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Sustainability of a beef cattle production system in Mediterranean marginal areas

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Abstract. The aim of this work was to evaluate the strategic role of Sardinian marginal areas in the sustainability of beef cattle production systems. The study was conducted between April and November 2011 in an experimental area (24 ha, 670 m a.s.l.) of North-West Sardinia, dominated by woody vegetation, mainly oak species, with an herbaceous cover limited to the 12% of the surface. Twenty-four calves, divided in 4 groups according to the breed: Sarda, castrated Sarda, Sardo-Modicana and a progeny by Charolaise bull and Sarda cow, were used. The animals after weaning, at 6 month of age and $168.5 \text{ kg} \pm 16.2$ of live weight (LW, means \pm SE), were raised at pasture (0.4 LU ha^{-1}) receiving a supplementation from the end of summer. Monthly animals were weighted and the herbage availability was monitored. The farm meteorological data were registered daily. The pattern of LW and growing rate ($\text{kg head}^{-1}\text{day}^{-1}$) show a strong dependence from herbage availability, the latter becoming negative during the summer. The studied system shows a shortness of feed during summer and beginning of autumn, due to the delay of autumn rain, confirming the strong relationship between animal performance and seasonal changes in Mediterranean conditions.

Keywords. Beef cattle – Grazing system – Low input agriculture.

Durabilité d'un système de production de bovins à viande dans les zones marginales Méditerranéennes

Résumé. Le but de ce travail était d'évaluer le rôle stratégique des zones marginales dans la durabilité de systèmes de production de bovins à viande en Sardaigne. L'étude a été réalisée entre Avril et Octobre 2011 dans une zone expérimentale (24 ha, 670 m d'altitude) du Nord-ouest de la Sardaigne, dominée par une végétation ligneuse, chêne principalement, avec une couverture herbacée limitée à 12% de la surface. Vingt-quatre veaux, répartis en 4 lots selon la race: Sarde, Sarde castrés, Sarde-modicaine et un croisement (taureau Charolaise x vache Sarde), ont été utilisés. Les animaux après le sevrage, à 6 mois d'âge et $168,5 \text{ kg} \pm 16,2$ de poids vif (moyenne \pm ES), ont été maintenus au pâturage tout le temps ($0,4 \text{ UGB ha}^{-1}$) et ont reçus une supplémentation de la fin de l'été. Le poids vif des animaux et la disponibilité d'herbe ont été mesurés chaque mois. Les données météorologiques ont été enregistrées quotidiennement. Le poids vif et le taux d'accroissement ($\text{kg tête}^{-1} \text{ jour}^{-1}$) des veaux montrent une forte dépendance de la disponibilité herbe, ce dernier devenant négatif au cours de l'été. Le système étudié montre une pénurie de l'alimentation pendant l'été et au début de l'automne, en raison du retard des pluies d'automne, ce qui confirme la forte relation entre la performance des animaux et les changements saisonniers dans les conditions méditerranéennes.

Mots-clés. Bovin à viande – Système de pâturage – Agriculture à faibles intrants.

I – Introduction

Beef cattle production system in Mediterranean marginal areas is an important activity and represents an ancestral tradition. The typical raising system is based on grazing areas where the animals, suckler cattle and their calves, are free to graze and receive a small amount of supplements. At weaning, at 8 months of age, calves are sold to be fattened in specialized areas where they lost the specificity of the product in the fattening centres (Ligios *et al.*, 2005). For economic reasons the rural population have abandoned the typical raising system exposing

the environment at risk of fire and desertification, encroachment of scrubland and woods, erosion and flooding. The sustainable use of the pasture and forestland could represent a development opportunities for the systems: the utilization of these resources by cattle can be beneficial in reducing the production costs; for the conservation of landscape; for the prevention of forest fire; and can also contribute to the maintenance of human local populations. As shown by Scotti *et al.* (2005) cattle can covered their annual energetic requirement up to 80%, grazing in wooded areas in Mediterranean environment, when a rational management is applied. The aim of this work was to evaluate the role of Mediterranean marginal area, represented by pasture based on oak tree forest, in the feeding sustainability of beef cattle production system during the spring-autumn period.

II – Materials and methods

The experiment, still ongoing, is conducted at the Experimental Farm of Agris Sardegna located in Macomer (Sardinia, Italy; lat 39°N, long 9 °E, 670 m a.s.l.). Data are referred to the spring-autumn period of 2011 (from April to November). The studied area is characterized by Mediterranean climate with hot, dry summers and mild and rainy winters ($T_{max} = 28.1^{\circ}\text{C}$; $T_{min} = 3.3^{\circ}\text{C}$; total annual rainfall = 905 mm). Meteorological data were recorded daily, by an automatic weather station located in the experimental site. The experimental area (24 ha), is dominated by woody vegetation, represented by *Quercus pubescens*, with open glades limited to the 12% of the total surface.

Animals: twenty-four calves, divided in 4 groups according to the breed: Sarda (S), castrated Sarda (Sc), Sardo-Modicana (SM) and a progeny by Charolaise bull and Sarda cow (F1), were used. The animals after weaning, at 6 month of age and $168.5 \text{ kg} \pm 16.2$ of live weight (LW, mean \pm SE st.dev.), were raised at pasture (0.4 LU ha^{-1}) receiving a supplementation from the end of summer to the beginning of autumn ($1.70 \text{ kg head}^{-1} \text{ day}^{-1}$ of a commercial concentrate and $3.0 \text{ kg DM head}^{-1} \text{ day}^{-1}$ of natural pasture hay). Calf live weight (LW, kg) was recorded monthly and calf growing rate (CGR, $\text{kg head}^{-1} \text{ day}^{-1}$) was calculated.

Pasture: herbage on offer (HO, t DM ha^{-1}) was monitored monthly by cutting 40 stripes ($0.10 \text{ m} \times 5 \text{ m}$) randomly selected throughout the experimental area. Sward height (SWH, cm) was also measured with weighted plate (150 records per ha). In the forage samples were determined fresh and dry weight (oven dried at 60°C until constant weight) and chemical composition, evaluate on dry matter (% DM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL). The samples were analysed using a Foss NIRSystems (Hoganas, Sweden) model 5000 NIR reflectance monochromator spectrometer, after calibration with traditional chemical analysis (NIRS, Shenk and Westerhaus, 1994).

Statistical analysis: HO, SWH and chemical composition of herbage on offer were analyzed with the GLM procedure of SAS using the experimental period as fixed effect; LW were analyzed with the GLM procedure of SAS using the breed as fixed effect and the pre-experimental LW as covariate; CGRs were analyzed with Mixed procedures of SAS using breed, period and their interaction as fixed effect and animal as random effect.

III – Results

During the experimental period, air mean temperature increased from Spring ($T_{mean} = 14.3^{\circ}\text{C}$) to Summer ($T_{mean} = 21.4^{\circ}\text{C}$), and gradually decreased afterwards. Rainfall decreased notably from spring (April-June = 130 mm) to summer (July-August total = 22 mm) and increased only in late autumn (November = 204 mm)

The patterns of herbage on offer (HO, t DM ha^{-1}) and sward height (SWH, cm) are consistent with herbage growth trend in Mediterranean natural pasture, that is, also, clearly reflected by the pasture quality (Table 1). HO resulted very low, also in spring. The quality on offer resulted

good, with high CP due to the high incidence of legume species in HO (data not shown). HO had an upward trend in quality and quantity only in late November, as consequence of late autumn rain, nevertheless it remained still very low. Overall the pasture under study is characterized, in particular in spring, by an amount of HO lower than those measured by other authors. In Mediterranean mountain conditions Acciario *et al.* (2011) found HO = 4.9 and 3.6 t DM ha⁻¹ in April and June, respectively and, in the same site, Sitzia and Fois (2008) found HO = 2.3 and 1.7 t DM ha⁻¹ during two spring seasons characterized by very different amount of rainfall (160 mm vs 60 mm, respectively).

Table 1. Pasture sward height (SWH, cm), herbage on offer (HO, t DM ha⁻¹) and its nutrient content (% DM) during the trial (Lsmeans ±SE)

	April	May	June	July	September	October	November
SWH	6.3±0.32d	9.6±0.52 b	11.0±0.55 a	7.8±0.62c	2.5±0.21e	1.3±0.13 f	2.8±0.10 e
HO	0.93±0.09 bc	1.11±0.09 b	1.4±0.09 a	0.88±0.06 c	0.29±0.05 d	0.07±0.02 e	0.29±0.03 d
DM	21.8±0.94e	22.8±0.63e	33.4±1.6d	65.0±2.57b	70.9±1.85a	50.9±6.40c	24.8±1.39e
CP	16.9±0.76a	14.0±0.34b	9.9±0.39c	6.0±0.29de	4.3±0.57f	4.6±0.73ef	7.2±0.82d
NDF	41.0±1.40d	48.6±0.93c	58.9±1.28b	63.5±0.33ab	68.6±2.73a	66.6±4.03ab	58.2±3.50b
ADF	23.0±1.09e	27.8±0.52d	35.5±0.54c	40.9±1.05b	46.5±1.24a	46.4±1.89a	40.7±2.49b
ADL	4.4±0.52e	4.8±0.23e	6.8±0.46d	8.7±0.61c	10.7±0.66b	12.5±0.51ab	13.3±1.19a

Values in the same row with different letters differ significantly ($P<0.001$).

Average calf live weight increased from 168.5±5.26 in April to 193.1±4.97 kg per head in July. In September and October the animals lost weight (LW=178.5±4.45 in October). In November S and F1 (LW=198.4 and 200.4 kg respectively, $P>0.05$) recovered their weight faster than Sc (169.4 kg; $P<0.05$) being SM (180.5 kg) an intermediate (Fig. 1).

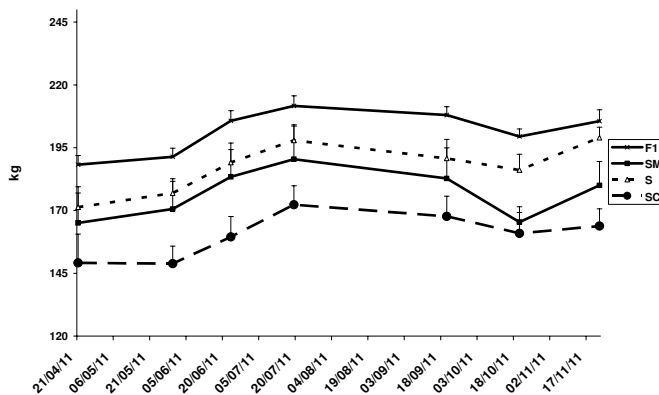


Fig. 1. Calf live weight pattern (kg LW) during the experimental period (Lsmeans ±SE).

Calf growing rate (CGR, kg head⁻¹day⁻¹) was strongly affected by herbage availability and quality (Fig. 2). During late spring, with an herbage allowance per day of 1.7 kg DM head⁻¹, the highest growing rate have been recorded: 0.530±0.06 and 0.330±0.06 kg head⁻¹day⁻¹ (LSmeans±SE) in June and July, respectively, ($P<0.05$). This is confirmed by Acciario *et al.*

(2011) that found a higher growth rate ($0.78 \pm 0.06 \text{ kg day}^{-1}$) in Sarda calves raised at pasture when herbage availability was 4.7 t DM ha^{-1} .

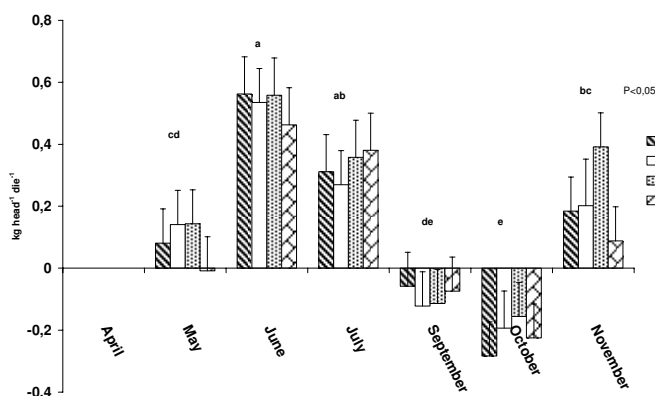


Fig. 2. Calf growing rate ($\text{kg head}^{-1} \text{ day}^{-1}$) during the experimental period (Lsmeans \pm SE). Different letters above the bars show significant difference between data.

After July HO drastically decreased and calves tended to lost weight until a supplementation was offered. No significant difference was found on CGR between the breeds studied.

IV – Conclusions

The studied system showed a shortness of feed during summer and beginning of autumn, because of the delay of autumn rain, confirming the strong relationship between animal performance and seasonal meteorological pattern in Mediterranean conditions. The important lost of weight recorded during the summer in all tested breed demonstrated that the feed production in marginal areas could be insufficient to assure an economical return in cattle meat farming system when based completely on grazing forage. More studies need to identify and quantify other services provided to the ecosystem in order to consider the beef cattle farming system not only as an exclusively economic activity.

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