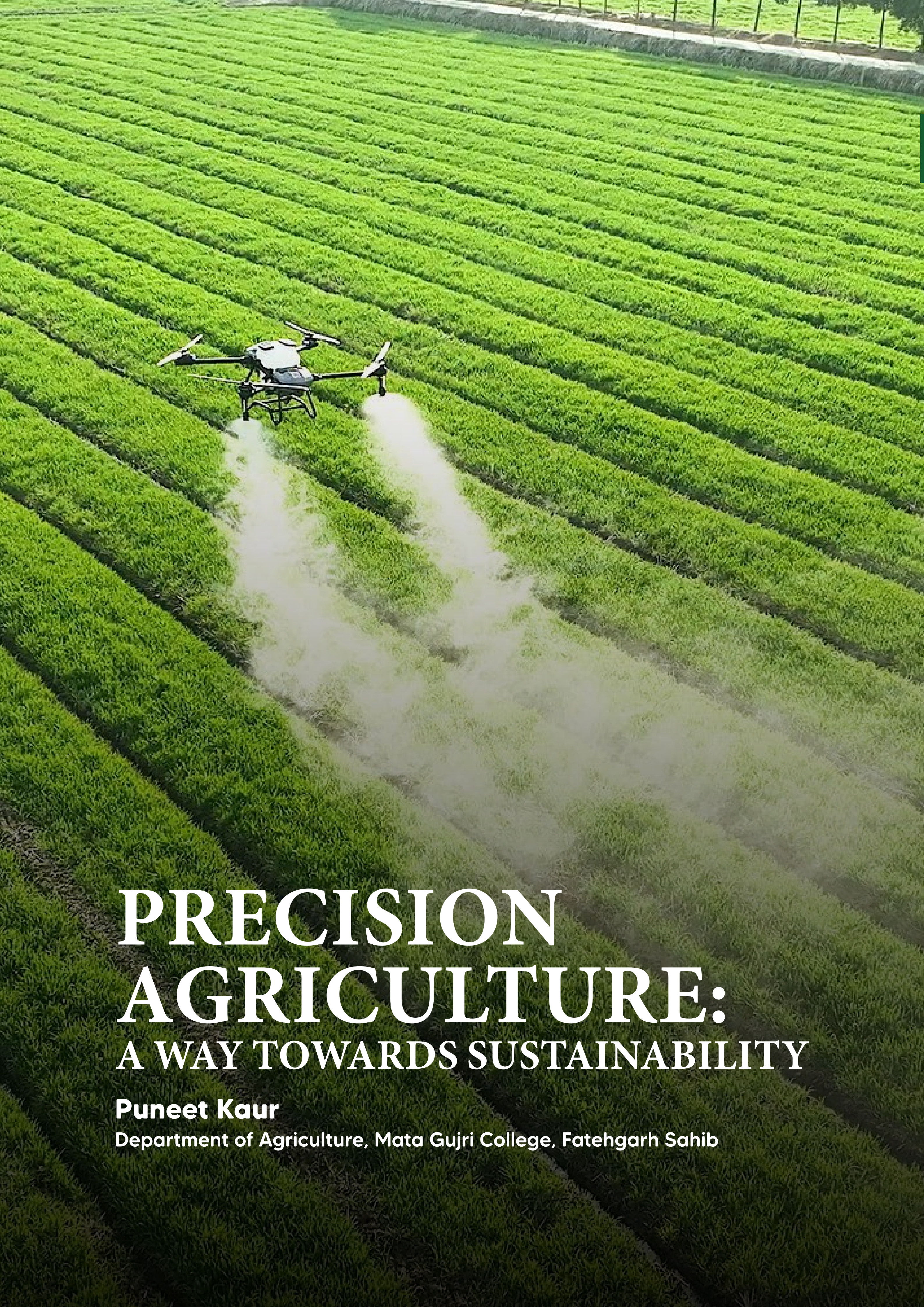

PRECISION AGRICULTURE:

A WAY TOWARDS SUSTAINABILITY

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INTRODUCTION

Precision agriculture, also known as precision farming, is one of the modern farming technologies that helps the farmers manage their fields in a more precise and accurate manner while maximizing the effectiveness of crop inputs. According to Pierce and Nowak (1999), "Precision agriculture can be defined as the application of principles and technologies to manage spatial and temporal variability associated with all aspects of agricultural production for the purpose of improving crop performance and environmental quality". It considers within-field and between-field variability and various measures for sowing, fertilizer requirements and plant protection etc. are carried out based on the particular conditions of a given field. Therefore, precision agriculture is actually an information- and technology-based farming system that intends to enhance the site-specific and overall farm productivity and profitability while reducing the adverse effects on biodiversity and the environment.

NEED FOR PRECISION AGRICULTURE

1. To optimise the productivity and profitability of the agricultural crops.
2. Optimum utilization of inputs like water, fertilizers, pesticides, herbicides, farm equipment etc. depending upon site-specific management and to improve their efficiency.
3. To improve growers' income by reducing the production costs and boosting the overall yields as compared with the traditional cultivation practices.
4. Conservation of available resources from soil erosion, water-logging, nutrient loss, pollution etc.
5. To enhance the quality and quantity of the agricultural produce to meet the growing population demands.
6. To determine and analyse the information accurately for the best management decisions to be implemented.

STEPS INVOLVED IN PRECISION FARMING

1. **Identification and assessment of variability:** It is the critical first step in which both the spatial and temporal variabilities are identified using grid soil sampling, crop scouting and other methods, after which precision technologies are used to obtain real-time and fast assessment.
2. **Management of variability:** Once the variations are analysed reliably, growers need to follow the management recommendations in order to adjust their agronomic inputs with the identified conditions. Then, site-specific and accurate application control equipment should be used.
3. **Evaluation:** This involves monitoring the outcome in terms of profitability analysis, environmental assessment and technology transfer rate for further potential improvements.

The 5 R's of Precision Agriculture: The precision farming technologies aim to assist the farmers in optimum utilization of the inputs by considering the given 5R's-

1. **Right Source:** Determine the type of nutrient sources and plant protectants needed by the particular crop and its soil type.
2. **Right rate:** Identify the field variations to decide the accurate quantity of water, fertilizers and other inputs according to crop needs for their efficient use.
3. **Right time:** Application time is dependent on several factors such as crop growth stage, climate, plant nutrient demand and uptake. In order to reduce wastage of inputs and

improve crop performance, the optimal application time should be selected.

4. **Right place:** Nutrient uptake and their efficiency can be enhanced by suitable placement of fertilizers in the fields. Modern technologies like GPS based variable applicators can be used to provide fertilizers in specific zones within a field as determined in soil maps rather than uniform spread over a large area.
5. **Right manner:** Depicts procedure or the method by which the management practices are carried out. For instance, in crop nutrient management, it refers to the method of nutrient application, i.e. broadcasting, dribbling, fertigation etc.

TECHNOLOGIES INVOLVED

1. **Remote Sensing (RS):** Remote Sensing is an art and science of gathering information about a distant object or even the earth's surface without actually coming into any physical contact with it. The sensors used can simply be portable gadgets or mounted on aircraft or satellites. The data and images obtained using such sensors provide a mapping tool to distinguish crops, evaluate their health, estimate yields and monitor other farming practices. Remotely-sensed images help to detect plant stress related to nutrients, plant density, moisture, weed infestation, pests and diseases along with their precise location and extent of damage. Thus, remote sensing can indicate in-season variability that impacts crop yield so as to take effective measures within time to improve the profitability of the standing crop.

Stages involved in remote sensing include:

A. Emission of EMR (Electromagnetic Radiation) from an energy source (sun)
B. Transmission of energy to the target through the atmosphere
C. Interaction with the object involving further emission and reflection
D. Recording of energy by the sensor
E. Transmission of the gathered information to the processing station
F. Interpretation of the data digitally or electronically
G. Analysis and application

2. **Geographic Information System (GIS):** The use of this system began in 1960. GIS is basically a computerized data storage and retrieval system that consists of hardware, software and methodologies used to support the compilation, storage, retrieval and analysis of feature attributes and location data to produce maps. Its main feature is that unlike conventional maps, it stores the information as a collection of thematic layers, including crops, yield, soil nutrient levels, soil survey maps, rainfall, diseases and pests followed by the conversion of digital information into clear and accessible form. GIS allows multiple detailed data to be drawn graphically, which can be used for timely decision-making. Information on field topography, irrigation, soil types, crop yield and application rates of different chemicals can be provided by the GIS database which upon interpretation is used to understand the relations between several elements that influence a site-specific crop. Growers then use it to identify most suitable locations for planting crops.

3. **Global Positioning System (GPS):** It is a satellite-based navigation system that helps to record information of a specific position in terms of latitude, longitude and elevation with an accuracy ranging between 100 and 0.01 m. It consists of three basic components, namely GPS ground control stations, GPS satellites and receivers. GPS satellites broadcast signals that allow receivers to identify the exact location even while in motion. As farmers can locate precise field features like soil type, weed invasion, disease or pest occurrence etc., they can apply inputs such as seeds, herbicides, fungicides, fertilizers and water supply depending upon such in-field variabilities.

4. **Variable-Rate Technology (VRT):** Also called variable-rate applicator (VRA), this automated technology can be put into use for different farming operations such as seeding, irrigation, and the application of fertilizers, herbicides, fungicides and pesticides. It comprises three basic components, i.e. the control computer, locator and an actuator. Once the soil or input application map is loaded into a computer mounted on VRA, it uses that information along with a GPS receiver to direct a controller that supplies the right quantity and kind of inputs at a variable rate in the right place.

5. **Yield monitoring and mapping:** Grain yield monitors are installed in highly automated systems like combines that estimate and record the grain flow in their clean-grain elevator. These monitors, when linked with a GPS receiver, provide data for yield maps that assist farmers in making appropriate management decisions related to input applications (seed, fertilizer, irrigation, soil conditioners, fungicides etc.). Yield measurements of several years can be taken into account to determine better management practices.