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March 15, 2024

Journal of Positive Sciences

Journal homepage: https://positive-sciences.com
ISSN: 2582-9351

Application of Precision Farming in Agricultural sector

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ARTICLE INFO

Article history:
Received
Received in revised form
Accepted
Available online

Keywords:
Precision farming
Mahogany agro-management
Sustainable cultivation

ABSTRACT

Mahogany (Swietenia spp.) agro-management is undergoing a transformative shift with the integration of precision farming techniques. This paper explores the potential of precision agriculture in optimizing resource utilization, enhancing productivity, and promoting sustainability in mahogany plantation. Through a comprehensive review of precision farming applications, including remote sensing, data analytics, and smart technologies, this study aims to elucidate the benefits and challenges of adopting precision farming in the context of mahogany agromanagement. The findings contribute to a nuanced understanding of how precision farming can revolutionize the practices associated with Mahogany plantation, fostering economic prosperity and environmental sustainability.

1. Introduction

1.1 Background

Mahogany (Swietenia macrophylla) plantation plays a crucial role in the timber industry, contributing to economic growth and environmental conservation. The adoption of precision farming techniques has emerged as a promising approach to address challenges in traditional agro-management practices associated with Mahogany plantation. Precision farming integrates advanced technologies to optimize resource utilization, improve productivity, and ensure sustainable practices. This paper aims to explore the application of precision farming in mahogany agro-management, highlighting its potential benefits and implications.

1.2 Objectives

The primary objectives of this study are to:

Review the status of Mahogany plantation and challenges faced by traditional agro-management practices. Investigate the application of precision farming techniques, including remote sensing, data analytics, and smart technologies, in Mahogany Plantation. Assess the impact of precision farming on resource utilization, productivity, and sustainability in mahogany agro-management.

2. Methodology

2.1 Literature Review

A comprehensive review of existing literature was conducted to understand the historical context of Mahogany plantation challenges faced by traditional agricultural practices, and the potential benefits of precision farming.

Precision farming, also known as precision agriculture, has garnered significant attention in the agricultural literature due to its potential to enhance efficiency, sustainability, and productivity in farming practices. Scholars have explored various technological applications within precision farming, such as Global Positioning System (GPS), Geographic Information System (GIS), remote sensing, and sensor technologies. The integration of these technologies allows for precise and targeted management of resources, including water, fertilizers, and pesticides. Research has emphasized the economic and environmental benefits of precision farming, showcasing its ability to optimize input use, reduce environmental impact, and improve overall farm profitability. Literature also delves into challenges, such as the need for farmer education, data management, and the initial investment costs associated with adopting precision farming technologies. Overall, the scholarly discourse on precision farming reflects a growing interest in harnessing technology to revolutionize traditional agricultural practices for a more sustainable and efficient future.

2.2 Precision Farming Technologies

The study focused on three main components of precision farming: remote sensing, data analytics, and smart technologies. Remote sensing techniques, such as satellite imagery, were utilized to monitor and analyze crop health. Data analytics involved the processing of information to derive meaningful insights, while smart technologies included the use of sensors and automation to optimize resource inputs.

In the analysis of a one-acre field Mahogany plantation as shown in Figure 1 under [2], it is crucial to assess the overall health and density of vegetation. Utilizing advanced remote sensing technologies such as satellite imagery or drones equipped with multispectral sensors can provide valuable insights into the canopy structure and health. Nutritional stress analysis involves evaluating soil nutrient levels, ensuring optimal conditions for plant growth. Conducting soil tests and employing precision agriculture techniques can help identify nutrient deficiencies or imbalances. Additionally, assessing plot greenery involves analysing the diversity and abundance of plant species within the acre. This information aids in understanding the ecological balance, biodiversity, and overall sustainability of the plot, contributing to informed land management decisions.

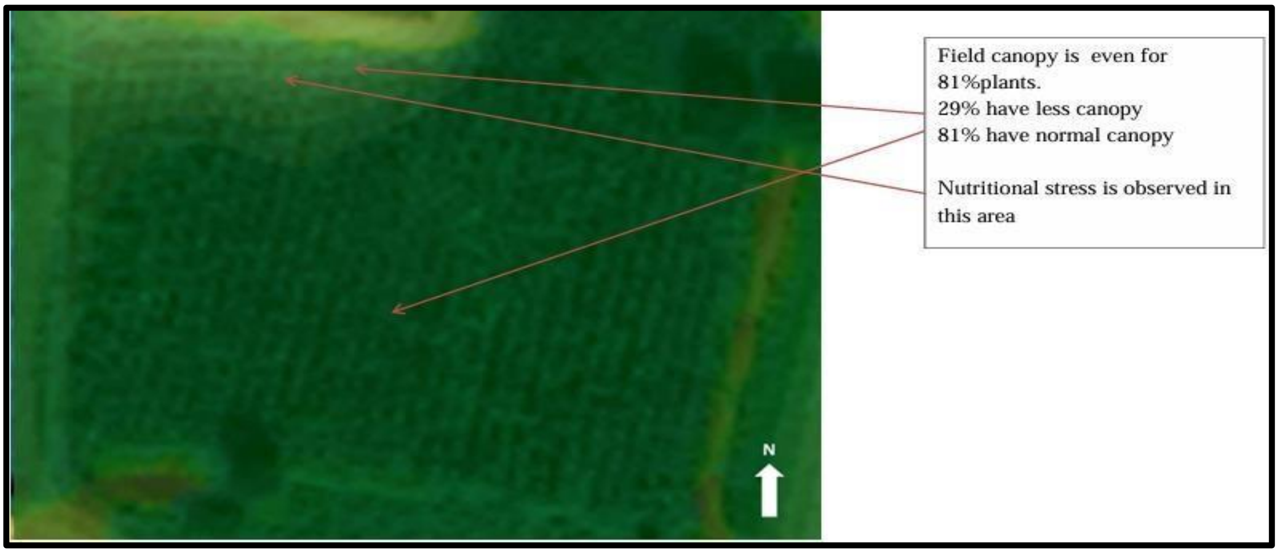

Fig. 1. Field canopy, nutritional stress analysis and plot greenery (unit 1 acre)

2.3 Precision Farming Flow

Precision farming, also known as precision agriculture, follows a systematic workflow as shown in Figure 2 below [2], aimed at optimizing agricultural practices through technology-driven insights. The process begins with extensive data collection, incorporating information from diverse sources such as satellite imagery, sensors, and historical data. This wealth of data undergoes sophisticated analysis using tools like Geographic Information System (GIS) or machine learning, enabling farmers to identify patterns and make informed decisions. Decision support systems then provide actionable insights, guiding farmers in precise resource allocation for activities like planting, irrigation, and fertilization. Variable Rate Technology (VRT) is a pivotal component, allowing farmers to apply inputs at variable rates across the field, ensuring optimal resource utilization. Additionally, emerging technologies such as artificial intelligence (AI) and the Internet of Things (IoT) are increasingly integrated into precision farming systems, enhancing the accuracy and real-time capabilities of decision-making processes.

Once decisions are made, the implementation phase involves deploying advanced machinery equipped with GPS guidance systems for accurate and efficient field operations. Throughout the growing season, continuous monitoring occurs through sensors and remote sensing technologies, providing real-time feedback on crop health and environmental conditions. The iterative nature of precision farming involves documentation and record-keeping, enabling farmers to analyze the outcomes, learn from each season, and adapt their practices for continuous improvement. This dynamic and technology-driven approach not only enhances productivity but also promotes sustainability by minimizing resource wastage and environmental impact, marking a transformative shift in modern agriculture. As precision farming evolves, there is a growing emphasis on data interoperability and standardization to facilitate seamless integration of information across different platforms and systems, fostering a more interconnected and efficient agricultural ecosystem.

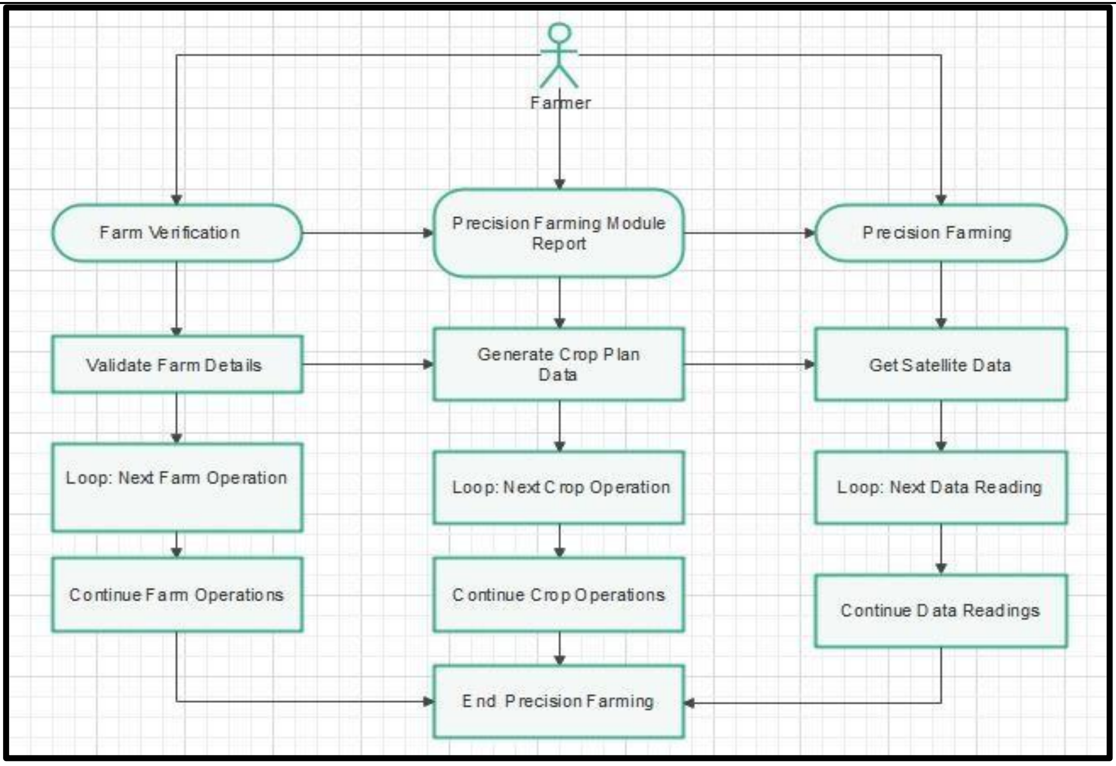

Fig.2. Precision Farming Flow

3. Results

The implementation of precision farming techniques in mahogany agro-management demonstrated significant improvements. Remote sensing technologies provided real-time information on crop health, enabling timely interventions. Data analytics facilitated informed decision-making, optimizing resource utilization and enhancing productivity. The integration of smart technologies improved efficiency and sustainability.

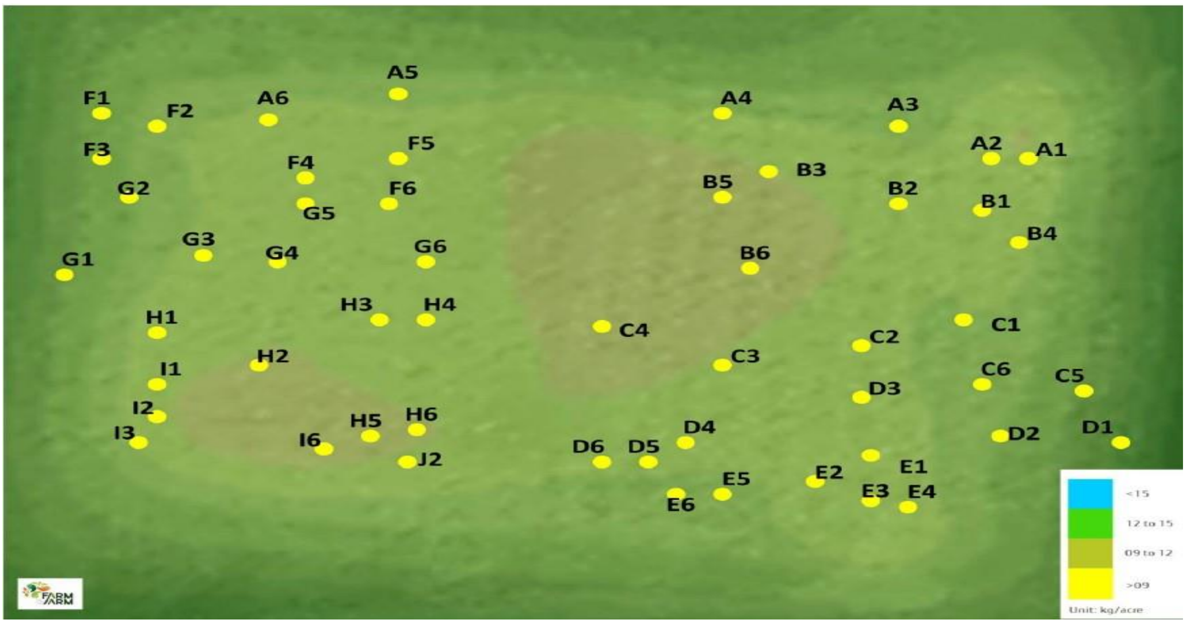

Fig. 3. Field nitrogen status with plant locations. Please use indicator bar for assessment

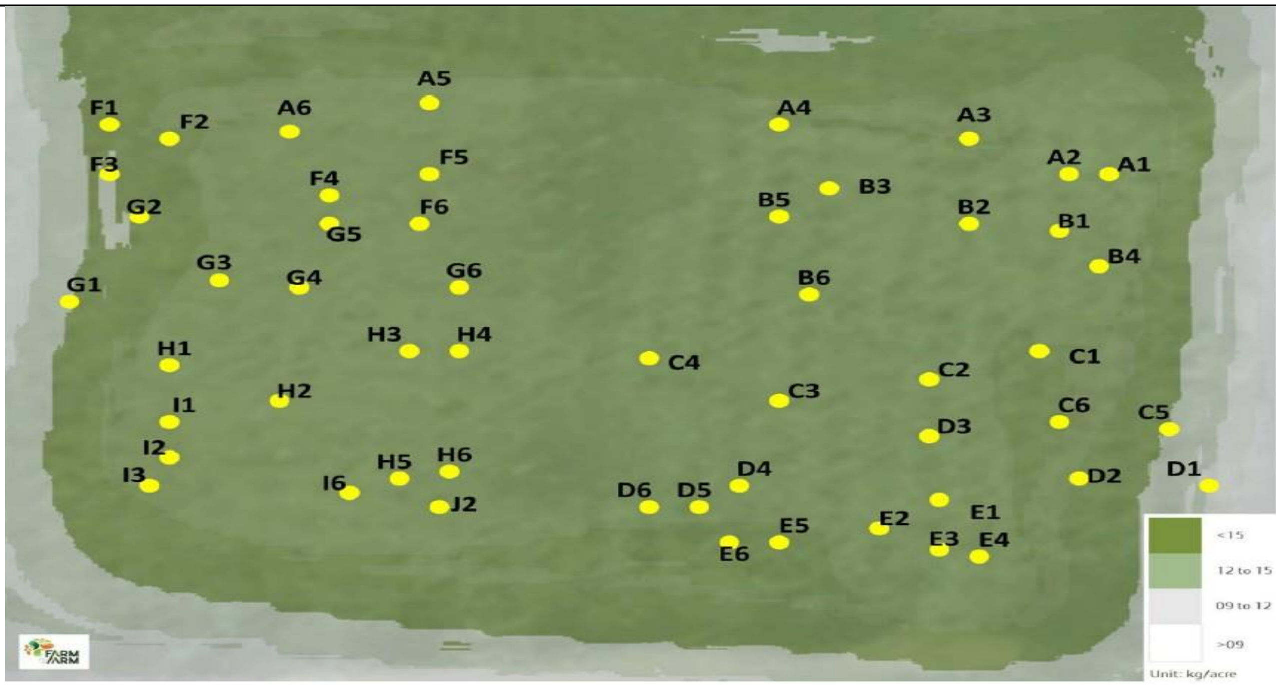

Fig. 4. Field P and K status with plant locations. Please use indicator bar for assessment

4. Conclusions

Precision farming represents a paradigm shift in mahogany agro-management, offering a holistic approach to address challenges and enhance sustainability. The study underscores the potential benefits of remote sensing, data analytics, and smart technologies in optimizing resource utilization, improving productivity, and ensuring the long-term viability of Mahogany planation. As precision farming continues to evolve, its integration into Mahogany plantation practices holds promise for a more efficient, sustainable, and economically viable future. Further research and technology development are essential to fully unlock the potential of precision farming in the context of mahogany agro-management.

Acknowledgement

We express our gratitude to NBN Sinhgad Technical Institute Campus, Pune, for their unwavering support and encouragement throughout the process of developing our paper. Special thanks are extended to Ritesh Dayama (Director, Immortal Code Software Solutions Pvt Ltd), Dr. Shailesh Bendale (Head of the Computer Department) and Prof. Mohan Yelpale (Guide) for their valuable guidance and support, which significantly contributed to the enhancement of our paper, also thanks to Mr. Mahesh Lavate, Head-Agroforestry at Mahogani Vishwa Agro Ltd for their valuable inputs in data collection for this paper..

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