

IMPACT OF SCAVENGER WELLS ON CROPS AND GROUNDWATER TABLE

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ABSTRACT

Scavenger well extracts fresh and saline water through dual pumping, resulting in lowering the water table and maintaining the equilibrium between both aquifers.

This study was under taken to analyze the impact of scavenger wells on extent of water table control, cropping pattern, crop yield and land utilization in Irrigation subdivision Khadro Sanghar Sindh, Pakistan.

The results show that the water table has decreased at least 132 cm below the surface in most of the study area. Field survey results show that crop yield has increased 50% for cotton. Abandoned land has dropped from 78% to 28% of Culture able Command Area (CCA), which are under trenches, uneven topography and saline drains. As a result the land value has increased by six to ten times at many places.

INTRODUCTION

Irrigation is considered to be the lifeblood of agriculture, as 90% of agricultural production is being produced from irrigated lands in Pakistan (1).

Along the major canals in the Nawabshah and Sanghar areas, there are extensive areas where a layer of fresh groundwater overlies deeper saline water. The problem of extracting the fresh water is not new. It is conventionally tackled by using skimming wells. The drawback of extraction in this way is that only a very small capacity well should be used in this way. A second method is to draw normal discharge and accept that when the well becomes saline, it must be abandoned and a new well drilled. This has been done by farmers in area and requires drilling a new well after three years or so (2).

Scavenger wells can be effective in handling this problem. Scavenger well abstracts groundwater from both fresh and saline aquifers as shown in Figure 1.

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This results in lowering of groundwater levels. Fresh water can be used to rehabilitate saline land by providing the fresh water for leaching of salts from soil profile and Irrigation for later cropping. Where as saline water is discharged to saline drains. Abstraction from both aquifers prevents the excessive up coning of the interface and maintaining equilibrium.

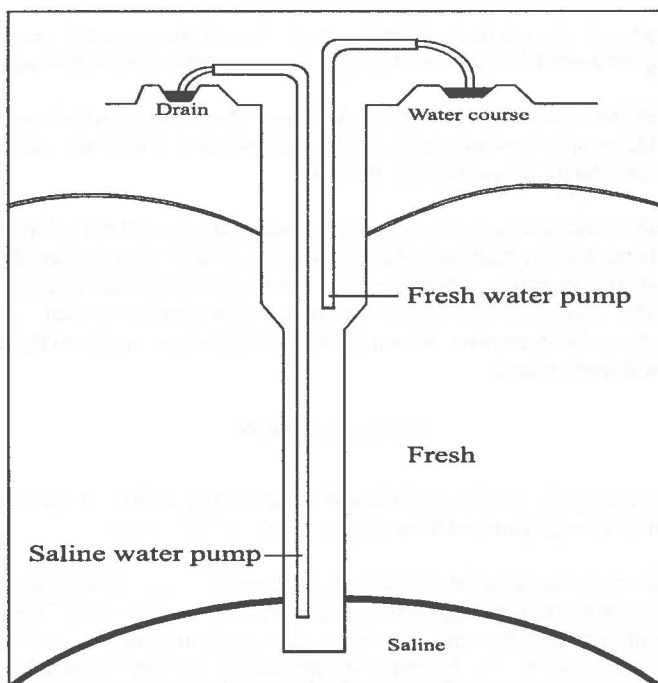


Fig. 1: Schematic scavenger well

The main environmental impact of scavenger wells is recovery of abandoned land. Early monitoring of scavenger wells has indicated a significant lowering of groundwater levels and recovery of about 30,000 ha of land in the Nawabshah District (3).

A series of 189 scavenger wells were installed in Nawabshah while construction of 175 scavenger wells in Sanghar is in progress.

METHODOLOGY

Eight scavenger wells starting from JRS-43 to JRS-50 as shown in Figure 2 were studied in Irrigation subdivision Khadro. Except JRS-47, all studied scavenger

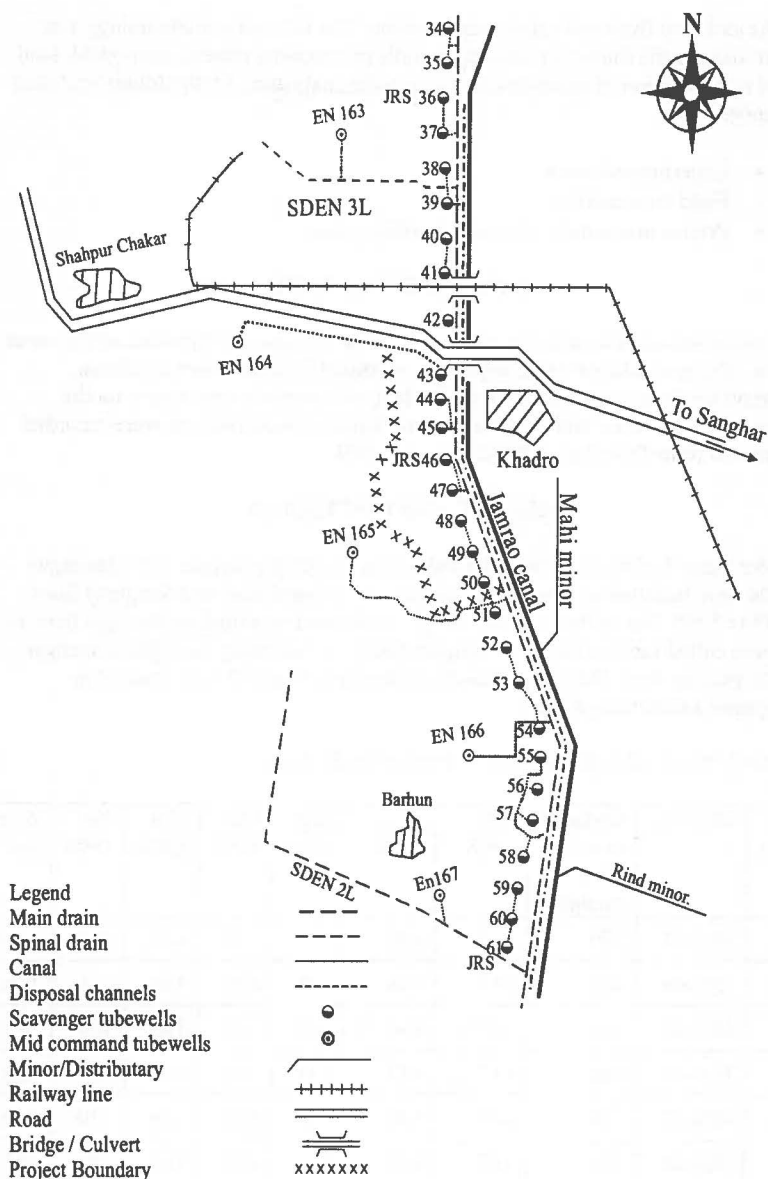


Fig. 2: Location map showing project area under investigation.

wells had both fresh and saline water outlets. The following methodology was used to study the impact of scavenger wells on cropping pattern, crop yield, land used and elevation of groundwater table in the study area. Methodology included as under

- Experimental work
- Field data analysis
- Project area survey (through questionnaire)

EXPERIMENTAL WORK

An auger was used to drill observation holes to measure the elevation of the water table. The groundwater table depth was recorded in equilibrium condition. Observation holes were drilled with the help of a pushing type auger; on the second day the water table depths were measured. Measurements were recorded on month basis from July 1998 to January 1999.

RESULT AND DISCUSSION

Under Stage 1 of the Left Bank Outfall Drain (LBOD) program, 189 scavenger wells were installed in Nawabshah component (Nawabshah and Sanghar) from 1993 to 1995. Out of these, 79 scavenger wells were installed on the right bank of Jamrao called Jamrao Right Scavengers (JRS). In this study the eight scavenger wells starting from JRS-43 to JRS-50 as shown in Figure 2 were studied in Irrigation subdivision Khadro.

Table 1. Water table Depth (cm) in Project Study Area

S. No	JRS No.	Distance of well from canal(m)	July 1998	Aug 1998	Sept 1998	Oct 1998	Nov 1998	Jan 1999	Average
1.	JRS-43	370	132	134	130	133	137	140	134.33
2.	JRS-44	160	137	134	135	136	138	141	136.66
3.	JRS-45	430	167.5	164.75	166	162	165	168	165.54
4.	JRS-46	480	142.25	143	141	146	143	147	143.71
5.	JRS-47	220	147	146	144	142	149	170	149.66
6.	JRS-48	500	167	164	162	165	164	170	165.33
7.	JRS-49	310	114	116	113	115	112	116	114.33
8.	JRS-50	350	127	125	129	128	130	132	128.50

Water table Depth (cm)

The data pertaining to post project water table depth recorded from various points during this study (July to November 1998 and January 1999), are shown in Table 1.

It can be seen that the water table depth is deepest at JRS-45 and 48, while highest in the JRS-49 area. Water table depths in JRS-45, 47 and 48 areas are in safe range, as required for major crops (Table 2). Although the water table depths in areas surrounding JRS-43, 44 and 46 are decreasing steadily towards safe range. Areas around JRS-49 and 50 may take one year or more to reach the desirable depth, even if meteorological conditions go in favour.

Table 2. Effect of different water table depths on crop yields

Water table depths [cm]	Crop yield decrease (%)					
	Cotton	Sugarcane	Wheat	Barseem	Summer Fodder	Mango
0-25	98	91	79	77	80	100
25-50	57	66	49	45	27	100
50-75	35	46	28	24	0	100
75-100	21	29	13	9	0	87
100-125	12	10	5	2	0	63
125-150	5	5	1	0	0	38
150-175	0	0	0	0	0	0

Source: Water Sector Investment Planning Study, Vol 1 [4]

Only one piezometer was located in the project study area (JRS-43 to JRS-50). This piezometer was near JRS-49 area. It is reported that during the preproject period (1988-1995), the water table measured in October was as high as 78 cm in 1994 and as low as 146 cm in 1988. In the postproject period (1997) the Scarp Monitoring Organization (SMO) found the water table at 220 cm, reflecting that the water table depth has drastically dropped from 1994 position i.e. 78 cm. However the water table was found 115 cm in October 1998, which shows that the water table has not lowered as much due to scavenger wells as found by SMO. This may be due to the fact that SMO piezometer was located in between scavenger well and spinal drain and it does not represent the area.

FIELD DATA ANALYSIS:

Impact of Scavenger Wells on Land Use

The land use of the study area at Khadro has been found for the total command area of two watercourses HB (Hamzo Baghrani)/2R (Right) and LS (Laski)/1R (Right) in deh Hamzo Baghrani, Laski and Kulan. Which were 432 ha. Due to the rising groundwater table and associated salinization of non-cropped areas, the amount of abandoned land was increasing and cultivated land was decreasing. As a result farmers were forced to grow crops on their best land. Table 3 indicates the land use of pre and postproject period. Land cultivation data were obtained from Revenue and Irrigation Departments record for the period of 1989-1998. The Kharif (Summer) crop for 1998 was observed in the present study.

Table 3. Land use (ha) in Project Study Area from 1989 -1998

S.No	Year	Land Under cultivation		Land Abandoned	
		ha	%age of CCA	ha	%age of CCA
1	1989*	89.62	21.96	318.38	78.04
2	1991**	83.50	20.46	324.50	79.54
3	1995**	163.84	40.16	244.16	59.84
4	1996**	211.84	51.92	196.16	48.08
5	1997**	252.50	61.89	155.50	38.11
6	1998**	283.12	69.40	124.88	30.60
7	1998***	292.58	71.71	115.42	28.29

* Revenue Data

** Irrigation Department Data

*** Present study

Before the installation of scavenger wells (1989), only 22% of CCA was under cultivation and about 78% of the land was abandoned due to waterlogging and salinity. The deterioration of land was under way. After the installation of scavenger wells, groundwater table lowered to a significant depth, which results in recovery of abandoned land. Results show that cultivated land area is increasing and abandoned land area is decreasing. By the end of 1998 cultivated land had increased from 22% to 72%. Table 3 shows that abandoned land were only 28% in 1998. This 28% of the project study area was under trenches, saline

drains, and irregular topography. Some landlords in the areas had sold their land to contractors for dredging of soil for embankment of Jamrao and spinal drain.

Impact of Scavenger Wells on Cropping Pattern

A crop survey of Kharif (1998-1999) was made in the project study area; Figure 3 shows the preproject (1989) and post project (1995-1998) cropping pattern. In the preproject period (1989), cotton, rice, fodder, garden and other crops were cultivated on 22.10, 48.47, 10.11, 5.74 and 3.20 hectares, respectively. While in the postproject period cotton, rice, fodder, garden, chilies, and other crops were cultivated on 219.30, 5.60, 41.65, 14.87, 1.65 and 9.51 hectares, respectively.

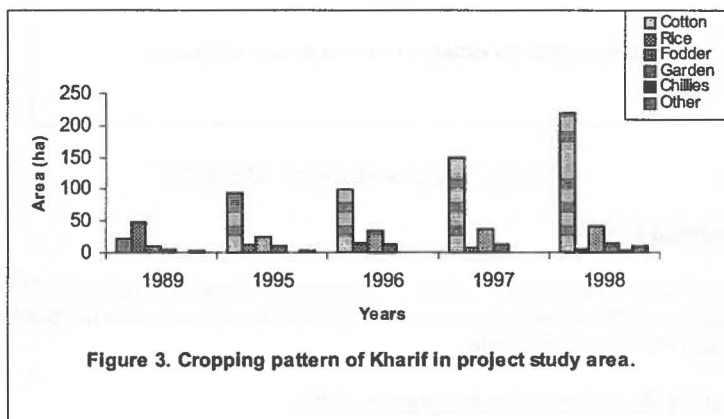


Figure 3. Cropping pattern of Kharif in project study area.

Figure 4 shows that the preproject (1990-1991) and post project (1997-1998) crops of Rabi (Winter). This shows that in preproject status, wheat, oil seeds, fodder and garden were cultivated on 56.29, 5.86, 15.97, 5.38 and 2.33 hectares, respectively.

It can also be seen in this Figure that in the postproject of Rabi season (1997-1998), wheat, oilseeds, fodder, garden, onion and other crops were cultivated on 204.17, 33.65, 25.55, 13.34, 3.17 and 3.24 hectares, respectively. It is obvious from the results that scavenger wells had improved the land for cultivation by dropping the water table to a desirable depth and reducing the soil salinity to safer levels. It was further observed that cropped areas in post project period were increasing compared to preproject level.

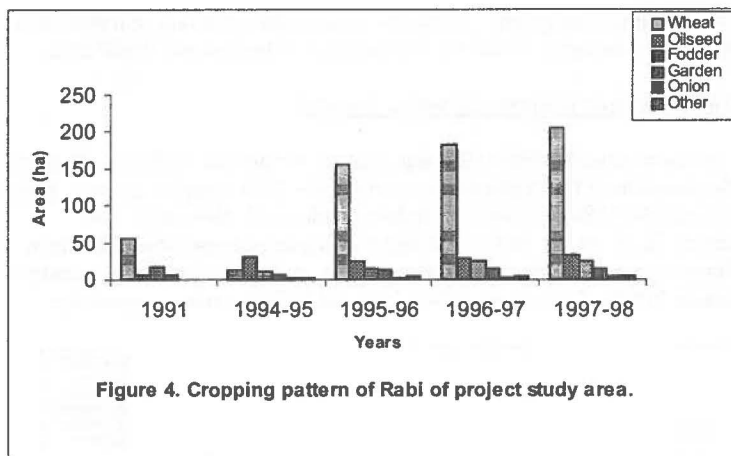


Figure 4. Cropping pattern of Rabi of project study area.

PROJECT AREA SURVEY RESULTS

Abandoned Land

The project area survey results show that percentage abandoned land of individual holdings was 25% or more in most cases. Previously reported value of abandoned land, as 28% seems reasonable.

Scavenger Wells Operation and Responsibility

Respondents reported most of Scavenger wells functional and operational responsibility was shared by Water and Power Development Authority (WAPDA) and Irrigation Department. Fresh water from scavenger wells is only used for Irrigation purposes. There is no awareness or willingness to use this precious source of fresh water for drinking purpose although it meets the quality standards. In some cases this water is drained out in to the saline drains. The problem of weeds was commonly reported by respondents, which cause restriction in the flow of saline water and hence flooding of the nearby land.

Land value

The field survey data shows that the minimum preproject land value was in the range Rs.500 to Rs.2500 rupees per hectare. The majority of respondents however reported that land value was high and fluctuated between Rs.2500 to Rs.7500 per hectare in preproject period. The lowering of water table and leaching of salts at deeper depths due to scavenger wells and subsequent Irrigation

have increased the land value in the postproject period. The majority of respondents reported that, at present, land value was about Rs.87, 500 to Rs150, 000 per hectare, while maximum land value reported was Rs.200, 000 or more per hectare.

Impact of Scavenger Wells on Crop Yield

The field survey results show pre and postproject crop yield of project study area. Before the installation of scavenger wells crop yield was very low. The majority of respondents reported that yield of the cotton crop was between 0.48-0.8 tons per hectare, yield of rice was 1.0-1.5 tons per hectare, and yield of wheat was 0.5-1.5 tons per hectare. After functioning of scavenger wells, landlords had cultivated cash crops on most of the cropland. The crop yield had also improved, up to 1.0-2.0 tons for cotton. These results seem realistic against Agriculture Extension Department data shown in Table 4.

Table: 4 Crop yield

S.No.	Year	Crops (Ton/ha)		
		Wheat	Rice	Cotton
1.	1990-91	2.27	1.53	0.31
2.	1991-92	2.41	1.54	0.43
3.	1992-93	2.19	0.89	0.32
4.	1993-94	2.11	1.89	0.45
5.	1994-95	2.11	1.56	0.52
6.	1995-96	2.07	2.27	0.59
7.	1996-97	2.08	2.35	0.65
8.	1997-98	2.56	2.13	0.72
9.	1998-99	2.58	2.03	2.63

Source: Sindh Agriculture Extension Department, Pakistan.

CONCLUSION

The study resulted in following conclusions:

1. Generally scavenger wells have lowered the water table below 132 cm, except for the area around JRS-49, where the water table has dropped to 115 cm (not as much as 220cm as claimed by WAPDA).
2. It has been estimated that the crop area in the project study area has increased from 22% to 72%.
3. Survey results showed that crop yield of cotton and wheat in the project study area has also increased significantly. As a result the land value has increased at least by six to ten times.

ACKNOWLEDGEMENT

The authors wish to express the sincere thanks to Miss Saira Syed Senior School Teacher Army Public School Chhor cantonment for her help in preparing Figures and graphs.

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