EVALUATION OF WATER MANAGEMENT PRACTICES AT THREE OUTLETS OF JOE-SHEIKH (CANAL) PESHAWAR, PAKISTAN

Nisar Ahmad, Javed Akhtar Tariq, M. Zubair Khan and M. Ahmad Shah

ABSTRACT

The research work was conducted at three sampled watercourses, namely Rashida, Jhagra and Sheikhtakar, of Joe Sheikh (Canal) Peshawar during 1997-98 and 2006. The actual water supply and allocation at each outlet, conveyance losses including seepage and leakage losses in the watercourses, and farmers' water distribution practices were evaluated. Cut-throat flume was used to measure actual supply and conveyance losses. The water allocation data were obtained from the records of Irrigation Department. Farmer’s water distribution practices were determined using questionnaire proforma. The irrigation water allocation to Rashida, Jhagra and Sheikhtakar watercourses were 39, 35 and 42 L s⁻¹ respectively. Majority of the time, the actual water supplies measured were less than the allocated discharges. Delivery performance ratios were below unity most of the time at the three sampled watercourses. Conveyance losses were 9.56, 4.7 and 7.1 L s⁻¹ per 1000 meter at Rashida, Jhagra and Sheikhtakar watercourses respectively. Total conveyance losses of 17.38, 14.08 and 15.49 L s⁻¹, 3.04, 2.50 and 4.39 L s⁻¹ and leakage losses of 14.34, 8.58 and 11.1 L s⁻¹ were determined for the whole lengths of Rashida, Jhagra and Sheikhtakar watercourses respectively. Field interviews indicated that water distribution among farmers was inequitable. Coefficient of Variation in water allocation found was 88.38, 30.58 and 18.83 % at Rashida, Jhagra and Sheikhtakar watercourses respectively. Family water distribution was practiced in the command areas of the watercourses. At three sampled watercourses 73, 46.5 and 40% were tenants. All the farmers interviewed told that there were no disputes on maintenance of watercourses; however the farmers informally clean their watercourses once or twice per year. No formal water users associations exist in the area. Owners maintained watercourses better than tenants.

Keywords: Dpr, Joe Sheikh, Management, Practices, Pakistan, Water Canal, Water Courses

INTRODUCTION

This research study was carried out to get an understanding of irrigation water management in civil canal irrigation with a focus on water allocation and actual supply, measurement of the conveyance, seepage and leakage losses and the farmers’ water distribution practices.

The Joe Sheikh Canal is one of the oldest canals of the NWFP, which was constructed on self-help bases on the right bank of Kabul during the reign of Mughal Emperor Aurang Zeb towards the end of seventeenth century. Later it became part of the Kabul river canal system. The canal shares its intake with the Kabul River Canal. During the colonial British time it was enlarged and upgraded and handed over to the local authorities to be operated as civil canal.

Civil canals are those canals where there is no government responsibility for management of irrigation water below the head gate of the system. The role of government is limited to delivery of a fixed ration of water into the system. There are no standard operational procedures, either in the main and secondary canal or at watercourse level and each canal is unique, and it is impossible to characterize them in a more systematic manner (Murray-Rust, D.H. 1997).

Bhutta (1990) quoted by Latif and Shahid (1994) studied equity of water distribution and indicated that discharge at the heads of tertiary canals were less than 75% of the design value for 40% of the operating time. Average discharge varied from 250% more in head reaches to zero (of the design value) in tail reaches. The provision and adjustment in the head gate of a distributary on daily basis can substantially improve discharge conditions in the tertiary canals of the distributary. Similarly Ahmad et al. (1999) determined the actual water supply remained below the allocated might be due to variable level of supply in the system, closing and opening of outlets and rainfall. The coefficient of variation in the supply, 4-21 % within the watercourses, showed strong variable supply. Delivery Performance Ratio (DPR) found was very rarely unity. Analysis of status of water distribution indicated that water users had transformed the official water distribution to informal water distribution by arranging their turns to their working schedules, rainfall, staggering and insufficient supply not fulfilling the requirements. The percentage of tenants and size of land holding was variable in the three studied tertiary units. No formal water user associations existed in the area but the farmers were informally organized and desilted the watercourses once per year.

Researchers Hanks (1965); Clyma and Corey (1973,74); Johnson et al., (1978); Colorado State University staff (1979); Thomas and Bower (1980); Ashraf and Munir (1981); Rehmaw et al., (1987); Khan (1995-97); Ahmad and Fakhr-i-alam (1996); Ahmad et al., (1996-2006), worked on the magnitude of conveyance losses in Pakistan, and irrigation water losses found were in the range of 30 - 50 % in the unlined watercourses and 3 - 9 % in the lined sections of the watercourses. Inadequate capacity, improper cross section, clogging of watercourse, leaky outlets and field turnouts, channel storage, obstructions like trees,
Weeds, debris, sediment, rodent holes and poor alignment are the causes for water losses in unlined watercourses. Cracks in the plastered side walls and damaged brick lining and poor maintenance were the main causes of water losses in the lined channels.

Mirza and Qazi (1992) studied the WUAs in Pakistan and found that WUAs are non-functional, particularly when the watercourse renovation is over but the need for farmers water management organization has been felt ever since the informal modes of organization like the village Punchayat failed. Reasons for failure include factional tendencies, vested interests, centralized bureaucracy and individual or group izzat (honour). Data were obtained from 225 respondents from 15 watercourses in Punjab province. It was found that disputes and offenses were common but the authorities were deemed to be unaware or indifferent. Farmers were in the main ignorant of the correct organizational process in water management.

**MATERIALS AND METHODS**

**Description of the Selected Site**

The research site is located in the command area of Kabul River Canal (KRC) system, at Joe Sheikh Canal, about 20 km towards east from Peshawar, Pakistan, south of Tarnab Farm in NWFP Pakistan. Kabul River Canal was constructed in early 1900s. This canal (KRC) gets water directly from the Kabul River just down stream of Warsak Dam. The length of the Joe Sheikh Canal is 15193 meters. There are 55 outlets along the Joe Sheikh Canal. Head discharge of Joe Sheikh Canal is 350 cusecs (10m³/s). Water allowance of the Canal is 0.84 L⁻¹ ha⁻¹. Total cultural command area is 29000 acres or 11736 ha. Three watercourses were selected along Joe Sheikh Canal for a detailed study. The details of the watercourses are as following:

**Rashida Outlet (RD# 123850/L)**

It is located at latitude 34° 00’ 47.2” N and longitude 71° 39’ 43.2” E. The elevation of this Nakka is 310 meters with respect to mean sea level. The outlet type is APM (barrel). The allocated discharge of the watercourse is 35 L s⁻¹. The approximate length of the watercourse is 1819 meters. The watercourse cultivable command area (CCA) is 81.4 hectares. This watercourse irrigated the fields of Chamkani and Jhagra villages. The major crops were orchards, maize (corn), alfalfa and vegetables.

**Sheikhtakar Outlet (RD# 123980/L)**

It is located at latitude 34° 00’ 46.1” N and longitude 71° 39’ 45.4” E. The elevation of this Nakka is 315 meters with respect to mean sea level. The outlet type is APM (barrel). The allocated discharge of the watercourse is 39 L s⁻¹. The approximate length of the watercourse is 2182 meters. The watercourse cultivable command area (CCA) is 151.5 hectares. This watercourse irrigated the fields of Kalookhel, Nasirpur and Masma villages. The major crops were wheat, orchards, maize (corn), alfalfa and vegetables.

**Irrigation Water Supply and Allocation**

Each tertiary unit has some fix rate of flow at the outlet. This rate of flow is termed as water allocation. Allocation data for the sample watercourses were collected from the records of the Irrigation Department. Actual water supplies to the sample watercourses were determined by Cutthroat flume. The principal involved in measuring the discharges, is reading the gauge and using the related Tables. Cutthroat Flume (10.16 cm x 0.91 m) was used for discharge measurement and was placed in a straight section of a channel, parallel to the direction of flow.

**Performance Assessment**

Delivery Performance Ratio (DPR) was computed for each watercourse. It is the ratio between actual supply (Qa) and allocated discharge (Qd). A DPR of unity indicates that the Outlet is drawing irrigation water according to allocation.

**Measurements of Conveyance Losses**

The losses in the selected watercourses were measured by the “inflow-out-flow” method. Long sections of 500, 650 and 500 meters were selected at each sample watercourse and flumes were installed at beginning and at the end sections. The discharge at inlet and exit locations of the section in each watercourse was measured. The difference between the two values showed the conveyance losses in the section selected. Lag time can be defined as taken by water to reach from first flume to second one. It was determined for fluctuating flows. For determination of lag time relatively straight and weed free sections of 20 meters length were selected for each watercourse.

**Measurement of Seepage and Leakage Losses**

Seepage losses were determined by Ponding Method. In this method a watercourse section of
about one meter in length was used. The change in depth was recorded until the steady state seepage was obtained. The measurement was stopped when the seepage rate became steady state. Leakage losses were determined by subtracting the seepage losses from the total conveyance losses.

**Farmers Water Distribution Practices**

Water distribution, maintenance, tenancy status, landholding and duration of irrigation, time per unit area were determined during the research period from interviews with farmers at their farm fields. For this purpose fifteen farmers at each sampled watercourse were interviewed. Questions asked were on (i) Mode of water distribution, (ii) Day of irrigation turn, (iii) WUA, (iv) Size of land holding and (v) Tenancy status.

**RESULTS AND DISCUSSION**

**Performance Assessment**

At Rashida watercourse the discharge observations showed that majority of the time actual discharges were lower than the allocated discharge, while a few times it reached the limit up to 42.1 L s\(^{-1}\) during June, July, and September as shown in Fig.1. The average discharge of watercourse during research period was 29.0 ± 5.0 L s\(^{-1}\).

The study of DPR at Rashida watercourse showed that it performed well during mid June, mid July and majority of the time in September as shown in Fig.2.

Similarly majority of the time the actual discharges were lower than the allocated discharge at Jhagra watercourse. The discharges were below than allocated discharge during 2nd week of June, last week of July, 3rd week of August, 1st and 2nd weeks of September as shown in Fig.3. The average discharge of watercourse during research period was 40.3 ± 7.65 L s\(^{-1}\).

The DPR of Jhagra watercourse showed that it performed close to unity during the last week of June, mid of July, 1st weeks of August and September. Its performance was very poor during the first week of July, mid of August to the start of September as shown in Fig.6.

Opening and closing of outlets, rainfall, variable level of water in the canal, debris in the outlets were the possible reasons for the variations in discharges and performance of outlets.

**Conveyance Losses**

The conveyance losses of Rashida, Jhagra, and Sheikhtakar watercourses are presented in Tables I, II and III. The average conveyance losses for Rashida watercourse were 4.78 L s\(^{-1}\) or 22.5 % or 9.56 L s\(^{-1}\) per 1000 m length of the watercourse. The average conveyance losses for Jhagra watercourse were 3.09 L s\(^{-1}\) or 17.4 % or 4.7 L s\(^{-1}\) per 1000 m length. The average conveyance losses at Sheikhtakar watercourse were 3.55 L s\(^{-1}\) or 14.10 % or 7.1 L s\(^{-1}\) per 1000 m length. The total conveyance losses for these sampled watercourses were 17.38, 14.08 and 15.49 L s\(^{-1}\) during the study period. Reasons for such losses were distance from the outlet, unlined canal, weeds, silt accumulation and poor maintenance.

**Seepage Losses**

The seepage rates and seepage losses found by three ponding tests in three watercourses are shown in Table IV. The seepage losses found at sampled watercourses, Rashida, Jhagra and SheikhTakar ranged from 2.5 to 4.39 L s\(^{-1}\) respectively. The factor affecting seepage losses were vegetation within the watercourse, roots and rodents holes, watercourse maintenance conditions and wetted perimeter of the watercourse. Seepage rate was higher at the beginning due to relatively dry soil at the start of the experiment and decreased with time and became relatively constant after 6 hours.

**Leakage Losses**

The leakage losses were determined by subtracting the seepage losses from the total conveyance losses as shown in Table V.

**WATER MANAGEMENT PRACTICES**

**Tenancy, Land Holding, Irrigation Duration and WUAs**

At Rashida watercourse 46.5% were tenants, 33.5% owners and 20% owner cum tenants. At this watercourse land holding ranged from 0.20 to 1.77 ha and duration of irrigation ranged from 0.30 to 2.50 hrs. Formal WUAs inexisted. The reasons inexistence of WUAs was lack of unity and farmers belonged to different villages. All respondents told that desilting took place twice per year.

At Jagra watercourse 40% were tenants, 40% owners and 20% owner cum tenants. Land holding
ranged form 0.30 to 2.02 ha. The duration of irrigation ranged from 0.50 to 2.00 hrs. Formal WUAs inexisted. The reasons were lack of unity, illitarcy and farmers belonging to different villages. All respondents told that desilting took place twice per year. There were no disputes reported on maintenance work.

At Sheikhtakar watercourse 73% are tenants, 13.5% owner and 13.5% owner cum tenants. At this watercourse land holding ranged form 1.62 to 0.10 ha and duration of irrigation ranged from 0.15 to 3.25 hrs. Formal WUA did not exist. Informal WUA existed and one person acted as a leader for organizing farmers for desilting of the watercourse. The 40% water users responded that desilting took place twice while 60% said once. There were no disputes reported on maintenance.

**Principle of Water Distribution**

At Rashida watercourse the data regarding irrigation time showed that a minimum time of individual farmer was 37 min ha$^{-1}$ and maximum of 371 min ha$^{-1}$. High variability of irrigation time existed among farmers. There was no fixed principle of water distribution among farmers. This can be seen in fig. 7.

At Jagra watercourse the minimum irrigation time was 49 min/ha and maximum of 148 min ha$^{-1}$. Out of fifteen farmers only three got 59 and four 74 min ha$^{-1}$. Four farmers received near 90 min/ha and only one farmer got more than 140 min ha$^{-1}$, which is exceptionally high allocation compared to other farmers. It is shown in fig. 8. This indicated that no proper method of water distribution existed in the sample watercourse among water users.

At Sheikhtakar watercourse minimum irrigation time was 74 min ha$^{-1}$ and maximum 120 min ha$^{-1}$. Irrigation duration data reflected that water distribution was in inequitable manner. Fig 9. indicated that all farmers got irrigation water for 70 or more than 70 minutes per hectare. Eleven out of 15 water users received more than 70 minutes. These 11 farmers got water for higher duration in the range of 20 to 50 minutes.

The Coefficient of Variation of irrigation times at three sampled watercourses were 88.38, 30.58, and 18.83 %. The highest dispersion in irrigation water duration in min ha$^{-1}$ at Radhida watercourse may be due to status of the farmers where 73 % were tenants. The minimum of 18.83 % was determined for Sheikhtakar watercourse where 40 % farmers were tenants. Similarly at Jhagra watercourse, the dispersion in irrigation durations was 30.58 % and higher than Sheikhtakar with 46.5 % tenants. In general the water distribution and duration of irrigation water per hectare is inequitable in Joe Sheikh Canal command area. Inadequacy and discharge variation is in agreement with Azam and Hussain (1990). Conveyance losses are in agreement with the minimum conveyance losses determined by Ejaaz anfd Khan (1995) and Rehmat (1987). Water distribution pattern somewhat matches with the findings of Beeker and Latif (1993) in which the water users modified the schedule in an informal way and inequity existed in water distribution among water users.

**CONCLUSIONS**

i. Discharges at the three watercourses were variable and supplies were lower than the allocated discharges.

ii. Total conveyance losses were the highest at Sheikhtakar watercourse.

iii. Family based water distribution (Warabandi) was followed in the irrigated area.

iv. No formal WUAs were found in the irrigated area.

v. Desilting took place once or twice during one irrigation calendar year. No disputes on maintenance work.

vi. Owners maintained watercourses better than tenants.

**RECOMMENDATIONS**

i. Watercourses should be lined to reduce conveyance losses. Low cost lining should be adopted after concrete lining.

ii. Farmers should be advised to increase the frequency of desilting and weeding.

iii. In order to study the impact of the social organization among farmers in tertiary units on the water distribution, studies in different tertiary units under different social conditions are required.
Fig. 1. Discharge Variation at Rashida Watercourse

Fig. 2. DPR of Rashida Watercourse

Fig. 3. Discharge Variation at Jhagra Watercourse

Fig. 4. DPR of Jhagra Watercourse
Fig. 5  Discharge variation at Sheikhtakar Watercourse

Fig. 6  DPR of Sheikhtakar Watercourse

Fig. 7  Water Allocation at Rashida Watercourse
Table I  Conveyance Losses of Rashida Watercourse

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Table II  Conveyance Losses for Jhagra Watercourse

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Table III  Conveyance Losses of Sheikhtakar Watercourse

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Table V  

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