Chapter 53
Mitigation of Climate Change Impacts Through Treatment and Management of Low Quality Water for Irrigation in Pakistan

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ABSTRACT

The Indus Plains of Pakistan are situated in arid to semi-arid climate where monsoon rains are erratic and mostly fall in the months of July and August. These rains are not only insufficient to grow even a single crop without artificial irrigation but also cause flood havoc very frequently that is associated with the climate change. The Indus river transports water for agriculture, industry and domestic usage within the basin and downstream. The Indus Basin is among the few basins severely affected by global warming and resulting climate change. The alteration in temporal and spatial patterns of rainfall has resulted in unexpected drought and floods. About 70 to 80% of total river flows occur in summer season due to snow melt and monsoonal rainfalls. Lack of storage reservoirs has decreased the ability to regulate flood water as well as its potential use during the drought season along with cheap hydro-electricity generation. The sedimentation in the system has limited the storage capacity of the existing three reservoirs by 28%. Consequently carry over capacity of these storage structures is only 30 days compared to 120 to 220 days in India and 900 days in Colorado Basin. Pakistan is facing shortage of good quality water

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due to competition among agricultural and non-agricultural sectors, this scenario will continue rather will further aggravate in future. According to the climate change scenario, the warming is reflected in the river-flow data of Pakistan, especially during the past 2-3 decades. To bridge the gap between fresh water availability and demand, ground water is being pumped to meet the irrigation requirements of crops. The pumped ground water (70-80%) is brackish and could become a sustainability issue in the long run. The prolonged agricultural uses of such water will deteriorate soils, crops and human living environments. Water quality parameters usually considered include electrical conductivity (EC) for total soluble salts, and sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) reflect the sodicity hazards. In order to limit or even to eliminate adverse effects of such waters, certain treatment and/or management options are considered as important pre-requisites. For bringing down high concentration of total soluble salts, dilution with good quality water is the doable practice. To decrease high SAR of irrigation water, a source of calcium is needed, dilution (with good quality water) will decrease SAR by the square root times of the dilution factor, while use of acids will be cost-intensive rather may adversely impact the soil health. For high RSC, dilution with low $CO_3^{2-}+HCO_3^-$ *water will serve the purpose, addition of Ca-salts will raise* $Ca^{2+}+Mg^{2+}$ *to bring a decrease in water RSC, while acids will neutralize* $CO_3^{2-}+HCO_3^-$ *to lower water RSC. Gypsum is the most economical and safe amendment while acids could also decrease RSC but at higher relative cost. City wastewater and seed priming in aerated gypsum solution is also presented. Such practices at small and/or large scale surely will help a lot to sustain the food security and the environment in the days to come where climate change has to be experienced round the world. Therefore, a well-coordinated program is necessary to create awareness among different sections of the society including the policy makers, general public, organizations, industrialists and farmers.*

INTRODUCTION

The Indus Plains of Pakistan are situated in arid to semi-arid climate zones where rains during monsoon are erratic and mostly fall during the months of July to September. These rains cause flood havoc very frequently that is associated with the climate change; floods during the years of 2010, 2011 and 2014 are very good examples to such climate change impacts those resulted in hundreds of human and animal deaths as well as caused billion dollar loss to infrastructures, soil quality and crops. The Indus river transports water for agriculture, industry and domestic usage within the basin and downstream. About 70 to 80% of total river flows occur in summer due to snow melt and monsoonal rains.

The effect of climate change is not limited to water availability only but it also affects crop yields and thus the food security and worsens the human living environments. The increasing soil salinity might cause additional harm in future, if less annual rainfall and higher temperatures prevailed at the current rate in future due to climate change. Due to reduction in annual rainfall, sufficient leaching of salts will not be achieved and higher temperatures will further aggravate the salt stress in regions already threatened by soil salinity (Sommer et al., 2013). The availability of water in Pakistan has decreased from 5300 m^3/year/person in 1950's to 1066 m^3/person/year in 2010 and it is estimated to be < 850 m^3 per capita by the year 2025 (WAPDA, 2011). The World Bank has included Pakistan in the list of 17 countries predicted to encounter severe water shortages by 2025. There is immense need and scope to develop additional surface water storage for drought periods since a plenty of river water is discharging into the Arabian Sea, ≈ about 34 to 37 million acre foot (MAF) water is discharged into the sea. Such policy issues have