

Climate-Resilience Farming in Saline-affected regions of Haryana, India Building Small Farmers' Capacities

Pawan Kumar
S M Sehgal Foundation.
Gurugram, Haryana. India



Introduction

Salinity in soil and water is one of the major constraints in sustainable food production in many parts of the world, affecting 20% of cultivated land and 33% of irrigated land. [Pooja Shrivastava and Rajesh Kumar. Soil salinity: A serious environmental issue and plant growth promoting bacteria as one of the tools for its alleviation. Saudi J Biol Sci. 2015 Mar; 22(2): 123–131. Published online 2014 Dec 9. doi: 10.1016/j.sjbs.2014.12.001.]

Furthermore, salinized areas are increasing at the rate of 10% annually for various reasons such as low precipitation, high surface evaporation, saline water irrigation, and poor cultural practices.[Jamil A., S. Riaz, M. Ashraf, and M. R. Foolad. Gene expression profiling of plants under salt stress. Crit. Rev. Plant Sci. 2011; 30(5):435–458.] In India alone, the area under salt-affected soils is about 6.73 million ha. Together the states of Gujarat (2.23 m ha), Uttar Pradesh (1.37 m ha), Maharashtra (0.61 m ha), West Bengal (0.44 m ha), Haryana (.233 m ha), and Rajasthan (0.38 m ha) account for almost 75% of saline and sodic soils in the country.

The states of Rajasthan, Haryana, and Punjab, in the northwestern arid part of the country, suffer greatly from the problem of marginal quality waters.[D K Singh and Anshuman Singh. Salinity Research in India Achievements, Challenges and Future Prospects. ICAR-Central Soil Salinity Research Institute, Karnal, Haryana.] The present area under salt-affected soils (6.73 million ha) in the country is estimated to almost triple to 20 million ha by 2050. And 32 to 84% of the groundwater in different Indian states is already rated either saline or alkali. [P. S. Minhas. Saline water management for irrigation in India, Agricultural Water Management, Volume 30, Issue 1, March 1996, Pages 1–24.] The problem of poor quality water will significantly increase in the near future with the planned expansion in irrigated areas and intensive use of natural resources.

Economic losses due to salinity are likely to increase manifold with a projected increase in salt-affected soils. India's population is increasing at 1.7% per year, but the net cultivable area is almost constant.[Salt-affected Soils of Rewari District, Haryana: Distribution and Characteristics Ashim Datta^{1*}, Madhurama Sethi¹, Nirmalendu Basak¹, Anil Kumar Yadav², Anil R. Chinchmalatpure³, M. L. Khurana⁴ and Arijit

Barman¹, Journal of Soil Salinity and Water Quality 8(2), 144–152, 2016.] To feed the burgeoning population of the country, these soils need to be reclaimed and brought under productive cultivation.

The Adaptive Technologies-Agriculture program of S M Sehgal Foundation identifies innovative agricultural practices suitable to local agro-climatic conditions. The program promotes saline agriculture, builds small farmers' resilience to climate change, and improves farm productivity in salt-affected farmland.

Study Conducted

With the objective to analyze the effect of saline water irrigation on yields of salt-tolerant crops, the study was conducted in three blocks[Block is a district subdivision for the purpose of Rural Development Department and panchayati raj institutes.] of Nuh district,[A district (zila) is an administrative division of an Indian state or territory.] engaging 78 farmers from 13 salt-affected villages. The farmers who have saline soil and saline water sources for irrigation were selected for the study.

Salt-tolerant varieties of cereal, vegetable, and oil crops were given to 78 selected farmers. Variety KRL 10 for wheat (cereal), Saki F1 for broccoli Indum, Ruby Queen for beetroot (vegetables), and CS 58 for mustard (oil crop) were selected for demonstrations on the farmers' fields. The area for demonstration varied from 0.4 acre to 1 acre, as only one-acre[Acre is a unit of land that is 4,047 m².] plots were considered for this study.

In order to assess the salinity level, soil and water samples were collected from each farmer's field before planting the crops. Two water samples were collected during the crop season. Direct seed sowing was done for wheat, mustard, and beetroot in the months of October and November, whereas broccoli seedlings were transplanted in September.

Farm support such as trainings on a crop-specific package of practices; field preparation, seed sowing methods, fertilizer applications, diseases and pest management, and harvesting were provided to all the farmers.

A data analysis of water and soil from the demonstrated plots showed that the minimum and maximum salinity of water used for irriga-



tion varied from 0.97 to 4.158 for broccoli, 2.178 to 6.922 for beetroot, 0.97 to 7.946 for mustard, and 2.882 to 7.946 for wheat. Soil EC varied from 0.15 to 4.29 dS/m, with pH between 6.5 to 8.8.

An economic viability analysis was done calculating the gross benefits for each crop. A comparative benefit analysis of broccoli and beetroot was done with salt-tolerant wheat (STW) and salt-tolerant mustard (STM). Similarly, the gross benefits received from STW and STM were compared with salt-intolerant wheat (SITW) and mustard (SITM). All four crops are grown in winter season; therefore the comparative study helps farmers make decisions on the selection of crops and area under each crop.

Results and Discussions

The results showed an inverse relationship between water salinity and the yield of the crops. With an increase in water salinity, the yield was reduced, though no set trend was observed between salinity and yield. Figures below show impacts of saline water irrigation on the yields of different crops.

It is observed that salinity has an inverse relationship with yields of the crops. The yield of the crop decreases with an increase in salinity. Among the four crops, broccoli is most sensitive to salinity, and the yield reduces up to 1.81 MT/ acre with an increase of 3.19 dS/m water salinity; whereas wheat is the least affected with salinity, wherein the yield is decreased only 0.81 MT/ acre with an increase in salinity from 2.88 to 7.94. Wheat crops are more salt tolerant than mustard because wheat requires 5–6 irrigations, whereas mustard needs one to two irrigations.

In terms of economic benefit of the crops, broccoli is found to be more profitable than other crops and provides the highest income of INR 107,292 per acre compared with INR 72,400, INR 41,634, and INR 40,646 received respectively from beetroot, mustard, and wheat.

Moreover, the broccoli crop also resulted in higher returns of 61.83% (INR 66,342) and 62.16% (INR 66,692) over STW and STM respectively; whereas beetroot resulted in 43.44% (INR 31,450) and 43.92% (INR 31,800) higher returns per acre against STW and STM. A similar comparative study done between STW and STM with local salt-intolerant varieties of wheat and mustard showed that STW (KRL10)

and STM (CS58) gave higher results per acre of 6.20% (INR 2431) and 7.53% (INR 2847) respectively compared to local salt-intolerant varieties.

Conclusions

Broccoli and beetroot are more profitable crops to be grown in saline water between 2.178 to 6.92 dS/m salinity, whereas wheat and mustard are well adopted to high salinity and can withstand up to salinity of 7.946 dS/m. The germination of STW and STM are higher than SITW and SITM, which helps farmers use appropriate seed rates.

Results of the soil test taken before and after crop cultivation showed no significant change in soil EC. The reason was that farmers have been using saline water for many years, and soil salinity is neutralized after monsoon rain. Due to high permeability and poor water-holding capacity, salt deposits are leached down through the rainwater and do not negatively impact the soil quality.

Greater income from broccoli, beetroot, and salt-tolerant varieties has increased farmers' confidence in cultivating salt-tolerant crops; the high germination rate of salt-tolerant wheat and mustard reduces the seed rate and the cost of cultivation; and the use of local groundwater for irrigation reduces the cost of irrigation without adversely impacting soil chemical properties, all of which will help in better adoption rates going forward.

To benefit the larger community, Sehgal Foundation will continue to provide extension services to farmers of salt-affected villages and motivate them to shift from low-input intensive crops to high-value salt-tolerant crops and harvest better return using saline water. It is expected that the increased use of saline water in agriculture will stop saline groundwater encroachment toward freshwater pockets.

The effective use of saline water will reduce the water pumping cost as well as create huge potential for small farmers, particularly those without access to freshwater. In the long term, with the adoption of salt-tolerant crops and varieties, farmers will be able to fetch more income thereby helping them come out of the vicious cycle of extreme poverty.