Production and grazing utilization of Medicago arborea by Sarda ewes and their performance in an extensive grazing system

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Production and grazing utilization of *Medicago arborea* by Sarda ewes and their performance in an extensive grazing system

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Abstract. A crop of 1000 seedlings (25-30 cm in height) of the shrub *Medicago arborea* was established in spring 2017 in the experimental farm of Bonassai (N-W Sardinia, Italy) to study its forage production and nutritive value in Sarda sheep grazing system. Plants were transplanted at 1 m from each other in rows 4 m apart (2500 plant ha^{-1}). In 2018, plant height and diameter were measured, monthly. In July 2018 and in January 2019 (grazing periods) a plot (3500 m^2) of *M. arborea* was grazed by 24 mature Sarda dairy ewes for 14 days. Before the beginning and after the end of each grazing period, the available edible biomass (dry matter) and its nutritive value were evaluated. All ewes were supplemented with concentrate and hay. Animal performance was assessed three times during each grazing period, at the beginning (Beg), the middle (Mid) and the end (End). Available edible biomass was 604 ±40 and 526 ±26 kg ha^{-1} in July and January, respectively. Crude protein content was always greater than 150 g kg^{-1} DM. In both grazing periods, the ewes ingested more than 80% of the available crop edible biomass. The body weight and body condition score of ewes did not change between Beg and End of grazing. Daily milk production decreased at the end of the grazing period due to a reduced dry matter availability. Milk fat, protein, and casein did not significantly change between Beg and End of grazing. To conclude, *M.arborea* could contribute to cover dairy sheep requirements during periods of herbage shortage.

Keywords. *Medicago arborea* – Dairy ewes – Grazing system – Edible biomass.

Production de* Medicago arborea *et utilisation par des brebis Sarde au pâturage

***Résumé**. Une plantation de 1000 plants (de 25 à 30 cm de hauteur) de l'arbuste* Medicago arborea *a été établie au printemps 2017 dans la ferme expérimentale de Bonassai (nord-ouest de la Sardaigne, Italie) pour étudier sa production fourragère et sa valeur nutritive dans le système de pâturage extensif de la brebis de race Sarde. Les plants ont été transplantés à 1 m les uns des autres, en rangs espacés de 4 m (2500 plantes ha^{-1}). En 2018, la hauteur et le diamètre des plants ont été mesurés tous les mois. En juillet 2018 et en janvier 2019 (saisons de pâturage), une parcelle (3500 m^2) de M. arborea a été pâturée pendant quatorze jours par vingt-quatre brebis laitières Sardes. Avant le début et après la fin de chaque saison de pâturage, la biomasse consommable (matière sèche) et sa valeur nutritive ont été évaluées. Toutes les brebis ont été supplémentées avec du concentré et du foin. Les performances des animaux et le comportement alimentaire au pâturage ont été évalués à trois reprises au cours de chaque saison de pâturage : au début, au milieu et à la fin. En juillet et en janvier, la biomasse consommable était de 604 ± 40 et 526 ± 26 kg ha^{-1} de MS, respectivement. La teneur en protéines était toujours supérieure à 150 g kg^{-1} de MS. Les brebis ont ingéré plus de 80% de la biomasse consommable. On n'a pas enregistré de variation de poids vif ou de note d'état corporel des brebis au cours de la période de pâturage. La production du lait journalière a été réduite à la fin de la période de pâturage en raison d'une moindre quantité de matière sèche disponible. Les taux protéique et butyreux ainsi que la caséine du lait n'ont pas changé de manière significative pendant la période de pâturage. Cette étude suggère que M. arborea peut contribuer à couvrir les besoins énergétiques des animaux en période de carence en herbe.*

***Mots-clés.** Medicago arborea – Ovins laitiers – Système de pâturage – Biomasse consommable.*

I – Introduction

Climate change indicators (i.e. droughts, floods, soil erosion) suggest the adoption of farming systems adapted to the expected climatic conditions (Altieri and Nicholls, 2013). Soil conservation practices, use of perennial native plant species and low inputs crops are indicated as putative strategies to face variable environmental conditions (Wall and Smit, 2005). In this context, woody species such as drought resistant forage shrubs could have an important role in Mediterranean livestock systems (Papanastasis *et al*., 2008). Tree medic (*Medicago arborea* L.) is a leguminous shrub native to the Mediterranean region, drought and cold resistant. Its growing season last from autumn until late spring with a growth stasis in summer, depending on rainfall distribution (Amato *et al.,* 2004, Papanastasis *et al.,* 2008, de Koning *et al.,* 2000). *M. arborea* has high nutritive value and palatability and can complement biomass production of natural pasture which is usually low from late spring up to early autumn and in winter. Dry matter (DM), production ranges from 1 to 3 t y^{-1} depending on environmental conditions (Amato *et al.,* 2004). Moreover *M. arborea* has shown to reduce soil erosion in endangered marginal areas (Andreu *et al.,* 1998). If properly managed, *M. arborea* could become an interesting forage resource for farms, by saving annual soil tillage and avoiding the cultivation of forage crops. Its lifespan, which depends on adaptation to environmental conditions and genetic resistance to plant disease, could be at least 10 years. This study aims to evaluate *M. arborea* crop forage production and its nutritive value under Sardinia climatic conditions, with a management consisting in an intensive grazing by sheep twice a year, in winter and early summer. Grazing periods and management were chosen with the aim to tackle the shortage of herbaceous pasture that occurs in Mediterranean environment, meanwhile keeping shrub plant growth under control by grazing (Stringi *et al.,* 1997, Amato *et al.,* 2004). Moreover, the study aims to assess animal performance response during the two grazing periods.

II – Materials and methods

The experiment was carried out at the *Bonassai* research station (NW Sardinia, Italy, 40°39'46''N, 8°21'46''E, 33 m.a.s.l) from spring 2017 to early winter 2019 on a clay loam alkaline soil (pH 8.2) with a high content of active lime (109.6 g kg^{-1}) and exchangeable K (335 mg kg^{-1}), an average content of total N (1.69 g kg^{-1}) and a low assimilable P (10.4 mg kg^{-1}). The average long term annual rainfall, minimum and maximum temperature are 583 mm, 9.8°C and 21.7°C, respectively (source ARPAS http://www.sar.sardegna.it/).

In spring 2017 a crop of 1000 seedlings (25-30 cm in height) of *M. arborea* was established in a tilled and fertilized field (92 kg ha^{-1} P_2O_5). Plants were hand-transplanted at 1 m from each other in rows 4 m apart (2500 plant ha^{-1}). A mulching film was placed on the plant rows to prevent weed growth. From January to December 2018, plant height and diameters (in row direction and perpendicularly) were measured, monthly.

In July 2018 and in January 2019 (grazing periods) a plot (3500 m^2) of *M. arborea* was grazed by twenty-four mature *Sarda* dairy ewes (stocking rate 10 LU ha^{-1}) for 14 days and 6 hours per day. Grazing periods started when the edible biomass available was deemed adequate to feed the sheep for an estimated grazing time of at least 14 days. This period of time has been considered a prerequisite to assess animal response. Sheep were selected for similar body weight (BW), body condition score (BCS) and, if milked, milk production. The experimental animals were 4-5 years old lactating (milked) ewes in January and dry ewes in July. All ewes were supplemented according to the typical feeding management of *Sarda* ewes: in July with 500 g $head^{-1}day^{-1}$ of Italian ryegrass hay and 100 g $head^{-1}day^{-1}$ of concentrate, and in January with 700 g $head^{-1}day^{-1}$ of alfalfa hay and 500 g $head^{-1}day^{-1}$ of concentrate.

Before grazing, herbage biomass between rows was removed by cutting at low height to minimize herbaceous pasture availability. At the beginning (Beg), in the middle (Mid) and at the end (End)

of each grazing period (grazing time) animal response in terms of milk yield and composition, body weight (BW) and body condition score (BCS) were assessed. Before and after each grazing period, in 15 plants randomly chosen inside the experimental area, the available edible biomass (DM kg ha^{-1}) was evaluated by hand plucking of all leaves, flowers, pods and twigs (<3mm of diameter). Samples were oven-dried at 65°C to determinate the content of crude protein (CP), neutral detergent fibre (NDF), and *in vitro* DM digestibility (IVDMD) by near-infrared reflectance spectrometry (NIRS). Animal data were analysed using a GLM model of SAS (SAS Institute, 2002), with grazing time within each grazing period as fixed effect, and Tukey-Kramer *t*-test to separate means.

III – Results and discussion

2017 and 2018 were both characterized by maximum annual temperatures higher than long term values (22.6°C and 22.1°C, respectively) associated with low rainfall in 2017 (368.4 mm) and high rainfall in 2018 (833.8 mm). In 2018 plant height ranged between 36.5±0.4 and 80.4±0.6 cm, and plant diameter between 27.9±0.6 and 71.1±0.8 cm. In July 2018, after grazing, plant height and diameter decreased by 9.2 and 19.5 cm, respectively. Edible biomass available was 604 ±40 kg ha^{-1} and 526 ±26 kg ha^{-1} in July 2018 and January 2019, respectively (Table 1). In January, the forage nutritive value was slightly higher than in July, with higher CP and IVDMD contents and lower NDF and ADF contents. Sheep ingested over 80% of the available edible biomass in July (494 ±35 g $head^{-1}$.day) and over 90% in January (528 ±26 g $head^{-1}$.day). Thus, after grazing the standing biomass was 103 ±8 and 29 ±2 kg ha^{-1} in July and January, respectively. These results are comparable with that found by Stringi *et al.* (1997) in Sicily where a tree medic crop was grazed by a similar stocking rate of *Comisana* sheep in January and June.

Table 1. Tree medic edible biomass, at the beginning of grazing in July and January (mean ±SE)

Season	Edible DM (kg ha^{-1})	CP (g kg^{-1})	NDF (g kg^{-1})	ADF (g kg^{-1})	IVDMD (g kg^{-1})
July 2018	604 ± 40	161 ± 2	418 ± 3	312 ± 3	669 ± 3
January 2019	526 ± 26	199 ± 3	348 ± 4	252 ± 3	728 ± 4

Table 2. Body weight (BW, kg) and body conditions score (BCS) of ewes in July 2018 and January 2019 (mean ±SE)

Grazing Time	July 2018		January 2019	
	BW	BCS	BW	BCS
Beg	47.02 ± 1.14	2.64 ± 0.06	43.62 ± 2.49	2.49 ± 0.05
Mid	44.55 ± 1.21	2.58 ± 0.05	43.43 ± 0.70	2.54 ± 0.04
End	46.85 ± 1.36	2.62 ± 0.05	44.10 ± 0.70	2.44 ± 0.05

Body weight and BCS did not change between Beg and End of grazing in July and January (Table 2). This result shows the ability of M. arborea to keep sheep in similar body conditions than when they are managed in the traditional forage system. In January, daily milk yield decreased from Mid to End of the grazing period (2130 ±75.81 and 1850 ± 73.38 g $head^{-1}d^{-1}$, respectively, $P<0.05$), likely due to a reduced availability of edible biomass at the end of the grazing period (Fig. 1). Salis *et al*. (2018) observed an increased milk yield in *Sarda* ewes grazing *Tagasaste* forage shrub, with edible biomass higher than 500 kg ha^{-1}. In this context when shrub edible biomass is strongly reduced, animals could be moved to others pasture, or should be fed supplements. Milk fat, protein and casein did not significantly change from Beg to End whereas some differences were detected in the first part of grazing period (from Beg to Mid). Milk protein significantly increased (4.79 ± 0.07 *vs*

5.03 ± 0.07 %, P<0.05) whereas casein decreased (3.66 ±0.06 vs 2.89 ±0.05 %, P<0.01). Moreover, milk urea increased in Mid (58.14 mg/100mL^{-1}) and End (52.05 mg/100mL^{-1}) of grazing as compared to Beg (38.85 mg/100mL^{-1}, P<0.01).

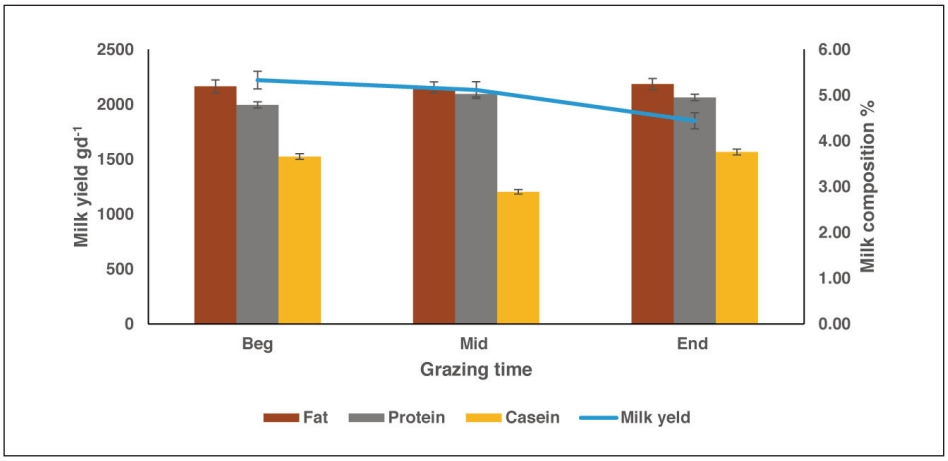

Fig. 1. Sheep milk yield (g head^{-1}d^{-1}) and its chemical composition (%, g 100mL^{-1}) in January.

IV – Conclusions

Medicago arborea proved tolerant to alkaline soil with high content of active lime. The plants grazed twice a year were able to tolerate (in the 2 experimental years) a high stocking rate that limited plant size. They showed a good re-growth after grazing and offered more than 1000 kg DM ha^{-1} of edible biomass per year, covering the energetic requirement of animals during periods characterized by herbage shortage. The high protein content (always > 150 g kg DM^{-1}) and IVDMD of *Medicago arborea* highlight the quality of this forage that allowed high milk yield and milk quality, without relevant changes of BW and BCS. *Medicago arborea* crop could be integrated among the forage resources in rainfed Mediterranean sheep systems, despite its low growth and low weed competition in the first year after establishment. Further research is needed to check if intercropping forage species between shrub rows could improve productivity and economical sustainability of *M. arborea* crop-system.

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