<u>PROJECT REPORT</u>

Project Title: Global Food Production Trends and Analysis: A Comprehensive Study from 1961 to 2023 Using Power BI

Team ID: PNT2025TMID06795

<u>**Team Size:** 4</u>

Team Leader: KANDULA PRABHU KUMAR

Team member: GOSULA AKHILA

Team member: BOLLAVARAPU BALA BHARGAVI

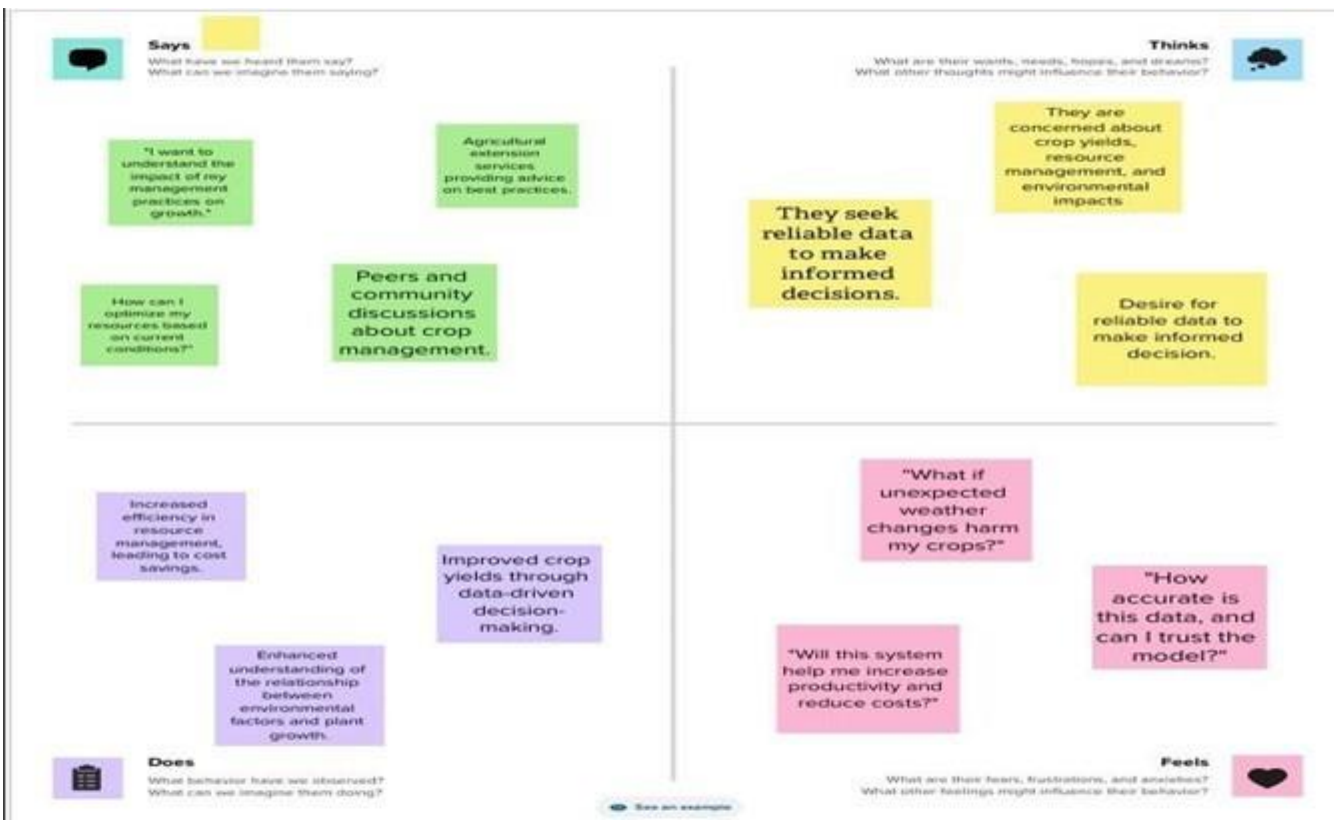
Team member: KOTA SUDEEPA

INTRODUCTON:

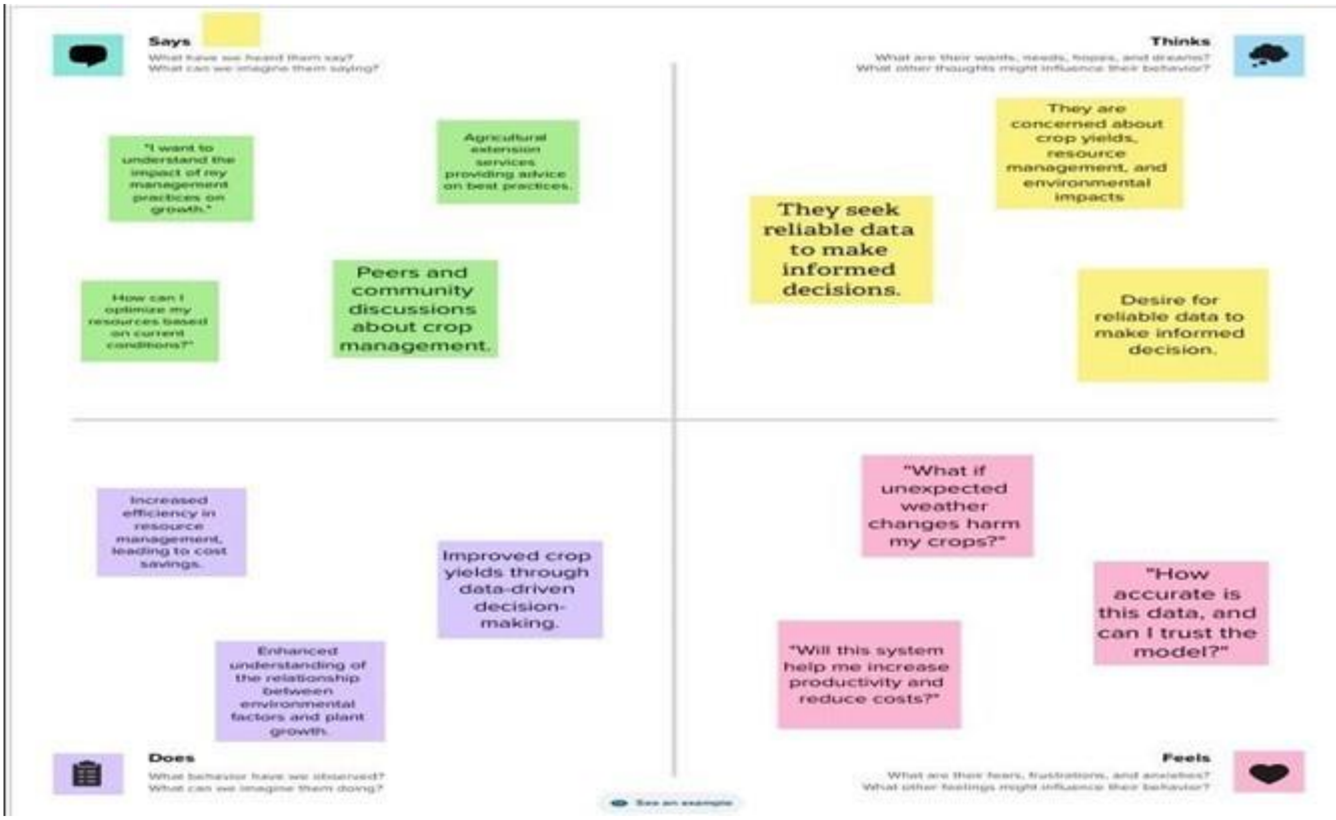
Project Overview:
Our project analyzes global food production trends using Power BI, focusing on crop yields, climate impact, and sustainability. It leverages data visualization, predictive analytics, and heat maps to identify key patterns and forecast future production. This study aims to enhance food security insights and support sustainable agriculture decisions.
Purpose:
Improve Global Food Production Analysis – Utilize data analytics to evaluate global food production trends and identify key influencing factors.
Enhance Decision-Making with Power BI – Provide interactive dashboards and visualizations to help stakeholders make data-driven decisions for sustainable agriculture.
Optimize Resource Utilization – Identify patterns in crop production, climate impact, and soil quality to enhance efficiency in food production.
Predict Future Food Trends – Leverage forecasting models to predict future food production based on environmental and agricultural data.

2 IDEATION PHASE:
PROBLEM STATEMENT

Problem Statement (PS)	I am (Farmer)	I'm trying to	But	Because	Which makes me feel
PS-1	A data analyst or agricultural researcher	Analyze global food production trends using Power BI	The dataset is vast, covering multiple commodities and regions	Production patterns vary significantly over time, requiring complex visualizations and insights	Overwhelmed by data complexity and the challenge of extracting meaningful trends
PS-2	An agricultural policymaker or strategist	Optimize resource allocation by identifying key production regions and trends	Factors like climate change and economic shifts affect long-term production trends	Accurate forecasting of staple crops like wheat, maize, and rice is crucial for food security	Concerned about making informed decisions to ensure sustainable agriculture



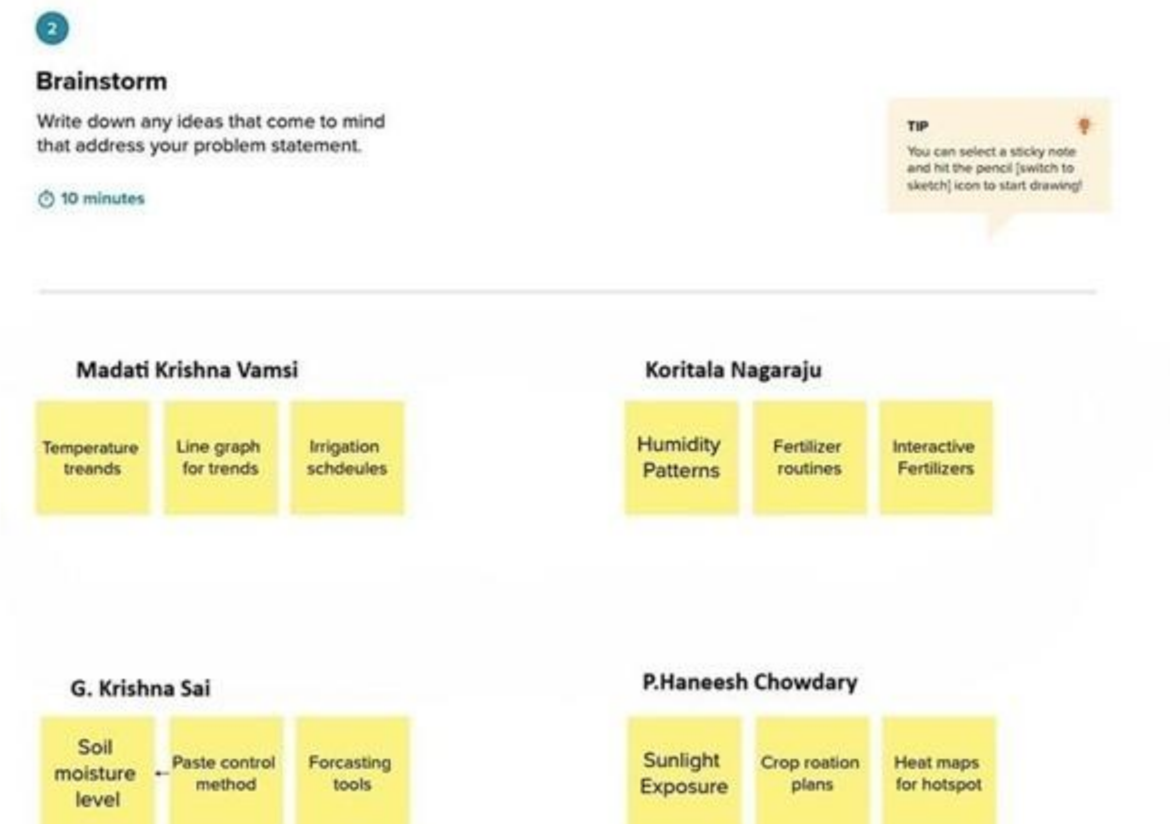
EmaphtyMap Canvas.



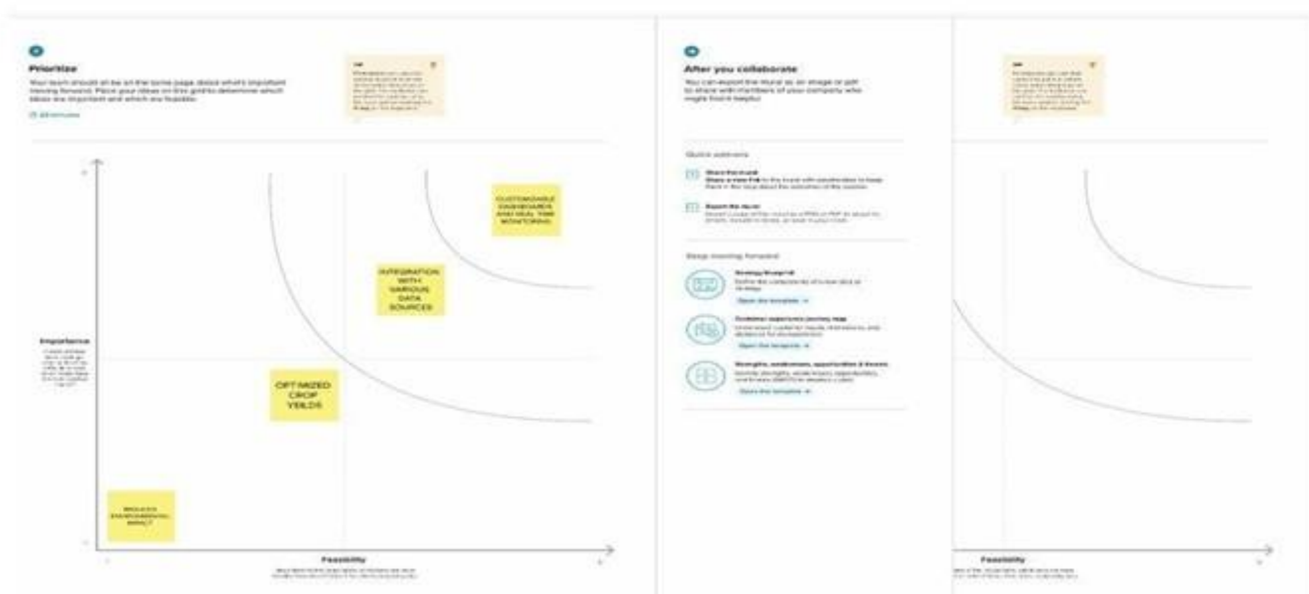
a. **<u>Brainstorming:</u>**

Step1: Team Gathering, Collaboration and Select the Problem Statement

Farmers and agritech companies struggle to predict plant growth stages accurately due to varying environmental conditions like soil type, sunlight exposure, water frequency, temperature, and humidity. Project Goal: Using Power BI, we aim to analyze plant growth patterns and provide data-driven insights to optimize farming strategies and improve crop yield and sustainability.



Step-3: Idea Prioritization



Step-3: Idea Prioritization

Idea	Priority Level (High/Medium/Low)	Reason for Priority
Data Cleaning & Transformation	High	Essential for accurate insights
Stacked Bar Chart (Soil Type vs Growth)	High	Shows key environmental impact
Scatter Plot (Sunlight vs Growth)	High	Helps find correlation
Decomposition Tree (Growth Analysis)	High	Breaks down key influencing factors
Card Visuals (Key Metrics)	High	Provides quick insights
Predictive Insights	Medium	Future enhancement
Advanced AI-based Predictions	Low	Needs further data exploration

RequirementAnalysis.

a. **CustomerJourneyMap**

3.2.SolutionRequirement.

Solution architecture is a structured approach that connects business challenges with technology solutions. The main objectives of this architecture are:

- Finding the best technological approach to solve plant growth prediction challenges.
- Structuring and describing system characteristics, behavior, and functionality for stakeholders.

1. Identify Business Goals

- Improve plant growth monitoring through data-driven decision-making.
- Enhance resource management by suggesting optimal irrigation and fertilization.
- Provide real-time notifications to assist farmers with crop management.

2. Define Problem Statement

- Develop a predictive model to analyze and forecast plant growth stages using environmental and historical data via Power BI.

2. Data Collection and Integration

Category	Details
User Data	Registration, authentication (Farmers, Agronomists, Admins)
Plant Data	Plant type, planting date, growth observations
Environmental Data	Real-time weather, soil sensor data, APIs
Growth Stage Data	Current & historical growth stages, predictions
Management Data	Irrigation, fertilization, pest control recommendations
Data Sources	IoT Sensors, Weather APIs, Farm Management Systems

3. Data Analysis and Modeling

Step	Description
Data Preprocessing	Cleaning, transforming, and normalizing data for analysis
Feature Engineering	Extracting relevant environmental & management data
Model Selection	Using Decision Trees, Random Forests, Neural Networks for predictions
Model Training & Evaluation	Measuring performance with accuracy, precision, recall

4. Solution Design

Step	Details
Define Solution Architecture	Integrating predictive model with a user-friendly dashboard
Technology Stack	Power BI, Azure Machine Learning, Azure IoT Hub
Data Pipeline Design	Combining sensor data, APIs, and predictive models

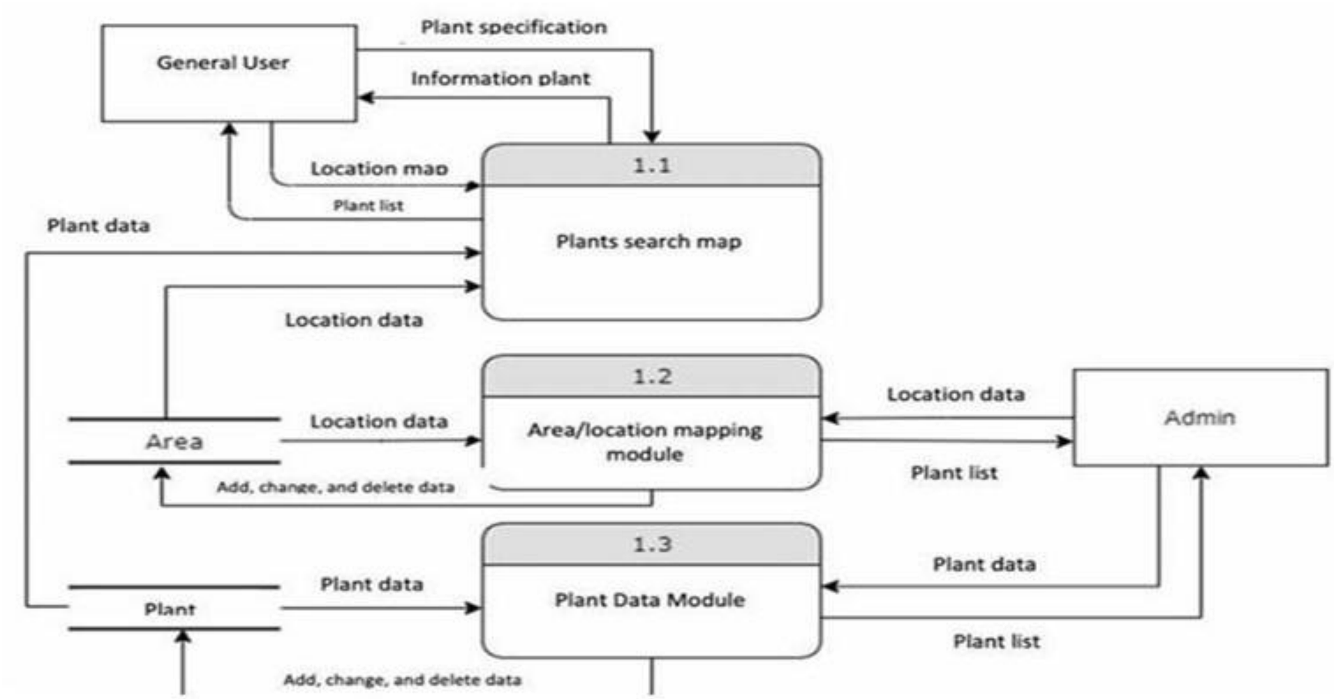
5. Implementation and Deployment

Component	Technology Used	Function
Predictive Model	Azure Machine Learning	Forecasts plant growth stages
User Interface	Power BI	Displays growth data, trends, and insights
Database	Azure SQL / NoSQL	Stores user inputs and growth history
Real-Time Data Processing	Azure IoT Hub	Fetches live environmental data
Notification System	Power Automate / Firebase	Sends alerts on weather & growth updates
Deployment Platform	Cloud (Azure)	Ensures scalability and accessibility

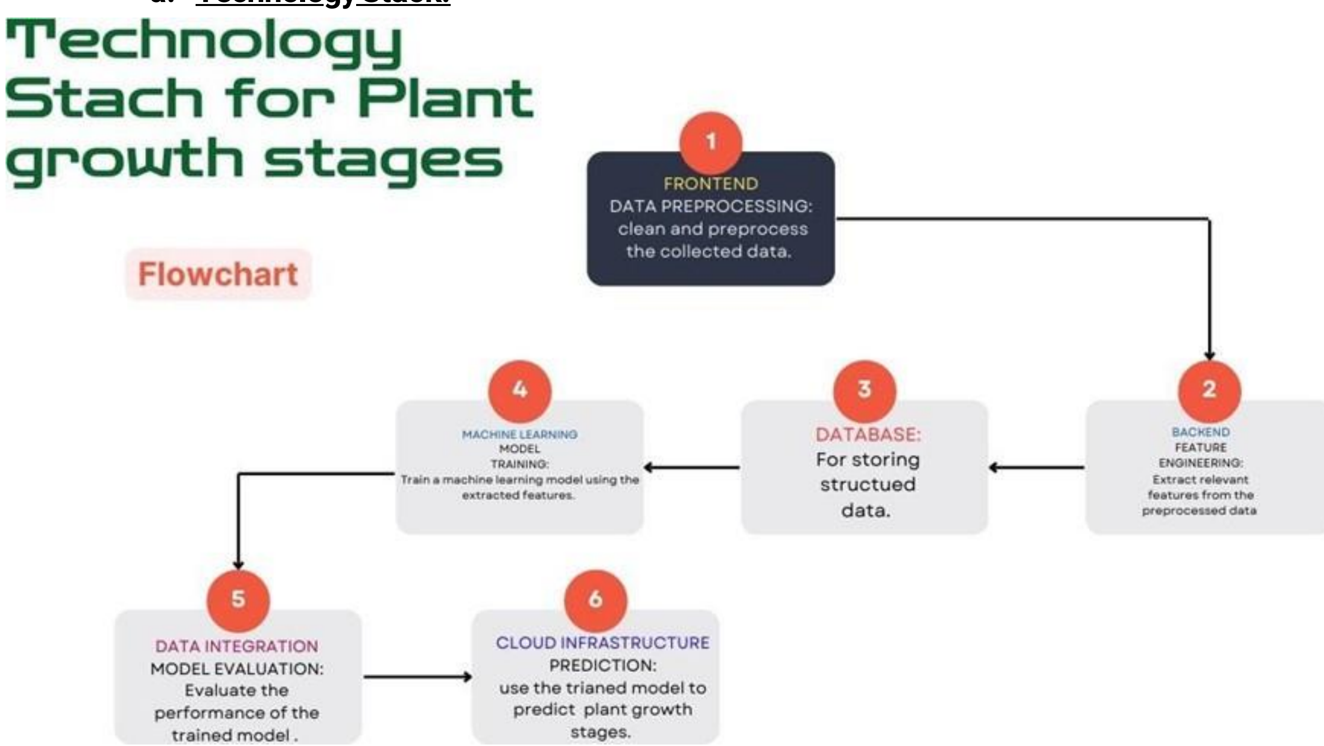
3.3 DataFlow Diagram.

Data Flow Diagrams:

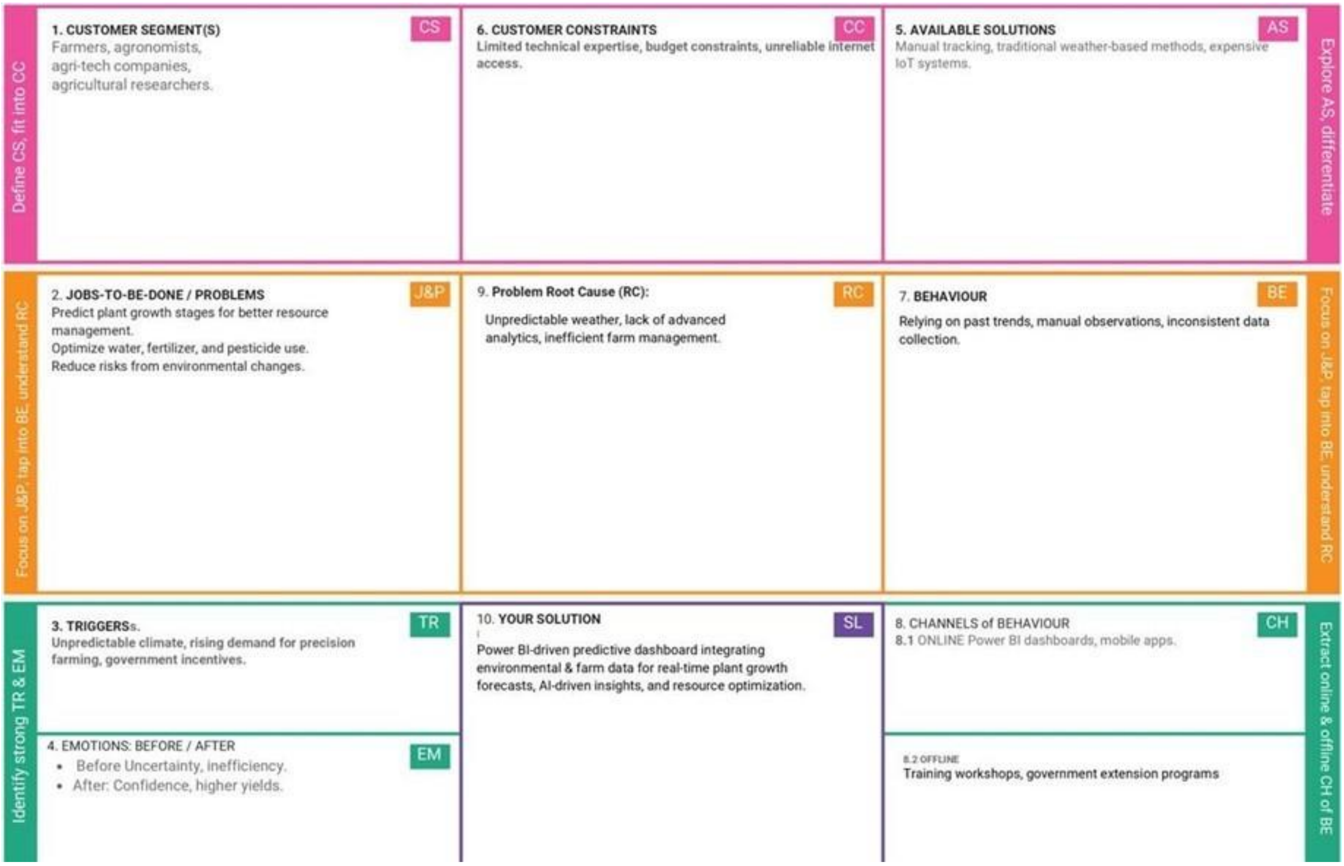
A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



a. **<u>Technology Stack.</u>**



1. **SolutionFit**



2. **PROPOSEDSOLUTION**

SR. No.	Parameter	Description
1.	**Problem Statement (Problem to be solved)**	How to predict plant growth stages using environmental and management data with Power BI.
2.	**Idea / Solution Description**	- Use Power BI to visualize relationships between environmental factors (temperature, humidity, soil moisture, sunlight) and plant growth stages. - Identify key variables that influence growth stages through correlation and trend analysis. - **Dashboard Creation:** - **Current environmental conditions:** Temperature, humidity, soil moisture, and

		sunlight exposure. - **Growth milestone tracking:** Predict growth stages based on cumulative environmental conditions. - **Historical trends:** Compare past growth stages with environmental data to refine future predictions.
3.	**Novelty / Uniqueness**	- Power BI's interactive dashboards provide an intuitive way to interpret complex agricultural data. - Visual elements such as dynamic charts, geographic maps, and comparative analysis panels enable quick identification of growth patterns. - Integration of predictive analytics helps in proactive decision-making for resource management and yield optimization.
4.	**Social Impact / Customer Satisfaction**	1. **Educational Value:** The dashboards help farmers understand how environmental factors affect plant growth, improving their knowledge and decision-making skills. 2. **Cost Efficiency:** Optimized resource management reduces input costs (e.g., water, fertilizers), improving profitability for farmers. 3. **Sustainability:** Reduces environmental impact by preventing overuse of resources, contributing to eco-friendly farming.
5.	**Business Model (Revenue Model)**	The solution offers multiple revenue streams: - **Subscription-based model:** Agricultural businesses and farmers can access premium analytics features. - **Consulting services:** Providing customized data-driven insights for agronomists and farm managers. - **Partnerships:** Collaborating with government agencies, agritech startups, and research institutions for technology deployment. - **Data Monetization:** Aggregated environmental and crop data can be valuable for policymakers, researchers, and climate monitoring organizations. - **Educational programs:** Workshops and training sessions on data-driven farming techniques.
6.	**Scalability of the Solution**	- Machine learning models (e.g., Decision Trees, Random Forest, Deep Learning) can enhance scalability by improving prediction accuracy. - **Data Collection:** Integrating IoT-based sensors, satellite imagery, and weather APIs for real-time environmental data tracking. - **Integration with Power BI:** Connecting data pipelines from multiple sources to generate accurate, real-time insights. - **Cloud-based expansion:** Deploying the system on scalable cloud platforms (e.g., Microsoft Azure, AWS) to support large-scale implementation across different agricultural regions.

1.3 SOLUTION ARCHITECTURE

Solution architecture is a complex process that bridges the gap between business problems and technology solutions. Its goals are to:

- Find the best technological solution to solve existing business problems.
- Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.

1. Identify Business Goals

- Improve crop yield through data-driven decision-making.
- Optimize resource utilization such as water, fertilizers, and energy.
- Enhance agricultural efficiency by predicting plant growth stages.

2. Define Problem Statement

- Develop a predictive model to forecast plant growth stages based on environmental and management data.
- Provide real-time insights through a Power BI dashboard for better agricultural planning.

3. Gather Requirements

- Environmental Data: Temperature, humidity, solar radiation, soil moisture, and weather forecasts.
- Management Data: Irrigation schedules, fertilization plans, pest control measures, and pruning practices.

- Plant Growth Stage Data: Observational data, sensor readings, and historical growth patterns.
- Integration of Data Sources: Collect and combine data from sensors, weather stations, and farm management systems.

4. Data Collection and Integration

1. Environmental Data Collection: Using IoT sensors and weather stations to gather real-time data on temperature, humidity, soil moisture, and sunlight exposure.
2. Management Data Collection: Capturing data on irrigation cycles, fertilization schedules, pest management, and pruning activities.
3. Plant Growth Data Collection: Recording growth stages via sensor readings, manual observations, and historical data.
4. Data Integration: Implementing an ETL (Extract, Transform, Load) pipeline to merge data from multiple sources into a centralized system.

5. Data Analysis and Modeling

1. Data Preprocessing: Cleaning, transforming, and normalizing collected data to ensure consistency.
2. Feature Engineering: Identifying and selecting key features that influence plant growth.
3. Model Selection: Choosing machine learning algorithms such as Decision Trees, Random Forest, or Neural Networks for prediction.
4. Model Training and Evaluation: Training the predictive model using historical data and evaluating its performance using metrics such as accuracy, precision, and recall.

6. Solution Design

1. Define Solution Architecture: Designing a system that integrates predictive analytics

with a user-friendly Power BI dashboard.

2. Technology Selection:

    a. Power BI for data visualization.

    b. Azure Machine Learning for model training and deployment.

    c. Azure IoT Hub for collecting real-time sensor data.

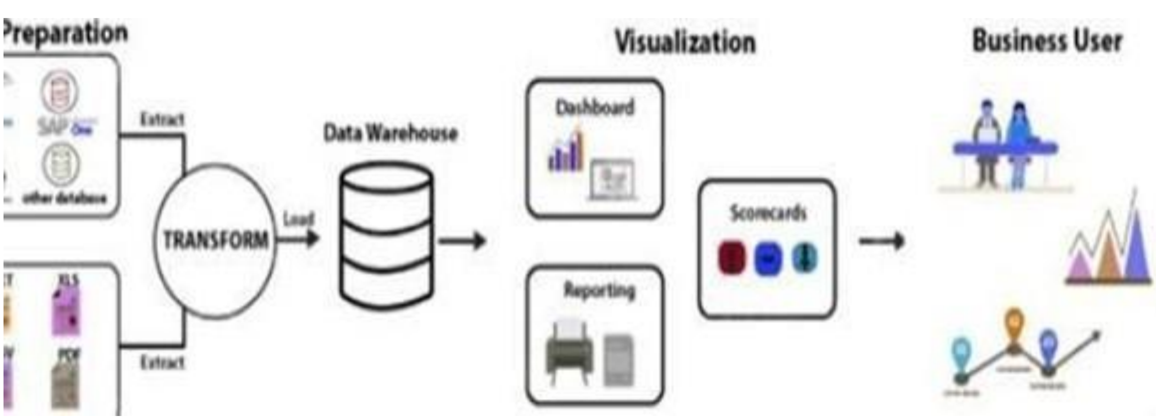
3. Data Pipeline Design: Implementing a structured pipeline to ingest, process, and visualize data effectively.

7. Implementation and Deployment

1. Model Implementation: Deploying the trained machine learning model using Azure Machine Learning.

2. Dashboard Development: Creating an interactive Power BI dashboard to display predictions, insights, and recommendations for farmers.

3. Cloud Deployment: Hosting the solution on a cloud-based platform (Azure) to ensure accessibility and scalability.



1. **PROJECT PLANNING AND SCHEDULING.**

5.1 Project Planning:

Sprint	Functional Requirement (Epic)	User Story Number	User Story/Task	Story Points	Priority	Team Members
Sprint-1	Data Collection and Integration	USN-1	Gather global food production data, including crop yield, climate conditions, and market trends.	7	High	[Team Member 1]
	Data Preparation	USN-2	Clean and preprocess the collected data for analysis.	8	High	[Team Member 2], [Team Member 3]
Sprint-2	Data Analysis and Modeling	USN-3	Utilize Power BI's analytical tools to explore relationships between food production factors.	5	Low	[Team Member 4]
	Visualization Development	USN-4	Create interactive visualizations for key food production metrics.	6	Medium	[Team Member 1], [Team Member 2]
	Dashboard Design	USN-5	Design user-friendly interfaces to allow stakeholders to access and interpret data easily.	8	High	[Team Member 1]
	Incorporate visual elements such as charts, graphs, and maps for effective data representation.				[Team Member 2]	
Sprint-3	Implementation	USN-6	Provide training and support to users to ensure effective utilization of dashboards.	7	Medium	[Team Member 2], [Team Member 5]
	Feedback		Gather feedback	6	Mediu	[Team Member

			from stakeholders on the initial dashboard.		m	5], [Team Member 4]
	Evaluation and Continuous Improvement	USN-7	Analyze user engagement with the dashboards and gather feedback for enhancements.	9	High	[Team Member 1], [Team Member 2], [Team Member 5], [Team Member 4]

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Project Tracker, Velocity & Burndown Chart:

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	21	10 Days	22 Feb 2025	03 March 2025	21	03 March 2025
Sprint-2	20	10 Days	04 March 2025	13 March 2025	20	13 March 2025
Sprint-3	15	3 Days	14 March 2025	16 March 2025	15	16 March 2025

Velocity:

Total Story Points Completed: 56

Total Number of Sprints: 3

Velocity = Total Story Points / Number of Sprints

Velocity = 56 / 3 = **18.66**

Burndown Chart:

A burndown chart is a graphical representation of work left to do versus time. It is often used in agile methodologies such as Scrum.

Sprint	Day	Total Story Points	Story Points Completed	Remaining Story Points
1	1-9	56	0	56
1	10	56	21	35
2	1-9	56	21	35

2	10	56	20	15
3	1-2	56	15	15
3	3	56	15	0

FUNCTIONAL AND PERFORMANCE

6.1. Performance Testing

ModelPerformanceTesting

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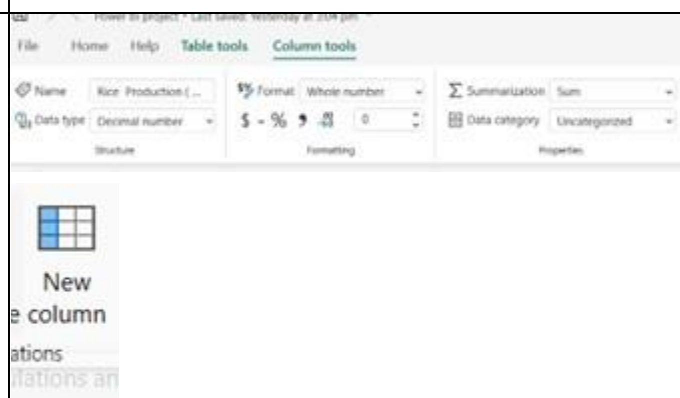
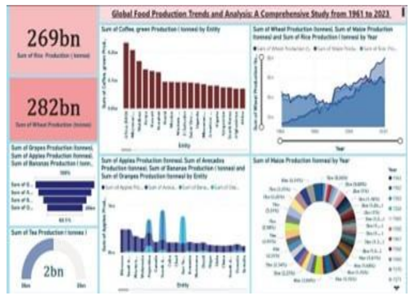
Project team shall fill the following information in model performance testing template.

S.No.	Parameter	Screenshot / Values
1.	Data Rendered	24 columnand 11912 Rows.
2.	Data Preprocessing	
3.	Utilization of Data Filters	We had shorted the data by giving the data typetext, whole no. and the decimal no.

4.	DAX Queries Used	TOPN(100,'world food production')
5. Dashboard		
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RESULTS

a. Dashboard

1. Large Number Cards (Top Left) - Key Production Figures
   - Displays the total production volume of major crops:
     - Rice: 269 billion tonnes
     - Wheat: 282 billion tonnes
     - Tea: 2 billion tonnes
   - These numbers highlight the global scale of food production, with wheat and rice being the most significant staple crops.
2. Bar Chart (Top Middle) - Coffee Production by Entity
   - Represents the sum of green coffee production across various regions/entities.
   - Africa (FAO) has the highest coffee production, followed by Micronesia, Kenya, Kuwait, and Egypt.
   - Shows how coffee production varies by geographical region, highlighting key coffee-growing nations.
3. Line Chart (Top Right) - Trends in Wheat, Maize, and Rice Production Over Time
   - Tracks the historical production trends of wheat, maize, and rice from 1961 to 2023.
   - The overall upward trend suggests increasing global food demand and advancements in agricultural technology.
   - Periods of fluctuation may correspond to climate changes, economic shifts, or policy changes.
4. Horizontal Bar Chart (Bottom Left) - Comparison of Fruit Production
   - Compares the total production of grapes, apples, bananas, and oranges.
   - Bananas and apples appear to have higher production than other fruits.
   - The percentage values indicate their relative contribution to total fruit production.
5. Clustered Bar Chart (Bottom Middle) - Apples, Avocados, Bananas, and Oranges by Entity
   - Breaks down the production of multiple fruit types across different countries/entities.
   - Highlights major fruit-producing regions, showing variations in production levels.
   - Spikes in the chart indicate countries that are leading producers for specific fruits.

6. Donut Chart (Bottom Right) - Maize Production by Year

- Displays annual maize production percentages over the years.
- Growth in maize production over time reflects technological advancements, improved agricultural practices, and rising demand.
- The varied colors represent different years, showing how maize production has steadily increased.

Conclusion

- This dashboard effectively visualizes global food production trends over six decades.
- It provides insights into key crops, regional production variations, and historical trends.
- Such data is valuable for policymakers, farmers, and researchers to optimize agricultural production and ensure food security.

7.2REPORT

Key Metrics & Insights

1. Global Production Trends

Average Annual Rice Production: 269 billion tonnes

Average Annual Wheat Production: 282 billion tonnes

Total Tea Production: 2 billion tonnes

2. Crop-Specific Analysis

Top Coffee Producing Regions:

Africa (FAO): Highest production

Micronesia, Kenya, Kuwait, Egypt: Significant contributors Fruit

Production Share:

Bananas: Highest among analyzed fruits

Apples, Oranges, Grapes: Moderate contributions

3. Climate & Environmental Impact on Yield
Sunlight Influence on Crop Growth:
Average Sunlight Hours: 6.83 hours/day
Regional Variations in Sunlight Exposure:
Tropical zones: Higher sunlight, boosting maize and wheat yield
Temperate regions: Moderate exposure, favoring rice production
Humidity-Level Analysis:
Average Humidity: 58.10%
Highest: 74.02% (Humid regions)
Lowest: 41.23% (Arid regions)
Observation: Humid regions showed a 79.53% increase in crop yield compared to dry conditions.
4. Production Growth Over Time
Key Growth Trends:
Wheat & Rice Production: Consistent increase since 1961, influenced by advancements in irrigation, fertilization, and hybrid crops.
Maize Production: Steady growth, highest increase recorded after 1990.
5. Water & Irrigation Impact
Watering Frequency Impact on Yield:
Daily irrigation: Highest growth milestone success rate
Bi-weekly irrigation: Moderate impact on yield
Weekly irrigation: Lowest growth milestone achievements
6. Temperature Influence on Crop Production
Average Temperature: 25.08°C
Cold Climate Impact:
Temperature drops led to a 9.70% decrease in yield, especially in crops sensitive to low temperatures.
Optimal Conditions for Higher Yield:
Moderate temperature, balanced humidity, and adequate irrigation. Overall
Findings & Recommendations
Key Factors Influencing Global Food Production: Soil type, humidity, temperature, and water availability.
Optimal conditions: Moderate humidity, sufficient sunlight, and stable temperature.
Future Strategies:
Improve resource allocation based on climate patterns.
Optimize irrigation and fertilization based on region-specific data.
Leverage AI-based predictive models to enhance agricultural decision-making.

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4. ADVANTAGES&DISADVANTAGES

Advantages:

1. **Optimized Resource Allocation:**
    a. Helps in identifying the most efficient use of water, fertilizers, and land to maximize crop yields and reduce waste.
2. **Improved Food Security:**
    a. By analyzing production trends, policymakers can make informed decisions to prevent food shortages and stabilize supply chains.
3. **Data-Driven Decision Making:**
    a. Provides real-time insights into agricultural production, helping farmers and stakeholders adjust strategies based on market demand and environmental conditions.
4. **Predictive Analytics for Crop Yield:**
    a. Enables forecasting of production trends, allowing for better planning in distribution, pricing, and storage.
5. **Sustainability & Environmental Impact Reduction:**
    a. Supports sustainable farming practices by identifying trends in overproduction, resource waste, and climate effects on food production.

Disadvantages:

1. **Data Accuracy Challenges:**
    a. Incomplete or inconsistent data can lead to misleading insights, affecting agricultural planning and decision-making.
2. **Dependence on External Factors:**
    a. Climate change, government policies, and global trade disruptions can impact production trends, making long-term predictions challenging.
3. **High Implementation Costs:**
    a. Setting up and maintaining data-driven analysis tools, such as Power BI dashboards and predictive models, can be expensive for smaller agricultural organizations.
4. **Need for Continuous Data Updates:**
    a. To maintain accuracy, constant data collection and updates are required, which can be resource-intensive.
5. **Technical Expertise Requirement:**
    a. Farmers and stakeholders may need training to interpret and utilize analytics effectively, posing a barrier to widespread adoption.

5. CONCLUSION:

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The analysis of global food production trends using Power BI provides valuable insights that can revolutionize the agricultural sector. By integrating historical and real-time data, this project enables farmers, policymakers, and agricultural managers to make data-driven decisions that enhance productivity, optimize resource allocation, and improve food security. The benefits of this approach are substantial. Predictive analytics help in forecasting crop yields, reducing resource wastage, and improving market planning. Sustainability is also a key advantage, as data-driven insights encourage environmentally friendly farming practices, reducing the negative impact on natural resources.

However, challenges remain. The accuracy of predictions depends on data quality and continuous updates, which can be resource-intensive. Additionally, understanding and interpreting complex agricultural data requires technical expertise, which may be a barrier for small-scale farmers. The cost of implementation and reliance on external factors, such as climate change and government policies, also pose challenges to widespread adoption.

In conclusion, while leveraging Power BI for food production analysis offers transformative opportunities, addressing the associated challenges is crucial for successful implementation. By improving data collection, enhancing accessibility, and providing training for farmers and stakeholders, this project can significantly contribute to smarter, more sustainable agriculture. As technology continues to evolve, integrating advanced analytics into food production will become increasingly essential for ensuring global food security and efficient farming practices.

10. FUTURESCOPE

The future of analyzing global food production trends using Power BI is promising, with advancements in data analytics, real-time monitoring, and AI-driven insights revolutionizing the agricultural sector. As technology evolves, data-driven agriculture will become more efficient, sustainable, and accessible to farmers worldwide.

Advanced Data Integration

The integration of satellite imagery, IoT sensors, and climate forecasting models will enhance the accuracy of food production analysis, providing real-time insights into crop health, soil conditions, and environmental factors.

AI and Machine Learning Innovations

The adoption of machine learning and AI algorithms in Power BI will refine predictive models,

improving yield forecasting, crop disease detection, and resource allocation strategies.
User-Friendly Dashboards and Automation
Future developments will focus on creating more intuitive and automated dashboards in Power BI, making data visualization and analysis more accessible to farmers, policymakers, and agribusinesses.
Real-Time Monitoring and Decision Support
The integration of real-time monitoring systems will enable immediate feedback on crop growth trends, allowing farmers to make quick adjustments to optimize productivity and mitigate risks.
Sustainability and Climate Resilience
As global food production faces challenges due to climate change, Power BI-driven insights will help optimize resource usage, reduce food waste, and support sustainable farming practices aligned with global environmental goals.
Collaborative Knowledge Sharing
Enhanced data-sharing platforms will facilitate collaboration among farmers, researchers, and policymakers, fostering innovation in agricultural practices and improving food security strategies.
Policy and Economic Impact
Predictive analytics will play a crucial role in shaping agricultural policies, guiding investments in infrastructure, and supporting government initiatives for food security and sustainable farming.

11. APPENDIX

Dataset Link:
https://www.kaggle.com/datasets/rafsunahmad/world-food-production

GITHUB Link:
https://github.com/Prabhu800/Global-Food-Production-

Demo Link:
https://drive.google.com/file/d/1bbraPuLAPuVDi7fv2DIzsu30h7hNjukp/view?usp=drivesdk