Measuring rumen pH on farms with wireless telemetry boluses shows the impact of farm routine

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ABSTRACT

In 2013 rumen pH boluses began to be deployed on UK dairy farms on a regular basis with encouraging results. There are now over 40 herds using rumen pH boluses and continuing to use them on a regular basis. This paper reviews the experience of veterinary practitioners in analysing the rumen pH and temperature measured by wireless telemetry. The bolus used in this study, the farmBolus by eCow lodges permanently in the reticulo-rumen and records data continuously. These data are downloaded with an enhanced mobile phone at typically fortnightly intervals. Over 100 data sets were recorded on a variety of farm and feeding systems (TMR, grazing only, grazing and concentrate, robotic milking and dry cows at grass) over 100 days. The data show a great range of pH profiles and a wide range of dynamic pH diurnal patterns. The threshold for sub-acute ruminal acidosis (SARA) used was 5.75 pH as the reticulo-rumen is consistently 0.25 pH units above the ventral sac where traditional measures of rumen fluid are presumed to be taken by rumenocentesis. From the current dataset few animals had pH values below 5.75, and this was not directly associated with high levels of compound feed. Several high yielding herds had pH values in lactating cows in the range 6.2 to 6.8 pH indicating that they were at low risk of SARA. By overlaying multiple daily pH plots in the same herd a clear picture emerges of the daily routine of the cow which could be mapped to feeding routines and regularity of management practices. We conclude that regularity of daily routine should be added to the estimation of pH in addition to feed parameters.

KEYWORDS: cows, rumen, bolus, pH, wireless, SARA, acidosis

The first report of direct measurement of the rumen pH by wireless telemetry was in 2008 (Mottram et al) and the technique has been used in research all over the world (Li, Danscher and Plaizier,2013) since then. However, to the authors' knowledge there have been no published

reports of bolus pH field data from farmers and their advisers to date. Existing methods for measuring ruminal pH in commercial cows are based on either rumenocentesis or through use of an oral sampling tube (Tajik & Nazifi, 2011). Both methods are invasive and can only gain one data point from an unknown location within the rumen. Rumen pH is known to be highly variable in time, with up to 2.5 pH range through the day and varying spatially up to 0.5 pH units from top to bottom within the rumen (Gasteiner et al 2008). The wireless telemetry bolus was intended to replace these crude techniques with a continuous recording of data from a fixed location within the rumen-reticulum, thereby overcoming the variability in data. This report is about our experience of using the wireless bolus on farms and some of the variability in data and outcomes from different feeding regimes.

The boluses used were the farmBolus from eCow Ltd. The farmBolus was 115mm long by 26.5 mm diameter weighing 200g, causing it to stay in the reticulo-rumen. The sensor end was made of stainless steel which inverts the bolus into a normally sensor-down position in cows with a normal shaped reticulum. A temperature probe was embedded in the stainless steel end cap, which has machined holes to allow rumen liquor to flow past the sensor tangentially without permitting direct impact of stones or grit on the glass sensing bulb.

The bolus measured pH and temperature every 60 seconds, took an average value every 15 minutes and stored up to 2700 lines of data; i.e. 96 lines of data per day stored over 28 days. If data was not collected within 28 days the file on the bolus was overwritten from the beginning.

The bolus was administered by mouth with a standard bolling gun. The bolus had a temperature switch which caused it only to activate when the temperature was above 31^{o}C. The device was calibrated at manufacture and was stated to be accurate for four weeks after shipment. Once in the cow, pH drift was said to be less than ±0.1 pH unit per 30 days but this was impossible to verify in non-fistulated animals. The veterinarian or nutritionist visited the farms with an adapted mobile phone handset and stood near the cow on the left front side to download the data.

Over 120 boluses were shipped to 30 farms in South West England in a collaboration between Mole Valley Farmers, eCow Devon Ltd and the Royal Agricultural University. The farms were selected to represent a variety of systems found in this area from grass based low input/output systems to very high yielding continuously housed TMR systems.

The data received back from farms showed a range of pH values from 5.2 to 7.0 pH, and were highly dynamic. The daily variation was considerable and very dependent on the system of feeding. Cows with very low pHs often showed no clinical signs of illness suggesting that traditional animal-based measures are of limited value. Values of pH below 5.75 were rare, showing that in this self-selected study in one year SARA was not in line with prevalence reported by Atkinson, 2013. A feature of this study was the impact of well managed routines in reducing day-to-day variation in rumen pH profiles; future studies are needed to numerically express subfertility, lameness and metabolic health to enable statistical analysis of the relationship between these conditions and parameters of rumen pH.

Examples of typical pH data under different systems are displayed in figures 1.-8. To demonstrate typical profiles of different production systems.

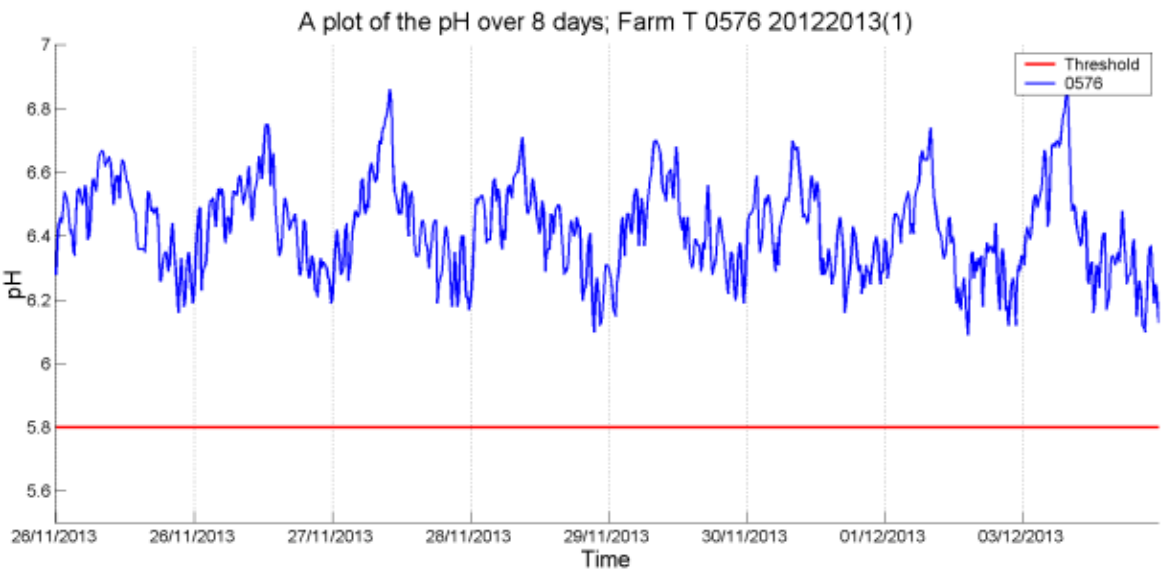

Figure 1 A typical pH profile during winter feeding; the cow sleeps and ruminates at night and eats regularly

Robot

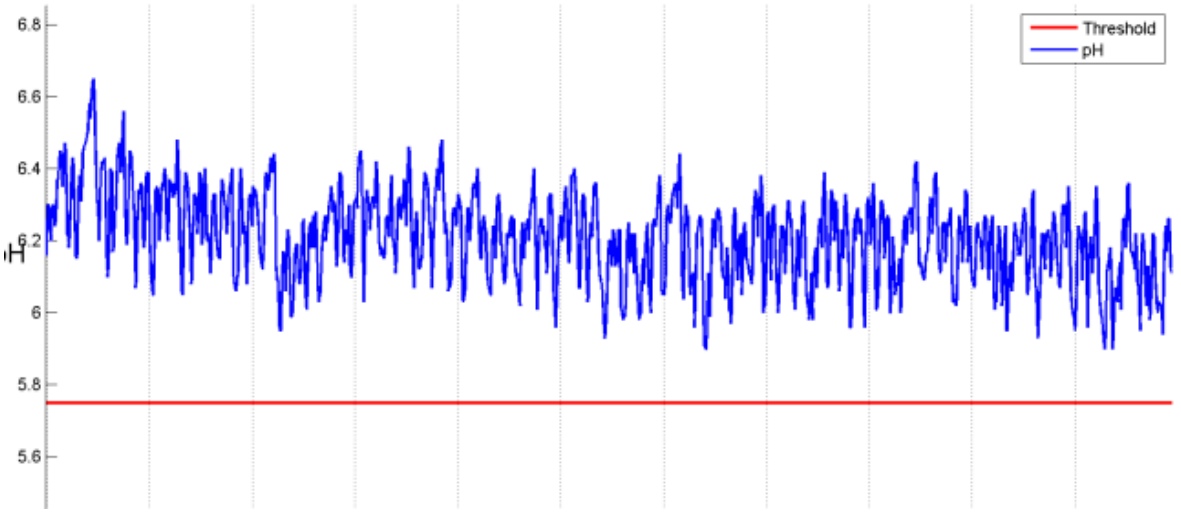

Figure 2 For this voluntary milking system there is more night time feeding activity; a potential example of how little and often feeding may maintain a safe pH with a narrow range

Grazing and Compound

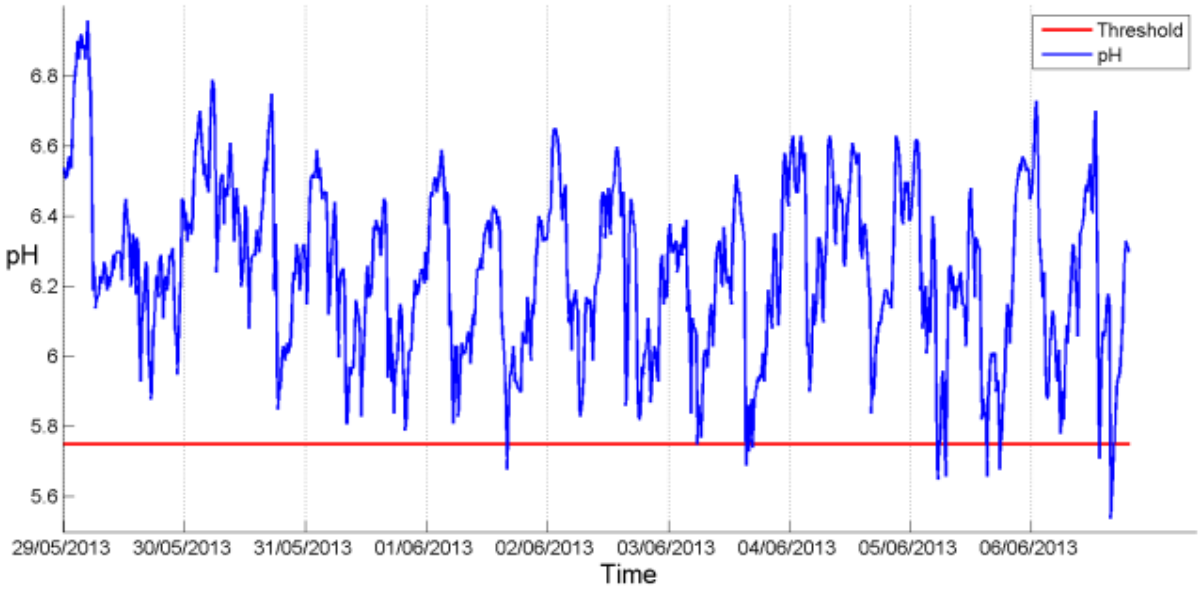

Figure 3 A typical West Country summer system with two large dips in pH per day. These may be caused by parlour slug-feeding of concentrate or access to fresh grass (or both). The peaks may be caused by the cow being unable to access feed during collection and milking.

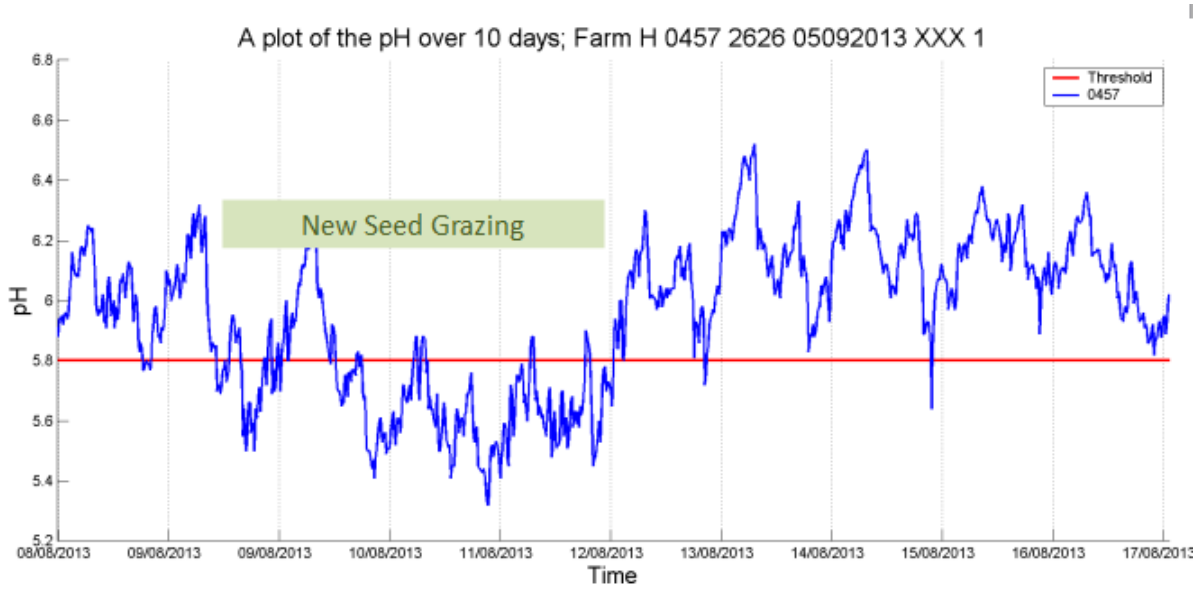

Figure 4. Decline in pH corresponding to access to new grass, which may be low in functional fibre, high in short-chain carbohydrates and highly digestible.

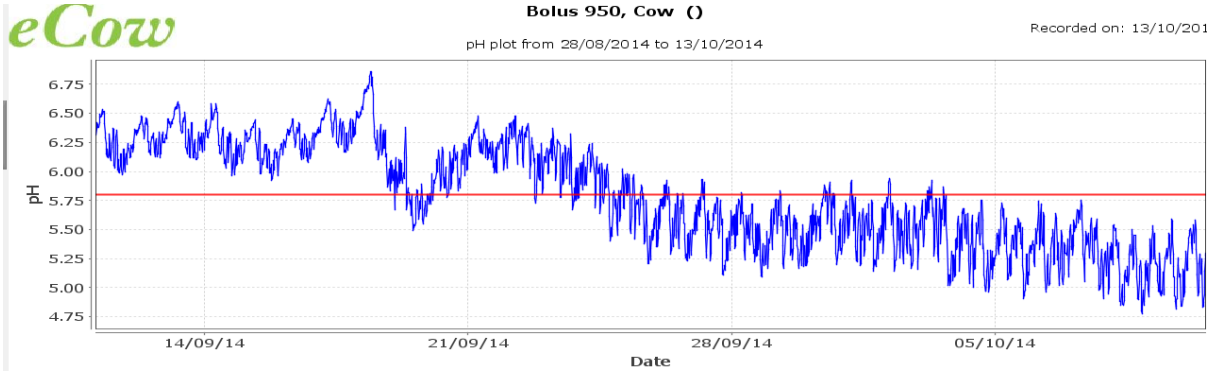

Figure 5. An example of declining pH below conventional pH thresholds The animals remained clinically unremarkable.

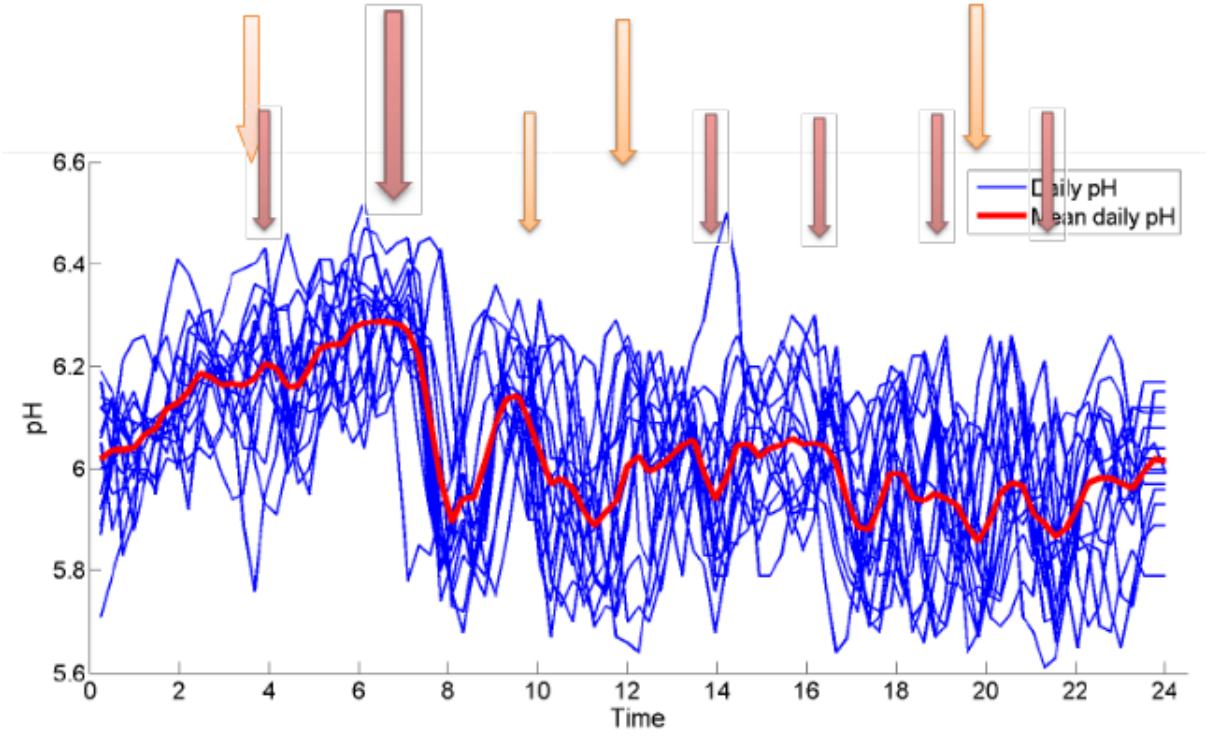

Figure 6 Overlaying the daily graphs (blue) and obtaining a mean pH per hour (red) helps show the regularity of the cow's responses and the relatively narrow degree of variance.

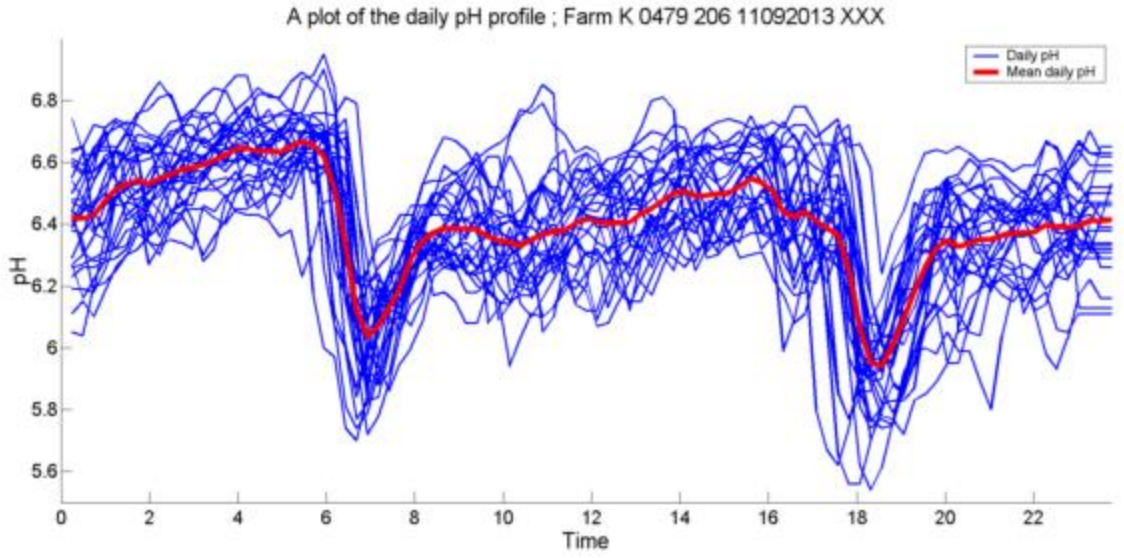

Figure 7 The cow needs regularity to maintain a stable rumen flora.

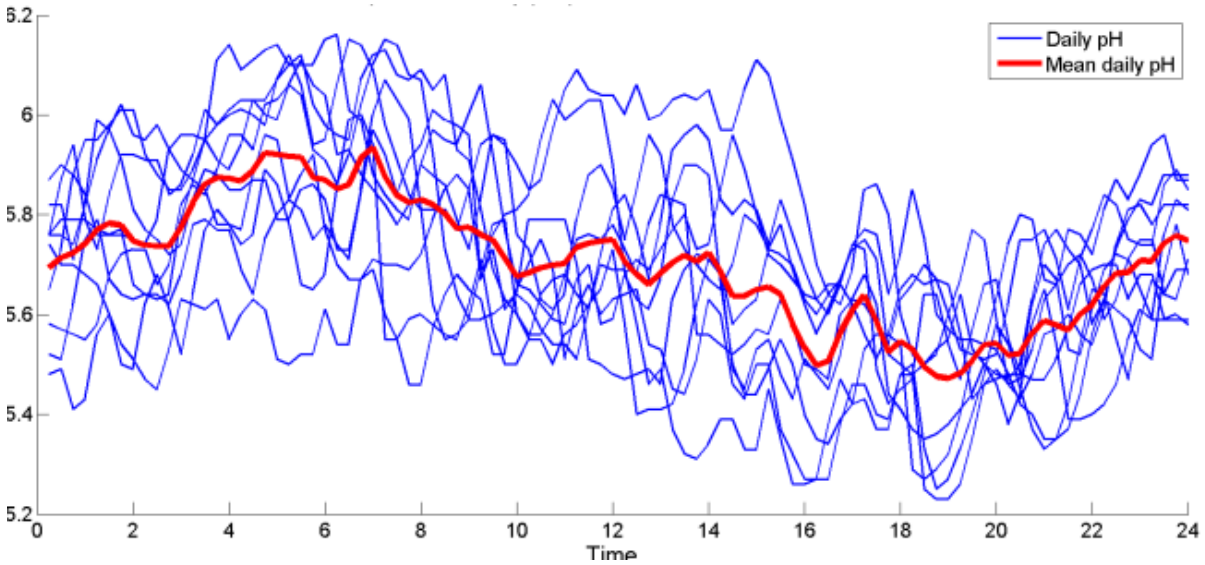

Figure 8 This farm complained of infertility and poor performance, the pH is quite low but it is the irregularity which is the key feature

References

Atkinson, O, 2013, Prevalence of subacute ruminal acidosis (SARA) on UK dairy farms, Proceedings of the BCVA.

Gasteiner J, M. Fallast, S. Rosenkranz, J. Häusler, K. Schneider, T. Guggenberger. 2008, Measuring rumen pH and temperature by an indwelling and wireless data transmitting unit and application under different feeding conditions. Tierhaltung und Tiergesundheit

Mottram, T., Lowe, J., McGowan, M. and Phillips, N. (2008) Technical note: A wireless telemetric method of monitoring clinical acidosis in dairy cows. Computers and Electronics in Agriculture. 64(1): 45-48

J. Tajik and S. Nazifi, 2011. Diagnosis of Subacute Ruminal Acidosis: A Review. Asian Journal of Animal Sciences, 5: 80-90.