APPLICATION OF THE SIMULATION MODEL CROPSYST TO AN INTENSIVE FORAGE SYSTEM IN NORTHERN ITALY

R. Confalonieri, T. Maggiore, L. Bechini

Department of Crop Science, University of Milano, Via Celoria 2, 20133 Milano, Italy.

Introduction

The increased animal farming intensity in european agriculture occurred in the last decades can threaten the quality of surface and ground water, in particular for the risk of nitrate leaching and nutrient surplus (Borin et al., 1997; Grignani and Zavattaro, 2000). Cropping system simulation models (eventually supported by GIS) are useful tools to provide indications for manure and fertilizers management. Simulation models were used in Italy with different crops, soils, weather and management conditions; however, most works carried out in northern Italy did not consider forage systems, no references exist for the simulation of the intensive rotation Italian ryegrass - silage maize and few works are available for systems including perennial crops like alfalfa. The objectives of this work were to set up and evaluate the performances of the model CropSyst (Stockle and Nelson, 1999) in simulating crop growth and water - nitrogen (N) balances for two forage systems in northern Italy.

Methods

To calibrate and test the model we have used data collected in Lodi, northern Italy, (latitude 45°19' N, longitude 9°28') between 1995 and 1999, on a 5-year ongoing experiment which compared a 1-year forage rotation (Italian ryegrass - silage maize) and a 6-year forage rotation (3 years of Italian ryegrass - silage maize and 3 years of alfalfa). The experimental factors (solid or liquid manure and top dressing given or not) are arranged in a split-split-plot design with three replicates. The soil is sandy-loam. The measured variables are: crop biomasses (DM) and plant N concentration (PNC) at harvest/clipping; soil mineral N content (SNC) and soil water content (SWC) periodically during crop growth (at 0-30 cm and 30-60 cm depth). CropSyst is a deterministic cropping system simulation model, with daily time step; it predicts crop growth and development, and related water and N budgets. The version 2.02.31 (September, 1999) was used. Alfalfa crop parameters were calibrated by using data from the first 2 years of alfalfa meadows seeded in 1996 and 1997. The data from the third year were used to test the model. Maize crop parameters have been calibrated by Bechini (1999). Italian ryegrass crop parameters were calibrated by using unpublished data from five field experiments carried out in Lodi between 1992 and 1999 (experiments cited in Bechini et al., 2001). The cascade infiltration model was preferred to the solution of the Richard's equation because it was found more stable. To calibrate model parameters involved with water infiltration and N transformations in the soil (field capacity, mineralization rate adjustment and nitrification rate adjustment), data from the first year were used; the other experimental data were used to test the model. The agreement between observed and predicted values was expressed by using the indices proposed by Loague and Green (1991) and by the parameters of the regression equation.

Results

Model performance after calibration of alfalfa crop growth parameters is shown in Figure 1: although the effects of root reserves (crown) on spring re-growth are not codified in this simulation model, biomass accumulated in the first cut of the year is well predicted. Simulated and measured yields are significantly different only for the last cut of the second year. Agreement between measured and simulated alfalfa PNCs after calibration is shown in the table: the model is not reliable because the increasing N

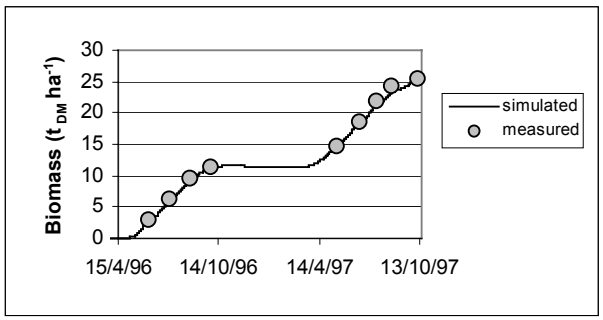

Figure 1. Measured and simulated cumulative harvested biomass for the first two years of alfalfa meadow (solid manure)

concentration from spring to autumn is not reproduced and an almost constant value is simulated. Test of alfalfa calibrated parameters on the third year of data gave the results shown in the table. Some examples of model application to the whole rotation (treatment: solid manure without top dressing) are shown in Figure 2 (DM) and in the table.

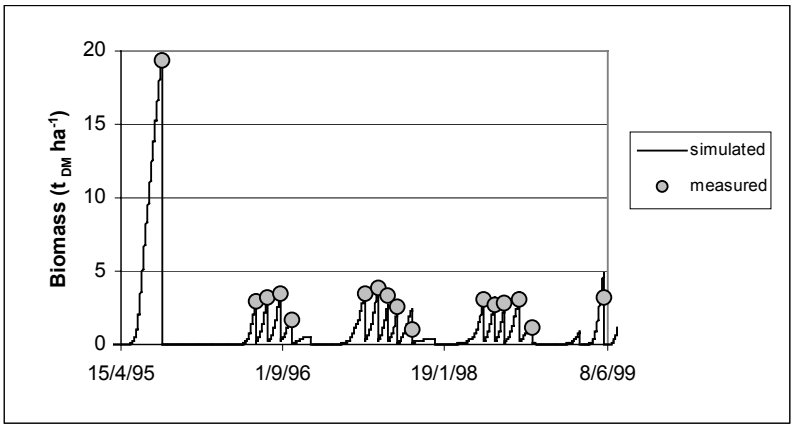

Figure 2. Measured and simulated harvested biomass for the forage rotation: silage maize, 3 years of alfalfa, Italian

Variables	RRMSE (%)	EF	CRM	CD	Slope	Intercept	R2
SWC, 0-30cm	17	0.26	-0.05	1.01	0.68	0.09	0.43
SWC, 30-60cm	19	0.24	-0.05	1.83	0.80	0.04	0.31
SNC, 0-30cm	151	-1.02	0.04	1.42	-0.23	20.43	0.04
SNC, 30-60cm	191	-3.06	-0.55	0.48	-0.27	15.58	0.13
PNC, maize, 1995	32						
PNC, alfalfa, 1996-98	12	-0.19	0.04	3.87	0.31	2.07	0.01
DM, maize, 1995	2						
DM, alfalfa, 1996-98	33	-0.17	-0.13	0.70	0.51	1.16	0.32
DM, ryegrass, 1999	1						
DM, alfalfa, 1998 (test)	51	-2.20	-0.38	0.23	0.41	1.10	0.46
DM, alfalfa, 1999 (test)	35	-2.87	0.23	0.40	-0.20	3.28	0.03

Discussion and conclusions

The agreement between observed and simulated data was not satisfactory for most of the variables. Simulation of soil variables was more precise for the 0-30 cm layer. Alfalfa biomass at cuts was accurately simulated almost always. Even if in this work the date of cutting was specified by the user, a modification for the model is proposed for automatic scheduling of clipping according to thermal time (alfalfa is normally cut at flower bud stage).

References

Bechini L., 1999. PhD thesis, Department of Crop Science, University of Milano.
Bechini L. et al., 2001. These proceedings.
Borin M. et al., 1997. European Journal of Agronomy, **6**:1/2, 101-112.
Grignani C. and Zavattaro L., 2000. European Journal of Agronomy, **12**:3/4, 251-268.
Loague K.M. and Green R.E., 1991. Journal of Contaminant Hydrology, **7**, 51-73.
Stöckle C.O. and Nelson R., 1999. CropSyst User's Manual. BSYSE, WSU, Pullman, WA, USA.

We acknowledge Dr. Cesare Tomasoni, Dr. Lamberto Borrelli and Dr. Pietro Marino Gallina.