General Water Quality Definitions

Individual Constituents are common water-quality parameters or elements found in ground and surface waters (see Table 1).

Table 1: Individual Constituents [2]

Trace Element	Recommended Maximum Concentration for Agricultural Water (mg/L)
Arsenic (As)	0.10
Cadmium (Cd)	0.01
Copper (Cu)	0.20
Lead (Pb)	5.0
Manganese (Mn)	0.20
Nickel (Ni)	0.20
Selenium (Se)	0.02
Zinc (Zn)	0.50

Toxicity is the damage to plant tissue or plant nutrient imbalance caused by a specific solute[2].

Salinity Threshold is the maximum level of salinity that crops can tolerate without significant loss in yield[2].

TDS (Total dissolved solids) is the degree of mineralization of most natural waters. TDS measures ionic and nonionic species dissolved in water and units are usually expressed as mg of salt per liter of water (mg/L) or parts per million (ppm) [2, 4].

EC (Electrical Conductivity) is a measure of a solution's ability to conduct electricity. It measures only ionic species dissolved in water. Salts dissolve in water and form positive ions (cations) and negative ions (anions); therefore, salts can be measured by EC. The most common cations are: calcium, magnesium, and sodium. The most common anions are chloride, sulfate, and bicarbonate[3]. The units for conductance are generally expressed as Seimens/meter (S/m) or deciSeimens/meter (dS/m).

EC_w represents the salinity of the irrigation water source (see Figure 1 and Figure 2)[2].

EC_e represents the salinity of the saturated soil paste (soil samples are first saturated with distilled water, the soil water extracted, and the EC is measured on the extracted water). This term also refers to average root zone salinity[3].

SAR (Sodium Adsorption Ratio) is the relative abundance of sodium as compared to calcium and magnesium. Large SAR values represent a high relative abundance of sodium. High sodium concentrations paired with low calcium and magnesium concentrations leads to impaired plant growth and reduced soil health[1].

Sodicity is the deterioration of soil structure induced by an excessive proportion of sodium in relation to calcium and magnesium[2].

Leaching fraction (LF) is the fraction of water applied to a field that actually drains below the root zone[3].

Salinity

"Across Colorado, it is estimated that almost 1 million acres are impacted by excess salts." Jessica Davis[6]

Fact: Salinity accumulations are common in irrigated soils, especially in Colorado's semi-arid climates[8].

Reason: Even the best quality water carries dissolved solids and salts. Application of water by irrigation, in time, results in salt buildups[8].

Impact: Plants (even those that are considered tolerant) are most sensitive to salinity during the seedling and emergence periods. The plant root is most affected by salinity in soils. Salinity disrupts the uptake and transport of nutrients, cell permeability, growth and metabolic processes of the plant[7].

Main Factors: The main factors contributing to salinity accumulations under irrigation are poor irrigation application efficiency, poor irrigation uniformity, shallow water tables, and irrigation water source chemistry[8].

Management Techniques: Careful irrigation management can alleviate salinity problems and includes applying the appropriate leaching fraction to reduce salts, ensuring uniformity and efficiency of water distribution through proper irrigation scheduling, and proper drainage for shallow water tables[8].

Leaching: Leaching is the process of flushing accumulated salts below the root zone by adding extra water to a field (leaching fraction). Figure 3 shows the leaching process[9].

"However it is important to remember that over irrigation- to the extent that it raises the water table to within the plant rooting zone- is undesirable." [9]

Leaching can be done once or twice a year and is best done in the fall (before pesticides and nutrients are applied to the soil)[6]. Table 2 gives an estimate of water needed to leach salts. Actual salt reduction depends on water quality, soil texture, and drainage[6].

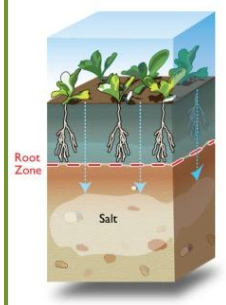


Figure 3: Leaching[5]

Table 2: Leaching Water Required [4]

Estimated water application needed to leach salts.	
Percent Salt Reduction	**Amount of Water Required**
50%	6 inches
80%	12 inches
90%	24 inches
Example: If a soil's electrical conductivity is 4 dS/m, and you want to reduce it to 2 dS/m. This represents a 50 percent reduction in salts. Therefore, 6 inches of water would be required.	

Efficiency/Uniformity

Efficiency is a measure of how well a desired target application amount is met[8].

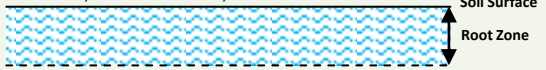
However, high efficiency does not mean that water is not wasted. Since efficiency does not describe how well water is distributed across the soil surface or how uniformly it is able to infiltrate into the soil- another parameter is needed, irrigation application uniformity[8].

Uniformity is a measure of how well irrigation water is distributed over the field surface[8].

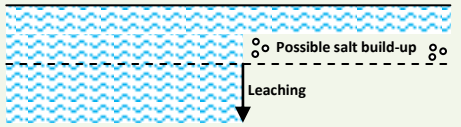
BOTH efficiency and uniformity are crucial to good salinity management. Figure 4 illustrates a center pivot irrigation system- a good example of irrigation efficiency and uniformity working together.

Examples[8]:

1. Target Amount met, even distribution, *E= 100%* *U=100%*



2. Target Amount met, half of field receives more than target, half gets same amount less than target amount. *E= 100%* *U=50%*



3. Target amount exceeded by a factor of 2, even distribution. *E= 50%* *U=100%*

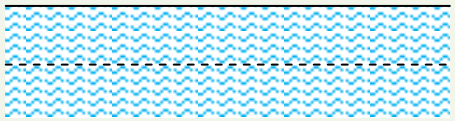
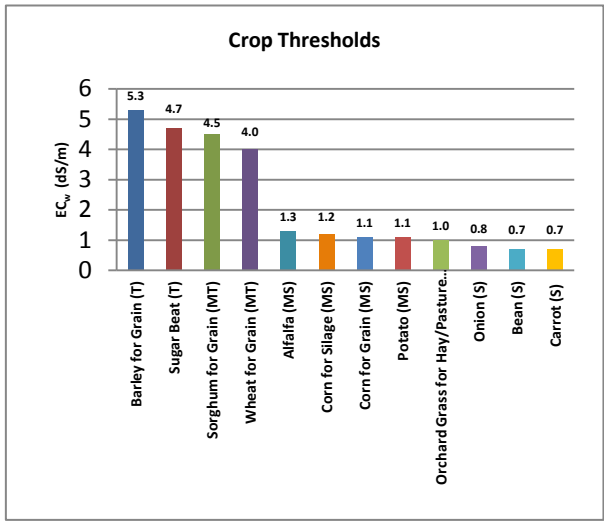


Figure 4: Center Pivot Irrigation System[10]

"Anything that CAN be done to improve efficiency and uniformity SHOULD be done."
Grant Cardon- CSU Soil and Crop Sciences [8]

Figure 1: Crop Salinity Thresholds and Tolerance Ratings [2]

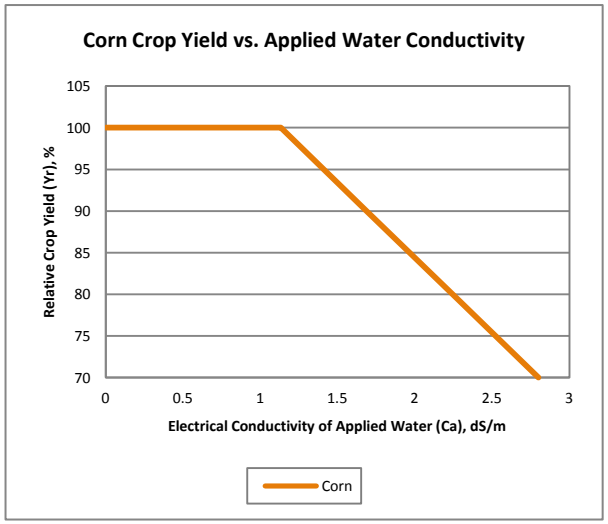
*For Northern Colorado



Crop Salt Tolerance Ratings:

(S) – Sensitive
(MS) – Moderately Sensitive
(MT) – Moderately Tolerant
(T) – Tolerant

Figure 2: Corn Crop Yield Decline with Increased Conductivity of Applied Water [2]



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Agricultural Water Quality

General Information