Chapter 15
Machine Learning Algorithms for Predictive Pest Modeling in Agricultural Crops

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ABSTRACT

Food security and maximum yield depend on accurate pest prediction and crop management. An in-depth analysis of this cutting-edge area is the goal of this book chapter, which will explore predictive pest modeling using machine learning (ML) algorithms. The introduction establishes the section by stressing the significance of ML in transforming crop pest management and the value of predictive pest modeling. Furthermore, it will delve into various ML techniques designed for pest modeling.

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Differentiating between supervised, unsupervised, and semi-supervised learning techniques, it will outline a range of ML methods. Moreover, to help practitioners make an educated decision, it will also focus on the criteria for algorithm selection in pest prediction. It concludes with a detailed overview of ML algorithms' revolutionary potential in agricultural operations and their importance in predictive pest modeling.

OVERVIEW OF PREDICTIVE PEST MODELING

Predictive pests modeling is necessary for modern agriculture, where the effects of pest infestations lead to crop production losses, decline in yields, and affect food quality negatively (Mustafa et al., 2024; Rodríguez & Niemeyer, 2005). It is estimated by the Food and Agriculture Organization (FAO) of the United Nations that diseases and pests annually decrease global food production by 30% (Becker-Ritt & Carlini, 2012). The Global climate change scenario, with various calamities occurring at regular intervals and inconsistent weather conditions, have further exacerbated the emergence of agricultural pests (Mondal et al., 2015; Mourtzinis & Conley, 2024). This global warming complicates to manage pests and diseases as it implicates on world economy, agricultural production, and food security (Eruaga, 2024; Karthikeyan et al., 2020). Hence, data collection is vigorous to be collected from the fields using sensors/robots. Subsequently, this data is sent to a cloud server through the Internet of Things (IoT) either locally or remotely and stored, processed & analyzed over there (Dhal et al., 2024; Romeo et al., 2020). The data can be turned into valuable insights with the use of big data and AI-driven approaches. Big data and AI-driven approaches can convert the data into effective insights. A Decision Support System (DSS) helps users to do better engagement and decide more effectively (Poszler & Lange, 2024; Zhai et al., 2020). It helps users to improve or adopt suitable strategies for the agricultural system.

Machine learning (ML), a subfield of artificial intelligence, has indicated significant potential to enhance several scopes from the perspective of the agriculture 4.0 revolution (Bhargava et al., 2024; Zhai et al., 2020). AI (Artificial Intelligence), refers to computer programs or systems that can independently learn and conduct operations without any human interaction. This technique consists of using a computer to carry out evaluations based on the analysis of given data (Ahmed & Pathan, 2018; Ochuba et al., 2024). Here, “data” is used to mean some examples or samples. Most of the time, more specifically with supervised learning, labeled data, which is a set that contains instances where each has an associated output. Unsupervised learning tasks, in contrast, use unlabeled data, as the model identifies patterns and structures on its own without prior knowledge of desired outcomes (Chlingaryan et

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