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Research Paper

Utilization of Precision Agricultural Technology in Increasing Rice Production Efficiency at PT Buyung Putra Pangan, Pemulutan, Ogan Ilir, South Sumatra Indonesia

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Abstract
The use of Precision Agricultural Technology (PAT) is increasingly becoming the main focus in efforts to increase the efficiency of rice production in Indonesia. This research aims to identify the benefits, challenges and environmental impacts of implementing PAT on rice fields owned by PT. Buyung Putra Pangan in Pelabuhan Dalam Village, Pemulutan, Ogan Ilir, South Sumatra. The research method used is a combination of qualitative and quantitative approaches, through literature reviews from various relevant sources as well as observations and interviews in the field. The research results show that PAT has great potential in increasing the efficiency of rice production through the use of advanced technology such as soil sensors, drones for fertilization, seed dispersal, and eradication of plant pest organisms. The main benefits of PAT include increasing productivity, reducing production costs, and preserving the environment through more efficient use of inputs. However, implementing PAT in rice fields owned by PT. Buyung Putra Pangan still faces challenges, such as high initial investment costs, training requirements for farmers, and limited supporting infrastructure. Apart from that, there are also environmental impacts that need to be considered, such as the risk of soil and water contamination due to excessive use of pesticides and chemical fertilizers. Therefore, collaborative efforts are needed between the government, research institutions, the private sector and farmers to overcome these challenges and maximize the benefits of PAT in increasing the efficiency of rice production in a sustainable manner.

Keywords
Challenges; Environmental Impact; Implementation; Precision Agricultural Technology; Rice Production Efficiency

1. INTRODUCTION

PT Buyung Putra Pangan, is one of Indonesia's leading producers and distributors of premium rice, known for its popular brands such as Topi Koki and HOKI. Established in 2003 as a continuation of a family business founded in 1977 in Palembang, the company is distinguished by its commitment to product innovation, production efficiency, and environmental sustainability (IDN Financials, 2024). It operates modern processing facilities in Jakarta, Subang, and South Sumatra, and employs advanced irrigation and drainage technology on its 300-hectare farm in Pemulutan to increase yield and support year-round cultivation (Kompasiana, 2024). The company also actively contributes to national food security initiatives by collaborating with farmer cooperatives and supporting the development of food estates (Sriwijaya Media, 2021). Its sustainable practices, such as converting rice husks into renewable energy and producing animal feed, further reinforce its role as a responsible and forward-thinking player in Indonesia's rice industry (Liputan6, 2022; Top Business, 2021).

Utilization of agricultural technology is the use of various technological innovations in agricultural practices to increase efficiency, productivity and sustainability of agricultural production (Gebbers and Adamchuk, 2010). Examples include the use of soil sensors, drones, geographic information systems (GIS), and mobile applications in various aspects of crop cultivation and animal husbandry (Food and Agriculture Organization (FAO), 2021). One example of the use of agricultural technology is the use of soil sensors to monitor soil conditions in real-time (Wheeler and Von Braun, 2013). This sensor can measure various soil parameters such as humidity, pH, nutrient content and temperature. The information obtained from these sensors can then be used to optimize the use of fertilizer and water, thereby increasing the efficiency of resource use and reduc-

ing negative impacts on the environment (Schimmelpfennig, 2016). Precision agriculture in rice and other agricultural crops is quite promising but the initial funding is quite high (Rahim et al., 2023).

Drone technology is also increasingly popular in modern agriculture (Muchsiri et al., 2023). Drones are used for land mapping, monitoring plant growth, fertilizing, sowing seeds, watering, and early detection of pests and diseases. With drones, farmers can quickly identify problems on their land and take proactive corrective action. In addition, geographic information systems (GIS) play an important role in the spatial analysis of agricultural land. GIS helps farmers in mapping land, planning irrigation, and determining optimal planting patterns. This technology enables more accurate and efficient decision making in land management. Overall, the use of agricultural technology opens up new opportunities to increase production efficiency, reduce risks and increase farmers' income. With the adoption of the right technology and adequate support, agricultural technology can be the key to achieving food security and sustainable agricultural development.

Rice production at PT Buyung Putra Pangan, Pemulutan, Ogan Ilir, South Sumatra, shows the importance of technology in managing rice fields. Precision agriculture technology, which combines information technology with agricultural practices, offers potential solutions to increase rice production efficiency and overcome existing challenges (Gebbers and Adamchuk, 2010). The application of environmentally friendly technology according to Muchsiri et al. (2023) will provide benefits in the form of the availability of food in good quantity and quality, reducing negative impacts on the environment, increasing the welfare of farmers and increasing food security. This is all part of sustainable development as advocated by Djazuli et al. (2023).

Although precision agriculture technology has shown promising results in developed countries, its application in Indonesia is still limited (Zhang et al., 2020). Previous research has tended to focus on technical aspects in countries with more advanced agricultural infrastructure, without considering the specific conditions and unique needs of rice farming in Indonesia (Schimmelpfennig, 2016). Therefore, further research is needed regarding the adaptation and implementation of this technology to increase the efficiency of rice production specifically in Indonesia (Norton and Alwang, 2020).

This research aims to identify and analyze the potential of precision agricultural technology in increasing the efficiency of rice production in rice fields owned by PT Buyung Putra Pangan, Pemulutan, Ogan Ilir, South Sumatra. It is hoped that the results of this research can provide practical guidance for farmers and policy makers regarding the implementation of this technology, in order to encourage a sustainable and efficient increase in rice production as expected by Hartono and Sumekar (2018).

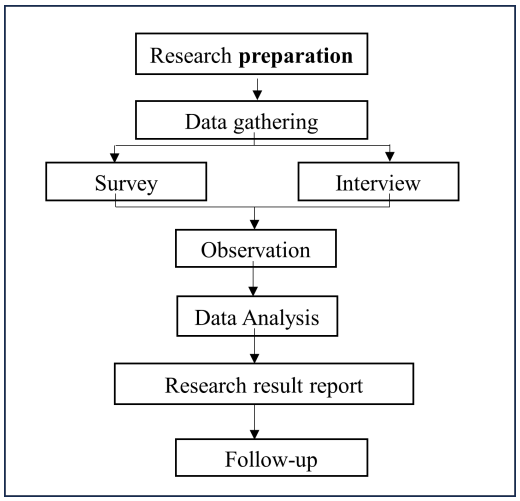

Figure 1. Flowchart of the research

2. EXPERIMENTAL SECTION

2.1 Material and Methods

This research was conducted from February to April 2025 in the rice cultivation area of PT Buyung Putra Pangan, located in Pelabuhan Dalam, Pemulutan, Ogan Ilir, South Sumatra. The study used a qualitative descriptive design supported by field observations and structured interviews with key personnel, including field supervisors, agricultural technicians, and machinery operators. The sampling was purposive, focusing on individuals directly involved in the implementation of precision agriculture technologies, to ensure relevant and in-depth data collection. The research process followed a systematic approach: (1) identifying the technological components used (e.g., drones, GIS, sensors), (2) observing their operational procedures, (3) interviewing stakeholders about efficiency and challenges, and (4) evaluating field results. Data were analyzed using descriptive methods supported by frequency analysis and percentage interpretation. Although no complex statistical tests were applied, data interpretation relied on comparison between observed outputs (e.g., yield, input efficiency) before and after technology application, ensuring a practical and evidence-based conclusion.

3. RESULT AND DISCUSSION

The results of field observations and interviews on the application of precision agriculture in the rice fields of PT Buyung Putra Pangan, located in Pelabuhan Dalam, Pemulutan, Ogan Ilir, South Sumatra, are summarized in the following table. The following table summarizes the precision agricultural tools and technology used in the rice fields of PT. Buyung Putra Pangan. From the table it is clear that not all tools and technologies used in the rice fields of PT. Buyung Putra Pangan yet. Many still are still planned. Nevertheless, the management was committed seriously to

Table 1. The precision agriculture tools and technologies used in the rice fields of PT Buyung Putra Pangan

No	Tools/technology	Function	Benefits
1	Fertilizer Drones	Distributes fertilizer evenly over large areas	Time and cost efficiency, more uniform fertilizer spread
2	Crop Monitoring Drones	Monitors crop growth and detects pests	Early detection of crop issues, quick response
3	Pesticide Spraying Drones	Applies pesticides precisely	Reduces excessive pesticide use
4	Soil humidity Sensor (planned)	Measures soil moisture levels	Optimizes water usage, efficient irrigation
5	Soil pH Sensors (panned)	Monitors soil acidity levels	Adjusts fertilizer use for optimal crop yield
6	Soil nutrition Sensors (planned)	Measures nutrient content in the soil	More targeted fertilizer management
7	Geographical information system (GIS) (planned)	Analyzes spatial data and maps agricultural land	Efficient planning for planting patterns and irrigation
8	GPS based Tractors (GPS) (planned)	Provides automatic tractor guidance	High precision, fuel efficiency
9	Sensor Based Irrigation System (planned)	Activates irrigation automatically based on soil moisture	Efficient water use, reduces drought risk

Source: PT. Buyung Putra Pangan (2025).

apply most of the tools and technologies for the precision agriculture in the near future.

The utilization of precision agricultural technology at PT Buyung Putra Pangan has significantly enhanced rice production efficiency, as evidenced by the company's adoption of advanced tools such as drones, GIS mapping, and controlled irrigation systems across its 300-hectare rice fields. Key benefits likely include increased crop yields, optimized resource usage (fertilizers, water, labor), and cost reductions. However, challenges such as initial investment costs, the need for skilled labor, and technology maintenance may also be identified. The research will recommend strategies for enhancing technology adoption and maximizing its benefits in rice production.

The adoption of precision agriculture technologies offers significant advantages compared to traditional farming methods that rely solely on manual practices. Precision technologies, such as drones, soil sensors, and GPS-guided equipment, enhance productivity through optimized resource management, enabling farmers to achieve higher yields with greater consistency. These technologies promote efficient use of water, fertilizers, and pesticides, reducing operational costs and minimizing environmental impacts, such as soil degradation and water contamination. Additionally, real-time monitoring and data-driven decision-making allow for early detection of pests and diseases, leading to timely interventions and improved crop health. In contrast, conventional farming methods often result in inefficient resource utilization, higher labor dependency, inconsistent yields, and greater vulnerability to risks due to the absence of predictive tools. Although the initial investment in precision agriculture technologies may be high, the long-term benefits in terms of cost efficiency, sustainability, and risk reduction make them a valuable asset for modern agricultural practices. Based on results of interview with staff working at the PT Buyung putra pangan it is well understood that a comparison between using precision agriculture technologies and not using technologies at all in rice production can be summarized in the following table.

The utilization of precision agricultural technology at PT Buyung Putra Pangan has significantly improved rice production efficiency across various aspects of farm management. Prior to the adoption of these technologies, crop yields were moderate and inconsistent due to reliance on manual practices, inefficient resource usage, and delayed responses to pest and disease outbreaks. However, with the integration of advanced tools such as drones, soil sensors, and GPS-guided equipment, rice yields have become higher and more consistent. Fertilizer and water usage are now optimized through precise application and sensor-based irrigation systems, reducing waste and operational costs. Additionally, the early detection of pests and diseases through drone monitoring enables timely interventions, minimizing crop damage. The dependency on manual labor has decreased, leading to faster operations and improved time

Table 2. Comparison between using precision agriculture technologies and nor using technologies at all in rice production at PT. Buyung putra pangan

Aspect	With Precision Agriculture Technologies	Without Precision Agriculture Technologies
Productivity	Higher due to optimized input usage and monitoring	Lower due to inefficient resource managements
Resource Efficiency	Efficient use of water, fertilizers, and pesticides	High risk of overuse or underuse of resourcess
Cost Efficienc	y Reduced operational costs in the long term	Higher costs due to waste and manual labor requirementss
Labor Requirement	Reduced need for manual labor with automation	High dependence on manual labors
Pest and Disease Control	Early detection and targeted treatment	Late detection leading to widespread crop damages
Environmental Impact	Reduced chemical runoff and optimized resource use	Higher risk of soil and water contaminations
Decision Making	Data-driven decisions with real-time insights	Relies on experience and guessworks
Yield Consistency	More consistent yields across different seasons	Variable yields due to inconsistent farming practicess
Monitoring and Evaluation	Real-time monitoring of crop and soil conditions	Limited monitoring, reactive approach to problemss
Initial Investment	High upfront costs for equipment and training	Low initial costs but higher long-term operational expensess
Risk Management	Better risk management with predictive analysis	Higher risk due to lack of predictive tools

Source: PT. Buyung Putra Pangan (2025).

efficiency. Environmental impacts, such as soil degradation and water contamination, have been minimized due to controlled input usage. Furthermore, decision-making has shifted from experience-based judgments to data-driven strategies, enhancing the accuracy and effectiveness of farm management. Overall, the implementation of precision agricultural technology has transformed rice production at PT Buyung Putra Pangan into a more sustainable, cost-effective, and productive operation. The following table showed how the utilization of precision agricultural technology at PT. Buyung Putra Pangan significantly improves rice production efficiency:

The implementation of precision agricultural technology at PT. Buyung Putra Pangan, while offering significant benefits, also presents several challenges that need to be addressed to ensure its sustainability and effectiveness. One of the primary challenges is the high initial investment cost required to purchase advanced equipment such as drones, soil sensors, and GPS-guided machinery. This financial burden can be particularly challenging for small-scale farmers or organizations with limited budgets. Additionally, the need for skilled labor poses another significant obstacle, as operating sophisticated technologies and interpreting data accurately require specialized knowledge and technical expertise. Without proper training programs, the lack of skilled personnel can hinder the full utilization of these technologies.

Another challenge is the maintenance of technological equipment, which demands regular servicing to ensure optimal performance. Maintenance costs, along with the risk of equipment malfunction or software issues, can lead to increased operational expenses and potential disruptions in farming activities. Connectivity limitations also pose a concern, as precision agriculture often relies on stable internet connections and GPS signals, which may be inconsistent in remote or rural areas. Furthermore, managing large volumes of data generated by sensors and devices presents its own set of difficulties, including risks of data loss, misinterpretation, and security breaches.

Resistance to change among farmers can also slow down the adoption of precision agriculture technologies, especially when there is a lack of awareness or understanding of

Table 3. Comparison between before and after using precision technology at the rice field belonging to PT. Buyung Putra Pangan

Aspect	Before Using Precision Technology	After Using Precision Technology
Crop Yield	Moderate and inconsistent due to manual practices	Higher and more consistent yields
Fertilizer Efficiency	Excessive or insufficient application	Optimized application with precise distribution
Water Usage	High water consumption with inefficient irrigation	Reduced water usage through sensor-based irrigation
Pest and Disease Control	Late detection causing significant crop damage	Early detection with drones, enabling timely intervention
Labor Requirement	High dependency on manual labor	Reduced manual labor through automation
Operational Costs	Higher costs due to inefficiency and resource wastage	Lower long-term costs with efficient resource management
Environmental Impact	Risk of soil degradation and water contamination	Minimized environmental impact through controlled inputs
Decision Making	Based on experience, prone to human error	Data-driven decisions for improved accuracy
Time Efficiency	Time-consuming manual processes	Faster operations with automated machinery
Risk Management	Reactive approach to crop issues	Proactive risk management with real-time monitoring

Source: PT. Buyung Putra Pangan (2025).

the long-term benefits. Lastly, environmental factors such as harsh weather conditions can affect the durability and performance of technological equipment, potentially reducing its lifespan. To overcome these challenges, solutions such as government subsidies, training programs, robust technical support, improved infrastructure, and awareness campaigns are essential. By addressing these issues, PT Buyung Putra Pangan can maximize the potential of precision agriculture to enhance rice production efficiency sustainably. In the following table we highlight the challenges associated with the utilization of precision agricultural technology at PT. Buyung Putra Pangan.

The application of precision agriculture at PT. Buyung Putra Pangan in Pelabuhan Dalam, Pemulutan, Ogan Ilir, South Sumatra, demonstrates a shift toward modern, data-driven farming practices. Field observations and interviews reveal that while several precision agriculture tools such as fertilizer drones, crop monitoring drones, and pesticide spraying drones are already in use, many technologies—including soil sensors, GIS, and GPS-based tractors—are still in the planning stages (Interview in the company, 2025). Despite this, management has shown strong commitment to fully implementing these technologies in the near future (Sofyan, field staff of PT. Buyung Putra Pangan).

The adoption of these tools has led to notable improvements in productivity and resource efficiency (Pangumboro and Islamiyah, 2024). For example, fertilizer drones ensure even distribution, leading to time and cost savings while optimizing nutrient application (Rahim et al., 2023). Similarly, crop monitoring drones enable early pest detection, facilitating quick responses to prevent widespread crop damage (Muchsiri et al., 2023). Pesticide spraying drones minimize chemical overuse, thus reducing environmental risks (Interview with Sofyan, field staff of PT. Buyung Putra Pangan).

However, challenges remain. High initial investment costs, the need for skilled labor, and technology maintenance are significant barriers (Rahim et al., 2023). Interviews with staff at PT. Buyung Putra Pangan highlighted these issues, particularly the complexity of operating advanced technologies and interpreting data (Muchsiri et al., 2023) (Sofyan, field staff of PT. Buyung Putra Pangan). Nevertheless, the long-term benefits—such as higher yields, reduced labor dependency, and minimized environmental impacts—outweigh the initial challenges (Rahim et al., 2023).

A comparative analysis between precision agriculture and traditional farming methods illustrates the advantages

Table 4. Challenges associated with the utilization of precision agricultural farming at PT Buyung Putra Pangan

Challenge	Description	Impact	Potential Solutions
High Initial Investment	Significant costs for purchasing advanced equipment	Financial burden, especially for small-scale farmers	Government subsidies, financial support, phased adoption
Need for Skilled Labor	Requires trained personnel to operate and interpret data	Limited workforce with the necessary technical skills	Training programs, capacity-building initiatives
Technology Maintenance	Regular maintenance needed to ensure optimal performance	Increased operational costs and potential equipment downtime	Establish maintenance schedules, partnerships with tech providers
Technical Issues	Risk of equipment malfunction or software errors	Disruption in farming operations	Reliable technical support, routine system checks
Connectivity Limitations	Dependence on stable internet and GPS signals	Inconsistent performance in remote or rural areas	Use of offline-capable devices, infrastructure improvements
Data Management	Handling large volumes of data from sensors and devices	Risk of data loss, misinterpretation, or security issues	Data management systems, staff training in data analysis
Adaptation Resistance	Reluctance among farmers to adopt new technologies	Slower technology adoption rates	Demonstration projects, awareness campaigns
Environmental Sensitivity	Equipment may be affected by harsh weather conditions	Reduced equipment lifespan and performance	Weather-resistant equipment, protective measures

Source: PT. Buyung Putra Pangan (2025).

of adopting modern technologies. Precision agriculture improves productivity, resource efficiency, and pest management while reducing environmental impact and operational costs (Rahim et al., 2023). In contrast, traditional methods result in inefficient resource use, inconsistent yields, and higher vulnerability to crop risks (Muchsiri et al., 2023). This comparison underscores the transformative potential of precision agriculture in rice production.

Before the integration of precision technologies, rice production at PT. Buyung Putra Pangan faced issues like inconsistent yields, inefficient resource use, and delayed pest control (Sofyan, fielf staff of PT Buyung Putra Pangan, 2025). The introduction of tools such as drones, GPS-guided tractors, and soil sensors has significantly improved these areas, leading to higher yields, optimized input use, and more consistent production outcomes (Rahim et al., 2023). Data-driven decision-making now guides farm management, replacing reliance on manual practices and human judgment, thereby increasing efficiency and reducing risks (Sofyan, fielf staff PT Buyung Putra Pangan, 2025). Nevertheless, the successful adoption of precision agriculture at PT. Buyung Putra Pangan is contingent on addressing several key challenges. High initial costs for equipment acquisition, the requirement for skilled labor, and ongoing maintenance needs are notable obstacles (Muchsiri et al., 2023). Moreover, issues such as technical malfunctions, connectivity limitations in rural areas, and the complexities of data management further complicate implementation (Rahim et al., 2023). Resistance to change among farmers and environmental factors affecting equipment durability also hinder full-scale adoption (Muchsiri et al., 2023). To overcome these challenges, strategies such as government subsidies, training programs, technical support, and improved infrastructure are essential (Rahim et al., 2023). Additionally, demonstration projects and awareness campaigns can help shift farmer perceptions, promoting wider acceptance of these technologies (Muchsiri et al., 2023). By addressing these barriers, PT Buyung Putra Pangan can fully harness the benefits of precision agriculture, ensuring sustainable and efficient rice production.

4. CONCLUSIONS

This study concludes that precision agriculture at PT Buyung Putra Pangan improves rice production efficiency, resource use, and environmental sustainability. Technologies like drones, soil sensors, and GIS enhance yields and decision-making. Despite challenges such as high costs and skill requirements, with proper support, this approach can significantly advance food security and sustainable farming in Indonesia.

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