Automated daily body weight measurements in dairy cattle: What can we do with them?

Michael van Straten[1,2], Nahum Y Shpigel[2], Michael Friger[3]

[1]"Hachaklait", Mutual Society for Veterinary Services, Caesarea Industrial Park, Israel
[2]Koret School of Veterinary Medicine, Faculty of Agriculture, Hebrew University of Jerusalem, Israel
[3]Department of Epidemiology and Health Service Evaluation, Faculty of Health Sciences, Ben-Gurion University of the Negev, Israel

Negative Energy Balance (NEB)

- All dairy cows undergo a state of NEB in early lactation
- All of them recover eventually
- Excessive NEB or poor adaptation to NEB negatively affect health and reproduction
- There exists individual variability in the way cows respond/adapt to NEB
- This variability is important

Methods used to assess NEB

Method	Cow level	Applicable	Automated
Calorimetric methods	✓	-	-
cNEB	±	-	-
BCS	✓	✓	±
Metabolic & endocrine parameters	✓	✓	±
Milk composition	✓	✓	±
Body weight	✓	✓	✓

Main Objective

- To analyze, characterize and identify factors of daily BW curves in high producing dairy cows associated with poor adaptation to a state of NEB

Population

- 7 Commercial dairy farms
- Different geographical regions in Israel
- Automated BW measurements 3 X day (SAE-Afikim walk-through scales)
- Israeli Holstein cows
- Zero grazing, open sheds, TMR

Commercial, high producing dairy farms

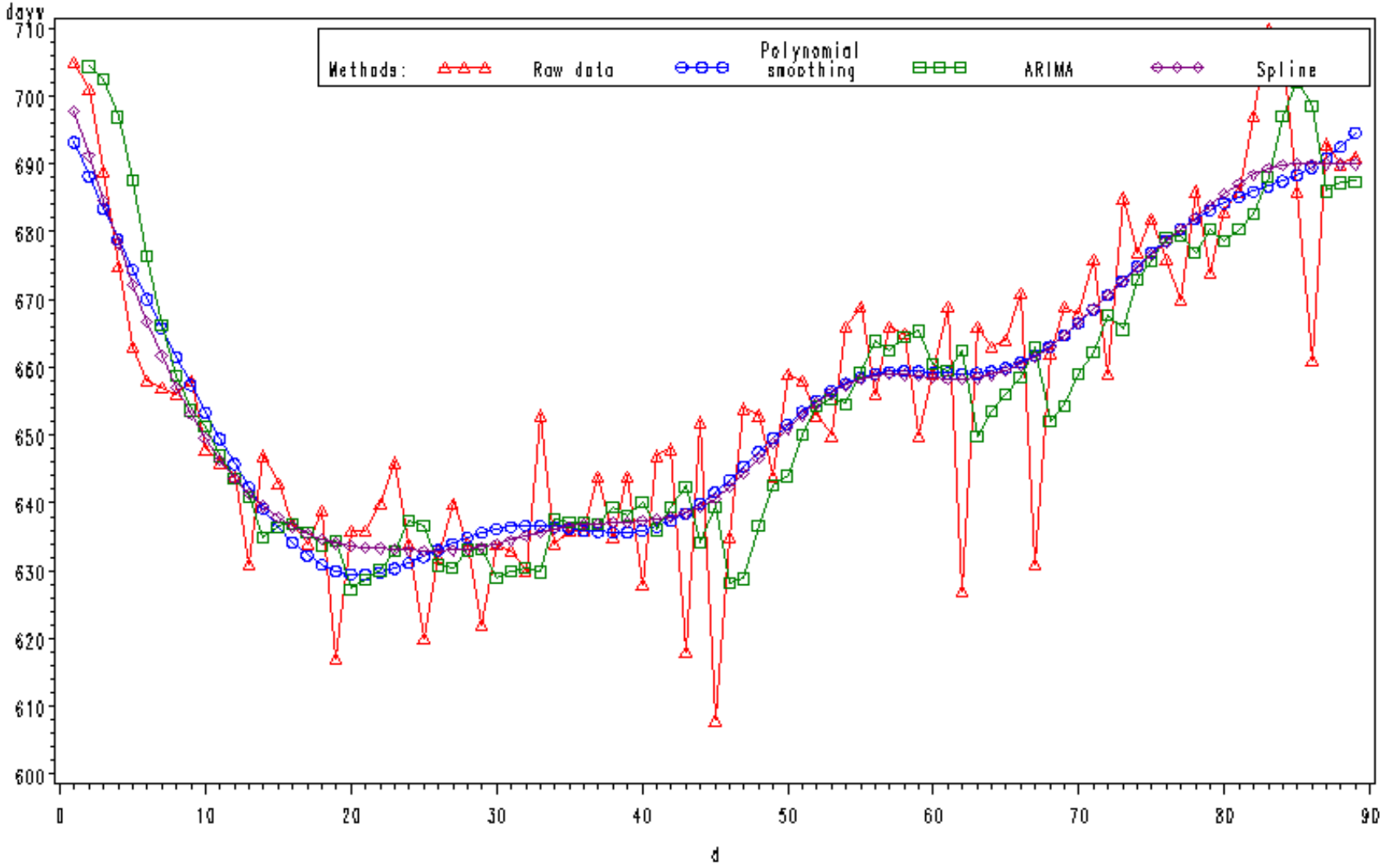
Table 1. Size, average milk yield per cow, and geographical region of the participating farms (Herd Book Summaries, 2006, ICBA, Caesarea Industrial Park, Israel)

		Average yield per cow				
Farm	Cows,[1] n	Milk (kg)	Fat (%)	Protein (%)	SCC ($\times 10^3$/mL)	Geographical region
YO	824	11,604	3.52	3.18	193	Golan Heights
MC	386	13,000	3.67	3.21	135	Western Judean hills
DA	512	12,987	3.58	3.13	143	Northern Negev
NI	251	12,784	3.53	3.21	155	Inner coastal area
HA	810	11,717	3.58	3.17	193	Negev
LO	257	11,587	3.46	3.17	199	Arava valley
YA	255	11,813	3.61	3.18	193	Arava valley

[1]Number of cows: annual average, including n cows.

AfiWeigh™

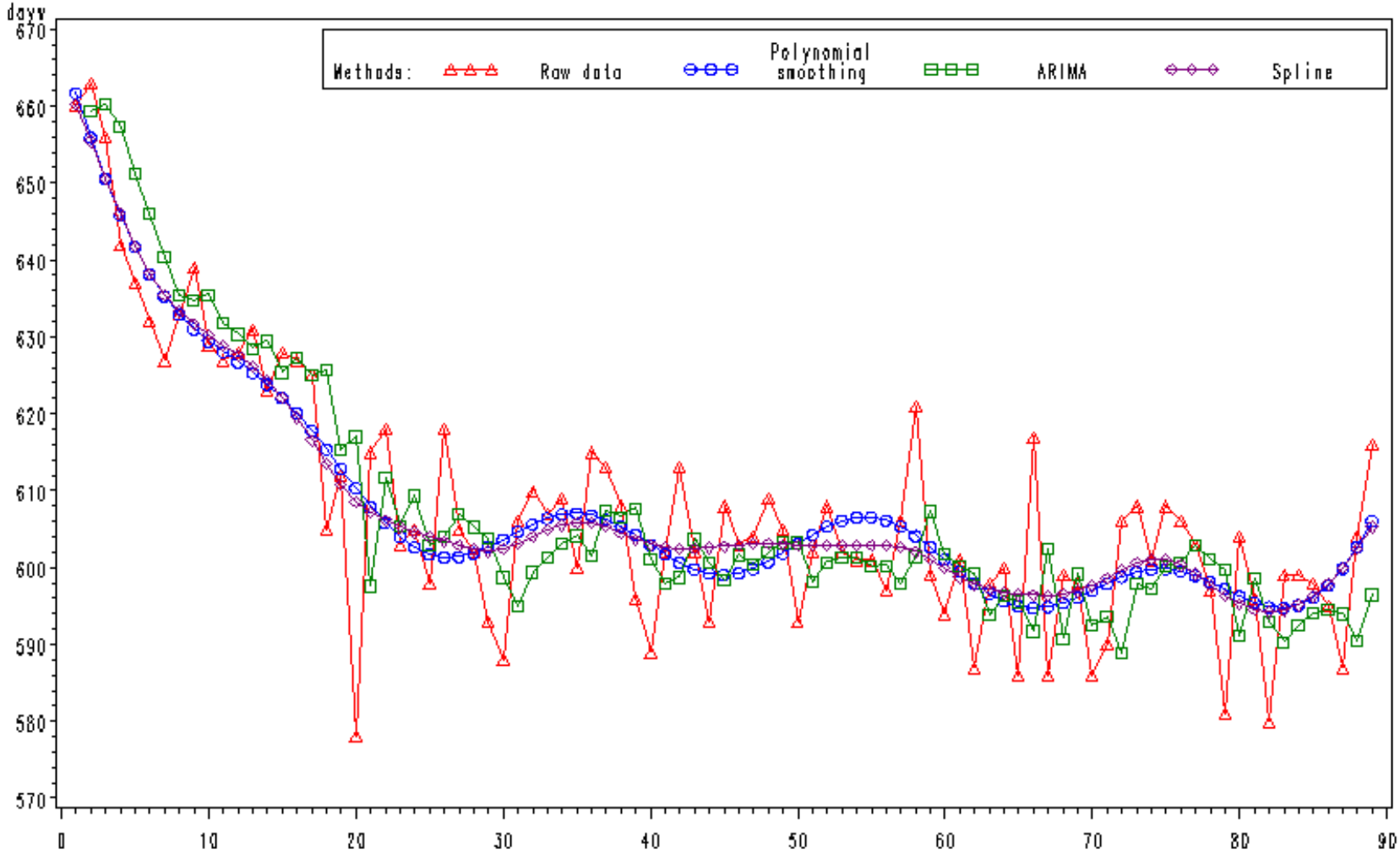
Daily BW measurements



kg

DIM

Daily BW measurements



kg

DIM

What would a "standard" cow do?

- 250,920 BW values, 7 farms
- 3 Parity groups
- Data:
  - Smoothed using penalized cubic splines
  - Modeled using mixed models with a complex e term
- Relative BW: $(BW_C - BW_{(t)})/BW_C$

Standard relative BW curves

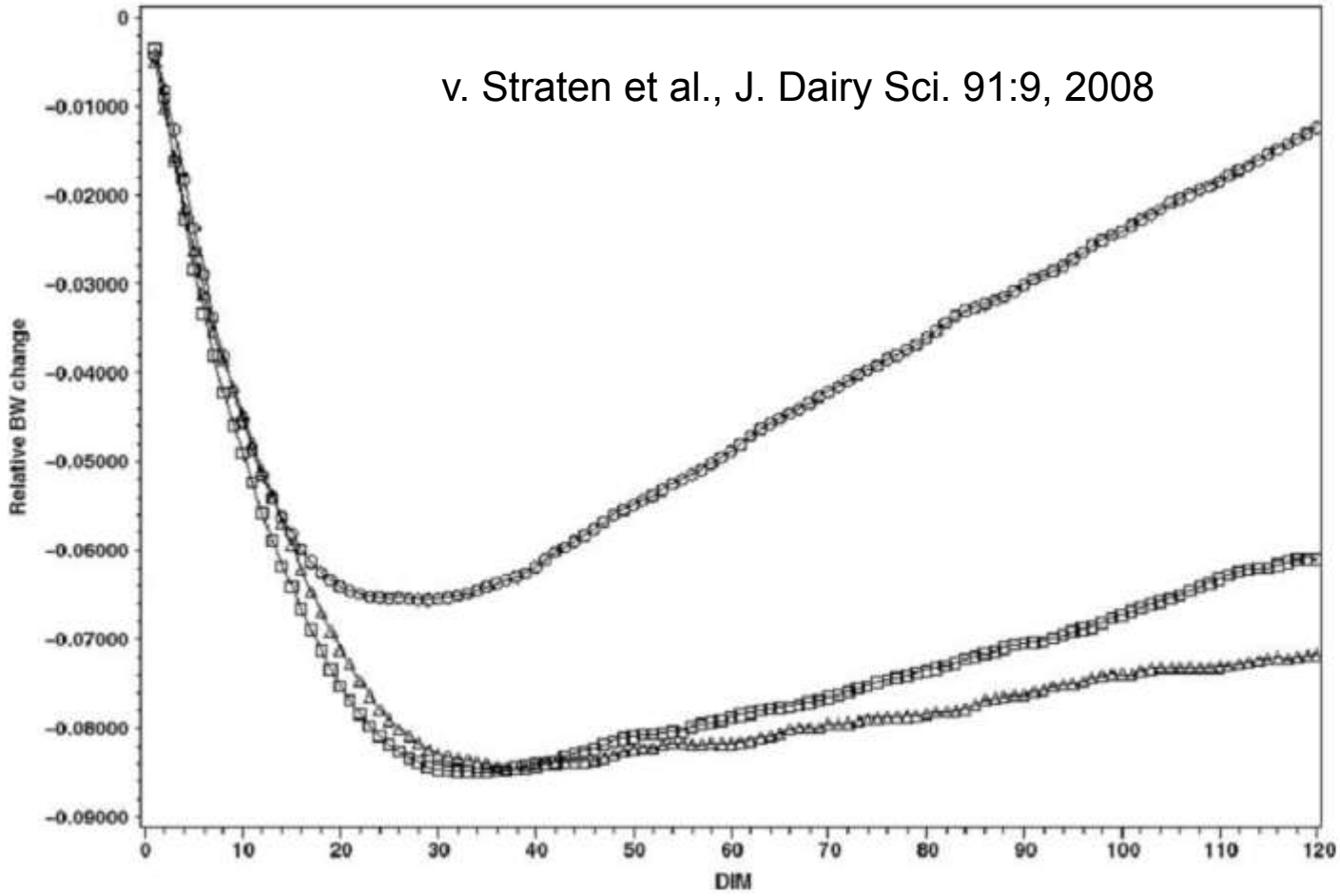
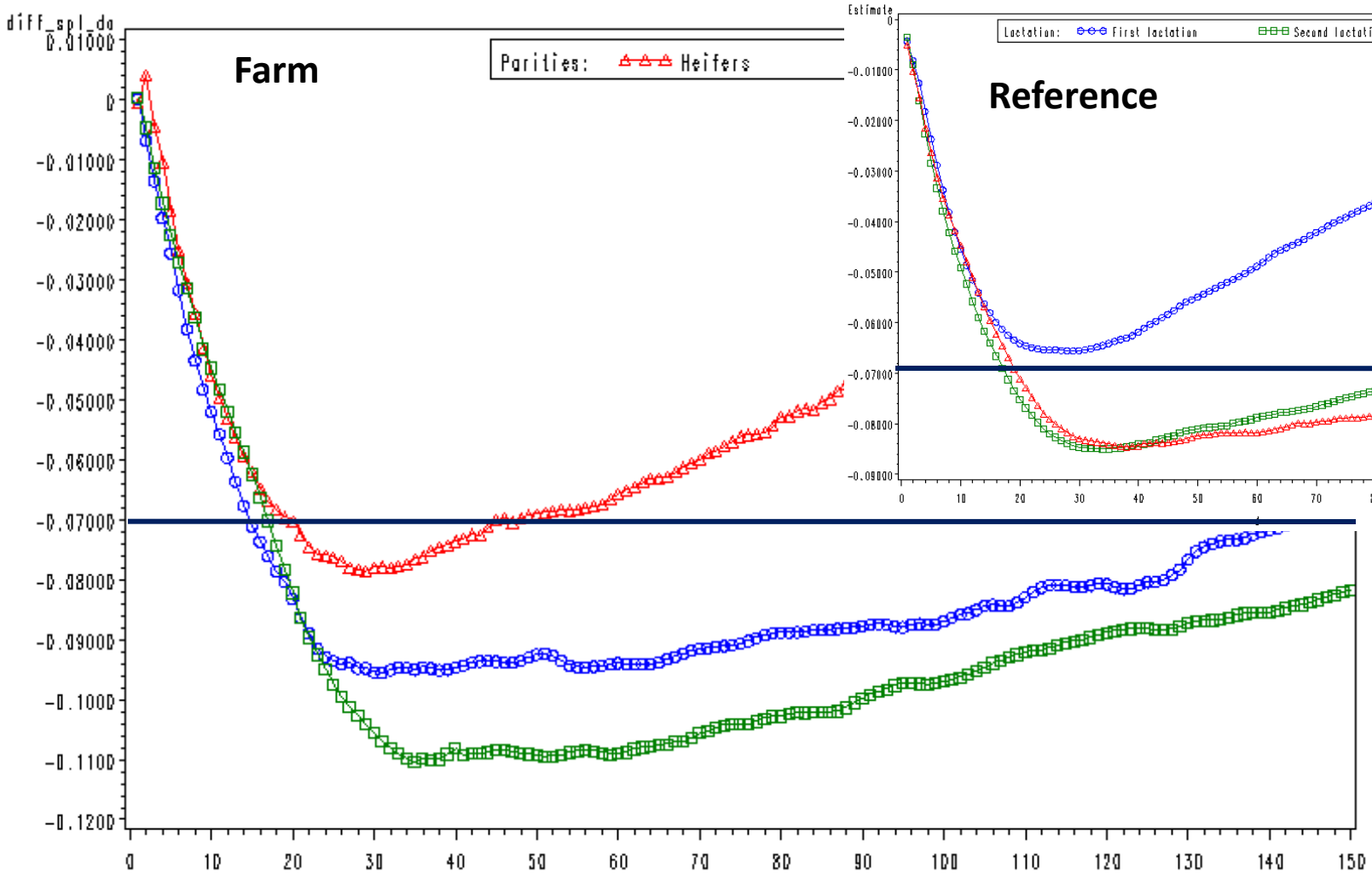
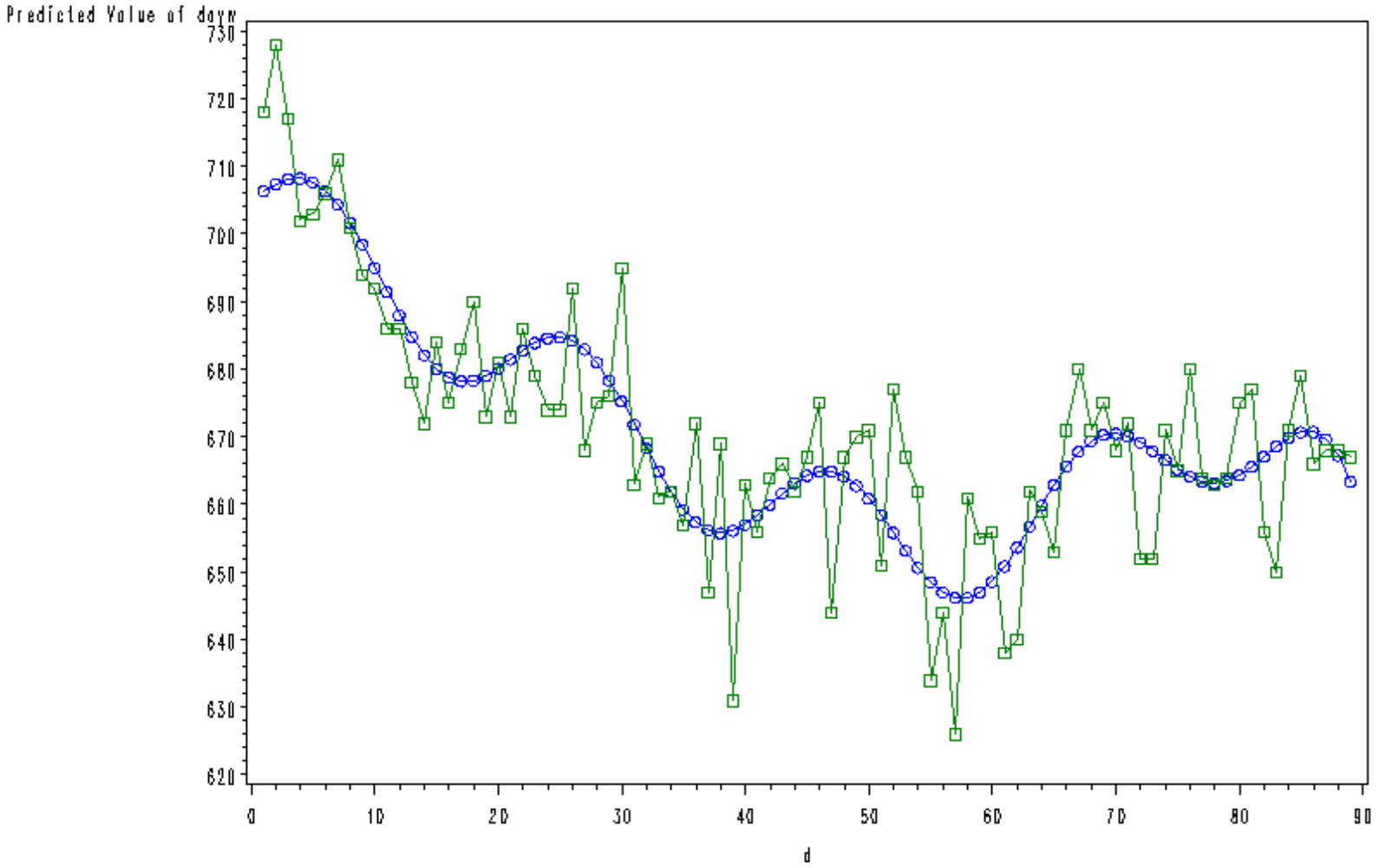


Figure 2. Relative BW change from calving to 120 DIM for first-parity (○), second-parity (□), and older (Δ) cows, adjusted for farm and repeated BW measurements of the same cow.

Standard relative BW curves as a tool?



Cyclic changes in BW



Cyclic changes in BW

Table 5. Time-series analysis of daily BW of individual cows: number of cows (%) with the corresponding level of adjusted R^2 and with or without a significant effect for a 7- or 21-d cycle, obtained from a polynomial regression model with polynomials up to the eighth order and harmonic functions for 7- and 21-d cycles, respectively

	Number of cows (%) by farm							
Item	DA	HA	LO	MA	NI	YA	YO	Total (%)
Adjusted R^2								
0–0.25	45 (15.7)	84 (34.0)	16 (12.2)	51 (15.5)	31 (15.8)	31 (21.4)	133 (16.0)	391 (18.0)
0.25–0.50	65 (22.7)	59 (23.9)	13 (9.9)	47 (14.3)	40 (20.4)	26 (17.9)	137 (16.5)	387 (17.9)
0.50–0.75	139 (48.4)	80 (32.4)	41 (31.3)	121 (36.8)	77 (39.3)	39 (26.9)	283 (34.0)	780 (36.0)
0.75–1.00	38 (13.2)	24 (9.7)	61 (46.6)	110 (33.4)	48 (24.5)	49 (33.8)	279 (33.5)	609 (28.1)
7-d cycle								
Absent	266 (92.7)	222 (89.9)	109 (83.2)	296 (90.0)	182 (92.9)	123 (84.8)	722 (86.8)	1,920 (88.6)
Present	21 (7.3)	25 (10.1)	22 (16.8)	33 (10.0)	14 (7.1)	22 (15.2)	110 (13.2)	247 (11.4)
21-d cycle								
Absent	224 (78.0)	185 (74.9)	98 (74.8)	209 (63.5)	106 (54.0)	92 (63.5)	538 (64.7)	1,452 (67.0)
Present	63 (22.0)	62 (25.1)	33 (25.2)	120 (36.5)	90 (46.0)	53 (36.5)	294 (35.3)	715 (33.0)
Total	287	247	131	329	196	145	832	2,167

v. Straten et al., J. Dairy Sci. 91:9, 2008

Do 21-day cycles in BW mean anything?

Table 6. Farm-adjusted odds ratios with corresponding 95% confidence intervals (CI) for variables with a significant effect on the probability of being diagnosed with inactive ovaries

Variable	Odds ratio	95% CI	*P*-value
Summer calving			
No	1.79	1.274–2.508	0.001
Yes	1	—	
BCS at calving			
≤2.5	1.91	1.283–2.857	0.008
≥3.75	1.02	0.578–1.810	0.313
2.5 < BCS < 3.75	1	—	

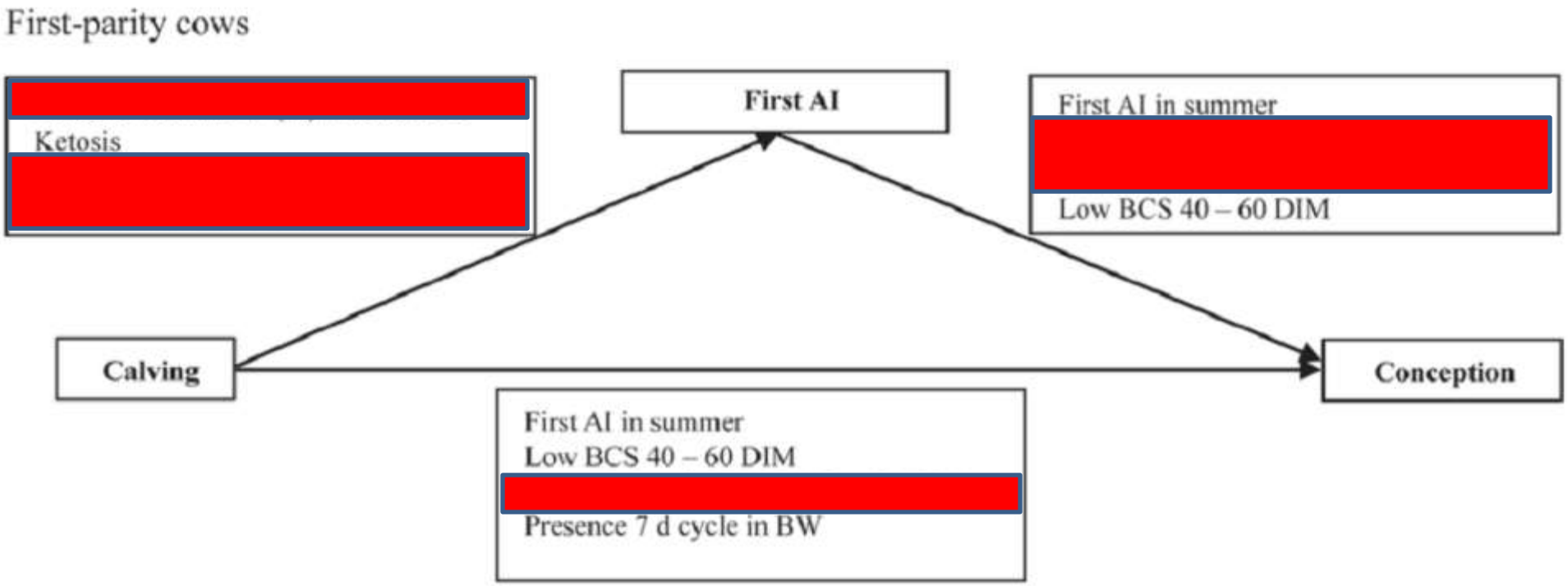
v. Straten et al., J. Dairy Sci. 91:9, 2008

Cows without 21-d cycles were more likely to be diagnosed with inactive ovaries than cows with 21-d cycles

BW loss after calving: fertility

- Relative BW (RBW) loss vs. absolute BW loss
- Extreme RBW loss in the first 10 d after calving in first parity cows: extended **calving ⇨ conception** interval (OR 0.79, 95%CI 0.67-0.94)
- Extreme RBW loss calving to nadir: ⇩conception at 1st insemination (OR 0.80, 95%CI 0.67-0.96)
- Extreme RBW loss calving to nadir: extended **first insemination ⇨ conception** interval (OR 0.72, 95%CI 0.61-0.85)

BW and reproduction, 1st parity



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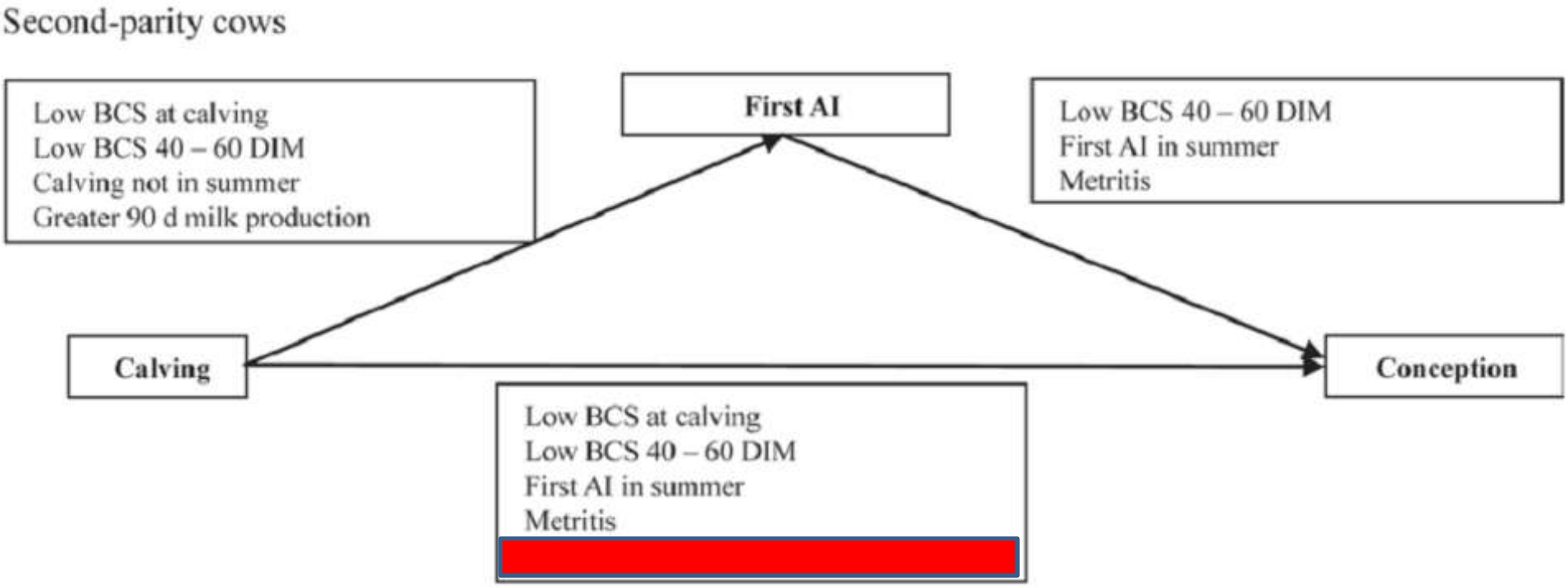
BW and reproduction, 2nd parity



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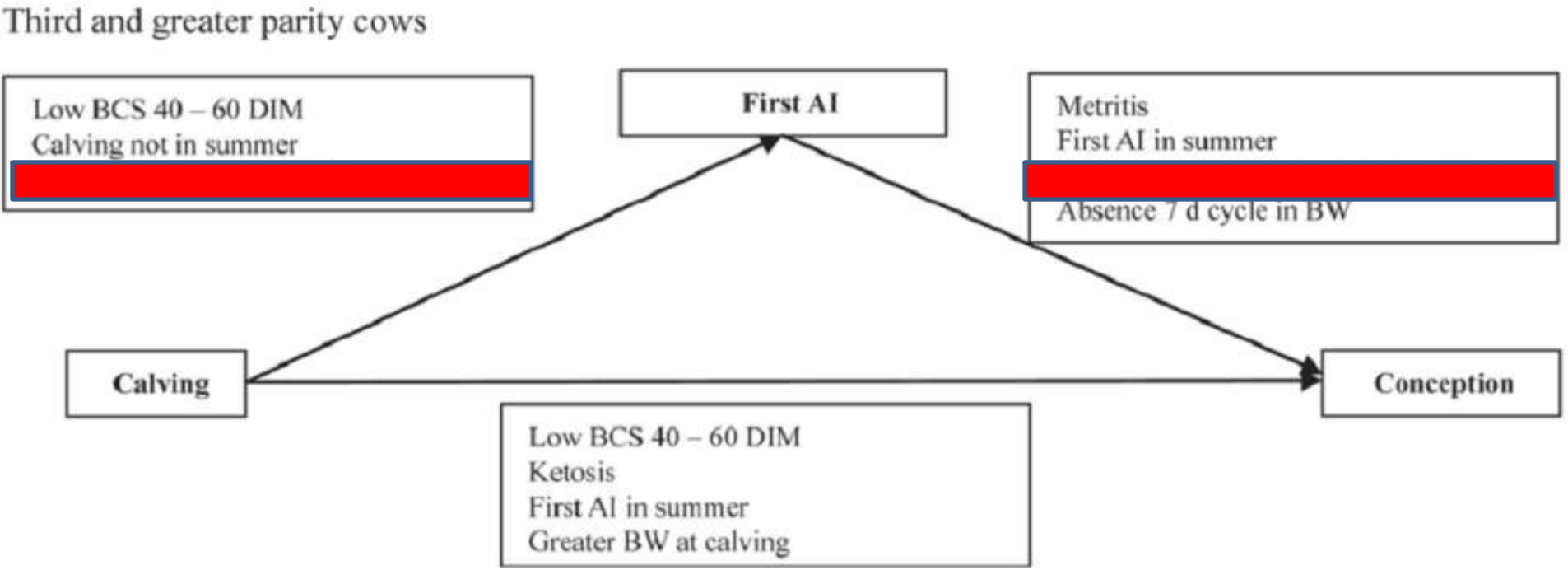
BW and reproduction, 3rd parity



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BW loss after calving: udder health

- Cows with high SCC on first test-day excluded
- Relative BW (RBW) loss vs. absolute BW loss
- Upper quartile in RBW loss calving to nadir: 25% increase in odds for an event SCC >250,000 cells/mL (P = 0.0064)
- Upper quartile in RBW loss calving to nadir: 43% increase in odds for an event SCC >400,000 cells/mL (P = 0.0003)

Table 3. Results of generalized mixed models with random herd effects for quantifying relationships between various covariates and all events of SCC >250,000 cells/mL or SCC >400,000 cells/mL

	Event of SCC >250,000 cells/mL			Event of SCC >400,000 cells/mL		
Variable	OR[1]	95% CI[2]	*P*-value	OR	95% CI	*P*-value
Parity						
1	0.38	0.32 to 0.46	<0.0001	0.33	0.26 to 0.41	<0.0001
>1	1			1		
Lactation stage (DIM)						
≤90	0.27	0.22 to 0.32	<0.0001	0.29	0.23 to 0.37	<0.0001
91 to 180	0.61	0.53 to 0.70	<0.0001	0.69	0.59 to 0.82	<0.0001
>180	1			1		
Ketosis						
Yes	1.44	1.20 to 1.72	<0.0001	1.33	1.06 to 1.67	0.0139
No	1			1		
[redacted]						
Summer calving						
Yes	0.85	0.73 to 0.99	0.0396	0.71	0.59 to 0.87	0.0007
No	1			1		
BCS at 40 to 60 d postpartum						
<2.5	1.12	0.97 to 1.29	0.1132			
>3.5	2.88	1.28 to 6.49	0.0108			
2.5 ≤ BCS ≤ 3.5	1					
BCS at calving						
<2.5				1.21	0.93 to 1.58	0.1502
>3.5				0.62	0.43 to 0.91	0.0156
2.5 ≤ BCS ≤ 3.5				1		

[1]OR = odds ratio adjusted for all other covariates included in the model.

[2]95% CI = 95% confidence interval.

[3]UQRLCN = upper quartile in relative BW loss from calving to nadir BW. Upper quartile values were 12.3, 15.0, and 15.7% for first-, second-, and third-parity and older cows, respectively.

v. Straten et al., J. Dairy Sci. 92:9, 2009

Use of automated BW measurements

- Standard RBW curves: identification of farms in which cows are suffering from extreme RBW loss
- Extreme RBW loss in early lactation: poor reproductive performance and events of elevated SCC
- Monitoring the presence of 21 day cycles in BW: indirect assessment of ovarian activity in a herd
- Extreme RBW loss in early lactation: identification of cows suffering from poor adaptation to NEB

I thank the farms for their cooperation:

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Thank you for your attention