MANAGEMENT OF SMALL-SCALE WATER LOGGING THROUGH SURFACE DRAIN MAINTENANCE

Tahir Sarwar, S. M. Bilal, Naveedullah, M. Jamal Khan and Javaid Tariq

ABSTRACT
The present study was conducted during 2003-2005 and focuses on existing maintenance condition of surface drain and the effect of drain maintenance on water logging and crop production at Surizai project area, located about 40 km South of Peshawar. It has predominantly water logging problem with water table ranging 0.54 to 0.78 m from the ground surface. Half of the waterlogged area is fallow and the major crops growing in the area are sugarcane, maize and wheat. Yield of these crops were 47, 36 and 37% lower as compared to waterlogged area. Spacing of the field drains ranged from 8 to 374 m with highest drain density at the tail portion of the project area where water logging was also high. The hydraulic conductivity of the site varied from 0.73 to 3 m/day. A deep open drain was constructed by Irrigation Department in 1985 but was not properly maintained since its construction. With the farmers’ participation tail portion main drain (about 3 km) was desilted and rehabilitated according to engineering design. Cleaning and rehabilitation of the drain has resulted in significant lowering of water table in the project area. Farmers have now started cultivating their lands which were kept barren for the last 20 year due to severe waterlogging problem and significant increase in the crop yield have been reported. It is concluded that million of Rupees can be saved by regular cleaning of the surface drains. However, farmers’ participation plays a key role in achieving the desired targets.

INTRODUCTION
It is well established that waterlogging and salinity both in water and soil impair the performance of many agricultural crops and as such threaten the validity of achieving the projected food requirements. For many reasons enumerated in the literature, it is becoming inevitable that future crop production will have to depend on the use of brackish or saline water and soil considered unfit at present by today's agricultural standards (Richard, 1954).

Extent of waterlogging and salinity reported by different agencies gave quite different figures. In some cases almost 100% variations in values are reported. WAPDA (1979) reported 0.023 ha surface soil salinity based on the survey of 8.50 Mha of Indus basin in NWFP. Qureshi and Lennard (1998) reported that the total salt affected soil of NWFP is 0.472 Mha. Similarly, water logging in irrigated areas of NWFP estimated by WAPDA (1980-81) is 0.176 Mha out of which 0.113 Mha has water table depth above 5 feet. According to Govt. of Pakistan (1995), the waterlogged area in NWFP is 0.24 Mha during June, 1993.

The overall objective of the study is to develop appropriate technology package for the alleviation of small-scale waterlogging and salinity problem in NWFP for farmers by using participatory approach. The specific objectives of the study are: to compare cropping pattern and yield in water logged and non-water logged areas; to investigate the existing maintenance condition of surface drains at Surizai (Peshawar); and to study the impact of improved surface drainage on water table fluctuation

MATERIALS AND METHODS
Surizai – Peshawar Project Area
The study was conducted during 2003-2005 at Surizai site which is located about 40 km south of Peshawar. The area comprises of about 500 ha land having basin topography which is saline and scattered waterlogged. The soil is dense having platy structure down 1 meter in the profile. The observation reveals that the major problem of waterlogging arises due to restricted infiltration and drainage. Salinity also develops on the upper few centimeter of soil again due to restricted drainage. The working hypothesis is that by improving infiltration and avoiding the waterlogged zone, the yield can be enhanced.

The area is situated between Surizai and Urmar minors of Warsak Gravity canal. Surizai minor, Urmar minor and one direct outlet from Warsak Gravity canal irrigate project area. The central part of the area is severely waterlogged due to seepage from these three channels. A deep open drain was constructed by Irrigation Department in 1985. The total radial length of drain is about 6.2 km. It starts at head of project area and crosses the tail boundary at radial length 2.98 km (Kakar, 2000). The design discharged of drain was 142 lit/sec. Laterals from farmers fields disposes water in the main drain. As it is a deep open drain, it carry surface as well as subsurface runoff water to disposes it in Bara River.

Socio-Economic Survey
To assess the socio-economic status of the farmers, a questionnaire proforma was developed. Thirty
farmers were interviewed in the project area. According to the general survey, most of the farmers are poor and have small land holdings. Majority of the population depends on agriculture and livestock. However, off-farm enterprises, small business employment in public in private organizations are the other main source of income. There is no WUA in the project area. The farmers of the project area are cooperative and are willing to work with in an association.

**Dimension of Drains**
The dimensions (length, width and depth) of all the existing field drains were determined at both sites by using measuring tape and wheel type odometer.

**Intensity of Field Drains**
Intensity of the field drains in waterlogged areas was determined using the following formula:

\[
\text{Intensity of drain (m/ha)} = \frac{\text{Length of Drain (m)}}{\text{Cultivated Area (ha)}}
\]

**Rehabilitation of Main Drain and Selected Field Drains**
For assessment of sediment deposition in the main drain profile survey was carried. The main drain at the research site was badly in need of cleaning. In this regard several meetings were held with the farmers and the main drain was desilted and remodeled.

**Water table Depth Measurement**
Information about waterlogging of the selected sites was determined through questionnaire proforma while actual water table depth was determined by installation of observation wells of the selected sites. However, in case of heavy rainfall events water table data is being taken more intensively to study their effect on water table fluctuation. Water table contour maps were prepared for the study areas to get an insight into the severity of waterlogging problem and to make preventive measures accordingly.

Farmers at both sites have constructed field drains to facilitate movement of surface and subsurface water towards the main drain. However, the size and density of these field drains vary considerably within the research areas. Therefore, water table depth under different field drain densities is being monitored and compared to see which density is more effective in controlling the waterlogging problem.

**Installation of Observation Wells**
An observation is open hole, which is partially filled with gravels, and perforated pipe is placed in the hole. The region around the pipe is backfilled with gravels so that water flows freely into and out of the pipe depth and the hole. The effect of drain maintenance on water table depth is being monitored by installing of observation wells at the research sites. Twelve observation wells have been installed at Surizai, Peshawar.

**RESULTS AND DISCUSSION**

**Land Holding and Tenancy Status**
The farm size varied from 0.40 to 10.52 ha with an average value of 3.2 ha. Majority of the farmers (45%) are tenant, 42% are owner and only 13% are owner/tenant. Main source of income is farming (85%), and the rest is other than farming. There is no WUA and 49% of the total CCA area is waterlogged.

**Cropping Pattern and Yields of Major Crops**
The cropping pattern and yields of major crops for Kharif and Rabi seasons in waterlogged and non-waterlogged areas were assessed through questionnaire Performa (Fig. 1 to 3). Thirty (30) farmers of the research area were interviewed to collect the data on cropping pattern and crop yield. Collected data from interview was then analyzed using the SPSS program (Statistical Package for Social Sciences). The data analysis shows that half of the waterlogged area remains fallow both in Kharif and Rabi season. Major crops in area are sugarcane, maize and wheat. Comparison showed that yield of sugarcane, maize, potato and wheat in non-waterlogged area were 47, 36, 4 and 37% lower as compared to water logged area (Fig.3).

![Fig. 1. Cropping pattern of Kharif season in (a) non-waterlogged and (b) waterlogged areas of Surizai](image-url)
Fig. 2. Cropping pattern of Rabi season in (a) non-waterlogged and (b) waterlogged areas of Surizai

Fig. 3. Yield of different crops in waterlogged and non-waterlogged areas

Rehabilitation of Main Drain and Field Drains

Surizai Main Drain

A detailed longitudinal profile survey of Surizai main drain was carried out in June 2003 (Fig. 4). The overall bed slope of the drain is 0.0058 m/m. The depth of the existing drain from ground surface ranged from 0.41 m to 3.84 m with average 1.73 m. The top width of the existing drain varied from 2.30 to 8.25 m with average 4.84 m. The existing bed level of the drain ranged from 0.30 m to 2.50 m with average 0.90 m. The tail portion of the drain (about 3 km) has severe waterlogging and salinity problem. With participation of the farmers, the tail portion of the drain will be desilted and cleaned.
Field Drain
Dimensions (length, width, depth and spacing) of field drains at Surizai site was determined with the help of measuring tape and Odometer on North and South sides (right and left) of main drain. Total numbers of field drains on North and South sides are 58 and 48, respectively. The dimensions of field drains on both sides are given in Table I. The frequency analysis was performed on drain spacing and drains were grouped into 4 classes (0-25, 25-50, 50-75, and >75 m). The maximum drain spacing (41%) was found in the class 25-50m. The rest of classes were about 20% (Fig. 5)

Table I. Field drains dimensions and spacing at Surizai, Peshawar

<table>
<thead>
<tr>
<th>Dimensions (m)</th>
<th>North Side</th>
<th>South Side</th>
<th>Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Length</td>
<td>189</td>
<td>18</td>
<td>207</td>
</tr>
<tr>
<td>Width</td>
<td>1.83</td>
<td>0.30</td>
<td>1.52</td>
</tr>
<tr>
<td>Depth</td>
<td>1.83</td>
<td>0.15</td>
<td>1.52</td>
</tr>
<tr>
<td>Spacing</td>
<td>374</td>
<td>8</td>
<td>248</td>
</tr>
</tbody>
</table>

Fig. 5. Intensity of drain spacing in waterlogged areas at Surizai, Peshawar
**Water Table Depth**

Information about waterlogging of the selected locations was determined through questionnaire proforma while actual water table depth was determined by installation twelve observation wells (four each at head, middle and tail) of the selected site. Water table depths were measured from these observation wells on weekly basis and after each rainfall event with the help of electric water level indicator. Average water table depth from the ground surface was 0.76 m and it ranged from 0.12 to 1.24 m. The daily rainfall events occurred during the study period ranged from 2 to 80 mm. It is obvious from the Fig. 6 that during the consecutive heavy rainfall events the water table reaches close to the ground surface and severely affects the crop yield. Due to choking of the main drain especially at the tail reaches waterlogging becomes severe during rainy season (winter and summer).

![Fig. 6. Water table fluctuation and rainfall at Surizai, Peshawar](image)

**Ground Water Contour Maps**

Water table contour maps were developed for the months of April, May, June, July, August, September, October, November and December 2003 of the Surizai research Site (Peshawar) from the water table data of observation wells and open wells in the main drain command area (Fig. 7 & 8). Results show that in the month of April more areas developed waterlogged condition as compared to May and June. During the month of July, 2003 due to heavy rainfall waterlogging has increased as compared to April, 2003. The percentage of waterlogged area under different categories of water table depth from the ground surface is given in Table II. In general about 20% of the command area of the drain has severe waterlogging problem mainly due to poor maintenance of the main drain.

<table>
<thead>
<tr>
<th>Months</th>
<th>Classification of waterlogged area according to depth from the ground surface at Surizai Peshawar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water table Depth (m)</td>
</tr>
<tr>
<td></td>
<td>&lt;1</td>
</tr>
<tr>
<td></td>
<td>Area (ha)</td>
</tr>
<tr>
<td>April, 2003</td>
<td>56.203 (6.19%)</td>
</tr>
<tr>
<td>May, 2003</td>
<td>40.71 (4.48%)</td>
</tr>
<tr>
<td>June, 2003</td>
<td>30.226 (3.33%)</td>
</tr>
<tr>
<td>July, 2003</td>
<td>96.6 (10.64%)</td>
</tr>
</tbody>
</table>
Fig. 7. Ground water contour map for the month of April 2003 at Surizai Peshawar.

Fig. 8. Ground water contour maps for the month of Dec. 2003 at Surizai Peshawar.
CONCLUSIONS AND RECOMMENDATIONS
Cleaning and rehabilitation of surface drains result in significant lowering of water table. Millions of Rupees can be saved by regular cleaning of surface drains. Farmers’ participation play crucial role in achieving the desired objectives.

REFERENCES


