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Multiple-benefits of Mediterranean grasslands: livestock and honeybee foraging values and pasture qualities

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Abstract. A long-term study was conducted to determine the multiple responses of pasture and livestock to different management systems in Mediterranean grassland. A grazing trial was set in the eastern Galilee, Israel, comprising two stocking densities (0.55 and 1.1 cows ha-1) and two protocols, continuous and split-paddock grazing. Growth dynamics, botanical composition, diversity and nutritional quality of the pasture were determined. Livestock production, foraging potential of honeybees and landscape visual qualities were defined as well. It was shown that intensive use of Mediterranean grassland with high stocking density during the growing season can be economically feasible. Species diversity was found to be remarkably stable across all grazing treatments. Lower relative growth rates under grazing were detected as heavier stocking density reduced standing biomass, but herbage quality increased along with grazing intensity. Cattle grazing did not decrease the forage potential of open landscapes for honeybees; some of the examined parameters even revealed positive effects. In addition to animal production, Mediterranean grasslands have significant landscape values that are becoming increasingly important, they provide a wide range of ecological services. The multiple benefits of these landscapes can justify the expense of necessary interventions that cannot be justified by any single benefit.

Keywords. Beef cattle, botanical composition, diversity, herbaceous biomass, honeybees.

Bénéfices multiples des prairies méditerranéennes : Valeurs fourragères et de butinage et qualités du pâturage pour bétail et abeilles mellifères

Résumé. *Une étude à long terme a été menée pour déterminer les réponses multiples du pâturage et du bétail à différents systèmes de gestion dans les prairies méditerranéennes. Un essai de pâturage a été conduit dans l'est de la Galilée, Israël, comprenant deux densités de chargement (0,55 et 1,1 vache ha^{-1}) et deux protocoles, pâturage continu et pâturage en parcelles divisées. La dynamique de croissance, la composition botanique, la diversité et la qualité nutritionnelle du pâturage ont été déterminées. La production du bétail, le potentiel de butinage des abeilles mellifères et les qualités visuelles du paysage ont également été définis. Il a été montré que l'usage intensif des prairies méditerranéennes avec une forte densité de chargement pendant la saison de croissance peut être économiquement faisable. La diversité des espèces s'est avérée remarquablement stable sur tous les traitements de pâturage. Des taux relativement faibles de croissance sous pâturage ont été détectés tandis qu'une densité de chargement lourde réduisait la biomasse sur pied, mais la qualité de l'herbage a augmenté en même temps que l'intensité de pâturage. Le pâturage des bovins n'a pas diminué le potentiel de butinage dans les paysages ouverts pour les abeilles mellifères ; certains des paramètres examinés ont même révélé des effets positifs. En plus de la production animale, les prairies méditerranéennes ont des valeurs paysagères significatives qui deviennent de plus en plus importantes, car elles fournissent une vaste gamme de services écologiques. Les multiples bénéfices de ces paysages peuvent justifier de dépenser pour des interventions nécessaires qui ne sont pas justifiables par un seul bénéfice pris isolément.*

Mots-clés. *Bovins à viande – Composition botanique – Diversité – Biomasse herbacée –* Abeille mellifère.

I – Introduction

Domestic livestock have been grazing Mediterranean ecosystems for at least 10,000 years. The millennia of human use for agriculture and pastoralism have shaped a highly heterogeneous "Mediterranean mosaic landscape" (Naveh, 1998). Traditional yearlong grazing, usually at high stocking rates, generated open vegetation, resilient to heavy grazing pressure and to fire (Perevolotsky and Seligman, 1998). In the past, in Israel, the open landscapes were mainly subjected to traditional heavy grazing of goats. At present, beef cattle husbandry has become the main alternative livestock-related use of these areas. Lately a comprehensive, multifunctional grazing system approach has been developed, which, in addition to meat production, economic and social aims, also considers ecological, cultural, recreational and political issues (Henkin, 2011).

Generally, Mediterranean grasslands are dominated by annuals (Seligman, 1996), they generate high levels of biodiversity and as a consequence a range of other environmental services (Bugalho and Abreu, 2008). Land management decisions regarding these ecosystems have led to changes in vegetation, which, in turn, result in changes in the multiple benefits that can be obtained from the land (Koniak and Noy-Meir, 2005). In Israel, open areas that are dominated by Mediterranean herbaceous vegetation are situated mainly in the eastern Galilee, and the southern Carmel. The control of grazing to enhance multiple-use of these areas is a challenge for landscape management. It was shown that structural criteria are an efficient and objective methodology for evaluating the effects of grazing on the recreational value of Mediterranean woodland mosaic landscapes (Henkin *et al*., 2007). Koniak and Noy-Meir (2005) suggested that the maximum potential contribution to picnicking value was found in herbaceous patches as in a relatively high tree formation.

A considerable fraction of Israel's natural open landscapes are used simultaneously as a source for feeding animals and for honeybee forage (Kaminer, 2011; Shapira, 2014). Since cattle grazing directly affect plant richness, abundance and composition, it also affects bee activity and honey yield during spring. Therefore, beekeepers are concerned that cattle grazing decreases the forage potential of flowers for bees, through its effect on plant diversity and abundance. The aim of this paper is to present ways by which grazing can be implemented in the context of the Mediterranean rangelands of Israel to enhance animal production, foraging potential, nature conservation, landscape visual qualities and the production of honeybees.

II – Materials and methods

The study was conducted at the Karei Deshe experimental farm, which is located in the eastern Galilee in the north-east of Israel (long. 35^{0}35'E; lat. 32^{0}55'N; altitude 60 - 250 m a.s.l.). The topography is hilly, covered with basaltic rocks. The area has a Mediterranean climate, characterized by wet, mild winters and hot, dry summers. The average seasonal rainfall is 560 mm, falling mostly in winter and spring with wide variation among years and months. The vegetation is a hemicryptophytic grassland dominated by *Hordeum bulbosum* L., *Echinops* spp., *Bituminaria bituminosa* L. and many annual species. The study area is based on a long-term grazing trial that was initiated in 1994 (Henkin *et al*., 2015) and maintained for more than 20 years, to cover a range of grazing scenarios. The study includes four main treatments: two stocking densities, moderate (1.8 ha. per cow) and high (0.9 ha. per cow) and two management protocols: continuous stocking and split paddock where each paddock was divided into two equal sub-paddocks for early and late grazing. The paddocks were stocked with medium-frame crossbred cows with about 20% blood from local eastern Mediterranean breeds. Supplementary feeding (poultry litter) was given as a source of nitrogen (N) at the end of the abundant dry pasture period and during the dry period in the summer.

Pasture utilization, supplementary feed consumed, live weight and conception rate of herds were measured. Standing biomass and plant composition were evaluated along permanent

transects in all paddocks. In addition, plant and bee surveys were conducted in grazed paddocks and compared to those of adjacent ungrazed paddocks in three different geographic locations in Israel: Karei Deshe experimental station, Ramat Hanadiv and Lachish. In each site data were collected in 3-6 rounds of sampling during the green season.

III – Results and discussion

Animal production in Mediterranean rangelands is one of the most important economic uses of the landscape, but as for other multiple benefits beyond grazing, its direct and indirect effects on the environment could be both positive and negative. Under present-day conditions, grazing by cattle as a sole means of management will not always lead to the formation of landscape vegetation and/or composition that meets all the criteria for multiple uses of natural lands. This depends mainly on the initial vegetation formation and the grazing management applied in terms of density and timing. In the case of livestock production it was shown (Henkin *et al*., 2015) that on Mediterranean grassland, intensive use of the pasture, which included high stocking density during the growing season, can increase weaned live-weight per area unit with no discernible long-term damage to the pasture (Fig. 1). In addition, it was found that herbage quality was significantly higher in paddocks grazed continuously or early in the season and with the increasing of grazing intensity, since these practices ensured younger herbage and plant re-growth (Henkin *et al*., 2011). On the other hand, heavier stocking density reduced standing biomass at the end of the growing season (Henkin *et al*., 2015).

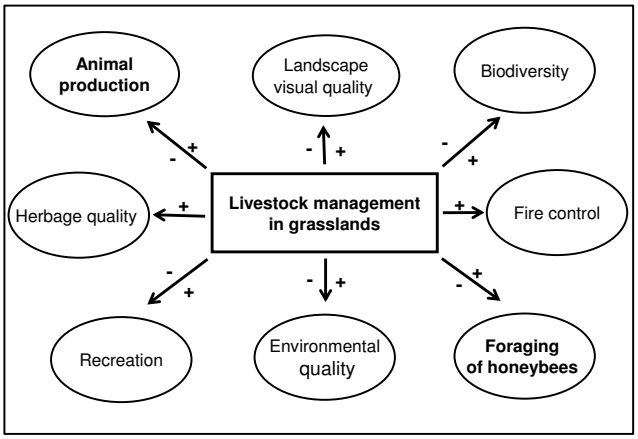

Fig 1. Multiple benefits and losses of Mediterranean grassland as a result of cattle grazing.

The main effects of grazing on the relative cover of plant functional groups were related to early *vs*. late seasonal grazing. A reduction in tall grass cover at higher stocking densities was found to be correlated with increased cover of less palatable groups such as annual and perennial thistles, as well as shorter and prostrate groups such as short annual grasses, but, species diversity and equitability were remarkably stable across all grazing treatments (Sternberg *et al*., 2015). Consequently, in two different studies, Kaminer (2011) and Shapira (2014) showed that honeybee forage activity of the grazed landscape is strongly correlated to floral abundance and especially to particular plant species phenology. Crucifers seemed to be important nectar suppliers and the flower abundance of only few nectar plant species decreased significantly after grazing; this is probably the result of the long evolutionary history of grazing known in this

area. So, combining the result of both studies shows that overall, honeybee forage seemed to benefit from the grazing and mainly from the moderate grazing density.

In addition, (Divinski, personal communication) landscape visual qualities were determined by a questionnaire given to the public inquiring about their preferences. The answers showed that the control treatment, landscape with no grazing was selected as the most preferred. As for environmental quality, it was found (Noy-Meir and Oron, 2001) that conservation of the geophyte flora in Mediterranean vegetation required livestock grazing at moderate to high intensities in part of the area of each community and light or no grazing in other parts.

IV – Conclusions

In addition to animal production, Mediterranean grasslands have significant landscape values that are becoming increasingly important. They provide a wide range of ecological services. The multiple benefits of these landscapes can justify the expense of necessary interventions that cannot be justified by any single benefit. We conclude that if landscape values are taken into account when making management decisions relating to grazing systems, the overall benefits derived from the rangeland can be increased.

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