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Evaluation of a Southern Mediterranean forage farming system

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Abstract. The research carried out in the pastures of the Nebrodi Mountains (Sicily, Southern Italy) shows high variability of climate and vegetation in relation to altitude. Agricultural improvement practices and grazing management are occasional. There are also areas of high yield as well as highly degraded areas due to soil erosion and over-grazing. Stabilizing seasonal forage yield even in difficult years is one of the most significant problems related to pasturage in this area. So a biennial research project (2006 and 2008) was carried out in a representative farm to evaluate daily growth cycle, seasonal yield, fodder value and forage quality of a natural pasture, an improved pasture, an under tree pasture and a meadow, to estimate forage system efficiency. The results show that yield was related to the amount of spring rainfall and phosphate fertilizers; the meadow did not modify forage quality, quantity or seasonal availability.

Keywords. Mediterranean environment – Nebrodi Mountains – Forage farming system.

Evaluation des systèmes fourragères dans l'environnement méditerranéen

Les recherches menées dans les monts Nebrodi (côte nord-est de la Sicile) ont montré une grande variabilité du climat et des éléments de la végétation en fonction de l'altitude. Les techniques d'amélioration ainsi que d'exploitation des pâturages sont occasionnelles. La stabilisation du rendement saisonnier de fourrage, même dans les années difficiles, est un des problèmes les plus importants pour les pâturages de cette zone. Dans ce but une recherche biennale (entre 2006 et 2008) a été menée dans des fermes représentatives, afin de comparer l'efficacité de quatre systèmes fourragèrs : pâturage naturel, pâturage amélioré, pâturage boisé et prairie. La courbe de production quotidienne, le rendement saisonnier, la composition floristique, la valeur nutritionnelle ainsi que la qualité du fourrage ont été évalués. Les résultats indiquent que la production a fluctué en fonction des pluies printanières et de la fumure phosphatique ; l'introduction de la prairie artificielle n'a pas amélioré la disponibilité de fourrage, au point de vue quantitatif, qualitatifs ainsi que temporelle.

Mots-clés. *Environnement méditerranéen – Monts Nebrodi – Systèmes fourragèrs.*

I – Introduction

The pasture lands of the Park of Nebrodi Mountains, are the most extensive in Sicily, at an altitude ranging from 700 to 1500 m a.s.l. (Copani *et al.*, 2008). The main problem of forage production in these areas is not only its scarcity but its marked seasonality. The ongoing modifications to livestock farms in this area (abandonment of transhumance, reduction in the number of animals bred, improvements in dairy products) require higher stability and equilibrium of pasturage. To evaluate whether pasture quality could be improved, during two years (2006 and 2008), the forage system of a typical farm in this area and the effects of some agronomic practices were studied.

II – Materials and methods

The study was carried out between 2006 and 2008 in a representative forage-livestock farm in the Nebrodi Park (S. Teodoro, Sicily, Italy): latitude 37°49'35'' N and longitude 14°41'18'' E,

altitudes between 800 m a.s.l. (low pasture) and 1000 m a.s.l. (high pasture), with an average slope between 15%-20% and a Typic Xerorthents soil (USDA). The farm pastures cover 92 hectares (Table 1) grazed by 350 sheep (0.6 LU ha^{-1}). In autumn 2005, low and high pasture were fertilized with 150 units of P_2O_5 as mineral perphosphate. In autumn 2006, an artificial meadow was introduced: 38 hectares of natural pasture was surface tilled, fertilised with phosphorus (100 units of P_2O_5) and sown with a mixture of forage crops: sulla sweet-vetch (*Hedysarum coronarium* L.) (40%), clovers (*Trifolium pratense* L., *Trifolium alexandrinum* L.) (20%), Italian ryegrass (*Lolium multiflorum* Lam.) (20%) and alfalfa (*Medicago sativa* L.) (20%).

Table 1. Forage resources (ha) in the studied farming system

Year	Forage resources (ha)			
	Low pasture 894 m a.s.l.	**High pasture 951 m a.s.l.**	**Meadow 942 m a.s.l.**	**Under tree pasture 1000 m a.s.l.**
2006	10	40	0	42
2008	0	12	38	42

All the pastures were evaluated according to the simulated grazing of Corrall and Fenlon (1978), with plots of 6 m^2. At each cutting the following data were recorded: fresh and dry production, the contribution of the main botanical families (Poaceae, Legumes, others); on a sample of forage the crude protein content (Kjeldhal method, AOAC) and fibre content (Van Soest *et al*.,1991) as acid detergent fibre (ADF) and neutral detergent fibre (NDF) were analysed. The animal feed balance was calculated from the availability of fodder resources and livestock needs (Cassaniti *et al.*, 2002). The daily requirement of 1 LU was considered equal to 18 kg DM for animals in lactation and 13.5 kg DM for animals not in lactation (Bittante *et al.*, 1997). The graphical representation of the feed system was made according to Pardini and Rossini (1997).

III – Results and discussion

During 2006 rainfall was 640 mm and the mean temperature was 14.2℃. In 2008, total rainfall of 669 mm and a mean temperature of 14.5℃ were recorded (Fig. 1). The rainfall was lower than the multi-annual average (Climatologic Atlas of Sicily, SIAS). In 2008, the scarce spring rainfall (April and May) strongly affected the yield.

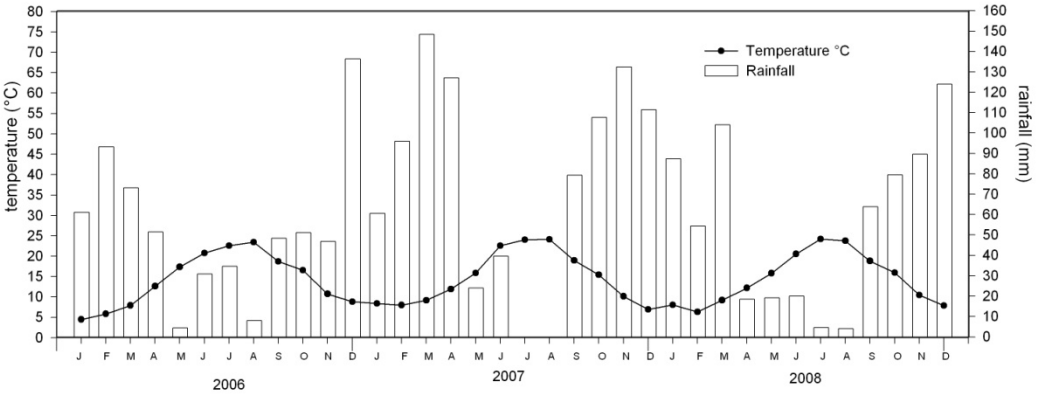

Fig. 1. Temperature and rainfall trend (monthly values) at the Vignazza station (820 m a.s.l.) during the trial.

Production varied between a minimum of 1.93 t ha^{-1} dry matter yield (DMY) in 2008 and a maximum of 4.88 t ha^{-1} DMY in 2006 (Table 2). The DMY of 2006 was 2.02 t ha^{-1} DMY (low pasture), 4.88 t ha^{-1} DM (high pasture) and 2.37 t ha^{-1} DM (under-tree pasture). In 2008 the pasture yield was 2.59 t ha^{-1} DMY, lower, therefore, by almost 40% than 2006 caused by scarce spring rainfall. The yield of under-tree pasture was equal to 1.93 t ha^{-1} DM. The meadow DMY (2.21 t ha^{-1}) was not very different to that of natural pasture. Phosphoric fertilization improved yield from 14% (high pasture, with mostly Poaceae species) to 35% (low pasture, with mostly legumes) (Table 2).

Table 2. Biomass yield (t ha^{-1}) of different farming resources (2006-2008) and biomass yield of fertilized pasture. In 2006 for each row different letter are significantly for $P \leq 0.05$

Year	Altitude	Forage resources	Biomass yield (t ha^{-1})	
2006	894	Pasture low	2.02b	3.11a†
	951	Pasture high	4.88a	5.65a†
	969	Under tree pasture	2.37	
		Weighted average	*3.42*	
2008				
	951	Pasture high	2.59	
	1000	Under tree pasture	1.93	
	942	Meadow	2.21	
		Weighted average	*2.13*	
2006/2008		*Average*	*2.78*	

†Fertilized pasture.

According to the Corrall and Fenlon growth curve, the production season had a duration of almost 60 days in both years: from April to mid-June in 2006, fifteen days earlier in 2008.

In the first year, the daily growth rate was 141.6 kg ha^{-1} d^{-1} in the 'high' pasture, while the lowest, 50.5 kg ha^{-1} d^{-1} was for the under-tree pasture.

In the 'high' site the contribution of species of the Poaceae family was of almost 80% and around 30 in the 'low' site in 2006. In the 'high' pasture the legume species in both years did not overpass the 5%, whereas in the 'low' site they were 45% (2006). The phosphoric fertilization has slightly increased the presence of legume species in the 'low' site (until 55%), but did not modified the floristic composition of the 'high' site where the legume crops were almost totally absent. The mixed meadow has shown a good balance and stability among the two big families, as it was conceived at the moment of the mixture preparation: between 50 and 60% of Poaceae, between 25 and 40% of the legumes species. The pasture under the trees have shown a floristic composition with legume crops close to 5% and Poaceae ranging between 20% and 60%. In this situation the 'other palatable species' are prevailing (between 45% and 80%). The remarkable presence of other species then Poaceae and legumes in this site could be ascribed to the nature of the soil, rich of skeleton and with limited depth. As far as the quality aspect is concerned, the crude protein decreased in both years from 9.1% to 5.3% in 'high' pasture and from 15.1% to 9.3% in 'low' pasture in 2006, whereas in 2008 the values ranged from 11.7% to 8.4% in 'low' pasture and from 13.1% and 8.1% in 'high' pasture.

Phosphoric fertilization did not modify crude protein content in the 'high' pasture (constituted mainly of grass species), while in the 'low' pasture it increased by one percent (16.5%). The under-tree pasture showed crude protein values ranging from 12.1% to 9.4%. The mixed meadow values were very close to these, even slightly higher (between 13.6% and 9.3%). At the same time as the reduction in crude protein, there was an increase in the NDF and ADF fraction of the fiber, especially at the 'high' site, the richest in Poaceae species (Fig. 2).

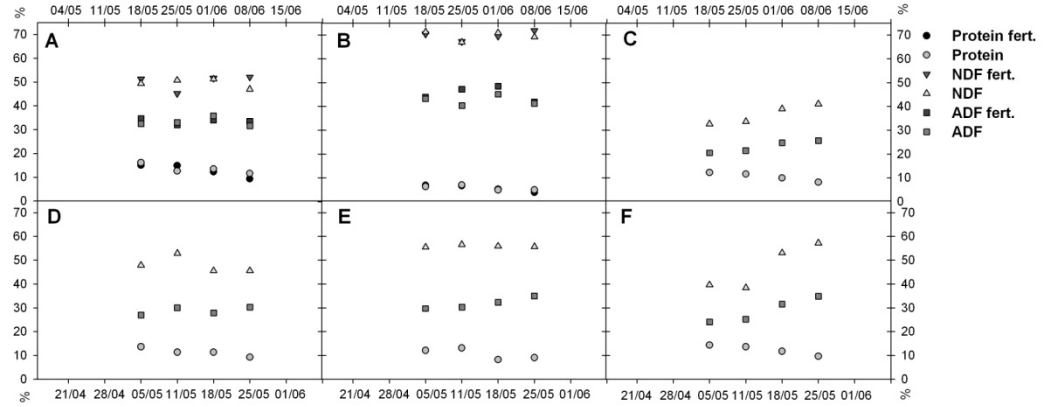

Fig. 2. Variation of protein content (%) and fiber content (ADF and NDF) in 2006 (above) for low fertilized and unfertilized pasture (A), high fertilized and unfertilized pasture (B), under-tree pasture (C) and in 2008 (below) for meadow (D), high pasture (E), under-tree pasture.

The self-sufficiency rate of the system was 88% in 2006 and 73% in 2008, the difference being linked to the different yields (Fig. 3). The yield of the mixed meadow was very close to that of the natural pasture; this may be explained by the environmental conditions (soil and climate) driving the ecological equilibrium of the agro-ecosystem. The feed deficit was therefore equal to 5 t yr^{-1} of dry matter in 2006 and 10.5 t yr^{-1} of dry matter in 2008.

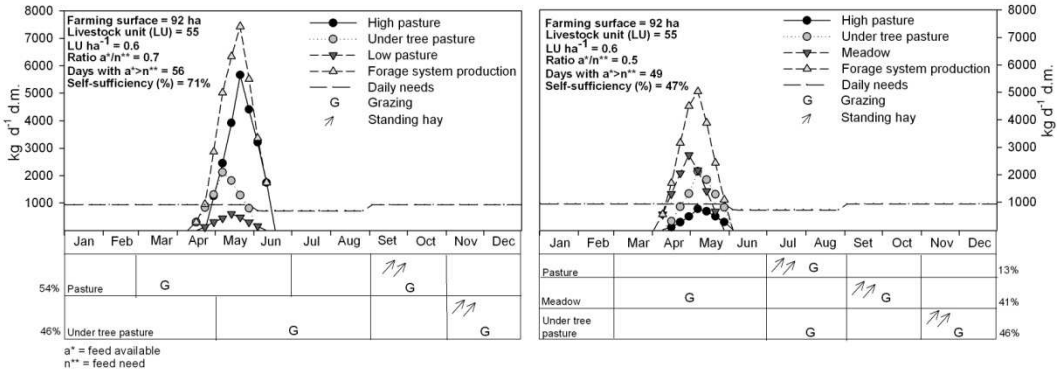

Fig. 3. Forage system and single resources daily growth curves, daily needs curve and time of resources utilization in 2006 (left) and 2008 (right).

IV – Conclusions

The forage system generally shows a good balance because its level of feed deficit, thanks to the low animal stocking rate, is lower than the average of the farms in the area (between the 40% and 60%). The interannual deficit appears to be linked especially to rainfall which remains a strong instability factor. Phosphoric fertilization was able to fill the deficit gap especially when there are a lot of legume species. The choice of the farmer to introduce a meadow did not increase the yield but increased its quality.

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