# REGIONAL YIELD PREDICTION OF WINTER WHEAT BASED ON RETRIEVAL OF LEAF AREA INDEX BY REMOTE SENSING TECHNOLOGY

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**Abstract:** Crop yield data is a key indicator for national food security and sustainable development of society. Winter wheat is one of the most important main crops and Huanghuaihai Plain is the most important productive region in North China. Because the crop leaf area index (LAI) has a close relation with plant transpiration and photosynthesis, many researches have shown that the LAI indicator can effectively reflect crop growth condition and is one of most important parameters to predict crop yield and that it has a better relationship with crop yield. So, depending on the crop LAI in critical growth stage can predict crop yield more accurately. But most of these above conclusions were drawn from the results in smaller region. In this paper, we would attempt to have a research on regional winter wheat yield prediction based on retrieval of leaves area index depending on 10-day EOS/MODIS NDVI data in the Plain at a larger scale.

Our study region was located in Hengshui City which included 11 counties in the Plain. We also distributed some field measured point in the 11 counties in the year of 2004, 2007 and 2008. In the three years, the number of field measured point was 32, 50 and 55 respectively. During the process of field observation, we measured the crop LAI in each critical growth stage of winter wheat and the final yield.

Firstly, the relationships were established between the measured LAI of each critical growth stage and final crop yield. The critical growth stage of winter wheat included reviving stage, jointing stage, booting stage, heading stage, flowering stage and milk stage. After analyzing the statistical parameters, we selected out the best model and best period for winter wheat yield prediction based on the retrieval of leaves area index. During the research, the data of the year of 2004 and 2007 was used to establish the relationships while the data of 2008 was used to validate these models.

In order to increase the accuracy of each model between measured LAI and final yield in critical crop growth stage, we improved the quality of measured LAI and 10-day MODIS-NDVI. Considering the

difference and variation of crop phenology and observation time in each measured point, we interpolated the field measured LAI in each point in time dimension and got the LAI of winter wheat of each day. Then we calculated the average LAI of each critical growth stage considering crop LAI of each day. In this process of time interpolation, we used the Gaussian model to simulate curve of LAI in the whole crop growth process according to the crop growth curve essential features. Finally, the accuracy of LAI simulation was more than 91% and it could meet the basic data need of crop yield prediction. In order to improve the quality of 10-day MVC MODIS-NDVI, especially to eliminate the cloud-contaminated data and abnormal data in the MODIS-NDVI series, the Savitzky-Golay filter was applied to smooth the 10-day NDVI data.

At present, the method of retrieving LAI includes empirical model, radiation transfer (RT) model, lookup table (LUT) method and neural network (NN) method. Although each method has its own strongpoint and shortcomings, the empirical model is more prevalent in modeling the relationship between LAI and vegetation index (VIs). The NDVI index was more widely used in this domain. So, in this paper, we used the curve estimation module of SPSS software to establish the relationship between the winter wheat field measured LAI and MODIS NDVI data and retrieved the LAI for each critical growth stage.

Finally, we predicted the winter wheat yield of the year of 2008 in our study region. Compared with field measured winter wheat yield, the relative error of yield estimation was between -5.42% and 4.83%, and RMSE was 257.33 kg/ha. We could draw a conclusion that this method of crop yield prediction based on the retrieval of LAI by remote sensing technology was relatively accurate and feasible. It was very significant to learn the regional winter wheat yield in the pre-harvest time.

**Key words:** leaf area index; MODIS; NDVI; yield prediction; winter wheat; Gaussian model; Savitzky-Golay filter