HYDRO-SALINITY SYSTEM IN A CANAL COMMAND AREA

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The hydro-salinity system of the two adjoining watercourses was studied over an eight-year period. Different sources of irrigation contribute about 1390 tonnes of salts in the rootzone annually. This figure represents 79.50% through tubewells, 11.30% through canal supplies and the remaining 9.20% due to dry period capillarity. The removal of salts was estimated to be 1153 tonnes with 41.40% due to over irrigation, 32.50% from rainfall during irrigation, 9.70% through watercourse losses and remaining 6.40% taken up by various crops, causing a net addition of 0.63 tonnes of salts per hectare annually.

INTRODUCTION

Successful operation of any irrigation project apart from the favourable social and economic conditions depends largely upon the technical operation of the project to enable good crop growth for an indefinite period. The main technical problem in irrigation is the determination of the quantity of irrigation water to be applied for the regulation of salinity and quantity of drainage to be removed to meet the optimal situation for crop growth. This needs the development and maintenance of soil rootzone in which soil, air and salt balance are favourable for crop growth. The relationship between the quantity of soluble salts brought into an area by the irrigation water and the quantity removed from the area by the drainage water is called the "salt balance" of the area. Therefore, in an irrigated area, a favourable salt balance, a condition wherein the output of salts equals or exceeds the input must be maintained if irrigated agriculture is to be permanent.

In order to assess the performance of irrigation in a particular situation, it is essential to have the adequate information on the quality of irrigation water, its effect on the physical and chemical properties of soil, water transmission characteristics and salt build up. This study was conducted to investigate the dynamics of salinity characteristics of surface flows as well as the rootzone salt balance keeping in view the total salts added through irrigation supplies and dry period capillarity, and their removal through leaching, groundwater outflows, etc.

METHODOLOGY

This study was conducted in the command area of two adjoining watercourses bearing mogha No. 52810-L and 47850-L located on the Shahkot distributory (Fig. 1). The basic data regarding these water courses are presented in Table 1. The rootzone depth was taken as 1.25 m which covers the rooting depth of about 90% of the crops grown in the studied area.

For the purpose of estimating the total salts added into the system and their leaching towards groundwater, water samples from the canal, tubewells and upper layer of groundwater were collected and analyzed (Table 2).

Sources of Salts Inflow

Canal supply: The major source of irrigation in this area is canal water. Continuous collection of data over an eight-year period indicated that the average annual irrigation application through canal supplies was 1576.16 ac. ft. This volume of water was estimated using the monthly average discharge measured at the head of both outlets and the time of operation of distributory. With the salt content of 81 ppm computed from the water analysis (Table 2), the total salts accumulated in the rootzone of command area of water courses were estimated as 157 tonnes annually.

tubewells was estimated from the electric meter reading after calibration as follows:

Time of operation (hr) = Tubewell working unit x 5.625/60
(115)

Time of operation (hr) = Tubewell working unit x 5.833/60
(113)

Table 1. Basic data regarding the studied watercourses

Location	52810-L	47850-L
Culturable command area (ha)	220.67	154.47
Main watercourse* length (m)	5010.00	3729.50
Farmer's branch length (m)	23395.00	15480.00
Total channel length (m)	28405.00	19209.00
"Sarkari Khal" (%)	17.64	19.41
Length of watercourse per hectare	127.56	122.77
Number of operators	57.00	52.00
Average irrigated holding size (ha)	3.90	3.01
Annual cropping intensity (%)	132.70	131.60
Mogha design discharge (l sec^{-1})	42.50	38.00
Average observed discharge (l sec^{-1})	29.72	39.65
Soil type	Silt loam	Silt loam

* Main watercourse means the community watercourse which is not the property of an individual also called "Sarkari Khal".

Tubewell supply: As this area is located under SCARP, so canal water is applied after mixing with public tubewells installed at the head of each water course. During the study period, no private tubewell was observed in the command area. The total volume of water supplied through these tubewells was estimated from average weekly discharge and the actual time the tubewells remained in operation. The time of operation of these

The annual application of water was estimated as 498.33 and 420.67 ac. ft through tubewell No. 115 and No. 113 respectively. With the salt contents of 1024 ppm and 921.6 ppm (Table 2), the total accumulation of salts through tubewell water was estimated as 1105 tonnes annually.

Groundwater source: Deep percolation due to poor irrigation applications and excessive seepage from irrigation canals contributed greatly to watertable fluctuations. The depth of watertable and the salinity of groundwater play an important role in the accumulation of salts from groundwater. Variation in watertable was determined from the observation made through series of observation wells installed in the command area.

Based on five years data it was observed that watertable varied between 6 to 13 ft from soil surface during the dry period (Fig. 2). This range of watertable depth after deducting rooting depth causes an overall contribution of 135 ac. ft to the crop water requirements (Doorenbos and Pruitt, 1977).

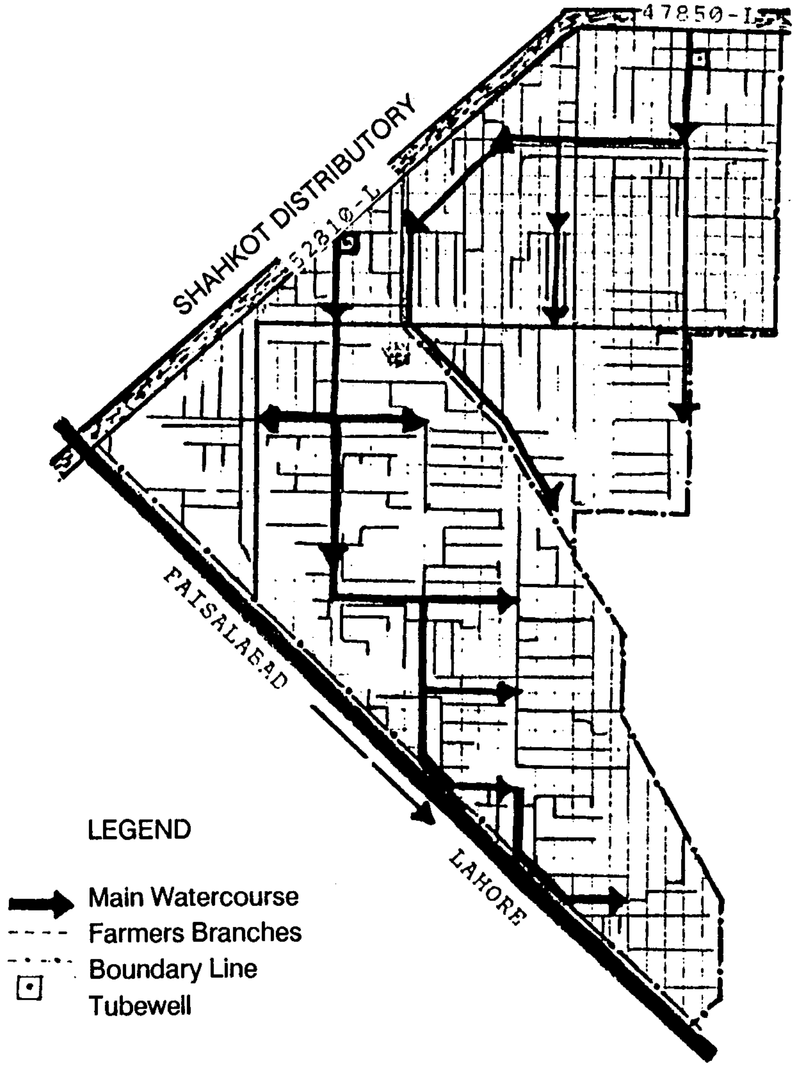

Fig. 1. Watercourse Layout and Command Area Map of Adjoining Watercourses No. 52810-L and 47850-L.

upper layer of groundwater, the total salts removed through deep percolation water were estimated as 478 tonnes annually.

Table 3. Removal of salts by different crops

Crops	Cropped area (acre)	Salt removed/ acre (tonnes)	Total removal (tonnes)
Maize	78.40	0.041	3.210
Wheat	585.65	0.040	23.436
Rice	184.53	0.700	18.453
Sugarcane	81.16	0.240	19.480
Cotton	15.49	0.020	0.318
Fodder	243.47	0.034	8.278

Rainfall during irrigation: The rainfall has a very favourable influence in suppressing the salts from rootzone. This effect becomes much pronounced when rainfall occurs immediately after irrigation. The removal of salts from rootzone during irrigation was studied for several years. Rainfall above two inches at a time was assumed to be contributing towards the groundwater on the whole command area, while for two inches and less than that duration, the component of deep percolation was calculated taking into account the respective soil moisture deficiencies. The study revealed that about 30% of total annual rainfall leaves rootzone leaching about 375 tonnes of salts annually.

Watercourse losses: In the canal command, water is supplied to the cropland through a network of canals, distributories and watercourse conveyance system. From the canals water is diverted into the small, largely earthen watercourses leading to individual fields. Considerable water losses occur in these watercourses. Ashraf *et al.* (1977) reported the wastage of almost 40% of irrigation water in these watercourses. Awan (1983) studied the operational analysis of watercourse losses and reported that of the total losses, almost 8.60% is percolated deep below the rootzone causing a removal of 227 tonnes of salts annually.

Crop uptake: Although most of the salts are removed from rootzone through overirrigation, rainfall and watercourse losses as discussed above, some proportion of salts is also taken up by the crop. The removal of salts by various crops grown in the studied area was estimated. The major crops grown in the study area with their respective cropped acreage and removal of salts by each crop are shown in Table 3.

CONCLUSIONS

Based on the discussion given above, the following conclusions could be drawn from this study:

1. The net addition of salts to the rootzone was estimated as 0.63 tonnes per hectare annually.
2. The major source of salt accumulation in the rootzone of studied area is poor quality tubewell water.
3. The salt load contains higher percentage of sodium contents causing general hardening of surface soil and thereby affecting the agricultural productivity of the area.
4. The additional application of water is needed for leaching of salts to control the salinity level in the rootzone.

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