Dynamic monitoring of litter size at herd and sow level

Claudia Bono
C. Cornou
A. R. Kristensen

EAAP - Bratislava, August 28th 2012
Dias 1

Background

Problem

- Increasing herd sizes
- Growing competition from countries with lower production costs

Solution

- Good management

  Problem

  - Existing Management Information Systems (MIS) are *static* and typically computed every quarter or year

  Solution

  - Dynamic approach

Objective

Develop new and more reliable methods for dynamic production monitoring

- Implementation of automatic methods for detection of systematic deviations from the expected results

Project

The project is divided into three parts that correspond to the analysis levels

First phase:

Sequential estimation of litter size profile and sow effects

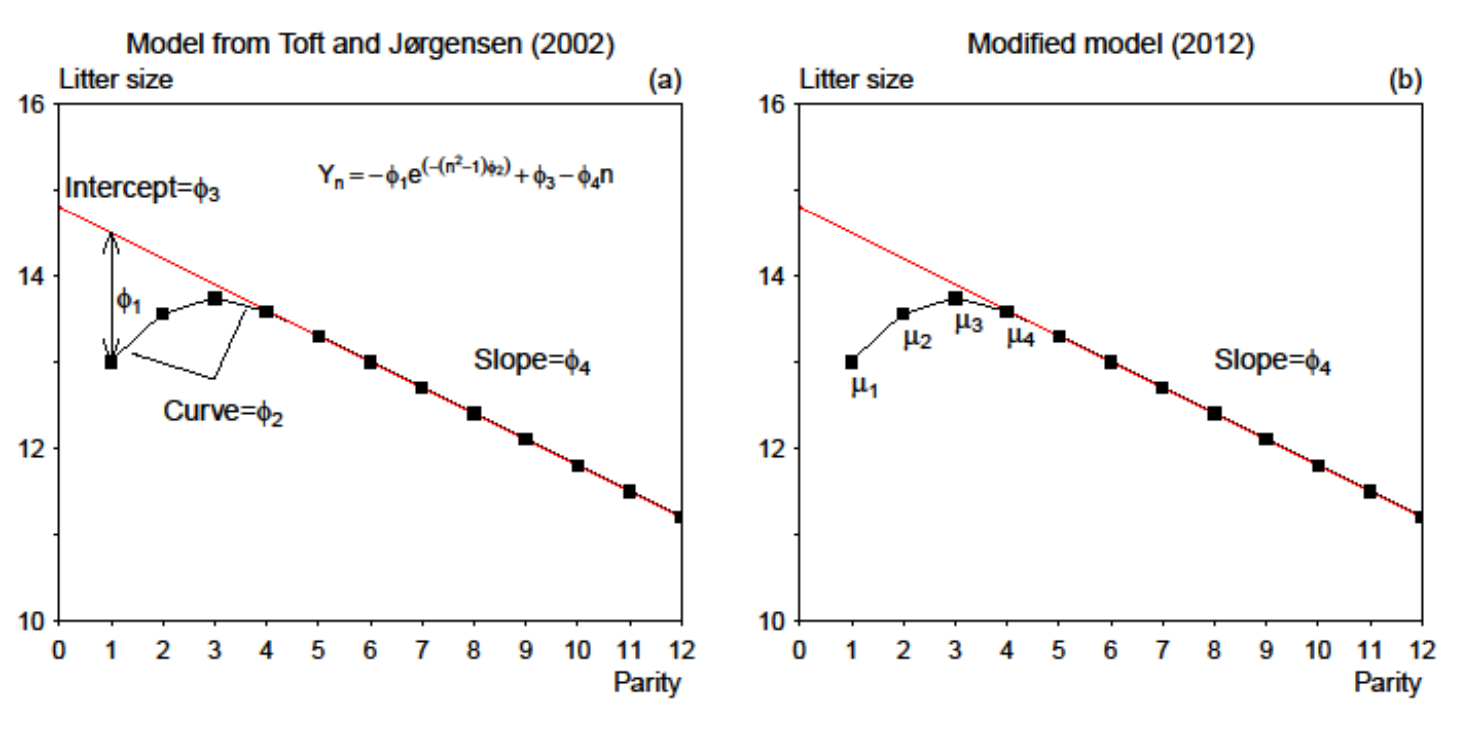
- Overall presentation of the project
- Implementation of a previous litter size model with emphasis on sow's properties and herd level

Second phase: Sequential estimation of farrowing rate in sow herds

Third phase: Sequential estimation of mortality rate in sow herds

Material and methods

A model based on Toft and Jørgensen (2002) was implemented:



Material and methods

Dynamic Linear Model (DLM)

DLM consists of two equations.

Observation equation → $$Y_t = F_t'\theta_t + v_t,$$

System equation → $$\theta_t = G_t\theta_{t-1} + w_t,$$

Yt, consists of observed litter sizes of all sows farrowing at week *t*.

θt, expresses how the parameter values may change over time.

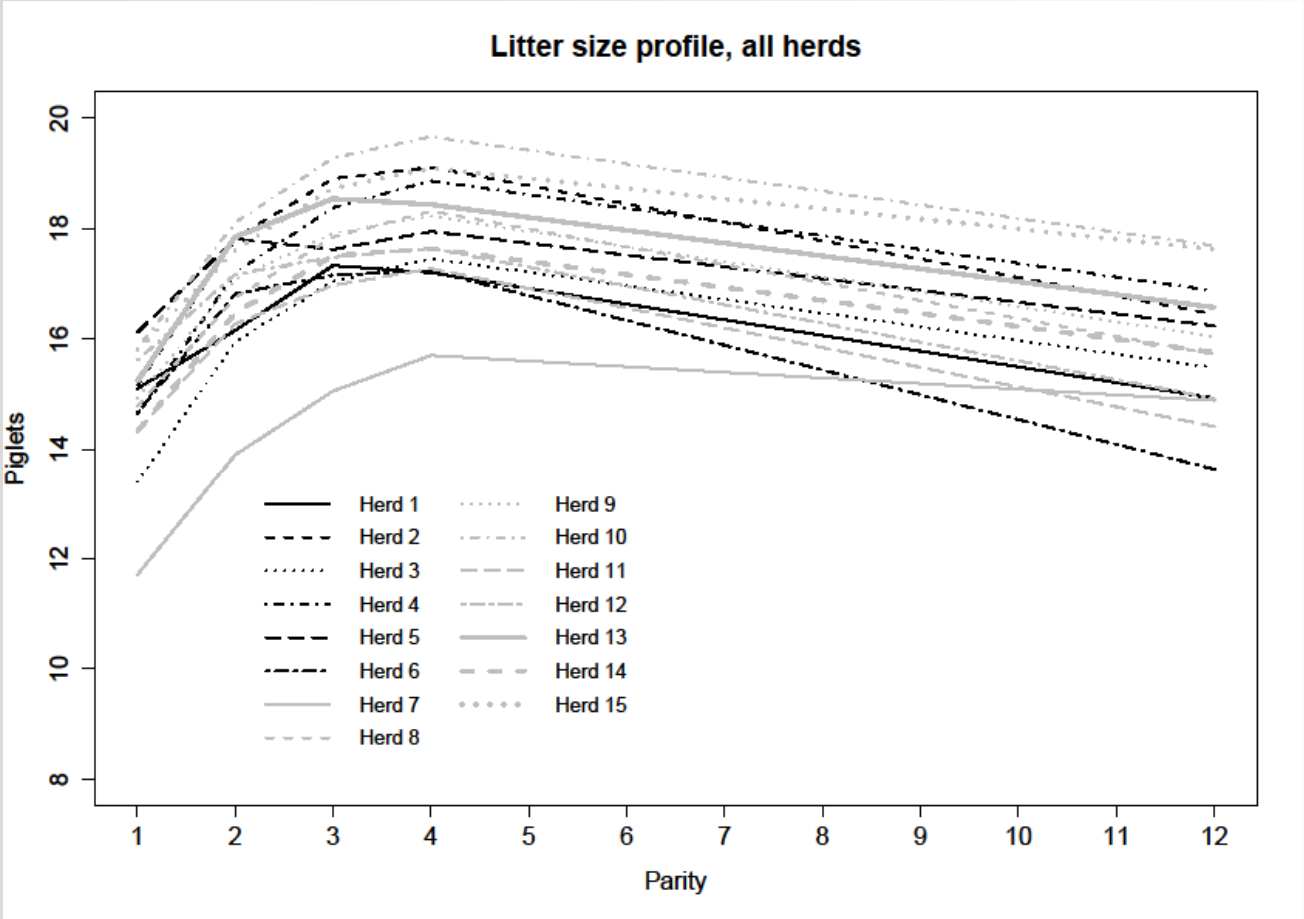
The parameter vector for week t will be:

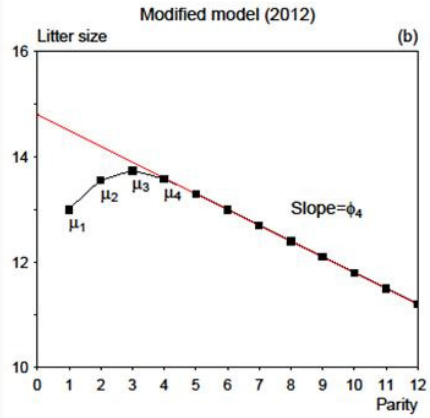
$$\theta_t = (\mu_{1t}, \mu_{2t}, \mu_{3t}, \mu_{4t}, \phi_{4_t}, \delta_t, M_1(n_1t), \ldots, M_N(n_Nt))'.$$

Material and methods

- Once that the herd specific parameters (μ_1, μ_2, μ_3, μ_4, Φ_4) and the time trend (δ_t) were calculated, at any week the last week's estimate is available as a result of the Kalman filter application
- The estimation of the individual property of each sow in the herd is also available
- Expectation-Maximization (EM) algorithm technique was used for estimation of the system variance
- Detection methods (Control chart and V-mask) were applied in order to monitor out-of-control situations

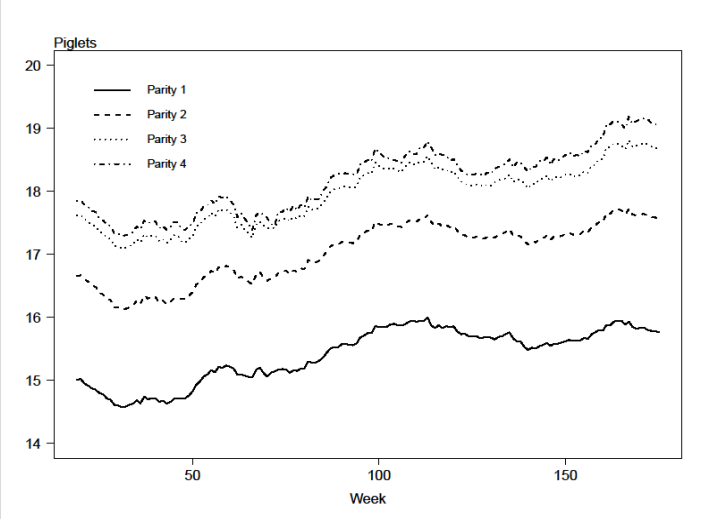
Results – Average of litter size per parity

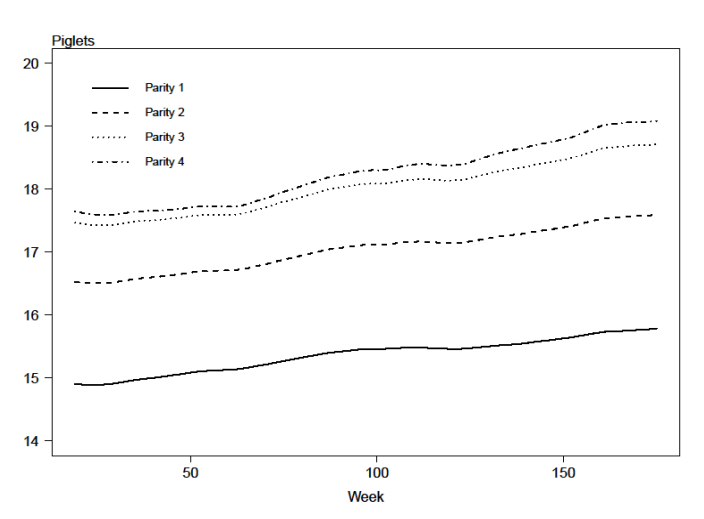




The profile of most of the herds appears as expected and confirms the shape of the litter size profile.

Results – Litter size per parity (3 years)

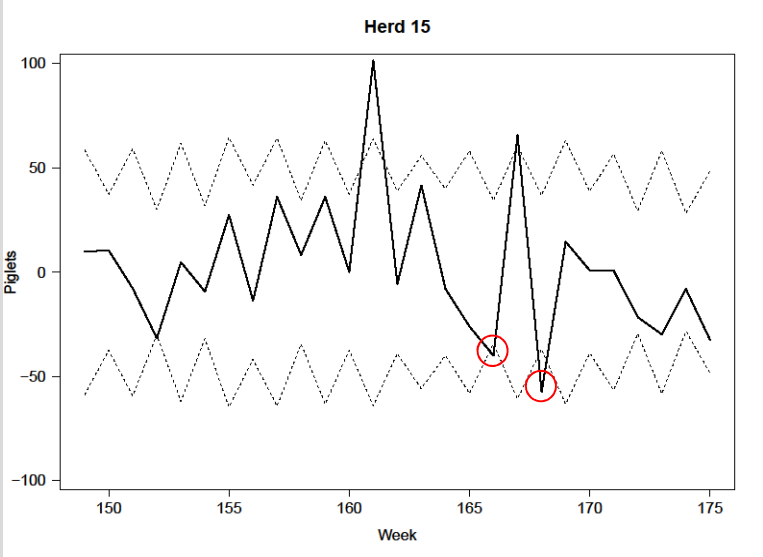


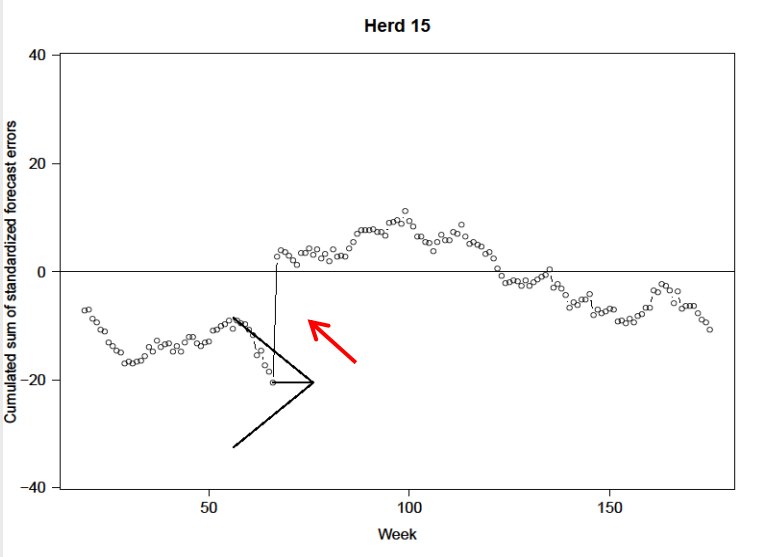


This picture shows filtered and smoothed data

- The smoothing reduces the temporary random fluctuation seen in the filtered data
- The smoothing represents the best possible estimate
- Whereas the filtered obtained for a given week will not change later on, the corresponding smoothed value will change on the light of the later observations

Results – Detection methods





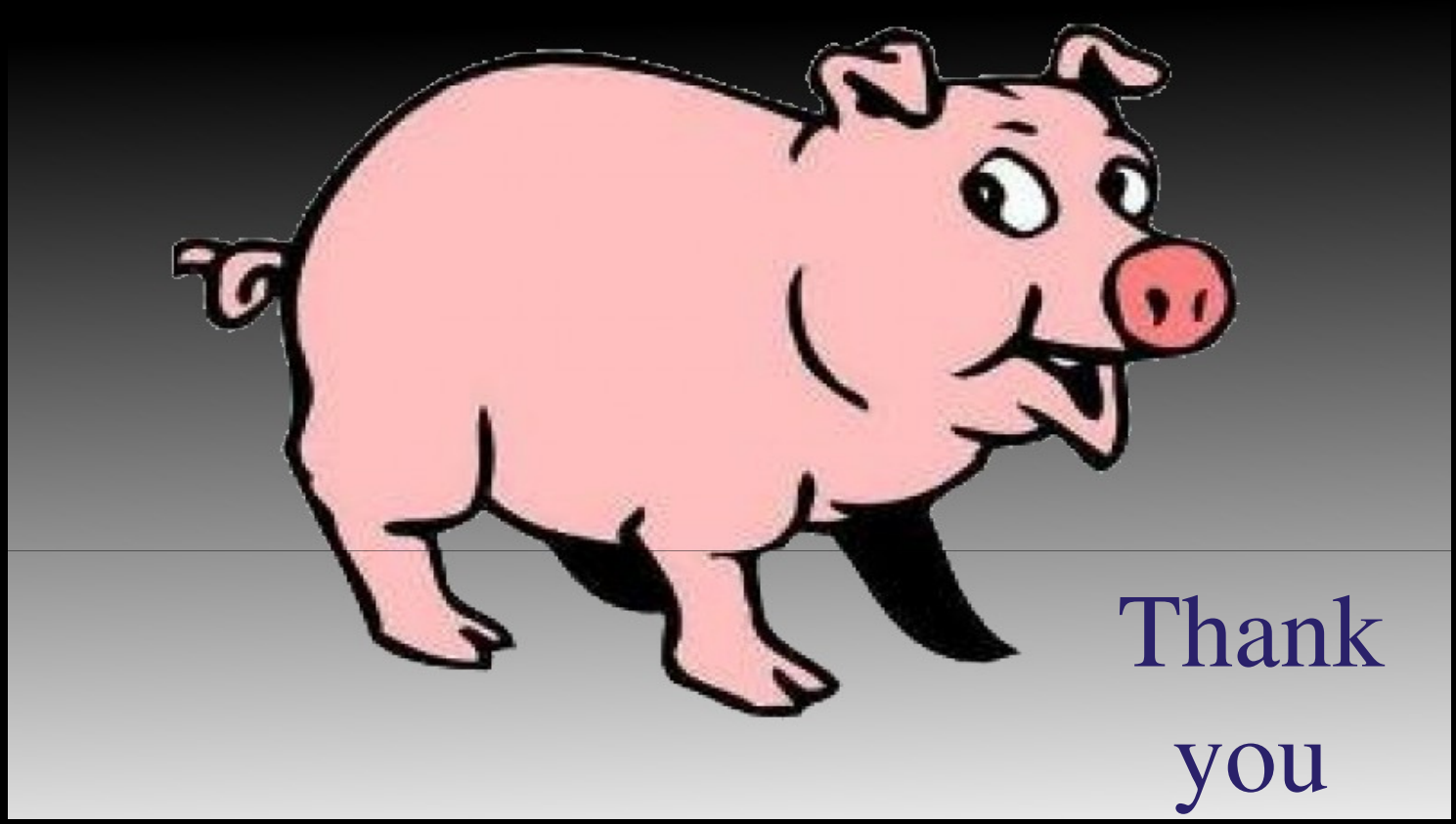
Results were monitored both in a short and long time period.

- Monitoring methods:
  - Control Chart → Short time horizon (26 weeks)
  - V-mask applied on Cusum → Long time horizon (3 years)
- The total number of ”negative” alarms in 15 herds is 90, indicating a mean of 2 alarms per herd per year

Conclusions and Perspectives

♦ The system for monitoring farrowing at herd and sow level based on a combination of Dynamic Linear Model, V-mask and Control Chart has proven to be a useful tool for modelling litter size week by week in short and long period.

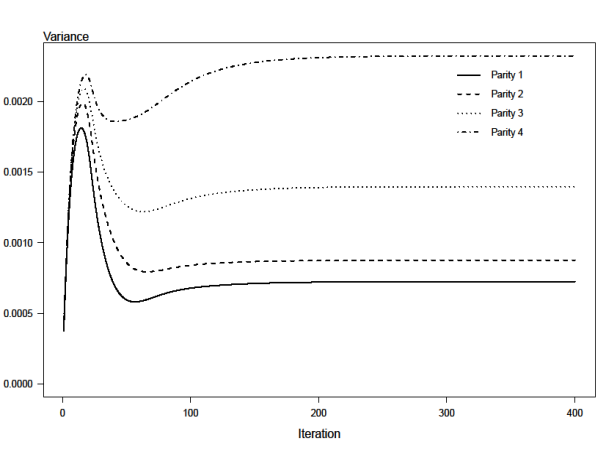
♦ Farrowing rate as well as mortality rate can be included in the model to make it a fully functional management tool to monitor and predict production in a dynamic way.



Dynamic production monitoring in pig herds I: Modelling and monitoring litter size at herd and sow level.
Livestock Science (2012),
http://dx.doi.org/10.1016/j.livsci.2012.07.023

Results

Variance



Correlation

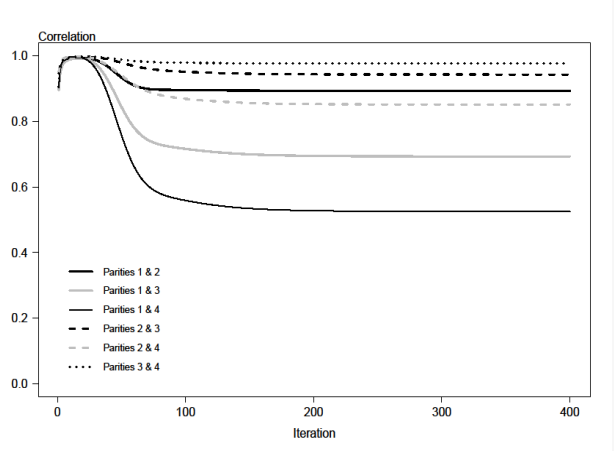


Table : Upper left matrix of the system variance-covariance W (6 x 6). Values of the correlations are shown below the diagonal.

Matrix #	1	2	3	4	5	6
1	0.00072	0.00071	0.00069	0.00068	0	0
2	*0.90*	0.00087	0.00104	0.00121	0	0
3	*0.69*	*0.95*	0.00139	0.00176	0	0
4	*0.53*	*0.85*	*0.98*	0.00232	0	0
5	*0*	*0*	*0*	*0*	1.52e-10	0
6	*0*	*0*	*0*	*0*	*0*	1.48e-10

- EM-algorithm provided stable and suitable results
- High correlations between herd level averages at subsequent parities have been found
- Weekly variances are very low