EFFECT OF DIFFERENT PERFORMANCE AND COW FEATURE INPUT VALUES ON ESTIMATIONS OF FEED COSTS FOR LACTATING DAIRY COWS

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ABSTRACT

Complete lack of data, poor quality data, or a major time lag until data becomes available are all reasons for poor business decision-making ultimately resulting in reduced profitability. At a dairy farm good decision making is highly dependent on the availability of high quality and current data about different parameters of the production unit, i.e., the cow. Unfortunately, despite the availability of many technologies and data on dairy farms today, dairy producers continue to lack tools that provide an accurate and detailed account of individual cow profitability with minimal effort and in real time. Thus, most of the individual cow decision-making continues to be done based on averages for the herd or groups, parameters that do not truly reflect cow profitability, and in some cases perception or "gut feeling". To overcome this barrier to good business decision-making, I propose using daily values for cow inputs and outputs to estimate dry matter intake and feed cost which is a leading expense for dairy farms and thus, an important value to estimate overall cow profitability. In this study, I used data from existing precision technologies for commercial dairy farms that monitor parameters of performance and cow features required by equations to calculate feed intake by cattle. Substantial differences for estimations of dry matter intake and feed cost for lactating dairy cows were observed when representing scenarios when data from precision technologies were or were not available.

BIOGRAPHICAL SKETCH

Sami Ullah was born on April 8th, 1988, in a town of Azad Jammu & Kashmir, Pakistan named Bhimber. He was raised working with water buffalos of his family and developed a passion for animal science. After high school, Sami attended Sindh Agriculture University in Tandojam, Pakistan and earned his Doctor of Veterinary Medicine degree in May 2012. With a core interest in dairy animals, Sami started a full-time job at a commercial dairy farm in Pakistan as a junior veterinarian. In 2014 he got accepted in an internship program in USA and came to Texas, where he spent 3 years working on different dairy farms. He moved to New York in 2016 and started a full-time job as transition cow manager and hospital in-charge at a commercial dairy farm in upstate New York. In 2020, Sami attended Cornell University to pursue a Master of Professional Studies degree in Animal Science, with a concentration in Dairy Production and Business management. Upon graduation, Sami is looking to begin his career in dairy industry as a sales and technical support person. Sami's primary interests include dairy cow health and performance, dairy farm operational efficiency and dairy farm business management.

DEDICATION

I dedicate this project to all my past, present teachers, and future mentors, especially those who are actively working within the dairy industry. Dairy industry is very keenly nourishing the world and so desperately needed but unfortunately, largely undervalued. I really admire and appreciate all the scientists and dairy professionals for their dedication to feed the world.

I also dedicate this project to my beloved wife who supported me throughout this period to accomplish my dreams and excel in my career.

ACKNOWLEDGMENTS

I would like to thank the dairy farm for sharing their data to use in this project. I would like to acknowledge the support that I have received from Dr. Julio O Giordano (Cornell University) Mr. Martin Perez (PhD Scholar, Cornell University, Dept. of Animal Science) and my brother Umair Nawaz throughout the completion of this project, as well as others in Cornell University, Department of Animal Science.

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INTRODUCTION

Dairy producers are constantly challenged with making decisions about the herd and individual cows such as culling, breeding, grouping, treating, and feeding cows among many others. Thus, good business decision-making in dairy farming depends on the availability of high quality and current data about the profitability of the business production unit, i.e., the cow. Unfortunately, because most if not all farms lack measures of individual cow profitability most of the individual cow decision making continues to be done based on averages for the herd or groups, certain parameters of performance that do not necessarily reflect cow profitability (e.g., monthly milk production, number of health events, genetics), and in some cases perception or "gut feeling". Thus, new approaches and tools for estimating individual cow profitability might help improve decision-making in dairy farms.

The proliferation of automation in the modern dairy herd for daily tasks means that large quantities of data are being, or can be, routinely collected. Analysis of these data can be conducted at both the herd level and individual cow level to inform economic decision-making (Roche et al., 2009) and allow true comparisons between cows rather than averages. For example, the large amount of detailed individual cow data generated by multiple sensor and non-sensor systems currently used (or available) by commercial dairy farms (e.g., milk volume and components meters, scales, feed management software, automated BCS) could be used to calculate individual cow daily overall cash flow by accounting for milk value, feed cost, and other input and outputs values such as disease prevention and treatment costs, reproductive costs, facilities, milking, and other operating expenses.

A major challenge is to estimate feed cost because none of the precision technologies available for commercial farms use can monitor dry matter intake for individual cows. A potential solution to overcome this limitation is to use data from precision technologies which enable tracking cow production performance and cow features such as body weight for individual cows to predict intake based on validated equations. Once intake is estimated, data can be integrated with other inputs and outputs as well as market prices to calculate feed cost for individual cows in real time. Although these estimations may not be as accurate as those based on measurement of individual cow intake, they might be more accurate than estimations based on averages for groups of cows or for periods during lactation for individual cows. Therefore, we hypothesized that predictions of individual cow intake based on data from precision technologies would differ from predictions based on single group averages for specific periods of the lactation. Thus, the objective of this study was to compare estimations of individual cow daily feed intake and feed cost calculated based on detailed individual cow performance and feature data from precision technologies versus average values for groups of cows to represent conditions in which data from precision technologies are not available.

MATERIALS AND METHODS

Animals and data

This project was conducted using a subset of data collected for another study conducted at a commercial dairy farm in Tompkins County, New York from January of 2018 to April of 2020. During the study period the average number of milking cows was 1,376 (range: 1,296 to 1,455) and the average number of dry cows was 207 (range: 149 to 262). For this project, we used data from a total of 334 cows (107 primiparous and 227 multiparous). All procedures with animals were approved by the Institutional Animal Care and Use committee of Cornell University.

Cows were housed in free-stall barns with concrete flooring and six or eight rows of stalls. Fans and sprinklers were placed above the feeding lane. A TMR was delivered once daily, and cows had ad-libitum access to feed and water. Cows were milked in a 60-stall rotary parlor three times a day at ~8 h intervals. At every milking, an inline milk meter (Afimilk MPC, Afimilk Ltd., Kibbutz Afikim, Israel) and milk analyzer (Afilab, Afimilk Ltd., Kibbutz Afikim, Israel) collected data for milk yield (g), milk components [fat (%), protein (%), lactose (%)], and milk conductivity (mmHo).

The subset of data used for this study was transferred to Excel for further analysis. Only cows with the most complete data for daily observations from 3 to 150 days in milk (DIM) were selected. A small proportion of missing values were filled using data for the previous day or days depending on data availability. All values were converted to kilograms and week of lactation was determined by dividing DIM by 7 and rounding up values with decimals.

Estimations of feed intake

The dry matter intake (DMI) of individual cows was calculated by using the National Research Council equation of 2001:

DMI = [(0.372F x FCM) + {0.0968 x (BW^0.75)}] x [1-EXP {-0.192 x (WOL + 3.67)}]

Where:

DMI = dry matter intake in kg

FCM = fat correct milk at 4%

BW = body weight in kg

EXP = exponential

WOL = week of lactation

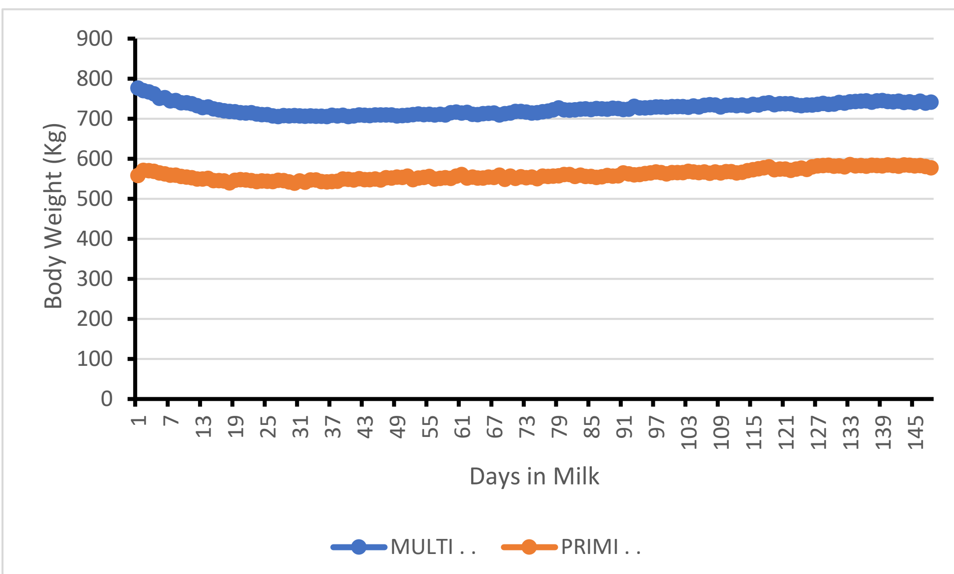
Fat corrected milk (FCM) was calculated by using formula:

FCM 4% = [0.4 x daily milk yield] + [15 x daily milk fat]

Different calculations of DMI were conducted by using different input values for individual cows for milk yield, milk fat, and body weight to represent scenarios in which daily data from precision technologies were available versus scenarios that represented common types of data availability at commercial farms. All calculations were conducted separately for primiparous and multiparous cows. For the estimation of DMI based on detailed data from precision technologies (Scenario 1), daily values for individual cows for milk yield, fat yield, and BW were used. On the other hand, to represent a scenario in which no daily data from precision technologies were available (Scenario 2), average values for specific periods of lactation were used. Specifically, a single average value for BW from all cows from 3-21 and then from 22-150 DIM, and single monthly values for milk yield and fat yield from all cows for each month from calving until 150 DIM were used.

RESULTS

(A)



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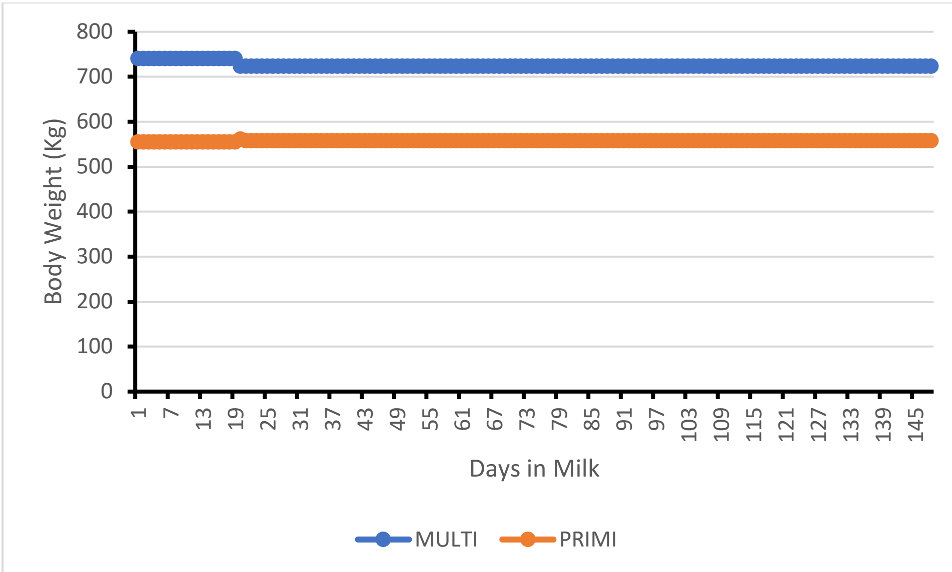
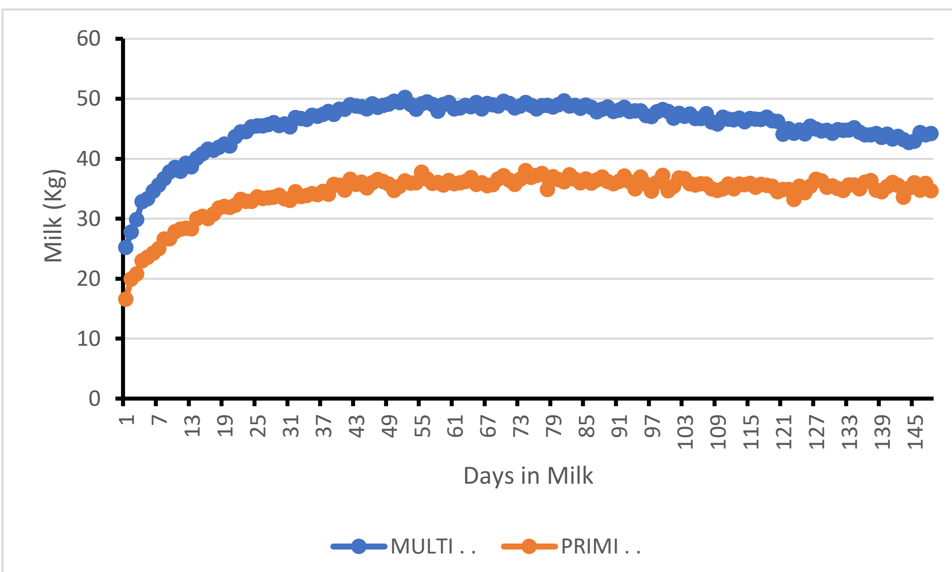


Figure 1. (A) Average daily body weight for all multiparous and primiparous cows and (B) single average body weight from 3-21 and 22-150 DIM for all multiparous and primiparous cows.

(A)



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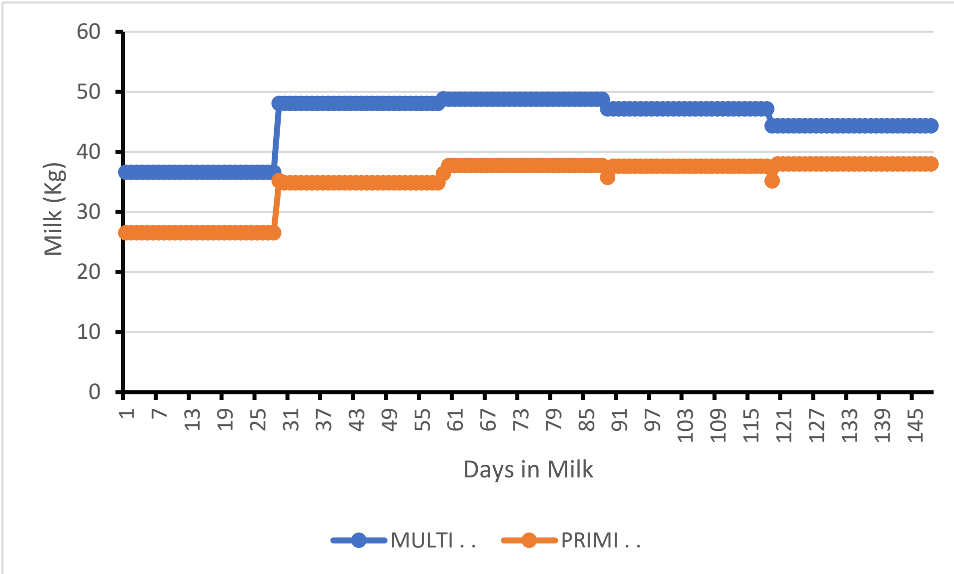
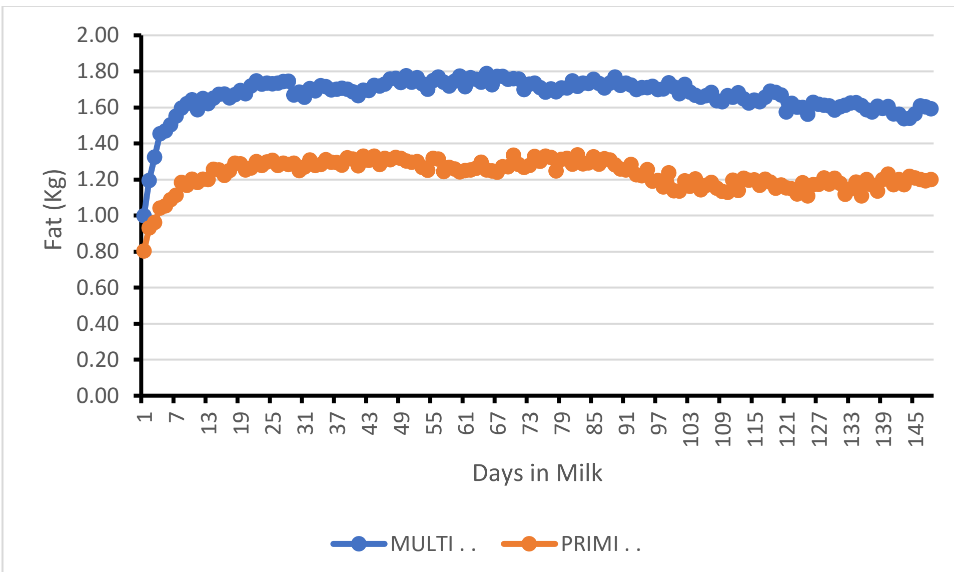


Figure 2. (A) Daily milk yield curves for all multiparous and primiparous cows and (B) milk yield based on monthly averages from all cows.

(A)



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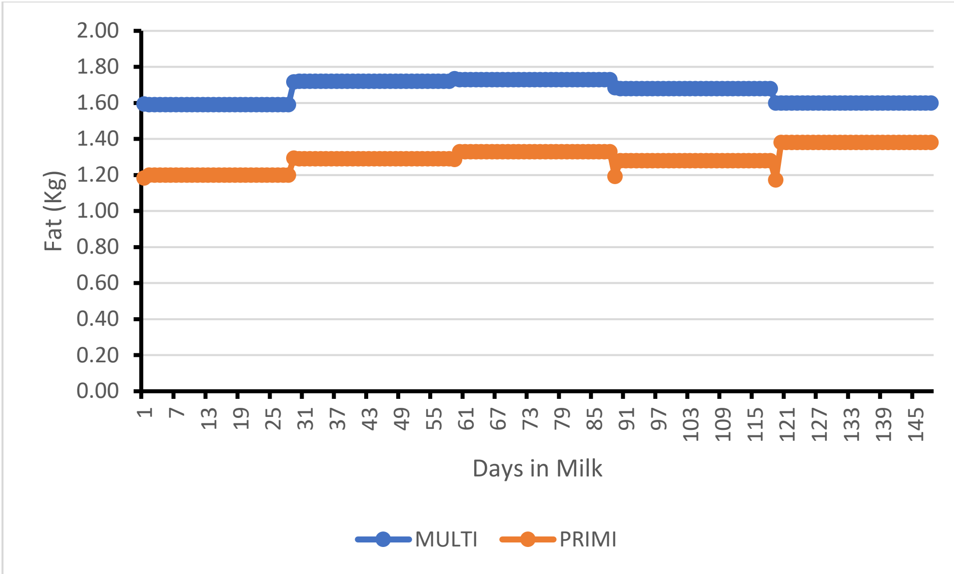
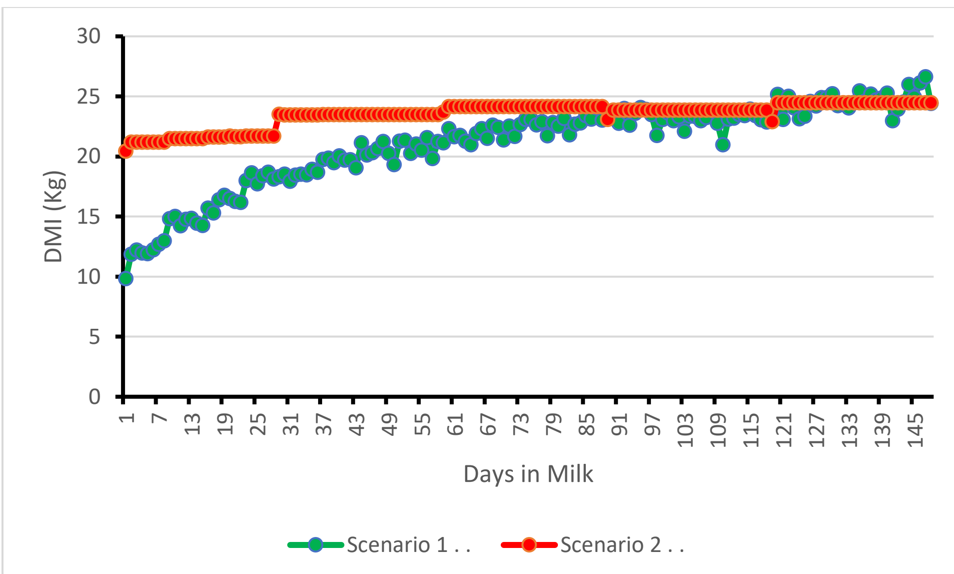


Figure 3. (A) Daily milk fat yield curves for all multiparous and primiparous cows and (B) milk fat yield based on monthly averages from all cows.

(A)



(B)

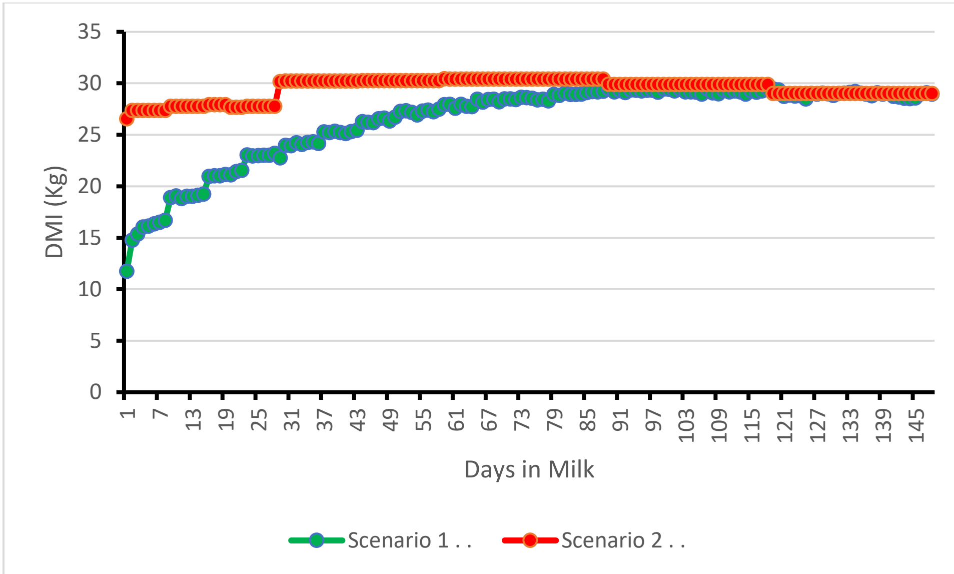


Figure 4. Dry matter intake estimations for scenario 1 and 2 for (A) primiparous and (B) multiparous cows.

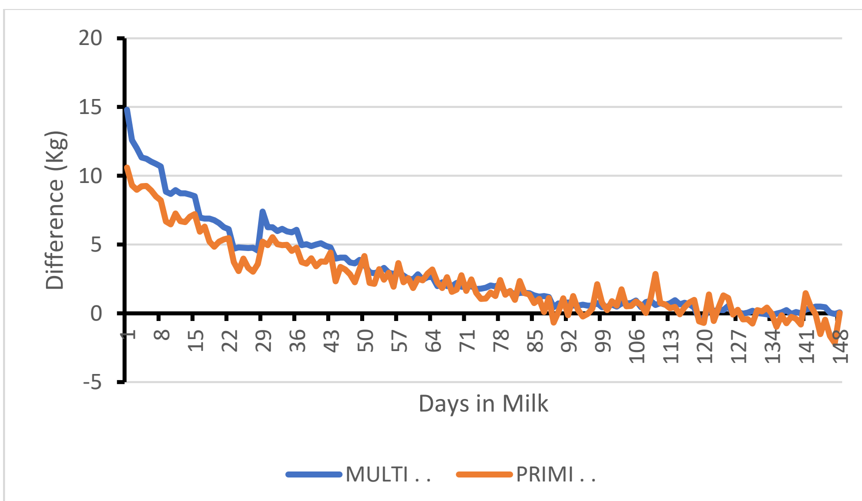


Figure 5. Daily difference in DMI between Scenario 1 and 2. Scenario 1 used individual daily BW, daily fat and daily milk whereas Scenario 2 used a single average value for BW from 3-21 DIM and a single average value from 22-150 DIM. Single monthly average values were used for milk yield and milk fat yield.

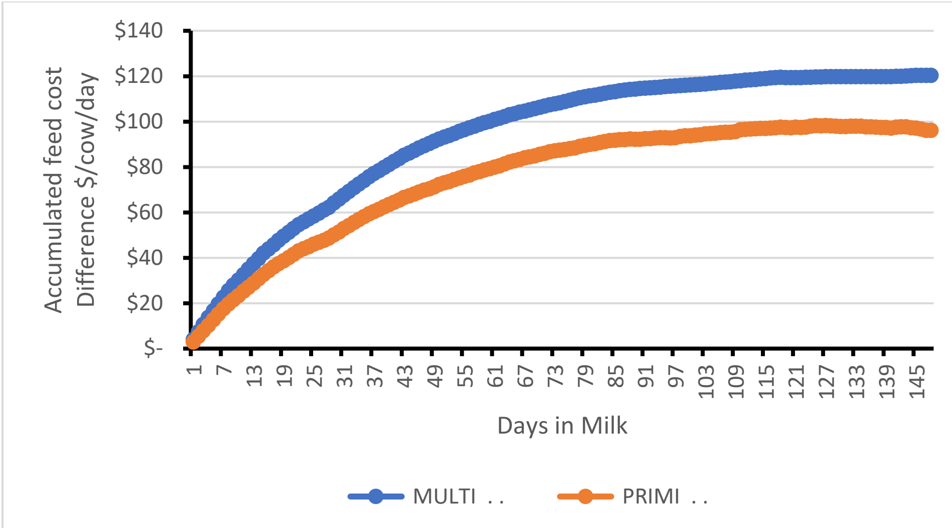


Figure 6. Accumulated feed cost difference between scenario 1 and scenario 2. Scenario 1 = individual daily BW, daily fat yield, and daily milk yield and Scenario 2 = single average BW value for 3-21 DIM and single average for 22-150 DIM, single monthly average values for milk yield and milk fat yield.

Table 1. Accumulated values for DMI (kg) and feed cost ($) from 3-21, 22-150, and 3-150 DIM, for primiparous cows.

Scenario	DMI 3-21 DIM	Accum. Feed Cost	DMI 22-150 DIM	Accum. Feed Cost	DMI 3-150 DIM	Accum. Feed Cost
1	262.21	$70.08	2,858.49	$771.79	3,120.70	$841.87
2	405.56	$109.50	3,071.06	$829.19	3,476.62	$938.69

Table 2. Accumulated values for DMI (kg) and feed cost ($) from 3-21, 22-150, and 3-150 DIM, for multiparous cows.

Scenario	DMI in 3-21DIM	Accum. Feed Cost	DMI in 22-150 DIM	Accum. Feed Cost	DMI in 3-150 DIM	Accum. Feed Cost
1	341.04	$92.08	3,574.65	$965.15	3,915.69	$1,057.23
2	524.25	$141.55	3,837.40	$1,036.10	4,361.65	$1,177.65

DISCUSSION

Results from this study demonstrated large differences (~$100 to $120 per cow) for accumulated feed cost up to 150 DIM in both primiparous and multiparous cows when estimated using detailed data from precision technologies versus average values to represent lack of precision technologies on farm. In this case we used daily milk weight and milk fat yield data generated by an in-line milk monitoring sensor system and body weight data generated by a walk-over scale. This scenario, which represented the availability of these sensor systems on farms, was compared with a typical scenario for commercial dairy farms that participate in monthly milk testing programs. In the latter case, the farm would only have available average milk and fat yield data for individual cows once per month. For body weight, we used an average value for all cows from 3 to 21 DIM and then from 22 to 150 DIM under the assumption that body weight from cows at these stages of lactation would be known. Although this is not likely the case for most commercial dairy farms, it is possible to obtain an approximation of average adult body weight at a farm by collecting body weight from a subgroup of cows with simple tools such as a measuring tape.

Interestingly, the largest daily differences were observed in early lactation due to differences in DMI as large as 3 to 10 kg for primiparous and 5 to 15 kg per cow per day for multiparous cows. These observations are the result of the changing dynamic for milk production and body weight for dairy cows. Milk production ramps up rapidly within the first 30 to 60 DIM whereas body weight declines to reach a plateau within 30 to 45 d after calving. This dynamic in early lactation generates the largest difference when compared to average values which cannot properly represent the trajectory of the parameters used in estimation of DMI. On the other hand, once milk production peaks and body weight remain stable, average values become more similar to individual cow daily values reducing the differences in estimations.

In summary, this study demonstrated the potential added value of precision technologies for monitoring performance parameters and cow features for predicting individual cow feed intake and feed cost. These technologies could then be used to improve business decision-making at commercial dairy farms through better monitoring of individual cow profitability.

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