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Precision Agriculture Innovation in Agriculture

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Abstract

Precision farming refers to the latest trends in agriculture that use technology to improve quality, quantity, and productivity, thereby ensuring profitability, sustainability, betterment, and preservation of the environment. The paper discusses the development and needs for precision agriculture in India with its existing problems and opportunities. The challenges in the future cannot be resolved with ancient methods. In order to make agriculture efficient and sustainable, investment in new technologies accompanied by research and development is required. Agronomics is the highest contributor to national income. More than 70% of the total workforce is dependent on it. The agriculture industry needs top priority because the government and the nation both would fail to succeed in this sector. The paper identifies various challenges associated with the adoption of precision farming in India and the technologies that could be used for better results and the betterment of both farmers and the Agri industry of India. Keywords: Precision, technology, digital, information, obstacles, approach

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Introduction

In order to increase profits, facilitate reduction of waste and maintain a qualitative environment, crop production (seed, fertilizer, pesticides, etc.) should be managed with the use of technology. Agriculture is called the backbone of the economy.

In today's world, technological innovations are reshaping farming activities because digital technologies have caused new concepts to emerge, which are how precision farming appeared, where a new branch of science lately engages in agriculture. The United States initially invented the concept of precision agriculture in the early 1980s. It was initially based on the Global Positioning System initially, developed by the United States of America. Precision agriculture is an informative and technical agriculture management system. The usage of inputs (i.e., chemical fertilizers and pesticides) is based on the adequate quantity, adequate time, and adequate place.

Precision agriculture is straightforward words, "A modern farming management system using the latest technology to improve the agricultural production processes, which results in controlling the usage of fertilizer, cost, water, and environmental impact." The difference between traditional Management and Precision Management is shown in Figure 1.

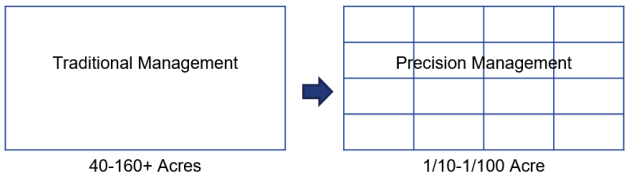


Figure 1. Traditional Management v/s. Precision Management.

Precision agricultural is information-intense. One-third of the global population depends on farming to survive. Although precision agricultural technologies need huge investments in developing countries, farmers are trying to implement this. However, awareness and assistance are required for + farmers in India. Three gears that precision agriculture focuses on are information, technology, and management.

The UN projects' results show that the global population will increase up to 9.7 billion by 2050, which leads the global agricultural production up to 69%; therefore, to level this, food production must effectively double from current levels to feed everyone [1]. With new ideas and technological advancements in precision agriculture, every farmer can feed 265 people on an equivalent acreage. Much of this drastic growth is predicted from many countries like India, China, Brazil, etc., which possess a huge geographical area concerning arable land for agriculture. The world food production must witness a rise by 70 percent to feed the whole world population to maintain the population explosion and static rise in income.

The regular implementation of precision farming is achieved by introducing various technologies, like GPS, GSM, and now using android devices and various smart android applications by using the camera, accelerometer, microphone, etc [2].

Success in precision farming is based on how well it is implemented to assess, manage, and monitor the timescale in crop production, which is used to analyze the current and potential abilities. Precision farming concept is embedded with technology. It is implemented by a specific technology, which effectively assesses and manages many factors, which are the essential details of farming, which is never before obtainable, and when it worked correctly, at levels of quality never before achieved.

More effective use of many inputs from various data analyzed from the sensors will increase crop yield and quality without affecting the environment. It can end in sustainable farming and sustainable development. It will reduce the hazards to the environment, especially groundwater contamination and nitrate leaching, by optimizing agrochemical products.

Hence, precision agriculture is about doing the right thing, at the right place, in the right way, at the proper time. Farmers need to be encouraged efficiently by conducting training programs to provide knowledge about technology and its related specification, which would motivate them to organize them as modern agricultural actors within the 21st century, is shown in Figure 2.

Literature Review

In the early 1900s, hybridization was the latest technology. Therefore, science was believed to be at its limit, but this has changed. Innovations like the arrival of the latest fertility, biotechnology tools, and crop protection catapulted the industry forward. It is interesting to note that most changes, which occur in farming technology, have often been handled with risk. The basic concept of precision farming is collecting data, and decision-making processes on that data have been an essential part. The working progress and execution of precision farming have been made possible by using Geographic Information Systems (GIS)

Industry Background of PA

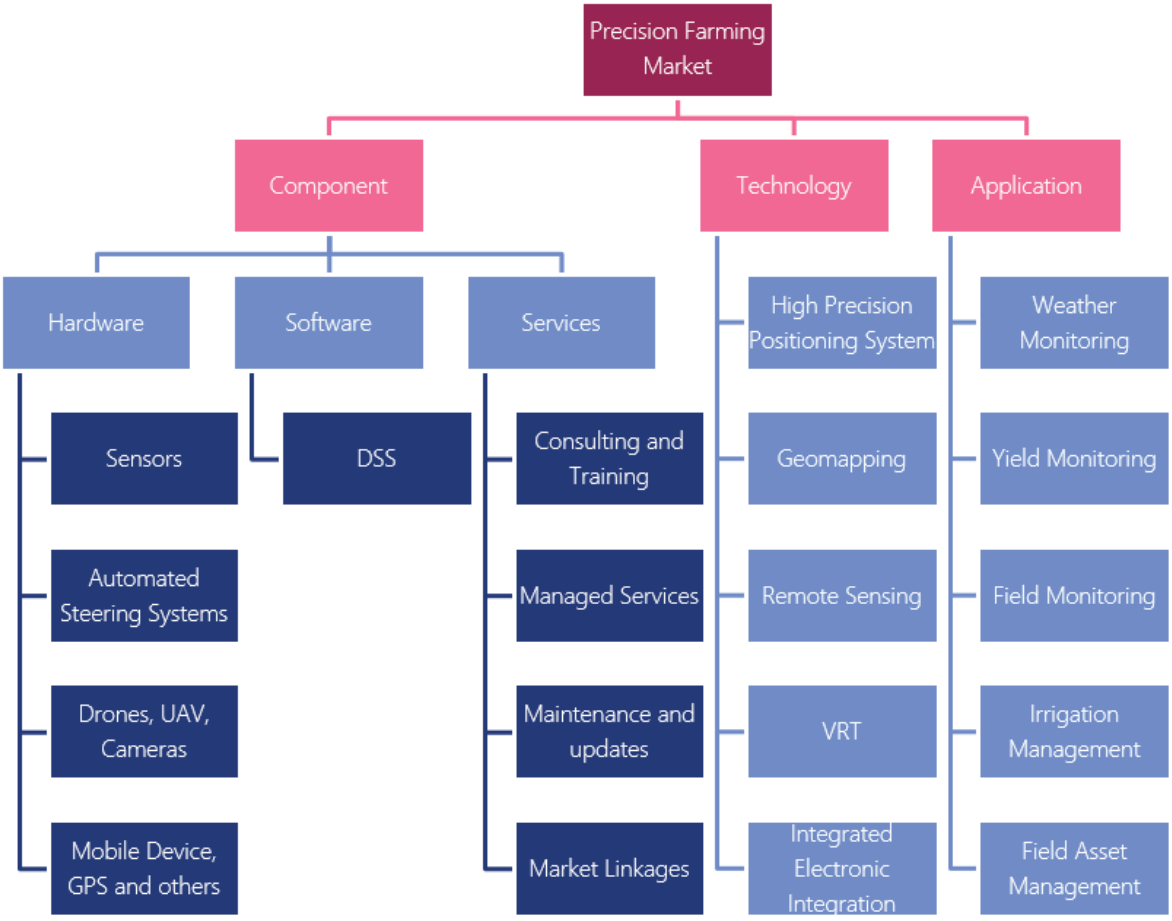


Figure 2. Precision Agriculture Industry Background.

and Global Positioning System. The data were collected with exact position by GPS receivers for mapping roads, field boundaries, irrigation systems, areas, and crops, which had problems like weeds or disease, using the above-mentioned technologies mentioned earlier.

Stated that most of the major agriculture community is illiterate, making precision farming difficult; therefore, guidelines will be provided through an interactive interface to overcome these [3]. The purpose was to create a repository to store data, and which would later help in decision-making [4]. This paper has proposed the reasons to adopt a particular technology and stated that profit is the foremost reason and environmental benefits come second. Also, stated that educated and experienced farmers work for profit and the younger farmers work for environment.

With an increase in the world's population, the availability of food to all will be a challenge [5]. These challenges need to be addressed by adopting technology, such as IOT (INTERNET OF THINGS), as it has great potential to play. The wastage of resources and cost of operation is reduced.

It is stated that the importance of improving the water usage in irrigation, agriculture, and how I will help in water monitoring [6]. Attention is paid to advanced monitoring methods for precision agriculture [7]. Talks about how precision farming is related to industry 4.0, also known as agriculture 4.0, underline the importance of an integrated information system (IIS). Also stated how raw data becomes information only when useful during the decision-making process.

This paper focused on the factors that policymakers need to take into consideration while adopting the policy [8]. A model, "Adapted Unified Theory of Acceptance and Usage of Technology (AUT2)," was developed to know individual farmers' intentions to adopt precision farming.

Their paper discusses the Precision farming tools (Pft's). Precision farming is technology-based farming, where many new and complicated tools are used and how these digital tools affect the farmer's work [9].

In this paper, they have discussed the limitations or challenges faced by the farmers while implementing precision farming and defining the role of management information systems in processing data [10].

Research Methodology

Agriculture is excessively important, as around 60% of the population worldwide depends on agriculture today. Agriculture demands technology and data processing in the future to establish innovation in food production.

"Technological development, like the utilization of data systems and data transmission, has introduced radical changes to the agricultural working environment. In recent years, as by 2050, the world's population will reach 9.1 billion (34% greater than today), with 70% of the global population will be urban (equal to 49% today). In order to supply food to this large population, food production must increase by 70% [11].

The technologies used in smart farming will increase food production in the face of constraints, such as climate change and other issues in the environment."

Precision agriculture is highly beneficial, with some excellent educational institutes working on the latest technologies and R&D for the improvement in the agriculture sector.

The focus should be on

- High impact area (low yield resulting per acre high impact)
- Manageable Area (arable land – not too small or too big)
- Proximity to Research Centre (access to domain experts, scientist, and right resources)
- Farmers are techno-savvy and financial well off
- High on financial literacy

Technologies Involved

GPS/GNSS

This innovation is utilized in agriculture for routing. It empowers the consistent information assortment, giving exact position data, which leads to productive analysis and control of much geospatial information. GPS has supplanted the stripped natural eye, field area, and experienced mystery in tractor guidance, crop exploring, and other farm assignments. GPS empowers the farmers to precede with work during low permeability climatic conditions like rain, dust, haze, and darkness. The execution of precision agriculture and site-explicit cultivating has been empowered by consolidating GPS and geographic information frameworks. Analysts and crop advisors utilize the information from GPS to battle vermin proficiently, creepy crawlies, or weed invasions in the field. Harvest dusters that are furnished with GPS can fly over fields while applying synthetic compounds to the poor regions as they were. These minimize com-

pound float by reducing over splashing in zones that do not require showering. Accordingly, it is helpful for the earth's ground [12].

IoT

The Internet of things is prepared to encourage prolonged farming to ensure high levels of farming. Smart agribusiness is getting progressively typical among farmers, and innovative farming is rapidly turning into the standard. Farmers have just started utilizing some innovative cultivating strategies and advancements to improve the efficiency of their daily working processes, as the sensors set in fields permit farmers to get details of both the geology and assets inside a territory, additional factors like acidity and temperature of the dirt. Tech is used in climate forecast to predict weather patterns [12].

Farmers can utilize their cell phones to track their gear, crops remotely, and different things on the field and acquire details on their animal's feeding and produce. They can even utilize this innovation to run measurable predictions for the crops and domesticated animals.

What is more! Drones turned into a valuable device for farmers to study their territories and generate crop information.

As a solid model, John Deere (one of the most significant names in farming gear) has started associating its tractors to the net and has made a system to show information about farmers' crop yields. Like smart vehicles, the enterprise spearheads self-driving tractors, which will discharge farmers to perform different duties and further increment efficiency.

Mobile Apps

The portable agriculture applications have truly increased boundless acceptance among present-day producers because of their flexible nature. These applications can perform many tasks inside the farm fields, which incorporate making farm maps, managing property information, exploring the farm, and flying agricultural automatons over the field, among numerous different employments that the farmers require. The helpful and convenient nature of Agri-portal applications is the thing that has empowered them to acknowledge prevalence among farmers. Rural experts have kept on picking benefits and profitability by utilizing versatile innovation improvements. Extending from information collection and tracking machine execution to recording crop exploring exercises and controlling automatons, portable applications are currently a key part of the realm of precision agribusiness [12].

Sensors

The accurate monitoring of crops is done by the implementation of smart sensors and mapping fields. This method allows the farmers to optimize fertilizers, weed treatments, and water only if needed. Sensors are important tools in modern agriculture management. They are deployed to boost productivity in agriculture and reduce both cost and impact on the environment. It optimizes nitrogen fertilizer use, which reduces the amount of nitrous oxide released from soil, and soil health is managed and monitored, eliminating nutrient depletion. There are various sensing technologies; some of them are implied in precision agriculture to give data to observe and optimize crop yields.

- **Optical Sensors:** The purpose of an optical sensor is to measure a physical quantity of light, which is used to measure soil properties. These Sensors can be fixed on the agriculture equipment, mainly on vehicles, and are developed to know the moisture content, chemical content, and fertility of the soil.
- **Location Sensors:** GPS maps the locations by knowing the geo-points, such as latitudes, longitudes, and altitudes of the fields.
- **Electrochemical Sensors:** These sensors tell about the pH and nutrient contents of the soil. Electrodes in these sensors work by detecting specific ions within the soil.

Rate controllers

They are used as stand-alone systems. It is important to monitor and reduce chemical inputs, like pesticides and fertilizers, either liquid or granular, in the field, which is done by Rate controllers and monitors the speed of vehicles used for work in the field.

Precision Irrigation Systems

There is much focus on the irrigation system. Drip irrigation and better management of farms through good irrigation systems are important to achieve efficiency in water use on the fields. The focus is on farmers to teach them the language of irrigation.

Scope and Adoption of Precision Farming

It is essential to take PA forward by making an immense asset of designers, researchers, and agricultur-

ists to create different innovation segments. Furthermore, it is conceivable with incredible labor and thus great R and D, PA to succeed.

In precision farming for mini-farms, compact farm machinery, technologies like robots can be used, which are not indulging in compacting the soil and are runnable on the source of renewable fuels, such as biogas, compressed biogas, and agriculture residual formed electricity. In such farms, precision agriculture tends to be effective, as many farms in the US and Europe have already started using robots. There are several compact robotic machines and drones available. It could be an ideal way to boost the precision agriculture application.

Industries need to take hold since they will develop the technical machine and found out the leasing agencies leading to job creation in precision agriculture. More students would be able to pursue their careers in agriculture.

Market Components

- Sensors will dominate the precision farming market in 2025 with a share of over 18%, as shown in Figure 3.
- The high-precision positioning systems held a dominant share of over 27% in 2018.
- The yield monitoring application segment held a significant portion of over 24% of the market in 2018.
- Irrigation Management is poised to grow at 32% over the next five years in emerging markets [13]

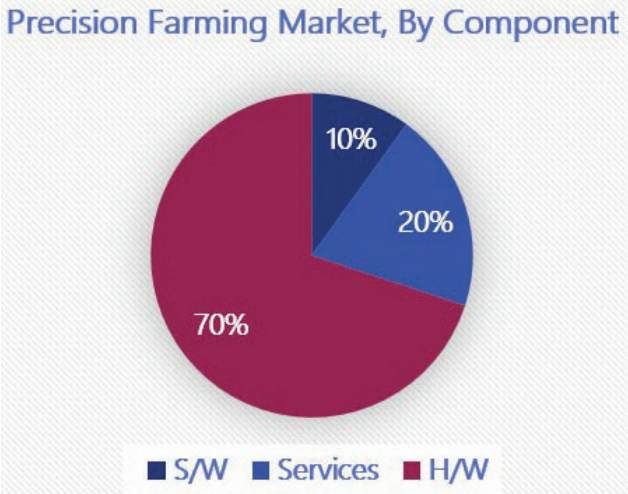


Figure 3. Precision Farming Market, by Component.

Indicative Approach

Figure 4. shows the Detailed Approach to Precision Farming.

Obstacles

In Precision Agriculture, the paradigm associated with it is a foremost concern, but the technologies have never been the concern. Technologies determined and accepted to be a remarkable notion only in some areas where it is feasible for farmers markets. The sophistication of precision agriculture demands a higher expenditure.

In order to reinstate the development cost, innovators and companies are trading the types of machinery and equipment is on a higher price scale. These are easily accessible by the farmers willing to spend a huge

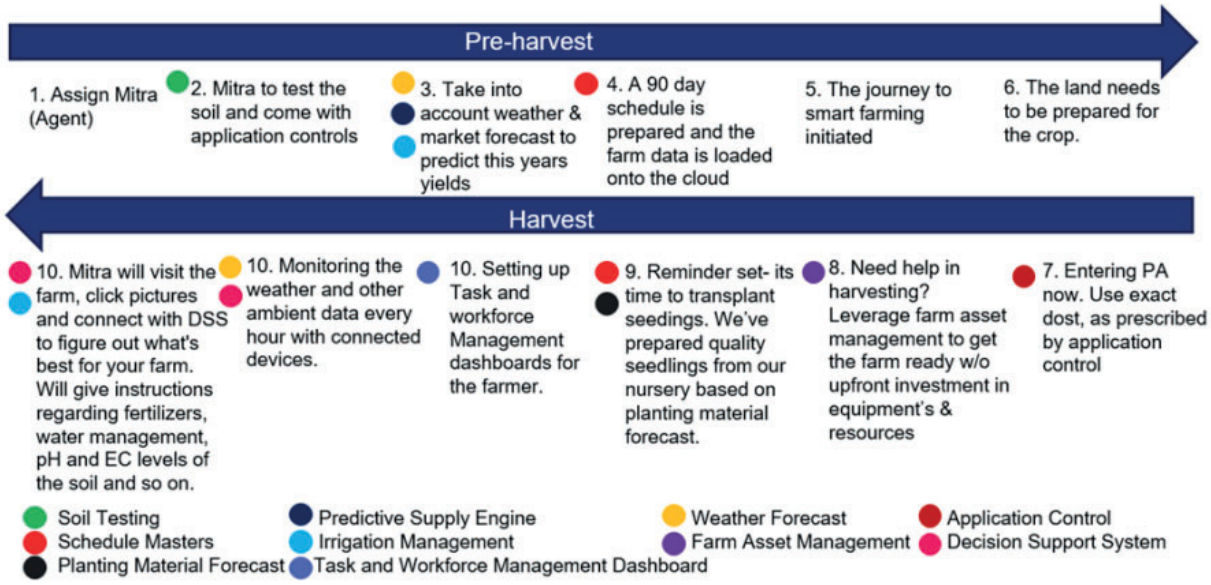


Figure 4. Approach to Precision Farming.

amount of money on developing an economically viable solution.

Furthermore, operating these machines is quite complex. It requires knowing the detailing of the us module along with a basic understanding of technology. The result is that inducing access to precision agriculture is quite difficult and onerous in the locale, which marks the scarcity of resources, education, and expenditures. Perhaps, it is strongly recommended to find a way to spread precision agriculture at the global level to enhance food availability further.

Information gathered may be advanced for farmers. In this manner, investigation and understanding devices may also be required, which is an extra expense.

Farmers' education and awareness about the usefulness of precision farming could change the rigid behavior of the farming industry for being techno-friendly. The money-saving advantage examination proportion is another key point. Farmers cannot unquestionably build up when they would earn back the original investment and beat their expenses and inevitably show signs of improvement pay off, like the after-effect of Precision Farming.

Farmers are not so financially sound, which is one of the major drawbacks of implementing Precision agriculture; mostly small-scale farmers suffer due to this and are afraid to invest. They continue using their traditional techniques for farming.

Good internet connectivity is still the issue in rural locations, making precision farming a tough choice for farmers [14]. The bandwidth speeds and network issues must be given utmost importance, or implementation of digital farming will remain problematic. The use of AI will shoot up, relieving farmers of most of their decision-making roles. However, the amount of e-waste generation will also rise. Without proper management, we will have another big problem at our hands before one is solved. The challenges are aplenty, and it remains to be seen how well we prepare ourselves to face them.

In huge farms, the old farming methods that involve more hard work and personal inspections cannot be followed, which would lower the speed of food production. Smart work and automation in farming would solve the existing problems.

Results and Discussion

PA is doing a great job, but there is a need for more predictive maintenance tools that would anticipate damages and help avoid losses. Teaching farmers about the same is the need of the hour. Farmers should have an entire knowledge, so the platforms are often configured optimally.

Small-scale farmers usually find it difficult to participate in the implementation of precision farming, the reason being they are less aware of the technologies and lack enough funds to invest, but this could be solved only if a large MNC can accept the agreement with small-scale farmers and assist in technical help and financial aids required for implementing Precision agriculture.

In return, the farmers can agree to share their profit percentage. The government can actively participate in providing financial, nonfinancial, and technical assistance [15].

Unsurprisingly, technology heavyweights, such as IBM, Amazon, and Microsoft, are also taking precision agriculture seriously. For instance, Microsoft has a beta platform called "Farm Beats" that intends to be the "underlying plumbing" of the precision agriculture world. Farm Beats solves the farm connectivity problem using TV white spaces (the frequency of unused TV channels) to connect the farm to the cloud. A lot of the decisions that growers make are based on guesswork. It is important to replace that guesswork with data." "It is not just about growing more food. We need to grow more nutritious food, good food, and we need to grow that increased good food without harming the environment [17]. "

Potential solutions for challenges do exist. Like other industries faced with multiple technologies and business model disruptions, players in the precision agriculture field need to take some unconventional steps. First, a critical look at future core competencies is necessary. An understanding of the required investments to build or acquire these core competencies must be developed. Based on this understanding, companies must evaluate how they can finance the transition from old core competencies to new core competencies. Even more importantly, a decision must be made on managing the transition phase itself, during which both sets of competencies need to be supported. Accordingly, resources need to be pooled across industry participants and potentially between competitors.

Conclusions

Farming in India should be an important concern. Precision agriculture should be given utmost impor-

tance, as it has various opportunities for farmers. The right kind of technology can be identified for their work, which would ease working. However, farmers should be educated about the same [15]. The government should take the initiative and provide loans to the industry in an easy manner and provide them opportunities to learn the use of technology to motivate and uplift themselves in PA activities. Precision farming will become the standard. Automation will help farmers manage the farm with fewer people, and the agriculture sector will further consolidate [16]. The degree of professionalism will increase, especially on large farms. A shortage of qualified people in the field of agriculture will be a major challenge. The Internet of things and advanced analytics are two major attributes in the new farming industry. Data science plays a major role, as advanced analytics helps forecast data and ensure that things are done right in the field. The farmers need to be focused and coordinate with data science companies to learn how analytics work, which would, in turn, help farmers to plan actions accordingly. Educating farmers is the need to operate the right kind of activities in farming and make it better with less hard work and more smart work. Precision agriculture should become the only choice in agriculture to meet tomorrow's needs and today's requirements.

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