Research Experiences for Undergraduates (REU) 2012 Abstract

BOGEN, S., FRANCIS, A., ROBINS, J., WESTHOEK, A., EDA, S., LENHART, S., and A. KANAREK. Agent-based model for Johne's disease dynamics in a dairy herd. National Institute for Mathematical and Biological Synthesis, Knoxville, TN, University of Tennessee Knoxville, TN, Capital University, Columbus, OH, University of Wisconsin, Madison, WI, Wageningen University, The Netherlands.

Johne's disease is an infectious gastrointestinal disease in ruminants caused by *Mycobacterium avium* ssp. *paratuberculosis* that causes diarrhea, emaciation, decreased milk production and eventually death. The disease is transmitted in utero and via milk and colostrum to calves, and fecal-orally to all age classes. Financial losses due to the disease are estimated to be over $200 million in the US dairy industry. The goal of this study was to identify the primary transmission pathways driving disease dynamics, and determine which management strategies and diagnostic tests are most effective in decreasing the prevalence of Johne's disease in dairy herds, in an economically viable way.

An agent-based, discrete time model was developed to simulate Johne's disease dynamics in a US dairy herd. Spatial aspects of disease transmission were taken into account by using six spatial compartments: five separate barns and a pasture. The effects on disease prevalence and economics were studied for different scenarios: three colostrum management strategies, five levels of assumed fecal-oral transmission, with and without fecal-oral transmission in the pasture, and culling and colostrum management decisions based on ELISA or EVELISA diagnostic tests.

The disease prevalence is highly dependent on the maximum probability of infection through the fecal-oral route, for which there is no widely accepted estimate. Assuming no fecal-oral transmission on the pasture markedly decreased total disease prevalence. Additionally, with more opportunities for calves to drink potentially contaminated colostrum, the disease prevalence increases. Culling and colostrum management based on both ELISA and EVELISA testing resulted in lower disease prevalence compared to the no-testing scenario, especially at low values of fecal-oral transmission. However, the disease prevalence does not decrease over time. Our model implies that testing and culling alone is not enough to control Johne's disease, but more accurate parameter estimation is needed to justify conclusions from the model. Results of the economic analysis of using the ELISA and EVELISA tests were inconclusive, but could be an area of further study.