# MEASURING IRRIGATION WATER LOSSES THROUGH BORDER DYKES*

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## INTRODUCTION

In border dyke irrigation systems some of the irrigation water is lost through and below dykes and it becomes unavailable to the crop. If these losses are not accounted for in the research work an error of unknown magnitude enters into the consumptive use, irrigation efficiency, etc., calculations. Small experimental plots surrounded by the dry land present an extreme condition where border losses may become relatively important in total water use calculations. A sampling program was designed and conducted to provide data which made it possible to calculate border losses from the gravimetric soil moisture determinations.

## PROCEDURE

Border loss determinations were carried out at the consumptive use of water project in Swift Current. The soil in the test area is a well drained alluvial fine sandy loam to fine sand. Two plots each of Rambler alfalfa, potatoes, and wheat were selected for the study. The 30- by 30-foot test plots were surrounded by earth dykes approximately six to eight inches high. At each sampling site 2-inch auger holes were arranged in a straight line at right angles to the dyke and all sampling holes were spaced 12 inches

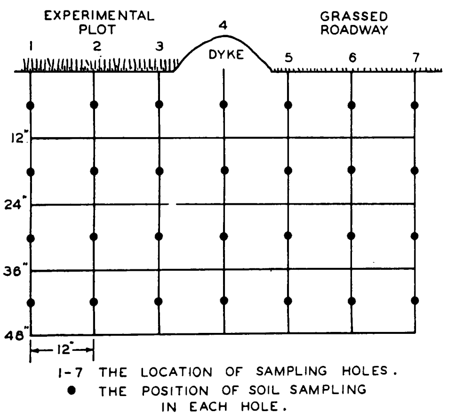


Figure I. A typical section below a dyke and the soil sample locations.

apart (figure 1). Soil samples were taken at 6-, 18-, 30- and 42-inch depths. The depth of the number four hole at the center of the dyke was measured from the ground surface, not from the top of the dyke. Irrigation water was applied at 4-, 3- and 2-inch rates through gated pipes to the same plots during each of two summers.

Soil sampling was carried out 24 hours before and after each irrigation. The period before-and-after-irrigation sampling was deliberately shortened to allow less time for evaporation from the soil surface which could not be measured. It was believed that the possibility of an incomplete equalization of the moisture in the soil profile at the sampling time as shown by Staple (2), Richards (1), and Wilcox (3) was less significant as compared to the larger evaporation losses which would have occurred during a longer time period between before-and-after-irrigation sampling. Water that could eventually have drained further downward beyond the sampling depth was still within the sampling region at the end of the 24-hour period. The short time period between irrigations and the soil sampling also reduced the possible errors from deep percolation losses. A shorter period between irrigations and soil sampling during the heat of the summer has been recommended by Wilcox (4).

The described sampling technique made it possible to plot a soil cross section through a dyke extending three feet inside and the same distance outside the center line of the dyke. A 4-foot depth of the soil profile was used in soil moisture calculations. Before irrigation moisture percentage was subtracted from the after irrigation moisture percentage and the difference was entered at the appropriate place on the soil profile. These figures made it possible to draw isoquants separating areas of different moisture increases (figure 2). Differences of less than two percent were considered to indicate no change in the soil moisture for calculating purposes. This assumption agreed with the observations by Wilcox (3) who reported standard deviations in sampling small areas ranging from 0.47 to 2.96 percent of soil moisture. The next moisture range was two to five percent increase.

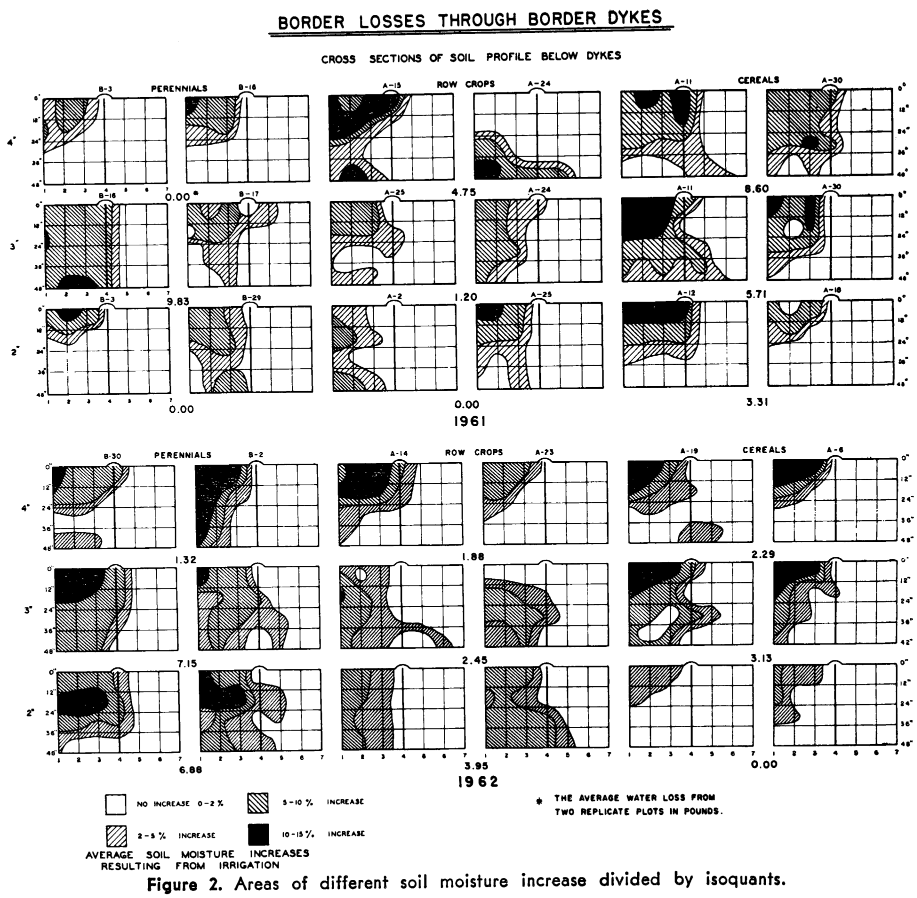


Figure 2. Areas of different soil moisture increase divided by isoquants.

Following that 5 to 10 to 15 percent increases were separated by isoquants into their respective areas on the cross-sectional diagram. Figure 2 shows areas of different moisture increases within the soil profile.

A planimeter was used for measuring the surface areas between 2 to 5, 5 to 10, and 10 to 15 percent isoquants located outside the dyked area. On the diagram only areas extending to the right from number four hole were measured as these represented water losses from irrigated land. Readings on the diagram were converted into actual areas in square feet by multiplying with the appropriate scale ratio.

Actual areas and average moisture increases in percent between isoquants were used to calculate the number of pounds of water that had seeped outside of the dyke at each sampling location.

Calculations were made for a block of soil one foot wide, four feet deep, reaching out to the zero to two percent moisture line which was considered to be unchanged.

Sample calculations:

$$\frac{A \times B \times C \times D}{100} = \text{in pounds of water per lineal foot of dyke.}$$

A—average moisture increase in percent 2 to 5%; (3.5%)

B—the weight of one cubic foot of water in pounds (62.4)

C—the bulk density of the soil (1.16)

D—the actual measured area between isoquants outside of the center line of the dyke in square feet (0.475)

$$\frac{3.5 \times 62.4 \times 1.16 \times 0.475}{100} = 1.2 \text{ lbs}$$

The actual bulk densities as determined for each plot were used in calculations. Water losses in pounds were calculated for each moisture range and each soil profile. The data were tabulated according to the application rates and crops.

RESULTS

The average water losses for each pair of duplicate plots varied from 9.83 to zero pounds of water per lineal foot of dyke (figure 2). Generally higher losses occurred from plots that contained higher soil moisture prior to irrigation. Also, higher application rates tended to contribute more heavily to border losses.

The average loss from plots in perennial crops was 4.20, from cereal plots, 3.81, and from the row crops 2.37 pounds of water per lineal foot of dyke. The average for all crop and application rates was 3.47 pounds per lineal foot of dyke. This loss presented about three percent of the water applied to a 30- x 30-foot dyked plot.

This sampling and calculating technique provided data on the magnitude of water losses from border dyked areas, on a fine sandy loam to fine sandy soil. The errors in consumptive use studies arising from water lost outside of a border dyked area are about equal to errors involved in determining soil moisture by the gravimetric sampling technique. Border dykes are efficient barriers to the lateral movement of water.

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**SPRAY COVERAGE**

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SUMMARY

A Hunter Colour and Colour Difference meter can distinguish between variations in area of coloured precipitates of zinc and copper spray compounds. The accuracy obtainable is at least equal to visual methods of comparing unknown coverages to prepared samples whose coverage has been determined by using a transparent squared grid or by planimeter. Special precautions are necessary to minimize the effect of background colour. All sensitizing solutions should be freshly prepared in clean pyrex containers. Sensitized filter papers should be dried and stored in a cool dark place for not more than two days. Leaves that are to be pressed between sensitized paper should be wilted to avoid staining the paper by chlorophyll. While the method of obtaining coloured precipitates involves no special equipment the Hunter Colour Difference meter costs approximately $3800. Where large numbers of leaf samples are involved its speed of operation and repeatability probably justify the cost. The instrument is very versatile and can be utilized for many projects involving colour assessment.

For zinc a suitable colour standard was a ceramic wall tile with Hunter colour values of Rd = 47.3, a = 19.1 and b = 7.6. Good results were obtained provided there were no chlorophyll stains.

For copper two colour standards were used. For spray coverage below 50 percent Munsell colour 5BG8/2 gave best results and for spray coverage over 50 percent Munsell colour 2.5YR 5/4 gave best results although neither method worked as well as the zinc.

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