

Optimization and Simulation Modelling for Managing Waterlogging in Semi-arid Region of Haryana, India

ABSTRACT

The sustainability of the rice-wheat cropping system in an irrigated semi-arid region of Haryana State (India) is under threat due to continuous rise in the poor quality groundwater table. The recharge analysis shows that groundwater table in the area has been rising at an average rate of 0.158 m per year since 1989. A linear programming optimization model was formulated to determine the optimal cropping pattern and water resources allocation in order to maximize net annual returns from the study area. The model was subjected to various land and water resources constraints and was solved using the LINGO software package. Subsequently, a two-dimensional groundwater simulation model was developed for the study area by using software SAHYSMOD. The model examined the long-term (10- year) effect of different scenarios on the groundwater table under existing and optimal conditions. The spatial variations in the model are considered through a network of nodes (grids). In this study, the entire study area was divided into 44 square nodes. The results of the optimization model show that the annual net returns has increased to Rs 3417.72 million under the optimal cropping pattern from Rs 2734.06 million from the existing. The results of model, SAHYSMOD, show that under existing conditions the watertable would rise between 0.45-1.31 m during simulation period in almost all the nodes. Under the optimal conditions, the watertable would fall at an average rate of 0.11-1.47 m during the simulation period under different nodes. The results also reveal that in most of the nodes the watertable can be maintained at a safe depth by reducing rice area between 3-7% and increasing tubewell draft by 1-4%. This can be concluded from the scenarios that groundwater pumping has higher impact on the overall water balance of the study area as compared to the other alternatives. As the watertable has been rising continuously, suitable water management strategies such as increasing groundwater pumping and using it conjunctively with canal water, changes in cropping pattern, and canal lining are recommended to bring the watertable down to a safe limit and to prevent its further rise.

Keywords: *Waterlogging, groundwater recharge, water management, semi-arid region, LINGO, optimal cropping pattern, SAHYSMOD, India.*