# Generative AI for Dairy Life Trajectory Modeling: Transforming Milk Recording and Sensor Data into Actionable Farm Intelligence

Miles Asha*[1], Jiang Jicai[2], Maltecca Christian[2], Fourdraine Robert[1]

[1] DRMS, [2] North Carolina State University

The objectives of this presentation are to demonstrate methods to leverage generative AI by integrating many different data sources (historical records and real-time data) to provide actionable information to dairy producers.

There is a common challenge in the U.S. dairy industry: farmers need to decide which heifers to raise for better profitability based on limited early-life information, and these early management decisions impact both individual cow and overall farm profitability years into the future. A wealth of data is available to help a farm make better decisions, but most of this information is used retrospectively, after a decision has been made. A research project is underway to develop a novel AI approach using large language models (LLMs) to predict dairy cattle lifetime profitability from early-life indicators. This project adapts autoregressive transformer architectures—proven successful for temporal event modeling in healthcare and finance—to process cow life trajectories as sequences of timestamped events. Our approach treats each cow's life as a "sentence" where events like birth weight, illness, and breeding are "words" that the model learns to interpret in context. The transformer architecture captures long-range dependencies (e.g., calf pneumonia affecting milk production years later) while incorporating temporal dynamics through specialized encoding mechanisms. Beyond prediction, the model generates synthetic life trajectories for data augmentation. This feature could allow small farms with limited historical data to benefit from insights derived from large-scale datasets. The model provides probabilistic profitability predictions and simulates management interventions, transforming reactive decisions into proactive optimization. Training of the model relies on parlor sensor data, health, genetic, and breeding records from Dairy Records Management Systems (DRMS). Here we demonstrate two simple examples 1) the probability of cow termination (culling or death) within the next 180 days, and 2) the probability of major health events (including mastitis, lameness, ketosis, and fever) within the next 90 days. These predictions are probabilistic rather than deterministic, reflecting biological variability and management uncertainty. Outcomes from this work have the potential to significantly shift livestock management by synthesizing millions of life experiences into actionable intelligence accessible to every farmer, regardless of operation size. Predicting future performance can lead to proactive intervention strategies improving profitability measured by limiting losses of animals and improved health.