Delta Hearings, Dec. 6, 1976
Reference to water quality
under subirrigation.
University of California
Robert S. Ayers

QUESTION:

At the Delta Hearing, December 6, 1976 during the University of California presentation, the question was asked about as follows:

If the water quality guidelines as presented in exhibit UC-1 and UC-2 need to be modified for use of subsurface irrigation as stated on page 8, line 26 and 27 of the UC-2 exhibit (FAO-29), can you suggest a way to modify?

ANSWER:

We suggest the equation near bottom of page 24, UC exhibit 2 (FAO-29) may be useful.
Equation is:

$$Y = 100 - b\,(EC_e - a)$$

This uses the salinity of the soil saturation extract (EC_e) as the controlling quality parameter and this equation can then be solved for EC_e to determine the EC_e that corresponds to a designated loss in yield:

$$EC_e = \frac{100 + ab - y}{b}$$

Our assumption of the crop tolerance tables in comparing EC_e (soil salinity) and EC_w (water salinity) is that

$$EC_w \times 3/2 = EC_e$$

The water salinity (EC_w) equivalent to the EC_e can, therefore, be substituted for EC_e and the equation then becomes-

$$EC_w \times 3/2 = EC_e = \frac{100 + ab - y}{b}$$

or

$$EC_w = \frac{100 + ab - y}{b} \quad (2/3)$$

(This gives quality of water needed for yield Y. "a" and "b" from crop tolerance tables.)

From testimony of Mr. J. Meyer, regarding the data from UC exhibits 4,5 and 6 (Delta Organic Soil Salinity and Nutrient Status Study), there are indications that, under the management existing at the study sites, the relationship of soil salinity (EC_e) to water salinity (EC_w) was from about $EC_w \times 5/2 = EC_e$ to $EC_w \times 10/2 = EC_e$.

If these values are used in the same equations as being appropriate for the subirrigation and management for the location

UC-8

and crop, the equation becomes

$$EC_w = \frac{100 + ab - y}{b} \quad (2/5)$$

or

$$EC_w = \frac{100 + ab - y}{b} \quad (2/10)$$

As an example:

Crop= corn

a= 1.7 mmhos/cm for 0 loss in yield (from tolerance tables.)

b= 12.05% loss in yield for each 1 EC_e unit change in soil salinity (from $\frac{100}{10-1.7}$ = 12.05% per EC_e unit).

A comparison of water quality needed (EC_w) with surface irrigation (assumption as stated) and with subirrigation (management, leaching etc. as existing at locations of study) may then be useful.

For example:

Crop= corn

a= 1.7 mmhos/cm (from 0% yield decrement column).

b= 12.05 percent yield loss expected per unit change in EC_e (from $\frac{100}{10-1.7}$ in crop tolerance tables using values shown in 0% yield decrement and Maximum EC_e column.

For surface irrigation (16% leaching fraction and $EC_w \times 3/2 = EC_e$).

$$EC_w = \frac{100 + (1.7 \times 12.05) - 100}{12.05} \quad (2/3) = 1.13 \text{ mmh/cm water needed.}$$

For subsurface irrigation (leaching and management as at study site and $EC_w \times 5/2 = EC_e$ or $EC_w \times 10/2 = EC_e$).

$$EC_w = \frac{100 + (1.7 \times 12.05) - 100}{12.05} \quad (2/5) = 0.68$$

$$EC_w = \frac{100 + (1.7 \times 12.05) - 100}{12.05} \quad (2/10) = 0.34$$

} Range of quality needed for 100% yield.

If less than 100% yield is acceptable, the appropriate % yield can be substituted for y.

For example, using an 85% yield as acceptable, and corn as the crop, the same comparisons as before can be made:

For surface irrigation (16% leaching fraction as for tolerance tables, and $EC_w \times 3/2 = EC_e$).

$$EC_w = \frac{100 + (1.7 \times 12.05) - 85}{12.05} (2/3) = 1.96 \text{ mmho/cm}$$ (quality needed for 85% yield)

For subsurface irrigation (leaching and management as at study site and $EC_w \times 5/2 = EC_e$, or $EC_w \times 10/2 = EC_e$).

$$EC_w = \frac{100 + (1.7 \times 12.05) - 85}{12.05} (2/5) = 1.18 \text{ mmho/cm}$$

$$EC_w = \frac{100 + (1.7 \times 12.05) - 85}{12.05} (2/10) = 0.59 \text{ mmho/cm}$$

} Range of quality needed for 85% yield.

NOTE: The full impact of a change in water quality will not normally result in the first year of change but will usually take two or more years unless special practices are adopted to speed the effects.

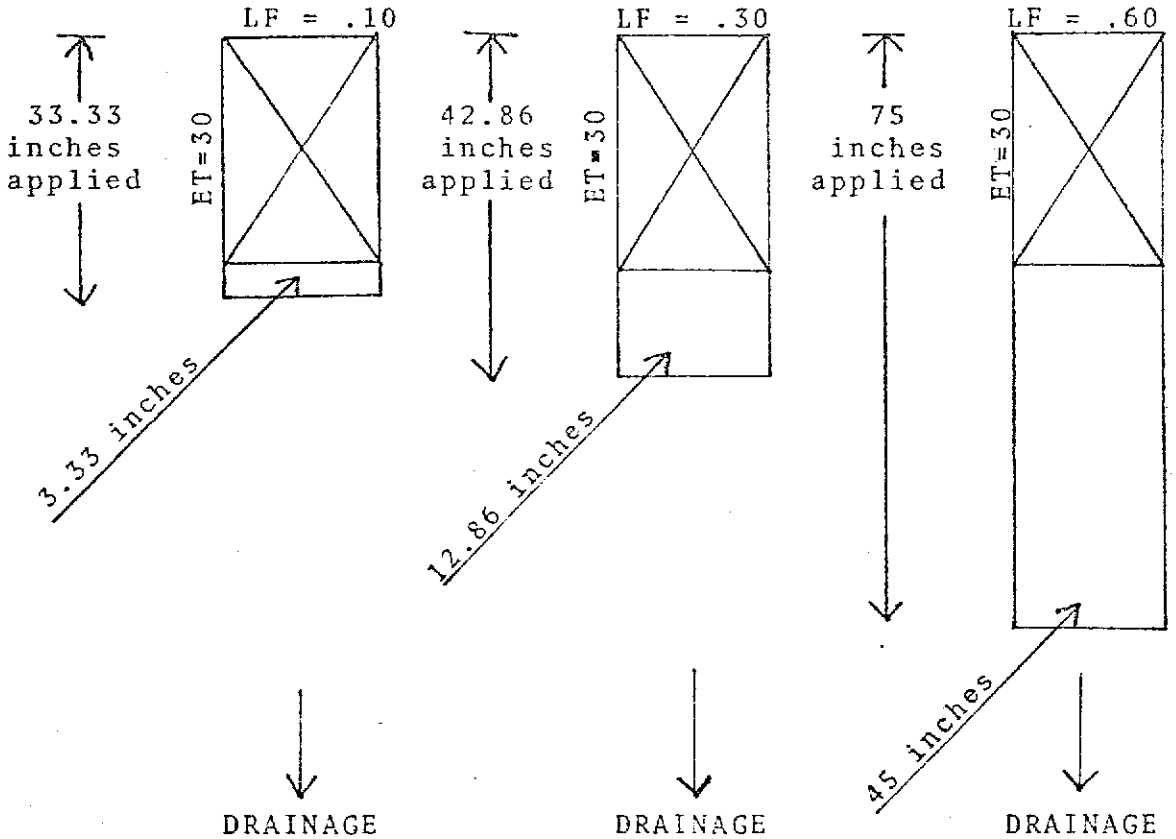
FIGURE 1.

Delta Hearings, Dec. 6, 1976
Reference to Schematic Diagram
of leaching fractions.
University of California
Robert S. Ayers

WATER MANAGEMENT

Quality of applied water EC_w= 0.75 mmhos/cm
(500 mg/l)

Crop demand ET= 30 inches



EC_w x inches of water applied= EC_{dw} x inches of water drained

$$EC_{dw} = \frac{EC_w \times \text{inches applied}}{\text{inches drained}} \qquad \left(\text{Inches Applied} = \frac{ET}{1-LF}\right)$$

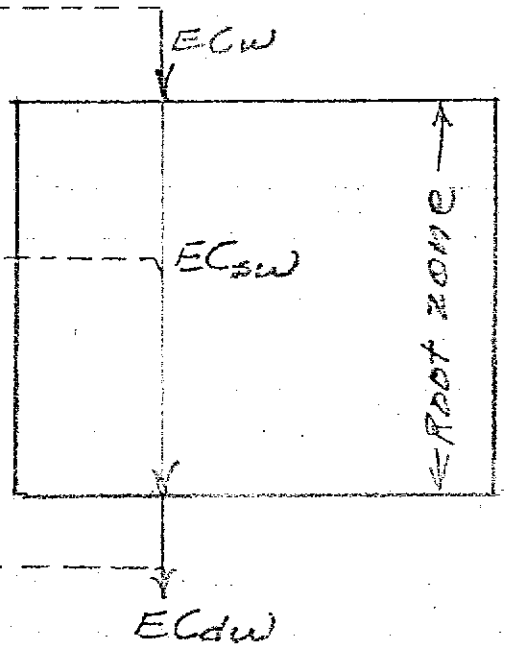
UC-8

Terms Used
Robert S. Ayers

Salinity of water applied= EC_w in millimhos per centimeter
$EC_w \times 640 \cong$ mg/l or ppm
mg/l= milligrams per liter $\cong$ ppm
ppm= parts per million $\cong$ mg/l
EC= electrical conductivity in millimhos per centimeter (mmhos/cm).
1 mmho/cm= 1000 micromhos/cm
1 micromho/cm= .001 mmho/cm
Salinity of soil water= EC_{sw} in mmho/cm
Salinity of drainage water= EC_{dw} in mmho/cm
Salinity of soil saturation extract= EC_e in mmho/cm

Salinity of applied water= EC_w
EC of water is determined by an electrical conductivity measurement of the water.

Salinity of applied water on average, concentrates about 3 times in becoming soil water. $EC_w \times 3 = EC_{sw}$



Salinity of soil water= EC_{sw}
Sometimes is measured as for water but on water extracted and collected from the wet soil under a vacuum.

More often it is estimated from the EC_e as determined on an extract from a saturated soil paste as made up and extracted in a prescribed manner in the laboratory. $EC_e \times 2 = EC_{sw}$

Salinity of drainage water= EC_{dw}
As described for EC_{sw}. Drainage water percolates at near the same salinity as the soil water so the relationship $EC_e \times 2 = EC_{dw}$ is generally used but the soil salinity (EC_e) is determined on soil taken from below the depth of rooting but above any water table that may exist.

Soil salinity= EC_e
A representative sample of soil is dried and ground, and then sufficient distilled water is added and mixed to form a saturated soil paste. Part of the water is then extracted with vacuum. The EC of the extract is then determined and reported as EC_e in millimhos per centimeter. It is the accepted standard for measurement and reporting of soil salinity and is the starting point for crop tolerance tables.

$EC_e \times 2 = EC_{sw}$
$EC_e \times 2/3 = EC_w$ (on basis of the assumptions of UC-Guidelines and
$EC_w \times 3/2 = EC_e$ equal to 16% leaching fraction.)