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Assessing the sustainability of wheat-based cropping systems using APSIM: model parameterisation and evaluation

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Abstract. Assessing the sustainability of crop and soil management practices in wheat-based rotations requires a well-tested model with the demonstrated ability to sensibly predict crop productivity and changes in the soil resource. The Agricultural Production Systems Simulator (APSIM) suite of models was parameterised and subsequently used to predict biomass production, yield, crop water and nitrogen (N) use, as well as long-term soil water and organic matter dynamics in wheat/chickpea systems at Tel Hadya, north-western Syria. The model satisfactorily simulated the productivity and water and N use of wheat and chickpea crops grown under different N and/or water supply levels in the 1998–99 and 1999–2000 experimental seasons. Analysis of soil-water dynamics showed that the 2-stage soil evaporation model in APSIM's cascading water-balance module did not sufficiently explain the actual soil drying following crop harvest under conditions where unused water remained in the soil profile. This might have been related to evaporation from soil cracks in the montmorillonitic clay soil, a process not explicitly simulated by APSIM. Soil-water dynamics in wheat–fallow and wheat–chickpea rotations (1987–98) were nevertheless well simulated when the soil water content in 0–0.45 m soil depth was set to 'air dry' at the end of the growing season each year. The model satisfactorily simulated the amounts of NO_3-N in the soil, whereas it underestimated the amounts of NH_4-N. Ammonium fixation might be part of the soil mineral-N dynamics at the study site because montmorillonite is the major clay mineral. This process is not simulated by APSIM's nitrogen module. APSIM was capable of predicting long-term trends (1985–98) in soil organic matter in wheat–fallow and wheat–chickpea rotations at Tel Hadya as reported in literature. Overall, results showed that the model is generic and mature enough to be extended to this set of environmental conditions and can therefore be applied to assess the sustainability of wheat–chickpea rotations at Tel Hadya.

Additional keywords: wheat, chickpea, Mediterranean, model evaluation, soil water, soil nitrogen.