European Economic Letters
ISSN 2323-5233
Vol 15, Issue2 (2025)
http://eelet.org.uk

Harnessing AI for predicting Climate Change Effects on Fig Plantation

[1] **Mr. Navnath Shete**
Asst. Professor,
Dr. Vishwanath Karad MIT World Peace University, Pune.
[2] **Dr. Zarina Shaikh**
Asso. Professor, Poona Institute of Management Sciences and Entrepreneurship, Pune
[3] **Dr. Ravindra Ashok Karande**
Asst. Professor,
Plant Pathology, RCSM College of Agriculture, Kolhapur.

I. ABSTRACT

This study looks at how artificial intelligence can help predict how climate change affects Fig plantation. This paper discusses how we predict and understand the impact of climate change on the plantation. The paper explores how Artificial Intelligence can be used to forecast and understand the effects of climate change on the plantation. By utilizing Artificial Intelligence in climate studies, we can better understand environmental changes and respond more effectively to protect Fig plantation from the effects of climate change.

In this research study, we used the Naïve bayes classifier, which is good at figuring out risks based on weather patterns. By analysing historical data, we can train it to predict how future climate changes might impact fig yield and diseases. This knowledge can assist fig farmers adapt their practices, like choosing drought-resistant fig varieties or installing irrigation systems, to ensure the health of their trees in a changing climate.

Keywords: Artificial Intelligence, fig cultivation, climate prediction, Naïve Bayes classifier, agriculture, fig plantation

II. INTRODUCTION

The utilization of artificial intelligence and climate science within agriculture enables comprehension and mitigation of the impacts of climate change on fig plantations. Fig plantations, are valued for their economic importance and ecological contributions, are increasingly vulnerable to the uncertainties brought about by shifting weather patterns and environmental stressors. The application of Artificial Intelligence technologies, including sophisticated machine learning algorithms and advanced deep learning systems, offers a novel approach to unravelling the intricate relationship between climate change and fig tree dynamics.

Fig plantations play an important role in many ecosystems and agricultural landscapes, making them a focal point for research into the effects of climate change on plant species resilience and productivity. By harnessing the power of Artificial Intelligence-driven insights, researchers aim to not only forecast how climate change influences fig tree growth patterns and fruit yield but also to optimize resource allocation, mitigate risks associated with climate variability and foster adaptive strategies for sustainable fig tree cultivation practices.

This research paper endeavours to delve deeply into the transformative potential of Artificial Intelligence-based climate prediction models in revolutionizing fig tree cultivation methods. By integrating Artificial Intelligence expertise with agricultural knowledge, this study seeks to pave the way for innovative strategies that promote resilience, sustainability, and productivity in fig plantation farming amidst a backdrop of ever-changing climatic conditions.

III. LITERATURE REVIEW:

In this research paper, an architecture for the digital neural network which can be parameterised and programmed, as well as methodology for its design and programming was given [1].

In this research paper, the authors used the Maxent algorithm create habitat suitability models for current and future climates, as well as to analyse changes in the fig region of Mexico [2].

In this research paper, the authors explored whether rapid climate change and insect incursions had a combined effect on fig tree yield, and discovered that fig yield decreased by 25% during the study period and was influenced by both causes [3].

In this research paper, the input data was an 8-row and 303-column data table, which was used by the authors to train a feedback neural network. The neural network had one hidden layer and 10 neurons, and it exhibited dynamic nonlinear behaviour [4].

In this research paper, a statistical model was created using simulation data from the ENSEMBLE project with the aim of estimating crop yield based on different climatic conditions and variables [5].

In this research paper, a neural network model was employed to forecast future climate change, revealing increases in evaporation and average air temperature alongside a decrease in wind speed [6].

In this research paper, it investigates how climate change affects fig trees, specifically the combined impacts of water stress and high temperatures on several cultivars. This study gives light on the significance of how fig trees respond to environmental changes, particularly variations in water supply and temperature swings [7].

In this research paper, the researchers have addressed various limitations of traditional climate models, particularly in capturing extreme events and enhancing high-resolution simulations. It discusses various ML methods like neural networks, decision trees, highlighting their potential in advancing climate research. [8]

In this research paper, researchers analysed the correlation between climate change and health impacts. They employed various Artificial Intelligence techniques like neural networks and machine learning to analyse the correlation. [9]

In this research paper, the study highlights how Artificial Intelligence can help breed crops that are more resilient to environmental changes, such as drought, high temperatures, and other extreme weather conditions. [10]

In this research paper, demonstrates how Artificial Intelligence is used in agriculture for a variety of tasks, including field harvesting, health monitoring, pest control, and deficiency diagnosis. Machine Learning and Artificial Intelligence are replacing traditional approaches in the agricultural sector to improve efficiency and productivity. [11]

In this research paper, it focuses on using machine learning models to predict crop yields for Irish Potato and Maize. Various algorithms were used, with Random Forest proving most effective. Their study aimed to assist farmers in crop selection, fertilizer optimization and disease detection, emphasizing the role of automation and data-driven decision making in agriculture. [12]

IV. METHODOLOGY:

The following methodology outlines the approach taken in this research paper to analyse historical fig plantation data, select appropriate models, evaluate their performance, and predict the impacts of climate change on fig cultivation.

The flowchart presented in Figure 1 offers an overview of the sequential steps involved in this research paper.

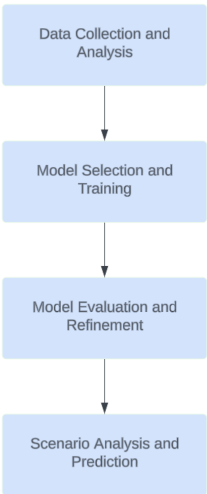

Figure 1 Overview of the methodology

1. Data Collection and Analysis

Historical data collection:

We need to gather comprehensive historical data on fig yield and quality parameters such as size, sugar content, and shelf life. This data can be obtained from records kept by the plantation or through direct measurement and sampling.

Climate data collection:
Access reliable sources such as regional weather stations or meteorological organizations to acquire historical climate data from datasets available on the internet. Collect information on temperature, precipitation, humidity, and wind patterns, spanning the entire period of fig cultivation.

Disease Incident Data:
Conduct regular visual scouting of the plantation to detect signs of common fig diseases like fig rust, fig mosaic, and fig anthracnose. Keep track of the kind and severity of outbreaks, as well as the weather conditions that accompanied them. Figure 2 depicts a healthy fig leaf, Figure 3 shows Fig Rust on fig leaves, and Figure 4 depicts one of the fig rust symptoms. Figure 5 shows leaves afflicted with fig mosaic. Figure 6 shows leaves infected with fig anthracnose.


Figure 2: Healthy Fig leaf [13]


Figure 3: Leaves infected with fig rust [14]


Figure 4: Fig Rust symptoms - necrosis and curling of leaf [14]

European Economic Letters
ISSN 2323-5233
Vol 15, Issue2 (2025)
http://eelet.org.uk

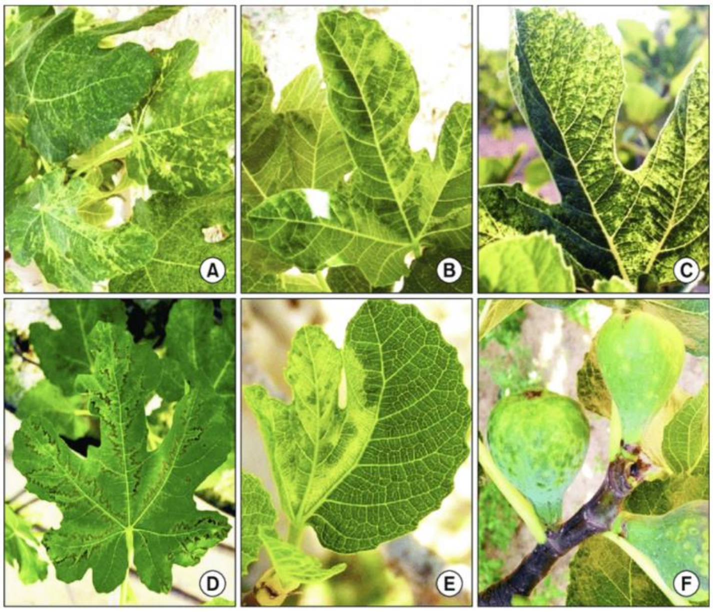

Figure 5: Fig leaves infected with fig mosaic [15]

Figure 6: Leaves infected with fig anthracnose [16]

Pollination Monitoring Rates:
Monitor pollination rates by observing natural pollinators like fig wasps or by recording fruit set (development of fertilized ovaries into figs). Correlate these observations with weather patterns to assess the impact of climate variability on pollination activity.

High-Resolution Satellite Imagery:
Utilize high-resolution satellite imagery to analyze factors like land surface temperature, vegetation health, and soil moisture. This data can provide valuable insights into environmental conditions affecting fig growth.

Soil Analysis:
Conduct detailed soil analysis beyond basic soil type, focusing on nutrient levels (nitrogen, phosphorus, potassium), pH, and organic matter content. Understanding soil properties is crucial as they directly impact nutrient availability and overall fig health.

2. Model Selection and Training

Naïve Bayes Classifier:
We will select the Naive Bayes classifier for classification tasks, such as assessing disease risk levels based on climate conditions. Naive Bayes is well-suited for this scenario due to its simplicity, computational efficiency, and suitability for high-dimensional data.

Training the Model:
We will train the Naive Bayes model using historical data on climate conditions and corresponding fig plantation outcomes. The model learns the probability of each outcome (e.g., high disease risk) given specific combinations of climate variables.

Advantages and Limitations:
Advantages of Naive Bayes would include that it is simple and efficient, but it also has certain limitations, particularly the assumption of conditional independence among features.

3. Model Evaluation and Refinement
Performance Metrics:
Selecting suitable metrics for evaluating the success of an AI model depends on the nature of the task it's designed to perform. For instance, in classification tasks, metrics such as accuracy, precision, and recall are commonly employed, whereas regression projects often utilize metrics like Mean Squared Error (MSE) and R-squared to assess performance.

Hyperparameter Tuning:
In order to improve the model's performance on test data, it is necessary to fine-tune its hyperparameters. Grid search and random search are two techniques that can be used to methodically investigate alternative parameter combinations.

Ensemble Learning:
This is an optional step, we can consider ensemble learning techniques to combine predictions from multiple models for potentially improved accuracy and robustness.

4. Scenario Analysis and Prediction
Climate change scenarios:
Plans to fine-tune hyperparameters to attain peak performance on test data under various climate change scenarios.

Model Predictions:
Run the trained Artificial Intelligence models with different climate scenarios to predict their impacts on fig plantation outcomes. Analyze the model outputs to identify potential risks and opportunities associated with climate change, such as changes in yield, fruit quality, disease pressure, and water requirements.

By following this detailed plan, we can systematically analyze historical data, train and evaluate Artificial Intelligence models, and make performed predictions about the impacts of climate change on fig plantations.

V. CONCLUSION

This research study focused on how Artificial Intelligence-powered climate prediction models can transform fig cultivation under climate change. We proposed a methodology for Artificial Intelligence integration, including data collection, model training, evaluation, scenario analysis. By analyzing historical data and various climate factors, Artificial Intelligence models can learn complex relationships impacting fig plantations.

While a Naïve Bayes classifier offers advantages, its limitations need to be considered. Model evaluation and refinement are crucial for optimal performance. The actual power lies in generating climate change scenarios and predicting their effects. Analyzing these predictions allows fig plantation managers to develop proactive adaptation strategies, ensuring long-term sustainability.

In conclusion, Artificial Intelligence offers a promising tool for leveraging climate data to predict and mitigate climate changes in fig cultivation. By embracing this data-driven approach, fig plantation managers can make informed decisions, optimize resources, and foster sustainable practices for a changing climate.

VI. REFERENCES

[1] Acosta, Gerardo & Tosini, Marcelo. (2001). A firmware digital neural network for climate prediction applications. 127 - 131. 10.1109/ISIC.2001.971496.

[2] Martínez-Macias KJ, Márquez-Guerrero SY, Martínez-Sifuentes AR, Segura-Castruita MÁ. Habitat Suitability of Fig (Ficus carica L.) in Mexico under Current and Future Climates. Agriculture. 2022; 12(11):1816. https://doi.org/10.3390/agriculture12111816

[3] Mellal MK, Khelifa R, Chelli A, Djouadi N, Madani K. Combined Effects of Climate and Pests on Fig (Ficus carica L.) Yield in a Mediterranean Region: Implications for Sustainable Agricultural Strategies. Sustainability. 2023; 15(7):5820. https://doi.org/10.3390/su15075820

[4] Altıparmak, Hamit & Salama, Ramiz & Gökçekuş, Hüseyin & Uzun Ozsahin, Dilber. (2021). Predict Future Climate Change Using Artificial Neural Networks. 10.1007/978-3-030-64765-0_9.

[5] Altinsoy, Hamza & Kurt, C. & Kurnaz, Levent. (2013). Analysis of the Effect of Climate Change on the Yield of Crops in Turkey Using a Statistical Approach. 10.1007/978-3-642-29172-2_53.

[6] Amin, Zahraa & Khaleefa Ali, Seroor. (2022). Climate change prediction using artificial neural network. IOP Conference Series: Earth and Environmental Science. 961. 012003. 10.1088/1755-1315/961/1/012003.

[7] Aroua Ammar, Imed Ben Aissa, Mohamed Gouiaa, Messaoud Mars, Fig (Ficus carica L.) vulnerability to climate change: Combined effects of water stress and high temperature on ecophysiological behaviour of different cultivars, South African Journal of Botany,
Volume 147, 2022, Pages 482-492, ISSN 0254-6299,
https://doi.org/10.1016/j.sajb.2022.02.014.

[8] Molina, M. J., O'Brien, T. A., Anderson, G., Ashfaq, M., Bennett, K. E., Collins, W. D., Dagon, K., Restrepo, J. M., & Ullrich, P. A. (2023). A Review of Recent and Emerging Machine Learning Applications for Climate Variability and Weather Phenomena. Artificial Intelligence for the Earth Systems, 2(4), 220086. https://doi.org/10.1175/AIES-D-22-0086.1

[9] Khan MHU, Wang S, Wang J, Ahmar S, Saeed S, Khan SU, Xu X, Chen H, Bhat JA, Feng X. Applications of Artificial Intelligence in Climate-Resilient Smart-Crop Breeding. International Journal of Molecular Sciences. 2022; 23(19):11156. https://doi.org/10.3390/ijms231911156

[10] Beans, Carolyn. (2020). Inner Workings: Crop researchers harness artificial intelligence to breed crops for the changing climate. Proceedings of the National Academy of Sciences of the United States of America. 117. 27066-27069. 10.1073/pnas.2018732117.

[11] Javaid, Mohd & Haleem, Abid & Haleem Khan, Ibrahim & Suman, Rajiv. (2022). Understanding the potential applications of Artificial Intelligence in Agriculture Sector. Advanced Agrochem. 2. 10.1016/j.aac.2022.10.001.

[12] Kuradusenge M, Hitimana E, Hanyurwimfura D, Rukundo P, Mtonga K, Mukasine A, Uwitonze C, Ngabonziza J, Uwamahoro A. Crop Yield Prediction Using Machine Learning Models: Case of Irish Potato and Maize. Agriculture. 2023; 13(1):225. https://doi.org/10.3390/agriculture13010225

[13] https://mrplantgeek.com/2020/05/26/fiddle-leaf-fig-care-secrets/

[14] Latinovic, Jelena & Radisek, Sebastjan & Latinović, Nedeljko. (2015). SEVERE INFECTION OF FIGS BY FIG RUST PATHOGEN CEROTELIUM FICI IN MONTENEGRO. 61. 10.17707/AgricultForest.61.2.08.

[15] Bayoudh, Chokri & Manel, Elair & Labidi, Rahma & Majdoub, Afifa & Mahfoudhi, Naima & Mars, Messaoud. (2017). Efficacy of Tissue Culture in Virus Elimination from Caprifig and Female Fig Varieties (Ficus carica L.). The plant pathology journal. 33. 288-295. 10.5423/PPJ.OA.10.2016.0205.

[16] https://www.gardeningknowhow.com/edible/fruits/figs/treating-fig-anthracnose.htm