Radiation Use Efficiency on Campos Grasslands with Contrasting Grazing Methods

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Radiation use efficiency on campos grasslands with contrasting grazing methods

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Introduction

In Uruguay, natural grasslands cover about 67% of the lands of the country. The Basaltic region occupies 4 millions of hectares and it has the highest proportion of natural grasslands of the country. In these pastures, livestock management is applied traditionally associated with intense grazing, with high loads, high sheep / cattle relations, with long periods of occupation and continuous grazing or with short rest periods. This livestock management is the main reason of degradation of natural grasslands. In Basaltic deep soils, it results in the loss of high value species with a decrease in productivity (Millot *et al*., 1987). However, with a controlled method that adjust grazing time and intensity of defoliation it is possible to avoid the degradation of the natural grasslands and reverse it in overgrazed sites.

Traditionally, aboveground net primary production (ANPP) was estimated from biomass cuts made at the fields. Today, it is possible to estimate ANPP using remote sensing techniques by synthetic images of enhanced vegetation index (EVI). The EVI is correlated with the fraction of photosyntethically active radiation absorbed by plants (fPAR), providing the link of ANPP estimation covering larger areas and taking repeated measurements over time in the same place (Piñeiro *et al*., 2006). The radiation use efficiency (RUE) is the effectiveness with which fPAR is transformed in PPNA and is known to vary according to temperature, precipitation and species composition (Monteith, 1972; Piñeiro *et al*., 2006).

Taking all these into consideration, we set as aims of this work: a) to calibrate RUE and b) study the temporal variability of RUE for two contrasting grazing methods.

Materials and Methods

The study was conducted on five livestock farms located in the Basaltic region, north-eastern of Uruguay. In each site, two contrasting pastures with different historical grazing management (controlled *vs* continuous stocking rate) were selected. Data was collected between September 2013 and February 2015.
RUE coefficient was estimated following Monteith equation (1972):
ANPP= APAR x RUE -> RUE= ANPP / APAR.
Where APAR is the absorbed photosynthetically active radiation and ANPP is the aboveground net primary production.
ANPP was estimated using the technique of regrowth in three exclusion cages (Gardner, 1986). Biomass was cut at 1cm in boxes 20 x 50cm with shears every 45-50 days. The harvested material was dried in forced air oven at 60°C.
The APAR is given by the following equation:
APAR= fPAR x PAR
Where fPAR was obtained as a function of ENVI synthetic images from MODIS sensor with a spatial resolution 250m x 250m (US Geological Survey). The incident photosynthetically active radiation (PAR) was estimated as the 48% of the radiation calculated by sunshine hours from agro-climatic stations of the National Institute of Agricultural Research (INIA). RUE data were analyzed with a one-way ANOVA and the means were compared with T test for paired samples.

Results and Discussion

Between grazing methods, RUE average values throughout the evaluated period were statistically different ($p < 0.05$), with controlled management reporting values above 44% (Table 1). These values are consistent with those obtained by Piñeiro *et al*., (2006) in natural grasslands of the Flooding Pampa in Argentina (0,2-1,2g.MJ-1). Therefore, changes in species composition caused by grazing method affect RUE coefficient (Le Roux *et al*., 1997).

Table 1._RUE average (± standard error)

	Grazing method	
	Controlled (g.MJ^{-1})	**Traditional (g.MJ^{-1})**
Mean	0,49 a	0,34 b

Letters indicate significant difference (p<0,05).

When analysing seasonal variation between grazing methods, there were no statistical differences in RUE values. Climatic conditions, such as high rainfall and high temperatures could have influenced rapid restoration of the vegetation, masking the grazing methods differences. Whereas, seasonal variation of RUE for each grazing methods separately, was significantly different within seasons (p <0.05)(Fig. 1). In the traditional grazing method, Spring 2013-2014, Summer 2015 (0.18 vs 0,57-0,48g.MJ-1), Winter 2013 -Spring 2014 (0.21 vs. 0,57g.MJ-1) and Summer 2014-Spring 2014 (0.29 vs. 0,57g.MJ-1) (p <0.05) (Fig. 1) were found statistically different in terms of RUE:. Whereas, in controlled grazing method, only Spring 2013-Winter 2014, Spring 2014 (0.32 vs. 0,63-0,66g.MJ-1), and Fall 2014-Spring 2014 (0.39 vs. 0,66g.MJ^{-1}) (p <0.05) (Fig. 1).were statistically different. These differences should be studied with more details in the future, since data is lacking in the region.

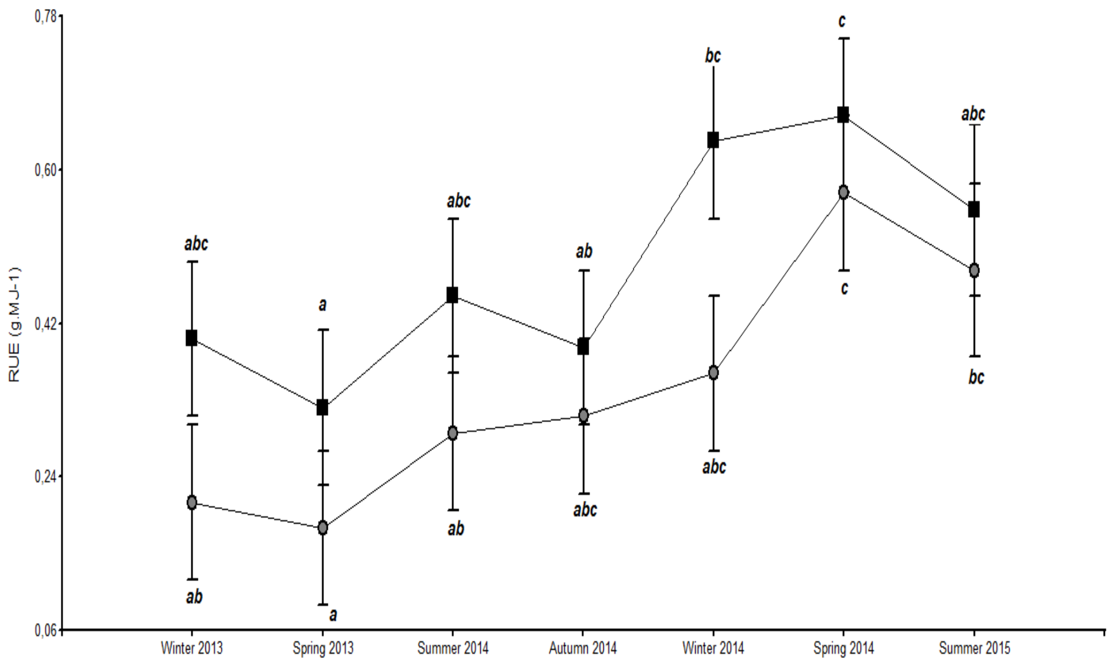

Fig 1. Seasonal variation of RUE for both grazing methods. Circle:Traditional; Square:Controlled. Letters indicate significant difference in seasonal variation for each grazing method separetly (p<0,05).

Conclusion

In natural grasslands of the basaltic region of Uruguay, livestock management regimes associated with high loads, high sheep / cattle relations, with long periods of occupation and no rest periods generates changes in the floristic composition. These changes could cause a decrease in productivity due to lower efficiency in the transformation of solar radiation into biomass. The RUE values obtained could be used in the estimation of a more accurately ANPP in natural grasslands on deep soils of the basaltic region.

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