Implementation of CTR Dairy Model Using the Visual Basic for Application Language of Microsoft Excel

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ABSTRACT

The goal of the article is to implement the CTR Dairy model using the Visual Basic for Application (VBA) language of Microsoft Excel. CTR Dairy is a dynamic simulation model for grazing lactating dairy cows that predicts milk production and profit over feeding based on ruminal digestion and absorption of nutrients under discontinuous feeding schedules. The CTR Dairy model was originally developed as a research tool using a proprietary computer simulation software called SMART that required the SMART client to run the program. As SMART software is now discontinued, and its client is no longer available, rewriting the model in the VBA language using Microsoft Excel for inputs and outputs makes the program available to a broad range of users including dairy farmers, extension advisors, dairy nutrition consultants and researchers. Dairy farmers can use the new version of the CTR Dairy program to manipulate the herbage allowance and the access time to the grazing paddock, as well as the timing of supplemental feeding, to improve the utilization of the pasture and to increase the production of the milk.

KEYWORDS

Dairy Cattle, Discontinuous Feeding Systems, Feeding Schedule Evaluation, Grazing System, Modeling, Ration Evaluation

INTRODUCTION

CTR Dairy is a dynamic simulation model for grazing lactating dairy cows that predicts milk production and profit over feeding based on ruminal digestion and absorption of nutrients under discontinuous feeding schedules. The following biological background is based on Chilibroste (2008). While most rumen simulation models assume relatively ‘steady state’ conditions, the practical need for models that can represent discontinuous feeding regimes, caused by not feeding cattle totally mixed rations (TMR) that cause rumen pool sizes to vary with time of the day, was highlighted (Dijkstra et al., 2005). Compared with continuous feed input, discontinuous feeding may result in distinctly different profiles of non-glucogenic to glucogenic volatile fatty acids (VFA) and rumen pH values.
that could temporarily negatively affect fiber degradation. Moreover, deviations from widely used Monod-equations, that represent microbial substrate utilization and growth in most metabolic models, may be transient conditions of the rumen ecosystem (Dijkstra et al., 2002).

In modern dairy management systems, it has become common to offer cows feed on an ad libitum basis. Confined cows are often kept in loose housing systems and, to prevent feed selection, are offered a TMR. Thus, feed intake becomes relatively independent of individually expressed intake behavior as the management objective is to make intake behavior a function of the diet, rather than of the animal. This contrasts to foraging cattle, where animal selection is integral to behaviour. Providing nutritionally balanced diets for foraging cattle is generally achieved by supplementing pasture with feed supplements at various times of the day. Cattle foraging behavior, and their strategies to obtain a balanced nutrient profile in pastoral ecosystems, are determined by their short and long-term physiological state, pasture availability, as well as the feeding level and type of supplements (Chilibroste et al., 2005). Feed intake behavior of cattle is characterized by alteration, during the day, of eating, rumination, rest and social activities (Gibb et al., 1997). Factors that control eating and grazing time are less well understood than factors that control intake rate, such as bite mass, time per bite and the ratio between prehension and manipulation of jaw movements (Chilibroste, 1999; Laca et al., 1994). Whereas short-term changes in metabolizable energy supply and gut fill are probably involved in controlling meal size and frequency, it is longterm signals, such as changes in body energy stores that influence dry matter (DM) intake. The role of learning on DM intake control was highlighted by Provenza (1995), although total DM intake and diet selection at grazing are mediated by different foraging strategies that result from integration by cattle of short and long-term information (Forbes, 1995), suggesting a very complex process.

To represent and predict the unique processes of ingestion and digestion under discontinuous feeding situations, such as grazing, it is essential that a rumen model simulate the resulting diurnal fermentation processes. Recently, results of a series of grazing experiments that varied the allowed grazing time, as well as the combinations of rumen fill and fasting length before grazing, were used to evaluate a mechanistic, dynamic model (Chilibroste et al., 2001) that aimed to predict digestion and absorption of nutrients, and was based on a previously developed model (Dijkstra et al., 1996), in which cattle were fed sugarcane based diets. The increase in prediction error with increased length between two consecutive meals (Chilibroste et al., 2001), highlighted the need for diurnal definition of model parameters, such as fractional passage and degradation rates, and the dynamics and kinetics of soluble feed fractions in the rumen.

The CTR Dairy model was originally developed as a research tool using a proprietary computer simulation software called SMART that required the SMART client to run the program. As SMART software is now discontinued, and its client is no longer available, rewriting the model in the Visual Basic for Application (VBA) language using Microsoft Excel for inputs and outputs makes the program available to a broad range of users including dairy farmers, extension advisors, dairy nutrition consultants and researchers.

As its name suggests, the VBA language is closely related to Visual Basic and uses the Visual Basic Runtime Library. However, VBA code can only run within a host application such as Excel, rather than as a stand-alone program. Code written in VBA is compiled to Microsoft P-Code (packed code), which the host application (Excel) stores as a separate stream in its files (e.g., .xlsx, .xlsm). The intermediate code is then executed by a virtual machine (hosted by the host application). CTR Dairy saves data in text files encoded using the Extensible Markup Language (XML). These data files are both human-readable and machine-readable and also the CTR Dairy program to interact with other programs written in other programming languages.

As CTR Dairy does not formulate a ration, the user must first use a ration formulation program such as PC Dairy (Ahmadi et al, 2013) to formulate a least cost ration, and then use the unique feature of CTR Dairy to find the best feeding schedule to optimize milk production and to maximize profit over feeding.
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