A Project Report On

Global Food Production Trends and Analysis

A Comprehensive Study From (1961-2023) Using Power BI

Submitted for fulfilment of Experiential Project Based Learning(EPBL)

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Chapter 1: INTRODUCTION

1.1 Project Overview

The Global Food Production Trends and Analysis (1961–2023) Using Power BI is a data visualization project designed to analyze historical trends, regional variations, and key factors influencing global food production. By leveraging Power BI, the project will transform raw data into interactive dashboards and insights, helping stakeholders understand production patterns, identify challenges, and forecast future trends.

1.2 Purpose

1. **Analyze Long-Term Trends** – Examine food production patternsacross different regions and categories from 1961 to 2023.
2. **Identify Leading Producers** – Determine the top food-producingcountries and their contributions to global supply.
3. **Explore Crop and Livestock Growth** – Study production changes inmajor food categories, including cereals, vegetables, fruits, dairy, and meat.
4. **Impact Assessment** – Assess the impact of climate change,population growth, and policies on food production.
5. **Data Visualization** – Leverage Power BI to create interactivedashboards for effective data representation and analysis.

Chapter 2: IDEATION PHASE

2.1 Problem Statement

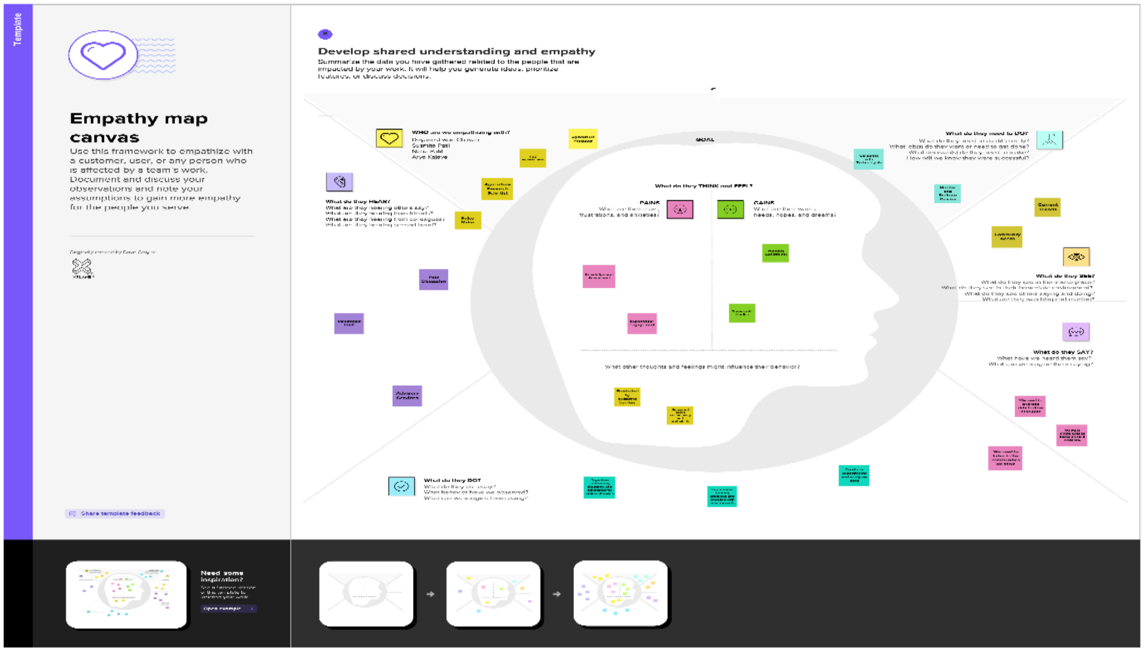
Global food production has undergone significant transformations from 1961 to 2023 due to factors such as population growth, climate change, technological advancements, and policy changes. However, understanding these complex trends and their implications is challenging due to the vast and fragmented nature of agricultural data.

Despite the availability of food production data, stakeholders—including policymakers, researchers, and agribusinesses—struggle to derive meaningful insights due to:

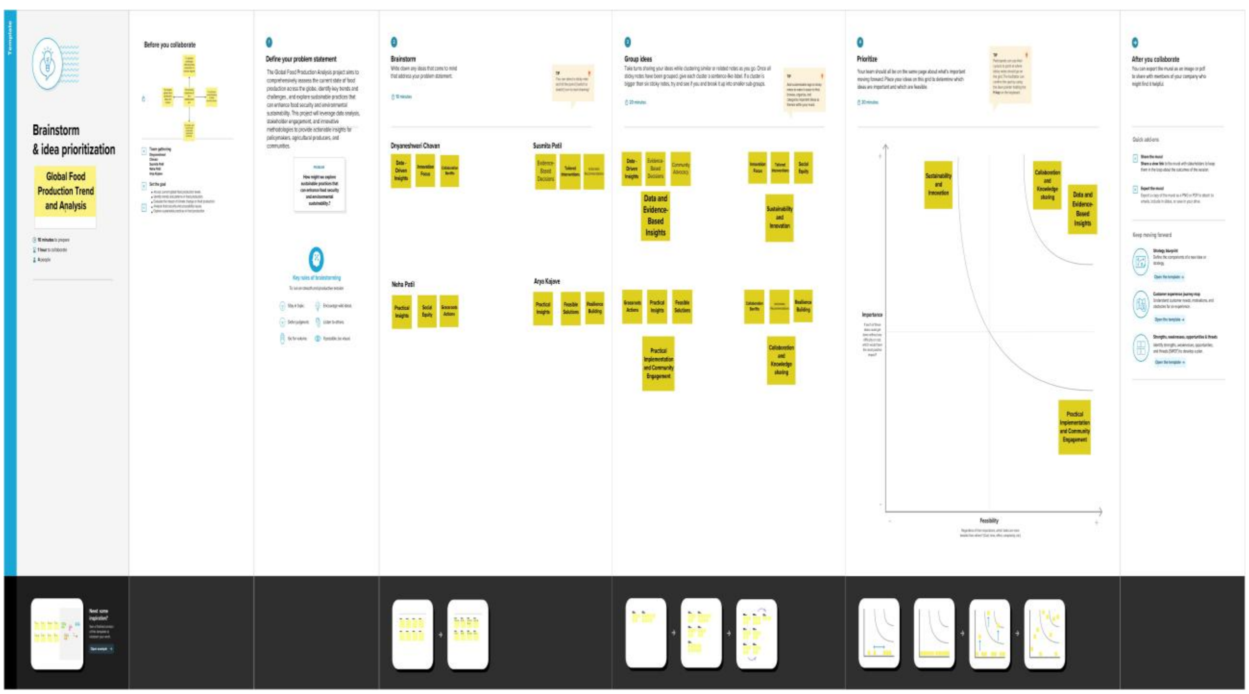
Data Overload & Complexity: Large datasets spanning multiple decades and regions are difficult to analyze manually.

Lack of Clear Trends & Patterns: Identifying production shifts, regional disparities, and emerging risks requires advanced analytical tools.

2.2 Empathy Map Canvas



Brainstorming:



Chapter 3: REQUIREMENT ANALYSIS

3.1 Customer Journey Map :

3.1 Solution Requirement

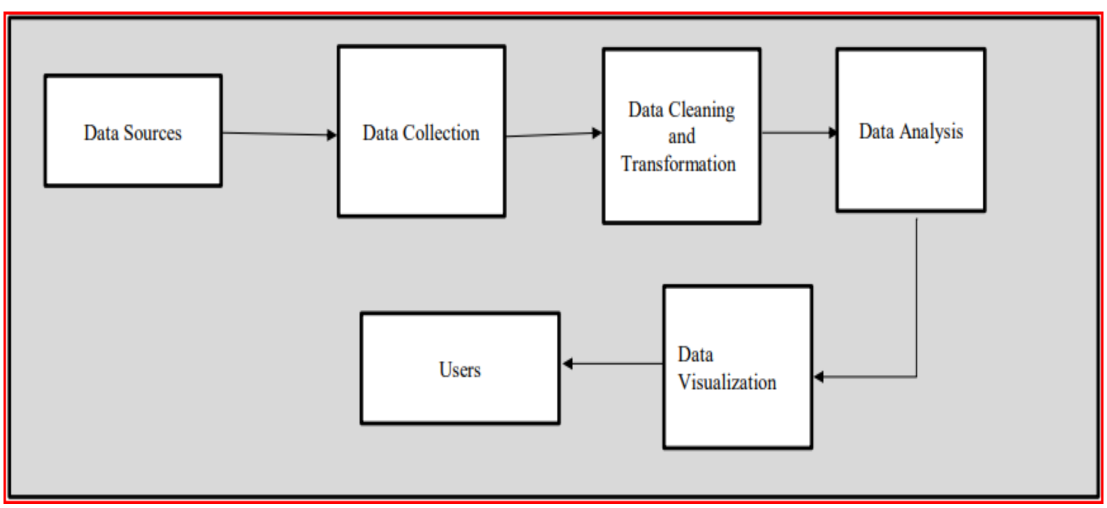
3.1.1 Functional Requirements

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Data Ingestion & Processing	Ability to import data from multiple sources (FAO, World Bank, USDA, climate databases).
		Automated data cleaning, transformation, and integration.
		Support for structured (CSV, Excel, SQL) and unstructured (API, web scraping) data sources.
FR-2	Data Modeling & Storage	Design an optimized data model for efficient querying and analysis
		Establish relationships between datasets (e.g., linking food production to climate and population data).
		Implement data aggregation for trend analysis at yearly, decade-wise, and country levels.
FR-3	Power BI Report Creation	Design interactive dashboards for food production trends
		Create visualizations for staple crops (rice, wheat, maize)
		Develop regional comparison charts for fruit production
FR-4	Insights C Decision Support	Identify key trends in food security C production growth
		Provide data-driven recommendations for stakeholders
		Enable export of reports for business C policy use

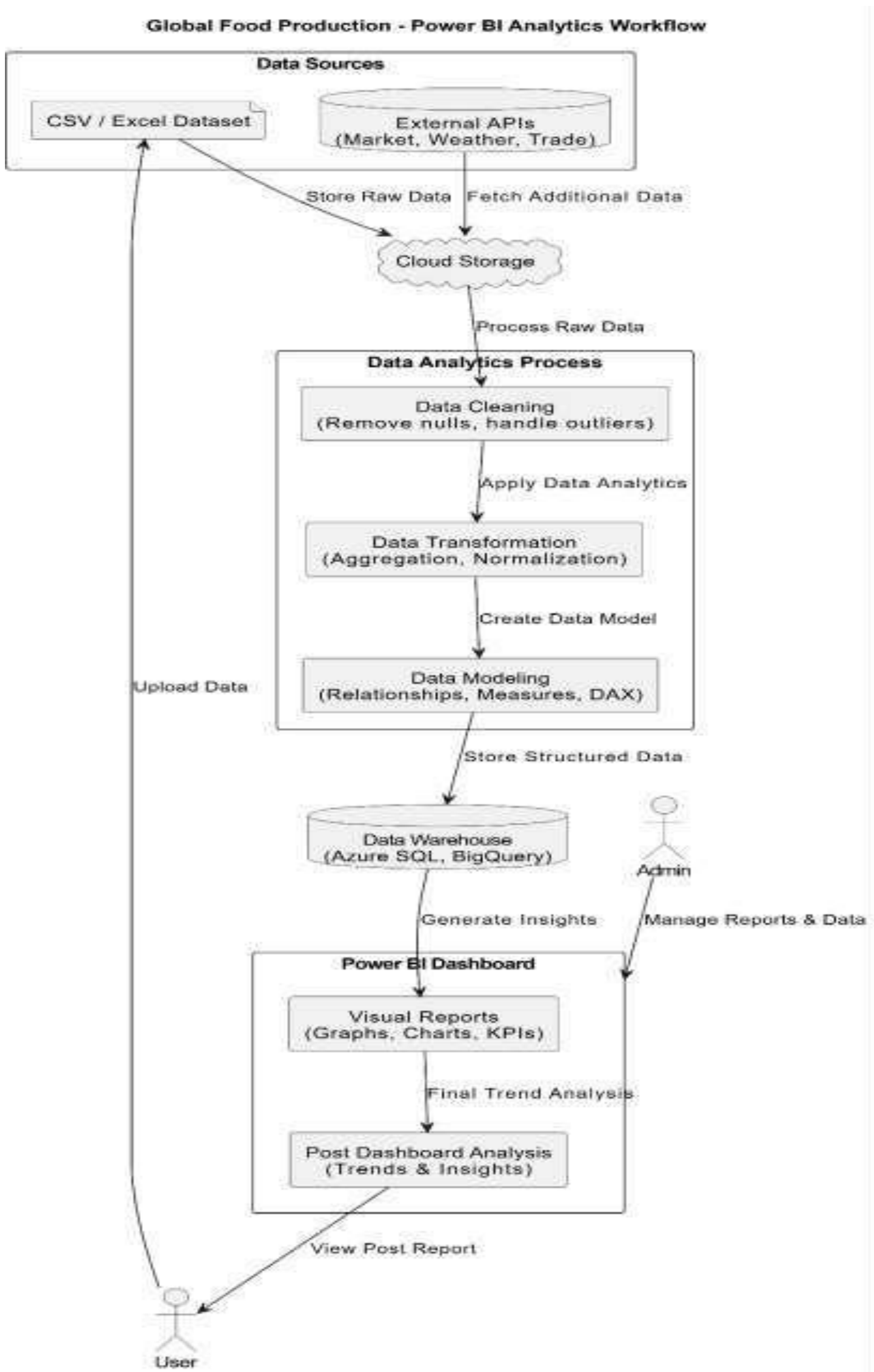
3.1.2 Non-Functional Requirements

FR No.	Non-Functional Requirement	Description
NFR-1	Performance & Scalability	Efficient handling of large datasets spanning over 60 years.
		Quick loading and responsiveness for real-time analysis.
NFR-2	User Experience & Accessibility	Intuitive and user-friendly design with easy navigation.
		Mobile-friendly dashboards for remote access.
		Multi-language support for global users.
NFR-3	Security & Data Governance	Role-based access control for different users (analysts, policymakers, researchers).
		Compliance with data privacy standards (GDPR, FAO guidelines).
		Secure cloud or on-premise data storage solutions.
NFR-4	Integration & Extensibility:	Compatibility with other BI tools and enterprise systems.
		API integration for real-time data updates.

3.1 Data Flow Diagram



3.2 Technology Stack



Chapter 4: PROJECT DESIGN

4.1 Problem-Solution Fit

The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer'sproblem. It helps entrepreneurs, marketers and corporate innovators identify behavioralpatterns and recognize what would work and why

PURPOSE :

- Solve complex problems in away that fitsthe state of your customers.
- Succeed faster and increase your solution adoption by tapping into existing mediums and channels of behavior
- Sharpen your communication and marketing strategy with the right triggers and messaging.
- Increase touch-points with your company by find ingtheright problem-behavi or fit and building trust by solving frequent annoyances, or urgent or costly problems.

4.2 Proposed Solution :

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	There was a lack of detailed analysis of global food production trends, which is crucial for agricultural decision-making and food security.
2.	Idea / Solution description	Using Power BI, food production data from 1961 to 2023 was analysed, focusing on key commodities such as rice, wheat, maize, coffee, tea, and various fruits like apples, bananas, and grapes. The study provides interactive visualizations to track trends and regional contributions.
3.	Novelty / Uniqueness	This study uniquely leverages Power BI to visualize long-term trends and regional contributions, offering real-time insights and comparative analysis for better decision-making.
4.	Social Impact / Customer Satisfaction	The analysis benefits agricultural decision-makers, policymakers, and farmers by providing **data-driven insights** that can help improve foodsecurity and promote sustainable production practices.
5.	Business Model (Revenue Model)	This data analytics solution can be monetized through **subscription-based services**, consultancy for agricultural firms, or by providing insights to policymakers and research institutions.
6.	Scalability of the Solution	The solution can be scaled by integrating **more agricultural commodities**, real-time data updates

4.3 Proposed Solution :

Solution architecture is a complex process – with many sub-processes – that bridgesthe gap between business problems and technology solutions. Its goals are to:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behaviour, and other aspects of thesoftware to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed, anddelivered.

Architecture Overview:

The project leverages Power BI for data visualization and analytics to study globalfood production trends from 1961 to 2023. The architecture consists of:

1. Data Sources:
    - FAO and other global food production datasets (CSV, Excel, SQLdatabases)
    - Public APIs for agricultural production statistics
    - Historical datasets manually processed for trend analysis
2. Data Processing & Transformation:
    - Data cleaning and transformation using **Power Query** in Power BI
    - Creating relationships between various datasets (commodities,regions, years)
    - Aggregating data for insightful reporting
3. Data Modeling & Storage:
    - Data is structured and stored in **Power BI's in-memory model**
    - Measures and calculated columns created using **DAX (Data AnalysisExpressions)**
4. Visualization & Reporting Layer:
    - Power BI Dashboards & Reports featuring:
        - Gauge Charts (Tea production analysis)
        - Bar & Stacked Charts (Fruit & coffee production comparison)
        - Area Charts (Trends of wheat, maize, and rice over time)
        - Donut Charts (Maize production distribution)
    - Interactive filtering by year, region, and commodity

    Deployment & Accessibility:

    - Hosted on **Power BI Service** for real-time data access
    - Reports shared via **Power BI Embedded & Power BI Mobile** for accessibility
5. Scalability & Future Enhancements:
    - Integration with real-time data sources via **APIs**
    - Expansion to include more agricultural commodities and regional insights

Example - Solution Architecture Diagram:

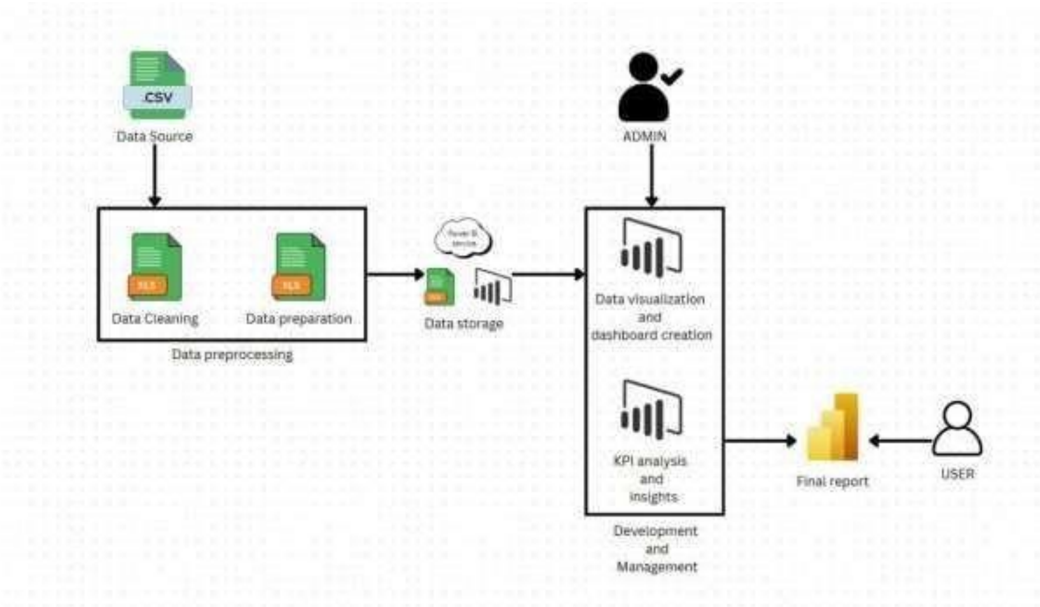


Figure 1: Architecture and data flow of the Global food production analysis system

1) Data Source:

- Import datasets from CSV files (WHO, UNICEF, World Bank).

2) Data Cleaning & Processing:

- Handle missing values and normalize data using Power Query in Power BI.
- Create calculated fields (Malnutrition Rate %, Country Rankings).

3) Data Storage:

- Store processed data in Power BI's data model for optimized querying.

4) Visualization & User Interaction:

- Display charts, KPIs, and tables for analysis.
- Allow users to interact via filters, slicers, and drill-down option.

Report Generation:

- Export insights in PDF, CSV, or Excel formats for further use.

Chapter 5: PROJECT PLANNING & SCHEDULING

5.1 Project Planning:

Product Backlog, Sprint Schedule, and Estimation:

Sprint	Functional Requirement(Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Data Collection	USN-1	Identify and gather data sources for food production.	5	High	Dnyaneshwari Chavan
	Data Preparation	USN-2	Clean and preprocess collected data for analysis.	8	High	Susmita Patil
	Dashboard Design	USN-3	Create wireframes for PowerBI dashboard layout.	3		Neha Patil
		USN-4	Define key metrics and visualizations for thedashboard.	5	High	Arya Kajave Susmita Patil
Sprint-2	Data Modeling	USN-5	Build data models in PowerBI to connect data sources.	8	High	Neha Patil
	Visualization Development	USN-6	Create interactive visualizations for keymetrics.	8	High	Dnyaneshwari Chavan Neha Patil
	Testing	USN-7	Conduct testing of dashboard functionality andaccuracy.	5	Medium	Dnyaneshwari Chavan
	Feedback Collection	USN-8	Gather feedback from stakeholders on initial dashboard.	3	Medium	Neha Patil
Sprint-3	Training and Documentation	USN-9	Develop training materialsfor stakeholders.	5	High	Susmita Patil
		USN-10	Conduct training sessions for users on Power BI dashboard.	5	High	Arya Kajave
	Launch	USN-11	Officially launch the PowerBI dashboard.	3	High	Dnyaneshwari Chavan Susmita Patil

						Neha Patil Arya Kajave
	Evaluation	USN-12	Evaluate dashboard effectiveness and gather further feedback.	5	Medi um	Dnyaneshwari Chavan Susmita Patil Neha Patil Arya Kajave

<u>Project Tracker, Velocity & Burndown Chart:</u>

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date(Planned)	Story Points Completed (ason Planned End Date)	Sprint ReleaseDate (Actual)
Sprint-1	21	10 Days	20 Feb 2025	01 March 2025	21	01 March 2025
Sprint-2	20	10 Days	02 March 2025	11 March 2025	21	11 March 2025
Sprint-3	17	2 Days	12 March 2025	13 March 2025	13	13 March 2025

<u>Velocity:</u>

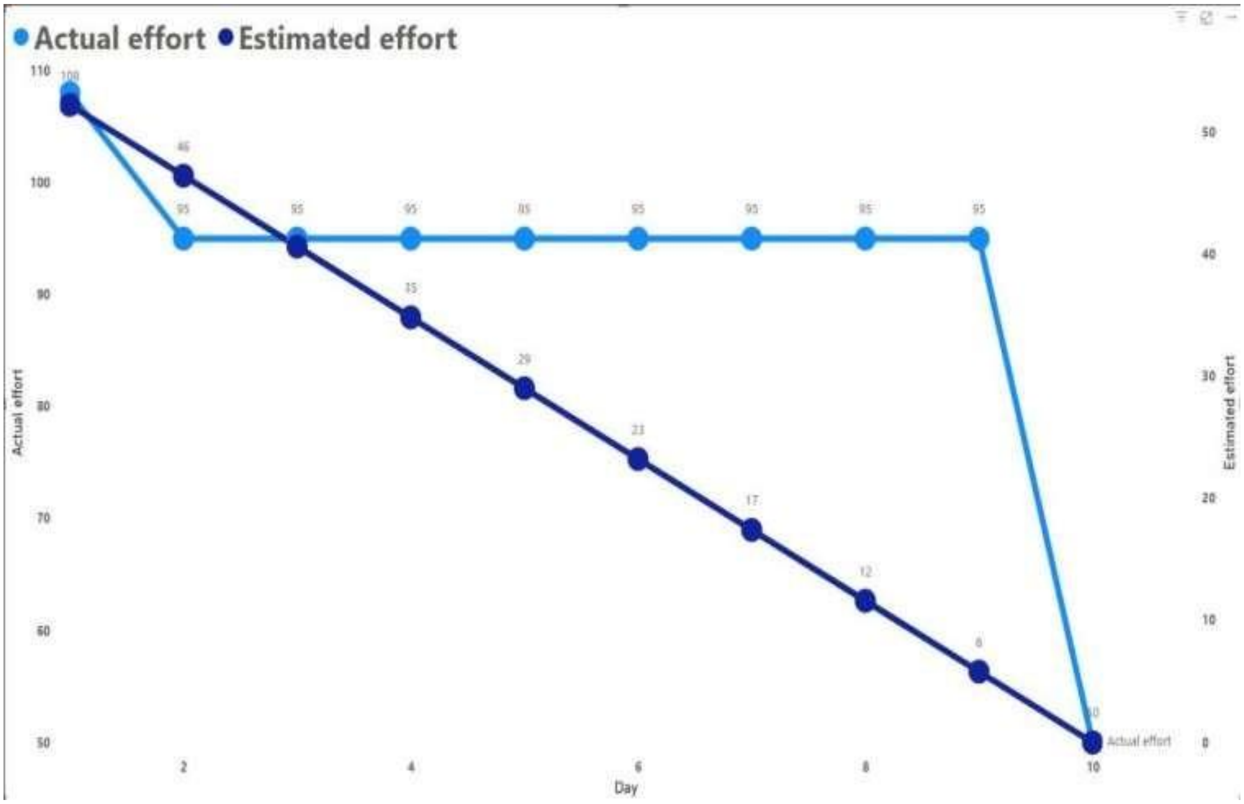
Total Story Points Completed: 58

Total Number of Sprints = 3
Velocity = Total Story Points Completed / Number of Sprints
Velocity = 58 / 3 ≈ 19.33

Burndown Chart:

A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress overtime.

Sprint	Day	Total Story Points	Story Points completed	Remaining Story Points
1	1	58	0	58
	2	58	0	58
	3	58	0	58
	4	58	0	58
	5	58	0	58
	6	58	0	58
	7	58	0	58
	8	58	0	58
	9	58	0	58
	10	58	21	37
2	1	58	21	37
	2	58	21	37
	3	58	21	37
	4	58	21	37
	5	58	21	37
	6	58	21	37
	7	58	21	37
	8	58	21	37
	9	58	21	37
	10	58	45	13
3	1	58	45	13
	2	58	58	0



Chapter 6: FUNCTIONAL AND PERFORMANCE TESTING

The Functional and Performance Testing phase ensures that the Power BI Global Food Production Dashboard meets the required performance, accuracy, and usability. This section evaluates the system's ability to handle large datasets, execute DAX queries efficiently, and provide a seamless user experience.

6.1Performance Testing

Performance testing was conducted to assess data rendering, preprocessing, filtering, query execution, dashboard responsiveness, and report generation.

Model Performance Testing Summary

S.No.	Parameter	Details
1	Data Rendered	Tables Used: Country-wise-average Table (Columns: 11, Rows: 140) Malnutrition-estimates Table (Columns: 20, Rows: 923)
2	Data Preprocessing	Replaced errors in Survey Sample column with 0. Changed data types for Severe Wasting, Underweight, Overweight, Wasting, Stunting, U5 Population in both tables. Removed null values to improve consistency.
3	Utilization of Data Filters	Filters Used: - Top 10filter in Line Chart. - Top 5filter in Clustered Bar Chart.
4	DAX Queries Used	Aggregations & Measures: - Avg_Stunting = AVERAGE('malnutrition-estimates'[Stunting]) - Total_U5_Population = SUM('malnutrition-estimates'[U5
5	Dashboard Design	Population ('000s)]) - YoY_Stunting_Change = VAR PrevYear = CALCULATE(AVERAGE('malnutrition-estimates'[Stunting]), PREVIOUSYEAR('malnutrition-estimates'[Year])) RETURN AVERAGE('malnutrition-estimates'[Stunting]) - PrevYear - Malnutrition_Severity = IF([Stunting] >= 40, "High", IF([Stunting] >= 20, "Medium", "Low")) - Income_Group = SWITCH([Income Classification], 0, "Low Income", 1, "Lower-Middle Income", 2, "Upper-Middle Income", 3, "High Income")

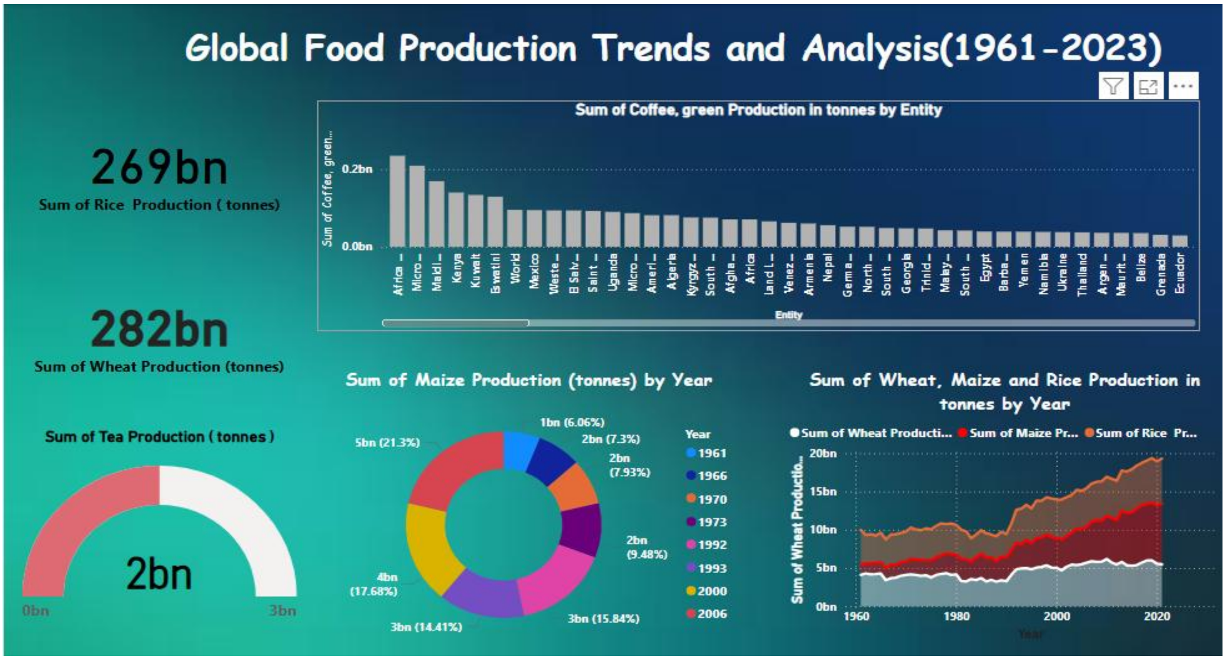
		No. of Visualizations: - Card – Sum of Overweight - Card – Sum of Stunting - Card – Sum of Underweight - Card – Total_U5_Population - Clustered Bar Chart – Year-wise Stunting Change - Slicer – Year & Country - Line Chart – Top 10 Countries by Average Stunting - Clustered Bar Chart – Stunting, Underweight, and Wasting by Income Classification - Map – World Rate for Malnutrition
6	Report Design	Report includes: - Summary Cards for Key Malnutrition Indicators - Comparison Charts (Year-wise, Country-wise, Income Classification) - Global Malnutrition Map for easy visualization

Performance Optimization Strategies Implemented

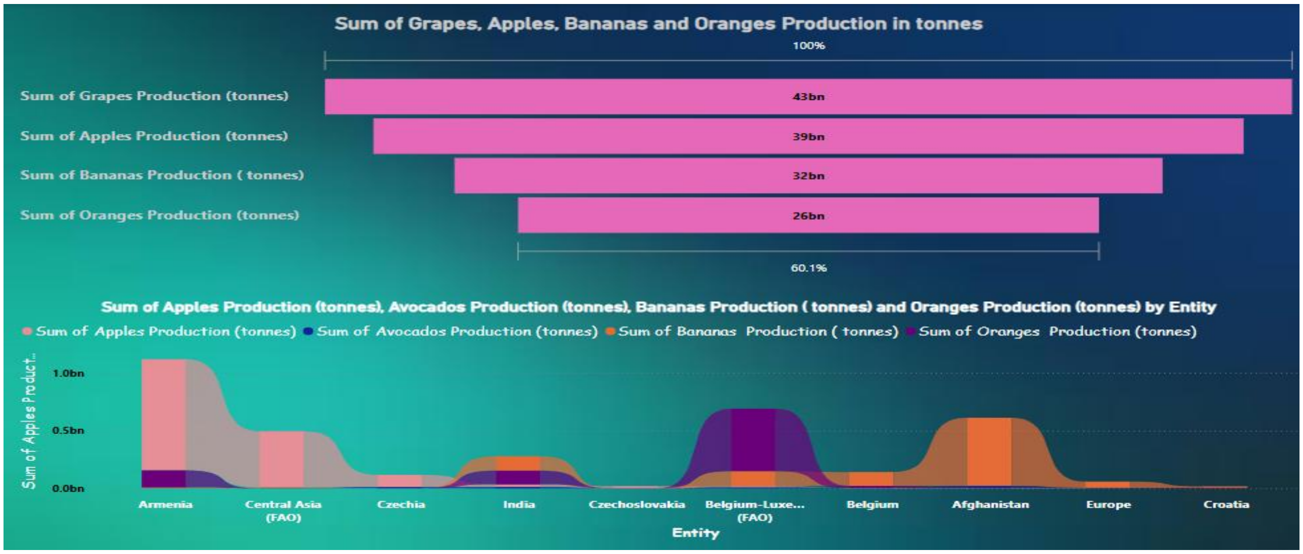
- Data Model Optimization: Removed unnecessary columns, optimized data types.
- DAX Performance Tuning: Used optimized DAX queries to improve calculation speed.
- Filter & Query Optimization: Applied Top N filters for efficient visualization rendering.
- Data Aggregation Techniques: Summarized datasets to improve query execution time.

Chapter 7: RESULTS

7.1 Screenshots of Report and Observations



7.2 Screenshots of Dashboard and Observations:



Chapter 8: ADVANTAGES & DISADVANTAGES

8.1 Advantages

Advantages:

1. Centralized Data Access**:**

Provides a single point of access for global food production data, helping stakeholders like governments, NGOs, businesses, and researchers stay informed.

2. Informed Decision-Making**:**

Facilitates data-driven decisions by offering real-time and historical data. This helps policymakers and businesses plan for food security, resource allocation, and future food production strategies.

3. Tracking Sustainability and Environmental Impact**:**

Allows users to track the environmental impact of food production, such as greenhouse gas emissions, water usage, and land degradation, promoting more sustainable practices.

4. Identification of Trends**:**

Helps in identifying global food production trends, such as shifts in crop yields, regional production shifts, and emerging challenges (e.g., climate change effects or pest outbreaks).

5. Early Warning for Food Crises**:**

Enables early detection of potential food shortages or crises, which could be caused by natural disasters, geopolitical tensions, or other disruptions, allowing for proactive response measures.

6. Improved Resource Management**:**

Provides insights into how efficiently global resources are being used in food production, helping to optimize agricultural practices and reduce waste.

7. Global Comparisons**:**

Facilitates cross-country or regional comparisons, enabling policymakers to assess performance and improve food systems globally.

8. Data Transparency**:**

Improves transparency by providing open access to data about food production, which is crucial for building trust among stakeholders and the public.

8.2 Disadvantages

1. Data Accuracy and Reliability:

The accuracy and quality of the data presented might be inconsistent, as food production data can vary by region or depend on different reporting standards or systems.

2. Complexity of Interpretation:

The data can be overwhelming and complex for non-experts to interpret. For effective use, users may need advanced data analytics skills or expert support.

3. Cost and Infrastructure:

Setting up and maintaining a comprehensive dashboard can be expensive, requiring robust data collection infrastructure and constant updating to keep the data relevant and current.

4. Data Gaps:

There may be significant data gaps, especially in developing countries where food production data may not be as thoroughly collected or reported. This could skew the global picture.

5. Over-Simplification:

Aggregated data can sometimes mask critical local issues, such as regional food insecurity or unequal distribution, making it difficult to address specific, localized problems.

Chapter 9: CONCLUSION:

A Global Food Production Dashboard is an essential tool for monitoring and analyzing global agricultural trends. Its primary advantages include centralized access to data, informed decision-making, tracking sustainability, and providing early warnings for potential food crises. This allows stakeholders from governments to businesses to respond proactively to emerging challenges in the food production sector.

However, there are notable disadvantages to consider, such as issues related to data accuracy, complexity in interpretation, the cost of infrastructure, and potential data gaps. Additionally, while dashboards provide valuable data, they may not always offer clear, actionable insights, and their effectiveness is highly dependent on the quality of the data and technology available.

Ultimately, a Global Food Production Dashboard can significantly enhance global food systems management, and the ability to transform raw data into meaningful actions.

Chapter 10: FUTURE SCOPE

The future of **Global Food Production Dashboards** is promising, especially with advancements in technology, data analytics, and a growing global focus on food security and sustainability. Here are several areas where the scope of such dashboards can expand:

1. Integration with AI and Machine Learning:

- Future dashboards will likely incorporate artificial intelligence (AI) and machine learning (ML) to enhance data prediction, trend analysis, and early warning systems. This could enable more accurate forecasts of crop yields, pest outbreaks, climate impacts, and other variables, allowing for better planning and resource allocation.

2. Real-time Data and IoT Integration:

- The integration of real-time data from IoT (Internet of Things) sensors in agricultural fields will allow for continuous monitoring of crop health, soil quality, water usage, and weather conditions. This will provide more accurate, granular insights into food production dynamics, especially at a local level.

3. Enhanced Geographic and Regional Customization:

- Dashboards will likely offer better customization for specific regions, considering local agricultural conditions, climate, and socioeconomic factors. This could lead to more actionable and region-specific insights, supporting localized food security strategies and interventions.

4.Blockchain for Transparency and Traceability:

- The integration of blockchain technology could further enhance the transparency and traceability of food production data, ensuring authenticity and reducing fraud. This would benefit food supply chains, allowing consumers and businesses to track the origins and sustainability of their food.

5. Collaboration with Climate and Environmental Data:

- Future dashboards will incorporate more detailed climate and environmental data to understand the broader impacts of climate change on food production. By integrating information like temperature changes, precipitation patterns, and soil health, dashboards can provide a holistic view of how global food production is being affected by environmental shifts.

6. Personalized and Predictive Alerts:

- Dashboards will evolve to offer more personalized predictive alerts. For instance, farmers could receive region-specific alerts on weather patterns or pest infestations, while governments might get early warnings about potential food shortages in specific areas due to supply chain disruptions or climate impacts.

7. Improved Collaboration Across Sectors:

- The future of these dashboards lies in greater collaboration among governments, private sector organizations, NGOs, and international bodies. This could lead to shared data systems, enabling coordinated responses to global food crises, improved trade and distribution policies, and more efficient global food security efforts.

8. Big Data Analytics and Visualization:

- As data collection expands, dashboards will leverage big data analytics to process vast amounts of information and present it in more intuitive, user-friendly formats. This will make the data more accessible and actionable for a broader range of stakeholders, including policymakers, businesses, and farmers.

9. Addressing Food Waste:

- Future dashboards could focus more on tracking food waste across the supply chain, offering insights on inefficiencies and opportunities for reducing waste. This would be critical in enhancing food security by optimizing the available food supply and minimizing losses.

10. Enhanced Focus on Global Equity and Sustainability:

- There will likely be a stronger emphasis on equity in food production. Future dashboards may include data on global disparities in food access, help identify regions most at risk of food insecurity, and monitor the progress of sustainable agricultural practices globally.

Chapter 11: APPENDIX

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

GitHub Link : https://github.com/dnyaneshwari64/Global-Food-Production-Trends-and-Analysis-A-Comprehensive-Study-from-1961-to-2023-Using-Power-BI