Monitoring growth in finishers by weighing selected groups of pigs – a dynamic approach

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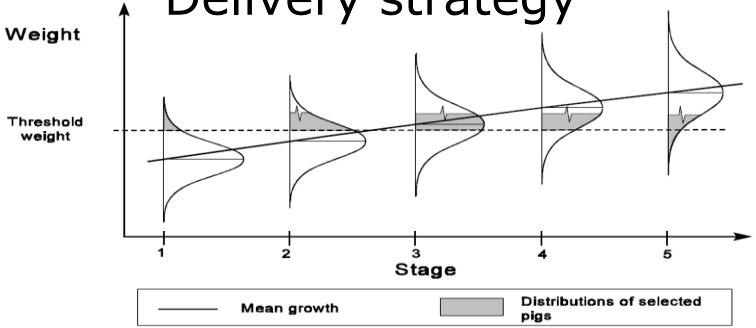
What we can learn from weighing selected groups of pigs

Production control

Delivery strategy



From Kure, 1997

Stygar & Kristensen, EAAP, Warszawa 2015

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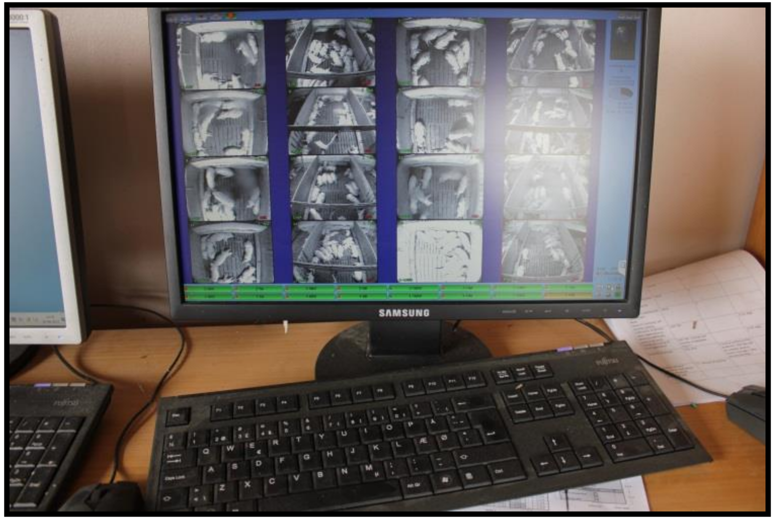
Costs of weighing

Expensive



Stygar & Kristensen, EAAP, Warszawa 2015

From Kure, 1997

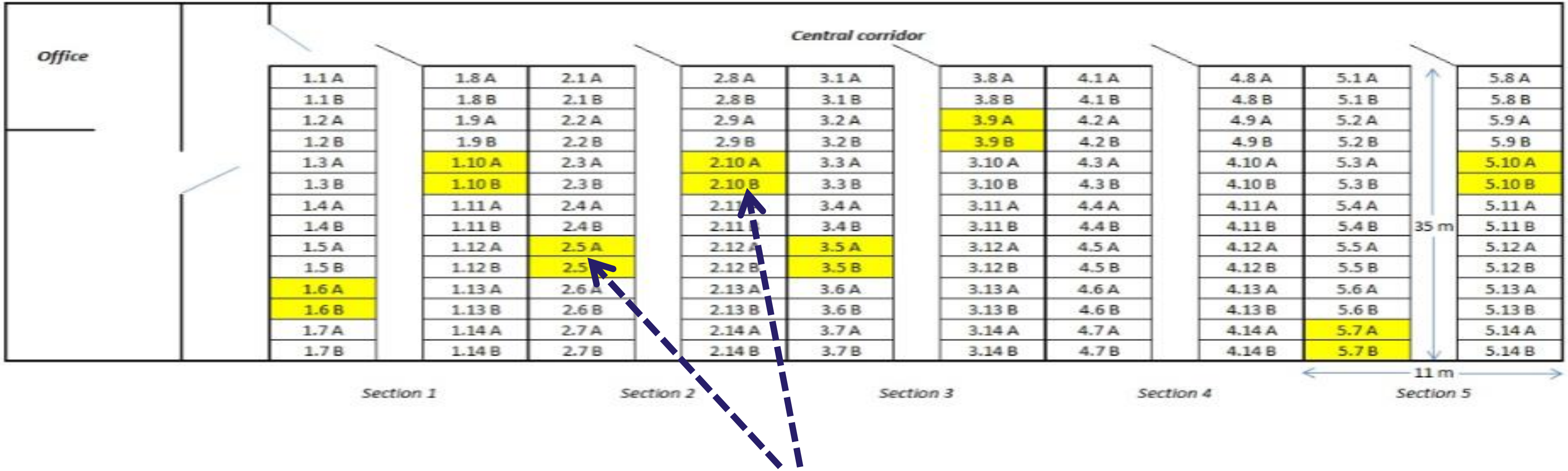
Objectives of this study

- Develop the monitoring and decision support tool
  - Production control
  - Marketing decisions (forecasting number of pigs above certain body weight threshold)
- Quantify the value of information in finishers (including or excluding the information on body weight)

Material and methods – data from the herd

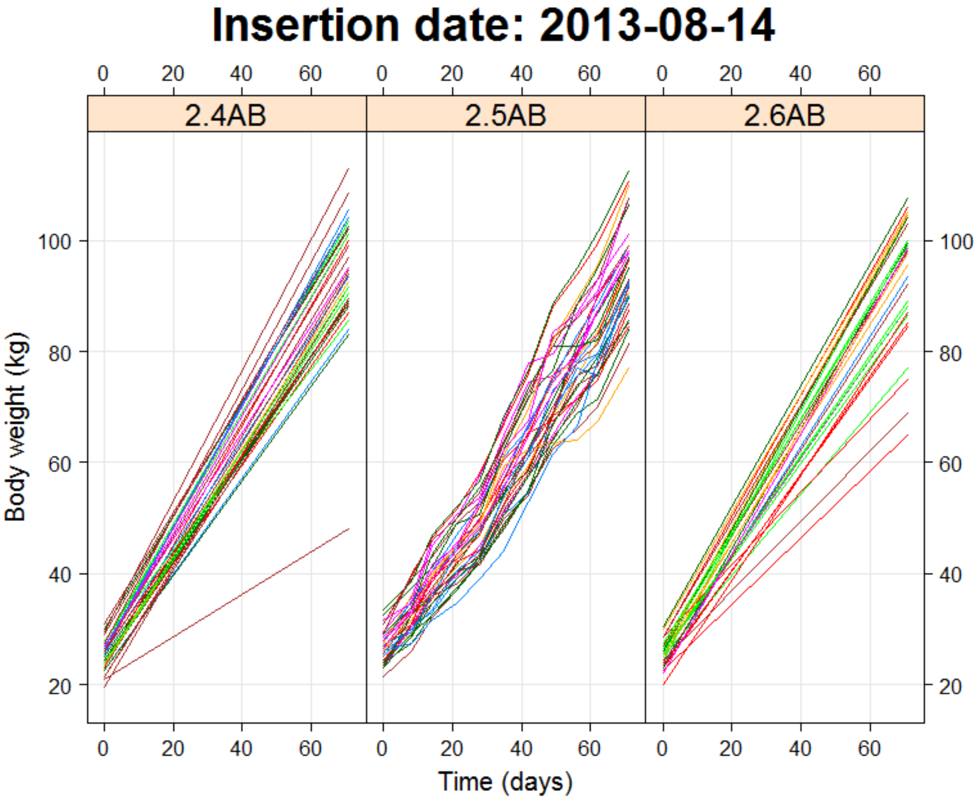
Batch number	Section	Insertion date	Number of BW measurements	Number of observations in all measurements
Batch 1	1	2012-09-26	14	1641
Batch 2	1	2013-01-15	13	1666
Batch 3	2	2013-05-08	10	1521
Batch 4	2	2013-08-14	11	1573
Batch 5	2	2013-11-20	11	782
Batch 6	2	2014-03-21	10	716
Batch 7	2	2014-07-01	10	651
Batch 8	2	2014-10-09	10	622
Batch 9	2	2015-01-14	10	628

Material and methods – data from the herd



16 % pigs

Material and methods – data from the herd



Material and methods – data used in setting model parameters and in reference data set

Batch number	Learning data set	Testing data set
Batch 1	746	
Batch 2	702	
Batch 3	566	
Batch 4	646	927
Batch 5	641	
Batch 6	570	
Batch 7	552	
Batch 8	539	
Batch 9	489	

Material and methods –Multivariate Dynamic Linear model and Kalman filter

Observation equation: $Y_t = F_t' \theta_t + v_t, \quad v_t \sim N(\underline{0}, I\tau^2)$

System equation: $\theta_t = G_t \theta_{t-1} + W_t, \quad W_t \sim N(\underline{0}, W_t)$

θ_t	*Parameter vector*
F_t	*Design matrix*
G_t	*System matrix*
V	*Observational variance*
W	*System variance*

Material and methods – parameter estimation

$$y_{i,j,k,t} = (\beta_0 + B_{0,k} + b_{0,j,k}) + (\beta_1 + B_{1,k} + b_{1,j,k})t + (\beta_2 + B_{2,k} + b_{2,j,k})t^2 + A_{i,j,k,t} + \varepsilon_{i,j,k,t}$$

Herd

Fixed effects

Batch effect

$$B_i = \begin{bmatrix} B_{0,k} \\ B_{1,k} \\ B_{2,k} \end{bmatrix} \sim N(\mathbf{0}, diag(\sigma_0^2, \sigma_1^2, \sigma_2^2))$$

Animal effect

$$A_{i,j,k,t} \sim N(0, \sigma_{At}^2)$$

Pen effect

$$b_j = \begin{bmatrix} b_{0,j,k} \\ b_{1,j,k} \\ b_{2,j,k} \end{bmatrix} \sim N(\mathbf{0}, diag(\sigma_{0,j}^2, \sigma_{1,j}^2, \sigma_{2,j}^2))$$

Measurement error

$$\varepsilon_{i,j,k,t} \sim N(0, \sigma_t^2)$$

Material and methods –Multivariate Dynamic Linear model and Kalman filter

Prior : $(\theta_t|D_{t-1}) \sim N(a_t, R_t)$
in which $a_t = G_t m_{t-1}$ and $R_t = G_t C_{t-1} G_t^T + W_t$.

One step forecast:
$(Y_t|D_{t-1}) \sim N(f_t, Q_t)$
in which $f_t = F_t^T a_t$ and $Q_t = F_t^T R_t F_t + V_t$.

Posterior:
$(\theta_t|D_t) \sim N(m_t, C_t)$
in which $m_t = a_t + A_t e_t$ and $C_t = R_t - A_t Q_t A_t^T$.

Material and methods –Multivariate Dynamic Linear model and Kalman filter

Sequential forecast for k steps ahead for j=1,…,k:

$$(\theta_{t+j}|D_{t-1}) \sim N(a_t(j), R_t(j))$$

in which $a_t(j) = G_{t+j}a_t(j-1)$ and $R_t(j) = G_{t+1}R_t(j-1)G_{t+1}^T + W_{t+j}$

Forecast distribution:

$$(Y_{t+j}|D_t) \sim N(f_t(j), Q_t(j))$$

in which $f_t(j) = F_{t+1}^T a_t(j)$ and $Q_t(j) = F_{t+j}^T R_t(j) F_{t+j} + V_{t+j}$

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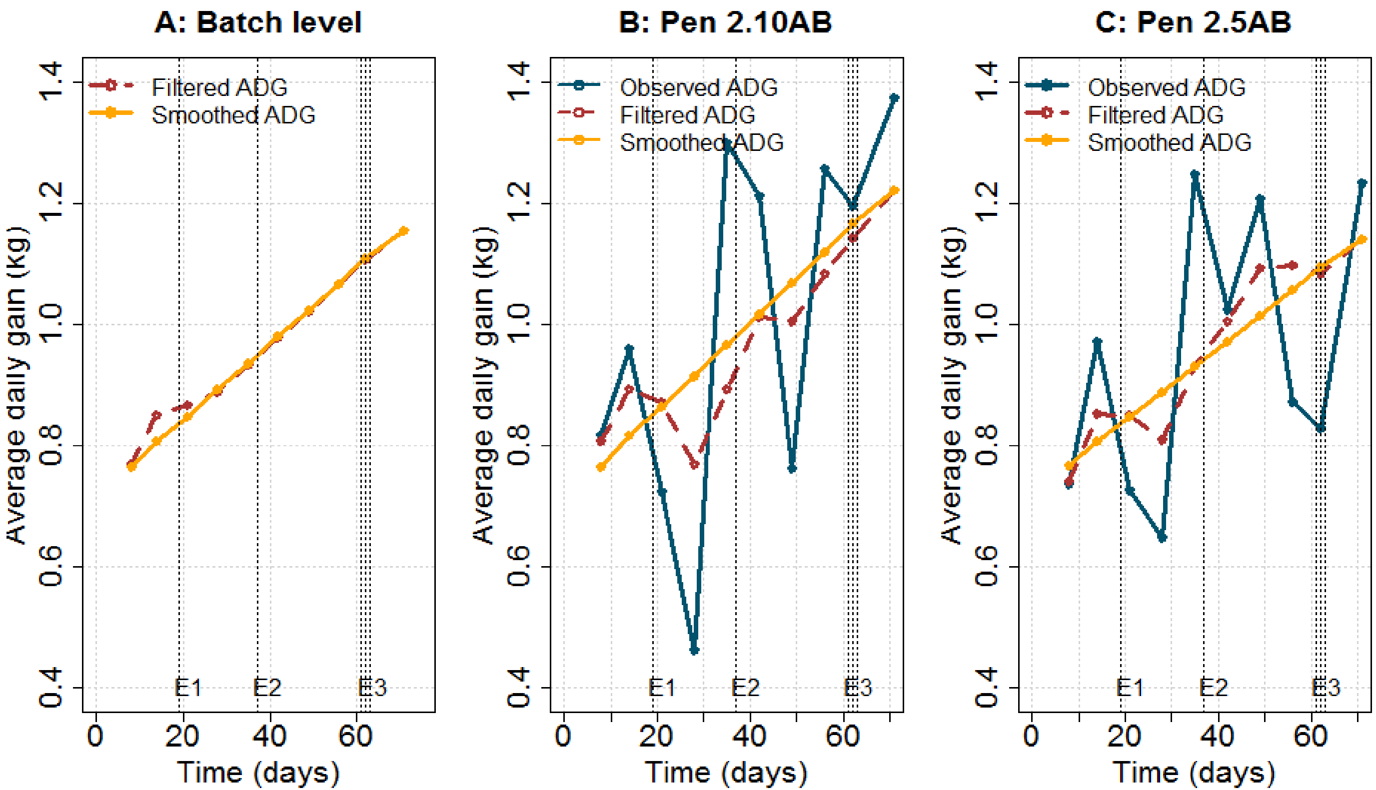
Results – production control



Results – delivery decisions

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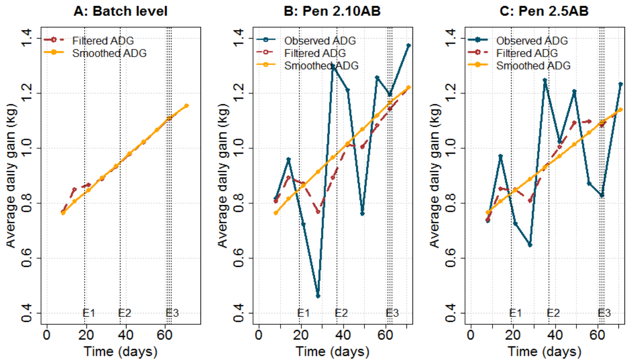
Frequency of observations in learning data set	Scenario	Forecasted mean and SD of pigs above given threshold at week of first delivery[1]		
		90 kg	95 kg	105 kg
No observations – based on initial information about herd	I – Herd level	286 (100)	231 (106)	124 (92)
Observations only at insertion	II – Batch level	262 (109)	200 (111)	91 (84)
	III – Pen level	261 (109)	200 (111)	91 (84)
	IV – Pig level	258 (102)	201 (103)	98 (80)
Observations at insertion and every second week	V – Pen level	290 (58)	211 (60)	69 (41)
	VI– Pig level	276 (53)	207 (54)	86 (38)
Observations at insertion and every week	VII – Pen level	295 (57)	213 (60)	71 (42)
	VIII – Pig level	277 (53)	210 (55)	88 (40)
Actually observed		313	232	67

Conclusions

- Kalman filter is providing a concise framework for combination information from different sources thus increasing the precision of knowledge as further observations were done.
- Presented model framework could be used to monitor BW at section level.



Conclusions

- Model can be used to inform farmer about the starting week of the delivery as well as number of pigs ready to market from a given pen.

- Further economic evaluation is necessary !!

Thank you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