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Goat production systems in north Moroccan woodlands: forage production and use of silvopastoral resources

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Abstract. In northern Morocco, goats feed partly or totally in the woodlands. These forest rangelands currently undergo a huge pressure, related to climate changes and anthropic pressure. This study aimed to evaluate the pastoral potential of these woodlands and to investigate their use. We selected two forest rangelands (Beni Arouss and Derdara) where goat farming has been the dominant activity for decades. To estimate forage production (biomass), we used the method of the reference module. In the same period, interviews were carried out with goat herders. An average of ninety-six plant species was counted in each rangeland. The pastoral shrubs, mainly *Arbustus unedo, Cistus crispus, Cistus monspeliensis, Erica arborea, Lavandula stoechas* and *Pistacia lentiscus*, were the main species eaten by goats. For biomass, significant differences were noted according to season and sampling site, with a maximum forage production in spring of 3143 kg DM per hectare and 2905 kg DM per hectare, observed respectively in Beni Arouss and in Derdara. Furthermore, we identified degraded areas dominated by annual species together with species of low pastoral interest and thorny plants. During drought season, when the pastoral offer is limited, pruning of trees is performed during grazing. Due to climate changes and overgrazing, we expect that availability and quality of woodlands used for grazing will continue to decrease over the next decades. The reasonable use of pastures, including a reduction in grazing pressure, should be developed to ensure their sustainability.

Keywords. Northern Morocco – Goat – woodland – Biomass – Rangeland.

Systèmes de production caprine dans les forêts du nord du Maroc: production fourragère et utilisation des ressources sylvopastorales

Résumé. *Au nord du Maroc, les caprins tirent tout ou partie de leurs rations des forêts. Les parcours forestiers connaissent actuellement une forte pression, liée aux changements climatiques et à la pression anthropique. Cette étude visait à évaluer le potentiel pastoral de ces forêts pâturées et à étudier leur utilisation. Nous avons sélectionné pour l'étude deux pâturages forestiers (Beni Arouss et Derdara), où l'élevage de chèvres est pratiqué depuis des décennies. Pour estimer la production fourragère (biomasse), nous avons utilisé la méthode du module de référence. Durant la même période, nous avons mené des entretiens avec les éleveurs de chèvres. Quatre-vingt-seize espèces de plantes en moyenne ont été identifiées dans chaque parcours. Les arbustes pastoraux, principalement* Arbustus unedo, Cistus crispus, Cistus monspeliensis, Erica arborea, Lavandula stoechas *et* Pistacia lentiscus*, constituent la majeure partie du régime alimentaire des caprins. Pour la biomasse, des différences significatives ont été notées en fonction de la saison et des sites d'échantillonnage, avec une production fourragère maximale au printemps de 3143 kg MS/ha et de 2905 kg MS/ha, respectivement à Beni Arouss et Derdara. En outre, les recherches ont montré l'apparition de zones dégradées dominées par des espèces annuelles ainsi que par des espèces à faible intérêt pastoral et des espèces végétales épineuses. Pendant la saison de sécheresse, lorsque l'offre pastorale est limitée, et l'émondage des ligneux est effectué au moment du pâturage. En raison des changements climatiques et du surpâturage, nous nous attendons à ce que la disponibilité et la qualité des espaces boisées exploités pour le pâturage continue à diminuer au cours des prochaines décennies. L'utilisation raisonnable des pâturages, y compris via une réduction de la pression de pâturage, devrait être mise en oeuvre pour assurer leur durabilité.*

Mots-clés. *Nord du Maroc – Caprins – Forêt – Biomasse – Parcours.*

I – Introduction

In the Mediterranean basin, woodlands are normally mixtures of tree, shrub, and herbaceous species. Mediterranean forest rangelands are considered as the main forage resource for animal feeding. In addition, they provide goods and services for the local population and benefits for pasture productivity and biodiversity (Plieninger *et al*., 2015). During the last decades, forest rangelands have undergone profound changes, leading to a major forage imbalance between supply and demand (FAO, 2011).

Moroccan forest rangelands are traditionally an integral part of goat feeding systems and consequently of extensive livestock systems. In the northern part of Morocco, called also Rif mountain, the woodland is under pressure due to climate change, overgrazing and to to the misuse use of silvopastoral resources such as pruning (Chebli *et al*., 2018). In order to design and promote a sustainable and integrated development of forest rangelands, we need first an evaluation of the seasonal and annual forage availability and the determination of the current forest rangelands use. This study was conducted in two forest rangelands of northern Morocco exclusively grazed by goats. The aim was to assess their floristic composition, forage availability, and to investigate their modalities of use.

II – Materials and methods

The study was conducted in two forest rangelands called Beni Arouss (35°32' N, 5°57' W) and Derdara (35°28' N and 5°18' W), located in Tetouan and Chefchaouen provinces, respectively. The climate is Mediterranean, hyper-humid with cold winter and torrential rainfalls (1000-1400 mm), and warm summer. Temperature ranges from 3 to 14 °C in winter and from 18 to 38 °C in summer (Chebli *et al*., 2018).

The study was conducted over a period of nine months to assess the seasonal variation of forest rangelands qualitatively and quantitatively.

The qualitative evaluation of forest rangelands concerned floristic diversity. Plant identification was carried out directly in the field based on prior botanical knowledge. To identify plant local names, we relied on the survey with herders. In each sampling period, an herbarium was collected to determine the seasonal floristic composition. For the quantitative study, forage availability was assessed by determining the biomass of palatable species. Measurements were performed during three seasons: autumn, spring, and summer. Plant biomass was measured using the stratification method as described by Chebli *et al*. (2016). Each forest pasture was divided into four sites to control rangeland heterogeneity. Forty quadrats (10 quadrats/site) were installed in each forest rangelands. The size of the quadrats adopted for measurement of biomass was 40m² (4m x 10m) for shrubs and 1m² for the herbaceous layer. Several surveys were conducted with herders during the study period to gather details on the modalities of use of forest rangelands. Goat behavior was analyzed throughout direct observation as described by (Meuret *et al*.,1985). Data were analyzed using analysis of variance (ANOVA). Tukey-Kramer HSD test was used to perform the multiple comparisons for all pairs of means. Effects were regarded as significant at $p < 0.05$. The statistical procedures were performed using the SAS software.

III – Results and discussion

1. Floristic composition

Beni Arouss and Derdara are two forest rangelands characterized by an important number of pastoral plant species, among which many shrubs and trees. An average of ninety-six plant species was

counted in each site. Both forest rangelands contained three distinct vegetation groups: shrubs (*Arbutus unedo L., Calicotome villosa L., Cistus crispus L., Cistus monspeliensis* L., *Cistus salviifolius* L., *Erica arborea* L., *Lavandula stoechas* L., *Myrtus communis* L., *Phillyrea media* L., and *Pistacia lentiscus* L.), trees *(Quercus ilex* L., *Quercus suber* L., and *Olea europaea* L.), and herbaceous plants. Woody plants made up more than 90% of the forage selected by goats, according to their seasonal availability. Herders confirmed the appearance of unpalatable species in the overgrazed sites, such as site 4 in Beni Arouss, and site 3 and 4 in Derdara. Four unpalatable species were identified, namely: *Anagallis arvensis* L, *Arisarum vulgare* (Targioni-Tozzetti), *Coriaria myrtifolia* L., *Daphne gnidium* L., and *Ranunculus sardous* (Crantz). As reported by Chebli al. (2016) who studied similar forest rangelands, the presence of unpalatable species might be explained mainly by overgrazing.

2. Forage production

Forage production differed significantly between sampling sites, for each forest rangeland ($P<0.05$). The average forage production recorded was 2327 kg DM/ha and 2106 kg DM/ha, respectively in Beni Arouss and Derdara (Fig. 1). Regardless of the season, site 1 in each rangeland displayed a significantly higher forage production. This could be explained by a high vegetation density in site 1, dominated mainly by shrubs and trees, which limited goat movements and consequently reduced grazing pressure. Site 4 of each rangeland was considered as an intensively grazed area. In this site, dominated by small shrubs and herbaceous plants, we recorded low forage production and low regeneration of palatable species.

Season affected significantly forage production ($P<0.05$), with a higher forage production recorded in Spring both in Beni Arouss (3143 kg DM/ha) and in Derdara (2905 kg DM/ha) (Fig. 1). This might be explained by favorable growing conditions due to the precipitation recorded in winter and early spring.

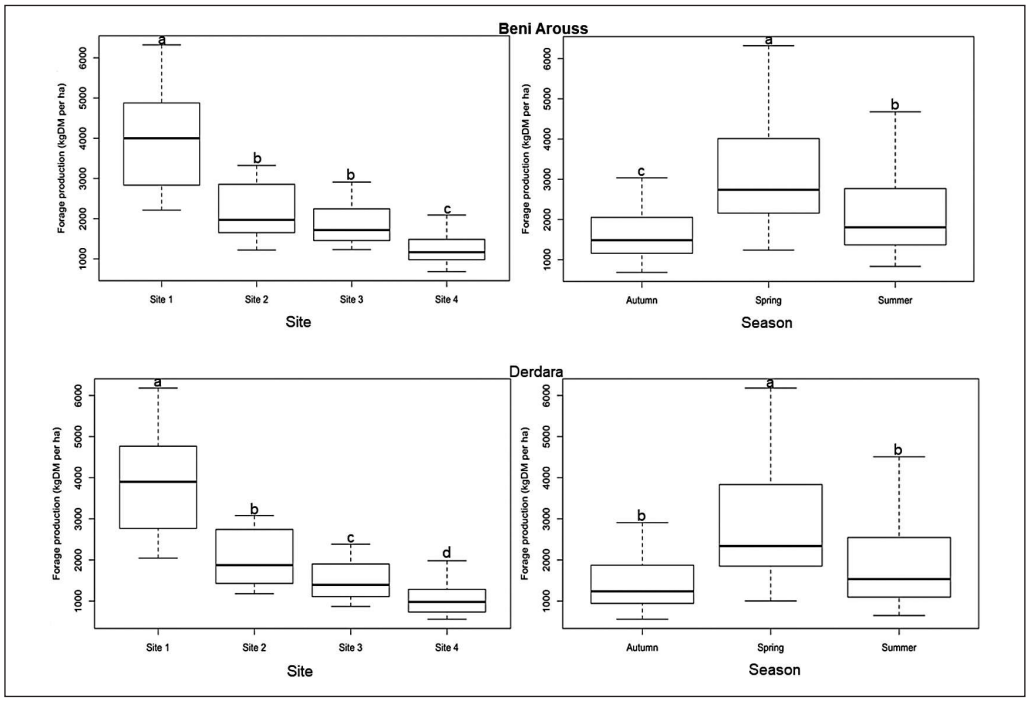

Fig. 1. Sampling site and season effects on forage production in Beni Arouss and Derdara. a-c Different letters indicate that values are significantly different ($p<0.05$).

3. Forest rangeland use

In northern Morocco, small forests are mainly used as a land reserve for agricultural activities, and large forests are used for grazing and fuelwood harvesting (Chebli *et al*., 2018).

Goats are herded by the breeder himself or by a younger family member. Grazing is practiced throughout the year (9 to 12 hours per day), except during the rainy periods (mid-autumn to mid-winter) where grazing time is reduced to only 2 to 3 hours per day. During the winter, access to pasture becomes difficult, which explains the pruning practice in order to reduce the burden of forage supplementation. The spatial distribution of goats is not determined by specific grazing management rules. Goats are concentrated for a long time on the same pasture conducting to overgrazing and therefore to the appearance of low palatable species and to the disappearance of palatable species. According to our observations and survey with herders, goats' itinerary and diet depends on the season and on forage availability. In spring, goats consume herbaceous species and shrubs: *C. crispus., C. monspeliensis, C. salviifolius, A. unedo* and *L. stoechas*. During the summer, goats' diet is composed by *A. unedo, E. arborea,* and even tree branches of *Q. ilex, Q. suber* and *O. europaea*. In spring, 62% of animal activity is devoted to grazing, against 69% in summer. The short duration of grazing in spring compared to summer can be explained by the high forage availability, coinciding with the vegetative peak of pastoral species.

IV – Conclusions

In northern Morocco, forest rangelands represent the most important feed source for goats. Forage availability varied according to season and grazing intensity. The continuous use of pastoral resources and the lack of pasture management has considerably reduced the palatable pasture species and has allowed the appearance of less palatable species. Management actions and use of silvopastoral resources, including a reduction in grazing pressure, should be developed to ensure a better productivity and the sustainability of these forest resources.

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