Abstract

Environmental concerns from dairy farms arise primarily because of the potential negative impacts of manure and urine excretions by dairy cattle on air, soil, and water resources. In addition, increasing opportunities are arising for using manure as a source of renewable energy. Consequently, it is important to assess the amounts of manure excreted by dairy herds. Regulatory agencies use only a few animal groups and average herd characteristics to estimate steady manure excretion. However, manure excretion varies seasonally and should be predicted based on dynamic herd group characteristics. Prediction parameters are periodically revised and improved by regulatory agencies. This study describes the creation of a stochastic dynamic herd model to predict seasonal manure excretion with improved predictor parameters.

Introduction

• Environmental concerns from dairy farms arise primarily because of the potential negative impacts of manure and urine excretions.

• Objective: To develop a stochastic dynamic model of herd performance to predict seasonal manure excretion by using local herd characteristics and better predictor parameters.

Materials and Methods

Stochastic simulation of milking cow dynamics

A Markov-chain approach (Cabrera et al., 2006; deVries, 2004; St-Pierre and Thraen, 1999) simulates the dynamics of the dairy herd by calculating the number of cows (MC) in each of more than 1,400 to-be-defined cow production stages, by month.

Let 

\[ MC_{l,m,i} = MC_{l-1,m-1,i} + (MC_{l-1,m-1,i} \times (1 - CR_{l,m,i})) \]  

for all \( l \geq 2, m \geq 2, \) and \( i \).

Milking Cows

\[ MC_{l,m,i} = MC_{l-1,m-1,i} \]  

Pregnant Cows

\[ MC_{l,m,i} = MC_{l-1,m-1,i} \]  

Non-Pregnant Cows

\[ MC_{l,m,i} = MC_{l-1,m-1,i} \]  

To start a simulation, the total number of adult cows in a herd is assigned to the cow state of first lactation, first month of milk, and non-pregnant (CM). Then, the simulation model distributes these cows and populates all possible cow states.

New Mexico Indices

• Dairy Herd Improvement Association (DHIA) records for New Mexico, compiled in 2006 by the processing centers of Raleigh, NC (http://www.dhia.org), Provo, UT (http://www.dhiprovo.com/), and Agri-Tech of Visalia, CA (http://www.agritech.com/).

• Monthly data from 23 dairy farms across New Mexico including detailed information of herd size, milk production, pregnancy rates, and culling rates.

Sensitivity of Manure Excretion to Pregnancy Rate

• Higher pregnancy rates lead to more lactating females and therefore greater predicted manure excretion.

Sensitivity of Manure to Culling Rate

• Lower culling rates determine more animals remaining in the herd and consequently higher amounts of manure excreted.

Conclusions

• Predictions of the seasonal variation of manure excretion create a better opportunity for calculating manure use and recycling needs, and aids in addressing issues relative to bioenergy production, planning of storage, management, and assessment of environmental impacts.

• This modeling approach is a substantial contribution to current stage of manure excretion in dairy farms located in North Florida; A comparison of three models. J. Dairy Sci. 89: 1830-1841.

• This is a “working-in-progress” application, which will be permanently improved and updated.

• This is a “baseline” application, which will serve to integrate other dairy farm components.

References


