Research Activities using the ART-MSR Method of Automatic Recording and Interpretation of Rumination and Feeding Behavior

Franz Nydegger[1)*], Andreas Münger [2)], Hansjörg Frey [3)]

1) Agroscope ART Tänikon 1, CH-8356 Ettenhausen, Switzerland, ++41 52 368 33 16,
2) Agroscope ALP Liebefeld-Posieux, CH-1725 Posieux, Switzerland

3) Vocational Education and Training Centre for Nature and Nutrition,

CH-6276 Hohenrain, Switzerland

**Corresponding author. E-mail: franz.nydegger@art.admin.ch*

Abstract:

Since its development in 2009 the ART-MSR-Rumination and Feeding Sensor has been used in several research projects. Measurements focused mainly on detailed analysis of rumination and feeding behavior of dairy cows. Comparisons of different diets (e.g. silage/non silage, grazing/non grazing), the impact of an automatic feeding system on feeding and ruminating behavior as well as experiments to monitor metabolism, energy conversion and activity under grazing conditions were subjects of the research projects. In this projects more than 600 files (usually 24 h recording time) have been analyzed. Users were content with the functions and the reliability of the loggers. Nevertheless they criticize the rather complex and laborious data analyzing process.

Key words: Jaw Movement Recording, Ruminating, Feeding, Grazing

Material

In 2010 ART and MSR-Electronics introduced the ART-MSR-Rumination and Feeding Sensor (MSR Electronics, Henggart, Switzerland) and published the validation results (Nydegger et al. 2010). The jaw movement sensor allows measurement of an animal's jaw activity without affecting its natural behavior.

The measuring unit comprises a noseband sensor (NBS) and a MSR 145 Logger. The NBS consists of a vegetable oil-filled silicone tube with a built-in pressure sensor and is integrated into a halter. Recording capacity is roughly one day; the data are subsequently transmitted to a PC via USB interface. A pattern-matching based software tool (R Development Core Team) allocates individual jaw movements to "rumination", "eating" and "other activities" (Scheidegger 2008).

In the meantime the system has been used in several experimental trials by researchers in five institutions. An overview shows the field of application, the main goals of the experiments, as well as the user's appreciation on functionality, reliability and handling of the method.

Results

The system was used to monitor differences in ruminating and feeding activity comparing different feed rations and different feeding processes. Further subjects were investigations related to individual variation and inter-individual differences.

ART-MSR sensors were used in an ART experiment comparing the impact of three rations on rumination and feeding activity. A total of 144 files, one day recording time each, were analyzed. The rations were characterized grass silage-, maize silage- or hay-based.

An impact was reported on ruminating time per kg dry matter intake and ruminating bits per bolus (Table 1). In a first experiment a maize silage-based ration (*m*) was compared to a grass silage-based ration (*g*). Daily dry matter intake (DMI) was 1.9 kg higher for ration *m* compared to ration *g*. Therefore feeding data (chews) is related to 1 kg of DMI and ruminating data is related to 1 bolus. For feeding and ruminating *g* ration cows made more chews (+12 %) compared to *m* ration. In contrast with ration *g* they chewed less per bolus (-13%) and ruminating time was lower by 8 % compared to ration *m*.

TABLE 1: Feeding and ruminating activities, comparison of two rations based on grass or maize silage.

		Per 1 kg DMI				
Average	Chews/ Bolus	Ruminating time min	Boli	Chews ruminating	Feeding time min	Chews feeding
Based on grass silage	52	26	35	1845	17	1122
Based on maize silage	60	24	32	1645	15	1001
Difference	8	-1.7	-3.8	-199	-1.8	-121
Diff % (m 100%)	13.1	-7.1	-12.1	-12.1	-12.1	-12.1

In a second experiment ration *m* was compared to a ration based on hay (*h*). Daily dry matter intake was higher by 1.6 kg for ration m compared to ration h. Feeding ration *h* chews per kg daily dry matter intake were higher (+30%) and the number of boli was higher by 10 % compared to ration *m*. The number of chews per bolus was in the same order for both rations.

TABLE 2: Feeding and ruminating activities, comparison of a ration based on hay and a ration rich in grass silage.

		Per 1 kg DMI				
Average	Chews/ Bolus	Ruminating time min	Boli nbr	Chews ruminating	Feeding time min	Chews feeding
Hay-based	57	28	34	1944	27	1236
Maize silage-based	58	27	31	1900	26	956
Difference	1.0	-1.6	-3	-43	-1.0	-280
Diff % (m 100%)	1.7	-6.1	-11.1	-2.3	-3.9	-29.3

Grothmann, Moser, Zähner, Nydegger and Steiner (2012) determined the influence of a more frequent feeding on food intake and behavior of dairy cows. The trials were carried out with a herd of 34 dairy cows at the research center ART. The cows were offered a partially

mixed ration by an automatic feeding system and an individual concentrate ration at a feeding station. Three feeding frequencies were compared, once daily (FF1), ten times daily (FF10) and twelve times daily (FF12). For each feeding frequency behavior of 10 cows was recorded (Table 3). 158 of 180 records could be utilized.

There was no significant influence of the feeding frequency on total food intake, feeding and ruminating time neither on the aggressive behavior at the feeding rack.

TABLE 3: Feeding and ruminating characteristics at three feeding frequencies.

Feeding frequencies	Feeding time (min)	Ruminating time (min)	Chews feeding (n)	Chews ruminating (n)	Boli ruminating (n)
FF1	295.6 ± 51.9	433.1 ± 56.3	18545 ± 3683	30487 ± 5367	558.7 ± 96.6
FF10	317.1 ± 58.3	430.5 ± 81.5	20229 ± 4140	30953 ± 6942	557.6 ± 121.8
FF12	308.2 ± 63.8	404.5 ± 86.0	19510 ± 4671	28709 ± 7657	544.2 ± 106.9

Vocational Education and Training Centre for Nature and Nutrition (VETN), analyzed ruminating and feeding behavior of two groups in summertime The indoor feeding (IF) herd was kept in a free-stall barn and fed a mixed ration composed of corn silage, grass silage, and 1094 (±150) kg of concentrates per cow and year. The pasture-based feeding (PF) herd was full-time on pasture. Energy corrected milk yield was considerably higher for the IF cows: 9607 (± 2304) kg, compared to the PF cows: 5681 (± 1233) kg per lactation ($p < 0.01$). Behavior was recorded over 8 x 24 h on both groups with 4 cows each. In these trials important differences in jaw movements and feeding time occurred. On average cows on non grazing diet ruminated during 448 min/d with an average of 57 chews per bolus compared to 394 min/d with 52 chews per bolus on grazing diet (Table 4). Cows fed in the barn spent 310 min/d feeding whilst their peers spent 620 min/d grazing. These differences are all significant ($p< 0.01$).

TABLE 4: Feeding and ruminating with a grazing (PF) and a non grazing (IF) diet.

	Mean	SD	Mean	SD
Diet	NG	NG	G	G
n	32		32	
Ruminating time (min)	448.5	62.3	394.5	65.6
p	**			
Chews/bolus (nbr)	57.3	7.3	52.5	6.3
p	**			
Feeding time (min)	310.1	56.7	619.9	73.2
p	**			
Boli/24h (nbr)	554	65	510	69
p	**			
Ruminating chews/24h (nbr)	31873	6293	26740	4616
p	**			
Feeding chews/24 h (nbr)	20508	4839	46943	6040
p	**			

ALP utilized the ART-MSR sensor method on 24 cows in experiments to monitor metabolism, energy conversion and feeding and locomotional behavior under grazing conditions. In all 120 files have been analyzed.

L. Trösch, vetsuisse Zürich used ART-MSR loggers recording behavior of three groups. In group 1 ten cows were observed over a period of 24 h, in groups 2 and 3 ten cows over a period of five days.

The Research Institute of Organic Agriculture FiBL studies the impact of roughage-only diets on cows. In this project 56 cows were involved and a total of 168 files (24 h recording time) were analyzed.

Christian Pahl, Christian-Albrechts-University Kiel, Institute of Agricultural Engineering, compared rumination recordings of two types of rumination sensors, namely a pressure sensor, ART-MSR, and an acoustic sensor, RuminAct, with each other. 527 records of rumination time per 2 hours were evaluated and compared to contemporaneous direct observation (Pahl et al. 2012).

Practicability and reliability

Users were content with the functions of the loggers. Over a period of three years three out of 30 loggers dropped out. Occasionally oil had to be added. Five loggers were damaged by mechanical shock or ruptures of the cable connection logger to sensor.

The following failures were reported by Grothmann: Five cases malfunction of the logger, one case lost of halter, and the other malfunctions were caused by loose fit of the halter.

The necessity of using learning datasets for the classification of the activities is rather time consuming. To improve analyzing speed for users an adapted script in “R” and an extra Excel-work-sheet was set up. These tools enable to analyze several data sets in a batch.

Conclusions

Compared to existing measuring systems as IGER (Rutter at al. 1997, Ungar et al. 2005), the ART-MSR jaw movement sensor has significant advantages in terms of animal wearing comfort and operator handling. The MSR 145 logger’s memory capacity is sufficient for more than 24 h and hence good for measurements over one day’s feeding. Newer loggers from the same manufacturer are equipped with memory cards of considerably greater capacity which will store several days’ recordings. The use of ART-MSR loggers in the mentioned research activities showed a high reliability of this equipment. The current monitoring system is reported to be suitable for research purposes. The previously described new script for batch computing helps to reduce analyzing time, but in all the method is still too time consuming for other applications than research purposes.

With the development of a new System (RumiWatch) that works with a similar measuring method but applying real-time analysis and wireless transmission to a herd management PC, recording and analysis of rumination and feeding activities are drastically improved (Zehner et al. 2012).

Further stages of development are planned. This will contribute to an improved management of animal health to secure animal welfare and profitability of dairy farming.

References:

Rutter, S.M., Champion, R.A. and Penning, P.D. (1997). An automatic system to record foraging behaviour in free-ranging ruminants. Applied animal behaviour science,, Vol. 54, 185 – 195.

Ungar, E.D., Rutter, S.M. (2005). Classifying cattle jaw movements: Comparing IGER Behaviour Recorder and acoustic techniques. Applied animal behaviour science, Vol. 98, 11 - 27.

Scheidegger, A. (2008). Klassifikation des Fressverhaltens von Kühen. Diplomarbeit, ZHAW.

Nydegger, F., Gygax, L. and Egli, W. (2010). Automatic measurement of rumination and feeding activity using a pressure sensor. Conference AgEng 2010, European Society of Agricultural Engineers. Clermont-Ferrand, France 2010, September 6-8, 2010, AgEng, 1-8.

Grothmann, A., Moser, L., Zähner, M., Nydegger, F. and Steiner, A. (2012). Einfluss verschiedener Futtervorlagehäufigkeiten auf das Wiederkau- und Liegeverhalten von Milchkühen, ETH-Tagung 2012, 2012

Pahl, C., Haeussermann, A., Mahlkow-Nerge, K., Grothmann, A., Hartung, E. (2012). Comparison of rumination activity records of pressure sensors and acoustic sensors. Conference AgEng 2012.

Zehner, N., Niederhauser, J.J., Nydegger, F., Grothmann, A., Keller, M., Hoch, M., Haeussermann, A., Schick, M. (2012). Validation of a new health monitoring system (RumiWatch) for combined automatic measurement of rumination, feed intake, water intake and locomotion in dairy cows. Conference AgEng 2012.