
Software Requirements Specification for AgroWave

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1.Introduction

AgroWave represents a pioneering fusion of agricultural expertise and cutting-edge technology, poised to revolutionize farming practices worldwide. By harnessing the power of machine learning, real-time data analytics, and expert consultation, AgroWave empowers farmers with predictive insights and tailored recommendations to optimize crop management, enhance resource utilization, and mitigate risks. With features spanning from crop prediction and fertilizer recommendation to direct crop sales and secure payment processing, AgroWave not only facilitates informed decision-making but also fosters economic opportunities and promotes agricultural sustainability. Through AgroWave, we envision a future where technology serves as a catalyst for positive change in agriculture, driving prosperity and resilience for farmers and communities alike.

1.1 Problem Statement

Many farmers rely on traditional methods and lack access to comprehensive digital solutions tailored to their specific needs. The existing systems for crop and fertilizer recommendations, expert consultations, tool hiring, and weather forecasting are often disjointed, user-unfriendly, and not personalized. Moreover, farmers have limited access to direct sales channels, making it difficult to reach customers and secure fair prices for their crops. This lack of integration and accessibility leads to suboptimal farming practices, reduced yields, and limited profitability.

Specific Issues:

- **Inaccurate Crop Recommendations:** Farmers often lack access to precise and personalized crop recommendations based on soil and weather conditions, leading to inefficient crop planning and reduced yields.
- **Inefficient Fertilizer Use:** Inappropriate or excessive use of fertilizers due to lack of specific guidance can degrade soil quality and reduce crop productivity.
- **Limited Expert Access:** Farmers find it challenging to consult with agricultural experts promptly and regularly, hindering their ability to make informed decisions about crop management and pest control.
- **Tool Hiring Difficulties:** Renting agricultural machinery and tools is often cumbersome, lacks a streamlined digital process, and is inaccessible to many farmers.
- **Weather Uncertainty:** Unreliable weather information hampers farmers' ability to plan and execute farming activities effectively, increasing the risk of crop failure.
- **Market Access:** Limited access to direct sales channels prevents farmers from reaching customers, obtaining fair market prices, and enhancing their profitability.
- **Lack of Agricultural News:** Farmers struggle to stay updated with the latest agricultural news and developments, which are crucial for informed decision-making.

1.2 Purpose

The purpose of the Agrowave project is to empower farmers by providing an integrated digital platform that leverages advanced technologies, including machine learning, to address the specific challenges they face. This platform aims to optimize crop selection and yield by offering accurate and personalized crop recommendations based on soil data and weather conditions. It enhances fertilizer usage through precise guidance on application rates, improving soil health and crop productivity. The project also facilitates expert consultations, enabling farmers to receive timely advice and make informed decisions. By streamlining the process of hiring agricultural machinery and tools, Agrowave ensures ease of access and cost-effectiveness. Additionally, the platform provides reliable weather forecasts to help farmers plan their activities and mitigate risks associated with adverse weather conditions. Agrowave enables direct crop sales, ensuring fair prices and reducing dependency on middlemen, thereby enhancing farmers' profitability. Furthermore, the platform keeps farmers informed with the latest agricultural news and developments, promoting the adoption of innovative farming techniques. Finally, robust security measures are implemented to protect user data, ensuring privacy and trust. Overall, Agrowave aims to improve agricultural productivity, sustainability, and economic well-being for farmers through a comprehensive and user-friendly digital solution.

1.3 Project Scope

We're going to create a system that helps farmers with many things like knowing what crops to grow and what fertilizers to use. It'll also give them advice from experts and help them sell their crops easily. We'll include features like checking the weather and keeping track of what crops are in stock. Our goal is to make farming simpler and more profitable for farmers by providing all these helpful tools in one place.

1.3.1 Access Control:

Implementing security measures to ensure that only authorized users can access and use the platform, safeguarding sensitive data and transactions.

1.3.2 Crop Recommendation:

Providing farmers with suggestions on which crops to grow based on factors like soil type, climate, and market demand.

1.3.3 Fertilizer Recommendation:

Offering guidance on the types and quantities of fertilizers to use for optimal crop growth and soil health.

1.3.4 Agricultural Tool Hire:

Facilitating access to farming equipment and machinery on a rental basis, helping farmers reduce costs and improve efficiency.

1.3.5 Weather Forecast:

Providing real-time weather updates and forecasts to help farmers plan and manage their farming activities effectively.

1.3.6 Maintain System:

Ensuring the smooth functioning of the platform by regularly updating software, fixing bugs, and addressing user feedback and issues.

1.3.7 Add to Cart:

Allowing farmers to select and add items like seeds, fertilizers, and equipment to their shopping carts for easy purchase.

1.3.8 Crop Buy and Sale:

Allowing farmers to buy inputs like seeds and fertilizers and sell their produce directly through the platform, thereby streamlining the procurement and sales process.

1.3.9 Manage Profile:

Allowing farmers to create and manage their profiles, including personal information, farm details, and preferences.

1.3.10 Selling History:

Keeping track of past sales transactions, helping farmers analyze their performance and make informed decisions.

1.3.11 Expert Consultation:

Enabling farmers to seek advice and guidance from agricultural experts regarding crop management, pest control, and other farming practices.

1.3.12 Agriculture News:

Offering access to relevant news and information related to agriculture, including market trends, government policies, and technological advancements.

1.4 Glossary

This section provides definitions for all document names, acronyms, and abbreviations. The application domain's terms and concepts are defined.

HTML – Hyper Text Markup Language

JS – JavaScript

CSS – Cascading Style Sheets

PHP – Hypertext Preprocessor

Python

SRS – Software Requirement Specification

UI – User Interface

API – Application Programming Interface

MB – Megabytes

1.5 References

- IEEE. IEEE Std 830-1998 IEEE Recommended Practice for Software Requirements
- Specifications. IEEE Computer Society, 1998.
- Software Engineering 9th Edition by Lan Sommerville.
- Requirements Engineering Fundamentals by Klaus Pohl.
- Database System Concepts 6th Edition by Abraham Silber Schatz

1.6 Overview

Our project aims to create a user-friendly system to help farmers with their farming tasks. It will include features like recommending which crops to grow and suggesting the best fertilizers to use. Farmers can also get advice from experts, check the weather, and buy or sell crops easily through the platform. We'll make sure the system is secure and easy to use, and we'll keep it updated to ensure it runs smoothly. Overall, our goal is to make farming simpler and more profitable for farmers by providing all these helpful tools in one place.

2.Stakeholders

2.1 Primary Stakeholders:

2.1.1 Farmers

Description:

Farmers are the main users of the Agrowave platform. They depend on it for guidance on various aspects of crop management, such as crop and fertilizer recommendations, weather forecasts, and

pest control. Additionally, the platform provides farmers with access to marketplaces for buying and selling crops and the ability to consult with agricultural experts.

Needs:

- Accurate and timely information on crop and fertilizer recommendations.
- Reliable weather forecasts and agricultural news.
- Easy access to expert consultations for advice on farming practices.
- Tools for managing crop sales and maintaining transaction histories.
- Secure and user-friendly interface for managing their profiles and farm activities.

Responsibilities:

- Provide accurate data for crop and soil analysis.
- Utilize the platform's features to improve farming practices.
- Follow expert advice and recommendations.
- Manage their profile and sales history.
- Engage in the marketplace for buying and selling crops.

2.1.2 Agricultural Experts

Description:

Agricultural experts provide valuable insights and guidance to farmers. They help farmers make informed decisions about crop selection, pest control, soil management, and other farming techniques. Their expertise is crucial for improving crop yield and overall farm productivity.

Needs:

- Efficient scheduling and notification system to manage consultations.
- Access to relevant data and context about farmers' issues.
- User-friendly interface for managing consultation sessions.
- Tools to provide tailored advice and recommendations based on specific farmer needs.

Responsibilities:

- Provide accurate and timely advice to farmers.
- Accept and manage consultation requests.
- Maintain availability for consultation sessions.
- Keep their profiles updated with relevant expertise and contact information.

2.1.3 Customers

Description:

Crop buyers purchase crops directly from farmers through the Agrowave platform. They ensure a smooth and transparent transaction process, which benefits both the buyers and the farmers. The platform enables buyers to browse available crops, add items to their cart, and complete purchases.

Needs:

- Intuitive browsing and purchasing process.
- Reliable information about crop quality and availability.
- Secure and efficient transaction handling.
- User-friendly interface for managing orders and transactions.

Responsibilities:

- Browse and select crops for purchase.
- Complete transactions securely and efficiently.
- Provide feedback on purchases and the overall experience.

2.1.4 Admin

Description:

Administrators are responsible for overseeing and managing the Agrowave platform. Their roles include maintaining system integrity, managing user accounts, monitoring transactions, and ensuring data security. They play a crucial role in ensuring the smooth operation and reliability of the platform.

Needs:

- User management tools to handle account creation, updates, and deletions.
- Monitoring and reporting systems to track platform activity and performance.
- Security protocols to protect user data and prevent unauthorized access.
- Communication channels to interact with users and address their concerns.

Responsibilities:

- Ensure the platform is running smoothly and efficiently.
- Manage user accounts and resolve any account-related issues.
- Monitor transactions and platform usage for anomalies or issues.
- Implement and enforce data security measures and protocols.

2.1.5 System

Description:

The system refers to the Agrowave application itself, encompassing its software, hardware, and network components. It is designed to facilitate interactions among farmers, experts, tool providers, and crop buyers, providing a seamless and efficient platform for agricultural activities.

Needs:

- Robust and scalable infrastructure to handle varying loads and ensure high availability.
- Secure and efficient data storage solutions to manage large volumes of agricultural data.
- Reliable network connectivity to support uninterrupted access and transactions.
- Regular updates and maintenance to keep the system up-to-date and secure.

Responsibilities:

- Provide a user-friendly interface for all stakeholders to interact with the platform.
- Ensure data integrity, security, and confidentiality at all times.
- Support seamless transactions and communications between different user groups.
- Continuously monitor system performance and address any technical issues promptly.

2.2 Secondary Stakeholders:

2.2.1 Agricultural Tool Suppliers

Description:

Agricultural input suppliers provide farmers with essential inputs equipment. They play a crucial role in ensuring that farmers have the necessary resources to perform successful farming operations.

Needs:

- Efficient distribution channels to deliver tools to farmers.
- Accurate demand forecasts to manage inventory.
- Platform to advertise and sell their products to farmers.
- Reliable payment processing for transactions.

Responsibilities:

- Supply quality agricultural tools to farmers.
- Manage inventory and distribution logistics.
- Ensure timely delivery of tools to farmers.
- Provide product information and support to farmers.

2.2.2 Weather Forecast Providers

Description:

Weather forecast providers offer accurate and timely weather forecasts to the Agrowave system. Their data helps farmers plan agricultural activities and mitigate weather-related risks, such as droughts, floods, and storms.

Needs:

- Reliable data feed to provide continuous weather updates.
- Accurate and timely weather forecasts.
- Integration with the Agrowave platform for seamless data access.

Responsibilities:

- Provide accurate weather forecasts to the system.
- Ensure minimal downtime and reliable data feed.
- Update weather data regularly to reflect current conditions.

2.2.3 Payment Service Providers

Description:

Payment service providers facilitate secure and efficient payment transactions between farmers and crop buyers. They ensure that payments are processed timely and financial security is maintained for all parties involved.

Needs:

- Secure payment processing system.
- Efficient transaction handling to ensure timely payments.
- User-friendly interface for managing payments and transactions.
- Fraud prevention and security measures to protect transactions.

Responsibilities:

- Process payments securely and efficiently.
- Ensure timely payments to farmers.
- Provide customer support for payment-related issues.
- Implement and maintain security measures to prevent fraud.

2.2.4 Fertilizer Manufacturers

Description:

Fertilizer manufacturers produce fertilizers that farmers use to improve soil fertility and enhance crop yield. Their products contribute significantly to agricultural productivity and sustainability.

Needs:

- Accurate demand forecasts to manage production.
- Distribution channels to deliver fertilizers to farmers.
- Platform to advertise and sell their products.
- Reliable payment processing for transactions.

Responsibilities:

- Produce and supply quality fertilizers to farmers.
- Manage inventory and distribution logistics.
- Ensure timely delivery of fertilizers to farmers.
- Provide product information and usage guidelines to farmers.

This detailed breakdown provides a comprehensive view of each stakeholder's role, needs, and responsibilities, ensuring the effective operation and success of the Agrowave system.

3. Design and Implementation Constraints

To ensure project success, we've identified design and implementation limitations. These constraints encompass the following:

We have employed design and implementation constraints to ensure the success of this project. It also refers to a tool that allows developers and testers to inspect and interact with the application's user interface (UI) elements.

The design and implementation constraints for the Agrowave platform:

Scalability: The platform needs to be designed to handle a large number of users, transactions, and data. It should be able to scale easily and efficiently as the user base and demand grow.

Security: The platform needs to be secure to protect sensitive information such as user data, financial information, and transaction details. This includes measures such as data encryption, secure payment gateways, and secure user authentication.

Availability: The platform needs to be highly available and reliable to ensure users can always access the platform and its services. This includes measures such as redundancy, load balancing, and disaster recovery.

User Experience: The platform needs to provide a seamless and intuitive user experience for all stakeholders, including farmers, consumers, agro-solution providers, agricultural equipment providers, logistics providers, and financial institutions. This includes features such as easy navigation, responsive design, and personalized recommendations.

Data Management: The platform needs to be designed to manage and store large amounts of data related to users, products, transactions, and other relevant information. This includes measures such as database design, data security, and data backup.

Integration: The platform needs to integrate with various third-party services such as payment gateways, logistics providers, and other relevant services. This requires an API-based architecture that can easily integrate with other systems.

Technology Stack: The platform needs to be built using appropriate technology stacks that can support its features and requirements. This may include programming languages such as Python, JavaScript, and Java, frameworks such as Django and Node.js, and databases such as PostgreSQL and MongoDB.

Testing: The platform needs to be thoroughly tested to ensure its functionality, security, and performance. This includes unit testing, integration testing, and acceptance testing.

Compliance: The platform needs to comply with relevant laws and regulations related to data protection, financial transactions, and other relevant areas. This includes measures such as GDPR compliance, PCI DSS compliance, and other relevant regulations.

3.1 User Interface Technology

The visual layout of the components that a user could interact with a website or technical product is referred to as user interface design, or UI design. In other terms, it is a website's visual design.

3.1.1 Programming Language

PHP: The general-purpose programming language (GPPL) is PHP. It is mostly used as a server-side scripting language for the creation of websites. Web development is also simplified by the PHP frameworks. This framework makes it easier to reuse existing code and eliminates the need to create lengthy, intricate code for web apps. The majority of PHP frameworks are free source and simple to use. Because PHP is open-source and cost-free, developers may install it easily and utilize it right away. All major operating systems, including Windows, Unix, Linux, etc., support PHP. Web applications created using PHP may simply operate on any platform. PHP makes a safe connection with databases and connects to them with ease. It features an integrated module that may be used to quickly connect to the database. The primary purposes of the PHP framework are to simplify the construction of web applications and to automatically maintain the code. The builtin tools and features of PHP frameworks make it simpler to defend online applications from outside assaults and security risks.

3.1.2 CSS Framework

Cascading Style Sheets (CSS) is a language for specifying the appearance of a document written in a markup language like HTML. Along with HTML and JavaScript, CSS is a key component of the World Wide Web. Semantic UI is a website using UI component framework. Developers may use Semantic UI to create websites with quick and clear HTML, as well as a fully mobile responsive experience. Semantic UI offers a React-integrated version called Semantic UI React, which includes the following functionalities:

- Bootstraps,
- Declarative API.
- Augmentation.
- Shorthand Props.
- Sub Components.
- Auto Controlled State

3.1.3 Bootstrap

Bootstrap is a sizable repository of reusable code that comes in handy for developers. It is a JavaScript, CSS, and HTML frontend development framework. Using Bootstrap, web developers and designers can easily create fully responsive websites. It might be regarded as the most wellliked CSS framework for creating mobile-first and responsive applications.

3.2 Server-Side Technology

Server-side development refers to the actions that take place behind the scenes when an application is used. It primarily focuses on databases, scripting, website architecture, backend logic, APIs, and Servers.

3.2.1 Application Server

In the context of the E-Filing System, the application server plays a crucial role in facilitating the operation and management of the system. It provides the runtime environment necessary for running the web-based application and handling the processing of requests from users. An application server is a modern form of platform middleware. It is system software that resides between the operating system (OS) on one side, the external resources (such as a database management system [DBMS], communications and Internet services) on another side and the users' applications on the third side. The function of the application server is to act as host (or container) for the user's business logic while facilitating access to and performance of the business application. The application server must perform despite the variable and competing traffic of client requests, hardware and software failures, the distributed nature of the larger-scale applications, and potential heterogeneity of data and processing resources required to fulfill the business requirements of the applications.

4. Requirement Specification

All the requirements based on the elicitation process are described in this section.

4.1 Functional Requirement

Functional requirements are specifications that describe the system's functions or capabilities from a user's perspective. They outline what the system should do and how it should behave under specific conditions. Functional requirements are typically expressed as actions or tasks that the system must perform, and they are crucial for defining the system's behavior and determining its success in meeting user needs.

4.1.1 Access Control

FR-1	Access Control		
Description	The system should authenticate users before granting access to its features and functionalities to ensure security and privacy.		
Stakeholders	Admin, Farmer, Expert, Customer	Priority	High

4.1.2 Crop Recommendation

FR-2	Crop Recommendation		
Description	The system should analyze crop and soil data provided by the user and recommend suitable crops for cultivation based on the analysis.		
Stakeholders	Farmers, System	Priority	High

4.1.3 Fertilizer Recommendation

FR-3	Fertilizer Recommendation		
Description	The system should provide recommendations for suitable fertilizers based on the analysis of crop and soil data.		
Stakeholders	Farmers, System	Priority	High

4.1.4 Agriculture Tool Hire

FR-4	Agriculture Tool Hire		
Description	The system should enable farmers to hire agricultural machinery and equipment for farm operations such as plowing, planting, and harvesting.		
Stakeholders	Farmers, Customers	Priority	Medium

4.1.5 Weather Forecast

FR-5	Weather Forecast		
Description	The system should provide weather forecasts to help farmers plan their farming activities effectively.		
Stakeholders	Farmers, System	Priority	Medium

4.1.6 System Maintenance

FR-6	System Maintenance		
Description	The system should provide administrative functionalities to maintain and manage the overall system operations, including updates, backups, and user management.		
Stakeholders	Farmers, Customers, System	Priority	High

4.1.7 Add to Cart

FR-8	Add to Cart		
Description	The system should enable customers to add crops to a virtual shopping cart for purchase, facilitating a seamless buying experience.		
Stakeholders	Farmers, Customers	Priority	Medium

4.1.8 Crop Buy and Sale

FR-9	Crop Buy and Sale		
Description	The system should facilitate direct sales of crops to customers, allowing farmers to market their produce efficiently.		
Stakeholders	Farmers, Customers	Priority	High

4.1.9 Manage Profile

FR-10	Manage Profile		
Description	The system should allow users to create, update, and manage their profiles, including personal information and preferences.		

Stakeholders	Farmers, Customer, Admin, Experts	Priority	Medium
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4.1.10 Selling History

FR-11	Selling History		
Description	The system should maintain a record of crop sales history for each farmer to track their past transactions and performance.		
Stakeholders	Farmers	Priority	Low

4.1.11 Expert Consultation

FR-12	Expert Consultation		
Description	The system should allow farmers to consult with agricultural experts for guidance and advice on crop cultivation and management.		
Stakeholders	Farmers, Experts	Priority	Medium

4.1.12 Agriculture News

FR-13	Agriculture News		
Description	The system should deliver agricultural-related news and updates to keep farmers informed about the latest trends, technologies, and policies.		
Stakeholders	Farmers, System	Priority	Low

4.2 Data Requirement

Data requirements outline the essential information needed for the Agrowave application to function effectively. They ensure the system captures, stores, and manages relevant data to meet the needs of farmers, customers, tool providers, and experts, facilitating efficient decision-

making and smooth transactions within the agricultural community.

4.2.1 User Information

Description: Comprehensive details about users, including personal and contact information. This data encompasses farmers, customers, agricultural experts, and tool providers, ensuring effective communication and personalized service delivery. Accurate user data is essential for account management and targeted interactions.

Stakeholders: Farmers, Customers, Experts

Priority: High

4.2.2 Crop Data

Description: Detailed information on various crops, including types, growth cycles, optimal soil conditions, and expected yields. This data helps farmers select suitable crops and manage their cultivation practices effectively, while also aiding experts in providing informed recommendations.

Stakeholders: Farmers, Agricultural Experts

Priority: High

4.2.3 Soil Data

Description: Information about different soil types, including pH levels, nutrient composition, and overall soil health. This data supports farmers in making decisions about soil treatment and crop suitability, and helps experts offer precise soil management advice.

Stakeholders: Farmers, Agricultural Experts

Priority: High

4.2.4 Weather Data

Description: Historical and real-time weather information, covering temperature, rainfall, humidity, and forecasts. Access to accurate weather data enables farmers to plan their agricultural activities, mitigate risks, and optimize crop yields by responding to weather changes promptly.

Stakeholders: Farmers

Priority: Medium

4.2.5 Crop Stock Data:

Description: Inventory details of crops available for sale, including quantities, quality

assessments, and storage conditions. This data is crucial for managing sales, ensuring transparency between farmers and buyers, and optimizing the supply chain.

Stakeholders: Farmers, Customers

Priority: High

4.2.6 Tool and Equipment Data:

Description: Information on agricultural tools and equipment available for hire or purchase, including specifications, availability, and rental terms. This data helps farmers access necessary tools efficiently and supports tool providers in managing their inventories and rental services.

Stakeholders: Farmers, Customers

Priority: High

4.2.7 Expert Consultation Data:

Description: Information on consultations provided by agricultural experts, including the type of advice given, follow-up recommendations, and farmer feedback. This data facilitates continuous improvement of expert services and ensures farmers receive relevant and effective guidance.

Stakeholders: Farmers, Agricultural Experts

Priority: Medium

4.2.8 News and Updates Data:

Description: Information on the latest agricultural news, trends, and updates. Providing users with current news helps them stay informed about market trends, policy changes, and new agricultural practices.

Stakeholders: Farmers, Agricultural Experts, Customers

Priority: Low

4.3 Performance Requirement

Performance requirements specify how well the system should respond in terms of speed, throughput, and resource utilization. They define criteria for the system's responsiveness, scalability, and efficiency under varying conditions. These requirements ensure that the system can handle the expected workload without degradation in performance and meet user expectations for speed and reliability.

4.3.1 System Availability:

Description: The system should be available 99.9% of the time to ensure uninterrupted access for all users, including farmers, crop buyers, tool providers, and experts. This high availability is critical for supporting continuous operations and user satisfaction.

Stakeholders: All users

Priority: High

4.3.2 Response Time:

Description: The system should provide a response time of less than 2 seconds for user queries and actions, including searches, form submissions, and page loads. Quick response times are essential for maintaining an efficient and user-friendly experience.

Stakeholders: All users

Priority: High

4.3.3 Scalability:

Description: The system should be able to scale efficiently to handle increased load during peak usage times, such as harvest seasons or promotional events. It should support up to 10,000 concurrent users without degradation in performance, ensuring reliability during high traffic periods.

Stakeholders: Platform Administrators, All users

Priority: High

4.3.3 Data Processing Speed:

Description: The system should process and update data in real-time, or within a maximum of 5 seconds for larger datasets. This ensures timely information for decision-making and transactions, which is crucial for users who rely on up-to-date data.

Stakeholders: Farmers, Customers, Experts

Priority: High

4.3.4 Transaction Throughput:

Description: The system should be capable of processing a minimum of 1,000 transactions per second. This capacity is necessary to handle sales, purchases, and rentals efficiently, supporting

smooth and rapid transaction processing.

Stakeholders: Farmers, Customers, Payment Service Providers

Priority: High

4.3.5 Load Time for Heavy Pages:

Description: Pages with heavy content, such as detailed crop information or tool listings with multiple images, should load within 5 seconds. Maintaining fast load times for content-rich pages ensures a seamless user experience.

Stakeholders: All users

Priority: Medium

4.3.6 Search Functionality Performance:

Description: The search functionality should return results within 1 second, ensuring users can quickly find the information they need. Fast search results improve the efficiency and satisfaction of users interacting with the platform.

Stakeholders: All users

Priority: High

4.3.7 Batch Processing:

Description: The system should handle batch processing tasks, such as bulk updates to crop listings or batch data imports, within an acceptable time frame of 30 minutes for up to 10,000 records. Efficient batch processing is important for maintaining data accuracy and system performance.

Stakeholders: Admin

Priority: Medium

4.3.8 Mobile Optimization:

Description: The system should be optimized for mobile devices, ensuring that all features are fully accessible and responsive on smartphones and tablets. Mobile page load times should be under 3 seconds, catering to the needs of users who access the platform on-the-go.

Stakeholders: Farmers, Customers

Priority: High

4.3.9 Error Rate:

Description: The system should maintain an error rate of less than 0.1% for all operations, including data entry, transactions, and system processes. High reliability and accuracy are critical to maintaining user trust and operational integrity.

Stakeholders: All users

Priority: High

5. Requirement Engineering Process

Software requirements are established using requirements engineering (RE), which involves understanding and capturing customer needs or requirements. The requirements engineering process includes several key steps:

- Requirement elicitation techniques
- Requirement validation

5.1 Requirement Elicitation Techniques

Requirement elicitation, also known as "requirement gathering," is the process of investigating and discovering system requirements from users, clients, and other stakeholders. Various techniques can be employed to elicit requirements effectively:

5.1.1 Hold Interviews

Interviews are one-on-one or small group discussions with stakeholders to gather program criteria. These sessions help in obtaining specific demands from participants and identifying any conflicts or issues.

- Short description about project
- Product details
- Dealing with farmers & customer
- Transaction & feedback system

5.1.2 Perform Document Analysis

Document analysis is a requirement elicitation technique that involves examining existing documentation related to the system to understand its functionalities, constraints, and user requirements. Analysis can help to determine which performance should remain and functionality that isn't in use. This technique is particularly useful for gaining insights into how the current system operates, identifying areas for improvement, and understanding stakeholder needs without directly interacting with them.

5.2 Sample of Requirement Collection

The process of requirement collection serves as a foundational step in the development of any project, providing crucial insights into the needs, preferences, and expectations of key stakeholders. This document presents an introduction to a sample requirement collection process conducted for the Agrowave project, focusing on gathering insights from both farmers and agricultural experts.

Requirement collection involves systematically gathering and analyzing information from stakeholders to identify essential features and functionalities for the proposed Agrowave platform. Through a combination of structured interviews, surveys, and observations, the goal is to gain a comprehensive understanding of the user requirements and system constraints.

5.2.1 Requirement Collection - 1

The requirement collection phase of the Agrowave project aimed to gather insights and preferences from a diverse pool of stakeholders, primarily farmers.

Interview

Methodology:

The requirement collection process utilized a structured interview approach, wherein participants were asked a series of predefined questions related to their preferences, challenges, and expectations concerning their farming activities and the proposed Agrowave application. Interviews were conducted in-person and digitally, allowing for flexibility and inclusivity in participation. Responses were recorded, transcribed, and analyzed for common themes and patterns.

Participants:

A total of 25 farmers from various regions and types of farming participated in the requirement collection process. Participants were selected randomly to ensure representation across different

demographics, including gender, age, and type of crops grown. Their diverse perspectives and experiences provided valuable insights into the needs and preferences of the broader farming community.

Findings:

Key findings from the requirement collection interviews include:

- High demand for accurate crop and fertilizer recommendations.
- Preference for a user-friendly interface to access expert consultations and hire tools.
- Desire for timely notifications regarding weather forecasts and market trends.
- Interest in direct crop sales to customers with transparent transaction processes.
- Concerns about security and privacy in accessing and using the application.

Key Requirements:

Based on the findings, the following key requirements were identified for the Agrowave application:

- Accurate crop and fertilizer recommendations.
- User-friendly interface for expert consultations and tool hiring.
- Notification system for weather updates and market trends.
- Platform for direct crop sales with secure transaction management.
- Robust security measures to protect user data.

Assumptions:

The requirement collection process operated under the following assumptions:

- Participants provided honest and representative feedback.
- Preferences and needs expressed by participants are reflective of broader farmer sentiments.
- Technical feasibility and resource availability to implement identified requirements.

Limitations:

Limitations encountered during the requirement collection phase include:

- Limited sample size due to resource constraints.
- Potential biases in participant selection and responses.

Difficulty in capturing nuances and complexities of user preferences in a structured interview format.

Conclusion:

The requirement collection process served as a foundational step in understanding the needs and expectations of farmers regarding the Agrowave application. Key insights gleaned from participant interviews have informed the development of essential features and functionalities to enhance the farming experience. Moving forward, continued collaboration with stakeholders and iterative refinement of requirements will be essential to ensure the success and relevance of the Agrowave project.

5.2.2 Requirement Collection - 2

This document outlines the requirements gathered from interviews conducted with 8 agricultural experts. The objective was to understand the perspectives, challenges, and preferences of experts regarding the proposed Agrowave application.

Methodology:

Interviews with agricultural experts were conducted in-person and digitally, utilizing a structured questionnaire to gather insights into their experiences, needs, and expectations. Responses were recorded, transcribed, and analyzed to identify common themes and requirements.

Participants:

A total of 8 agricultural experts participated in the requirement collection process. Experts were selected based on their experience and involvement in various agricultural domains, ensuring representation across different specializations and regions.

Findings:

Key findings from the expert interviews include:

- Desire for a streamlined platform to provide consultations and advice to farmers.
- Need for access to real-time data on weather and crop conditions.
- Interest in features that facilitate the dissemination of best practices and research findings.
- Concerns about user authentication and security measures within the application.

Key Requirements:

Based on the findings, the following key requirements were identified for the Agrowave application:

- User-friendly interface for managing and providing expert consultations.
- Integration of real-time weather data and crop conditions.
- Features to facilitate the sharing of best practices and research.
- Secure authentication mechanisms to ensure expert access and data integrity.

Assumptions:

The requirement collection process operated under the assumption that experts provided honest and representative feedback based on their experiences and needs within the agricultural sector.

Limitations:

- Limitations encountered during the requirement collection phase include:
- Potential biases in participant selection and responses.
- Difficulty in capturing the full spectrum of expert perspectives and requirements within the scope of the interviews.

Conclusion:

The requirements gathered from agricultural experts serve as valuable insights into the features and functionalities needed to enhance the Agrowave application's effectiveness and usability. Moving forward, collaboration with experts and ongoing refinement of requirements will be essential to ensure the successful implementation and adoption of the application.

5.2.3 Requirement Collection - 3

This document outlines the requirements gathered from interviews conducted with agricultural tool providers. The objective was to understand the perspectives, challenges, and preferences of tool providers regarding the proposed Agrowave application.

Interview

Methodology:

The requirement collection process utilized a structured interview approach, wherein participants were asked a series of predefined questions related to their preferences, challenges, and expectations concerning their interaction with farmers and the proposed Agrowave application. Interviews were conducted in-person and digitally, allowing for flexibility and inclusivity in participation. Responses were recorded, transcribed, and analyzed for common themes and patterns.

Participants:

A total of 15 agricultural tool providers participated in the requirement collection process. Participants were selected based on their experience and involvement in providing tools and equipment to farmers, ensuring representation across different types of tools and geographical locations.

Findings:

Key findings from the requirement collection interviews include:

- High demand for a platform to list and advertise agricultural tools and equipment.
- Preference for a user-friendly interface to manage tool listings and rental requests.
- Need for a secure and efficient transaction system to handle tool rentals and sales.
- Interest in receiving notifications and updates on rental requests and tool availability.
- Concerns about security and privacy in accessing and using the application.

Key Requirements:

Based on the findings, the following key requirements were identified for the Agrowave application:

- Comprehensive tool listing and advertising platform.
- User-friendly interface for managing tool listings and rental requests.
- Secure and efficient transaction system for tool rentals and sales.
- Notification system for updates on rental requests and tool availability.
- Robust security measures to protect user data.

Assumptions:

The requirement collection process operated under the following assumptions:

- Participants provided honest and representative feedback.
- Preferences and needs expressed by participants are reflective of broader tool provider sentiments.
- Technical feasibility and resource availability to implement identified requirements.

Limitations:

Limitations encountered during the requirement collection phase include:

- Limited sample size due to resource constraints.

- Potential biases in participant selection and responses.
- Difficulty in capturing nuances and complexities of user preferences in a structured interview format.

Conclusion:

The requirement collection process served as a foundational step in understanding the needs and expectations of agricultural tool providers regarding the Agrowave application. Key insights gleaned from participant interviews have informed the development of essential features and functionalities to enhance the tool rental and sales experience. Moving forward, continued collaboration with stakeholders and iterative refinement of requirements will be essential to ensure the success and relevance of the Agrowave project.

5.2.4 Requirement Collection - 4

Introduction

This document outlines the requirements gathered from interviews conducted with customers. The objective was to understand the perspectives, challenges, and preferences of customers regarding the proposed Agrowave application.

Interview

Methodology

The requirement collection process utilized a structured interview approach, wherein participants were asked a series of predefined questions related to their preferences, challenges, and expectations concerning their interaction with farmers and the proposed Agrowave application. Interviews were conducted in-person and digitally, allowing for flexibility and inclusivity in participation. Responses were recorded, transcribed, and analyzed for common themes and patterns.

Participants

A total of 20 customers participated in the requirement collection process. Participants were selected based on their experience and involvement in purchasing agricultural products, ensuring representation across different demographics and geographical locations.

Findings

Key Findings from Interviews:

- High demand for a platform to browse and purchase fresh agricultural products directly from farmers.
- Preference for a user-friendly interface to facilitate easy browsing, ordering, and payment processes.
- Need for reliable delivery services and clear communication about delivery times.
- Interest in receiving updates on new product listings, promotions, and order status.
- Concerns about security and privacy in accessing and using the application.

Key Requirements

Based on the findings, the following key requirements were identified for the Agrowave application:

- Comprehensive product listing and browsing platform.
- User-friendly interface for browsing, ordering, and payment.
- Reliable delivery services and clear communication channels for delivery updates.
- Notification system for updates on product listings, promotions, and order status.
- Robust security measures to protect user data.

Assumptions:

The requirement collection process operated under the following assumptions:

- Participants provided honest and representative feedback.
- Preferences and needs expressed by participants are reflective of broader customer sentiments.
- Technical feasibility and resource availability to implement identified requirements.

Limitations

Limitations encountered during the requirement collection phase include:

- Limited sample size due to resource constraints.
- Potential biases in participant selection and responses.
- Difficulty in capturing nuances and complexities of user preferences in a structured interview format.

5.3 Conflict Requirements and Negotiations

The requirement collection process served as a foundational step in understanding the needs and expectations of customers regarding the Agrowave application. Key insights gleaned from participant interviews have informed the development of essential features and functionalities to enhance the customer experience. Moving forward, continued collaboration with stakeholders and iterative refinement of requirements will be essential to ensure the success and relevance of the Agrowave project.

Conflict Requirement 1: Real-time Data Accuracy vs. System Performance

Description:

- Farmers want real-time data on crop prices, weather conditions, and market trends to make informed decisions.
- Experts demand accurate data analytics for providing reliable advice.
- System performance may be affected by the constant update and retrieval of real-time data.

Negotiations:

- **Data Prioritization:** Implement a system where critical data (e.g., weather alerts) is prioritized for real-time updates, while less critical data (e.g., historical market trends) is updated less frequently.
- **Caching Mechanism:** Use data caching to store frequently accessed information temporarily, reducing the load on the system and improving performance.
- **Scheduled Updates:** Allow farmers and experts to customize their data update preferences, opting for real-time updates only when necessary and scheduling less critical updates during off-peak hours.

Conflict Requirement 2: Comprehensive Tool Listings vs. User Interface Simplicity

Description:

- Tool Providers require a comprehensive platform to list a wide range of agricultural tools and equipment.
- Farmers prefer a simple and easy-to-navigate user interface to quickly find and rent tools.

Negotiations:

- **Categorization:** Organize tools into clear categories and subcategories, allowing for a comprehensive listing without overwhelming the user interface.
- **Search and Filter Options:** Implement advanced search and filter functionalities to help

farmers quickly find specific tools without browsing through extensive lists.

- **User Feedback:** Regularly gather feedback from farmers to identify and address any usability issues, ensuring the interface remains user-friendly while accommodating comprehensive listings.

Conflict Requirement 3: Secure Transactions vs. Ease of Access

Description:

- Farmers and Customers want secure and reliable transaction processes to protect their financial information.
- All Stakeholders need a system that is easy to access and use without cumbersome security protocols.

Negotiations:

- **Two-Factor Authentication:** Implement two-factor authentication (2FA) to enhance security without significantly impacting ease of access.
- **User Education:** Provide clear instructions and support to help users understand and efficiently use security features.
- **Balancing Security Layers:** Implement layered security measures that protect sensitive transactions while allowing easier access to less critical functionalities.

Conflict Requirement 4: Detailed Information vs. Data Privacy

Description:

- Farmers and Experts require detailed information on crop types, soil conditions, and other agricultural data to optimize farming practices.
- System must ensure the privacy and security of sensitive user data.

Negotiations:

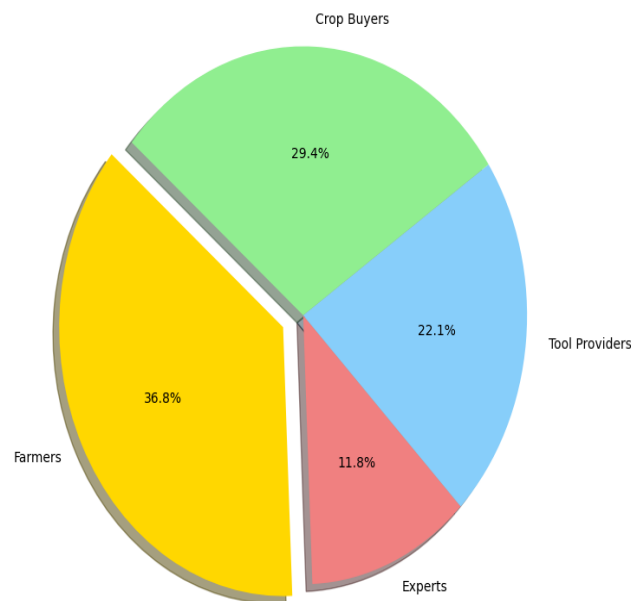
- **Data Anonymization:** Use anonymization techniques to provide detailed agricultural data without compromising the privacy of individual users.
- **Consent Management:** Implement a robust consent management system where users can control what data they share and with whom.
- **Data Aggregation:** Present detailed information in aggregated form to protect individual privacy while still providing valuable insights.

5.4 Distribution of Stakeholder Interviews

5.4.1 Pie Chart:

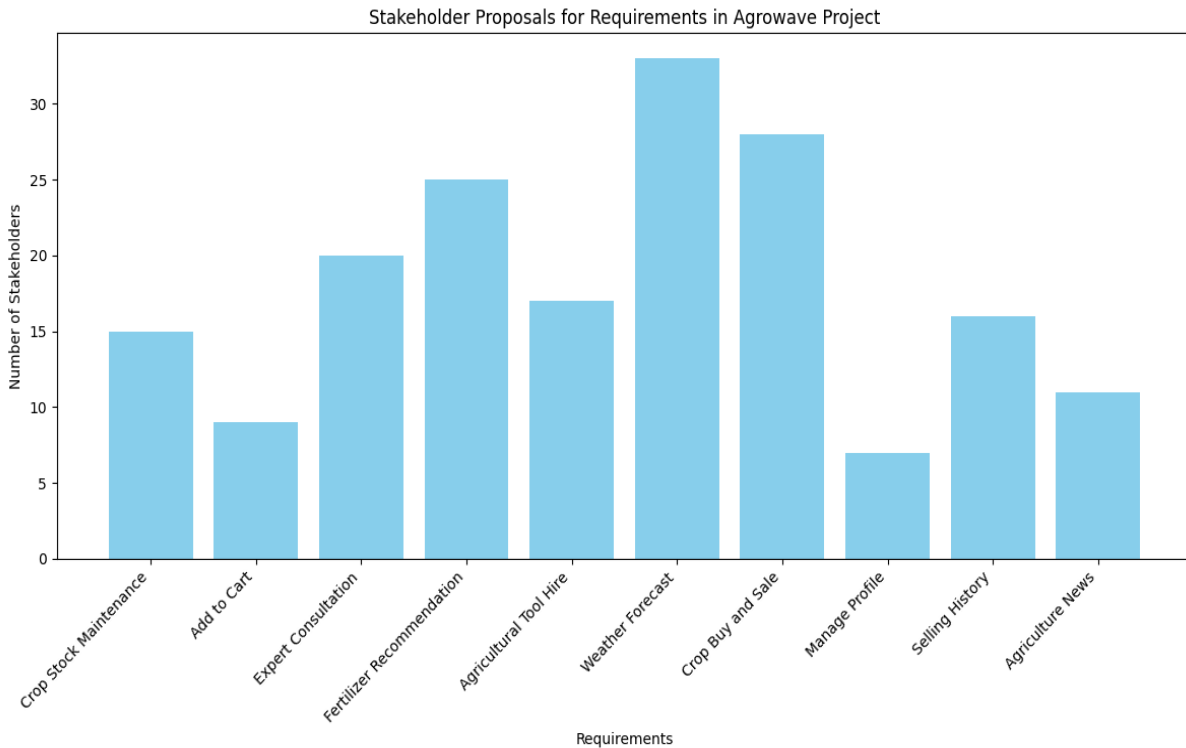
The pie chart illustrates the distribution of interviews conducted among various stakeholders for the Agrowave project. It represents the percentage of interviews held with farmers, experts, tool providers, and crop buyers. This visualization helps in understanding the engagement and involvement of different stakeholders in the project.

Distribution of Interviews Among Stakeholders



5.4.2 Bar Chart:

The bar chart displays the number of stakeholders who proposed different requirements for the Agrowave project. Each requirement is listed on the X-axis, and the number of stakeholders proposing each requirement is depicted on the Y-axis. This visualization provides insights into the prioritization of requirements based on stakeholder inputs.



5.5 Requirement Validation

Requirement validation ensures that the requirements are correct and reflect the quality you want from this program. In the beginning, our requirements looked good, but when we read them and tried to work with them, they came out having ambiguities and gaps.

5.5.1 Walkthrough

A walkthrough is a review of the requirement documents conducted by a team of stakeholders, developers, and experts. They review the requirements and provide feedback on their completeness, correctness, and consistency.

5.5.2 Prototype Testing

Creating a working prototype of the application and testing it with users to validate the requirements and identify any issues or areas for improvement. It is a working model of the system. It can be used to validate the requirements by allowing stakeholders and users to interact with the system and provide feedback on its functionality and usability.

5.5.3 User Acceptance Testing (UAT)

UAT is a testing process where end-users test the system to verify if it meets their requirements. This process can help validate the requirements and ensure that the system meets the needs of the users.

5.5.4 Requirements Traceability

Using the traceability information to verify that all requirements have been implemented in the application.

This requirement collection process provides a comprehensive overview of the functional and non-functional requirements, stakeholders, and key use cases for the Agrowave project. Continued collaboration with stakeholders and iterative refinement of requirements will ensure the success and relevance of the Agrowave application.

6. Use Case Diagram

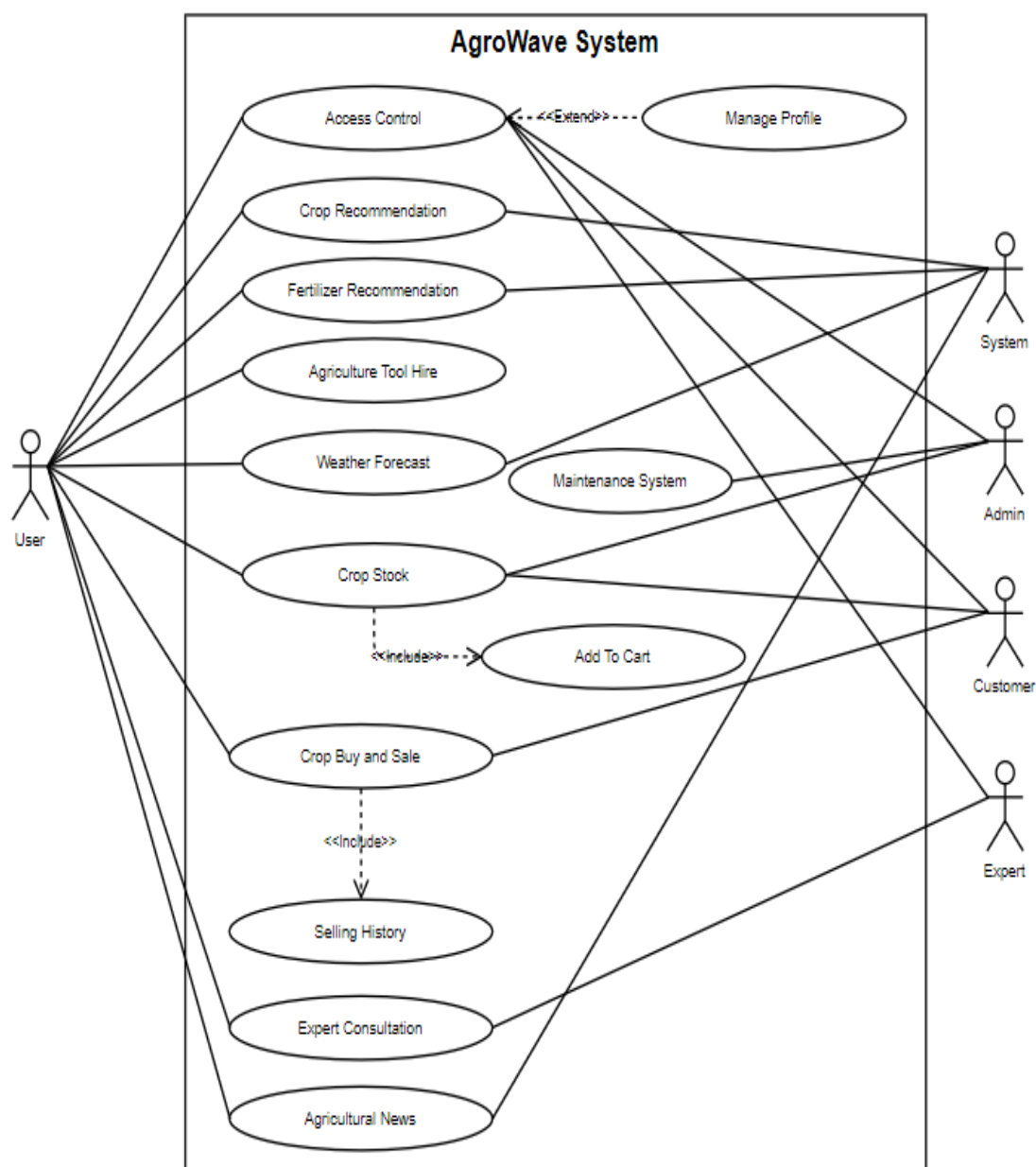


Figure 1: Use Case Diagram

7. Use Case Descriptions

UC-1: Access Control

Use case No.	UC-1
Use case	Access Control
Description	The Access Control use case ensures that only authorized users can access the system. It includes user authentication through email and password and determines the level of access based on user roles.
Actors	Primary Actor: Admin, Customer, Farmer, Expert Secondary Actor: N/A
Preconditions	<ul style="list-style-type: none"> The user must have a registered account with the system. The user's email and password must be stored securely in the system.
Success End Condition	The user is successfully authenticated and granted access to the system's features according to their role.
Failed End Condition	The user is not authenticated and is denied access to the system. An error message is displayed, indicating the reason for the failure.
Trigger	The user attempts to log into the system.
Basic Flow	<ol style="list-style-type: none"> 1. User Login Request: The user navigates to the login page and enters their email and password. 2. Submit Credentials: The user submits the login form. 3. Validate Credentials: The system checks the submitted email and password against the stored credentials. 4. Alternative Flow 3a (Invalid Credentials): If the email or password is incorrect, the system displays an error message and denies access. Return to step 1. 5. Successful Authentication: If the credentials are valid, the system identifies the user's role (e.g., Farmer, Expert, Customer, System Administrator). 6. Grant Access: The system grants access to the user, allowing them to access features based on their role. 7. Access Features: The user is redirected to the appropriate dashboard or home page.

Alternative flow:	<p>3a. Invalid Credentials:</p> <ul style="list-style-type: none"> • The system checks the submitted email and password against the stored credentials. • If the credentials are invalid, the system displays an error message indicating incorrect email or password. • The user is prompted to re-enter their credentials or use the "Forgot Password" option. • The use case returns to step 1. <p>4a. Account Locked:</p> <ul style="list-style-type: none"> • If the user fails multiple login attempts, the system may lock the account for security reasons. • The system displays a message indicating that the account is locked and provides instructions for unlocking it. • The user must follow the provided instructions to unlock their account before attempting to log in again.
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UC-2: Crop Recommendation

Use case No.	UC-2
Use case	Crop Recommendation
Description	The Crop Recommendation use case involves providing farmers with tailored recommendations on which crops to plant based on various data inputs such as soil type, climate conditions, and historical crop performance. This helps farmers make informed decisions to optimize their yield and profitability.
Actors	<p>Primary Actor: Farmer, System</p> <p>Secondary Actor: N/A</p>
Preconditions	<p>The farmer must be logged into the system.</p> <p>The system has access to relevant data sources (soil data, climate data, historical crop performance data, etc.).</p>
Success End Condition	The system provides a list of recommended crops suitable for the farmer's specific conditions.
Failed End Condition	The system is unable to provide a recommendation and notifies the farmer of the issue.
Trigger	The farmer selects the option to get crop recommendations from the system.
Flow	Basic Flow:

	<ol style="list-style-type: none"> 1. Access Crop Recommendation: The farmer logs into the system and navigates to the crop recommendation section. 2. Input Data: The farmer provides necessary data inputs such as soil type, current climate conditions, and any other relevant information. 3. Data Retrieval: The system retrieves additional data required for analysis, including historical crop performance data and regional climate data. 4. Analyze Data: The system analyzes the provided and retrieved data using machine learning algorithms to determine the best crops for the given conditions. 5. Alternative Flow 4a (Insufficient Data): If the system detects insufficient data, it prompts the farmer to provide additional information. 6. Generate Recommendation: The system generates a list of recommended crops along with explanations for each recommendation. 7. Display Recommendations: The system displays the crop recommendations to the farmer. 8. Farmer Reviews: The farmer reviews the recommendations and decides whether to accept them. 9. Alternative Flow 7a (Farmer Requests More Info): If the farmer needs more information about a recommendation, the system provides detailed explanations and additional resources.
Alternative Flow	<p>Alternative Flow:</p> <p>4a. Insufficient Data:</p> <ul style="list-style-type: none"> • The system detects that the provided data is insufficient for making an accurate recommendation. • The system prompts the farmer to provide additional information, such as more detailed soil analysis or specific climate conditions. • The farmer provides the additional data, and the system re-analyzes the information. <p>7a. Farmer Requests More Info:</p> <ul style="list-style-type: none"> • The farmer requests more detailed information about one or more of the recommended crops. • The system provides detailed explanations, including potential yield, market value, and best practices for cultivation.

UC-3: Fertilizer Recommendation

Use case No.	UC-3
Use Case	Fertilizer Recommendation
Description	The Fertilizer Recommendation use case provides farmers with personalized recommendations on the types and amounts of fertilizers to use for their crops. This recommendation is based on soil data, crop type, growth stage, and environmental conditions to enhance crop yield and soil health.
Actors	Primary Actor:

	Farmer, System Secondary Actor: N/A
Preconditions	The farmer must be logged into the system. The system has access to relevant data sources (soil data, crop data, environmental conditions, etc.).
Success End Condition	The system provides a list of recommended fertilizers along with the appropriate quantities for the farmer's specific conditions.
Failed End Condition	The system is unable to provide a recommendation and notifies the farmer of the issue
Trigger	The farmer selects the option to get fertilizer recommendations from the system.
Basic Flow	Basic Flow: <ol style="list-style-type: none"> 1. Access Fertilizer Recommendation: The farmer logs into the system and navigates to the fertilizer recommendation section. 2. Input Data: The farmer provides necessary data inputs such as soil test results, crop type, current growth stage, and environmental conditions. 3. Data Retrieval: The system retrieves additional data required for analysis, including historical crop performance and nutrient requirements for the specific crop. 4. Analyze Data: The system analyzes the provided and retrieved data using algorithms to determine the best fertilizers and application rates for the given conditions. 5. Alternative Flow 4a (Insufficient Data): If the system detects insufficient data, it prompts the farmer to provide additional information. 6. Generate Recommendation: The system generates a list of recommended fertilizers along with application instructions and quantities. 7. Display Recommendations: The system displays the fertilizer recommendations to the farmer. 8. Farmer Reviews: The farmer reviews the recommendations and decides whether to accept them.
Alternative Flow	Alternative Flow: <ol style="list-style-type: none"> 4a. Insufficient Data: <ul style="list-style-type: none"> • The system detects that the provided data is insufficient for making an accurate recommendation. • The system prompts the farmer to provide additional information, such as more detailed soil analysis or specific environmental conditions. • The farmer provides the additional data, and the system re-analyzes the information.

	<p>7a. Farmer Requests More Info:</p> <ul style="list-style-type: none"> • The farmer requests more detailed information about one or more of the recommended fertilizers. • The system provides detailed explanations, including nutrient composition, expected benefits, and best practices for application. • The farmer reviews the additional information and proceeds to decide.
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UC-4: Agriculture Tool Hire

Use case No.	UC-4
Use case	Agriculture Tool Hire
Description	The Agriculture Tool Hire use case allows farmers to rent agricultural machinery and equipment through the system. This feature helps farmers access necessary tools without the need to purchase them, optimizing their farming operations and reducing costs.
Actors	<p>Primary Actor: Farmer, Customer</p> <p>Secondary Actor: System</p>
Preconditions	<p>The farmer must be logged into the system.</p> <p>The system must have a database of available agricultural tools and equipment from various providers.</p> <p>Equipment providers must have registered and listed their tools in the system.</p>
Success End Condition	The farmer successfully hires the required agricultural tools and equipment.
Failed End Condition	The system is unable to process the hire request and notifies the farmer of the issue.
Trigger	The farmer selects the option to hire agricultural tools from the system.
Basic Flow	<ol style="list-style-type: none"> 1. Access Tool Hire Section: The farmer logs into the system and navigates to the agriculture tool hire section. 2. Browse Tools: The farmer browses the available tools and equipment, viewing details such as type, availability, rental rates, and provider information. 3. Select Tool: The farmer selects the required tool or equipment. 4. Check Availability: The system checks the availability of the selected tool for the desired rental period. 5. Alternative Flow 4a (Tool Not Available): If the tool is not available for the desired period, the system suggests alternative tools or rental periods. 6. Provide Rental Details: The farmer provides rental details, including the rental period and any special requirements.

	<ol style="list-style-type: none"> 7. Confirm Hire: The system confirms the hire details and calculates the total rental cost. 8. Submit Request: The farmer submits the hire request. 9. Notification to Provider: 10. Notification to Provider: The system notifies the equipment provider about the hire request. 11. Provider Confirmation: The equipment provider confirms the availability and rental terms. 12. Alternative Flow 9a (Provider Denies Request): If the provider denies the request, the system notifies the farmer and suggests alternative tools or providers. 13. Payment Process: The farmer proceeds to payment, and the system processes the rental fee. 14. Confirm Hire and Schedule Delivery: The system confirms the hire and schedules the delivery of the equipment to the farmer's location. 15. Delivery of Equipment: The equipment is delivered to the farmer by the provider. 16. Use Equipment: The farmer uses the rented equipment for the specified period. 17. Return Equipment: After the rental period, the equipment is picked up by the provider or returned by the farmer as per the agreed terms.
Alternative Flow	<p>4a. Tool Not Available:</p> <ul style="list-style-type: none"> • The system checks the availability of the selected tool and finds it unavailable for the desired period. • The system suggests alternative tools or adjusts the rental period based on availability. • The farmer selects an alternative tool or rental period and proceeds with the hire request. <p>9a. Provider Denies Request:</p> <ul style="list-style-type: none"> • The equipment provider denies the hire request due to unavailability or other reasons. • The system notifies the farmer and suggests alternative tools or providers. • The farmer selects an alternative option and resubmits the hire request.

UC-5: Weather Forecast

Use case No.	UC-5
Use case	Weather Forecast
Description	The Weather Forecast use case provides farmers with up-to-date weather information and forecasts for their specific location. This feature helps farmers plan their agricultural activities, such as planting, irrigation, and harvesting, based on accurate weather predictions.
Actors	Primary Actor: Farmer, System

	Secondary Actor: N/A
Preconditions	The farmer must be logged into the system. The system must be connected to a reliable weather API to retrieve weather data.
Success End Condition	The system provides accurate and timely weather forecasts to the farmer for their specified location.
Failed End Condition	The system is unable to retrieve or display weather information and notifies the farmer of the issue.
Trigger	The farmer selects the option to view the weather forecast from the system.
Basic Flow	<ol style="list-style-type: none"> 1. Access Weather Forecast: The farmer logs into the system and navigates to the weather forecast section. 2. Specify Location: The farmer either allows the system to use their current location or manually enters the location for which they need the weather forecast. 3. Retrieve Weather Data: The system sends a request to the weather API to retrieve current weather conditions and forecast data for the specified location. 4. Alternative Flow 3a (API Error): If the weather API returns an error, the system displays a notification to the farmer about the issue. 5. Display Weather Information: The system displays the current weather conditions, including temperature, humidity, wind speed, and precipitation. 6. Show Forecast: The system shows the weather forecast for the next four days, including daily highs and lows, chance of precipitation, and any weather warnings or alerts. 7. Provide Recommendations: Based on the weather forecast, the system may provide recommendations for agricultural activities (e.g., delay planting due to expected heavy rain). <ol style="list-style-type: none"> a. Farmer Reviews: The farmer reviews the weather information and recommendations to plan their activities.
Alternative Flow	<p>3a. API Error:</p> <ul style="list-style-type: none"> • The system sends a request to the weather API to retrieve weather data. • The weather API returns an error or fails to respond. • The system displays a notification to the farmer indicating that weather information is currently unavailable and suggests trying again later. <p>6a. Severe Weather Alerts:</p> <ul style="list-style-type: none"> • The system receives severe weather alerts from the weather API. • The system highlights these alerts and provides specific recommendations or warnings to the farmer. • The farmer reviews the alerts and takes necessary precautions.

UC-6: Crop Stock

Use case No.	UC-6
Use case	Crop Stock
Description	The Crop Stock use case allows farmers to manage their inventory of crops. This feature helps farmers keep track of the quantity, type, and condition of their crops, enabling them to make informed decisions about sales, storage, and future planting.
Actors	Primary Actor: Farmer, Customer Secondary Actor: Admin
Preconditions	The farmer must be logged into the system. The system must have a database to store crop inventory information.
Success End Condition	The farmer successfully updates, views, and manages their crop inventory in the system.
Failed End Condition	The system is unable to process the crop inventory request and notifies the farmer of the issue.
Trigger	The farmer selects the option to manage crop stock from the system.
Basic Flow	<ol style="list-style-type: none"> 1. Access Crop Stock Section: The farmer logs into the system and navigates to the crop stock section. 2. View Current Inventory: The system displays the current crop inventory, including details such as crop type, quantity, storage location, and condition. 3. Update Inventory: The farmer selects an option to update the inventory, such as adding new crops, updating quantities, or marking crops as sold or spoiled. 4. Alternative Flow 3a (Insufficient Data): If the farmer does not provide all necessary data, the system prompts for additional information. 5. Enter Crop Details: The farmer enters the details of the crop, including type, quantity, and storage details. 6. Save Changes: The system saves the updated inventory information. 7. Confirm Update: The system confirms that the crop inventory has been successfully updated. 8. Review Inventory: The farmer reviews the updated inventory to ensure accuracy.
Alternative Flow	<p>3a. Insufficient Data:</p> <ul style="list-style-type: none"> • The system detects that the farmer has not provided all necessary information for the inventory update. • The system prompts the farmer to enter the missing details.

	<ul style="list-style-type: none">• The farmer provides the additional information, and the system proceeds to save the inventory update. 5a. Save Error: <ul style="list-style-type: none">• The system encounters an error while saving the inventory update.• The system notifies the farmer of the error and provides an option to retry or cancel the update.• The farmer retries the save operation, or cancels and contacts support if the issue persists.
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UC-7: Crop Buy and Sale

Use case No.	UC-7
Use case	Crop Buy and Sale
Description	The Crop Buy and Sale use case allows farmers to list their crops for sale and enables customers to purchase these crops directly through the system. This feature helps streamline the process of selling and buying crops, providing a marketplace for farmers and customers.
Actors	Primary Actor: Farmer, Customer Secondary Actor: Admin
Preconditions	The farmer must be logged into the system. The customer must be logged into the system. The system must have a database to store crop listings and transaction details.
Success End Condition	The farmer successfully lists crops for sale, and the customer successfully purchases crops through the system.
Failed End Condition	The system is unable to process the crop listing or purchase request and notifies the user of the issue.
Trigger	The farmer selects the option to list crops for sale, or the customer selects the option to buy crops.
Basic Flow	Crop Sell: <ol style="list-style-type: none">1. Access Crop Sale Section: The farmer logs into the system and navigates to the crop sale section.2. Create New Listing: The farmer selects an option to create a new crop listing.3. Enter Crop Details: The farmer enters details about the crop, including type, quantity, price, and any other relevant information.

	<ol style="list-style-type: none"> 4. Alternative Flow 3a (Insufficient Data): If the farmer does not provide all necessary data, the system prompts for additional information. 5. Submit Listing: The farmer submits the crop listing. 6. Save Listing: The system saves the crop listing and makes it available in the marketplace. 7. Confirm Listing: The system confirms that the crop listing has been successfully created. 8. View Listings: The farmer can view their active listings and manage them as needed. <p>Basic Flow for Customer (Buying Crops):</p> <ol style="list-style-type: none"> 1. Access Marketplace: The customer logs into the system and navigates to the marketplace section. 2. Browse Listings: The customer browses available crop listings. 3. Select Crop: The customer selects a crop listing they are interested in purchasing. 4. View Details: The system displays detailed information about the selected crop. 5. Add to Cart: The customer adds the selected crop to their cart. 6. Proceed to Checkout: The customer reviews their cart and proceeds to checkout. 7. Enter Payment Information: The customer enters payment and delivery details.
Alternative Flow	<p>3a. Insufficient Data:</p> <ul style="list-style-type: none"> • The system detects that the farmer has not provided all necessary information for the crop listing. • The system prompts the farmer to enter the missing details. • The farmer provides the additional information, and the system proceeds to save the listing. <p>7a. Payment Error:</p> <ul style="list-style-type: none"> • If there is an issue with the payment, the system prompts the customer to re-enter payment details or choose a different payment method. • Confirm Purchase: The customer confirms the purchase. • Process Payment: The system processes the payment and updates the inventory. • Notify Farmer and Customer: The system notifies both the farmer and the customer about the successful transaction. <p>Arrange Delivery: The farmer arranges the delivery of the crops to the customer</p>

UC-8: Expert Consultation

Use case No.	UC-8
Use case	Expert Consultation

Description	The Expert Consultation use case enables farmers to seek advice and consultation from agricultural experts. This feature facilitates communication between farmers and experts to address specific farming issues, provide guidance, and improve farming practices
Actors	Primary Actor: Farmer, Expert Secondary Actor: Admin
Preconditions	The farmer and expert must be logged into the system. The system must have a database of registered experts. Trigger: The farmer selects the option to request expert consultation from the system.
Success End Condition	The farmer successfully connects with an expert and receives consultation.
Failed End Condition	The system is unable to process the consultation request or connect the farmer with an expert and notifies the farmer of the issue.
Trigger	The farmer selects the option to request expert consultation from the system.
Basic Flow	<ol style="list-style-type: none"> 1. Access Consultation Section: The farmer logs into the system and navigates to the expert consultation section. 2. Request Consultation: The farmer requests a consultation by providing details about their issue or question. 3. Select Expert: The system presents a list of available experts based on the farmer's query. 4. Schedule Consultation: The farmer selects an expert and schedules a consultation time. 5. Alternative Flow 4a (Expert Not Available): If the selected expert is not available, the system suggests alternative experts or times. 6. Notify Expert: The system notifies the selected expert of the consultation request. 7. Expert Confirms: The expert reviews the request and confirms their availability.
Alternative Flow	<p>4a. Expert Not Available:</p> <ul style="list-style-type: none"> • The system detects that the selected expert is not available at the requested time. • The system suggests alternative experts or consultation times. • The farmer selects an alternative and schedules the consultation. <p>6a. Expert Denies Request:</p> <ul style="list-style-type: none"> • The expert reviews the consultation request and denies it due to unavailability or other reasons. • The system notifies the farmer and suggests alternative experts. • The farmer selects a different expert and resubmits the request.

UC-9: Agriculture News

Use case No.	UC-9
Use case	Agriculture News
Description	The Agriculture News use case provides farmers with up-to-date news and information related to agriculture. This feature helps farmers stay informed about the latest developments, trends, policies, and events that could impact their farming activities.
Actors	Primary Actor: Farmer Secondary Actor: System
Preconditions	The farmer must be logged into the system. The system must have access to a reliable News API to fetch agriculture-related news.
Success End Condition	The system successfully retrieves and displays relevant agriculture news to the farmer
Failed End Condition	The system is unable to retrieve or display news information and notifies the farmer of the issue.
Trigger	The farmer selects the option to view agriculture news from the system.
Basic Flow	<ol style="list-style-type: none"> 1. Access News Section: The farmer logs into the system and navigates to the agriculture news section. 2. Request News Data: The system sends a request to the News API to retrieve the latest agriculture-related news. 3. Alternative Flow 2a (API Error): If the News API returns an error, the system displays a notification to the farmer about the issue. 4. Retrieve News Data: The News API responds with the latest news articles and information. 5. Display News Articles: The system displays the retrieved news articles to the farmer, including headlines, summaries, and links to full articles. 6. Filter and Sort: The farmer can filter and sort the news articles based on categories such as recent news, policy updates, market trends, and weather-related news. 7. Read Articles: The farmer selects an article to read in detail. 8. Provide Feedback (Optional): The farmer can provide feedback on the news articles (e.g., rating the relevance or usefulness of the information).
Alternative Flow	2a. API Error: <ul style="list-style-type: none"> • The system sends a request to the News API to retrieve news data. • The News API returns an error or fails to respond. • The system displays a notification to the farmer indicating that news information is currently unavailable and suggests trying again later.

UC-10: System Maintenance

Use case No.	UC-10
Use case	System Maintenance
Description	The Manage System use case allows administrators to maintain and manage the Agrowave system. This includes tasks such as updating system settings, managing user accounts, monitoring system performance, and ensuring the overall smooth operation of the platform.
Actors	Primary Actor: Admin Secondary Actor: N/A
Preconditions	<ul style="list-style-type: none"> The admin must be logged into the system with appropriate permissions. The system must have administrative modules for managing different aspects of the platform.
Success End Condition	The admin successfully updates system settings, manages user accounts, and monitors system performance without any issues.
Failed End Condition	The system is unable to process management requests or encounters errors, notifying the admin of the issue
Trigger	The admin selects the option to manage the system from the system dashboard.
Basic Flow	<ol style="list-style-type: none"> Access Management Dashboard: The admin logs into the system and navigates to the management dashboard. View System Status: The system displays the current status, including performance metrics, user activity, and recent changes. Manage User Accounts: The admin selects the option to manage user accounts. Update System Settings: The admin selects the option to update system settings, such as configuration options, thresholds, and notifications. Monitor System Performance: The admin views performance metrics and logs to monitor system health and identify any potential issues. Perform Maintenance Tasks: The admin executes routine maintenance tasks, such as data backups, software updates, and security checks. Alternative Flow 6a (Maintenance Error): If an error occurs during maintenance, the system logs the error and notifies the admin with possible solutions. Save Changes: The admin saves any updates or changes made during the management session. Confirm Updates: The system confirms that the changes have been successfully applied. Log Out: The admin logs out of the system.
Alternative Flow	3a. Invalid User Data: <ul style="list-style-type: none"> The admin attempts to update user accounts with incomplete or incorrect data.

	<ul style="list-style-type: none"> The system detects the invalid data and prompts the admin to correct the errors. The admin corrects the data and resubmits the update. <p>6a. Maintenance Error:</p> <ul style="list-style-type: none"> An error occurs during a maintenance task, such as a failed data backup or software update. The system logs the error and notifies the admin. The admin reviews the error details and follows recommended solutions to resolve the issue.
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UC-11: Add to Cart

Use case No.	UC-11
Use case	Add to Cart
Description	The Add to Cart use case allows customers to select crops they wish to purchase and add them to a virtual shopping cart. This feature facilitates the shopping process, enabling customers to review their selected items before proceeding to checkout.
Actors	Primary Actor: Customer Secondary Actor: Admin
Preconditions	<ul style="list-style-type: none"> The customer must be logged into the system. The system must have a catalog of available crops for sale.
Success End Condition	The customer successfully adds crops to their cart and is able to proceed to checkout.
Failed End Condition	The system is unable to add the selected crops to the cart and notifies the customer of the issue.
Trigger	The customer selects the option to add a crop to their cart from the system
Basic Flow	<ol style="list-style-type: none"> Access Marketplace: The customer logs into the system and navigates to the marketplace section. Browse Listings: The customer browses available crop listings. Select Crop: The customer selects a crop they are interested in purchasing. View Crop Details: The system displays detailed information about the selected crop, including type, quantity, price, and seller information. Add to Cart: The customer clicks the "Add to Cart" button. Update Cart: The system adds the selected crop to the customer's cart and updates the cart summary.

	<p>7. Alternative Flow 6a (Insufficient Stock): If there is insufficient stock for the selected quantity, the system notifies the customer and suggests modifying the quantity.</p> <p>8. Confirm Addition: The system confirms that the crop has been successfully added to the cart.</p> <p>9. View Cart: The customer can view their cart to review the selected items, modify quantities, or remove items.</p> <p>10. Proceed to Checkout: The customer proceeds to checkout when ready to complete the purchase.</p>
Alternative Flow	<p>6a. Insufficient Stock:</p> <ul style="list-style-type: none"> • The system detects that the selected quantity exceeds the available stock. • The system notifies the customer of the insufficient stock and suggests reducing the quantity or selecting a different crop. • The customer modifies the quantity or selects a different crop to add to the cart.

UC-12: Manage Profile

Use case No.	UC-12
Use case	Manage Profile
Description	The Manage Profile use case allows users to update and maintain their personal and account information within the system. This feature ensures that users can keep their profiles accurate and up-to-date, including contact information, preferences, and other relevant details.
Actors	<p>Primary Actor: Farmer, Expert, Customer</p> <p>Secondary Actor: Admin</p>
Preconditions	The user must be logged into the system.
Success End Condition	The user successfully updates their profile information, and the system saves the changes.
Failed End Condition	The system is unable to update the profile information and notifies the user of the issue.
Trigger	The user selects the option to manage or edit their profile from the system.

Basic Flow	<ol style="list-style-type: none"> 1. Access Profile Section: The user logs into the system and navigates to the profile section. 2. View Current Profile: The system displays the current profile information, including personal details, contact information, and preferences. 3. Select Edit Option: The user selects the option to edit their profile. 4. Update Profile Information: The user updates their profile information, such as name, email, phone number, address, and preferences. 5. Alternative Flow 4a (Invalid Data): If the user enters invalid data, the system prompts for corrections. 6. Save Changes: The user submits the updated profile information. 7. Confirm Update: The system saves the changes and confirms that the profile has been successfully updated. 8. View Updated Profile: The user views the updated profile to ensure accuracy.
Alternative Flow	<p>4a. Invalid Data:</p> <ul style="list-style-type: none"> • The user enters incomplete or incorrect information while updating the profile. • The system detects the invalid data and prompts the user to correct the errors. • The user corrects the data and resubmits the update.

UC-13: Selling History

Use case No.	UC-13
Use case	Selling History
Description	The Selling History use case allows farmers to view their past transactions, including details of crops sold, dates, quantities, prices, and buyers. This feature helps farmers keep track of their sales performance and manage their business records effectively.
Actors	<p>Primary Actor:</p> <p>Farmer</p> <p>Secondary Actor:</p> <p>Admin</p>
Preconditions	<ul style="list-style-type: none"> • The farmer must be logged into the system. • The system must have a record of the farmer's past transactions.
Success End Condition	The farmer successfully views their selling history
Failed End Condition	The system is unable to retrieve or display the selling history and notifies the farmer of the issue.

Trigger	The farmer selects the option to view their selling history from the system.
Basic Flow	<ol style="list-style-type: none">1. Access Selling History Section: The farmer logs into the system and navigates to the selling history section.2. Request Selling History: The farmer requests to view their selling history.3. Retrieve Data: The system retrieves the farmer's past transactions from the database.4. Alternative Flow 3a (No Transaction Data): If there are no past transactions, the system notifies the farmer that no selling history is available.5. Display Selling History: The system displays the retrieved selling history, including details such as crop types, quantities, prices, dates of sale, and buyer information.6. Filter and Sort: The farmer can filter and sort the selling history based on different criteria such as date range, crop type, or buyer.7. View Detailed Transaction: The farmer selects a specific transaction to view more detailed information.8. Export Data (Optional): The farmer has the option to export the selling history data for record-keeping or analysis purposes.9. Log Out: The farmer logs out of the system.
Alternative Flow	<p>3a. No Transaction Data:</p> <ul style="list-style-type: none">• The system detects that there are no past transactions for the farmer.• The system notifies the farmer that no selling history is available.• The farmer returns to the main dashboard or chooses another option

8. Activity Diagram

An activity diagram is a visual representation of the flow of activities or actions within a system or process. It shows the sequence of tasks, decision points, and branching paths, using symbols like nodes and edges to illustrate the workflow. Activity diagrams help to understand, analyze, and communicate the behavior of systems or processes efficiently.

These diagrams are created by using PlantUML.

Diagrams source code: <https://github.com/asifse27/AgroWave>

8.1 Activity Diagram of UC-1 Access Control

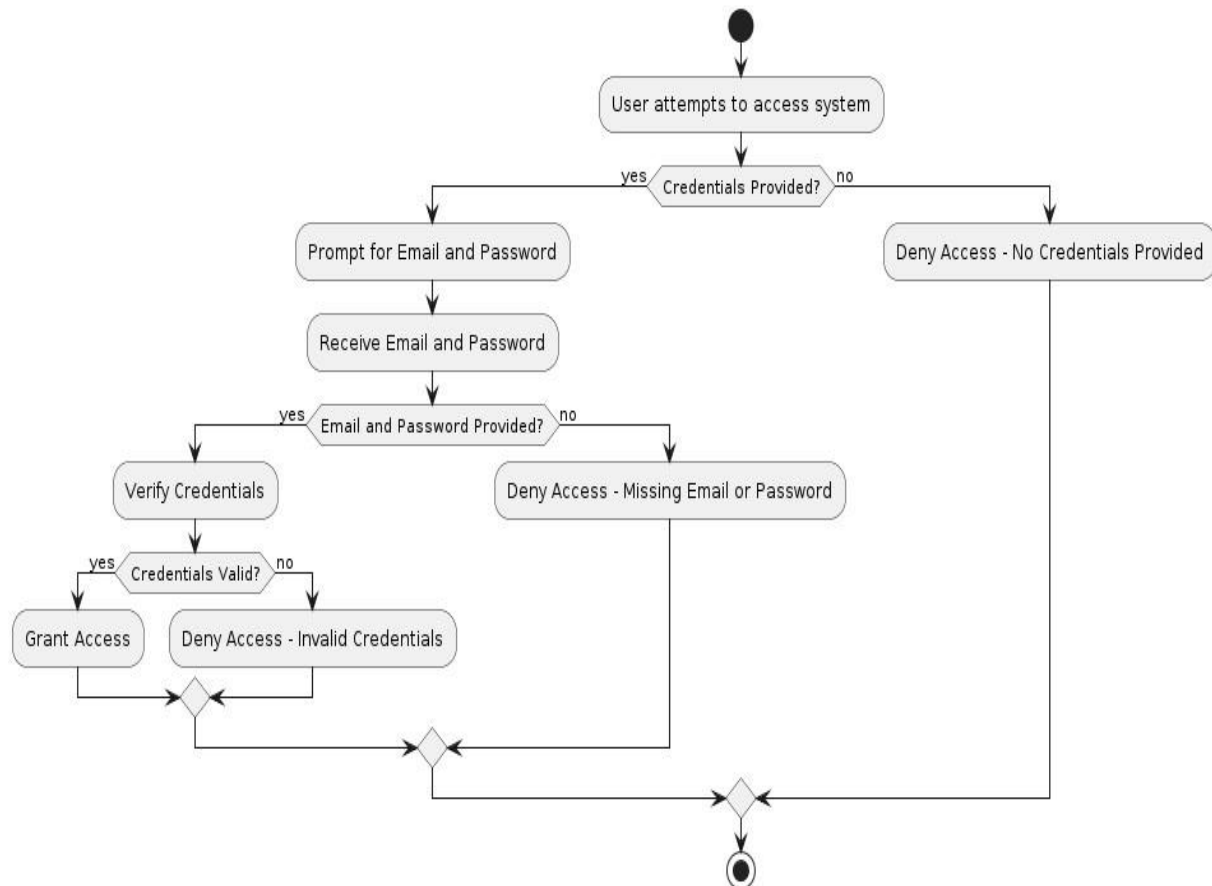


Figure 2: Access Control

8.2 Activity Diagram of UC-2 Crop Recommendation

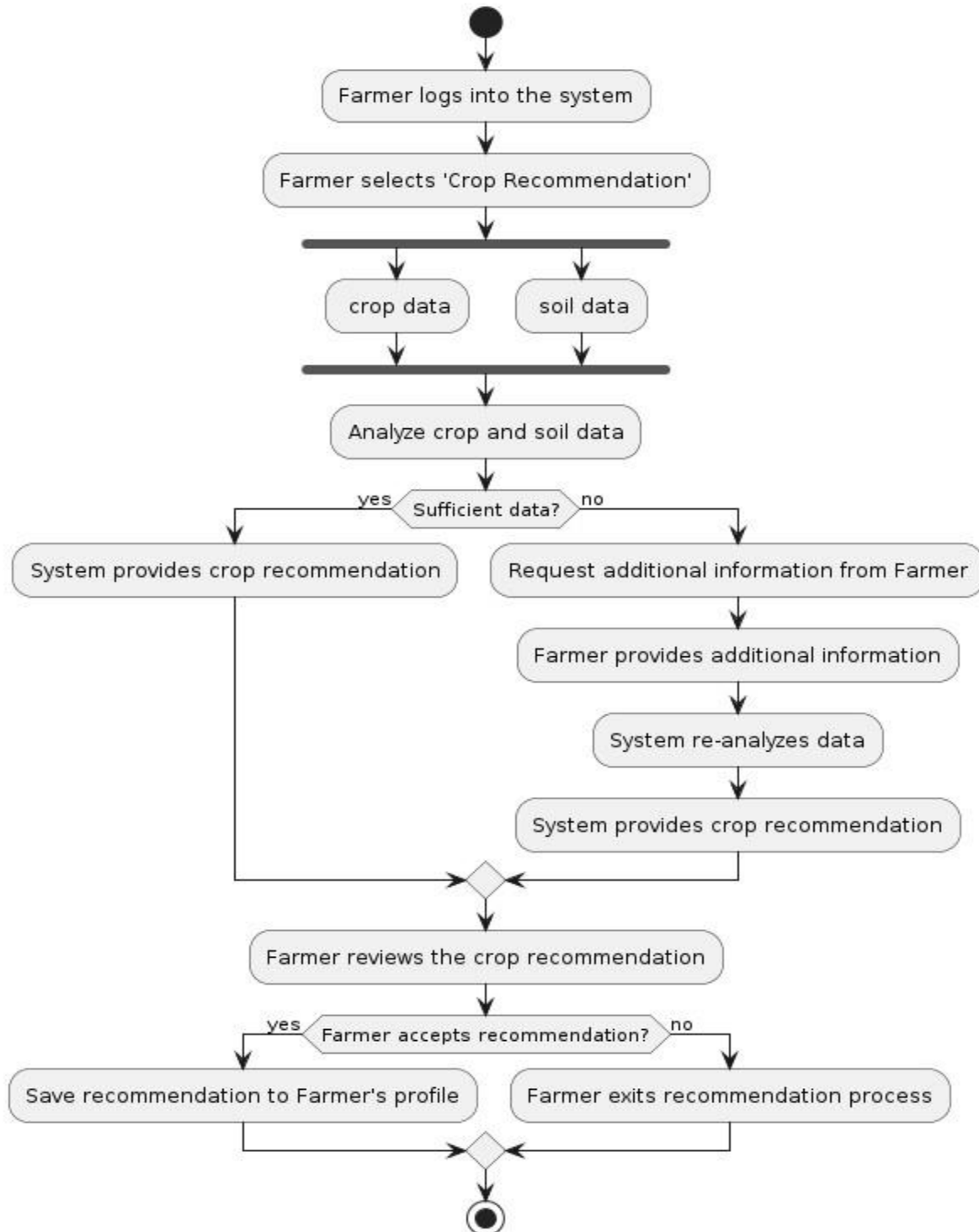


Figure 3: Crops Recommendation

8.3 Activity Diagram of UC-3 Fertilizer Recommendation

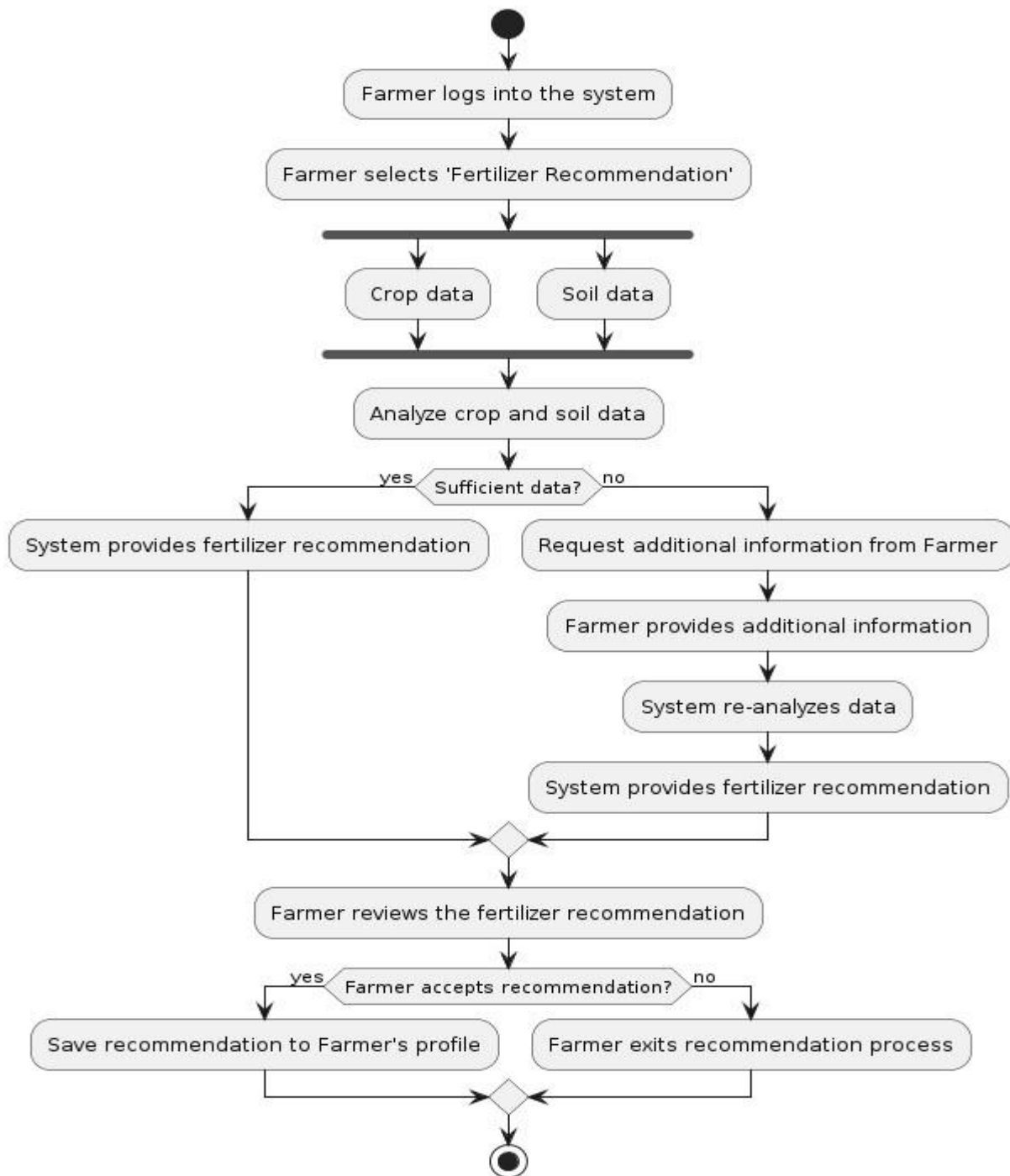


Figure 4: Fertilizer Recommendation

8.4 Activity Diagram of UC-4 Agricultural Tool Hire

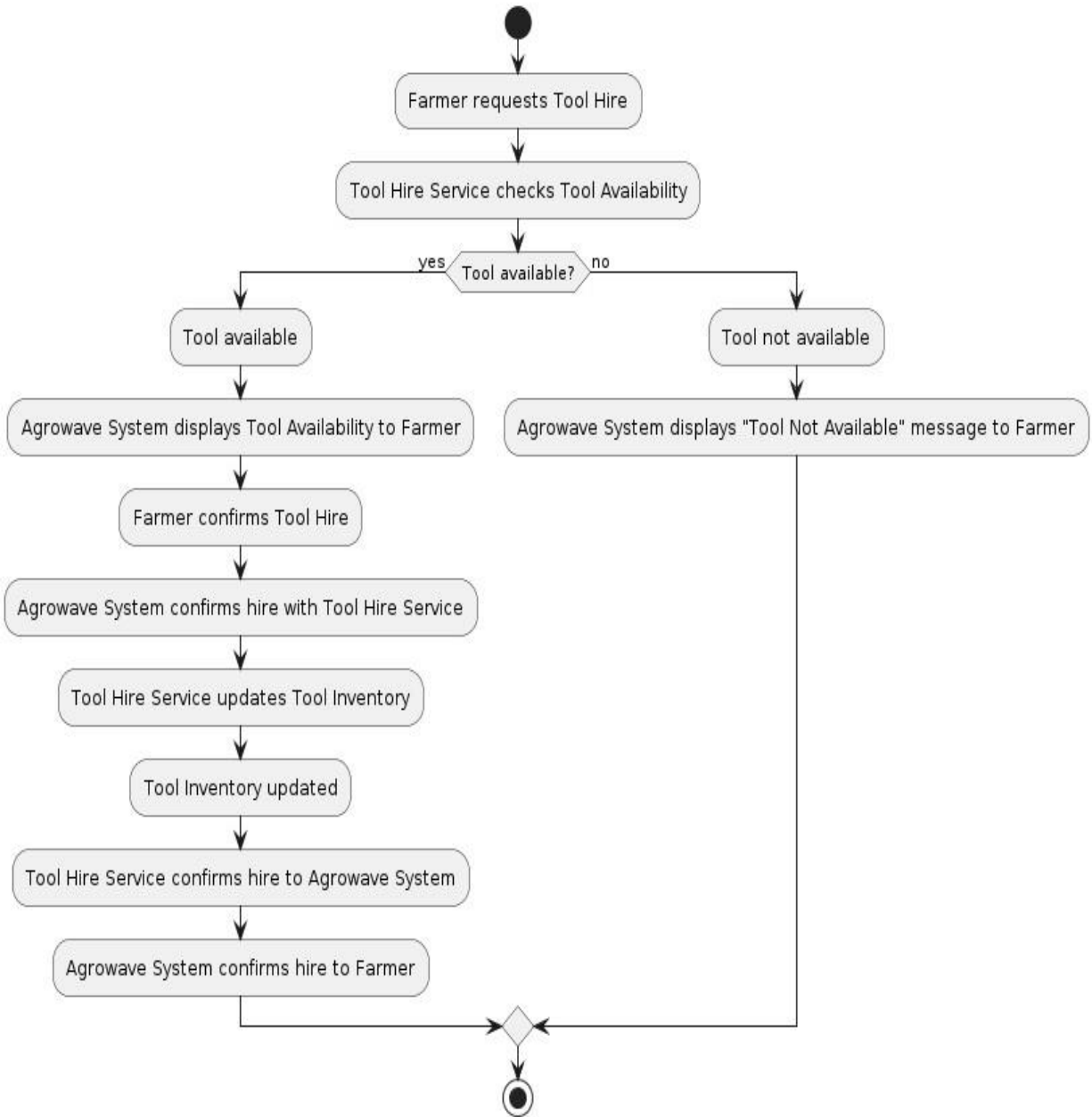


Figure 5: Agriculture Tool Hire

8.5 Activity Diagram of UC-5 Weather Forecast

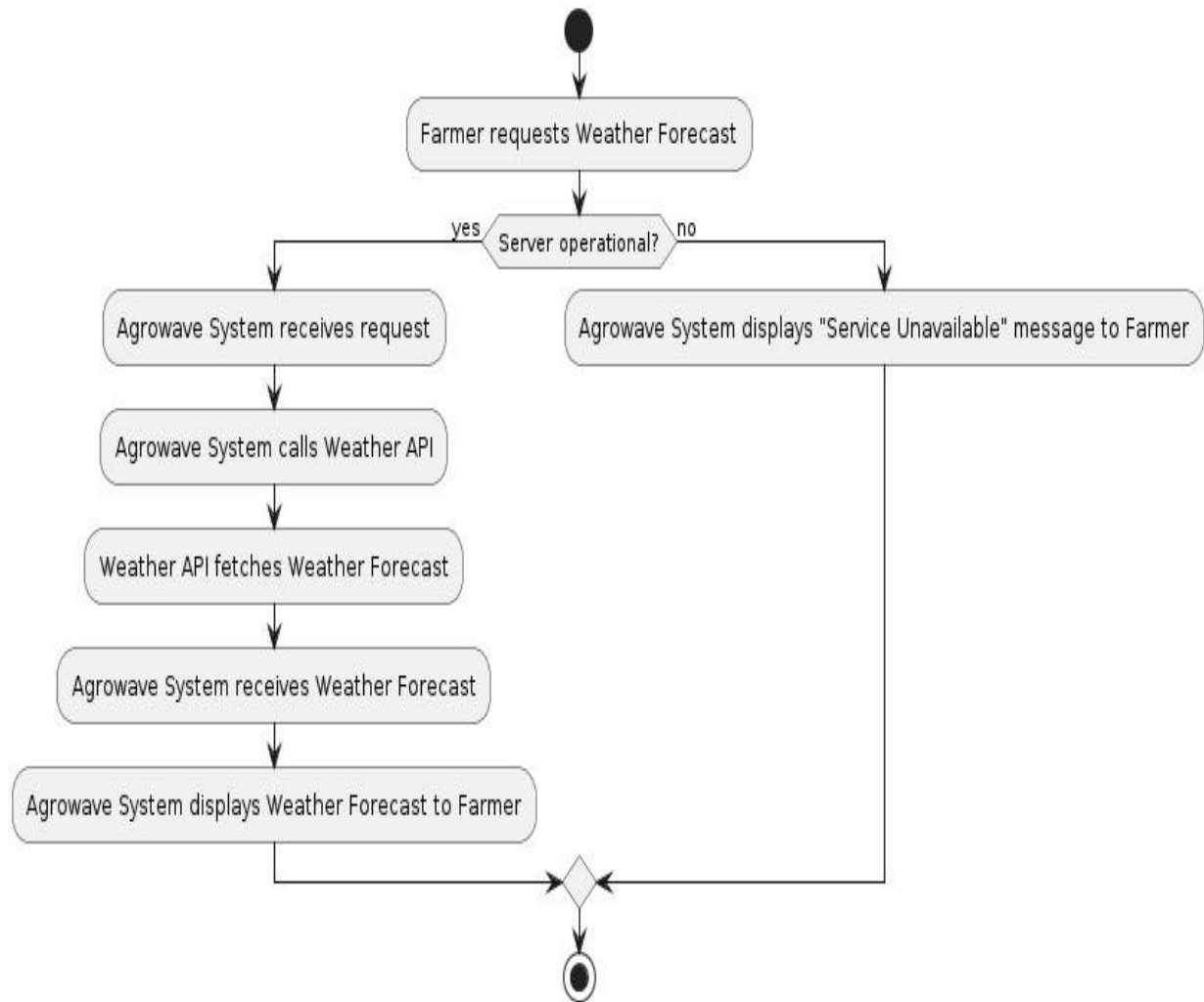


Figure 6: Weather Forecast

8.6 Activity Diagram of UC-6 Crops Stock

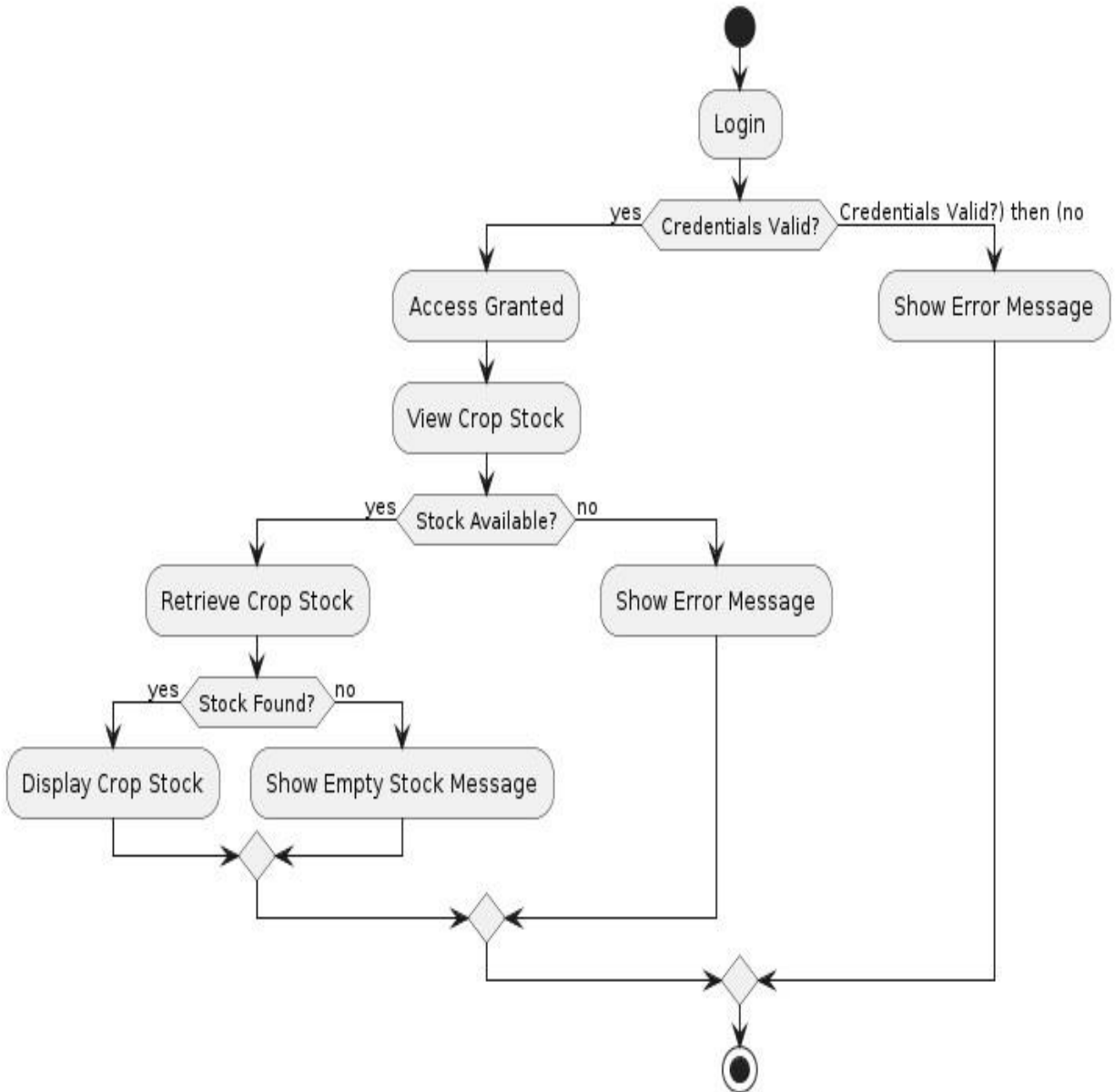


Figure 7: Crops Stock

8.7 Activity Diagram of UC-7 Crops Buy and Sale

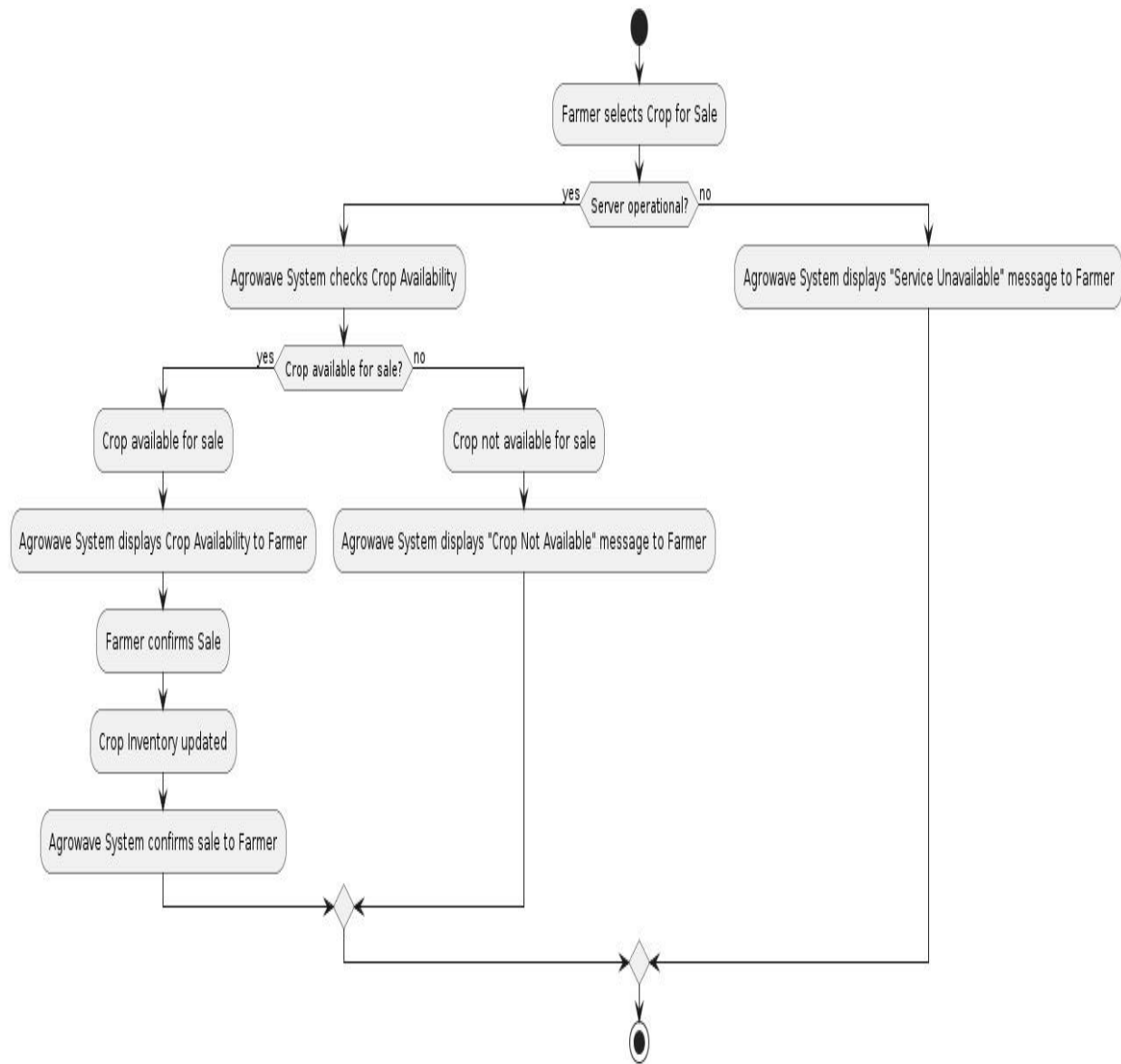


Figure 8: Crops Buy and Sale

8.8 Activity Diagram of UC-11 Add to Cart

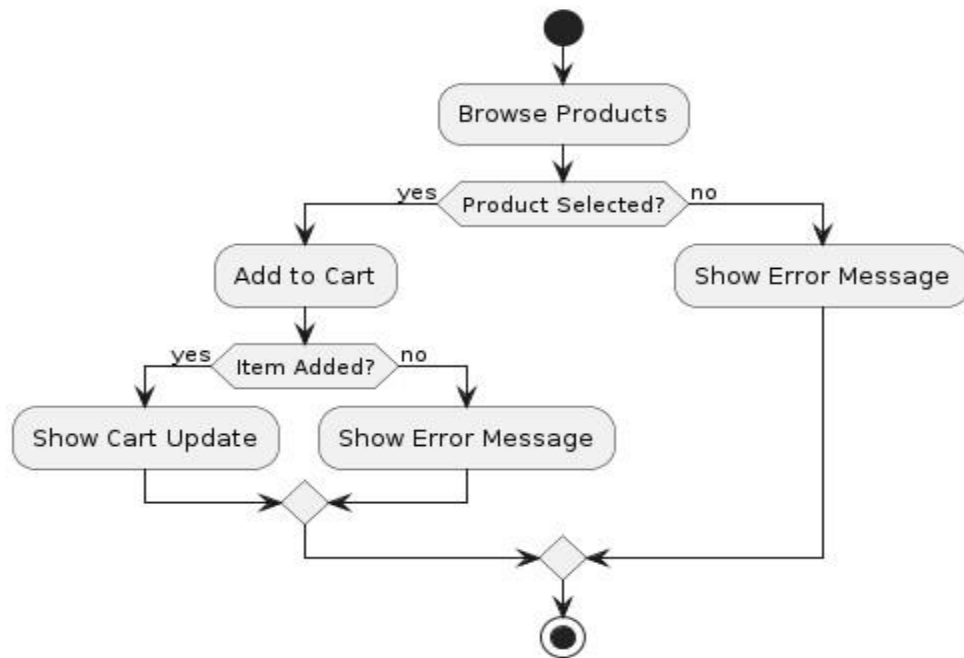


Figure 9: Add to Card

8.9 Activity Diagram of UC-13 Selling History

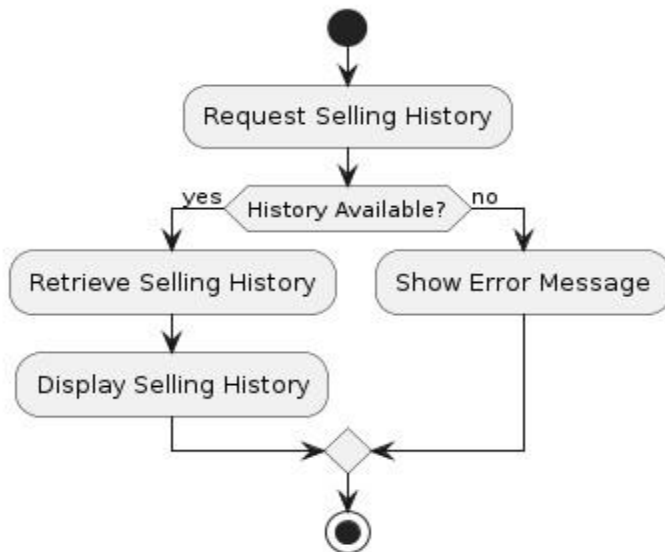


Figure 10: Selling History

8.10 Activity Diagram of UC-8 Expert Consultation

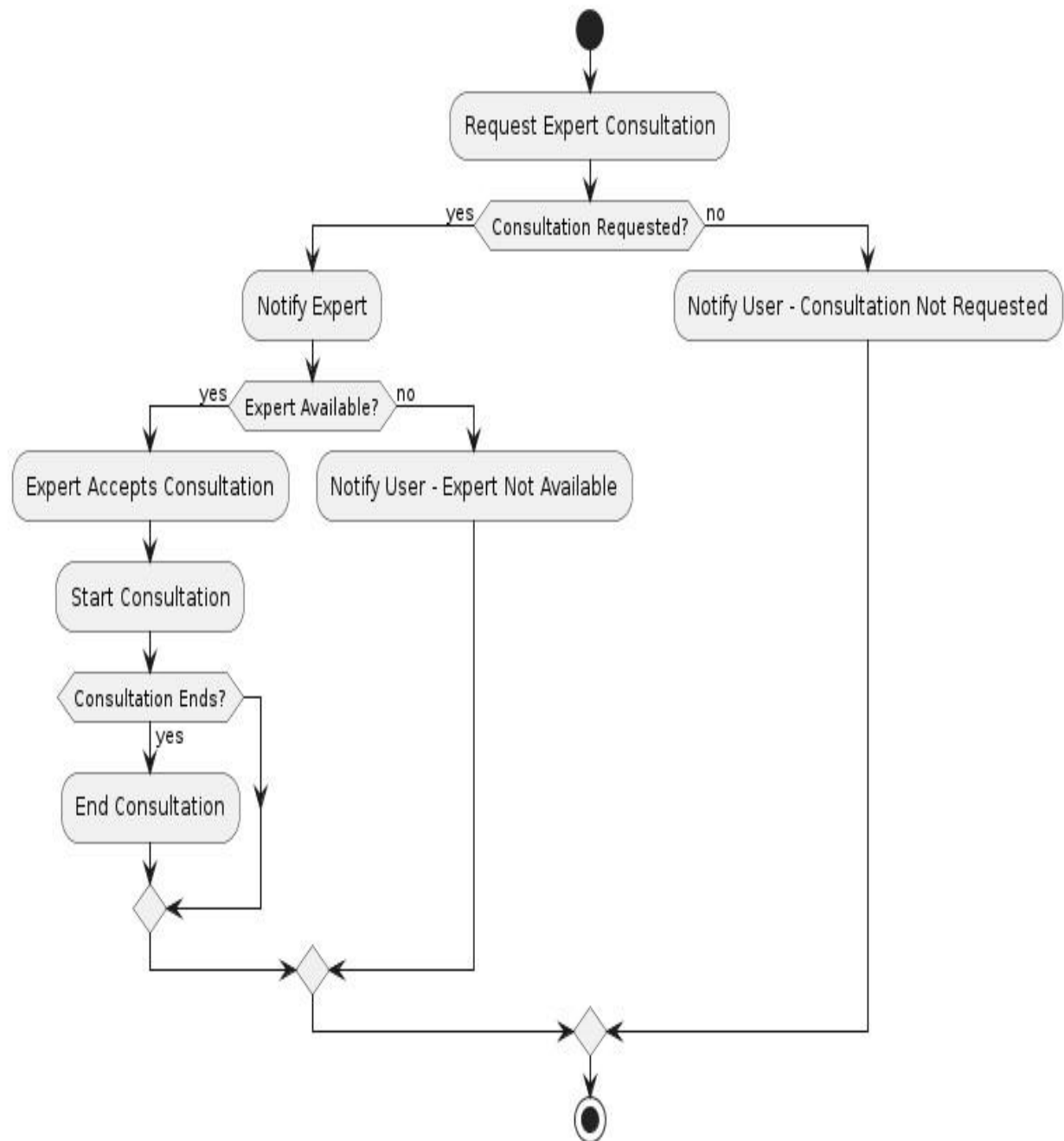


Figure 11: Expert Consultant

8.11 Activity Diagram of UC-9 Agriculture News



Figure 12: Agriculture News

8.12 Activity Diagram of UC-12 Manage Profile

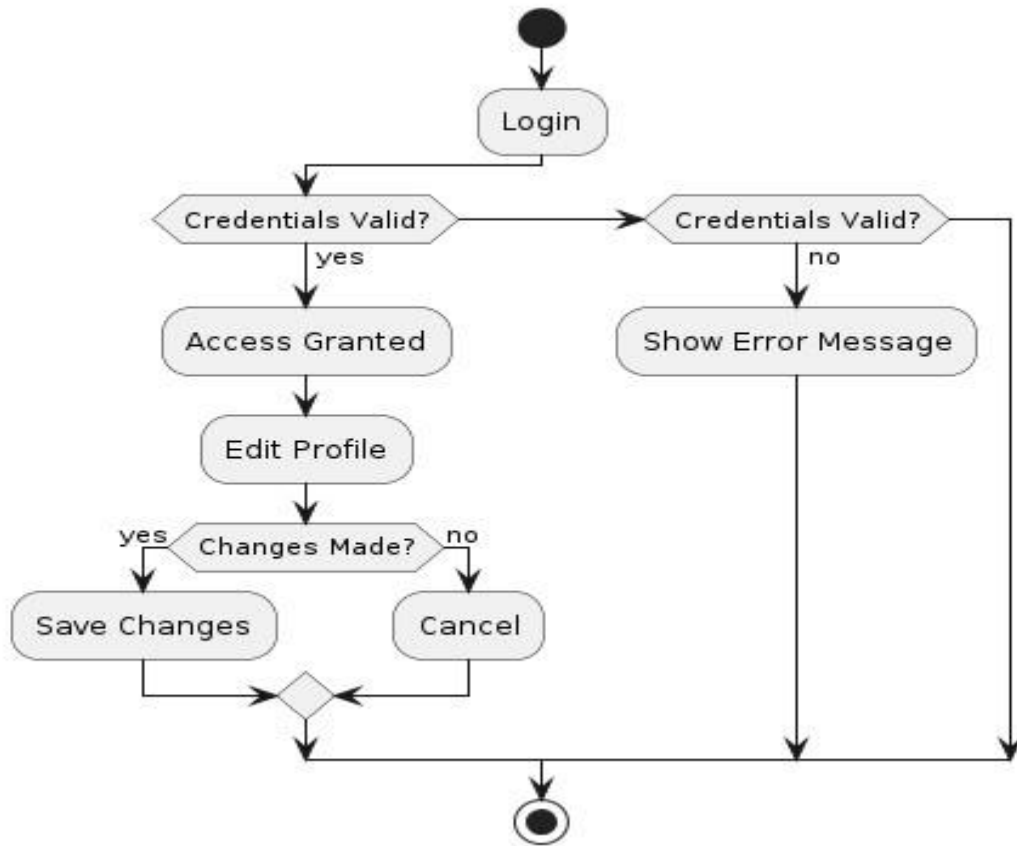


Figure 13: Manage Profile

8.13 Activity Diagram of UC-10 System Maintenance

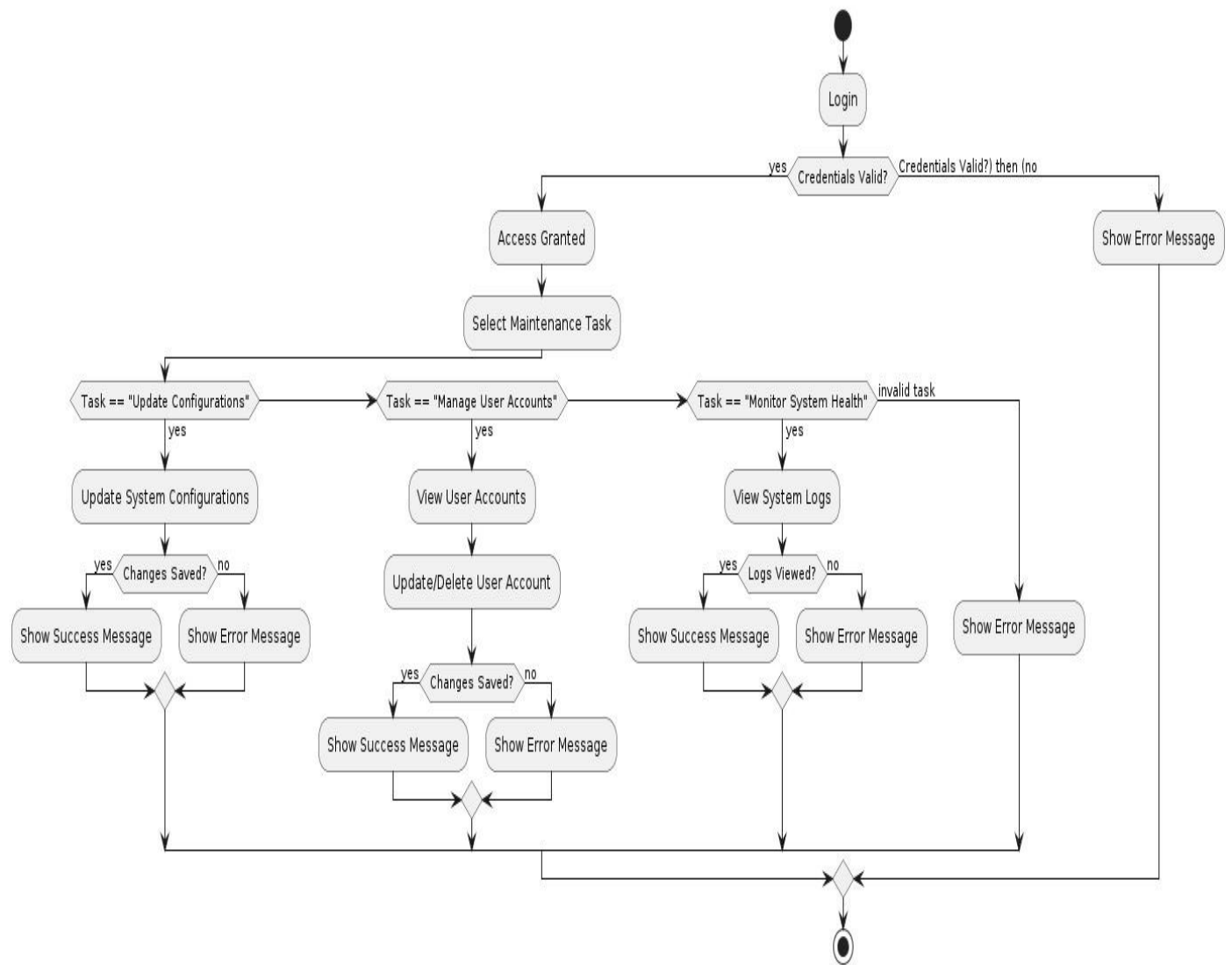


Figure 14: System Maintenance

9. Swimlane Diagram

A swimlane diagram is a type of activity diagram that organizes activities into distinct categories called "swimlanes." Each swimlane represents a specific actor, role, or organizational unit, clearly delineating responsibilities and interactions within a process. Swimlane diagrams help to visualize complex workflows, identify inefficiencies, and improve communication by illustrating who does what and when in a process. They are particularly useful for processes involving multiple participants or departments.

These diagrams are created by using PlantUML.

Diagrams source code: <https://github.com/asifse27/AgroWave>

9.1 Swimlane Diagram of Access Control

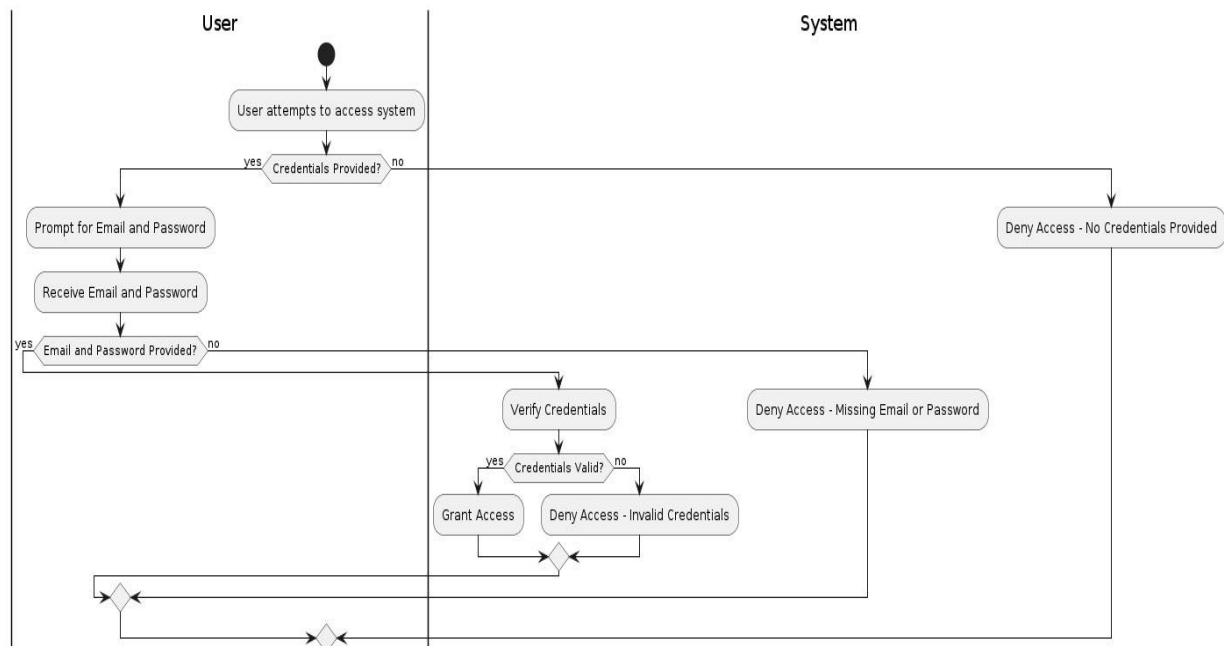


Figure 15: Access Control

9.2 Swimlane Diagram of Crops Recommendation

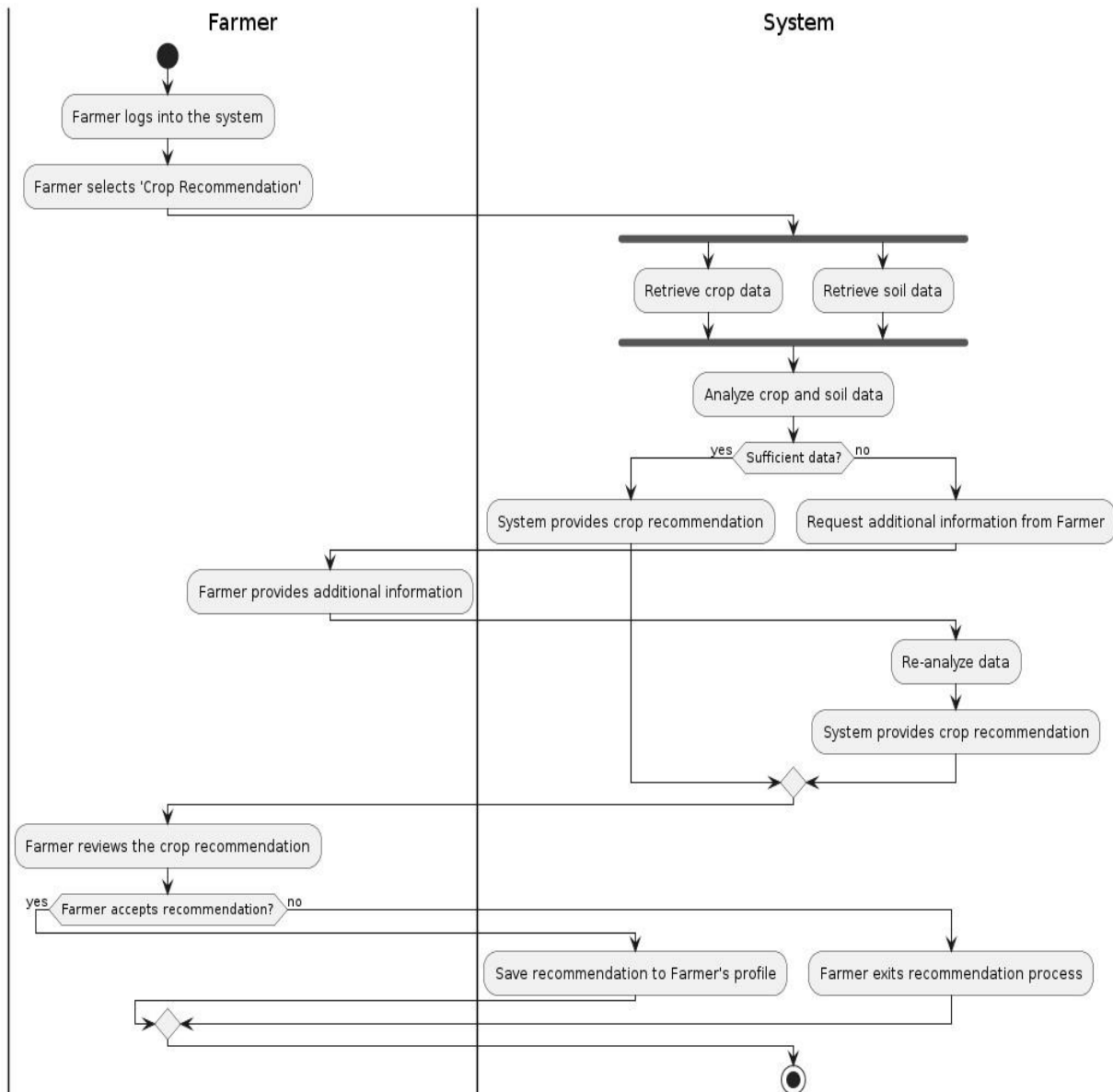


Figure 12: Crops Recommendation

9.4 Swimlane Diagram of Agriculture Tool Hire

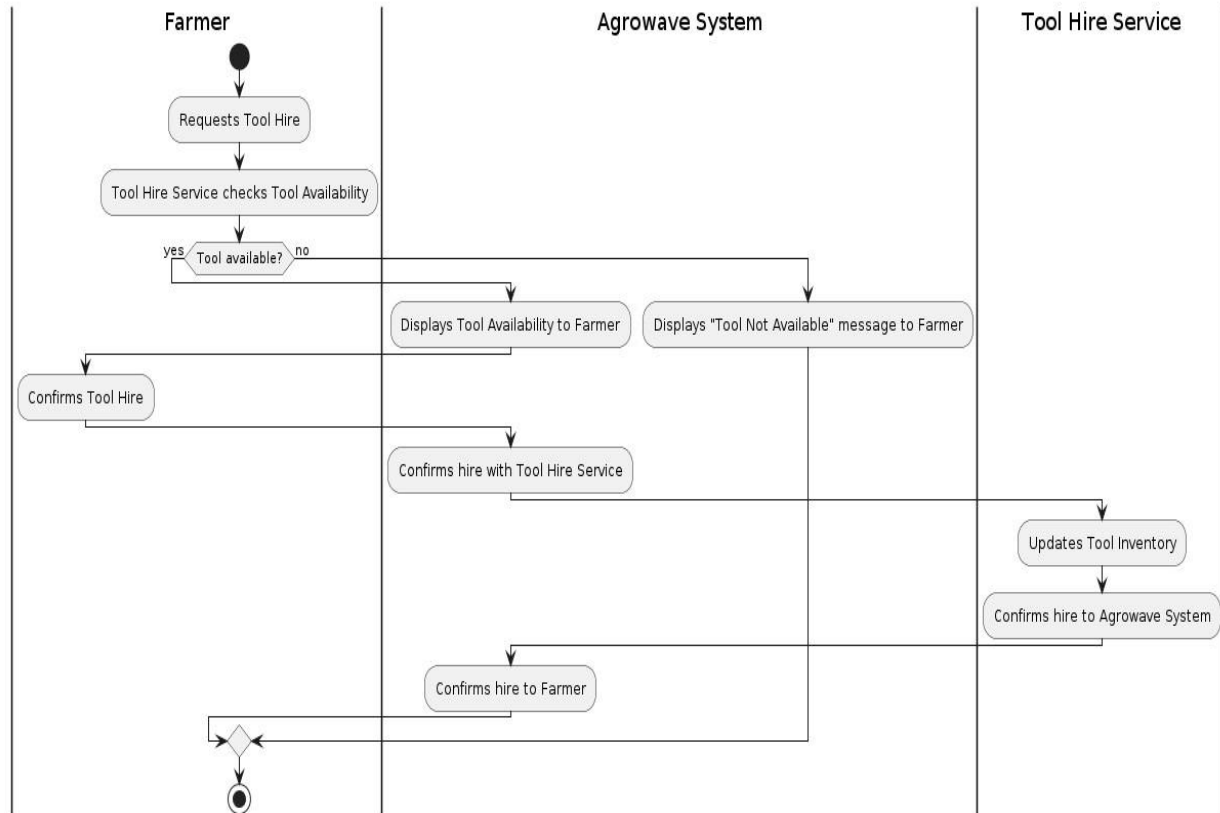


Figure 14: Agriculture Tool Hire

9.5 Swimlane Diagram of Weather Forecast

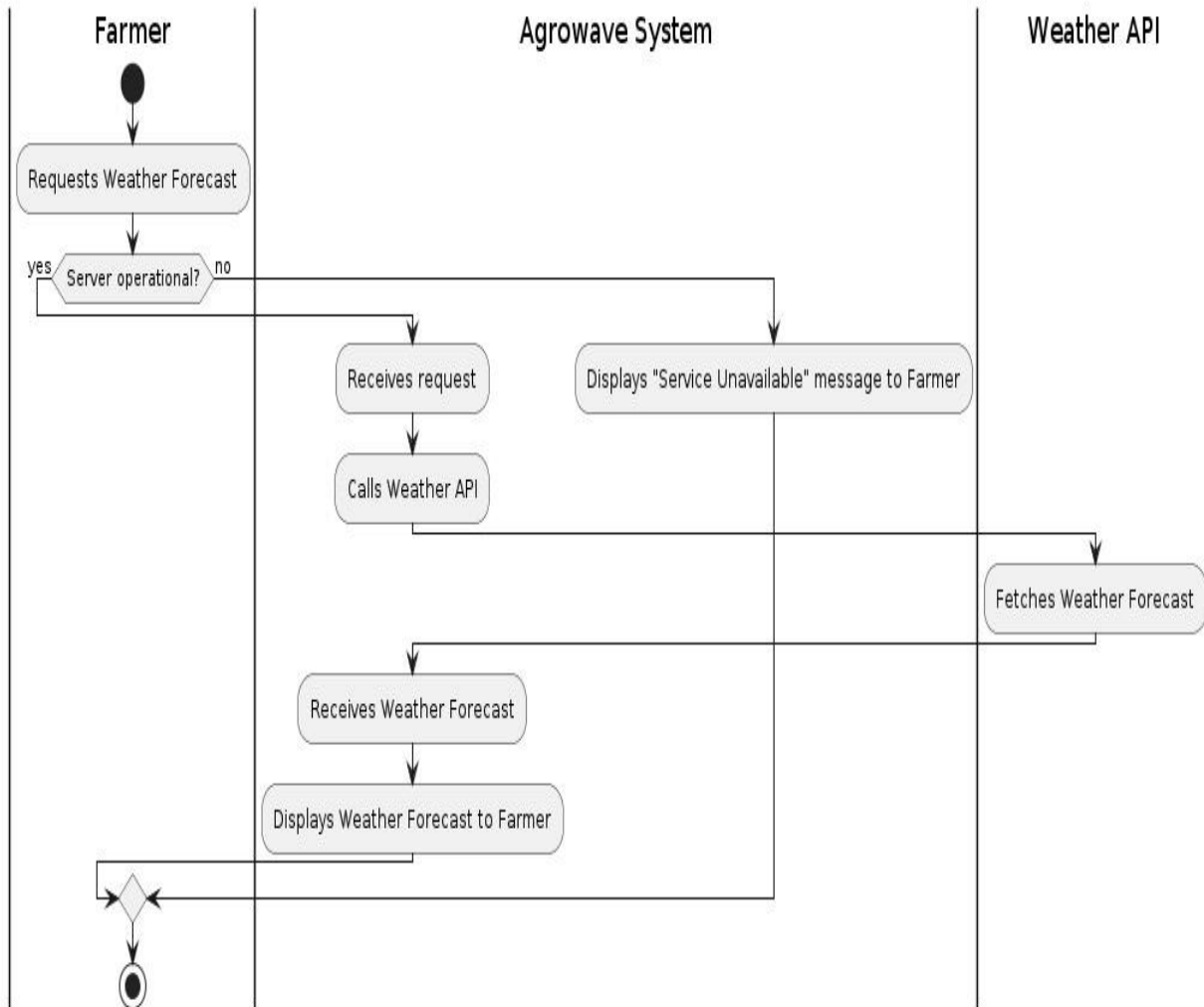


Figure 15: Weather Forecast

9.6 Swimlane Diagram of Crops Stock

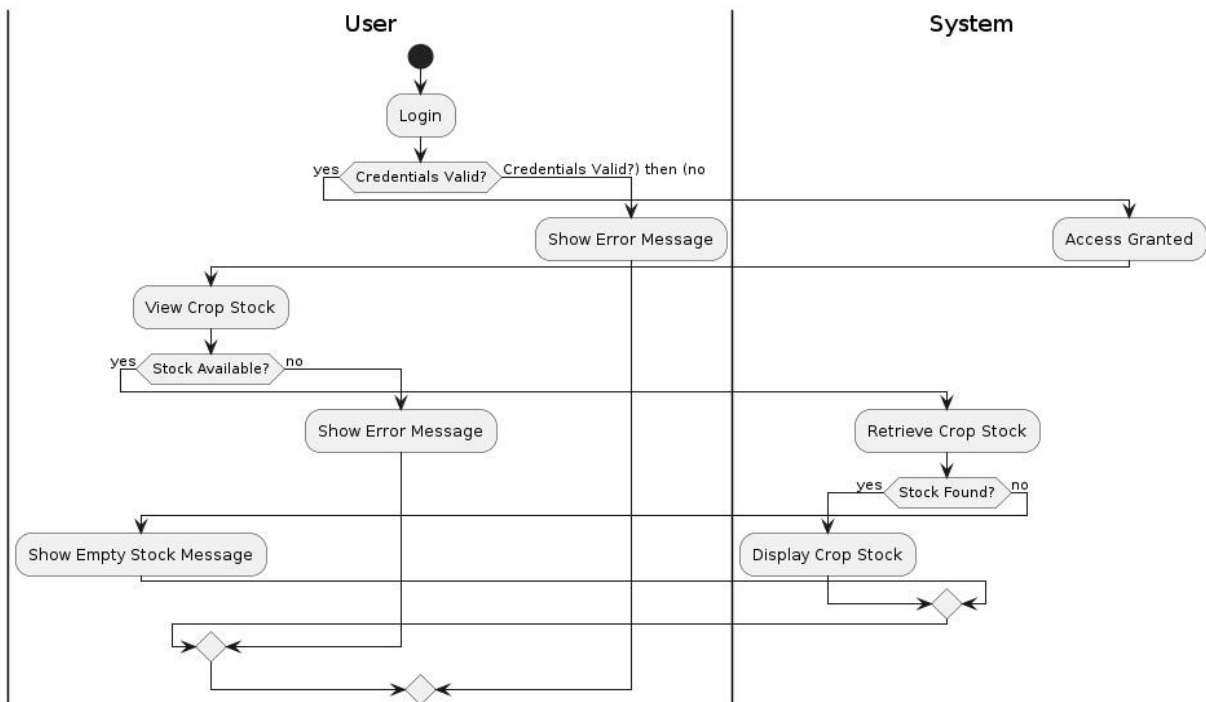


Figure 16: Crops Stock

9.7 Swimlane Diagram of Crops Buy and Sale

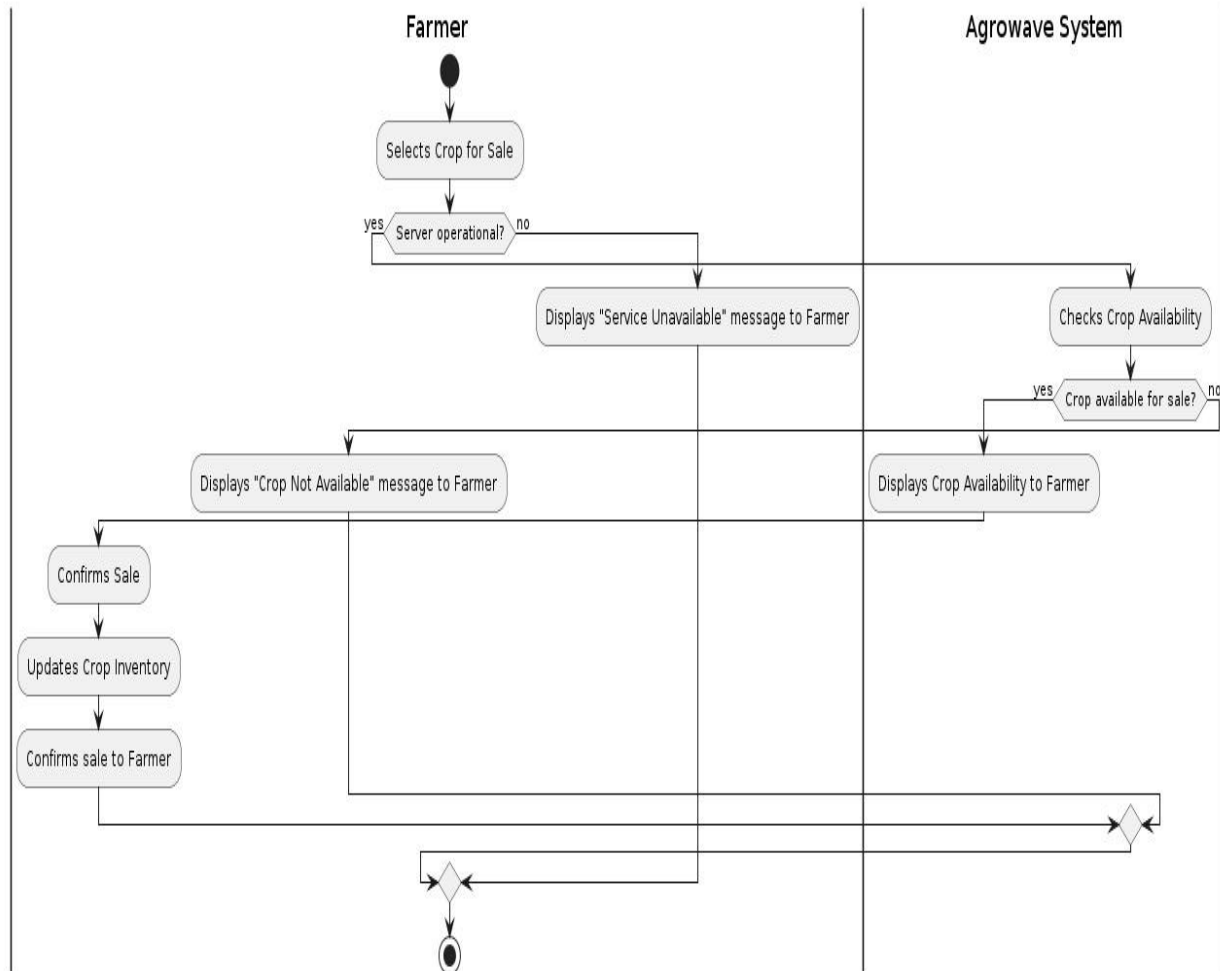


Figure 17: Crops buy and sale

9.8 Swimlane Diagram of Add to Cart

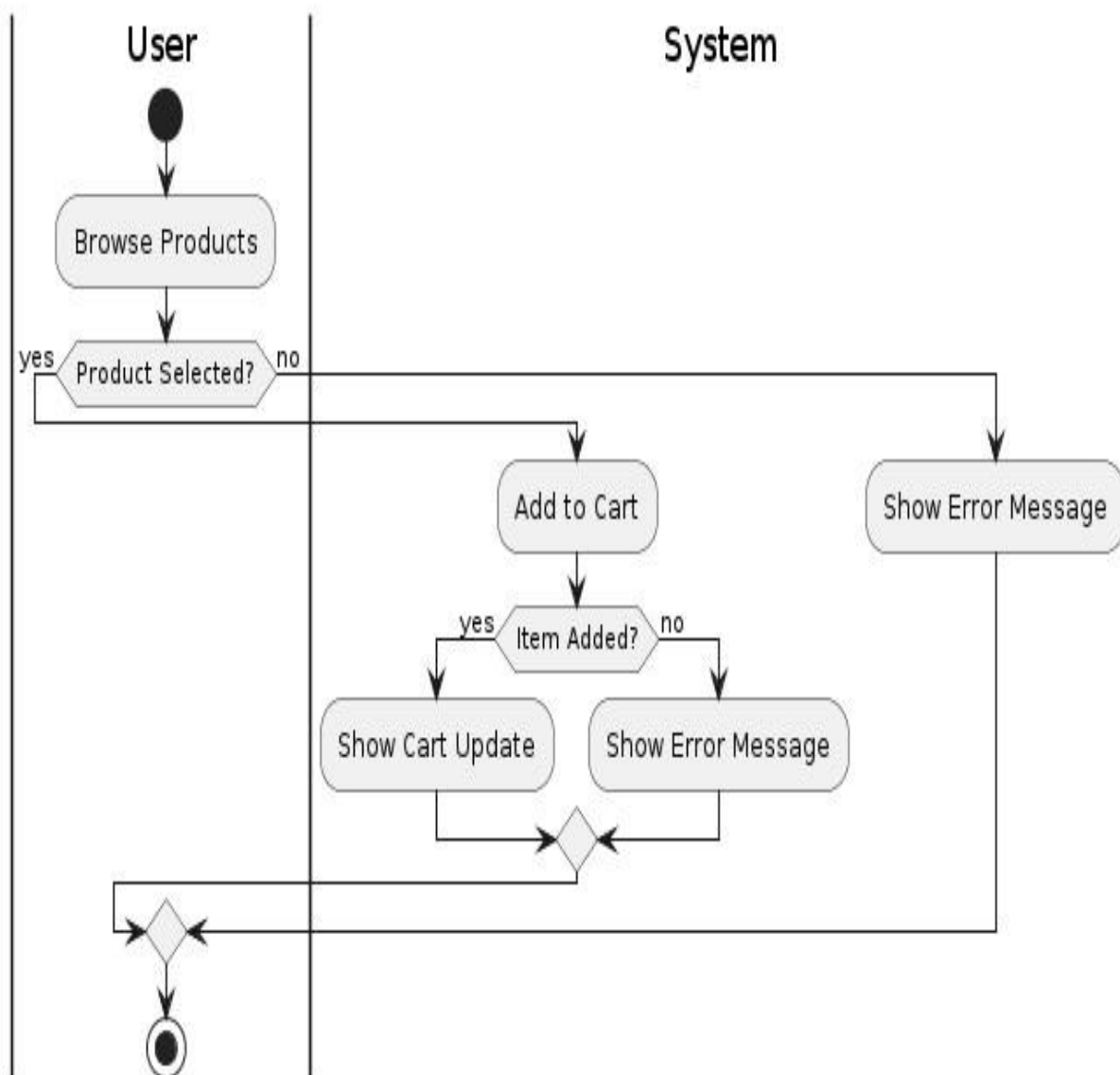


Figure 18: Add to Cart

9.9 Swimlane Diagram of Selling History

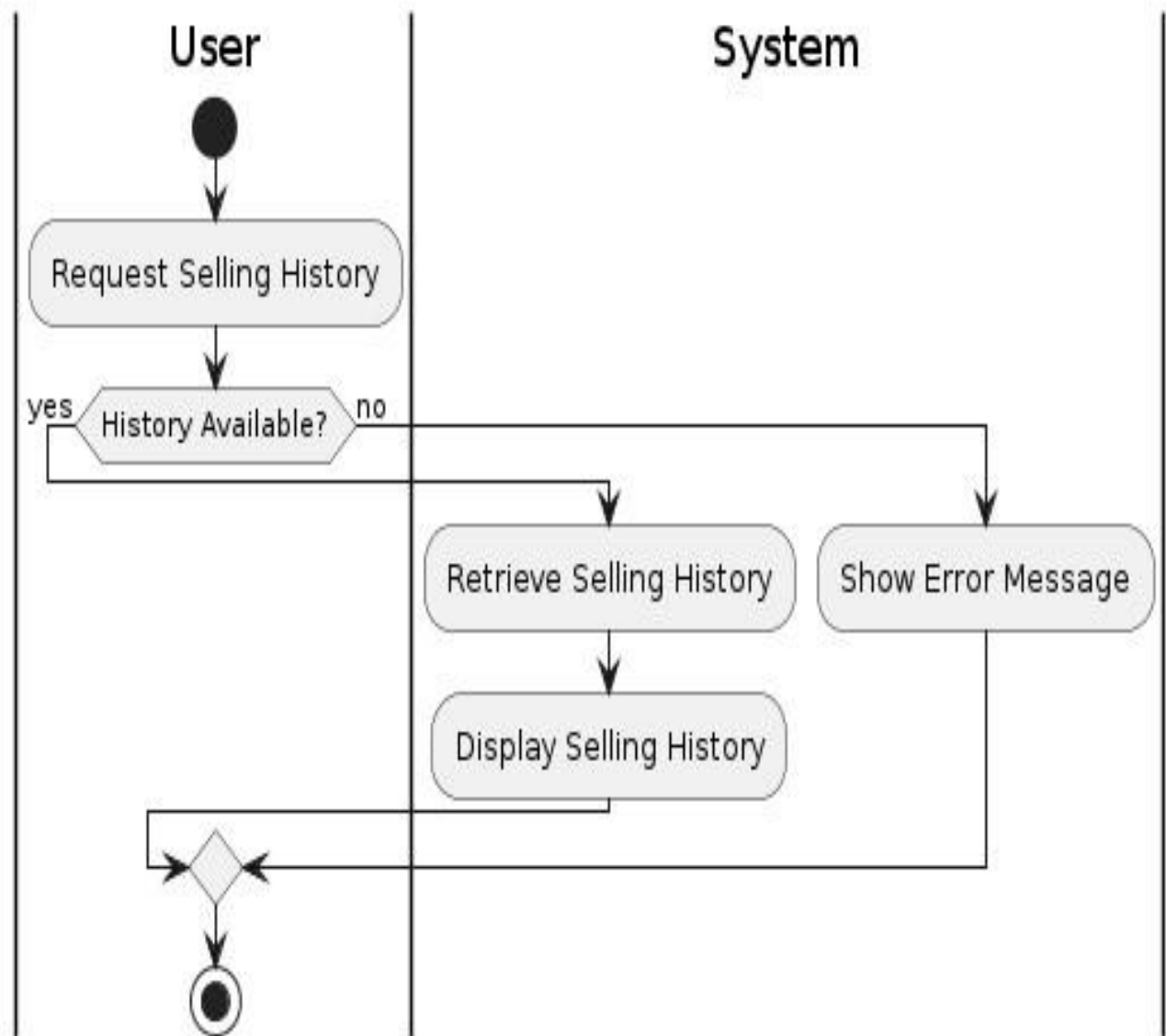


Figure 18: Selling History

9.10 Swimlane Diagram of Expert Consult

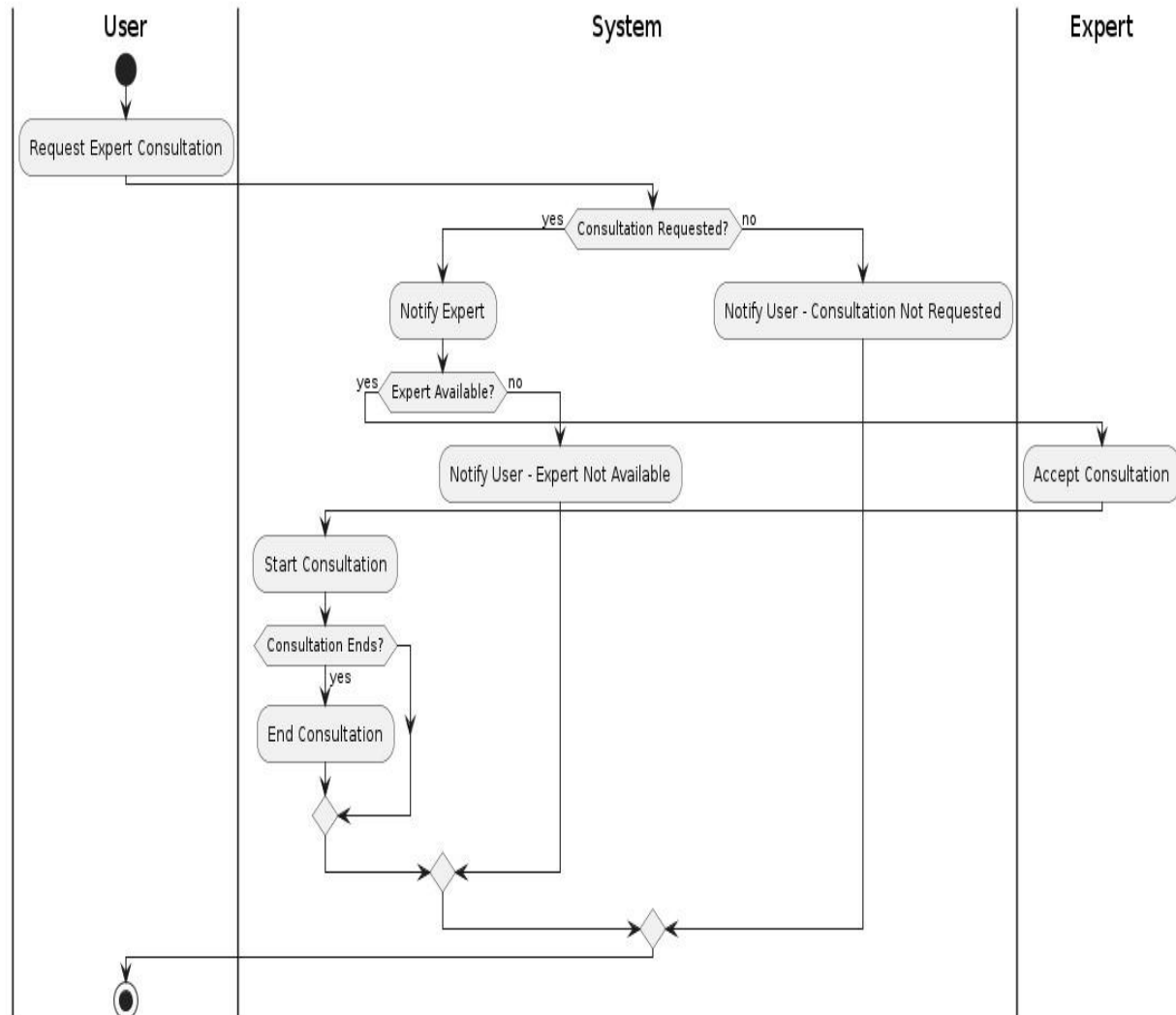


Figure 18: Expert Consult

9.11 Swimlane Diagram of Agriculture News

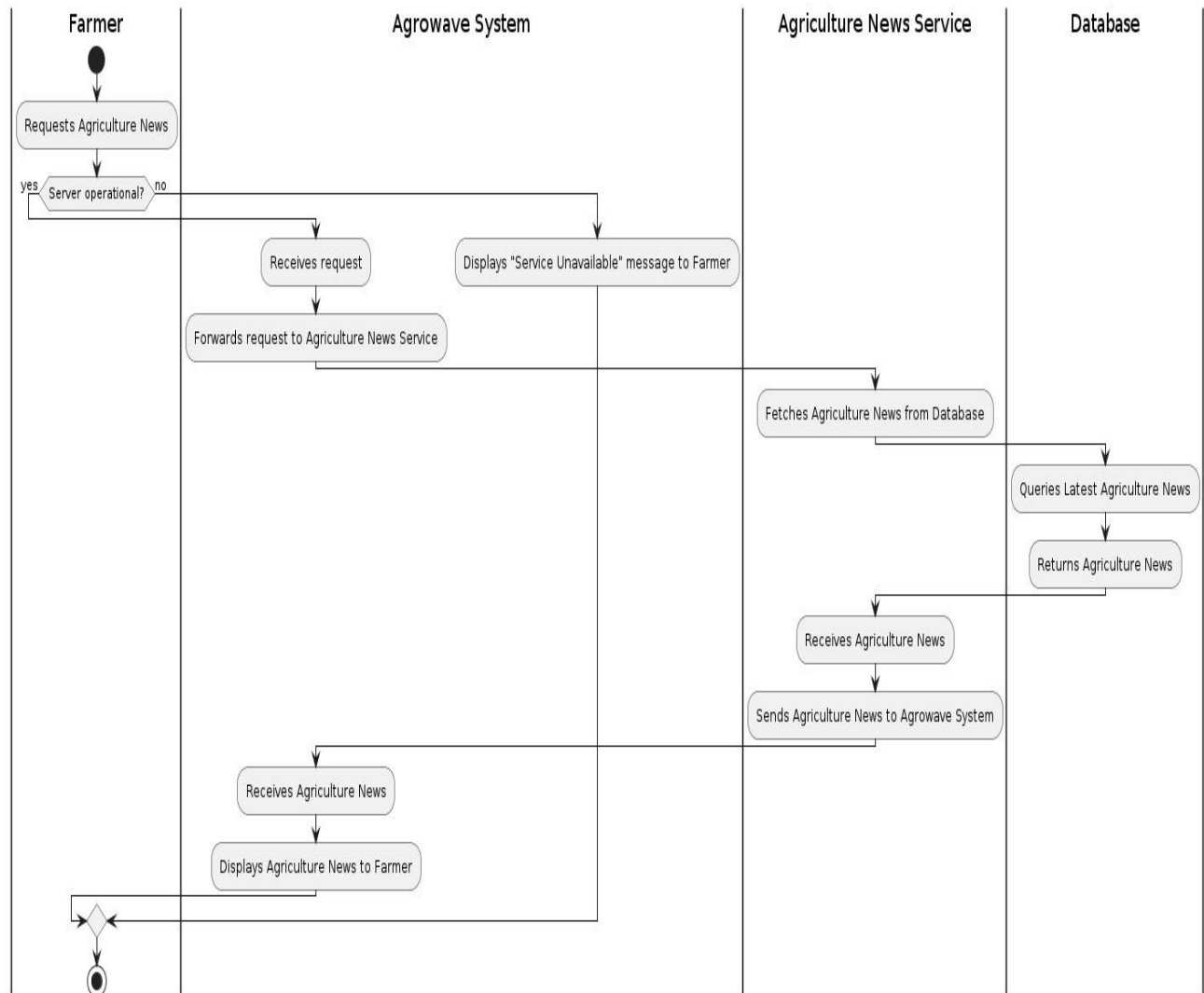


Figure 18: Agriculture News

9.12 Swimlane Diagram of Manage Profile

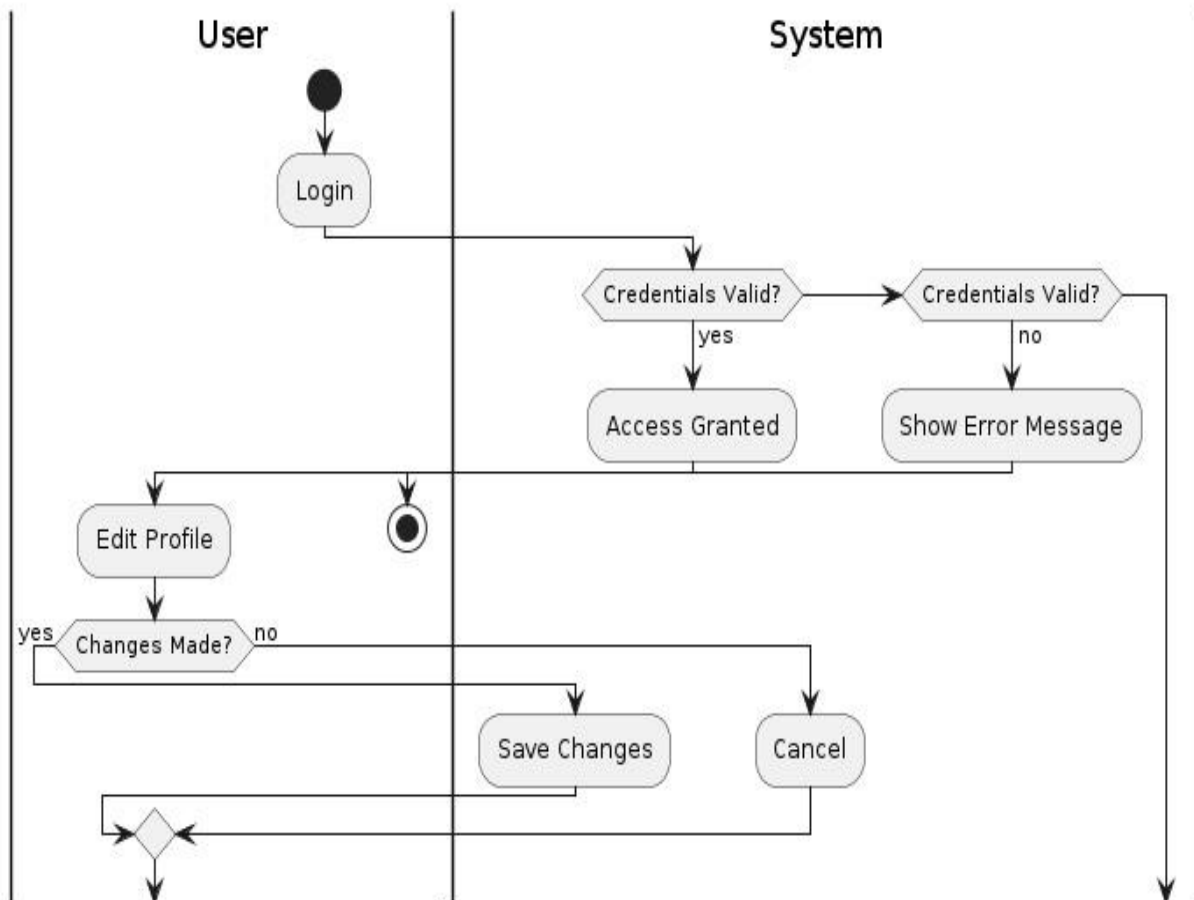


Figure 18: Manage Profile

9.12 Swimlane Diagram of System Maintenance

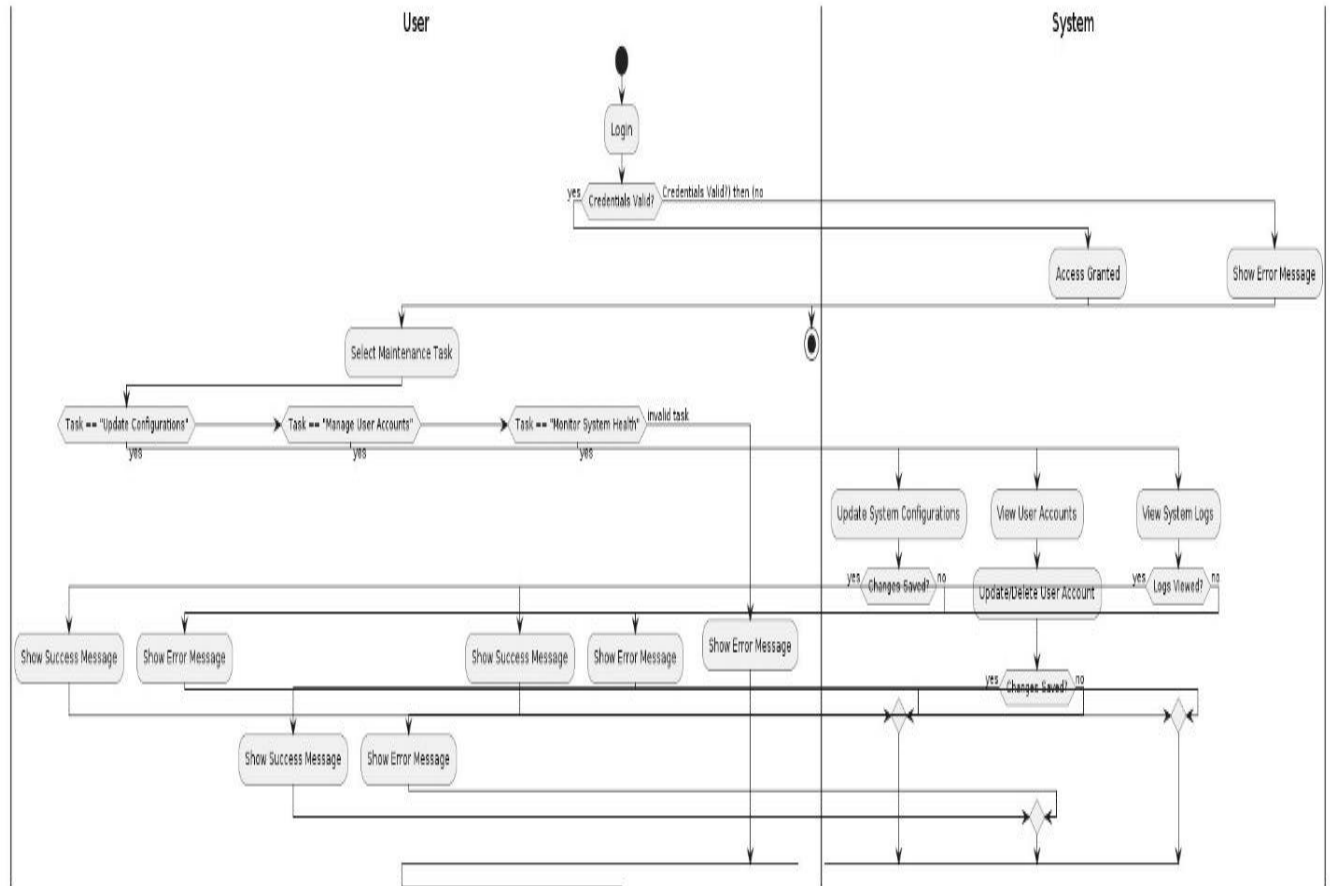


Figure 18: System Maintenance

10. Sequence Diagram

A sequence diagram is a type of interaction diagram that depicts the flow of messages between objects or components in a system over time. It shows the chronological sequence of interactions among different entities, illustrating how they collaborate to accomplish a specific task or scenario. Sequence diagrams are useful for visualizing the dynamic behavior of systems and understanding the sequence of steps involved in a particular process or use case.

These diagrams are created by using PlantUML.

Diagrams source code: <https://github.com/asifse27/AgroWave>

10.1 Sequence Diagram of Access Control

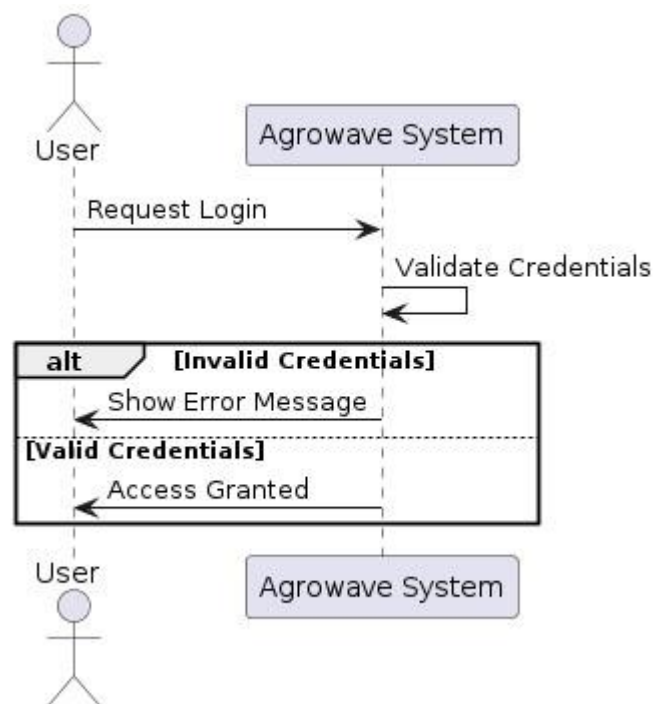


Figure 27: Access Control

10.2 Sequence Diagram of Crops Recommendation

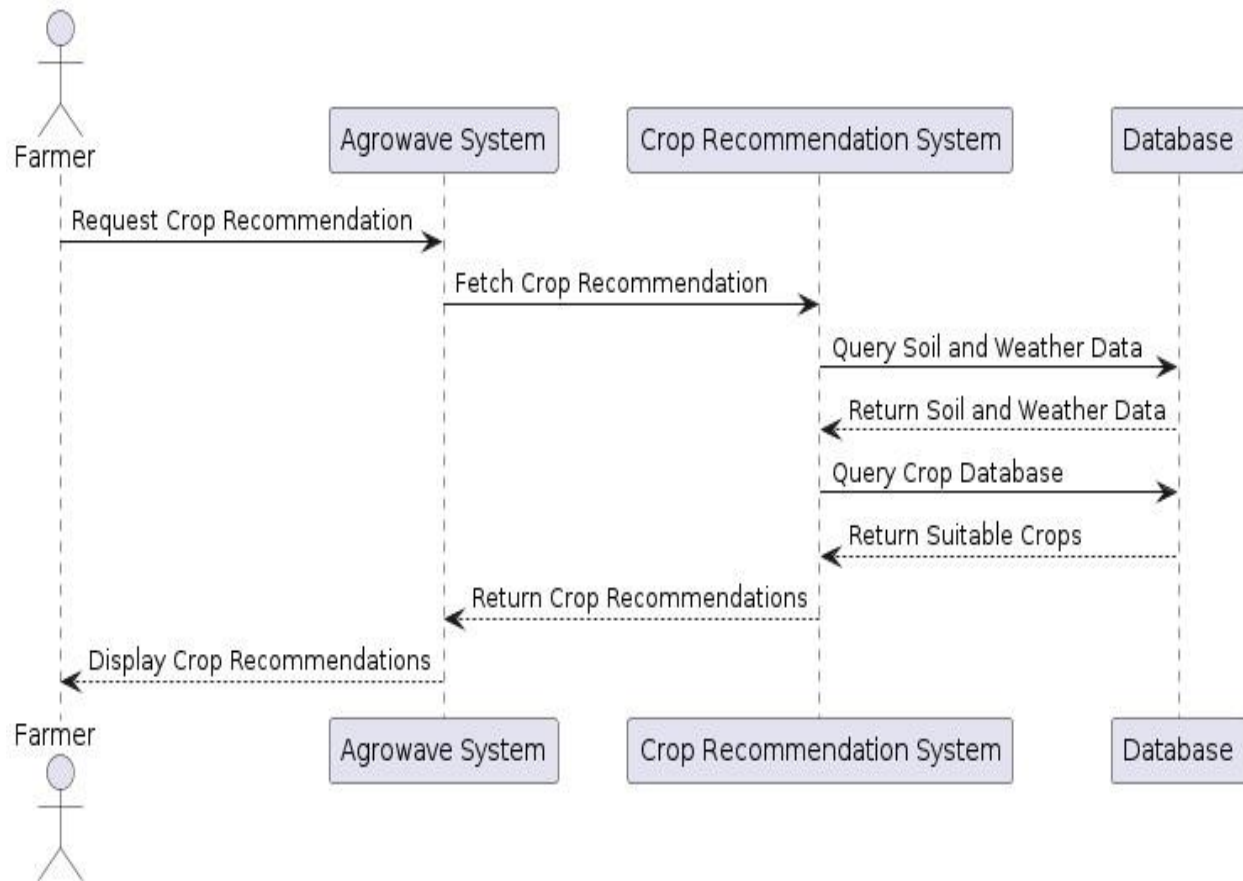


Figure 28: Crops Recommendation

10.3 Sequence Diagram of Fertilizer Recommendation

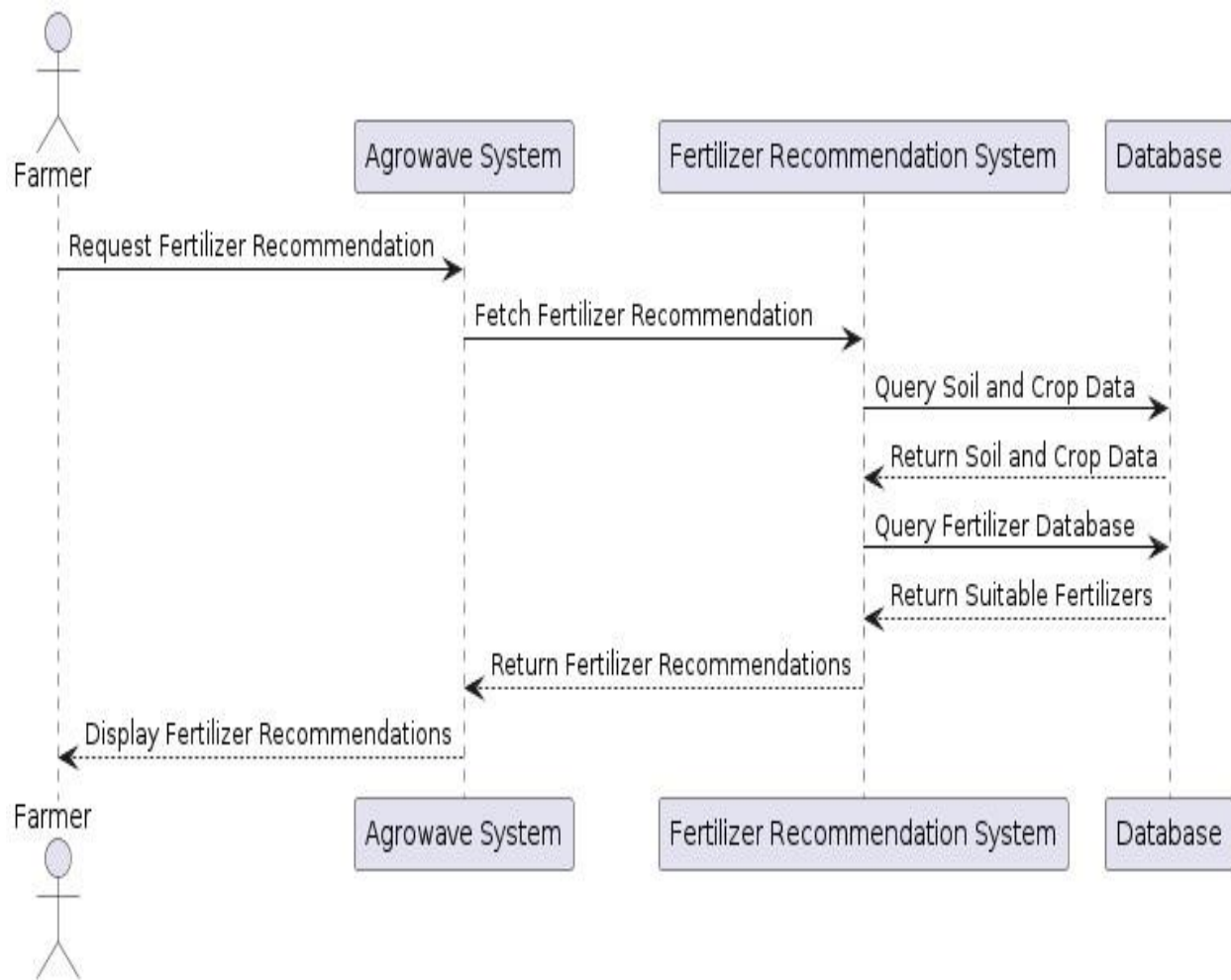


Figure 29: Fertilizer Recommendation

10.4 Sequence Diagram of Agriculture Tool Hire

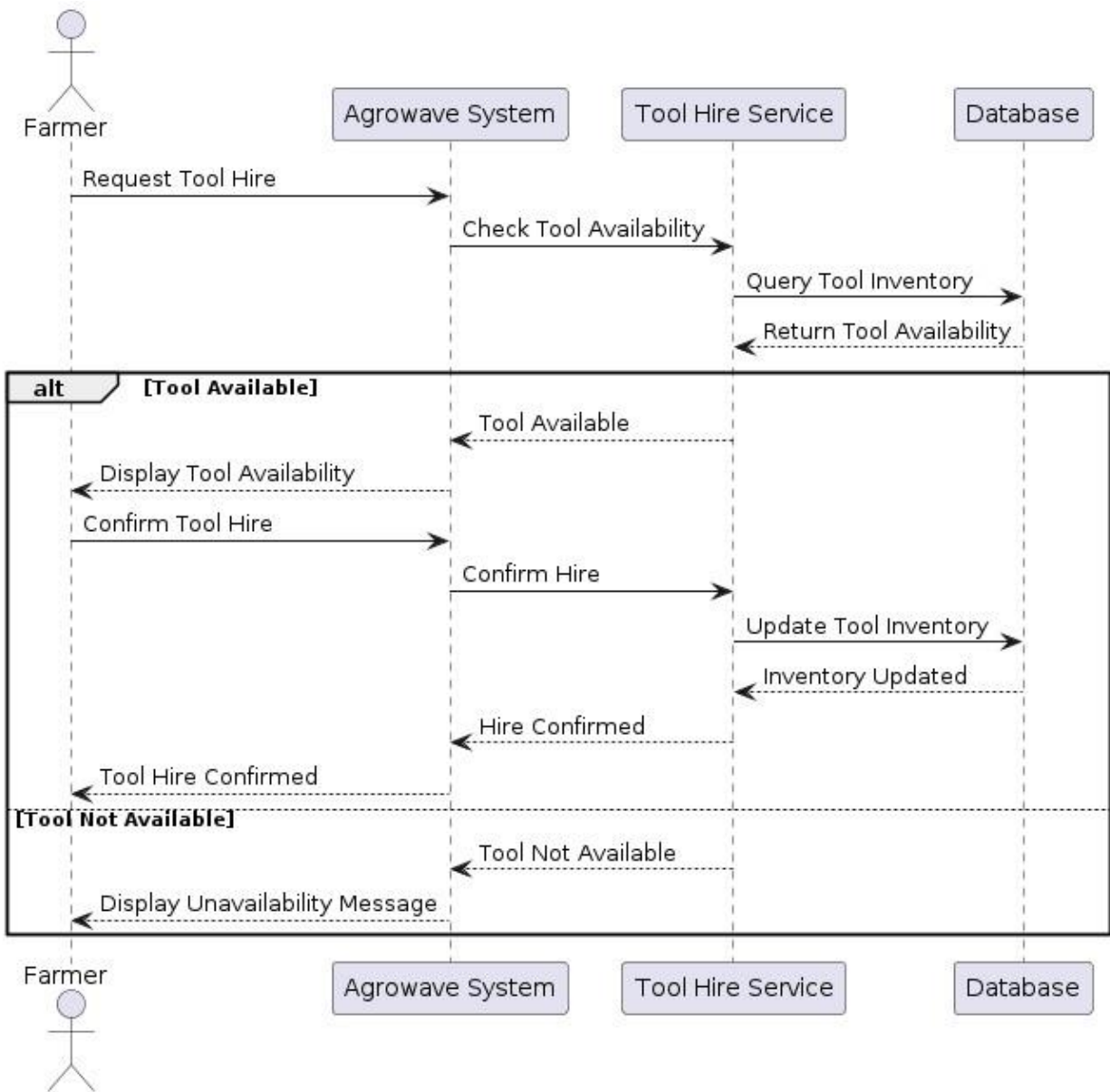


Figure 29: Agriculture Tool Hire

10.5 Sequence Diagram of Weather Forecast

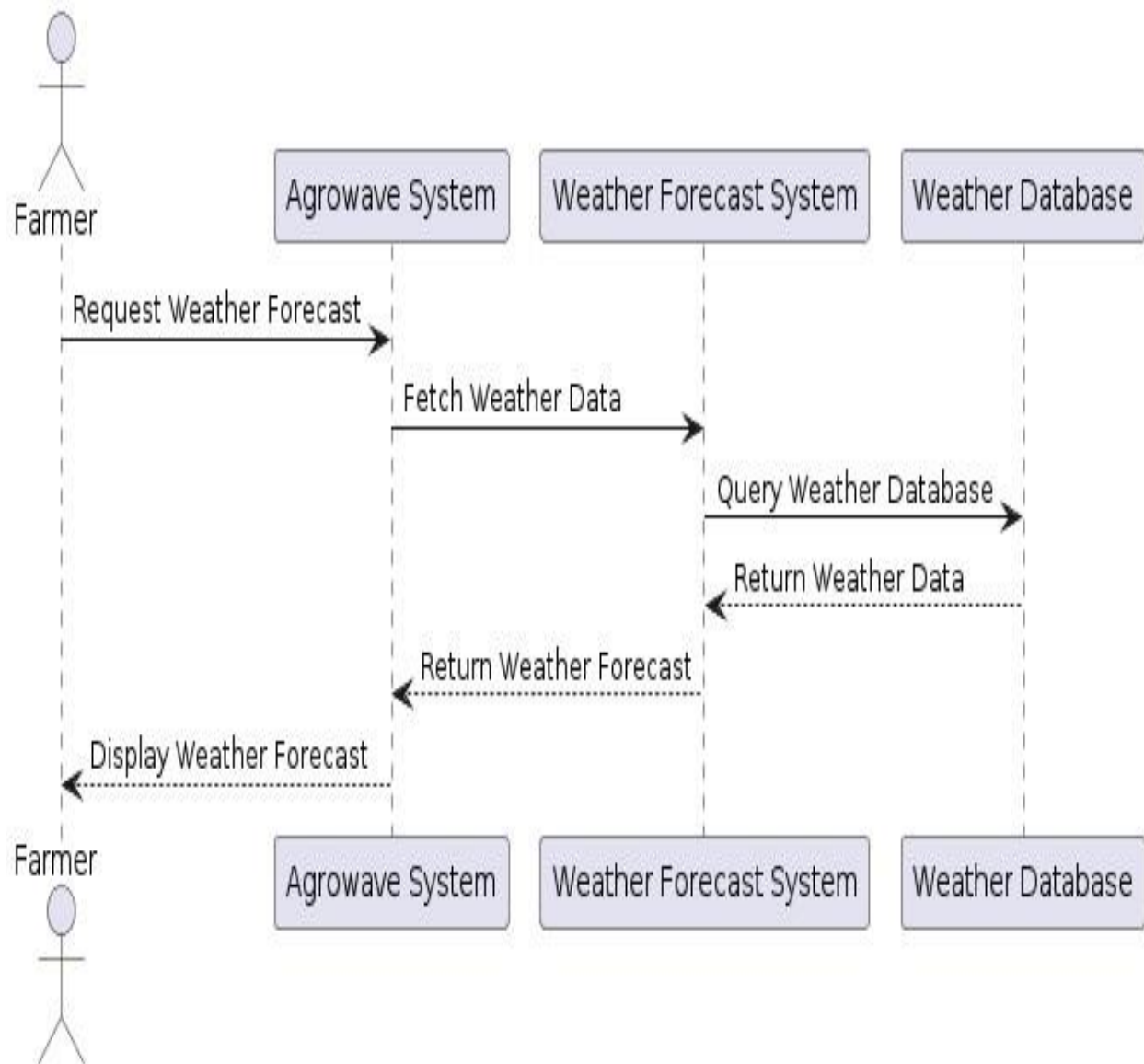


Figure 30: Weather Forecast

10.6 Sequence Diagram of Crops Stock

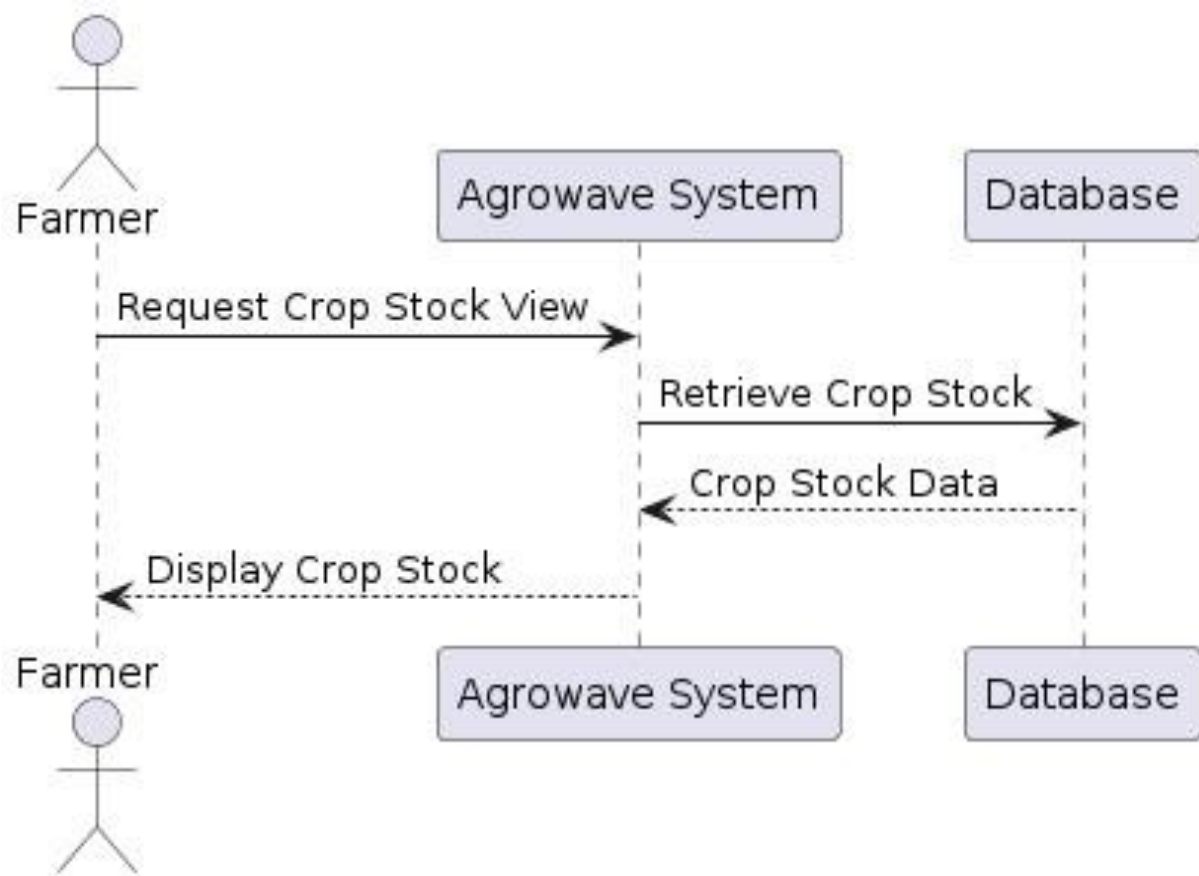


Figure 30: Crops Stock

10.7 Sequence Diagram of Buy and Sale

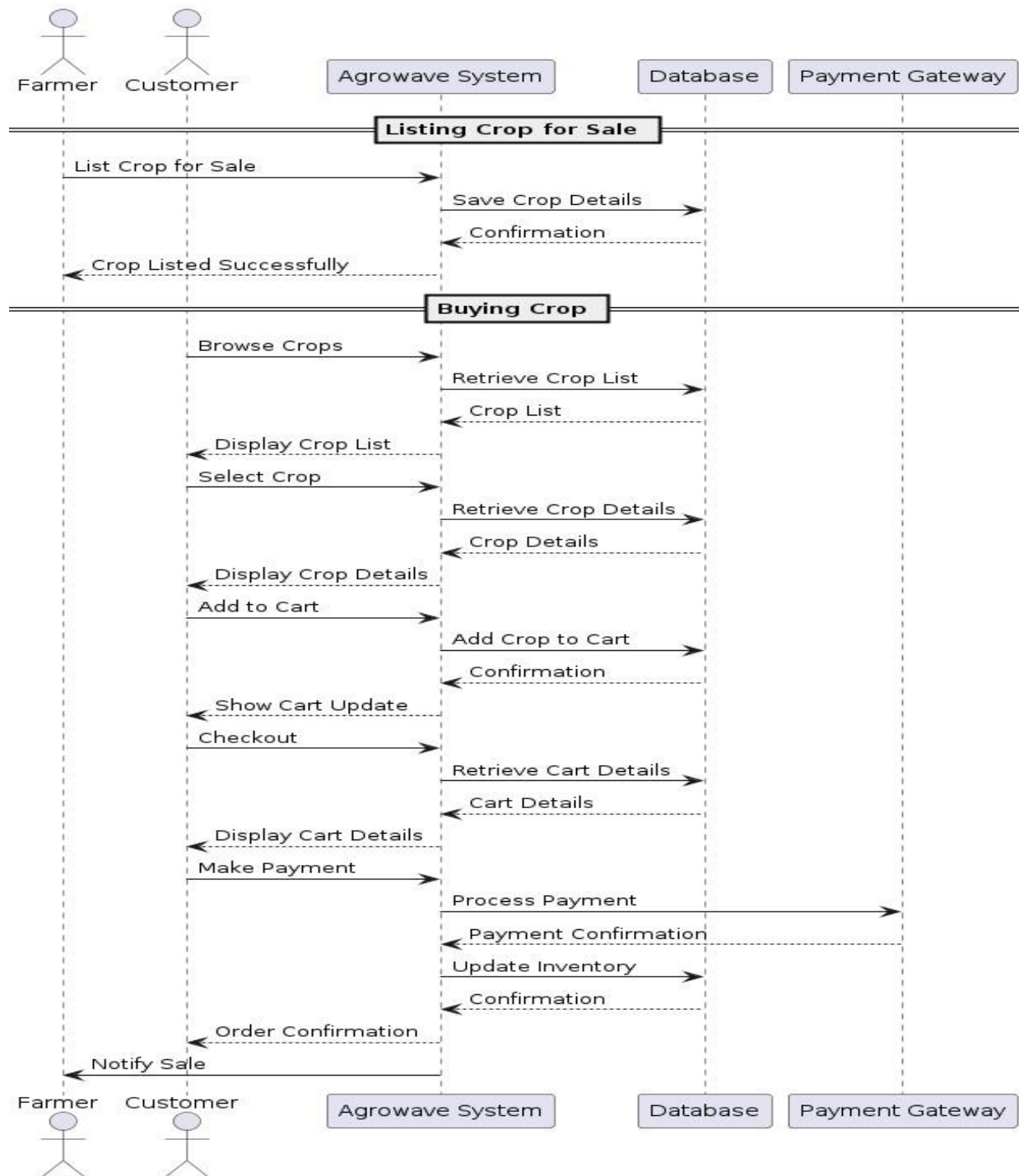


Figure 31: Buy and Sale

10.8 Sequence Diagram of Add to Cart

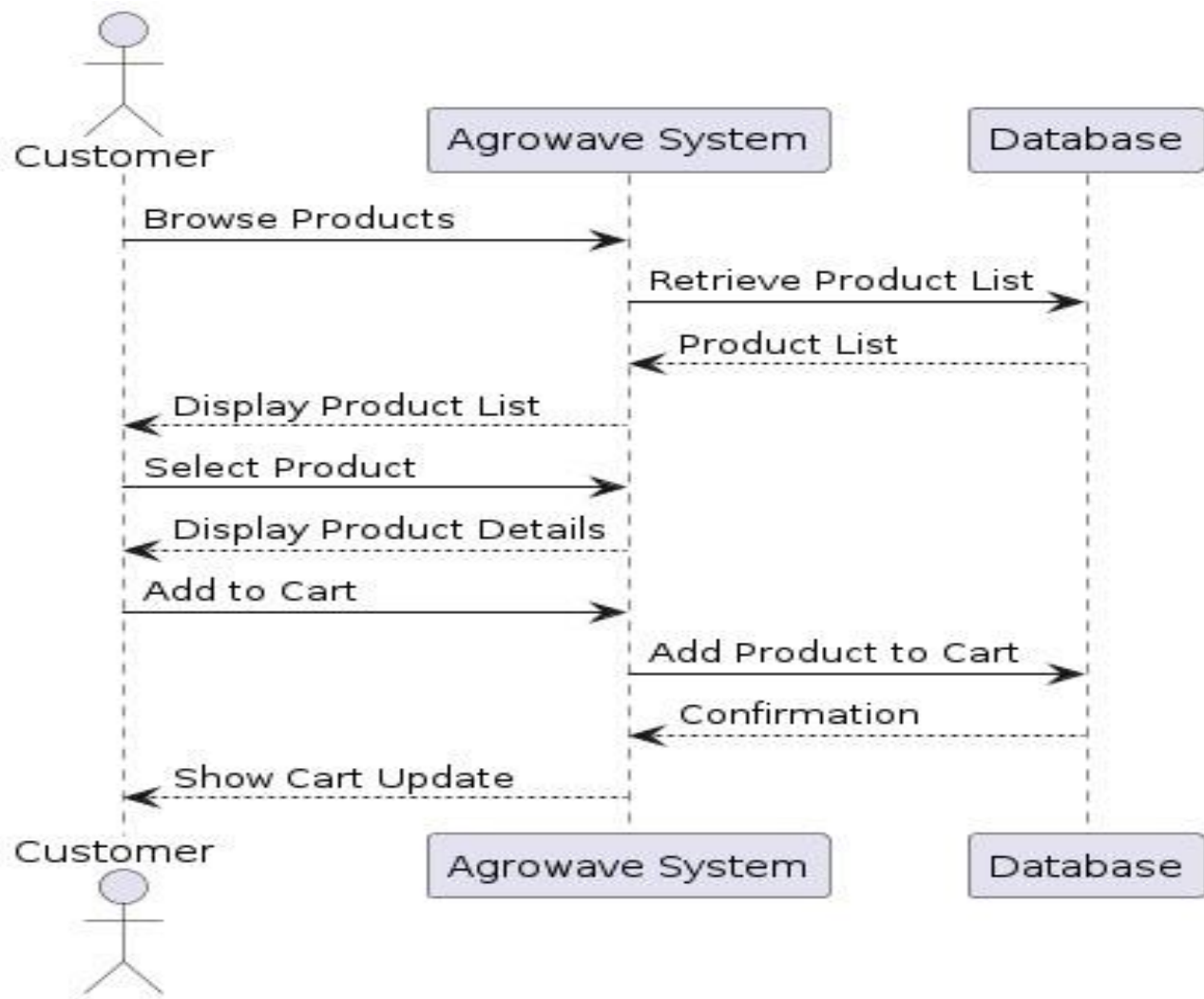


Figure 32: Add to Cart

10.9 Sequence Diagram of Selling History

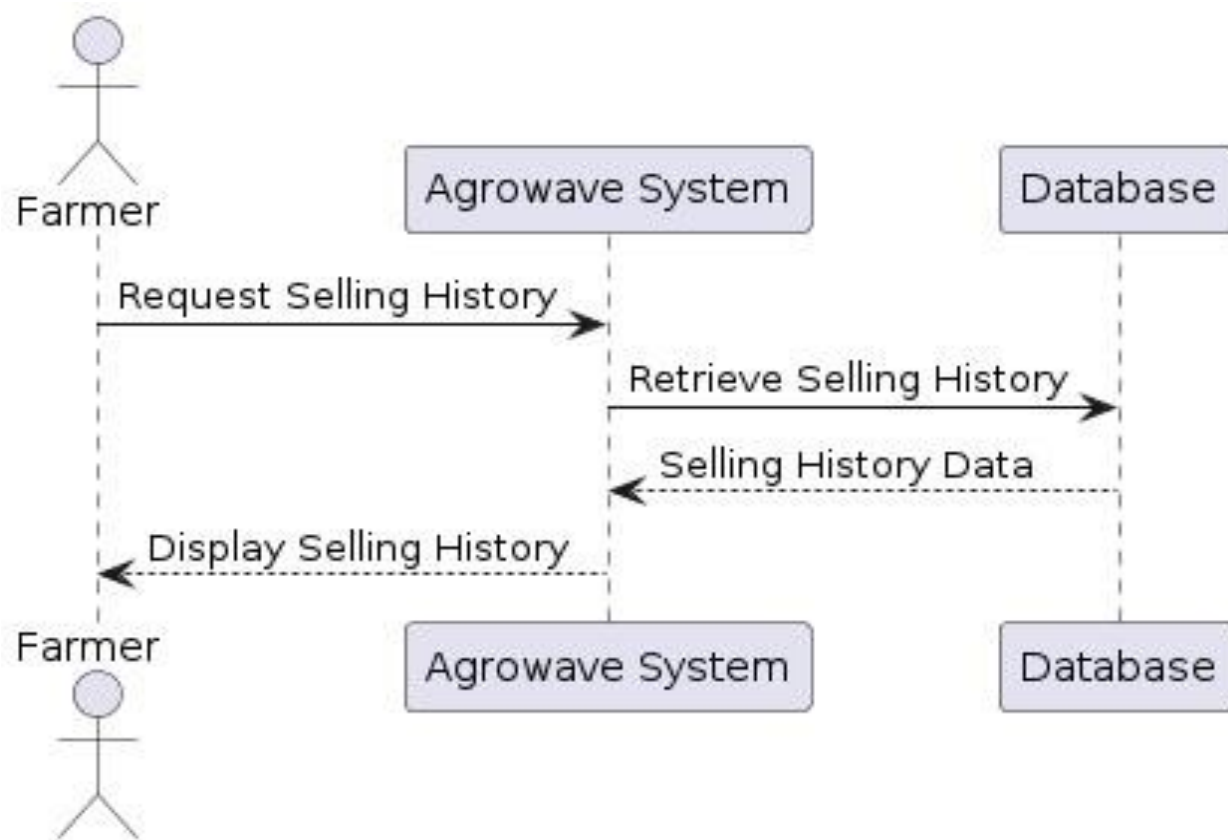


Figure 33: Selling History

10.10 Sequence Diagram of Expert Consult

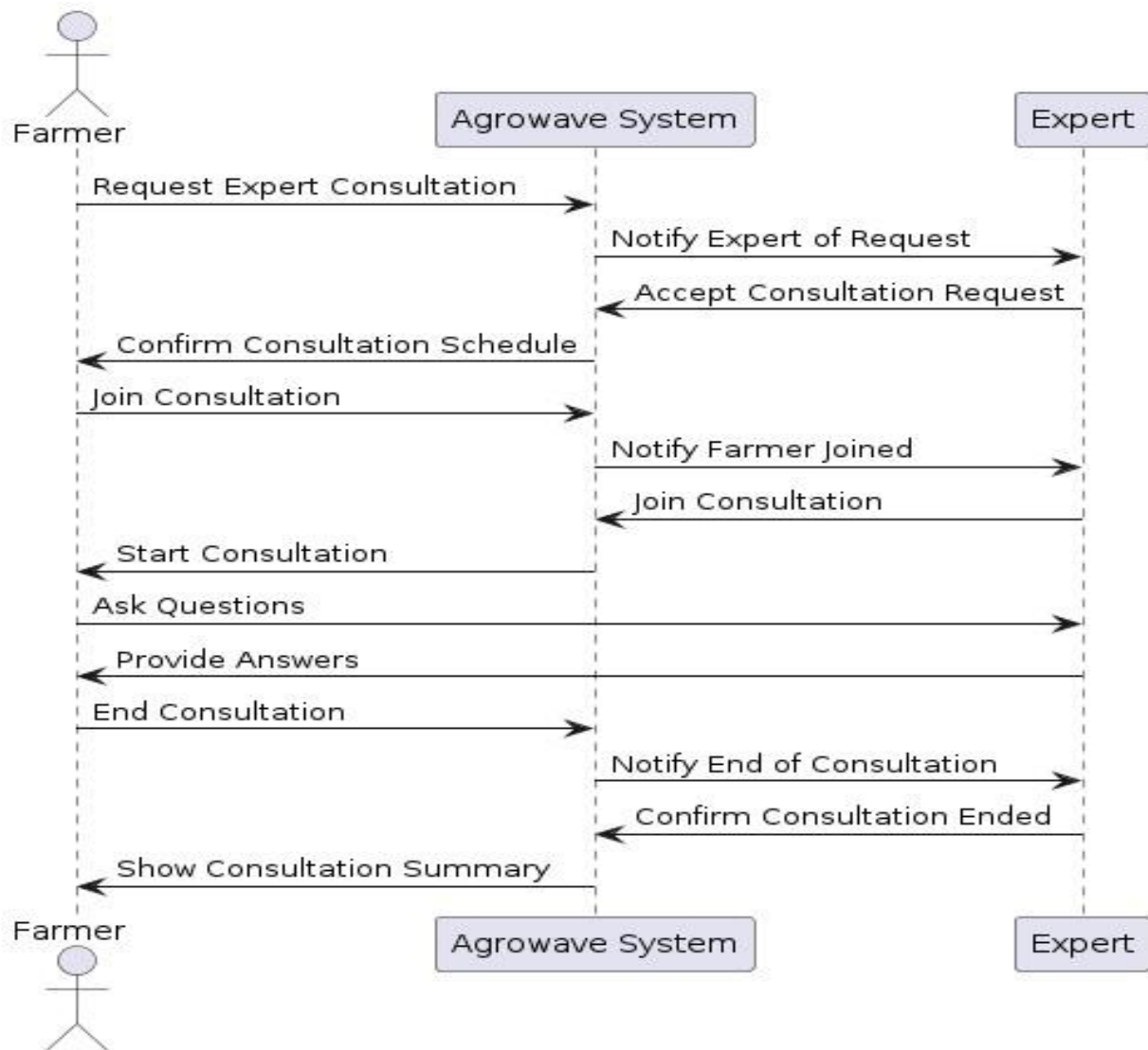


Figure 34: Expert Consultant

10.11 Sequence Diagram of Agriculture News

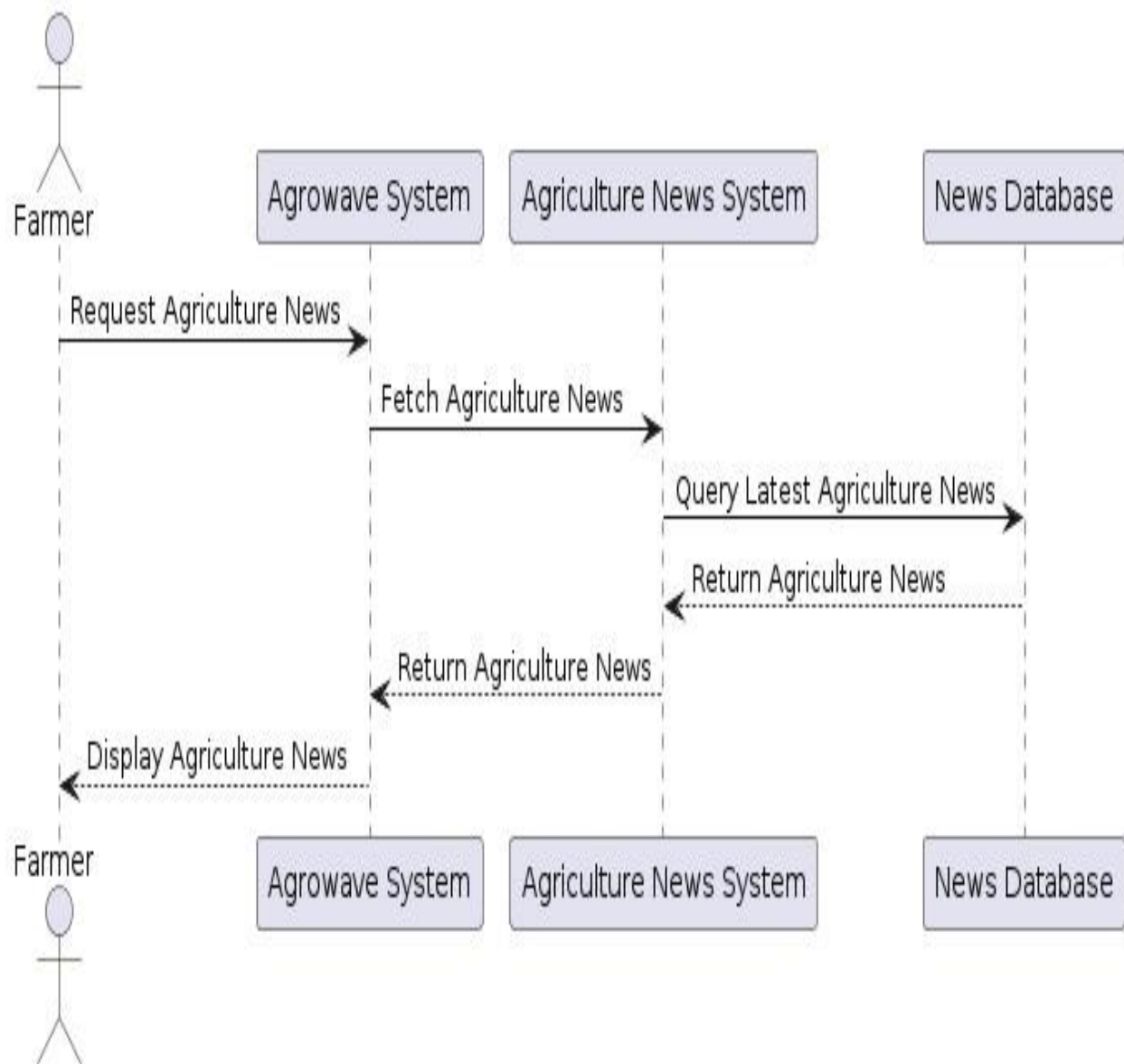


Figure 34: Agriculture News

10.12 Sequence Diagram of Manage Profile

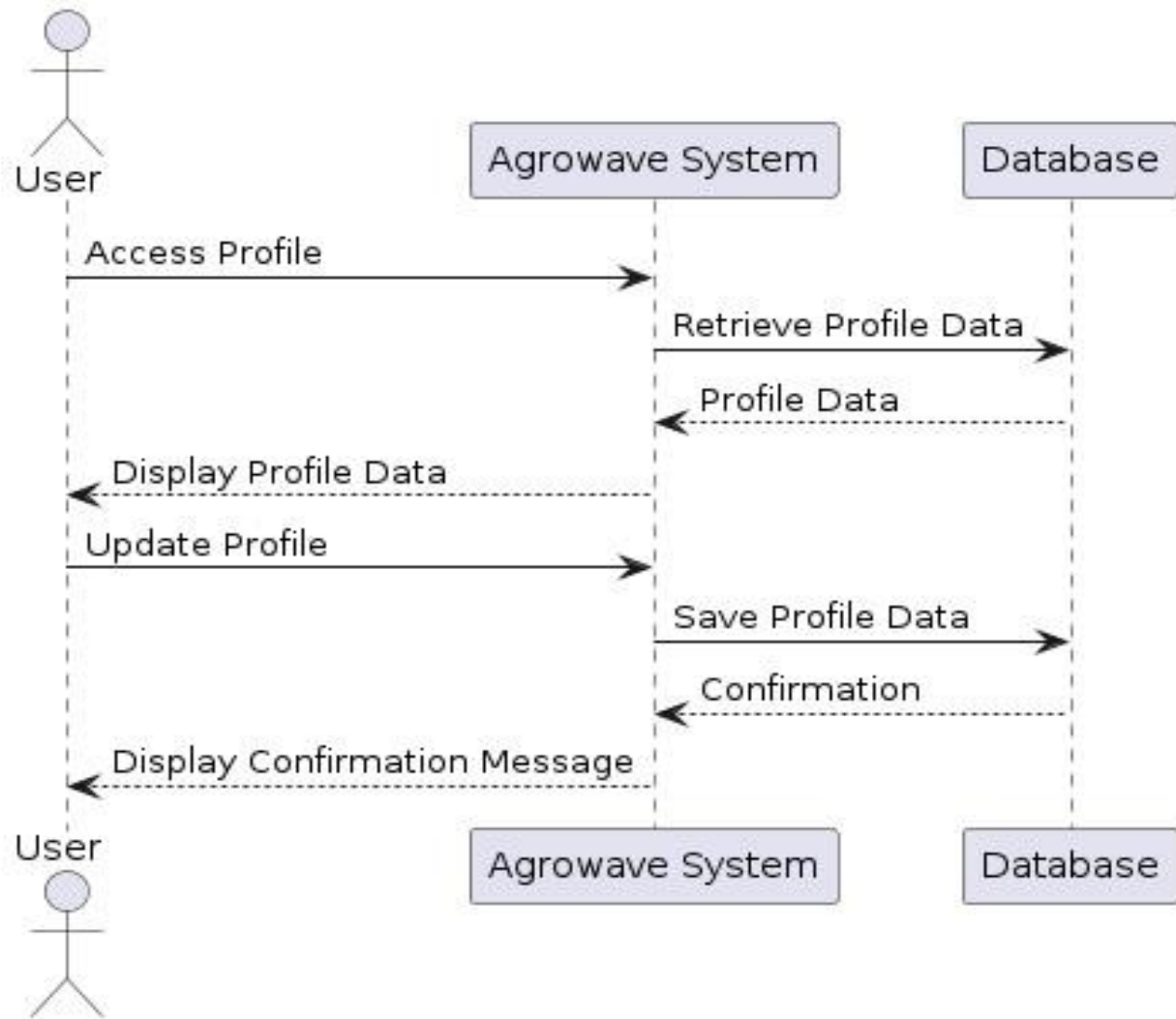


Figure 34: Manage Profile

10.13 Sequence Diagram of Maintain System

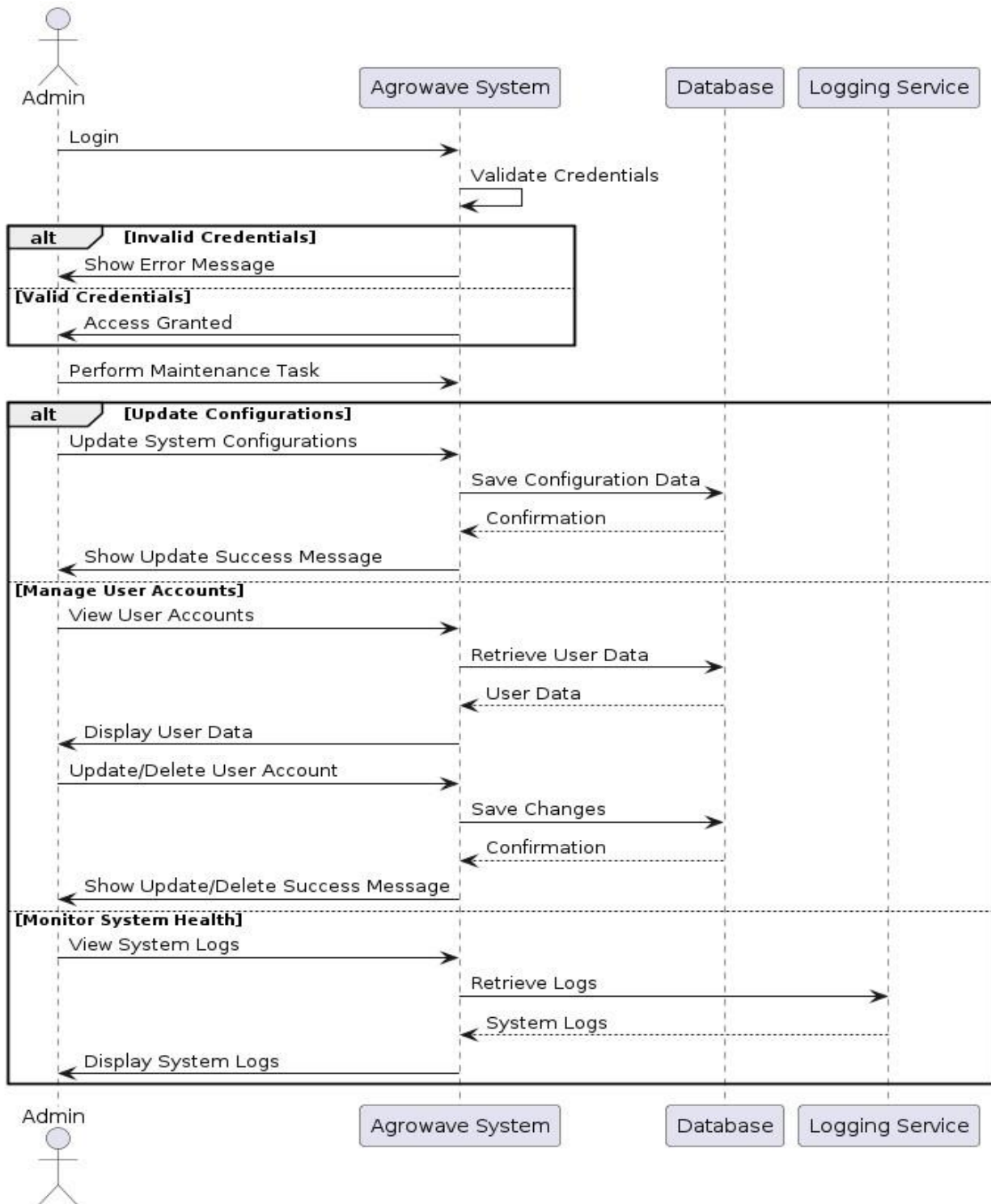


Figure 34: Maintain System

11.Requirement Traceability Matrix

The Requirement Traceability Matrix (RTM) is a key project management tool used to ensure that all project requirements are adequately addressed throughout the project lifecycle. It provides a comprehensive view of the relationship between requirements, their corresponding functional and non-functional specifications, and associated use cases. By tracking requirements from their origin through to implementation, the RTM helps in verifying that all requirements are fulfilled, thus ensuring completeness and facilitating impact analysis in case of changes. The matrix also aids in identifying any gaps in the process and enhances the overall quality of the project deliverables.

Requirement ID	Requirement Description	Functional Requirement	Non-Functional Requirement	Use Case Reference
REQ-001	User authentication	FR-001	PR-001	UC-001, UC-002
REQ-002	Crop recommendation	FR-002	PR-002	UC-003, UC-004
REQ-003	Expert consultation	FR-003	PR-003	UC-004, UC-005
REQ-004	Crop stock management	FR-004	PR-004	UC-006
REQ-005	Add to cart	FR-005	PR-005	UC-007
REQ-006	Selling history	FR-006	PR-006	UC-008, UC-009
REQ-007	Manage profile	FR-007	PR-007	UC-011
REQ-008	Agriculture news	FR-008	PR-008	UC-012, UC-013
REQ-009	Equipment rental	FR-009	PR-009	UC-004, UC-013
REQ-010	Fertilizer recommendation	FR-010	PR-0010	UC-004, UC-013
REQ-011	Real-time weather updates	FR-011	PR-011	UC-003, UC-010
REQ-012	Secure payment processing	FR-012	PR-012	UC-002, UC-011

