

Association between temporal patterns in continuously monitored reticuloruminal pH data and production characteristics in dairy cows

Denwood, M.J.^{1*}, Jensen, D.B.^{1,2}, Kleen, J. L.³, Jonsson, N. N.^{4,5}

* md@sund.ku.dk

¹ Department of Veterinary and Animal Sciences, University of Copenhagen, Denmark

³ CowConsult, Coldinne, Germany

² Business Economics Group, Wageningen University, 6706 KN Wageningen, the Netherlands

⁴ Institute of Biodiversity Animal Health and Comparative Medicine, University of Glasgow, UK

⁵ Harbro Ltd, Birkhill Mill, Lanarkshire, UK

Objectives

- Bolus devices allow reticuloruminal pH to be continuously monitored over an extended time period
- This produces a large amount of data that is difficult to interpret
- Are there simple and useful methods of summarising these data?

Materials and Methods

- Reticuloruminal pH data were recorded at 600 second intervals over 45 consecutive days from 24 apparently healthy, co-managed cattle
- Data from each animal were fit to a non-linear model incorporating a smoothing spline term between days along with two modified sinusoidal functions with frequencies corresponding to (a) once per day and (b) the time interval between three milking events per day
- Daily summary statistics for each animal were then calculated based on the raw data (e.g. the number of extreme low and high pH observations) as well as daily aggregation of the residuals from the fitted model
- These were then correlated to deviations in daily observed milk yield and dry matter intake observed from the same animal two days later

Table 1: Results of two linear mixed models relating four different daily pH summary statistics to the days-in-milk-corrected milk yield and dry matter intake observed two days later from the same cow

Parameter	Corrected Milk Yield		Dry Matter Intake	
	Estimate	p-value	Estimate	p-value
Mean residual	-0.137	0.911	0.019	0.988
Mean absolute residual (MAR)	-8.633	< 0.001	-8.698	< 0.001
Low pH observations	0.041	0.056	0.015	0.530
High pH observations	0.003	0.877	0.018	0.396

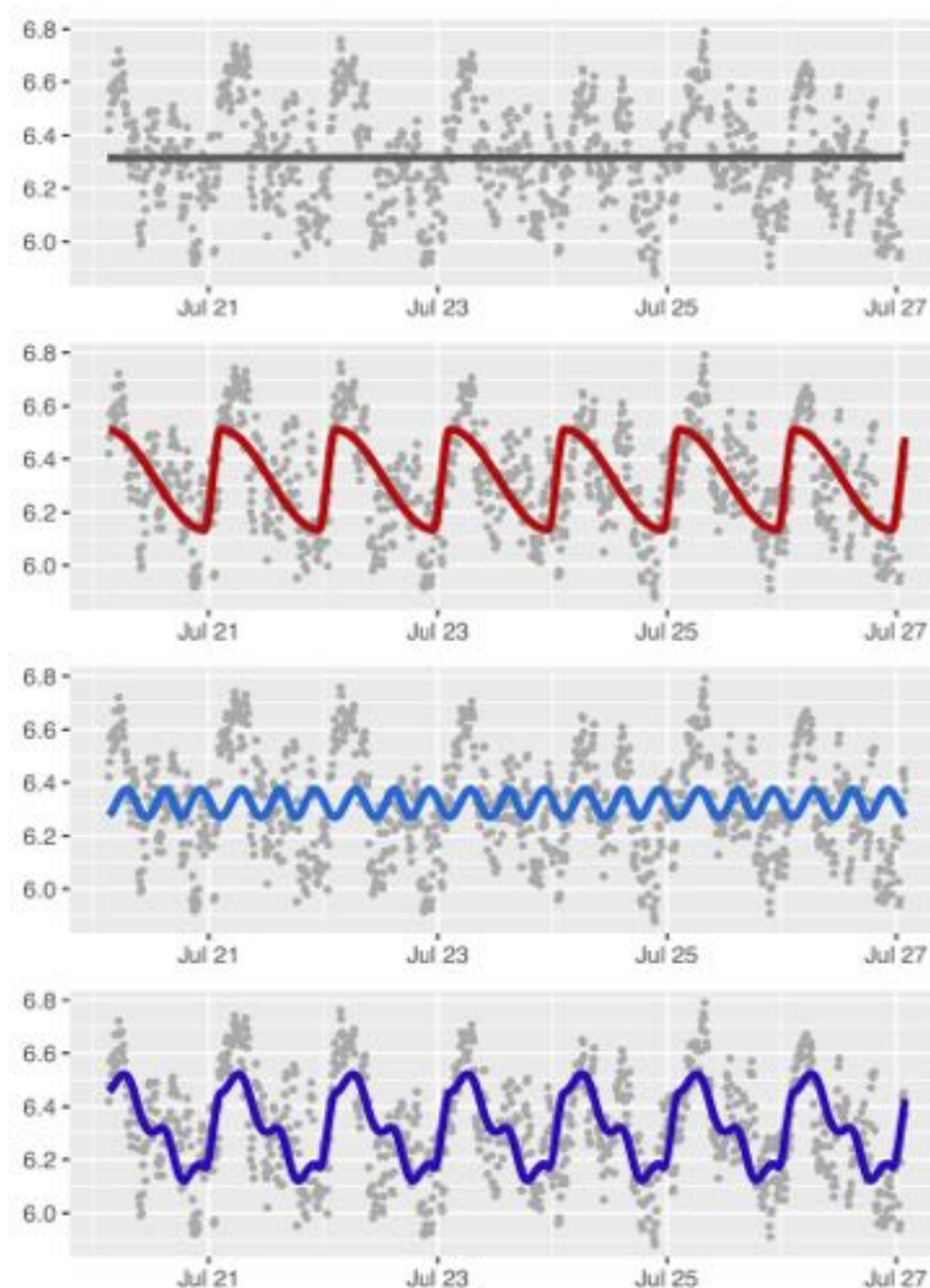


Figure 1: Observed pH values (y axis) from a single animal over a 7-day period (grey dots) overlaid with the smoothing term (black line), daily skewed sine wave (red line), milking-related skewed sine wave (blue line), and combined model (purple line)

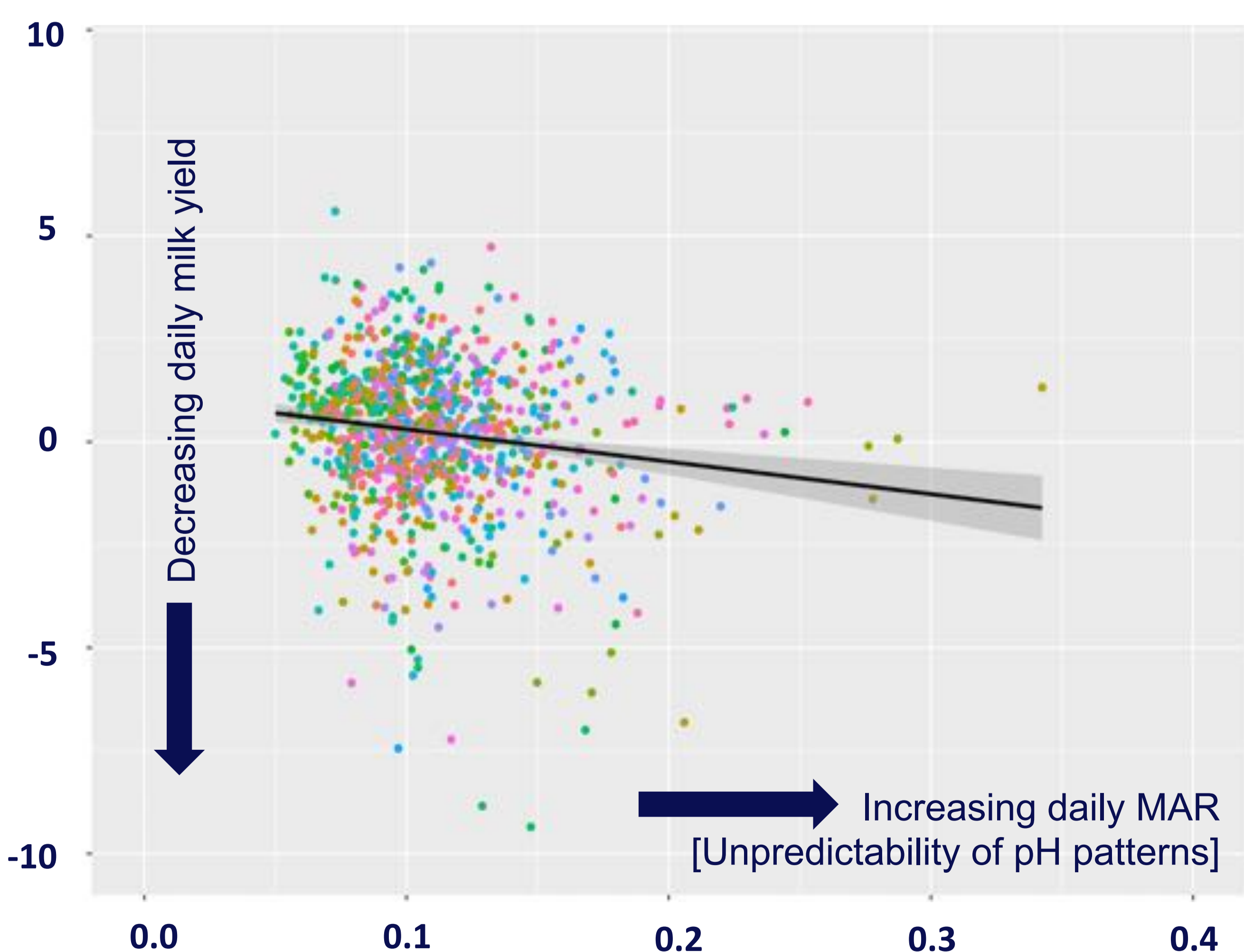


Figure 2: Daily mean absolute residual (MAR; x-axis) vs. deviation from expected daily milk yield in the same animal (kg; y axis) for 24 animals (different colours)

Results & Conclusions

- Approximately 30% of the overall variation in pH observations is explained by the modified sine wave with daily frequency, plus an additional 20% for the second sine wave and 5% for the smoothing spline term describing variation between days
- When summarised at daily level, increasing MAR (reflecting decreased predictability of pH patterns) was strongly negatively associated with clinically and economically relevant production characteristics
- Additional work has shown that daily MAR based on simplified versions of these methods can distinguish between feeding management for groups of both dairy and beef cattle
- Further work investigating the utility of these models as a real-time predictive system for nutritional imbalance is ongoing
- The methods presented have been implemented as a self-contained R package to provide daily summaries for any arbitrary dataset:

<https://github.com/boydorr/BolusPH>