Development of Agro-Forestry Models to assess productivity and environmental protection capacity

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Background:

Many agricultural and silvicultural models were developed during the last 50 years. However, only a few agro-forestry models have been made available in the last two decades while the available models describe the involved processes in a rather simple way.

Materials and Methods:

- Agro-forestry system (grassland and trees) at Reiffenhausen, Germany
- Measurements of soil water contents, biomass growth and nitrification in the tree strip as well as in 1m and 4m distance
- Simulation of tree growth (TreeDyn) and grassland growth (Hurley-Pasture) including the shadowing function of the new Expert-N agro-forestry module

Objectives:

- Description of agro-forestry systems by use of an improved process-based soil-plant system model
- Simulation of crop and grassland growth in the transition zone between trees and crop/grass

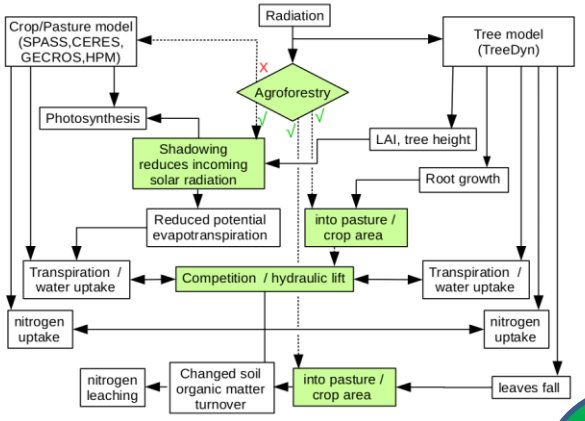

Fig. 1 Flowchart of the Expert-N agro-forestry module

Results:

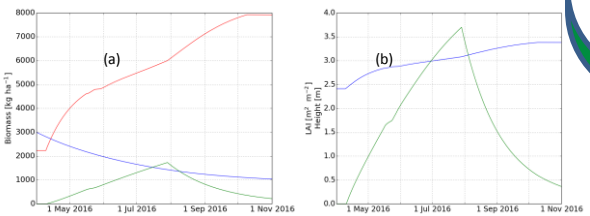

Fig. 2 Simulations of tree growth: (a) Wood (solid red line), leaves (solid green line), roots (solid blue line) and (b) Tree height (solid blue line) and leaf area index (solid green line)

Distance from tree strip	1m			4m		
Harvest dates	With AF module	Measured	Without AF module	With AF module	Measured	Without AF module
6 June	4249	4154	6086	5190	4986	5854
20 July	1223	1067	3769	2708	2242	2937
28 September	571	679	3440	2535	1706	2930

Tab. 1 Simulated (with and without agro-forestry module) and measured grassland harvest (kg ha^{-1}) at 3 harvest dates in 2016.

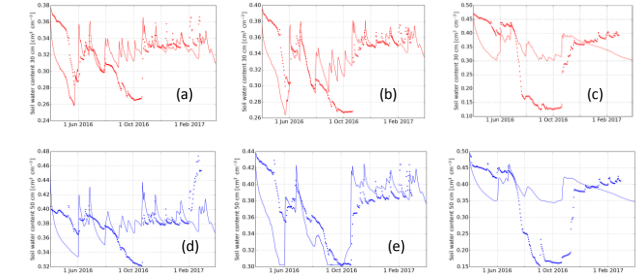

Fig. 3 Measured (large dots) and simulated (thin solid lines) soil water contents in 30cm depth (first row, red) and 50cm depth (second row, blue): (a), (d) 1m and (b), (e) 4m distance from tree strip, (c), (f) tree strip

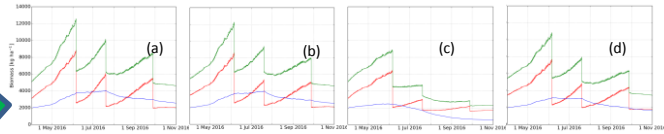

Fig. 5 Simulations of grassland biomass: Total (solid green lines), above ground (solid red lines), roots (solid blue lines). Without agro-forestry module (a and b) and with agro-forestry module in (c) 1m and (d) 4m distance from tree strip; same soil configuration for (a) and (c) as well as for (b) and (d).

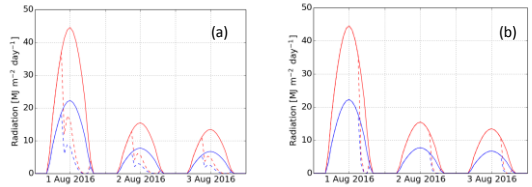

Fig. 4 Solar radiation (red lines) and simulated PAR (blue lines) without (solid lines) and with (dashed lines) reductions due to shadowing by the agro-forestry module using tree height and LAI simulations: (a) 1m and (b) 4m distance from tree strip

Summary and outlook: The application of the Expert-N agro-forestry module strongly changes the simulations of grassland growth, especially when the distance to the tree strip is small. With the future integration of more processes, impacts of various management options on soil and ecosystem properties of agro-forestry systems can be analyzed by the new model.