Modeling the Growth of Alfalfa (*Medicago sativa*) in the Pampas Region

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The 21st International Grassland Congress / 8th International Rangeland Congress took place in Hohhot, China from June 29 through July 5, 2008.

Proceedings edited by Organizing Committee of 2008 IGC/IRC Conference

Published by Guangdong People's Publishing House

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Key words: lucerne, primary productivity, incident radiation, actual evapotranspiration

Introduction Carrying capacity of grazing systems on the Pampas (Argentina) and its secondary production depend on the aboveground net primary productivity (ANPP) of their forage resources. While there is descriptive information about the seasonal variability in the productivity of grown perennial forage species, there is less information about the environmental controls of this variability from a long time series and spatially well distributed in the region. Among the cultivated species, the alfalfa (*Medicago sativa*) is the most important forage legume because the large sown area and the wide environmental gradient it occupies. Simulation models that allow estimating crop growth have been developed for various parts of the world (McCown et al., 1996). The objective of this study was to construct a model to estimate the PPNA for this species, from local soil and climate data.

Materials and methods We used data from biomass harvests from a three-year crop network test (Chamber of Seed Traders-CSBC), located at different sites in the Argentine Pampa and for 7 years (1996—2003). We averaged for each month the daily PPNA, calculated from the aboveground biomass accumulated between successive cuts. We worked with the information of four experimental sites located between 31° and 37° south latitude and 59° and 63° west longitude and covering an mean annual temperature ranges from 13.6℃ to 18.4℃ and annual precipitation from 840 mm to 1123 mm. Out of a total of 316 cuts, cuts for the establishment phase and those periods of low growth rates were eliminated. The monthly ANPP were correlated, through multiple regressions, with the average monthly temperature, precipitation, incident radiation (Rad) and actual evapotranspiration (ETr). The latter was estimated from the above variables and data such as soil field capacity and wilting point. We evaluated the best model developed with information from the northern location, using the data from that location is not taken into account for the construction of the model and those for the other three seats, for its validation.

Results and discussion The model that best explained the PPNA includes Rad and ETr [mean monthly daily ANPP (kg DM / ha.day) = 4.24 * Rad + 4.71 * ETr − 8.93]. The application of this model for the whole dataset showed a good agreement against the measured ANPP (Figure 1). Overall, the model presented a satisfactory adjustment for all the analyzed locations (Figure 2). The slope of the relationship between estimated and measured by cuts was not significant different to the line 1:1 ($p=0.92$). This model does not include ANPP monthly values that exceed 70 Kg DM/ha.day, believing that these values would be explained by factors not taken into account in the design of the model, such as soil fertility or structural variables of cultivation.

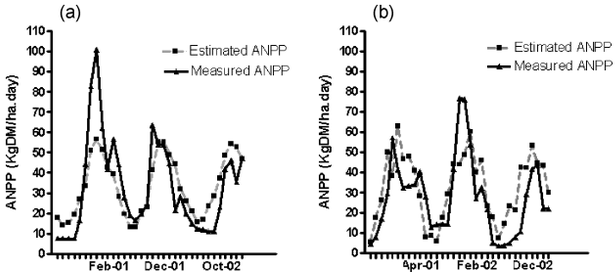

Figure 1 *Seasonal dynamics of the ANPP (2000/2003), for two contrasting sites: (a) Rafaela and (b) Cnel. Suárez.*

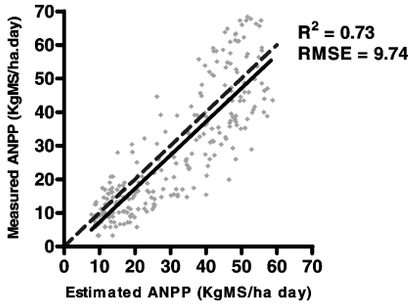

Figure 2 *Relationship between the measured and the estimated by the model ANPP for the four sites. Full line is the regression line and the dashed line is the 1:1 relationship.*

Conclusions Our results suggest that it is possible to estimate the ANPP from climatic data for a wide range of conditions in the Argentinean Pampas. The model could help to better understand the controls of ANPP and to make a more accurate planification of stocking rate in grazing systems. Moreover, it could help to estimate the effects of climate changes on the ANPP of alfalfa.

Reference

McCown R.L., Hammer G.L., Hargreaves J.N.G., Holzworth D.P. & Freebairn D.M., 1996. APSIM: a Novel Software System for Model Development, Model Testing and Simulation in Agricultural Systems Research. *Agricultural Systems* 50: 255-271.