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Abstract & Author Information

A large Markovian linear program model for dairy herd decision-making
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The purpose of the study was twofold: 1) propose an innovative modeling framework using Markovian linear programming to optimize dairy farm net returns under different decision schemes and 2) illustrate the model with a practical application. A dairy herd population was represented by cow state variables defined by parity (1 to 15), month of lactation (1 to 24), and pregnancy status (0 non-pregnant and 1 to 9 pregnant). A database of 326,000 lactations of Holsteins was used to parameterize reproduction, mortality and involuntary culling. Five diets were studied to assess economic, environmental, and herd structural outcomes. Diets varied in proportions of forage, corn grain, and soybean meal within and between lactations, which determined dry matter intake, milk production, and N excretion. The problem was set up as a Markovian linear program model containing 5580 decision variables and 2792 constraints. The model optimized the net return of the steady state dairy herd population having two options in each state: keeping or replacing an animal. Hence, the model identified the maximum net return that included a cost benefit function of the N excretion associated with the optimal policy. The problem was solved using the Risk Solver Platform with the Standard LP/Quadratic engine. The optimal policy with 2008 milk, feed, and livestock prices called to replace open cows between 11 and 14 months after calving depending on parity and diet, with higher culling rates for lower parities and high corn grain diet. High corn grain diet resulted in $22.8 and $61.8/mo per cow higher net returns compared with intermediate and no-corn grain diets. The model detected an opportunity to substitute corn grain for forage in mid and late lactation to increase net return and decrease N excretion. With lower milk prices and higher feed prices, the model suggested lower replacement rates and increased use of forage to increase net profit, which consequently decreased N excretion.

KEYWORDS
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