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# Adaptation of goats feeding systems to the adverse economic conditions by changing the grazing management practices

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**Abstract.** The economic sustainability of the intensive sheep and goats systems in the Mediterranean region has been compromised by the current economic crisis, which has worsened the impacts of the high costs of purchased feeds and the high dependency on capital. An alternative option to overcome these issues is the extensification of farming systems which provides livestock farmers with the necessary flexibility to adjust their livelihoods according to the external circumstances. Thus, they can modify the grazing system, the daily grazing duration and the supplementation management according to the availability of necessary resources in order to achieve an acceptable level of flock productivity. The purpose of the present study was to investigate the shepherds grazing management practices and the characteristics of the flock's movement in a communal rangeland. For this purpose, the case of a herded goat farm was investigated for three seasons (spring, summer and autumn) throughout two consecutive years during the economic crisis when the cost of feedstuffs increased and the selling price of milk decreased. Collars with GPS devices were placed on adult female goats' neck for four consecutive days during each test period. The GPS data were analysed using GIS tools. According to the results grazing spatial patterns per season were differentiated as the shepherd took into account the cost of supplementation, the forage availability per season and criteria to prevent overgrazing.

**Keywords.** Extensive systems – Shepherd – Rangeland – Supplementation – GPS tracking.

## **Adaptation du système d'alimentation des chèvres aux conditions de crise économique en modifiant la gestion du pâturage**

**Résumé.** La durabilité économique des systèmes intensifs de moutons et de chèvres dans la région méditerranéenne a été compromise par la crise économique actuelle, qui a empiré les impacts des coûts élevés des aliments achetés et de la forte dépendance du capital. Une autre option pour remédier ces problèmes c'est l'extensification des systèmes agricoles qui offre aux éleveurs la flexibilité nécessaire pour ajuster leurs moyens de subsistance selon les circonstances extérieures. Ainsi, ils peuvent modifier le système de pâturage, la durée quotidienne du pâturage et la gestion des suppléments selon la disponibilité des ressources nécessaires afin d'atteindre un niveau acceptable de productivité du troupeau. Le but de la présente étude était d'étudier les pratiques de gestion du pâturage des bergers et les caractéristiques du mouvement du troupeau dans un parcours communal. À cette fin, le cas d'une ferme de chèvres chevronnée a été étudié pendant trois saisons (printemps, été et automne) pendant deux années consécutives de la crise économique lorsque le coût des aliments a augmenté et le prix de vente du lait a diminué. Des colliers avec des dispositifs GPS ont été placés sur le coude des chèvres adultes pendant quatre jours consécutifs au cours de chaque période d'essai. Les données GPS ont été analysées à l'aide d'outils GIS. Selon les résultats, les modèles spatiaux de pâturage par saison ont été différenciés car le berger a pris en compte le coût de la supplémentation, la disponibilité fourragère par saison et les critères pour prévenir le surpâturage.

**Mots-clés.** Système extensif – Berger – Parcours – Supplémentation – GPS.

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## I – Introduction

The sustainability of intensive sheep and goats systems in the Mediterranean region is threatened by the current economic crisis, due to their high dependency on capital and the increasing prices of purchased feeds (Ragkos *et al.*, 2016). These limitations are less strong in extensive production systems, as in these systems an essential part of feeding requirements are covered by grazing, which reduces feeding costs. Indeed, grazing in extensive pastoral systems provides farmers with the necessary flexibility to adjust their livelihoods according to the external circumstances (Baker and Hoffman, 2006). Shepherds can modify the grazing system, the daily grazing duration and the supplementation management according to the availability of necessary resources in order to achieve an acceptable level of flock productivity (Bonanno *et al.*, 2008).

The purpose of the present study was to investigate the shepherds grazing management practices and the characteristics of the flock's movement in a communal rangeland in response to different economic constraints.

## II – Materials and methods

The study was conducted in Evros region, Northeastern Greece, during three seasons (spring, summer and autumn) for two consecutive years (2010 and 2011). A flock of 650 Greek local breed goats, which grazed in communal rangeland close to the small village of "Megalo Derio" (41°14'N; 26°01'E, 380 m a.s.l.) was investigated. The production system was the traditional sedentary extensive in which the flock, after the daily grazing, returned to the barn to be housed during the night. Goats were hand-milked twice per day (early morning and late afternoon) during the lactation stage that lasted from early March to late August.

The shepherd led the flock to the rangeland during the grazing period and made decisions about the direction of flock's routes taking into account the forage availability. He also managed the duration of the daily grazing time considering the productive stage of goats as well as the supplementary feeding he wanted to provide. During the study period, the shepherd significantly modified the amounts of supplementary feeds. This decision was based on their price as well as the selling price of the milk. Particularly, the goats received 400g corn grains and 400 g wheat grains per head during the spring and summer of 2010. During the spring of 2011, in addition to the same amounts of corn and wheat grains, the farmer supplied to the goats also 400 g alfalfa hay per head in order to increase their productivity, since milk price was high, but he totally discontinued supplementary feeding during the summer of 2011, because prices of supplementary feeds increased markedly. No additional supplementary feeding was provided to the flock during the autumn (both 2010 and 2011) as the lactation stage had been completed.

In order to study the animals' movement, GPS data loggers were placed on their neck (ten during 2010 and twenty during 2011) during four consecutive days per test period. The devices were set to record the geographical position every 5 sec. The processing of GPS data was performed using Quantum GIS 2.16 software ([www.qgis.org](http://www.qgis.org)). The GPS locations for each animal were converted into trajectories, i.e. the sequence of location points and segments connecting them (Calenge *et al.*, 2009). The analysis was performed using only complete individual daily trajectories (n=74 in 2010; n=211 in 2011). The "duration" (h/d) was calculated as the time elapsed between the first and the last position recorded that indicates the total time the collared goats spent daily in the rangeland. The "distance" travelled daily (km/d) was calculated by summing each segment length corrected for the altitudinal gradient between the initial and final position.

The metrics of goats' trajectories (duration and distance) were sorted according to the three seasons of grazing (spring, summer and autumn) of the two years under investigation (2010 and 2011).

The analysis of the effect of the season on the above measurements within each trial year was carried out using one-way ANOVA. Tukey–Kramer HSD test was used to perform the multiple comparisons for all pairs of means. The significance level was set to  $P < 0.05$ . The statistical analysis was performed using version 8.0 of the JMP software (SAS Institute Inc, Cary, North Carolina).

### III – Results and discussion

The metrics of the goats' trajectories are given in Table 1, and movement paths shown in Fig. 1. During 2010, the duration and the distance of goats' trajectories (2.4 h/d and 3.2 km/d, respectively) were significantly shorter in summer compared to the other seasons. During this period, the goats were in late lactation and their nutritional needs were lower than in spring. The shepherd continued to supply supplementary feds and reduced the time the flock spent in the rangeland. On the contrary, in 2011 the duration and the distance of goats' trajectories were longest in summer of 2011 and shortest in spring (Table 1).

To meet the requirements of the goats in early lactation during spring 2011, the shepherd increased supplementary feeding as respect to spring 2010, keeping the flock in the fenced area 1 (FA1) and providing extra alfalfa hay, which allowed him to reduce the grazing duration. During summer 2011, despite the fact that the goats were still in late lactation, the shepherd stopped providing any supplementary feed. He modified the feeding and the grazing system in order to face the increased prices of the purchased feedstuffs (cereal grains and alfalfa hay) and the sharp decrease of the selling price of milk. He decided to increase the grazing time of the goats in order to meet their nutritional needs by increasing the forage intake, as the forage is the cheapest source for the ruminants' feeding (Molle *et al.*, 2004).

**Table 1. Metrics describing goats' trajectories in 2010 and 2011. Data show mean  $\pm$  standard deviation**

Year	2010				2011			
Season	Spring	Summer	Autumn	P-value	Spring	Summer	Autumn	P-value
Tracks (n)	19	24	31		70	74	67	
Duration (h/d)	8.4 $\pm$ 0.9 <sup>A</sup>	2.4 $\pm$ 0.4 <sup>B</sup>	8.0 $\pm$ 0.8 <sup>A</sup>	***	3.3 $\pm$ 0.2 <sup>C</sup>	9.8 $\pm$ 0.8 <sup>A</sup>	7.9 $\pm$ 0.4 <sup>B</sup>	***
Distance (km/d)	10.0 $\pm$ 2.7 <sup>B</sup>	3.2 $\pm$ 0.5 <sup>C</sup>	13.9 $\pm$ 2.2 <sup>A</sup>	***	5.0 $\pm$ 0.9 <sup>C</sup>	11.4 $\pm$ 1.5 <sup>A</sup>	9.4 $\pm$ 1.4 <sup>B</sup>	***

Means in the same row followed by the same letter are not significantly different ( $P \leq 0.05$ ).\*\*\* $P < 0.001$ .

In autumn, goats were in the dry period, they did not receive supplementary feeds and their nutritional needs were covered exclusively by grazing. For this reason, the shepherd led the flock to the fenced areas (FA2 in 2010 and FA1 in 2011) far away from the barn (Fig. 1) close to less-grazed areas in order to gain access to better forage resources.

Therefore, the shepherd was able to strongly modify, the movement paths of the flock and their spatial distribution, also by shifting the position of shelters (Jouven *et al.*, 2010). In doing so, he took into account not only his experience regarding the seasonal differences in forage availability and quality, but also criteria to prevent overgrazing, as the area was grazed by other flocks (mainly of goats and less of sheep). Similar variations in the characteristics of goats' itineraries and management practices have been reported (Feldt and Schlecht, 2016). Indeed, the balance among the grazing time, the animal need, the type and the amount of the supplementary feeds according to their cost, is common pursuit in the extensive farming systems (De Rancourt *et al.*, 2006).

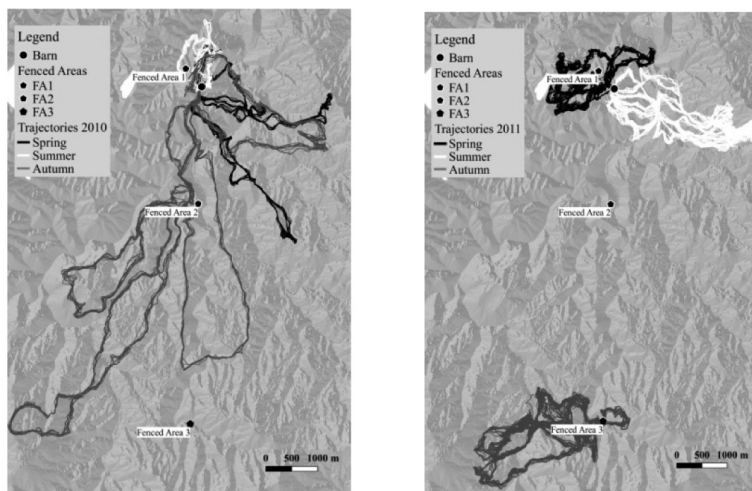


Fig. 1. Goats' trajectories and movement patterns in the study area during 2010 and 2011.

## IV – Conclusions

This case study demonstrates that the shepherd and his grazing management practices profoundly affected the characteristics of the goats' itineraries during grazing to respond to the economic constraints dictated by the trade-off between the milk price and the cost of supplementary feeding. When feed costs were high and the milk price low, the shepherd decided to replace supplementary feeds with pasture, by increasing duration and distances of daily grazing, and increasing his working time. The grazing patterns were different in each year and season, reflecting how the shepherd used his experience about forage availability and quality according to the variability of seasonal conditions in order to lead the flock in better feeding resources. This allowed flexibility to adapt feeding and grazing management practices in accordance with adverse economic conditions.

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