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SHORT COMMUNICATION

Quality of Underground Water of Tehsil Khanewal- An Overview

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Introduction

Agriculture is the back bone of Pakistan's economy of Pakistan with 21 % contribution to GDP and providing livelihood to about 45 % of the total labor force of the country. The industry of Pakistan is mainly agro based (Economic survey of Pakistan, 2009-10). Due to change in climate and thereby extended drought, surface water resources of the country had reduced by 70% in 2003, compared with normal years (Kahlown et al., 2003). Unfortunately, canal water is not sufficient to meet requirements of soil and crop under intensive cropping system. A water quality study has shown that out of 560,000 tube wells in Indus Basin, about 70% are pumping sodic water which in turn is affecting the soil health and crop yield (Kahlown et al., 2003).

The ground waters of different areas and depths have different types of salts which deteriorate the soil accordingly (Masood and Gohre, 2000). It is also reported that 73.38% (681) of the 922 water samples analyzed by the soil and water laboratory Vehari during the year 2006-07, were unfit for irrigation purpose, while 11.93% (110) were marginally fit and only14.21 (131) were found fit for irrigation purpose (Ashraf et al., 2008). According to the estimates, discharge of 50-60 % of the existing wells was brackish in nature (Ashraf et al., 2009) and still more formidable figures of Lahore district declaring that groundwater of 76.6% villages of the district was detrimental for crops and soil health (Ali et al., 2009).

According to Shakir et al. (2002), 64 water samples were collected from new tube well bores from various locations of district Kasur to check the quality of under-groundwater for irrigation purpose. The results show that electrical conductivity of the samples varied from 524 to 5700 µS cm^{-1}, sodium adsorption ration of the samples ranged from 0.49 to 26.00, while residual sodium carbonate ranged from 0.00 to 17.00 meL^{-1}. Out of 64 samples, 26 samples were fit, 8 marginally fit and 30 unfit for irrigation.

The successful crop production on sustainable basis, mainly depends on the quality of groundwater. The common characteristics considered are electrical conductivity (EC), sodium adsorption rations (SAR) and residual sodium carbonate (RSC) (Idris and Shafiq, 1999). The concentration and composition of dissolved constituents in water determine its quality for irrigation use. It is difficult to define the critical limits of EC, RSC and SAR because the effect of different qualities of water of soil health and crop yield is also governed by the type of soil, climate and management practices (Singh et al., 1992).

Gravity of the situation of groundwater of the majority districts of Pakistan implies that something will have to be done without further loss of time to prevent the rapid conversion of productive fertile lands of Pakistan into unproductive barren lands. Besides, making investment on creating awareness among farming community about bio-saline technology/ saline agriculture by the private and public sectors, a watchful eye on the quality and quantity of ground water of every district of Pakistan by all the stakeholders and timely tackling the detrimental impact of brackish groundwater by using the available technology to the possible extent is imperative.

Materials and Methods

The advisory water samples received from tehsil Khanewal of the district during the period 2006 to 2012 by the soil and water testing laboratory Khanewal were analyzed for Electrical Conductivity (EC), Cations (Ca+Mg, Na) and Anions (CO_3, HCO_3, Cl) by the methods described by page et al. (1982) and U.S. Salinity Lab. Staff (1954). Residual sodium carbonates (RSC) and sodium adsorption ratio (SAR) were determined by following formulae of U.S Salinity Lab. Staff (1954).

RSC (meq/L) = $(CO_3+HCO_3) – (Ca + Mg)$
SAR = $Na/\sqrt{Ca + Mg/2}$

The criteria used for evaluation of irrigation water were proposed by Malik et al. (1984) (Table 1).

Table 1 Irrigation water quality criteria.

Parameter	Status	Richards, (1954)	WAPDA 1981	Muhammad 1986	Malik et at. 1984
EC (µS cm^{-1})	Suitable	750	<1500	<1500	<100
	Marginal	751-2250	1500-3000	1500-2700	>1250
	Unsuitable	>2250	>3000	>2700	>1250
SAR	Suitable	<10	<10	<7.5	<6
	Marginal	10-18	10-8	7.5+15	6-10
	Unsuitable	>18	>18	>15	>10
RSC(me/L)	Suitable	<1.25	<2.5	<2.0	<1.25
	Marginal	1.25-2.5	2.5-5.0	2.0-4.0	1.25-2.5
	Unsuitable	>2.5	>5.0	>4.0	>2.5
Cl (me/L)	Suitable	<4.5	-	0-3.9	-
	Marginal	-	-	-	-
	Unsuitable	>4.5	-	>3.9	-

The analyzed data of the water samples thus recorded during the period from to 2006-2012 were categorized into the number and percentage of fit, marginally fit and unfit samples on the basis of their EC, SAR and RSC values (Tables 2-3). The data of total numbers of unfit water samples were further scrutinized.

To establish the degree in percentage of the total impact of each of the parameters (EC,SAR,RSC) in the unfitness of ground water , sole impact of each (EC or SAR or RSC) was summed up with its impact as one particular parameter along with one or both of the other two parameters (Table 4). The contents of the tables 2,3,4 are shown (Fig. 1) graphically as shown in the figures to suitability or otherwise, of ground water for irrigation purpose.

Table 2. Quality of analyzed water samples suitability for irrigation purpose (2006-2012).

S. No	Year	Total Samples	Fit	Marginally Fit	Unfit
1	2006-07	222	46	22	154
2	2007--08	161	4	5	152
3	2008--09	176	33	23	120
4	2009—10	127	10	11	106
5	2010—11	129	23	19	87
6	2011--12	155	21	11	123
Total	**970**	**137**	**91**	**742**	
% age		**14.12**	**9.40**	**76.5**	

Results and Discussion

Review of the data revealed that 76.5% (742) water samples were unfit out of 970 samples (Table 2). Some earlier studies also indicate higher percentage of unfit ground water samples. Ashfaq et al. (2009) reported that water of 50-60% was not suitable for sustainable crop production and soil. Similarly, Main et al. (2008) reported that overall 64% of the water samples analyzed under ADP project of the Punjab Government were found unfit for irrigation and results in increased soil salinity and alkalinity in the area.

Table 3 Quality of unfit water samples analyzed for their suitability for irrigation on the basis of different parameters (2006-2012).

Year	**Unfit Samples**	**Unfit due to**						
		Ec	**SAR**	**RSC**	**Ec+ SAR**	**Ec+ RSC**	**SAR+ RSC**	**Ec+ SAR+RSC**
2006-07	154	37	-	28	03	31	-	55
2007-08	152	36	-	17	17	26	-	56
2008-09	120	57	-	-	22	11	-	30
2009-10	106	34	-	09	03	37	-	23
2010-11	87	30	-	12	32	-	-	13
2011-12	123	57	-	02	10	21	5	28
TOTAL	**742**	**251**	-	**68**	**87**	**126**	**5**	**205**
% age		**33.83**	-	**9.16**	**11.73**	**17.00**	**0.67**	**27.63**

Table 4 Cumulative impact of a particular parameter (EC, SAR, RSC) in the hazardness of unfit water samples inclusive of its soil impact as one of the factors along with one or both of the other parameters (Table 3).

Parameters	Individual +% impact of hazardness of the parameter included in various combination of parameters/factors (From Table 3)	Total Cumulative percentage of Hazardness of each parameter /factor
EC	33.83+11.73+17+27.63	90%
RSC	9.16+17+0.67+27.63	54%
SAR	0+11.73+0.67+27.63	40%

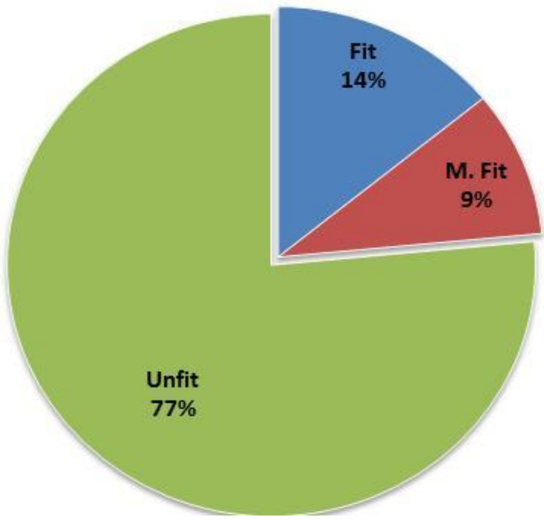

Fig. 1 Total water samples analyzed (percentage) for their suitability for irrigation purpose (2006-2012).

The percentage hazardness of various parameters / factors (EC, SAR, RSC) and combinations thereof, EC is the leading / factor rendering 251 (33.83 %) of the total 742 water samples unfit. After that, EC + SAR +RSC comprising with a figure of 27.65 % (251), EC+ SAR of 17% (126/) and RSC rendered 9.16 % (68) samples unfit as the sole factor. The category comprising of SAR + RSC just 0.67 % (05) while no ground water was found unfit by SAR as the only factor causing a particularly water sample unfit for irrigation purpose.

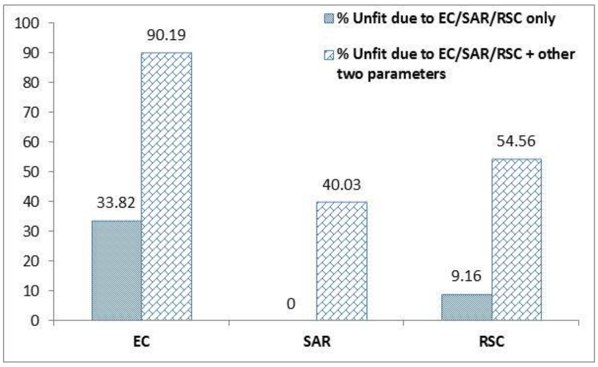

Fig. 2 Percent impact of each parameter (Ec, SAR, RSC) in unsuitability of water for irrigation purpose.

EC convincingly superseded the percent cumulative impact of the other two parameters with astonishing opening figure of above 90% (674/742) , followed by RSC 54% (484/742) and SAR 40% (297/742; Table 4), which indicate the sodicity hazard in the ground water i.e., SAR and RSC are summed up (9.16+17+ 0.67+27.63+0+11.73), it come out to be a little above 66 % 90 % cumulative hazardous impact of the leading parameter. The results of this study also indicate that 90 out of every 100 unfit water samples have salinity hazard, while 66 out of every 100 have sodicity hazard.

As scarcity of canal water, most of our farmers have no option but to use groundwater substantially for irrigation purpose without knowing to its suitability for irrigation purpose. The injudicious use of the brackish ground water pumped out through tube wells or turbines etc. is gradually piling up tons of a variety of salts in our field which are transforming our productive soils into unproductive salt affected soils leading to decrease in the yield of the crops, orchard and vegetables. Fortunately, the sodicity caused by the use of groundwater with RSC and SAR beyond the permissible limits (Chaudry and Rana, 1975) reported that water having< 7.5 SAR and 1.25 me L- 1 RSC did not create problems to soil and crops. Irrigation water having EC<3.0 dSm^{-1}, SAR < 10 (mmol L^{-1})1/2 and RSC< 2.50 me L^{-1} is safe for coarse textured soils without creating any potential hazard (WWF, 2007). Use of soil and water amendments like gypsum, acids (sulfuric acid) and the acidifiers (sulfur etc.) to a great extent but regretfully there is no effective chemical treatment for eliminating the deleterious effects of salinity due to EC of the groundwater or that of the soil beyond the permissible limits. The only option left to combat the menace of the salinity is alternate irrigation of the groundwater (tube-well / turbines) with canal water and adopting the saline agricultural technology. Cultural practices like ridge or bed sowing, growing of salt tolerant crops and varieties, use of organic manures etc. (FAO, 1992).

Use of gypsum stone in the pool of the tube-well/ turbines or its lining in the water channel to amend the deleterious effects of the higher SAR or RSC of the groundwater further increases the EC as gypsum itself is a salt.

Conclusion

It is concluded that if we apply injudicious use of brackish water, we have no way left but to ensure abundant supply of the canal water to our farms. The construction of big water reservoirs and dams offer the best possible solution to the tangle. Fortunately, Pakistan has plenty of rivers which usually cause flood and loss of life and property because of absence of ample water storage facilities (dams / reservoirs etc.). Constructions of big water reservoirs /dams like Kala Bagh dam will certainly go a long way in turning our deserts into lush green fields with crops and orchard by uninterrupted supply of the much-needed electricity cheaper rates.

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