MAIZE YIELD FORECASTING IN MALAWI USING SATELLITE DATA AND A SOIL WATER BALANCE MODELLING APPROACH

By

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ABSTRACT

The potential of using Normalized Difference Vegetation Index (NDVI) and the AgroMetShell (AMS) to forecast and estimate maize yield at Rural Development Project (RDP) level in Malawi was investigated. NDVI is derived from the National Oceanic and Atmospheric Administration (NOAA) series of polar-orbiting satellites. AMS is a soil water balance water balance modeling software that produces a number of output parameters (potential yield predictors) that can be used to develop regression models for yield estimation and or forecasting.

Using climatic, NDVI and yield data for the years 1983 to 2004, NDVI parameters were correlated with rainfall and yield to establish NDVI-rainfall and NDVI-yield relationships. NDVI parameters tested include cumulative, seasonal maximum, seasonal averages, dekadal and monthly increments, and dekadal and monthly values. Overall, most of the NDVI parameters tested gave little or no correlation with maize yield in most RDPs. Dekadal and monthly NDVI values were found to be positively and significantly correlated with maize yield especially towards the end of the growing season (March and April) for a number of RDPs. Regression equations were developed for only eight of the thirty RDPs in which high correlations were observed for consecutive dekads. There was no consistency in the RDPs giving high correlation from one NDVI parameter to the other. Between the hybrid and local maize varieties no variety took precedence over the others in giving higher correlations. For the few regression models developed, the coefficients of determination (r^2) ranged from 0.23 to 0.54.

AMS output parameters were correlated then regressed with maize yield at RDP level. Similar combinations of parameters were used for all the RDPs in a particular agroclimatological zone. Soil water deficit and actual evapotranspiration during the reproductive phases were identified to be critical in yield determination for most areas. RDPs with high values of r^2 were distributed across the country but the Lakeshore and Shire Valley areas had most of the RDPs giving significant r^2 values. The 1983/84 to 2001/02 seasons were used to develop regression models for maize yield estimation and forecasting. Hybrid maize regression models gave higher r^2 than the local maize models. r^2 values for AMS parameters and maize yield ranged between 0.08 and 0.82. For hybrid maize variety, 19 out of 30 RDPs gave $r^2>0.40$ while for the local variety, 15 out of 30 RDPs realized $r^2>0.40$. The standard errors for the regression models were higher for the hybrid than for the local variety. The models were tested with data from the same seasons used to develop them. In most RDPs the models simulated the yield well. Models were also tested with independent data (for 2002/03 season). In the majority of the RDPs tested, the errors of prediction fell within the standard error bands.

For the eight RDPs where regressions were done for both approaches, generally the AMS-developed yield models gave higher r^2 values compared to the NDVI-developed models. The AMS approach can be recommended for yield estimation and prediction in Malawi, while the NDVI approach needs further refinement before it can be implemented on an operation level.