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Compromise Programming Based Model for Augmenting Food Production with Minimum Water Allocation in a Watershed: a Case Study in the Indian Himalayas

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Abstract A compromise programming based model has been developed for maximizing food production with minimum allocation of available water at watershed scale after meeting human, livestock and environmental needs under different scenarios. Agricultural water allocation in conjunction with available land resources under a set of constraints has been examined. The formulated model has the potential to analyze the implications of water availability on agricultural water allocation plans, and consequently food production. A case study in Indian Himalayan region, where despite abundant availability of water, rainfed agriculture is mostly practiced by majority of farmers with a primary objective of self-sufficiency in food production, well demonstrates the applicability of the developed model. Three distinct scenarios affecting water availability were considered. Analysis of imposition of fixed mandatory outflows of 20 to 70 % (as per water source) for satisfying environmental needs with present production mix revealed water scarcity within the study watershed ranging from 4 to 66 % across various quarters of an year, which necessitates optimum utilization of rainfed fallow land by allocating it to high value crops ginger and lentil (6 to 32 times more than existing allocation) on one hand, and drastic reduction (76 to 100 %) of area under all irrigated crops (except onion with 4–6 times increase) on the other, to achieve the conflicting objectives. The compromise plans also suggested increase (by 14 % in environmental watershed scenario) or decrease (by 29 % in degraded watershed scenario) in size of livestock population as per scenario based water availability. Overall, the compromise plans were