Irrigation scheduling and water availability at watercourse command

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Abstract. A model that simulated the irrigation schedules of a farm at watercourse command was developed to predict net farm return, benefit-cost ratio, water use, percent water utilized, deep percolation, rainfall contribution and net return per unit of water applied including rainfall. Schedules for three selected farms on a watercourse command of Tw #62394L from MONA, Sargodha, Pakistan were simulated with 3 fixed-rotation and 2 demand strategies to evaluate the allowable soil water depletion criteria. Evaluation of the simulations (1973–82) showed that the water availability reduced the net farm return of 15 and 31% at the middle and tail farms, respectively, from that of the head farm. Therefore, the existing water allocation procedure (WARABANDI) should include watercourse conveyance losses to provide equitable water distribution on a watercourse command. Demand water availability can increase the net farm return of 25 and 26% in strategies 4 and 5, respectively, by changing the fixed-rotation system to a demand system. Changing the fixed-rotation system to a demand system requires either the use of existing private tubewells or the installation of new private tubewells.

Introduction

The limited water availability to a farm makes the water allocation to different fields a complex problem. Therefore, the water allocation in a watercourse command area is more likely to be based on the judgement of the farmer than on any scientific method. The nature of farmer's decisions depends on the availability of water, application efficiency, season of the year and the crops already grown or planned for planting. Since the complexities of water allocation to different fields cannot be completely modeled, simplified approaches must be used to develop the procedures for water allocation to different fields.

The use of improved management strategies provides an opportunity to implement an irrigation scheduling programme on a watercourse command with the system constraints, water distribution rules, water availability, crop priorities and on-farm extension recommendations. Although management options
are limited when water is delivered through a fixed-rotation system, the irrigation scheduling approach can be applied to improve the irrigation management and water allocation at the farm using simplified approaches.

Dudley et al. (1971a) described the short-run problem of water use at farm level using a two-state variable stochastic dynamic programming model in a variable environment. The optimal irrigation strategies were sensitive to changes in biological assumptions within the model, thus involved the need to base the assumptions on experimental data. Later Dudley et al. (1971b) described the intermediate-run problem of deciding the crop and area to plant at the beginning of an irrigation season using a simple growth model and the available water supply from a reservoir. The results indicated that the acreage to plant and irrigate was an approximately linear function of the water supply reservoir volume at the beginning of the season. Dudley (1972) further described the long-term problem of determining the best size of area to develop for irrigation. The series of models developed by Dudley et al. (1971a, 1971b, 1972) and Dudley (1972) was based on simple approaches used for estimating crop irrigation water requirements and water distribution at the farm. Anderson & Maass (1974) revised their original simulation model to simulate the effect of water supply and operating rules on production and income on irrigated farms. The major limitation of the model was that simple approaches were used to estimate irrigation requirements and allocation of water to different fields. Walker et al. (1979) developed a simulation model which analyse irrigation scheduling at the farm level rather than to schedule real-time irrigations. The model was limited in the number of fields and farm size and lacks the ability to include actual water distribution patterns. Reuss (1980) used the Walker et al. (1979) model and simulated the irrigation schedules using 3 water availability levels. Johnson & Reuss (1984) further modified the model of Walker et al. (1979) to include an economic module.

The objective of this study was to develop a model for scheduling irrigations and allocating water at farm level in a surface irrigation system and to evaluate alternative management strategies in a watercourse command. The non-equitable water supply to the farmers located on a watercourse command is one of the major problems due to the distribution losses. Management strategies are used to simulate irrigation schedules for 3 farms selected at the head (H), middle (M) and tail (T) of a watercourse command and evaluate the effects of management strategies and water availability on 8 dependent variables. Simulated schedules were analysed to evaluate the allowable depletion criteria.

In the Indus basin irrigation system, a watercourse serves a unit command area of 100–500 ha. The system operates on a continuous flow and the water allocation to farmers is based on a fixed-rotation of weekly intervals (WARABANDI). Data from MONA Reclamation Experimental Project, Bhalwal, Sargodha of Pakistan were used to calibrate the model and to define