

# SMART AGRICULTURE USING PA FOR CROP FAILURE MANAGEMENT

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**Abstract** - Agricultural production are expected to increase by 70% in 2050 to meet the demands of increasing population. However, Traditional agriculture (TA) practices cause unpredictable production, resource overutilisation, and unregulated waste production, while affecting climate change through greenhouse gas emissions. Precision agriculture (PA) is one of the latest fast paced agriculture technologies. PA strives to improve agricultural productivity, land-use efficiency, production costs, environmental quality and sustainability. Despite expanding research on new technology adoption, PA continues to suffer from a lack of agreement on its conceptualisation. This initiative would assist farm managers and agriculture analysts in identifying PA implementations and current PA technology for adoption while providing decision-making support.

**Key Words:** Agriculture

## I. INTRODUCTION

PA initiative started in late 1950s and early 60s when the first GPS was introduced and the field of precision agriculture is continuously evolving , with the introduction of new technologies such as sensors, drones, and autonomous vehicles, as well as advances in Data gathering and analysis techniques. Today, precision agriculture is being used by farmers around the world to improve the quality, productivity, and Environmental sustainability amidst their day to day operational aspect.

### PA involved Revolution in Farming

The world is at the brim to follow and latest technological facts to improve food productivity to meet the growing demands of the general people . Long ago in 1990s the second revolution known as the Green revolution took place. Due to scientific progression genetically modified newer sets of crops that are pest resistant and need less water were introduced, leaving each farmer able to feed more number of people with same soil resources as earlier.

The World population is expected to reach around 10 billion by 2050 and food production must be 30% more than the current levels to feed every person. Advanced analytical capabilities and constantly improving IoT capabilities, like precision agriculture drones, will be key elements in the third revolution.

### Precision Agriculture and Predictive Farming

According to McKinsey, the invention and adoption of PA is shaped by the following trends- Big Data and Advanced Analytic Capabilities, and Robotics — Key factors Considered: aerial imagery, sensors, and sophisticated local weather forecasts. In simple words farming that collects and uses data from lands for managing and optimizing the production of crops is known as predictive farming.

Predictive farming is analogous to taking a pill to target an ailment. The solutions are highly tailored from the type of crop suitable for a land to the use of pesticides in targeted regions only. Adopting precision agriculture and modern farming reduces production costs and wastage, as the tailored needs of each land are catered to. Precision agriculture is practiced by adopting crop management software and technical equipment. Rigorous data collection is done on soil testing, plot measurement, weather pattern analysis, and crop analysis through sensor-equipped devices placed on the fields. The data is calibrated to devise conclusions, and based on those results, a detailed and precise set of practices can be adopted.

### Scope of PA

Precision Farming include the adoption of the same set of practices that use smart farming technologies to cater to the needs of individual plots and crops. Big data analytics software such as Cropin Grow (SmartFarm) or robots such as drones can get detailed information on the plot, soil type, suitable crops, irrigation, and fertilizer needs. The information obtained is used to tailor a very unerring selection of crops, fertilizer quantity, and watering needs.

Precision agriculture helps farmers live a debt-free life as production costs and losses are reduced and overall environmental impact is also minimized.

### Advantages of Precision Agriculture

By using precision agricultural technologies and practices, farmers can target their inputs (such as seeds, fertilizers, and pesticides) to specific areas of the field that need them the most, rather than applying them uniformly across the entire field. This targeted approach can help farmers save the expense on inputs, as well as increase crop yield and quality. In addition, precision agricultural technologies can help farmers monitor and manage their crops more effectively, allowing them to respond to potential problems (such as pests or diseases) more quickly and effectively.

Farmers can leverage sensors and mapping tools to precisely apply fertilizers at the right rate and location. In addition, precision agricultural technologies can help farmers optimize their irrigation practices, which can save water and energy.

Since details of areas in a single farm can be traced, precision agriculture benefits farmers in many ways.

Discussed below are some of its key advantages are done based on the data received from the sensors that collect and analyze the data

- A refined set of cultivation practices and choice of crops based on the suitability of land
- Elimination of volatility and risk
- Waste management
- Reduced production costs
- Minimum environmental impact
- Optimized use of fertilizers
- Water management with optimized irrigation practices
- Improved soil health

## II. LITERATURE REVIEW

Precision agriculture, also known as precision farming, is a farm management approach that leverages technology and data analysis for site-specific crop and livestock management. It aims to optimize inputs like water, fertilizer, and pesticides, leading to increased productivity, reduced environmental impact, and improved economic returns.

[1] R. Chin, C. Catal, and A. Kassahun, "Plant disease detection using drones in precision agriculture," *Precis.Agric.*, 2023, DOI: 10.1007/s11119-023-10014-y. The automation of plant disease detection using drones. Presented an identification of common diseases, pathogens, crop types, drone categories, stakeholders, machine learning (ML) tasks, data, techniques to support decision-making, agricultural product types, and challenges of drone-based

plant disease identification and decision taking using UAV view.

[2] D. L. Corwin and E. Scudiero, *Review of soil salinity assessment for agriculture across multiple scales using proximal and/or remote sensors*, 1st ed., vol. 158. Elsevier, 2019. DOI: 10.1016 /bs .agron .2019.07.001

Monitoring tool to address soil spatial variability mapping. Also presented a characterisation of spatial variability of soil salinity using geo referenced soil electrical conductivity (ECa).

[3] S. Verma, A. Bhatia, A. Chug, and A. P. Singh, *Recent advancements in multimedia big data computing for IoT applications in precision agriculture: Opportunities, issues, and challenges*, vol. 163. Springer Singapore, 2020. DOI: 10.1007/978-981-13-8759-3\_15

Multimedia data collection and decision-making ability approach in PA with IoT sensors along with wireless communication technologies. Wireless sensor network (WSN). Cellular wireless communication technologies such as 3G, 4G LTE and 5G.

[4] L. J. Méndez-Vázquez, A. Lira-Noriega, R. Lasacovarrubias, and S. Cerdeira-Estrada, "Delineation of site-specific management zones for pest control purposes: Exploring precision agriculture and species distribution modeling approaches," *Comput. Electron. Agric.*, vol. 167, no. September, p. 105101, 2019, DOI: 10.1016/j.compag.2019.105101

Pest detection management control using site specific zoning techniques. An unmanned aerial system (UAS) is used to capture geo referenced data using high-resolution multispectral images.

[5] P. Gonzalez-De-Santos, R. Fernández, D. Sepúlveda, E. Navas, L. Emmi, and M. Armada, "Field robots for intelligent farms—inhering features from industry," *Agronomy*, vol. 10, no. 11, 2020, DOI:10.3390/agronomy10111638

Advanced machinery with the utilisation of different types of sensors for specific purposes.

Translation of automated factory concept into automated farm utilizing advance machinery.

Mobile robots such as UAVs and UAS

[6] M. Filip *et al.*, "Advanced Computational Methods for Agriculture Machinery Movement Optimization with Applications in Sugarcane Production," *Agriculture*, vol. 10, no. 10, 2020, DOI:10.3390/agriculture10100434

Field operations in agriculture, focusing on the optimization of agricultural machinery's movement in sugarcane production. Approaches based on spatial division configuration, route planning, and cost parameters (fuel and time consumption) were presented.

### III. EXISTING SYSTEM

• Precision Farming is generally defined as an information and technology based farm management system to identify, analyze and manage variability within fields by doing all practices practices of crop production production in right place at right time and in right way for optimum profitability, sustainability and protection of the land resource.

#### 3.1 Objectives of precision farming

To develop a methodology for identifying the causes of within field variation in crop performance.

- To develop practical guidelines required to implement precision farming technology to achieve best management.
- To explore the possibility of using remote sensing methods and GIS to enable management decisions to be made in real time during the growth of the crop

#### 3.2 Need of precision farming

- To increase production efficiency
- To improve product quality
- Use of chemicals more efficiently
- Energy conservation
- To increase input use efficiency
- Soil and ground water protection
- Improve soil structure

#### 3.3 Components of precision farming

- Information or data base
- Technology
  - Global Positioning System
  - Differential Global Positioning System
  - Geographic information systems
  - Remote sensing
- Management

#### 3.4 Steps in precision farming

- Identification and assessment of variability
  - Grid soil sampling
  - Crop scouting
  - Use of precision technologies for assessing variability
- Management of variability
  - Variable rate application
  - Yield monitoring and mapping
  - Quantifying on farm variability
- Evaluation of precision farming

#### 3.5 Scope of precision farming in India

- In India, major problem is the small field size. More than 58 percent of operational holdings in the country have size less than 1ha.
- The crop yields are very low ( $\approx 1\text{t ha}^{-1}$ ) and very good potential exists for increasing productivity of rain-fed Cropping systems.

#### 3.6 Advantages of precision farming

- Overall yield increase
- Efficiency improvement
- Reduced production costs
- Better decision making in Agricultural management
- Reduced environmental impact

#### 3.7 Limitations of Existing System

- High Initialization and Maintenance cost.
- Data quality matters.
- Agriculturalist need more technical and analytical Skills
- Social and ethical factor is a hinderance
- All these factors can contribute to the operational complexity of modern farming strategy , as well as limit the sharing of information among different stakeholders.

### IV. PROPOSED SYSTEM

#### Technologies Used

**Satellite positioning systems (GPS):** Enable farmers to monitor crop conditions using a network of orbiting satellites that send precise locational details to Earth from space.

**Geographic Information Systems (GIS):** Provide information on data parameters used to understand the relationships between factors affecting a crop on a specific site.

**Sensors (optical):** Provide essential information on soil properties, plant fertility and water status, Environmental Status

**Grid soil sampling:** A method for site specific soil management.

**Remote sensing:** Data collected through satellites that assist in evaluating crop health and related parameters.

**Variable rate technology:** Automates applying materials such as fertilisers, pesticides, seeds, and irrigation on the land.

**Laser land levellers:** Levelling of a field within a certain degree of the desired slope using a guided laser beam throughout the field.

**Combine harvesters with yield monitors:** Continuously measure and record the grain flow in the combine's clean grain elevator. When linked with a GPS receiver, a yield monitor furnishes the necessary data for yield maps.

**Leaf coloured charts:** An instant, easy and low-cost technique for N diagnosis of a crop

**Automated irrigation systems:** Systems that allow for minimal manual intervention apart from surveillance. Systems (drip, sprinkler, surface) is automated with timers, sensors or computers, or mechanical appliances.

## Drones and satellite imagery

Drone and satellite technology are used in precision farming. This often occurs when drones take high quality images while satellites capture the bigger picture. Aerial photography from light aircraft can be combined with data from satellite records to predict future yields based on the current level of field biomass. Aggregated images can create contour maps to track where water flows, determine variable-rate seeding, and create yield maps of areas that were more or less productive.

## The Internet of things

The Internet of things is the network of physical objects outfitted with electronics that enable data collection and aggregation. IoT comes into play with the development of sensors<sup>[54]</sup> and farm-management software. For example, farmers can spectroscopically measure nitrogen, phosphorus, and potassium in liquid manure, which is notoriously inconsistent.<sup>[46]</sup> They can then scan the ground to see where cows have already urinated and apply fertilizer to only the spots that need it. This cuts fertilizer use by up to 30%.<sup>[53]</sup> Moisture sensors<sup>[55]</sup> in the soil determine the best times to remotely water plants. The irrigation systems can be programmed to switch which side of tree trunk they water based on the plant's need and rainfall.

Innovations are not just limited to plants—they can be used for the welfare of animals. Cattle can be outfitted with internal sensors to keep track of stomach acidity and digestive problems. External sensors track movement patterns to determine the cow's health and fitness, sense physical injuries, and identify the optimal times for breeding. All this data from sensors can be aggregated and analyzed to detect trends and patterns.

As another example, monitoring technology can be used to make beekeeping more efficient. Honeybees are of significant economic value and provide a vital service to agriculture by pollinating a variety of crops. Monitoring of a honeybee colony's health via wireless temperature, humidity and CO<sub>2</sub> sensors helps to improve the productivity of bees, and to read early warnings in the data that might threaten the very survival of an entire hive.

## Smartphone application[[s

[A possible configuration of a smartphone-integrated precision agriculture system

Smartphone and tablet applications are becoming increasingly popular in precision agriculture. Smartphones come with many useful applications already installed, including the camera, microphone, GPS, and accelerometer. There are also applications made dedicated to various agriculture applications such as field mapping, tracking animals, obtaining weather and crop information, and more. They are easily portable, affordable, and have high computing power.

## Machine learning

Machine learning is commonly used in conjunction with drones, robots, and internet of things devices. It allows for the input of data from each of these sources. The computer then processes this information and sends the appropriate actions back to these devices. This allows for robots to deliver the perfect amount of fertilizer or for IoT devices to provide the perfect quantity of water directly to the soil. Machine learning may also provide predictions to farmers at the point of need, such as the contents of plant-available nitrogen in soil, to guide fertilization planning. As more agriculture becomes ever more digital, machine learning will underpin efficient and precise farming with less manual labour.

## Work flow diagram

### 1. GPS Sensors

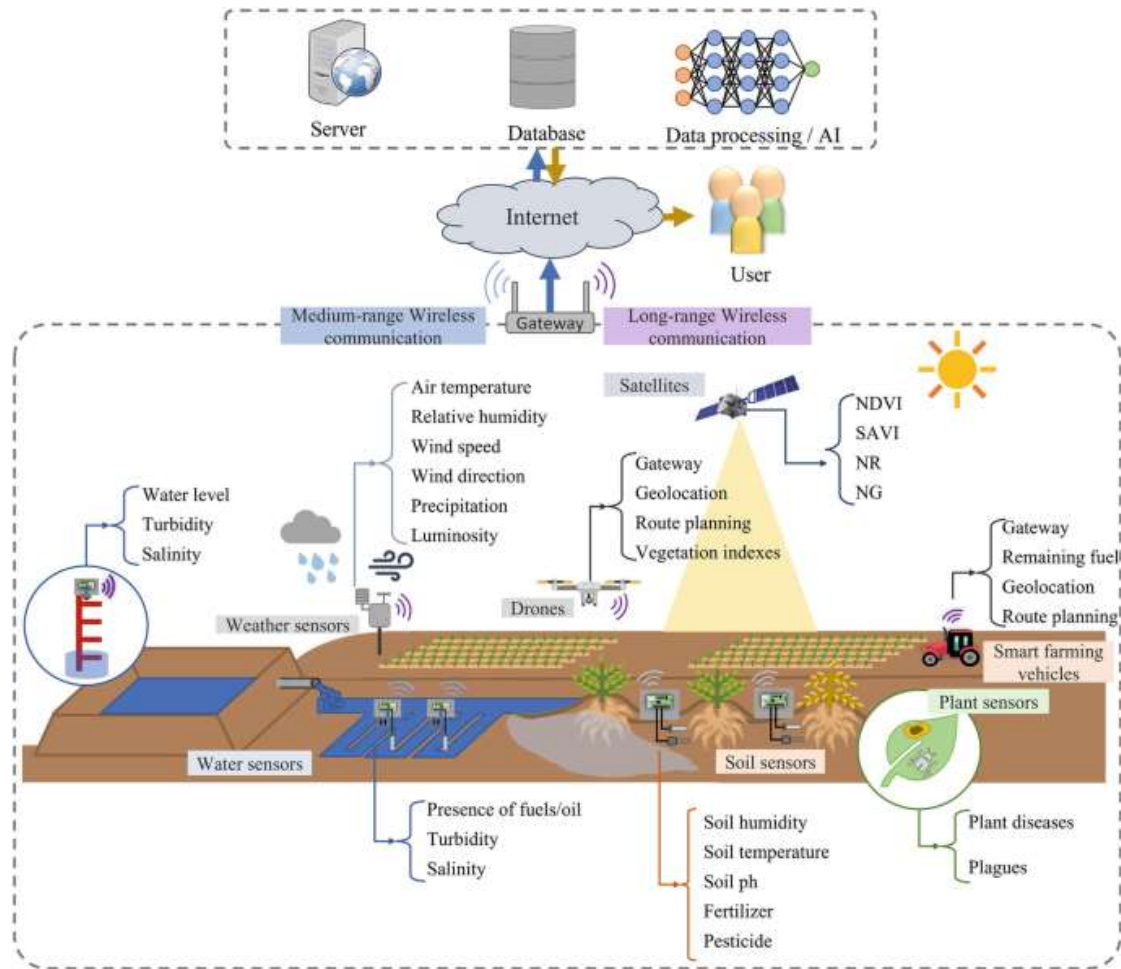
This sensor is generally associated with the automotive and cellular communication industries. They are highly advantageous to smart agriculture. With regards to the mechanical side of agriculture, which involves plant harvesting and related farming techniques, the use of GPS sensors have being adopted with us of highly precise vehicle guidance systems. In many farming applications, such as tilling a field, making use of auto-guided systems can enhance field routing, reduce overlapping processes and eventually reduce the quantity of time required to complete a task.

### 2. Agricultural Temperature Sensors

Regarding smart agriculture, temperature sensors are crucial in two key categories. These categories are ambient condition monitoring and mechanical asset monitoring. For instance, ice wine harvesting usually occurs within a narrow temperature window when temperatures first reach between -10°C and -12°C during a harvesting season. The ice wine industry requires a highly accurate temperature and humidity sensor to give a precise prediction of the temperature forecast. These types of sensors do not only play an important role in monitoring the ambient conditions of physical space, but they play a crucial role in virtually all smart agriculture asset monitoring applications.

### 3. Asset Monitoring

This is one more application in smart agriculture that makes use of temperature sensing as an evaluative role. As well as observing the plants that are being harvested, temperature sensors take note of the equipment that gathers these plants. Whenever an equipment system is in need of minor maintenance, is underperforming, or is critically failing, the temperature sensor dishes out an alert. They are highly effective in virtually every that relates to the predictive and reactive maintenance system. This in turn protects against overheating and detrimental failure of equipment.



#### 4. Accelerometer Sensor

This is quite similar to the use of temperature sensors in maintenance prediction. Accelerometers are vastly made use of across the smart agriculture industry to predict and assist with required maintenance. They are mostly used on moving components and motors. Their major aim is to detect slight variations in movement and vibration inconsistencies and foretell when standard maintenance is required or a compromised component needs to be replaced. However, this sensor is usually associated with farming and other agriculture, accelerometers play an indispensable role in the maintenance of vital smart agriculture equipment. Accelerometers can also be used in various automated systems and tracking methods. For instance, a low-power accelerometer makes it easier and faster to monitor the status of an adjustable spray nozzle on the end of a fertilization beam. With adverse technology, the use of autonomous drones in smart agriculture depends critically on accelerometers and IMU (inertial measurement units) to track motion, speed, crash events, and even position in space.

#### Smart Cameras use in Agriculture

When it comes to smart camera technology, it is far from the old analog sensor. Smart cameras have been increasingly adopted for a variety of smart agriculture applications. Various companies such as Blue River Technology, a division of John Deere, have adopted the use of smart camera technology to detect weeds and other plant locations. As a result of this, an automatic and accurate dispensation of herbicides and fertilizer is carried out. This makes use of chemical utilization and increases overall productivity while decreasing chemical usage. One of the most significant challenges in agriculture is the issue of pest control. With the use of smart cameras, farmers can now detect pests in real-time and effectively monitor actions against pests without necessarily harming helpful agricultural insects. Smart cameras can also take the place of semi-legacy sensing devices such as ambient light monitoring, thereby enabling a simplified system and a reduction in the component count.

## V.CONCLUSION

Precision farming is the application of specific inputs at various rates to optimize economic efficiency and reduce wastage. The use of precision agriculture sensors aids farmers makes a smooth move from the old ways of carrying out farming activities. In conclusion, the smart agriculture industry is ever-increasing, especially with new solutions that come to the market on a daily bases. Equipment and devices that aggregate sensor data, communicate important information to farmers, and optimize the numerous agricultural processes are critically important. The importance of different types of sensors can not be over-emphasized as they help meet the demand for food, magnify yields and minimize resources. These different types of precision agriculture sensors are easy to operate and cheaper in the long run. They make life easier for farmers and increase the overall quantity and quality of products delivered. It is advisable that every farm owner should consider smart farming that assist environmental Impact analysis also with data sensors.

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