A new approach to predicting the fat content in 2x milking

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Abstract

Traditionally, the estimation of the 24-hour fat content from a one-milking sample has required conducting a large study with multiple samples during the recording day from thousands of cows from different herds and milking intervals. In this study, we show how a large amount of practical data can be used for creating a local calculation method without additional samples. In the Finnish case, some 7.5 million samples with data on preceding milking intervals were used, combined with what we know about the analysed milk composition and about the individual cows. The results are also compared from the point of view of how well they alleviate the differences between milking times and intervals.

Summary

This paper describes the current status with 24-hour yield calculations in the Finnish milk recording system, as well as the historical reasons behind the choices made. The results of each method are also shortly analysed. The methods are found to be working reasonably well, but not perfectly. New correction factors were calculated out of the local data set.

Keywords: Milk recording, conventional milking, 24-hour yield calculation.

Introduction

In the Finnish milk recording, owner sampling has been common practice since the 1980's, and appr 95% of all herds now record by that method, with their own private recording equipment. At the same time, 90% of all samples are reportedly taken from one milking only. Farmers are also responsible for some 90% of milk recording data capture. In September 2019, 40.0% of all recordings during the previous rolling 12-month period came from automatic milking. This article presents the 24-hour yield calculation methods currently in use.

Historical overview

Up until 2003, the only available sampling method in Finland was proportional sampling. 24-hour yields were simply calculated by adding up milk weights and using the analysed values as they come.

This approach, however, started to be problematic due to three main reasons. Firstly, in a farmer-recording system it became evident that many samples were in fact not exactly proportional between the evening and morning milkings. Secondly, the results showed that a number of farmers were taking samples from one milking only. And the third reason was the advent of automatic milking which made it impossible to continue the old way.

For these reasons, it was decided to allow one-milking sampling starting April 2003.

Currently used methods

In traditional milking systems, milk weights are measured at two consecutive milkings (or three, if the cows are milked thrice per day). Some 10% of all herds claim to take proportional samples, and no correction is applied to their laboratory analyses. For fat content in one-milking samples from traditionally milked herds, the Delorenzo and Wiggans (1986) correction is applied with the received factors.

In automatic milking systems, the milk weights are collected during a 96-hour period and these results are used for calculating a 24-hour yield for each cow (Lazenby *et al*., 2002). In this calculation, the preceding intervals are taken into account to adjust to uneven individual cow measurement periods.

The fat and protein yields, however, are estimated on the basis of a one-milking sample, using data of only two preceding milkings (Peeters and Galesloot,2002). This method was also tried for milk weights but some herds with irregular cow traffic had a lot of problems with that, so the approach was changed in 2016. Also, the original Peeters and Galesloot method was found to produce slightly underestimated fat contents when compared to dairy deliveries, so in 2017, the method was updated by the corrections suggested by Roelofs *et al*. (2006), adding factors like stage of lactation, parity, and hour of the day to the equation.

Evaluation of current methods

To evaluate how the methods are working, a very simple comparison was made with average

24-hour yields produced by each method. The results for the whole Finnish dairy cow population are shown in table 1. In general, the differences between the methods are small.

However, we notice here that the calculation does not entirely cover the difference between fat contents in morning and evening milk. The correction factors used are already 33 years old and are based on data from a significantly lower yield level. Typical Finnish feeding also produces high milk fat contents which is maybe not entirely in keeping with the data used for making these formulae.

Automatically milked cows also tend to obtain a lower 24-hour fat content than cows from conventional milking systems. This was presumed to be due to higher milk yield, but due to the fact that the automatic milking herds have a significantly higher proportion of Holsteins, the results were recalculated for Holstein breed only (Table 2). Here the difference between morning samples and samples from automatic milking was slightly smaller.

Table 1. Corrected and recorded 24-hour averages by method, all cows.

		Average result			
Sampling scheme	**Nr of samples**	**Milk, kg**	**Butterfat, %**	**Protein, %**	**Cell count**
One-milking sample (Z), milking time 4-10 AM	255,461	29.8	4.30	3.58	157
Z sample, milking time 2-8 PM	309,974	30.2	4.51	3.61	187
Proportional (P) sample	112,620	29.6	4.41	3.61	167
Z sample, automatic milking	370,908	33.4	4.23	3.56	214

Table 2. Corrected and recorded 24-hour averages by method, Holstein cows only.

		Average result			
Sampling scheme	**Nr of samples**	**Milk, kg**	**Butterfat, %**	**Protein, %**	**Cell count**
One-milking sample (Z), milking time 4-10 AM	116,009	31.3	4.17	3.52	161
Z sample, milking time 2-8 PM	142,204	31.9	4.36	3.56	184
Proportional (P) sample	45,191	31.4	4.25	3.55	167
Z sample, automatic milking	231,346	34.8	4.14	3.52	216

The accumulated data set

Since 2003, a data set of 7.5 million recordings has accumulated with data on the time of the sampled and preceding milking as reported by the farmer, the lab analysis results, and the 24-hour milk yield. Grouped according to the preceding interval, the analysed fat content gives a nice sigmoid curve with the highest fat content found after a 540 to 630 minutes' interval (9 to 10.5 hours) and the lowest at 810 to 930 minutes (13.5 to 15.5 hours).

The results were also divided into subgroups according to lactation number, phase of lactation, and breed. The effect of the preceding milk interval on milk fat seems to be bigger with older cows and in the beginning of lactation. It was also bigger with Ayrshire cows as compared with Holsteins. At this point, however, the decision was made not to take these factors into account when calculating new correction factors.

Table 3. Average analysed milk fat by preceding interval class, 2003 - 2020

Interval before sampling, minutes	Number of samples	Average interval in the class	Average fat content analysed, %
<510	93,577	495	4.20
510-540	19,523	525	4.70
540-570	111,268	555	4.79
570-600	253,807	585	4.83
600-630	1,461,587	615	4.75
630-660	919,968	645	4.66
660-690	1,168,683	675	4.56
690-720	223,877	705	4.42
720-750	517,447	735	4.28
750-780	212,428	765	4.16
780-810	924,014	795	4.12
810-840	698,463	825	4.09
840-870	1,104,778	855	4.07
870-900	154,561	885	4.05
900-930	77,024	915	4.07
>930	26,977	945	4.13

Calculation of new factors

The results above were turned into a simple set of correction factors, dependent solely on the preceding interval. In order to do this, two assumptions were made:

1. A 24-hour recording day was assumed. This way, we can deduce the second milking interval from the one we know and mirror the fat percent for that milking.
2. Milk secretion rate was assumed to be constant around the 24-hour period. This allows us to deduce the share of the 24-hour yield produced at each milking.

These assumptions allow us to create the new correction factors by mirroring the milk yield and milk fat content in the milking whose actual data we have not got. This way, we get the following formula:

Table 4. Calculation of the mirrored milking and the correction factors.

Interval before sampling, minutes	Average fat in the sampled milking, %	Share of 24-hour milk yield in the sampled milking	Mirrored interval, minutes	Average fat in the mirrored milking, %	Calculated 24-hour average fat, %	Correction factor
<510	4.21	0.34	>930	4.14	4.16	0.989
510-540	4.77	0.36	900-930	4.08	4.33	0.907
540-570	4.82	0.39	870-900	4.05	4.35	0.903
570-600	4.84	0.41	840-870	4.07	4.38	0.906
600-630	4.76	0.43	810-840	4.09	4.37	0.919
630-660	4.66	0.45	780-810	4.12	4.36	0.936
660-690	4.56	0.47	750-780	4.16	4.35	0.953
690-720	4.43	0.49	720-750	4.29	4.36	0.984
720-750	4.29	0.51	690-720	4.43	4.36	1.016
750-780	4.16	0.53	660-690	4.56	4.35	1.046
780-810	4.12	0.55	630-660	4.66	4.36	1.059
810-840	4.09	0.57	600-630	4.76	4.37	1.070
840-870	4.07	0.59	570-600	4.84	4.38	1.076
870-900	4.05	0.61	540-570	4.82	4.35	1.073
900-930	4.08	0.64	510-540	4.77	4.33	1.062
>930	4.14	0.66	<510	4.21	4.16	1.006

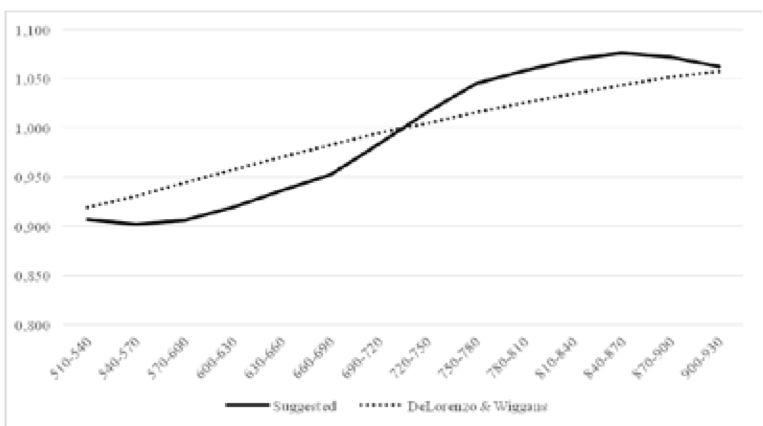

Figure 4. The obtained correction factors compared to the DeLorenzo and Wiggans (1986) factors

Table 5. Analysed and corrected fat in milk samples between September 2020 and March 2021.

Sample type	Number of samples	Analysed protein, %	Analysed fat, % (direct average)	24-h fat, % (weighted avg)
Morning samples	54,486	3.66	4.25	4.52
Evening samples	66,684	3.70	4.73	4.48
Proportional samples	22,528	3.68	4.44	4.45

*Correction factor = [(Sampled milk * sampled fat) + (Mirrored milk * mirrored fat)]/(sampled milk + mirrored milk)*

Comparing the obtained correction factors with those used in the original DeLorenzo and Wiggans method, we can see that the new factors form more of a sigmoid curve than a straight line. They will thus correct the analysed results with greater effect than the old method, especially when the preceding interval is around 10 or 14 hours.

Application of the new factors

These new factors were taken into use in the Finnish milk recording system in July 2020. Looking at the results now, we have managed to bridge the gap in 24-hour fat content between evening and morning samples. It is also easy to do a recalculation of the factors on a regular basis, and make changes if the situation has changed.

Conclusions

The earlier 24-hour calculation methods are performing on a satisfactory level. However, it seems that the historical fat correction factors needed recalculation to make the obtained estimates more accurate. The new factors were obtained from a large data set by mirroring the milking whose data did not exist. The factors have been taken into use, and are performing better than the old ones. They can easily be recalculated in the future.

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