Approximately 50 per cent of Australia’s dairy farms base cow nutrition on grazed pasture and other forages augmented with at least one tonne of grain (concentrate) per lactation. Grain represents a substantial part of the feed costs in these systems so an improved understanding of pasture substitution would benefit feed management, production and ultimately profitability.

Pasture intake is known to reduce as the quantity of concentrate feed increases. However, additional factors including pasture availability, nutritive value, stage of lactation and weather can all influence grazing behaviour and the amount of pasture substitution that occurs. Due to the dynamic and complex nature of this system, the substitution rate and marginal milk response for a given situation are usually estimated at the whole of herd.

At the Tasmanian Institute of Agriculture, we are using high tech on-animal sensors, developed by CSIRO, to monitor the grazing behaviour of cows under varying management scenarios, including grain feeding rate. By combining the on-animal sensor data with visual observations and using sophisticated modelling, we are starting to unravel the relationship between grazing behaviours, milk production and grain consumption on an individual cow basis.

We are dealing with highly dynamic systems. We know pasture quality varies diurnally as sugars increase and then decline, and that fibre content increases as pasture matures. We also know cows vary in their genetic propensity for milk production and that production is modified by stage in lactation, number of lactations and body condition. Weather conditions can affect pasture and cows, adding another dynamic element.

While many cow factors such as current milk production, body condition and stage of lactation are already taken into account when developing grain feeding strategies, how much pasture is or could be eaten cannot be included in the calculation.

Many dairies have the capability to feed grain in the dairy on an individual cow basis. However, this is often not done but instead cows are fed as subgroups of the herd. With the ability to individually monitor a cow’s grazing behaviour, this data may be applied to achieve a better utilisation of individual feeding.

Using sophisticated on-animal sensors, we were able to capture and record the grazing behaviour of individual cows. With this data we initially hoped to better understand what cows were doing in the paddock and how their intake was modified by feeding grain in the dairy.

### Methods

This study was conducted on 24 Holstein-Friesian cows from the TIA Dairy Research Facility herd. Two groups, each of 12 cows, were established and balanced for means and variances (± SD) of milk production (25.0 ± 3.9 litres per day), days in milk (71 ± 9 days), body weight (480 ± 34 kg), and age (4.6 ± 1.9 yr).

Each group of cows was allocated to one of two concentrate feeding levels, 6.0 or 0.0kg DM/day. Cows received 50% of their concentrate feed allocation of Coprice® Dairy Pellets (CP = 14% of DM; ME = 12 MJ ME/kg of DM) twice daily during milking via automatic feeders. Feeding treatments commenced on 25th of October 2012 and ceased on 31st December 2012.

Cows were milked twice daily through a herringbone dairy at approximately 6.30am and 3.30pm. Milk yield for each cow at each milking was recorded automatically.

Pastures were predominantly perennial ryegrass and cows were rotationally grazed as one herd, with daily forage allocation allowance of approximately 30kg DM/cow/day of feed on offer above ground.

Between 27th November and 13th December, each of the 24 cows was fitted with a collar which consisted of a FleckTM with wireless networking. Each collar had a number of sensors including...
GPS, 3-axis accelerometer, 3-axis magnetometer and data storage capacity. The collar number, time (seconds), latitude and longitude were collected and saved in the dataset.

The dataset generated from the cow collars combined with observed visual behaviours was used to establish algorithms that allow for the generation of a model that can capture the behaviour of the animal (Figures 1 and 2). In this trial, the battery life of the collars was 14 days but new solar powered collars are now being used, providing greater continuity of recording.

**Results**

A significant difference in the proportion of time spent grazing between the two grain feeding groups was found. Cows receiving 0kg of concentrate spent more time grazing than cows receiving 6kg. Similarly, cows receiving 6kg of concentrate were found to spend significantly more time ruminating than cows receiving 0kg.

Between approximately 7am and 12pm (the period following morning milking), there was significant difference in the proportion of time spent grazing between the two grain feeding groups (Figure 1).

Between approximately 7pm and 2am and also between 9am and 12pm, there was a significant difference in the proportion of time spent ruminating between the grain feeding groups (Figure 2).

These observations were consistent with results from other studies, where behaviour was measured visually. These results gave us confidence in the collars as systems for collection of this data.

Our results suggest that grazing time, as an indicator of pasture substitution, is reduced following the morning milking but not in the period following afternoon milking. As suggested by Angela Sheahan et al. (2013), this indicates different factors may regulate grazing behaviour at differing times of the day.

Technology, such as the cow collar sensors deployed in this study, in combination with individual bail feeding technologies and a greater understanding of the factors known to affect hunger and satiety in dairy cows could potentially result in development of new feeding approaches. Such knowledge, data and technologies will be required to develop and research new approaches to optimise individual bail feeding and economically optimise individual cow performance in pasture based systems.

A $2.2 million project brings together the Tasmanian Institute of Agriculture and CSIRO to extend research conducted during Sense-T’s Stage 1 Beef and Dairy project. Researchers will further enhance their pasture prediction model by using sensors and data to allow farmers to predict and prepare for different scenarios, and will further develop on-animal sensors to better monitor health, grazing and productivity in the dairy and livestock industries. More information at http://www.sense-t.org.au/projects-and-research/agriculture

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