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## Precision Farming in Nigeria: Advancement, Prospects and Challenges of Adoption

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### ABSTRACT

*This study focuses on the development, prospects and barriers of precision farming's uptake in Nigerian society. The idea that precision farming may increase agricultural yields and streamline farming operations is the foundation of the study. Secondary data which include government publications, scholarly journals, books, digital and internet sources, among others, were used in the study to analyze problems with precision farming advancement, prospect and challenges. According to the report, precision farming is an urgent issue that should not only be left to farmers alone but also be primarily handled by the government because of how sophisticated and technological it is. The study came to the conclusion that it is important to comprehend what precision farming entails since it is a major change in agricultural methods and provides effective instruments to boost output, cut expenses, and lessen environmental impact.*

**Keywords:** Precision Agriculture, Digital Agriculture, Agricultural Technologies Agricultural Innovation

### INTRODUCTION

For a long time, the agricultural sector has formed the backbone of economies across the world, supplying food, fiber, and increasingly fuel to an expanding global population. Agricultural technologies have emerged as a revolutionary force in contemporary agriculture in recent years, presenting previously unheard-of chances for efficiency, profitability, and sustainability. Among these, precision technology also referred to as precision agriculture stands out as a farm management strategy that updates traditional agricultural methods.

Precision farming, also known as precision agriculture, relies heavily on efficiency and data-driven decision-making. It involves using information technology (IT) to ensure that crops and soil get exactly what they need for optimal health and yield. Despite its lack of widespread acceptance on the continent, precision farming is a crucial solution to the food crisis now afflicting several African countries. Farmers may gather and evaluate data about their operations thanks to precision agriculture. This entails keeping an eye on worker productivity, weather, crops and animals, and soil quality. By collecting this data, farmers can evaluate their progress and make informed decisions (Tsan et al., 2019). Two of the major challenges facing modern agriculture are increasing agricultural yields while preserving environmental sustainability and a strong push toward technical innovation. In this case, precision farming is an essential tactic for enhancing crop protection and operating efficiency. Precision farming is a management strategy that uses digital technology, sensors, and geographic data to track and control agricultural field variability. By facilitating targeted actions, this approach lowers waste and increases operational performance. In essence, precision farming is a cutting-edge method that maximizes resource management, boosts production, and reduces environmental impact by utilizing cutting-edge technologies. Precision farming technology in agriculture includes a wide range of components, including GPS navigation, control systems, sensors, robotics, drones, autonomous vehicles, and variable rate technologies. By maximizing crop cultivation at the field level, it enables precision farming in agriculture. By enabling farmers to watch, measure, and respond to crop variability with previously unheard-of accuracy, precision agriculture technology ensures profitability, sustainability, and environmental

protection. It increases agricultural yield and reduces waste by using analytics and data to enhance planting, fertilizing, and irrigation methods.

Food production is predicted to increase by 50% by 2050 in order to feed the world's rapidly growing population (FAO, 2020). It is doubtful that this need will be satisfied in the absence of innovative technology to improve food security, as traditional methods may not be adequate. Precision farming has emerged as a key tactic to solve these problems, with a focus on productivity, sustainability, and efficiency. It makes use of cutting-edge technologies like Geographic Information Systems (GIS), remote sensing, drone technology, and data analytics to boost agricultural output while minimizing environmental impact (Fountas et al., 2020). Due to advancements in technology and infrastructure, precision farming is growing in popularity in industrialized countries (Roberts et al. as cited by Anho et al. 2023). However, due to challenges including poor digital infrastructure, high costs, and a lack of technical skills, Sub-Saharan Africa and Nigeria in particular, has adopted these advances more slowly (Mabaya et al., 2022).

The education sector is crucial in promoting the adoption of precision farming because it gives farmers, agronomists, and extension agents the skills they need to use these cutting-edge technologies, because of population increase and the urgent need for food security, particularly in Nigeria and other parts of Sub-Saharan Africa. Precision farming might significantly boost agricultural yield in the area. However, for it to be successfully accepted and implemented, agricultural workers' level of education, awareness, and skill competency is essential (Tsan et al., 2019). Precision farming education has the ability to raise the standard of agricultural education in Nigeria and increase the usage of data-driven technologies when included into curricula.

However, the combination will guarantee that students enter the workforce prepared to contribute significantly to Nigeria's strong, productive agricultural systems, where agriculture is a key source of revenue and food security is a top priority. Precision farming has a number of advantages, such as:

- Resource savings: better use of fertilizers, water, and crop protection products, which results in lower operational costs and a smaller ecological effect.
- Enhanced productivity: higher agricultural yields as a result of timely and focused efforts.
- Environmental sustainability: reduced emissions and improved water and soil quality.
- Better product quality: enhanced, superior harvests that satisfy consumer needs.

In order to increase production, it can be helpful in the following ways.

- Drone monitoring: use drones to assess crop health and identify regions in need of targeted treatments.
- Variable-rate fertilization: increasing efficacy and decreasing excess by administering fertilizers according to the unique requirements of each field area.
- Smart irrigation systems, which employ sensors to track soil moisture levels and adjust watering in real time to ensure optimal water utilization.

Precision agriculture and other cutting-edge farming technology have drastically altered how food is grown around the world, including in Nigeria. Numerous aspects of agricultural output are impacted by the substantial and diverse consequences, including:

**Enhanced Efficiency and Productivity:** Farmers may use their resources more effectively thanks to precision technologies. By sowing seeds and applying fertilizer in precisely the appropriate places and quantities, precision agricultural technology such as GPS-guided tractors—reduces waste and ensures that crops receive the finest care possible. This figure shows the effectiveness and efficiency of technology-assisted farming by increasing productivity and yields on the same amount of land.

**Environmental Sustainability:** Precision agriculture and sustainability go hand in hand since these technologies reduce the environmental effect of farming. By maximizing the use of water, fertilizer, and pesticides, precision technology significantly reduces the environmental effect of farming. By reducing runoff and chemical leaching into water bodies, it preserves ecosystems and reduces pollution.

**Cost Reduction:** Precision agricultural technology helps farmers cut operational costs by decreasing waste and improving resource efficiency. The fact that smart precision farming saves water, fertilizer, and

pesticides further emphasizes the necessity for precision farming to reduce the environmental effect of agricultural practices.

**Data-Driven Decision Making:** Real-time data and analytics from precision agriculture systems provide farmers the information they need to make informed decisions. Examples of this include when and where to plant, how to optimize crop rotations, and when to harvest for best quality and production. More flexible and responsive agricultural techniques for higher yield are the outcome of real-time data analysis and action. Additionally, using accurate technology in agriculture requires a multi-step, meticulous approach:

**Evaluation of Needs and Goals:** To begin, assess the specific needs of your farm and set clear goals for what you intend to achieve using precision technology. Examples of this include raising yield, reducing input costs, and limiting environmental impact.

**Research and Investment:** Examine the many precision agriculture technologies and systems available and determine which ones best suit your goals and requirements. This stage may involve talking to experts, attending workshops, or seeing other farms that are successfully implementing precision agriculture. Purchasing the right technology is crucial, therefore consider both the upfront costs and potential long-term benefits (Eweoya et al. 2021).

**Education and Training:** Ensure that you and your staff have been trained to use the new technology. This may include formal training courses, on-the-job training, or hiring new workers with the necessary expertise. This will help to reduce production costs and guarantee that it is absorbed at both the subsistence and commercial levels (Egbule, 2018).

**Optimization and Integration:** Integrate the new technology with your existing farming methods. There will likely be a period of adjustment as you learn to make the most of the technology to achieve the desired outcomes.

**Data Management:** Establish a system to manage the data generated by precision agricultural technologies. This involves collecting, storing, evaluating, and acting upon data to assist decision-making processes. When we take into account the continuous evaluation and adaptation necessary for the successful use of precision technology in agriculture, it is evident that innovation goes beyond data management and machinery optimization. This ongoing process of technological innovation directly led to Brandon Bioscience's innovative development of PSI (Plant Signal Induction) Technology, which is a significant breakthrough in modern agricultural practices (Nyaga et al. 2021).

### **Precision Farming in Nigeria**

Large-scale agricultural projects in the North and tech-driven efforts in the South-West are the main drivers of precision farming, a developing, high-potential strategy in Nigeria that uses AI-powered drones, Internet of Things (IoT) sensors, and GIS data to increase crop yields by 25–30%. By optimizing fertilizer, water, and pest control, it addresses poor production and food poverty; however, adoption is currently impeded by high costs and a lack of technical expertise among smallholders in the country's agricultural sector.

Nigeria's economy depends heavily on agriculture, which employs over 70% of the workforce and contributes significantly to the GDP of the nation (World Bank, 2022). The Nigerian agricultural industry has encountered problems including low production, limited machinery, poor land usage, a changing environment, and postharvest losses despite playing a crucial part in the country's growth. Precision Agriculture (PA) is becoming more and more important as a result of these difficulties, which emphasize the necessity for a contemporary, technologically advanced approach to farming. In order to improve field-level management in crop production, precision agriculture also known as precision farming or smart farming—uses cutting-edge technologies like Geographic Information Systems (GIS), Global Positioning Systems (GPS), drones, data analytics, variable rate technology (VRT), the Internet of Things (IoT), and Artificial Intelligence (AI). The goal is to guarantee that soil and crops get exactly what they

require for maximum productivity and health. It emphasizes "doing the right thing in the correct setting at the appropriate moment and in the right way," with the goal of maximizing productivity while reducing environmental impact (Aragie et al., 2023).

Since the 1990s, Nigerian farming has gradually transitioned from conventional methods to more data-driven systems due to the growth and use of precision agriculture. Climate change, population expansion, the need for food security, developments in mobile technology, and international support for smart agriculture are just a few of the local and global variables that have impacted this shift. There has been a consistent rise in awareness, pilot projects, and the usage of precision agricultural instruments in various locations, even if Nigeria is still in the early stages of adoption compared to wealthy nations. Three stages may be identified in the development of precision agriculture in Nigeria from 1990 to 2023: the introduction phase (1990–2005), the experimental phase (2006–2015), and the integration and scale-up phase (2016–2023).

Nigerian agricultural methods at the time were mostly traditional, depending on local expertise and low-level automation. Nigeria's experience with GPS and GIS was restricted to scholarly research and donor-funded pilot initiatives, whereas industrialized nations integrated these technology into their farming methods. For agricultural and soil research, organizations like the National Agricultural Extension and Research Liaison Services (NAERLS) and the International Institute of Tropical Agriculture (IITA) started investigating remote sensing and spatial data mapping (An et al., 2022). Lack of infrastructure, expensive digital equipment, little ICT knowledge among farmers, and little government investment for agricultural technology were major constraints during this time. In Nigeria, formal testing with PA technologies began during this time. New opportunities for disseminating agricultural information were brought about by the growing usage of mobile phones, the availability of satellite photos, and improved internet connectivity. Research institutions and farmers were connected through ICT platforms and mobile-based extension services (Barasker et al., 2024).

## RESEARCH METHOD

The qualitative research design was used in the investigation. This design makes it possible to investigate, comprehend, and analyze the study's background using a flexible, non-numerical framework. Secondary data, such as previously gathered information from internal organization records and external sources including government publications, scholarly journals, books, digital and internet sources, among others, were used in this study. These offer thorough information for analysis.

## CONCLUSION

The current study concludes that understanding precision farming is crucial because it represents a significant shift in agricultural operations and provides useful tools to increase productivity, reduce costs, and minimize environmental impact. By using technology, farmers can make the most of their business like never before. Precision farming will help solve environmental problems and meet the world's growing food demand in the future. Starting small, focusing on areas with the most potential value, and then increasing implementation as you gain experience and observe results is the key for farmers implementing precision farming. By using precision farming, farmers can take the lead in a future for agriculture that is more efficient, sustainable, and productive. Because of its revolution, food production is evolving.

### Suggestions

The study looks at Nigerian farmers' adoption of precision farming, including its development, realization, and obstacles. Because precision farming will be too complicated for farmers to understand and use on their own, the report argued that farmers shouldn't manage it alone. The government should provide knowledge to assist farmers in adopting precision farming because of its complex nature, which would therefore lead to higher agricultural yields and crop output. Also, educational institutions should incorporate precision agriculture into their curriculum to abreast learners with its tenet in farming practices. In addition, agricultural extension services should be made available to offer technical guidance to farmers in the application of precision agriculture.

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