Nitrogen Mineralization Variability at Field Using Vegetation Spectral Indices

Zubillaga, Mercedes[1], Esteban Mosso[1] & Matías Redel[1]

Cátedra de Fertilidad y Fertilizantes, Facultad de Agronomía, Universidad de Buenos Aires[1], Av.San Martin 4453 C1417DSE CABA,Argentina. E:mail: mzubilla@agro.uba.ar

INTRODUCTION AND OBJETIVES

Spatial variability in N mineralization, even within a small field, represents a potential problem in estimating the quantity of N mineralized under field conditions. The techniques to determine soil N mineralization are time consuming and could be economically prohibitive for precision farming which requires quick estimates of soil nitrogen.

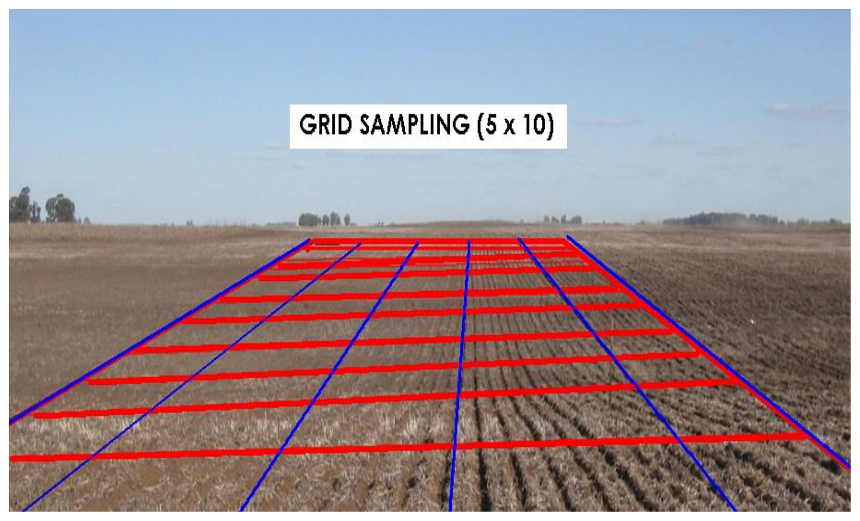
Remote sensing techniques were used to detect the nitrogen mineralization spatial variability at field scale. The aims of this study were 1) to explore the N mineralization variability within a field in the Central Western Pampas, and 2) to determine if N mineralization parameters were related to vegetation indices derived from spectral remote sensing.

MATERIALS AND METHODS

Prior to maize sowing, the field was sampled in a grid pattern (5 rows and 10 columns) where soil samples were taken.

A long-term aerobic incubation was carried out with these samples to measure potentially mineralizable N. The data of cumulative net N mineralized with time (Nt) were fit to Nt= N0.(1-e-k t), where t is time and N0 is the N mineralization potential.

A N balance study was conducted in the field at each of the grid sites for estimating the apparent mineralized N (Nap). Nap is calculated as the difference between the plant N accumulation and the variation soil inorganic nitrogen at the beginning and end of the growing season period.



Spectral indices (NVDI, REIP and TCARI) were taken at crop early stages (**V6** and **V10**).

Indices	Formula
NDVI	$(R_{800}-R_{670})/(R_{800}+R_{670})$
TCARI	$3(R_{700}-R_{670})-0.2(R_{700}-R_{550})(R_{700}/R_{670})$
REIP	$700+40((R_{670}+R_{780})/2-R_{710})/(R_{730}-R_{710})$

Classical statistics and geostatistics were used to analyze the data. Correlation matrices were calculated among vegetation spectral indices and mineralization parameters.

RESULTS

At field scale the N mineralization showed a great spatial variability (Fig 1). Both of the variables were explained by the spectral indices of early crop stages (Table 1).

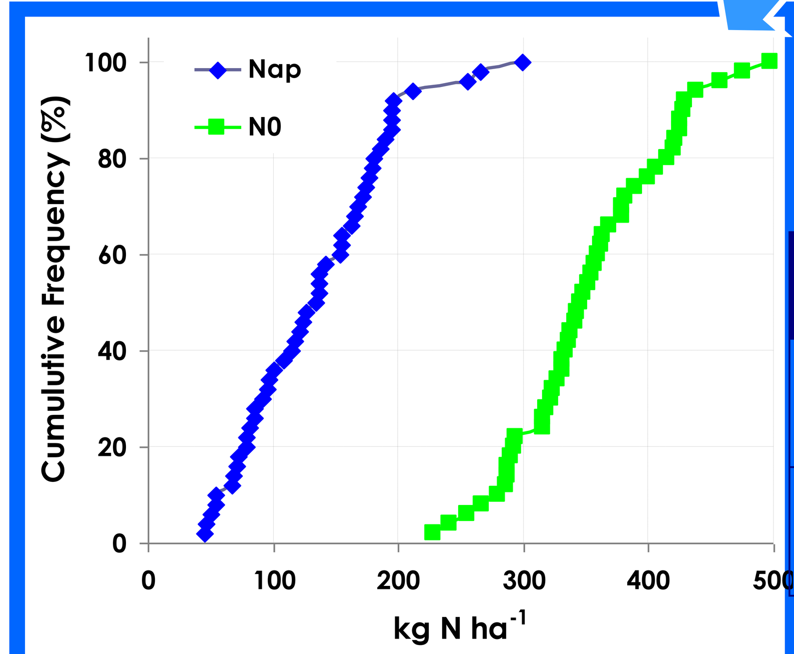
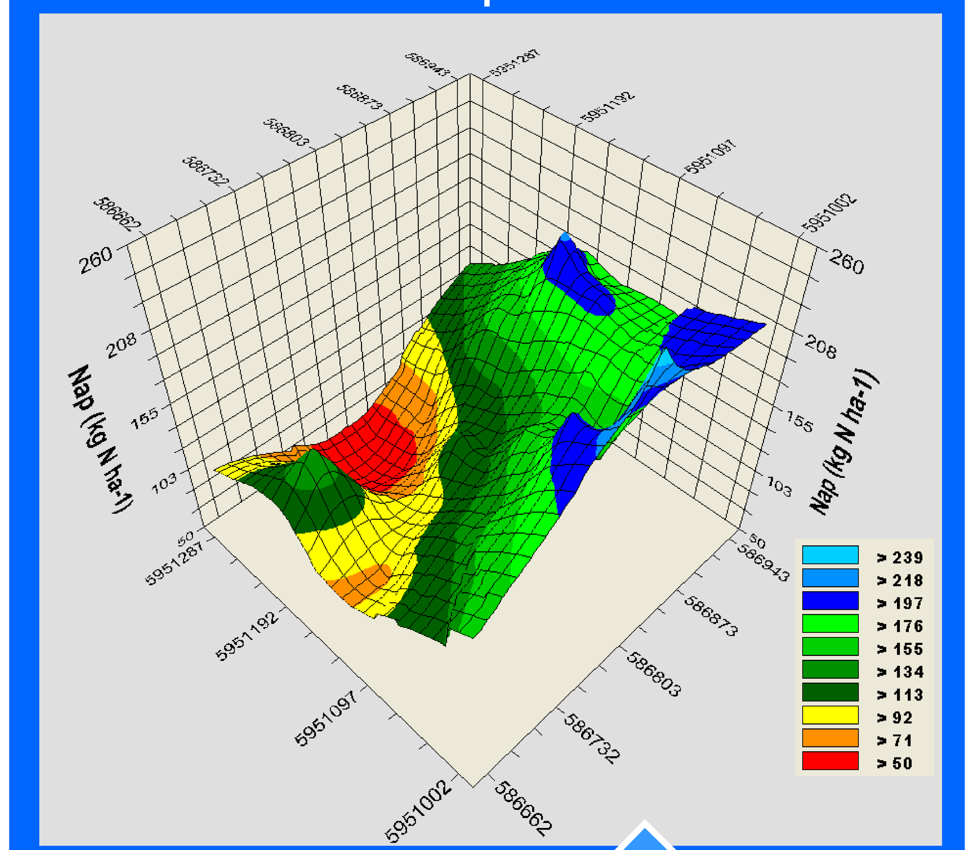


Figure 1

Table 1. Pearson correlation coefficients for N mineralization and spectral indices

	Spectral Indices	Crop Stages V6	V10
N0	NVDI	**0.41****	**0.64 ****
	REIP	0.24	**0.63 ****
	TCARI	0.14	**0.43 ****
Nap	NVDI	**0.69 ****	**0.75 ****
	REIP	0.20	**0.77 ****
	TCARI	**0.44 ****	**0.46 ****

Distribution of Nap at field scale



The semivariograms had strong spatial dependence for Nap and N0, so the spatial distribution of the N mineralization at field scale were estimated by krigging.

The errors in the N mineralization predictions at field scale were lower using spectral indices as covariate. These results are shown for Nap (Figures 2 and 3) and N0 (Figures 4 and 5).

Distribution of N0 at field scale

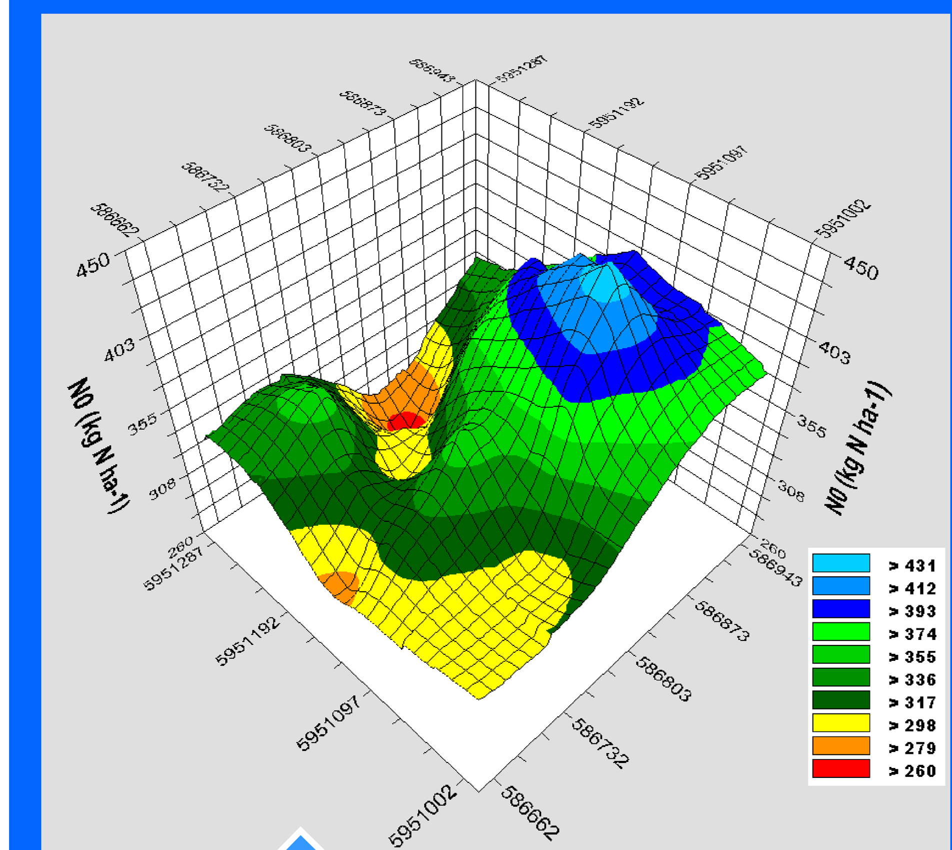


Table 2 Parameters of the cross semivariograms models for spectral indices with Nap and N0 as a covariate

	Nugget	Sill	Range (m)	R²
N0				
NVDI6	0.001	2.931	310	0.66
NVDI10	0.18	7.77	206	0.78
REIP10	4.20	291.7	183	0.71
TCARI10	0.001	2.002	208	0.86
Nap				
NVDI6	0.01	4.039	237	0.89
NVDI10	0.01	8.04	241	0.86
TCARI6	0.01	2.02	280	0.91
REIP10	1.00	414	284	0.78

There were direct spatial correlations between the N mineralization and spectral indices. The spherical model was the best fit to the data of cross semivariograms. Almost all the variability had spatial structure and the range varied from 183 to 300 m (Table 2).

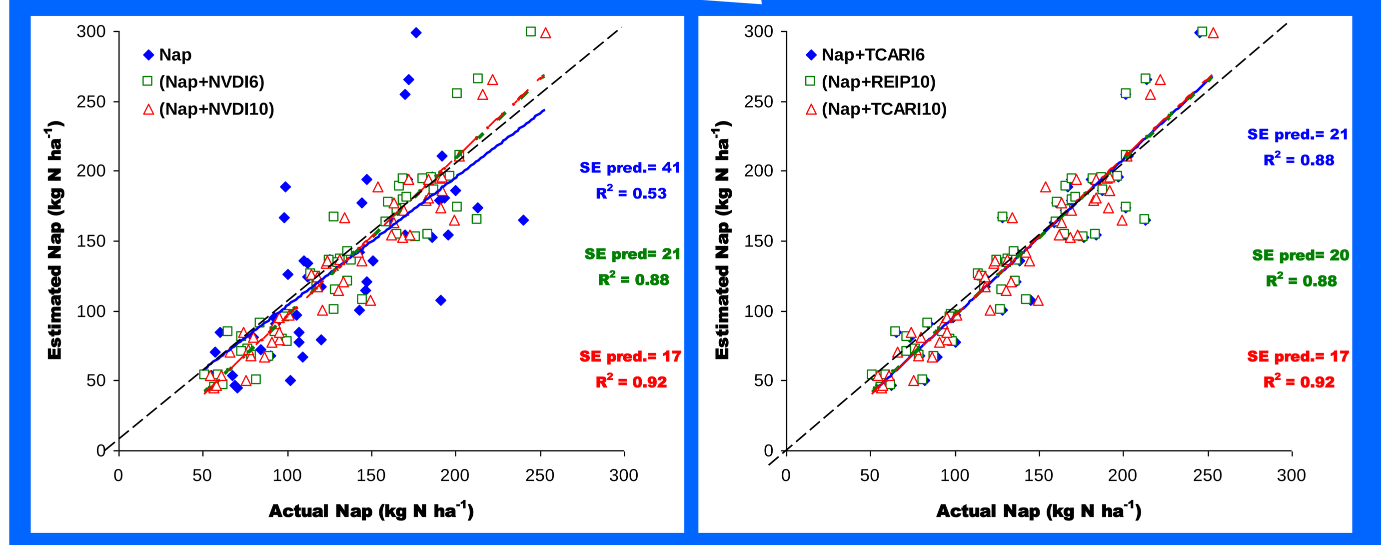


Figure 2 and 3: Cross Validation (kriging and cokriging) for Nap.

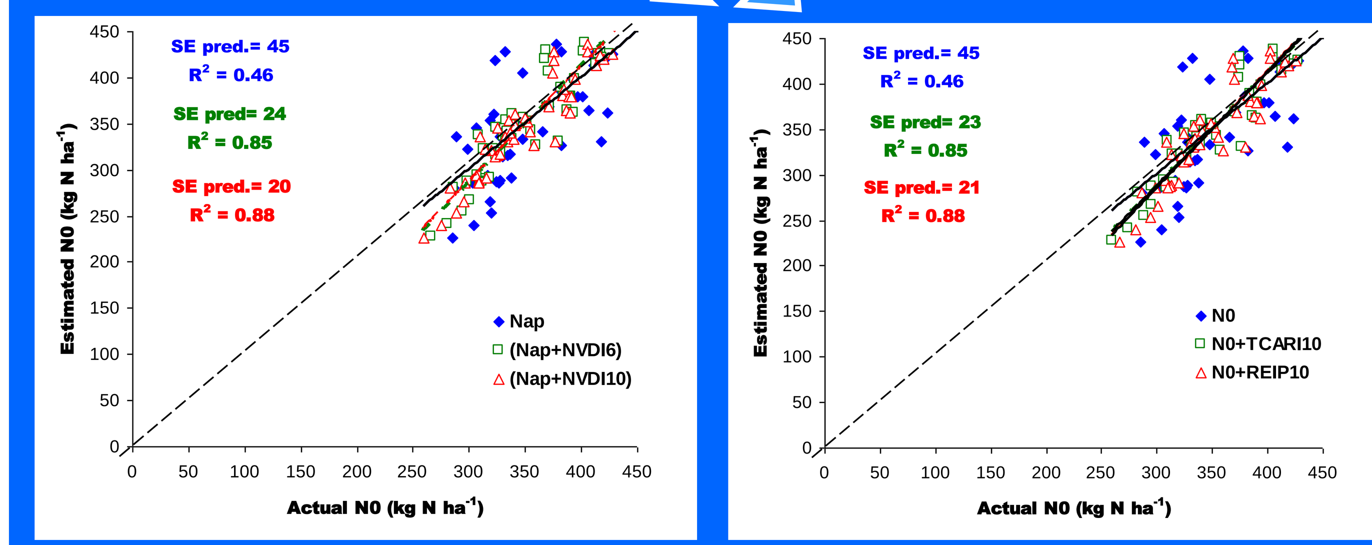


Figure 4 and 5: Cross Validation (kriging and cokriging) for N0.

CONCLUSIONS

In the Central Western Pampas, it is necessary to consider the variability in N mineralization to properly estimate rates of N fertilization. Spectral indices have improved the prediction of nitrogen mineralization within the field. The results are promising because have demonstrated that expensive soil measurements combined with secondary information, such as remotely sensed (spectral) data, and geostatistical techniques were adequate to map N mineralization at field scale.

This work was funded by UBACyT 20020100100757