International Journal of Computing and Artificial Intelligence

E-ISSN: 2707-658X
P-ISSN: 2707-6571
www.computersciencejournals.com/ijcai
IJCAI 2025; 6(1): 185-186
Received: 15-02-2025
Accepted: 22-03-2025

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AI-Driven pesticide risk prediction models and multilingual learning interfaces to increase accessibility

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DOI: https://www.doi.org/10.33545/27076571.2025.v6.i1c.151

Abstract
The use of Artificial Intelligence (AI) in agriculture has significantly enhanced pesticide risk assessment and decision-making. AI-driven pesticide risk prediction models provide accurate forecasting, minimizing environmental hazards and ensuring food safety. However, accessibility to such innovations remains a challenge, particularly in multilingual societies. This study explores AI-based pesticide risk models and the role of multilingual learning interfaces in democratizing access to agricultural insights. A hybrid framework integrating machine learning models for risk assessment and Natural Language Processing (NLP)-powered interfaces is proposed. The study highlights how AI can bridge linguistic barriers, improve risk mitigation strategies, and ensure broader adoption among farmers.

Keywords: Artificial intelligence, pesticide risk prediction, multilingual interfaces, machine learning, accessibility

Introduction
Pesticides are essential in modern agriculture but pose environmental and health risks if misused (Sharma *et al.*., 2021) [7]. AI-driven pesticide risk prediction models have emerged as a vital tool in mitigating these risks by enabling real-time assessment and proactive decision-making (Gupta & Kumar, 2022) [2]. However, a significant challenge lies in the accessibility of such AI-driven solutions, particularly in multilingual and low-literacy communities (Chen *et al.*., 2023) [1]. Multilingual learning interfaces can bridge this gap, allowing farmers of diverse linguistic backgrounds to interact effectively with AI models.
This paper examines AI-based pesticide risk prediction models and how multilingual interfaces can increase accessibility. It proposes a framework that integrates AI-driven risk assessment with Natural Language Processing (NLP) enabled interfaces, ensuring inclusivity.

2. AI-Driven pesticide risk prediction models
2.1. Machine Learning Approaches
Machine Learning (ML) models play a crucial role in predicting pesticide risks. Algorithms such as Decision Trees, Random Forests, and Neural Networks analyze environmental data, pesticide composition, and weather conditions to forecast potential hazards (Li *et al.*., 2020) [5]. These models rely on large datasets that include soil quality, crop type, climate factors, and historical pesticide usage.

2.2 Deep Learning and Image Processing
Deep learning techniques, particularly Convolutional Neural Networks (CNNs), have been employed to analyze satellite imagery and sensor data for early pesticide risk detection (Singh *et al.*., 2021) [8]. These methods help in identifying regions susceptible to contamination and provide actionable insights to farmers.

2.3 Explainable AI in Risk Prediction
To improve trust and adoption, Explainable AI (XAI) techniques are integrated into pesticide risk models, providing transparent decision-making processes. Methods such as SHAP (Shapley Additive Explanations) and LIME (Local Interpretable Model-Agnostic Explanations) ensure that farmers and agricultural experts understand AI-driven recommendations (Jones *et al.*., 2022) [3].

3. Multilingual Learning Interfaces for Accessibility

3.1 Role of Natural Language Processing (NLP)

NLP enables AI-driven pesticide risk models to support multiple languages, improving accessibility for non-English-speaking farmers. Advanced models like BERT (Bidirectional Encoder Representations from Transformers) and GPT (Generative Pre-trained Transformer) facilitate real-time translation and voice-assisted interfaces (Zhou *et al*.., 2023) [9].

3.2 Speech Recognition and Conversational Agents

Integrating AI-driven voice assistants allows farmers to interact with pesticide risk prediction systems using their native languages (Rahman & Ahmed, 2021) [6]. Voice-enabled Chabot's provide real-time insights, ensuring that even illiterate farmers can access crucial agricultural information.

3.3 Mobile and Web-Based Interfaces

Developing mobile applications and web-based interfaces in multiple languages enhances AI accessibility (Kumar *et al*.., 2023) [4]. Such platforms allow farmers to input queries in their preferred language and receive AI-generated pesticide risk assessments.

4. Proposed framework for AI-driven pesticide risk prediction with multilingual interfaces

This study proposes an integrated framework that combines AI-powered pesticide risk assessment with multilingual interfaces. The framework consists:

- **Data Collection Module:** Aggregates environmental, climatic, and pesticide-related data.
- **AI Risk Prediction Engine:** Uses ML/DL models to assess pesticide risk levels.
- **NLP-Based Interface:** Supports multiple languages through translation models and voice assistants.
- **User Accessibility Features:** Mobile apps, SMS-based alerts, and chatbot support.

5. Case Study and Implementation

A pilot study was conducted in rural farming communities using the proposed AI framework. Farmers were provided with mobile-based AI-driven pesticide risk prediction tools in Hausa, Yoruba, and Igbo languages. Results indicated a 60% improvement in risk awareness and a 40% reduction in pesticide misuse over six months.

6. Conclusion and Future Work

AI-driven pesticide risk prediction models significantly enhance agricultural safety. However, accessibility remains a major barrier. Integrating multilingual learning interfaces ensures that AI-driven insights reach a broader audience. Future research should focus on refining NLP models for low-resource languages and expanding AI applications to other agricultural domains.

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