Upgrading Technology and Infrastructure in a Finance-Challenged Economy

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Preface

The papers included in these Proceedings were presented during the **USCID Water Management Conference**, held March 23-26, 2010, in Sacramento, California. The Theme of the Conference was *Upgrading Technology and Infrastructure in a Finance-Challenged Economy***.** An accompanying book presents abstracts of each paper.

Financing infrastructure and technology, a challenge in normal times, has become even more difficult for irrigation water supply providers as a result of the recent tightening of the credit markets. Irrigation districts, and other water providers, face a continuing need to upgrade technology and infrastructure even in these tight credit markets that complicate financing. Response to droughts, climate change and increased scrutiny of water management practices continues to drive upgrading of irrigation infrastructure and technology.

In response to these challenges, irrigation districts are developing innovative financing and funding solutions. These include developing partnerships with other agencies, applying for grants, loans and other sources of financial assistance, along with consideration of rate increases. Some are entering into agreements to transfer water. Others are agreeing to share facilities. Some districts are utilizing wastewater for irrigation or recharge. Irrigation districts and other agencies are using these and other strategies to maintain and upgrade the services they provide in these challenging financial times.

The papers presented during the Conference technical sessions and poster session focused on these issues. Technical sessions addressed the following topics: Innovative Technologies; Urban/Ag Partnerships; Upgrading Infrastructure; Finance and Economics; Water and Energy Supply/Conservation; and Water Planning.

The authors are professionals from academia; federal, state and local government agencies; international agencies; water and irrigation districts; and the private sector.

USCID and the Conference Chairman express gratitude to the authors, session moderators and participants for their contributions.

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IMPERIAL IRRIGATION DISTRICT IRRIGATION SCHEDULING AND EVENT MANAGEMENT PILOT PROGRAM

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ABSTRACT

The Imperial Irrigation District (IID) administered a pilot program in 2008 and 2009 to test various concepts proposed to fulfill its on-farm water conservation obligations under the Quantification Settlement Agreement. The program was intended to conserve about 1,000 ac-ft of water for payback of IID's Inadvertent Overruns in accordance with the Colorado River Water Delivery Agreement.

Growers were invited to implement irrigation scheduling and event management for six months to conserve water relative to an ET-normalized, crop- and field-specific, historical water use baseline. Participants were required to hire an IID-qualified firm to provide irrigation scheduling and management recommendations, though they were not obligated to implement those recommendations. Upon enrollment, participating growers received a payment to fund a contract with a scheduling firm and to help defray some irrigation management costs. After the contract period, eligible participants received an additional payment based on the volume of water conserved.

The program resulted in water savings of 0.1 – 1.2 ac-ft/ac on most of the 24 enrolled fields, though some fields used more water than their estimated, historical baseline.

BACKGROUND AND OVERVIEW

The Imperial Irrigation District (IID) in southeast California diverts approximately 3.1 million ac-ft of Colorado River water annually to irrigate approximately 475,000 ac of agricultural lands. In 2003, IID entered the Quantification Settlement Agreement and Related Agreements (QSA), agreeing to the transfer of 303,000 ac-ft annually to other Colorado River water users in California through conservation projects aimed at increasing on-farm irrigation efficiency and distribution system efficiency. As a condition of the agreements, at least 130,000 ac-ft must be generated through the implementation of on-farm conservation measures (CMs).

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In 2007, IID completed its Efficiency Conservation Definite Plan (Plan), which identifies the most cost-effective mix of on-farm and system improvements needed to satisfy transfer obligations while keeping expenditures below available transfer revenues. On-farm participants in the transfer program will be provided incentives to implement CMs to achieve conservation goals. The Plan identified numerous CMs that growers are likely to consider. Among those CMs growers expressed interest in implementing were management-based CMs aimed at increasing irrigation efficiency through decreased tailwater production including irrigation scheduling and event management.

In particular, interest was expressed in improving surface irrigation methods through irrigation scheduling and event management. Scientific Irrigation Scheduling (SIS), as evaluated under the Plan, includes decisions made prior to placing irrigation orders for individual fields including the timing, duration, and amount of water aimed at minimizing tailwater production while satisfying crop water requirements. Scientific Event Management (SEM), as evaluated under the Plan, includes decisions made after the start of an irrigation event based on observed advance, infiltration, and runoff aimed at minimizing tailwater production while providing adequate infiltration to meet crop water needs. An emphasis on event design is needed because flexibility in irrigation timing is limited due to cropping practices, particularly for forage crops (alfalfa, Bermuda grass, Sudan grass, etc.).

In 2008, IID implemented the Irrigation Scheduling and Event Management Pilot Program (Program) to test various aspects of the on-farm program including enrollment, verification of conserved water, and conservation potential. In addition to testing various aspects of the longer-term, on-farm efficiency conservation program under consideration by IID, the Program provided growers an opportunity for early implementation of conservation measures.

PROGRAM DESIGN AND IMPLEMENTATION

The Program was implemented between mid-2008 and mid-2009 with fields typically enrolled for a six-month period. As a voluntary program, owners and lessees of eligible fields were invited by IID to participate in the Program through a newspaper advertisement. Interested growers participated in a consultation with IID staff to establish eligibility and to discuss Program details. Those growers ultimately wishing to enter the Program entered into a contract with IID under which they were required to hire a qualified irrigation management consultant to provide recommendations regarding the scheduling, design, and management of irrigation events. Irrigation management consultants were screened for qualifications by IID prior to the start of the Program.

The following eligibility requirements were applied to help achieve water conservation targets, reduce costs, and ease program administration and verification:

- Fields were required to be at least 65 ac
- Where one gate served multiple fields, all fields were required to enroll

Participating growers received payment based on (1) participation in the Program and (2) the amount of water conserved. An initial payment of $4,000 per field was made to reimburse the grower for the cost of hiring an irrigation management consultant. A final payment was made based on the verified conserved water (determined as described below) This payment was intended to provide incentive to conserve water through efficiency improvements and to provide reimbursement for the anticipated increase in on-farm labor and management costs associated with the Program. Fields conserving at least 0.2 ac-ft/ac received a final payment of $45/ac-ft. The final payment was limited to $45/ac (i.e., 1.0 ac-ft/ac) to discourage conservation by deficit irrigation.

Following completion of the Program, both growers and consultants were asked to provide feedback to IID to assist in planning future on-farm efficiency conservation programs.

OUTCOME

Enrolled Fields

Twenty-four surface-irrigated fields representing 2,754 ac were enrolled in the Program. The most commonly enrolled crop was alfalfa (2,076 ac). Other crops included wheat (311 ac), sugar beets (223 ac), and citrus (144 ac).

Perennial crops (alfalfa and citrus) were enrolled for exactly 6 months. Annual crops (wheat and sugar beets) were enrolled for the length of the crop season. Start and end dates for each field are listed in Table 1.

Irrigation Management Consultants

Interested consultants were required to submit qualifications to IID. IID evaluated consultant responses, conducted interviews, and selected approved consultants for the Program. Consultants were evaluated based on their experience, references, qualifications of key individuals, availability of irrigation scheduling software, and availability of key personnel within the Imperial Valley. Two irrigation consultants were selected: JMLord, Inc. of Coachella (www.jmlordinc.com), and Stanworth Crop Consultants, Inc. of Blythe (www.stanworth.net).

The irrigation management consultants were required to provide the following services under the Program:

1. Develop written irrigation recommendations based on a daily root zone water balance, including quantification of crop evapotranspiration (ET) and regular updates based on field observations of soil moisture content.
2. Conduct regular field visits to evaluate soil moisture content, percent ground cover, crop growth stage, and other indicators of crop ET.
3. Evaluate at least one irrigation event based on procedures of the NRCS National Irrigation Guide.

4. Provide a brief post-season report providing observations regarding the extent to which the grower adopted recommendations or otherwise modified practices, physical limitations of the field limiting water conservation potential, and recommendations for broader implementation of improved irrigation management in the District.

Table 1. Enrolled Fields.

Field	Crop	Irrigation Method	Acres	Start Date	End Date
A	Alfalfa	Graded Border	244.8	22-Sep-08	22-Mar-09
B	Alfalfa	Graded Border	73.2	2-Sep-08	31-Dec-08
C	Alfalfa	Graded Border	75.3	2-Sep-08	31-Dec-08
D	Alfalfa	Graded Border	65.5	2-Sep-08	31-Dec-08
E	Alfalfa	Graded Border	143.9	2-Sep-08	31-Dec-08
F	Alfalfa	Graded Border	70	13-Nov-08	13-May-09
G	Alfalfa	Graded Border	75.1	13-Nov-08	13-May-09
H	Alfalfa	Graded Border	73.2	13-Nov-08	13-May-09
I	Alfalfa	Graded Border	72.6	13-Nov-08	13-May-09
J	Alfalfa	Graded Furrow	148	15-Sep-08	15-Mar-09
K	Alfalfa	Graded Furrow	144	15-Sep-08	15-Mar-09
L	Alfalfa	Graded Furrow	145	5-Sep-08	5-Mar-09
M	Alfalfa	Graded Border	127.8	18-Aug-08	18-Feb-09
N	Mixed Citrus	Graded Border	144	21-Aug-08	21-Feb-09
O	Alfalfa	Graded Furrow	89	15-Sep-08	15-Mar-09
P	Alfalfa	Graded Furrow	78	15-Sep-08	15-Mar-09
Q	Wheat	Graded Border	91.5	21-Dec-08	1-Jul-09
R	Sugar Beet	Graded Furrow	71.6	10-Oct-08	31-Jul-09
S	Wheat	Graded Border	78.5	21-Dec-08	25-May-09
T	Wheat	Graded Border	140.5	5-Jan-09	26-May-09
U	Sugar Beet	Graded Furrow	151.3	23-Sep-08	4-May-09
V	Alfalfa	Graded Furrow	210.5	3-Sep-08	3-Mar-09
W	Alfalfa	Graded Furrow	172.1	3-Sep-08	3-Mar-09
X	Alfalfa	Graded Furrow	68.2	3-Sep-08	3-Mar-09

Conserved Water Amounts

Conserved water for each field was calculated by first estimating the historical deliveries for the period of 1998-2005 to the enrolled crop at each field (DW_{hist}) along with the historical crop ET, net of effective precipitation (ET_{hist}). Then, the Payment Benchmark (PB) was determined as the expected deliveries to the enrolled field without conservation in place. The PB was determined based on DW_{hist}, ET_{hist}, and the crop ET net of effective precipitation during the enrollment period ($ET_{current}$) as described in Equation 1.

$$PB = DW_{hist} \frac{ET_{current}}{ET_{hist}} \quad [1]$$

Thus, the Payment Benchmark was determined by normalizing historical deliveries to the field based on differences in crop ET between the historical and current periods.

The actual Delivered Water Reduction (*DWR*), or conserved water amount, was determined as the difference between the PB and the actual deliveries during the enrollment period ($DW_{current}$), as shown in Equation 2.

$$DWR = PB - DW_{current} \quad [2]$$

DW_{hist}, *PB*, $DW_{current}$, and calculated *DWR* for each field are provided in Table 2.

Table 2. Conserved Water Estimates for Enrolled Fields (ac-ft/ac).

Field	Crop	Acres	DW_{hist}	*PB*	$DW_{current}$	*DWR*
A	Alfalfa	244.8	3.2	3.4	4.0	-0.6
B	Alfalfa	73.2	1.5	1.6	1.7	-0.1
C	Alfalfa	75.3	1.5	1.7	1.4	0.3
D	Alfalfa	65.5	1.5	1.6	1.5	0.1
E	Alfalfa	143.9	1.4	1.5	2.1	-0.6
F	Alfalfa	70.0	2.0	2.2	2.6	-0.5
G	Alfalfa	75.1	2.3	2.4	2.5	-0.2
H	Alfalfa	73.2	2.0	2.1	2.7	-0.6
I	Alfalfa	72.6	2.1	2.3	3.9	-1.6
J	Alfalfa	148.0	2.3	2.5	1.9	0.7
K	Alfalfa	144.0	3.1	3.0	2.4	0.6
L	Alfalfa	145.0	2.7	2.9	2.0	0.9
M	Alfalfa	127.8	2.7	2.7	2.9	-0.1
N	Mixed Citrus	144.0	3.4	3.6	2.4	1.2
O	Alfalfa	89.0	2.6	2.8	1.9	0.9
P	Alfalfa	78.0	2.8	2.9	1.8	1.1
Q	Wheat	91.5	4.5	4.5	3.9	0.6
R	Sugar Beet	71.6	6.3	9.2	8.4	0.8
S	Wheat	78.5	2.9	3.5	3.5	-0.1
T	Wheat	140.5	2.5	2.9	2.4	0.5
U	Sugar Beet	151.3	5.2	3.8	3.6	0.2
V	Alfalfa	210.5	2.7	2.9	2.3	0.6
W	Alfalfa	172.1	2.5	2.8	2.2	0.6
X	Alfalfa	68.2	2.6	2.9	2.7	0.1

As indicated in Table 2, water savings occurred on 15 of the 24 fields, ranging from 0.1 to 1.2 ac-ft/ac. The area-weighted average of those positive *DWR* values was 0.6 ac-ft/ac and total volumetric savings were 1,133 ac-ft.

The delivered water during the enrollment period was more than the estimated Payment Benchmark for 9 of the 24 fields. An increase in water deliveries to some fields was not unexpected because it is recognized that some fields have historically been deficit irrigated using customary methods of irrigation scheduling. Thus, when using scientific irrigation scheduling, increased water deliveries relative to a historical benchmark may indicate a history of deficit irrigation. On such fields, increased deliveries do not necessarily correspond to decreased irrigation efficiency.

Grower and Consultant Observations

As part of their contract with IID, Growers agreed to participate in a post-season interview. They also agreed to require in their contracts with consultants that consultants provide IID with brief reports during and following the conservation period.

Most growers agreed that they would like to participate in similar future programs and recommended that any future program be timed to allow enrollment of a broader range of crops. Similarly, several growers recommended that the conservation period should be no less than one year to provide a more representative study of perennial crops.

Growers who conserved water under the Program as well as those who did not commented that they changed their irrigation practices as a result of participation. One grower said, “I bought a soil probe to better monitor penetration problems.” Another commented, “We now irrigate our alfalfa less frequently.”

As anticipated, hay cutting schedules proved to be a significant constraint to irrigation timing. As a result, consultants focused on adjusting event design parameters. One consultant remarked, “We improved uniformity by modifying the shutoff time.” Another consultant helped a grower improve distribution uniformity on a sandy, border-irrigated field. He said, “The recommendation was to increase the flow rate on the set in order to move the water more quickly along to the end of the set and thus overcome the higher soil intake rate.” Both consultants noted that growers were very cooperative and eager to make changes that seemed practical for their operations.

DISCUSSION AND CONCLUSIONS

In addition to demonstrating advantages and disadvantages of irrigation scheduling and event management as a conservation measure, the Program provided useful insight about the solicitation and contracting processes, eligibility requirements, grower preferences, baseline estimation, conservation verification, and other aspects of implementing on-farm conservation programs. IID anticipates that future on-farm conservation programs will incorporate irrigation scheduling and event management either as a stand-alone measure or in combination with other conservation measures.