



COLORADO WATER CONSERVATION BOARD

ALTERNATIVE AGRICULTURAL WATER TRANSFER METHODS COMPETITIVE GRANT PROGRAM



GRANT APPLICATION FORM

Implementation of Deficit Irrigation

Regimes: Demonstration and Outreach

South Platte

Program/Project Name

River Basin Name

\$154,734

\$20,000

Amount of Funds Requested

Amount of Matching Funds

Instructions: This application form must be submitted in electronic format (Microsoft Word or Original PDF). The application can be emailed or a disc can be mailed to the address at the end of the application form. The Alternative Agricultural Water Transfer Methods Competitive Grant Program, Criteria and Guidelines can be found at <http://cwcb.state.co.us/LoansGrants/alternative-agricultural-water-transfer-methods-grants/Pages/main.aspx>. **The criteria and guidelines must be reviewed and followed when completing this application.** You may attach additional sheets as necessary to fully answer any question, or to provide additional information that you feel would be helpful in evaluating this application. Include with your application a cover letter summarizing your request for a grant. If you have difficulty with any part of the application, contact Todd Doherty of the Water Supply Planning Section (Colorado Water Conservation Board) for assistance, at (303) 866-3441 x3210 or email at todd.doherty@state.co.us. Generally, the applicant is also the prospective owner and sponsor of the proposed program/project. If this is not the case, contact Todd before completing this application.

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Part A. - Description of the Applicant(s) (Program/Project Sponsor);

1.	Applicant Name(s):	Colorado State University		
	Mailing address:	Office of Sponsored Programs 2002 Campus Delivery 200 West Lake Street Fort Collins, Colorado 80523-2002		
	Taxpayer ID#:	846000545	Email address:	Linda.Loing@ColoState.edu
	Phone Numbers: Business:	970-491-6586		
	Home:			
	Fax:	970-491-6147		

3. If the Contracting Entity is different then the Applicant, please describe the Contracting Entity here.

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4. Provide a brief description of your organization. The applicant may be a public or private entity. Given the diverse range of potential applicants, not all of the following information may be relevant. Where applicable and relevant the description should include the following:

Founded in 1870 as the Colorado Agricultural College, CSU is the home to one of the strongest community-service programs in the country. For the past 100 years, CSU Extension has been helping Coloradoans with some of their most challenging issues. As a result of CSU Extension partnership with eXtension.org, everyone with a computer can access an extensive network of experts who can assist with their day-to-day questions. An important example of CSU Extension activities is the development of guidelines to help Colorado crop producers to employ BMPs that protect the state's water resources while allowing producers to remain economically competitive.

Part B. - Description of the Alternative Water Transfer Program/Project –

1. Purpose of the Program/Project

Among the available Alternative Agricultural Water Transfer Methods (ATMs), deficit irrigation is one that if successfully implemented, can offer significant benefits to both agricultural and M&I users. However, deficit irrigation practices require accurate water management to achieve increased water productivity (more crop per drop), and accurate documentation of consumptive use to meet state regulations and maintain historical return flows. Numerous research studies have been conducted in the past aimed to develop a wide variety of techniques for managing irrigations and documenting water balance components under deficit irrigation regimes. While some of these techniques can be used in practical applications of deficit irrigation, most are complicated and/or data-intensive and their application will likely remain limited to research studies. This proposal aligns with the recommendations stipulated in the CWCB Technical Memorandum entitled “Alternative Agricultural Water Transfer Methods Grants Program Summary and Status Update” of November 2012. In particular this proposal aligns with the second recommendation in section 1.3.1 South Platte Basin, page 6, of the report that refers to supporting “demonstration/pilot projects to determine the feasibility of new concepts or techniques as needed”. In addition, we believe that transferring technology and educating water users and regulators on different aspects of implementing a technically and economically feasible deficit irrigation program will be determinant toward the adoption of this practice as a viable and mutually-beneficial ATM. The importance of training water users is also emphasized in the November 2012 report (section 2.2, page 10), as the project completion report by the Colorado Corn Growers Association “recommends that the CWCB produce educational materials that would assist a lay person with understanding water transfers.”

The specific goals of the proposed demonstration and outreach project are:

- To demonstrate the feasibility (technical and economic) and resource-requirement of using selected water management techniques to quantify the water balance components and consumptive use under different deficit irrigation levels, on crops such as corn and sunflower, on clayey to sandy soil types, with pressurized and surface irrigation methods, and under different agronomic practices. Technical feasibility involves a practical, cost-effective monitoring approach and economic feasibility involves understanding and demonstrating crop water productivity, production costs and farmer incentives. Numerous sensors and their related equipment (e.g., infra-red thermometers, dataloggers, neutron probe, multispectral scanner, etc.) required to achieve this goal will be provided by CSU.
- To educate and train water users and regulators about using these techniques and their advantages and disadvantages (including limitations) through a variety of outreach and extension activities, such as publishing online and printed manuals including user-friendly spreadsheets, fact sheets, newsletters, and magazine articles; holding field days and a training workshop (video recordings to be made available online); and, creating a YouTube channel to upload short informational video clips.

This project will build upon the results of previous studies to demonstrate, transfer technology and educate on how some of the most promising techniques can be used, with minimal instrumentation, to document water balance components under deficit irrigation regimes. One example of previous studies is the research conducted by Taghvaeian et al. (2012) in the Lower South Platte Project Research farm near Iliff, Colorado. The funding was provided, from 2010 to 2012, by Colorado Water Conservation Board to Parker Water and Sanitation District. In this project CSU was a partner that participated in several tasks. Specifically the title of

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the project was “Lower South Platte Irrigation Research and Demonstration Project.” We were directly responsible for Task 1 “to develop a practical means of calculating and verifying consumptive water use and water savings in alternative systems that will satisfy water court requirements.” In Task 1B of this study, a relatively simple and empirical approach, based on crop canopy temperature, air temperature and relative humidity, was implemented and calibrated to estimate corn water stress (CWS) levels and posteriorly, along with reference evapotranspiration (ET_{ref} , computed using weather data) the crop water use was determined under deficit irrigation management. Results from the application of the CWS approach indicated that crop water use (or ET), values were accurate when compared with ET values estimated using a complex land surface energy balance model. In addition, Taghvaeian et al. (2013) conducted a similar study in the Limited Irrigation Research Farm (LIRF) near Greeley, Colorado and showed that the same approach could be used with minimum instrumentation to quantify water stress and water use for corn under deficit irrigation.

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2. Study Area/Service Area Description

Four sites will be used for demonstration and training purposes of this project within the South Platte River Basin Area:

- a) The first site is the Limited Irrigation Research Farm (LIRF), which is located close to the city of Greeley, Colorado. This site is operated and managed by the USDA ARS Water Management Research (WMR) Unit. The predominant soil type is Olney fine sandy Loam. Grain corn and sunflower will be planted at this site under 12 different levels of irrigation applications, ranging from full irrigation (100%) to providing only 40% of the water requirement during different stages of growth. The irrigation is provided using a pressurized drip system. Yield monitoring will be performed by the WMR and the data will be used to evaluate water productivity (yield/water used) of different deficit irrigation treatments.
- b) The second site is located within the LIRF limits. The time and effort required as well as the machinery and equipment needed to manage this site will be provided by the Northern Water personnel as in-kind contribution to this proposal. The site will be planted to corn while the irrigation will be a surface or gravity irrigation system. A similar deficit irrigation scheme as the ARS fields will be adopted. Different agronomic practices (e.g. twin-row vs. single row planting) and their effect on corn water use and yield will be demonstrated at this site. Previous experiments at this site have revealed that agronomic practices can have a significant effect on crop water stress productivity under deficit irrigation, mainly due to decreased competition among individual plants. Figure 1 depicts the location of the Greeley sites. A CoAgMet weather station (Greeley 4) is within the limits of these sites.

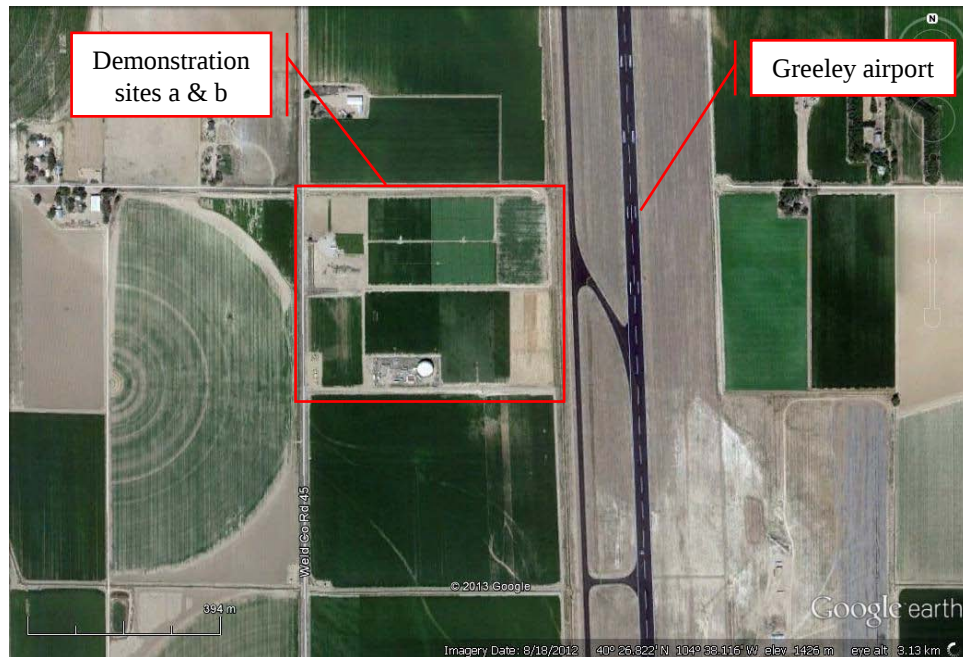


Figure 1. Location of LIRF demonstration sites, drip irrigation and surface irrigation fields.

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- c) The third site is the CSU Agricultural Research Development and Education Center (ARDEC), field 3100, located north of Fort Collins, Colorado. In this field, a new center pivot, capable of variable rate irrigation (VRI) that uses speed and nozzle control, was installed in 2012. The system irrigates approximately 18 acres. The soil texture type is Kim loam and Nunn clay loam. Figure 2 shows the location of the ARDEC demonstration site.



Figure 2. Location of ARDEC demonstration site, center pivot.

Corn will be planted in this field and irrigation plots will include full irrigation (to meet 100% of the crop consumptive water use or ET), deficit irrigation levels at 80%, 60% and 40% of corn ET. In addition a non-irrigated plot will be included as well. There will be three replications of each irrigation level.

- d) Site four is located near La Salle, CO. This field is a center pivot (Figure 3) site managed by a Central Colorado Water Conservancy District (CCWCD) farmer. The soil type is a loamy sand soil. The system irrigates 95 acres of alfalfa. Similarly, different levels of deficit irrigation amounts will be implemented and monitored with the proposed techniques. A second limited irrigation center pivot field will be identified, managed by a farmer, and preferably planted to corn.

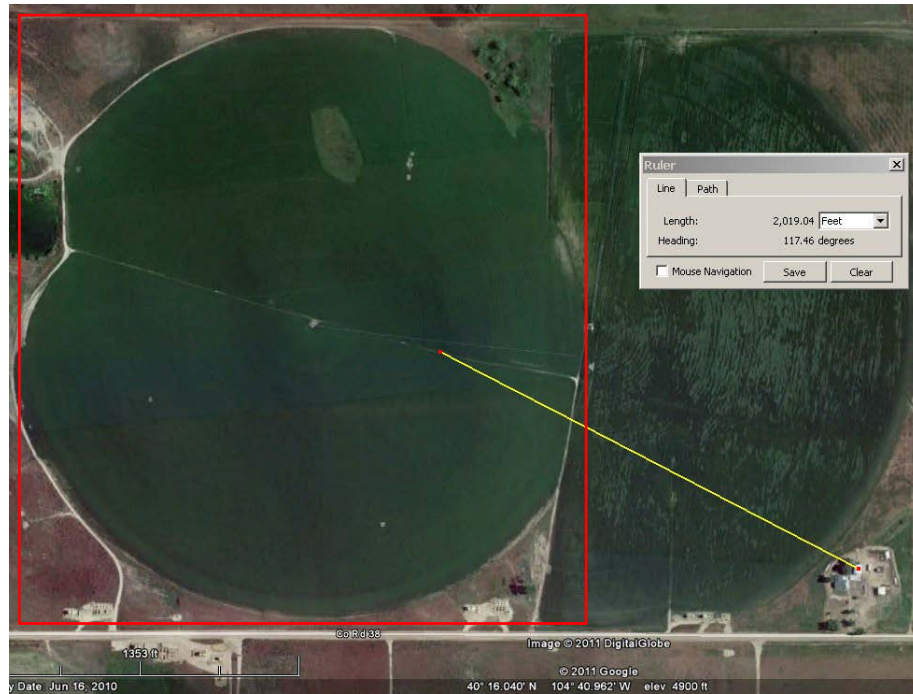


Figure 3. Line of sight for the wireless transmission of soil moisture data from the datalogger in the field (Randy Ray's) to the receiving antenna/computer housed in a shed near La Salle, CO.

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3. Description of the Alternative Water Transfer Method

The type of water transfers that will be implemented is the reduced consumptive use through deficit irrigation and agronomic practices. The transferable consumptive use will be quantified, using several available techniques that are explained in detail in section 5. The information on actual and salvaged consumptive use will be further analyzed in conjunction with irrigation application data (measurements) to document the return flows.

4. Program/Project Eligibility

Please describe how the proposed program/project meets each of the following eligibility requirements (please see Criteria and Guidelines for additional information regarding the alternative water transfer methods/strategies that qualify for funding). Note: If these requirements are addressed in other parts of the application you may simply reference the applicable section(s).

- a) A description of how, if implemented, the proposed program/project will protect property and water rights.

Deficit irrigation changes historic irrigation practices and return flows. This Project will develop a reliable and practical monitoring system to document the saved CU under deficit and the impact on return flows from the water balance analysis. The essential element of any transfer is quantifying CU and the augmentation requirement to maintain return flows for the protection of others water rights and that is the main objective of this Project.

- b) Identified group(s) of agricultural users that are or may be willing to transfer a portion of their water and identified entity(s), group(s) or area(s) where the transferred water could or would be put to the new use and a description of the new use.

This proposal does not address this item.

- c) The program/project must at a minimum conceptually describe the technical, institutional, and legal elements of the water transfer. Grant monies may be used to address one or more of these elements. If grant monies are not requested for all three elements, the grant applicant must describe how the applicant has or intends to address the elements, which are not included in the grant request, through other efforts.

This project addresses the technical element of water transfer. This is done by monitoring and documenting deficit irrigation through different methods that vary in complexity and associated cost.

- d) If grant monies are proposed for use for legal assistance then the use of those funds shall be oriented toward advancing the knowledge of alternative agricultural water transfer methods and techniques; not for preparation of a specific water court case. The total requested funds for legal assistance shall not exceed 40 percent of the total grant request. In addition, grant monies proposed for use for legal assistance must be used to collaboratively address issues and concerns related to agricultural water

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transfer. Funds shall not be used to solely advance the cause of the project proponents.

This project does not request funds for legal assistance.

- e) A minimum of a 10 percent cash match of total project cost (past expenditures and “in kind” can not be counted toward the 10 percent match).

The minimum of 10% cash match requirement is satisfied through funds committed by collaborators as CCWCD, Northern Water, and the USDA ARS WMR.

5. Program/Project Evaluation Criteria

The following grant evaluation criteria will be used by the CWCB to evaluate and make recommendations to fund, partially fund or not fund a grant application. The criteria are aimed at advancing alternative transfer methods from the literature and studies to actual on the ground projects/programs that provide reliable water supply and sustain key elements of the agricultural area from which the water is transferred. The applicant should fully address and explain in detail in the application how, and the extent to which, the proposed project/program meets each of the criteria. However, it should be noted that the project does not have to meet all of the criteria to be eligible to receive funding and the criteria below are not listed in any order of important or priority.

- a. The proposed project/program builds upon the work of former alternative water transfer methods efforts and addresses key areas that have been identified. For more detailed information on this work, please refer to the draft report: *Alternative Agricultural Water Transfer Methods Grant Program Summary and Status Update*, November 2012.

Response: This proposal builds on the efforts and results obtained during the 2010-2012 project entitled “Lower South Platte Irrigation Research and Demonstration Project.” In this project, it was established that soil water balance and monitoring crop water use utilizing relatively simple thermal-based sensors and weather data can provide accurate estimates of crop water stress and water use. Therefore, this project is a natural extension of such efforts in that technology transfer and education opportunities are sought.

- b. The proposed project addresses one or more key recommendation(s) in the report: *Alternative Agricultural Water Transfer Methods Grant Program Summary and Status Update*, November 2012.

Response: This proposal aligns with the second recommendation in section 1.3.1 South Platte Basin, page 6, of the report that refers to supporting “demonstration/pilot projects to determine the feasibility of new concepts or techniques as needed.”

- c. Preference will be given to projects that provide additional matching resources in the form of cash, past expenditures and in-kind contributions that are in addition to the required 10% cash match.

Response: This project provides a cash matching (cost share) that satisfies the 10% minimum required. In addition the in-kind contributions include instrumentation (neutron probe sensor, infra-red

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thermometers and loggers, multispectral radiometer, processing software, and time (effort) and expertise from collaborators. Past expenditures include those incurred during the 2010-2012 “Lower South Platte Irrigation Research and Demonstration Project.”

- d. The proposed project/program has the ability/potential to produce a reliable water supply that can be administered by the State of Colorado, Division of Water Resources.

Response: Savings in crop consumptive water use through the practice of deficit irrigation can potentially provide a reliable water supply for M&I uses. This project will demonstrate practical techniques to quantify consumptive use savings from deficit irrigation. These techniques can help DWR administer the amounts of transfers from agricultural to M&I uses.

- e. The proposed project/program produces information that is transferable and transparent to other users and other areas of the state (i.e., would provide an example “template” or roadmap to others wishing to explore alternate transfer methods).

Response: The proposed project does produce information that is transferable and transparent to other users and other areas of the state. Guidelines for the implementation of the proposed monitoring of crop water use will be produced, along with spreadsheets (and extension literature) that will facilitate the computation and interpretation of the data collected.

- f. The proposed project/program addresses key water needs identified in SWSI 2010 or as identified in a basin’s needs assessment.

Response: Yes, the project addresses keeping the farms in business through the implementation of deficit irrigation and the encouragement to transfer consumptive water use saved under this irrigation water management. The monitoring of crop water use techniques herein proposed will allow for the documentation of saved consumptive use.

- g. The proposed project/program advances the preservation of high value agricultural lands. Value can be viewed as: the value of crops produced, the value the agriculture provides to the local community, and the value the agricultural area provides for open space and wildlife habitat.

Response: The proposed project will constitute a tool that if implemented will help in the preservation of prime agricultural lands and the sustainability of irrigated agriculture.

- h. The proposed project/program addresses water quality, or provides other environmental benefits to rivers, streams and wetlands.

Response: The proposed project does not address water quality. However, the practice of deficit irrigation has the potential to reduce over-irrigation and non-point source pollution from agricultural chemicals and nutrients.

- i. The proposed project/program increases our understanding of and quantifies program/project costs. This could include: institutional, legal, technical costs, and third party impacts.

Response: The proposed project does address costs involved in implementing a given water management strategy or method. A spreadsheet will be created for this purpose.

- j. The proposed project/program does not adversely affect access to other sources of water (not subject to/participating in the program) where owners of these water rights may wish to pursue traditional transfer of their rights to other users.

Response: Yes, it does not affect access to other sources of water.

- k. The proposed project/program provides a perpetual water supply for the new and/or alternate use and preserves agricultural production and/or helps sustain the area’s economy from which the transfer is occurring.

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Response: It does not guarantee a perpetual water supply. However, if a farmer has his/her water right limited or if he/she wants to monitor a deficit irrigation scheme for water use transfer then the tools derived from this project will be useful for that purpose through the monitoring of adopted schemes throughout the crop growing season.

- l. The quantity of water produced by the proposed project/program. Preference will be given to programs that can address larger water supply needs.

Response: This project does not address this subject.

- m. Applicants are encouraged to develop projects demonstrating participation and/or support from a diverse set of stakeholders and interests.

Response: This project involves collaboration among two irrigation districts (CCWCD and NCWCD or NW), one nationally recognized research and demonstration facility (USDA ARS WMR) and CSU research and extension personnel.

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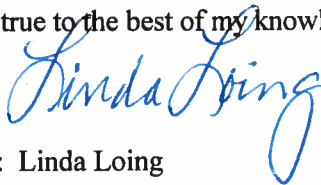
PAYMENT

Payment will be made based on actual expenditures and invoicing by the applicant. Invoices from any other entity (i.e. subcontractors) cannot be processed by the State. The request for payment must include a description of the work accomplished by major task, and estimate of the percent completion for individual tasks and the entire water activity in relation to the percentage of budget spent, identification of any major issues and proposed or implemented corrective actions. The last 5 percent of the entire water activity budget will be withheld until final project/water activity documentation is completed. All products, data and information developed as a result of this grant must be provided to the CWCB in hard copy and electronic format as part of the project documentation. This information will in turn be made widely available to the public and help promote the development of alternative agricultural transfer methods.

Additional Information – If you would like to add any additional pertinent information please feel free to do so here.

The above statements are true to the best of my knowledge:

Signature of Applicant:



Print Applicant's Name: Linda Loing

Project Title: Research Administrator, Office of Sponsored Programs, Colorado State University

Return this application to:

Mr. Todd Doherty
Colorado Water Conservation Board
Water Supply Planning Section
1580 Logan Street, Suite 200
Denver, CO 80203
Todd.Doherty@state.co.us