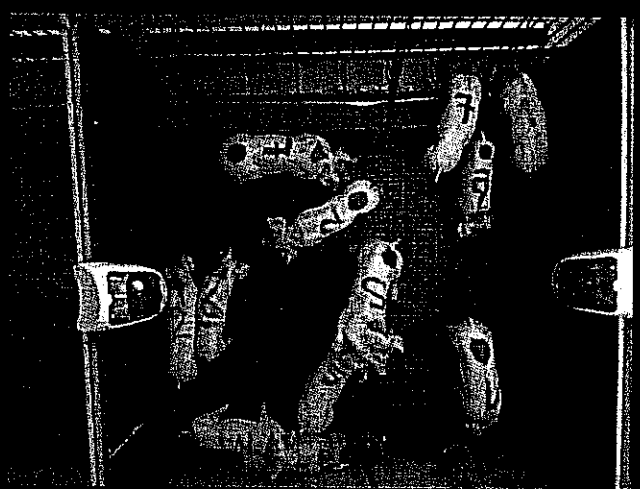

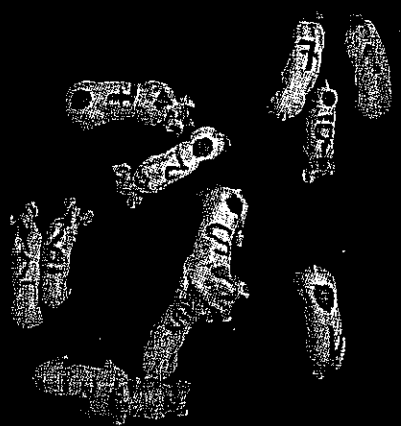

Precision Livestock Farming '13

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A novel method of calculating a SARA index by wireless rumen pH telemetry

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Abstract

The wireless rumen pH telemetry bolus has been used in research in fistulated animals since 2005 where the requirement is high accuracy and raw data output. Commercial farmers require information to make management decisions, usually about dietary constituents. This paper describes the construction and use of a Sub-Acute Rumen Acidosis (SARA) index combining the mean daily value, the evenness of the daily profile, the lowest pH values in the period and the depth of drop in pH after a meal. Boluses were placed in two cows in a commercial farm in May 2012 each in a group of 60 cows and data downloaded by wireless every 28 days at afternoon milking for five months. The cows were fed a Total Mixed Ration (TMR) for average group yields of 11000 litres per 305 days. Reticulum pH rarely fell below 5.8 and the usual daily range was 0.5 pH units usually above 6.45, well clear of the SARA range. The bolus data were used to rule out acidosis 35 days post partum in contra-indication to dung analysis. At 110 days the SARA index registered high risk and subsequent analysis showed SARA was present in the group and feed was adjusted accordingly. A trial using 60 boluses on ten farms is in progress in 2013 to evaluate the decisions and resultant outcomes that different farmers make with bolus information.

Introduction

Reports of rumen wireless telemetry pH measurement boluses used in research have been available since Mottram *et al.* 2008. However, there have been no reports of the use farmers and their advisers make of rumen pH and temperature data. Existing methods for detecting SARA in commercial cows are based on either rumenocentesis or through use of a sampling tube (Tajik & Nazifi, 2011). Both methods are invasive and can only gain one data point from an unknown location within the rumen whereas the rumen pH is 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 is 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. The pilot study described here had the intention of both checking the operability of the bolus in farm conditions and the use the farmer and his nutritionist made of the data.

Materials and methods

The boluses used were the eBolus from eCow Ltd. The eBolus is 115mm long by 26.5 mm diameter weighing 200g. The sensor end is made of stainless steel which inverts the bolus into a normally sensor down position in cows with a normal shaped reticulum. The electronics is encapsulated with a cold poured resin coat that has proved resilient against rumen liquor in trials and obviates the need for vulnerable seals. The sensor is a combined electrode pH probe routinely used in applications in industry. The temperature probe is 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.

Figure 1: An eBolus ready for deployment

The weight of the bolus allows it to remain in the reticulum for the life of the cow. The bolus contains no toxic materials at doses harmful to the cow. The bolus measured pH and temperature every 60 s and took an average value every 15 minutes and stored up to 2700 lines of data in a .csv format date, time, pH, temp, battery V, which at 96 lines of data per day stored over 28 days of data. If data was not collected the file on the bolus was overwritten from the beginning.

The bolus is administered by mouth with a standard bolling gun, the only restriction on operation is that a period of 2 hours should be allowed for it to migrate to the reticulum. The bolus has a temperature switch which causes it only to activate when the temperature is above 31C, this enables a long shelf life of 2-3 years. As with all pH sensors the device needs to be calibrated before use and the calibration is accurate for four weeks in normal storage. Once in the cow drift is less than ±0.1 pH unit per 30 days. The radio frequency used is in the free to use ISM band, in this study we wanted to compare the utility of two available frequencies 433 MHz and 868 MHz and identify any operational issues with the different frequencies.

In this study two boluses were inserted into two fresh calved commercial cows on 28th May 2012. The herd of 170 cows averages 34 litres per day through the year on a wholly housed system with total mixed ration (TMR) system based on maize and grass silage with additional straights feeds. Data was downloaded onto a tablet computer every 28 days at afternoon milking until January 2013.

Results and Discussion

The data exhibited the classic saw tooth profile of the diurnal feeding and ruminating cycle and the raw data for one cow are presented in Figure 2.

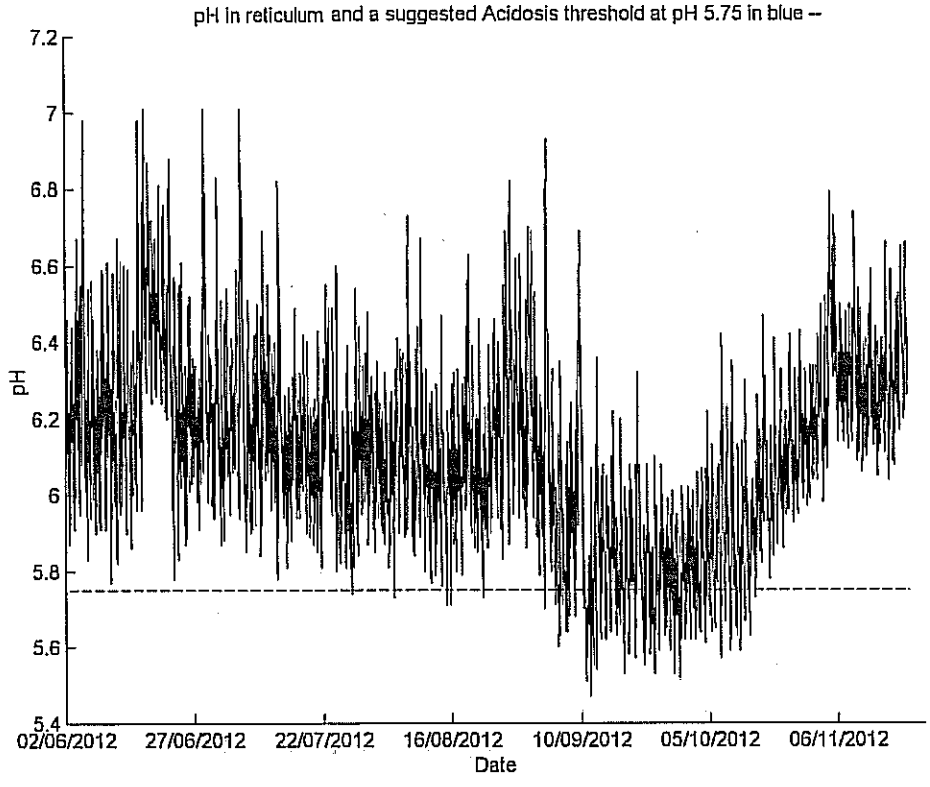

Figure 2: A continuous profile of rumen pH for 150 days in a cow in 2012

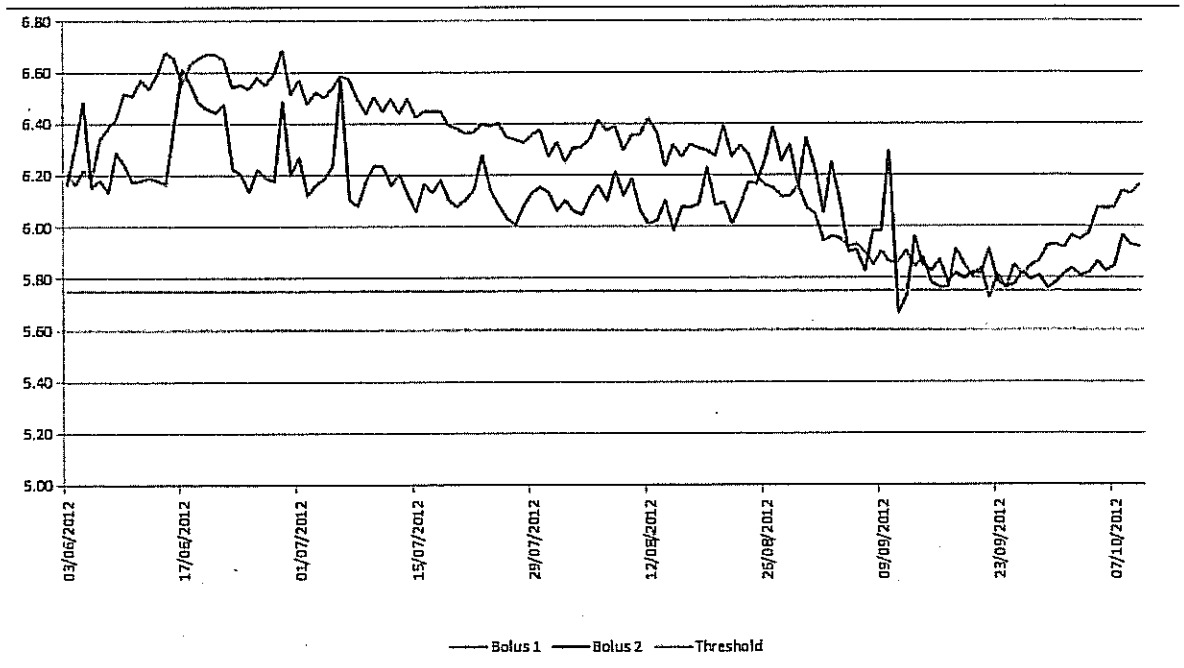

Figure 3: The mean daily profile recorded from boluses in two commercial cows for four months in 2012

The mean daily plot for both cows are displayed on the same time line in Figure 4. The two cows were in different groups until September. The cow with bolus 2 suffered from some mastitis infections in June and this may have caused the sudden spikes in rumen pH when she may have been eating less. In June the herd manager believed his cows were suffering from SARA and reduced the concentrate feed – hence the rise in pH in this period. After the data for June was presented the diagnosis of SARA was questioned and the silage was found to have a mycotoxin contamination and feeding was changed, leading to a stabilisation of milk proteins and increased yield. As the summer progressed the mean pH slowly reduced until the cows became at risk of SARA indicated by the threshold of 5.8 pH units. The feed was adjusted and the rumen pH recovered.

The data was processed to create an acidosis index by combining four main parameters.

- The mean daily profile
- The flatness of the daily feeding profile
- The time below pH 5.8
- The depth of drop after a feed

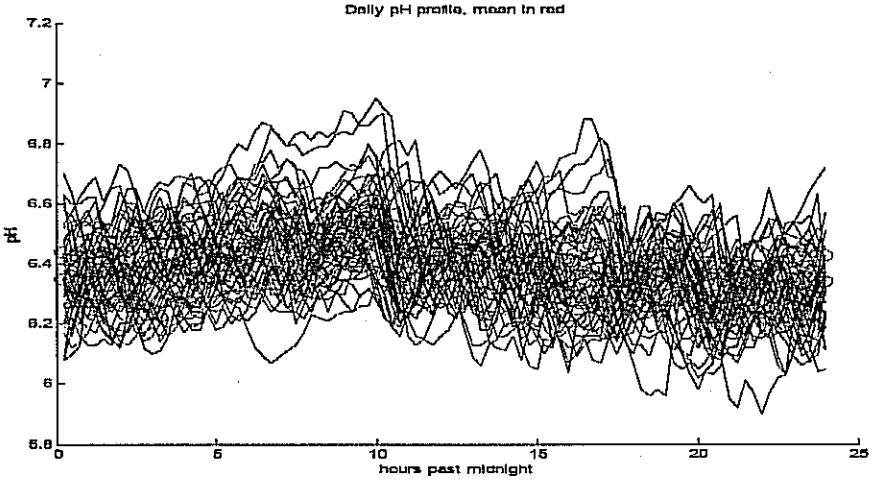

Figure 4: The mean daily feeding profile was built up by overlaying the data for each day. The flatter the curve the better. This one normally ranges by only 0.2 pH units.

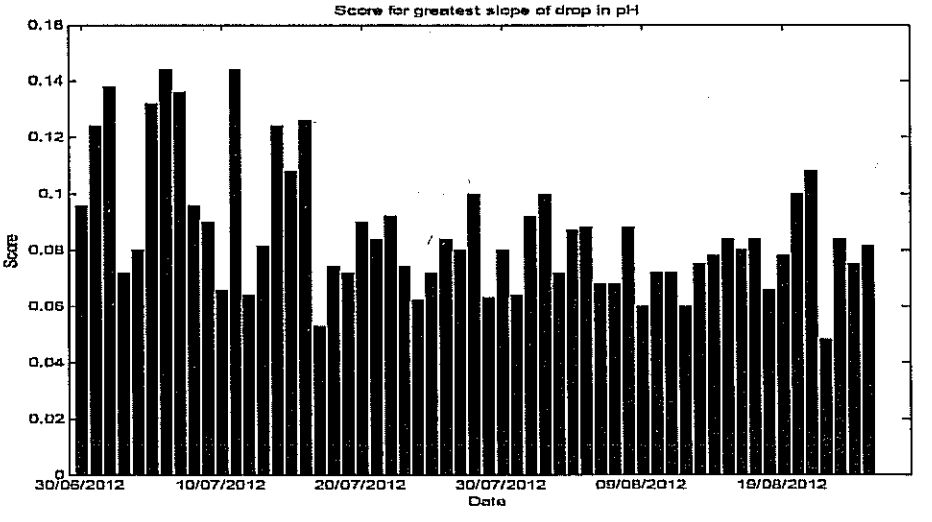

Figure 5: An element of the index based on the depth of drop after a feed

The temperature sensor gave a useful indicator of drinking activity. The summer was not hot at the farm and variations of drinking behaviour are due to factors such as access to water. The average number of drinks was 6 per day.

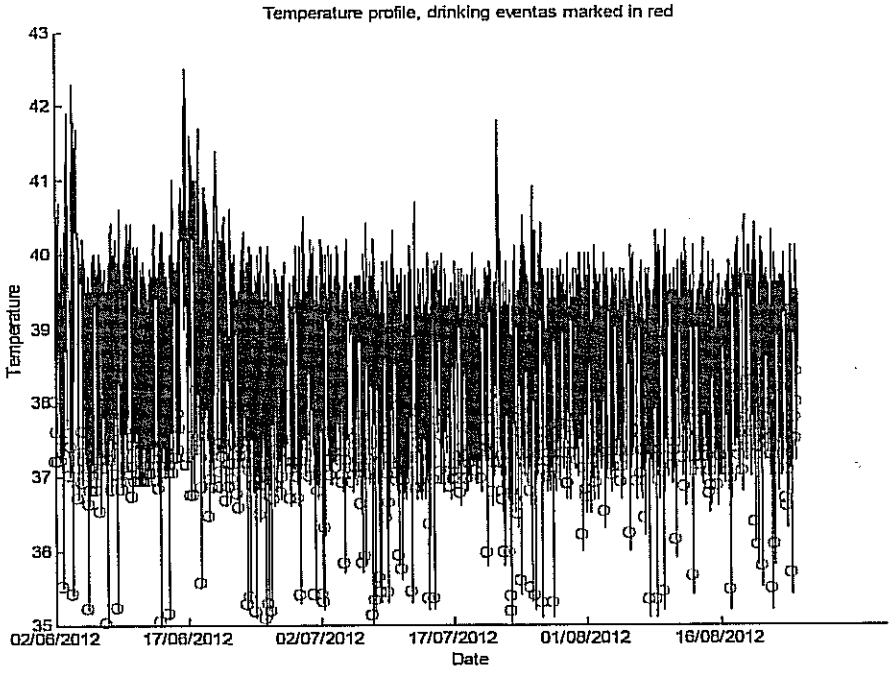

Figure 6: Drops in temperature indicate drinking, temperatures above 40C indicate infections

The data are aggregated together to produce an index on a per cow basis.

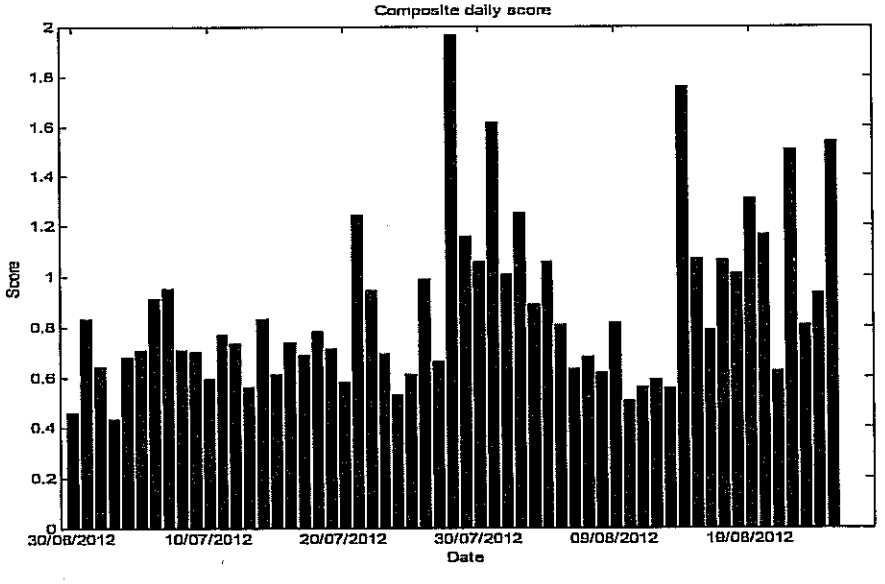

Figure 7: Agregated index indicating the increasing risk of SARA during summer 2012

Data continued to be downloaded from the boluses within the cows until January 2013 some 7 months after insertion. However, inspection of the data received after November 2012 indicated that the sensor was no longer functioning across the expected range and we concluded that the electrodes had become contaminated after over150

days in operation. Due to the pilot study nature of this trial data was collected at 28 day intervals, however, for better response to nutritional change daily or weekly checks would be preferable.
The signal from the bolus transmitting at 433 MHz could be read at 5 m from the cow and it became normal to download from this cow in the milking parlour pit. The signal from the 902 MHz bolus could only be read from 1-2 m and it was necessary to hold the cow in a stall for consistent downloads.

Conclusions

These results indicate that a rumen pH measurement bolus can be used in a rational manner to maintain rumen pH above a level where SARA is indicated in high yielding dairy cows. The boluses gave accurate data for over 150 days. The 433 MHz frequency gave better transmission from the cow than 902 MHz, unfortunately this frequency is only legal in some parts of the world. In 2013 a larger trial will be conducted with 60 boluses on 10 farms with a variety of diets with weekly data downloads. We propose that the combination of measures of rumen pH are a better indicator of risk of SARA than crude thresholds particularly when captured invasively.

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