IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Precision Fertilizer

[1]Mrs. Kirubadevi M , [2]Hari GG, [3]Karthikeyan AS ,[4] Jeganathan S

[1]Assistant Professor, 2,3,4Student

Bachelor of Information Technology,

Sri Shakthi Institute of Engineering and Technology, Coimbatore, India

1. Abstract—

As global populations continue to rise, the pressure on agricultural systems to produce higher yields with limited resources intensifies. The project "Precision Fertilizer" addresses these challenges by leveraging precision agriculture technologies to enhance the efficiency and effectiveness of fertilizer use in crop production. This initiative focuses on developing a holistic framework that integrates advanced data analytics, soil health diagnostics, and real-time monitoring systems. By utilizing tools such as Geographic Information Systems (GIS), remote sensing, and IoT devices, we aim to gather detailed information on soil composition, moisture levels, and nutrient availability across diverse agricultural landscapes. Through the application of machine learning algorithms, the project seeks to analysis these data sets to create predictive models that determine the optimal types and amounts of fertilizers required for specific crops at different growth stages. This targeted approach not only maximizes nutrient uptake but also minimizes the risks of over-fertilization, which can lead to soil degradation and waterway pollution. Ultimately, "Precision Fertilizer" aspires to demonstrate the economic and ecological benefits of precision nutrient management, paving the way for a new paradigm in sustainable agriculture. The expected outcomes include increased crop yields, reduced fertilizer costs for farmers, and a significant decrease in the environmental footprint of agricultural practices. This research not only tackles immediate agricultural challenges but also contributes to long-term food security and environmental sustainability.

2. INTRODUCTION

Designing soil and crop management practices in relation to variations in the field environment in terms of soil type, moisture and nutrient contents is not new to farmers. This was especially so to small-scale farmers in Sub-Saharan Africa (SSA) before the agrarian revolution when they planned their management practices based on site conditions to optimize the use of soil resources and external inputs. However, after the introduction of inorganic fertilizer use, the practice has been largely abandoned and replaced by blanket recommendations [1]. However, large variation in conditions across locations, farmers, and markets means that "One size fits all" recommendations are inappropriate. The goal of precision agriculture (PA) is to remedy that and the official definition of PA by the International Society for Precision Agriculture is "A management strategy that gathers, processes and analyzes temporal, spatial and individual data and combines them with other information to support management decisions according to estimated variability for improved resource use efficiency, productivity, quality, profitability and sustainability of agricultural production".

Precision agriculture has been indicated to involve an increased number of 'correct' decisions per unit area of land per unit time with increases in quantity and/or quality of production and/or the environment along with more efficient use of inputs [2]. This moves the attention from simply spatial resolution to superiority of decisions in both space and time. It also means that it does not imply a particular technology or set of technologies, but that decisions can be made by a range of technologies including soil and crop sensors, global navigation satellite systems (GNSS), such as the global positioning system (GPS), and geographic information systems (GIS), variable rate application (VRA) technologies, etc., as well as being made by humans.

3. APPLICATIONS

1. Variable Rate Application (VRA)

- **What it is**: VRA is a technology that adjusts the amount of fertilizer applied to different areas of a field based on soil nutrient levels, crop requirements, and environmental conditions.
- **How it works**: Using data from soil sensors, satellite imagery, or drones, farmers can create prescription maps that direct fertilizers to be applied in variable amounts across the field.
- **Benefits**: This reduces fertilizer waste, lowers costs, and prevents over-fertilization, which can lead to nutrient runoff and pollution.

2. Soil Testing and Mapping

- **What it is**: Precision fertilizer application begins with understanding the nutrient content of the soil. Comprehensive soil tests can determine the levels of nitrogen, phosphorus, potassium, pH, and other key elements.
- **How it works**: Through grid or zonal soil sampling, farmers identify spatial variations in soil fertility across their fields. This data is then used to customize fertilizer application.

3. Real-time Nutrient Monitoring

- **What it is**: Sensors embedded in the soil or mounted on equipment monitor nutrient levels and crop health in real-time.
- **How it works**: These sensors collect data on soil moisture, temperature, and nutrient concentrations, which is used to adjust fertilizer application dynamically.
- **Benefits**: Provides immediate feedback on crop needs, reducing the likelihood of nutrient deficiency or excess, and optimizing fertilizer use throughout the growing season.

4. Drones and Remote Sensing

- **What it is**: Drones equipped with cameras or multispectral sensors capture high-resolution images of crops and fields, allowing for precise nutrient management.
- **How it works**: Drones can assess crop health by detecting signs of stress, pest damage, or nutrient deficiencies. These images can be analyzed to create detailed maps of where fertilizer is needed.
- **Benefits**: Increases the accuracy of fertilizer applications and enables farmers to apply fertilizers only where necessary, reducing costs and environmental impact.

5. Fertilizer Placement

- **What it is**: Precision application techniques allow for more targeted placement of fertilizers.
- **How it works**: Tools such as fertigation (applying fertilizers through irrigation) or banding (placing fertilizer directly next to the root zone) are used to maximize nutrient uptake by crops.
- **Benefits**: These methods improve nutrient efficiency, reduce losses due to volatilization or leaching, and enhance crop productivity.

6. Nutrient Management Software

- **What it is**: Software tools help farmers manage the application of fertilizers by integrating various data sources, such as soil tests, weather forecasts, and crop needs.
- **How it works**: These platforms analyze data to recommend optimal fertilizer types, rates, and timing based on current field conditions.
- **Benefits**: Improves decision-making and ensures that fertilizer applications are both effective and cost-efficient.

7. Nutrient Recovery and Recycling

- **What it is**: Precision fertilizer techniques can also be applied to recover and recycle nutrients from organic or waste sources.

How it works: Technologies like anaerobic digestion, composting, or bioreactors can convert agricultural waste into nutrient-rich fertilizer that can be used in the field.

4. IMPLEMENTATION

1 Data Collection

• Gather data from soil sensors, weather forecasts, crop types, and historical yields. Clean and normalize the data (remove outliers, standardize units).
• Identify key features influencing fertilizer needs (nutrient levels, soil type, weather conditions).

2 Model Development

• Choose a machine learning model (e.g., regression, decision trees) to predict optimal fertilizer amounts.
• Split the data into training and test sets and train the model.

3 Model Evaluation

• Evaluate performance using metrics like MAE and RMSE.
• Implement an optimization technique (e.g., genetic algorithm) to refine fertilizer application rates.

4 User Interface

• Develop a UI for farmers to input real-time data and receive tailored fertilizer recommendations.
• Collect farmer feedback and adjust the model for continuous improvement.

4 . TECHNOLOGIES USED

1. Global Positioning System (GPS)

- What it is: GPS technology provides precise location data that allows for accurate mapping and navigation in the field.
- How it works: GPS-equipped equipment, such as tractors or spreaders, can follow exact paths with minimal overlap or gaps, ensuring even distribution of fertilizers.
- Applications: Used for Variable Rate Application (VRA), where fertilizer application rates are adjusted based on field-specific requirements.

2. Geographic Information System (GIS)

- What it is: GIS software is used to analyze spatial data from fields and integrate it with other data sources (soil maps, yield maps, weather data, etc.).
- How it works: GIS software processes data collected from GPS and other sensors to create detailed maps that guide fertilizer application, showing areas of high or low fertility and zones that need more

or less input.

- Applications: Field mapping, prescription mapping, and spatial analysis to optimize fertilizer placement.

3. Variable Rate Technology (VRT)

- What it is: VRT is a set of tools that enable the application of fertilizers at variable rates across a field, based on soil properties, crop needs, and other factors.
- How it works: VRT systems use data from soil sensors, yield monitors, and GIS maps to control the flow rate of fertilizer application in real time.
- Applications: Adjusting fertilizer rates to ensure that areas of the field with different soil fertility or crop requirements receive the right amount of fertilizer.

4. Soil Sensors and Soil Testing

- What it is: Soil sensors measure parameters such as nutrient levels, moisture content, pH, and temperature directly in the soil.
- How it works: These sensors can be mounted on equipment or placed in the ground to provide real-time data on soil health and nutrient needs, which is then used to guide fertilizer application.
- Applications: Real-time soil nutrient monitoring and site-specific fertilizer application, ensuring nutrients are applied where they are needed most.

5. Drones and Remote Sensing

- What it is: Drones equipped with multispectral or hyperspectral sensors capture images of fields to monitor crop health and soil conditions.
- How it works: Drones fly over fields and collect imagery that is processed into maps showing areas of nutrient deficiency, water stress, or other issues. This data informs decisions about fertilizer application.
- Applications: Crop health monitoring, precision mapping for nutrient deficiencies, and guiding targeted fertilizer application.

6. Precision Sprayers and Spreaders

- What it is: Automated spraying and spreading equipment that precisely applies liquid or granular fertilizer based on data from sensors, GPS, and VRT systems.
- How it works: These machines can adjust the application rate automatically according to field prescriptions, applying more or less fertilizer depending on the crop's needs.
- Applications: Localized fertilizer application to minimize waste and optimize nutrient uptake.

7. Variable Rate Irrigation (VRI)

- What it is: VRI systems combine irrigation with precision fertilization to apply both water and nutrients to specific parts of a field.
- How it works: Using data from sensors and VRT systems, VRI can adjust water and fertilizer delivery in real-time, ensuring uniform application based on soil moisture levels and crop requirements.
- Applications: Fertigation (fertilizer application through irrigation systems), optimizing both water and nutrient use.

5. REFERENCES

1. Soropa, G.; Nyamangara, J.; Nyakatawa, E.Z. Nutrient status of sandy soils in smallholder areas of Zimbabwe and the need to develop site-specific fertiliser recommendations for sustainable crop intensification. *S. Afr. J. Plant Soil.* 2019, *36*, 149–151. [Google Scholar] [CrossRef]
2. McBratney, A.; Whelan, B.; Ancev, T.; Bouma, J. Future directions of precision agriculture. *Precis. Agric.* 2005, *6*, 7–23. [Google Scholar] [CrossRef]
3. Lowenberg-DeBoer, J.; Erickson, B. Setting the Record Straight on Precision Agriculture Adoption. *Agron. J.* 2019, *111*, 1552–1569. [Google Scholar] [CrossRef] [Green Version]
4. Nyaga, J.M.; Onyango, C.M.; Wetterlind, J.; Söderström, M. Precision agriculture research in sub-Saharan Africa countries: A systematic map. *Precis. Agric*. under review.
5. Lowder, S.K.; Skoet, J.; Raney, T. The Number, Size, and Distribution of Farms, Smallholder Farms, and Family Farms Worldwide. *World Dev.* 2016, *87*, 16–29. [Google Scholar] [CrossRef] [Green Version]
6. Centre for Evidence Based Conservation. *Guidelines for Systematic Reviews in Environmental Management*, version 4.2; Collaboration for Environmental Evidence: Bangor, UK, 2013. [Google Scholar]
7. Were, K.; Bui, D.T.; Dick, O.B.; Singh, B.R. A comparative assessment of support vector regression, artificial neural networks, and random forests for predicting and mapping soil organic carbon stocks across an Afromontane landscape. *Ecol. Indic.* 2015, *52*, 394–403. [Google Scholar] [CrossRef]
8. Nkwari, P.K.M.; Rimer, S.; Paul, B.S.; Ferreira, H. Heterogeneous wireless network based on Wi-Fi and ZigBee for cattle monitoring. In Proceedings of the 2015 IST-Africa Conference, Lilongwe, Malawi, 6–8 May 2015; pp. 1–9. [Google Scholar]
9. Voortman, R.L.; Brouwer, J. An empirical analysis of the simultaneous effects of nitrogen, phosphorus and potassium in millet production on spatially variable fields in SW Niger. *Nutr. Cycl. Agroecosyst.* 2003, *66*, 143–164. [Google Scholar] [CrossRef]