Computerized solutions for periodic checking of electronic milk meters

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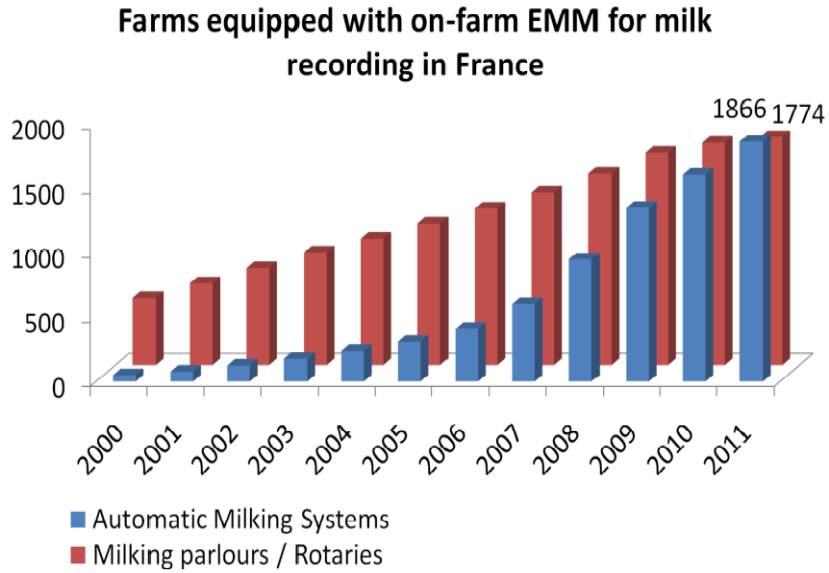
Introduction and context

- **In the main countries producing milk**
  - 2 to 25 % of farms with EMM (De Koning, 2008)
  - Increasing number of farms equipped
  - Milk Performance Rec.= Checking once a year
- **Milk meter control is labour intensive and expensive**
- **Urgent need of simplification and modernization**



Statistical validation

A possible way of simplification

- **Use continuous data from EMM**
- **Apply smart statistical methods**
- **Switch from manual checking to monitoring**
- **Potential benefits**
  - Supplement / Replace water test
  - Continuous monitoring
  - Remote control

ICAR Recording Devices SC

The « DataCal » Project

Project objectives

What ?

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

Why ?

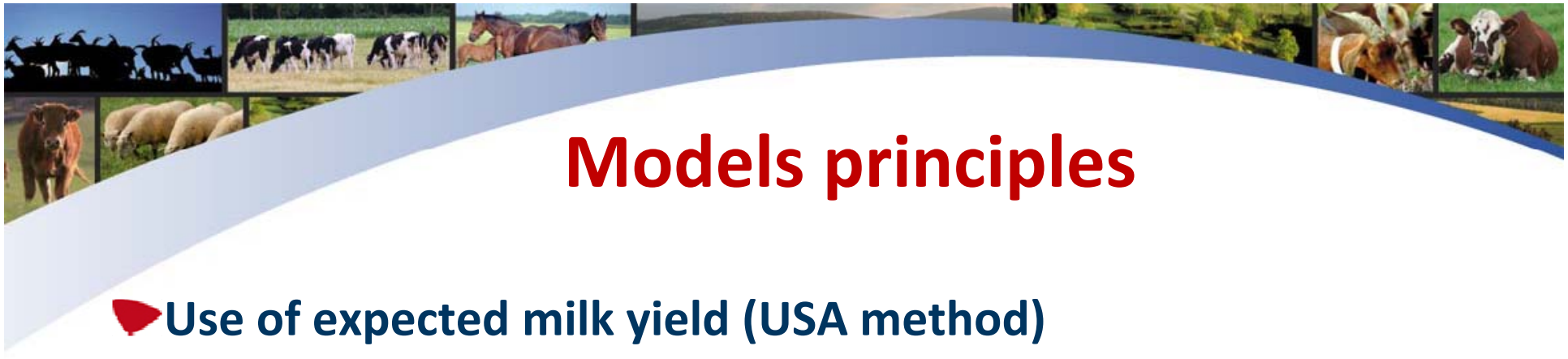
Encourage manufacturers or ICAR members to implement them in their software and use them on the field.

Project milestones

- Review existing models/methods
- Test of the models on farms
- Refine parameters
- Update the Guidelines with the best models

Review existing models

- **5 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 (USA method)**
- **All others were never used and not tested on more farms**



Models principles

Use of expected milk yield (USA method)

- For a cow and a milking session :

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

- For an EMM and a milking session :

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

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

- Milk yield per stand vs. overall average milk yield on all stands.
- For a stand **s** and a milking session **m :**

  Deviation$_{ms}$ (kg) = μ_{ms} * AveYield$_m$

  Deviation factor μ_{ms} = 0 if EMM is working properly

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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)

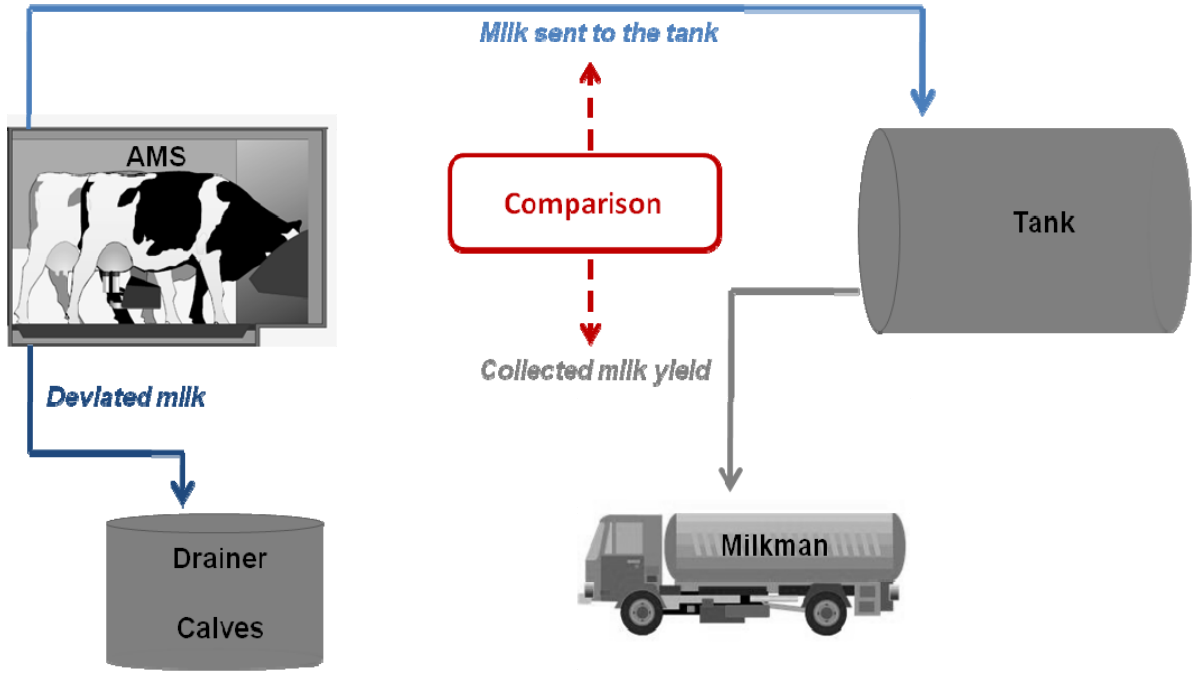
Mean residuals ε per meter reveals if a meter is faulty or not.

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



Tests of the models on farms

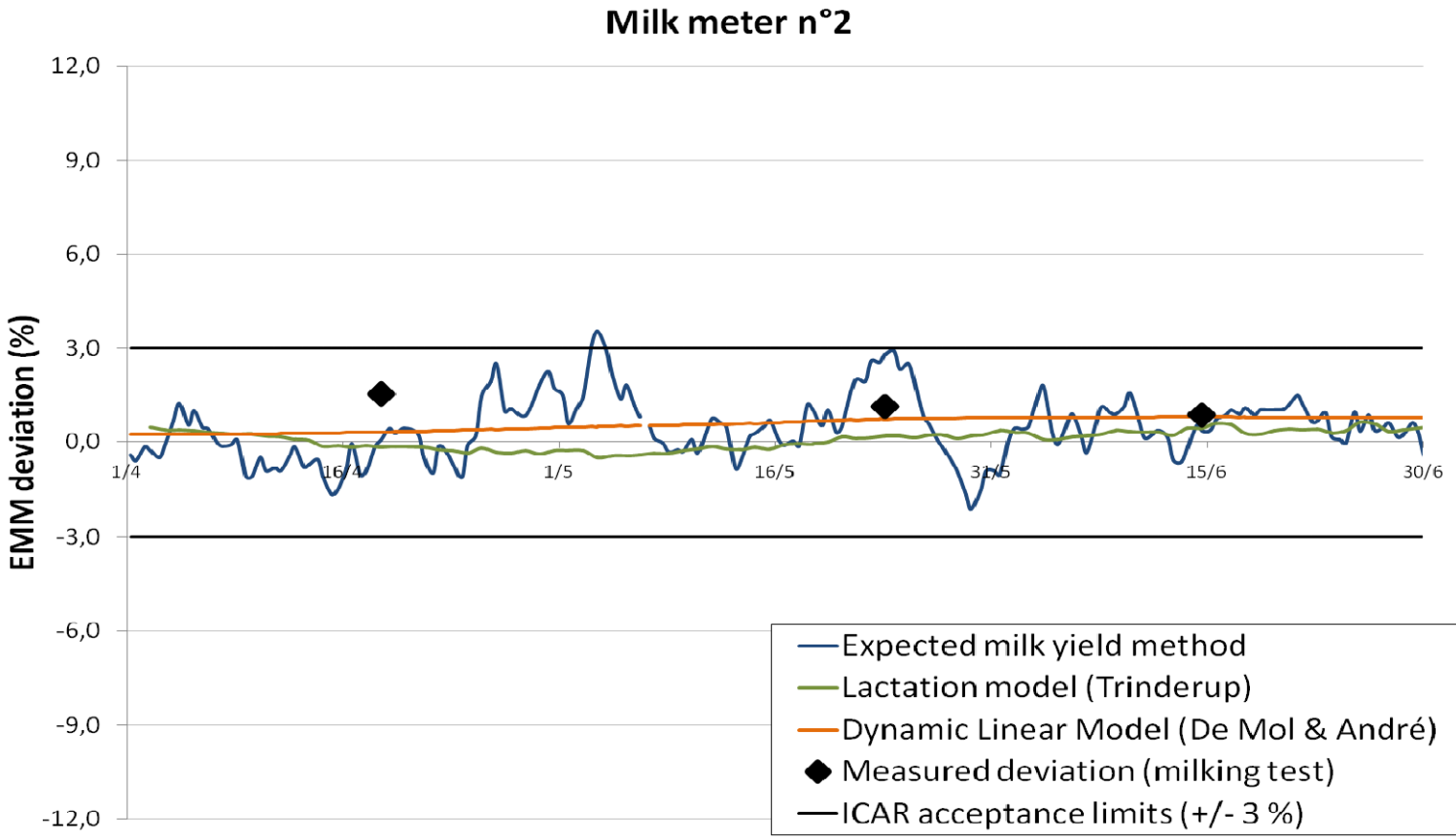
Experimental farms

- **Multi Stand milking parlour**
  - 28 stands rotary
  - Approx. 140 Holstein cows - 2 milkings/day
  - 3 meters voluntarily out of calibration for 10 days
- **Automatic Milking System**
  - 1 Robot
  - Approx. 75 Holstein cows
  - Tank collection time and volume was precisely registered
- **Each EMM manually checked on both farms (milking tests on 5 cows)**

Tests of the models on farms

Results – Multi Stand

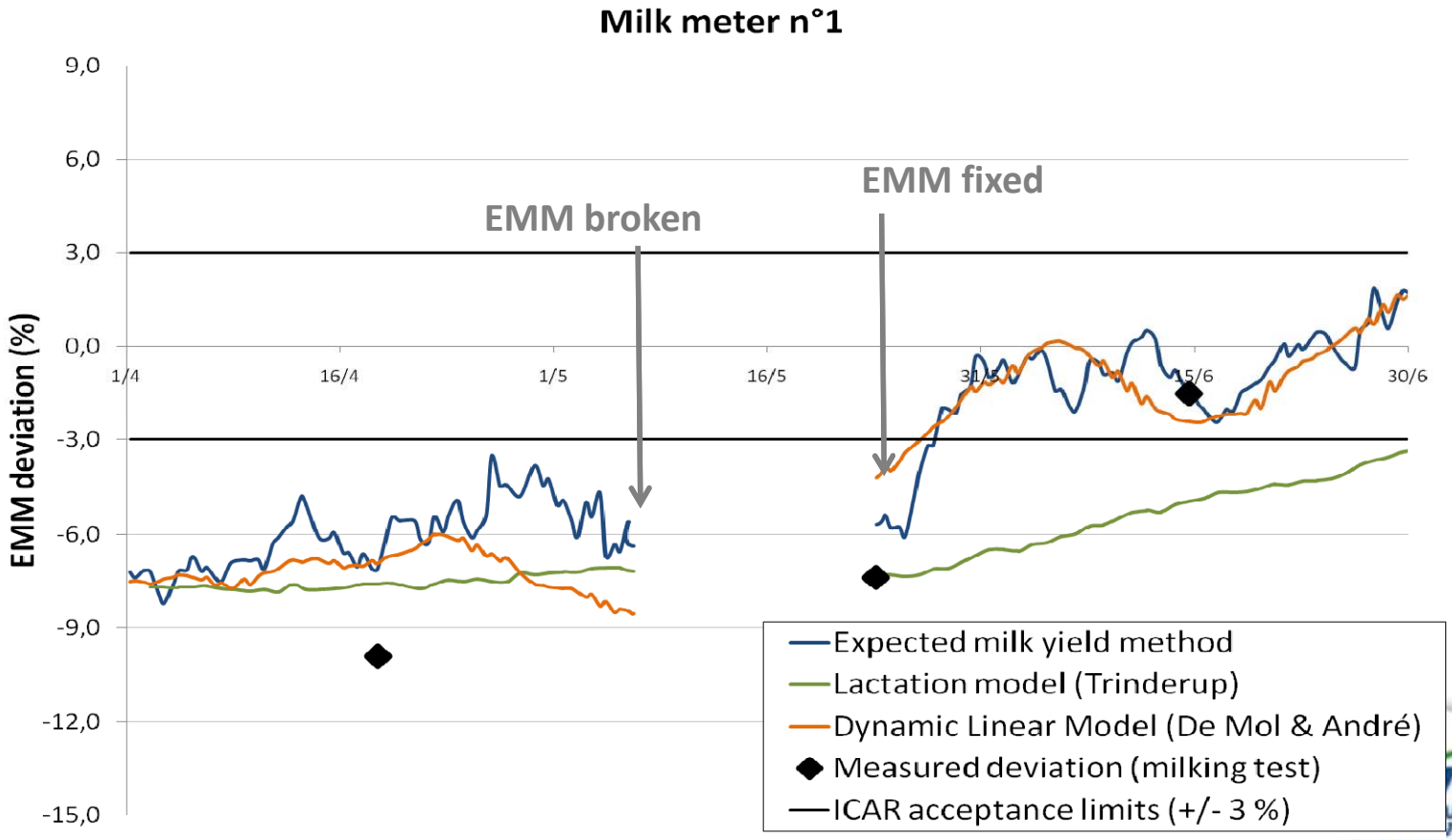
Example of a correct milk meter



Tests of the models on farms

Results – Multi Stand

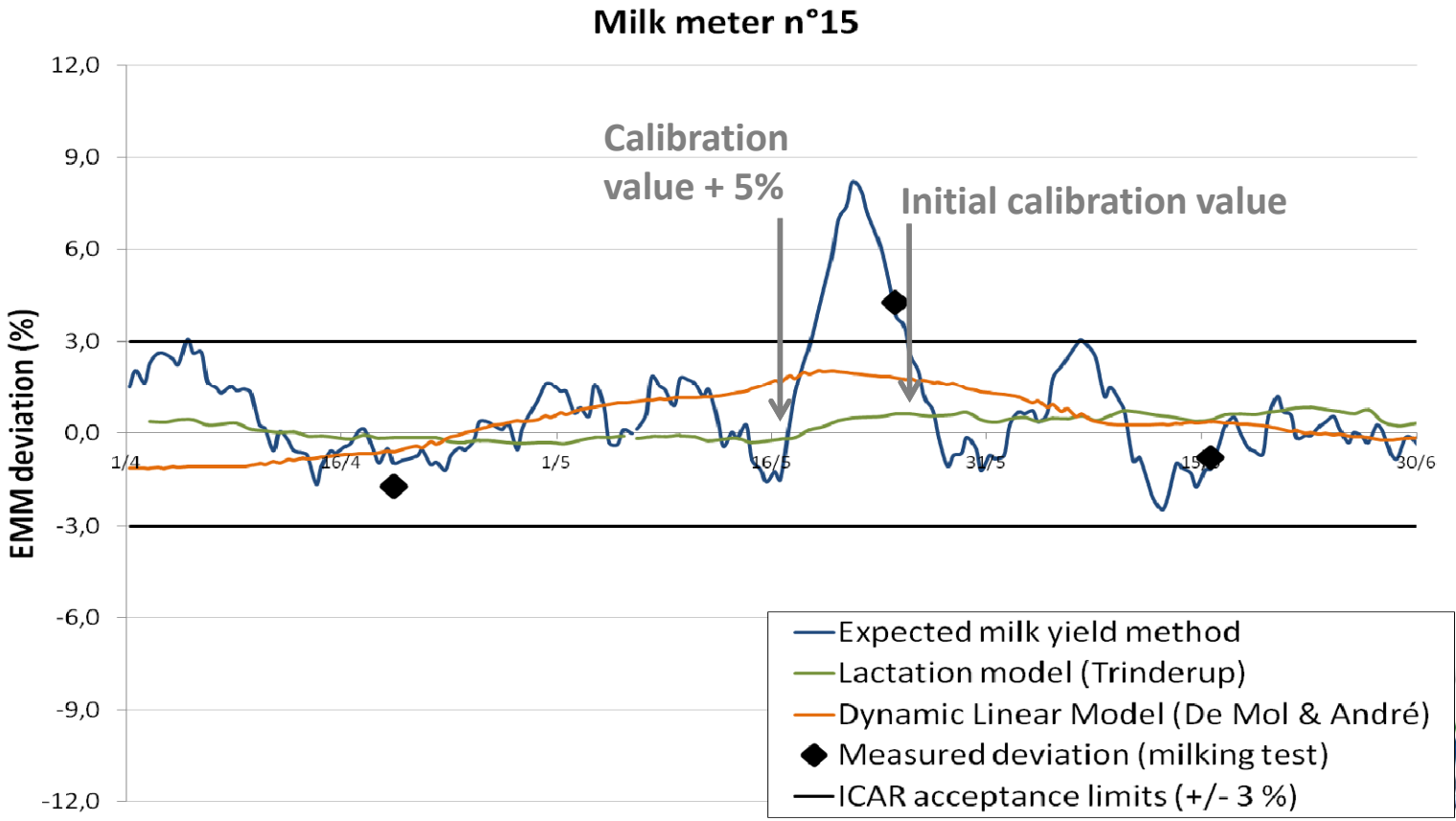
Example of a faulty milk meter



Tests of the models on farms

Results – Multi Stand

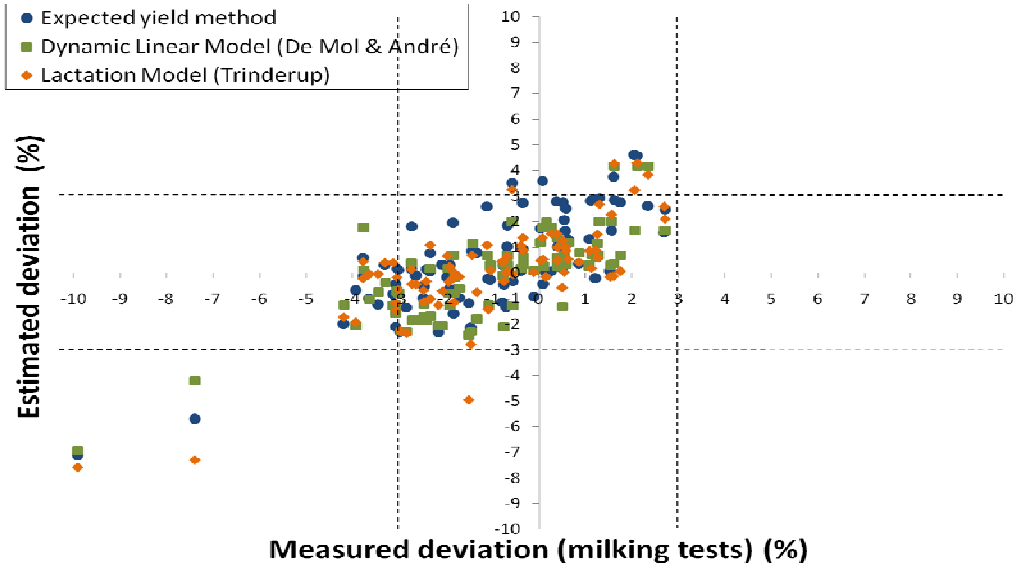
Example of a punctual provocked deviation



Tests of the models on farms

Results – Multi Stand

- **Measured vs. Estimated deviations**
  - Slight differences between methods
  - Used reference is not a golden standard
  - Comparison of daily deviations with smoothed deviations
  - Efficient enough to detect deviating meters

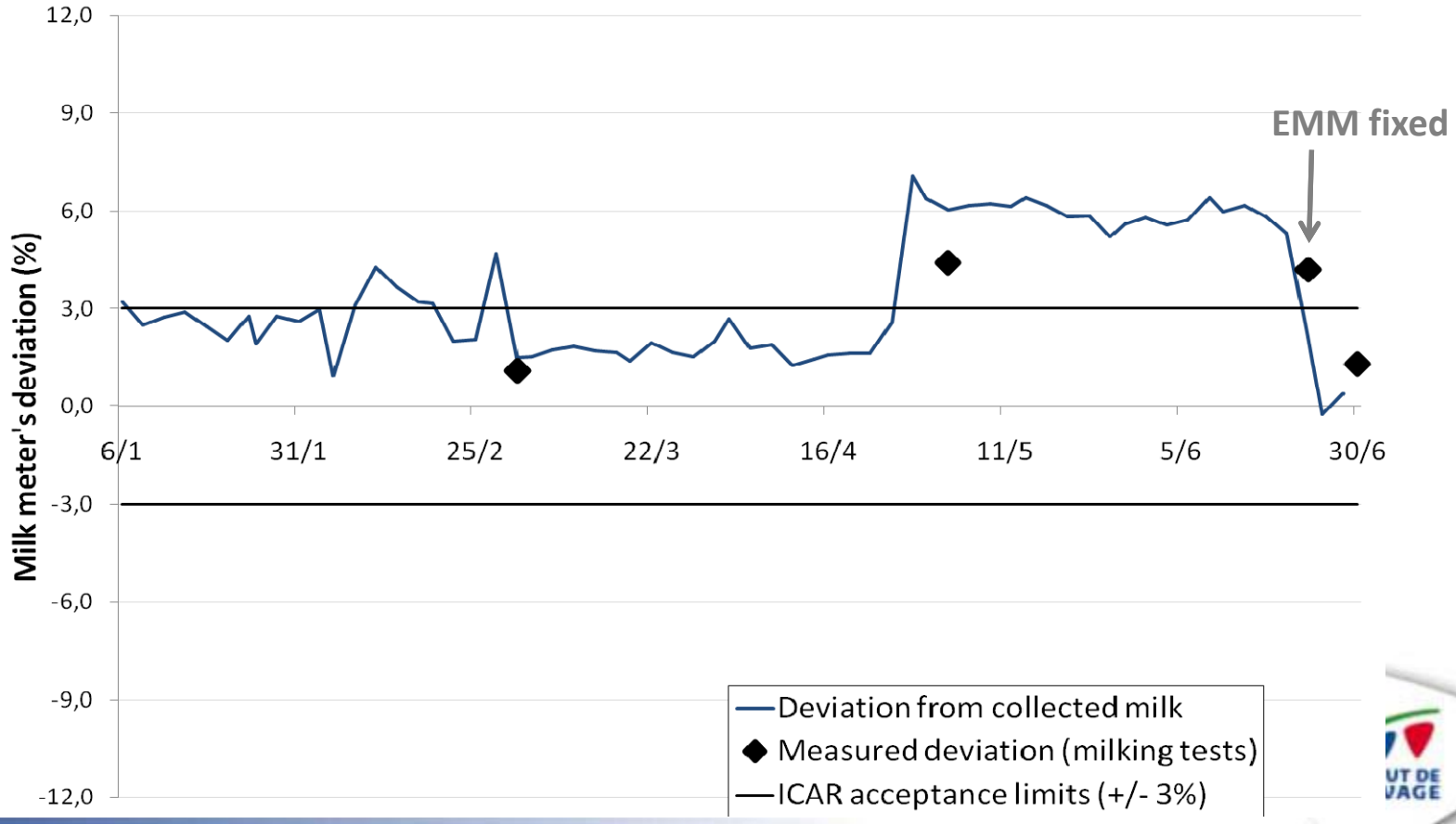


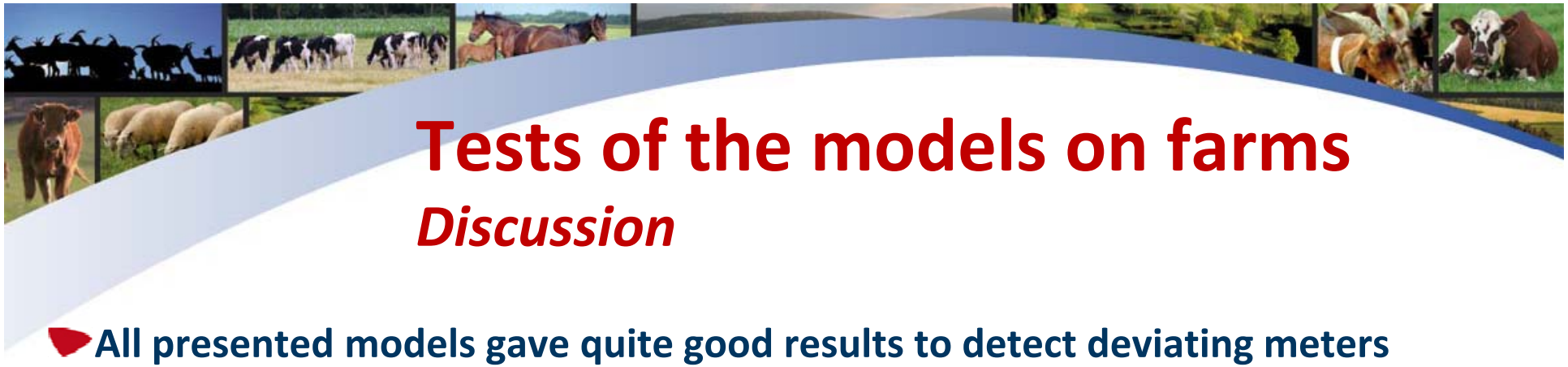
Correlation n = 84	Expected Yield Method	Lactation Model	DLM
Lactation Model	0.81		
DLM	0.78	0.89	
Measured deviation	**0.74**	**0.73**	**0.75**

Tests of the models on farms

Results – AMS

Robot 1 box





Tests of the models on farms

Discussion

- **All presented models gave quite good results to detect deviating meters**
- **Validated on private farms for both robots and milking parlours**
- **Expected yield and Collected yield methods are easy to implement in a software**
- **Some requirements**
  - Parameters (Animal ID, Yield, Date and time of milking, Collection volume,…)
  - Reliable cow ID – Link with PC
- **Some limitations**
  - What about Robots with more than 1 box ?
  - ID errors, missing values, etc.
  - Do not replace annual routine maintenance

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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 / procedures than the presented ones can be subjected by the manufacturers, member organizations or software suppliers, but they must be approved by ICAR.***

Conclusions

- Statistical methods will be useful tools to monitor EMM accuracy in the near future in supplement of the field controls.
- Must be deployed on the field as soon as possible to allow and to maintain an efficient quality control.
- Manufacturers and Milk Recording Organizations should implement them in their next Herd Management or Advice Softwares.

Thanks for your attention