# IRRIGATION SCHEDULING FOR OPTIMAL WATER USE

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Eight years monthly average climatic data collected from the Shahkot Project area were used to predict the irrigation schedules with and without rainfall contribution for the wheat, sugarcane, berseem and tobacco crops. The CROPWAT computer model version 5.5 (1989) as developed by Food and Agriculture Organization (FAO) was used for the prediction of irrigation schedules. The model results indicated 3, 11, 3, 7 and 4, 16, 4, 9 number of irrigations with and without rainfall contribution for wheat, sugarcane, berseem and tobacco crops respectively.

## INTRODUCTION

In the canal command, water is supplied over a large area through a net work of canals, distributories and minors. The supply of irrigation water to different distributories and outlets is based upon the water requirements of crops. Scheduling of irrigation according to the crop water requirements is essential for the maximum crop yield and efficienct use of irrigation water. The advantage of irrigation scheduling includes minimizing of water and energy use as well as deep percolation losses on one hand and on the other ensuring water availability to plants without placing them under stress. Criteria most suitable for scheduling irrigation vary from one situation to another. When water is scarce or expensive, irrigation should be scheduled to maximize the crop production per unit of water applied and where the good land is a limiting factor, irrigation should be scheduled to maximize crop production per unit of planted area. The wheat, sugarcane, berseem and tobacco are the main crops grown in the project area during 'Rabi' i.e. October to March. Sometimes because of irregular canal supplies and fixed warabandi system underirrigation or overorrigation of these crops is possible. Underirrigation could reduce the crop yield while the overirrigation may result in raising of ground water table thus causing water logging in the area. To achieve the higher irrigation efficiencies and better crop yields irrigation scheduling practices of these crops need to be improved.

## MATERIALS AND METHODS

**Soil data:** Hydrometric analysis of the soils at the head, middle and tail reaches of the command areas of different watercourses in the project area showed that dominating soils are loam, sandy clay loam and sandy loam (Sajjad, 1989). As the different areas have different soil components, therefore, an average of soil properties concerning the soil type was used. In the model overall texture was taken as sandy clay loam with total available soil moisture of 130 mm/m (FAO, 24).

**Climatic data:** Eight years data regarding evaporation, temperature, relative humidity, wind speed and rainfall were collected from the project area. A meteorological observatory was installed for this purpose and data were collected continuously twice a day. From the data of evaporation pan, the evaporation of the command area was calculated. This evaporation pan with a diameter of 120.7 cm and a height of 25 cm placed about 15 cm above the ground was located in a cropped area. Monthly average of these data was used for the estimation of reference crop evapotranspiration ($ET_o$).

**Crop evapotranspiration:** The evapotranspiration ($ET_c$) of crop depends in addition to the climatic factors on crop factors such as crop species, stage of crop development and ground cover of soil. The reference crop evapotranspiration was determined by Hargreaves and Pan Evapotranspiration methods. A comparison of both methods is shown in Fig. 1. In the model,pan evaporation method was used due to its high accuracy. Crop coefficienct values for sugarcane, wheat and berseem were taken from OFWM field manual and for tobacco FAO paper (24) was used. The yield response factor ($K_y$) for the different crops during different growth periods are taken from FAO paper 33.

**Field application losses:** Different fields at the head, middle and tail reaches of different watercourses were used for the estimation of application losses during irrigation. Gravimetric method was used for the soil moisture determination and the discharge at the field inlet was measured with the help of of 3"-8' cut throat flume. The average application losses in the project area were found in the range of 20 to 30%.

**Rainfall adjustment:** Monthly average rainfall data were used for the incorporation of rainfall in the irrigation scheduling of crops. To account for losses due to surface runoff and deep percolation, effective rainfall was calculated following the procedure outlined by United States Bureau of Reclamation (USBR) using the following equations. A comparison of total and effective rainfall for each month of the year is shown in Fig. 2.

$P_{eff} = P_{tot}\ (125 - 0.2^{*}\ P_{tot}/125)$ for $P < 250$ mm

$P_{eff} = 125 + 0.1\ P_{tot}$ for $P > 250$ mm

where

$P_{eff}$ = Effective rainfall

$P_{tot}$ = Total rainfall

**Initial soil moisture depletion:** Initial soil moisture depletion indicates the soil moisture contents at the start of growing season. In the model, zero per cent depletion means fully wetted soil profile (field capacity), was assumed for all crops at the start of growing season.

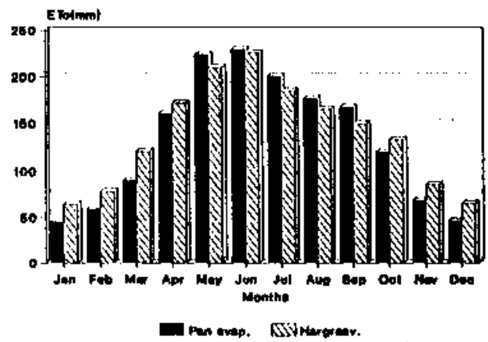


Fig. 1. Comparison of $ET_o$ (pan evaporation and Hargreaves method)

## RESULTS AND DISCUSSION

Eight years climatic data collected from the Shahkot Project area were used to estimate the total irrigation requirements, total gross irrigation requirements, number of irrigations and average irrigation interval for wheat, sugarcane, berseem and tobacco crops with and without rainfall contribution. The results are presented in Tables 1 and 2. The results show that almost 1 to 5 number

**Table 2. Schedules as predicted by the model considering rainfall**

| Crops | Total net irrigation (mm) | Total gross irrigation (mm) | No. of irrigations | Ave. irrigation interval (days) |
|---|---|---|---|---|
| Wheat | 238.5 | 318.0 | 3 | 57 |
| Sugarcane | 930.9 | 1241.3 | 11 | 21 |
| Berseem | 279.1 | 372.2 | 3 | 49 |
| Tobacco | 365.6 | 487.5 | 7 | 14 |

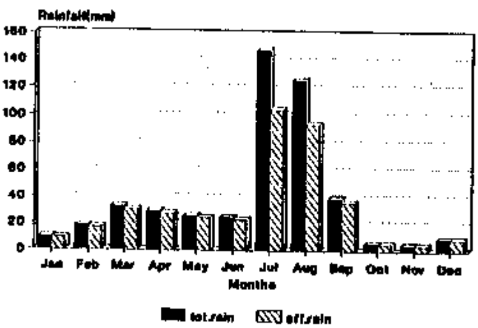


Fig. 2. Comparison of rainfall and effective rainfall

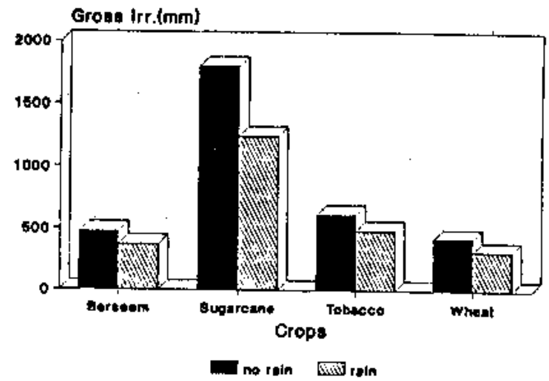


Fig. 3. Comparison of gross irrigation with and without rain

of irrigations can be reduced by making the effective use of rainfall. The average irrigation interval was also found to increase from 3 to 13 days without affecting the yields. The total gross irrigation requirements of wheat, sugarcane, berseem and tobacco crops were also found to be reduced almost 20 to 30% by the rainfall contributions as shown in Fig. 3. The higher difference between net and gross irrigation was observed in case of sugarcane because of higher number of irrigations as application efficiency during each irrigation on an average was found to be 75%.

The minimum irrigation interval was found in case of tobacco due to its shallow rooting depth, resulting in lesser total available water.

A comparison of pan evaporation and Hargreaves methods for estimation of reference crop evapotranspiration shows that Hargreaves method underestimates by 5 to 10% during summer and overestimates 15 to 20% during winter than pan evaporation method as shown in Fig. 1.

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