A Web Based System To Support Farmers In Bangladesh With AI Features

by

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A project submitted to the Department of Computer Science and Engineering
in partial fulfillment of the requirements for the degree of
B.Sc. in Computer Science and Engineering

Department of Computer Science and Engineering
Brac University
January 2026.

Abstract

Agriculture is the main source of livelihood in Bangladesh but many farmers still face serious problems such as limited access to market information, accurate weather forecast, crop health support and proper financial management tools. These challenges often reduce farm productivity and income. To address these issues, this project presents a web base all in one smart farming solution that uses modern digital technology to support farmers in their daily activities.

The system provides a user friendly dashboard where farmers can easily view region based weather updates, crop health status, market prices, buyer demand, Inventory records and financial summaries on a single platform. Real time market information helps farmers make better decisions about when and where to sell their crops. The system also analyzes soil data, weather conditions and crop types to suggest proper use of fertilizers and pesticides. Farmers can upload crop images to detect diseases using AI based image analysis and receive instant guidance.

Additionally, the platform includes inventory and financial management features to track resources, income, expenses and profit. Overall, this smart farming solution helps farmers reduce costs, improve productivity, increase market access and support data driven decision making, contributing to sustainable agricultural development in Bangladesh.

Keywords: Smart Farming, Market Information System, Crop Disease Detection, Weather Forecasting, Inventory Management,Finance Management, Machine Learning, Bangladesh Agriculture

Dedication

We dedicate this work our my beloved parents, whose unconditional love, support, and sacrifices have been the foundation of our journey. We also dedicate this work to the Libaration War martyrs, July martyrs and Osman Bin Hadi, whose courage, sacrifice, and devotion to the nation will always be remembered with respect and gratitude.

Declaration

It is hereby declared that

1. The thesis submitted is my/our own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. We have acknowledged all main sources of help.

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Acknowledgement

We are deeply thankful to our supervisor Md Aquib Azmain sir for his valuable guidence and supports for this project.

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Chapter 1

Introduction

1.1 Background

Agriculture is still a very important part of Bangladesh's economy. More than 40% of people depend on it for their jobs and it contributes about 11% to the country's GDP. Even though agriculture plays such a big role, the sector faces many challenges. These include low use of modern technology, poor management of resources, weak connections to markets and frequent damage caused by climate change. Most farmers in Bangladesh are small scale farmers. Many of them do not have access to digital tools, up to date information or data based advice. Because of this, they often struggle to increase crop production, reduce losses and earn better income.

To help solve these problems, this research proposes an AI based agricultural management platform that is designed for Bangladesh's local farming conditions. The platform uses real time data, simple machine learning techniques and an easy to use system to support farmers in their daily activities. It can provide crop suggestions based on local conditions, weather alerts, crop disease detection using images and predictions of market prices. The system also includes financial tools and e-commerce features so that farmers can sell their products directly to buyers in a fair and transparent way. By offering support in multiple languages and providing different dashboards for different users, the platform can be used by farmers, agribusinesses and other stakeholders. Overall, the proposed system aims to make agriculture more resilient, inclusive and sustainable while supporting Bangladesh's development goals and the Sustainable Development Goals.

1.2 Problem Statement

Agriculture is one of the most important sectors in Bangladesh. However, most farming activities even today depend on traditional methods. Many farming decisions are made based on guesses or past experience rather than proper data. As a result, there is very little use of data based or technology driven approaches in agriculture. In rural areas, farmers usually do not have access to modern facilities such as crop health monitoring systems, reliable weather updates or information about market demand. Because of this, their decisions are often inconsistent and sometimes incorrect.

One major problem farmers face is detecting crop diseases. In most cases, diseases are noticed only after clear symptoms appear or even at a later stage. This late detection often causes reduced crop yield and financial losses. Unpredictable weather conditions like sudden rainfall, drought and changes in temperature further increase the risks of farming and make it harder for farmers to plan their activities.
Farmers also commonly use seeds, fertilizers and pesticides without proper guidance which can lead to poor crop quality and damage to soil health over time. In addition, many farmers lack basic logistical support and practical knowledge. They usually do not keep records of their income and expenses and do not have effective ways to manage inventory. Moreover, they do not have access to centralized market information. This makes it difficult to understand product demand or set fair prices. Overall, these challenges show a clear need for modern and smart farming solutions. Technologies can help farmers make better, data driven decisions, reduce risks and improve productivity and income.

1.3 Objective

Based on the problems discussed earlier this project aims to design a farmer panel that provides a simple and well organised way to manage all necessary activities through a single platform. The main goal is to help farmers make better decisions by using digital tools and real time information. Each feature of the panel is designed to serve a specific purpose and support farmers in their daily work.

- Dashboard: The dashboard gives farmers a quick summary of important farming activities and system updates. It helps them understand key information at a glance without needing technical knowledge.
- Yield Management:This module allows farmers to record and track crop production data. Thus, they can plan better and improve overall crop yield.
- Crops Health: This section helps farmers monitor the health of their crops and identify possible diseases or issues using digital support tools.
- Weather Information: This feature provides up to date weather information so farmers can plan farming tasks properly and reduce risks caused by sudden weather changes.
- Market Information: This section shares market related data like demand and trends. It helps farmers make better decisions about selling their products.
- Manage Finance: This module enables farmers to easily record income and expenses. A simple financial view helps them understand profit and loss.
- Manage Inventory: This feature allows farmers to keep track of farming resources like seeds , fertilizers and stored products which helps prevent shortages and reduce waste.

1.4 Methodology In Brief

A modular and user's feedback are follows to maintain the project of web based smart farming system. The methodology prioties to build farmer friendly panel that integrates farming module, market module ,inventory module and financial management module into one single platform.

1. **Requirement Analysis:** The system requirements are gathered through analyzing common problems in farming sector mostly faced by farmers. For example tracking finance record, shortage knowledge of crop price on current market price , unpredictable weather etc. In these system, a dashboard panel were designed to access all kinds of features.

2. **System Design:** This system follows the clear modular structure where each module offers farmer panel , dashboard, yield management , crops health, weather information , market information , finance and inventory. Each feature is designed such a way to ensure simplicity and usability.

3. **User Interface Development:** A simple user interface was maintained while developing to make the system easy to use for farmers. The left navigation panel allows quick access to all features. Charts and visual elements are used to present data in an easy-to-understand format.

4. **Backend Development:** The backend is developed to handle user authentication, data storage, and business logic. Separate services manage financial records, inventory data, crop-related information, and user activities. Secure APIs are used to connect the frontend and backend.

5. **Data Processing and Analytics:** The system processes farming, financial, and market data to generate summaries, comparisons, and insights. Basic analytics are used to show income vs. expense, expense distribution, and activity records.

6. **Data Collection and Integration:** Seed and fertilizer planning data are collected from annual release documents provided by BRAC and BIRRI, along with additional relevant sources. Weather and market information are integrated from reliable platforms to provide real-time updates. Kaggle datasets are also used for model training to improve predictive accuracy

Chapter 2

Literature Review

2.1 Review Of Existing Research

1. **Artificial Intelligence to Improve Food and Agriculture Sector :** Despite climate change, resource scarcity, and food safety problems, global food production must increase by 60–110 billion. It is a big challenge for us to mitigate this issue [10], [18]. To address these problems, Machine Learning and artificial intelligence can play vital roles to optimize agricultural production and increase the rate of crop sustainability in bad situations [5], [13]. AI system is like human intelligence with advanced decision-making capability, and is changing the field of agriculture through applications like NLP (Natural Language Processing) for analyzing the data of agriculture [15]. It also uses computer vision for accessing crop data and its live health condition, and ML models detect diseases, predict weather, and yield estimation [11], [12]. To contribute in data-driven farming solutions, these methodologies include supervised, unsupervised, and reinforcement learning [14]. To measure soil and monitor crop health in real time, it uses drones and sensors [7]. Many AI-powered tools help to optimize pest control and irrigation [18]. By automatic defect detection, AI ensures safety in food processing with VGG-16, a deep learning model, and achieved high accuracy in identifying plant diseases [13]. Moreover, by analyzing satellite data, AI models predict weather conditions and aid farmers in planning [6]. However, adopting AI facilities creates challenges among the farmers due to adoption of new technologies, human labor layoffs, infrastructure issues, etc. Despite seeming problems, using AI is revolutionary for the agriculture sector to produce more in a systematic way and ensure sustainability [13], [18].

2. **Extreme Weather Events (EWE) in Agriculture :** Extreme weather events such as heat waves, floods, droughts, and hail storms are happening more often and are seriously affecting agriculture. These events damage crops and soil, reduce farm productivity, and threaten food security and farmers' income around the world [4], [17]. According to the Intergovernmental Panel on Climate Change (IPCC), extreme weather events are those that occur very rarely, falling below the 10th percentile or above the 90th percentile of observed weather patterns [4]. Because of this growing risk, research on how extreme weather affects agriculture has increased [17].

The popular Scopus database was used to analyze research trends, research gaps for between climate changes and agriculture production. The study was observed on 19 major crop systems across five continents and took help of text mining techniques.Since 2008, the number of studies on extreme weather events in agriculture has risen sharply [17].

Most research were conducted on some important key factors such as temperature changes, droughts, and rainfall variability. These factors strongly affect the production of major crops such as wheat and maize [1], [8]. However, there are very few studies were conducted on high-value crops like tomatoes and mangoes ,even though they are economically important [17]. In addition, modern tools such as satellite images, artificial intelligence (AI), and remote sensing are not widely used to track extreme weather events and crop health [6].

In addition, the review also shows that economic impacts of extreme weather were got more periodized and studied in developed countries meanwhile developing and underdeveloped countries receive much less attention [17]. As a result more research should be conducted on this regions for social, economic, and policy solutions to support small-scale farmers.

To conclude, minimizing the impact of extreme weather on agriculture requires more research. More focus should be highlighted on high-value crops. The use of advanced technologies like AI and remote sensing for real-time monitoring and the development of risk management strategies for small farmers in developing countries. By addressing these issues on these specific areas and applying policies, agriculture can better adapt to climate change and ensure food security and economic stability despite growing climate challenges [4], [17].

2.2 Summary Of Key Findings

In the 21st century, a major concern is global food security whereas the population grows. These resulting the rising of demand of food supplies. However, to meet with challenges, farmers need to adopt modern technologies such as artificial intelligence and logistic support systems to increase food production.These technologies help in crop disease detection, fertilizer planning, drone-based crop monitoring, and remote sensing.

Chapter 3

Requirements, Impacts and Constraints

3.1 Final Specifications And Requirements

Functional Requirements

1. **User Authentication & Authorization**

   (a) **User Registration**

   - The system will allow new users (farmers) to create an account using valid details such as name, email/phone, password, and location.
   - The system will store user credentials in the database.

   (b) **User Login**

   - The system will allow registered users to log in using their credentials.
   - The system will authenticate users using secure authentication mechanisms (e.g., JWT).
   - The system will deny access to unauthorized users.

   (c) **User Logout**

   - The system will allow users to securely log out of the application.
   - The system will invalidate active sessions after logout.

2. **Home Module**

   (a) **Dashboard Display**

   - The system will display a dashboard after successful login.
   - The dashboard will show quick access to all modules (weather, crop health, finance, etc.).
   - The dashboard will display summary information such as alerts or notifications.

3. **About Module**

   (a) **Application Information**

- The system will display information about the Smart Farming System.
- The system will describe system objectives, mission, and vision.

4. **Weather Forecast Module**

   (a) **Weather Data Retrieval**
   - The system will retrieve real-time weather data using a weather API.
   - The system will fetch weather data based on the user's location.

   (b) **Weather Display**
   - The system will display temperature, humidity, rainfall, and forecast data, including the next 5 days.
   - The system will update weather information periodically.

5. **Crop Health Module**

   (a) **Image Upload**
   - The system will allow users to upload crop images.
   - The system will validate image format and size.

   (b) **Disease Detection**
   - The system will analyze uploaded images using a machine learning model.
   - The system will identify the crop disease based on image analysis.

   (c) **Result & Recommendation**
   - The system will display the detected disease name and confidence score.
   - The system will provide treatment or medicine recommendations.

6. **Yield Management Module**

   (a) **Field Image Upload**
   - The system will allow users to upload yield images, and ML will calculate yield size.
   - The system will store crop data for future reference.

   (b) **Field Properties**
   - The system will allow users to input soil properties such as pH and nutrient content.

   (c) **Yield Estimation**
   - The system will estimate expected yield based on input data.
   - Based on inputs and properties, farmers can see crop recommendations, seed planning, and fertilizer planning.

7. **Market Information Module**

(a) **Market Price Retrieval**

- The system will retrieve market prices for crops from external sources or APIs.
- The system will support crop-wise price listing.

8. **Finance Management Module**

(a) **Expense Tracking**

- The system will allow users to record farming expenses (seeds, fertilizer, labor, salary, etc.).
- The system will categorize expenses.

(b) **Income Tracking**

- The system will allow users to record income from crop sales.
- The system will calculate profit or loss.

(c) **Financial Reports**

- The system will generate monthly and yearly financial summaries.
- The system will present financial data in an understandable format.

9. **Inventory Management Module**

(a) **Inventory Entry**

- The system will allow users to add inventory items such as seeds, fertilizers, and tools.
- The system will store quantity and usage details.

(b) **Inventory Update**

- The system will allow users to update or delete inventory items.
- The system will automatically update stock levels after inventory in or out.

(c) **Inventory Alerts**

- The system will notify users when inventory reaches a low level.

Non Functional Requirements

10. **Performance Requirements**

- The system will respond to user requests within time limits.
- Disease prediction results should be generated within a few seconds.

11. **Security Requirements**

- The system will encrypt sensitive user data such as passwords.
- The system will use secure communication protocols (HTTPS).
- The system will restrict access to authenticated users only.

- The system will prevent unauthorized data access.

12. **Usability Requirements**
    - The system will be easy to use for farmers with minimal technical knowledge.
    - The system will provide clear navigation and readable interfaces.
13. **Accuracy Requirements**
    - The crop disease detection system will provide accurate predictions.
    - The system will display confidence scores for transparency.
14. **Reliability Requirements**
    - The system will be available 24/7 except during maintenance.
    - The system will handle failures without data loss.

3.2 Feasibility Study

Technology

- Internet access in the rural area of Bangladesh is so common now.
- Smartphones are also common in the educated farmer society.
- APIs are available, such as weather and market data.
- Machine learning-based disease detection is also possible.

Economical Feasibility

- The development cost is low.
- Reduces fertilizer waste, crop loss, and wrong investment.
- Profitable for the farmers.
- It can also be a SaaS / subscription product.

Operational Feasibility

- UI is simple.
- Training is not complex for educated people.
- Modular design.

3.3 Target Customer

- **Agri Entrepreneurs / Farmers:** In Bangladesh, we targeted educated people who are interested in agriculture and farming. As they seek ROI, good planning, and market strategy, we provide them with all necessary tools and insights through our project.
- **Progressive Farmers:** In our country, farmers who are technology-friendly aim to increase yield and access markets more efficiently.
- **Agri Students:** Students who have an interest in agricultural data and related projects.
- **Agri Officers:** NGO or government officers who may use the system for advisory and decision-support services.

3.4 Societal Impact

- **Increasing Farmers' Income:** We all know that Bangladesh is an agricultural country and millions of people earn their livelihood by agriculture.But for the lack of resources and organised guidance they cannot reach their expectation. Here we came and provided them with features like market management, finance managements, yield management , crop diseases detection. As a result farmers will get the knowledge easily and their profits will increase.
- **Encouraging Youth:** Many educated youth in Bangladesh did not prefer agriculture for their career.Because it is seen as a risky field to work on. As our system will provide profit estimation, investment planning and market analysis. It will easily increase the youth to work and invest in this sector.
- **Reducing Rural Poverty:** Higher farm income will improve household earnings and living standards, helping reduce rural poverty.
- **Food Security:** As our system suggestions seed plannng , fertilizer planning efficently, it does less affect on the food.That's how our project ensures food security.
- **Reducing Urban Migration:** With better income in rural areas, fewer people will move to cities, reducing pressure on urban centers.

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3.5 Environmental Impact

- **Optimized Fertilizer Use:** This project will help farmers move from excessive fertilizer use to optimized application. As a result, soil pollution will be reduced.
- **Water Wastage:** Through planned irrigation methods, water wastage will also be reduced.

- **Chemical Use:** Disease-specific treatment advice will help reduce unnecessary chemical usage.

3.6 Project Management Plan

Core Modules

- **Authentication**
  - Login
  - Registration
- **Informational**
  - Home
  - About
  - Smart Farming Features
  - Weather Forecast
  - Yield Management
  - Crop Health (Disease Detection & Recommendations)
  - Market Information (crop prices, demand)
- **Management Modules**
  - Manage Finance
  - Manage Inventory

Project Schedule

Phase 1: Planning & Requirement Analysis

Tasks:

- Finalize functional requirements for each module
- Define user flow (farmer journey)
- Select tech stack
- Database schema design

Deliverables:

- Requirement document
- ER diagram
- API list

Phase 2: System Design

Tasks:

- Backend architecture (FastAPI / NestJS)
- Frontend wireframes
- ML integration plan (Crop Health)
- API contracts

Deliverables:

- Architecture diagram
- UI wireframes
- API specification

Phase 3: Authentication & Core Pages

Modules: Login, Registration, Home, About
Tasks:

- JWT authentication
- Role-based access (if needed)
- Basic UI pages

Deliverables: Secure login/registration, Functional home page

Phase 4: Weather Forecast Module

Tasks:

- Integrate weather API
- Location-based forecast
- UI display (temperature, rain, humidity)

Deliverables: Working weather forecast feature

Phase 5: Crop Health Module

Tasks:

- ML model integration (disease detection)
- Image upload API
- Prediction + confidence score
- Treatment/prescription mapping

Deliverables: Crop disease detection system, Recommendation output

Phase 6: Yield Management Module

Tasks:

- Yield estimation logic
- Yield data input (pH, nutrients, etc.)

Deliverables: Yield prediction, seed planning, fertilizer planning, land marking

Phase 7: Market Information Module

Tasks:

- Market price data (API or scraped data)
- Crop-wise price listing
- Trend view

Deliverables: Market price data

Phase 8: Finance & Inventory Management

Modules: Manage Finance, Manage Inventory
Tasks:

- Expense & income tracking
- Inventory CRUD (seeds, fertilizer, tools)
- Reports

Deliverables: Finance summary, Inventory management system

Phase 9: Integration, Testing & Optimization

Tasks:

- Module integration
- API testing

Deliverables: Stable integrated system

Technology Stack

- Backend: FastAPI / NestJS
- Frontend: React / Next.js
- Database: PostgreSQL
- ML: TensorFlow / Keras / Computer Vision
- DevOps: Docker, GitHub
- APIs: Weather API, Market data

3.7 Risk Management

- **ML prediction:** This could create wrong treatment. Through manual guidance and provide data with confidence, we have to mitigate the risk. Our system will provide manual guidance through video calling by experts.
- **Low user adoption:** This could lead to project failure. By providing simple UI and training, it can be mitigated.
- **Inaccurate Market Data:** This could lead to wrong decisions. Showing the data source and date might mitigate this.

3.8 Economic Analysis

Our smart farming system is easy and affordable for farmers. First, they can pay a small monthly fee to use all features. Later, they can make a one-time payment to fully own and power up the system. In the future, we can also add advertisements for farming products, giving farmers useful suggestions and creating extra income for the platform.

Chapter 4

Methodology

4.1 System Architecture Overview

- **Presentation Layer (Frontend):** Next.js is used to render the server side and also generate static sites for user interfaces for farmers and administrators. It shows relevant features to different users.
- **Application Layer (Backend):** NestJS handles the business logic, including calculating recommendations and controlling transactions. Authentication ensures secure login/signup and provides access based on user roles. API endpoints communicate between the UI and backend logic.
- **Data Layer (Database + ML Models):**
  - PostgreSQL stores structured data and acts as the main database.
  - ML Models handle image processing for example crop disease detection and land image analysis. It's also handle crop predictions based on soil nutrients.
    - **U-Net:** Performs image segmentation to detecting disease areas in crop images.
    - **ResNet50:** Classifies images and extracts features, distinguishing healthy from unhealthy crops.
    - **Random Classifier:** Suggest optimal crops based on environmental and soil data.
- **DevOps:** ML models are containerized using Docker for making compatibility to across all types of devices. Git and GitHub is used for version control of both code and models.

4.2 Diagrams

4.2.1 Usecase Diagram

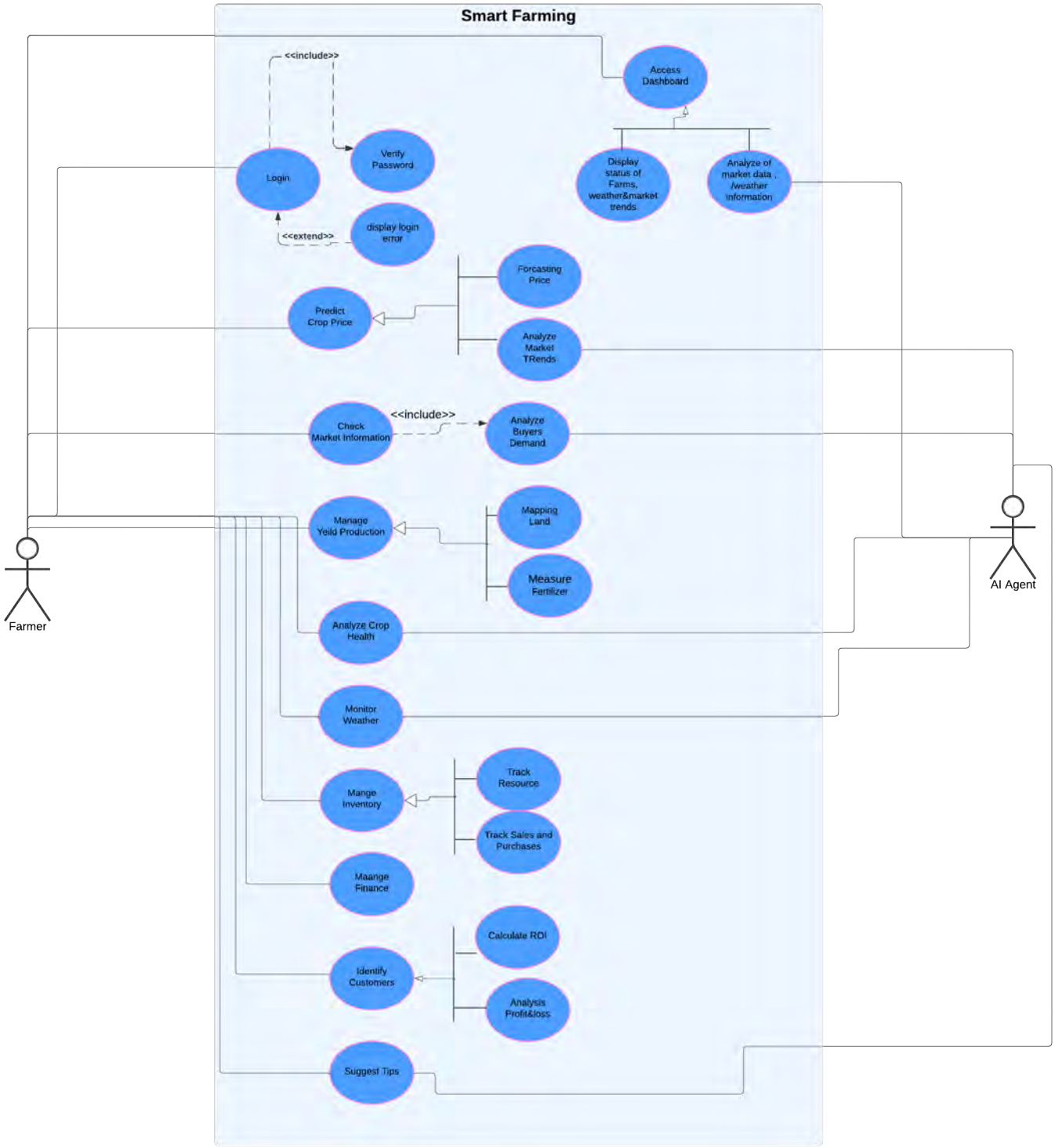

Figure 4.1: Usecase Diagram.

4.2.2 Activity Diagram

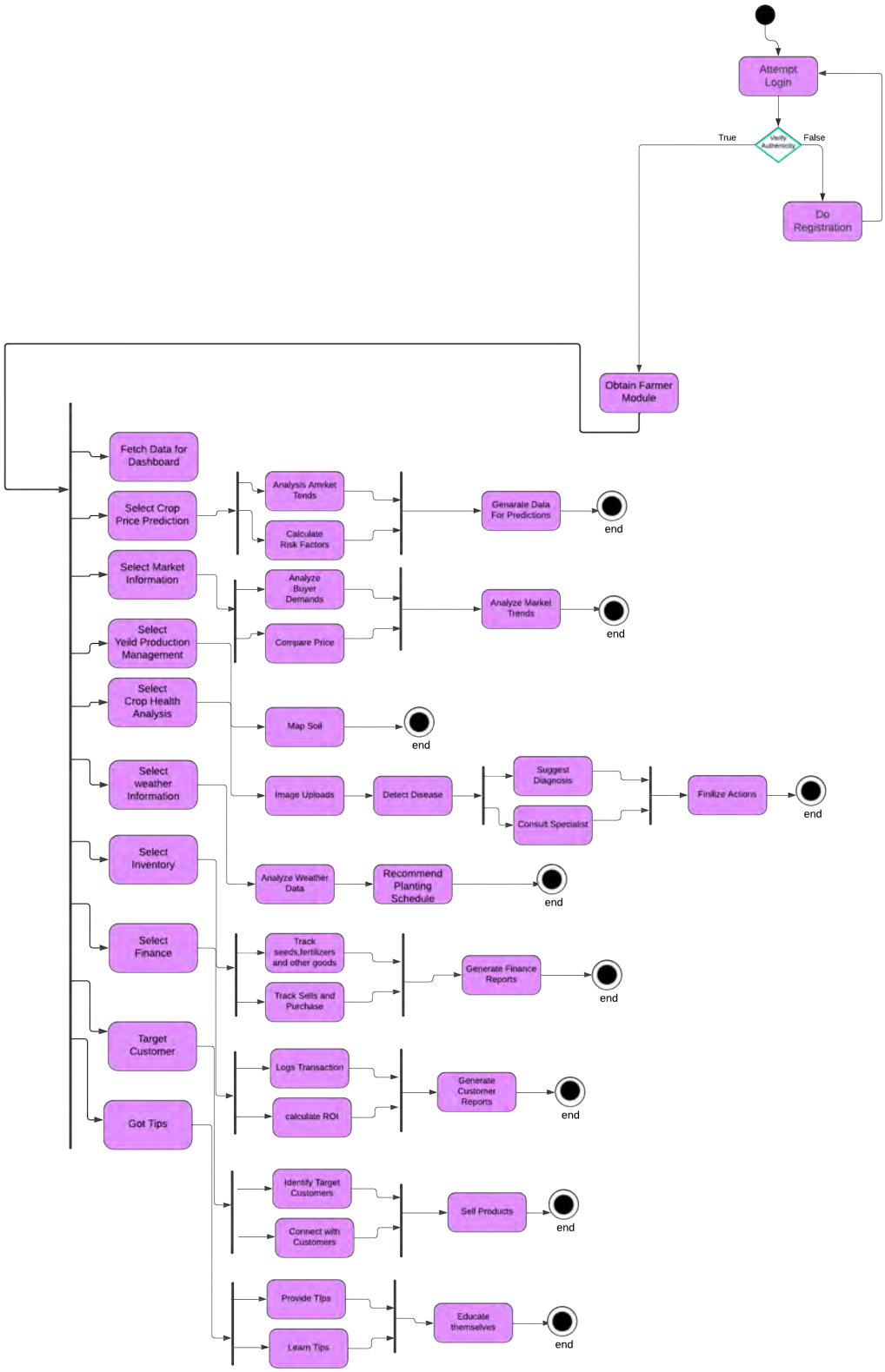

Figure 4.2: Activity Diagram.

4.2.3 Activity Diagram

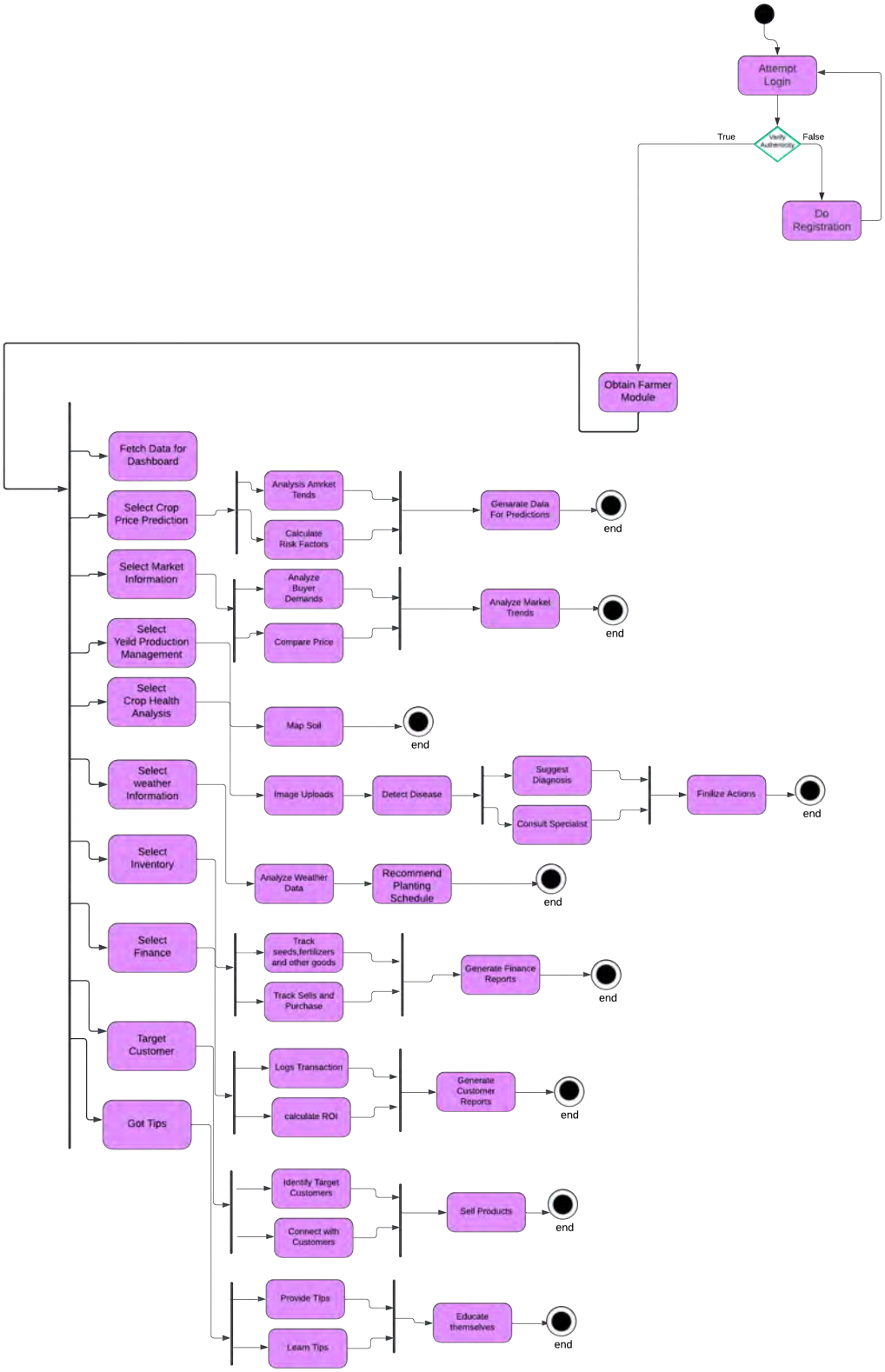

Figure 4.3: Activity Diagram.

4.3 Data Collection

- **Crop Disease Dataset:** Used datasets from Kaggle to identify and analyze crop diseases.[16]
- **Boundary Detection Dataset:** For this type of dataset, we need coco json dataset and Roboflow provides labeled images to detect field boundaries accurately.[20]
- **Crop Recommendation Dataset:** Historical and nutrient-based crop data from Kaggle is used for crop suggestions.[19]
- **Seed & Fertilizer Planning Dataset:** Data is collected from PDFs and websites like BIRRI, BRAC, and agriculture portals.[2], [3], [9], [21], [22], [23], [24]
- **Processing & Storage:** All collected data is uploaded in Google LLM and extracted as JSON for use in the system

4.3.1 Data Cleaning

- **Pre-validated Data:** All datasets are already verified and free from errors.
- **Noise-Free Data:** Data does not contain duplicate or irrelevant records.
- **Consistent Formatting:** Data follows a uniform structure across all sources.
- **Model-Ready Dataset:** Clean data is directly used for training ML models.

4.3.2 Summary of Dataset

- **Crop Disease Dataset:** For this dataset, we compiled this dataset from the original github repo: So we have around 87k RGB photos of crop leaves. We are dividing it 80/20 into training and validation datasets and we are left with a tiny test set of only 33 images for final predictions.[16]
- **Field Boundary Dataset:** For the field boundary dataset, we have used data from Roboflow. And, Coco-JSON was used for detecting the margin of cultivateable land. Thus, it provides a near to accurate margin.[20]
- **Crop Recommendation Dataset:** The crop recommendation dataset is used for crop recommendation, the system works with soil and environment attributes like Nitrogen (N), Phosphorous (P), Potassium (K), temperature (50-75 o F), soil pH to recommend best or profitable crop for the land. [19]
- **Seed & Fertilizer Planning Dataset:** This dataset provides us with everything we need in order to plan for seed selection and fertilizer applications by each crop as follows: Crop Name, Crop Recommended seed varieties, Seed rate per Unit Area, Soil Type, Fertilizer Type Quantity

No of Nitrogen (N) Potassium (P) Phosphorous (K) required per unit mass (Nutrients) Distributed respectively by crop. .[2], [3], [9], [21], [22], [23], [24]

Chapter 5

Result Analysis

5.1 ML Model Performance Evaluation(Statistical Overview)

This section discusses **evaluation criteria:** key metrics or criteria -accuracy, efficiency, reliability, **Testing Methods**

5.1.1 Crop Disease Detection

For crop disease identification, a ResNet-50 model pre-trained on ImageNet was used. Transfer learning allowed the model to achieve strong performance even with limited agricultural image data.

Metric	Value	Description
Validation Accuracy	0.9968	Proportion of correctly predicted disease labels.
Validation Top-5 Accuracy	0.9999	Proportion where the correct label is among the model's top 5 predictions.
Validation Loss	0.0405	Measure of error; lower value indicates better generalization.

Table 5.1: Crop Disease Detection Model Performance

The high validation accuracy indicates that the model can reliably identify crop diseases from leaf images. The low validation loss suggests effective generalization rather than overfitting. In the system, users upload an image of an affected crop leaf, and the model returns the predicted disease name along with a confidence score. Based on the prediction of disease, treatment and medicine recommendations are suggested in the system

5.1.2 Field Boundary Detection

Field boundary detection was implemented using U-Net model. This model was selected due to its effectiveness in pixel-level image segmentation .The Dice

score indicates acceptable rate of overlap between predicted field boundaries and ground truth masks. Although the IoU value is moderate, the model performs adequately.

Metric	Value	Description
Validation IoU	0.6984	Intersection over Union; measures overlap between predicted and ground truth field boundaries.
Validation Dice Score	0.8098	Dice coefficient; indicates good overlap between predicted boundaries and ground truth masks.

Table 5.2: Field Boundary Detection Model Performance

The Dice score indicates good overlap between predicted field boundaries and ground truth masks. Although the IoU value is moderate, the model performs adequately under real-world conditions where images may vary in quality, lighting, and perspective. This module supports land marking,land size and yield-related analysis.

5.1.3 Crop Recommendation System

Crop recommendation was implemented using Random Forest Classifier for handling non-linear relationships among soil and environmental features.

Metric	Value	Description
Overall Accuracy	0.9932	Proportion of correctly predicted crop recommendations. High precision, recall, and F1-scores indicate balanced model performance across crop categories.

Table 5.3: Crop Recommendation System Performance

The classification report shows high precision, recall, and F1-scores across all crop categories. Minor variations have been shown in crops with similar soil requirements such as blackgram, lentil, rice, and maize. However, both macro and weighted averages remain at 0.99 which indicates of balanced model performance. This model allows farmers to receive crop recommendations based on soil properties such as pH and different kind of soil nutrients.

5.2 Comparisons And Discussions

Now a days, Farming is becoming more technology-driven around the world. In many developed countries, farms use IOT based sensors, drones, and advanced machines to monitor crops, detect diseases, and manage irrigation. These tools give real-time information and accurate predictions. In our project, Due to

cost and infrastructure limitations, we collect farm data through simple forms filled by farmers instead of sensors. The forms let farmers share important information about their crops, weather, and activities. This method is practical,easy, and cost-effective for our local context but not recommend in long run. Utilizing this data with AI and our integrated platform, farmers get a clear view of their farm.

5.3 A Complete Guide of User Manual

5.3.1 Registration

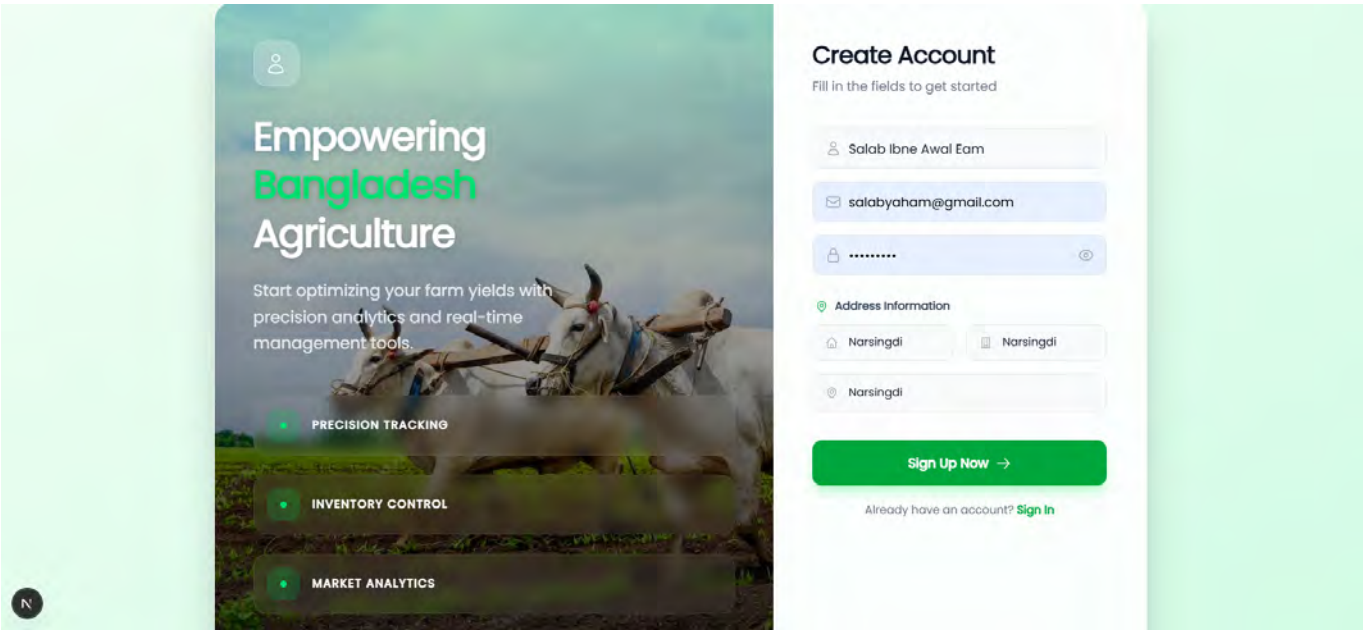

Figure 5.1: Resgistration Page

This is the very first page of the website where it pops up to Create Account as a registration for an user. Or, if they already have an account, they can directly login using email and password. To create an account, the user needs to provide their name (in the name box), email (in the email box), preferred password (password box) and their current address (in the address information).

Verify Email

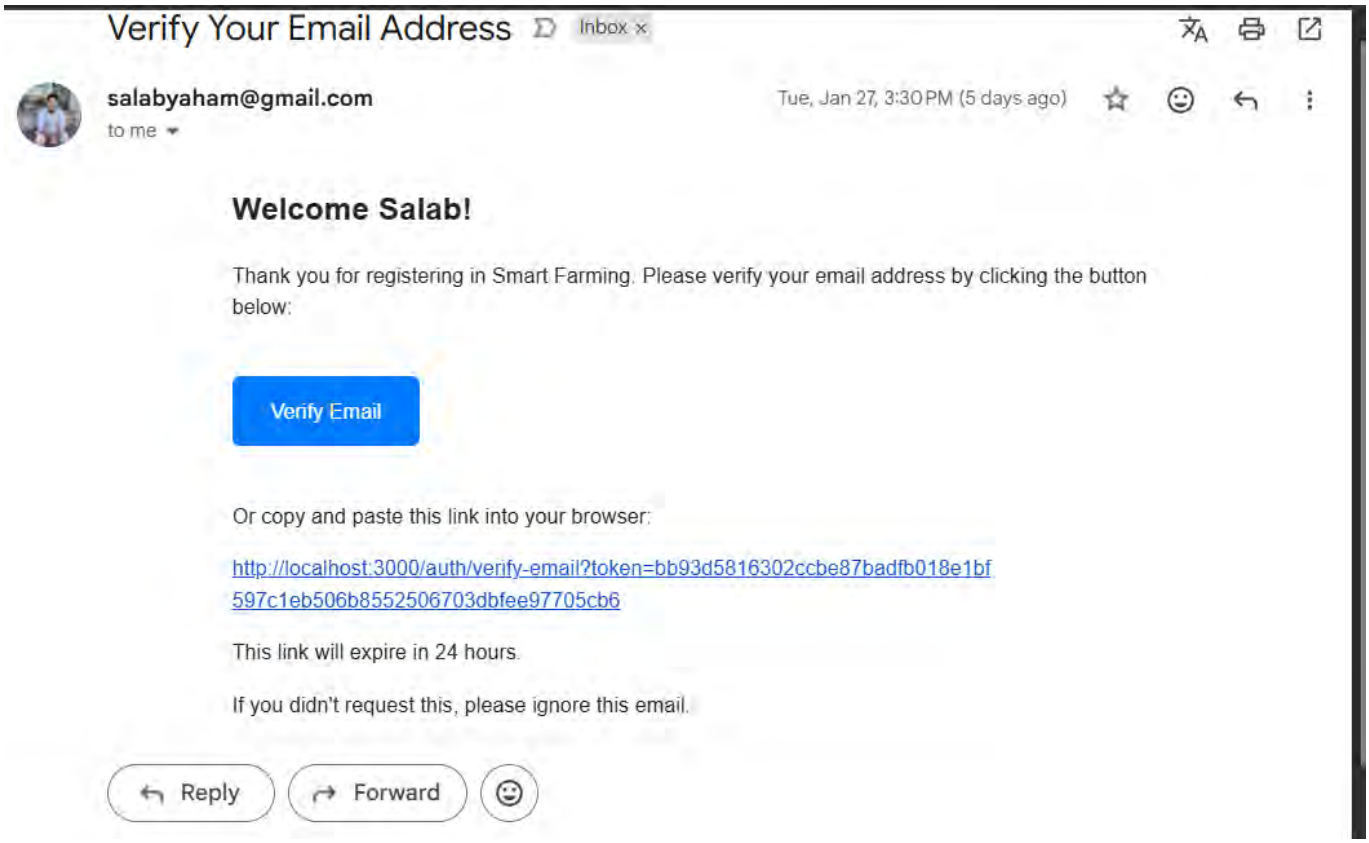

Figure 5.2: Verification Link

After providing all the information correctly, the user needs to verify the email for authenticity. An email will be sent automatically from the website. From the user end, users can go through the verification link and verify themselves if it was them trying to create an account.

Click Email


```
object {2}
  message : "Email verified successfully. You can now log in."
  user {3}
    id : "8697105e-d124-4c12-b0bc-b8e709c1a683"
    email : "tasirhasan2025@gmail.com"
    name : "SM Tasirul Hsasan"
```


Figure 5.3: Verify Email

After the verification is done, a message will pop up as “Email verified successfully. You can now log in.” And an account under the user name will be created and assigned. The user data will be saved. And later on when they log in email and password will be enough to verify their identity.

5.3.2 Login

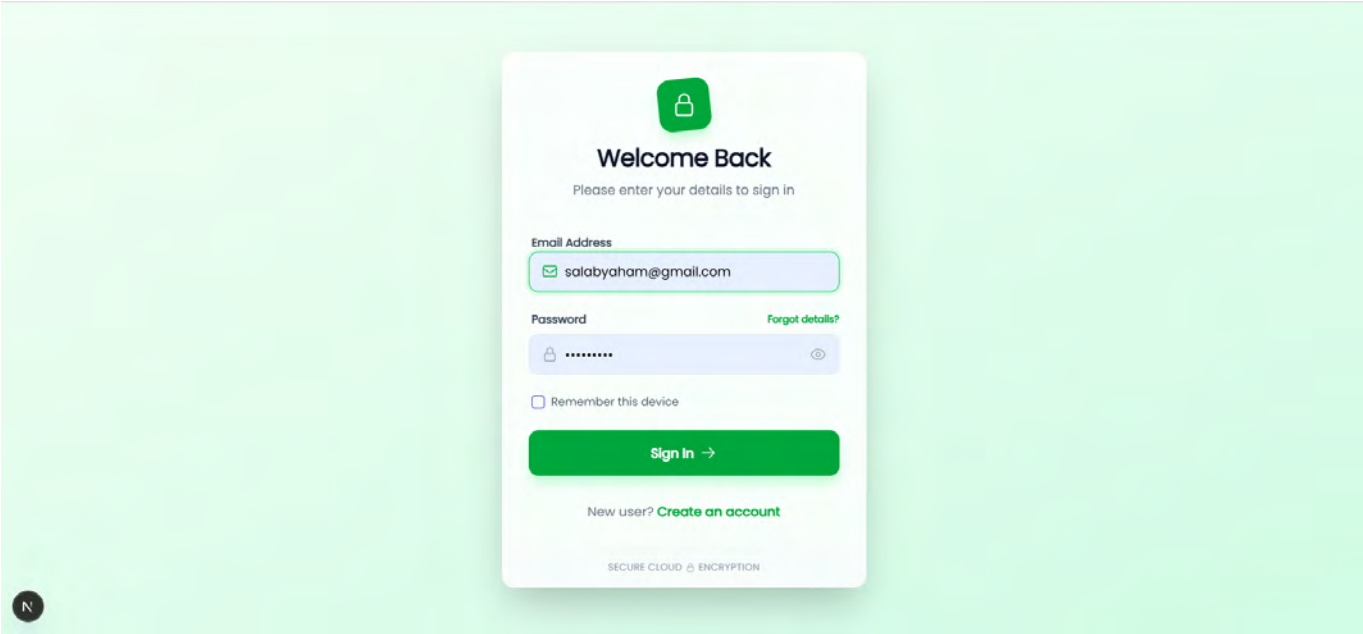

Figure 5.4: Login Page

In this part, users have to provide the registered email and password to login the system.

5.3.3 Panel

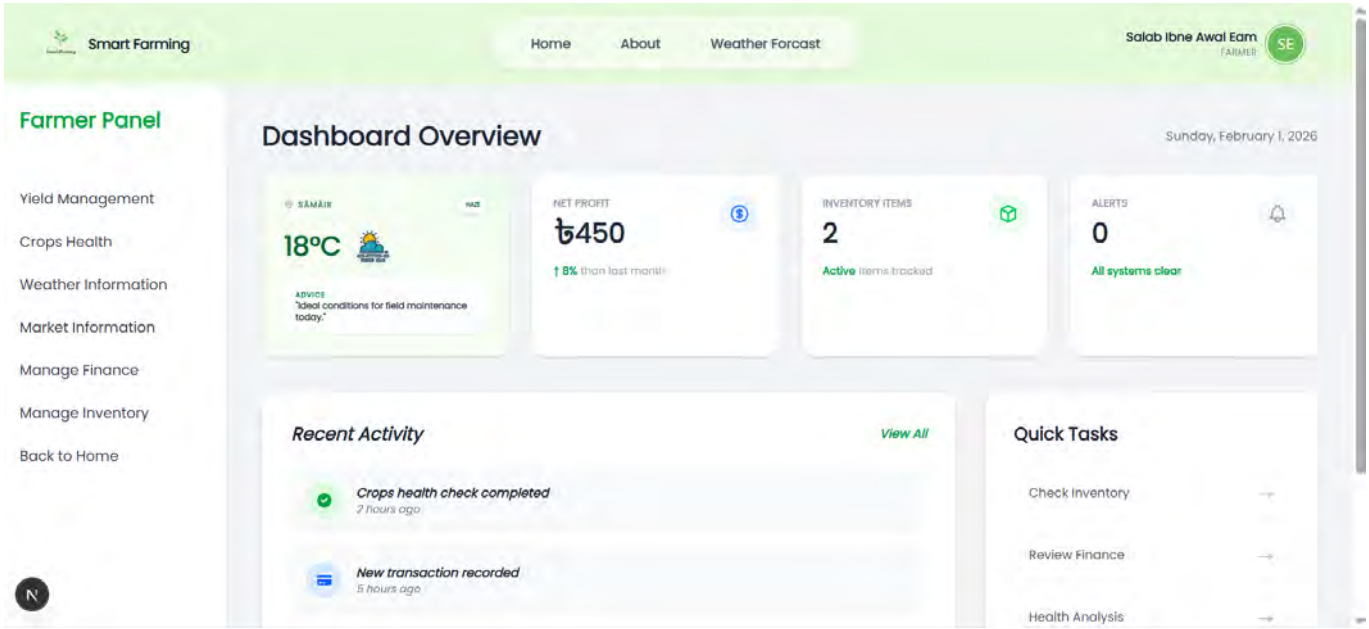

Figure 5.5: Dashboard Page

After logging in, this is the very first or the primary dashboard panel, from where users can access every panel as per their requirements. Initially, it will show the weather update, net profit,inventory items and alert. Also, as of the user data, it will save recent activity of the user and they can access it anytime.

5.3.4 Yield Management

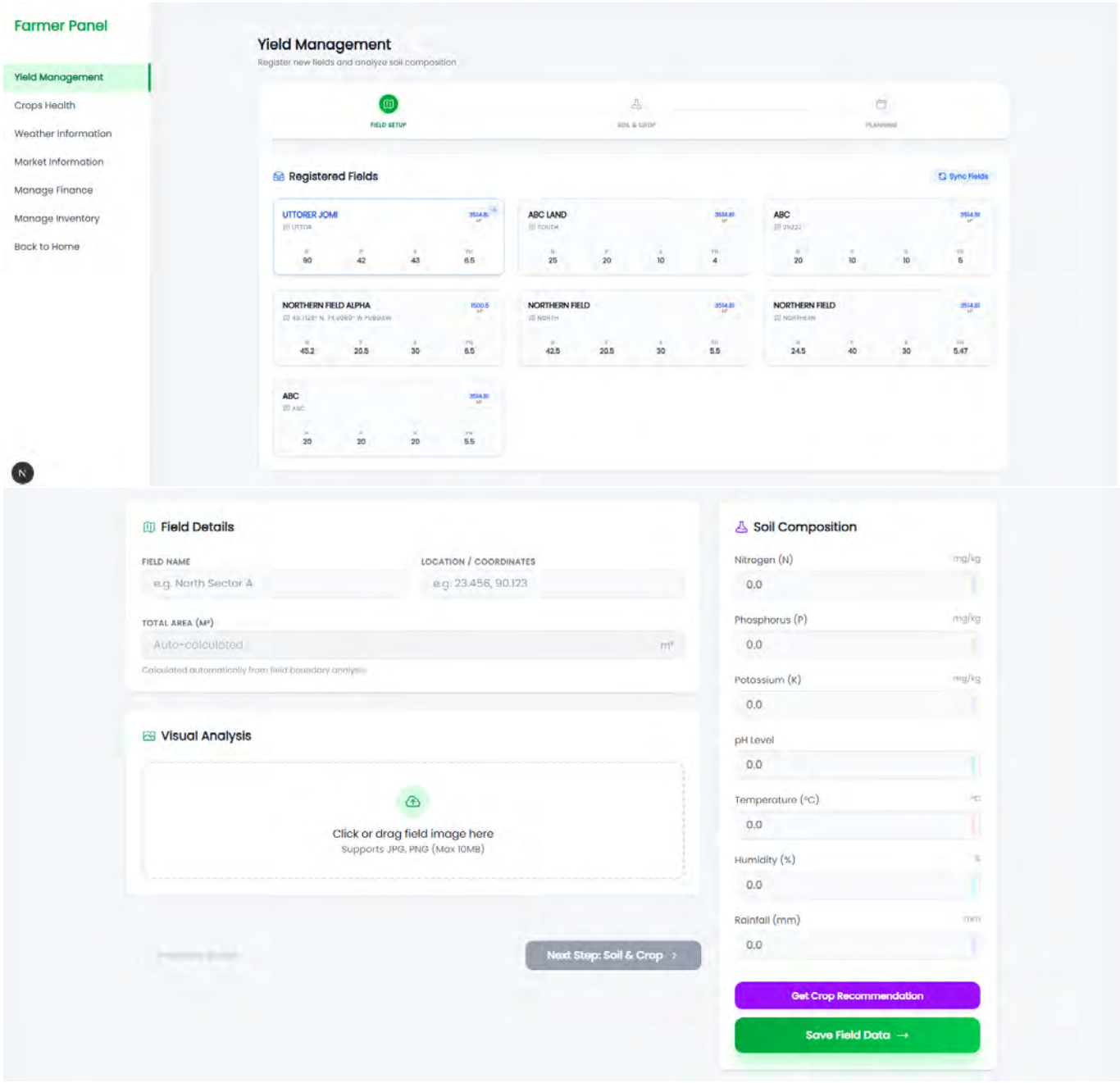

Figure 5.6: Yield Management

Here, users need to create field details as they see fit. They can choose names and put locations. Also, here users should put known data of the field.

Save Field Data Input

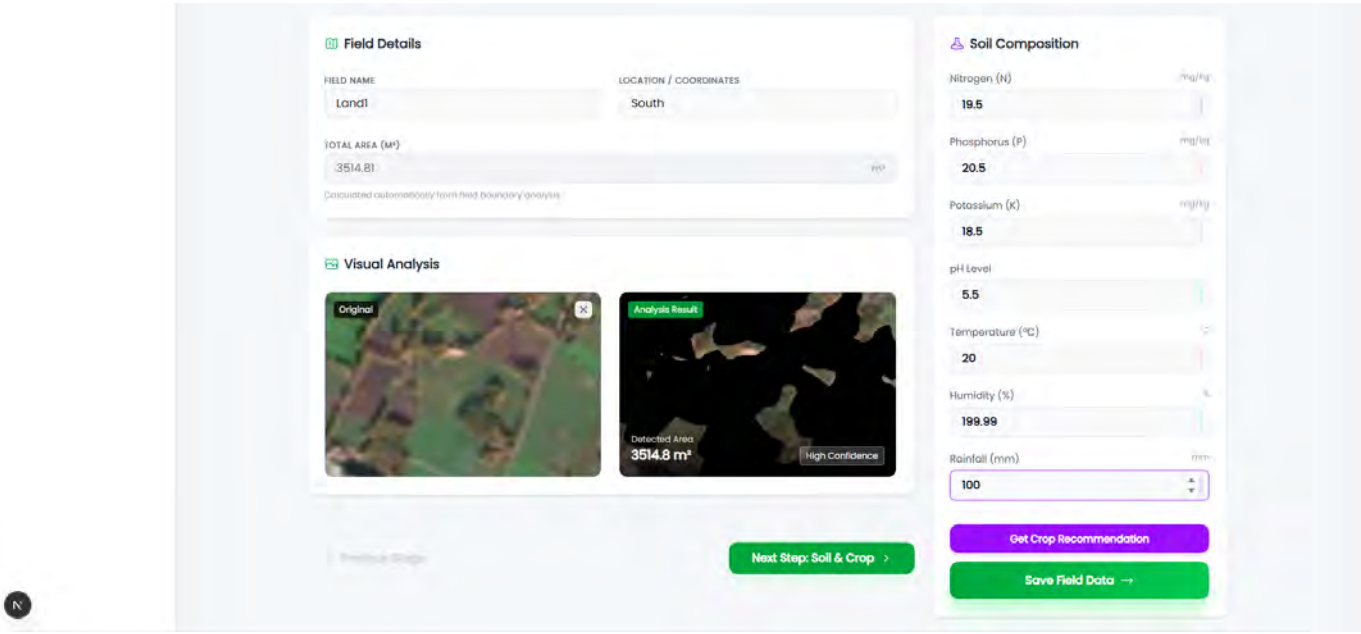

Figure 5.7: Field Data

After putting the known data. Most importantly the visual map of the field, and soil composition data will be saved and it will help the user to get detailed analysis later and improve the user experience. As of the Soil composition data, the user can get it by examining the field with the help of experts or compatible hardware

Output Of Save Field Data

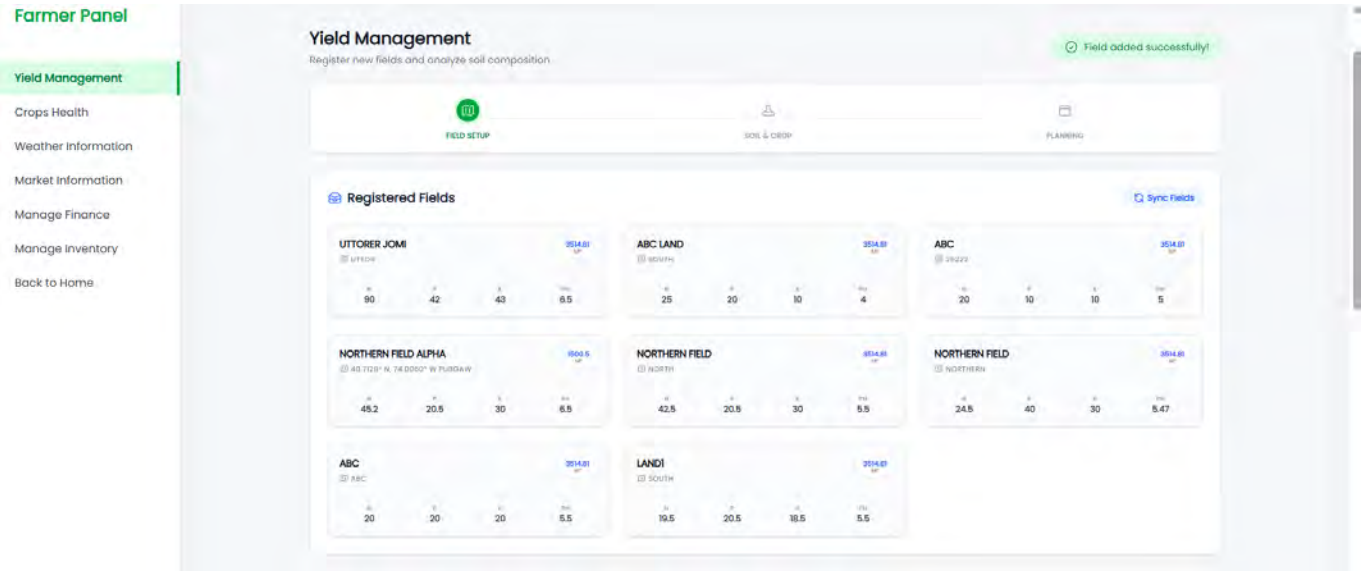

Figure 5.8: Show Save Field Data

After the user saves the field data, the output shows as follows. Under the land section, it shows a summary of soil composition.

Crop Recommendation (input)

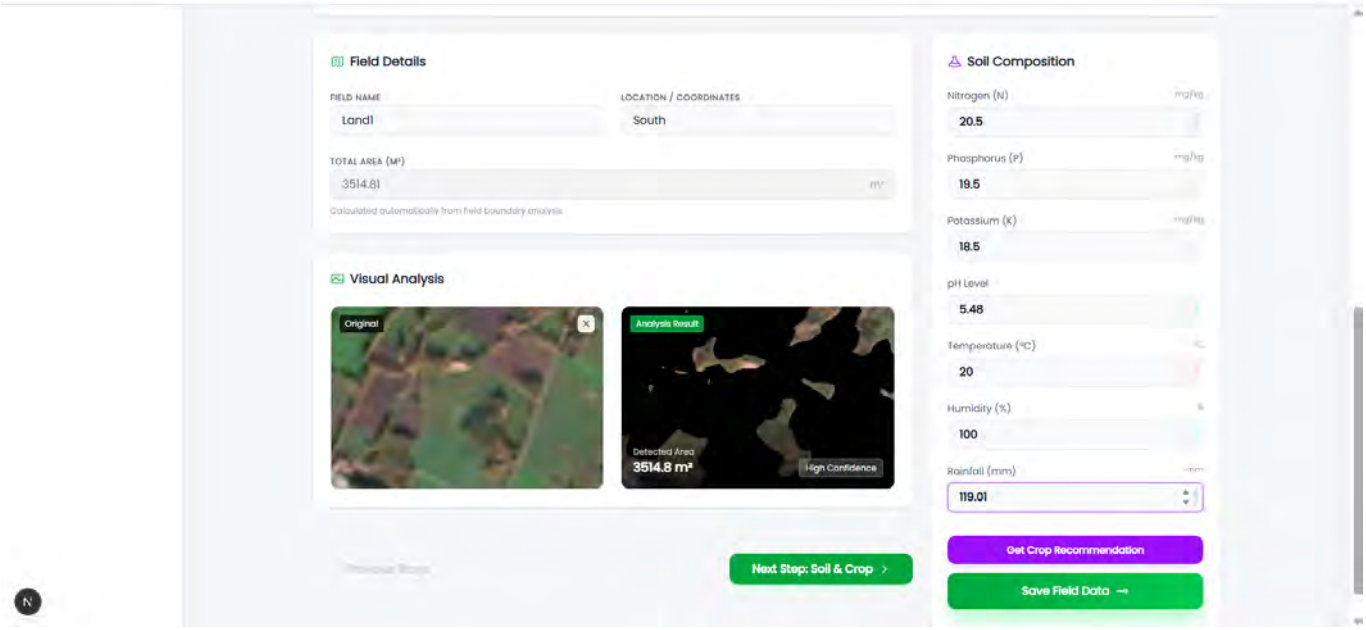

Figure 5.9: Crop Recommendation Input

According to the soil composition data, the system will suggest the best crop for the field. Also, the system will take the weather forecast into consideration to recommend the best crop.

Crop Recommendation (output)

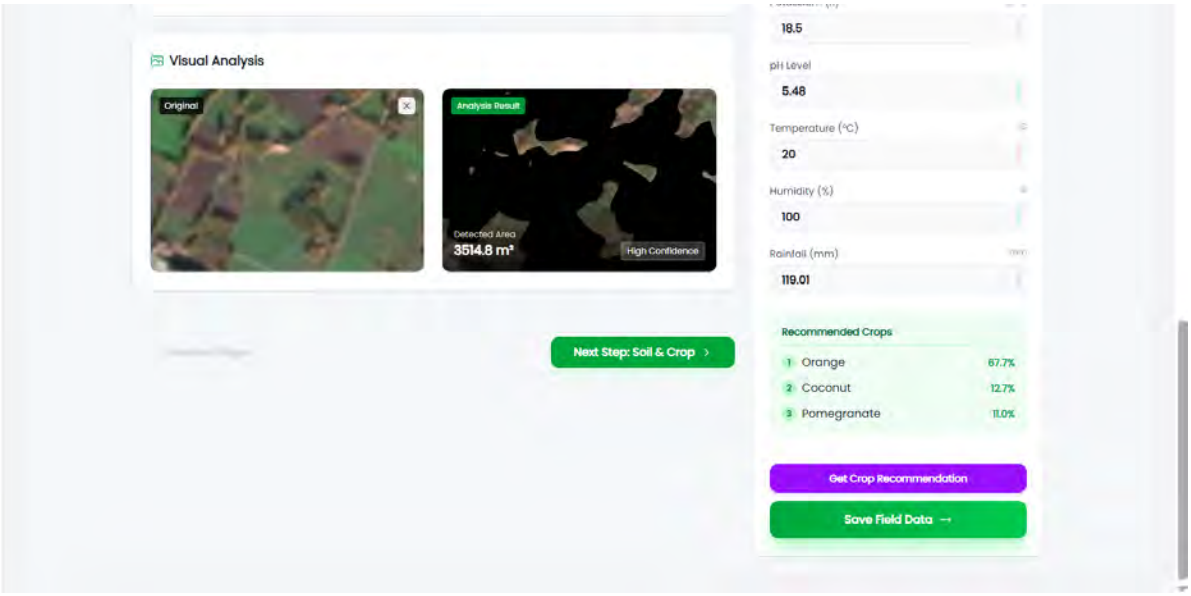

Figure 5.10: Crop Recommendation Output

After all the required inputs, the system will suggest the best 3 crops for the field. As of the picture it is suggesting Orange as 43%, Pomegranate 22%, Pigeonpeas 7.3% as best possible crops to cultivate.

Seed planner

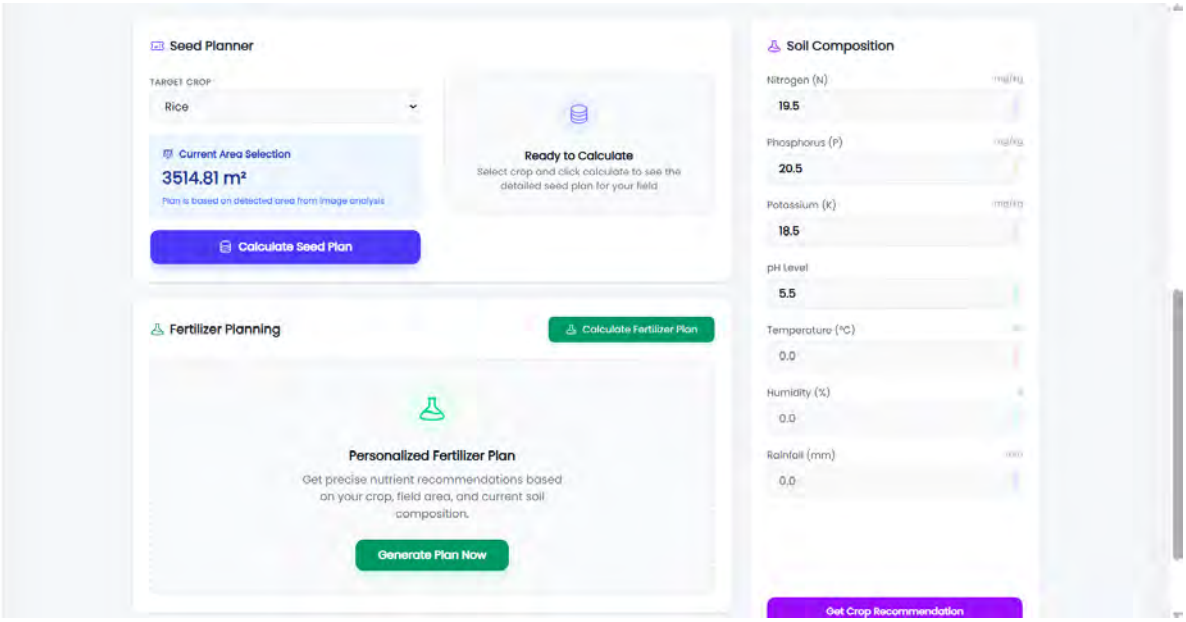

Figure 5.11: Seed Planner View

As per the crop recommendation when the user/farmer will select the crops as per his choice, the system will take the land size into consideration, then it will start calculating the total unit of seeds required for the farmer to get the best output.

Calculated Seeds

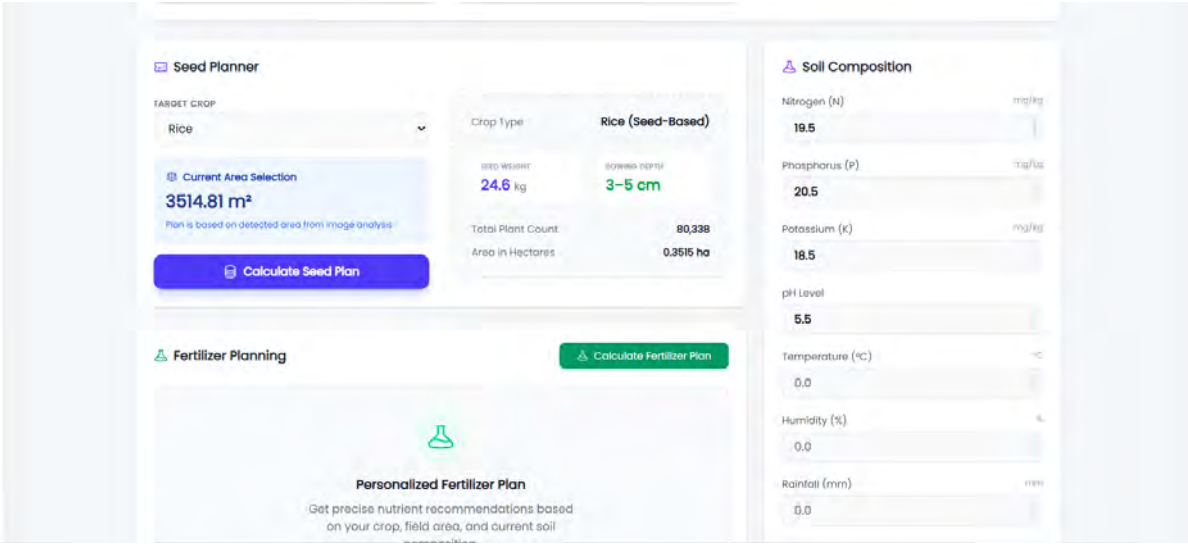

Figure 5.12: Calculated Seeds Based On Input

The calculation result comes as follows, total unit of seeds required will show as KG and distance between 2 seeds. And also as per secondary result, it will show total plant count and land area in Hectores.

Fertilizer Plannig

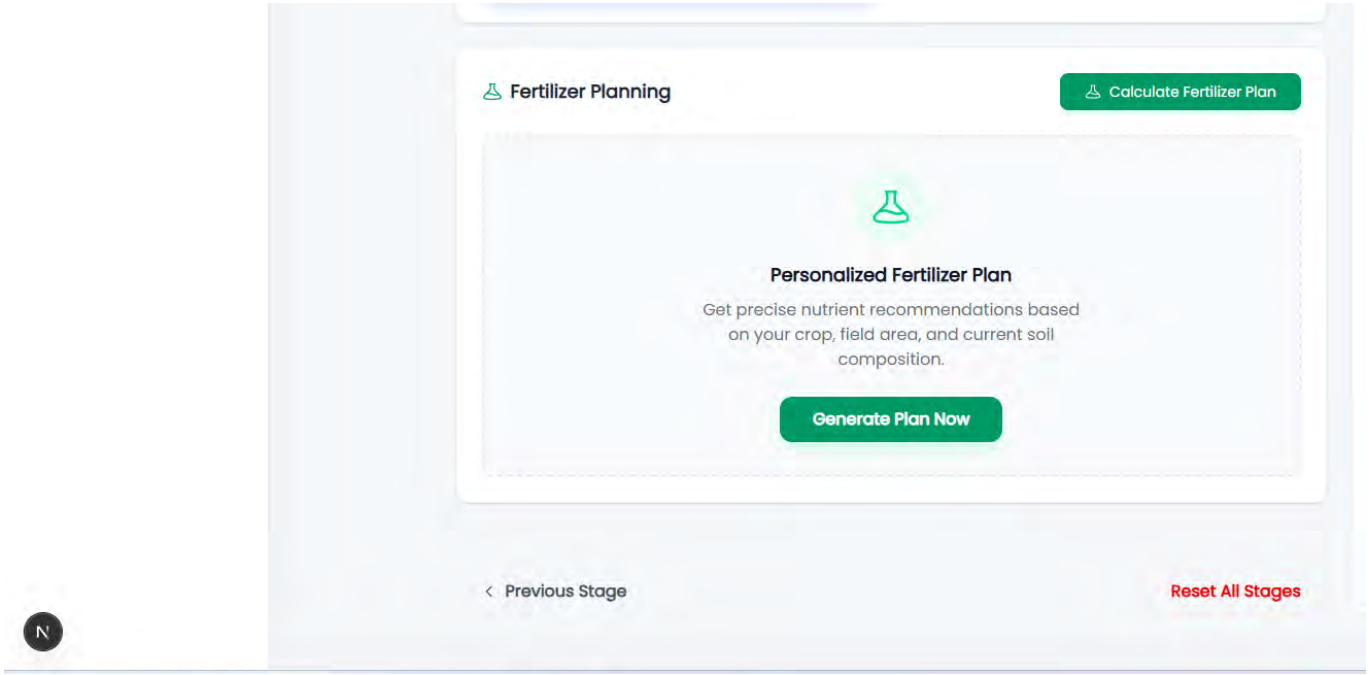

Figure 5.13: Fertilizer Planning

After seeds, fertilizers are the most important element for the fields. The system will take the soil analysis data, and take the deficiency of minerals in soil to analyse and provide output as per requirements.

Fertilizer Planning Output

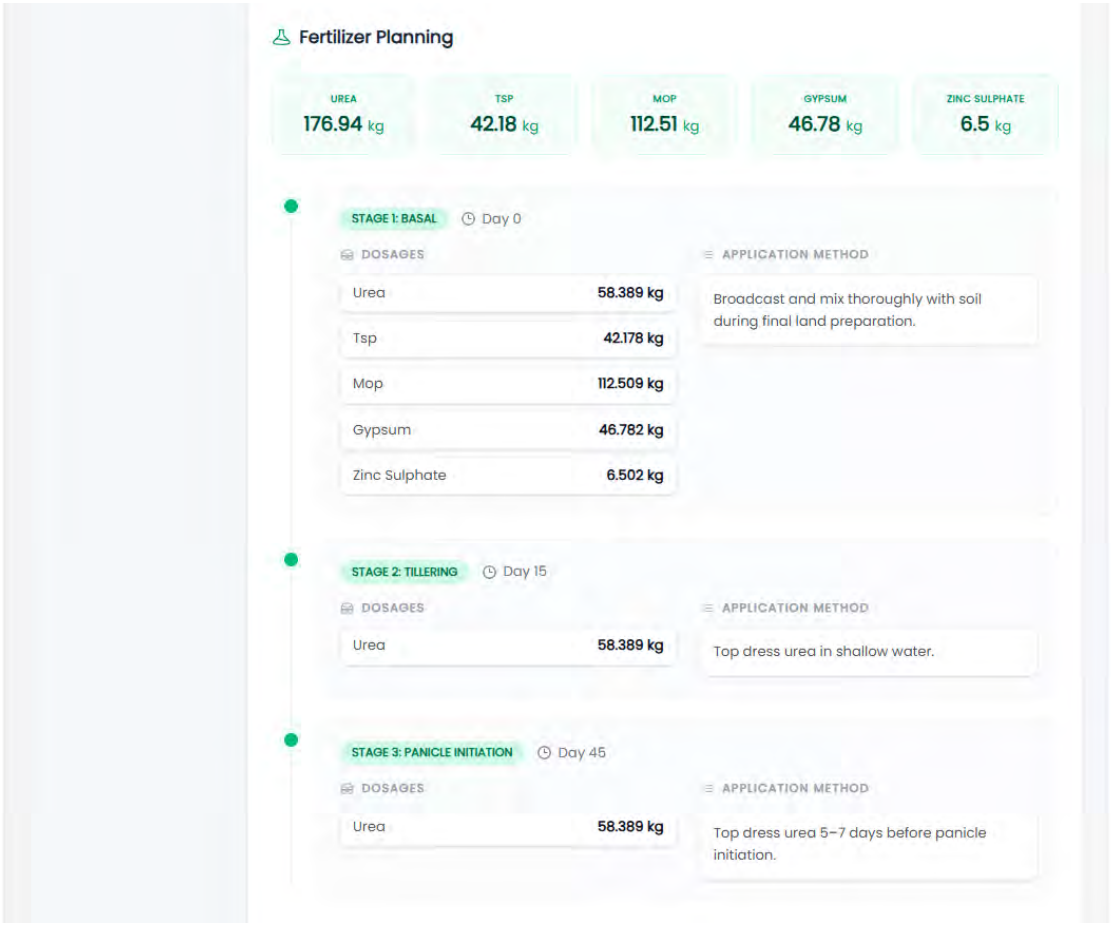

Figure 5.14: Fertilizer Planning Output

After taking all the factors into consideration, the system will provide the output for required fertilizer. For example, for 0.35 hectares of land, the farmer will need Urea 58.389 KG, TSP 42.178 KG, MOP 112.509 KG. Also, the system will suggest different timeframes such as stage and Fertilizer application methods. And to get the best result out of the field the user/farmer should follow the application method.

5.3.5 Crop Health

5.4 Crop Health UI

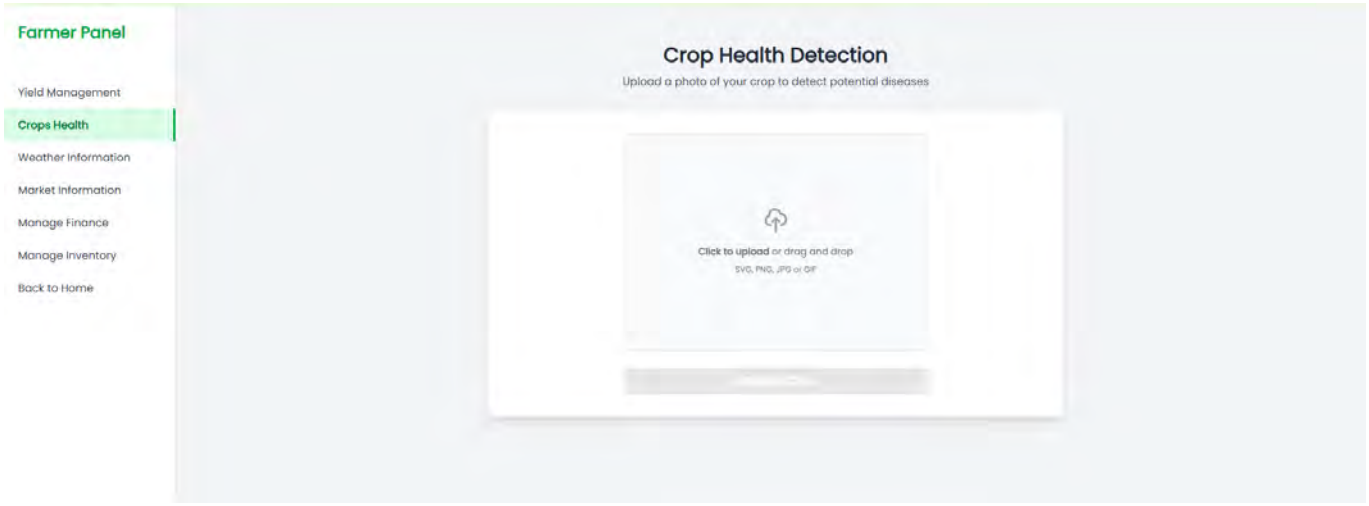

Figure 5.15: Crop Health UI

When the crops start to grow, there's a danger of losing all the crops. There might be infection or diseases, natural disasters, attacks of insects, rats, birds and many more. For that, there have to be some precautions. Here, we will consider disease and natural disaster.

5.5 Diseased Crop Picture Add

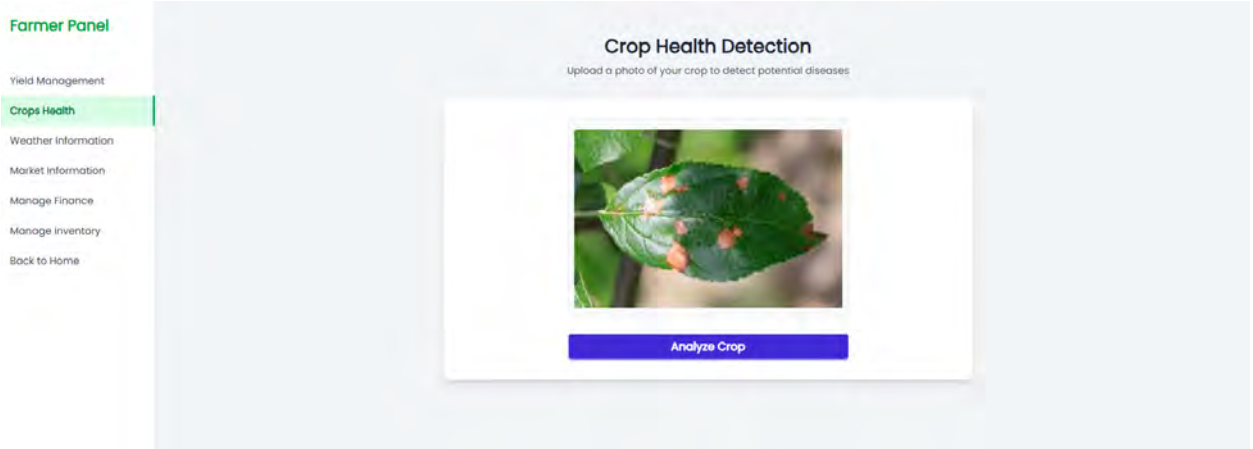

Figure 5.16: Uploads Disease Crop Picture

User is can upload or attach the picture of the infected plant, after uploading the user should tap on analyze crop.

5.6 Crop Health Detection

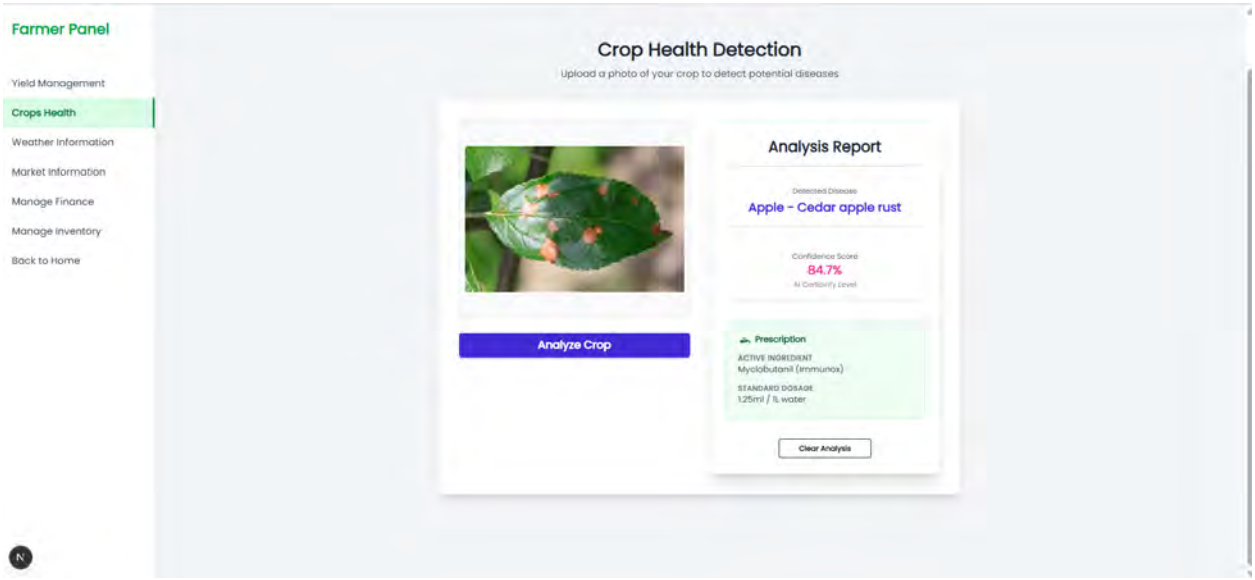

Figure 5.17: Detection And Prescription

After analyzing the picture of the infected part of the crop the system is able to successfully detect the disease. Here, for the test subject we used Apple leaf and the system detected the disease as Cedar Apple Rust. After detection the user can also get a prescription for the disease or suggestion to save the plant or other plants from being infected.

5.6.1 Weather Information

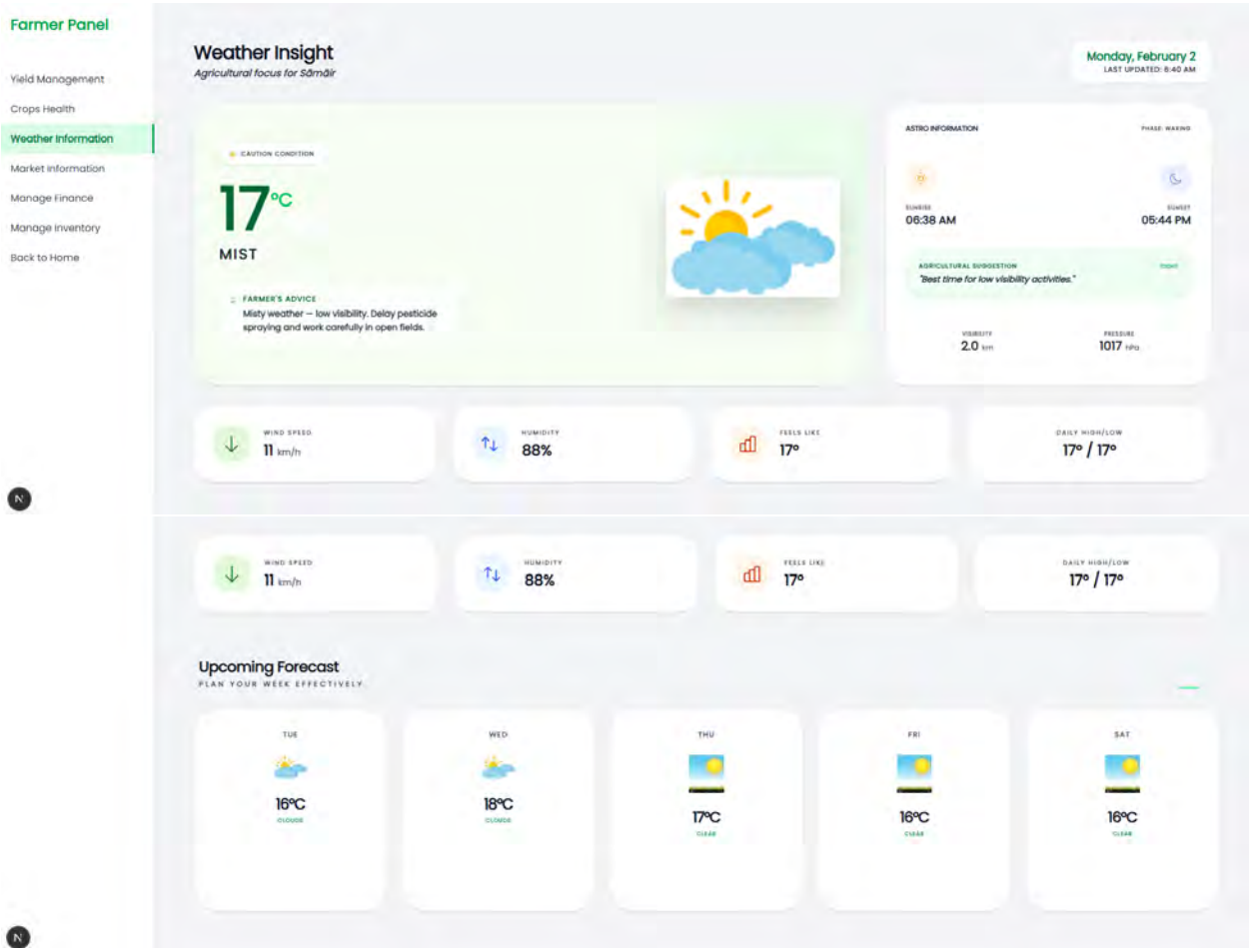

Figure 5.18: Weather information

To predict the weather or natural disasters, the system will take real time weather forecasts and show a quick update to the user for upcoming 5 days.

5.6.2 Market Information

Market information Overall Page

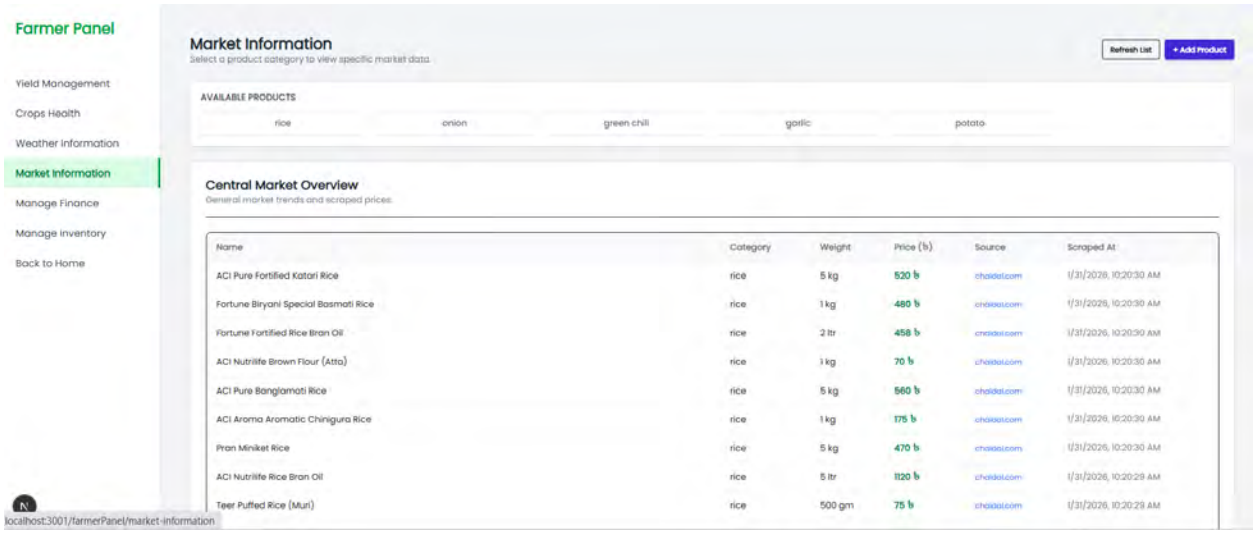

Figure 5.19: Market Information Table

There will be real time market information. Product price per unit. Farmers can get to know the price of regular crop prices from here.

After Clicking Add Product

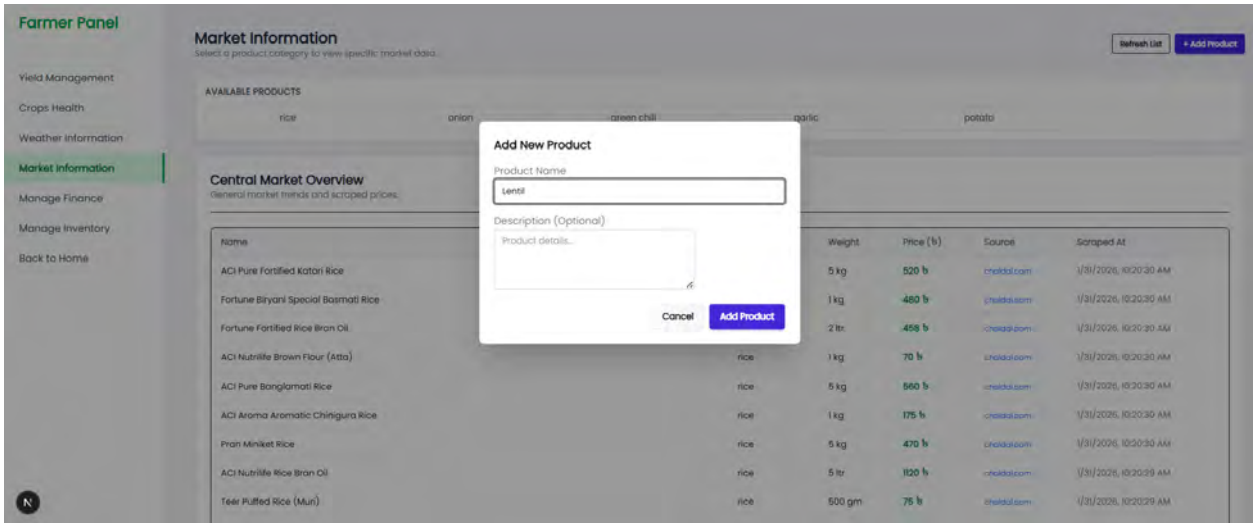

Figure 5.20: Market Information Table

By clicking add product we can add a new product and its details in the description part. Finally, after clicking the add product the system will update the list with the new product and all the details.

Market Data Of Selected Product

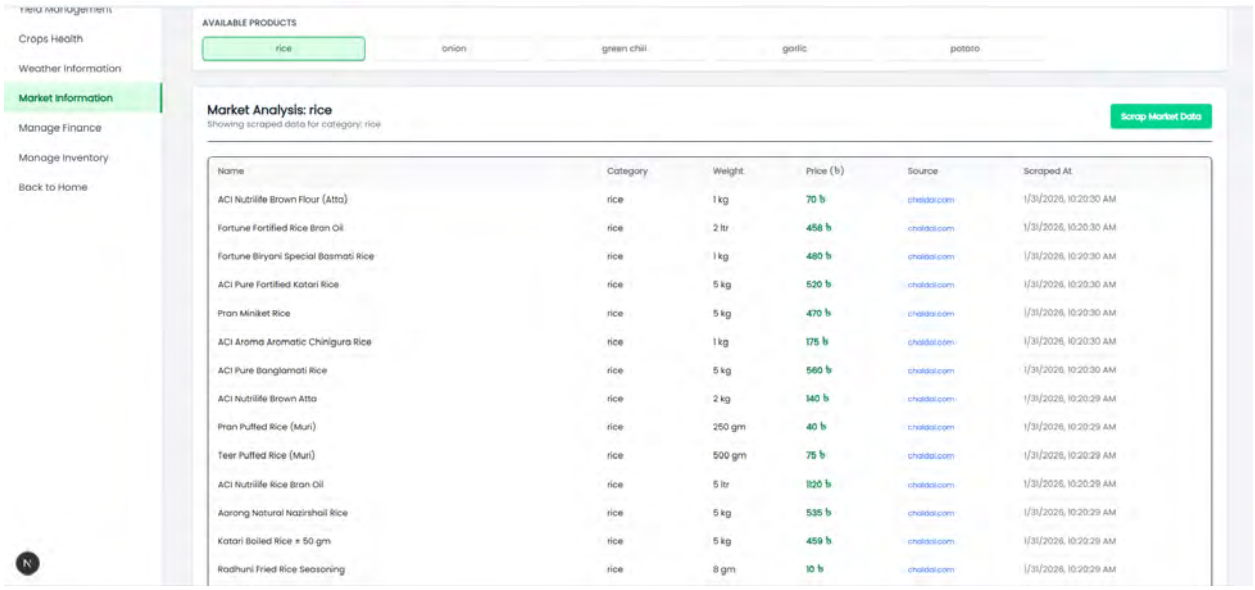

Figure 5.21: Market Information Table Of Selected Products

After clicking on a general product to filter, the system will show all the related products and its details. i.e. unit and price and available products.

After Clicking Scrap Market Data

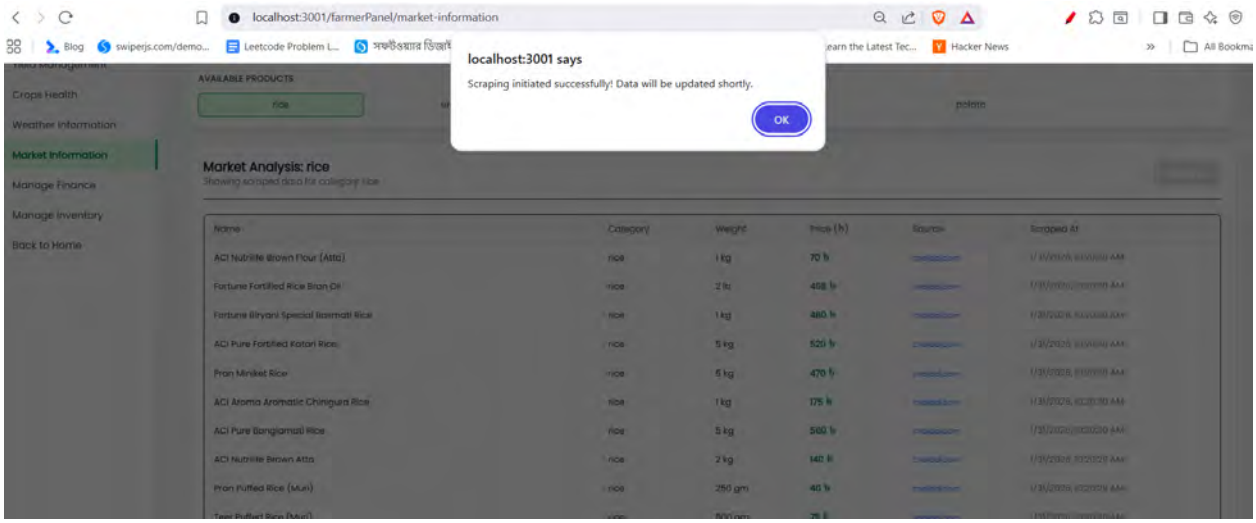

Figure 5.22: Scraping Market Data

To get a real time update of a product, scrapping data from a linked source is the easiest way. It will update all the information immediately and provide a real time update.

Scraped Market Data

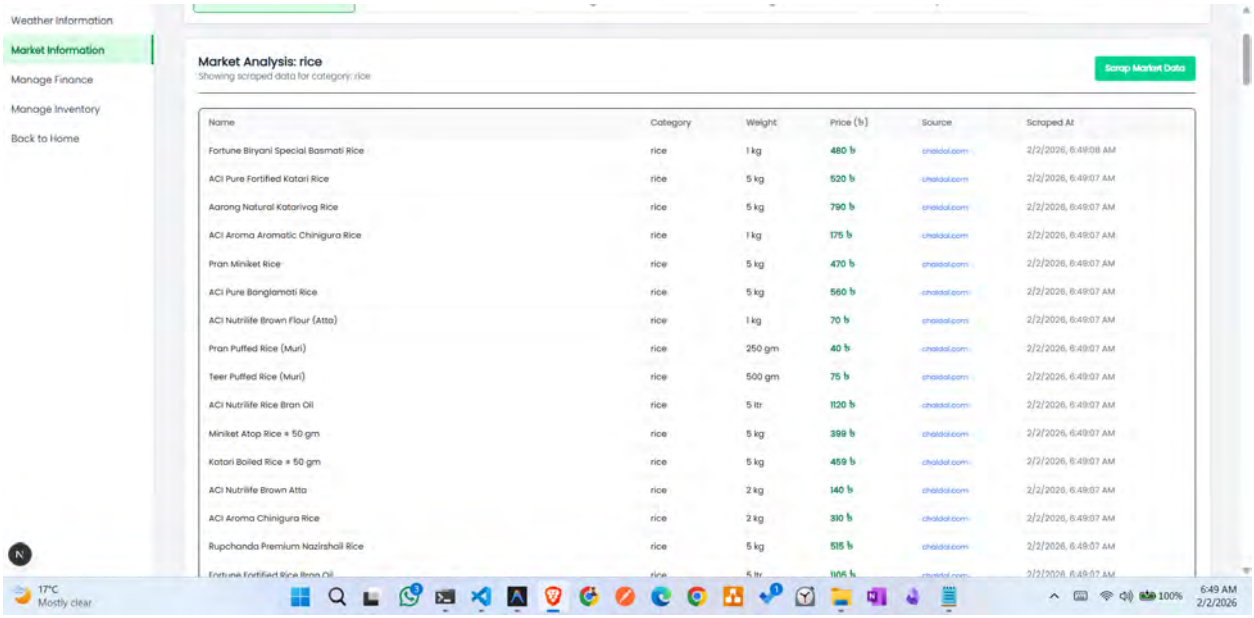

Figure 5.23: Scraped Market Data

The scrapped market data is showing real time updated data. Unit price, weight etc.

5.6.3 Inventory

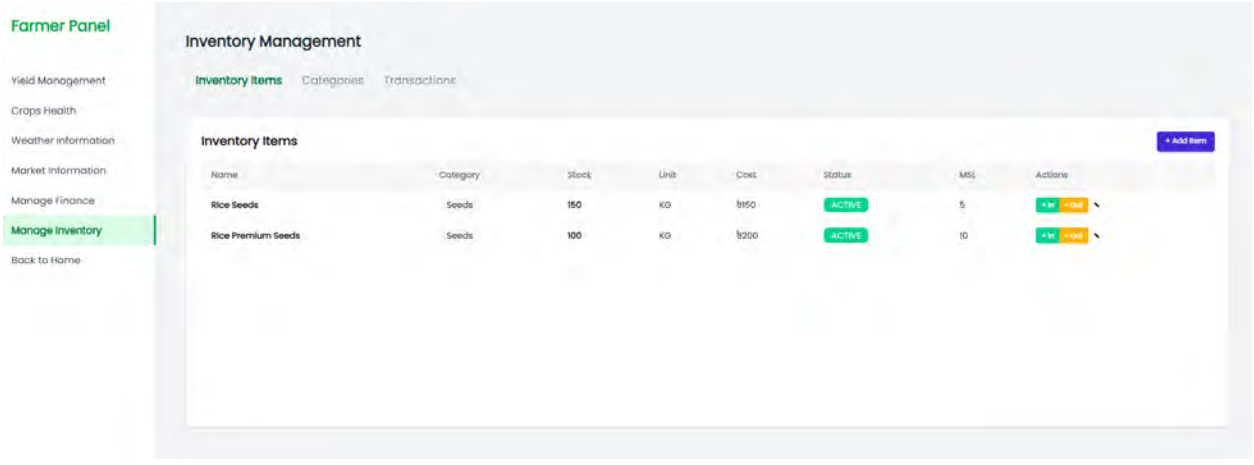

Figure 5.24: Inventory Items

The inventory management works as follows, we can add product or remove it from inventory. So the basic operation is, product stock brings in or out as per remaining units.

Add Items

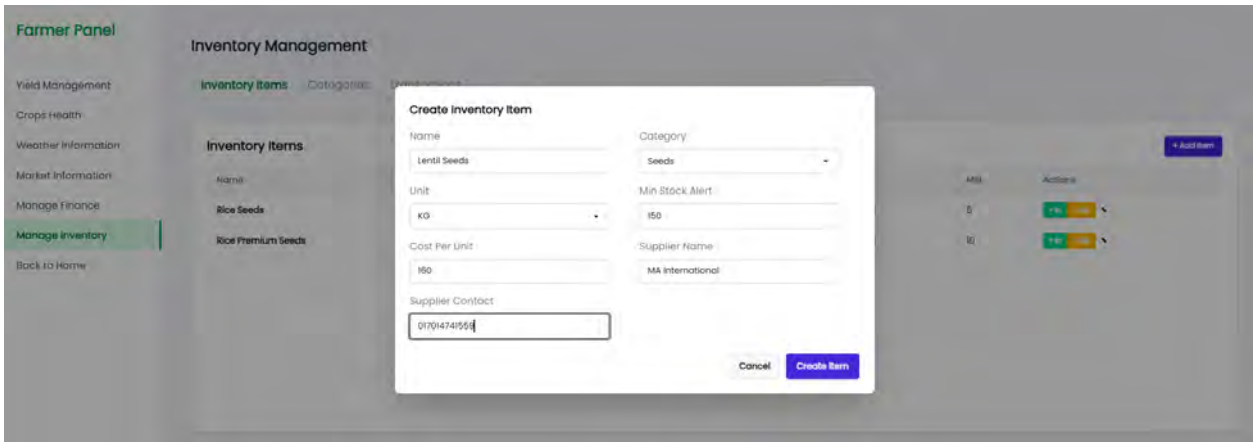

Figure 5.25: Adding Inventory Items

To add a product in the inventory, the user should click on the Add item button, that will open a pop up tab that says create inventory item. After filling up the required fields the user should click on create item. Thus, it will add the product as a stock item.

Stock In Or Out

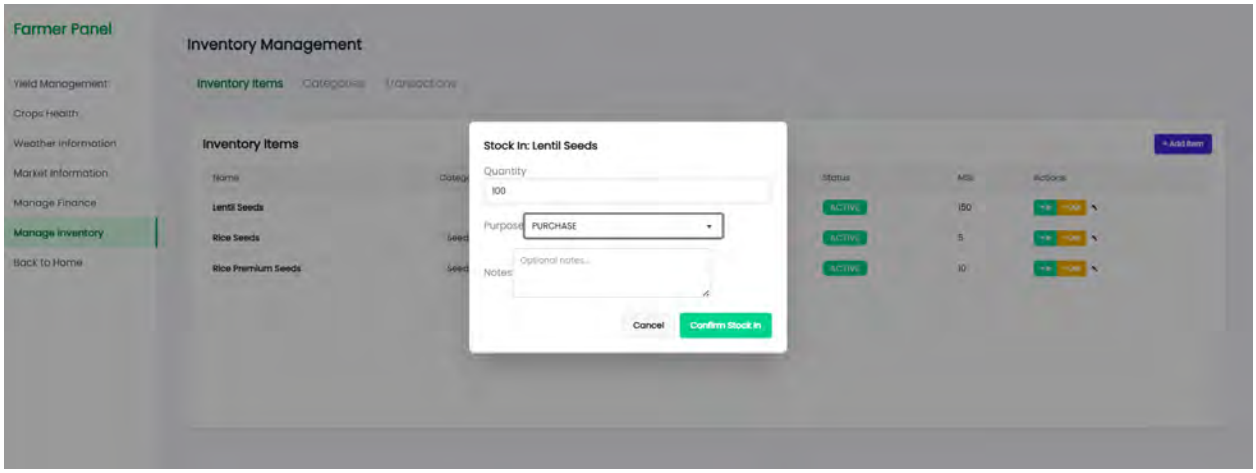

Figure 5.26: Stock Add

The stock in pop-up shows the quantity and notes/reason for purchase. To add item in stock, user have to use the stock in button

After stock In Or Out

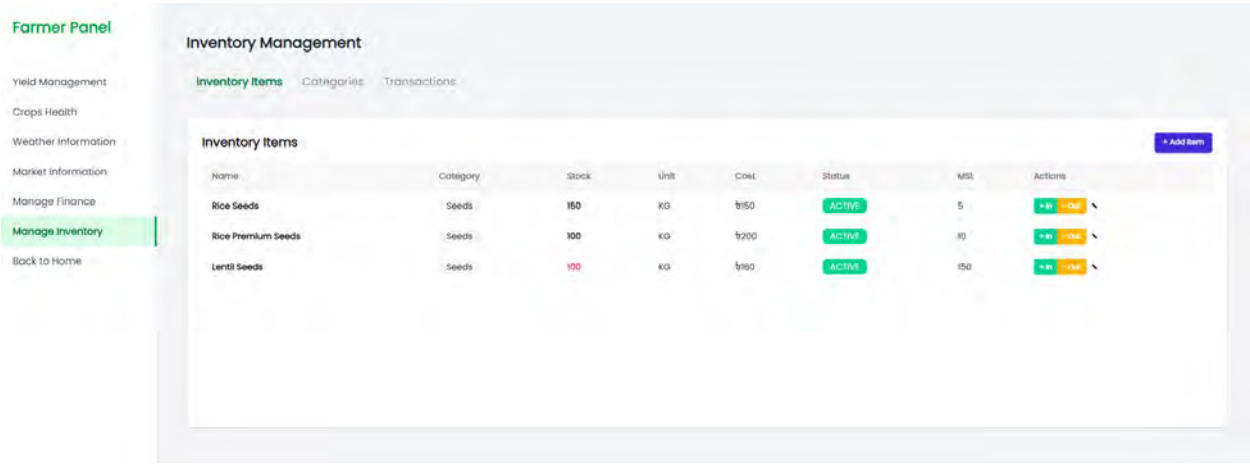

Figure 5.27: After Stock Add

After stocking in, the items are added to inventory. It is registered as stocked and it is showing the total amount that has been added.

Inventory Categories

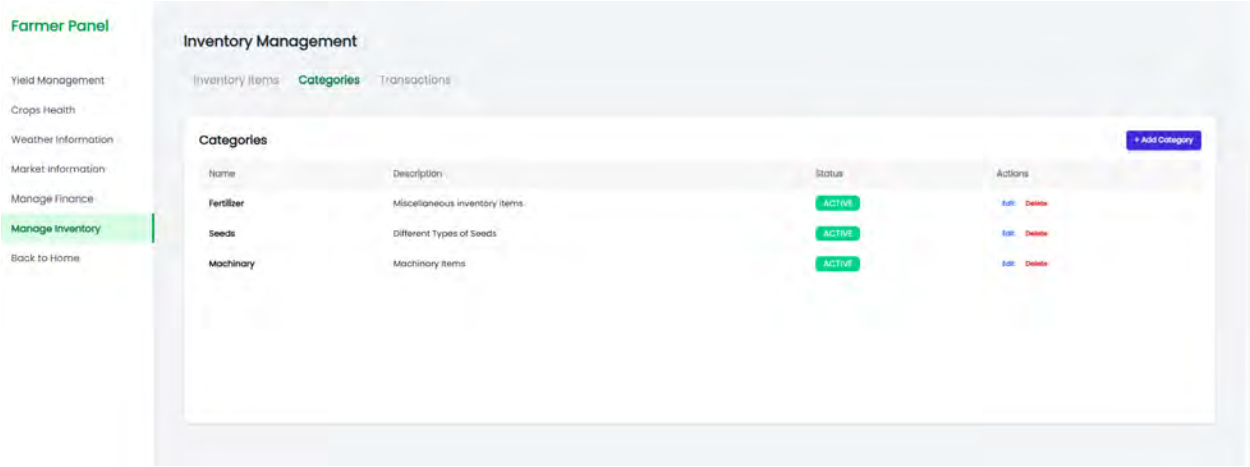

Figure 5.28: Showing Inventory Categories

To differentiate among the products, i.e Fertilizer, Seed or Crop user shall use the interface that says Categories. And it will immediately divide the available products into different categories.

Add New Category

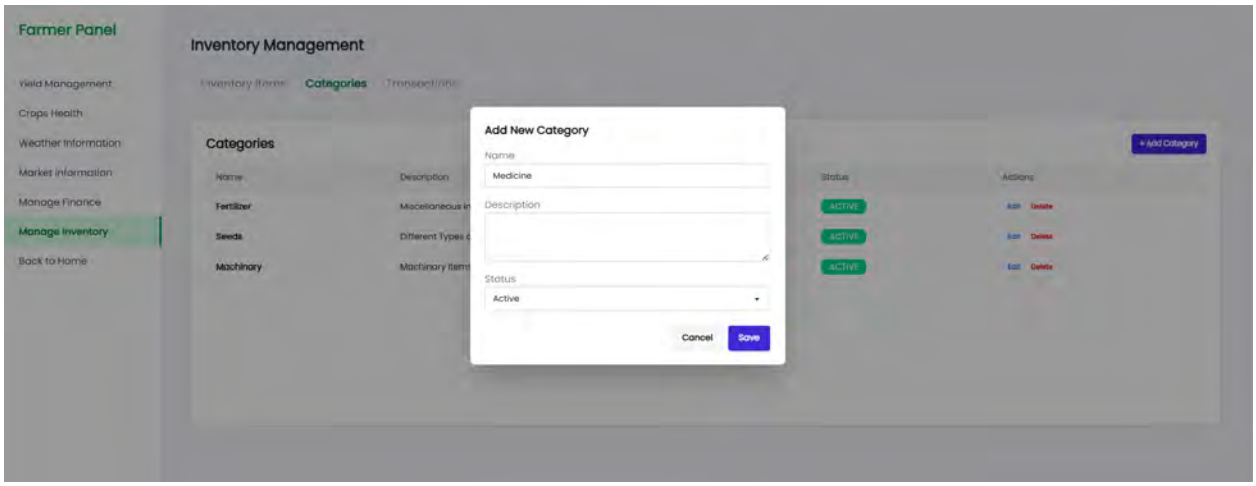

Figure 5.29: Add New Category

If the user needs to add a new item, such as a Machinery item, there might be crops, Machines that are used in harvest. Users can do that by clicking the Add Category button.

After Adding New Category

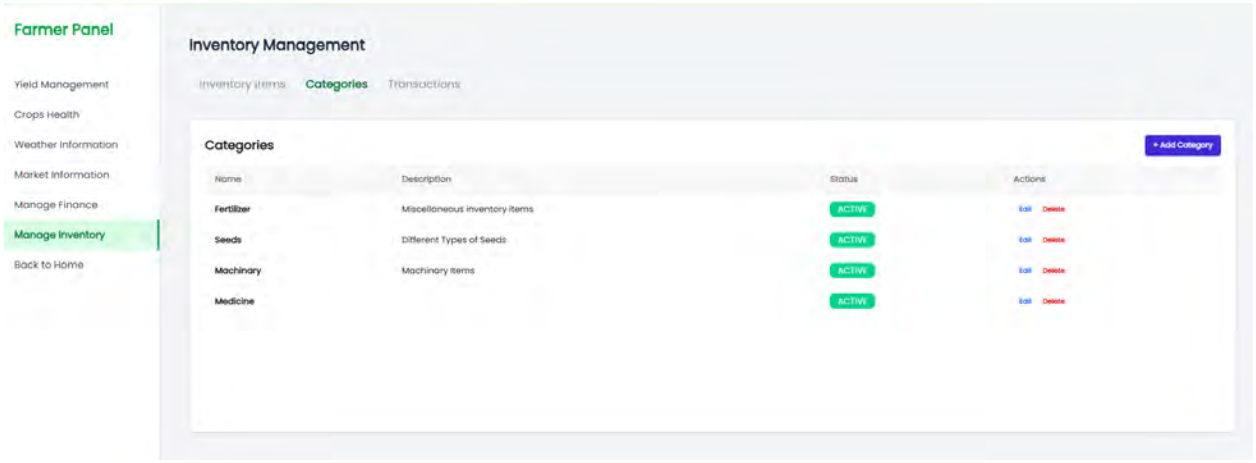

Figure 5.30: Added New Category

After adding a new category the new item will be shown as listed.

Transection History

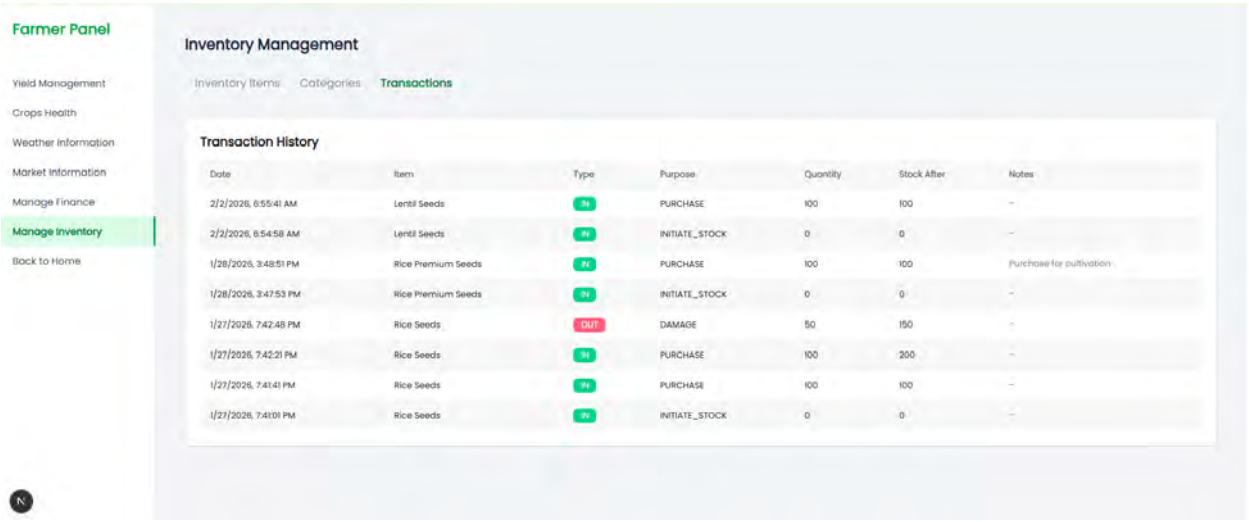

Figure 5.31: Transaction

To see the expenses, income, losses, damages the transaction history tab gives almost all the solutions. It comes with all the summary of the transaction, as why it happened, what is the present stock, how much was the expense. Also, the user can keep manual notes to keep track.

History of Specific Items

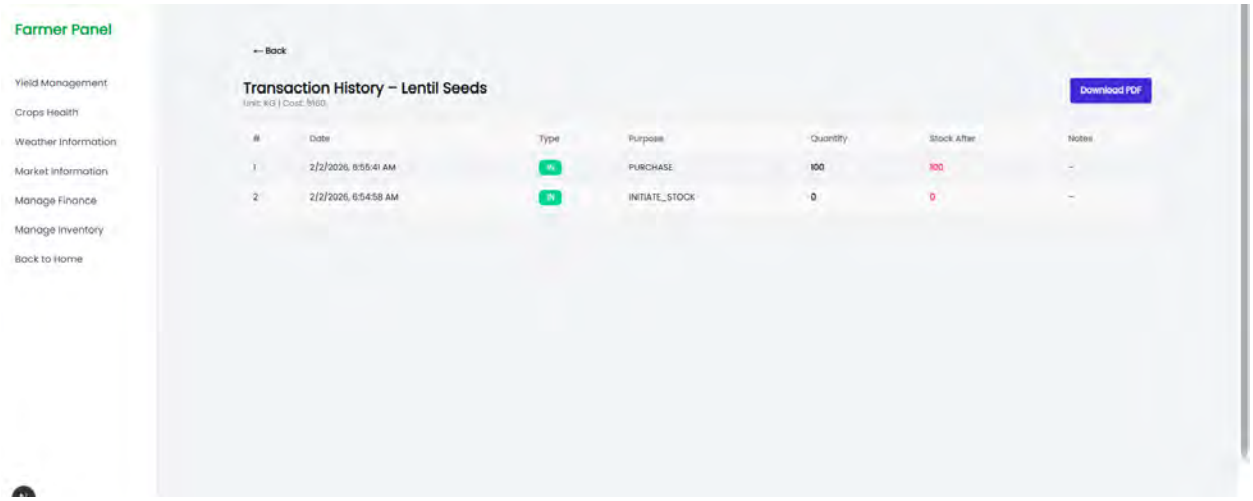

Figure 5.32: Transaction History Of Specific Items

Also, from the transaction history, there are also options to see for a particular products' total history.

Download pdf

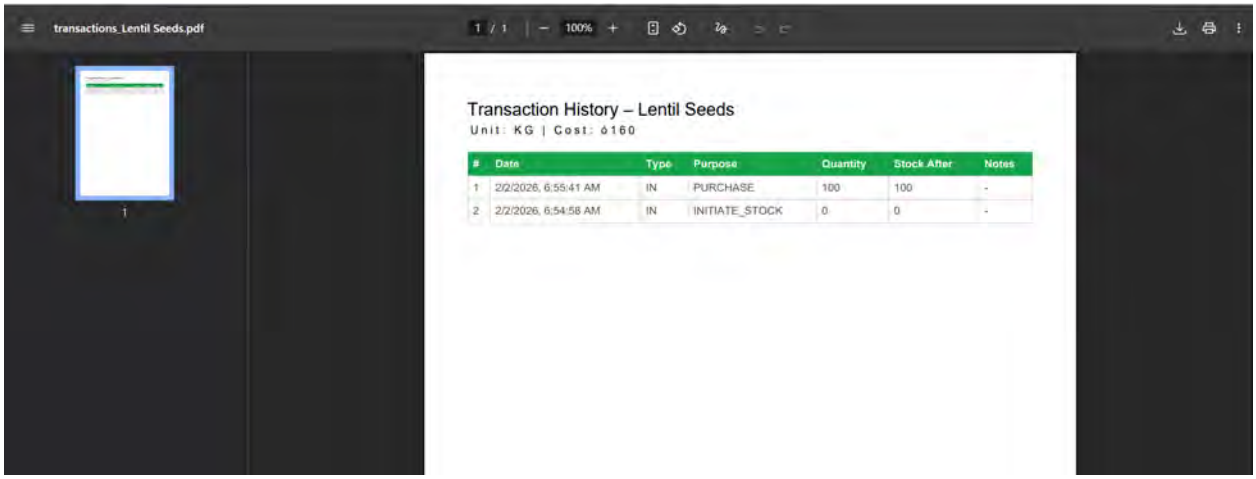

Figure 5.33: Pdf Downlaod

Finally, if the user needs to download a complete report, they can do it by simply clicking the download pdf button.

5.6.4 Finance

Finance Overview (Finance Dasboard)

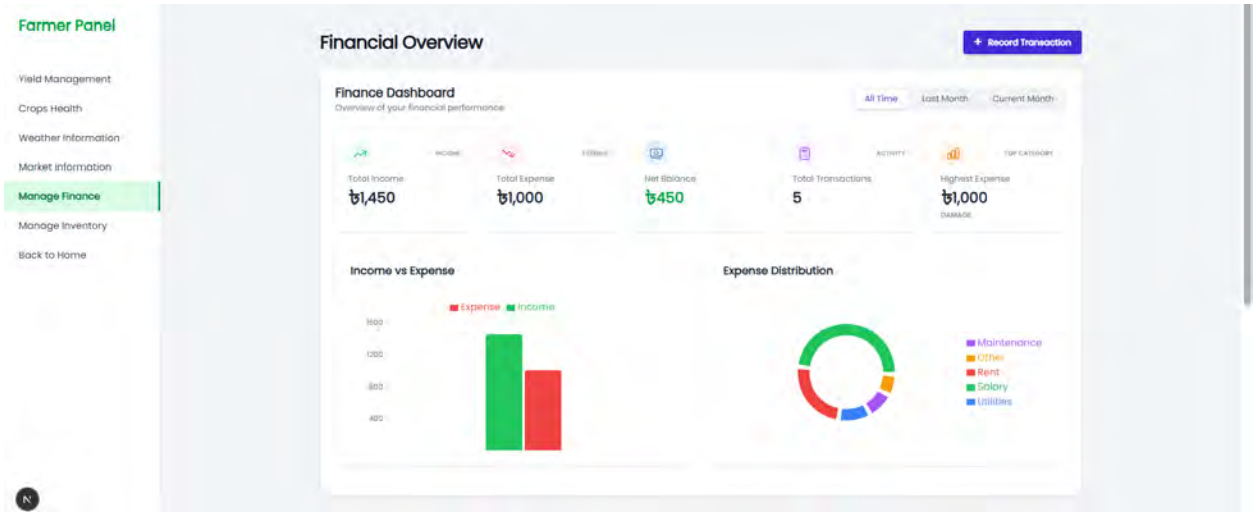

Figure 5.34: Dashboard

The Financial dashboard will show the income, expenses, total transactions, losses. There's even a graph to define them and a pie chart as well.

Record New Transection

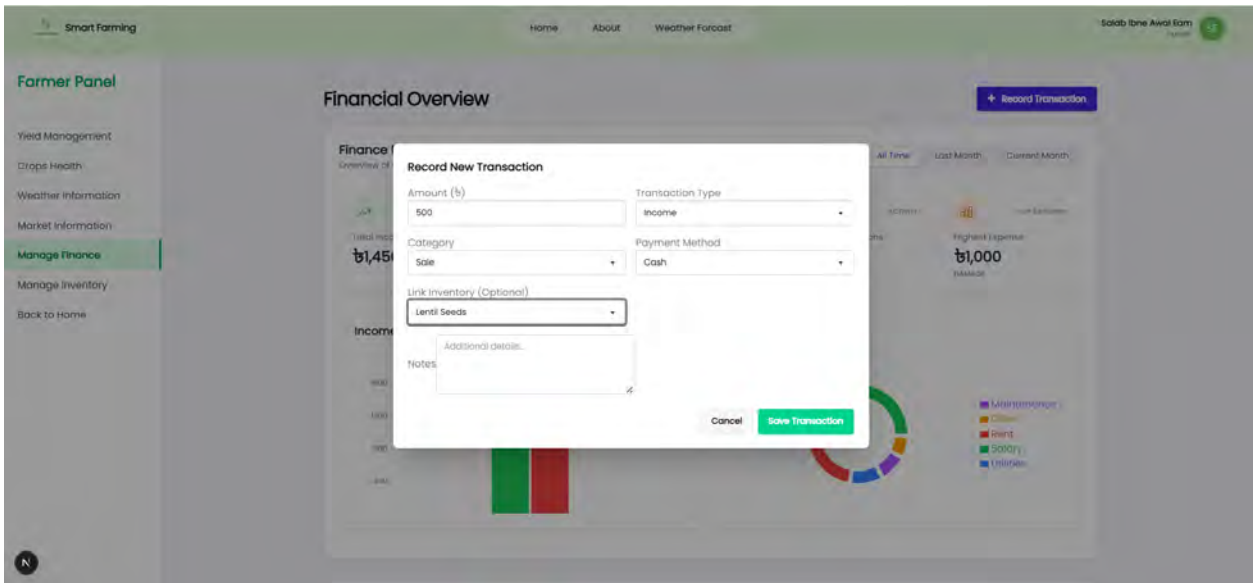

Figure 5.35: Transaction Add

If there is a new transaction from the user, they can simply put a new transaction history by clicking the Record Transaction button. Users need to add some information and fill some required fields, but they can keep a proper track by this.

Transaction History

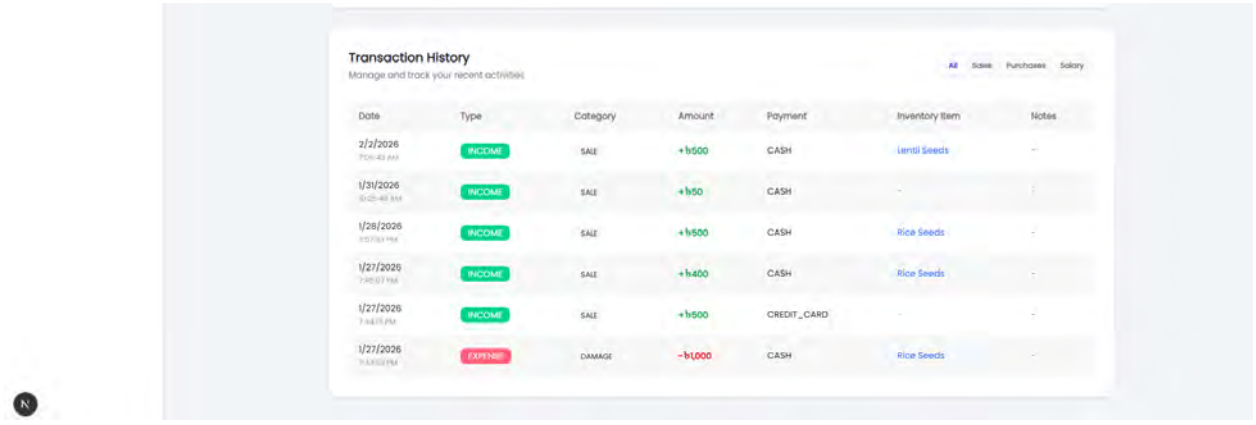

Figure 5.36: Transaction History

To see every transaction history based on sales, expenses, purchases and damage users shall select the All button.

Transaction History Based On Category (ex: Sales)

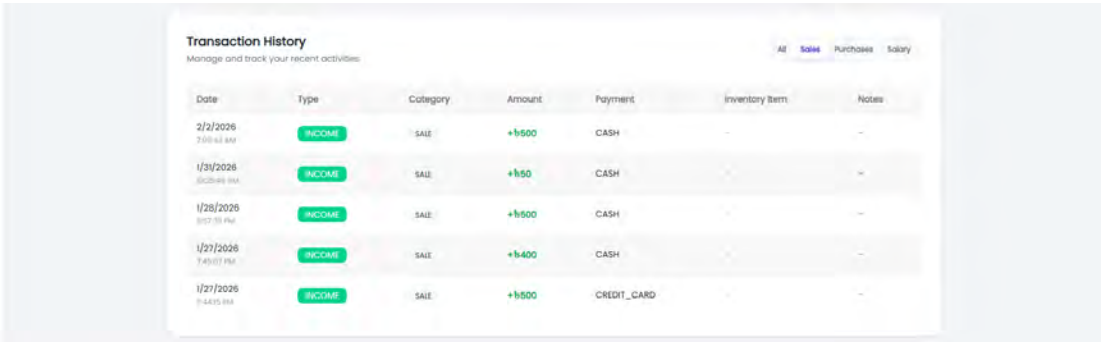

Figure 5.37: Transaction History On Category

If the user wants to see the transaction took place by a particular method, the user can filter it and see for themselves.

Chapter 6

Conclusion

6.1 Summary of Findings

In this project, we developed a Smart Farming system that helps farmers manage their crops , AI, and an integrated platform. Farmers provide data about their crops, weather conditions, and farm activities through simple forms, and the system analyzes it to give results.The platform includes multiple modules to support complete farm management. The Weather Information module helps plan irrigation and field activities, while Crop Health tracking enables farmers to monitor plant growth and detect issues early. Fertilizer Planning and Seed Planning modules guide farmers on what inputs to use and when, optimizing resources and improving productivity. The inventory and finance modules allow farmers to manage supplies of goods, track expenses, and maintain financial records easily.

6.2 Recommendations for Future Work

In the future, the system can be improved by adding more IOT based features to increase its effectiveness. For example, Sensors can be used to automatically collect data from soil, water usage and weather conditions. In addition, satellite images and drones can be used to monitor crop health, irrigation and fertilizer use over large areas. A mobile app can be introduced in this platform to make easier upload and update data in the panel and receive alerts on their phone app. In addition, a real time chat option beyond agricultural experts can provide quick advice . A secure payment system can be implemented to support online purchases. A multivendor e-commerce platform can also be connected between farmers, suppliers and consumers. All of these together can make a all in one farming solution in the Bangladesh.

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