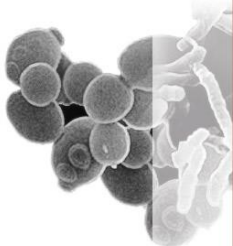


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SARA score based on reticulo-rumen (RR) pH kinetics in dairy cows

C.Villot, K. Biard, A. Boudon, C. Martin, M. Silberberg

Clothilde Villot



**INTERNATIONAL SYMPOSIUM
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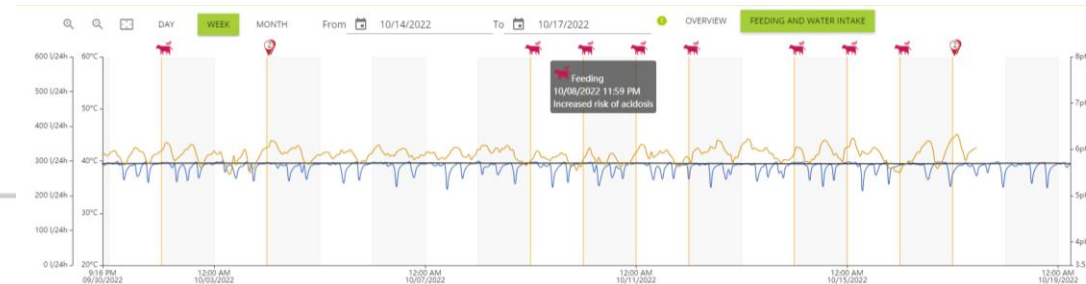
June 4-8, 2023 • Florianópolis, Brazil

New tool → New indicators and thresholds for accurate diagnostic

Continuous glucose monitoring

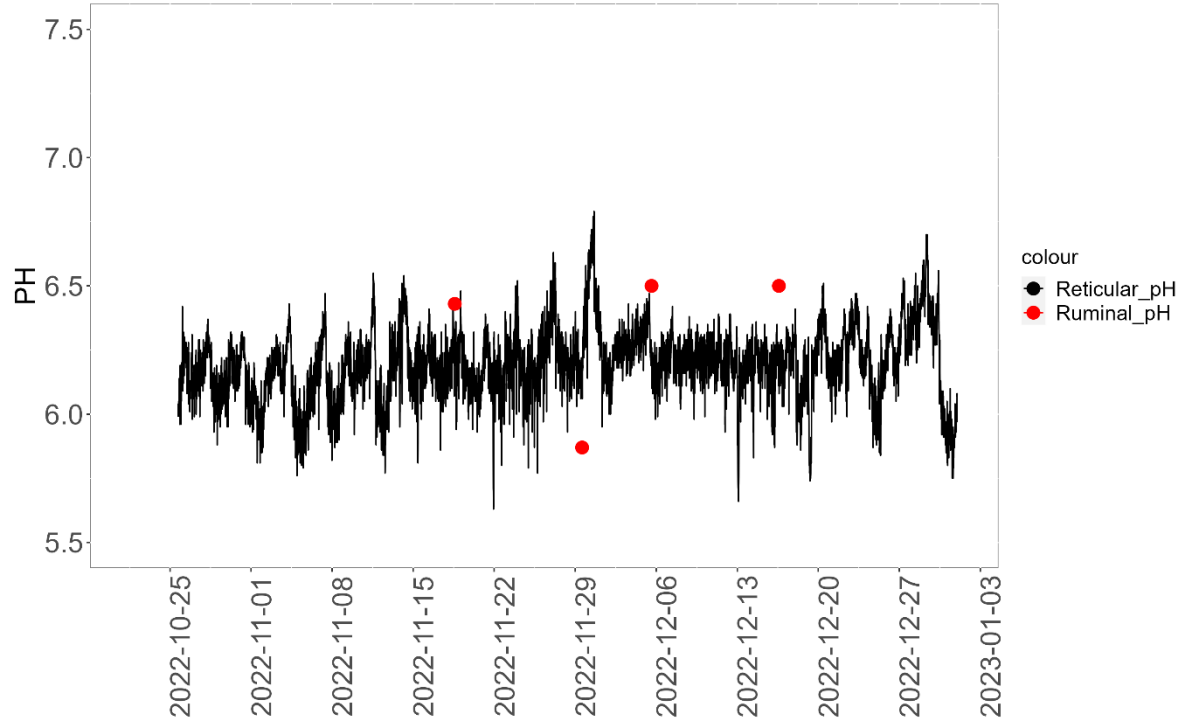


Continuous reticular monitoring

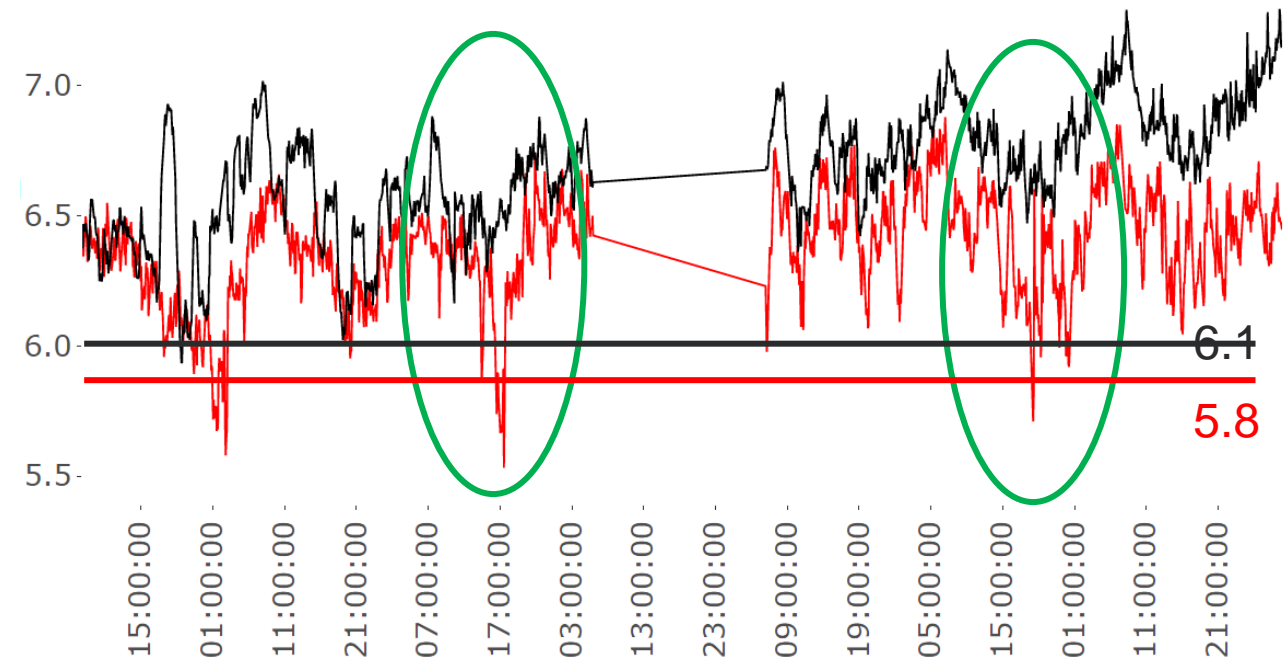


Reticular pH ≠ Ruminal pH

Raw reticular pH with spot ruminal pH



Reticular and ruminal pH



Physiological ruminal pH = 6.1 → SARA threshold = 5.8 *Zebeli et al., 2008*

Physiological reticular pH = 6.3 → SARA threshold = 6.0 *Neubauer et al., 2017*

Reticulo-rumen pH indicators

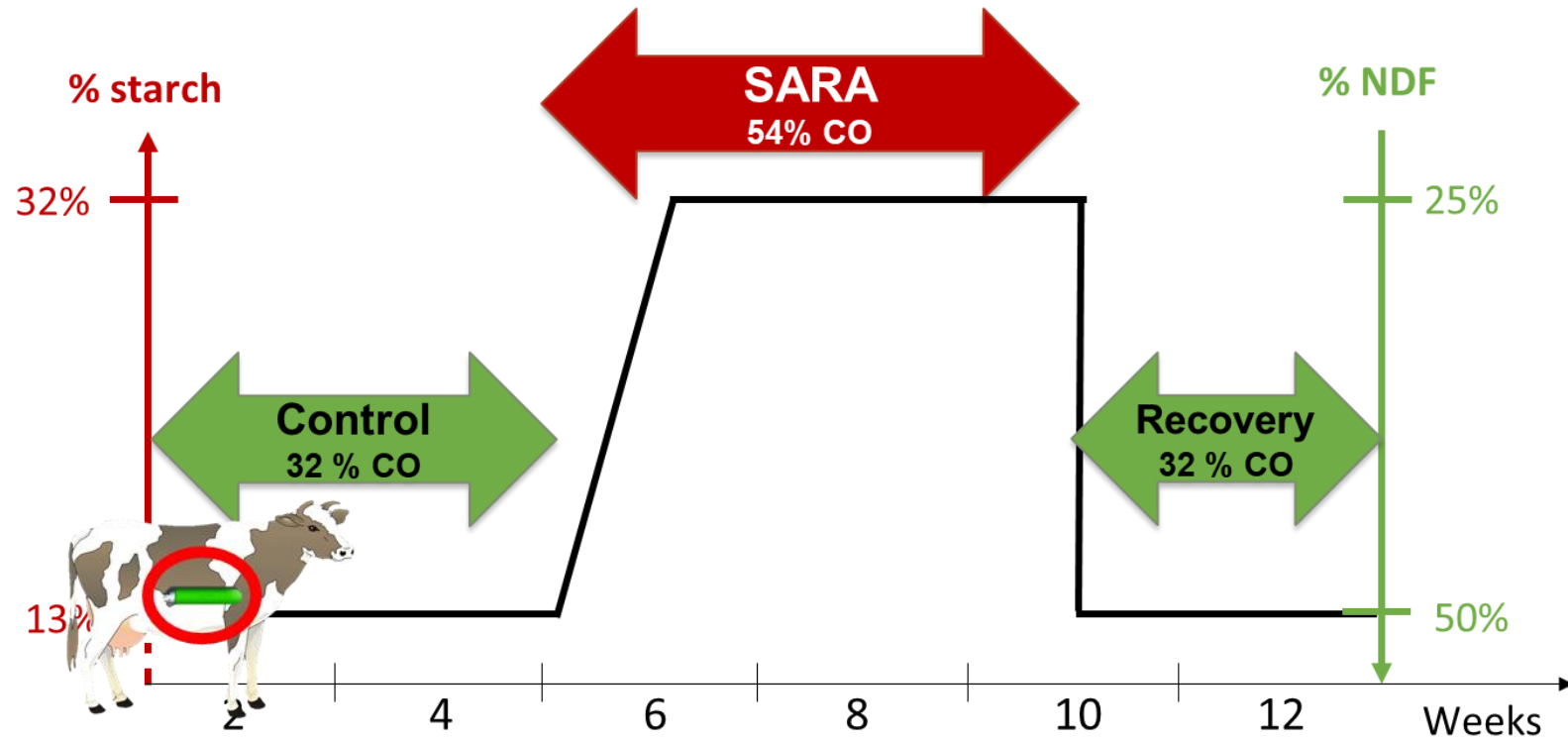
Different categories of pH indicators:

1. **Absolute** : pH mean, pH min, pH max, fixed thresholds (*ie*: pH 5.8)
2. **Relative** : inter-animal variability, adaptive threshold (*ie*: $NpH < -0.3$)
3. **Dynamic** : kinetics (drop numbers)

Objective:

Finding a combination of RR indicators to detect rumen disorders on **individual basis** with the use of reticulo-rumen sensors

M&M

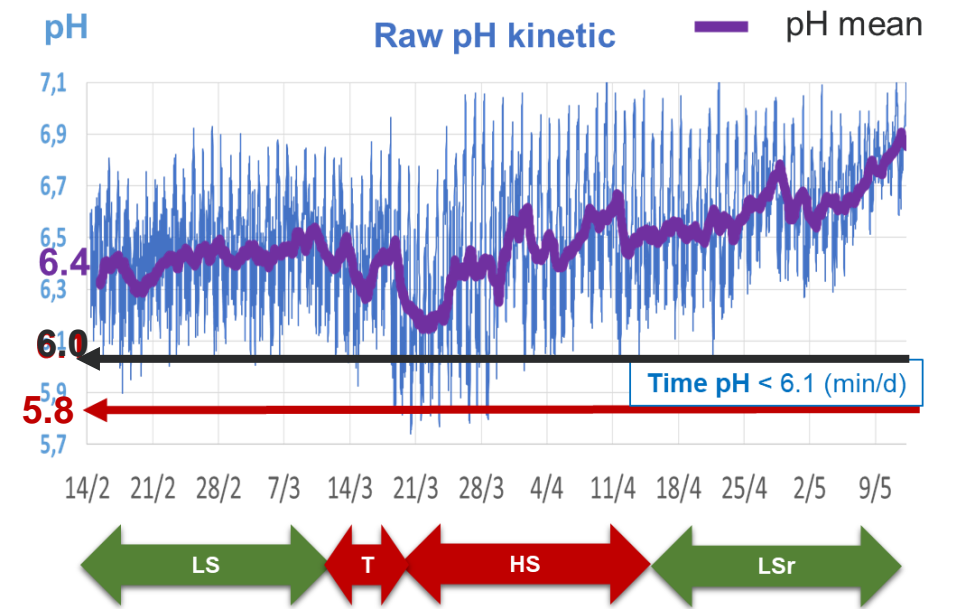


Trial 1 10 primiparous Holstein, 27.5 kg/d of milk, DIM=135

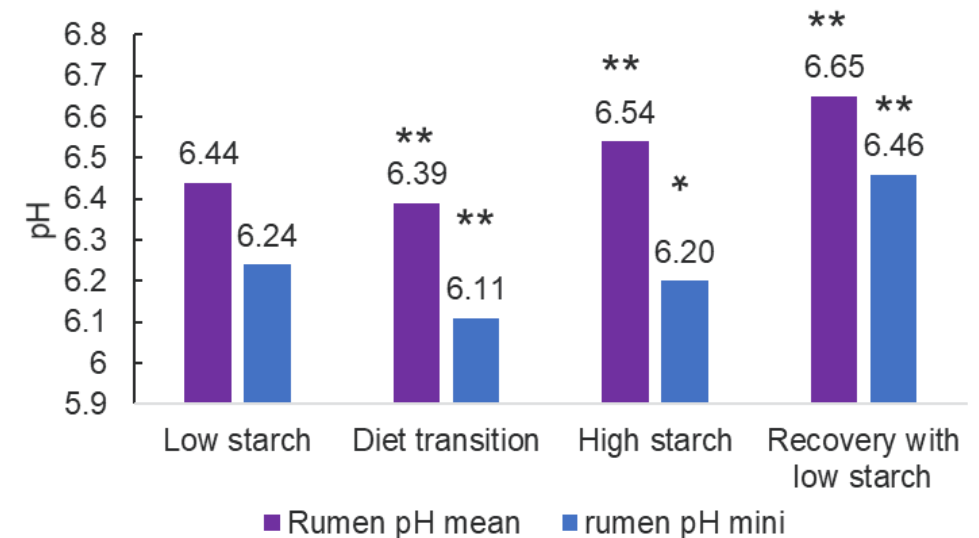
Trial 2 6 multiparous Holstein, 35 kg/d of milk, DIM =

1. Absolute pH indicators

- ✓ Historical one, still a reference for peer review
- ✓ Valuable but limited information
- ✓ Dependent of initial and physiological pH pattern of each animal
- ✓ Dependent of sensors drift/noise (not anymore so true since some suppliers seems to apply a corrective algorithm)



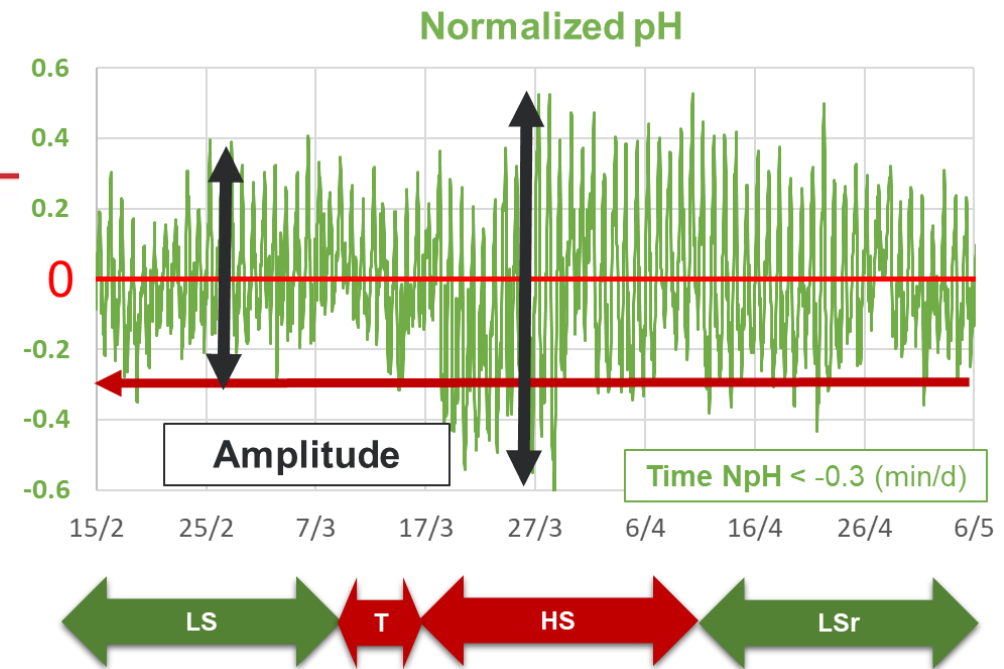
Evolution of pH mean and pH mini during the trial



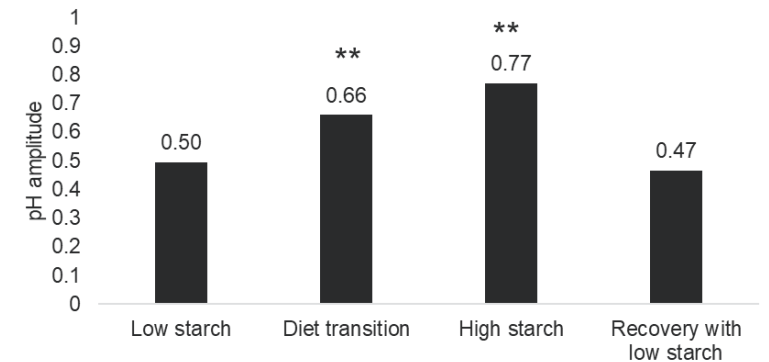
** : P<0.05, * : P<0.5 with LSD as the ref value, Villot et al, 2017

2. Relative pH indicators

- ✓ Sensors drift & noise discarded
- ✓ Inter-animal variability took into account
- ✓ Adaptive thresholds
- ✓ How to normalize the pH kinetics under farm conditions?

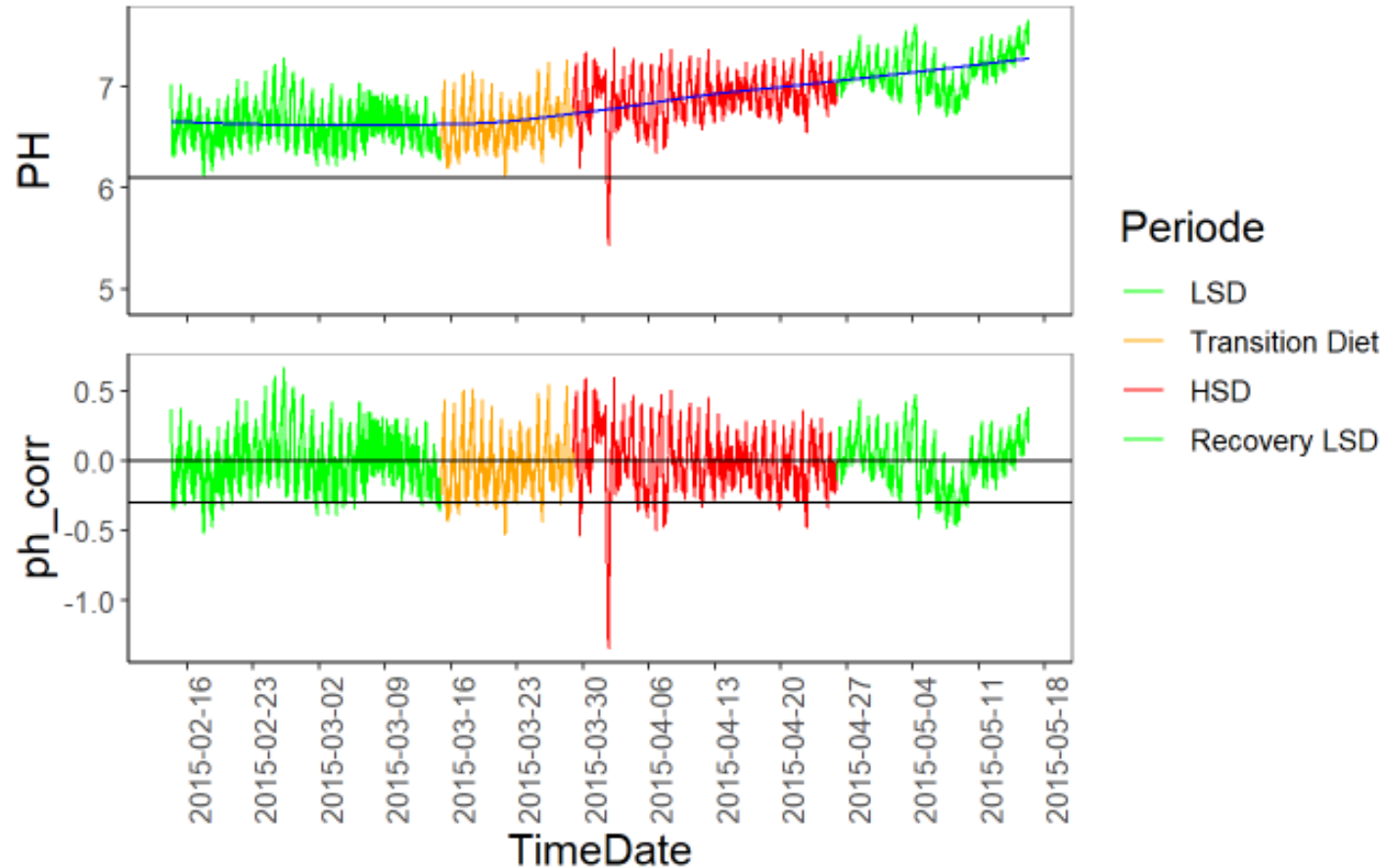


Evolution of pH amplitude during the trial



** : P<0.05, * : P<0.5 with LS as the ref value, Villot et al, 2017

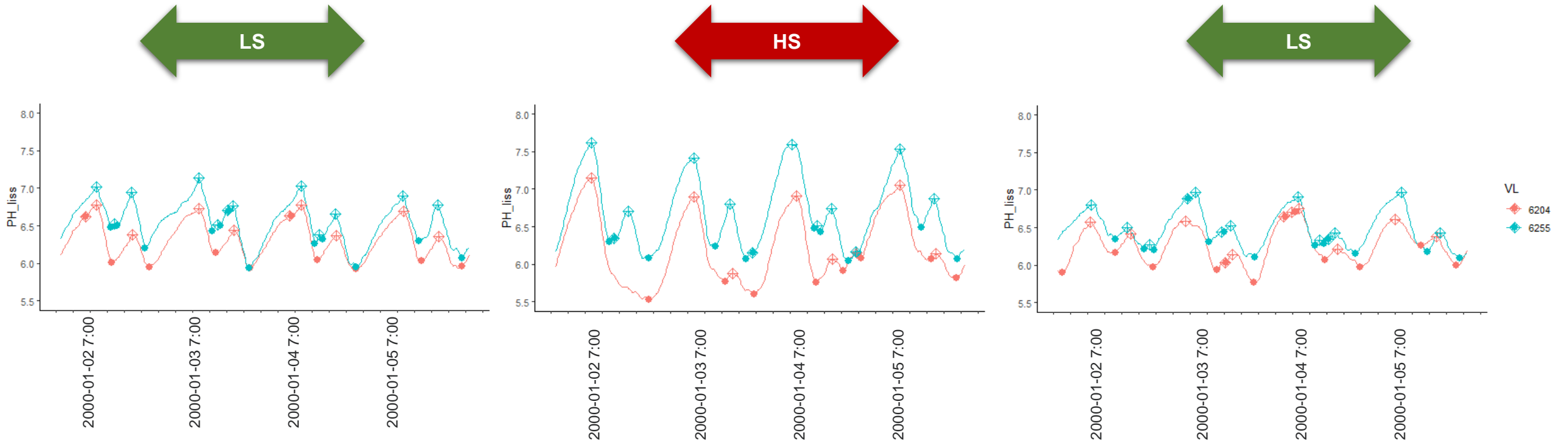
Sensors drift => A reality



Sometime already corrected by the sensor manufacturer before they provide you the data!

3. Visual observation of pH curves during diet changes

Zoom on pH curve over 4 days



Do you see a different pH pattern between diet?

3. Dynamic pH indicators

- Working on individual pH curve (pattern) of each animal
- Old story

Animal (2008), 2:10, pp 1437–1448 © The Animal Consortium 2008
doi:10.1017/S1751731108002656



Meta-analysis of 0 to 8 h post-prandial evolution of ruminal pH

C. Dragomir^{1,4}, D. Sauvant^{2†}, J.-L. Peyraud³, S. Giger-Reverdin² and B. Michalet-Doreau¹

¹Unité de Recherches sur les Herbivores, INRA, 63122, St-Genès Champanelle, France; ²UMR INRA INA P-G, Physiologie de la Nutrition et Alimentation, 16 rue Claude Bernard, 75231 Paris Cedex 05, France; ³UMR INRA/ENSAR Production du Lait, 35590 St Gilles, France; ⁴National R-D Institute for Animal Biology and Nutrition, Calea Bucuresti 1, Balotesti, Ilfov 077015, Romania

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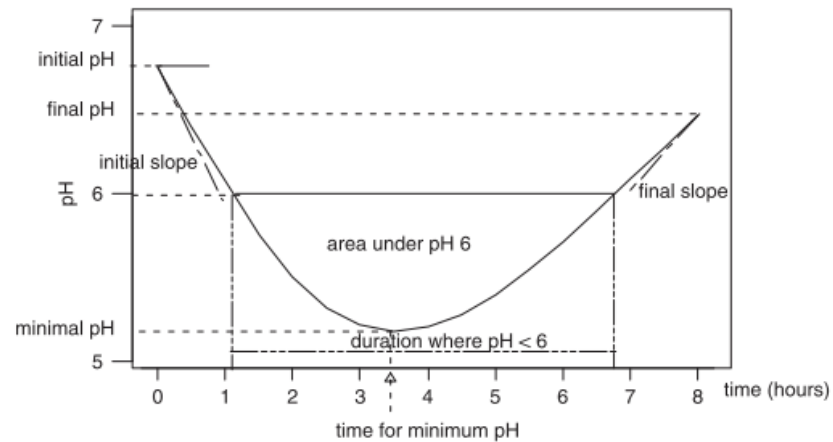
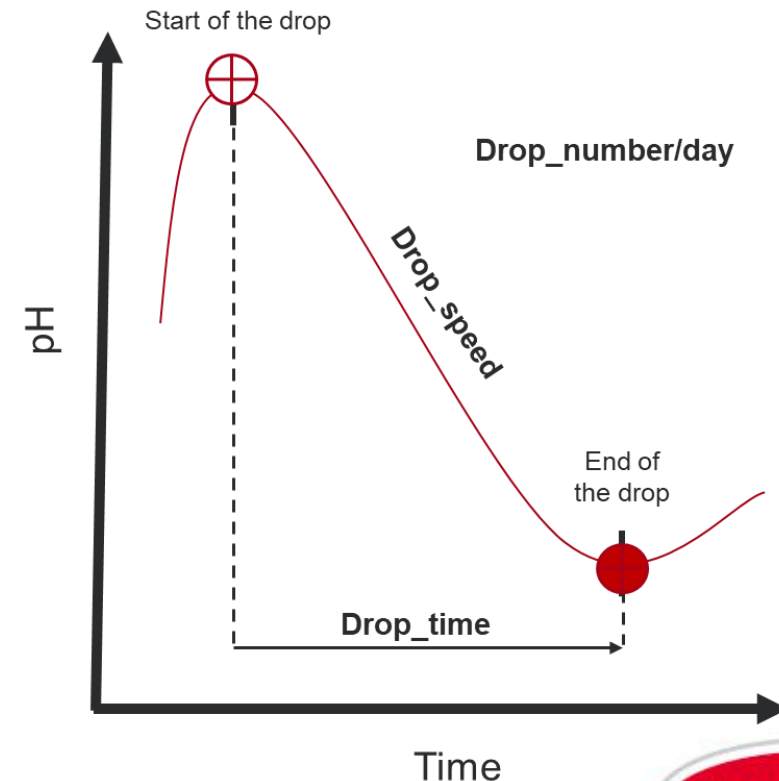


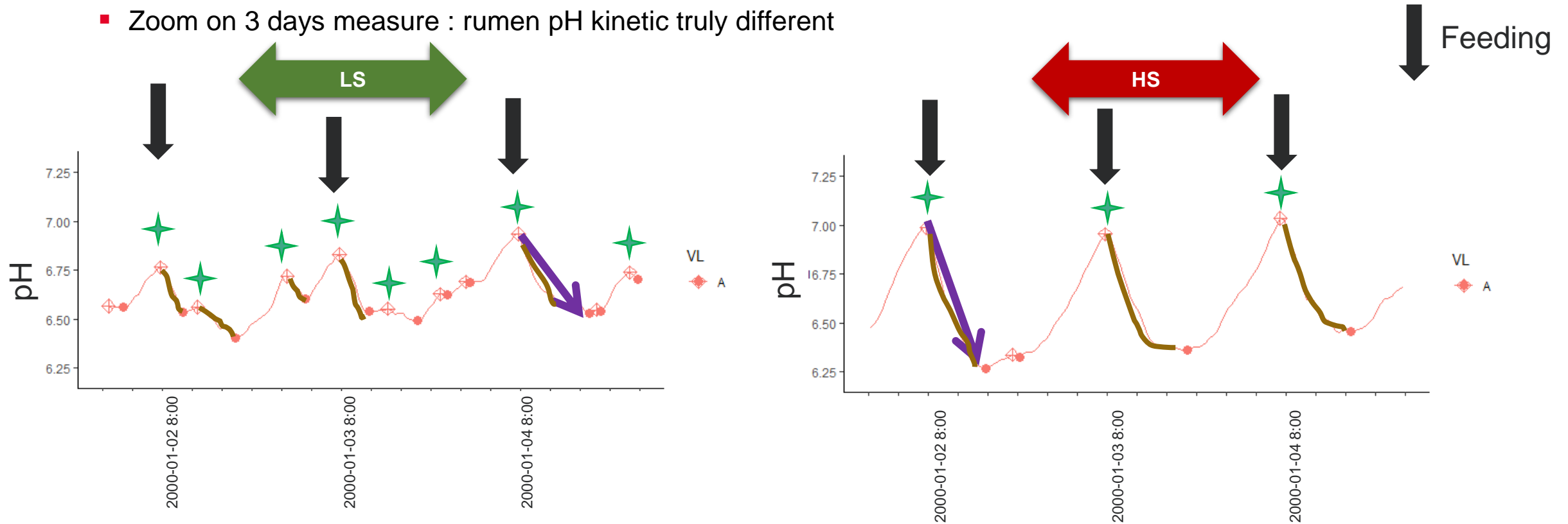
Figure 1 Generic curve of pH and potential pH variables.

- Focusing on the curve pattern



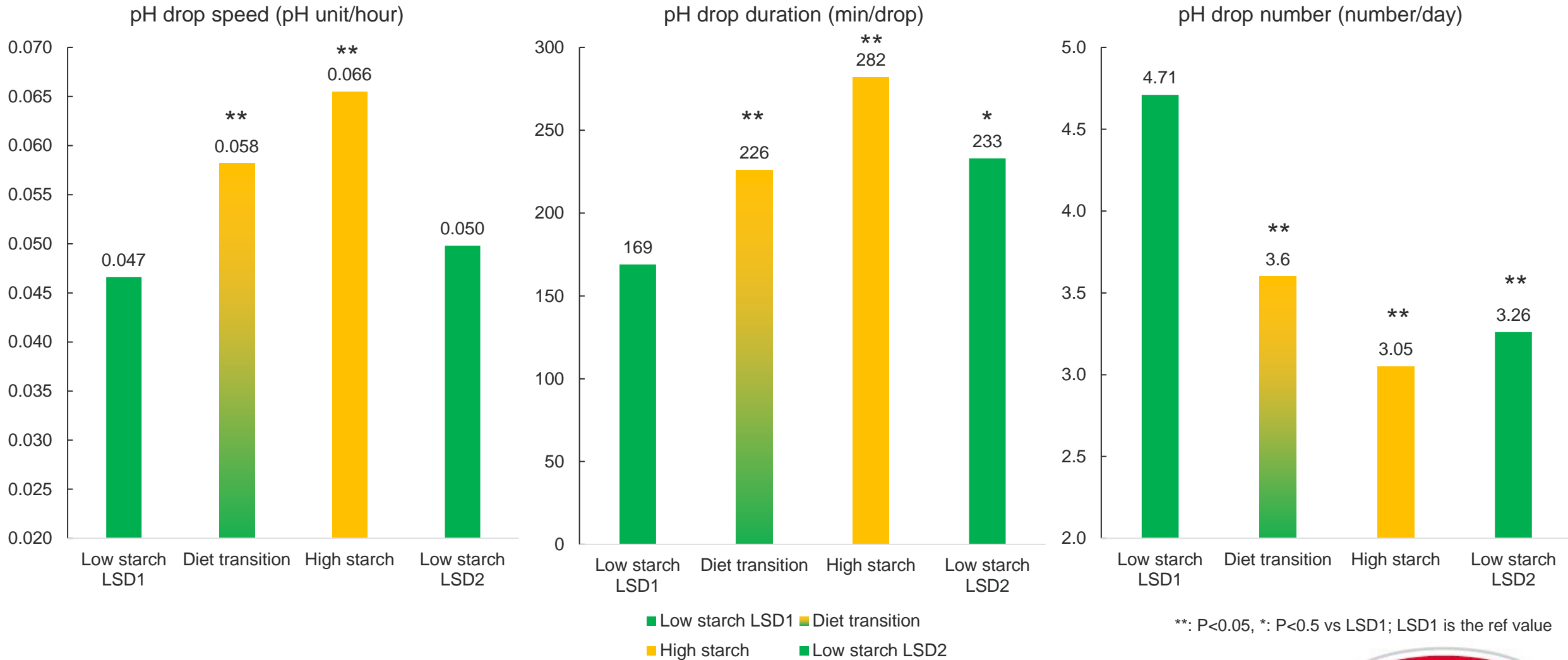
3. Dynamic pH indicators modified during diet changes

- Zoom on 3 days measure : rumen pH kinetic truly different



- A cow under SARA seems to have :
 - Faster pH drops
 - Longer total time of pH drop
 - Less number of pH drops

3. Dynamic pH indicators during rumen disorders



Dynamic indicators are able to significantly discriminate rumen disorders in experimental conditions

4. External validation (experimental condition)

Trial 2

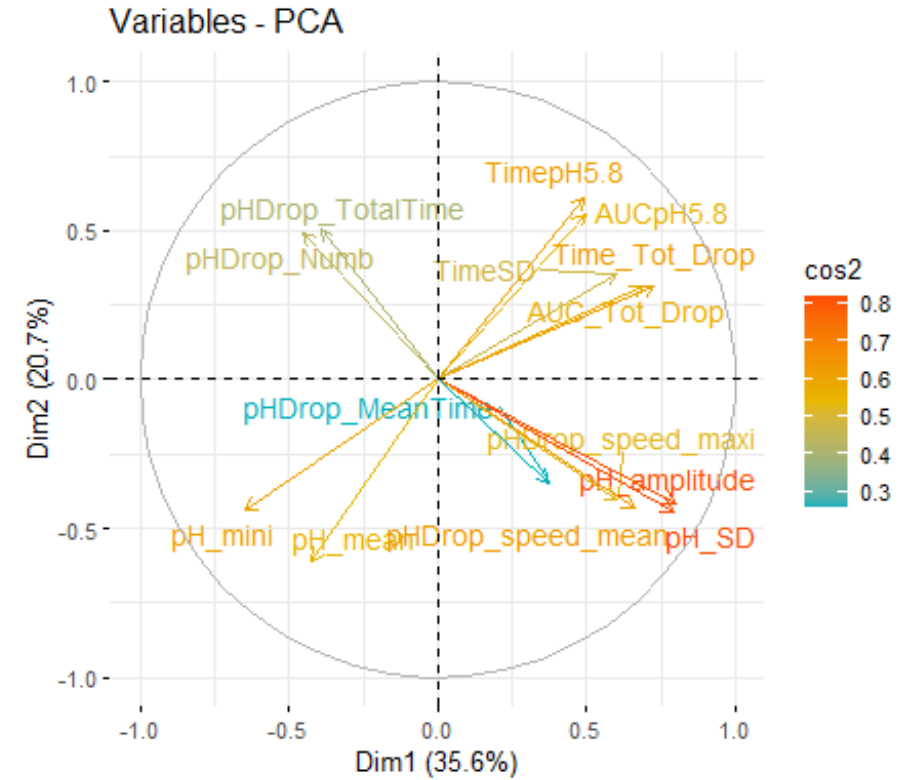
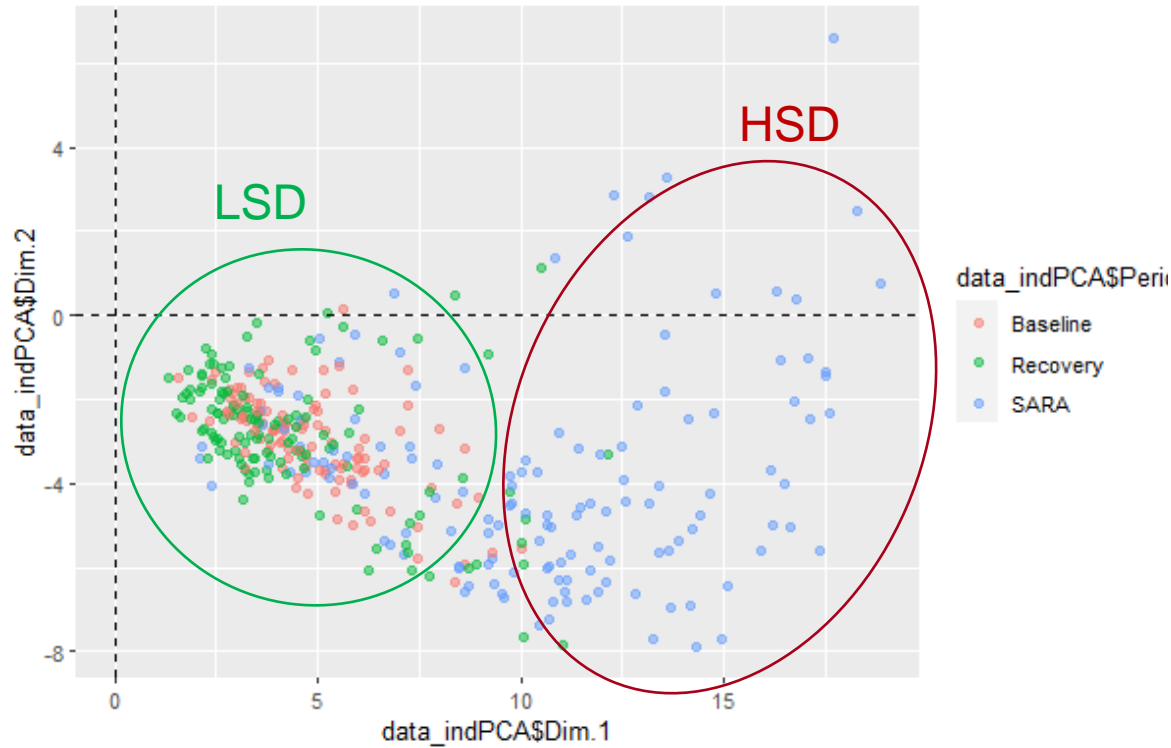
pH indicators
Traditional
Relative
Dynamic

	LSD	HSD	Recovery
pH mean	6.36	6.36	6.40
Total time below pH 6.1, min/d [‡]	170	379*	125*
pH amplitude	1.08	1.53**	1.08
Total time below -0.3 pH unit, min/d [‡]	224	447**	202
pH drop number	3.38	2.75**	3.07
pH drop speed mean, pH unit/h	0.08	0.13**	0.08
Average duration of pH drop, min	186	254**	229*

[‡]Data were log10 transformed

** P<0.01, * P<0.1 Dunnett post hoc test with LSD as the reference

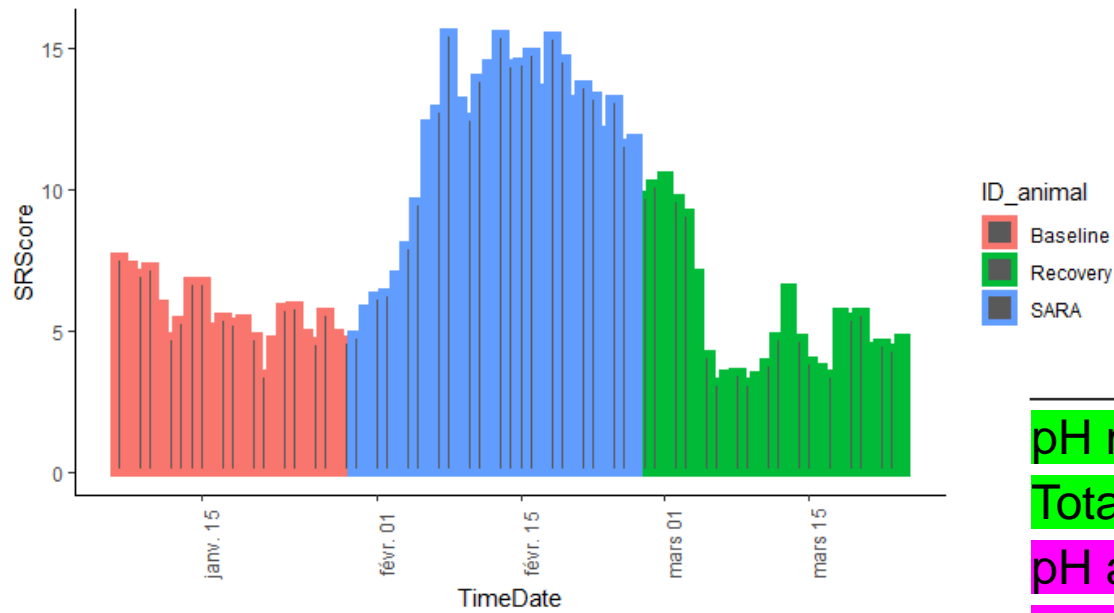
Towards a SARA score including several daily pH indicators



SARA Score

Trial 2

Evolution of SRScore



pH indicators
 Traditional
 Relative
 Dynamic

	LSD	HSD	Recovery
pH mean	6.36	6.36	6.40
Total time below pH 6.1, min/d [‡]	170	379*	125*
pH amplitude	1.08	1.53**	1.08
Total time below -0.3 pH unit, min/d [‡]	224	447**	202
pH drop number	3.38	2.75**	3.07
pH drop speed mean, pH unit/h	0.08	0.13**	0.08
Average duration of pH drop, min	186	254**	229*
SARA score	5.7	12.0**	5.6

‡ Data wer log10 transformed
 ** P<0.01, * P<0.1 Dunnett post hoc test with LSD as the reference



Conclusion

- New tool to record continuous reticular pH => additional reticular indicator to diagnose SARA
- Predicting the effects of feeding high- vs. low-starch diets was more accurate using the pH curve descriptors than the daily pH means.
- New indicators poorly related to the mean pH or absolute threshold-related variables => additional information on pH variation
- Combining several pH indicators not impacted by sensor drift improves the diagnostic of rumen dysfunction.

=> Addition of individual animal physiology traits

Litterature: what is going on?

“The traditional criteria for SARA provide **low diagnostic utility**, the probability of detection of animals with pH values below specified thresholds being affected by a **strong effect of time of day and herd**. Cows with **lower pH deviations had a higher milk yield**”

“Given the **large pH variation in time and location** within the rumen, it is of little surprise that there is **no scientific consensus** regarding pH-related thresholds for identification of acidosis.”

“We aim to **define and diagnose abnormal** reticuloruminal pH by identifying **deviations from normal pH** patterns rather than the number of observations below a given threshold.”

“**Substantial drift** of non-retrievable rumen pH sensors, and the **difficulty to calibrate** these sensors, **limits** their application. The use of this characteristic, as well as **summarizing parameters obtained from fitting equations to cumulative pH data**, is recommended to identify pH variation in relation to acidosis.”

“**pH patterns**, rather than time pH <6, were associated with metabolic health and feed intake. Moreover, **pH deviations** of the harmonic model were negatively associated with feed intake and rumination behavior. This research confirms the **biological importance of pH metrics focusing on pH variation and pH deviations** and provides deeper insight into its associations with metabolic health status, feed intake, and activity during early lactation. A possible reason for the limited improvement in predictive ability could be related to the importance of **feeding behavior (i.e., the eating events) rather than total DMI** in determining pH dynamics (Dijkstra et al., 2020).”



Describing temporal variation in reticuloruminal pH using continuous monitoring data

M. J. Denwood,^{1*} J. L. Kleen,[†] D. B. Jensen,^{*} and N. N. Jonsson^{‡§}
¹Department of Veterinary and Animal Sciences, University of Copenhagen, 1870 Frederiksberg C, Denmark
[†]CowConsult, Goldmine, 26532, Germany
[‡]Institute of Biodiversity Animal Health and Comparative Medicine, University of Glasgow, Glasgow, G61 1QH, United Kingdom
[§]Harbro Ltd., Birkhill Mill, Lanarkshire, ML11 0NJ, United Kingdom



Review: Rumen sensors: data and interpretation for metabolic processes

J. Dijkstra^{1*}, S. van Gastelen², K. Dieho³, K. Nichols¹ and A. Bannink²

¹Animal Nutrition Group, Wageningen University & Research, 6700 AH Wageningen, the Netherlands; ²Wageningen Livestock Research, Wageningen University & Research, 6700 AH Wageningen, the Netherlands; ³Provimi – Cargill Premix and Nutrition, 3072 AN Rotterdam, the Netherlands

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Evaluation of reticuloruminal pH measurements from individual cattle: Sampling strategies for the assessment of herd status

Nicholas N. Jonsson^{1,2,3,4*}, Joachim L. Kleen¹, R. John Wallace¹, Ivan Andonovic¹, Craig Michie¹, Marianne Farish¹, Malcolm Mitchell¹, Carol-Anne Duthie¹, Dan B. Jensen⁵, Matthew J. Denwood¹

¹College of Medical, Veterinary and Life Sciences, University of Glasgow, Bielden, G61 1QH, UK
²Harbro Ltd, Turffabri, Aberdeen, AB23 4PA, UK
³Cow Consult, Völsberg, Bielefeld, 33623, Germany
⁴University of Aberdeen, Aberdeen, AB25 22D, UK
⁵Department of Electronic and Electrical Engineering, University of Strathclyde, Glasgow, G1 1SN, UK
⁶Animal and Veterinary Science, SRUC, Easter Bush, Midlothian, EH25 9RG, UK
⁷Department of Veterinary and Animal Science, University of Copenhagen, 1870 Frederiksberg C, Denmark



Development of a SARA risk score and its prediction using milk mid-infrared spectra in early-lactation cows

A. Mensching^{1,2*}, M. Zschiesche³, J. Hummel², C. Grellet⁴, N. Gengler⁵, S. Dänicke⁶ and A. R. Sharifi^{1,2}

¹Animal Breeding and Genetics Group, Department of Animal Sciences, University of Goettingen, 37075 Goettingen, Germany
²Center for Integrated Breeding Research, University of Goettingen, 37075 Goettingen, Germany
³Ruminant Nutrition Group, Department of Animal Sciences, University of Goettingen, 37077 Goettingen, Germany
⁴Wallon Agricultural Research Center, Knowledge and Valorization of Agricultural Products Department, 5030 Gembloux, Belgium
⁵TERRA Research and Training Center, Gembloux Agro-Bio Tech, University of Liege, 5030 Gembloux, Belgium
⁶Institute of Animal Nutrition, Friedrich-Loeffler-Institut, Federal Research Institute for Animal Health, 38116 Brunnswick, Germany



Different reticuloruminal pH metrics of high-yielding dairy cattle during the transition period in relation to metabolic health, activity, and feed intake

S. Heirbaut¹, D. Berge Jensen², X. P. Jing^{1,3}, B. Stefańska⁴, P. Lutakome^{1,5}, L. Vandaele⁶ and V. Fievez^{1*}

¹Laboratory for Animal Nutrition and Animal Product Quality, Department of Animal Sciences and Aquatic Ecology, Faculty of Bioscience Engineering, Ghent University, 9000 Ghent, Belgium
²Department of Veterinary and Animal Sciences, Production, Nutrition and Health, Faculty of Health and Medical Sciences, Gronnegårdsvej 2, DK-1870 Frederiksberg C, Denmark
³State Key Laboratory of Grassland and Agro-Ecosystems, International Centre for Tibetan Plateau Ecosystem Management, School of Life Sciences, Lanzhou University, Lanzhou 730000, China
⁴Department of Grassland and Natural Landscape Sciences, Poznań University of Life Sciences, Dojazd 11 Street, 60-632 Poznań, Poland
⁵School of Agricultural and Environmental Sciences, Mountains of the Moon University, PO Box 837, Fort Portal, Uganda
⁶LIVO, Scheidweg 68, 9090 Melle, Belgium

