SMART FARMING SOLUTION

UIT2602 – WEB PROGRAMMING

A PROJECT REPORT

Submitted by

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KALAVAKKAM

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Sri Sivasubramaniya Nadar College of Engineering
(An Autonomous Institution, Affiliated to Anna University)

BONAFIDE CERTIFICATE

Certified that this project titled "Smart Farming Solutions" is the Bonafide work of "Sriram M– 3122 22 5002 136, Tharunkumar S– 3122 22 5002 147 and is submitted for project End Semester Examination held on <Date>.

Signature of examiner

Submitted on ----------

Internal Examiner **External Examiner**

1. ABSTRACT:

Smart farming leverages modern technologies to enhance productivity and decision-making in agriculture. This project presents a comprehensive smart farming solution that provides real-time crop prices, crop and fertilizer recommendations, and data-driven insights to assist farmers and stakeholders.

By integrating machine learning models such as Random Forest Regressor and Decision Trees, the system forecasts crop prices and suggests optimal crops and fertilizers based on soil and environmental conditions.

The platform includes both a web interface and a mobile application developed using Flutter, connected to a Flask-based backend via Node.js APIs, ensuring accessible and user-friendly interaction for diverse users. Additionally, an inventory management system has been integrated, utilizing MongoDB Atlas for efficient cloud-based data storage and performing full CRUD operations. This system manages farm products, equipment, sales details, customer information, and also supports sales reporting with export to Excel functionality, offering streamlined and organized resource tracking for better farm management.

2. INTRODUCTION:

Agriculture remains vital to global food security, yet traditional methods—driven by experience and intuition—can lead to inefficiencies and missed market opportunities. This Smart Farming Solution harnesses machine learning, cloud computing, and cross-platform development to deliver real-time insights and streamline farm operations.

Core Features

- **Real-Time Crop Pricing:** Live tracking and visualization for nearly 100 crops to guide selling decisions.

- **Intelligent Recommendations:**
    - **Crop Selection:** Suggests best crops based on soil (pH, NPK

levels) and environmental factors (temperature, humidity, rainfall).
    - **Fertilizer Use:** Recommends optimal fertilizer mixes to boost yield and reduce waste.

- **Price Forecasting:** Uses Random Forest and Decision Tree models to predict price trends, presented in clear graphical form.

- **Multi-Platform Access:** Responsive web portal (Flask + Node.js APIs) and a Flutter mobile app ensure farmers have insights at their fingertips.

- **Inventory Management:** MongoDB Atlas-backed module with full CRUD for products, equipment, customers, and sales—plus Excel export for reporting.

By combining data-driven analytics with an intuitive interface, this platform empowers farmers to optimize resource use, increase profitability, and adapt quickly to market dynamics—all from one unified system.

3. LITERATURE SURVEY:

- A range of tools and studies underpin the components of our Smart Farming Solution, though few combine them end-to-end.

- Market Price Tracking:

  Platforms like AgriPrice (2018) and CropSense (2020) aggregate real-time commodity prices and offer trend dashboards or SMS alerts, but typically cover a limited crop set.

- Recommendation Systems:

  ML-based models such as CropAdvisor (2019) and AgriSmart (2021) use Random Forests and decision trees

on soil and weather data to boost yield predictions and optimize rotations, yet rarely integrate fertilizer guidance alongside crop choice.

- Price Forecasting:
  Tools like PricePredict (2020) and AgriCast (2023) employ ARIMA, LSTM, and ensemble regressors to forecast prices with under 10–18% error, but often lack seamless linkage to planting or sales modules.

- Inventory Management:
  Solutions such as FarmTrack (2020) and AgriERP (2022) provide cloud-based CRUD for farm inputs, equipment, and sales with reporting features (including Excel export). However, they operate as standalone ERPs without real-time analytics or recommendations.

4. DELIVERABLES:

Machine Learning Models

- Random Forest Regressor for real-time crop price forecasting
- Decision Tree Classifier for crop and fertilizer recommendation

Mobile Application (Flutter)

- Real-time data visualization via RESTful API calls (crop prices, forecasts)
- Interactive crop and fertilizer recommendation screens
- Inventory management UI for CRUD operations on products, equipment, customers, and sales
- Sales report generation and export to Excel

Web Dashboard (Node.js / Express)

- Crop Price Forecast: graphical view of predicted price trends
- Crop Recommendation: input-driven suggestions based on soil & environmental data
- Fertilizer Recommendation: tailored nutrient plans for selected crops
- Inventory Management: full CRUD interfaces for farm products, equipment, customer records, and sales transactions
- Sales Reporting: tabular sales summaries with Excel export functionality
-

Backend Services

- Flask microservices hosting ML endpoints
- Node.js / Express APIs for data retrieval, recommendation logic, and inventory operations
- MongoDB Atlas cloud database for scalable, secure storage of all application data

5. Requirement Engineering

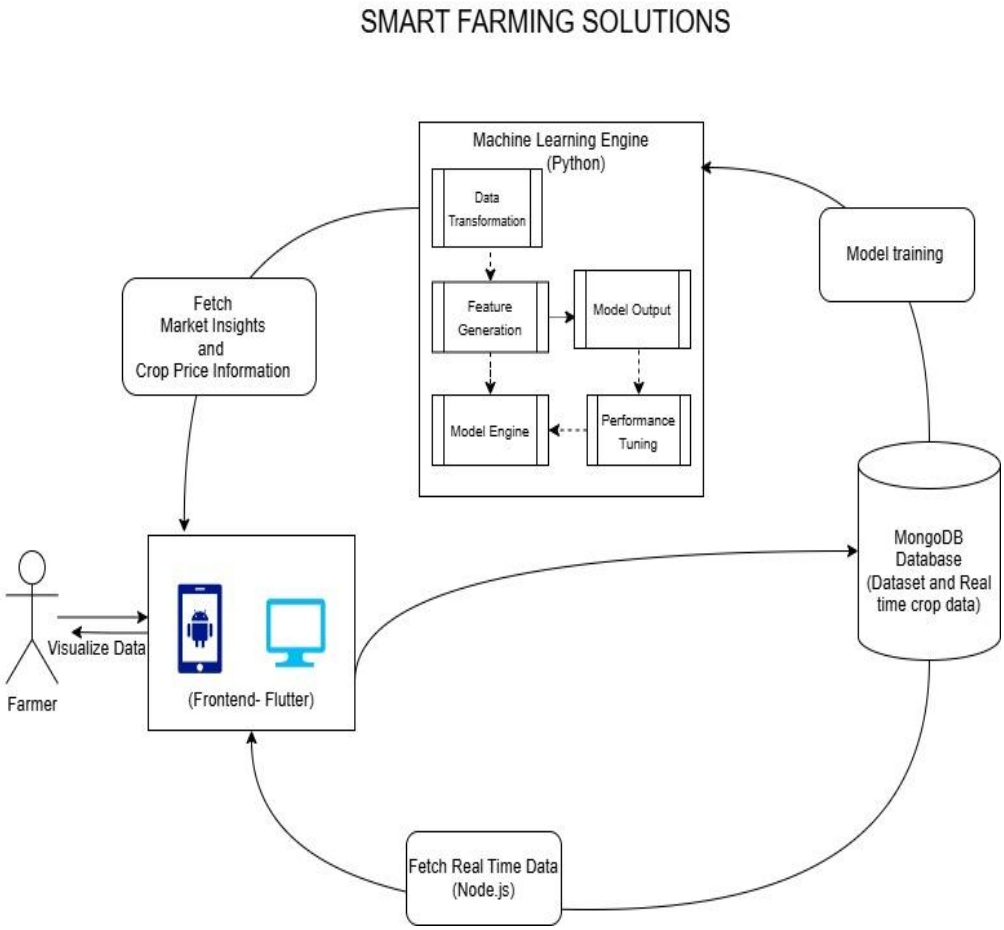
Sprint #	Epic	User Story #	Requirement / User Story	Essential or Desirable	Description of the Requirement	Remarks
1	Crop Price Data Acquisition	1	Develop a user-friendly interface	Essential	Develop a module for acquiring crop price data from appropriate datasets.	Ensure variety and correctness of the data
2	Data Preprocessing	2	Artifact removal And Feature Extraction	Essential	Develop methods for removing Artifacts like unused indices and extract features	Use appropriate algorithms/ techniques for artifact removal and extract features.
3	Random Forest Training	3	Train Random Forest model.	Essential	Train an Random Forest model using preprocessed crop price data	Evaluate the model using evaluation techniques.
4	Random Forest, Decision Tree, XgBoost, Logistic Regression Training	4	Train Random Forest, Decision Tree, XgBoost, Logistic Regression	Essential	Train Random Forest, Decision Tree, XgBoost, Logistic Regression using crop recommendation data	Evaluate the model using evaluation techniques.

5	Random Forest, Decision Tree, XgBoost, Training	4	Train Random Forest, Decision Tree, XgBoost	Essential	Train Random Forest, Decision Tree, XgBoost, using fertilizer recommendation data	Evaluate the model using evaluation techniques.

6. RISK MANAGEMENT

Risk #	Risk Description	Probability	Impact	Mitigation Plan
Consistency Issues	Inconsistent normalization across different subjects could lead to unreliable model training and evaluation.	Medium	High	Implement standard procedures for normalization and ensure they are uniformly applied to all datasets.
Model Overfitting	The Transformer model might overfit to the training data, reducing its performance on unseen data.	Medium	High	Use regularization techniques such as dropout. Implement cross-validation and monitor performance on a validation set.
Training Time	Training Transformer models can be very time-consuming, especially with large crop price. Crop recommendation, fertilizer recommendation datasets.	Medium	Medium	Utilize powerful hardware (GPUs/TPUs). Optimize training process with techniques like batch normalization and early stopping.

7. ARCHITECTURE DIAGRAM:



The architecture of the smart farming solution is built on a modular and scalable design that combines machine learning intelligence, a robust backend, and interactive frontends across web and mobile platforms. At the heart of the system lies the machine learning layer, which powers three primary functionalities: crop price forecasting, crop recommendation, and fertilizer recommendation.

The crop price forecasting model utilizes a Random Forest Regressor trained on historical market data for over 100 crops. This model takes in various features such as crop type, region, seasonality, and historical trends to predict future prices. It outputs insights like the top five crops expected to gain or lose in price and provides a 12-month forecast visualized through graphs. Similarly, the crop recommendation system, built using a Random Forest

Classifier, processes environmental and soil parameters like pH, temperature, rainfall, and humidity to recommend the most suitable crops. For fertilizer recommendation, a Decision Tree model is employed, which takes input such as soil nutrient values (NPK) and crop type, then suggests the appropriate fertilizer type and dosage.

These machine learning models are trained offline, saved as serialized .pkl files, and loaded into a Flask-based backend. The Flask application serves as the API layer, handling all incoming requests, preprocessing data, running predictions using the loaded models, and returning results in JSON format. The backend exposes endpoints for each functionality—price prediction, crop suggestion, and fertilizer advice—making it easy for frontend interfaces to access the intelligence.

On the web frontend, a combination of HTML, CSS, and JavaScript is used to build a user-friendly interface. The web pages interact with the backend through API calls, which are optionally routed via a Node.js server. The web interface provides users with dashboards to view price trends, input forms for crop and fertilizer recommendations, and dynamic visualizations using tools like Chart.js or D3.js.

For users on mobile devices, a Flutter-based mobile application provides a seamless experience. This cross-platform app connects directly to the Flask APIs using HTTP requests and presents results through an intuitive interface. Features include real-time crop price dashboards, interactive input forms for recommendations, and forecast visualizations using packages like fl_chart. The app also supports basic offline caching for areas with limited connectivity.

Communication between the frontend and backend is handled via standard RESTful APIs, ensuring a clean and decoupled interaction. The backend is designed to be stateless, scalable, and ready for cloud deployment on platforms like Heroku, Python Anywhere. While the current system operates without a central database, it can be extended with Firebase, SQLite, or MongoDB to store user history, preferences, or logs.

In summary, the architecture integrates intelligent machine learning models with a flexible backend and dual-platform frontend systems. This design ensures that farmers and agricultural stakeholders can access powerful insights, recommendations, and forecasts—anytime, anywhere, on both web and mobile platforms.

8. ML MODEL DESCRIPTION:

Crop Price Prediction

Model: Random Forest Regressor
Data: Historical market prices of 100+ crops from government and private sources.
Features: Crop name, location, time, supply, demand metrics.

Output:

- Top 5 gainers (price increase)
- Top 5 losers (price drop)
- Next 12-month price forecast with visual graphs
- Justification: Random Forest performs well in handling time-series data with non-linearity and avoids overfitting.

Crop Recommendation

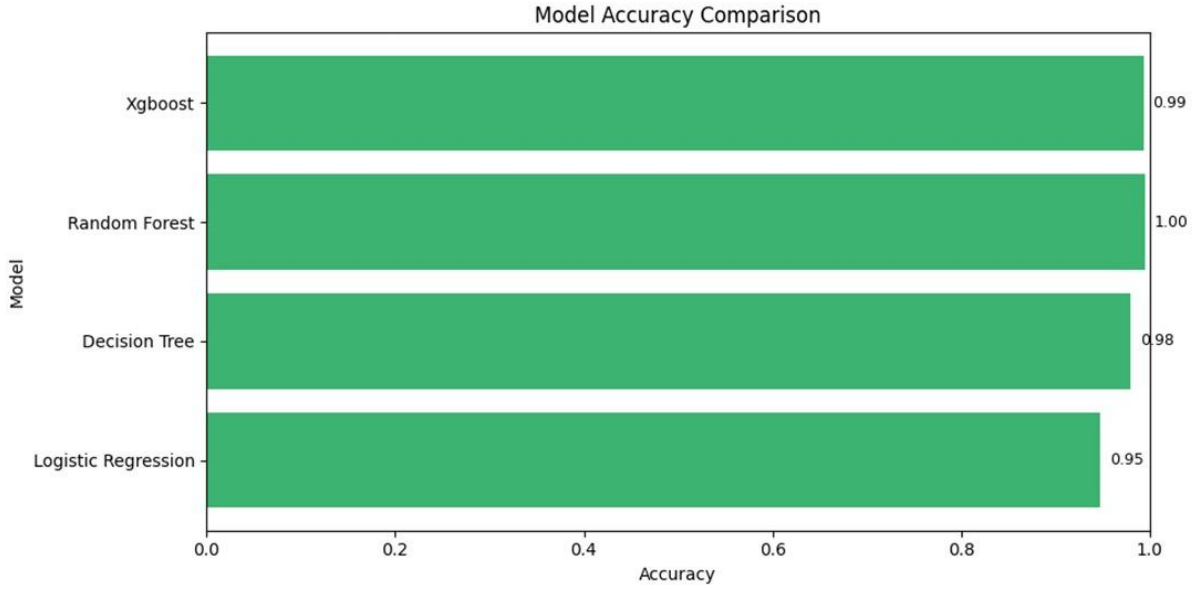
- Model: Random Forest Classifier
- Inputs: Soil type, pH value, rainfall, temperature, humidity
- Output: Best-suited crops for the given conditions

Fertilizer Recommendation

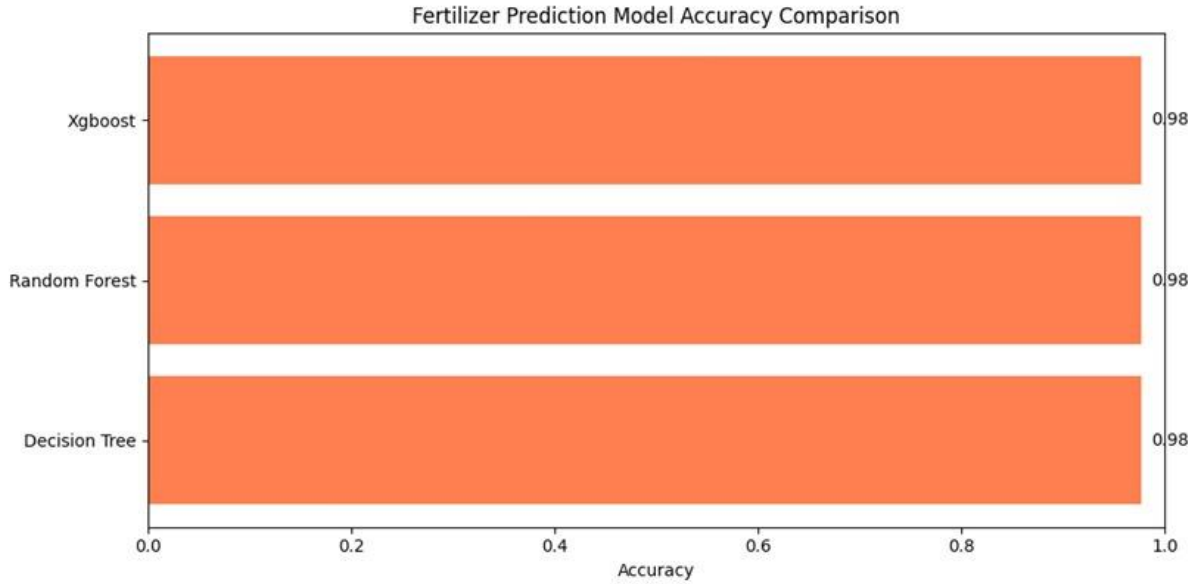
- Model: Decision Tree
- Inputs: Crop type, soil nutrient levels (N, P, K), pH
- Output: Suitable fertilizer(s) and dosage

9. MODEL EVALUATION:

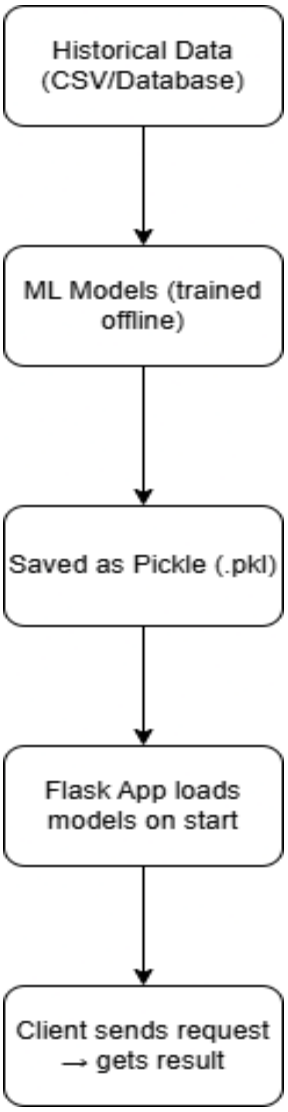
1.Crop Recommandation System



2.Fertilizer Recommandation System



OVERVIEW DIAGRAM:



10. MOBILE APPLICATION DESCRIPTION:

Platform: Flutter (cross-platform)
Connectivity: REST API calls to the Flask and Node.js backends

Features:

- User Login & Registration
- Real-Time Crop Prices Dashboard
- Crop Recommendation Form with interactive result display
- Fertilizer Suggestion Module based on soil and crop data
- Forecast Graphs (e.g., via the fl_chart package)

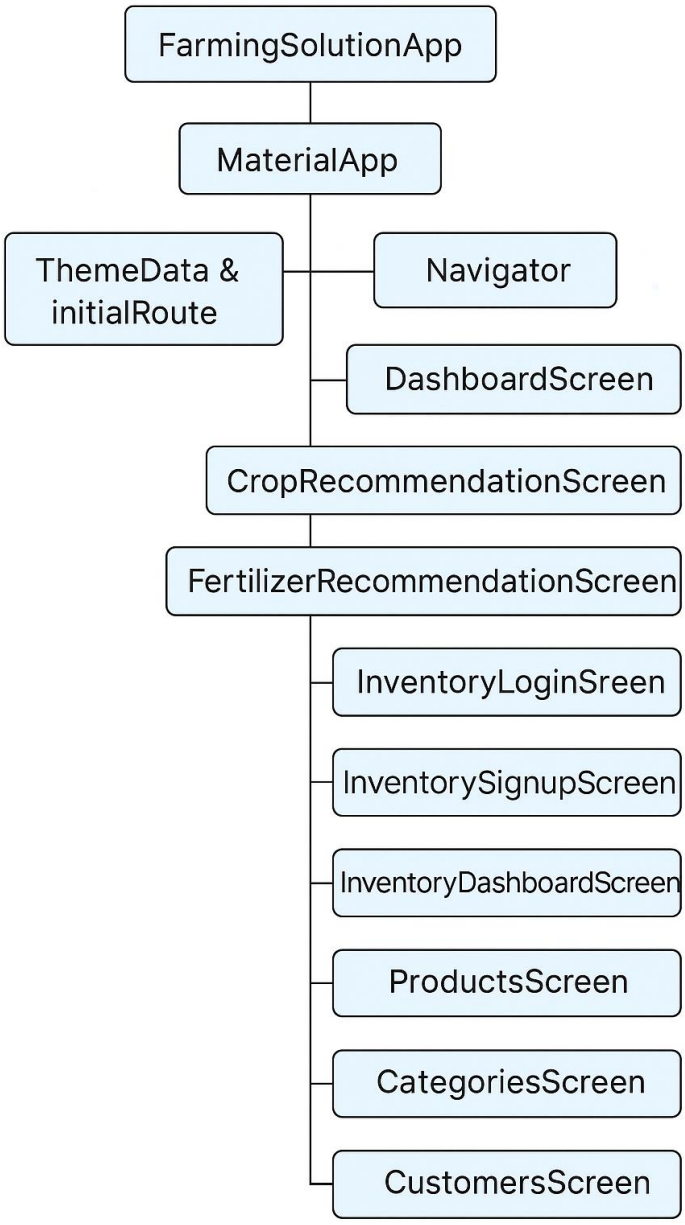
Inventory Management

- CRUD operations for farm products, equipment, customer profiles, and sales records
- View and update stock levels on the go
- Generate and export sales reports to Excel

UI/UX

- Simple, intuitive design optimized for rural connectivity
- Offline caching of last-fetched data (prices, recommendations, inventory) for continued access in low-network areas

11. MOBILE OVERVIEW WIDGET DIAGRAM:



12. WEB DESCRIPTION:

Frontend: HTML/CSS/JavaScript
Backend: Flask (Python) microservices, exposed via Node.js / Express APIs

Pages:

- **Dashboard**
  - Price “winners” and “losers” widgets
  - Interactive visualizations of current market data
- **Crop Recommendation**
  - Input form for soil & environmental parameters
  - Dynamic result display of suggested crops
- **Fertilizer Recommendation**
  - Tool to select crop and input soil nutrients
  - Output of optimal fertilizer mix
- **Price Forecast**
  - Interactive charts showing monthly price trends and forecasts
- **Inventory Management**
  - **Products & Equipment:** Create, read, update, delete entries
  - **Customer Records:** CRUD customer profiles and contact info
  - **Sales Module:** Log transactions, adjust stock levels
  - **Reports:** Generate sales summaries and download as Excel

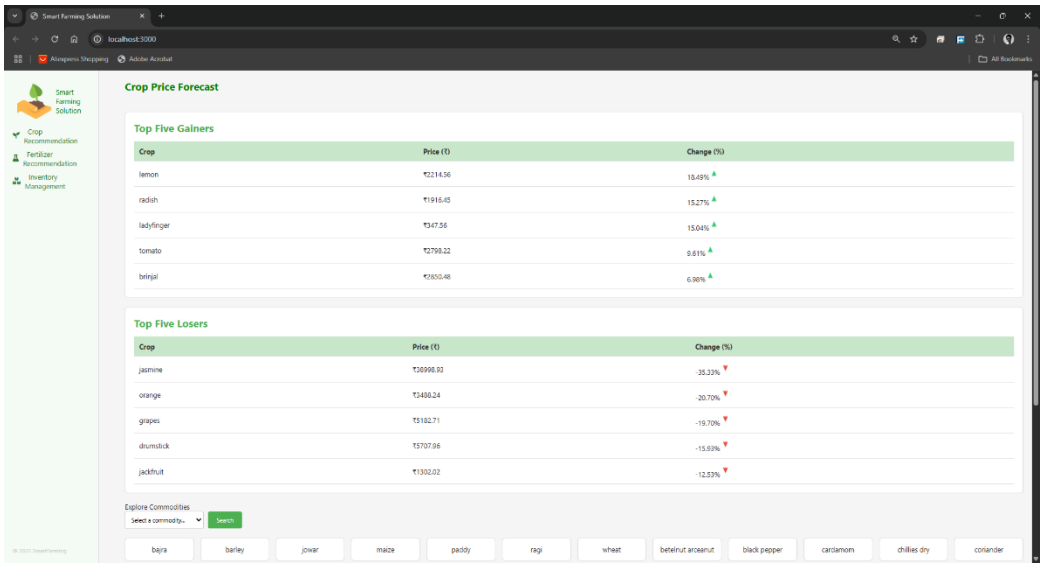
Tools & Libraries:

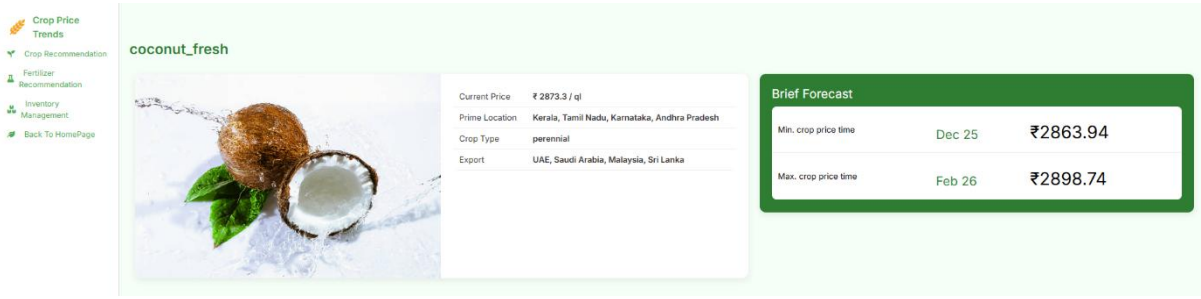
- **Charts & Graphs:** Chart.js and D3.js for interactive, responsive visualizations
- **Data Tables:** Ploty lightweight table library for inventory grids
- **Styling:** CSS Grid for layout, responsive design for desktop and tablet

13. LIMITATIONS AND CONSIDERATIONS:

These results indicate the model is ready for deployment as a highly accurate, cost-effective irrigation trigger that could reduce hardware complexity. However, the system requires further validation across seasonal variations and different environmental conditions to ensure robustness against sensor noise and changing agricultural patterns. Periodic model retraining and continuous performance monitoring are recommended to maintain this high level of accuracy in real-world applications, where factors like soil type variability and weather extremes may impact performance. The findings strongly support implementing a moisture-centric monitoring approach while highlighting the need for ongoing evaluation as the system scales to different farming conditions.

14. WEB INTERFACES:

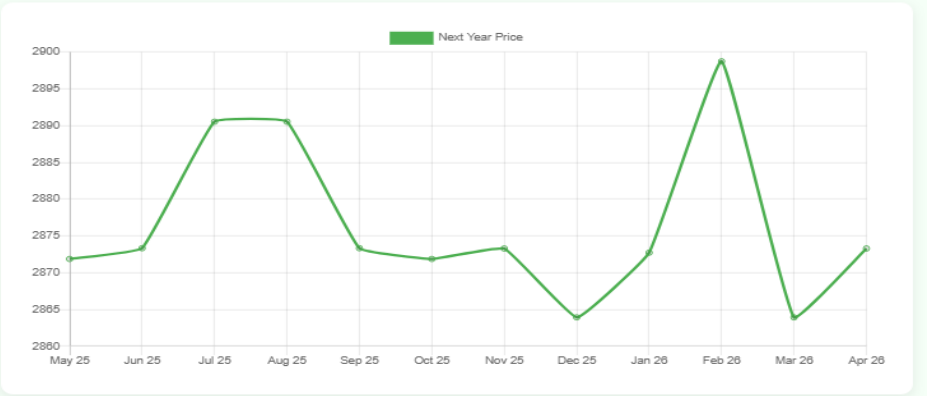




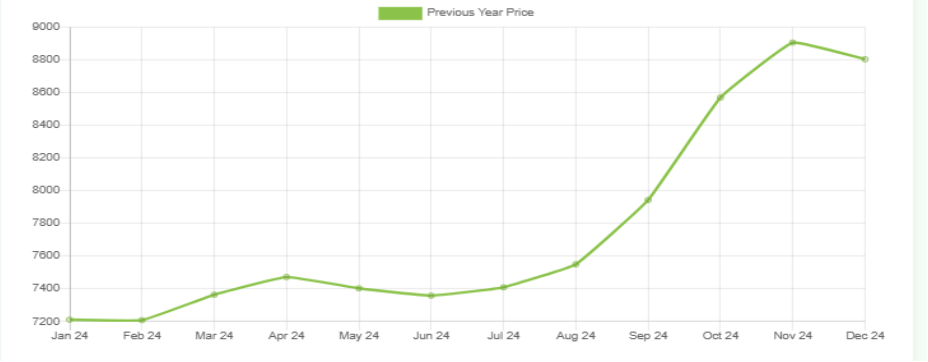
Forecast Trends

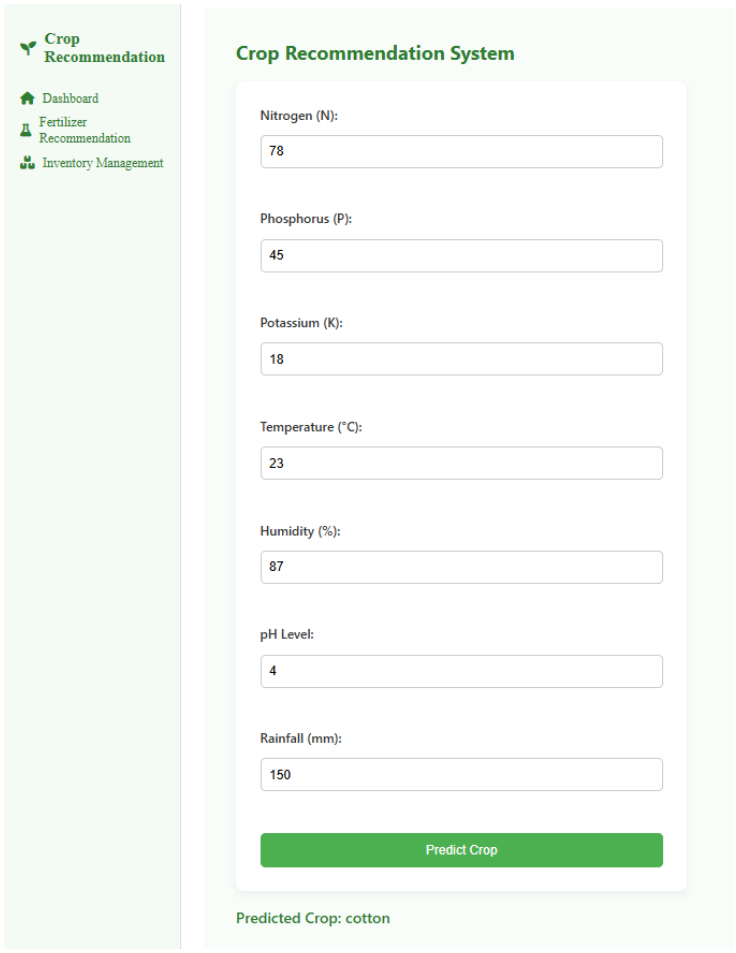
Month	Price (per Qtl.)	Change
May 25	₹2871.88	-0.05% ▼
Jun 25	₹2873.34	0% ▲
Jul 25	₹2890.54	0.6% ▲
Aug 25	₹2890.54	0.6% ▲
Sep 25	₹2873.34	0% ▲
Oct 25	₹2871.88	-0.05% ▼
Nov 25	₹2873.3	0% ▲
Dec 25	₹2863.94	-0.33% ▼
Jan 26	₹2872.74	-0.02% ▼
Feb 26	₹2898.74	0.89% ▲
Mar 26	₹2863.94	-0.33% ▼
Apr 26	₹2873.3	0% ▲

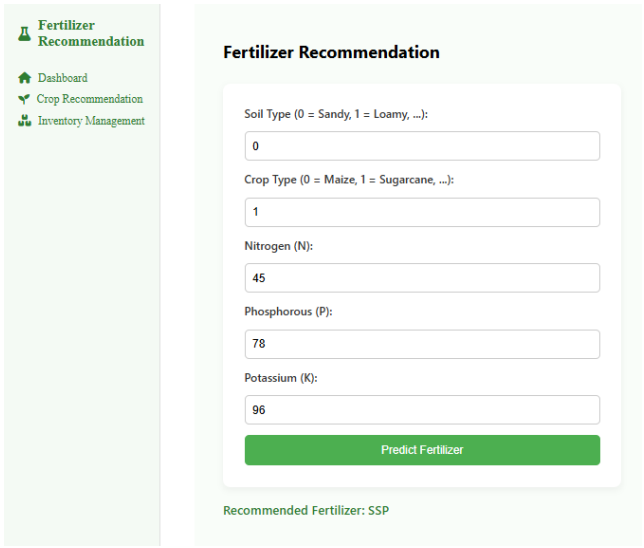
Forecast Price Trend

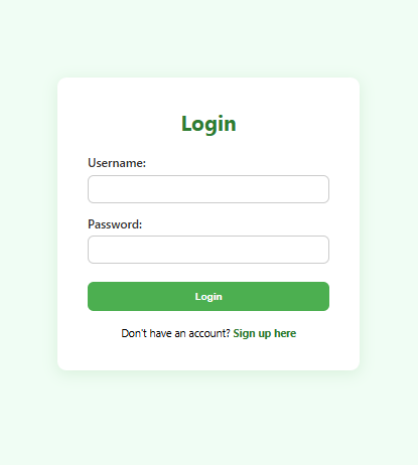


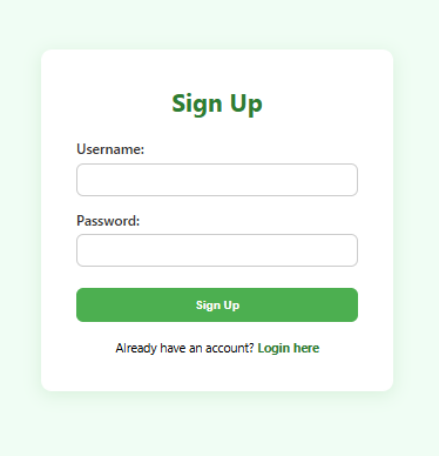
Previous Year Price Trend




Crop Recommendation
Dashboard
Fertilizer Recommendation
Inventory Management
Crop Recommendation System
Nitrogen (N):
78
Phosphorus (P):
45
Potassium (K):
18
Temperature (°C):
23
Humidity (%):
87
pH Level:
4
Rainfall (mm):
150
Predict Crop
Predicted Crop: cotton


Fertilizer Recommendation
Dashboard
Crop Recommendation
Inventory Management
Fertilizer Recommendation
Soil Type (0 = Sandy, 1 = Loamy, ...):
0
Crop Type (0 = Maize, 1 = Sugarcane, ...):
1
Nitrogen (N):
45
Phosphorous (P):
78
Potassium (K):
96
Predict Fertilizer
Recommended Fertilizer: SSP


Login
Username:
Password:
Login
Don't have an account? Sign up here


Sign Up
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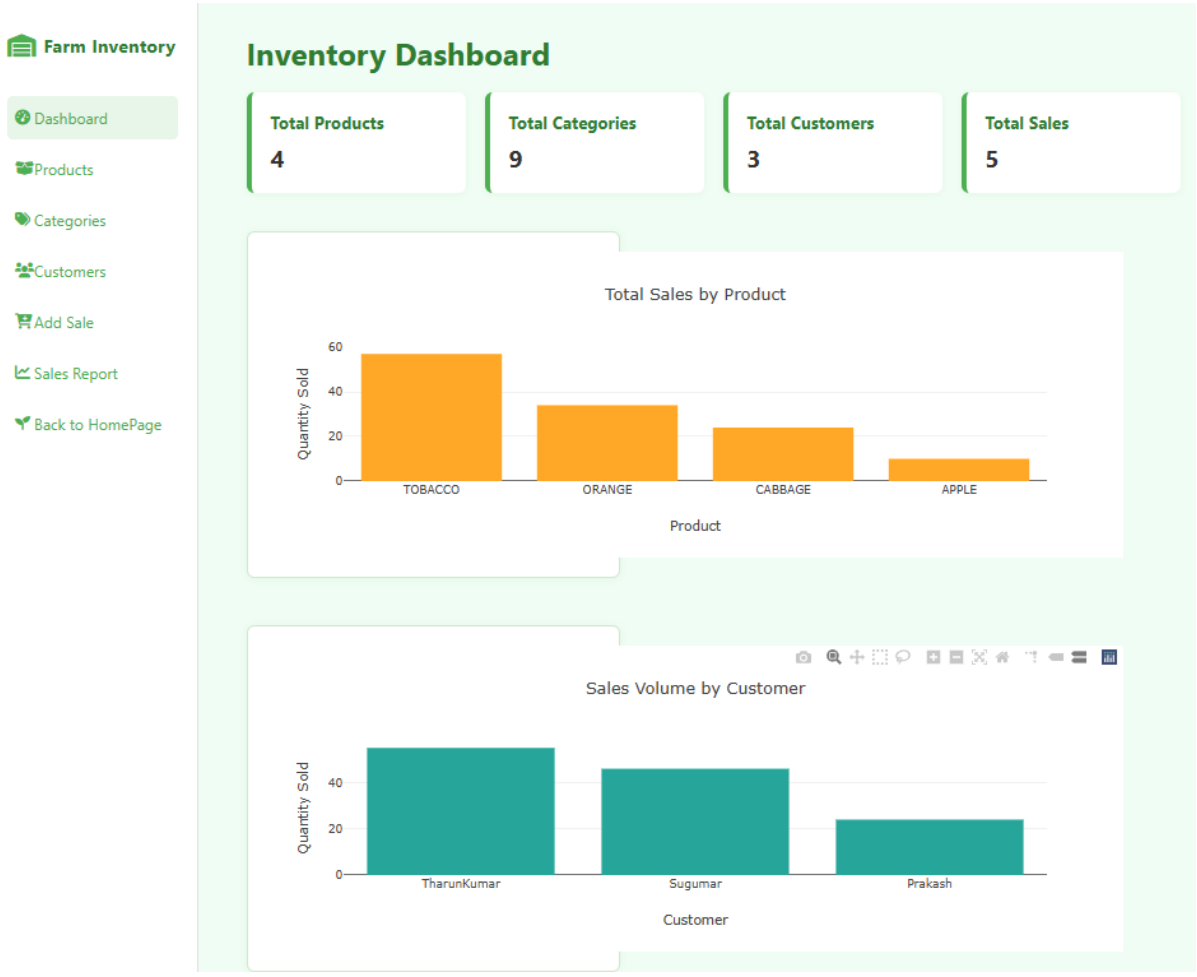
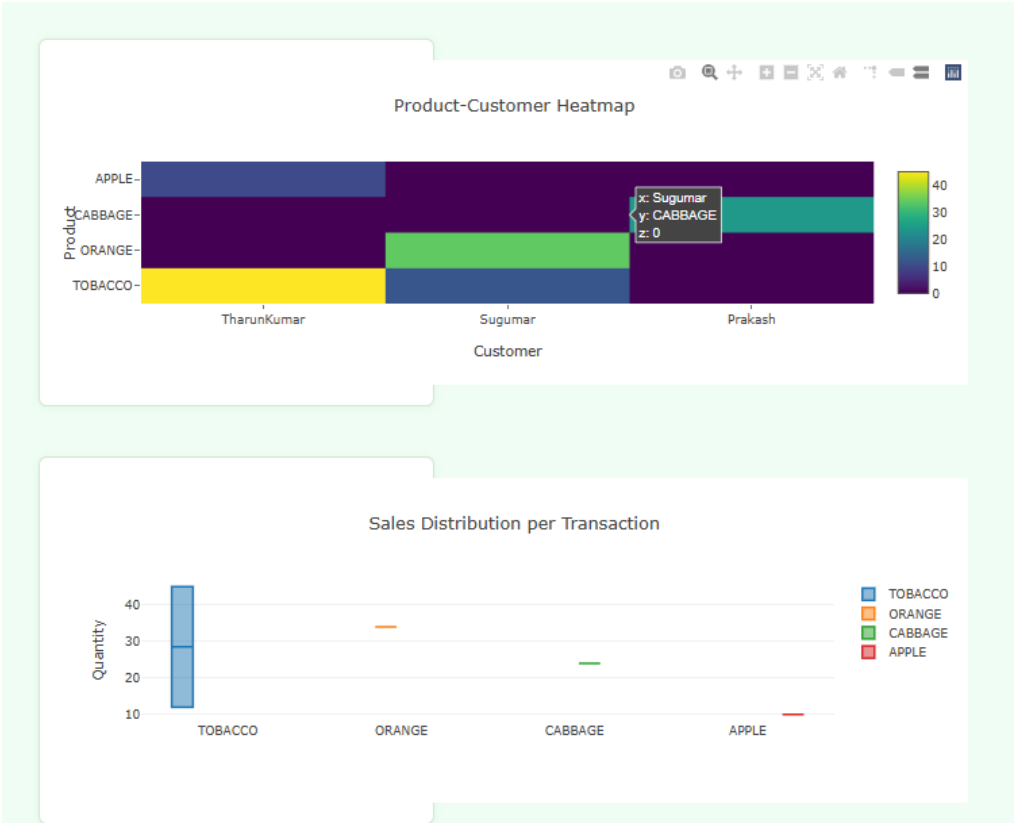
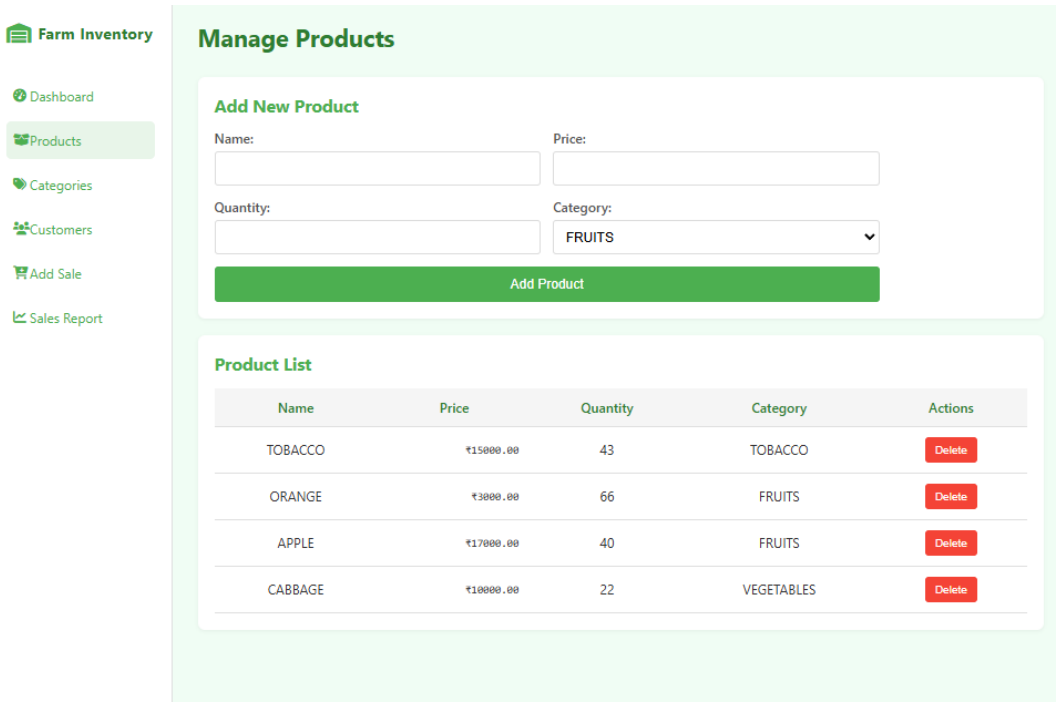
Password:
Sign Up
Already have an account? Login here


Farm Inventory
Dashboard
Products
Categories
Customers
Add Sale
Sales Report
Back to HomePage
Inventory Dashboard
Total Products
4
Total Categories
9
Total Customers
3
Total Sales
5
Total Sales by Product
Quantity Sold
60
40
20
0
TOBACCO
ORANGE
CABBAGE
APPLE
Product
Sales Volume by Customer
Quantity Sold
40
20
0
TharunKumar
Sugumar
Prakash
Customer


Product-Customer Heatmap
APPLE
CABBAGE
ORANGE
TOBACCO
Product
x: Sugumar
y: CABBAGE
z: 0
40
30
20
10
0
TharunKumar
Sugumar
Prakash
Customer

Sales Distribution per Transaction
Quantity
40
30
20
10
TOBACCO
ORANGE
CABBAGE
APPLE
TOBACCO
ORANGE
CABBAGE
APPLE


Farm Inventory
Dashboard
Products
Categories
Customers
Add Sale
Sales Report
Manage Products
Add New Product
Name:
Price:
Quantity:
Category:
FRUITS
Add Product
Product List
Name
Price
Quantity
Category
Actions
TOBACCO
₹15000.00
43
TOBACCO
Delete
ORANGE
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CABBAGE
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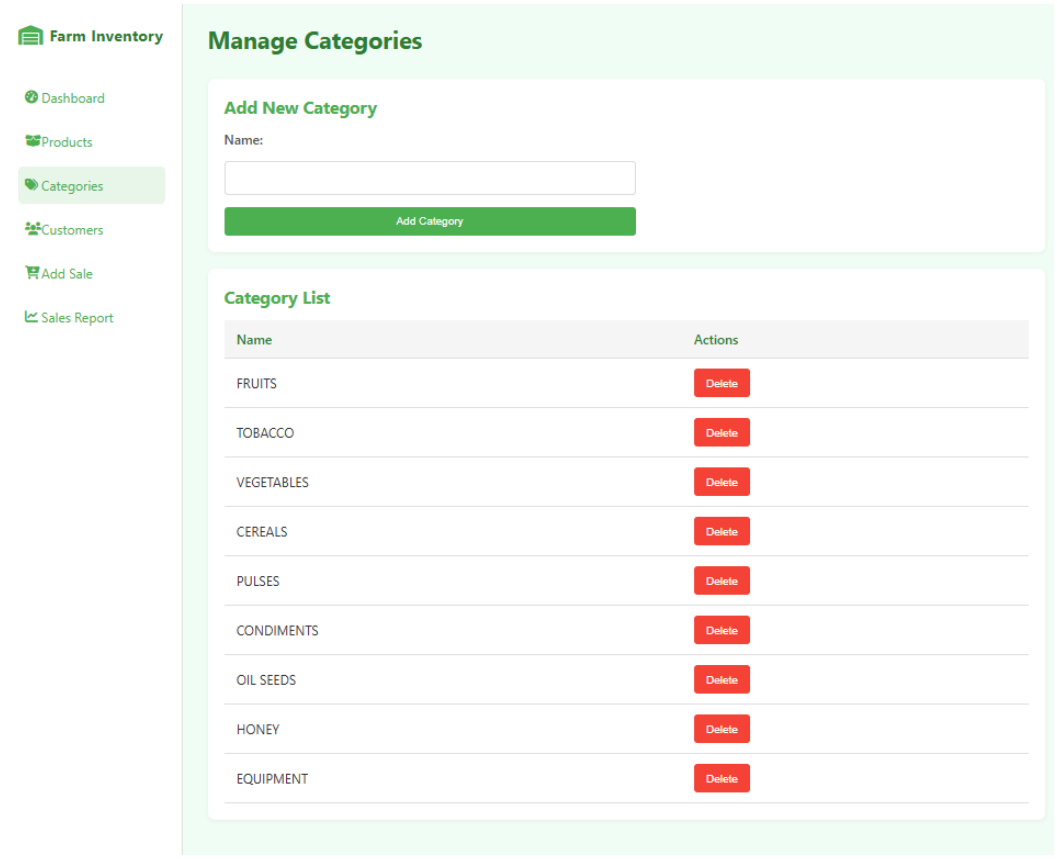
22
VEGETABLES
Delete


Farm Inventory
Dashboard
Products
Categories
Customers
Add Sale
Sales Report
Manage Categories
Add New Category
Name:
Add Category
Category List
Name
Actions
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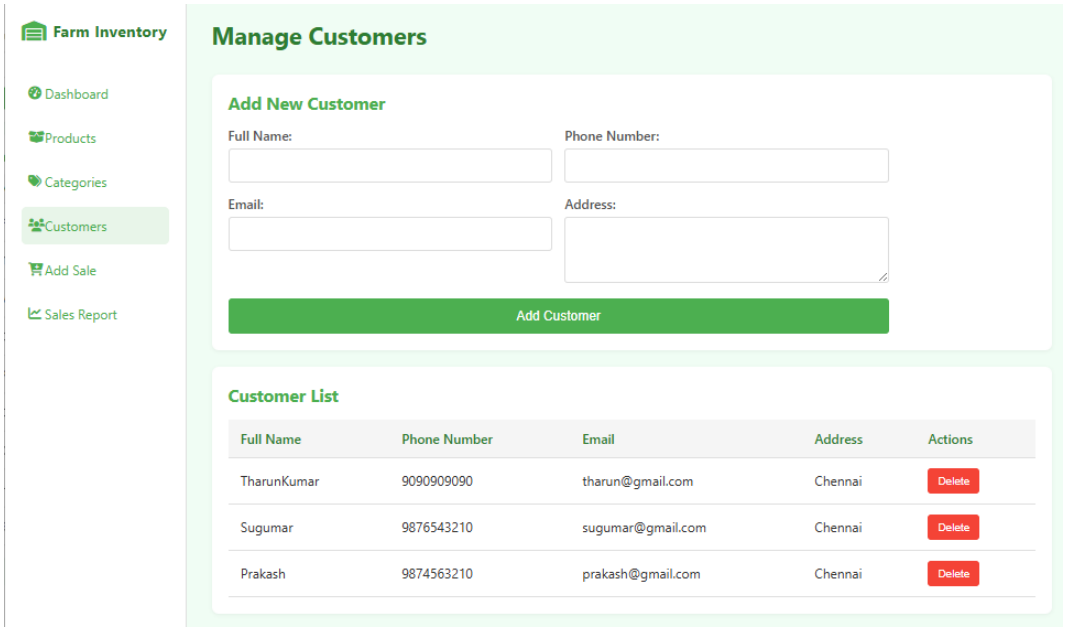
VEGETABLES
CEREALS
PULSES
CONDIMENTS
OIL SEEDS
HONEY
EQUIPMENT
Delete


Farm Inventory
Dashboard
Products
Categories
Customers
Add Sale
Sales Report
Manage Customers
Add New Customer
Full Name:
Phone Number:
Email:
Address:
Add Customer
Customer List
Full Name
Phone Number
Email
Address
Actions
TharunKumar
9090909090
tharun@gmail.com
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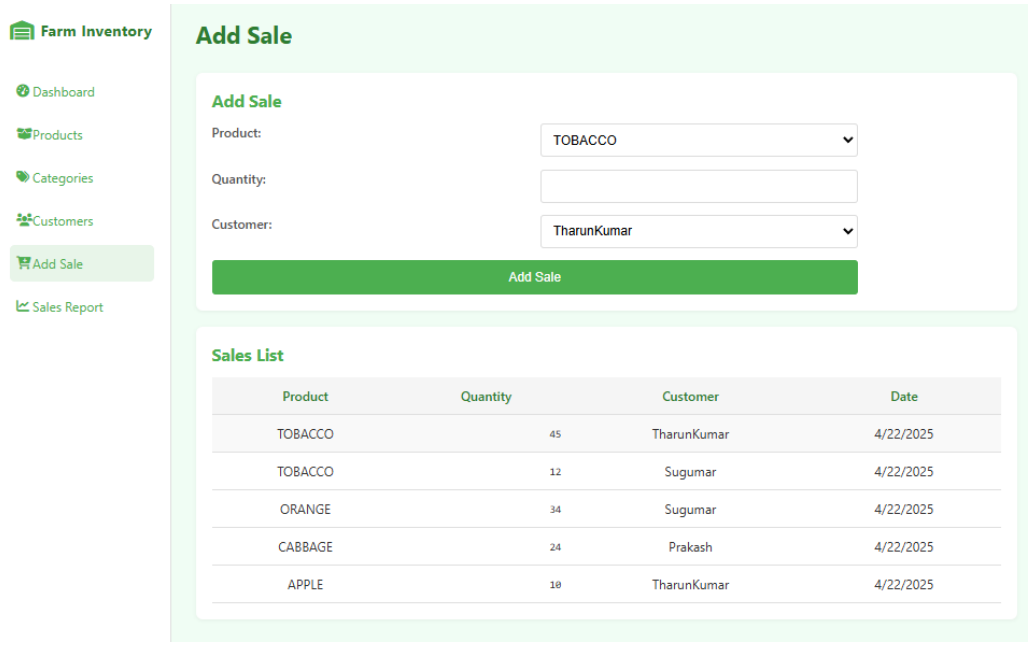
Farm Inventory
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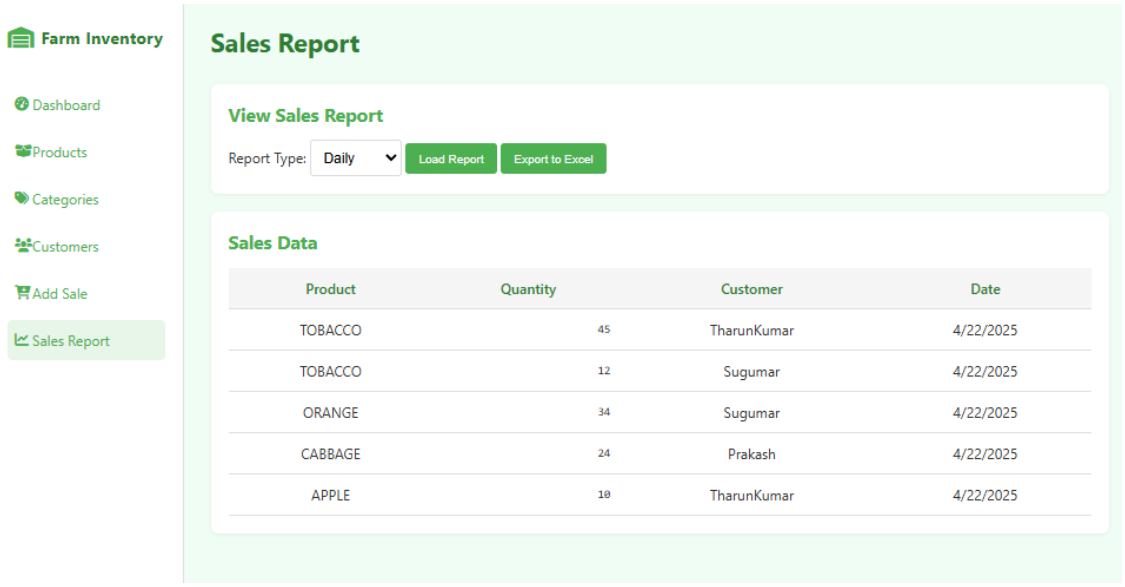
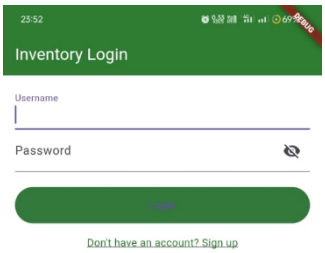
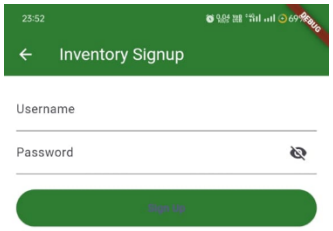
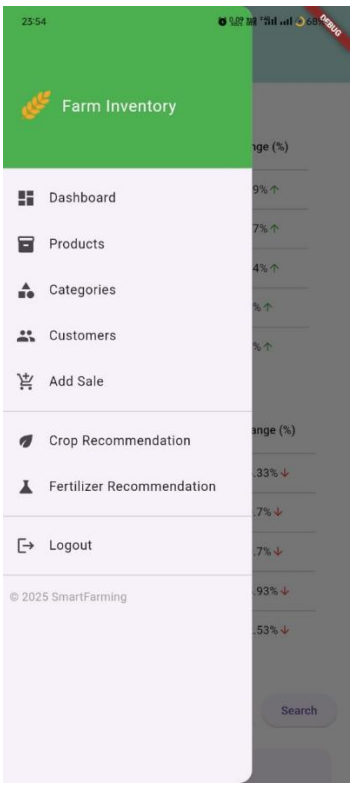
Products
Categories
Customers
Add Sale
Sales Report
Add Sale
Add Sale
Product:
TOBACCO
Quantity:
Customer:
TharunKumar
Add Sale
Sales List
Product
Quantity
Customer
Date
TOBACCO
45
TharunKumar
4/22/2025
TOBACCO
12
Sugumar
4/22/2025
ORANGE
34
Sugumar
4/22/2025
CABBAGE
24
Prakash
4/22/2025
APPLE
10
TharunKumar
4/22/2025

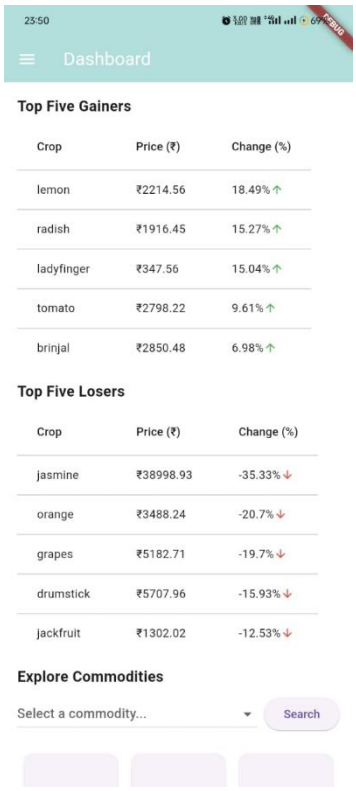

Farm Inventory
Dashboard
Products
Categories
Customers
Add Sale
Sales Report
Sales Report
View Sales Report
Report Type:
Daily
Load Report
Export to Excel
Sales Data
Product
Quantity
Customer
Date
TOBACCO
45
TharunKumar
4/22/2025
TOBACCO
12
Sugumar
4/22/2025
ORANGE
34
Sugumar
4/22/2025
CABBAGE
24
Prakash
4/22/2025
APPLE
10
TharunKumar
4/22/2025

15. MOBILE APP INTERFACES:

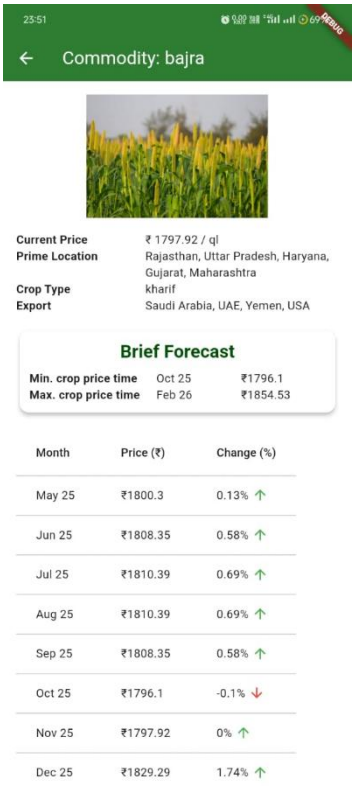


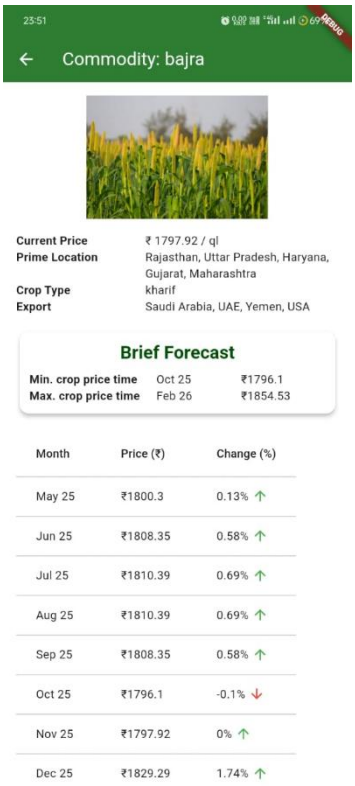







23:50
Dashboard
Explore Commodities
Select a commodity...
Search
bajra
barley
jowar
maize
paddy
ragi
wheat
betelnut arceanut
black pepper
cardamom
chillies dry
coriander
cumin
garlic
ginger dry
tamarind
turmeric
coir fibre


23:51
Commodity: bajra
Current Price ₹ 1797.92 / ql
Prime Location Rajasthan, Uttar Pradesh, Haryana, Gujarat, Maharashtra
Crop Type kharif
Export Saudi Arabia, UAE, Yemen, USA
Brief Forecast
Min. crop price time Oct 25 ₹1796.1
Max. crop price time Feb 26 ₹1854.53
Month Price (₹) Change (%)
May 25 ₹1800.3 0.13%
Jun 25 ₹1808.35 0.58%
Jul 25 ₹1810.39 0.69%
Aug 25 ₹1810.39 0.69%
Sep 25 ₹1808.35 0.58%
Oct 25 ₹1796.1 -0.1%
Nov 25 ₹1797.92 0%
Dec 25 ₹1829.29 1.74%


23:51
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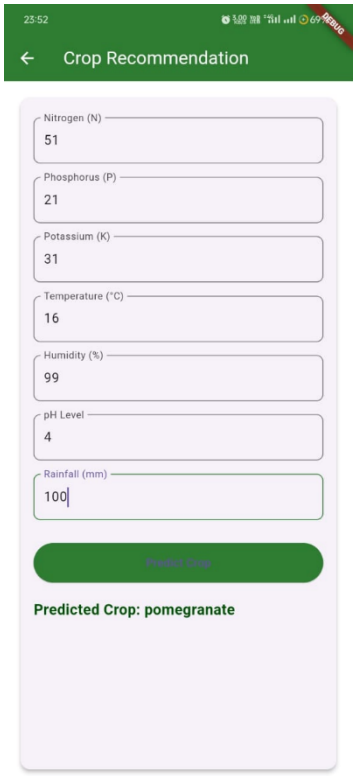
Oct 25 ₹1796.1 -0.1%
Nov 25 ₹1797.92 0%
Dec 25 ₹1829.29 1.74%

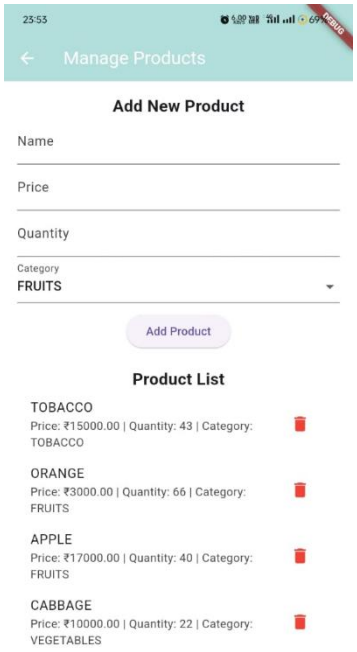

23:51
Commodity: bajra
Oct 25 ₹1796.1 -0.1%
Nov 25 ₹1797.92 0%
Dec 25 ₹1829.29 1.74%
Jan 26 ₹1800.44 0.14%
Feb 26 ₹1854.53 3.15%
Mar 26 ₹1829.29 1.74%
Apr 26 ₹1797.92 0%
Forecast Price Trend
Previous Year Price Trend

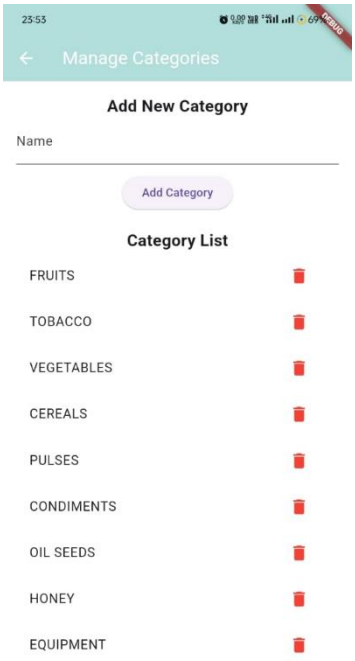

23:52
Crop Recommendation
Nitrogen (N)
51
Phosphorus (P)
21
Potassium (K)
31
Temperature (°C)
16
Humidity (%)
99
pH Level
4
Rainfall (mm)
100
Predict Crop
Predicted Crop: pomegranate

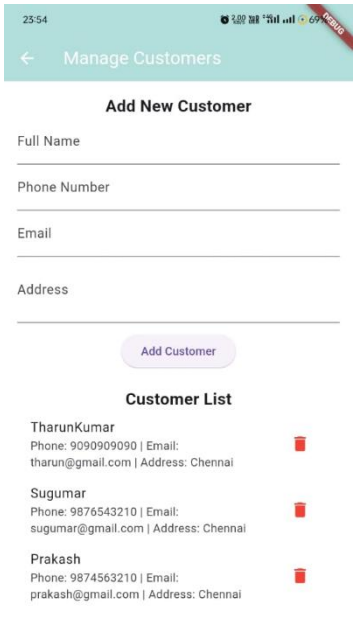

23:52
Fertilizer Recommendation
Soil Type (0 = Sandy, 1 = Loamy, ...)
0
Crop Type (0 = Maize, 1 = Sugarcane, ...)
2
Nitrogen (N)
13
Phosphorous (P)
55
Potassium (K)
49
Recommended Fertilizer: SSP-MOP

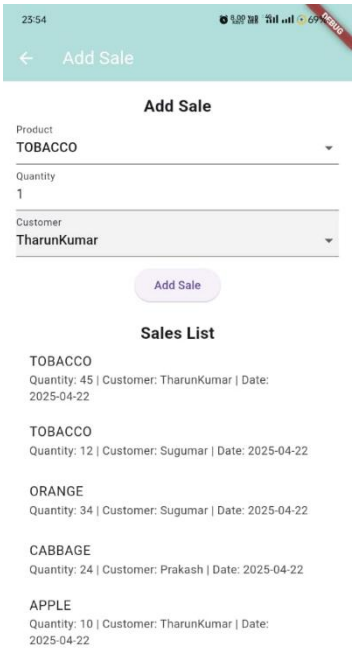

23:53
Inventory Dashboard
Inventory Dashboard Summary
Total Products 4
Total Categories 9
Total Customers 3
Total Sales 5
Total Sales by Product
TOBACCO
ORANGE
CABBAGE
APPLE
Sales Volume by Customer


23:53
Inventory Dashboard
TharunKumar
Sugumar
Prakash
Product-Customer Heatmap
TOBACCO
ORANGE
CABBAGE
APPLE
Average Sales per Transaction
TOBACCO
ORANGE
CABBAGE
APPLE


23:53
Manage Products
Add New Product
Name
Price
Quantity
Category
FRUITS
Add Product
Product List
TOBACCO
Price: ₹15000.00 | Quantity: 43 | Category: TOBACCO
ORANGE
Price: ₹3000.00 | Quantity: 66 | Category: FRUITS
APPLE
Price: ₹17000.00 | Quantity: 40 | Category: FRUITS
CABBAGE
Price: ₹10000.00 | Quantity: 22 | Category: VEGETABLES


23:53
Manage Categories
Add New Category
Name
Add Category
Category List
FRUITS
TOBACCO
VEGETABLES
CEREALS
PULSES
CONDIMENTS
OIL SEEDS
HONEY
EQUIPMENT


23:54
Manage Customers
Add New Customer
Full Name
Phone Number
Email
Address
Add Customer
Customer List
TharunKumar
Phone: 9090909090 | Email: tharun@gmail.com | Address: Chennai
Sugumar
Phone: 9876543210 | Email: sugumar@gmail.com | Address: Chennai
Prakash
Phone: 9874563210 | Email: prakash@gmail.com | Address: Chennai


23:54
Add Sale
Add Sale
Product
TOBACCO
Quantity
1
Customer
TharunKumar
Add Sale
Sales List
TOBACCO
Quantity: 45 | Customer: TharunKumar | Date: 2025-04-22
TOBACCO
Quantity: 12 | Customer: Sugumar | Date: 2025-04-22
ORANGE
Quantity: 34 | Customer: Sugumar | Date: 2025-04-22
CABBAGE
Quantity: 24 | Customer: Prakash | Date: 2025-04-22
APPLE
Quantity: 10 | Customer: TharunKumar | Date: 2025-04-22

16. FUTURE SCOPE:

- IoT Integration: Add support for sensor data for real-time soil and weather monitoring.
- Multilingual Support: Enable regional languages in the UI for broader adoption.
- Blockchain Integration: For secure, transparent crop transactions and supply chain traceability.
- Community Forum: Add farmer forums or chatbots for peer advice.

17. CONCLUSION:

This Smart Farming Solution delivers an integrated, data-driven platform that empowers farmers across the entire production cycle—from market price awareness to crop selection, fertilizer optimization, and resource management. By harnessing machine learning models for price forecasting and recommendations, providing real-time dashboards, and embedding a MongoDB Atlas-backed inventory module (with full CRUD and Excel reporting), the system tackles critical challenges of yield maximization, input efficiency, and operational transparency. Although real-world deployment will require ongoing refinement such as expanding data sources, enhancing offline resilience, and fine-tuning ML accuracy this unified, tech-enabled framework establishes a robust foundation for sustainable and profitable agriculture.

18. REFERENCES:

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- Patel, A., Sharma, N., & Verma, S. (2018). AgriPrice: Automated web crawler system for real-time crop price aggregation. International Journal of Agricultural Information Systems, 9(2), 98–110.

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