# Evaporation Pan: A Tool for Irrigation Scheduling

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**ABSTRACT**: Agriculture is the major consumer of water in Pakistan. However, water application and water use efficiencies are very low. The main reason for low efficiency is the over irrigation by the farmers. Farmers normally over irrigate the field due to lack of proper knowledge about irrigation scheduling. Significant quantities of water could be saved by adopting irrigation scheduling. Irrigation scheduling is the procedure used to determine the time and depth of water application for each irrigation. However, it is not easy for common farmers to adopt proper irrigation scheduling practices due to difficulties in soil moisture measurement. Nevertheless, an evaporation pan may help the farmers to devise irrigation scheduling. In this investigation, an evaporation pan attached with a Marriott bottle was used for irrigation scheduling purposes. The evaporation pan predicted the soil moisture close to that predicted by the gravimetric method. For wheat crop, irrigation scheduling saved about 50% irrigation water irrespective of irrigation method used with out affecting crop yield.

**KEYWORDS:** Irrigation scheduling, Evaporation pan, Moisture measurement, Water application efficiency.

## INTRODUCTION

Like many countries of the world, water resources of Pakistan are diminishing quantitatively and qualitatively. Agriculture is the major consumer of water in Pakistan. However, water use efficiency (WUE) is very low. The main reason for low efficiency is the over irrigation by the farmers. Farmers normally over irrigate the fields due to: (i) lack of proper knowledge about irrigation scheduling; and (ii) with the intention that more water will produce more yield. However, more applications of water may result in low WUE and low net income. Moreover, over irrigation leaches the nutrients out of the root zone and decrease the crop yield. Particularly, under skimmed water (freshwater overlying saline groundwater) applications, more water applications, more cost, more danger of salinity built up in the root zone and less net income (Ashraf *et al*., 2001). The increasing needs of water for agricultural and non-agricultural activities require that the available water resource, both surface and groundwater be used efficiently and carefully. Proper irrigation scheduling makes it possible to use water prudently.

Irrigation scheduling is the procedure used to determine the time and depth of water application for each irrigation. The time of water application is normally based on fixed depletion of stored soil water whereas the depth of application is equal to the value of soil water depletion plus some additional water to account for non-uniformity in water application and leaching fraction. Therefore, the time and depth of water application also depends on the root zone depth and the salt concentration in the root zone.

In spite of the importance of irrigation scheduling, its application in the field has been a difficult task mainly due to the measurement of soil moisture. Soil moisture measurement by Time Domain Reflectometry (TDR), Neutron Probe, Gamma Ray Attenuation *etc*. involve costly equipment and require high skill for their use. Soil moisture measurement by gravimetric method is labourious and time consuming and is destructive method. The use of tensiometers for the measurement of soil moisture requires special skill for their operation and maintenance. Moreover, these work for a limited range of matric potential *i.e.* up to -100 kPa (Cassel and Klute, 1986; Mullins, 1991). The gypsum blocks could not get popularity among the farmers due to their sensitivity to measurement at high salinity, calibration of each block before use and more

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time required for equilibrium. Moreover, the calibration changes considerably with time (Welling *et al.*, 1985). Computation of crop water requirement from climatalogical data is labourious and cumbersome and requires many variables such as temperature, wind speed, humidity *etc*. Evaporation pan has also been used widely to determine crop water requirements and irrigation scheduling. However, it is difficult for a common farmer to maintain exact water level in pan, and to read exact level in the pan. Moreover, filling the pan from out side to maintain water level at the required depth is also a problem. Nevertheless, evaporation pan can be attached with a Marriott bottle to make it simple for a common farmer to design irrigation scheduling. The purpose of this study was to investigate the usefulness of evaporation pan to predict soil moisture deficit in the field for irrigation scheduling purposes.

## MATERIALS AND METHODS

The study was conducted at Akram's farm Nabishah, Bhalwal. A skimming well with 16 strainers was installed at the farm. The discharge of the skimming well was about 28 lps. A 90° V-notch weir was installed in the diversion channel of the skimming well to measure the discharge. A small observatory was established at one corner of the field. A standard class A evaporation pan was placed on a wooden frame, 20 cm above the ground surface. The pan was painted with white colour from inside and outside. It was filled to a level of 20 cm from the bottom. A Marriott bottle was attached to the pan that maintained water level at 20 cm (Figure 1). Loss of water from the pan was monitored from the Marriott bottle. A standard rain gauge was placed at a height of 1.37 m above the ground surface. The soil was a sandy loam in texture and was deficient in organic matter (about 0.4%). Before each irrigation, soil samples were collected up to 90 cm depths at 15 cm interval to determine moisture contents gravimetrically.

Maize variety, Pioneer 3062, was sown on 8$^{th}$ July 2000 on the field adjacent to the skimming well on an area of 0.8 acre. The corn was sown on furrow ridges. The field was divided into two plots of equal size (0.4 acre), each consisting of 35 ridges. One plot had regular furrows whereas the other had every alternate furrow blocked. The row-to-row and plant-to-plant distances were 75 and 18 cm, respectively. After the harvesting of corn, the land was prepared for wheat sowing. Wheat was sown on 12$^{th}$ November 2000, 0.4 acre was sown on furrow beds using furrow bed shaper and another 0.4 acre was sown with a rabi drill (referred to as basin). On another field, wheat was sown on the rice-harvested field with zero tillage seed drill on 28$^{th}$ November, 2000.

Irrigation was applied to maize and wheat at 30 and 40% maximum allowable depletion (MAD), respectively. It was based on the crop water requirement and leaching fraction to account for managing the root-zone salinity. The field capacity of a sandy loam soil is 0.11 $m^3$ water $m^{-3}$ and its wilting point is 0.03 $m^3$ water $m^{-3}$. Therefore, available moisture content becomes 0.08 $m^3$ water $m^{-3}$ (Allen *et al*., 1998). Considering root zone depth of 1.50 m, 30 and 40% MAD becomes 36 and 48 mm, respectively. Hence, irrigations were applied to maize and wheat when evaporation from the pan reaches to about 36 and 48 mm, respectively.

## RESULTS AND DISCUSSIONS

Figure 2 shows monthly average pan evaporation rate during the experimental period. Pan evaporation rate was minimum *i.e.* between 1-2 mm/day during the months from November to February - the months of low temperature. The evaporation rate however, was maximum in the months from May to June and was in the order of about 5 mm/d. It seems that evaporation rate starts increasing gradually from January and comes to peak during May-June and then again starts declining.

Figures 3 and 4 show the soil moisture deficit at the time of irrigation for alternate and regular furrows. The evaporation pan under - estimated the soil moisture deficit (on an average about 15%) than estimated gravimetrically. However, before each irrigation, moisture content was within the limit of available moisture content in both the treatments. Figure 3 also shows depth of water applied against the soil moisture deficit. The depth of water applied was always greater than the soil moisture deficit. It was mainly due to the non-uniformity in water application.

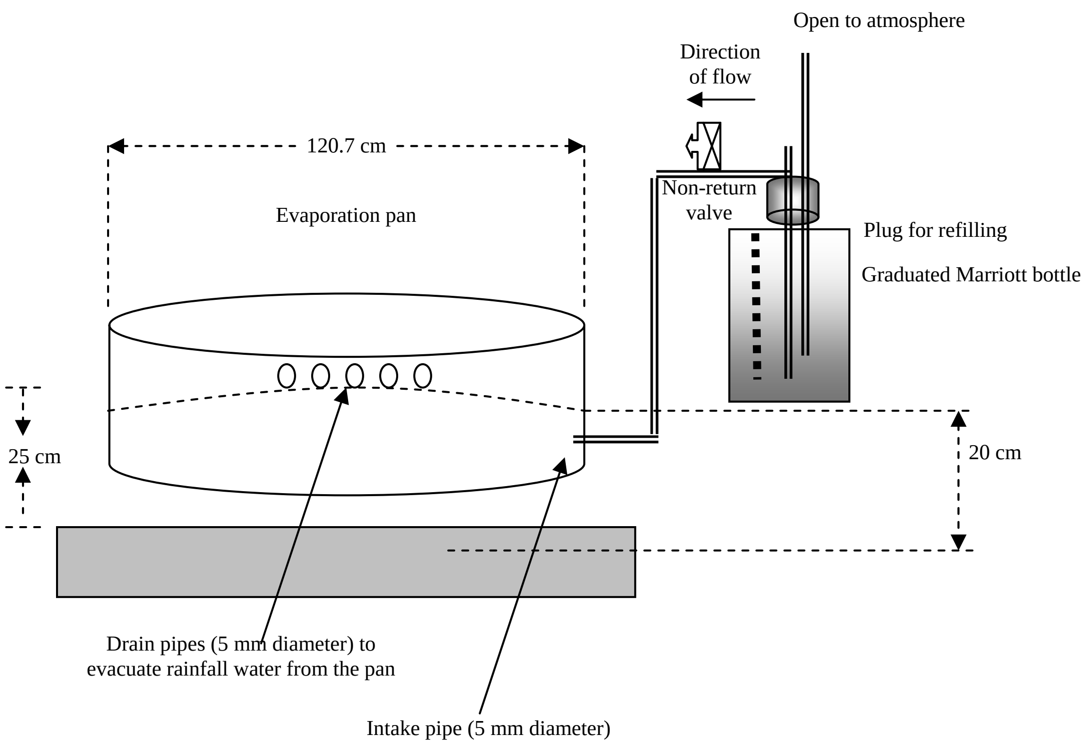


Figure 1: *Schematic Diagram of the Modified Class- A Evaporation Pan*

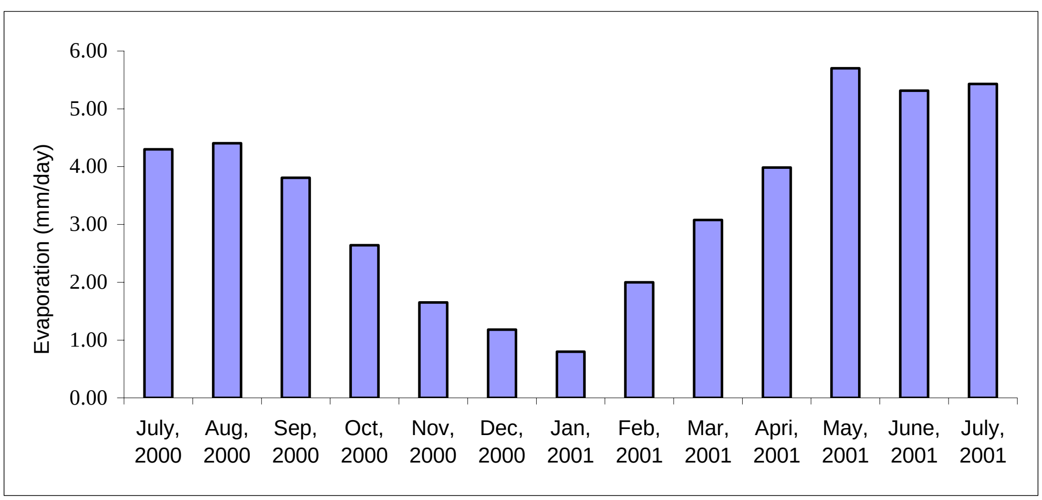


Figure 2: *Monthly Average Pan Evaporation at the Experimental Farm during the Study Period*

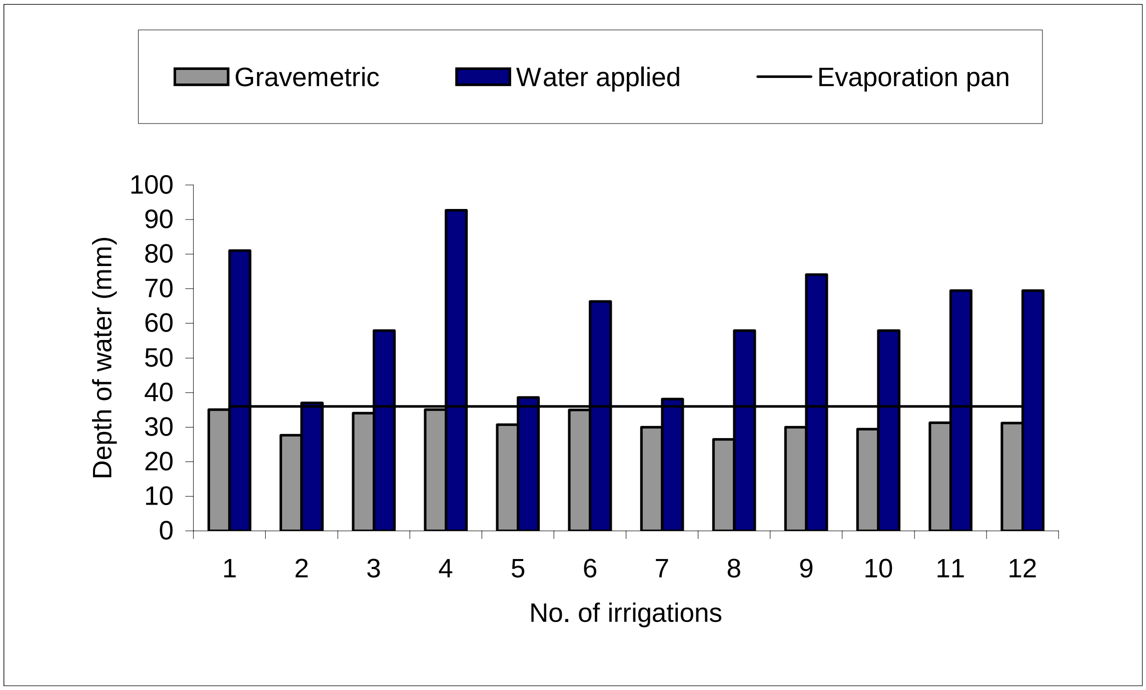


Figure 3: *Soil Moisture Deficit and Depth of Water Applied for Alternate Furrows*

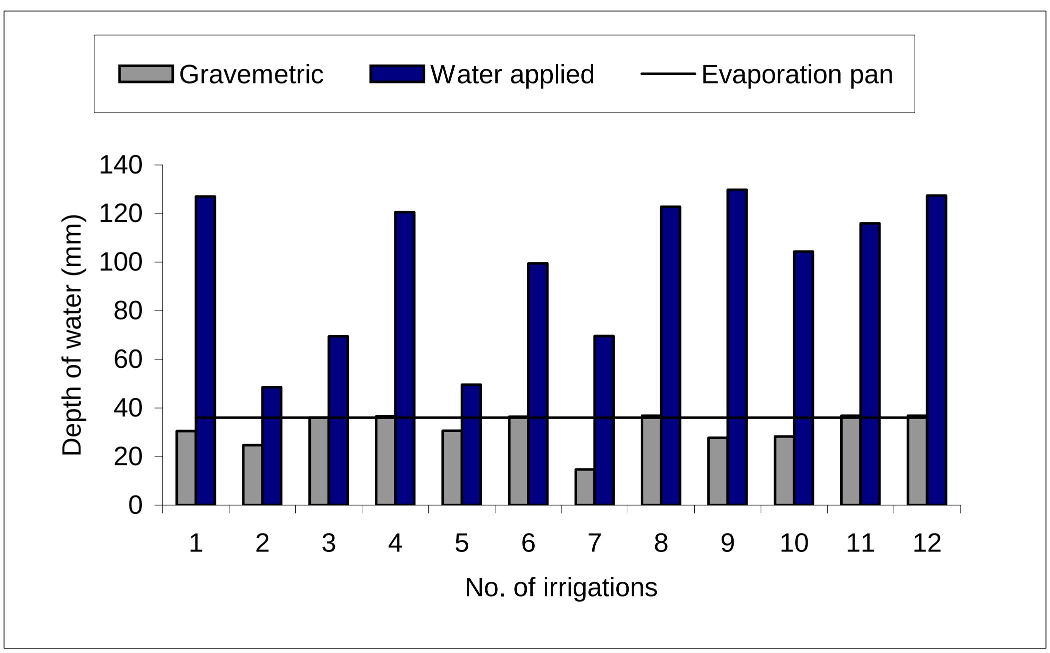


Figure 4: *Soil Moisture Deficit and Depth of Water Applied for Regular Furrows*

Figures 5 to 7 show soil moisture deficit at the time of irrigation and depth of water applied for bed and furrow, basin and zero tillage plots. These figures also show that against a planned soil moisture deficit of 48 mm shown by the evaporation pan, the soil moisture deficit by the gravimetric method was almost 2 times less. The evaporation pan under-predicted the soil moisture deficit upto 50% and may, therefore, be safe for use for irrigation scheduling particularly where skimmed water is used for irrigation. This under prediction may take care of the leaching fraction.

Figure 8 shows the number of irrigations and depth of water applied in farmer's field where no irrigation scheduling procedures was used. The farmer applied about 79 cm water with 7 irrigations, almost double than water applied under the scheduled fields. The figure also explains the psychology of the farmers towards irrigation. If the farmer gets more water *i.e.* tubewell + canal, he applies more water *e.g.* irrigation 1, 2 and 5. If he gets less water, then he applies less as was the case with the irrigation 3, 4, 6 and 7. It is therefore clear from the above discussion that irrigation scheduling alone can save at least 50% irrigation water irrespective of irrigation method used without affecting crop yield.

Since it is not possible for common farmers to measure the soil water content/soil matric potential or to calculate the crop water requirement in the field, an evaporation pan may help them to plan for irrigation scheduling. A simple method may be the provision of a graduated Marriott bottle attached with pan in the field and training of the farmer to apply irrigation when the water loss from the Marriott bottle equals 30 or 40% MAD depending upon the soil and crop types. However, further research is needed to test the effectiveness of evaporation pan in the field for planning irrigation scheduling with varying MAD, water quality, soil and crops.

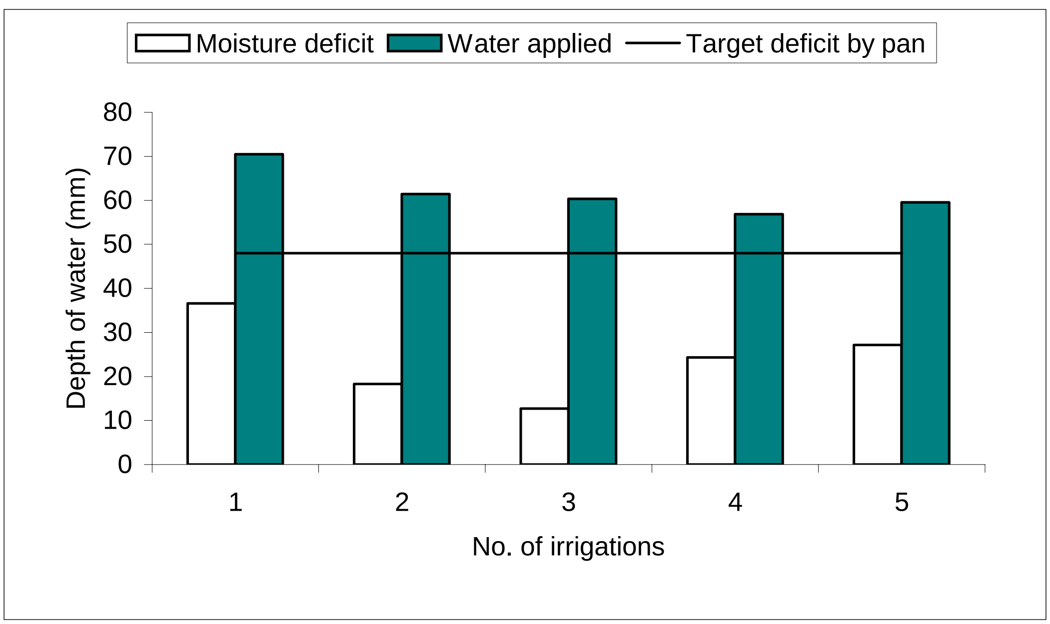


Figure 5: *Soil Moisture Deficit and Depth of Water Applied for Bed & Furrow Fields*

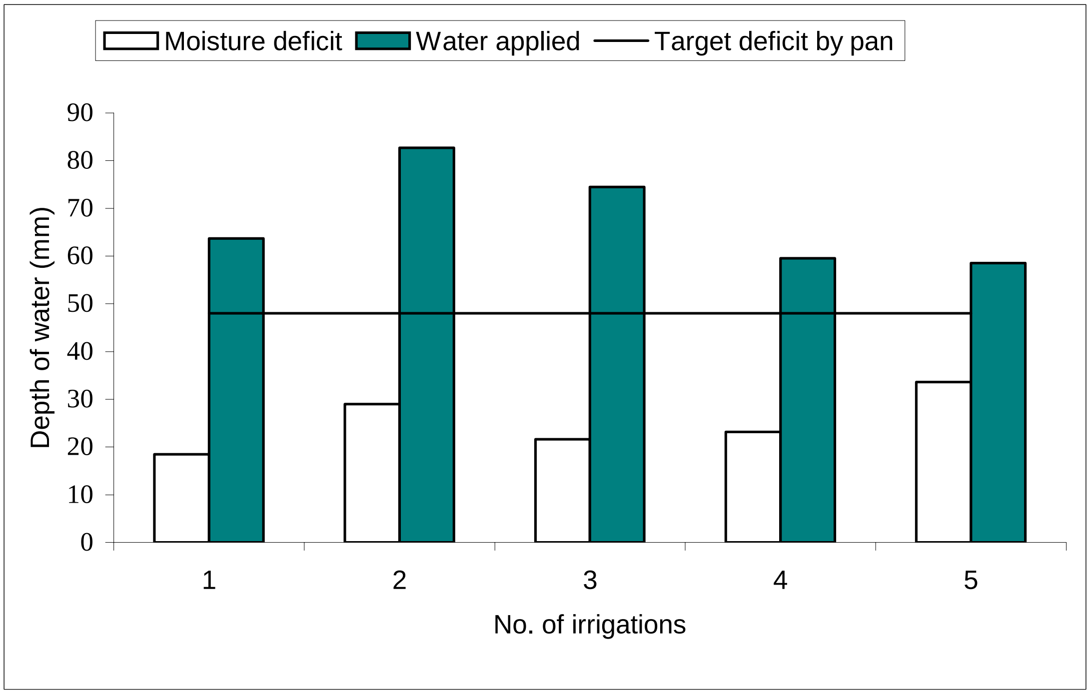


Figure 6: *Soil Moisture Deficit and Depth of Water Applied for Zero Tillage Fields*

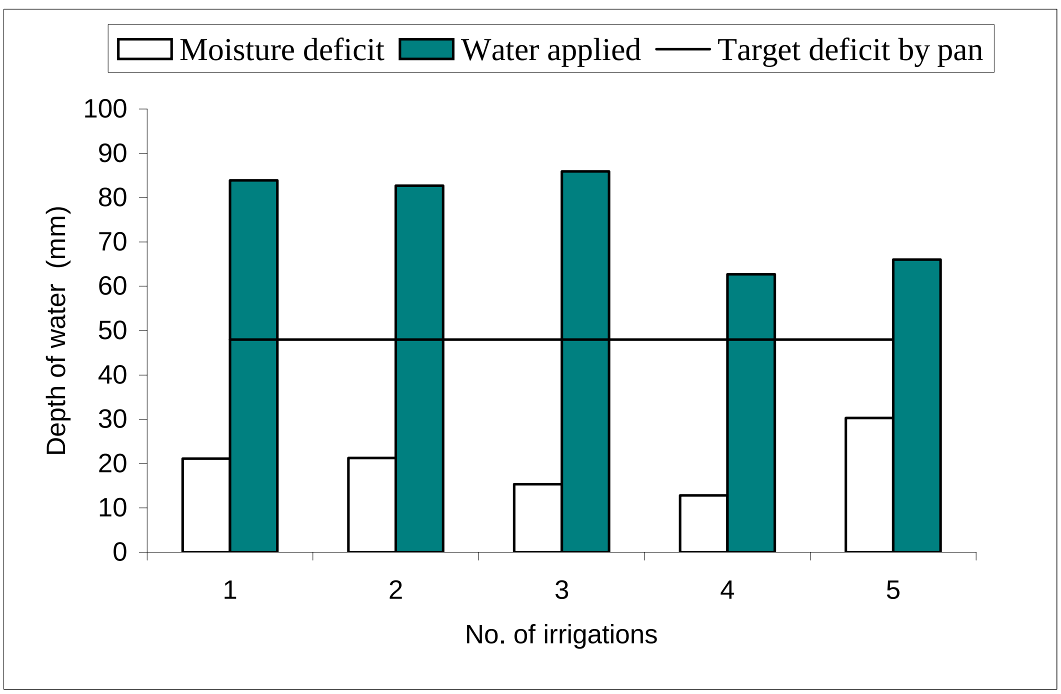


Figure 7: *Soil Moisture Deficit and Depth of Water Applied for Basin Fields*

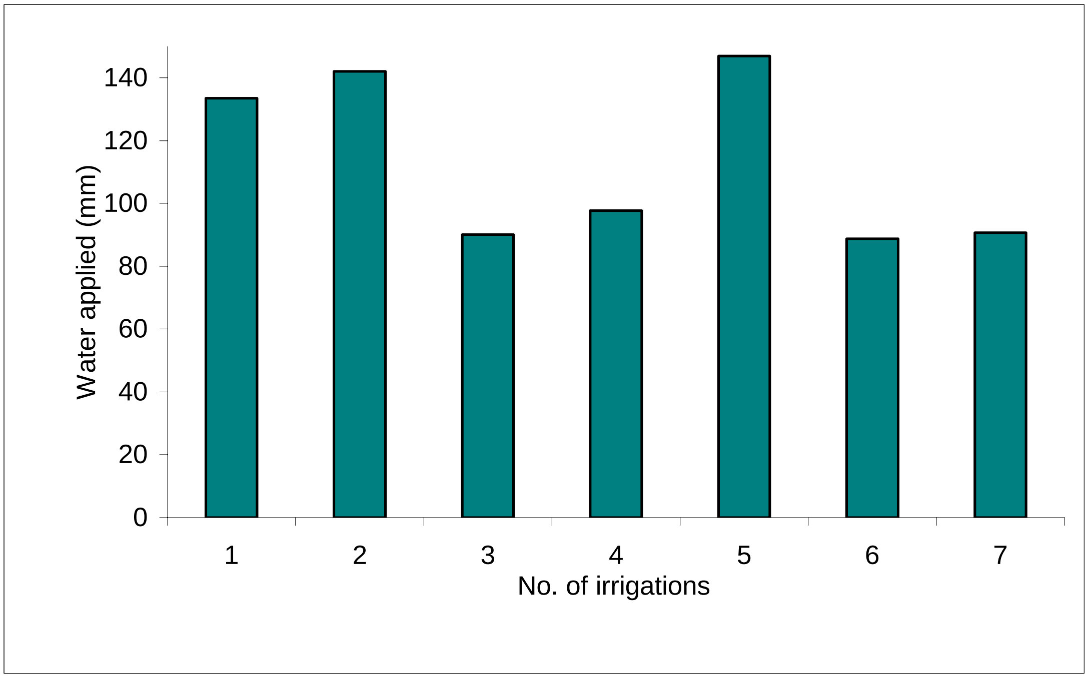


Figure 8: *Water Applied by Farmers without Adopting Irrigation Scheduling*

## CONCLUSIONS

The evaporation pan under-predicted the soil moisture deficit and may be safe to use for irrigation scheduling under skimmed water applications. The evaporation pan may help the common farmers to plan for irrigation scheduling. A simple method may be the provision of a graduated Marriott bottle attached with pan in the field and training of the farmers to apply irrigation when the water loss from the Marriott bottle equals the maximum allowable depletion, depending upon the soil and crop types.

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