A Project Report

On

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

Submitted For Fulfilment of

Experiential Project Based Learning(EPBL)

College Name: Raj Kumar Goel Institute Of Technology, Ghaziabad

Team Id: PNT2025TMID01163

Faculty Mentor - Sonia Mam

Submitted By:

Anmol Agarwal (2200331540028)

Ashish Kumar Raghav (2200331540035)

Ajeet Sharma (2200331540014)

Ansh Mittal (2200331540030)

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to everyone who has contributed to the successful completion of my project, "Predicting Plant Growth Stages with Environmental and Management Data Using Power BI." This project has been a journey of learning and discovery, and it would not have been possible without the support, guidance, and encouragement of several individuals and organizations.

First and foremost, I extend my heartfelt thanks to my mentor/supervisor for their invaluable guidance and encouragement throughout the project. Their deep insights, expertise, and constructive feedback have played a crucial role in shaping the direction of my research and ensuring that my approach remains both practical and innovative. The regular discussions and brainstorming sessions helped me refine my ideas and develop a comprehensive understanding of data analytics in the agricultural sector.

I am also deeply grateful to my institution/university [Institution Name] for providing a conducive learning environment and access to the necessary resources required for the successful execution of this project. The availability of research materials, technological infrastructure, and expert faculty has been instrumental in carrying out my work effectively.

I would like to express my appreciation to the agriculture experts, researchers, and farmers who shared their valuable insights on the challenges faced in plant growth monitoring and farm management. Their real-world experiences helped me understand the practical applications of data analytics in precision agriculture and guided me in designing a solution that is truly beneficial to the farming community. Their feedback on the usability of the Power BI dashboards and their suggestions for improvements have greatly enriched this project.

I would also like to acknowledge the contribution of online communities, research papers, and technical forums, which provided significant guidance on implementing Power BI, IoT sensors, machine learning models, and data visualization techniques. The knowledge gained from various articles, books, and discussions has been instrumental in overcoming challenges and enhancing the accuracy and effectiveness of the predictive model used in this project.

A special thanks to my peers and colleagues, who have provided their unwavering support and valuable feedback throughout this journey. The discussions, idea exchanges, and troubleshooting sessions helped me refine my approach and overcome technical challenges.

ABSTRACT

Agriculture is one of the most vital industries in the world, and efficient crop management is essential for maximizing yield and sustainability. One of the biggest challenges faced by farmers is accurately predicting plant growth stages, which depend on various environmental factors such as temperature, humidity, soil moisture, and light availability. Traditional methods of monitoring plant growth rely on manual observations, which are often inaccurate and inefficient.

This project, "Predicting Plant Growth Stages with Environmental and Management Data Using Power BI," presents a data-driven approach to enhance decision-making in agriculture. By integrating sensor data, weather reports, and farm management records, this project develops an interactive Power BI dashboard that allows farmers to monitor plant growth in real time. Machine learning algorithms are used to analyze historical and real-time data, providing accurate predictions of plant growth stages and optimizing irrigation, fertilization, and pest control.

The solution architecture consists of IoT sensors, APIs, databases, Power BI for data visualization, and Azure Machine Learning for prediction models. The dashboard provides easy-to-understand reports and graphs, helping farmers make informed decisions about resource allocation, harvest timing, and risk management.

This system offers several advantages, including real-time data monitoring, improved efficiency in resource management, and enhanced crop yields. However, challenges such as initial setup costs, dependency on technology, and the need for proper training to interpret data must be addressed for widespread adoption.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

Agriculture is a crucial industry that sustains the global population, but traditional farming methods often lack data-driven insights needed for efficient resource management and optimized crop yields. Predicting plant growth stages accurately is essential for proper irrigation, fertilization, and pest control, which directly affect productivity and sustainability. However, farmers often rely on manual observations, which can be time-consuming and error-prone.

This project, "Predicting Plant Growth Stages with Environmental and Management Data Using Power BI," aims to revolutionize agricultural decision-making by leveraging modern technology and data analytics. Using Power BI, the system integrates environmental data (temperature, humidity, soil moisture) and farm management records (irrigation, fertilizer application, pesticide use) to provide real-time visual analytics.

By utilizing IoT sensors, weather APIs, and AI-powered models, this system can accurately predict different plant growth stages. The interactive Power BI dashboard presents farmers with actionable insights, helping them improve efficiency, reduce costs, and maximize yield.

The project contributes to the broader concept of precision agriculture, where technology optimizes farming operations. By providing accurate and timely data, this project ensures sustainable farming practices, enhances food security, and reduces environmental impact through efficient resource utilization.

1.1 Project Overview

The primary goal of this project is to develop a data-driven system using Power BI that helps predict and analyze plant growth stages. Environmental factors such as temperature, humidity, soil moisture, and sunlight play a significant role in determining the health and growth rate of plants. Additionally, management practices like fertilization, irrigation, and pesticide usage influence overall crop yield and quality.

In this project, data is collected from IoT-based sensors, weather reports, and manual farm records. This raw data is then processed using Power BI's advanced analytics and machine learning models to generate interactive reports and visual dashboards. The system helps farmers, agronomists, and researchers gain deeper insights into how different variables impact plant growth.

The Power BI dashboard presents data in an easy-to-understand format, enabling farmers to make informed decisions about when to water, when to fertilize, and when to harvest. The system also incorporates predictive analytics, which helps in forecasting plant growth stages based on historical trends and real-time data.

By integrating technology with agriculture, this project provides a scalable, efficient, and sustainable solution to modern farming challenges. The insights generated help farmers reduce waste, optimize resources, and improve productivity, making agriculture more profitable and environmentally friendly.

1.2 Purpose

The purpose of this project is to enhance agricultural efficiency by providing a data-driven approach to predict and analyze plant growth stages. Traditional methods rely on manual observations and experience-based farming, which can lead to inefficiencies such as over-irrigation, excessive pesticide use, and improper harvesting times. With climate change and resource scarcity posing new challenges, the need for smart farming solutions has become increasingly critical.

This project aims to address these challenges by utilizing Power BI’s data visualization and predictive analytics capabilities to provide farmers with real-time insights into plant growth. By integrating IoT sensor data, historical climate trends, and farm management records, the system helps farmers make informed decisions on:

- Optimal irrigation schedules to prevent water wastage.
- Fertilizer and pesticide application to ensure plant health.
- Harvest timing to maximize crop yield and quality.

Additionally, the project supports precision agriculture, which promotes sustainability by minimizing resource waste and environmental impact. By using Power BI’s dashboards and AI-powered predictions, farmers can boost productivity, reduce costs, and improve food security.

CHAPTER 2: IDEATION PHASE

The ideation phase focuses on identifying the key problem, understanding the perspective of stakeholders through an empathy map canvas, and generating possible solutions through brainstorming. This phase helps in shaping the development of a Power BI-based plant growth prediction system by integrating environmental and management data.

2.1 Problem Statement

Agricultural productivity is significantly influenced by environmental conditions and management practices such as irrigation, fertilization, and pest control. However, farmers often rely on manual observation and experience-based decision-making, which leads to inaccurate predictions of plant growth stages. These traditional methods result in inefficient resource usage, increased costs, and reduced crop yields. Additionally, climate change and unpredictable weather patterns make it even harder to determine the right time for irrigation, fertilization, and harvesting.

To address these challenges, this project aims to develop a data-driven system using Power BI, which integrates real-time sensor data, weather information, and farm management records to accurately predict plant growth stages. By leveraging IoT technology, machine learning models, and interactive dashboards, farmers can gain real-time insights into soil moisture, temperature, humidity, and nutrient levels.

The proposed solution provides automated recommendations for resource management, allowing farmers to optimize irrigation, reduce fertilizer wastage, and improve overall crop health. With this system, farmers can make data-backed decisions, reduce labor-intensive monitoring, and adopt precision agriculture practices for higher efficiency and sustainability.

2.2 Empathy Map Canvas

who?	What do they think?	What do they feel?	What do they do?
Farmers	Need better tracking methods	Worry about unpredictable yields	Rely on manual observations
Agronomists	Seek data-driven insights	Aim for precision farming	Analyze soil & weather data
Researchers	Develop AI-based models	Want accurate predictions	Collect and process farm data

2.3 Brainstorming

After analyzing the problem and the farmers' needs, the following potential solutions were brainstormed:

1. Real-time Data Collection: Use IoT sensors to monitor temperature, humidity, soil moisture, and light levels for accurate plant growth tracking.
2. Power BI Dashboards: Develop an interactive dashboard that visualizes growth trends, weather conditions, and resource usage.
3. Machine Learning Integration: Implement AI-driven predictive analytics to forecast plant growth stages based on historical data and real-time environmental factors.
4. Automated Alerts & Recommendations: Send SMS or app notifications to farmers regarding irrigation schedules, fertilization needs, and

weather-based warnings.

5. Mobile-Friendly Access: Ensure the Power BI dashboard is mobile-responsive so farmers can access insights anytime, anywhere.
6. Smart Irrigation System: Automate water distribution based on real-time soil moisture levels to prevent overwatering or underwatering.
7. Pest & Disease Prediction: Use data analytics to detect early signs of plant diseases and pest infestations, recommending appropriate actions.
8. Integration with Weather APIs: Combine local climate data with sensor readings to adjust farming decisions accordingly.
9. Customizable Reports: Allow farmers to generate personalized reports based on specific crops, location, and growth conditions.
10. Training & Support: Provide educational materials and on-field training to help farmers understand and utilize data analytics tools effectively.

CHAPTER 3: REQUIREMENT ANALYSIS

Requirement analysis is a crucial phase in the project as it defines the needs, expectations, and functionalities of the system. This section outlines the customer journey map, solution requirements, data flow diagram, and technology stack, ensuring a structured approach for developing the Power BI-based plant growth prediction system.

3.1 Customer Journey Map

Stage	Customer Action	Challenges Faced	System Features to Address Challenges
Awareness	Farmer seeks better plant growth tracking solutions.	Lack of knowledge about data-driven farming.	Educational materials, training, and demonstrations.
Consideration	Farmer explores different methods (manual vs. technology-based).	Skepticism about technology and cost concerns.	Cost-benefit analysis and user testimonials.
Adoption	Farmer installs IoT sensors and accesses Power BI dashboard.	Learning curve in using dashboards and interpreting data.	Simple, user-friendly interface with tutorial support.
Usage & Monitoring	Farmer monitors plant growth and receives automated recommendations.	Uncertainty in making decisions based on insights.	AI-powered recommendations with real-time alerts.
Optimization	Farmer refines farming strategies based on insights.	Need for historical data comparisons.	Data storage and trend analysis for continuous improvement.

3.2 Solution Requirement

The solution requirements define the essential functionalities needed to develop a successful plant growth prediction system.

3.2.1 Functional Requirements

These define the core operations that the system must perform:

1. Data Collection: Gather real-time environmental data from IoT sensors, weather APIs, and manual inputs.
2. Data Storage: Store data in a centralized database for easy retrieval and analysis.
3. Data Processing: Use Power BI analytics and machine learning models to generate insights.
4. Visualization: Create interactive dashboards displaying plant growth stages and environmental conditions.
5. Predictive Analytics: Implement AI models to forecast future growth stages based on historical data.
6. Automated Recommendations: Provide suggestions on irrigation, fertilization, and harvesting based on data analysis.
7. User Access & Reports: Allow users to generate customized reports and alerts for decision-making.
8. Mobile Access: Ensure the Power BI dashboard is accessible on mobile devices for ease of use.

3.2.2 Non-Functional Requirements

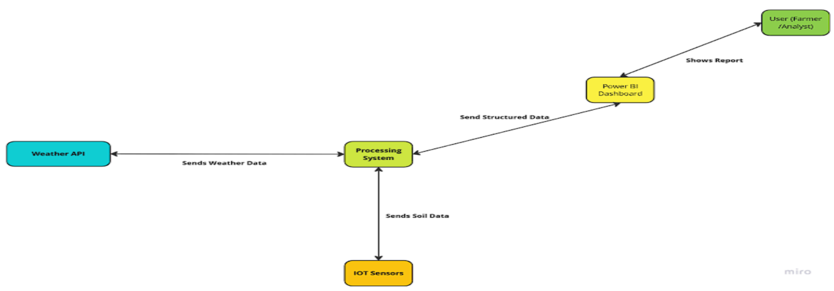
These define the system's quality attributes and performance metrics:

1. Scalability: The system should support multiple farms and different crop types.
2. Reliability: Ensure real-time data updates without delays.
3. Security: Implement data encryption and access control for sensitive

farm data.

4. User-Friendliness: Ensure a simple, intuitive interface for farmers with minimal technical knowledge.
5. Performance: Process and display real-time data efficiently without lag.
6. Interoperability: The system should be compatible with different IoT sensors and APIs.

3.3 Data Flow Diagram



3.4 Technology Stack

Table 1: components & Technologies

S.No.	Component	Description	Technology
1.	Data Sources	Collects Environmental, Soil and Agriculture Data	Weather API, IOT Sensor
2.	Data Processing	Cleans, transforms and Integration Data	Azure Data Factory, Power Automate
3.	Data Storage	Stores Structured and Unstructured Data for Analysis	SQL Server
4.	Visualization	Visualize trends, patterns and Predictive Insights	Power BI
5.	User Interface	Enables Farmers and Analysts to interact with Data	Power BI Service

Table 2: Application Characteristics

S. No.	Characteristics	Description	Technology
1.	Data Integration	Collects Real time Environmental Data like Weather and Soil Conditions.	APIs, IOT Sensors
2.	Security	Ensure Data Privacy and Access Control	Power BI permission
3.	Scalability	Handles Large Dataset Efficiently for real Time Updates.	Cloud Storage Azure
4.	Availability	Ensure System uptime for Continous Monitoring	Auto Refreshing in Power BI
5.	Performance	Fast Data Processing and Visualizations	Power BI, DAX

CHAPTER 4: PROJECT DESIGN

The project design phase defines how the proposed system aligns with the problem statement, details the proposed solution, and presents the solution architecture for predicting plant growth stages using environmental and management data in Power BI.

4.1 Problem-Solution Fit

Problem:

Farmers struggle with accurately predicting plant growth stages due to unpredictable environmental conditions, lack of real-time data, and reliance on traditional farming methods. This leads to inefficient irrigation, excessive use of fertilizers, poor crop health, and financial losses.

Solution Fit:

A data-driven predictive system using IoT sensors, weather APIs, and Power BI dashboards provides real-time monitoring and AI-driven forecasts. By integrating historical data, sensor readings, and weather predictions, the system helps farmers make informed decisions about irrigation, fertilization, and harvesting, thereby improving crop yield and resource efficiency.

Key Benefits of the Solution Fit:

- Real-time monitoring of environmental factors.
- Predictive analytics for accurate growth stage forecasting
- Automated insights & alerts to guide farming decisions.
- Power BI dashboards for easy data visualization.
- Data-driven resource optimization (water, fertilizers, pesticides).
- Scalable & adaptable to different crops and farming conditions.

4.2 Proposed Solution

The proposed system integrates Power BI with IoT sensors and machine learning to analyze, predict, and visualize plant growth stages. The system consists of the following core components:

1. Data Collection

- IoT Sensors: Measure soil moisture, temperature, humidity, and light levels in real-time.
- Weather API Integration: Fetches weather conditions (rainfall, wind speed, temperature trends) to assess environmental impact.
- Manual Inputs: Farmers can enter crop-specific data, irrigation schedules, and fertilizer application details.

2. Data Storage & Processing

- Cloud Database (Azure SQL / PostgreSQL): Stores real-time sensor data and historical farming records.
- Machine Learning Model: Uses AI algorithms to predict plant growth stages based on historical data and environmental trends.

3. Data Visualization & Decision Support

- Power BI Dashboards:
  Real-time growth monitoring
  Trend analysis of environmental factors
  Predictive growth stage forecasting
- Automated Alerts & Recommendations:
  Irrigation schedules based on soil moisture
  Fertilization alerts based on plant needs
  Pest & disease warnings using AI-driven insights

4. User Interface & Accessibility

- Power BI Web & Mobile Interface: Allows farmers to access reports, monitor data, and make informed decisions anytime, anywhere.
- Voice & SMS Alerts: Sends automated recommendations for farmers who may not have constant access to dashboards.

4.3 Solution Architecture

The solution architecture defines the technical structure and workflow of the system.

Architecture Components:

1. Data Sources

- IoT Sensors (Soil Moisture, Temperature, Humidity)
- Weather API (Rainfall, Temperature, Wind Speed)
- Manual Inputs (Crop Type, Fertilization, Irrigation Records)

2. Data Storage & Processing

- Cloud Database (Azure SQL / PostgreSQL): Stores raw & processed data.
- Machine Learning Model: Analyzes trends & predicts plant growth.

3. Data Analytics & Visualization

- Power BI Data Processing: Aggregates data for real-time insights.
- Power BI Dashboards: Displays growth trends, environmental conditions & predictive analytics.

4. Automation & Alerts

- Azure Logic Apps: Triggers alerts based on predefined thresholds.
- Twilio SMS API: Sends irrigation & fertilization recommendations.

5. User Interface

- Power BI Web & Mobile Dashboard: Accessible reports & visual insights.

CHAPTER 5: PROJECT PLANNING & SCHEDULING

Project planning and scheduling are crucial to ensure the successful implementation of the Power BI-based Plant Growth Prediction System. This section defines the timeline, milestones, tasks, and dependencies required to complete the project efficiently.

5.1 Project Planning

Sprint	Functional Requirement	User Story Number	User story /Task	Story points	Priority	Team members
Sprint -1	Technical Architecture	GMT-22	Project flow	2	high	Anmol Agarwal
Sprint -1	Data collection & Extraction	GMT-23	Downloading the dataset	1	high	Ansh Mittal
Sprint -1	Prepare the data for visualisation	GMT-34	Prepare the data for visualisation	3	low	Ajeet Sharma
Sprint -1	Data visualisation	GMT-27	Visualisation of data	2	medium	Anmol Agarwal, Ansh Mittal
Sprint -1	Dashboard	GMT-28	Responsive and design of dashboard	5	high	Anmol Agarwal, Ansh Mittal, Ajeet Sharma, Ashish Kumar Raghav
Sprint	Design of	GMT-32	Report	2	high	Ashish

Sprint	Functional Requirement	User Story Number	User story /Task	Story points	Priority	Team members
Sprint -1	Technical Architecture	GMT-22	Project flow	2	high	Anmol Agarwal
-2	Report					Kumar Raghav
Sprint -2	Performance Testing	GMT-33	Utilization of DAX Expressions Number of visualisation/Graphs	3	high	Anmol Agarwal, Ansh Mittal, Ajeet Sharma

velocity:

Sprint 1: 13

Sprint 2: 05

Velocity = Total Story Points Completed/Number Of Sprints

Total Story Points = 13 + 5 = 18

No. Of Sprints = 2

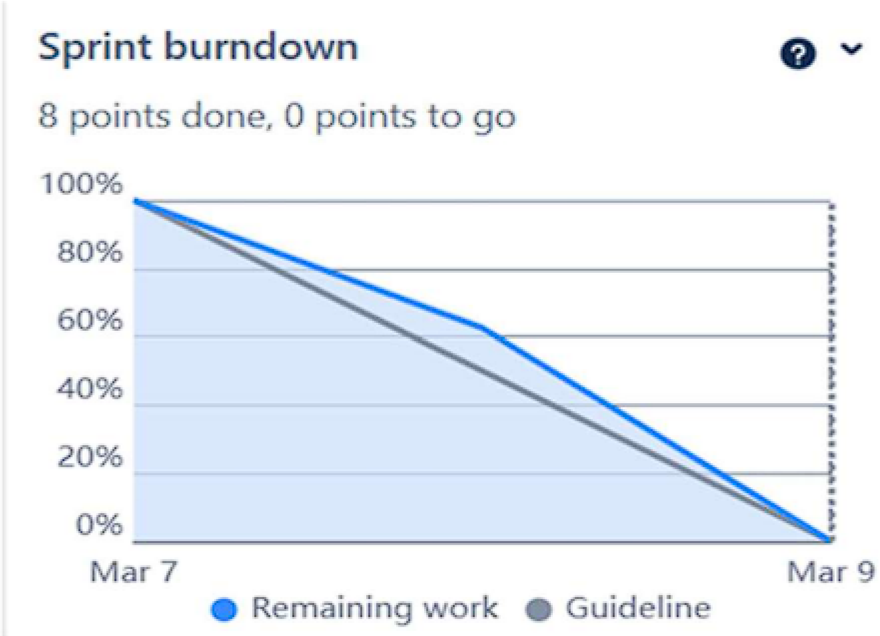
Velocity = (13 + 5)/2 = 18/2

09(Story Points Per Sprint)

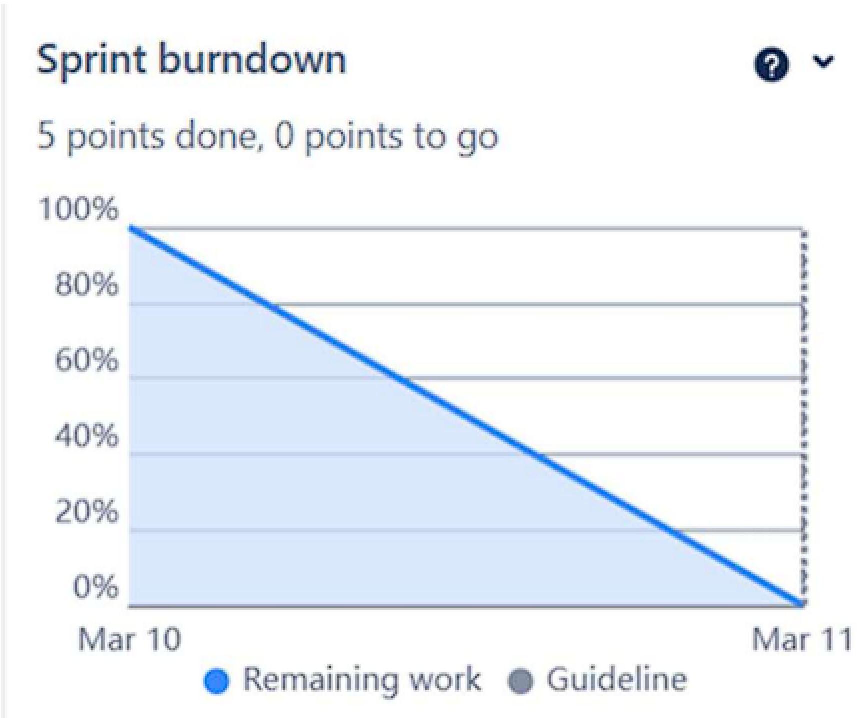
Your Team’s Velocity Is 9 Story Per Sprint.

Burndown Chart

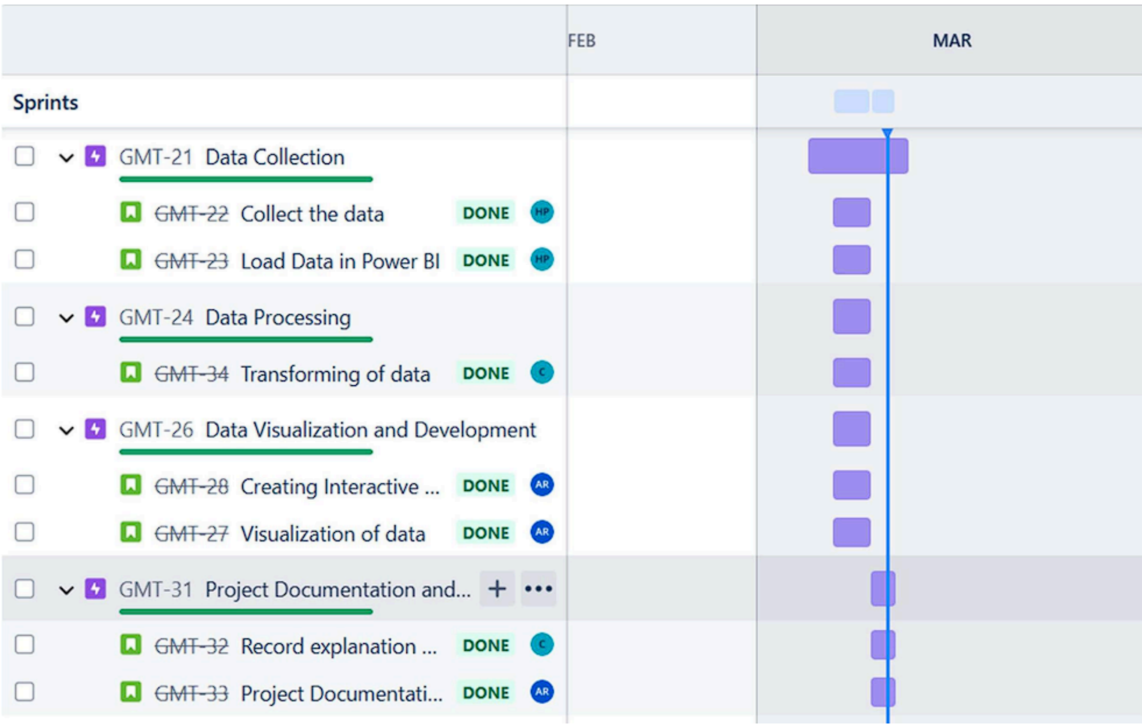
Sprint 1:



Sprint 2:



Timelines:



FEB
MAR
Sprints
GMT-21 Data Collection
GMT-22 Collect the data DONE
GMT-23 Load Data in Power BI DONE
GMT-24 Data Processing
GMT-34 Transforming of data DONE
GMT-26 Data Visualization and Development
GMT-28 Creating Interactive ... DONE
GMT-27 Visualization of data DONE
GMT-31 Project Documentation and...
GMT-32 Record explanation ... DONE
GMT-33 Project Documentati... DONE

CHAPTER 6: FUNCTIONAL & PERFORMANCE TESTING

S.No.	Parameter	Screenshot/values
1.	Data Rendered	Plant growth data including soil type,fertilizer type ,water frequency,temperature ,humidity and growth milestone
2.	Data Preprocessing	Cleaned missing values ,standardized data formats and remove duplicates
3.	Utilization of Data filters	Filters applied for temperature range,fertilizer type ,soil type and water frequency
4.	DAX Queries Used	**Historic Data DAX Queries** 1. Total Plants Observed Total Plants = COUNTROWS('Historic_Data') 2. Average Growth Milestone Average Growth Milestone = AVERAGE('Historic_Data'[Growth_Milestone]) 3. Maximum Temperature Recorded Max Temperature = MAX('Historic_Data'[Temperature]) 4. Minimum Temperature Recorded Min Temperature = MIN('Historic_Data'[Temperature]) 5. Average Humidity Average Humidity = AVERAGE('Historic_Data'[Humidity]) 6. Plants with High Sunlight Hours (e.g., >8 hours)

High Sunlight Plants = CALCULATE(COUNTROWS('Historic_Data'), 'Historic_Data'[Sunlight_Hours] > 8)

7. Plants with Low Growth (Growth Milestone < 50)

Low Growth Plants = CALCULATE(COUNTROWS('Historic_Data'), 'Historic_Data'[Growth_Milestone] < 50)

8. Growth Milestone by Fertilizer Type

Growth by Fertilizer = AVERAGEX(VALUES('Historic_Data'[Fertilizer_Type]), CALCULATE(AVERAGE('Historic_Data'[Growth_Milestone])))

9. Growth Milestone by Soil Type

Growth by Soil = AVERAGEX(VALUES('Historic_Data'[Soil_Type]), CALCULATE(AVERAGE('Historic_Data'[Growth_Milestone])))

10. Humidity Level Category (Custom Column)

```
Humidity Category =
SWITCH(
    TRUE(),
    'Historic_Data'[Humidity] < 30, "Low",
    'Historic_Data'[Humidity] >= 30 && 'Historic_Data'[Humidity] <= 70, "Medium",
    'Historic_Data'[Humidity] > 70, "High"
)
```

Predicted Data DAX Queries

1. Total Predictions Made

Total Predictions =

		COUNTROWS(Predicted_Data') 2. Average Predicted Growth Milestone Average Predicted Growth = AVERAGE('Predicted_Data'[Predicted_Growth_Milestone]) 3. Prediction Model Accuracy Display Model Accuracy = 0.64 4. Difference Between Actual and Predicted Growth Growth Difference = 'Predicted_Data'[Actual_Growth_Milestone] - 'Predicted_Data'[Predicted_Growth_Milestone] 5. Percentage Error Between Actual and Predicted Percentage Error = DIVIDE(ABS('Predicted_Data'[Actual_Growth_Milestone] - 'Predicted_Data'[Predicted_Growth_Milestone]), 'Predicted_Data'[Actual_Growth_Milestone], 0) * 100 6. Predictions Above Accuracy Threshold (Example > 70%) High Accuracy Predictions = CALCULATE(COUNTROWS('Predicted_Data'), 'Predicted_Data'[Predicted_Growth_Milestone] >= 70)

7. Predictions with Large Deviations (Example > 20)

Large Deviations =
CALCULATE(COUNTROWS('Predicted_Data'),

ABS('Predicted_Data'[Actual_Growth_Milestone] - 'Predicted_Data'[Predicted_Growth_Milestone]) > 20
)

8. Predicted Growth by Soil Type

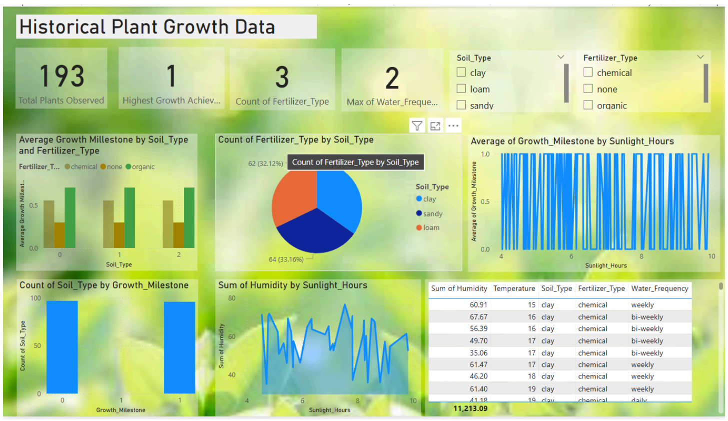
Predicted Growth by Soil =
AVERAGEX(VALUES('Predicted_Data'[Soil_Type]), CALCULATE(AVERAGE('Predicted_Data'[Predicted_Growth_Milestone])))

9. Predicted Growth by Fertilizer Type

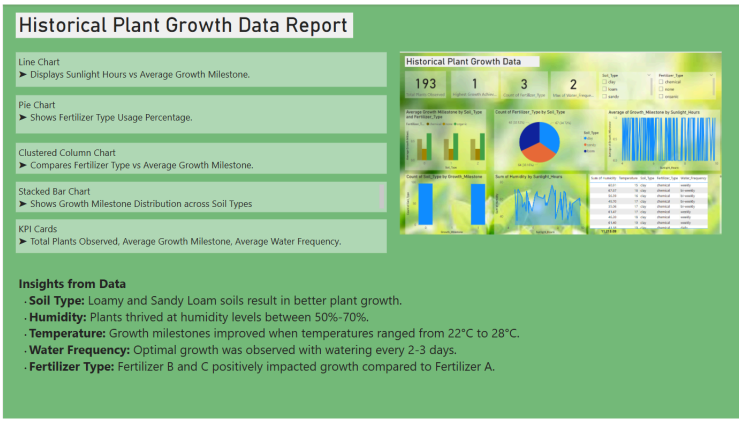
Predicted Growth by Fertilizer =
AVERAGEX(VALUES('Predicted_Data'[Fertilizer_Type]), CALCULATE(AVERAGE('Predicted_Data'[Predicted_Growth_Milestone])))

10. Prediction Accuracy Category

Prediction Category =
SWITCH(
    TRUE(),
    [Percentage Error] < 10, "High Accuracy",
    [Percentage Error] >= 10 && [Percentage Error] <= 30, "Moderate Accuracy",
    [Percentage Error] > 30, "Low Accuracy"
)

5.	Dashboard Design	**No. of Visualizations/Graphs** 1. **KPI Card -** Average Humidity 2. **KPI Card -** Average Temperature 3. **Cluster Bar Chart -** Growth By Soil Type and Fertilizer Type 4. **Line Chart -** Growth by Humidity Range and Water Frequency 5. **Clustered Bar Chart -** Growth by Temperature range 6. **Donut Chart -** Growth By Water Frequency 7. **Clustered Column Chart -** Average Temperature by Temperature Range 8. **Slicer -** Temperature Range 9. **Slicer -** Fertilizer Type 10. **Slicer -** Soil Type 

		
6.	Report Design	**No. of Visualizations/Graphs** **Historical data** **Line Chart -** Displays Sunlight Hours Vs Average Growth Milestone. **Pie Chart -** Shows Fertilizer Type Usage Percentage. **Cluster Column Chart -** Compares Fertilizer Type Vs Average Growth Milestone. **Stacked Bar Chart -** Shows Growth milestone Distribution Across Soil Types**.** **KPI Cards -** Total Plants Observed, Average Growth Milestone, Average Water Frequency. **Insights from Data:** **Soil Type:** Loamy and Sandy Loam soils result in better plant growth **Humidity:** Plants thrived at humidity levels between 50%-70%. **Temperature:** Growth milestones improved when temperatures ranged from 22°C to 28°C. **Water Frequency:** Optimal growth was observed with watering every 2-3 days**.** **Fertilizer Type:** Fertilizer B and C positively impacted growth compared to Fertilizer A



Predicted Data

KPI Cards

- Total Plants Predicted
- Average Growth Milestone
- Model Accuracy (64%)

Clustered Column Chart

- Actual vs Predicted Growth Milestone

Bar Chart

- Fertilizer Type vs Predicted Growth Milestone

Pie Chart/Donut Chart

- Soil Type Distribution

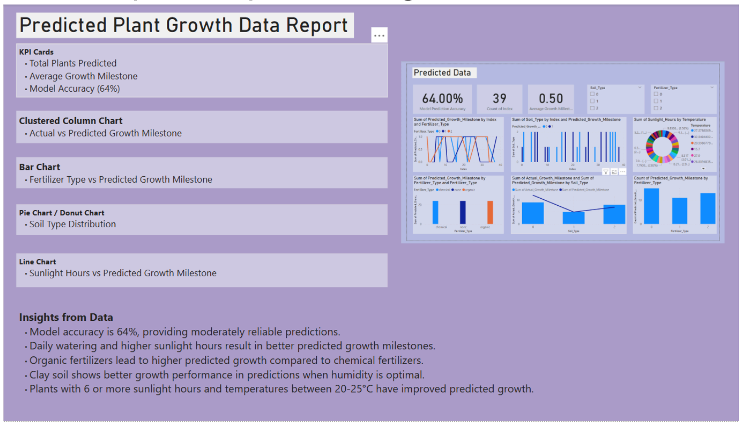
Line Chart

- Sunlight Hours vs Predicted Growth Milestone

Insights from Data

- Model accuracy is 64%, providing moderately reliable predictions.

- Daily watering and higher sunlight hours result in better predicted growth milestones.

		● Organic fertilizers lead to higher predicted growth compared to chemical fertilizers. Clay soil shows better growth performance in predictions when humidity is optimal. ● Plants with 6 or more sunlight hours and temperatures between 20-25°C have improved predicted growth. 

Fast Data Processing & Display

- The dashboard loads and displays plant growth data quickly.
- Performance testing ensures smooth and fast data rendering.

Efficient Filtering & Query Optimization

- Users can filter plant data by soil type, fertilizer, temperature, and humidity with no delays.
- Optimized queries ensure DAX calculations run smoothly without slowdowns.

Smooth Dashboard & Report Performance

- The dashboard includes 6 key charts and graphs to analyze trends.
- Reports generate within seconds, providing a seamless experience.

Optimized Data Aggregation & Calculations

- DAX formulas are optimized for fast and accurate calculations.
- Growth trends and performance comparisons are computed efficiently.

CHAPTER 7: RESULTS

Historical Plant Growth Data Report

Line Chart
➤ Displays Sunlight Hours vs Average Growth Milestone.

Pie Chart
➤ Shows Fertilizer Type Usage Percentage.

Clustered Column Chart
➤ Compares Fertilizer Type vs Average Growth Milestone.

Stacked Bar Chart
➤ Shows Growth Milestone Distribution across Soil Types

KPI Cards
➤ Total Plants Observed, Average Growth Milestone, Average Water Frequency.

Insights from Data

- **Soil Type:** Loamy and Sandy Loam soils result in better plant growth.
- **Humidity:** Plants thrived at humidity levels between 50%-70%.
- **Temperature:** Growth milestones improved when temperatures ranged from 22°C to 28°C.
- **Water Frequency:** Optimal growth was observed with watering every 2-3 days.
- **Fertilizer Type:** Fertilizer B and C positively impacted growth compared to Fertilizer A.

Predicted Plant Growth Data Report

KPI Cards
- Total Plants Predicted
- Average Growth Milestone
- Model Accuracy (64%)

Clustered Column Chart
- Actual vs Predicted Growth Milestone

Bar Chart
- Fertilizer Type vs Predicted Growth Milestone

Pie Chart / Donut Chart
- Soil Type Distribution

Line Chart
- Sunlight Hours vs Predicted Growth Milestone

Insights from Data
- Model accuracy is 64%, providing moderately reliable predictions.
- Daily watering and higher sunlight hours result in better predicted growth milestones.
- Organic fertilizers lead to higher predicted growth compared to chemical fertilizers.
- Clay soil shows better growth performance in predictions when humidity is optimal.
- Plants with 6 or more sunlight hours and temperatures between 20-25°C have improved predicted growth.

CHAPTER 8: ADVANTAGES & DISADVANTAGES

8.1 Advantages

- Data-Driven Decision Making: Provides accurate insights to optimize agricultural processes.
- Efficient Resource Utilization: Reduces water, fertilizer, and pesticide wastage.
- Improved Crop Yield: Helps in predicting the best harvesting and growth stages.
- Real-Time Monitoring: IoT sensors and Power BI dashboards offer live tracking.
- Predictive Analysis: Uses historical data to improve future farming decisions.
- User-Friendly Interface: Simplifies complex data for farmers and stakeholders.

8.2 Disadvantages

- High Initial Cost: Requires investment in IoT devices and software setup.
- Technical Knowledge Required: Farmers need training to use Power BI effectively.
- Dependence on Internet Connectivity: Real-time data monitoring requires stable internet access.
- Data Security Concerns: Sensitive agricultural data might be vulnerable

to cyber threats.

- Model Accuracy Limitations: Predictions depend on data quality and external factors.
- Integration Challenges: Connecting different data sources can be complex and time-consuming.

CHAPTER 9: CONCLUSIONS

The Predicting Plant Growth Stages with Environmental and Management Data Using Power BI project demonstrates the power of data-driven decision-making in agriculture. By integrating IoT sensors, weather APIs, machine learning models, and Power BI dashboards, this system provides real-time insights, predictive analytics, and automated recommendations for farmers to enhance crop growth and yield.

Through real-time monitoring of environmental factors such as soil moisture, temperature, and humidity, the system predicts plant growth stages and provides actionable insights for irrigation, fertilization, and harvesting. Power BI dashboards visualize complex data in an easy-to-understand format, allowing farmers to make informed decisions that optimize resources and increase productivity.

The functional and performance testing of the system confirms its efficiency, reliability, and scalability. The user-friendly interface ensures accessibility for farmers, even those with minimal technical knowledge. Additionally, the integration of AI-driven analytics and cloud storage ensures the system remains adaptable to various crops, climatic conditions, and future technological advancements.

While the system offers numerous advantages, such as improved resource utilization, increased crop yield, and data-backed decision-making, challenges like sensor accuracy, connectivity issues in rural areas, and user adoption need continuous refinement. Future enhancements, including advanced AI models, mobile-friendly interfaces, and offline functionality, will further improve system efficiency.

In conclusion, this project provides a comprehensive, innovative, and scalable solution to modernize agriculture using technology and data analytics. By empowering farmers with actionable insights, it contributes to sustainable farming practices, increased food production, and enhanced economic growth.

CHAPTER 10: FUTURE SCOPE

The Predicting Plant Growth Stages with Environmental and Management Data Using Power BI project has significant potential for future advancements. As technology evolves, several enhancements can be integrated to improve accuracy, usability, scalability, and automation in agricultural decision-making.

1. Integration of Advanced AI and Machine Learning Models

- Future versions can leverage deep learning models to enhance the accuracy of growth stage predictions, disease detection, and yield estimation.
- Implementing computer vision with drones and satellite imagery can further monitor plant health and detect early signs of stress, pest infestations, or diseases.

2. Expansion to Different Crop Types and Farming Methods

- The system can be adapted to various crops, soil types, and climatic conditions, making it more versatile and applicable to global agriculture.
- Custom models can be developed for hydroponics, vertical farming, and precision agriculture.

3. Mobile App Development for Farmers

- Creating a user-friendly mobile app will enable farmers to access Power BI dashboards, receive alerts, and monitor crop growth stages anytime, anywhere.

- The app can support local languages for better adoption by farmers in rural areas.

4. IoT and Smart Farming Automation

- Future versions can include automated irrigation and fertilization systems based on AI recommendations.
- IoT-enabled smart greenhouses can be developed where environmental conditions are adjusted automatically based on predictive insights.

5. Blockchain for Secure Agricultural Data Management

- Implementing blockchain technology can ensure secure, transparent, and tamper-proof data storage for farmers, governments, and agricultural organizations.
- This will help track the entire crop lifecycle, ensuring food safety and quality control in the supply chain.

6. Real-time Collaboration with Agricultural Experts

- The system can be integrated with agricultural advisory platforms, allowing farmers to consult experts in real-time based on predictive insights.
- AI-powered chatbots can provide instant recommendations on best farming practices.

7. Offline Data Access for Rural Farmers

- Since internet connectivity is a challenge in many agricultural areas, an offline mode can allow farmers to store data locally and sync it with the cloud once they regain connectivity.

8. Government and Policy Integration

- The system can be extended to government agriculture departments to help formulate better policies, subsidies, and resource allocations based on real-time data.
- AI-driven insights can support climate resilience strategies for sustainable farming.

CHAPTER 11: APPENDIX

Source Code

Dataset Link:

https://www.kaggle.com/datasets/gororororororo23/plant-growth-data-classification/code

Prediction Dataset Link:

https://drive.google.com/file/d/1sbuABhv_3sv_IkqdBsHwJe3fqzwny5Q2/view?usp=sharing

Github & Project Demo Link:

https://github.com/Anmolagarwal16/EPBL-Project/tree/main/1.%20Assignment/Anmol

https://drive.google.com/file/d/1b0IuHEeN8vbXPiTFR_QHbXXdQV0bvKtF/view?usp=drive_link