Alternatives

to Permanent Dry Up of Formerly Irrigated Lands

June 2013

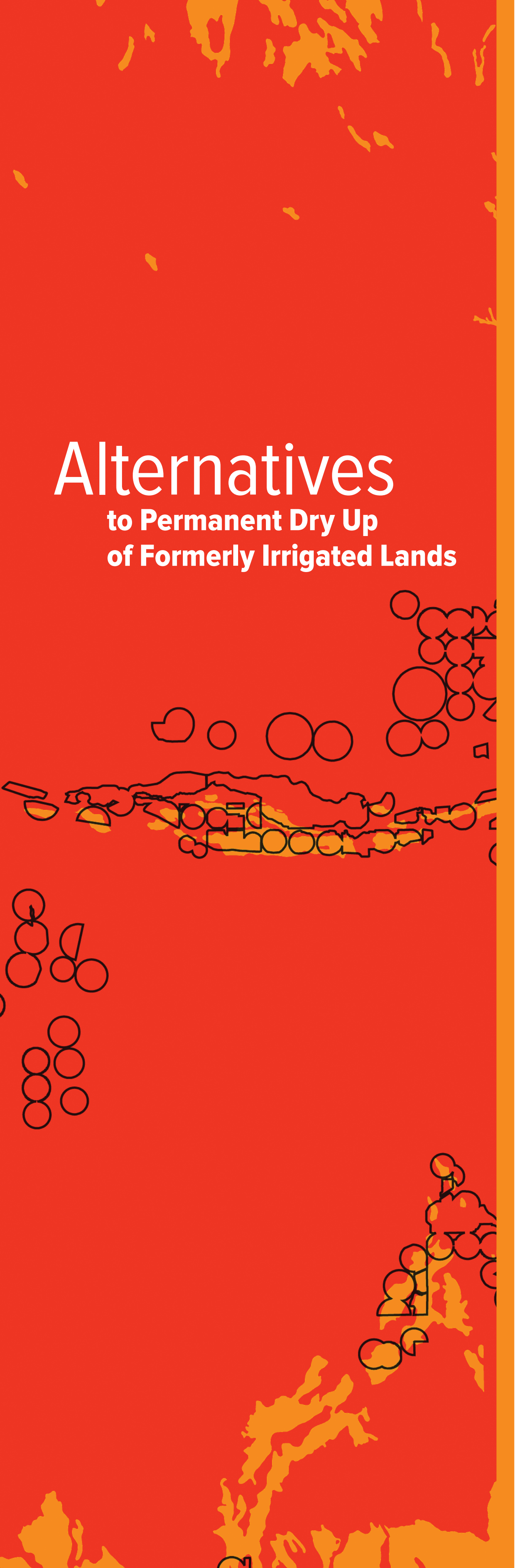
Prepared by

ECCV Water & Sanitation District

Colorado Water Conservation Board

DiNatale Water Consultants

Colorado State University
College of Agricultural Sciences
Department of Agricultural & Resource Economics



ACKNOWLEDGMENTS

This report and the associated research were made possible by a grant from the Colorado Water Conservation Board (CWCB) through the Alternative Agricultural Transfer Methods Program under the guidance of Todd Doherty, CWCB Water Planning Section.

The East Cherry Creek Valley Water and Sanitation District (ECCV) was the project sponsor, providing cash funding and in-kind services. Arapahoe County Water and Wastewater Authority (ACWWA) and the United Water and Sanitation District also provided cash funding and participated as project partners with ECCV. Chris Douglass, ECCV, served as the project manager.

PRIMARY INVESTIGATORS & PROJECT TEAM

DiNatale Water Consultants
Kelly DiNatale
Arista Hickman
Matt Bliss
Peter DiNatale

Colorado State University
Neil Hansen
Troy Bauder
John Deering
Robert Flynn
Erik Wardle

The Law Offices of Tod J. Smith
Tod J. Smith

TECHNICAL REVIEW

Dan Smith
Joe Brummer

Graphic Design : : Jeremy Carlson

Contents

LIST OF ABBREVIATIONS

AF	Acre-foot
ACWWA	Arapahoe County Water and Wastewater Authority
AFY	Acre-feet per year
APH	Actual Production History
ATM	Alternative Transfer Method
AWC	Available water capacity
Bu/ac	Bushels per acre
C/N	Carbon to nitrogen ratio
CREP	Conservation Resource Enhancement Program
CRP	Conservation Reserve Program
CRS	Colorado Revised Statutes
CSU	Colorado State University
CU	Consumptive use
CWCB	Colorado Water Conservation Board
CWT	Yield expressed as the number of hundred weights (1 ton = 20 CWT)
EC	Electrical conductivity
ECCV	East Cherry Creek Valley Water and Sanitation District
ET	Evapotranspiration
FSA	Farm Service Agency
FT	Feet
GIS	Geographic information system
GPS	Global positioning system
IPM	Integrated pest management
IPPs	Identified Projects and Processes
Lbs/ac	Pounds per acre
LEMA	Local Enhanced Management Area
M&I	Municipal and industrial
N	Nitrogen
NRCS	Natural Resources Conservation Service
OM	Organic matter
P	Phosphorus
RMA	Risk Management Agency (part of the USDA)
SPDSS	South Platte Decision Support System
SWSI	Statewide Water Supply Initiative
USDA-ARS	U.S. Department of Agriculture's Agricultural Research Service

Executive Summary

Through the Statewide Water Supply Initiative (SWSI) process, the Colorado Water Conservation Board (CWCB) has identified that transfers of agricultural water will continue to be a major source of new water supply to meet increasing municipal and industrial (M&I) demands in the State.

- The South Platte River Basin along the Front Range has the largest existing and projected M&I demands.
- In order to provide reliable water supplies to meet M&I demands, municipal and domestic water providers have acquired and continue to acquire agricultural water rights.
- The Colorado water court process strongly favors the permanent dry up of irrigated land when an M&I provider transfers water for municipal use. This is often termed "buy and dry."

This report on the Alternative Transfer Method Project (the Project) evaluates alternatives to permanent dry up of formerly irrigated lands. It was sponsored by the East Cherry Creek Valley Water District (ECCV), a water provider for the southeastern portion of the Denver metropolitan area. Funding was provided in part through the CWCB's Alternative Agricultural Water Transfer Methods Grants Program and cash funding, along with in-kind contributions provided by ECCV, Arapahoe County Water and Wastewater Authority, and United Water and Sanitation District.

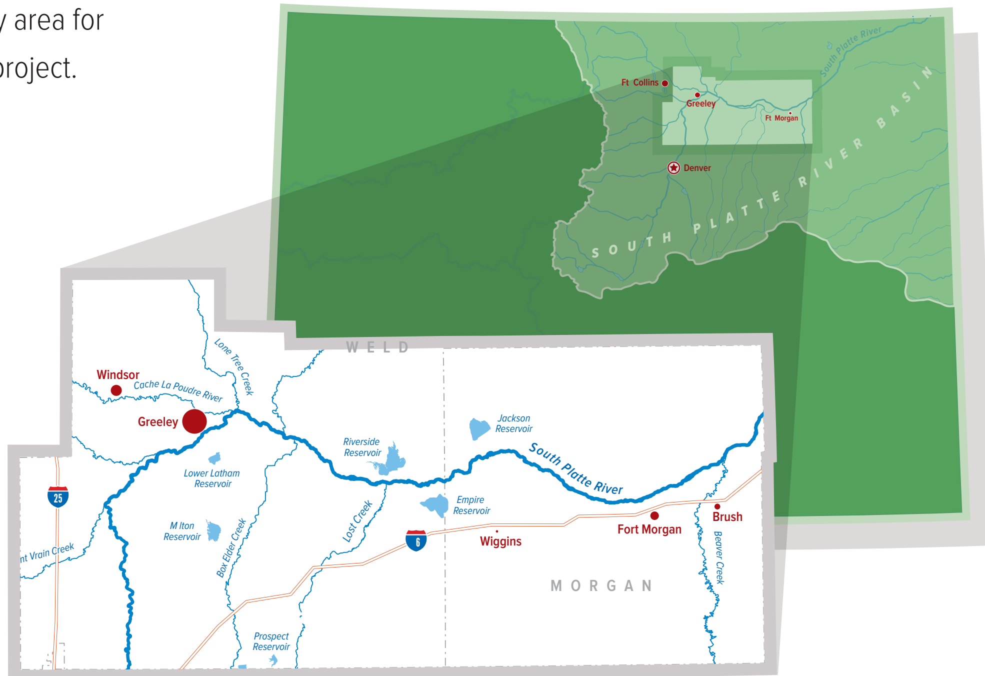
Uses of Formerly Irrigated Lands

There are several possible outcomes for the use of formerly irrigated land once the water has been transferred; it can be:

- Developed for residential, commercial or industrial uses
- Revegetated with native grasses
- Dry land farmed
- Farmed with a reduced supply of water, termed limited irrigation

This study evaluated the economic factors of revegetation, dry land farming or limited-irrigation farming on currently irrigated land within southern Weld and Morgan counties, an area that will likely be the source of future M&I acquisitions and water transfers. The study area is shown in Figure 2-1 from the report.

figure **2-1.** Study area for this project.



Revegetation

Revegetation of formerly irrigated lands is often required as part of a water court transfer decree.

- Revegetation can take 2 to 5 years or longer before vegetation is successfully established.
- Successful revegetation efforts can range in cost from approximately $170 to nearly $500 per acre and involve significant administrative costs.
- Revegetation may require supplemental irrigation for successful establishment of native grasses.
- Revegetated lands may be eligible for Conservation Resource Program (CRP) lease payments.

Dry Land and Limited Irrigation as Alternatives to Permanent Dry Up and Revegetation

The irrigated land within the study area was evaluated for potential conversion to dry land farming or limited-irrigation practices, assuming that some of these lands would be subject to water transfers. The following are major factors that determine the viability of dry land or limited-irrigation farming:

- Projected yield of dry land or limited-irrigation crop based on
  - › Precipitation during the growing season
  - › Available water-holding capacity of the soils
  - › Amount and timing of the reduced water supply made available for limited irrigation (limited irrigation assumed 6 inches of water supply for limited irrigation)

- Economic factors, including
  - › Crop prices
  - › Property taxes for dry land and limited-irrigation farms
  - › Crop insurance for dry land and limited-irrigation farms

- Water court issues with dry land and limited irrigation compared to permanent dry up and revegetation, including potential reductions in transferable water due to ongoing agricultural operations on the parcel

Precipitation during the growing season and available water-holding capacity were mapped over the entire study area using GIS. Figures 4-4 and 4-5 show the precipitation during the wheat and corn growing seasons, respectively. There is greater precipitation in the western portion of the study area during the winter and spring, favoring small grains such as wheat. During the corn growing season (May through September), there is greater precipitation in the eastern portion of the study area.

Using GIS, the growing season precipitation was combined with the available soil water-holding capacity to estimate average crop yields throughout the study area. This data was combined with farm budgets developed by Colorado State University Agriculture Extension to estimate the

figure **4-4.** Precipitation during the crop growing season for winter wheat (September 24 to July 1).

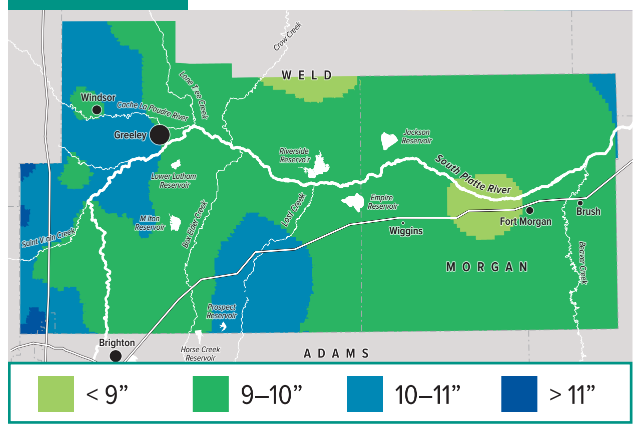
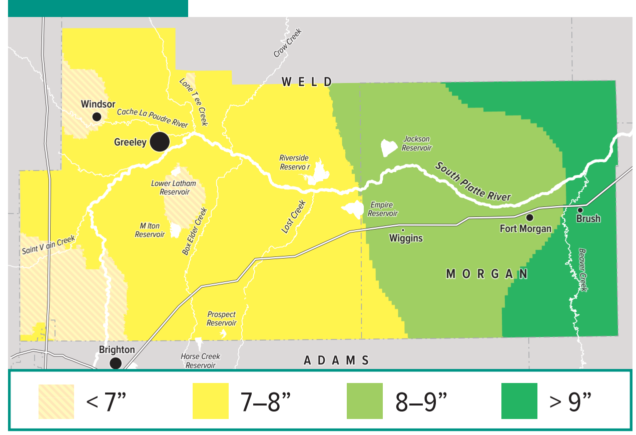


figure **4-5.** Precipitation during the crop growing season for corn (May 14 to September 30).



average economic return for various crops throughout the study area. The estimated yields and economic returns were projected onto currently irrigated parcels as mapped by the South Platte Decision Support System (SPDSS 2005).

The farm budgets were used to estimate an economic break-even yield for each type of dry land and limited-irrigation crop. An analysis was performed on only the currently irrigated lands with a projected crop yield of at least the break-even yield. The amount of currently irrigated land that is projected to produce at least the break-even yield varies by crop and irrigation practice, ranging from 97% of the irrigated parcels for limited-irrigation proso millet, to zero acres for dry land sunflower (Table 5-2). The economic analysis of these parcels indicates that dry land and limited-irrigation practices may by viable economically on a long-term basis, but the economic return for most dry land and limited-irrigation practices are significantly lower than the economic return expected from irrigated crops (Figure 5-1).

Mapping of the projected economic returns for dry land and limited-irrigation wheat, corn and proso millet are shown in Figures 5-8 through 5-13. While corn and wheat have been at high market prices in recent years compared to historical levels, millet has experienced even greater increases in market price than corn and wheat. The following table summarizes the approximate percentage of the irrigated lands in the study area that are estimated to produce a break-even economic return on average (between -$50 and $50 per acre), and the percentage of land that is estimated to produce an average economic return of greater than $50 per acre.

Economic return of dry land and limited irrigation on currently irrigated lands

Crop	Percent of lands currently irrigated with estimated average break-even economic return	Percent of lands currently irrigated with estimated average economic return greater than $50 per acre
Dry land wheat	83	11
Limited-irrigation wheat	35	65
Dry land corn	25	0
Limited-irrigation corn	38	54
Dry land millet	67	19
Limited-irrigation millet	7	93
Dry land sunflower	0	0
Limited-irrigation sunflower	28	0

Limited irrigation of wheat, corn and proso millet may provide the best economic opportunities and largest amount of potential suitable lands for limited-irrigation farming. The least viable crop evaluated in the study was sunflower, both dry land and limited-irrigation production. The estimated *figure* **5-8.** Economic return for wheat —dry land.

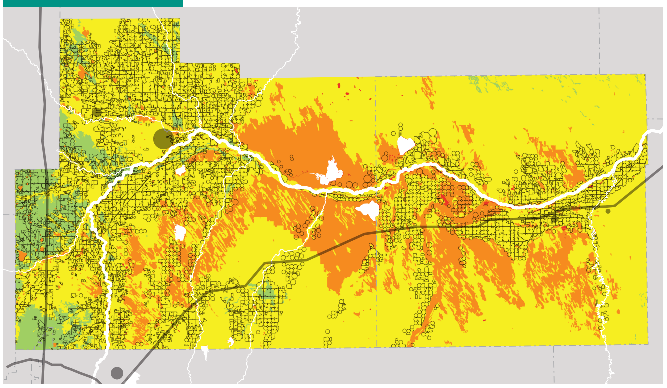


figure **5-9.** Economic return for wheat —limited irrigation.

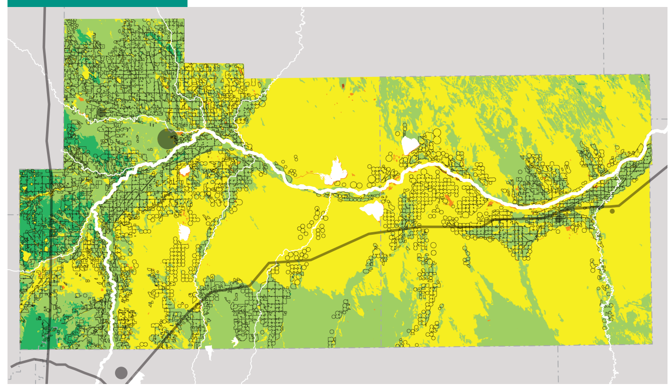


figure **5-10.** Economic return for corn —dry land.

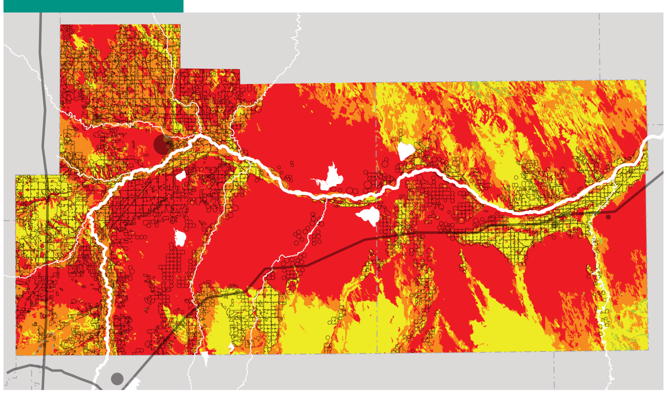


figure **5-11.** Economic return for corn —limited irrigation.

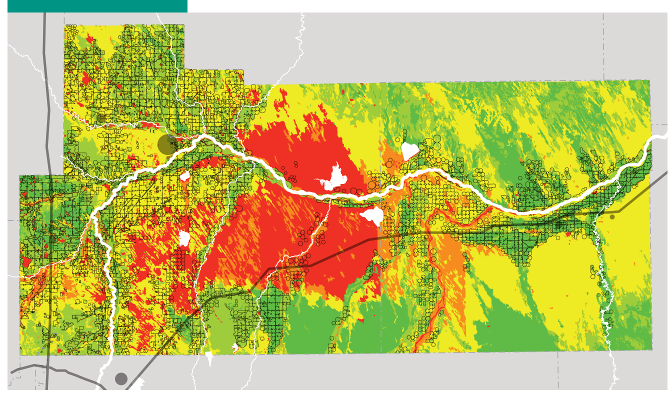


figure **5-12.** Economic return for proso millet—dry land.

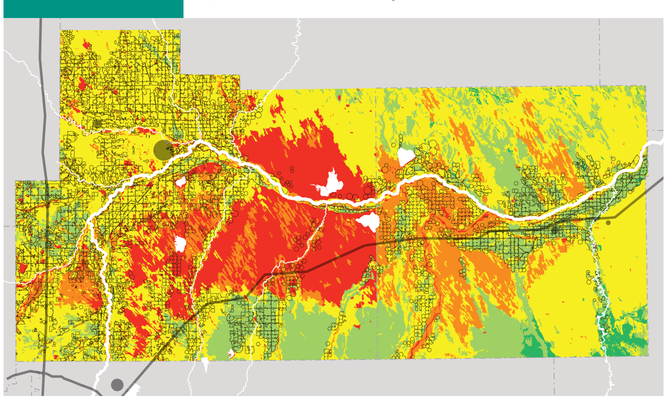
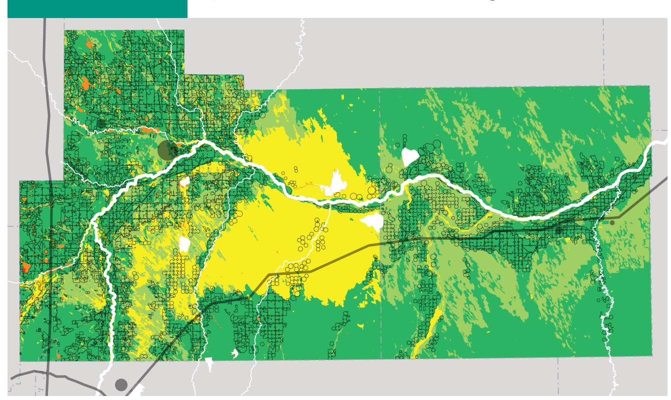


figure **5-13.** Economic return for proso millet—limited irrigation.



Economic Gain *(or Loss)* per Acre

($100+) | *($100)–($50)* | *($50)–$50* | $50–$100 | $100+

Irrigated Parcels

economic returns are heavily dependent on crop prices, which can fluctuate significantly from year to year. For example, the current price for proso millet is very high compared to historical averages, and the market is relatively small, which can cause more uncertainty than with more stable-priced crops, such as wheat and corn. An analysis of the variability of price and yields inherent in the dry land and limited-irrigation crops is presented in Appendix A, and shows that all eight crops evaluated in this study can vary from significant losses (low yield and low price) to significant gains (high yield and high price).

Reverse Incentives (Disincentives) to Limited Irrigation

The study indicated the potential for economic profitability on a majority of the currently irrigated acres in the study area if a limited-irrigation supply were available. However, there are a number of state and federal governmental practices that serve as reverse incentives to the use of limited irrigation on irrigated lands that will be subject to water transfers. These are:

In Colorado, farm land is assessed as either dry land or irrigated. The difference in irrigated vs. dry land taxes per acre is approximately $10 in Weld County and $4.50 in Morgan County.

No designation is made between fully and partially irrigated (limited-irrigation) land.

- Federal crop insurance is available only for dry land or fully irrigated crops. A farmer intending to implement limited crop irrigation on formerly fully irrigated land cannot insure it as irrigated. Instead, it would have to be insured as non-irrigated.

- The economic value of 6 inches of historical water supply left with the land as part of a water court transfer exceeds the anticipated long-term economic return from limited irrigation. In simple terms, the projected financial returns from selling the water to an M&I user are greater than the projected returns from continuing with limited irrigation.

- The total economic return from dry land or limited-irrigation farming may be insufficient to justify continued farming operations.

- The water court transfer approval process has historically used the traditional "buy and dry" approach, where irrigated land is permanently dried up and revegetated with native grasses.

- The permanent dry up and revegetation with native grasses is the most prevalent approach in a water transfer and supported by the water court, objectors and the State Engineer.

- The water court transfer of a portion of the historical consumptive use, with the remainder left for limited irrigation, is difficult to decree and administer because of the maintenance of historical return flows and allocation of consumptive use to the water left for limited irrigation.

- Some dry land and limited-irrigation crops have deeper root systems than native grasses and may result in reduced consumptive use credits to a transferring entity if the groundwater levels are within the crop root zone.

Policy Considerations

There are three policy areas identified in the study that serve as reverse incentives for the implementation of limited irrigation on irrigated lands subject to a water court transfer:

- The current Colorado property taxation policy does not differentiate between full- and limited-irrigation parcels.

- The USDA Risk Management Agency does not issue crop insurance for limited-irrigation crops.

- There are barriers in the water court transfer process and post-decree water rights administration to the transfer of water under a limited-irrigation concept.

Recommendations

Recommendations to address the three policy considerations include:

- Support changes to section 39-1-103, Colorado Revised Statutes, which governs property valuation, or the accompanying Land Valuation Manual, prepared by the Department of Local Affairs, Division of Property Taxation, to allow for a different property valuation for limited-irrigation farming.

- Conduct a study specific to the South Platte Basin for determining crop insurance parameters for limited irrigation and support a change in the federal crop insurance program to cover limited-irrigation crops.

- Encourage state agencies, including the Division Engineer and Attorney General, as a matter of public policy, to support dry land and limited-irrigation agriculture on formerly irrigated land, both during the water court transfer process and for implementation in Substitute Water Supply Plans, interruptible water supply agreements and post-decree farming operations.

- Conduct a study to evaluate if limited-irrigation farming can be successful with the M&I user transferring the reliable portion of the transferred water supplies needed for M&I use by:

    - Cooperating with ditch companies, water conservancy districts or other agencies to develop recharge plans to regulate the transferred M&I surplus supplies to create an augmentation supply for limited-irrigation operations in most years.

    - Maximizing the use of existing farm infrastructure under limited-irrigation farming with the reduced and less-reliable supplies made available via recharge and augmentation plans.

- Provide funding for the development of an updated table on “percent reduction in transferable consumptive use on lands no longer irrigated” for typical dry land and limited-irrigation crops applicable to the study area.

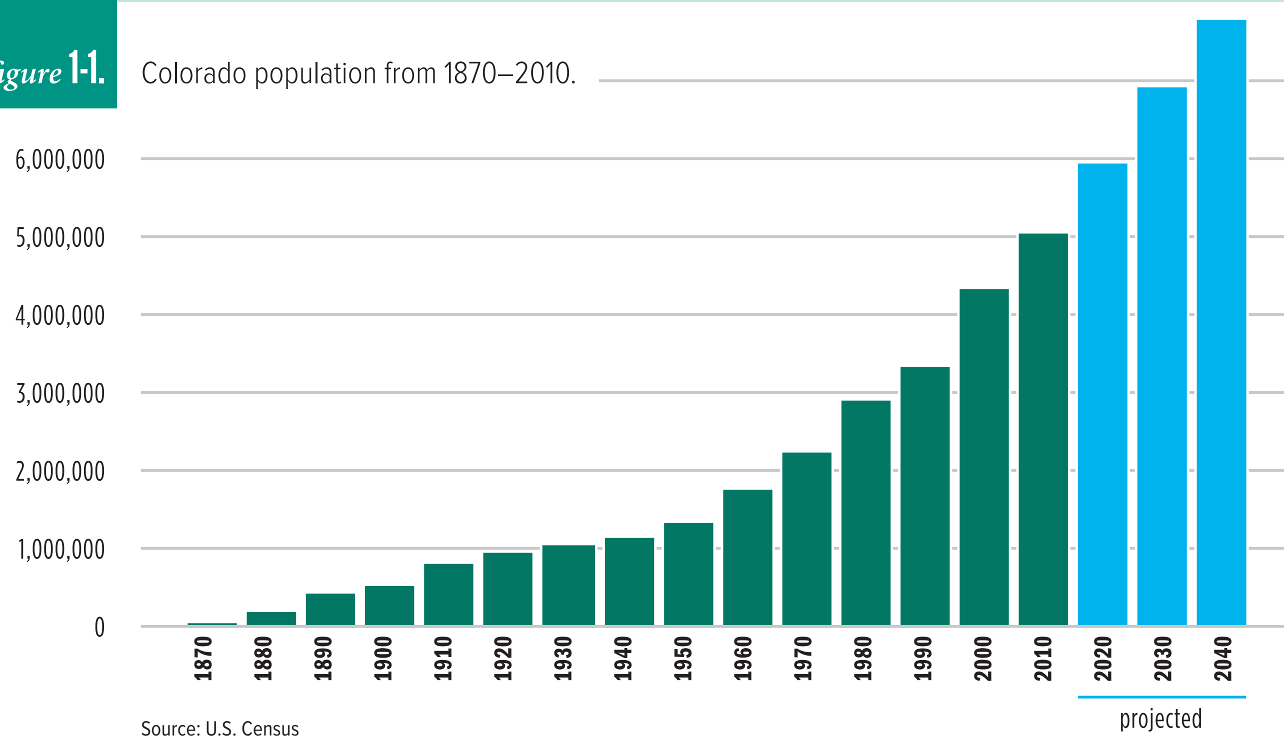
- Provide funding for the evaluation of return flow patterns from limited-irrigation farming.

Section 1: Introduction

Over the past half-century, the State of Colorado has experienced tremendous population growth, with the majority of that growth occurring in towns and cities along the Front Range (approximately from Colorado Springs to Fort Collins). The State's population has increased from less than 2 million people in 1960 to just over 5 million in 2010 (State of Colorado, Department of Local Affairs 2013).

This growth has been accompanied by increased municipal and industrial (M&I) demand for water, and water providers turned — and continue to turn — to agricultural water supplies to meet a portion of that increasing demand. Transfers from agricultural use to M&I most often require that irrigation ceases on the agricultural lands. This type of transfer is often termed "buy-and-dry." Through the Statewide Water Supply Initiative (SWSI) process, the Colorado Water Conservation Board (CWCB) concluded that transfers of agricultural water will continue to be a major source of new water supply to meet increasing M&I demands in the State. This is particularly true within the South Platte River Basin, which includes the Denver metropolitan area and several northern Front Range cities, such as Loveland, Greeley and Fort Collins and which has the largest existing and projected M&I demands (CDM/Colorado Water Conservation Board 2012).

figure 1-1. Colorado population from 1870–2010.



Source: U.S. Census

This report on the Alternative Transfer Method Project (the Project) evaluates alternatives to permanent dry up of formerly irrigated lands and was sponsored by the East Cherry Creek Valley Water District (ECCV), a water provider for the southeastern portion of the Denver metropolitan area. Funding was provided through the CWCB's Alternative Agricultural Water Transfer Methods Grants Program and cash funding, along with in-kind contributions provided by ECCV, Arapahoe Water and Wastewater Authority, and United Water and Sanitation District. The Project evaluates the potential to convert previously irrigated land into dry land farming land or limited-irrigation practices, and to describe the results of revegetation efforts in the South Platte Basin.

The remainder of this report's Section 1 provides background information on the transfer of irrigated lands to M&I use and on challenges associated with developing Alternative Transfer Methods (ATMs) for the South Platte Basin — specifically water law considerations and attitudes of M&I providers. Section 2 details the Project's objectives, methods and study area. Section 3 describes historical dry land and limited-irrigation practices. Section 4 uses mapping of rainfall and soil types to identify areas where dry land and limited-irrigation practices may be feasible from both agronomic and economic perspectives. Section 5 details the economic issues associated with the ATMs. Section 6 describes research efforts by Colorado State University (CSU) to develop feasible methods of long- and short-term revegetation plans. Section 7 provides an analysis of the legal, engineering and other issues associated with implementation of approaches other than permanent dry up of agricultural lands. Section 8 provides an analysis of the potential benefits, issues and incentives to implement a different approach to dry up and revegetation. Section 9 summarizes the key findings from previous sections and includes recommendations.

1.1 Background

Agricultural water use is the major water use in the State, accounting for more than 80% of total water use (CDM/Colorado Water Conservation Board 2004). The South Platte River Basin comprises the highest amount of irrigated acreage of all of Colorado's seven major river basins, accounting for nearly a quarter of the total irrigated acreage in the State. Table 1-1 presents the current (2010) irrigated acreage in Colorado by major river basin, duplicated from the SWSI 2010 update (CDM/Colorado Water Conservation Board 2010). Total water diversions for agricultural use in the South Platte Basin are approximately 4,000,000 acre-feet per year (AFY), compared to M&I diversions of approximately 1,000,000 AFY. The proximity of the source, seniority and certainty of acquiring and transferring agricultural water are contributing factors driving the transfer of water from agriculture to M&I use in the South Platte Basin (DiNatale Water Consultants 2012).

The transfer of water from agricultural to M&I use results in a reduction of irrigated acreage. This practice is referred to as traditional agricultural transfers and has been classified by some as "buy-and-dry." Irrigation ceases on the agricultural land due to water court restrictions against continuing use to irrigate the lands with the transferred water rights (see Section 1.2), which assures that the M&I user obtains the full legally available amount of water.

Table **1-1.** Current irrigated acres by river basin.[1]

Basin	Irrigated Acres	Percentage of Colorado's Irrigated Acres
Arkansas	428,000	12%
Colorado	268,000	8%
Gunnison	272,000	8%
North Platte	117,000	3%
Republican	550,000	16%
Rio Grande	622,000	18%
South Platte[2]	831,000	24%
Southwest	259,000	7%
Yampa-White	119,000	3%
Statewide Total	3,466,000	100%

1 Reproduced from Statewide Water Supply Initiative, 2010, Appendix I, Table 2 (CDM/Colorado Water Conservation Board 2010)

2 Includes the Metro Basin Roundtable, exclusive of the Republican River Basin.

The CWCB has conducted studies to quantify the potential future reduction of irrigated agriculture and to investigate ATMs that could provide for a variety of water-sharing methods between agricultural and M&I water use. As part of the ongoing SWSI program, the CWCB developed a water portfolio trade-off tool that projects the number of irrigated acres that will be lost to satisfy projected future M&I demands. The tool incorporates a variety of assumptions about water conservation, population growth rates, location of growth, potential for West Slope water development and the success of other projects already in the planning stages (referred to as "Identified Projects and Processes" or IPPs). The trade-off tool analysis indicates that in the coming decades, irrigated acreage will decline throughout the State due to a variety of reasons, including the urbanization of previously irrigated lands and municipal transfers. In the South Platte Basin, traditional municipal transfers are projected to cause the majority of the loss of irrigated acreage. The potential changes in irrigated acreage were developed by river basin as part of the SWSI 2010 effort, and the results are shown in Table 1-2.

The SWSI projections indicate that the South Platte Basin may experience a reduction of between 301,000 and 424,000 acres of currently irrigated land by 2050 (CDM/Colorado Water Conservation Board 2010), which is between 36 and 51% of the current irrigated acreage. This estimate is based on "status quo conditions" used in the trade-off tool (see the 2010 Statewide Water Supply Initiative Update for additional detail on scenarios). First, urbanization (development) is projected to be responsible for between 47,000 to 58,000 acres of the reduction, driven by population growth along the Front Range and expansion onto irrigated acreage. In the South Platte Basin, much of this growth will occur in the Denver metropolitan area and in Larimer and southern Weld counties. Second, irrigated acreage lost to identified M&I water transfers (IPPs) is projected to be 74,000 to 110,000 acres. And third, an additional 166,000 to 242,000 acres of irrigated land will be lost to additional traditional M&I transfers not previously identified as IPPs under the "status quo" projections.

The South Platte Basin may experience a reduction of between 301,000 and 424,000 acres of currently irrigated land by 2050.

Given the significant reductions in irrigated acreage projected to meet future M&I demand, there has been increasing interest in investigating and developing a variety of ATMs that would keep at least a portion of the irrigated acreage in production. The Project investigates dry land farming, limited-irrigation farming, and revegetation options and challenges. The CWCB has already identified significant challenges to implementing ATMs in Colorado (CDM/Colorado Water Conservation Board 2011, DiNatale Water Consultants 2012); the most pertinent to this Project are the legal limitations generally used in agricultural transfers and the attitudes of M&I water providers towards ATMs.

1.2 Water Law and Water Transfers

Colorado water law allocates water according to the doctrine of prior appropriation, sometimes described as the principle of "first in time, first in right." Water rights decreed earlier in time are referred to as "senior rights," with rights decreed after the development of reliable supplies in

Table **1-2.** Future irrigated acres by river basin.

Basin	Current Irrigated Acres	Decrease in Irrigated Acres Due to Urbanization		Decreases in Irrigated Acres Due to Other Reasons	Decreases in Irrigated Acres from Identified Projects and Processes (IPPs)		Decreases in Irrigated Acres from Agricultural to Municipal Transfers to Address M&I Gap for SWSI 2010 Status Quo Portfolio		Estimated 2050 Irrigated Acres	
		Low	High		Low	High	Low	High	Low	High
Arkansas	428,000	2,000	3,000	—	13,000	16,000	39,000	73,000	336,000	374,000
Colorado	268,000	40,000	58,000	—	16,000	17,000	—	—	193,000	212,000
Gunnison	272,000	20,000	26,000	—	900	1,300	—	—	244,700	251,100
North Platte	117,000	—	—	—	—	—	—	—	117,000	117,000
Republican	550,000	300	600	109,000	—	—	—	—	440,400	440,700
Rio Grande	622,000	800	1,000	80,000	—	—	2,900	5,400	535,600	538,300
South Platte	831,000	47,000	58,000	14,000	74,000	110,000	166,000	242,000	407,000	530,000
Southwest	259,000	4,000	6,000	—	—	1,300	—	—	251,700	255,000
Yampa–White	119,000	1,000	2,000	—	—	—	—	—	117,000	118,000
Statewide Total	3,466,000	115,100	154,600	203,000	103,900	145,600	207,900	320,400	2,642,400	2,836,100

Reproduced from Appendix I of Statewide Water Supply Initiative, 2010, Table I-2 (CDM/Colorado Water Conservation Board 2010) each basin generally referenced as "junior." In the South Platte River Basin, the majority of senior water rights were decreed for agricultural use, dating from the 1860s through 1880s. There are senior water rights originally decreed for M&I use, but the vast majority of M&I rights currently in use were originally decreed senior agricultural rights that were transferred at a later date to M&I use.

In order to provide reliable water supplies to meet M&I demands, municipal and domestic water providers have acquired and continue to acquire agricultural water rights. In Colorado, changes in the type or location of a water right are determined by the water court to ensure other vested water rights are not injured by the change. Transfers often only apply to a fraction of an overall water right or water rights portfolio, for example, when a limited number of shares in an irrigation company are transferred, but other shares remain in agricultural use. Typically, the entity that has purchased and is seeking to transfer the agricultural water right files an application with the water court for a change of use. That transferring entity calculates the historical consumptive use (CU) and the historical return flows associated with the historical agricultural water use. That calculation is evaluated by any entities objecting to the change in use and ultimately determined by the water court or as a result of negotiation between the litigating parties. The CU determination establishes the amount of water that can be transferred for M&I use.

In order to prevent injury to other vested water rights, the new CU of the changed use cannot exceed the amount historically consumed by the agricultural use. Historical CU is determined by the amount of water removed from the river system by crop evapotranspiration as well as deep percolation losses to nontributary groundwater aquifers. All other irrigation water that returns to the river system via drainage ditches or groundwater infiltration is considered the historical return flow component of the water use. Historical return flows must be maintained at the same location, timing, quantity and rate of flow as had historically occurred in order to prevent injury to other water rights.

As a result of Colorado water law requiring that only historical consumptive use can be transferred (water that used to be consumed by plant growth but no longer is), most M&I water rights acquisitions include dry up covenants as an assurance of achieving the maximum consumptive use through the water court transfer process (DiNatale Water Consultants 2012). Dry up covenants typically require the seller of the water right to agree to permanently cease irrigation of the lands historically irrigated with the water rights that are sold and transferred. The dry up covenants are normally recorded in public records to ensure that the dry up provision is enforceable with future landowners. The end result is that irrigated agricultural production on the land ceases.

1.3 M&I Survey of Attitudes Toward Agriculture Transfers

A previous Alternative Transfer Method Study, entitled *Water Partnerships: An Evaluation of Alternative Agricultural Water Transfer Methods in the South Platte Basin* (DiNatale Water Consultants 2012) included surveys of agricultural water users and 22 M&I water providers in the South Platte Basin. The overall findings for the 22 surveyed M&I providers can be summarized as follows:

1. The majority (74%) of M&I providers intend to acquire and transfer agricultural water rights as part of their normal water supply planning.

2. With regard to Alternative Transfer Methods, water providers are most familiar with interruptible supply agreements, rotational fallowing and extended period water leases, but it is unlikely that these or the other ATMs will be used as part of future water supply planning.

3. The most important factors for M&I providers when evaluating water supply development and acquisitions and also the primary concerns when evaluating ATM arrangements were:

    a. The need for a permanent supply

    b. Ownership of water rights, or preference to own all agricultural water rights

    c. Certainty and reliability in yield or unwillingness to develop supplies that may not be permanent at the end of the agreement period

The results of this survey, together with the CWCB SWSI investigations, indicate that regardless of the success of planned major storage projects and other IPPs, there will be a significant number of agricultural transfers in the South Platte to meet increasing M&I demand.

Section 2: Project Description

2.1 Project Objectives

Even with the preference of most South Platte M&I providers for traditional transfers that result in permanent dry up, there is an opportunity to evaluate approaches that maintain some continued level of agricultural production. This Project explored those opportunities, whether as part of a permanent transfer or as part of a rotational fallowing or interruptible supply agreement. The two primary alternatives to the permanent revegetation of fallowed land that were evaluated are:

- Dry land farming — Farming with no amount of supplemental water, relying entirely on natural precipitation
- Limited irrigation — Dry land farming with the allocation of a specified minimum amount of supplemental water needed to provide greater assurances of producing a dry land crop yield under most climatic conditions

The following issues are associated with dry land and limited-irrigation farming and temporary fallowing, such as under a rotational fallowing or interruptible water supply agreement. This report incorporates an analysis of these issues in subsequent sections.

- For some irrigated land, there is potential for conversion to dry land farming, but production levels will be reduced. Other irrigated land is not suitable for dry land farming due to very low rainfall and/or poor soil conditions.
- In areas where dry land farming may be suitable, potential crops and crop rotations must be identified on a site-specific basis using soil type and rainfall patterns. For example, dry land grain crops such as winter wheat and proso millet may be viable, but likely will require a rotation with a summer fallow year. Dry land corn and sunflower require higher amounts of precipitation and are generally best suited to counties in Eastern Colorado where summer precipitation is more adequate.
- Some irrigated regions are in a summer rain shadow where dry land farming is limited to annual forage crops or summer fallow. Summer fallow is an inefficient system, but it does allow for capture and storage of water in the soil profile for a subsequent

crop and can reduce the risk of dry land crop failure. In addition, the costs associated with reducing risk with summer fallow are high. The water storage efficiency of a fallow period is often less than 20% (only 20% or less of the rain during fallow remains in the soil at the time of crop planting), but can be improved to some extent through changes in tillage and cropping practices. Fallowing returns no income and leaves soil prone to erosion and degradation.

When converting irrigated land to dry land, allowing limited irrigation could eliminate the need for fallowing, reduce the risk of crop failure and soil degradation, and significantly increase productivity and profit.

As an alternative to permanent or rotational fallowing when converting irrigated land to dry land, allowing a permanent, minimal, fixed allocation of irrigation water could potentially eliminate the need for fallowing, reduce the risk of crop failure and soil degradation, and significantly increase productivity and profit. The specific amounts and timings of limited-irrigation allocations vary by crop and location. For example, some dry land crops, like winter wheat, would benefit significantly from filling the soil profile prior to planting. Other crops, like corn, are dependent on water availability during critical growth stages like silking/tasselling. Thus, water transfer agreements that allow some limited irrigation must be specific in the amounts and timing of any limited-irrigation water supply.

While a priority was placed in this study on evaluating alternatives to permanent dry up and revegetation, in some situations involving a permanent transfer of water rights, permanent revegetation is the most logical outcome due to the preference of the landowner or the soil and environmental conditions. The complexity of converting formerly irrigated land to permanent vegetation is often underestimated, frequently resulting in high costs and sometimes complete failure. This Project evaluated and mapped areas where dry land or limited-irrigation farming is not recommended due to soil and environmental conditions.

2.2 Project Study Area

The Project study area included the southern portion of Weld County (South Weld) and all of Morgan County (Figure 2-1). This area was selected because it is a likely area for future M&I agricultural acquisitions, as these lands are just downstream of the urbanizing areas. Generally, the majority of irrigated lands in this area are not lands likely to urbanize.

The South Platte Decision Support System (Colorado Water Conservation Board/Colorado Division of Water Resources 2012) mapped irrigated acres in the South Platte Basin by crop type, irrigation method and water source for several time periods. A summary of irrigated acres by crop type for the study area is shown in Table 2-1 and Figure 2-3. Southern Weld County had 373,000 total irrigated acres and Morgan County had 134,000. Corn was the largest irrigated crop in both county study areas — 126,000 acres in South Weld and 65,000 acres in Morgan County. Alfalfa was the next largest irrigated crop, with 109,000 acres in South Weld and 37,000 acres in Morgan.

figure 2-1. Study area for this project.

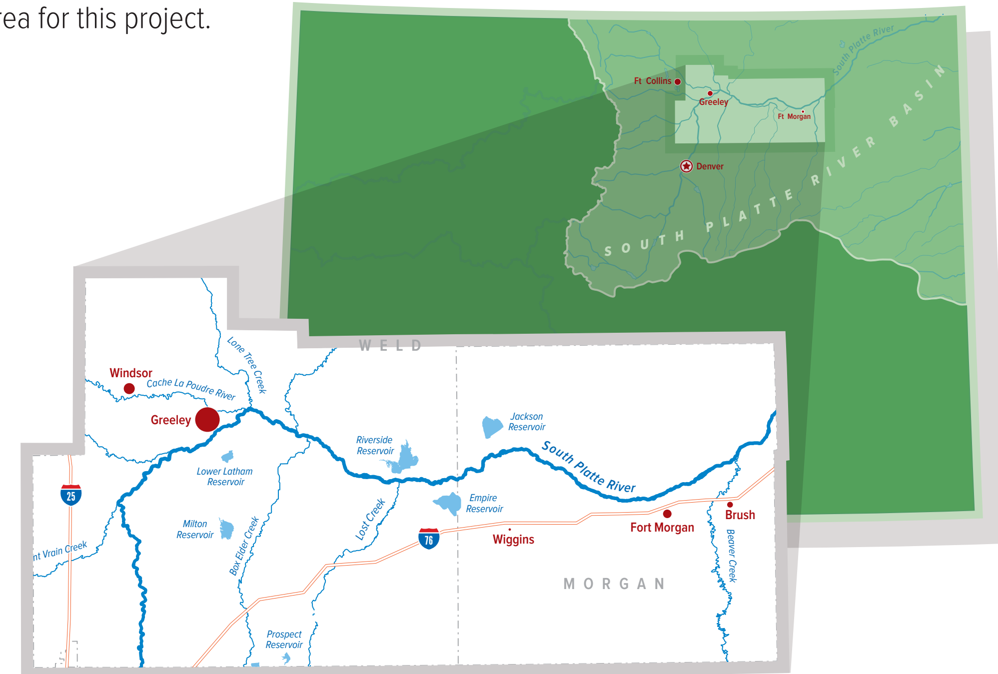


figure 2-2. Irrigated parcels in the study area.

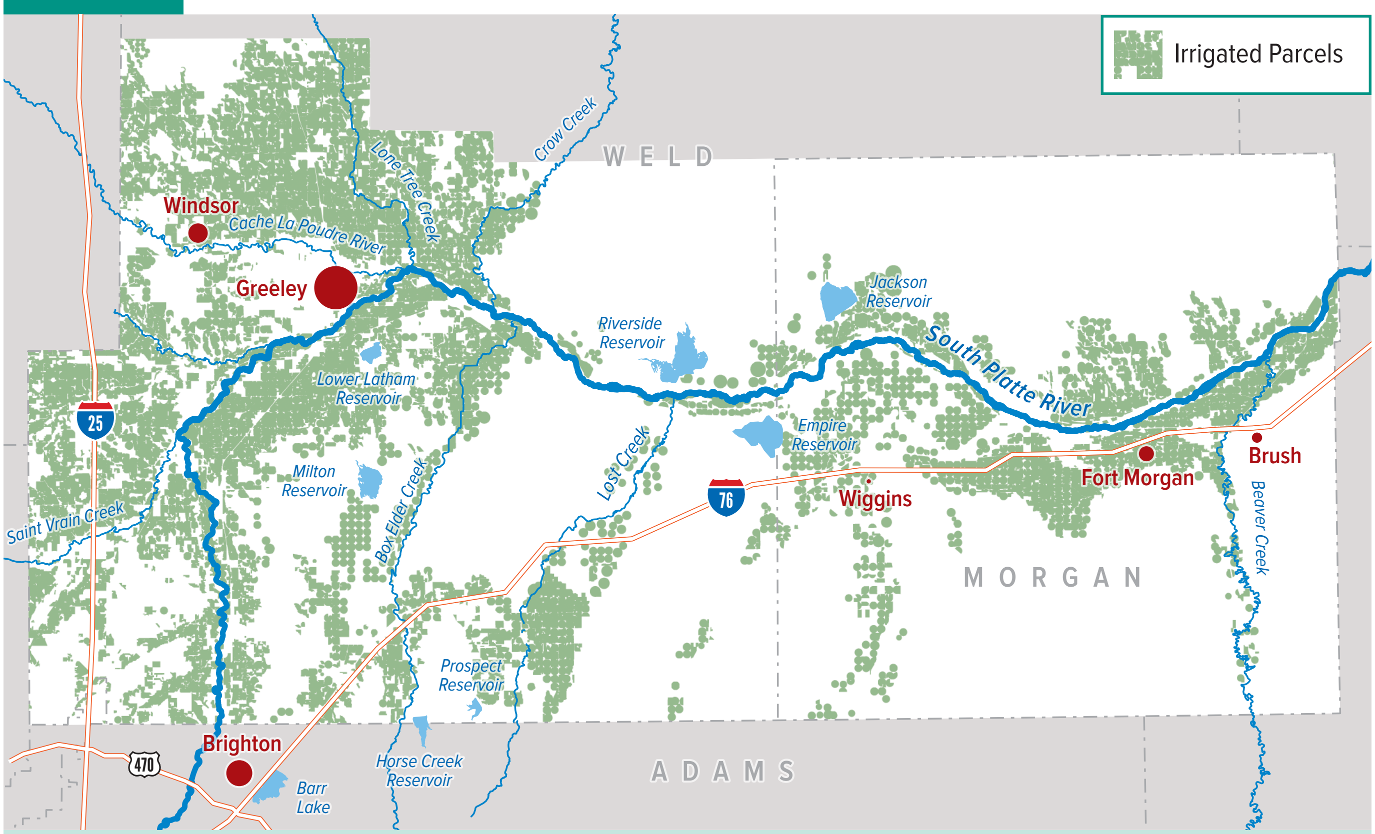
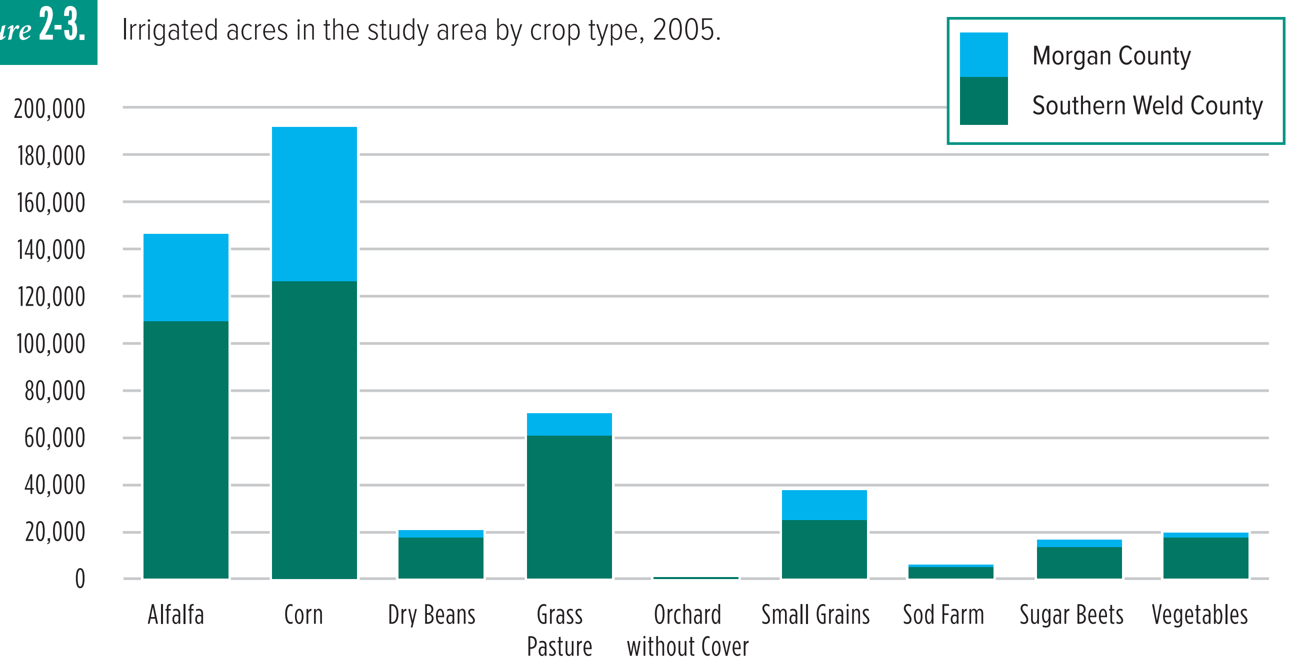


Table **2-1.** Irrigated acres in study area by crop type, 2005.

Crop Type	Southern Weld	Morgan	Total
Alfalfa	108,586	37,289	**145,875**
Corn	126,012	65,447	**191,459**
Dry Beans	17,173	3,211	**20,384**
Grass Pasture	61,090	8,640	**69,729**
Orchard without Cover	774	—	**774**
Small Grains	24,340	13,508	**37,848**
Sod Farm	4,357	630	**4,988**
Sugar Beets	13,532	2,864	**16,396**
Vegetables	17,089	2,505	**19,594**
Total	**372,952**	**134,095**	**507,048**

figure **2-3.** Irrigated acres in the study area by crop type, 2005.



Section 3: Conversion of Irrigated Lands to Dry Land Farming and Limited Irrigation

3.1 Historical Dry Land Practices in Eastern Colorado

figure **3-1.** Example of fallow with partial residue cover.

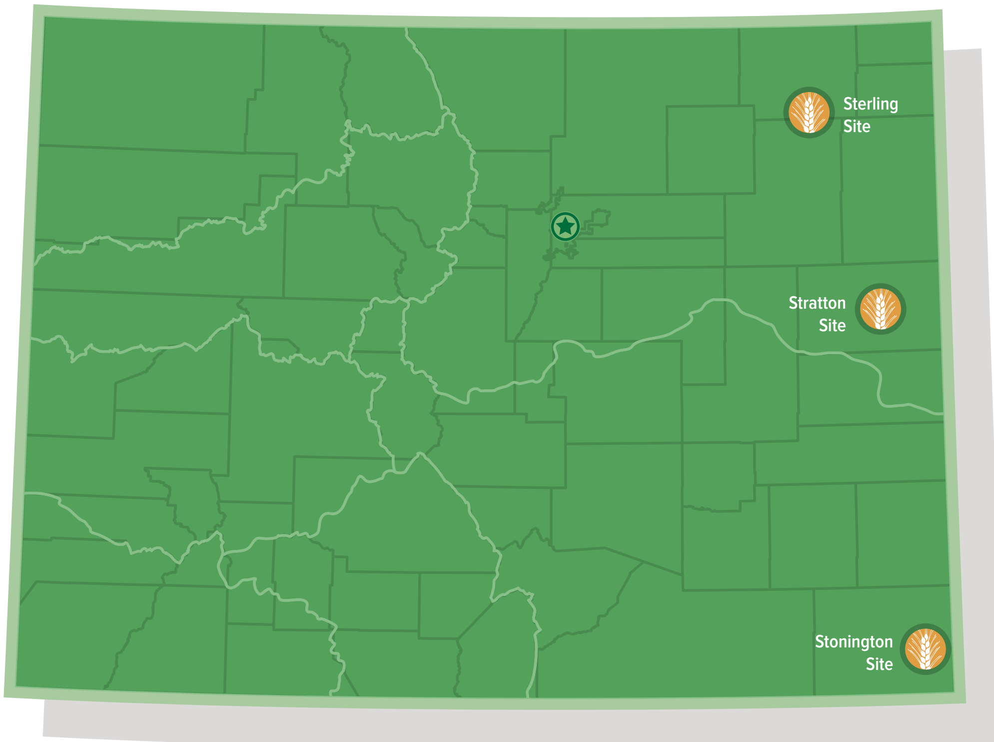
Historically, agricultural producers have managed the non-irrigated agricultural lands in Eastern Colorado on a rotation of winter wheat and summer fallow. In this rotation, winter wheat is typically planted in September and harvested the following July. After the July wheat harvest, there is a 14-month-long fallow period during which no crop is grown (Figure 3.1). The goal of the long fallow period is to capture and store moisture in the soil for the next planting. While the wheat–fallow rotation reduces the risk of drought-induced crop failure, it has major limitations, including soil degradation and erosion, lack of crop diversity and poor water use efficiency.

Colorado State University has conducted dry land cropping systems research in Eastern Colorado since 1986 to explore the potential of a range of crop rotations in the semiarid climate of the region (Peterson and Westfall 2004). The locations of the long-term dry land cropping systems sites are shown in Figure 3-2.

A key innovation identified in the long-term study is the use of a no-till system. In this system, crops are planted directly into the residue from the previous crop without disturbing the soil with tillage. No-till avoids drying out the soil and maintains crop residues on the soil surface. The research concluded that by adopting no-till practices, a crop rotation with fallow every third or fourth year provides a 25 to 40% increase in net annual income, compared to the traditional wheat–fallow rotation (Peterson and Westfall 2004). These findings have significantly increased the adoption of more intensive crop rotations in the dry land production systems in Eastern Colorado, where long-term average annual precipitation is 16 inches or greater. In those areas, it is common for producers to implement 3-year crop rotations with a winter wheat–summer crop–summer fallow

By adopting no-till practices, a crop rotation with fallow every third or fourth year provides a 25 to 40% increase in net annual income, compared to the traditional wheat-fallow rotation.

figure **3-2.** Map of Colorado long-term dry land cropping systems study sites.

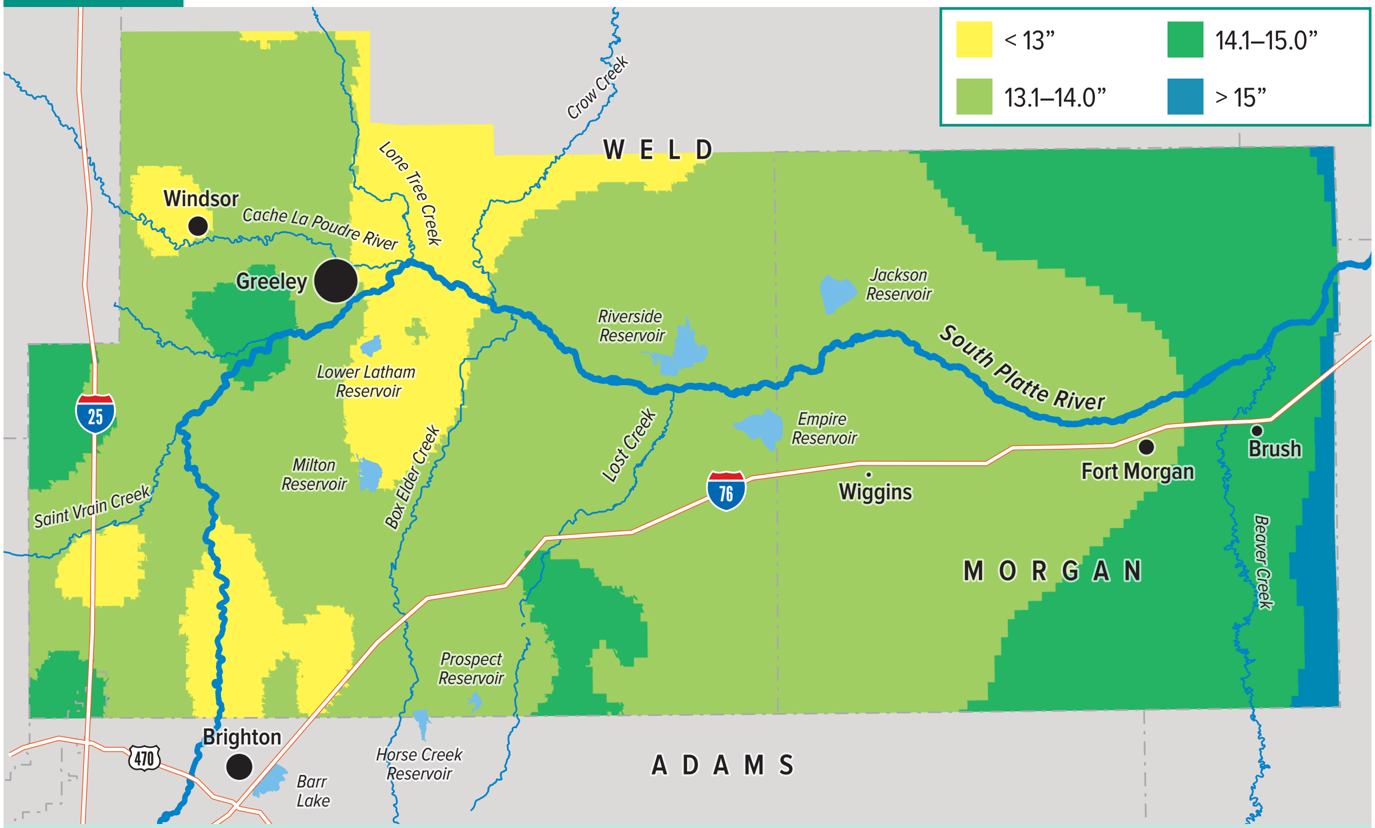


rotation. Summer crops used in the 3-year rotation include corn, proso millet, sunflower or sorghum. While the long-term study applies to areas with long-term average annual precipitation of 16 inches or more, the focus area for the current CSU study is a drier region, with precipitation ranging from 12 to 15 inches. The average annual precipitation increases from west to east, with the greatest annual precipitation on the eastern-most boundary of the study area (Figure 3-3).

There are a few dry land cropping system studies in Colorado in locations with precipitation similar to that of the Project study area. Among the most relevant is a dry land crop production study conducted by Colorado State University at Briggsdale, Colorado, from 1999–2005 (Peairs et al. 2012).

The study's primary objective was to determine crop production in an environment with less than 15 inches of annual precipitation. The long-term average annual precipitation at Briggsdale is 13.7 inches, but during the study period the average was only 9.4 inches and ranged from 7.5 to 12.8 inches.

Another objective was to evaluate alternative crops and fallow frequency for this environment. The study compared four no-till crop rotations ranging from one summer fallow every other year to continuous cropping *figure* **3-3.** Average annual precipitation for South Weld and Morgan counties.



with no summer fallow. Reductions in wheat yields of 11 to 78% were observed in dry land systems without fallow, compared to the traditional 2-year wheat–fallow system (Table 3-1). Wheat yields were related to the amount and timing of growing season precipitation (Table 3-1).

In dry years, wheat after fallow had the largest yield advantage over wheat in continuous cropping. Crops such as corn, sunflower, soybean, grain sorghum, Austrian winter pea and forage soybean, all of which were used at least once in the 6-year cropping system, had low yields and were too risky for dry land production in this stressful environment.

These results indicate that the most suitable cropping systems were those with fallow every other year or every third year (2- to 3-year rotations). Well-adapted annual forage crops (used for animal feed) were identified as reasonable choices for the summer crop in a 3-year rotation. Promising forage crops include forage sorghum, hay-type millets and triticale. Figure 3-4 shows a forage sorghum crop.

Another relevant, ongoing, dry land cropping study led by CSU is being conducted 28 miles east of Byers, Colorado (Barbarick et al. 2012). The study objective is to compare agronomic rates of commercial nitrogen fertilizer to an equivalent rate of biosolids in wheat–fallow and wheat–

corn–fallow rotations. However, for the current study, the nitrogen source is not as important as the general observation of wheat production level in the low-precipitation environment. For the years 2000–2012, average annual precipitation ranged from 5 to 15.8 inches and averaged 10.6 inches. Wheat yields in the wheat–fallow rotation ranged from 0 to 72 bushels per acre (bu/ac) and averaged 33 bu/ac. In the wheat–corn–fallow rotation, wheat yields ranged from 0 to 68 bu/ac and averaged 30 bu/ac. Corn yields averaged 36 bu/ac and ranged from 0 to 113 bu/ac.

3.2 Potential for Conversion of Irrigated Land to Dry Land or Limited-Irrigation Crops

A study was conducted by Colorado State University at the Agricultural Research, Development, and Education Center (ARDEC) north of Fort Collins to evaluate the conversion of irrigated land to limited-irrigation or dry land cropping (N.C. Hansen, Colorado State University, Associate Professor, personal communication, May 30, 2013). The locations of the Briggsdale, Byers and ARDEC site are shown in Figure 3-5.

The dry land crop rotation evaluated was initially a wheat–fallow rotation (2005–2006), which was subsequently converted to a dry land wheat–corn rotation (2007–2012). The annual rainfall amounts ranged from 4.4 to 16.1 inches and averaged 10.6 inches. Winter wheat yield ranged from 16 to 56 bu/ac and averaged 36 bu/ac (Table 3-2). Dry land corn yield ranged from 7 to 67 bu/ac and averaged 43 bu/ac. Both wheat and corn yields were

Table **3-1.** Dry land winter wheat yield in crop rotations with and without a summer fallow preceding the wheat from 2000–2005 and the precipitation during the vegetative (September to March) and reproductive (April to June) growth stages of wheat at Briggsdale, Colorado.

Year	Wheat After Fallow	Wheat in Continuous Cropping	Precipitation, Sep–Mar (inches)	Precipitation, Apr–Jun (inches)
		(bushels/acre)		
2000	19.4	15.6	4.70	3.70
2001	45.2	44.1	2.20	8.00
2002	19.4	18.2	1.90	2.20
2003	46.0	32.7	2.90	4.90
2004	42.2	30.9	2.00	4.40
2005	20.6	30.3	3.10	5.60
Mean	32.1	28.6	2.80	4.80

Source: Peairs et al. 2012.

positively related to the amount of growing season precipitation.

The CSU-ARDEC study also evaluated a limited-irrigation wheat–corn–sunflower crop rotation, where average irrigation applied was 3.6, 8.1 and 7.3 inches to wheat, corn and sunflower, respectively. In these studies, limited irrigation was not a fixed percentage of evapotranspiration demand, but was based on applying irrigation water during the reproductive growth stage of the crops while avoiding irrigation during vegetative growth stages. Average yields were 48 bu/ac, 144 bu/ac and 2158 lbs/ac for wheat, corn and sunflower, respectively (Table 3-2).

figure **3-4.** Sorghum seeded into winter wheat residue.

figure **3-5.** Locations of CSU research sites.

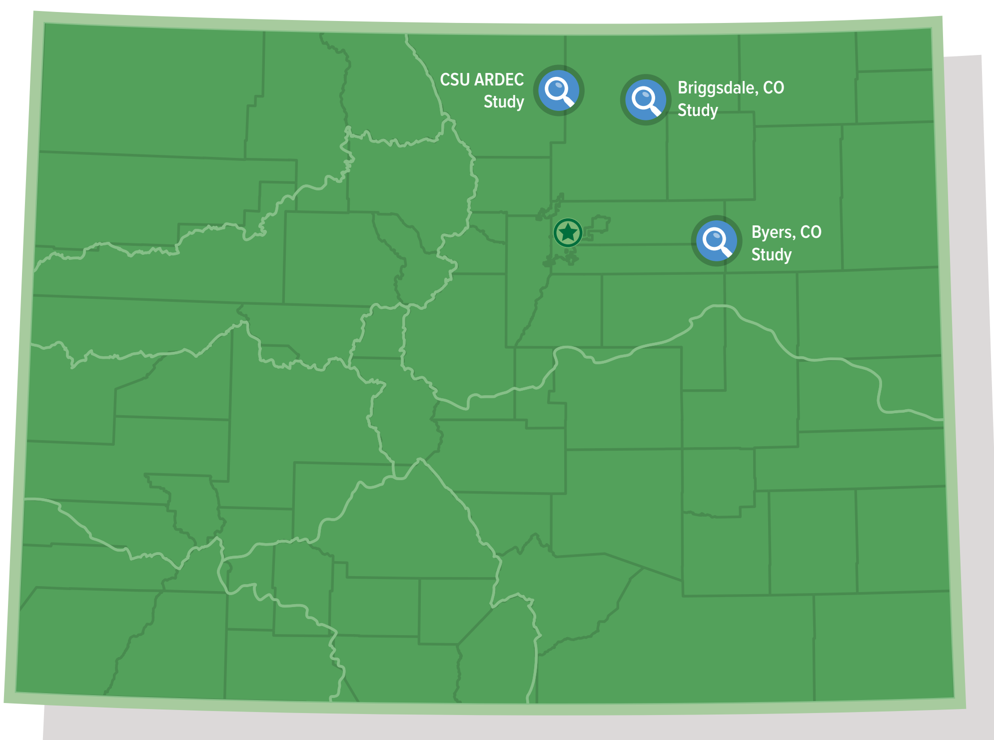


Table **3-2.** Crop yields in dry land, limited, and full irrigation crop rotations from 2005–2012 at the CSU Agricultural Research, Development, and Education Center (ARDEC) near Fort Collins, Colorado.

Irrigation	Crop	Units	2005	2006	2007	2008	2009	2010	2011	2012	Avg.
Growing season precipitation	—	*in*	*11.6*	*4.4*	*10.4*	*11.5*	*11.2*	*12.5*	*12.2*	*6.8*	*10.1*
Dry land	corn	bu/acre	n/a	n/a	24	55	67	45	61	6.6	43
Dry land	wheat	bu/acre	n/a	44	22	27	48	44	53	16	36
Limited	corn	bu/acre	163	121	101	180	190	153	123	126	144
Limited	wheat	bu/acre		44	33	*	63	52	62	54	48
Full	corn	bu/acre	237	177	186	173	215	196	177	131	186
Full	alfalfa	tons/acre	n/a	3.4	3.8	4.2	5.6	2.6	4.2	3.2	3.8

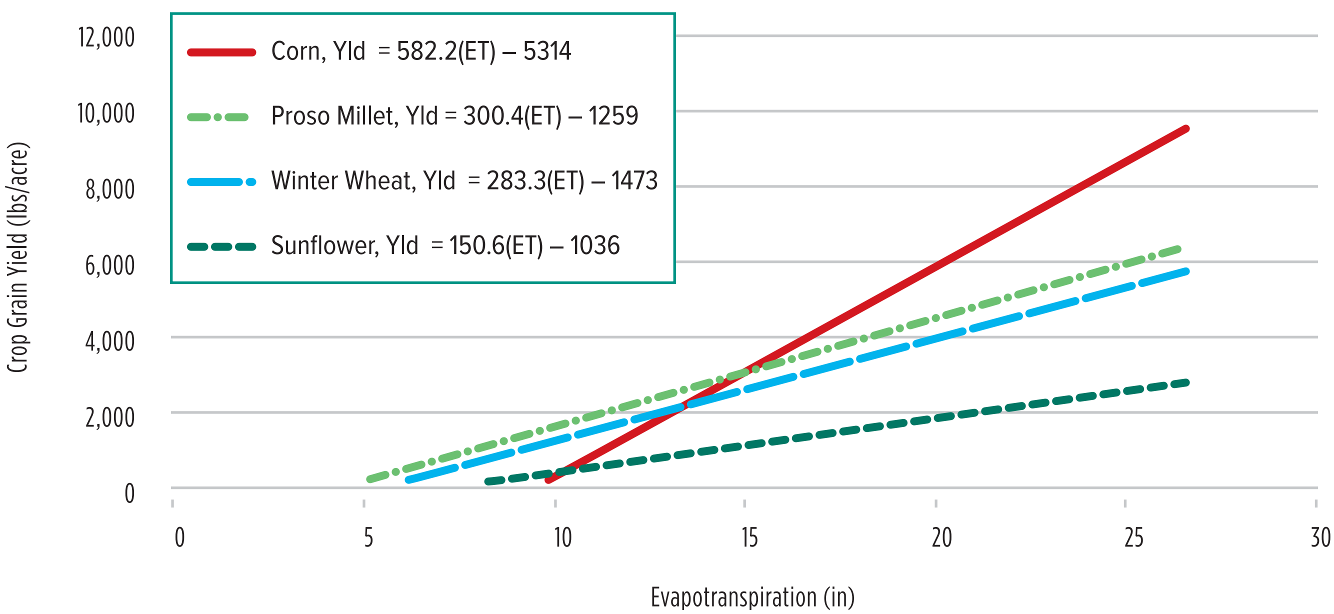
* No grain yields were taken due to low germination at planting or loss crop due to hail.

2005 and 2010 were alfalfa establishment years.

Section 4: Identification and Mapping of Lands by Suitability for Revegetation, Dry Land or Limited Irrigation

The potential for dry land or limited-irrigation crop production of currently irrigated land within the study area was investigated. The approach used was to combine crop-water-production functions (relationships that estimate crop yield based on water input) and GPS data for precipitation and soil water-holding capacity to estimate dry land and limited-irrigation yields. Soil water-holding capacity is a function of the texture of the soil. For example, soils with high amounts of sand do not retain as much water as soils with less sand and more clay. The crop-water-production functions used are shown in Figure 4-1 and were developed by the U.S. Department of Agriculture's Agricultural Research Service (USDA-ARS) (Nielsen 2006).

figure 4-1. Crop yield vs. evapotranspiration.

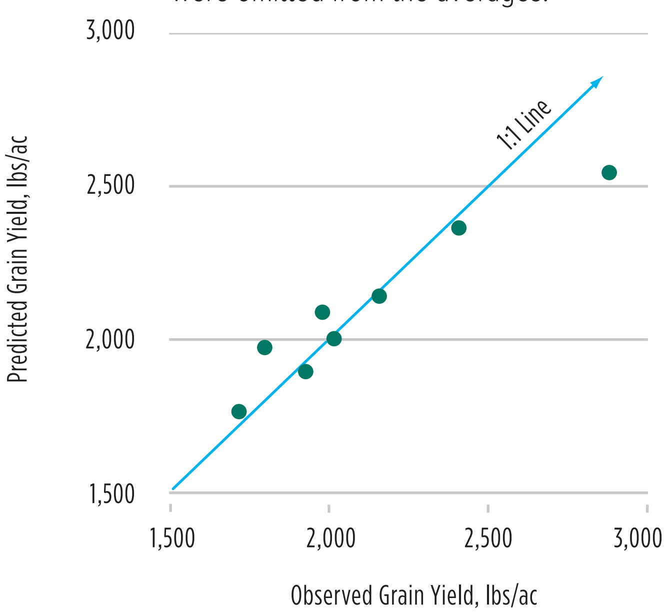


Corn grain yield (lbs/ac) = 582.2 (water input, in) – 5314 (convert to bu/ac using 56 lbs/bu)
Proso millet grain yield (lbs/ac) = 300.4 (water input, in) – 1259 (convert to bu/ac using 50 lbs/bu)
Winter wheat grain yield (lbs/ac) = 283.3 (water input, in) – 1473 (convert to bu/ac using 60 lbs/bu
Sunflower grain yield (lbs/ac) = 150.6 (water input, in) – 1036

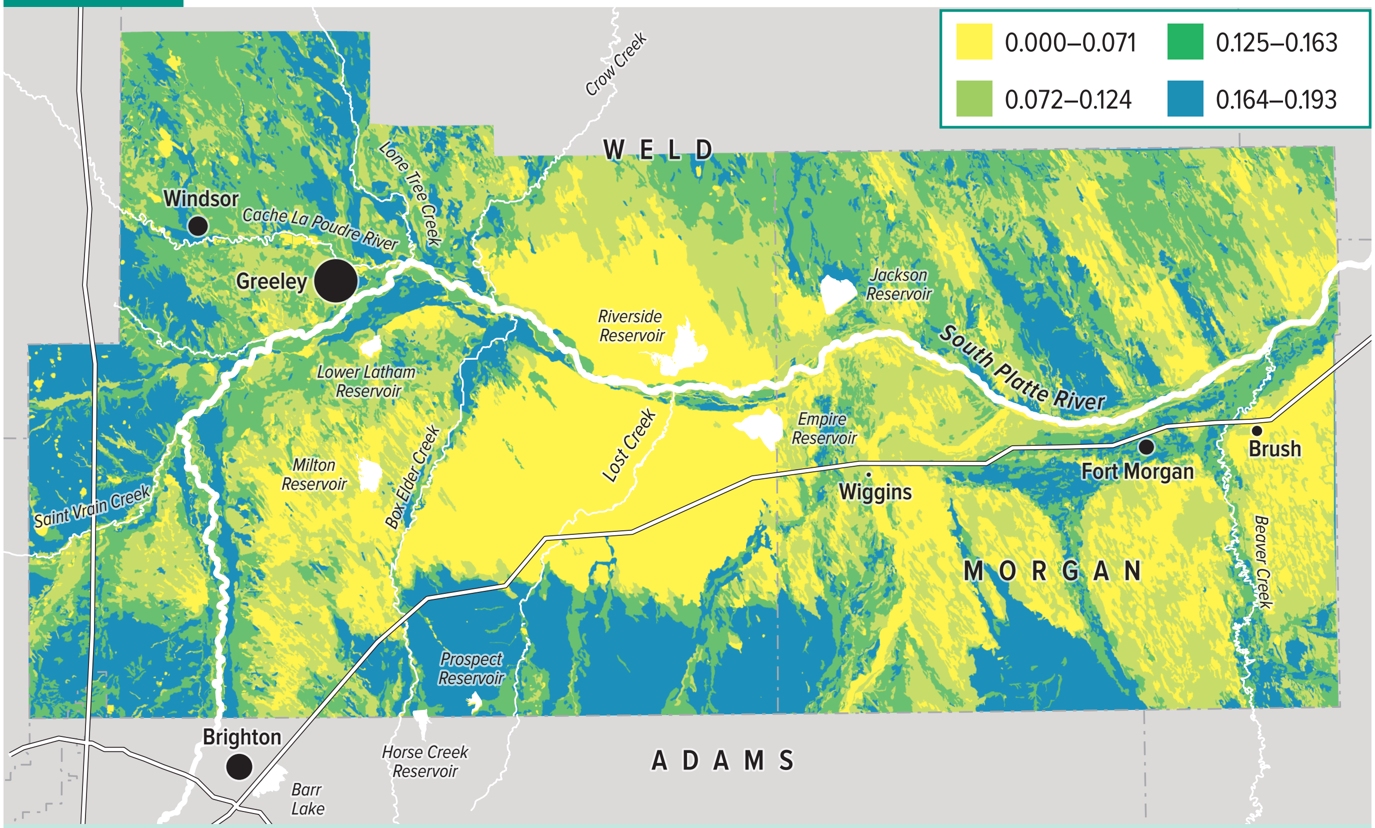
The water input was computed from GIS data-layers (PRISM Climate Group 2012), combining growing season precipitation and a fixed percentage of the available water-holding capacity of the soil (U.S. Department of Agriculture, Natural Resources Conservation Service, Soil Survey Staff 2012). Calculations in this report assume that plant-available soil moisture content was 70% of the soil's available water capacity at planting. This value can be changed to represent wetter or dryer soil conditions at planting, and this variable can have a significant effect on yield. However, the intent of the study was to identify relative differences in potential yield as a function of soil type and precipitation patterns, and, for this purpose, using a fixed percentage is appropriate. For the limited-irrigation scenario, a fixed amount of irrigation is added to the precipitation and stored soil moisture.

Growing seasons were determined based on the average date of planting and harvest for the CSU field studies (conversion to dry land farming and limited irrigation) relevant to this region. The growing seasons used were September 24 to July 1 for winter wheat, May 14 to September 30 for corn, June 11 to September 9 for proso millet and June 11 to September 30 for sunflower. The precipitation database (PRISM) used for long-term average precipitation reports precipitation by month. Therefore, precipitation was determined by multiplying the monthly precipitation value by the percentage of growing season days in that month. Available water-holding capacity was computed using a weighted average of the water-holding capacity by soil layer to a depth of 3 feet for wheat and proso millet and 4 feet for corn and sunflower, a representative rooting depth for these crops. A simple validation of the crop-water-production functions was performed by using the average observed growing season precipitation, soil water and crop yield reported from the Briggsdale, Byers and ARDEC field studies. As shown in Figure 4-2, there was a good correlation between the observed and predicted yields.

figure **4-2** Observed grain yields, averaged over the life of the study (wheat, corn and sunflower) from field experiments in Briggsdale, Byers and Fort Collins and grain yields predicted using crop-water-production functions developed by D.C. Nielsen (Nielsen 2006). Years of total crop failure were omitted from the averages.



The average weighted available water capacity (AWC) of the soil types in the study area are shown in Figure 4-3. The average growing season precipitation for wheat and corn are shown in Figures 4-4 and 4-5, respectively. The two growing seasons have very different precipitation patterns. Precipitation for the corn growing *figure* **4-3.** Variation in soil-available water-holding capacity, which is determined by a depth-weighted average of available water-holding capacity of individual soil layers to a depth of 4 feet.



season is dominated by a pattern of increasing precipitation from west to east during summer months, with a notable rain shadow zone in the middle section. During the wheat growing season, conditions are relatively drier in the central and eastern parts of the study area. When the growing season precipitation patterns are combined with the available water-holding capacity of the soil, the water-limited crop production potential can be inferred. Maps of growing season precipitation for proso millet and sunflower (not shown) have patterns similar to the map for corn and were not included.

Yield estimates were made by using the growing season precipitation and soil water-holding capacity as inputs in the crop-water-production functions to predict spatial variation of potential productivity of a crop. Figures 4-6 and 4-7 illustrate the predicted yields of winter wheat under dry land conditions and limited irrigation, assuming the addition of 6 inches of irrigation water and sprinkler irrigation with an irrigation efficiency of 0.85, resulting in 5.1 inches of water used by the crop. Dry land winter wheat production averaged 25 bu/ac over the entire study area. The variability in yield was primarily associated with variation in soil type, with yields ranging from 9 to 37 bu/ac. The addition of limited irrigation to the winter wheat increased the mean yield to 49 bu/ac.

figure **4-4.** Precipitation during the crop growing season for winter wheat (September 24 to July 1).

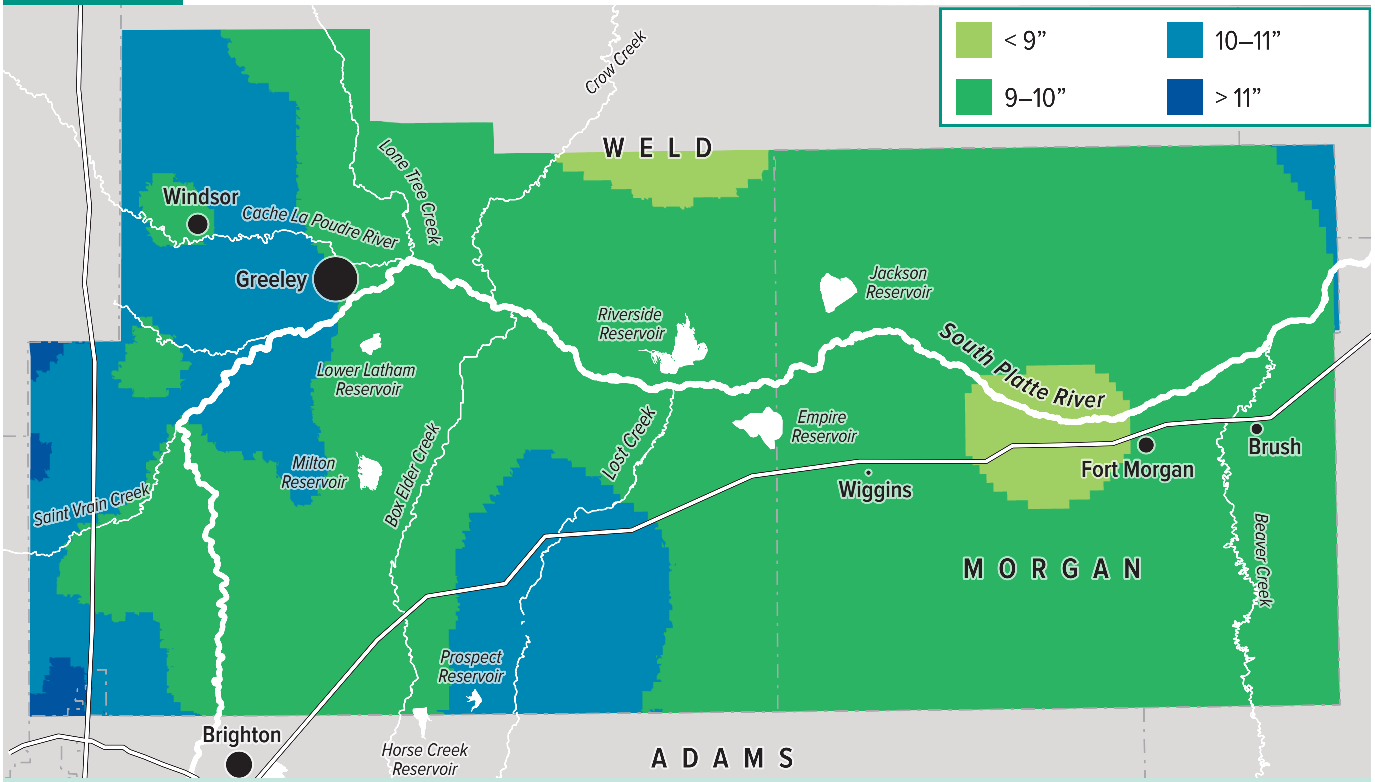


figure **4-5.** Precipitation during the crop growing season for corn (May 14 to September 30).

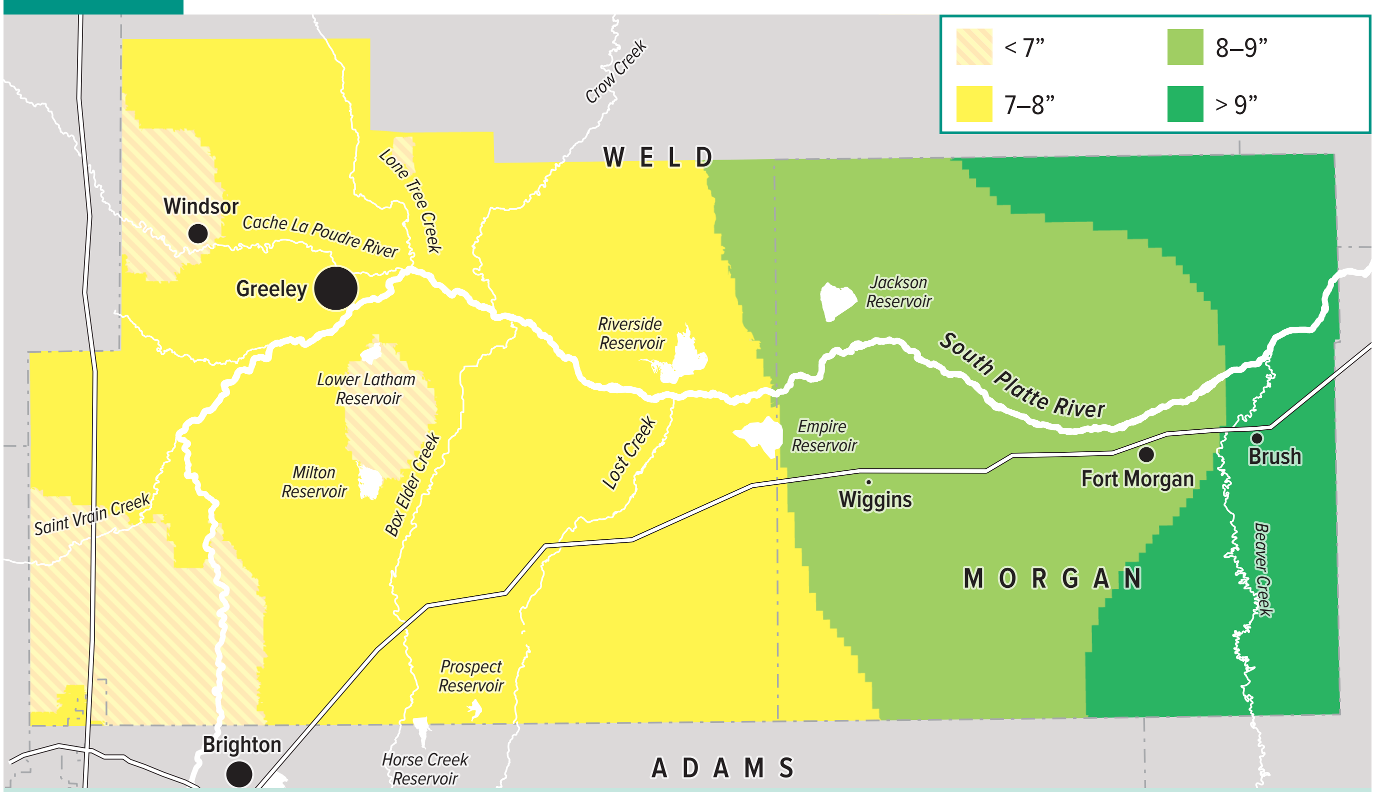


figure **4-6.** Predicted average annual yields for wheat – dry land.

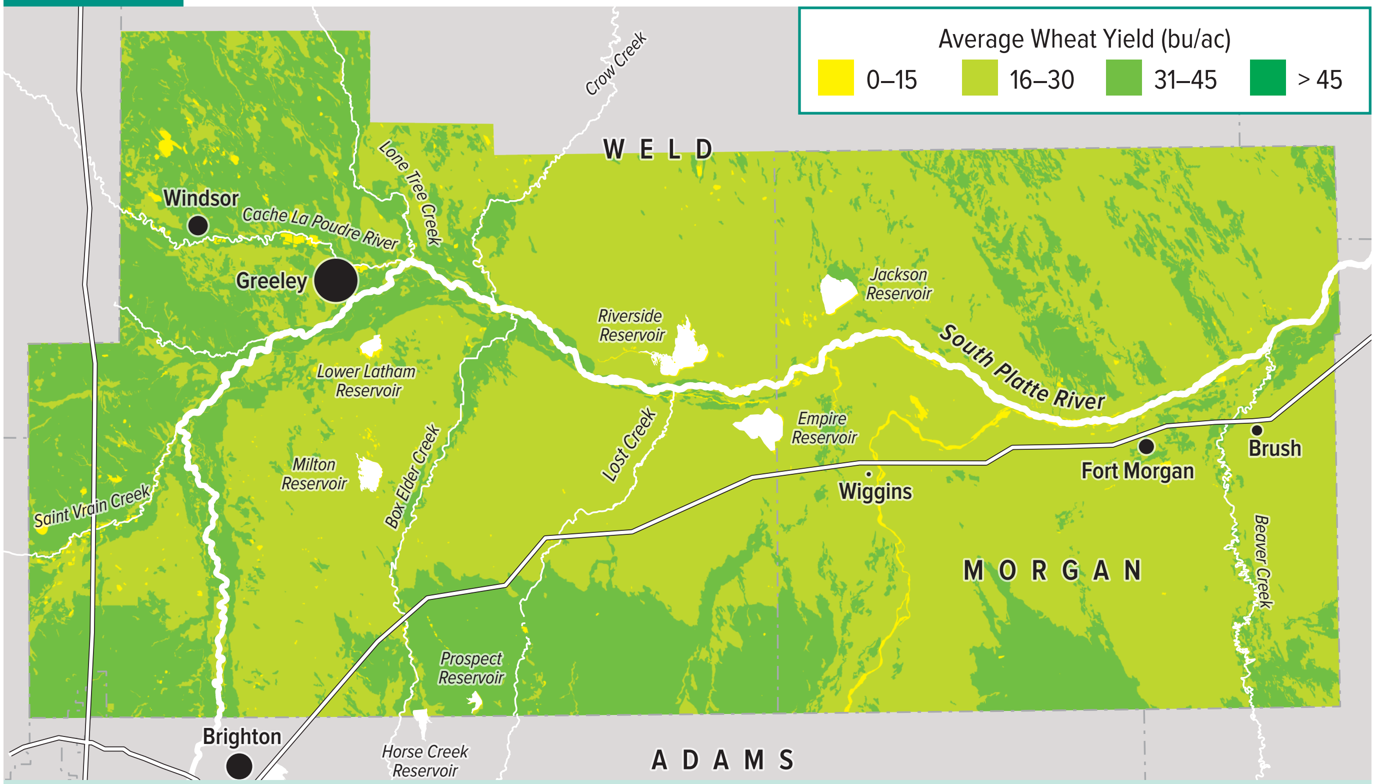
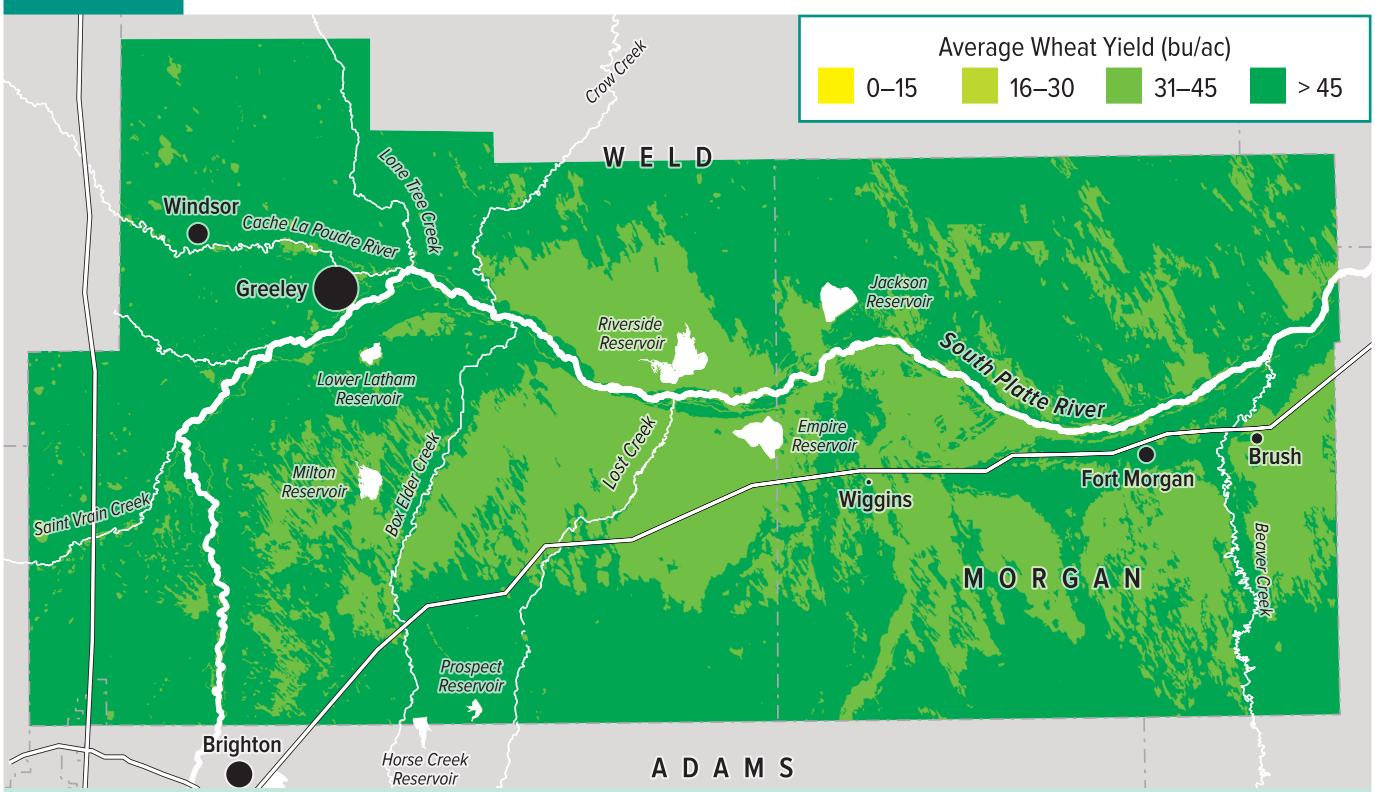


figure **4-7.** Predicted average annual yields for wheat – limited irrigation (6 inches).



Figures 4-8 and 4-9 illustrate the predicted yields of corn under dry land conditions and with the addition of 6 inches of irrigation water, assuming sprinkler irrigation with an irrigation efficiency of 0.85, resulting in 5.1 inches of water use by the crop. Predicted yields of dry land corn indicate the high risks of growing corn in dry land environments where annual precipitation is less than 16 inches and rainfall is lacking during the critical summer months. The average dry land corn yield was only 20 bu/ac, and many parcels show a failure of corn to yield any grain. With limited irrigation, corn in this area can have moderate and potentially economically viable yields. Average yield of corn under limited irrigation was 71 bu/ac.

Proso millet is a short-season summer crop that requires little water and is well-adapted to this region. Average proso millet yields were 21 and 51 bu/ac under dry land (Figure 4-10) and limited irrigation (Figure 4-11), respectively. Sunflower yields averaged 410 lbs/ac under dry land (Figure 4-12) and 1,160 lbs/ac with limited irrigation (Figure 4-13). These are low to moderate yields for sunflower.

Spatial variation in soil and precipitation patterns have a significant effect on the potential success of dry land and limited-irrigation crop production. As a whole, successful dry land farming in this region is limited by low rainfall conditions and soils with low water-holding capacity. In areas with better quality soils, winter wheat may be the crop most suited for dry land production. Wheat is able to respond to water in the soil at planting or to irrigation water applied in spring and early summer. For all crops evaluated, the ability to apply limited irrigation at key growth stages can potentially increase crop yield. For wheat and proso millet, limited-irrigation yields were predicted to double the yields for dry land conditions, and for corn and sunflower, limited irrigation increased yields nearly three-fold. However, these yield estimates assume that the limited amount of irrigation water would be available during critical growth stages. For corn, the most sensitive time period is July 15 to August 20. Applying irrigation to corn prior to this time period does not guarantee a strong yield response. For surface irrigation rights, water may not be available at the critical time period for corn or other late-season crops. For this reason, wheat may also be the best crop choice for limited irrigation.

For wheat and proso millet, limited-irrigation yields were predicted to double the yields for dry land conditions. For corn and sunflower, limited irrigation increased yields nearly threefold.

While this study did not forecast yields of annual forage crops, these crops may also be favorable for production under limited-irrigation systems. There is a growing demand for forage crops along the Front Range because they are less sensitive to the timing of irrigation. Forage sorghum, triticale and hay-millet are good forage crops for this area.

figure 4-8. Predicted average annual yields for corn – dry land.

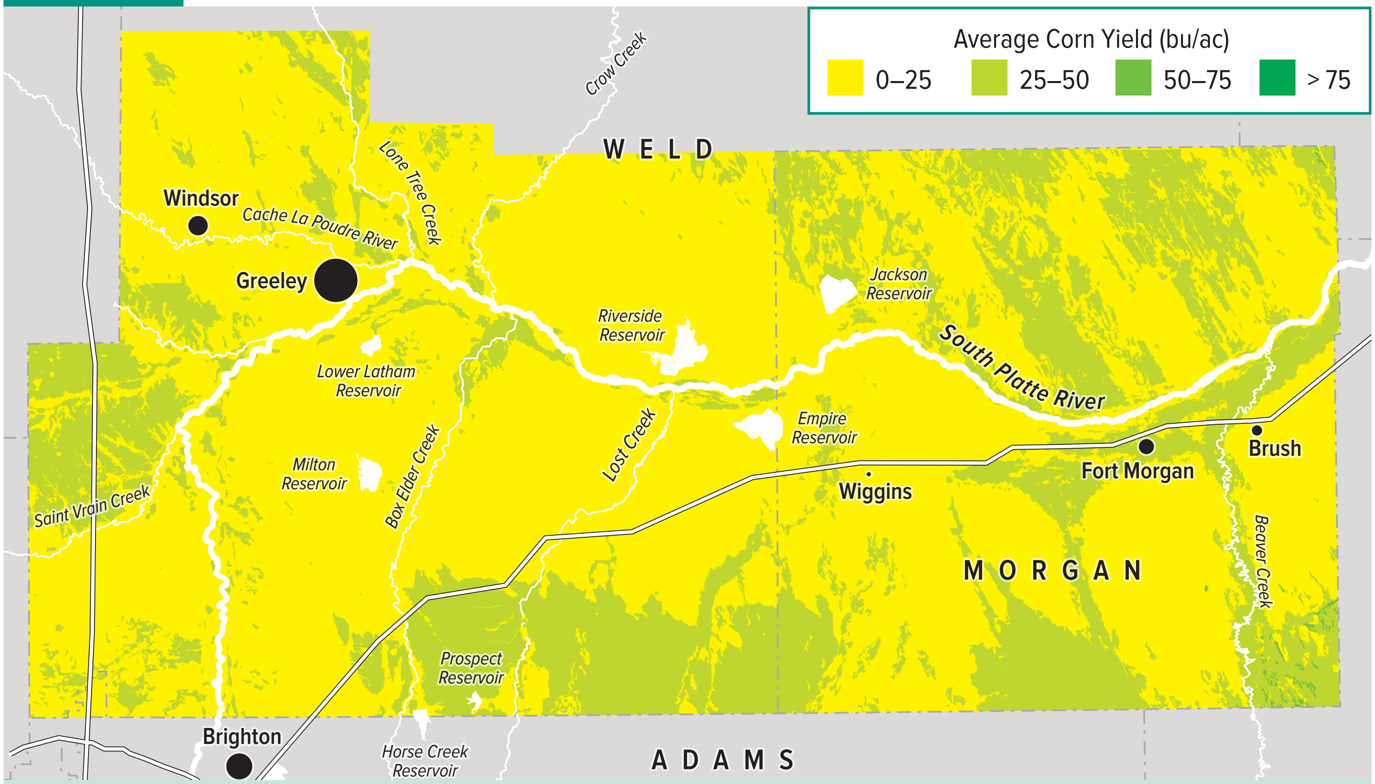


figure 4-9. Predicted average annual yields for corn – limited irrigation (6 inches).

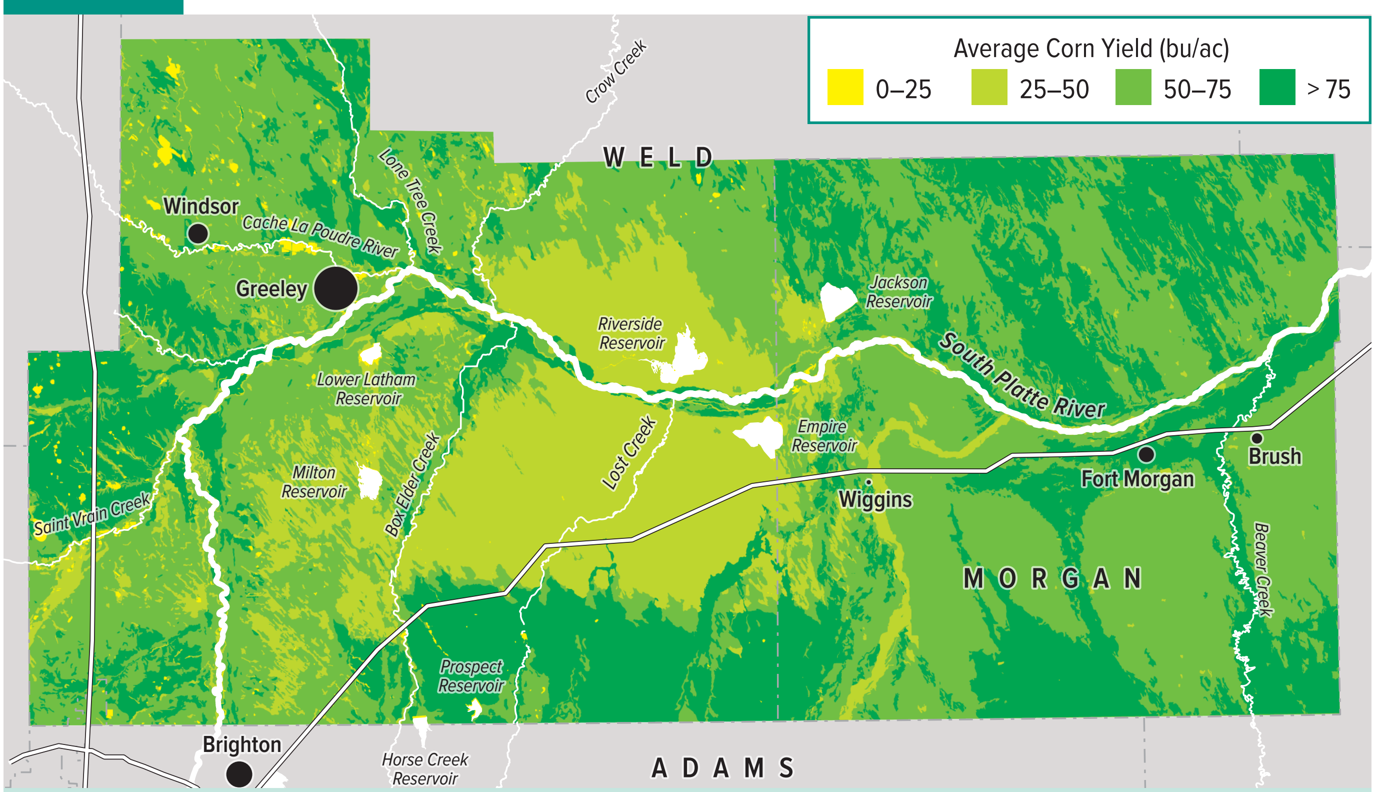


figure **4-10.** Predicted average annual yields for proso millet – dry land.

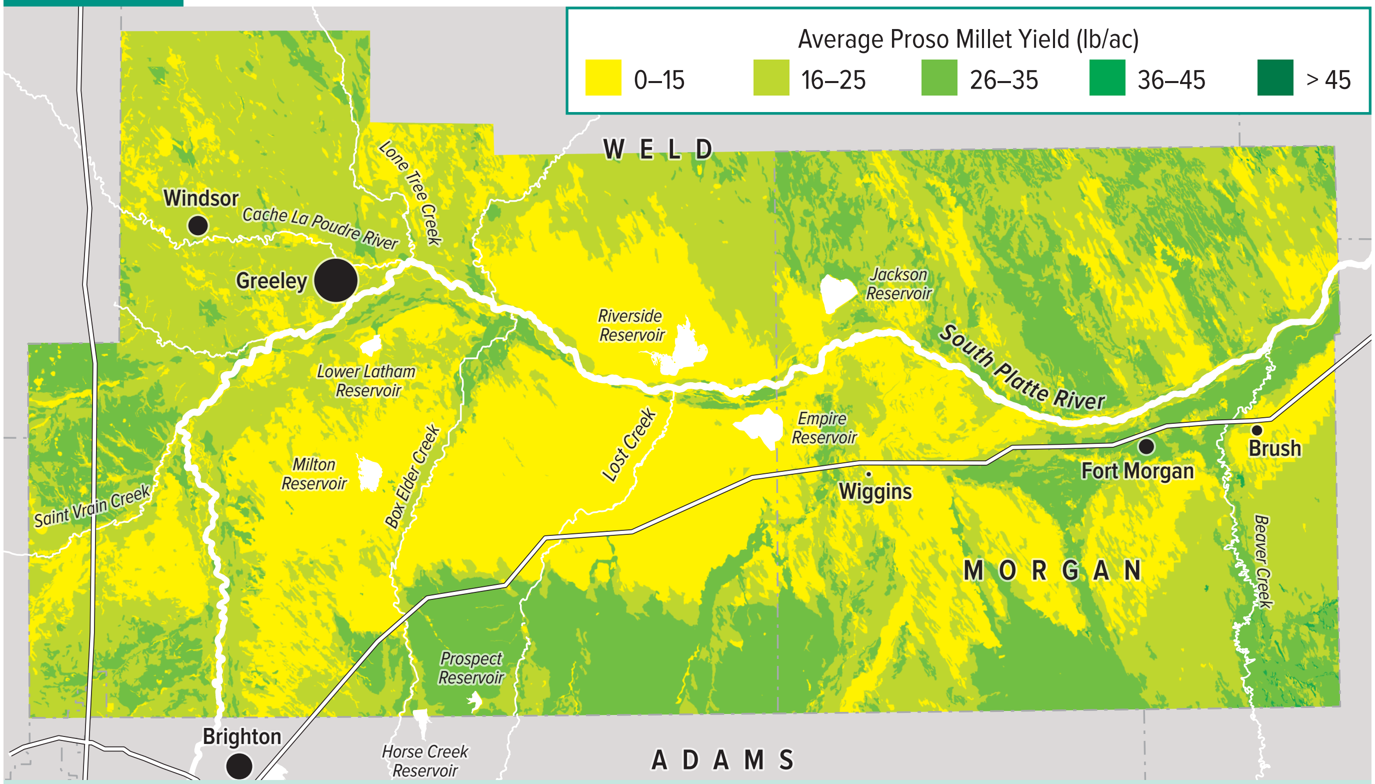


figure **4-11.** Predicted average annual yields for proso millet – limited irrigation (6 inches).

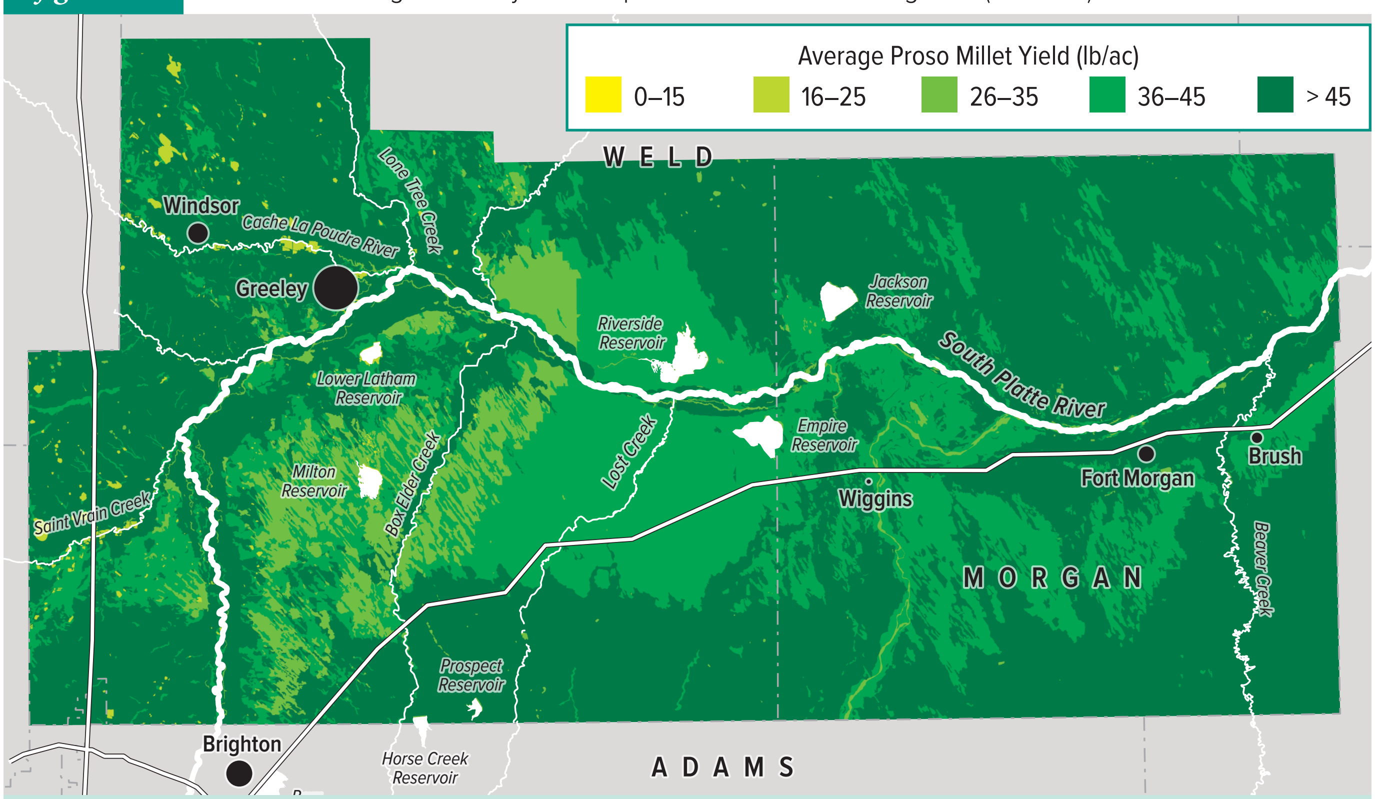


figure **4-12.** Predicted average annual yields for sunflower – dry land.

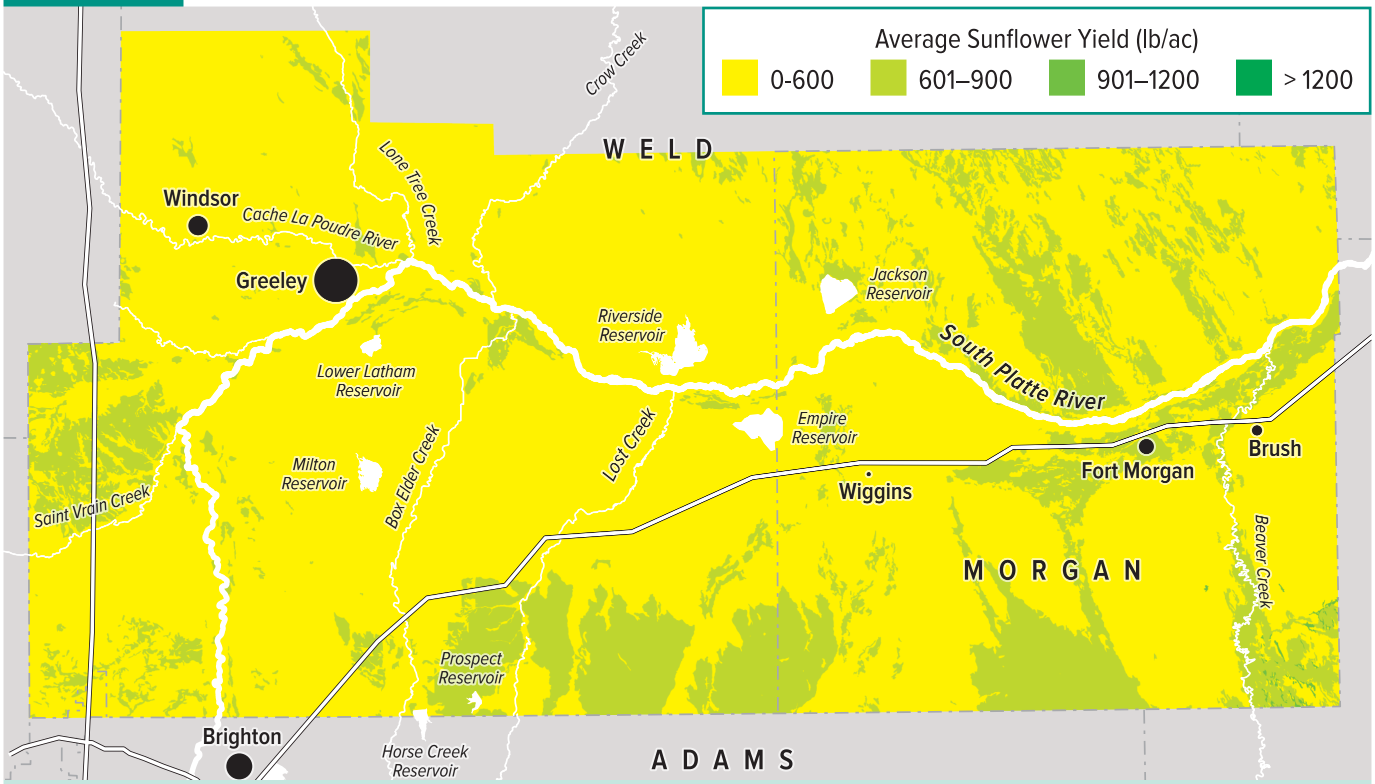
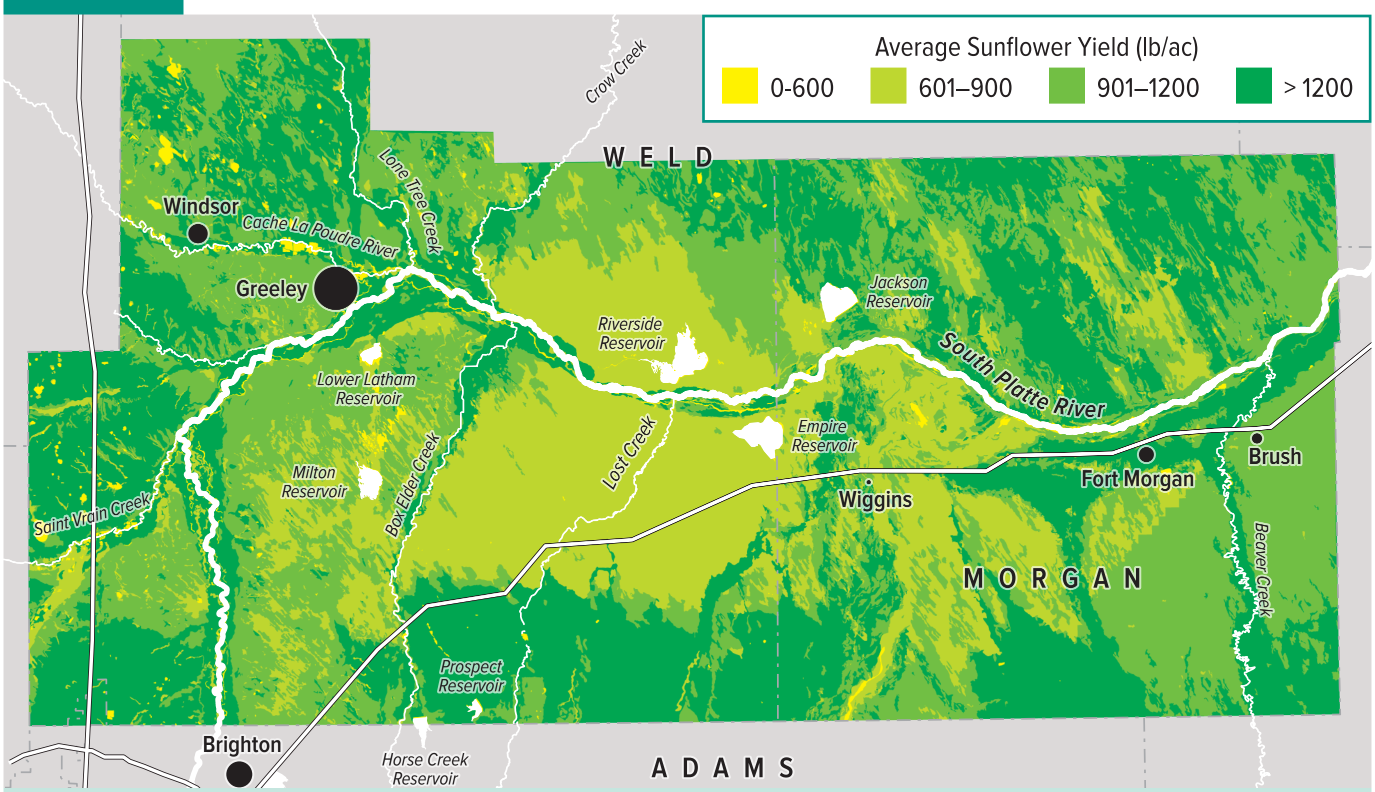


figure **4-13.** Predicted average annual yields for sunflower – limited irrigation (6 inches).



Section 5: Economic Issues With Conversion to Dry Land or Limited Irrigation

Economic issues associated with the possible conversion of irrigated land to dry land or limited irrigation were identified and investigated. Among the issues evaluated were:

- The crop insurance implications of having a specified volume of irrigation supply for a dry land crop
- The costs to the farmer to maintain an irrigation system that would be used only infrequently to provide limited irrigation for a dry land crop
- The likely property tax classification that would result if a dry land crop were to have very limited irrigation
- The net economic production of this land under conventional dry land and partial irrigation/dry land cropping

5.1 Issues and Costs Associated With Crop Insurance

Currently, the USDA Risk Management Agency (RMA) recognizes only two practices for crop production, irrigated and non-irrigated. If a producer intends to implement limited crop irrigation on a unit that had Actual Production History (APH) built on full irrigation, that unit could not be insured as irrigated. Instead, it would have to be insured as non-irrigated. The current procedure allows insured producers that become aware of decreased irrigation water before coverage begins to reduce the number of irrigated acres planted in the crop in order to irrigate the planted acres to full irrigation levels. Producers may plant and report as irrigated only those acres for which they can show they have adequate water and facilities to produce the yield on which the guarantee is based. The remainder of the acres can be planted and reported as non-irrigated.

The possibility of future insurance options for limited-irrigation practices is being investigated. The RMA has a cooperative agreement with the University of Nebraska to assist producers facing reduced irrigation water supplies. As a part of this agreement, yield adjustment tables are being developed for most counties in Nebraska, Western Kansas and Eastern

Table 5-1. Example eduction in irrigated corn production based on reduced irrigation supply (Sheridan County, Kansas).

Color Coding:

Red = Crop reduction dips below the 65% of T-Yield or Transitional Yield (in this case, for corn), which is the default yield. Therefore, it is not profitable to irrigate because the crop yield would be at the default level. Transitional Yield varies based historical irrigation but ranges from approximately 120–210 bushels per acre. (Numbers in red are bolded.)

Green, White = The amount of reduction in crops. There is no difference between numbers shown in green vs. white; both indicate the reduction in bushels per acre that result in the reduction in historical water supply. (Numbers in green are italicized.)

Historical Irrigation Supply, Inches	Reduction in Historical Irrigation Supply, Inches														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Reduction in Bushels per Acre														
1	*-11.8*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*
2	*-11.5*	*-23.3*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*
3	*-11.3*	*-22.8*	*-34.6*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*
4	*-11*	*-22.3*	*-33.9*	*-45.6*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*
5	*-10.8*	*-21.8*	*-33.1*	*-44.7*	*-56.4*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*
6	*-10.5*	*-21.3*	*-32.3*	*-43.6*	*-55.2*	*-66.9*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*
7	*-10.2*	*-20.7*	*-31.5*	*-42.5*	*-53.8*	*-65.4*	**-77.1**	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*
8	*-9.9*	*-20.1*	*-30.6*	*-41.4*	*-52.4*	*-63.7*	**-75.2**	**-87**	*na*	*na*	*na*	*na*	*na*	*na*	*na*
9	-9.5	*-19.4*	*-29.6*	*-40.1*	*-50.9*	*-61.9*	*-73.2*	**-84.8**	**-96.5**	*na*	*na*	*na*	*na*	*na*	*na*
10	-9.2	-18.7	*-28.6*	*-38.8*	*-49.3*	*-60.1*	*-71.1*	**-82.4**	**-93.9**	**-105.7**	*na*	*na*	*na*	*na*	*na*
11	-8.8	-17.9	-27.5	*-37.3*	*-47.5*	*-58*	*-68.8*	**-79.9**	**-91.1**	**-102.7**	**-114.4**	*na*	*na*	*na*	*na*
12	-8.3	-17	-26.2	-35.7	*-45.6*	*-55.8*	*-66.3*	**-77.1**	**-88.1**	**-99.4**	**-111**	**-122.7**	*na*	*na*	*na*
13	-7.8	-16.1	-24.8	-34	-43.5	*-53.4*	*-63.6*	*-74.1*	**-84.9**	**-95.9**	**-107.2**	**-118.8**	**-130.5**	*na*	*na*
14	-7.2	-14.9	-23.2	-32	-41.1	-50.7	*-60*	*-70.8*	**-81.3**	**-92**	**-103.1**	**-114.4**	**-125.9**	**-137.7**	*na*
15	-6.4	-13.6	-21.3	-29.6	-38.4	-47.5	-57.1	*-67*	**-77.2**	**-87.7**	**-98.4**	**-109.5**	**-120.8**	**-132.3**	**-144.1**
16	-5.4	-11.8	-18.9	-26.7	-35	-43.7	-52.9	-62.4	*-72.3*	**-82.5**	**-93**	**-103.8**	**-114.8**	**-126.1**	**-137.7**
17	-2.9	-8.3	-14.7	-21.9	-29.6	-37.9	-46.7	-55.8	-65.4	**-75.3**	**-85.5**	**-96**	**-106.7**	**-117.8**	**-129.1**
18	0	-2.9	-8.3	-14.7	-21.9	-29.6	-37.9	-46.7	-55.8	-65.4	**-75.3**	**-85.5**	**-96**	**-106.7**	**-117.8**
19	0	0	-2.9	-8.3	-14.7	-21.9	-29.6	-37.9	-46.7	-55.8	-65.4	**-75.3**	**-85.5**	**-96**	**-106.7**
20	0	0	0	-2.9	-8.3	-14.7	-21.9	-29.6	-37.9	-46.7	-55.8	-65.4	**-75.3**	**-85.5**	**-96**
21	0	0	0	0	-2.9	-8.3	-14.7	-21.9	-29.6	-37.9	-46.7	-55.8	-65.4	**-75.3**	**-85.5**
22	0	0	0	0	0	-2.9	-8.3	-14.7	-21.9	-29.6	-37.9	-46.7	-55.8	-65.4	**-75.3**
23	0	0	0	0	0	0	-2.9	-8.3	-14.7	-21.9	-29.6	-37.9	-46.7	-55.8	-65.4
24	0	0	0	0	0	0	0	-2.9	-8.3	-14.7	-21.9	-29.6	-37.9	-46.7	-55.8
25	0	0	0	0	0	0	0	0	-2.9	-8.3	-14.7	-21.9	-29.6	-37.9	-46.7
26	0	0	0	0	0	0	0	0	0	-2.9	-8.3	-14.7	-21.9	-29.6	-37.9
27	0	0	0	0	0	0	0	0	0	0	-2.9	-8.3	-14.7	-21.9	-29.6
28	0	0	0	0	0	0	0	0	0	0	0	-2.9	-8.3	-14.7	-21.9
29	0	0	0	0	0	0	0	0	0	0	0	0	-2.9	-8.3	-14.7
30	0	0	0	0	0	0	0	0	0	0	0	0	0	-2.9	-8.3

Source: U.S. Department of Agriculture, Risk Management Agency, Topeka Regional Office 2011.

Colorado. These tables provide an estimated yield reduction associated with decreased irrigation. An example of one of these yield reduction tables is shown below for irrigated corn (Table 5-1).

The yield reduction table illustrates the reduction in APH that would be associated with a reduction in irrigation water supply. This reduced APH would be used as the new yield guarantee when setting insurance coverage prior to crop planting. For example, if a parcel had an irrigation water use of 20 inches and expected a 7-inch water supply reduction, a 21.9-bushel decrease in yield would be calculated into the adjusted APH.

The Topeka Regional Office of RMA has been working with researchers at the University of Nebraska, Kansas State University and Colorado State University to review the validity of the yield adjustment tables and the potential implementation in the crop insurance program in the region. Although this limited project was moving forward to be in place for the 2013 crop year, it is being implemented for 2013 only in a Local Enhanced Management Area (LEMA) in Sheridan County, Kansas. Producers in Sheridan County submitted a LEMA plan that requires a reduction of close to 20% in average irrigation levels over the next 5 years. At the urging of Kansas Governor Sam Brownback, this limited application of the yield adjustment tables was approved by USDA-RMA to provide access to limited-irrigation crop insurance for these producers as they face limited water supplies moving forward.

To implement coverage for a limited-irrigation practice, a special provision statement would be added to allow insurance for a less than fully irrigated crop if a yield reduction is made to the irrigated APH yield. Yield adjustment tables would be published on the special provisions for making these yield adjustments. Yield adjustments would continue to be made until the APH yield was representative of the limited-irrigation yield. The reduced yield would become the yield upon which the insurance guarantee is based. Amendments would be made to the RMA procedures and handbooks. A documentation tool/certification form for recording historical and current-year water application would be needed. Carrying out a limited-irrigation practice would be voluntary for producers, as they would be free to cut back on insured irrigated acres when water supplies were reduced or file for prevented planting coverage, if eligible (Waechter 2012).

5.2 Maintenance of Irrigation Systems

Conversations with several irrigation service company representatives and university irrigation specialists have revealed that while some maintenance costs would be reduced under a limited-irrigation scenario, approximately in line with the reduced amount of water applied, annual maintenance items would be the same under full or limited irrigation. Many maintenance costs under limited irrigation would be similar to those for full irrigation due to annual maintenance and normal wear and tear of the irrigation system being in the elements (freeze/thaw) that are unrelated to water volume applied. System infrastructure and parts subject to deterioration from water contact would last longer than under a fully irrigated situation, so in this area costs would be reduced. Colorado State University enterprise budgets for acres with a full water supply in Northeastern Colorado use a common irrigation repair cost of $10 per acre to account for annual maintenance costs for irrigation systems, nozzle replacement, etc.

5.3 Property Tax Classifications

Classification of property for tax purposes in Colorado is performed by individual county tax assessors, but is ultimately governed by the Division of Property Taxation within the Colorado Department of Local Affairs. Within the Land Valuation Manual provided by the Division of Property Taxation, it is apparent that county assessors are bound by a strict set of guidelines that ultimately come down to the following basic principle: If water is available to irrigate, it will remain classified as irrigated land, regardless of the amount of irrigation water that is available.

After a property is classified, the assessed valuation of the property is a function of its income-producing potential based on the formulas and procedures provided by the Division of Property Taxation. Although county assessors have the discretion to determine "production areas" around farms with similar cropping practices or water delivery methods, discussions with representatives in the Weld and Morgan county assessor's offices have revealed that none currently have established areas for limited irrigation (personal communication with Duane Robson, Weld County Assessor's Office, January 1, 2013 and with Karina Brauous, Morgan County Assessor's Office, October 25, 2012). This appears to be due to the fact that limited irrigation is still a fairly rare circumstance and levels of limited irrigation vary from year to year and farm to farm. The authority to determine production areas around farms with similar cropping practices or water delivery methods may be an issue that could allow assessors to value parcels with limited-irrigation availability at lower levels of production. One recommendation within the guidelines that could delay the development of a limited-irrigation production practice is the determination of the average yield for the 10 years preceding. Unless an adjustment was allowed, a 10-year period would have to elapse to set this value.

The difference in property tax rates between dry land and irrigated land are fairly small relative to crop production costs. For example, two selected parcels in Morgan County are taxed at a rate of $0.66 per acre for dry land and $5.16 per acre for irrigated land. This difference in tax rates of $4.50 per acre is only about one-half of 1% of the total estimated production costs of $727 per acre for 2012 irrigated corn in Northeast Colorado. It should be noted, however, that this analysis does not account for the potential aggregate effect of reduced tax rates on tax revenues when large acreages within a single tax district are transitioned from irrigated to either dry land or limited irrigation.

The following summarizes the investigations related to the property tax for irrigated vs. non-irrigated agricultural land within the study area:

- No designation is made between fully and partially irrigated (limited irrigation) land.

- Assessors value land at the value of production to landowner; gross returns – expenses = net value of production

- There is a 10-year rolling window; every 2 years 2 years are added to the time window and 2 are dropped.

- The difference in irrigated vs. dry land taxes per acre are approximately $10 in Weld County and $4.50 in Morgan County.

- Farming or production areas for assessment purposes may be established by an individual ditch system or by a group of ditches. Other production areas can be established around farms with similar cropping practices or water delivery methods.

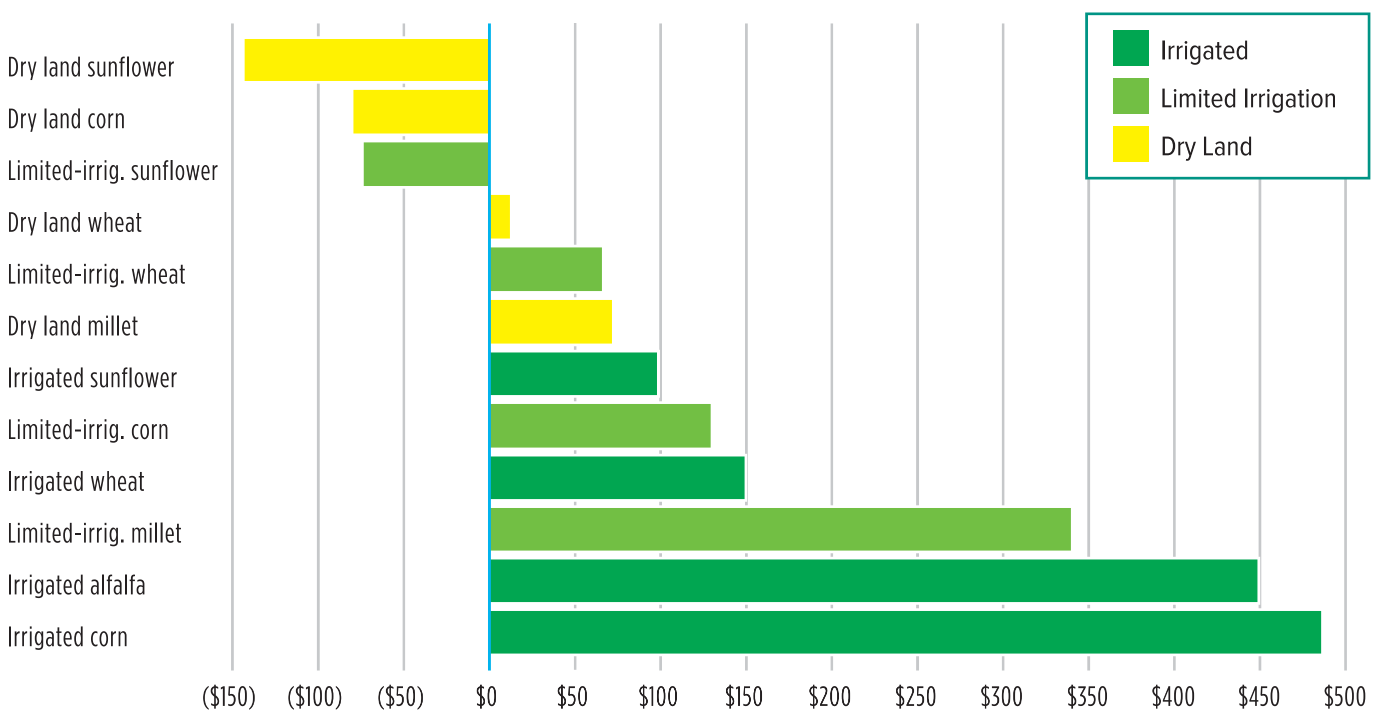
- A change in the assessment process that provides for a reduced value for limited irrigation may have tax revenue implications for the county, affecting local governments, schools and other special districts.

5.4 Net Economic Production of Land Under Dry Land and Limited-Irrigation Cropping

Economic returns can be estimated using the predicted yields of dry land and limited-irrigation farming developed in Section 4 and the attached enterprise budgets for wheat, corn, proso millet and sunflower (see Appendix A). Because the yield estimates vary geographically due to variations in soil type and precipitation amounts and timing, a wide range of economic returns are shown. The enterprise budgets are similar to published enterprise budgets developed by Colorado State University for Northeastern Colorado with the exception of crop insurance. Crop insurance premiums and indemnities are not calculated in these budgets because they are site-specific in their calculation and, as of yet, no procedure has been set for limited-irrigation crop insurance in Colorado. Therefore, the extremes (both positive and negative) of the economic returns shown in the following tables will be reduced once actual crop insurance premiums or indemnities are included (i.e., crop insurance premiums reduce positive economic returns, and indemnity payments mitigate losses). The break-even yield of the various crops is also shown in the bottom section of Table 5-2, and indicates the yield per acre necessary to pay for production costs.

Conversion of irrigated acreage to dry land farming or limited-irrigation farming results in lower crop yields per acre and a resultant reduction in net farm income. Figure 5-1 shows the yield for corn, wheat and sunflower produced using irrigation, limited-irrigation and dry land practices (limited-irrigation and dry land yields are over the entire study area). The economic return values for the irrigated crops are derived from enterprise budgets for irrigated corn and irrigated alfalfa developed by Colorado State University. Figure 5-2 shows the comparison of net farm income per acre for irrigated alfalfa, wheat, sunflower and corn, and several average net income amounts for the Dry land and limited-irrigation crops considered in this study area.

figure **5-1.** Average economic return per acre based on 2012 prices and average crop yield.



Irrigated crop values are from South Platte data 2012 (Appendix A).

Table **5-2.** Break-even and mean yields for winter wheat, corn, proso millet and sunflower produced under dry land and limited irrigation in study area.

		Winter Wheat		Corn		Proso Millet		Sunflower	
		Dry Land	Limited irrigation	Dry Land	Limited irrigation	Dry Land	Limited irrigation	Dry Land	Limited irrigation
		bu/ac		bu/ac		bu/ac		lbs/ac	
	Yield required for break-even cost	27	44	37	62	20	34	1,020	1,538
Mean predicted yields	Entire study area [1]	26	50	15	64	18	48	337	1,071
Mean predicted yields	Irrigated parcels in study area [2]	29	53	18	69	20	50	419	1,164
Mean predicted yields	Break-even or better irrigated parcels in study area	32	54	40	76	25	51	n/a	1,559
	Acres of break-even or better	345,129	464,180	12,175	364,387	299,457	495,706	0	684

1 Study area comprises nearly 2,000,000 acres

2 Study area includes 506,000 irrigated acres

figure **5-2.** Average economic return per acre based on 2012 prices and average crop yield for the study area.

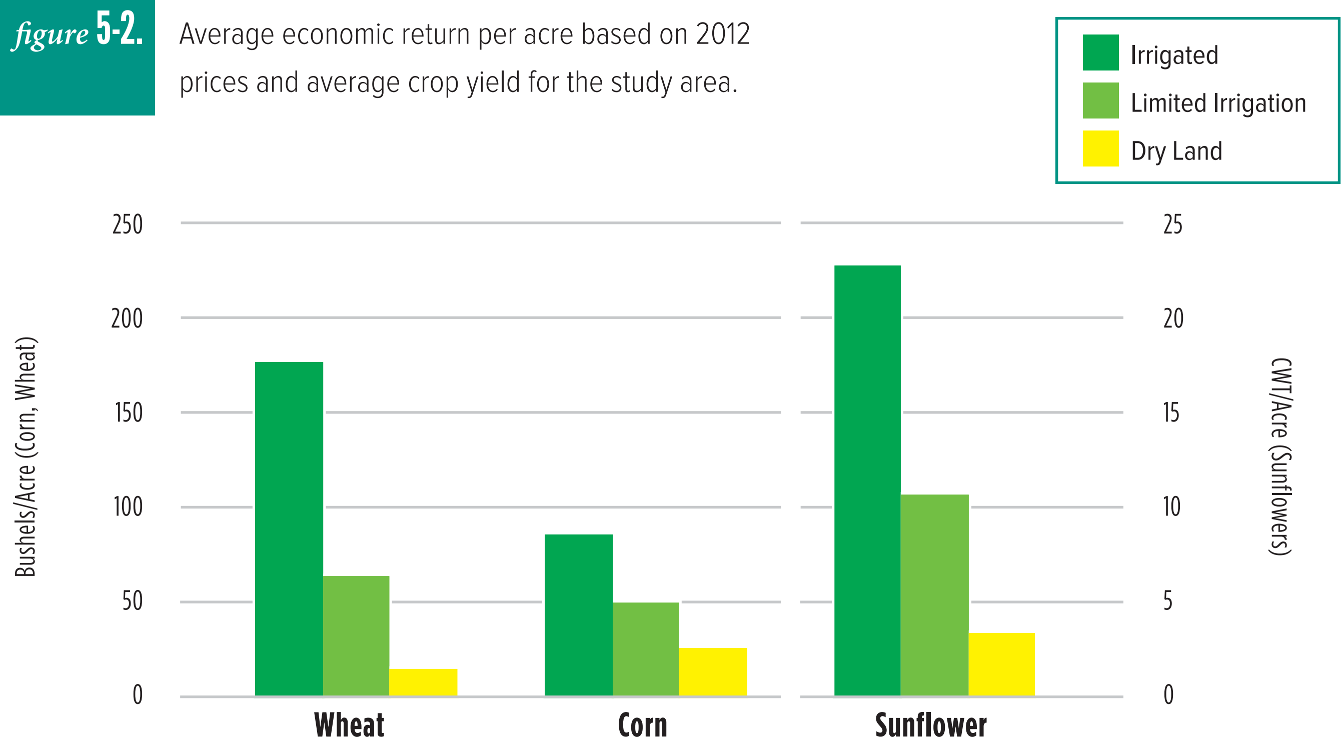
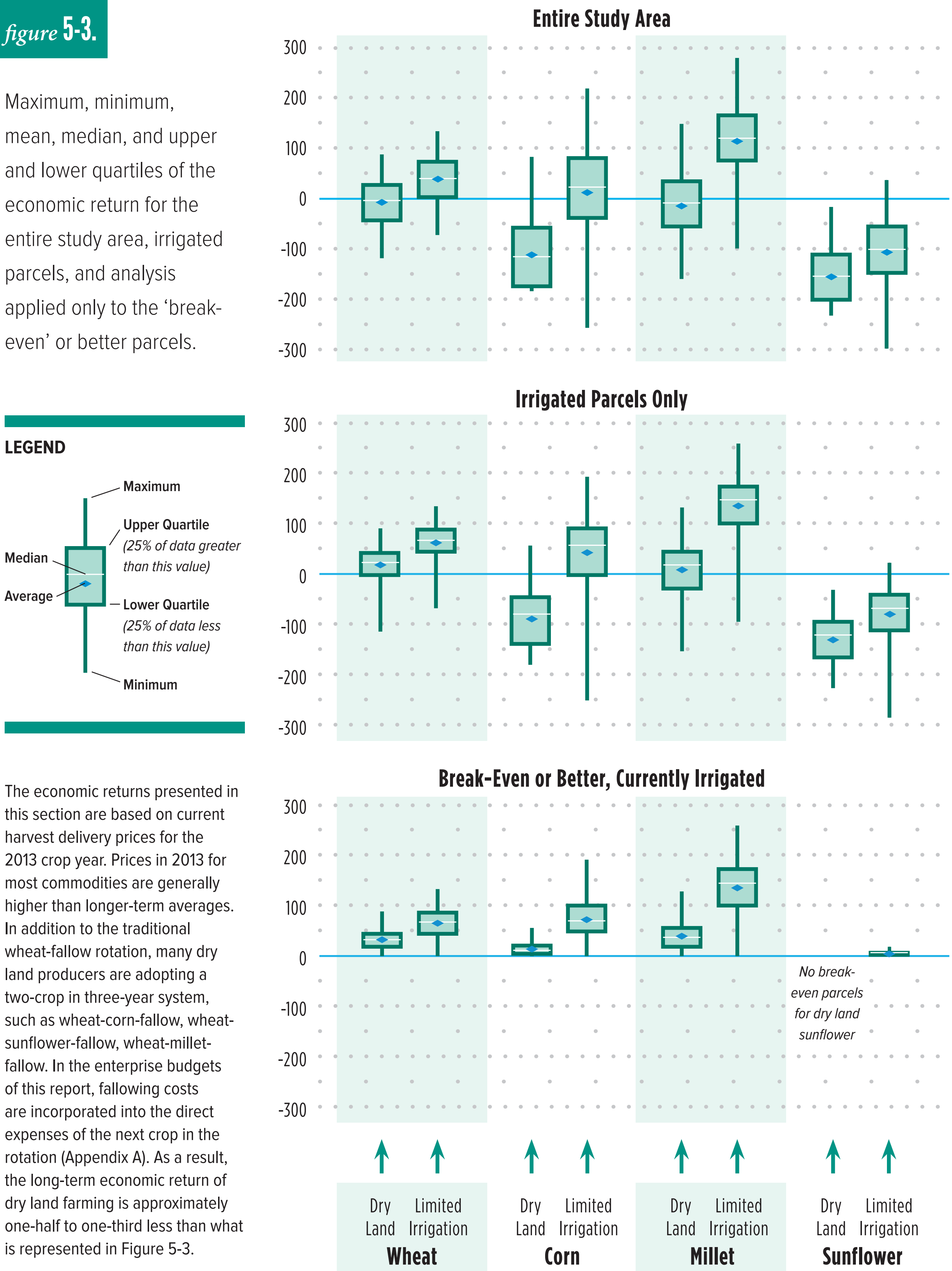


figure **5-3.**

Maximum, minimum, mean, median, and upper and lower quartiles of the economic return for the entire study area, irrigated parcels, and analysis applied only to the 'break-even' or better parcels.



The economic returns presented in this section are based on current harvest delivery prices for the 2013 crop year. Prices in 2013 for most commodities are generally higher than longer-term averages. In addition to the traditional wheat-fallow rotation, many dry land producers are adopting a two-crop in three-year system, such as wheat-corn-fallow, wheat-sunflower-fallow, wheat-millet-fallow. In the enterprise budgets of this report, fallowing costs are incorporated into the direct expenses of the next crop in the rotation (Appendix A). As a result, the long-term economic return of dry land farming is approximately one-half to one-third less than what is represented in Figure 5-3.

Table 5-2 shows the crop yield required to break even economically as determined from the GIS data, and the mean crop yield for the entire study area, irrigated parcels only, and irrigated parcels above the break-even yield only. The economic return for each crop was computed throughout the study area, based on crop yield and the costs shown in the enterprise budgets. As shown in Table 5-2, the economic return improves for dry land and limited irrigation on irrigated parcels only.

Figure 5-3 shows the maximum, minimum, mean, median, and upper and lower quartiles of the economic return. The top-most chart in Figure 5-3 represents the entire study area, the middle chart represents the analysis applied only to currently irrigated parcels, and the lower chart represents the analysis applied only to the "break-even or better" parcels. Selection of the break-even or better parcels demonstrates the potential economic return from carefully selected parcels that are best matched to the dry land or limited-irrigation options, based on soil and precipitation conditions.

The projected net losses for many of the crops clearly illustrate the risk associated with dry land crop production in most of the study area. When only the areas that are currently irrigated are considered for conversion to dry land or limited irrigation, the net economic return increases for most crops, but this does not account for the added importance of selecting an appropriate crop for the local soil type and precipitation patterns. Table 5-2 and Figure 5-3 also show that careful selection of lands that, on average, are predicted to break even may produce substantial gains per acre, but still represent a reduction from full irrigation. As a point of comparison, the enterprise budget for irrigated corn shows an expected return of $200/acre, which is approximately 25 times the mean of dry land corn on break-even or better parcels, and 3 times the mean of limited-irrigation corn on break-even or better parcels.

Careful selection of lands that are predicted to break even may produce substantial gains per acre, but still represent a reduction from full irrigation.

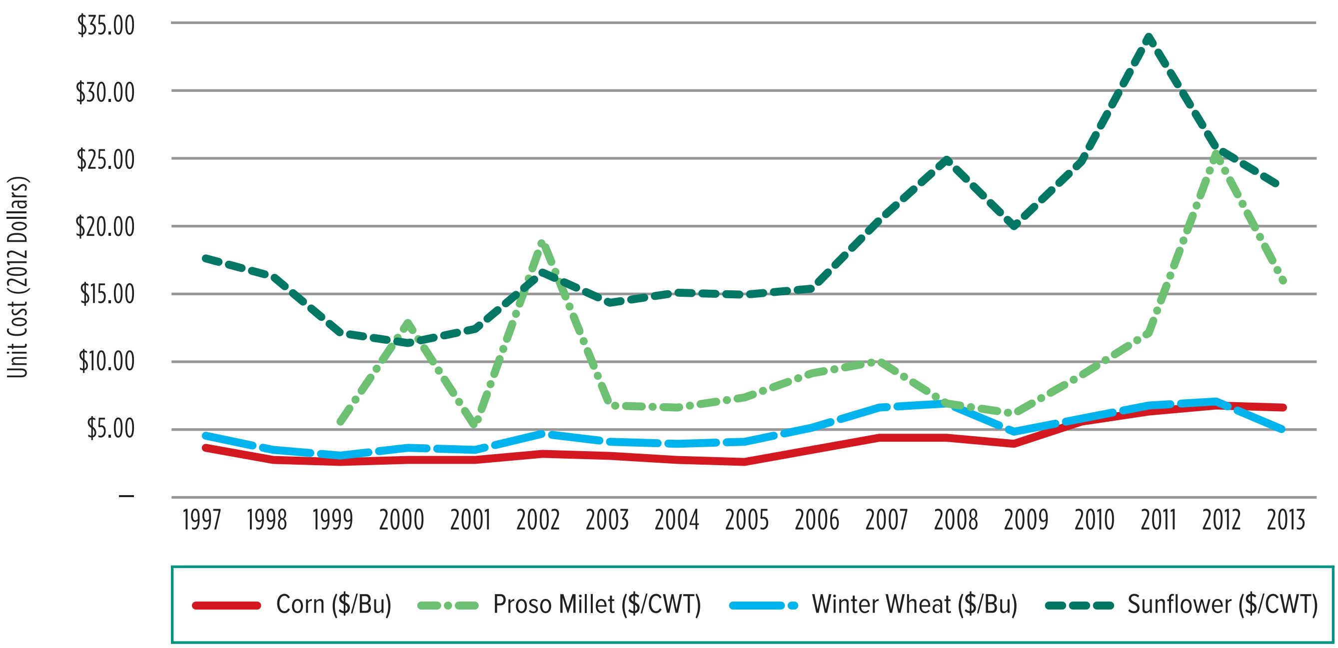
Only proso millet produced a positive value for average economic return, and this is largely influenced by the higher-than-average current prices for proso millet. The addition of a limited amount of irrigation resulted in positive economic return values for winter wheat, corn and proso millet. The presented results for proso millet should be interpreted with some caution. The grain prices used for this study reflect a current high demand for proso millet and are significantly higher than historical prices. The supply and price for proso millet fluctuates greatly. Farmers who have the ability to produce proso millet and store the grain until prices are high have had the most economic success with this crop.

Figure 5-4 shows historical prices for the four crops used in this study, adjusted for inflation to 2012 dollars. This figure indicates that if commodities fall back to historical levels, the economic return of dry land and limited irrigation will likely suffer, unless production costs decrease proportionally.

The following charts illustrate the projected economic return for currently irrigated parcels in southern Weld County and Morgan County for each crop type produced under dry land or limited irrigation. The data were produced by intersecting the irrigated acres layers for southern Weld and Morgan counties with the economic return results using GIS. The categories are based on a range of economic return. Since crop prices vary year to year, an economic return within the range of a loss of $50 per acre to a gain of $50 per acre was considered as the break-even range. An economic return worse than a loss of $50 per acre is considered a net loss and an economic return greater than positive $50 per acre is considered a net gain. Breaking even and not earning a profit may still result in a farmer recovering all of his or her costs, depending on the farmer and accounting practices.

In Morgan County, the analysis computed the potential economic return if the existing 132,940 irrigated acres were converted to dry land or limited-irrigation lands. Based on current prices, limited-irrigation millet is estimated to be the most profitable crop. Millet prices, however, can fluctuate significantly depending on the production for that specific year (see Figure 5-4).

figure **5-4.** Historical harvest delivery prices for corn, wheat, millet and sunflower.

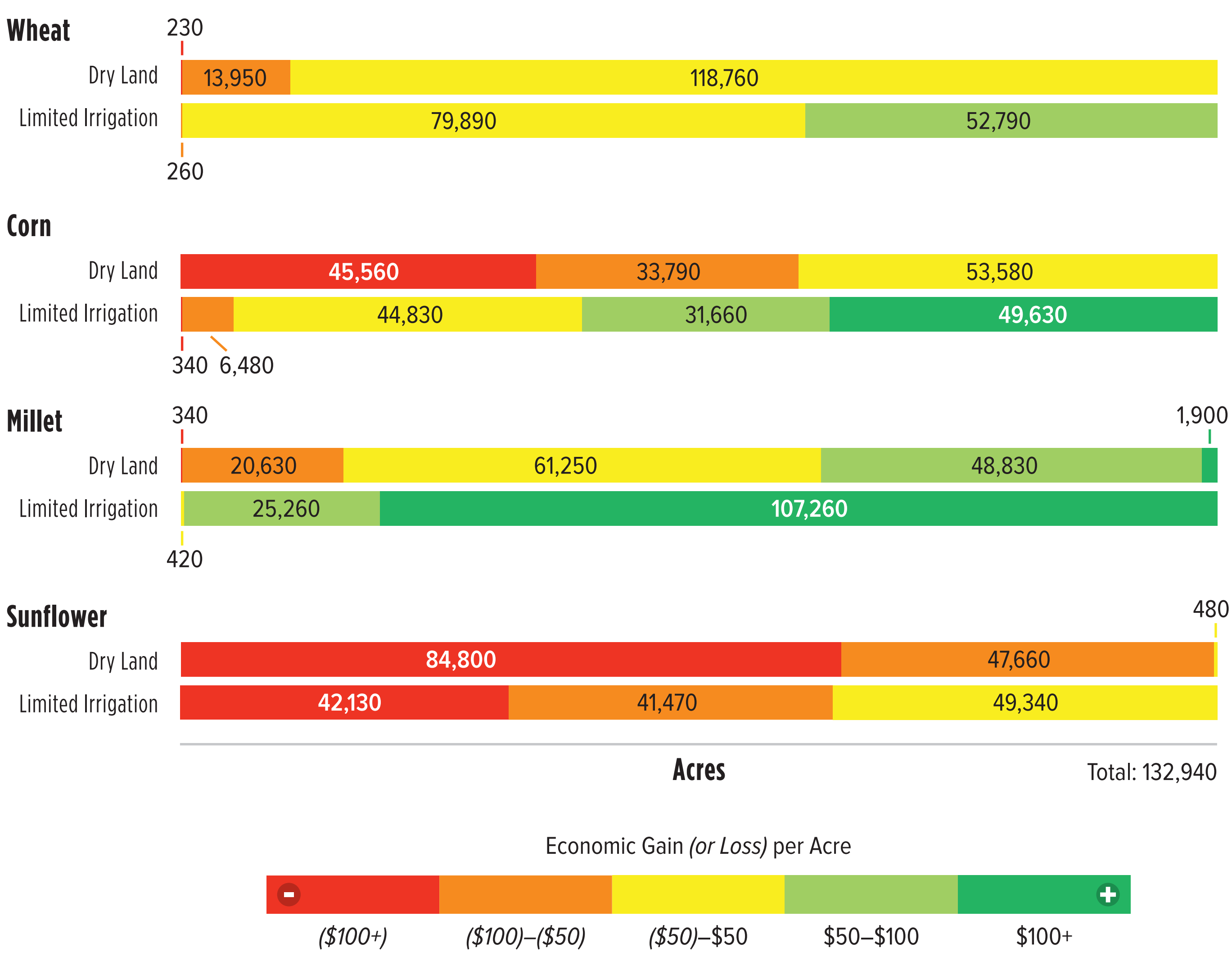


Source: U.S. Department of Agriculture, National Agricultural Statistics Service, Colorado Field Office 2006 and 2012.

Figure 5-5 indicates that growing dry land wheat, limited-irrigation wheat, limited-irrigation corn and dry land millet may also result in a net gain or at least in recovering costs, depending on where they are grown (refer to Figures 5-8, 5-9, 5-11 and 5-12 for specific locations). Producing limited-irrigation sunflower, dry land sunflower or dry land corn will likely result in a net loss, and only limited-irrigation sunflower and dry land corn may result in breaking even, depending on where they are grown.

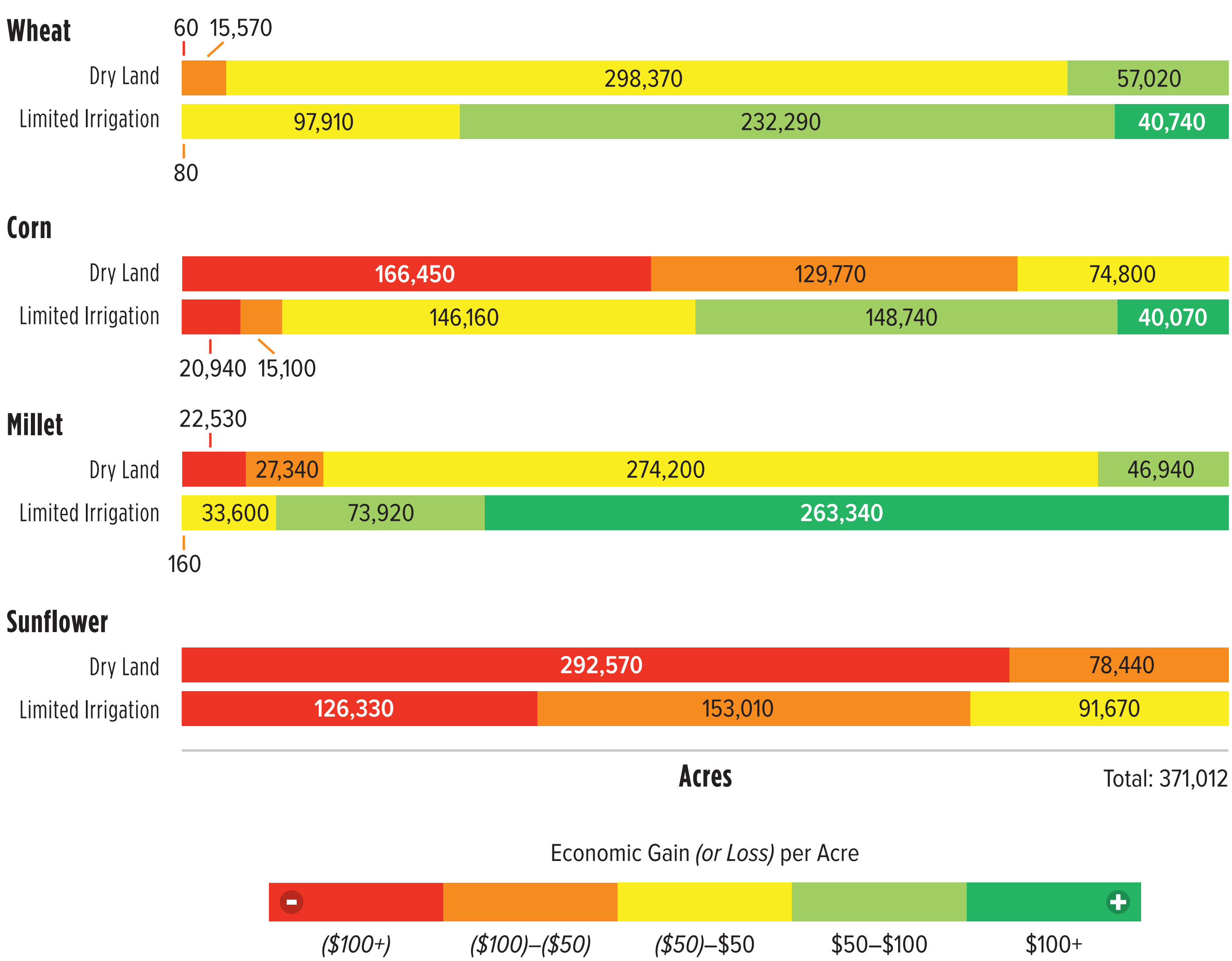
In southern Weld County, the results are similar to those for Morgan County. The analysis was applied to the 371,010 irrigated acres in southern Weld County. Based on current prices, the limited-irrigation millet would be the most profitable. Figure 5-6 indicates that producing limited-irrigation wheat, dry land wheat, limited-irrigation corn and dry

figure **5-5.** Morgan County economic return by crop type produced under dry land or limited irrigation.



land millet may also result in a net gain or breaking even for some farms. However, in some cases growing dry land millet or limited-irrigation corn will result in a net loss. Again, these results depend upon which irrigated parcels the crops are grown (refer to Figures 5-11 and 5-12 for specific locations). Similar to results for Morgan County, producing limited-irrigation sunflower, dry land sunflower or dry land corn in southern Weld County will likely result in a net loss, and only limited-irrigation sunflower and dry land corn may result in breaking even, depending on where they are grown.

figure **5-6.** Southern Weld County economic return by crop type produced under dry land or limited irrigation.



The results of the total economic return by crop type produced under dry land or limited irrigation for the study area as a whole are shown in Figure 5-7. The study area includes 503,950 irrigated acres. Based on current prices, many of the irrigated parcels will be most profitable if limited-irrigation millet is grown. Producing limited-irrigation wheat, dry land wheat, limited-irrigation corn and dry land millet may also result in a net gain or breaking even. However, in some cases growing dry land millet or limited-irrigation corn will result in a net loss, depending on the location of the irrigated parcels (refer to Figures 5-11 and 5-12 for specific locations). Again, producing limited-irrigation sunflower, dry land sunflower or dry land corn will likely result in a net loss, and only limited-irrigation sunflower and dry land corn may result in breaking even, depending on where they are grown.

figure **5-7.** Total economic return by crop type produced under dry land or limited irrigation in both Morgan and southern Weld counties.

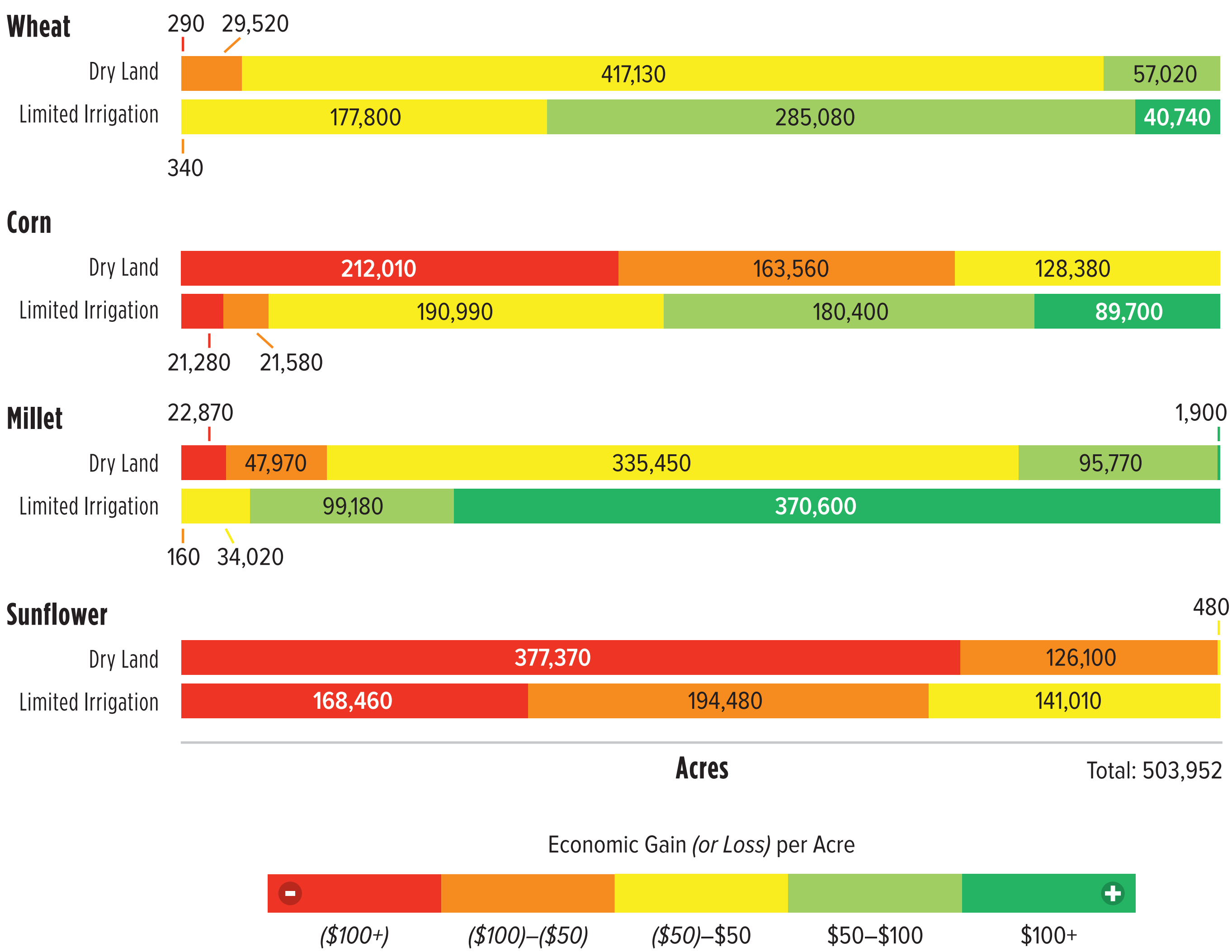


figure 5-8. Economic return for wheat - dry land.

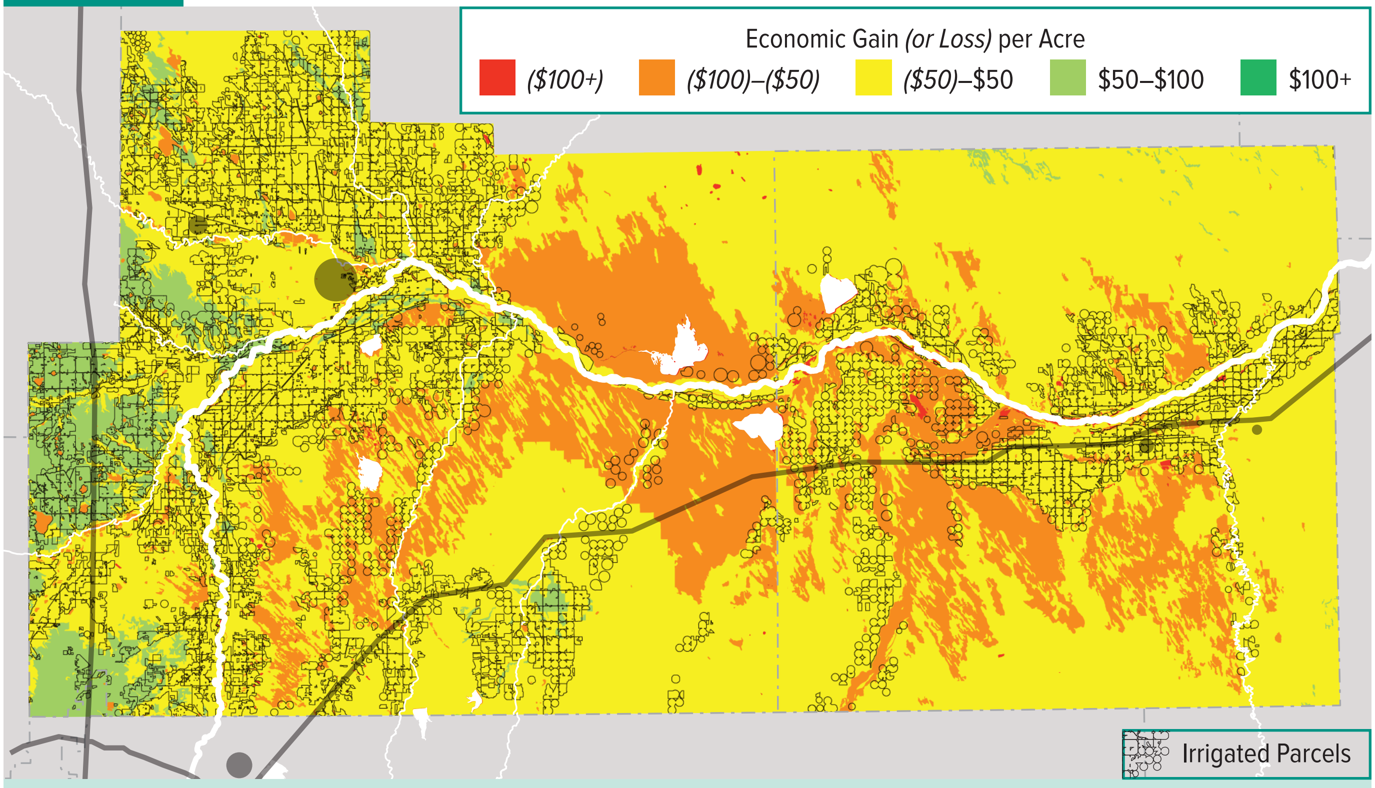


figure 5-9. Economic return for wheat - limited irrigation.

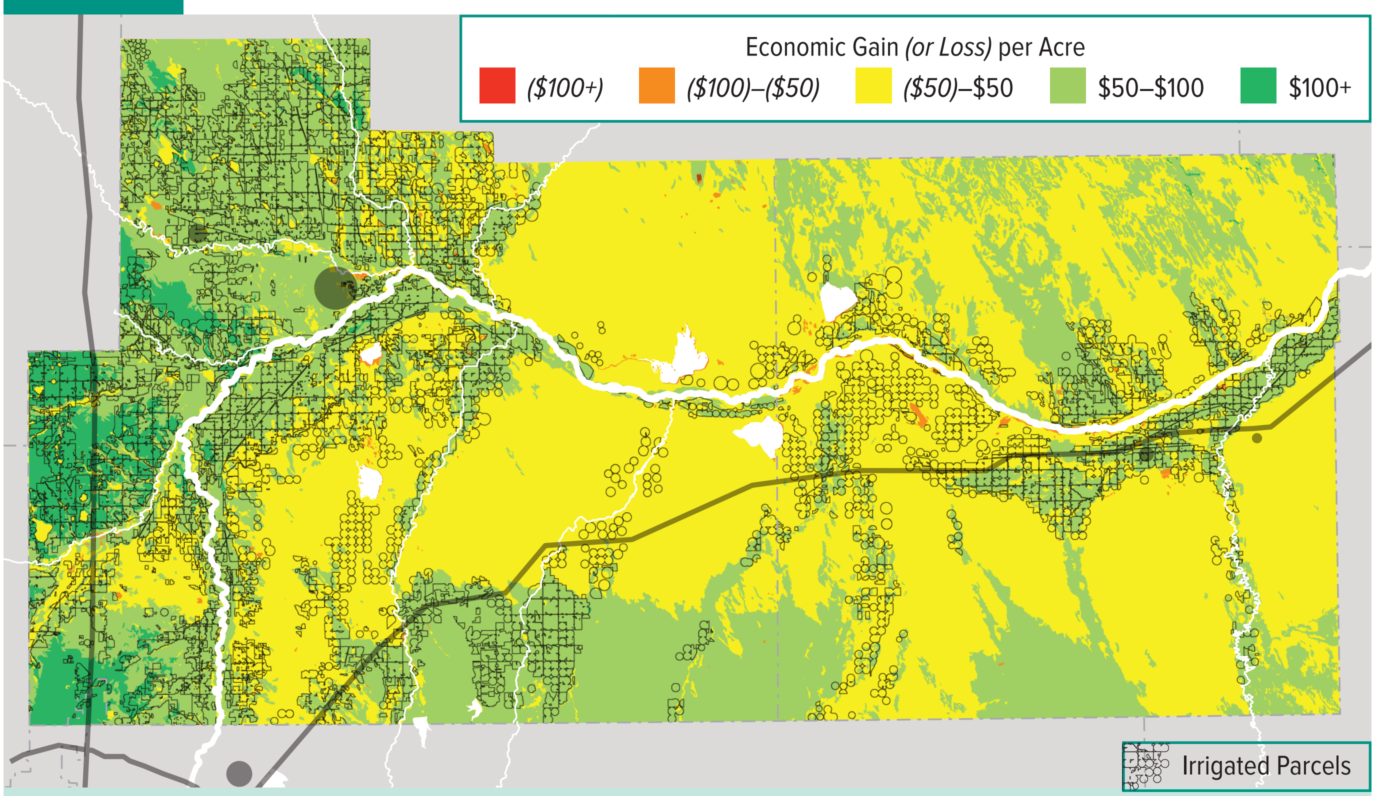


figure **5-10.** Economic return for corn - dry land.

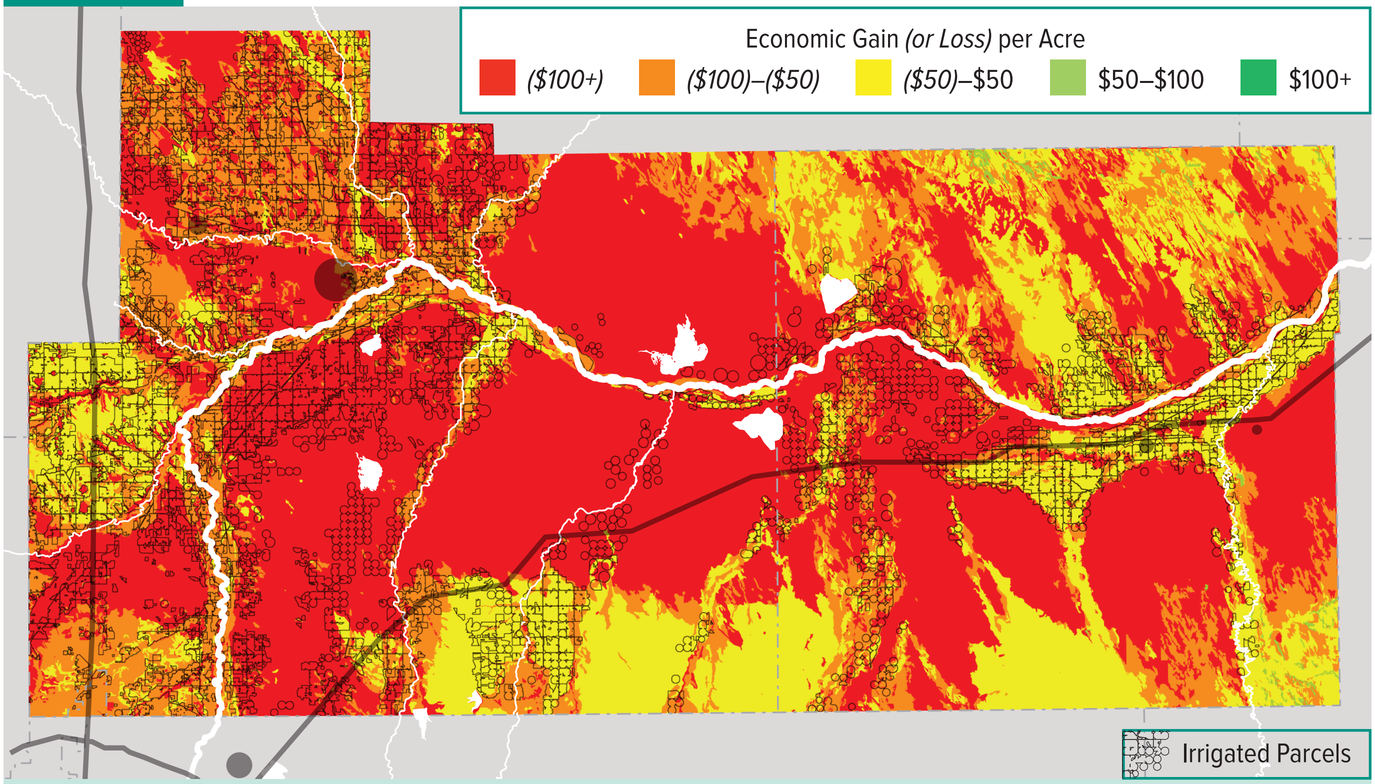


figure **5-11.** Economic return for corn - limited irrigation.

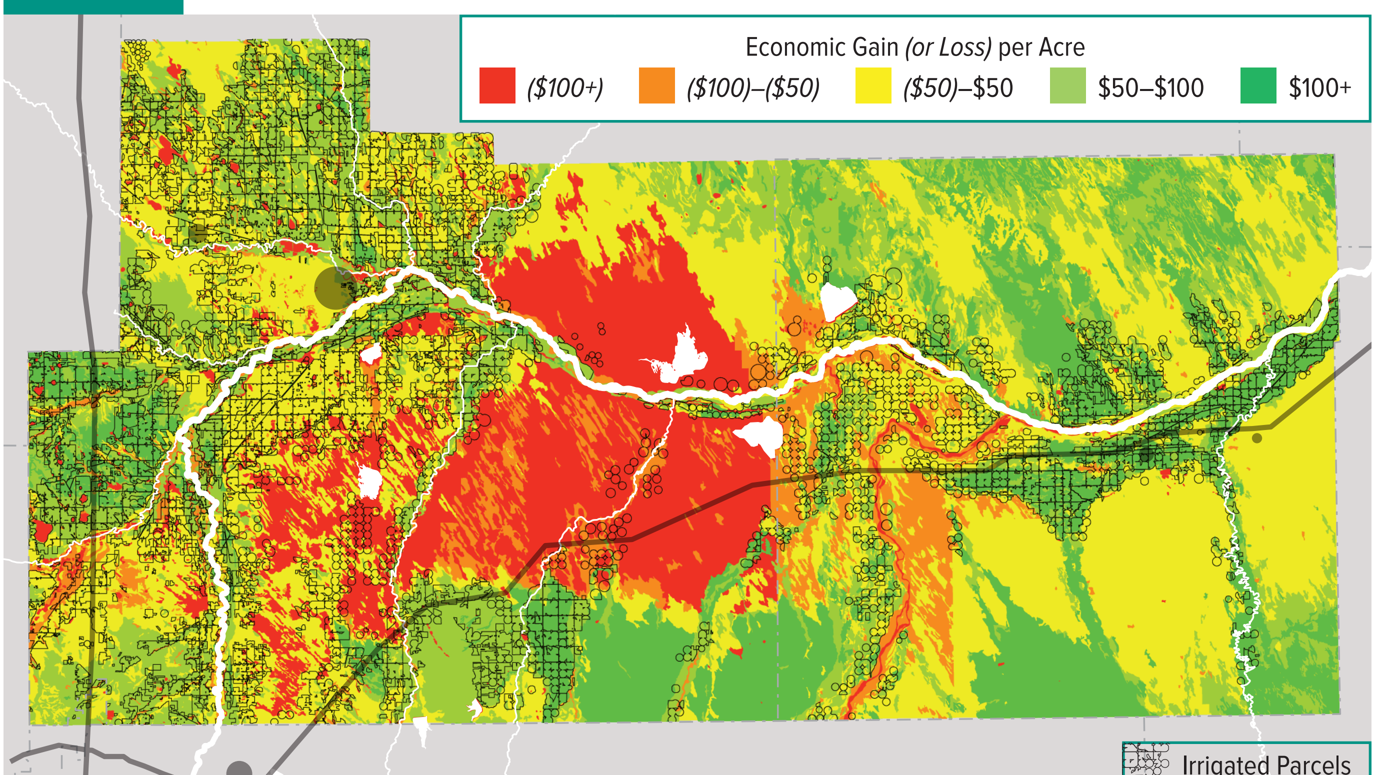


figure **5-12.** Economic return for proso millet - dry land.

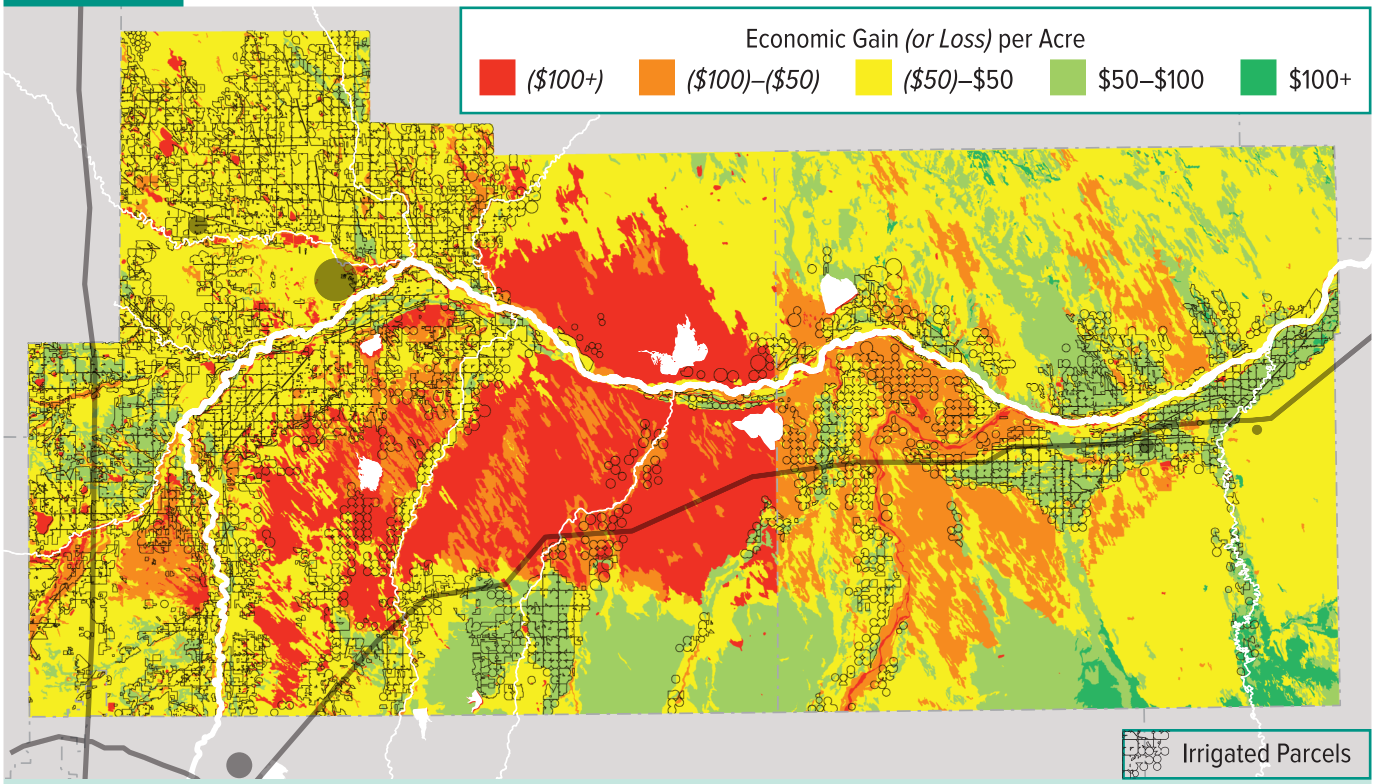


figure **5-13.** Economic return for proso millet - limited irrigation.

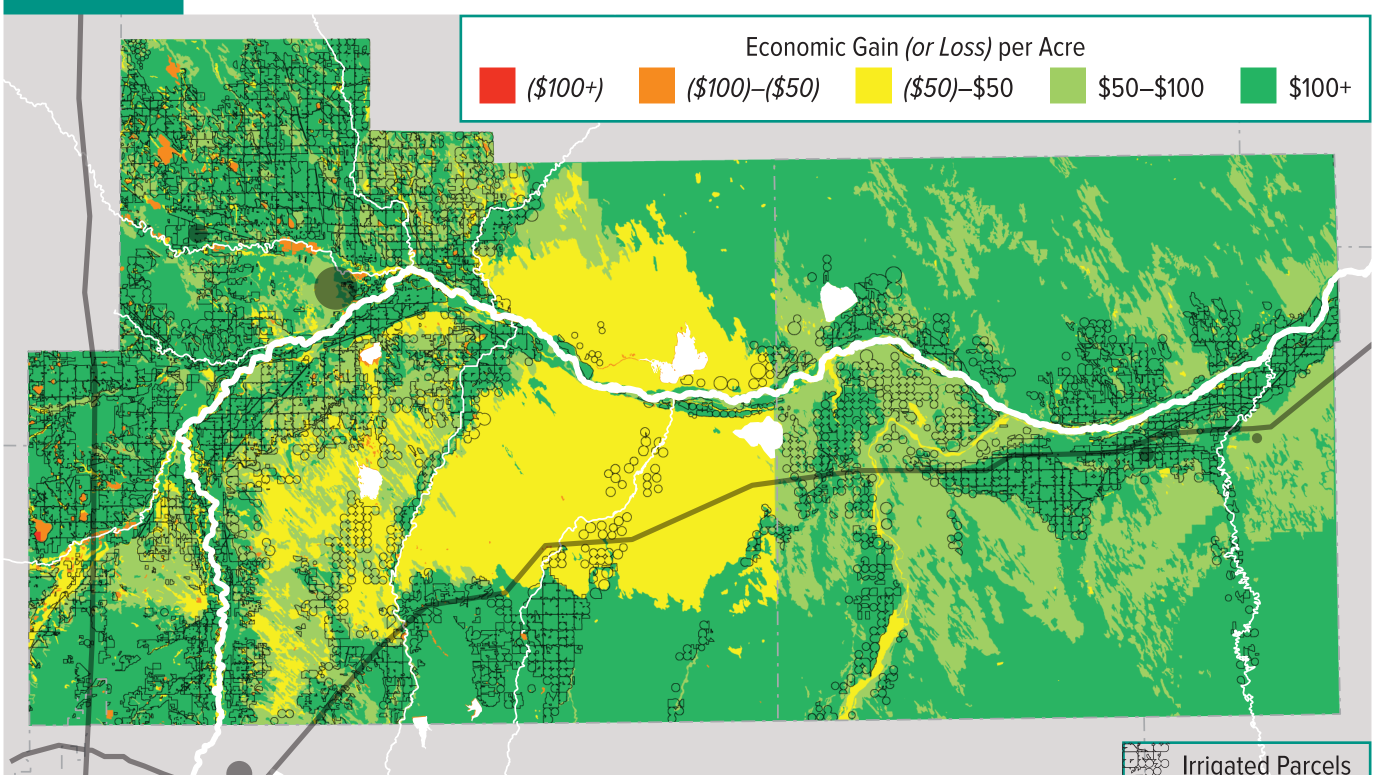


figure **5-14.** Economic return for sunflower - dry land.

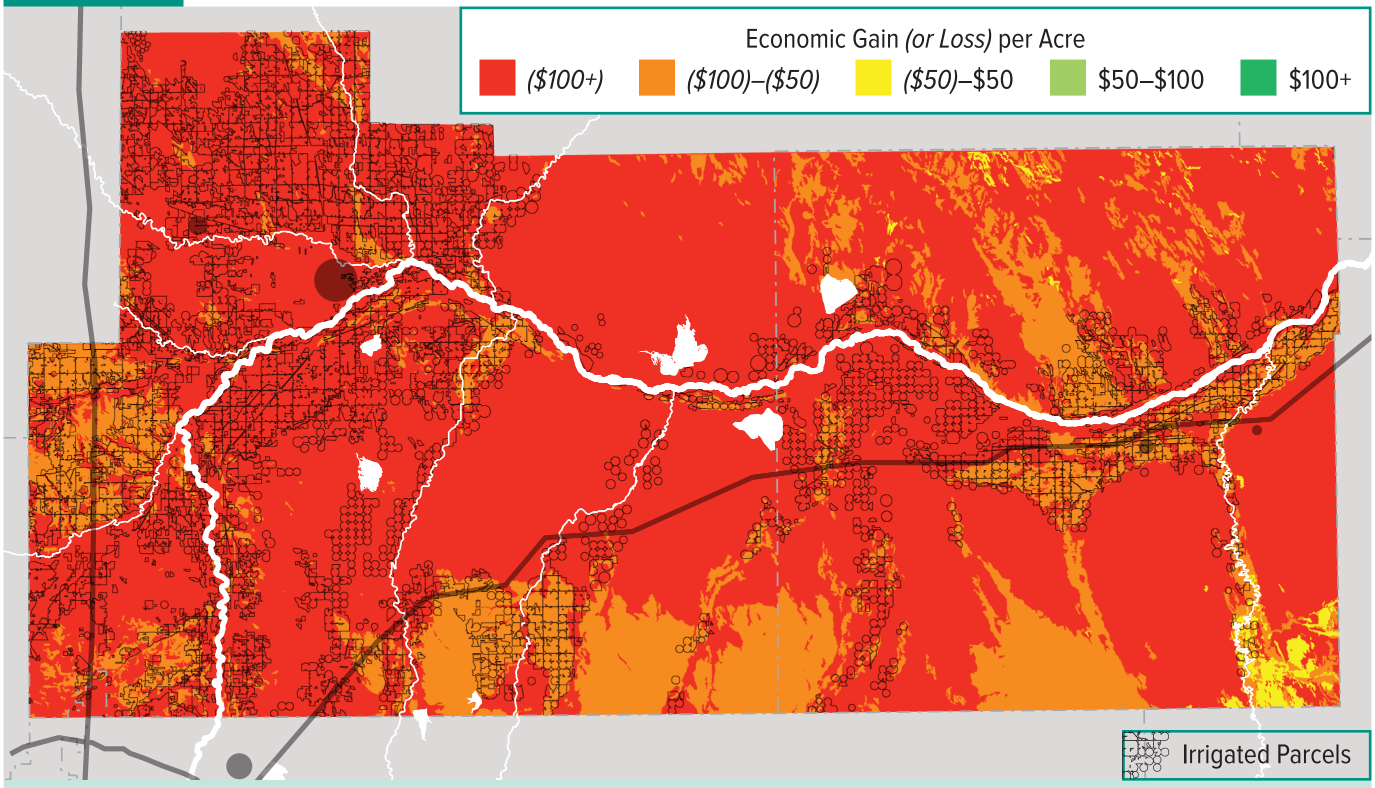
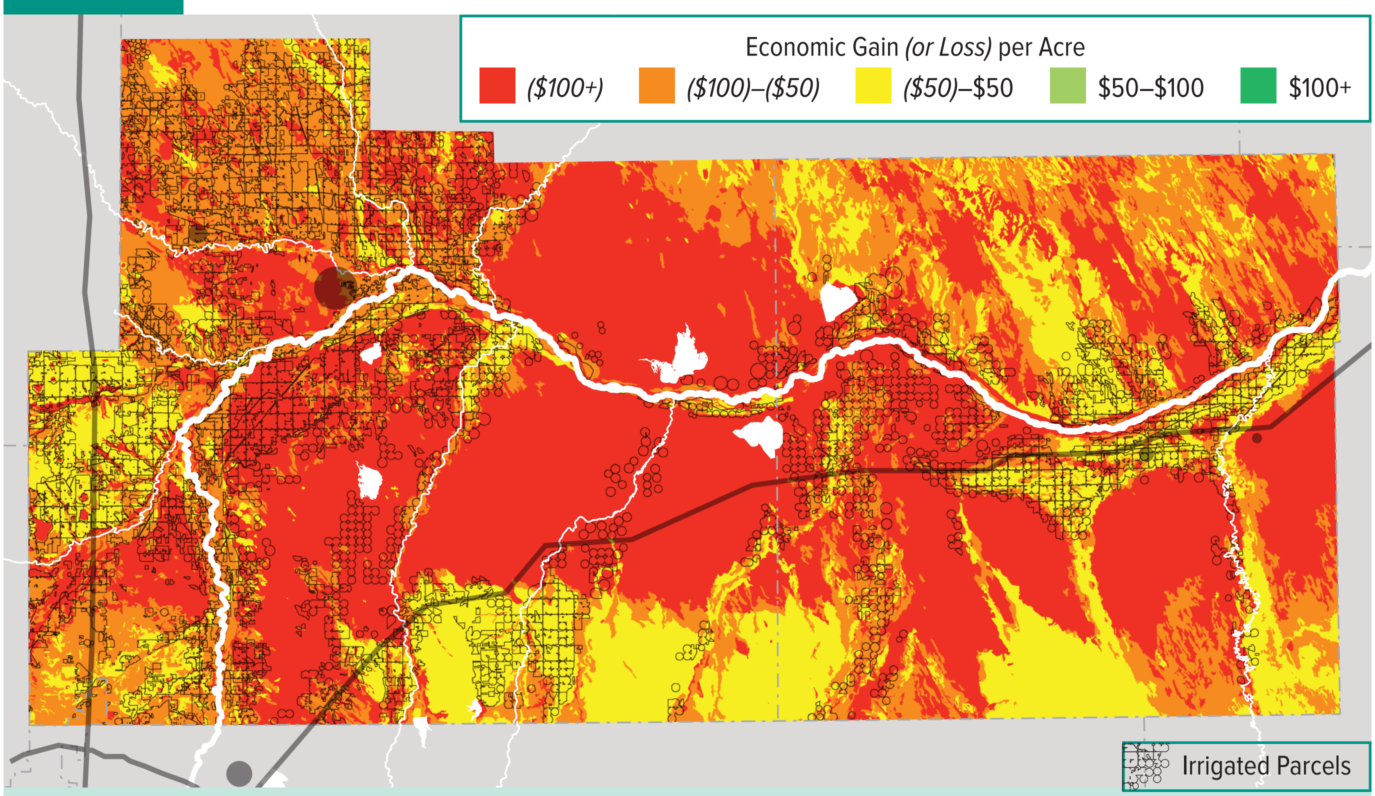


figure **5-15.** Economic return for sunflower - limited irrigation.



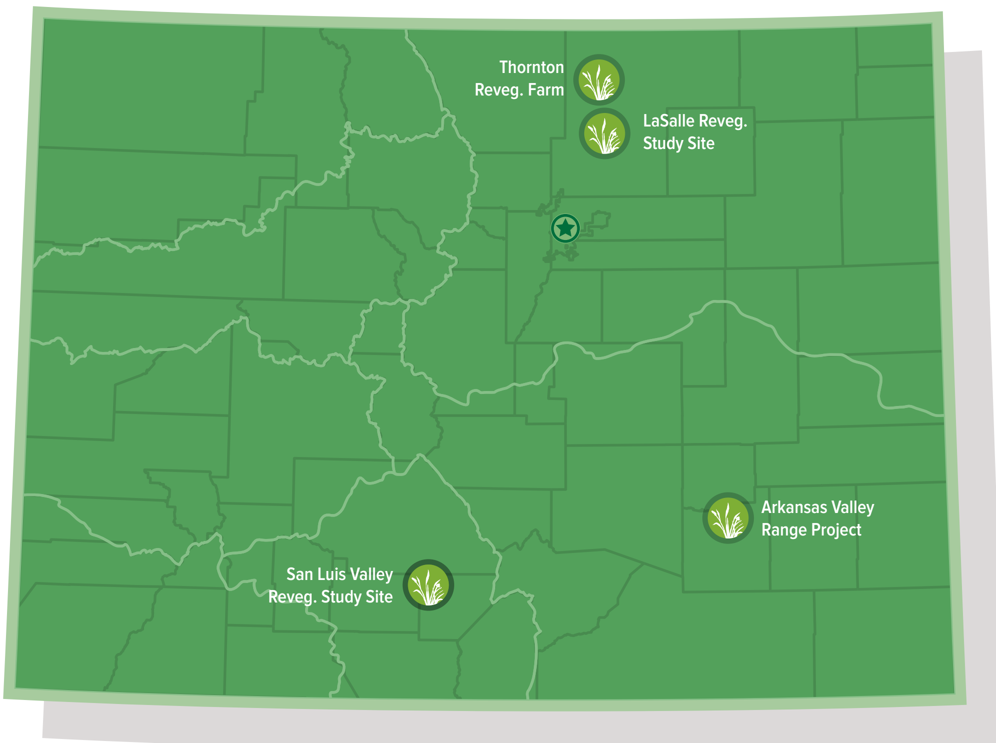
Section 6: Revegetation of Previously Irrigated Lands

Temporary or permanent loss of irrigation water from farms in the semiarid climate of Colorado can result in severe economic and ecological problems. Abruptly halting intensively managed irrigated crop production may result in several negative consequences: residual soil nutrients threaten water quality, weed infestations elicit aesthetic and nuisance complaints from neighbors, wind and water erosion can be significant, and compaction and salinity can initially limit non-irrigated crop and restoration planting choices. The soil conditions that exist after decades of farming are not conducive to the establishment of perennial grasses, which is often impeded by soil salinity, compaction, low organic matter and poor infiltration (Sutherland et al. 1990). Weeds tend to exploit the higher levels of plant-available nutrients, particularly nitrogen in these soils, giving them a competitive advantage over desirable perennial vegetation. For example, evaluations documented adequate cover of desirable vegetation on only 35% of revegetation trials in southeast Colorado (Sutherland and Knapp 1988).

As part of this Project, a field project was continued that is evaluating approaches that can be employed for successful revegetation of previous irrigated lands. The field study evaluates several cover crop options on a farm near LaSalle, Colorado, and has a goal to provide cover crop recommendations for farmers who need to temporarily fallow irrigated land, such as under a rotational fallowing or interruptible supply agreement, to assume dry land production or to establish grasses in formerly irrigated fields that are subject to dry up covenants. The emphasis of this field project was to use methods that were successful but as low-cost as practical to implement.

In addition to the field project, a tour of other revegetation sites in Colorado was made and managers of the sites were interviewed (Figure 6-1). Themes from the tour and results of the field project have been combined to develop a Draft Revegetation Fact Sheet, which is included below. The fact sheet will be reviewed by two technical experts, updated and then made available in both print and online formats.

figure 6-1. Revegetation site locations.



Draft Fact Sheet: Revegetation Strategies for Transitioning to Non-Irrigated Grassland

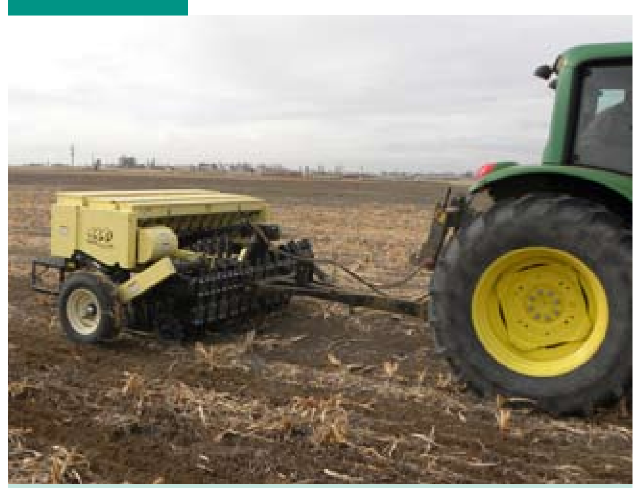
Note: No endorsement of products mentioned with this document is intended nor is criticism implied of products not mentioned.

Introduction

Temporary or permanent loss of irrigation water from farms in the semiarid region of Colorado can result in aesthetic, economic and ecological problems. Without a sustainable and permanent vegetative cover, previously irrigated land frequently will only support sparse, weedy vegetation. The soil conditions that exist after decades of farming are not typically conducive to permanent grass establishment and are often impeded by soil salinity, low organic matter and poor infiltration (Sutherland and Knapp 1988, Banerjee at al. 2006). Weeds tend to exploit the higher levels of plant-available nutrients, particularly nitrogen (N) in these soils, giving them a competitive advantage over desirable perennial vegetation. For example, evaluations documented adequate cover of desirable vegetation on only 35% of revegetation trials in southeast Colorado (Sutherland and Knapp 1988).

Abruptly halting irrigated crop production can cause economic hardship to a farm and the surrounding community (Pritchett and Thorvaldson 2006). In addition to production losses, loss of water to fields that have been intensively managed results in many negative consequences: residual soil nutrients threaten water quality, weed infestations compete with perennial grass establishment, wind and water erosion potential can be significant, and compaction and salinity can initially limit non-irrigated crop and perennial planting choices.

figure **FS-1.** Planting grass in cover crop residue.



The primary goal of this fact sheet is to provide general strategies for land managers who need to temporarily fallow irrigated land or establish permanent vegetation in formerly irrigated fields. We utilized published literature studies, field experience at a research site and information gleaned through interviews with ongoing revegetation projects throughout Colorado for producing this report. It should be noted, however, that the research and experience on this topic is still limited, and additional work is needed to develop more specific and detailed recommendations for Colorado.

Considerations for Successful Transitions

Treat Previously Irrigated Fields as Disturbed Sites

Ecologically, most irrigated fields in Colorado are "disturbed" sites. While the disturbance to the soil system is not as serious as that at a construction site, mine, or oil and gas exploration pad, these fields may have poor soil structure, compaction, low organic matter, and occasional high residual nutrient (nitrogen and phosphorus) and salinity levels. Poor soil structure, compaction and low organic matter are frequently referred to as poor soil health (see Ehmke 2013 for a definition of soil health) and are the result of decades of tillage, monoculture cropping, occasional over-irrigation and traffic from heavy equipment. Poor soil health usually does not prevent these fields from being highly productive for irrigated crop production as long as inputs of irrigation water, nutrients and pest-control chemicals are available. Crop species have been adapted to these conditions and are bred to produce maximum grain and/or forage yield when inputs and management are present. Frequently, native or other species seeded to replace irrigated crops are not well-adapted to poor soil health in a disturbed environment and are overrun by many weedy species that are well-adapted to poor soil conditions.

Previous Cropping System

Ideally, a landowner planning to discontinue production on an irrigated field will plan the final cropping sequence to improve soil health prior to dry up. Similarly, when dry up of irrigated land is enforced, making some allowances for land and water management that facilitates revegetation will improve ecological outcomes. This process could include less tillage, minimized compaction, soil amendments, such as compost, and possibly conversion to a perennial crop, such as alfalfa or grass, before water is removed. If the water that has been removed is the subject of a water transfer, deep-rooted crops, such as alfalfa, will not be suitable if high groundwater exists, as dry land alfalfa in an area of high groundwater (between 1 to 8 feet) will result in a reduction of consumptive use credit based on terms of water court transfer decrees.

Management decisions and crop rotations during the previous cropping seasons prior to the removal of irrigation water may influence the success of revegetation.

- Careful nutrient management will help keep carryover N levels to a minimum. Consulting herbicide product labels will assure that selected products will not limit revegetation.

- Effective weed control may help reduce weed growth during the revegetation stages. Low-residue crops, such as dry beans, sugar beets, onions and other vegetables, should be avoided for the last cropping season prior to irrigation curtailment, as these crops will leave a bare disturbed soil, prone to wind and water erosion.

- Choosing a small-grain crop, such as winter wheat or barley, will produce a good residue cover as seen in Figure FS-2 and, if managed correctly, can limit nutrient carryover.

- Finally, consider practices that reduce soil compaction, such as minimizing heavy traffic during harvest and avoiding excessive tillage and traffic during periods of high soil moisture.

figure **FS-2.** High crop residue prevents wind erosion.

Assessing Soil Conditions

Site-specific conditions should dictate the approach managers take to revegetation. Before attempting to revegetate a site, the soil chemical and physical conditions should be assessed to determine if remediation, amendment or modification is required prior to planting. Initially, the soil sample taken from the site should be assessed to determine the available soil nutrient status, organic matter content, salinity and soil texture. The soil nutrient nitrogen (N) is the most critical and will typically be in the form of soil nitrate. High residual N will promote weed growth over native or introduced species in these environments and may delay revegetation. High

figure **FS-3.** LaSalle revegetation site with cover crop test plots.

soil phosphorus (P) is generally not a problem for revegetation purposes and may even be beneficial since natural soil fungi (mycorrhizae), which aids in P uptake by plants, can be depleted in heavily tilled soils. The primary concern with high P is water quality, as P is prone to runoff with eroding soil to nearby water bodies.

If high levels of residual soil N are present, there are several options available to lower them. The first option is to plant a cover crop or series of crops to remove the N from the soil through plant uptake. The crop can be harvested as forage or tilled into the ground to improve soil organic matter. Trials near LaSalle, Colorado, from 2007–2010 utilized this strategy to successfully remove available soil N prior to perennial plant establishment. This approach is highly recommended and is shown in Figure FS-3.

Table **FS-1.** Soil variables to assess prior to planting.

Soil Parameter	Level of Concern	Potential Action
Nitrogen as nitrate	> 15–20 ppm	Cover crop, high C/N ratio amendment
Organic matter	< 1.0 %	Consider organic amendment
Salinity (ECe)*	> 4.0 dS/m†	Ensure good drainage, select tolerant species
Compaction	Hard pan present	Vertical tillage (chisel, rip)
Soil texture	N/A	Select correct species mix according to soil type

* Electrical conductivity of the extract

† decisiemens per meter

Another option is to amend the site with high carbon to nitrogen (C/N) amendments or mulches, such as wheat straw, corn stover or high C/N compost. The high C/N material will immobilize the available N into microbial biomass, which will improve soil health. However, this option will require incorporation of the material and may not be appropriate for highly erosive sites. The final option is simply to wait and allow the N to be naturally attenuated through uptake by weeds, leaching and immobilization. However, this strategy is least desirable from an environmental and aesthetic standpoint.

Next, the soil sample should be assessed for the organic matter (OM) content using a soil test. The OM content is closely related to soil health and will give some indication of the soil's potential for other problems, such as water infiltration and crusting. Previously irrigated sites may also be affected by saline soils, especially in poorly drained soils or areas of the state with poor water quality. These conditions are particularly relevant in the Arkansas River Valley as well as parts of the South Platte and western Colorado. High salinity will affect revegetation success because plants vary tremendously in their tolerance to soluble salts, particularly during germination. Soil salinity is typically measured as electrical conductivity (EC) of a saturated soil paste. This is relatively inexpensive information to obtain and can save time and money in the revegetation process (Waskom et al. 2012).

Finally, the soil sample should be assessed to determine the soil textural classification (percentages of sand, silt and clay), which is important to understand for species selection. This information can be obtained through a routine soil sample analysis. A less precise but still useful source of information on soil type and texture is a soil survey done by the U.S.

Department of Agriculture, Natural Resources Conservation Service (USDA/NRCS). While still available at many county Farm Service Agency offices in hard copy, a more convenient approach is to utilize online versions available at the USDA/NRCS website at http://soils.usda.gov/. Table FS-1 summarizes the soil parameters to assess prior to planting.

Weed Control

Weed control prior to planting and following plant establishment are critical to successful revegetation. Most weeds, particularly annual weeds, are colonizers during early stages of ecological succession in disturbed plant communities. This is because they are better adapted to poor soil health, high nutrients and dry conditions than many of the perennial species that are desirable for long-term persistence of desirable revegetation on a site. Invasive or noxious weeds should be eradicated or under significant control prior to planting. Check with your local county weed department or the noxious weed program at the Colorado Department of Agriculture (Colorado Department of Agriculture 2013) for help identifying or controlling noxious and difficult-to-control weeds, as shown in Figure FS-4. The best long-term strategy will include a variety of control mechanisms, often referred to as integrated pest management (IPM), rather than a strict reliance on herbicides or other controls. The IPM approach includes controls that are chemical (herbicides), physical (tillage, mowing), cultural (cover crops) and biological (insects or grazing). Weeds should be controlled to limit the weed seed bank in the soil that will compete with perennial vegetation, to preserve soil moisture and to comply with county weed ordinances.

Weed control does not end after planting, and long-term weed control (which is typically required as part of any water court decree that requires revegetation) is vital to the success of revegetation efforts. If successful germination is achieved, early weed control using herbicides is difficult and generally not recommended since small plants are sensitive to herbicide damage. Mowing is generally the best option to keep weeds

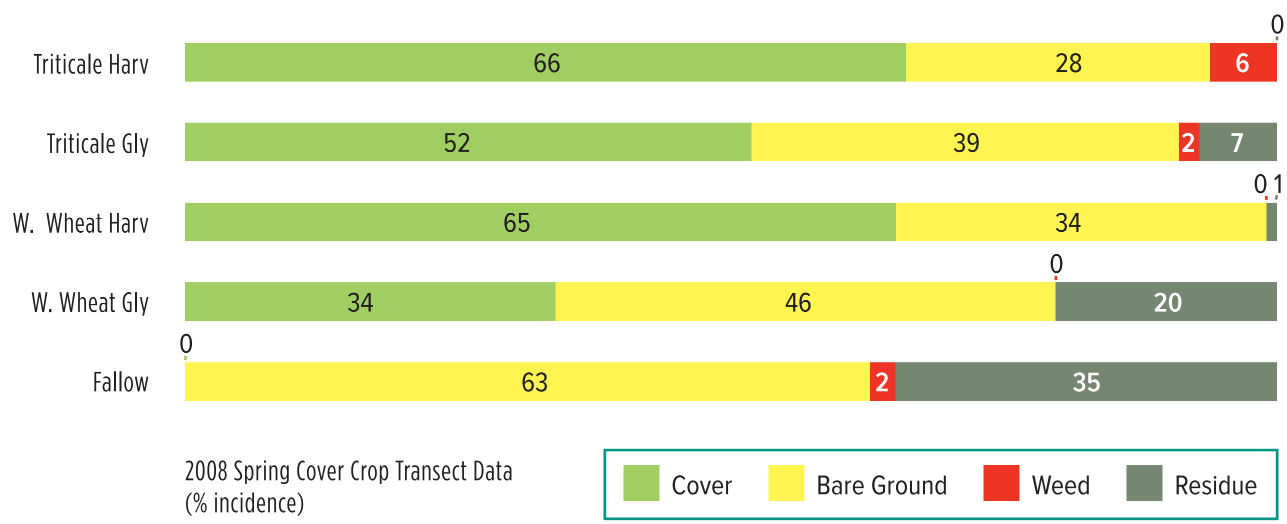
figure **FS-4.** Weed control in previously irrigated fields can be challenging.

figure **FS-5.** Weed competition seriously impairs new seedling growth if uncontrolled.

figure **FS-6.** Overview of LaSalle plots as they looked on September 8, 2008. These are pure cover crops.

from outcompeting perennial vegetation for the first 6 months to a year after planting. In the following years, a variety of controls, including herbicides, are recommended to reduce weed pressure and give perennial vegetation a chance to compete. Weed control measures for many fields will be required for several years following planting. This intensive weed control period will likely last 3 to 5 years following planting, and some weed control measures may be required beyond when a site is considered "established" by the NRCS or other certifying entities. Consider spot rather than broadcast spraying when weed populations are unevenly distributed across fields. Uneven distribution will be more likely with invasive and/or perennial weeds, as shown in Figure FS-5. Grazing, mowing and harvesting grass after establishment has benefited some projects, providing help with weed control, maintaining a healthy stand of grass and reducing hazards such as fire (Brian Foss, City of Thornton, personal communication, August 30, 2012). Besides weeds, landowners and managers can experience problems from other pests, such as grasshoppers and prairie dogs.

figure **FS-7.** Spring ground cover at LaSalle revegetation site illustrating effectiveness of various cover crops for providing ground cover and weed suppression. 'Harv' indicates the treatment was harvested and 'Gly' indicates it was terminated by spraying.

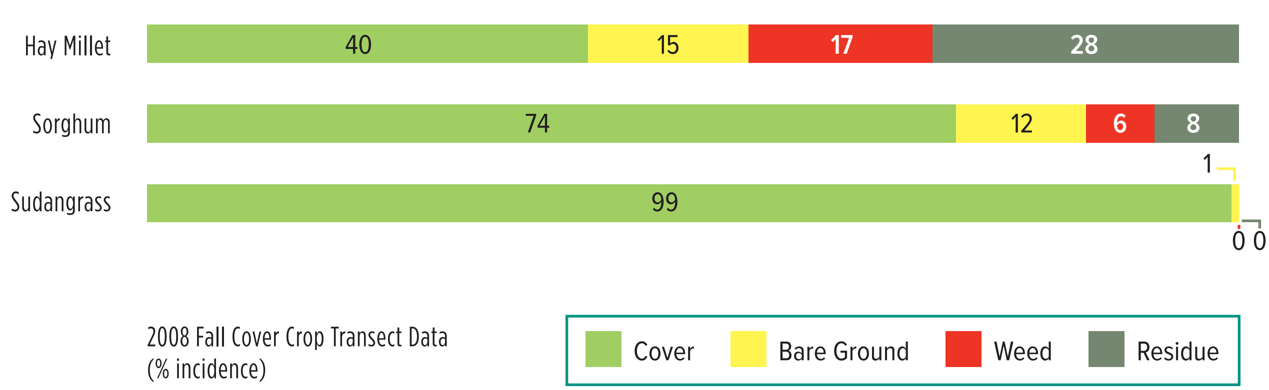


Temporary Cover Crops

In many situations, land managers may have sites where plans for revegetation are uncertain or the planned planting will be delayed. One strategy is to use cover crops to bridge the transition from irrigated to dry land crop production or grassland. The right cover crop or mix of cover crops can provide interim weed suppression, wildlife habitat, soil erosion control, nutrient uptake, soil health improvement and a potential source of animal forage and income. At the LaSalle revegetation site, CSU researchers tested summer crops, such as forage sorghum, sorghum-sudangrass, and millet, and winter annuals, such as wheat and triticale (Figure FS-7), for weed control and soil cover from 1 to 4 years before planting perennial grasses (Figure FS-6). Forage sorghum and sorghum-sudangrass offered the best cover and weed control in this study (Figure FS-8).

When irrigation water is not available, cover crops need to be terminated with sufficient time for soil moisture to be replenished before planting perennial vegetation. Termination should also be done before the cover crop goes to seed to prevent competition. Cover crop growth can be terminated using herbicides, swathing or mowing. Costs for cover crops can be kept low through no-till planting and careful seeding rates that are sometimes recouped through harvesting forage and the reduced weed control requirements. The USDA/NRCS has specifications for a cover crop (USDA/NRCS 2007) when cost sharing with that agency is involved. Another reference for cover crop considerations is *Managing Cover Crops Profitably* (Sustainable Agriculture Research & Education 2012).

Figure **FS-8.** Fall ground cover at LaSalle revegetation site illustrating effectiveness of various cover crops for providing ground cover and weed suppression.



Plant Materials

The appropriate choices for plant materials depend upon a number of site-specific conditions and the potential use(s) of the site following revegetation. Natural conditions that will influence choices for plant material include soil type and texture, localized climate and precipitation patterns, and current native vegetation in the area. However, the goals and planned land use for the site following revegetation is also an extremely important consideration. Potential land uses that can change plant species include grazing, open space, wildlife habitat, and/or residential, commercial or industrial development. While dry up covenants or government programs may dictate native or natural species establishment, some uses may be more suitable to improved grass species that are easier to establish. Potential choices for dry land (non-irrigated) and limited-irrigation situations by soil type are shown in Tables FS-2 and FS-3, respectively.

Table **FS-2.** Possible choices of plant materials for Eastern Colorado – non-irrigated.

Loamy Soils	Sandy Soils	Saline Soils
Wheatgrasses — Newhy, Pubescent, Intermediate Western, and Crested Regar Meadow, Smooth Brome, Pauite Orchardgrass, Blue Grama, Sideoats Grama, Switchgrass, Russian Wildrye	Switchgrass, Sand Bluestem, Western Wheatgrass, Little Bluestem, Sand Lovegrass, Yellow Indiangrass, Indian Ricegrass, Sand Dropseed, Prairie Sandreed	Wheatgrasses — Tall, Newhy, Western, Intermediate and Pubescent Alkali Sacaton (not on sandy soils)
Legumes — Alfalfa,* Sainfoin	Legumes — Alfalfa*, Sainfoin	Legumes — Alfalfa*

* Alfalfa or other deep-rooted plantings would not be recommended for revegetation of lands where the consumptive use has been transferred via a water court action if depth of groundwater is less than 8 feet.

Table **FS-3.** Possible choices of plant materials for Eastern Colorado – supplemental water available.

Loamy Soils	Sandy Soils	Saline Soils
Wheatgrasses — Newhy and Pubescent Regar Meadow, Smooth Brome, Pauite Orchardgrass, Switchgrass, Big Bluestem	Switchgrass, Sand Bluestem, Western Wheatgrass, Little Bluestem, Yellow Indiangrass	Wheatgrasses —Tall, Newhy, Western, and Pubescent Reed Canary Grass, Garrison Creeping Foxtail, Alkali Sacaton
Legumes — Alfalfa,* Sainfoin	Legumes — Alfalfa*, Sainfoin	Legumes — Alfalfa*

* Alfalfa or other deep-rooted plantings would not be recommended for revegetation of lands where the consumptive use has been transferred via a water court action if depth of groundwater is less than 8 feet. Data modified from a presentation by Roy Roath (Roath 2005).

Two useful resources for plant selection and planting techniques for native plants are *Native Plant Revegetation Guide for Colorado*, available through the Colorado Department of Natural Resources, and *Plant Materials Technical Note No. 59*, published by the USDA/NRCS (Taliga and Sharkoff 2012).

Tillage and Planting

To till or not to till prior to planting is a question that will need to be determined by site characteristics. Tillage may be appropriate for weed control, land smoothing, alleviation of compaction, incorporation of amendments, seed bed preparation and other purposes, but should be minimized as much as possible, especially on highly erodible fields (U.S. Department of Agriculture, Natural Resources Conservation Service, Colorado 2007). Since perennial vegetation establishment will require several years to achieve acceptable plant cover, crop or cover crop residue can be critical to reducing erosion from wind and water. Each tillage operation will consume soil moisture and bury valuable crop residue, and also can stimulate buried weed seeds to germinate. Consult with a local USDA/NRCS field office to determine soil erosion potential (K factor) before making decisions regarding tillage operations. If tillage is deemed necessary, retain a minimum of 30% residue cover to prevent erosion or consult with USDA/NRCS Table 1 (USDA/NRCS 2007). A standing cover crop residue, such as 12 inches of forage sorghum stubble, greatly reduces erosion potential, captures snow and protects young seedlings. If a clean seedbed is present, consider seeding a companion crop of sterile winter wheat or oats.

Land managers should not expect to achieve a quality stand of perennial vegetation if using poor planting equipment or equipment not designed for the desired species. Planting should be accomplished by a modern grass drill with less than a 12-inch row spacing, a small seed box, and double-disc furrow openers, preferably with depth bands and packer wheels. Many warm-season grass species are extremely light and fluffy, which may require a seed box agitator to achieve uniform seed drop. Many newer drill models are capable of planting in no-till or minimum-till environments. Dormant-season planting is often recommended in many environments for both warm- and cool-season species. This practice involves planting when soil temperatures are cool enough to inhibit seed germination in the late fall or early spring. When soil temperatures rise later in the spring, the planted seed is in the ground, ready to grow and potentially has an advantage over weedy vegetation. Closely follow seeding rate recommendations from the NRCS (see Taliga and Sharkoff 2012) and experienced seed distributors. Be sure to adjust seeding rate according to the percent pure live seed on the seed label.

figure **FS-9.** Successful revegetation at the Arkansas Valley Range Project.

figure **FS-10.** LaSalle revegetation site warm-season grass mix, fall 2012.

Water Availability

Irrigation water for perennial plant establishment is being used by some projects in the Arkansas (Figure FS-9) and San Luis valleys, but other locations, such as the City of Thornton in northern Colorado, are achieving successful transition without irrigation (Brian Foss, City of Thornton, personal communication, August 30, 2012). The body of research available in the literature that covers this topic is not Colorado-specific and is mixed regarding the correct approach (Oldfather et al. 1989, Banerjee et al. 2006). Applied irrigation water will stimulate weed seed germination and weed growth in addition to the seeded plants, creating competition and complicating establishment. If irrigation is used, land managers should make sure the irrigation water quality is compatible with the species being planted. Highly saline water may impede the germination and growth of some plants, and water with a high sodium-to-calcium ratio, referred to as the sodium-adsorption ratio, will reduce infiltration and accentuate soil crusting (Bauder et al. 2011).

Most likely, locations with extremely dry climates and very sandy soils, such as the San Luis Valley, will require some water to achieve good stands in a timely fashion (Richard Sparks, Irrigation Water Management Specialist, USDA/NRCS, personal communication, September 7, 2012 and Brian Taylor, Arkansas Valley Range Project, personal communication, September 6, 2012). This is supported by research conducted in drier climates such as Arizona (Thacker and Cox 1988). Other areas with more precipitation and soils with higher water-holding capacity may not require additional water, but having the option of irrigation gives the land manager more flexibility. In the LaSalle revegetation study, plots were established using both warm- and cool-season grass mixes on a loamy sand soil without additional irrigation when the plots received near-average precipitation (Figures FS-10 and FS-11). However, during the extremely dry summer of 2010, plantings largely failed when shallow-precipitation events germinated seeds but failed to provide enough moisture to allow seedlings to establish. Intensive annual weed pressure also outcompeted young plants for moisture. Large (4 or more acres) demonstration plots that were planted in 2012 had very little germination due to drought, but will be observed during 2013 to determine if replanting is necessary. Costs, water availability and irrigation system suitability for establishing small-seeded grasses will determine whether supplemental irrigation is prudent for a given situation.

Timeline and Budget

Revegetation of most previously irrigated sites will be a long-term process. Experiences from several entities and studies in Colorado have shown that landowners and other stakeholders should expect at least 5 years of weed control and other management practices after initial plantings. It is also not unusual to have to replant due to weed pressure, drought or other complications. However, experience has also shown that if a poor stand is present during the first year after planting, it is usually better to give the planting another year to establish, rather than replant immediately. Many seeds, especially native seeds, have a fairly long dormancy period and may germinate later when conditions are more favorable for growth. It cannot be emphasized enough that good weed control and some management several years past planting is required to achieve satisfactory results.

While seeding cost is a significant expense of revegetation, land preparation and weed control expenses following establishment can also be significant. The costs identified in Table FS-4 will vary considerably depending upon site-specific conditions and revegetation goals. Water and irrigation system costs for plant establishment need to be considered if watering is an option for establishment. Other costs that can be significant, but are not identified in Table FS-4, include irrigation system/infrastructure removal, land leveling and irrigation road removal. If land is eventually going to be used for grazing, costs for fencing and watering facilities need to be considered. Finally, a large cost often not considered is the opportunity cost (lost revenue) of the land for irrigated or dry land farming or grazing while the land is being revegetated. These costs should be estimated to be at least the cash lease value of the land for whichever agricultural activity would be taking place. The costs in Table FS-4 were determined for a test site that did not include any supplemental irrigation for plant establishment. Total cost estimates range from $170 to $465 per acre over a 5-year period. If supplemental irrigation is needed for plant establishment, these costs should be added to the costs shown in Table FS-4.

Total revegetation cost estimates range from $170 to $465 per acre over a 5-year period.

figure **FS-11.** LaSalle revegetation site cool-season grass mix, fall 2012.

Summary

Achieving a successful transition from irrigated crops to perennial vegetation should be viewed as a long-term process. The previous crop should be compatible with revegetation goals, soil conditions should be assessed and remedied if undesirable, and interim measures, such as cover crops, should be considered, especially if revegetation is going to be delayed. A clear message from personal experiences, research and the literature is that weed control is extremely important before and after planting, and the need for weed control will continue for several years following planting. Costs for this process are significant, and attempts to avoid costs up front will likely result in paying later with failed stands, poor weed control and repeated planting. Irrigation water may be necessary in extremely sandy soils or drier environments, but specific information on the amount and duration is not available at this time. Proper planting equipment and technique is necessary to start the process with the best chance for success. Most of the revegetation work that has been done on previously irrigated land in Colorado has required persistence, adaptive management and the acceptance of some trial and error to find the best approach for local conditions.

Table **FS-4.** Potential costs associated with revegetation on previously irrigated fields ($/acre).

	Year 1	Year 2	Year 3	Year 4	Year 5
Categories					
Weed control prior to planting	15–25				
Tillage/seed bed prep	0–40				
Amendments	0–50				
Cover crop establishment	0–20				
Cover crop termination	0–25				
Cover crop harvest income*	(0–250)				
Planting		10–20			
Seed		25–105			
Post planting mowing		12–16	24–32**	12–16	12–16
Post planting herbicide			30–50**	15–25	15–25
Total ($/acre)	**15–160**	**47–141**	**54–82****	**27–41**	**27–41**

* Assumes partial harvest for forage

** Two applications of herbicide or two mowing events

Section 7: Water Law and Water Rights Engineering Issues

General Colorado water law as it applies to changes of use of agricultural water rights was described in Section 1. Currently most, if not all, agricultural to M&I Colorado water court transfers are based upon:

- Transfer of all available consumptive use (CU) to the M&I user
- Cessation of all irrigation
- Permanent dry up of the formerly irrigated parcel

Most often, following a change to M&I use, all irrigation water is removed from the farm. While leasebacks may be exercised for some period of time, ultimately the land will not be irrigated. To protect the lands from which irrigation water has been removed, the water courts typically impose terms and conditions requiring the revegetation or other suitable use of the land, which can include dry land farming or urbanization (residential, commercial and industrial development). Section 37-92-103(10.5) of the Colorado Revised Statutes defines "revegetation" as "the establishment of ground cover of plant life demonstrated to be, without irrigation, reasonably capable of sustaining itself under the climatic condition, soils, precipitation, and terrain prevailing for the lands from which irrigation water is removed. Grasses or other plants used for the purpose of revegetation shall not be noxious as such plants are defined under the provisions of the 'Colorado Noxious Weed Act,' article 5.5 of title 35, C.R.S."

Section 37-92-305(4.5)(a) of the Colorado Revised Statutes provides, in part, that a change of an agricultural water right *shall* include terms and conditions "designed to accomplish the revegetation and noxious weed management of lands from which irrigation water is removed." That section also provides that the applicant for the change of water rights "may, at any time, request a final determination under the court's retained jurisdiction that no further application of water will be necessary in order to satisfy the revegetation provisions. *Dry land agriculture may not be subject to revegetation order of the court*" [emphasis added]. The statutes do not define "dry land" agriculture.

The water courts have consistently applied terms and conditions, pursuant to these statutes, requiring the complete cessation of irrigation except to revegetate the former agricultural land. For example, in the recently decreed "FRICO case" — *Application for Water Rights of the Farmers Reservoir & Irrigation Co., et al.* Case No. 2002CW403, District Court, Water Division No. 1 (May 11, 2009) — the water court required that parcels from which the irrigation water was being changed "may not be irrigated by any source of water presently or in the future unless the Water

Court enters a Decree approving such irrigation." In addition, to obtain 100% of the full CU decreed, the applicants were required to kill the "alfalfa or native grasses … through deep tilling or chemical treatment." If not killed, the transferrable CU is reduced "according to the following table when depth to groundwater is less than eight (8) feet." The reduction in transferrable CU is based upon the depth of groundwater present after the transfer. If groundwater continues to be consumed by plants on the property, whether existing or revegetated, that amount is deducted from the transferrable CU derived from the irrigation water historically applied on the land. Table 7-1 shows the standard reduction of CU included in South Platte Basin water transfer decrees based on depth to groundwater on lands that are no longer irrigated and have been revegetated with native grasses or alfalfa.

***Table* 7-1.** Percent reduction in transferable consumptive use on lands no longer irrigated.

Depth to Groundwater (feet)	Percent Reduction in Transferable Consumptive Use	
	Native Grass	Alfalfa
1	85	100
2	50	90
3	30	75
4	20	50
5	15	35
6	10	20
7	5	15
8	0	10

Other potential dry-land crops have estimated maximum root zone depths of 2.5-3.0 feet for millet, 4.0-6.0 feet for wheat, 3.0-4.0 feet for corn,5.0-6.0 feet for sunflower, and 6.0 feet for milo sorghum.

In the FRICO case, the court provided a caveat, allowing for no reduction in consumptive use credits if the Division Engineer determines that "native grasses (not including alfalfa) that are present prior to the time of revegetation are sufficiently shallow rooted so that an insignificant amount of ground water is being consumed by the native grasses due to subirrigation, regardless of the depths to groundwater … ." As a result, to obtain full consumptive use credit, the applicants were required to demonstrate that the parcels from which the irrigation water was being changed were either revegetated with shallow-rooted crops (including existing shallow-rooted crops), dry land farmed, or used for residential, industrial or commercial purposes. The applicants are allowed to use the changed water to establish the revegetation cover and have 10 years from the date of decree to comply with the water court's revegetation conditions.

The terms and conditions applied in the FRICO case are representative of those applied in most transfer cases that do not contemplate continuing use of irrigation water (absent a subsequently decreed new source of water). However, in *City of Thornton v. Bijou Irr. Co.*, 926 P.2d 1, 83-86 (Colo. 1996), the Colorado Supreme Court recognized that the water court had the inherent authority to require revegetation or other suitable use of the land before the legislature's enactment of the revegetation statutes quoted above, which, the Court found, simply codified the water court's existing authority. In reaching that decision, the Supreme Court found that imposing terms and conditions to protect the land from which the water was being transferred was within the water courts' authority "to ensure that water resources are utilized in harmony with the protection of other valuable state resources," *Thornton v. Bijou*, 926 P.2d at 86, citing *Castle Engineer v. Castle Meadows, Inc.*, 856 P.2d 496, 505 (Colo.

1993); *Southeastern Colorado Water Conservancy District v. Shelton Farms, Inc.*, 529 P.2d 1321, 1327 (Colo. 1974) and "to balance the beneficial use of water with the preservation of other natural resources …," *Thornton v. Bijou*, 926 P.2d at 86, citing *Sheldon Farms*, 529 P.2d at 1327. Likewise, the Court had previously recognized that the "[o]ptimum use [of water] can only be achieved with proper regard for all significant factors, including environmental and economic concerns," in *re Rules & Regulations Governing the Use, Control and Protection of Water Rights,* 674 P.2d 914, 935 (Colo. 1983).

Allowing a limited amount of irrigation water to supplement dry land farming is within the water courts' authority and unquestionably meets the goals recognized by the Court in *Thornton v. Bijou*. In many cases, when there is no urbanization, the value of formerly irrigated land on which there is limited irrigation will be greater than the economic value of dry land farming the land or revegetating the land, which provides no economic return. Just as the water court has the authority to impose revegetation requirements prior to enactment of the statutes quoted above, it is within its current authority to allow limited irrigation to supplement dry land farming in lieu of revegetation. How that is accomplished raises significant legal and engineering questions that will be considered and determined within the course of the water court proceedings to change the water rights to M&I uses.

As discussed in Section 1, in any change of water rights an applicant is limited to transferring and consuming only the CU component of the water right — the amount removed from the river system by crop evapotranspiration as well as deep percolation losses. The remainder must be returned to the river system in the same location, time, quantity and rate of flow as has historically occurred to prevent injury to other water rights. The water courts and the parties to transfer cases have developed accepted methodologies for meeting these legal requirements. While each case varies, all parties and the court agree generally upon the correct method to calculate the CU and return flow components. These "knowns" provide a level of certainty to the legal process that encourages applicants to continue with "buy and dry" approaches.

Leaving a portion of the irrigation water on the farm to support limited-irrigation farming creates an entirely new set of "unknowns" that will have to be addressed in water court proceedings. This brings about a level of uncertainty and additional costs. Issues that will initially need to be addressed by the buyer and seller include, but certainly are not limited to, the following:

Leaving a portion of the irrigation water on the farm to support limited-irrigation farming creates an entirely new set of "unknowns" that will have to be addressed in water court proceedings.

1. How much water will be left with the land

2. Which of the available water right priorities will be left with the land and which will be transferred to the M&I or other user

3. Whether the irrigation water will be available when it is most needed by the crop

4. Whether the water can be delivered by the ditch company at the time that it is most needed

Legal issues, the fundamentals of which have been resolved in the "buy and dry" scenario, will need to be determined. To assure non-injury, the transferrable CU cannot exceed the amount historically consumed by the crops grown on the property. Calculating the CU becomes more problematic when a portion of the water continues to be used for irrigation, as does the maintenance of the historical timing, location and flow rates of the return flow component of the water right. Variables in making these determinations will include:

1. The type of crop grown

2. The depth of the crop's root zone and the impact of the groundwater level

3. The effect on the timing and amount of return flows when significantly less water is applied over the land

4. The application of less water at limited intervals, which may result in an increase or decrease in the consumptive use of the water being applied, thereby impacting the transferrable CU

5. The ability or willingness of the Division Engineer to administer a split of the water and the associated volumetric limits and return flow obligations

These and other unknowns create additional legal risks and costs for an M&I user who is changing agricultural water rights, as well as for the farmer who is trying to determine the potential economic return of retaining a small portion of the water right being sold. An alternative, and potentially simpler, approach to achieve water court approval would be to quantify the entire historical CU in the water transfer and include terms and conditions in the decree that allow limited irrigation using a portion of the transferred CU. This approach would quantify the return flows associated with the limited irrigation and how those return flows can be used as an offset against the total historical return flow obligations.

Section 8: Comparison of Options to Permanent Dry Up

The analyses presented in this report identify dry land farming and limited-irrigation farming as two options to permanent dry up and revegetation. Most water court decrees for transfers of water from agricultural use to M&I use require that the M&I end user ensure that lands will be dried up and successfully revegetated. The dry up results in taking the land permanently out of agricultural production. Dry land farming and limited irrigation present options to keep agricultural land in production, subject to a water court transfer, while still serving as a source of water for M&I water providers. These options are two of several potential choices that are evaluated through the wider CWCB Alternative Agricultural Water Transfer Methods Grants Program. The evaluation in this report is generally limited to permanent transfer of the water to the M&I user, in contrast to other ATMs, such as interruptible supply or rotational fallowing that involve a temporary cessation of irrigation. Some of the results of this study, such as revegetation guidelines and dry land crops that can be grown while land is temporarily fallowed, have applicability to other ATMs, such as interruptible supply and rotational fallowing.

This section compares the benefits and potential issues and challenges to permanent dry up, dry land farming and limited-irrigation farming, based on results of the analysis presented in Sections 3 through 7. The benefits and challenges may apply to both the buyer and seller, and depend on a variety of factors, including soil conditions, precipitation patterns, type of irrigation in use, crop prices, and legal and administrative challenges. The purpose of this comparison is to highlight these benefits and challenges that directly impact the buyer and seller in a free market environment, such as the logistics and technical challenges of revegetation, dry land or limited-irrigation agricultural operation of irrigated lands subject to a water court transfer. The results are not intended to analyze any potential indirect social, economic and demographic effects of transfers to M&I, nor to direct policy in favor of any of the options.

Water rights acquisition costs can vary significantly based on a number of market conditions. These include current urban growth pressures, the strength of the local agricultural economy and crop prices, location and seniority of water rights, and potential water court transfer risks. Based on informal discussions with several water rights providers acquiring water rights in the study area, the range of costs for water rights is $5,000 to greater than $10,000 per AF of average yield CU. We use $7,000 per AF of average annual CU for this study.

8.1 Benefits and Issues Associated With Permanent Dry Up and Revegetation

As reported in Section 7, agricultural transfers normally require dry up of the formerly irrigated lands in order to satisfy the legal condition that historical consumptive use of the agricultural use has not been expanded through the change of use to the M&I provider. Any expansion of historical CU would reduce the amount of water available to other vested water rights holders and cause injury. Perhaps the simplest explanation for the dry up provision in change-of-use decrees is that the non-expansion of use is partially demonstrable by verifying that nothing is growing on the formerly irrigated lands, with the exception of native vegetation sustained by natural precipitation.

The long history and widespread use of the dry up provisions in change-of-use decrees in Colorado has resulted in a known and predictable process in water court. As discussed in Section 7, the reduction of uncertainty through the water court process is attractive to M&I providers and therefore often employed. Furthermore, a transferring entity has a fixed end point, at which there are no further obligations from the transferring entity. For example, once revegetation has been achieved in accordance with the decree, the provider has no further obligations to maintain, preserve and grow native vegetation on the formerly irrigated parcel.

Through a traditional water court transfer, the M&I provider attempts to maximize the amount of transferable yield that can be changed to M&I use, usually minimizing its water rights acquisition costs. By transferring the largest amount of water per acre permissible, the process inherently minimizes the number of irrigated acres that are affected by the transfer for a given amount of water transferred to the M&I. In more recent transfer decrees, the transferable yield to an M&I provider may be further reduced if any remaining vegetation or the plants used for revegetation on the formerly irrigated field have roots that extend deep enough into the groundwater system to draw on groundwater.

Once the irrigation water has been sold and the irrigated lands dried up, the landowner may be eligible for federal farm subsidies under the Conservation Reserve Program (CRP), which

> *"is a land conservation program administered by the Farm Service Agency (FSA). In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality. Contracts for land enrolled in CRP are 10–15 years in length. The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat."*
>
> —(U.S. Department of Agriculture, Farm Service Agency 2013)

Enrollment in CRP is a competitive process and favors lands in environmentally sensitive areas, such as farms very close to streams or wetlands. CRP payments are not available to farmers who choose to continue farming formerly irrigated lands under dry land or limited-irrigation farming practices. According to the Morgan and Weld county FSA offices, CRP pays approximately $26 per acre, ranging from $17 to $44 depending on soil type. The land-owner must establish and maintain native grasses. The CRP contracts can be renewed at the end of the term. In the San Luis Valley of Colorado, local water users are leveraging another federal subsidy known as the Conservation Resource Enhancement Program (CREP) to remove lands from production in order to protect the local aquifer. CREP is an offshoot of the CRP, but is more limited in geography and scope.

When irrigated lands are dried up as part of a water court transfer, the agricultural production on the land normally ceases. Leasebacks from the water provider to the original agricultural user for use on the historically irrigated lands are a common practice, for the water provider does not have an immediate need for the water.

Dry up of irrigated land that has been revegetated may have localized negative impacts on local property tax revenues unless the proceeds from the sale of the water are used to start a local business or some other local economic activity. There may be positive impacts on a greater regional basis based on the urban use of the transferred water that results from higher taxable values and revenues from residential, commercial and industrial properties.

While the revegetation process for the M&I end user is a known and predictable process from a water court perspective, the logistics of successfully revegetating historically irrigated fields can entail a difficult, lengthy and costly process. As was discussed in previous sections, the success of revegetation depends on many factors, including soil and climatic conditions. Generally, water court decrees require that the M&I user must ensure successful revegetation, but the party responsible for the revegetation costs is negotiated as part of the water acquisition transaction, and may be borne entirely by the M&I user, entirely by the seller or some combination. Revegetation costs are estimated to range from $170 to $465 per acre over a 5-year period. Assuming a water purchase price of $7,000 per AF of average CU, and between 1 and 1.5 feet of CU per acre, the revegetation costs amount to roughly 2.5 to 6.5% of the total transaction cost, depending on the amount of CU per acre. Thus, while revegetation may be difficult and time-consuming to accomplish, the costs are a relatively small fraction of the overall cost of the water to the M&I user, and that cost may be borne in part by the seller, depending on the terms of the transaction.

While revegetation may be difficult and time-consuming to accomplish, the costs are a relatively small fraction of the overall cost of the water to the M&I user.

Table **8-1.** Summary of pros and cons of dry up and revegetation discussed in this section.

Pros	Cons
Involves a known and predictable process in water court (benefits the M&I transferor).	Removes land from agricultural production.
Provides for a known end to obligations on the land at the completion of dry up and acceptance of successful revegetation.	Potentially reduces local property tax revenue.
Minimizes the number of acres removed from irrigated production.	Entails potentially lengthy, difficult process for successful revegetation.
Minimizes the risk of reductions in transferable consumptive use credits.	
Offers the potential for the landowner to enter land into CRP subsidy programs once it is dried up.	
Entails little capital outlay (revegetation cost is a relatively small fraction of the overall transaction cost).	

8.2 Benefits and Issues Associated With Dry Land Farming

Converting formerly irrigated lands into dry land farming is an option that maintains agricultural production on the formerly irrigated lands, albeit at a reduced level. Maintaining agriculture in the rural communities keeps a portion of the direct and indirect economic benefits of irrigated agriculture.

Similar to with traditional dry up transfers, dry land faming by definition does not use irrigation water to farm. This allows the M&I transferor to maximize the transfer of consumptive use per acre, minimizing the number of acres that would be removed from irrigated production for a given volume of a water transfer. In more recent transfer decrees, the M&I's transferable CU will be reduced if the dry land crops' roots extend to groundwater. Table 7-1 shows typical reductions in transferable CU for native grasses and alfalfa for groundwater levels less than 8 feet below the surface. The purchaser may require shallow-rooted crops if dry land farming is to be attempted on a formerly irrigated parcel.

Dry land farming on a formerly irrigated parcel will not require the costs of revegetation with native grasses. This will save between $170 and $465 per acre, and potentially several years of effort. As described in Section 8.1, the costs of revegetation are negotiated as part of the water acquisition transaction, so costs are not necessarily saved by the M&I transferor or the agricultural seller, and represents approximately 2.5 to 6.5% of the transaction value. The revegetation costs are also comparable to a single year's net revenue on an irrigated acre (see Tables 3 and 5 in Appendix A).

As described in Section 7, there is uncertainty about revegetation requirements if dry land farming ceases on the property for any reason, including economic infeasibility in the future. Water court transfer decrees may provide for retained jurisdiction, resulting in a requirement for the transferring M&I user to revegetate the property, even if there have been many years of dry land farming on the parcel. One possible approach to address this concern is to include revegetation covenants on the formerly irrigated parcel that would require the landowner to revegetate the land if dry land farming ever ceased. If dry land farming ceased due to economic infeasibility and the landowner refused to revegetate, a lien could be placed on the property to enforce this provision. Another option would be to escrow estimated revegetation costs from the proceeds of the water sale into an interest-bearing account for a defined period of time that would be used to revegetate the land in the event of economic failure of the dry land farming operation.

Section 5 illustrated that much of the land in the study area is not suitable for dry land farming from an economic return standpoint. Table 5-2 shows that over the entire study area, the average economic return of dry land crops is a loss, expect for proso millet, which is due to the current high prices for this crop. Tables in Appendix B show that variation in price and yield of the various dry land crops may produce net economic benefits, but all dry land farming carries a substantial risk of negative economic return (loss). In addition to the traditional wheat-fallow rotation, many dry land producers are adopting a two-crop in three-year system, such as wheat-corn-fallow, wheat-sunflower-fallow or wheat-millet-fallow. In the enterprise budgets of this report, fallowing costs are incorporated into the direct expenses of the next crop in the rotation (Appendix A). As a result, the long-term economic return of dry land farming is approximately one-half to one-third less.

Table **8-2.** Summary of pros and cons of dry land farming.

Pros	Cons
Land remains in agricultural production with associated local economic multipliers, though at a lower level than with irrigated agriculture.	Uncertainty is created about revegetation requirements if dry land farming operations cease, including: • Retained jurisdiction of the transfer decree that makes the M&I transferor ultimately responsible for revegetation • No known timeframe or standard to end M&I entity responsibility for revegetation of the land • Potential for reduced consumptive use credit based on dry land crop selected and groundwater level
The number of acres removed from irrigated production is minimized.	Much of the land in the study area is not suitable for dry land farming from an economic standpoint.
Revegetation costs are avoided, though these costs are a relatively small fraction of the water acquisition cost (approximately 2.5 to 6.5%).	Much more acreage than for irrigated agriculture is required to produce similar economic returns.
	Local property tax revenue is potentially reduced.

Table 5-2 also shows that the acres in the study area of formerly irrigated acres that are expected to produce at least the break-even yield (at 2012 prices) vary by crop. These parcels would be the best candidates for dry land farming. Because the economic return of dry land farming is so much lower than for irrigated agriculture, the amount of land that would be required to achieve a similar economic return as does irrigated agriculture increases by approximately 5 to 10 times. This may drive future consolidation of formerly irrigated agricultural parcels into larger dry land farming operations. The property tax impacts are similar or identical to those described in Section 8.1.

8.3 Benefits and Issues Associated With Limited-Irrigation Farming

Converting formerly irrigated lands into limited-irrigation farming is an option that maintains agricultural production on the formerly irrigated lands, albeit at a reduced level relative to irrigated agriculture, and at a higher level than with dry land farming on an individual parcel basis. Maintaining agriculture in the rural communities preserves a portion of the direct and indirect economic benefits of irrigated agriculture. However, limited-irrigation farming will necessarily remove more acres from full irrigation than either the native revegetation or dry land farming option. This occurs because, for any given volume of water needed by the transferring M&I entity, a portion of the historical CU is not transferable to the M&I user because it is remaining on the farm for irrigation.

For example, if we assume there is 1.5 feet of historical irrigation water application on a farm and the limited-irrigation use requires 6 inches of application, only two-thirds of the historical CU is available to transfer to the M&I entity. For a fixed volume of water required by the M&I entity, limited irrigation will require the acquisition and removal of a portion of the CU from 50% more acres. The additional acreage required compared to dry up options increases as the total CU of the farm decreases. The increased impact to the irrigated acreage may result in a more significant economic impact than with the native revegetation and dry land farming options, even though the crop yield from limited-irrigation farming is greater than with native vegetation or dry land farming. Table 8-3 demonstrates this concept.

As discussed in this section, limited-irrigation farming on a formerly fully irrigated parcel will not require the costs of revegetation with native grasses. Like with dry land farming, there is uncertainty surrounding long-term responsibility for revegetation of the property if the limited irrigation ceases (see Section 8.2). As discussed in Section 5.3, crop insurance is available for fully irrigated crops and for dry land crops, but there is no system in place for limited-irrigation crops. Without crop insurance, *Table* **8-3.** Irrigated acres converted from full irrigation to native revegetation or dry land compared to limited irrigation and economic impact.

	Native Revegetation or Dry Land	Limited Irrigation
M&I water need (AF of CU)	1,000	1,000
Historical application on farm (ft)	1.5	1.5
Historical application remaining on farm (ft)	0	0.5
Historical application available for M&I transfer	1.5	1
Transferable CU (at 70% efficiency) (AF CU per acre)	1.05	0.7
Acres removed from full irrigation (AF of need / CU / acre)	950	1,430
Average economic yield (irrigated corn) ($/acre)[1]	$484	$484
Average economic yield (limited-irrigation corn) ($/acre)[2, 3]	$0	$160
Reduction in farm revenue due to transfer ($/acre)	-$483	-$323
Total reduction in farm revenue due to transfer ($) (acres removed from production × reduced revenue per acre)	-$458,850	-$461,890

1 Enterprise budget for irrigated corn in the South Platte Valley (Appendix A Table 11)

2 Dry land corn average return is a loss, so assume native revegetation with no crop

3 Limited irrigation from enterprise budget (Section 5.4)

risk of loss may be greater than many producers are willing to accept, especially if they have utilized crop insurance for formerly irrigated lands. In addition, the limited-irrigation yields presented in Section 4 assume 85% irrigation efficiency, which necessitates the use of a sprinkler. The sprinkler lease cost is included in the enterprise budgets for the limited-irrigation options and is included in the economic return values. Parcels that already have a sprinkler would see increased economic returns under the limited-irrigation option beyond those presented in Section 4. Because the economic return of limited-irrigation farming is so much lower than with irrigated agriculture, the amount of land that would be required to achieve an economic return similar to that of irrigated agriculture increases by 3 times for corn. This could potentially drive future consolidation of formerly irrigated agricultural parcels into larger limited-irrigation farming operations.

One of the advantages to the native revegetation or dry land farming options is that the legal question of expansion of CU is answered by simply observing whether any crops are being irrigated on the property and monitoring groundwater levels. With the limited-irrigation option, the historical agricultural CU is split between the farm and the M&I transferor. This has the potential to become infeasible from a day-to-day administrative standpoint. One option to eliminate the administrative complexities is for the M&I user to transfer the full amount and to lease back a portion of the transferred CU water to the irrigator. Claims for return flows from the limited-irrigation use would likely be contested by objectors in the water court transfer due to the deficit irrigation approach with a far less than full water supply. Additional analysis after the limited-irrigation practice is established may provide evidence of return flows that potentially could be used to meet return flow obligations from the transfer.

Much of the land in the study area is suitable for limited-irrigation farming from a net economic return standpoint (Figures 5-5 through 5-7). The economic return, however, is significantly less compared to that of full irrigation, but a majority of the acreage produces break-even or better economic return for limited-irrigation corn, millet and wheat. However, if an irrigator decides to not sell a portion of the full irrigation water right to the M&I entity, the cost of the water not sold must be considered as an economic investment into the continued agricultural operations. While this cost is not a direct cost associated with the production of a crop, it is an opportunity cost, e.g., the value of the water not sold and the return on that resource from the limited-irrigation farming. Using the example

Table **8-4.** Summary of pros and cons of limited-irrigation farming.

Pros	Cons
Land remains in agricultural production, though at a lower level than with fully irrigated agriculture, but higher than with dry land farming or native revegetation.	Uncertainty is created about revegetation requirements if limited-irrigation operations cease, including: • Difficult water court transfer process • Retained jurisdiction of the transfer decree that makes the M&I transferor ultimately responsible for revegetation • Uncertain timeframe or standard to end M&I responsibility for revegetation of the land Possible solutions include recorded revegetation covenants or escrowing of future revegetation costs at the time of the water sale.
Revegetation costs are avoided, though these costs are relatively small fraction of the water acquisition cost (approximately 2.5 to 6.5%).	Additional impacted acreage is required to provide the same volume of water to the M&I transferor.
Much of the land in the study area is suitable for limited-irrigation farming from an economic standpoint if focused on limited-irrigation corn, wheat or millet.	Much more acreage than for irrigated agriculture is required to produce similar economic returns.
	Existing crop insurance programs are not configured for limited irrigation.
	Local property tax revenue is potentially reduced.
	Use of a sprinkler is required for increased efficiency. Properties with existing sprinklers may see higher economic returns.
	Economic opportunity cost of not selling all the available CU to the M&I may not be covered by the economic gain of limited-irrigation farming.
	Administrative challenges associated with sharing CU may increase costs or affect feasibility altogether. Possible solutions include full transfer and leaseback by the M&I entity, but the costs be prohibitive.

in Table 8-3 and further assuming that the cost of water paid by an M&I entity is $7,000 per AF of CU, the farmer forgoes $3,500 per acre (0.5 AF of water use under limited irrigation times $7,000). This is a one-time cost, and the economic return developed from the use of this resource should be compared to a reasonable rate of return that could have been achieved by investing the $3,500 elsewhere. For example, a 4% return on $3,500 is approximately $140 per year. This suggests that if the economic return of limited irrigation is less than $140 per acre, the investment of resources by not selling does not result in a recovery of this investment. An examination of Figure 5-3 suggests that only limited-irrigation millet on average produces approximately this economic return.

Alternatively, limited irrigation could be an attractive alternative using less reliable supplies such that the value of the water used for deficit irrigation is not evaluated as part of the cost. Many M&I providers are acquiring and transferring agricultural rights to increase the reliability or firm yield of their supplies to ensure the ability to meet reasonable water demands during extended drought periods. As a result, in average and wet years, these M&I providers may have surplus water that cannot be used or stored in their systems. Under current practices, cities often lease this surplus to farmers for irrigation, but the decision is often not made until late spring, and may be too late for some farmers to order seed and plant. In order to provide a more predictable assessment of water available for irrigation use, M&I providers could lease surplus supplies to an agricultural augmentation plan for recharge. Recharge ponds can be selected so the recharge accretions can augment pumping of irrigation water for limited-irrigation farming operations. Recharge ponds with longer accretion lagging periods could allow for limited-irrigation practices to plan well in advance for specific crops and timing of pumping. Under this variation on limited irrigation, the transferring farmer receives the entire economic benefit of selling the water right and a minimum number of acres are affected, but limited irrigation would only occur in years when there are a sufficient number of augmentation credits available from surplus M&I supplies. In extended periods of average to below average conditions, the M&I provider would not have surplus water, and the limited irrigation practice would not occur and the land would be fallowed until such time that surplus water has been recharged and augmentation credits are again available.

Section 9: Summary of Findings and Recommendations

9.1 Findings

The key findings identified in this report are listed below.

Projections of loss of irrigated acres

1. The Colorado Water Conservation Board's Statewide Water Supply Initiative identified that a significant number of the agricultural water rights associated with irrigated acres in the South Platte Basin will be acquired and transferred to municipal and industrial (M&I) use over the next 50 years.

2. A certain number of agricultural rights have been identified as components of the Identified Projects and Processes (IPPs) of M&I water providers.

3. Additional agricultural water rights may be acquired and transferred if IPPs are not permitted or developed to the planned amounts.

Alternative uses for lands subject to dry up

1. Development for other land uses, such as residential, commercial or industrial (urbanization)

2. Permanent dry up and revegetation with native grasses

3. Dry land agriculture

4. Limited-irrigation agriculture, or dry land farming with the allocation of a specified minimum amount of supplemental irrigation water

Irrigated acres in the study area

1. Southern Weld and Morgan counties (study area) are likely areas for future water acquisitions on lands that will not be highly urbanized in the next 50 years.

2. As of 2005, there were approximately 371,000 irrigated acres in southern Weld County and 133,000 in Morgan County.

3. The primary crops grown are corn and alfalfa, with lesser amounts of grass hay, pasture, small grains (wheat, barley, millet and others), dry beans, sugar beets and vegetables.

Water court transfer process

1. The water court transfer approval process is biased towards the traditional "buy and dry" approach, where irrigated land is permanently dried up and revegetated with native grasses.

2. The dry up and revegetation approach is the most prevalent approach used by water court applicants.

3. The dry up and revegetation approach is accepted by water court objectors and the Division Engineer.

4. There is a standard "percent reduction in transferable consumptive use on lands no longer irrigated table" used in water court to reduce transferrable consumptive use (CU) based on depth to groundwater. This table does not include dry land crops, which are, in some instances, treated as native grasses. These dry land crops may have a lesser root depth than those used for native grasses in the table.

5. The water court transfer of a portion of the historical use, with the remainder left for limited irrigation, will be difficult to decree and administer. A simpler approach is to quantify and transfer the entire historical CU and, as part of the decree, leave a portion of the transferred CU on the land for limited irrigation.

Water rights acquisition costs

1. Water rights acquisition costs in the study area vary by location and seniority of the water rights, but generally range from $5,000 to over $10,000 per acre-foot (AF) of average annual CU.

2. For this report's analysis, an average cost of $7,000 per AF of average annual CU was used.

Revegetation

1. Permanent dry up and revegetation is widely accepted through the water court transfer process.

Potential for dry land agriculture

1. The combination of precipitation patterns and soil types for southern Weld County and Morgan County are not generally favorable for dry land agriculture.

2. Precipitation patterns for southern Weld county are generally more favorable for small grains than corn.

3. Precipitation patterns for Morgan County are generally more favorable for corn than small grains.

4. Projected economic return for the optimal dry land crop for individual subregions within the study is less than $50 per acre on average.

5. Dry land farming in the study area would be marginal in terms of economic return.

6. Of the 504,000 irrigated acres in the study area, 57,020 acres of wheat or 97,670 acres of proso millet would be expected to have net economic return greater than $50 per acre. Note some of these acreages may overlap and the analysis is based on current market prices. The recent prices for proso millet are well above historical averages (Figure 5-7).

Potential for limited-irrigation agriculture

1. Limited-irrigation farming can result in greater yields and profitability than dry land agriculture.

2. Six inches of water use has been assumed for the limited-irrigation concept analyzed in this report.

3. Projected economic return for the break-even or better parcels using limited-irrigation corn within the study are approximately one-third of the irrigated corn yield.

4. At an estimated price of $7,000 per AF, the value of water left on a parcel for limited-irrigation farming is $3,500 per acre.

5. Excluding the value of the water rights used for limited-irrigation farming, approximately 325,820 acres of wheat, 270,100 acres of corn and 469,780 acres of proso millet would be expected to

have net profits greater than $50 per acre. Note some of these acreages may overlap and the analysis is based on current market prices. The recent prices for proso millet are well above historical averages (Figure 5-7).

6. Current state law does not provide for a property tax classification for limited-irrigation land. Agricultural land is classified as irrigated or non-irrigated.

7. Current crop insurance policies will not cover limited-irrigation crops.

9.2 Recommendations

This study's key recommendations regarding limited-irrigation farming are listed below.

1. Where feasible, evaluate the net economic benefits — locally, regionally and statewide — of limited-irrigation farming as an alternative to revegetation or dry land farming.

2. Encourage state agencies, including the Division Engineer and Attorney General, as a matter of public policy, to support dry land and limited-irrigation agriculture on formerly irrigated land both during the water court transfer process and for implementation in Substitute Water Supply Plans, interruptible water supply agreements and post-decree farming operations.

3. Provide funding for the development of an updated table on "percent reduction in transferable consumptive use on lands no longer irrigated" for typical dry land and limited-irrigation crops applicable to the study area.

4. Provide funding for the evaluation of return flows from limited-irrigation farming.

5. Support changes to CRS 39-1-103, which governs property valuation, or the accompanying Land Valuation Manual prepared by the Department of Local Affairs, Division of Property Taxation, to allow for a different property valuation for limited-irrigation farming.

6. Conduct a study specific to the South Platte Basin for determining crop insurance parameters for limited irrigation and support a change in the federal crop insurance program to cover limited-irrigation crops.

Works Cited and Bibliography

Barbarick, K.A., N.C. Hansen, and J.P. McDaniel. 2012. *Biosolids Application to No-Till Dryland Rotations*. Technical Report 12-6. Fort Collins, Colo.: Colorado Agricultural Experiment Station.

CDM/Colorado Water Conservation Board. 2004. *Statewide Water Supply Initiative*.

CDM/Colorado Water Conservation Board. 2010. *Statewide Water Supply Initiative Update.*

CDM/Colorado Water Conservation Board. 2011. *Alternative Agricultural Water Transfer Methods Grant Program Summary*.

Colorado Water Conservation Board/Colorado Division of Water Resources. 2012. *Colorado's Decision Support System: Division 1 — South Platte,* table row for "Division 1 Irrigated Lands 2005." Data set accessed at http://cdss.state.co.us/GIS/Pages/Division1SouthPlatte.aspx.

DiNatale Water Consultants, Inc. 2012. *Water Partnerships: An Evaluation of Alternative Agricultural Water Transfer Methods in the South Platte Basin*. In association with Colorado State University College of Agricultural Sciences, Department of Agricultural and Resource Economics, Ecological Resource Consultants, Inc. Prepared for the Farmers Reservoir and Irrigation Company and Colorado Water Conservation Board. http://dinatalewater.com/pdf/water_partnerships.pdf.

Gebre-Amlak, Assefa, Dennis A. Kaan, and John Deering, eds. 2012. *Golden Plains Area Agricultural Handbook*. Volume IX. Fort Collins, Colo.: Colorado State University.

Nielsen, D.C. 2006. "Central Great Plains Yield Calculator." U.S. Department of Agriculture, Agricultural Research Service website. Updated June 6, 2013. http://www.ars.usda.gov/Services/docs.htm?docid=19206.

Peairs, F.B., N.C. Hansen, G.A. Peterson, D.G. Westfall, J.C. Herman, D. Poss, L. Sherrod, T. Shaver, T. Randolph, and J. Rudolph. 2012. *Agronomic and Entomological Results from 7 Years of Dryland Cropping Systems Research at Briggsdale, Colorado*. Technical Report 6-12. Fort Collins, Colo.: Colorado Agricultural Experiment Station.

Peterson, G.A., and D.G. Westfall. 2004. "Managing Precipitation Use in Sustainable Dryland Agroecosystems." *Annals of Applied Biology* 144(2):127–138.

PRISM Climate Group, Oregon State University. 2012. "30-Arcsec Monthly Precipitation Normals for 1981-2010." Accessed Oct 23. Available at http://prism.oregonstate.edu.

State of Colorado, Department of Local Affairs. 2013. "Historical Census Population – Parameters." Accessed June 4. https://dola.colorado.gov/demog_webapps/hcp_parameters.jsf.

State of Colorado, Department of Local Affairs, Division of Property Taxation. 2013. "Land Valuation Manual." Updated March 19.

U.S. Department of Agriculture, Farm Service Agency. 2013. "Conservation Reserve Program." Updated May 14. https://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=crp.

U.S. Department of Agriculture, National Agricultural Statistics Service, Colorado Field Office. 2006. *Colorado Agricultural Statistics*. http://www.nass.usda.gov/Statistics_by_State/Colorado/Publications/Annual_Statistical_Bulletin/2006bulletin.pdf.

U.S. Department of Agriculture, National Agricultural Statistics Service, Colorado Field Office. 2012. *Colorado Agricultural Statistics.* http://www.nass.usda.gov/Statistics_by_State/Colorado/Publications/Annual_Statistical_Bulletin/Bulletin20122.pdf.

U.S. Department of Agriculture, Natural Resources Conservation Service, Soil Survey Staff. 2012. "Soil Survey Geographic (SSURGO) Database for Colorado South Weld County and Colorado Morgan County." Accessed April 20. http://soildatamart.nrcs.usda.gov.

U.S. Department of Agriculture, Risk Management Agency, Topeka Regional Office. 2011. "Current Procedures for Limited Irrigation." May 19 presentation at meeting for Water District 6, Sheridan and Thomas counties held at Kansas Water Office.

Waechter, Jay. 2012. "Proposed Procedures for Limited Irrigation for Crop Insurance." Paper presented at 24th annual Central Plains Irrigation Conference, Colby, Kansas, February 21–22.

References for Draft Fact Sheet: Revegetation Strategies for Transitioning to Non-Irrigated Grassland

Banerjee, M.J., V.J. Gerhart, and E.P. Glenn. 2006. "Native Plant Regeneration on Abandoned Desert Farmland: Effects of Irrigation, Soil Preparation, and Amendments on Seedling Establishment." *Restoration Ecology* 14(3):339–348.

Bauder, T.A., R.M. Waskom, P.L. Sutherland, and J.G. Davis. 2011. "Irrigation Water Quality Criteria." Colorado State University Extension Factsheet No. 0.506. Updated April 19, 2013. http://www.ext.colostate.edu/pubs/crops/00506.html.

Colorado Department of Agriculture. 2013. "Noxious Weed Species." Accessed June 5. http://www.colorado.gov/cs/Satellite/ag_Conservation/CBON/1251618874438.

Colorado Department of Natural Resources. 1998. *Native Plant Revegetation Guide for Colorado*. Caring for the Land Series, Volume III. http://www.parks.state.co.us/SiteCollectionImages/parks/Programs/CNAP/CNAPPublications/RevegetationGuide/revegetation.pdf.

Ehmke, T. 2013. "Soil Health: Building for the Future." *Crops & Soils Magazine*. American Society of Agronomy website. https://www.agronomy.org/files/publications/crops-and-soils/soil-health.pdf.

Oldfather, S., J. Stubbendieck, and S.S. Waller. 1989. "Evaluating Revegetation Practices for Sandy Cropland in the Nebraska Sandhills." *Journal of Range Management* 42(3):257–259.

Roath, R. 2005. "Establishing Perennials on Previously Irrigated Lands: How to Make Informed Choices." Presentation at Central/CSU Water Program, Central Colorado Water Conservancy District, November 30. http://waterquality.colostate.edu/documents/previouslyirrigated.pdf.

Sustainable Agriculture Research & Education. 2012. *Managing Cover Crops Profitably*, third edition. Edited by Andy Clark.

Sutherland, P.L., K.L. Conrad, D.A. Miller, J.A. Knapp, and W.G. Hassell. 1990. "Revegetation of Previously Irrigated Cropland: I. Development of a Research and Demonstration Program." *Rangelands* 12(1):12–16.

Sutherland, P.L., and J.A. Knapp. 1988. "The Impacts of Limited Water: A Colorado Case Study." *Journal of Soil and Water Conservation* 43(4):294–298.

Taliga, C., and J. Sharkoff. 2012. "Plant Suitability and Seedling Rates for Conservation Plantings in Colorado." Plant Materials Technical Note

No. 59 (Revised). http://efotg.sc.egov.usda.gov/references/public/CO/COPMTN_59.pdf.

Thacker, G.W., and J.R. Cox. 1988. "Revegetation of Retired Farmland: Evaluation of Six Range Grasses Under Three Irrigation Regimes." Forage and Grain: A College of Agriculture Report. Tucson: University of Arizona, College of Agriculture.

Thacker, G.W., and J.R. Cox. 1991. "Revegetation of Retired Farmland: Response of Range Grasses to Establishment Irrigations and Microcatchment Water Harvesting." Forage and Grain: A College of Agriculture Report. Tucson: University of Arizona, College of Agriculture.

Thorvaldson, J., and J. Pritchett. 2006. *Economic Impact Analysis of Reduced Irrigated Acreage in Four River Basins in Colorado*. Colorado Water Institute Completion Report No. 207. Fort Collins, Colo.: Colorado Water Resources Research Institute. http://limitedirrigation.agsci.colostate.edu/present/economic_activity.pdf.

U.S. Department of Agriculture, Natural Resources Conservation Service, Colorado. 2007. "Conservation Practice Specification Range Planting — Code 550." FOTG, Section IV, Standards and Specifications. Available at http://efotg.sc.egov.usda.gov/references/public/CO/CO550_spec.pdf.

Waskom, R.M., T. Bauder, J.G. Davis, and A.A. Andales. 2012. "Diagnosing Saline and Sodic Soil Problems." Colorado State University Extension Factsheet No. 0.521. Updated April 19, 2013. http://www.ext.colostate.edu/pubs/crops/00521.html

Appendices

The following appendices provide tables of prices and budget costs for irrigated, limited-irrigation and dry land crops, and break-even analysis and alternative prices for variable crop yields.

Appendix A: 2012 Crop Enterprise Cost Estimates

Economic analysis of the crops reviewed in this study were from the CSU *Golden Plains Area 2012 Agricultural Handbook*. The prices included in these tables were used in other appendices and in Figure 5-2.

Appendix B: Price and Yield Variability Analysis

Tables in this appendix display the variability in economic yield under variable price and yield assumptions, and compare the range of economic returns for a variety of fully irrigated crops and the dry land and limited-irrigation options. The tables further compare the estimated economic return over the entire study area, on currently irrigated parcels, and on currently irrigated parcels with estimated yields better than the break-even yield shown in Table 5-2. The prices were varied up to 25% above and below the base price (2013 prices), and also include a long-term average price (1997 to 2013, adjusted to 2012 dollars). The yields were varied up to 25% above and below the base yield. The base yield for irrigated crops was taken from the 2012 enterprise budgets (Appendix A). The base yield for the dry land and limited irrigation crops comes from the GIS analyses presented in Section 4 (full study area) and Section 5 (irrigated parcels and break-even parcels).

Appendix C: Crop Enterprise Cost Estimates for Current Harvest Delivery Prices for 2013

Tables in this appendix contain the price or cost/unit that producers would be looking at in the winter/spring when deciding which crops to grow for the upcoming crop year. Crop insurance premiums and indemnities are not calculated in these budgets because they are site-specific in their calculation, and, as of yet, no procedure has been set for limited-irrigation crop insurance in Colorado. Therefore, the extremes (both positive and negative) of the economic returns shown in the following tables will be reduced once actual crop insurance premiums or indemnities are included (i.e., crop insurance premiums reduce positive economic returns, and indemnity payments mitigate losses). The average crop yield for the entire study area is used for the quantity for each crop (Table 5-2).

Appendix A:
2012 Crop Enterprise Cost Estimates

Economic analysis of the crops reviewed in this study were from the CSU *Golden Plains Area 2012 Agricultural Handbook*. The prices included in these tables were used in other appendices and in Figure 5-2.

CROP ENTERPRISE COST ESTIMATES FOR 2011 IN NORTHEASTERN COLORADO

John Deering – Northern Region Agriculture and Business Management Specialist
Dennis A. Kaan – Golden Plains Area Director

Introduction

Estimated production costs and returns for the major crops grown in Northeastern Colorado are included in this section for 2012. It would only be fair to call the following cost of production estimates, or budgets, "typical" and hopefully representative of the area. These budgets are not averages, but rather represent typical costs as reported by producers in Northeastern Colorado and from data provided by the USDA-NASS Colorado field office. These budgets represent no one single individual, as all producers are different with unique management techniques, machinery complements, chemical applications, market timing and uncontrollable fortune with frost, hail, rain and insects. No attempt was made to conform these results to ideal production recommendations. Our goal is simply to report typical production costs from actual production.

These cost of production estimates conformed to the traditional economic method of accounting for all variable and fixed costs of production. Starting in 2006, the Mississippi State Budget generator became the software of choice to develop the enterprise budgets. Expected returns on land are capitalized using a capitalization rate based on the "real" rate of interest, which is the rate of interest paid minus the inflation rate. Net receipts need to be large enough to give the operator a four percent return on the land investment. If receipts are large enough to cover these items, the operator then has a positive return to management and risk. From a business management standpoint, farmers must earn positive receipts in order to provide for family living expenses, pay debt, earn positive returns on their investments and make new investments when feasible.

Variability in Input Use and Conditions

Caution is urged when using these 'typical' production cost and return estimates. This is especially true for agricultural lenders, appraisers, insurance adjusters, landlords and government agencies. Even among this survey group, which was pre-screened to be typical of the area, there were great differences. These differences were seldom due to good or bad management, but rather due to a variety of weather and pest conditions, soils, and irrigation management.

Table 1 lists typical fertilizer rates for the crops specified in this publication. Again, these rates are not meant to be recommendations for fertilizer requirements, but rather are typical rates reported by producers participating in the survey process. Also, the survey instrument does not inquire as to the usage of soil testing by producers for plant nutrients. As a result, no correlation can be made between the typical fertilizer rate reported and actual plant nutrient requirements.

In addition to crop yield and input rates, the survey instrument sent to producers asked for cultural practices, machinery compliments and machinery values. Machine cost variability from one producer to the next was often impacted by management choices. An operator that chooses to purchase newer machinery may feel they realize enough from increased dependability and lower repair costs that the extra investment is warranted. The typical machine complement in use is 7 to 15 years of age. When replacement machines are purchased they are not always new. As stated previously, positive returns to "management and risk" would have to be used to initiate replacement machinery purchases if that is a management priority.

Price Received

As always, a key management perspective for producers will be to pay close attention to production costs, marketing plans and price information. This is especially important in the current environment of rising commodity prices as production costs, and land rents have begun to rise again as well, putting pressure on profits in future years if commodity prices fall below their current levels. All local commodity prices were above FSA established loan rates for the 2012 marketing year. Table 2 presents a summary of the county loan rates for the Golden Plains Area.

Estimated Production Costs and Returns for Irrigated Crops

Tables 3 through 10 describe enterprise production costs and returns for irrigated crops in Northeastern Colorado. These enterprises include alfalfa, dry edible beans, corn, table stock potatoes, sugar beets, oil sunflowers, soybeans and winter wheat. All irrigated budgets are produced under center pivot irrigation. The alfalfa enterprise is assumed to be in production 5 years. Alfalfa establishment costs are amortized over a 5-year time period as a result. Crop rotations for dry bean production typically assumed production once every three or four years. Crop rotations that include potatoes or sugar beets typically assumed production of these crops once every four years. Corn was the crop typically used to fill out the rotations. Tables 11, 12, and 13 describe irrigated corn, sugar beet, and winter wheat enterprises for the South Platte River valley. These enterprises also assume center pivot irrigation and sugar beet production once every four years.

Estimated Production Costs and Returns for Dryland Crops

Many dryland producers are adopting a two crop in three-year system such as wheat-corn-fallow, wheat-sunflower-fallow, or wheat-millet-fallow. As a result there are two dryland winter wheat budgets defined in this report. Table 14, the conventional wheat-fallow budget, charges all fallow costs against the wheat crop, employing traditional tillage operations for weed control in the fallow period. Tables 14 through 18 describe reduced-till intensive cropping system enterprises for winter wheat, corn, millet, and oil-type sunflowers. In these reduced-till intensive cropping system budgets, fallow expenses from wheat harvest to summer crop planting (9 months) are charged to the summer crop enterprise. Fallow expenses from summer crop harvest to wheat planting (11 months) are charged to the wheat enterprise. Fallow operations include a combination of herbicide use and tillage operations for weed control in the reduced-till budgets.

The breakeven analysis feature at the bottom of each budget was new to the enterprise budget format last year. This feature allows us to see the per acre bottom line effect of positive or negative changes in price and/or yield while holding all inputs constant. By matching various different scenarios in this way, we can get a feeling for the relative production and marketing risks of each crop enterprise. In Table 5 - Irrigated Corn, price received was $6.80/bushel while quantity harvested was 192 bushel/acre. For the 2012 crop year, this combination results in $577.58 net receipts per acre before factor payments (Row 3, Column 3). The result of a 25% reduction in yield holding price constant at $6.80/bushel is 251.18, or a net gain of $251.18 per acre before factor payments, (Row 1, Column 3). It should be noted that the 25% (+/-) ranges shown in these tables are meant for illustration purposes only and do not represent the worst or best case scenarios for each crop enterprise.

Acknowledgments:

We would like to thank the following cooperators for providing crop enterprise cost and return data over the years: Tim Stahlecker, Lester Hasart, Ryan Neibur, Garret Metcheck, and Gerhard Heintges of Kit Carson County. Byron Weathers, Jim Lenz, Max Olsen, Duard and Darus Fix, and Alan Welp of Yuma County; Steve Firme of Phillips County; Terry Kuntz and John Wright of Washington County; Dave Wagers of Morgan County.

Table 1. Typical Fertilizer Application Rates for Irrigated and Dryland Crops.

	Nitrogen (N)[1]	**Phosphate (P)**[1]	**Potassium (K)**[1]
	Lbs/Acre	Lbs/Acre	Lbs/Acre
Irrigated Crops			
Corn	218	45	15
Sugar Beets	160	35	0
Pinto Beans	52	65	16
Winter Wheat	60	12	0
Potatoes	280	148	150
Alfalfa	65	60	73
Corn, South Platte Valley	175	30	50
Sugar Beets, South Platte Valley	120	35	60
Dryland Crops			
Winter Wheat	40	12	0
Corn	60	32	24
Oil Sunflowers	50	10	0
Millet	25	0	0

[1] These values are typical rates reported by producers participating in the survey process and are not meant to be recommendations for fertilizer requirements.

Table 2. National Loan Rates for Wheat, Corn, Sunflowers and Soybeans (2013 Crop Year)

Crop	Unit	Average	Kit Carson	Phillips	Sedgwick	Washington	Yuma
Wheat	**$/Bu**	2.90	2.90	2.89	2.89	2.95	2.89
Corn	**$/Bu**	2.00	2.02	1.95	1.95	2.08	2.00
Sunflower	**$/Cwt**	10.93	11.05	10.90	10.83	10.90	10.98
Soybeans	**$/Bu**	4.68	4.73	4.64	4.64	4.64	4.73

Table 3. 2012 Estimated Production Costs and Returns - Irrigated Alfalfa in Northeastern Colorado.

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION:						
ALFALFA (Round Bales)	TONS	210.00	4.90	1029.00		
TOTAL RECEIPTS				**1029.00**	**210.00**	
DIRECT COSTS						
Operating Preharvest						
ESTABLISHMENT ALLOCATION (5 Years)	DOLS	52.25	1.00	52.25	10.66	______
FERTILIZER	DOLS	102.84	1.00	102.84	20.99	______
HERBICIDE	DOLS	26.32	1.00	26.32	5.37	______
CUSTOM APPLICATION	DOLS	7.00	1.00	7.00	1.43	______
INSECTICIDE	DOLS	18.79	1.00	18.79	3.83	______
IRRIGATION ENERGY	DOLS	96.08	1.00	96.08	19.61	______
IRRIGATION REPAIR	DOLS	10.24	1.00	10.24	2.09	______
SPRINKLER LEASE	DOLS	70.00	1.00	70.00	14.29	______
CUSTOM AERIAL SPRAY	DOLS	8.00	1.00	8.00	1.63	______
INTEREST EXPENSE [3]	DOLS			13.70	2.80	
Total Preharvest	DOLS			**405.22**	**82.70**	
Operating Harvest						
FUEL	DOLS			4.83	0.99	______
REPAIR & MAINTENANCE	DOLS			8.64	1.76	______
LABOR	DOLS			4.21	1.00	______
BALING [1]	DOLS			98.00	20.00	______
HAULING/STACKING [2]	DOLS			19.60	4.00	______
Total Harvest				**135.28**	**27.61**	
Total Operating Costs				**540.50**	**110.31**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			16.43	3.35	______
GENERAL FARM OVERHEAD	DOLS			10.00	2.04	______
REAL ESTATE TAXES	DOLS			15.42	3.15	______
Total Property and Ownership Costs	DOLS			**41.85**	**8.54**	
TOTAL DIRECT COSTS				**582.35**	**118.85**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**446.65**	**91.15**	
FACTOR PAYMENTS						
LAND @ 4.00%	DOLS			162.50	33.16	
RETURN TO MANAGEMENT AND RISK	DOLS			**284.15**	**57.99**	

1 Baling = $15/Bale (Round Baler)
2 Hauling/Stacking = $3/Bale
3 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/TON				
			-25%	-10%		+10%	+25%
			$ 157.50	$ 189.00	$ 210.00	$ 231.00	$ 262.50
ALTERNATIVE YIELDS	-25%	3.7	$ (3.54)	$ 112.22	$ 189.40	$ 266.57	$ 382.33
	-10%	4.4	$ 112.22	$ 251.14	$ 343.75	$ 436.36	$ 575.27
TONS		4.9	$ 189.40	$ 343.75	$ 446.65	$ 549.55	$ 703.90
	+10%	5.4	$ 266.57	$ 436.36	$ 549.55	$ 662.74	$ 832.52
	+25%	6.1	$ 382.33	$ 575.27	$ 703.90	$ 832.52	$1,025.46

Table 5. 2012 Estimated Production Costs and Returns - Irrigated Corn in Northeastern Colorado.

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION:						
CORN	BU	6.80	192.00	1305.60		
TOTAL RECEIPTS				**1305.60**	**6.80**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	83.69	1.00	83.69	0.44	
FERTILIZER	DOLS	161.38	1.00	161.38	0.84	
HERBICIDE (APPLIED)	DOLS	28.58	1.00	28.58	0.15	
INSECTICIDE	DOLS	14.42	1.00	14.42	0.08	
IRRIGATION ENERGY	DOLS	98.36	1.00	98.36	0.51	
IRRIGATION REPAIR	DOLS	10.24	1.00	10.24	0.05	
CROP INSURANCE	DOLS	57.00	1.00	57.00	0.30	
SPRINKLER LEASE	DOLS	70.00	1.00	70.00	0.36	
CUSTOM AERIAL SPRAY	DOLS	8.00	1.00	8.00	0.04	
CROP CONSULTANT	DOLS	8.00	1.00	8.00	0.04	
FUEL	DOLS			21.96	0.11	
REPAIR & MAINTENANCE	DOLS			7.61	0.04	
LABOR	DOLS			8.40	0.04	
INTEREST EXPENSE [2]	DOLS			20.22	0.11	
Total Preharvest	DOLS			**597.86**	**3.11**	
Operating Harvest						
FUEL	DOLS			6.80	0.04	
REPAIR & MAINTENANCE	DOLS			5.09	0.03	
LABOR	DOLS			1.66	0.01	
HAULING [1]	DOLS			38.40	0.20	
Total Harvest				**51.95**	**0.27**	
Total Operating Costs				**649.81**	**3.38**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			52.79	0.27	
GENERAL FARM OVERHEAD	DOLS			10.00	0.05	
REAL ESTATE TAXES	DOLS			15.42	0.08	
Total Property and Ownership Costs	DOLS			**78.21**	**0.41**	
TOTAL DIRECT COSTS				**728.02**	**3.79**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**577.58**	**3.01**	
FACTOR PAYMENTS						
LAND @ 4.00%	DOLS			162.50	0.85	
RETURN TO MANAGEMENT AND RISK	DOLS			**415.08**	**2.16**	

1 Hauling Machinery & Labor Charges = $0.20/Bushel

2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/BU				
			-25%	-10%		+10%	+25%
			$ 5.10	$ 6.12	$ 6.80	$ 7.48	$ 8.50
ALTERNATIVE YIELDS	-25%	144.0	$ 6.38	$ 153.26	$ 251.18	$ 349.10	$ 495.98
	-10%	172.8	$ 153.26	$ 329.52	$ 447.02	$ 564.53	$ 740.78
BUSHELS		192.0	$ 251.18	$ 447.02	$ 577.58	$ 708.14	$ 903.98
	+10%	211.2	$ 349.10	$ 564.53	$ 708.14	$ 851.76	$ 1,067.18
	+25%	240.0	$ 495.98	$ 740.78	$ 903.98	$ 1,067.18	$ 1,311.98

Table 8. 2012 Estimated Production Costs and Returns - Irrigated Oil Sunflowers in Northeastern Colorado.

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION:						
SUNFLOWERS	CWT	25.70	20.30	521.71		____
TOTAL RECEIPTS				**521.71**	**25.70**	
DIRECT COSTS:						
Operating Preharvest						
SEED	DOLS	40.72	1.00	40.72	2.01	____
FERTILIZER	DOLS	42.87	1.00	42.87	2.11	____
HERBICIDE	DOLS	44.57	1.00	44.57	2.20	____
CUSTOM APPLICATION	DOLS	7.00	2.00	14.00	0.69	____
INSECTICIDE	DOLS	16.49	1.00	16.49	0.81	____
IRRIGATION ENERGY	DOLS	54.62	1.00	54.62	2.69	____
IRRIGATION REPAIR	DOLS	10.00	1.00	10.00	0.49	____
SPRINKLER LEASE	DOLS	70.00	1.00	70.00	3.45	____
CROP INSURANCE	DOLS	37.00	1.00	37.00	1.82	____
CUSTOM AERIAL APPLICATION	DOLS	8.05	1.00	8.05	0.40	____
CROP CONSULTANT	DOLS	8.00	1.00	8.00	0.39	____
FUEL	DOLS			4.95	0.24	____
REPAIR & MAINTENANCE	DOLS			1.84	0.09	____
LABOR	DOLS			0.84	0.04	____
INTEREST EXPENSE [2]	DOLS			12.39	0.61	____
Total Preharvest	DOLS			**366.34**	**18.05**	
Operating Harvest						
FUEL	DOLS			8.06	0.40	____
REPAIR & MAINTENANCE	DOLS			4.51	0.22	____
LABOR	DOLS			1.05	0.05	____
HAULING [1]	DOLS			5.08	0.25	____
Total Harvest				**18.70**	**0.92**	
Total Operating Costs				**385.03**	**18.97**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			18.34	0.90	____
GENERAL FARM OVERHEAD	DOLS			10.00	0.49	____
REAL ESTATE TAXES	DOLS			11.34	0.56	____
Total Property and Ownership Costs	DOLS			**39.68**	**1.95**	
TOTAL DIRECT COSTS:				**424.71**	**20.92**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**97.00**	**4.78**	
FACTOR PAYMENTS						
LAND @ 4.00%	DOLS			162.50	8.00	
RETURN TO MANAGEMENT AND RISK	DOLS			**-65.50**	**-3.23**	

1 Hauling Machinery & Labor Charges = $0.25/Cwt

2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/CWT				
			-25%	-10%		+10%	+25%
			$ 19.28	$ 23.13	$ 25.70	$ 28.27	$ 32.13
ALTERNATIVE YIELDS	-25%	15.2	$ (131.25)	$ (72.56)	$ (33.43)	$ 5.70	$ 64.39
	-10%	18.3	$ (72.56)	$ (2.13)	$ 44.83	$ 91.78	$ 162.21
CWT		20.3	$ (33.43)	$ 44.83	$ 97.00	$ 149.17	$ 227.42
	+10%	22.3	$ 5.70	$ 91.78	$ 149.17	$ 206.56	$ 292.64
	+25%	25.4	$ 64.39	$ 162.21	$ 227.42	$ 292.64	$ 390.46

Table 9. 2012 Estimated Production Costs and Returns - Irrigated Winter Wheat in Northeastern Colorado.

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION:						
HARD RED WINTER WHEAT	BU	7.10	91.40	648.94		
TOTAL RECEIPTS				**648.94**	**7.10**	
DIRECT COSTS:						
Operating Preharvest						
SEED	DOLS	28.88	1.00	28.88	0.32	
FERTILIZER	DOLS	97.86	1.00	97.86	1.07	
IRRIGATION ENERGY	DOLS	55.02	1.00	55.02	0.60	
IRRIGATION REPAIR	DOLS	10.24	1.00	10.24	0.11	
CROP INSURANCE	DOLS	55.00	1.00	55.00	0.60	
SPRINKLER LEASE	DOLS	70.00	1.00	70.00	0.77	
FUEL	DOLS			11.14	0.12	
REPAIR & MAINTENANCE	DOLS			4.92	0.05	
LABOR	DOLS			2.00	0.02	
INTEREST EXPENSE [2]	DOLS			11.73	0.13	
Total Preharvest	DOLS			**346.79**	**3.79**	
Operating Harvest						
FUEL	DOLS			9.10	0.10	
REPAIR & MAINTENANCE	DOLS			3.25	0.04	
LABOR	DOLS			1.66	0.02	
HAULING [1]	DOLS			18.28	0.20	
Total Harvest				**32.29**	**0.35**	
Total Operating Costs				**379.08**	**4.15**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			32.29	0.35	
GENERAL FARM OVERHEAD	DOLS			10.00	0.11	
REAL ESTATE TAXES	DOLS			15.42	0.17	
Total Property and Ownership Costs	DOLS			**57.71**	**0.63**	
TOTAL DIRECT COSTS:				**436.79**	**4.78**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**212.15**	**2.32**	
FACTOR PAYMENTS						
LAND @ 4.00%	DOLS			162.50	1.78	
RETURN TO MANAGEMENT AND RISK	DOLS			**49.65**	**0.54**	

1 Hauling Machinery & Labor Charges = $0.20/Bushel
2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%
3 Capital and Labor Payments are included in Machinery Operating and Ownership Costs.

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/BU				
			-25%	-10%		+10%	+25%
			$ 5.33	$ 6.39	$ 7.10	$ 7.81	$ 8.88
ALTERNATIVE YIELDS	-25%	68.6	$ (71.76)	$ 1.25	$ 49.92	$ 98.59	$ 171.59
	-10%	82.3	$ 1.25	$ 88.85	$ 147.26	$ 205.66	$ 293.27
BUSHELS		91.4	$ 49.92	$ 147.26	$ 212.15	$ 277.05	$ 374.39
	+10%	100.5	$ 98.59	$ 205.66	$ 277.05	$ 348.43	$ 455.51
	+25%	114.3	$ 171.59	$ 293.27	$ 374.39	$ 455.51	$ 577.18

Table 11. 2012 Estimated Production Costs and Returns - Irrigated Corn in South Platte Valley.

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION						
CORN	BU	6.80	176.40	1199.52		______
TOTAL RECEIPTS				**1199.52**	**6.80**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	61.37	1.00	61.37	0.35	______
FERTILIZER	DOLS	161.38	1.00	161.38	0.91	______
HERBICIDE	DOLS	73.72	1.00	73.72	0.42	______
INSECTICIDE	DOLS	22.56	1.00	22.56	0.13	______
IRRIGATION ENERGY	DOLS	64.07	1.00	64.07	0.36	______
IRRIGATION REPAIR	DOLS	10.24	1.00	10.24	0.06	______
CROP INSURANCE	DOLS	52.00	1.00	52.00	0.29	______
SPRINKLER LEASE	DOLS	70.00	1.00	70.00	0.40	______
CUSTOM AERIAL SPRAY	DOLS	8.00	1.00	8.00	0.05	______
CROP CONSULTANT	DOLS	8.00	1.00	8.00	0.05	______
FUEL	DOLS			20.06	0.11	______
REPAIR & MAINTENANCE	DOLS			9.85	0.06	______
LABOR	DOLS			6.01	0.03	______
INTEREST EXPENSE [2]	DOLS			19.64	0.11	______
Total Preharvest	DOLS			**586.90**	**3.33**	
Operating Harvest						
FUEL	DOLS			8.34	0.05	______
REPAIR & MAINTENANCE	DOLS			5.44	0.03	______
LABOR	DOLS			1.66	0.01	______
HAULING [1]	DOLS			35.28	0.20	______
Total Harvest				**50.72**	**0.29**	
Total Operating Costs				**637.62**	**3.61**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			54.94	0.31	______
GENERAL FARM OVERHEAD	DOLS			10.00	0.06	______
REAL ESTATE TAXES	DOLS			13.25	0.08	______
Total Property and Ownership Costs	DOLS			**78.19**	**0.44**	
TOTAL DIRECT COSTS				**715.81**	**4.06**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**483.71**	**2.74**	
FACTOR PAYMENTS						
LAND @ 4.00%	DOLS			162.50	0.92	
RETURN TO MANAGEMENT AND RISK	DOLS			**321.21**	**1.82**	

1 Hauling Machinery & Labor Charges = $0.20/Bushel

2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/BU				
			-25%	-10%		+10%	+25%
			$ 5.10	$ 6.12	$ 6.80	$ 7.48	$ 8.50
ALTERNATIVE YIELDS	-25%	132.3	$ (41.08)	$ 93.86	$ 183.83	$ 273.79	$ 408.74
	-10%	158.8	$ 93.86	$ 255.80	$ 363.75	$ 471.71	$ 633.65
BUSHELS		176.4	$ 183.83	$ 363.75	$ 483.71	$ 603.66	$ 783.59
	+10%	194.0	$ 273.79	$ 471.71	$ 603.66	$ 735.61	$ 933.53
	+25%	220.5	$ 408.74	$ 633.65	$ 783.59	$ 933.53	$ 1,158.44

Table 13. 2012 Estimated Production Costs and Returns - Irrigated Winter Wheat in South Platte Valley.

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION:						
HARD RED WINTER WHEAT	BU	7.10	85.30	605.63		
TOTAL RECEIPTS				**605.63**	**7.10**	
DIRECT COSTS:						
Operating Preharvest						
SEED	DOLS	22.80	1.00	22.80	0.27	
FERTILIZER	DOLS	98.31	1.00	98.31	1.15	
HERBICIDE (APPLIED)	DOLS	50.59	1.00	50.59	0.59	
IRRIGATION ENERGY	DOLS	38.44	1.00	38.44	0.45	
IRRIGATION REPAIR	DOLS	10.24	1.00	10.24	0.12	
CROP INSURANCE	DOLS	53.00	1.00	53.00	0.62	
SPRINKLER LEASE	DOLS	70.00	1.00	70.00	0.82	
FUEL	DOLS			10.87	0.13	
REPAIR & MAINTENANCE	DOLS			5.11	0.06	
LABOR	DOLS			2.40	0.03	
INTEREST EXPENSE [2]	DOLS			12.66	0.15	
Total Preharvest	DOLS			**374.42**	**4.39**	
OPERATING HARVEST:						
FUEL	DOLS			6.12	0.07	
REPAIR & MAINTENANCE	DOLS			3.19	0.04	
LABOR	DOLS			1.62	0.02	
HAULING [1]	DOLS			17.06	0.20	
Total Harvest				**27.99**	**0.33**	
Total Operating Costs				**402.41**	**4.72**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			33.52	0.39	
GENERAL FARM OVERHEAD	DOLS			10.00	0.12	
REAL ESTATE TAXES	DOLS			11.77	0.14	
Total Property and Ownership Costs	DOLS			**55.29**	**0.65**	
TOTAL DIRECT COSTS:				**457.70**	**5.37**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**147.93**	**1.73**	
FACTOR PAYMENTS						
LAND @ 4.00%	DOLS			162.50	1.91	
RETURN TO MANAGEMENT AND RISK	DOLS			**-14.57**	**-0.17**	

1 Hauling Machinery & Labor Charges = $0.20/Bushel

2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/BU				
			-25%	-10%		+10%	+25%
			$ 5.33	$ 6.39	$ 7.10	$ 7.81	$ 8.88
ALTERNATIVE YIELDS	-25%	64.0	$ (117.03)	$ (48.90)	$ (3.48)	$ 41.94	$ 110.08
	-10%	76.8	$ (48.90)	$ 32.86	$ 87.37	$ 141.87	$ 223.63
BUSHELS		85.3	$ (3.48)	$ 87.37	$ 147.93	$ 208.49	$ 299.34
	+10%	93.8	$ 41.94	$ 141.87	$ 208.49	$ 275.11	$ 375.04
	+25%	106.6	$ 110.08	$ 223.63	$ 299.34	$ 375.04	$ 488.60

Table 14. 2012 Estimated Production Costs and Returns - Dryland Winter Wheat in Northeastern Colorado. Conventional-Till Wheat - Fallow Rotation

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION						
HARD RED WINTER WHEAT	BU	7.10	32.42	230.18		
TOTAL RECEIPTS				**230.18**	**7.10**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	9.08	1.00	9.08	0.28	
FERTILIZER	DOLS	55.12	1.00	55.12	1.70	
HERBICIDE	DOLS	9.72	1.00	9.72	0.30	
CUSTOM APPLICATION	DOLS	6.08	1.00	6.08	0.19	
CROP INSURANCE	DOLS	32.00	1.00	32.00	0.99	
FUEL	DOLS			13.72	0.42	
REPAIR & MAINTENANCE	DOLS			9.22	0.28	
LABOR	DOLS			2.45	0.08	
INTEREST EXPENSE [2]	DOLS			4.81	0.15	
Total Preharvest	DOLS			**142.20**	**4.39**	
Operating Harvest						
FUEL	DOLS			7.79	0.24	
REPAIR & MAINTENANCE	DOLS			3.25	0.10	
LABOR	DOLS			1.65	0.05	
HAULING [1]	DOLS			6.48	0.20	
Total Harvest				**19.17**	**0.59**	
Total Operating Costs				**161.37**	**4.98**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			46.51	1.43	
GENERAL FARM OVERHEAD	DOLS			10.00	0.31	
REAL ESTATE TAXES	DOLS			2.39	0.07	
Total Property and Ownership Costs	DOLS			**58.90**	**1.82**	
TOTAL DIRECT COSTS:				**220.27**	**6.79**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**9.91**	**0.31**	
FACTOR PAYMENTS						
LAND @ 4.00%[3]	DOLS			32.50	1.00	
RETURN TO MANAGEMENT AND RISK	DOLS			**-22.59**	**-0.70**	

1 Hauling Machinery & Labor Charges = $0.20/Bushel

2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%

3 Includes allocation of fallow acres in the rotation

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/BU				
			-25%	-10%		+10%	+25%
			$ 5.33	$ 6.39	$ 7.10	$ 7.81	$ 8.88
ALTERNATIVE YIELDS	-25%	24.3	$ (90.80)	$ (64.90)	$ (47.64)	$ (30.37)	$ (4.48)
	-10%	29.2	$ (64.90)	$ (33.83)	$ (13.11)	$ 7.61	$ 38.68
BUSHELS		32.4	$ (47.64)	$ (13.11)	$ 9.91	$ 32.93	$ 67.45
	+10%	35.7	$ (30.37)	$ 7.61	$ 32.93	$ 58.25	$ 96.23
	+25%	40.5	$ (4.48)	$ 38.68	$ 67.45	$ 96.23	$ 139.39

Table 15. 2012 Estimated Production Costs and Returns - Dryland Winter Wheat in Northeastern Colorado. Reduced-Till in a Two-Crop in Three-Year Rotation.

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION						
HARD RED WINTER WHEAT	BU	7.10	40.56	287.98		
TOTAL RECEIPTS				**287.98**	**7.10**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	9.08	1.00	9.08	0.22	
FERTILIZER	DOLS	55.12	1.00	55.12	1.36	
HERBICIDE	DOLS	32.82	1.00	32.82	0.81	
CUSTOM APPLICATION	DOLS	7.00	1.00	7.00	0.17	
CROP INSURANCE	DOLS	32.00	1.00	32.00	0.79	
FUEL	DOLS			8.83	0.22	
REPAIR & MAINTENANCE	DOLS			6.93	0.17	
LABOR	DOLS			2.30	0.06	
INTEREST EXPENSE [2]	DOLS			5.39	0.13	
Total Preharvest	DOLS			**159.47**	**3.93**	
Operating Harvest						
FUEL	DOLS			7.79	0.19	
REPAIR & MAINTENANCE	DOLS			3.25	0.08	
LABOR	DOLS			1.65	0.04	
HAULING [1]	DOLS			8.11	0.20	
Total Harvest				**20.80**	**0.51**	
Total Operating Costs				**180.27**	**4.44**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			35.91	0.89	
GENERAL FARM OVERHEAD	DOLS			10.00	0.25	
REAL ESTATE TAXES	DOLS			2.39	0.06	
Total Property and Ownership Costs	DOLS			**48.30**	**1.19**	
TOTAL DIRECT COSTS:				**228.57**	**5.64**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**59.40**	**1.46**	
FACTOR PAYMENTS						
LAND @ 4.00%[3]	DOLS			32.50	0.80	
RETURN TO MANAGEMENT AND RISK	DOLS			**26.90**	**0.66**	

1 Hauling Machinery & Labor Charges = $0.20/Bushel

2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%

3 Includes allocation of fallow acres in the rotation

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/BU				
			-25%	-10%		+10%	+25%
			$ 5.33	$ 6.39	$ 7.10	$ 7.81	$ 8.88
ALTERNATIVE YIELDS	-25%	30.4	$ (66.59)	$ (34.19)	$ (12.59)	$ 9.01	$ 41.40
	-10%	36.5	$ (34.19)	$ 4.69	$ 30.60	$ 56.52	$ 95.40
BUSHELS		40.6	$ (12.59)	$ 30.60	$ 59.40	$ 88.20	$ 131.40
	+10%	44.6	$ 9.01	$ 56.52	$ 88.20	$ 119.88	$ 167.39
	+25%	50.7	$ 41.40	$ 95.40	$ 131.40	$ 167.39	$ 221.39

Table 16. 2012 Estimated Production Costs and Returns - Dryland Corn in Northeastern Colorado. Reduced-Till in a Two-Crop in Three-Year Rotation.

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION						
CORN	BU	6.80	19.50	132.60		
CROP INSURANCE INDEMNITY PAYMENT	DOLS			65.85		
TOTAL RECEIPTS				**198.45**	**6.80**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	58.94	1.00	58.94	3.02	
FERTILIZER	DOLS	62.35	1.00	62.35	3.20	
HERBICIDE	DOLS	37.36	1.00	37.36	1.92	
CUSTOM APPLICATION	DOLS	7.00	1.00	7.00	0.36	
CROP INSURANCE	DOLS	25.00	1.00	25.00	1.28	
FUEL	DOLS			5.94	0.30	
REPAIR & MAINTENANCE	DOLS			2.80	0.14	
LABOR	DOLS			1.96	0.10	
INTEREST EXPENSE [2]	DOLS			7.05	0.36	
Total Preharvest	DOLS			**208.40**	**10.69**	
Operating Harvest						
FUEL	DOLS			7.55	0.39	
REPAIR & MAINTENANCE	DOLS			5.21	0.27	
LABOR	DOLS			1.45	0.07	
HAULING [1]	DOLS			3.90	0.20	
Total Harvest				**18.11**	**0.93**	
Total Operating Costs				**226.51**	**11.62**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			32.12	1.65	
GENERAL FARM OVERHEAD	DOLS			10.00	0.51	
REAL ESTATE TAXES	DOLS			2.46	0.13	
Total Property and Ownership Costs	DOLS			**44.58**	**2.29**	
TOTAL DIRECT COSTS				**271.09**	**13.90**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**-72.64**	**-7.10**	
FACTOR PAYMENTS						
LAND @ 4.00%[3]	DOLS			32.50	1.67	
RETURN TO MANAGEMENT AND RISK	DOLS			**-105.14**	**-8.77**	

1 Hauling Machinery & Labor Charges = $0.20/Bushel

2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%

3 Includes allocation of fallow acres in the rotation

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/BU				
			-25%	-10%		+10%	+25%
			$ 5.10	$ 6.12	$ 6.80	$ 7.48	$ 8.50
ALTERNATIVE YIELDS	-25%	14.6	$ (130.65)	$ (115.73)	$ (105.79)	$ (95.84)	$ (80.92)
	-10%	17.6	$ (115.73)	$ (97.83)	$ (85.90)	$ (73.96)	$ (56.06)
BUSHELS		19.5	$ (105.79)	$ (85.90)	$ (72.64)	$ (59.38)	$ (39.49)
	+10%	21.5	$ (95.84)	$ (73.96)	$ (59.38)	$ (44.79)	$ (22.91)
	+25%	24.4	$ (80.92)	$ (56.06)	$ (39.49)	$ (22.91)	$ 1.95

Table 17. 2012 Estimated Production Costs and Returns - Dryland Proso Millet.
Reduced-Till in a Two-Crop in Three-Year Rotation.

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION						
PROSO MILLET	CWT	25.30	7.30	184.69		
CROP INSURANCE INDEMNITY				47.23		
TOTAL RECEIPTS				**231.92**	**25.30**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	4.13	1.00	4.13	0.57	
FERTILIZER	DOLS	30.34	1.00	30.34	4.16	
HERBICIDE	DOLS	12.30	1.00	12.30	1.68	
CUSTOM APPLICATION	DOLS	7.00	1.00	7.00	0.96	
CROP INSURANCE	DOLS	11.00	1.00	11.00	1.51	
FUEL	DOLS			9.33	1.28	
REPAIR & MAINTENANCE	DOLS			4.90	0.67	
LABOR	DOLS			2.48	0.34	
INTEREST EXPENSE [2]	DOLS			2.85	0.39	
Total Preharvest	DOLS			**84.33**	**11.55**	
Operating Harvest						
FUEL	DOLS			15.50	2.12	
REPAIR & MAINTENANCE	DOLS			7.86	1.08	
LABOR	DOLS			4.11	0.56	
HAULING [1]	DOLS			2.92	0.40	
Total Harvest				**30.39**	**4.16**	
Total Operating Costs				**114.72**	**15.72**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			43.44	5.95	
GENERAL FARM OVERHEAD	DOLS			10.00	1.37	
REAL ESTATE TAXES	DOLS			2.39	0.33	
Total Property and Ownership Costs	DOLS			**55.83**	**7.65**	
TOTAL DIRECT COSTS				**170.55**	**23.36**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**61.37**	**1.94**	
FACTOR PAYMENTS						
LAND @ 4.00%[3]	DOLS			32.50	4.45	
RETURN TO MANAGEMENT AND RISK	DOLS			**28.87**	**-2.52**	

1 Hauling Machinery & Labor Charges = $0.40/CWT
2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%
3 Includes allocation of fallow acres in the rotation

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/CWT -25%	-10%		+10%	+25%
			$ 18.98	$ 22.77	$ 25.30	$ 27.83	$ 31.63
ALTERNATIVE YIELDS	-25%	5.5	$ (66.66)	$ (45.89)	$ (32.03)	$ (18.18)	$ 2.60
	-10%	6.6	$ (45.89)	$ (20.95)	$ (4.33)	$ 12.29	$ 37.22
CWT		7.3	$ (32.03)	$ (4.33)	$ 14.14	$ 32.61	$ 60.31
	+10%	8.0	$ (18.18)	$ 12.29	$ 32.61	$ 52.92	$ 83.40
	+25%	9.1	$ 2.60	$ 37.22	$ 60.31	$ 83.40	$ 118.03

Table 18. 2012 Estimated Production Costs and Returns - Dryland Oil Sunflowers in Northeastern Colorado. Reduced-Till in a Two-Crop in Three-Year Rotation.

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION						
SUNFLOWERS	CWT	25.70	7.80	200.46		______
CROP INSURANCE INDEMNITY				64.40		______
TOTAL RECEIPTS				**264.86**	**25.70**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	26.37	1.00	26.37	3.38	______
FERTILIZER	DOLS	42.46	1.00	42.46	5.44	______
HERBICIDE	DOLS	42.72	1.00	42.72	5.48	______
CUSTOM APPLICATION	DOLS	7.00	2.00	14.00	1.79	______
INSECTICIDE	DOLS	10.59	1.00	10.59	1.36	______
CROP INSURANCE	DOLS	42.00	1.00	42.00	5.38	______
CUSTOM AERIAL APPLICATION	DOLS	8.00	1.00	8.00	1.03	______
FUEL	DOLS			3.65	0.47	______
REPAIR & MAINTENANCE	DOLS			2.07	0.27	______
LABOR	DOLS			1.20	0.15	______
INTEREST EXPENSE [2]	DOLS			6.76	0.87	______
Total Preharvest				**199.82**	**25.62**	
Operating Harvest						
FUEL	DOLS			8.89	1.14	______
REPAIR & MAINTENANCE	DOLS			5.06	0.65	______
LABOR	DOLS			1.57	0.20	______
HAULING [1]	DOLS			1.95	0.25	______
Total Harvest				**17.47**	**2.24**	
Total Operating Costs				**217.29**	**27.86**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			22.49	2.88	______
GENERAL FARM OVERHEAD	DOLS			10.00	1.28	______
REAL ESTATE TAXES	DOLS			2.73	0.35	______
Total Property and Ownership Costs	DOLS			**35.22**	**4.52**	
TOTAL DIRECT COSTS				**252.51**	**32.37**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**12.35**	**-6.67**	
FACTOR PAYMENTS						
LAND @ 4.00%[3]	DOLS			32.50	4.17	
RETURN TO MANAGEMENT AND RISK	DOLS			**-20.15**	**-10.84**	

1 Hauling Machinery & Labor Charges = $0.25/Cwt

2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%

3 Includes allocation of fallow acres in the rotation

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/CWT				
			-25%	-10%		+10%	+25%
			$ 19.28	$ 23.13	$ 25.70	$ 28.27	$ 32.13
ALTERNATIVE YIELDS	-25%	5.9	$ (139.75)	$ (117.20)	$ (102.16)	$ (87.13)	$ (64.58)
	-10%	7.0	$ (117.20)	$ (90.13)	$ (72.09)	$ (54.05)	$ (26.99)
CWT		7.8	$ (102.16)	$ (72.09)	$ (52.05)	$ (32.00)	$ (1.93)
	+10%	8.6	$ (87.13)	$ (54.05)	$ (32.00)	$ (9.95)	$ 23.13
	+25%	9.8	$ (64.58)	$ (26.99)	$ (1.93)	$ 23.13	$ 60.71

Appendix B: Price and Yield Variability Analysis

Tables in this appendix display the variability in economic yield under variable price and yield assumptions, and compare the range of economic returns for a variety of fully irrigated crops and the dry land and limited-irrigation options. The tables further compare the estimated economic return over the entire study area, on currently irrigated parcels, and on currently irrigated parcels with estimated yields better than the break-even yield shown in Table 5-2. The prices were varied up to 25% above and below the base price (2013 prices), and also include a long-term average price (1997 to 2013, adjusted to 2012 dollars). The yields were varied up to 25% above and below the base yield. The base yield for irrigated crops was taken from the 2012 enterprise budgets (Appendix A). The base yield for the dry land and limited irrigation crops comes from the GIS analyses presented in Section 4 (full study area) and Section 5 (irrigated parcels and break-even parcels).

Irrigated Corn — Economic Return

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/BU) -25%	-10%	Base	+10%	+25%
			$ 3.89	$ 3.77	$ 4.53	$ 5.03	$ 5.53	$ 6.29
ALTERNATIVE YIELDS (Bushels/Acre)	-25%	138.2	$ (184.62)	$ (200.74)	$ (96.51)	$ (27.02)	$ 42.47	$ 146.70
	-10%	165.8	$ (77.16)	$ (96.51)	$ 28.57	$ 111.96	$ 195.35	$ 320.43
	Base	184.2	$ (5.52)	$ (27.02)	$ 111.96	$ 204.61	$ 297.26	$ 436.24
	+10%	202.6	$ 66.12	$ 42.47	$ 195.35	$ 297.26	$ 399.18	$ 552.06
	+25%	230.3	$ 173.58	$ 146.70	$ 320.43	$ 436.24	$ 552.06	$ 725.78

Irrigated Wheat — Economic Return

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/BU) -25%	-10%	Base	+10%	+25%
			$ 5.01	$ 4.94	$ 5.92	$ 6.58	$ 7.24	$ 8.23
ALTERNATIVE YIELDS (Bushels/Acre)	-25%	68.6	$ (104.09)	$ (108.95)	$ (41.29)	$ 3.81	$ 48.92	$ 116.58
	-10%	82.3	$ (35.46)	$ (41.29)	$ 39.90	$ 94.03	$ 148.15	$ 229.34
	Base	91.4	$ 10.29	$ 3.81	$ 94.03	$ 154.17	$ 214.31	$ 304.52
	+10%	100.5	$ 56.04	$ 48.92	$ 148.15	$ 214.31	$ 280.46	$ 379.70
	+25%	114.3	$ 124.67	$ 116.58	$ 229.34	$ 304.52	$ 379.70	$ 492.46

Irrigated Sunflower — Economic Return

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/CWT) -25%	-10%	Base	+10%	+25%
			$ 18.73	$ 17.06	$ 20.48	$ 22.75	$ 25.03	$ 28.44
ALTERNATIVE YIELDS (CWT/Acre)	-25%	15.2	$ (139.51)	$ (164.93)	$ (112.98)	$ (78.34)	$ (43.70)	$ 8.25
	-10%	18.3	$ (82.47)	$ (112.98)	$ (50.63)	$ (9.07)	$ 32.50	$ 94.84
	Base	20.3	$ (44.45)	$ (78.34)	$ (9.07)	$ 37.12	$ 83.30	$ 152.57
	+10%	22.3	$ (6.42)	$ (43.70)	$ 32.50	$ 83.30	$ 134.10	$ 210.30
	+25%	25.4	$ 50.62	$ 8.25	$ 94.84	$ 152.57	$ 210.30	$ 296.89

Irrigated Alfalfa — Economic Return

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/TON) -25%	-10%	Base	+10%	+25%
			$ 147.85	$ 187.50	$ 225.00	$ 250.00	$ 275.00	$ 312.50
ALTERNATIVE YIELDS (Tons/Acre)	-25%	3.7	$ (39.00)	$ 106.71	$ 244.53	$ 336.40	$ 428.28	$ 566.09
	-10%	4.4	$ 69.67	$ 244.53	$ 409.90	$ 520.15	$ 630.40	$ 795.78
	Base	4.9	$ 142.12	$ 336.40	$ 520.15	$ 642.65	$ 765.15	$ 948.90
	+10%	5.4	$ 214.56	$ 428.28	$ 630.40	$ 765.15	$ 899.90	$ 1,102.03
	+25%	6.1	$ 323.23	$ 566.09	$ 795.78	$ 948.90	$ 1,102.03	$ 1,331.71

Dry Land Wheat — Economic Return (Full Study Area)

				ALTERNATIVE PRICES ($/BU)				
			1997–2013 Avg (2012 dollars)	-25%	-10%	Base	+10%	+25%
			$ 5.01	$ 4.94	$ 5.92	$ 6.58	$ 7.24	$ 8.23
ALTERNATIVE YIELDS (Bushels/Acre)	-25%	19.4	$ (75.19)	$ (76.57)	$ (57.39)	$ (44.61)	$ (31.83)	En
	-10%	23.3	$ (55.74)	$ (57.39)	$ (34.38)	$ (19.04)	$ (3.70)	$ 19.30
	Base	25.9	$ (42.78)	$ (44.61)	$ (19.04)	$ (2.00)	$ 15.04	$ 40.61
	+10%	28.5	$ (29.81)	$ (31.83)	$ (3.70)	$ 15.04	$ 33.79	$ 61.91
	+25%	32.4	$ (10.36)	$ (12.65)	$ 19.30	$ 40.61	$ 61.91	$ 93.87

Limited-Irrigation Wheat — Economic Return (Full Study Area)

				ALTERNATIVE PRICES ($/BU)				
			1997–2013 Avg (2012 dollars)	-25%	-10%	Base	+10%	+25%
			$ 5.01	$ 4.94	$ 5.92	$ 6.58	$ 7.24	$ 8.23
ALTERNATIVE YIELDS (Bushels/Acre)	-25%	37.1	$ (100.89)	$ (103.52)	$ (66.87)	$ (42.43)	$ (18.00)	$ 18.65
	-10%	44.6	$ (63.71)	$ (66.87)	$ (22.89)	$ 6.44	$ 35.76	$ 79.74
	Base	49.5	$ (38.93)	$ (42.43)	$ 6.44	$ 39.02	$ 71.60	$ 120.47
	+10%	54.5	$ (14.14)	$ (18.00)	$ 35.76	$ 71.60	$ 107.44	$ 161.20
	+25%	61.9	$ 23.04	$ 18.65	$ 79.74	$ 120.47	$ 161.20	$ 222.28

Dry Land Corn — Economic Return (Full Study Area)

				ALTERNATIVE PRICES ($/BU)				
			1997–2013 Avg (2012 dollars)	-25%	-10%	Base	+10%	+25%
			$ 3.89	$ 3.77	$ 4.53	$ 5.03	$ 5.53	$ 6.29
ALTERNATIVE YIELDS (Bushels/Acre)	-25%	11.1	$ (138.22)	$ (139.52)	$ (131.15)	$ (125.57)	$ (120.00)	$ (111.63)
	-10%	13.3	$ (129.60)	$ (131.15)	$ (121.11)	$ (114.42)	$ (107.73)	$ (97.69)
	Base	14.8	$ (123.85)	$ (125.57)	$ (114.42)	$ (106.99)	$ (99.55)	$ (88.40)
	+10%	16.3	$ (118.10)	$ (120.00)	$ (107.73)	$ (99.55)	$ (91.37)	$ (79.10)
	+25%	18.5	$ (109.48)	$ (111.63)	$ (97.69)	$ (88.40)	$ (79.10)	$ (65.16)

Limited-Irrigation Corn — Economic Return (Full Study Area)

				ALTERNATIVE PRICES ($/BU)				
			1997–2013 Avg (2012 dollars)	-25%	-10%	Base	+10%	+25%
			$ 3.89	$ 3.77	$ 4.53	$ 5.03	$ 5.53	$ 6.29
ALTERNATIVE YIELDS (Bushels/Acre)	-25%	48.1	$ (121.20)	$ (126.81)	$ (90.53)	$ (66.34)	$ (42.15)	$ (5.86)
	-10%	57.7	$ (83.79)	$ (90.53)	$ (46.99)	$ (17.96)	$ 11.07	$ 54.61
	Base	64.1	$ (58.85)	$ (66.34)	$ (17.96)	$ 14.29	$ 46.55	$ 94.93
	+10%	70.5	$ (33.91)	$ (42.15)	$ 11.07	$ 46.55	$ 82.03	$ 135.24
	+25%	80.2	$ 3.49	$ (5.86)	$ 54.61	$ 94.93	$ 135.24	$ 195.72

Dry Land Proso Millet — Economic Return (Full Study Area)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/CWT) -25%	-10%	Base	+10%	+25%
			$ 10.51	$ 12.00	$ 14.40	$ 16.00	$ 17.60	$ 20.00
ALTERNATIVE YIELDS (CWT/Acre)	-25%	13.5	$ (16.05)	$ 4.07	$ 36.58	$ 58.26	$ 79.93	$ 112.44
	-10%	16.3	$ 12.44	$ 36.58	$ 75.60	$ 101.61	$ 127.62	$ 166.63
	Base	18.1	$ 31.43	$ 58.26	$ 101.61	$ 130.51	$ 159.41	$ 202.76
	+10%	19.9	$ 50.42	$ 79.93	$ 127.62	$ 159.41	$ 191.20	$ 238.88
	+25%	22.6	$ 78.91	$ 112.44	$ 166.63	$ 202.76	$ 238.88	$ 293.07

Limited-Irrigation Proso Millet — Economic Return (Full Study Area)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/CWT) -25%	-10%	Base	+10%	+25%
			$ 10.51	$ 12.00	$ 14.40	$ 16.00	$ 17.60	$ 20.00
ALTERNATIVE YIELDS (CWT/Acre)	-25%	36.0	$ 108.96	$ 162.48	$ 248.95	$ 306.60	$ 364.26	$ 450.73
	-10%	43.2	$ 184.74	$ 248.95	$ 352.73	$ 421.91	$ 491.09	$ 594.86
	Base	48.0	$ 235.25	$ 306.60	$ 421.91	$ 498.78	$ 575.64	$ 690.95
	+10%	52.8	$ 285.77	$ 364.26	$ 491.09	$ 575.64	$ 660.20	$ 787.03
	+25%	60.1	$ 361.55	$ 450.73	$ 594.86	$ 690.95	$ 787.03	$ 931.16

Dry Land Sunflower — Economic Return (Full Study Area)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/CWT) -25%	-10%	Base	+10%	+25%
			$ 18.73	$ 17.06	$ 20.48	$ 22.75	$ 25.03	$ 28.44
ALTERNATIVE YIELDS (CWT/Acre)	-25%	2.5	$ (182.95)	$ (187.16)	$ (178.55)	$ (172.81)	$ (167.07)	$ (158.45)
	-10%	3.0	$ (173.49)	$ (178.55)	$ (168.22)	$ (161.32)	$ (154.43)	$ (144.10)
	Base	3.4	$ (167.19)	$ (172.81)	$ (161.32)	$ (153.67)	$ (146.01)	$ (134.53)
	+10%	3.7	$ (160.89)	$ (167.07)	$ (154.43)	$ (146.01)	$ (137.59)	$ (124.96)
	+25%	4.2	$ (151.43)	$ (158.45)	$ (144.10)	$ (134.53)	$ (124.96)	$ (110.60)

Limited-Irrigation Sunflower — Economic Return (Full Study Area)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/CWT) -25%	-10%	Base	+10%	+25%
			$ 18.73	$ 17.06	$ 20.48	$ 22.75	$ 25.03	$ 28.44
ALTERNATIVE YIELDS (CWT/Acre)	-25%	8.0	$ (198.94)	$ (212.35)	$ (184.94)	$ (166.67)	$ (148.40)	$ (120.99)
	-10%	9.6	$ (168.85)	$ (184.94)	$ (152.05)	$ (130.12)	$ (108.20)	$ (75.30)
	Base	10.7	$ (148.79)	$ (166.67)	$ (130.12)	$ (105.76)	$ (81.40)	$ (44.85)
	+10%	11.8	$ (128.73)	$ (148.40)	$ (108.20)	$ (81.40)	$ (54.59)	$ (14.39)
	+25%	13.4	$ (98.64)	$ (120.99)	$ (75.30)	$ (44.85)	$ (14.39)	$ 31.29

Dry Land Wheat — Economic Return (Irrigated Parcels Only)

				ALTERNATIVE PRICES ($/BU)				
			1997–2013 Avg (2012 dollars)	-25%	-10%	Base	+10%	+25%
			$ 5.01	$ 4.94	$ 5.92	$ 6.58	$ 7.24	$ 8.23
ALTERNATIVE YIELDS (Bushels/Acre)	-25%	22.5	$ (59.90)	$ (61.49)	$ (39.30)	$ (24.51)	$ (9.72)	$ 12.47
	-10%	27.0	$ (37.39)	$ (39.30)	$ (12.68)	$ 5.07	$ 22.82	$ 49.45
	Base	30.0	$ (22.39)	$ (24.51)	$ 5.07	$ 24.80	$ 44.52	$ 74.11
	+10%	33.0	$ (7.38)	$ (9.72)	$ 22.82	$ 44.52	$ 66.22	$ 98.76
	+25%	37.5	$ 15.12	$ 12.47	$ 49.45	$ 74.11	$ 98.76	$ 135.74

Limited-Irrigation Wheat — Economic Return (Irrigated Parcels Only)

				ALTERNATIVE PRICES ($/BU)				
			1997–2013 Avg (2012 dollars)	-25%	-10%	Base	+10%	+25%
			$ 5.01	$ 4.94	$ 5.92	$ 6.58	$ 7.24	$ 8.23
ALTERNATIVE YIELDS (Bushels/Acre)	-25%	40.1	$ (85.95)	$ (88.79)	$ (49.19)	$ (22.79)	$ 3.61	$ 43.21
	-10%	48.1	$ (45.78)	$ (49.19)	$ (1.67)	$ 30.01	$ 61.69	$ 109.21
	Base	53.5	$ (19.00)	$ (22.79)	$ 30.01	$ 65.21	$ 100.41	$ 153.21
	+10%	58.8	$ 7.78	$ 3.61	$ 61.69	$ 100.41	$ 139.13	$ 197.21
	+25%	66.9	$ 47.95	$ 43.21	$ 109.21	$ 153.21	$ 197.21	$ 263.21

Dry Land Corn — Economic Return (Irrigated Parcels Only)

				ALTERNATIVE PRICES ($/BU)				
			1997–2013 Avg (2012 dollars)	-25%	-10%	Base	+10%	+25%
			$ 3.89	$ 3.77	$ 4.53	$ 5.03	$ 5.53	$ 6.29
ALTERNATIVE YIELDS (Bushels/Acre)	-25%	14.1	$ (126.43)	$ (128.08)	$ (117.43)	$ (110.33)	$ (103.23)	$ (92.58)
	-10%	16.9	$ (115.45)	$ (117.43)	$ (104.65)	$ (96.13)	$ (87.60)	$ (74.82)
	Base	18.8	$ (108.13)	$ (110.33)	$ (96.13)	$ (86.66)	$ (77.19)	$ (62.99)
	+10%	20.7	$ (100.81)	$ (103.23)	$ (87.60)	$ (77.19)	$ (66.77)	$ (51.15)
	+25%	23.5	$ (89.83)	$ (92.58)	$ (74.82)	$ (62.99)	$ (51.15)	$ (33.40)

Limited-Irrigation Corn — Economic Return (Irrigated Parcels Only)

				ALTERNATIVE PRICES ($/BU)				
			1997–2013 Avg (2012 dollars)	-25%	-10%	Base	+10%	+25%
			$ 3.89	$ 3.77	$ 4.53	$ 5.03	$ 5.53	$ 6.29
ALTERNATIVE YIELDS (Bushels/Acre)	-25%	52.5	$ (103.92)	$ (110.05)	$ (70.42)	$ (43.99)	$ (17.57)	$ 22.07
	-10%	63.0	$ (63.06)	$ (70.42)	$ (22.85)	$ 8.86	$ 40.57	$ 88.13
	Base	70.0	$ (35.81)	$ (43.99)	$ 8.86	$ 44.09	$ 79.32	$ 132.17
	+10%	77.1	$ (8.57)	$ (17.57)	$ 40.57	$ 79.32	$ 118.08	$ 176.22
	+25%	87.6	$ 32.29	$ 22.07	$ 88.13	$ 132.17	$ 176.22	$ 242.28

Dry Land Proso Millet — Economic Return (Irrigated Parcels Only)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/CWT) -25%	-10%	Base	+10%	+25%
			$ 10.51	$ 12.00	$ 14.40	$ 16.00	$ 17.60	$ 20.00
ALTERNATIVE YIELDS (CWT/Acre)	-25%	15.7	$ 6.20	$ 29.47	$ 67.06	$ 92.12	$ 117.18	$ 154.78
	-10%	18.8	$ 39.14	$ 67.06	$ 112.17	$ 142.24	$ 172.32	$ 217.43
	Base	20.9	$ 61.10	$ 92.12	$ 142.24	$ 175.66	$ 209.08	$ 259.20
	+10%	23.0	$ 83.06	$ 117.18	$ 172.32	$ 209.08	$ 245.83	$ 300.97
	+25%	26.1	$ 116.00	$ 154.78	$ 217.43	$ 259.20	$ 300.97	$ 363.63

Limited-Irrigation Proso Millet — Economic Return (Irrigated Parcels Only)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/CWT) -25%	-10%	Base	+10%	+25%
			$ 10.51	$ 12.00	$ 14.40	$ 16.00	$ 17.60	$ 20.00
ALTERNATIVE YIELDS (CWT/Acre)	-25%	38.1	$ 130.78	$ 187.38	$ 278.83	$ 339.80	$ 400.78	$ 492.23
	-10%	45.7	$ 210.92	$ 278.83	$ 388.58	$ 461.75	$ 534.91	$ 644.66
	Base	50.8	$ 264.35	$ 339.80	$ 461.75	$ 543.04	$ 624.34	$ 746.28
	+10%	55.9	$ 317.77	$ 400.78	$ 534.91	$ 624.34	$ 713.76	$ 847.90
	+25%	63.5	$ 397.91	$ 492.23	$ 644.66	$ 746.28	$ 847.90	$ 1,000.33

Dry Land Sunflower — Economic Return (Irrigated Parcels Only)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/CWT) -25%	-10%	Base	+10%	+25%
			$ 18.73	$ 17.06	$ 20.48	$ 22.75	$ 25.03	$ 28.44
ALTERNATIVE YIELDS (CWT/Acre)	-25%	3.3	$ (168.80)	$ (174.27)	$ (163.08)	$ (155.62)	$ (148.16)	$ (136.97)
	-10%	3.9	$ (156.51)	$ (163.08)	$ (149.65)	$ (140.70)	$ (131.74)	$ (118.31)
	Base	4.4	$ (148.32)	$ (155.62)	$ (140.70)	$ (130.75)	$ (120.80)	$ (105.88)
	+10%	4.8	$ (140.13)	$ (148.16)	$ (131.74)	$ (120.80)	$ (109.86)	$ (93.44)
	+25%	5.5	$ (127.84)	$ (136.97)	$ (118.31)	$ (105.88)	$ (93.44)	$ (74.79)

Limited-Irrigation Sunflower — Economic Return (Irrigated Parcels Only)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/CWT) -25%	-10%	Base	+10%	+25%
			$ 18.73	$ 17.06	$ 20.48	$ 22.75	$ 25.03	$ 28.44
ALTERNATIVE YIELDS (CWT/Acre)	-25%	8.9	$ (183.01)	$ (197.84)	$ (167.52)	$ (147.32)	$ (127.11)	$ (96.79)
	-10%	10.7	$ (149.73)	$ (167.52)	$ (131.15)	$ (106.90)	$ (82.65)	$ (46.27)
	Base	11.8	$ (127.54)	$ (147.32)	$ (106.90)	$ (79.95)	$ (53.01)	$ (12.59)
	+10%	13.0	$ (105.35)	$ (127.11)	$ (82.65)	$ (53.01)	$ (23.37)	$ 21.09
	+25%	14.8	$ (72.08)	$ (96.79)	$ (46.27)	$ (12.59)	$ 21.09	$ 71.61

Dry Land Wheat — Economic Return (Break-Even or Better Parcels Only)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/BU) -25%	-10%	Base	+10%	+25%
			$ 5.01	$ 4.94	$ 5.92	$ 6.58	$ 7.24	$ 8.23
ALTERNATIVE YIELDS (Bushels/Acre)	-25%	23.9	$ (53.04)	$ (54.73)	$ (31.19)	$ (15.50)	$ 0.20	$ 23.74
	-10%	28.6	$ (29.16)	$ (31.19)	$ (2.94)	$ 15.89	$ 34.72	$ 62.97
	Base	31.8	$ (13.25)	$ (15.50)	$ 15.89	$ 36.82	$ 57.74	$ 89.13
	+10%	35.0	$ 2.67	$ 0.20	$ 34.72	$ 57.74	$ 80.76	$ 115.29
	+25%	39.8	$ 26.55	$ 23.74	$ 62.97	$ 89.13	$ 115.29	$ 154.52

Limited-Irrigation Wheat — Economic Return (Break-Even or Better Parcels Only)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/BU) -25%	-10%	Base	+10%	+25%
			$ 5.01	$ 4.94	$ 5.92	$ 6.58	$ 7.24	$ 8.23
ALTERNATIVE YIELDS (Bushels/Acre)	-25%	40.5	$ (84.11)	$ (86.98)	$ (47.02)	$ (20.38)	$ 6.27	$ 46.23
	-10%	48.6	$ (43.58)	$ (47.02)	$ 0.94	$ 32.91	$ 64.88	$ 112.83
	Base	54.0	$ (16.55)	$ (20.38)	$ 32.91	$ 68.43	$ 103.95	$ 157.23
	+10%	59.4	$ 10.47	$ 6.27	$ 64.88	$ 103.95	$ 143.03	$ 201.64
	+25%	67.5	$ 51.01	$ 46.23	$ 112.83	$ 157.23	$ 201.64	$ 268.24

Dry Land Corn — Economic Return (Break-Even or Better Parcels Only)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/BU) -25%	-10%	Base	+10%	+25%
			$ 3.89	$ 3.77	$ 4.53	$ 5.03	$ 5.53	$ 6.29
ALTERNATIVE YIELDS (Bushels/Acre)	-25%	29.2	$ (67.73)	$ (71.14)	$ (49.10)	$ (34.41)	$ (19.71)	$ 2.33
	-10%	35.1	$ (45.01)	$ (49.10)	$ (22.65)	$ (5.02)	$ 12.61	$ 39.06
	Base	38.9	$ (29.86)	$ (34.41)	$ (5.02)	$ 14.57	$ 34.16	$ 63.55
	+10%	42.8	$ (14.71)	$ (19.71)	$ 12.61	$ 34.16	$ 55.71	$ 88.04
	+25%	48.7	$ 8.01	$ 2.33	$ 39.06	$ 63.55	$ 88.04	$ 124.77

Limited-Irrigation Corn — Economic Return (Break-Even or Better Parcels Only)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/BU) -25%	-10%	Base	+10%	+25%
			$ 3.89	$ 3.77	$ 4.53	$ 5.03	$ 5.53	$ 6.29
ALTERNATIVE YIELDS (Bushels/Acre)	-25%	56.1	$ (90.21)	$ (96.75)	$ (54.46)	$ (26.26)	$ 1.94	$ 44.24
	-10%	67.3	$ (46.60)	$ (54.46)	$ (3.70)	$ 30.14	$ 63.97	$ 114.73
	Base	74.7	$ (17.53)	$ (26.26)	$ 30.14	$ 67.73	$ 105.33	$ 161.73
	+10%	82.2	$ 11.54	$ 1.94	$ 63.97	$ 105.33	$ 146.69	$ 208.72
	+25%	93.4	$ 55.14	$ 44.24	$ 114.73	$ 161.73	$ 208.72	$ 279.22

Dry Land Proso Millet — Economic Return (Break-Even or Better Parcels Only)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/CWT) -25%	-10%	Base	+10%	+25%
			$ 10.51	$ 12.00	$ 14.40	$ 16.00	$ 17.60	$ 20.00
ALTERNATIVE YIELDS (CWT/Acre)	-25%	18.3	$ 33.69	$ 60.83	$ 104.70	$ 133.95	$ 163.19	$ 207.06
	-10%	21.9	$ 72.13	$ 104.70	$ 157.34	$ 192.43	$ 227.53	$ 280.17
	Base	24.4	$ 97.75	$ 133.95	$ 192.43	$ 231.43	$ 270.42	$ 328.91
	+10%	26.8	$ 123.38	$ 163.19	$ 227.53	$ 270.42	$ 313.31	$ 377.65
	+25%	30.5	$ 161.82	$ 207.06	$ 280.17	$ 328.91	$ 377.65	$ 450.76

Limited-Irrigation Proso Millet — Economic Return (Break-Even or Better Parcels Only)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/CWT) -25%	-10%	Base	+10%	+25%
			$ 10.51	$ 12.00	$ 14.40	$ 16.00	$ 17.60	$ 20.00
ALTERNATIVE YIELDS (CWT/Acre)	-25%	38.3	$ 132.75	$ 189.62	$ 281.52	$ 342.79	$ 404.06	$ 495.97
	-10%	46.0	$ 213.28	$ 281.52	$ 391.81	$ 465.33	$ 538.86	$ 649.15
	Base	51.1	$ 266.96	$ 342.79	$ 465.33	$ 547.03	$ 628.72	$ 751.26
	+10%	56.2	$ 320.65	$ 404.06	$ 538.86	$ 628.72	$ 718.59	$ 853.38
	+25%	63.8	$ 401.18	$ 495.97	$ 649.15	$ 751.26	$ 853.38	$ 1,006.56

Dry Land Sunflower — Economic Return (Break-Even or Better Parcels Only)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/CWT) -25%	-10%	Base	+10%	+25%
			$ 18.73	$ 17.06	$ 20.48	$ 22.75	$ 25.03	$ 28.44
ALTERNATIVE YIELDS (CWT/Acre)	-25%	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	-10%	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Base	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	+10%	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	+25%	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Limited-Irrigation Sunflower — Economic Return (Break-Even or Better Parcels Only)

			1997–2013 Avg (2012 dollars)	ALTERNATIVE PRICES ($/CWT) -25%	-10%	Base	+10%	+25%
			$ 18.73	$ 17.06	$ 20.48	$ 22.75	$ 25.03	$ 28.44
ALTERNATIVE YIELDS (CWT/Acre)	-25%	11.6	$ (132.19)	$ (151.55)	$ (111.99)	$ (85.61)	$ (59.23)	$ (19.66)
	-10%	13.9	$ (88.75)	$ (111.99)	$ (64.50)	$ (32.85)	$ (1.19)	$ 46.29
	Base	15.5	$ (59.79)	$ (85.61)	$ (32.85)	$ 2.33	$ 37.50	$ 90.26
	+10%	17.0	$ (30.83)	$ (59.23)	$ (1.19)	$ 37.50	$ 76.19	$ 134.22
	+25%	19.3	$ 12.61	$ (19.66)	$ 46.29	$ 90.26	$ 134.22	$ 200.17

Appendix C: Crop Enterprise Cost Estimates for Current Harvest Delivery Prices for 2013

Tables in this appendix contain the price or cost/unit that producers would be looking at in the winter/spring when deciding which crops to grow for the upcoming crop year. Crop insurance premiums and indemnities are not calculated in these budgets because they are site-specific in their calculation, and, as of yet, no procedure has been set for limited-irrigation crop insurance in Colorado. Therefore, the extremes (both positive and negative) of the economic returns shown in the following tables will be reduced once actual crop insurance premiums or indemnities are included (i.e., crop insurance premiums reduce positive economic returns, and indemnity payments mitigate losses). The average crop yield for the entire study area is used for the quantity for each crop (Table 5-2).

Estimated Production Costs and Returns - Dry Land Winter Wheat

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION						
HARD RED WINTER WHEAT	BU	6.58	25.90	170.42		
TOTAL RECEIPTS				**170.42**	**6.58**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	9.08	1.00	9.08	0.35	
FERTILIZER	DOLS	37.12	1.00	37.12	1.43	
HERBICIDE	DOLS	32.82	1.00	32.82	1.27	
CUSTOM APPLICATION	DOLS	7.00	1.00	7.00	0.27	
FUEL	DOLS			8.83	0.34	
REPAIR & MAINTENANCE	DOLS			6.93	0.27	
LABOR	DOLS			2.30	0.09	
INTEREST EXPENSE [2]	DOLS			3.64	0.14	
Total Preharvest	DOLS			**107.72**	**4.16**	
Operating Harvest						
FUEL	DOLS			7.79	0.30	
REPAIR & MAINTENANCE	DOLS			3.25	0.13	
LABOR	DOLS			1.65	0.06	
HAULING [1]	DOLS			5.18	0.20	
Total Harvest				**17.87**	**0.69**	
Total Operating Costs				**125.59**	**4.85**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			35.91	1.39	
GENERAL FARM OVERHEAD	DOLS			10.00	0.39	
REAL ESTATE TAXES	DOLS			0.92	0.04	
Total Property and Ownership Costs	DOLS			**46.83**	**1.81**	
TOTAL DIRECT COSTS:				**172.42**	**6.66**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**-2.00**	**-0.08**	
FACTOR PAYMENTS						
LAND @ 4.00%[3]	DOLS			56.00	2.16	
RETURN TO MANAGEMENT AND RISK	DOLS			**-58.00**	**-2.24**	

1 Hauling Machinery & Labor Charges = $0.20/Bushel
2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%
3 Includes allocation of fallow acres in the rotation

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/BU				
			-25%	-10%		+10%	+25%
			$ 4.94	$ 5.92	$ 6.58	$ 7.24	$ 8.23
ALTERNATIVE YIELDS	-25%	19.4	$ (76.56)	$ (57.39)	$ (44.61)	$ (31.82)	$ (12.65)
	-10%	23.3	$ (57.39)	$ (34.38)	$ (19.04)	$ (3.71)	$ 19.30
BUSHELS		25.9	$ (44.61)	$ (19.04)	$ (2.00)	$ 15.04	$ 40.60
	+10%	28.5	$ (31.82)	$ (3.71)	$ 15.04	$ 33.79	$ 61.91
	+25%	32.4	$ (12.65)	$ 19.30	$ 40.60	$ 61.91	$ 93.86

Estimated Production Costs and Returns - Dry Land Corn

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION						
CORN	BU	5.03	14.78	74.34		
TOTAL RECEIPTS				**74.34**	**5.03**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	28.57	1.00	28.57	1.93	
FERTILIZER	DOLS	39.02	1.00	39.02	2.64	
HERBICIDE	DOLS	37.36	1.00	37.36	2.53	
CUSTOM APPLICATION	DOLS	7.00	1.00	7.00	0.47	
FUEL	DOLS			5.94	0.40	
REPAIR & MAINTENANCE	DOLS			2.80	0.19	
LABOR	DOLS			1.96	0.13	
INTEREST EXPENSE [2]	DOLS			4.29	0.29	
Total Preharvest	DOLS			**126.94**	**8.59**	
Operating Harvest						
FUEL	DOLS			7.55	0.51	
REPAIR & MAINTENANCE	DOLS			5.21	0.35	
LABOR	DOLS			1.45	0.10	
HAULING [1]	DOLS			2.96	0.20	
Total Harvest				**17.17**	**1.16**	
Total Operating Costs				**144.11**	**9.75**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			26.07	1.76	
GENERAL FARM OVERHEAD	DOLS			10.00	0.68	
REAL ESTATE TAXES	DOLS			0.92	0.06	
Total Property and Ownership Costs	DOLS			**36.99**	**2.50**	
TOTAL DIRECT COSTS				**181.10**	**12.25**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**-106.76**	**-7.22**	
FACTOR PAYMENTS						
LAND @ 4.00%[3]	DOLS			56.00	3.79	
RETURN TO MANAGEMENT AND RISK	DOLS			**-162.76**	**-11.01**	

1 Hauling Machinery & Labor Charges = $0.20/Bushel
2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%
3 Includes allocation of fallow acres in the rotation

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/BU				
			-25%	-10%		+10%	+25%
			$ 3.77	$ 4.53	$ 5.03	$ 5.53	$ 6.29
ALTERNATIVE YIELDS	-25%	11.1	$ (139.28)	$ (130.92)	$ (125.34)	$ (119.77)	$ (111.40)
	-10%	13.3	$ (130.92)	$ (120.88)	$ (114.19)	$ (107.50)	$ (97.46)
BUSHELS		14.8	$ (125.34)	$ (114.19)	$ (106.76)	$ (99.32)	$ (88.17)
	+10%	16.3	$ (119.77)	$ (107.50)	$ (99.32)	$ (91.14)	$ (78.88)
	+25%	18.5	$ (111.40)	$ (97.46)	$ (88.17)	$ (78.88)	$ (64.94)

Estimated Production Costs and Returns - Dry Land Proso Millet

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION						
PROSO MILLET	CWT	16.00	9.03	144.50		
TOTAL RECEIPTS				**144.50**	**16.00**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	4.13	1.00	4.13	0.46	
FERTILIZER	DOLS	30.34	1.00	30.34	3.36	
HERBICIDE	DOLS	12.30	1.00	12.30	1.36	
CUSTOM APPLICATION	DOLS	7.00	1.00	7.00	0.78	
FUEL	DOLS			9.33	1.03	
REPAIR & MAINTENANCE	DOLS			4.90	0.54	
LABOR	DOLS			2.48	0.27	
INTEREST EXPENSE [2]	DOLS			2.47	0.27	
Total Preharvest	DOLS			**72.95**	**8.08**	
Operating Harvest						
FUEL	DOLS			15.50	1.72	
REPAIR & MAINTENANCE	DOLS			7.86	0.87	
LABOR	DOLS			4.11	0.46	
HAULING [1]	DOLS			3.61	0.40	
Total Harvest				**31.08**	**3.44**	
Total Operating Costs				**104.03**	**11.52**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			43.44	4.81	
GENERAL FARM OVERHEAD	DOLS			10.00	1.11	
REAL ESTATE TAXES	DOLS			0.92	0.10	
Total Property and Ownership Costs	DOLS			**54.36**	**6.02**	
TOTAL DIRECT COSTS				**158.39**	**17.54**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**-13.89**	**-1.54**	
FACTOR PAYMENTS						
LAND @ 4.00%[3]	DOLS			56.00	6.20	
RETURN TO MANAGEMENT AND RISK	DOLS			**-69.89**	**-7.74**	

1 Hauling Machinery & Labor Charges = $0.40/CWT
2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%
3 Includes allocation of fallow acres in the rotation

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/CWT				
			-25%	-10%		+10%	+25%
			$ 12.00	$ 14.40	$ 16.00	$ 17.60	$ 20.00
ALTERNATIVE YIELDS	-25%	6.8	$ (77.11)	$ (60.85)	$ (50.01)	$ (39.17)	$ (22.92)
	-10%	8.1	$ (60.85)	$ (41.34)	$ (28.34)	$ (15.33)	$ 4.18
CWT		9.0	$ (50.01)	$ (28.34)	$ (13.89)	$ 0.56	$ 22.24
	+10%	9.9	$ (39.17)	$ (15.33)	$ 0.56	$ 16.46	$ 40.30
	+25%	11.3	$ (22.92)	$ 4.18	$ 22.24	$ 40.30	$ 67.40

Estimated Production Costs and Returns - Dry Land Oil Sunflowers

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION						
SUNFLOWERS	CWT	22.75	3.37	76.56		
TOTAL RECEIPTS				**76.56**	**22.75**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	26.37	1.00	26.37	7.84	
FERTILIZER	DOLS	42.46	1.00	42.46	12.62	
HERBICIDE	DOLS	42.72	1.00	42.72	12.69	
CUSTOM APPLICATION	DOLS	7.00	2.00	14.00	4.16	
INSECTICIDE	DOLS	10.59	1.00	10.59	3.15	
CROP INSURANCE	DOLS	23.34	1.00	23.34	6.94	
CUSTOM AERIAL APPLICATION	DOLS	8.00	1.00	8.00	2.38	
FUEL	DOLS			3.65	1.08	
REPAIR & MAINTENANCE	DOLS			2.07	0.62	
LABOR	DOLS			1.20	0.36	
INTEREST EXPENSE [2]	DOLS			6.10	1.81	
Total Preharvest				**180.50**	**53.64**	
Operating Harvest						
FUEL	DOLS			8.89	2.64	
REPAIR & MAINTENANCE	DOLS			5.06	1.50	
LABOR	DOLS			1.57	0.47	
HAULING [1]	DOLS			0.84	0.25	
Total Harvest				**16.36**	**4.86**	
Total Operating Costs				**196.87**	**58.50**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			22.49	6.68	
GENERAL FARM OVERHEAD	DOLS			10.00	2.97	
REAL ESTATE TAXES	DOLS			0.92	0.27	
Total Property and Ownership Costs	DOLS			**33.41**	**9.93**	
TOTAL DIRECT COSTS				**230.28**	**68.43**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**-153.71**	**-45.68**	
FACTOR PAYMENTS						
LAND @ 4.00%[3]	DOLS			32.00	9.51	
RETURN TO MANAGEMENT AND RISK	DOLS			**-185.71**	**-55.19**	

1 Hauling Machinery & Labor Charges = $0.25/Cwt
2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%
3 Includes allocation of fallow acres in the rotation

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/CWT				
			-25%	-10%		+10%	+25%
			$ 17.06	$ 20.48	$ 22.75	$ 25.03	$ 28.44
ALTERNATIVE YIELDS	-25%	2.5	$ (187.21)	$ (178.60)	$ (172.85)	$ (167.11)	$ (158.50)
	-10%	3.0	$ (178.60)	$ (168.26)	$ (161.37)	$ (154.48)	$ (144.14)
CWT		3.4	$ (172.85)	$ (161.37)	$ (153.71)	$ (146.06)	$ (134.57)
	+10%	3.7	$ (167.11)	$ (154.48)	$ (146.06)	$ (137.64)	$ (125.00)
	+25%	4.2	$ (158.50)	$ (144.14)	$ (134.57)	$ (125.00)	$ (110.65)

Estimated Production Costs and Returns - Limited-Irrigation Winter Wheat

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION						
HARD RED WINTER WHEAT	BU	6.58	49.51	325.78		
TOTAL RECEIPTS				**325.78**	**6.58**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	12.17	1.00	12.17	0.25	
FERTILIZER	DOLS	49.77	1.00	49.77	1.01	
HERBICIDE	DOLS	32.82	1.00	32.82	0.66	
CUSTOM APPLICATION	DOLS	7.00	1.00	7.00	0.14	
SPRINKLER LEASE	DOLS	60.00	1.00	60.00	1.21	
IRRIGATION REPAIR	DOLS	10.00	1.00	10.00	0.20	
WATER CHARGE	$/INCH	3.00	5.00	15.00	0.30	
FUEL	DOLS			8.83	0.18	
REPAIR & MAINTENANCE	DOLS			6.93	0.14	
LABOR	DOLS			2.30	0.05	
INTEREST EXPENSE [2]	DOLS			7.17	0.14	
Total Preharvest	DOLS			**211.99**	**4.28**	
Operating Harvest						
FUEL	DOLS			7.79	0.16	
REPAIR & MAINTENANCE	DOLS			3.25	0.07	
LABOR	DOLS			1.65	0.03	
HAULING [1]	DOLS			9.90	0.20	
Total Harvest				**22.59**	**0.46**	
Total Operating Costs				**234.58**	**4.74**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			35.91	0.73	
GENERAL FARM OVERHEAD	DOLS			10.00	0.20	
REAL ESTATE TAXES	DOLS			6.20	0.13	
Total Property and Ownership Costs	DOLS			**52.11**	**1.05**	
TOTAL DIRECT COSTS:				**286.69**	**5.79**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**39.09**	**0.79**	
FACTOR PAYMENTS						
LAND @ 4.00%[3]	DOLS			56.00	1.13	
RETURN TO MANAGEMENT AND RISK	DOLS			**-16.91**	**-0.34**	

1 Hauling Machinery & Labor Charges = $0.20/Bushel
2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%
3 Includes allocation of fallow acres in the rotation

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/BU				
			-25%	-10%		+10%	+25%
			$ 4.94	$ 5.92	$ 6.58	$ 7.24	$ 8.23
ALTERNATIVE YIELDS	-25%	37.1	$ (103.44)	$ (66.79)	$ (42.36)	$ (17.93)	$ 18.72
	-10%	44.6	$ (66.79)	$ (22.81)	$ 6.51	$ 35.83	$ 79.81
BUSHELS		49.5	$ (42.36)	$ 6.51	$ 39.09	$ 71.66	$ 120.53
	+10%	54.5	$ (17.93)	$ 35.83	$ 71.66	$ 107.50	$ 161.25
	+25%	61.9	$ 18.72	$ 79.81	$ 120.53	$ 161.25	$ 222.33

Estimated Production Costs and Returns - Limited-Irrigation Corn

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION						
CORN	BU	5.03	64.12	322.52		
TOTAL RECEIPTS				**322.52**	**5.03**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	38.31	1.00	38.31	0.60	
FERTILIZER	DOLS	52.32	1.00	52.32	0.82	
HERBICIDE	DOLS	37.36	1.00	37.36	0.58	
CUSTOM APPLICATION	DOLS	7.00	1.00	7.00	0.11	
SPRINKLER LEASE	DOLS	60.00	1.00	60.00	0.94	
IRRIGATION REPAIR	DOLS	10.00	1.00	10.00	0.16	
WATER CHARGE	$/INCH	3.00	5.00	15.00	0.23	
FUEL	DOLS			5.94	0.09	
REPAIR & MAINTENANCE	DOLS			2.80	0.04	
LABOR	DOLS			1.96	0.03	
INTEREST EXPENSE [2]	DOLS			8.07	0.13	
Total Preharvest	DOLS			**238.76**	**3.72**	
Operating Harvest						
FUEL	DOLS			7.55	0.12	
REPAIR & MAINTENANCE	DOLS			5.21	0.08	
LABOR	DOLS			1.45	0.02	
HAULING [1]	DOLS			12.82	0.20	
Total Harvest				**27.03**	**0.42**	
Total Operating Costs				**265.80**	**4.15**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			26.07	0.41	
GENERAL FARM OVERHEAD	DOLS			10.00	0.16	
REAL ESTATE TAXES	DOLS			6.20	0.10	
Total Property and Ownership Costs	DOLS			**42.27**	**0.66**	
TOTAL DIRECT COSTS				**308.07**	**4.80**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**14.46**	**0.23**	
FACTOR PAYMENTS						
LAND @ 4.00%[3]	DOLS			56.00	0.87	
RETURN TO MANAGEMENT AND RISK	DOLS			**-41.54**	**-0.65**	

1 Hauling Machinery & Labor Charges = $0.20/Bushel
2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%
3 Includes allocation of fallow acres in the rotation

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/BU				
			-25%	-10%		+10%	+25%
			$ 3.77	$ 4.53	$ 5.03	$ 5.53	$ 6.29
ALTERNATIVE YIELDS	-25%	48.1	$ (126.65)	$ (90.36)	$ (66.18)	$ (41.99)	$ (5.70)
	-10%	57.7	$ (90.36)	$ (46.82)	$ (17.80)	$ 11.23	$ 54.77
BUSHELS		64.1	$ (66.18)	$ (17.80)	$ 14.46	$ 46.71	$ 95.09
	+10%	70.5	$ (41.99)	$ 11.23	$ 46.71	$ 82.19	$ 135.40
	+25%	80.2	$ (5.70)	$ 54.77	$ 95.09	$ 135.40	$ 195.87

Estimated Production Costs and Returns - Limited-Irrigation Proso Millet

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION						
PROSO MILLET	CWT	16.00	24.02	384.34		
TOTAL RECEIPTS				**384.34**	**16.00**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	5.54	1.00	5.54	0.23	
FERTILIZER	DOLS	40.68	1.00	40.68	1.69	
HERBICIDE	DOLS	12.30	1.00	12.30	0.51	
CUSTOM APPLICATION	DOLS	7.00	1.00	7.00	0.29	
SPRINKLER LEASE	DOLS	60.00	1.00	60.00	2.50	
IRRIGATION REPAIR	DOLS	10.00	1.00	10.00	0.42	
WATER CHARGE	$/INCH	3.00	5.00	15.00	0.62	
FUEL	DOLS			9.33	0.39	
REPAIR & MAINTENANCE	DOLS			4.90	0.20	
LABOR	DOLS			2.48	0.10	
INTEREST EXPENSE [2]	DOLS			5.85	0.24	
Total Preharvest	DOLS			**173.08**	**7.21**	
Operating Harvest						
FUEL	DOLS			15.50	0.65	
REPAIR & MAINTENANCE	DOLS			7.86	0.33	
LABOR	DOLS			4.11	0.17	
HAULING [1]	DOLS			9.61	0.40	
Total Harvest				**37.08**	**1.54**	
Total Operating Costs				**210.16**	**8.75**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			43.44	1.81	
GENERAL FARM OVERHEAD	DOLS			10.00	0.42	
REAL ESTATE TAXES	DOLS			6.20	0.26	
Total Property and Ownership Costs	DOLS			**59.64**	**2.48**	
TOTAL DIRECT COSTS				**269.80**	**11.23**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**114.54**	**4.77**	
FACTOR PAYMENTS						
LAND @ 4.00%[3]	DOLS			56.00	2.33	
RETURN TO MANAGEMENT AND RISK	DOLS			**58.54**	**2.44**	

1 Hauling Machinery & Labor Charges = $0.40/CWT
2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%
3 Includes allocation of fallow acres in the rotation

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/CWT				
			-25%	-10%		+10%	+25%
			$ 12.00	$ 14.40	$ 16.00	$ 17.60	$ 20.00
ALTERNATIVE YIELDS	-25%	18.0	$ (53.61)	$ (10.37)	$ 18.46	$ 47.28	$ 90.52
	-10%	21.6	$ (10.37)	$ 41.52	$ 76.11	$ 110.70	$ 162.58
CWT		24.0	$ 18.46	$ 76.11	$ 114.54	$ 152.98	$ 210.63
	+10%	26.4	$ 47.28	$ 110.70	$ 152.98	$ 195.25	$ 258.67
	+25%	30.0	$ 90.52	$ 162.58	$ 210.63	$ 258.67	$ 330.73

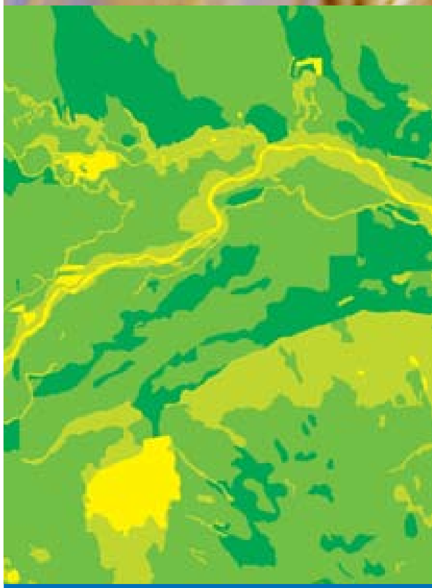
Estimated Production Costs and Returns - Limited-Irrigation Oil Sunflowers

	Unit	Price or Cost/Unit	Quantity	Value or Cost Per Acre	Value or Cost/Unit Production	Your Farm
GROSS RECEIPTS FROM PRODUCTION						
SUNFLOWERS	CWT	22.75	10.71	243.64		______
TOTAL RECEIPTS				**243.64**	**22.75**	
DIRECT COSTS						
Operating Preharvest						
SEED	DOLS	35.36	1.00	35.36	3.30	______
FERTILIZER	DOLS	56.93	1.00	56.93	5.32	______
HERBICIDE	DOLS	42.72	1.00	42.72	3.99	______
CUSTOM APPLICATION	DOLS	7.00	2.00	14.00	1.31	______
SPRINKLER LEASE	DOLS	60.00	1.00	60.00	5.60	______
IRRIGATION REPAIR	DOLS	10.00	1.00	10.00	0.93	______
WATER CHARGE	$/INCH	3.00	5.00	15.00	1.40	______
INSECTICIDE	DOLS	10.59	1.00	10.59	0.99	______
CROP INSURANCE	DOLS	23.34	1.00	23.34	2.18	______
CUSTOM AERIAL APPLICATION	DOLS	8.00	1.00	8.00	0.75	______
FUEL	DOLS			3.65	0.34	______
REPAIR & MAINTENANCE	DOLS			2.07	0.19	______
LABOR	DOLS			1.20	0.11	______
INTEREST EXPENSE [2]	DOLS			9.90	0.92	______
Total Preharvest				**292.76**	**27.34**	
Operating Harvest						
FUEL	DOLS			8.89	0.83	______
REPAIR & MAINTENANCE	DOLS			5.06	0.47	______
LABOR	DOLS			1.57	0.15	______
HAULING [1]	DOLS			2.68	0.25	______
Total Harvest				**18.20**	**1.70**	______
Total Operating Costs				**310.96**	**29.04**	
Property and Ownership Costs						
MACHINERY OWNERSHIP COSTS	DOLS			22.49	2.10	______
GENERAL FARM OVERHEAD	DOLS			10.00	0.93	______
REAL ESTATE TAXES	DOLS			6.20	0.58	______
Total Property and Ownership Costs	DOLS			**38.69**	**3.61**	______
TOTAL DIRECT COSTS				**349.65**	**32.65**	
NET RECEIPTS BEFORE FACTOR PAYMENTS				**-106.01**	**-9.90**	
FACTOR PAYMENTS						
LAND @ 4.00%[3]	DOLS			32.00	2.99	
RETURN TO MANAGEMENT AND RISK	DOLS			**-138.01**	**-12.89**	

1 Hauling Machinery & Labor Charges = $0.25/Cwt
2 Interest on Operating Capital is calculated on 1/2 of pre-harvest operating costs at 7%
3 Includes allocation of fallow acres in the rotation

BREAKEVEN ANALYSIS - PER ACRE RETURNS OVER TOTAL DIRECT COSTS ($/ACRE)

			ALTERNATIVE PRICES $/CWT				
			-25%	-10%		+10%	+25%
			$ 17.06	$ 20.48	$ 22.75	$ 25.03	$ 28.44
ALTERNATIVE YIELDS	-25%	8.0	$ (212.60)	$ (185.19)	$ (166.92)	$ (148.64)	$ (121.23)
	-10%	9.6	$ (185.19)	$ (152.30)	$ (130.37)	$ (108.44)	$ (75.55)
CWT		10.7	$ (166.92)	$ (130.37)	$ (106.01)	$ (81.64)	$ (45.10)
	+10%	11.8	$ (148.64)	$ (108.44)	$ (81.64)	$ (54.84)	$ (14.64)
	+25%	10.7	$ (166.92)	$ (130.37)	$ (106.01)	$ (81.64)	$ (45.10)



DiNatale
WATER CONSULTANTS

303-709-7044
1035 Pearl Street, Suite 334
Boulder, CO 80302

www.dinatalewater.com