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A Model for the Spread of Rift Valley Fever in Livestock with Vertical Transmission

Rift Valley Fever (RVF) is a zoonotic infectious disease spread by mosquitoes and transmitted between several animals species and occasionally humans. We present and analyze a new model for mosquito-transmitted disease that includes vertical transmission mechanisms from an infected mosquito mother to infected offspring. In particular, we model the spread of RVF in cattle and mosquito populations, extending existing models for vector-borne diseases to include vertical transmission and an egg/larvae stage. We analyze the importance of vertical transmission in predicting the spread of RVF and discuss how modeling can reduce the uncertainty of the estimates of disease prevalence. We also make this extended model reactive to environmental changes and demonstrate that even if the endemic equilibrium has a low ratio of infectious vectors and animals, a large pulse of vectors resulting from increased hatch and survival rates due to high rainfall events can result in a large epidemic.