JOURNAL OF AGRICULTURE & SOCIAL SCIENCES
1813–2235/2005/01–4–355–358
http://www.ijabjass.org

Appraisal of Shallow Water Status of Gakhra Kalan, District Gujrat (Pakistan) for Irrigating Crop Fields

ZAHID PERVAIZ
Soil Fertility Department, Gujrat, Pakistan
E-mail: zahidpervaiz58@yahoo.com

ABSTRACT

This study was carried out to provide guidelines to farmers and researchers for better crop production by adopting water management practices. A total of 52 water samples from handpumps (depth 30±5 feet) in 13 villages were collected from union council Gakhra Kalan and determined for electrical conductivity (EC), sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) during September, 2002 to August, 2003. Of these 7(13%) were fit, 8 (15%) marginally fit and the rest 37 (72%) unfit. Hand pumps water was found more brackish than tubewell (depth 60±5 feet). Most of the water samples are unfit due to higher EC, RSC or both. Almost all the area had highly saline water, which is affecting yield of various crops.

Key Words: EC; SAR; RSC; Shallow water; Gakhra Kalan

INTRODUCTION

Agriculture is the back bone of Pakistan's economy, employing 54% of the labour force, accounting for 26% of GDP (Anonymous, 2002) and contributing to the export earning considerably. Pakistan has one of the largest irrigation systems in the world. The largest continuous gravity flow canal system for irrigation carrying 82 MAF canal water (Anonymous, 2002) is falling short for crops due to increase cropping intensity and non-agriculture demands over the years (Mohtadullah *et al*., 1993). Most of the irrigated area (Indus plain) of Pakistan receives average rainfall of 200mm, which is insufficient to grow a single crop (Anonymous, 2001-02). To meet this shortage, ground water is being exploited, out of which 70-75% is brackish (Ghafoor *et al*., 1991). Ahmed and Chaudhry (1968) and Younis (1977) stated variation in water status at different depth in Pakistan. Continuous use of such ground water without appropriate management or any amendment could make the soil saline/sodic. By now about 3.0 MAF soils have developed surface salinity/sodicity due to the use of poor quality irrigation waters (Rafique, 1990). However, low quality waters can be used for irrigation and ameliorating salt-affected soils if proper management practices are followed (Suarez & Lebron, 1993; Ghafoor *et al*., 2000; Qadir *et al*., 2001).

In Gujrat district subsoil water is being used for irrigation regularly alone or along with canal water. The 40% water of Gujrat district is fit, 23% marginally fit and the rest 37% are unfit for irrigation (Pervaiz *et al*., 2003). During field visit or contact of farmers of Gakhra Kalan (situated in irrigated area in the South West corner of district Gujrat) reported that rice crop usually fails at penical stage and soil salinity/ sodicity is developing day by day due to use of brackish water. So a detail study of tube well waters and nearest handpumps waters were conducted. The study revealed that only 7% samples of tube well having depth of 60±5 feet were fit, 33% marginally fit and the rest 60% unfit for irrigation purposes (Pervaiz, 2005). Keeping in view the severity of brackish water in union council Gakhra Kalan, it was decided to compute the data of handpumps water samples also for guideline of the farmer, researcher and policy maker. The results of handpumps groundwater (30±5 feet) are discussed in this paper.

MATERIALS AND METHODS

Groundwater samples from hand pumps (depth 30±5 feet) were collected from 13 villages of union council covering four side (East, West, North & South) of the village with in the radius of 1 kilometer from the village during 2002-03. A total of 52 samples from depth of 30±5 were collected in polypropylene bottles after 2-3 minutes of hand pumping and analyzed within three days for EC, CO_3^{2-}, HCO_3^-, Cl^-, SO_4^{2-}, Na^+, and Ca^{2+}+Mg^{2+} by the methods given by Richards, 1954.The EC was determined by electrical conductivity meter. The Ca^{2+}+Mg^{2+} were determined by taking 10mL aliquot in china dish and titrated against 0.01N EDTA solution using NH_4Cl-NH_4OH buffer solution and Eriochrome Black-T as indicator where as Na^+ was determined by difference. Carbonate and bicarbonate were determined by taking 10ml aliquot in china dish and titrated against 0.01N H_2SO_4 solution using phenolphthalein and methyl orange as indicator whereas chloride was determined from the same samples titrating against 0.005N silver nitrate solution using potassium chromate as indicator (Richards, 1954). Sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) were computed (Richards, 1954). Based on EC, SAR and RSC status the water samples were categorized according to

USDA Handbook-60 (Richards, 1954). Simple statistical analyses (means, standards deviation, & percentage) were done (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

Data with respect to different quality parameters (EC, SAR & RSC) of union council Gakhra Kalan and its villages are presented in Table I and their fitness are given in Table II. Data in Table I revealed that ranges of EC, SAR and RSC of union council Gakhra Kalan were 0.87 to 4.08 dS m^{-1}, 0.55 to 16.50 and 0 to 5 me L^{-1}, respectively. The highest value of EC (4.08 dS m^{-1}) was found in village Khanwali, SAR value (16.50) in village Jamobola and RSC value (5 meq L^{-1}) in village Nawan Lok Noshera. Data in Table I further revealed that SAR is not the great problem of the area. Data in Table II revealed that 13% water samples of the area were fit, 15% marginally fit and the rest 72% unfit for irrigation purposes. Out of 37 unfit water sample, maximum unfit water is due to higher EC (24) followed by RSC (9) and EC+RSC (4) Table IV.

Average ranges of EC, SAR and RSC for fit water samples were 0.93 to 1.47 dS m^{-1}, 1.63 to 4.55 and 0.50 to 0.70 meq L^{-1} respectively (Table III). Ranges of EC and RSC for marginally fit water samples were 1.58 to 2.18 dS m^{-1} and 1.50 to 2.50 meq L^{-1} respectively (Table IV). Ranges of EC and RSC of unfit water samples were 2.32 to 3.73 dS m^{-1} and 2.80 to 4.80 meL^{-} respectively (Table IV). Result of this study indicated that hand pumps underground water average values of EC, SAR and RSC are comparatively higher (Table I) than tube well water at depth of 60±5 feet (Pervaiz, 2005). So that it becomes imperative to go in depth beyond 60±5 feet for the search of good quality of ground water for irrigation purposes. The results of this study are in agreement with those of Ahmed and Chaudhry (1968) and Younis (1977) who reported the

Table I. Data profile of villages of union council Gakhra kalan, districts Gujrat during the year September 2002 to August 2003.

Sr.No	Name of village	Hand Pump (Depth 30 ± 5 feet) Electrical conductivity (dS m^{-1})				Sodium adsorption ratio				Residual sodium carbonate (meq L^{-1})			
		Minimum	Maximum	Mean	S.D.	Minimum	Maximum	Mean	S.D.	Minimum	Maximum	Mean	S.D.
1	Chak wassan	2.42	3.01	2.74	0.26	8.57	10.53	9.61	1.04	0	2.50	0.65	1.23
2	Dewan Kot	2.88	3.65	3.21	0.35	6.52	8.11	7.48	0.68	0	0	0	0
3	Gakhra Kalan	1.15	2.54	1.81	0.76	3.71	11.19	7.37	3.95	0.67	3.06	1.86	1.35
4	Gakhra Khurd	1.37	2.90	2.27	0.69	0.55	6.80	4.63	2.78	0	1.50	0.53	0.71
5	Jamobola	1.19	3.24	2.57	0.95	4.33	16.5	11.55	5.27	0	3.1	1.68	1.28
6	Kang Chanan	0.87	1.86	1.28	0.45	0.73	5.3	2.68	2.25	0.5	3.7	1.83	1.55
7	Kang Sehari	1.07	1.84	1.41	0.33	1.33	6.10	3.54	2.28	0	3.8	1.20	1.75
8	Keeranwala	1.29	3.03	2.17	0.71	4.17	11.13	8.38	3.02	2.1	4.8	3.3	1.12
9	Khanwali	2.18	4.08	3.34	0.88	7.28	12.16	9.76	2.16	0	1.8	0.58	0.85
10	Kot Kana	1.47	2.32	1.71	0.41	3.78	4.71	4.39	0.42	0	2.8	0.88	1.33
11	Nawan Lok	2.64	3.58	3.14	0.47	7.31	9.75	8.88	1.11	0	0	0	0
12	Nawan Lok Noshera	1.21	1.65	1.40	0.18	5.72	8.6	7.23	1.27	3.5	5.0	4.15	0.69
13	Ruppoki	2.38	2.49	2.44	0.05	6.31	10.10	8.46	1.78	0	2.3	1.58	1.06
Union Council Gakhra Kalan		0.87	4.08	2.27	0.85	0.55	16.50	7.23	3.40	0	5.0	1.40	1.54

S.D= Standard deviation

Table II. Underground water quality of union council Gakhra Kalan district Gujrat during the year September, 02 to August, 2003

Sr.No	Name of village	No of sample	Quality of water Fit	M.Fit	Unfit
1	Chak wassan	4	-	-	4(100)
2	Dewan Kot	4	-	-	4(100)
3	Gakhra Kalan	4	2(50)	-	2(50)
4	Gakhra Khurd	4	-	2(50)	2(50)
5	Jamobola	4	-	1(25)	3(75)
6	Kang Chanan	4	2(50)	1(25)	1(25)
7	Kang Sehari	4	2(50)	1(25)	1(25)
8	Keeranwala	4	-	1(25)	3(75)
9	Khanwali	4	-	1(25)	3(75)
10	Kot Kana	4	1(25)	1(25)	2(50)
11	Nawan Lok	4	-	-	4(100)
12	Nawan Lok Noshera	4	-	-	4(100)
13	Ruppoki	4	-	-	4(100)
	Total	52	7(13)	8(15)	37(72)

Figures in parenthesis are percentage of their respective village samples analysed.

Table III. Distribution of useable underground water in respect of EC, SAR and RSC of union council Gakhra Kalan, district Gujrat during September, 02 to August, 2003

Sr.No	Village	No of sample	Statistics	Water quality EC (dS m^{-1})	SAR	RSC (meq L^{-1})
1	Gakhra Kalan	2	n	2	2	2
			Average	1.16	3.97	0.69
			S.D	0.01	0.36	0.02
2	Kang Chanan	2	n	2	2	2
			Average	0.93	2.81	0.55
			S.D	0.09	0.11	0.07
3	Kang Sehari	2	n	2	2	2
			Average	1.16	1.63	0.50
			S.D	0.13	0.42	0
4	Kot Kana	1	n	1	1	1
			Average	1.47	4.55	0.70
	Total	7	-	-	-	-

n = number of samples having EC, SAR and RSC out of useable water samples of the respective village. S.D = Standard deviation.

Table IV. Distribution of marginally fit and unfit underground water in respect of EC, SAR and RSC of union council Gakhra Kalan, district Gujrat during the year September, 02 to August, 2003.

Estimations	Statistical Character	Chak wassan	Dewan Kot	Gakhra Kalan	Gakhra Khurd	jamobola	Kang Chanan	Kang Sehari	Keeranwala	Khanwali	Kot Kana	Nawan Lok	Nawan Lok Noshera	Ruppoki
							Marginally fit water							
EC (dSm^{-1})	n	-	-	-	1	-	-	1	-	1	1	-	-	-
	Ave	-	-	-	210	-	-	1.84	-	2.18	1.58	-	-	-
	%	-	-	-	50	-	-	100	-	100	100	-	-	-
RSC (meq L^{-1})	n	-	-	-	1	1	-	-	1	-	-	-	-	-
	Ave	-	-	-	1.50	2.0	-	-	2.10	-	-	-	-	-
	%	-	-	-	50	100	-	-	100-	-	-	-	-	-
EC+RSC	n	-	-	-	-	-	1	-	-	-	-	-	-	-
	EC Ave	-	-	-	-	-	1.86	-	-	-	-	-	-	-
	RSC AVE	-	-	-	-	-	2.50	-	-	-	-	-	-	-
	%	-	-	-	-	-	100	-	-	-	-	-	-	-
Total		-	-	-	2	1	1	1	1	1	1	-	-	-
							Unfit water							
EC (dSm^{-1})	n	4	4	-	2	2	-	-	-	3	1	4	-	4
	Ave	2.74	3.21	-	2.81	2.99	-	-	-	3.73	2.32	3.14	-	2.44
	%	100	100	-	100	67	-	-	-	100	50	100	-	100
RSC (meL^{-1})	n	-	-	-	-	-	1	1	2	-	1	-	4	-
	Ave	-	-	-	-	-	3.70	3.80	3.15	-	2.80	-	4.15	-
	%	-	-	-	-	-	100	100	67	-	50	-	100	-
EC+ RSC	n	-	-	2	-	1	-	-	1	-	-	-	-	-
	EC Ave	-	-	2.46	-	3.11	-	-	3.03	-	-	-	-	-
	RSC AVE	-	-	3.03	-	3.10	-	-	4.8	-	-	-	-	-
	%	-	-	100	-	33	-	-	33	-	-	-	-	-
Total		4	4	2	2	3	1	1	3	3	2	4	4	4

variation in water status at different depth in Pakistan.

Waters with EC 0.75 to 2.25 dS m^{-1} can not be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control is required and plant with good salt tolerance should be selected whereas waters having EC 2.25 to 5 dS m^{-1} are not suitable for irrigation under ordinary conditions but may be used occasionally under very special circumstances. The drainage must be permeable and adequate, irrigation water must be applied in excess to provide considerable leaching and highly salt tolerant crops should be selected.

Water with SAR up to 10 can be used for irrigation on almost all soils with little danger of the development of harmful level of exchangeable sodium. However, sodium sensitive crops such as stone fruit trees and avocados may accumulate injurious concentration of sodium. Water with SAR between 10 and 18 will present appreciable sodium hazards in fine textured soils having high cation exchange capacity, especially under low leaching conditions, unless gypsum is present in the soil. This water may be used on coarse textured or organic soil with good permeability (Richards, 1954).

Almost all the water samples of the villages of union council are highly saline and sodic and are not suitable for irrigation under ordinary condition, but may be used occasionally under very special circumstances such as, soil must be permeable, drainage must be adequate, and irrigation water must be applied in excess to provide considerable leaching. Moreover alternate supply of canal water and highly salt tolerant crops should be selected. The area where canal water is insufficient, underground water is brackish and soils are salt affected; the farmers should promote biosaline agriculture along with addition of farmyard manure/green manure. Goat, sheep and fish farming can also raise the farmer's income.

The unfit water due to high electrical conductivity causes salinization (Ghafoor *et al*., 1990, 1993). It is imperative to find good quality of irrigation water by increasing the depth of bore or change of site of bore if has to use for all type of crops. The sodium adsorption ratio (SAR) indicates the relative proportion of Na^+ to Ca^{2+}+Mg^{2+}, whereas residual sodium carbonate is an index, which indicates the sodium hazards (sodication of soil). The unfit water samples (containing excess of carbonate & bicarbonate) for irrigation will precipitate soil solution calcium and increase solution sodium, resulting in soil dispersion (Emerson & Bakker, 1973) as well as impaired nutrient uptake by plants (Kanwar & Chaudhry, 1968.). It is, therefore, recommended that unfit water samples may need special management practices if is has to be used for irrigation. It is preferable however that use of such water should be avoided in order to sustain farm production.

CONCLUSIONS

1. Hand pump water of union council Gakhra Kalan are more brackish than tube well waters, so farmers should go in depth beyond 65 feet for search of good quality of ground water for irrigation purposes.
2. Much of the water is unfit due to higher EC followed by RSC and EC+RSC.
3. SAR is not a major problem of the area.
4. Almost all the area has highly saline water.

REFERENCES

Ahmed, A. and G.R. Chaudhry, 1968. *Irrigated Agriculture of Pakistan*. Shahzad Nazir, 61-b/2, gulberg III, Lahore 11.pp. 1–5, 16

Anonymous, 2001-02. *Economic survey*. Government of Pakistan, Economic Advisors Wing, Finance Division, Islamabad, Pakistan

Anonymous, 2002. Pakistan Statistical Year Book, 2002. Federal Bureau of Statistics Division, Government of Pakistan, Islamabad, Pakistan

Emerson, W.W. and A.C. Bakker, 1973. The comparative effect of exchangeable Ca: Mg and Na on some soil physical properties of red brown earth soils. 2. The spontaneous dispersion of aggregates in water. *Australian J. Soil Res*., 11: 151–2

Ghafoor, A., F. Ullah and M. Abdullah, 1990. Use of high Mg brackish water for reclamation of saline sodic soil. 1. Soil improvement. *Pakistan J. Agric. Sci*., 27: 294–8

Ghafoor, A., M. Qadir and R.H. Qureshi, 1991. Using brackish water on normal and salt-affected soil in Pakistan: a review. *Pakistan J. Agric. Sci*., 28: 273–8

Ghafoor, A., M. Azam and M. Shoaib, 1993. Characterization of tube well and hand pump waters in the Faisalabad tehsil. *Pakistan J. Soil. Sci*., 8: 1–2

Ghafoor, A., M. Rizwan and G. Murtaza, 2000. Utilization of brackish water for reclaiming different textured saline-sodic soils having different ECe to SAR ratio. pp. 121–8. *In*: Natl. Seminar on Drainage in Pakistan. 16-17, 2000, Jamshoro, Hyderabad, Pakistan

Kanwar, J.S. and M.L. Chaudhry, 1968. Effect of Mg on the uptake of nutrients from the soil. *J. Res. Punjab Agric. Uni*., 3: 309–19

Mohtadullah, K., C.A.U. Rehman and C.M. Munir, 1993. *Water for the 21st Century.* Environ. and Urban affairs Div., Govt. Pakistan, Islamabad, Pakistan

Pervaiz, Z., 2005. Characterization of Irrigation Quality of Ground Water in Union Council Gakhra Kalan, District Gujrat (Pakistan). *Int. J. Agric. Biol*., 7: 269–71

Pervaiz, Z., S.S.H. Kazmi and K.H. Gill, 2003. Characterization of irrigation quality of ground water in Gujrat district. *Pakistan J. Soil Sci*., 22: 48–54

Qadir, M., A. Ghafoor and G. Murtaza, 2001. Use of saline-sodic waters through phytoremediation of calcareous saline-sodic soils. *Agric. Water Manag*., 47: 1–14

Rafique, M., 1990. Soil resources and soil related problems in Pakistan. P. 16–23. *In*: Ahmad, M., M.I. Akhtar and M.I. Nizami (ed.). *Soil Physics Application Under Stress Environment. Proc. Symp. Applied soil physics in stress environment,* Islamabad, Jan. 22–6, 1989. BARD Project, PARC, Islamabad, Pakistan

Richards, L.A., 1954. *U.S. Salinity Lab. Staff. Diagnosis and Improvement of Saline and Alkali Soil.* USDA Handbook 60. Washington D.C. US

Steel, R.G.D.and J.H. Torrie, 1980. *Principles and procedures of Statistics. A Biometrical Approach*. 2nd. Ed. Mc Graw Hill Book Company Inc. New York

Suarez, D.L. and I. Lebron, 1993. Water quality for irrigation with highly saline water. *In*: *Towards the Rational Use of High Salinity Tolerant Plants*, 2: 289–397

Younis, M.M., 1977. Water quality in Indus Plain. Keynote paper. pp. 283–92. *In*: *proc. Seminar on Water Management for Agricultural*, Nov. 15-17, 1977, Lahore, Pakistan

(Received 05 April 2005; Accepted 20 June 2005)