

Impact of dairy herd reproductive performance simulated with a Markov-chain model on predicted enteric CH₄ emission, excretion of N and P, and profitability

Our objective was to estimate the impact of reproductive performance on environmental impacts of predicted enteric CH₄ emission, excretion of N and P, and on herd profitability. A Markov chain model was applied to simulate herd dynamics based on productive and reproductive input parameters. Different herd structures were obtained after simulation of herds with 12 (Low) vs. 22% (High) 21d-Pregnancy Rate. Lactation curves from a commercial farm were used to simulate milk production whereas DMI was calculated based on NRC 2001 empirical equation. Diets for cows in early (0 to 150 DIM) or late (>150 DIM) lactation contained 16.7 vs. 15.4% CP, 44.2 vs. 41.4% NFC, 10.4 vs. 11.2% hemicellulose (HC), 16.7 vs. 23% cellulose (CEL) and 0.38 vs. 0.34% P, respectively. Dry cows diet was formulated to contain 13.2% CP, 34.8% NFC, 14.3% HC, 24.8% CEL and 0.27% P. Enteric CH₄ emission was predicted by an empirical equation ($\text{CH}_4 \text{ g/d} = [(0.814 + 0.122 \times \text{intake NFC kg} + 0.415 \times \text{intake HC kg} + 0.633 \times \text{intake CEL kg})/0.05565]$). The difference between N and P intake (g/d) and milk N and P secretion (g/d) was used as a predictor of N and P excretion (g/d). Profit (\$/cow per yr) for High and Low were calculated by summation of: income over feed cost, culling cost, reproductive program cost, and calf value. Compared with Low, High resulted in higher milk production per lactating cow (40.3 vs. 41.8 kg/d), lower percentage of lactating cows (90.6 vs. 88.8%), lower average DIM (188 vs. 176), and higher income over feed cost (7.76 vs. 7.83 \$/cow per d). In addition, High outperformed Low by \$69.4 cow/yr. Emission of CH₄ and CH₄/milk were 425 g/d and 11.6 g/kg for Low and 419 g/d and 11.4 g/kg for High, a 1.5 and 2.3% reduction. Compared with Low, High N and P excretion were reduced by 1.2% (373 vs. 369 and 45 vs. 44 g/d, respectively). Under conditions of this case study, the model indicated that changing a dairy herd structure through improved reproductive performance reduced environmental impacts while improving profitability.

Keywords: Reproductive performance, Methane, Nitrogen and Phosphorus, Economics