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Numerical simulation to assess potential groundwater recharge and net groundwater use in a semi-arid region

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Abstract Accurate assessment of deep percolation (potential groundwater recharge) under different field crops is essential for sustainable management of scarce water resources and proper planning of crop rotation in irrigated, semi-arid regions of the world. The potential recharge from commonly grown field crops in semi-arid Indo-Gangetic Plain (IGP) of India was estimated using HYDRUS-1D model, where, irrigation, evapotranspiration, and soil moisture dynamics were simulated. Simultaneously, net groundwater use by different cropping patterns was also calculated. Among the hydraulic parameters, n was found most sensitive for water percolation. During rainy season, 293.8 and 159.1 mm water was percolated below the root zone of cotton and soybean, respectively, which accounted for 39.4 and 32.9% of the water input. During winter season, 66.8 and 30.3 mm water was percolated below the root zone of winter maize and mustard, respectively, accounting for 20.5 and 10.6% of added water. It was observed that net groundwater use was positive for cotton, soybean, and summer maize with the values of 168.8, 159.1, and 18.0 mm year^{-1}, respectively, and negative for rice, wheat, winter maize, and mustard. For the eight most important cropping patterns of semi-arid IGP, the net groundwater use was negative and varied between −4.4 mm year^{-1} for cotton-maize and −423 mm year^{-1} for rice-wheat. With these cropping patterns, the overall rate of decline of groundwater was 231 mm year^{-1}. It was found that maize-wheat and soybean-wheat cropping patterns consume much less water than rice-wheat cropping pattern and therefore are suitable to arrest the declining trend of groundwater in semi-arid IGP of India.

Keywords HYDRUS-1D · Irrigation · Moisture dynamics · Net groundwater use · Potential recharge · Root zone · Water flux

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Introduction

Groundwater is the primary source of water for about 40% of the world's population, 50% of the global food production, and 40% of industrial requirement (Foster and Chilton 2003; Seiler and Gat 2007). Particularly, arid and semi-arid areas of the world are more dependent on groundwater in comparison to humid areas.