# USING fPAR AS MODELLING PARAMETER FOR TOBACCO YIELD ESTIMATION IN REGIONAL CROPPING AREAS


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**ABSTRACT.**

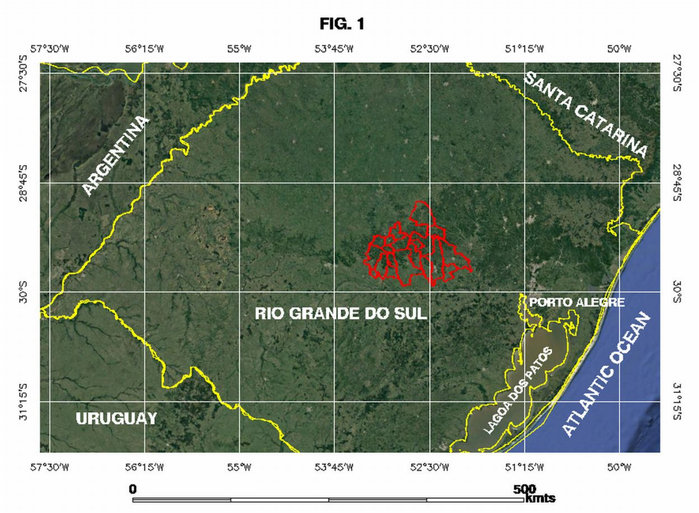
Remote sensing has shown its usefulness in many applications for the tobacco crop evaluation (bibl.) At present there are several satellital platforms offering to the analyst plenty of data covering spectral earth reflectance and spectral-derived parameters at different temporal, spectral and spatial resolutions. Of particular interest in agriculture are those parameters associated to the development and status of the crops as for instance different vegetation indexes (NDVI, EVI, SAVI,etc.), LAI, fPAR, etc. Such parameters can be evaluated at high (30m to 1 m or less) or low (250, 500m, 1km or higher) spatial resolution according the extension of the area of interest. The present paper deals with an area of ca. 72000 km$^2$ covering seventeen tobacco growing municipalities in Rio Grande do Sul State in Brazil. For studying such an extensive area it was worked with low spatial resolution data from NASA's MODIS instrument and selecting fPAR as modeling parameter. In some preparative phases it was also employed Landsat satellite imagery covering 30m x 30m per pixel.

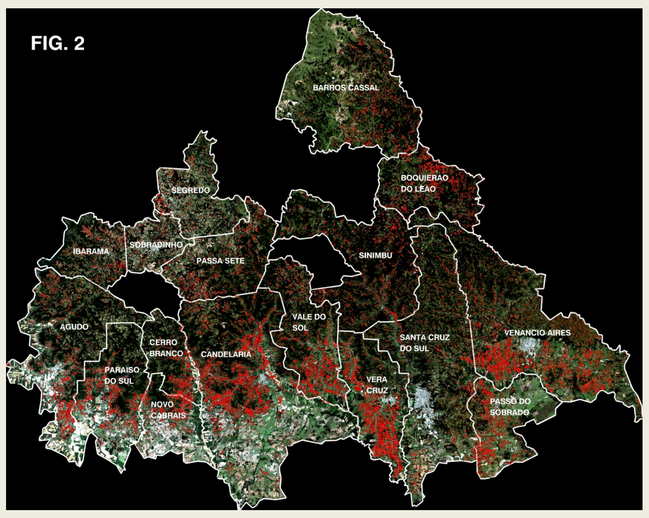

**SATELLITAL PLATFORM AND fPAR MODELING PARAMETER.**

The MODIS instrument (Moderate Resolution Image Spectroradiometer) operate on board of NASA´s *Terra* and *Acqua* solar synchronous satellites that orbit at 705 km over the Earth. Modis has 36 spectral bands covering from the visible to the thermal infrared spectra. According to the spectral bands considered the spatial resolution could cover 250, 500 or 1km. Application of the data obtained from these bands to specific algorithms generate more than forty products related with atmospheric, terrestrial and oceanic topics. MODIS has high temporal resolution, from daily data to global weekly and monthly compositions. The modeling parameter chosen was the proportion of available radiation in the specific photosynthetically spectral range of 400 to 700nm that a canopy absorbs (fPAR) and it is directly related to primary production without using mechanistic biome models. MODIS fPAR data are corrected for atmospheric effects and adjusted to nadir and solar angles. We employed 1 km as pixel spatial resolution.

**STUDY AREA AND DATA COLLECTION.**

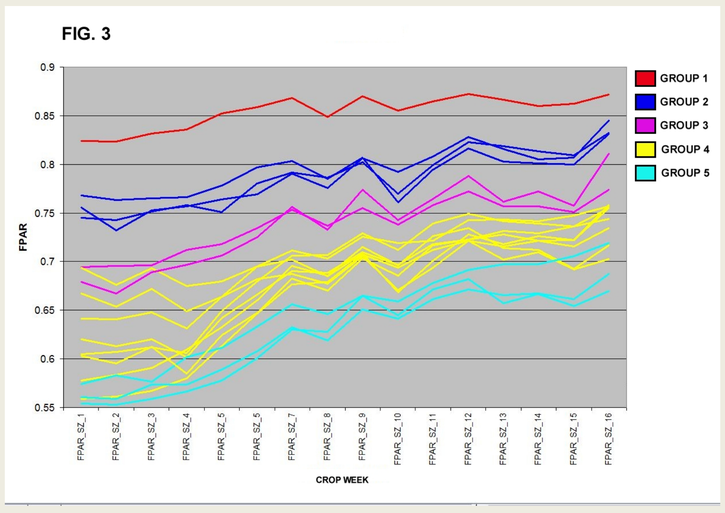
Fig.1 shows the covered area projected over a true color Landsat image. Fig.2 results from a thematic statistical classification showing in red color the tobacco planted areas. After their vectorization these areas were projected over a MODIS fPAR image to calculate the average of said parameter for every week during the total period of development (16 weeks). This process was applied to historic MODIS data for 9 consecutive tobacco crops (2002-2003 to 2011-2012)for the model calibration. Data of two additional crops (2013-2014 and 2015-2016) were added for validation. This data collection generated 2448 fPAR samples for calibration and 544 for validation.

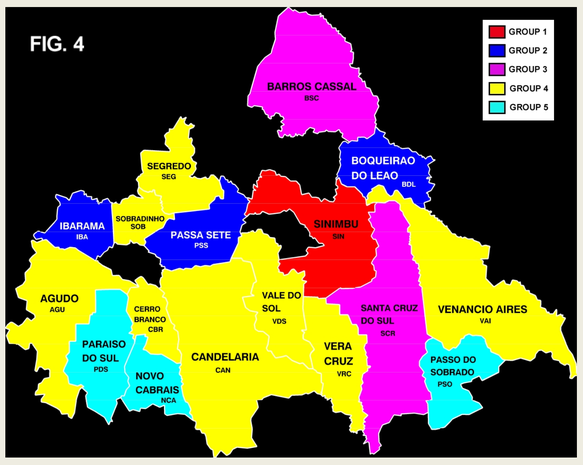


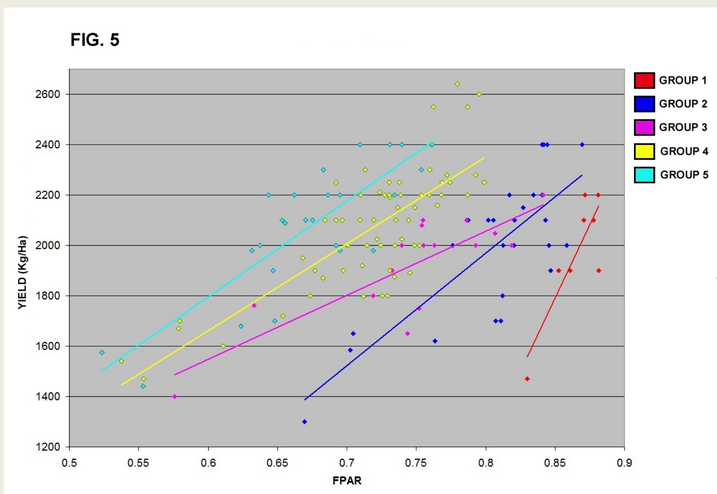




**CALIBRATION PROCESS.**

Considering the average weekly crop profiles for the various municipalities five groups of different behavior are evident. These are identified in the Fig.3 and Fig.4 with individual colors. The different behavior could be associated to various biome factors. For reducing the eventual "noise" associated to these factors it was decided to do separate calibrations for the five detected groups. Moreover, for increasing the "tobacco purity" of the tobacco crop pixels it was selected a week at the end of the crop period (15$^{th}$ week) for doing the calibration. The dispersogram in Fig.5 summarizes the regression lines (tobacco yield vs. fPAR) for the five groups. The "Earth true" for every group vas calculated with the data published for the *INSTITUTO BRASILEIRO GERAL DE ESTADISTICAS (IBGE).*




| GROUP | % ABS. ERROR | IN YIELD |
|---|---|---|
| | 2013 - 2014 | 2015-2016 |
| 1 | 1.0 | 4.0 |
| 2 | 7.0 | 7.0 |
| 3 | 5.1 | 7.2 |
| 4 | 6.0 | 6.3 |
| 5 | 8.6 | 5.2 |

Fig.6

**RESULTS.**

The evaluation of the method was done through the data from crops 2012-2013 and 2013-2014. The results obtained present the proposed method as a good alternative when compared with other remote sensing and terrestrial tobacco yield estimation methods, especially when dealing with very extensive regional areas. The absolute error for the five groups in the 2012-2013 crops and 2013-2014 crops are presented in Fig. 6.