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# Machine Learning Techniques to Enhance Management and Decision-Making in Commercial Banana Plantations (*Musa* AAA) in Ecuador

**Ronald Villamar-Torres[1*]; Odalys Morán-Maffare[1]; Luis Godoy-Montiel[1]; Danilo Yánez-Cajo[1]; Ángel Cedeño-Moreira[1]; Marcos Heredia-Pinos[1]; Gregorio Vásconez-Montufar[1]; María Romero-Román[1] and Milton Cabezas-Guerrero[1*].**

[1]Agricultural and Livestock Engineering, Faculty of Animal and Biology Sciences, Quevedo State Technical University, Quevedo, Ecuador.
*Corresponding authors: rvillamart@uteq.edu.ec ; mcabezas@uteq.edu.ec

**Abstract**

This research aims to optimize management and decision-making in commercial banana plantations (*Musa* AAA) in Ecuador through the use of advanced machine learning techniques, with a particular emphasis on identifying and grouping lots affected by Moko, a disease caused by *Ralstonia solanacearum race 2*. The initial component of the study involves analyzing the health status of the plantations using high-resolution images obtained by drones and extracting the Normalized Difference Vegetation Index (NDVI), thereby detecting anomalies associated with Moko outbreaks. This information has been crucial for applying clustering techniques, such as K-means, where specific metrics were used to segment lots according to the intensity of the infection, facilitating the identification of those with the highest concentration of outbreak sites. Additionally, other clustering algorithms, including DBSCAN and hierarchical methods, have been implemented to classify the lots based on post-harvest bunch quality. This segmentation has proven fundamental for decision-making, as it differentiates between high- and low-quality lots, thus optimizing the value chain and logistics in product commercialization. The methodological approach further extends to the analysis of nutritional data, where clustering models have been employed to identify lots with similar nutritional profiles. This information enables the development of highly precise fertilization plans, ensuring greater efficiency in the application of inputs and resource optimization. Furthermore, predictive tools such as linear regression have been explored, driven by the limited number of observations in certain scenarios. At the same time, other predictive algorithms—logistic regression, decision trees, k-nearest neighbors, random forests, and neural networks—are being tested on various datasets from other banana plantations. This comprehensive set of techniques and models significantly contributes to the improvement of agricultural management, enabling early and precise interventions that translate into increased productivity and sustainability in banana cultivation.

***Keywords:*** *Machine Learning, NDVI, Clustering, Postharvest Quality, Agricultural Management.*