Computerized solutions for periodic checking of electronic milk meters

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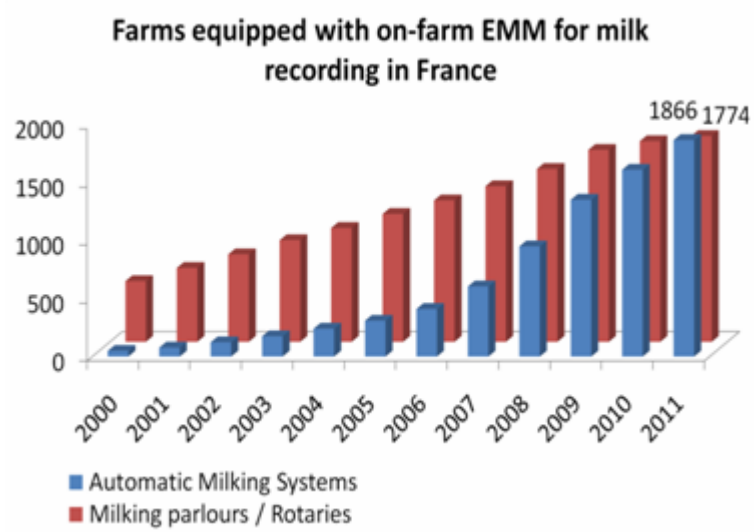
Introduction and context

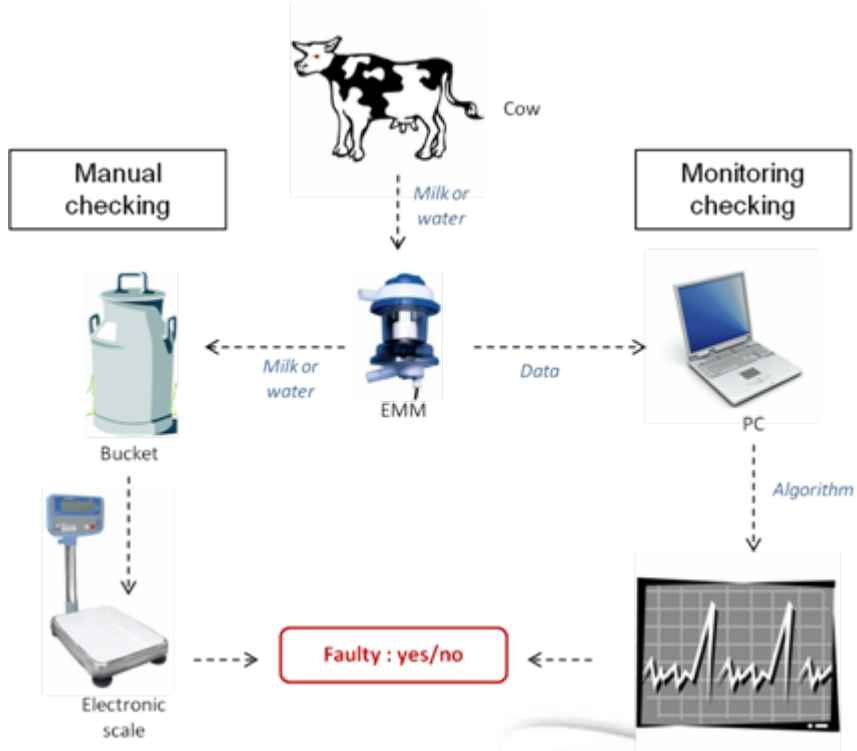
- **In the main countries producing milk**
  - 2 to 25 % of the farms are equipped with EMM
  - Milk recording = Checking once a year
- **Increasing nb of farms equipped**
  - Exponential increase of AMS
  - Linear increase of milking parlours
- **Milk meter control is**
  - Labour intensive and not enhancive
  - Costly
- **Data exchange technologies and statistics allow new possibilities of simplification**



Statistical validation

A possible way of modernisation

- **Use of smart statistical methods**
- **Switch from manual checking to monitoring**
- **Potential benefits**
  - Supplements / Replace the expensive water test
  - Water test is once a year – monitoring is continuous
  - Could be done remotely = visit only if necessary



ICAR Recording Devices SC

The « DataCal » Project

Project definition and objectives

What ?

Update the ICAR guidelines to provide standardized statistical models for validating accuracy of electronic milk meters.

Why ?

So manufacturers or ICAR members' technicians can take data from electronic milk meters from a long period to determine the accuracy levels of the meters involved.

Project team

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- **Marlene Trinderup**, DK, Agrotech
- **Steven Sievert**, USA, DHIA/QSC
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Project main milestones

1. Review existing models
2. Test of the models on farms
3. Refine data/model parameters
4. Validation of the best models/methods
5. Update the Guidelines

Review existing models

- **6 models reviewed**
  - **Lefcourt, 1999, USA** – Several stands milking parlours
  - **De Mol & André, 2009, NL** - Several stands milking parlours and AMS
  - **Trinderup, 2009, DK** - Several stands milking parlours
  - **Olsson, 2011, SW** - Several stands milking parlours
  - **Method used in the USA** - Several stands milking parlours
- **Only one is currently in use**
- **All others were not validated on more farms**

Best models principles

Use of expected milk yield (method used in USA)

- For any given cow and a milking session :

  Expected yield = Ave. yield of last 5 AM or PM milkings x Herd Factor

  Deviation from expected (kg) = Measured yield (kg) – Expected yield (kg)

- For a given EMM and a milking session :

  Deviation (%) = ∑ cow deviations / ∑ expected yields

- Required parameters:

  - **Cow ID**
  - **Milking Stand ID**
  - **Milk yield**
  - **Date and time of milking**

Best models principles

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Use of a Dynamic Linear Model (De Mol & André, 2009)

- Comparison of the milk yield per stand with the overall average milk yield on all stands.
- For a given stand **s** and a milking session **m :**

$$Deviation_{ms}\ (kg) = AveYield_{ms} - AveYield_{m}$$

$$Deviation_{ms}\ (kg) = \mu_{ms} * AveYield_{m}$$

$$Deviation\ factor\ \mu_{ms} = 0\ if\ EMM\ is\ working\ properly$$

- Required parameters:
  - **Milking Stand ID**
  - **Milk yield**
  - **Date and time of milking**

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Best models principles

Use of a lactation model (Trinderup, 2009)

$$Y_i = \alpha_1(Date_i) + \alpha_2(Milking_i) + \beta_1 * DIM_i + \beta_2 * DIM^2_i + \beta_3 * DIM^3_i + \beta_4 * 1/DIM_i + \beta_5(Milking_i) * DIM_i + \beta_6(Milking_i) * DIM^2_i + \beta_7(Milking_i) * DIM^3_i + \beta_8(Milking_i) * 1/DIM_i + a(Cow_i) + \varepsilon_i$$

with:

Y_i : observed milk yield (kg)

Cow_i : cow identification

$Date_i$: date of milking

DIM_i : days in milk

$Milking_i$: classification of milking according to time of day (two times: am/pm; three times: am/pm/night)

ε_i : residual (kg)

Mean residuals ε per meter reveals if a meter is faulty or not.

- Required parameters:
  - **Cow ID, Milk yield, Parity, DIM,**
  - **Milking Stand ID**
  - **Date and time of milking**

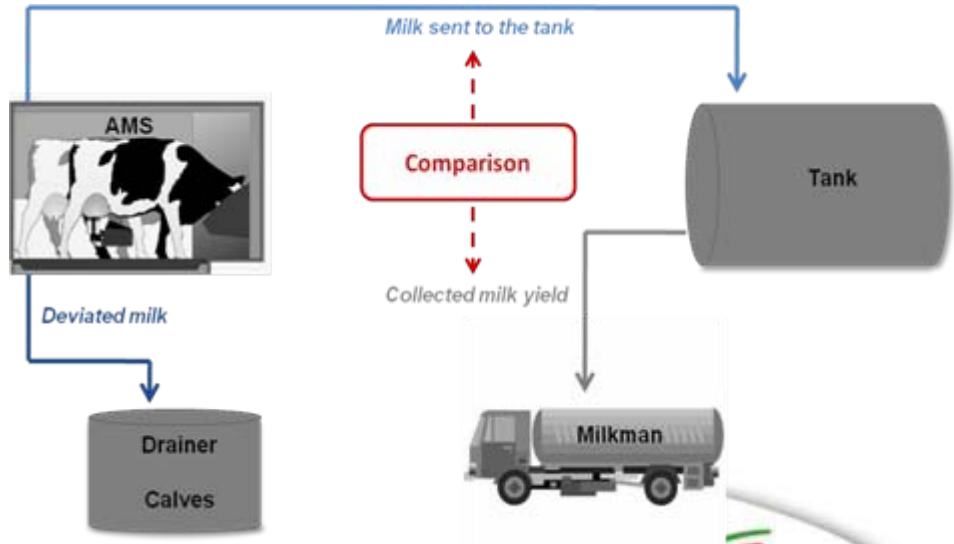
Best models principles

Use of collected milk (Automatic milking systems)

- Comparison between measured and collected milk
- Between 2 milk collections :

Deviation (kg) = ∑ milk yields sent to the tank – Collected milk yield

- Required parameters:
  - **(Cow ID)**
  - **Milk yield and destination**
  - **Date and time of milking**
  - **Date, time and volume of milk collection**



Tests of the models on farms

Experimental farms

- **Multi Stand milking parlour**
  - Méjusseaume Experimental Farm (INRA)
  - 28 stands rotary
  - Approx. 140 holstein cows - 2 milkings/day
  - Data gathered from sept 2010 to june 2011
  - EMM checked 3 times between april to june 2011 (5 cows/meter)
  - 3 meters voluntarily out of calibration for 10 days (+3%, +5%, -10 %)

Tests of the models on farms

Experimental farms

Automatic Milking System

- Derval Experimental farm (Idele and CA 44)
- 1 box AMS
- Approx. 75 holstein cows
- Data gathered from july 2010 to july 2011
- EMM checked 4 times between january to july 2011 (5 cows/meter)
- Tank collection time and volume was precisely registered

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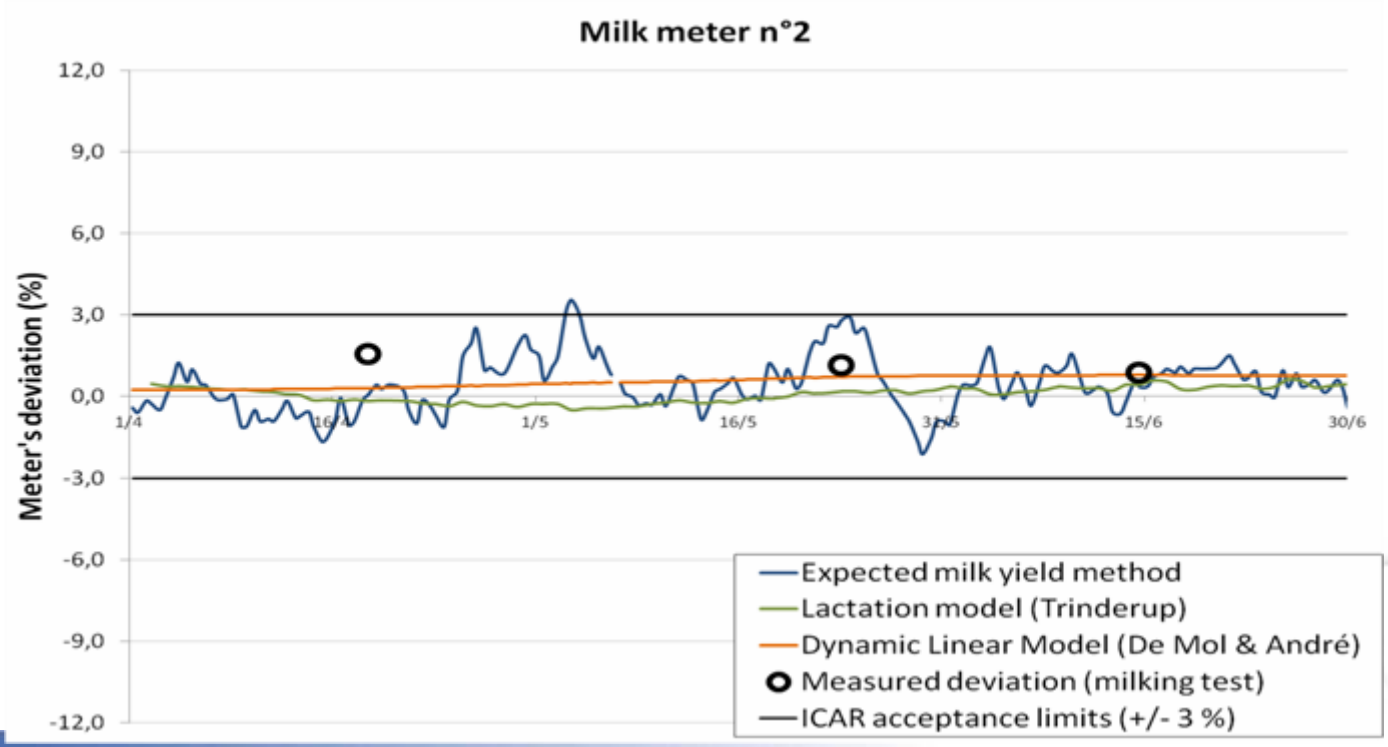
Tests of the models on farms

Results – Multi Stand

Correct milk meter

- All models give the same results : EMM deviation is inside the acceptance limits
- Confirmed by the measured deviation
- More variability observed with the expected yield method

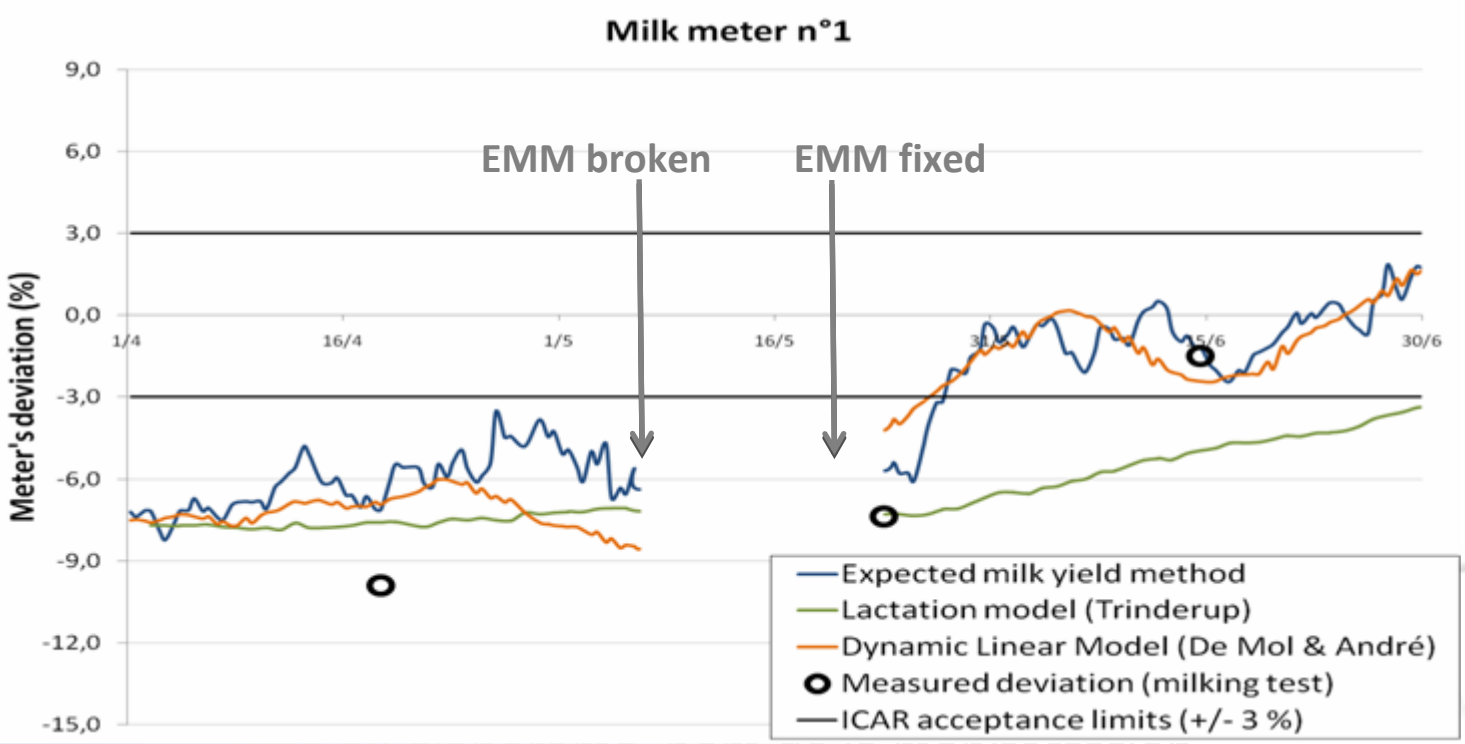


Tests of the models on farms

Results – Multi Stand

Faulty milk meter

- All models found the EMM out of calibration
- Fixing not immediately detected by Trinderup model

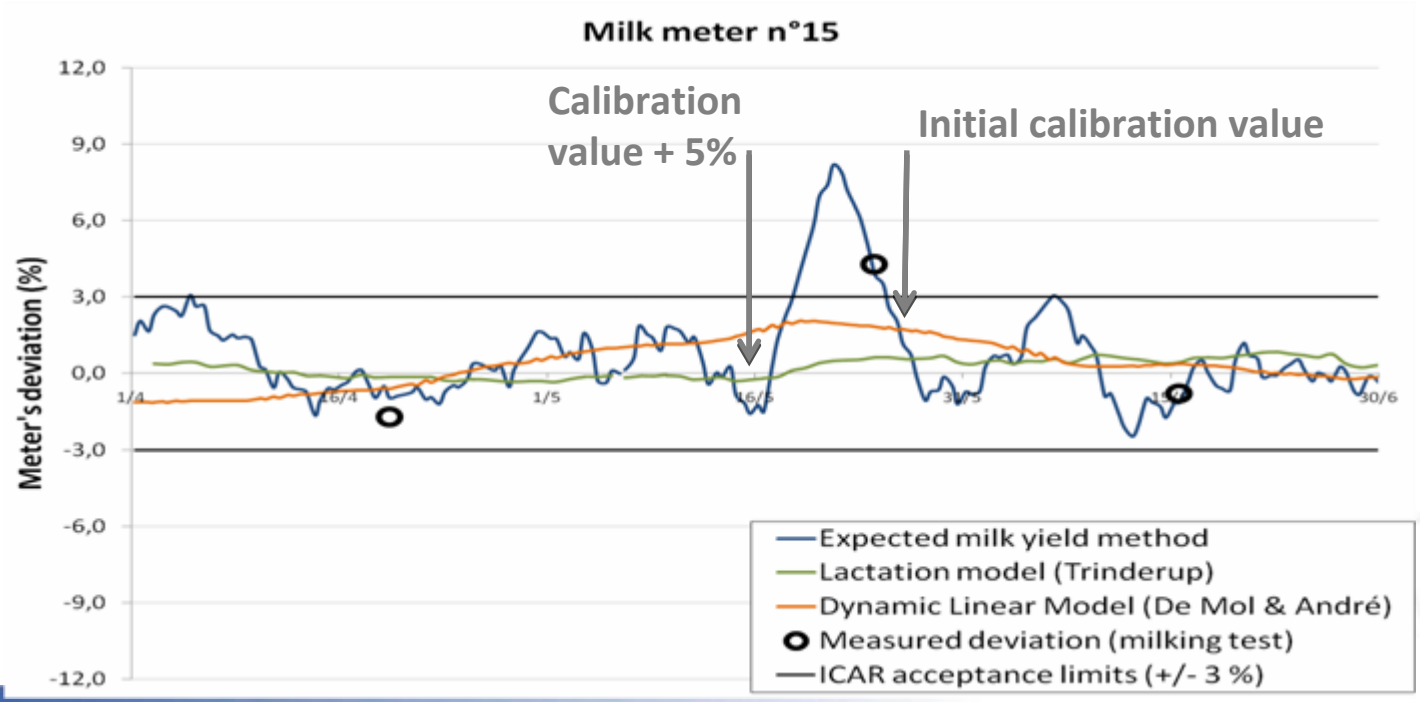


Tests of the models on farms

Results – Multi Stand

Voluntarily faulty milk meter

- Punctual deviation not detected by 2 of the models
- Expected yield method was sensible to the changes of calibration

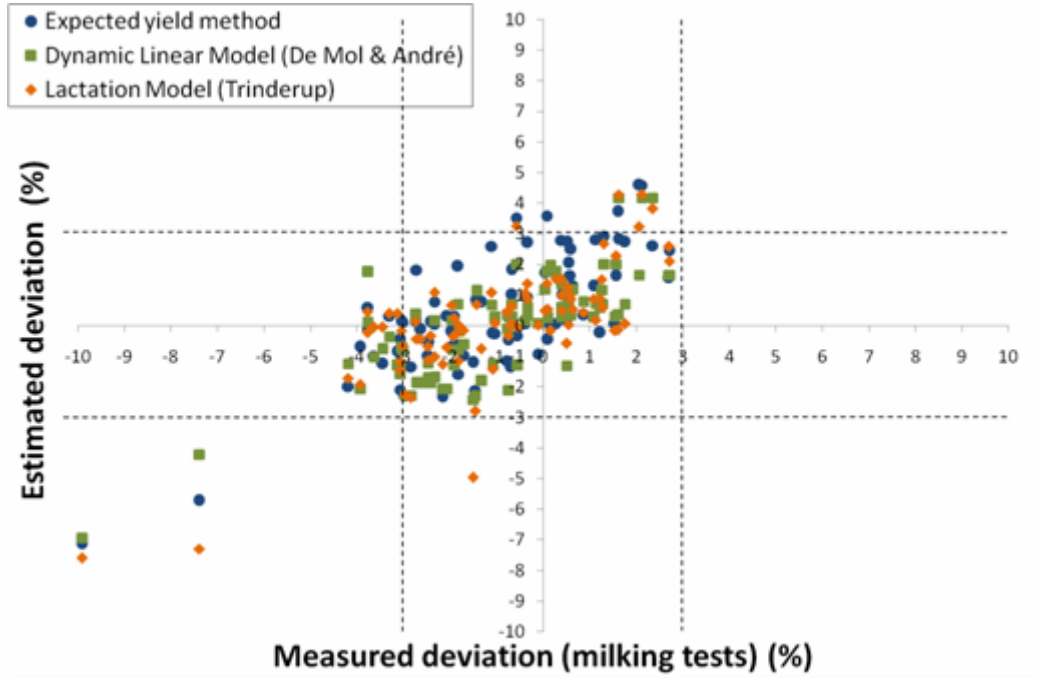


Tests of the models on farms

Results – Multi Stand

Deviation correlations

- Correlations with measured deviations from 0.73 to 0.75
- Correlations between models from 0.78 to 0.89
- Efficient to detect high deviating and properly working meters
- Measured deviations are not golden standards (only 5 cows each meter)
- Comparison of daily deviation with smoothed deviation



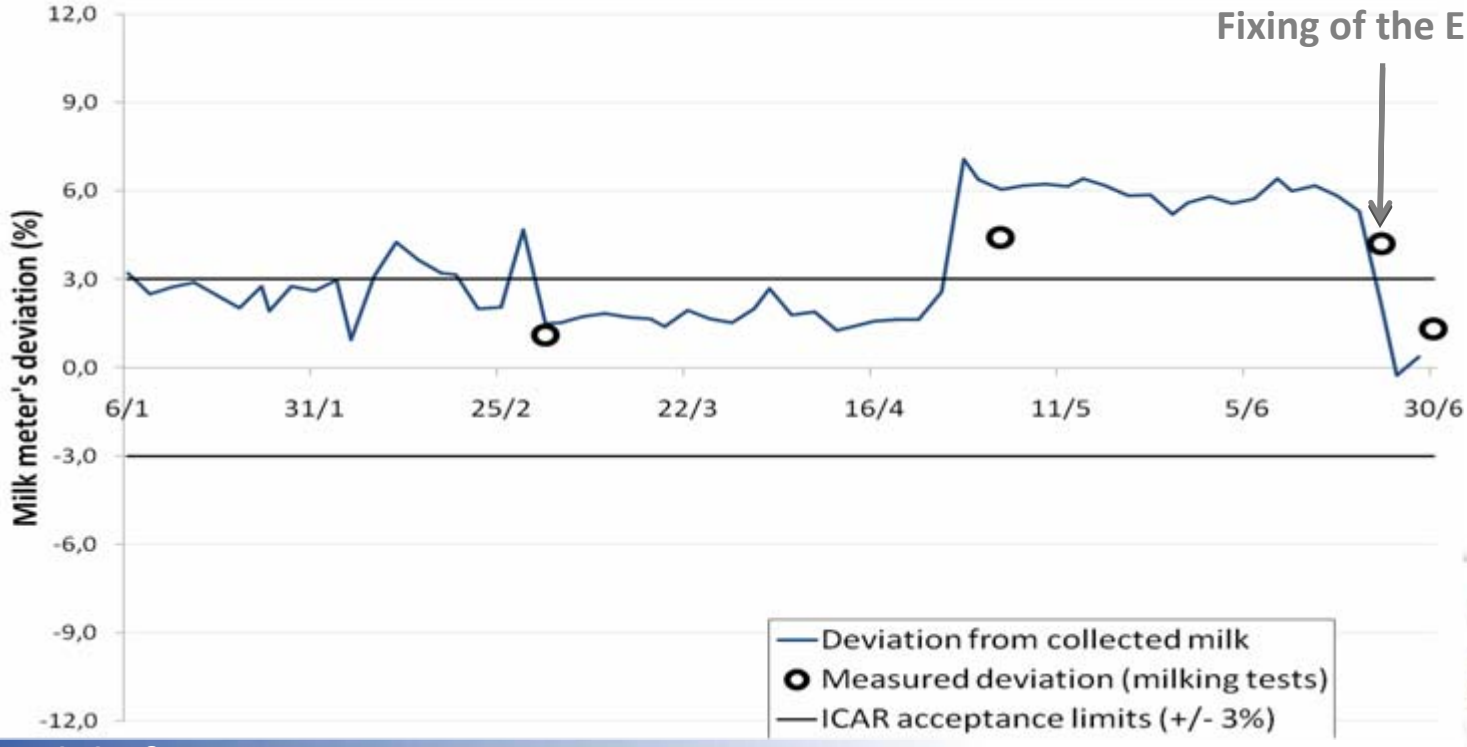
Correlation coef. n = 84	Expected Yield Method	Lactation Model	DLM
Lactation Model	0.81		
DLM	0.78	0.89	
Measured deviation	**0.74**	**0.73**	**0.75**

Tests of the models on farms

Results – AMS

AMS 1 box

- Deviation and fixing were detected by the alternative method
- Results confirmed by manual checking



Tests of the models on farms

Discussion

- **All presented models gave quite good results to detect deviating meters**
- **They can be used as useful tools to modernise EMM checking activity**
- **Expected yield and AMS methods are easy to implement in a software**
- **Nevertheless these methods**
  - Can't be used without a rigorous animal ID (problems if ID errors)
  - Need to record precisely some information (ex: tank collection time for AMS method)
  - Do not answer to the case of AMS with more than 1 box
  - Do not replace annual routine maintenance as recommended by manufacturers

Guidelines update

- **Section 11.6.2 : Calibration tests of on farm installed milk recording devices**
  - **New Section 11.6.2 .1**: Computerized solutions for periodic checking

- **General statements**
  - *If the computerized methods are applied as outlined they can replace the annual routine test.*
  - *The requirements is to run these statistical checks at least once per year but for best practice in quality assurance it is recommended to run this more frequently, for instance at time of milk recording visits.*
  - *These methods have to be used for **routine test only** and not for the installation test.*
  - ***Other methods / procedure than the presented ones can be subjected by the manufacturers, member organizations or software suppliers, but they must be approved by ICAR.***

Conclusions

- These statistical methods are useful tools to monitor EMM checking in the near future
- They must be deployed on the field as soon as possible
- We encourage Manufacturers and Milk Recording Organizations to implement these solutions in their next Herd Management or Advice Softwares

Thanks for your attention