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Use of remote sensing derived parameters in a crop model for biomass prediction of hay crop

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Pre-harvest yield forecasting is a critical challenge for producers, especially for large agricultural areas. During previous decades, numerous crop models were developed to predict crop growth and yield at daily time, most often for wheat or maize, and also for grasslands. Crop models require several input parameters that describe soil properties (e.g. field capacity), plant characteristics (e.g. maximal rooting depth) and management options (e.g. sowing dates, irrigation and harvest dates), which are referred to as the soil, plant and management families of parameters. Remote sensing technology has been extensively applied to identify spatially distributed values of some of the accessible parameters in the soil, plant and management families.

The aim of this study was to address the feasibility, merits and limitations of forcing remote-sensing-derived parameters (LAI values, harvest and irrigation dates) in the PILOTE crop model, targeting the Total Dry Matter (TDM) of hay crops.

Results show that optical images are suitable to feed PILOTE with LAI values without inducing significant errors on the predicted Total Dry Matter (TDM) values (Root Mean Square Error "RMSE" = 0.41 t/ha and Mean Absolute Percentage Error "MAPE" = 22%). Moreover, optical images with revisit times lower than 16 days are adequate to feed PILOTE with remotely sensed harvest dates (RMSE < 0.44 t/ha, MAPE < 10.8%).

Finally, feeding PILOTE with noisy irrigation dates that were estimated from SAR images also enabled reliable model predictions, at least when attaching a random uncertainty of "only" 3 days to the real known irrigation dates. The case of one or several undetected irrigations has also been explored, with the expected conclusion that undetected irrigations significantly affect model predictions only in dry periods. For the tested soil properties and climatic conditions, a maximum underestimation of TDM of approximately 1.55 t/ha (reference TDM of 3.43 t/ha) was observed in the second crop growth cycle when ignoring two irrigations out of four in this same cycle.

Keywords: Crop model, PILOTE, Forcing, Remote Sensing, Hay, Biomass.