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A within-herd state transmission model for MAP infection in farms co-grazing deer and sheep in New Zealand

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Pastoral farming in New Zealand (NZ) is characterized by all-year grazing and strong seasonality of production cycles. Sheep, beef and deer commonly co-graze on the same pasture concurrently or sequentially. *Mycobacterium avium* subspecies *paratuberculosis* (MAP) is the causative agent of Johne's disease (JD), occurring worldwide in farmed ruminants. JD is a chronic wasting disease limiting the production in intensive farming systems. MAP infection is endemic in all livestock species in NZ. This pathogen is sub-classified into type I (S, sheep) and type II (C, cattle) strains. In mixed species pastoral systems, both MAP types occur, are transmitted between species, and have been associated with different prevalence of infection and incidence of JD on New Zealand farms. Considering the interaction of C and S strains on inter-species MAP transmission dynamics allowed us to evaluate the beneficial impact of selected co-mingling strategies on prevalence of infection and incidence of JD in the two respective species. We developed a two-host two-strain state-transition model of MAP transmission dynamics among deer and sheep grazing the same pasture. The transmission was driven primarily by pasture contamination. Seasonal density changes and age-related grazing management influenced pasture contamination levels. MAP transmission was simulated with both type I and type II strains competing for hosts. The impact of two co-grazing interaction types between deer and sheep were studied (either concurrent or sequential). This model predicts the prevalence of MAP infection and incidence of JD in sheep and deer with two different strains of MAP, for different patterns of co-grazing. This contributes to identify optimal co-grazing strategies in multi-species farms regarding JD management.