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Evaluation of Conveyance Losses in Three Unlined Watercourses of the Warsak Gravity Canal

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Abstract: This study revealed that the losses of water from the three watercourses were 27.11, 25.85 and 31.25 on total length basis and the losses on 100 meter length basis were 3.62, 3.15 and 4.47 percent, respectively. The conveyance efficiency worked out to be 72.89, 74.15 and 68.75 percent, respectively. The main causes responsible for water losses were leakages from naccas, curves in the watercourse (No.3), high density of vegetation, problem of siltation, deposition of sediments, weak and un-compacted banks, lack of maintenance and holes made by rodents. Improvements suggested were lining, proper inlet structures and regular periodical cleaning.

Key word: watercourse, losses, conveyance, Pakistan

Introduction

Watercourses in the Indus Basin lose 30 to 50 of their flow. Reducing watercourse conveyance losses by 5 percentage points would provide the same amount of additional water to the field as the construction of an 11 billion cub. meter storage reservoir (Trout and Bowers, 1979).

Ashraf and Munir (1981) reported that about half of water (45 percent) was lost during conveyance in watercourses from outlet to the field, in Pakistan during 1973-74.

Clyma and Corey (1974) reported that equitable distribution of water cannot be accomplished without an improved distribution (watercourse) system from the mogha to the fields. They further suggested that the watercourse improvement when coupled with precision land leveling and introduction of proper irrigation structures such as siphon tubes, permanent gates (naccas) and measuring devices, the distribution system become complete. Johnson *et al.* (1979) reported that over half of the water delivered from the channel system to watercourses managed by the farmers was not made available to the crops in Pakistan. Most of this water loss was due to the loss of water through the bank of watercourses. Lack of maintenance and cleaning was a result of inadequate organization of the 10 to 150 farmers who used the watercourse, and a deficiency of knowledge concerning the amount of their water lost. Haq *et al.* (1980) studied water losses and delivery efficiency in Balochistan from source to the field and found that losses were about 24 which were half the water losses recorded in Punjab. Ahmad and Khan (1990) compared water losses in main watercourse and branch watercourse under the MONA SCARP Unit. They found that in long watercourses of 9 km length, the main watercourse contributed 93 to the total conveyance losses because it was in operation for 100 time of each turn. The field watercourses were in operation of about 4.3 hours per week per square of the selected command, and length was also limited. This research study was undertaken to find out the conveyance losses of three unlined watercourses of Malkandair Farm (Agriculture University Peshawar) and recommend measures for improving watercourse conveyance efficiency.

Materials and Methods

Site Description: The NWFP Agriculture University has a 327 acres farm located on its West side and is known as "Malkandair Farm". The farm has been divided into five sectors A,B,C,D and E.

The watercourses under study were located in sector 'D' of the Malkandair Farm, coming out of Warsak Gravity Canal. The characteristics of soils in which the three watercourses have been constructed are given in Table 1.

Table 1: Soil characteristics of the watercourses

Water course (WC) No	Sand (%)	Silt (%)	Clay (%)	Textural class
1	44.16	52.40	3.28	Silt loam
2	48.92	49.00	2.08	Silt loam
3	50.60	47.28	2.12	Sandy loam

Procedure of Water Losses Measurement: Conveyance water losses measurements were made by "Inflow-Outflow" method described by Trout and Kemper (1980), using cut throat flume as the measuring device. Discharge of water was measured on the head and tail of each watercourse and efforts were made to observe all the visible possible causes which could contribute to the losses from the watercourses. On each watercourse two flumes of 3 ft x 8 inch size were installed. Flume "A" was installed near the head ensuring a straight and clean section. Flume "S" was installed at the tail of each watercourse. The flumes were checked using a carpenter level both in longitudinal and transverse section.

After checking the level of the flumes, they were completely sealed from sides and bottom with the mud. The level of the flumes, was again checked after sealing. The time of installation was noted on wrist watch. Before taking any reading on flume, it was ensured that the flow of water was steady through the flume and without any obstruction or trashes in order to avoid hindrance in flow. After 30 minutes, the flow was closely observed for uniformity and steadiness. Readings on flume "A" were observed at the gauges fixed on the upstream side (H_a) and downstream side (H_b) and noted down in the note book. The flow condition was ascertained whether the flow was "free flow" or "submerged flow" using the following formula:

$H_b/H_a \times 100 < 65$ percent free flow
$H_b/H_a \times 100 > 65$ submerged flow

Similar observations were recorded on the flume "B". Actual discharge at head and tail, were taken from the chart using the recorded data.

Conveyance Losses: The water losses percentage in the conveyance system was calculated as follow:

$$\text{Water losses percentage} = [(Q_1-Q_2)/Q_1]*100$$

$$\text{Losses in 100 meter} = \frac{\text{Percent loss} * 100}{\text{Total length in meter}}$$

Where:
Q_1 = Measured discharge at head (cusecs)
Q_2 = Measured discharge at tail (cusecs)

Table 2: Conveyance efficiency of Malkandair Farm

WC No.	Total length (m)		H_a (ft)	H_b (ft)	Q_1 cusecs	Q_2 cusecs	Water loss (%)		E_c (%)
							Total length	/100 m	
1	750	Head	0.80	0.24	2.49	-	27.11	3.62	72.89
		Tail	0.69	0.16	-	1.815			
2	820	Head	0.78	0.22	2.36	-	25.85	3.15	74.15
		Tail	0.74	0.54	-	1.75			
3	700	Head	0.86	0.68	2.32	-	31.25	4.47	68.75
		Tail	0.65	0.20	-	1.595			

Conveyance Efficiency: Conveyance efficiency of watercourse was determined as follow:

E_c = 100 - Water losses percentage

or $E_c = (Q_2/Q_1) \times 100$

Where:

E_c = Conveyance efficiency of watercourse (%)

Q_1 = Measured discharge at head (cusecs)

Q_2 = Measured discharge at tail (cusecs)

Results and Discussion

The results from Table 2, revealed that losses from the watercourses were 27.11 percent, 25.85 and 31.25 percent, for watercourse No. 1,2 and 3, respectively on total length basis and 3.62 percent, 3.15 and 4.47 on 100 meter length basis. Whereas the values for conveyance efficiency were: 72.89 percent, 74.15 and 68.75 for watercourse No. 1,2 and 3, respectively. These results were broadly in line with the findings of Haq *et al*. (1980) and Trout and Bowers (1979). Haq *et al*. (1980) studied the water losses and found that losses were about 24 percent.

The highest losses in case of watercourse No.3 which are 31.25 on total length basis and 4.47 on 100 meter length basis could be attribilted to the following reasons:

This watercourse was comparatively new so the sides were not compacted, well and thus the chances for the seepage were enhanced. As the soil of this watercourse was comparatively more permeable so due to high permeability and infiltration this watercourse showed higher water loss. Due to rodent activities large size holes were appeared which were key to high water losses. Poor alignment, leakage from the turnouts, lack of maintenance and sediments, all contributed in hugh water losses. As far as the watercourses No. 1 and No. 2 were concerned, the water losses per total length basis were 27.11 and 25.85 percent, and per 100 meter basis were 3.62 and 3.15 percent, respectively. The conveyance efficiencies were 72.89 and 74.15 percent. In these cases the major losses occurred through the earthen (Kacha) naccas for each plot on both sides of the watercourses. Loose earthen material from the nearby soil was used to close these outlet structures, when used. They become saturated during the flow of water in the watercourses and partial erosion of the material occurred and so considerable loss of irrigation took place.

The other source of water losses, was seepage from the beds and sides of watercourses. As a whole if the conveyance efficiencies of these watercourses were compared with that of No. 3, then it would be concluded that conveyance efficiencies for these watercourses were not too low to be objectionable because of compacted clay on the banks which resulted in reduced seepage.

As a result of this work and from the perusal of other pertinent literature review work the following methods and measures were suggested for minimizing the losses in conveyance system and for improvement of the watercourses.

Proper improvement with brick, concrete lining, with naccas and check may be done so as to save the high amount of water lost through seepage, rodents holes, and other losses etc.

Profile survey of the complete watercourse should be carried out in order to record the elevation of the ditch bottom, full supply level, the banks and commanded fields for proper design of the watercourse so that the authorized discharge is accommodated in the watercourse section with proper freeboard. Beds and banks of the watercourses should be compacted in order to minimize losses through horizontal and vertical seepage. Banks should not be built from porous materials. In order to avoid leakage from the kacha turnouts, pucca nacca with gate should be installed. This practice would also minimize the labour used by the farmers for irrigating their fields. Growth of vegetation on banks and in channels should be discouraged. Regular periodical cleaning of the silt, sediments and other materials should be carried out. Efforts should be made to destroy and seal the holes made by rodents.

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