Chapter - 18
Quality of Water for Irrigation and Management

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Introduction

The characteristics of water quality have become important in water resources planning and development for drinking, industrial and irrigation purposes (Shakoor, 2015). Water quality is the basic to judge the fitness of water for its proposed application for existing conditions. The current information is required, provided by water quality monitor for optimum development and management of water for its proficient uses (Haydar *et al*., 2009).As a major input of agricultural production, irrigation accounts for more than two thirds of the systematic supply of water, but irrigation potential still needs to be increased to maintain self-sufficiency in food production. For this, a two-pronged strategy needs to be adopted. The first is the implementation of corrective measures to address the major deficiencies in the irrigation sector and their rapid development with a view to harnessing the full potential of the available water resources under the second strategy. Our country is an agricultural country. Therefore, it is natural that we should accept the quality of irrigation water and the need of water management on priority basis for the increase of agricultural production. Although agricultural production has increased substantially as a result of major irrigation projects, the problems of waterlogging, salinity and loss of valuable bio-resources have arisen due to excessive irrigation and inadequate water distribution. An effective strategy is needed to deal with these problems. Almost all types of irrigation water have some amount of soluble substances. The concentration of dissolved substances in water determines the quality of irrigation water. Some crops and lands can tolerate the effects of salt and substances dissolved in water, while other crops have a harmful effect. The following factors affect the quality of irrigation:

1. Concentration of dissolved salts in irrigation water: Water of electrical conductivity more than 2250 mhos/cm at 25 ^{o}C is unsuitable for irrigation. Water with 750 mhos/cm at 25 ^{o}C electrical conductivity can irrigate salt tolerant crops.
2. Concentration of sodium and ratio of sodium to the combination of calcium and magnesium: Irrigation water is considered harmful due

to the presence of sodium, but the amount of sodium in most harmful water is found to be more than the sum of calcium and magnesium. Such water is helpful in making the irrigation such water is making the irrigation site sterile.

3. Boron concentration: three ppm only tolerant crops can be grown on the presence of boron (3 parts in 10 lakh parts). one ppm Water containing less quantity of boron is safe for irrigation.
4. Concentration of carbonate and bicarbonate: Irrigation should not be done if the amount of carbonate and bicarbonate in irrigation water is more than 2.5 ml-equivalent per liter.

Water management is the planning and using water for agricultural purposes. Under this, irrigation (giving water to plants the available water) and drainage (extracting waste water from the field) are included. We are well aware of the fact that there is a deep relationship between land, water and plants.

A certain amount of moisture is required for the growth of plants. When the water required for the growth of plants is not supplied by natural resources and then the water supply of plants has to be done artificially, which we call irrigation. For management, it is necessary that at the right time, in the right amount and in the right way, water-management should be done for the crop. Just as the yield of plants is affected due to lack of water, in the same way the growth of plants stops in excess of water and the production capacity is reduced, so irrigation and drainage are complementary to each other for proper water management. Under irrigation management, the need of timely and proper water-demand of crops is met, while drainage is planned to remove more water from the area than required. Water management includes the methods, systems and techniques of water conservation, its treatment, use, utilization and removal of water to provide a socially and environmentally acceptable level of product or source at a low cost. By adopting water conservation technology, the flow of water in the watershed can be controlled. And through this collect water at many places for various uses. Water use is governed and controlled by developing a source of water supply for drinking, industrial or agricultural use.

Irrigation - Measures to improve water quality

This chapter addresses several aspects of irrigation water quality and criteria to determine water quality. It will also cover management issues and soil responses to the use of irrigation water of varying quality. The information presented in this chapter is an updated and improved version of an excerpt from an earlier irrigation water quality manual Shahid SA (2004)

It is a difficult task for the farmers to choose the irrigation water, as it is a compulsion to irrigate with the available water. In this way, irrigation with contaminated water results in deteriorating soil condition as well as reduces production.

It can be reduced by the following measures

1. Mixing lime in irrigation water.
2. Irrigation by mixing good water with bad water can reduce the effect of contaminated water.
3. Mixing sulfuric acid and gypsum in irrigation water.
4. Mixing water containing organic matter with irrigation water.
5. Irrigation by separating harmful salts from irrigation water.

Things to note in Irrigation Water Management

The concentration and composition of soluble salts in water will determine its quality for various purposes (human and livestock drinking, irrigation of crops, etc.). The quality of water is, thus, an important component with regard to sustainable use of water for irrigated agriculture, especially when salinity development is expected to be a problem in an irrigated agricultural area. USSL Staff (1954)

1. Irrigation should be done according to climate and crop water demand.
2. Crops should be selected according to the availability of irrigation water. So that water can be used efficiently.
3. Available water for irrigation should be used in maximum area.
4. Irrigation should be done in selected varieties at their critical stages.
5. Crops should be kept weed free, so that more available water can be used by the crops.
6. Balanced fertilizer should be used in prescribed quantity for maximum benefit in crop production of available water.
7. Continuous monitoring of the drain should be done while carrying water from the water source to the field.
8. Moisture conservation measures should be adopted to keep the water supplied by irrigation in the root zone of the crops for maximum time.
9. The efficiency of irrigation can be increased by adopting new methods of irrigation (shower, drip or drop-drop irrigation method).
10. The desired benefits can be obtained from any irrigation project by proper management of drainage.

In order to get maximum yield per unit of water, it is necessary to pay attention to the following points while irrigating

Forecasts of water withdrawals on a global scale predict sharp increases in future demand to meet the needs of the urban, industrial, and environmental sectors. This is due to the fact than more than one billion people do not yet have access to running water or sanitary facilities, and also to insufficient attention being paid, until now, to meet the water requirements of natural ecosystems. Given that the single biggest water problem worldwide is scarcity (Jury and Vaux, 2005) there is significant uncertainty about what the level of water supply will be for future generations. Thus, some of the water losses are unavoidable and are needed to maintain the salt balance; however, they can be minimized with efficient irrigation methods and by appropriate management. Reducing ET without a penalty in crop production is much more difficult, however, because evaporation from crop canopies is tightly coupled with the assimilation of carbon (Tanner and Sinclair, 1983)

1. When to irrigate.
2. How to irrigate, in 3 quantity irrigation water should be used, with 4 type of water.

In practical terms, the knowledge of irrigation time can be done by adopting the following methods

a) Looking at the external factors of the plant.
b) By looking at the condition and visible symptoms of the plant water content soil of the properties of the soil.
c) On the basis of the amount of water received in the land and the moisture stress.
d) To determine irrigation on the basis of climatic data.
e) On the basis of critical stage of growth of plants.
f) With the help of indicator plants.
g) On the basis of moisture content of leaves of plants.

The most suitable method of irrigation is that in which there is an equal distribution of water as well as least loss of water and maximum area can be irrigated with minimum water. For proper use of irrigation water, it is necessary that the desired quantity of water is always used. Where less water than required adversely affects the growth of the crop, while excess water is damaged by runoff/diversion as well as has a detrimental effect on the growth of crops.

The total amount of irrigation water used for the crop (irrigation number x amount of water used per irrigation) is called water delta. The number of irrigations and the water delta has a special effect on plant growth. It has been found that using the same amount of water is more beneficial than irrigating with small amounts several times. Often, 100% water is not useful while irrigating, so more water has to be given in the field than required. It is called by the name of total water. It is derived from the following formula-

Total quantity of water = quantity of water supply required for irrigation

The interval between two irrigations is called the frequency of irrigation. While irrigating various crops, it is necessary that the irrigation of a particular crop should be completed within a fixed period, because there is a possibility of a huge reduction in the yield due to delay. The amount of time taken by one irrigation in a field at the maximum utilization rate of a crop, this is called the period of irrigation. In common parlance, the number of days in which a field is irrigated at a time is called the period of irrigation.

Remember, any cropping system ultimately affects water, land and climate. Therefore, these natural resources should be conserved in such a way that along with their optimum use, their use efficiency also increases. For this, by specializing the various cropping subdivision wise systems spread in the country, the causes of agro-ecology subdivision wise geo-bio-physical and social variability will have to be ascertained and on the basis of this, future strategies will have to be prepared for efficient use of natural resources.

There is a need to create a database of reliable data on availability of water resources from various sources, status of development of water resources, method of water use and distribution, problem of pollution and related socio-economic aspects so that water resources development and management To provide a solid basis for the preparation of the plan.

Thus, in a nutshell, it can be said that water resource management is a multi-faceted process involving constructive improvement in basic physical infrastructure, management system and management system for operation, along with other production inputs, provision of multi-stage and quality water at works and socio-economic aspects need to be included.

Table 1: Guidelines for interpretations of water quality for irrigation

Potential Irrigation Problem			**Units**	**Degree of Restriction on Use**		
Salinity (affects crop water availability)						
				None	**Slight to Moderate**	**Severe**
	EC_w		dS/m	< 0.7	0.7 – 3.0	> 3.0
	(or)					
	TDS		mg/l	< 450	450 – 2000	> 2000
Infiltration (affects infiltration rate of water into the soil. Evaluate using EC_w and SAR together)						
SAR	= 0 – 3	and EC_w	=	> 0.7	0.7 – 0.2	< 0.2
	= 3 – 6		=	> 1.2	1.2 – 0.3	< 0.3
	= 6 – 12		=	> 1.9	1.9 – 0.5	< 0.5
	= 12 – 20		=	> 2.9	2.9 – 1.3	< 1.3
	= 20 – 40		=	> 5.0	5.0 – 2.9	< 2.9
Specific Ion Toxicity (affects sensitive crops)						
Sodium (Na)						
Surface irrigation			SAR	< 3	3 – 9	> 9
Sprinkler irrigation			me/l	< 3	> 3	-
Surface irrigation			me/l	< 4	4 – 10	> 10
Sprinkler irrigation			me/l	< 3	> 3	
Boron (B)			mg/l	< 0.7	0.7 – 3.0	> 3.0

Laboratory determinations and calculations needed to use the guidelines are given in Table 1 and Figure 1, along with the symbols used. Analytical procedures for the laboratory determinations are given in several publications: USDA Handbook 60 (Richards 1954), Rhoades and Clark 1978, FAO Soils Bulletin 10 (Dewis and Freitas 1970), and Standard Methods for Examination of Waters and Wastewaters(APHA 1980).The method most appropriate for the available equipment, budget and number of samples should be used. Analytical accuracy within ±5 percent is considered adequate.

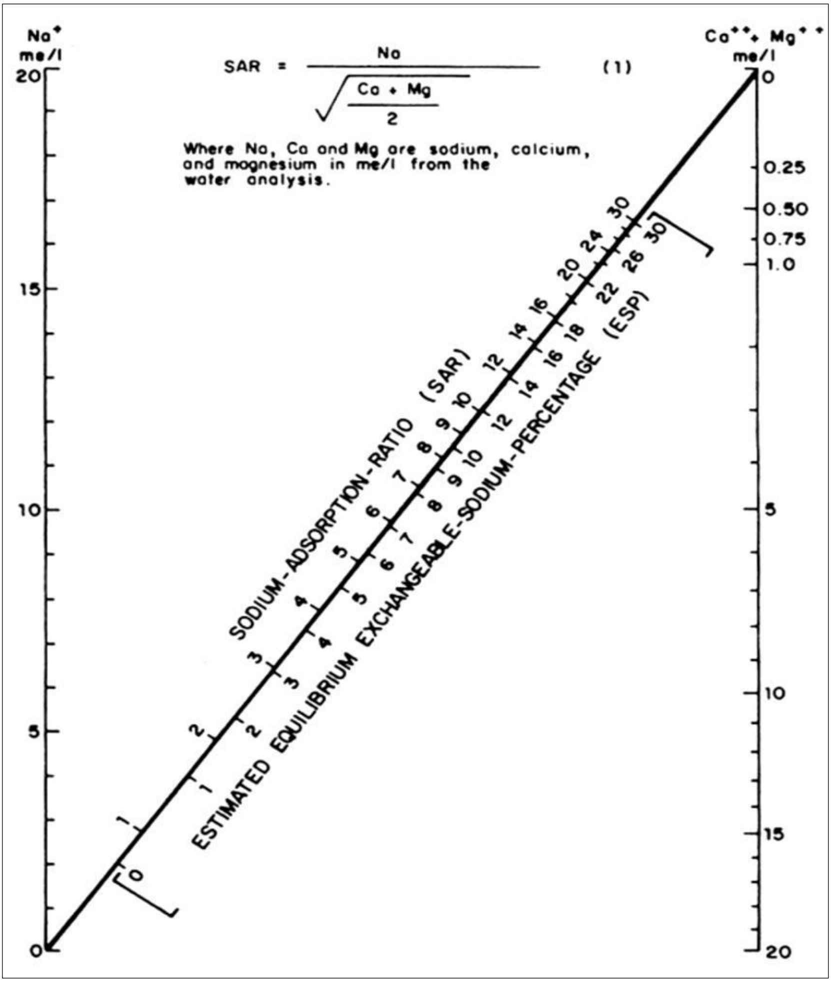

Fig 1: Monogram for determining the SAR value of irrigation water and for estimating the corresponding ESP value of a soil that is at equilibrium with the water (Richards 1954)

References

1. Dewis J. and Freitas F. 1970 Physical and chemical methods of soil and water analysis. FAO Soils Bulletin 10. FAO, Rome. 275 p.
2. Haydar, S., M. Arshad and J.A. Aziz (2009). Evaluation of Drinking Water Quality in Urban Areas of Pakistan: A Case Study of Southern Lahore. Pak. J. Engg. Appl. Sci., 5:16-23.
3. Jury WA, Vaux Jr H. 2005. The role of science in solving the world's

emerging water problems. Proceedings of the National Academy of Sciences, USA 102, 15715–15720.

4. Richards L.A. 1954 Diagnosis and improvement of saline and alkali soils. USDA Agricultural Handbook No. 60, US Department of Agriculture, Washington DC. 160 p.
5. Rhoades J.D. and Clark M. 1978 Sampling procedures and chemical methods in use at the United States Salinity Laboratory for Characterizing Salt-affected Soils and Waters. Memo Report. US Salinity Laboratory, Riverside, California.
6. Shakoor, A. (2015). Hydrogeologic assessment of spatio-temporal variation in groundwater quality and its impact on agricultural productivity. PhD Thesis, Department of Irrigation and Drainage, University of Agriculture, Faisalabad
7. Shahid SA (2004) Irrigation water quality manual. ERWDA Soils Bulletin No 2, 29 pp.
8. Tanner CB, Sinclair TR. 1983. Efficient water use in crop production: research or re-search?. In: Taylor HM, Jordan WR, Sinclair TR, eds. Limitations to efficient water use in crop production. Madison, WI: ASA, CSSA, SSSA, 1–27.
9. USSL Staff (1954) Diagnosis and improvement of saline and alkali soils. USDA Handbook No 60. Washington DC, USA 160 pp