ABSTRACT

Effective water management is gaining importance as multipurpose use of water increases. Furthermore, increasing costs of labour and energy call for more effective procedures of irrigation scheduling even in those cases in which water is in ample supply. This research work aims at developing an integrated decision support system to an irrigation management problem using conjunctive use of simulation and optimization techniques. The simulation model is developed for the management and forecasting the yield levels of the crop and irrigation requirements at an on-farm level. The optimization model is used to find an optimal allocation strategy for the system.

The simulation model includes mechanisms for simulating root growth,soil-water movement and crop yield. The model incorporated easily obtainable soil and crop parameters. The root growth over the crop growing season is simulated as a function of soil, crop and management practices by developing two location specific root growth models viz., (i) modified exponential model and (ii) sigmoidal model coupled with exponential function. The models require as input data the maximum rooting depth to be achieved under a particular set of soil, crop and management practices, and the days until the root depth attains a maximum value. The yield of crop is simulated as a function of relative evapotranspiration during various physiological stages of plant growth by developing an additive dated water production function. Practical experiments on root growth as a function of time for rice and wheat crops were conducted to validate the root growth models. Root length estimation was done using three methods mainly (i) direct method (ii) opisometer method and (iii) Neuman's line intersection method. A comparison was made between experimental observations of rice and wheat crops and the estimates derived from several previously developed root growth models and the models developed in the study. The experimental results clearly indicate that both the developed root growth models had a high degree of accuracy comparable with or better than other reported empirical models. A similar comparison was made between the experimental observations and the estimates derived from the additive and multiplicative crop production models and the model developed in the present study on wheat crop. The developed model was found to have an edge over the Stewart model which proved to be the best amongst the other additive models. The verifications clearly indicated that the irrigation water requirements and crop yields are simulated with a high degree of accuracy.

The optimization model is developed utilizing the above yield values and the irrigation requirements of rice and wheat crops generated from the irrigation management model using deterministic linear programming and chance constrained linear programming approaches to arrive at an optimal allocations of land to each crop for maximum net benefit. The chance constrained model take the cognizance of randomness of yield levels and irrigation water requirements for various crops. Monte Carlo simulation technique was adopted to generate the crop yields and irrigation requirements of other crops in the study area which are not generated from the irrigation management model. The results clearly indicate that a change in the existing

cropping pattern is desirable and is consistent with maximization of net benefit to the project area. Sensitivity analysis was also carried out at various probability risk levels and increased availability levels of ground water to determine the impact on crop net income. The existing supply of water in the study area is found to be inadequate to allow the best use of land resources at lower probability levels. The resulting cropping patterns from chance constrained programming at various risk levels of irrigation requirements provide guide lines for the tradition bound farmers who have a low risk bearing ability as well as to the risk bearing farmers of the command area.

The case study clearly brought out the need for the revised approach to enhance the socio-economic status of the village within the avilable resources. The work also provided guidelines for future extent of resource development and revised allocations.