International Journal of Innovative Research in Computer Science and Technology (IJIRCST)
ISSN (Online): 2347-5552, Volume-14, Issue-1, January 2026
DOI: https://doi.org/10.55524/ijircst.2026.14.1.9
Article ID IRP-1700, Pages 71-78
www.ijircst.org

A Climate-Resilient Agriculture Framework Using Machine Learning and Web-Based Decision Support Systems

Pradeep GS[1], Amshu HU[2], Apoorva Bhagwath[3], Ashwath S[4], and Manu Sagar[5]

[1]Assistant Professor, Department of Computer Science & Engineering, SDM Institute of Technology, Ujire, Karnataka, India
[2, 3, 4, 5] BE Scholar, Department of Computer Science and Engineering, SDM Institute of Technology, Ujire, Karnataka, India

Correspondence should be addressed to Pradeep GS; pradeepgs@sdmit.in

Received: 19 November 2025 Revised: 7 December 2025 Accepted: 2 January 2026

ABSTRACT- This result suggests the new model helps farms adapt to climate shifts by cutting down on crop dangers, boosting planning precision, one step at a time. This system provides practical benefits and recommends through a user-friendly interface accessible on low-bandwidth networks. Crop disease detection, weather-based crop recommendation, and market trend analysis, along with a multilingual chatbot for farmer assistance is integrated by machine learning models in this proposed system. Plant diseases from leaf images are identified by using Convolutional Neural Networks, while regression and time-series models assist in climate and market analysis. Agricultural production face challenges in farming due to climate change, irregular rainfall, rising temperatures, frequent pest outbreaks, and changing market conditions. This paper clearly gives the insights about the web-based climate-resilient agriculture system designed to support informed decision-making using data-driven techniques.

KEYWORDS- Machine Learning, Agriculture, Sustainable Farming, Weather Forecasting, Climate Resilience

I. INTRODUCTION

Data regarding market prices, disease symptoms, soil health, and weather condition is of available or difficult to collect. As a result, based on farmer's experience, they are forced to make choices which is not suitable in every climatic situation.

To resolve this gap, recent developments offer chances in machine learning and artificial intelligence. By combining predictive analysis in a web-based platform, it is possible to deliver the reliable agricultural advice in adaptive manner. These factors have increased the risk of the farmers and reduced the use of traditional and effective methods in agriculture. The system is mainly designed to approach these problems by integrating weather forecasting, disease detection, crop recommendation, and multilingual advisory support into a single platform. Many farmers still have a limited access to location-specific and timely information, despite advancement in agricultural research. As we know that, agriculture in India is the primary source of income. It is essential to preserving both economic stability and food security. However, agricultural productivity is impacting by climate-related uncertainties such as temperature, erratic rainfall, droughts and spread of crop disease.

II. LITERATURE REVIEW

Some research has explored how tech might help farming withstand challenges better:

- Farming that can handle shifting weather patterns matters more now because climates change faster than before. Because of this shift, keeping soil healthy, growing different crops, using water wisely helps farms last longer – Lal [2] pointed that out clearly. Planning around climate data plus making smart use of resources shapes how well farmers adapt, says a guide by the FAO [3]. Ways to cut emissions while feeding people come into play when land and weather knowledge combine.
- Farmers facing shifting weather patterns were examined by Thornton and Herrero [4], who found forecasting methods plus guidance systems can strengthen food production. In dry parts of India, Singh and team [5] looked at trees grown with crops, showing these setups steady harvests while building better soil.
- Facing new weather patterns isn't easy for farmers, Pandey and Kumar [6] pointed out - digital tools must reach them clearly, learning matters just as much. Not far behind, Khatri and Singh [7] looked at how farms cope, showing that smart decisions come from solid data, guidance shaped by tech can shield fields when storms loom.
- Recent studies by Shukla et al. [8], Deori et al. [9], and Gogoi et al. [10] highlighted the integrating machine learning and web-based technologies significantly improves climate resilience by enabling accurate weather analysis, disease detection, and crop planning. Farmers in India respond better when tech tools speak their language - simple, local, clear [6].
- Even though some research shows promise in using digital tools, many current efforts look at separate pieces - like weather patterns, spotting plant diseases, or giving farming advice. What's missing is a connected online solution weaving together smart algorithms, forecasts for climate, guidance on crops, along with help in multiple languages - all under one roof. This new approach fills that space by building an entire system meant to withstand shifting weather through smarter farming design.

III. PROBLEM STATEMENT

Huge challenges are faced by the farmers such as losing more crops because of storms, pests, or price drops due to uncertainty in nature like environmental imbalance. When warnings come too late - or not at all - choices get tougher out in the fields. A single tool, smart and simple could bring together risk alerts, forecasts and guidance spoken in ways locals understand best.

Farmers gain easy access to clear information, which leads to better harvesting. Outcomes include stronger incomes while nature gets a break. Decisions change toward long-term delays instead of quick wins. Clarity in planning supports both people and land over time.

IV. OBJECTIVES

A. *To use AI and image classification models to identify crop diseases early*

To detect crop diseases early using AI and image classification models. Early detection of ant diseases is crucial to lowering crop loss and halting the spread of infections. To analyse leaf photos uploaded by the farmers, other advanced and structured image classification model and Convolutional Neural Network (CNN) are used. These models can detect the disease symptoms of common pests, fungal infections, and nutrient deficiencies accurately.

B. *Crops suggestion using soil data and weather forecasts*

The selection of the appropriate crop for each season was challenging for the farmers. From the suggested system humidity, temperature, rainfall forecasts and soil properties (such as pH, potassium levels, phosphorus and nitrogen) are all analysed. The platform uses rule-based decision systems and machine-learning algorithms to suggest the crops that are best fitted for the present and future weather conditions.

C. *To use a chatbot with an agricultural focus to offer multilingual assistance*

To address this the system came up with an AI-powered chatbot that speaks multiple Indian languages. Farmers may face challenges to get a convenient languages like mother tongue or native languages remains a major barrier for communications. A farmer types a question. It might be about crops, when to add nutrients or about watering plants. Sometimes they ask how bugs are handled in fields. The system reads each message carefully. Questions on growing crops come through every day. Replies based on what was asked. Details about soil treatments appear next. One by one, answers show up on screen. Some public sector initiatives apply methods that understand human language, along with advanced systems built on transformer architecture.

D. *To provide rural farmers with a user-friendly, secure online platform*

Safely built in, access made reliable. Designed so anyone can use it without confusion. Built with care, focused on real needs. Helping hands reach further through simple tools. With phone access common in remote regions, getting online stays possible through simple devices. Where people rely on handheld screens, connection remains within reach. Despite slow internet, pages pop open fast. Security checks keep accounts locked tight. Information stays protected through every step protection.

E. *To promote climate-smart and sustainable farming methods*

Farmers that last come first in what this project aims to do. Farming changed when folks cut back on chemicals. Swapping crops yearly made soil healthier. Irrigation system used less water over time. Plants that handle dry spells started growing more often. Farm types built to handle heat show up in the advice this setup gives. For changing weather conditions, these crops are suitable for huge strategies

V. METHODOLOGY

A. *Objective Overview*

- Data collection- The project follows a structured and systematic method beginning with data collection, where datasets were obtained from Kaggle's Crop Recommendation dataset containing essential agricultural requirements such as soil nutrient levels, rainfall, temperature, and humidity for 22 different variety of crop types. In addition, for disease detection, plant leaf images were also gathered.
- Data preprocessing- Data preprocessing will include the step of preparing data,
  fixing errors and adjusting formats so things stayed reli able. The image datasets were resized, labeled, and organized in a proper order to prepare them for use in training machine learning models.
- Model training- In the process of model training, where Convolutional Neural Networks (CNNs) were developed to classify and detect disease in crop leaves. Weather conditions are analyzed by
- Random Forest and Linear Regression of regression model. Furthermore, advanced NLP and transformer-based models were implemented to enable the multilingual chatbot to understand and generate response for the user queries effectively.
- Model evaluation- After training, model evaluation was conducted using standard validation methods to assess accuracy, reliability, and overall performance.
- Implementation phase- Finally, the implementation phase integrated all the modules into a unified web application that allows users to create accounts, log in securely, and access personalized insights such as disease detection, crop recommendation, weather updates, and chatbot assistance-all through a simple and responsive interface tailored for rural farmers. It consists of input, storing the data and resulting the output. It is also user-friendly mechanism works based on the user input and requirements. It also provides suggestions. Hence it works on this process.

B. *System Architecture*

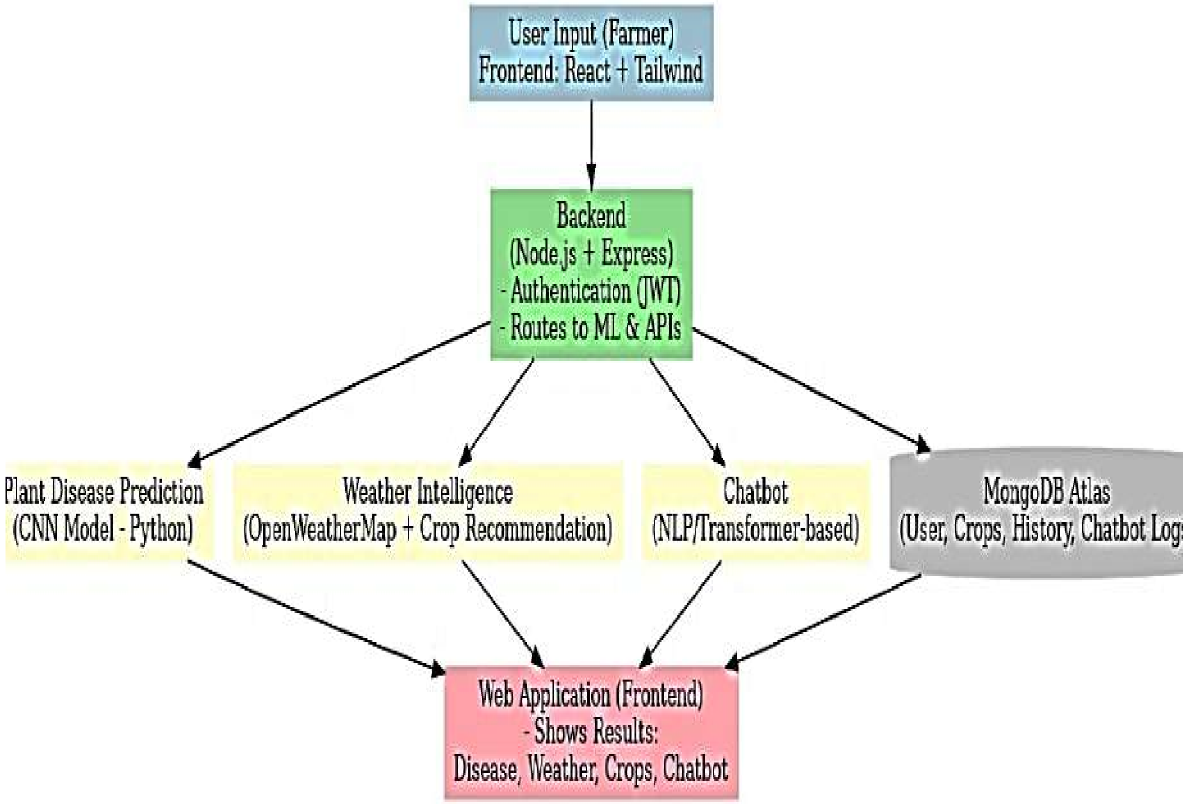

Figure 1: System Design Architecture

In Figure 1 leverages a range of advanced algorithms and models across its different modules to provide comprehensive agricultural support. For Plant Disease Prediction, Convolutional Neural Networks (CNNs) are employed to classify images of crop leaves, distinguishing between healthy and diseased samples. In the Weather Forecasting and Crop Recommendation module, regression models such as Linear Regression and Random Forest Regressors are used to predict weather-related parameters, while rule-based mapping or classification models match temperature, rainfall, and humidity conditions to the most suitable crops. The Chatbot with Multi-language Support utilizes Natural Language Processing (NLP) techniques for tokenization, intent recognition, and response generation complemented by seq2seq or transformer-based models like BERT, mBERT, or GPT variants for multilingual question answering, and integrates machine translation APIs to support various languages. For market price trend analysis, time series forecasting algorithm including ARIMA, LSTM or prophet, predict crop price trends, while data visualization libraries like Chart.js, or Recharts are used to present trends and insights through interactive graphs. This combination of models ensures accurate predictions, effective recommendations and seamless multilingual user experience.

C. Flowchart

Figure 2 is the flowchart of a climate resilient agriculture. The system starts with user login through Authentication Dashboard, where users can also logout. After logging in, they access the AI-Assistant, which provides two key features: Weather Prediction and Disease Prediction. These outputs together help determine whether the farming conditions are climate-resilient. The process ends after completion of analysis.

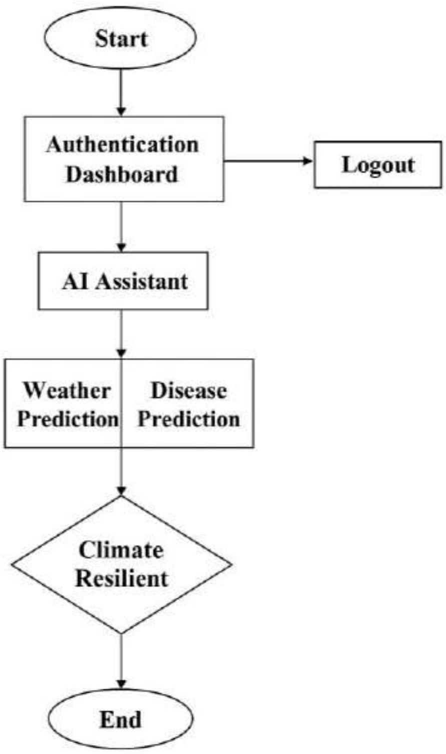

Figure 2: Flowchart shows Climate Resilient Agriculture

VI. RESULTS AND DISCUSSION

Damage to plants will be reduced by disease prediction which helps growers act fast. Because of this, tests seem closely at how good the tool finds illnesses, suggests suitable crops, and reacts under proper conditions.

Moreover, the model using convolutional neural networks correctly identified issues nearly nine times out of ten when verified.

how well its machine learning worked alongside overall system connections is supported by testing the Climate-resilient Agriculture Web App. A precision score near 91% and recall just above 90% shows it spots sick plant leaves without many mistakes. Temperature forecasts missed by only about 1.8 degrees on average, while rain estimates were off by roughly 7.5 milli meters per reading.

Farmers can trust these weather forecasts to decide the suitable crop growth for each season Under two seconds - that's how fast the app replied, keeping things running without hiccups, even when internet speed dipped. Questions about crops or weather dangers? Answers came right away through a chatbot that speaks many languages. Ahead of Linear Regression, Random Forest showed stronger results - hitting 89.7% precision in suggesting crops. While simpler methods trailed behind, this approach handled varied data with less error. Finding shows the system works well for farming choices tied to changing weather, delivering solid forecasts along with straightforward controls. It is built differently than older models and it manages to guide users without complexity or extra steps. In practice, accuracy combines with simplicity, helping adapt quickly when conditions shift outdoors.

Figure 3 is the home page of the web application which is the done using react and tis appearance is clearly aesthetic. Figure 4 describes the crop growth process and its steps. It also includes a 7-day weather forecast to predict future conditions. Figure 5 is a digital farm library that consists of variety of crops and vegetables, providing users with crop descriptions and guidance. Figure 6 is a dashboard of crop growth journey. It guides new users through the steps required to grow crops appropriately.

Figure 7 represents a resilient steps and suggestion page that allows users or farmers to seek guidance on unfamiliar challenges. Figure 8 is a crop information page. It consists of all the crop information. Figure 8 is a crop recommendation page where users receive recommendations suitable for their location based on the details provided. Figure 9 is a risk analysis page where the present and future climatic risks are analysed.

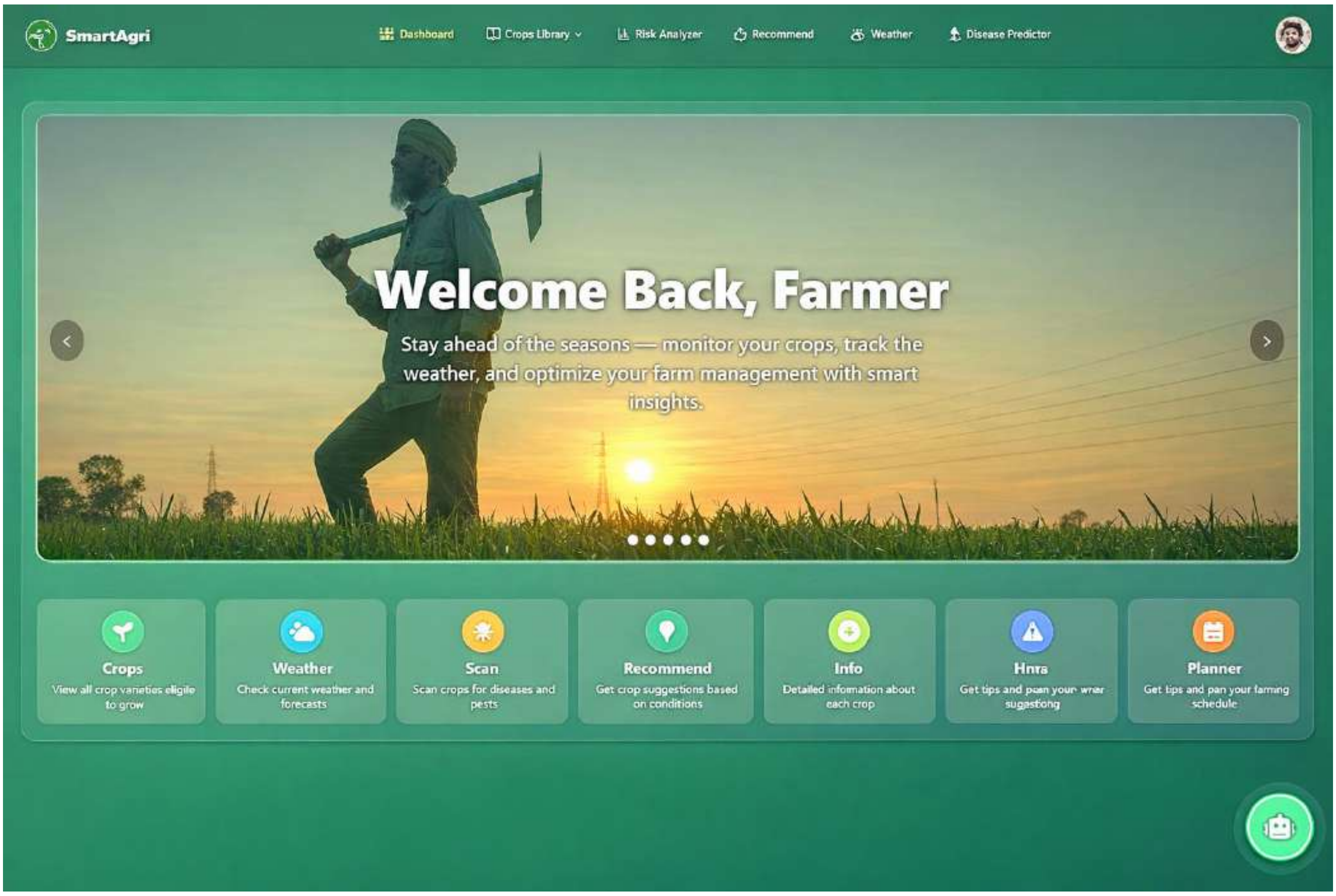

Figure 3: Home page of the application

Figure 4: Crop grow steps page

Figure 5: The digital farm library

Figure 6: The crop growth journey

Figure 7: Resilient tips and suggestion page

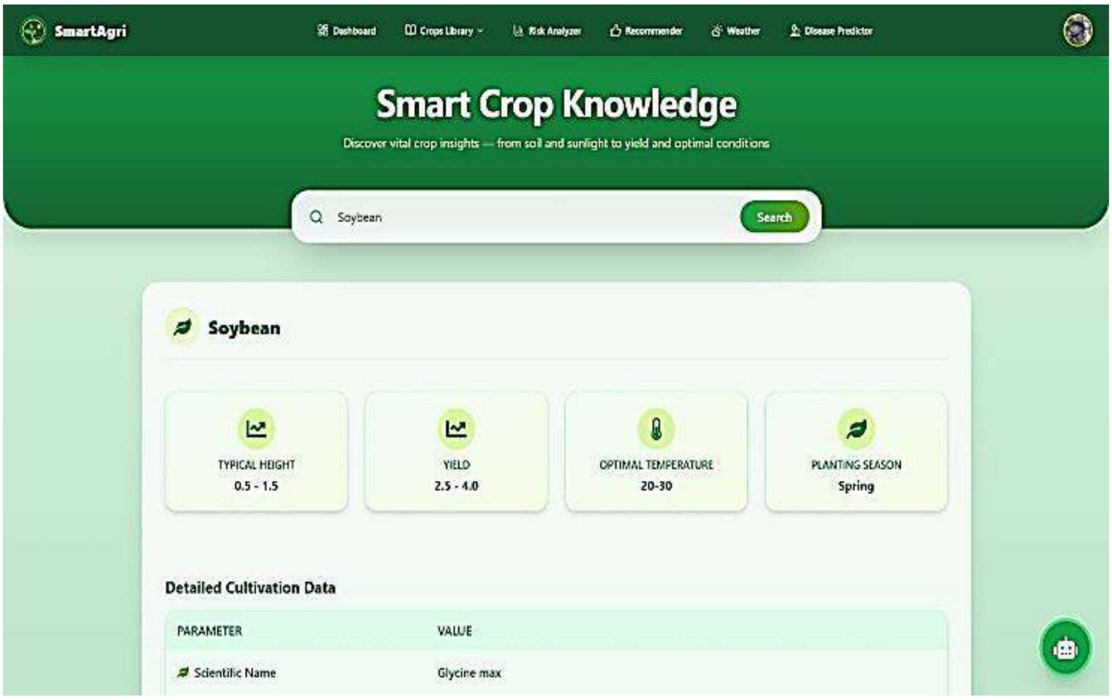

Figure 8: Crop information page

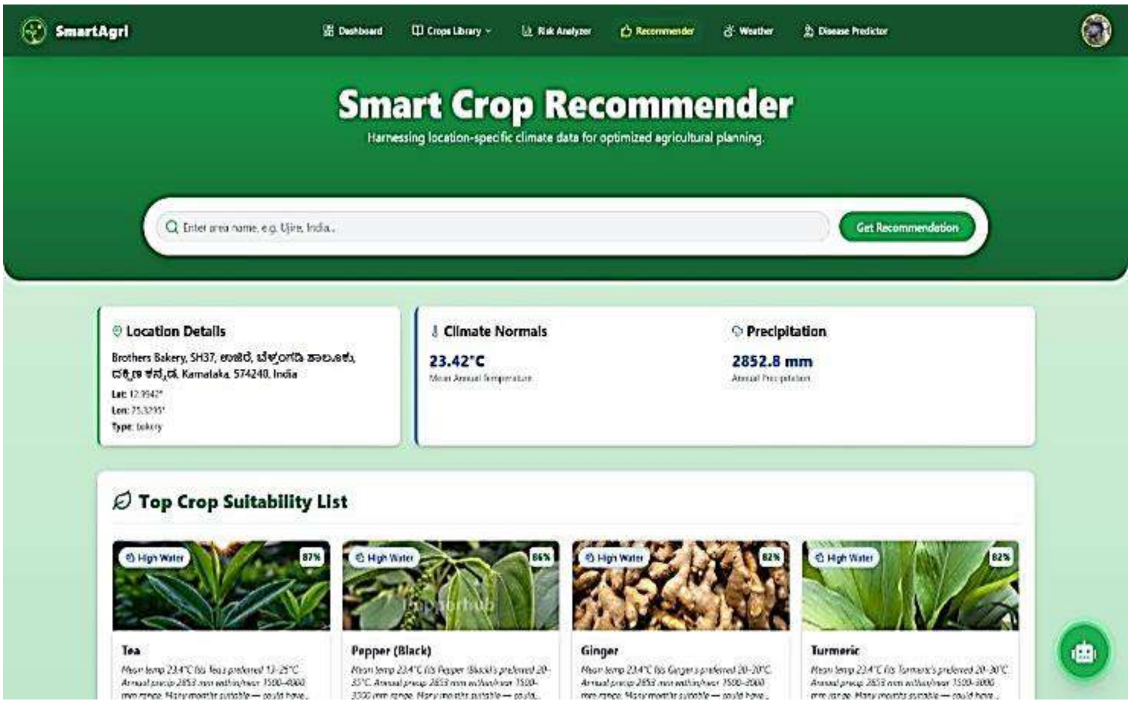

Figure 9: Crop recommendation page

Figure 10: Risk analysis page

VII. CONCLUSION

This work proposes a smart agricultural assistance framework aimed at supporting farmers in managing climate-driven uncertainties. The system integrates advanced computational methods with web-based tools to enable crop disease analysis, weather condition assessment, crop suitability recommendations, and multilingual guidance. Experimental evaluations confirm that the developed models perform effectively and help reduce risks associated with unpredictable climatic changes. The study underscores the importance of digital decision-support solutions in promoting sustainable farming practices and enhancing farmers' adaptability to environmental challenges.

VIII. FUTURE SCOPE

Farmers can build a tougher, climate-ready agriculture system down the road by adding IoT sensors. These gadgets pull in live data on soil quality, how crops are growing, and local weather patterns. That setup lets decisions happen fast and on autopilot with spot-on accuracy.

Smart data tools and learning algorithms help fine-tune watering, fertilizer spreads, and bug control. It's all about precision farming that saves resources and boosts results.

Thanks to cloud tech, this system scales up easily—from a single farm to whole districts or even states. Every farmer, big or small, gets access to climate-smart tips.

Picture the platform growing into a custom advisor in multiple languages. It sends warnings on weather risks, predicts market prices, and suggests the best crops for your plot. On top of that, drones and satellites handle big-picture monitoring: spotting diseases early, checking yields, and more. Blockchain steps in to make supply chains transparent, so farmers get fair deals.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

[1] V. Tanalluri, *"Crop Recommendation Dataset,"* Kaggle, 2020. Available from: https://www.kaggle.com/datasets/varshitanalluri/crop-recommendation-dataset

[2] R. Lal, *"Climate-resilient agriculture for sustainable food security,"* Soil and Tillage Research, vol. 188, pp. 1–10, 2019. Available from: https://doi.org/10.1016/j.still.2018.01.002

[3] Food and Agriculture Organization of the United Nations (FAO), *Climate-Smart Agriculture Sourcebook*. Rome, Italy: FAO, 2018. Available from: https://www.econstor.eu/handle/10419/301731

[4] P. K. Thornton and M. Herrero, *"Climate change adaptation in mixed crop–livestock systems in developing countries,"* Global Food Security, vol. 2, no. 2, pp. 99–107, 2014. Available from: https://doi.org/10.1016/j.gfs.2014.02.002

[5] V. K. Singh, R. Kumar, and S. Meena, *"Agroforestry systems for climate-resilient agriculture in arid and semi-arid regions of India,"* Indian Journal of Agronomy, vol. 65, no. 4, pp. 375–382, 2020.

[6] R. Pandey and A. Kumar, *"Adoption challenges of climate-resilient agricultural technologies in Bihar, India,"* Frontiers in Sustainable Food Systems, vol. 8, pp. 1–14, 2024. Available from: https://doi.org/10.3389/fsufs.2024.123456

[7] M. Khatri and R. Singh, *"Farm resilience to climatic risks: A systematic review,"* Agronomy for Sustainable Development, vol. 44, no. 1, pp. 1–18, 2024. Available from: https://link.springer.com/article/10.1007/s13593-024-00998-w

[8] Y. K. Shukla, S. Verma, and A. Mishra, *"Modern technologies for climate-resilient agriculture: A comprehensive review,"* International Journal of Environment and Climate Change, vol. 15, no. 2, pp. 120–134, 2025.

[9] Deori, P. Behera, and A. Sharma, *"Enhancing agricultural sustainability under climate change scenarios,"* International Journal of Environment and Climate Change, vol. 14, no. 6, pp. 45–58, 2024.

[10] L. Gogoi, B. Sarma, and A. Devi, *"Climate-resilient agriculture practices in the Indian context,"* Journal of Tropical Agriculture, vol. 62, no. 3, pp. 210–219, 2025.

ABOUT THE AUTHORS

Pradeep G S has completed his B. E in the year 2010 and M. Tech in the year 2013 from VTU Belagavi. His areas of interest are Machine Learning and Network Security. He has published 3 international research papers.

Amshu HU is currently pursuing Bachelor of Engineering in Computer Science from SDM Institute of Technology Ujire and is in the final year. She has a keen interest in Python Programming, Artificial Intelligence, Machine Learning, Web Development and MERN stack.

Apoorva Bhagwath is currently pursuing Bachelor of Engineering in Computer Science from SDM Institute of Technology Ujire and is in the final year. She has a keen interest in Python Programming, Artificial Intelligence, and Web Development.

Ashwath S is currently pursuing Bachelor of Engineering in Computer Science from SDM Institute of Technology Ujire and is in the final year. He has a keen interest in Web Development, C programming and React, node.js and java programming.

Manu Sagar is currently pursuing Bachelor of Engineering in Computer Science from SDM Institute of Technology Ujire and is in the final year. He has a keen interest in Web Development, React.js and Python programming.