Technical Session 16: New Milk Recording Methods and Services

Analysis of the accuracy of lactation qualification methods and use of weighting factors for genetic evaluation

R. Vallée, G. Augier, X. Bourrigan
Context of this French study

- Number of dairy cows and herds in 2020
  - 2,300,000 dairy cows and 32,000 herds (72 cows by herd)
- 8 protocols in Dairy Cattle Milk Recording
  - A protocol by MRO’s technician
  - B protocol by farmer
  - C protocol, by MRO’s technician and farmer
    and T, Z methods (AT, BT, BZ, CZ protocols) with Liu’s method
    *Possibility C method without alternation (AC*) with Liu’s method*
  - and Robots (AR, BR protocols) with at least two samples by cow
    *Possibility only one sample (AR*, BR*) with Peeters&Galesloot’s method*

→ Used methods approved by ICAR to answer expectations of farmers, changes in measuring equipment, new services,…
Context of the French study

 ➢ Methods by protocols

<table>
<thead>
<tr>
<th>Combination between protocol and method</th>
<th>Individual lactation qualification methods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>A</td>
<td>A4 (1)</td>
</tr>
<tr>
<td>B</td>
<td>B4</td>
</tr>
<tr>
<td>AT</td>
<td>AT4</td>
</tr>
<tr>
<td>BT</td>
<td>BT4</td>
</tr>
<tr>
<td>BZ</td>
<td>BZ4</td>
</tr>
<tr>
<td>CZ</td>
<td>CZ4</td>
</tr>
<tr>
<td>AR</td>
<td>AR4</td>
</tr>
<tr>
<td>BR</td>
<td>BR4</td>
</tr>
</tbody>
</table>

(1) The accuracy level is higher for A4 method in comparison with A9 method

From requirements defined in the French Guidelines: interval between calving date-1st test-day, interval between test-day, minimum number of test-day during the first 305 lactation days
Context of the French study

➢ The evolution of protocols & methods

% of herds by protocols in 2020

A = 48%
AT = 25%
Robots AR BR = 13%
B BT BZ = 12%
CZ = 2%
Aims of this study

➢ Many protocols and methods are proposed
   ▪ A, AT, AR, B, BT, BR, BZ, CZ with 4 to 9 possible methods
➢ Willingness to evaluate the accuracy of protocols, methods
   ▪ On lactation reference-305 days from relevant data sets in comparison with A4, AR4 methods (gold standard)
   ▪ Calculation of $R^2$, bias, std dev of bias on criteria milk yields, fat%, fat yields, protein%, protein yields for each method
➢ Calculate weighting factors for genetic evaluation
   ▪ A lactation model is used in France for genetic evaluation
   ▪ Necessity to update first weighting factors implemented since 2001
   ▪ From new relevant data sets
   ▪ With a model which takes into account $R^2$ and repetabiltty by criteria
Description of the data sets

➢ Two data sets
  ▪ First 19,047 lactations reference-305 days A4, separate am/pm milkings from Holstein breed (for T, Z, C methods)
    \[
    \text{Average Milk yields } 9,172 \text{ kg, Fat yields } 351 \text{ kg, Protein yields } 285 \text{ kg}
    \]
  ▪ Second with 8,250 lactations reference-305 days AR4, at least 2 samples from Holstein 74%, Montbéliarde 22% breeds (for R methods)
    \[
    \text{Average Milk yields } 9,495 \text{ kg, Fat yields } 361 \text{ kg, Protein yields } 303 \text{ kg}
    \]

➢ Selection criteria
  ▪ Maximum delay between calving - first test-day 60 days
  ▪ At least 7 test-day during the lactation
  ▪ Lactation days: minimum 280, maximum 399
  ▪ Lactation number < 10
Statistical method

➢ Methodology
  ▪ From reference data set A4 method, simulation of A8 method by keeping one test-day out of two on lactation
  ▪ Calculation of lactation 305 days from A8 method
  ▪ Comparison with reference-305 days A4 method
  ▪ Accuracy on criteria: milk yields, fat%, protein%, fat yields, protein yields
  ▪ Same methodology used for AR4 method (versus AR8 method)

➢ Extrapolation of accuracy
  ▪ For other methods A5, A6, A7 and A9 versus AR5,…
  ▪ By linear regression model
Some results of accuracy by lactation qualification methods
Results of R² on lactation - Methods type 4

<table>
<thead>
<tr>
<th>Protocol/Method</th>
<th>Milk Y.</th>
<th>Fat%</th>
<th>Protein%</th>
<th>Fat Y.</th>
<th>Protein Y.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference A4 AR4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>AT4 Liu</td>
<td>0.997</td>
<td>0.962</td>
<td>0.997</td>
<td>0.989</td>
<td>0.997</td>
</tr>
<tr>
<td>AC*4 Liu</td>
<td>0.966</td>
<td>0.853</td>
<td>0.955</td>
<td>0.940</td>
<td>0.971</td>
</tr>
<tr>
<td>AR*4 P&amp;G</td>
<td>0.997</td>
<td>0.878</td>
<td>0.997</td>
<td>0.954</td>
<td>0.997</td>
</tr>
</tbody>
</table>

For fat% the # of accuracy between AT4 Liu, AC*4 Liu= 11%

For fat yields the # of accuracy between AR4, AR*4 P&G= 5%
Results of $R^2$ on lactation - Methods type 8

<table>
<thead>
<tr>
<th>Protocol/Method</th>
<th>Milk Y.</th>
<th>Fat%</th>
<th>Protein%</th>
<th>Fat Y.</th>
<th>Protein Y.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A8</td>
<td>0.972</td>
<td>0.902</td>
<td>0.946</td>
<td>0.955</td>
<td>0.966</td>
</tr>
<tr>
<td>AT8 Liu</td>
<td>0.967</td>
<td>0.861</td>
<td>0.940</td>
<td>0.945</td>
<td>0.963</td>
</tr>
<tr>
<td>AC*8 Liu</td>
<td>0.925</td>
<td>0.749</td>
<td>0.894</td>
<td>0.876</td>
<td>0.928</td>
</tr>
<tr>
<td>AR8</td>
<td>0.980</td>
<td>0.941</td>
<td>0.963</td>
<td>0.970</td>
<td>0.979</td>
</tr>
<tr>
<td>AR*8 P&amp;G</td>
<td>0.979</td>
<td>0.845</td>
<td>0.961</td>
<td>0.930</td>
<td>0.978</td>
</tr>
</tbody>
</table>

For fat yields the # of accuracy between AT8 Liu, AC*8 Liu= 7%

For fat% the # of accuracy between AR8, AR*8 P&G= 10%
Calculation of weighting factors

➢ Methodology
  ▪ $R^2$ of each protocol and method
  ▪ The repeatability (Rep) of each criteria
    - $0.5$ for milk yields, fat yields, protein yields
    - $0.7$ for fat% and protein%

➢ Description of the formula
  ▪ Weighting factor= $1 - \frac{\text{Rep}}{[1 - \text{Rep} + (1 - R^2 / R^2)]}$
  ▪ Example: A8 method for milk yields: $R^2= 0.972$ and Rep= 0.5
    = $1 - 0.5 / [1 - 0.5 + (1 - 0.972 / 0.972)]$
    = $0.95$ applied for this lactation on criteria milk yields, in genetic evaluation
Some results of weighting factors by lactation qualification methods
Comparison of weighting factors (old & new)

<table>
<thead>
<tr>
<th>OLD Factors</th>
<th>Method 4</th>
<th>Method 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol/Method</td>
<td>Milk Y.</td>
<td>Fat %</td>
</tr>
<tr>
<td>A</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>AT LIU</td>
<td>0.99</td>
<td>0.94</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NEW Factors</th>
<th>Method 4</th>
<th>Method 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol/Method</td>
<td>Milk Y.</td>
<td>Fat %</td>
</tr>
<tr>
<td>A</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>AT LIU</td>
<td>0.99</td>
<td>0.88</td>
</tr>
</tbody>
</table>

For AT4 Liu, overall no # between old and new factors except fat%
For A8 AT8 Liu, new factors are lower for fat&prot.%, better for fat&prot. yields
Results of weighting factors for new protocols

<table>
<thead>
<tr>
<th>FACTORS</th>
<th>Method 4</th>
<th>Method 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol/Method</td>
<td>Milk Y.</td>
<td>Fat %</td>
</tr>
<tr>
<td>AC*LIU</td>
<td>0.93</td>
<td>0.64</td>
</tr>
<tr>
<td>AR*P&amp;G</td>
<td>1</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Overall the level of weighting factors is relevant between methods 4 and 8 for new protocols.

In the case of low accuracy level, especially for fat%, it will be necessary to assess the impact and the additional number of lactations on genetic evaluation.
Conclusion - Discussion

➢ About the context in milk recording
  ▪ Willingness of France Genetics Breeding to propose all the protocols & methods approved by ICAR to the farmers
  ▪ The wish is to simplify and to reduce the cost of Milk Recording mainly in big herds and AMS Robots

➢ Changes in the FGE Guidelines from 2020
  ▪ New protocols (AC Liu, Robots Peeters & Galesloot)
  ▪ New individual lactation qualification model in 2020 (more simple and in accordance with ICAR Guidelines)

➢ Link lactation qualification and genetic evaluation
  ▪ Update and calculation of weighting factors by methods and criteria
  ▪ To improve the QUALITY of genetic evaluation
Thank you for your attention