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Biomass production and use of silvopastoral areas in the Rif Mountains of Morocco

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Abstract. In Northern Morocco, the forest rangelands provide goods and services, which satisfy the diverse needs of local population. These silvopastoral areas represent the most important feed sources for goats in the Rif Mountain. This study aims to evaluate the biomass production and investigate the use of a silvopastoral area (Derdara) exclusively used by goatherds. For biomass production, we used the method of the reference module. A survey on using pasture by breeders was realized during the biomass evaluation period. The pastoral shrubs, mainly *Arbutus unedo, Cistus crispus, Cistus monspeliensis, Erica arborea, Lavandula stoeches* and *Mentha pulegium,* represent the fundamental diet for goats. Breeders use pasture throughout the year, except on rainy days where they resort to limbing. The pasture was characterized by a diversity average level of pastoral flora (94 species) dominated by shrubs. The biomass produced was estimated at 1867 kg dry matter per hectare composed for 74% by shrubs. Significant differences were observed concerning the intensity of the canopy cover, depending on the season and according to sampling sites. The continuous use of the same pasture for a long time, can explain the appearance of low pastoral value species in the study area, such as *Arisarum vulgare*, *Daphne gnidium* and *Ranunculus sardous*. The reasonable use of silvopastoral resources, including a reduction in grazing pressure, should be developed to ensure better productivity and sustainability of these resources.

Keywords. Pasture – Goat – Derdara – Sustainability.

La production de biomasse et l'utilisation des zones sylvopastorales dans les montagnes du Rif du Maroc

Résumé. *Au nord du Maroc, les pâturages forestiers fournissent des biens et services, qui répondent aux divers besoins de la population locale. Ces zones sylvopastorales représentent la principale source d'alimentation pour les caprins dans les montagnes du Rif. Cette étude vise à évaluer la production en biomasse et à étudier le mode d'utilisation d'une zone sylvopastorale (Derdara) exclusivement utilisée par les caprins. Pour la production en biomasse, nous avons utilisé la méthode du module de référence. L'enquête avec les éleveurs sur le mode d'utilisation des pâturages a été réalisée pendant la période d'évaluation de la biomasse. Les arbustes pastoraux, principalement* Arbutus unedo*,* Cistus crispus*,* Cistus monspeliensis*,* Erica arborea*,* Lavandula stoeches *and* Mentha pulegium*, constituent les principaux aliments consommés par les caprins. Les éleveurs utilisent pâturage toute l'année, sauf pendant les jours pluvieux où ils ont recours à l'ébranchage. Le pâturage est caractérisé par un niveau moyen de diversité de la flore pastorales (94 espèces) dominées par des arbustes. La biomasse produite a été estimé à 1 867 kg de matière sèche par hectare composé à 74% d'arbuste. Des différences significatives ont été observées selon la saison et selon les sites d'échantillonnage concernant l'intensité du couvert forestier. L'utilisation continue du même pâturage pendant une longue période, peut expliquer l'apparition d'espèces de faible valeur pastorale, dans la zone d'étude, tels que* Arisarum vulgare*,* Daphne gnidium *et* Ranunculus sardous*. L'utilisation raisonnable des ressources sylvopastoraux, y compris une réduction de la pression de pâturage, devrait être développé pour assurer une meilleure productivité et la durabilité de ces ressources.*

Mots-clés. *Pâturage – Caprin – Derdara – Durabilité.*

I – Introduction

Silvopastoral areas in the Mediterranean basin are dynamic social-ecological systems with a high diversity of management and ecological conditions (Pinto-Correia, 2000). Silvopastoral systems are characterized by integrating trees with forage and livestock production, and pastures that can be natural, improved or cultivated (Castro *et al*., 2010). In Northern Morocco, traditional forest and silvopastoral management practices are still prevalent. These forest rangelands provide goods and services, which satisfy the diverse needs of local population, and represent the most important feed sources for goats in the Rif Mountain. Silvopastoral area is under pressure due to climate change, overgrazing, population and especially bad operating practices of silvopastoral resources such as limbing (Chebli *et al*., 2012). For a sustainable and integrated development of silvopastoral area, it is essential to establish a resource assessment system.

We conducted this study in a silvopastoral area of the Moroccan Rif Mountains (Derdara) exclusively used by goat's herds to assess botanical composition and biomass production, and investigate the use of this silvopastoral area.

II – Materials and methods

The study was conducted in Derdara, a part of the Chefchaouen district, located in the Northern Morocco. The pasture concerned in our study is located at 35° 28' N 5° 18' W and from 1195 to 1250 m above sea level. The climate is Mediterranean, with mean min and max temperatures of 3°C and 41°C respectively, while the total annual precipitation is 500 mm.

The area of study is forest rangelands exploited by goat breeders. The study was investigated over a period of eight months to assess the species composition and the productivity of pastoral plants by evaluating the vegetation qualitatively and quantitatively.

The qualitative evaluation of vegetation concerned the floristic diversity. In each sampling period, a herbarium was collected to determine the floristic composition.

For quantitative evaluation, biomass production has mainly concerned the palatable species. Measurements were performed during three seasons (Winter, Spring and Summer 2015). Plant biomass was measured using the non-destructive method known as the reference module. In order to control spatial heterogeneity, we used the stratification method as proposed by Qarro (1996), Kouraimi (1997), Chebli *et al*. (2012 and 2014). According to the density of cork oak, four homogenous sites were identified. In each site we identified the number of quadrats needed to control heterogeneity of silvopastoral area (6 quadrats/site). The size of the quadrats adopted for measurement of biomass is 2m x 5m for shrubs strata and 1m x 1m for herbaceous strata.

Several surveys were conducted with breeders during the study period to gather information on modalities of using pastures.

III – Results and discussion

Derdara pasture is characterized by a relatively rugged topography. Soil is poor and strongly susceptible to erosion. Vegetation structure is mainly shrub-dominated.

1. Botanical composition

In Derdara, pasture was characterized by an average level of diversity of pastoral flora (94 species) dominated by shrubs (Table 1). Pastoral species that dominate Derdara pasture and who constitute over 50% of the forage species selected by goats are represented in Table 1. These last year's breed-

ers noticed abundance of unpalatable species in degraded areas (Site 3 and 4) dominated by annual unpalatable plant species such as *Arisarum vulgare* (Targioni-Tozzetti) and *Coriaria myrtifolia* L. This situation can be explained mainly by misuse of some part of rangeland (Site 3 and 4), causing overexploitation of pastoral resources and contributes to appearance of low palatability species.

Table 1. Principal botanical composition of palatable and unpalatable flora in Derdara pasture

Plant	Site 1	Site 2	Site 3	Site 4
Palatable species				
Arbutus unedo	+++	+++	++	+
Cistus crispus	++	+++	+	+
Cistus monspeliensis	++	+++	+	+
Erica arborea	+++	++	+	+
Quercus suber	+++	++	+	–
Lavandula stoechas	+	++	+	+
Myrtus communis	+	+		
Pistacia lentiscus	++	+++	+	–
Unpalatable species				
Anagallis arvensis	–	–	++	++
Arisarum vulgare	–	–	+	++
Coriaria myrtifolia	–	–	+	+
Daphne gnidium	–	–	–	++
Ranunculus sardous	–	–	+	+

+ + + Species very abundant.
+ + Moderately abundant species.
+ Weakly abundant species.
– Absent.

2. Biomass production

Derdara pasture (Sites 1 and 2) is characterized by dense vegetation mainly dominated by shrub strata. The pastoral feed offer is very high compared to Site 3 and Site 4 (Table 2). The difference in pastoral production, depending on the season and according to sampling sites, is statistically highly significant (P <0.001). The higher pastoral production is estimated in Site 1 (3607 kg DM per hectare). The other sites are considered as permanent pasture sites, mainly Sites 3 and 4. This difference can be explained in part by continuous use of pastoral resources and lack of appropriate pasture management. For season, the higher production is observed in the spring (2465 kg DM per hectare), which coincides with the growth phase of most species groups (vegetative peak).

Table 2. Effect of sampling site and season on biomass production in Derdara pasture

	Site (Si)								Signification		
	1	2	3	4	Mean	SEM1	SEM2	SEM3	Si	Season	Si*Season
Winter	2149	1096	928	554	1182^{c}	38.13	33.10	66.04	<.0001	<.0001	<.0001
Spring	4779	2404	1785	893	2465^{a}						
Summer	3894	1837	1362	726	1955^{b}						
Mean	3607^{d}	1779^{a}	1358^{b}	724^{c}							

SEM1: Standard error of the mean for comparison between sites.
SEM2: Standard error of the mean for comparison between seasons.
SEM3: Standard error of the mean for comparison between site*season.
a-c Different letters in the same line or same column indicate that values are significantly different (p<0.05).

3. The use of silvopastoral resources

Goat herds are driven mostly by breeders themselves. Grazing is practiced throughout the year from mid-winter to mid-autumn. During this time of the year, pastures are in restoration phase of their groundcover with maximum forage production during the months of April and May. Goats spend most of the day on silvopastoral areas (7-8 hours per day). During rainy periods, intensity of pasture use decreases, with a reduced frequency during winter (2-3 hours per day) as access to the pastures become difficult, which explains the use of delimbing by breeders to reduce burdens of supplementation.

The herd movements in silvopastoral areas are anarchic. Goats concentration for long time on the same pasture causes overgrazing and therefore the appearance of unpalatable species and disappearance of palatable species. Goats travel itinerary are based on access and availability of forage. The average distance traveled by goats was estimated to eight km per day.

IV – Conclusions

Silvopastoral areas in Derdara remain a large area for forest grazing. Biomass production varies greatly from one site to another. The anarchic use of silvopastoral resources contribute to appearance of overgrazed pastures and of unpalatable plant species.

The silvopastoral resources on these areas, despite all forms of degradation, continues to play an important role for all agricultural activities of the local population, representing a fundamental source of feed for livestock. A lack of actions for the development of these resources could prevent the animal and people needs to be met.

The pressure on the silvopastoral resources in the mountain Rif could lead to their irreversible degradation. Consequently, it will be necessary to adopt a rational use of rangelands, on a seasonal schedule and / or depending on the state of resources, convincing breeders to work together for pasture use.

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