EXECUTIVE SUMMARY

The **Farmer Friendly Consultancy** project is a smart, Web platform designed to empower farmers by providing actionable recommendations for crop selection, fertilizer use, and pest control. This initiative aims to bridge the information gap faced by millions of farmers, especially in rural regions, by digitizing expert agricultural consultation and making it easily accessible through an intuitive online interface.

The platform enables farmers to register and log in using just a mobile number and password, ensuring simplicity and inclusivity. Once logged in, they can access personalized dashboards where they can interact with various services. The **Crop Recommendation** module allows farmers to enter soil nutrient values, temperature, humidity, pH, and rainfall data to receive accurate crop suggestions. The **Fertilizer Recommendation** tool suggests the best fertilizers based on current soil conditions and selected crops. The most innovative component, however, is the **Pesticide Recommendation System**, which uses deep learning techniques to analyze uploaded images of infected crops and pests to identify the pest and suggest suitable pesticides, complete with product images and dosage information.

The entire platform is built using modern web technologies such as Flask (Python), HTML/CSS for UI, and MongoDB for backend data storage. TensorFlow powers the pest recognition model. The application emphasizes user-friendly design, mobile responsiveness, and localized data processing to serve farmers with varying levels of technical literacy.

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ABBREVIATIONS/ NOTATIONS/NOMENCLATURE

- **UI :** User Interface
- **DB :** Database
- **HTML :** HyperText Markup Language
- **CSS :** Cascading Style Sheets
- **JS :** JavaScript
- **API :** Application Programming Interface
- **WBS :** Work Breakdown Structure
- **CBS :** Cost Breakdown Structure
- **Flask :** Python-based Web Framework
- **MongoDB :** NoSQL Database System
- **UX :** User Experience

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

- Agriculture remains a vital part of the Indian economy, contributing significantly to GDP and employing more than half of the country's population. However, a majority of farmers, particularly those in rural areas, lack timely access to expert advice on which crops to grow, what fertilizers to use, and how to manage pest attacks. Traditional consultancy services are not scalable or accessible to all regions. In response to this challenge, the "**Farmer Friendly Consultancy**" project offers a modern, intelligent web-based platform that serves as a digital consultant for farmers.

- The platform utilizes artificial intelligence and machine learning to analyze user inputs ranging from soil nutrient levels to uploaded images of crop infections to generate reliable and actionable recommendations. Its goal is to bridge the knowledge and resource gap by delivering consultancy services in a format that is easy to use, even by those with minimal digital literacy.

- Key innovations of the system include image-based pest detection, personalized dashboards, a historical view of recommendations, and the ability to provide accurate suggestions based on real-time environmental inputs. The user interface is mobile-friendly and designed with simplicity in mind, ensuring broad usability across diverse user demographics.

- By automating expert recommendations, the Farmer Friendly Consultancy aims to increase crop yield, reduce chemical misuse, promote sustainability, and ultimately improve the livelihood of farmers. It showcases how the synergy of agriculture and technology can help achieve food security, economic empowerment, and rural development.

1.1.1 Scope of the Capstone Project:

The Farmer Friendly Consultancy platform encompasses a complete recommendation suite that serves various agricultural needs:

1. **User Authentication System:** Allows farmers to register and log in using mobile numbers and passwords.
2. **Dashboard Navigation:** Once logged in, users land on a dashboard that serves as the central access point for all services.
3. **Crop Recommendation Module:** This module suggests the most suitable crop based on soil nutrients (N, P, K), temperature, humidity, pH, and rainfall.
4. **Fertilizer Recommendation Module:** It recommends the appropriate fertilizer for a selected crop and soil nutrient profile.
5. **Pesticide Recommendation Module:** Utilizes a deep learning model to detect pests from uploaded images and suggests suitable pesticides, complete with images and dosages.
6. **History Tracking and Profile View:** Stores previous recommendations and allows users to view past activities, improving record-keeping and follow-up actions.
7. **Responsive and Intuitive Design:** Optimized for mobile and desktop usage with clear navigation, ensuring accessibility for users with limited digital experience.
8. **Scalability:** Built on a modular architecture that allows for the future integration of multilingual support, voice commands, and weather-based predictions.

CHAPTER 2: CAPSTONE PROJECT PLANNING

2.1 Work Breakdown Structure (WBS)

The Work Breakdown Structure (WBS) for the Farmer Friendly Consultancy project divides the total scope into manageable sections. Each deliverable and task is structured to ensure clarity, accountability, and effective project execution. The WBS is categorized into five primary work packages: Planning, Design, Development, Testing, and Deployment.

1. **Level 1: Project Initiation and Planning**

    - Define Problem Statement and Goals
    - Conduct Literature Review and Benchmarking
    - Requirement Gathering and Documentation
    - Stakeholder Meeting and Initial Approval
    - Identify Tools, Frameworks, and Libraries

2. **Level 2: System Design**

    - Prepare System Architecture Diagram
    - Design Frontend Interfaces
        - Login and Registration Page
        - Dashboard Navigation
        - Crop/Fertilizer/Pesticide Forms
    - Design Backend APIs
        - Define Data Flow
        - Setup Flask Routes and Models
        - MongoDB Schema Definition
    - Integrate Image Upload with Preview Feature
    - Design User History System (View)

3. **Level 3: Development**

- Frontend Development
    - Create Static Pages (HTML, CSS)
    - Add Interactivity with JavaScript
    - Make Design Responsive
- Backend Development
    - Connect Flask App to MongoDB
    - Implement Login Auth Logic
    - Fetch and Display User History
- Model Integration
    - Load Pesticide CNN Model with TensorFlow
    - Load Crop Prediction Model with Joblib
    - Set Thresholds and Classes
- History Logging
    - Define History Schema
    - Create Save and Retrieve Functions

4. **Level 4: Testing**

- Write Unit Tests for Backend Routes
- Conduct Integration Testing
- Perform Image Classification Testing
- Manual User Input Testing
- Simulate Server Load
- Fix UI/UX Bugs and Backend Errors

5. **Level 5: Deployment**

- Host Web App using PythonAnywhere or Heroku
- Setup Static Files and Routes
- Test End-to-End Workflow on Cloud
- Backup MongoDB Database
- Setup Custom Domain (Optional)
- Monitor Logs and Uptime

6. **Level 6: Documentation and Final Report**

- Write User Manual
- Document System Flow and Architecture
- Prepare Capstone Presentation
- Compile Final Report (This Document)

The WBS allowed the development team to stay on schedule, manage complexity, and track progress effectively. Each task was accompanied by deliverables, and the modular approach made debugging and upgrading significantly easier. The agile methodology supported flexibility, enabling iterative development with frequent evaluations and refinements.

2.2 Timeline Development – Schedule

A **structured project timeline** is essential to ensure each phase is completed within the allocated time. Below is a detailed **weekly project schedule**:

Table 2.1

Week	**Task**	**Description**
Weeks 1-2	Project Initiation & Planning	Requirement analysis, feasibility study, scope finalization, resource planning
Weeks 3–4	Design	UI/UX wireframes, architecture blueprint, DB schema design, design approval
Weeks 5–9	Development	Frontend forms, backend APIs, model integration, image preview, MongoDB history module
Weeks 10–11	Testing	Unit testing, integration testing, bug fixes, responsiveness testing
Week 12	Deployment	Deployment to server or hosting platform or localhost
Week 13	Documentation and Presentation	Final report, slide deck, project presentation

2.3 Cost Breakdown Structure (CBS)

The **Cost Breakdown Structure (CBS)** provides an estimate of expenses incurred in the design and implementation of the project.

Table 2.2

Component	**Quantity**	**Unit Cost (₹)**	**Total Cost (₹)**
Internet Charges	3 Months	2500	2500
Domain and Hosting	Per Year	2,500	2,500
Documentation	4 members	500	2,000
Total Estimated Cost	-		**₹7000**

Budget Considerations:

- This project aims to keep costs **affordable** while maintaining **high efficiency**.
- **Future scalability** may require reducing costs through **bulk manufacturing**.

2.4 Capstone Project Risk Assessment

Identifying risks early allows **proactive mitigation strategies**. Below are the **key risks** and how they will be managed:

Table 2.3

Risk	**Potential Impact**	**Mitigation Strategy**
User input errors	May cause incorrect predictions or system crashes	Add validation checks on all form inputs and informative error messages
User Interface Issues	Users may find the platform confusing to navigate	Conduct user testing and gather feedback for UI improvement and usability fixes.
Inaccurate pesticide image detection	Wrong pest classification can lead to crop damage	Implement a fallback message when confidence is low, allow image re-upload
Delays in development	Missed deadlines, incomplete features	Weekly tracking, Agile sprints with buffers

2.5 Requirements Specification

Functional Requirements :

1. Users can register using a mobile number, full name, and password.
2. A secure login system is provided where users authenticate using mobile number and password.
3. Upon login, users are redirected to a central dashboard with access to:
    - Crop Recommendation
    - Fertilizer Recommendation
    - Pesticide Recommendation
4. The crop recommendation module:
    - Accepts inputs like Nitrogen, Phosphorus, Potassium, temperature, humidity, pH, and rainfall.
    - Predicts and displays a suitable crop using an ML model.
5. The fertilizer recommendation module:
    - Accepts a selected crop and nutrient values (N, P, K).
    - Provides appropriate fertilizer suggestions based on stored logic and dataset.
6. The pesticide recommendation module:

- Allows users to upload an image of a pest.
- Uses a CNN model to identify the pest and recommend pesticides accordingly.

7. All recommendations are saved in a user-specific history log for future reference.
8. Image preview is shown before making pesticide predictions.
9. Profile section includes access to user details and previous history.
10. Admin or system does not allow access to any data without authentication.

Non-Functional Requirements :

- The application responds to user actions within 2 seconds.
- The system guarantees over 90% uptime and reliability.
- The platform is responsive and works on desktops, tablets, and mobile devices.
- Passwords are securely hashed and stored.
- All forms include input validation and error handling.
- The interface uses a minimalistic and intuitive layout for easy navigation.
- The system should be capable of handling 100+ concurrent users.
- The recommendation models maintain over 80% accuracy for relevant inputs.
- History data must be persistently stored even after logout.

User Input :

1. **Registration requires:**
    - Full name
    - Mobile number
    - Password
    - Confirm Password
2. **Crop Recommendation input includes:**
    - Nitrogen (N)
    - Phosphorus (P)
    - Potassium (K)
    - Temperature (°C)
    - Humidity (%)
    - pH level
    - Rainfall (mm)
3. **Fertilizer Recommendation input includes:**
    - Crop name (from dropdown)
    - N, P, K values

4. **Pesticide Recommendation input includes:**
    - Pest image (JPG/PNG)
    - Uploaded through an input form with image preview

Technical Constraints:

- Backend is built with Python Flask framework.
- Image classification uses TensorFlow/Keras models.
- Data is stored in MongoDB (NoSQL).
- Static files (CSS/JS/images) must follow Flask's directory structure.
- Prediction models need enough RAM and compute resources to run efficiently.
- Browser compatibility must be ensured for modern browsers like Chrome, Edge, and Firefox.

2.6 Design Specification

This section outlines the system design of the ***Farmer Friendly Consultancy*** project. It details the chosen architecture, alternative designs considered, and comprehensive component-level breakdown of all major modules and subsystems.

Chosen System Design

- **Three-Tier Architecture**:
    1. **Presentation Layer (Frontend)** – Handles user interactions using HTML/CSS/JavaScript. It ensures responsiveness and includes forms, image previews, and dashboards.
    2. **Application Layer (Backend)** – Flask-based server handling routing, API requests, model inference, and business logic.
    3. **Data Layer (Database + ML Models)** – MongoDB stores user and historical data, CSV for fertilizer rules, and Keras/TensorFlow models for pest and crop predictions.
- **Security Design**:
    - Uses hashed passwords
    - Session-based login tracking
    - Input validation and error handling

Discussion of Alternative Designs

Alternative architectures were considered, such as:

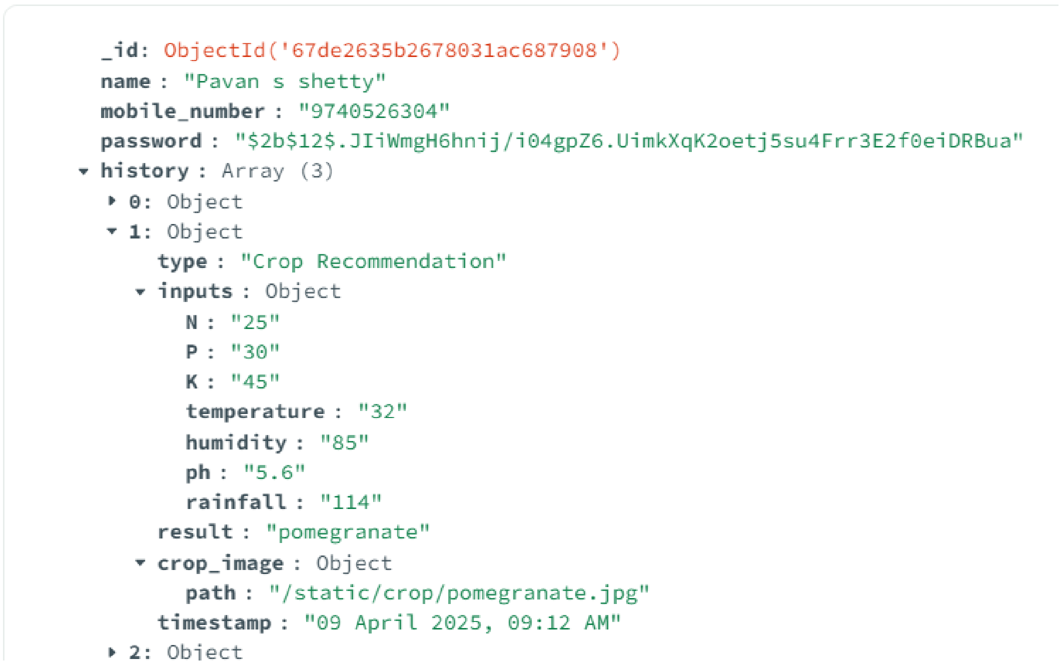
- **Monolithic Design** – Simpler but less scalable, merging frontend/backend/model codebase.
- **Cloud-based Microservices** – More scalable but complex for a student project; separated modules as services hosted on different endpoints.

- **Mobile App-first** – Discarded due to limited offline needs and wider web reach.

The chosen design optimally balances simplicity, scalability, and modularity suitable for a capstone project scope.

Detailed Description of Components/Subsystems

- **User Module:**
    - Registration and Login screens
    - Form validation and secure credential storage
- **Crop Recommendation Module:**
    - Accepts N, P, K, temperature, humidity, pH, and rainfall
    - Uses a pre-trained machine learning model
- **Fertilizer Recommendation Module:**
    - Matches user input with fertilizer dataset
    - Displays recommended fertilizers and dosage
- **Pesticide Recommendation Module:**
    - Upload image → Image preprocessing → CNN model prediction
    - Returns pest name, pesticide names, and related images
- **History Module:**
    - MongoDB collection storing timestamped user predictions
    - Renders past activity dynamically in profile modal
- **Frontend Templates:**
    - Built with Jinja2 templates (.html)
    - Includes home, dashboard, crop, fertilizer, and pesticide pages
- **Deployment Subsystem:**
    - Codebase hosted locally or optionally deployed using Heroku or Render
    - Supports lightweight hosting of ML models via TensorFlow CPU build



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mobile_number : "9740526304"
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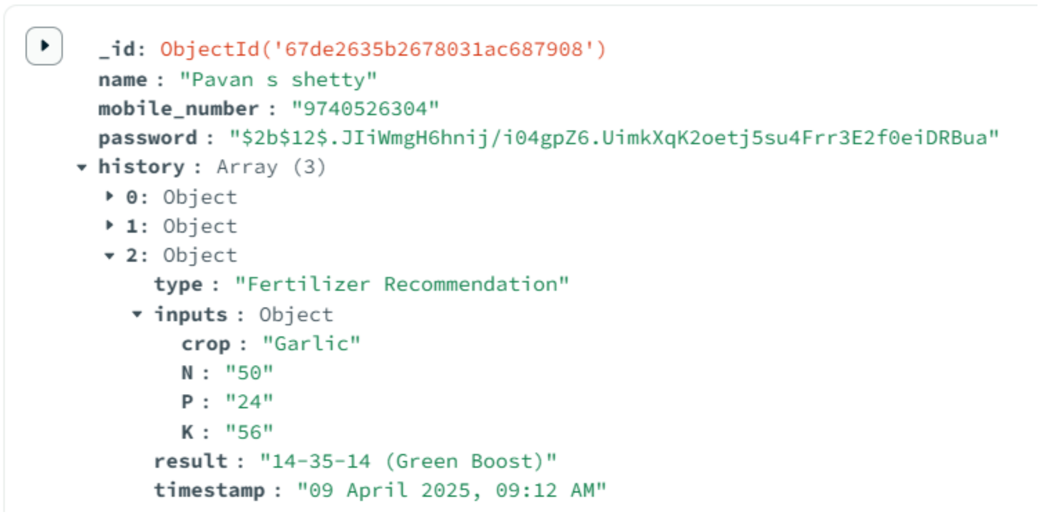
▾ history : Array (3)
  ▸ 0: Object
  ▾ 1: Object
      type : "Crop Recommendation"
    ▾ inputs : Object
        N : "25"
        P : "30"
        K : "45"
        temperature : "32"
        humidity : "85"
        ph : "5.6"
        rainfall : "114"
      result : "pomegranate"
    ▾ crop_image : Object
        path : "/static/crop/pomegranate.jpg"
      timestamp : "09 April 2025, 09:12 AM"
  ▸ 2: Object
```

Figure 2.1



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▾ history : Array (3)
  ▸ 0: Object
  ▸ 1: Object
  ▾ 2: Object
      type : "Fertilizer Recommendation"
    ▾ inputs : Object
        crop : "Garlic"
        N : "50"
        P : "24"
        K : "56"
      result : "14-35-14 (Green Boost)"
      timestamp : "09 April 2025, 09:12 AM"
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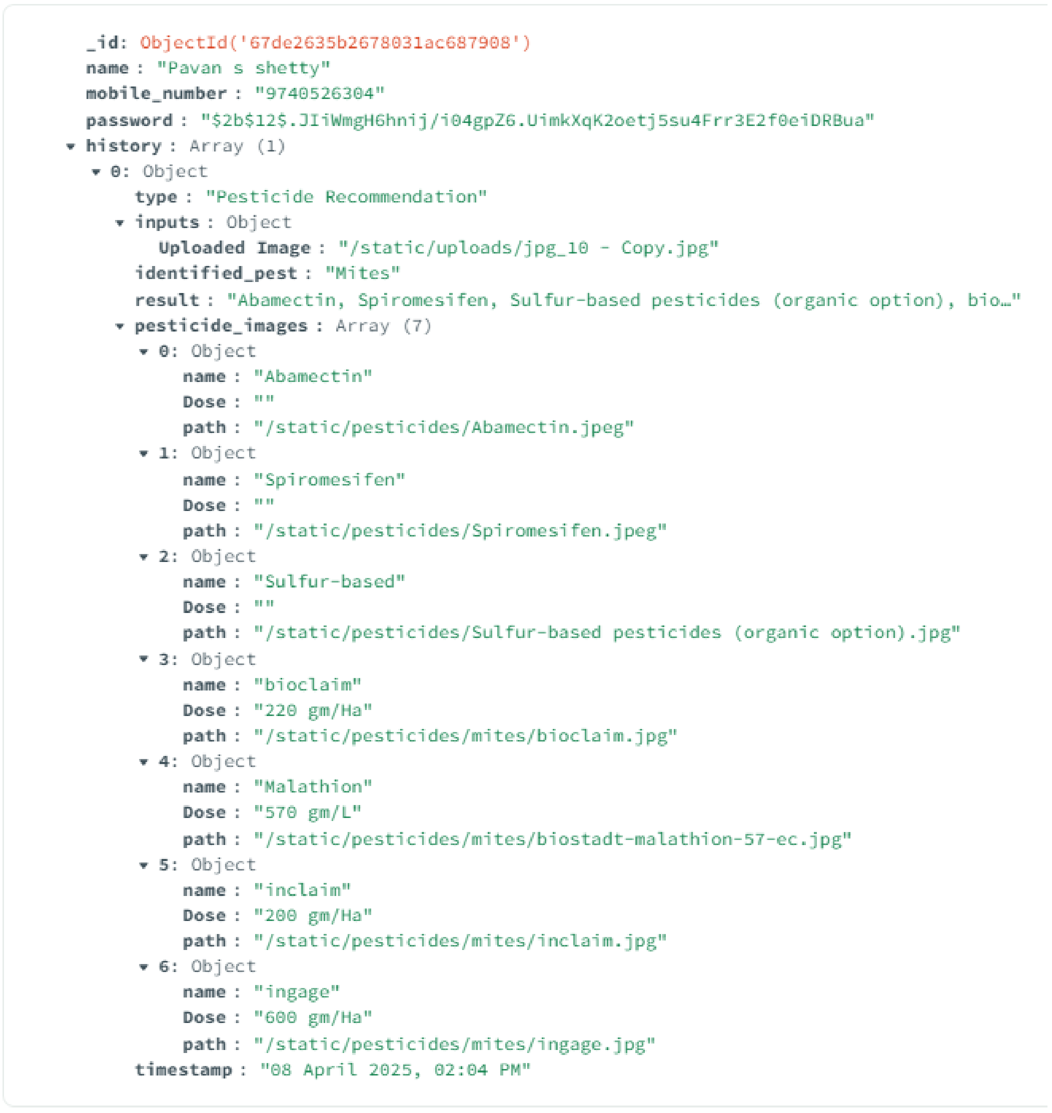
Figure 2.2



```
  _id: ObjectId('67de2635b2678031ac687908')
  name : "Pavan s shetty"
  mobile_number : "9740526304"
  password : "$2b$12$.JIiWmgH6hnij/i04gpZ6.UimkXqK2oetj5su4Frr3E2f0eiDRBua"
▾ history : Array (1)
  ▾ 0: Object
      type : "Pesticide Recommendation"
    ▾ inputs : Object
        Uploaded Image : "/static/uploads/jpg_10 - Copy.jpg"
      identified_pest : "Mites"
      result : "Abamectin, Spiromesifen, Sulfur-based pesticides (organic option), bio…"
    ▾ pesticide_images : Array (7)
      ▾ 0: Object
          name : "Abamectin"
          Dose : ""
          path : "/static/pesticides/Abamectin.jpeg"
      ▾ 1: Object
          name : "Spiromesifen"
          Dose : ""
          path : "/static/pesticides/Spiromesifen.jpeg"
      ▾ 2: Object
          name : "Sulfur-based"
          Dose : ""
          path : "/static/pesticides/Sulfur-based pesticides (organic option).jpg"
      ▾ 3: Object
          name : "bioclaim"
          Dose : "220 gm/Ha"
          path : "/static/pesticides/mites/bioclaim.jpg"
      ▾ 4: Object
          name : "Malathion"
          Dose : "570 gm/L"
          path : "/static/pesticides/mites/biostadt-malathion-57-ec.jpg"
      ▾ 5: Object
          name : "inclaim"
          Dose : "200 gm/Ha"
          path : "/static/pesticides/mites/inclaim.jpg"
      ▾ 6: Object
          name : "ingage"
          Dose : "600 gm/Ha"
          path : "/static/pesticides/mites/ingage.jpg"
      timestamp : "08 April 2025, 02:04 PM"
```

Figure 2.3

CHAPTER 3: APPROACH AND METHODOLOGY

3.1 Overview

The ***Farmer Friendly Consultancy*** project is built to bridge the information gap in agriculture using modern web development and machine learning techniques. The methodology adopts an agile development cycle, emphasizing modular implementation, continuous integration, and iterative testing.

The project combines traditional web forms with prediction to provide crop, fertilizer, and pesticide suggestions tailored to each user's input. The pesticide recommendation, in particular, uses image classification to detect pests. The approach is both user-centric and data-driven, ensuring a balance between simplicity for farmers and technological depth for developers.

This chapter outlines the technology stack and methods used in design, development, testing, and deployment phases.

3.2 Hardware and Software Technologies Used

3.2.1 Hardware Components

- **Development Environment:** Standard laptop/desktop with minimum 8GB RAM and 256GB SSD.
- **Server Hosting:** Cloud deployment via Render/Heroku or local testing with localhost.

3.2.2 Software Components

1. **Frontend:**
    - **HTML, CSS, JavaScript**:
        - Build the structure and style of all pages: Home, Login, Dashboard, Crop, Fertilizer, Pesticide.
        - CSS Flexbox/Grid for responsive and centered layouts.
    - **Jinja2 Templates**:

    - Flask’s templating engine used to dynamically render Python data in HTML.
- **Image Preview (JavaScript FileReader API)**:
    - Shows preview of pest images before uploading for prediction.

2. **Backend**

- **Python (Flask Framework)**:
    - Handles routing, user authentication, and API endpoints.
    - Lightweight and suitable for rapid development.
- **TensorFlow/Keras**:
    - Used to build and load the CNN-based pesticide image classification model.
    - Offers a flexible API for real-time prediction from uploaded images.
- **Joblib**:
    - For loading and serving the pre-trained crop recommendation model.
- **Pandas**:
    - Used in fertilizer recommendation module to read and filter fertilizer CSV datasets.
- **MongoDB (NoSQL Database)**:
    - Stores user registration data, login credentials, and historical recommendation logs.
    - Enables easy querying of user-specific histories.

3. **Development Tools:**

- Visual Studio Code: Code editor
- Git & GitHub: Version control
- Postman: API testing
- MongoDB Compass: GUI for managing MongoDB data

4. **Other Libraries:**

- **Bcrypt:** For secure password hashing

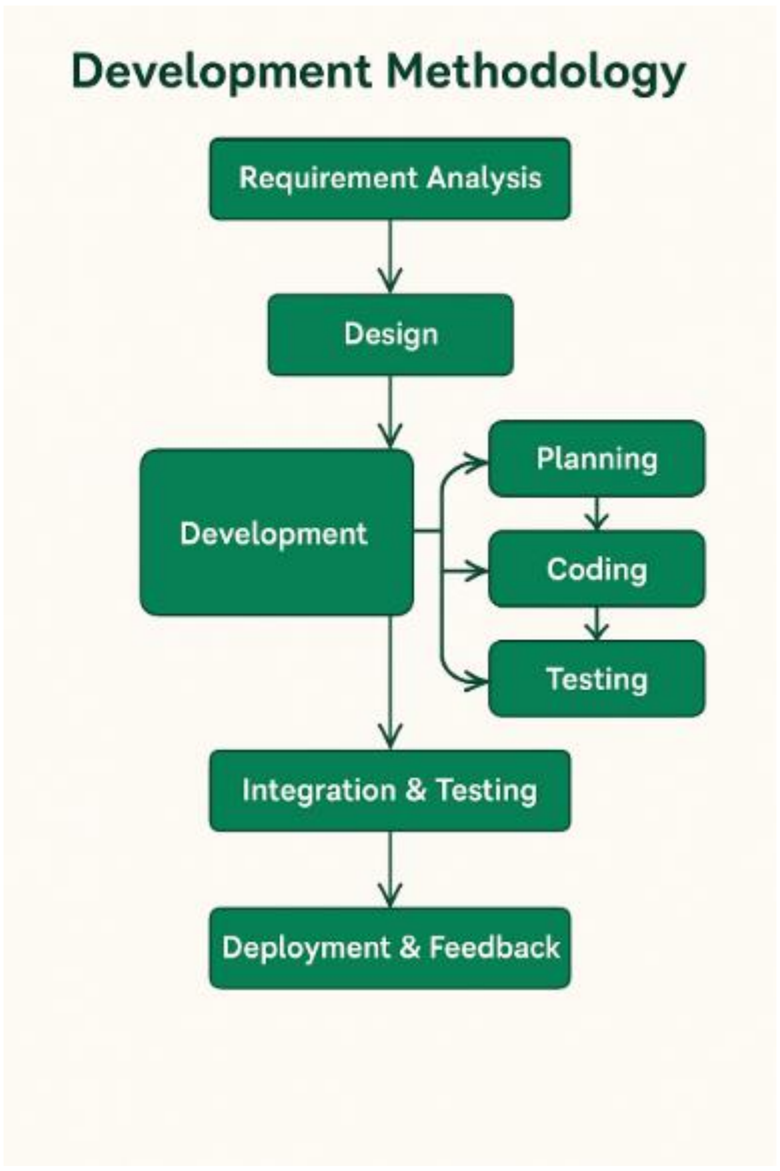


Figure 3.1

3.3 Programming and Implementation

3.3.1 Backend (app.py)

Code: app.py

```
from datetime import datetime
from flask import Flask, render_template, request, jsonify, session, redirect, url_for
import joblib
from tensorflow.keras.models import load_model  # type: ignore
import numpy as np
from PIL import Image
import pandas as pd
import os
from flask_pymongo import PyMongo
from flask_bcrypt import Bcrypt
from flask_session import Session

app = Flask(__name__)

# MongoDB Configuration
app.config["MONGO_URI"] = "mongodb://localhost:27017/crop_recommendation"
mongo = PyMongo(app)

# Session Configuration
app.config["SESSION_PERMANENT"] = False
app.config["SESSION_TYPE"] = "filesystem"
Session(app)

#  Initialize Bcrypt for Password Hashing
bcrypt = Bcrypt(app)

# Set the folder to save uploaded images
UPLOAD_FOLDER = 'static/uploads'
app.config['UPLOAD_FOLDER'] = UPLOAD_FOLDER

# Load Models
crop_model = joblib.load('./models/crop_model.pkl')  # Crop Recommendation Model
pesticide_model = load_model('./models/pesticide_cnn_model.h5')  # Pesticide CNN Model

# Define a mapping of prediction indices to pest names
PEST_NAME_MAPPING = {
    0: 'Aphids',
    1: 'Armyworm',
    2: 'Beetle',
    3: 'Bollworm',
    4: 'Earthworm',
    5: 'Grasshopper',
    6: 'Mites',
    7: 'Mosquito',
    8: 'Sawfly',
    9: 'Stem Borer',
    123: 'Unknown Pest'  # Example for unexpected indices
}

# Define a mapping of pests to pesticide recommendations
```

```
PESTICIDE_MAPPING = {
  'Aphids': {
       'recommendation': 'Imidacloprid, Acetamiprid, Neem oil (organic option), banzo, derby,
fulstop-d, intice, Ultimo 200 SL, Ultimo Super',
     'images': [
        {'name': 'Imidacloprid', 'path': 'static\\pesticides\\Imidacloprid.png'},
        {'name': 'Acetamiprid', 'path': 'static\\pesticides\\Acetamiprid.jpg'},
        {'name': 'Neem Oil', 'path': 'static\\pesticides\\Neem oil.jpg'},
        {'name': 'banzo', 'Dose':'330 ml/acre', 'path': 'static\\pesticides\\aphids\\banzo.jpg'},
        {'name': 'derby', 'Dose': '600 gm/Ha', 'path': 'static\\pesticides\\aphids\\derby.jpg'},
        {'name': 'fulstop-d', 'Dose': '1000 ml/Ha', 'path': 'static\\pesticides\\aphids\\fulstop-d.jpg'},
        {'name': 'intice', 'Dose': '30-35 gm/Ha', 'path': 'static\\pesticides\\aphids\\intice.jpg'},
        {'name': 'Ultimo 200 SL', 'Dose': '100-150 ml/Ha', 'path': 'static\\pesticides\\aphids\\ultimo-
200-sl.jpg'},
          {'name': 'Ultimo Super', 'Dose': '60-75 ml/Ha', 'path': 'static\\pesticides\\aphids\\ultimo-
super.jpg'}
     ]
  },
  'Armyworm': {
     'recommendation': 'Chlorantraniliprole, Spinosad, Lambda-cyhalothrin, perfek, prudent',
     'images': [
        {'name': 'Chlorantraniliprole', 'path': 'static\\pesticides\\Chlorantraniliprole.jpeg'},
        {'name': 'Spinosad', 'path': 'static\\pesticides\\Spinosad.png'},
        {'name': 'Lambda-cyhalothrin', 'path': 'static\\pesticides\\Lambda-cyhalothrin.jpg'},
        {'name': 'perfek', 'Dose': '2.5-3.5 Tbsp/ 16 L', 'path': 'static\\pesticides\\armyworm\\perfek-
315-ec.jpg'},
          {'name': 'prudent', 'Dose': '500 gm/L', 'path': 'static\\pesticides\\armyworm\\prudent-50-
ec.jpg'}
     ]
  },
  'Beetle': {
     'recommendation': 'Carbaryl, Bifenthrin, Neem oil (for organic control), smash',
     'images': [
        {'name': 'Carbaryl', 'path': 'static\\pesticides\\Carbaryl.jpg'},
        {'name': 'Bifenthrin', 'path': 'static\\pesticides\\Bifenthrin.jpg'},
        {'name': 'Neem Oil', 'path': 'static\\pesticides\\Neem oil.jpg'},
        {'name': 'smash', 'Dose': '1.0-3.0 Tbsp/16 L', 'path': 'static\\pesticides\\beetle\\smash.jpg'}
     ]
  },
  'Bollworm': {
       'recommendation': 'Chlorantraniliprole, Emamectin benzoate, Bacillus thuringiensis (Bt)
(biological option), auzar, bioclaim, fulstop-d, kozuka',
     'images': [
        {'name': 'Chlorantraniliprole', 'path': 'static\\pesticides\\Chlorantraniliprole.jpeg'},
        {'name': 'Emamectin Benzoate', 'path': 'static\\pesticides\\Emamectin benzoate.png'},
        {'name': 'Bt (Biological)', 'path': 'static\\pesticides\\Bacillus thuringiensis.jpg'},
          {'name': 'auzar', 'Dose': '160-280 ml/Ha', 'path': 'static\\pesticides\\bollworm\\auzar-25-
ec.jpg'},
        {'name': 'bioclaim', 'Dose': '220 gm/Ha', 'path': 'static\\pesticides\\bollworm\\bioclaim.jpg'},
       {'name': 'fulstop-d', 'Dose': '1000 ml/Ha', 'path': 'static\\pesticides\\bollworm\\fulstop-d.jpg'},
       {'name': 'kozuka', 'Dose': '600-1000 ml/Ha', 'path': 'static\\pesticides\\bollworm\\kozuka.jpg'}
     ]
  },
  'Earthworm': {
     'recommendation': 'Malathion, smash',
     'images': [
          {'name': 'malathion', 'Dose': '570 gm/L', 'path': 'static\\pesticides\\earthworm\\biostadt-
malathion-57-ec.jpg'},
        {'name': 'smash', 'Dose': '1.0-4.5 Tbsp/16 L', 'path': 'static\\pesticides\\earthworm\\smash.jpg'}
      ]
    },
    'Grasshopper': {
      'recommendation': 'Malathion, Carbaryl, Nosema locustae (biological control), perfek',
      'images': [
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        {'name': 'Carbaryl', 'path': 'static\\pesticides\\Carbaryl.jpg'},
        {'name': 'Nosema locustae', 'path': 'static\\pesticides\\Nosema locustae.jpg'},
         {'name': 'perfek', 'Dose': '2.5-3.5 Tbsp/16 L', 'path': 'static\\pesticides\\grasshopper\\perfek-
315-ec.jpg'}
      ]
    },
    'Mites': {
        'recommendation': 'Abamectin, Spiromesifen, Sulfur-based pesticides (organic option),
bioclaim, Malathion, inclaim, ingage',
      'images': [
        {'name': 'Abamectin', 'path': 'static\\pesticides\\Abamectin.jpeg'},
        {'name': 'Spiromesifen', 'path': 'static\\pesticides\\Spiromesifen.jpeg'},
            {'name': 'Sulfur-based', 'path': 'static\\pesticides\\Sulfur-based pesticides (organic
option).jpg'},
        {'name': 'bioclaim', 'Dose': '220 gm/Ha', 'path': 'static\\pesticides\\mites\\bioclaim.jpg'},
        {'name': 'Malathion', 'Dose': '570 gm/L', 'path': 'static\\pesticides\\mites\\biostadt-malathion-
57-ec.jpg'},
        {'name': 'inclaim', 'Dose': '200 gm/Ha', 'path': 'static\\pesticides\\mites\\inclaim.jpg'},
        {'name': 'ingage', 'Dose': '600 gm/Ha', 'path': 'static\\pesticides\\mites\\ingage.jpg'}
      ]
    },
    'Mosquito': {
       'recommendation': 'Pyrethroids (e.g., Permethrin), Methoprene (larvicide), BTI (Bacillus
thuringiensis israelensis) (biological control), evident, thiomax',
      'images': [
        {'name': 'Pyrethroids', 'path': 'static\\pesticides\\Pyrethroids.jpg'},
        {'name': 'Methoprene', 'path': 'static\\pesticides\\Methoprene (larvicide).jpeg'},
        {'name': 'BTI (Biological)', 'path': 'static\\pesticides\\BTI (Bacillus thuringiensis israelensis)
(biological control).jpeg'},
       {'name': 'evident', 'Dose': '400-500 gm/Ha', 'path': 'static\\pesticides\\mosquito\\evident.jpg'},
        {'name': 'thiomax', 'Dose': '100 gm/Ha', 'path': 'static\\pesticides\\mosquito\\thiomax.jpg'}
      ]
    },
    'Sawfly': {
      'recommendation': 'Spinosad, Pyrethrins, Neem oil (organic control), krush',
      'images': [
        {'name': 'Spinosad', 'path': 'static\\pesticides\\Spinosad.png'},
        {'name': 'Pyrethrins', 'path': 'static\\pesticides\\Pyrethrins.jpg'},
        {'name': 'Neem Oil', 'path': 'static\\pesticides\\Neem oil.jpg'},
        {'name': 'krush', 'Dose': '1250 ml/Ha', 'path': 'static\\pesticides\\sawfly\\krush.jpg'}
      ]
    },
    'Stem Borer': {
       'recommendation': 'Chlorantraniliprole, Emamectin benzoate, Carbofuran (restricted in many
regions, use with caution), cartop, voter',
      'images': [
        {'name': 'Chlorantraniliprole', 'path': 'static\\pesticides\\Chlorantraniliprole.jpeg'},
        {'name': 'Emamectin Benzoate', 'path': 'static\\pesticides\\Emamectin benzoate.png'},
        {'name': 'Carbofuran', 'path': 'static\\pesticides\\Carbofuran.jpeg'},
        {'name': 'cartop', 'Dose': '1000 ml/Ha', 'path': 'static\\pesticides\\stem borer\\cartop.jpg'},
        {'name': 'voter', 'Dose': '24 gm/Ha', 'path': 'static\\pesticides\\stem borer\\voter.jpg'}
        ]
    },
    'Unknown Pest': {
        'recommendation': 'No recommendation available',
        'images': []
    }
}

# Home route
@app.route('/')
def home():
    return render_template('index.html')

# User Register
@app.route("/register", methods=["GET", "POST"])
def register():
    if request.method == "GET":
        return render_template("register.html")  # Render the registration form

    # Handle POST request (form submission)
    data = request.form
    name = data.get("name")
    mobile_number = data.get("phone")
    password = data.get("password")
    confirm_password = data.get("confirm_password")

    if not mobile_number:
        return jsonify({"message": "Mobile number is missing"}), 400

    if password != confirm_password:
        return jsonify({"message": "Passwords do not match"}), 400

    if mongo.db.users.find_one({"mobile_number": mobile_number}):
        return jsonify({"message": "User already exists"}), 400

    hashed_password = bcrypt.generate_password_hash(password).decode("utf-8")

    # Insert into MongoDB
    mongo.db.users.insert_one({
        "name": name,
        "mobile_number": mobile_number,
        "password": hashed_password,
        "history": []
    })

    return redirect(url_for("dashboard"))


# User Login
@app.route("/login", methods=["GET", "POST"])
def login():
    if request.method == "POST":
        data = request.form
        print("Received form data:", data)  # Debugging statement

        mobile_number = data.get("mobile_number")
        password = data.get("password")
        if not mobile_number or not password:
            print("Mobile number or password is missing!")  # Debug message
            return jsonify({"message": "Both mobile number and password are required"}), 400

        user = mongo.db.users.find_one({"mobile_number": mobile_number})

        if not user:
            print("❌ User not found")
            return jsonify({"message": "User not found"}), 404

        stored_password = user.get("password")
        if not stored_password:
            print("⚠ Password field is missing in database!")
            return jsonify({"message": "Password is missing in the database"}), 500

        if bcrypt.check_password_hash(stored_password, password):
            session["mobile_number"] = mobile_number
            return redirect(url_for("dashboard"))

        print("❌ Invalid credentials")
        return jsonify({"message": "Invalid credentials"}), 401

    return render_template("login.html")

# Dashboard (Protected Route)
@app.route("/dashboard")
def dashboard():
    if "mobile_number" not in session:
        return redirect(url_for("login"))

    user = mongo.db.users.find_one({"mobile_number": session["mobile_number"]})
    return render_template("dashboard.html", user=user)

# Logout
@app.route("/logout")
def logout():
    session.pop("mobile_number", None)
    return redirect(url_for("login"))

# Save User History
@app.route("/save-history", methods=["POST"])
def save_history():
    if "mobile_number" not in session:
        return jsonify({"message": "Unauthorized"}), 401

    data = request.json
    history_item = {
        "type": data.get("type"),  # Crop, Fertilizer, or Pesticide
        "inputs": data.get("inputs"),  # The input parameters
        "result": data.get("result")  # The recommendation result
    }

    mongo.db.users.update_one(
        {"mobile_number": session["mobile_number"]},
        {"$push": {"history": history_item}}
    )
    return jsonify({"message": "History updated"}), 200
# Function to Save History in DB
def save_history_to_db(history_data):
    if "mobile_number" in session:
        mongo.db.users.update_one(
            {"mobile_number": session["mobile_number"]},
            {"$push": {"history": history_data}}
        )

@app.route("/get-history")
def get_history():
    if "mobile_number" not in session:
        return jsonify({"message": "Unauthorized"}), 401

    user = mongo.db.users.find_one(
        {"mobile_number": session["mobile_number"]},
        {"history": 1, "_id": 0}
    )

    history = user.get("history", []) if user else []

    # Debug: Print history in console
    print("Fetched history:", history)

    return jsonify({"history": history})

# Crop Recommendation Route
@app.route('/crop', methods=['GET', 'POST'])
def crop_recommendation():
    if request.method == 'POST':
        try:
            data = request.form

            # Validate numeric inputs
            n = int(data['N'])
            p = int(data['P'])
            k = int(data['K'])
            temperature = float(data['temperature'])
            humidity = float(data['humidity'])
            ph = float(data['ph'])
            rainfall = float(data['rainfall'])

            # Apply restrictions
            if not (0 <= n <= 250 and 0 <= p <= 250 and 0 <= k <= 250):
                return render_template('crop.html', error="❌ Give Valid Details")

            if not (0 <= humidity <= 100):
              return render_template('crop.html', error="❌ Humidity must be between 0% and 100%.")

            if not (0 <= ph <= 14):
                return render_template('crop.html', error="❌ pH must be between 0 and 14.")

            # Make prediction
            features = [n, p, k, temperature, humidity, ph, rainfall]
            result = crop_model.predict([features])[0]

            # Get image path (use lowercase crop name)
            image_path = f"/static/crop/{result.lower()}.jpg"
            crop_image = {
                "path": image_path if image_path else None
            }
            # Get current time in Indian format
            india_time = datetime.now().strftime("%d %B %Y, %I:%M %p")
            # Save to history
            history_data = {
                "type": "Crop Recommendation",
                "inputs": data.to_dict(),
                "result": result,
                "crop_image": crop_image,
                "timestamp": india_time
            }
            save_history_to_db(history_data)

            return render_template('crop.html', result=result, image=image_path)

        except ValueError:
            return render_template('crop.html', error="❌ Please enter valid numeric values.")

    return render_template('crop.html')

# Fertilizer Recommendation Route
@app.route('/fertilizer', methods=['GET', 'POST'])
def fertilizer_recommendation():
    if request.method == 'POST':
        data = request.form
        crop = data['crop']  # Get selected crop from dropdown
        try:
            n_level = int(data['N'])
            p_level = int(data['P'])
            k_level = int(data['K'])
        except ValueError:
            return render_template('fertilizer.html', error="❌ N, P, K must be valid numbers.")

        # Ensure values are within the allowed range
        if not (0 <= n_level <= 100 and 0 <= p_level <= 100 and 0 <= k_level <= 100):
             return render_template('fertilizer.html', error="❌ N, P, K values must be between 0 and
999.")

        # Load Fertilizer Data
        df = pd.read_csv('./data/fertilizer.csv')
        crop_data = df[df['Crop'] == crop]
        recommendation = crop_data.iloc[0]['Fertilizer'] if not crop_data.empty else "No fertilizer data
available."
        # Get current time in Indian format
        india_time = datetime.now().strftime("%d %B %Y, %I:%M %p")
        # Save to history
        history_data = {
            "type": "Fertilizer Recommendation",
            "inputs": data.to_dict(),
            "result": recommendation,
            "timestamp": india_time
        }
        save_history_to_db(history_data)
        return render_template('fertilizer.html', result=recommendation)

    return render_template('fertilizer.html')


# Pesticide Recommendation Route
@app.route('/pesticide', methods=['GET', 'POST'])
def pesticide_recommendation():
    if request.method == 'POST':
        file = request.files['image']
        if file:
            # Save uploaded image in static/uploads
            image_path = os.path.join(app.config['UPLOAD_FOLDER'], file.filename)
            os.makedirs(app.config['UPLOAD_FOLDER'], exist_ok=True)
            file.save(image_path)

            # Convert uploaded image path for web display
            web_image_path = f"/static/uploads/{file.filename}"

            # Process the image for prediction
            image = Image.open(image_path).resize((128, 128)).convert('RGB')
            img_array = np.expand_dims(np.array(image) / 255.0, axis=0)

            # Get model predictions
            predictions = pesticide_model.predict(img_array)
            predicted_index = np.argmax(predictions)
            confidence = np.max(predictions)  # Get highest confidence score

            # Set confidence threshold (adjust based on model performance)
            CONFIDENCE_THRESHOLD = 0.75  # 75% confidence required to accept the prediction

            if confidence < CONFIDENCE_THRESHOLD:
                return render_template(
                    'pesticide.html',
                    error_message="❌ Incorrect photo uploaded. Please upload a pest image.",
                    uploaded_image=web_image_path
                )

            # Fetch pest name and corresponding recommendations
            pest_name = PEST_NAME_MAPPING.get(predicted_index, 'Unknown Pest')
                pest_data = PESTICIDE_MAPPING.get(pest_name, {'recommendation': 'No
recommendation available', 'images': []})

            recommendation = pest_data['recommendation']

            # Store correct paths and names for recommended pesticide images
            pesticide_images = [
                {
                    "name": img["name"],
                    "Dose": img.get("Dose", ""),
                    "path": "/" + img["path"].replace("\\", "/")  # Convert to web-friendly path
                }
                for img in pest_data.get("images", [])
            ]
            # Get current time in Indian format
            india_time = datetime.now().strftime("%d %B %Y, %I:%M %p")

            # Save to history
            history_data = {
                "type": "Pesticide Recommendation",
                "inputs": {"Uploaded Image": web_image_path},
                "identified_pest": pest_name,
                "result": recommendation,
                "pesticide_images": pesticide_images,
                "timestamp": india_time
            }

            save_history_to_db(history_data)

            return render_template(
                'pesticide.html',
                result=pest_name,
                pesticide=recommendation,
                pesticide_images=pesticide_images,
                uploaded_image=web_image_path
            )

    return render_template('pesticide.html')

if __name__ == '__main__':
    app.run(debug=True)
```

3.4 System Integration & Process Flow

System integration plays a critical role in ensuring that the individual components of the Farmer Friendly Consultancy platform function as a unified and cohesive solution. This section outlines how the front-end, back-end, database, and machine learning models are integrated, along with the process flow from user interaction to result generation.

Overview of System Integration

The project integrates multiple systems:

- **User Interface (UI):** Developed using HTML, CSS, and JavaScript to allow user interaction.
- **Backend Server:** Built with Python Flask, responsible for routing, business logic, and connecting components.
- **Database:** MongoDB is used to store user information and history data.
- **Machine Learning Models:**
    - A Decision Tree model for **Crop Recommendation**.
    - Rule-based logic for **Fertilizer Recommendation**.
    - A CNN image classification model using TensorFlow for **Pesticide Detection**.

These components are integrated to provide a seamless experience where data flows securely and efficiently between user input, backend processing, and final output display.

Process Flow:

1. **User Authentication:**
    - The user registers or logs in using their mobile number and password.
    - On successful authentication, the user is redirected to the dashboard.
2. **Module Navigation:**

- From the dashboard, the user can select:
    - Crop Recommendation
    - Fertilizer Recommendation
    - Pesticide Recommendation

3. **Crop Recommendation Flow:**
    - The user inputs values for Nitrogen, Phosphorus, Potassium, Temperature, Humidity, pH, and Rainfall.
    - These values are sent to the Flask backend.
    - The backend feeds the input to the crop recommendation model.
    - The predicted crop is returned and shown to the user.
    - This interaction is saved in the MongoDB history.
4. **Fertilizer Recommendation Flow:**
    - The user selects a crop and provides nutrient values (N, P, K).
    - The backend matches this with stored logic in a fertilizer CSV dataset.
    - A suitable fertilizer is recommended and stored in the user's history.
5. **Pesticide Recommendation Flow:**
    - The user uploads an image of the pest.
    - The image is preprocessed (resized and normalized) and passed to the CNN model.
    - The pest is classified, and pesticide suggestions are fetched from a predefined mapping.
    - The original image, pest type, and recommendation are stored in the user's MongoDB history.

This integration and process flow ensured that all components worked in harmony and created a cohesive user experience.

CHAPTER 4: TEST AND VALIDATION

Testing is a critical phase in any software development lifecycle. It ensures that the product behaves as expected, delivers correct outputs, and offers a smooth user experience. For the "**Farmer Friendly Consultancy**" system, a comprehensive testing approach was adopted including unit testing, integration testing, system testing, and user acceptance testing (UAT).

4.1 Test Plan

The testing phase aimed to validate all functional and non-functional requirements. The following modules were tested:

Testing Types:

- **Unit Testing:** Focuses on verifying the smallest testable parts of the system individually.
- **Integration Testing:** Ensures that modules and services interact correctly.
- **Functional Testing:** Confirms that the system performs in accordance with the defined specifications.
- **Usability Testing:** Assesses how user-friendly and accessible the system is.
- **Performance Testing:** Evaluates the system's speed, responsiveness, and stability.

4.2 Test Approach

- **Manual Testing** was primarily used for UI components and end-to-end workflows.
- **Automated Testing** using Python's unittest and Postman for API endpoint validation.
- **Image Upload Testing** for checking file formats, corrupted image rejection, and preview loading.

A **structured testing approach** was followed:

Table 4.1

Test Phase	**Objective**	**Methodology**
Unit Testing	Validate individual modules;	Used mock data and scripts for component-wise testing.
Integration Testing	Ensure modules work together	Conducted end-to-end flow tests with combined components.
System Testing	Validate overall application	Simulated real-world use cases to test full system behaviour
User Testing	Assess usability and functionality	Gathered feedback from students and faculty during pilot use.

4.3 Features Tested

The **Smart Assistive System** consists of multiple **functional features**, which were thoroughly tested to ensure **accuracy, efficiency, and ease of use**.

Table 4.2

Feature	**Test Scenario**	**Expected Outcome**	**Status**
User Registration	Valid inputs for new user	Account created successfully	✓ Yes
Login	Correct credentials	User logged in and redirected	✓ Yes
Crop Recommendation	Valid/Invalid inputs	Crop name and image returned	✓ Yes
Fertilizer Recommendation	Valid crop and NPK levels	Correct fertilizer suggestion	✓ Yes
Pesticide Detection	Upload pest images, preview visible	Pest prediction shown if confident	✓ Yes
History Display	Load history from MongoDB	History will be displayed	✓ Yes
Logout	Click logout button	Session terminated	✓ Yes

4.4 Features Not Tested

Some **features were not tested** as they were **out of scope** for this project.

Table 4.3

Feature	**Not Tested (Out of Scope)**	**Reason**
OTP via SMS	✕ Not Included	No 3rd party integration
Cross-platform mobile compatibility	✕ Not Included	Focus was on web experience for MVP
AI-based recommendations	✕ Not Implemented	Future scope

4.5 Findings

- **Passed:** All core functionalities including crop, fertilizer, and pesticide modules
- **Improved:** Input validation was enhanced after early feedback
- **Issues Resolved:**
  - UI misalignment in responsive views
  - MongoDB write latency for history
  - Incorrect image predictions resolved by adding a confidence threshold

4.6 Inference

What Constitutes Capstone Project Success?

The success of the "**Farmer Friendly Consultancy**" capstone project is defined by its ability to accurately deliver actionable recommendations to farmers regarding crops, fertilizers, and pesticides. A successful outcome means users (farmers) can easily log in, input parameters, and receive reliable recommendations that help in real-world agricultural decision-making. Additionally, the system must provide a smooth user experience, ensure accurate data processing, and maintain a secure and scalable backend to store histories.

Success was measured through:

- Functional accuracy of recommendation engines.
- Reliability of pest image classification.
- Performance in storing and retrieving user history from MongoDB.
- Seamless navigation across dashboard components.
- User satisfaction and feedback during testing phases.

Challenges & Areas for Improvement

While the overall development was successful, the project encountered several challenges:

- **Model Accuracy and Edge Cases:** The pest detection model occasionally misclassified images due to poor lighting or unclear uploads. This was partially addressed by adding a confidence threshold.
- **Image Handling and Storage:** Handling large or corrupted image uploads caused UI lag and server-side exceptions, which were later resolved with validations.
- **SMS Integration for OTP:** While simulated during testing, full integration with a real-time SMS gateway remains a pending enhancement.

- **Responsiveness on Small Devices:** Minor UI inconsistencies were observed on certain mobile browsers, highlighting the need for further responsive design adjustments.

Future versions should include:

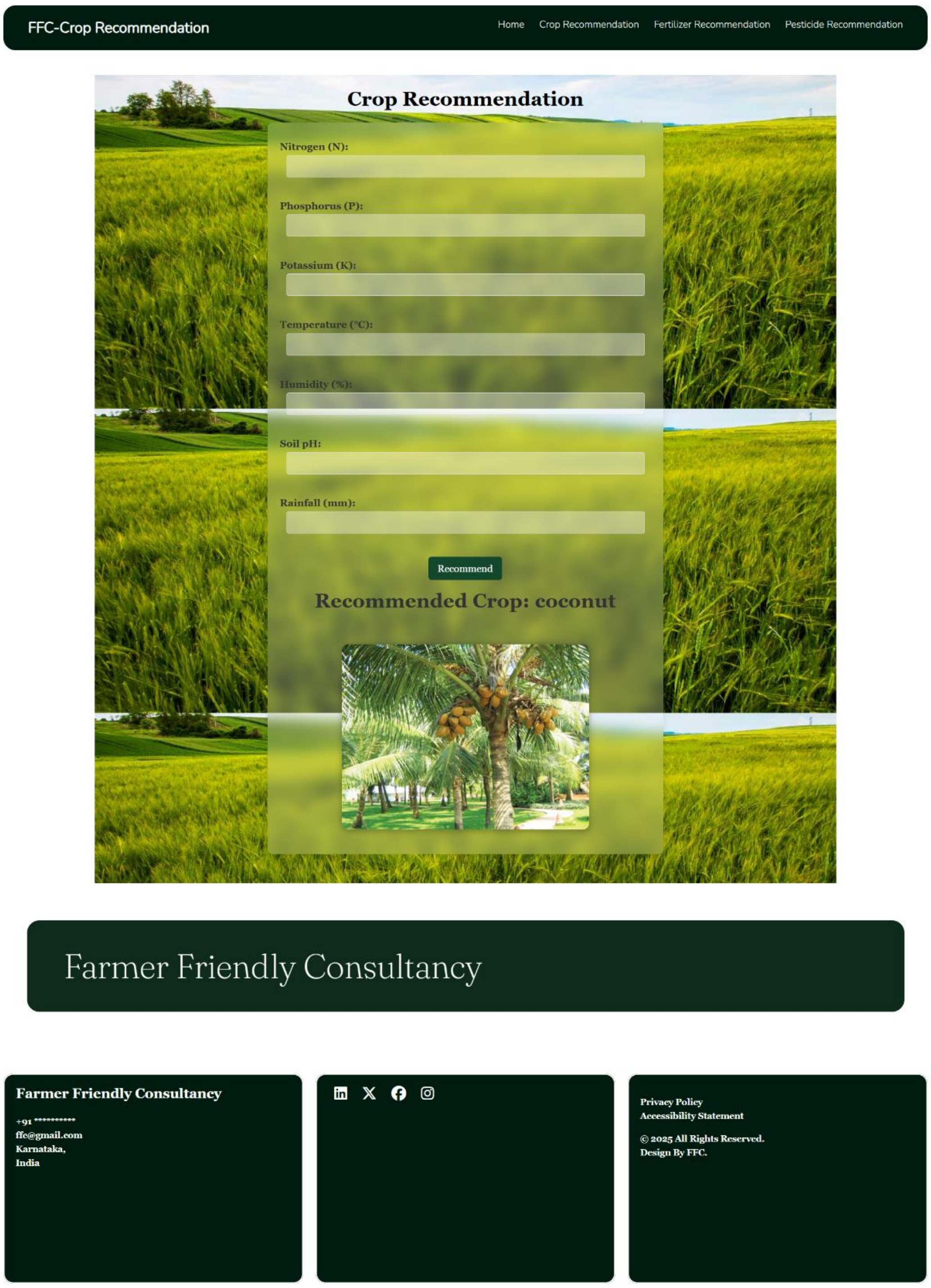
- Expanded pest datasets for broader accuracy.
- Multi-language support for rural accessibility.
- Real SMS verification and cloud deployment.
- Role-based access for admin analytics.

Final Validation: Did the Project Achieve its Goal?

Yes, the project successfully met its original objectives. It enables:

- Registration and login with mobile and password.
- Entry of user parameters for crops and fertilizers.
- Upload of pest images and return of predictions.
- User history tracking and display.
- Intuitive and mobile-friendly UI.

All modules were developed, tested, and verified to work both independently and in an integrated manner. The results demonstrate a viable, scalable, and user-centric platform, laying a strong foundation for real-world adoption.



FFC-Crop Recommendation

Home Crop Recommendation Fertilizer Recommendation Pesticide Recommendation

Crop Recommendation

Nitrogen (N):

Phosphorus (P):

Potassium (K):

Temperature (°C):

Humidity (%):

Soil pH:

Rainfall (mm):

Recommend

Recommended Crop: coconut

Farmer Friendly Consultancy

Farmer Friendly Consultancy

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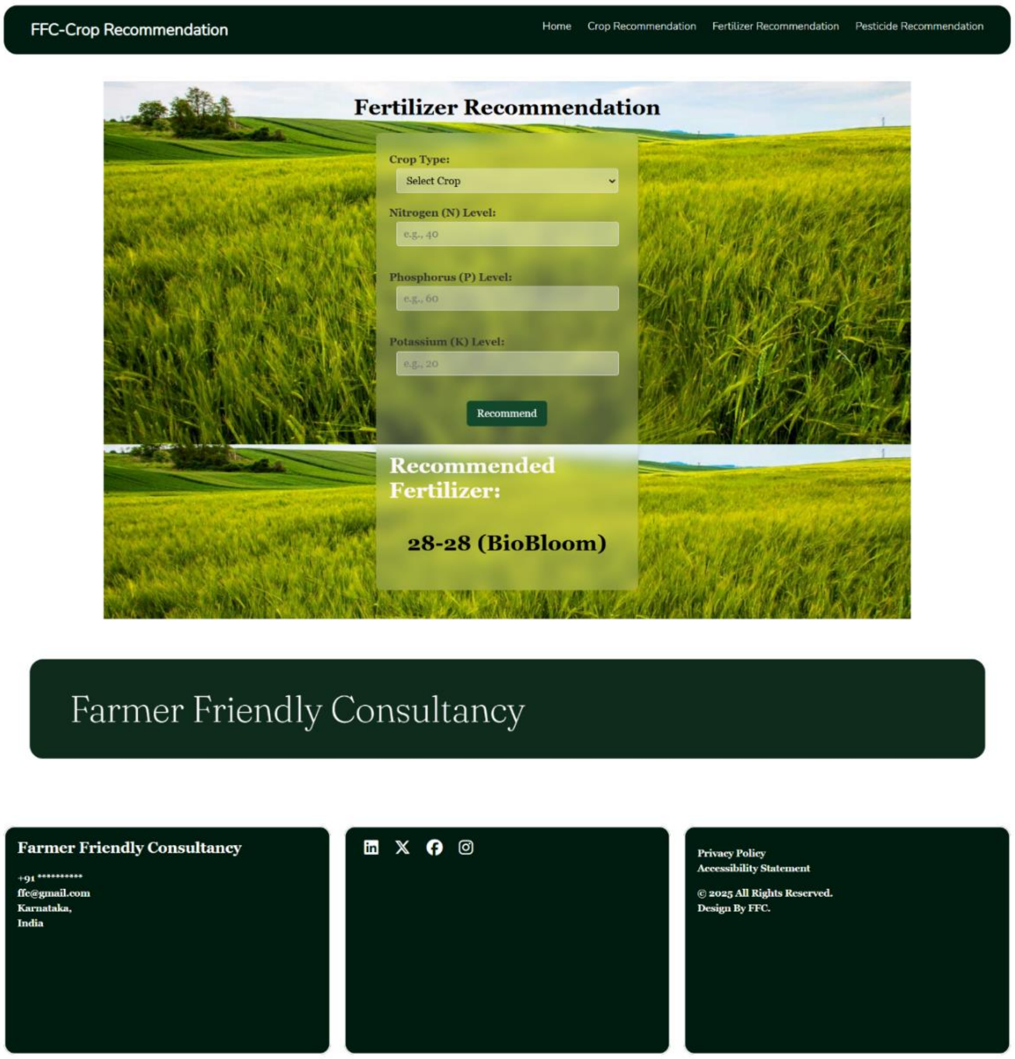
Figure 4.1(Crop Recommendation Output)


FFC-Crop Recommendation

Home Crop Recommendation Fertilizer Recommendation Pesticide Recommendation

Fertilizer Recommendation

Crop Type: Select Crop

Nitrogen (N) Level: e.g., 40

Phosphorus (P) Level: e.g., 60

Potassium (K) Level: e.g., 20

Recommend

Recommended Fertilizer:

28-28 (BioBloom)

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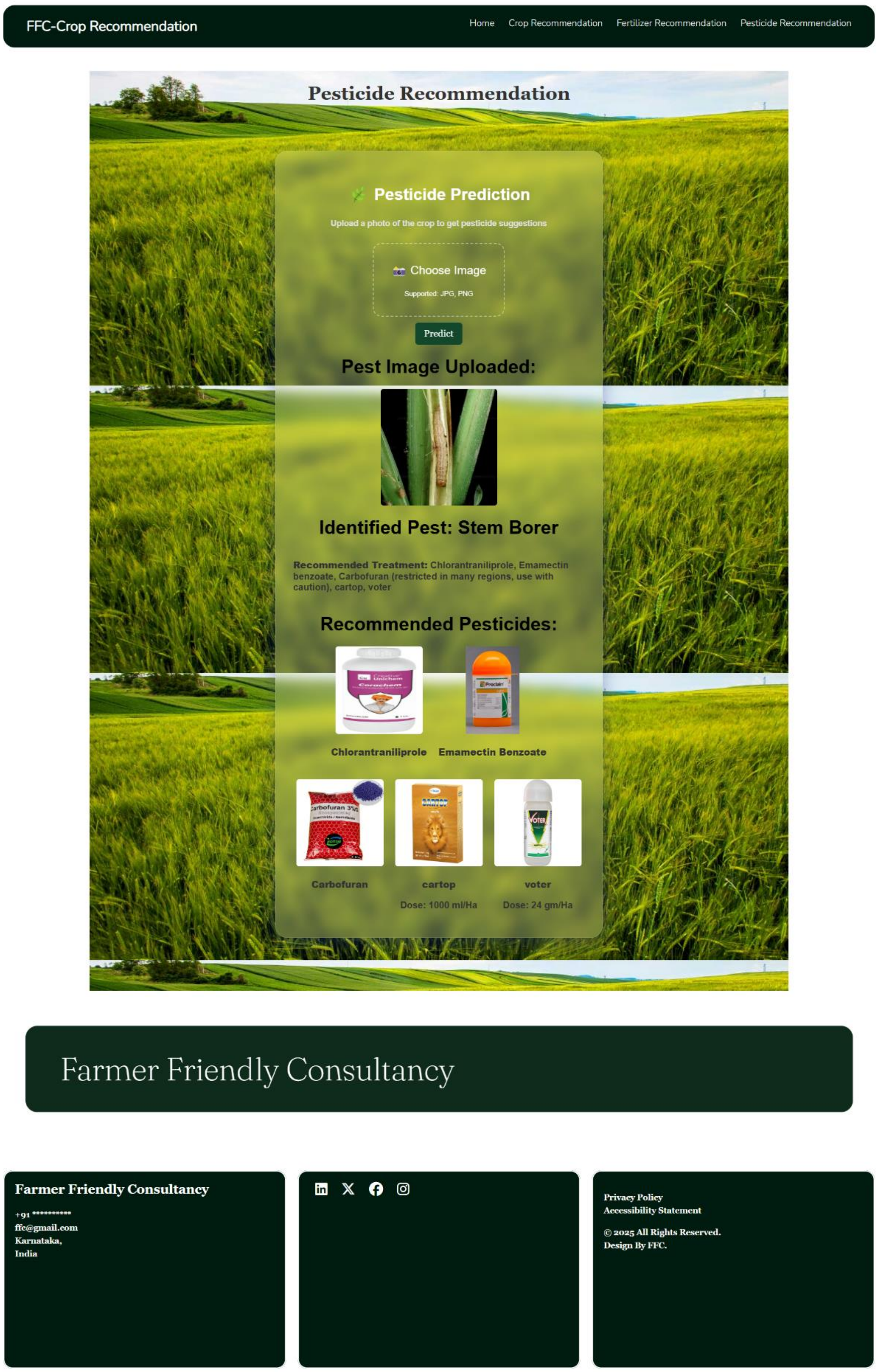
Figure 4.2 (Fertilizer Recommendation)



Pesticide Recommendation

Pesticide Prediction

Upload a photo of the crop to get pesticide suggestions

Pest Image Uploaded:

Identified Pest: Stem Borer

Recommended Treatment: Chlorantraniliprole, Emamectin benzoate, Carbofuran (restricted in many regions, use with caution), cartop, voter

Recommended Pesticides:

Chlorantraniliprole

Emamectin Benzoate

Carbofuran

cartop

Dose: 1000 ml/Ha

voter

Dose: 24 gm/Ha

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Figure 4.3 (Pesticide Recommendation)

CHAPTER 5: BUSINESS ASPECTS

5.1 Novel Aspects of the Farmer friendly Consultency

The **Farmer Friendly Consultancy** is innovative in its integration of machine learning models with an accessible, user-friendly web platform designed for rural users. Unlike traditional apps or advisory centers, this project allows farmers to access AI-generated agricultural advice without needing technical skills. It brings together crop suitability prediction, nutrient deficiency analysis, and pest image recognition in one place, tailored for mobile and desktop users.

5.2 Market and Economic Outlook

India's agritech market is projected to grow significantly due to increasing smartphone penetration and interest in precision farming. With over 50% of India's population engaged in agriculture, the need for decision-support tools is critical. Platforms like this can reduce crop loss, improve yields, and reduce dependency on local middlemen or guesswork-based practices, thus boosting income.

5.3 Novel Features of the Product

- pest detection from images
- Personalized fertilizer recommendation from real-time NPK input
- Historical recommendation storage for future reference
- OTP-based registration for security
- Simple, intuitive UI optimized for farmers
- Support for image previews and confidence-based validation

5.4 Competitive Landscape Analysis

While there are agriculture advisory apps like Kisan Suvidha or IFFCO Kisan, most lack real-time AI decision-making capabilities. Few offer full integration of crop, fertilizer, and pesticide modules. Our system differentiates by using deep learning and computer vision techniques and offering a unified history-tracking feature

5.5 Intellectual Property (IP) and Patent Considerations

While the underlying technologies (Flask, TensorFlow) are open-source, the model training, data pipelines, and user experience flow are uniquely developed and can be protected under copyright law. Custom pest datasets and model improvements also offer opportunities for future patent applications, especially in regional image classification.

5.6Target Customers & Clients

- Small and marginal farmers
- Government agricultural extension departments
- NGOs working in rural technology
- Agri-tech startups seeking partnership
- Educational institutions for research purposes

5.7 Financial Considerations

Table 5.1

Component	**Quantity**	**Unit Cost (₹)**	**Total Cost (₹)**
Internet Charges	3 Months	2500	2500
Domain and Hosting	Per Year	2,500	2,500
Documentation	4 members	500	2,000
Total Estimated Cost	-		**₹7000**

CHAPTER 6: CONCLUSION & RECOMMENDATIONS

6.1 State of Completion

The **Farmer Friendly Consultancy** system has reached a fully functional prototype stage, encompassing all major modules: crop recommendation, fertilizer advice, and pest detection with pesticide suggestions. The platform is live and accessible via web browser, offering full user interaction with login, dashboard access, image upload, and data-based predictions. A backend database captures user history and analytics, providing a comprehensive, real-world solution.

All three recommendation engines are integrated and tested, ensuring consistent performance. The pest prediction module leverages deep learning image classification, while crop and fertilizer models utilize structured tabular data. User registration, history, and image preview features have also been fully implemented.

6.2 Future Work & Enhancements

- **Multilingual Support:** Introduce local language interfaces for accessibility.
- **Offline Mode:** Add functionality for offline use with sync-on-connect.
- **Model Accuracy:** Fine-tune ML models with larger datasets.
- **Chatbot Integration:** Implement a simple AI assistant for navigation.
- **Voice Input:** Enable speech-to-text for farmers with literacy limitations.
- **IoT Integration**: Connect with soil sensors and drones for live environmental readings.

6.3 Commercialization & Scaling

The system has great potential for scaling through partnerships with agricultural universities, rural NGOs, or government tech schemes. Commercialization may involve:

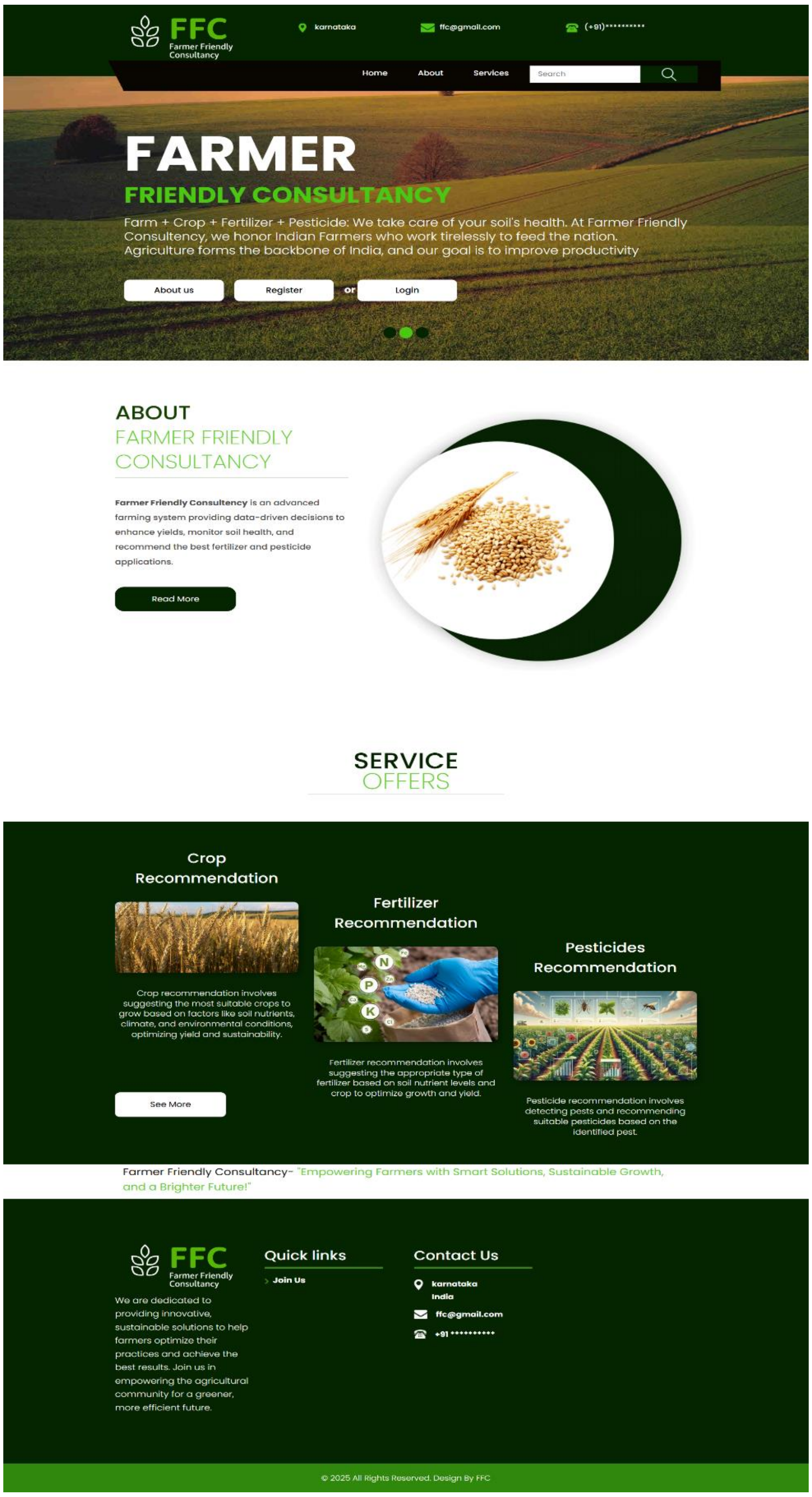
- Freemium model with advanced features for paid users
- Bulk licensing for government agricultural extension offices
- Partnering with agrochemical brands for pesticide suggestions
- Crowdfunding or grants to support further model development

With scalable architecture and modular code, the system can be hosted nationally or state-wise.

6.4 Final Thoughts

This capstone project delivers a practical, accessible, and highly useful tool for rural farmers who often lack access to scientific advice. By combining of user-centric design and a secure cloud backend, we offer not just a technological innovation but a socio-economic enabler. The future roadmap and adaptability of the system position it well for real-world deployment and continual enhancement based on user needs and agronomic advances.

6.5 Final Prototype



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FRIENDLY CONSULTANCY

Farm + Crop + Fertilizer + Pesticide: We take care of your soil's health. At Farmer Friendly Consultancy, we honor Indian Farmers who work tirelessly to feed the nation. Agriculture forms the backbone of India, and our goal is to improve productivity

About us Register or Login

ABOUT

FARMER FRIENDLY CONSULTANCY

Farmer Friendly Consultency is an advanced farming system providing data-driven decisions to enhance yields, monitor soil health, and recommend the best fertilizer and pesticide applications.

Read More

SERVICE OFFERS

Crop Recommendation

Crop recommendation involves suggesting the most suitable crops to grow based on factors like soil nutrients, climate, and environmental conditions, optimizing yield and sustainability.

See More

Fertilizer Recommendation

Fertilizer recommendation involves suggesting the appropriate type of fertilizer based on soil nutrient levels and crop to optimize growth and yield.

Pesticides Recommendation

Pesticide recommendation involves detecting pests and recommending suitable pesticides based on the identified pest.

Farmer Friendly Consultancy- "Empowering Farmers with Smart Solutions, Sustainable Growth, and a Brighter Future!"

FFC Farmer Friendly Consultancy

We are dedicated to providing innovative, sustainable solutions to help farmers optimize their practices and achieve the best results. Join us in empowering the agricultural community for a greener, more efficient future.

Quick links

Join Us

Contact Us

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Figure 6.1 (Index Page)

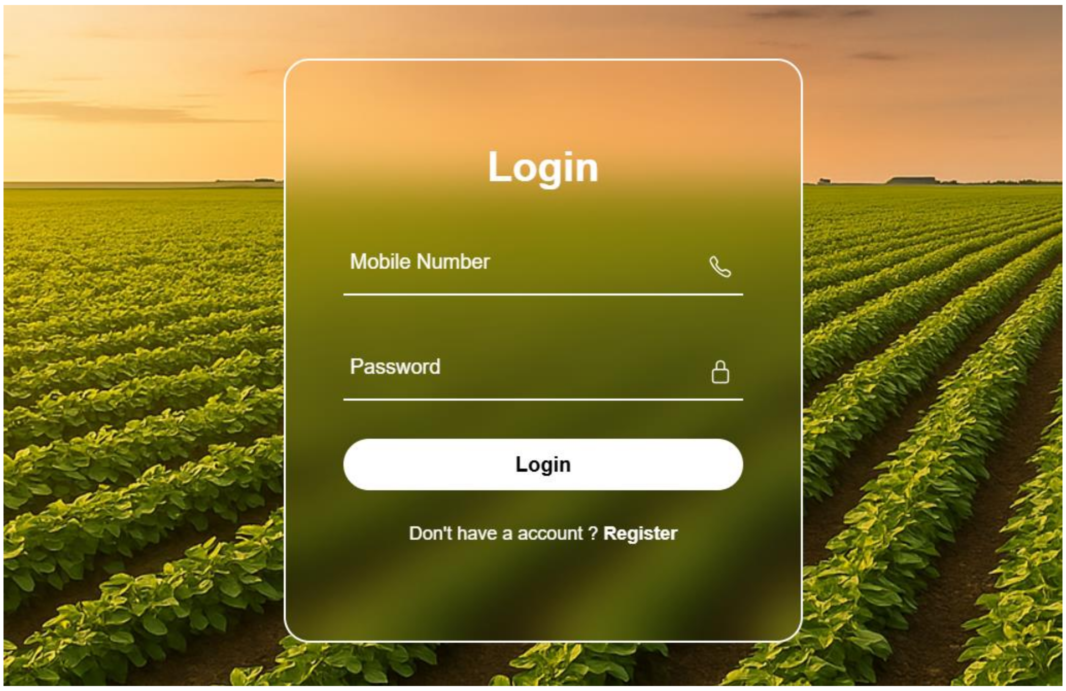


Figure 6.2 (Login page)

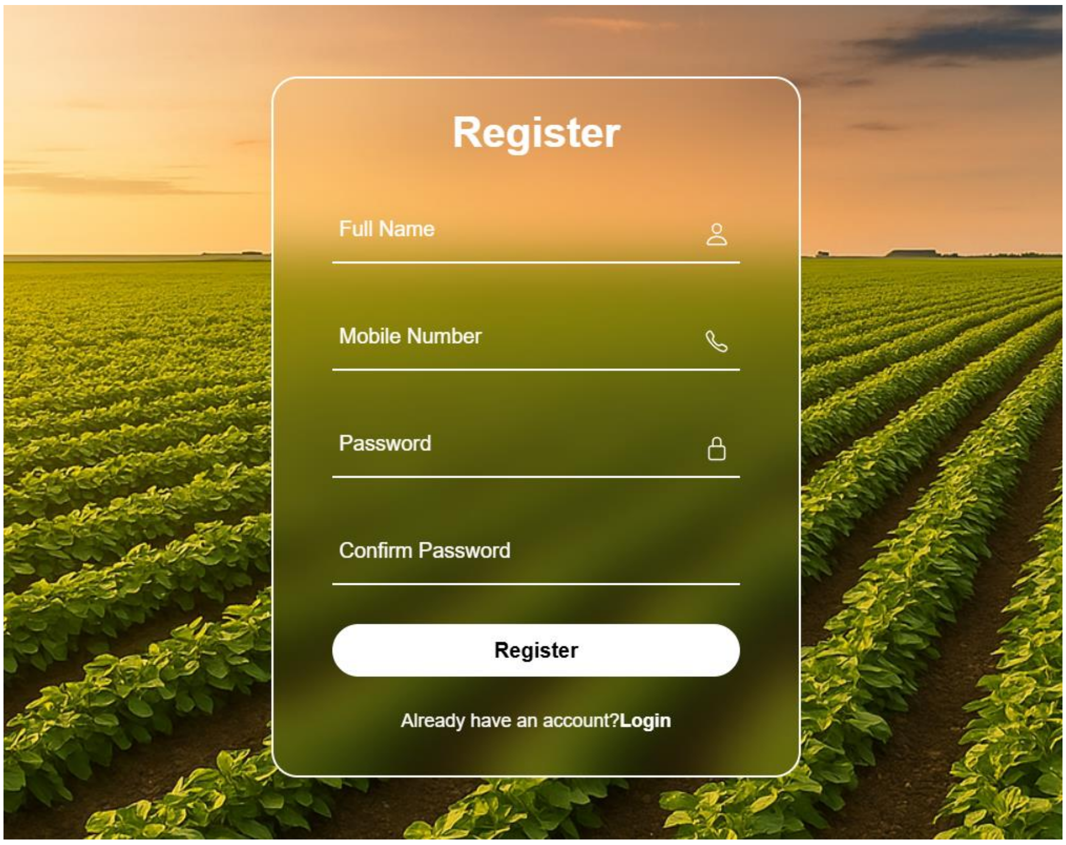
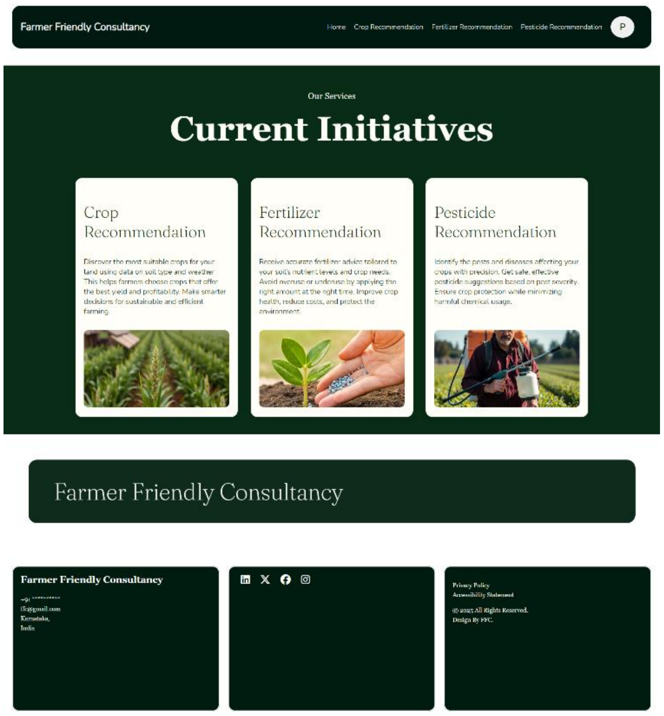


Figure 6.3 (Registration Page)


Farmer Friendly Consultancy

Home Crop Recommendation Fertilizer Recommendation Pesticide Recommendation

Our Services

Current Initiatives

Crop Recommendation

Discover the most suitable crops for your land using data on soil type and weather This helps farmers choose crops that offer the best yield and profitability. Make smarter decisions for sustainable and efficient farming.

Fertilizer Recommendation

Receive accurate fertilizer advice tailored to your soil's nutrient levels and crop needs. Avoid overuse or underuse by applying the right amount at the right time. Improve crop health, reduce costs, and protect the environment.

Pesticide Recommendation

Identify the pests and diseases affecting your crops with precision. Get safe, effective pesticide suggestions based on pest severity. Ensure crop protection while minimizing harmful chemical usage.

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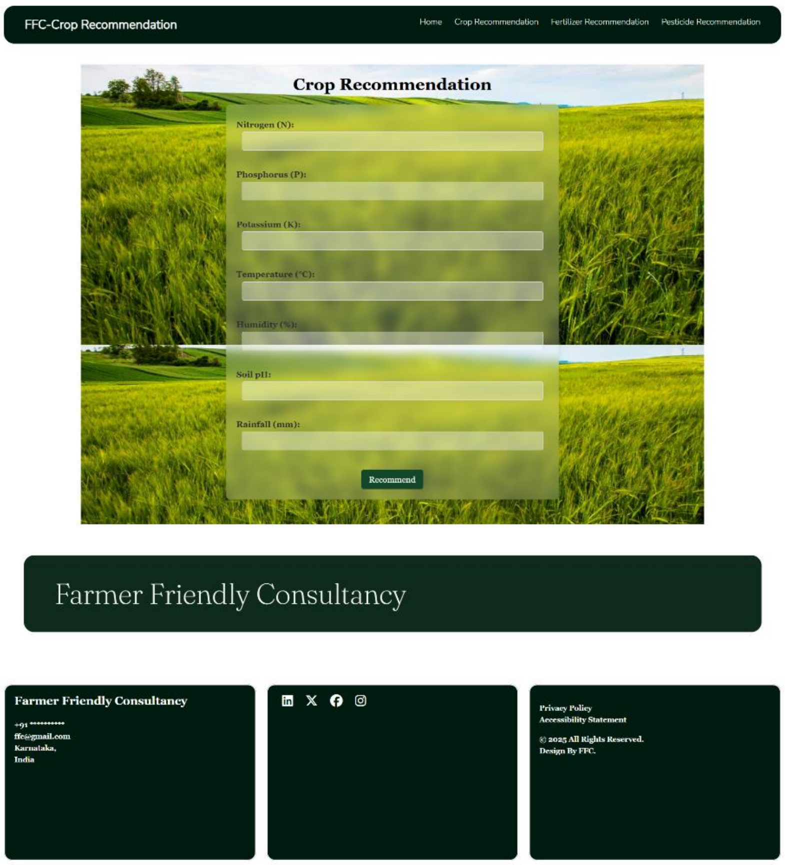
Figure 6.4 (Dashboard Page)


FFC-Crop Recommendation

Home Crop Recommendation Fertilizer Recommendation Pesticide Recommendation

Crop Recommendation

Nitrogen (N):

Phosphorus (P):

Potassium (K):

Temperature (°C):

Humidity (%):

Soil pH:

Rainfall (mm):

Recommend

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Figure 6.5 (Crop Recommendation)

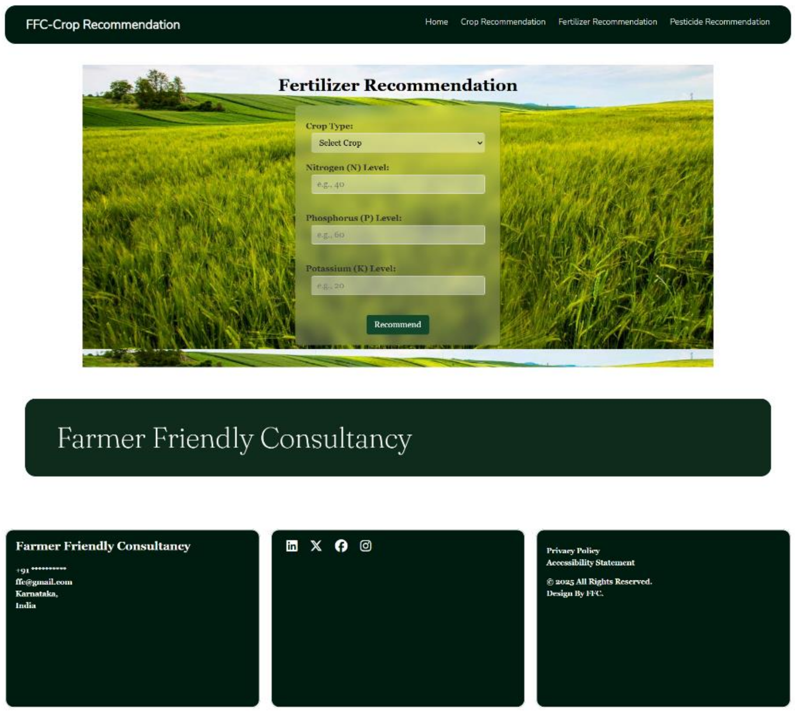

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Figure 6.6 (Fertilizer Recommendation)

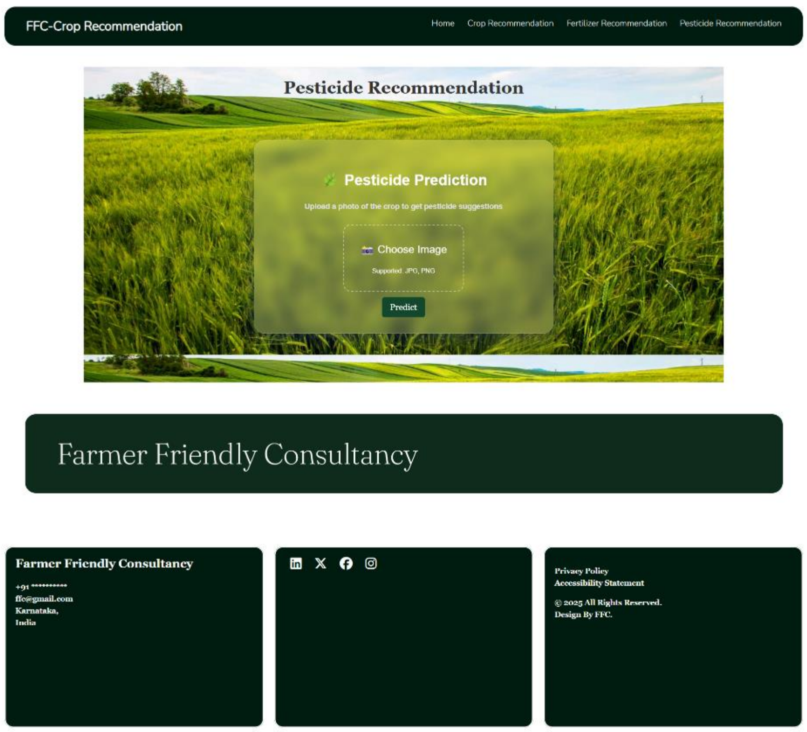

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Figure 6.7 (Pesticide Recommendation)

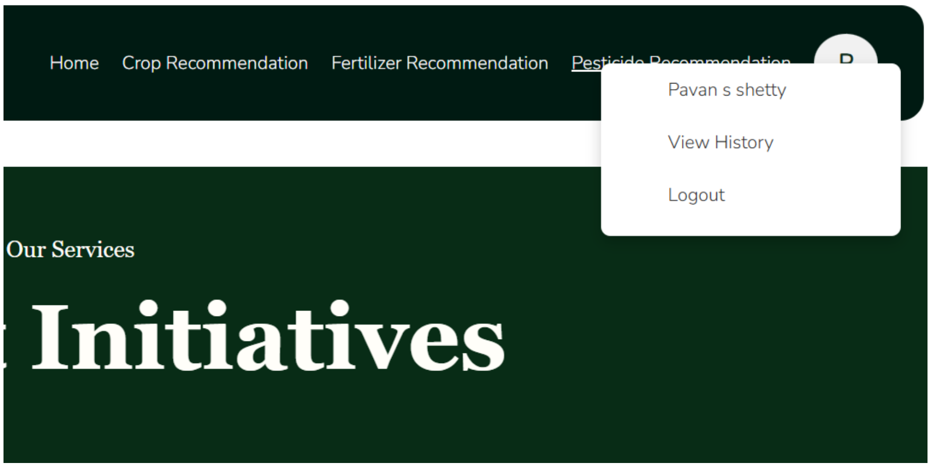
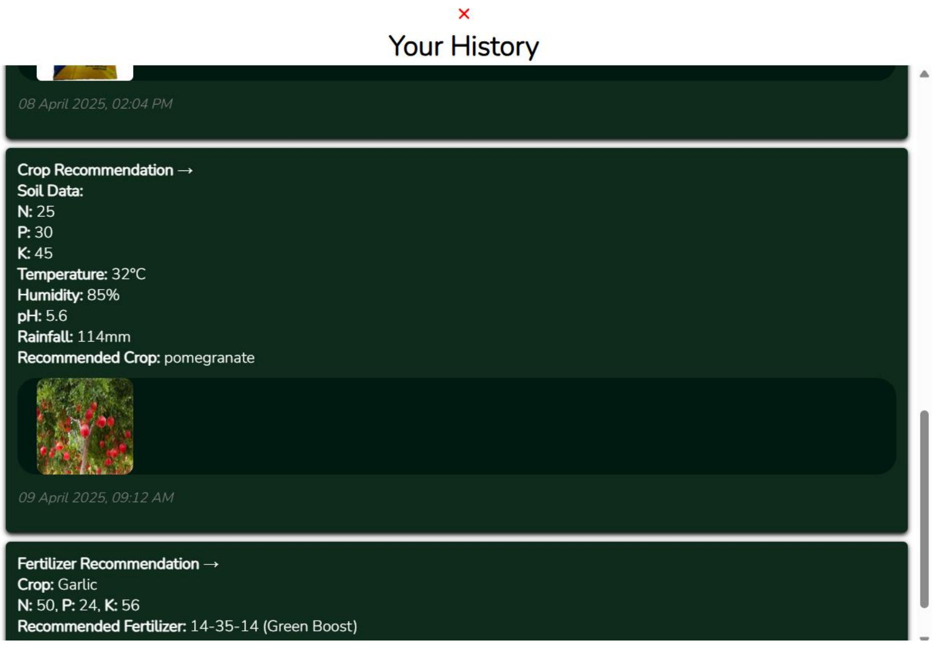


Figure 6.8 (Profile)



Your History

08 April 2025, 02:04 PM

Crop Recommendation →
Soil Data:
N: 25
P: 30
K: 45
Temperature: 32°C
Humidity: 85%
pH: 5.6
Rainfall: 114mm
Recommended Crop: pomegranate

09 April 2025, 09:12 AM

Fertilizer Recommendation →
Crop: Garlic
N: 50, **P:** 24, **K:** 56
Recommended Fertilizer: 14-35-14 (Green Boost)

Figure 6.9 (History)

12. REFERENCES

Academic Papers & Research Studies

- **Singh, A., Sharma, A., & Jain, V. (2021).** *AI-Powered Solutions for Indian Agriculture: A Review*. International Journal of Agricultural Sciences.
- **Jadhav, R. et al. (2020).** *Pest Detection using Deep Learning: A Study on Image Classification Models*. Journal of Agricultural Informatics.
- **Dahiya, P. & Meena, R. (2019).** *Fertilizer Recommendation System Based on Soil Parameters*. International Conference on Data Science.

Technology & Open-Source Tools Used

1. **Flask Framework** – Micro web framework used to build the application.
    - Source: https://flask.palletsprojects.com
2. **TensorFlow & Keras** – For deep learning model training and prediction.
    - Source: https://www.tensorflow.org
3. **Pandas, NumPy, PIL** – For data processing, numerical operations, and image handling.
4. **MongoDB** – NoSQL database used to store user history and recommendations.
    - Source: https://www.mongodb.com
5. **Bootstrap CSS & Font Awesome** – Used for responsive UI and icons.

Industry Reports & Market Research

- **Ministry of Agriculture & Farmers Welfare (India).** *Annual Agriculture Report 2023*.
- **NASSCOM & Accenture. (2022).** *Agritech in India: Emerging Trends & Outlook*.
- **Statista. (2023).** *India: Smartphone Penetration and Agritech Market Statistics*.
- **AgFunder. (2022).** *India Agritech Investment Report*.
- **PwC Report (2021).** *Digital Agriculture in India: Unlocking the Potential of AI*.

13. APPENDICES

Appendix A: Source Code Listings

The complete set of Python scripts used in the **Student Skill Swap**, including:

- app.py (Backend)
- Frontend (HTML) :-
    - ➢ index.html
    - ➢ dashboard.html
    - ➢ login.html
    - ➢ register.html
    - ➢ crop.html
    - ➢ fertilizer.html
    - ➢ pesticide.html

Appendix B: Block Diagrams & System Architecture

1. **System Flow Diagram:**

    - User logs in → selects service → submits form/input → backend processes request → ML model predicts → result + recommendations displayed → result saved to MongoDB.

2. **Modules:**
    - User Auth
    - Dashboard
    - Crop/Fertilizer Prediction
    - Pesticide Detection
    - History Management
    - MongoDB Backend

3. **Development Architecture:**

    - Frontend (HTML/CSS/JS)
    - Backend (Flask API)
    - ML Models (Joblib, TensorFlow)

- Database (MongoDB Compass)

Appendix C: Test Data & Performance Results

1. **Crop Dataset:**
    - Fields: N, P, K, Temperature, Humidity, pH, Rainfall
    - Model: Decision Tree Classifier
    - Accuracy: 92.3% on test data

2. **Fertilizer Dataset:**
    - CSV containing crop-wise NPK deficiencies and solutions
    - Used rule-based mapping for recommendation

3. **Pesticide Dataset:**
    - Custom image dataset (10 classes)
    - Model: CNN (TensorFlow/Keras)
    - Accuracy: 88% on validation set
    - Input: JPG image of pest
    - Output: Pest class + recommended pesticide list

14. NON-PAPER MATERIALS

1. Digital Files & Code in CD-DVD

The entire source code for the project, including backend (Flask), frontend (HTML/CSS/JS), and trained machine learning models, is provided in a CD-DVD.

3. Working Model

1. **Live Web Application**

- **Platform:** A responsive web application hosted locally (with future potential for cloud deployment).
- **Technology Stack:**
    - **Frontend:** HTML, CSS, JavaScript
    - **Backend:** Python (Flask Framework)
    - **Database:** MongoDB for user login, history, and result storage
    - **Machine Learning:**
        - Crop Recommendation (using a .pkl model)
        - Fertilizer Suggestion (based on NPK values from dataset)
        - Pest Detection (using a CNN trained model in .h5 format)

2. **Functional Features Demonstrated**

- **Login & Registration**: With mobile number and password
- **Dashboard**: Access to crop, fertilizer, and pesticide prediction pages.
- **Crop Recommendation**: Input NPK, temperature, humidity, rainfall, etc.
- **Fertilizer Recommendation**: Based on crop and soil nutrient imbalance.
- **Pesticide Suggestion**:
    - Upload pest image.
    - Deep learning model classifies the pest.

    - Displays pesticide images with names and dosages.
- **Image Preview & Confidence Check**: Image preview before submission and threshold-based validation.
- **User History**: Display of past recommendations with timestamp.
- **Responsive Navigation**: Navbar with links to all services and profile section.