Title: Predicting Plant Growth Stages with Environmental and Management Data Using Power BI

1. Introduction

1.1 Project Overview

This project aimed to develop a data-driven solution for predicting plant growth stages based on various environmental and management factors. Using Power BI, we integrated data from multiple sources, visualized it, and created predictive models to forecast the growth stages of crops. This tool allows farmers and agricultural stakeholders to optimize their planting and management strategies, improving crop yields and reducing risks due to environmental changes.

The goal of this project is to develop a system that uses environmental and management data to predict plant growth stages. By integrating data from various sources (e.g., temperature, humidity, irrigation schedules, etc.), the system aims to help farmers optimize their agricultural practices, improve crop yields, and mitigate risks due to climate variability. The predictions are visualized and analysed using Power BI to support better decision-making and resource allocation.

Scope:

This project focuses on:

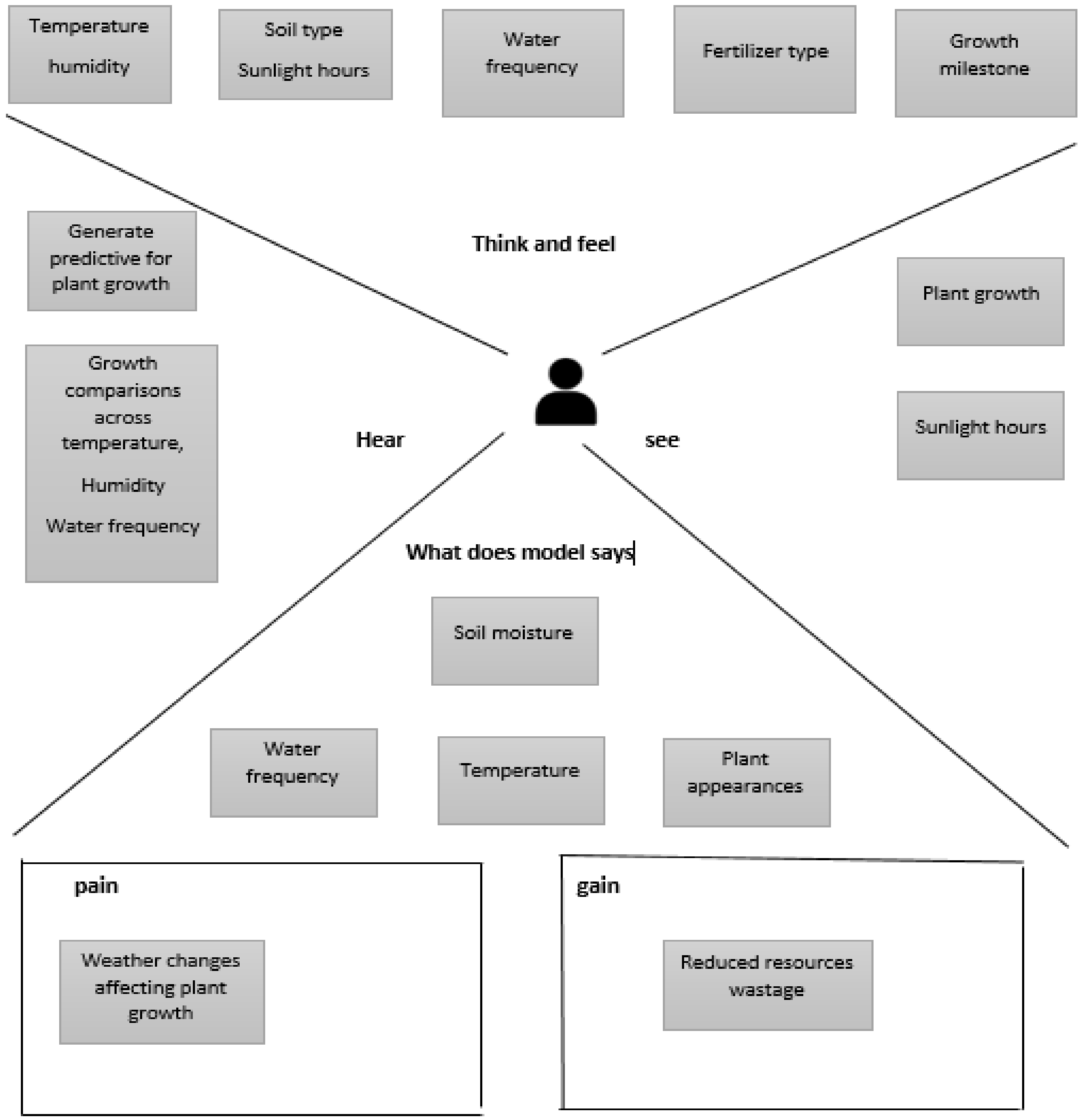
- **Data Integration**: Combining data from various sources (e.g., weather data, irrigation schedules, and soil conditions) into a unified system.
- **Predictive Analytics**: Using forecasting techniques and machine learning models to predict plant growth stages based on historical and real-time data.
- **Power BI Visualizations**: Creating dynamic and user-friendly dashboards that display growth predictions, trends, and actionable insights.
- **Resource Optimization**: Helping farmers allocate resources such as water, fertilizers, and labour efficiently based on predicted plant needs.

2.Ideation phase

2.1 Problem Statement:

In modern agriculture, farmers face several challenges that impact crop production, including unpredictable weather patterns, inefficient resource allocation, and the inability to forecast plant growth accurately. Environmental factors such as temperature, humidity, soil conditions, and precipitation have a direct influence on plant growth, but traditional farming practices often lack the tools to predict these factors' impact in real-time. Additionally, mismanagement of resources like water, fertilizers, and pesticides can lead to suboptimal crop yields and unnecessary environmental harm.

2.2 Empathy Map Canvas



2.3 Brainstorming

3. Requirement Analysis

3.1 Customer Journey map

Stage	Go al	User Action	Emoti on	Touchpoin ts	Pain Points	Opport unity
Awaren ess	User learns about the app.	Sees ads or recommendat ions.	Curious , Interest ed	Website, Social Media, Advertise ment, App Store	Unclear functionality .	Simple onboardi ng with explanat ion
Onboar ding	User installs the app and sets it up.	Downloads, signs up, enters data.	Excited but uncertain	Welcome screen, tutorial, data entry forms	Information overload, data complexity.	Guided data entry, tooltips for help.
Data Collection	User enters data for predictions.	Enters environmenta l, management data.	Involved, Overwhel med	Data input screens, help features, summary page	Too much data, confusion.	Simplify inputs with pre-sets or tips.
Predicti on & Insights .	User gets predictions on plant growth.	Reviews charts and insights.	Empowere d but unclear	Line charts, bar charts, dashboard	Data interpret ation, accuracy of predictio ns	Actiona ble insights, clear explanat ions
Decisio n- Making	User takes action on the recommendat ions.	Follows actions for plant care.	Confident, Dependent	Task scheduler, alerts, reminders	Risk of inaction, inaccurate suggestions	Notificat ions and reminder s for actions.
Monitoring & Feedback	User tracks progress and receives feedback.	Monitors plant growth.	Reassured, Concerned	Real-time monitoring, push notifications	Lack of clear feedback on progress.	Visual feedback on plant health.

3.2 Solution Requirement

Project Design Phase-II
Solution Requirements (Functional & Non-functional)

Date	13 march 2025
Team ID	PNT2025TMID03012
Project Name	Predicting Plant Growth Stages with Environmental and Management Data Using Power BI
Maximum Marks	4 Marks

Functional Requirements:

Following are the functional requirements of the proposed solution.

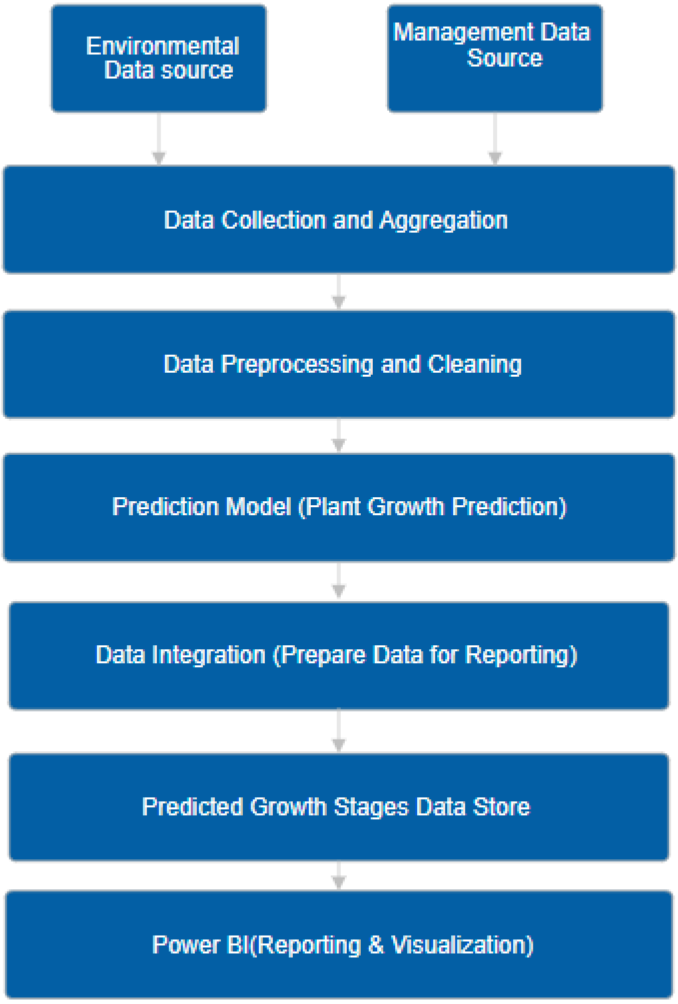
FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Data collection	1.Collect environmental data (temperature ,soil moisture,humidity) 2.Collect managemental data (fertilizer)
FR-2	Data processing	Store raw data in .excel Clean and transform data
FR-3	Power bi dashboard	Display predicted growth stages visually

Non-functional Requirements:

Following are the non-functional requirements of the proposed solution.

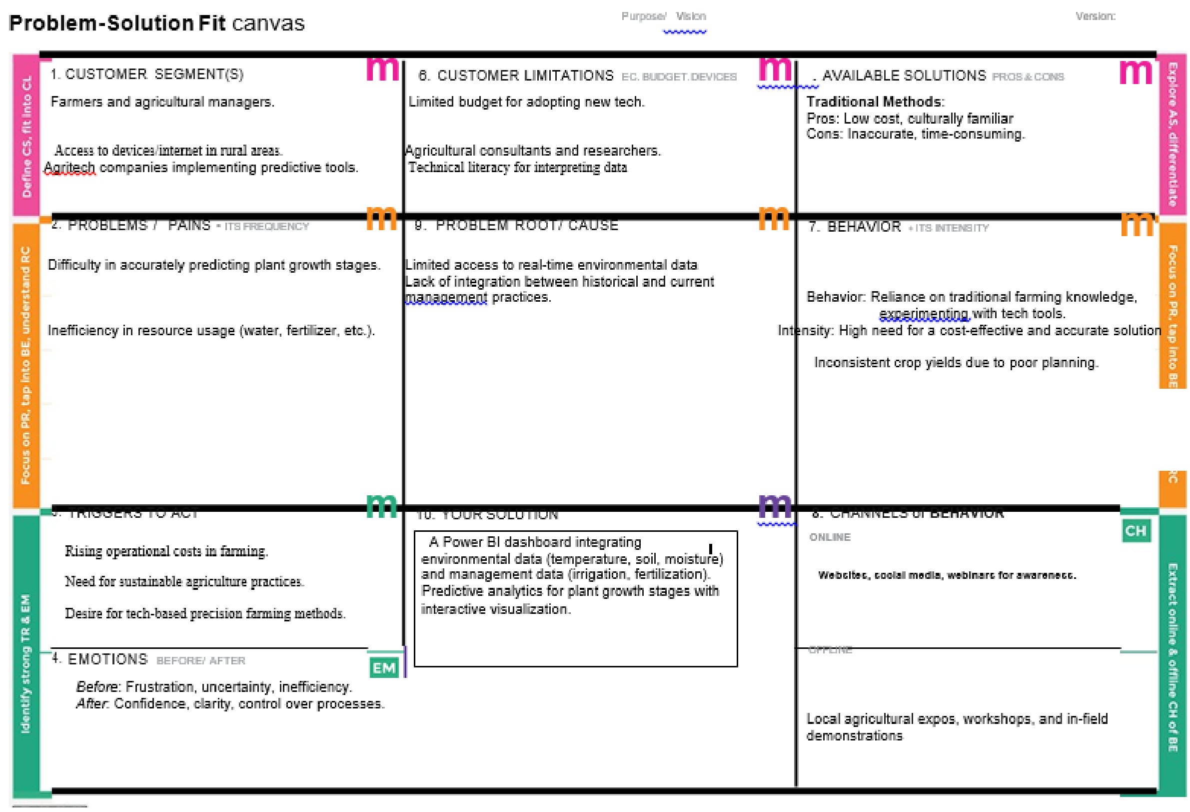
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The power dashboard should have an intuitive ui enabling farmers and agronomists to easily understand with data
NFR-2	**Security**	Security in Power bi to protect sensitive agricultural data
NFR-3	**Reliability**	Ensure data processing
NFR-4	**Performance**	Optimize power bi queries and dashboards to ensure real time data visualization
NFR-5	**Availability**	Power bi services for continue monitoring
NFR-6	**Scalability**	System should handle increasing data

3.3 Data Flow Diagram



4. Project design

4.1 Problem Solution Fit



4.2 Proposed Solution

Date	15 February 2025
Team ID	PNT2025TMID03012
Project Name	
Maximum Marks	2 Marks

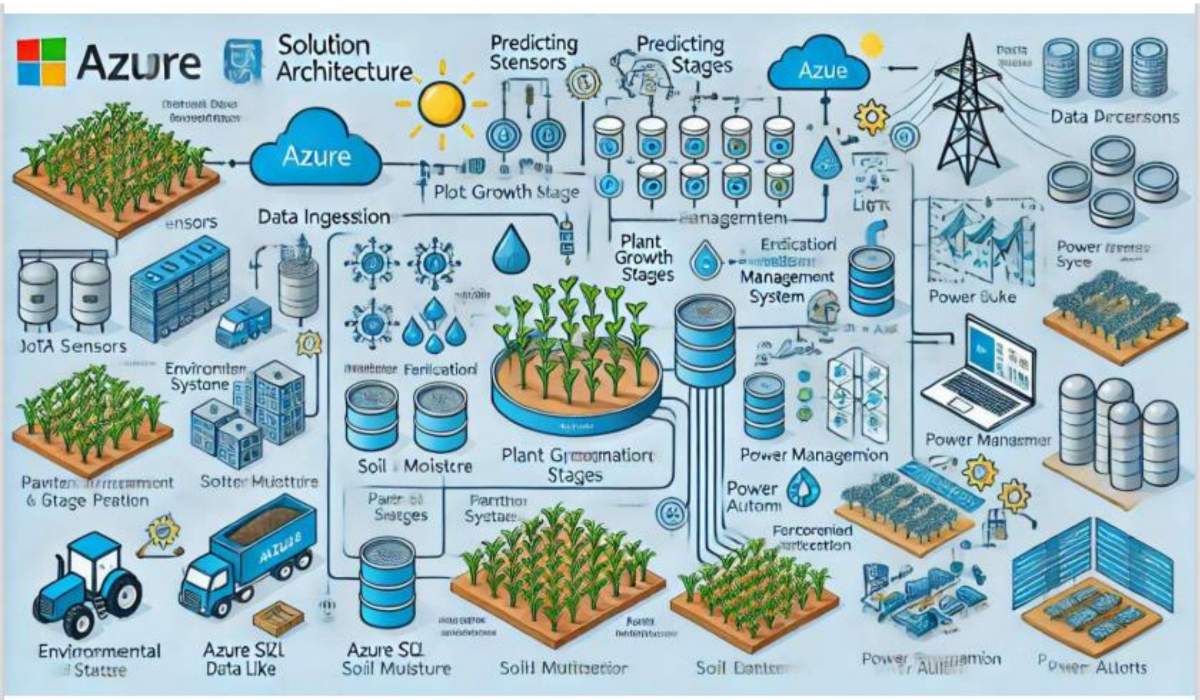
Proposed Solution Template:

Project team shall fill the following information in the proposed solution template.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Farmers and agricultural researchers struggle to accurately track and predict plant growth stages due to varying environmental conditions and management practices. A data-driven approach is needed to enhance decision-making and improve crop yield.
2.	Idea / Solution description	Our solution leverages Power BI to analyse environmental factors(temperature,humidity,soil moisture) And management data (fertilization, irrigation) to predict plant growth stages. The interactive

		dashboards providers insights for optimizing agricultural practices.
3.	Novelty / Uniqueness	Unlike traditional manual observation methods, our solution uses real-time data analytics and visualization to provide accurate, predictive insights. This reduces guesswork and enhances precision agriculture
4.	Social Impact / Customer Satisfaction	Farmers can make informed decisions on resource allocation, improving efficiency and sustainability
5.	Business Model (Revenue Model)	The model can be offered as a subscription based SaaS platform,where farmers, agribusiness , and researchers can access insights through a Power BI dashboards.
6.	Scalability of the Solution	The solution can be expanded to different crops and regions by integrating more datasets and AI models. It can also be integrated with IoT sensors and automated farm management systems for real-time monitoring.

4.3 Solution Architecture



5. Project Planning and Scheduling

5.1 Project Planning

A Sprint fixed period or duration in which a team works to complete a set of tasks

An **Epic** is a **big task or project** that is too large to complete in one sprint. It is broken down into **smaller tasks (stories)** that can be completed over multiple sprints.

A **Story** is a small task . It is part of an **Epic**.

A **Story Point** is a number that represents how much effort a story takes to complete. (usually in form of Fibonacci series)

- **1-** Very Easy task
- **2-** Easy task
- **3-** Moderate task
- **5-** Difficult task

Sprint 1: (5 Days)

Data Collection

Collection of Environmental Data 2

Collection of Management Data **2**

Data Preprocessing

Handling Missing Environmental Data **3**

Handling Missing Management Data 2

Sprint 2 (5 Days)

Model Building

Building Growth Prediction Model 8

Testing Growth Prediction Model 5

Deployment

Power BI Deployment and Integration 3

Total Story Points

Sprint 1 = 9

Sprint 2 = 16

Velocity= Total Story Points Completed/ Number of Sprints

Total story Points= 16+9 =25

No of Sprints= 2

Velocity = 16/2=8

8 (Story Points per Sprint)

Your team's velocity is 8 Story Points per Sprint.

6. Functional and Performance Testing

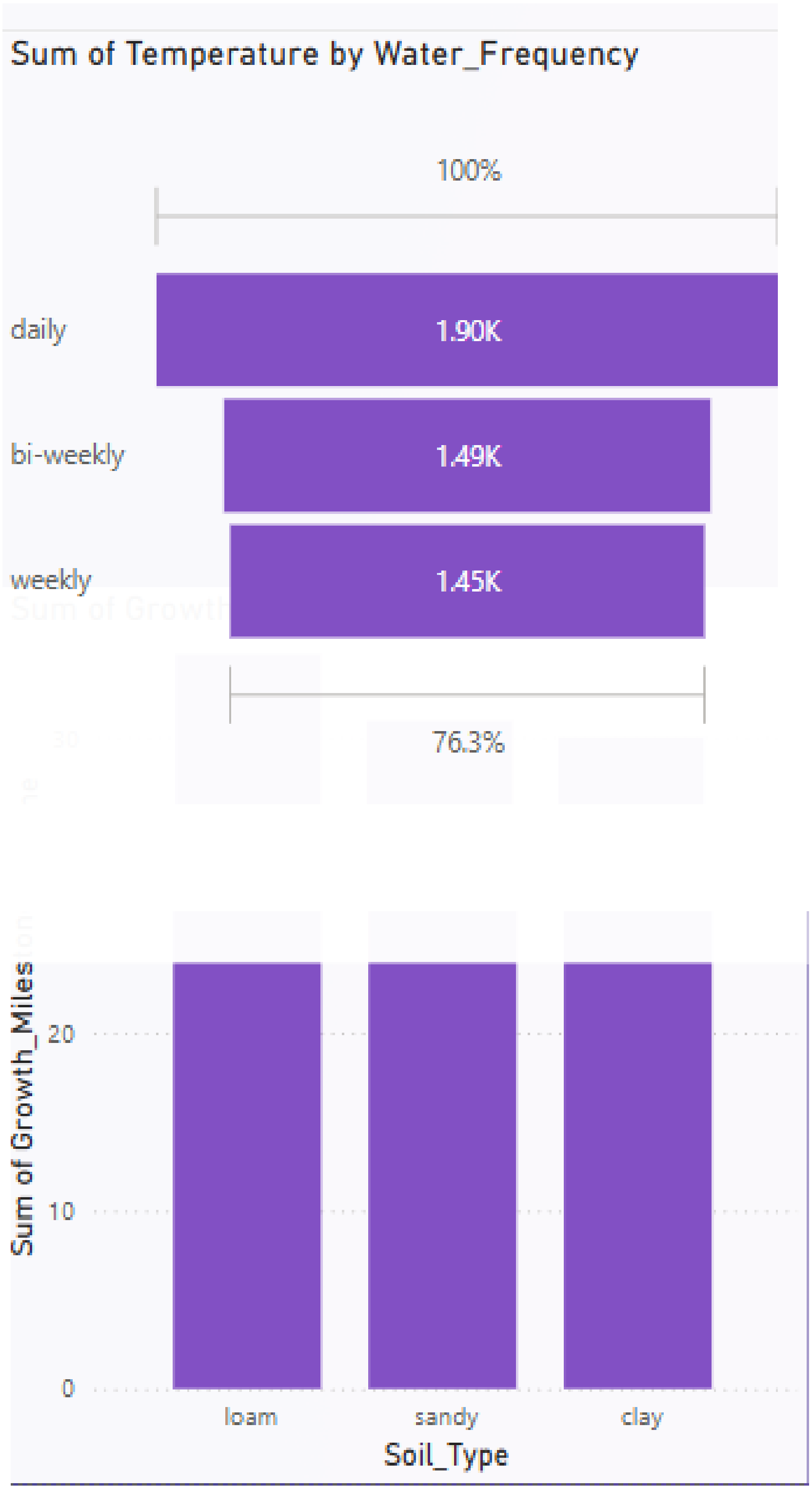
6.1 Performance Testing

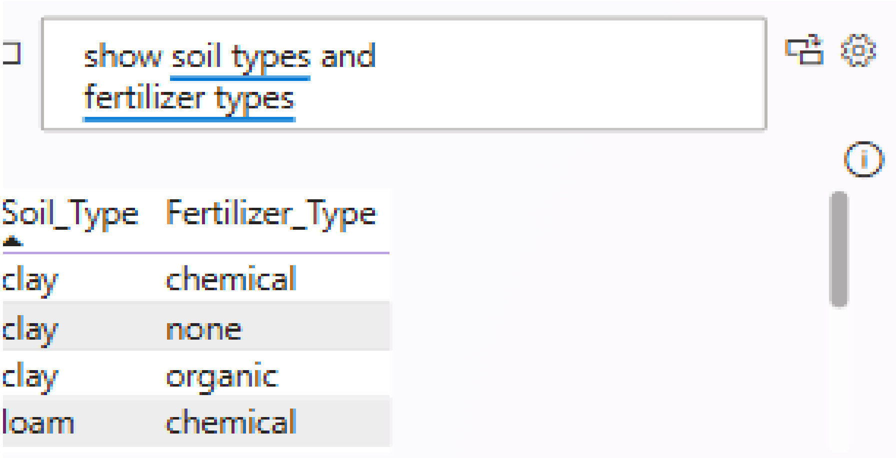
Key Areas for Performance Testing:

1. **Data Loading and Query Performance**:
   - Measure time to load data and perform calculations.
   - Test query execution times using **Power BI Performance Analyzer** and **DAX Studio**.
2. **Report Rendering Time**:
   - Test how long it takes for reports to load and render visuals.
   - Measure with **Power BI Performance Analyzer** or browser tools.
3. **Data Refresh Time**:
   - Measure how long it takes for data to refresh in Power BI from external sources (e.g., sensors).
   - Use **Power BI Service** or **Data Gateway** to monitor refresh times.
4. **Scalability Testing**:
   - Test performance with increasing data volume (from weeks to months or years of data).
   - Monitor performance as data grows using **Power BI Performance Analyzer**.
5. **Concurrency Testing**:
   - Simulate multiple users interacting with the reports at the same time.
   - Use tools like **Azure Load Testing** to simulate users.
6. **User Interaction Performance**:
   - Measure response time for user interactions (filters, slicers, drilldowns).
   - Test how quickly interactions update the visuals.

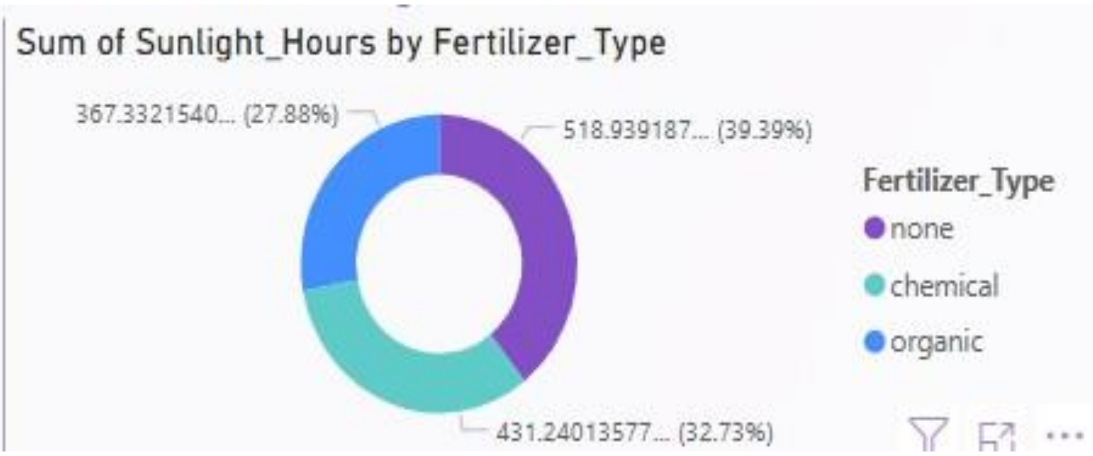
7. Results

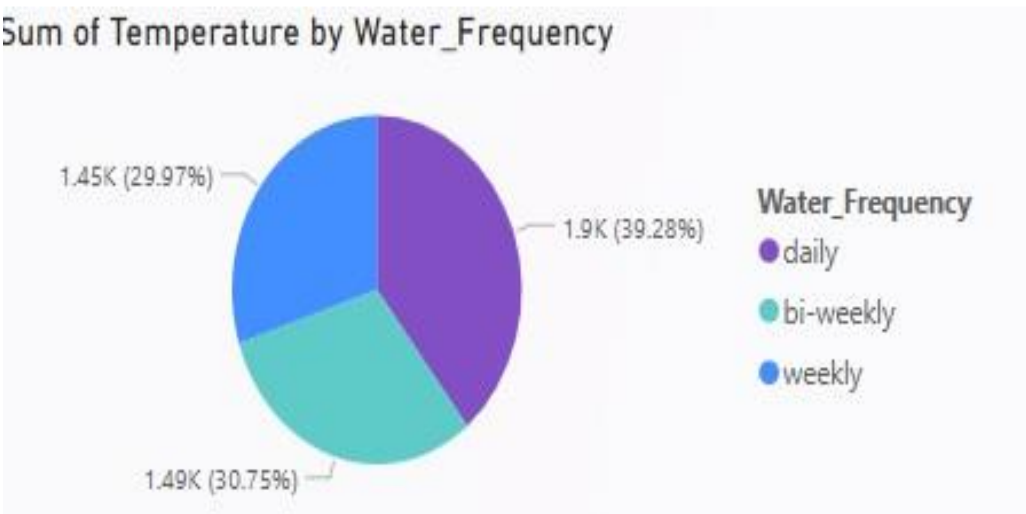
7.1 Output Screenshots



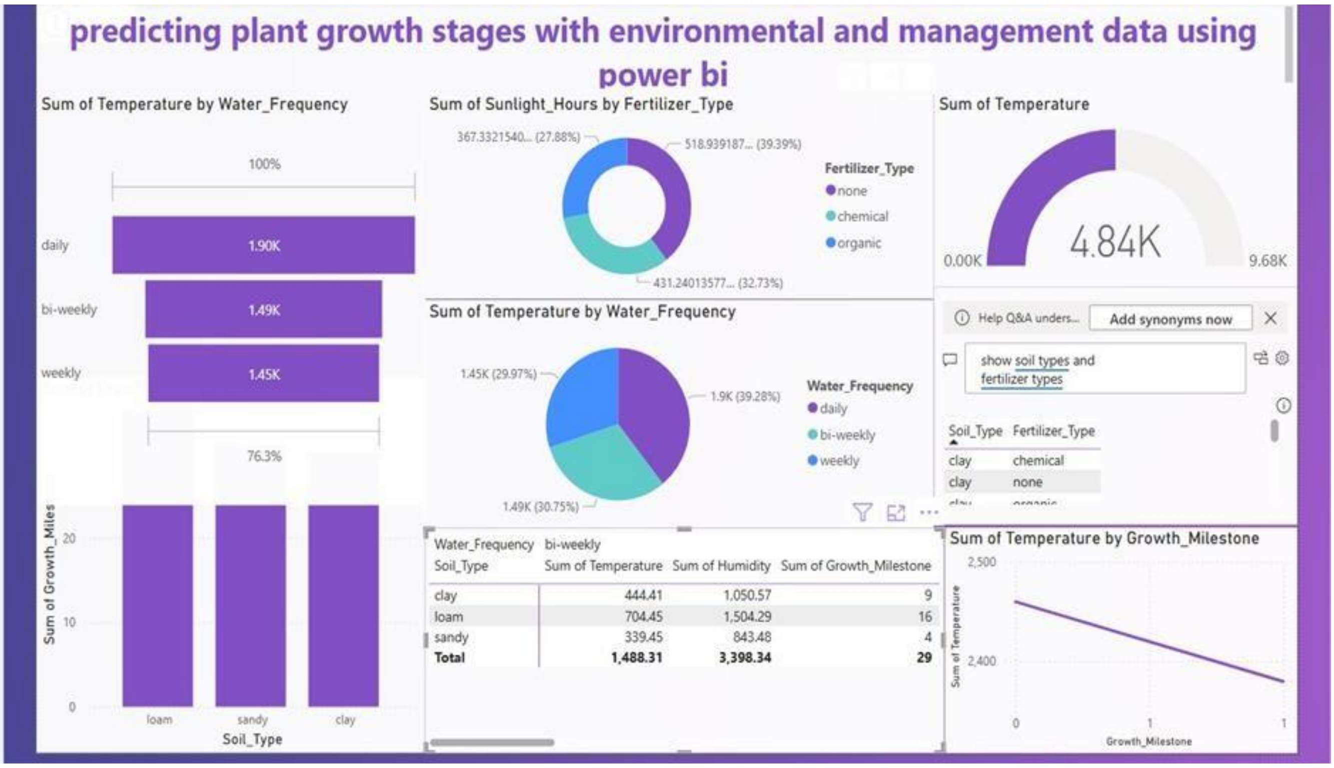


Soil_Type	Fertilizer_Type
clay	chemical
clay	none
clay	organic
loam	chemical





Water_Frequency	bi-weekly		
Soil_Type	Sum of Temperature	Sum of Humidity	Sum of Growth_Milestone
clay	444.41	1,050.57	9
loam	704.45	1,504.29	16
sandy	339.45	843.48	4
Total	**1,488.31**	**3,398.34**	**29**


predicting plant growth stages with environmental and management data using power bi
Sum of Temperature by Water_Frequency
100%
daily
1.90K
bi-weekly
1.49K
weekly
1.45K
76.3%
Sum of Sunlight_Hours by Fertilizer_Type
367.3321540... (27.88%)
518.939187... (39.39%)
431.24013577... (32.73%)
Fertilizer_Type
none
chemical
organic
Sum of Temperature
4.84K
0.00K
9.68K
Sum of Temperature by Water_Frequency
1.45K (29.97%)
1.9K (39.28%)
1.49K (30.75%)
Water_Frequency
daily
bi-weekly
weekly
Help Q&A unders...
Add synonyms now
show soil types and fertilizer types
Soil_Type Fertilizer_Type
clay chemical
clay none
Sum of Growth_Miles
20
10
0
loam
sandy
clay
Soil_Type
Water_Frequency bi-weekly
Soil_Type Sum of Temperature Sum of Humidity Sum of Growth_Milestone
clay 444.41 1,050.57 9
loam 704.45 1,504.29 16
sandy 339.45 843.48 4
Total 1,488.31 3,398.34 29
Sum of Temperature by Growth_Milestone
2,500
2,400
Sum of Temperature
0
1
1
Growth_Milestone

8. Advantages and Disadvantages

Advantages:

1. **Data Visualization**: Interactive and dynamic dashboards for easy interpretation of plant growth stages.
2. **Ease of Use**: User-friendly interface with drag-and-drop features, making it accessible to non-technical users.
3. **Advanced Analytics**: Supports complex DAX formulas and integrates with **R**/ **Python** for predictive modeling.
4. **Data Integration**: Can connect to multiple data sources (sensors, databases, cloud) for comprehensive insights.
5. **Scalability**: Handles large datasets efficiently, allowing growth over time.

Disadvantages:

1. **Learning Curve**: Requires some training for advanced features like DAX and data modeling.
2. **Performance with Large Datasets**: Can experience slowdowns with very large datasets or complex calculations.
3. **Limited Predictive Modeling**: While it supports **R** and **Python**, Power BI isn’t primarily built for deep machine learning.
4. **Licensing Costs**: Power BI Pro and Premium versions can incur additional costs for teams or large-scale deployments.
5. **Limited Offline Access**: Cloud-based Power BI reports require internet access for full functionality.

9. Conclusion

The project of predicting plant growth stages using environmental and management data with Power BI offers significant potential to enhance agricultural decision-making. By integrating real-time environmental data and management practices, Power BI allows for accurate predictions and visual insights, enabling farmers to optimize resources, improve plant health, and boost crop yield.

10. Future Scope

1. **IoT Integration**: Connect real-time sensor data (e.g., soil moisture, temperature) to improve prediction accuracy and automate farming decisions.
2. **Machine Learning & AI**: Enhance predictive models for plant growth stages and provide personalized farming recommendations.
3. **Automated Data Collection**: Streamline data collection and updates from sensors or cloud sources for continuous insights.
4. **Pest & Disease Prediction**: Use predictive analytics to detect pest infestations or diseases based on environmental data and growth patterns.
5. **Global Insights**: Expand the system to support multi-regional or global data for broader insights and comparisons.
6. **Mobile App Integration**: Provide mobile access for farmers to view real-time data and predictions on-the-go.

11. Appendix

1. **Source code**
2. **Dataset Link**
3. **GitHub & Project Demo Link**