Smart agriculture support system for Aloe Vera

Project ID: 2025-26J-166

Project Proposal Report

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BSc (Hons) in Information Technology Specializing in Information Technology

Department of Computer Science
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DECLARATION

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I declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning, and to the best of our knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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The above candidate is carrying out research for the undergraduate Dissertation under my supervision.

.... 2025/08/30..........

Signature of the Supervisor

Ms. Jenny Krishara

Date

.... 2025/08/30..........

Signature of the Co-Supervisor

Dr. Dinuka Wijendra

Date

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ABSTRACT

Small and medium-scale Aloe Vera farmers in Sri Lanka face significant challenges due to the absence of accurate, real-time market price forecasting systems, which limits their ability to make informed decisions on harvesting, selling, and distribution. This research develops a Smart Aloe Vera Price Forecasting System that predicts short-term and seasonal price fluctuations using advanced statistical and predictive modeling techniques, constructed from daily and historical datasets such as farm-gate prices, wholesale/retail market trends, weather conditions, and supply chain records. The system is designed to detect anomalies such as sudden price drops, unusual demand surges, and market disruptions, while generating predictive alerts and actionable recommendations in both Sinhala and English to support localized farmer decision-making. Recommendations include optimal harvesting time, storage strategies, and market channel selection (direct selling, wholesale, or value-added production), tailored to maximize profitability and reduce exploitation by intermediaries. The modular system integrates mobile data collection, price curve modeling, anomaly detection, and a farmer-friendly mobile/web dashboard, allowing real-time visualization, interactive forecasting, and easy comparison across markets. Although final implementation is ongoing, the system is expected to outperform traditional intuition-based decision-making by delivering reliable price forecasts, enabling farmers to negotiate better, reduce losses, and strengthen market competitiveness. This innovation contributes to sustainable agriculture by improving income stability, empowering farmers with accessible localized technology, and promoting data-driven market participation.

Keywords: Aloe Vera, Price Forecasting, Market Prediction, Anomaly Detection, Sustainable Agriculture

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1 INTRODUCTION

Aloe Vera has emerged as one of the most commercially significant medicinal and cosmetic crops worldwide, with a rapidly growing demand in the pharmaceutical, food, and skincare industries. The global Aloe Vera market is projected to expand steadily, driven by increasing consumer preference for herbal-based products and rising applications across industries [2]– [10]. Reports indicate that Aloe Vera gel and extract markets are expected to witness consistent growth over the next decade, with Asia-Pacific countries, including Sri Lanka and India, playing a key role in cultivation and exports [5], [9], [26].

In Sri Lanka, Aloe Vera is cultivated both as a small-scale livelihood crop and as a commercial commodity. Research highlights its potential under organic fertilizer management [21] and the suitability of different regions for Aloe Vera cultivation [22]. Furthermore, Aloe Vera cultivation has been promoted in rural areas such as Kalpitiya to strengthen community livelihoods [23]. Despite its potential, the industry faces challenges in price stabilization, farmer income security, and value-chain transparency.

One of the most pressing issues is the absence of a real-time price monitoring and forecasting system for Aloe Vera in Sri Lanka. Farmers often depend on middlemen to sell their produce, creating a price gap between the initial farm-gate price and the final market price received by exporters, cosmetic companies, or pharmaceutical manufacturers [12], [13], [15]. Studies on vegetable markets in Sri Lanka show how predictive modeling can improve market efficiency and reduce farmer vulnerability [1], but similar approaches for Aloe Vera remain underexplored.

Currently, Aloe Vera farmers struggle to understand whether the prices they receive are fair, as middlemen often exert significant influence over the supply chain. This leads to scenarios where farmers sell raw leaves at very low margins, while middlemen resell to wholesalers or processing companies at a higher rate, and the final market price increases substantially [14], [17], [18]. Such disparities highlight the need for a transparent farm-to-market price forecasting framework that not only predicts future Aloe Vera price trends but also visualizes price transitions from farmers to middlemen and larger businesses.

Therefore, this research aims to develop a Smart Aloe Vera Price Forecasting System that leverages historical and real-time data from sources such as HARTI [16], the Dambulla Dedicated Economic Centre [17], and the Department of Census and Statistics [18]. By providing farmers with accessible price predictions and insights in both Sinhala and English, the system seeks to empower them in decision-making, reduce exploitation by intermediaries, and strengthen sustainable agricultural practices.

Figure 1:1 Aleo Vera

1.1 Background & Literature Survey

Aloe Vera is a fast-growing crop in Sri Lanka that is widely used for medicinal, cosmetic, and food industries. Despite its high potential, Aloe Vera farming remains underdeveloped compared to other crops. One of the key challenges farmers face is the lack of reliable market information. Prices fluctuate significantly depending on demand, seasonality, and buyer type—whether selling to middlemen or directly to business owners. At present, farmers often depend on informal networks or fixed buyer agreements, which reduces their bargaining power and profitability. This situation highlights the need for a systematic approach to price monitoring and forecasting tailored specifically to Aloe Vera farmers.

Previous research in agricultural price forecasting has mostly focused on staple crops such as rice, maize, and wheat. Studies have applied statistical models like ARIMA and exponential smoothing to predict short-term price changes, showing good performance in stable markets [1][2]. More recently, machine learning approaches, such as Prophet and LSTM neural networks, have been used for commodities including fruits and vegetables, proving effective at capturing nonlinear trends and seasonal effects [3][4]. However, little research has been carried out on Aloe Vera, particularly in the Sri Lankan context, where the market is growing but lacks transparency.

To develop an effective Aloe Vera price forecasting system, mastery of both traditional econometric models and advanced machine learning techniques is required. ARIMA remains a strong baseline for time series analysis, while Prophet is designed for seasonality and holiday effects, and LSTM models excel in identifying complex patterns in data streams. Beyond price data, integrating external signals such as weather conditions, export demand, and processing industry needs provides richer insights, aligning with approaches seen in modern Agri-tech platforms [5][6]. Current state-of-the-art solutions in agricultural technology combine real-time data streams with mobile-based decision support tools, but most focus on yield prediction or pest detection rather than market intelligence [7][8].

This project differs from prior work by directly targeting the Aloe Vera sector, offering real-time and localized price predictions. Unlike general commodity forecasting, the system is tailored to multiple value-chain levels, showing differences between farm-gate prices, middlemen margins, and business buyer prices. Furthermore, it acts as a personalized adviser for farmers, providing alerts and visualizations in local languages. By addressing a gap in current research and practice, this system aims to empower Aloe Vera farmers in Sri Lanka with financial intelligence, enabling them to shift from reactive selling to strategic market planning.

1.2 Research Gap

Although agricultural price forecasting has been studied for various staple crops such as rice, maize, and vegetables, there remains a significant gap when it comes to non-traditional and high-value crops like Aloe Vera. Most existing research has focused on yield prediction, pest control, or climate adaptation, with relatively little emphasis on providing farmers with direct, real-time market intelligence. In particular, the Aloe Vera sector in Sri Lanka, despite its rapid growth and expanding demand from cosmetic, food, and pharmaceutical industries, has not received adequate research attention. Farmers currently rely on word-of-mouth information, personal networks, and middlemen for price updates, which creates asymmetry in market knowledge and leaves small and medium-scale producers vulnerable to exploitation. Furthermore, existing forecasting systems developed in other countries are not localized; they do not account for the specific dynamics of Sri Lanka's Aloe Vera value chain, where price variations occur between farmers, intermediaries, and business buyers.

Another major gap is the lack of integration between real-time data sources and predictive models. Previous studies often rely only on historical prices and simple statistical models, which are unable to fully capture sudden market shocks, seasonal trends, or external influences such as weather changes and export demand. While advanced machine learning models such as LSTM and Prophet have shown promise in broader agricultural markets, their application to Aloe Vera pricing remains unexplored. Additionally, there is very limited research on how price forecasting tools can be made farmer-friendly through mobile applications, interactive dashboards, and notifications in local languages. Most available systems are designed for policymakers or traders, rather than individual farmers who need actionable and personalized advice.

The research presented in this proposal seeks to address these gaps by developing the first Aloe Vera-specific price forecasting system for Sri Lanka. Unlike previous studies, this approach combines multiple forecasting techniques—statistical, machine learning, and external factor integration—to improve accuracy and adaptability. It also emphasizes usability by designing a platform tailored to farmers, with multilingual support, visual charts showing price differences across the value chain, and real-time alerts about market opportunities. By filling the gap between academic research and practical farmer needs, this project aims to shift Aloe Vera farming from reactive price-following to proactive price planning. Ultimately, this research not only addresses the absence of Aloe Vera market forecasting in Sri Lanka but also contributes to the broader field of agricultural economics by demonstrating how localized, data-driven tools can improve financial intelligence for under-supported crops.

Table 1:1 Comparison of former research

Application Reference	Collection of Aloe Vera price history	Integration of external signals	Real-time price forecasting	Farmer advisory alerts	Price comparison (Farmer → Middleman → Business owner)
Research [7]	✓	✗	✗	✗	✗
Research [9]	✓	✓	✗	✗	✗
Research [14]	✓	✓	✓	✗	✗
Research [21]	✗	✓	✓	✗	✗
Research [23]	✓	✗	✓	✓	✗
Proposed System	✓	✓	✓	✓	✓

1.3 Research Problem

Aloe Vera cultivation in Sri Lanka has gained momentum due to its rising demand in local and international markets for use in cosmetics, food, and pharmaceutical products. Despite this potential, Aloe Vera farmers face persistent market-related challenges that limit profitability and discourage long-term investment in the crop. The most critical issue is the absence of a structured and reliable system for forecasting Aloe Vera prices. At present, farmers depend on informal communication channels, middlemen, or delayed reports for price information, which creates uncertainty and weakens their bargaining power. This dependency not only reduces transparency in the supply chain but also allows intermediaries to capture most of the profit margins while farmers are left with minimal returns.

Another problem lies in the lack of access to real-time, localized market intelligence. Unlike staple crops such as rice or tea, Aloe Vera has not been supported by institutional research on price monitoring or demand analysis. Farmers are therefore unable to plan harvesting schedules, decide whether to sell raw leaves, processed gel, or planting materials, or identify the right time to enter into contracts with buyers. Price fluctuations caused by seasonality, weather changes, and shifts in consumer demand further complicate decision-making. Without accurate forecasts, farmers often sell their produce at unfavorable prices, which leads to inconsistent income and financial vulnerability.

Existing forecasting tools, where available, are generic and not adapted to Aloe Vera. They often use outdated statistical methods or ignore external signals such as export demand, climate factors, and global market trends. Furthermore, most systems are not designed for practical use at the farmer level, as they lack user-friendly interfaces, multilingual support, or personalized alerts. This creates a digital divide where technological advancements fail to reach the small- and medium-scale farmers who need them most.

The research problem, therefore, centers on how to design a forecasting system that not only predicts Aloe Vera prices accurately but also addresses accessibility, transparency, and farmer empowerment. The challenge is to develop a solution that integrates multiple forecasting methods, incorporates real-time data, and presents results in an actionable and farmer-friendly manner. Solving this problem is vital, as it will enable Aloe Vera farmers to shift from reactive selling to proactive planning, improve their income stability, and strengthen their position within the agricultural value chain. By tackling this issue, the research directly contributes to building a more sustainable and equitable Aloe Vera market ecosystem in Sri Lanka.

2 OBJECTIVES

2.1 Main Objective

The main objective of this research is to develop a real-time Aloe Vera price forecasting system that can guide Sri Lankan farmers in making better selling decisions. The system aims to study how Aloe Vera prices change across different stages of the supply chain—from farmers to middlemen and finally to business owners—and identify the key factors that influence these changes, such as seasonal demand, climate, and market trends. By providing accurate forecasts and easy-to-understand insights, the system will help farmers plan their sales, avoid losses, and increase their profits. The system aims to transform traditional price monitoring into proactive price planning by integrating historical data, external market signals, and advanced forecasting methods into a farmer-friendly platform

2.2 Specific Objectives

To achieve the main objective, the research defines the following specific objectives:

1. Data Collection: Gather historical Aloe Vera price data from farmers, middlemen, and business buyers across different regions.
2. Data Preprocessing: Clean, organize, and structure the collected data to ensure it is accurate and suitable for analysis.
3. Trend Analysis: Identify patterns, seasonal variations, and high-demand products in historical price data.
4. Forecasting Model Application: Apply and compare advanced forecasting techniques such as ARIMA, Prophet, and Long Short-Term Memory (LSTM) networks to determine the most accurate method for price prediction.
5. Integration of External Factors: Incorporate variables like climatic conditions, local market demand, and global Aloe Vera trade trends to improve prediction accuracy.
6. User Interface Design: Develop a bilingual (Sinhala and English) mobile and web interface for farmers to visualize trends, track prices, and receive alerts.

7. Supply Chain Visualization: Display how prices fluctuate across different stages of the supply chain to enhance transparency.
8. Real-Time Alerts: Provide notifications and actionable recommendations when prices are predicted to rise or fall.
9. Farmer Empowerment: Enable farmers to make data-driven decisions that increase profitability, reduce dependency on middlemen, and support sustainable Aloe Vera farming.

3 METHODOLOGY

The smart Aloe Vera price forecasting system helps farmers know what their crops are worth and plan better. First, it collects price data from farmers, middlemen, and markets, then cleans and organizes it. Using this data, the system predicts future prices and spots any sudden drops or unusual trends. It also shows how prices change along the chain—from the farm to middlemen to bigger buyers. Finally, the system gives farmers practical advice, like the best time to sell, which market to choose, and ways to get better profits, all in both Sinhala and English so it's easy to understand.

3.1 System Architecture

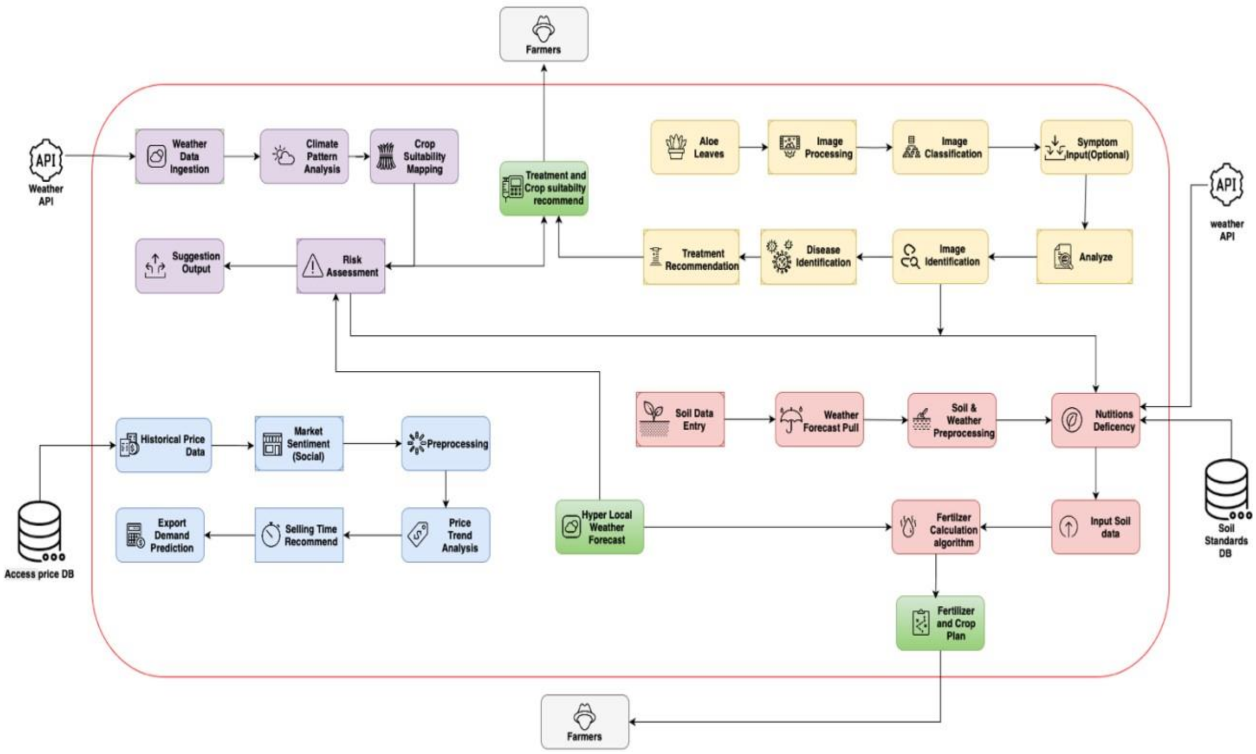

Figure 3:1 Overall System Diagram

The system architecture has been designed to ensure smooth data flow between Aloe Vera farmers, market data sources, processing servers, and decision-support interfaces. The system begins with data collection at the farm and market levels, where prices from farmers, middlemen, and wholesale/export markets are gathered, along with seasonal trends and other relevant factors. This data is transmitted via mobile devices or internet-enabled tools to a central server or cloud environment. The server hosts the machine learning models that analyze the data to predict short-term and seasonal Aloe Vera prices, detect anomalies, and calculate expected profitability for farmers. These insights are then communicated back to the users through a mobile-friendly application or web dashboard. The architecture is modular, allowing easy integration of additional features such as alerts for sudden price drops, multi-market comparisons, or value-chain analysis. By relying on real-time data flow, the system aims to reduce delays between market observation and farmer feedback, helping them make timely, informed decisions to maximize income.

3.1.1 Software Solution

The Aloe Vera Price Forecasting system is designed as a user-friendly, data-driven platform to help farmers make informed decisions. The system starts with data collection, gathering historical and real-time prices from farmers, middlemen, wholesale markets, and export channels. External factors such as seasonal trends and weather conditions are also included. All this data is stored in a central database (MySQL or MongoDB) for easy access and management.

The backend, developed in Python, processes and cleans the data before passing it to the machine learning models that predict short-term and seasonal price trends. The system also identifies sudden price changes or anomalies, ensuring farmers are alerted to unusual market conditions.

The frontend is a mobile-friendly application developed in React Native, allowing users to visualize price trends, compare prices along the value chain (farmer →

middleman → wholesale/export), and receive actionable recommendations. Notifications are sent in both Sinhala and English to maximize accessibility.

The software follows a modular architecture, with separate components for data collection, processing, prediction, visualization, and alerts. This structure makes it easy to maintain, update, and expand the system in the future. Overall, the solution enables seamless integration of market data, forecasting, and farmer decision support, providing transparency and empowering farmers to optimize their profits.

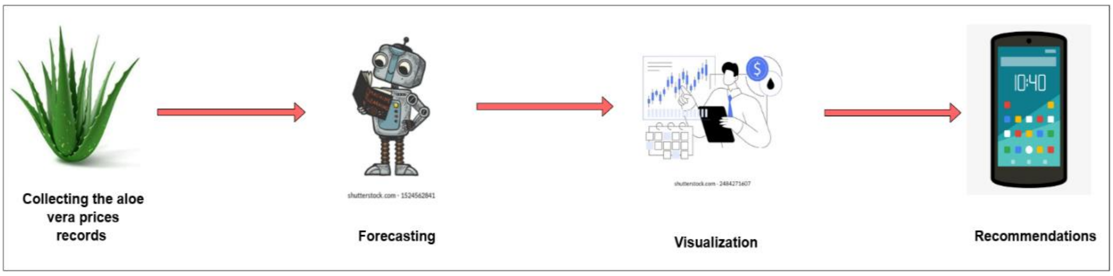

Figure 3:2 Component diagram

Table 3:1 Technologies, Techniques, Architectures

Category	**Specific Tools / Technologies**
Programming Frameworks	Python, React Native
Cloud and Hosting Services	AWS
Development environment	VS Code
Machine Learning	Preprocessing Techniques
System Architecture	Client-Server Model, RESTful APIs
Data Storage	SQL/NoSQL Databases, Cloud Storage Solutions

3.1.2 Commercialization and Business Plan

The Aloe Vera Price Forecasting system has great potential to help farmers, traders, and other stakeholders make better decisions about selling and buying Aloe Vera. The main users are small and medium-scale farmers, local middlemen, and wholesalers who need reliable price information to plan their sales and purchases. By using this system, farmers can see predicted prices, understand how prices change along the supply chain, and decide the best time and place to sell their crops.

The business can operate on a subscription model, where farmers pay a small monthly fee to access real-time forecasts, alerts, and recommendations through a simple mobile app. Extra income can come from detailed market analysis reports that middlemen, exporters, or agricultural cooperatives might purchase.

Marketing the system can focus on direct communication with farmers, working with agricultural societies, cooperatives, and government programs, and using social media to reach rural communities. Training sessions or demo workshops can be organized so farmers learn how to use the app effectively and trust the information it provides.

The platform is designed to be scalable, meaning it can expand to include more crops or cover more regions in the future. By providing clear price insights and helping farmers earn better profits, the system supports fair trade, transparency, and sustainable agriculture, making it useful not just for business but also for improving the livelihoods of rural communities.

3.1.3 Future Scope

The Aloe Vera Price Forecasting system has many possibilities for growth and improvement in the future. Currently, it focuses on predicting prices for farmers and showing how prices move from farmer → middleman → wholesale/export, but it can be expanded in several ways.

1. More Crops: The system can be adapted to predict prices for other crops, vegetables, or fruits, helping a larger group of farmers manage their sales and profits.
2. Advanced Analytics: Future versions can include more advanced features like demand forecasting, seasonal trend analysis, and predictive alerts for supply shortages or market surges.
3. Integration with Marketplaces: The system could be linked directly to online marketplaces or e-commerce platforms, allowing farmers to sell their crops at the best prices based on real-time data.
4. Mobile and IoT Integration: Farmers could input data via smart devices or IoT sensors, like crop quantity or quality, which would make predictions even more accurate.
5. Decision Support Tools: The system can provide recommendations for pricing, storage, and distribution strategies, helping farmers maximize profits and reduce losses.
6. Regional Expansion: Beyond Sri Lanka, the system can expand to other countries where Aloe Vera farming is common, adapting to local market conditions and currencies.
7. Sustainability & Traceability: In the long term, the system could track fair pricing, eco-friendly practices, and supply chain transparency, supporting sustainable agriculture and ethical trade.

4 PROJECT REQUIREMENTS

4.1 Functional Requirements

1. User Registration & Login
   - The system shall allow users (farmers, traders) to register and log in securely.

2. Data Collection & Storage
   - The system shall collect Aloe Vera price data from multiple sources (farm-gate, middleman, wholesale, export). The system shall store user-entered data (farm-gate prices) in the database.

3. Data Preprocessing
   - The system shall clean, normalize, and prepare raw datasets for ML models.

4. Price Forecasting (ML Core)
   - The system shall apply machine learning models to predict short-term and seasonal Aloe Vera prices.

5. Visualization
   - The system shall provide graphical representations (charts, curves) of historical prices and forecasts. The system shall display price gaps from farmer → middleman → wholesale → big business.

6. Dashboard & User Interface
   - The system shall provide a mobile-friendly dashboard to view forecasts, graphs, and recommendations..

7. Multilingual Support
   - The system shall support Sinhala and English for all major functions.

4.2 Non - Functional Requirements

1. Performance Requirements
    - The system shall generate price forecasts in under 5 seconds for a typical query. The system shall handle at least 100 concurrent users without significant performance drop (scalable for more in future).

2. Usability Requirements
    - The system shall provide a simple, farmer-friendly UI with charts and minimal text. The system shall support Sinhala and English for all interfaces. The mobile app shall work on low-cost smartphones with limited processing power.

3. Reliability & Availability
    - The system shall provide 95% uptime during normal operation. The system shall automatically back up datasets daily to prevent data loss. The system shall recover within 2 minutes after a minor failure.

4. Security Requirements
    - The system shall require user authentication (login with username/password). The system shall encrypt sensitive data (user info, price records) in storage and transmission.

5. Scalability Requirements
    - The system shall allow adding new crops in the future (not limited to Aloe Vera). The system architecture shall support expansion to more districts/markets.

6. Maintainability Requirements
    - The system shall be built in a modular architecture (data, model, visualization, and notifications separated). The ML model shall be retrainable when new datasets are available. System updates shall be deployable without downtime.

7. Portability Requirements
    - The system shall run on both Android and iOS (via React Native). The system shall be accessible via web browser as well.

4.3 System Requirements

1. VS Code – To implement and manage the codebase
2. Python – To build the backend, machine learning models, and forecasting functions.
3. SQL - To store price datasets, farmer inputs, and market records.
4. React Native – To design a cross-platform mobile-based application

4.4 User Requirements

1. Simple Access

   - Users should be able to access the system via a mobile app (Android/iOS) or web browser.

2. Language Support

   - The system must be available in Sinhala and English for easy understanding.

3. Real-time Price Information

   - Farmers should see the current Aloe Vera prices (farm-gate, middleman, wholesale, and export).

1. Price Forecasting

   - Users should receive predicted prices for upcoming days/weeks to plan harvesting and selling.

2. Visual Representation

   - Graphs/charts should show price changes over time and the price gap between farmer → middleman, → big business.

4.5 Wireframes

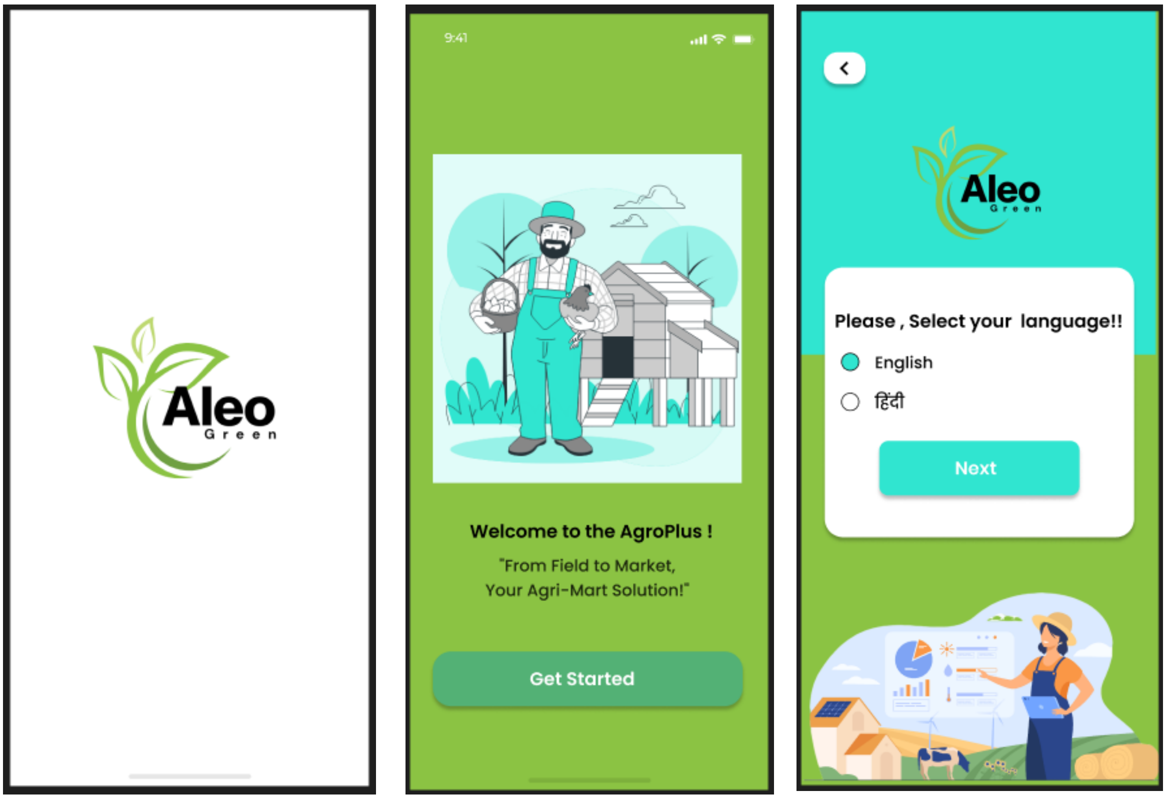

Figure 4:1 Wireframes of the process

5 GANTT CHART

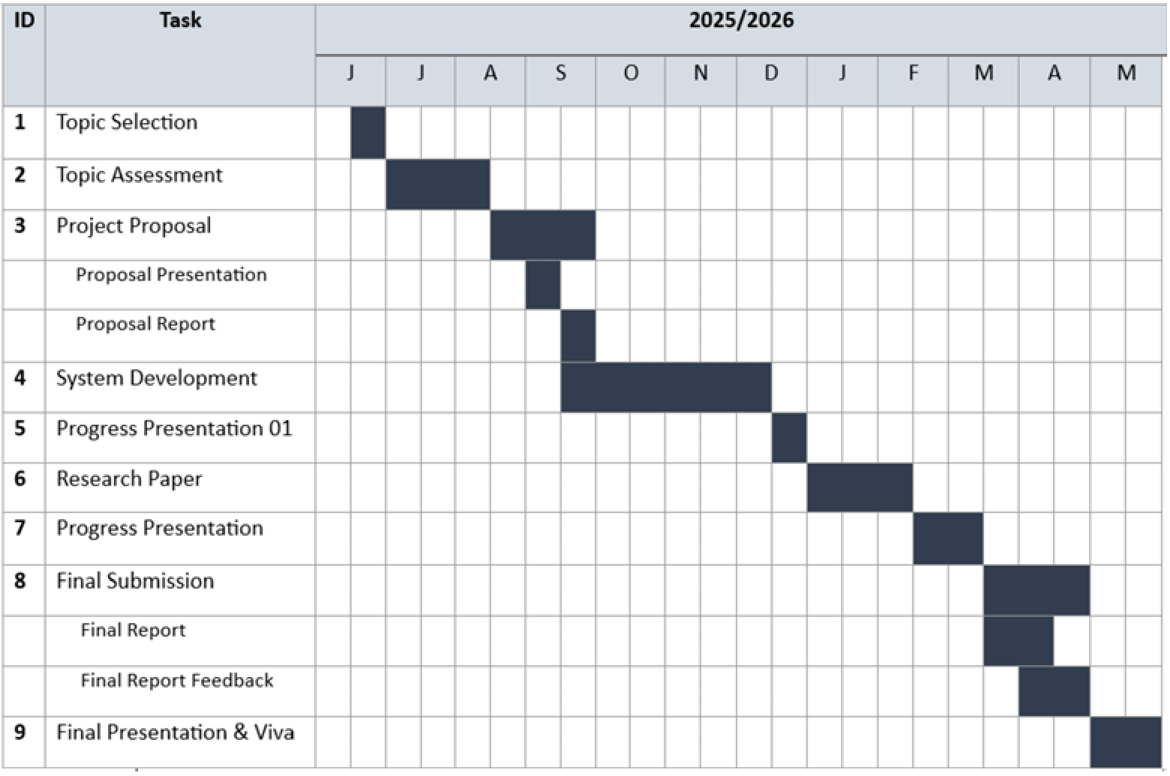

Figure 5:1 Gantt Chart

5.1 Work Breakdown Structure

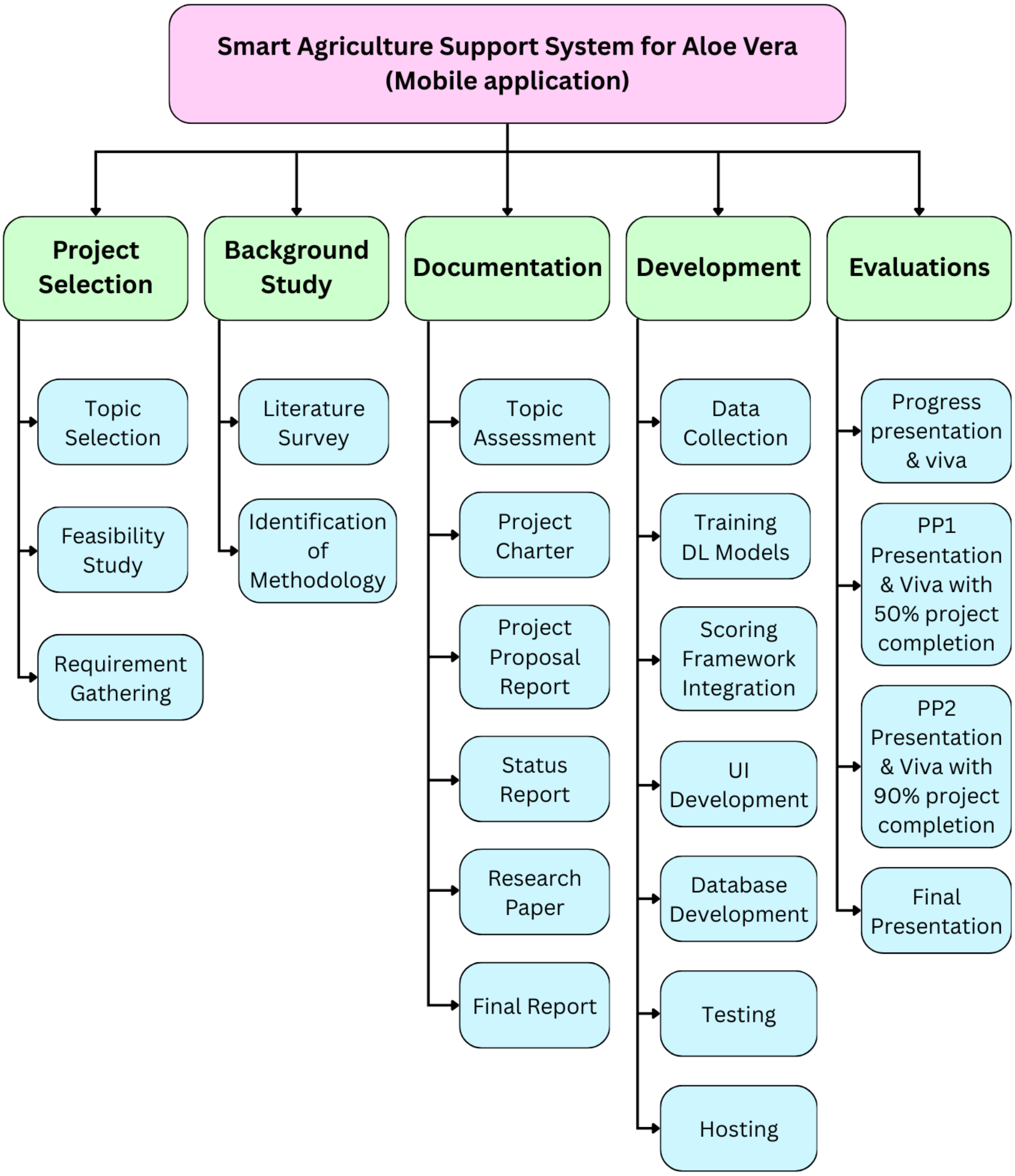

Figure 5:2 Work Breakdown Chart

6 BUDGET AND BUDGET JUSTIFICATION

Table 6.1 below shows the overall budget for the proposed system.

Table 6:1 Expenses for the proposed system

Expenses	
Requirement	**Cost (Rs.)**
Travelling costs for the field visit and data collection	20,000.00
Deployment cost	20,000.00
Hosting cost	9000.00
Total Expenses	**49,000.00**

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APPENDICES

Appendix A: Field Visit and Sample Data Collection

As part of the research study, a field visit was carried out in Lunugamvehera to observe Aloe Vera cultivation and collect real-world data. During the visit, discussions were held with local farmers to understand the current pricing system, challenges in selling Aloe Vera