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Cattle distribution under rotational grazing as affected by mineral mix supplements and traditional salt placement in Alpine environments

M. Pittarello[1,*], M. Probo[1], G. Iussig[1], M. Lonati[1], G. Lombardi[1] and D.W. Bailey[2]

[1]University of Torino, Department of Agricultural, Forest and Food Sciences
Via Leonardo da Vinci 44, Grugliasco, 10095 TO (Italy)
[2]New Mexico State University, Department of Animal and Range Sciences,
Las Cruces, NM 88003 (USA)
*e-mail: marco.pittarello@unito.it

Abstract. Effects of strategically placed mineral mix supplement (MMS) and traditional salt placement (TS) on cattle distribution were compared within Val Troncea Natural Park (Italy). Loose salt (TS) was placed on the rocks traditionally used by the farmers within flat and herbaceous areas. MMS blocks were strategically placed along 50-m transects in steep and shrub-encroached sites. Each TS and MMS treatment area was paired with a control site without supplements. Grazing period within each pasture was divided into two equal sub-periods during which TS and MMS were available. Eleven cows were tracked at 15 minute intervals with GPS collars. Both TS and MMS placement areas were used more ($P<0.001$) than associated control areas. No differences were detected ($P>0.05$) in the time spent near TS and MMS. During both periods, cattle preferred areas with gentler terrain, closer to streams, closer to TS or MMS points, and with higher forage pastoral value. During TS periods, cattle preferred ($P<0.01$) areas with higher percentage of large leaf grasses, whereas during MMS periods cattle avoided ($P<0.01$) areas with higher bare ground and rock cover. Since we did not detect differences in the time spent in MMS and TS placement sites, strategically placed MMS appears to be a very promising tool to increase the use of steep and shrub-encroached areas and to enhance cattle distribution within large pastures.

Keywords. Beef cows – Feed blocks – Cattle distribution – GPS-tracking – Rotational grazing system.

Influence de l'emplacement de blocs minéraux à lécher et de sel traditionnel sur la répartition des animaux au pâturage dans les milieux alpins

Résumé. *Les effets de l'emplacement de blocs minéraux (MMS) et de sel en vrac (TS) sur la répartition des animaux au pâturage ont été comparés dans le Parc Naturel Val Troncea (Italie). TS a été placé sur des rochers traditionnellement employés par les éleveurs dans des milieux plats et herbacés. MMS ont été stratégiquement placés le long de transepts de 50 m en milieux abrupts et embroussaillés. Chaque aire avec TS et MMS a été associée avec une aire témoin sans aucun supplément. La période de pâturage des animaux à l'intérieur de chaque parcelle a été partagée en deux périodes pendant lesquelles TS et MMS étaient disponibles. La position des vaches a été enregistrée à l'aide de colliers GPS toutes les 15 minutes. Les aires de placement de TS et de MMS ont été exploitées par les animaux d'une façon plus fréquente que les aires témoin ($P<0,01$). Aucune différence n'a été relevée ($P>0,05$) parmi les aires à TS et à MMS. Pendant les deux périodes, les vaches ont préféré les milieux avec des terrains doux, près des ruisseaux et des points avec TS ou MMS, et caractérisés par une valeur pastorale de la végétation plus élevée. Pendant les périodes TS, les vaches ont préféré ($P<0,01$) les milieux avec des pourcentages élevés de graminées à feuilles larges, tandis que pendant les périodes MMS les vaches ont évité ($P<0,01$) les milieux avec des couverts importants de sol nu et de rochers. Puisque aucune différence de temps passé près des aires MMS et TS n'a été relevée, le placement stratégique de MMS pourrait être un moyen efficace pour augmenter l'exploitation des milieux raides et embroussaillés et pour améliorer la distribution des animaux au pâturage.*

Mots-clés. *Vaches allaitantes – Blocs nutritionnels – Répartition des animaux – Collier GPS – Pâturage tournant.*

I – Introduction

Grazing distribution is a critical component of cattle management on mountainous rangelands (Del Curto *et al.,* 2005). Strategic supplement placement has been used to manipulate cattle grazing patterns in the United States (e.g., Bailey and Welling, 2007), Brazil (Goulart *et al.,* 2008) and Western Italian Alps (Probo *et al*., 2013). During the 20th century, socio-economic transformations have led to a large-scale decline in livestock farming and agriculture in the Alps. People moved to the cities in the plains, and the number of traditional agro-pastoral activities has diminished. The ecological consequences of undergrazing or complete elimination of domestic animals grazing are usually evident where conditions are suitable for tree and shrub growth. Targeted livestock grazing using rotational grazing systems (RGS) and strategic supplement placement to lure the cattle towards underused and shrub encroached areas may be effective to avoid or slow down this process. The goal of this study was to evaluate how the strategic placement of mineral mix supplement (MMS) and traditional salt (TS) placed by farmers can affect the grazing patterns of beef cows managed under RGS. Our hypothesis was that TS would be more attractive than MMS because it is traditionally placed in flat areas, which are more accessible and often offer better quality forage. In contrast, MMS was placed in underused, steep and shrub encroached sites, which are less accessible. The specific objectives were: (i) to identify the most important geomorphological and vegetation factors affecting cattle grazing patterns in sub-alpine and alpine pastures managed under RGS with large paddocks and MMS or TS available; and (ii) to determine if MMS is an effective tool to increase the use of undergrazed areas.

II – Materials and methods

The study was conducted in the Val Troncea Natural Park (44°57' N, 6°57' E), which is a protected area representative of the socio-economic changes that occurred on Western Italian Alps. A total of 119 Piedmontese beef cows, including heifers and non-lactating cows, grazed from 20 June to 26 August 2013 in four paddocks in rotation according to a pastoral plan. Only three paddocks were monitored because the first one was used to familiarize cows to MMS blocks. Pastures were 6 ha (not monitored), 27 ha, 45 ha and 60 ha in size. Although the paddocks differed in size, each of them was used for about 20 days, because their carrying capacity was similar. Fourteen randomly selected cows were tracked with Global Position System (GPS) collars (GPS Model Corzo, Microsensory SLL, Fernán Núñez, Andalusia, Spain). Positions were recorded every 15 min, with an average accuracy of 6 meters. The grazing period within each pasture was divided into two equal sub-periods. The two supplements (i.e. MMS or TS) were randomly assigned to the two sub-periods in order for cattle to have access to both supplements in each pasture. TS (NaCl, 25 kg) was placed in traditional locations 2-3 times by the farmer during the sub-period. MMS was placed *ad libitum* at five steep, undergrazed, and shrub-encroached locations along a 50 m transect on poles (5 kg blocks). MMS blocks were arranged to gradually attract cows from gentle to moderate herbaceous dominated sites to steep and shrub dominated sites. In contrast, TS was placed on flat rocks within flat herbaceous areas to simulate the traditional use by farmers (i.e. to concentrate cattle for periodic herd counts and health inspections within accessible sites). The average slope of MMS sites was 26.6° ± 4.12, whereas TS was 16.9° ± 2.28. A paired control area with similar geomorphological and vegetation conditions was identified for each supplement (TS or MMS) placement site. Pastures were subdivided into 50 x 50 m grid cells in order to study the spatial patterns of the grazing cows. Starting from the center of each cell, the cover of shrubs, herbaceous species, bare ground, and rocks were visually estimated within a 20 m buffer area. The ratio among thin leaf, medium leaf, and broad leaf herbaceous species (including grasses and sedges) was assessed by a visual estimation. Moreover, vegetation composition was visually estimated to identify the vegetation type (Cavallero *et al*., 2007) and to estimate the Forage Pastoral Value (Daget and Poissonet, 1971). Distance to the

nearest water was calculated from the center of each grid cell. A 20 m buffer area was created around the center of each grid cell. Average slope of each 20 m radius buffer was calculated from a Digital Terrain Model (DTM, 5 m resolution) and GIS software (Quantum Gis 2.0.1, Quantum Gis Development Team 2012 and ArcMap 10, ESRI 2010). For the evaluation of spatial grazing patterns during the two MMS and TS sub-periods, only positions recorded (27259) when cattle are generally most active and grazing (0600 to 2200 hours) were considered (Probo, unpublished data). Spatial locations were recorded by 11 out of 14 GPS collars, because 3 of them failed. Relationships between environmental variables and spatial use of pastures when supplemented with MMS and TS were analyzed with a Generalized Linear Mixed Model (GLMMs, Zuur *et al*., 2009). The number of positions recorded in each 20 m buffer were modeled using 9 environmental predictors. Predictors were standardized (Z-scores) to allow for analysis of effect size by scrutinizing model parameters (β coefficients). A correlation analysis was used to exclude predictors with high collinearity (r>|0.80|). Time spent by cows near MMS and TS was defined considering the number of GPS fixes within 10 m of the supplement (Bailey and Welling, 2007). To evaluate the time spent within MMS and TS placements and their corresponding control areas, the number of GPS positions to placement and control sites was counted. To compare the time spent near MMS and TS placements we used a GLMM. The model included cow and paddock as random effects and supplement type (MMS or TS period) as a fixed effect. To evaluate if MMS and TS areas were frequented more than related control areas, we used the same type of analysis and the model included cow and paddock as random effects and treatment (control or supplement placement area) as a fixed effect. Because the dependent variable in all models was based on count data, a poisson distribution was initially assumed, but the test of overdispersion prior to model fitting showed that a negative binomial distribution was more appropriate. Statistical models were fitted in R version 3.0.1. (R Development Core Team 2012) via the glmmAMDB R package using a negative binomial distribution.

III – Results

During the study, 10 of 11 collared cows (90%) visited MMS sites, while 11 of 11 cows visited TS sites. The GLMM β coefficients were used to assess the importance of environmental variables affecting spatial use of pasture by cattle under MMS and TS sub-period (Table 1).

Table 1. GLMM with environmental variables affecting spatial use of pasture by cattle under MMS and TS supplement period

	MMS grazing period			TS grazing period		
	β[1]	SE[2]	*P* value	β[1]	SE[2]	*P* value
Shrub cover	-0.10	0.076	n.s	-0.16	0.09	P<0.10
Thin leaf grass cover	0.03	0.082	n.s	0.05	0.09	n.s
Medium leaf grass cover	0.10	0.065	n.s	0.14	0.08	P<0.10
Broad leaf grass cover	0.06	0.055	n.s	0.27	0.07	P<0.001
Bare ground + Rocks	-0.35	0.103	P<0.001	-0.13	0.12	n.s
Forage pastoral value (PV)	0.11	0.048	P<0.05	0.17	0.05	P<0.01
Distance to TS or MMS points	-0.39	0.048	P<0.001	-0.20	0.06	P<0.001
Distance to water source	-0.18	0.051	P<0.001	-0.39	0.07	P<0.001
Slope	-0.40	0.042	P<0.001	-0.44	0.05	P<0.001

[1]Stand β indicates that each coefficient of the variables (β) has been standardized, that is, measured from their means in units of standard deviations.

[2]SE is of standardized coefficients (β).

[3]ns indicates not significant (P>0.05).

With both MMS and TS placements, cattle preferred gentler terrain (P<0.001), areas closer to streams (P<0.001), MMS or TS placements (P<0.001), and areas with higher forage pastoral value (P<0.05). During TS periods, cattle preferred (P<0.01) areas with more broad leaf grasses and with low shrub cover, whereas during MMS periods cattle avoided (P<0.01) areas with higher bare ground and rock cover. Thin leaf and medium leaf cover were not important predictors of cattle use in either the MMS or the TS periods. Time spent by each cow near (within 10 m) MMS sites (22.89 ± 0.48 min/week, mean ± SE) was greater (P<0.001) than that spent in paired control areas (4.2 ± 0.12 min/week). Cows also spent more time (P<0.001) within 10 m of TS sites (32.48 ± 0.61 min/week) than at paired control areas (19.11 ± 0.61 min/week). However, we did not detect any difference in the time cows spent within 10 m of MMS and TS placements.

IV – Discussion and conclusion

Similar to other research, cows in this study preferred gentler slopes over steeper slopes (Bailey *et al*., 1996). Cattle preferred to graze in areas closer to water, with higher forage quality and more palatable species in both sub-periods. Nevertheless, cows tended to select areas with steep terrain close to MMS placement to the same degree as gentle terrain. In TS periods cows selected sites with higher broad leaf cover, which are typically associated to flat areas. In TS periods, cows avoided sites with higher shrub cover suggesting a preference for open pastures, while in MMS periods there was no evidence of cows avoiding shrub encroached locations. The MMS blocks were placed within steep slopes, shrub encroached, and historically underused areas. In contrast, TS was supplied by the farmer on flat rocks within sites with gentle slopes several years before and during the study. Correspondingly, it is not surprising that cattle used TS sites because of the ease of access. In addition, cows likely remembered the TS placement sites since cattle have accurate spatial memory (Bailey *et al.,* 1996). With both MMS and TS placements, cows spent more time near supplement than in corresponding control sites. Although historical cattle use likely differed in TS and MMS treatment areas, no differences in the time spent within a 10 m buffer of placement sites were detected during the study. The similarity in the time spent in MMS and TS placement sites suggests that cows grazed steep and shrub dominated areas when MMS was placed nearby at the same intensity than flat and herbaceous areas with salt available. This result indicates that strategic placement of MMS may be effective in changing cattle grazing patterns. Although more research is needed, strategically placed MMS appear to be a promising tool to enhance grazing distribution within large pastures and increase cattle use of shrub dominated areas. Grazing in steep, shrub encroached areas by cattle facilitates trampling, defoliation, and fecal deposition which may help to restore vegetation structure and composition around supplement sites, reducing shrub abundance and increasing fertility of soil and forage quality and quantity in the years to come (Probo *et al*., 2013).

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