Colorado River Basin Region Water Quality Control Board Success Story:
Irrigation Strategies for Erosion Reduction in the Salton Sea Watershed

The Salton Sea is the largest inland body of water in California and provides significant habitat for wildlife. The Sea also supports REC-1 and REC-2 activities such as camping, bird watching, fishing, boating, hiking, and hunting. Silt, pesticides, and nutrients from local agriculture runoff threaten beneficial uses of the Salton Sea and its tributaries.

As much as 3.0 million acre-feet of Colorado River water are used every year to irrigate more that 500,000 acres of land in the Imperial Valley. Agricultural runoff to the Imperial Valley Agriculture Drains, New River, Alamo River, and Salton Sea contains sediments, pesticides, and nutrients that caused these waterbodies to be listed on the State's 303(d) List of Impaired Waters. Therefore, efforts to meet the expected TMDL standards for sediment, pesticides, and nutrients will likely necessitate efforts to reduce sediment runoff from farm operations in the Imperial and Coachella Valleys. Currently, the two TMDLs of concern to Imperial Valley growers are the Salton Sea Nutrient TMDL (still in development phase) and the silt/sediment TMDLs for drains and rivers in the Imperial Valley.

To assist crop growers in complying with Basin Plan and TMDL water quality objectives, a demonstration project funded by a federal 319 (h) grant was conducted at the University of California Desert Research and Extension Center (UCDREC) near Holtville, California in 2001 through 2003. Two irrigation management strategies were implemented on lettuce fields at UCDREC; 1) polyacrylamide (PAM) applied through irrigation water, and 2) surge irrigation. This project showed that these two irrigation management practices could be implemented to help growers achieve silt/sediment TMDL objectives for drains and rivers in the Salton Sea Watershed.

Polyacrylamides (PAMs) are effective in controlling surface erosion in soil and improving aggregate stability. PAMs mimic soil organic matter by acting as stabilizing agents in building up soil aggregates and reducing removal of sediments from agricultural fields. Surge irrigation is a process where irrigation water is turned on and off as it flows down the furrow. Properly managed surge irrigation systems can save water and reduce surface runoff. This method has proven to be effective in reducing soil erosion from furrow irrigation fields and also offers the potential for semi-automation and reduction in labor and energy cost. PAM treatments and surge irrigation were designed to assess the effectiveness in reducing silt and soluble phosphorous in surface runoff water. The impact of theses practices on surface runoff water quality and crop yields was evaluated.

The application of PAM through irrigation water on lettuce fields resulted in significant improvements in the quality of surface runoff water when the sediment concentration in runoff water was high. Silt loads in surface runoff water were reduced by as much as 90% with the application of PAM, compared to normal irrigation practices. Implementation of surge irrigation on lettuce resulted in significant improvements in water quality, and no significant impact on yield, when the concentration of sediment was high. In addition to the reduction in silt loads, both management practices reduced the concentration of soluble phosphorous in surface runoff water.

Table 1. Average lettuce yield (40-lb cartons per acre)

Year	Treatment					
	A	B	C	D	E	F
2001	520	548	539	545	538	546
2002	597	623	592	619	616	601
2003	685	652	693	702	687	703

*Treatments (A: 0 ppm PAM, B: 5 ppm PAM, C: 10 ppm PAM, D: 15 ppm PAM, E: 0 ppm PAM+surge, F: 10 ppm PAM+surge).

The economic impacts of the implementation of these irrigation practices on alfalfa and lettuce production costs were also evaluated. The cost of implementing one of the management practices mentioned in this report varies from $5 to $25 per acre. The additional costs to implement management practices to reduce sediment load in drainage water represent approximately 0.5% to 2.5% of the total production costs of alfalfa and approximately 0.1% to 0.5% of the total production costs of lettuce. It was found that the application of PAM at low rates (5-10 ppm) was the most cost effective measure that could be implemented to improve water quality and could be economically feasible for both field and vegetable crops grown in the Imperial Valley.

Table 2. Additional labor costs for implementing surge and PAM on alfalfa and lettuce fields-Imperial Valley (2002-2003 cost estimates)

Crop	Total costs (normal production practices) $/acre	Additional labor costs for the implementation of Surge Irrigation $/acre per year	Additional labor costs for the implementation of PAM $/acre per year
Alfalfa	$911.40	$13.88	$0.46-1.38
Lettuce	$ 4617.02	$16.19	$0.1.38-2.76

Table 3. Total costs for improving water quality-Lettuce field 2003

Treatment	A: Normal practice	B: PAM-5 ppm	C: PAM-10 ppm	D: PAM-15 ppm	E: Surge irrigation	F: Surge+PMA-10 ppm
TSS (mg/L) in runoff water	155	25	9	11	62	22
Total sediment load in runoff water tons/acre (80-acre field)*	0.1273	0.0205	0.0074	0.0090	0.0509	0.0181
% reduction in sediment load	0	83.9	94.2	92.9	60.0	85.8
Tons of sediment removed per acre	0	0.1068	0.1199	0.1183	0.0764	0.1092

Additional labor costs ($/acre)	0	$0.92	$0.92	$0.92	$16.19	$17.11
PAM cost/acre	0	$4.00	$8.00	$12.00	0	$8.00
Total costs/acre	0	$4.92	$8.92	$12.92	$16.19	$25.11
Total costs of implementing practice per ton of sediment removed from runoff water	0	$46.07	$74.40	$109.21	$211.91	$229.95

* Assumes average water use of approximately 3.0 ac-ft/ac and 20% runoff.

As irrigators and farm managers become more attentive to the quantity of water applied and the quality of drainage water leaving their fields, they must adjust their irrigation practices to ensure compliance with Basin Plan and TMDL water quality objectives. This 319 (h) grant project brought the use of PAMs and surge irrigation to the forefront for both farm managers/irrigators and regulators as a useful best management practice.

Table 4. Average runoff water turbidity (NTU) for the lettuce field

Year		Treatment					
	Block	A	B	C	D	E	F
2002	I	24.94	22.44	9.23	10.36	12.59	44.00
	II	11.43	25.56	17.05	9.01	36.00	17.94
	II	27.60	22.02	51.76	63.77	12.40	27.80
	Average 2002	21.32	23.34	26.01	27.71	20.33	29.91
2003	I	149.65	19.01	4.90	4.51	47.67	5.87
	II	62.79	14.74	3.44	6.80	43.50	17.07
	II	145.51	16.64	3.49	6.41	45.30	19.56
	Average 2003	119.31	16.80	3.94	5.91	45.49	14.17

*Treatments (A: 0 ppm PAM, B: 5 ppm PAM, C: 10 ppm PAM, D: 15 ppm PAM, E: 0 ppm PAM+surge, F: 10 ppm PAM+surge).

Table 5. Average runoff water TSS (mg/L) for the lettuce field

Year		Treatment					
	Block	A	B	C	D	E	F
2002	I	36	32	16	17	20	60
	II	18	36	26	15	50	27
	II	39	32	70	85	20	39
	Average 2002	31	34	37	39	30	42
2003	I	194	28	10	10	64	11
	II	84	23	8	13	59	26
	II	188	25	8	12	61	29
	Average 2003	155	25	9	11	62	22

*Treatments (A: 0 ppm PAM, B: 5 ppm PAM, C: 10 ppm PAM, D: 15 ppm PAM, E: 0 ppm PAM+surge, F: 10 ppm PAM+surge).

Table 6. Average runoff water PO_4 (mg/L) for the lettuce field

Year	Treatment

	Block	A	B	C	D	E	F
2003	I	1.72	0.53	0.70	0.66	0.79	0.28
	II	0.94	0.70	0.60	0.63	0.58	0.70
	II	1.01	0.67	0.71	0.56	0.72	0.49
	Average 2003	1.22	0.63	0.67	0.62	0.70	0.49

*Treatments (A: 0 ppm PAM, B: 5 ppm PAM, C: 10 ppm PAM, D: 15 ppm PAM, E: 0 ppm PAM+surge, F: 10 ppm PAM+surge).

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