Forecasting tool used by the UN expands its range of crops to include alfalfa

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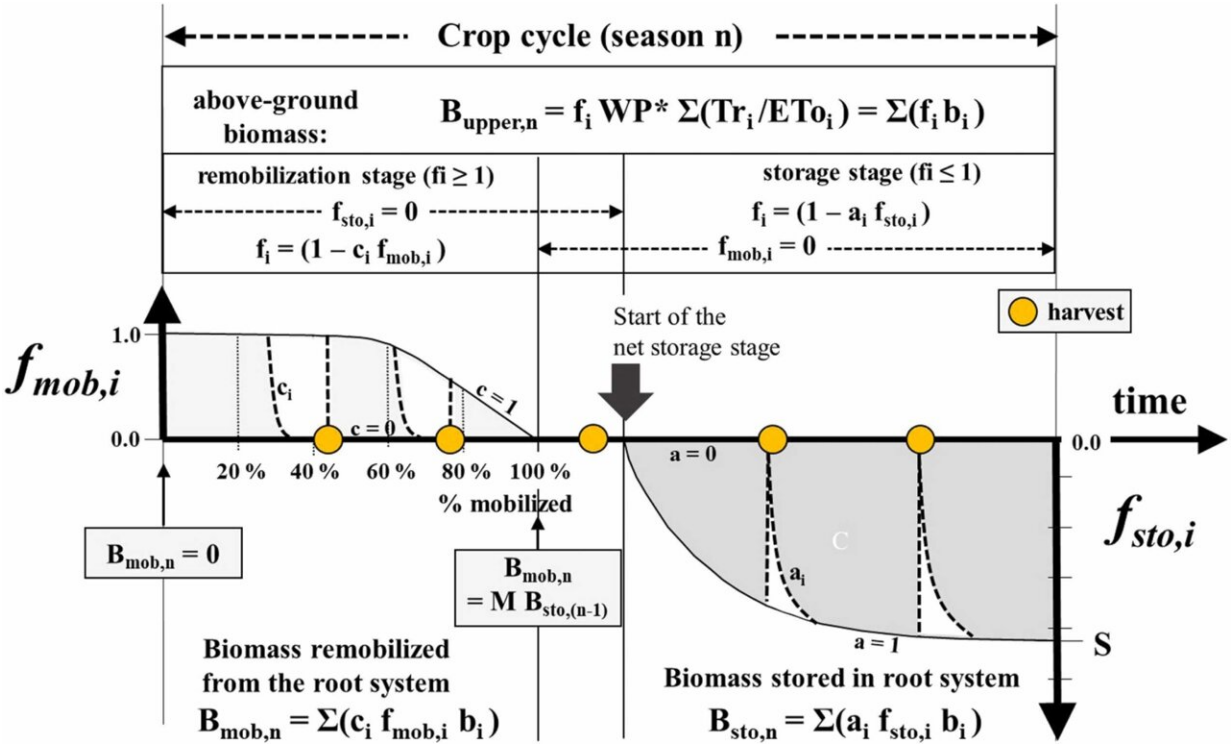

Schematic representation of the simulation of the total above-ground biomass ($B_{upper,n}$) in the nth season, for alfalfa. During the spring (net remobilization stage), the transfer to the above-ground parts of the Mth fraction of the assimilates stored below ground in the previous season ($B_{sto,(n-1)}$), is simulated by increasing the biomass at day i (b_i) with a fraction (c_i $f_{mob,i}$). To stimulate growth, the adjustment factor c_i is 1 as long as CC increase. When the maximum canopy cover is reached, c_i is zero and remobilisation is halted. From mid-season (start of the net storage stage), a fraction (a_i $f_{sto,i}$) of b_i is stored in the root system. The adjustment factor a_i for regrowth is zero on a day of harvest, and gradually increases to 1 during regrowth. Credit: *Agricultural Water Management* (2023).

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The Department of Agronomy at the University of Cordoba, together with the IAS–CSIC, has improved the AquaCrop growth simulation model used by the UN by introducing the option of simulating alfalfa yield with precision.

AquaCrop is the crop model created by the UN's Food and Agriculture Organization (FAO). Playing an essential role in its development was Elías Fereres, a Professor Emeritus in the María de Maeztu Unit of Excellence at the University of Cordoba's Department of Agronomy (DAUCO). This model, which after almost 20 years of life is the second most used in the world in research, allows simulating the response of crop yields according to climate, soil and irrigation management, something very important in areas where water is a limiting factor in production.

Until now, this model only allowed user the ability to simulate the yield of annual crops (herbaceous crops with annual cycles), but not perennial crops. This has changed, thanks to new work by the DAUCO and IAS–CSIC, which includes the simulation of alfalfa in AquaCrop, offering valid crop yield predictions for different climates and zones.

Alfalfa is a perennial forage crop that lasts three to five years in Mediterranean climates, and is cut several times each year, as it resprouts again (four to eight cuts per year). To model the life cycle of this crop and to be able to predict harvests, "there were two main challenges in the simulation, which were these periodic cuttings and resprouting during the same season, and the fact that alfalfa, as a perennial crop, stores reserves in autumn and uses them in spring to grow, so growth in spring is not only determined by photosynthesis, but

also by these reserves that the plant stores," explained Professor Fereres.

Therefore, it was necessary to include in the model a routine describing both the transfer of photo assimilates between the aerial part and the underground storage organs, and the plant's use of these assimilates for growth.

Yield data collected in Belgium, Turkey and Canada for different alfalfa cultivars, various years, and different field and irrigation management strategies, was used to calibrate the model. To verify this model, 81 yield data points across different climates, varieties, zones, and irrigation schedules were used, which constitutes a robust tool for predicting alfalfa production in different environments. The paper is published in the journal *Agricultural Water Management*.

"The results were very good after this verification. We were able to simulate the performance with very good correlations between the simulated and the real data obtained," Fereres said, since no systematic overestimation or underestimation was detected by the model.

AquaCrop's future challenges

By introducing the variables of crop, climate, soil and irrigation management (whether there is water or not and, if there is, how irrigation is distributed) it is possible to simulate the maximum yield that might be obtained in each case. In this way, irrigation can be adapted to optimize management for greater production.

"After 20 years of use it is a very well optimized application, which has been tested on many crops, and in many environments, and the evidence supports that it works well and is getting better," says Fereres about the application, whose seventh version has just been released, now including the option of modeling alfalfa yield.

In the future, the application could be adapted to include woody crops, a challenge, according to Fereres, who says, "Since simulating the production of trees is very difficult due to the phenomenon of alternation (trees produce more one year and less the following),and because tree production is determined by the growth and development of previous years."

More information: Dirk Raes et al, Simulation of alfalfa yield with AquaCrop, *Agricultural Water Management* (2023). DOI: 10.1016/j.agwat.2023.108341

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