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Voisin's Rational Grazing system for small ruminant feeding in Mediterranean areas

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Abstract. Small ruminant grazing systems in Mediterranean areas are still linked to traditional practices based on continuous grazing, which, in certain cases, lead to a suboptimal exploitation of the herbage and to a reduced economic and ecosystem performance. In South America, for at least 40 years, many farmers have adopted intensive (controlled) rotational or Voisin' s Grazing System (VRG), to maximize the production of aboveground plant biomass and to increase profitability. Using portable and/or permanent fencing and watering systems, VRG consists in applying a high instantaneous stocking density, rotating the animals among paddocks to manage pasture growth and consumption, according to the growth rate of plants, species composition, soil and climatic conditions. The total time that animals occupy a paddock must be very short to prevent the grazing of regrowth in the same residence time. This technique, recently applied by small ruminant farmers, makes it possible to: (i) regenerate degraded pastures and meadows in marginal areas, (ii) increase harvesting efficiency and productivity of lowland pastures, (iii) obtain a diet more stable and of higher quality for livestock, (iv) increase the stock of carbon in soils, and (v) enrich plant and animal biodiversity as a result of increased soil fertility. From the literature, we draw some examples of VRG application in ruminant production, considering the most recent research works and independent observation, with the aim of listing the benefits that have been verified in terms of productivity, mitigation of CO_2 emissions and effects on the ecosystem, as well as the possibilities of adoption in the Mediterranean basin.

Keywords. Voisin's grazing system – Livestock sustainability – Grazing management.

Pâturage tournant intensif pour l'alimentation des petits ruminants en régions méditerranéennes

Résumé. *Les systèmes de pâturage des petits ruminants dans les régions méditerranéennes sont encore liés aux pratiques traditionnelles basées sur le pâturage continu, qui, dans certains cas, conduisent à une exploitation inefficace de l'herbe et à des performances économiques et écosystémiques médiocres. En Amérique du Sud, depuis au moins 40 ans, de nombreux agriculteurs ont adopté le système de rotation intensif (contrôlé) de Voisin (VRG), afin de maximiser la production de biomasse aérienne des plantes et d'augmenter la rentabilité de leur élevage. Utilisant des clôtures et des systèmes d'arrosage portables et/ou permanents, le VRG consiste à appliquer un chargement instantané élevé, en faisant tourner les animaux entre parcs pour gérer la croissance et la consommation des pâturages en fonction de la vitesse de croissance des plantes, des espèces présentes, des conditions pédoclimatiques. Le temps de séjour sur un parc doit être suffisamment court pour éviter le pâturage de repousses durant un même passage. Cette technique, récemment appliquée par des éleveurs de petits ruminants, permet de : (i) régénérer les pâturages et prairies dégradés dans les zones marginales, (ii) accroître l'efficacité de la récolte et la productivité des pâturages de basse altitude, (iii) obtenir un régime alimentaire plus stable et de meilleure qualité pour le bétail, (iv) accroître le stock de carbone dans les sols et (v) enrichir la biodiversité végétale et animale, grâce à l'augmentation de la fertilité des sols. Nous proposons quelques exemples d'applications du VRG dans la production de ruminants, en prenant en compte les travaux de recherche les plus récents et des observations indépendantes, dans le but de répertorier les avantages vérifiés en termes de productivité, de réduction des émissions de CO_2 et d'effets sur l'écosystème, ainsi que les possibilités de mise en œuvre dans le bassin méditerranéen.*

Mots-clés. *Pâturage Rationnel Rotatif – Durabilité – Gestion du pâturage.*

I – Introduction

Pasture-based farming systems have undergone an evolution in recent decades, in terms of intensification, structural, economic, social and environmental factors. Special attention has been paid to critical points for sustainability. However, in the Mediterranean area, less attention has been devoted to the management of grazing systems in relation to grass productivity/nutritional characteristics and animal production responses, as well as the best options to be taken depending on the local context.

Among different rotational grazing techniques (Bernués *et al*., 2011), the Voisin's Rational Grazing (VRG) system (Voisin, 1959), represents an intensive management of pastures, with two main rules: (i) rest and stocking periods must vary with the growth rate of plants; (ii) the total time that animals occupy a paddock must be very short to prevent the grazing of regrowth in the same residence time. Recently, Pinheiro Machado (2010) added some technical recommendations, such as planting trees, diversifying species in all paddocks, no tilling of the soil, and no use of agrochemicals. The rotation of ruminants among paddocks, by means of portable fencing, allows a variable rest period, which must be sufficiently long to allow the plants to completely re-grow. The introduction of animals in the individual paddock is carried out with at high density and with a very short residence time, ranging from 12 hours to 3 days.

This technique is widespread in Latin America, mainly for beef and dairy cattle farming, as well as for small ruminants (Fig. 1). It is conceivable that with appropriate adaptations, this technique could also be used in the Mediterranean environment. In this paper we review some of the theoretical advantages of VRG.

Fig. 1. Sheep in a Voisin's Rational Grazing system, "El Mate" farm, Cordoba (Argentina). Photos courtesy of Bruno Basquetto.

II – Methods and theoretical framework

A literature review was carried out to identify those publications reporting VRG system with small ruminants and cattle. The selection of publications was performed with a research on the Internet using the current databases available (Scopus, Science Direct, Google Scholar and Google). In this review, according to the scientific and technical literature, we focused on the VRG system and its effects on herbage productivity and pastoral value, animal performance and ecosystem services, including carbon sequestration and biodiversity conservation.

III – Evidences from the literature

1. Pasture characteristics and animal performance

One of the means by which VRG systems are claimed to increase animal performance, is to improve the productivity of above-ground biomass and the nutritional quality of pasture. Feria *et al*. (2002) compared VRG, rotational and continuous grazing systems for fattening cattle, concluding that VRG increased the production of dry matter of about 30 to 40% compared to continuous grazing with different rainfall regimes (Table 1).

Table 1. Seasonal grass availability (in kg dry matter/animal/d) as a function of grazing management Feria *et al*., 2002

Season	VRG	Rotational grazing	Continuous grazing	SD
Scarce rainfall I	18.4[a]	15.7[b]	13.2[b]	1.2*
Rainy season	23.2[a]	20.1[b]	18.6[b]	0.9**
Scarce rainfall II	19.7[a]	14.5[b]	13.1[b]	0.3**

[ab] Uncommon letters in the same row differ for P < 0.05; * P < 0.05 ** P < 0.01.

The analysis of the nutritional value of herbage in the dry season, showed a higher crude protein in VRG (8.31%) compared to the other grazing systems (7.02% and 6.17%) (Table 2).

Table 2. Chemical composition of the herbage during the dry season (whole plant). Feria *et al*., 2002

Grazing system	DM%	CP%	CF%	Digestibility %	Ash %
VRG	35.05	8.31[a]	31.53	54.00	7.45[a]
Rotational grazing	38.57	7.02[b]	33.41	53.00	7.93[b]
Continuous grazing	36.33	6.17[c]	33.76	52.94	9.71[b]
SE	0.93	0.35**	1.19	0.91	0.50*

[abc] Uncommon letters in the same column differ for P <0.05; * P <0.05 ** P <0.01. DM: Dry Matter; CP: Crude Protein; CF: Crude Fibre.

Donnola (2018) estimated the difference in grass production for grazing dairy cows in *Pian Cansiglio* (Veneto, Italy). The results were 2,500 kg DM/ha/year in the case of continuous grazing, 5,500 and 6,000 kg of DM/ha/year for the first two years of application of VRG, which represents a productivity increase of more than 100%.

It is known that cattle and sheep grazing at high stocking densities tend to be more voracious, avoiding selective grazing, conversely to free grazing. This change in feeding behaviour results in natural weed control and in an increase in the number of plants per square meter. The increase in the number of species and the greater density of plants progressively increases the nutritional quality of the pasture (Feria *et al.,* 2002).

Feria *et al*. (2002) found significant differences in beef daily weight gain, with 0.51 kg/head/day for VRG compared to 0.41 kg and 0.42 kg in rotational grazing and continuous grazing systems, respectively. More recently, Kuhnen *et al*. (2015), observed a lower milk production in VRG-fed cows compared to a more intensive feeding regime, but with substantial benefits in terms of farm income and ecosystem services. Ojeda-Falcón *et al*. (2018), reported that the stocking density in a farm in the province of Santa Fe (Argentina) practising VRG in the last 18 years, reached 4.35 Animal Units/ha, which is over 4 times the typical grazing load of the area.

2. Ecosystem services

The increase in biomass production directly generates an increase in the fixation of CO_2 from the atmosphere by the plants. Seó *et al*. (2017) found that VRG can stock more carbon than no-tillage (NT) fields (VRG = 115.0 Mg C ha^{-1}; NT = 92.5 Mg C ha^{-1}; $p < 0.00009$), with the greatest difference at a depth of 0-10 cm (VRG = 41 Mg C ha^{-1}; NT = 32 Mg C ha^{-1}; $p < 0.00008$). In VRG, 95% of C was in the soil, 1% in the aerial part of plants, and 4% in the roots. In terms of production performance, VRG produced 0.15 kg of milk kg^{-1} of C stored, and NT 0.13 kg of milk kg^{-1} of C stored.

Sanchez *et al*. (1996) reported that the quantity of insects in the soil decreased from 75% to 35.5% from the moment of the beginning of VRG to 4 years after its application. Insects decreased due to the large increase in oligochaetes in a proportion of 32.2% together with the appearance of other groups such as diplopods, isopods, and arachnids belonging to the Myriapoda, Crustaceae and Arachnida classes respectively, with a net contribution to increasing edaphic biodiversity. The authors concluded that the biomass of such groups after the application of VRG was 11.25 times higher than to that before the start of the experiment.

The increase in the number and proportion of plants, added to a lower total trampling, maintains highly fragile ecosystems in more stable situations, avoiding erosion, desertification and invasion. Rojas Paez and Zulay (2016) assessed the soil loss of continuous grazing and VRG with cattle, and concluded that VRG, with one-day occupations, generates less long-term soil losses due to the shorter residence time. VRG would also increase plant biodiversity. Hack *et al*. (2009) evaluated the floristic composition of a natural meadow grazed with VRG and continuous system, observing a greater diversity in the floristic composition for the first one.

IV – Conclusions

This review confirms that the VRG is a strategy to be considered also for Mediterranean environments and small ruminant production. Although the works reported were carried out with cattle, various personal communications and informal publications confirm these same benefits in the application of the VRG technique with sheep and goats. Unfortunately, no specific publications have been found and the literature remains rather limited, with many knowledge gaps as for example profitability, workflows, self-reliance, resilience, adaptation to climate conditions, animal welfare and hazards.

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