

Water scarcity and crop management: a global challenge

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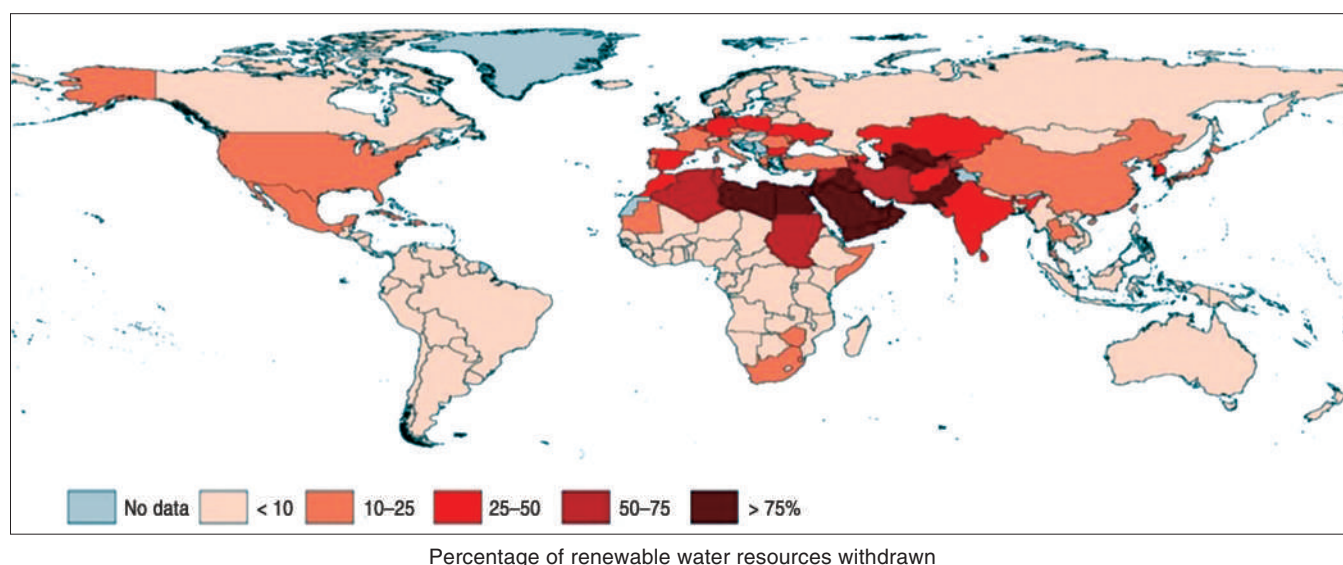
Arid and semi-arid places around the world are suffering due to severe climate and lack of water. By 2025, India would need to produce 350 million metric tonnes of food grains to meet the demands of its growing population. Farmers are using poor quality water such as saline and alkaline, sewage and industrial effluent due to a lack of excellent quality water. These are readily available water sources with a considerable amount of plant nutrients. Long-term use of saline and alkaline water can significantly increase soil salinity and alkalinity, restricting plant development. On the other hand, sewage and industrial effluents have heavy metals that are harmful to animals and pollute food chain. In drought-prone areas, the safe use of marginal quality water may be a viable option for agricultural production. Crop production benefits from the application of contemporary tools and techniques for soil moisture conservation, measures improve water and nutrient use efficiency. Now agriculture's top priority is to popularize water conservation technology with the support of various agencies.

Keywords: Crop Production, Heavy metals, Moisture conservation, Plant nutrient, Soil health

WATER is a crucial resource in the agricultural system. Farmers are forced to use water of marginal quality as freshwater availability decreases. Only 3% of the earth's surface is covered with freshwater, of which 75.2% is frozen in the polar regions and the

remaining 22.6% is present as groundwater. Both the availability of water and electricity are driving factors for the establishment of industry and the growth of megacities. This suggests that, as a result of the growing trend of urbanization, the demand for drinking water is

increasing. America possesses 45% of the world's freshwater, followed by Asia (28%), Europe (16%), and Africa (16%). As the world's population grows, so does its unequal distribution pattern, forcing people to consume low-quality water for domestic purposes. The Central



Ground Water Board (CGWB) report also stated that water levels have been declining at a pace of 1 meter per year in the majority of India's locales. Groundwater (GW) resources are depleting at an alarming rate in most parts of the world, and they may not be able to fulfil future demands from agriculture and industry.

Management of marginal quality water

Agricultural activities make use of a variety of poor quality water resources. Given below are some of the benefits and limits of these resources.

Saline and alkaline water: Several types of salts are present in water that augment the salt concentration (Na^+ , Ca^{++} , Mg^{++} , K^+ , HCO_3^- , CO_3^- , SO_4^{2-} and Cl^-) or electrical conductivity. Because of primary and secondary sources, the majority of water is saline. Primary salinity is caused by natural rock in water but secondary salinity or irrigation generated salinity is caused by poor management methods. Continuous and indiscriminate use of saline and alkaline water leads to considerable salt accumulation in the soil profile. A pH less than 8.5, electrical conductivity (EC) more than 4 dS/m, and primarily soluble sodium chloride and sulphate, calcium, and magnesium salts characterize saline soils (Table 1). Apart from soluble boron, large amounts of carbonate and bicarbonate are also present in saline soils. These soils are known as 'reh' and 'thur' in India. As a mediator of osmotic stress, excessive salt in the soil reduces crop plant water intake from the soil. Many crop plants are more sensitive to salt, resulting in necrosis, leaf tip and margin burning, and eventual death. In plants, an excess of salt also generates a nutritional imbalance. Organic amendments (compost, FYM, and green manuring), salt tolerant cultivars, and salt leaching with non-saline water are all important management strategies for saline soils.

Higher concentrations of carbonates (HCO_3^- , CO_3^-) of sodium are dominant in some soils making them alkaline. In Indian states, it is well known as 'Usar' and

Table 1. Classification of saline water (FAO 2012)

Water class	Electrical conductivity (dS/m)	Salt concentration (mg/L)	Type of water
Non-saline	<0.7	<500	Drinking and irrigation water
Slightly saline	0.7–2	500–15,00	Irrigation water
Moderately saline	2–10	1500–7000	Primary drainage water and groundwater
Highly saline	10–25	7000–15,000	Secondary drainage water and groundwater
Very highly saline	25–45	15,000–35,000	Very saline groundwater
Brine	>45	>45 000	Sea water

'Kallar'. It has pH more than 8.5, EC lower than 4 dS/m and exchange sodium per cent (ESP) more than 15. Alkaline soils decrease agricultural output, damage soil structure, and reduce microbial biomass in the soil. Chemical amelioration with gypsum, as well as agronomic management approaches are required to ameliorate these soils. The amount of gypsum to be used should be determined by the sodium content of the soil.

Sewage: "Waste (usually liquid) emanating from a community; may be constituted of domestic, municipal wastewaters, or industrial discharges," according to the EPA. Municipal and household water consumption is expected to double to 108 billion m^3 (7% of total demand) by 2030, while industrial demand is expected to quadruple to 196 billion m^3 (13%), bringing overall demand increase close to 3% per year. Sewage is abundantly produced, mainly in peri-urban areas. It has a lot of water and plant nutrients. Organic matter supplied by sewage water reduces the

rate at which chemical fertilizers are applied during crop production. With slight restrictions on heavy metal concentration and biological load, this sort of water is suitable for crop production. Pre-treatment is one of the most basic application tactics used in crop production. Pre-requisites for sewage utilization include regular monitoring and analysis of physico-chemical properties of sewage and agriculturally cultivated soil.

Industrial effluent: Many sectors, such as tannery, paper and pulp, metallurgical, agro-processing units, and electric industries play a key role in the nation's economic progress. These units produce a large volume of wastewater with metals or groups of metals, which has a carcinogenic effect on animals and humans. Long-term effluent application has resulted in a massive build-up of heavy metal in soils. Reduced water intake, metabolic activity, biomass and yield reduction are all indications of these metals, and necrotic signs on plant



Physico-chemical analysis of sewage

parts are a common diagnostic mark. For non-food crops, the safe use of industrial wastewater is a requirement. Effluent should be treated before being applied to a crop field. Flower plant cultivation and landscaping are promoting its use for long-term agricultural output.

Land use and management system

By mediating global climatic events, agricultural water requirements are increasing in tandem with rising global temperatures. This is another element that is crucial in fighting the negative effects of climate change on agricultural crop productivity. Long-term adaptation solutions at a global scale require the employment of contemporary and land management practices, as well as increased water use efficiency. Climate change effect and vulnerability assessments require predictions or estimates of potential future adaptations. The efficacy of adaptation techniques in a given system determines the risk of future climate change. There are following major classes of adaptations:

- Adjustment of sowing dates based on seasonal changes.
- Development of region specific crop varieties or species.
- Water supply pattern and irrigation method.
- Promotion of agroforestry.
- Management and sustainable use of agricultural inputs.

Fertilizer/nutrient management

Application of fertilizers based on soil fertility condition has a significant impact on crop growth. For plant nutrient mobilization in soil solution, poor soil health needs a higher volume of irrigation. Water circulation within the plant is substantially affected by optimal nutrition and the most favourable soil tillage, which is a highly effective strategy for battling drought. Plants in poor nutritional conditions must absorb more water to meet their nutrient requirements, which results in low moisture conditions and has a detrimental impact on plant growth and crop yield. As a result, applying the appropriate amount of fertilizer at the suitable time can help alleviate environmental stress and water scarcity. The use of silicon as a fertilizer helps to alleviate the negative effects of climate change by boosting plant tolerance to drought and increasing crop output.

Using drought management techniques

Drought is a climatic state in which the rate of evaporation is higher than the rate of precipitation. These areas have a severe ecosystem with thorny and bushy plants, and plants that require less water to cultivate. Conservation agriculture, adjustments in plant to plant, row to row distance, date of sowing time, efficient use of FYM and fertilizers, use of soil moisture conservation

measures, rain water collection, inter-cropping, and other drought management strategies are all needed in these locations. It is also advised that effective water management practices must be popularized at the community level with the support of government and non-governmental organizations (NGOs) throughout the country.

SUMMARY

Freshwater availability is dwindling over the world as time passes. Agricultural crop production techniques require a lot of water to produce enough food grain to feed the world's growing population. Farmers must rely on low-quality water to maximize water potential which has a larger concentration of soluble salt as well as a significant amount of trace metal. Long-term use of poor quality water has a negative impact on soil health and crop productivity. With adequate treatment and moisture conservation measures, it is possible to better exploit the water potential of marginal grade water resources. In water-scarce settings, combining soil moisture methods with improved soil health management alternatives could boost food grain yield.

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Automated drip fertigation

Automated drip fertigation in okra crop were evaluated for improving water use efficiency at Udaipur, Rajasthan. Different components of automated drip system were soil moisture sensor, controller, water meter and relay system. Irrigation water was applied automatically based on availability of soil



Automated drip fertigation for increasing water productivity of okra crop at Udaipur

moisture in the crop root zone sensed by soil moisture sensor. Crop performance was better with automated drip irrigation at 100% field capacity (FC) along with application of 100% recommended dose of fertilizers (RDF) through fertigation in equal splits at 4 days interval. Under this treatment, okra yield was 8.60 t/ha and water use efficiency was 0.24 t/ha-cm. There was 41.6% total water saving and 109% higher crop yield compared to the control (i.e. water application through manual drip irrigation along with 100% RDF through fertigation in equal splits at 6 days interval).

Source: ICAR Annual Report (2020)