monitor and control the pest and disease at lower costs.
9. Some states like Punjab, Haryana use high doses of fertilizer and pesticides.
10. For example, the state of Punjab has 1.5% of total geographical area of India, but uses 1.38 million tones (nearly 10% of all India fertilizer consumption) of NPK fertilizer along with 60% of weedicides used in India.
11. Overall exploitation of land as well as excessive use of agriculture input are typical problems of these areas.

12. Stress management is another area where Precision Framing can help Indian farmers in scheduling irrigation more profitably by varying the timing, quantity and placement of water.
13. Mechanization of farming helps the farmers to reduce the labor cost and to improve the accuracy of farming including quality seed selection, weed removing, pesticide and fertilizer application, harvesting and sorting of the crop as per the quality.
14. There are many limitations to adoption of Precision Farming in developing countries in general and India in particular.
15. Some of these limitations are common to those in other regions; however, following are specific to Indian conditions: 1. The culture and perceptions of the users, 2. Small farm size, 3. Lack of success stories, 4. Heterogeneity of cropping systems and market imperfections, 5. Land ownership, infrastructure and institutional constraints, 6. Lack of local technical expertise, 7. Availability, quality and cost of data.

KEY CHALLENGES TO PRECISION FARMING IN INDIA

Though widely adopted in developed countries, the adoption of precision farming in India is yet in infancy primarily due to its unique pattern of land holdings, poor infrastructure, lack of farmers' inclination to take risk, socio-economic and demographic conditions. The small size of farms and fields in most of Indian agriculture limits economic gains from currently available precision farming technology, while the population density, and public concerns for the environment, food safety and animal welfare means that those potential benefits are being given more attention.

OPPORTUNITIES AND CHALLENGES

Precision Agriculture can have a positive impact on environmental quality. The opportunity exists to show producers how changing production practices will not place crops at risk and produce positive economic and environmental benefits. Conducting experiments on precision agriculture will require field or farmscale studies and perhaps watershed-scale adoption of new management practices.

Completing this type of study will require:

1. Appropriate questions that can beaddressed at the field scale.
2. Methods for measuring environmental endpoints that will demonstrate the efficacy of management practices.
3. Commitment to multiple years of study to overcome meteorological variation.
4. Adequate monitoring equipment for crop production, soil properties, and environmental quality in order to understand the changes occurring due to the management practices.
5. Use of comparison fields or farms in which no changes are made to provide a validation of the improved practices.
6. Cooperation of producers to implement the practices ,vith minor modifications across years so that variations can be isolated to the management practice and not producer influence.
7. Data base structure that includes geographic information layers and accurate global positioning system equipment to position any treatments in the same area across years.
8. Funding sources that will allow for long-term studies across large areas.
9. Interdisciplinary teams that will address the critical problems in experimental design, implementation, and evaluation of results.

10. Commitment from the scientists, producers, and educators involved to maintain interest in the project over a sufficient period of time to allow the original objectives to be achieved.

PRECISION FARMING CONCERNS FOR INDIAN AGRICULTURE :-

1. Farmers in developed countries typically own large farms (10-1000 ha or more) and crop production systems are highly mechanized in most cases.
2. Large farms may comprise several fields in differing conditions.
3. Even within a relatively small field (<30 ha) the degree of pest infestation, disease infection and weed competition may differ from one area to another.
4. In conventional agriculture, although a soil map of the region may exist, farmers still tend to practice the same crop management throughout their fields: Crop varieties, land preparation, fertilizers, pesticides and herbicides are uniformly applied in spite of variation.
5. Optimum growth and development are thus not achieved.
6. Furthermore, there is inefficient use of inputs and lab Labour.
7. Availability of information technology since the 1980s provides farmers ,vith new tools and approaches to characterize the nature and extent of variation in the fields, enabling them to develop the most appropriate management strategy for a specific location, increasing the efficiency of input application.

PRACTICAL PROBLEMS/ISSUES IN PRECISION AGRICULTURE/FARMING

1. Small land holdings.
2. Heterogeneity of cropping systems and market imperfections.
3. Complexity of tools and techniques requiring new skills.
4. Lack of technical expertise knowledge and technology.
5. Infrastructure and institutional constraints including market imperfections.

STEPS TO BE TAKEN FOR IMPLEMENTING PF IN INDIA :-

a) Creation of multidisciplinary teams involving agricultural scientists in various fields, engineers, manufacturers and economists to study the overall scope of PA.

b) Formation of farmer's co-operatives since many of the precision agriculture tools (GIS, GPS etc) are costly.

c) Government legislation restraining farmers using indiscriminate farm inputs and thereby causing ecological/environmental imbalance would induce the farmer to go for alternative approach.

d) Pilot study should be conducted on farmer's field to show the results of PA implementation.

e) Creating awareness amongst farmers about consequences of applying imbalanced doses of farm inputs like irrigation, fertilizers, insecticides and pesticides.