The WAVE-model (Water and Agrochemicals in the soil and Vadose Environment), simulating one-dimensional transport of water, solute and heat in the unsaturated zone, was used to simulate the behaviour of water and nitrogen in soils cropped with winter wheat and sugar beet. Soil water transport was modelled using the Richards equation, while solute transport was described with a convection equation. Soil mineral nitrogen transformations were simulated using first-order kinetics, while for the organic matter turnover three organic matter pools were considered. A summary model was used to simulate crop growth.

The performance of the integrated model was evaluated in a deterministic way using field data for a three-year period. The data of the first year were used for the model calibration. The remaining set of data was used to evaluate the capacity of the model to predict soil water content, the soil nitrate-N content, the soil ammonia-N content, the soil temperature, the soil water pressure head, the leaf area development and the dry matter accumulation in different plant organs. A screening sensitivity analysis indicated that the calculated nitrogen balance was sensitive to the soil hydraulic properties and the crop $K_c$-factors for the given scenario. The effect of uncertainty of the sensitive hydraulic properties on the calculated nitrogen balance was investigated using Monte Carlo simulation. Taken into consideration the variability on the soil hydraulic parameters, predicted nitrate-N flux out of the soil profile at a depth of one meter ranged for the simulated period (three years) between $-10$ and $+10$ kg ha$^{-1}$. 