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Mathematical Modeling for Cost Analysis of EVELISA-based Johne's Disease Control

Johne's disease (JD) is a chronic granulomatous enteritis of ruminants caused by *Mycobacterium avium* subsp. *paratuberculosis* (MAP), an environmental bacterium found in 68% of US dairies tested. The disease is of particular concern to the US dairy industry, resulting in annual economic losses in excess of $220 million. Using a nine-compartment system of difference equations, we modeled the spread of JD on a typical dairy herd, incorporating the use of a test and cull management strategy.

In our model, we included contact structure of dairy cattle with the possibility of adult infections to better simulate JD epidemiology on a dairy farm. In the simulation, cattle that tested as strongly positive were immediately removed from the farm, and calves were not fed with colostrums / milk from those cattle.

The model was used to evaluate the cost-effectiveness of control measures based on a recently developed ethanol vortex enzyme-linked immunosorbent assay (EVELISA). In previous studies, the EVELISA test showed much higher diagnostic sensitivity (97.4%) than that of current ELISA tests (~30%). Versus no testing, use of the EVELISA for JD control resulted in average per capita savings of $82.45 after ten years, which compared favorably with the use of the commercially available ELISA test that saw average per capita savings of only $51.17 after ten years.