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Validation of HappyMoo MIR energy balance models on external datasets with feed restriction

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Outline

- **HappyMoo project**
- **Key results from energy balance (EB) workpackage**
- **Presentation of the external datasets**
- **Validation of EB models in feed restriction conditions**

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HappyMoo project



HappyMoo project



Knowing dairy cows' welfare from milk mid-infrared spectrum

Health

Lameness

Hoof diseases

Lameness scoring

Mastitis

Acute phase proteins

MastiMIR : global indicator

Stress

Chronic

Acute

Heat stress

Hunger

Negative energy balance

Liveweight

Body condition scores

Milk components



HappyMoo project



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Key results energy balance workpackage

Key results

MIR-based predictions



Lameness

Mastitis

Stress

Hunger



Negative energy balance

Model	n	Mean	SD	SECV	R2cv
EB [MJ NEL/day]	16993	0.32	21.41	10.65	0.75
DMI [kg]	14804	21.77	2.52	1.38	0.70
FE [kg ECM/DM kg]	20747	1.48	0.31	0.15	0.76



Bodyweight

Model	n	Mean	SD	SECV	R2cv
Bodyweight	12051			51,7	0.51



Body condition scores

Model	n	Mean	SD	SECV	R2cv
BCS	12601	2.53	0.48	0.38	0.35



Milk components

Model	n	Mean	SD	SECV	R2cv
C18:1 cis 9	1762	0.744	0.25	0.06	0.94
BHB	7166	63.3	49.9	64.59	0.61
Acetone	1996	0.052	0.047	0.09	0.60
Citrate	599	8.89	2.19	0.76	0.88



Model	
Glu6P	Model not released. Too low performances.
Isocitrate	
GluFree	

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External datasets for validation

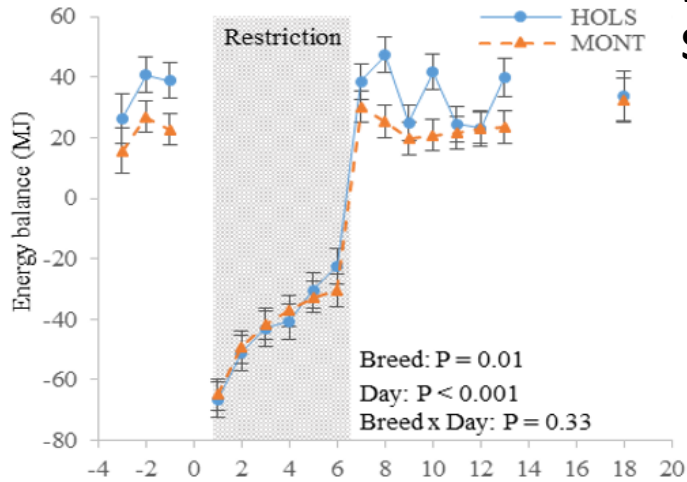
External datasets : 2 protocols

Short and intense restriction



Billa et al. 2020;
<https://doi.org/10.3168/jds.2019-17466>

19 cows – 2 spectra/day from d-3 to d+24
 Standardized spectra



- Energy balance
- DMI
- Bodyweight
- Plasma metabolites :
 - Glucose
 - NEFA
 - BHB
 - Glutamate
- Milk metabolites :
 - FA (CPG)
 - Glucose
 - Isocitrate
 - BHB
 - Glutamate
 - Glucose-6-Phosphate
 - NAGase

Gold : existing model but package/API/script not yet available

Green : available models

Feed restriction at mid-lactation



Fischer et al. 2020;
<https://doi.org/10.3168/jds.2019-17654>

28 cows – 3 spectra /cow : D21 – before restriction – during restriction
 Spectra partially standardized

- Energy balance
- DMI
- Bodyweight and BCS
- Plasma metabolites & hormones:
 - Glucose
 - NEFA
 - BHB
 - IGF-1, insulin
- Milk metabolites :
 - FA (CPG)
 - Galactose
 - Glucose
 - Isocitrate
 - BHB
 - Glutamate
 - Glucose-6-Phosphate

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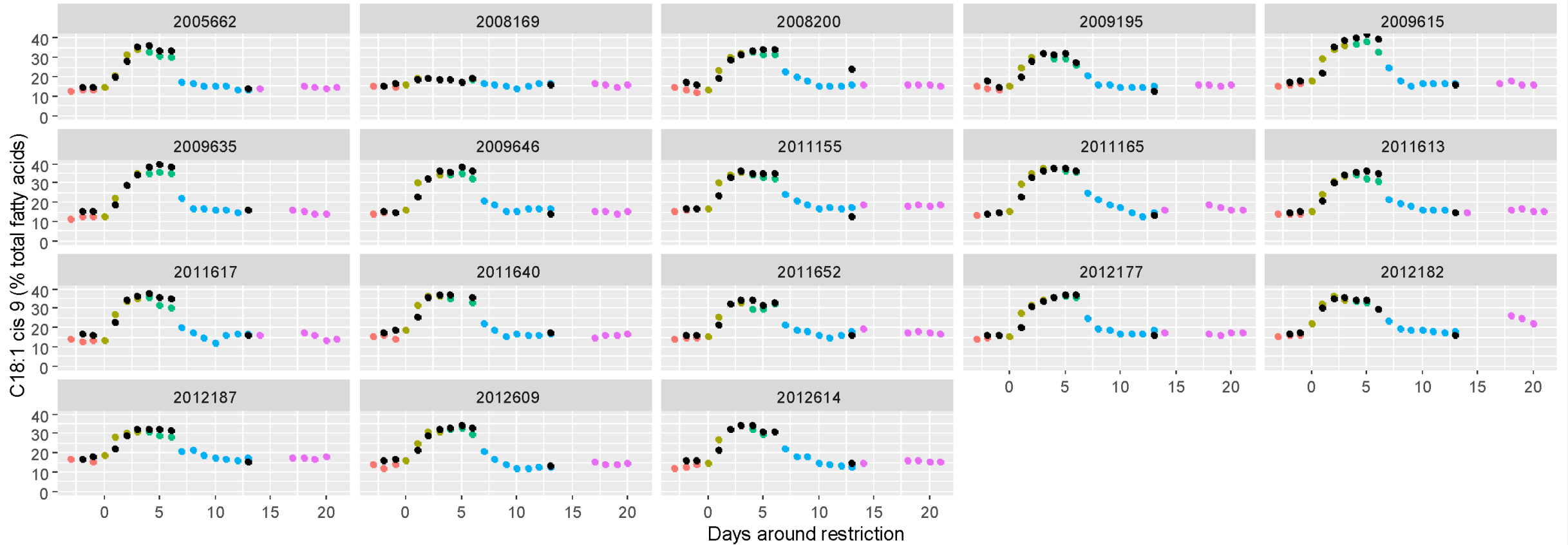


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Results

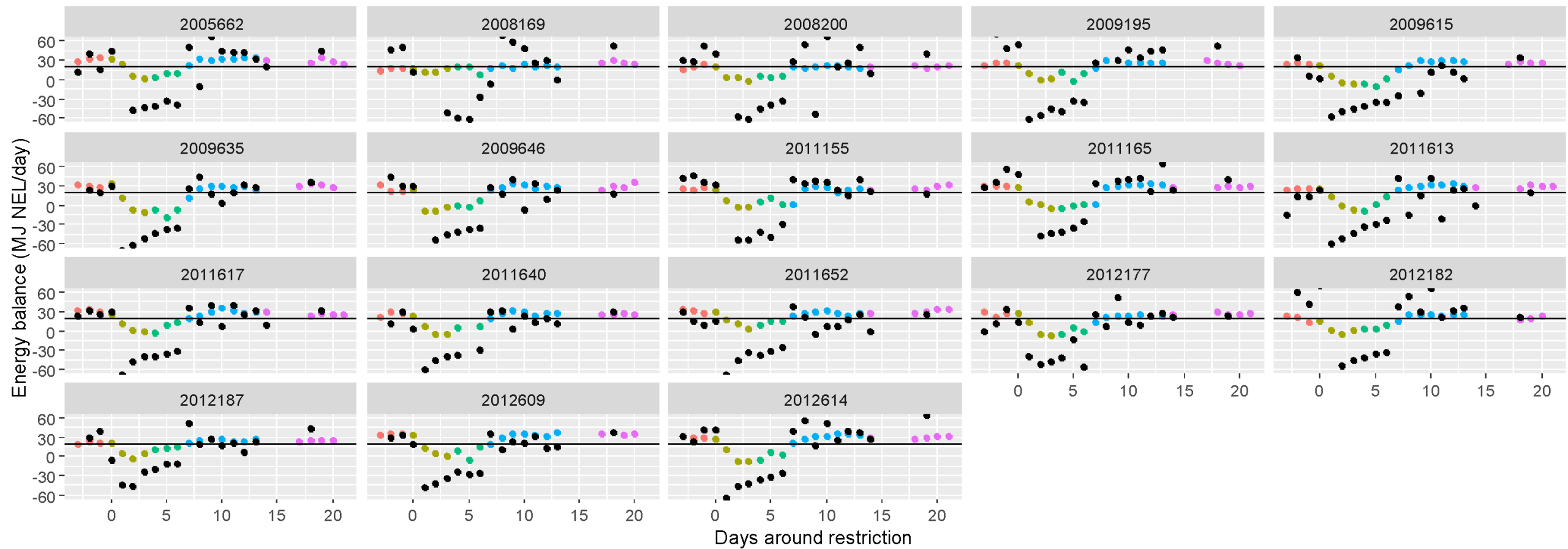
C18:1 cis 9 (% AGT)



Period ● before restriction ● beginning of restriction ● end of restriction ● week following of restriction ● 2nd week after restriction

Observed data in black

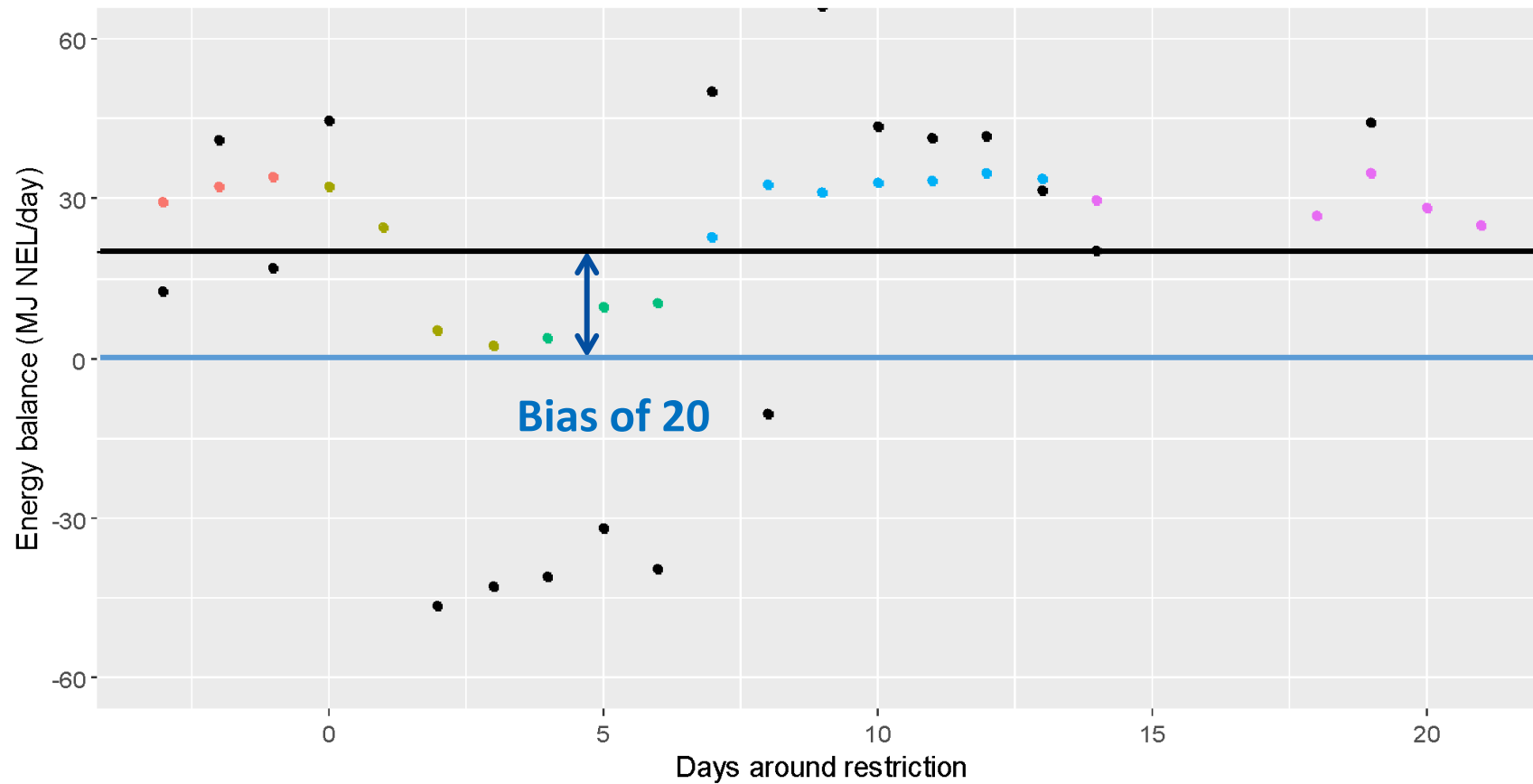
Energy balance



Period ● before restriction ● beginning of restriction ● end of restriction ● week following of restriction ● 2nd week after restriction

Observed data in black

Energy balance

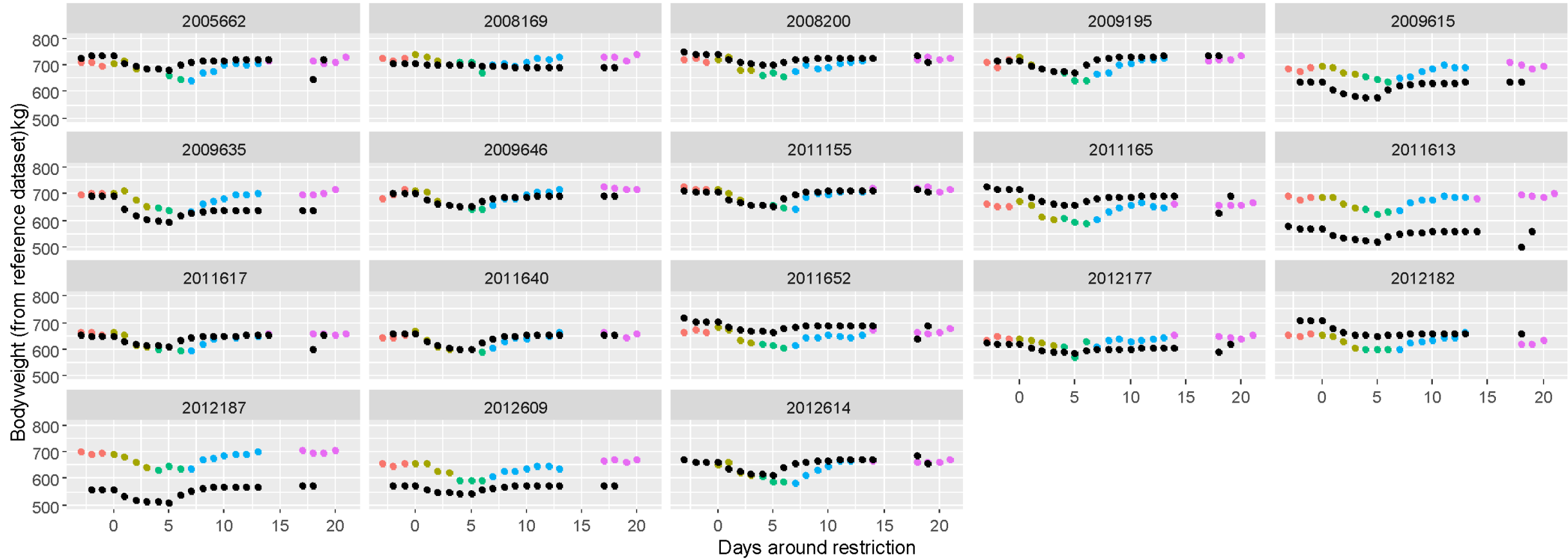


- Different calculation methods :**
- **GfE (German system) 2001, 2008 and 2009 for calibration dataset**
 - **INRAE (French system) 2007 for validation dataset**

Period • before restriction • beginning of restriction • end of restriction • week following of restriction • 2nd week after restriction

Observed data in black

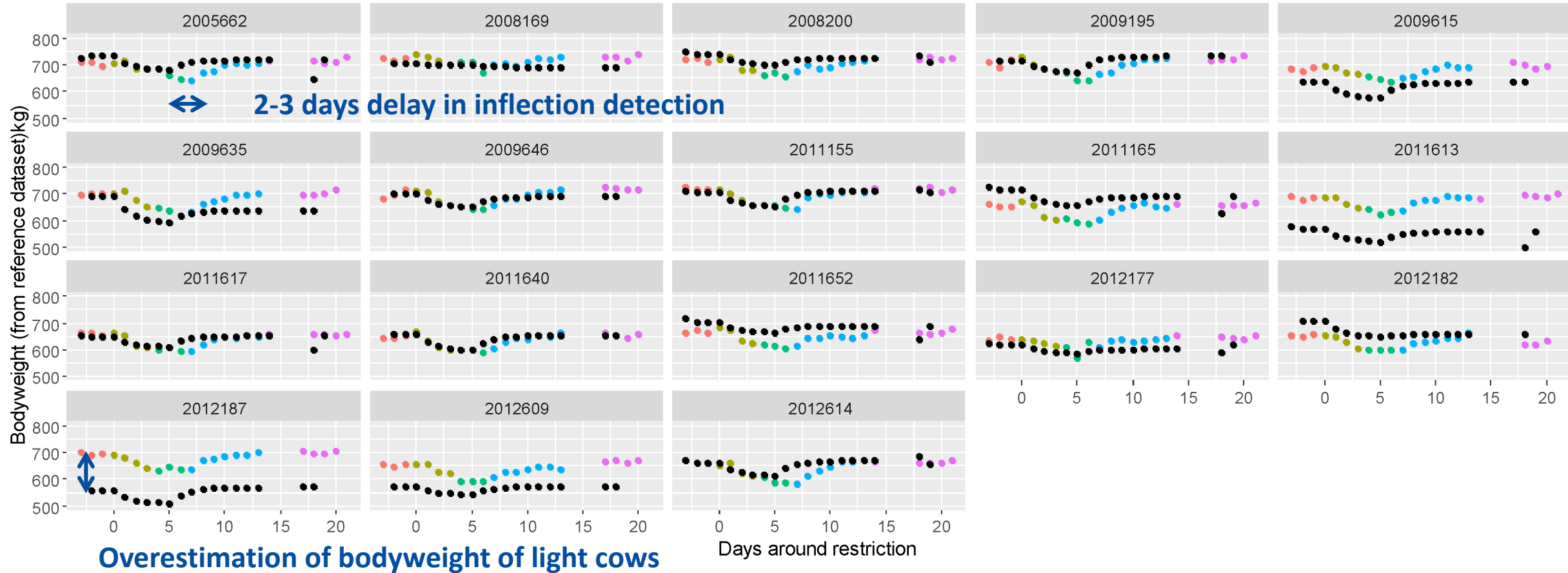
Bodyweight



Period ● before restriction ● beginning of restriction ● end of restriction ● week following of restriction ● 2nd week after restriction

Observed data in black

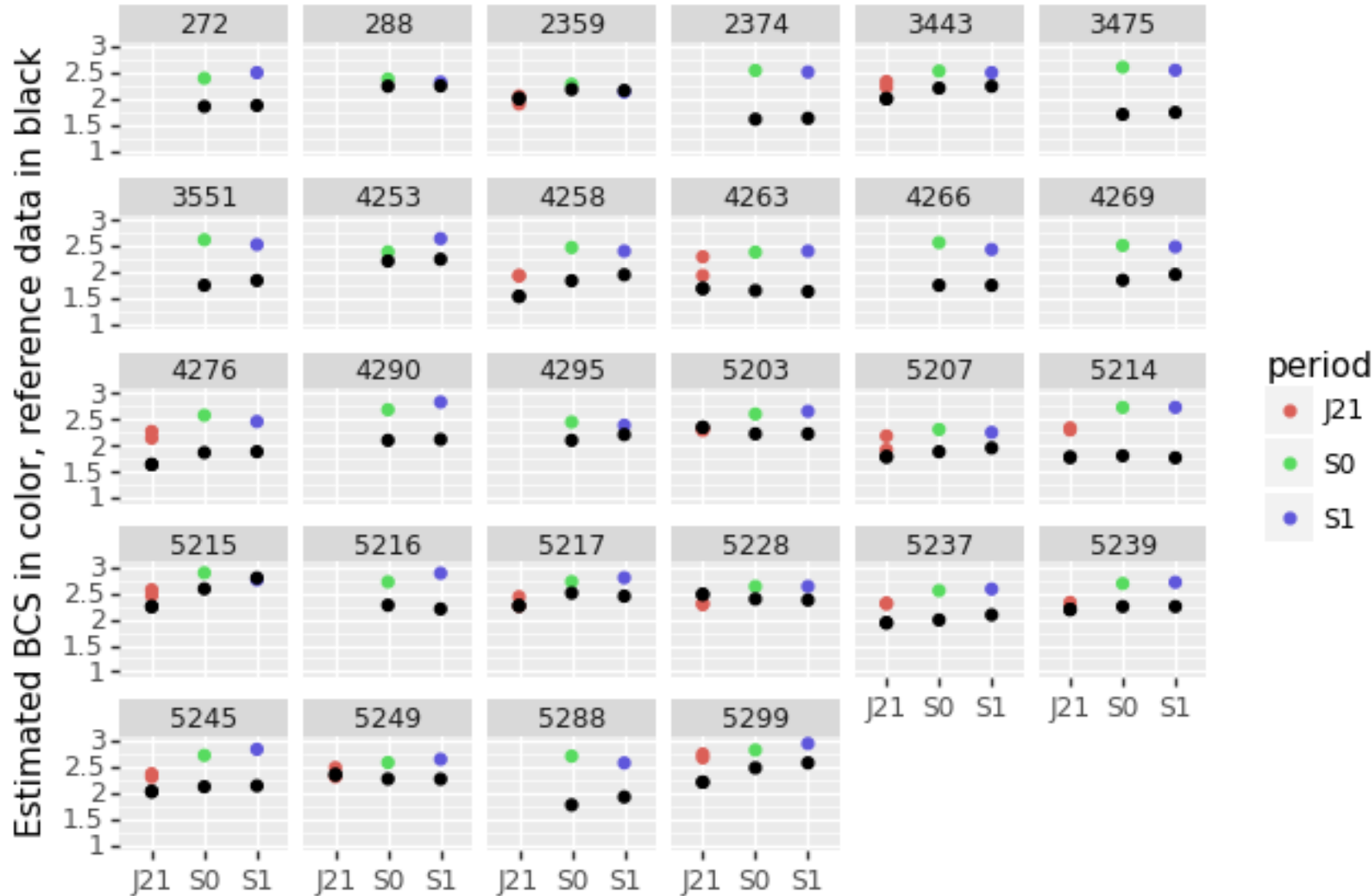
Bodyweight



Period ● before restriction ● beginning of restriction ● end of restriction ● week following of restriction ● 2nd week after restriction

Observed data in black

BCS



Synthesis of the results

	Short and intense restriction		Feed restriction at mid-lactation	
	RMSE	R ²	RMSE	R ²
C18:1 cis 9 (g/100g milk)	0.2	0.85		
C18:1 cis 9 (% of FA)	2.8	0.91	1.1	0.94
EB (MJ NEL/day)	33.9	0.55	14.1	0.29
DMI (kg)	6.4	0.68	2.6	0.5
BHB in milk (μmol/L)	Not relevant – R ² = 0.18			
NAGase (mmol/L)	1.0	0.33	0.7	0.25
Bodyweight (kg)	55	0.17	53.9	0.35
BCS	Not relevant			

Conclusion

C18:1 cis 9 equation

MIR equation very accurate ($R^2 > 0.90$)
Reactive indicator of feed restriction
Can be used at the beginning of lactation or later

EB and DMI equations

Predictions very correlated to C18:1 cis 9
Added values to validate on databases

BHB equation

Indicator of ketosis
Validation not possible here (only low BHB values in dataset) but validated on other datasets

BCS and bodyweight equations

Lack of accuracy and of reactivity compared with C18:1 cis 9

Steps in progress and to come

Validation in commercial farms

Holicow



Thank you for your attention !

Thank you to all contributors !

