Evalution of Polymers for Controlling Sprinkler Run-off from Vegetable Fields on the Central Coast of California

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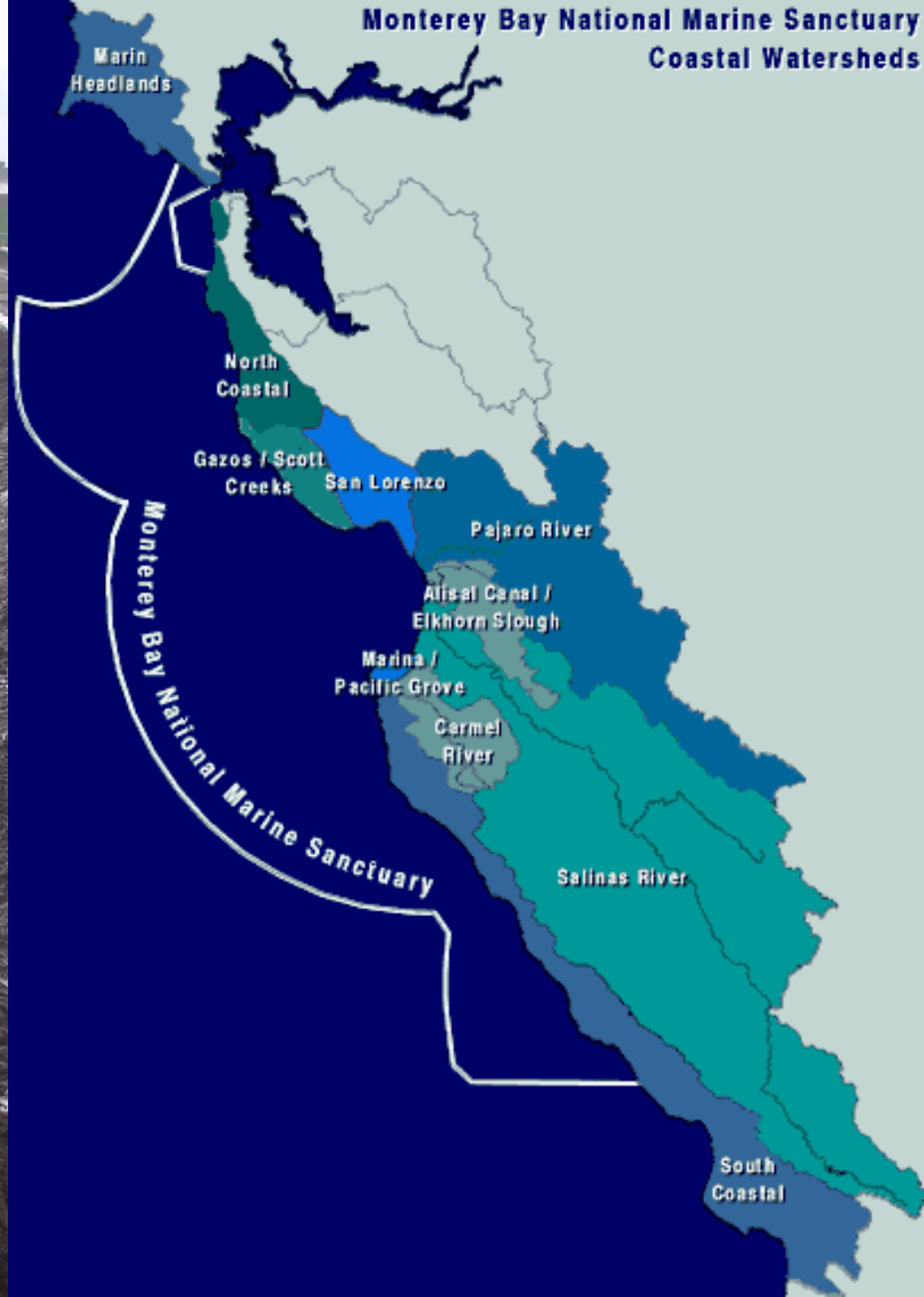
2 to 3 vegetable crops per year

High rates of water and fertilizer applied to maximize economic returns for yield and quality.

Central Coast Water Quality Impairments:

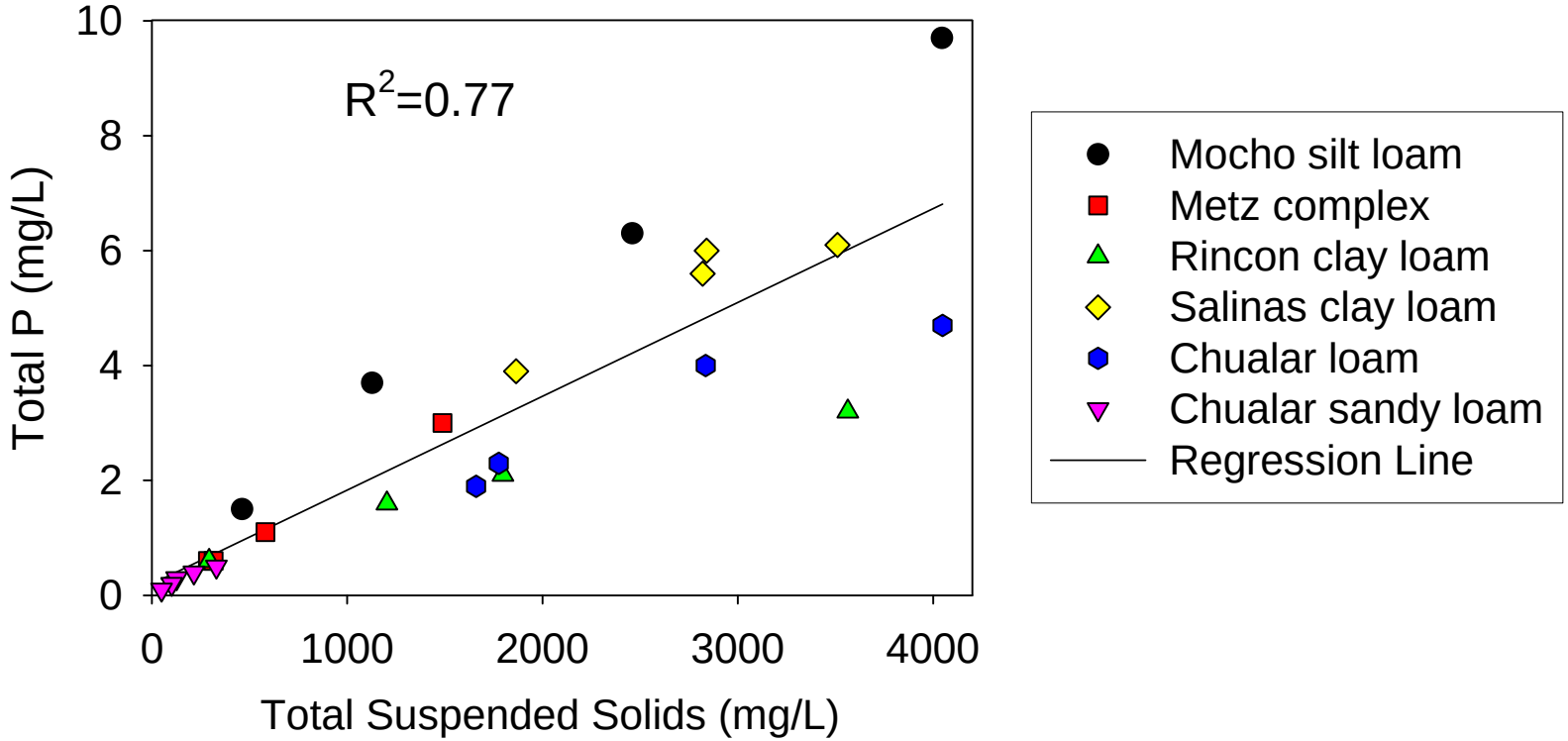
- bacterial pathogens
- nutrients (P and N)
- sediments
- pesticides
- salts



Stand Establishment
Run-off = 0 to 25% of Applied Water

Sediment Basin

Total P concentration in Run-off is linked to the Sediment concentration



Polyacrylamide (PAM)

Linear PAM

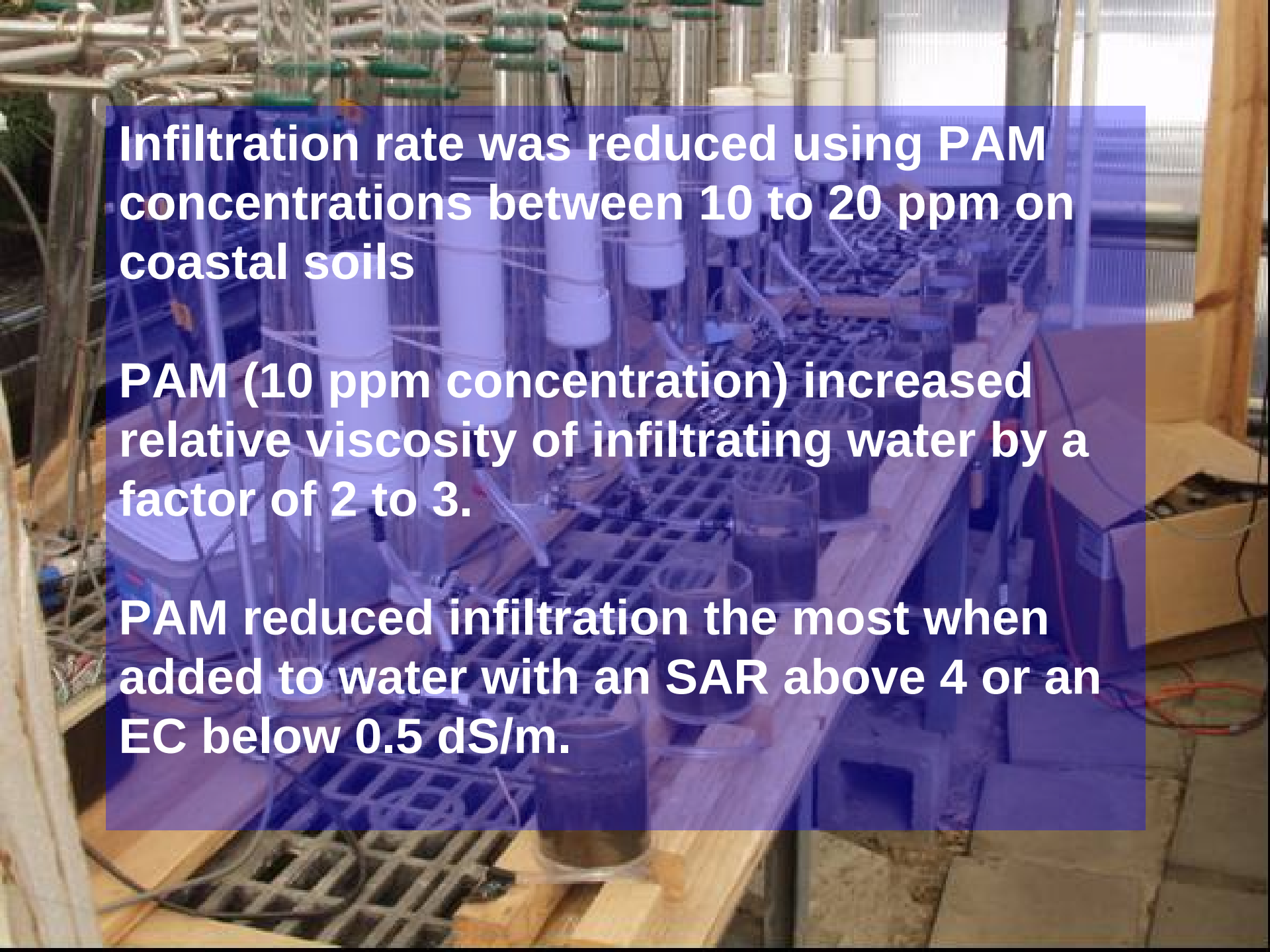
- Water soluble
- Molecular weight: 12-15 Mg mol^{-1};
- Charge: moderately anionic (15-20%)

Polyacrylamide (PAM) use in Soil Conservation

- About 1 million acres of irrigated lands are treated with PAM in United States.
- PAM acts by stabilizing soil structure, increasing infiltration, and flocculating sediments
- PAM used primarily in furrow irrigation

Experimental Approach

- **2003 Column Studies (10 soils)**
- **2003 Field Infiltration Studies (6 sites)**
- **2004 Replicated Field Trials (6 sites)**
- **2005-2006 Split-field demonstrations (10 sites)**
- **2007 Large plot replicated field trials**



Infiltration rate was reduced using PAM concentrations between 10 to 20 ppm on coastal soils

PAM (10 ppm concentration) increased relative viscosity of infiltrating water by a factor of 2 to 3.

PAM reduced infiltration the most when added to water with an SAR above 4 or an EC below 0.5 dS/m.

Recirculating Infiltrometer Field Experiments

Effects of PAM on Infiltration (Recirculating Infiltrometer)

Soil Type	Final Infiltration Rate PAM	Final Infiltration Rate Control	Total Infiltration PAM	Total Infiltration Control
	--- mm/hr ---		----- mm -----	
Mocho silt loam	7.5	3.5	18.4	16.9
Metz complex	7.9	7.3	19.8	18.9
Rincon clay loam	2.6	4.0	13.7	13.9
Salinas clay loam	5.2	5.0	18.0	26.6
Chualar loam	5.8	4.2	18.7	18.6
Chualar sandy loam	159.0	197.3	247.5	349.5
average	32.4	38.4	57.6	76.5

= statistically significant

Effects of PAM on Suspended Sediments (Recirculating Infiltrometer)

Soil Type	Total Suspended Solids PAM	Total Suspended Solids Control	Turbidity PAM	Turbidity Control
	--- TSS mg/L ---		--- Turbidity NTU ---	
Mocho silt loam	244	2024	55	1977
Metz complex	156	669	18	473
Rincon clay loam	412	1715	51	1013
Salinas clay loam	240	2759	59	2437
Chualar loam	306	2580	129	2992
Chualar sandy loam	36	165	24	183
average	224	1592	54	1459

= statistically significant

Effects of PAM on Phosphorus in Run-off (Recirculating Infiltrometer)

Soil Type	Soluble P PAM	Soluble P Control	Total P PAM	Total P Control
	--- Soluble P mg/L ---		----- Total P mg/L ----	
Mocho silt loam	0.35	0.78	0.85	5.30
Metz complex	0.09	0.16	0.35	1.33
Rincon clay loam	0.31	0.44	0.68	1.88
Salinas clay loam	0.36	0.64	0.80	5.40
Chualar loam	0.28	0.46	0.58	3.23
Chualar sandy loam	0.09	0.12	0.14	0.30
average	0.24	0.42	0.55	2.80

= statistically significant

2004 Replicated Sprinkler Trials (5 ppm PAM-Amber 1200D)

CHEM-TAINER

Effect of PAM on Nutrients and Sediments (Replicated Sprinkler Trials 1-3)

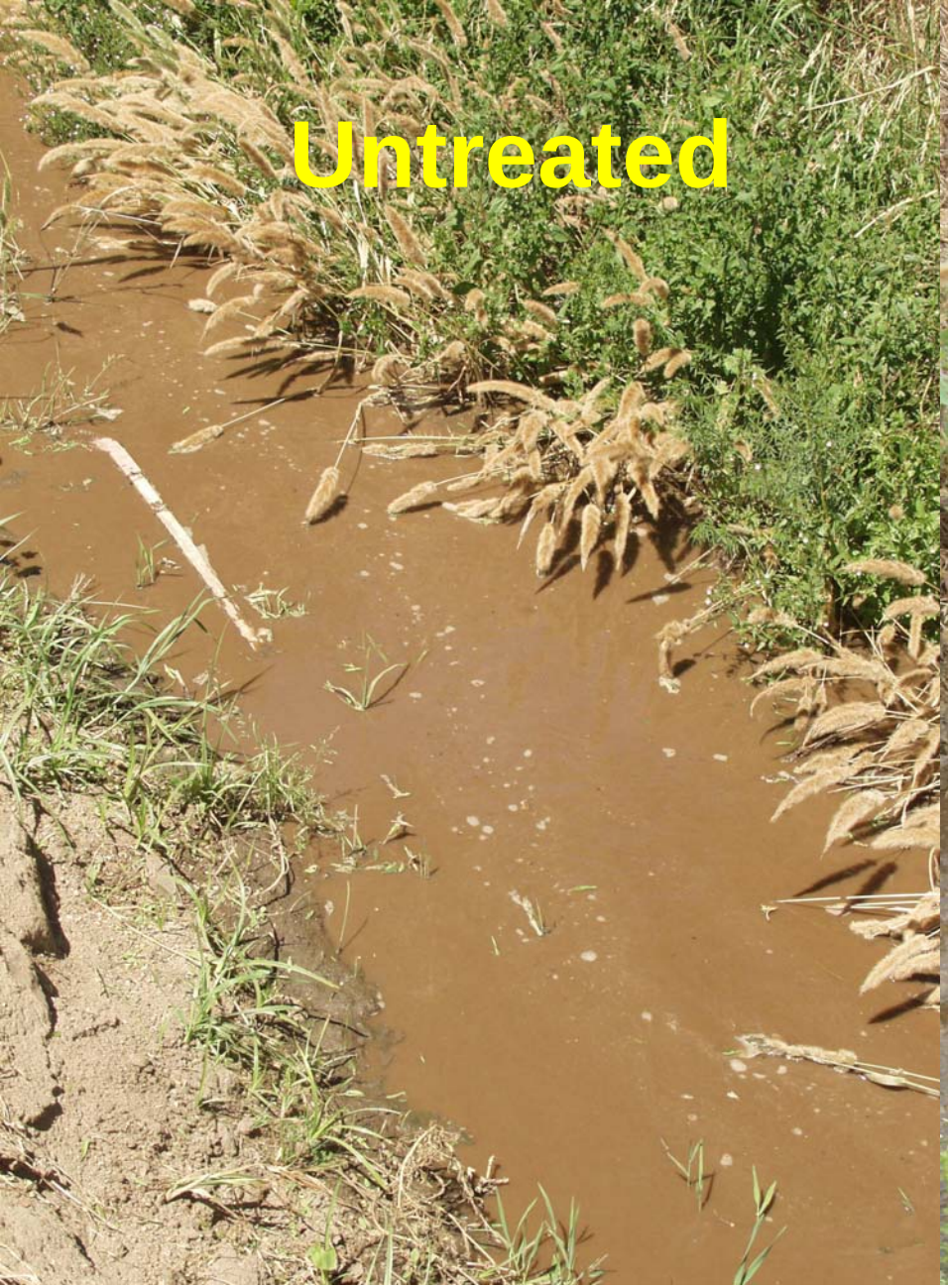
Treatment	Total Kjeldahl N	NO_3 -N	P (soluble)	P (total)	Total Disolved Solids	Total Suspended Solids	Turbidity
	mg/L						NTU
	trial 1						
PAM[1]	2.30	6.2	0.32	0.42	1027	42	40
Untreated	4.78	5.1	0.49	2.37	863	964	2456
F-test	0.003	NS[2]	NS	0.0002	NS	0.004	0.0003
	trial 2						
PAM	2.54	11.7	1.24	1.26	494	99	89
Untreated	2.96	10.0	0.74	1.34	464	433	785
F-test	NS	NS	NS	NS	NS	0.017	0.007
	trial 3						
PAM	2.10	18.5	0.94	1.68	491	313	301
Untreated	4.18	21.9	1.08	4.45	510	1959	4645
F-test	0.013	NS	0.01	0.017	NS	0.010	0.007

1. 5 ppm concentration of Amber 1200D
2. not statistically significant at $P < 0.10$ level.

Split-Field Trials (2005)

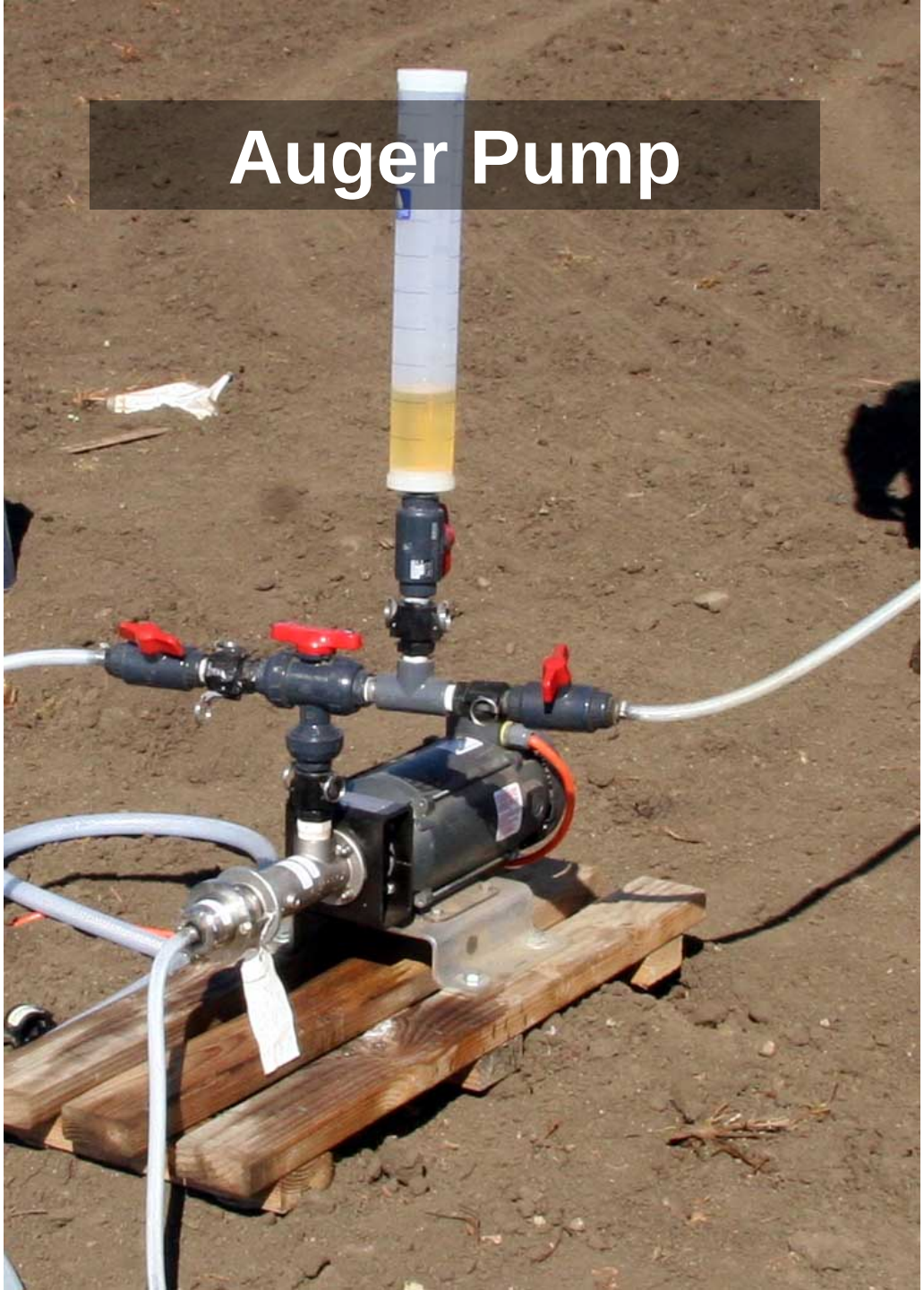
Summary of Split-Field Trials (2005)

Treatment	Total N	NO3-N	P (Total)	P (Soluble)	Total Suspended Solids	Turbidity
	ppm					NTU
	Watsonville (clay loam)					
PAM (5 ppm)	0.8	58.6	1.2	1.2	47	33
Control	2.9	48.4	2.0	0.9	652	1289
	Salinas (sandy loam)					
PAM (5ppm)	1.4	1.7	0.7	0.7	72	63
Control	4.2	1.7	1.9	0.7	985	2291
	Salinas (sandy loam)					
PAM (10 ppm)	2.7	1.3	0.4	0.2	179	108
Control	5.5	1.8	2.4	0.5	1332	3536
	Chualar (loamy sand)					
Pam (5 ppm)	2.3	2.7	1.9	0.8	646	218
Control	11.8	6.5	8.2	2.1	3870	503
	Santa Maria					
Pam (5 ppm)	1.6	14.78	0.6	0.51	60	13
Control	7.0	17.02	10.1	0.95	5930	4417
	Gilroy (silt loam)					
Pam (4 ppm)	1.2	8.1	1.0	0.9	74	42
Control	4.0	6.5	3.5	1.2	2057	2408


Untreated

PAM-treated

Auger Pump



Summary

- ✓PAM at < 5 ppm reduced suspended sediments by 90%, and total N and P by as much as 70% in tail water run-off from overhead sprinklers.

- ✓ PAM did not increase infiltration rates and therefore run-off volumes were not reduced.

- ✓Applying PAM at concentrations > 10 ppm may increase run-off.

- ✓Auger pump was the most user friendly method to inject low rates of liquid formulations PAM into a pressurized irrigation system.

Thank You!