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A simple decision support web-application for precise nitrogen application in durum wheat cultivation

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Introduction

Decision support systems (DSS) based on the use of crop simulation models, coupled with seasonal weather forecasts, can provide more reliable crop response predictions as regards N fertilization, thus enabling farmers to adjust the timing and the amount of N to be distributed, reducing wastes and increasing profitability. We implemented a highly automated web-based DSS, which integrates proximal sensing data, seasonal weather forecasts and crop modelling, in order to produce in-season estimates of N prescriptions for durum wheat.

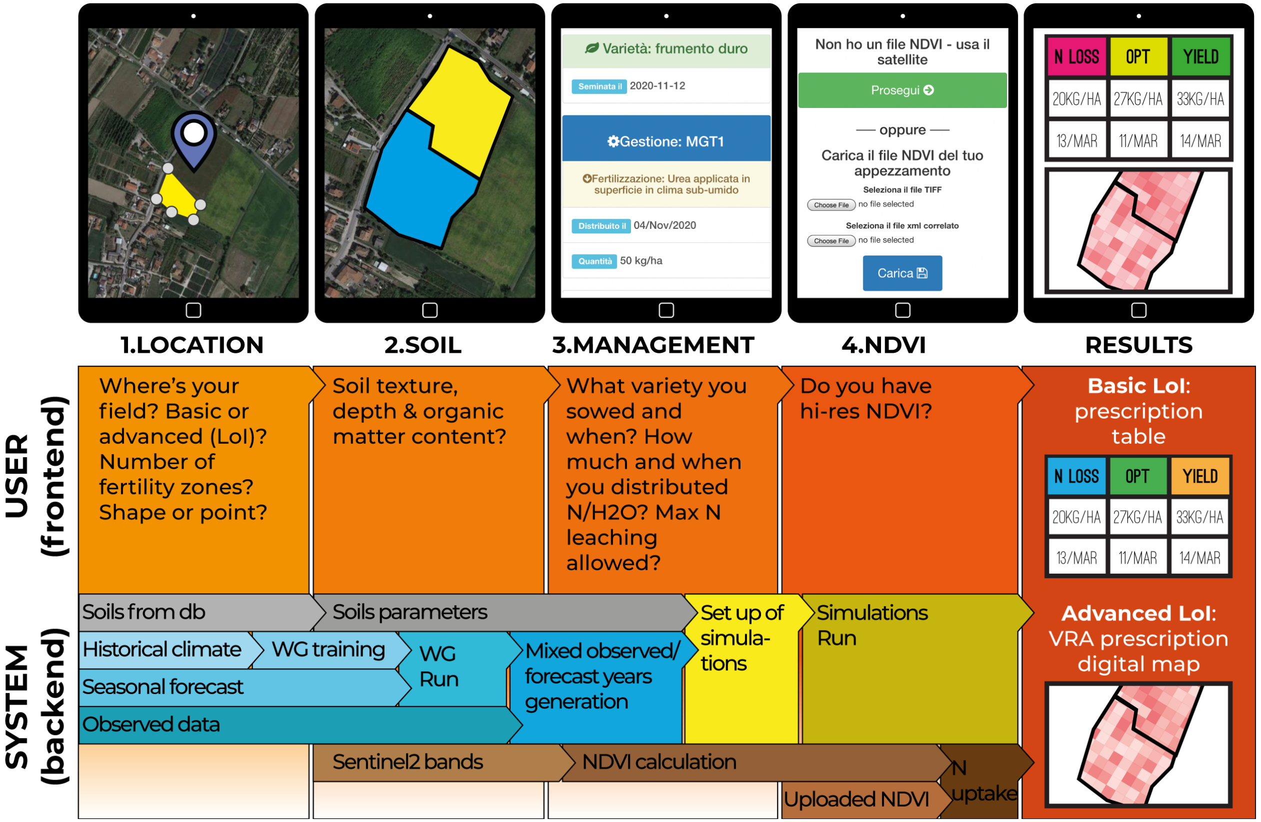
Materials and Methods

Each DSS run calculates the amount of N to be distributed in areas with homogeneous soil characteristics (FZ) by estimating the potential crop N uptake at the end of the season and the actual N taken up right before the fertilization date. A process-based crop simulation model is coupled with seasonal forecasts (i.e. a set of monthly anomalies of meteorological variables for the months ahead). The crop model is fed with observed weather data (at the time of the run), joined with a set of weather data generated according to the seasonal forecast. The actual crop N uptake is estimated from normalized difference vegetation index (NDVI) maps acquired at the time of the run, whose values are then converted to crop N uptake with an exponential relationship. The system first defines three optimum N rates, based on maximization of yield, or economic revenue, or minimization of N leaching (environmental criteria) respectively. For each of them, and for each FZ, the amount of N is calculated as the difference between the simulated N uptake at the end of the season and the actual N uptake right before the fertilization date, corrected by a N fertilization efficiency factor.
The DSS has 3 integrated modules (the crop simulation, the weather and the N prescription), 4 databases (crop varieties, meteo, soils, NDVI) and the graphical user interface (GUI).

The data to feed the model are mostly gathered automatically (from local and remote databases) on the basis of the few information the farmer is required to provide (the location of the field and the management of the crop, i.e. the sowing date, the cultivar, and any previous N and water application in terms of dates and amounts). 100 forecast daily weather series are generated for each run. To identify the optimum N rate to supply, a sensitivity analysis is performed with increasing N amounts for each of the 100 combined observed-forecast years. Finally, the ensemble mean is calculated and used as the estimator of final crop yield and N uptake.

Results

The user can choose between 2 levels of interaction with the DSS: basic and advanced. Both need only 4 steps in order to produce the results, prescription table or maps, depending on the level chosen.



Conclusions

The DSS is able to reproduce real-world dynamics with very few information, and therefore time, from the user. This is accomplished thanks to the high automatization of the system in retrieving and managing all the information needed.

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