**Harvesting Precision: Innovating Agriculture with Nano sensor RFID Tags for pH and Moisture Monitoring**

**Submitted**

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**Under the Guidance of**

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**(Duration: 1/07/2024 to 1/04/2025)**



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**DECLARATION**

**I/We declare that the project work contained in this report is original and it has been done by me under the guidance of my project guide.**

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**CERTIFICATE**

**This is to certify that MUDE VENKATA TEJA, GUDDITI SREE VANI, PALYAM LOKINI bearing Regd. No: BU21EECE0100106, BU21EECE0100430, BU21EECE0100197 has satisfactorily completed the Mini Project Entitled in partial fulfillment of the requirements as prescribed by the University for the VIIIth semester, Bachelor of Technology in “Electrical, Electronics and Communication Engineering” and submitted this report during the academic year 2024-2025.**

**Signature of the Guide Signature of HOD**

**Table of contents**

[**Chapter 1: Introduction 1**](#_heading=h.gjdgxs)

[1.1 Overview of the Problem Statement 1](#_heading=h.30j0zll)

[1.2 Objectives and Goals 1](#_heading=h.1fob9te)

[**Chapter 2: Literature Review 2**](#_heading=h.3znysh7)

[**Chapter 3: Strategic Analysis and Problem Definition 3**](#_heading=h.2et92p0)

[3.1 SWOT Analysis 3](#_heading=h.tyjcwt)

[3.2 Project Plan - GANTT Chart 3](#_heading=h.1t3h5sf)

[3.3 Refinement of Problem Statement 3](#_heading=h.2s8eyo1)

[**Chapter 4: Methodology 4**](#_heading=h.17dp8vu)

[4.1 Description of the approach 4](#_heading=h.3rdcrjn)

[4.2 Tools and Techniques Utilized 4](#_heading=h.26in1rg)

[4.3 Design Considerations 4](#_heading=h.lnxbz9)

[**Chapter 5: Implementation 5**](#_heading=h.1ksv4uv)

[5.1 Description of how the project was executed 5](#_heading=h.44sinio)

[5.2 Challenges faced and solutions implemented 5](#_heading=h.2jxsxqh)

[**Chapter 6:Results 6**](#_heading=h.z337ya)

[6.1 outcomes 6](#_heading=h.3j2qqm3)

[6.2 Interpretation of Results 6](#_heading=h.1y810tw)

[6.3 Comparison with existing literature or technologies 6](#_heading=h.2xcytpi)

[**Chapter 7: Conclusion 7**](#_heading=h.1ci93xb)

[**Chapter 8: Future Work 8**](#_heading=h.2bn6wsx)

[Here write Suggestions for further research or development Potential improvements or extensions 8](#_heading=h.qsh70q)

[**References 9**](#_heading=h.1pxezwc)

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# **Chapter 1: Introduction**

## **1.1 Overview of the problem statement**

Agriculture is crucial to India's economy, with 57.47% of the population dependent on it and 41.36% of the land dedicated to it, contributing 18.2% to the GDP. Despite this, the sector faces declining soil fertility, inefficient water use, and inconsistent crop yields. Traditional farming methods and limited access to technology further hinder productivity. Current sensor technologies in precision agriculture face issues such as durability, environmental adaptability, and data accuracy, especially in diverse soil conditions.

## **1.2 Objectives and Goals**

**Develop a durable MXene-based sensor**:

Create a sensor with high conductivity and chemical stability to ensure reliable performance in diverse environmental conditions.

**Incorporate RFID technology**:

Enable wireless communication for real-time soil data monitoring and collection.

**Optimize conductometry**:

Enhance the accuracy of ion concentration measurements to provide precise data on soil pH and moisture levels.

**Field testing and validation**:

Assess the sensor's effectiveness in improving crop growth and resource management in various agricultural settings.

**Empower farmers with data**:

Provide tools that support data-driven decision-making, improving productivity and sustainability in farming.

# **Chapter 2: Literature Review**

**Key Publications:**

* Two-Dimensional MXenes for Energy Storage.
  + Naguib, M., et al. (2014)
  + **Summary:**

MXenes were introduced as a new class of 2D materials, demonstrating exceptional properties for energy storage applications. Composed of transition metal carbides, nitrides, or carbonitrides, MXenes exhibit high electrical conductivity, chemical stability, and a large surface area. These characteristics make MXenes promising candidates for a range of applications beyond energy storage, including sensor technology, due to their ability to conduct electricity efficiently and withstand harsh environmental conditions.

* MXenes: A New Family of Two-Dimensional Materials.
  + Alhabeb, M., et al. (2017)
  + **Summary:**

They expanded on the understanding of MXenes by detailing their synthesis methods and unique properties. This comprehensive review categorized different types of MXenes and discussed their tunable surface chemistry and hydrophilicity. These features are particularly beneficial for sensor applications, as they allow for customization of the sensor's response to environmental changes. The review emphasized the potential of MXenes to address limitations in traditional sensors, such as their adaptability to various environmental conditions, which is crucial for developing effective soil sensors in precision agriculture.

* Advanced Soil Sensors for Precision Agriculture.
  + Li, X., et al. (2018)
  + **Summary:**

Reviewed the state-of-the-art in soil sensor technology, focusing on the development of sensors for measuring soil moisture, pH, and nutrient levels. The study identified key challenges faced by traditional sensors, such as issues with durability and accuracy in heterogeneous soil conditions. Li et al. pointed out that integrating new materials, like MXenes, could significantly enhance sensor performance. The research highlighted the need for sensors that are both sensitive and adaptable, capable of providing reliable data across different soil types and environmental conditions, which aligns with the potential advantages of MXene-based sensors.

* Wireless Soil Moisture Monitoring Systems for Precision Agriculture.
  + Zhang, Q., et al. (2019)
  + **Summary:**

Explored the integration of wireless technology with soil moisture monitoring systems. The study emphasized the importance of real-time data collection and remote monitoring for effective water management in precision agriculture. Zhang et al. highlighted the use of Radio Frequency Identification (RFID) technology to enable wireless data transmission from soil sensors. The review suggested that combining RFID with MXene-based sensors could offer a robust solution for continuous and accurate soil monitoring, addressing existing limitations and providing scalable solutions for precision farming.

* Ni3C MXene nanosheets are an efficient binder-less electrocatalyst for oxygen evolution reaction.
  + Aksha Gilbert Prince, Lignesh Durai, Sushmee Badhulika. (2022)
  + **Summary:**

Low-cost, stable Ni-MXene electrocatalysts, synthesized via HF-free solvothermal etching of Ni-MAX, show promise for large-scale water-splitting. The NiMX/NF electrode achieves an overpotential of 245 mV at 100 mA/cm², with enhanced activity due to the Ni²⁺/³⁺ redox couple and carbon. The catalyst retains 83% current density after 14 hours, making it suitable for industrial oxygen evolution reaction (OER) applications.

**Key Resources – Whitepaper| Application Notes | Datasheet| Others**

* Journal of Materials Chemistry A
* IEEE Sensors Journal

**Existing Implementations – Products| Opensource| GitHub etc**

* Wireless Sensor Networks (WSNs) in Agriculture
* Tensiometer-Based Soil Moisture Monitoring

# Chapter 3: Strategic Analysis and Problem Definition

## 3.1 SWOT Analysis

### **Strengths:**

1. **Innovative Technology**: The use of RFID-enabled MXene-based conductometric sensors introduces cutting-edge technology for real-time soil monitoring, offering high sensitivity and accuracy.
2. **Cost-Effectiveness**: By utilizing affordable materials and scalable technology, the project has the potential to be accessible for small-scale farmers, promoting widespread adoption.
3. **Sustainability**: Optimizing resource use (water, fertilizers) promotes sustainable farming practices, reducing environmental impacts and ensuring long-term soil health.
4. **Data-Driven Decision Making**: Farmers can rely on real-time data to make informed decisions, improving productivity, crop yields, and resource efficiency.

### **Weaknesses:**

1. **Initial Cost of Implementation**: While long-term benefits are clear, the initial investment for setting up the sensor infrastructure might be a barrier for some farmers, especially in low-income regions.
2. **Technical Knowledge**: Farmers may need training to effectively use and understand the data provided by the sensors, potentially slowing down adoption rates.
3. **Sensor Durability**: Although MXene is known for its stability, extreme environmental conditions in some regions may affect the long-term durability and performance of the sensors.

### **Opportunities:**

1. **Large-Scale Adoption**: Precision agriculture is gaining global attention. This project can tap into international markets, offering solutions to both developed and developing countries.
2. **Partnerships and Collaborations**: Collaborations with agricultural research institutions, government programs, and tech companies can accelerate development, testing, and deployment.
3. **Expansion of Sensor Applications**: Beyond pH and moisture, the technology could be adapted to monitor other important soil factors like nutrient levels or temperature, further enhancing farming efficiency.
4. **Government Support for Innovation**: With the global push for sustainable agriculture and food security, this project could benefit from government funding or incentives aimed at promoting agricultural technology.

### **Threats:**

1. **Competition**: The market for precision farming technologies is competitive, with other companies developing similar sensors. Maintaining technological superiority and affordability is key.
2. **Economic Fluctuations**: Farmers in developing regions may face financial difficulties, limiting their ability to invest in new technologies, especially during economic downturns or natural disasters.
3. **Regulatory Challenges**: Navigating different countries' regulatory landscapes for agricultural technologies could present obstacles for large-scale implementation.
4. **Technological Obsolescence**: As technology evolves rapidly, there is always a risk that newer, more advanced solutions could emerge, making current systems outdated.

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### 3.2 Project Plan - GANTT Chart

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Main Project Phases and Subtasks

1. Harvesting Precision: Innovating Agriculture (Overall Project):

- 80% Complete: This indicates that the entire project is 80% complete so far.

2. Phase-1 Completed:

- 100% Complete: This task is fully done, marking the end of Phase-1 of your project. This phase likely includes initial setup, planning, and maybe early prototype development.

Subtasks Breakdown:

1. Abstract:

- 100% Complete: The abstract section has been fully completed, which might refer to the abstract of the research paper, proposal, or documentation for the project.

2. Literature Review:

- 70% Complete: The literature review is 70% complete, indicating that you're still gathering and analyzing prior research and publications relevant to the project, especially in fields like RFID sensors, precision agriculture, and MXene materials.

3. Required Analysis:

- 100% Complete: This task has been fully finished, suggesting that you’ve completed the analysis required for the project's technical foundation or feasibility study, possibly involving sensor parameters, data collection methods, or environmental factors.

4. Development:

- 65% Complete: The development of the sensor technology or system for pH and moisture monitoring is currently 65% complete. This could include hardware development (sensor fabrication), software integration, or field testing.

Timeline

- Abstract: Starts around mid-August and completes around the end of the month.

- Literature Review: Begins in mid-August and continues into the first week of September.

- Required Analysis: Runs from mid-August and finishes in early September.

- Development: Started around the end of August and is planned to continue until mid-October.

The overall project seems to be progressing well, with key tasks like the abstract and required analysis already completed, while the literature review and development are nearing completion.

##### 3.3 Refinement of problem statement

# Chapter 4 : Methodology

## 4.1 Description of the approach

### 4.2 Tools and techniques utilized

#### 4.3 Design considerations

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# Chapter 5 : Implementation

## 5.1 Description of how the project was executed

### 5.2 Challenges faced and solutions implemented

# Chapter 6:Results

## 6.1 outcomes

### 6.2 Interpretation of results

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#### 6.3 Comparison with existing literature or technologies

# Chapter 7: Conclusion

Here write Suggestions for further research or development and Potential improvements or extensions

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# Chapter 8 : Future Work

#### Here write Suggestions for further research or development Potential improvements or extensions

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# References