From milk recorder to bulk tank: understanding factors affecting consistency in fat and protein reporting

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Abstract

Irish dairy producers milk record their cows, on average, 4 times annually; results reported include milk fat and protein percent (as well as milk yield). Farmers receive a mean herd (i.e, bulk tank) fat and protein percent generally every two days. Discrepancies often exist between both measures taken at approximately the same day.

The mean of the reported fat and protein percent of all cows milk recorded on a given day in a herd was compared to the bulk milk results taken on the same day; also compared was the mean of the three bulk milk collections taken before and after a milk recording event.

The dataset comprised of 4,660 test day milk recordings from 1,784 herds in the year 2023. Fat and protein percentages were, on average, underestimated for the milk recording sample compared to the bulk samples. The discrepancy between test day milk recordings and bulk collections were greater for fat percentage then protein percentage.

On average, milk recorded fat and protein percentages both underestimated relative to the bulk collections. The mean of the three bulk collections taken after a milk recording deviated, on average, more from the milk recording values, while those taken on the same day and before the recording were better aligned.

The Pearson correlations between milk recorded and bulk tank fat percent taken on the same day was 0.857 whilst the mean of the three bulk collections before and after a given milk recording had respective Pearson correlation of 0.841 and 0.828.

The root mean square error (RMSE) of the residuals between milk recorded and bulk collected fat on the same day were 0.347, whereas the RMSE for the mean of the three bulks collections before and after a milk recording were 0.353 and 0.424, respectively. This analysis also highlighted the influence of factors such as the type milk recording device, herd average cow yields and seasonal effects on the values reported in both milk recordings and bulk collections. However, they only scratch the surface when trying to gain a true understanding of the reasons discrepancies, particularly in fat % occur.

Keywords: milk recording; Irish dairy.
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Introduction

Milk recording (MR) is a crucial management tool for Irish dairy farmers, providing valuable insights into herd health and performance. Since the abolition of milk quotas in 2015, the practice of milk recording has grown steadily on Irish dairy herds. According to the latest figures from the ICBF database, over 1.1 million cows are milk recording across 9,100 herds. Typically, Irish dairy producers milk record their cows' four times annually, receiving data on milk fat, protein percentages, and yield.

Farmers also receive bulk tank (BT) results, which report the mean herd fat and protein percentages approximately every two days. However, discrepancies often arise between the results obtained during milk recordings and the bulk milk samples, even when both are measured on the same day.

The primary objective of this study is to explore and quantify the discrepancies between milk recording and bulk milk collection results on Irish dairy farms. Furthermore, the study aims to investigate factors that may contribute to inconsistencies in the reported fat and protein percentages, thereby improving the understanding of why differences may occur.

Material and methods

Data

The data used in this study were sourced from a pre-existing database managed by the Irish Cattle Breeding Federation (ICBF). Test day milk recording (MR) and bulk tank (BT) herd averages were extracted from this database. MR samples were recorded using the alternative AM-PM recording scheme, as approved by the International Committee for Animal Recording (ICAR, 2021). BT samples were collected and reported by dairy processors during on-farm bulk milk collections.

The dataset included 4,660 test day MR records from 1,784 herds, each of which had a corresponding bulk tank recording taken on the same day. All herds had a minimum of four milk recordings in 2023 and were contracted to supply milk to dairy processors.

Analysis

The mean fat and protein percent of all cows recorded in a herd on a given test day were compared to the corresponding bulk milk results collected on the same day. Additionally, comparisons were made to the mean fat and protein percent of the three bulk milk collections taken both before and after a milk recording event. Accuracy was assessed using Pearson correlations and the root mean squared error (RMSE) of the residuals between MR and BT results.

Results

Summary statistics

Table 1 presents the summary statistics for fat and protein percentages recorded during MR and BT collections, including the mean, standard deviation (SD), and minimum/ maximum values.

On average , MR fat and protein percent is underestimated compared to the BT with the largest discrepancies occurring in fat percent. These discrepancies are reflected by Pearson correlations of 0.853 and 0.929 for fat and protein percent, respectively, with corresponding RMSE values of 0.352 for fat and 0.124 for protein percent.

The mean of the three bulk milk collections taken after a milk recording deviated more from the milk recording values than those taken on the same day or before the recording. Pearson correlations between MR and BT fat percent taken on the same day

Table 1. Summary statistics of MR & DB milk fat and protein percentage.

Trait		Mean	SD	Min/Max
MR	Fat %	4.33	0.56	2.87/7.12
	Protein %	3.67	0.29	2.92/5.07
BULK	Fat %	4.52	0.52	3.36/6.88
	Protein %	3.75	0.29	2.97/4.91

Table 2. Pearson correlation and RMSE between MR fat percent and the bulk fat percent taken on the same day, the mean of the 3 bulks before and after.

Fat %	Pearson Correlation	RMSE
Same Day MR-Bulk	0.857	0.347
Mean of Three Bulks Before	0.841	0.353
Mean of Three Bulks After	0.828	0.424

Table 3. The Impact of recording service type on Pearson Correlations and RMSE of fat and protein percent between MR and bulk samples.

Recording type	Number of herds	Fat % correlation	Fat % RMSE	Protein % correlation	Protein % RMSE
EDIY	2,036	0.89	0.36	0.94	0.13
Manual	2,624	0.82	0.35	0.92	0.12

were 0.857, while the correlations for the mean of the three bulk collections before and after the MR were 0.841 and 0.828, respectively. The RMSE of the residuals between MR and BT fat percent was 0.347 for same-day comparisons, and 0.353 and 0.424 for the bulk collections before and after, respectively.

Impact of recording type

Table 3 shows the impact of milk recording device type on the Pearson correlations and RMSE for fat and protein percent between MR and BT samples. The EDIY recording method had higher correlations and RMSE values compared to the manual recording method.

Impact of test day yield and season

Average test day cow yields ranged from less than 10L to 40L across all test day MR events. Herds were categorized based on average test day cow yield, and Pearson correlations and RMSE were calculated within each category. A downward trend was observed in fat percent correlations as test day yields increased, suggesting that discrepancies in fat percent grow with higher yields. However, the differences in RMSE across yield categories were less pronounced. Similarly, correlations for fat percent were lower during the peak milk season, when yields were higher, compared to the off-peak season when yields were lower. The RMSE across seasons showed

only minor differences, suggesting that discrepancies in fat percent are less sensitive to seasonal variations than yield levels.

Discussion

This comparative analysis highlights some of the challenges in aligning milk recording (MR) results with bulk tank (BT) samples. The discrepancies observed are likely due to a combination of factors beyond just milk recording type, yield, and seasonality. These potential contributors include:

- **Multiple Milkings in Bulk Tanks**: Milk composition and yield can vary significantly from one milking to the next (Quist et al., 2008). Consequently, aligning the results of a bulk tank sample, which often contains milk from several milkings, with a single milk recording sample is inherently difficult.
- **Assumption of Gold Standard**: While this analysis focuses on identifying factors affecting MR results, it is important to acknowledge that we lack insight into the factors influencing BT sampling. Bulk tank sampling procedures are generally well-documented; however, limited information is available on specific factors impacting fat and protein percentages during bulk collections. Given the sensitivity of MR samples, particularly in determining fat percentages (Fouz et al., 2009), various sources of error may exist during BT collection, potentially affecting the consistency of results when comparing BT to MR sample.
- **Variety of Milking Meters**: Irish dairy farmers use a wide variety of milking meters. Around 50% of herds use electronic DIY (EDIY) systems, such as Tru-Test meters, while the remaining herds rely on various manual meters, including ICAR-approved, non-ICAR-approved, jar meters, and others. The frequency of servicing and calibration of these meters to both manufacturer and ICAR standards is largely unknown and is often left to the discretion of farmers, introducing another layer of potential error that may contribute to inconsistency in reporting.
- **Inconsistent milking machine performance**: Milking machine performance metrics, such as vacuum level and milk flow rate, have been shown to significantly impact overall milking performance (Besier and Bruckmaier, 2016). Air leaks in liners or sub optimal liner type can lead to fluctuations in vacuum and flow rates and result in under- or over-milking, which may have a considerable impact on a given MR sampling (O'Callaghan and Gleeson, 2004).

A follow-up study has been commissioned to investigate the relationship between milking machine performance and MR reporting. This study will provide a more comprehensive understanding of the factors contributing to MR discrepancies at the farm level.

Conclusion

On average, fat and protein percent reported in milk recordings are underestimated compared to bulk tank results, with the largest discrepancies observed in fat percent reporting. While factors such as recording method, yield, and seasonality influence these discrepancies, they do not fully explain them. The underlying issues likely stem from the milk recording infrastructure, including milking machine performance, calibration, and certification. Additional research is necessary to understand the causes behind the misalignment of MR and BT fat and protein percentages.

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