UNIVERSITY of GUELPH

ONTARIO AGRICULTURAL COLLEGE

DEPARTMENT OF ANIMAL BIOSCIENCES

MSc Defence

MILKING THE MODEL: ENHANCING THE NASEM (2021) SYSTEM INTO THE DIGITAL TWIN OF A DAIRY COW FOR INTELLIGENT DIET FORMULATION

Chidinma Unigwe

Date: Wednesday August 6, 2025 at 1:00 pm

The PhD Defence for Chidinma Uniqwe has been scheduled for August 6, 2025 at 1:00 pm. The defence will be held online via Teams and in room 141: https://teams.microsoft.com/l/meetup-join/19%3ameeting_ZWQzODIzMzYtMDdlNi00ODNiLTkwMjMtMGU2ZDE1MjlhY2Y4%40thread.v2/0?context=%7b%22Tid%22%3a%22be62a12b-2cad-49a1-a5fa-85f4f3156a7d%22%2c%22Oid%22%3a%22dfbebf32-99ae-4022-a68f-422f93e11c7f%22%7d

Exam Committee:

Examining Chair: Dr. Lee-Anne Huber

Advisor: Dr. John Cant

Advisory Committee Member: Dr. Jennifer Ellis

Additional Member: Dr. Michael Steele

Abstract:

Optimization of diet formulation for lactating dairy cows can be facilitated with a digital twin that simulates changing milk yields over a 305-day lactation cycle, generating a lactation curve that reflects real-world patterns. This study modified the NASEM (2021) dairy cow model by introducing dynamic scaling factors into the equations for milk fat and protein prediction. These factors, referred to as adaptive multipliers, were calibrated using weekly data on dry matter intake (DMI), diet composition, and milk components from DePeters et al. (1985) and Holter et al. (1993) to simulate milk fat and protein yields over a 305-day lactation cycle. Protein multipliers were applied to the NASEM (2021) protein yield equation, while the NASEM (2021) milk fat yield equation was scaled using a fat multiplier. The multipliers were adjusted iteratively to minimize residuals until the predicted and observed yields aligned within a 0.01 g tolerance, generating a digital twin for the Holter et al. and DePeters et al. datasets. Curve fitting techniques were used to model the progression of multipliers and DMI, which were subsequently applied to simulate full lactation curves.