Anais VIII Simpósio Brasileiro de Sensoriamento Remoto, Salvador, Brasil, 14-19 abril 1996, INPE, p. 17-18.

Zea mays yield prediction using satellite information and a simulation model

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Crop yield prediction represents an important instrument for making economical and technological decisions in agricultural production. It is also important for Governmental Organizations to analyze the annual market situation, specially those assigned to exportation.

Several studies demonstrated the advantages of satellite information and crop models to predict crop yield in extensive agricultural areas. The temporal resolution and low cost of satellite information derived from NOAA AVHRR images represents an advantage. However, it is difficult to distinguish land use with the spatial resolution obtained from these images. On the other hand, crop models, considering crop functioning have a high predictive capacity; but some input variables are not always available, so calibration works for local conditions are required.

The main objective of this study was to compare the predictive behavior of satellite information and a crop model (CERES-Maize) concerning the interannual variation of maize yields in the Pampas Region of Argentina.

We selected as study areas 5 counties of Buenos Aires Province with similar crop management conditions. In each county we processed the digital information derived from monthly NOAA AVHRR GAC images of South America and ran the Ceres-Maize model for the period 1981-1990.

For each study area we correlated the mean monthly NDVI (Normalized Difference Vegetation Index) from October to March with observed yields of maize. To run the model we considered a complete cycle hybrid, Dekalb 3S41, and the crop management that characterizes the whole region. Initial soil water content was set according to the occurred rainfall and the water accumulated in the soil during 4 months before planting.

January NDVI values showed the better association with the observed yields for each county (R^2=0.59) with a mean error of 3.91 qq/ha **(Figure 1).** There was no interaction NDVI-county, but a significant effect of the county. In this way we obtained five curves, one for each county, with the same slope but different y-intercepts. The differences observed in the y-intercepts could be related to regional climatic variability.

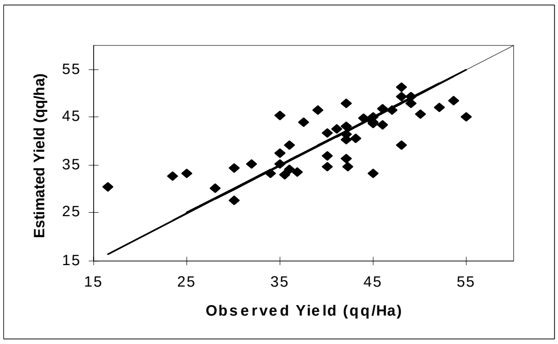

Figure 1: **Relationship between observed and estimated yields (qq/ha) by January NDVI derived from NOAA-AVHRR GAC images. (-) 1:1 .**

CERES-Maize predicted yields with a R^2=0.76 **(Figure 2)** and a mean error of 3.29 qq/ha, which represents an error of 8.2 % related to the mean observed data (40.37 qq/ha).

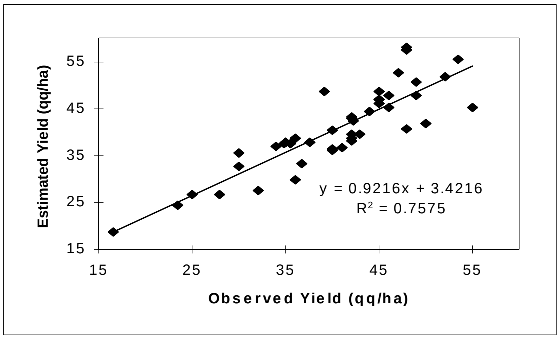

Figure 2: **Linear correlation between observed and estimated yields (qq/ha) using the CERES-Maize model.**

Comparing the results obtained with both methods, we observed that crop model simulation explained better the interannual variation of observed maize yields (r2=0.76 vs r2=0.59) than monthly NDVI. Also, comparing the Mean Absolute Error (MAE) and the Root Mean Square Error (RMSE) of both methods, Ceres-Maize performance was better in estimating maize yields **(Table 1).**

	CERES-Maize	NOAA-AVHRR
Obs. Mean	40.36	40.36
Est. Mean	40.62	40.36
N	45	45
MAE	3.29	3.91
RMSE	4.24	5.94
r^2	0.76	0.59

Table 1 : Comparative statistics parameters. Obs. Mean = Average of observed yields. Est. Mean = Average of estimated yields. N = Number of cases. MAE = Mean absolute error. RMSE = Root mean square error. r^2 = Regression coefficient.

The inputs necessary to run these models are not always available on a daily basis for the whole area. The satellite data, however, resumes in one monthly image the information needed to make the prediction.

We concluded that using satellite information together with other meteorological indexes (i.e. drought index) or as input for simulation models will improve maize yields prediction.

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