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"Reconcile land system changes
with planetary health"

Weather-guided late blight management: Reconciling potato production with environmental health in Rwanda

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Abstract

Climate change is intensifying regional weather variability, particularly in Rwanda's topographically diverse landscapes, where site-specific microclimates complicate agricultural management. These shifts are especially challenging for crops like potato, where late blight—caused by *Phytophthora infestans*—poses an increasing threat. Farmers often rely on routine, calendar-based fungicide applications, which leads to chemical overuse, raising both economic and environmental concerns, particularly for smallholders farming in ecologically sensitive zones.

This study evaluated the effectiveness of a real-time, weather-guided approach to late blight management that considers both disease pressure and potato variety tolerance. Building on a network of automated weather stations and field-deployed LoRaWAN-based IoT sensors, the system enhances the application of the SIMCAST disease forecasting model. Weather data—collected at high spatial and temporal resolution—was used to estimate site-specific infection risk. These results informed a digital Decision Support System (DSS), which delivered targeted fungicide recommendations tailored to prevailing conditions and varietal tolerance, communicated directly to farmers via SMS.

On-farm trials were conducted in collaboration with smallholder farmers over two growing seasons along an altitude transect from Nyange (2000 m asl) to Kinigi (2400 m asl). Four potato varieties—Ndamira (susceptible), Twihaze (tolerant), and Kirundo and Cyerekezo (moderately tolerant)—were tested under DSS-guided and conventional weekly spray regimes.

Results showed fungicide use reductions ranging from 10 % to 90 % without yield penalties, depending on cultivar and location, with the most significant reductions in the tolerant varieties. The susceptible variety achieved up to 50 % fungicide reduction in some locations. In certain cases, yields under DSS management were higher than those under routine spraying, demonstrating that targeting chemical use to actual disease risk can improve both efficiency and outcomes.

This research highlights a practical, climate-smart solution that combines real-time data and ecological principles to reduce chemical footprints, support smallholder resilience, and reconcile agricultural productivity with environmental sustainability in vulnerable ecosystems.

Keywords: Climate change, IoT decision support system (DSS), *Phytophthora infestans*, sustainable precision agriculture

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