A comparison of alternatives of milk recording schemes for dairy sheep

Summary
A total of 307 lactations of ewes from synthetic line (13/16 East Friesian Milk Sheep, 3/16 Polish sheep breeds) were investigated. Ewes were milked after weaning, starting on the 60th day of lactation, for the period of four months. Milk recording was conducted using the A30 scheme during the morning and afternoon milkings. Twenty one simplified milk recording schemes were investigated, taking into account the data from 4 or 6 control milkings, and estimating the differences between milk production, protein and fat contents on the basis of the simplified and the A30 methods. The accuracy of the methods to estimate milk (protein, fat) yields was verified using the pairwise test. Among the tested 4-measurement methods, the most useful – in terms of the accuracy of milk, protein and fat yield estimations – were models, in which milk recording is conducted once a month, only in the morning or afternoon. The application of such methods does not result in the deterioration of accuracy of milk recording for sheep and makes it possible to lower the costs connected with recording by approximately 50%.

Key Words: sheep, milk recording, milk composition

Zusammenfassung
Titel der Arbeit: Vergleich alternativer Methoden der Milchleistungsprüfung bei Milchschafen

Schlüsselwörter: Schaf, Milchleistungsprüfung, Milchzusammensetzung

Introduction
In many countries with a high standard of sheep breeding, profits gained from sheep milk are second only to the revenue from the sale of slaughter lambs. We are witnessing the same trend in Poland, where there is an increasing interest in this type of production as an alternative source of income in sheep breeding, especially among breeders in the lowland regions of our country (WOJTOWSKI et al., 1999).
A significant factor affecting the standard of production in case of milking sheep is the adequate development of milk recording schemes (GUT et al., 1999). The recording
results and a good selection programme have contributed to a considerable increase in the milk yields in the European Union countries of the Mediterranean region (BARILLET et al., 1996).

Monthly recording of two daily milkings (the "A" method) is the standard method for dairy cattle (GABINA et al., 1986). The fixed costs of the A method in relation to the commercial value of the final product are about 2 or 3 times larger in milking sheep than in cattle (BARILLET and ROUSELLEY, 1987; SANNA et al., 1994). The simplified milk recording schemes present many potential advantages including: lower costs for the dairyman, less disruption of daily farm routine and an increased number of herds participating (DICKINSON and MC DANIEL, 1970; WÖJTOWSKI et al., 1999).

A simplification of the official method for milk recording is A30; it provides monthly recordings of two daily milkings, which can be achieved by:

- Measuring two daily milkings every 45 and 60 days (A45 and A60)
- Measuring only one milking a day (alternately morning and afternoon, AT)

A great number of researchers (BARILLET et al., 1987; BOULOC et al., 1991, Wójtowski and Gut, 1996) have found that the alternate methods are more exact than the A45 and the A60 methods.

Material and Methods

A total of 307 lactations of ewes from synthetic line (13/16 East Friesian Milk Sheep, 3/16 Polish sheep breeds) at the Experimental Farm of the Agricultural University of Poznań, from years 1997-1999 were utilised for this study. Four times, every 30 days, the milk yields were recorded and milk samples for the estimation of protein and fat contents were collected at morning and afternoon milkings, from the 60th day until the 180th day after lambing (the end of lactation). Data from each 8 milk recordings were collected for all ewes included in the study.

Twenty one simplified milk recording schemes were investigated, taking into account the data from 4 or 6 control milkings, and estimating the differences between milk production, protein and fat contents on the basis of the simplified and the A30 methods.

The Daily Milk Yield (DMY) in the models, in which milk recording was to be done once a day, was calculated by doubling the morning or afternoon milk yields (models 6d, 7d, 8d, 9d) or by multiplying the morning or afternoon milk yields by an adjustment factor $K_k$ (models 6k, 7k, 8k, 9k, 13k, 14k). A similar adjustment factor was used e.g. by WIGGANS (1981), DE LORENZO and WIGGANS (1986), BOULOC et al. (1991). The $K_k$ adjustment factor was used because, of all the procedures of calculation, that proposed by GIACCONE et al. (1996) and PORTOLANO et al. (1997), it was the most exact, irrespective of the method tested.

The adjustment factor $K_k$ was calculated both for the morning recording ($K_{km}$), and for the afternoon one ($K_{ka}$), according to the following formulas:

$$K_{km} = \frac{MTMY + ATMY}{MTMY}$$
\[ K_{T_n} = \frac{MTMY + ATMY}{ATMY} \]

where: MTMY – Morning Total Milk Yield
ATMY – Afternoon Total Milk Yield

The production of protein and fat was calculated for each ewe in the way analogous to that used for milk yields.

In models 11 and 12, in which the 3rd and 4th or 5th and 6th milk recordings were omitted (Tab. 1), the figures for milk (protein, fat) yield level obtained during the previous recording were multiplied by the double number of days (i.e. 60). In turn, in models 11a and 12a, data from both milk recordings next to the omitted recording were multiplied by the number of days increased by 50% (i.e. 30 + 15).

<table>
<thead>
<tr>
<th>Milking recording scheme</th>
<th>I M</th>
<th>II M A</th>
<th>III A M</th>
<th>IV A M</th>
</tr>
</thead>
<tbody>
<tr>
<td>M - morning milking (Morgengemelk); A - afternoon milking (Abendgemelk)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ - used control recording (angewandte Einzelprüfung)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d - morning (afternoon) milk (protein, fat) yield multiplied by 2 (Morgen (Abend) Milch-(Protein-, Fett-) menge multipliziert durch 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k - morning (afternoon) milk (protein, fat) yield multiplied by ( K ) (Morgen (Abend) Milch-(Protein-, Fett-) menge multipliziert durch ( K ))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a - multiplier adjusting the consecutive control recordings (Multiplikator für die Überbrückungsrechnung)</td>
<td></td>
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</tr>
</tbody>
</table>

In order to determine the accuracy of the simplified milk recording schemes, for each ewe a difference was calculated between the total milk (protein, fat) yield established using the reference method and the yield estimated with the use of the simplified scheme.

\[ D = A_1 - A_n \]

where: \( A_1 \) - milk (protein, fat) yield determined using the reference method (A30),
\( A_n \) - milk (protein, fat) yield estimated with one of the simplified methods (n=21)

The statistical analysis was conducted using the pairwise test (MORRISON, 1967)
with the statistical package SAS ver. 6.12 (1996).

The following hypothesis was proposed:

\[ H_0 : \mu_1 - \mu_2 = \delta_0 \text{ assuming that } \delta_0 = 0; \]  
(i.e. \( \mu_1 = \mu_2 \))

against an alternative hypothesis saying that the difference equals \( \delta_1 \),  
i.e. \( H_1 : \mu_1 - \mu_2 = \delta_1 \), where \( \delta_1 \neq 0 \) and \( \delta_0 = \delta_1 \).

### Results and Discussion

Table 1 presents a review of the investigated models of simplified milk recording schemes, including the control milking marked for each model. Table 2 presents a comparison of accuracy between the methods used and the official method for milk recording schemes in sheep, the A30 method, in terms of milk, protein and fat yield measurements, where the differences are expressed in kg and in percentages.

#### Table 2

Differences between the A30 and the simplified milk recording schemes (Differenzen zwischen der A30 und der vereinfachten Milchleistungsprüfungsschematas)

<table>
<thead>
<tr>
<th>Milking recording scheme (Schema der Milchleistungsprüfung)</th>
<th>Total milk yield (Gesamte Milchmenge)</th>
<th>Total protein production (Gesamte Proteinmenge)</th>
<th>Total fat production (Gesamte Fettmenge)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg</td>
<td>%</td>
<td>kg</td>
</tr>
<tr>
<td>A30</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2 (A60)</td>
<td>9.926 **</td>
<td>14.83 **</td>
<td>0.514 **</td>
</tr>
<tr>
<td>3 (A60)</td>
<td>-9.926 **</td>
<td>-14.83 **</td>
<td>-0.514 **</td>
</tr>
<tr>
<td>4</td>
<td>2.667 *</td>
<td>3.32 *</td>
<td>0.107</td>
</tr>
<tr>
<td>5</td>
<td>-2.667 *</td>
<td>-3.32 *</td>
<td>-0.107</td>
</tr>
<tr>
<td>6d</td>
<td>0.864</td>
<td>1.41</td>
<td>0.028</td>
</tr>
<tr>
<td>7d</td>
<td>-0.864</td>
<td>-1.41</td>
<td>-0.028</td>
</tr>
<tr>
<td>6k (ATM30)</td>
<td>-0.482</td>
<td>-0.52</td>
<td>-0.052</td>
</tr>
<tr>
<td>7d</td>
<td>-0.864</td>
<td>-1.41</td>
<td>-0.028</td>
</tr>
<tr>
<td>7k (ATS30)</td>
<td>0.484</td>
<td>0.67</td>
<td>0.048</td>
</tr>
<tr>
<td>8d</td>
<td>9.296 **</td>
<td>12.34 **</td>
<td>0.543 **</td>
</tr>
<tr>
<td>8k</td>
<td>-0.020</td>
<td>-0.43</td>
<td>0.013</td>
</tr>
<tr>
<td>9d</td>
<td>-9.296 **</td>
<td>-12.34 **</td>
<td>-0.543 **</td>
</tr>
<tr>
<td>9k</td>
<td>0.023</td>
<td>0.58</td>
<td>-0.016</td>
</tr>
<tr>
<td>10</td>
<td>6.297 **</td>
<td>9.07 **</td>
<td>0.310 **</td>
</tr>
<tr>
<td>11</td>
<td>4.036 **</td>
<td>6.39 **</td>
<td>0.135 **</td>
</tr>
<tr>
<td>11a</td>
<td>-1.130</td>
<td>-1.34</td>
<td>-0.088</td>
</tr>
<tr>
<td>12</td>
<td>3.629 *</td>
<td>5.76 *</td>
<td>0.204 **</td>
</tr>
<tr>
<td>12a</td>
<td>-0.204</td>
<td>-0.32</td>
<td>-0.035</td>
</tr>
<tr>
<td>13d</td>
<td>4.627 **</td>
<td>6.02 **</td>
<td>0.256 **</td>
</tr>
<tr>
<td>13k</td>
<td>0.071</td>
<td>0.22</td>
<td>-0.003</td>
</tr>
<tr>
<td>14d</td>
<td>-4.627 **</td>
<td>-6.02 **</td>
<td>-0.256 **</td>
</tr>
<tr>
<td>14k</td>
<td>-0.101</td>
<td>0.29</td>
<td>0.004</td>
</tr>
</tbody>
</table>

** (*): P<0.01 (**) P<0.05)

Among the 21 investigated methods, ten did not differ from the A30 method assumed as standard, both in terms of accuracy of milk yield measurements, and the corresponding data for protein and fat. The most accurate result, differing from the one obtained using the A30 method by only 0.22% (for milk yield), 0.39% (for protein production) and 0.38% (for fat production, respectively), was given by the 13k method with 6 recordings.
The 6-recording methods, similar to the A30 method as far as estimation accuracy is concerned (i.e. 11a, 12a, 13k, 14k; P > 0.05), were slightly better than those based on 4 recordings, i.e. 6, 6k, 7, 7k, 8k and 9k. The absolute difference in the estimated milk yields between these groups of models ranged generally from 0.2 to 0.4%.

In all investigated models, a better accuracy of estimation was obtained using the Kk adjustment factor.

Taking into consideration the accuracy of the estimated levels of milk, protein and fat production in the 4-recording schemes, it turned out that the most accurate were the 8k and 9k models. These are measurements based on one recording daily (either morning or afternoon) conducted every 30 days.

Two of the models tested in this study: 6k (ATM30) and 7k (ATS30), are classical alternate methods, as AT is measuring only one milking a day, alternately morning or afternoon, every 30 days. Their accuracy in terms of milk yield measurements is similar to that obtained in the 8k and 9k models (D = -0.48 kg and 0.49 kg of milk, respectively; equivalent to -0.52% and 0.67%, respectively). The precision of protein production estimation using those models, however, is considerably lower than that obtained in the 8k and 9k models (D > ±1%, Table 2).

The accuracy of milk yield estimation using the A60 method developed in this study, with respect to the A30 method (D = -14.83%; Table 2), was worse than those achieved by NARDONE et al. (1991) for milking sheep (D = 8.8%), as well as GIACCONDE et al. (1996) for a flock of goats (D = 6.48%). Better accuracy was also given by PORTOLANO et al. (1997), who estimated 345 lactations of Comissana sheep (D = -6.42%). In both papers, the estimated differences between milk yields calculated using the A30 method, and the ATM30 and ATS30 methods were almost identical as the one arrived at in this study. PORTOLANO et al. (1997) reported D = 0.80% and D = -0.57%, respectively.

GIACCONDE et al. (1996) found that if they used the Kk adjustment factor, the alternate methods beginning with the morning milking were more exact than the methods that began with the afternoon milking. The results in this study are consistent with the above trend (Table 2). From a practical point of view, the procedure taking into consideration the adjustment factor in model Kk tends to be more labour consuming only to a limited degree, thus resulting in a relatively small increase in the recording costs. The role of the recording supervisor in that case is limited only to a single individual milk recording (either the morning one or the afternoon one) and a single (morning or afternoon) measurement of the total amount of milk in the container collecting yields from the evaluated ewes.

**Conclusion**

This study showed the feasibility of simplifying the standard milk recording scheme (the A30 method) in the work on the creation of a synthetic line of sheep with a high percentage (13/16) of the Friesian sheep genotype. Among the tested 4-measurement methods, the most useful – in terms of the accuracy of milk, protein and fat yield estimation – were the models, in which milk recording is conducted once a month, only in the morning or afternoon. The application of such methods does not result in the deterioration of accuracy of milk recording for sheep and makes it possible to
lower the costs connected with recording by approximately 50%. Research results indicated a necessity to include in the developed models other data apart from yields, e.g. the production of basic milk components. Moreover, they confirmed the effectiveness of the $K_k$ adjustment factor in the sheep milk recording schemes using simplified methods.

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