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Precision Farming: A Modern Approach to Agriculture and Dairy Farming

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Agriculture with its allied activities is the largest sector in India revealing 70% dependency of its rural households for their livelihood and has played important roles for food and nutritional security, poverty alleviation, employment generation and sustainable development. Indian is the largest producer of cotton, pulses and milk, second largest producer in food grains, fruits and vegetables, and third in egg production. Agriculture sector alone contributes about 19.9% towards Gross Domestic Product (GDP) of India. Food grain production has experienced considerably a significant jump from about 51 million tonnes during 1950 to 314.51million tonne in 2021-2022 (Economic survey). The production of horticulture products has doubled over the past quarter century and the value of global trade in horticulture crops now exceeds that of cereals. For the first time, horticulture production surpassed food production in India during 2013-14 and continues to excel currently (334.60million tonnes). India is characteristically a country of small agricultural farms, where approximately 80% of total land holdings in the country are less than 2 ha with 30% irrigated land only. India produces a wide variety of agricultural products because of its varied agro-climatic regions but low farm productivity is major concern, which is around 33% of the best agricultural farms world over. Indian farmers can get more remuneration from the same piece of land with fewer inputs once the productivity gets increase. At present, agriculture is facing major challenges due to shrinking land holding, depleting water and other related resources. There is an urgent need for adopting farmer friendly location-specific production and management strategies in a concerted manner to achieve vertical growth in production with ensured quality of produce and judicious use of natural resources for better return per unit area.

Concept of Precision farming

Precision farming (PF) has emerged as a management practice with the potential to increase profits by utilizing more precise information about agricultural resources. Precision farming has proved positive resulted in terms of resource utilization, greater productivity and ecological balance. This agriculture approach involves managing the variability at the sub field level to best utilize resources and minimize environmental impact. The adoptions of precision-agriculture technologies have so far mostly been limited to parts of developed countries (Say et al., 2018). In India, technologies related to precision agriculture that have been adopted include drip and sprinkler irrigation which have been growing steadily, although still accounting for only a fraction of irrigated areas in India. Satellites broadcast singles that allow GPS receivers to compute their location. This information is provided in real time, meaning that continuous position information is provided while in motion. Remote sensing is collection of data from a distance. Data sensors can simply be handheld devices, mounted on aircraft or satellite based. An important function of an agricultural GIS is to store layers of information, such as yields, soil survey maps, remotely sensed data, crop scouting reports and soil nutrient levels.

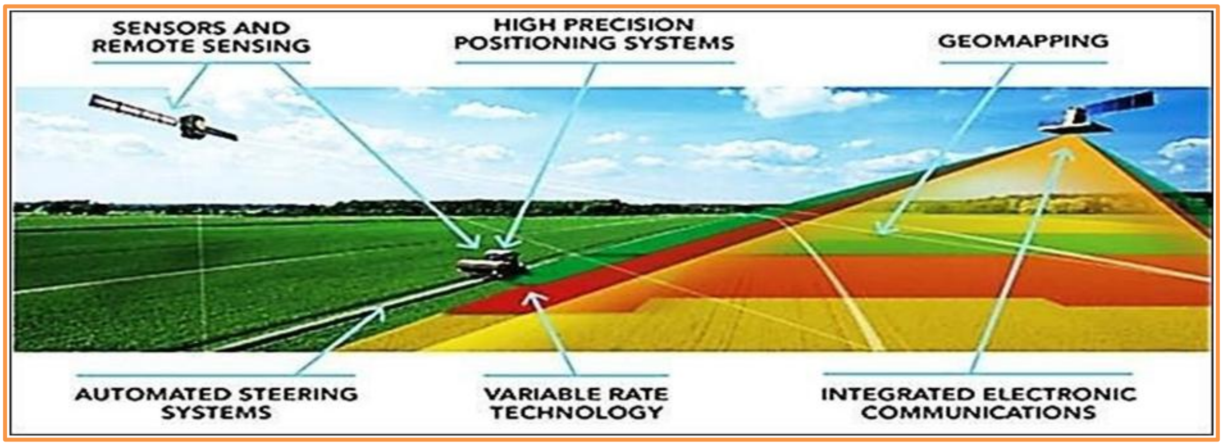

Fig 1: Components of Precision farming

Adoption trends around world

The adoptions of precision-agriculture technologies have, so far, mostly been limited to parts of developed countries. In Australia 90 per cent of farmers had been using some type of precision agriculture, and 20 percent of farmers had been using yield mapping and variable rate fertilizer application. In Germany, about 10 - 30 percent of farmers were using some form of precision agriculture in 2016 .In the United States, the use of precision agriculture started growing in the 2000s, and spread considerably, although at varying rates across crops and the types of precision agriculture .In developing countries, the use of precision agriculture has been limited. In Malaysia, site- specific fertilization is being applied to rubber plantations, and other precision technologies have started being applied for oil palm, although not to rice fields (Mondal and Basu 2009)

In India, technologies related to precision agriculture that have been adopted include drip and sprinkler irrigation, which have been growing steadily, although still accounting for only a fraction of irrigated areas in India .Similarly, while similarly accounting for a tiny fraction of areas within India, adoptions of laser-land-leveling technologies have been growing in parts of India, including Western Uttar Pradesh and Haryana.

Objectives of Precision Farming

Higher profitability and sustainability: Maximum profit can be achieved in each zone or site of a field by optimizing precise application of inputs like variety, seed, fertilizer, herbicide, pesticide etc. as per crop demand, which can be determined by weather, soil characteristics (nutrient availability, texture and drainage etc.) and historic crop performance.

Optimizing production efficiency: Identification of variability in yield potential may offer possibilities to optimize production quantity at each site or within each zone using differential approaches under given set of field conditions.

Increasing efficiency of inputs: Efficient use of inputs like fertilizers, seeds etc. according to the yield potential of soil at a given location.

Effective and efficient pest management: Minimizing inputs cost for crop production is one of the important objectives of precision farming, which can result in getting higher return and better environmental services. Site-specific variable rate application recommends the application of chemicals i.e. herbicides, pesticides at the area of problem with targeted approach in comparison to conventional farming methods.

Optimizing product quality: Product quality can be optimized by using sensors for the detection of quality attributes of a crop, which helps in taking decision on input application as per the target.

Conservation of soil, water and energy: A comprehensive approach under precision farming begins from crop planning, assessing field variability, which includes those tillage practices which disturb the soil to its minimum level. In addition to this, water is efficiently applied by using techniques like drip irrigation, sprinkler irrigation etc. with the principle of more crop

Minimizing environmental impact: Better management decisions under precision farming are made to modify inputs for meeting out the production needs, which ensures no or negligible loss of any applied input to the environment. Per drop. In all such precision applications, very less energy is used thus leading to conservation of energy also.

Basic Steps in Precision Farming

1. Assessing variation
2. Managing variation and
3. Evaluation

The available technologies enable us in understanding the variability and by giving site specific agronomic recommendations we can manage the variability that make precision agriculture viable. Finally evaluation must be an integral part of any precision farming system.

1. Assessing variability

Assessing variability is the critical first step in precision farming. Since it is clear that one cannot manage what one does not know. Factors and the processes that regulate or control the crop performance in terms of yield vary in space and time. Quantifying the variability of these factors and processes and determining when and where different combinations are responsible for the spatial and temporal variation in crop yield is the challenge for precision agriculture. The major part of precision agriculture lies in assessing to spatial variability. It needs the observations at crop growth and development over the growing season, which is nothing but the temporal variation. Hence, we need both the space and time statistics to apply the precision farming techniques.

2. Managing variability

Once variation is adequately assessed, farmers must match agronomic inputs to known conditions employing management recommendations. Those are site specific and use accurate applications control equipment. We can use the technology most effectively. In site-specific variability management. We can use GPS instrument, so that the site specificity is pronounced, and management will be easy and economical. While taking the soil/plant samples, we have to note the sample site coordinates and further we can use the same for management. This results in effective use of inputs and avoids any wastage, and this is what we are looking for. The potential for improved precision in soil fertility management combined with increased precision in application control make precise soil fertility management as attractive, but largely unproven alternative to uniform field management.

3. Evaluation

There are three important issues regarding precision agriculture evaluation. Economics Environment Technology transfer .The most important fact regarding the analysis of profitability of precision agriculture is that the value comes from the application of the data and not from the use of the technology. Potential improvements in environmental quality are often cited as a reason for using precision agriculture. Reduced agrochemical use, higher nutrient use efficiencies, increased efficiency of managed inputs and increased production of soils from degradation are frequently cited as potential benefits to the environment. precision agriculture feasible, agronomic principles and decision rules can make it applicable and enhanced production efficiency or other forms of value can make it profitable. The term technology transfer could imply that precision agriculture occurs when individuals or firms simply acquire and use the enabling technologies.

Components of precision farming

- Global positioning system
- Remote Sensing
- Sensors and data loggers
- Geographic Information Systems (GIS)

- Variable rate applicator
- Yield monitoring and mapping

Precision dairy farming (PDF)

Dairy farming is a decision-intensive enterprise daily, which must rely on holistic approach to maintain a profitable system that is accountable to consumers for well- being, environmental impacts, and product quality. However, the narrow profit margin in dairy farming has intensified the drive for increasing the production and efficiency. Among various options in effective management of dairy farm, focusing on individual animal is one of the effective methods apart from group or herd management. Maltz (2000) reported that 'smallest production unit in the dairy is the individual cow'. Hence, precision agriculture in general, and precision dairying in particular, aims to manage the basic production unit in order to exploit its maximal production capacity.

Benefits of precision dairy farming

- Improved product quality
- Improve management of large herds Reduce labour requirements
- Timely and informed decisions
- Minimized adverse environmental impacts Reduced costs
- Increased efficiency
- Animal health and well-being

Recent technologies in Agriculture and dairy industry:

1. Agricultural robotics
2. Hyperspectral imaging in agriculture
3. Drones in agriculture
4. Radio frequency identification
5. Automated feeding system
6. Milk yield and milk electrical conductivity

Status of precision dairy farming in India

In India, few farms/ organizations have adopted precision technologies which were developed with the help of Indian and foreign companies in dairy farming sector.

1. Information Network for Animal Productivity & Health (INAPH)

National Dairy Development Board (NDDB) has developed an Information Network for Animal Productivity & Health (INAPH), a desktop/ android tablet-based field IT application that facilitates the capturing of real time reliable data on breeding, nutrition and health services delivered at farmer's doorstep. The application can be operated through computers/netbooks as well as hand-held devices (Windows phone & Android tablets) with internet connectivity. Data collected in the field is stored in the central database at NDDB, Anand.

2. COWEL is a computer-based decision support system that contains attributes regarding housing and management conditions. These attributes are technical specifications that contain various technical units called levels. These levels are ranked from best-to-worst regarding welfare, based on scientific information about animal-based parameters. This information, inserted in the model as statements, was weighted depending on the impact it has on welfare by using weighting categories.

MOIRA (Management of Insemination through Routine Analysis) is a computer program that is a module of DAISY, the Dairy Information System which suggests when to inseminate the animal. This decision support system uses the results of milk progesterone tests to determine when to inseminate cows. Series of weekly tests for each cow, to check for estrous cyclicity. Subsequently, the program lists cows for alternate day tests to identify the days when they should be served, and if necessary, a cow can be served without being seen in heat. The work which led to the development of MOIRA showed that ovulation detection rates of 98% were achieved; in commercial herds the rate is around 85%. As pregnancy rates were unchanged, the effect of MOIRA is to reduce calving to conception interval and the culling rate for failure to conceive.

3. SARSA Green in West-Bengal has developed the Geographical Information System for integrated dairy farm management which helps in integrating the whole dairy farm in a more precise way to get correct information about various aspects. GIS has added new vistas in the field by including different units like fodder production, shed management, cattle feed plant, diary plant and different farming system.

4. The development of wireless sensor network for animal management

The IIT-Delhi and NDRI, Karnal was developed a wireless ad hoc sensor network (WSN) to identify the animals through sensor nodes and to monitor the behaviour of animals which include the movement (3D), jumping, position, temperature etc. Such data is required to monitor the behavioural changes in the animals which in turn helps in heat detection, early diagnosis of ailments like mastitis, lameness etc. and in assessing the comfort zone of animals, group behaviour etc. Data transmission is in ad hoc manner instead of fixed base station.

Reasons for adoption and constraints to adoption of precision farming

- Lack of finance and credit facilities
- Drip installation and water-soluble fertilizers are expensive
- Lack of knowledge about precision farming technologies
- Labour scarcity
- Farmers' perception on yield impact of low quantity of inputs
- Lack of water availability and pumping efficiency
- Lack of technical skill to follow precision farming recommendations
- Market tie-ups lead to low price fixation for the produce / unprofitable negotiations
- Inadequate training and demonstrations and weak research – extension – farmer relationship
- Inadequate size of landholdings for adoption of precision farming

Conclusion

The precision farming adoption is still in developing stage where the western countries and Australia are using very well than developing counties. As the technologies shows improving the yield with decreasing input cost with minimizing the environmental degradation, adoption of it is beneficial to the farmers and growth of the countryThe adoption of precision dairy farming is growing in the india, it is a positive for increasing production and productivity with earlier detection of diseases.

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