# Uso de cámaras para el manejo del bienestar animal en sistemas de pastoreo extensivo

# Use of point of view cameras for welfare management i n extensive grazing systems

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## RESUMEN

Los patrones de pastoreo pueden ser un indicador importante para la evaluación del bienestar en sistemas extensivos. El objetivo de este estudio fue comprobar si el video transportado por los animales es un método apropiado para evaluar el comportamiento del pastoreo de ovejas. Para probar los cambios en la duración del pastoreo, la frecuencia de pastoreo y la tasa de pastoreo, se utilizaron cámaras de gran angular (Go-Pro e infrarrojo nocturno) para acceder a las actividades diurnas y nocturnas de pastoreo de ovejas durante dos semanas a finales de primavera, la estación con mayores cambios en el clima y el crecimiento vegetativo. Se seleccionaron tres ovejas de un rebaño de 15 para la observación focal. El comportamiento de forrajeo de todo el rebaño se registró mediante muestreo por exploración con un intervalo de 10 minutos. La duración del período de pastoreo aumentó significativamente entre la primera (44,6 ± 41,4 s) y la segunda semana (94,0 ± 57,0 s) ($F = 10{,}295$, $P < 0{,}05$). Por el contrario, la duración de periíodo de pastoreo difiere entre las horas de pastoreo ($F = 4.523$, $P < 0.05$), con un pico para el período de pastoreo del atardecer (128.1 ± 88.8 s). El pastoreo nocturno no difirió significativamente para ninguno de los parámetros de pastoreo, aunque se observó una tendencia general para una mayor duración del pastoreo a lo largo del tiempo. Las ovejas pasan la parte caliente del día acostadas bajo los árboles y usan más de un árbol como áreas de descanso. Se demostró una correlación significativa entre el comportamiento de pastoreo estimado a partir del muestreo focal con cámaras de video y el muestreo por exploración ($r2 = 0{,}83$). Concluimos que las cámaras de video transportadas por los animales son un método apropiado para evaluar las variaciones ovinas de la estructura del comportamiento del pastoreo, permitiendo entender las diferencias de patrones de pastoreo adaptativo que pueden ser útiles para el manejo del bienestar en sistemas extensivos.

**Palabras clave:** *Cámaras transportadas por animales, desnutrición, patrón de pastoreo, protocolos de bienestar, sistemas silvopastoriles.*

## ABSTRACT

Grazing patterns can be a major indicator for welfare assessment in extensive systems. The aim of this study was to test animal-borne video as a method to evaluate sheep grazing behavior.

To test the changes in grazing duration, grazing frequency and grazing rate, we used wide angle cameras (Go-Pro and infra-red night vision) to access diurnal and nocturnal grazing activities of ewes in a native sward, during two weeks in late spring, the season with greatest changes in weather and vegetative growth. Three ewes were chosen from a flock of 15 animals for focal observation. The foraging behaviour of the entire flock were recorded by scan sampling with a 10-minute interval. Grazing bout duration increased significantly between the first (44.6 ± 41.4 s) and the second week (94.0 ± 57.0 s) ($F=10.295$, $P<0.05$). Conversely, grazing bout duration differed among grazing hours ($F=4.523$, $P<0.05$), with a peak for the dusk grazing period (128.1 ± 88.8 s). Nocturnal grazing did not differ significantly for any of the grazing parameters, although a general trend for longer grazing duration through time was observed. Sheep spend the hot part of the day lying in shade under trees and use more than one tree as resting areas. A significant correlation was shown to exist between the grazing behaviour estimated from focal sampling with video cameras and the scan sampling ($r2=0.83$). We concluded that animal-borne video cameras are a method appropriate for assessing sheep variations of grazing behaviour structure allowing to understand differences of adaptive grazing patterns that can be useful for welfare management in extensive systems.

**Palabras clave:** *Animal-borne cameras, grazing patterns, silvo-pastoral systems, undernutrition, welfare protocols.*

# INTRODUCTION

Sheep production is frequently the only possible enterprise in less favoured areas. The principal husbandry systems are mainly low-input and pasture-based. Extensive grazing systems can be considered as natural systems of livestock production. Compared with intensively farmed animals have more freedom to express and control their behaviour. Nevertheless, extensive systems can also present threats to welfare mainly arising from variable climate and availability of nutrients. High standards of animal welfare in these systems require focus on key events, for example, providing appropriate nutrition at critical times in the annual cycle. In Mediterranean sylvo-pastoral systems, one of these critical periods is late spring, when a decrease in nutrients and biomass available in pastures overlaps heat stress and ewes' late gestation. Under free ranging conditions and to adapt to the vegetation growth cycle and to environmental conditions the animal's grazing behaviour can evidence relevant variations, such the length of time spent grazing or a shift in overall meal pattern with an increase in nocturnal grazing events. The study of sheep grazing patterns and behavioral responses to environmental limitations is a major external indicator of welfare, as timing of feeding affects how rapidly, extensively, and efficiently feed ingestion, rumination, fermentation, and metabolism occur (Nikkhah, 2013).

During the day, behavior recording is relatively simple through live observation. However, observations at night are restricted by limited sight in the dark. Besides, it is difficult to predict whether the presence of an observer may alter the normal behavior, unless we use recording tools. Point of view cameras have been used in wildlife (Moll *et al.*, 2007) and we explored the potential to unravel the relations between foraging behaviour of livestock and feed resources that can be used latter on for selection of animals with a larger behavioural capacity for adaptation.

The aim of this study was to test animal-borne video as a method to evaluate sheep grazing behavior as a welfare indicator for extensive systems, as well as to assess if individual activities were related to group behavior.

# MATERIALS AND METHODS

*Study site and experimental flock*

The study was conducted in the region of Alentejo, Portugal, 12 km south-west of Évora within the University of Évora's Mitra Experimental Station (38°31'44''N, 8°01'00''W). Meteorological data was recorded by a meteorological station during the days of the experiment, which were April 19$^{th}$ and 20$^{th}$ (week 1), May 3$^{rd}$ and 4$^{th}$ (week 2) and May 18th and 19th (week 3) of 2017. Fifteen adult non-lactating Black Merino ewes were stocked together under continuous grazing in a 2.3 ha paddock of permanent native sward without any other feed supplement distribution.

*Observation of individual activities*

Grazing behavior was recorded through animal borne cameras. Three individuals were selected from the flock to carry GoPro® Hero2 (GoPro Inc. San Mateo, California, USA) cameras during the day, that were attached at 6 am, 10 am, 2 pm and 6 pm. Additionally, we used a infrared night vision PatrolEyes HD 1080P SC-DV1 (PatrolEyes. Ada Township, Michigan USA) at 9 pm. In total, a period of 24 hours was covered per week, starting at 6 pm.

*Observation of flock activities*

During the days of the trials, from 6 am to 8 pm, the foraging behaviors of the flock were recorded by scan sampling with a 10-minute interval. Apart from the brief times when the equipment was changed, animals were not otherwise disturbed.

*Data analysis and statistics*

The video footages were analyzed through the software Behavioral Observation Research Interactive Software (BORIS®, www.boris.unito.it). Only three state behaviors were taken into account: grazing, walking and other, which included all the other behaviors. The behaviors were considered mutually exclusive. Screen captures of both GoPro® and PatrolEyes® are shown in Fig. 1. In order to compare the periods of video recording, the shortest length was taken into account and each video footage was considered as a period of the day (Table 3). Data recorded from group observations were also gathered in periods for later comparison.

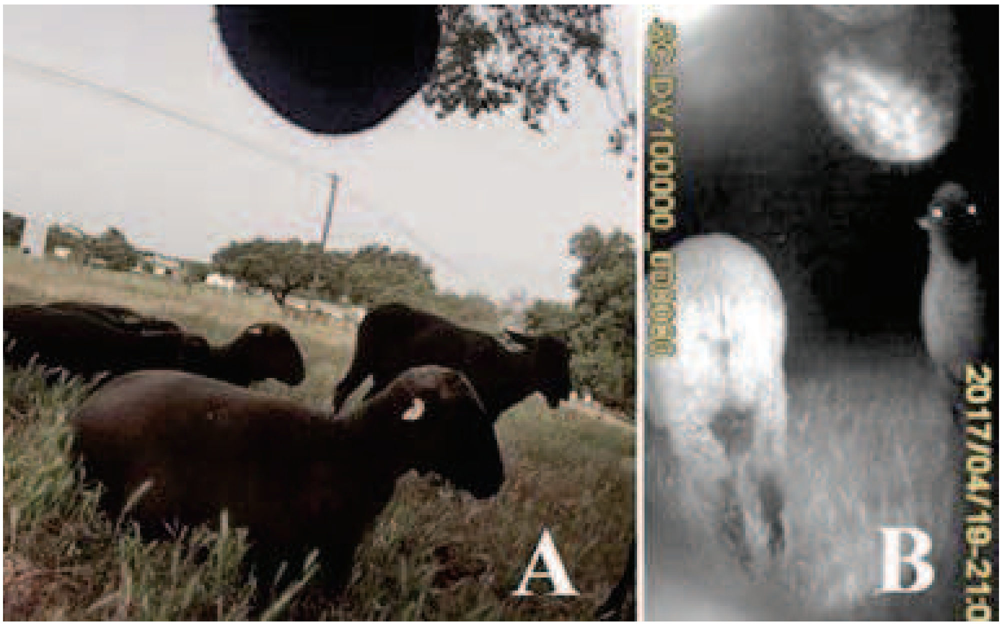


**Figura 1.** Screenshots of video footages: (A) Day time with GoPro; (B) Nocturnal shooting with PatrolEyes.

A crossover design with switchback and an extra period was used, and grazing parameters were analysed using mixed models with hours as repeated measures. The comparison of grazing activities within hours, both for individual and group, was done using one-way Tukey's multiple comparison test. Comparison of individual grazing behavior with group grazing behavior, was made using a Spearman's correlation.

# RESULTS

*Meteorological conditions*

The three weeks were similar in general meteorological conditions (detailed data shown in Table 2).

**Table 2.** Meteorological conditions during the days of the experiment

| | Week 1 | | Week 2 | | Week 3 | |
|---|---|---|---|---|---|---|
| | April 19th | April 20th | May 3rd | May 4th | May 18th | May 19th |
| Sunrise | 06:50 | 06:48 | 06:32 | 06:31 | 06:17 | 06:17 |
| Sunset | 20:12 | 20:13 | 20:26 | 20:27 | 20:39 | 20:40 |
| T (°C) | 19.8 | 18.3 | 20.9 | 18.7 | 15.6 | 16.6 |
| Tmax (°C) | 27.8 | 26.7 | 31.4 | 25.8 | 22.6 | 25.4 |
| Tmin (°C) | 11.5 | 10.3 | 9.9 | 13.6 | 10 | 8.2 |
| Rainfall (mm) | 0 | 0 | 0 | 0 | 0 | 0 |

(T) Daily average temperature; (Tmax) maximum temperature; (Tmin) minimum temperature.

*Individual observations*
Week effect did not influence significantly grazing duration nor number of bouts. However, it did influence grazing bout duration, which was longer in the second week. Same hours differed significantly for grazing duration (F = 14.146, df = 4, P < 0.001) and number of bouts (F = 4523, df = 4, P < 0.001).

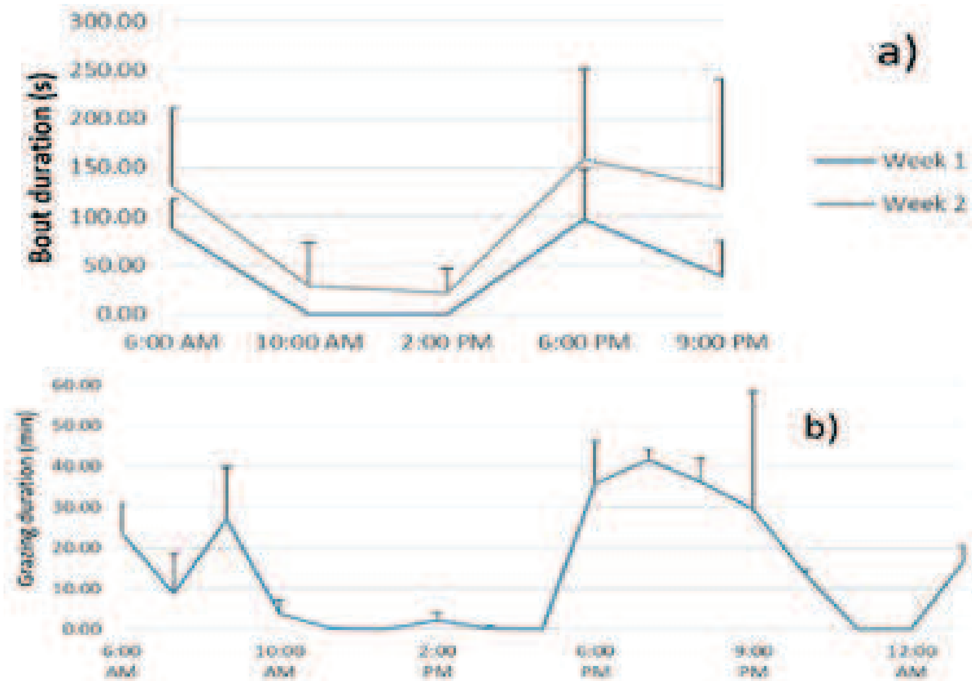


**Figure 2.** Grazing behaviour patterns: a) Bout duration through the day in the first two weeks; b) Grazing duration per hour

The period with highest values of grazing duration, number of bouts and bout duration was 6 pm – 9 pm, though for grazing duration it was not significantly different from 6 am – 9 am, and for bout duration it was not significantly different from 6 am -9 am nor 9 pm – 2 am (Table 3).

**Table 2.** Grazing duration, number of bouts and bout duration.

| | Grazing duration (min) | | Number of bouts | | | |
|---|---|---|---|---|---|---|
| Period | Mean | SD | Mean | SD | Mean | SD |
| 6 am – 9 am | 22.3ab | 11.82 | 12.58b | 6.45 | 109.18ab | 59.15 |
| 10 am – 1 pm | 0.9c | 2.28 | 0.92c | 1.8 | 14.74b | 31.98 |
| 2 pm – 5 pm | 0.64c | 1.25 | 1.08c | 1.74 | 10.76b | 20.06 |
| 6 pm – 9 pm | 36.3a | 7.43 | 20.67a | 6.26 | 128.09a | 74.42 |
| 9 pm – 2 am | 14.3bc | 18.45 | 7.17bc | 6.65 | 83.70ab | 88.76 |

Means with different superscripts differ significantly (Tukey's, P<0.05)

As grazing duration was not significantly different between the two weeks, both means were combined to demonstrate grazing behavior pattern through the hours of the day. There were three important periods of grazing at dusk, dawn and during the night (Fig. 2.a). The most important one is from 6pm to 9pm. Details of grazing duration are displayed in Fig. 2.b. Nocturnal grazing did not differ significantly for grazing duration, number of bouts or grazing bout duration. Nonetheless, grazing duration was continuously longer through time. There was not any grazing from 2am to 5am.

*Group observations and correlation between observations*
Grazing behavior followed the same pattern in the two weeks. The only significant difference in the behaviors between the weeks were for standing, which was higher in the first week (F = 22.948, df = 1, P < 0.01. The hours differed for resting ruminating (F = 3.854, df = 3, P = 0.038) and more significantly for grazing (F = 10.684, df = 3, P < 0.001) and resting (F = 13.923, df = 3, P < 0.001). Individual observations were positively correlated with group observation (Spearman's, $r^2$ = 0.838).

# DISCUSSION

When observing grazing duration, number of bouts and bout duration through the hours of the day, all three follow the same pattern. The highest values for grazing duration are in the periods corresponding 6 am to 9 am and 6 pm to 9 pm, which is in accordance to previous studies (Hester *et al.*, 1996; Medeiros *et al*., 2007). The fact that grazing duration and number of bouts were not significantly different between the first two weeks may suggest that the variations in the pasture were insufficient to significantly change grazing behavior. In fact weather conditions and photoperiod were very similar between experimental weeks. The continuous increase in grazing duration through weeks may indicate a decrease in forage quality (47% to 53% NDF/kgDM). However, the difference was not statistically significant. The maximum temperature in the first day of the second week was above 30°C. This may have caused some thermal stress in the animals, which responded with an increase in nocturnal and morning grazing. By studying sheep grazing behavior in Greece, Karasabbidis (2014) has reported a negative relationship between time spent on grazing and air temperature. This may be the reason why the grazing pattern of the group was concentrated more intensely in the beginning and in the end of the day. During the day, the trees provide shade and rest areas and ruminating were observed mainly from 9am to 6pm, an interval in which grazing was sporadic. These results are in accordance to those reported by Arnold (1984). The positive relationship between individual and group observation was strong, proving that this method is indeed accurate. Rook y Penning (1991) and Gautrais *et al.* (2007) have reported synchronization of grazing behavior in sheep. Such phenomena explain the positive correlation obtained in the present study.

# CONCLUSION

Among the grazing parameters, grazing bout duration and nocturnal activity, measured with point-of-view cameras, show variation in accordance with abiotic factors and vegetation cycle that supports them to be potential indicators of nutritional environment that is essential for assessment of welfare in extensive systems. According to AWIN protocol (2015), appropriate nutrition should be assessed using indicators such as lamb mortality and body condition. In that respect the aforementioned parameters stand out also as a promising animal-based tool for assessing welfare of large flocks, because for a flock of 250-299 ewes, circa 25% should be sampled for individual assessment. The use of point of view cameras will allow individual assessment minimizing the number of animals handled.

Point-of-view cameras could provide simultaneous information on feeding (appropriate nutrition), housing (assess to shade/shelter) and appropriate behavior (expression of social and other behaviors), 3 of the 4 principles for Welfare Quality®. Although the results were encouraging, further tests of validity, reliability and feasibility should be performed before they could be used in a welfare assessment protocol. Based on our preliminary results, we nevertheless recommend that grazing pattern should be used as an indicator for welfare assessment in extensive systems.

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