2004 WATER USE EFFICIENCY PROPOSAL

APPENDIX A: Project Information Form

Applying for: ☐ Urban ☒ Agricultural

1. (Section A) **Urban or Agricultural Water Use Efficiency Implementation Project**
   - ☐ (a) implementation of Urban Best Management Practice, #__________________________
   - ☐ (b) implementation of Agricultural Efficient Water Management Practice, #_______________
   - ☐ (c) implementation of other projects to meet California Bay-Delta Program objectives, Targeted Benefit # or Quantifiable Objective #, if applicable _______________
   - ☐ (d) Specify other: _________________

2. (Section B) **Urban or Agricultural Research and Development; Feasibility Studies, Pilot, or Demonstration Projects; Training, Education or Public Information; Technical Assistance**
   - ☒ (e) research and development, feasibility studies, pilot, or demonstration projects
   - ☐ (f) training, education or public information programs with statewide application
   - ☐ (g) technical assistance
   - ☐ (h) other

3. Principal applicant (Organization or affiliation): University of California, Davis

4. Project Title: Water Use Efficiency in Sacramento Valley Rice Cultivation

5. Person authorized to sign and submit proposal and contract:

Name, Title	René Domino Contract and Grant Analyst
Mailing Address	Office of the Vice Chancellor for Research, Sponsored Programs, 118 Everson Hall, One Shields Ave Davis, CA 95616
Telephone	530-752-3764
E-mail	rhdomino@ucdavis.edu

6. Contact person (if different):	Name, title.	James E. Hill Extension Agronomist
	Mailing address.	Agronomy & Range Science UC Davis One Shields Ave Davis, CA 95616
	Telephone E-mail	(530) 752-3458 jehill@ucdavis.edu

7. Grant funds requested (dollar amount): $681,294

(from Table C-1, column VI)

8. Applicant funds pledged (dollar amount): $58,508

9.Total project costs (dollar amount): $739,802
(from Table C-1, column IV, row n)

10. Percent of State share requested (%) 92%
(from Table C-1)

11. Percent of local share as match (%) 8%
(from Table C-1)

12. Is your project locally cost effective?

Locally cost effective means that the benefits to an entity (in dollar terms) of implementing a program exceed the costs of that program within the boundaries of that entity.
(If yes, provide information that the project in addition to Bay-Delta benefit meets one of the following conditions: broad transferable benefits, overcome implementation barriers, or accelerate implementation.)

☐ (a) yes
☒ (b) no

11. Is your project required by regulation, law or contract?
If no, your project is eligible.
If yes, your project may be eligible only if there will be accelerated implementation to fulfill a future requirement and is not currently required.
Provide a description of the regulation, law or contract and an explanation of why the project is not currently required.

☐ (a) yes
☒ (b) no

12. Duration of project (month/year to month/year): 1/2006 to 1/2009

13. State Assembly District where the project is to be conducted: 08

14. State Senate District where the project is to be conducted: 05

15. Congressional district(s) where the project is to be conducted: 01

16. County where the project is to be conducted: Yolo

17. Location of project (longitude and latitude): 121º 44’ W
38º 33’ N

18. How many service connections in your service area (urban): NA

19. How many acre-feet of water per year does your agency serve:
Rice ac-ft = approximately 2-2.5 million in the Sacramento Valley

20. Type of applicant (select one):

- ❑ (a) City
- ❑ (b) County
- ❑ (c) City and County
- ❑ (d) Joint Powers Authority
- ❑ (e) Public Water District
- ❑ (f) Tribe
- ❑ (g) Non Profit Organization
- ☒ (h) University, College
- ❑ (i) State Agency
- ❑ (j) Federal Agency
- ❑ (k) Other
  - ❑ (i) Investor-Owned Utility
  - ❑ (ii) Incorporated Mutual Water Co.
  - ❑ (iii) Specify ____________________

21. Is applicant a disadvantaged community? If ‘yes’ include annual median household income.
(Provide supporting documentation.)

- ❑ (a) yes, ______median household income
- ☒ (b) no

2004 Water Use Efficiency Proposal Solicitation Package
APPENDIX B: Signature Page

By signing below, the official declares the following:

The truthfulness of all representations in the proposal;

The individual signing the form has the legal authority to submit the proposal on behalf of the applicant;

There is no pending litigation that may impact the financial condition of the applicant or its ability to complete the proposed project;

The individual signing the form read and understood the conflict of interest and confidentiality section and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant;

The applicant will comply with all terms and conditions identified in this PSP if selected for funding; and

The applicant has legal authority to enter into a contract with the State.

____________________	______________________________	________
Signature	Name and title	Date

STATEMENT OF WORK: SECTION ONE: RELEVANCE & IMPORTANCE

Contributions toward California Bay-Delta Program Goals

Over one-half million acres of irrigated rice are grown annually in the Sacramento Valley above the Delta. The crop is near or at the top of farm gate value in nearly all the eight counties in which it is produced and thus is highly important to the livelihoods of rural communities in the Valley. Most of the rice irrigation water is surface run-off from the Sierra Nevada, Cascade, and Klamath mountains supplied by the federal Central Valley Project, the State Water Project and local water surface projects. Less than 10% of the irrigation water is from groundwater sources (Hill et al., 1992). Water demands in rice cultivation are continually adjusting to changes in pesticide regulations, straw decomposition practices, water market prices and transfers, and the weather. Additionally, competing domestic, industrial, and environmental water demands are steadily increasing.

Careful water management is critical to successful rice cultivation. Besides the basic evapotranspiration requirements, California rice farmers require water for many cultural uses such as in flooding for aerial seeding, air temperature regulation for protection against spikelet sterility, weed suppression, draining and reflooding for pesticide applications, nutrient control, salinity management, post-harvest straw decomposition, and waterfowl habitat (Williams, 2003). General straw disposal methods include soil incorporation by conventional tillage and by winter flooding and wet rolling. Winter flooding is particularly important providing over 250 thousand acres as wetland habitat for over-wintering waterfowl in the Pacific Flyway. Waterfowl use of winter-flooded rice fields is one of the most successful couplings of farming and environmental stewardship (Bird et al., 2000; Ormerod and Watkinson, 2000). With the mandatory reduction of post-harvest straw burning, growers began winter-flooding fields to promote straw decomposition. While these flooded fields provide critical habitat to waterfowl in the Pacific Flyway, there is increasing evidence that waterfowl foraging increases straw decomposition (Bird et al., 2000). Another issue is that rice seeding is gradually changing in response to herbicide resistant weeds and rising costs, from conventional water seeding to various forms of dry seeding. Dry seeding may avoid certain aquatic pests and allow the use of unique weed control methods. These systems require different water management and fertilizer methods compared to water seeding. Dry seeding practices have not been evaluated with respect to water requirements in California rice.

While much research has been done on water quality in rice fields and agricultural drains (Orlando and Kuivila, 2004), less information is known concerning the quantities of water used in California rice cultivation. California's Department of Water Resources (CDWR) estimates the annual average amount of applied water for California rice cultivation ranges from 4.3 to 6.9 acre feet (California Department of Water Resources, 1998), and CDWR estimates evapotranspiration in California rice cultivation ranges from 3.0 to 3.8 acre feet (California Department of Water Resources, 1998). However, there are no estimates that describe the amount of water used for each stage of conventional and alternative cultural rice practices (seeding, weed control, temperature control, straw decomposition, and waterfowl habitat). Updated information should be collected on actual inflows and outflows of water in current cultivation practices at the field level. As alternative seeding practices are becoming more common, crop water use (ET_c) of drill and flood planted rice should also be compared. Using pre-existing data the spatial variability and quantities of water usage for each cultivation practice should be estimated throughout California's rice-growing regions.

Goals & Objectives of Project

Objective 1: *Comparing Crop Water Use (ET_c) of Drill and Flood Planted Rice (Snyder)*

Rice in California has traditionally been water-seeded into a continuously flooded field. Since the mid 1990s, rice irrigation has changed due to increased dry seeding and midseason draining for herbicide applications. The first objective of this project is to study evapotranspiration (ET_c) from rice where (1) the rice is planted into standing water, (2) the rice is drill seeded into tilled soil, flushed, and later permanently flooded, and (3) the rice is drill seeded into no-tilled soil, flushed, and later flooded. The purpose of the experiment is to quantify differences in crop water use between treatments and to develop and refine crop coefficients. In part, this is an expansion of an earlier project funded by the California Rice Research Board to measure rice ET_c conducted during 2000 and 2001, but only in continuously flooded rice. In that project, we found that the rice crop coefficient (K_c) values were lower than those commonly used to estimate rice ET_c during the midseason and were higher than expected during early growth (as the canopy developed). We discovered that there was a high correlation between the ET_c and available energy (net radiation minus heat storage) on both an hourly and a daily time scale. Net radiation, which is the main source of energy for evaporation, decreased as the canopy developed and reflected sunlight from the water surface. As a result, the energy available for evaporation decreased as the canopy grew. However, more than two years of data are needed to confirm this theory. In addition, it is likely that net radiation will be lower over a non-flooded dry seeded field. Dry seeded canopies, however, develop slowly, thus net radiation may be higher for the period following the permanent flood until canopy cover catches up with water-seeded rice. Research is needed to determine the impact of this irrigation strategy on seasonal rice evapotranspiration.

Rice culture is changing from what was once nearly all water seeding into continuously flooded fields to rotations with dry seeding—either broadcast or drilled. Our goal in this proposed project is to monitor ET_c in these different forms of rice planting, including minimum tillage. Because of lower net radiation and less water on the surface to evaporate, it is believed that planting into a field without permanent flooding may reduce ET_c. We also hope to develop the K_c values for dry seeded rice and to further investigate the relationship between water temperature fluctuations and K_c values in a warmer and more typical rice growing area.

Objective 2: *Spatial Modeling of Cultural Water (Plant)*

We propose to develop a spatial model to quantify the amount of water used throughout the year at each stage of California rice production. The model will be based on partitioning measured inflows (precipitation and applied water) and outflows (evapotranspiration, run-off, and percolation) for the region. Water-use in specific cultural practices will then be estimated using secondary information such as tailwater reuse, draining and reflooding for pesticide applications, winter flooding, and temperature data. The study will be limited to the Glenn-Colusa Irrigation District (GCID) where the data needed for the model already exists, such as evapotranspiration models, land-use layers, and pesticide usage. Most of the spatial data sources have been previously collected at various scales of resolution and geographic extent by GCID. This study will explore how to incorporate multi-scale data into a water-use model. The study will also explore how the model can be then interpreted at multiple scales (Bierkens et al., 2000). Once the spatial model is built, it will be used to compare estimated water usage in conventional California rice cultivation practices in continuously flooded rice, with estimated water usage in alternative rice cultivation practices, such as dry seeding. Finally the study will explore how the multi-scale results may be applied to improve water use within regional water districts, local farms and at larger scales.

The spatial model will describe how water for rice culture is used at multiple scales in California rice cultivation. In building the model we will explore how the water data sets are collected at different scales and combined into a spatial model. We will determine how the spatial water model will be applied to multiple scales. We will determine how much cultural water typical California rice cultivation practices use across the region. Using the model we will determine how much water alternative rice cultivation practices would use. The results of the spatial model will be compared to other estimates of water use.

Objective 3: *Comparison of infield water use under different crop establishment systems*
Water use in any specific rice field is the sum of crop ET, percolation and runoff. Percolation rates are soil dependent and generally low because of the heavy clay soils on which rice is produced. Water flow through can be highly variable depending on the method of stand establishment, pesticide use requirements (drain or no drain), reflooding, equipment use (particularly ground application equipment use) and other cultural factors. Little is known about total in-field water use under different crop establishment methods. We propose to evaluate water use in conventional continuously flooded water-seeded fields, dry-seeded fields and minimum tillage delayed stale seedbed fields. Little information exists on water use in the latter two methods which are increasing in importance due to the need to use alternative seeding methods to combat weeds. We will monitor inflows and outflows in replicated basins and in commercial rice fields to better understand water use and how it might be improved under each of these cultural methods.

STATEMENT OF WORK: SECTION TWO: MERIT & FEASIBILITY

Experimental Procedure to Accomplish Objectives

Objective 1. *Comparing Crop Water Use (ET_c) of Drill and Flood Planted Rice*
Crop evapotranspiration (ET_c) is often approximated as the product of reference evapotranspiration (ET_o) and a crop coefficient (K_c) factor. Reference evapotranspiration, which approximates the evapotranspiration of an irrigated pasture, is intended to account for variations in weather and the K_c factor accounts for biological, ecophysiological, and agronomic differences between the crop and the reference evapotranspiration. The K_c factor is determined as the ratio ET_c/ET_o using simultaneous measurements or estimates of ET_o and measured ET_c. While ET_o is commonly estimated using one of several equations available in the literature and weather variables measured over an extensive, irrigated grass surface, ET_c is measured using a lysimeter or with micrometeorological methods.

In this proposed research, we will measure ET_c using the surface renewal method. The method has been thoroughly described in Paw U and Brunet (1991), Paw U et al. (1995), Snyder et al. (1996), and Spano et al. (1997). Then we will estimate K_c values for rice using ET_o estimated from a nearby CIMIS station. The experiment will be conducted in the Sacramento Valley. The SR weather station will be set up in a rice check to measure all of the parameters needed to estimate ET_c. An eddy covariance system will be used to calibrate the SR method on occasion. In this experiment we will replicate measurements over three rice paddies to make same-day comparisons between the planting treatments. One of the weather stations was purchased for use in the 2000 and 2001 experiments. Two more stations are needed to collect data over the plantings drilled into till and no-till treatments.

Objective 2. *Spatial Modeling of Cultural Water*
The goal of this water-use model is to spatially assess how much water is used in each stage of rice cultivation including water used for cultural practices such as aerial seeding, temperature regulation, and weed suppression.

The model will estimate water-use based on pre-existing spatial data in a Geographic Information System (ArcGIS). Inflows, such as precipitation, irrigation, and recaptured water, will be estimated using precipitation data, GCID Sacramento River Diversion records, GCID turnout water level record, and GCID recapture records. Outflows, such as evapotranspiration, run-off, and percolation, will be estimated from GCID's Sacramento River return records, CDWR's model of evapotranspiration of rice (ETc), and a soil model. Based on the concept of conservation of matter, the model is based on the property that water is conserved throughout the system. The amount of water input to the system, primarily precipitation and Sacramento River diversions, must be accounted for throughout the model. The model should have no detectable differences between inflow and outflow water quantities.

Within the system, water used for the following cultural practices will be calculated: flooding for seeding, draining for pesticide application and reflooding, temperature control to prevent floret sterility, and winter flooding for straw decomposition and waterfowl habitat. Field-level water use for some cultural practices, including initial flooding for seeding and winter flooding, have been preliminarily estimated throughout the year based on previous reports (Hill et al., 1992; Williams, 2003). Water use for pesticide regimes will be predicted using Glenn and Colusa County Agriculture Commission records of the timing for chemical applications. Most of the pesticides have recommended water levels during application, and these will be used to extrapolate how much water was used for each chemical application. Water use for conventional flow-through tailwater management will be extrapolated from previous field level studies on the water usage of tailwater system during the 1990's. The results of the water-use model will be interpreted at the field, farm, regional, and district-level scales.

A goal of this project is to estimate the amount of water used in cultural practices during rice cultivation based on preexisting spatial data sets. Given that these data sets were collected by different researchers at many different spatiotemporal scales and that the results of the model will be interpreted at multiple scales, the spatial model for this project must account for issues of scale. We will investigate each step of the model building process in terms of scale. Each step involved in upscaling and downscaling and the effect of scaling manipulations on the results and interpretation of the model will be examined. Integration of data from multiple sources including methods of aggregating data, such as averaging and interpolation, and methods of disaggregation, such as introducing stochastic variability will be investigated (Bierkens et al., 2000). The appropriate scale for field, farm, regional, and district evaluation of the model will be determined. It will also be determined if the model has the same form at multiple scales (Bierkens et al., 2000). Through such careful examination the multiple data layers will be appropriately scaled for analysis. For example, in district level analysis some data layers will need to be upscaled: precipitation, temperature, and evapotranspiration data may be interpolated. For district level of analysis the soil layer may need to be downscaled by introducing stochastic variability. The model's estimates will be compared to the total inflow and outflows of the Glenn-Colusa Irrigation Canal (GCID, 2003), and the model should account for all amounts of water reported by the GCID. Additionally, the proposed modeling effort will augment on going efforts by DWR (personal communication, Tito Cervantes, DWR, Red Bluff) to quantify the consumptive use of water by agriculture in the Sacramento Valley. Project results can potential refine estimates generated by DWR's Agriculture Water Use Model. The collaboration will also provide a meaningful comparison between west side (GCID - UC) and east side water use (Western Canal – DWR) in rice farming systems.

The model will be modified to evaluate the water usage of alternative practices across space, time, and scale. Several of these alternative practices will be explored including dry seeding, dry straw incorporation, straw baling, and alternative tailwater management systems. To evaluate if dryland seeding uses more or less water than conventional water seeding the model will account for decreased water use during seeding, but the model will also demonstrate changes in water use due to alterations in pesticide and fertilizer use. The model will also explore water usage in alternative straw practices such as straw baling and dry straw incorporation. Alternative tailwater management systems that may be explored include re-circulating tailwater recovery, static water irrigation, and gravity tailwater recapture irrigation systems (Hill et al., 1991).

Objective 3. . *Comparison of infield water use under different crop establishment systems.*
We will monitor in-field water use in six commercial rice fields and at an experimental site at the California Rice Experiment Station (RES). The field sites will be selected on the basis of management practices so that we can compare 1) dry seeded with continuously flooded rice and 2) winter flooded (for waterfowl habitat) with non-winter flooded rice. The experimental sites at the RES will compare water use in water seeded (continuously flooded) vs. dry seeding and delayed stale seedbed minimum tillage seeding. The experimental site is outfitted with independent inflow and outlow in 0.6 acre basins replicated four times. Inflow will be measured with inline McCrometers (8" at the exp site and as appropriate for field sites) and outflow will be measured by "V" notch weirs coupled to pressure transducers to determine water height over the weir. These systems will be automated for continuous water inflow and outflow measurements. Field percolation rates will be determined by the difference of inflow and outlow less Et.

Project Plan

Year 1 – 2006-2007

Task 1. Comparing Crop Water Use (ET_c) of Drill and Flood Planted Rice

Sub-Task 1.1. Collect Et Data

Month of initiation: 4/06

Month of completion: 10/06

Description of Task: Install, calibrate Et measuring equipment and collect data throughout the rice growing season

Funds: $49,734 Jr. Specialist
$55,590 Et equipment
$1,500 travel

Sub-Task 1.2 Analyze and report data

Month of initiation: 7-12/06

Month of completion: 1/07

Description of Task: Download and analyze data. Summarize and write reports and present information to various groups of interest.

Funds: See Jr. Specialist Salary and Benefits from task 1.1 above
$15,418 Program Rep to prepare reports, work with advisory groups, prepare presentations, plan conference and outreach activities.

Task 2. Spatial Modeling of Cultural Water

Sub-Task 2.1. Collect Spatial Data

Month of initiation: 1/06

Month of completion: 1/07

Description of Task: Determine data needed for model and availability of pre-existing data. Have GSR initiate contact with appropriate agencies and researchers. Collect pre-existing spatial data from Glenn-Colusa Irrigation District, UC Cooperative Extension, County Agricultural Commissioners, etc.

Funds: $5000 for travel (100 trips x $50 per trip)
$22503 for GSR III Salary and Benefits
$7804.92 (matching funds) for Richard Plant's partial Salary and Benefits

Sub-Task 2.2 Develop Spatial Model

Month of initiation: 1/06

Month of completion: 1/07

Description of Task: Develop spatial model of cultural water-use in rice cultivation for Glenn-Colusa Irrigation District using a geographic information system (GIS) and other spatial modeling software.

Funds: $4000 for computer and software
See Task 2.1 for GSR III Salary and Benefits
See Task 2.1 for Richard Plant's Salary and Benefits

Sub-Task 2.3 Report Initial Findings

Month of initiation: 1/06

Month of completion: 1/07

Description of Task: Report on initial data collection and model results. Identify problems with model and solutions. Participate in workshops and conferences.

Funds: See Task 2.1 for Travel Funds
See Task 2.1 for GSR III Salary and Benefits
See Task 2.2 for Computer and Software
See Task 2.1 for Richard Plant's Salary and Benefits

Task 3. Measuring Actual In-Field Water Use

Sub-Task 3.1. Collect in-field water use
Month of initiation: 1/06
Month of completion: 12/06
Description of Task: Maintain "V" notch weirs, stilling wells, pressure tranduces and in-line flow meters in fields and at the rice experiment station site for year around monitoring to collect data for both seasonal use and winter flooding.

Funds: $21,917 Jr. Specialist (0.5)
$51,750 water measuring equipment (micrometers, v notch weirs, data loggers)
$5,000 travel

Sub-Task 3.2 Analyze and report data
Month of initiation: 3-12/06
Month of completion: 1/07
Description of Task: Download and analyze data. Summarize and write reports and present information to various groups of interest.

Funds: See Jr. Specialist Salary and Benefits from task 3.1 above
$15,418 Program Rep to prepare reports, work with advisory groups, prepare presentations, plan conference and outreach activities.

<u>Year 2 – 2007-2008</u>

Task 4. Comparing Crop Water Use (ET_c) of Drill and Flood Planted Rice

Sub-Task 4.1. Collect Et Data
Month of initiation: 4/07
Month of completion: 10/07
Description of Task: Install, calibrate Et measuring equipment and collect data throughout the rice growing season

Funds: $49,734 Jr. Specialist
$55,590 Et equipment
$1,500 travel

Sub-Task 4.2 Analyze and report data
Month of initiation: 7-12/07
Month of completion: 1/08
Description of Task: Download and analyze data. Summarize and write reports and present information to various groups of interest.

Funds: See Jr. Specialist Salary and Benefits from task 1.1 above
$15,418 Program Rep to prepare reports, work with advisory groups, prepare presentations, plan conference and outreach activities.

Task 5. Spatial Modeling of Cultural Water

Sub-Task 5.1. Collect Spatial Data
Month of initiation: 1/07
Month of completion: 1/08
Description of Task: See Sub-Task 2.1
Funds: $5000 for travel (100 trips x $50 per trip)
$23628 for GSR III Salary and Benefits
$8195.16 (matching funds) for Richard Plant's partial Salary and Benefits

Sub-Task 5.2 Develop Spatial Model
Month of initiation: 1/07
Month of completion: 1/08
Description of Task: See Sub-Task 2.2
Funds: See Task 5.1 for GSR III Salary and Benefits
See Task 5.1 for Richard Plant's Salary and Benefits

Sub-Task 5.3 Report Initial Findings
Month of initiation: 1/07
Month of completion: 1/08
Description of Task: See Sub-Task 2.3
Funds: See Task 5.1 for Travel Funds
See Task 5.1 for GSR III Salary and Benefits
See Task 5.1 for Richard Plant's Salary and Benefits

Task 6. Measuring Actual In-Field Water Use

Sub-Task 6.1. Collect in-field water use
Month of initiation: 1/07
Month of completion: 12/07
Description of Task: Maintain "V" notch weirs, stilling wells, pressure tranduces and in-line flow meters in fields and at the rice experiment station site for year around monitoring to collect data for both seasonal use and winter flooding.
Funds: $21,917 Jr. Specialist (0.5)
$51,750 water measuring equipment (micrometers, v notch weirs, data loggers)
$5,000 travel

Sub-Task 6.2 Analyze and report data
Month of initiation: 3-12/07
Month of completion: 1/08
Description of Task: Download and analyze data. Summarize and write reports and present information to various groups of interest.
Funds: See Jr. Specialist Salary and Benefits from task 3.1 above
$15,418 Program Rep to prepare reports, work with advisory groups, prepare presentations, plan conference and outreach activities.

Year 3 – 2008-2009

Task 7. Comparing Crop Water Use (ET_c) of Drill and Flood Planted Rice

Sub-Task 7.1. Collect Et Data
Month of initiation: 4/08
Month of completion: 10/08
Description of Task: Install, calibrate Et measuring equipment and collect data throughout the rice growing season
Funds: $49,734 Jr. Specialist
$55,590 Et equipment
$1,500 travel

Sub-Task 7.2 Analyze and report data
Month of initiation: 7-12/08
Month of completion: 1/09
Description of Task: Download and analyze data. Summarize and write final report and present information to various groups of interest. Write and distribute extension and outreach publications with recommendations for water and irrigation management in rice.
Funds: See Jr. Specialist Salary and Benefits from task 1.1 above
$15,418 Program Rep to prepare reports, work with advisory groups, prepare presentations, plan conference and outreach activities.

Task 8. Spatial Modeling of Cultural Water

Sub-Task 8.1. Collect Spatial Data
Month of initiation: 1/08
Month of completion: 1/09
Description of Task: See Sub-Task 2.1
Funds: $5000 for travel (100 trips x $50 per trip)
$24810 for GSR III Salary and Benefits
$8604.92 (matching funds) for Richard Plant's partial Salary and Benefits

Sub-Task 8.2 Develop Spatial Model
Month of initiation: 1/08
Month of completion: 1/09
Description of Task: See Sub-Task 2.2
Funds: See Task 8.1 for GSR III Salary and Benefits
See Task 8.1 for Richard Plant's Salary and Benefits

Sub-Task 8.3 Report Initial Findings
Month of initiation: 1/08
Month of completion: 1/09
Description of Task: See Sub-Task 2.3
Funds: See Task 8.1 for Travel Funds
See Task 8.1 for GSR III Salary and Benefits
See Task 8.1 for Richard Plant's Salary and Benefits

Task 9. Measuring Actual In-Field Water Use

Sub-Task 3.1. Collect in-field water use

Month of initiation: 1/08

Month of completion: 12/08

Description of Task: Maintain "V" notch weirs, stilling wells, pressure transducers and in-line flow meters in fields and at the rice experiment station site for year around monitoring to collect data for both seasonal use and winter flooding.

Funds: $21,917 Jr. Specialist (0.5)
$51,750 water measuring equipment (micrometers, v notch weirs, data loggers)
$5,000 travel

Sub-Task 3.2 Analyze and report data

Month of initiation: 3-12/08

Month of completion: 1/09

Description of Task: Download and analyze data. Summarize and write final reports and present information to various groups of interest.

Funds: See Jr. Specialist Salary and Benefits from task 3.1 above
$15,418 Program Rep to prepare reports, work with advisory groups, prepare presentations, plan conference and outreach activities.

Environmental Documentation

This is not a "project" as defined by CEQA.

Disadvantaged Community

We are not a disadvantaged community.

STATEMENT OF WORK: SECTION THREE: MONITORING & ASSESSMENT

This research project is intended to improve the understanding of water use in Sacramento Valley rice production. It will build on previous studies conducted by researchers at the California Department of Water Resources and the University of California. The overall objectives of this study are twofold. The first is to develop an accurate estimate of water use, both overall and broken down by cultural practice, and incorporate this into a spatial database. The second objective is to carry out experiments comparing water use between conventional flood seeding and a proposed alternative practice, drill seeding, that is likely to be adopted in the future.

The initial baseline data will be collected in cooperation with the GCID and the Department of Water Resources. Internal comparisons will be made where possible of the consistency of values of quantities calculated from more than data source. In addition, the model will be cross validated by the standard practice of comparing known values of data with values of the same quantity calculated from the model with the data value excluded. Experimental data collected as a part of the second overall objective will be internally assessed using standard experimental techniques. In addition, the data will be used to predict quantities whose values have been measured independently, permitting a validation of the model and a test of the data quality.

Crop Water Use in Drill and Flood Seeding
Crop water use as measured by ET_c will be estimated for conventional flooded seeding and alternative drill seeding. The spatial model will be built using high quality pre-existing spatial data sets and compare water-use in conventional and alternative practices. The field results of the ET_c estimates and the field measurements will be scaled-up and compared with the spatial model.

Crop water use will also be compared in drill and flood seeded systems using direct measurements in a set of replicated trials. This will provide two means of comparing water use in these systems, and measurements made through these two methods will be compared for internal consistency.

Spatial Modeling of Cultural Water Use
The spatial model will be assessed by comparison with the GCID water records. The model's estimates will be compared to the total inflow and outflows of the Glenn-Colusa Irrigation Canal (GCID, 2003), and the model should account for all amounts of water reported by the GCID. Additionally, an error budget may be developed for all of the various data layers.

Dissemination of Results
Information developed from this project will be shared freely with collaborators in the GCID and Department of Water Resources. It will be distributed to a wider audience through field meetings, field days, workshops, publications and other media—both through the University of California Cooperative Extension system and the California Rice Commission (the rice producer organization). Information will be disseminated at these meetings regularly throughout the duration of the project. The results will be reported on the UCCE rice website through and in the

regional newsletter “UC Rice Research Quarterly.” We will develop practical publications for wide distribution. Costs for monitoring, evaluating, and distributing the results are built into the initial equipment purchase and salary requests.

QUALIFICATION OF THE APPLICANTS AND COOPERATORS

Project Managers (For Resumes See End Attachments)

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External Cooperators

1. Tito Cervantes, Chief, Land and Water Use Section, Northern District, California Department of Water Resources. 530-529-7389. (See attached letter of support).

2. Rice Farmers

3. Rice Irrigation Districts (such as GCID and Western Canal)

Participation in Previous Water Use Efficiency Grants

1. Dr. Hill has held previous grants related to water quality in rice that also had components of WUE. From 1992-1998 he was PI on a USDA Water Quality Demonstration Project for rice in California as well as holding an EPA/Water Quality S-319 Nonpoint Source Pollution grant supplemental to the demonstration project. Currently he is in the final stages of contract preparation on a CALFED water quality Prop 50 grant in rice. Although these grants are for water quality research and education, water irrigation and management is inextricably related.

2. Dr. Snyder was the principle investigator on the California Irrigation Management Information System project, which was funded by DWR for $3.5 million to develop the CIMIS weather network to provide ET information to California.

3. Dr. Hanson recently has been involved in a CALFED grant investigating differences in crop evapotranspiration between furrow and drip irrigation of processing tomatoes. At the same time, he was involved in a grant from the Bureau of Reclamation/Westlands Water District to determine the feasibility in using drip irrigation for processing tomato production in salt-affected soil. He was also involved in a USDA grant to demonstrate several approaches for reducing surface runoff from rice fields in the Sacramento Valley. He also received grants from the USDA and the California Energy Commission to develop a series of manuals on irrigation water management.

4. Dr. Mutters has conducted research on water use efficiency at the plant and system levels. From 1988 to 1990 in a USDA and USAID sponsored project, he investigated genotypic and drought induced differences in carbon isotope discrimination and associated variance in gas exchange characteristics. As part of a US-EPA funded field based project, he studied system level water use efficiency and photosynthetic response of selected crops grown under continually elevated atmospheric carbon dioxide.

OUTREACH, COMMUNITY INVOLVEMENT, AND ACCEPTANCE

Industry representatives have already shown interest and support for this work, and we expect that the industry as well as water agency personnel will cooperate in the development of educational materials and in their dissemination. Once a consensus has been developed about management practices, we will expedite the diffusion of this information through several important rice grower meetings—the Annual Rice Field Day at the Rice Experiment Station, Biggs, and the UCCE Winter Grower Meetings, attended by more than 500 rice farmers and industry representatives. We will expand our UCCE rice website to include these materials and through our regional newsletter “UC Rice Research Quarterly.” We will develop practical publications for wide distribution. In previous water quality programs to reduce outflows of pesticides from ricefield tailwaters, three publications (Hill et al., 1982; Hill et al., 1991; and Roberts et al., 1998) coauthored by UC and agency people were “required reading” in the pesticide permitting program of the county Agricultural Commissioners’ Offices, demonstrating the educational value of our outreach and education programs which were very influential in the adoption of new water management practices by rice farmers. We propose to develop publications as needed in this project to achieve similar high adoption rates.

INNOVATION

The sustainability of rice production in the Sacramento Valley depends not only on seasonal crop use but winter flooding for straw decomposition and conjunctive use of rice fields and water for environmental enhancement. A comprehensive assessment of water used in rice integrating seasonal crop use (Et), single field crop and winter use (runoff and percolation) with a regional analysis using spatial tools now available has not been done. This project will provide a much improved analysis of the total water requirements for rice which include both crop productivity and public good. The model developed from this project will allow estimations across scales and should be easily extrapolated to rice areas not specifically studied within the project.

BENEFITS AND COSTS

Labor Costs (Salaries & Fringe Benefits)

Over the three years of the project a Graduate Student Researcher (GSR) will develop the spatial model of cultural water and analyze the results of the model ($96,160 – salary, fringe benefits, and UC fees). A full-time Junior Specialist will collect and analysis data on crop water use (ET_c) of drill and flood planted rice ($173,747 – salary and fringe benefits). A part-time Junior Specialist will collect and analysis data on in-field water use ($64,423 – salary and fringe benefits). A part-time Program Representative will administer the project ($65,128 – salary and fringe benefits). Partial salaries and benefits of Jim Hill and Richard Plant will be paid with matching funds ($46,806 – matching funds for partial salary and benefits).

Equipment & Supply Costs

To develop the spatial model of cultural water we will need to purchase a computer and software ($4,000). To collect the crop water use (ET_c) data we will need to purchase three Surface Renewal Stations ($15,687), an Eddy Covariance Station ($35,403), and spare parts ($4,500). To measure in-field water use we will need to purchase fifteen 8” McCrometers ($12,900), 27 V Notch Weirs ($4,050), 27 data loggers ($27,000), and other miscellaneous spare parts ($7,800).

Travel Costs

Over the three years of the project funds are needed to travel from UC Davis to various field sites in the Sacramento Valley, including Glenn-Colusa Irrigation District Offices in Willow, California and the Rice Experiment Station in Biggs, California. To disseminate the information funds are also need to travel to conferences and workshops ($34,500).

Benefits of Project

Rice production requires approximately 2 to 2.5 million ac ft of water in the Sacramento Valley. Additionally, perhaps 150,000 ac ft are used in the winter flooding for the enhancement of waterfowl habitat. At the upper end of irrigation systems water may be diverted more or less directly into rice fields. However, the outflows from rice fields are collected in agricultural drains and may be reused several times as water flows serially through the Sacramento Valley where it is eventually returned to the Sacramento River system. While rice water use has been estimated from irrigation district records and field measurements, there has not been a comprehensive study to 1) evaluate water use at spatial scales and 2) to evaluate water requirements under changing cultural practices. The benefits of this work will be to establish and model rice water use at the regional scale as well as at the field level. From this work we will be able to look for efficiencies in water use at both scales. Additionally, water use for environmental enhancement from the practice of winter flooding has not been accurately measured. The results of this work will provide the tools needed to determine whether or not water may be used more efficiently, how much water savings, if any, might be achieved, how stream flows might be improved as a result, and the requirements for environmental water, its sources and use efficiency (rain vs. diversions, etc.). This data could be very useful for farmers and agencies in determining how best to use water to maintain the livelihoods and economy of the Sacramento Valley rice industry, the environmental benefits of rice and water, water marketing and stream flows.

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