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Short Communication

Surveying tubewell water suitability for irrigation in four tehsils of district Kasur

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Abstract

Four tehsils of district Kasur (Chunian, Pattoki, Kot Radha Kishan and Kasur) were surveyed and five villages were selected in each tehsil at random. Two water samples were collected from each village and were analyzed for various irrigation water quality parameters. The results indicated that 60% tubewell were unfit from Chunian, 90% from Pattoki, 90% from Kot Radha Kishan and 80% from Kasur tehsil. Overall, 20% of total tubewells water sampled had quality parameters within the acceptable limits whereas 80% were unfit for irrigation. About 97% waters were unfit due to high salinity (EC > 1250 μS cm^{-1}), 63% were due to high sodium adsorption ratio (SAR > 10 mmol L^{-1})$^{1/2}$ and 97% were due to high residual sodium carbonate (RSC > 2.5 me L^{-1}). It may be inferred that use of poor quality irrigation water will cause deterioration in soil health, which consequently will result in poor crop production. Hence, it is emphasized that tubewell discharging unfit water should be used by following sound management practices like precision land leveling, inclusion of high salt tolerant crops in traditional cropping system, occasional deep ploughing in heavy textured soil, occasional flushing of the soil profile with heavy irrigation to reduce the salt concentration in the root zone and application of organic and inorganic amendments like pressmud, poultry manure, farm yard manure and gypsum or acid/acid formers etc, however the management options must be on the basis of analysis of water quality parameters.

Keywords: Tube well, irrigation, brackish water, Kasur

The canal water supply is one cusec for 350 acres (Ansari, 1995), which is not sufficient to meet the water requirement of the crops raised under intensive cropping system in Pakistan. Hence, to overcome the shortage of surface water, farmers are forced to use ground water to supplement the canal supplies for irrigation. Of 55 MAF ground water pumped, 70-75% is brackish (Ahmad and Chaudhry, 1988). The continuous use of such poor quality ground water can cause salinity/sodicity. About 6.68 m ha land in Pakistan has developed surface salinity/sodicity. Many researchers (Hornick and Parr, 1987; Aslam *et al.,* 1988; Khan *et al.,* 1991; Hussain *et al.,* 1994; Ghafoor *et al.,* 1999; Murtaza *et al*., 2002; Mahmood *et al*., 2006 and Ahmad *et al*., 2007) have reported that unscientific use of brackish water deteriorates the soil health and crop yield. Waheed *et al*. (2010) while studying the suitability of groundwater for irrigation purpose suggested that for long-term utilization of a soil and to prevent any potential hazardous effects on its health, recommendations regarding irrigation water must be with respect to textural class of the soil. Also, they proposed the cultivation of *Atriplex* spp., *Acacia* and *Eucalyptus* on degraded soils being irrigated with poor quality water. Whereas, Ali *et al.* (2009) declared that the ground water quality is of great concern for the sustainability in soil health and crop productivity. Also, Kashif *et al.* (2009) prioritized the monitoring of water quality for preventing the hazards of irrigation water. Similarly, Keshavarzi *et al.* (2010) recommended proper management of irrigation water to minimize the login of salts to soil because of the usage of poor quality irrigation water. While, Bennett *et al.* (2007) declared that the usage of brackish water for irrigation without its proper management is a major source of soil salinity.

Now as the quality of irrigation water has a major concern in sustaining the soil health and crop production so, keeping this in view the present study was undertaken to assess the suitability of water for irrigation of different tubewells running in four tehsils of Kasur district.

Four tehsils of district Kasur are Chunian, Pattoki, Kot Radha Kishan and Kasur. Five villages from each tehsils were selected during 2008-2009 to monitor the tubewell water quality for irrigation. Two tubewells per village were randomly sampled. The water samples were collected after half an hour running of tubewell. The analytical work was carried out in Soil and Water Testing Laboratory, Kasur following the methods described by U.S. Salinity Laboratory Staff (1954). The water samples were analyzed for EC, cations, anions and then SAR and RSC were computed as under:

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$SAR = Na^{+}/ \sqrt{(Ca^{++} + Mg^{++})/2}$

$RSC = (Co_3^{--} + Hco_3^{--}) - (Ca^{++} + Mg^{++})$

For assessing the suitability of water of the sampled tubewell, the results were compared with the irrigation water quality criteria used by Malik *et al.* (1984) which is presented in table 2.

The information on irrigation water quality of forty tubewells running in twenty different villages of four tehsils of the district Kasur are given in table 1. The criteria used to compare the data are given in table 2. The results are discussed as under:

Tehsil Kasur

The EC of the water samples ranged from 544 to 3235 $\mu S\ cm^{-1}$, SAR from 0.09 to 13.95 $(mmol\ L^{-1})^{1/2}$ and RSC from 0.0 to 15.2 me L^{-1}. Out of ten water samples, 1 was fit, 1 was marginally fit and 8 were unfit for irrigation (Table 3). Amongst the unfit, 7 were unfit due to high EC, SAR and RSC whereas 1 was unfit due to high SAR and RSC. The farmers are advised to use marginally fit water by managing occasionally deep ploughing along with heavy irrigation of good quality water and application of 3-4 trollies of organic manure (OM) in order to tackle the little hazard of salinization contained in with the use of these waters. However, if this marginally fit water is the only available source then along with above said practices, the salt tolerant crops (Barley, wheat, sorghum, rice) and fruit trees (Guava) etc should be added (Waheed *et al.,* 2010). So for as the usage of 8 unfit water is concerned, it is emphasized that their usage should be avoided because they will deteriorate the soil by salinity/sodicity build up. However, if in some areas these underground unfit waters are the only source of irrigation water then these waters could be used with special management practices (Ashraf *et al.,* 2005; Ahmad *et al*., 2007). For example one water sample, which is unfit due to high SAR and RSC, is hazardous because its high SAR will affect soil permeability and infiltration. Also there will be a toxic effect of high concentration of sodium on sensitive crops. Whereas high RSC of these waters will further aggravate the sodium hazard by raising the SAR values (as increased concentration of Co_3^{--} and Hco_3^{--} reduces the calcium and magnesium concentrations in soil by precipitating them resultantly sodium concentration becomes high in soil which will raise the soil SAR values). The hazardous effects of such high SAR and RSC irrigation waters could be reduced by increasing the calcium concentration through the addition of gypsum/calcium chloride or acids/acid formers either in water or soil (Ali *et al*., 2009). Application of pressmud, poultry manure, farm yard manure, deep ploughing and cultivation of halo tolerant species/crop cultivars have also been advised to ameliorate the hazardous effects of such underground water applications (Ashraf *et al.,* 2005; Ahmad *et al.,* 2007; Farooq *et al*., 2008).

Regarding seven water samples unfit due to high EC, SAR and RSC, there will be salinity problem due to their high EC (ranged from 1203 to 3235 μ S cm^{-1} because of which 949 to 2552 kg of salts will be added in an acre as a result of their 1 acre foot of irrigation) along with sodicity because of high SAR and RSC as discussed earlier. In order to deal with such hazardous water where their use is unavoidable and farmer has no other option then the following integrated approaches are feasible:

- ✓ Maintaining the leveling of land
- ✓ Occasional deep ploughing
- ✓ Application of gypsum, pressmud,/poultry manure/farm yard manure.
- ✓ Growing of high salt tolerant crop instead of traditional cropping system
- ✓ If the soils have also become degraded then the above-discussed hazardous water could be used to grow *Eucalyptus* and *Acacia* for timber and fuel, and *Atriplex* spp. for grazing purposes (Waheed *et al.,* 2010). Adoption of biosaline agriculture, addition of farmyard manure/green manure, sheep, goat and fish farming can also add in the farmer's income under these types of situations (Pervaiz *et al.,* 2003).

Tehsil Chunian

Amongst the measured water quality parameters of the sampled tubewells of Chunian tehsil, the EC ranged from 643 to 2500 $\mu S\ cm^{-1}$, SAR from 0.29 to 15.9 $(mmol\ L^{-1})^{1/2}$ and RSC from 0.0 to 15.2 me L^{-1}. The analytical data indicates that 6 water samples were unfit, 3 were fit and 1 was marginally fit (Table 3). Among the 6 unfit, 3 were unfit due to high EC and RSC which could build up soil salinity by accumulating high amounts of salts (1594 to 1972 kg salts could be added per acre foot irrigation as the EC of these 3 samples ranges from 2020 to 2500 $\mu S\ cm^{-1}$). The management practices for such type of waters are addition of gypsum in order to neutralize the high concentration of Co_3^{--} and HCo_3^{--} on one hand while using high salt tolerant crops, occasional deep ploughing and flushing of soil profile with good quality water on the other hand are advisable practices under the situation. Irrigation scheduling (reduction in interval of irrigation compared to traditional irrigation) and addition of organic matter could also help in ameliorating the hazardous effects of such water. For the remaining 3 unfit water samples that were unfit due to high value of all the three quality parameters i.e. EC, SAR and RSC, the hazards contained in these waters and the management practices related to their usage have already been discussed in the section of tehsil Kasur.

Tehsil Kot Radha Kishan (KRK)

It is evident from the data of waters of tehsil KRK that value of EC ranged from 964 to 3292 µS cm^{-1}, SAR from 2.37 to 20.0 and RSC from 1.7 to 10.8 me L^{-1}. All the ten samples were unfit for irrigation. Fifty percent waters were hazardous due to high EC and RSC while the remaining fifty percent were unfit due to high EC, SAR and RSC (Table 3). Recommendations regarding the usage of these hazardous waters are alike as discussed for the waters of tehsil chunian.

Table 1: Analysis of water sample for different water quality parameter (EC, SAR, RSC) of the entire tubewell running in four tehsils of district Kasur

Name of Tehsil	Village Name	Farmer Name	EC (µS cm^{-1})	SAR (m mol L^{-1})$^{1/2}$	RSC (me L^{-1})	Possible amount of salt that could be added per acre foot of irrigation (kg/acre)
Kasur	Naul	Nadeem Haroon-u-Rashid	1641	10.0	5.8	1295
		Hassan Ali	544	0.09	Nil	429
	Pattwan	Ghulam Rasool	1491	10.1	6.0	1176
	Kalan	Muhammad Bashir Ahmed	1203	10.03	6.2	949
	Bulandi Utar	Sheikh Siddique	1421	11.7	6.3	1121
		Shabbir Ahmad	1390	11.1	7.8	1097
	Dolay Wala	Muhammad AshrafTahir	3235	14.3	9.9	2552
		Maqbool Ahmad	1195	2.74	Nil	943
	Sahad	Muhammad Yousif	1686	13.95	9.17	1330
		Muhammad Munir	1876	10.35	5.0	1480
Chunian	Chunian	Brother Agri. Farm	2363	15.9	5.4	1864
		Haji Ghulam Abbas Malik	643	0.56	0.7	507
	Kando	Imaran Ali	4375	39.9	15.2	3451
	Ranghar	Amir Mushtaq	653	0.29	Nil	515
	Umar Bagga	Muhammad Ibrahim	1459	7.1	6.3	1151
		Muhammad Ibrahim	2500	12.65	8.33	1972
	Kul	Sher Muhammad	1041	1.13	0.6	821
		Asroop Khan	792	0.82	Nil	625
	Munawarian	Shabir Iqbal	2020	8.39	3.45	1594
		Munir Iqbal	2150	8.51	3.53	1696
Pattoki	Bhai Kot	Rehmat Ali	1440	8.20	1.50	1136
		Ali Khan	1000	4.23	0.80	789
	Jaguwala	Ali Muhammad	2360	8.2	6.30	1862
		Karam Elahi	2410	9.0	7.91	2138
	Bhoy Asil	Javaid	2416	13.2	8.5	1906
		Muhammad Sharif	2260	10.7	8.4	1783
	Juggian	Master Ashraf	2178	8.6	6.6	1718
		Riaz Ahmad	2785	8.3	5.6	2197
	Hanjrai	Amir Shehzad	3120	11.71	4.21	2462
	Kalan	Fazal Din	3210	11.93	4.67	2533
Kot	Ghaniay Kay	Muhammad Arshad	1465	10.2	7.6	1156
Radha		Muhammad Aslam Zahid	964	2.37	1.7	761
Kshan	Kot Nasir	Ali Haidar Khan	1800	4.90	3.65	1420
	Khan	Nawab Mubarik Ali	1975	3.98	3.9	1558
	Baghiarmar	Muhammad Aslam	1997	18.36	7.3	1576
		Malik Ashraf	2590	20.0	8.4	2043
	Chack No.	Chaudhry Sabbir	1701	14.5	10.8	1342
	59	Bashir Ahmad	2995	13.6	5.0	2363
	HalarKay	Master Yousif	3292	9.7	5.8	2597
	Paimar	Muhammad Abdullah	2426	17.8	7.0	1914

Table 2: Irrigation water quality criteria

Status	EC (µS cm^{-1})	SAR	RSE (me L^{-1})
Suitable	< 1000	6	< 1.25
Marginal	1001-1250	6-10	1.25-2.5
Unsuitable	> 1250	> 10	> 2.5

The comparisons of the results amongst the tehsils showed that maximum number of fit waters (30%) were in Chunian while minimum in KRK where none of the water was fit. Overall picture of the analysis data depicted that out of forty tubewells surveyed, thirty-two (80%) were discharging unfit water for irrigation amongst which twenty were having values of all the three quality parameters (i.e. EC, SAR and RSC) higher than the fit limits. The other ten waters were having higher values of EC and RSC while among the rest of the two unfit waters, one was having high values of SAR and RSC and the other having high value of EC only. As these 80% unfit waters have a variety of hazards in them so in order to deal with these no single management practice will tackle their harmful effects. So, several practices could be adopted integratedly to handle them if such waters are to be used necessarily. Moreover, the results regarding the nature of hazards i.e. proportion of EC, SAR and RSC in 32 unfit waters showed that 31 were having high values of EC ranging from 1390 to 4375 µS cm^{-1} which could add 1097 – 3452 kg of salts per acre with every one acre foot of irrigation (Table 2) and may result in soil deterioration by reason of salinity build up and 31 were having high values of RSC which varied from 3.45 to 15.2 me L^{-1} and could increase the sodium hazards by reducing

Table 3: Irrigation water quality of forty tubewells running in twenty different villages of four tehsils in district Kasur

Name of Tehsil	Name of Village	Fit	M. Fit	Unfit	Unfit due to						
					EC	SAR	RSE	EC + SAR	EC + RSE	SAR + RSC	EC + SAR+ RSC
Kasur	Naul	1	-	1	-	-	-	-	-	-	1
	Pattw\an Kalan	-	-	2	-	-	-	-	-	1	1
	Bulandi Otar	-	-	2	-	-	-	-	-	-	2
	Dolay Wala	-	1	1	-	-	-	-	-	-	1
	Sahad	-	-	2	-	-	-	-	-	-	2
Chunian	Chunian	1	-	1	-	-	-	-	-	-	1
	Kando Ranghar	1	-	1-	-	-	-	-	-	-	1
	Umar Bagga	-	-	2	-	-	-	-	1	-	1
	Kul	1	1	-	-	-	-	-	-	-	-
	Munawanrian	-	-	2	-	-	-	-	2	-	-
Pattoki	Bhai Kot	1	-	1	1	-	-	-	-	-	-
	Jaguwala	-	-	2	-	-	-	-	1	-	1
	Bhoay Asil	-	-	2	-	-	-	-	-	-	2
	Juggian	-	-	2	-	-	-	-	2	-	-
	Hanjrai Kalan	-	-	2	-	-	-	-	-	-	2
Kot Radha Kishan	Chaniay Kay	-	1	1	-	-	-	-	-	-	1
	Kot Nasir Khan	-	-	2	-	-	-	-	2	-	-
	Baghiarmar	-	-	2	-	-	-	-	-	-	2
	Chack No. 59	-	-	2	-	-	-	-	1	-	1
	Halar Kay Paimar	-	-	2	-	-	-	-	1	-	1
Total		**5**	**3**	**32**	**1**	**-**	**-**	**-**	**10**	**1**	**20**

Tehsil Pattoki

Analysis of samples from 10 tubewells in the Pattoki tehsil illustrated that EC varied from 1000 to 3210 µS cm^{-1}; SAR from 4.23 to 13.2 (mmol $L^{-1})^{1/2}$ and RSC from 0.80 to 8.5 me L^{-1}. It is apparent from the data presented in table 1 that 90% of the waters had values higher than the fit limits and were in unfit class. The remaining 10% represent irrigation water of good/fit quality. Distribution of the hazards was almost similar to those in the water of Chunian tehsil (i.e. 3 waters were unfit due to high EC and RSC while 5 were due to high EC, SAR and RSC) except one that is unfit due to high EC only (Table 3). The recommendations regarding the usage of these unfit waters are the same as discussed for the waters of Chunian tehsil. The only addition regarding the use of one water that was unfit due to high EC is that it could be used by mixing with good quality water in the ratio of 2:1 (two parts of tubewell water and one part of good quality water).

Ca and Mg concentration in soil and raising SAR of the soil solution in soils. Whereas, 20 waters were having high values of SAR ranging from 10.03 to 39.9 (mmol $L^{-1})^{1/2}$ and could affect soil permeability and infiltration due to high concentration of Na^+ whose high concentration is also toxic for sensitive crops.

Conclusively, it is emphasized that use of brackish water should be avoided to maintain soil health and for sustainable crop yield where good quality water is manageable. However, if the use of brackish water becomes necessary in an area where underground water may be the only source of irrigation, then such water should be used with proper management practices like precision land leveling, inclusion of high salt tolerant crops in traditional cropping system, occasional deep ploughing in heavy textured soil, occasional flushing of the soil profile with heavy irrigation to reduce the salt concentration in the root zone, scheduling of irrigations (i.e. increasing the number of irrigation by reducing the amount of water per irrigation keeping the total delta of water for the crop same), using high EC water by mixing with good quality water and application of organic and inorganic amendments like pressmud, poultry manure, farm yard manure and gypsum or acid/acid formers, however the development of management options requires the analysis of quality parameters.

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