Beneficial Reuse: Using Wastewater in Agriculture

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Water Reuse

- Current fresh water use by irrigated agriculture is likely not sustainable
- Irrigated agriculture cannot compete economically with the urban sector in a competitively priced water market
- Agriculture can utilize treated municipal waste waters, agricultural drainage waters and brackish ground waters
- Water reuse can reduce nutrient and contaminant discharge

Ocean Disposal

LA County Sanitation District 2004

363,500 acre ft/year of effluent discharged

216,000 acre ft/year reclaimed

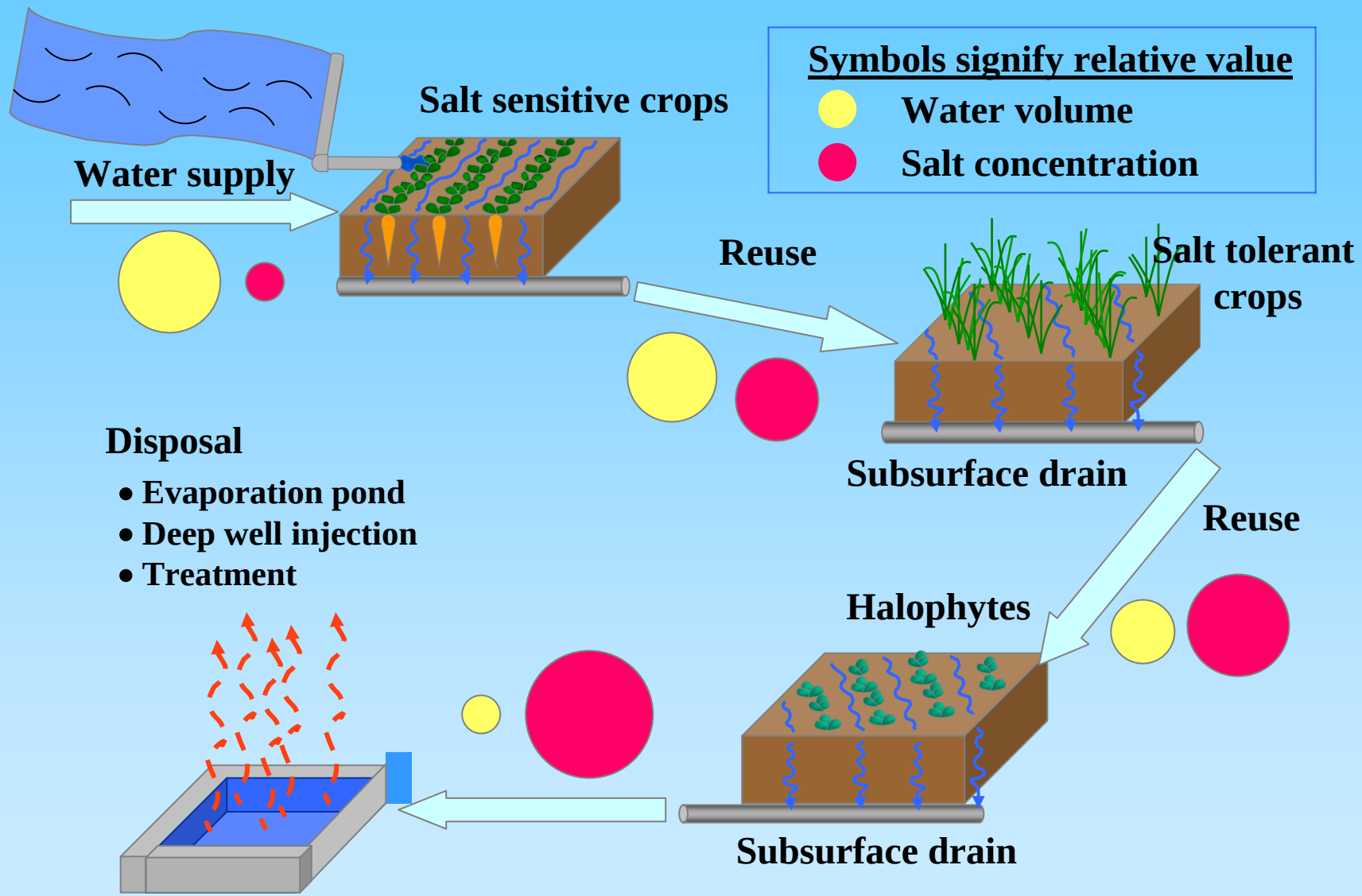
City of Los Angeles Hyperion Plant Discharge

average flow 500,000 acre ft/year

Salinity Levels of discharge waters are lower than in Colorado River water at Parker Dam

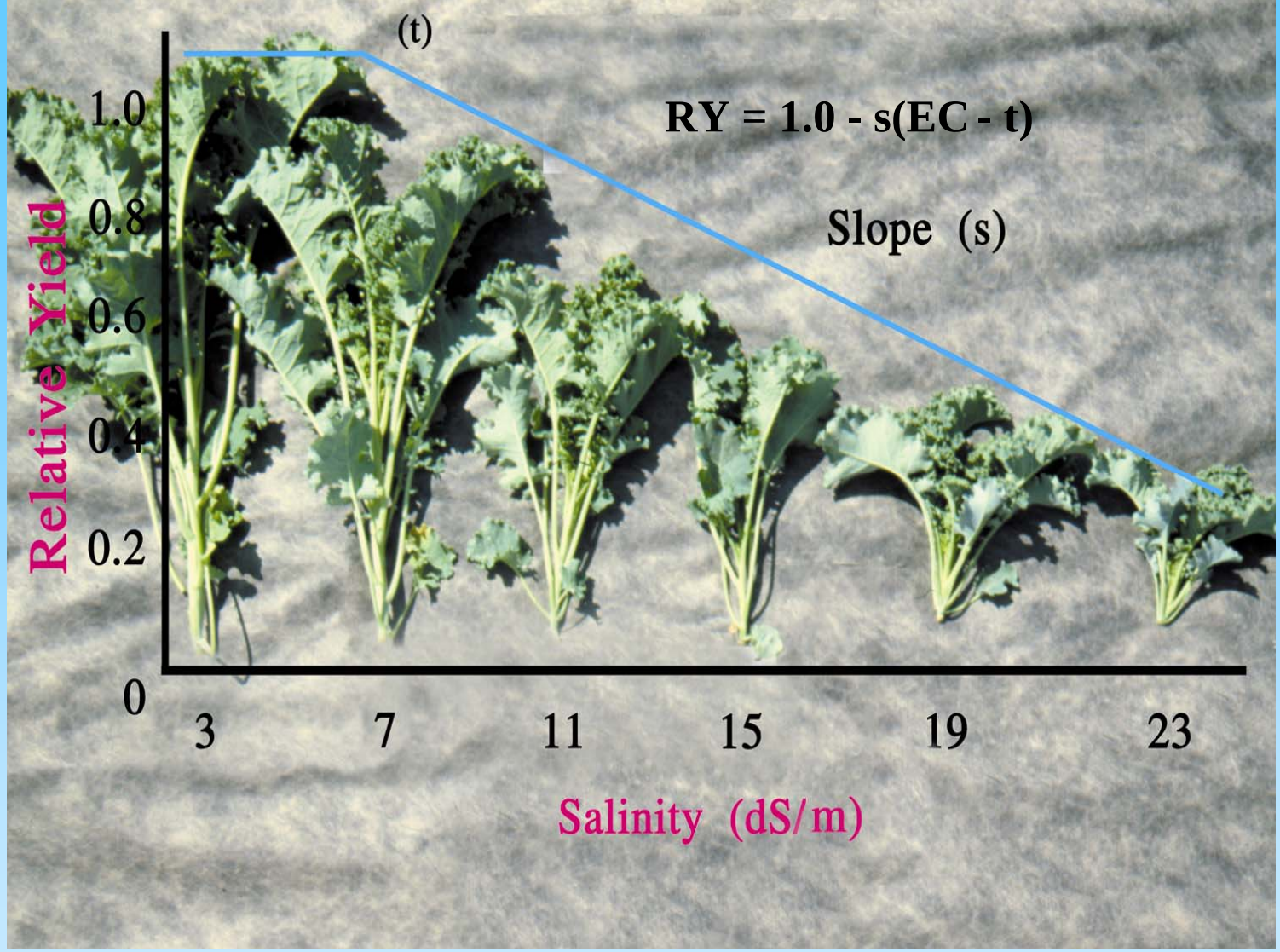
Water Reuse

- **Tertiary water treatment, necessary for aquifer recharge is expensive.**
- **Agricultural use can avoid the need for nutrient removal, as nutrients add value to irrigation water.**
- **Agricultural use can reduce the drainage volume below that of an RO plant in one cycle and further reduce the volume with multiple uses (2% or less of initial volume).**

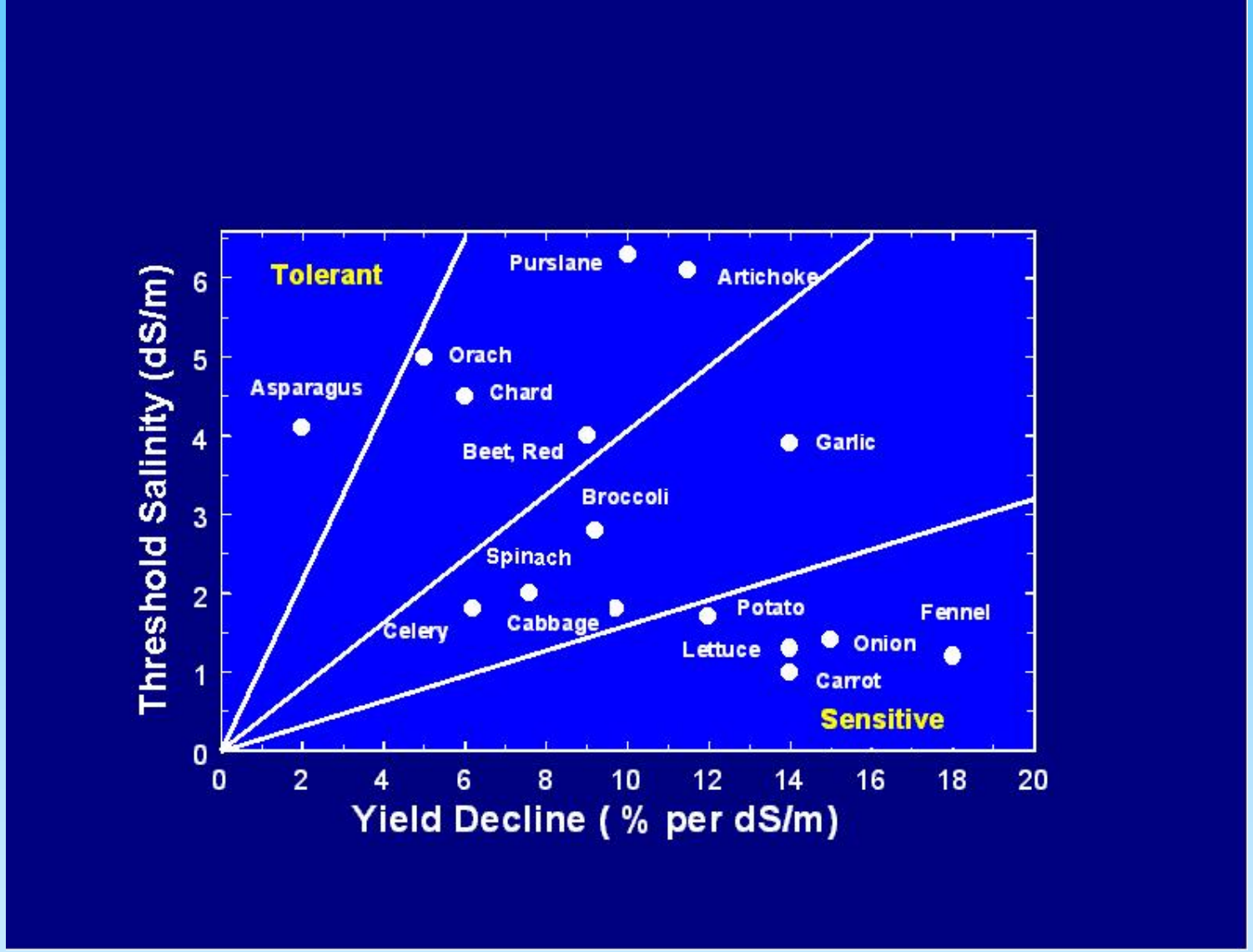

Symbols signify relative value
Water volume
Salt concentration
Water supply
Salt sensitive crops
Reuse
Salt tolerant crops
Subsurface drain
Disposal
• Evaporation pond
• Deep well injection
• Treatment
Reuse
Halophytes
Subsurface drain

Water Quality Issues with Reuse of Treated Wastewaters

- Organic contaminants (pharmaceuticals, pesticides etc.)
- Pathogens (bacteria and viruses)
- Inorganic components (elevated pH and alkalinity), high proportion of Na and Cl salts, elevated B content



Shannon. M.C., C.M. Grieve, S.M. Lesch & J.H. Draper. 2000. Analysis of salt tolerance in nine leafy vegetables irrigated with saline drainage water. J. Amer. Soc. Hort. Sci. 125:658-664.



Shannon. M.C., & C.M. Grieve 1999. Tolerance of vegetable crops to salinity. Scientia Horticulturae. 78:5-38.

Response of Leafy Vegetables to Irrigation with Saline-Sodic Waters

Methods

- **Outdoor sand tanks**
- **Nine vegetable crops**
- **Six salinity treatments with ion compositions typical of San Joaquin Valley drainage effluents; EC_{iw} =3, 7, 11, 15, 19, 23 dS m^{-1}**
- **Nine vegetable crops with two salinization dates**

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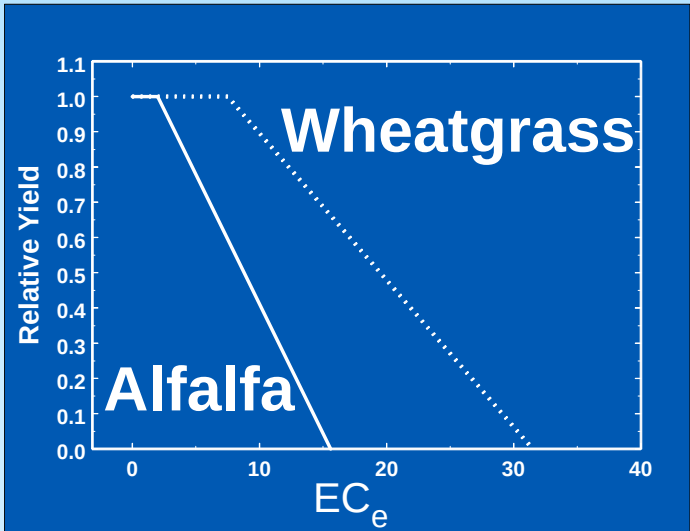
Results

- **Chard, salad greens, kale and pac choi have potential for use in drainage water reuse systems provided salinity is moderate and irrigation practices are appropriate.**
- **Irrigation with moderately saline water did not affect vegetable nutrient quality or consumer acceptability**

Salt Tolerance Parameters

Forage	Threshold Ec_e* (dS/m)	Slope (%)	Rating
Alfalfa†	2.0	7.3	MS
Tall Wheatgrass‡	7.5	4.2	T
Kikuyugrass	.....	NA	.....

*** EC_e = ~ 1.5 EC_{iw} (Ayers and Westcot 1985)**
† Bernstein and Francois 1973
‡ Bernstein and Ford 1958



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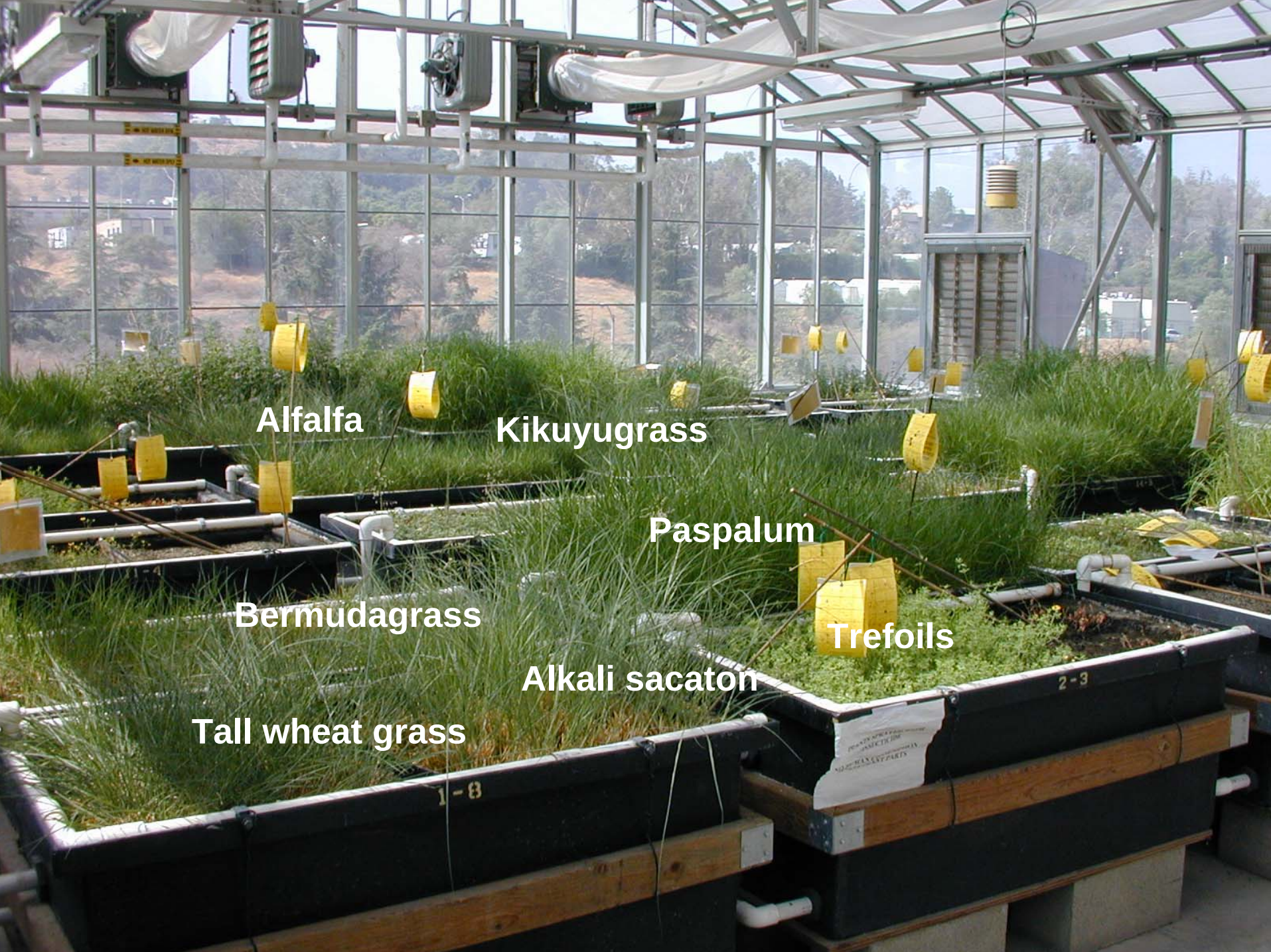
Irrigation Water Compositions

Salinity	Ca	Mg	Na	SO_4	Cl	Se	Mo
EC (dS m^{-1})	---------- meq l^{-1} ----------					---ppm---	
15	26	28	123	116	53	0.5	0.5
25	28	56	233	208	111	0.5	0.5


Alfalfa
Kikuyugrass
Paspalum
Bermudagrass
Trefoils
Alkali sacaton
Tall wheat grass
1 - 8
2 - 3

Effect of Saline Irrigation Waters on Cumulative Biomass Production

	Final Harvest	
	15 dS m^{-1}*	25 dS m^{-1}
	----------t ha^{-1}----------	
Alfalfa	28	15
Wheatgrass	20	17
Kikuyugrass	18	15

In sand culture experiments: ECiw = ECsw. ECsw = ~ 2 ECe

Grattan, S.R., C.M. Grieve, J.A. Poss, P.H. Robinson, D.L. Suarez & S.E. Benes. 2004. Evaluation of salt-tolerant forages for sequential water reuse systems. I. Biomass production. Agric. Water Mange.70:109-120.


Ca-Mg-K
Cl
0.15 MPa
67


76
Ca-Mg-K
SO_4
0.15 MPa
71

Common Name	Constituent Improved by Salinity
Fruit and Vegetable Crops	
Melon	Increased TSS, firmness, improved post-harvest firmness
Onion	Reduction in bulb pungency
Tomato	Increased TSS, vitamin C, lycopene, sugars, acidity
Pepper	Increased lycopene
Squash	Increased TSS, fruit firmness
Oil Seed Crops	
Sunflower	Increased oleic acid

Research Needs

- **Plant response to irrigation waters of differing ion composition – yield and quality**
- **Salinity – nutrient – ion composition – toxic element interactions for prediction of yield**
- **Optimal management practices when using a combination of fresh and recycled water for irrigation**
- **Feasibility study on costs/benefits of construction of delivery systems from coastal treatment plants to agricultural regions**