CROP FORESCASTING ACTIVITIES AT INPE

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ABSTRACT

Agriculture plays an important role to the Brazilian economics and weights significantly in the Gross National Products; agricultural commodities are responsible for about 60% of the total exportation.Thus, timely and precise crop information is essential for decision-makers to take trade action. For the past 15 years, the Brazilian Institute for Space Research (INPE) had worked toward the goal of establishing a crop forecasting system using remotely sensed data. Results of research activities and on-going projects are presented in this paper.

Agricultural productions contribute significantly to national economics. Timely and precise information about crop condition, planting area and expected production are important parameters for decision-makers. These crop statistics,which are normally collected by conventional methods,are costly and time-consuming. With the launch of satellite - LANDSAT series, a new era begins for data acquisition considering the characteristics of the synoptic view and repetitivity of LANDSAT system. The Brazilian Institute for Space Research (INPE) is the organization responsible for LANDSAT data acquisition and processing; also a lot of efforts have been concentrated on research and technology transfer of remote sensing techniques.

One of the first research projects carried out in the agronomy group for crop survey purpose was executed in 1975. In this study LANDSAT digital data for the north of São Paulo State were investigated by an interactive image analysis system. In order to evaluate the cost-and-effectiveness of this crop area estimation system, ground information and CIR aerial photographs taken at the same time of LANDSAT pass were served as control to check the classification performance. The results not only provided basic information about crop distribution, sampling error and the statistical method for data analysis, but also defined the optimum scale and period for aircraft survey[1,2]. Agricultural damages caused by frost could be evaluated by remotely sensed data. In July 1975,when a severe cold struck southern Brazil,both CIR aerial photographs and LANDSAT digital data,in the northwestern of Parana State,were used to evaluate crop damage. The damaged coffee crop showed a unique spectral response and could be easily identified using

the interactive image analyzer. Wheat was also classified, but the discrimination of the damaged wheat from undamaged was not quite successful. However, 3 phenological stages of wheat were separated by CIR aerial photographs and each wheat stage was associated with a different percentage of crop loss. In this manner crop loss, due to frost damage of the whole study area, could be evaluated[3,4]. CIR aerial photographs were also used to detect the "fumagine" disease (Capnodium citri, Webber) on citrus. The infested trees showed a brownish color on CIR photographs[5].Since 1977 sugarcane is the principal study target due to its importance for the national energy program. After several experiments a methodology for sugarcane visual interpretation using multitemporal LANDSAT imagery (1:250,000) was established. Sugarcane inventory of São Paulo State was carried out for the crop year 1978-79 and 1979-80. So far we are at the technology transfer stage and the application of this methodology for a multistate region will be tested. It is expected that in 1986 this system of sugarcane area estimation will be operational for the whole country[6,7].

In order to test the computer-aided classification system for crop area estimation, wheat in Cruz Alta, Rio Grande do Sul State,was studied. In this project various classifiers and spatial filtering were investigated[8,9] and the feasibility of using regression or ratio estimate was evaluated. The optimum size of sampling unit and the number of units required to satisfy a prefixed precision and accuracy were studied. The results showed that LANDSAT data could serve as an auxiliary variable for regression estimate[10]. In addition to crop identification and area estimation,LANDSAT data can also be

used to identify irrigated area[11] and plowed soil[12]. The experiment of bare soil was conducted to verify whether pre-planting LANDSAT data could be used to estimate the area for summer cropping based on the plowed soil. The advantage of using preplanting LANDSAT data is to avoid the problem of cloud coverage which frequently occurs in the summer. The results were encouraging; the estimated "will-be" crop area incorporating with the farmers' planting intention could provide parameters for early season crop forecasting.

Research efforts were also made toward the R&D of crop yield estimation. Empirical crop-weather regression models using monthly mean of meteorological data for corn[13] and soybeans[14] were constructed for the Regional Agricultural Division (DIRA)of Ribeirão Preto. These models explained 91% yield variation for corn and 83% variation for soybeans. However, the adverse climatic change occurs normally in a short time period, thus the substitution of monthly means for weekly means should improve the model predicability. An experiment showed the expected results[15]. This statistical regression approach is simple to operate but for areas where confident long-term historical data are not available, a good yield model for estimation purpose is hard to obtain. Therefore, an agrometeorological model based on crop water use and yield response was also studied[16]. In this study the estimated sugarcane yield was calculated according to the relationship among the actual evapotranspiration,the maximum evapotranspiration,the yield response factor and the maximum expected harvested yield. The difference between the yield estimate obtained from the agrometeorological model and the information provide by sugarcane mills was 2.5%. Another

approach of sugarcane yield estimation using LANDSAT spectral data was also evaluated. The rationale behind this approach is that secondary productivity is proportional to vegetation production. Various vegetation indices were derived from LANDSAT spectral data and significant correlations ($\alpha = 0.05$) were found between most of the vegetation indices and sugarcane yield[16]. Besides spectral data in the visible and near infrared wavelengths, thermal infrared data are also efficient for crop stress detection. A field experiment result showed that this information could be useful to irrigation management and corn yield estimate[17]. With the advance in remote sensing technology more experiments using TM, SPOT or microwave data should be studied. Future researches will emphasize on the development of a multicrop forecasting system. To achieve this goal, activities such as stratification, definition of sampling approach, multicrop identification/classification method, data storage/ retrieval and area/yield aggregation will be performed.

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