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Research article

Evaluation of the RumiWatchSystem for measuring grazing behaviour of cows

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HIGHLIGHTS

- The RumiWatchSystem can successfully monitor behaviour of grazing cows.
- High correlation between RumiWatchSystem and visual observation in determining time budget for different cow activities.
- High correlation between RumiWatchSystem and visual observation in determining grazing bites and rumination chews.
- The RumiWatchSystem was proven to be an accurate research tool for measuring detailed grazing behaviour of cows.

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ABSTRACT

Feeding behaviour is an important parameter of animal performance, health and welfare, as well as reflecting levels and quality of feed available. Previously, sensors were only used for measuring animal feeding behaviour in indoor housing systems. However, sensors such as the RumiWatchSystem can also monitor such behaviour continuously in pasture-based environments. Therefore, the aim of this study was to validate the RumiWatchSystem to record cow activity and feeding behaviour in a pasture-based system. The RumiWatchSystem was evaluated against visual observation across two different experiments. The time duration per hour at grazing, rumination, walking, standing and lying recorded by the RumiWatchSystem was compared to the visual observation data in Experiment 1. Concordance Correlation Coefficient (CCC) values of CCC = 0.96 for grazing, CCC = 0.99 for rumination, CCC = 1.00 for standing and lying and CCC = 0.92 for walking were obtained. The number of grazing and rumination bouts within one hour were also analysed resulting in Cohen's Kappa (κ) = 0.62 and κ = 0.86 for grazing and rumination bouts, respectively. Experiment 2 focused on the validation of grazing bites and rumination chews. The accordance between visual observation and automated measurement by the RumiWatchSystem was high with CCC = 0.78 and CCC = 0.94 for grazing bites and rumination chews, respectively. These results indicate that the RumiWatchSystem is a reliable sensor technology for observing cow activity and feeding behaviour in a pasture based milk production system, and may be used for research purposes in a grazing environment.

1. Introduction

With increasing scale on farms, and declining available labour, there is a requirement for technologies that assist farmers in their day to day management. Animal management involves ensuring the health and welfare of the animals; reacting to certain events in the animal reproductive cycle and improving efficiency in feed provision for conversion into an animal product, such as milk or meat. Especially in a pasture based system the balance between the feed offered and the herd demand needs to be optimized to maximise grass utilisation while simultaneously ensuring that animals are well fed at pasture. Shortage in labour and time to observe animals makes it difficult for farmers to monitor all animals intensely.

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Automated monitoring for quantifying physiological and behavioural parameters, e.g. oestrus, somatic cell count and feeding behaviour, can give an insight into overall health status, important animal events as well as helping with feeding management. For a continuous monitoring of these physiological and behavioural parameters sensor-based, easy-to-use tools for farmers need to be developed.

One of the best indicators of health and welfare of dairy cows is feeding behaviour. A study by Bareille et al. (2003) showed that feed intake was influenced by a number of different diseases such as milk fever, ketosis or hoof lesions. There is a benefit to detect emerging diseases earlier by monitoring the feeding behaviour of dairy cows automatically. Previous research has shown that a decline in rumination time can be used as a reliable predictor of both health and fertility events and is also mentioned to be an indicator for cow stress (Herskin et al., 2004). Feeding behaviour can also be used to optimise grassland management decisions with a focus on increasing animal intake and reducing grass residuals. It is of key importance to measure, manage and allocate accurately the feed available and offered to the cows, irrespective of the farming system in order to optimise farm efficiency and profitability. The estimation of feed intake based on behavioural parameters, such as feeding time or bite frequency, provides valuable information that can be used to manage cows. Pahl et al. (2015) conducted a study in an indoor feeding system to compare feeding and chewing time with measured intake data obtained by weighing of the feeding troughs. They concluded that it was appropriate to use feeding behaviour for estimating intake in barn systems.

Some methods have been developed to predict intake in grass-based systems (Undi et al., 2008), such as the N-alkane-method (Dillon and Stakelum, 1988). This method determines the feed intake by the usage of an orally applied bolus with synthetic faeces marker. These measurements are labour-intensive, time-consuming and invasive, as the cows have to be dosed orally twice a day over a 2-week period. An alternative approach used to determine feed intake was the IGER animal recording system (Mezzalira et al., 2014). This consisted of a noseband sensor that measured jaw movement by electrical resistance (Rutter et al., 1997). It could identify and measure grazing and rumination. However, the maximum recording period of this system was 24 h, and the analysis of the data via the “Graze software” was very laborious (Rutter, 2000). Furthermore, the distribution and commercial support for this technology has ceased in recent years. But a new technology, the RumiWatchSystem may have the potential to improve data capture and replace the IGER animal recording system.

The RumiWatchSystem was initially developed by Nydegger and Bollhalder (2010) at the Swiss Federal Research Institute (Agroscope, Tänikon, Switzerland) for behavioural measurements on cows fed indoors and is commercially distributed by the company (Itin + Hoch GmbH, Liestal, Switzerland) since 2010. It is well established as a sensor technology in indoor housing systems (Ruuska et al., 2016) and has undergone a number of modifications in development as a research and advisory tool (Zehner et al., 2012). Most of the modifications were conducted to optimize the analysis software, the RumiWatch Converter, based on development of different algorithms to analyse the raw data. In a study of Zehner et al. (2017) different versions of the RumiWatch Converter were validated in indoor housing systems against visual observation. Further modifications of applied algorithms in the RumiWatch Converter, such as the definition of each grazing bite, were conducted to record grazing behaviour as feeding behaviour differs in indoor housing systems and pasture-based systems. As it is absolutely critical that any animal behaviour sensor operates correctly in monitoring the appropriate parameters, the objective of this study was to validate an updated and adapted version of the RumiWatchSystem for the measurement of grazing behaviour in a pasture-based milk production system. Two separate experiments were conducted to validate parameters such as grazing, rumination, walking, standing and lying time, as well as grazing bites and rumination chews.

2. Material and methods

Validation of the RumiWatchSystem was conducted in two separate experiments with individual cow herds at Teagasc, Animal and Grassland Research and Innovation Centre (Fermoy, Co. Cork, Ireland, 50°07′N; 8°16′W). Experiments 1 and 2 took place in the periods of 10th to 19th of May 2016 and 31st of May to 2nd of June 2016, respectively. The experimental grazing areas represented permanent grassland with 70% perennial ryegrass and 30% annual meadow grass. This study was part of a larger study where different levels of feed allowance were allocated to dairy cows across different periods of the lactation and for different durations.

2.1. Sensor technology

The RumiWatchSystem consists of two separate devices with associated software packages for managing the sensors (RumiWatch Manager) and analysing data (RumiWatch Converter).

The RumiWatch halter incorporates a noseband pressure sensor, a 3-axis accelerometer as well as a data logger. The noseband sensor comprises an oil-filled tube with a built-in pressure sensor. The pressure inside the tube changes with alternation due to chewing activities and is recorded in a 10 Hz resolution. Those raw data are saved on an integrated 4 GB SD-card for up to 4 months, which is implemented together with the data logger in a protective box on the right side of the halter. On the left side, there is a power supply with two 3.6 V batteries integrated in a similarly constructed box. Based on different pressure signatures of the noseband pressure sensor, the RumiWatch Converter is able to detect jaw movements and classifies them based on frequency and rhythm together with acceleration patterns into grazing bites/chews, rumination chews or any other activity. Additionally, the time duration of those different classifications is recorded. Further information about technical components can be found in Werner et al. (2016), Zehner et al. (2012) and Zehner et al. (2017).

The RumiWatch pedometer consists of a protective plastic box with a 3-axisaccelerometer integrated. Similar to the halter, there is an SD-Card and a data logger connected with the 2 3.6 V batteries built into the box. Acceleration raw data for the x-, y- and z- axis are recorded in a 10 Hz resolution. The RumiWatch Converter is able to classify the acceleration raw data by applying specific algorithms into standing, walking, lying as well as amount of strides. Further information about the development and validation can be found in Alsaaod et al. (2015).

The RumiWatch Manager 2 (V.2.1.0.0) and the RumiWatch Converter (V.0.7.3.36) were used for Experiments 1 and 2 of the current study. There were two different approaches for time resolutions. The 1-min summary data were categorized into different focal behaviour classifications by the RumiWatch Converter. The Converter also created numerical values based on a calculation of the time duration (min per period) of focal behaviours in each of the defined time resolutions, e.g. 5-min, 10 min, 1 h summaries.

The RumiWatch Converter V.0.7.3.36 used three different parameters to monitor and calculate grazing time. Two parameters considered in this study were used to calculate grazing time. EAT1 determined grazing with head position down, EAT2 determined grazing with head position up. Furthermore, there were parameters for grazing and rumination bout behaviour integrated in the RumiWatch Converter V.0.7.3.36 with grazing bouts and rumination bouts. A grazing bout was defined as an event, where grazing was detected for a minimum duration of 7 min and the inter-bout