

Article title	Simulating the impact of water saving irrigation and conservation agriculture practices for rice–wheat systems in the irrigated semi-arid drylands of Central Asia
Authors	K.P. Devkota , G. Hoogenboom , <u>K.J. Boote</u> , Upendra Singh , J.P.A. Lamers , M. Devkota , P.L.G. Vlek
Keywords	Water, Rice, Wheat
Abstract	<p>Resource scarcity (labor, water, and energy) and high production costs are challenging the sustainability of conventional methods for rice and wheat establishment in <u>Central Asia</u>. Water saving irrigation and conservation agriculture (CA) practices (e.g., dry seeded rice, zero tillage wheat, residue retention) are potential alternative, resource-saving establishment methods. The Decision Support System for Agrotechnology Transfer (DSSAT) Cropping System Model (CSM) can both be a valuable ex-ante and ex-post tool to evaluate the effects of water saving irrigation and resource saving CA-practices. The CSM-CERES-Rice and CSM-CERES-Wheat models of DSSAT were evaluated using experimental data from the 2008 to 2010 rice and wheat seasons as monitored in Urgench, the Khorezm region of Uzbekistan for growth, development of these crops, as well as soil mineral nitrogen (N) and volumetric soil moisture content in these cropping systems. Thereafter, the models were used to explore the long-term impact of water saving irrigation and CA-practices on grain yield, soil organic carbon (SOC) dynamics, N dynamics, and water balance in a rice–wheat rotation for 39 years starting from 1971. The simulation results showed that the simulated yield of water-seeded rice without residue retention and flood irrigation (WSRF-R0-FI) is likely to remain the highest and constant over 39 years. The simulated yield of dry seeded rice (DSR) with alternate wet and dry (AWD) irrigation and varying levels of residue retention was penalized for the initial years. However, the simulated rice yield increased after 13 years of CA-practices and continued to increase for the remaining years. Wheat did not experience a yield penalty for any of the treatments and simulated yield increased over time across all CA-practices based treatments. In the long-term, the effect of tillage methods and different residue levels for both rice and wheat were apparent in terms of grain yield and SOC build up. The results of the sensitivity analysis showed that WSR using AWD irrigation with puddling (WSRF-R0-AWD-Puddled) could give equivalent yield with that of WSRF-R0-FI and that irrigation water for rice could be reduced from 5435 mm to 2161 mm (or by 60%). Deep placement of urea in DSR (CT-DSR-AWD-DPUS) has the potential to increase yields of DSR by about 0.5 t ha⁻¹. Despite the huge water saving potential through the adoption of water saving AWD irrigation in DSR, a major challenge will be to prevent N losses. Substantial amounts of N losses through leaching, immobilization by residue mulch, combined with gaseous losses through volatilization and denitrification are the major causes for the lower simulated yield of rice for the AWD treatments. During the rice season, the implementation of water saving irrigation can improve water use efficiency by reducing percolation and seepage losses, which is an option in particular for WSRF-R0-FI. For both crops, the water use efficiency can be improved by lowering evaporation losses e.g. through residue retention on the soil surface. The creation of a sub-surface hard pan (puddling) and deep placement of urea super granules/pellet (DPUS) fertilizer could be the key for water saving and better yields of rice. Because CA-practices require almost three times less irrigation water than conventional method, and provide a long-term positive impact on grain yields of both</p>

	crops, the CA-practices should be considered for double, no-till, rice–wheat cropping systems in the irrigated semi-arid drylands of Central Asia.
Publication date	2015-12-15
Citations	K.P. Devkota, G. Hoogenboom, K.J. Boote, U. Singh, J.P.A. Lamers, M. Devkota, P.L.G. Vlek, Simulating the impact of water saving irrigation and conservation agriculture practices for rice–wheat systems in the irrigated semi-arid drylands of Central Asia, Agricultural and Forest Meteorology, Volumes 214–215, 2015, Pages 266-280, ISSN 0168-1923, https://doi.org/10.1016/j.agrformet.2015.08.264 .
Article link	https://doi.org/10.1016/j.agrformet.2015.08.264