SOUTHERN DELTA ELECTRICAL CONDUCTIVITY WATER QUALITY OBJECTIVES

PRESENTATION BY

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SWRCB based the Southern Delta Agricultural Water Quality Objectives on:

Calculated maximum salinity of applied water that sustains 100% yield of salt sensitive crops grown in the southern Delta (surface irrigation of mineral soils) per the University of California Guidelines and Irrigation Paper 29 of the Food and Agricultural Organization of the United Nations.

Concern for Delta Water Salinity Levels

- Delta water quality important for agriculture even prior to the construction of:

  The Central Valley Project -1944

  The State Water Project – 1968

- Concern was salinity intrusion from the Pacific Ocean and the San Francisco Bay, particularly in dry years

Prior to Construction of CVP and SWP

- During dry years, such as 1931, water with an EC of about 1.56 mmhos/cm extended into the southern Delta as far as the Grant Line Canal and Upper Roberts Island

Control of Delta Salinity

- D-1275 and D-1291 were adopted in 1967 to, among other things, require the CVP and the SWP to control the salinity level in the Delta.

Issue for SWRCB

- Issue in 1975
- What appropriate salinity level should be required to protect the beneficial use of water for the irrigation of Agricultural crops in the Delta?
- Predominant crops: (Beans, Corn and Alfalfa)

Testimony Pertaining to Delta Agriculture – December 1976

Irrigation and Agronomy Experts from the University of California Agricultural Experiment Station testified

- Robert Ayers
- Roy Branson
- Franz Kegel
- Jewell Meyer

Summary of UC Testimony (1)

- Irrigation water adds salt to soil
- Plants use water, leave salt
- Good farm management and water application practices are necessary
- Excess salt must be leached from soil
- Leached salt add salt to Delta water

Summary of UC Testimony (2)

Corn Studies on Peat Soils

- Difficult to farm under ideal conditions
- Generally below sea level
- Impossible to leach with sub- irrigation
- Difficult to leach with surface irrigation

Summary of UC Testimony (3)

Corn Studies on Mineral Soils

- Leaching fractions of 15% to 16% can be achieved with normal irrigations and winter precipitation
- Nine study locations during dry year (1976) found highest soil salinities and lowest apparent leaching fractions occurred where irrigation water was of highest quality (0.7 mmhos/cm)

Terminology

- Salinity refers to total dissolved ionic solids (TDS) in water expressed in:

  parts per million (ppm),

  parts per thousand (ppt)

  milligrams per kilogram (mg/Kg)

Terminology

- Electrical Conductivity (EC) is a measurement of the salinity of water where
- EC units are expressed in

  millimhos per centimeter (mmhos/cm) (old)

  deciSiemens per meter (dS/m) (new)

  mmhos/cm = dS/m

  uS/cm = 10dS/m

Terminology

- EC of Irrigation Water (EC_i, EC_{iw}, EC_w)
- EC of Soil Water (EC_e, EC_{sw})
- EC of Drainage Water (EC_d, EC_{dw})

Summary of UC Testimony (4)

- Good leaching and low salt accumulations were found in all locations where the irrigation water supply averaged 1.1 mmhos/cm
- The wide variability in Delta soils contributed more to the variability in the salt accumulation than did the salinity of the water supply

Summary of UC Testimony (5)

- Despite the above findings:
- UC Experts stated in December 1976

  "This study has shown that salinity is a problem now in the Delta. Given the wide variety of soils in the South Delta, good yields and diversity of crops appear to be related to water quality and levels of farm management"

SWRCB Focus in Adopting D-1485

- It appears that in 1976 the SWRCB was most concerned with protecting crops grown on difficult to manage peat soils.
- The Board asked:

  "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?"

UC Response

Mr. Ayers developed a four page answer that basically said:

- …in order to achieve a 100% corn yield on mineral soils using surface irrigation, a 16% leaching fraction with a water quality of 1.13 mmhos/cm would be needed.
- …in order to achieve a 100% corn yield on peat soils with subsurface irrigation a water quality of 0.42 to 0.85 mmhos/cm would be needed.

SWRCB Adopted Water Quality Objectives for Agricultural Beneficial uses

- San Joaquin River at Airport Way Bridge,Vernalis
- Maximum 30-day running average of mean daily EC
- April – August: EC = 0.7 mmhos/cm
- September – March: EC = 1.0 mmhos/cm

Salinity Research After D-1485 (1)

- Hoffman, et al (1983) reported on 3-year corn experiment in Delta and concluded

  "For subirrigation, an EC_i up to 1.5 dS/m did not decrease yield as leaching had reduced EC_{sw} below the threshold.

  "..surface irrigation with water of up to 6 dS/m after mid-season (end of July) did not reduce yield below that of treatments where the salinity of the irrigation water was not increased mid-season."

Salinity Research After D-1485 (2)

- Pritchard, et al (1983) reported

  “At the soil water salinity threshold of corn grain (3.7 dS/m), the average ratio is 1.7 which results in a maximum value of 2.2 dS/m of EC_i without yield loss under normal conditions. With subirrigtion and below normal rainfall, as in 1981, the maximum value of EC_i would be 0.8 dS/m”.

Salinity Research After D-1485 (3)

- Isadoro-Ramerez, Berenguer-Merelo and Grattan (2004) reported

  "When and EC_w of 1.1 dS/m is considered over the 53-year rainfall series (Davis) the model predicts that the seasonal mean EC_e is 0.94 dS/m. In 80% of the years, the mean seasonal EC_e is less than 1.0 dS/m, the yield threshold for salt-sensitive bean. For 50 of the 53 years, the seasonal mean EC_e for individual years is 1.05 or lower, which would result in a predicted yield reduction of 1% or less. However, this predicted reduction in yield potential is less than the error associated with the yield threshold value itself."

Salinity Research After D-1485 (4)

- Isadoro-Ramerez, Berenguer-Merelo and Grattan (2004) summarized as follows:

  "Given these results, and taking into account all the other factors that potentially impact crop yield (e.g., weather, water stress, and biotic stresses) and the conservative nature of all inputs into the model, the use of 1.1dS/m as the threshold EC value for irrigation water is considered protective for beans, and thus all other agricultural uses of the water in the Davis area."

Southern Delta Service Area

- It is estimated that about 90% of the crops irrigated with San Joaquin River water in the Southern Delta are planted on mineral soils
- Beans most salt sensitive crop grown
- All beans are grown on mineral soils
- EC of 1.1 dS/m protective of beans and other crops grown with San Joaquin River water

Figure 1. Bean Yield (San Joaquin County) & Annual Salinity of the San Joaquin River at Vernalis, 1980-2003,

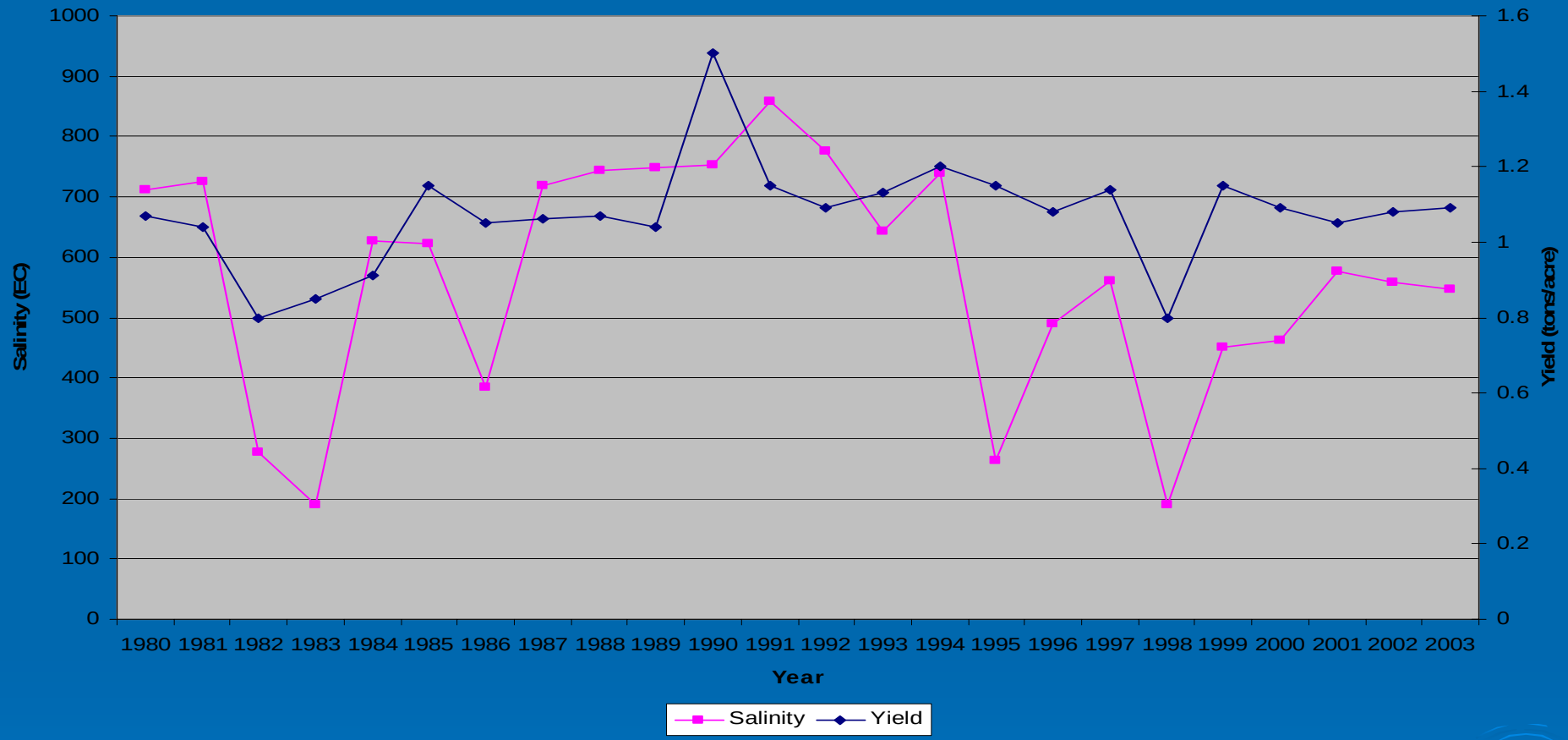
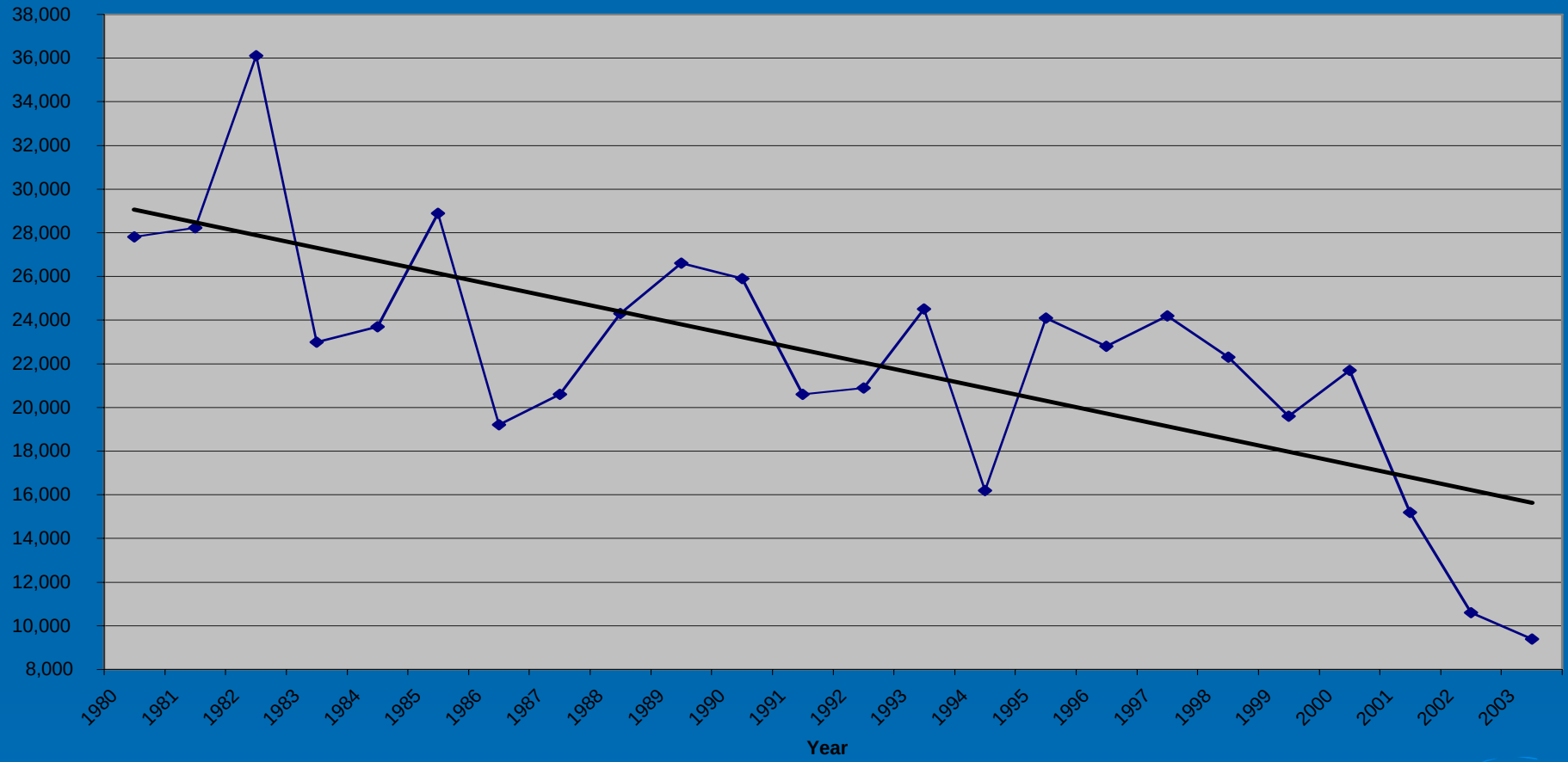


Figure 2. San Joaquin County Beans Harvested, acres (1980-2003)



Conclusions

- Excellent crops are produced in the Southern Delta
- Farm management practices are more important than irrigation water salinity, within the range of Delta water quality, in regard to producing crop yields
- Even under the best circumstances, it is difficult to manage poor soils with a shallow water table
- Irrigation water with an EC = 1.1 dS/m is adequate to provide sustained 100% yield of salt sensitive crops grown in the southern Delta

Recommended Water Quality Objectives for Agricultural Beneficial uses

- San Joaquin River at Airport Way Bridge,Vernalis
- Maximum 30-day running average of mean daily EC
- January - December: EC = 1.1 dS/m

Methodology for Determining Compliance

- Change methodology to utilize the San Joaquin Basin 60-20-20 water year hydrologic classification index rather than the Sacramento River index.