INTRODUCTION

The ICAR Lactation Working Group carried out a Survey in 2000 among all ICAR member countries (Miglior et al., 2000). Almost 20% of the countries (representing 60% of milk recorded cows worldwide) were offering flexible options to farmers in terms of milk recording, i.e. a varying combination of the following: recording from one to twelve-week interval(s), full and/or alternate recording, supervised and/or unsupervised milking. Results from the same Survey showed the increasing usage of milking robots across member countries (42%). The heterogeneity of handling data collected with milking robots was also quite evident across all countries, due in part to the lack of robotic milking standards. With a growing number of available options and use of milking robots, new updated ICAR guidelines were necessary to standardize treatment of data collected under various milk recording systems. In 2002 the ICAR guidelines for milk recording were reviewed and updated and preliminary guidelines for milk recording from robot (automatic milking systems, AMS) were drafted (Miglior et al., 2002).

Capturing milk, fat and protein yield data is central to the purpose of milk recording and genetic evaluation programs. In traditionally milked 2x and 3x herds, milk weight and composition data from 1, 2 or 3 milkings, each with an associated milking interval, can be used in combination with established adjustment factors to generate accurate estimates of the required 24-hour yields. In AMS herds it is possible to capture each cow’s milking times, milk weights and associated time interval between milkings. With the use of specialized sampling equipment (shuttle), it is possible to collect a sample from every milking during a 24-hour test period. However, while the electronic capture of the weights and times is automatic and requires little or no human intervention during the test period, the same is not true for the sampling process. Although automatic sampling equipment exists, and can readily be used to obtain composition samples, the sampling equipment requires some degree of periodic supervision to remove full sample vials and load empty ones.

The challenge is to find a balance between the cost associated with recording data collected from AMS herds and the accuracy of 24-hr yield of milk, fat and protein.

ESTIMATION OF 24-HOUR MILK YIELD

For management purposes, the robotic milking software generates a rolling average daily milk yield based on the preceding 14 days production. Unfortunately, a historic 14-day average carries considerable momentum and lag, and best estimates the production of the cow 7 days earlier. Depending on whether the cow is pre- or post-peak, this milk yield will either under-estimate or over-estimate the true yield on the day of the milk test.

Milk yield data for a 24-hour period in herds milked twice or three times a day can be obtained by weighing all milkings during the period, or weighing the milk produced at a single milking and using established adjustment factors to predict the 24-hour yield. The adjustment factors are based on traditional milking intervals. Depending on a cow’s parity, stage of lactation and production level, AMS systems allow individual cows to visit the milking station at variable intervals, from once to 5 or 6 times a day. This flexibility results in a range of milking intervals, some of which are quite short (3 or 4 hours for early lactation cows) and others quite long (up to 14 or more hours for cows nearing the end of lactation). Most AMS systems facilitate the electronic capture of milk weights during a designated 24-
hour test period. In most cases this can be used to calculate an accurate 24-hour milk yield. However, for cows that visit the milking station infrequently, or if all milk is not evacuated from the udder during one or more of the milkings during the test day, the milk yield estimates can be inaccurate.

A study by Lazenby et al. (2002) has identified the optimal number of milkings or days to accurately estimate 24-hour milk yield in AMS milked cows. The average of most recent milk weights was calculated using a number of preceding milkings or a number of preceding days. If number of milkings was used, the optimal estimate of the milking rate was obtained using an average of current milking together with the 12 most recent milkings back in time. The optimal estimate was the maximum value of the difference curve at which the correlation with the ‘true’ 24-hour milk yield was greatest and the variance across milkings was minimized. If number of days was used, the optimal estimate of the milking rate was obtained using an average of all milkings occurred in the last 96 hours (4 most recent days). In Table 1 percent of maximum difference for various number of milkings and days is reported. The optimal estimate was shown to be independent from stage of lactation and parity.

### Table 1 Percent maximum for different number of days and milkings

<table>
<thead>
<tr>
<th>Days</th>
<th>Percent Max.</th>
<th>Current milking + most recent milkings</th>
<th>Percent Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>49.38%</td>
<td>10</td>
<td>97.85%</td>
</tr>
<tr>
<td>2</td>
<td>77.26%</td>
<td>11</td>
<td>99.08%</td>
</tr>
<tr>
<td>3</td>
<td>92.34%</td>
<td>12</td>
<td>99.70%</td>
</tr>
<tr>
<td>4</td>
<td><strong>98.91%</strong></td>
<td>13</td>
<td><strong>99.81%</strong></td>
</tr>
<tr>
<td>5</td>
<td>98.50%</td>
<td>14</td>
<td>99.40%</td>
</tr>
</tbody>
</table>

**ESTIMATION OF 24-HOUR FAT AND PROTEIN YIELD**

Calculation of fat and protein percent must be based on milk weights at time of sampling. The 24-hour protein percentage can be predicted by the protein percentage of the sample without adjustment. However, the 24-hour fat percentage is more difficult to predict, as levels of fat percent are inversely proportional to the amount of milk yield. It is important therefore to have a close connection between time of samples and actual milk yields. A study by Peeters and Galesloot (2002) has shown that the best prediction of 24-hour fat percentage was achieved through use of multiple regression. The best model included fat percentage, protein percentage, milk yield and milking interval of the sampled milking, milk yield and milking interval of the preceding milking, and the interaction between milking interval and the ratio of fat to protein percentage of the sampled milking.

After the estimation of 24-hour fat and protein percentages, 24-hour fat and protein yield were computed using the preceding 24-hour average milk yield. A disadvantage of this procedure is that a 24-hour milk yield computed using an average of the last day is subject to a higher degree of variability as was shown by Lazenby et al. (2002) (see Table 1). The study by Peeters and Galesloot (2002) also concluded that one single sample sufficed to get a satisfactory estimate for 24-hour fat yield, as long as certain restrictions were maintained: correct matching, interval of at least 4 hours and no interrupted milking). However, a German study by Buenger et al. (2002) found that it was not possible to accurately estimate the daily fat content from only one single test. Likewise, a recent investigation by Hand et al. (2004) concluded a more accurate estimation of fat and protein yield was achieved when every sample of a cow in a given time period was collected and analyzed. A sampling period of 16 hours seemed a good compromise, between accuracy and duration of sampling period.
SAMPLING PERIOD IN AMS HERDS

Given the high variability of milking frequency within and across cows during a 24-hour period, the best estimate of fat and protein percentages could be then calculated when samples are taken through the complete period. However, a 24-hour sampling is not always a feasible solution for milk recording agencies due to higher cost of this procedure. A less than 24-hour sampling period could be sufficient for a reasonable estimation of fat and protein percentages.

Depending on the size of the herd, milk recording may need to be performed 3 or more times during the 24-hour test period, often necessitating at least one night-time visit to the milking station. Most producers with AMS, who subscribe to milk recording services, and the milk recording supervisory staff, would prefer to limit the duration of a robotic milk test to a more manageable period of time.

A study by Hand et al. (2002) indicated that there was a reduction in the accuracy of the 24-hour fat and protein yield estimate as the length of the sampling period decreased from 18 to 12 hours. While a 24-hour sampling period was undesirable from a labour and cost perspective, a sampling period of 14 or 16 hours seemed practical resulting in a minimal loss in accuracy in the range of a 0.10 to 0.15 kilogram deviation in absolute 24-hour yield. The concern that by reducing the sampling period the number of samples per cow decreased and some cows on a low frequency milking schedule would not be sampled, was legitimate. While the number of repeated samples per cow decreased, 4 % to 7 % of cows in the herd were not sampled at all when a 16 or 14 hour sampling period was used.

A French investigation by Bouloc et al. (2002) concluded that an estimation of daily performances at least as accurate as in the case of an AT control was obtained from 17 hours of sampling. By sampling during the day, the sampling time was reduced to 15 hours without penalizing cows for non content result.

CONCLUSION

In the last few years preliminary research worldwide has allowed to establish initial guidelines for milk recording in AMS herds. The balance between accuracy and cost of recording seems to be with a sampling period of 16 hours, where all samples are analyzed and a 24 hour yield is computed as an average of the last 4 days or last 12 milkings. The 24-hour protein percentage can be predicted by the protein percentage of the sample without adjustment. Best prediction of 24-hour fat percentage is instead achieved through use of multiple regression. After the estimation of 24-hour fat and protein percentages, 24-hour fat and protein yield can be computed using the preceding 24-hour average milk yield. A disadvantage of this procedure is that a 24-hour milk yield computed using an average of the last day is subject to a very high degree of variability. Current research attempts to address the problem of obtaining an accurate estimate of fat and protein percentages based on the right connection between the most accurate 24-hour milk yield with the 24-hour fat and protein yield.

REFERENCE


