‘An Integrated Approach to Water Conservation for Agriculture in the Texas Southern High Plains’

8th Annual Report

to the

Texas Water Development Board

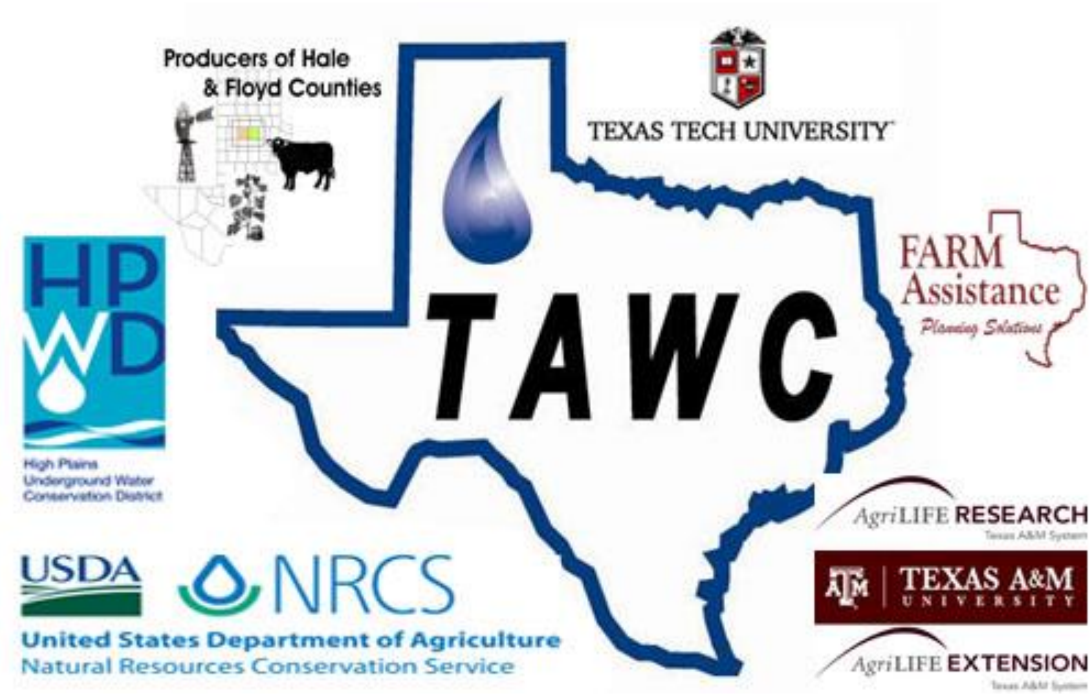
Texas Alliance For Water Conservation

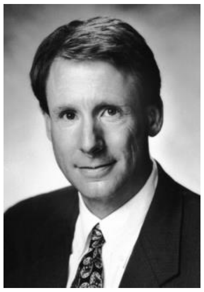
TAWC

“Water is Our Future”

June 1, 2013; Revised September 17, 2013

TEXAS ALLIANCE FOR WATER CONSERVATION PARTICIPANTS:





Appreciation is expressed to
Senator Robert Duncan
and the
Texas Water Development Board

With their vision for the future of Texas and their passion for the protection of our Water Resources this project is made possible

The future of our region and our state depend on the protection and appropriate use of our water resources.

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WATER CONSERVATION DEMONSTRATION PRODUCER BOARD

Glenn Schur, Chair

Boyd Jackson, Co-Chair

Eddie Teeter, Secretary

Keith Phillips

Mark Beedy

Jeff Don Terrell

Jody Foster

Lanney Bennett

Louis (Bubba) Ehrlich

Rick Kellison (ex-officio), Project Director

The Producer Board of Directors is composed of producer representatives within the focus area of Hale and Floyd Counties and is specifically charged to:

1) Ensure the relevance of this demonstration project to meet its objectives;
2) Help translate the results into community action and awareness;
3) Ensure the credibility and appropriateness of work carried out under this project;
4) Assure compatibility with and sensitivity to producer needs and concerns; and
5) Participate in decisions regarding actions that directly impact producers.

The board elects their chair, chair-elect, and secretary. Individuals serving on this board include representation of, but are not limited to producers cooperating in specific demonstration sites. The Chair serves as a full voting member of the Management Team. The Project Director serves in an *ex officio* capacity on the Producer Board. Meetings of the Producer Board of Directors are on an as-needed basis to carry out the responsibilities of the project and occur at least once annually in conjunction with the overall Management Team.

The value of this board to the project continues to be a key factor in its success.

TEXAS ALLIANCE FOR WATER CONSERVATION 2012 PARTICIPANTS

Texas Tech University
Dr. Chuck West, Project Administrator*
Mr. Rick Kellison, Project Director*
Mr. Philip Brown*
Dr. David Doerfert*
Dr. Phillip Johnson*
Dr. Stephan Maas*
Dr. Eduardo Segarra*
Mr. Tom Sell*
Dr. Jeff Johnson
Ms. Samantha Borgstedt,
  Communications Director
Ms. Christy Barbee,
  Secretary/Bookkeeper

Texas A&M AgriLife Extension
Dr. Steven Klose*
Mr. Jeff Pate*
Dr. Calvin Trostle*
Mr. Jay Yates*
Dr. Nithya Rajan

High Plains Underground Water Conservation District No. 1
Mr. Jim Conkwright*
Mr. Gerald Crenwelge

USDA - Natural Resources Conservation Service
Mr. Monte Dollar (retired)*

* Indicates Management Team member

USDA – Agricultural Research Service
Dr. Ted Zobeck
Dr. Veronica Acosta-Martinez

Producer Board Chairman
Mr. Glenn Schur

Graduate Research Assistants
(past and present)
Rebekka Martin (completed 2005)
Pamela Miller (completed 2006)
Nithya Rajan (completed 2007)
Paul Braden (completed 2007)
Jurahee Jones (completed 2008)
Justin Wienheimer (completed 2008)
Katie Leigh (completed 2008)
Heather Jones (completed 2010)
Yue Li (completed 20111)
Lindsay Graber (completed 2011)
Song Cui (completed 2011)
Swetha Dorbala
Morgan Newsom
Jarrott Wilkinson
Rachel Oates
Cody Zilverberg (completed 2012)
Jennifer Zavaleta
Nichole Sullivan
Lisa Fultz (completed 2012)
Marko Davinic
Melissa Murharam

Producers of Hale and Floyd counties

Ronnie Aston
Mark Beedy
Lanney Bennett
Randy Bennett
Troy Bigham
Bill Dollar
Louis (Bubba) Ehrlich
Bernie Ford
Gerald Ford
Jody Foster
Scott Horne
Boyd Jackson
Jimmy Kemp
Brett Marble
Charles Nelson
Danny Nutt
Keith Phillips
John Paul Schacht
Glenn Schur
Dan Smith
Don Sutterfield
Brian Teeple
Eddie Teeter
Jeff Don Terrell
Aaron Wilson

The dedication of all these participants is gratefully acknowledged.

‘AN INTEGRATED APPROACH TO WATER CONSERVATION FOR AGRICULTURE IN THE TEXAS SOUTHERN HIGH PLAINS’

OBJECTIVE

To conserve water in the Texas Southern High Plains while continuing agricultural activities providing the needed productivity and profitability for producers, communities, and the region.

BACKGROUND

The Texas High Plains currently generates a combined annual economic value of crops and livestock that exceeds $9.9 billion ($2.4 crops; $7.5 livestock; Texas Agricultural Statistics, Texas Department of Agriculture, 2012) but is highly dependent on water from the Ogallala Aquifer. Ground water supplies are declining in this region (The Cross Section Vol. 58 No.6, High Plains Underground Water Conservation District No. 1, 2012) while costs of energy required to pump water are escalating. Improved irrigation technologies including low energy precision application (LEPA) and subsurface drip (SDI) irrigation have increased water use efficiencies to over 95%, but have not always led to decreased water use. Furthermore, agriculture is changing in the Texas High Plains in response to a growing dairy industry and to current U.S. policy placing emphasis on renewable biofuels, especially ethanol. Both the dairy and the ethanol industries are increasing demands for grain crops, primarily corn. Feeds demanded by the dairy industry also include corn for silage and alfalfa, both of which require irrigation at levels above the current major cropping systems in this region. In addition to increasing water scarcity, unstable grain prices, fertilizer costs and uncertain energy costs are driving changes in this region.

Diversified systems that include both crops and livestock have long been known for complementary effects that increase productivity. Research conducted at Texas Tech over the past 15 years has shown that an integrated cotton/forage/beef cattle system, compared with a continuous cotton monoculture, lowered irrigated water use by about 25%, increased profitability per unit of water invested, diversified income sources, reduced soil erosion, reduced nitrogen fertilizer use by about 40%, and decreased needs for other chemicals, while maintaining similar cotton yields per acre between the two systems (Allen et al., 2005; 2007; 2008; 2012). Profitability was similar for the integrated system as compared to the cotton monoculture system. Furthermore, soil health was improved, more carbon was sequestered, and soil microbial activities were higher in the integrated system compared with the cotton monoculture (Acosta-Martinez et al., 2004; 2008; 2010). This ongoing replicated research originally provided the information for designing the demonstration project and now provides the basis for interpretation of results from the demonstration project. Together, the demonstration sites coupled with the replicated research are providing a uniquely validated approach to discovery and implementation of solutions to preserving and protecting our water resource while offering viable agricultural solutions to the Texas High Plains and beyond.

No single technology will successfully address water conservation. Rather, the approach must be an integration of agricultural systems, best irrigation technologies, improved plant genetics, and management strategies that reduce water demand, optimize water use and value, and maintain an appropriate level of productivity and profitability. Water conservation must become both an individual goal and a community ethic. Educational programs are needed at all levels to raise awareness of the necessity for, the technology to accomplish, and the impact of water conservation on regional stability and economics. As increasing state and global populations drive an increasing demand for agricultural products, the future of the High Plains, the state of Texas, and indeed the world depends on our ability to protect and appropriately use our water resources.

A multidisciplinary and multi-university/agency/producer team, coordinated though Texas Tech University, assembled during 2004 to address these issues. In September of 2004 the project *'An Integrated Approach to Water Conservation for Agriculture in the Texas Southern High Plains'* was approved by the Texas Water Development Board and funding was received in February, 2005 to begin work on this demonstration project conducted in Hale and Floyd Counties. A producer Board of Directors was elected to oversee all aspects of this project. Initially, 26 producer sites were identified to represent 26 different 'points on a curve' that characterize and compare cropping and livestock grazing system monocultures with integrated cropping systems and integrated crop/livestock approaches to agriculture in this region. The purpose is to understand where and how water conservation can be achieved while maintaining acceptable levels of profitability. Results of this study assist area producers in meeting the challenges of declining water supplies and reduced pumping capacities by demonstrating various production systems and water saving technologies.

REPORT OF THE FIRST EIGHT YEARS

In the first year of any demonstration or research project, the data should be interpreted with caution. Some factors related to system installation and data collection will change over time and therefore do not function at project inception in the same manner as they do as the system matures. For each added year of reporting, some data will be missing because there is only a partial year's accounting or because some data are not yet complete. However, because each annual report updates and completes each previous year, the current year's annual report is the most correct and comprehensive accounting of results to date and will contain revisions and additions for the previous years.

Because this project uses existing farming systems that were already functioning at the beginning of the project, the startup time was minimized and even in the first year, interesting data emerged that had meaningful interpretations. These data become more robust and meaningful with each additional year's data.

A key strategy of this project is that all sites are producer owned and producer driven. The producers make all decisions about their agricultural practices, management strategies, and marketing decisions. Thus, practices and systems at any specific site are subject to change from year to year as producers strive to address changes in market opportunities, weather, commodity prices, and other factors that influence their decisions. This project allows us to measure, monitor, and document the effects of these decisions. As this project progresses, it is providing a valuable measure of changes in agricultural practices in this region and the information to interpret what is driving these changes.

Sites were picked originally by the Producer Board of Directors in response to the request for sites that would represent a range of practices from high-input, intensive management systems to low-input, less intensive practices. The sites represent a range from monoculture cropping practices (one type or species of annual crop at the site per year), multi-cropping systems (more than one crop species per year on a field), integrated crop and livestock systems (part of the site produced annual crops and part forage-based livestock production), and all-forage/livestock systems. Irrigation practices include subsurface drip, center pivot, furrow, and dryland systems.

It is important to recognize that these data and their interpretations are based on certain assumptions. These assumptions are critical to being able to compare information across the different sites in this demonstration project. These assumptions are necessary to avoid differences that would be unique to a particular producer or site that have nothing to do with understanding how these systems function. Thus, we have adopted certain constants across all systems such as pumping depth of wells to avoid variables that do not influence system behavior but would bias economic results. This approach means that the economic data for an individual site are valid for comparisons of systems but do not represent the actual economic results of the specific location. Actual economic returns for each site are also being calculated and made available to the individual producer but are not a part of this report.

WEATHER DATA

2005

The 2005 growing season was close to ideal in terms of temperatures and timing of precipitation. The precipitation and temperatures for this area are presented in Figure 1 along with the long-term means for this region. While hail events occurred in these counties during 2005, none of the specific sites in this project were measurably affected by such adverse weather events. Year 1, 2005, also followed a year of abnormally high precipitation. Thus, the 2005 growing season likely was influenced by residual soil moisture.

Precipitation for 2005, presented in Table 1, is the mean of precipitation recorded at the 26 sites during 2005, beginning in March when the sites were identified and equipped. Precipitation for January and February are amounts recorded at Halfway, TX; the nearest weather station.

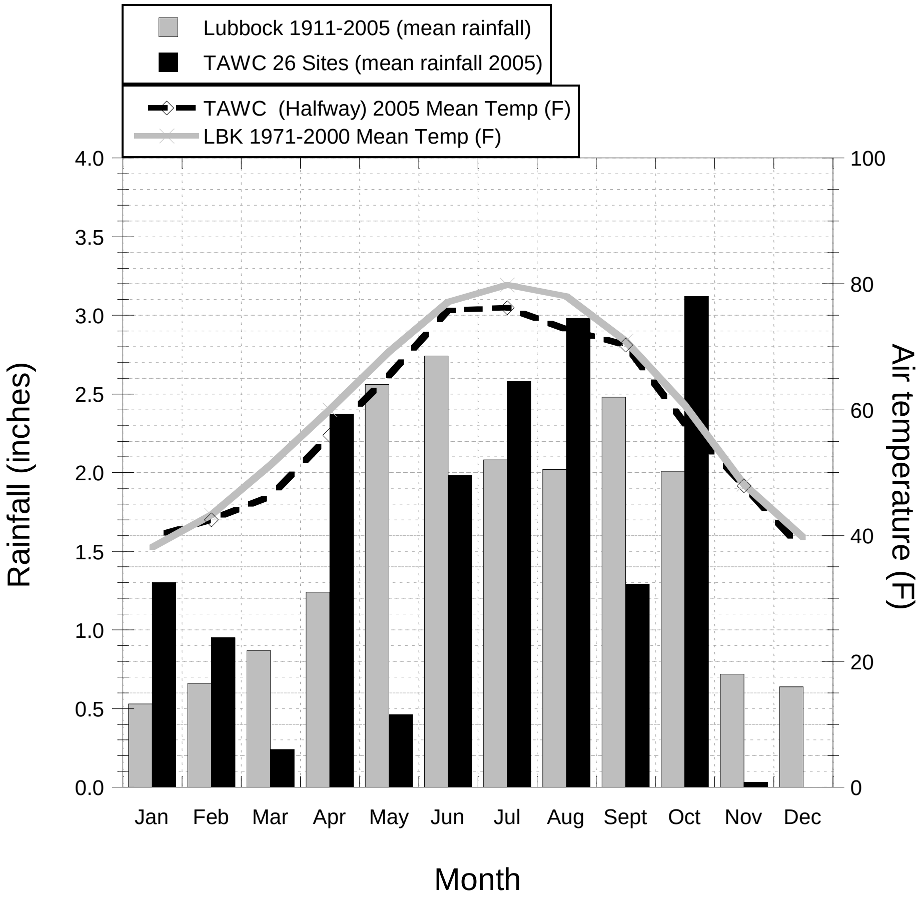


Figure 1. Temperature and precipitation for 2005 in the demonstration area compared with long term averages.

Table 1. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2005.

SITE	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1	0	0	0.4	1.3	0.2	1.7	2.2	2.4	2	4.1	0	0	**14.3**
2	0	0	0.4	1.8	0.5	1.4	2.4	3.6	0.8	3.4	0	0	**14.3**
3	0	0	0.7	2	0.6	1.4	2.5	4	0.4	3.2	0	0	**14.8**
4	0	0	0.6	8	0.3	1.4	2.2	3.2	0.1	1	0	0	**16.8**
5	0	0	0.6	2.9	0.4	1.5	3.2	4.2	0.6	1.7	0	0	**15.1**
6	0	0	0.5	1.5	0.4	3	2.4	1	2	4.2	0	0	**15.0**
7	0	0	0.5	1.5	0.6	2.6	2.4	1.5	3.3	3	0	0	**15.4**
8	0	0	0	1.5	0.6	2.6	2.4	1.5	3.3	3	0	0	**14.9**
9	0	0	0.5	1.5	0.5	2.6	2	1	3	3.3	0	0	**14.4**
10	0	0	0.4	1	0.2	2	1.8	1	1.6	3.1	0	0	**11.1**
11	0	0	0	1.2	0.4	3	2	1.7	1.8	4.3	0	0	**14.4**
12	0	0	0	0.7	0.4	3.2	2	2.2	1.2	2.8	0	0	**12.5**
13	0	0	0	1.7	0.4	3.4	3	2.6	1.2	4	0	0	**16.3**
14	0	0	0	1.3	0.5	1.8	3	2.2	2.2	3	0	0	**14.0**
15	0	0	0.4	1.3	0.5	2	3.6	4	2	5.4	0	0	**19.2**
16	0	0	0	1.4	0.4	2	3.2	3.4	1.8	4.1	0	0	**16.3**
17	0	0	0	2	0.5	2.2	3	3.6	1.6	4.6	0	0	**17.5**
18	0	0	0	4	0.9	1	2.8	4.8	0	3	0	0	**16.5**
19	0	0	0	3.2	0.5	1	2	4.6	0	2.6	0	0	**13.9**
20	0	0	0	2.8	0.4	1.6	3.4	4	0.8	2	0.4	0	**15.4**
21	0	0	0	1.2	0.6	2.5	2	2.5	2	4	0.3	0	**15.1**
22	0	0	0	5.8	0.3	1.6	2.6	4	0.2	0.6	0	0	**15.1**
23	0	0	0	3	0.3	1.2	2.9	3.6	0.5	0.9	0	0	**12.4**
24	0	0	0.8	4.8	0.3	1	2.9	4	0.4	0.8	0	0	**15.0**
25	0	0	0	2.3	0.9	2	2.4	3.4	0	7.4	0	0	**18.4**
26	0	0	0	2	0.4	1.7	2.8	3.4	0.7	1.7	0	0	**12.7**
Average	**0**	**0**	**0.2**	**2.4**	**0.5**	**2.0**	**2.6**	**3.0**	**1.3**	**3.1**	**0**	**0**	**15.0**

2006

The 2006 growing season was one of the hottest and driest seasons on record marked by the longest period of days with no measurable precipitation ever recorded for the Texas High Plains. Most dryland cotton was terminated. Rains came in late August and again in October delaying harvests in some cases. No significant hail damage was received within the demonstration sites.

Precipitation for 2006, presented in Figure 2 and Table 2, is the actual mean of precipitation recorded at the 26 sites during 2006 from January to December. The drought and high temperatures experienced during the 2006 growing season did influence system behavior and results. This emphasizes why it is crucial to continue this type of real-world demonstration and data collection over a number of years and sets of conditions.

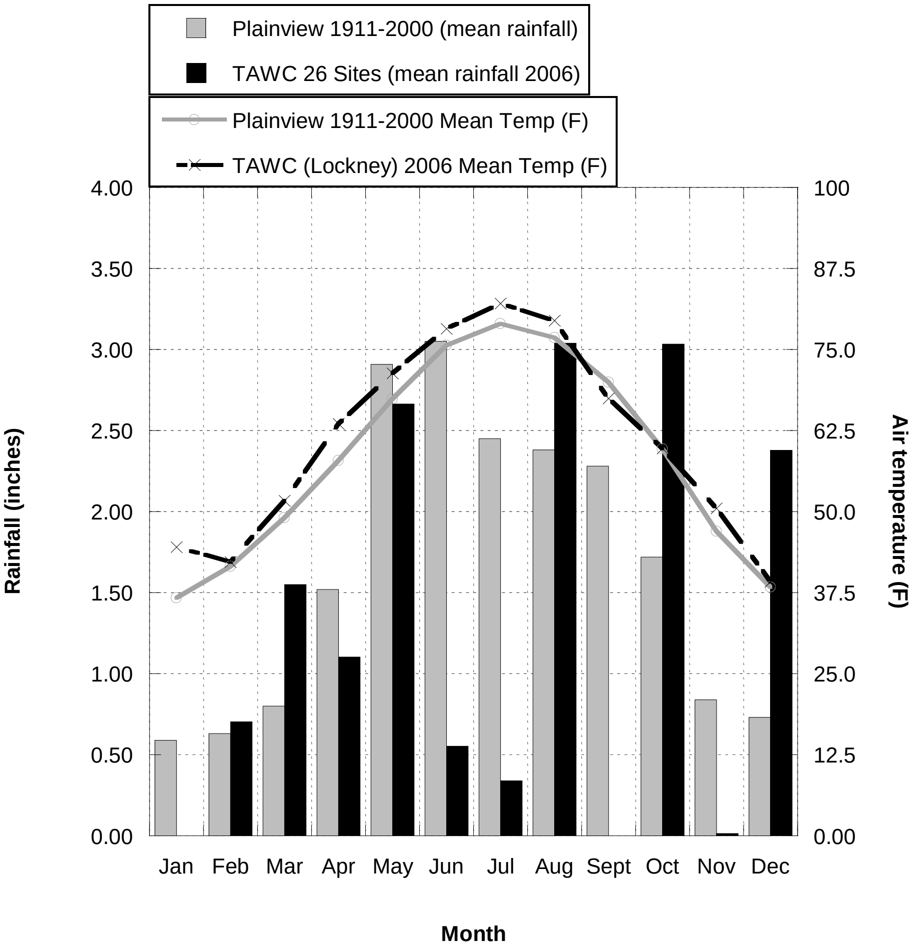


Figure 2. Temperature and precipitation for 2006 in the demonstration area compared with long term averages.

Table 2. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2006.

SITE	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1	0	0.9	1.7	1.2	2.6	0.5	0.55	2.3	0	2.87	0	2.6	**15.22**
2	0	0.8	1.9	1.1	1.9	0.2	0	2.6	0	3.05	0	1.8	**13.35**
3	0	0.6	1.5	0.9	2.6	0.7	0.22	3	0	3.14	0	3.2	**15.86**
4	0	0.5	1.4	1.1	2.7	0.2	0.4	3.8	0	2.56	0	2.8	**15.46**
5	0	0.7	1.4	1.8	3.2	0.4	0.57	4	0	2.78	0	2.8	**17.65**
6	0	0.7	1.5	0.8	3	0.4	0.2	5.4	0	2.6	0	2.7	**17.30**
7	0	0.5	1.3	0.9	1.92	0.5	0.33	3.8	0	2.75	0	2.1	**14.10**
8	0	0.5	1.3	0.9	1.92	0.5	0.33	3	0	2.75	0	2.1	**13.30**
9	0	0.6	1.5	0.8	1.82	0.5	0.12	3.8	0	3.28	0	2.4	**14.82**
10	0	0.6	1.5	1	3	0.4	0.11	3.1	0	2.8	0.1	2.4	**15.01**
11	0	0.5	0.7	0.4	2.5	0.4	0.1	3.5	0	3.3	0	1.6	**13.00**
12	0	0.8	1.4	0.8	2.2	0.9	0.2	1.9	0	3.3	0	2	**13.50**
13	0	1	1.8	0.8	2.2	1.1	0.1	2.7	0	3.05	0	1.8	**14.55**
14	0	0.8	1.8	1	2.8	0.3	0	1.6	0	3.8	0	2.6	**14.70**
15	0	1.4	2.2	1.4	2.8	0.4	0	2	0	4.4	0.1	2.6	**17.30**
16	0	1	2.2	1.3	2	0.8	0.2	2.6	0	2.69	0	2.2	**14.99**
17	0	0.8	2	1.3	2	1	0.3	3.3	0	3.38	0.1	3.2	**17.38**
18	0	0.7	1.2	1.2	1.8	1.1	0.74	2.6	0	3.11	0	3.6	**16.05**
19	0	0.6	1.3	1.1	1.3	1.4	0.75	1.2	0	3.11	0	2.3	**13.06**
20	0	0.6	1.4	1.3	3.8	0.4	0.55	4.07	0	2.56	0	2.2	**16.88**
21	0	0.9	2.6	1.4	2.8	0.4	0.73	2.2	0	3.54	0.1	2.7	**17.37**
22	0	0.6	1.5	1.3	3.8	0.3	0.22	1.8	0	2.66	0	1.9	**14.08**
23	0	0.4	0.9	1.1	3.8	0.2	0.55	3.6	0	3.7	0	2	**16.25**
24	0	0.5	1.6	1.2	4	0.7	0.12	2.8	0	2.64	0	2.3	**15.86**
26	0	0.7	1.3	1.3	3	0.3	0.86	4.3	0	2.49	0	1.7	**15.95**
27	0	0.6	1.4	1.3	3.8	0.4	0.55	4.07	0	2.56	0	2.2	**16.88**
Average	**0**	**0.7**	**1.6**	**1.1**	**2.7**	**0.6**	**0.3**	**3.0**	**0**	**3.0**	**0**	**2.4**	**15.40**

2007

Precipitation during 2007 totaled 27.2 inches (Table 3) and was well above the long-term mean (18.5 inches) for annual precipitation for this region. Furthermore, precipitation was generally well distributed over the growing season with early season rains providing needed moisture for crop establishment and early growth (Figure 3). Many producers took advantage of these rains and reduced irrigation until mid-season when rainfall declined. Growing conditions were excellent and there was little effect of damaging winds or hail at any of the sites. Temperatures were generally cooler than normal during the first half of the growing season but returned to normal levels by August. The lack of precipitation during October and November aided producers in harvesting crops.

Precipitation for 2007, presented in Figure 3 and Table 3, is the actual mean of precipitation recorded at the 26 sites during 2007 from January to December. Growing conditions during 2007 differed greatly from the hot dry weather encountered in 2006.

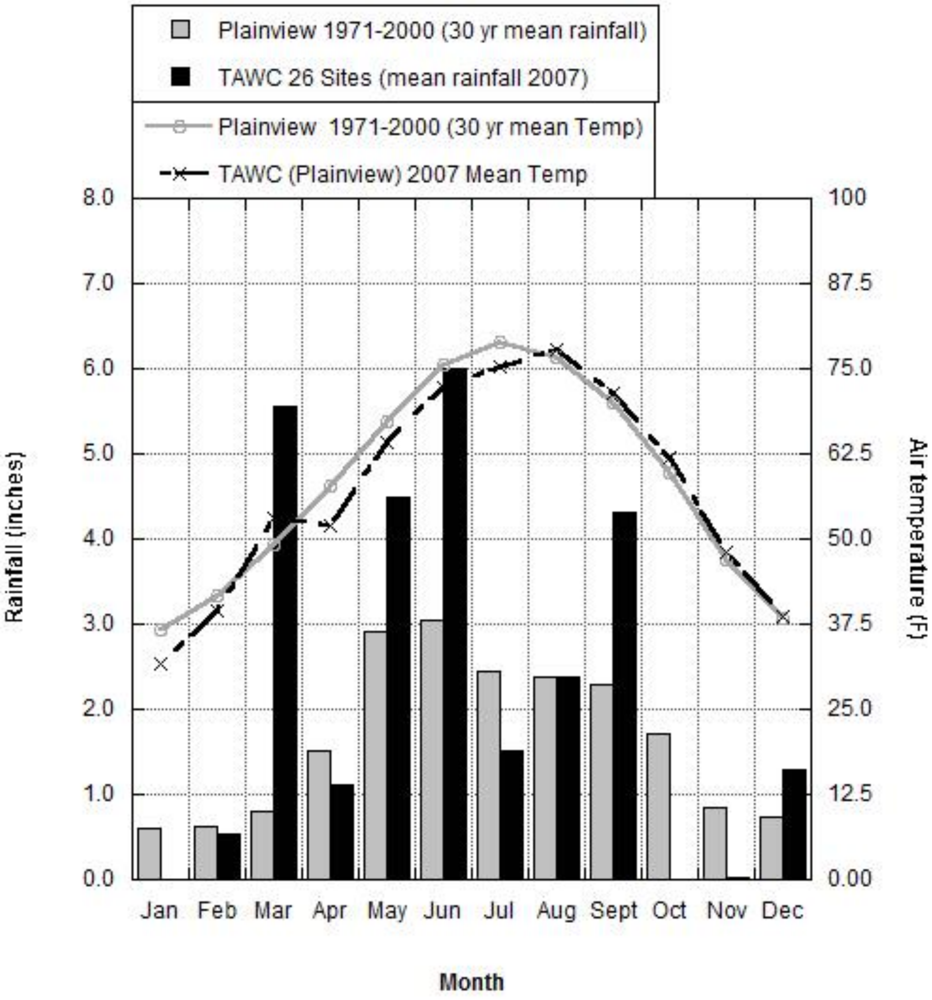


Figure 3. Temperature and precipitation for 2007 in the demonstration area compared with long term averages.

Table 3. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2007.

SITE	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
1	0	0.74	5.4	0.8	4.92	4.75	0.71	2.3	3.6	0	0	1.2	**24.42**
2	0	0.52	3.7	0.8	2.86	6.93	1.32	3	4.8	0	0	1.2	**25.13**
3	0	0.47	4.8	0.9	2.74	6.88	1.41	2.4	4.4	0	0	1	**25.00**
4	0	0.29	7.6	0.9	3.53	6.77	4	1.5	5	0	0	1	**30.59**
5	0	0.72	6	1.1	5.09	7.03	0.79	1.2	4.7	0	0	1.2	**27.83**
6	0	0.46	6	0.7	5.03	5.43	0.54	2	4.5	0	0	1.4	**26.06**
7	0	0.9	6.4	1	5.4	4.12	0.74	1.2	3.2	0	0	1.4	**24.36**
8	0	0.9	6.4	1	5.4	4.12	0.74	1.2	3.2	0	0	1.4	**24.36**
9	0	0.42	4.8	0.6	5.13	4.05	0.75	1.6	3	0	0	1	**21.35**
10	0	0.41	4.8	0.6	4.62	6.62	0.81	2.2	4.5	0	0	1.2	**25.76**
11	0	0.41	4.6	1.5	4.74	6.8	1.2	3.4	5.3	0	0	1	**28.95**
12	0	0.41	6.7	1.3	5.3	6.6	1.6	3	5.3	0	0	1	**31.21**
13	0	0.41	5.5	0.6	5	7.1	2	3	4	0	0	1.3	**28.91**
14	0	0.52	6.2	0.9	5.29	3.79	0.71	2.6	3.8	0	0	1.8	**25.61**
15	0	0.52	6.75	4	5.29	4.25	0.71	2.5	4	0	0	3	**31.02**
16	0	0.45	5	1	3.6	5.65	0.85	2.5	4.2	0	0	1	**24.25**
17	0	0.67	5.3	1	3.85	7.27	1.5	3.2	4.6	0	0	1.2	**28.59**
18	0	0.52	5.8	1.9	4.54	5.61	2.22	3	4	0	0	1.2	**28.79**
19	0	0.55	4	1	4.7	7.7	2.8	3.9	4.5	0	0	2	**31.15**
20	0	0.41	5.6	0.8	4.06	7.24	1.15	3	4.8	0	0	1	**28.06**
21	0	0.52	7.4	2	5.3	5.28	1.17	3.4	5.4	0	0	1.4	**31.87**
22	0	0.34	6.2	0.9	3.9	6.88	3.17	1.8	4	0	0	1	**28.19**
23	0	0.4	4.6	0.7	4.65	7.86	2.19	2	4.5	0	0	0.5	**27.40**
24	0	0.91	5.4	0.9	3.22	3.47	3.94	1.7	4.2	0	0	1.8	**25.54**
26	0	0.48	4	0.8	4.76	6.45	1.31	1	3.8	0	0	1.2	**23.80**
27	0	0.41	5.6	0.8	4.06	7.24	1.15	3	4.8	0	0	1	**28.06**
Average	**0**	**0.5**	**5.6**	**1.1**	**4.5**	**6.0**	**1.5**	**2.4**	**4.3**	**0**	**0**	**1.3**	**27.20**

2008

Precipitation during 2008, at 21.6 inches, was above average for the year (Table 4). However, the distribution of precipitation was unfavorable for most crops (Figure 4). Beginning the previous autumn, little rain fell until December and then less than an inch of precipitation was received before May of 2008. Four inches was received in May, well above the average for that month. This was followed by below average rain during most of the growing season for crops. In September and October, too late for some crops and interfering with harvest for others, rain was more than twice the normal amounts for this region. Following the October precipitation, no more rain came during the remainder of the year. This drying period helped with harvest of some crops but the region entered the winter with below normal moisture.

Temperatures during 2008 were close to the long-term mean for the region (Figure 4).

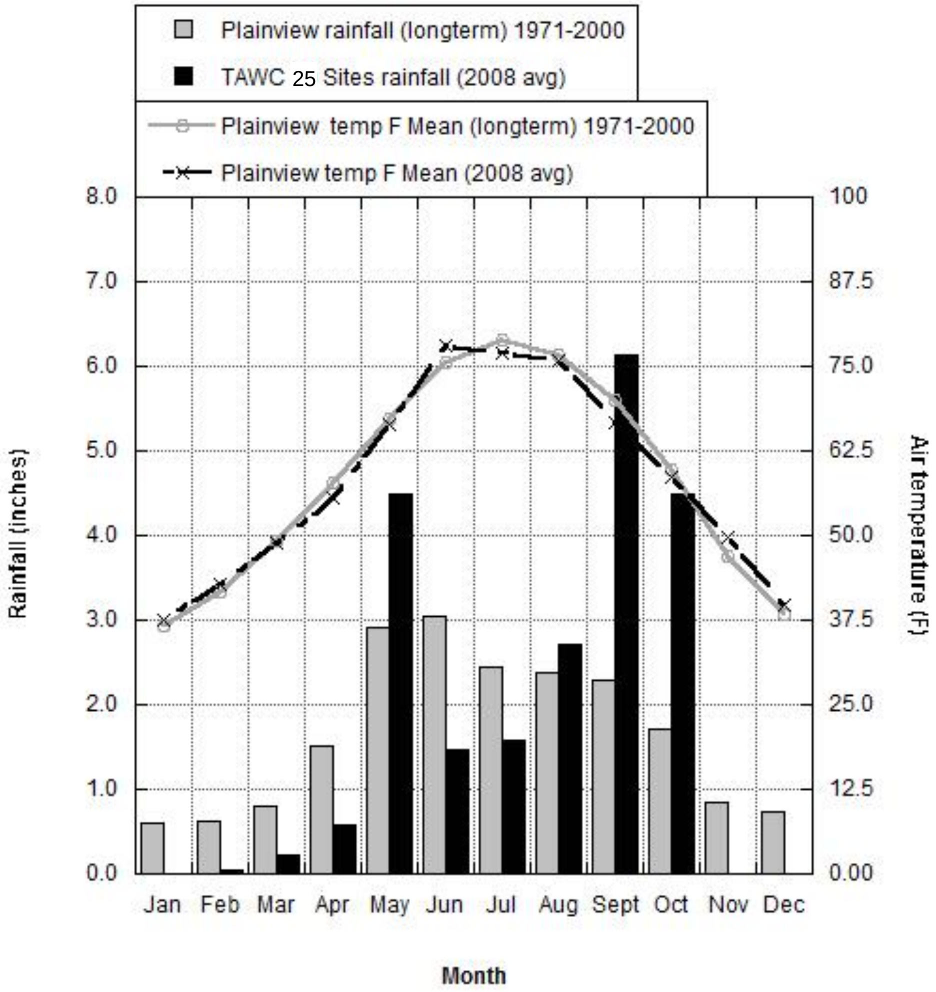


Figure 4. Temperature and precipitation for 2008 in the demonstration area compared with long term averages.

Table 4. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2008.

SITE	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
2	0	0	0.2	0.8	4.75	1.7	1	2.1	5.4	4.1	0	0	**20.1**
3	0	0	0.2	0.5	4.5	1.1	0.95	2	4.7	4.4	0	0	**18.4**
4	0	0	0.4	0.6	4	2.9	1.1	4.1	3	2.9	0	0	**19.0**
5	0	0	0	0.2	4	1.5	0.5	4.2	5	3.5	0	0	**18.9**
6	0	0	0.2	0.5	4.2	1.2	1.9	4	9.4	6	0	0	**27.4**
7	0	0	0	0.6	5.6	1.2	3.2	1.8	8.6	6.5	0	0	**27.5**
8	0	0	0	0.6	5.6	1.2	3.2	1.8	8.6	5.4	0	0	**26.4**
9	0	0	0	0.4	4.1	1	2.4	1.7	5.5	4	0	0	**19.1**
10	0	0	0	0.4	4.5	0.9	1	2.7	6.9	4.8	0	0	**21.2**
11	0	0	0.4	0.5	5.3	1.1	1.7	3.2	7.6	4.3	0	0	**24.1**
12	0	0	0.2	0.6	5	1.5	1.6	2.25	6.5	4.2	0	0	**21.9**
14	0	0.2	0.4	0.9	5	1.3	1.6	2.5	7.4	6	0	0	**25.3**
15	0	0.2	0.4	0.9	5	1.5	2.5	2.5	7.4	6	0	0	**26.4**
17	0	0	0.2	1.1	5	1.8	1.8	2.6	6.4	5.6	0	0	**24.5**
18	0	0.2	0.4	0.2	3.6	1.3	0.7	2.2	3	4	0	0	**15.6**
19	0	0.2	0.4	0.8	5	1	1.1	2.1	4.25	4.8	0	0	**19.7**
20	0	0	0.4	0.5	5	1.9	1.4	4.8	6.8	4.2	0	0	**25.0**
21	0	0.2	0.4	0.8	5	1.5	4	2.4	6	4.2	0	0	**24.5**
22	0	0	0.2	1	4.6	3	1.1	2.6	5	3.2	0	0	**20.7**
23	0	0	0.2	0.2	1.3	1.1	1	2.4	5.5	3.4	0	0	**15.1**
24	0	0	0.4	0.9	4.2	2.9	1.4	2.1	3.5	3	0	0	**18.4**
26	0	0	0.2	0.2	3.2	0.5	1.4	2.3	5.3	3.3	0	0	**16.4**
27	0	0	0.4	0.5	5	1.9	1.4	4.8	6.8	4.2	0	0	**25.0**
28	0	0	0	0.4	4.5	0.9	1	2.7	6.9	4.8	0	0	**21.2**
29	0	0	0	0.4	4	1	0.7	1.8	6.4	4.7	0	0	**19.0**
Average	**0**	**0.04**	**0.2**	**0.6**	**4.5**	**1.5**	**1.6**	**2.7**	**6.1**	**4.5**	**0**	**0**	**21.6**

2009

Precipitation during 2009 totaled 15.2 inches averaged across all sites. This was similar to precipitation in 2005, the first reporting year for this project. However, in 2005 above-average winter moisture was received followed by precipitation in April that was nearly twice the long-term mean (Figure 1). July, August, and October precipitation were also higher than normal in that year. In 2009, January began with very little precipitation that followed two months of no precipitation in the previous year (Figure 4). Thus, the growing season began with limited soil moisture. March and May saw less than half of normal precipitation. While June and July were near of slightly above normal, August, September, October and November were all below normal. December precipitation was above normal and began a period of higher than normal moisture entering 2010.

Temperatures in February and March were above the long-term mean and peak summer temperatures were prolonged in 2009. However, by September, temperatures fell below normal creating a deficit in heat units needed to produce an optimum cotton crop.

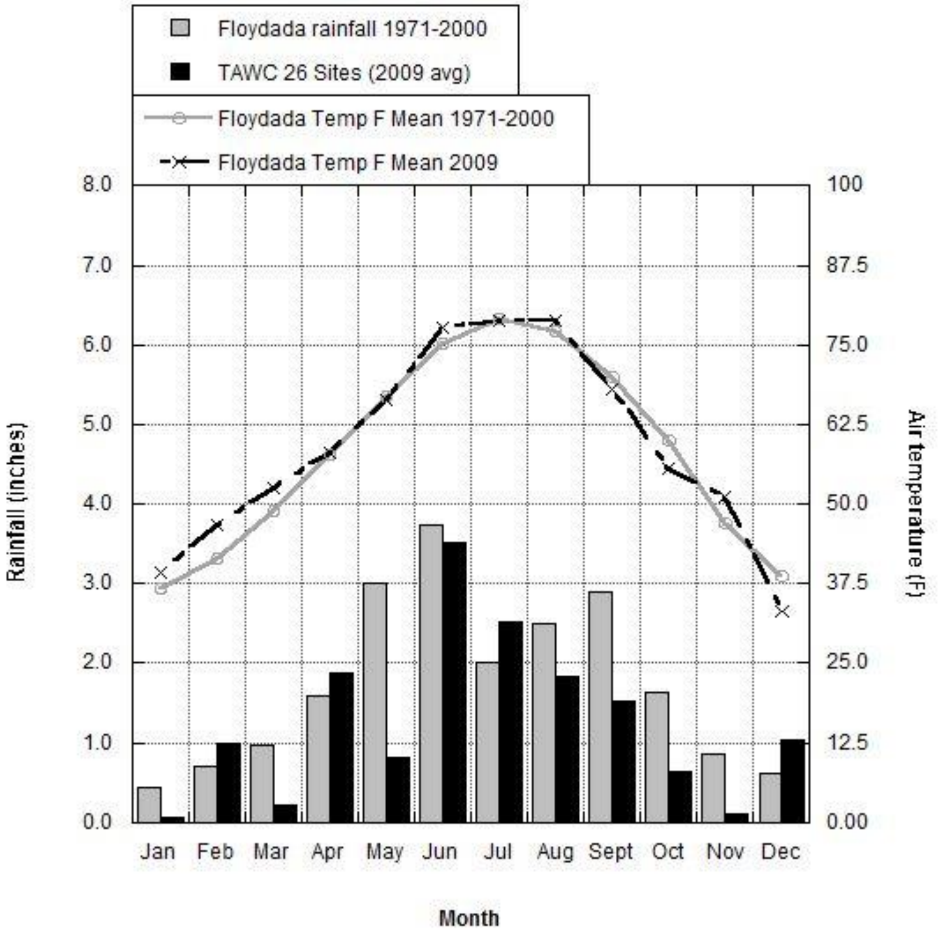


Figure 5. Temperature and precipitation for 2009 in the demonstration area compared with long term averages.

Table 5. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2009.

SITE	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2	0.08	1.22	0.27	2.30	0.12	3.13	2.23	2.57	0.24	1.18	0.15	1.61	**15.10**
3	0.10	1.45	0.32	2.74	0.30	4.79	2.33	0.00	0.07	1.41	0.18	1.92	**15.60**
4	0.09	1.25	0.27	2.37	0.14	4.73	1.90	2.58	2.01	0.80	0.18	0.99	**17.30**
5	0.07	0.96	0.21	1.82	0.68	4.58	3.92	1.73	1.72	0.68	0.06	0.27	**16.70**
6	0.05	0.78	0.17	1.47	1.07	2.01	2.86	3.55	0.20	0.02	0.09	0.73	**13.00**
7	0.05	0.75	0.16	1.42	0.52	2.89	2.24	1.22	1.60	0.60	0.09	1.55	**13.10**
8	0.05	0.75	0.16	1.42	0.52	2.89	2.24	1.22	1.60	0.60	0.09	1.55	**13.10**
9	0.04	0.59	0.13	1.12	0.73	2.20	2.48	1.34	1.65	0.59	0.08	0.66	**11.60**
10	0.04	0.56	0.12	1.05	0.44	2.13	2.64	3.01	2.18	0.41	0.06	0.56	**13.20**
11	0.04	0.63	0.14	1.18	0.86	2.56	2.21	1.25	1.31	0.61	0.08	0.83	**11.70**
14	0.12	1.80	0.39	3.41	1.10	0.81	4.21	0.67	0.02	0.00	0.14	1.41	**14.10**
15	0.09	1.33	0.29	2.52	1.50	0.84	1.25	0.16	2.79	1.30	0.16	1.77	**14.00**
17	0.04	0.64	0.14	1.21	0.51	2.88	1.90	2.88	3.41	0.55	0.05	0.69	**14.90**
18	0.08	1.14	0.25	2.16	0.66	6.25	1.50	1.63	2.26	0.35	0.09	0.75	**17.10**
19	0.07	0.95	0.21	1.80	0.85	5.41	2.31	2.53	1.89	0.00	0.12	0.66	**16.80**
20	0.06	0.84	0.18	1.59	0.37	3.87	2.43	3.41	2.09	0.37	0.11	0.89	**16.20**
21	0.06	0.80	0.18	1.52	0.58	2.70	1.43	3.35	1.83	0.51	0.08	0.77	**13.80**
22	0.11	1.56	0.34	2.95	1.01	3.75	0.98	1.86	2.05	0.96	0.24	1.19	**17.00**
23	0.09	1.26	0.28	2.38	0.76	4.84	1.29	1.59	1.96	0.75	0.00	0.91	**16.10**
24	0.08	1.19	0.26	2.25	1.31	6.82	2.38	1.73	0.28	0.66	0.12	0.51	**17.60**
26	0.08	1.09	0.24	2.06	1.91	4.21	4.61	0.99	0.19	0.63	0.12	1.29	**17.40**
27	0.06	0.89	0.19	1.68	1.22	3.64	3.14	1.78	1.86	0.86	0.11	1.18	**16.60**
28	0.05	0.71	0.15	1.33	0.97	2.89	2.49	1.41	1.48	0.69	0.09	0.94	**13.20**
29	0.13	0.45	0.44	0.94	0.41	2.9	3.26	2.35	2.82	0.75	0.22	1.41	**16.08**
30	0.08	1.09	0.24	2.06	1.91	4.21	4.61	0.99	0.19	0.63	0.12	1.29	**17.40**
Average	**0.07**	**0.99**	**0.23**	**1.87**	**0.82**	**3.52**	**2.51**	**1.83**	**1.51**	**0.64**	**0.11**	**1.05**	15.15

2010

The project sites and the region received above average rainfall for the 2010 calendar year with an average of 28.9 inches measured across the project, as indicated in Table 6 and illustrated in Figure 6. Much of this rainfall came in the late winter and early spring/summer months, with above average rainfall from January through July, and significant rainfall amounts in the months of April and July. Temperatures for the year were slightly above average during the late fall and early spring months across the TAWC sites, allowing for increased soil temperatures at planting, further stabilizing the germination and early growth stages of the upcoming crops. An average of 6.0 inches fell on the project sites in April and 6.5 inches in July which when combined with the favorable conditions of the previous three months, provided ideal conditions for the 2010 summer growing season. The abnormally high rainfall continued in July and October allowing for summer crops to receive needed moisture during the final stages of production. This record high rainfall allowed some producers to achieve record yields, specifically on cotton and corn, while maintaining or decreasing their irrigation use from previous years of the project.

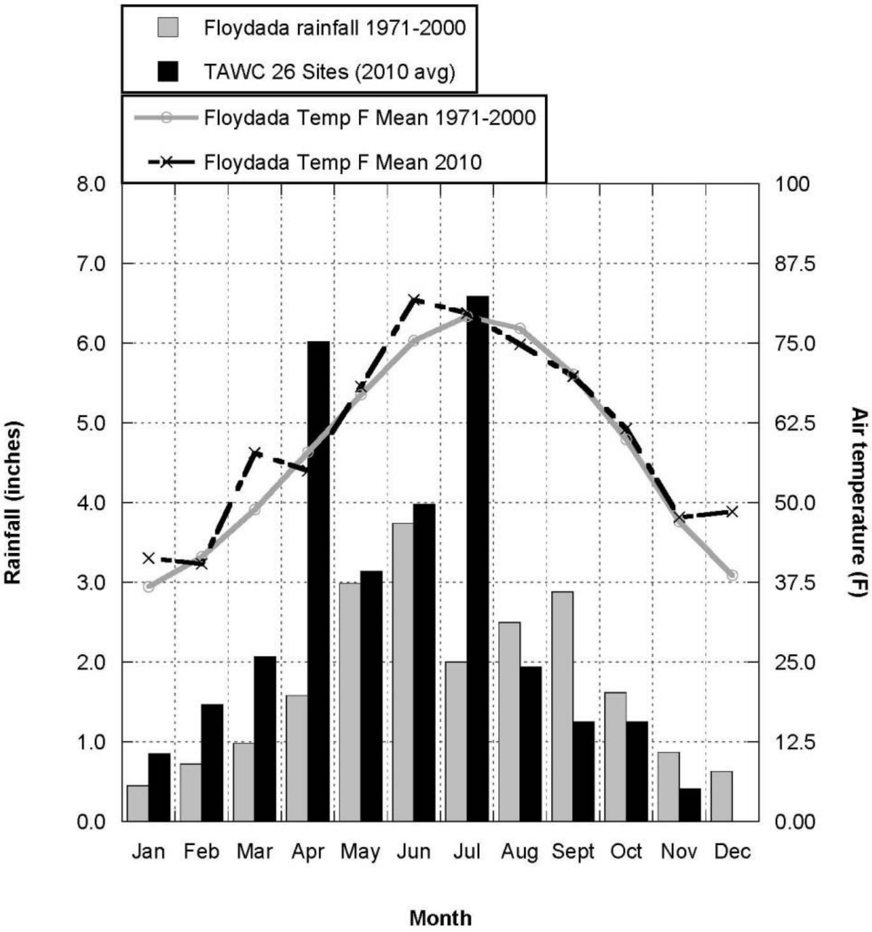


Figure 6. Temperature and precipitation for 2010 in the demonstration area compared with long term averages.

Table 6. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2010.

SITE	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2	1.5	1.1	2.0	6.2	2.0	7.0	7.8	1.2	1.6	1.4	0.0	0.0	31.8
3	0.8	1.4	1.9	5.0	2.2	4.7	5.8	1.4	2.0	1.8	0.2	0.0	27.1
4	0.6	1.3	2.1	5.2	4.6	2.2	10.0	1.4	0.4	2.0	0.6	0.0	30.4
5	0.8	1.4	1.9	5.0	3.2	3.6	8.0	2.3	0.6	0.6	0.4	0.0	27.7
6	0.5	1.4	1.9	5.4	3.4	4.8	5.4	2.4	1.2	0.6	0.4	0.0	27.4
7	0.8	1.5	2.5	6.0	2.8	1.6	5.0	2.3	1.5	0.6	0.3	0.0	24.8
8	0.8	1.5	2.5	6.0	2.8	1.6	5.0	2.3	1.5	0.6	0.3	0.0	24.8
9	0.5	1.5	2.2	7.0	4.6	2.8	4.4	2.2	1.6	0.8	0.4	0.0	28.0
10	0.8	1.6	2.2	7.7	4.2	3.4	4.4	1.8	1.2	1.0	0.4	0.0	28.7
11	0.8	1.6	2.2	9.1	5.4	4.0	4.4	1.7	1.2	0.9	0.4	0.0	31.6
12	0.8	1.5	2.1	7.4	3.8	4.2	7.6	3.4	2.8	1.2	0.6	0.0	35.4
14	0.8	1.5	2.1	7.7	4.0	5.1	6.0	2.2	2.0	1.2	0.4	0.0	33.0
15	0.8	1.5	2.1	6.2	2.0	5.8	5.2	1.7	1.4	1.4	0.4	0.0	28.5
17	0.8	1.6	2.0	5.2	2.8	6.6	7.2	1.2	1.6	1.2	0.4	0.0	30.6
18	0.8	1.3	2.0	7.3	1.6	6.6	4.6	1.6	0.1	1.0	0.2	0.0	27.1
19	0.7	1.3	2.0	7.6	2.2	5.4	6.2	2.4	0.8	2.0	0.4	0.0	30.9
20	0.8	1.4	1.9	6.3	3.2	4.4	9.0	2.3	0.8	1.2	0.6	0.0	31.8
21	0.8	1.5	2.1	6.2	2.7	4.6	7.4	2.2	2.4	1.2	0.6	0.0	31.7
22	1.4	1.8	2.1	4.1	3.4	3.6	8.4	0.8	0.2	2.0	0.6	0.0	28.4
23	1.4	1.4	2.1	5.4	2.6	4.4	7.0	2.1	0.4	0.5	0.4	0.0	27.6
24	1.4	1.8	2.1	3.8	3.6	1.6	7.5	1.5	0.7	2.6	0.6	0.0	27.2
26	0.8	1.4	1.9	5.0	3.2	3.6	8.0	2.3	0.6	0.6	0.4	0.0	27.7
27	0.8	1.4	1.9	5.0	2.2	3.0	7.0	2.3	0.8	1.4	0.6	0.0	26.3
28	0.8	1.6	2.2	7.7	4.2	3.4	4.4	1.8	1.2	1.0	0.4	0.0	28.7
29	0.8	1.5	2.1	6.2	1.8	6.0	7.4	1.7	4.0	1.4	0.4	0.0	33.3
30	0.8	1.4	1.9	5.0	3.2	3.6	8.0	2.3	0.6	0.6	0.4	0.0	27.7
31	1.4	1.8	2.1	3.8	3.6	1.6	7.5	1.5	0.7	2.6	0.6	0.0	27.2
32	0.8	1.5	2.1	6.2	2.7	2.4	6.0	1.7	1.1	1.6	0.3	0.0	26.4
33	0.8	1.5	2.1	6.2	2.7	2.4	6.0	1.7	1.1	1.6	0.3	0.0	26.4
Average	**0.9**	**1.5**	**2.1**	**6.0**	**3.1**	**3.9**	**6.6**	**1.9**	**1.2**	**1.3**	**0.4**	**0.0**	**28.9**

2011

The project sites and the region received below average rainfall for the 2011 calendar year with an average of 5.3 inches (Figure 7 and Table 7), compared with a long term average of 18.5 inches. This was the worst drought the Texas High Plains had seen since the 1930's in that virtually no rainfall was received during the normal growing season. Several fields within sites recorded zero crop yields in 2011 because irrigation was insufficient to produce yields high enough to merit the harvest costs.

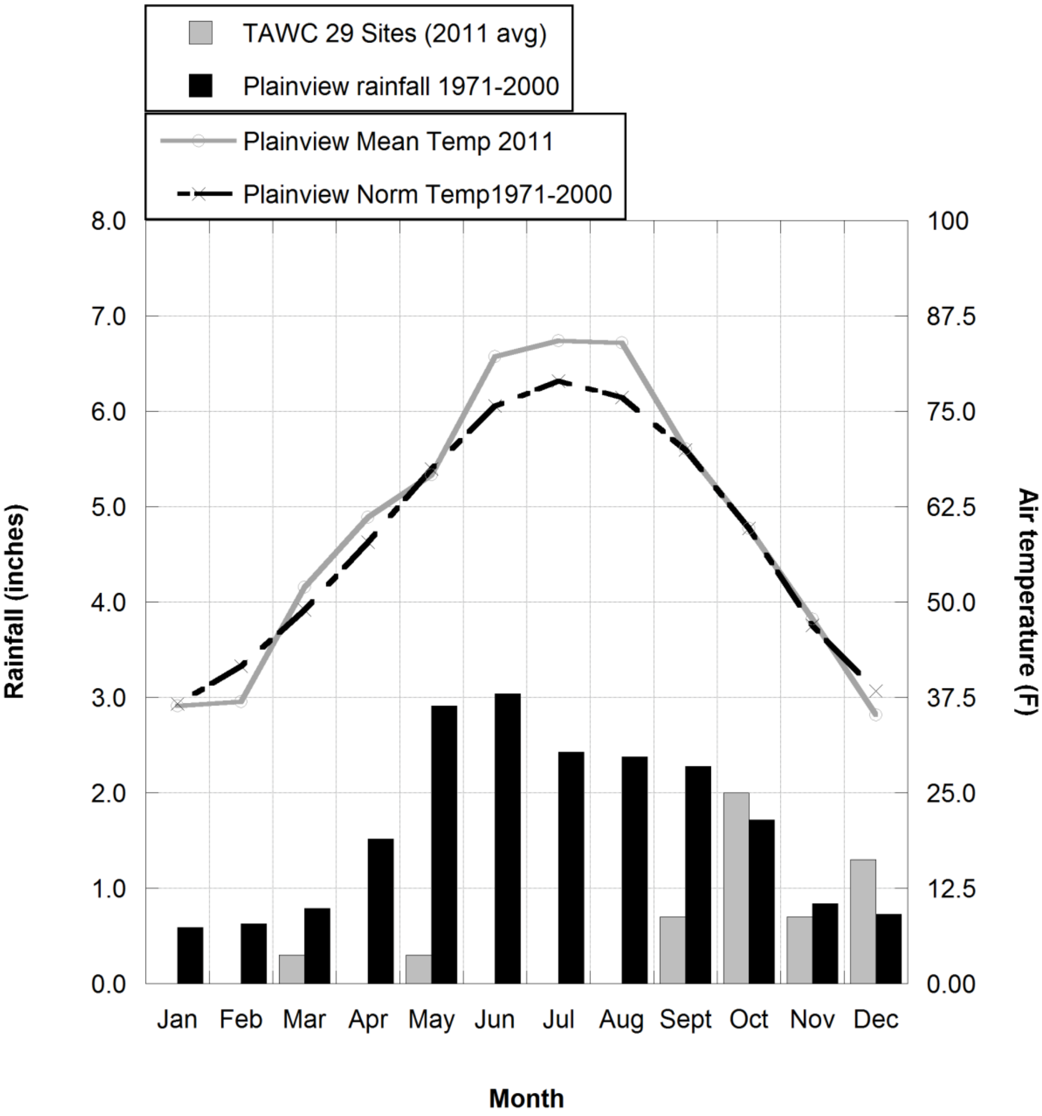


Figure 7. Temperature and precipitation for 2011 in the demonstration area compared with long term averages.

Table 7. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2011.

SITE	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	1.0	2.2	0.6	1.3	**5.3**
3	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.4	2.0	0.8	0.8	0.9	**5.1**
4	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.4	2.4	0.3	0.8	**4.5**
5	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.6	1.7	0.4	1.1	**4.3**
6	0.0	0.1	0.6	0.0	0.4	0.0	0.0	0.0	0.6	2.1	1.0	1.1	**5.9**
7	0.0	0.0	1.0	0.0	0.3	0.0	0.0	0.0	0.6	1.7	0.9	0.8	**5.3**
8	0.0	0.0	1.0	0.0	0.3	0.0	0.0	0.0	0.6	1.7	0.9	0.8	**5.3**
9	0.0	0.0	0.4	0.0	0.6	0.0	0.0	0.0	0.7	2.2	1.0	1.2	**6.0**
10	0.0	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.6	2.0	1.0	1.5	**6.0**
11	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.6	1.8	1.0	1.0	**4.7**
12	0.0	0.1	0.4	0.0	0.3	0.0	0.0	0.2	0.7	2.2	1.2	1.1	**6.2**
14	0.0	0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.8	2.0	1.0	1.2	**5.4**
15	0.0	0.1	0.0	0.0	0.4	0.0	0.0	0.0	0.8	2.0	1.0	1.2	**5.5**
17	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.6	2.0	0.6	0.8	**4.2**
18	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.6	2.5	0.5	1.4	**5.1**
19	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.6	2.5	0.5	1.4	**5.1**
20	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.2	0.8	1.9	0.6	1.4	**5.3**
21	0.0	0.0	0.6	0.1	0.4	0.0	0.0	0.0	0.4	1.8	0.9	1.1	**5.3**
22	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.9	2.1	0.3	0.8	**4.7**
23	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.4	1.4	0.1	1.4	**3.4**
24	0.0	0.0	0.6	0.0	0.1	0.0	0.0	0.0	0.9	3.0	0.1	2.8	**7.5**
26	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.6	1.7	0.4	1.1	**4.3**
27	0.0	0.0	0.0	0.1	0.5	0.0	0.0	0.0	1.0	1.6	0.4	1.2	**4.8**
28	0.0	0.0	0.4	0.0	0.5	0.0	0.0	0.0	0.6	2.0	1.0	1.5	**6.0**
29	0.0	0.1	0.0	0.0	1.0	0.0	0.0	0.0	0.4	2.2	0.8	1.4	**5.9**
30	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.6	1.7	0.4	1.1	**4.3**
31	0.0	0.0	0.6	0.0	0.1	0.0	0.0	0.0	0.9	3.0	0.1	2.8	**7.5**
32	0.0	0.1	0.0	0.0	0.4	0.0	0.0	0.0	0.8	2.0	1.0	1.2	**5.5**
33	0.0	0.1	0.0	0.0	0.4	0.0	0.0	0.0	0.8	2.0	1.0	1.2	**5.5**
Average	**0.0**	**0.0**	**0.3**	**0.0**	**0.3**	**0.0**	**0.0**	**0.0**	**0.7**	**2.0**	**0.7**	**1.3**	**5.3**

2012

The project sites and the region again received below average rainfall for the 2012 calendar year, with an average of 10.0 inches measured across the project (Figure 8 and Table 8). Slightly above average rainfall was received in the months of March, June and September. Mean temperatures ran slightly above normal early in the season, but were close to normal during the growing season.

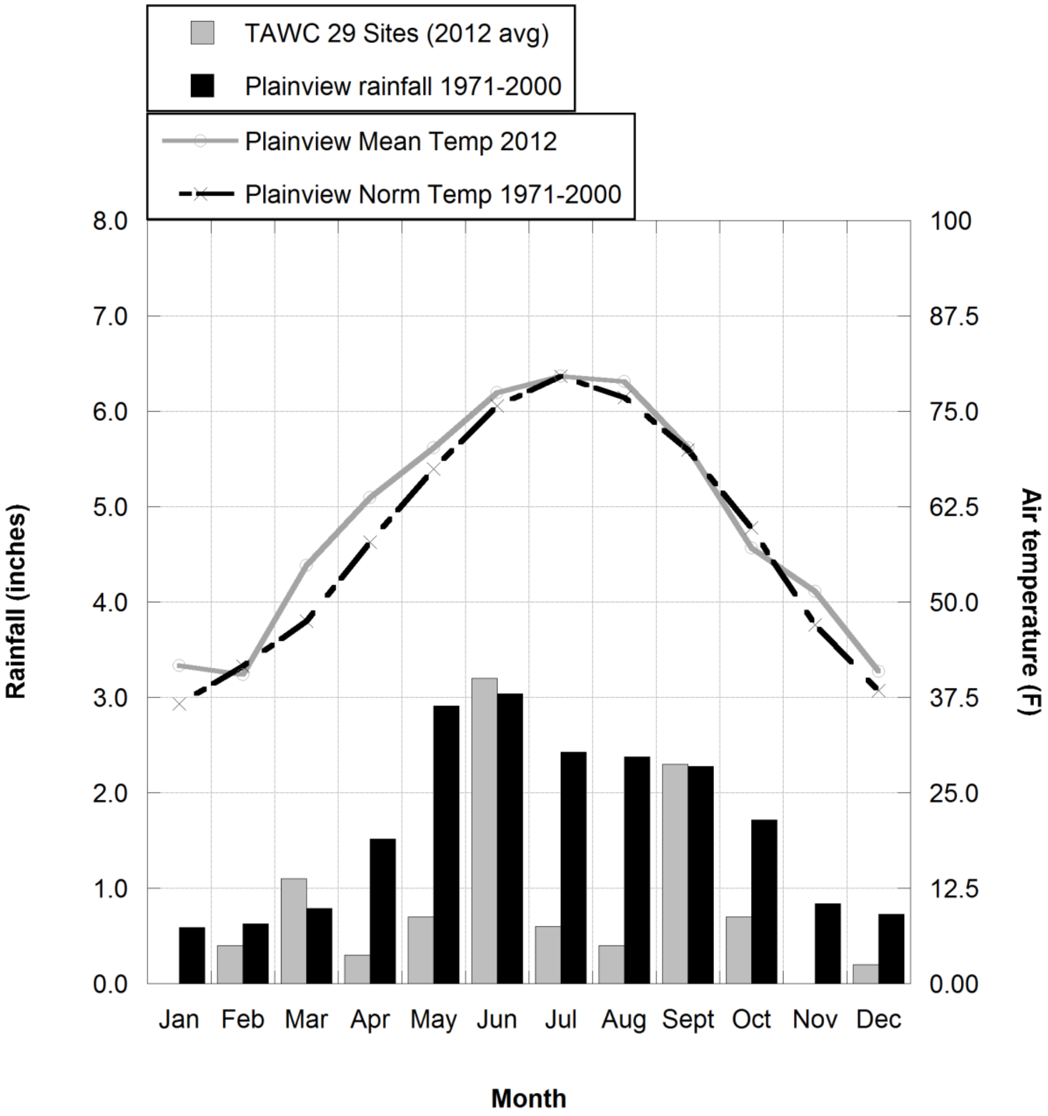


Figure 8. Temperature and precipitation for 2012 in the demonstration area compared with long term averages.

Table 8. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2012.

SITE	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2	0.0	0.5	1.0	0.7	1.0	3.3	0.8	0.6	2.0	0.6	0.0	0.2	10.7
3	0.0	0.4	1.2	0.8	0.6	0.7	0.4	0.6	1.4	0.7	0.0	0.0	6.8
4	0.0	0.5	1.2	0.0	1.6	2.9	0.5	0.4	3.3	0.8	0.0	0.2	11.3
5	0.0	0.6	0.8	0.0	0.4	2.9	1.0	0.2	2.8	1.5	0.0	0.0	10.2
6	0.0	0.3	0.0	0.0	0.0	3.7	0.6	0.3	2.0	0.1	0.0	0.4	7.3
7	0.0	0.2	1.0	0.4	0.3	5.2	0.1	0.4	2.2	0.2	0.0	0.2	10.2
8	0.0	0.3	1.0	0.4	0.3	5.2	0.1	0.4	2.2	0.2	0.0	0.2	10.3
9	0.0	0.3	1.0	0.4	0.4	4.9	1.4	0.4	4.2	0.5	0.0	0.2	13.7
10	0.0	0.6	1.4	0.2	0.6	3.4	0.4	0.2	2.2	0.2	0.0	0.3	9.5
11	0.0	0.4	2.0	0.2	0.8	4.2	0.1	0.2	2.6	0.2	0.0	0.2	10.9
12	0.0	0.5	1.9	0.4	0.9	2.5	0.2	0.1	1.9	0.4	0.0	0.3	9.1
14	0.0	0.4	1.8	0.1	0.6	3.3	0.2	0.4	2.2	0.4	0.0	0.3	9.7
15	0.0	0.4	1.8	0.1	0.7	2.9	0.2	0.4	2.2	0.2	0.0	0.4	9.3
17	0.0	0.4	1.0	0.7	1.0	2.7	0.7	0.4	2.4	0.5	0.0	0.2	10.0
18	0.0	0.3	0.5	0.0	0.8	2.6	0.2	0.8	2.4	1.0	0.0	0.1	8.7
19	0.0	0.4	1.0	1.2	1.2	3.3	0.4	1.0	2.8	1.0	0.0	0.2	12.5
20	0.0	0.4	1.2	0.2	0.4	3.4	1.4	1.0	2.4	1.0	0.0	0.4	11.8
21	0.0	0.5	1.5	0.2	0.8	2.9	0.2	0.1	2.1	0.5	0.0	0.1	8.9
22	0.0	0.6	1.0	0.0	1.0	3.4	1.2	0.5	3.1	0.8	0.0	0.1	11.7
24	0.0	0.2	2.0	1.5	0.7	4.0	3.0	0.3	1.8	3.6	0.0	0.1	17.2
26	0.0	0.6	0.8	0.0	0.4	2.9	1.0	0.2	2.8	1.5	0.0	0.0	10.2
27	0.0	0.5	1.0	0.0	0.5	2.7	1.4	0.9	2.2	1.8	0.0	0.1	11.1
28	0.0	0.6	1.4	0.2	0.6	3.4	0.4	0.2	2.2	0.2	0.0	0.3	9.5
29	0.0	0.4	1.3	0.2	1.4	2.8	0.4	1.2	2.0	0.4	0.0	0.3	10.4
30	0.0	0.6	0.8	0.0	0.4	2.9	1.0	0.2	2.8	1.5	0.0	0.0	10.2
31	0.0	0.5	1.2	0.0	1.6	2.9	0.5	0.4	3.3	0.8	0.0	0.2	11.3
32	0.0	0.4	0.0	0.0	0.7	2.9	0.0	0.0	0.0	0.2	0.0	0.4	4.6
33	0.0	0.4	0.0	0.0	0.7	2.9	0.0	0.0	0.0	0.2	0.0	0.4	4.6
34	0.0	0.3	0.0	0.0	0.0	3.2	0.7	0.6	2.4	0.1	0.0	0.2	7.5
Average	0.0	0.4	1.1	0.3	0.7	3.2	0.6	0.4	2.3	0.7	0.0	0.2	10.0

SUPPLEMENTARY GRANTS TO PROJECT

Grants directly used and/or their percentage used within the TAWC project sites are noted with an "*". Other grants and grant requests are considered complementary and outside of the TAWC project, but were obtained or attempted through leveraging of the base platform the TeCSIS-TAWC (Texas Coalition for Sustainable Integrated Systems and Texas Alliance for Water Conservation) programs represents and adds valuable information to this overall effort.

2006

Allen, V. G., Song Cui, and P. Brown. 2006. Finding a Forage Legume that can Save Water and Energy and Provide Better Nutrition for Livestock in West Texas. High Plains Underground Water Conservation District No. 1. $10,000 (funded).

2007

*Trostle, C.L., R. Kellison, L. Redmon, S. Bradbury. 2007. Adaptation, Productivity, & Water Use Efficiency of Warm-Season Perennial Grasses in the Texas High Plains. Texas Coalition, Grazing Lands Conservation Initiative, a program in which Texas State Natural Resource Conservation Service is a member. $3,500 (funded).

Li, Yue and V.G. Allen. 2007. Allelopathic effects of small grain cover crops on cotton plant growth and yields. USDA-SARE. Amount requested, $10,000 (funded).

Allen, V.G. and multiple co-authors. Crop-livestock systems for sustainable High Plains Agriculture. 2007. Submitted to the USDA-SARE program, Southeast Region, $200,000 (funded).

2008

Doerfert, D. L., Baker, M., & Akers, C. 2008. Developing Tomorrow's Water Conservation Researchers Today. Ogallala Aquifer Program Project. $28,000 (funded).

Doerfert, D.L., Meyers, Courtney. 2008. Encouraging Texas agriscience teachers to infuse water management and conservation-related topics into their local curriculum. Ogallala Aquifer Initiative. $61,720 (funded).

Request for Federal Funding through the Red Book initiatives of CASNR - $3.5 million. Received letters of support from Senator Robert Duncan, mayors of 3 cities in Hale and Floyd Counties, Glenn Schur, Curtis Griffith, Harry Hamilton, Mickey Black, and the Texas Department of Agriculture.

Prepared request for $10 million through the stimulus monies at the request of the CASNR Dean's office.

2009

Texas High Plains: A Candidate Site for Long-Term Agroecosystems Research. USDA-CSREES 'proof of concept' grant. $199,937 (funded).

Building a Sustainable Future for Agriculture. USDA-SARE planning grant, $15,000 (funded).

Maas, S., A. Kemanian, & J. Angerer. 2009. Pre-proposal was submitted to Texas AgriLife Research for funding research on irrigation scheduling to be conducted at the TAWC project site.

Maas, S., N. Rajan, A.C. Correa, & K. Rainwater. 2009. Proposal was submitted to USGS through TWRI to investigate possible water conservation through satellite-based irrigation scheduling.

Doerfert, D. 2009. Proposal was submitted to USDA ARS Ogallala Aquifer Initiative.

2010

*Kucera, J.M., V. Acosta-Martinez, V. Allen. 2010. Integrated Crop and Livestock Systems for Enhanced Soil C Sequestration and Biodiversity in Texas High Plains. Southern SARE grant. $159,999 (funded with ~15% applied directly to TAWC project sites).

*Calvin Trostle, Rick Kellison, Jackie Smith. 2010. Perennial Grasses for the Texas South Plains: Species Productivity and Irrigation Response, $10,664 (2 years).

2011

Johnson, P., D. Doerfert, S. Maas, R. Kellison & J. Weinheimer. 2011. The Texas High Plains Initiative for Strategic and Innovative Irrigation Management and Conservation. USDA-NRCS Conservation Innovation Grant. Joint proposal with North Plains Groundwater Conservation District. $499,848 (funded).

Allen, V. 2011. Long-Term Agroecosystems Research and Adoption in the Texas Southern High Plains. Southern SARE grant. $110,000 (funded).

*Maas, S. 2011. Auditing Irrigation Systems in the Texas High Plains. Texas Water Development Board. $101,049 (funded).

Maas, S. & co-authors. 2011. Development of a Farm-Scale Irrigation Management Decision-Support Tool to Facilitate Water Conservation in the Southern High Plains. USDA-NIFA. $500,000 requested.

Trostle, C. 2011. Dryland reduced Tillage/No Tillage Cropping Sequences for the Texas South Plains. $4,133 (funded from Texas State Support Committee, Cotton, Inc.,).

2012

Allen, V. 2012. Long-Term Agroecosystems Research and Adoption in the Texas Southern High Plains. Southern SARE grant. $110,000 (continued funding).

Trojan, S. & co-authors. 2012. Adapting to drought and dwindling groundwater supply by integrating cattle grazing into High Plains row-cropping systems. USDA-NRCS Conservation Innovation Grant. $348,847 requested.

Trostle, C. 2012. Dryland reduced Tillage/No Tillage Cropping Sequences for the Texas South Plains. $8,500 (funded from Texas Grain Sorghum Association).

Trostle, C. 2012. Dryland reduced Tillage/No Tillage Cropping Sequences for the Texas South Plains. $35,500 (funded from USDA Ogallala Aquifer Project).

West, C. 2012. Calibration and validation of ALMANAC model for growth curves of warm-season grasses under limited water supply. USDA-ARS USDA Ogallala Aquifer Project. $76,395 (funded).

DONATIONS TO PROJECT

2005

City Bank, Lubbock, TX. 2003 GMC Yukon XL. Appraised value $16,500.

2008

July 31, 2008 Field Day sponsors:

Coffey Forage Seeds, Inc.	$500.00
Agricultural Workers Mutual Auto Insurance Co.	$250.00
City Bank	$250.00
Accent Engineering & Logistics, Inc.	$100.00
Bamert Seed Co.	$100.00
Floyd County Supply	$100.00
Plainview Ag Distributors, Inc.	$100.00
Production-Plus+	$100.00

2010

February 3, 2010 Field Day sponsors:

Grain Sorghum Producers	$250.00
D&J Gin, Inc.	$250.00
Ronnie Aston/Pioneer	$500.00
Floyd County Supply	$200.00
Lubbock County	$250.00
City Bank	$250.00
High Plains Underground Water Conservation District	$250.00

August 10, 2010 Field Day sponsors:

Ted Young/Ronnie Aston	$250.00
Netafim USA	$200.00
Smartfield Inc.	$500.00
Floyd County Soil & Water Conservation District #104	$150.00
Grain Sorghum Producers	$500.00

Lucia Barbato, TTU Center for Geospatial Technology. Donation for server support software for TAWC database. $10,000.00

2011

February 24, 2011 Field Day sponsors:

Texas Corn Producers Board	$500.00
West Texas Guar, Inc.	$500.00
Texas Grain Sorghum Producers	$500.00
Happy State Bank	$500.00

August 4, 2011 Field Day sponsors:

Texas Corn Producers Board	$500.00
City Bank	$500.00
Texas Grain Sorghum Producers	$500.00
AquaSpy, Inc.	$250.00
NetaFim USA	$200.00
Panhandle-Plains Land Bank Association, FLCA	$ 50.00

2012

August 4, 2012 Field Day sponsors:

Texas Corn Producers Board	$500.00
City Bank	$500.00
Texas Grain Sorghum Producers	$500.00
AquaSpy, Inc.	$250.00
NetaFim USA	$200.00
Panhandle-Plains Land Bank Association, FLCA	$ 50.00

January 17, 2013 Field Day sponsors:

Texas Corn Producers Board	$500.00
Plains Cotton Growers	$250.00
Grain Sorghum Producers	$250.00
Ronnie Aston	$500.00
Ag Tech	$250.00
Diversified Sub-Surface Irrigation	$500.00

Visitors to the Demonstration Project sites

2005

Total Number of Visitors	190

2006

Total Number of Visitors	282

2007

Total Number of Visitors	36

2008

Total Number of Visitors	53

2009

Total Number of Visitors	33

2010

Total Number of Visitors	14 +

2011

Total Number of Visitors	11 +

2012

Total Number of Visitors	15 +

PRESENTATIONS

2005

1-Mar	Radio interview (KRFE)	Allen
17-Mar	Radio interview	Kellison
17-May	Radio interview (KFLP)	Kellison
21-Jul	Presentation to Floyd County Ag Comm.	Kellison
17-Aug	Presentation to South Plains Association of Soil & Water Conservation Districts	Kellison
13-Sep	Presentation at Floyd County NRCS FY2006 EQIP meeting	Kellison
28-Sep	Presentation at Floyd County Ag Tour	Kellison/Trostle/Allen
20-Oct	Presentation to Houston Livestock and Rodeo group	Allen/Baker
3-Nov	Cotton Profitability Workshop	Pate/Yates
10-Nov	Presentation to Regional Water Planning Committee	Kellison
16-Nov	Television interview (KCBD)	Kellison
18-Nov	Presentation to CASNR Water Group	Kellison/Doerfert
1-Dec	Radio interview (KRFE)	Kellison
9-Dec	Radio interview (AgriTALK – nationally syndicated)	Kellison
15-Dec	Presentation at Olton Grain Coop Winter Agronomy meeting	Kellison

2006

Date	Presentation	Spokesperson(s)
24-26 Jan	Lubbock Southwest Farm & Ranch Classic	Kellison
6-Feb	Southern Region AAAE Conference: The *value of water: Educational programming to maximize profitability and decrease water consumption* (poster presentation), Charlotte, NC	M. Norton/Doerfert
7-Feb	Radio Interview	Kellison/Baker
2-Mar	South Plains Irrigation Management Workshop	Trostle/Kellison/Orr
30-Mar	Forage Conference	Kellison/Allen/Trostle
19-Apr	Floydada Rotary Club	Kellison
20-Apr	Western Region AAAE Conference: *Conservation outreach communications: A framework for structuring conservation outreach campaigns* (poster presentation), Boise, ID	M. Couts/Doerfert
27-Apr	ICASALS Holden Lecture: *New Directions in Groundwater Management for the Texas High Plains*	Conkwright
18-May	Annual National AAAE Conference: *The value of water: Educational programming to maximize profitability and decrease water consumption* (poster presentation), Charlotte, NC	M. Norton/Doerfert
18-May	Annual National AAAE Conference: *Conservation outreach communications: A framework for structuring conservation outreach campaigns* (poster presentation), Charlotte, NC	M. Couts/Doerfert
15-Jun	Field Day @ New Deal Research Farm	Kellison/Allen/Cradduck/Doerfert
21-Jul	Summer Annual Forage Workshop	Trostle
27-Jul	National Organization of Professional Hispanic NRCS Employees annual training meeting, Orlando, FL	Cradduck (on behalf of Kellison)
11-Aug	2006 Hale County Field Day	Kellison
12-Sep	Texas Ag Industries Association Lubbock Regional Meeting	Doerfert (on behalf of Kellison)
11-Oct	TAWC Producer meeting	Kellison/Pate/Klose/Johnson
2-Nov	Texas Ag Industries Association Dumas Regional Meeting	Kellison
10-Nov	34th Annual Banker's Ag Credit Conference	Kellison
14-Nov	Interview w/Alphaeus Media	Kellison
28-Nov	Amarillo Farm & Ranch Show	Doerfert
8-Dec	2006 Olton Grain COOP Annual Agronomy Meeting	Kellison/Trostle
12-Dec	Swisher County Ag Day	Kellison/Yates
12-Dec	2006 Alfalfa and Forages Clinic, Colorado State University	Allen

2007

Date	Presentation	Spokesperson(s)
11-Jan	Management Team meeting (Dr. Jeff Jordan, Advisory Council in attendance)	
23—25 Jan	2007 Southwest Farm & Ranch Classic, Lubbock, TX	Kellison/Doerfert
6-Feb	Cow/Calf Beef Producer Meeting at Floyd County Unity Center	Allen
8-Feb	Management Team meeting	
13-Feb	Grower meeting, Clarendon, TX	Kellison
26-Feb	Silage workshop, Dimmitt, TX	
8-Mar	Management Team meeting	
21-Mar	Silage Workshop, Plainview, TX	Kellison/Trostle
22-Mar	Silage Workshop, Clovis, NM	Kellison/Trostle
30-Mar	Annual Report review meeting w/Comer Tuck, Lubbock, TX	
2-Apr	TAWC Producer meeting, Lockney, TX	
11-Apr	Texas Tech Cotton Economics Institute Research/Extension Symposium	Johnson
12-Apr	Management Team meeting	
21-Apr	State FFA Agricultural Communications Contest, Lubbock, TX (100 high school students)(mock press conf. based on TAWC info)	Johnson
7-May	The Lubbock Round Table meeting	Kellison
9-May	Area 7 FFA Convention, Texas State University, San Marcos, TX (distributed 200 DVD and info sheets)	Baker
10-May	Management Team meeting	
12-May	RoundTable meeting, Lubbock Club	Allen
15—17-May	21st Biennial Workshop on Aerial Photog., Videography, and High Resolution Digital Imagery for Resource Assessment: *Calibrating aerial imagery for estimating crop ground cover,* Terre Haute, IN	Rajan
30-May	Rotary Club (about 100 present)	Allen
7-Jun	Lubbock Economic Development Association	Baker
14-Jun	Management Team meeting	
18-Jun	Meeting with Senator Robert Duncan	Kellison
10-Jul	Management Team meeting	
24—26-Jul	Universities Council on Water Resources (UCOWR)/National Institutes for Water Resources (NIWR) Annual Conference: *Political and civic engagement of agriculture producers who operate in selected Idaho and Texas counties dependent on irrigation*, Boise, ID	Doerfert
30-Jul—3-Aug	Texas Vocational Agriculture Teachers' Association Annual Conference, Arlington, TX (distributed 100 DVDs)	Doerfert
9-Aug	Management Team meeting	

10-Aug	Texas South Plains Perennial Grass Workshop, Teeter Farm & Muncy Unity Center	Kellison/Trostle
13—15-Aug	International Symposium on Integrated Crop-Livestock Systems conference, Universidade Federal do Parana in Curitiba, Brazil	(Presentation made on behalf of Allen)
13—14-Aug	2007 Water Research Symposium: *Comparison of water use among crops in the Texas High Plains estimated using remote sensing,* Socorro, NM	Rajan
14—17-Aug	Educational training of new doctoral students, Texas Tech campus, Lubbock, TX (distributed 17 DVDs)	Doerfert
23-Aug	Cattle Feeds and Mixing Program	
12-Sep	West Texas Ag Chem Conference	Kellison
18-Sep	Floyd County Farm Tour	Trostle
20-Sep	Management Team meeting	
1-Oct	Plant & Soil Science Departmental Seminar: *Overview and Initial Progress of the Texas Alliance for Water Conservation Project*	Kellison
8-Oct	Plant & Soil Science Departmental Seminar: *Estimating ground cover of field crops using multispectral medium, resolution satellite, and high resolution aerial imagery*	Rajan
11-Oct	Management Team meeting	
4—8-Nov	American Society of Agronomy Annual meetings: *Using remote sensing and crop models to compare water use of cotton under different irrigation systems* (poster presentation), New Orleans, LA	Rajan
4—8-Nov	American Society of Agronomy Annual meetings: *Assessing the crop water use of silage corn and forage sorghum using remote sensing and crop modeling*, New Orleans, LA	Rajan
7—9-Nov	National Water Resources Association Annual Conference, Albuquerque, NM	Bruce Rigler (HPUWCD #1)
8-Nov	Management Team meeting (Comer Tuck in attendance)	
12—15-Nov	American Water Resources Association annual meeting: *Considering conservation outreach through the framework of behavioral economics: a review of literature* (poster presentations), Albuquerque, NM	M. Findley/Doerfert
12—15-Nov	American Water Resources Association annual meeting: Ho*w do we value water? A multi-state perspective* (poster presentation), Albuquerque, NM	L. Edgar/Doerfert
16-Nov	Water Conservation Advisory Council meeting, Austin, TX	Allen
19-Nov	Plant & Soil Science Departmental Seminar: *Finding the legume species for West Texas which can improve forage quality and reduce water consumption*	Cui
27—29-Nov	Amarillo Farm Show, Amarillo, TX	Doerfert/Leigh/Kellison
2—4-Dec	Texas Water Summit, San Antonio, TX	Allen
13-Dec	Management Team meeting	

2008

Date	**Presentation**	**Spokesperson(s)**
8-11-Jan	Beltwide Cotton Conference Proceedings: *Energy Analysis of Cotton Production in the Southern High Plains of Texas,* Nashville, TN	Johnson/Weinheimer
10-Jan	Management Team meeting	
1-Feb	Southwest Farm and Ranch Classic, Lubbock	Kellison
14-Feb	Management Team meeting (Weinheimer presentation)	
14-Feb	TAWC Producer Board meeting	Kellison
5-Mar	Floydada Rotary Club	Kellison
13-Mar	Management Team meeting	
25-Mar	National SARE Conference: New American Farm Conference: *Systems Research in Action,* Kansas City, MO	Allen
27-Mar	Media training for TAWC Producer Board	Doerfert/Kellison
Apr	Agricultural Economics Seminar: *Transitions in Agriculture,* Texas Tech University	Weinheimer
10-Apr	Management Team meeting	
5-May	Pasture and Forage Land Synthesis Workshop: *Integrated forage-livestock systems research*, Beltsville, MD	Allen
8-May	Management Team meeting	
9-Jun	Walking tour of New Deal Research farm	Allen/Kellison/Li/Cui/Cradduck
10-12-Jun	Forage Training Seminar: *Agriculture and land use changes in the Texas High Plains*, Cropland Genetics, Amarillo	Allen
12-Jun	Management Team meeting	
14-Jul	Ralls producers	Kellison
14-Jul	Water and the AgriScience Fair Teacher and Student Workshops	Kellison/Brown/Cradduck
15-Jul	Pioneer Hybrids Research Directors	Kellison
20-23-July	9th International Conference on Precision Agriculture, Denver, CO	Rajan
31-Jul	TAWC Field Day	all
8-Aug	TAWC Producer Board meeting	
12-Aug	Pioneer Hybrids Field Day	Kellison
9-Sep	Texas Ag Industries Association, Lubbock regional meeting	Allen
11-Sep	Management Team meeting	
16-Sep	Mark Long, TDA President, Ben Dora Dairies, Amherst, TX	Kellison/Trostle/ Cradduck
5-9-Oct	American Society of Agronomy Annual meeting, Houston	Rajan
8-Oct	American Society of Agronomy Annual meeting, Houston	Maas
15-Oct	State Energy Conservation Office (SECO) meeting	

16-Oct	Management Team meeting	
17-Oct	Thesis defense: *A Qualitative Investigation of the Factors that Influence Crop Planting and Water Management in West Texas*.	Leigh
20-Oct	Farming with Grass conference, Soil and Water Conservation Society, Oklahoma City, OK	Allen
23-Oct	Thesis defense: *Farm Level Financial Impacts of Water Policy on the Southern Ogallala Aquifer*	Weinheimer
13-Nov	Management Team meeting (Weinheimer presentation)	
17-20-Nov	American Water Resources Association Conference: *Farm-based water management research shared through a community of practice model*, New Orleans, LA	Leigh
17-20-Nov	American Water Resources Association Conference: *The critical role of the community coordinator in facilitating an agriculture water management and conservation community of practice*, New Orleans, LA	Wilkinson
17-20-Nov	American Water Resources Association Conference: *An exploratory analysis of the ruralpolitan population and their attitudes toward water management and conservation* (poster presentation), New Orleans, LA	Newsom
17-20-Nov	American Water Resources Association Conference: *Developing tomorrow's water researchers today* (poster presentation), New Orleans, LA	C. Williams
19-Nov	TTU GIS Open House	Barbato
Dec	Panhandle Groundwater District: *Farm Level Financial Impacts of Water Policy on the Southern Ogallala Aquifer,* White Deer, TX	Johnson/Weinheimer
2-4-Dec	Amarillo Farm Show	Doerfert
3-Dec	Dr. Todd Bilby, Ellen Jordan, Nicholas Kenny, Dr. Amosson (discussion of water/crops/cattle), Amarillo	Kellison
6-Dec	Lubbock RoundTable	Kellison
6-7-Dec	Meeting regarding multi-institutional proposal to target a future USDA RFP on water management, Dallas	Doerfert
11-Dec	Management Team meeting	
12-Dec	Olton CO-OP Producer meeting	Kellison
19-Dec	TAWC Producer meeting	Kellison/Schur/ Cradduck/Weinheimer

2009

Date	**Presentation**	**Spokesperson**
15-Jan	Management Team meeting	
21-Jan	Caprock Crop Conference	Kellison
27-29 -Jan	Southwest Farm & Ranch Classic (TAWC booth), Lubbock	Doerfert/Jones/Wilkinson/ Williams
27-Jan	Southwest Farm & Ranch Classic: *Managing Wheat for Grain*, Lubbock	Trostle
27-Jan	Southwest Farm & Ranch Classic: *2009 Planting Decisions – Grain Sorghum and Other Alternatives*, Lubbock	Trostle
28-Jan	Southwest Farm & Ranch Classic: *Profitability Workshop*, Lubbock	Yates/Pate
Feb	Floyd County crop meetings, Muncy	Trostle
Feb	Hale County crop meetings, Plainview	Trostle
12-Feb	Management Team meeting	
17-Feb	Crops Profitability workshops, AgriLife Extension and Research Center, Lubbock	Yates/Trostle
5-Mar	Crops Profitability workshops, AgriLife Extension and Research Center, Lubbock	Yates/Trostle
12-Mar	Management Team meeting	
1-Apr	Texas Tech Cotton Economics Institute Research Institutes 9th Annual Symposium (CERI): *Water Policy Impacts on High Plains Cropping Patterns and Representative Farm Performance*, Lubbock	Johnson/Weinheimer
9-Apr	Management Team meeting	
15-Apr	Texas Tech Forage Class	Kellison
21-Apr	Presentation to High Plains Underground Water District Board of Directors	Kellison
14-May	Management Team meeting	
27-May	Consortium for Irrigation Research and Education conference, Amarillo	Kellison
11-Jun	Management Team meeting	
22-24-Jun	Joint Meeting of the Western Society of Crop Science and Western Society of Soil Science: *Evaluation of the bare soil line from reflectance measurements on seven dissimilar soils* (poster presentation), Ft. Collins, CO	Rajan
26-Jun	Western Agricultural Economics Association: *Economics of State Level Water Conservation Goals*, Kauai, HI	Weinheimer/Johnson
7-Jul	Universities Council of Water Resources: *Water Policy in the Southern High Plains: A Farm Level Analysis*, Chicago, IL	Weinheimer/Johnson
9-Jul	Management Team meeting	
27-31 –Jul	Texas Agriscience Educator Summer Conference, Lubbock	Doerfert/Jones
6-Aug	Management Team meeting	
17-19–Aug	TAWC NRCS/Congressional tour and presentations, Lubbock, New Deal & Muncy	TAWC participants
27-Aug	Panhandle Association of Soil and Water Conservation Districts	Kellison
10-Sep	Management Team meeting	
8-Oct	Management Team meeting	
9-Oct	Presentation to visiting group from Colombia, TTU campus, Lubbock	Kellison
13-Oct	Briscoe County Field day, Silverton, TX	Kellison

1-5-Nov	Annual Meetings of the American Society of Agronomy, oral presentations: *Evapotranspiration of Irrigated and Dryland Cotton Fields Determined Using Eddy Covariance and Penman-Monteith Methods,* and *Relation Between Soil Surface Resistance and Soil Surface Reflectance,* poster presentation: *Variable Rate Nitrogen Application in Cotton Using Commercially Available Satellite and Aircraft Imagery,"* Pittsburgh, PA	Maas/Rajan
10-12-Nov	Cotton Incorporated Precision Agriculture Workshop: *Biomass Indices*, Austin, TX	Rajan/Maas
12-Nov	Management Team meeting	
Dec	United Farm Industries Board of Directors: *Irrigated Agriculture,* Lubbock	Johnson/Weinheimer
Dec	Fox 34 TV interview, Ramar Communications, Lubbock	Allen
1-3-Dec	Amarillo Farm Show, Amarillo	Doerfert/Jones/Oates/ Kellison
3-Dec	Management Team meeting	
10-Dec	TAWC Producer Board meeting, Lockney	Kellison/Weinheimer/Maas
14-Dec	Round Table meeting with Todd Staples, Lubbock, TX	Kellison
12-18 –Dec	Fall meeting, American Geophysical Union: *Vegetation cover mapping at multiple scales using MODIS, Landsat, RapidEye, and Aircraft imageries in the Texas High Plains,* San Francisco, CA	Rajan/Maas

2010

Date	Presentation	Spokesperson(s)
4-7-Jan	Beltwide Cotton Conference: *Energy and Carbon: Considerations for High Plains Cotton*, New Orleans, LA	Yates/Weinheimer
14-Jan	TAWC Management Team meeting	
3-Feb	TAWC Farmer Field Day, Muncy, TX	TAWC participants
6-9-Feb	Southern Agricultural and Applied Economics Association annual meeting: *Macroeconomic Impacts on Water Use in Agriculture*, Orlando, FL	Weinheimer
9-11-Feb	Southwest Farm & Ranch Classic (TAWC booth), Lubbock	Doerfert/Jones/Frederick
10-Feb	Southwest Farm & Ranch Classic, Lubbock	Kellison/Yates/Trostle/Maas
11-Feb	TAWC Management Team meeting	
9-March	TAWC Producer Board Meeting, Lockney	TAWC participants
11-March	TAWC Management Team meeting	
31-March	Texas Tech Forage Class	Kellison
8-April	TAWC Management Team meeting	
13-April	Matador Land & Cattle Co., Matador, TX	Kellison
13-May	TAWC Management Team meeting	
10-June	TAWC Management Team meeting	
30-June	TAWC Grower Technical Working Group meeting, Lockney	Glodt/Kellison
8-July	TAWC Management Team meeting	
9-July	Southwest Council on Agriculture annual meeting, Lubbock	Doerfert/Sell/Kellison
15-July	Universities Council on Water Resources (UCOWR): *Texas Alliance for Water Conservation: An Integrated Approach to Water Conservation*, Seattle, WA	Weinheimer
25-27-July	American Agricultural Economics Association annual meeting: *Carbon Footprint: A New Farm Management Consideration on the Southern High Plains,* Denver, CO	Weinheimer
27-July	Tour for Cotton Incorporated group, TAWC Sites	Kellison/Maas
August	Ag Talk on FOX950 am radio show	Weinheimer
10-Aug	TAWC Field day, Muncy, TX	TAWC participants
12-Aug	TAWC Management Team meeting	
30-Aug	Tour/interviews for SARE film crew, TTU campus, New Deal and TAWC Sites	TAWC participants
9-Sept	TAWC Management Team meeting	
14-Sept	Floyd County Farm Tour, Floydada, TX	Kellison
14-Oct	TAWC Management Team meeting	
27-Oct	Texas Agricultural Lifetime Leadership Class XII	Kellison

31-Oct—3-Nov	Annual Meetings of the American Society of Agronomy: *Carbon fluxes from continuous cotton and pasture for grazing in the Texas High Plains,* Long Beach, CA	Rajan/Maas
31-Oct—3-Nov	Annual Meetings of the American Society of Agronomy: *Closure of surface energy balance for agricultural fields determined from eddy covariance measurements,* Long Beach, CA	Maas/Rajan
8-Nov	Fox News interview	Kellison
8-Nov	Fox 950 am radio interview	Doerfert
9-Nov	Texas Ag Industries Association Regional Meeting, Dumas, TX	Kellison
18-Nov	TAWC Management Team meeting	
19-Nov	North Plains Water District meeting, Amarillo, TX	Kellison/Schur
1-3-Dec	Amarillo Farm & Ranch Show (TAWC booth), Amarillo	Doerfert/Zavaleta/Graber
9-Dec	TAWC Management Team meeting	
12-18-Dec	American Geophysical Union fall meeting: *Vegetation cover mapping at multiple scales using MODIS, Landsat, RapidEye, and Aircraft imageries in the Texas High Plains*, San Francisco, CA	Rajan/Maas

2011

Date	**Presentation**	**Spokesperson(s)**
13-Jan	High Plains Irrigation Conference	Kellison
13-Jan	TAWC Management Team meeting	
18-Jan	Fox Talk 950 AM radio interview	Doerfert/Graber/Sullivan
24-Jan	Wilbur-Ellis Company	Kellison
25-Jan	Caprock Crop Conference	Kellison
4-Feb	KJTV-Fox 34 Ag Day news program: *TAWC rep discusses optimal irrigation, Field Day preview*, Lubbock, TX	Glodt
6-8-Feb	American Society of Agronomy Southern Regional Meeting: *Seasonal Ground Cover for Crops in The Texas High Plains*, Corpus Christi, TX	Maas/Rajan
7-Feb	KJTV-Fox 34 Ag Day news program: *Risk management specialist gives best marketing options for your crop*, Lubbock, TX	Yates
8-Feb	KJTV-Fox 34 Ag Day news program: *Producer Glenn Schur shares his water conservation tips*, Lubbock, TX	Schur
8-10-Feb	Southwest Farm & Ranch Classic (TAWC booth), Lubbock, TX	Doerfert/Graber/Sullivan
9-Feb	Southwest Farm & Ranch Classic: *Managing Warm Season Annual Forages on the South Plains*, Lubbock, TX	Trostle
9-Feb	KJTV-Fox 34 Ag Day news program: *Rep of the HPWD discusses possible water restrictions*, Lubbock, TX	Carmon McCain
10-Feb	Hale County Crops meeting, Plainview, TX	Trostle
17-Feb	TAWC Management Team meeting	
23-Feb	Pioneer Hybrids	Kellison
24-Feb	2011 Production Agriculture Planning Workshop, Muncy, TX	TAWC participants
25-Feb	KJTV-Fox 34 Ag Day news program: *Producers gain knowledge about water conservation at TAWC Field Day*, Lubbock, TX	Doerfert
4-Mar	Texas Tech Forage class	Kellison
10-Mar	TAWC Management Team meeting (Maas presentation)	
30-Mar	West Texas Mesonet (Wes Burgett), TTU Reese Center, Lubbock, TX	Kellison/Brown/Maas/Rajan /Weinheimer
31-Mar—1-Apr	Texas Cotton Ginners Show (TAWC booth), Lubbock, TX	Doerfert/Graber/Sullivan
13-Apr	USDA-ARS/Ogallala Aquifer project (David Brauer), Lubbock, TX	Kellison/TAWC participants
13-Apr	KJTV-Fox 34 Ag Day news program: *TAWC introduces solution tools for producers*, Lubbock, TX	Weinheimer
14-Apr	TAWC Management Team meeting	

18-Apr	KJTV-Fox 34 Ag Day news program: *Cotton overwhelmingly king this year on South Plains*, Lubbock, TX	Boyd Jackson
18-Apr	KJTV-Fox 34 Ag Day news program: *Specialty, rotation crops not popular this growing season*, Lubbock, TX	Trostle
12-May	TAWC Management Team meeting	
17-May	KJTV-Fox 34 Ag Day news program: *Tools available to maximize irrigation efficiency*, Lubbock, TX	Kellison
18-May	Floydada Rotary Club, Floydada, TX	Kellison
9-Jun	TAWC Management Team meeting	
29-Jun—2-Jul	Joint meetings of the Western Agricultural Economics Association/Canadian Agricultural Economics Society: *Evaluating the Implications of Regional Water Management Strategies: A Comparison of County and Farm Level Analysis,* Banff, Alberta, Canada	Weinheimer
12-14-Jul	UCOWR/NIWR Conference: *Texas Alliance for Water Conservation: An Innovative Approach to Water Conservation: An Overview,* Boulder, CO	Kellison
12-14-Jul	UCOWR/NIWR Conference: *Sunflowers as an Alternative Irrigated Crop on the Southern High Plains*, Boulder, CO	Pate
12-14-Jul	UCOWR/NIWR Conference: *Economic Considerations for Water Conservation: The Texas Alliance for Water Conservation,* Boulder, CO	Weinheimer
12-14-Jul	UCOWR/NIWR Conference: *Determining Crop Water Use in the Texas Alliance for Water Conservation Project*, Boulder, CO	Maas
12-14-Jul	UCOWR/NIWR Conference: *What We Know About Disseminating Water Management Information to Various Stakeholders*, Boulder, CO	Doerfert
12-14-Jul	UCOWR/NIWR Conference: *Assessment of Improved Pasture Alternatives on Texas Alliance for Water Conservation,* Boulder, CO	Kellison
12-14-Jul	UCOWR/NIWR Conference: *Integrating forages and grazing animals to reduce agricultural water use*, Boulder, CO	Brown
21-Jul	TAWC Management Team meeting	
4-Aug	KXDJ-FM news radio interview	Weinheimer
4-Aug	TAWC Field Day, Muncy, TX	TAWC participants
11-Aug	TAWC Management Team meeting	
1-Sep	KJTV-Fox 34 Ag Day news program: *High Plains producers struggling to conserve water in drought*, Lubbock, TX	Boyd Jackson
5-Sep	KJTV-Fox 34 Ag Day news program: *New ideas, concepts emerging from surviving historic drought,* Lubbock, TX	Kellison
8-Sep	TAWC Management Team meeting (Brown presentation)	
29-Sep	Texas & Southwestern Cattle Raiser Association Fall meeting, Lubbock, TX	Kellison
13-Oct	TAWC Management Team meeting (Maas presentation)	

16-19-Oct	Annual Meetings of the American Society of Agronomy: *Satellite-based irrigation scheduling*, San Antonio, TX	Maas/Rajan
16-19-Oct	Annual Meetings of the American Society of Agronomy: *Comparison of carbon, water and energy fluxes between grassland and agricultural ecosystems*, San Antonio, TX	Maas/Rajan
16-19-Oct	Annual Meetings of the Soil Science Society of America: *CO2 and N2O Fluxes in Integrated Crop Livestock Systems* (poster presentation), San Antonio, TX	Lisa Fultz/Marko Davinic/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: *Dynamics of Soil Aggregation and Carbon in Long-Term Integrated Crop-Livestock Agroeceosystems in the Southern High Plains* (poster presentation), San Antonio, TX	Lisa Fultz/Marko Davinic/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: *Long-Term Integrated Crop-Livestock Agroecosystems and the Effect on Soil Carbon* (poster presentation), San Antonio, TX.	Lisa Fultz/Marko Davinic/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: *Soil Microbial Dynamics in Alternative Cropping Systems to Monoculture Cotton in the Southern High Plains*, San Antonio, TX.	Marko Davinic/Lisa Fultz/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: *Soil Fungal Community and Functional Diversity Assessments of Agroecosystems in the Southern High Plains*, San Antonio, TX.	Marko Davinic/Lisa Fultz/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: *Aggregate Stratification Assessment of Soil Bacterial Communities and Organic Matter Composition: Coupling Pyrosequencing and Mid-Infrared Spectroscopy Techniques*, San Antonio, TX.	Marko Davinic/Lisa Fultz/Jennifer Moore-Kucera
6-10-Nov	47th Annual American Water Resources Association: *The Use of Communication Channels Including Social Media Technology by Agricultural Producers and Stakeholders in the State of Texas*, Albuquerque, NM	Doerfert/Graber
6-10-Nov	47th Annual American Water Resources Association: *What We Know About Disseminating Water Management Information to Various Stakeholders*, Albuquerque, NM	Doerfert, et al.
6-10-Nov	47th Annual American Water Resources Association: *The Water Management and Conservation Instructional Needs of Texas Agriculture Science Teachers*, Albuquerque, NM	Doerfert/Sullivan
6-10-Nov	47th Annual American Water Resources Association: *The Attitudes and Opinions of Agricultural Producers Toward Sustainable Agriculture on the High Plains of Texas*, Albuquerque, NM	Doerfert, et al.
6-10-Nov	47th Annual American Water Resources Association: *The Issues That Matter Most to Agricultural Stakeholders: A Framework for Future Research* (poster presentation), Albuquerque, NM	Sullivan/Doerfert, et al.
10-Nov	TAWC Management Team meeting	
18-Nov	39th Annual Bankers Agricultural Credit Conference, Lubbock, TX	Kellison
22-Nov	KJTV 950 AM AgTalk radio interview	Trostle
29-Nov—1-Dec	Amarillo Farm Show (TAWC booth), Amarillo, TX	Doerfert/Graber/Sullivan/Kellison /Borgstedt
7-Dec	Plainview Lions Club, Plainview, TX	Kellison
8-Dec	TAWC Management Team meeting	
13-Dec	Channel Bio Water Summit (TAWC booth), Amarillo, TX	Borgstedt/Sullivan/Graber

2012

6-Mar	Lubbock Kiwanis Club	Kellison
7-Mar	Monthly Management Team Meeting	Kellison
23-Mar	New Mexico Ag Bankers Conference	Kellison, Klose
3-Apr	AgriLife Extension Meeting	Kellison
12-Apr	Monthly Management Team Meeting	Kellison
10-May	Monthly Management Team Meeting	Kellison
10-May	Carilllon Center	Kellison
11-May	Tours-Comer Tuck with the Texas Water Development Board	Kellison
14-May	Tours-Farm Journal Media	Kellison
17-May	Tours-Secretary of State Group	Kellison
14-June	Monthly Management Team Meeting	Kellison
19-June	Lloyd Author Farm	Kellison
20-June	Blake Davis Farm	Kellison
21-June	Glenn Schur Farm	Kellison
10-July	Tours-Justin Weinheimer	Kellison
12-July	Texas Agricultural Coop Council	Kellison
12-July	Texas Independent Ginners Conference	Kellison
18-July	Monthly Management Team Meeting	Kellison
16-Aug	Monthly Management Team Meeting	Kellison
5-Sep	Leadership Sorghum Class 1	Kellison
20-Sep	Monthly Management Team Meeting	Kellison
18-Oct	Monthly Management Team Meeting	Kellison
24-Oct	Texas Agriculture Lifetime Leadership	Kellison
30-Oct	Special Management Team Meeting	Kellison
8-Nov	Monthly Management Team Meeting	Kellison
27-28-Nov	Amarillo Farm & Ranch Show	Borgstedt/Doerfert/Kellison
13-Dec	Monthly Management Team Meeting	Kellison
16-18-Nov	48th Annual American Water Resources Association conference	Doerfert/Kellison/P. Johnson/Maas

20-Nov	Special Management Team Meeting	Kellison
3-Jan	KFLP Radio	Kellison
7-9-Jan	Beltwide Cotton Conference	Doerfert
15-Jan	Fox 950 AM	Doerfert
4-Feb	Texas Seed Trade Association	Kellison
14-Feb	Monthly Management Team Meeting	Kellison
21-Mar	Monthly Management Team Meeting	Kellison
29-30-Mar	Texas Gin Association Convention	Borgstedt/Doerfert
11-Apr	Monthly Management Team Meeting	Kellison

RELATED NON-REFEREED PUBLICATIONS

Rajan, N., and S. J. Maas. 2007. Comparison of water use among crops in the Texas High Plains estimated using remote sensing. Abstracts, 2007 Water Research Symposium, Socorro, NM.

Rajan, N., and S. J. Maas. 2007. Calibrating aerial imagery for estimating crop ground cover. In R. R. Jensen, P. W. Mausel, and P. J. Hardin (ed.) Proc., 21st Biennial Workshop on Aerial Photog., Videography, and High Resolution Digital Imagery for Resource Assessment, Terre Haute, IN. 15-17 May. 2007. ASPRS, Bethesda, MD.

Allen, V.G., D. Philipp, W. Cradduck, P. Brown, and R. Kellison. 2007. Water dynamics in integrated crop-livestock systems. Proc. Simpósio Internacional em Integraçâo Lavoura-Pecuâria. 13, 14, and 15 August, 2007. Curitiba, Parana, Brazil.

Acosta-Martínez, V., G. Burow, T.M. Zobeck, and V. Allen. 2007. Soil microbial diversity, structure and functioning under alternative systems compared to continuous cotton. Annual meeting of the American Society of Agronomy, New Orleans, LA. Nov. 4-8, 2007.

Deycard, Victoria N., Wayne Hudnall, Vivien G. Allen. 2007. Soil sustainability as measured by carbon sequestration using carbon isotopes from crop-livestock management systems in a semi-arid environment. Annual meeting of the American Society of Agronomy, New Orleans, LA. Nov. 4-8, 2007.

Doerfert, D., V. Allen, W. Cradduck, and R. Kellison. 2007. Forage sorghum production in the Southern Plains Region. Texas Alliance for Water Conservation, Summary of Research. Vol. 1, No. 1. Texas Tech Univ., Lubbock, TX.

Leigh, K., D. Doerfert. 2008. Farm-based water management research shared through a community of practice model. 44th Annual American Water Resources Association (AWRA) Conference, New Orleans, LA.

Maas, S. J., and N. Rajan. 2008. Estimating ground cover of field crops using medium-resolution multispectral satellite imagery. Agronomy Journal 100:320-327.

Rajan, N., and S. J. Maas. 2008. Acclimation of crops to soil water availability. Abstracts, Annual Meetings, Amer. Soc. Agronomy. 5-9 October, Houston, TX. (CD-ROM)

Maas, S. J., and N. Rajan. 2008. Estimating plant transpiration and soil evaporation using remote sensing. Abstracts, Annual Meetings, Amer. Soc. Agronomy. 5-9 October, Houston, TX. (CD-ROM)

Rajan, N., and S. J. Maas. 2008. Comparison of PVI and NDVI for estimating crop ground cover for precision agriculture applications. In Proc., 9th International Conference on Precision agriculture. 20-23 July, Denver, CO. (CD-ROM)

Robertson, G. P., V. G. Allen, G. Boody, E. R. Boose, N. G. Creamer, L. E. Drinkwater, J. R. Gosz, L. Lynch, J. L. Havlin, L. E. Jackson, S. T.A. Pickett, L. Pitelka, A. Randall, A. S. Reed, T. R. Seastedt, R. B. Waide, and D. H. Wall. 2008. Long-Term Agricultural Research: A Research, Education, and Extension Imperative. BioScience 58(7):604-645.

Johnson, J., P. Johnson, E. Segarra and D. Willis. 2009. Water conservation policy alternatives for the Ogallala Aquifer in Texas. *Water Policy*. 11: (2009) 537-552.

Weinheimer, J., and P. Johnson. 2009. Energy and Carbon. Considerations for High Plains cotton. 2010 Beltwide Cotton Conference. January 2010, New Orleans, LA.

Yates, J., J. Pate, J. Weinheimer, R. Dudensing, and J. Johnson. 2010. Regional economic impact of irrigated versus dryland agriculture in the Texas High Plains. Beltwide Cotton Conference. January, New Orleans, LA.

Weinheimer, J., N. Rajan, P. Johnson, and S.J. Maas. 2010. Carbon footprint: A new farm management consideration in the Southern High Plains. Selected paper, Agricultural & Applied Economics Association Annual Meeting. July 25-27, Denver, CO.

Weinheimer, J. 2010. Texas Alliance for Water Conservation: An integrated approach to water conservation. Universities Council on Water Resources. July, Seattle, WA.

Doerfert, D.L., L. Graber, D. Meyers, and E. Irlbeck. 2012. Traditional and social media channels used by Texas agricultural producers. Proceedings of the 2012 American Association for Agricultural Education (AAAE) Research Conference, Ashville, NC.

Doerfert, D., R. Kellison, P. Johnson, S. Maas, and J. Weinheimer. 2012. Crop production water management tools for West Texas farmers. Paper to be presented at the 2012 American Water Resources Association (AWRA) Annual Conference, November, Jacksonville, FL.

Maas, S. 2012. Combining remote sensing and crop modeling: It's like baking a cake. Abstracts, Annual Meetings of the American Society of Agronomy, October, Cincinnati, OH. (abstract)

Rajan, N., and S. J. Maas. 2012. Inter-annual variation in carbon dioxide and water fluxes from a grazed pasture in the semi-arid Texas High Plains. Abstracts, Annual Meetings, Amer. Soc. Agronomy. October, Cincinnati, OH. (abstract)

Rajan, N., M. Roy, S. J. Maas and F.M. Padilla. 2012. Soil background effects on reflectance-based estimates of leaf area index of cotton. Abstracts, Annual Meetings, Amer. Soc. Agronomy. October, Cincinnati, OH. (abstract)

Maas, S., & N. Rajan. 2012. Spectral Crop Coefficient Approach: Its Development and Validation. Proceedings, 2012 UCOWR/NIWR Annual Conference, 17-19 July 2012, Santa Fe, NM. (abstract)

Rajan, N., & S. Maas. 2012. Comparison of the Spectral Crop Coefficient and Standard Crop Coefficient Approaches. Proceedings, 2012 UCOWR/NIWR Annual Conference, 17-19 July 2012, Santa Fe, NM. (abstract)

Doerfert, D., R. Kellison, R., S. Maas, P. Johnson, & J. Weinheimer. Crop production water management tools for west texas farmers. 48th annual American Water Resources Association (AWRA) conference in Jacksonville, FL, November 2012

Doerfert, D. The Texas Alliance for Water Conservation: An integrated water resources management model for agriculture. 48th annual American Water Resources Association (AWRA) conference in Jacksonville, FL, November, 2012

Doerfert, D., Rutherford, T. Use of multi-user virtual environments (MUVEs) for training purposes. 48th annual American Water Resources Association (AWRA) conference in Jacksonville, FL, November, 2012

Graber, L., D. Doerfert, C.A. Meyers, & E.G. Irlbeck. 2012. Traditional and social media channels used by Texas agricultural producers. Proceedings of the American Association of Agricultural Education (AAAE) Western Region Conference, Bellingham, WA.

RELATED REFEREED JOURNAL ARTICLES

Acosta-Martinez, V., T.M. Zobeck, and V. Allen. 2004. Soil microbial, chemical and physical properties in continuous cotton and integrated crop-livestock systems. Soil Science Society of America Journal 68:1875-1884.

Allen, V.G., C.P. Brown, R. Kellison, E. Segarra, T. Wheeler, P.A. Dotray, J.C. Conkwright, C.J. Green, and V. Acosta-Martinez. 2005. Integrating cotton and beef production to reduce water withdrawal from the Ogallala Aquifer. Agronomy Journal 97:556-567.

Philipp, D., V.G. Allen, R.B. Mitchell, C.P. Brown, and D.B. Wester. 2005. Forage nutritive value and morphology of three old world bluestems under a range of irrigation levels. Crop Science 45:2258-2268.

Philipp, D., C.P. Brown, V.G. Allen, and D.B. Wester. 2006. Influence of irrigation on mineral concentrations in three old world bluestem species. Crop Science. 46:2033-2040.

Allen, V.G., M.T. Baker, E. Segarra and C.P. Brown. 2007. Integrated crop-livestock systems in irrigated, semiarid and arid environments. Agronomy Journal 99:346-360 (Invited paper).

Philipp, D., V.G. Allen, R.J. Lascano, C.P. Brown, and D.B. Wester. 2007. Production and water use efficiency of three old world bluestems. Crop Science. 47:787-794.

Marsalis, M.A., V.G. Allen, C.P. Brown, and C.J. Green. 2007. Yield and nutritive value of forage bermudagrasses grown using subsurface drip irrigation in the Southern High Plains. Crop Science 47:1246-1254.

Allen, V.G., C.P. Brown, E. Segarra, C.J. Green, T.A. Wheeler, V. Acosta-Martinez, and T.M. Zobeck. 2008. In search of sustainable agricultural systems for the Llano Estacado of the U.S. Southern High Plains. Agriculture Ecosystems and Environment 124:3-12. (Invited paper)

Acosta-Martinez, V., S. Dowd, Y. Sun, V. Allen. 2008. Tag-encoded pyrosequencing analysis of bacterial diversity in a single soil type as affected by management and land use. Soil Biology and Biochemistry, doi:10.1016/j.soilbio.2008.07.022.

Dudensing, J., J. Johnson, P., and C. Villalobos. 2008. Grazing alternatives in the face of declining groundwater: A case from the Southern High Plains of Texas. Texas Journal of Agriculture and Natural Resources 21:60-72.

Wheeler-Cook, E., E. Segarra, P. Johnson, J. Johnson and D. Willis. 2008. Water conservation policy evaluation: The case of the southern Ogallala Aquifer. Texas Journal of Agriculture and Natural Resources 21:89-102.

Rajan, N., and S.J. Maas. 2009. Mapping crop ground cover using airborne multispectral digital imagery. Precision Agriculture 10(4). http://www.springerlink.com/content/1385-2256

Allen, V.G., T. Sell, R. L. Kellison, P.N. Johnson, and P. Brown. 2009. Grassland environments: Factors driving change. In: Alan J. Franzluebbers (ed.) Farming with Grass: Achieving Sustainable Mixed Agricultural Landscapes. Soil Water Conservation Society e-book. http://www.swcs.org/en/publications/farming_with_grass/.

Acosta-Martinez, V., G. Burow, T.M. Zobeck, and V. Allen. 2010. Soil microbial communities and function in alternative systems to continuous cotton. Soil Science Society of America Journal 74:1181-1192.

Acosta-Martinez, V., S.E. Dowd, Y. Sun, D. Wester, and V. Allen. 2010. Pyrosequencing analysis for characterization of soil bacterial populations as affected by an integrated livestock-cotton production system. Applied Soil Ecology 45:13-25.

Maas, S., and Rajan, N. 2010. Normalizing and converting image DC data using scatter plot matching. Remote Sensing 2:1644-1661.

Maas, S., Rajan, N., and Kathilankal, J. 2010. Estimating crop water use of irrigated and dryland cotton in the Southern High Plains. Agronomy Journal 102:1641-1651.

Acosta-Martinez, V., et al. 2010. Long-term soil microbial community and enzyme activity responses to an integrated cropping-livestock system in a semi-arid region. Agriculture, Ecosystems and Environment 137:231-240.

Davinic, M., L. M. Fultz V. Acosta-Martinez, F. J. Calderón, S. B. Cox, S. E. Dowd, V. G. Allen, J. C. Zak, and J. Moore-Kucera. 2011. Pyrosequencing and mid-infrared spectroscopy reveal distinct aggregate stratification of soil bacterial communities and organic matter composition. Soil Biology and Biochemistry 46:63-72.

Zilverberg, C.J., P. Johnson, J. Weinheimer, and V.G. Allen. 2011. Energy and carbon costs of selected cow-calf systems. Rangeland Ecology and Management 64:573-584.

Allen, V.G., C. Batello, E.J. Berretta, J. Hodgson, M. Kothmann, X. Li, J. McIvor, J. Milne, C. Morris, A. Peeters and M. Sanderson. 2011. An international terminology for grazing lands and grazing animals. Grass and Forage Science 66:2-28.

Allen, V.G., C.P. Brown, R. Kellison, P. Green, C.J. P. Zilverberg, J. Johnson,. J. Weinheimer, T. Wheeler, E. Segarra, V. Acosta-Martinez, T.M. Zobeck, and J.C. Conkwright. 2012. Integrating cotton and beef production in the Texas Southern High Plains. I. Water use and measures of productivity. Agronomy Journal 104:1625-1642.

Zilverberg, C.J., V.G. Allen, C.P. Brown, P. Green, P. Johnson, and J. Weinheimer. 2012. Integrating cotton and beef production in the Texas Southern High Plains. II. Fossil fuel use. Agronomy Journal 104:1643-1651.

Song, Cui., V. G. Allen, P.C. Brown, and D.B. Wester. 2013. Growth and nutritive value of three old world bluestems and three legumes in the semiarid Texas High Plains. Crop Science 53:329-340.

Guo, W., S. and K. F. Bronson. 2012. Relationship between cotton yield and soil electrical conductivity, topography, and landsat imagery. Precision Agriculture 13:678-692.

Nair, S., S. Maas, C. Wang, and S. Mauget. 2012. Optimal field partitioning for center-pivot-irrigated cotton in the Texas High Plains. Agronomy Journal 105: 124-133.

Johnson, P., J. Zilverberg, V.G. Allen, J. Weinheimer, C.P. Brown, R. Kellison, and E. Segarra. 2013. Integrating cotton and beef production in the Texas Southern High Plains: III. An economic evaluation. Agronomy Journal. 105:929-937.

Davinic M., J. Moore-Kucera, V. Acosta-Martinez, J. Zak, and V. Allen. 2013. Soil fungal groups' distribution and saprophytic functionality as affected by grazing and vegetation components of integrated cropping-livestock agroecosystems. Applied Soil Ecology 66:61-70.

POPULAR PRESS

Wolfshohl, Karl. 2005. Can they save the Ogallala (and the farmer?). *Vistas* 13(2):17-19.

Blackburn, Elliott. 2006. Farmer-Initiated Water-Saving Programs Offer Fresh Approach. *Lubbock Avalanche-Journal*.

PBS video: *State of Tomorrow*, Episode 101. Alphaeus Media, Austin, Texas. Filmed Fall 2006; originally aired Spring 2007. http://www.stateoftomorrow.com/episodes/episode01.htm

Foster, Jerod. 2007. Learning to Conserve. *Archways* Vol. 2(1), p. 6-9.

Tietz, Neil. 2008. Trouble in Texas. *Hay & Forage Grower.* January 2008, p. 6-8.

Blackburn, Elliott. 2008. Aquifer's drop no cause for alarm – just caution. *Lubbock Avalanche-Journal.*

Martin, Norman. 2008. Texas Tech research farm field day focuses on forages. CASNR NewsCenter. http://www.depts.ttu.edu/agriculturalsciences/news

Martin, Norman. 2008. Perennial forages look promising on the plains. CASNR NewsCenter. http://www.depts.ttu.edu/agriculturalsciences/news

Martin, Norman. 2008. CASNR Distinguished Alumni honored at Merket Center. CASNR NewsCenter. http://www.depts.ttu.edu/agriculturalsciences/news

Staff. 2008. Texas Alliance for Water Conservation Announces 2008 Field Day. *The Farmer-Stockman*. April 25, 2008.

Martin, Norman. 2008. Water conservation field day set for July 31 in Muncy. CASNR NewsCenter. http://www.depts.ttu.edu/agriculturalsciences/news

Chandler, Cory. 2008. Good prices lead some growers to swap cotton for grain. CASNR NewsCenter. http://www.depts.ttu.edu/agriculturalsciences/news

Chandler, Cory. 2008. Hungry cows may extend life of Ogallala: Texas Tech Study. CASNR NewsCenter. http://www.depts.ttu.edu/agriculturalsciences/news

Texas Tech Today/Communications and Marketing video: Saving the Ogallala. August 1, 2008. http://today.ttu.edu/2008/08/saving-the-ogallala-video

Texas Tech Graduate School: Highlighting our graduate students . . .Katie Leigh, Agricultural Communications. http://www.depts.ttu.edu/gradschool/profiles/Highlighttext10_08.php

Doerfert, David. 2008. Farmer-Driven Water Demonstration Project Showing Results. September 22, 2008 Press Release.

Cleveland, Sean. 2009. New recruiting coordinator joins Plant and Soil Science staff. CASNR NewsCenter. http://www.depts.ttu.edu/agriculturalsciences/news

Blackburn, Jennifer. 2009. Working to Become Water Wise. *National Sorghum Producers Sorghum Grower*, Summer 2009.

Martin, Norman. 2009. Texas Tech Awarded Grant for New Carbon Cycling Focus. Texas Tech Today. http://today.ttu.edu/2009/10/usda-grant-for-carbon-cycling

Martin, Norman. 2009. Texas Tech Awarded USDA Grant for New Carbon Cycling Focus. CASNR NewsCenter. http://www.depts.ttu.edu/agriculturalsciences/news

Allen, Vivien Gore. 2009. Travel Course: Ecology and Grazing Lands Systems. *The Forage Leader*, p. 5.

High Plains Underground Water Conservation District No. 1. 14 January 2010. Texas Alliance for Water Conservation Finalizes Program for 2010 Pioneers in Agriculture Field Day & Workshop. http://www.hpwd.com/news.

Martin, Norman. 2010. CASNR's Hudson highlights Feb. 3 water conservation field day. CASNR NewsCenter. http://www.depts.ttu.edu/agriculturalsciences/news

Smith, Ron. 11 March 2010. Farm Press discusses benefits of SmartCrop, other water conservation practices. *Farm Press*: posted online by Taber Black at http://www.smartfield.com/2010/03.

Smith, Ron. 12 April 2010. Ag carbon benefit may be indirect. *Southwest Farm Press*. http://www.southwestfarmpress.com/energy/ag-carbon-benefit-indirect-0412.

Yates, Samantha. 2010. Competing for Profit. *ACC Newsletter*, Issue XV – May 2010, p. 1-5.

McCain, Carmon. June 2010. Irrigation Water use can be managed with technology. *The Cross Section*, Volume 56 – No. 6.

McCain, Carmon. June 2010. Texas Alliance for Water Conservation announces August 10 field day. *The Cross Section*, Volume 56 – No. 6.

Dizon, Alyssa. 19 June 2010. Ground View. *Lubbock Avalanche-Journal*, pages A-1, A-9 and A-11.

YouTube video: uploaded by MyPlainview on 11 August 2010. Texas Alliance for Water Conservation Field Day 2.wmv. http://www.youtube.com/watch?v=KDpMK2syVgQ

Porter, Richard. 11 August 2010. Sen. Duncan keynote speaker for Texas Alliance for Water Conservation. *Plainview Daily Herald*. http://www.myplainview.com/news

Lubbock Avalanche-Journal editorial/opinion. 27 August 2010. Conservation vital element of long-term water supply.

Elkins, Hardy. 2010. Sustainability on the High Plains. *The Agriculturist*, Fall 2010, p. 46-47.

Miller, Jessica. 22 November 2010. New technology helps producers monitor water use via phones. Fox 34 News, Ag Day Lubbock. http://www.myfoxlubbock.com/content/agdaylubbock/story/water-conservation-Aqua-Spy-cell-phones-Lockney/ZPwy-3pu3kWp11Ftx3LdZg.cspx

Southwest Farm Press. 22 February 2011. Water growing concern for Texas producers. http://southwestfarmpress.com/management/water-growing-concern-texas-producers

Black, Emily, KCBD NewsChannel 11. 2 March 2011. New website helps farmers battle drought. http://www.kcbd.com/story/15136451/new-website-helps-farmers-battle-drought

Martin, Norman. 15 March 2011. Wise Water Use; New irrigation, economic management tools launched. http://www.depts.ttu.edu/agriculturalsciences/news/?p=866

Lubbock Avalanche-Journal Lubbock Online local news. 17 March 2011. TAWC project offers irrigation management tools for farmers. http://lubbockonline.com/local-news/2011-03-17/tawc-project-offers-irrigation-management-tools-farmers

Porter, Richard, *Plainview Herald*. 20 March 2011. Researcher: Area farmers should manage for maximum profit. http://www.myplainview.com/news/article_631b5c12-5243-11e0-8e54-001cc4c03286.html#user-comment-area

Miller, Jessica, Fox KJTV-34 News Ag Day Lubbock. 18 April 2011. Cotton overwhelmingly king this year on South Plains. http://www.myfoxlubbock.com/news/local/story/Cotton-South-Plains-Ag-Day-Lubbock/VYH8A0qlG0eX4Dru1M5Kdw.cspx

Tietz, Neil, *Hay & Forage Grower, Volume 26, No. 5*. 2 May 2011. Water Worries: Declining Aquifers Threaten Agriculture. http://hayandforage.com/hay/alfalfa/declining-aquifers-threaten-agriculture-0501

Martin, Norman. 12 July 2011. Researchers fight brutal drought with new web-based tools for farmers. CASNR NewsCenter. http://today.ttu.edu/2011/07/texas-tech-researchers-fight-brutal-drought-with-web-based-tools-for-farmers

Miller, Jessica, Fox KJTV-34 News Ag Day Lubbock. 20 July 2011. Texas Tech researchers develop drought-management tools. http://www.myfoxlubbock.com/content/agdaylubbock/story/Drought-Texas-Tech/mrHBvZQHzUyWfXH_hMrSdw.cspx

Miller, Jessica, Fox KJTV-34 News Ag Day Lubbock. 22 July 2011. TAWC to host water conservation field day. http://www.myfoxlubbock.com/content/agdaylubbock/story/TAWC-field-day-Muncy-Texas/kZP8t98sDkeNzGNs25GBkg.cspx

Black, Emily, KCBD NewsChannel 11. 25 July 2011. Texas Tech researchers provide a new tool in farming. http://www.kcbd.com/story/15135807/texas-tech-researchers-provide-a-new-tool-in-farming

Miller, Jessica, Fox KJTV-34 News Ag Day Lubbock. 27 July 2011. One form of irrigation proving effective in severe drought. http://www.myfoxlubbock.com/news/local/story/Irrigation/6UjBzEFuPUyXk8TUv4FZRw.cspx

Graham, Fiona. 5 August 2011. Digital cloud lets farmer know when to water. BBC News: http://www.bbc.co.uk/news/business-14392244.

Smith, Ron. 8 August 2011. New regs, technology will prolong irrigation. *Southwest Farm Press*. http://southwestfarmpress.com/irrigation/new-regs-technology-will-prolong-irrigation

Southwest Farm Press. 12 August 2011. Irrigation management critical during drought. http://southwestfarmpress.com/irrigation/irrigation-management-critical-during-drought

Welch, Kirk. 25 August 2011. Strategic Steps: CASNR part of massive $500k plains conservation project. http://www.depts.ttu.edu/agriculturalsciences/news

Littlefield, Dee Ann. 25 August 2011. NRCS announces recipients of conservation innovation grants in Texas. *Southwest Farm Press:* http://southwestfarmpress.com/government/nrcs-announces-recipients-conservation-innovation-grants-texas

Ledbetter, Kay. 29 August 2011. AgriLife Research: Soil moisture-monitoring tools will pay off. http://www.sunbeltagnet.com/story/15350979/agrilife-research-soil-moisture-monitoring-tools-will-pay-off

McCain, Carmon. August 2011. Area water conservation demonstration projects receive NRCS grant. *The Cross Section*, Volume 57 – No. 8.

McCain, Carmon. August 2011. August 5 TAWC Pioneers in Agriculture Workshop and Field Day. *The Cross Section*, Volume 57– No. 8.

Smith, Ron. 1 September 2011. New regs, technology will prolong irrigation. *Southwest Farm Press*, Volume 38 – No. 16.

Ag Day Lubbock. By Jessica Miller, Fox 34 News, 1 September 2011. High Plains producers struggling to conserve water in drought. http://www.myfoxlubbock.com/news/local/story/Groundwater-water-conservation/3pY1hnvXoEenSc7X1Ymaag.cspx

Ag Day Lubbock. By Jessica Miller, Fox 34 News, 5 September 2011. New ideas, concepts emerging from surviving historic drought. http://www.myfoxlubbock.com/news/local/story/Texas-drought/yXVogCdJxkKR_gGuZBuI3g.cspx

Smith, Ron. 15 September 2011. Record breaking drought exposes irrigation system shortfalls. *Southwest Farm Press*, Volume 38, Number 18.

Fletcher, Kelsey. 23 September 2011. China agriculture prof joins ongoing Texas Tech water management project. CASNR NewsCenter. http://www.depts.ttu.edu/agriculturalsciences/news

Fletcher, Kelsey. 13 October 2011. Texas Tech gets water conservation funding boost from NRCS. CASNR NewsCenter. http://today.ttu.edu/2011/10/texas-tech-gets-500000-water-conservation-funding-boost-from-nrcs

Trojan, S., and C. West. 2012. Conserving water while maintaining economic viability by grazing introduced perennial grasses. Rangeland Issues 1(3):1-6.

THESES AND DISSERTATIONS

Dudensing, J. D'Wayne. 2005. An economic analysis of cattle weight gain response to nitrogen fertilization and irrigation on WW-B. Dahl Bluestem. M.S. Thesis, Texas Tech University, Lubbock.

Duch-Carvallo, Teresa. 2005. WW-B. Dahl old world bluestem in sustainable systems for the Texas High Plains. Ph.D. Dissertation, Texas Tech University, Lubbock.

Martin, Rebekka. 2005. Economic evaluation of an integrated cropping system with cotton. M.S. Thesis, Texas Tech University, Lubbock.

Miller, Pamela. 2006. West Texas High School Agriscience Teachers' Knowledge, Confidence, and Attitudes towards Teaching Water Quantity-Related Topics. M.S.Thesis, Texas Tech University, Lubbock.

Carr, Jessica Odette. 2007. An Examination of Rural Small Acreage Homeowners in Three West Texas Counties. M.S. Thesis, Texas Tech University, Lubbock.

Pauley, Patrick Stephen. 2007. Political and civic engagement of agriculture producers who operate in selected Idaho and Texas counties dependent on irrigation. Ph.D. Dissertation, Texas Tech University, Lubbock.

Rajan, Nithya. 2007. Estimation of crop water use for different cropping systems in the Texas High Plains using remote sensing. Ph.D. Dissertation, Texas Tech University, Lubbock.

Weinheimer, Justin. 2008. Farm Level Financial Impacts of Water Policy on the Southern Ogallala Aquifer. Ph.D. Dissertation. Texas Tech University, Lubbock.

Leigh, Katie. 2008. A Qualitative Investigation of the Factors that Influence Crop Planting and Water Management in West Texas. M.S. Thesis, Texas Tech University, Lubbock.

Wilkinson, Jarrott. 2009. The Relationship of Trust and Personality Factors of a Knowledge Source on the Information-Seeking Behaviors of Agriculture Professionals. M.S. Thesis, Texas Tech University, Lubbock.

Williams, Claire. 2009. The Effectiveness of Using a Workshop to Change Agriscience Teacher Behaviors Towards Agricultural Water Management Instruction. M.S. Thesis, Texas Tech University, Lubbock.

Jones, Heather. 2010. The Influence of a Professional Development Workshop on Teachers' Intentions to Include Water Management Content into Their Local Agriscience Curriculum. M.S. Thesis, Texas Tech University, Lubbock.

Li, Yue. 2011. Allelopathy in an integrated rye-cotton-beef cattle system. Ph.D. Dissertation. Texas Tech University, Lubbock.

Cui, Song. 2011. Finding forage legumes adapted to West Texas for reduction of water and energy use and improvement of nutritive value for livestock. Ph.D. Dissertation. Texas Tech University, Lubbock.

Graber, Lindsay. 2011. Traditional and Social Media Use by Texas Agricultural Producers. M.S. Thesis. Texas Tech University, Lubbock.

Sullivan, Nichole. 2012. Determining the Water Management Instructional Needs of Texas Agriscience Teachers. M.S. Thesis, Texas Tech University, Lubbock.

IN PRESS

Fultz, L.M., Moore-Kucera, J., Zobek, T.M., Acosta-Martínez, V. and Allen, V.G. 2013. Soil aggregate-carbon pools after 13 years under a semi-arid integrated crop-livestock agroecosystem. Soil Science Society of America Journal. (Accepted with revisions).

Li, Yue, F. Hou, J. Chen, C. P. Brown, and V. G. Allen. 2013. Long-term grazing of a rye cover crop by steers influences growth of rye and no-till cotton. Agronomy Journal (Accepted with revision).

Li, Yue, J. Chen, F. Hou, C. P. Brown, P. Green and V. G. Allen. 2013. Allelopathic influence of a wheat or rye cover crop on growth and yield of no-till cotton. Agron. J. (Accepted with revision).

SITE DESCRIPTIONS

BACKGROUND

This project officially began with the announcement of the TWDB grant in September, 2004. However, it was February, 2005, before all of the contracts and budgets were finalized and actual field site selections could begin. By February, 2005, the Producer Board had been named and was functioning, and the Management Team was identified to expedite the decision-making process. Initial steps were taken immediately to advertise and identify individuals to hold the positions of Project Director and Secretary/Accountant. Both positions were filled by June of 2005. By autumn 2005, the FARM Assistance position was also filled.

Working through the Producer Board, 26 sites were identified that included 4,289 acres in Hale and Floyd counties (Figure 9). Soil moisture monitoring points installed, maintained and measured by the High Plains Underground Water Conservation District No. 1 were purposely located close to these sites and GPS position coordinates were taken for each of these monitoring points. This was completed during 2005 and was operational for much of the 2005 growing season. All data recorded from these points continue to be maintained by the High Plains Underground Water District No. 1.

Total number of acres devoted to each crop and livestock enterprise and management type in 2005 - 2012 are given in Tables 9 - 16. These sites include subsurface drip, center pivot, and furrow irrigation as well as dryland examples. It is important to note when interpreting data from Year 1 (2005), that this was an incomplete year. We were fortunate that this project made use of already existing and operating systems; thus there was no time delay in establishment of systems. Efforts were made to locate missing information on water use while the original 26 sites were brought on-line. Such information is based on estimates as well as actual measurements during this first year and should be interpreted with caution. The resulting 2005 water use data, however, provided useful information as we began this long-term project. It is also important to note that additional improvements were made in 2006 in calibration of water measurements and other protocols.

In year 2 (2006), site 25 was lost to the project due to a change in land ownership, but was replaced by site 27, thus the project continued to monitor 26 sites. Total acreage in 2006 was 4,230, a decline of about 60 acres between the two years. Crop and livestock enterprises on these sites and the acres committed to each use by site are given in Table 10.

In year 3 (2007), all sites present in 2006 remained in the project through 2007. Total acreage was 4,245, a slight increase over year 2 resulting from expansion of Site 1 (Table 11).

In year 4 (2008), 25 sites comprised 3,967 acres (Table 12). Sites 1, 13, 16, and 25 of the original sites had left the project, and sites 28 and 29 were added.

In year 5 (2009), all sites present in 2008 remained in the project. Site 30 with 21.8 acres was added. Thus, 26 total sites were present in 2009 for a total of 3,991 acres (Table 13).

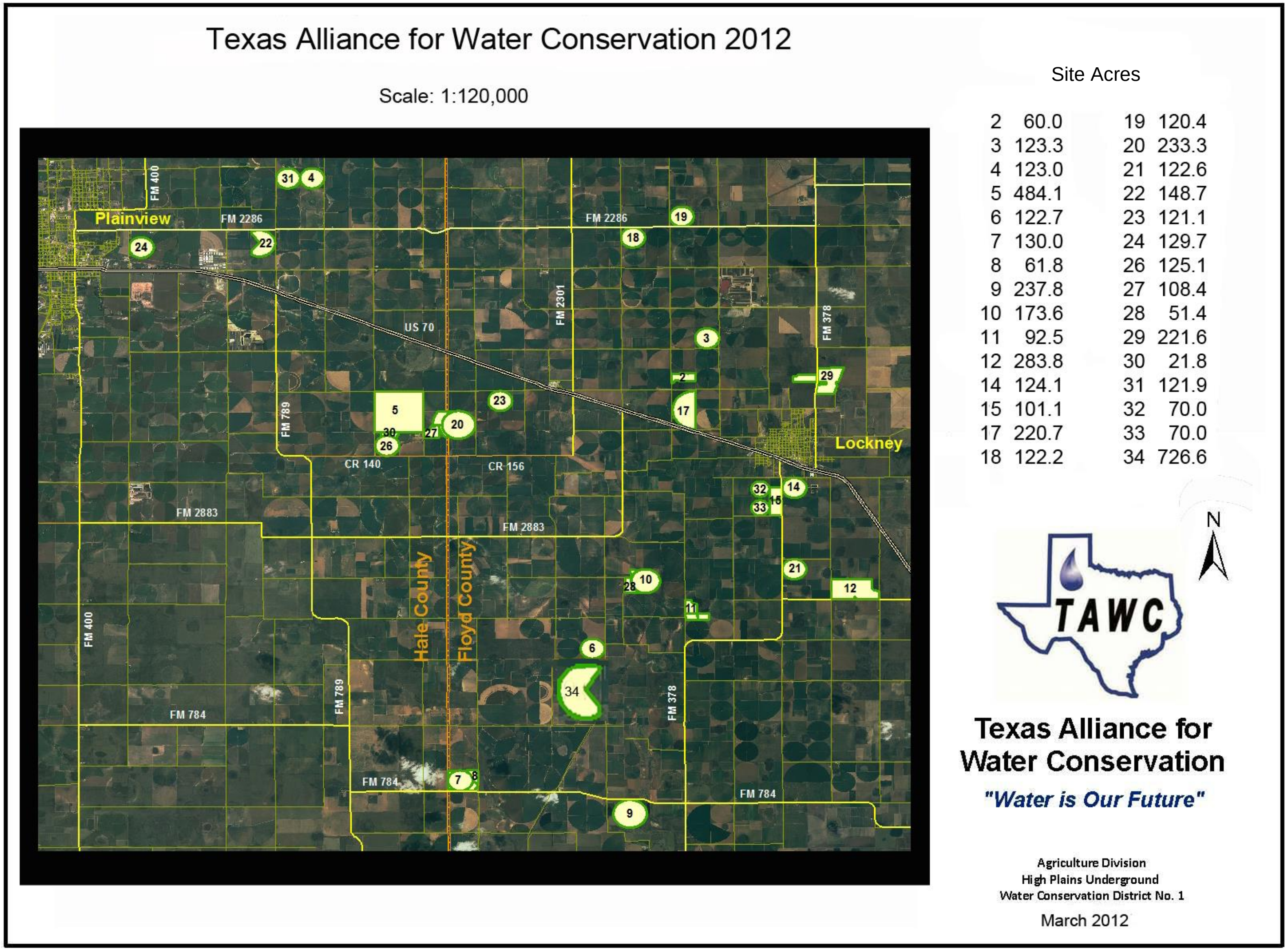
In year 6 (2010), three new sites were added as part of the implementation phase of the project (Table 14). These sites were designed to limit total irrigation for 2010 to no more than 15 inches. Crops grown included cotton, seed millet and corn. The purpose of these added sites was to demonstrate successful production systems while restricting the water applied. With the addition of sites 31, 32, and 33, the project now totaled 29 sites and increased the project acreage from 3,991 acres to 4,272 acres though these new sites were treated separately in this year. The new sites also increased the number of producers involved in the project by one.

In year 7 (2011), the previously mentioned implementation sites were incorporated into the whole project and no longer differentiated from other sites in management or data analysis due to changes in water policy. In addition, site 5 was converted from a livestock-only system to an annual cropping system. The site acreage declined from 626.4 to 487.6 by dropping the grassland corners but maintaining the cropping system under the center pivot. Site maps will be adjusted for 2012 to better reflect this change. Total acres for the project decreased from 4272 acres in 2010 to 4133 acres in 2011 as a result (Table 15).

In year 8 (2012), site 34 was added to the project (Table 16). The new 726.6 acres was partially offset by the exit of site 23 (121.1 acres). The 2012 report includes new satellite imagery of each site, and site information has been updated accordingly. As always minor corrections to site acreages continue to occur as discrepancies are discovered. Total acres for the project increased from 4133 acres in 2011 to 4732 acres in 2012 as a result of these site changes.

All numbers in this report continue to be checked and verified. *THIS REPORT SHOULD BE CONSIDERED A DRAFT AND SUBJECT TO FURTHER REVISION.* However, each year's annual report reflects completion and revisions made to previous years' reports as well as the inclusion of additional data from previous years. Thus, the most current annual report will contain the most complete and correct report from all previous years and is an overall summarization of the data to date.

The results of years 1-8 follow and are presented by site (Tables 9-16).



Site Acres

2	60.0	19	120.4
3	123.3	20	233.3
4	123.0	21	122.6
5	484.1	22	148.7
6	122.7	23	121.1
7	130.0	24	129.7
8	61.8	26	125.1
9	237.8	27	108.4
10	173.6	28	51.4
11	92.5	29	221.6
12	283.8	30	21.8
14	124.1	31	121.9
15	101.1	32	70.0
17	220.7	33	70.0
18	122.2	34	726.6

Figure 9. Site map index for 2012 (year 8).

Table 9. Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 26 producer sites in Hale and Floyd Counties during 2005.

Site	**irrigation type**	**System acres**	**cotton**	**corn grain**	**Corn silage**	**grain sorghum**	**forage sorghum**	**alfalfa**	**grass seed**	**hay**	**perennial forage**	**cattle**	**wheat for grain**	**wheat for silage**	**wheat for cover/grazing**	**Sunflowers**	**Rye**	**seed millet**
1	SDI	62.3	62.3															
2	SDI	60.9	60.9															
3	PIV	123.3	61.8			61.5												
4	PIV	123.1	109.8					13.3										
5	PIV/DRY	630						69.6			551.3	620.9						
6	PIV	122.9	122.9									122.9	122.9					
7	PIV	130							130									
8	SDI	61.8							61.8									
9	PIV	232.8	137								95.8	232.8					232.8	
10	PIV	173.6	44.5								129.1	129.1						
11	FUR	92.5	92.5															
12	DRY	283.9	151.2				132.7											
13	DRY	319.5	201.5										118					
14	PIV	124.2	124.2															
15	FUR	95.5	95.5															
16	PIV	143.1	143.1															
17	PIV	220.8	108.9		58.3						53.6							
18	PIV	122.2	61.5			60.7												
19	PIV	120.4	75.3															45.1
20	PIV	233.4			115.8		117.6							117.6				
21	PIV	122.7	122.7															
22	PIV	148.7	72.7	76														
23	PIV	100.3	51.5													48.8		
24	PIV	129.8	64.7	65.1														
25	DRY	178.5	90.9			87.6												
26	PIV	125.2	62.9	62.3														
	Total 2012 acres	**4281.4**	**2118.3**	**203.4**	**174.1**	**209.8**	**250.3**	**82.9**	**191.8**	**0**	**829.8**	**1105.7**	**240.9**	**117.6**	**0**	**48.8**	**232.8**	**45.1**
# of sites		**26**	**22**	**3**	**2**	**3**	**2**	**2**	**2**	**0**	**4**	**4**	**2**	**1**	**0**	**1**	**1**	**1**
Site	**irrigation type**	**System acres**	**cotton**	**corn grain**	**Corn silage**	**grain sorghum**	**forage sorghum**	**alfalfa**	**grass seed**	**hay**	**perennial forage**	**cattle**	**wheat for grain**	**wheat for silage**	**wheat for cover/grazing**	**Sunflowers**	**Rye**	**seed millet**

PIV = pivot irrigation SDI = subsurface drip irrigation FUR = furrow irrigation DRY = dryland, no irrigation (acres may overlap due to multiple crops per year and grazing).

Table 10. Irrigation type and total acres, by site, of crops, forages and acres grazed by cattle in 26 producer sites in Hale and Floyd Counties during 2006.

Site	irrigation type	System acres	cotton	corn grain	Corn silage	grain sorghum	forage sorghum	alfalfa	grass seed	hay	perennial forage	cattle	wheat for grain	wheat for silage	wheat for cover/grazing	Sunflowers	Rye	Oats	Triticale silage	Seed millet
1	SDI	135.2	135.2																	
2	SDI	60.9	60.9																	
3	PIV	123.3	123.3																	
4	PIV	123.1	44.4				65.4	13.3							65.4					
5	PIV/DRY	630						69.6			551.3	620.9								
6	PIV	122.9	122.9																	
7	PIV	130							130											
8	SDI	61.8							61.8											
9	PIV	232.8	137								95.8	95.8					137			
10	PIV	173.6					44.5				129.1	129.1						44.5		
11	FUR	92.5	92.5																	
12	DRY	283.9	132.7												151.2					
13	DRY	319.5	118										201.5							
14	PIV	124.2	124.2																	
15	FUR	95.5	67.1			28.4														
16	PIV	143.1	143.1																	
17	PIV	220.8	58.3		108.9						53.6	162.5		108.9						
18	PIV	122.2	60.7				61.2											61.2		
19	PIV	120.4	75.1																	45.3
20	PIV	233.4			117.6		115.8												115.8	
21	PIV	122.7	61.3	61.4								61.3			61.3					
22	PIV	148.7	72.7	76																
23	PIV	100.3	51.5	48.8																
24	PIV	129.8	65.1		64.7															
26	PIV	125.2	62.3	62.9																
27	SDI	46.2	46.2																	
	Total 2012 acres	**4222**	**1854.5**	**249.1**	**291.2**	**28.4**	**286.9**	**82.9**	**191.8**	**0**	**829.8**	**1069.6**	**201.5**	**108.9**	**277.9**	**0**	**137**	**105.7**	**115.8**	**45.3**
# of sites		**26**	**21**	**4**	**3**	**1**	**4**	**2**	**2**	**0**	**4**	**5**	**1**	**1**	**3**	**0**	**1**	**2**	**1**	**1**
Site	**irrigation type**	**System acres**	**cotton**	**corn grain**	**Corn silage**	**grain sorghum**	**forage sorghum**	**alfalfa**	**grass seed**	**hay**	**perennial forage**	**cattle**	**wheat for grain**	**wheat for silage**	**wheat for cover/grazing**	**Sunflowers**	**Rye**	**Oats**	**Triticale silage**	**Seed millet**

PIV = pivot irrigation SDI = subsurface drip irrigation FUR = furrow irrigation DRY = dryland, no irrigation (acres may overlap due to multiple crops per year and grazing)

Table 11. Irrigation type and total acres, by site, of crops, forages and acres grazed by cattle in 26 producer sites in Hale and Floyd Counties during 2007.

Site	irrigation type	System acres	cotton	corn grain	Corn silage	grain sorghum	forage sorghum	alfalfa	grass seed	hay	perennial forage	cattle	wheat for grain	wheat for silage	wheat for cover/grazing	Sunflowers	Rye	Oats	Triticale silage	Seed millet
1	SDI	135.2	135.2																	
2	SDI	60.9	60.9																	
3	PIV	123.3	61.5										61.8							
4	PIV	123.1	65.4					13.3				109.8	44.4		65.4					
5	PIV/DRY	620.9									620.9	620.9								
6	PIV	122.9	122.9																	
7	PIV	130							130											
8	SDI	61.8							61.8											
9	PIV	232.8				137					95.8	95.8					232.8			
10	PIV	173.6			44.5						129.1	129.1								
11	FUR	92.5	92.5																	
12	DRY	283.9	151.2			132.7														
13	DRY	319.5	201.5										118							
14	PIV	124.2	124.2																	
15	FUR	95.5	66.7			28.8														
16	PIV	143.1	143.1																	
17	PIV	220.8	108.9								167.2	167.2			108.9					
18	PIV	122.2				61.5							60.7							
19	PIV	120.4	75.8																	45.6
20	PIV	233.4			117.6		115.8												233.4	
21	PIV	122.7		61.3					61.4											
22	PIV	148.7	148.7																	
23	PIV	105.2		105.2																
24	PIV	129.8		129.8																
26	PIV	125.2		62.3								62.9								62.9
27	SDI	46.2	16.2		46.2															
	Total 2012 acres	**4217.8**	**1574.7**	**358.6**	**208.3**	**360**	**115.8**	**13.3**	**253.2**	**0**	**1013**	**1185.7**	**284.9**	**0**	**174.3**	**0**	**232.8**	**0**	**233.4**	**108.5**
# of sites		**26**	**15**	**4**	**3**	**4**	**1**	**1**	**3**	**0**	**4**	**6**	**4**	**0**	**2**	**0**	**1**	**0**	**1**	**2**
Site	**irrigation type**	**System acres**	**cotton**	**corn grain**	**Corn silage**	**grain sorghum**	**forage sorghum**	**alfalfa**	**grass seed**	**hay**	**perennial forage**	**cattle**	**wheat for grain**	**wheat for silage**	**wheat for cover/grazing**	**Sunflowers**	**Rye**	**Oats**	**Triticale silage**	**Seed millet**

Table 12. Irrigation type and total acres, by site, of crops, forages and acres grazed by cattle in 25 producer sites in Hale and Floyd Counties during 2008.

Site	irrigation type	total acres (no overlap)	cotton	corn grain	sunflowers	grain sorghum	grain sorghum for seed	grain sorghum for silage	forage sorghum for hay	pearl millet for seed	alfalfa	grass seed	hay	perennial pasture	cattle	wheat for grain	wheat for silage	wheat for grazing	grazing of crop residue	barley for seed	fallow or pens/facilities
2	SDI	60.9			60.9																
3	PIV	123.3	61.8			61.5										61.5					
4	PIV	123.1				65.4					13.3		13.3	13.3	44.4	44.4		44.4			
5	PIV/DRY	628.0											81.2	620.9	620.9						5.5
6	PIV	122.9	92.9	30.0																	
7	PIV	130.0										130.0	130.0	130.0							
8	SDI	61.8										61.8	61.8	61.8							
9	PIV	237.8	137.0											95.8	95.8						5.0
10	PIV	173.6		44.5									42.7	129.1	129.1	44.5					
11	FUR	92.5	47.3			45.2															
12	DRY	283.9						151.2													132.7
14	PIV	124.2	124.2																		
15	FUR	95.5	67.1													28.4					
17	PIV	220.8		108.9								111.9		111.9	220.8				108.9		
18	PIV	122.2	61.5			60.7											60.7				
19	PIV	120.4	75.0							45.4											
20	PIV	233.4				117.6		115.8					117.6			233.4					
21	PIV	122.7							61.3			61.4	122.7	61.4						61.3	
22	PIV	148.7		148.7																	
23	PIV	105.1	60.5		44.6																
24	PIV	129.8		129.8																	
26	PIV	125.2		40.4			22.5			62.3					125.2				125.2		
27	SDI	108.5	46.2	62.3																	
28	SDI	51.5		51.5																	
29	DRY	221.6	117.3												104.3			104.3			
	Total 2008 acres	**3967.4**	**890.8**	**616.1**	**105.5**	**350.4**	**22.5**	**267.0**	**61.3**	**107.7**	**13.3**	**365.1**	**569.3**	**1224.2**	**1340.5**	**412.2**	**60.7**	**148.7**	**234.1**	**61.3**	**143.2**
# of sites		**25**	**11**	**8**	**2**	**5**	**1**	**2**	**1**	**2**	**1**	**4**	**7**	**8**	**7**	**5**	**1**	**2**	**2**	**1**	**3**
Site	**irrigation type**	**total acres (no overlap)**	**cotton**	**corn grain**	**sunflowers**	**grain sorghum**	**grain sorghum for seed**	**grain sorghum for silage**	**forage sorghum for hay**	**pearl millet for seed**	**alfalfa**	**grass seed**	**hay**	**perennial pasture**	**cattle**	**wheat for grain**	**wheat for silage**	**wheat for grazing**	**grazing of crop residue**	**barley for seed**	**fallow or pens/facilities**

PIV = pivot irrigation SDI = subsurface drip irrigation FUR = furrow irrigation DRY = dryland, no irrigation

Table 13. Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 26 producer sites in Hale and Floyd Counties during 2009.

Site	**irrigation type**	**System acres**	**cotton**	**corn grain**	**Corn silage**	**sunflowers**	**grain sorghum**	**grain sorghum for silage**	**forage sorghum for hay**	**alfalfa**	**grass seed**	**hay**	**perennial pasture**	**cattle**	**wheat for grain**	**wheat for silage**	**wheat for grazing**	**grazing of crop residue**	**Oat silage**	**fallow or pens/facilities**
2	SDI	60.9	60.9																	
3	PIV	123.3	61.8				61.5													
4	PIV	123.1	13.3				28.4			16.0			16.0	98.3	65.4			98.3		
5	PIV/DRY	626.4										89.2	620.9	620.9						5.5
6	PIV	122.9	90.8	32.1																
7	PIV	129.9									129.9	129.9	129.9							
8	SDI	61.8									61.8	61.8	61.8							
9	PIV	237.8	137.0										100.8	100.8						
10	PIV	173.6	44.5										129.1	129.1						
11	FUR	92.5	68.1				24.4													
12	DRY	283.9						151.2												132.7
14	PIV	124.2	61.8												62.4					
15	FUR/SDI	102.8	102.8																	
17	PIV	220.8				108.9					53.6		111.9	111.9						
18	PIV	122.2	60.7												61.5					
19	PIV	120.3	60.2												60.1					
20	PIV	233.3	117.6		115.7															
21	PIV	122.6							61.2		61.4	61.4	61.4		61.2					
22	PIV	148.7	148.7																	
23	PIV	101.4						101.4								60.5			40.9	
24	PIV	129.7		64.6		65.1														
26	PIV	125.2		62.3		62.9								62.9			62.9			
27	SDI	108.5	48.8	59.7																
28	SDI	51.5	51.5																	
29	DRY	221.7	116.4												104.3					
30	PIV	21.8				21.8														
	Total 2009 acres	**3990.8**	**1244.9**	**218.7**	**115.7**	**258.7**	**114.3**	**252.6**	**61.2**	**16.0**	**306.7**	**342.3**	**1231.8**	**1123.9**	**414.9**	**60.5**	**62.9**	**98.3**	**40.9**	**138.2**
# of sites		**26**	**16**	**4**	**1**	**4**	**3**	**2**	**1**	**1**	**4**	**4**	**8**	**6**	**6**	**1**	**1**	**1**	**1**	**2**
Site	**irrigation type**	**System acres**	**cotton**	**corn grain**	**Corn silage**	**sunflowers**	**grain sorghum**	**grain sorghum for silage**	**forage sorghum for hay**	**alfalfa**	**grass seed**	**hay**	**perennial pasture**	**cattle**	**wheat for grain**	**wheat for silage**	**wheat for grazing**	**grazing of crop residue**	**Oat silage**	**fallow or pens/facilities**

PIV = pivot irrigation SDI = subsurface drip irrigation FUR = furrow irrigation DRY = dryland, no irrigation

Table 14. Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 26 producer sites in Hale and Floyd Counties during 2010.

Site	**irrigation type**	**System acres**	**cotton**	**corn grain**	**Corn silage**	**sunflowers**	**grain sorghum**	**grain sorghum for silage**	**forage sorghum for hay**	**alfalfa**	**grass seed**	**hay**	**perennial forage**	**cattle**	**wheat for grain**	**wheat for silage**	**wheat for grazing**	**grazing of crop residue**	**Triticale silage**
2	SDI	60.9		60.9															
3	PIV	123.3	61.8				61.5												
4	PIV	123.0	78.6						28.4	16.0			16.0		28.4				
5	PIV/DRY	628.0											628	628					
6	PIV	122.8	62.2	60.6															
7	PIV	130.0									130.0	130.0	130						
8	SDI	61.8									61.8	61.8	61.8						
9	PIV	237.8	137.0										100.8	100.8					
10	PIV	173.6		87.2									86.4	86.4					
11	FUR	92.5	69.6				22.9												
12	DRY	283.9																	
14	PIV	124.2	62.4												61.8				
15	FUR/SDI	102.8	102.8																
17	PIV	220.8		108.9									111.9	220.8					
18	PIV	122.2	61.5												60.7				
19	PIV	120.4	59.2												61.2				
20	PIV	233.4	115.8		117.6														115.8
21	PIV	122.6	61.2	61.4															
22	PIV	148.7		148.7															
23	PIV	121.1		121.1															121.1
24	PIV	129.7		129.7															
26	PIV	125.2	62.9	62.3										62.3	62.3		62.3		
27	SDI	108.5	59.7		48.8														
28	SDI	51.5	51.5																
29	DRY	221.7	104.3				117.4												
30	SDI	21.8		21.8															
	Total 2010 acres	**4012.2**	**1150.5**	**862.6**	**166.4**	**0.0**	**201.8**	**0.0**	**28.4**	**16.0**	**191.8**	**191.8**	**1134.9**	**1098.3**	**274.4**	**0.0**	**62.3**	**0.0**	**236.9**
# of sites		**26**	**15**	**10**	**2**	**0**	**3**	**0**	**1**	**1**	**2**	**2**	**7**	**5**	**5**	**0**	**1**	**0**	**2**
Site	**irrigation type**	**System acres**	**cotton**	**corn grain**	**Corn silage**	**sunflowers**	**grain sorghum**	**grain sorghum for silage**	**forage sorghum for hay**	**alfalfa**	**grass seed**	**hay**	**perennial forage**	**cattle**	**wheat for grain**	**wheat for silage**	**wheat for grazing**	**grazing of crop residue**	**Triticale silage**

PIV = pivot irrigation SDI = subsurface drip irrigation FUR = furrow irrigation DRY = dryland, no irrigation

Table 15. Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 29 producer sites in Hale and Floyd Counties during 2011.

Site	irrigation type	System acres	cotton	corn grain	Corn silage	fallow	grain sorghum	grain sorghum for silage	forage sorghum for hay	alfalfa	grass seed	hay	perennial forage	cattle	wheat for grain	wheat for silage	wheat for grazing	grazing of crop residue	Triticale silage	seed millet
2	SDI	60.9	41.3			**19.6**														
3	PIV	123.3	123.3																	
4	PIV	123.0	79.0						13.3	16.0					28.0					
5	PIV	487.6	347.8			**139.8**														
6	PIV	122.8	92.9	29.9																
7	PIV	130.0									130.0	130.0	130							
8	SDI	61.8									42.5	42.5	61.8							
9	PIV	237.8	137.0										100.8	100.8						
10	PIV	173.6	131.5										42.1	42.1						
11	FUR	92.5	74.5					18.0												
12	DRY	283.9	283.9																	
14	PIV	124.2	124.2																	
15	SDI	102.8	57.2		45.6															
17	PIV	220.8	108.9										111.9	111.9						
18	PIV	122.2	100.0												61.5					
19	PIV	120.4	120.4																	
20	PIV	233.4	117.6		115.8							117.6							117.6	
21	PIV	122.6	61.4	61.2																
22	PIV	148.7	148.7																	
23	PIV	121.1			121.1														121.1	
24	PIV	129.7	65.1	64.6																
26	PIV	125.2	62.9	62.3																
27	SDI	108.5	48.8		59.7															
28	SDI	51.5	51.5																	
29	DRY	221.7	221.7																	
30	SDI	21.8				21.8														
31	PIV	121.0	55.4																	66.1
32	PIV	70.0		70.0																
33	PIV	70.0		70.0																
	Total 2011 acres	**4132.8**	**2655.0**	**358.0**	**342.2**	**181.2**	**0.0**	**18.0**	**13.3**	**16.0**	**172.5**	**290.1**	**446.6**	**254.8**	**89.5**	**0.0**	**0.0**	**0.0**	**238.7**	**66.1**
# of sites		**29**	**23**	**6**	**4**	**3**	**0**	**1**	**1**	**1**	**2**	**3**	**5**	**3**	**2**	**0**	**0**	**0**	**2**	**1**
Site	**irrigation type**	**System acres**	**cotton**	**corn grain**	**Corn silage**	**fallow**	**grain sorghum**	**grain sorghum for silage**	**forage sorghum for hay**	**alfalfa**	**grass seed**	**hay**	**perennial forage**	**cattle**	**wheat for grain**	**wheat for silage**	**wheat for grazing**	**grazing of crop residue**	**Triticale silage**	**seed millet**

PIV = pivot irrigation SDI = subsurface drip irrigation FUR = furrow irrigation DRY = dryland, no irrigation

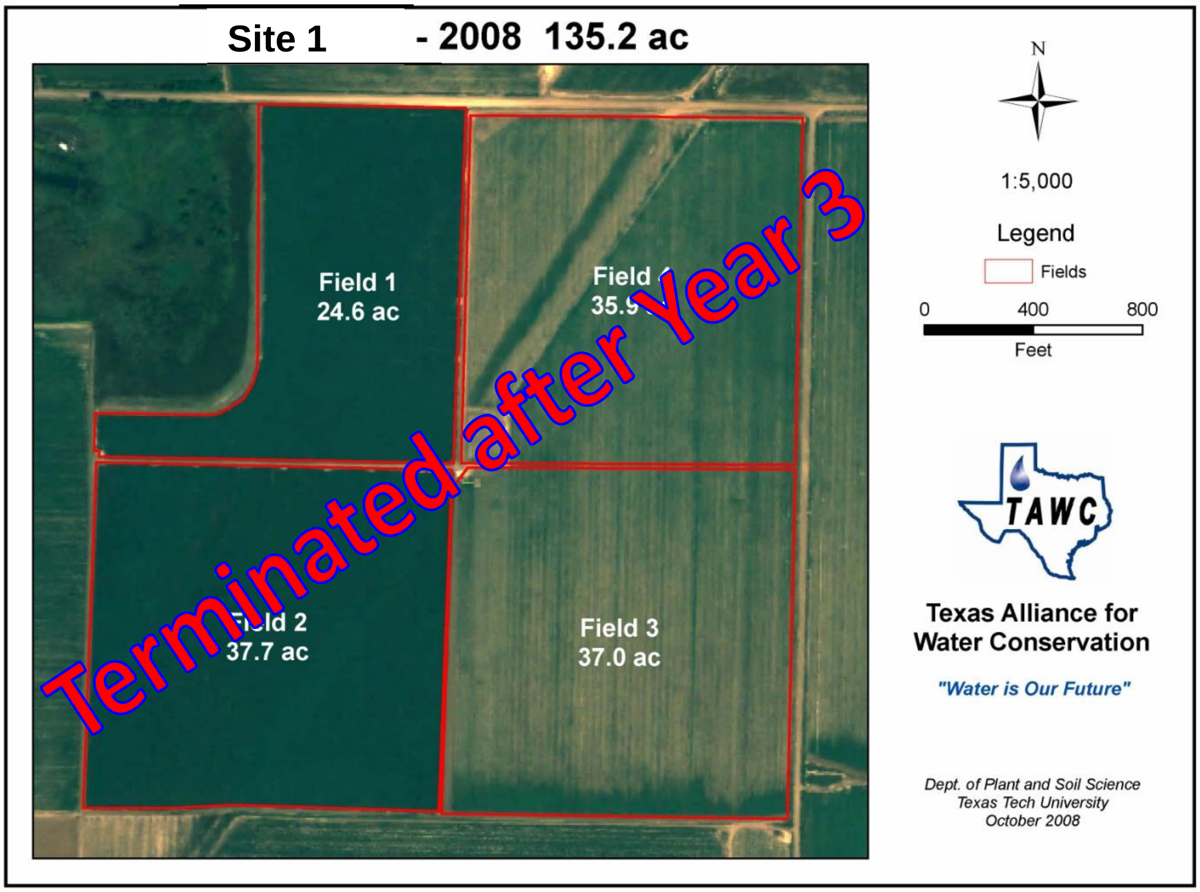
**Yellow notes abandoned, Tan partially abandoned, Brown fallowed

Table 16. Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 29 producer sites in Hale and Floyd Counties during 2012.

Site	irrigation type	System acres	cotton	corn grain	Corn silage	fallow	grain sorghum	Seed Sorghum	forage sorghum for hay	alfalfa	grass seed	hay	perennial forage	cattle	wheat for grain	wheat for silage	wheat for grazing	Sunflowers	Triticale silage	seed millet
2	SDI	60.0	24	36																
3	PIV	123.3	123.3																	
4	PIV	123.0	29.6					50.5	13.2	16					26.9					
5	PIV	484.1	398.3			**85.5**														
6	PIV	122.7		60.6		62.1														
7	PIV	130.0									130	130	130							
8	SDI	61.8									61.8	61.8	61.8							
9	PIV	237.8	137										100.8							
10	PIV	173.6			87.2								86.4							
11	FUR	92.5	92.5				92.5													
12	DRY	283.8	283.8			283.8														
14	PIV	124.1	62.4												61.7					
15	SDI	101.1	101.1				101.1													
17	PIV	220.7	54.5	54.4									111.8	111.8						
18	PIV	122.2																		
19	PIV	120.4	59.2			61.2														
20	PIV	233.3	115.7	117.6															115.7	
21	PIV	122.6	61.2						61.4						61.4					
22	PIV	148.7	148.7																	
24	PIV	129.7	65.1	64.6																
26	PIV	125.2	62.3															62.9		
27	SDI	108.4	59.6		48.8															
28	SDI	51.5	51.5	51.5																
29	DRY	221.6	117.3				104.3													
30	SDI	21.8	21.8																	
31	PIV	121.9	66.8																	55.1
32	PIV	70.0	70	70																
33	PIV	70.0		70																
34	PIV	726.6	364	182		362.6														
	Total 2012 acres	**4732.4**	**2569.7**	**706.7**	**136**	**855.2**	**297.9**	**50.5**	**74.6**	**16**	**191.8**	**191.8**	**490.8**	**111.8**	**150**	**0**	**0**	**62.9**	**115.7**	**55.1**
# of sites		**29**	**23**	**9**	**2**	**5**	**3**	**1**	**2**	**1**	**2**	**2**	**5**	**1**	**3**	**0**	**0**	**1**	**1**	**1**
Site	**irrigation type**	**System acres**	**cotton**	**corn grain**	**Corn silage**	**fallow**	**grain sorghum**	**Seed Sorghum**	**forage sorghum for hay**	**alfalfa**	**grass seed**	**hay**	**perennial forage**	**cattle**	**wheat for grain**	**wheat for silage**	**wheat for grazing**	**Sunflowers**	**Triticale silage**	**seed millet**

PIV = pivot irrigation SDI = subsurface drip irrigation FUR = furrow irrigation DRY = dryland, no irrigation

**Yellow denotes field was abandoned due to hail/drought, tan denotes partially abandoned, brown denotes fallowed



Site 1 Description

Total site acres: 135.2

Field No. 1 Acres: 24.6
Major soil type: Estacado clay loam; 1 to 3% slope

Field No. 2 Acres: 37.7
Major soil type: Lofton clay loam, 0 to 1% slope
Pullman clay loam, 1 to 3% slope

Field No. 3 Acres: 37.0
Major soil type: Pullman clay loam, 0 to 1% slope

Field No. 4 Acres: 35.9
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Subsurface Drip (SDI)
(Field 1 and 2 installed prior to 2004 crop year)
(Field 3 and 4 installed prior to 2006 crop year)

Pumping capacity, gal/min: 850

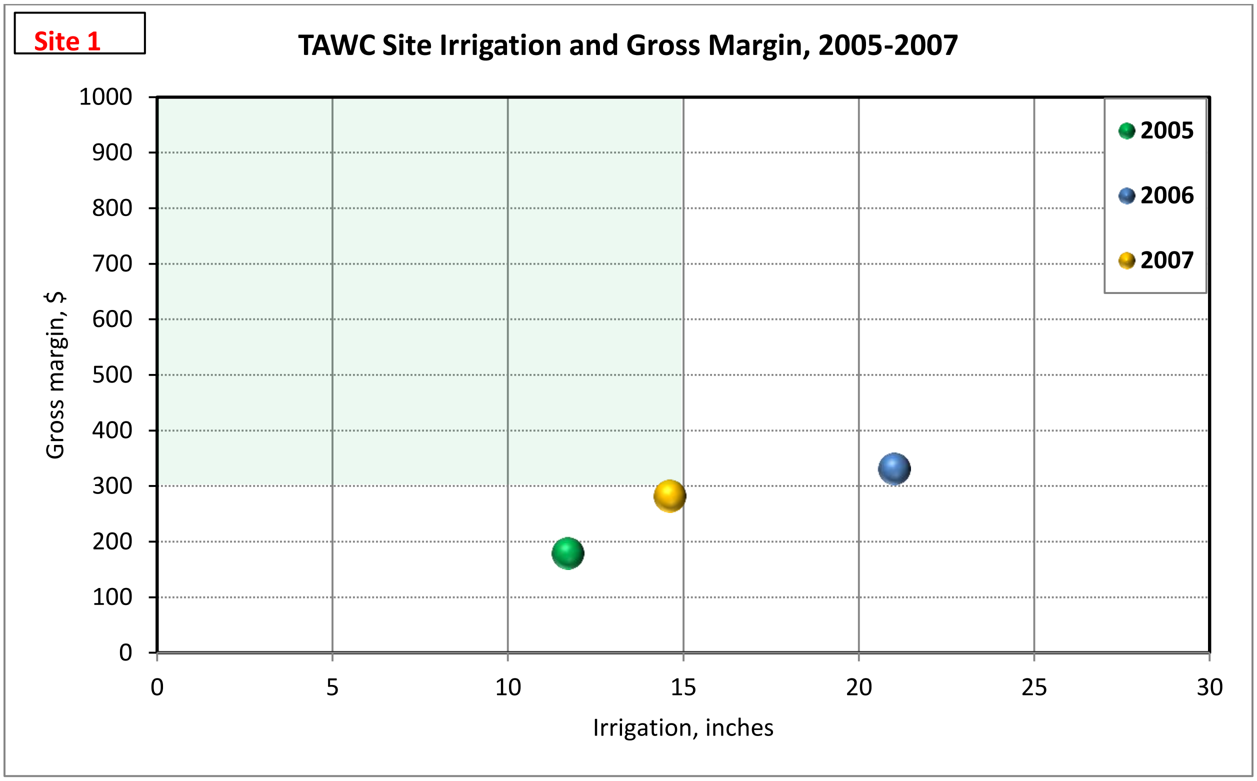
Number of wells: 2

Fuel source: Electric
Natural gas

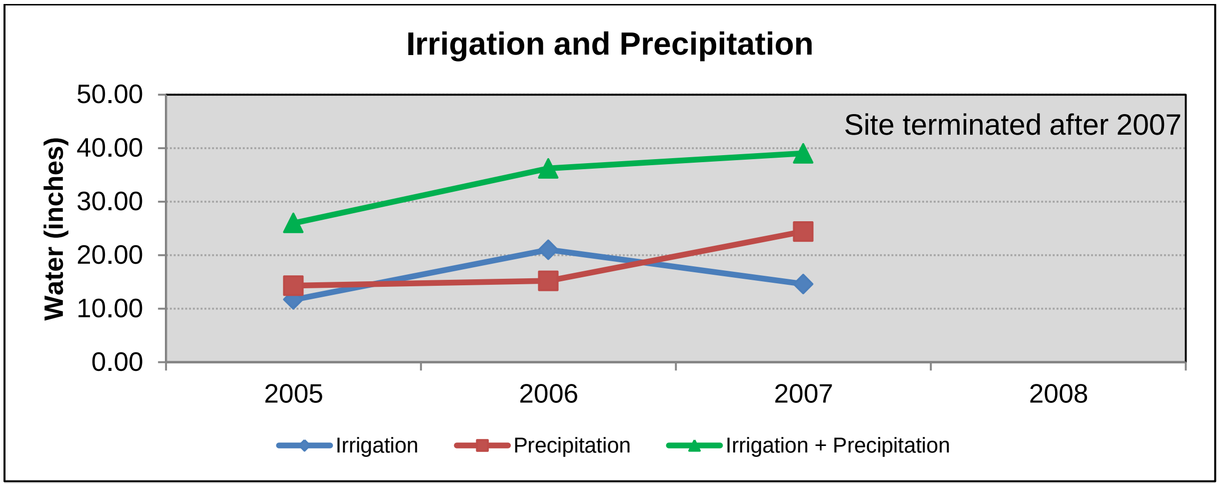
Comments: Drip irrigation cotton and corn system, conventional tillage with crops planted on 40-inch centers.

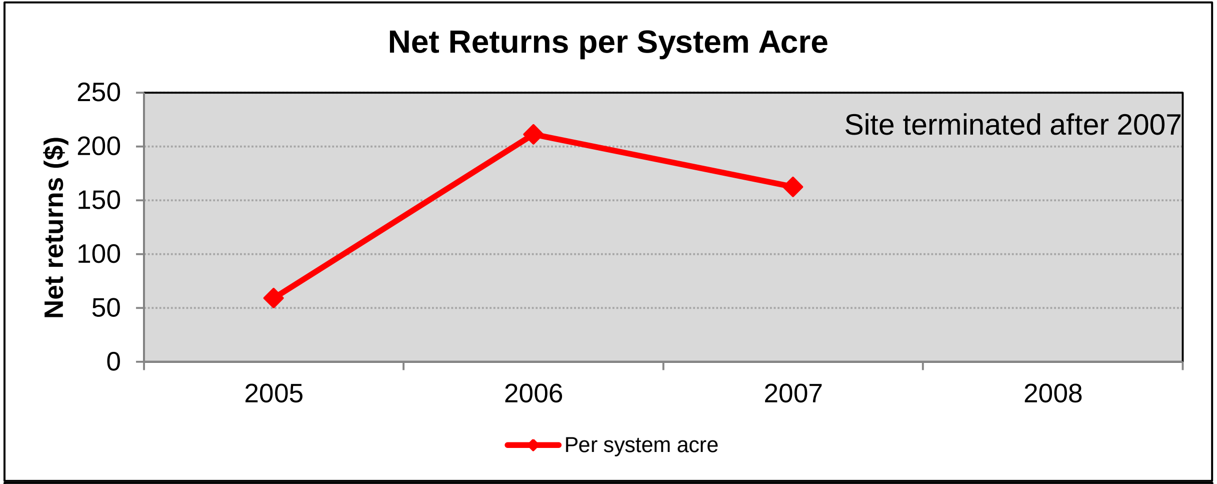
Site 1

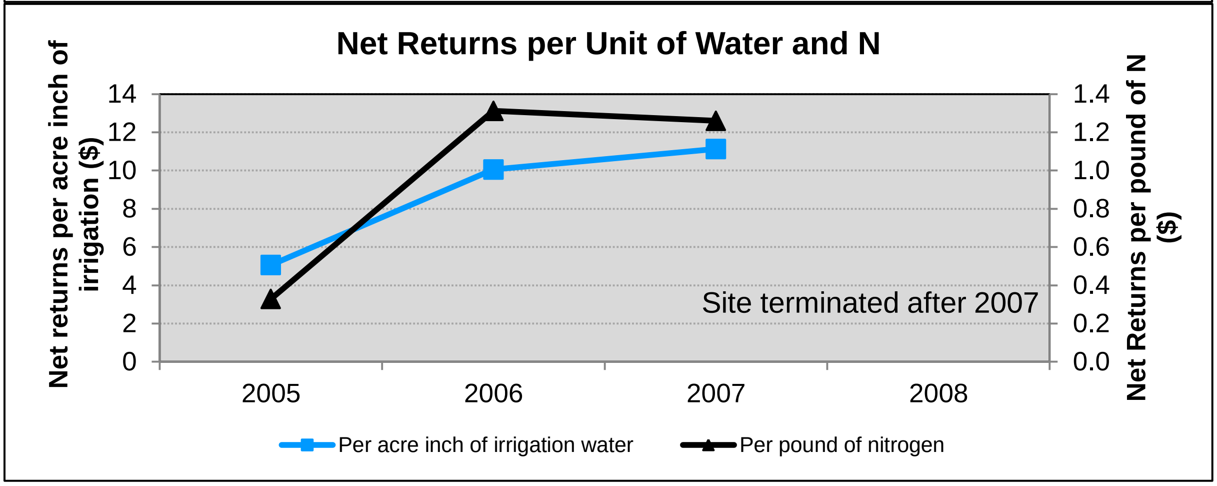
	Livestock	Field 1	Field 2	Field 3	Field 4
2005	None	Cotton	Cotton		
2006	None	Cotton	Cotton	Cotton	Cotton
2007	None	Cotton	Cotton	Cotton	Cotton
2008	Site terminated in 2008				

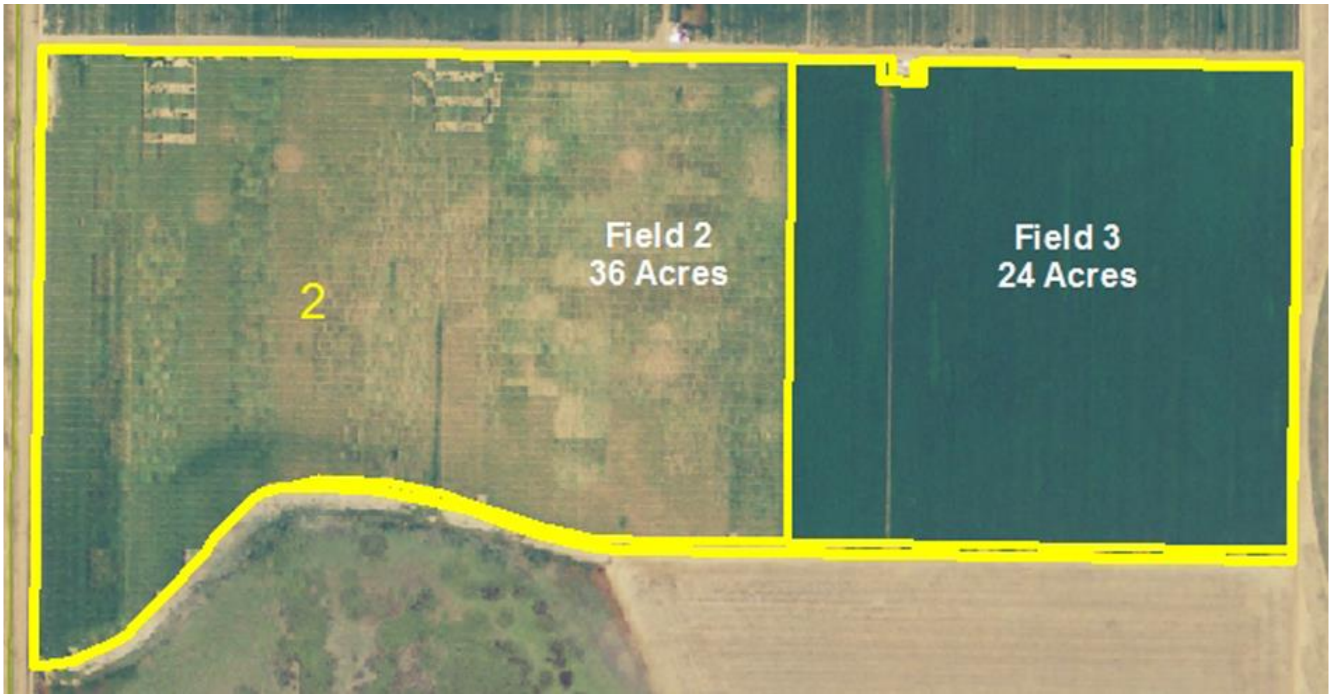


Site 1


Irrigation and Precipitation
Water (inches)
50.00
40.00
30.00
20.00
10.00
0.00
2005
2006
2007
2008
Site terminated after 2007
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
250
200
150
100
50
0
2005
2006
2007
2008
Site terminated after 2007
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
14
12
10
8
6
4
2
0
Net Returns per pound of N ($)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2005
2006
2007
2008
Site terminated after 2007
Per acre inch of irrigation water
Per pound of nitrogen



Site 2 Description

Total site acres:	60
Field No. 2 Acres:	36
Major soil type:	Pullman clay loam, 0 to 1% slope Olton clay loam, 1 to 3% slope
Field No. 3 Acres:	24
Major soil type:	Pullman clay loam, 0 to 1% slope Olton clay loam, 1 to 3% slope

Irrigation

Type:	Sub-surface Drip (SDI, installed prior to 2004 crop year)
Pumping capacity, gal/min:	360
Number of wells:	2
Fuel source:	Electric

Site 2

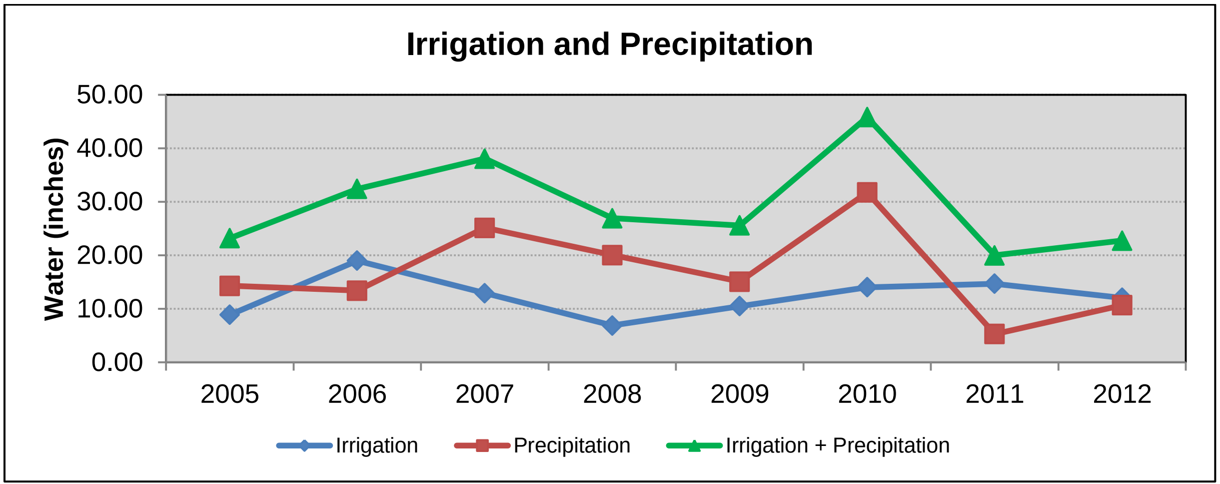
	Livestock	Field 1	Field 2
2005	None	Cotton	
2006	None	Cotton	
2007	None	Cotton	
2008	None	Sunflowers	
2009	None	Cotton	
2010	None	Corn	
	Livestock	Field 2	Field 3
2011	None	Cotton	Fallowed
2012	None	Corn	Cotton

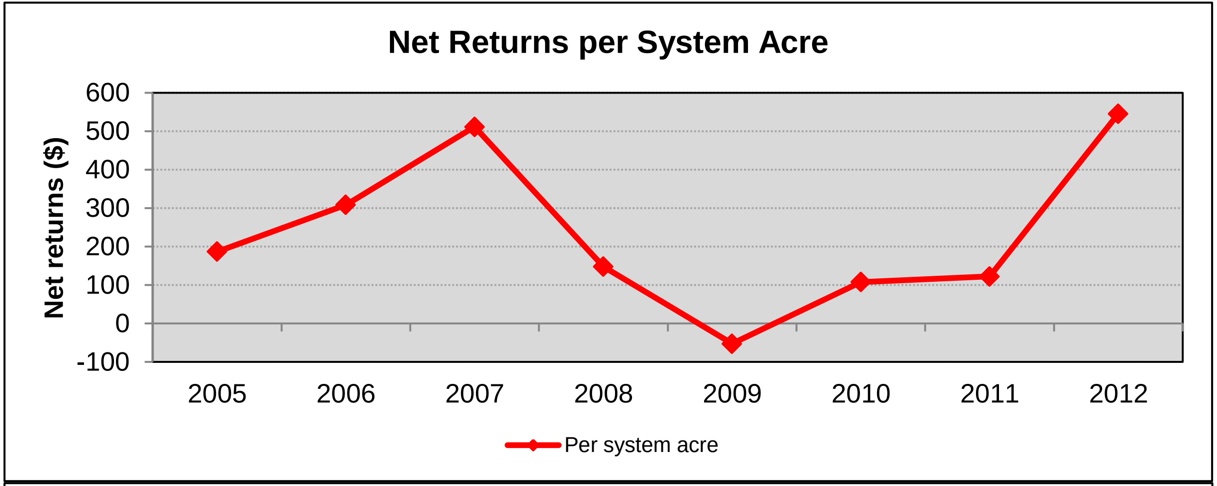
Comments: This drip site was planted to corn and cotton on 30-inch centers in 2012. In prior years the cropping mix for this site was corn, cotton or sunflowers.

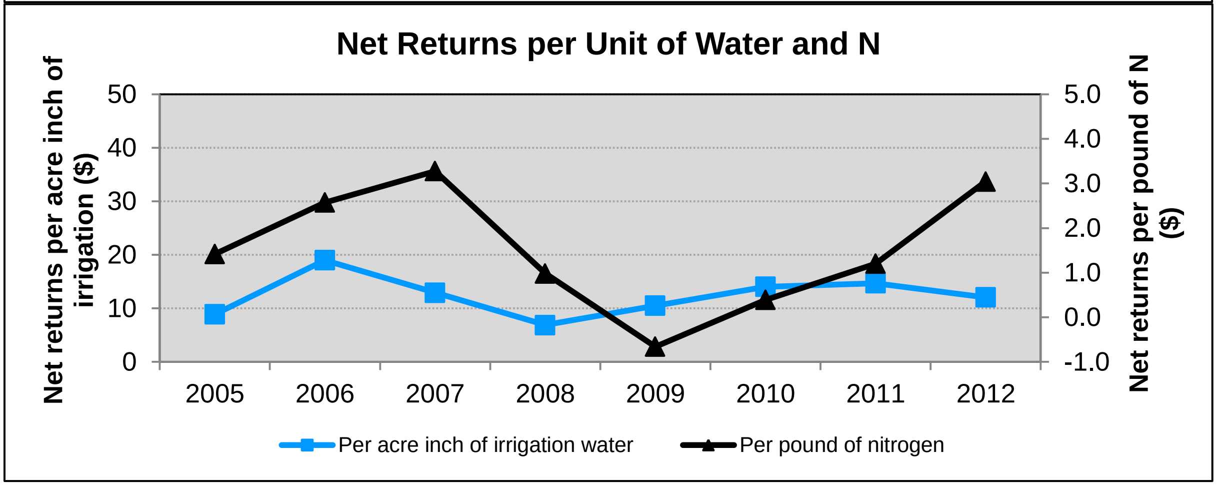
Cotton over Drip Irrigation

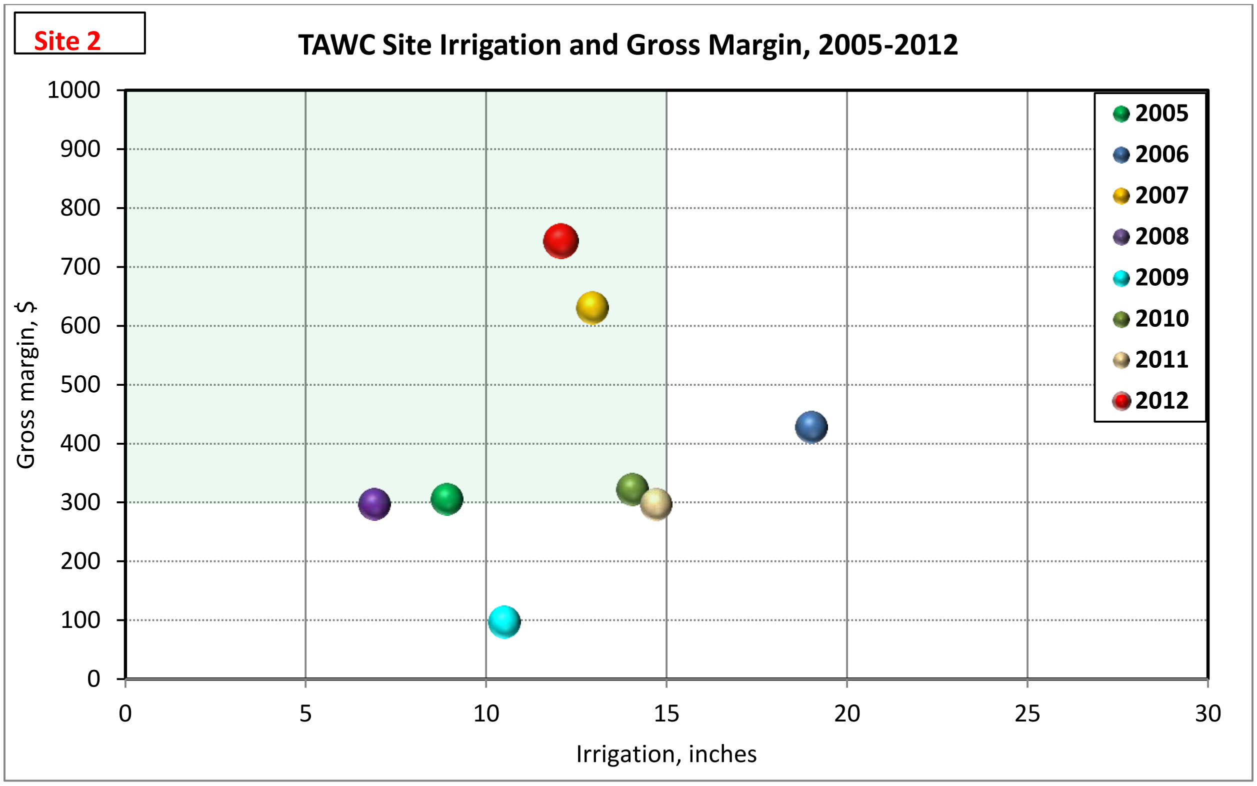
Corn field

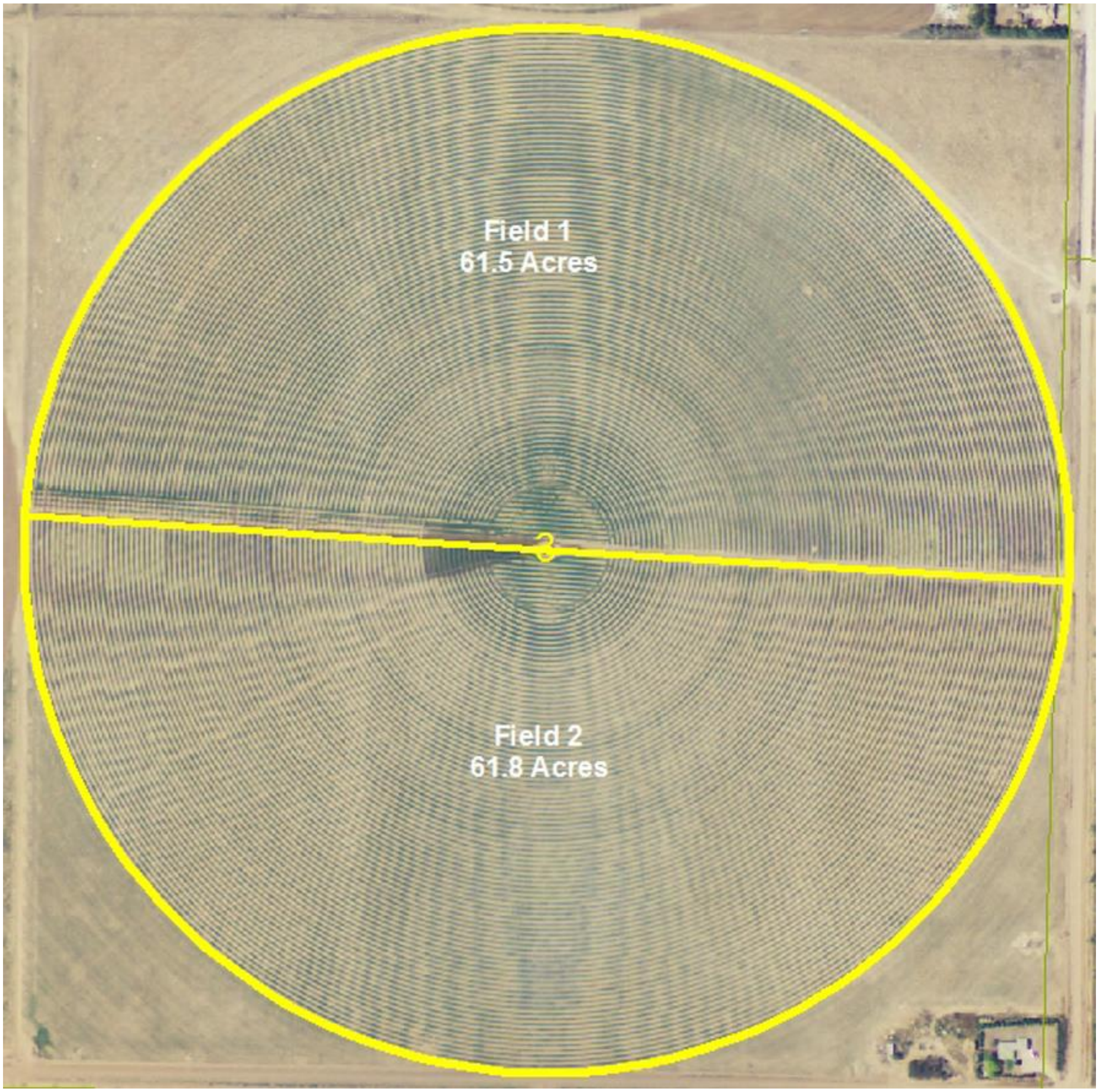
Site 2


Irrigation and Precipitation
Water (inches)
50.00
40.00
30.00
20.00
10.00
0.00
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
600
500
400
300
200
100
0
-100
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
50
40
30
20
10
0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 2
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012



Site 3 Description		Irrigation	
Total site acres:	123.3	Type:	Center Pivot (MESA)
Field No. 1 Acres:	61.5	Pumping capacity, gal/min:	450
Major soil type:	Pullman clay loam; 0 to 1% slope		
Field No. 2 Acres:	61.8	Number of wells:	2
Major soil type:	Pullman clay loam; 0 to 1% slope		
		Fuel source:	1 Natural gas 1 Electric

Site 3

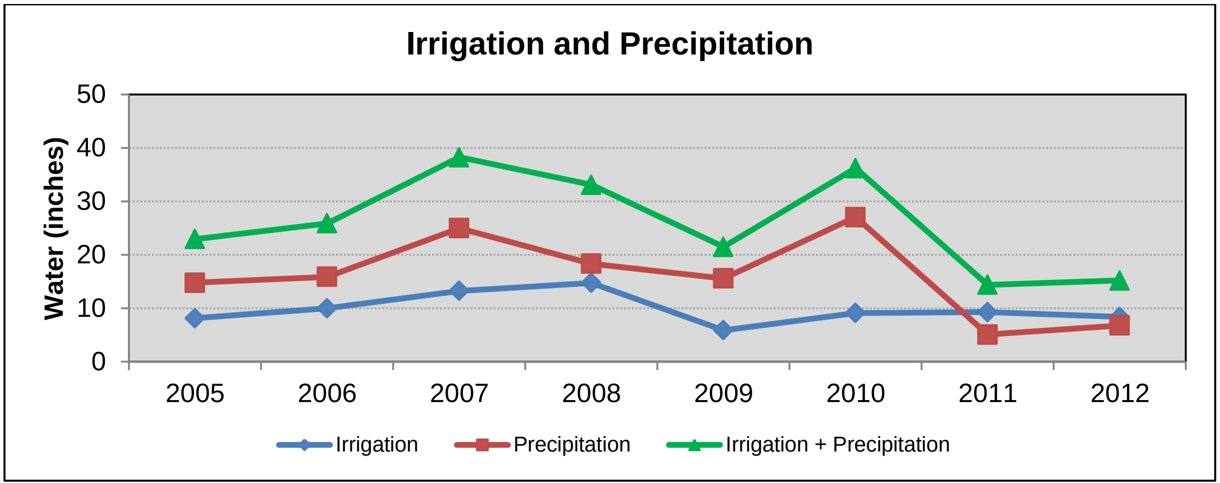
	Livestock	Field 1	Field 2
2005	None	Grain Sorghum	Cotton
2006	None	Cotton	Cotton
2007	None	Cotton following Wheat cover crop	Wheat for grain followed by Grain Sorghum
2008	None	Wheat for grain followed by Grain Sorghum	Cotton
2009	None	Wheat/Grain Sorghum	Cotton
2010	None	Cotton	Wheat/Grain Sorghum
2011	None	Cotton	Cotton
2012	None	Cotton	Cotton

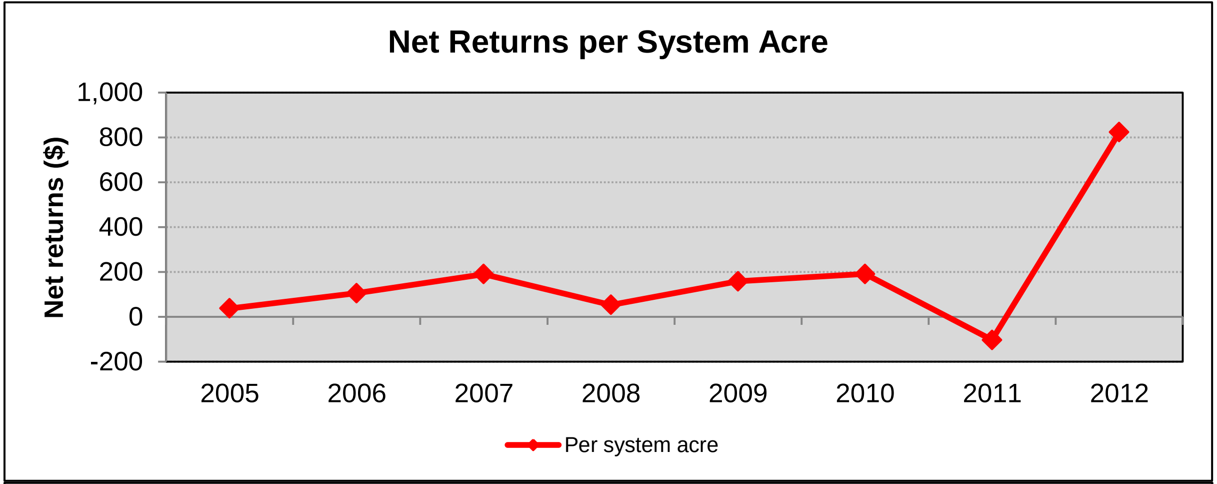
Comments: This is a pivot irrigated system using conventional tillage, and row crops are planted on 40-inch centers. Crops have included cotton, wheat and grain sorghum. In 2012 this site was planted to cotton in a skip-row pattern.

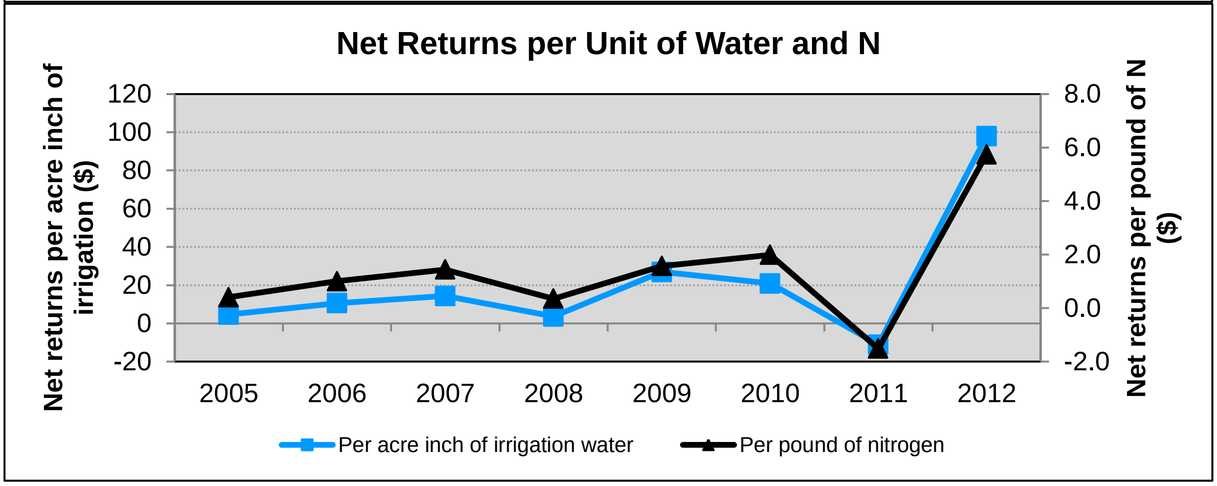
June skip-row cotton

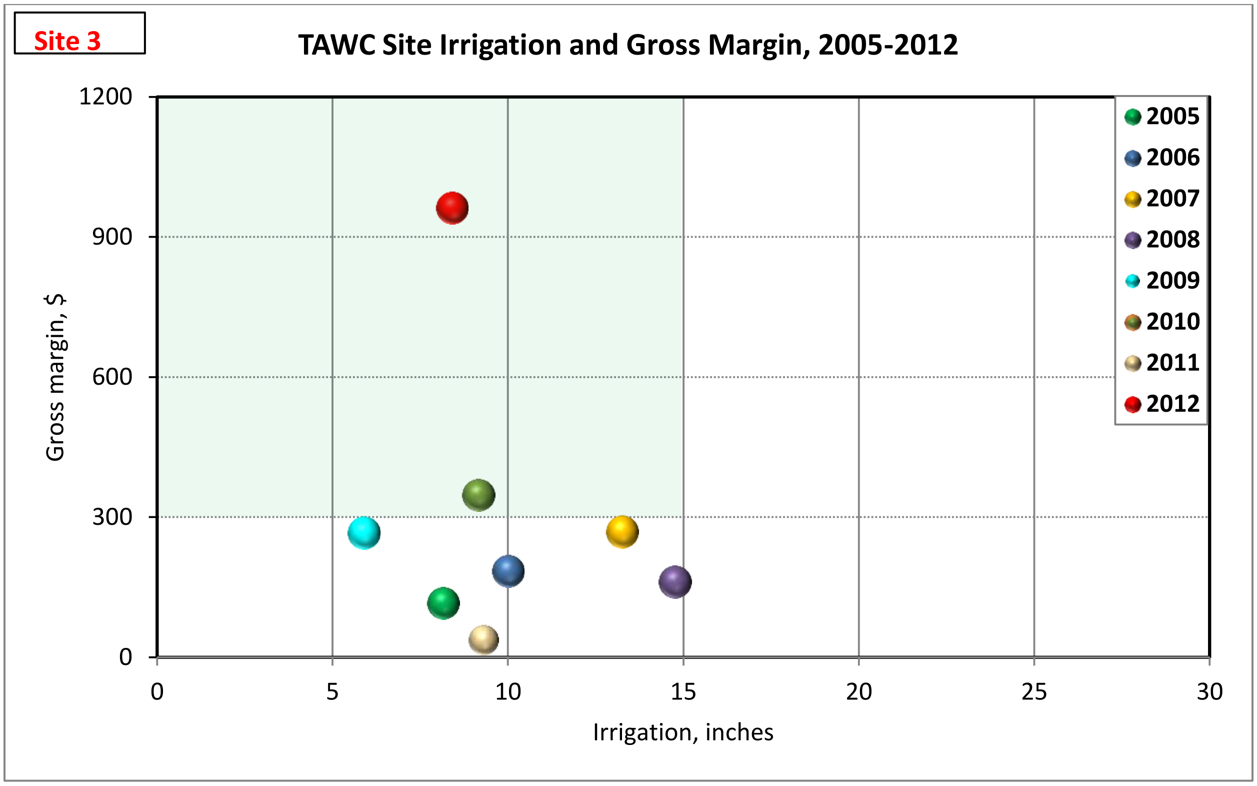
August cotton

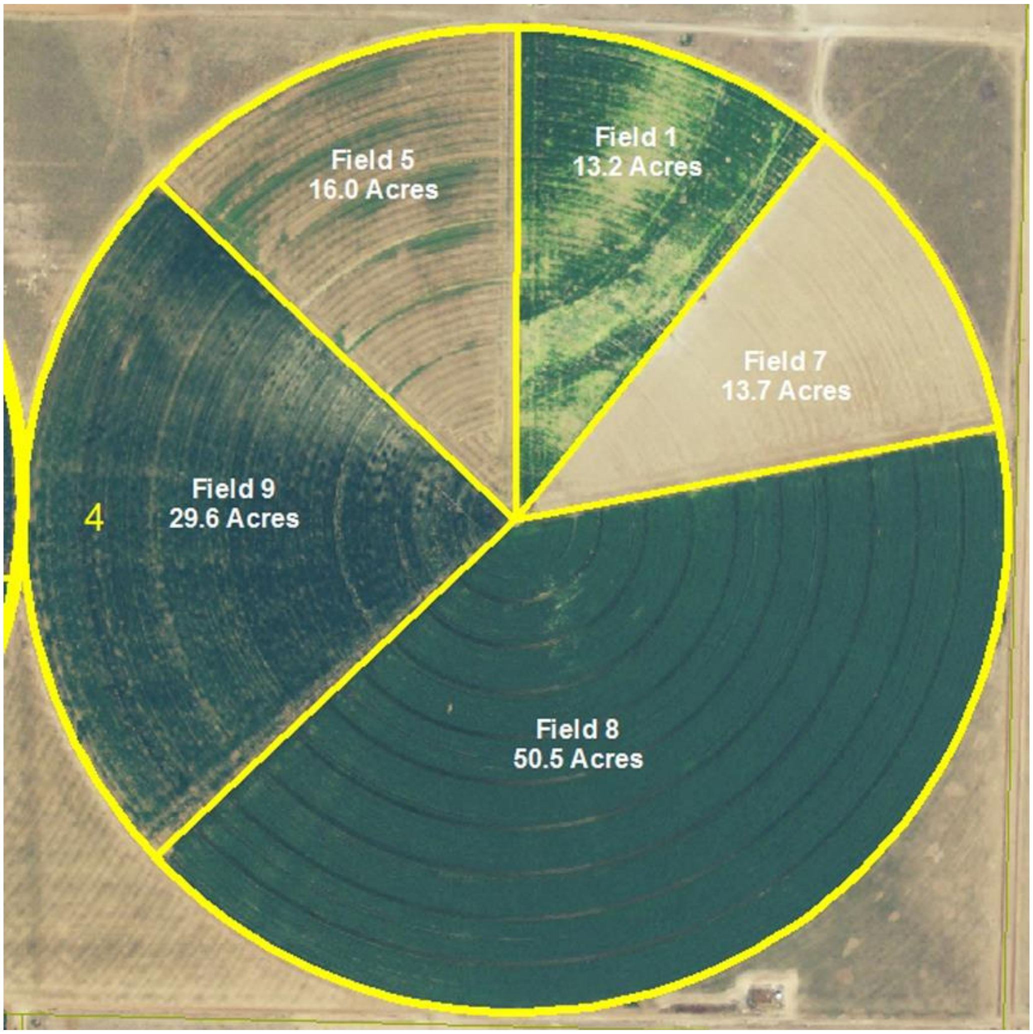
Site 3


Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
1,000
800
600
400
200
0
-200
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
120
100
80
60
40
20
0
-20
Net returns per pound of N ($)
8.0
6.0
4.0
2.0
0.0
-2.0
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 3
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1200
900
600
300
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012



Site 4 Description

Total site acres:	123.0
Field No. 1 Acres:	13.2
Major soil type:	Estacado clay loam, 1 to 3% slope
Field No. 5 Acres:	16.0
Major soil type:	Pullman clay loam, 0 to 1% slope
Field No. 7 Acres:	14.7
Major soil type:	Pullman clay loam, 0 to 1% slope
Field No. 8 Acres:	50.5
Major soil type:	Pullman clay loam, 0 to 1% slope
Field No. 9 Acres:	29.6
Major soil type:	Pullman clay loam, 0 to 1% slope

Irrigation

Type:	Center Pivot (LESA)
Pumping capacity, gal/min:	500
Number of wells:	3
Fuel source:	1 Natural gas 2 Electric

Site 4

	Livestock	Field 1	Field 2	Field 3	Field 4	Field 5
2005	None	Alfalfa for hay	Cotton following Wheat cover crop	Cotton following Wheat cover crop		
2006	None	Alfalfa for hay	Wheat for silage, followed by Forage Sorghum for silage and hay	Cotton		
2007	Cow-calf	Alfalfa for hay	Wheat for grazing (winter-spring) and cover crop, followed by Cotton	Wheat for grain, followed by Wheat for grazing (fall-winter)		
2008	Cow-calf	Alfalfa for hay	Grain Sorghum	Wheat for grain, followed by Wheat for grazing (fall-winter) and partly planted to Alfalfa		
2009	None	Cotton	Wheat/hay	Split into Fields 4 and 5	Grain Sorghum	Alfalfa
2010	None	Cotton	Cotton		Wheat/Forage Sorghum	Alfalfa
	Livestock	Field 1	Field 5		Field 6	Field 7
2011	None	Hay Grazer	Alfalfa		Cotton	Wheat
	Livestock	Field 1	Field 5	Field 7	Field 8	Field 9
2012	None	Wheat/haygrazer	Alfalfa	Wheat	Sorghum	Cotton

Comments: This pivot irrigated system uses strip tillage. Crops planted for 2012 include alfalfa, cotton, wheat, sorghum and forage sorghum. Forage sorghum and alfalfa were harvested for hay to be used in this producer’s cow-calf program.

Site 4

September Cotton

August Alfalfa

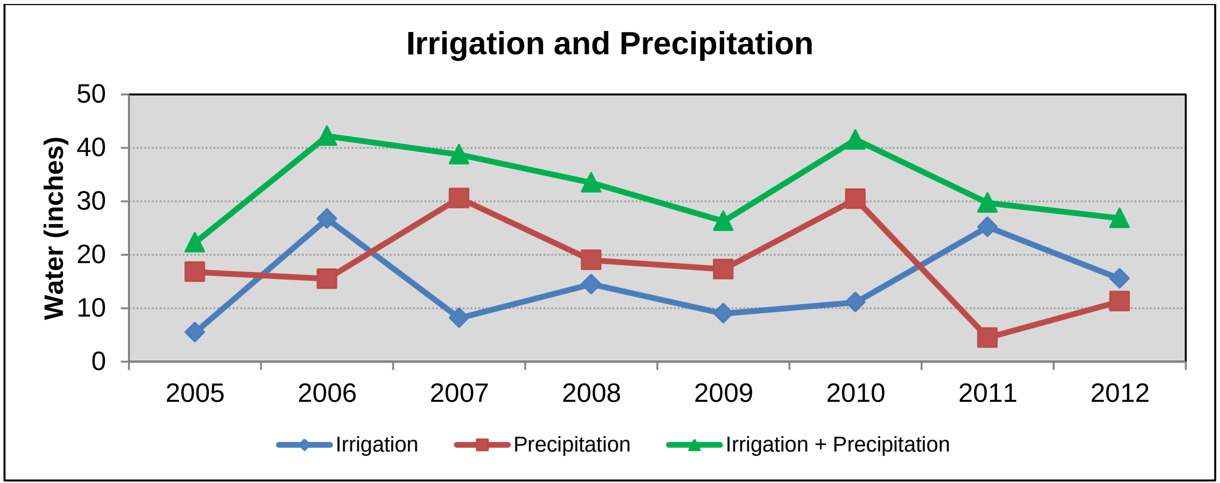
Swathed Alfalfa

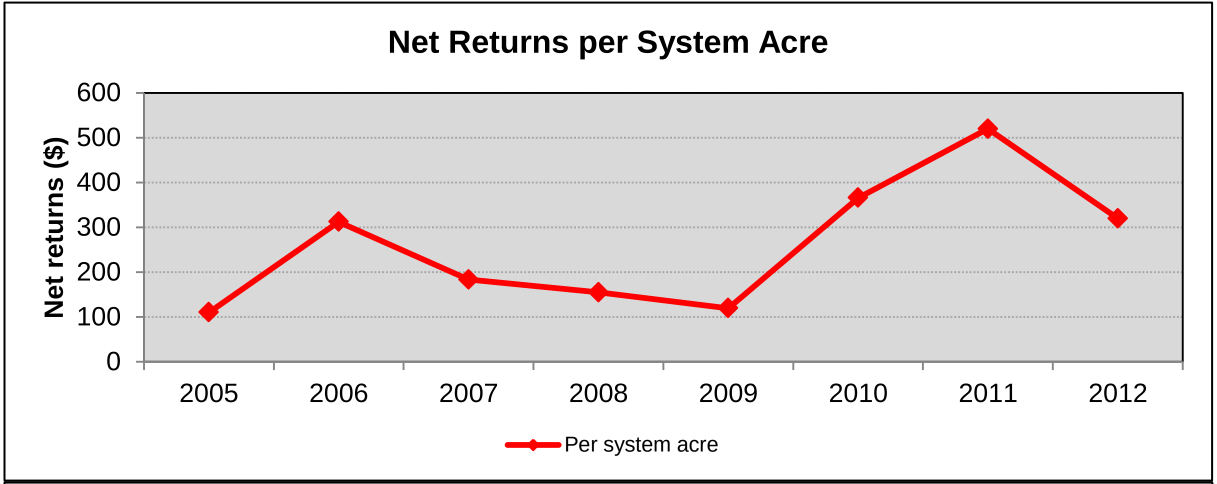
June Sorghum

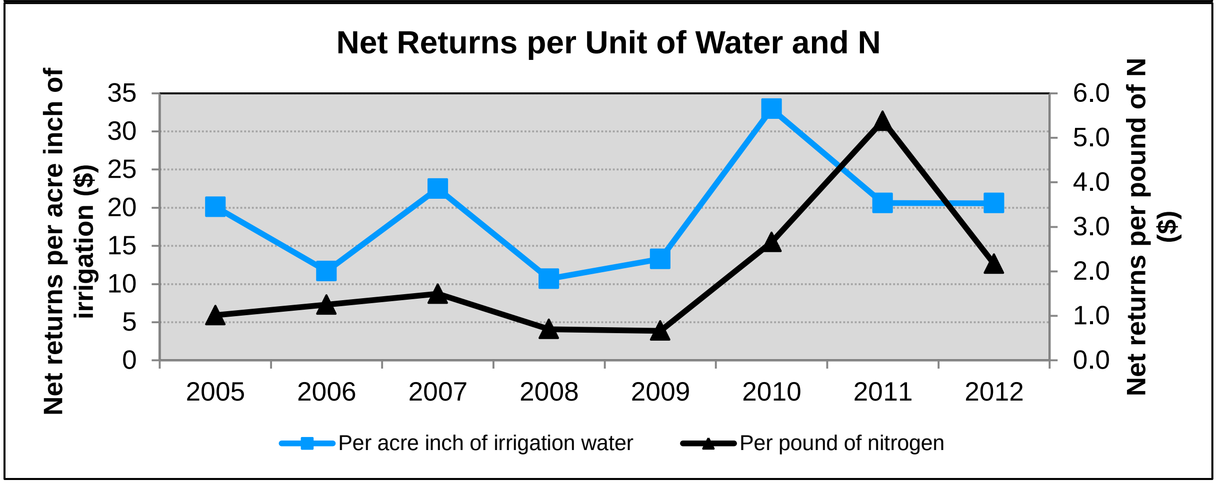
August Sorghum

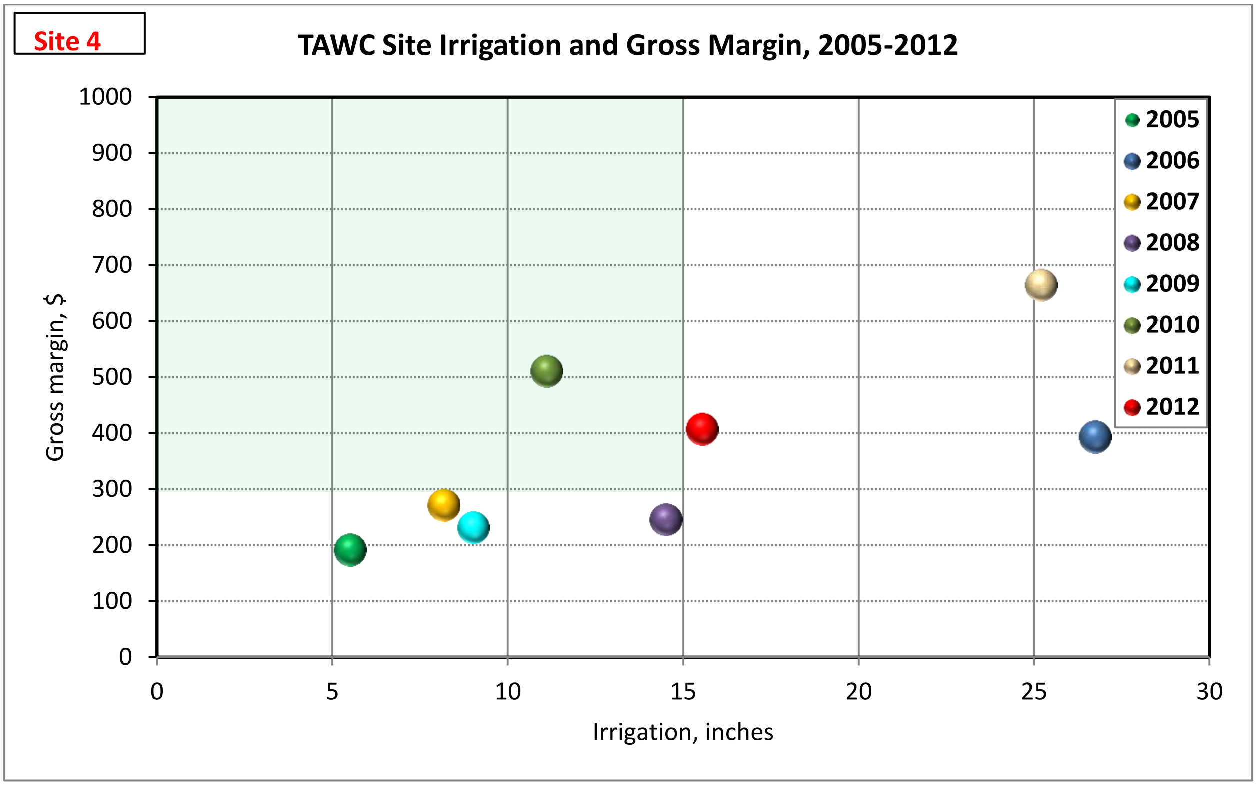
September Sorghum

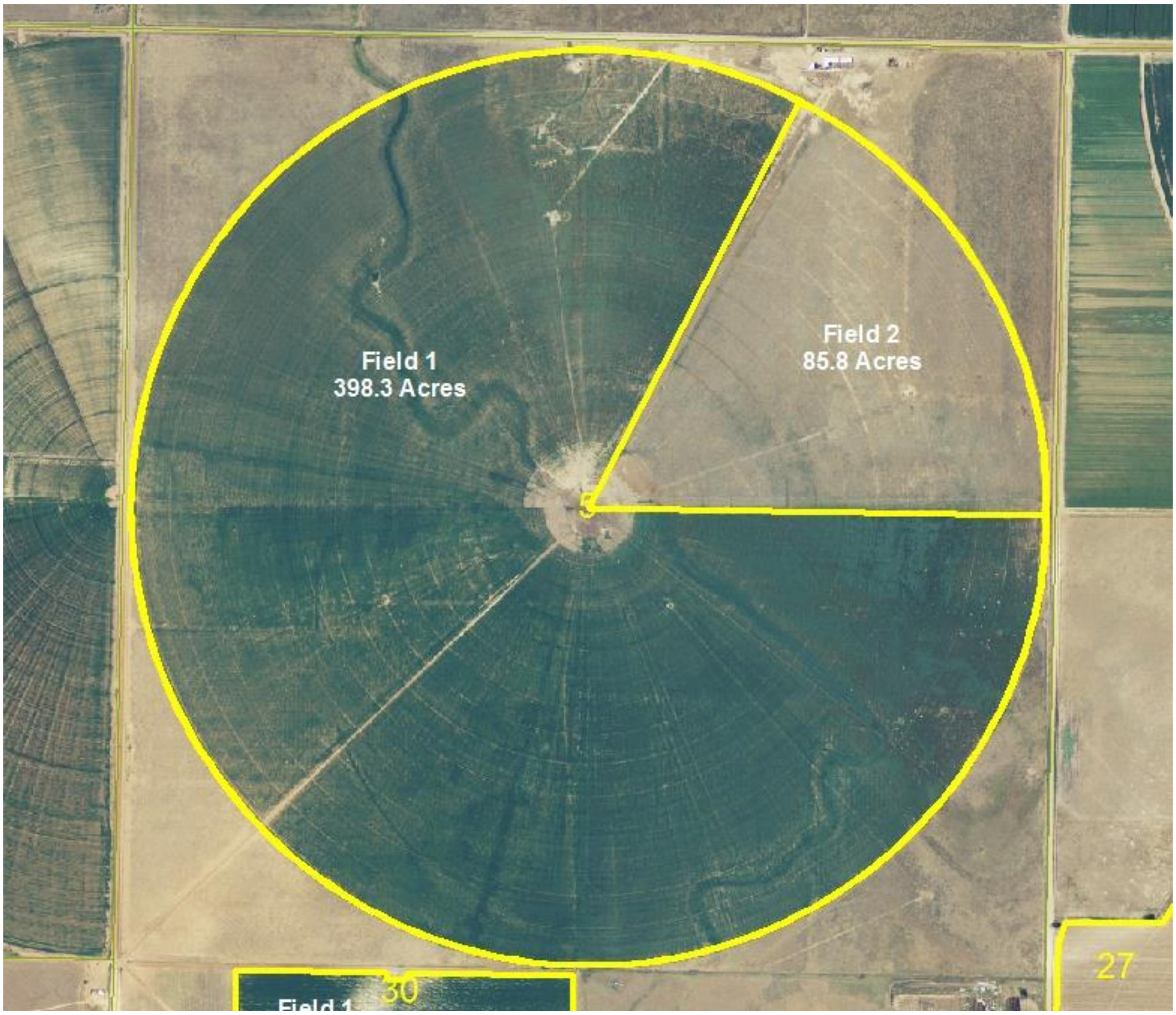
Site 4


Irrigation and Precipitation
Water (inches)
0
10
20
30
40
50
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
0
100
200
300
400
500
600
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
0
5
10
15
20
25
30
35
Net returns per pound of N ($)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 4
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012



Site 5 Description

Total site acres: 484.1

IRRIGATED

Field No. 1 Acres: 398.3
Major soil type: Bippus loam, 0 to 1% slope
Mansker loam, 0 to 3 and 3 to 5% slope
Olton loam, 0 to 1% slope

Field No. 2 Acres: 85.8
Major soil type: Olton loam, 0 to 1% slope
Bippus loam, 0 to 1% slope
Mansker loam, 0 to 3% slope

Irrigation

Type: Center Pivot (MESA)

Pumping capacity, gal/min: 1100

Number of wells: 4

Fuel source: Electric

Site 5 *Crops - Irrigated*

	Livestock	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6
2005	Cow-calf	Klein/Plains/Dahl/Blue grama/Buffalograss mixture for grazing	Plains/Blue grama/Klein mixture for grazing	Plains/Klein/Blue grama mixture for grazing	Plains/Blue grama/Klein mixture for grazing	Plains/Klein/Blue grama mixture for grazing	Alfalfa/Plains/Blue grama/Klein mixture for grazing
2006	Cow-calf	Klein/Plains/Dahl/Blue grama/Buffalograss mixture for grazing	Plains/Blue grama/Klein mixture for grazing	Renovated, Plains/Klein/Blue grama/Dahl mixture for grazing and hay	Plains/Blue grama/Klein mixture for grazing	Plains/Klein/Blue grama mixture for grazing	Alfalfa/Plains/blue grama/Klein mixture for grazing
2007	Cow-calf	Klein/Plains/Dahl/Blue grama/Buffalograss mixture for grazing	Plains/Blue grama/Klein mixture for grazing	Plains/Klein/Blue grama/Dahl mixture for grazing	Plains/Blue grama/Klein mixture for grazing	Renovated, Plains/Klein/Dahl mixture for grazing and hay	Dahl/Green sprangletop/Plains mixture for grazing and hay
2008	Cow-calf	Klein/Plains/Dahl/Blue grama/Buffalograss mixture for grazing	Plains/Blue grama/Klein mixture for grazing	Plains/Klein/Blue grama/Dahl mixture for grazing	Plains/Blue grama/Klein mixture for grazing	Renovated, Plains/Klein/Dahl mixture for grazing and hay	Dahl/Green sprangletop/Plains mixture for grazing and hay
2009	Cow-calf	Klein/Plains/Dahl/Blue grama/Buffalograss mixture for grazing	Plains/Blue grama/Klein mixture for grazing	Plains/Klein/Blue grama/Dahl mixture for grazing	Plains/Blue grama/Klein mixture for grazing	Renovated, Plains/Klein/Dahl mixture for grazing and hay	Dahl/Green sprangletop/Plains mixture for grazing and hay
2010	Cow-calf	Klein/Plains/Dahl/Blue grama/Buffalograss mixture for grazing	Plains/Blue grama/Klein mixture for grazing	Plains/Klein/Blue grama/Dahl mixture for grazing	Plains/Blue grama/Klein mixture for grazing	Renovated, Plains/Klein/Dahl mixture for grazing and hay	Dahl/Green sprangletop/Plains mixture for grazing and hay
	Livestock	Field 12	Field 13				
2011	None	Fallowed	Cotton/abandoned				
	Livestock	Field 1	Field 2				
2012	None	Cotton	Cotton				

Site 5 *Crops - Dryland*

	Field 7	Field 8	Field 9	Field 10	Field 11	Fields 12 and 13
2005	Plains/Blue grama mixture for grazing	Plains/Blue grama/Sand dropseed/Buffalograss mixture for grazing	Plains/Blue grama mixture for grazing	Plains/Blue grama mixture for grazing	Plains/Blue grama mixture for grazing	Pens and barns
2006	Plains/Blue grama mixture for grazing	Plains/Blue grama/Sand dropseed/Buffalograss mixture for grazing	Plains/Blue grama mixture for grazing	Plains/Blue grama mixture for grazing	Plains/Blue grama mixture for grazing	Pens and barns
2007	Plains/Blue grama mixture for grazing	Plains/Blue grama/Sand dropseed/Buffalograss mixture for grazing	Plains/Blue grama mixture for grazing	Plains/Blue grama mixture for grazing	Plains/Blue grama mixture for grazing	Pens and barns
2008	Plains/Blue grama mixture for grazing	Plains/Blue grama/Sand dropseed/Buffalograss mixture for grazing	Plains/Blue grama mixture for grazing	Plains/Blue grama mixture for grazing	Plains/Blue grama mixture for grazing	Pens and barns
2009	Plains/Blue grama mixture for grazing	Plains/Blue grama/Sand dropseed/Buffalograss mixture for grazing	Plains/Blue grama mixture for grazing	Plains/Blue grama mixture for grazing	Plains/Blue grama mixture for grazing	Pens and barns
2010	Plains/Blue grama mixture for grazing	Plains/Blue grama/Sand dropseed/Buffalograss mixture for grazing	Plains/Blue grama mixture for grazing	Plains/Blue grama mixture for grazing	Plains/Blue grama mixture for grazing	Pens and barns
	Livestock	Field 7,8,9,10,11				
2011	None	Corners/grass Plains/Blue grama Mixture for grazing (Not part of system-dropped in 2011)				

Comments: In 2012 this pivot irrigated site was planted to cotton and wheat. The cotton was planted on 30-inch centers and a cotton picker is used for harvest.

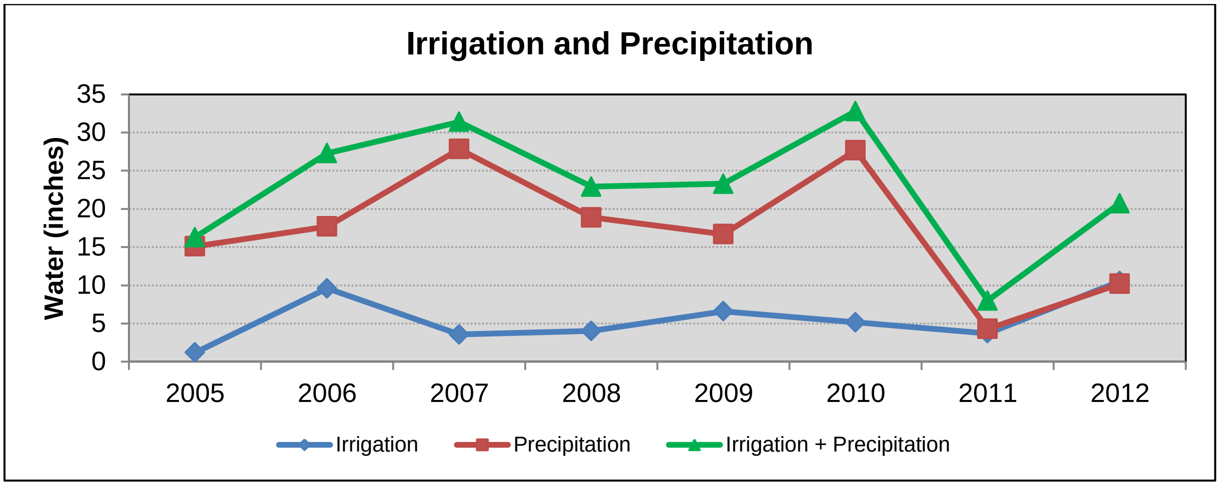
Site 5

June cotton

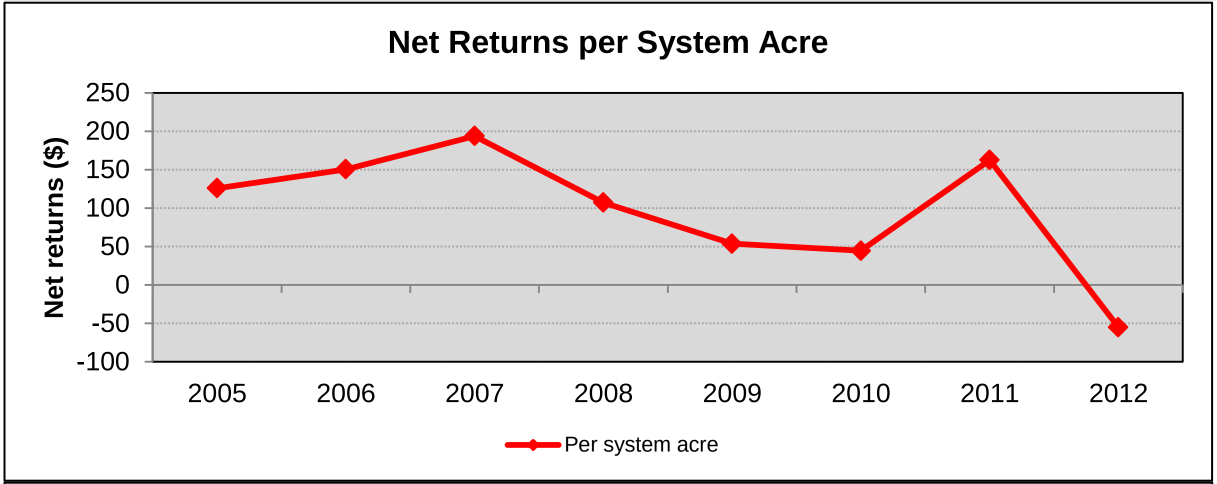
August cotton

Late January- cotton stalks

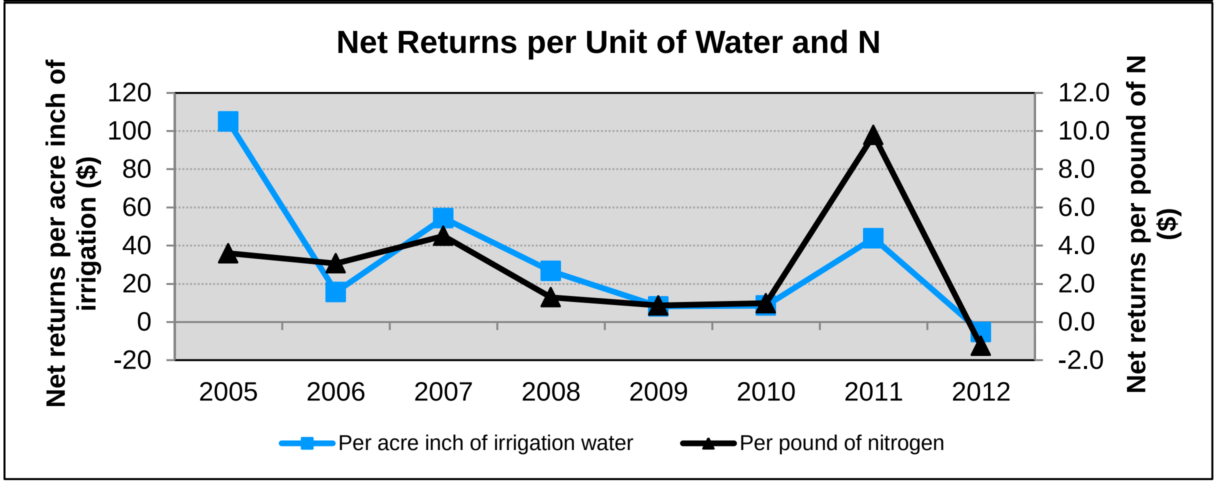
Site 5



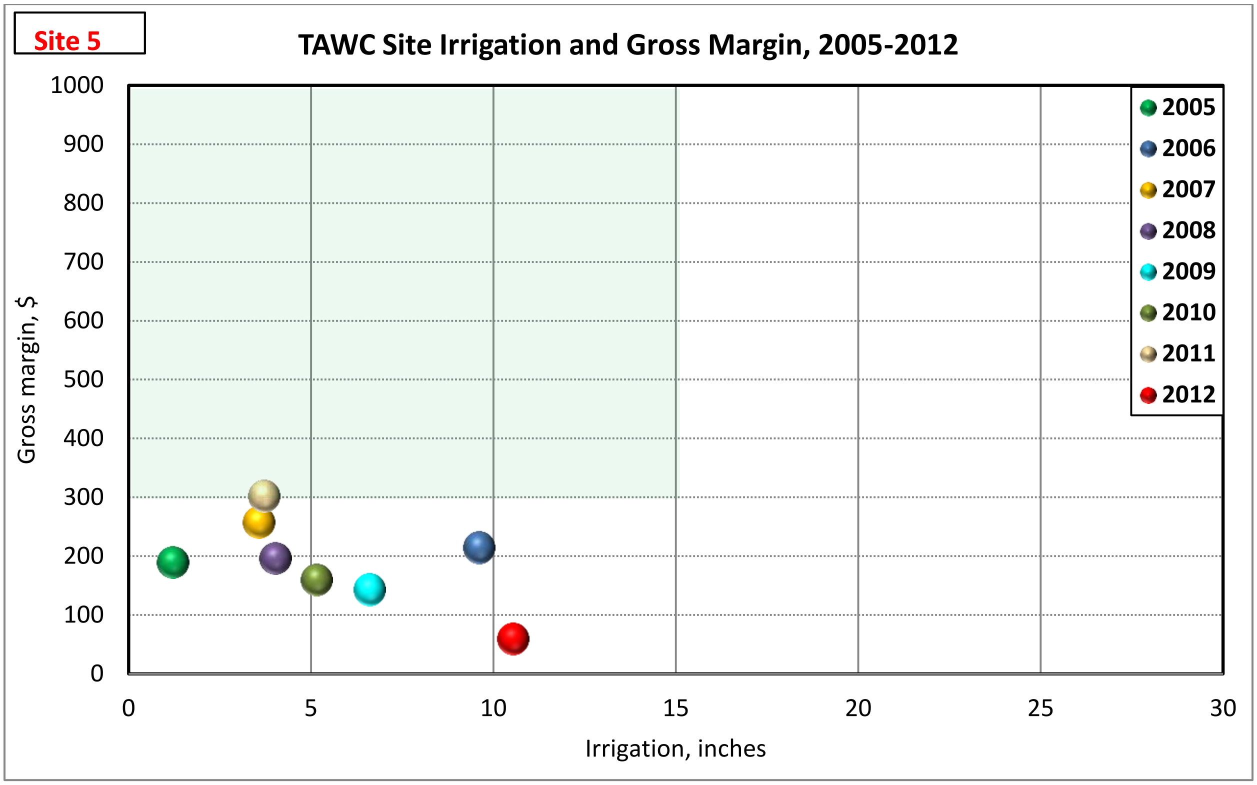
Irrigation and Precipitation
Water (inches)
35
30
25
20
15
10
5
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation

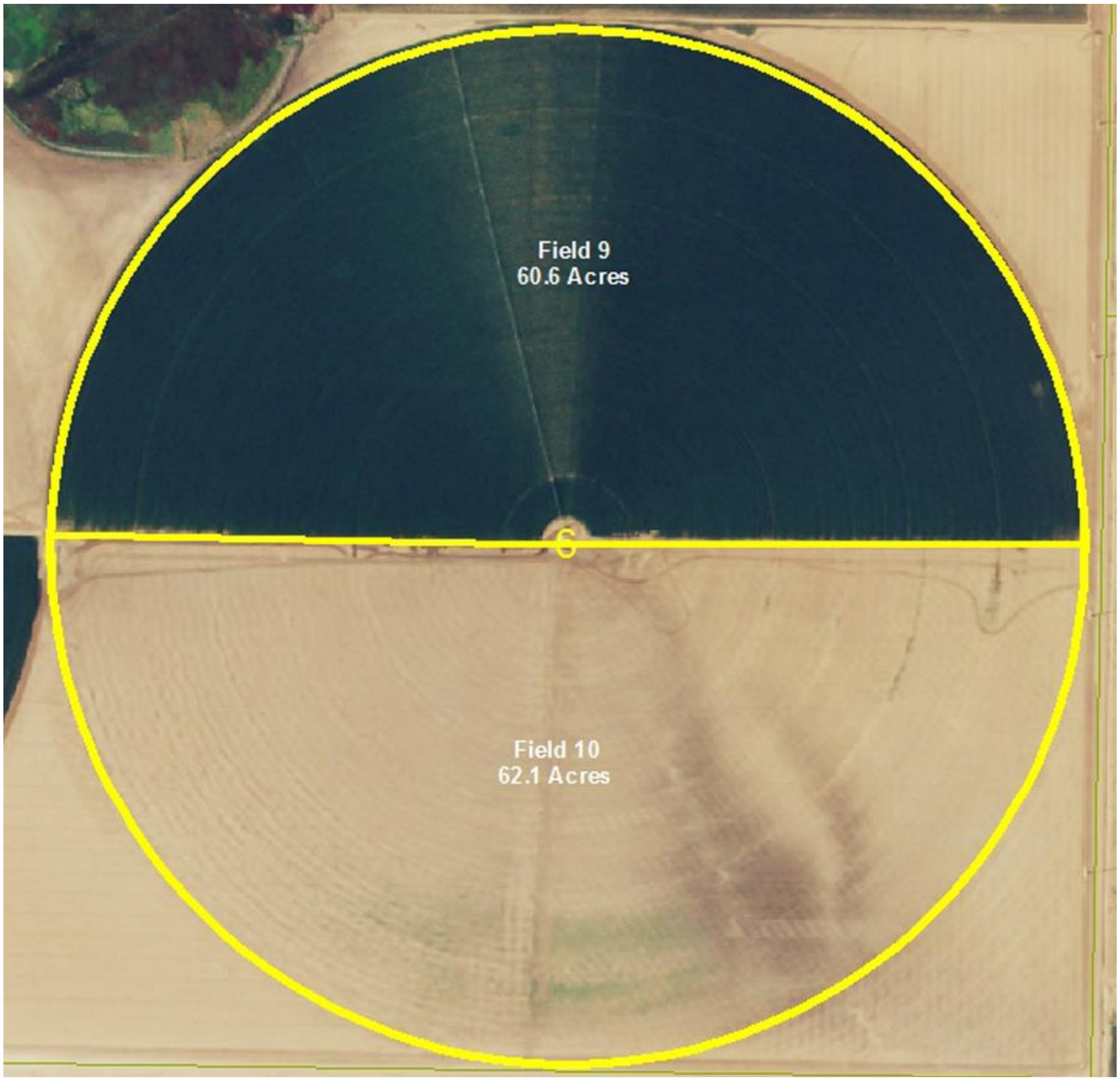


Net Returns per System Acre
Net returns ($)
250
200
150
100
50
0
-50
-100
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre



Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
120
100
80
60
40
20
0
-20
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 5
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012



Site 6 Description

Total site acres:	122.7
Field No. 9 Acres:	60.6
Major soil type:	Pullman clay loam, 0 to 1% slope
Field No. 10 Acres:	62.1
Major soil type:	Pullman clay loam, 0 to 1% slope

Irrigation

Type:	Center Pivot (LESA)
Pumping capacity, gal/min:	500
Number of wells:	4
Fuel source:	Natural gas

Site 6

	Livestock	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7	Field 8
2005	Stocker steers	Wheat for grazing and cover followed by Cotton							
2006	None	Cotton							
2007	None	Cotton							
2008	None	Split into Fields 2 and 3	Cotton	Corn for grain					
2009	None		Split into Fields 4 and 5		Cotton	Corn			
2010	None					Corn	Corn	Cotton	Cotton
2011	None					Cotton	Cotton	Cotton	Corn/Abandoned
	Livestock	Field 9	Field 10						
2012	None	Corn	Fallow						

Comments: In 2012 this site was planted to cotton on 40-inch centers and wheat. The cotton was lost to a June 4th hail storm and replanted to corn.

Site 6

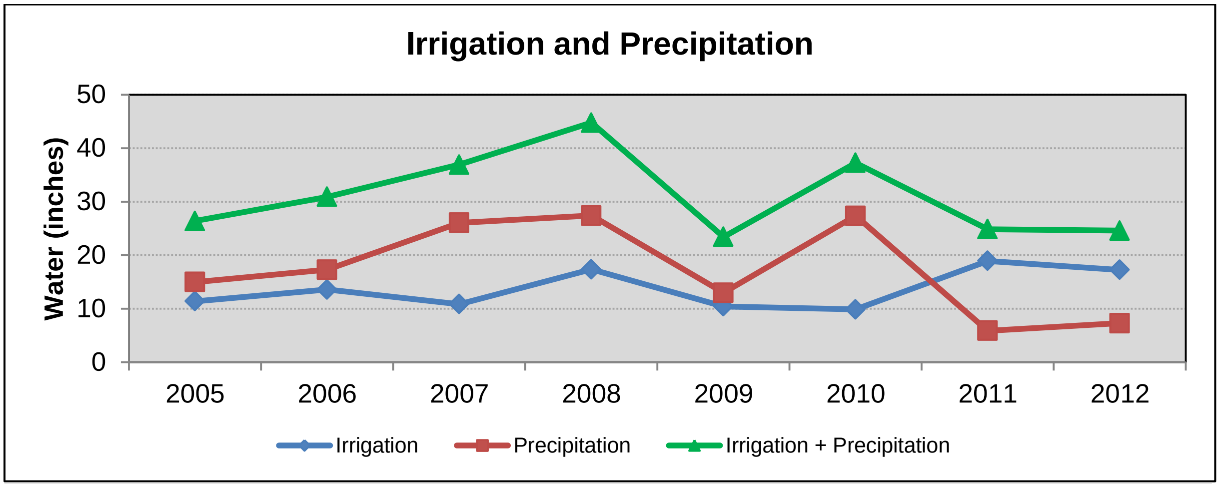
January wheat

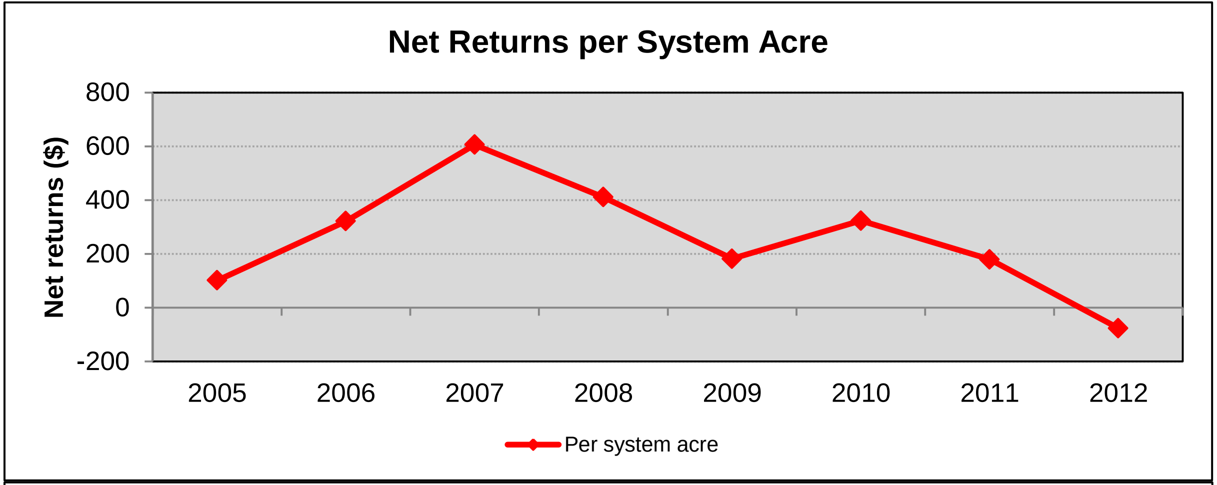
July corn

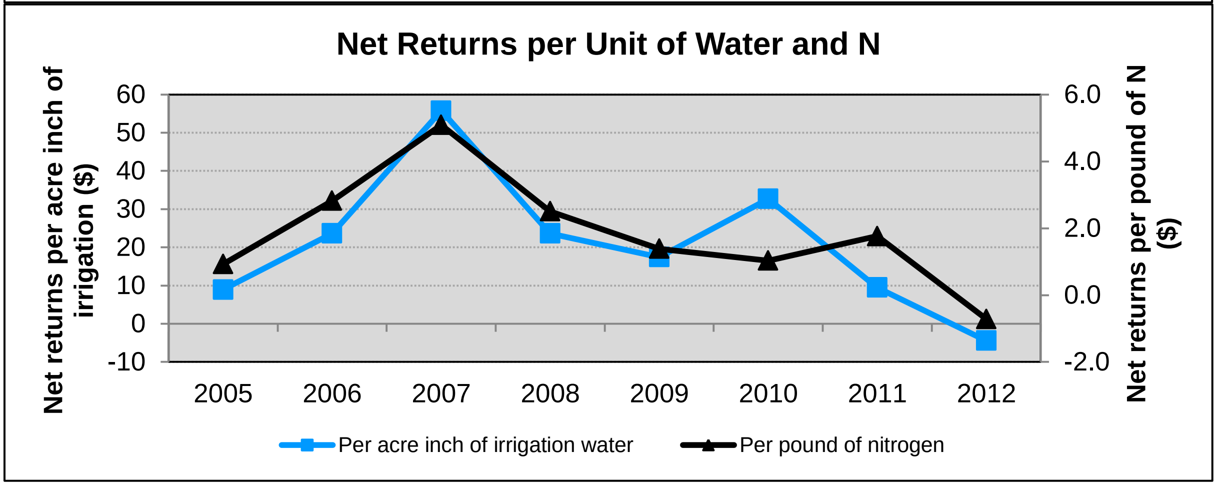
September corn

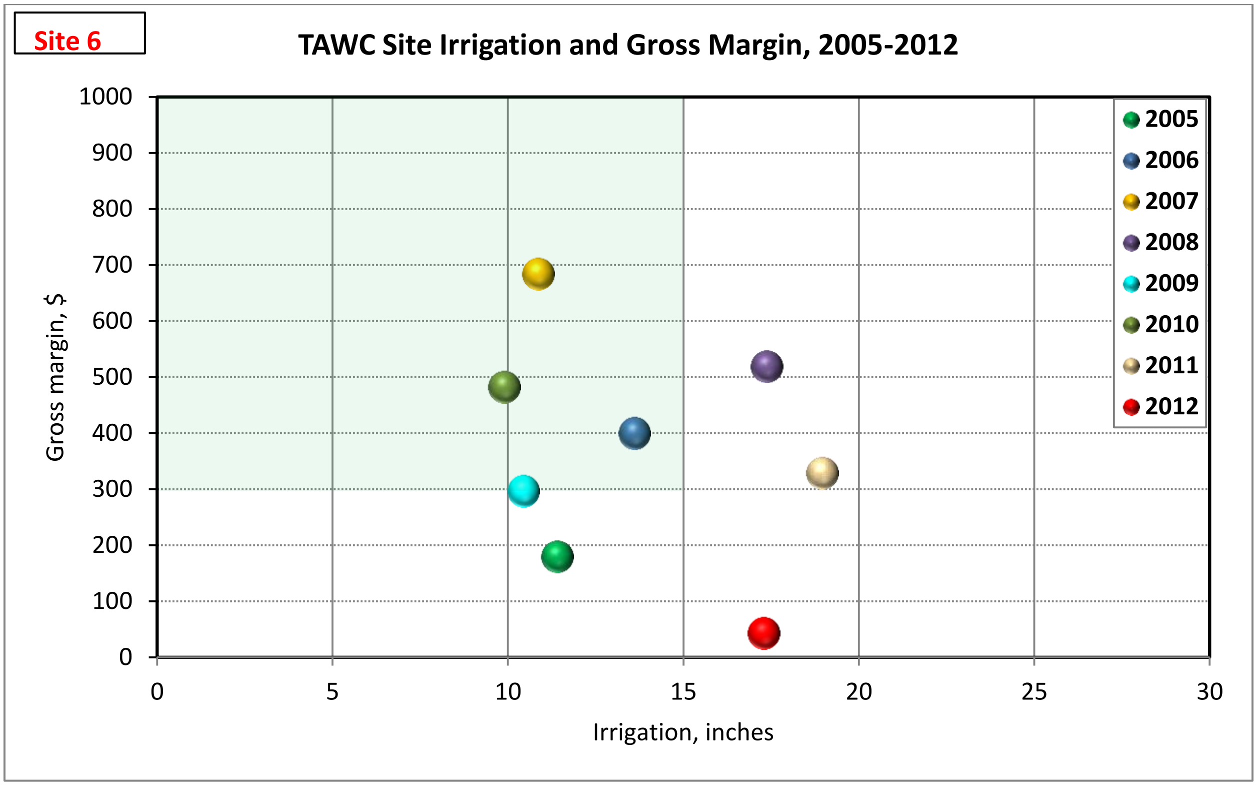
September ground preparation for wheat

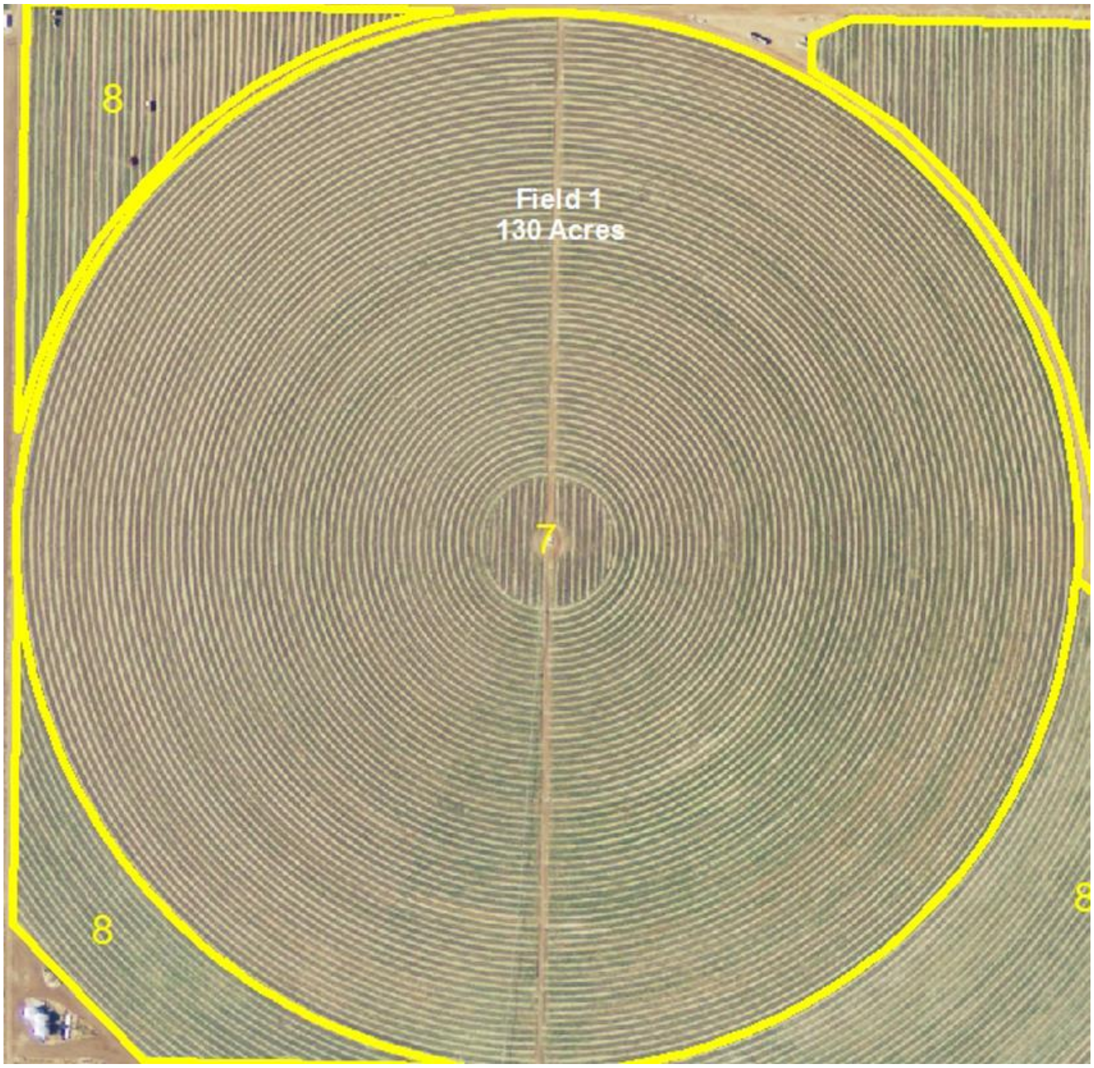
Site 6


Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
800
600
400
200
0
-200
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
60
50
40
30
20
10
0
-10
Net returns per pound of N ($)
6.0
4.0
2.0
0.0
-2.0
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 6
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012



Site 7 Description

Total site acres: 130.0

Field No. 1 Acres: 130.0
Major soil type: Pullman clay loam, 0 to 1% slope

Irrigation

Type: Center Pivot (LESA)

Pumping capacity, gal/min: 500

Number of wells: 4

Fuel source: Electric

Site 7

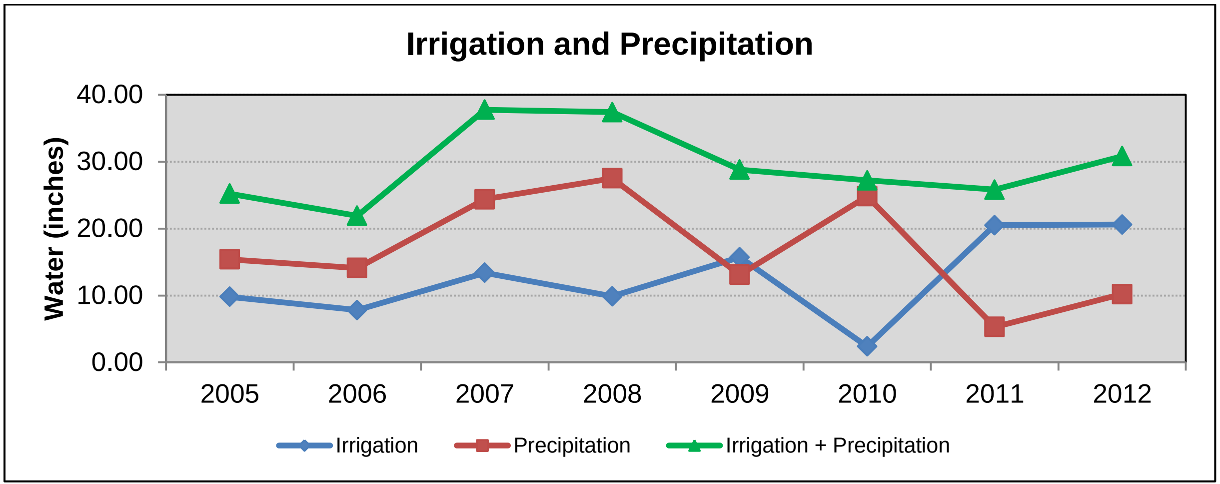
	Livestock	Field 1
2005	None	Sideoats grama for seed and hay
2006	None	Sideoats grama for seed and hay
2007	None	Sideoats grama for seed and hay
2008	None	Sideoats grama for seed and hay
2009	None	Sideoats grama for seed and hay
2010	None	Sideoats grama for seed and hay
2011	None	Sideoats grama for seed and hay
2012	None	Sideoats grama for seed and hay

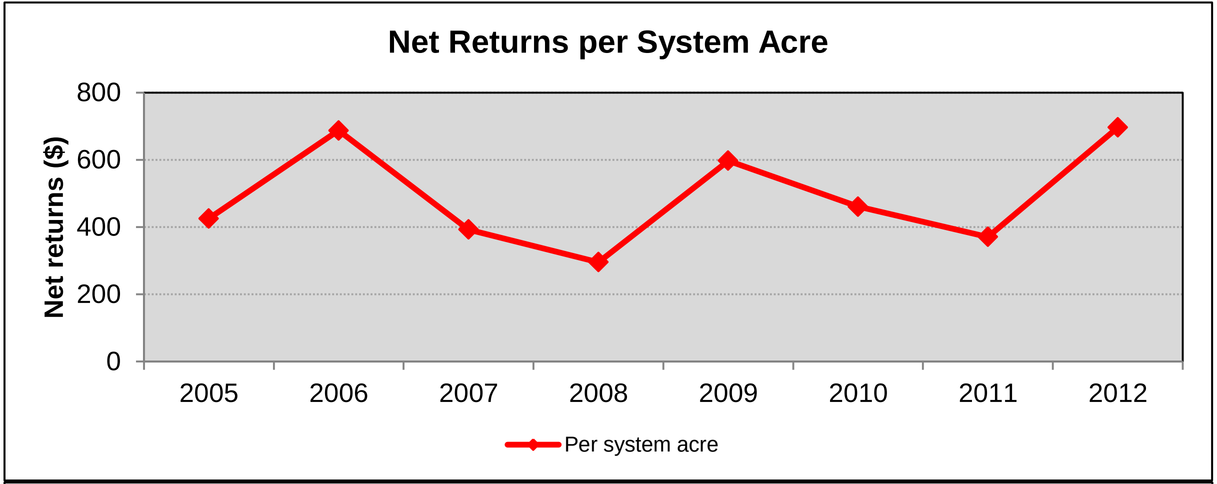
Comments: This is a pivot irrigated field of sideoats grama grown for seed production and the grass residue is round baled for hay and sold. This field was established to grass 18 years ago.

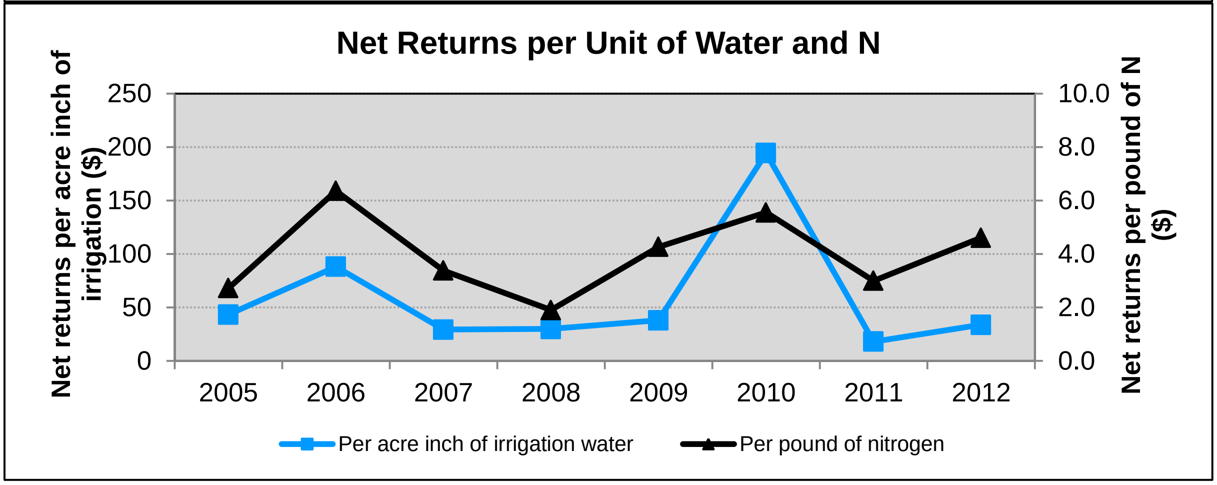
July sideoats grama ready for harvest

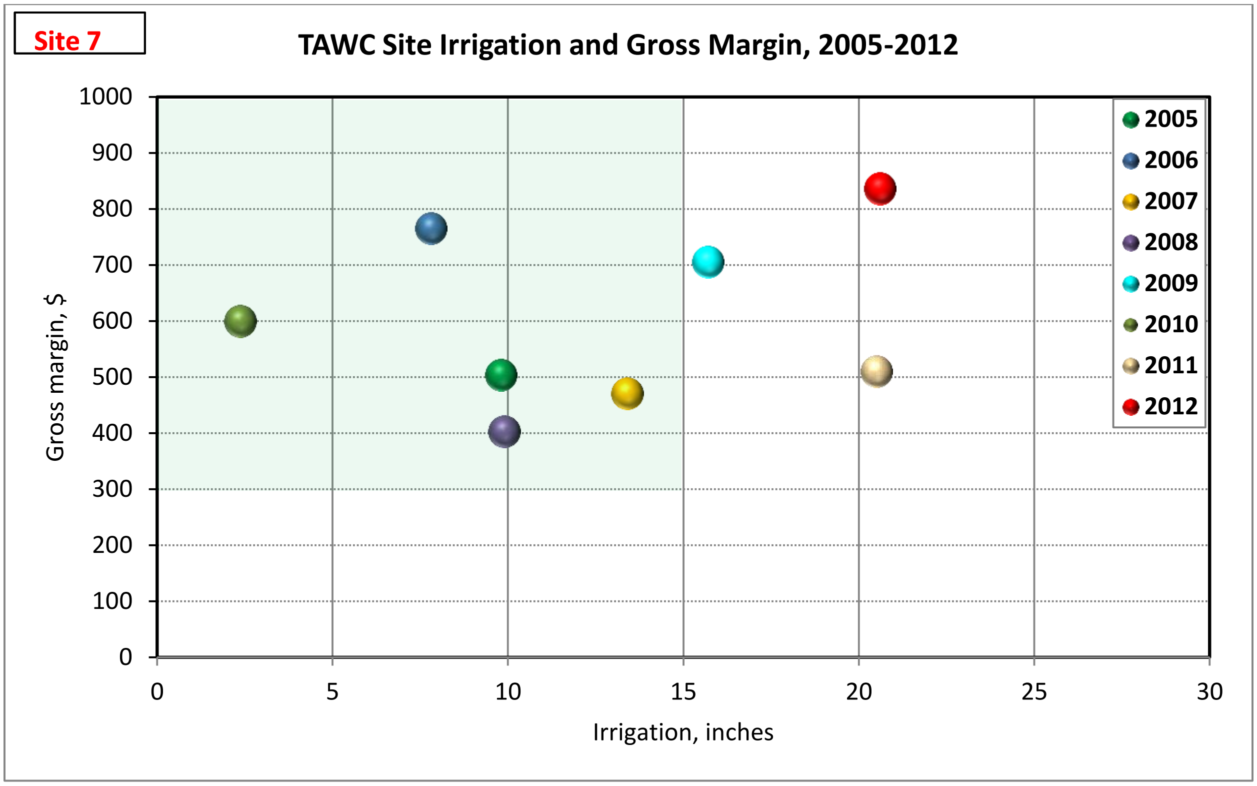
Sideoats round bales from hay harvest

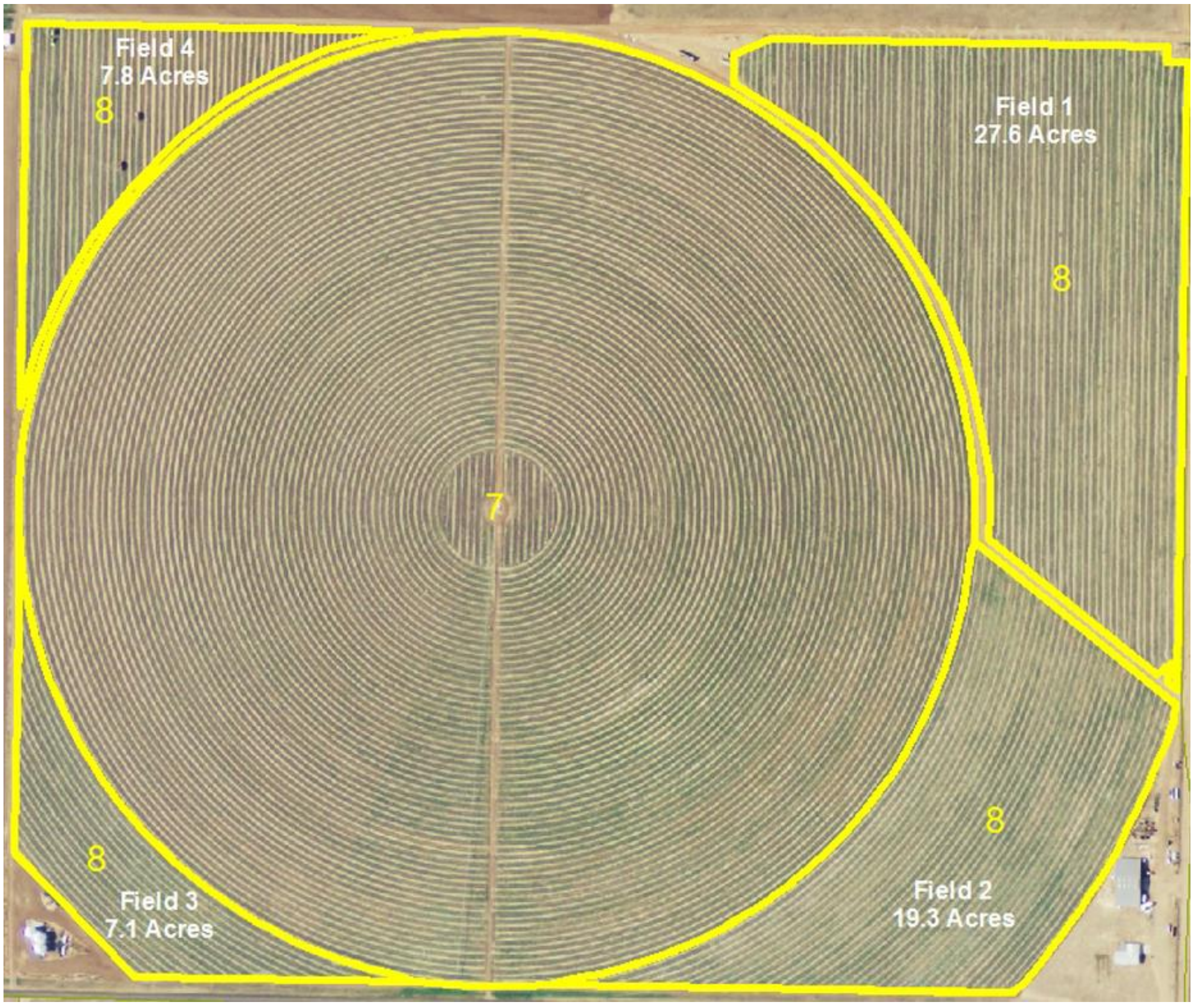
Site 7


Irrigation and Precipitation
Water (inches)
40.00
30.00
20.00
10.00
0.00
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
800
600
400
200
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
250
200
150
100
50
0
10.0
8.0
6.0
4.0
2.0
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 7
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012



Site 8 Description

Total site acres:	61.8
Field No. 1 Acres:	27.6
Major soil type:	Pullman clay loam, 0 to 1% slope
Field No. 2 Acres:	19.3
Major soil type:	Pullman clay loam, 0 to 1% slope
Field No. 3 Acres:	7.1
Major soil type:	Pullman clay loam, 0 to 1% slope
Field No. 4 Acres:	7.8
Major soil type:	Pullman clay loam, 0 to 1% slope

Irrigation

Type:	Sub-surface Drip (SDI)
Pumping capacity, gal/min:	360
Number of wells:	4
Fuel source:	Electric

Site 8

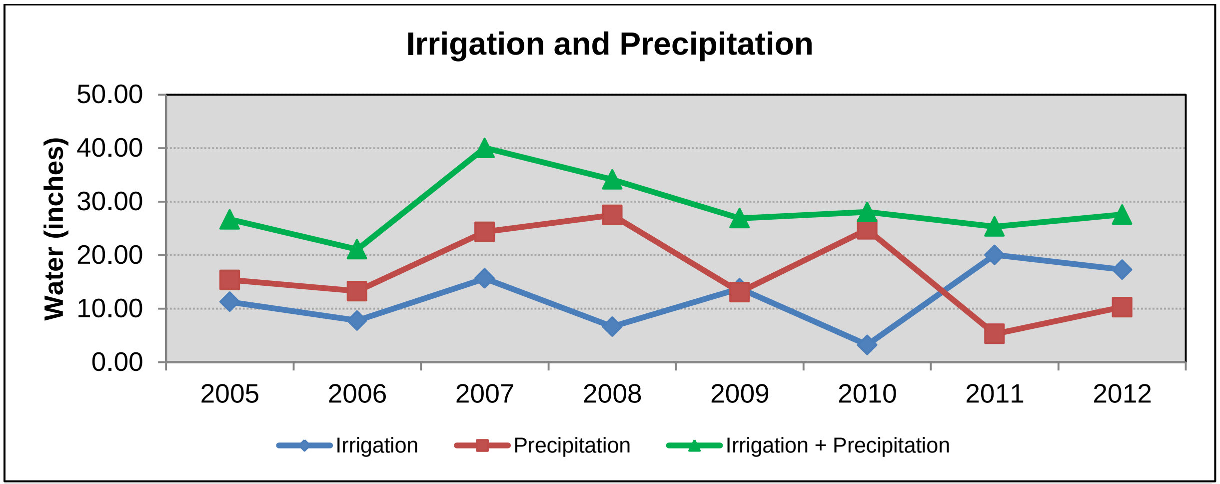
	Livestock	Field 1	Field 2	Field 3	Field 4
2005	None	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay
2006	None	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay
2007	None	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay
2008	None	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay
2009	None	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay
2010	None	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay
2011	None	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay
2012	None	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay

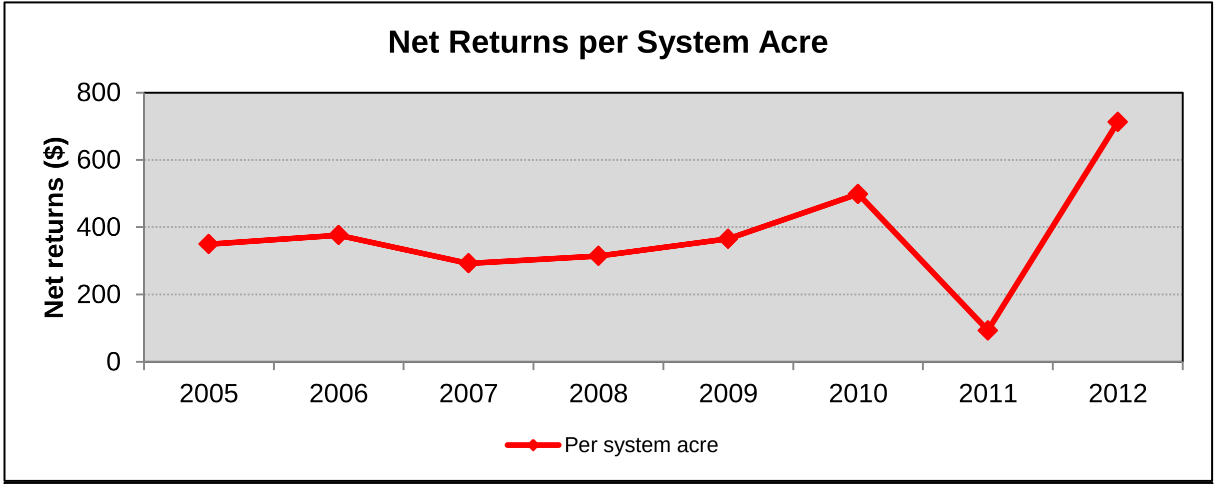
Comments: This is a drip irrigated field of side-oats grama grown for seed production and the grass residue is round baled for hay and sold. These four fields were put into drip irrigation nine years ago. Prior to the installation of drip these fields were furrow irrigated.

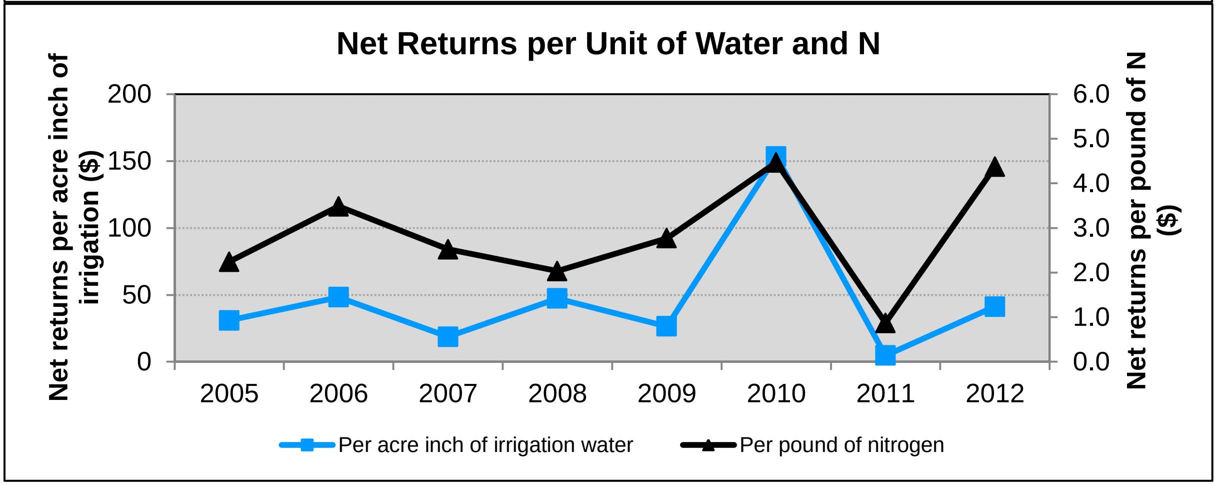
April sideoats over drip tape

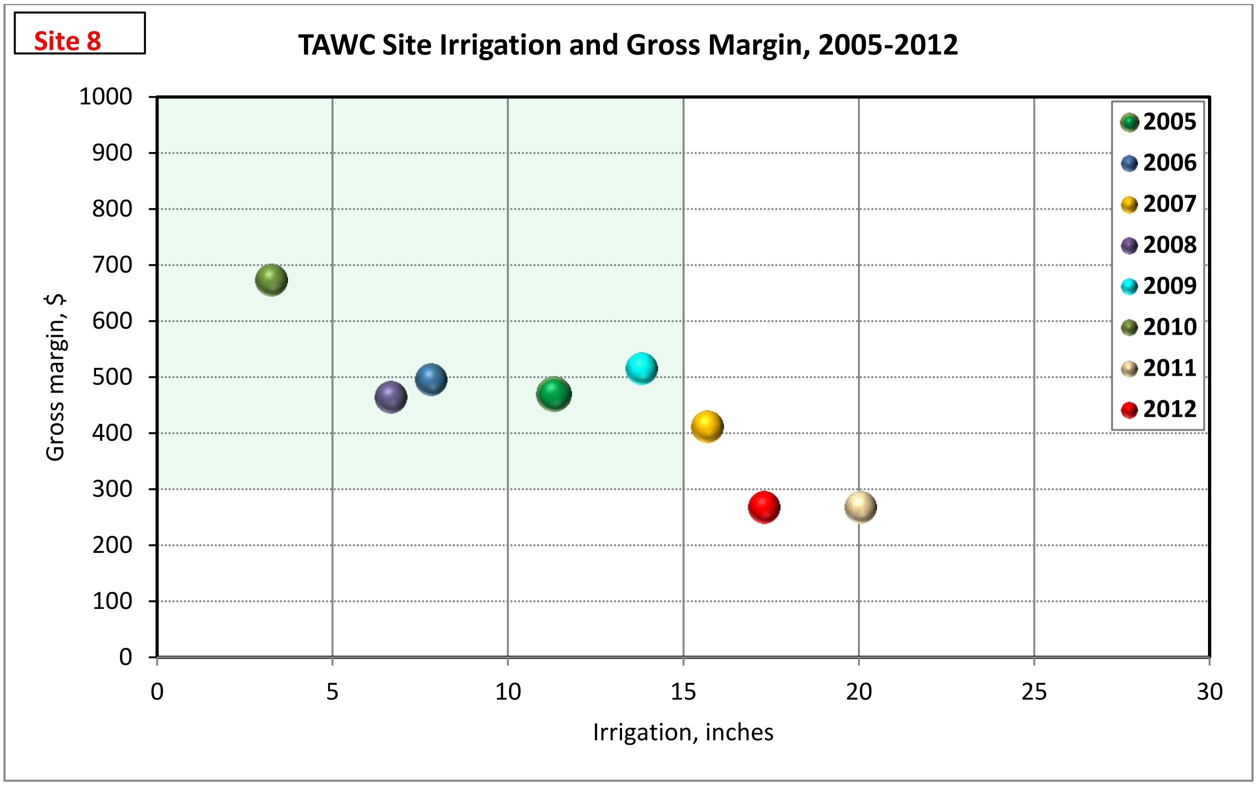
Sideoats swathed and ready for baling

Site 8


Irrigation and Precipitation
Water (inches)
50.00
40.00
30.00
20.00
10.00
0.00
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
800
600
400
200
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
200
150
100
50
0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 8
TAWC Site Irrigation and Gross Margin, 2005-2012
1000
900
800
700
600
500
400
300
200
100
0
Gross margin, $
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012

Site 9 Description

Total site acres:	237.8
Field No. 1 Acres:	100.8
Major soil type:	Mixed shallow soils
Field No. 2 Acres:	137.0
Major soil type:	Pullman clay loam; 0 to 1% slope

Irrigation

Type:	Center Pivot (MESA)
Pumping capacity, gal/min:	900
Number of wells:	4
Fuel source:	2 Natural gas 2 Diesel

Site 9

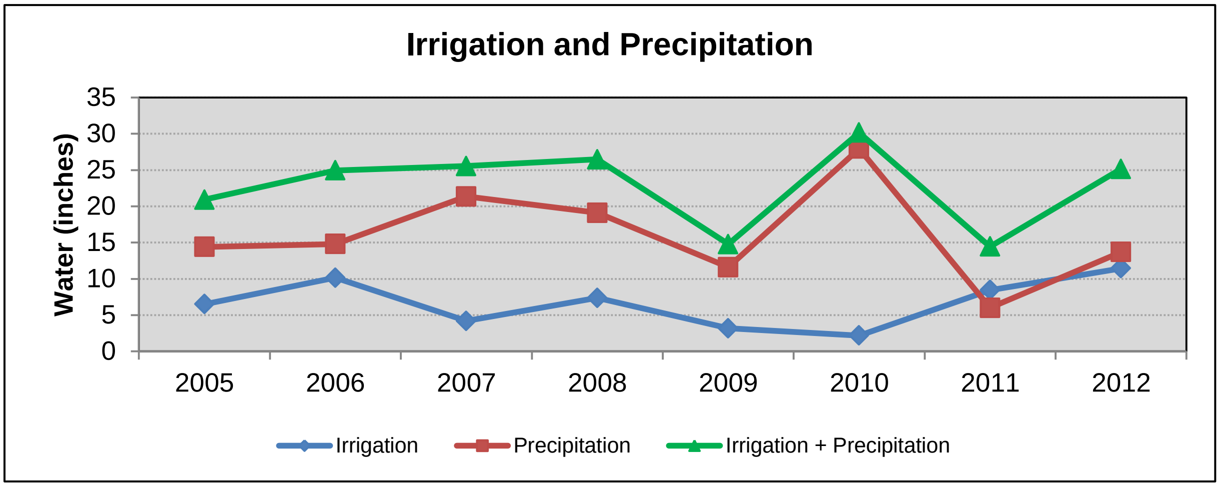
	Livestock	Field 1	Field 2
2005	Stocker steers	Klein/Buffalo/Blue grama/Annual forb mix interseeded with Rye for grazing	Rye for grazing and cover crop followed by Cotton
2006	Stocker steers	Klein/Buffalo/Blue grama/Annual forb mix interseeded with Rye for grazing	Cotton following Rye cover crop
2007	Stocker heifers	Klein/Buffalo/Blue grama/Annual forb mix interseeded with Rye for grazing	Grain Sorghum following Rye cover crop
2008	Cow-calf	Klein/Buffalo/Blue grama/Annual forb mix for grazing	Cotton
2009	None	Klein/Buffalo/Blue grama/Annual forb mix for grazing	Cotton
2010	Cow-calf	Klein/Buffalo/Blue grama/Annual forb mix for grazing and hay	Cotton
2011	Stocker	Klein/Buffalo/Blue grama/Annual forb mix for grazing and hay	Cotton
2012	Stocker	Klein/Buffalo/Blue grama/Annual forb mix for grazing and hay	Cotton

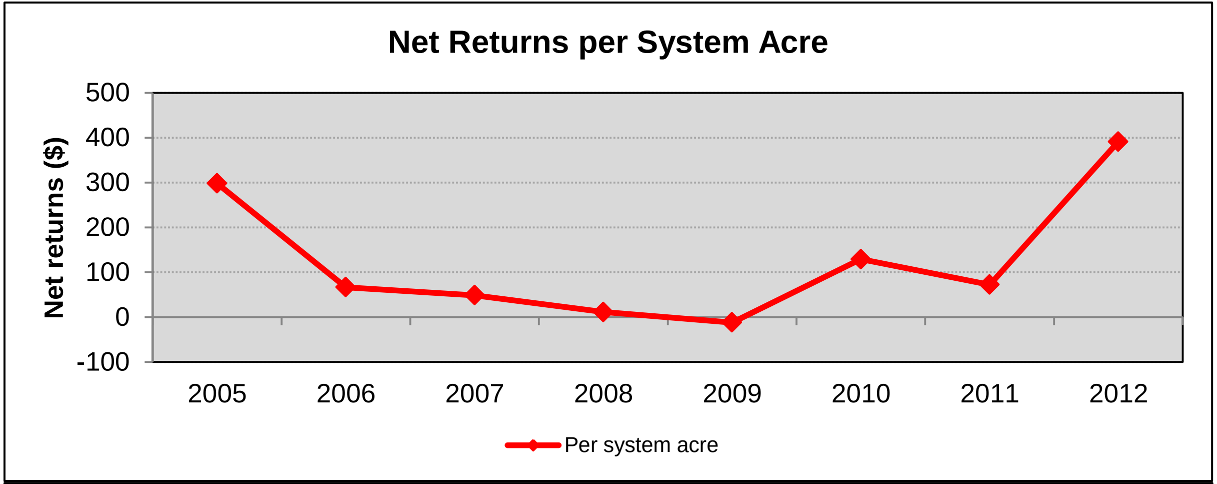
Comments: This site was returned to conventional tillage after 11 years of no-till production. Field 1 is predominantly kleingrass and used for cow-calf production. Field 2 was planted to cotton on 40-inch centers for 2012.

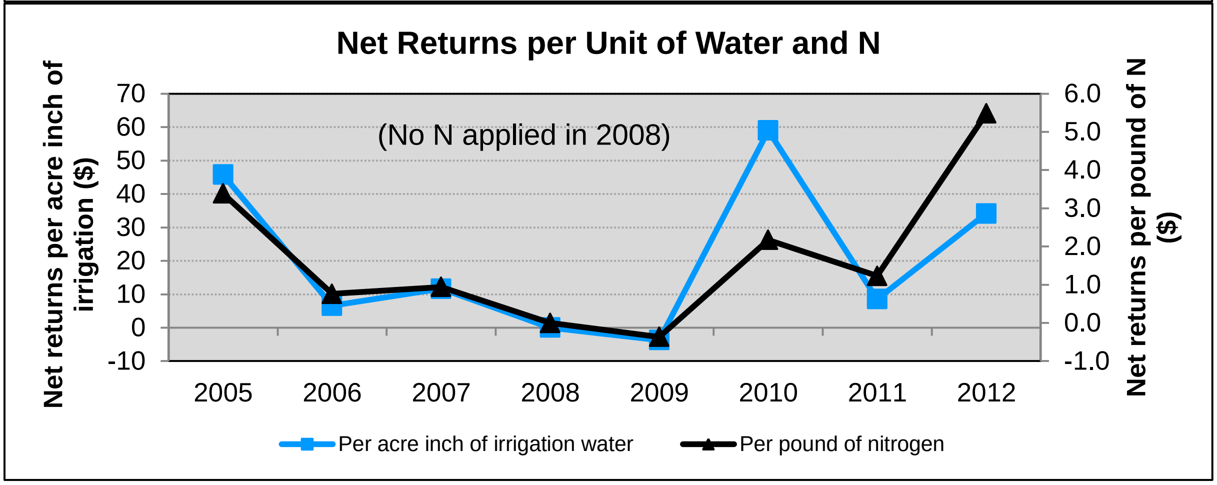
Field 1 in June

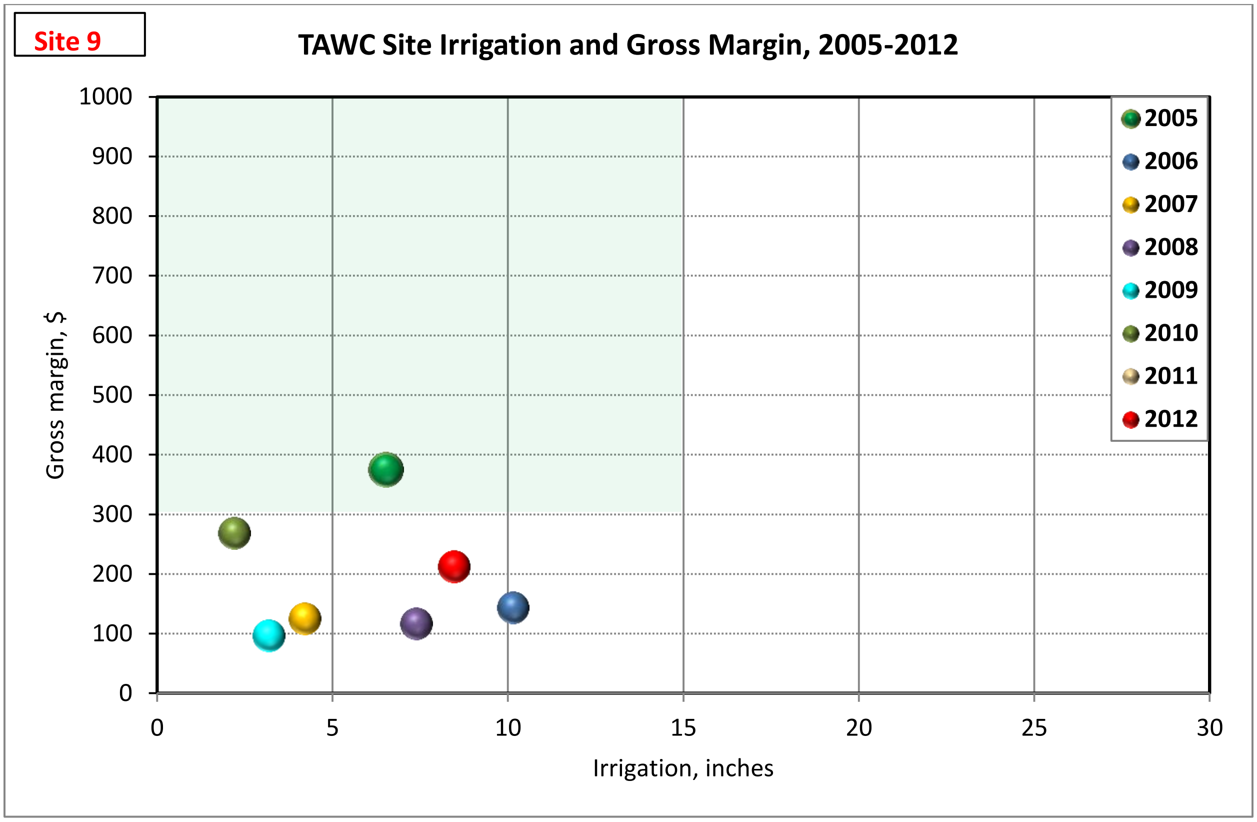
November cotton harvest

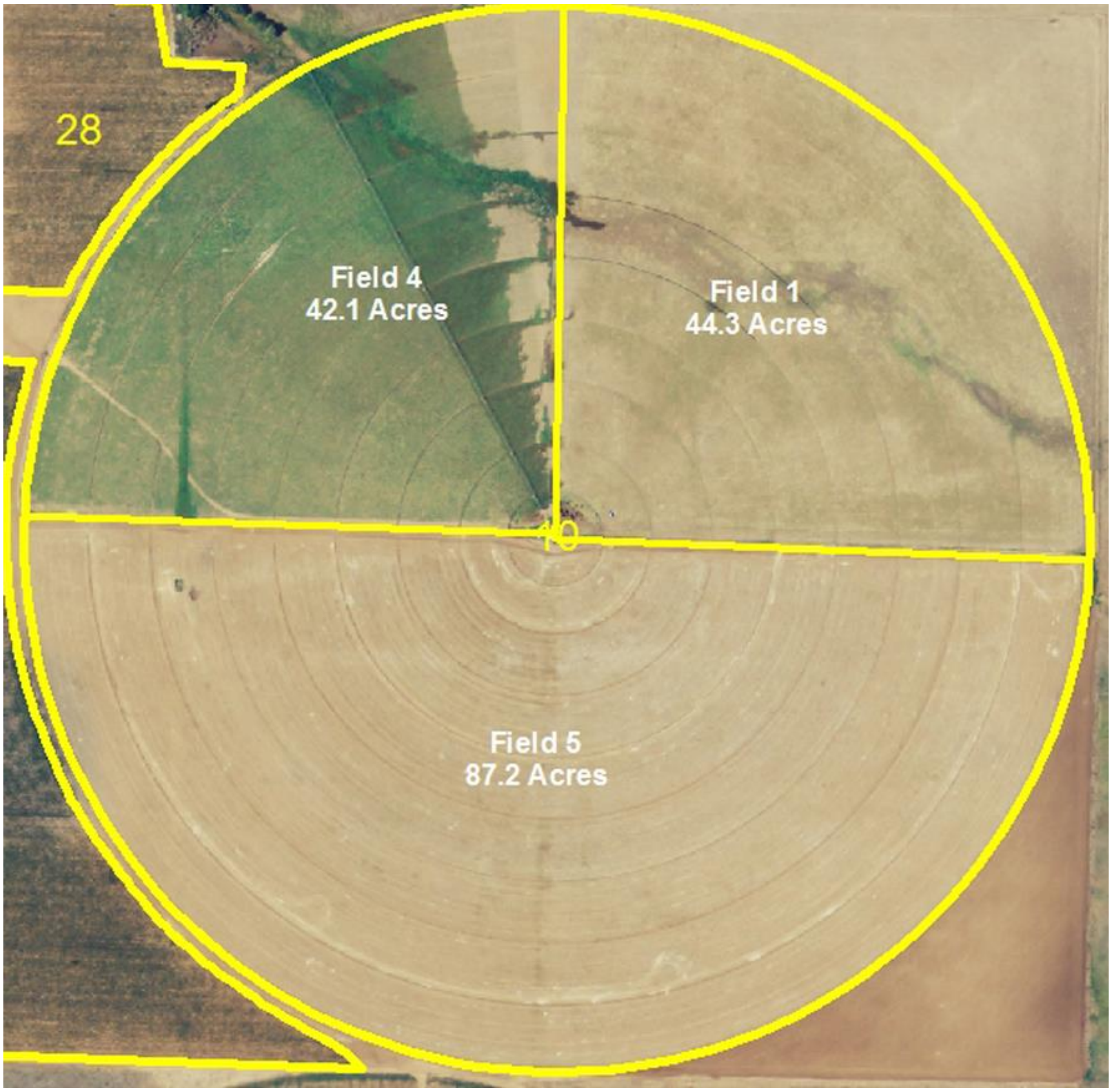
Site 9


Irrigation and Precipitation
Water (inches)
35
30
25
20
15
10
5
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
500
400
300
200
100
0
-100
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
70
60
50
40
30
20
10
0
-10
(No N applied in 2008)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 9
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012



Site 10 Description

Total site acres: 173.6

Field No. 1 Acres: 44.3
Major soil type: Pullman clay loam; 0 to 1% slope
Lofton clay loam; 0 to 1% slope
Estacado clay loam; 0 to 1% slope

Field No. 4 Acres: 42.1
Major soil type: Pullman clay loam; 0 to 1% slope
Estacado clay loam; 0 to 1% slope

Field No. 5 Acres: 87.2
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Center Pivot (LESA)

Pumping capacity, gal/min: 800

Number of wells: 2

Fuel source: Electric

System 10

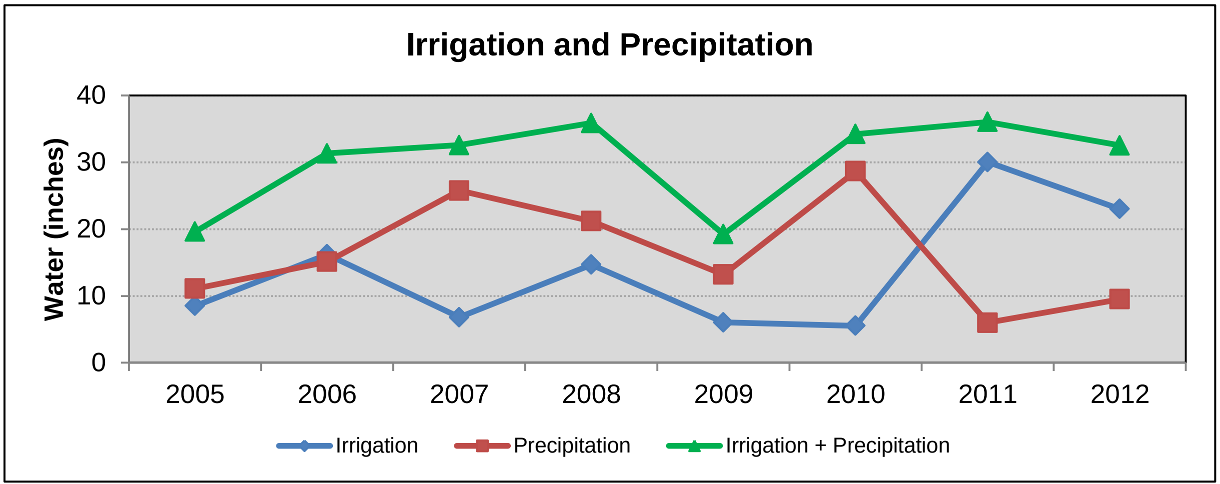
	Livestock	Field 1	Field 2	Field 3	Field 4
2005	Cow-calf	Dahl planted, no grazing this year	Cotton	Dahl for grazing and hay	Bermudagrass planted, some grazing
2006	Cow-calf	Dahl for grazing	Oats for hay followed by Forage Sorghum for hay	Dahl for grazing	Bermudagrass for grazing and hay
2007	Cow-calf	Dahl for grazing	Corn for silage following Wheat cover crop	Dahl for grazing and seed	Bermudagrass for grazing
2008	Cow-calf	Dahl for grazing	Wheat for grain followed by Corn for grain	Dahl for grazing and hay	Bermudagrass for grazing
2009	Cow-calf	Dahl for grazing	Cotton	Dahl for grazing	Bermudagrass for grazing
2010	Cow-calf	Dahl for grazing	Corn	Corn	Bermudagrass for grazing
2011	Cow-calf	Cotton	Cotton	Cotton	Bermudagrass for grazing
	Livestock	Field 1	Field 4	Field 5	
2012	Cow-calf	?	Bermudagrass for grazing	Corn Silage	

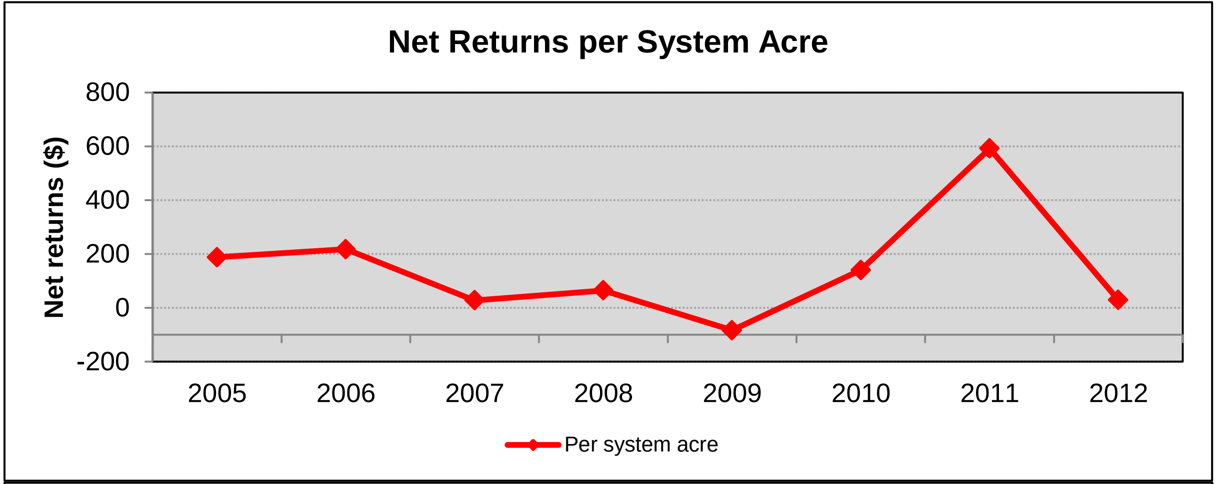
Comments: This is a two cell, pivot irrigated row crop, improved forage, cow-calf system. Old-world bluestem and bermudagrass are used in rotation for livestock grazing. One-half of this system was planted to corn on 40-inch centers for 2012.

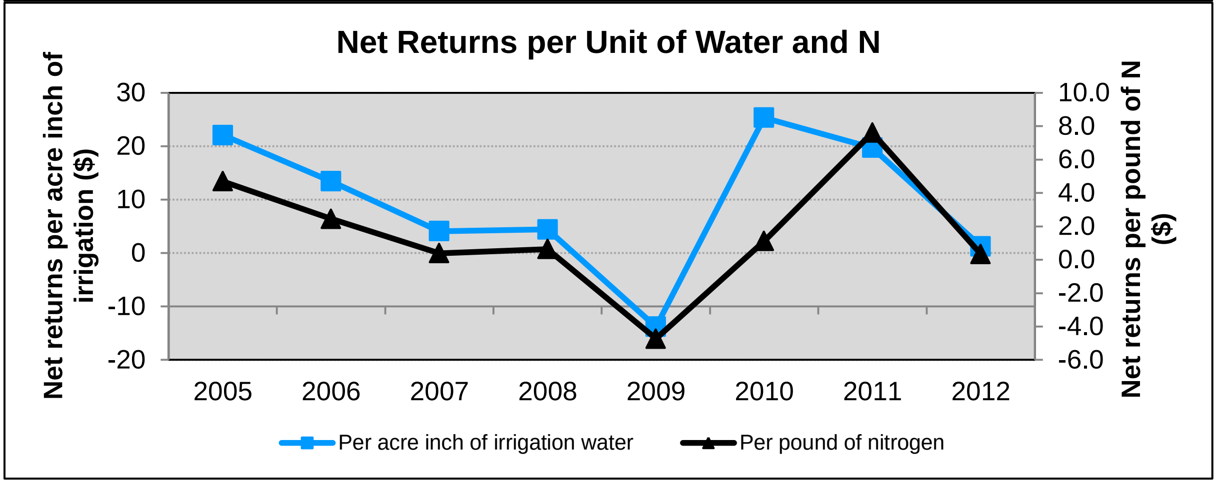
Rotational grazing

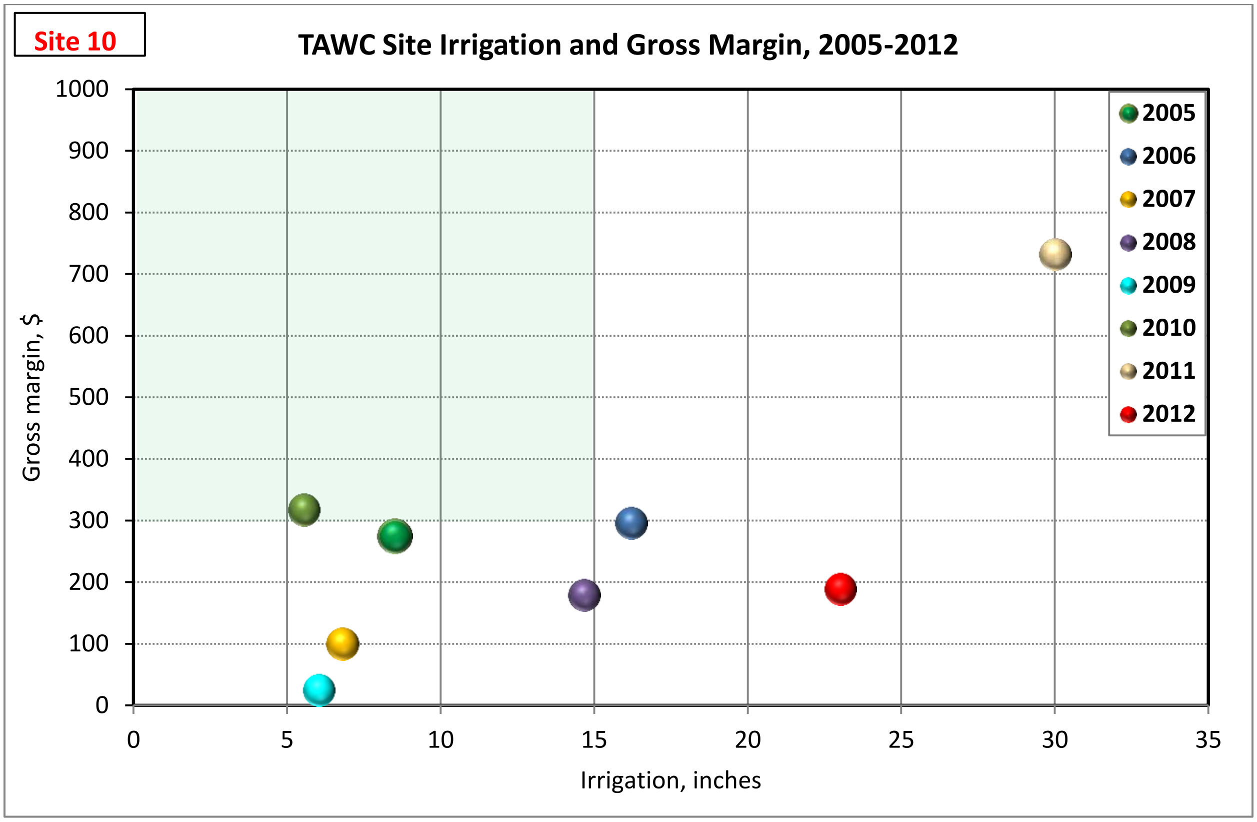
June corn

Site 10


Irrigation and Precipitation
Water (inches)
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
800
600
400
200
0
-200
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
30
20
10
0
-10
-20
2005
2006
2007
2008
2009
2010
2011
2012
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
Net returns per pound of N ($)
Per acre inch of irrigation water
Per pound of nitrogen


Site 10
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
35
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012

Site 11 Description

Total site acres:	92.5
Field No. 2 Acres:	24.4
Major soil type:	Pullman clay loam; 0 to 3% slope
Field No. 3 Acres:	22.9
Major soil type:	Pullman clay loam; 0 to 3% slope
Field No. 5 Acres:	45.2
Major soil type:	Lofton clay loam; 0 to 1% slope Olton clay loam; 1 to 3% slope Pullman clay loam; 0 to 3% slope

Irrigation

Type:	Furrow
Pumping capacity, gal/min:	490
Number of wells:	1
Fuel source:	Electric

Site 11

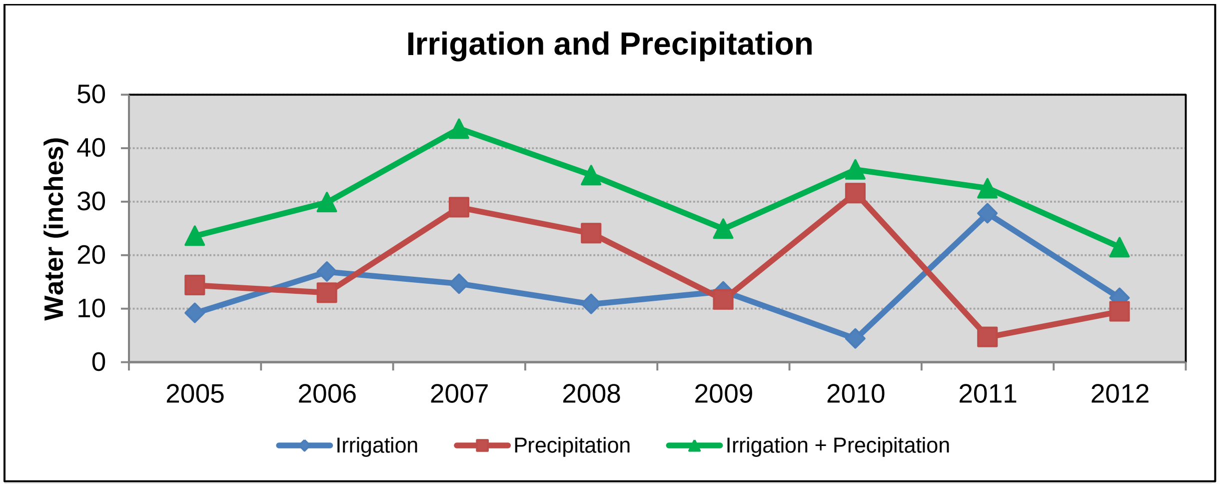
	Livestock	Field 1	Field 2	Field 3	Field 4
2005	None	Cotton following Wheat cover crop	Cotton	Cotton	
2006	None	Cotton	Cotton	Cotton	
2007	None	Cotton	Cotton	Cotton	
2008	None	Grain Sorghum	Cotton	Cotton	
2009	None	Cotton	Grain sorghum	Cotton	
2010	None	Cotton	Cotton	Grain Sorghum	
2011	None	Cotton	Cotton	Cotton	Grain Sorghum
	Livestock	Field 2	Field 3	Field 5	
2012	None	Milo	Milo	Milo	

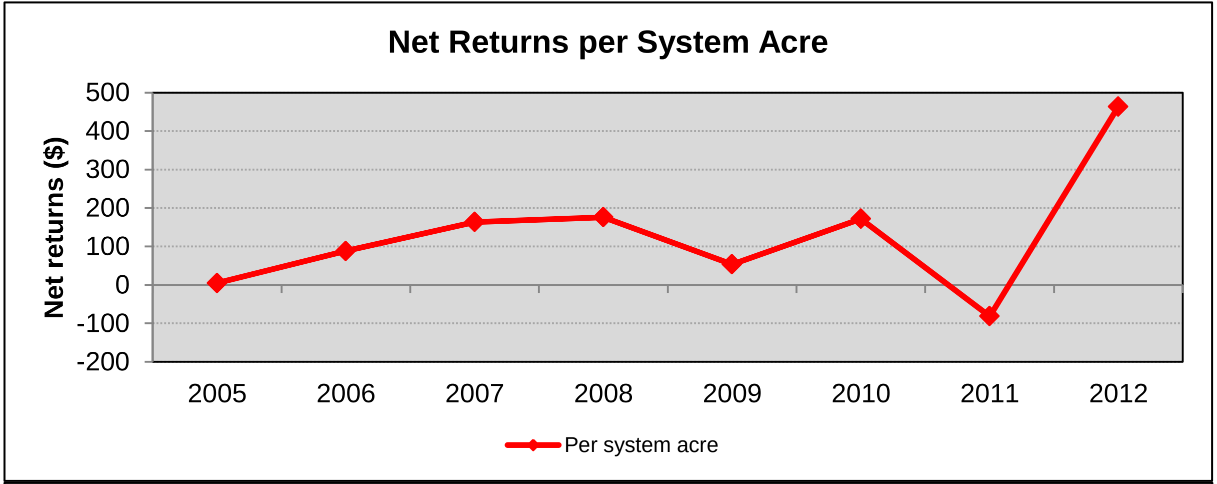
Comments: This is a furrow irrigated cotton and grain sorghum system using conventional tillage and planted on 40-inch centers. The cotton was lost to a June 4th hail storm and replanted to grain sorghum.

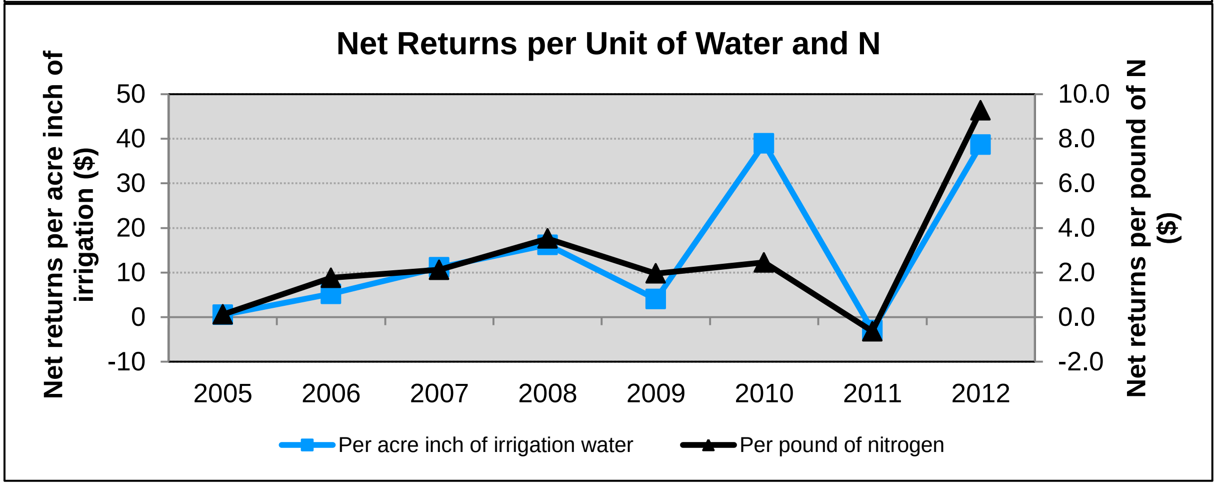
June cotton replanted to sorghum

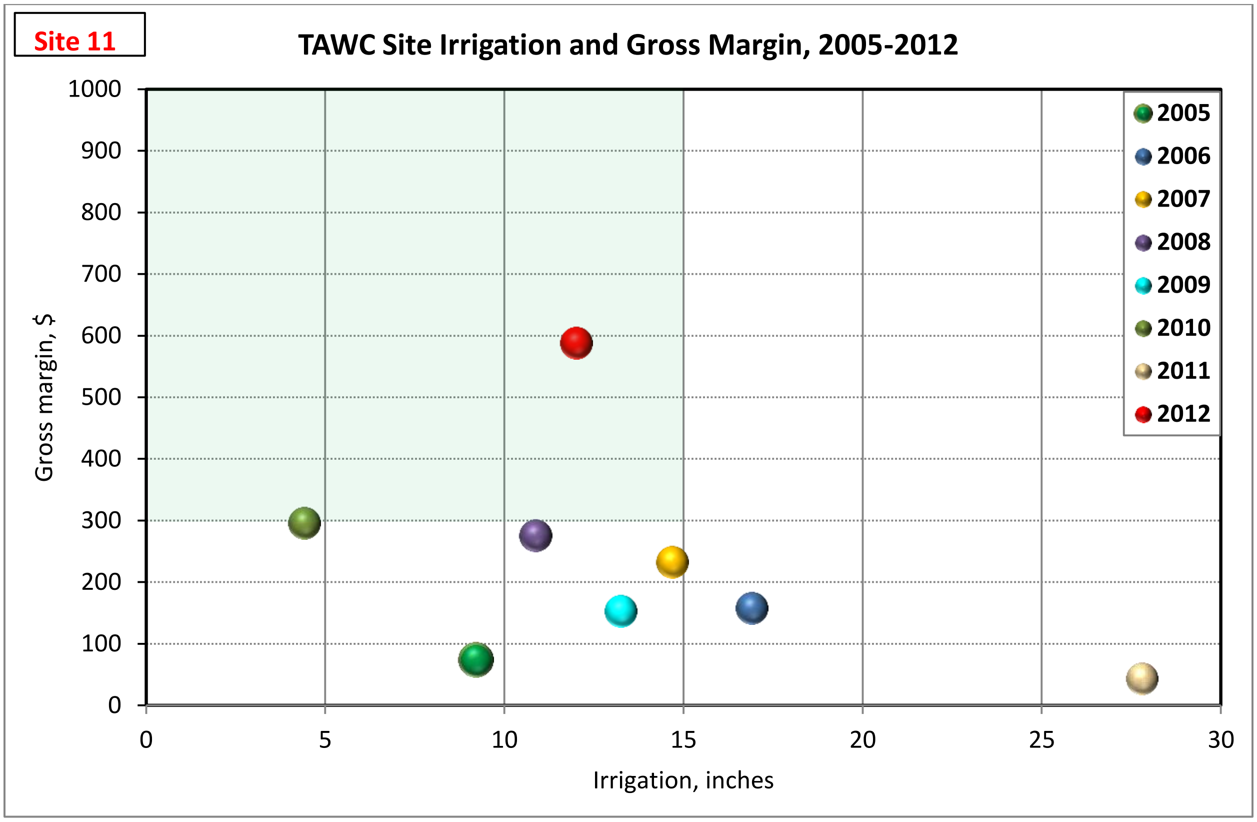
September grain sorghum

Site 11


Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
500
400
300
200
100
0
-100
-200
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
50
40
30
20
10
0
-10
Net returns per pound of N ($)
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 11
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012

Site 12 Description

Total site acres: 283.8

Field No. 1 Acres: 151.2
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 2 Acres: 132.7
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Dryland

Pumping capacity, gal/min: na

Number of wells: na

Fuel source: na

Site 12
Dryland Site

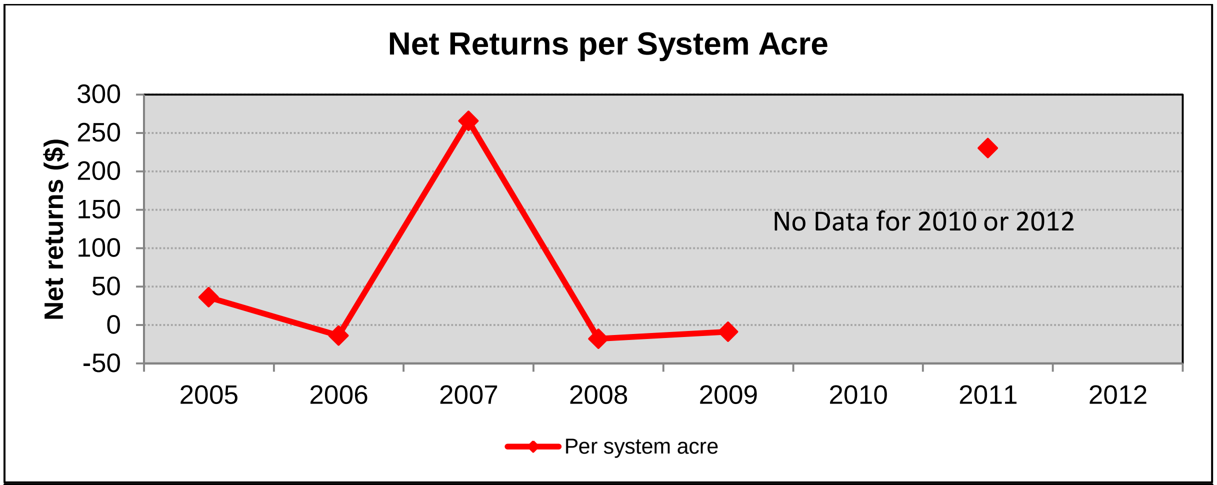
	Livestock	Field 1	Field 2
2005	None	Cotton following wheat cover crop	Forage sorghum for cover following Wheat
2006	None	Wheat for grain	Cotton following previous year cover of Forage Sorghum
2007	None	Cotton	Grain sorghum following wheat cover crop
2008	None	Grain sorghum for silage	Fallow, volunteer Wheat for cover crop
2009	None	Grain sorghum for silage	Fallow
2010	None	Cotton	Cotton
2011	None	Cotton	Cotton
2012	None	Fallow	Fallow

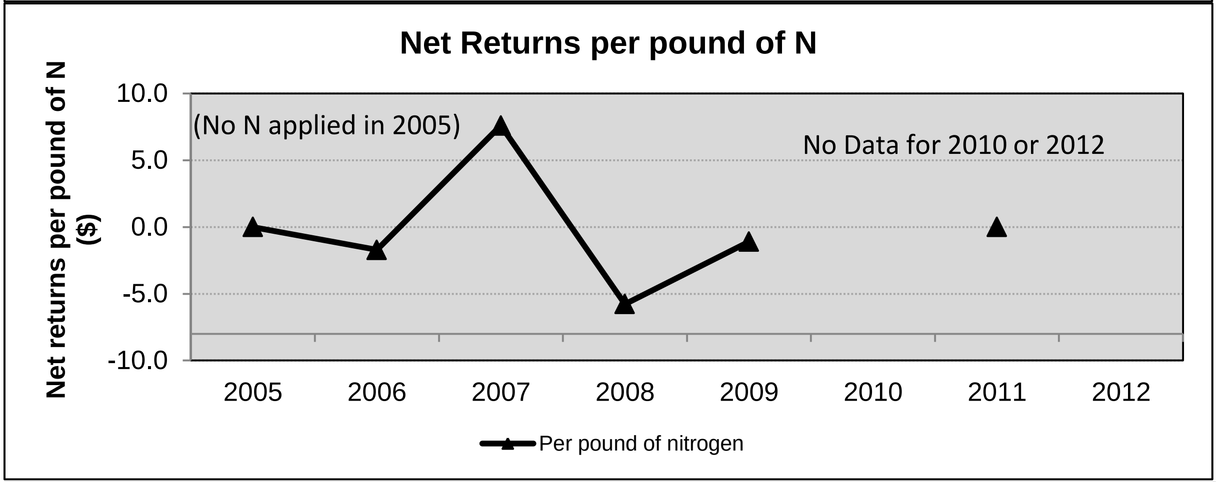
Comments: This dryland system uses cotton, grain sorghum and wheat in rotation. One field was planted to cotton in 2012 but not harvested.

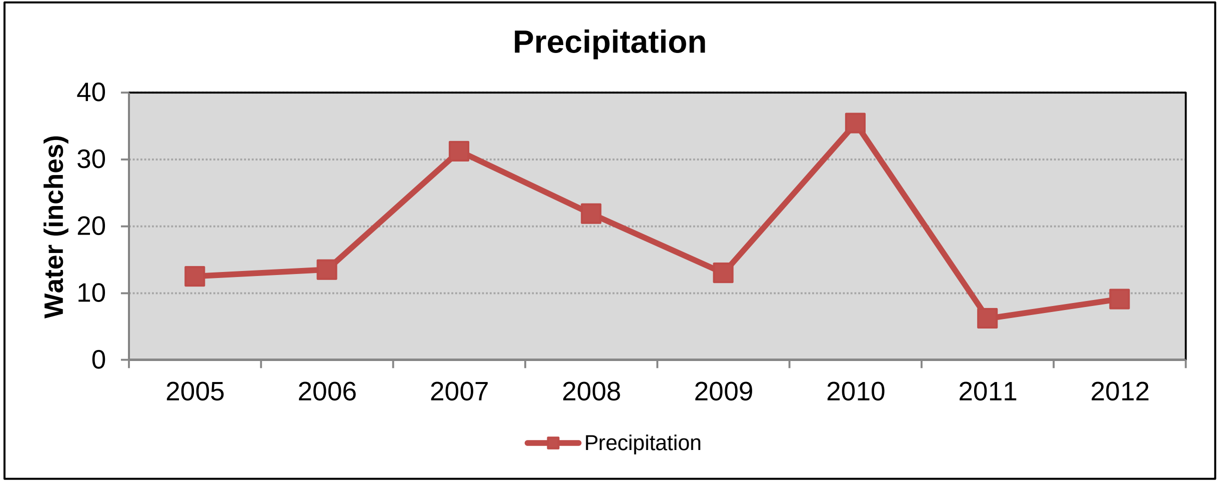
Late July cotton

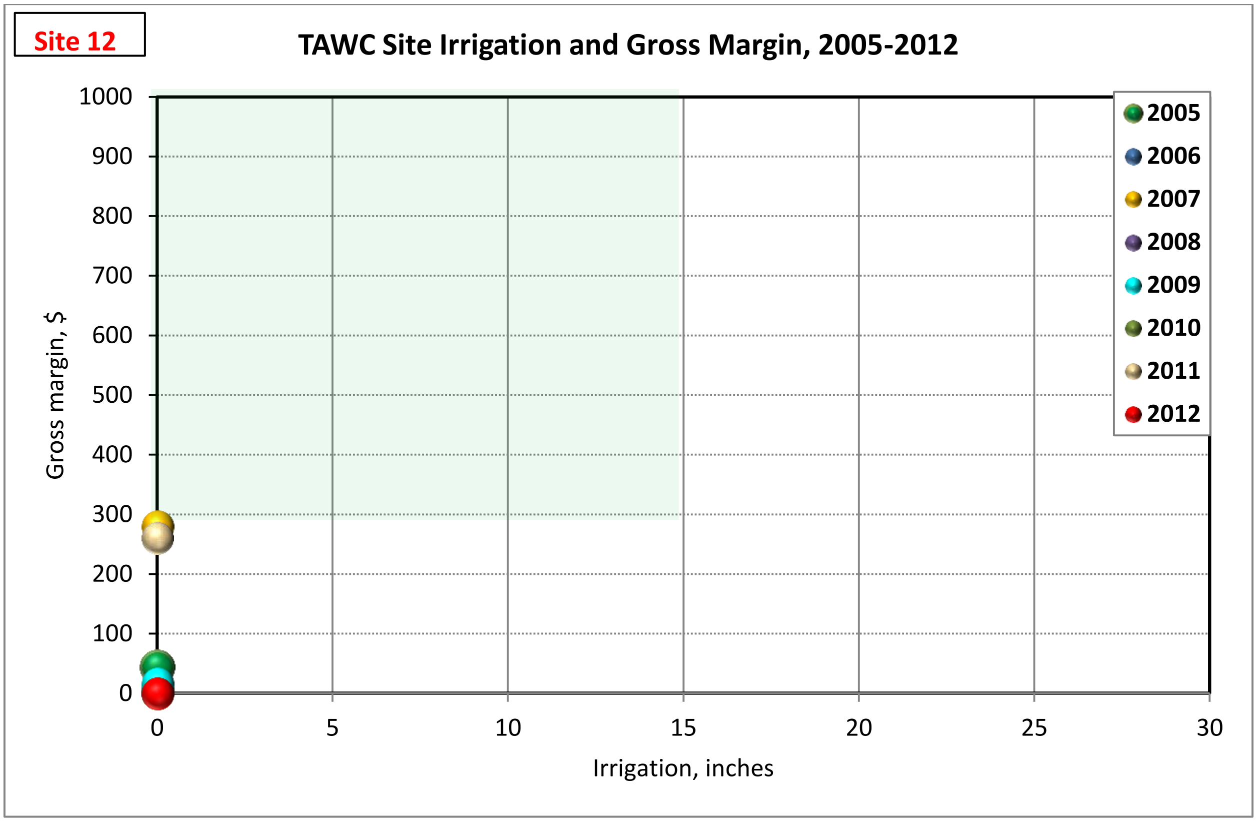
August No harvest to be made

Site 12 – Dryland Site

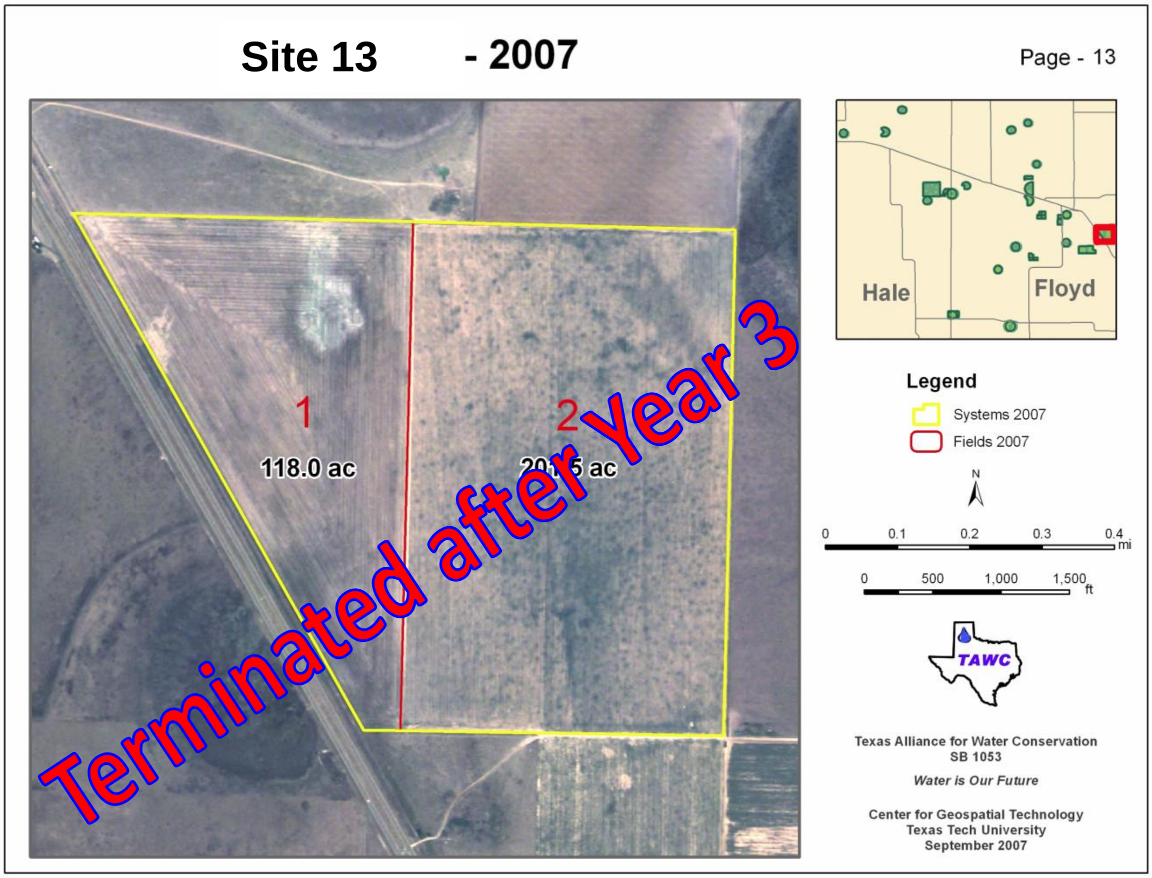








Dryland Site



Site 13 Description

Total site acres: 319.5

Field No. 1 Acres: 118.0
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 2 Acres: 201.5
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Dryland

Pumping capacity, gal/min:

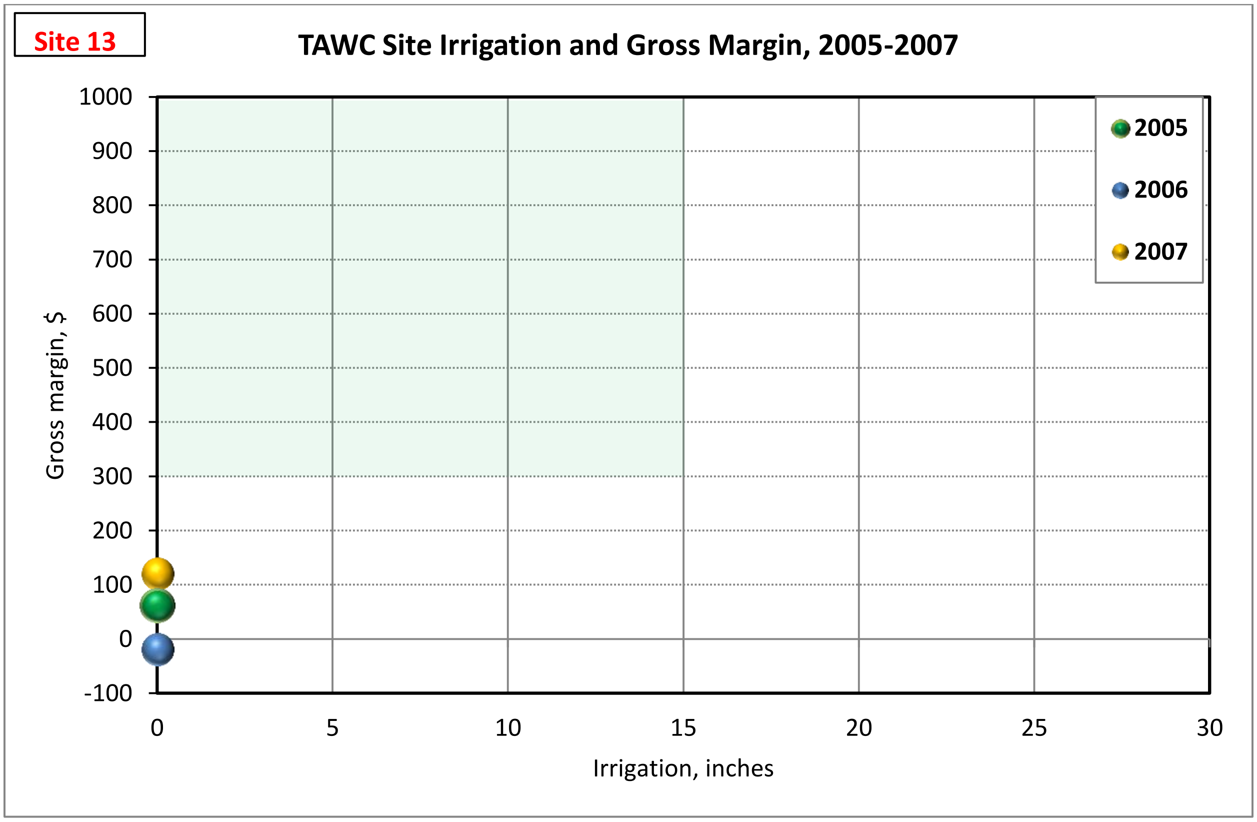
Number of wells:

Fuel source:

Comments: This dryland site used cotton and small grains in rotation. Cotton was planted on 40-inch centers under limited tillage. Small grains were drilled after cotton harvest.

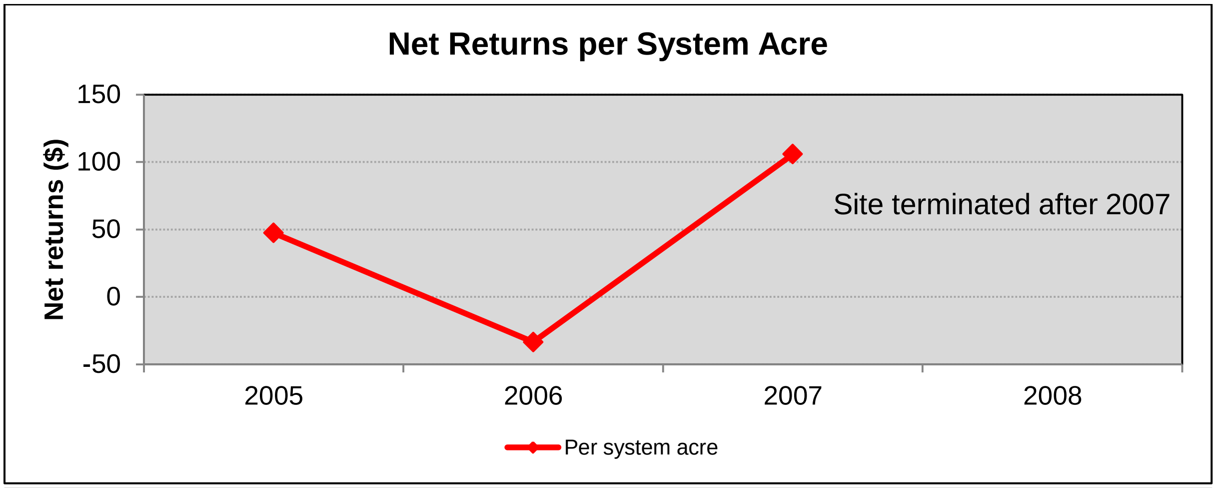
Site 13
Dryland Site

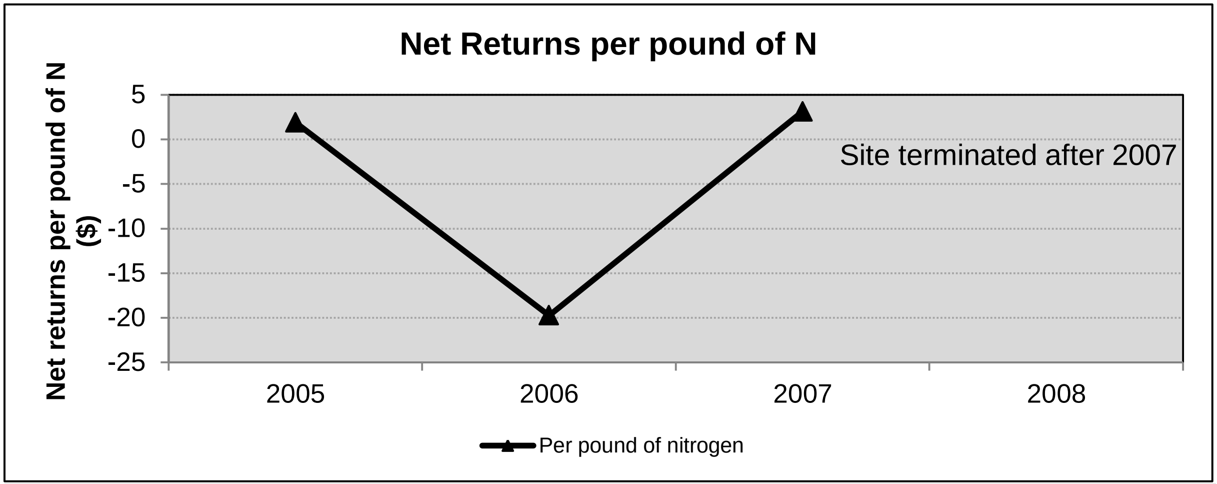
	Livestock	Field 1	Field 2
2005	None	Wheat for grain	Cotton following previous year's cover of Wheat stubble
2006	None	Cotton following previous year's cover of wheat stubble	Wheat lost to drought
2007	None	Wheat for grain	Cotton following wheat cover crop
2008	Site terminated for 2008		

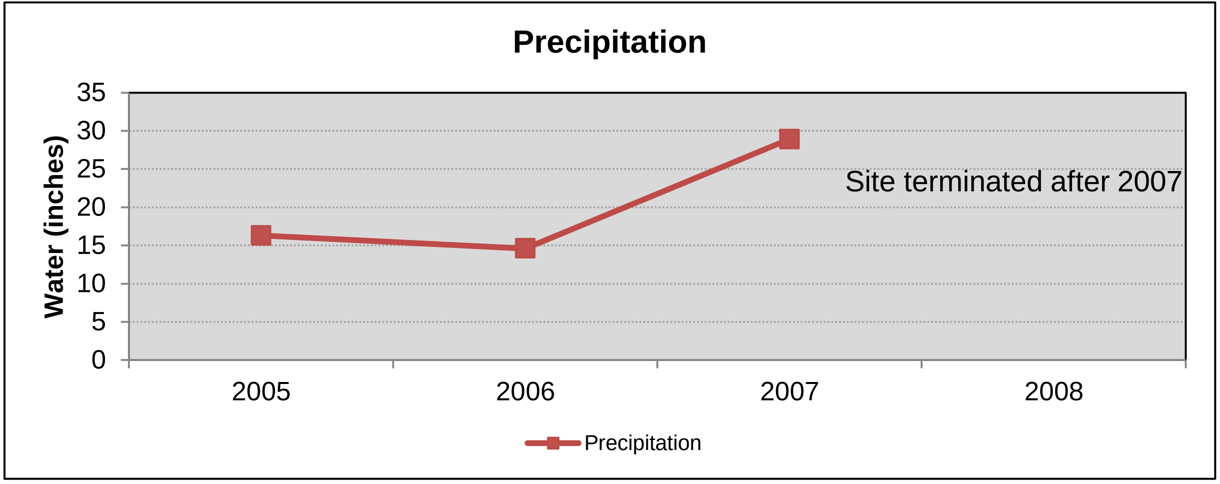


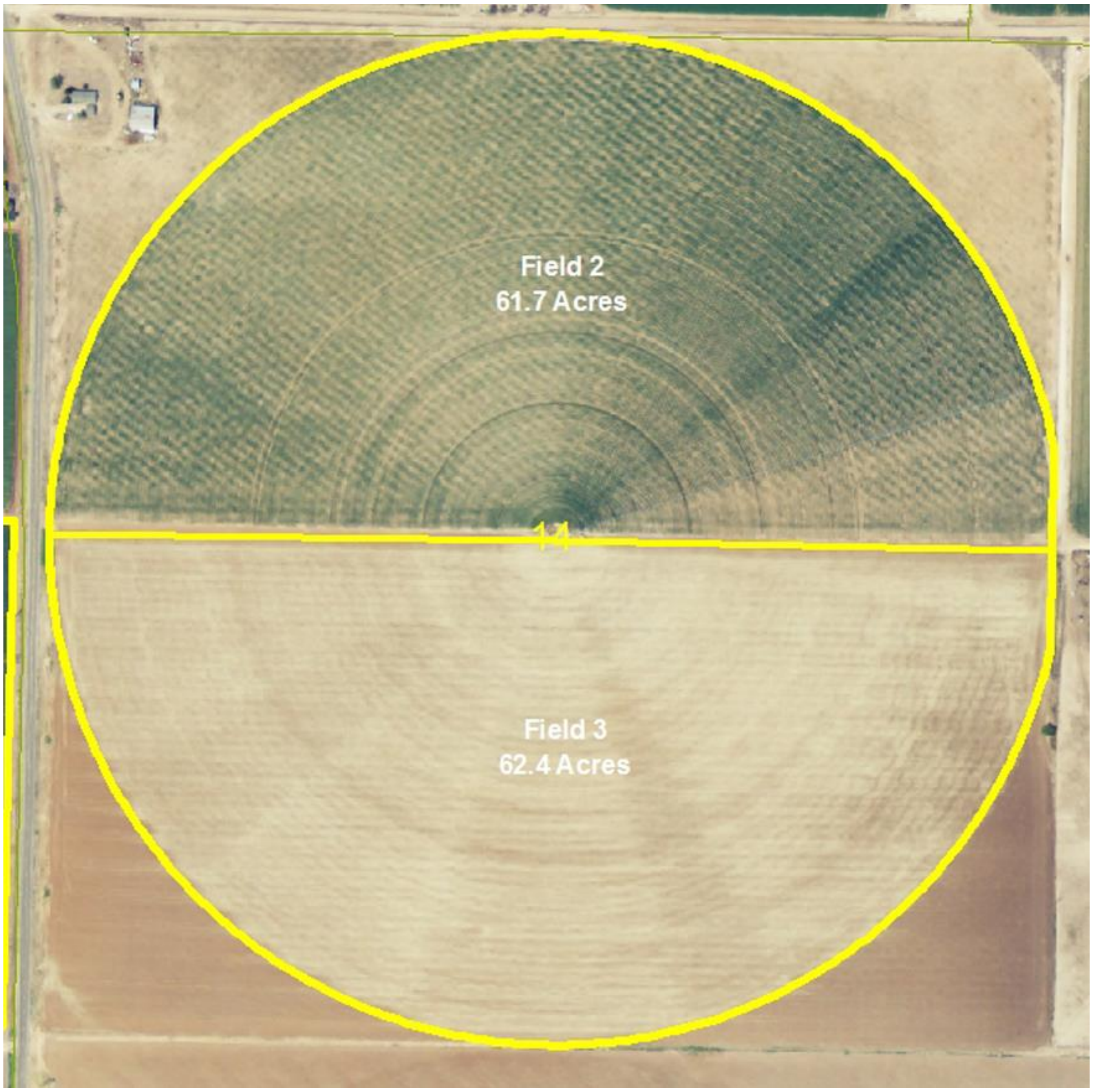
Dryland Site

Site 13 – Dryland Site









Site 14 Description

Total site acres:	124.1
Field No. 2 Acres:	61.7
Major soil type:	Pullman clay loam; 0 to 1% slope
Field No. 3 Acres:	62.4
Major soil type:	Pullman clay loan; 0 to 1% slope

Irrigation

Type:	Center Pivot (LEPA)
Pumping capacity, gal/min:	300
Number of wells:	3
Fuel source:	Electric

Site 14

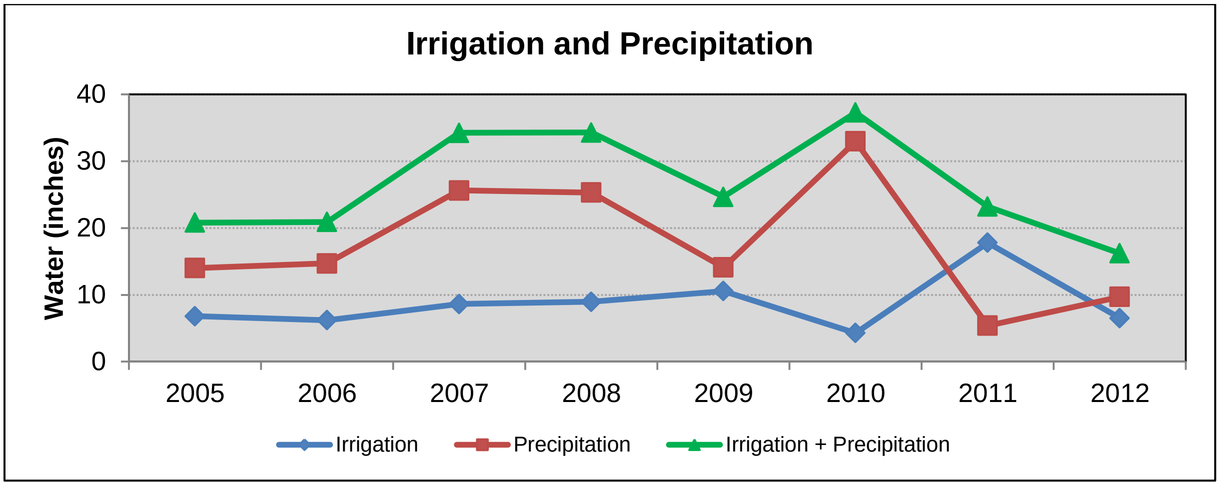
	Livestock	Field 1	Field 2	Field 3
2005	None	Cotton		
2006	None	Cotton		
2007	None	Cotton		
2008	None	Split into Fields 2 and 3	Cotton	Cotton
2009	None		Cotton	Wheat
2010	None		Wheat	Cotton
2011	None		Cotton	Cotton
2012	None		Wheat	Cotton

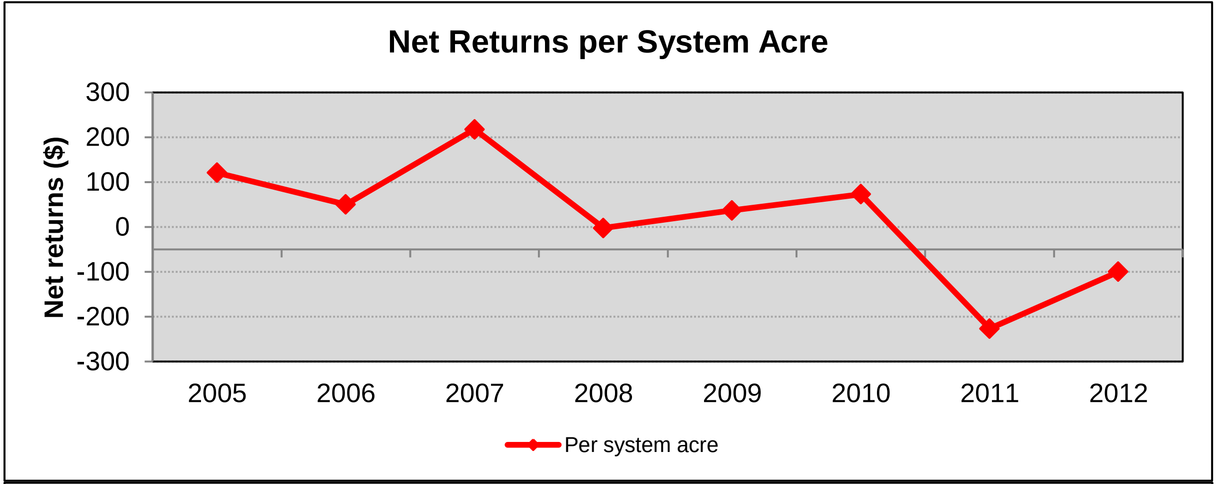
Comments: This is a pivot irrigated cotton and wheat rotation system with limited irrigation. This producer uses conventional tillage on 40-inch centers.

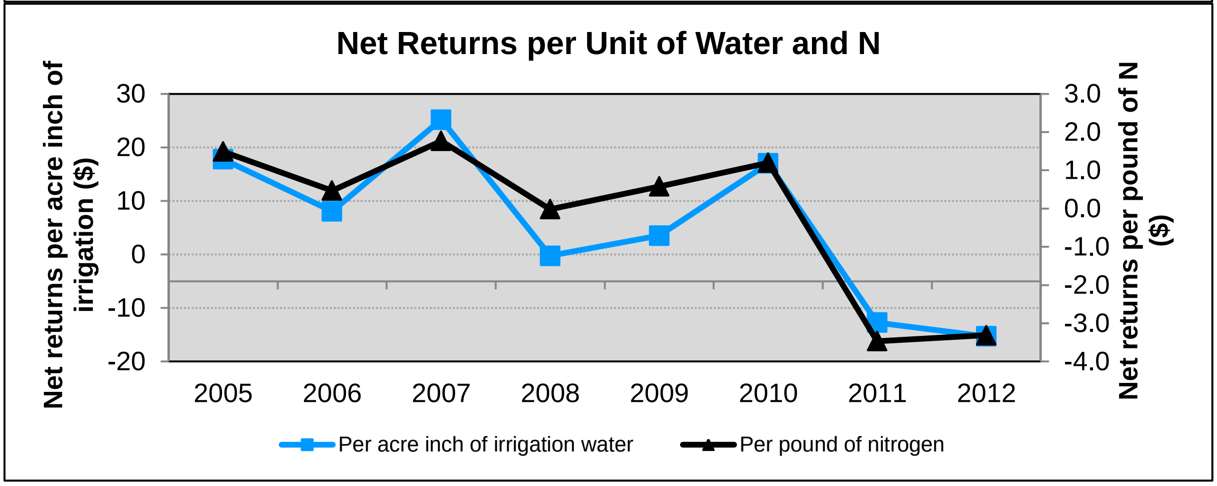
April wheat

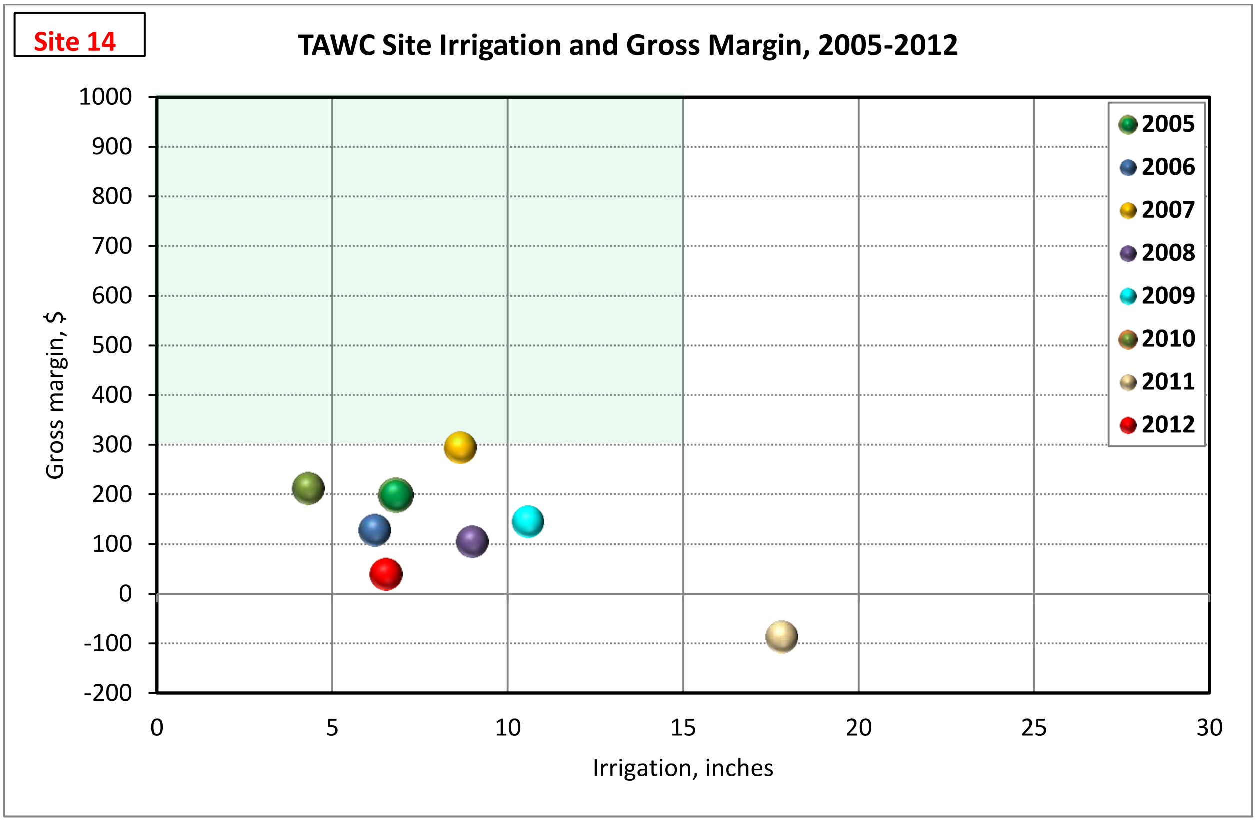
August cotton

Site 14


Irrigation and Precipitation
Water (inches)
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
300
200
100
0
-100
-200
-300
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
30
20
10
0
-10
-20
2005
2006
2007
2008
2009
2010
2011
2012
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
Net returns per pound of N ($)
Per acre inch of irrigation water
Per pound of nitrogen


Site 14
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012

Site 15 Description

Total site acres: 101.1

Field No. 8 Acres: 56.7
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 9 Acres: 44.4
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Subsurface Drip

Pumping capacity, gal/min: 290

Number of wells: 1

Fuel source: electric

Site 15

	Livestock	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7	Field 8	Field 9
2005	None	Cotton	Cotton							
2006	None	Cotton	Split into Fields 3 and 4	Cotton	Grain sorghum					
2007	None	Cotton		Grain Sorghum	Cotton					
2008	None	Split into Fields 5 and 6		Cotton	Wheat harvested, volunteer sheat for cover crop, replanted to Wheat	Cotton	Cotton			
2009	None			Cotton	Cotton	Cotton	Acres added to become Field 7	Cotton		
2010	None			Split into Fields 8 and 9				Split into Fields 8 and 9	Cotton	Cotton
2011	None								Corn	Cotton
2012	None								Milo	Milo

Comments: This has been a cotton, wheat and grain sorghum system in previous years. This year both fields were planted to cotton on 40-inch centers. The cotton crop was lost to hail on June 4th and replanted to grain sorghum.

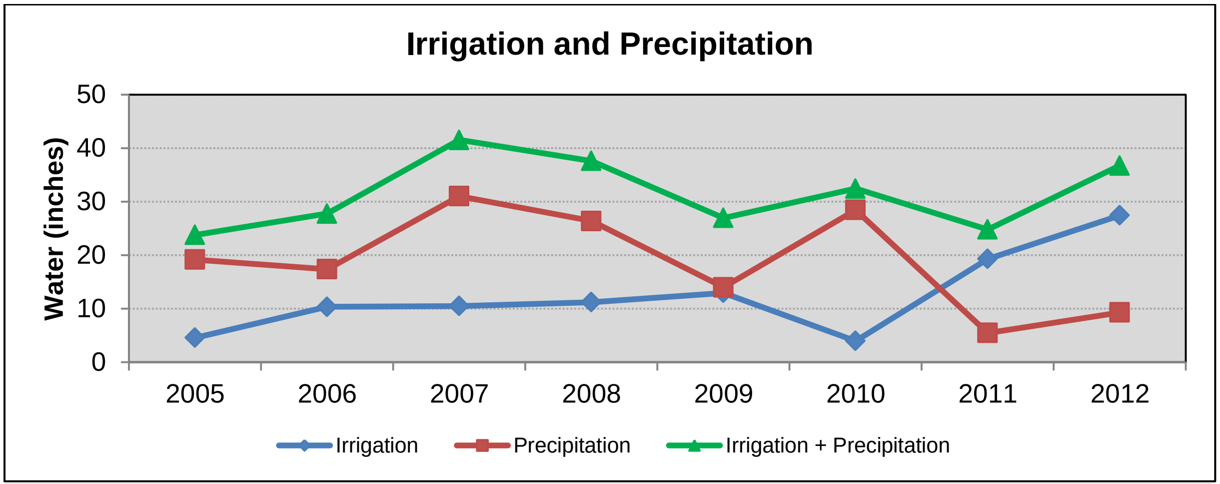
April wheat

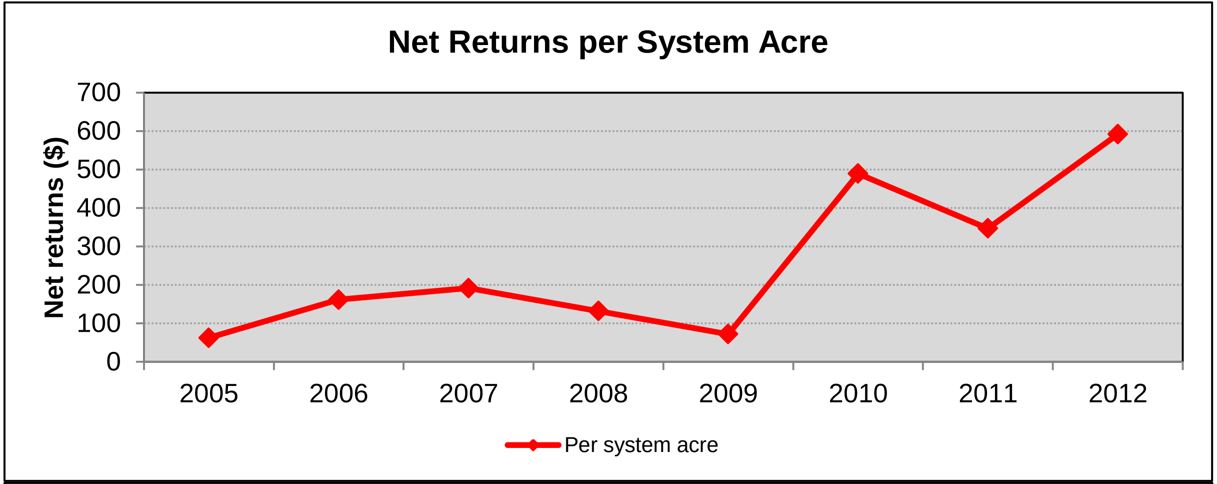
June cotton hailed out

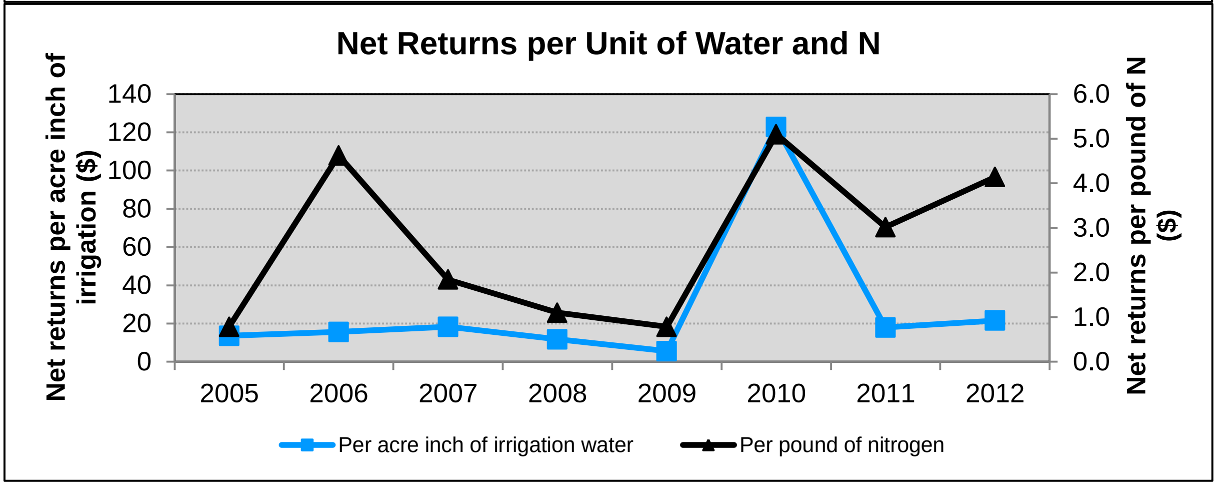
Replanted cotton to grain sorghum

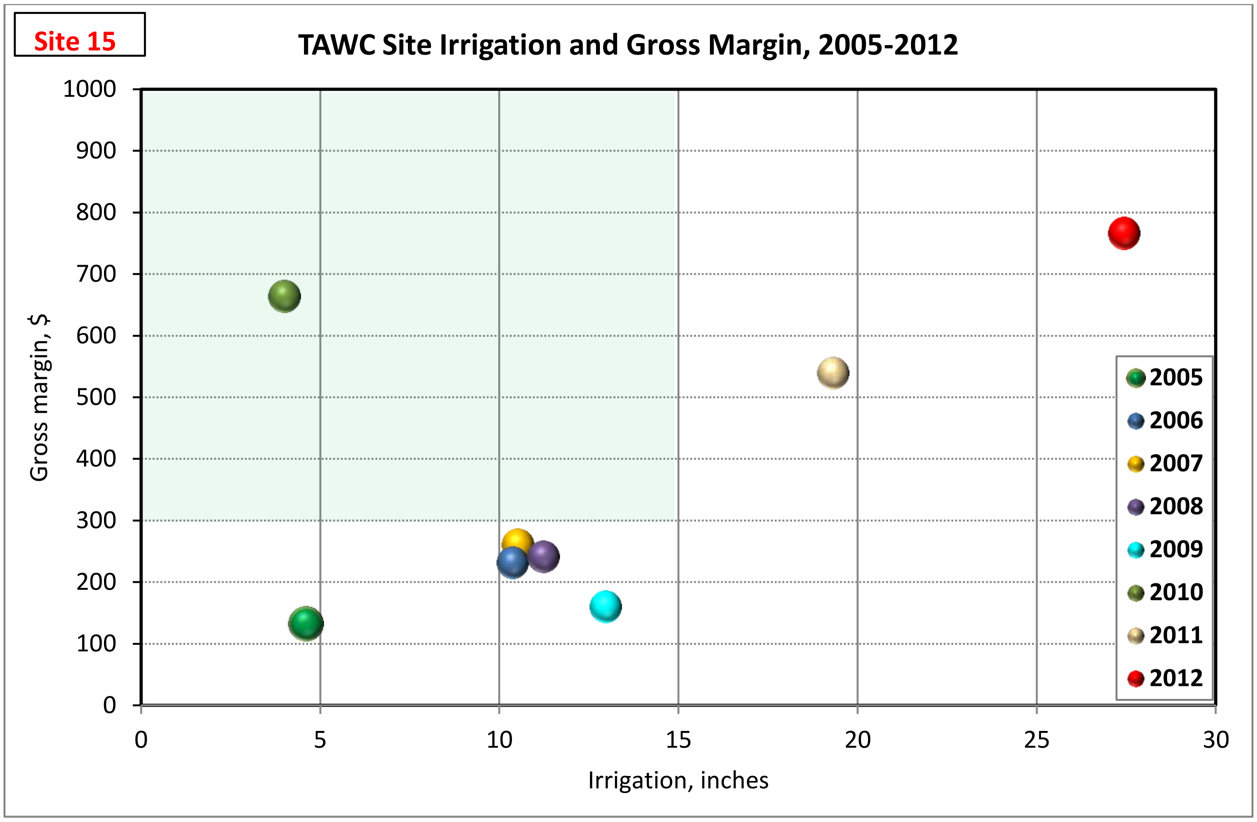
Grain sorghum nearing harvest

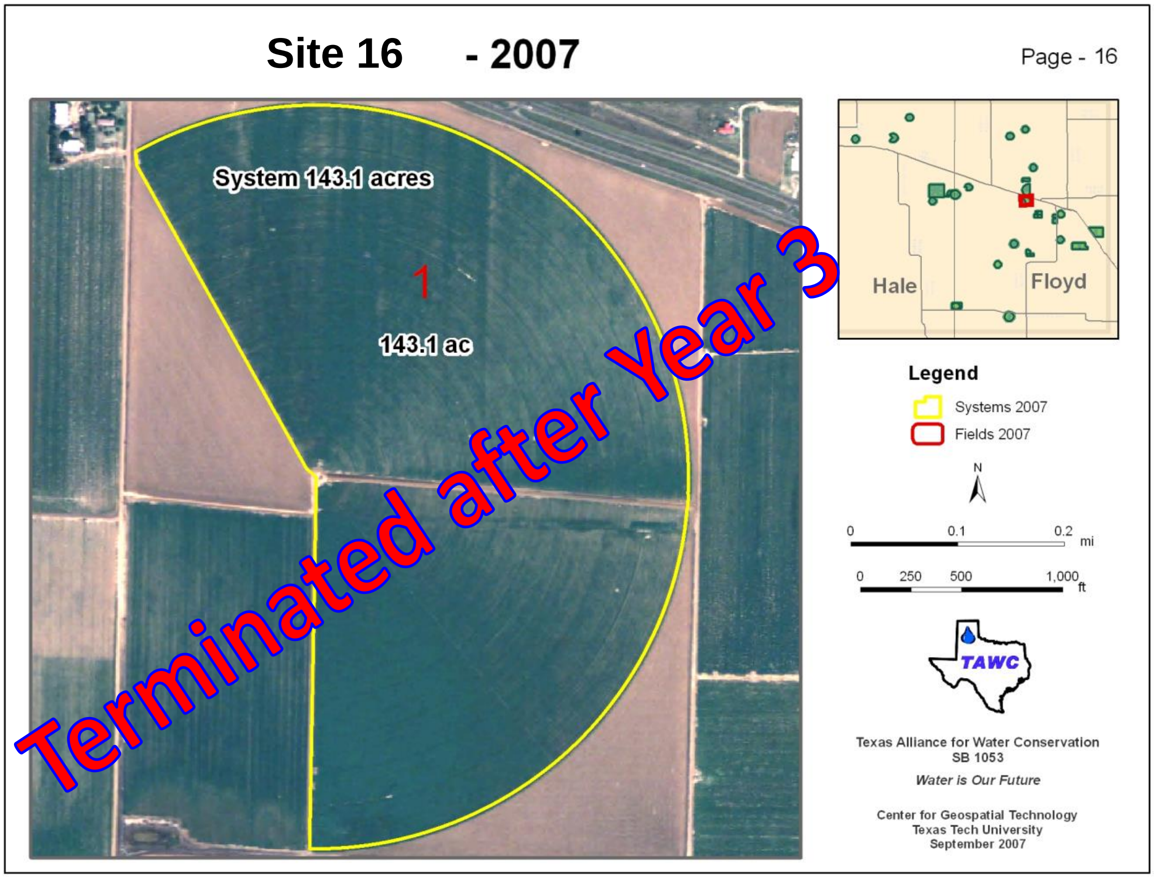
Site 15


Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
700
600
500
400
300
200
100
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
140
120
100
80
60
40
20
0
Net returns per pound of N ($)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 15
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012



Site 16 Description

Total site acres:	143.1
Field No. 1 Acres:	143.1
Major soil type:	Pullman clay loam; 0 to 1% slope

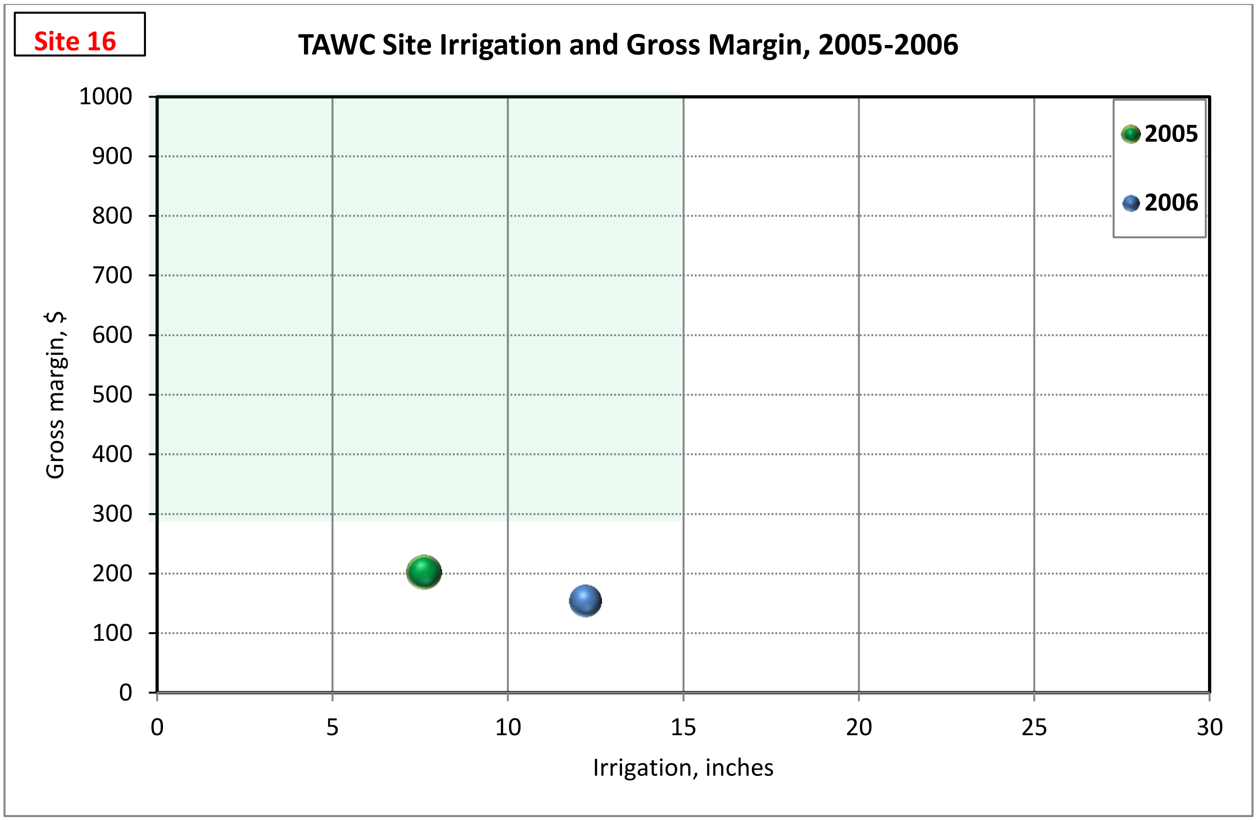
Irrigation

Type:	Center Pivot (LESA)
Pumping capacity, gal/min:	600
Number of wells:	3
Fuel source:	Electric

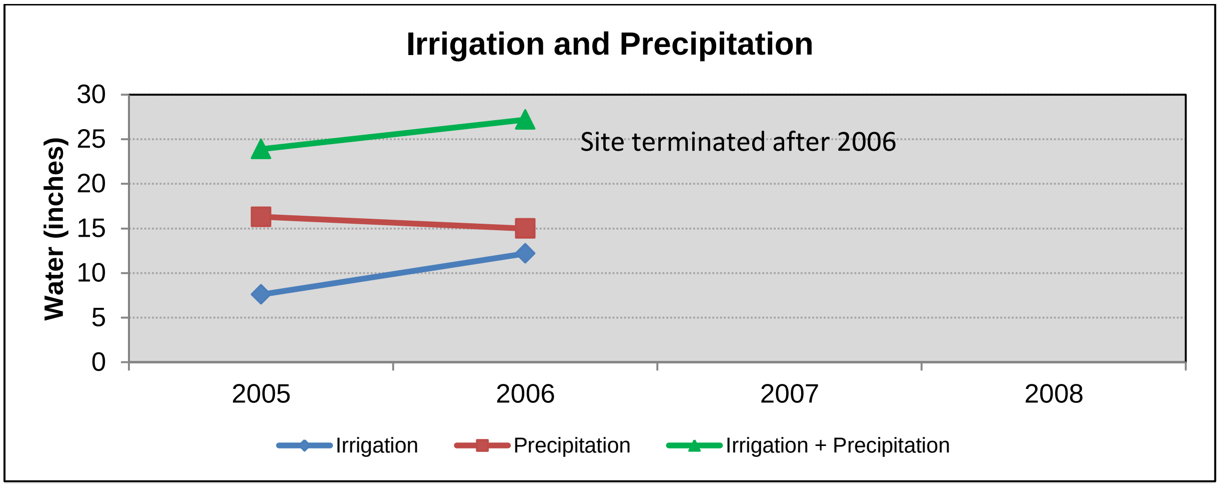
Comments: This pivot irrigated cotton site used conventional tillage and planted on 40-inch centers.

Site 16

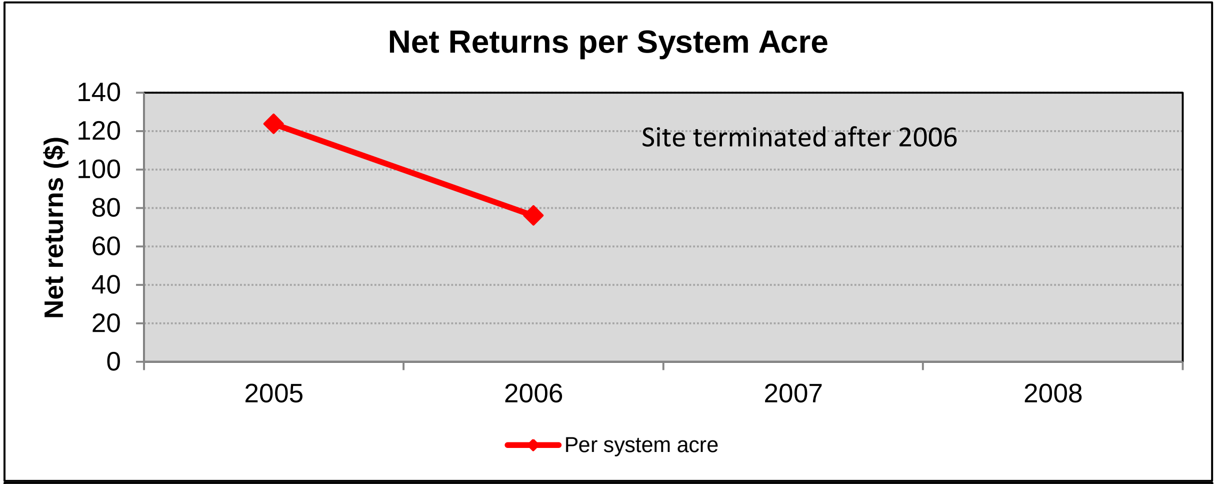
	Livestock	Field 1
2005	None	Cotton
2006	None	Cotton
2007	None	Cotton following wheat cover crop
2008	Site terminated for 2008	



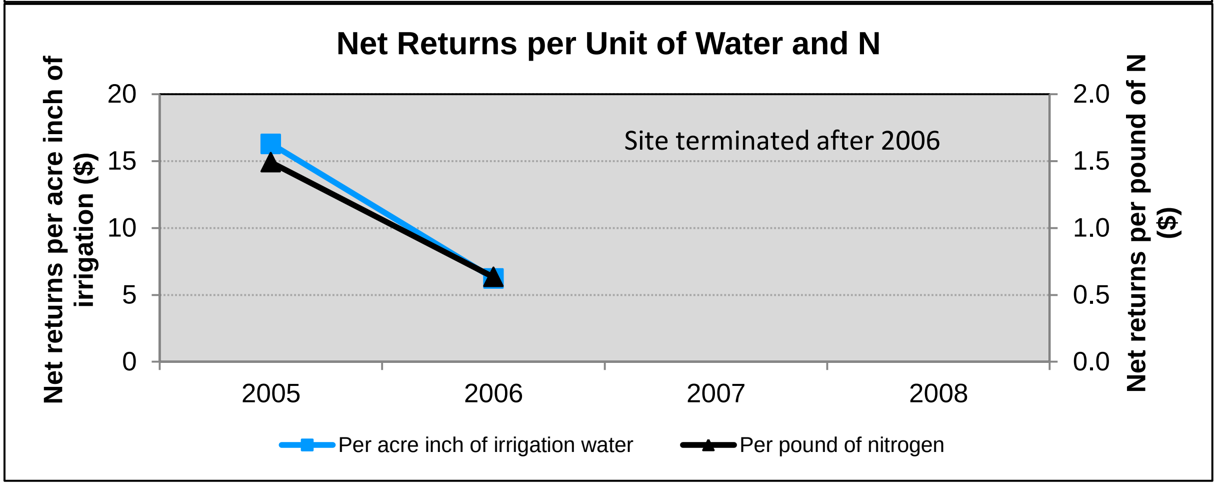
Site 16



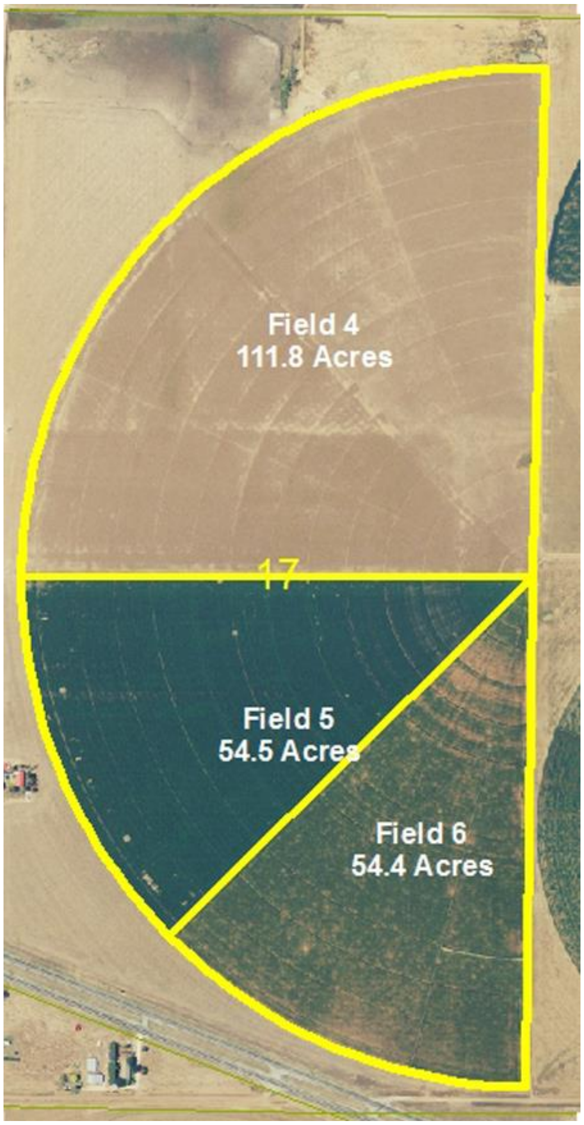
Irrigation and Precipitation
Water (inches)
30
25
20
15
10
5
0
2005
2006
2007
2008
Site terminated after 2006
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
140
120
100
80
60
40
20
0
2005
2006
2007
2008
Site terminated after 2006
Per system acre



Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
20
15
10
5
0
Net returns per pound of N ($)
2.0
1.5
1.0
0.5
0.0
2005
2006
2007
2008
Site terminated after 2006
Per acre inch of irrigation water
Per pound of nitrogen



Site 17 Description

Total site acres:	220.7
Field No. 4 Acres:	111.8
Major soil type:	Pullman clay loam; 0 to 1% slope
Field No. 5 Acres:	54.5
Major soil type:	Pullman clay loam; 0 to 1% slope
Field No. 6 Acres:	54.4
Major soil type:	Pullman clay loam; 0 to 1% slope

Irrigation

Type:	Center Pivot (MESA)
Pumping capacity, gal/min:	900
Number of wells:	8
Fuel source:	Electric

Site 17

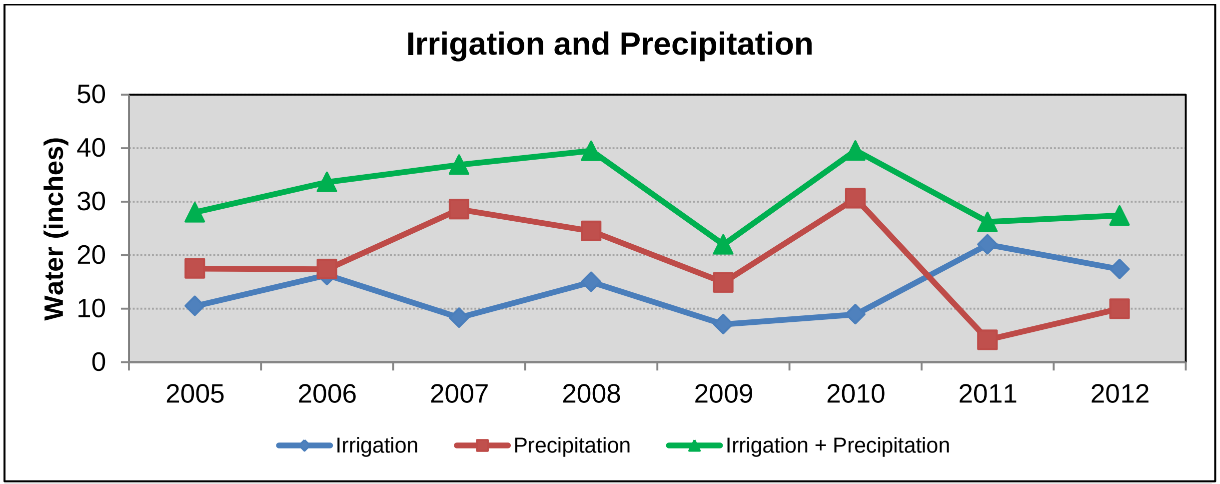
	Livestock	Field 1	Field 2	Field 3
2005	None	WW-B. Dahl grass for hay	Corn for silage, followed by wheat for grazing and cover	Cotton following cover crop of wheat
2006	Cow-calf	WW-B. Dahl grass for grazing and hay	Wheat for grazing and cover followed by cotton	Corn for silage, followed by wheat for grazing and cover
2007	Cow-calf	WW-B. Dahl grass for grazing and seed	WW-B. Dahl grass for grazing, hay, seed, established after wheat cover crop	Wheat for grazing and cover followed by cotton
2008	Cow-calf	WW-B. Dahl grass for grazing and seed	WW-B. Dahl grass for grazing and seed	Corn for grain and grazing of residue
2009	Cow-calf	WW-B. Dahl grass for grazing and seed	WW-B. Dahl for grazing	Sunflowers
2010	Cow-calf	WW-B. Dahl grass for grazing	WW-B. Dahl for grazing	Corn
2011	Cow-calf	WW-B. Dahl grass for grazing	WW-B. Dahl for grazing	Cotton
	Livestock	Field 4	Field 5	Field 6
2012	Cow-calf	WW-B. Dahl grass for grazing	Cotton	Corn

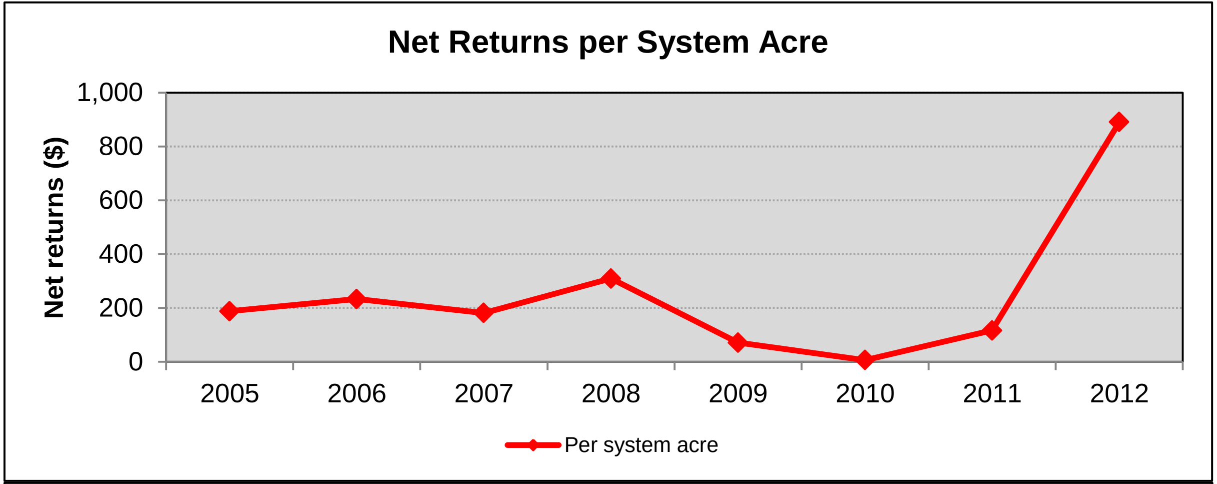
Comments: This pivot irrigated site has grown cotton, corn, sunflowers, and Old World bluestem. Corn and cotton were planted on thirty-inch centers. The Old World bluestem has been used for grazing and/or seed production. In 2012 the bluestem was not grazed due to the lack of rainfall, but was harvested for seed.

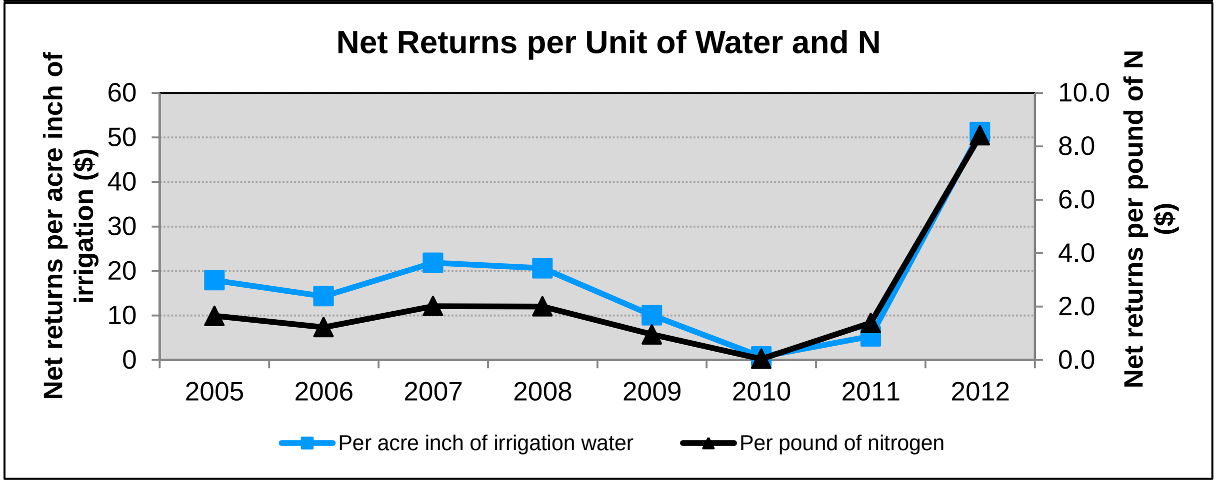
September old world bluestem

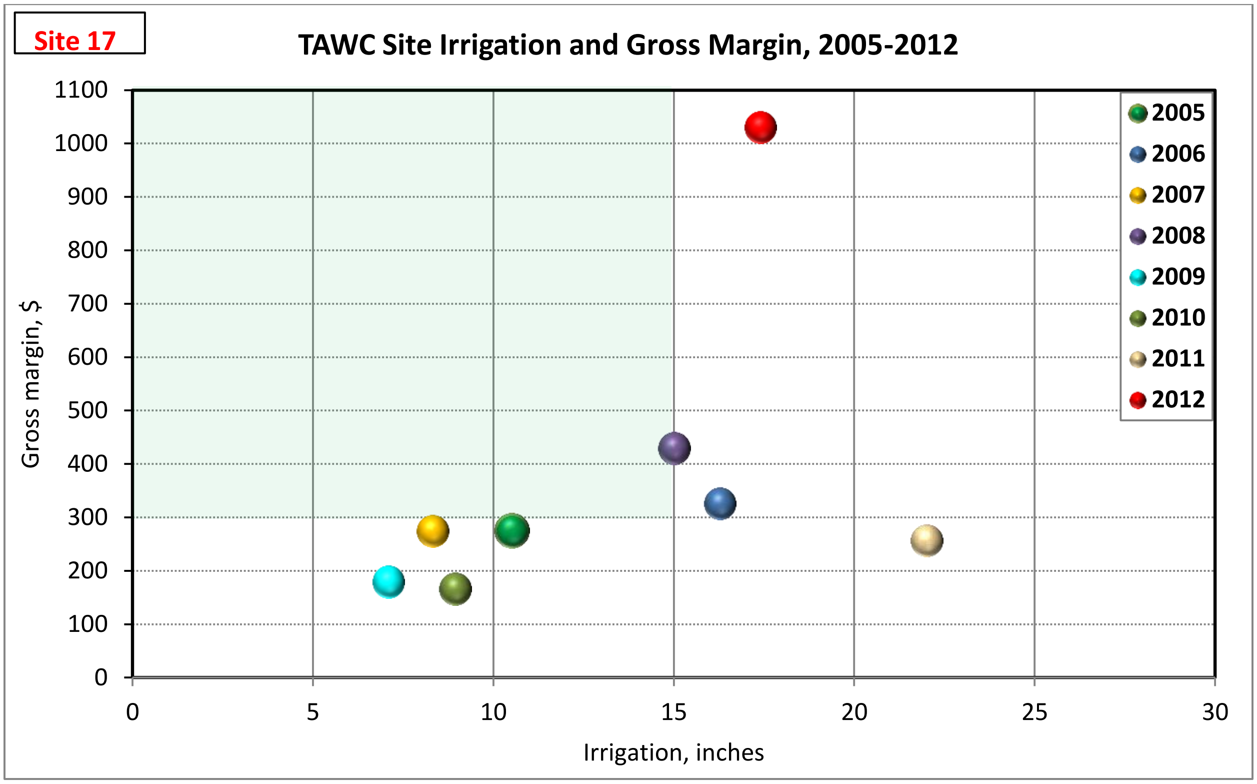
Corn in background with cotton in foreground

Site 17


Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
1,000
800
600
400
200
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
60
50
40
30
20
10
0
Net returns per pound of N ($)
10.0
8.0
6.0
4.0
2.0
0.0
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 17
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1100
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012

Site 18 Description		Irrigation	
Total site acres:	122.2	Type:	Center Pivot (LEPA)
Field No. 1 Acres:	60.7	Pumping capacity, gal/min:	250
Major soil type:	Pullman clay loam; 0 to 1% slope		
Field No. 2 Acres:	61.5	Number of wells:	3
Major soil type:	Pullman clay loam; 0 to 1% slope		
		Fuel source:	Electric

Site 18

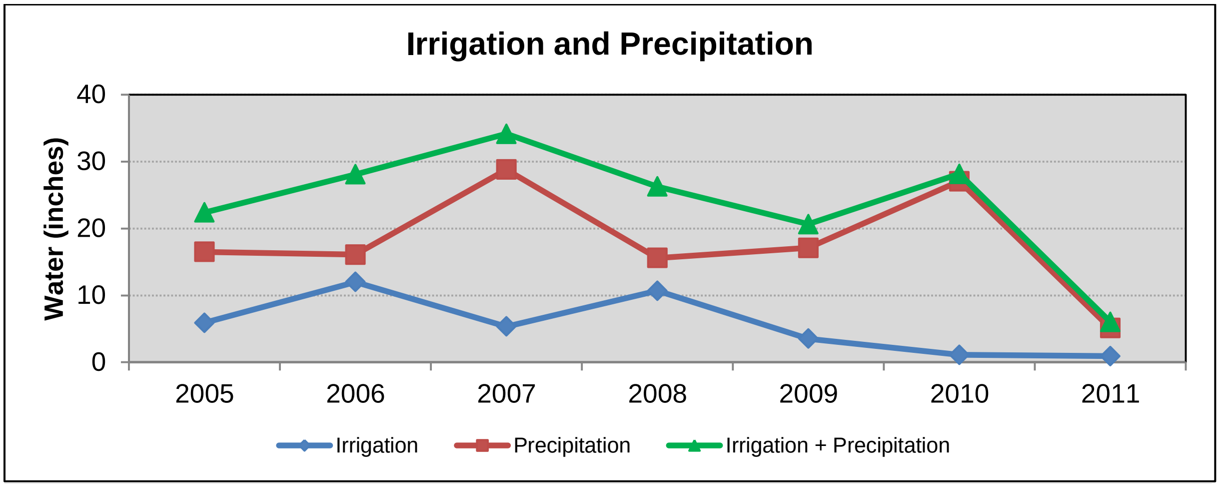
	Livestock	Field 1	Field 2
2005	None	Cotton	Grain sorghum
2006	None	Cotton	Oats for silage followed by forage sorghum for hay
2007	None	Wheat for grain	Grain sorghum
2008	None	Wheat for silage followed by grain sorghum	Cotton
2009	None	Cotton	Wheat
2010	None	Wheat	Cotton
2011	None	Cotton Abandoned	Wheat/cotton Abandoned both
2012	None	Cotton	Cotton

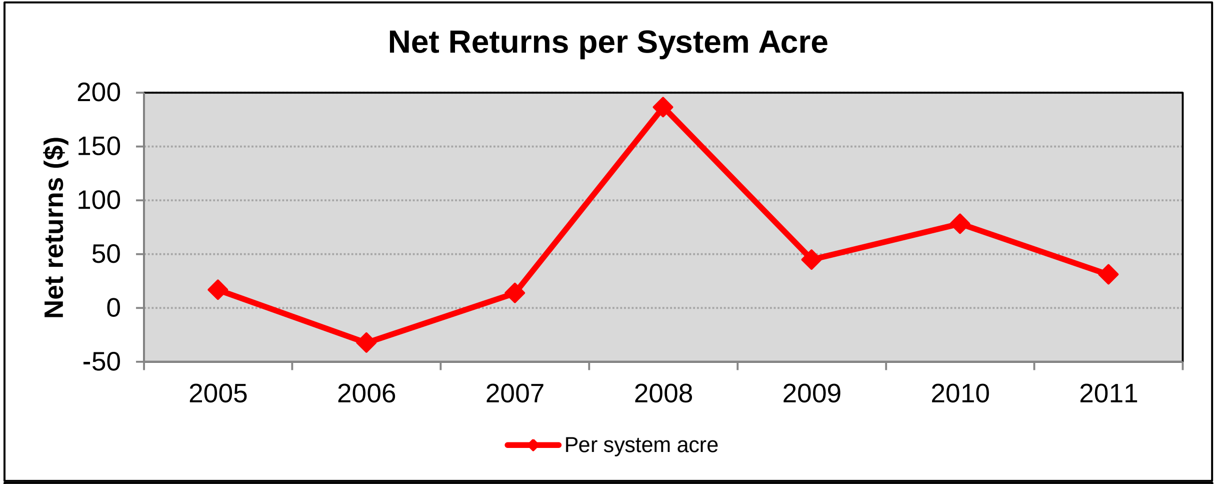
Comments: This is a pivot irrigated site with limited irrigation. Grain sorghum, cotton and wheat are planted on a rotational basis.

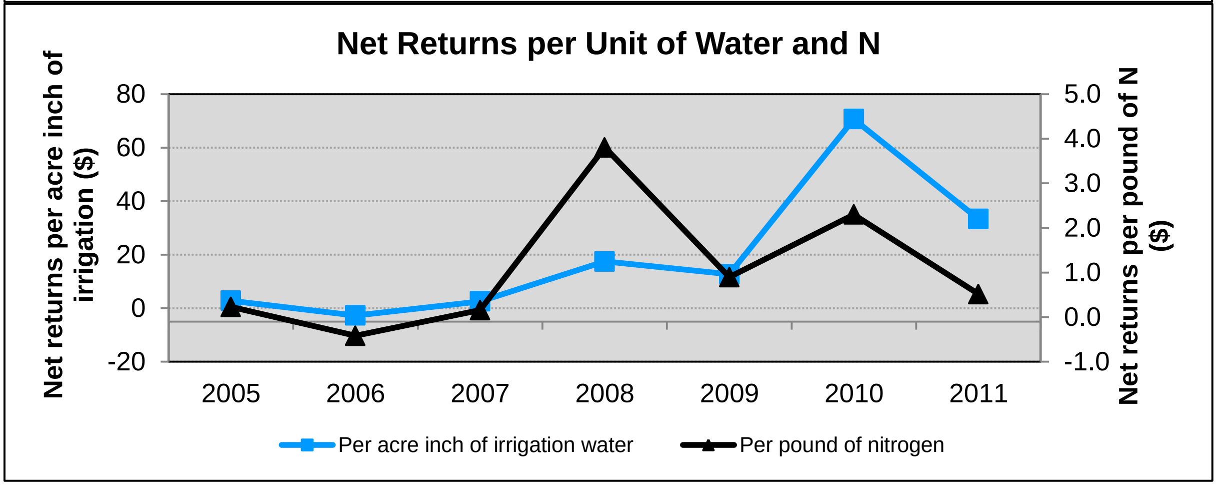
April wheat

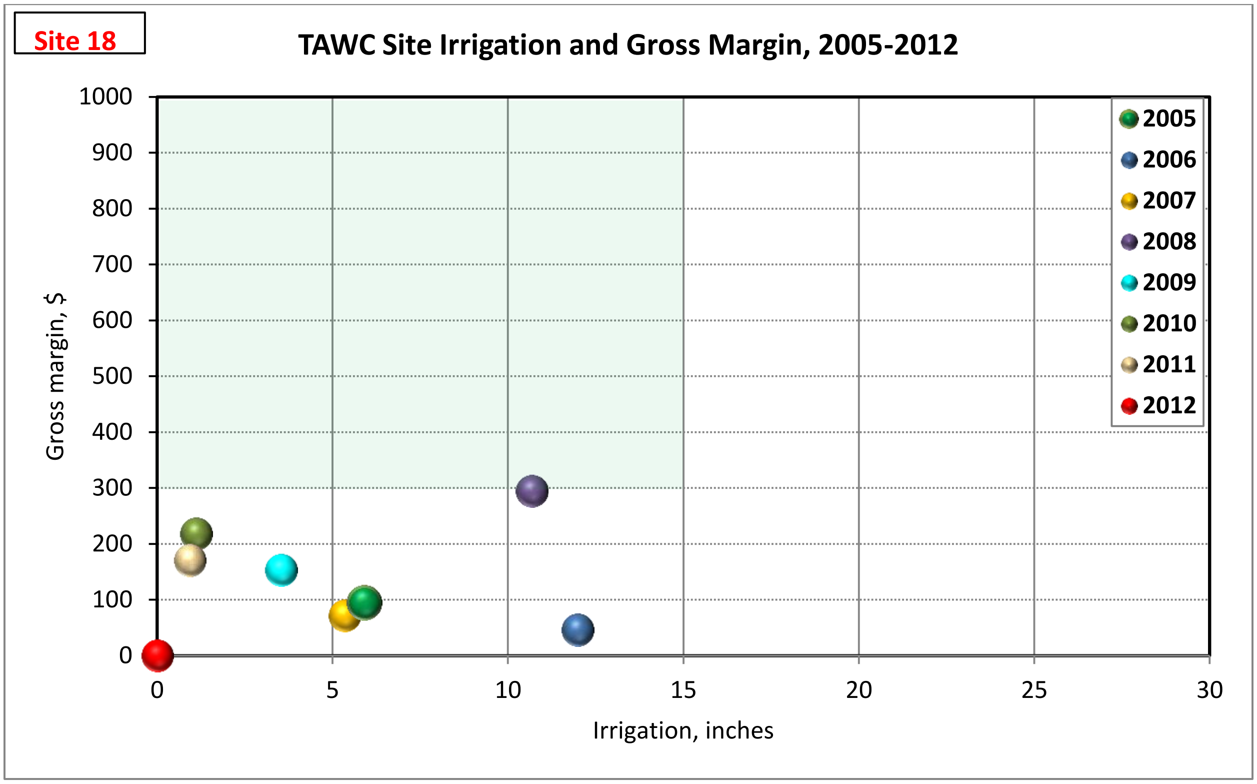
Abandoned cotton

Site 18 –**No Data was collected from Producer for 2012**

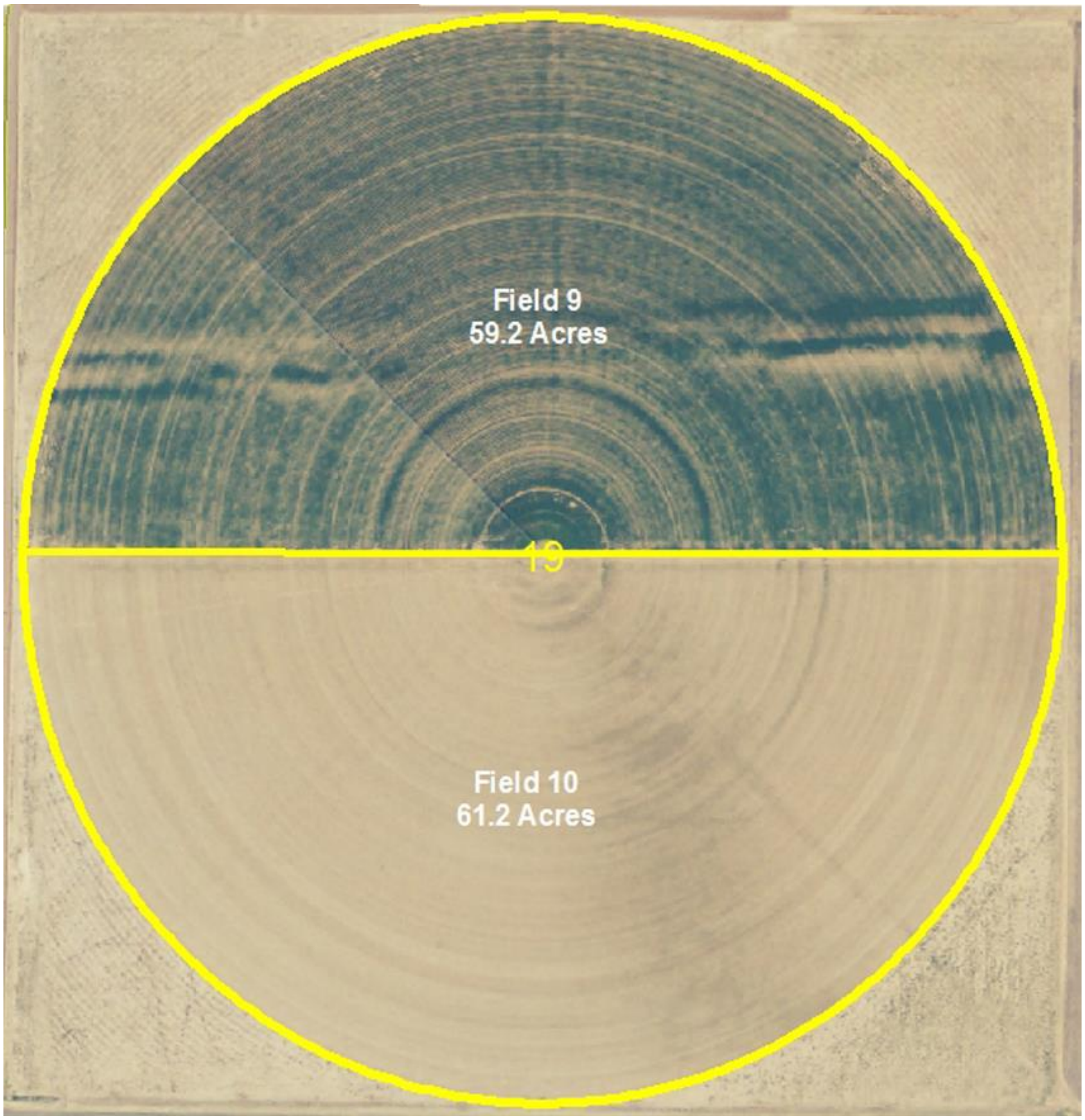








No Data collected from Producer in 2012



Site 19 Description

Total site acres: 120.4

Field No. 9 Acres: 59.2
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 10 Acres: 61.2
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Center Pivot (LEPA)

Pumping capacity, gal/min: 400

Number of wells: 3

Fuel source: Electric

Site 19

	Livestock	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7	Field 8	Field 9	Field 10
2005	None	Cotton	Pearlmillet for seed								
2006	None	Split into Fields 3 and 4		Pearlmillet for seed	Cotton						
2007	None			Split into Fields 5 and 6		Cotton	Pearlmillet for seed				
2008	None					Split into Fields 7 and 8		Cotton	Pearlmillet for seed		
2009	None							Split into Fields 9 and 10		Wheat	Cotton
2010	None									Cotton	Wheat
2011	None									Cotton	Cotton
2012	None									Cotton	Fallow

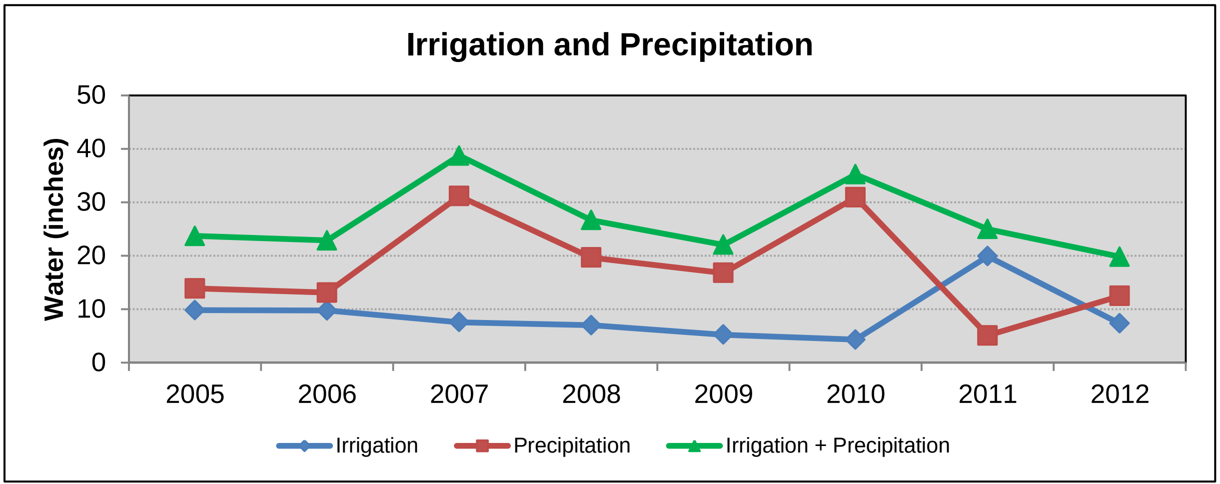
Comments: This is a pivot irrigated cotton and wheat site using conventional tillage. Cotton is planted on 40-inch centers in a skip-row pattern.

Cotton in June

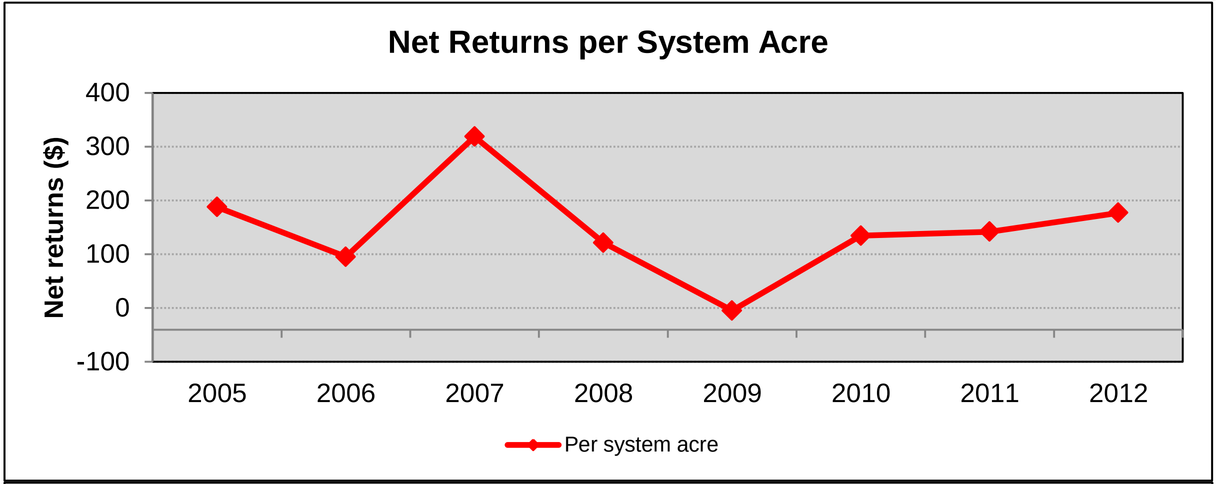
August cotton

August cotton

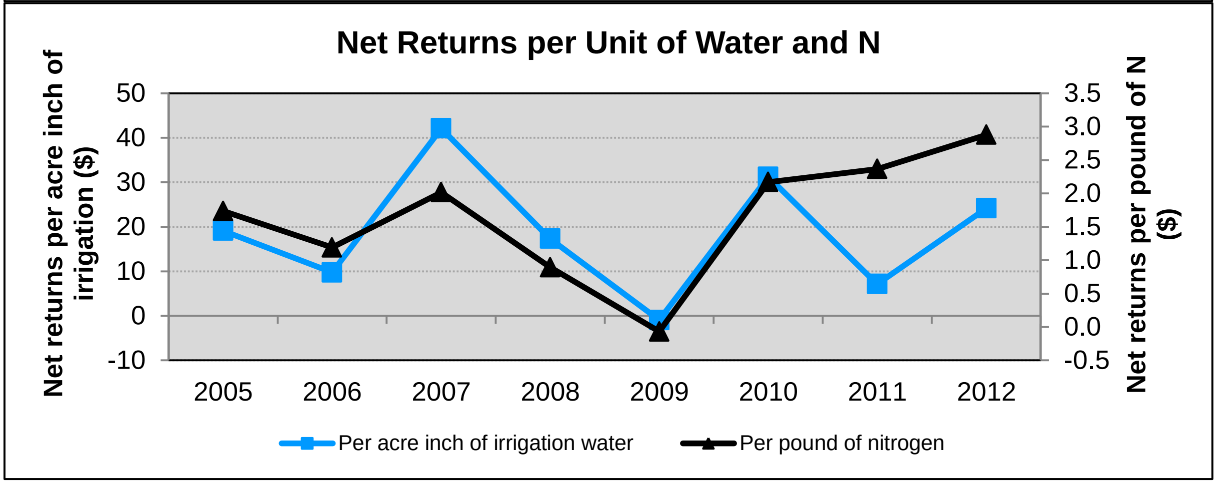
Site 19



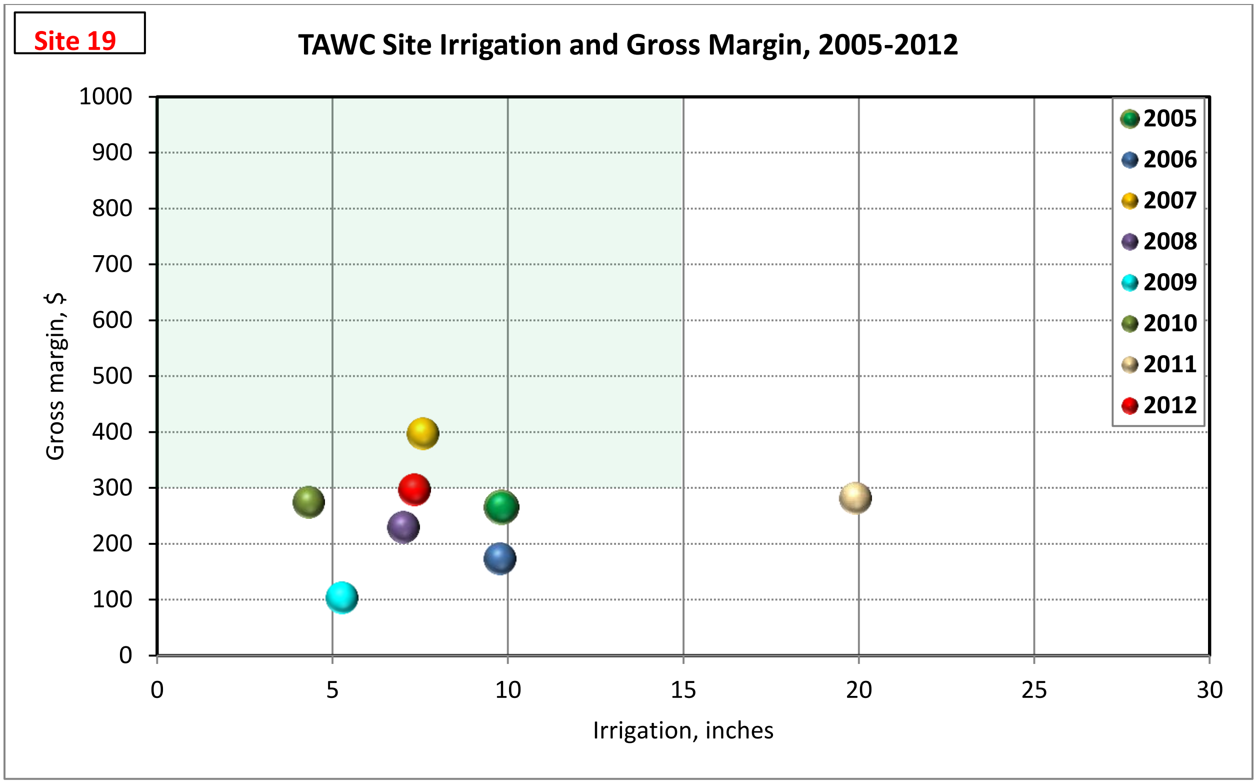
Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation

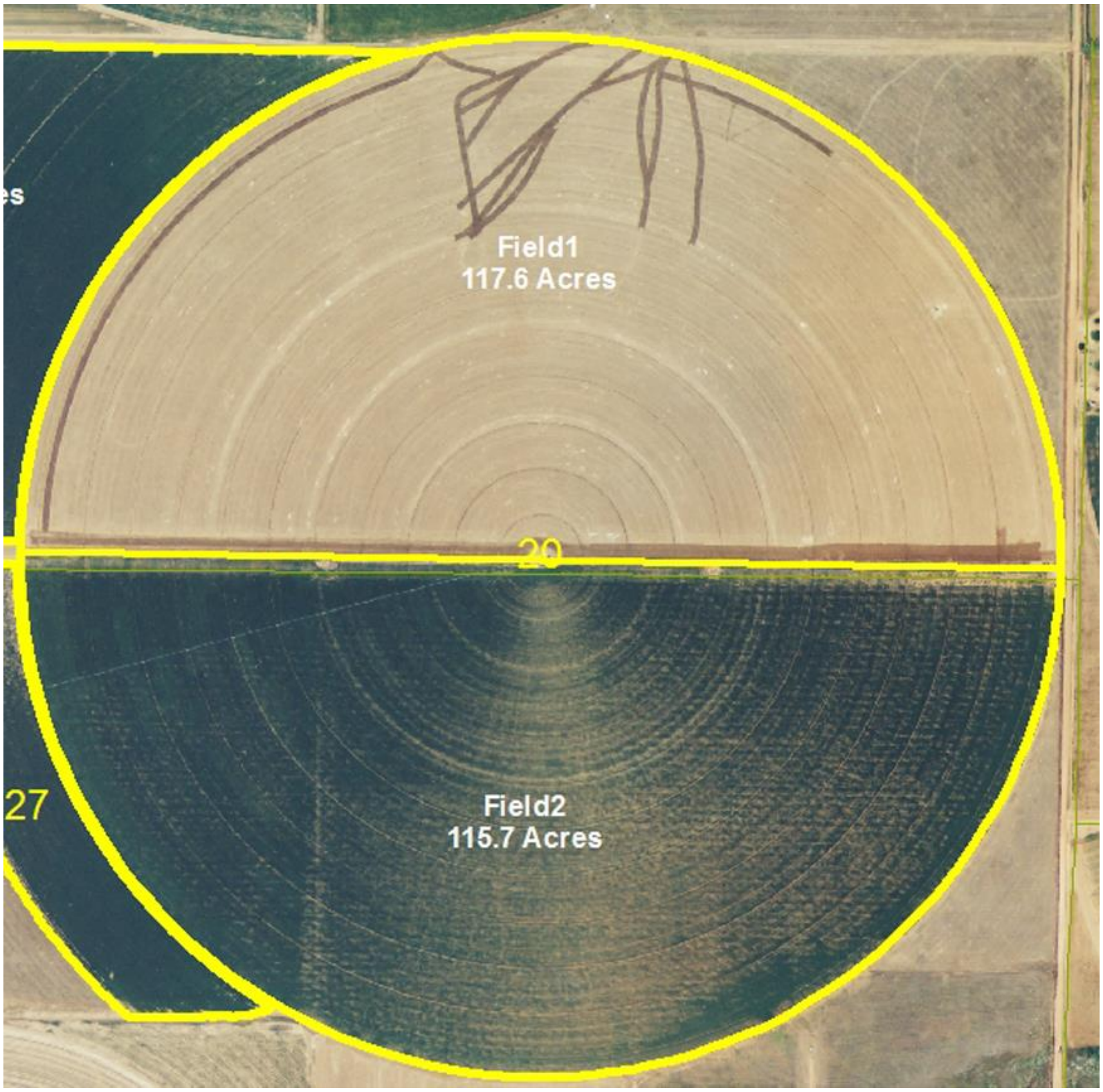


Net Returns per System Acre
Net returns ($)
400
300
200
100
0
-100
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre



Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
50
40
30
20
10
0
-10
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 19
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012



Site 20 Description

Total site acres:	233.3
Field No. 1 Acres:	117.6
Major soil type:	Pullman clay loam; 0 to 1% slope
Field No. 2 Acres:	115.7
Major soil type:	Pullman clay loam; 0 to 1% slope

Irrigation

Type:	Center Pivot (LEPA)
Pumping capacity, gal/min:	1000
Number of wells:	3
Fuel source:	Electric

Site 20

	Livestock	Field 1	Field 2
2005	None	Wheat for silage followed by forage sorghum for silage	Corn for silage
2006	None	Corn for silage	Triticale for silage followed by forage sorghum for silage
2007	None	Triticale for silage, followed by corn for silage	Triticale for silage, followed by forage sorghum for silage
2008	None	Wheat for grain followed by grain sorghum for grain and residue for hay	Wheat for grain followed by grain sorghum for silage
2009	None	Cotton	Corn for silage
2010	None	Corn for silage	Triticale for silage followed by cotton
2011	None	Triticale for silage/hay and cotton double crop	Corn for silage
2012	None	Corn	Triticale for silage followed by cotton

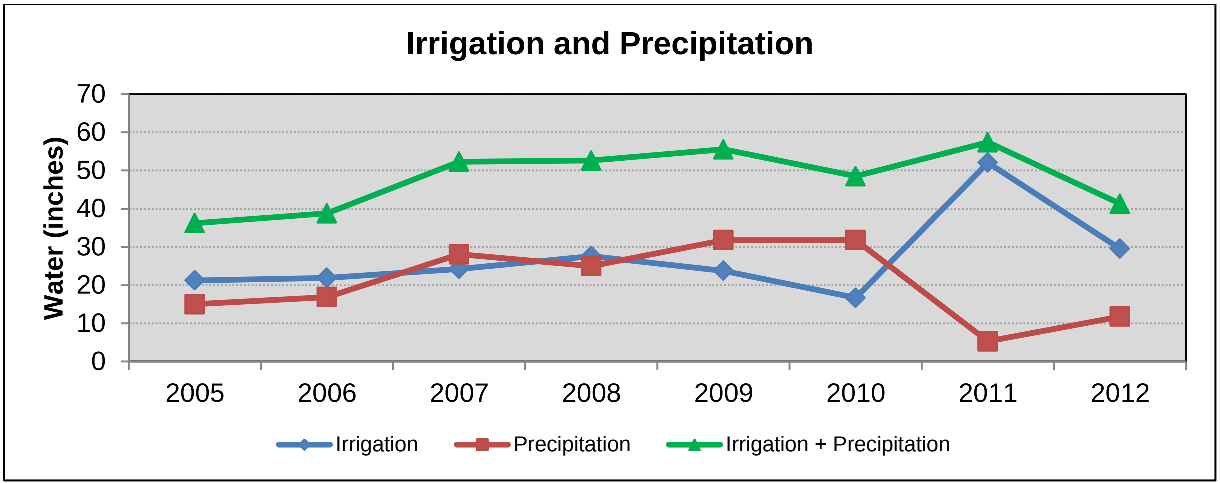
Comments: This site was planted to corn and triticale for silage. After triticale harvest, cotton was planted no-till on forty-inch centers and corn was planted on forty-inch centers.

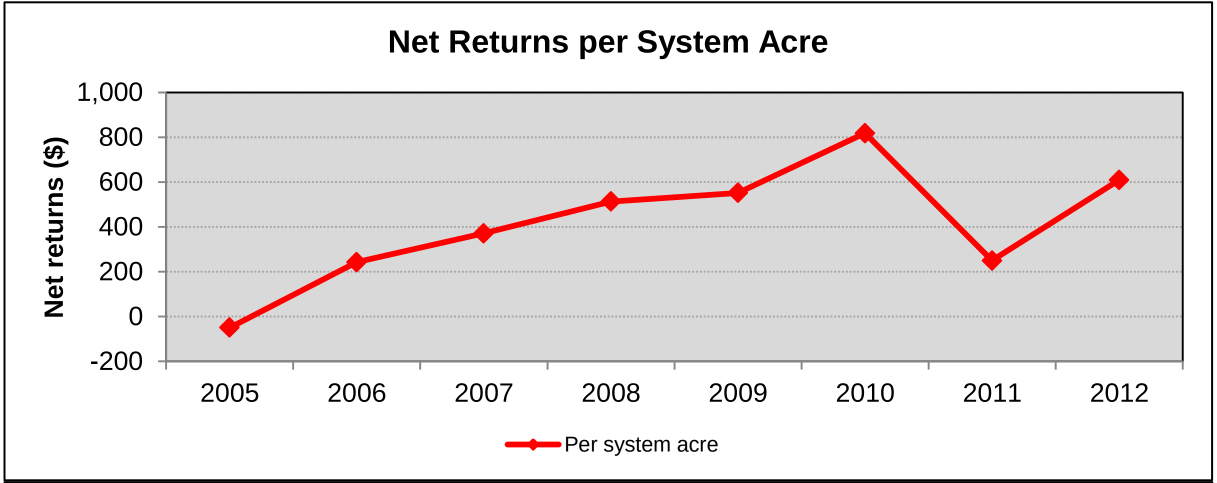
Triticale for silage

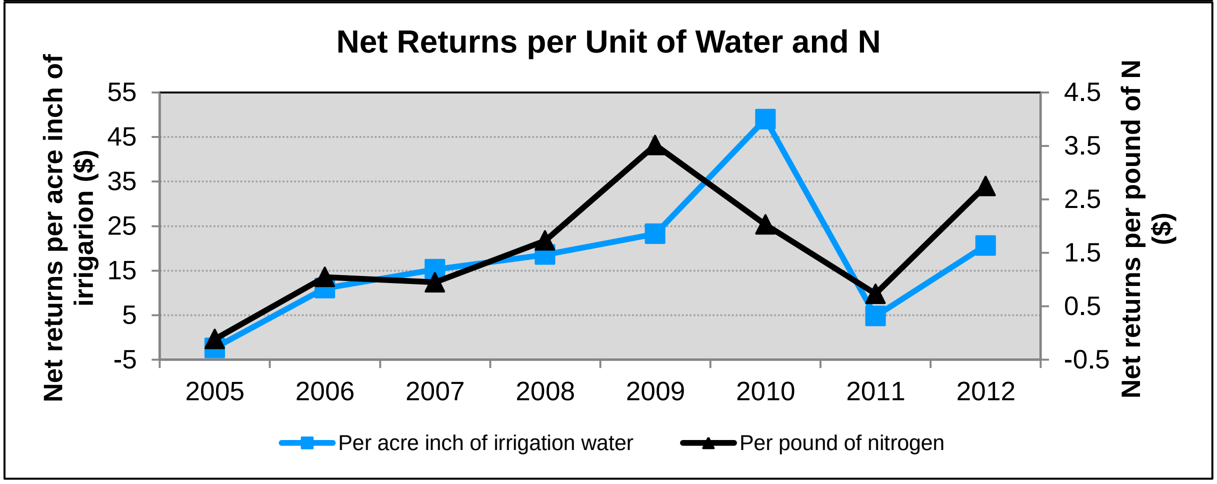
August cotton

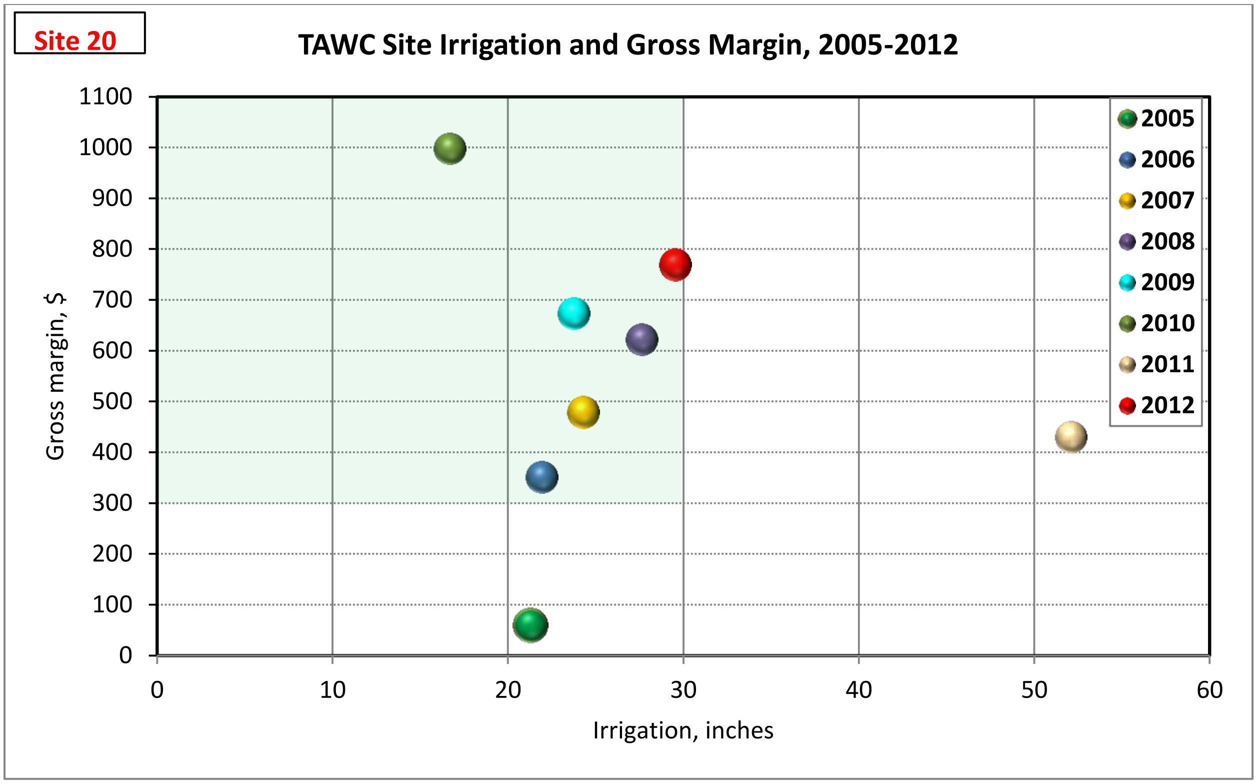
June corn

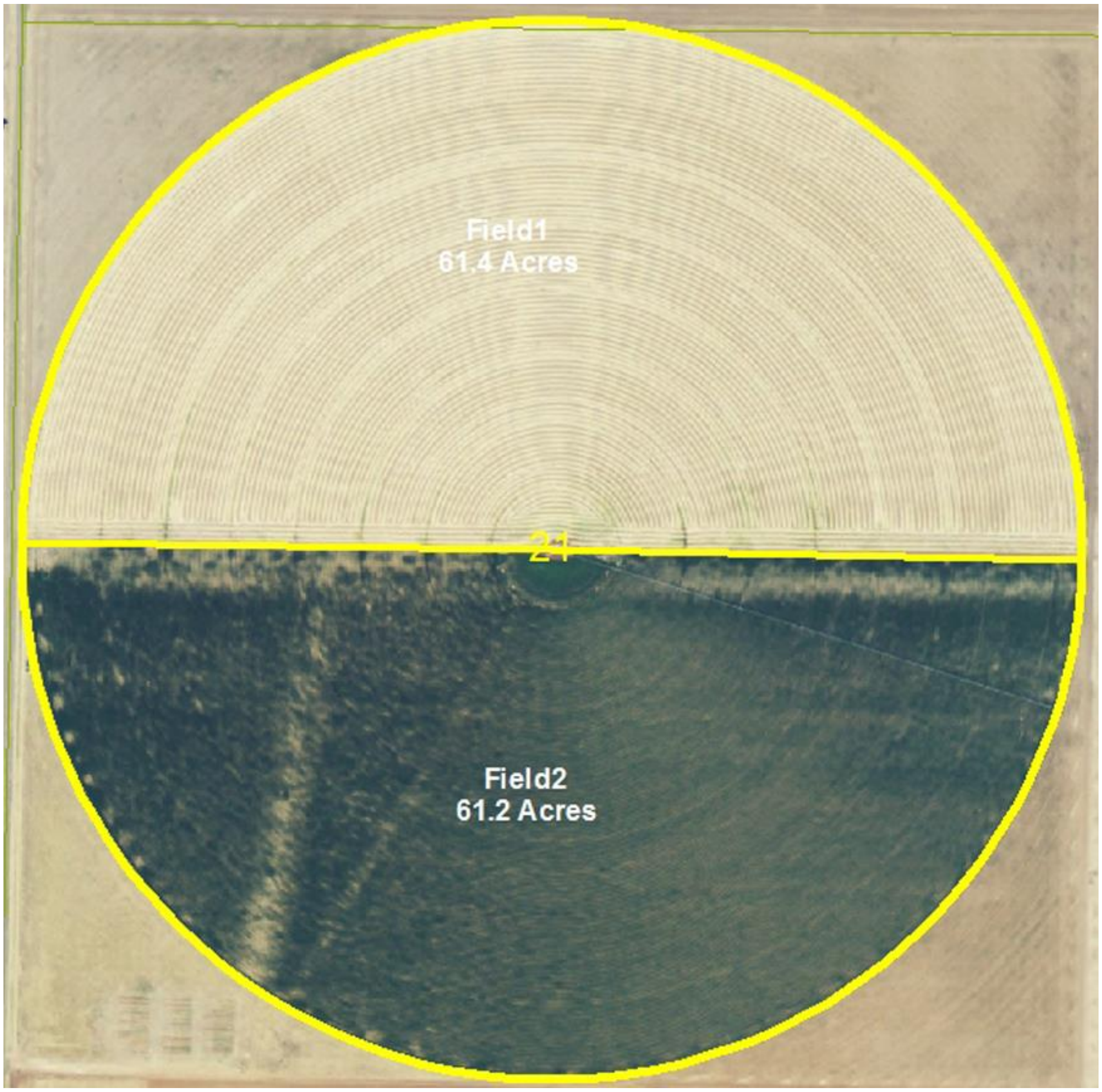
Site 20


Irrigation and Precipitation
Water (inches)
70
60
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
1,000
800
600
400
200
0
-200
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigarion ($)
55
45
35
25
15
5
-5
4.5
3.5
2.5
1.5
0.5
-0.5
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 20
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1100
1000
900
800
700
600
500
400
300
200
100
0
0
10
20
30
40
50
60
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012



Site 21 Description

Total site acres:	122.6
Field No. 1 Acres:	61.4
Major soil type:	Pullman clay loam; 0 to 1% slope
Field No. 2 Acres:	61.2
Major soil type:	Pullman clay loam

Irrigation

Type:	Center Pivot (LEPA)
Pumping capacity, gal/min:	500
Number of wells:	1
Fuel source:	Electric

Site 21

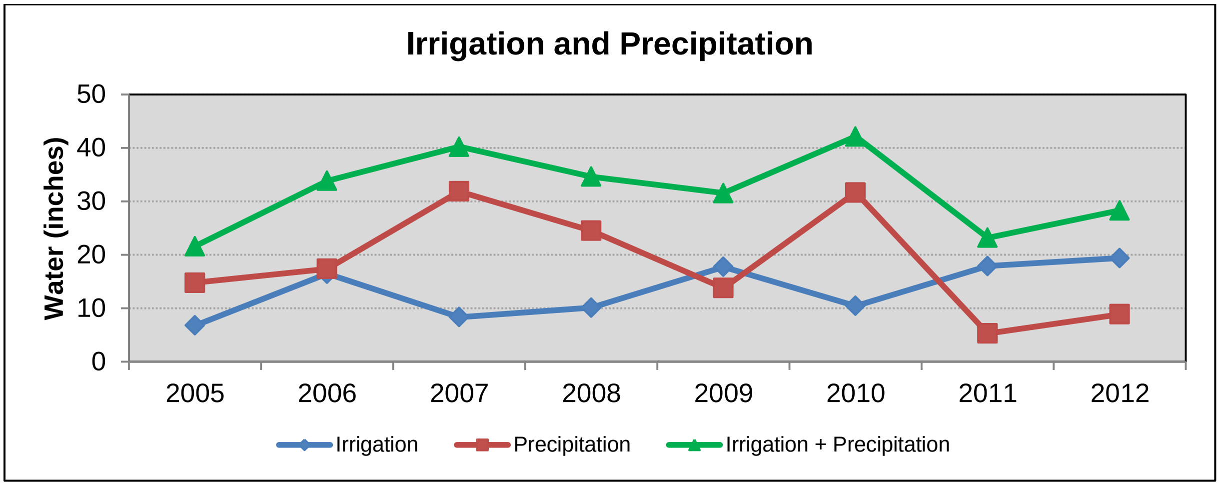
	Livestock	Field 1	Field 2
2005	None	Cotton	Cotton
2006	Stocker steers	Corn for grain	Wheat for grazing and cover followed by cotton
2007	None	Sideoats grama grass for seed and hay	Corn for grain
2008	None	Sideoats grama grass for seed and hay	Barley for seed followed by forage sorghum for hay
2009	None	Sideoats grama grass for seed and hay	Wheat/forage sorghum for hay
2010	None	Corn	Cotton
2011	None	Cotton	Corn abandoned
2012	None	Wheat/Haygrazer sudangrass	Cotton

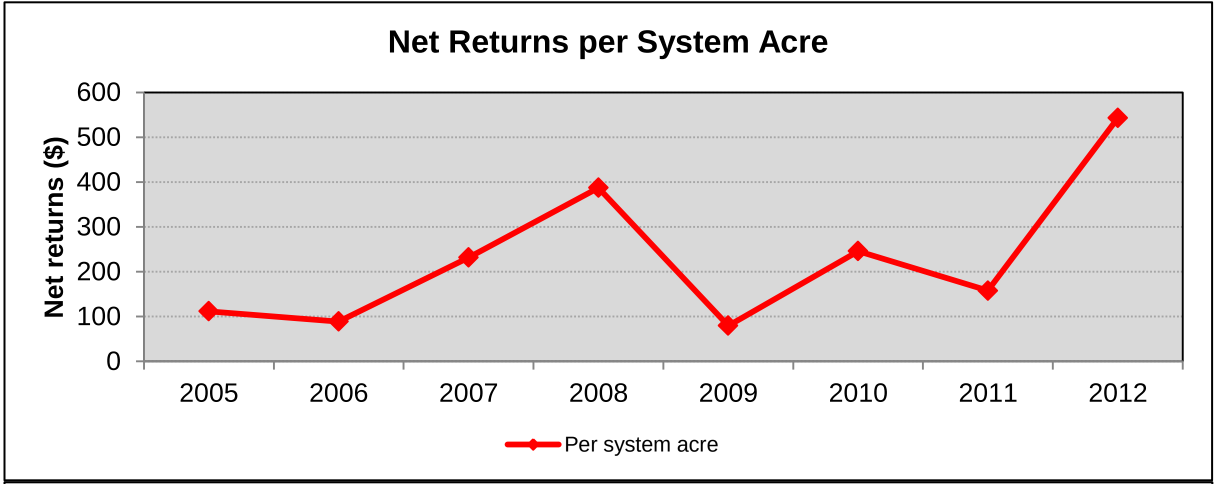
Comments: This is a pivot irrigated site with one-half planted to wheat and one-half planted to cotton. Both crops are planted on 40-inch centers using conventional tillage. Following wheat harvest this field was drilled to forage sorghum for hay production.

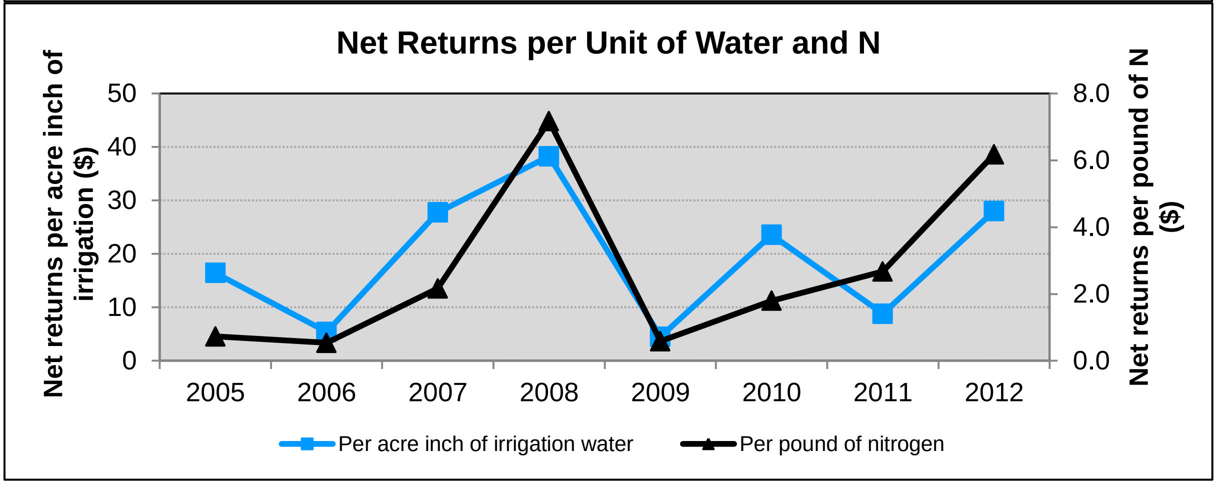
May wheat harvest

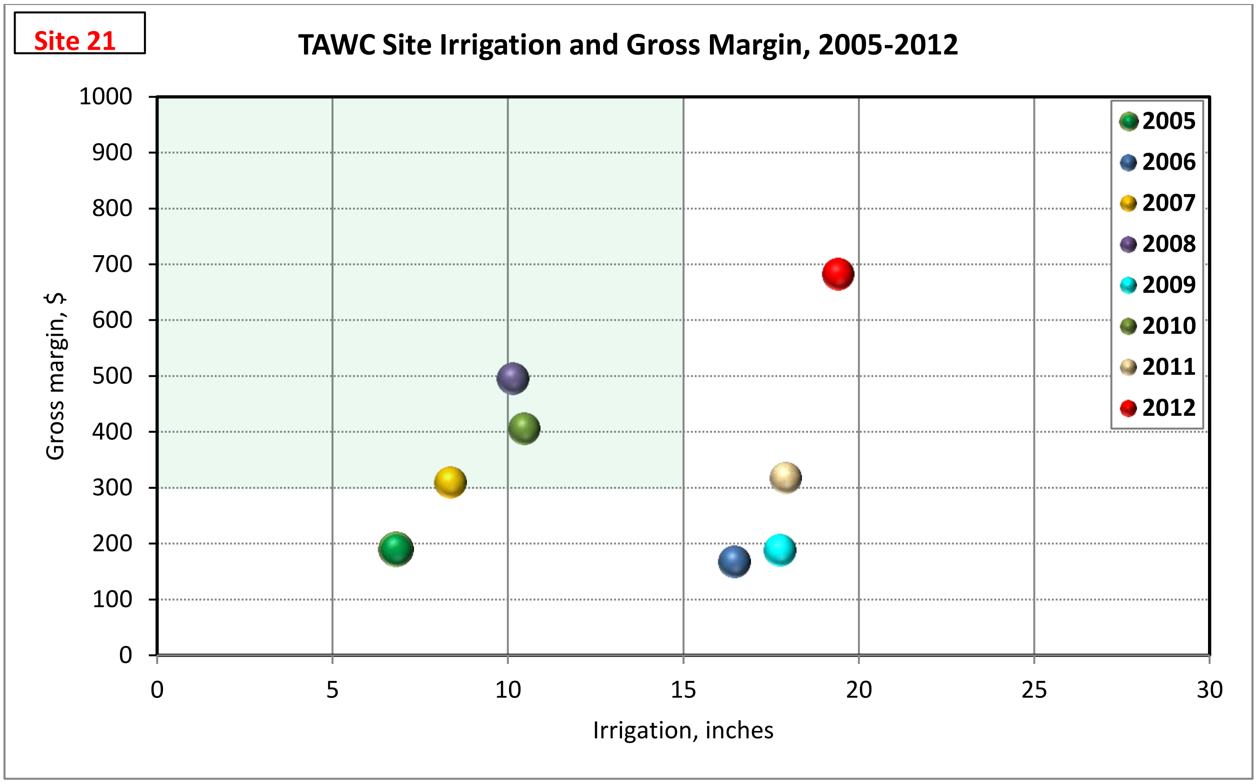
July cotton

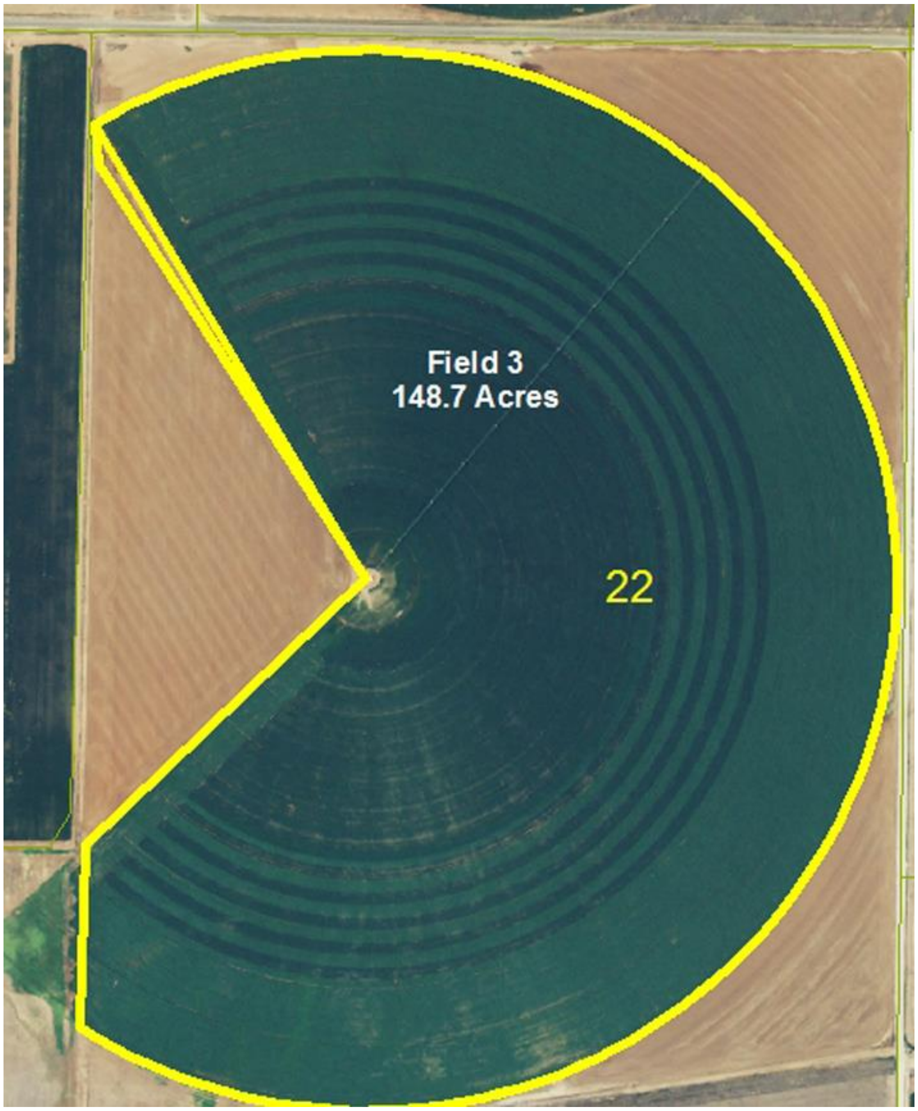
Site 21


Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
600
500
400
300
200
100
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
50
40
30
20
10
0
8.0
6.0
4.0
2.0
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 21
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012



Site 22 Description

Total site acres: 148.7

Field No. 3 Acres: 148.7
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Center Pivot (LEPA)

Pumping capacity, gal/min: 800

Number of wells: 4

Fuel source: Electric

Site 22

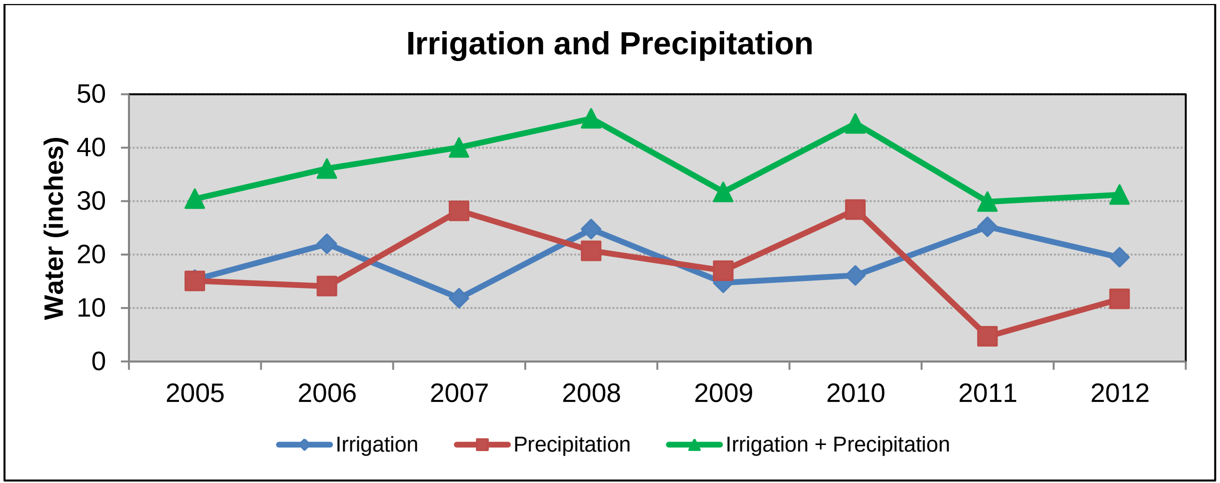
	Livestock	Field 1	Field 2	Field 3
2005	None	Corn for grain	Cotton	
2006	None	Cotton	Corn for grain	
2007	None	Cotton following wheat cover crop	Cotton	
2008	None	Corn for grain	Corn for grain	
2009	None	Combined into Field 3		Cotton
2010	None			Corn
2011	None			Cotton
2012	None			Cotton

Comments: This is a pivot irrigated corn and cotton system. In 2012 both fields were planted to cotton on thirty-inch centers.

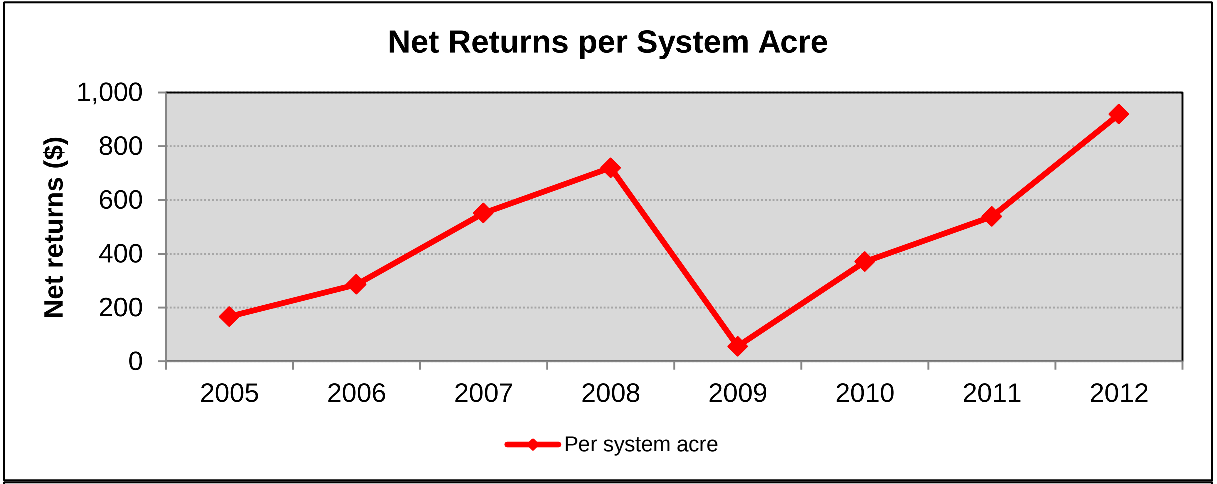
Pre-watering for cotton planting in April

Cotton on 30-inch centers

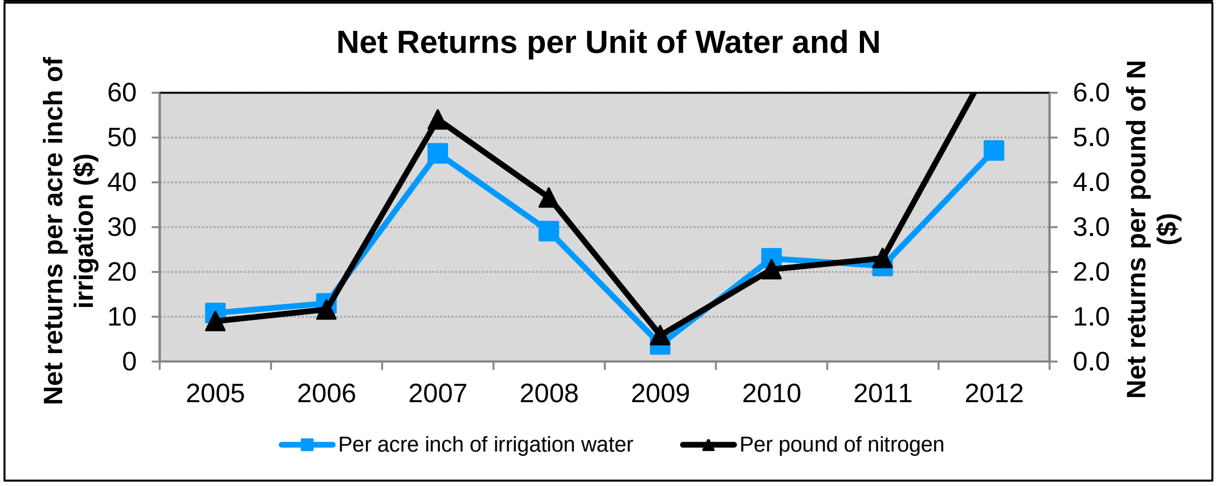
Site 22



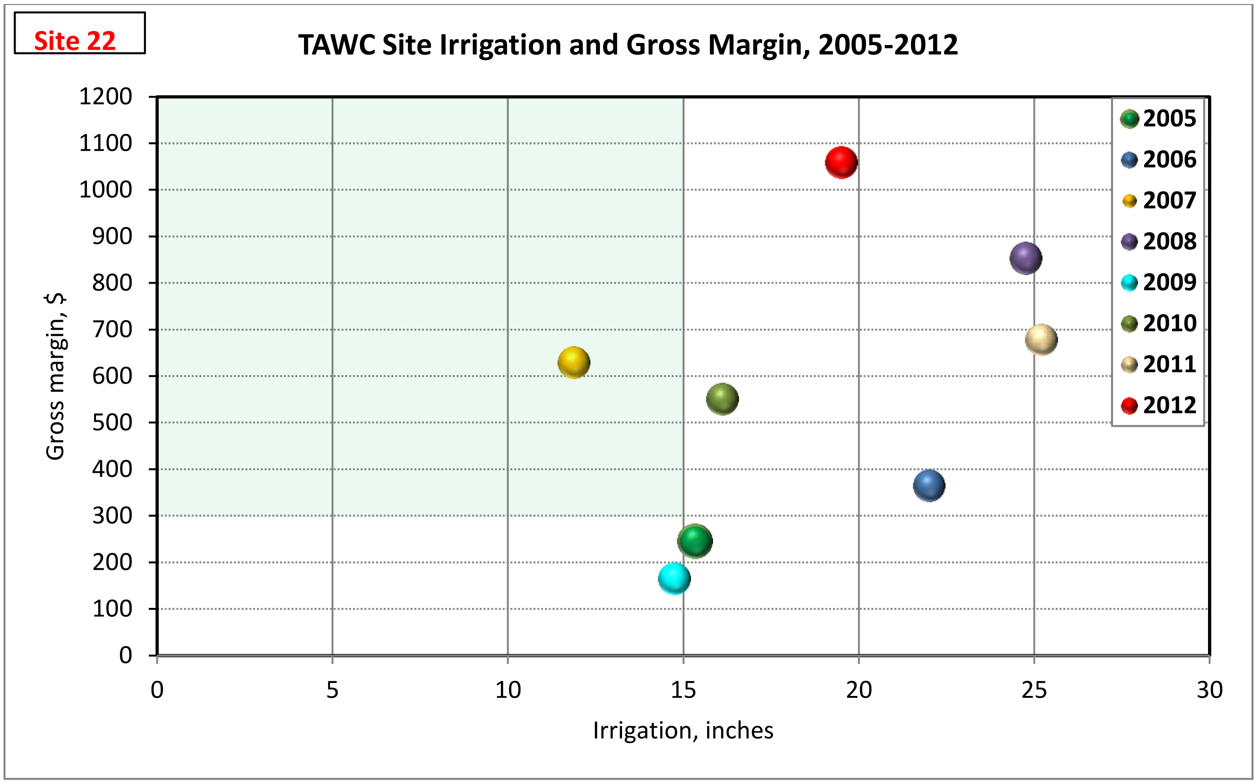
Irrigation and Precipitation
Water (inches)
0
10
20
30
40
50
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation

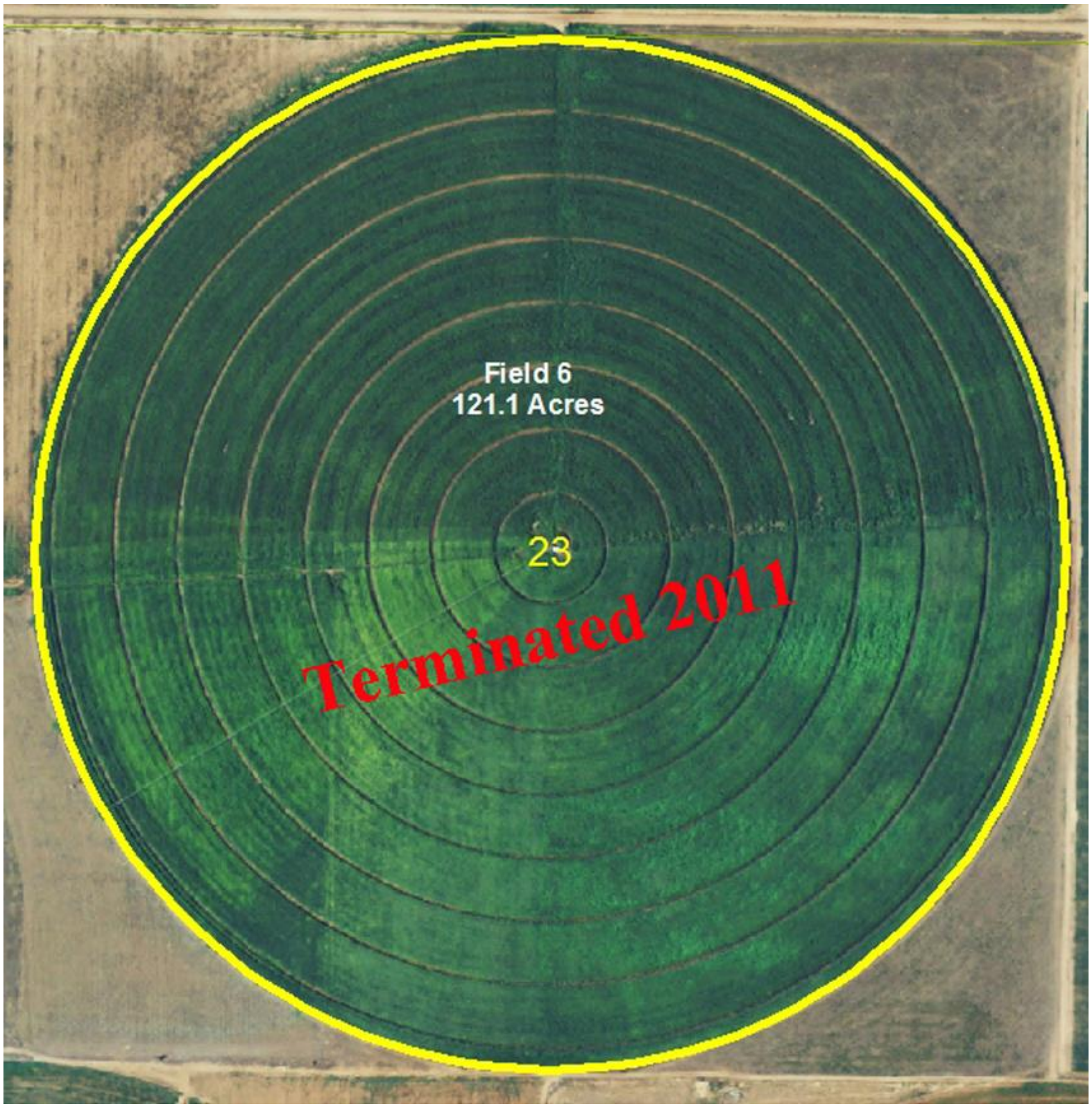


Net Returns per System Acre
Net returns ($)
0
200
400
600
800
1,000
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre



Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
0
10
20
30
40
50
60
Net returns per pound of N ($)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 22
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012



Site 23 Description

Total site acres:	121.1
Field No. 6 Acres:	121.1
Major soil type:	Pullman clay loam; 0 to 1% slope

Irrigation

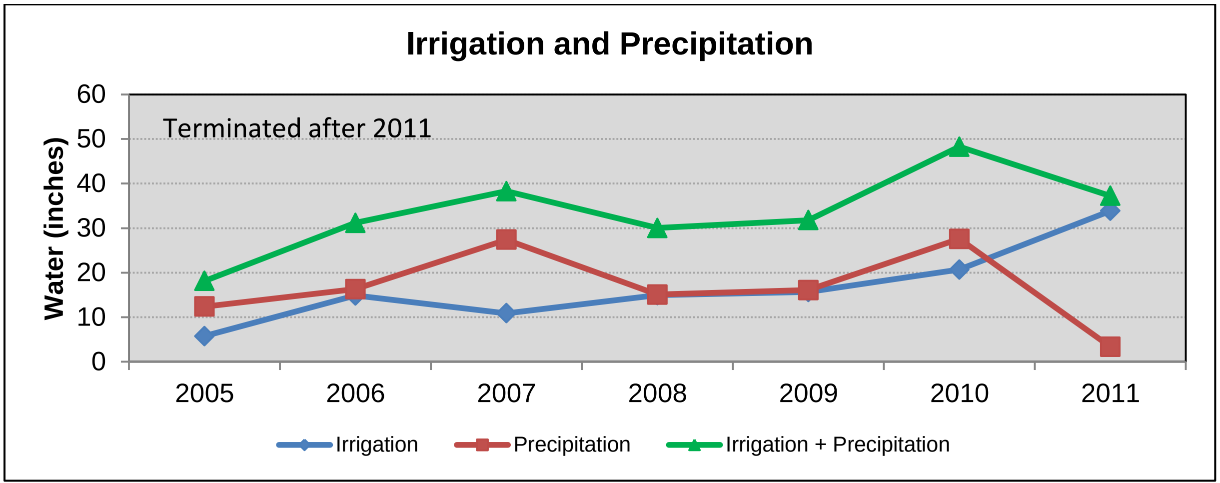
Type:	Center Pivot (LESA)
Pumping capacity, gal/min:	800
Number of wells:	2
Fuel source:	Natural gas

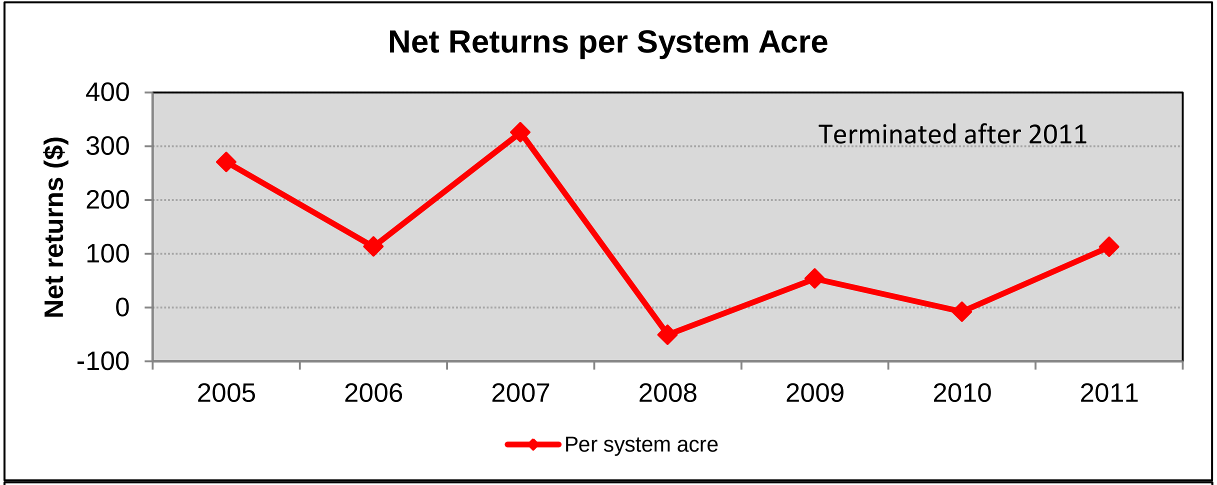
Site 23

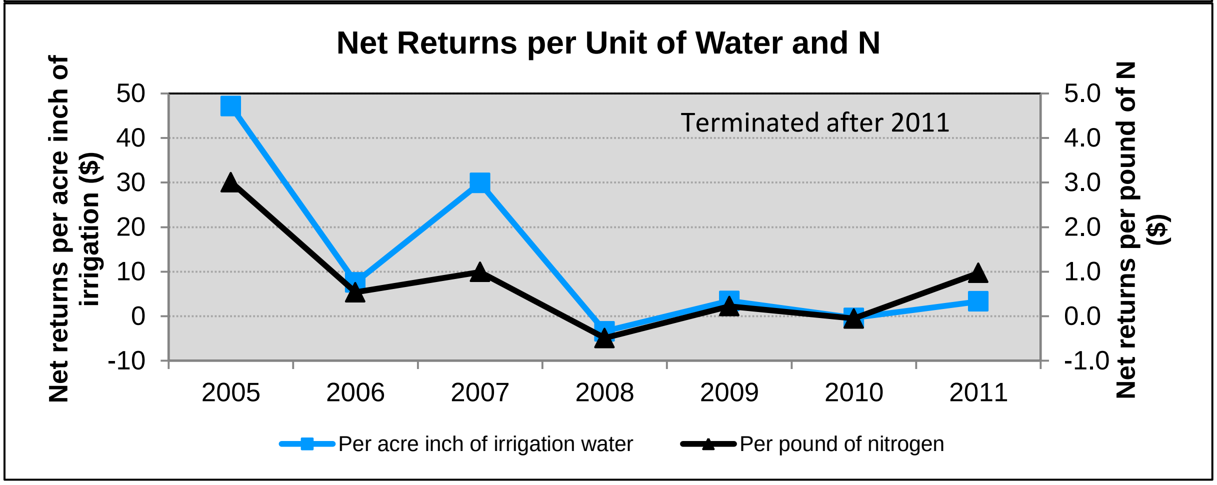
	Livestock	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6
2005	None	Cotton	Sunflowers for seed	Cotton (dryland)			
2006	None	Cotton	Corn for grain	Cotton			
2007	None	Corn for grain	Corn for grain	Corn for grain			
2008	None	Split into Fields 4 and 5		Sunflowers	Sunflowers	Cotton	
2009	None			Combined with Field 4	Oats/forage sorghum for silage	Wheat/forage sorghum for silage	
2010	None				Combined to create Field 6		Triticale for silage/corn for silage
2011	None						Triticale/corn silage

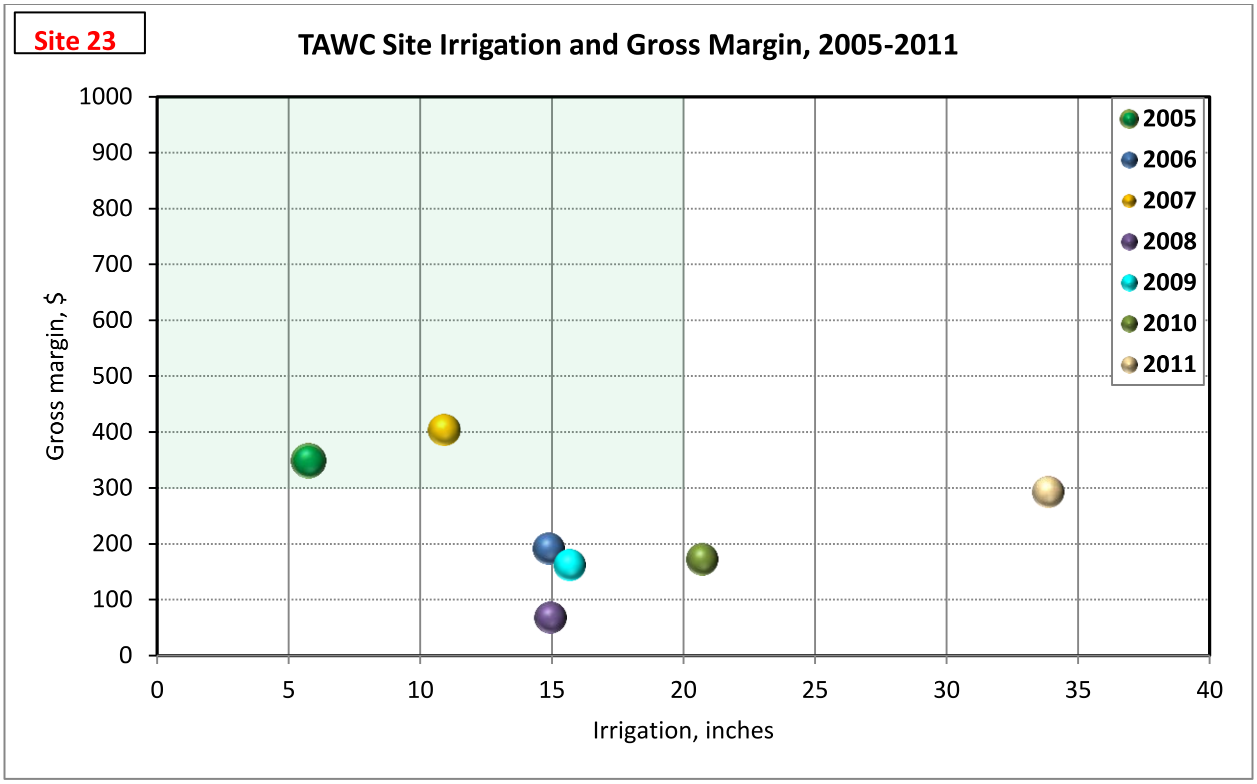
Comments: This pivot was planted to triticale then double cropped to corn with both crops being harvested for silage.

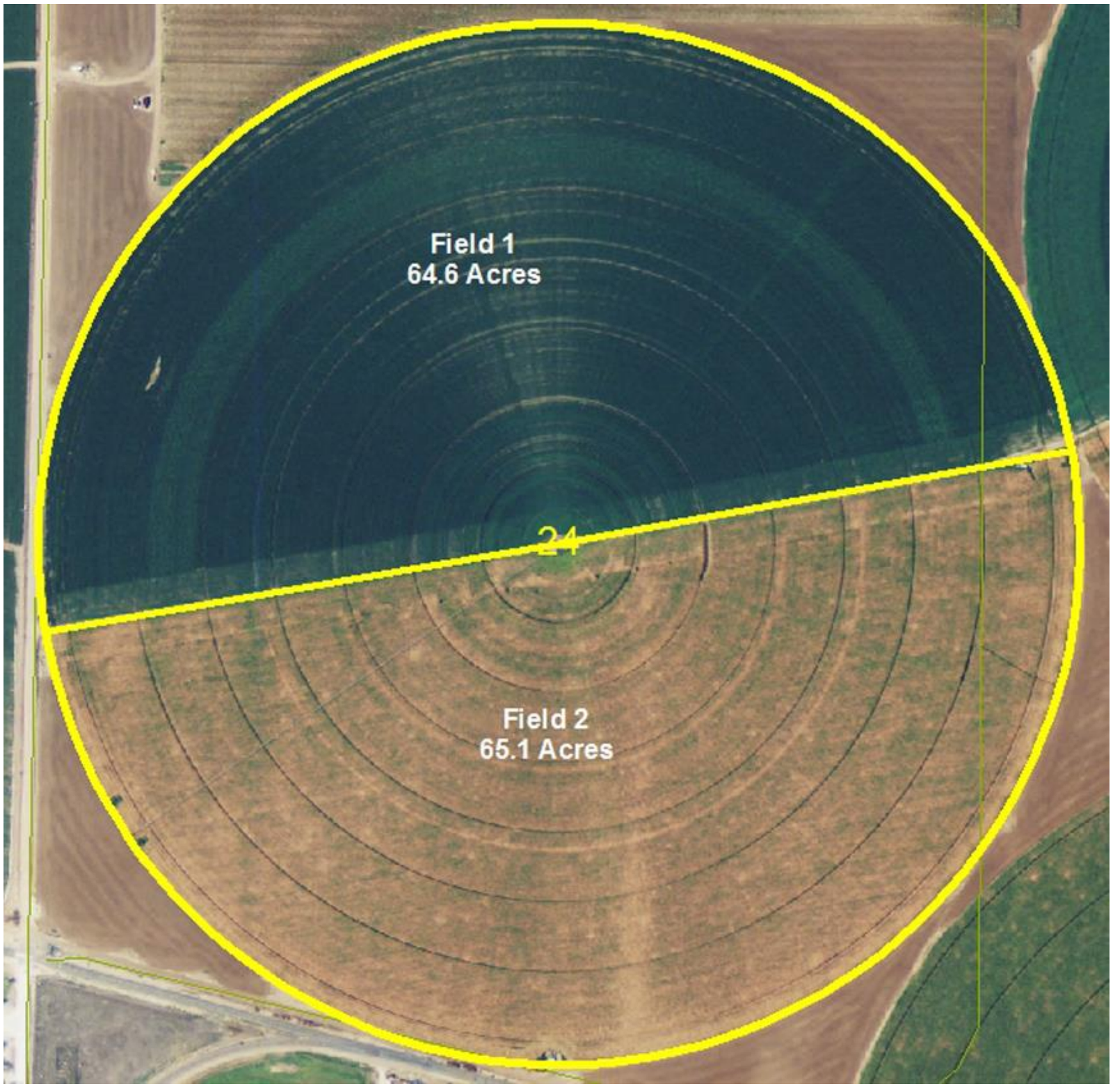
Site 23


Irrigation and Precipitation
Water (inches)
60
50
40
30
20
10
0
Terminated after 2011
2005
2006
2007
2008
2009
2010
2011
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
400
300
200
100
0
-100
Terminated after 2011
2005
2006
2007
2008
2009
2010
2011
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
50
40
30
20
10
0
-10
Net returns per pound of N ($)
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
Terminated after 2011
2005
2006
2007
2008
2009
2010
2011
Per acre inch of irrigation water
Per pound of nitrogen


Site 23
TAWC Site Irrigation and Gross Margin, 2005-2011
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
35
40
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011



Site 24 Description

Total site acres:	129.7
Field No. 1 Acres:	64.6
Major soil type:	Pullman clay loam; 0 to 1% slope
Field No. 2 Acres:	65.1
Major soil type:	Pullman clay loam; 0 to 1% slope

Irrigation

Type:	Center Pivot (LESA)
Pumping capacity, gal/min:	700
Number of wells:	1
Fuel source:	Diesel

Site 24

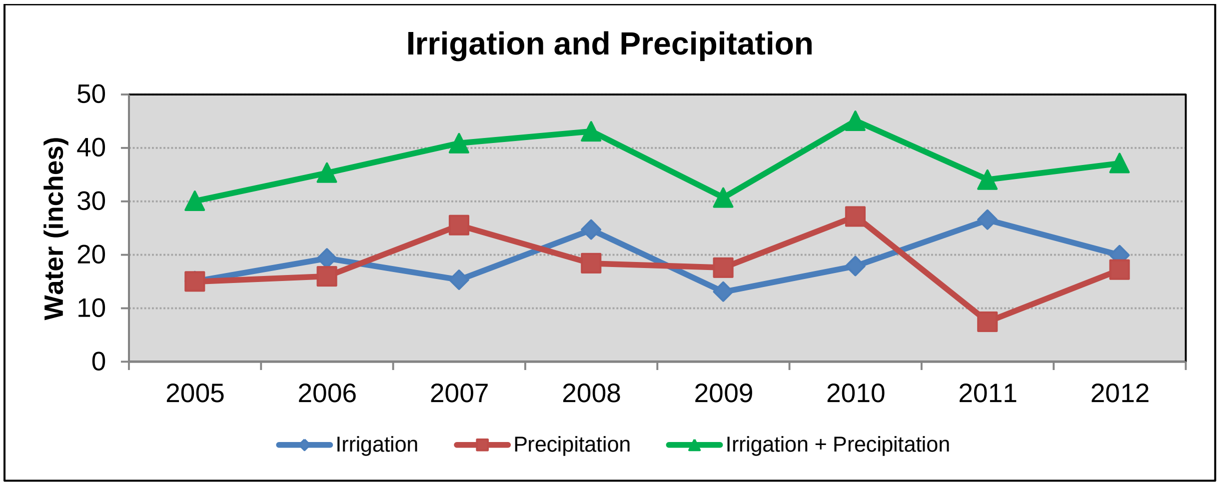
	Livestock	Field 1	Field 2
2005	None	Cotton	Corn for grain
2006	None	Corn for grain	Cotton
2007	None	Corn for grain	Corn for grain
2008	None	Corn for grain	Corn for grain
2009	None	Corn	Sunflowers
2010	None	Corn	Corn
2011	None	Corn	Cotton
2012	None	Cotton	Corn

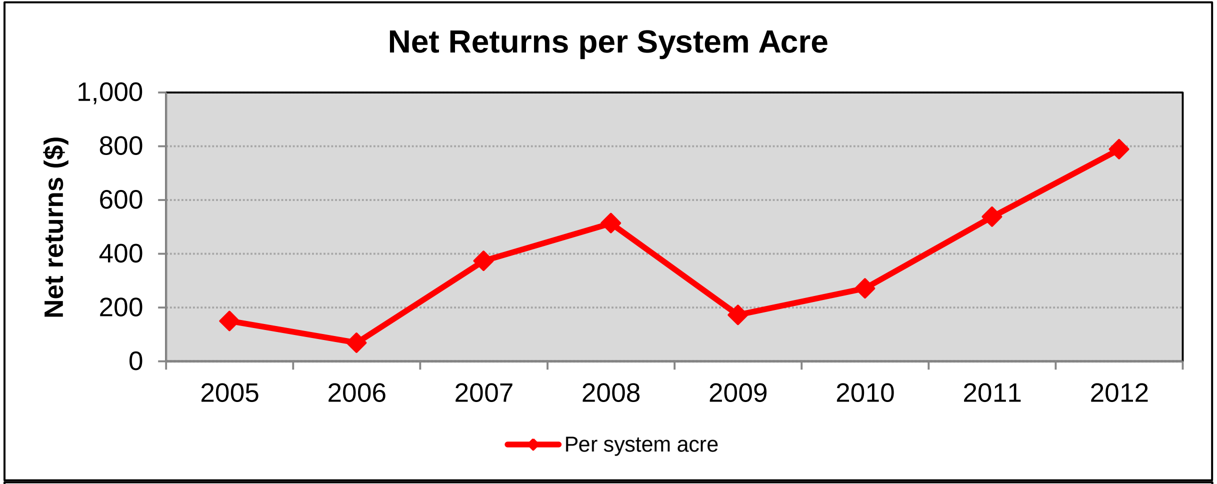
Comments: This has been a corn/cotton/sunflower pivot irrigated system using conventional tillage. In 2012 this system was planted to white food corn and cotton.

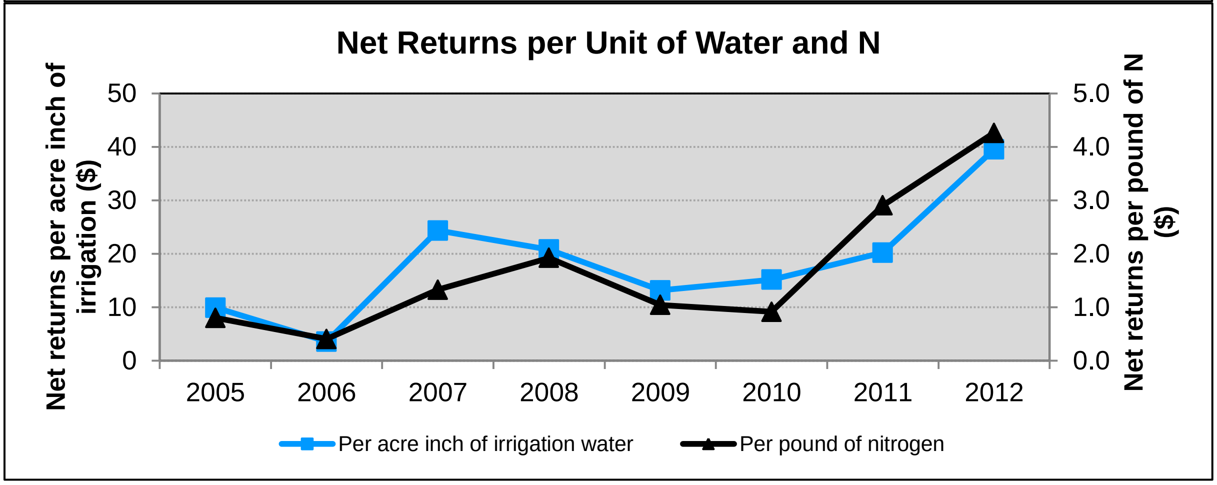
July corn

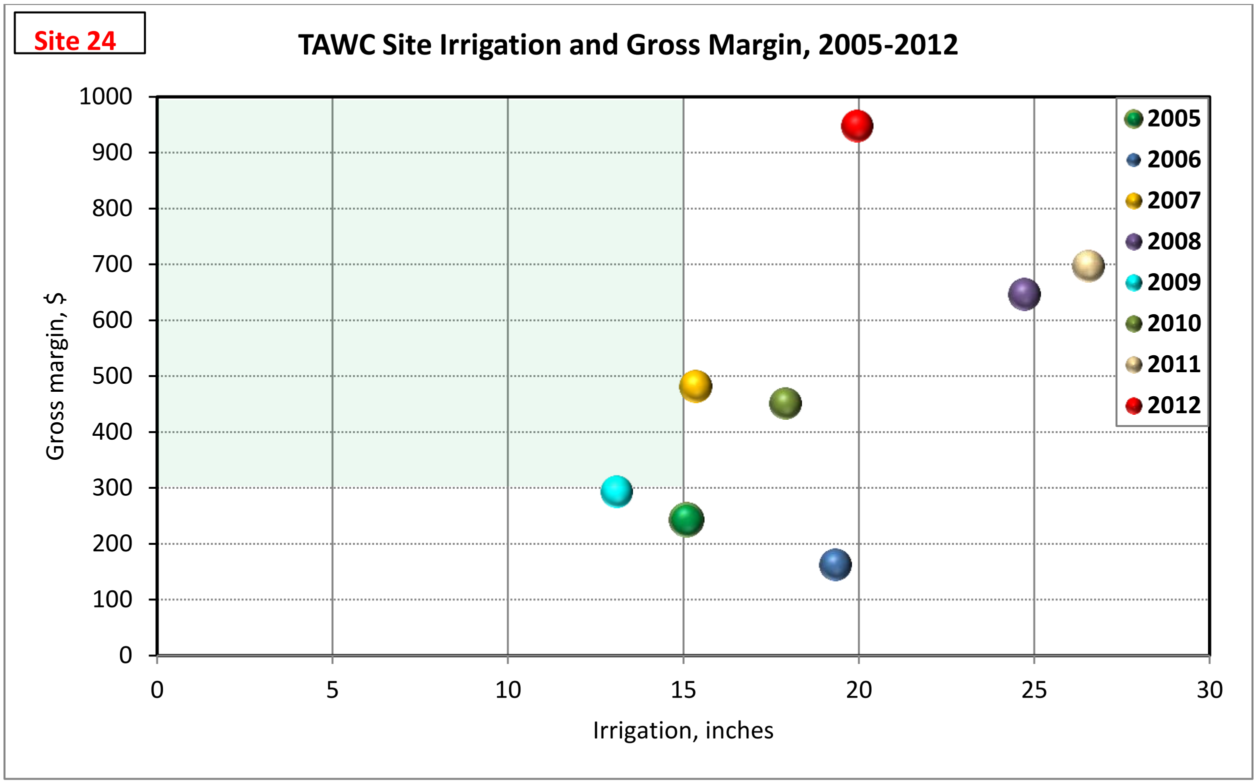
August cotton in bloom

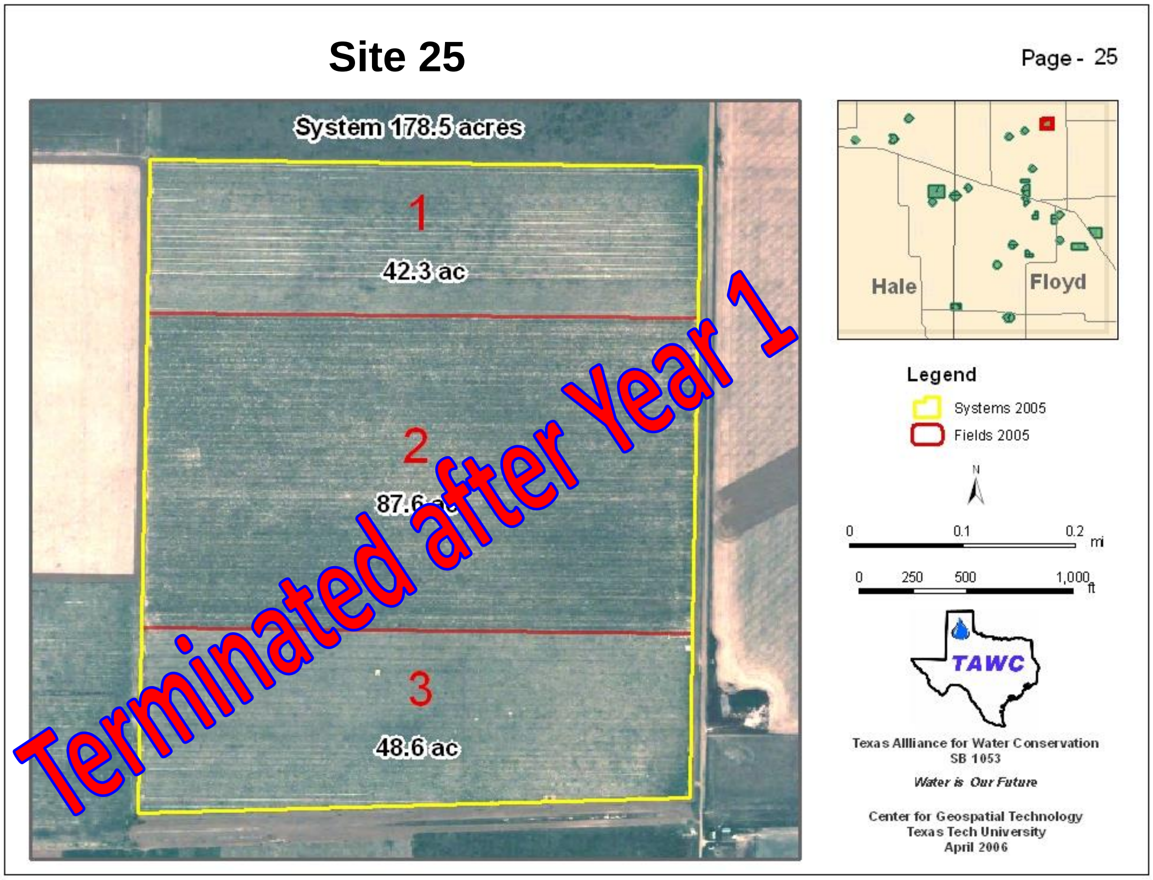
Site 24


Irrigation and Precipitation
Water (inches)
0
10
20
30
40
50
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
0
200
400
600
800
1,000
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
0
10
20
30
40
50
Net returns per pound of N ($)
0.0
1.0
2.0
3.0
4.0
5.0
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 24
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012



Site 25 Description

Total site acres:	178.5
Field No. 1 Acres:	42.3
Major soil type:	Pullman clay loam; 0 to 1% slope
Field No. 2 Acres:	87.6
Major soil type:	Pullman clay loam; 0 to 1% slope
Field No. 3 Acres:	48.6
Major soil type:	Pullman clay loam; 0 to 1% slope

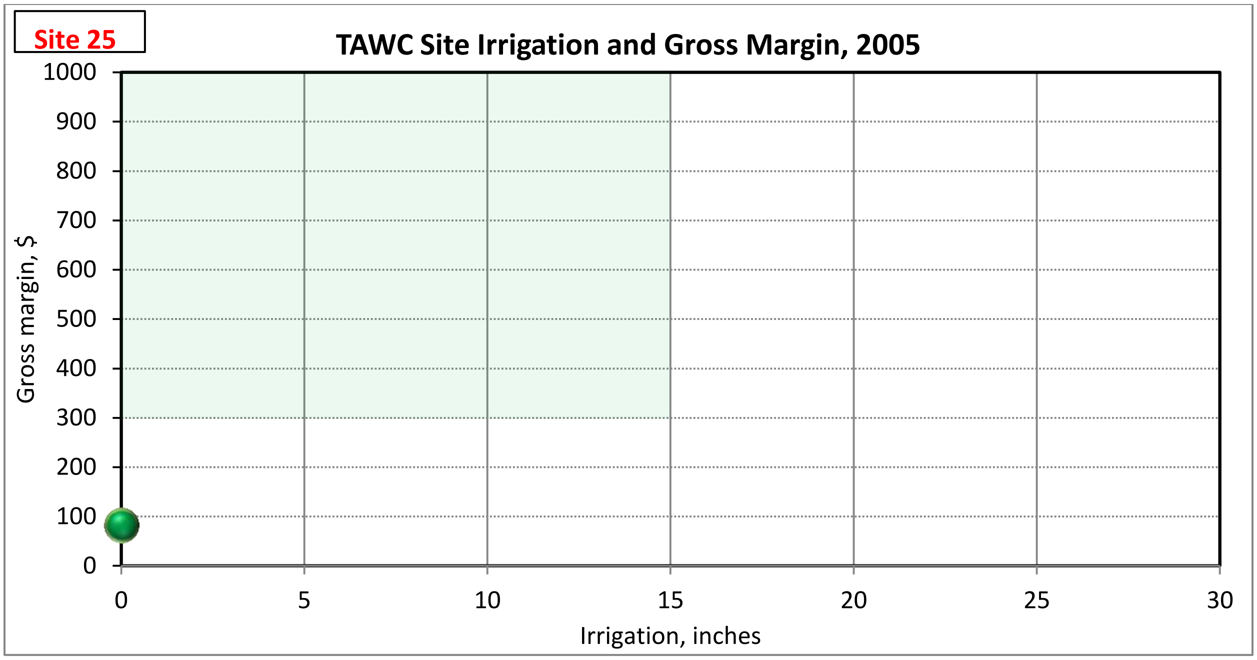
Irrigation

Type:	Dryland
Pumping capacity, gal/min:	
Number of wells:	
Fuel source:	

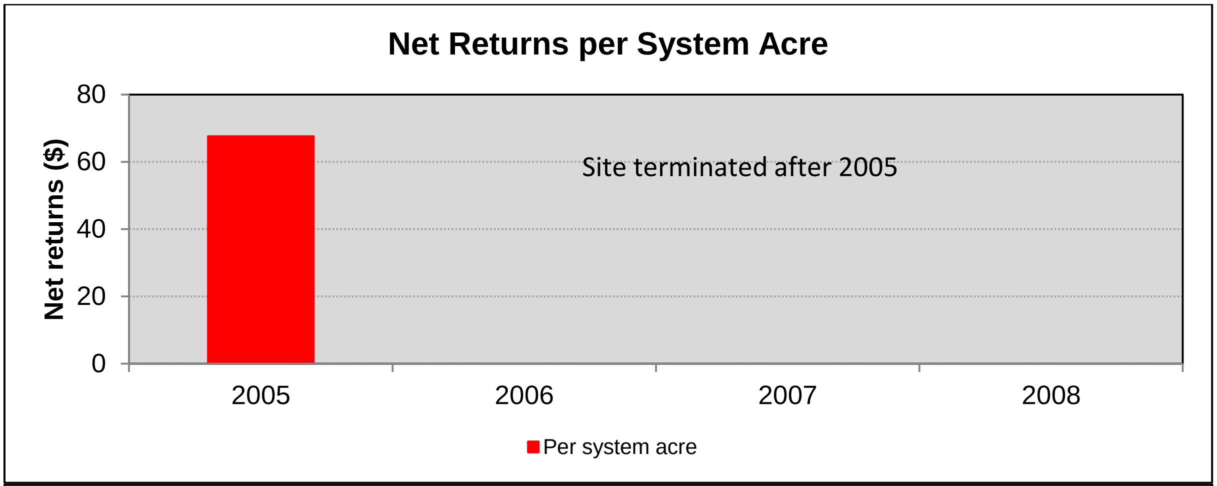
Comments: At this dryland site cotton and grain sorghum wee grown in rotation. The cotton was planted in standing grain sorghum stalks. Cotton and grain sorghum were planted on 40-inch centers.

Site 25
Dryland

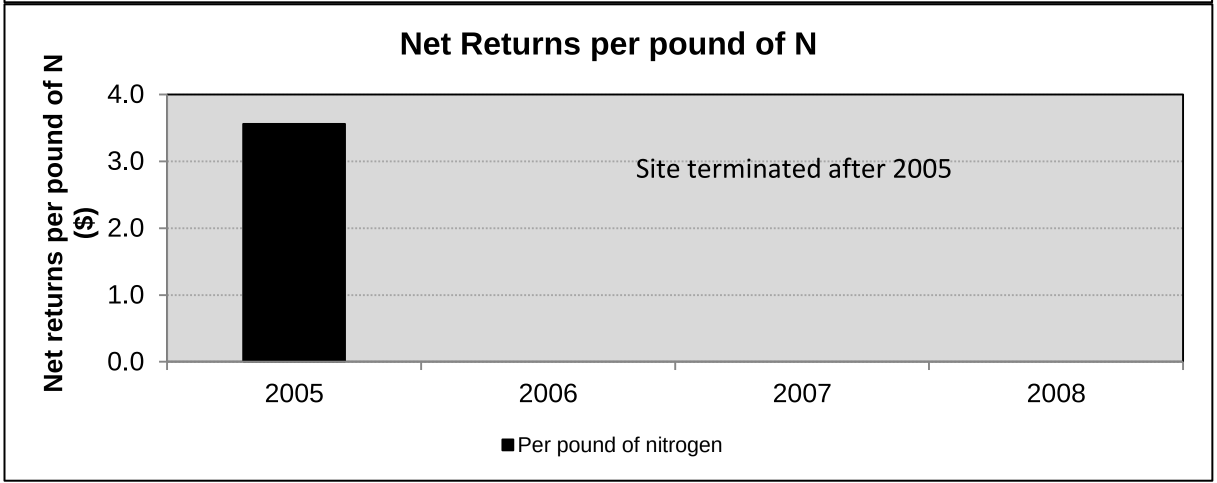
	Livestock	Field 1	Field 2	Field 3
2005	None	Cotton	Grain sorghum	Cotton
2006	Site terminated in 2006			



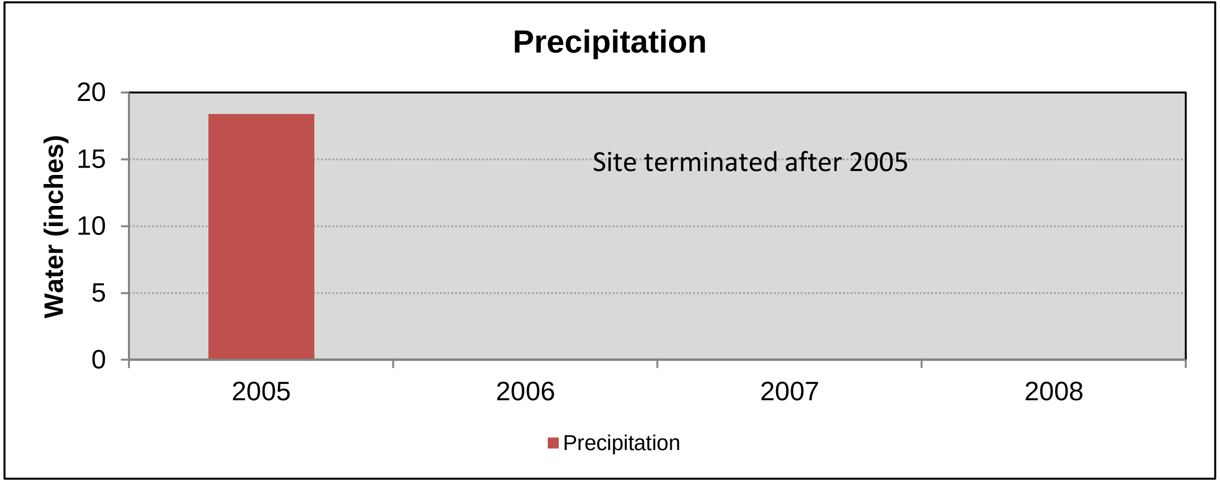
Site 25 - Dryland



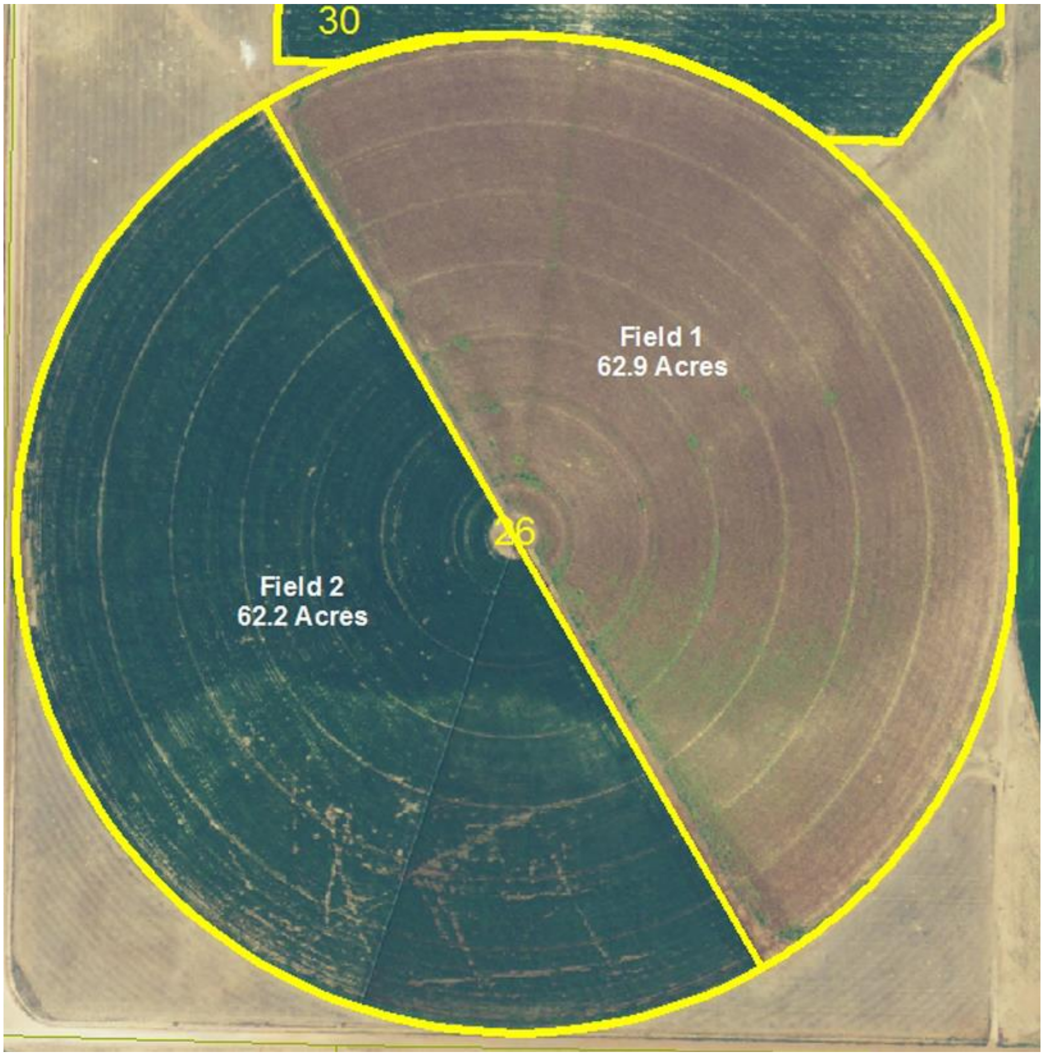
Net Returns per System Acre



Net Returns per pound of N



Precipitation



Site 26 Description

Total site acres:	125.1
Field No. 1 Acres:	62.9
Major soil type:	Bippus loam; 0 to 3% slope Mansker loam; 3 to 5% slope
Field No. 2 Acres:	62.2
Major soil type:	Bippus loam; 0 to 3% slope Mansker loam; 3 to 5% slope

Irrigation

Type:	Center Pivot (LESA)
Pumping capacity, gal/min:	600
Number of wells:	2
Fuel source:	1 Electric 1 Diesel

Site 26

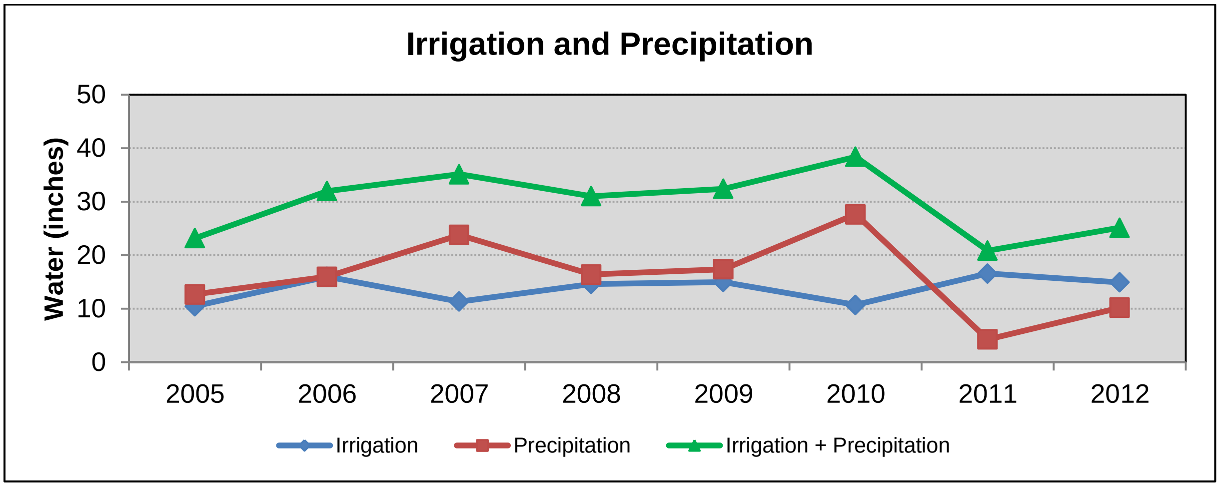
	Livestock	Field 1	Field 2	Field 3	Field 4
2005	None	Cotton	Corn for grain		
2006	None	Corn for grain	Cotton		
2007	Cow-calf	Pearlmillet for seed and grazing of residue	Corn for grain		
2008	Cow-calf	Split into Fields 3 and 4	Pearlmillet for seed and grazing of residue	Grain sorghum for seed and grazing of residue	Corn for grain and grazing of residue
2009	Stocker	Sunflowers	Corn	Combined to make fields 1 and 2	
2010	Cow-calf	Wheat for grazing/corn for grain	Cotton		
2011	None	Cotton	Corn		
2012	None	Sunflowers	Cotton		

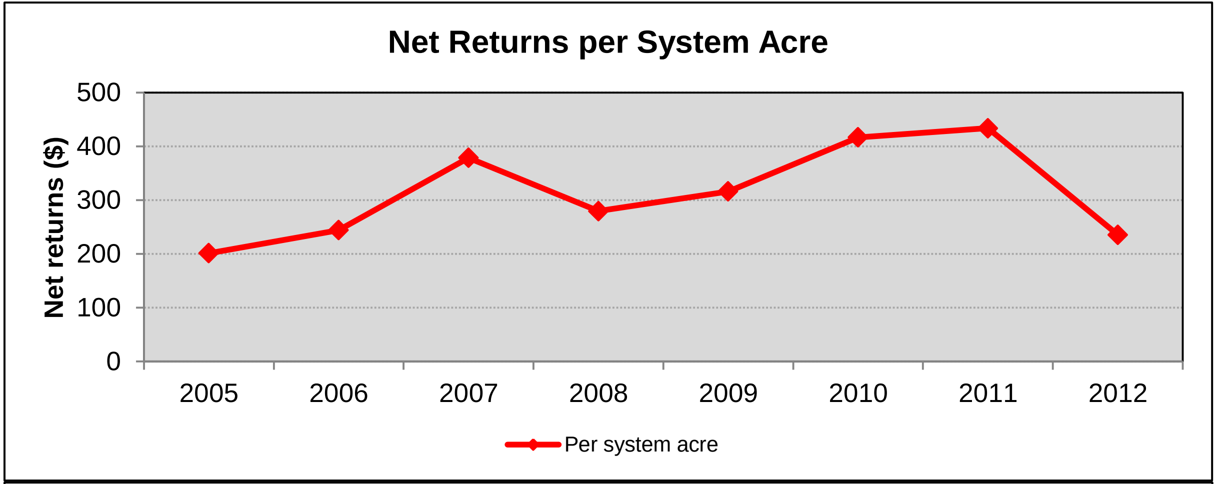
Comments: This was a sunflower/corn system for 2012. Cotton was planted on 20-inch centers.

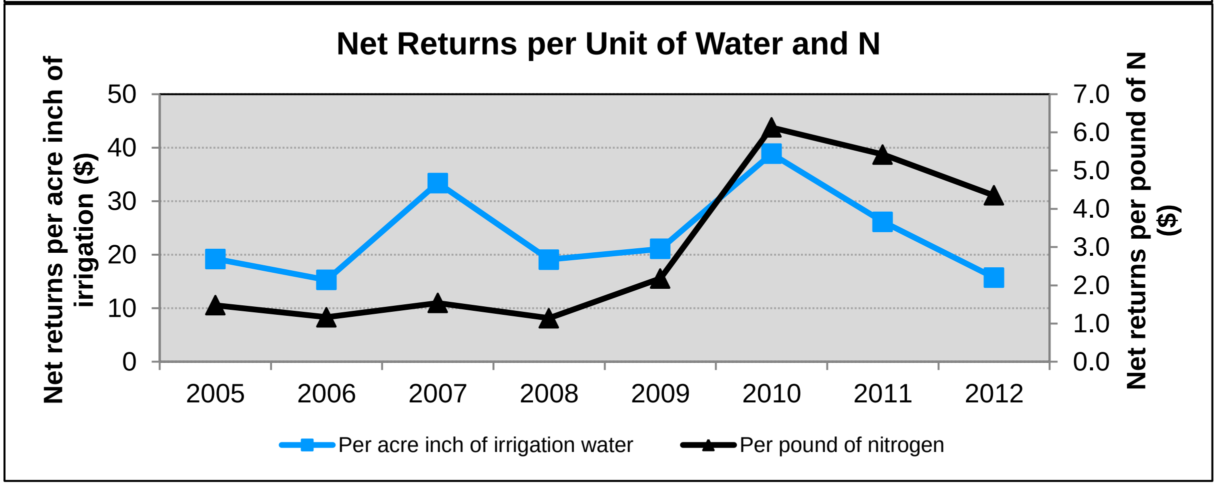
July sunflowers

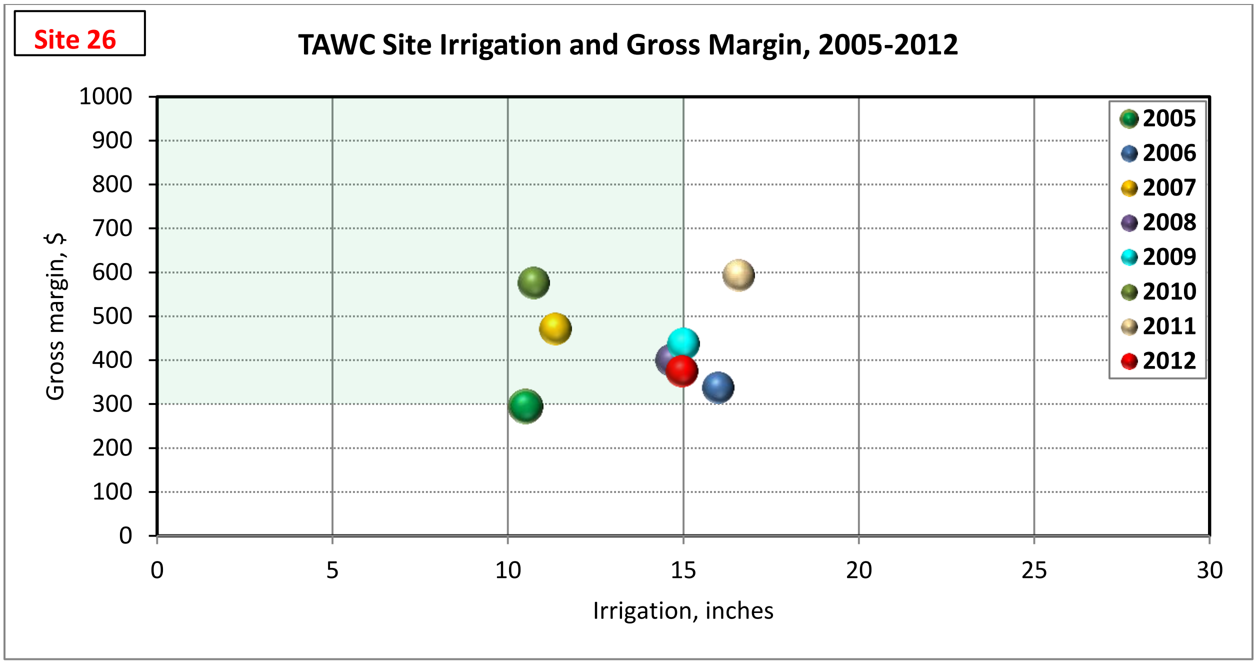
Cotton planted on 20” rows

Site 26


Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
500
400
300
200
100
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
50
40
30
20
10
0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 26
TAWC Site Irrigation and Gross Margin, 2005-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008
2009
2010
2011
2012

Site 27 Description

Total site acres: 108.4

Field No. 1 Acres: 46.1
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 3 Acres: 48.8
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 4 Acres: 13.5
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Subsurface Drip
(SDI, installed prior to 2006 crop year)
Pumping capacity, gal/min: 400

Number of wells: 2

Fuel source: Electric

Site 27

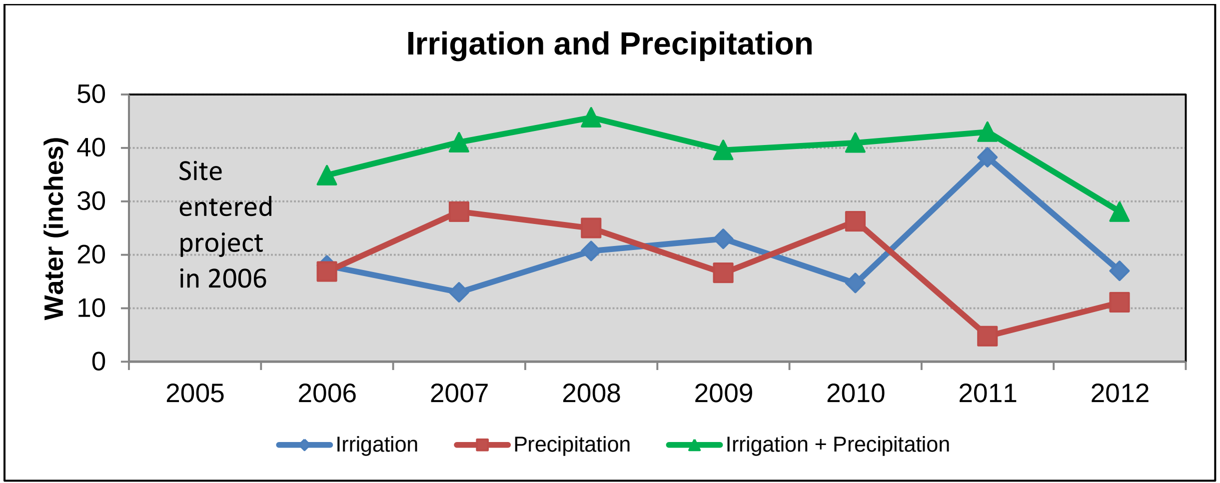
	Livestock	Field 1	Field 2	Field 3	Field 4
2005	Entered project in Year 2				
2006	None	Cotton following wheat cover crop			
2007	None	Corn for silage	Cotton following wheat cover crop		
2008	None	Cotton following wheat cover crop	Additional acres added to create Field 3	Corn for grain	Corn for grain – high moisture
2009	None	Corn for silage		Cotton	Corn for silage
2010	None	Cotton		Corn for silage	Cotton
2011	None	Corn abandoned		Cotton abandoned	Corn abandoned
2012	None	Cotton		Corn for silage	Cotton

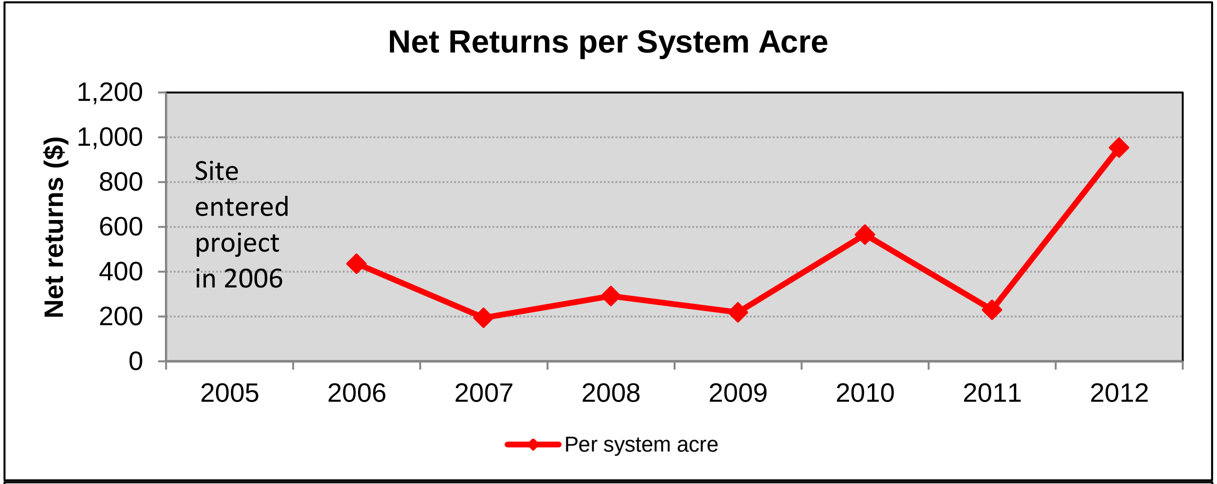
Comments: This is the sixth year for this cotton/corn drip irrigated site. Corn is planted on twenty-inch centers with cotton planted on forty-inch centers.

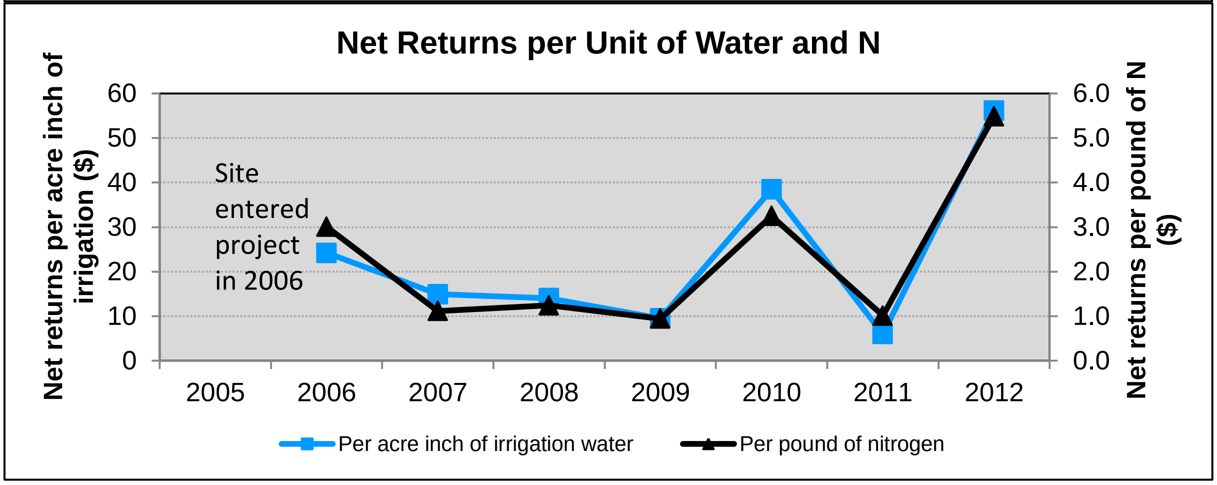
June corn

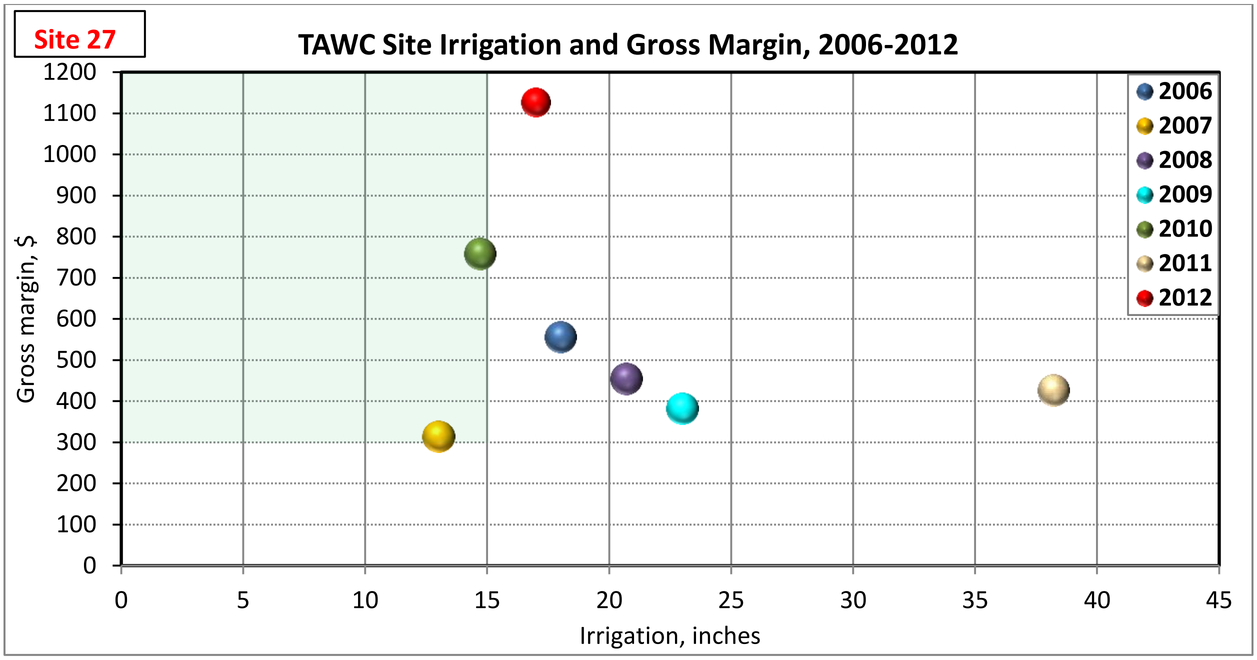
August cotton

Site 27


Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
Site entered project in 2006
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
1,200
1,000
800
600
400
200
0
Site entered project in 2006
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
60
50
40
30
20
10
0
Net returns per pound of N ($)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Site entered project in 2006
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 27
TAWC Site Irrigation and Gross Margin, 2006-2012
Gross margin, $
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
Irrigation, inches
0
5
10
15
20
25
30
35
40
45
2006
2007
2008
2009
2010
2011
2012

Site 28 Description

Total site acres:	51.4
Field No. 1 Acres:	51.4
Major soil type:	Pullman clay loam; 0 to 1% slope

Irrigation

Type:	Subsurface Drip (SDI)
Pumping capacity, gal/min:	300
Number of wells:	1
Fuel source:	electric

Site 28

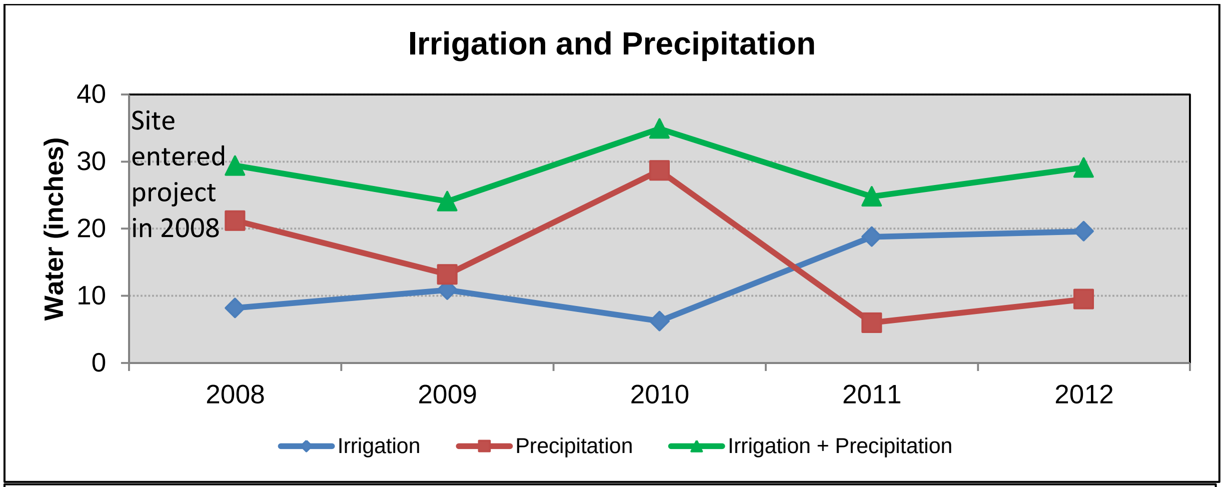
	Livestock	Field 1
2005	Entered project in Year 4	
2006		
2007		
2008	None	Corn for grain
2009	None	Cotton
2010	None	Cotton
2011	None	Cotton
2012	None	Cotton/Replant Corn

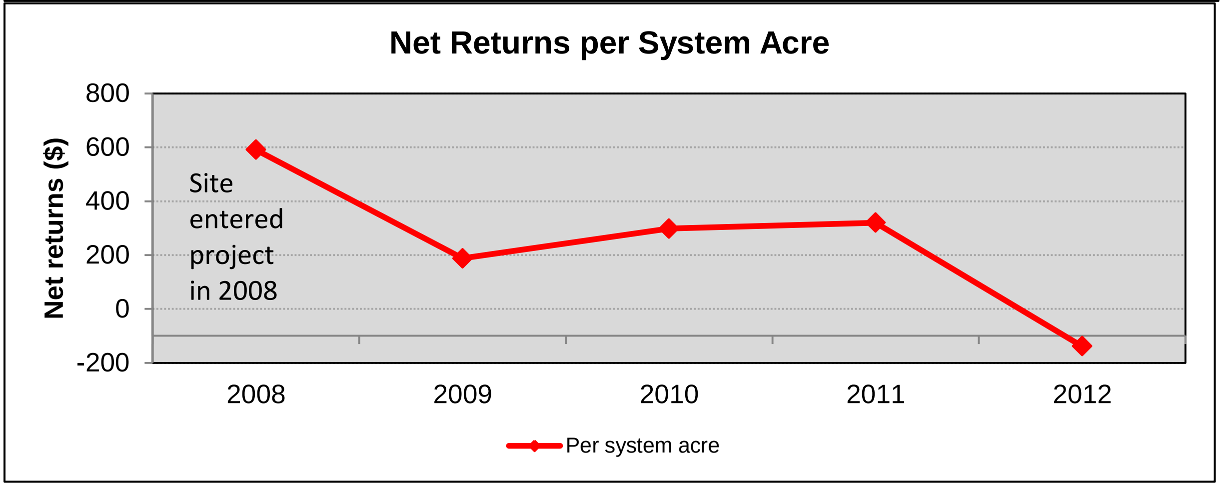
Comments: This is the fifth year for this drip irrigated site to be in the project. In 2012 this site was planted to cotton on 40-inch centers. The cotton was lost due to hail and replanted to corn.

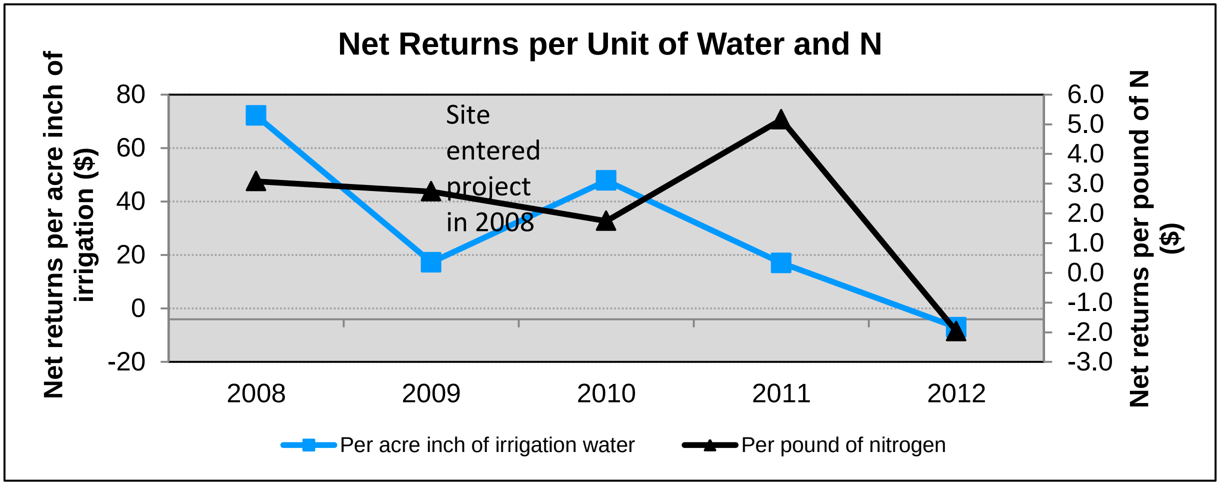
June cotton

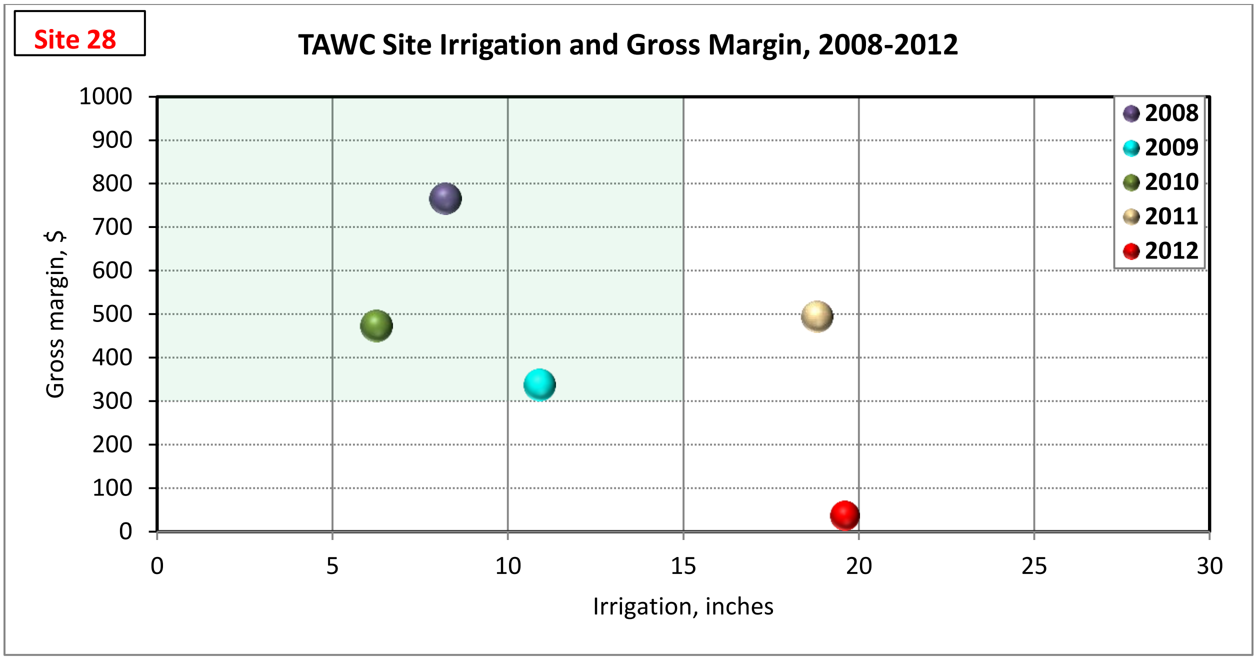
August corn

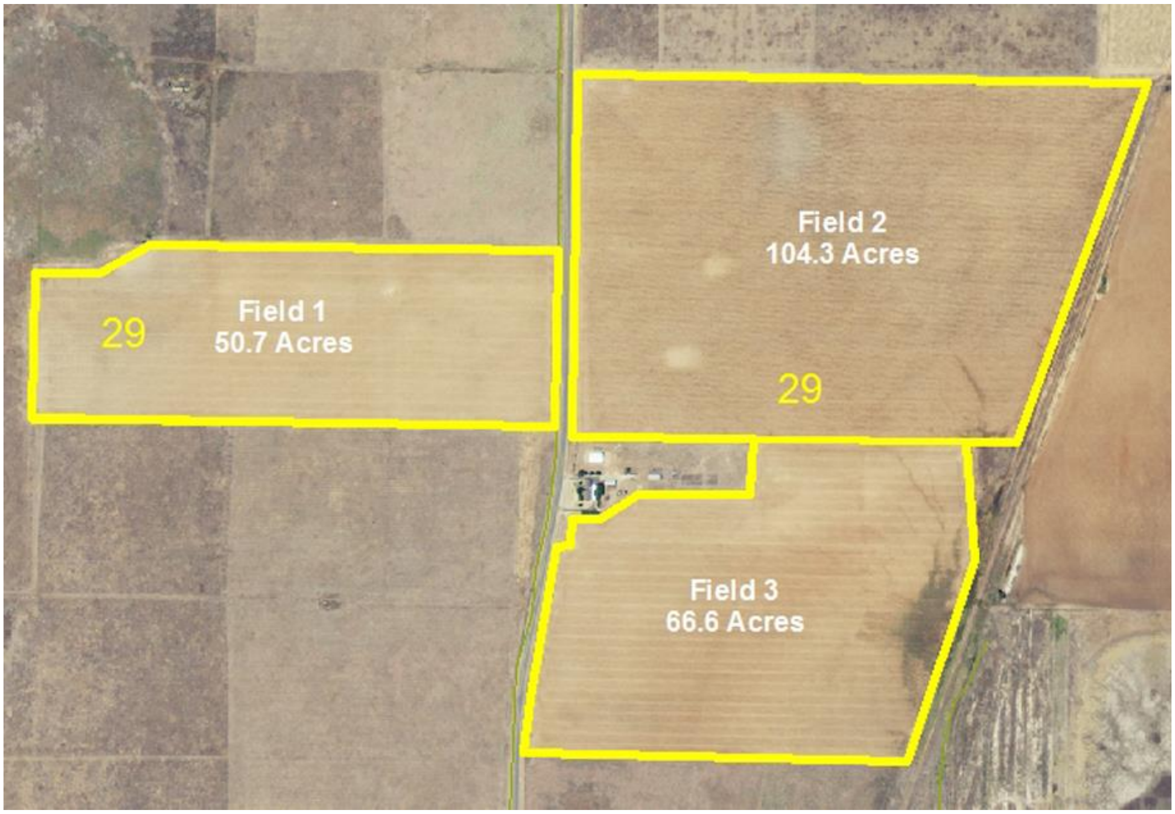
Site 28


Irrigation and Precipitation
Water (inches)
40
30
20
10
0
Site
entered
project
in 2008
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
800
600
400
200
0
-200
Site
entered
project
in 2008
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
80
60
40
20
0
-20
Site
entered
project
in 2008
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
Net returns per pound of N ($)
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 28
TAWC Site Irrigation and Gross Margin, 2008-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2008
2009
2010
2011
2012



Site 29 Description

Total site acres:	221.6
Field No. 1 Acres:	50.7
Major soil type:	Pullman clay loam; 0 to 1% slope
Field No. 2 Acres:	104.3
Major soil type:	Pullman clay loam; 0 to 1% slope
Field No. 3 Acres:	66.6
Major soil type:	Pullman clay loam; 0 to 1% slope

Irrigation

Type:	Dryland
Pumping capacity, gal/min:	na
Number of wells:	na
Fuel source:	na

Site 29
Dryland Site

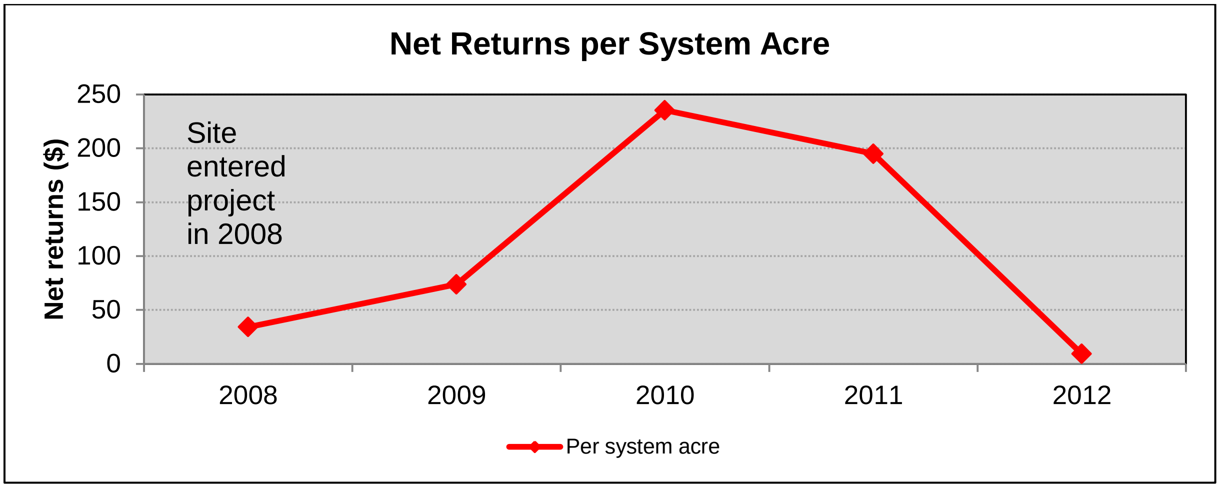
	Livestock	Field 1	Field 2	Field 3
2005	Entered project in Year 4			
2006				
2007				
2008	None	Cotton following wheat cover crop	Fallow, followed by wheat for cover and grazing	Cotton following wheat cover crop
2009	None	Cotton	Wheat	Cotton
2010	None	Cotton	Cotton	Grain sorghum
2011	None	Cotton	Cotton	Cotton
2012	None	Cotton	Grain sorghum	Cotton

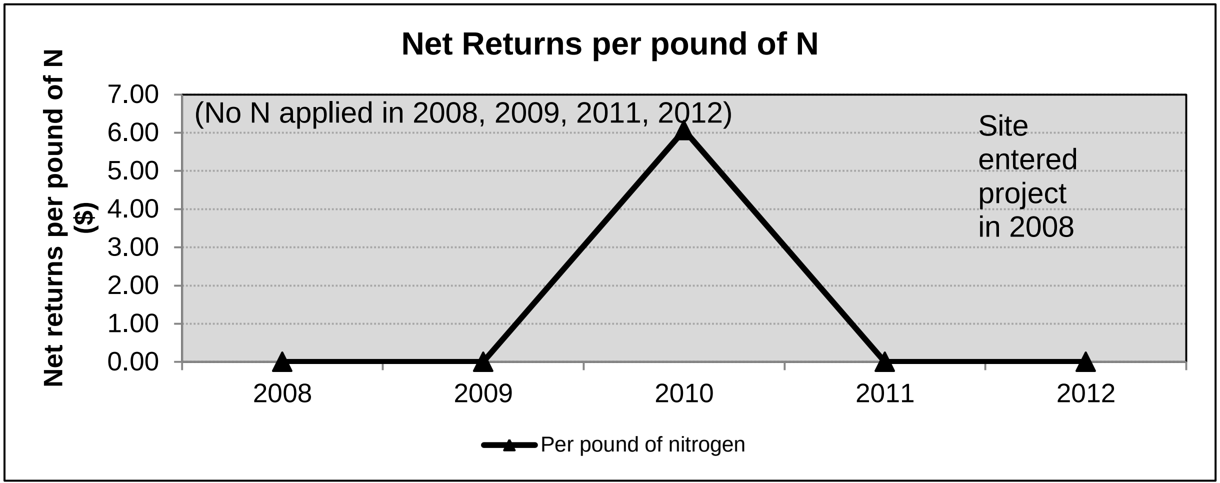
Comments: This is a conventional till dryland site using cotton and grain sorghum in rotation. Cotton and grain sorghum are planted on 40-inch centers.

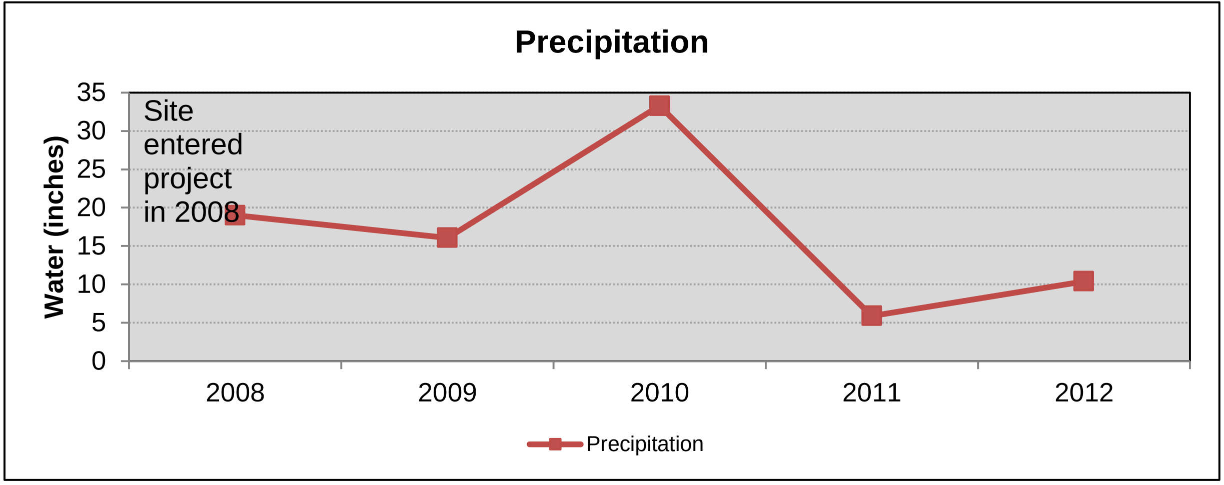
June cotton

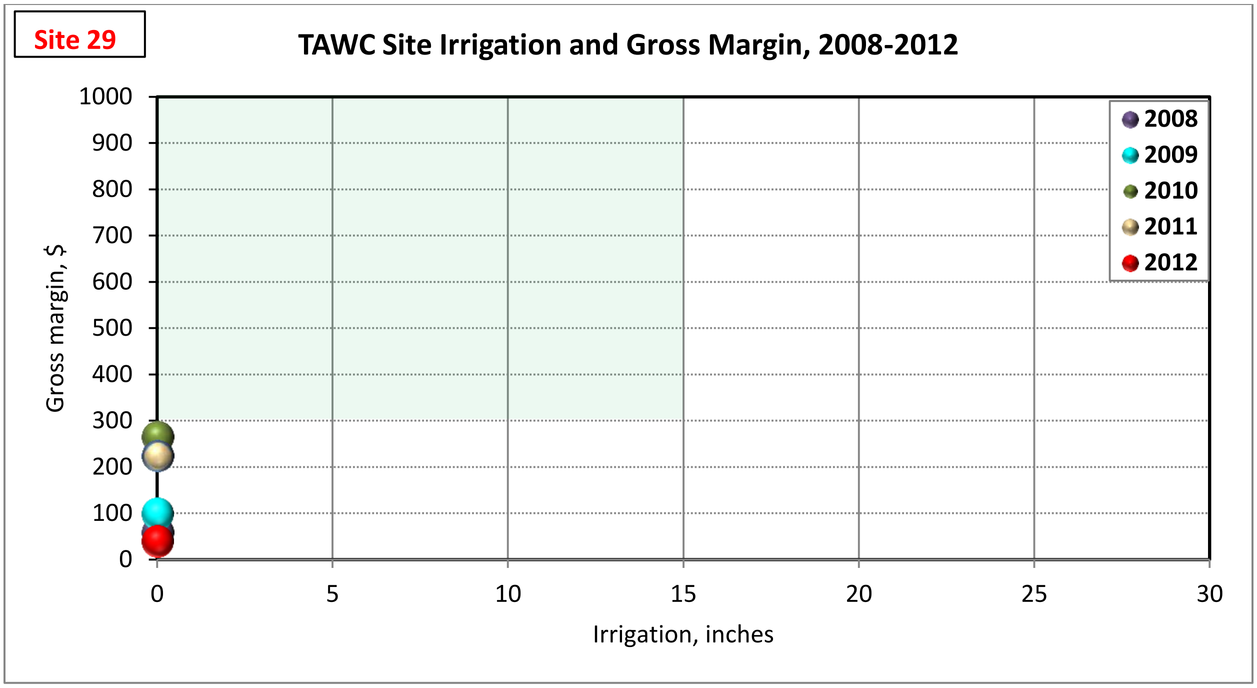
August grain sorghum (milo)

Site 29 – Dryland Site

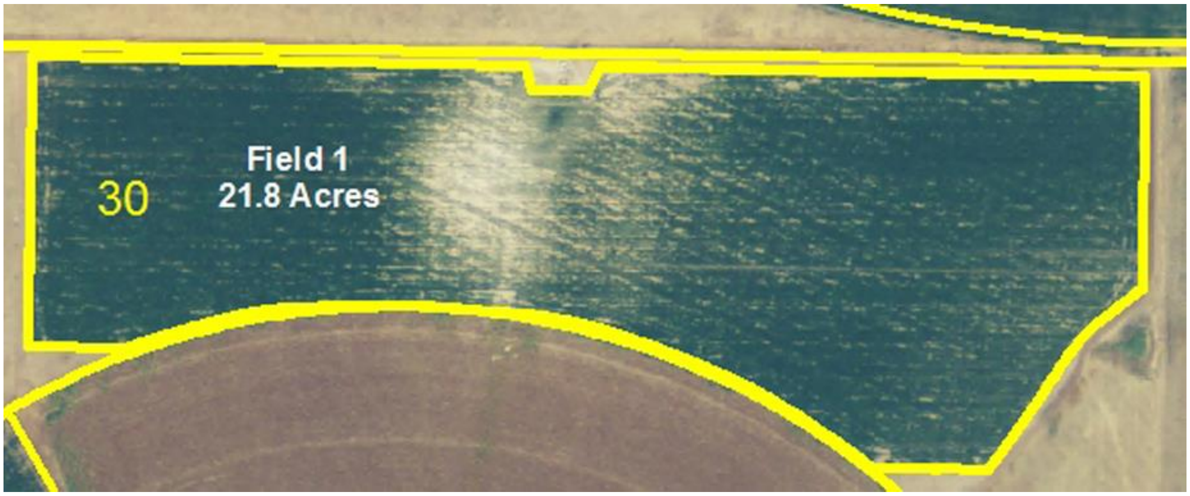








Dryland Site



Site 30 Description

Total site acres:	21.8
Field No. 1 Acres:	21.8
Major soil type:	Pullman clay loam; 0 to 1% slope

Irrigation

Type:	Sub-surface Drip (SDI)
Pumping capacity, gal/min:	150
Number of wells:	1
Fuel source:	Electric

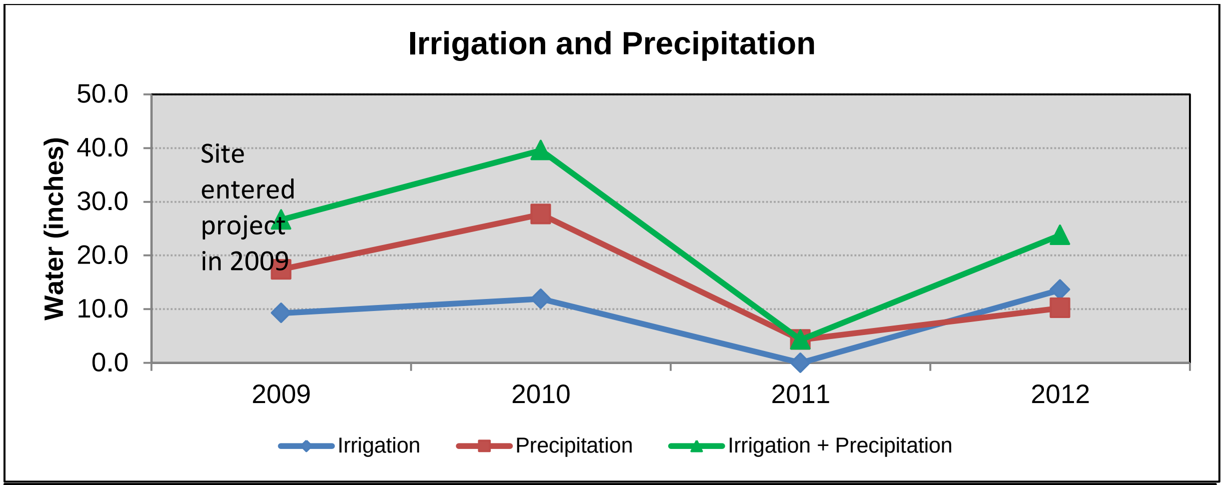
Site 30

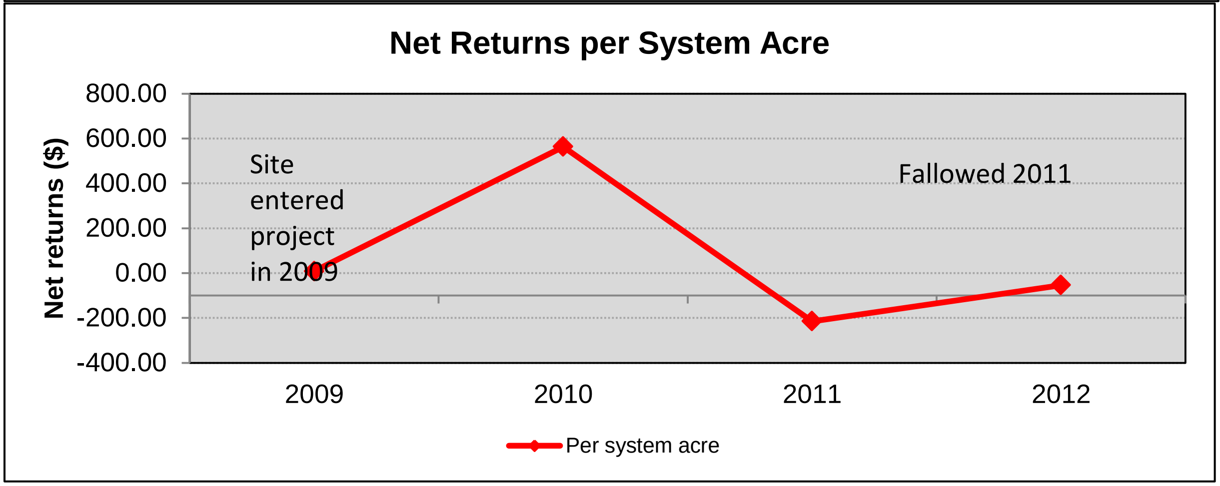
	Livestock	Field 1
2005	Entered project in Year 5	
2006		
2007		
2008		
2009	None	Sunflowers
2010	None	Corn
2011	None	Not planted
2012	None	Cotton

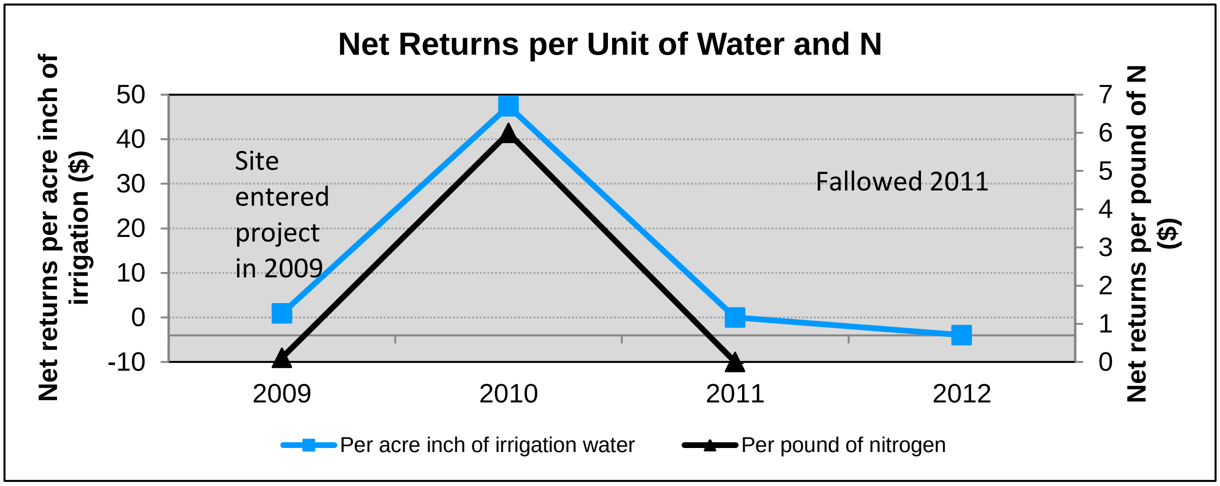
Comments: This site is drip irrigated and was planted to cotton using conventional tillage.

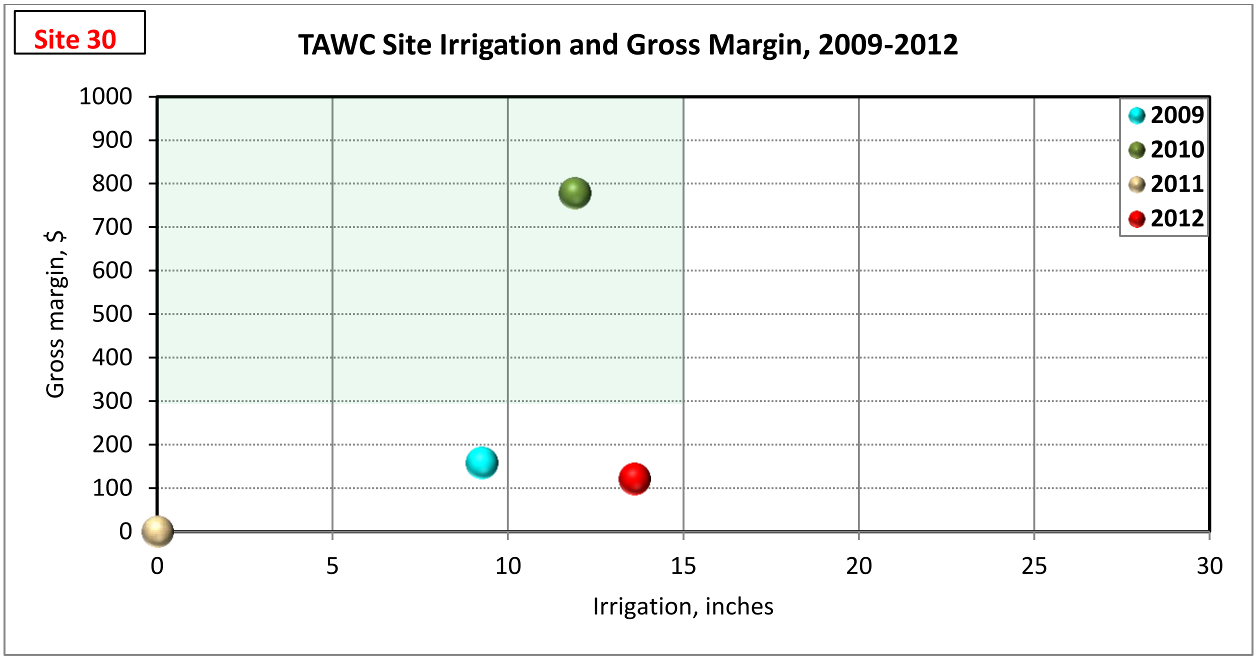
Cotton on drip in August

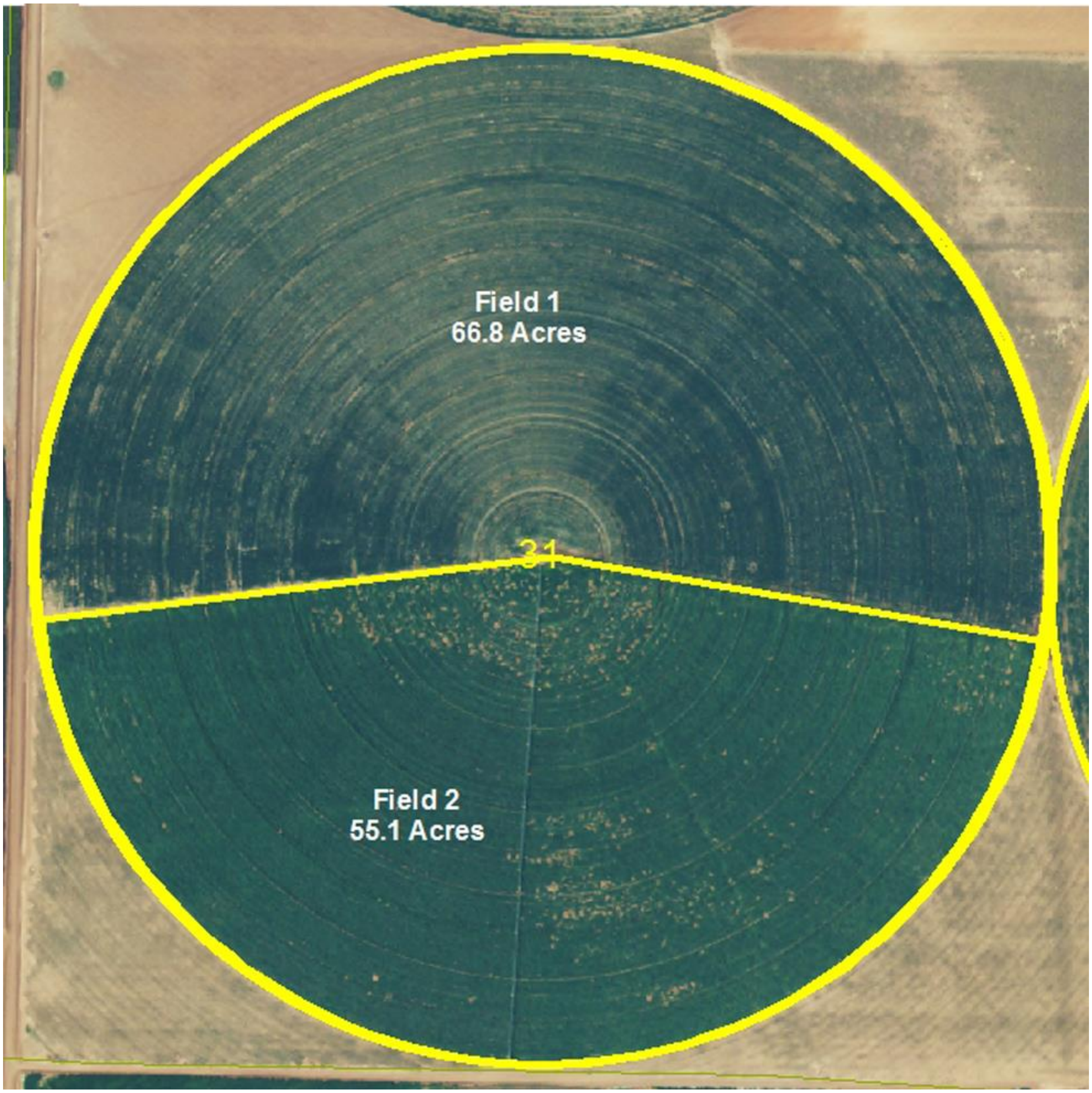
Site 30


Irrigation and Precipitation
Water (inches)
50.0
40.0
30.0
20.0
10.0
0.0
Site entered project in 2009
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
800.00
600.00
400.00
200.00
0.00
-200.00
-400.00
Site entered project in 2009
Fallowed 2011
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
50
40
30
20
10
0
-10
Net returns per pound of N ($)
7
6
5
4
3
2
1
0
Site entered project in 2009
Fallowed 2011
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 30
TAWC Site Irrigation and Gross Margin, 2009-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2009
2010
2011
2012



Site 31 Description

Total site acres:	121.9
Field No. 1 Acres:	66.8
Major soil type:	Pullman clay loam, 0 to 1% slope
Field No. 2 Acres:	55.1
Major soil type:	Pullman clay loam, 0 to 1% slope

Irrigation

Type:	Center pivot
Pumping capacity, gal/min:	450
Number of wells:	2
Fuel source:	Natural gas Electric

Site 31

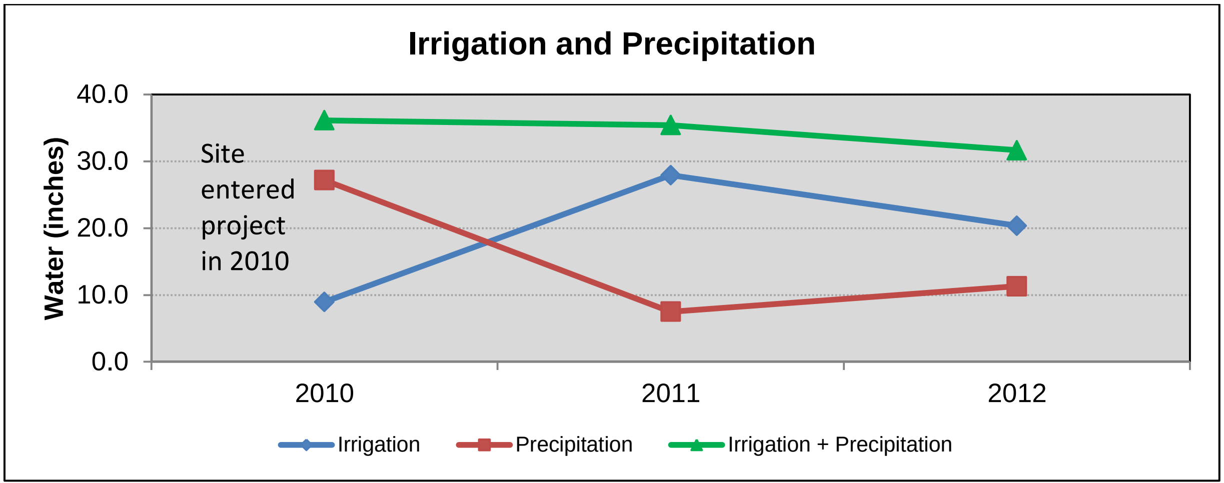
	Livestock	Field 1	Field 2
2005	Entered project in Year 6		
2006			
2007			
2008			
2009			
2010	None	Cotton	Seed millet
2011	None	Seed millet	Cotton
2012	None	Cotton	Seed millet

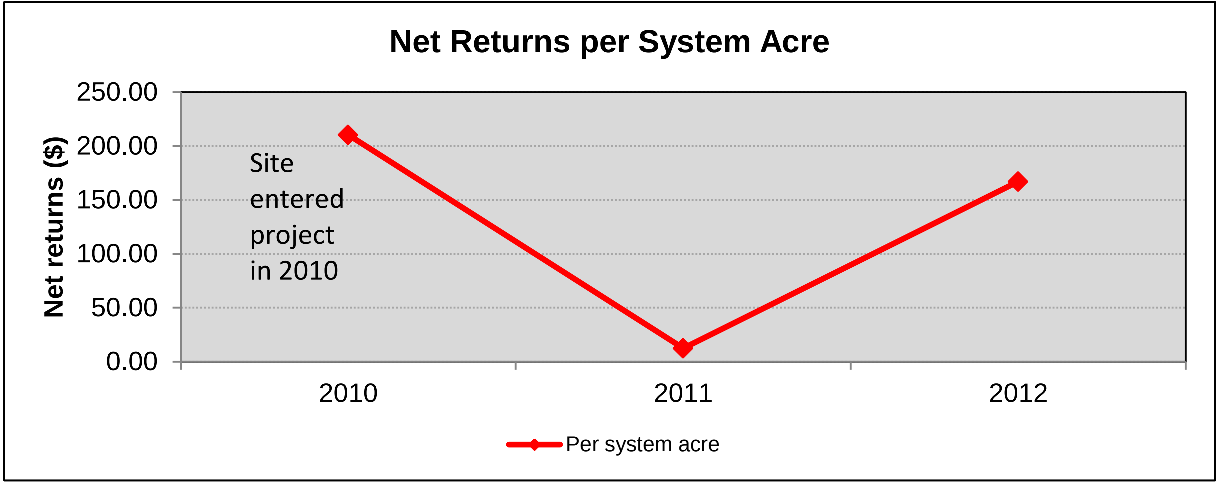
Comments: This is a pivot irrigated site which was planted to cotton and seed millet in 2012. Both crops were planted on 40-inch centers using conventional tillage.

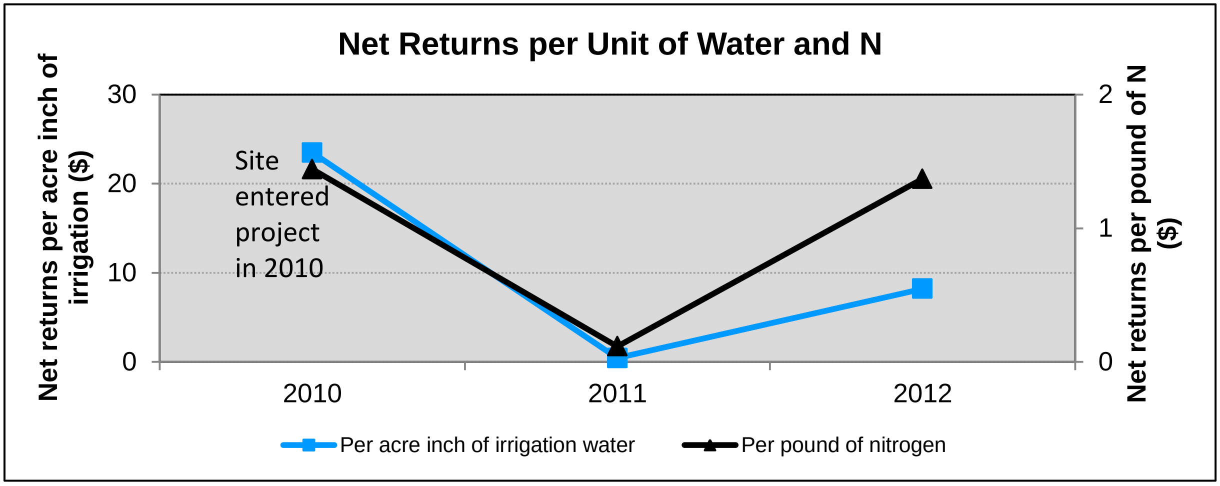
October cotton preparing for harvest

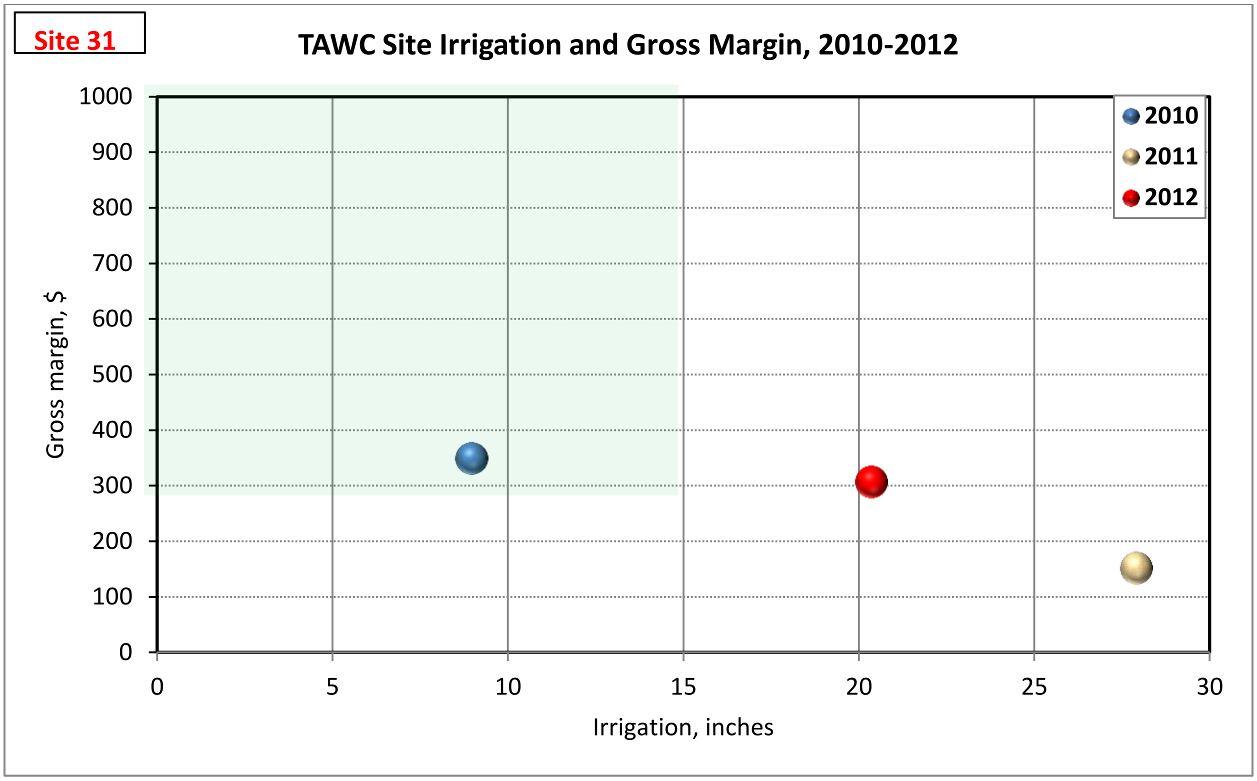
September seed millet

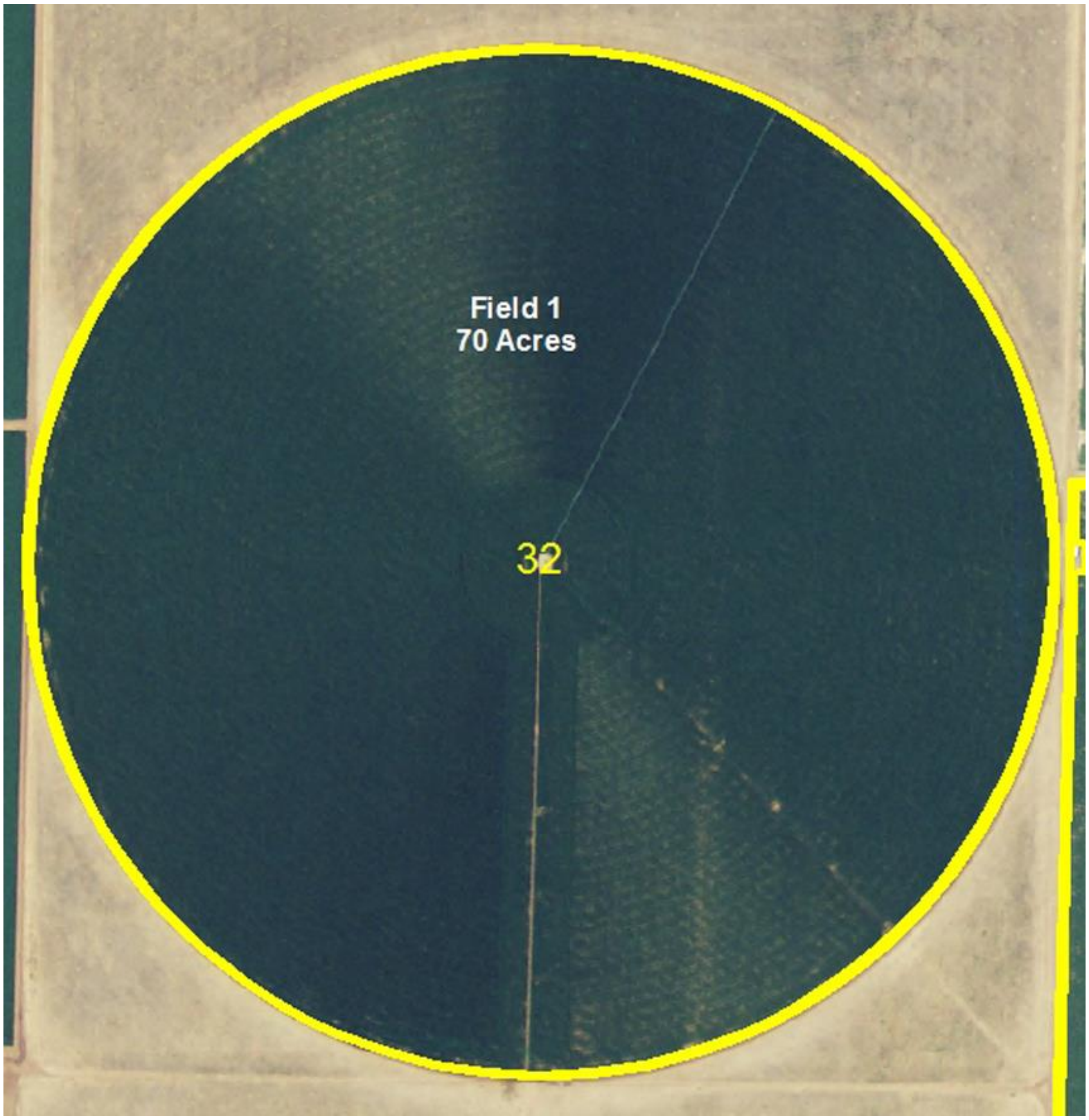
Site 31


Irrigation and Precipitation
Water (inches)
40.0
30.0
20.0
10.0
0.0
Site entered project in 2010
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
250.00
200.00
150.00
100.00
50.00
0.00
Site entered project in 2010
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
30
20
10
0
Net returns per pound of N ($)
2
1
0
Site entered project in 2010
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 31
TAWC Site Irrigation and Gross Margin, 2010-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
2010
2011
2012



Site 32 Description

Total site acres:	70.0		
Field No. 1 Acres:	70.0		
Major soil type:	Pullman clay loam, 0 to 1% slope		

Irrigation

Type:	Center pivot
Pumping capacity, gal/min:	350
Number of wells:	2
Fuel source:	Electric

Site 32

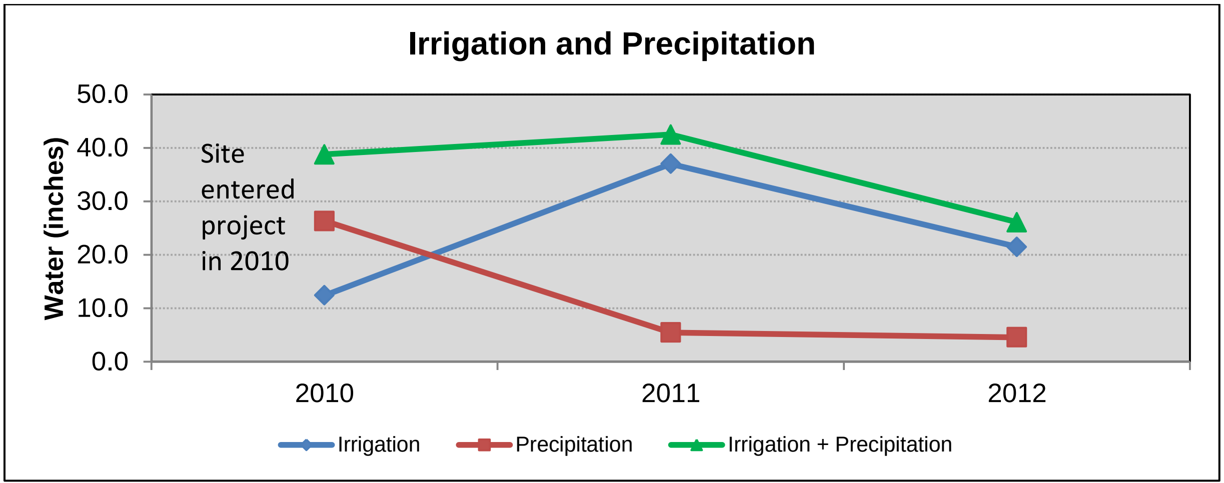
	Livestock	Field 1
2005	Entered project in Year 6	
2006		
2007		
2008		
2009		
2010	None	Corn
2011	None	Corn
2012	None	Corn

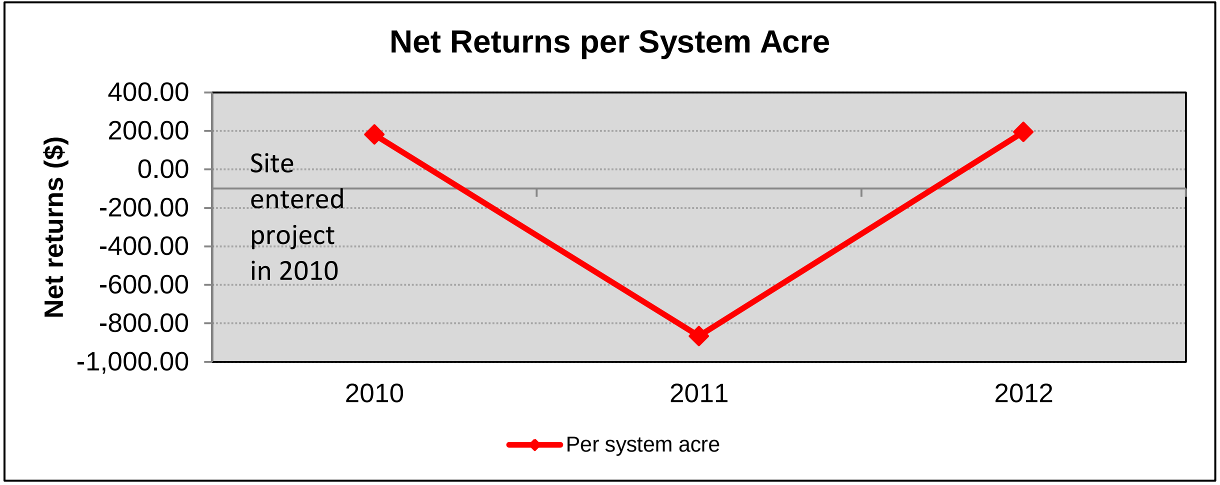
Comments: This is a pivot irrigated site which was planted to cotton on 40-inch centers for 2012. The cotton was lost due to a June 4th hail storm and replanted to corn.

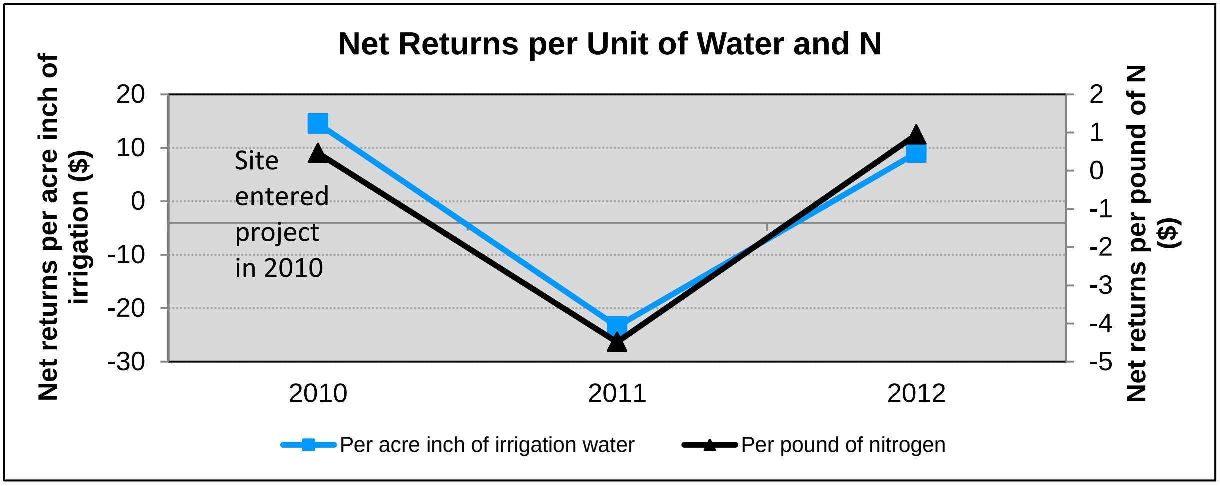
September corn

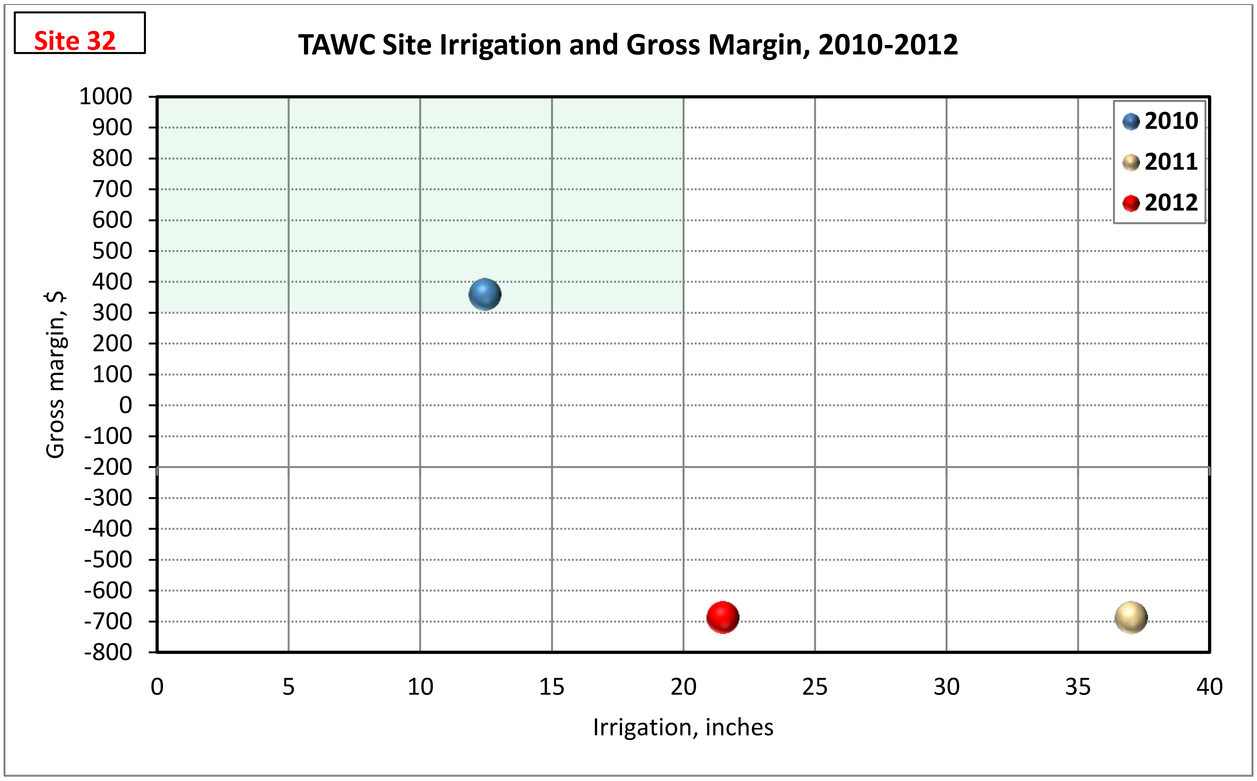
August corn harvest

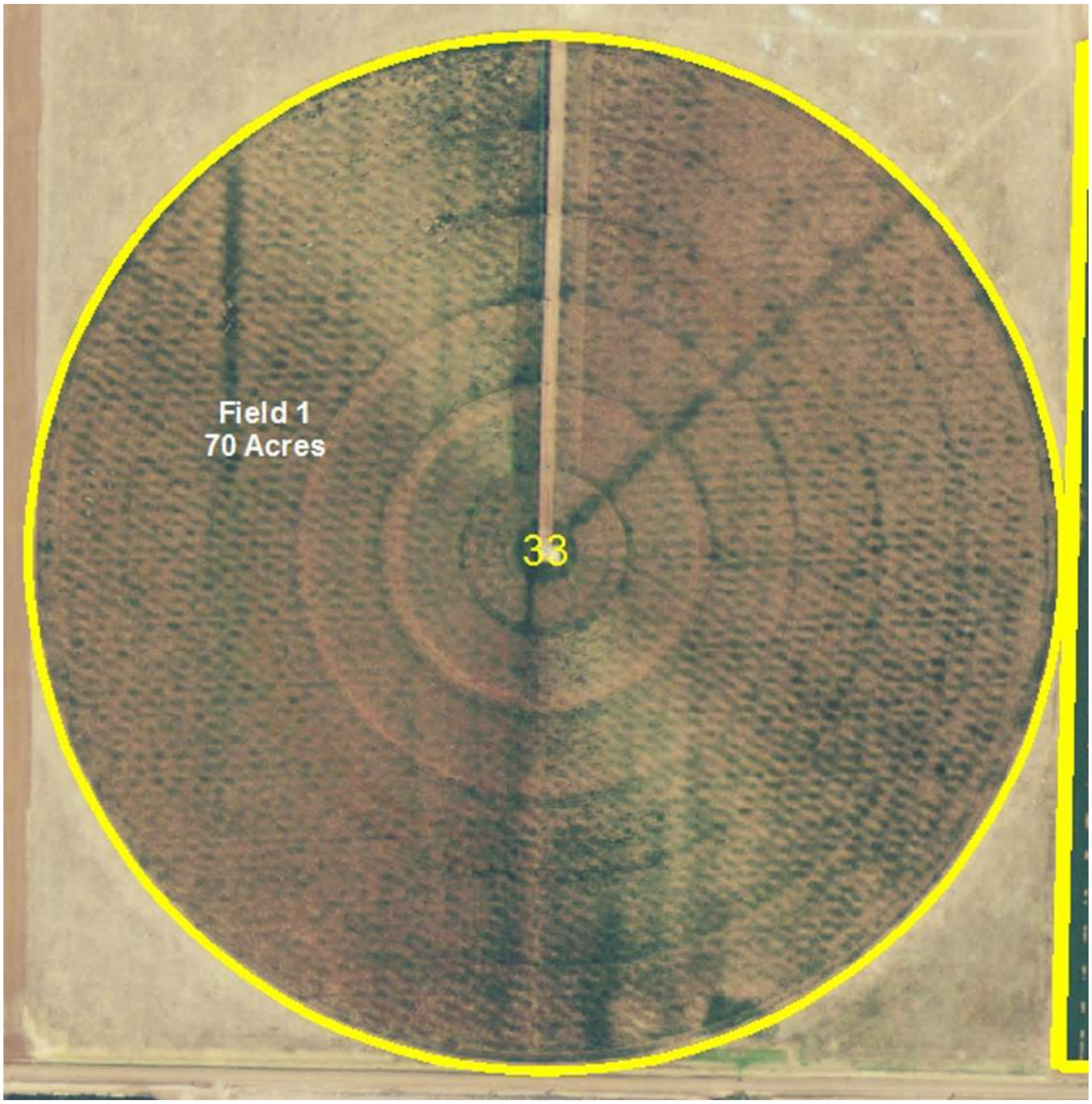
Site 32


Irrigation and Precipitation
Water (inches)
50.0
40.0
30.0
20.0
10.0
0.0
Site entered project in 2010
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
400.00
200.00
0.00
-200.00
-400.00
-600.00
-800.00
-1,000.00
Site entered project in 2010
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
20
10
0
-10
-20
-30
Net returns per pound of N ($)
2
1
0
-1
-2
-3
-4
-5
Site entered project in 2010
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 32
TAWC Site Irrigation and Gross Margin, 2010-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
0
5
10
15
20
25
30
35
40
Irrigation, inches
2010
2011
2012



Site 33 Description

Total site acres:	70.0
Field No. 1 Acres:	70.0
Major soil type:	Pullman clay loam, 0 to 1% slope

Irrigation

Type:	Center pivot
Pumping capacity, gal/min:	350
Number of wells:	2
Fuel source:	Electric

Site 33

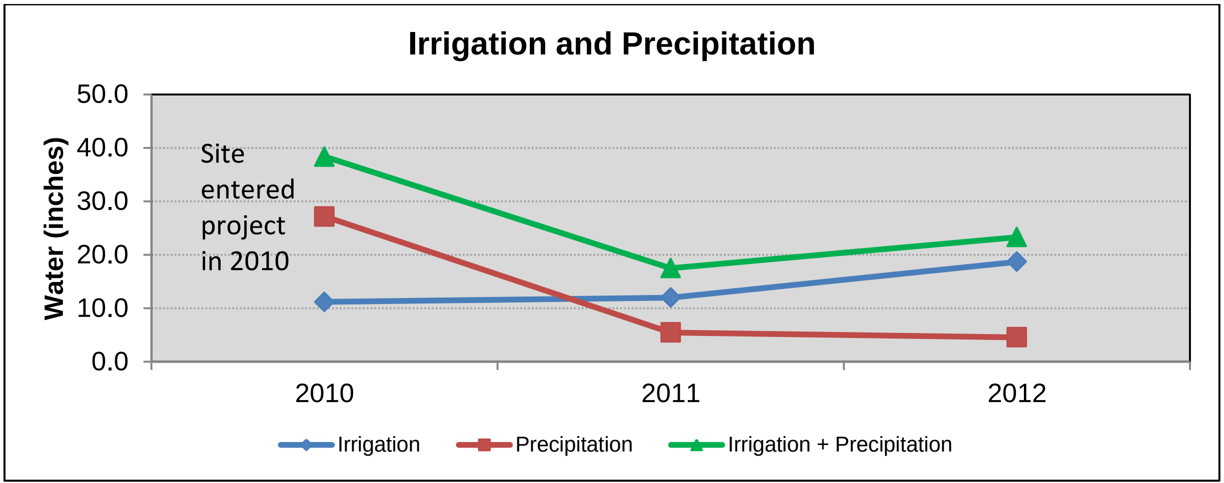
	Livestock	Field 1
2005	Entered project in Year 6	
2006		
2007		
2008		
2009		
2010	None	Cotton
2011	None	Corn
2012	None	Corn

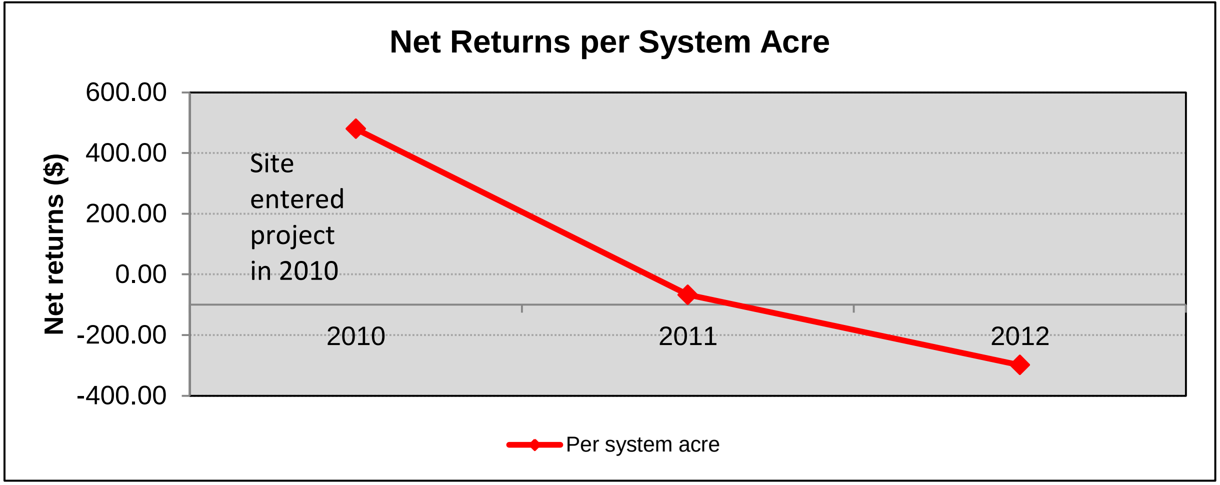
Comments: In 2012 this site was planted to cotton on 40-inch centers using conventional tillage. The cotton was lost to a June 4th hail storm and replanted to corn.

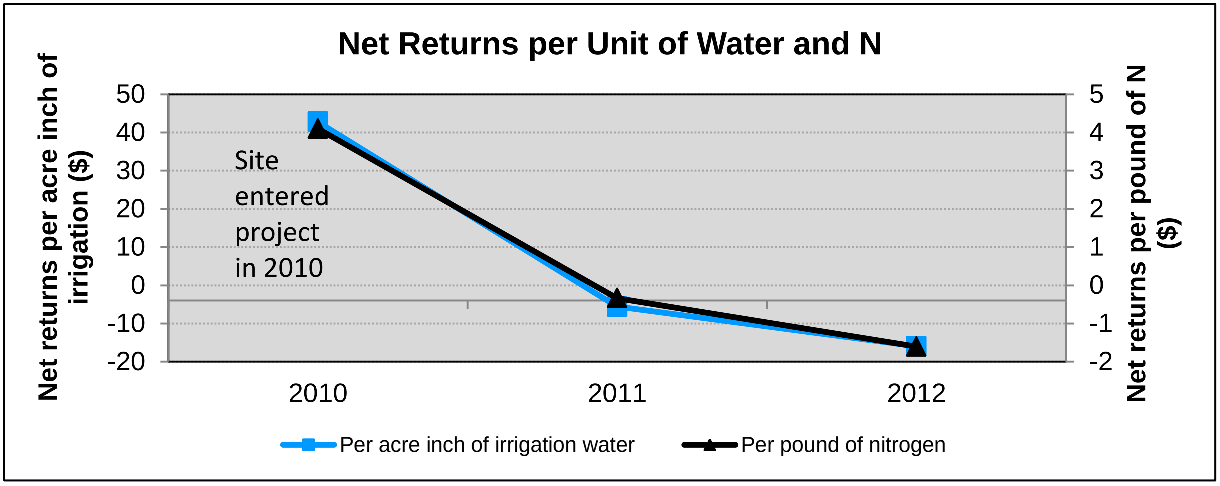
June cotton hailed out

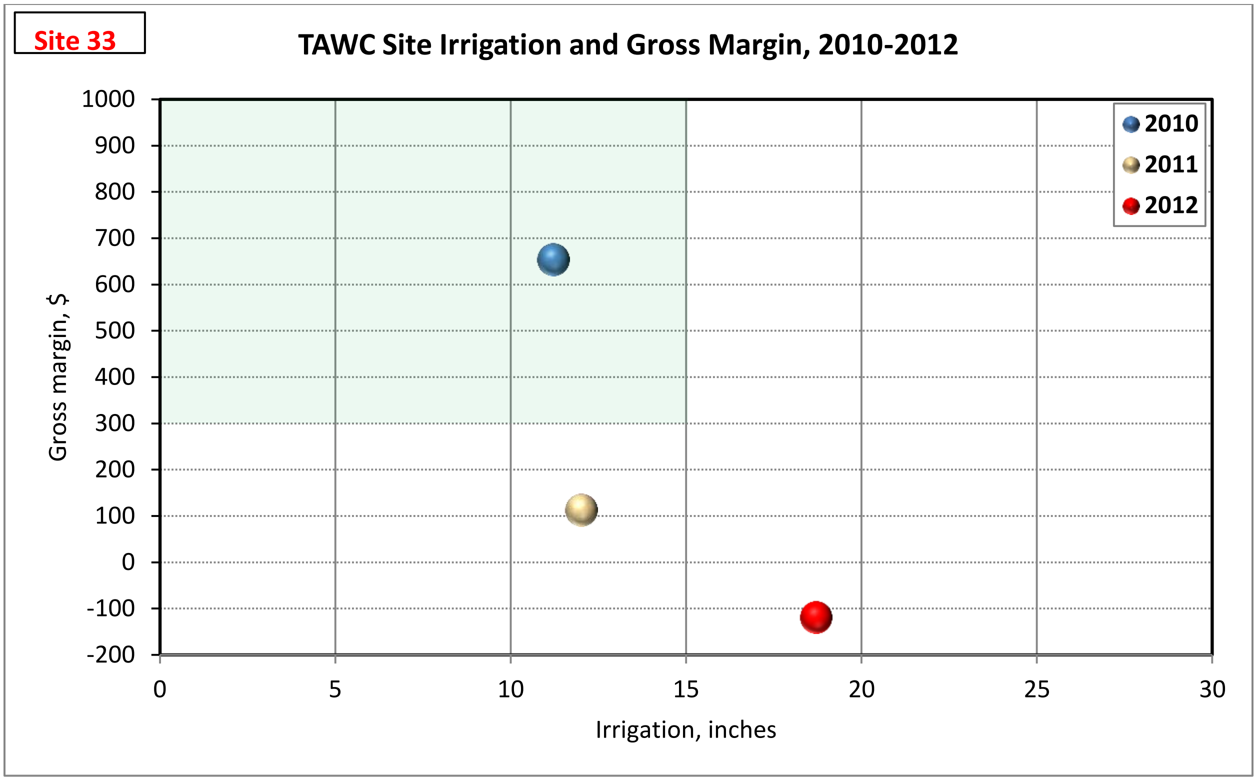
July Corn

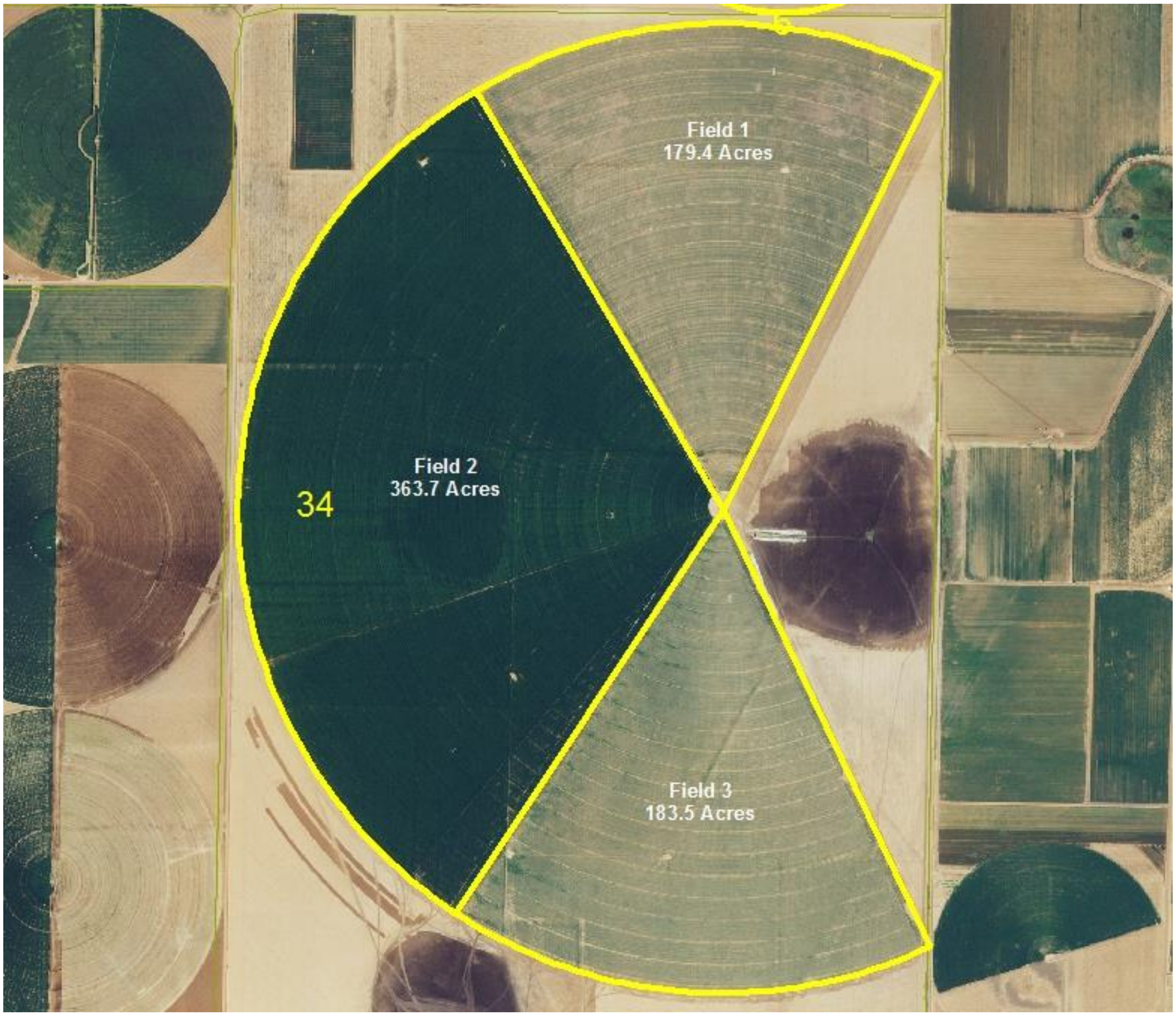
Site 33


Irrigation and Precipitation
Water (inches)
50.0
40.0
30.0
20.0
10.0
0.0
Site entered project in 2010
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
600.00
400.00
200.00
0.00
-200.00
-400.00
Site entered project in 2010
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
50
40
30
20
10
0
-10
-20
Site entered project in 2010
2010
2011
2012
5
4
3
2
1
0
-1
-2
Net returns per pound of N ($)
Per acre inch of irrigation water
Per pound of nitrogen


Site 33
TAWC Site Irrigation and Gross Margin, 2010-2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
0
5
10
15
20
25
30
Irrigation, inches
2010
2011
2012



Site 34 Description

Total site acres:	726.6
Field No. 1 Acres:	179.4
Major soil type:	Pullman clay loam, 0 to 1% slope
Field No. 2 Acres:	363.7
Major soil type:	Pullman clay loam, 0 to 1% slope
Field No. 3 Acres:	183.5
Major soil type:	Pullman clay loam, 0 to 1% slope

Irrigation

Type:	Center pivot
Pumping capacity, gal/min:	1200
Number of wells:	2
Fuel source:	Electric

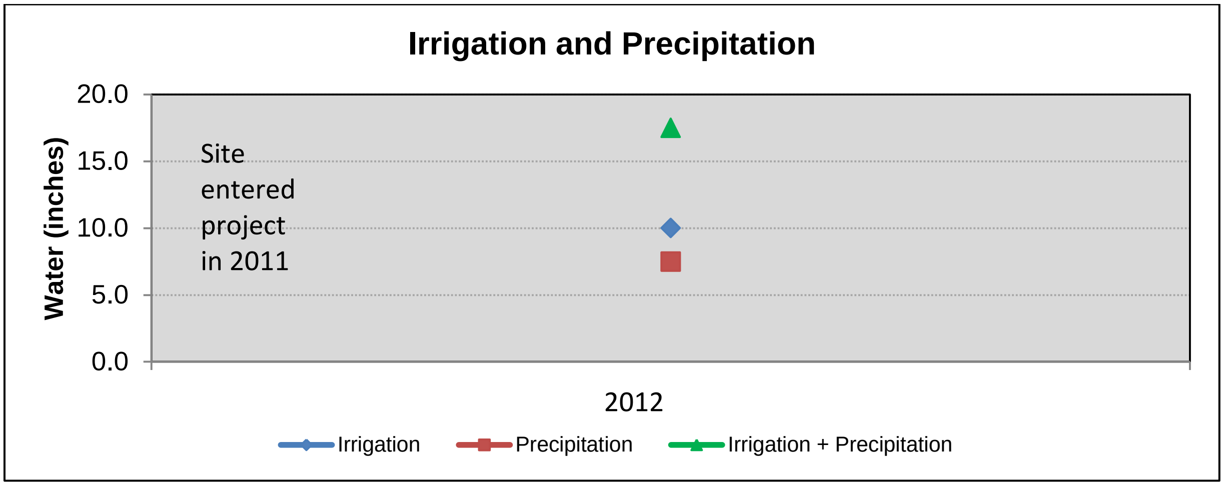
Site 34

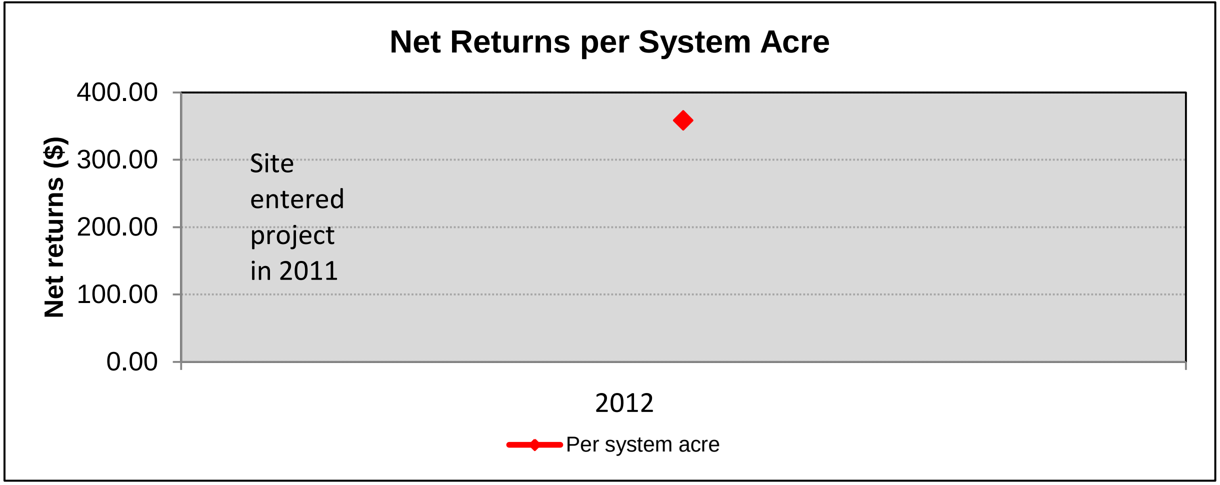
	Livestock	Field 1
2012	None	Cotton/Corn

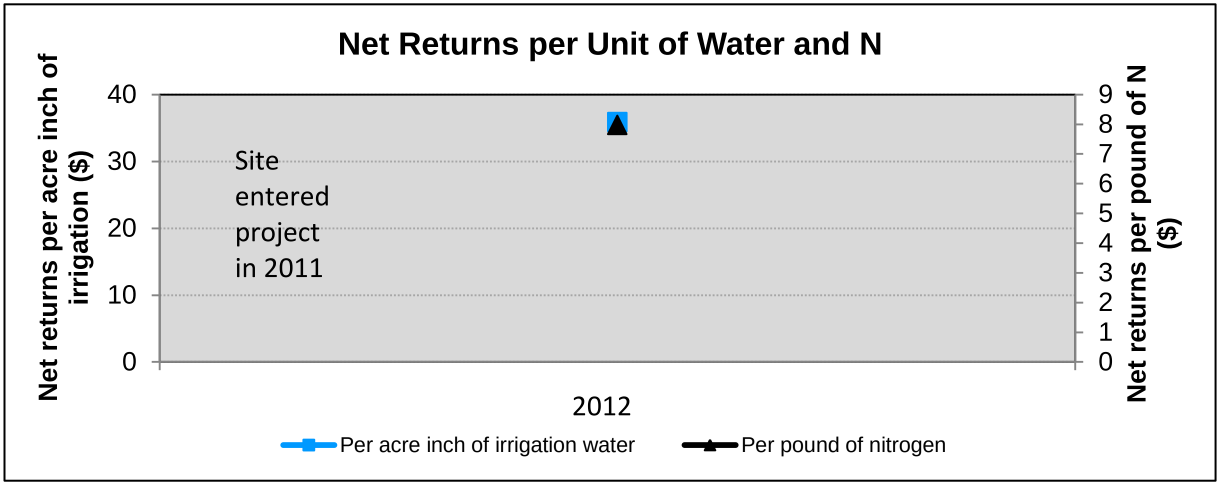
Comments: This is a new pivot site added in 2012. This producer uses limited tillage and incorporates cotton, corn, sunflowers and wheat in rotation.

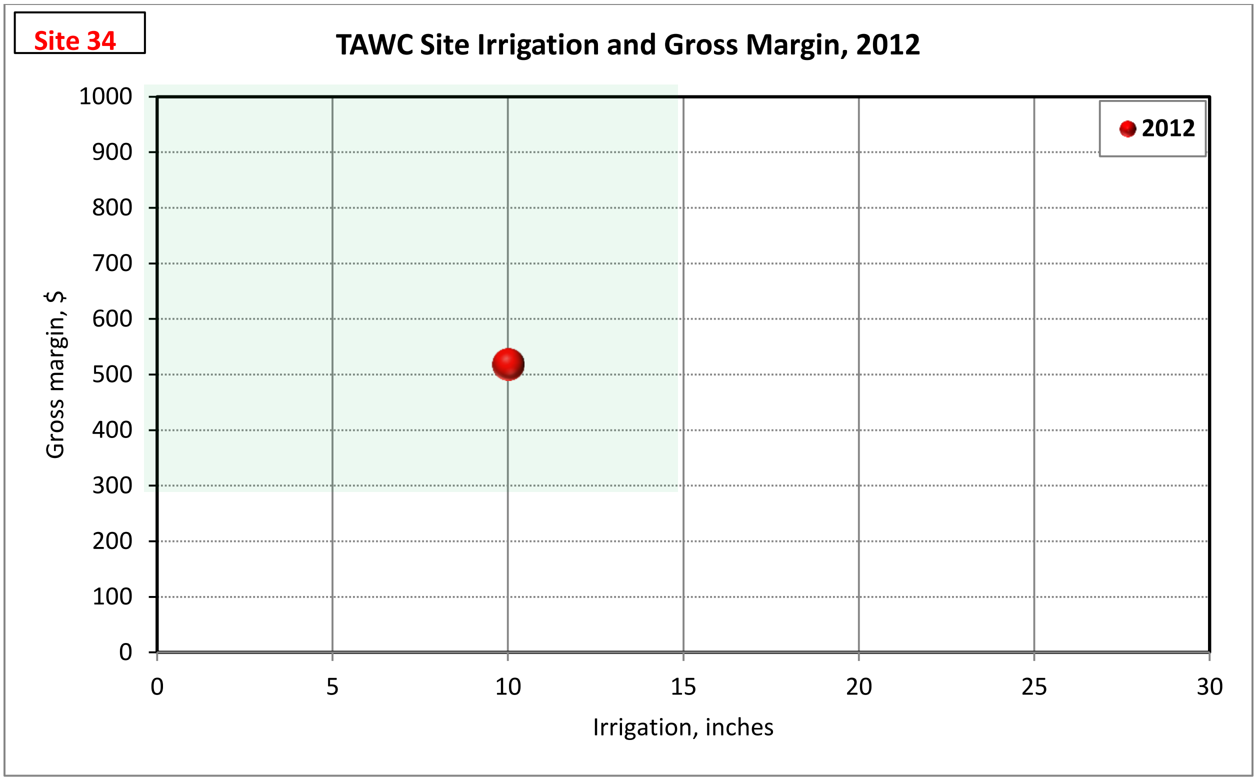
Cotton and Corn planted in 2012

Site 34


Irrigation and Precipitation
Water (inches)
20.0
15.0
10.0
5.0
0.0
Site entered project in 2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
400.00
300.00
200.00
100.00
0.00
Site entered project in 2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
40
30
20
10
0
9
8
7
6
5
4
3
2
1
0
Net returns per pound of N ($)
Site entered project in 2011
2012
Per acre inch of irrigation water
Per pound of nitrogen


Site 34
TAWC Site Irrigation and Gross Margin, 2012
Gross margin, $
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
Irrigation, inches
● 2012

OVERALL SUMMARY OF YEARS 1 through 8

With 8 years completed of this study, trends and patterns are emerging and more useful information is accumulating. Each year's results are highly influenced by weather, availability of irrigation water, input and commodity prices, anticipated prices for crops and livestock, and previous years' experiences. During these 8 years, annual precipitation ranged from a low of 5.3 inches (2011) to a high of 28.5 inches (2010), averaging 17.3 inches (2005-2012), which is slightly lower than the long-term mean (18.5 inches) for the region (Figure 10). Five of 8 years exhibited below-average rainfall, with the last two years, 2011 and 2012, substantially below average. The record-setting drought of 2011 (5.3 inches) was followed by another severe drought in 2012 (9.9 inches). Consequently, irrigation applied (mean of all sites) was greatest in these two years. Since 2011 was severely dry, storage of soil-profile water in spring of 2012 was extremely low. Very low summer precipitation was associated with high ambient temperatures during the growing season, causing high water losses via evapotranspiration and, for many sites, insufficient supply of irrigation water to meet crop water demand. Persistent drought in the fall and early winter of 2012 increased the risk of low soil water stores going into the 2013 growing season.

The potential amount of irrigation water saved summed across all sites was 2022 acre-feet, when considering the contribution of soil water in the root zone. See page 274-276 for details.

As in 2011, insufficient irrigation supply at some sites in 2012 resulted in abandonment of at least part of planted acres in order to focus available irrigation more effectively on fewer acres. Five fields of cotton comprising nearly 600 acres were abandoned or drastically reduced in irrigation due to severe water deficit. Corn grain yields for 2012 averaged 7475 lbs/acre (133.5 bu/acre), which was somewhat greater than in 2011, but still only 64% of the average across 2005-2010 (Table 29, page 226). Corn silage yield was only 6.3 tons/acre, or 21% of the 2005-2010 average, indicating drastic silage yield reduction. Cotton lint yield, however, was virtually unchanged from the 2005-2010 average.

Crop insurance played a role in 2012 in the producers' ability to recoup initial input costs as several fields in the TAWC were either abandoned or produced very low yields. Insurance indemnity payments within the crop budgets were handled one of two ways. If the producer's record book indicated what the insurance indemnity payment was, this value was incorporated into the budgeting process. If this value was not available or the producer did not know the particular insurance payment, the indemnity was estimated. This was done by using average county yields to simulate a farm's T yield (or trigger yield); a 65% coverage level was assumed for all grain and fiber crops, and a 2012 harvest price was used as the payment price. If the producer indicated any residual crop at the time of abandonment or if there was sufficient evidence to indicate that there was some crop left standing in the field at the time of the insurance claim, this was deducted from the 65% coverage yield. The net result was an estimate for the indemnity payment from crop insurance. This method was standardized for all dryland and irrigated crops within the TAWC sites.

Figures 10 and 11 show annual changes in returns above all costs and gross margins in relation to precipitation and irrigation. Gross margin equals total revenue less total variable costs. Returns above all costs equals gross margin less fixed costs and is the same as net returns. See p. 235 for definitions of economic terms.

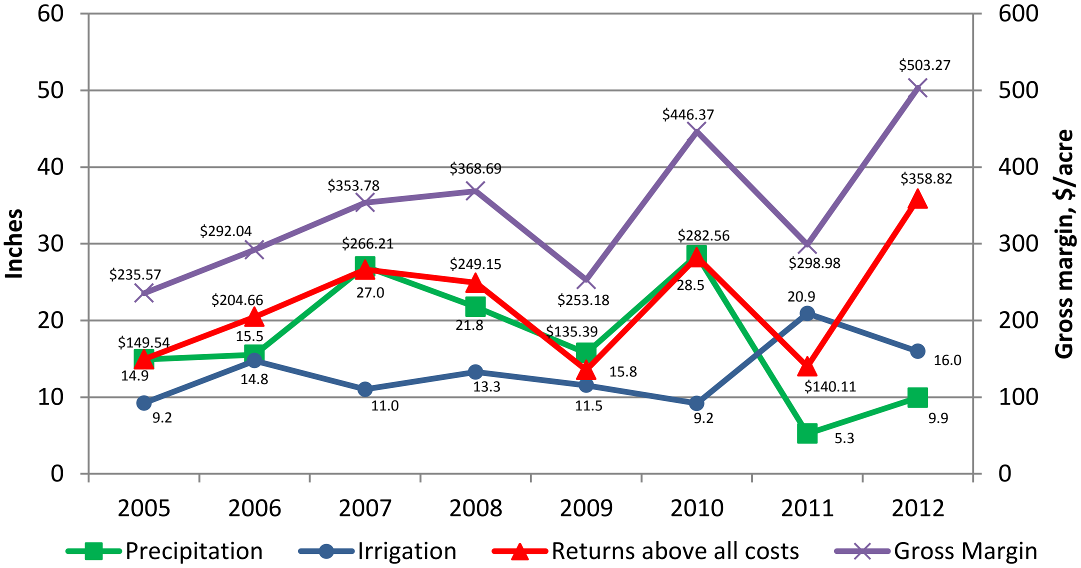


Figure 10. Average precipitation (inches), irrigation applied (inches), net returns above all costs ($/acre), and gross margin ($/acre) for irrigated sites only.

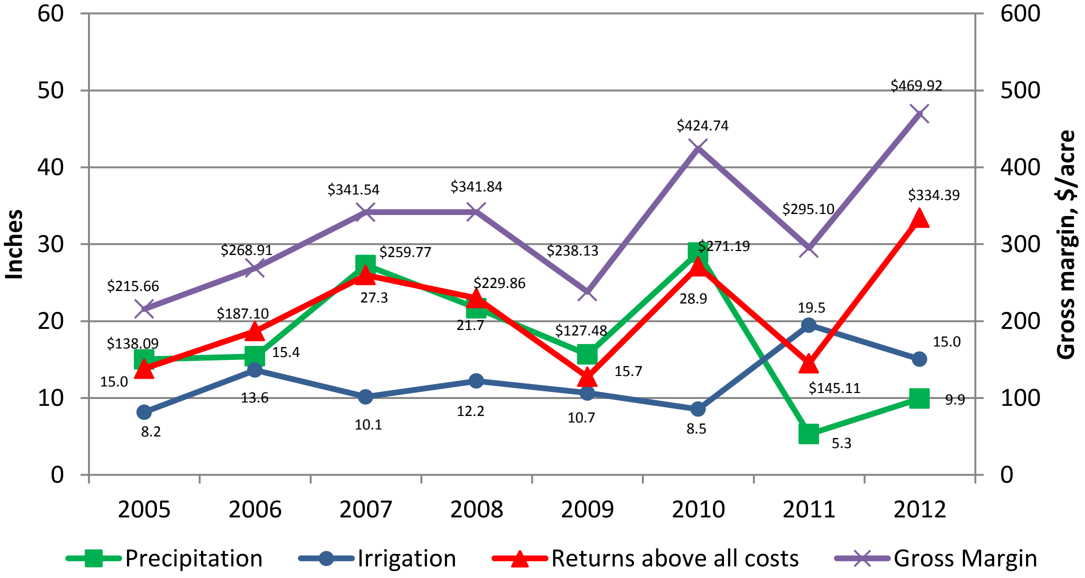


Figure 11. Average precipitation (inches), irrigation applied (inches), net returns above all costs ($/acre), and gross margin ($/acre) for all sites, irrigated and dryland.

Amount of irrigation applied averaged over 8 years on the irrigated sites only was 13.2 inches, with a range across years of 9.2 to 20.9 inches (Figure 10). The mean irrigation level of 13.2 would comply with current and projected future application restrictions for this region (21 inches across contiguous acres in 2012, stepping down to 18 inches in 2014 and to 15 inches in 2016). In the drought years of 2011 and 2012, average irrigation applied was 20.9 and 16.0 inches, respectively, which are near the restriction levels. Spikes in irrigation during a year like 2011 can be absorbed into an allowable 3-year rolling-average use to stay within tightened restrictions, especially if bracketed by wet years like 2010; however, protracted droughts over consecutive years may present challenges to staying within the tightening restriction.

When all sites including the non-irrigated fields (Figure 11) are included in the means, average irrigation applied declines from 13.2 to 12.2 inches, pointing out the importance of inclusion of non-irrigated acres within a producer's overall enterprise in assessing water use. As water availability declines, two basic strategies can be used alone or in combination to stretch water supplies: a) apply less water per acre to a level that still maintains profitable yields (70-80% of crop ET); and b) apply available water to fewer acres. Both approaches have merit depending on the crop species and variety, how water is allocated over the cropland, and the distribution of precipitation within a year. Choices of crop species/variety and the land allocation of water are under the control of the producer. Distribution of precipitation is not under their control and therefore only involves retrospective responses.

Total returns above all costs of production in 2012 ($334.39/ acre), including irrigated and dryland sites, were the highest of all 8 years of the project (Figure 11). Profitability in 2005 and 2009 were negatively impacted by high production costs in relation to values of crops and livestock. Low profitability in 2011 reflected reduction in livestock numbers and yield losses in crops, but was buffered by insurance payments. The relatively high returns in 2012 were favored by high commodity prices across many crop types and adequate irrigation available to attain profitable yields in cotton.

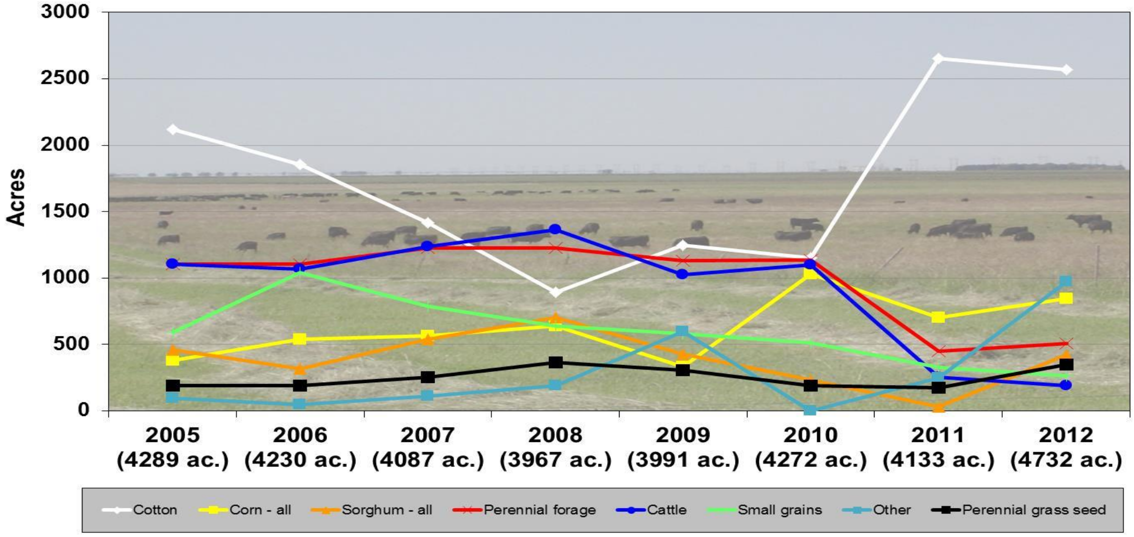


Figure 12. Number of acres that include cotton, sorghum, perennial forages, cattle, small grains and other crops within the producer systems in Hale and Floyd counties.

Producers in the TAWC project make their own decisions each season on enterprise selection and production practices. Land use reflects current crop and livestock prices, contracts, expected profitability, water supply, and decisions to terminate leases, sell property, or retire. Therefore, the number of acres and number of sites of the enterprise choices have varied. Figures 12 and 13 show the acreages and number of sites, respectively, that were devoted to cotton, corn, sorghum, perennial forages, cattle, small grains, and other crops. The total of enterprise acres exceeds total acres in the project in any given year due to double cropping and multi-use for livestock, e.g. harvesting a seed crop followed by harvesting hay from the regrowth in the same field. In 2012, irrigated cotton maintained the relatively high acreage attained in 2011 (Figure 12), reflecting expectation of favorable profitability and the ability of cotton to produce profitable yield with relatively low irrigation. Acreages of perennial forage and cattle pasture show declines in the latter years of the project, owing to liquidation and reduction of some herds. The most significant changes in crop acreage allocation were increased sorghum (grain + forage types) and other crops (mainly sunflower and seed crops). Corn acreage was little changed from the previous year.

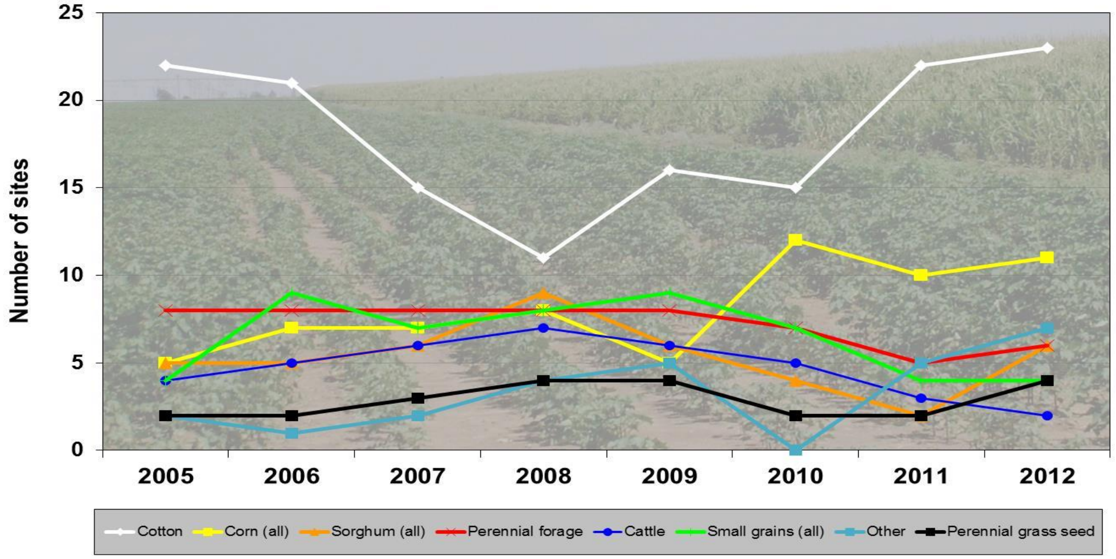


Figure 13. Number of sites that include cotton, corn, sorghum, perennial forages, cattle, small grains and other crops within the producer systems located in Hale and Floyd counties.

The trends in number of sites where different production systems are practiced are dynamic (Figure 13), but generally follow the trends in acreage distribution (Figure 12). Cotton was dominant in the first two years and most recent two years. The alternatives to cotton showed greater year-to-year fluctuation in the latter 4 years than in the first 4 years of the project. Other notable trends are the upsurge in corn sites after 2009, the steady decline in livestock sites after 2008, and a resurgence in sorghum sites after 2011.

Water Use and Profitability

Patterns are emerging with respect to profitability in relation to irrigation applied. This is important because of the constant need to increase water use efficiency by the crops and prolong the groundwater supply, while maintaining or even increasing profitability of agricultural production in the High Plains. To examine systems for meeting criteria of relatively low water use and high profitability, we arbitrarily selected a maximum of 15 inches of irrigation and a minimum of $300 gross margin per acre as a desired target for performance. Please note that these levels were selected only to identify whether certain sites and cropping systems consistently performed to those criteria and *not* to relate system performance to pumping restrictions nor to state a minimum amount of revenue required for economic viability.

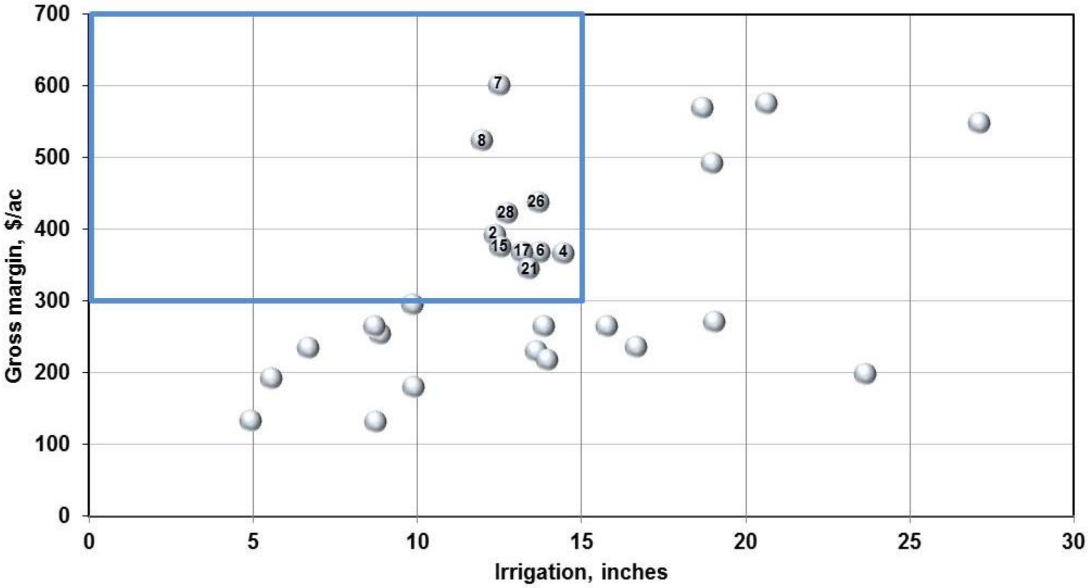


Figure 14. Gross margin per acre in relation to inches of applied irrigation averaged over 2005 to 2012. Points represent 23 sites which were irrigated in all years. The blue box brackets those sites meeting the arbitrary criteria of 15 or fewer inches irrigation and $300 or less gross margin per acre. Sites within the box are described in Table 17.

Table 17. Description of cropping system and irrigation type used in sites plotted in Figure 14 which meet criteria of 15 or fewer inches of irrigation and $300 or more gross margin/acre. Detailed descriptions of all sites shown in Tables 30 and 31 in Task 4 report, pp. 238 and 240.

Site	Cropping system	Irrigation type
2	Cotton/corn rotation	Subsurface drip
4	Multi-crop with cotton, alfalfa, cattle	Low elevation spray application
6	Multi-crop, cotton/corn in half pivots	Low elevation spray application
7	Continuous sideoats grama grass seed	Low elevation spray application
8	Continuous sideoats grama grass seed	Subsurface drip
15	Multi-crop with cotton, corn, sorghum	Subsurface drip
17	Multi-crop rotations with cow-calf	Mid elevation spray application
21	Multi-crop rotations, cotton, corn, wheat	Low energy precision application
26	Multi-crop rotations, cotton, corn, others	Low elevation spray application
28	Continuous cotton, cotton/corn in 2012	Subsurface drip

Ten sites met the arbitrary criteria of 15 or fewer inches of irrigation and $300 or more gross margin/acre, when averaged over 2005-2012 (Figure 14 and Table 17). Four sites that met the $300 gross margin per acre criterion but with average irrigation over 18 inches (points located to the right of the blue box in Figure 14) were cotton/corn rotations. Inclusion of corn in multi-cropping systems can produce high gross margins, but requires more irrigation than cotton. Sites 2, 6, 15, 17, 21, and 26 all included corn in the multi-crop rotations and met the double criteria of 15 inches and $300/acre, indicating that inclusion of corn in the cropping system can result in high return at low water use, averaged over years. Of the five sites that used subsurface drip irrigation, all had gross margins above $300/acre and four applied less than 15 inches of irrigation. See the

Task 4 report (pages 233-240) for discussion of gross margin per acre-inch of irrigation applied. Again, the two sites with grass seed production were among the highest ranked sites for gross return per acre-inch. When the analysis of all years from 2005 through 2013 is completed, clearer results of which type of cropping systems, irrigation technologies, and overall input managements favor high profitability at low water use will be ascertained.

2012 Project Year

Producer sites can be categorized according to type of farming system insofar as a site represents a conceptual farm. The system categories in use in 2012 were corn monoculture (entire site in corn only), cotton monoculture (entire site in cotton only), grass seed monoculture (entire site in grass seed production consisting of sideoats grama), integrated crop/livestock (site included cattle on pasture plus an annual crop and/or hay), and multi-cropping (more than one annual crop species harvested in the reporting year). All 2012 systems were capable of irrigation on at least part of the acreage. Other systems occurring in previous years but not in 2012 included cow-calf pasture, sunflower monoculture, cotton monoculture (dryland only), and multi-cropping (dryland only). A site categorized in one system is recategorized each year that the crop choice changes.

In 2012, corn monoculture, grass seed, and integrated crop/livestock each accounted for 7% of the sites, while cotton monoculture occupied 21% and multi-cropping occupied 58%. Averaged over the 8 years of the project, percentage allocations of the systems were similar to 2012 except that integrated crop/livestock was 15% and multi-cropping was 45% of the sites.

This section compares the cropping systems for net returns per acre and per acre-inch of irrigation, and usage of irrigation and nitrogen fertilizer for 2012. Grass seed production had by far the highest average net returns per acre at $700, followed by multi-cropping and cotton monoculture (Figure 15). Corn monoculture showed negative returns.

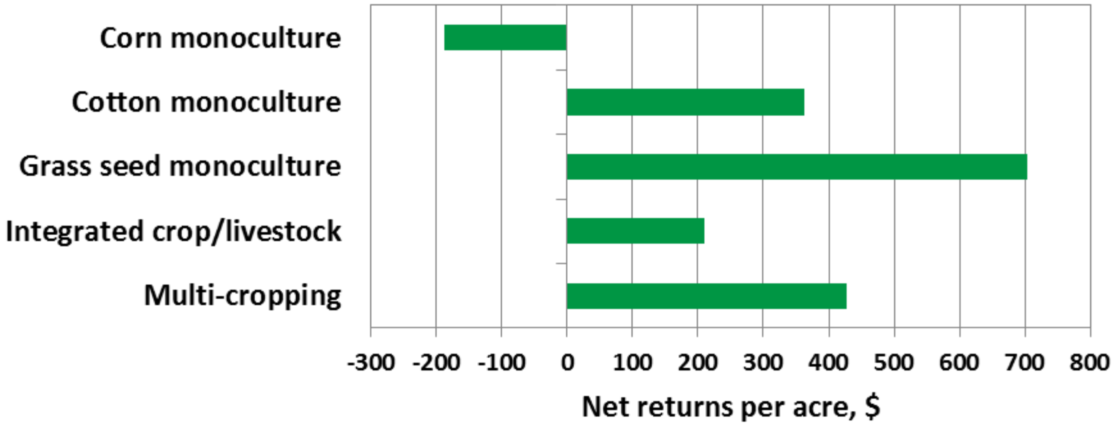


Figure 15. Net returns per acre for five cropping systems in 2012.

When these systems were examined in terms of net returns per acre-inch of irrigation applied (Figure 16, green bars), corn again was negative, with grass seed monoculture and cotton monoculture being highest, followed by multi-cropping. The blue bars in Figure 16 indicate average inches of irrigation applied per system. Grass seed had the highest application and cotton monoculture had the lowest. While not as dry as in 2011, the low rainfall in 2012 contributed to fairly high irrigation amounts and low yields in corn monocultures, which explains the negative net returns that year.

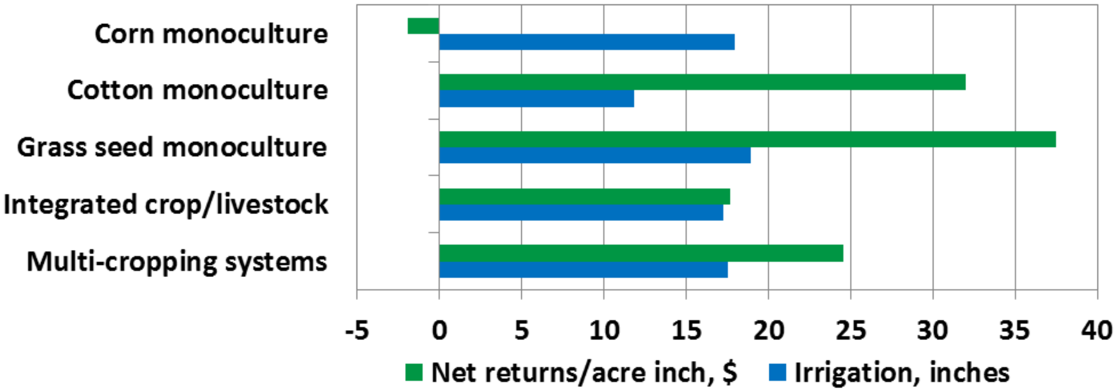


Figure 16. Net returns per acre-inch irrigation water (green bars), and inches of irrigation applied (blue bars) in five cropping systems in 2012.

Grass seed monocultures and corn monocultures had the highest application rates of nitrogen (N) fertilizer at around 150 lbs/acre (Figure 17). The lowest N applied was to the integrated crop-livestock systems and cotton monoculture at around 80 lbs/acre. In addition to the monetary cost of N fertilizer, release of nitrous oxide from the fertilizer can incur environmental risks because nitrous oxide is both ozone-depleting and a greenhouse gas.

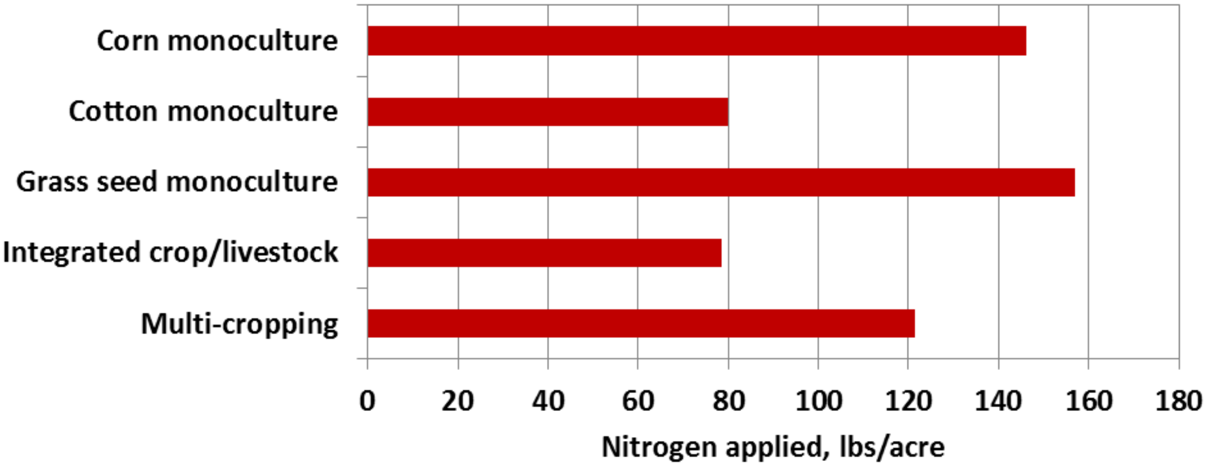


Figure 17. Pounds per acre of nitrogen applied in fertilizer in five cropping systems in 2012.

Project years 1 through 8

Average net returns per acre averaged over 8 years of the project (2005-2012) indicate that grass seed monoculture was the most profitable system at about $430 per acre (Figure 18). This system also had the highest net returns per acre-inch of irrigation water applied, which were similar to cotton in terms of total irrigation water used (Figure 19). The 8 years of this project now cover a wide range of weather and economic swings. It is notable that grass seed production appears more buffered against these variations than any of the other systems in that it yielded the greatest net returns per acre in 7 out of 8 years. While multi-cropping and cotton monoculture yielded similar average net returns per acre (around $220/acre), integrated crop-livestock was at $175 and corn monoculture was around $165/acre (Figure 18).

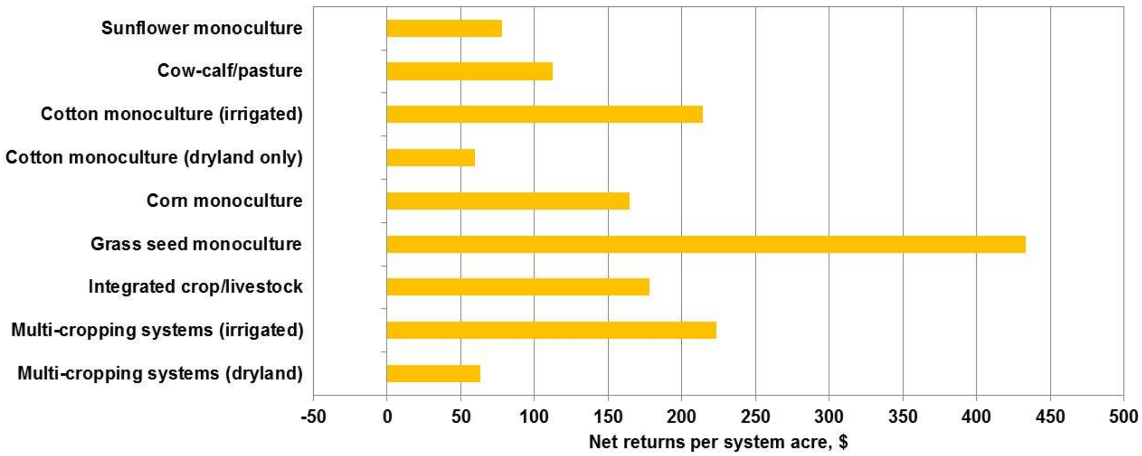


Figure 18. Net returns per system acre, average of 2005-2012, or for those years which those systems occurred. Data for cow-calf/pasture includes 2005-2010 only.

Irrigation applied was greatest for corn monoculture, followed by multi-cropping (Figure 19, blue bars). Irrigated cotton used about the same amount of irrigation as did grass seed and the integrated crop-livestock system. Net returns per acre-inch of irrigation applied were highest for grass seed, followed by cow-calf/pasture (Figure 19, green bars); the latter owing to low irrigation. With fairly high net returns per acre-inch of irrigation and low water usage, cattle production on perennial forages may offer a sustainable option as ground-water becomes more depleted. Net returns for irrigated cotton monoculture were ranked third. Corn monocultures were not present in some of the earlier years of this project and thus their means reflect fewer years. The droughts of 2011 and 2012 hit corn yields particularly hard, therefore with fewer years in the mean, the effects of drought have a proportionally greater effect on this crop. Sunflowers represent a specialty crop in this region and required less irrigation water than any system type with the exception of the cow-calf/pasture; however, returns per unit of water applied were also relatively low. Dryland systems have always had the lowest average net returns in this project.

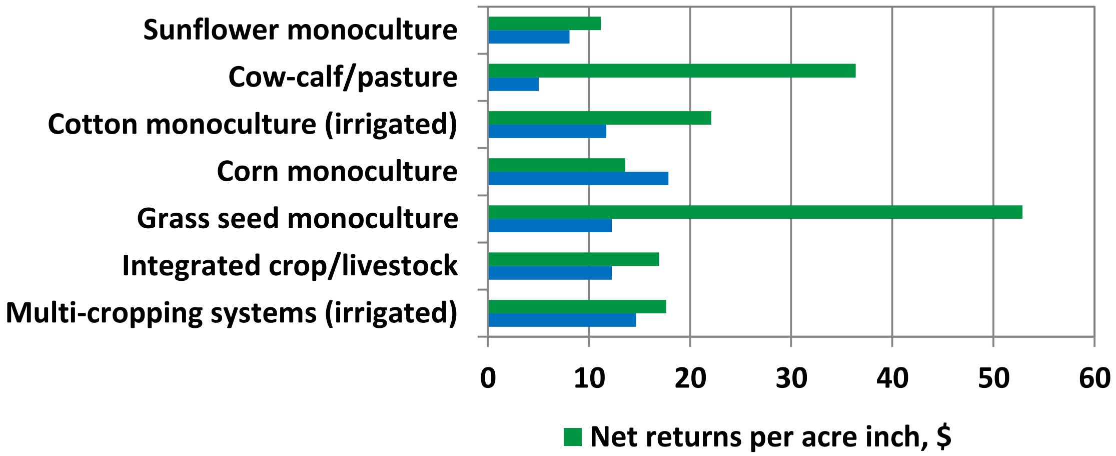


Figure 19. Net returns per acre-inch of irrigation water (green bars), and inches of irrigation applied (blue bars), average of 2005-2012. Data for cow-calf/pasture includes 2005-2010 only.

Dryland cotton and multi-cropping systems received the least nitrogen fertilizer per acre, whereas corn monoculture received by far the most (Figure 20). Cow-calf perennial grass pastures were the second lowest users of N fertilizer. For warm-season pasture grasses, 50 to 60 lbs of N/acre annually is generally considered adequate. In contrast, corn monocultures represented the other extreme with about 225 lbs N/acre received annually. All other systems received from about 110 to 130 lbs/acre of N.

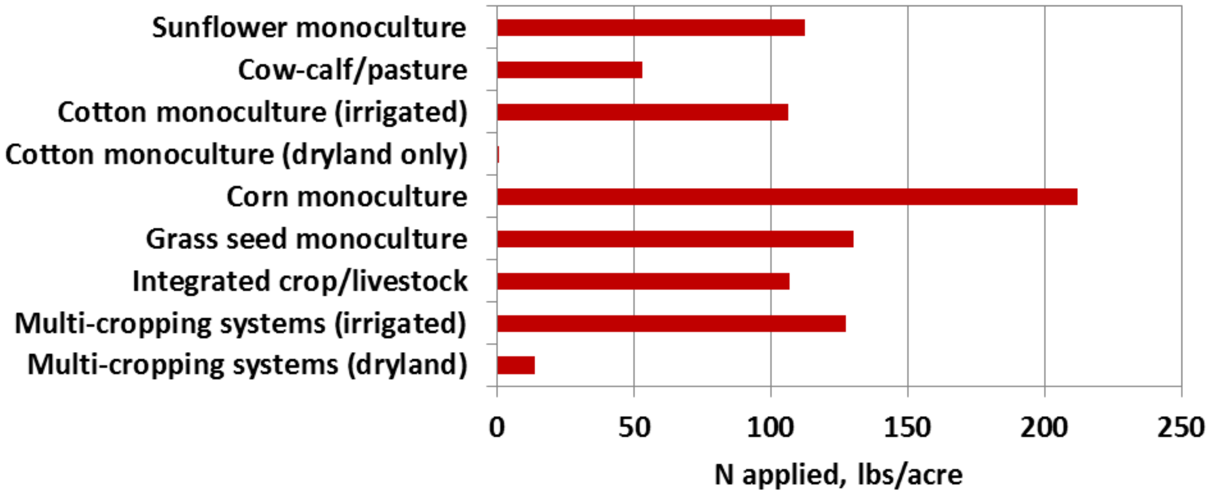


Figure 20. Pounds of nitrogen per acre applied in fertilizer, average of 2005-2012. Data for cow-calf/pasture includes 2005-2010 only.

Discussion

Over the 8 years of the project we have observed a number of system configurations under varied environmental conditions, irrigation technologies, and market conditions. Management is the key to how these systems behave under the extreme year to year variations experienced. Producers make strategic and tactical production decisions to maintain economic viability and utilize available resources efficiently. Strategic decisions relate to crop and livestock enterprise selection, whether it is year-to-year crop selection or longer term planning. Planting perennial grasses for seed and pasture production, integrating livestock into an operation, and the selection of irrigation technologies are examples of strategic decisions. Tactical decisions relate to enterprise management within the growing season, such as variety selection, fertilizer management, irrigation scheduling and harvest timing.

There are a number of irrigation management technologies such as Smart Crop, AquaSpy and NetIrrigate which aid specifically in the tactical decision process. We have been able to provide some of these technologies to producers within the TAWC project. Information received from these technologies in conjunction with measurement of evapotranspiration (ET) on a field by field basis has helped producers gain insight into better irrigation management techniques. Feedback from producers who have used these technologies has helped us formulate tools to address the short-term and long-term irrigation management challenges facing the region. Continual adoption of water-saving irrigation technologies and monitoring will contribute to greater advances in the efficiency of irrigation applied and amounts of water saved.

Two management tools were developed and made available to producers in the region through the TAWC Solutions web site (**http://www.tawcsolutions.org**) in early 2011. Use of these tools by producers within and outside TAWC has grown tremendously. As of early May 2013, there were nearly 500 people registered to log on to the web site. The Water Allocation Tool, the Irrigation Scheduling Tool, and the Resource Allocation Analyzer are the three practical tools available on this web site. These tools are free of charge to any producer.

The dissemination of results and information from the project through various outreach efforts is an important part of the project. Continuing activities as in previous years, field days were held in February 2012 at Muncy, TX and August 2012 at Plainview, TX. These field days allow attendees to visit several project sites and observe the technologies that are currently being demonstrated within the project to better manage and monitor irrigation use and timing. The February field day was devoted to a more in-depth discussion of results and analysis from the project as well as demonstration of the TAWC Solutions Tools. In addition to the field days, the project was represented at several farm shows within the region, which allowed further dissemination of findings and information regarding the project and demonstrations and producer interaction on the management tools that are being provided on the TAWC Solutions website.

The long term ability of this project to observe and monitor a variety of crop and integrated crop/livestock systems under various environmental conditions is now allowing us to provide valuable information on irrigation management and water conservation techniques to producers in the area. The management of the Ogallala water resource is critical to the continued economic success of agriculture in the region. Producers face many technical and climatic challenges. The information we are providing from this project will assist producers in meeting these challenges and allow the region to continue to lead in agricultural production through innovation.

Summaries of results from monitoring producer sites in 2005-2012 (Years 1-8).
Economic assumptions of data collection and interpretation:

1. Although actual depth to water in wells located among the 26 sites varies, a pumping depth of 300 feet is assumed for all irrigation points. The actual depth to water influences costs and energy used to extract water but has nothing to do with the actual functions of the system to which this water is delivered. Thus, a uniform pumping depth is assumed.

2. All input costs and prices received for commodities sold are uniform and representative of the year and the region. Using an individual's actual costs for inputs would reflect the unique opportunities that an individual could have for purchasing in bulk or being unable to take advantage of such economies and would thus represent differences between individuals rather than the system. Likewise, prices received for commodities sold should represent the regional average to eliminate variation due to an individual's marketing skill.

3. Irrigation system costs are unique to the type of irrigation system. Therefore, annual fixed costs were calculated for each type of irrigation system taking into account the average cost of equipment and expected economic life.

4. Variable cost of irrigation across all systems was based on a center pivot system using electricity as the energy source. The estimated cost per acre inch includes the cost of energy, repair and maintenance cost, and labor cost. The primary source of variation in variable cost from year to year is due to changes in the unit cost of energy and repair and maintenance costs.

5. Mechanical tillage operations for each individual site were accounted for with the cost of each field operation being based on typical custom rates for the region. Using custom rates avoids the variations among sites in the types of equipment owned and operated by individuals.

Economic Term Definitions

Gross Income – The total revenue received per acre from the sale of production including insurance indemnity payments.

Variable Costs – Cash expenses for production inputs including interest on operating loans.

Gross Margin – Total revenue less total variable costs.

Fixed Costs – Costs that do not change with a change in production. These costs are incurred regardless of whether or not there was a crop produced. These include land rent charges and investment costs for irrigation equipment.

Net Returns – Gross margin less fixed costs, or total returns above all costs.

Assumptions of energy costs, prices, fixed and variable costs (Tables 18-20)

1. Irrigation costs were based on a center pivot system using electricity as the energy source.

Table 18. Electricity irrigation cost parameters for 2005 through 2012.

Item	2005	2006	2007	2008	2009	2010	2011	2012
Gallons per minute (gpm)	450	450	450	450	450	450	450	450
Pumping lift (feet)	260	250	252	254	256	285	290	300
Discharge Pressure (psi)	15	15	15	15	15	15	15	15
Pump efficiency (%)	60	60	60	60	60	60	60	60
Motor Efficiency (%)	88	88	88	88	88	88	88	88
Electricity Cost per kWh	$0.085	$0.085	$0.090	$0.110	$0.140	$0.081	$0.086	$0.100
Cost of Electricity per Ac. In.	$4.02	$4.26	$5.06	$6.60	$3.78	$4.42	$4.69	$5.37
Cost of Maint. & Repairs per Ac. In.	$2.05	$2.07	$2.13	$2.45	$3.37	$3.49	$4.15	$3.83
Cost of Labor per Ac. In	$0.75	$0.75	$0.80	$0.90	$0.90	$0.90	$0.90	$1.00
Total Cost per Ac. In.	$6.82	$7.08	$7.99	$9.95	$8.05	$8.81	$9.74	$10.20

2. Commodity prices are reflective of the production year; however, prices were constant across sites.

Table 19. Commodity prices for 2005 through 2012.

Commodity	2005	2006	2007	2008	2009	2010	2011	2012
Cotton lint ($/lb)	$0.54	$0.56	$0.58	$0.55	$0.56	$0.75	$0.90	$0.90
Cotton seed ($/ton)	$100	$135	$155	$225	$175	$150	$340	$280
Grain Sorghum – Grain ($/cwt)	$3.85	$6.10	$5.96	$7.90	$6.48	$9.51	$9.75	$13.10
Grain Sorghum – Seed ($/lb)	-	-	-	-	-	-	-	$0.17
Corn – Grain ($/bu)	$2.89	$3.00	$3.69	$5.71	$3.96	$5.64	$5.64	$6.00
Corn – Food ($/bu)	$3.48	$3.55	$4.20	$7.02	$5.00	$4.88	$7.50	$7.50
Barley ($/cwt)	-	-	-	-	-	-	-	$14.08
Wheat – Grain ($/bu)	$2.89	$4.28	$4.28	$7.85	$5.30	$3.71	$5.75	$6.85
Sorghum Silage ($/ton)	$20.19	$18.00	$18.00	$25.00	$24.00	$24.00	$24.00	$24.00
Corn Silage ($/ton)	$20.12	$22.50	$25.00	$25.00	$42.90	$43.50	$43.50	$43.50
Wheat Silage ($/ton)	$18.63	$22.89	$22.89	$29.80	$26.59	$26.59	$26.59	$26.59
Oat Silage ($/ton) -	$17.00	$17.00	-	$14.58	-	-	-	$14.58
Millet Seed ($/lb)	$0.17	$0.17	$0.22	$0.25	-	$0.25	$0.25	$0.25
Sunflowers ($/lb)	$0.21	$0.21	$0.21	$0.29	$0.27	-	-	$0.39
Alfalfa ($/ton)	$130	$150	$150	$160	$160	$185	$350	$350
Hay ($/ton)	$60	$60	$60	$60	$60	-	-	$60
WWB Dahl Hay ($/ton)	$65	$65	$90	$90	-	$60	$200	$200
Hay Grazer ($/ton)	-	$110	$110	$70	$110	$65	$65	$125
Sideoats Seed ($/lb)	-	-	$6.52	$6.52	$3.90	$8.00	$5.70	$5.70
Sideoats Hay ($/ton)	-	-	$64	$64	$70	$60	$220	$220
Triticale Silage ($/ton)	-	-	-	-	-	-	-	$45
Triticale Forage ($/ton)	-	-	-	-	-	-	-	$24

3. Fertilizer and chemical costs (herbicides, insecticides, growth regulators, and harvest aids) are reflective of the production year; however, prices were constant across sites for the product and formulation.

4. Other variable and fixed costs are given for 2005 through 2012 in Table 20.

Table 20. Other variable and fixed costs for 2005 through 2012.

VARIABLE COSTS	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Boll weevil assessment: ($/ac)								
Irrigated cotton	$12.00	$12.00	$12.00	$1.50	$1.00	$1.00	$1.00	$1.00
Dryland cotton	$6.00	$6.00	$6.00	$1.50	$1.00	$1.00	$1.00	$1.00
Crop insurance: ($/ac)								
Irrigated cotton	$17.25	$17.25	$17.25	$20.00	$20.00	$20.00	$30.00	$30.00
Dryland cotton	$12.25	$12.25	$12.25	$12.25	$12.25	$12.25	$20.00	$20.00
Irrigated corn	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00
Irrigated corn silage	-	-	-	-	-	-	-	$11.00
Irrigated Wheat	-	-	-	-	-	-	-	$5.00
Irrigated Sorghum Grain	-	-	-	-	-	-	-	$2.00
Dryland Sorghum Grain	-	-	-	-	-	-	-	$2.00
Irrigated Sorghum Silage	-	-	-	-	-	-	-	$2.00
Irrigated Sunflowers	-	-	-	-	-	-	-	$5.00
Cotton harvest – strip and module ($/lint lb)	$0.08	$0.08	$0.08	$0.08	$0.08	$0.08	$0.08	$0.08
Cotton ginning ($/cwt)	$1.95	$1.75	$1.75	$1.95	$1.95	$1.95	$1.95	$1.95
Bags, Ties, & Classing ($/bale)	$17.50	$19.30	$17.50	$18.50	$18.50	$18.50	$18.50	$18.50
FIXED COSTS	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Irrigation system:								
Center Pivot system	$33.60	$33.60	$33.60	$33.60	$33.60	$40.00	$40.00	$40.00
Drip system	$75.00	$75.00	$75.00	$75.00	$75.00	$75.00	$75.00	$75.00
Flood system	$25.00	$25.00	$25.00	$25.00	$25.00	$25.00	$25.00	$25.00
Cash rent:								
Irrigated cotton, grain sorghum, sun-flowers, grass, pearl millet, and sorghum silage.	$45.00	$45.00	$45.00	$75.00	$75.00	$100.00	$100.00	$100.00
Irrigated corn silage, corn grain, and alfalfa.	$75.00	$75.00	$75.00	$100.00	$100.00	$140.00	$140.00	$140.00
Dryland cropland	$15.00	$15.00	$15.00	$25.00	$25.00	$30.00	$30.00	$30.00

5. The custom tillage and harvest rates used for 2005 were based on rates reported in USDA-NASS, 2004 Texas Custom Rates Statistics, Bulletin 263, September 2005. The custom rates used for 2006 were 115% of the reported 2004 rates to reflect increased cost of operation due to rising fuel prices and other costs while 2007 rates were 120% of the 2006 rates. 2008 rates were calculated at 125% of 2007 due to a 25% rise in fuel prices. 2009 rates were unchanged from 2008, as fuel prices stabilized. 2010 rates were estimated based on the most recent survey from Texas A&M AgriLife Extension. 2011 rates were increased approximately 39% from 2010 rates to adjust for increased fuel expenses of 26% and increased expenses for repairs and maintenance. 2012 rates were unchanged from 2011.

Table 21. Summary of results from monitoring 26 producer sites during 2005 (Year 1).

System	Site no.	Acres	Irrigation type[1]	System inches	Net return $/system acre	Net return $/inch water
Monoculture systems						
Cotton	1	61	SDI	11.7	84.02	7.19
Cotton	2	68	SDI	8.9	186.94	21
Cotton	14	125	CP	6.8	120.9	17.91
Cotton	16	145	CP	7.6	123.68	16.38
Cotton	21	123	CP	6.8	122.51	18.15
Cotton	11	95	Fur	9.2	4.39	0.48
Cotton	15	98	Fur	4.6	62.65	13.62
Multi-crop systems						
Cotton/grain sorghum	3	125	CP	8.3	37.79	4.66
Cotton/grain sorghum	18	120	CP	5.9	16.75	2.84
Cotton/grain sorghum	25	179	DL	0	67.58	na
Cotton/forage sorghum	12	250	DL	0	36	na
Cotton/pearlmillet	19	120	CP	9.5	186.97	19.12
Cotton/corn	22	148	CP	15.3	166.63	10.9
Cotton/corn	24	129	CP	14.7	149.87	9.96
Cotton/corn	26	123	CP	10.5	192.44	18.34
Cotton/sunflowers	23	110	CP	5.4	270.62	47.07
Cotton/alfalfa	4	123	CP	5.5	110.44	19.06
Cotton/wheat	13	315	DL	0	47.37	na
Cotton/corn silage/grass	17	223	CP	10.5	188.44	17.91
Corn/wheat/sorghum silages	20	220	CP	21.5	-48.6	-2.16
Crop-Livestock systems						
Cotton/wheat/stocker cattle	6	123	CP	11.4	162.63	9.04
Cotton/grass/stocker cattle	9	237	CP	6.5	298.14	46.17
Cotton/grass/cattle	10	175	CP	8.5	187.72	22.06
Forage/beef cow-calf	5	630	CP	1.23	125.89	93.34
Forage/Grass seed	7	61	SDI	9.8	425.32	37.81
Forage/Grass seed	8	130	CP	11.3	346.9	35.56

[1] SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

Table 22. Summary of results from monitoring 26 producer sites during 2006 (Year 2).

System	Site no.	Acres	Irrigation type[1]	System inches	Net return $/system acre	Net return $/inch water	Gross margin per inch irrigation
Monoculture systems							
Cotton	1	135	SDI	21	225.9	10.76	15.77
Cotton	2	61	SDI	19	308.71	16.25	22.56
Cotton	27	46	SDI	18	417.99	23.22	29.89
Cotton	3	123	CP	10	105.79	10.58	18.44
Cotton	6	123	CP	13.6	321.79	23.64	29.42
Cotton	14	124	CP	6.2	44.81	7.2	19.84
Cotton	16	143	CP	12.2	71.08	5.81	8.43
Cotton	11	93	Fur	16.9	88.18	5.22	9.37
Multi-crop systems							
Cotton/grain sorghum	15	96	Fur	11.2	161.89	14.51	20.78
Cotton/forage sorghum	12	284	DL	0	-13.72	na	na
Cotton/forage sorghum/oats	18	122	CP	12	-32.31	-2.69	3.86
Cotton/pearlmillet	19	120	CP	9.8	95.28	9.77	17.83
Cotton/corn	22	149	CP	22	285.98	12.98	16.55
Cotton/corn	24	130	CP	19.4	68.17	3.51	8.34
Cotton/corn	26	123	CP	16	243.32	15.22	21.08
Cotton/corn	23	105	CP	14.8	127.39	8.59	13.9
Cotton/alfalfa/wheat/ forage sorghum	4	123	CP	26.7	312.33	11.69	14.75
Cotton/wheat	13	320	DL	0	-33.56	na	na
Corn/triticale/sorghum silages	20	233	CP	21.9	242.79	10.49	15.17
Crop-Livestock systems							
Cotton/stocker cattle	21	123	CP	16.4	94.94	5.79	10.22
Cotton/grass/stocker cattle	9	237	CP	10.6	63.29	6.26	13.87
Cotton/corn silage/wheat/cattle	17	221	CP	13	242.21	14.89	20.64
Forage/beef cow-calf	5	628	CP	9.6	150.46	15.62	22.31
Forage/beef cow-calf	10	174	CP	16.1	217.71	13.52	18.4
Forage/Grass seed	7	130	CP	7.8	687.36	88.69	98.83
Forage/Grass seed	8	62	SDI	10.1	376.36	48.56	64.05

[1] SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

Table 23. Summary of results from monitoring 26 producer sites during 2007 (Year 3).

System	Site no.	Acres	Irrigation type[1]	System inches	Net return $/system acre	Net return $/inch water	Gross margin per inch irrigation
Monoculture systems							
Cotton	1	135	SDI	14.60	162.40	11.12	19.34
Cotton	2	61	SDI	12.94	511.33	39.52	48.79
Cotton	6	123	CP	10.86	605.78	55.78	63.02
Cotton	11	93	Fur	14.67	163.58	11.15	15.92
Cotton	14	124	CP	8.63	217.38	25.19	34.30
Cotton	22	149	CP	11.86	551.33	46.49	53.11
Corn	23	105	CP	10.89	325.69	29.91	37.12
Corn	24	130	CP	15.34	373.92	24.38	31.46
Perennial grass: seed and hay	7	130	CP	13.39	392.59	29.32	35.19
Perennial grass: seed and hay	8	62	SDI	15.67	292.63	18.67	26.33
Multi-crop systems							
Cotton/grain sorghum/wheat	3	123	CP	13.25	190.53	14.38	20.31
Cotton/grain sorghum	12	284	DL	0.00	265.71	Dryland	Dryland
Cotton/wheat	13	320	DL	0.00	105.79	Dryland	Dryland
Cotton/grain sorghum	15	96	Fur	10.50	191.68	18.26	24.92
Grain sorghum/wheat	18	122	CP	5.34	13.91	2.60	13.62
Cotton/pearlmillet	19	121	CP	7.57	318.61	42.10	52.49
Corn/sorghum/triticale silages	20	233	CP	24.27	371.14	15.29	19.76
Corn/perr. grass: seed and hay	21	123	CP	8.35	231.60	27.75	37.16
Corn silage	27	62	SDI	13.00	194.40	14.95	24.18
Crop-Livestock systems							
Wheat: cow-calf, grain/cotton/alfalfa hay	4	123	CP	8.18	183.72	22.47	33.30
Perennial grass: cow-calf, hay	5	628	CP	3.56	193.81	54.38	72.45
Perrenial grass, rye: stocker cattle/grain sorghum	9	237	CP	4.19	48.89	11.65	30.00
Perennial grass: cow-calf, hay/corn silage	10	174	CP	6.80	27.84	4.09	14.74
Perennial grass: cow-calf, seed, hay/cotton/wheat for grazing	17	221	CP	8.31	181.48	21.83	33.06
Pearlmillet: seed, grazing/corn	26	123	CP	11.34	378.61	33.39	41.65

[1] SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

Table 24. Summary of results from monitoring 25 producer sites during 2008 (Year 4).

System	Site no.	Acres	Irrigation type[1]	System inches	Net return $/system acre	Net return $/inch water	Gross margin per inch irrigation
Monoculture Systems							
Sunflowers	2	60.9	SDI	6.89	147.83	21.46	43.23
Perennial grass: seed and hay	7	130.0	CP	9.88	295.43	29.90	40.89
Perennial grass: seed and hay	8	61.8	SDI	6.65	314.74	47.33	69.89
Cotton	14	124.2	CP	8.97	-2.12	-0.24	11.87
Corn	22	148.7	CP	24.75	720.10	29.09	34.49
Corn	24	129.8	CP	24.70	513.54	20.79	26.20
Corn	28	51.5	SDI	8.20	591.15	72.09	93.43
Multi-crop systems							
Cotton/Wheat/Grain sorghum	3	123.3	CP	14.75	53.79	3.65	11.01
Cotton/Corn	6	122.9	CP	17.35	411.02	23.68	29.94
Cotton/Grain sorghum	11	92.5	Fur	10.86	176.14	16.22	25.43
Sorghum silage/fallow wheat	12	283.9	DL	0.00	-17.89	Dryland	Dryland
Cotton/Wheat	15	95.5	Fur/SDI	11.22	132.15	11.78	21.57
Cotton/Wheat silage/Grain sorghum hay & silage	18	122.2	CP	10.67	186.42	17.47	27.64
Cotton/Seed millet	19	120.4	CP	7.01	121.40	17.33	32.83
Wheat grain/Grain sorghum grain & silage/hay	20	233.4	CP	27.61	513.56	18.60	22.54
Barley seed/forage sorghum hay/perr. Grass: seed & hay	21	122.7	CP	10.13	387.20	38.24	48.96
Cotton/Sunflowers	23	105.1	CP	14.93	-50.54	-3.38	4.60
Cotton/Corn grain	27	108.5	SDI	20.69	291.15	14.07	22.01
Cotton/Wheat/fallow	29	221.6	DL	0.00	34.06	Dryland	Dryland
Crop-Livestock systems							
Wheat: cow-calf, grain/cotton/alfalfa hay	4	123.1	CP	14.51	154.85	10.68	17.00
Perennial grass: cow-calf, hay	5	628	CP	4.02	107.14	26.65	49.02
Perennial Grass: stocker cattle/Cotton	9	237.8	CP	7.26	11.63	1.60	16.25
Perennial grass: cow-calf, hay/Grass seed/Corn	10	173.6	CP	14.67	64.80	4.42	0.00
Perennial grass: cow-calf, seed, hay/cotton/wheat for grazing	17	220.8	CP	15.00	309.34	20.62	28.68
Pearlmillet: seed, Grain sorghum/Corn: grazing, hay	26	125.2	CP	14.65	279.69	19.09	27.36

[1] SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

Table 25. Summary of results from monitoring 26 producer sites during 2009 (Year 5).

System	Site no.	Acres	Irrigation type[1]	System inches	Net return $/system acre	Net return $/inch water	Gross margin per inch irrigation
Monoculture Systems							
Cotton	2	60.9	SDI	10.50	-52.29	-4.98	9.31
Perennial grass: seed and hay	7	129.9	CP	15.70	597.23	38.04	44.96
Perennial grass: seed and hay	8	61.8	SDI	13.80	365.46	26.48	37.35
Cotton	15	102.8	Fur/SDI	12.96	72.15	5.57	12.39
Cotton	22	148.7	CP	14.73	56.35	3.83	11.20
Cotton	28	51.5	SDI	10.89	187.72	17.24	31.01
Sunflower	30	21.8	SDI	9.25	8.13	0.88	17.10
Multi-crop systems							
Cotton/Grain Sorghum	3	123.3	CP	5.89	158.51	26.91	45.35
Cotton/Corn	6	122.9	CP	10.43	182.14	17.52	28.49
Cotton/Rye	9	237.8	CP	3.17	-11.71	-3.69	30.52
Cotton/Grain Sorghum	11	92.5	Fur	13.24	53.67	4.05	11.60
Sorghum silage/Wheat	12	283.9	DL	0.00	-8.81	Dryland	Dryland
Wheat grain/Cotton	14	124.2	CP	10.57	37.15	3.52	13.79
Wheat grain/Cotton	18	122.2	CP	3.53	44.88	12.71	43.47
Wheat grain/Cotton	19	120.3	CP	5.26	-4.88	-0.93	19.71
Corn silage/Cotton	20	233.3	CP	23.75	552.08	23.25	28.35
Wheat grain/Hay/perennial grass	21	122.6	CP	17.75	79.79	4.50	10.61
Oats/Wheat/Sorghum – all silage	23	105.2	CP	15.67	53.80	3.43	10.36
Corn/Sunflower	24	129.7	CP	13.09	172.53	13.18	22.42
Corn/Cotton	27	108.5	SDI	23.00	218.72	9.51	16.63
Wheat grain/Cotton	29	221.6	DL	0.00	73.79	Dryland	Dryland
Crop-Livestock systems							
Wheat/haygrazer; contract grazing, grain sorghum/cotton/alfalfa hay	4	123.1	CP	9.03	119.85	13.28	25.67
Perennial grass: cow-calf, hay	5	626.4	CP	6.60	53.76	8.15	21.79
Perennial grass: contract grazing, /Cotton	10	173.6	CP	6.04	-83.25	-13.79	4.20
Perennial grass: contract grazing, /sunflower/dahl for seed and grazing	17	220.8	CP	7.09	71.37	10.07	25.39
Corn/Sunflower, contract grazing	26	125.2	CP	14.99	316.22	21.09	29.16

[1]SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

Table 26. Summary of results from monitoring 26 producer sites during 2010 (Year 6).

System	Site no.	Acres	Irrigation type[1]	System inches	Net return $/system acre	Net return $/inch water	Gross margin per inch irrigation
Monoculture systems							
Corn	2	60.9	SDI	14.04	107.81	7.68	22.99
Perennial grass: seed and hay	7	130	CP	2.37	460.56	194.33	253.40
Perennial grass: seed and hay	8	61.8	SDI	3.25	498.82	153.48	207.33
Cotton	15	102.8	Fur/SDI	3.98	489.46	122.85	166.77
Corn	22	148.7	CP	16.10	370.88	23.04	34.22
Corn	24	129.7	CP	17.90	271.50	15.17	25.22
Cotton	28	51.5	SDI	6.24	298.35	47.81	75.86
Corn	30	21.8	SDI	11.90	563.63	47.36	65.43
Multi-crop systems							
Cotton/Grain Sorghum/Wheat	3	123.3	CP	9.15	191.55	20.93	38.10
Alfalfa/Cotton/Wheat/Hay	4	123	CP	11.11	365.89	32.92	45.99
Cotton/Corn	6	122.8	CP	9.88	323.38	32.72	48.88
Cotton/Grain Sorghum	11	92.5	Fur	4.41	6,9,10	38.93	67.25
	12	283.9	DL	0.00	0.00	Dryland	Dryland
Wheat grain/Cotton	14	124.2	CP	4.30	73.13	17.02	49.59
Wheat grain/Cotton	18	122.2	CP	1.11	78.24	70.66	197.11
Wheat grain/Cotton	19	120.3	CP	4.31	134.55	31.21	63.69
Corn/Trit Silage/Cotton	20	233.4	CP	16.69	817.74	49.01	59.80
Cotton/Corn	21	122.6	CP	10.45	246.09	23.54	38.85
Trit/Corn Silage	23	121.1	CP	20.70	-7.64	-0.37	8.33
Corn Silage/Cotton	27	108.5	SDI	14.70	565.29	38.46	51.59
Grain Sorghum/Cotton	29	221.6	DL	0.00	235.29	Dryland	Dryland
Crop-Livestock systems							
Perennial grass: cow-calf, Hay	5	628	CP	5.15	44.47	8.63	31.08
Perennial grass: contract grazing, /Cotton	9	237.8	CP	2.19	129.12	58.98	122.93
Perennial grass: contract grazing, /Corn	10	173.6	CP	12.00	140.43	25.32	57.36
Perennial grass: contract grazing, /Corn	17	220.8	CP	8.94	6.82	0.76	18.62
Wheat/Cotton/Corn, contract grazing	26	125.2	CP	10.73	416.76	38.85	53.75

[1] SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

Table 27. Summary of results from monitoring 29 producer sites during 2011 (Year 7).

System	**Site no.**	**Acres**	**Irrigation type[1]**	**System inches**	**Net return $/system acre**	**Net return $/inch water**	**Gross margin per inch irrigation**
Monoculture systems							
Cotton	2	60.9	SDI	16.61	122.37	7.37	17.90
Cotton	3	123.3	CP/MESA	9.30	-102.89	-11.07	3.99
Perennial grass: seed and hay	7	130	CP/LESA	20.50	370.64	18.08	24.91
Perennial grass: seed and hay	8	61.8	SDI	20.04	93.50	4.67	13.40
Cotton	12	283.9	DL	0.00	230.29	Dryland	Dryland
Cotton	14	124.2	CP/MESA	17.80	-226.26	-12.71	-4.85
Cotton	19	120.3	CP/LEPA	19.90	141.92	7.13	14.17
Cotton	22	148.7	CP/LEPA	25.20	538.44	21.37	26.92
Cotton	28	51.5	SDI	18.80	319.90	17.02	26.32
Cotton	29	221.6	DL	0.00	194.89	Dryland	Dryland
Fallow	30	21.8	SDI	0.00	-215.00	Fallow	Fallow
Corn	32	70	CP/LEPA	37.00	-866.35	-23.41	-18.55
Corn	33	70	CP/LEPA	12.00	-67.05	-5.59	9.41
Multi-crop systems							
Alfalfa/Cotton/Wheat /Haygrazer	4	123	CP/LEPA	25.32	519.67	20.53	26.26
Cotton/fallow	5	487.6	CP/LESA	3.71	162.53	43.82	81.56
Cotton/Corn	6	122.8	CP/LESA	18.94	179.82	9.49	17.40
Cotton/Grain Sorghum	11	92.5	Fur	27.80	-81.18	-2.92	1.58
Corn/Cotton	15	102.8	SDI	19.31	346.96	17.97	27.95
Wheat grain/Cotton	18	122.2	CP/MESA	0.93	31.02	33.35	183.89
Corn/Triticale Silage/Cotton	20	233.4	CP/LEPA	52.08	250.23	4.80	8.26
Cotton/Corn	21	122.6	CP/LEPA	17.91	157.78	8.81	17.75
Triticale/Corn Silage	23	121.1	CP/LESA	33.85	112.64	3.33	8.65
Corn grain/Cotton	24	129.7	CP/LESA	26.54	537.36	20.25	26.27
Corn/Cotton	26	125.2	CP/LESA	16.57	433.62	26.16	35.81
Corn Silage/Cotton	27	108.5	SDI	38.20	229.80	6.02	11.17
Cotton/Seed millet	31	121	CP/LEPA	27.90	12.26	0.44	5.46
Crop-Livestock systems							
Perennial grass: contract grazing, /Cotton	9	237.8	CP/MESA	8.45	72.39	8.56	25.12
Perennial grass: contract grazing, /Cotton	10	173.6	CP/LESA	30.02	592.02	19.72	24.38
Perennial grass: contract grazing, /Cotton	17	220.8	CP/MESA	22.00	116.96	5.32	11.68

[1] SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

Table 28. Summary of results from monitoring 29 producer sites during 2012 (Year 8).

System	**Site no.**	**Acres**	**Irrigation type[1]**	**System inches**	**Net return $/system acre**	**Net return $/inch water**	**Gross margin per inch irrigation**
Monoculture systems							
Cotton	3	123.3	CP/MESA	8.40	822.71	97.93	114.60
Cotton/fallow	5	484.1	CP/LESA	10.53	-55.06	-5.23	5.71
Corn grain/fallow	6	122.7	CP/LESA	17.29	-76.28	-4.41	2.52
Perennial grass: seed and hay	7	130	CP/LESA	20.60	696.38	33.80	40.60
Perennial grass: seed and hay	8	61.8	SDI	17.30	712.46	41.18	51.30
Cotton (No Data)	12	283.8	DL	0.00	0.00	Dryland	Dryland
Cotton/fallow	19	120.4	CP/LEPA	7.33	177.03	24.16	40.50
Cotton	22	148.7	CP/LEPA	19.50	918.83	47.12	54.30
Cotton	30	21.8	SDI	13.60	-53.60	-3.94	8.93
Corn grain	33	70	CP/LEPA	18.70	-298.65	-15.97	-6.34
Multi-crop systems							
Cotton/Corn grain	2	60	SDI	12.06	545.42	45.23	61.73
Alfalfa/Cotton/Wheat/ Seed Sorghum	4	123	CP/LEPA	15.54	320.03	20.59	26.24
Cotton (failed)/Grain Sorghum	11	92.5	Fur	12.00	463.87	38.66	49.07
Cotton/Wheat	14	124.1	CP/MESA	6.51	-99.71	-15.31	6.19
Cotton (failed)/Grain Sorghum	15	101.1	SDI	27.43	591.80	21.57	27.95
Perennial grass: contract grazing, /Cotton/Corn g.	17	220.7	CP/MESA	17.40	890.46	51.18	59.23
Wheat/Cotton (No Data)	18	122.2	CP/MESA	0.00	0.00	0.00	0.00
Corn/Trit Silage/Cotton	20	233.3	CP/LEPA	29.53	609.85	20.66	26.08
Wheat/Haygrazer/Cotton	21	122.6	CP/LEPA	19.41	542.88	27.97	35.19
Corn grain/Cotton	24	129.7	CP/LESA	19.94	788.27	39.53	47.55
Sunflowers/Cotton	26	125.1	CP/LESA	14.95	235.53	15.75	25.12
Corn Silage/Cotton	27	108.4	SDI	16.98	953.77	56.17	66.40
Cotton (hail)/Corn grain	28	51.5	SDI	19.6	-138.03	-7.04	1.89
Cotton/Grain Sorghum	29	221.6	DL	0.00	9.39	Dryland	Dryland
Cotton/Seed millet	31	121.9	CP/LEPA	20.36	167.05	8.21	15.08
Cotton (hail)/Corn grain	32	70	CP/LEPA	21.50	194.39	9.04	17.41
Cotton (hail)/Corn grain	34	726.6	CP/LESA	10.00	358.39	35.84	51.84
Crop-Livestock systems							
Perennial grass: contract grazing, /Cotton	9	237.8	CP/MESA	11.46	391.18	34.14	46.35
Perennial grass: contract grazing, /Cotton	10	173.6	CP/LESA	23.02	29.08	1.26	8.22

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[1] SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

Table 29. Overall summary of crop production, irrigation, and economic returns within all production sites in Hale and Floyd Counties during 2005-2012.

Item		2005	2006	2007	2008	2009	2010	2011	2012	Crop year Average
Mean Yields, per acre (only includes sites producing these crops, includes dryland) {Yield averages across harvested fields within sites}										
Cotton										
	Lint, lbs	1,117 (22) [1]	1,379 (20)	1,518 (13)	1,265 (11)	1,223 (16)	1,261 (15)	1166 (19)	1299 (16)	1,278.50
	Seed, tons	0.80 (22)	0.95 (20)	1.02 (13)	0.86 (11)	0.81 (16)	0.83 (15)	0.77 (19)	0.92 (16)	0.87
Corn										
	Grain, lbs	12,729 (3)	8,814 (4)	12,229 (4)	10,829 (8)	12,613 (4)	12,685 (10)	6,766 (4)	7475 (7)	10,517.50
	Silage, tons	30.9 (2)	28.3 (3)	27.3 (3)	-	38.3 (1)	31 (2)	20.5 (3)	6.3 (4)	26.09
Sorghum										
	Grain, lbs	4,147 (3)	2,987 (1)	6,459 (4)	6,345 (5)	6,907 (3)	4,556 (3)	1,196 (1)	6358 (2)	4,869.38
	Silage, tons	26.0 (1)	20.4 (2)	25.0 (1)	11.3 (2)	9.975 (2)	-	-	-	18.54
	Seed, lbs	-	-	-	3507 (1)	-	-	-	3396 (1)	3,438.00
Wheat										
	Grain, lbs	2,034 (1)	-	2,613 (5)	4,182 (5)	2,061 (6)	2,860 (6)	3,060 (1)	2052 (3)	2,694.57
	Silage, tons	16.1 (1)	7.0 (1)	-	7.5 (1)	3.71 (1)	-	-	-	8.58
	Hay, tons	-	-	-	-	2.5 (1)	-	-	-	2.50
Oat										
	Silage, tons	-	4.9 (1)	-	-	12.5 (1)	-	-	-	8.70
	Hay, tons	-	1.8 (1)	-	-	-	-	-	-	1.80
Barley										
	Grain, lbs	-	-	-	3,133 (1)	-	-	-	-	3,133.00
	Hay, tons	-	-	-	5.5 (1)	-	-	-	-	5.50
Triticale										
	Hay, tons	-	-	-	-	-	-	3(1)	-	3.00
	Silage, tons	-	21.3 (1)	17.5 (1)	-	-	13 (2)	2.5(2)	12 (1)	13.26
Sunflower										
	Seed, lbs	-	-	-	1,916 (2)	2,274 (4)	-	-	1903 (1)	2,031.00
Pearl millet for seed										
	Seed, lbs	3,876 (1)	2,488 (1)	4,002 (2)	2,097 (2)	-	-	1,800(1)	2014 (1)	2,712.83
Perennial forage										
Dahl										
	Seed, PLS lbs	-	-	-	30 (1)	83.14 (1)	-	-	62.8 (1)	58.65
	Hay, tons	-	-	-	2.5 (1)	-	-	-	-	2.50
SideOats										
	Seed, PLS lbs	313 (2)	268 (2)	183.5 (3)	192.9 (3)	362 (3)	212.5 (2)	200.75 (2)	267 (2)	249.96
	Hay, tons	3.6 (2)	2.1 (2)	1.46 (3)	1.66 (3)	1.83 (3)	1.1 (2)	0.5 (2)	1.9 (2)	1.77
Other										
	Hay, tons	-	-	-	0.11 (1)	4.3 (1)	2.4 (1)	-	-	2.27
Alfalfa										
	Hay, tons	8.3 (1)	9.18 (1)	4.90 (1)	12.0 (1)	9.95 (1)	9.0 (1)	10.6 (1)	8.4 (1)	9.04
Annual forage										
Forage Sorghum										
	Hay, tons	-	-	-	-	-	-	6.8 (1)	1.9 (2)	4.35
Precipitation, inches (including all sites)		15.0	15.4	27.3	21.7	15.7	28.9	5.3	10.0	17.40
Irrigation applied, inches (not including dryland)										
By System										
Total irrigation water (system average)		9.2 (26)	14.8 (26)	11.0 (25)	13.3 (23)	11.5 (24)	9.2 (24)	20.99 (27)	16.6 (26)	13.32
By Crop (Primary Crop)										
Cotton		8.7 (19)	14.3 (19)	11.3 (11)	12.2 (10)	12.5 (15)	7.4 (15)	23.2 (19)	14.8 (16)	13.05
Corn grain		17.4 (3)	21.0 (4)	12.5 (4)	21.7 (8)	19.2 (4)	12.8 (10)	27.1 (4)	22.1 (7)	19.23
Corn silage		18.0 (2)	24.0 (3)	12.6 (3)	-	24.3 (1)	18 (2)	34.7 (3)	22.5 (4)	22.01
Sorghum grain		7.5 (1)	4.2(1)	6.6 (4)	13.8 (5)	9.4 (3)	6.13(2)	27.8 (1)	19.7 (2)	11.70
Sorghum silage		15.0 (1)	12.5 (2)	13.5 (1)	11.5 (1)	15.7 (1)	-	-	-	13.64
Wheat grain		-	-	5.3 (3)	7.68 (4)	5.7 (5)	2.6 (6)	11.3 (1)	4.7 (3)	6.21
Wheat silage		7.5 (1)	16.3 (1)	-	5.5 (1)	15.7 (1)	-	-	-	11.25
Oat silage		-	4.3 (1)	-	-	15.7 (1)	-	-	-	10.00
Oat hay		-	4.9 (1)	-	-	-	-	-	-	4.90
Triticale silage		-	10.0 (1)	12.9 (1)	-	-	6.9 (2)	17.8 (2)	19.6 (1)	13.44
Barley grain		-	-	-	12.8 (1)	-	-	-	-	12.80
Small Grain (grazing)		0.5 (3)	0.8 (2)	0.8 (3)	-	-	-	-	-	0.70
Small Grain (grains)		-	-	5.3 (3)	8.7 (5)	5.7 (5)	2.6 (6)	11.3 (1)	4.7 (3)	6.38
Small Grain (silage)		7.5 (1)	10.2 (3)	12.9 (1)	5.5 (1)	15.7 (2)	6.9 (2)	17.8 (2)	19.6 (1)	12.01
Small Grain (hay)		-	4.9 (1)	-	-	-	-	-	-	4.90
Small Grain (all uses)		5.2 (5)	7.3 (10)	7.4(11)	8.2 (6)	8.6 (7)	3.7 (8)	15.6 (3)	8.4 (4)	8.00
Sunflower seed		-	-	-	9.6 (2)	8.9 (4)	-	-	15.1 (1)	11.20
Millet seed		-	-	-	9.6 (2)	-	-	29.4 (1)	22.0 (1)	20.33
Dahl										
hay		-	-	-	4.65 (1)	-	-	-	-	4.65
seed					9.4 (1)	8.9 (1)	-	-	8.2 (1)	8.83
grazing						4.1 (1)	4.6 (3)	8.9 (2)	22.7 (1)	10.08
Sideoats										
seed		-	-	-	8.0 (3)	15.3 (3)	2.8 (2)	20.3 (2)	18.9 (2)	13.06
Bermuda										
grazing		-	-	-	6.2 (1)	5.3 (1)	0 (1)	17.1 (1)	12.0 (1)	8.12
Other Perennials/Annuals										
hay		-	-	-	4.02 (1)	-	8.5 (1)	-	13.9 (2)	8.81
grazing		-	-	-	5.5 (1)	6.6 (1)	5.1 (1)	-	-	5.73
Perennial grasses (grouped)										
Seed		-	-	-	8.35 (4)	13.7 (4)	2.8 (2)	-	8.2 (1)	8.26
Grazing		-	-	-	5.85 (2)	5.3 (3)	3.8 (5)	11.6 (3)	10.8 (1)	7.47
Hay		-	-	-	4.33(2)	-	-	-	13.9 (2)	9.12
All Uses		6.5 (6)	8.8 (6)	7.1 (7)	6.7 (8)	10.1 (7)	3.5 (7)	11.6 (3)	11.7 (2)	8.25
Alfalfa		10.3 (1)	34.5 (1)	10.6 (1)	15.6 (1)	18.6 (1)	15.6 (1)	44.1 (1)	28.3 (1)	22.20
Income and Expense, $/system acre										
Projected returns		660.53	773.82	840.02	890.37	745.82	961.87	951.66	1063.98	861.01
Costs										
	Total variable costs (all sites)	444.88	504.91	498.48	548.53	507.69	537.14	677.42	578.28	537.17
	Total fixed costs (all sites)	77.57	81.81	81.77	111.98	110.65	153.55	149.98	135.53	109.61
	Total all costs (all sites)	522.45	586.72	580.25	660.51	618.34	690.69	827.40	713.80	650.02
Gross margin										
	Per system acre (all sites)	215.66	268.91	341.54	341.84	238.13	424.74	295.10	469.92	324.48
	Per acre inch irrigation water (irrigated only)	33.51	22.53	34.01	31.17	22.95	71.51	24.20	32.73	34.08
Net returns over all costs										
	Per system acre (all sites)	138.09	187.10	259.77	229.86	127.48	271.19	145.11	334.39	211.62
	Per acre inch of irrigation water (irrigated only)	21.58	15.88	24.99	20.89	9.99	43.71	9.60	22.89	21.19
	Per pound of nitrogen (all sites)	1.62	0.81	2.34	1.48	0.87	2.40	1.82	2.51	1.73

[1] Numbers in parenthesis refer to the number of sites in the mean.

REPORTS BY SPECIFIC TASK

TASK 2: Administration and Support
Annual Report ending February 28, 2013

2.1: Project Director: Rick Kellison. Project Administrator: Chuck West (TTU)

Although 2012 was well below average precipitation for our region, it was better than the 2011 growing season. After learning from weather events in 2011, producers adjusted their irrigated acres and crop mixes for 2012. Some of the TAWC sites did receive rain and hail on June 4, and most of the cotton acres affected were replanted to grain sorghum. By the fall, some perennial pastures had recovered, but were still a long way from full recovery.

On March 23, Jeff Pate and Rick Kellison were invited to make TAWC presentations to the New Mexico Ag Bankers Conference in Ruidoso. The 45 agricultural lenders in attendance were very interested in the TAWC tools to aid producers in planning and managing various cropping systems.

On April 2, TAWC management team members had their first meeting with Dr. Bill Robertson with the National Cotton Council. Dr. Robertson requested our cooperation in a pilot project to test the Keystone Alliance field print calculator. We are the second group nation-wide to be asked to be involved in this project. This web-based tool allows producers to evaluate and rank their production practices based on their sustainability. The objective is to test the tool and develop a method where producers might be able to receive a premium for commodities grown in a more sustainable manner. Of course, the most limiting factor to sustainable agricultural production in this region of Texas is the efficient and effective use of water. On December 10, 2012, we held a conference call to discuss how Keystone might include water conservation into their formula.

On April 16, Pate and Kellison held a TAWC tools training for a group of Texas A&M AgriLife county extension agents at the experiment station in Lubbock. This meeting was held to help agents understand how these tools could aid producers with crop systems pre-planning and in-season irrigation scheduling. We believe this was an excellent opportunity to extend the outreach of the TAWC demonstration project. These agents will have access to all site technology information through the growing season.

On May 11, Comer Tuck, of the Texas Water Development Board, met with Phil Brown and Rick Kellison to review the TAWC annual report. After completing the meeting, Comer and Kellison drove to the demonstration area to tour some of the project sites.

Linda Lind, with the Secretary of State's office, and a group of foreign journalists toured some of the TAWC sites on May 17. This group was very interested in how we were attempting to aid producers in these drought conditions. They had an opportunity to interview three of our producers.

During the first quarter Pate and Kellison met several times with various John Deere employees. John Deere is introducing a new type of soil moisture probe to aid producers with soil moisture monitoring and irrigation scheduling. We installed four of these probes in the TAWC project sites in 2012.

June 19, 20, and 21, Kellison made TAWC tools presentations. These producer meetings were held in Lorenzo, Littlefield, and Plainview with good attendance by area growers. Presentations were also made by Dr. Calvin Trostle, and representatives from John Deere Water, AquaSpy, and Smartfield. June 21, Kellison met with three representatives from Monsanto to discuss future cooperation on irrigation scheduling tools.

July 10, Kellison hosted Dr. Justin Weinheimer, with United Sorghum Checkoff, to view and meet with producers growing grain sorghum in the TAWC project. Kellison attended a meeting announcing future grant opportunities with the State of Texas Emerging Technology Funds. July 11 Kellison attended the first Texas Tech University campus-wide Water Summit.

Dr. Phil Johnson and Kellison made TAWC presentations to the Texas Agricultural Cooperative Council on July 12, with approximately one hundred attendees. The audience was comprosed of coop managers, agricultural lenders and Texas A&M AgriLife Extension personnel. Also on July 12, Kellison made a TAWC presentation to the Texas Independent Ginners Association Conference.

July 9, TAWC held its annual summer field day at the Ollie Liner Center in Plainview. There were approximately 65 in attendance at this field day. We visited two producers sites; Glen Schur and Scott Horne. Both producers made in-field presentations on their water management practices for the 2012 growing season. The Honorable Pete Laney (former Speaker of State House of Representatives) was the keynote speaker for the field day.

On September 3, TAWC hosted an appreciation cookout for all TAWC cooperators, their families, and the TAWC management team. The cookout was held at Ronnie Aston's seed barn south of Lockney. It appeared that a good time was had by all attending. The College of Agriculture at Texas Tech sponsored this event and we'll have a similar event in 2013.

The United Sorghum Checkoff launched its first class of a new program called Leadership Sorghum in September, 2012. Fifteen sorghum producers from eight states were selected for Leadership Sorghum Class 1. The program's first session was held September 4-6 in the Texas Panhandle introducing Class 1 to the sorghum seed industry and public research. An estimated 90% of all grain sorghum seed production comes from this region. On September 5, Kellison made a presentation about the TAWC project to Class1 at the ARS Lab in Lubbock.

On October 24, Kellison made a presentation to the Texas Agricultural Lifetime Leadership group (TALL). The TALL program is sponsored by Texas A & M University and comprises

25 outstanding young men and women from all across Texas. Each class will be involved in the TALL program for two years.

Beginning in October the TAWC management team has met at least twice monthly. The objective of these meetings was to develop an executive summary of the TAWC demonstration project from its inception to date. Each task leader has taken specific areas of the summary to complete. The summary will include such things as accomplishments of the project, water saved, economic drought impact, changes in available water, and future direction of the project. We plan to have this summary completed in early 2013.

On November 25 and 28, Kellison attended the Amarillo Farm Show and helped man the TAWC booth. While at the farm show on the 28th, TAWC received the Blue Legacy Award from the Texas Water Conservation Advisory Council and several of our management team were in attendance.

On December 17, Todd Carpenter, with Syngenta, and Kellison met in Lubbock. Syngenta is interested in incorporating the TAWC tools to aid producers in planning their cropping systems and in-season irrigation scheduling. Syngenta will have a pilot project in 2013 working with producers to test their new dashboard. There is a possibility that TAWC will be involved in this project.

Kellison spent much of January working on details for the TAWC annual winter field day, which was held on January 17 at the Unity Center, Muncy, Texas. This year featured a producer panel comprosed of Glenn Schur, Boyd Jackson, and Scott Horne. They shared how the drought of 2011 had impacted their cropping systems and irrigation management for 2012. They also discussed their management strategy for 2013, which included adopting the new water policy.

Senator Robert Duncan, Sarah Clifton, Dr. Chuck West and Kellison met on February 8, 2013 to review the TAWC seven year summary and the future direction of the TAWC project. One addition to the project for 2013 are regularly scheduled producer "Field Walks". The purpose of these "Field Walks" is to include producers, crop consultants, extension, and industry to evaluate specific fields for irrigation management and other crop inputs. We will demonstrate various irrigation scheduling technologies such as the TAWC ET program and various capacitance probe data. KFLP Radio will interview participants and air these interviews on their agronomic updates. We expect that these regular meetings will expose more producers to the management technologies available. Texas A&M AgriLife Extension personnel from Lubbock, Crosby, Floyd, Hale and Swisher counties have agreed to be involved in this effort.

On February 25, 2013, TAWC was involved in the Texas Ag Forum, held in Austin, Texas. Dr. Chuck West made a presentation on the TAWC Project. Dr. West and Kellison met with Comer Tuck and Cameron Turner after the Ag Water Forum. We discussed additions and corrections to the TAWC executive and seven year summaries. Presentations this year:

03-06-2012	Lubbock Kiwanis Club	Lubbock, Texas
03-23-2012	New Mexico Ag Bankers Conference	Ruidoso, New Mexico

04-03-2012	AgriLife Extension Meeting	Tulia, Texas
05-10-2012	Carillon Center	Lubbock, Texas
06-19-2012	Lloyd Author Farm	Lorenzo,Texas
06-20-2012	Blake Davis Farm	Littlefield, Texas
06-21-2012	Glenn Schur Farm	Plainview, Texas
07-12-2012	Texas Agricultural Coop Council	Ruidoso, New Mexico
07-12-2012	Texas Independent Ginners Conf.	Ruidoso, New Mexico
09-05-2012	Leadership Sorghum Class 1	Lubbock, Texas
10-24-2012	Texas Agriculture Lifetime Leadership	Hart, Texas
01-03-2013	KFLP Radio	Floydada, Texas
02-04-2013	Texas Seed Trade Association	Austin, Texas

Tours this year:

05-14-2012	Farm Journal Media
05-11-2012	Comer Tuck
05-17-2012	Secretary of State group
07-10-2012	Justin Weinheimer

Monthly management team meetings and site visits were made on a regular basis.

2.2: Administrative Coordinator: Christy Barbee, Unit Coordinator (TTU)

Position previously held by Angela Beikmann was vacated in March of 2012 and replaced by Christy Barbee in August of the same year. Year 8 main objectives for the secretarial/administrative and bookkeeping support role for the TAWC Project include the following:

Accurate Accounting of All Expenses for the Project Includes monthly reconciliation of accounts with TTU accounting system, quarterly reconciliation of subcontractors' invoices, preparation of itemized quarterly reimbursement requests, and preparation of Task and Expense Budget and Cost Sharing reported for Year 8 of the project. Budget was balanced for annual report and assistance was given preparing the annual report to completion.

Administrative Support for Special Events 1st annual Producer Appreciation Day was held on Monday September 3rd. Assistance was given with mail out and advertisement for event.

The TAWC Farmer Field Day was held at the Unity Center in Muncy Texas on January 17th, 2013. Sponsor donations were received and deposited and were used for Field Day expenses such as catering, venue rentals and print services. Assistance was given by helping to coordinate meals on the day of the event.

Ongoing Administrative Support Daily administrative tasks include correspondence through print, telephone and e-mail; completing various clerical documents such as

mileage logs, purchase orders, cost transfers, travel applications, human resource forms, and pay payroll paperwork; and other duties as requested or assigned.
Six monthly Management Team meetings have been attended and all minutes have been transcribed and distributed.

TAWC producer binders were assembled for each TAWC producer to categorize their records. These binders greatly assist the research team in acquiring useful data for this annual report and other communications.

TASK 3: FARM Assistance Program (Financial and Risk Management)
Annual Report ending February 28, 2013

Principal Investigator(s): Dr. Steve Klose, Jeff Pate and Jay Yates (AgriLife)

Texas AgriLife Extension Service, FARM Assistance Sub-Contract with Texas Tech University

Year 8 project progress regarding Task 3 in the overall project has occurred in several areas ranging from collaborating in project coordination and data organization to data collection and communication, as well as providing additional services to the area producers in conjunction with the TAWC project. A brief summary of specific activities and results follows.

Project Collaboration

A primary activity of initiating the FARM Assistance task included collaborating with the entire project management team and coordinating the FARM Assistance analysis process into the overall project concepts, goals, and objectives. The assessment and communication of individual producer's financial viability remains crucial to the evaluation and demonstration of water conserving practices. Through AgriLife Extension participation in management team meetings and other planning sessions, collaboration activities include early development of project plans, conceptualizing data organization and needs, and contributions to promotional activities and materials.

Farm Field Records

AgriLife Extension has taken the lead in the area of data retrieval in that FARM Assistance staff is meeting with producers multiple times each year to obtain field records and entering those records into the database. AgriLife Extension assisted many of the project participants individually with the completion of their individual site demonstration records (farm field records). Extension faculty have completed the collection, organization, and sharing of site records for all of the 2012 site demonstrations.

FARM Assistance Strategic Analysis Service

FARM Assistance service is continuing to be made available to the project producers. The complete farm analysis requires little extra time from the participant, and confidentiality of personal data is protected. Extension faculty have completed whole farm strategic analyses for several producers, and continue to seek other participants committed to the analysis. Ongoing phone contacts, e-mails, and personal visits with project participants promote this additional service to participants.

In addition to individual analysis, FARM Assistance staff has developed a model farm operation that depicts much of the production in the demonstration area. While confidentiality will limit some of the analysis results to averages across demonstrations, the model farm can be used to more explicitly illustrate financial impacts of water conservation practices on a viable whole farm or family operation.

FARM Assistance Site Analysis

While the whole farm analysis that is offered to participants is helpful to both the individual and for the operation of the project, the essential analysis of the financial performance of the individual sites continues. FARM Assistance faculty completed and submitted economic projections and analyses of each site based on 2011 demonstration data. These projections will serve as a baseline for future site and whole farm strategic analyses, as well as providing a demonstration of each site's financial feasibility and profitability. Each producer in the project received a copy of the analysis for the site based on the 2011 data. This analysis can be used by the producer to establish some economic goals for the future. Analyses in 2012 will be completed in summer of 2013, as yield data has only recently been finalized for the 2012 crop.

Economic Study Papers

FARM Assistance members completed a study paper utilizing the economic data on some sites within the TAWC project. The paper examined the profitability of irrigated cotton grown during the extreme drought conditions of 2011and 2012. The results of this paper were presented at the Beltwide Cotton Conference held in San Antonio, Texas, January 2013.

Continuing Cooperation

FARM Assistance members also continue to cooperate with the Texas Tech University Agriculture and Applied Economics Department by furnishing data and consulting in the creation of annual budgets. These budgets will later be used by FARM Assistance members to conduct site analysis for each farm in the TAWC project.

Conservation Innovation Grant

Nine additional sites operated by six producers have been selected. Beginning in 2012, data were collected from these sites, as well as the 29 existing sites in the TAWC project. All of these sites were furnished with soil moisture monitoring equipment, water metering devices, and center-pivot monitors. FARM Assistance members assisted in training producers in the use and interpretation of data from each of these devices. Two training days were held for producers, as well on-site meetings with each producer to adequately train each one about the equipment installed on his site.

Other Presentations

FARM Assistance members, along with project director Rick Kellison, made a presentation to agricultural lenders within the New Mexico Bankers Conference. Tools developed by the TAWC were demonstrated that show water savings, as well as decision-aid tools. These tools were developed for producers in the Texas High Plains, but proved to be useful to producers outside of this area.

Farm Days

Three Farm Days were held in July at sites in Hale, Crosby, and Lamb counties. The purpose of these Farms Days was to make producers aware of irrigation timing practices using soil moisture probes. These probes were located in fields adjacent to the meeting sites so as to allow attendees to see the data generated by the probe and see the irrigation operations taking place in the field.

Field Days

Two Field Days were held in the TAWC project during the 2012 growing season. The Summer Field Day was held August 9 and the Winter Field Day was held January 17. Both meetings were held at the Unity Center in Muncy, Texas The purpose of these meetings was to allow producers outside of the project to see what takes place within the project, as well as allow producers to hear about the latest research and policy that could have an impact on their operation . Personnel from AgriLife Extension, AgriLife Research, FARM Assistance, the High Plains Water District, and Texas Tech University were involved in these field days.

TASK 4: Economic Analysis
Annual Report ending February 28, 2013

Principal Investigator(s): Drs. Phillip Johnson and Eduardo Segarra, and Donna Mitchell

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The primary objectives of Task 4 are to compile and develop field level economic data, analyze the economic and agronomic potential of each site and system, and evaluate relationships within each system relative to economic viability and efficiency. In conjunction with Texas A&M AgriLife Extension, field level records of inputs, practices and production are used to develop enterprise budgets for each site. The records and enterprise budgets provide the base data for evaluation of the economics of irrigation technologies, cropping strategies, and enterprise options. All expenses and revenues are accounted for within the budgeting process. In addition to an economic evaluation of each site, energy and carbon audits are compiled and evaluated.

Major Achievements for 2012:

- 2012 represented the eighth year of economic data collection from the project sites. Data for the 2012 production year were collected and enterprise budgets were generated.

- TAWC cooperated with the National Cotton Council in a pilot project for the Fieldprint Calculator which is being developed by Field-to-Market – The Keystone Alliance for Sustainable Agriculture. The Fieldprint Calculator estimates the carbon and energy footprint for crop production. TAWC site information for 2006 through 2011 has been entered into the calculator. The results from the Fieldprint Calculator will be compared to the carbon and energy analysis previously completed for sites in the project. We have had discussions with Field-to-Market representatives the possibility of including additional criteria regarding water conservation into the Fieldprint Calculator.

Journal articles related to the TAWC in 2012:

- Allen, V., C.P. Brown, R. Kellison, p. Green, C. Zilverberg, P. Johnson, J. Weinheimer, T. Wheeler, E. Segarra, V. Acosta-Martinez, T. Zobeck, J. Conkwright. 2012. Integrating Cotton and Beef Production to Reduce Water Withdrawal from the Ogallala Aquifer in the Southern High Plains: I. Ten-years of effect on water use and productivity. Agronomy Journal 104:1625-1642.

- Zilverberg, C.J., V.G. Allen, C.P. Brown, P. Green, P. Johnson, J. Weinheimer. 2012. Integrating cotton and beef production to reduce water withdrawal from the Ogallala aquifer in the Southern High Plains: II. Ten-years of effect on energy and carbon. Agronomy Journal 104:1643-1651.

Proceedings related to the TAWC in 2012:

- Mitchell, D., P. Johnson, J. Johnson, R. Kellison, and J.A. Weinheimer. 2012. Texas High Plains Initiative for Strategic and Innovative Irrigation Management. Proceedings of 2012 Conference of the Universities Council on Water Resources. July 19, 2012. Santa Fe, New Mexico.

Presentations related to the TAWC in 2012:

- Johnson, P. Overview of the TAWC Project and Water Issues in the Texas High Plains. Sunray Cooperative Board Meeting at CoBank. January 10, 2012, Denver, CO.

- Tewari, R., J. Johnson, S. Amosson, B. Golden, L. Almas, and B. Guerrero. 2012. Evaluating Implementation costs of selected water conservation policies in the Southern Ogallala Region. Poster presentation at the Southern Agricultural Economics Association meetings, February 7, 2012, Birmingham, AL.

Demonstration Project Profitability Evaluation 2005 – 2012

Profitability for each demonstration site was calculated for the years 2005 through 2012. Efficiency related to the primary resources – land and applied irrigation water – was measured by gross margin per acre of land and gross margin per acre-inch of applied irrigation water. Gross margin (gross revenue less direct costs) was used as the measure of profitability.

Tables 29 and 30 give a summary of irrigation applied, gross margin per acre and per acre-inch of applied irrigation, irrigation technology, and crop or rotation for each site over the period 2005 through 2012. Table 30 ranks the sites by gross margin per acre. The average irrigation applied ranged from 6.65 to 27.14 inches. Sixteen sites had average gross margins over $300 per acre, with average irrigation ranging from 11.58 to 27.14 inches.

Figure 21 shows the distribution of gross margin per acre to inches of applied irrigation. The area delineated by the rectangle in the upper left corner of the chart represents gross margins greater than $300 per acre and applied irrigation of 15 inches or less. Ten sites met these criteria over the 8-year period 2005- 2012. Of these, sites 7 and 8 were monoculture grass seed production; site 28 was cotton; sites 6, 2, 30 and 15 were cotton/corn rotations; and sites 26, 4, 21 and 17 were multi-crop rotations with grazing. Five sites met the $300 gross margin per acre criterion with average irrigation over 18 inches, and were cotton/corn rotations.

Table 30 ranks the sites by gross margin per acre-inch of applied irrigation. Gross margin per acre-inch ranged from $47.96 to $14.07. Figure 22 shows the distribution of gross margin per acre and gross margin per acre-inch of applied irrigation. The area delineated by the rectangle in the upper right corner of the chart represents gross margin per acre over $300 and gross margin per acre-inch over $30. Six sites were in the "top ten" for gross margin per acre and gross margin per acre-inch of irrigation. These included sites representing grass seed monoculture (7 and 8), cotton (28), multi-crop rotation with grazing (26), cotton/corn rotation (2 and 30), and multi-crop rotation (15).

Over the years of the project certain sites have been taken out and sites have been added. The analysis presented here only included sites that have at least three (3) years of results. There were 3 sites added in 2010 and 1 additional site added to the project in 2012, however, these sites are not included in the analysis.

Abbreviations used in the tables: A – Alfalfa, CC – Cow/Calf, CT – Cotton, CR – Corn, CS – Corn Silage, FS – Forage Sorghum, GR – Grass, GS – Grass Seed, ML – Millett Seed, OS – Oat Silage, SC – Stocker Cattle, SF – Sunflowers, SR – Grain Sorghum, TR – Triticale, WH – Wheat, WS – Wheat Silage, CF – Conventional Furrow, LESA – Low Elevation Spray Application, LEPA – Low Energy Precision Application, MESA Mid Elevation Spray Application, SDI – Subsurface Drip System. Gross Margin (GM) represents Gross Revenues less Direct Costs.

Economic Term Definitions

Gross Income – The total revenue received per acre from the sale of production including insurance indemnity payments.

Variable Costs – Cash expenses for production inputs including interest on operating loans.

Gross Margin – Total revenue less total variable costs.

Fixed Costs – Costs that do not change with a change in production. These costs are incurred regardless of whether or not there was a crop produced. These include land rent charges and investment costs for irrigation equipment.

Net Returns – Gross margin less fixed costs, or total returns above all costs.

Table 30. Sites ranked by gross margin per acre, 2005 - 2012.

Site	Irrigation Applied	Gross Margin Per Acre	Gross Margin Per Acre Inch	Irrigation Technology	Crop or Rotation							
	Inches	$/Acre	$/Acre Inch		2005	2006	2007	2008	2009	2010	2011	2012
7	12.51	599.82	47.96	LESA	GS	GS	GS	GS	GS	GS	GS	GS
27	20.65	574.42	27.81	SDI		CT	CS	CT/CR	CT/CR	CT/CS	CT/CS	CT/CS
22	18.69	568.36	30.42	LEPA	CT/CR	CT/CR	CT	CR	CT	CR	CT	CT
20	27.14	548.16	20.20	LEPA	WH/FS/CR	CS/FS	TR/FS	WH/SR/FS	CS/CT	CR/TR/CT	CR/TR/CT	CS/TR/CT
8	12.03	523.61	43.54	SDI	GS	GS	GS	GS	GS	GS	GS	GS
24	18.98	490.84	25.86	LESA	CT/CR	CT/CS	CR	CR	CR/SF	CR	CR/CT	CR/CT
26	13.71	436.11	31.81	LESA	CT/CR	CT	CR/ML	SR/ML/CR	CR/SF/GR	WH/CT/CR/GS	CR/CT	CT/SF
28	12.75	421.80	33.09	SDI				CR	CT	CT	CT	CT/CR
2	12.61	390.90	30.99	SDI	CT	CT	CT	SF	CT	CR	CT	CT/CR
15	12.52	381.50	30.48	CF/SDI	CT	CT/SR	CT/SR	CT/WH/FALLOW	CT	CT	CR/CT	CT/SR
17	13.19	367.56	27.87	MESA	GR/CR/CT	GR/CC/CT/CR	GR/CC/CT	GR/CC/GS/CT/WH	GR/CC/SF/GS	GR/CR	GR/CT	GR/CT/CR
6	13.72	367.29	26.77	LESA	CT	CT	CT	CT/CR	CT/CR	CT/CR	CT/CR	CR/FALLOW
4	13.71	365.05	26.63	LESA	CT/A	CT/A/WH/FS	CT/WH/A/CC	A/SR/WH/CC	WH/FS/SR/CT/A	A/CT/WH/	A/CT/WH/HAY	WH/CT/GS

										HAY		
30	11.58	352.73	30.45	SDI					SF	CR	FALLOW	CT
21	13.41	344.90	25.73	LEPA	CT	CT/CR/SC	CR/GS	GS/FS	WH/HAY/GS	CT/CR	CT/CR	CT/WH/FS
10	14.66	294.41	20.09	LESA	GR/CC/CT	GR/CC/OS	GR/CC/CR	GR/CC/GS/CR	GR/CC/GS/CR	GR/CR	GR/CT	GR/CS
3	9.91	293.49	29.61	MESA	CT/SR	CT	WH/SR	CT/SR/WH	CT/SR	CT/SR/WH	CT	CT
5	7.05	264.62	37.55	MESA	GR/CC	GR/CC	GR/CC	GR/CC	GR/CC	GR/CC	CT/GS/FALLOW	CT/FALLOW
19	8.88	252.95	28.50	LEPA	CT/ML	CT/ML	CT/ML	CT/ML	CT/WH	CT/WH	CT	CT/FALLOW
23	16.66	234.52	14.07	LESA	CT/CR	CT	CR	CT	CR	CT	CT	CT/CR
9	6.65	234.02	35.17	MESA	GR/SC/CT	GR/SC/CT	GR/SC/SR	GR/SC/CT	CT/RYE	GR/CT	GR/CC/CT	CT/GR
11	13.64	228.21	16.73	CF	CT	CT	CT	CT	CT/SR	CT/SR	CT/SR	CT
14	8.68	154.14	17.77	LEPA	CT	CT	CT	CT	CT/WH	CT/WH	CT	CT/WH
18	5.05	135.10	26.75	LEPA	SR/CT	CT/OS/FS	WH/SR	CT/FS/FR	CT/WH	CT/WH	CT/WH	CT/WH
29	-	137.48	-	DL				CT/WH/FL	CT/WH	SR	CT	CT/SR
12	-	101.60	-	DL	CT/FS	CT/WH	CT/SR	FS	WH/FS	CT	SR	

Table 31. Sites ranked by gross margin per acre-inch of applied irrigation, 2005 - 2012.

Site	Irrigation Applied	Gross Margin Per Acre	Gross Margin Per Acre Inch	Irrigation Technology	Crop or Rotation							
	Inches	$/Acre	$/Acre Inch		2005	2006	2007	2008	2009	2010	2011	2012
7	12.51	599.82	47.96	LESA	GS	GS	GS	GS	GS	GS	GS	GS
8	12.03	523.61	43.54	SDI	GS	GS	GS	GS	GS	GS	GS	GS
5	7.05	264.62	37.55	MESA	GR/CC	GR/CC	GR/CC	GR/CC	GR/CC	GR/CC	CT/GS/FALLOW	CT/FALLOW
9	6.65	234.02	35.17	MESA	GR/SC/CT	GR/SC/CT	GR/SC/SR	GR/SC/CT	CT/RYE	GR/CT	GR/CC/CT	CT/GR
28	12.75	421.8	33.09	SDI				CR	CT	CT	CT	CT/CR
26	13.71	436.11	31.81	LESA	CT/CR	CT	CR/ML	SR/ML/CR	CR/SF/GR	WH/CT/CR/GS	CR/CT	CT/SF
2	12.61	390.9	30.99	SDI	CT	CT	CT	SF	CT	CR	CT	CT/CR
15	12.52	381.5	30.48	CF/SDI	CT	CT/SR	CT/SR	CT/WH/FL	CT	CT	CR/CT	CT/SR
30	11.58	352.73	30.45	SDI					SF	CR	FALLOW	CT
22	18.69	568.36	30.42	LEPA	CT/CR	CT/CR	CT	CR	CT	CR	CT	CT
3	9.91	293.49	29.61	MESA	CT/SR	CT	WH/SR	CT/SR/WH	CT/SR	CT/SR/WH	CT	CT
19	8.88	252.95	28.50	LEPA	CT/ML	CT/ML	CT/ML	CT/ML	CT/WH	CT/WH	CT	CT/FALLOW
17	13.19	367.56	27.87	MESA	GR/CR/CT	GR/CC/CT/CR	GR/CC/CT	GR/CC/GS/CT/WH	GR/CC/SF/GS	GR/CR	GR/CT	GR/CT/CR
27	20.65	574.42	27.81	SDI		CT	CS	CT/CR	CT/CR	CT/CS	CT/CS	CT/CS

6	13.72	367.29	26.77	LESA	CT	CT	CT	CT/CR	CT/CR	CT/CR	CT/CR	CR/FALLOW
18	5.05	135.10	26.75	LEPA	SR/CT	CT/OS/FS	WH/SR	CT/FS/FR	CT/WH	CT/WH	CT/WH	CT/WH
4	13.71	365.05	26.63	LESA	CT/A	CT/A/WH/FS	CT/WH/A/CC	A/SR/WH/CC	WH/FS/SR/CT/A	A/CT/WH/HAY	A/CT/WH/HAY	WH/CT/GS
24	18.98	490.84	25.86	LESA	CT/CR	CT/CS	CR	CR	CR/SF	CR	CR/CT	CR/CT
21	13.41	344.9	25.73	LEPA	CT	CT/CR/SC	CR/GS	GS/FS	WH/HAY/GS	CT/CR	CT/CR	CT/WH/FS
20	27.14	548.16	20.20	LEPA	WH/FS/CR	CS/FS	TR/FS	WH/SR/FS	CS/CT	CR/TR/CT	CR/TR/CT	CS/TR/CT
10	14.66	294.41	20.09	LESA	GR/CC/CT	GR/CC/FR	GR/CC/CR	GR/CC/GS/CR	GR/CC/GS/CR	GR/CR	GR/CT	GR/CS
14	8.68	154.14	17.77	LEPA	CT	CT	CT	CT	CT/WH	CT/WH	CT	CT/WH
11	13.64	228.21	16.73	CF	CT	CT	CT	CT	CT/SR	CT/SR	CT/SR	CT
23	16.66	234.52	14.07	LESA	CT/CR	CT	CR	CT	CR	CT	CT	CT/CR

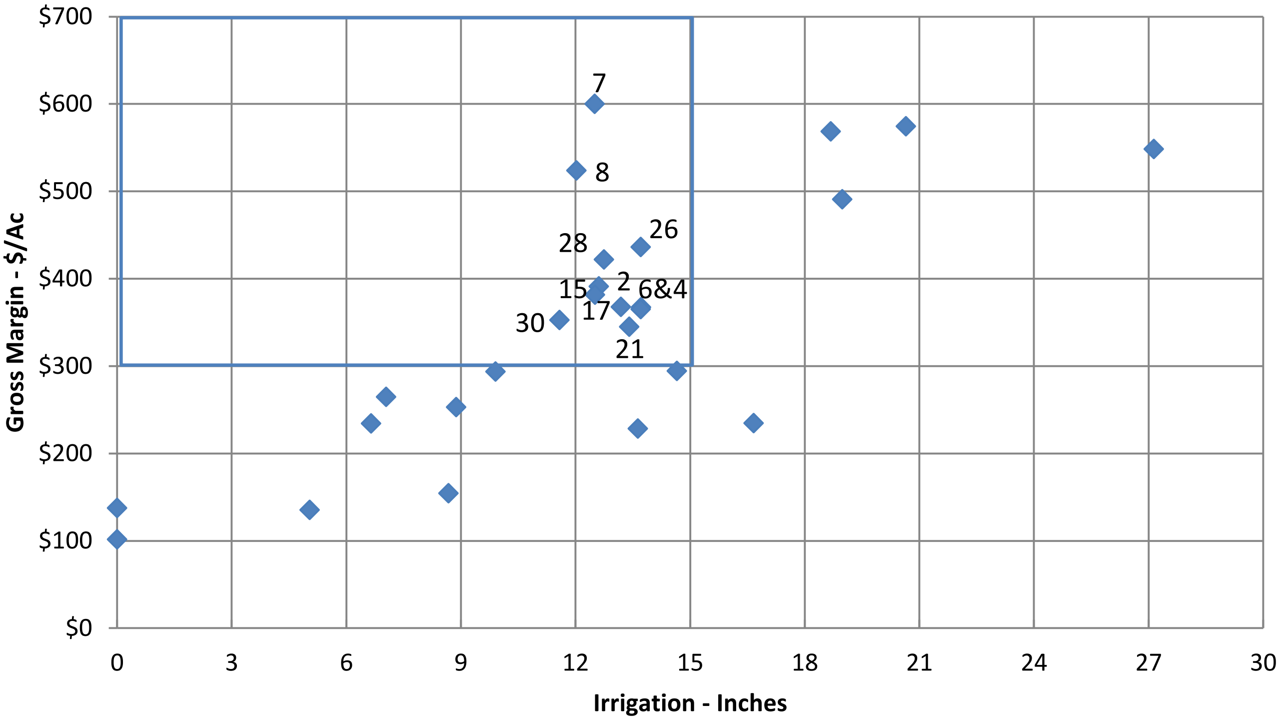


Figure 21. Gross margin per acre and inches of applied irrigation, 2005 - 2012.

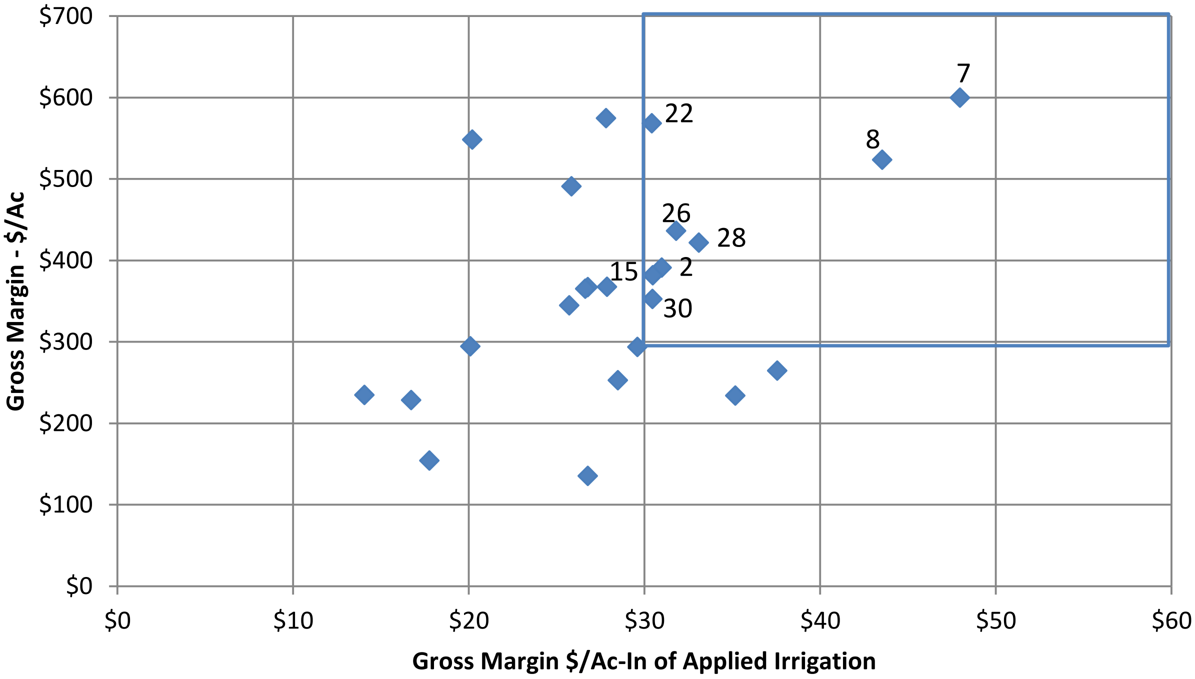


Figure 22. Gross margin per acre and gross margin per acre-inch of applied irrigation, 2005 - 2012.

TASK 5: Plant Water Use and Water Use Efficiency
Annual Report ending February 28, 2013

Principal Investigator(s): Drs. Steve Maas and Nithya Rajan

Several major areas of investigation were pursued during 2012. These are summarized in the following sections.

Test of Spectral Crop Coefficient Approach

Extensive tests of the Spectral Crop Coefficient (Ksp) approach in estimating crop water use were conducted during 2012 to demonstrate its accuracy and efficacy. The Ksp is a new component of the TAWC *Irrigation Scheduling Tool* (release in 2014) that involves satellite imagery to estimate crop ground cover. The Ksp is described by Rajan et al. (Rajan, N., S. J. Maas, and J. C. Kathilankal. 2010. Estimating crop water use of cotton in the Southern High Plains. Agronomy Journal 102:1641-1651). Tests of this approach had the following two goals:

(1.) To validate the accuracy of the K_{sp} approach in estimating actual crop water use;

(2.) To compare the performance of the K_{sp} approach versus standard crop coefficient approaches in estimating crop water use.

To provide data for testing the approach, evapotranspiration (ET) was measured using eddy covariance (EC). EC provides direct measurements of ET (Rajan, N., S. J. Maas, and J. C. Kathilankal. 2010. Estimating crop water use of cotton in the Southern High Plains. Agronomy Journal 102: 1641-1651). EC data were used from three dissimilar field situations: TAWC Field 1 in 2008, which supported fully irrigated cotton; TAWC Field 15 in 2010, which supported deficit-irrigated cotton; and TAWC Field 29 in 2008, which supported dryland cotton. Since both fields were irrigated using subsurface drip (SSD), the soil surface remained dry except after rain events. The soil surface for the dryland field also remained dry between rain events. EC data used in the validation were taken from the periods between rain events, which insured that the soil evaporation component of the measured ET was small. Therefore, ET used in the validation approximated actual crop water use (CWU) and thus could be compared to corresponding values of CWU estimated using Ksp. Weather data used in calculating CWU using the Ksp approach were taken from the West Texas Mesonet observing station located at Plainview.

Validation results are presented in Figure 23. Values of estimated versus measured daily CWU cluster along the 1:1 line for all three cropping systems, with an R^2 value of 0.781. The slope and intercept of the regression line through these points are not significantly different ($\alpha = 0.05$) from the slope and intercept of the 1:1 line, suggesting that the 1:1 line represents a best fit to the validation data. Average daily estimated and measured CWU values for the three systems are presented in Table 32. Estimated and measured CWU values are close between each system, and the estimated CWU averaged over all systems is less than 0.1 mm different from the corresponding measured value. These results confirm that the K_{sp} approach is an accurate estimator of CWU for a variety of cropping systems.

Results of comparing the K_{sp} approach to standard crop coefficient (K_c) approaches are presented in Figures 24 and 25. In Figure 23, daily estimates of CWU estimated using K_{sp} are plotted over the 2008 growing season for the fully irrigated cotton field (Site 1). Also shown in that figure are corresponding values of crop ET (ET_c) calculated using crop coefficients recommended for use by Texas AgriLife and New Mexico State University (NMSU). Two versions of the K_{sp} results are presented-- one calibrated using actual ground cover observations from the site, and the other using a standard K_{sp} curve determined from long-term satellite observations of TAWC sites. There is a big difference early in the growing season between the K_c results and the K_{sp} results. This is because the ET_c estimated using K_c includes soil evaporation, while CWU estimated using K_{sp} does not include soil evaporation. In the Next Generation TAWC Irrigation Scheduling Tool, soil evaporation is estimated separately using a two-layer soil water balance model. Later in the growing season, the results from the two approaches are in reasonable agreement, and both agree with the observed values of CWU for this site. This is because the cotton in Site 1 attained an almost complete crop canopy during this period. An underlying assumption of the K_c approach is that the crop growth is not restricted by water or other stresses.

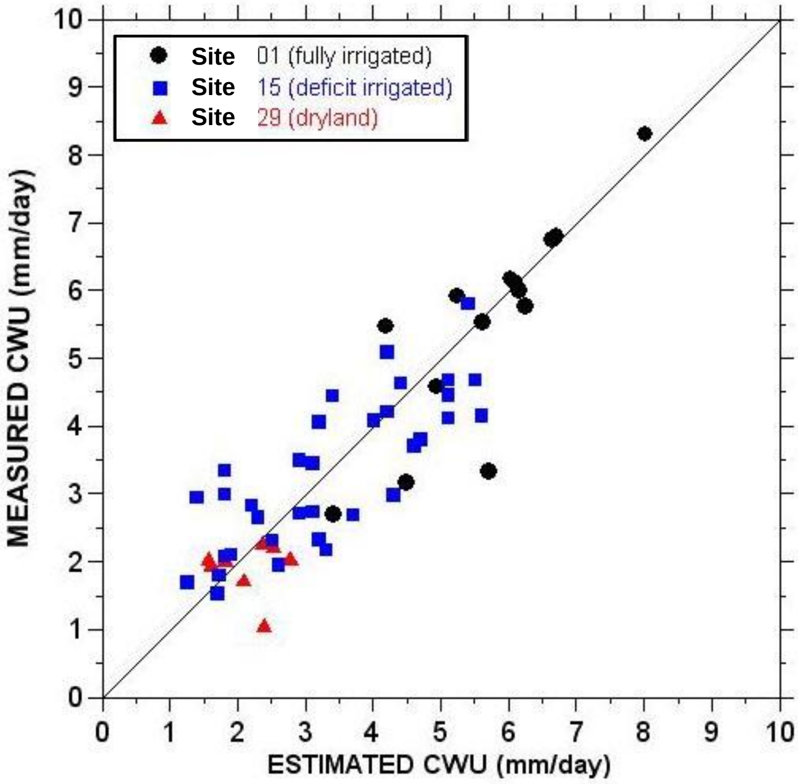


Figure 23. Estimated versus observed crop water use (CWU) for three cotton sites in TAWC.

Table 32. Average daily CWU (mm/day) for each of the three sites and for the combination of the data from the three sites.

	Site 1	Site 15	Site 29	All 3 Sites
Estimated	5.68	3.47	2.15	3.80
Measured	5.47	3.43	1.90	3.72

A different situation occurs in Figure 25. In this case, the methods are applied to the deficit-irrigated cotton in Site 15. Again, the two approaches produce different values early in the growing season owing to soil evaporation. However, in the middle portion of the growing season (DAY 220-260), the K_c approaches produce values that are markedly greater than the corresponding values from the K_{sp} approach. In addition, they markedly overestimate the actual values of CWU. The calibrated K_{sp} approach produced estimates of CWU that reasonably agree with observed values. During this period, the crop ground cover in Site 15 ranged from 30 to 60 percent as a result of the deficit irrigation. The K_{sp} approach was able to directly accommodate this sub-optimum condition.

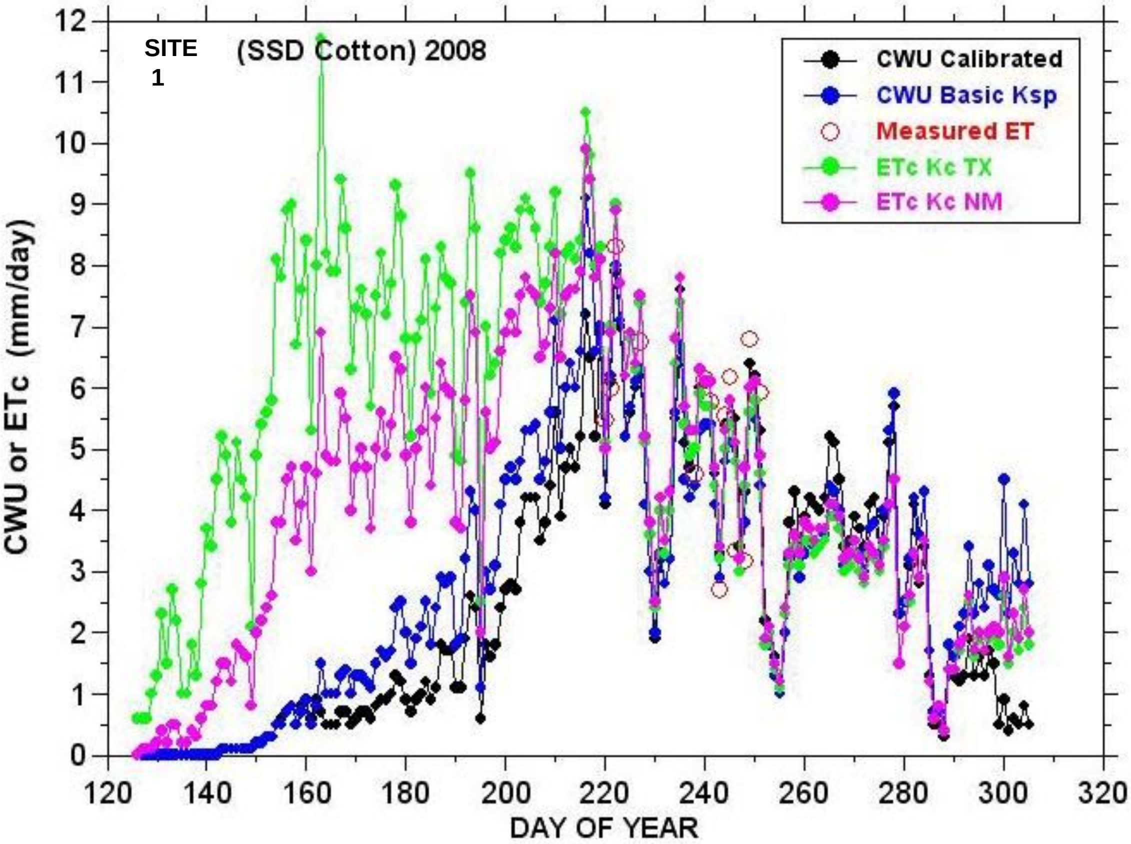


Figure 24. Daily crop water use (CWU) estimated using the K_{sp} and K_c approaches for Site 1.

The conclusions of this study are as follows. The spectral crop coefficient approach is effective in accurately estimating the actual water use of crops on a field-by-field basis. Both the standard crop coefficient (K_c) and the spectral crop coefficient (K_{sp}) approaches perform reasonably well for fully irrigated fields, where crop growth approaches “standard conditions.” However, the spectral crop coefficient approach does a much better job of estimating the actual water use of crops under non-standard conditions, particularly when calibrated using ground cover observations. The K_{sp} approach uses the same weather data required by the standard crop coefficient approach. The only additional information required is an estimate of crop ground cover. For irrigation scheduling intended to replace the water used by the crop, use of the spectral crop coefficient approach should prevent significant over-watering of the crop and potential depletion of water resources. These results were reported in two presentations made at the 2012 University Council on Water Resources (UCOWR) Conference in Santa Fe, NM.

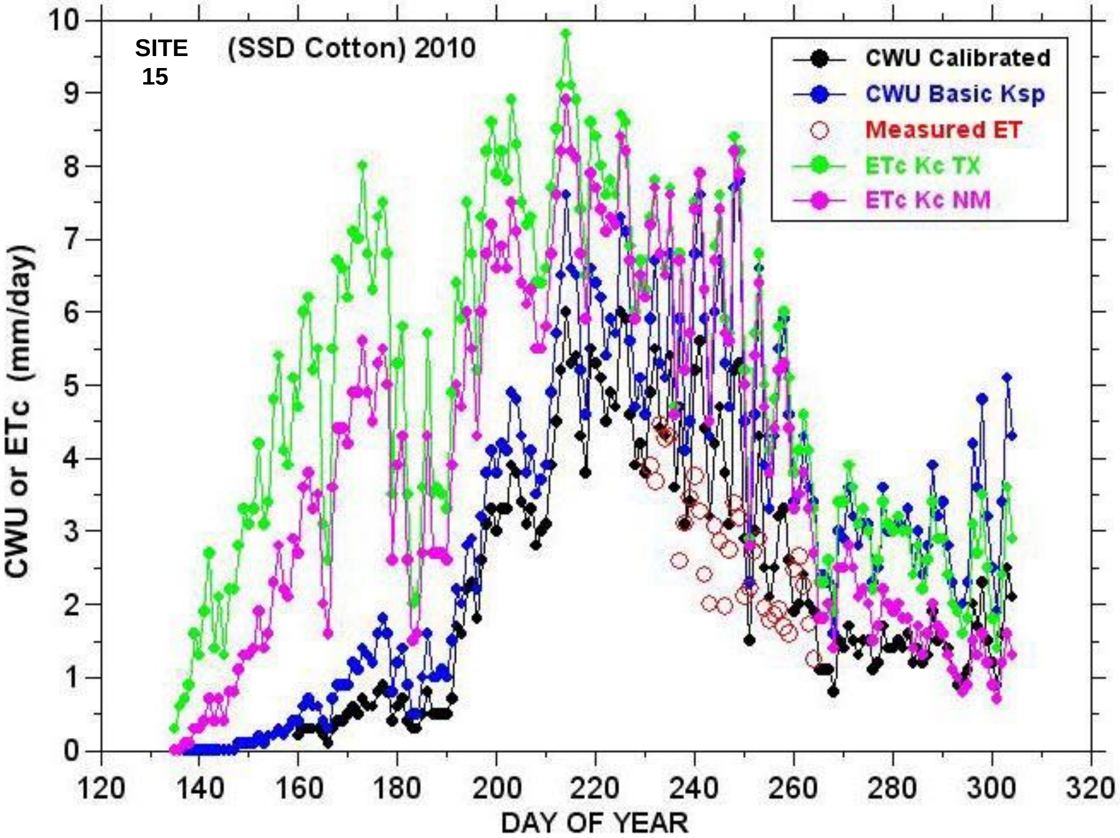


Figure 25. Daily crop water use (CWU) estimated using the K_{sp} and K_c approaches for Site 15.

Agro-ecosystem Carbon and Water Fluxes

Although native and managed grasslands in the semi-arid Texas High Plains are unique ecosystems adapted to this region, their role in regional carbon exchange processes has not been adequately studied, and they are not adequately represented in the current estimates of regional or continental scale carbon balance. Carbon balance is of interest here because it is tightly coupled to crop growth and therefore to crop water use and water use efficiency. Eddy covariance flux measurements have been obtained from TAWC Site 17 (an improved WW-B.Dahl pasture) since mid-2010. These measurements are contributing to our understanding of how grasslands in the region respond to the semi-arid Texas High Plains environment. Fortuitously, the measurement period for this site contains the mega-drought event of 2011. This offers us a special opportunity to investigate the impact of an extreme drought event on key carbon exchange processes in this agro-ecosystem. The main objectives of this study were to assess the impact of the drought on daily and seasonal net ecosystem exchange (NEE) of this pasture and compare the results to those obtained in 2010, which was a year with above-normal rainfall. We also examined the relationship between gross primary production (GPP), ecosystem respiration (R_{eco}) and light use efficiency as affected by temperature and grazing.

Meteorological differences between the two years were evident in the observations of rainfall (RF), air temperature (T_{air}), soil temperature (T_{soil}), relative humidity (RH) and vapor pressure deficit (VPD). The cumulative precipitation and seasonal distribution were noticeably different between 2010 and 2011 (Figure 26). The precipitation received during the 2010 peak growing season period (June-August) was 278 mm, which was much greater than the 9-year average precipitation of 153 mm recorded by the TAWC weather station located near the site. In contrast, the growing season precipitation received in 2011 was only 12 mm, or 8% of the 9-year average precipitation. The exceptionally dry 2011 summer was coupled with a higher average T_{air} as compared to 2010 during the period of peak growth in the summer months. Significant differences between the two years were also observed in T_{air} during June-September. The average T_{air} in June-August in 2011 was 3.3^{o}C higher than the corresponding value from 2010, while the average T_{air} during the flowering period in 2010 was 1.8^{o}C higher than in 2011. There were no significant differences between the average T_{air} values during the dormant seasons for the two years. The T_{soil} values recorded during the peak growth months were similar in both years. However, the T_{soil} values recorded in the flowering and dormant seasons in 2010 were higher compared to those recorded in 2011 ($p < 0.05$). Average RH values recorded for all growing season periods were significantly different between the two years. The dry, warm 2011 summer caused VPD to peak above 3.0 kPa on several days, and VPD values generally stayed above 2.0 kPa on most days during the summer. During the 2010 peak growth months, the VPD stayed below 2.0 kPa on most days. VPD values were similar in both years for the flowering and dormant seasons.

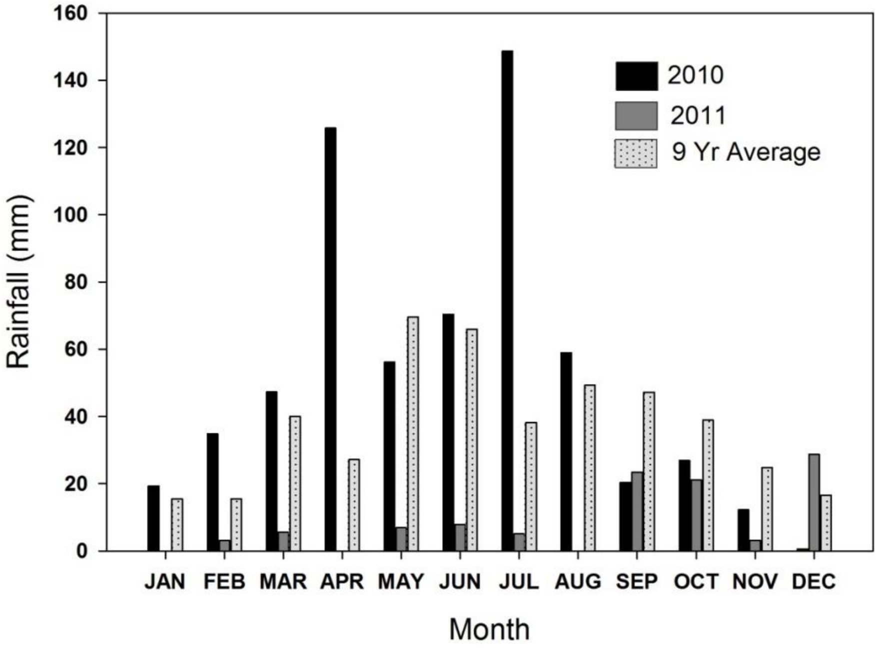


Figure 26. Monthly precipitation recorded at the pasture eddy covariance flux site near Lockney, TX, compared with 9-year average for this site.

Figure 27 presents daily accumulated carbon uptake of the pasture in 2010 and 2011, respectively. Daily NEE observed during the summer months of 2010 showed a net CO_2 uptake by the pasture (negative NEE) on most days. Daytime NEE showed a steady decrease following the establishment of the eddy flux tower on DOY 167 until DOY 179. This decrease was due to gradual soil drying. Above-average rainfall received after DOY 179 (a total of six rain events) caused a rapid increase in green biomass in late July (DOY193- 207). The peak carbon uptake of 27.9 g CO_2 m^{-2} day^{-1} was measured on DOY 202. Grazing started in the pasture on DOY 199. As grazing progressed, the removal of vegetation in the flux footprint area had a direct effect on NEE, with daily NEE values showing a rapid decrease and approaching zero at the end of grazing on DOY 227. The short-term carbon release occurring on 14 days (DOY 179, 182-184, 217-221 and 226-230) during the summer was primarily triggered by precipitation events (also termed “precipitation pulses”). The CO_2 released on those days ranged from near zero to as high as 13.2 gCO_2m^{-2}day^{-1} (DOY 218).

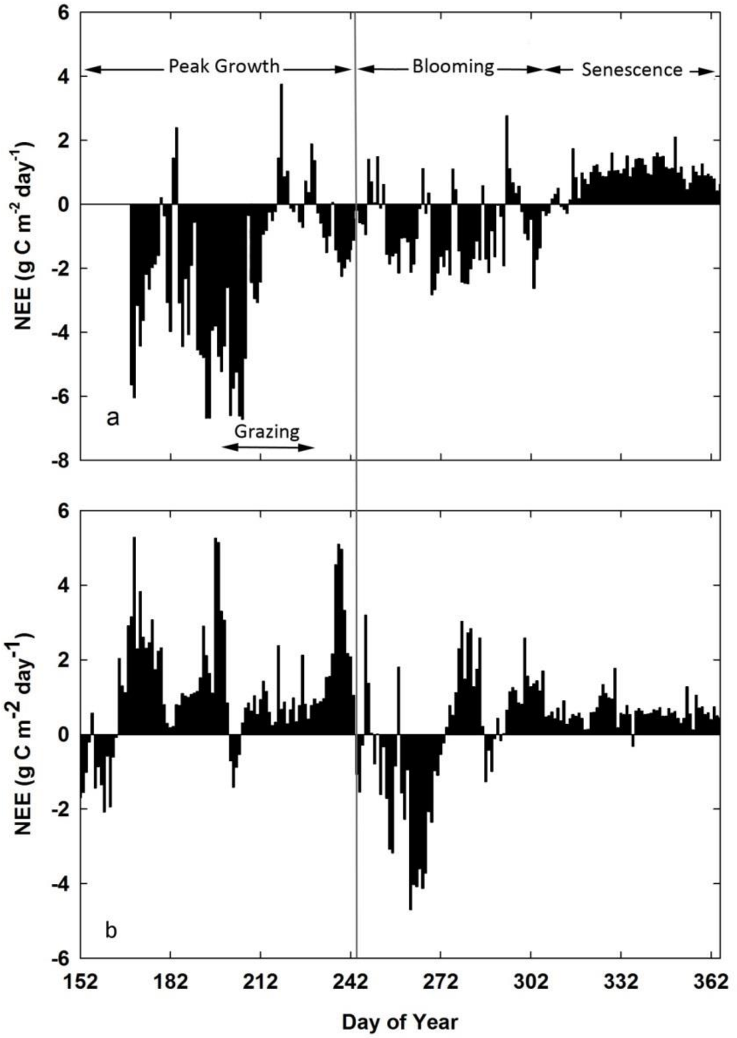


Figure 27. (a) Daily accumulated net ecosystem exchange (NEE) during the measurement period in 2010. **(b)** Daily accumulated NEE during the measurement period in 2011.

Unlike the rainy 2010 summer, the summer in 2011 was characterized by extreme drought which significantly impacted the CO_2 exchange of the pasture. Daily NEE in the summer of 2011 showed a net CO_2 release by the pasture (positive NEE). Diurnal variations in NEE in 2010 showed daytime CO_2 uptake and nighttime CO_2 release, as would be expected during the peak growth period of the pasture. However, the diurnal variations in NEE in 2011on the same day showed daytime CO_2 uptake near zero. Similar characteristics of diurnal variations were observed for most days during the 2011 summer. The CO_2 release peaked above 15 g CO_2 m^{-2} day^{-1} on 6 days (DOY 170, 172, 197, 198, 238 and 239) during the 2011 summer. Two small rain events in June and July of 2011 caused short-term periods of CO_2 uptake, but the pasture rapidly reverted to a dormant state as the soil dried.

September through October was the blooming period for the pasture in 2010. Daily NEE stayed relatively constant on most days during the blooming period. Similar to the summer months, precipitation triggered short-term pulse events on several days. The NEE gradually decreased following DOY 302. The pasture remained dormant from November through December, becoming a CO_2 source. The severe drought and poor growth during the summer months in 2011 caused the pasture to be in the dormant stage with no blooming occurred during September through October. The pasture was irrigated in late August and early September (DOY 237 and 250), which caused a brief greening of the pasture and gradual increase in NEE until DOY 262. As the soil dried out, the NEE again rapidly declined. This was followed by another short-lived increase in NEE after two small rainfall events on DOY 251 and 281. The pasture continued as a CO_2 source for the rest of the year.

At the beginning of the measurement period in 2010, the increase in cumulative NEE and GPP reflected the intensive growth period of the pasture. The pasture continued to sequester C until the end of the flowering period, where the GPP curve reached a peak. The NEE curve started declining at the onset of senescence because of the continued increase in R_{eco}. The pasture remained a carbon sink for the rest of the year. The total accumulated C for 2010 was 164 g C m^{-2}. In 2011, the total R_{eco} was greater than the gross photosynthetic production, which resulted in positive NEE throughout the measurement period. The occurrences of short-lived negative NEE events (see Figure 27) did not alter the general nature of the pasture as a C source during 2011. The net cumulative loss of C from the pasture for 2011 was 142 g C m^{-2}.

Carbon flux measurements made on a managed WW-B. Dahl old world bluestem pasture in the semi-arid Texas High Plains demonstrated that the dynamics of NEE, R_{eco} and GPP for this agro-ecosystem were strongly affected by environmental variables. In a year with adequate precipitation (2010), the pasture acted as a strong sink for C. In contrast, severe drought conditions in the following year (2011) resulted in the pasture acting as a strong source for C. In the absence of water stress conditions, temperature was the major driving variable for total ecosystem respiration. Although we did not explicitly model the effect of soil moisture on ecosystem respiration in the current study, our analysis showed that low soil moisture levels were the main factor associated with reducing the temperature sensitivity (Q_{10}) of ecosystem respiration. During 2010, grazing reduced NEE and GPP of the pasture, but the reductions were not sufficient to change the overall C balance of the ecosystem from a sink to a source. The extreme drought of 2011 caused the pasture grass to remain dormant throughout most of the year, and the ecosystem remained an overall carbon source throughout this period. These results support the need for continued study of pastures in the Southern High Plains to better understand the highly dynamic nature of their C exchange processes and their implications on regional and hemispheric C dynamics. Results of this study have been submitted for publication in *Agronomy Journal*.

Irrigation System Efficiency

During the 2012 growing season, complete irrigation audits were performed for three center pivot sites. Even though this study was performed with funds outside the TAWC grant, the results are reported here because all of these sites are part of the TAWC Demonstration Project (Sites 4, 21 and 31) and of direct importance in water conservation. Sites 21 and 31 were planted to cotton during the time of the irrigation audits, while the portion of Site 4 in which measurements were made was planted to alfalfa. All three sites were all set up for LEPA, although one site (Site 31) included one span set up as LESA (the fifth span from the outer edge of the pivot). The inclusion of this LESA span was intended to compare crop growth and yield under the two types of irrigation. This also provided the opportunity to compare water budgets for the two types of irrigation.

For all sites, direct measurements of emitter flow rate were made for the entire center pivot system. Emitter flow rates were measured by placing an emitter into a plastic jug (see Figure 28) and measuring the time it took for the water level in the jug to rise to a specified mark. The time was measured with a stop watch. By knowing the volume of water in the portion of the jug up to the mark (1/3 gal), the flow rate of the emitter could be calculated. It took approximately 2 hours to measure all the emitters on an 8-span center pivot system (typically around 192 emitters) using this method. Standard practice in many irrigation auditing efforts has been to determine the variation in emitter output along the length of the pivot system by catching the water at the soil surface below the emitters using catch cans. However, this is only an indirect estimate of emitter flow rate. The procedure used in this study provides more accurate direct measurements of emitter flow rates.

One of the audited sites (Site 31) had 7 spans set up for LEPA, but also has one span set up for LESA. This was done as part of the TAWC project to compare the effect of the two irrigation methods on crop growth and yield. It provided a good opportunity to collect data on the relative efficiencies of the two irrigation methods. Catch trays were used to measure the amount of irrigation water reaching the soil surface under each system (see Figure 29). These trays were 33 inches long, 14 inches wide, and 6 inches deep. Trays were used instead of catch cans because the low height of the emitters above the soil surface (nominally around 1 foot) made the catch cans ineffective in catching the water put out by the emitters. Catch cans are more effective when the source of water is several feet above the soil surface, as with MESA irrigation. In Site 31, one set of trays was placed to catch water from the LEPA emitters (span 4), while another set of trays was placed to catch water from the LESA emitters (span 5). The trays were placed so that their long dimension spanned the distance between adjacent rows of cotton. The cotton in this site was planted on 40-inch rows, so the trays covered most of the area between the rows. Depth of water in the trays was measured after the irrigation system passed over their location. Values from trays between the same pair of rows were averaged.

Figure 28. Measuring emitter flow rate in Site 4.

Figure 29. Catch trays placed between rows of cotton in Site 31.

Results from Site 31 showed that, of the water emitted by the LEPA emitters, approximately 1.66 inches reached the soil surface. For the LESA emitters, only around 1.48 inches reached the soil surface. With the LEPA emitters, water was applied directly to the soil surface between adjacent rows. Thus, there should have been little loss of water between the emitter and the soil surface. The LESA emitters sprayed water out horizontally, with a large portion being intercepted by the plant canopy. The difference between the values for the two systems could result from the water intercepted by the plant canopy, some of which went to wetting the leaves. Water from the wet leaves could later evaporate without reaching the soil surface. This could lead to a lower irrigation application efficiency for the LESA system as compared to the LEPA system.

Three criteria were identified for evaluating the performance of the three irrigation systems audited. These criteria are described below.

(i.) *Proper nozzle selection*. Theoretically, emitter flow rates should fall off linearly with distance from the center of the pivot according to the equation,

$$Q_e = [2 * L_s * Q_p * L_e] / [L_p]^2 \qquad \text{[Equation 1]}$$

where Q_e is the flow rate (gal/min) for a given emitter, L_s is the distance (ft) of the emitter from the center of the pivot, Q_p is the total flow (gal/min) rate for the pivot, L_e is the distance between emitters (ft), and L_p is the total length (ft) of the pivot ("Water Application Solutions for Center Pivot Irrigation", Nelson Irrigation Corp., Walla Walla, WA, 2008). This relationship assumes that the pivot is on level ground. For all three sites evaluated, L_p was 1280 ft and L_e was 6.67 ft (80 inches). Total flow rates measured during the audits for the three sites are presented in Table 33 below. These were calculated by summing the measured emitter flow rates for all emitters on the pivot.

Table 33. Total flow rates for irrigation systems audited.

SITE	Q_p (gal/min)	Pumping Rate* (gal/min)
4	468.2	500
21	427.3	500
31	543.2	500

*Reported by the farmer to TAWC and assumed approximate for the system.

How well the pivot was nozzled can be assessed by how closely the distribution of emitter rates along the pivot lies to the theoretical relationship (Equation 1).

(ii.) *Emitter uniformity*. Emitter-to-emitter variability along the pivot should be reasonably small. Substantial deviations can indicate the presence of defective or damaged nozzles. Variation in emitters is visible in the measured values of emitter flow rates. However, one should recognize that part of this variability is the result of random measurement errors. Emitter uniformity was assessed by statistically analyzing the emitter-to-emitter variability and using the results to construct confidence limits about the general trend in emitter flow rates calculated using linear regression analysis. Confidence limits equal to the overall regression plus or minus two standard deviations were constructed for each pivot. Variation in measured emitter rates within these confidence limits could be assumed to result from measurement error. Emitter rates lying outside these confidence limits could be considered to be non-uniform and likely to be associated with defective or damaged nozzles.

(iii.) *System application efficiency*. For the systems audited, application efficiency is considered to represent how much of the irrigation water emitted by the system makes it into and remains within the root zone so that it is available for uptake by the crop plants. For these systems, application efficiency (E_a) can be calculated as follows,

$$E_a = [W_i - W_a - W_s - W_p] / W_i \qquad \text{[Equation 2]}$$

where W_i is the water put out by the emitters, W_a is the water lost before it reaches the soil surface, W_s is the water lost through evaporation from the soil surface, and W_p is the water lost through deep percolation from the soil profile. Each of the terms on the right side of Equation 2 can be expressed as depth of water (inches). E_a is often expressed as a percentage. The terms in Equation 2 were evaluated for each system audited based on measurements or assumptions involving the type of irrigation system.

Assessments of these three criteria for each system audited are summarized as follows:

SITE 4. Figure 30 shows the emitter flow rates measured for this site. The solid black line shows the theoretical relationship described by Equation 1 for this system. The solid red line shows the least-squares linear regression determined from the observed emitter values. The pair of dashed lines show the upper and lower confidence limits around the regression line. There is no statistical difference between the black and red lines, suggesting that the selection of nozzles was appropriate for the system. A fall-off in emitter rates for the 6th and 7th spans was observed. This is visible in Figure 30, where the emitter rates for those spans fall below the line representing the theoretical relationship. This feature may be related to the topography of the site. In the portion of the site within which the system was situated during the audit, the ground under the three spans closest to the center was level. However, beyond the third span, the field fell away sharply down slope to the edge of the field. Emitter rates were somewhat above the theoretical line for the outer five spans, where water movement through the irrigation system was aided by gravity. During the audit, the irrigation system was being used to water the alfalfa section of the site, as indicated in Figure 28. Effects of under-irrigation were visible in the alfalfa canopy under these two spans, where plant height was noticeably greater under the emitter position.

Emitter-to-emitter uniformity was good in all spans except span 6. In span 6, eight emitters were noted in the site as putting out too little water. This is apparent in Figure 30, where points lie below the lower confidence limit. Two emitters (one in span 1 and the other in span 5) were putting out substantially more than neighboring emitters. On both, the nozzle of the emitter was missing, so flow from the emitters was uncontrolled. Even with these problems, 95% of the emitters were within the upper and lower confidence limits, suggesting reasonable uniformity for the system.

This was a LEPA system, so a relatively high application efficiency would be expected. Calculation of application efficiency for such a system is presented in the discussion for Site 31.

SITE 21. Of the three sites receiving complete audits, this site exhibited the best overall performance. As shown in Figure 31, the observed trend in emitter rate (solid black line) was very close to the theoretical relationship (solid red line). Variation in emitter rate was generally between the upper and lower confidence limits, except for one emitter in span 2 that was putting out too much water due to a missing nozzle. In addition, two emitters (one in span 6 and the other in span 7) were putting out too little water. This resulted in an overall uniformity of 98%. This was also evident from the cotton being irrigated, which displayed a very uniform canopy across the site.

Again, this was a LEPA system, so a relatively high application efficiency would be expected. See the discussion for Site 31 for calculation of application efficiency.

SITE 31. There was a tendency for emitter rates to be below the theoretical line (Figure 32) for spans 2 and 3, while above the line for spans 5 and 6. The site is relatively flat, so this is not a topography effect. The differences were not great, and there was no noticed effect on the cotton canopy being watered.

Emitter uniformity was generally good, with most of the emitter rates falling between the upper and lower confidence limits. There was one emitter in span 3 putting out markedly too much water, and one in span 4 putting out too little water. There were also two emitters at the end of the system putting out too much water. Still, the overall uniformity of this system was 97%.

In terms of conserving water, this site was of interest because of the comparison between LEPA and LESA emitters. As described earlier, data from the catch trays indicated that, of the water emitted by the LEPA emitters in span 4, approximately 1.66 inches reached the soil surface. Since the LEPA emitters put the water directly on the soil surface, the W_a term in Equation 2 would be approximately zero for the LEPA system and W_i would be 1.66 inches. For the LESA emitters in span 5, only around 1.48 in. reached the soil surface. The difference, which amounted to around 0.2 inches (5 mm) was likely lost by evaporation from the plant canopy wetted by the LESA emitters. This would represent the W_a term in Equation 2 for the LESA system. An insufficient number of microlysimeter measurements were obtained to directly evaluate the W_s term for the two systems. However, this term can be estimated for the two systems based on soil characteristics. For the type of soil in this site (an Amarillo sandy clay loam), the "upper limit for Phase 1 soil evaporation" (U) is approximately 0.35 inch (J. T. Ritchie, "Model for predicting evaporation from a row crop with incomplete cover," *Water Resources Research*, 1972, Vol. 8, No. 5, p. 1204-1213). This value represents the amount of water lost over time by the wet soil surface due to evaporation. For the LESA system, which wets the entire soil surface, this value of U would represent W_s in Equation 2. In contrast, the LEPA system wets only half the soil surface, so its corresponding value of W_s would be 0.175 inches. Since soil moisture measurements made in the fields at the time of the irrigation indicated no loss of water from the soil profile by deep percolation, the W_p term would be zero for both systems. Solving Equation 2, we obtain application efficiencies of 89.5% for the LEPA system and 66.9% for the LESA system. The efficiency for the LESA system assumes that there is a substantial crop canopy to intercept water before it reaches the soil surface. Without such a canopy, the corresponding application efficiency would increase to 78.9% for the LESA system.

Still, the LEPA system should be substantially more efficient in supplying water to the plants than a LESA system.

In a similar investigation conducted the previous year, a higher yield was reported by the producer for the LEPA span as compared to the LESA span, suggesting that the water applied by the LEPA system was more effective in producing yield.

No major deficiencies were noted for the three irrigation systems audited. Correction of the small number of defective emitters per system would not realize significant water savings. Correcting the below-trend application rates in the two inner spans of Site 4 would result in greater overall water use. No significant net decrease in water use would be realized by correcting the below- and above-trend application rates for the affected spans for Site 31.

As indicated by the comparison of LEPA and LESA systems in Site 31, substantial annual water savings could be realized by switching from LESA to LEPA, assuming the choice of crop allowed it. If we assume an average application efficiency of around 73% (midway between the values with and without a crop canopy) for the LESA system, a producer who applied 15 inches of irrigation during the year using LESA would have realized an additional 1.6 inches of water available to be taken up by the crop if the 15 inches had been applied using LEPA.

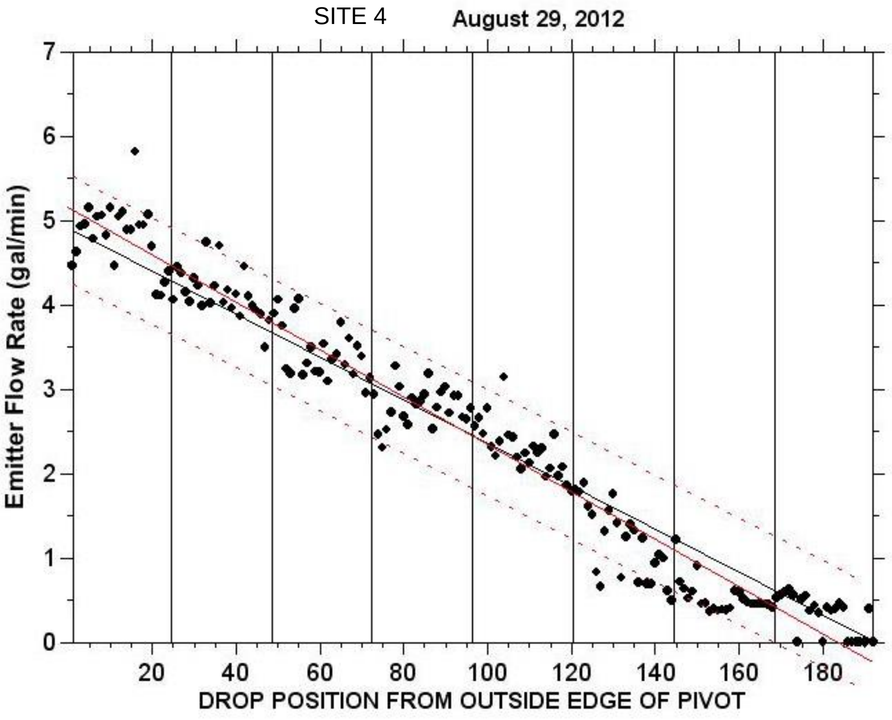


Figure 30. Trend in emitter flow rates for Site 4.

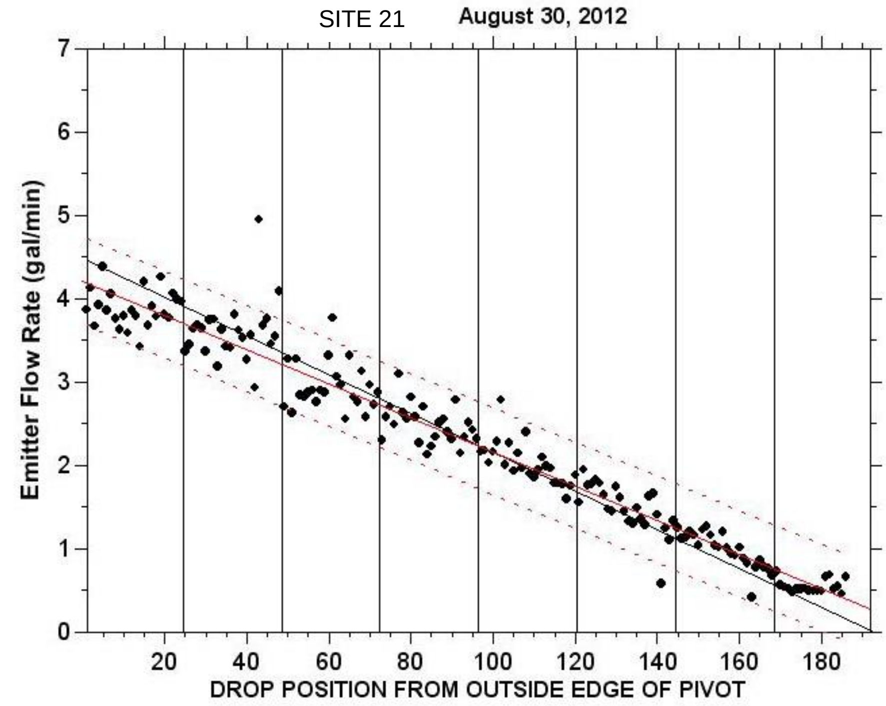


Figure 31. Trend in emitter flow rates for Site **2**1.

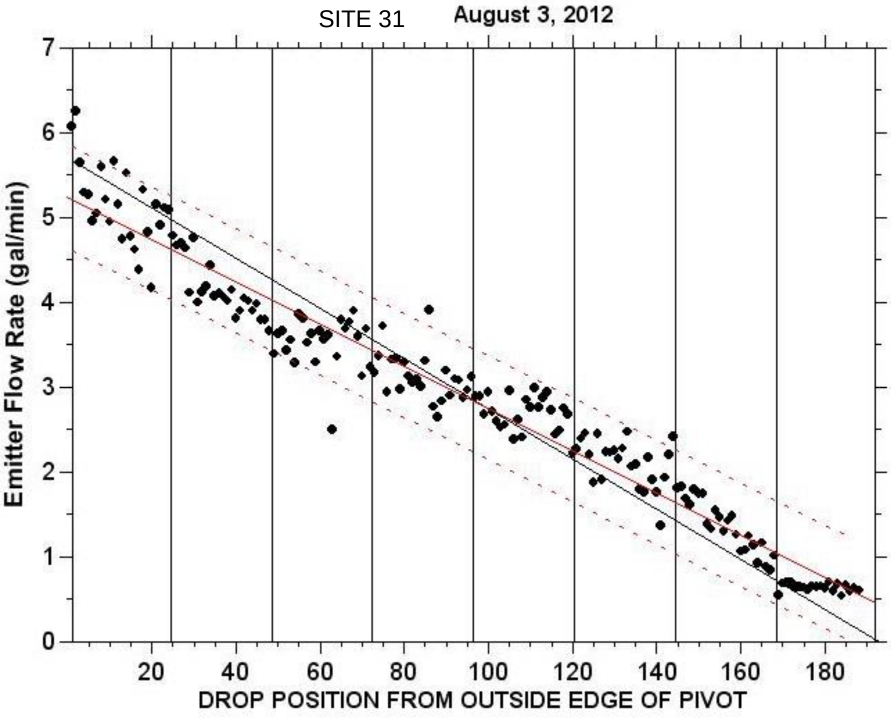


Figure 32. Trend in emitter flow rates for Site 31.

PUBLICATIONS AND PRESENTATIONS RELATED TO TAWC

Guo, Wenxuan, Stephan Maas and Kevin F. Bronson. 2012. Relationship between cotton yield and soil electrical conductivity, topography, and Landsat imagery. Precision Agriculture, 13(6): 678-692.

Nair, Shyam, Stephan Maas, Changgang Wang, and Steven Mauget. 2012. Optimal field partitioning for center-pivot-irrigated cotton in the Texas High Plains. Agronomy Journal, 105(1): 124-133.

Maas, Stephan. 2012. Combining Remote Sensing and Crop Modeling: It's Like Baking a Cake. Abstracts, Annual Meetings of the American Society of Agronomy, 21-24 October 2012, Cincinnati, OH. (abstract)

Rajan, Nithya, and S. J. Maas. 2012. Inter-Annual Variation In Carbon Dioxide and Water Fluxes From a Grazed Pasture In the Semi-Arid Texas High Plains. Abstracts, Annual Meetings, Amer. Soc. Agronomy. 21-24 October 2012, Cincinnati, OH**.** (abstract)

Rajan, Nithya, M. Roy, S. J. Maas and F.M. Padilla. 2012. Soil Background Effects On Reflectance-Based Estimates of Leaf Area Index of Cotton. Abstracts, Annual Meetings, Amer. Soc. Agronomy. 21-24 October 2012, Cincinnati, OH**.** (abstract)

Maas, Stephan, and Nithya Rajan. 2012. Spectral Crop Coefficient Approach: Its Development and Validation. Proceedings, 2012 UCOWR/NIWR Annual Conference, 17-19 July 2012, Santa Fe, NM. (abstract)

Rajan, Nithya, and Stephan Maas. 2012. Comparison of the Spectral Crop Coefficient and Standard Crop Coefficient Approaches. Proceedings, 2012 UCOWR/NIWR Annual Conference, 17-19 July 2012, Santa Fe, NM. (abstract)

TASK 6: Communications and Outreach
Annual Report ending February 28, 2013

Principal Investigator(s): Dr. David Doerfert (TTU)

Several activities were designed and implemented in 2012 towards the goal of expanding the community of practice that is developing around agricultural water conservation. Behind the scenes, additional steps were taken to increase the awareness and potential influence of the TAWC project beyond the region. David Doerfert and Samantha Borgstedt completed the majority of the work with assistance by graduate students funded by Texas Tech University.

More specific details of these and additional accomplishments are described below under each of the four communication and outreach tasks.

6.1 *Increase awareness, knowledge, and adoption of appropriate technologies among producers and related stakeholder towards the development of a true community of practice with water conservation as the major driving force.*

<u>6.1 — Accomplishments</u>

NEW – Summer Water Management Update meetings

In cooperation with Texas AgriLife Extension Service, TAWC hosted three Summer Water Management Update meetings taking place at individual farm locations on June 19-21, 2012. The first meeting was held Tuesday, June 19, at the barn of Lloyd Arthur in Lorenzo, Texas. There were approximately 22 people in attendance at this meeting. The second was held Wednesday, June 20, at the barn of Blake Davis in Littlefield, with approximately 18 people in attendance. The final meeting was held on Thursday, June 21, at the barn of Glenn Schur in Plainview. This meeting drew our largest crowd of approximately 30 attendees. Speakers at these meetings included representatives from John Deere Water and AquaSpy discussing their water monitoring technologies. Dr. Calvin Trostle of Texas AgriLife Extension Service also covered water requirements of various crops and how these technologies affect the timing of water application. Rick Kellison, TAWC project director, demonstrated how to use the TAWC tools. These meetings lasted two hours each and we had great response from producers. They liked the format and ability to ask questions on a one-on-one basis.

Farmer Field Day #1 (August 9, 2012)

Due to the continued drought, we focused on what results could be experienced by participants in this drought influenced growing season. The agenda included expert speakers, field tours where discussions were held with TAWC producers, a catered lunch, and keynote speaker Pete Laney. Sponsors also set up booths that attendees could visit during breaks and lunch. There were 60 people in attendance. Additional logistical work for this event included reserving facility, portable restrooms, tent, chairs, buses, caterer, speakers, and finalizing individual agendas. Based on post-workshop evaluation results submitted by the participants, attendees were very satisfied with all aspects of the program.

Farmer Field Day #2 (January 17, 2013)

The TAWC spring planning meeting that was held January 17, 2013, at the Unity Center in Muncy, TX. Planning activities included promotion of the events through radio advertisements, “save the date” cards, mail outs, press releases, email and social media. Additional effort was put forth towards the development of the morning program and coordination of speakers, facilitates and refreshments for the meeting, which included coffee and donuts as well as a catered lunch. Nearly 60 farmers and industry professionals attended the event. The meeting was also broadcast by KFLP All Ag, All Day Radio.

Informational Items Created & Disseminated

New materials were created for use in the TAWC booth including a “save the date” card for the 2012 & 2013 field days. In addition, a new summary of research summary was prepared titled "When Water Determines Your Success." This handout illustrated the return that sorghum, corn, and cotton returned for per inch of irrigation and is reportedly being used by the Kansas state government in their agriculture water discussions. Also new was a document titled "Increasing Sustainability of Production Agriculture: Glen Schur." This handout profiled one of the TAWC producers and his efforts to improve his water management practices including the use of TAWC Solution tools—Resource Allocation Analyzer and the Irrigation Scheduling tool.

In addition to these new items, work continued on the web-based water management guide for producers—a collaboration with several of the Texas commodity groups. This was created and on display during the farm shows for producer review and feedback.

Presentations and Project Promotions

Samantha Borgstedt and graduate assistant Nichole Sullivan staffed an information booth at the 2012 Texas Gin Association meeting March 29-30, 2012. Project materials were distributed to attendees and the TAWC tools and water management guide were shared. Project descriptions and summaries of research were distributed to 3,000 attendees.

The new materials were used in the TAWC booth at the 2012 Amarillo Farm & Ranch Show (Nov. 27-29, 2012) including a “save the date” card for the 2013 field day. Doerfert and Borgstedt staffed the booth experiencing heavier interest than in previous years. Project descriptions and summaries of research were also distributed to attendees.

Doerfert staffed an information booth at the 2013 Beltwide Cotton Conference in San Antonio January 7-9, 2013. Project materials were distributed to attendees and the TAWC tools and water management guide were shared.

Borgstedt had several on-air appearances that included the Farm Bureau Radio Network and two regional agriculture radio programs during the Summer 2012 months to promote the Summer Water Management meetings and the August field day. Doerfert appeared on Fox 950 AM radio on Tuesday, January 15th to share latest project activities including information related to the January field days.

Borgstedt and Kelly Harkey (new masters-level graduate assistant funded by Texas Tech University) update the project's Twitter and Facebook accounts regularly with new tweets/postings. In addition, reprints of all handouts were made to replenish dwindling supplies.

6.2 *Project communication campaign planning, implementation, and related research activities.*

As the communications and outreach activities move from the initial efforts to create awareness of the TAWC project and the launch of a community of practice to activities that will facilitate the adoption of the research results and best practices produced in the previous years, additional communication planning and research activities were conducted to achieve the desired future outcomes. The items that were accomplished are listed below.

6.2a — Accomplishments: *Communications Planning*

Photo documentation of the individual field sites continued with five visits during 2012 growing season. These photographs were used in the preparation of a variety of information resources as a visual indicator of the project activities and results. Additional project photos were taken during tours of the project sites and at various related events including the farmer field days.

Dr. Doerfert completed an award application to American Water Resources Association (AWRA) for integrated water management projects. While not selected as the national winner, the application lead to the project being asked to submit a case study about the TAWC so that others may learn about our success (Note: TAWC won the award in 2013). Dr. Doerfert will present a webinar in April 2013 highlighting the project and its collaborative efforts.

Finally, a clipping service was continued to help the project monitor the extent and type of print media coverage on the TAWC project. Content analysis illustrated that the drought was a driver in increased print media coverage of agriculture water-related topics.

6.2b — Accomplishments: *Research*

Dr. Doerfert met with representatives from six universities in Dallas on November 16-18, 2012 to continue efforts that would secure funding to expand the social science research efforts of the TAWC project. Discussions included establishing baseline data on community resiliency.

Three project-related papers were shared at the 48th annual American Water Resources Association (AWRA) conference in Jacksonville, FL, November 12-15, 2012. The paper titles and authors were:

- *Crop Production Water Management Tools for West Texas Farmers* by David Doerfert, Rick Kellison, Phil Johnson, Steve Maas, Justin Weinheimer.
- *The Texas Alliance for Water Conservation: An Integrated Water Resources Management Model for Agriculture* by David Doerfert
- *Use of Multi-user Virtual Environments (MUVEs) for Training Purposes* by David Doerfert and Tracy Rutherford.

Nichole Sullivan successfully defended her thesis research on March 27, 2012. Dr. Doerfert served as her committee chair. Nichole's study focused on Texas agriscience teachers in the semi-arid and arid regions of Texas and the inclusion of agricultural water management content in their local instructional efforts. The following is a quote from her thesis.

> *High school agriscience teachers are an important factor in the future success of the Texas agriculture industry. As one of the early influencers of future industry leaders, agriscience teachers help to shape individual students and the communities in which they teach and reside. Within this changing environment of dwindling water resources, changes in TEKS, and new technologies and regulations, we need to know what instructional support, in terms of materials and training, agriscience teachers need to enhance their instructional efforts and abilities in teaching TEKS-related water management and conservation curriculum in their classrooms. The purpose of this study was to determine the instructional needs of Texas agriculture science teachers as it pertains to the teaching of agricultural water management and conservation. A population of 658 Texas agriscience teachers was surveyed collecting quantitative data related to the teachers' beliefs, attitudes, and levels of inclusion, confidence, and importance of water-related material in classroom curriculum. Responses were voluntary and yielded a 74% response rate. Results indicated that agriscience teachers feel content relating to water management and conservation is important, but lack the confidence for full inclusion of the material into the classroom. Agriscience teachers identified instructional materials being used in the classroom along with how they seek out information on water management and conservation. The results will facilitate possible professional development activities for Texas agriscience teachers as well as teaching materials incorporating water management and conservation.*

Two Letters of Intent were filed with USDA Agriculture and Food Research Initiative Climate Change: Change Mitigation and Adaptation in Agriculture research area for potential research projects connected to the TAWC project. One was focused on the potential impact of various winter cover crops on soil moisture and the second sought to begin a data analytic system that facilitate a farmer's decision-making processes while being easy to read and use on mobile devices. Work is underway to submit full proposals for the April 2013 deadline.

To better understand the challenges that will need to be overcome to achieve wide-scale adoption of more efficient and effective water management practices and technologies, one-on-one interviews were conducted Doerfert and graduate assistants with the producers involved in the TAWC project. The rationale for using this population was that these farmers likely represent other farmers in the region who would be the most likely to be early adopters of change in their agriculture water management practices. To encourage honesty in their responses, the identity of the individual farmers was known only to the TAWC management team interviewer and was not shared with other members in the TAWC project except in summary form. The following is a detailed analysis of the interviews, followed by six summary bullets of the findings.

The most consistent response was that the farmers involved in the demonstration project increased their understanding of agricultural water management practices and technologies as a result of their involvement in the TAWC project. As 2012 was the initial year that reporting was required in the High Plains Underground Water District, the farmers in the TAWC felt that they benefitted from the installation of water and crop measurement technologies on their respective systems beginning for some as early as 2005. To that end, nearly all interviewed farmers expressed that they were initially uncertain as to their water availability and the amount of water they were applying with each irrigation event, but soon found themselves looking at the digital displays of the various data collection devices on a regular basis. From this initial learning outcome, the extent of additional learning-related activity varied greatly. Some producers were more willing to examine additional emerging technologies as they sought to determine which combination of data sources best facilitated their production goals and decision-making styles. Some producers would read the TAWC annual report from cover-to-cover and compare their outcomes to other producers and sites in the project, while others would only examine their system's outcomes. Similarly, some farmers attended each TAWC educational event while others did not, again focusing on their own systems and personal learning strategies versus those provided by others.

Consequently, it was clear from the interviews and consistent with previous research conducted in the TAWC project that West Texas farmers and ranchers are not a homogeneous population. Depending on the factors examined—number of information channels used, trust in information sources, beliefs about the management of water and related policy, propensity to change management practices from year-to-year, and individual comfort and personal preferences related to irrigation production practices utilized—six different segments emerged. The segmentation results illustrated that potentially three population segments exist in terms of influencers on adoption-related decision making: (a) those individuals who focus solely on economic-related information that maximizes profitability; (b) those who use a more system-oriented approach considering multiple factors (economics, availability of supportive resources (e.g. equipment, labor), water availability, and personal/family needs/goals) to make decisions even if the decision is not the most economically profitable; and (c) those driven by production traditions of their operation and local cultural norms to guide their decisions. Any segmentation can complicate strategies designed to increase rate and extent of adoption. As such, different tactics will be required for each identified segment. Unfortunately, such efforts are typically conducted with a fixed set of human and fiscal resources. Their potential effectiveness is likely diluted as change agents will either (a) concentrate efforts on only one segment, or (b) spread the limited resources over all segments. Either strategy yields less than ideal results towards collective water management goals.

The majority of the farmers in the TAWC project professed that the most influential factor for change in their production systems were other farmers in their personal networks. When asked from whom they most commonly seek information and who seeks information from them, nearly every farmer cited the same names. When examined further, some of these information exchange networks were formed during their K-12 education and were strengthened as each became the primary decision maker in their production enterprise. As such, change occurred when one member of this network made a change or adopted a new technology that was successful and shared the result with others in the network. While this seemingly confirms with previous adoption-related research, variance was seen in terms of innovativeness of the different networks identified, with some networks being more innovative or willing to try new technologies/practices than other networks. While one can argue that change is an individual behavior, it would appear that efforts to increase adoption of water management strategies and technologies must begin with an understanding of the networks that exist within the farmer population and the willingness of the members within these unique networks to consider change.

When questioned about the new technologies and production-related practices tested in the TAWC project, the producers generally saw their demonstrations as helpful but complex and, at times, overwhelming. Most often cited as a barrier to adoption were the costs related to the technology (e.g. unit cost, the total cost to fully adopt across their entire operation, labor/time to install), and the personal time necessary to learn the nuances of each technology. To the latter barrier, technologies such as crop stress sensors, soil moisture probes, and pivot management technologies operate independently of each other, thus requiring the farmer to examine the complex data generated from each crop production system in their farming enterprise to make daily (perhaps hourly) decisions. This was commonly perceived as too time consuming of a task as other aspects of their operation and their personal lives also required their attention.

Those seeking to adopt new water management technologies were increasingly looking to their crop consultants for assistance. Initially used for pest management assistance, the farmers stated that they were either asking or being offered by crop consultants assistance on all aspects of crop production including water management tactics. The interviews revealed that crop consultants were most frequently recommending practices and technologies that they were most knowledgeable of and, at times, were reportedly unwilling to recommend alternatives that they were unfamiliar with. As such, the capacity of crop consultants to fully understand and correctly apply water management technologies and practices to the variety of commodities and irrigation systems found in

West Texas is a potential barrier to wide-scale adoption. Until such time when farmers have a business analytics tool that seamlessly integrates data from all production-related technologies and sources into one easy-to-use mobile dashboard, the reliance on crop consultants for water management strategies and tactics is likely to increase. To facilitate their success and the adoption of more effective and efficient water management practices and technologies, efforts to initially prepare and update crop consultants must both improve in content and increase in frequency.

The final barrier to adoption identified through the interviews is likely the most difficult to overcome—the fear of change in what was commonly linked to individual water rights. All farmers interviewed stated that they had experienced negative reactions from other farmers who felt that their involvement in the TAWC project was the reason that the High Plains Underground Water District implemented the water restriction policies. Most commonly expressed as the source of this negative reaction from others was the belief that if the District had not known that profitable crop production systems could be achieved on 15 inches of irrigation (1.25 acre feet), then they would not have created the policy. While this negative reaction was not received from every farmer/stakeholder they interacted with, this reaction was strong enough to leave a lasting impression on those farmers involved in the project. Some of the interviewed farmers expressed surprise to this reaction from others as these same farmers would also frequently share that they did not believe they had the same levels of water available as they did years ago—a point more strongly expressed in light of current drought conditions. Yet despite this apparent contradiction in beliefs, the current negative reaction persists with the TAWC being perceived as the cause for the change in policy. While a portion of the farmers interviewed expressed that this experience caused them to question their continuation in the TAWC project, most saw the benefits from their involvement (both personally and as a service to other farmers) outweighing this negative reaction. While the passage of time during the implementation of the District's water restrictions may result in the non-TAWC farmers experiencing the same positive learning outcomes that those in the project gained, the segmentation described in the West Texas farm population combined with the strong influence of personal networks will likely make the overall change to more positive attitudes towards agricultural water management a slow process. To this point, the role of crop consultants may be the single, most important variable to changes in agriculture water management in West Texas.

The above analysis is summarized below:

- The most consistent response was that the farmers involved in the demonstration project increased their understanding of agricultural water management practices and technologies as a result of their involvement in the TAWC project.
- It was clear from the interviews and consistent with previous social science research conducted in the TAWC project that West Texas farmers and ranchers cannot be thought of a homogeneous population creating the need for multiple strategies when disseminating research results and best practices.

- The majority of the farmers in the TAWC project professed that the most influential factor for change in their production systems were other farmers in their personal networks.
- When questioned about the new technologies and production-related practices tested in the TAWC project, the producers generally saw the demonstration of these as helpful but complex and, at times, overwhelming. Most often cited as a barrier to adoption were the costs related to the technology (e.g. unit cost, the total cost to fully adopt across their entire operation, labor/time to install), and the personal time necessary to learn the nuances of each technology.
- Those seeking to adopt new water management technologies were increasingly looking to their crop consultants for assistance in dealing with greater technology complexity and time constraints for them to personally learn the new technologies.
- The final barrier to adoption identified through the interviews is likely the most difficult to overcome—the fear of change in what was commonly linked to individual water rights.

6.3 *Creation of longitudinal education efforts that include, but are not limited to, Farmer Field Schools and curriculum materials.*

6.3 — Accomplishments

Building on the thesis research completed by Lindsay Graber, plans are being made to increase the use of social media technologies in promoting the project and water conservation by producers.

As more have learned about the project, relevant education and project promotion outlets have emerged. To that end, Doerfert participated in the *Drought Outlook and Assessment* forum held on the Texas Tech campus on April 27, 2012 and the *Texas Water Summit* in Austin May 20-21, 2012.

6.4 *It is the responsibility of the leader for this activity to submit data and reports as required to provide quarterly and annual reports to the TWDB and to ensure progress of the project.*

6.4 — Accomplishments

- Timely quarterly reports and project summaries were provided as requested.

TASK 7: Producer Assessment of Operation
Annual Report ending February 28, 2013

Principal Investigator(s): Dr. Calvin Trostle (Texas A&M AgriLife Extension)

Support to Producers

Visits were made with eleven producers during 2012 about their operations as part of the ongoing producer assessment of their needs and what crop information they would like to have for their operation. Numerous research and extension reports were provided as needed in the TAWC area.

Common questions among producers in 2012 were on split pivot irrigation scenarios (see the base information, updated for 2013, at http://lubbock.tamu.edu/files/2013/03/Texas-South-Plains-Irrigation-Strategies-2013.pdf) whereby producers are choosing two different crops over which to spread water use (and demand) rather than require irrigation on a full circle at one time. Then as the drought deepened its grip, information was sought on how different crops respond to drought and what to do about water intensive crops that were failing and what to do.

Field Demonstrations

Lockney & Brownfield Range Grass & Irrigation Trials

One season-long harvest was conducted in early November. The trial was irrigated at the 0", 3", and 6" levels. Forage samples remain in storage for weighing and reporting. Growth was minimal, and all species still demonstrated effects of the 2011 drought as recovery was fair at best.

Opportunities to Expand TAWC Objectives

Project awareness: Commented on the project on eight different radio programs, answered producers phone calls, and information and the approach that the TAWC project is taking has helped shape other programs and Extension activities in the Texas South Plains.

Educational Outreach

Participated in four TAWC educational meetings in the region as well as three county Extension meetings covering the TAWC demonstration area in 2012. These included the Hale Co. crops conference, Floyd-Crosby crops conference, and a series of three TAWC irrigation meetings in June 2012.

Existing Texas A&M AgriLife Extension publications and reports were provided in the TAWC target area to at least 11 producers.

Support to Overall Project

Activities include attending five monthly management team meetings and/or producer advisory board meetings.

Report A

Perennial Grasses for the Texas South Plains: Species Productivity & Irrigation Response

Project conducted at: Eddie Teeter Farm, Lockney, Texas (seeded April 2006)
Mike Timmons Farm, Brownfield, Texas (initial seeding, June 2008; overseeded, May 2009)

Project Overview

Beginning in 2005 TAWC participants frequently discussed the slow but steady trend of producers converting cropland back into permanent grassland. Since then, due to expiring Conservation Reserve Program (CRP) contracts, a significant portion of land is being plowed up. There remains the opportunity for some of this land, where row cropping is problematic, could contain perennial pasture grasses irrigated at amounts considerably less than that applied to row crops. A trial was initiated in 2006 at the Eddie Teeter farm (Site 21), and a second site was initiated in Terry Co. in 2008 (and overseeded in 2009) as an outreach of the TAWC project into surrounding areas. Forage yields for 2006-2011 are summarized in the 2011 Annual Report. Yields for 2012 and stand density data taken in 2013 will be reported in the 2013 Annual and Final Report.

Report B

Irrigated Wheat Grain Variety Trial Results, Floyd Co., Texas, 2011.

Irrigated grain trials for wheat were added in the fall of 2008 in Floyd Co. to represent the eastern South Plains. Duplicate tests occur in Yoakum, Castro, and other counties in the Texas Panhandle. Results were summarized in the 2011 Annual Report.

For further information on recent Texas High Plains wheat variety trials, consult the multi-year irrigated and dryland summary at http://varietytesting.tamu.edu and the Extension list of recommended varieties at http://amarillo.tamu.edu/ (find under 'Agronomy' then 'Wheat'), or contact your local county/IPM Extension staff or Calvin Trostle.

TASK 8: Integrated Crop/Forage/Livestock Systems and Animal Production Evaluation
Annual Report ending February 28, 2013

Principal Investigator(s): Dr. Charles West, Phil Brown (TTU)

Writing and editing manuscripts for publication was a major focus over the last year of this reporting period. Dr. Charles West succeeded Dr. Vivien Allen in leading Task 8 and has assumed the overall role of Program Administrator of TAWC.

During this transition period Dr. Vivien Allen has remained part-time and continued work on completing publications derived from our over-all research effort. The following papers with references have been published and/or accepted for publication:

1. Allen, V.G., C.P. Brown, R. Kellison, P. Green, C.J. Zilverberg, P.Johnson, J. Weinheimer, T. Wheeler, E. Segarra, V. Acosta-Martinez, T.M. Zobeck, and J.C. Conkwright. 2012. Integrating cotton and beef production in the Texas Southern High Plains. I. Water use and measures of productivity. Agronomy Journal104:1625-1642.

2. Zilverberg, C.J., V.G. Allen, C.P. Brown, P. Green, P. Johnson, and J. Weinheimer. 2012. Integrating cotton and beef production in the Texas Southern High Plains. II. Fossil fuel use. Agronomy Journal 104:1643-1651.

3. P. Johnson, C.J. Zilverberg, V.G. Allen, J. Weinheimer, C.P. Brown, R. Kellison, and E. Segarra. 2013. Integrating cotton and beef production in the Texas Southern High Plains: III. An economic evaluation. Agronomy Journal 105:929-937.

4. Song Cui, V.G. Allen, C.P. Brown, and D.B. Wester. 2013. Growth and nutritive value of three old world bluestems and three legumes in the semiarid Texas High Plains. Crop Science 53:1-12.

5. Davinic, M., J. Moore-Kucera, V. Acosta-Martinez, J. Zak, and V. Allen. 2013. Soil fungal groups' distribution and saprophytic functionality as affected by grazing and vegetation components of integrated cropping-livestock agroecosystems. Applied Soil Ecology 66:61-70.

6. Fultz, L.M., J. Moore-Kucera, T.M. Zobek, V. Acosta-Martínez, and V.G. Allen. 2013. Soil aggregate-carbon pools after 13 years under a semi-arid integrated crop-livestock agroecosystem. Soil Science Society of America Journal (Accepted with revisions).

7. Zilverberg, C.J., C.P. Brown, P. Green, M.L. Galyean, and V.G. Allen. 2013. Three integrated crop-livestock systems in the Texas High Plains: productivity and water use. Agronomy Journal (Accepted with revisions).

8. Li, Yue, F. Hou, J. Chen, C.P. Brown, and V.G. Allen. 2013. Long-term grazing of a rye cover crop by steers influences growth of rye and no-till cotton. Agronomy Journal (Accepted with revision).

9. Li, Yue, J. Chen, F. Hou, C.P. Brown, P. Green and V.G. Allen. 2013. Allelopathic influence of a wheat or rye cover crop on growth and yield of no-till cotton. Agronomy Journal (Accepted with revision).

The number of forage/livestock systems taking part in the demonstration project has declined due to retirement of a TAWC producer, changes in market prices for competing commodities, and the historic drought of 2011 cause sell-off of some cattle. We believe that water-conserving forage/livestock systems will become increasingly important as aquiver levels continue to decline in the Texas High Plains. As we look to the future and the next phase of TAWC we are planning to increase again the number forage/livestock systems among the demonstration sites. New forage research is planned at the Texas Tech research station at New Deal which will complement the on-farm demonstrations of forage/livestock systems within TAWC. We intend to promote education of forages and their role in reducing water use through proper management and strategic use in forage/livestock systems.

TASK 9: Equipment, Site Instrumentation and Data Collection for Water Monitoring Annual Report ending February 28, 2013

Principal Investigator(s): Jim Conkwright and Gerald Crenwelge (HPWCD #1)

Total Water Efficiency Summary

Table 36 gives the information relating to the irrigation efficiency. The values are based on using 100% of ET (ET Crop Water Demand column) and 70% effectiveness for rainfall during the growing season, which has been used in the past annual reports. The "Total Water Potentially Used" column is the "Total Crop Water" compared to the ET Crop Water Demand.

The ET Crop Water Demand was calculated using the TAWC ET calculator (Irrigation Scheduling Tool) for the available crops that include cotton, corn and sorghum.

This year was another dry year. Several crops were abandoned because of the lack of rainfall and weak irrigation. The stress on crops was compounded by the fact that we had more days with high winds, high air temperature and very low humidity. Several crops were abandoned because the irrigation was not sufficient to establish a crop or to make a harvest once it was established. In some instances, irrigation was applied for insurance purposes only. Therefore, more irrigation was applied than would have been done by the producer. Crop insurance requires a certain amount of production including irrigation before a loss claim can be made, which requires the producer to continue applying irrigation even after he knows the crop is lost. He could lose his claim if he does not follow current insurance requirements.

The extreme weather conditions this year make an evaluation of water efficiency difficult. In most cases, the few fields that had ample irrigation had to use a large amount of water to insure an adequate crop while those that did not have much irrigation did not use as much water. This difference was not a management difference but a water availability issue that is difficult to translate to an efficiency value. The potential irrigation conserved in Table 34 is represented in the last column.

Table 34. Total water use efficiency (WUE) summary by various cropping and livestock systems in Hale and Floyd counties (2012).

Year	Site	Field	Crop	Harvest status	Application method	Acres	Irrigation Applied (Inches)	Effective Rainfall (70% of Actual Rain)	Total Crop Water (Inches)	ET Crop Water Demand (Inches)	Total Water Potentially Used (%)	Total Water Potential Water Demand Conserved (%)	Total Water Potential Use (inches)	Total Irrigation Potentially Conserved (acre-feet)
2012	2	2	corn (research)		SDI	36.7	10.1	5.2	15.3	35.4	43.2%	56.8%	20.1	61.5
2012	2	3	cotton		SDI	22.8	15.0	5.7	20.7	23.6	87.4%	12.6%	3.0	5.6
2012	3	1	cotton		MESA	61.4	8.1	3.1	11.2	23.0	48.7%	51.3%	11.8	60.3
2012	3	2	cotton		MESA	61.4	8.7	3.1	11.8	23.0	51.3%	48.7%	11.2	57.2
2012	4	1	haygrazer		LEPA	13.2	12.2	3.5	15.7		na	na	na	na
2012	4	1	wheat		LEPA	13.2	2.1	4.1	6.2		na	na	na	na
2012	4	5	alfalfa		LEPA	16.0	28.3	7.3	35.6		na	na	na	na
2012	4	7	wheat		LEPA	13.7	2.9	4.1	7.0		na	na	na	na
2012	4	8	grain sorghum		LEPA	50.5	16.8	5.3	22.1	27.6	80.1%	19.9%	5.5	23.1
2012	4	9	cotton		LESA	30.5	12.9	6.0	18.9	20.8	90.8%	9.2%	1.9	4.9
2012	5	2	cotton	Abandoned	LESA	80.0	2.5	5.9	8.4		na	na	na	na
2012	5	14	cotton		LESA	400.0	12.8	6.0	18.8	20.2	92.8%	7.2%	1.5	48.3
2012	6	9	corn		LESA	60.6	35.0	4.1	39.1	35.0	111.8%	-11.8%	-4.1	-20.9
2012	6	10	corn	Abandoned	LESA	62.1	6.9	4.1	11.0		na	na	na	na
2012	7	1	sideoats		LESA	130.0	20.6	6.2	26.8		na	na	na	na
2012	7	1	sideoats hay		LESA	130.0	na	6.2	na	na	na	na	na	na
2012	8	1-4	sideoats		SDI	61.8	17.3	6.2	23.5		na	na	na	na
2012	8	1-4	sideoats hay		SDI	61.8	na	6.2	na	na	na	na	na	na
2012	9	1	grass		MESA	100.8	4.2	8.5	12.7		na	na	na	na
2012	9	2	cotton		MESA	137.0	16.9	8.1	25.0	21.4	116.9%	-16.9%	-3.6	-41.3
2012	10	1	grass		LESA	44.3	3.6	5.0	8.6		na	na	na	na
2012	10	4	grass		LESA	42.1	4.8	5.0	9.8		na	na	na	na
2012	10	5	corn silage		LESA	87.2	28.5	3.2	31.7	37.6	84.4%	15.6%	5.9	42.7
2012	11	1	grain sorghum		Furrow	45.2	12.0	3.6	15.6	24.9	62.8%	37.2%	9.3	34.9
2012	11	2	grain sorghum		Furrow	24.4	12.0	3.6	15.6	24.8	63.1%	36.9%	9.2	18.6
2012	11	3	grain sorghum		Furrow	22.0	12.0	3.6	15.6	24.8	63.1%	36.9%	9.2	16.8
2012	12	1	fallow	Fallow	Dryland	151.2	0.0	0.0	0.0		na	na	na	na
2012	12	2	fallow	Fallow	Dryland	132.7	0.0	0.0	0.0		na	na	na	na
2012	14	2	wheat		MESA	61.8	4.0	3.2	7.2		na	na	na	na
2012	14	3	cotton		MESA	62.4	9.0	2.2	11.2	19.8	56.7%	43.3%	8.6	44.7
2012	15	8	grain sorghum		SDI	57.2	28.4	2.7	31.1	25.2	123.4%	-23.4%	-5.9	-28.1
2012	15	9	grain sorghum		SDI	45.6	26.2	2.7	28.9	25.2	114.7%	-14.7%	-3.7	-14.1
2012	17	4	bluestem		MESA	111.8	8.2	6.9	15.1		na	na	na	na

2012	17	5	cotton		MESA	54.5	18.2	5.3	23.5	23.3	100.8%	-0.8%	-0.2	-0.9
2012	17	6	corn		MESA	54.5	35.5	4.1	39.6	38.2	103.8%	-3.8%	-1.5	-6.6
2012	18	1	cotton	Abandoned	MESA	60.7	1.2	4.8	6.0		na	na	na	na
2012	18	2	cotton	Abandoned	MESA	61.5	2.1	4.8	6.9		na	na	na	na
2012	19	9	cotton		LEPA	59.2	14.9	6.8	21.7	19.7	109.9%	-9.9%	-1.9	-9.6
2012	19	10	fallow	Fallow	LEPA	61.2	0.6	6.8	7.4		na	na	na	na
2012	20	1	corn silage		LEPA	117.6	21.9	3.7	25.6	38.2	67.1%	32.9%	12.6	123.1
2012	20	2	cotton		LEPA	115.7	19.2	6.7	25.9	22.7	114.3%	-14.3%	-3.3	-31.3
2012	20	2	triticale silage		LEPA	115.7	19.6	4.4	24.0		na	na	na	na
2012	21	1	haygrazer		LEPA	61.4	15.6	2.2	17.8		na	na	na	na
2012	21	1	wheat		LEPA	61.4	6.7	4.1	10.8		na	na	na	na
2012	21	2	cotton		LEPA	61.2	15.6	4.4	20.0	23.6	84.8%	15.2%	3.6	18.3
2012	22	3	cotton		LEPA	148.7	19.5	6.6	26.1	21.8	119.6%	-19.6%	-4.3	-53.0
2012	24	1	cotton		LESA	64.6	17.0	8.5	25.5	22.8	112.2%	-12.2%	-2.8	-15.0
2012	24	2	corn silage		LESA	65.1	21.9	6.3	28.2	36.9	76.5%	23.5%	8.7	47.0
2012	26	1	sunflowers		LESA	62.9	15.1	3.1	18.2		na	na	na	na
2012	26	2	cotton		LESA	62.2	14.8	6.0	20.8	21.0	99.0%	1.0%	0.2	1.1
2012	27	3	corn silage		SDI	48.8	13.7	3.2	16.9	38.1	44.5%	55.5%	21.1	86.0
2012	27	1 & 4	cotton		SDI	59.7	15.9	6.4	22.3	22.7	98.6%	1.4%	0.3	1.5
2012	28	1	cotton		SDI	51.4	8.3	2.8	11.1	16.8	66.1%	33.9%	5.7	24.4
2012	29	1	cotton	Abandoned	Dryland	50.8	0.0	5.7	5.7		na	na	na	na
2012	29	2	grain sorghum	Abandoned	Dryland	104.3	0.0	5.7	5.7		na	na	na	na
2012	29	3	cotton	Abandoned	Dryland	66.6	0.0	5.7	5.7		na	na	na	na
2012	30	1	cotton		SDI	21.8	13.6	4.2	17.8	22.4	79.5%	20.5%	4.6	8.3
2012	31	1	cotton		LEPA	66.1	19.0	6.2	25.2	22.0	114.8%	-14.8%	-3.3	-18.0
2012	31	2	millet seed		LEPA	55.4	22.0	5.5	27.5		na	na	na	na
2012	32	1	corn		LEPA	70.0	21.6	3.2	24.8	28.5	87.1%	12.9%	3.7	21.5
2012	33	2	corn		LEPA	70.0	18.7	3.1	21.8	37.9	57.5%	42.5%	16.1	94.0
2012	34	1	cotton	Abandoned	LESA	178.7	6.0	4.8	10.8		na	na	na	na
2012	34	2	corn		LESA	363.8	14.0	2.7	16.7	27.0	61.7%	38.3%	10.3	313.5
2012	34	3	cotton	Abandoned	LESA	183.9	6.0	4.8	10.8		na	na	na	Na

TOTAL IRRIGATION POTENTIALLY CONSERVED OF 919 ACRE-FEET IS THE SUM OF VALUES IN THE LAST COLUMN (ONLY INCLUDES RAINFALL AND IRRIGATION, NOT SOIL MOISTURE.) SEE TABLE 36 FOR TOTAL IRRIGATION POTENTIALLY CONSERVED WITH CHANGES IN SOIL MOISTURE FACTORED IN.

Water Use Efficiency Summary

Water use efficiency values are shown in Table 35. Neutron probe data were used to determine the beginning and ending soil moisture of the growing season for the specific crop that was grown. Silage and hay yield values are converted to a dry weight equivalent.

The dry year in 2012 influenced the values greatly. In nearly every case, the soil moisture values declined significantly during the crop season. The data also show several sites that had a significant amount of irrigation applied but where the crop was still abandoned before harvest.

In evaluating the results briefly, it is again apparent that the LEPA and subsurface drip types of irrigation are more efficient than the other forms of irrigation this year. The values need to be evaluated in a more statistical method at a later time but the results clearly show that the yield per inch of irrigation is much more efficient.

Table 35. Water use efficiency (WUE) by various cropping and livestock systems in Hale and Floyd counties (2012).

Year	System	Field	Crop	Harvest status	Application Method	Acres	Inches Soil Moisture at Planting (0-5 ft)	Inches Soil Moisture at Harvest (0-5 ft)	Soil Moisture Contribution to WUE	Irrigation Applied (Inches)	Growing Season Rain (in)	Effective Rainfall (70% of Actual Rain)	Total Crop Water (Inches)	Yield (lbs/ac)	Yield Per Acre Inch Of Irrigation (lbs.)	Yield Per Acre Inch Of Total Water (lbs.)
2012	2	2	corn (research)		SDI	36.7	9.5	6.3	3.2	10.1	7.4	5.2	18.48	5678	562.2	307.3
2012	3	1	Cotton		MESA	61.4	7.6	4.7	2.9	8.1	4.4	3.1	14.08	1535	189.5	109.0
2012	3	2	Cotton		MESA	61.4	4	1.4	2.6	8.7	4.4	3.1	14.38	1535	176.4	106.7
2012	4	5	Alfalfa		LEPA	16	7	4.2	2.8	28.3	10.4	7.3	38.38	16840	595.1	438.8
2012	4	7	Wheat		LEPA	13.7	5.6	2.5	3.1	2.9	5.8	4.1	10.06	2820	972.4	280.3
2012	4	9	Cotton		LESA	30.5	4.8	3.2	1.6	12.9	8.6	6.0	20.52	1093	84.7	53.3
2012	5	14	Cotton		LESA	400	7.1	5.1	2	12.8	8.5	6.0	20.75	541	42.3	26.1
2012	6	9	Corn		LESA	60.6	3.6	3.2	0.4	35	5.9	4.1	39.53	9800	280.0	247.9
2012	7	1	Sideoats		LESA	130	10.7	6	4.7	20.6	8.8	6.2	31.46	263	12.8	8.4
2012	8	1-4	Sideoats		SDI	61.8	3	1.3	1.7	17.3	8.8	6.2	25.16	271	15.7	10.8
2012	9	1	Grass		MESA	100.8	6.9	2.6	4.3	4.2	12.2	8.5	17.04	na	na	na
2012	9	2	Cotton		MESA	137	2.1	1.1	1	16.9	11.6	8.1	26.02	1074	63.6	41.3
2012	10	4	Grass		LESA	42.1	3	0.9	2.1	4.8	7.1	5.0	11.87	na	na	na
2012	10	5	corn silage		LESA	87.2	8.4	8	0.4	28.5	4.6	3.2	32.12	17500	614.0	544.8
2012	11	3	grain sorghum		Furrow	22	8.4	4.8	3.6	12	5.2	3.6	19.24	4922	410.2	255.8
2012	12	2	Fallow	Fallow	Dryland	132.7	3	2.3	0.7	0		0.0	0.7	na	na	na
2012	14	3	Cotton		MESA	62.4	1.4	2.1	-0.7	9	3.2	2.2	10.54	530	58.9	50.3
2012	15	8	grain sorghum		SDI	57.2	3.7	6.2	-2.5	28.4	3.9	2.7	28.63	8152	287.0	284.7
2012	15	9	grain sorghum		SDI	45.6	7.4	4.5	2.9	26.2	3.9	2.7	31.83	7800	297.7	245.1

2012	17	4	Bluestem		MESA	111.8	0.7	3.1	-2.4	8.2	9.8	6.9	12.66	na	na	na
2012	17	6	Corn		MESA	54.5	9.7	9.2	0.5	35.5	5.9	4.1	40.13	11592	326.5	288.9
2012	18	1	Cotton	Abandoned	MESA	60.7	2.5	3.8	-1.3	1.24	6.8	4.8	4.7	na	na	na
2012	18	2	Cotton	Abandoned	MESA	61.5	0.7	4.1	-3.4	2.1	6.8	4.8	3.46	na	na	na
2012	19	9	Cotton		LEPA	59.2	8.7	1.7	7	14.9	9.65	6.8	28.655	990	66.4	34.5
2012	20	1	corn silage		LEPA	117.6	8.4	6.1	2.3	21.9	5.3	3.7	27.91	22750	1038.8	815.1
2012	20	2	triticale silage		LEPA	115.7	7	6.3	0.7	19.6	6.3	4.4	24.71	8400	428.6	339.9
2012	21	1	Wheat		LEPA	61.4	3.6	3.4	0.2	6.7	5.9	4.1	11.03	1416	211.3	128.4
2012	21	2	Cotton		LEPA	61.2	6	3.2	2.8	15.6	6.3	4.4	22.81	1540	98.7	67.5
2012	22	3	Cotton		LEPA	148.7	7.8	6.9	0.9	19.5	9.4	6.6	26.98	1756	90.1	65.1
2012	24	1	Cotton		LESA	64.6	5.3	2	3.3	17	12.2	8.5	28.84	1951	114.8	67.6
2012	24	2	corn silage		LESA	65.1	7.2	7.1	0.1	21.9	9	6.3	28.3	10298	470.2	363.9
2012	26	1	sunflower		LESA	62.9	4.7	0.2	4.5	15.1	4.4	3.1	22.68	1903	126.0	83.9
2012	26	2	Cotton		LESA	62.2	2.9	5	-2.1	14.8	8.6	6.0	18.72	1091	73.7	58.3
2012	27	3	corn silage		SDI	48.8	7	5.7	1.3	13.7	4.6	3.2	18.22	21000	1532.8	1152.6
2012	27	1 & 4	Cotton		SDI	59.7	9.1	5.5	3.6	15.9	9.2	6.4	25.94	2036	128.1	78.5
2012	28	1	Cotton		SDI	51.4	6.1	4	2.1	8.3	4	2.8	13.2	2700	325.3	204.5
2012	29	1	Cotton	Abandoned	Dryland	50.8	3.5	0.7	2.8	0	8.2	5.7	8.54	na	na	na

Irrigation Efficiency Summary

Table 36 highlights the irrigation efficiency aspects of this study.

The “Total Crop Water” column in this table is derived from adding the irrigation plus 70% of the growing season rainfall.

The “ET Provided to Crop From Irrigation” column illustrates a relatively low percentage of the required ET that irrigation provided this year on many of the crops. The assumption for this study at the beginning was that 100% of the irrigation would be normal. On average, only 54% of the ET was provided by irrigation this year. Again, the values are biased because of the extremely dry conditions this year and the fact that several fields were abandoned at some time during the growing season. A more comprehensive analysis needs to be done to compare the abandoned fields in the data, which will be explored in Phase 2 of this project.

The potential irrigation conserved as acre-feet of water is presented in the last column.

Table 36. Irrigation efficiency summary by various cropping and livestock systems in Hale and Floyd counties (2012).

Year	System	Field	Crop	Harvest status	Application Method	Acres	Irrigation Applied (Inches)	Total Crop Water (Inches)	ET Crop Water Demand (Inches)	ET Provided to Crop From Irrigation (%)	Potential Irrigation Conserved (%)	Potential Irrigation Conserved (Inches)	Total Irrigation Potentially Conserved (acre-feet)
2012	2	2	corn (research)		SDI	36.7	10.1	15.3	35.4	28.5%	71.5%	25.3	77.3
2012	2	3	cotton		SDI	22.8	15.0	20.7	23.6	63.5%	36.5%	8.6	16.4
2012	3	1	cotton		MESA	61.4	8.1	11.2	23.0	35.3%	64.7%	14.9	76.0
2012	3	2	cotton		MESA	61.4	8.7	11.8	23.0	37.9%	62.1%	14.3	73.0
2012	4	1	haygrazer		LEPA	13.2	12.2	15.7		na	na	na	na
2012	4	1	wheat		LEPA	13.2	2.1	6.2		na	na	na	na
2012	4	5	alfalfa		LEPA	16.0	28.3	35.6		na	na	na	na
2012	4	7	wheat		LEPA	13.7	2.9	7.0		na	na	na	na
2012	4	8	grain sorghum		LEPA	50.5	16.8	22.1	27.6	60.8%	39.2%	10.8	45.5
2012	4	9	cotton		LESA	30.5	12.9	18.9	20.8	61.9%	38.1%	7.9	20.2
2012	5	2	cotton	Abandoned	LESA	80.0	2.5	8.4		na	na	na	na
2012	5	14	cotton		LESA	400.0	12.8	18.8	20.2	63.4%	36.6%	7.4	246.7
2012	6	9	corn		LESA	60.6	35.0	39.1	35.0	100.0%	0.0%	0.0	0.0
2012	6	10	corn	Abandoned	LESA	62.1	6.9	11.0		na	na	na	na
2012	7	1	sideoats		LESA	130.0	20.6	26.8		na	na	na	na
2012	7	1	sideoats hay		LESA	130.0	na	na	na	na	na	na	na
2012	8	1,2,3,4	sideoats		SDI	61.8	17.3	23.5		na	na	na	na
2012	8	1,2,3,4	sideoats hay		SDI	61.8	na	na	na	na	na	na	na
2012	9	1	grass		MESA	100.8	4.2	12.7		na	na	na	na
2012	9	2	cotton		MESA	137.0	16.9	25.0	21.4	79.0%	21.0%	4.5	51.4
2012	10	1	grass		LESA	44.3	3.6	8.6		na	na	na	na
2012	10	4	grass		LESA	42.1	4.8	9.8		na	na	na	na
2012	10	5	corn silage		LESA	87.2	28.5	31.7	37.6	75.8%	24.2%	9.1	66.1
2012	11	1	grain sorghum		Furrow	45.2	12.0	15.6	24.9	48.2%	51.8%	12.9	48.6
2012	11	2	grain sorghum		Furrow	24.4	12.0	15.6	24.8	48.4%	51.6%	12.8	26.0
2012	11	3	grain sorghum		Furrow	22.0	12.0	15.6	24.8	48.4%	51.6%	12.8	23.5
2012	12	1	Fallow	Fallow	Dryland	151.2	0.0	na		na	na	na	na
2012	12	2	Fallow	Fallow	Dryland	132.7	0.0	na		na	na	na	na
2012	14	2	wheat		MESA	61.8	4.0	7.2		na	na	na	na
2012	14	3	cotton		MESA	62.4	9.0	11.2	19.8	45.4%	54.6%	10.8	56.3
2012	15	8	grain sorghum		SDI	57.2	28.4	31.1	25.2	112.6%	-12.6%	-3.2	-15.1
2012	15	9	grain sorghum		SDI	45.6	26.2	28.9	25.2	103.8%	-3.8%	-1.0	-3.7
2012	17	4	bluestem		MESA	111.8	8.2	15.1		na	na	na	na

2012	17	5	cotton		MESA	54.5	18.2	23.5	23.3	78.2%	21.8%	5.1	23.0
2012	17	6	corn		MESA	54.5	35.5	39.6	38.2	93.0%	7.0%	2.7	12.2
2012	18	1	cotton	Abandoned	MESA	60.7	1.2	6.0		na	na	na	na
2012	18	2	cotton	Abandoned	MESA	61.5	2.1	6.9		na	na	na	na
2012	19	9	cotton		LEPA	59.2	14.9	21.7	19.7	75.6%	24.4%	4.8	23.7
2012	19	10	Fallow	Fallow	LEPA	61.2	0.6	na		na	na	na	na
2012	20	1	corn silage		LEPA	117.6	21.9	25.6	38.2	57.4%	42.6%	16.3	159.4
2012	20	2	cotton		LEPA	115.7	19.2	25.9	22.7	84.7%	15.3%	3.5	33.5
2012	20	2	triticale silage		LEPA	115.7	19.6	24.0		na	na	na	na
2012	21	1	haygrazer		LEPA	61.4	15.6	17.8		na	na	na	na
2012	21	1	wheat		LEPA	61.4	6.7	10.8		na	na	na	na
2012	21	2	cotton		LEPA	61.2	15.6	20.0	23.6	66.1%	33.9%	8.0	40.8
2012	22	3	cotton		LEPA	148.7	19.5	26.1	21.8	89.4%	10.6%	2.3	28.5
2012	24	1	cotton		LESA	64.6	17.0	25.5	22.8	74.7%	25.3%	5.8	31.0
2012	24	2	corn silage		LESA	65.1	21.9	28.2	36.9	59.4%	40.6%	15.0	81.2
2012	26	1	sunflowers		LESA	62.9	15.1	18.2		na	na	na	na
2012	26	2	cotton		LESA	62.2	14.8	20.8	21.0	70.3%	29.7%	6.2	32.3
2012	27	3	corn silage		SDI	48.8	13.7	16.9	38.1	36.0%	64.0%	24.4	99.1
2012	27	1 & 4	cotton		SDI	59.7	15.9	22.3	22.7	70.2%	29.8%	6.8	33.6
2012	28	1	cotton		SDI	51.4	8.3	11.1	16.8	49.4%	50.6%	8.5	36.4
2012	29	1	cotton	Abandoned	Dryland	50.8	0.0	5.7		na	na	na	na
2012	29	2	grain sorghum	Abandoned	Dryland	104.3	0.0	5.7		na	na	na	na
2012	29	3	cotton	Abandoned	Dryland	66.6	0.0	5.7		na	na	na	na
2012	30	1	cotton		SDI	21.8	13.6	17.8	22.4	60.8%	39.2%	8.8	16.0
2012	31	1	cotton		LEPA	66.1	19.0	25.2	22.0	86.5%	13.5%	3.0	16.4
2012	31	2	millet seed		LEPA	55.4	22.0	27.5		na	na	na	na
2012	32	1	corn		LEPA	70.0	21.6	24.8	28.5	75.8%	24.2%	6.9	40.3
2012	33	2	corn		LEPA	70.0	18.7	21.8	37.9	49.3%	50.7%	19.2	112.0
2012	34	1	cotton	Abandoned	LESA	178.7	6.0	10.8		na	na	na	na
2012	34	2	corn		LESA	363.8	14.0	16.7	27.0	51.9%	48.1%	13.0	394.1
2012	34	3	cotton	Abandoned	LESA	183.9	6.0	10.8		na	na	na	na

****TOTAL IRRIGATION POTENTIALLY CONSERVED OF 2,022 ACRE-FEET IS THE SUM OF VALUES IN THE LAST COLUMN (INCLUDES SOIL MOISTURE CONTRIBUTION, IRRIGATION AND RAINFALL)** THIS IS A MORE COMPLETE ESTIMATE OF TOTAL IRRIGATION POTENTIALLY CONSERVED THAN THAT SHOWN IN TABLE 34 BECAUSE THE SOIL MOISTURE CONTRIBUTION TO CROP WATER UPTAKE IS ACCOUNTED FOR.**

http://www.tawcsolutions.org

TAWC SOLUTIONS:
MANAGEMENT TOOLS TO AID PRODUCERS IN CONSERVING WATER

Rick Kellison
Justin Weinheimer
Philip Brown

The **Texas Alliance for Water Conservation** released three web-based tools to aid producers at our February 2011 field day. Producers involved in the TAWC project had indicated the need for tools to aid them in making cropping decisions and managing these crops in season.

The **Irrigation Scheduling Tool** is a field level, crop specific ET tool to aid producers in irrigation management. The producer can customize this tool for beginning soil moisture, effective rainfall, effective irrigation application and percent ET replacement. Users can select from a list of local weather stations that supplies the correct weather information for each field. Once the decision is made on which crop a grower plants, this tool produces an in-season, check-book style water balance output to aid in irrigation applications.

The **TAWC Resource Allocation Analyzer** provide producers with a simple, comprehensive approach to planning and managing various cropping systems. The Resource Allocation Tool is an economic based optimization model that aids producers in making decisions about different cropping systems. Based on available irrigation water, projected cost of production and expected revenue, this model will aid producers in their decisions to plant various crops.

Because of implementation of new water policy by the High Plains Underground Water Conservation District, growers need a method to determine the amount of irrigation that they were allowed to apply to each irrigated acre. The **Contiguous Acre Calculator** allows growers to project specific levels of irrigation water to be applied to various delivery systems. The tool then calculates how much water can be banked for future use. Once the growing season is completed the producer can enter actual water applied and use it for record keeping.

Provided on the following pages are the usage instructions for each tool with more detail concerning each individual program as provided on our website.

TAWC ET

IRRIGATION SCHEDULING TOOL

THE *TAWC SOLUTIONS IRRIGATION SCHEDULING TOOL* is intended as an aid to producers in determining a more refined irrigation schedule. This program utilizes weather information collected from the Texas Tech Mesonet along with specific producer input information to automatically calculate and update the soil water balance for a specific crop based on information provided by the user. Some key inputs include: crop type, planting date, site rainfall, irrigation, and other environmental and producer information. This provides a checkbook-style water balance register with which a producer can determine when and how much water to apply for an irrigation event based on tracking of the soil water balance available to the crop at any given growth stage during the growing season. The TAWC Solutions Irrigation Scheduling Tool is designed to help producers make the most out of their irrigation regime while being conscious of this precious natural resource.

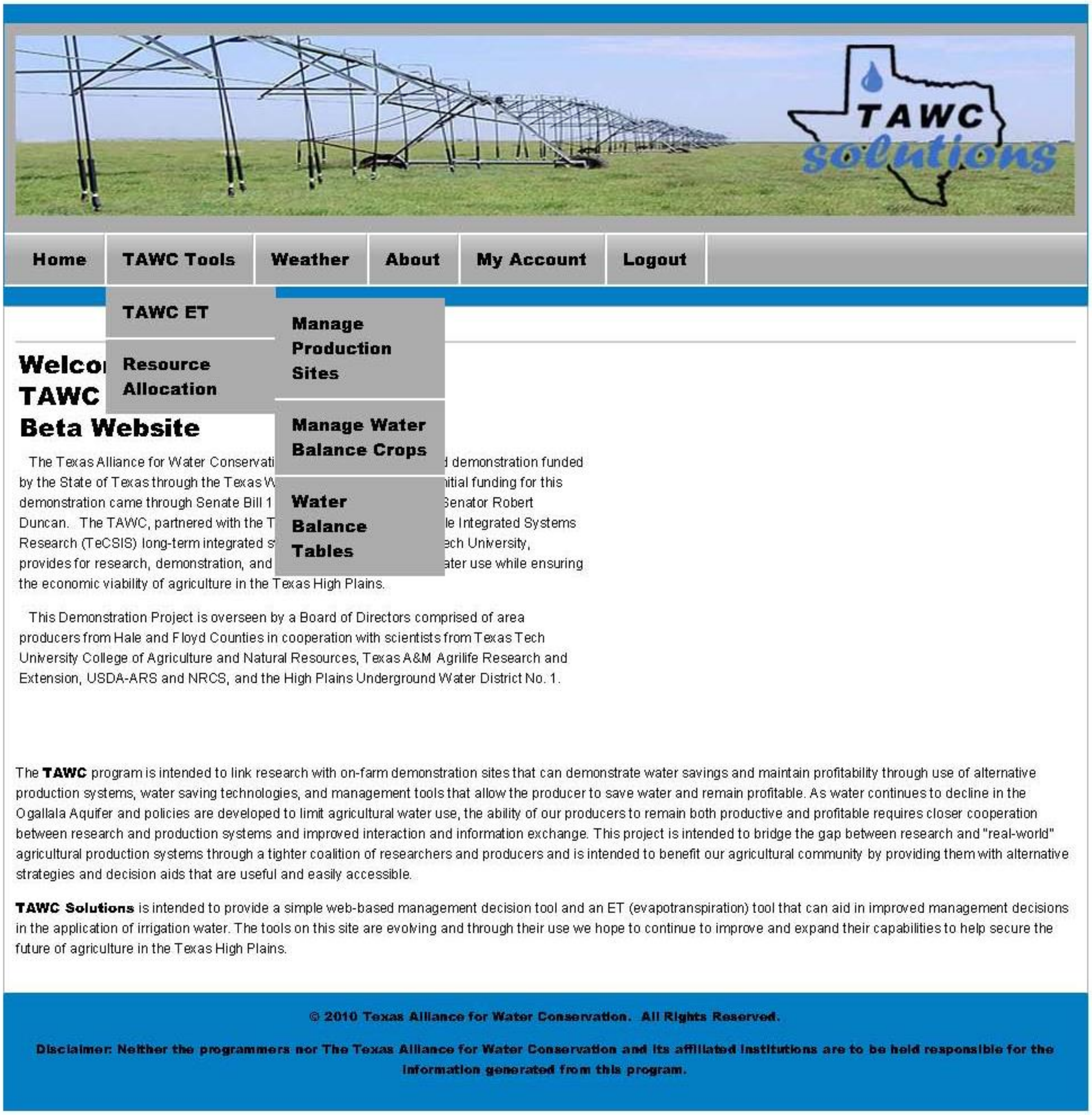
To utilize the **TAWC Solutions ET program** you must first create a User ID and Password by selecting **Request User ID/New Password** from the top of the TAWC Solutions homepage banner next to the logon prompts. Once this is completed, log into the site and place your mouse cursor over **TAWC Tools** from the Navigation menu at top and a drop down menu will appear with the following selections:

TAWC ET – Irrigation Scheduling Tool
Resource Allocation – Economic Decision Aid Tool

To begin, move your cursor over **TAWC Tools** then over **TAWC ET** on the main navigation menu and select **Manage Production Sites** from the side menu**.** A **Site** is considered a location and field is the irrigated field or crop for that location. There can be multiple fields per location (ie. pivot 1, pivot 2, drip 1 etc…).

Illustrations and instructions for use of the program are presented on the following pages.

Screen 1



Welco
TAWC
Beta Website

The Texas Alliance for Water Conservati … d demonstration funded
by the State of Texas through the Texas W … nitial funding for this
demonstration came through Senate Bill 1 … Senator Robert
Duncan. The TAWC, partnered with the T … le Integrated Systems
Research (TeCSIS) long-term integrated s … ech University,
provides for research, demonstration, and … ater use while ensuring
the economic viability of agriculture in the Texas High Plains.

This Demonstration Project is overseen by a Board of Directors comprised of area producers from Hale and Floyd Counties in cooperation with scientists from Texas Tech University College of Agriculture and Natural Resources, Texas A&M Agrilife Research and Extension, USDA-ARS and NRCS, and the High Plains Underground Water District No. 1.

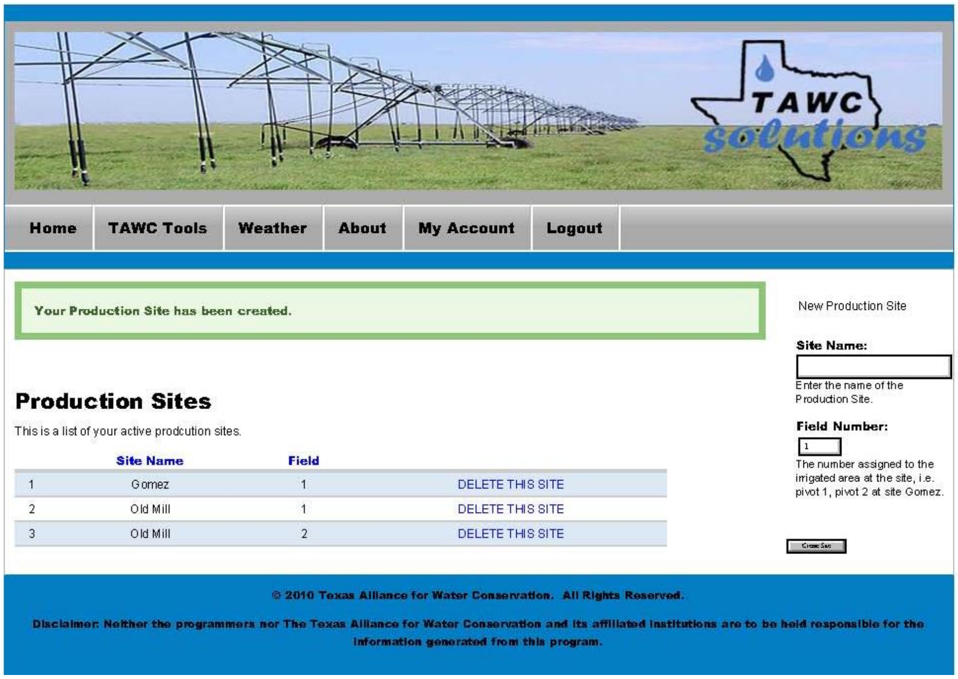
The **TAWC** program is intended to link research with on-farm demonstration sites that can demonstrate water savings and maintain profitability through use of alternative production systems, water saving technologies, and management tools that allow the producer to save water and remain profitable. As water continues to decline in the Ogallala Aquifer and policies are developed to limit agricultural water use, the ability of our producers to remain both productive and profitable requires closer cooperation between research and production systems and improved interaction and information exchange. This project is intended to bridge the gap between research and "real-world" agricultural production systems through a tighter coalition of researchers and producers and is intended to benefit our agricultural community by providing them with alternative strategies and decision aids that are useful and easily accessible.

TAWC Solutions is intended to provide a simple web-based management decision tool and an ET (evapotranspiration) tool that can aid in improved management decisions in the application of irrigation water. The tools on this site are evolving and through their use we hope to continue to improve and expand their capabilities to help secure the future of agriculture in the Texas High Plains.

Disclaimer: Neither the programmers nor The Texas Alliance for Water Conservation and its affiliated institutions are to be held responsible for the information generated from this program.

You will see a screen that states "There are no rows in this table." In the right column you have the option of entering a new site location name (ie. Gomez) in the box. Enter the desired name and irrigated field number (ie. pivot 1) and click "**Create Site".** You will then see a green confirmation box stating **"Your Production Site has been created"** with the new site name and an option to delete the site if desired. You can then create additional site locations and irrigated fields for each location as appropriate. A maximum of 10 fields per site location can be created. You can return to this page and create and delete site locations and fields as needs evolve or a new cropping year begins.

Screen 2



Your Production Site has been created.

Production Sites

This is a list of your active prodcution sites.

	Site Name	Field	
1	Gomez	1	DELETE THIS SITE
2	Old Mill	1	DELETE THIS SITE
3	Old Mill	2	DELETE THIS SITE

New Production Site

Site Name:

Enter the name of the Production Site.

Field Number: 1

The number assigned to the irrigated area at the site, i.e. pivot 1, pivot 2 at site Gomez.

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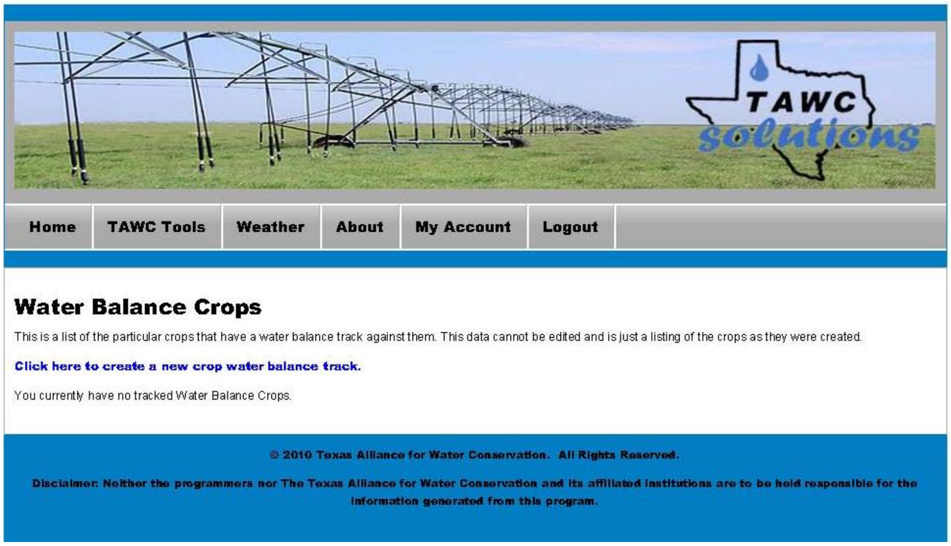
Return to **TAWC ET** on the navigation menu and select the next option "**Manage Water Balance Crops**", a new screen will appear with an option "Click here to create a new crop water balance track".

Screen 3



Water Balance Crops

This is a list of the particular crops that have a water balance track against them. This data cannot be edited and is just a listing of the crops as they were created.

Click here to create a new crop water balance track.

You currently have no tracked Water Balance Crops.

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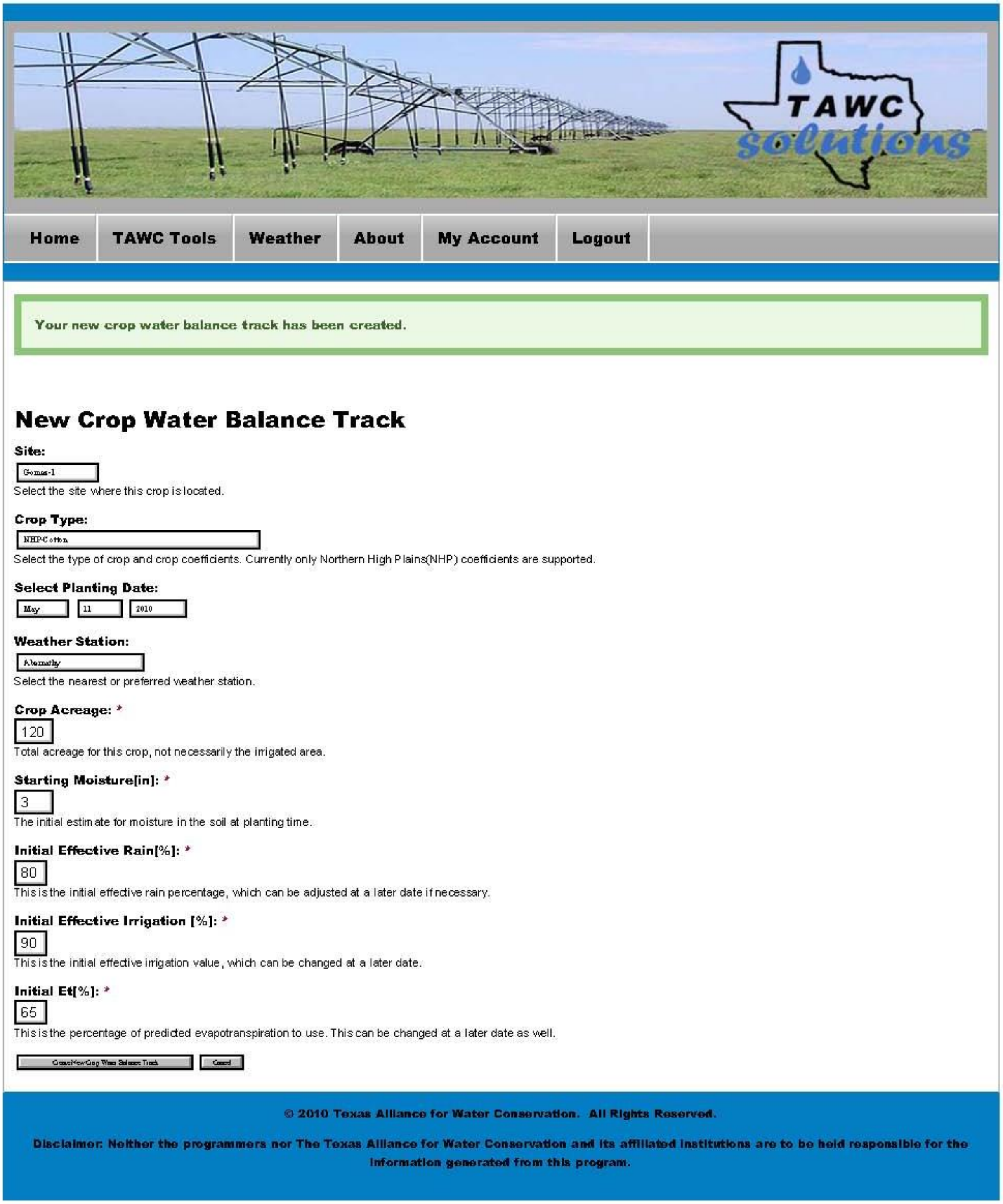
Click the text and a new **Crop Water Balance Track** information page will be presented. In the **Site** location box, select a previously entered **Production Site** from the drop down menu and provide all requested information, then select the "**Create New Crop Water**

Balance Track" button at the bottom of the page. You will then see a new page with a green confirmation box stating "**Your new crop water balance track has been created**".

Screen 4



Your new crop water balance track has been created.

New Crop Water Balance Track

Site:
Gomas-1
Select the site where this crop is located.

Crop Type:
NHP-Cotton
Select the type of crop and crop coefficients. Currently only Northern High Plains(NHP) coefficients are supported.

Select Planting Date:
May 11 2010

Weather Station:
Abernathy
Select the nearest or preferred weather station.

Crop Acreage: *
120
Total acreage for this crop, not necessarily the irrigated area.

Starting Moisture[in]: *
3
The initial estimate for moisture in the soil at planting time.

Initial Effective Rain[%]: *
80
This is the initial effective rain percentage, which can be adjusted at a later date if necessary.

Initial Effective Irrigation [%]: *
90
This is the initial effective irrigation value, which can be changed at a later date.

Initial Et[%]: *
65
This is the percentage of predicted evapotranspiration to use. This can be changed at a later date as well.

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Repeat this procedure for each **Production Site** and irrigation field created. Definitions for each input are provided on the next page.

The confirmation page will revert to default entries after clicking "Create New Crop Water Balance Track" for information requested and is not representative of the track just created.

Crop type: the appropriate crop being tracked for the specific site location and irrigation field.

Planting Date: date the irrigated crop is planted by selecting the appropriate month, day and year from the drop down menus.

Weather Station: select the closest weather station to the specific site location being tracked from the drop down menu list of stations from the Texas Tech Mesonet.

Crop Acreage: enter total field acres for a specific irrigated field.

Starting Moisture: an estimated soil profile water content in inches for your specific soil type based on soil probing to a depth of 3 feet within the field and is a number in 0.0 inches (ie. 2.5 inches).

Initial Effective Rain: the % (in whole numbers) rain that you expect to normally capture in any given rain event for your specific soil type (this number can be changed for any given event in the Daily Measurements table (ie. 85%).

Initial Effective Irrigation: the % (in whole numbers) of irrigation water that is expected to be absorbed by the soil profile at the site under a given irrigation method (ie. Sprinkler – 90%, Drip – 95%, etc…).

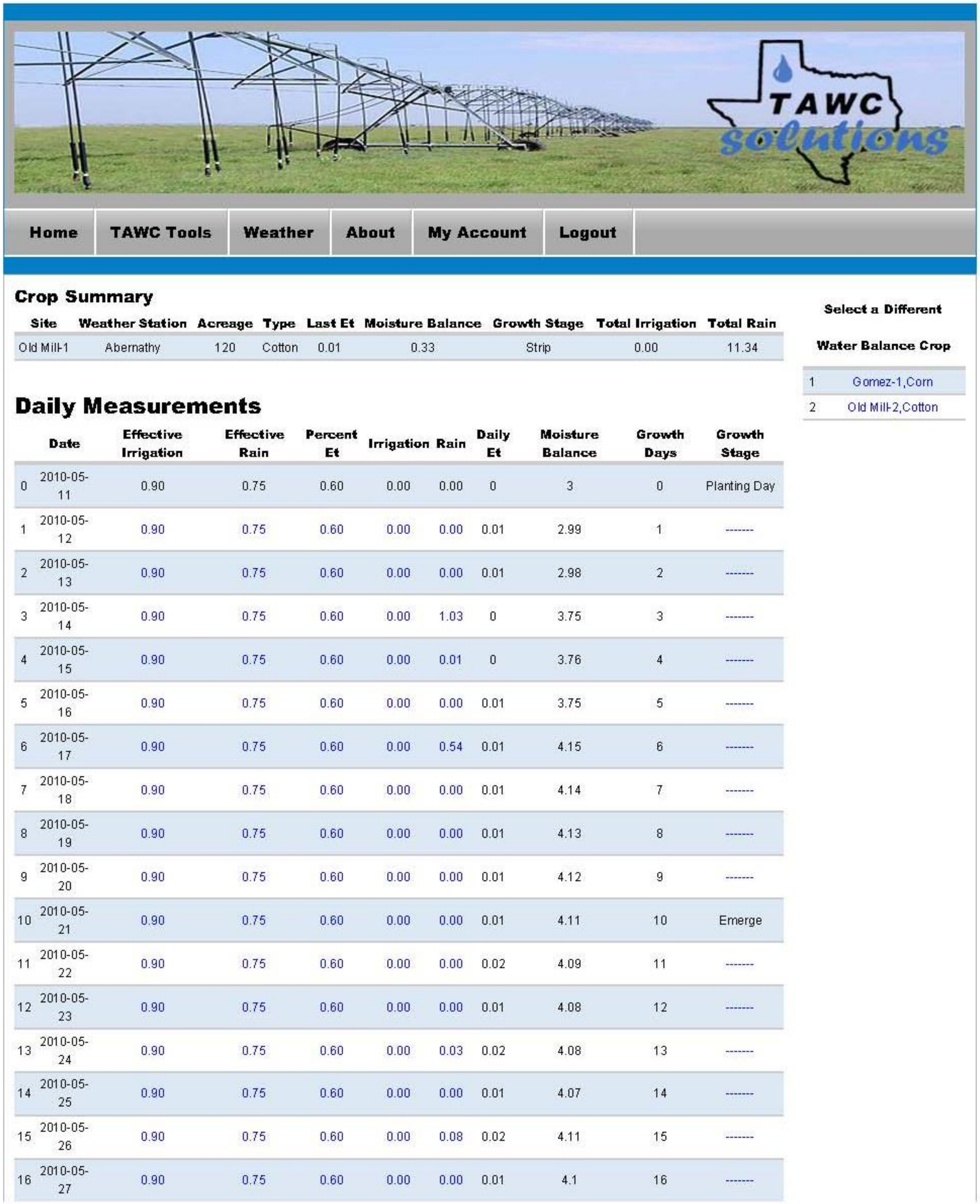
Initial ET: the % of ET or evapotranspiration that you desire to water a given crop and can vary from 0 to 100 % depending of specific producer management desires and goals.

NEXT SELECT **"WATER BALANCE TABLES"** FROM THE **TAWC ET** MENU.

You are now presented with the "Check Book" style register for monitoring and adjusting various parameters as the season progresses. The **Daily Measurements** table should be populated with default settings for Effective Irrigation, Effective Rain, and Percent ET based on the information you provided in creating a **Water Track**. You may change the displayed Water Balance Crop being monitored from the left hand column by selecting the desired crop to monitor and the page will update to display that specific location field and crop information. The top of the Table has a **Crop Summary** which maintains current information for the Site location and field selected including **Last ET**, current soil **Moisture Balance**, **Growth Stage**, **Total Irrigation**, and **Total Rain** received since the start date. This allows a producer to get a quick overview of the current status of his operation for that specific location and field.

Below this summary is the **Daily Measurements** table and is a day by day record of measurements for the selected water balance crop. The selected **Water Balance Crop** can be changed by clicking on the list of water balance crops in the right hand column.

Screen 5



Crop Summary

Site	Weather Station	Acreage	Type	Last Et	Moisture Balance	Growth Stage	Total Irrigation	Total Rain
Old Mill-1	Abernathy	120	Cotton	0.01	0.33	Strip	0.00	11.34

Select a Different Water Balance Crop

1	Gomez-1,Corn
2	Old Mill-2,Cotton

Daily Measurements

	Date	Effective Irrigation	Effective Rain	Percent Et	Irrigation	Rain	Daily Et	Moisture Balance	Growth Days	Growth Stage
0	2010-05-11	0.90	0.75	0.60	0.00	0.00	0	3	0	Planting Day
1	2010-05-12	0.90	0.75	0.60	0.00	0.00	0.01	2.99	1	-------
2	2010-05-13	0.90	0.75	0.60	0.00	0.00	0.01	2.98	2	-------
3	2010-05-14	0.90	0.75	0.60	0.00	1.03	0	3.75	3	-------
4	2010-05-15	0.90	0.75	0.60	0.00	0.01	0	3.76	4	-------
5	2010-05-16	0.90	0.75	0.60	0.00	0.00	0.01	3.75	5	-------
6	2010-05-17	0.90	0.75	0.60	0.00	0.54	0.01	4.15	6	-------
7	2010-05-18	0.90	0.75	0.60	0.00	0.00	0.01	4.14	7	-------
8	2010-05-19	0.90	0.75	0.60	0.00	0.00	0.01	4.13	8	-------
9	2010-05-20	0.90	0.75	0.60	0.00	0.00	0.01	4.12	9	-------
10	2010-05-21	0.90	0.75	0.60	0.00	0.00	0.01	4.11	10	Emerge
11	2010-05-22	0.90	0.75	0.60	0.00	0.00	0.02	4.09	11	-------
12	2010-05-23	0.90	0.75	0.60	0.00	0.00	0.01	4.08	12	-------
13	2010-05-24	0.90	0.75	0.60	0.00	0.03	0.02	4.08	13	-------
14	2010-05-25	0.90	0.75	0.60	0.00	0.00	0.01	4.07	14	-------
15	2010-05-26	0.90	0.75	0.60	0.00	0.08	0.02	4.11	15	-------
16	2010-05-27	0.90	0.75	0.60	0.00	0.00	0.01	4.1	16	-------

The only **Required** input for this table is for **Irrigation** events but through added user input and interaction with the program ET can be more accurately calculated for a producer's specific crop. The **TAWC ET** program is intended to be simple, yet flexible by allowing the producer to tailor irrigation based on specific crop and environmental factors. Columns displayed in a blue color may be manually adjusted at any time during the season. For example, if you click on a blue number in the column for **Effective Irrigation** a data entry box will pop up allowing you to change the **Effective Irrigation** % for any specific date during the growing season. An option also exists that allows you to select a checkbox that will apply this new value to all subsequent dates in the table or leave the box unchecked and make the change to the current date only. This applies to **Effective Irrigation**, **Effective Rain** and **Percent ET** columns.

For the **Irrigation** and **Rain** columns the user may click on a blue number for any specific date and enter an irrigation or rainfall event that applies to his specific location. Rainfall will be recorded automatically on a daily basis from the nearest **Weather Station** selected by the user during the creation of a **Water BalanceTrack** unless overridden by that user through manual entry. This allows the producer to better control the conditions of the specific field being monitored by manually updating rainfall measured at the individual site and thus more representative of the sites conditions. **However, the user must manually input each Irrigation event by clicking the blue number and entering each irrigation event amount in inches.**

The **Growth Stage** column is filled with estimated growth stages of the crop based on planting date. These values may be adjusted by the producer to more accurately represent the stage of his crop maturity thereby adjusting the calculated ET value for the crops current and subsequent growth stages. This is accomplished by clicking the blue lines in the column and selecting the appropriate growth stage for the calendar date from the drop down menu in the pop up.
For example if you planted cotton on May 9 the estimated **Emerge** date is May 19, however if emergence occurred a day earlier or a day later the actual **Emerge** date can then be adjusted by clicking the blue lines on the appropriate day and selecting the correct growth stage from the drop down menu. This same logic is followed through the season for **1st Square, 1st Bloom, Max Bloom, 1st Open, 25% Open, 50% Open, 95% Open, and Strip.** Adjusting these values to the actual date of occurrence adjusts the ET calculation to more appropriately reflect the plant requirements and potentially reduce water use. Adjustment of the plants growth stage is not a requirement but will allow the **ET calculation** to be more accurate for the crops individual stage of growth.

TAWC Resource Allocation Analyzer

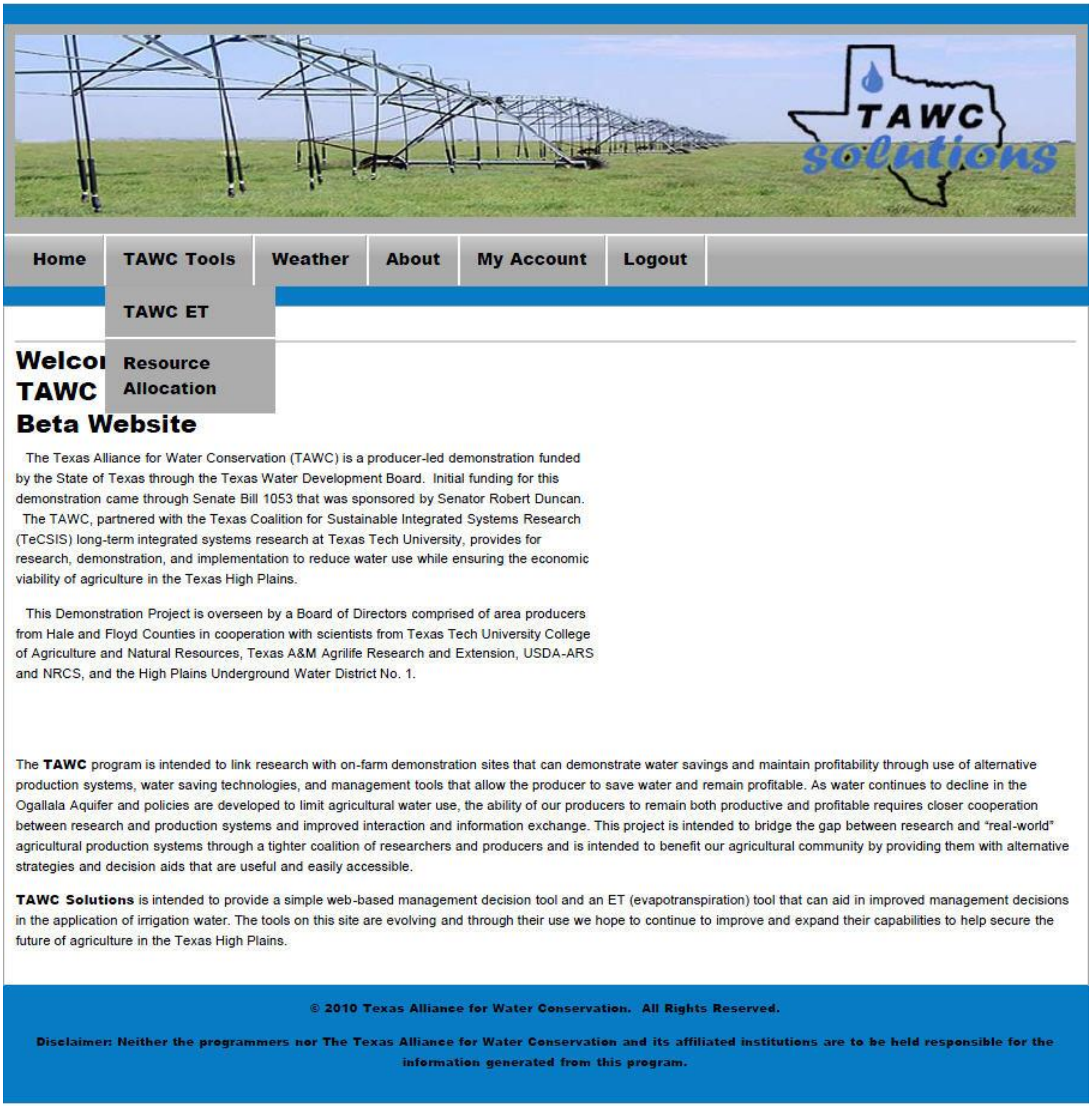
The *TAWC Resource Allocation Analyzer* is an economic-based decision aid which utilizes economic variables provided by an individual agricultural producer to estimate options for cropping systems which maximize per acre profits, whether at field or farm level. Utilizing information such as expected commodity prices, water availability, and enterprise options, irrigated agricultural producers can view cropping options which maximize their net returns per acre while accounting for irrigation demands and revenue potential. This user friendly aid is designed to provide the agronomic planning options to maintain profitability and sustainability in irrigated row crop agriculture.

To utilize the **TAWC Solutions Resource Analyzer** a User ID and Password must be created under **MY Account** in the Navigation menu. Once this is completed, log into the site and place the mouse cursor over **TAWC Tools** from the Navigation menu at top and a drop down menu will appear with the following selections:

TAWC ET Irrigation Scheduling Tool
Resource Allocation

To begin, move your cursor over **TAWC Tools** then, click on **Resource Allocation** as seen in **<u>Screen 1</u>**. This will take you to **<u>Screen 2</u>**.

Screen 1



Welcome to TAWC Beta Website

The Texas Alliance for Water Conservation (TAWC) is a producer-led demonstration funded by the State of Texas through the Texas Water Development Board. Initial funding for this demonstration came through Senate Bill 1053 that was sponsored by Senator Robert Duncan. The TAWC, partnered with the Texas Coalition for Sustainable Integrated Systems Research (TeCSIS) long-term integrated systems research at Texas Tech University, provides for research, demonstration, and implementation to reduce water use while ensuring the economic viability of agriculture in the Texas High Plains.

This Demonstration Project is overseen by a Board of Directors comprised of area producers from Hale and Floyd Counties in cooperation with scientists from Texas Tech University College of Agriculture and Natural Resources, Texas A&M Agrilife Research and Extension, USDA-ARS and NRCS, and the High Plains Underground Water District No. 1.

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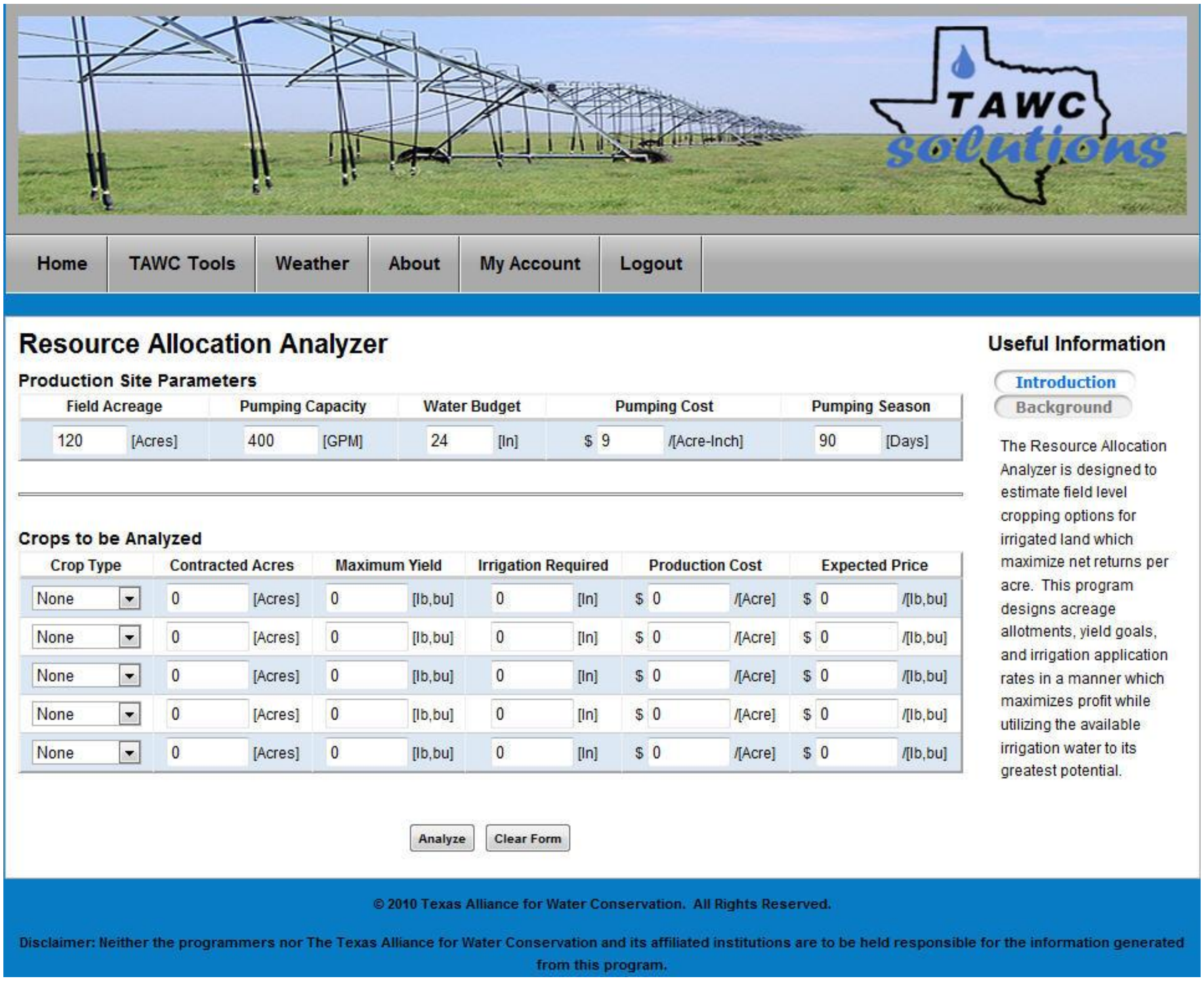
Screen 2



Resource Allocation Analyzer

Production Site Parameters

Field Acreage	Pumping Capacity	Water Budget	Pumping Cost	Pumping Season
120 [Acres]	400 [GPM]	24 [In]	$ 9 /[Acre-Inch]	90 [Days]

Crops to be Analyzed

Crop Type	Contracted Acres	Maximum Yield	Irrigation Required	Production Cost	Expected Price
None	0 [Acres]	0 [lb,bu]	0 [In]	$ 0 /[Acre]	$ 0 /[lb,bu]
None	0 [Acres]	0 [lb,bu]	0 [In]	$ 0 /[Acre]	$ 0 /[lb,bu]
None	0 [Acres]	0 [lb,bu]	0 [In]	$ 0 /[Acre]	$ 0 /[lb,bu]
None	0 [Acres]	0 [lb,bu]	0 [In]	$ 0 /[Acre]	$ 0 /[lb,bu]
None	0 [Acres]	0 [lb,bu]	0 [In]	$ 0 /[Acre]	$ 0 /[lb,bu]

Useful Information

The Resource Allocation Analyzer is designed to estimate field level cropping options for irrigated land which maximize net returns per acre. This program designs acreage allotments, yield goals, and irrigation application rates in a manner which maximizes profit while utilizing the available irrigation water to its greatest potential.

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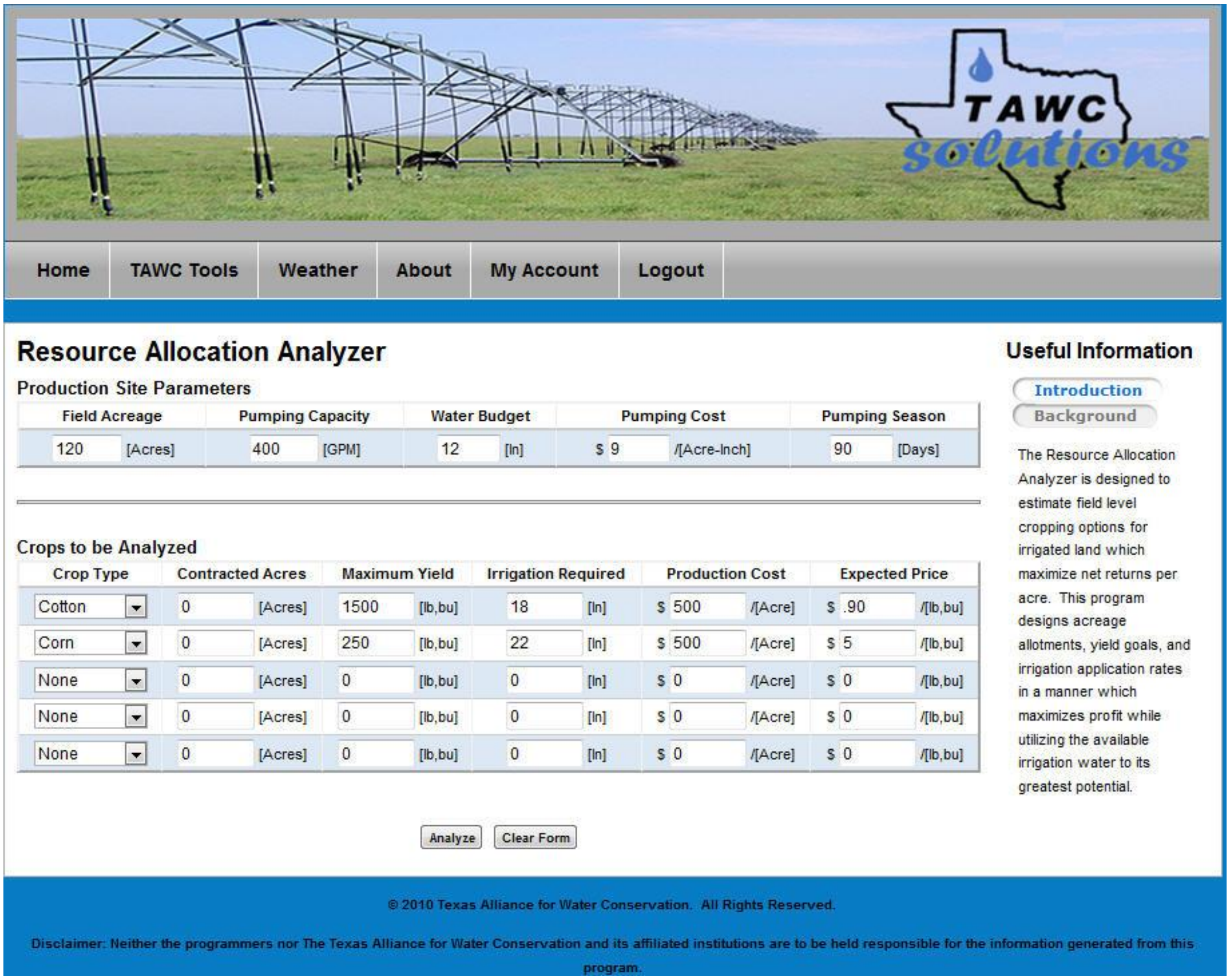
Screen 2 represents the platform of which the Resource Allocation Analyzer works from. This is the only input screen for the program. Default values appear for the Production Site Parameters but each field or cell can be modified if so desired. To start the process, select each production site parameter to fit the field or farm to analyze. For definitions of each parameter please refer to the definitions on page 6. With the Production Site Parameters set, choose 1 of 5 crops to analyze. A single crop or up to a maximum of 5 can be chosen for the analysis. An example of selecting corn and cotton is illustrated in **Screen 3**.

Screen 3



Resource Allocation Analyzer

Production Site Parameters

Field Acreage	Pumping Capacity	Water Budget	Pumping Cost	Pumping Season
120 [Acres]	400 [GPM]	12 [In]	$ 9 /[Acre-Inch]	90 [Days]

Crops to be Analyzed

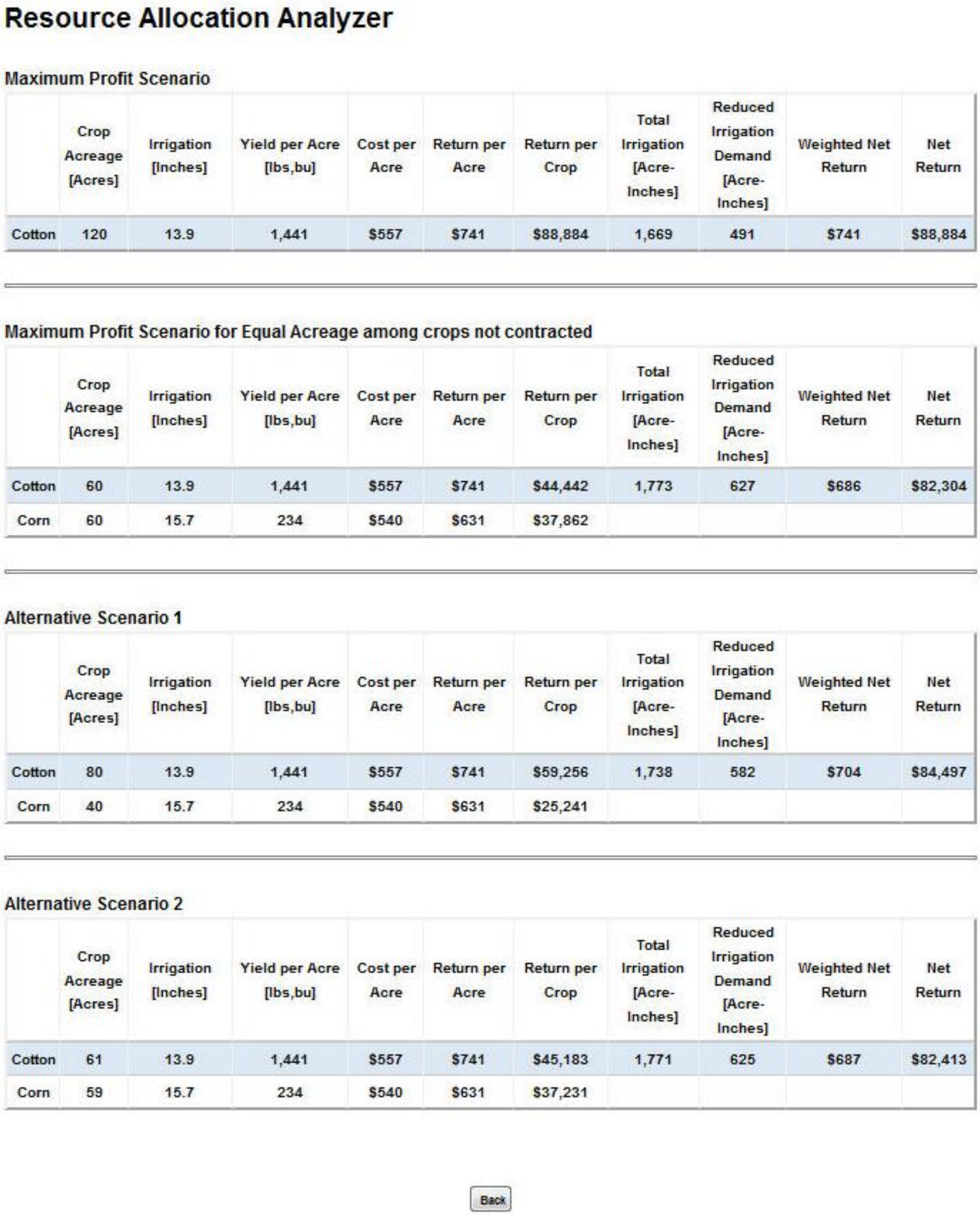
Crop Type	Contracted Acres	Maximum Yield	Irrigation Required	Production Cost	Expected Price
Cotton	0 [Acres]	1500 [lb,bu]	18 [In]	$ 500 /[Acre]	$ .90 /[lb,bu]
Corn	0 [Acres]	250 [lb,bu]	22 [In]	$ 500 /[Acre]	$ 5 /[lb,bu]
None	0 [Acres]	0 [lb,bu]	0 [In]	$ 0 /[Acre]	$ 0 /[lb,bu]
None	0 [Acres]	0 [lb,bu]	0 [In]	$ 0 /[Acre]	$ 0 /[lb,bu]
None	0 [Acres]	0 [lb,bu]	0 [In]	$ 0 /[Acre]	$ 0 /[lb,bu]

Useful Information

The Resource Allocation Analyzer is designed to estimate field level cropping options for irrigated land which maximize net returns per acre. This program designs acreage allotments, yield goals, and irrigation application rates in a manner which maximizes profit while utilizing the available irrigation water to its greatest potential.

Screen 4 illustrates the output from analyzing the crops and field parameters chosen in screen 3. The Maximum Profit Scenario indicates that the entire 120 acre field could be planted to cotton, with a yield goal of 1441 lbs utilizing 13.9 acre inches of water. This option will produce the highest net returns for the field at $88,884. The next three scenarios offer alternatives which can be compared against the maximum profit scenario. Definitions and descriptions of the output screen can be seen on Page 7. Utilizing the Back button at the bottom of the page, alternative runs can be conducted by adding or deleting crop chooses and varying the production site parameters.

Screen 4



Resource Allocation Analyzer

Maximum Profit Scenario

	Crop Acreage [Acres]	Irrigation [Inches]	Yield per Acre [lbs,bu]	Cost per Acre	Return per Acre	Return per Crop	Total Irrigation [Acre-Inches]	Reduced Irrigation Demand [Acre-Inches]	Weighted Net Return	Net Return
Cotton	120	13.9	1,441	$557	$741	$88,884	1,669	491	$741	$88,884

Maximum Profit Scenario for Equal Acreage among crops not contracted

	Crop Acreage [Acres]	Irrigation [Inches]	Yield per Acre [lbs,bu]	Cost per Acre	Return per Acre	Return per Crop	Total Irrigation [Acre-Inches]	Reduced Irrigation Demand [Acre-Inches]	Weighted Net Return	Net Return
Cotton	60	13.9	1,441	$557	$741	$44,442	1,773	627	$686	$82,304
Corn	60	15.7	234	$540	$631	$37,862				

Alternative Scenario 1

	Crop Acreage [Acres]	Irrigation [Inches]	Yield per Acre [lbs,bu]	Cost per Acre	Return per Acre	Return per Crop	Total Irrigation [Acre-Inches]	Reduced Irrigation Demand [Acre-Inches]	Weighted Net Return	Net Return
Cotton	80	13.9	1,441	$557	$741	$59,256	1,738	582	$704	$84,497
Corn	40	15.7	234	$540	$631	$25,241				

Alternative Scenario 2

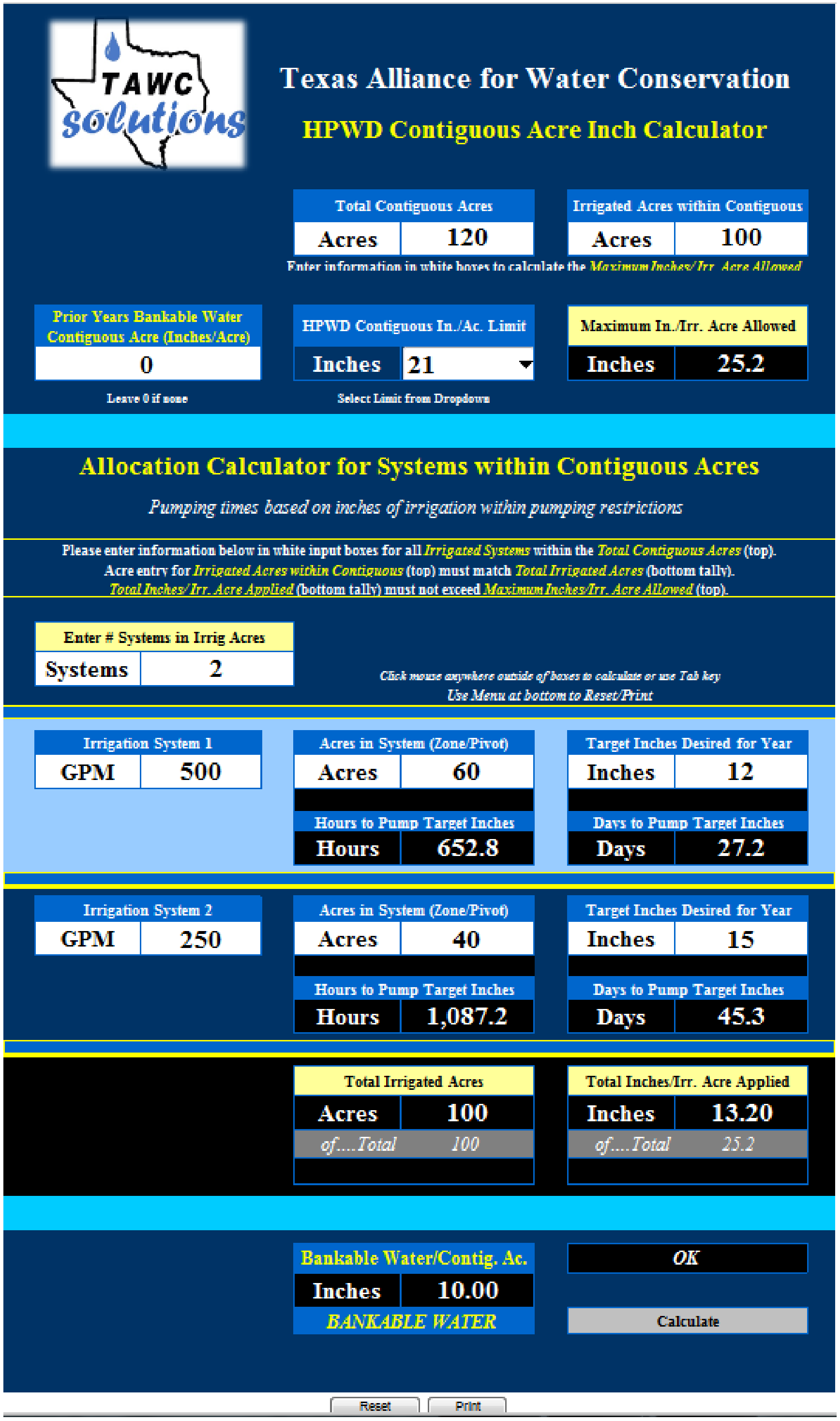
	Crop Acreage [Acres]	Irrigation [Inches]	Yield per Acre [lbs,bu]	Cost per Acre	Return per Acre	Return per Crop	Total Irrigation [Acre-Inches]	Reduced Irrigation Demand [Acre-Inches]	Weighted Net Return	Net Return
Cotton	61	13.9	1,441	$557	$741	$45,183	1,771	625	$687	$82,413
Corn	59	15.7	234	$540	$631	$37,231				

Production Site Parameters and Input Value Descriptions

Field Acreage - enter the amount of acres to be analyzed.
Pumping Capacity - enter the Gross Pumping Capacity at the delivery system. This value is estimated in gallons per minute or GPM.
Water Budget - select a water budget in acre inches as it applies to your field. This cell can be used to evaluate crop options under restricted water scenarios. The water budget is defaulted at 24 acre inches.
Pumping Cost - enter the per acre inch pumping cost for the field being analyzed.
Pumping Season - enter the typical length of irrigated days. This is used in conjunction with the Pumping Capacity to estimate the total amount of water that could be applied to the field.
Crop Type - choose from the pull down menu one of the five crops to be analyzed. (cotton, corn, sorghum, wheat, & sunflowers). A maximum of five crops can be analyzed.
Contracted Acres - enter an acreage value in this column only if you have contracted a crop by acres. The will produce solutions that must have at least as many acres for a crop as entered into this column. For example if entered 60 acres of contracted corn on a 120 acre pivot, then the solution will solve such that at least 60 acres of corn will be in production with the remaining water being allocated to another crop chosen.
Maximum Yield - enter the maximum yield for a chosen crop. This yield number should represent the realistic maximum yield which could be achieved on the field analyzed. For example, while genetics do allow for 2200 lbs of cotton to be produced, the field analyzed may have never produced more than 1500 lbs. In this case, 1500 lbs should be entered into the cell.
Production Cost - enter the total expenses incurred to produce the crop at the maximum yield, excluding pumping costs. Typically these expenses represent the total cash expenses such as seed, fertilizer, tillage operations, chemical applications, and other in field operations.
Expected Price - enter the price which is expected to be received upon selling or marketing the crop.

Output Definitions and Descriptions

Maximum Profit Scenario – This result provides an optimal level of crops acres, irrigation levels, and yield goals which maximize the total net returns per acre. This outcome can be a single crop or a combination of several crops of chosen.
Maximum Profit Scenario for Equal Acreage – This scenario produces the optimal outcome for all of the crops selected in the input screen and divides them equally among the field or farm acres analyzed.
Alternative Scenario 1 - This scenario presents the optimal chose of crop acreages, irrigation levels, and yield goals which maximize profit 5% below the true maximum.
Alternative Scenario 1 - This scenario presents the optimal chose of crop acreages, irrigation levels, and yield goals which maximize profit 10% below the true maximum.
Crop Acreage – the optimal acres by crop which could be planted to maximize net returns.
Irrigation – the optimal amount of irrigation required to produce the yield goal generated.
Yield Goal per Acre – the yield goal which maximizes net returns at the given irrigation level.
Cost per Acre – the total per acre cost of production including irrigation, at the optimal yield goal and irrigation levels.
Return per Acre – the net return per acre per crop representing the total revenue less total expenses.
Return per Crop – the total net returns per crop summed over the optimal acreage
Total Irrigation – the total amount of optimal irrigation applied in acre-inches.
Reduced Irrigation Demand – the amount of irrigation water that was not applied by avoiding producing at the maximum yield but by producing at the optimal level of yield and irrigation which maximized returns.
Weighted Net Return - the weighted amount of returns per acre if multiple crops were within the optimal solution.
Net Return - the total net returns over the acreage analyzed.



Texas Alliance for Water Conservation

HPWD Contiguous Acre Inch Calculator

Total Contiguous Acres: Acres 120

Irrigated Acres within Contiguous: Acres 100

Enter information in white boxes to calculate the *Maximum Inches/ Irr. Acre Allowed*

Prior Years Bankable Water Contiguous Acre (Inches/Acre): 0

Leave 0 if none

HPWD Contiguous In./Ac. Limit: Inches 21

Select Limit from Dropdown

Maximum In./Irr. Acre Allowed: Inches 25.2

Allocation Calculator for Systems within Contiguous Acres

Pumping times based on inches of irrigation within pumping restrictions

Please enter information below in white input boxes for all *Irrigated Systems* within the *Total Contiguous Acres* (top).
Acre entry for *Irrigated Acres within Contiguous* (top) must match *Total Irrigated Acres* (bottom tally).
Total Inches/ Irr. Acre Applied (bottom tally) must not exceed *Maximum Inches/Irr. Acre Allowed* (top).

Enter # Systems in Irrig Acres: Systems 2

Click mouse anywhere outside of boxes to calculate or use Tab key
Use Menu at bottom to Reset/Print

Irrigation System 1: GPM 500

Acres in System (Zone/Pivot): Acres 60

Target Inches Desired for Year: Inches 12

Hours to Pump Target Inches: Hours 652.8

Days to Pump Target Inches: Days 27.2

Irrigation System 2: GPM 250

Acres in System (Zone/Pivot): Acres 40

Target Inches Desired for Year: Inches 15

Hours to Pump Target Inches: Hours 1,087.2

Days to Pump Target Inches: Days 45.3

Total Irrigated Acres: Acres 100
of....Total 100

Total Inches/Irr. Acre Applied: Inches 13.20
of....Total 25.2

Bankable Water/Contig. Ac.: Inches 10.00
BANKABLE WATER

OK

TAWC Contiguous Acre Calculator

THE *TAWC CONTIGUOUS ACRE CALCULATOR* is a two-part tool.

The top portion of the calculator is intended to be used to aid producers in determining the maximum amount of water that may be applied per irrigated acre based on the High Plains Underground Water Conservation District (HPWD) rules regarding water withdrawal from the Ogallala Aquifer. This tool allows the producer to enter their total contiguous acres as defined by HPWD and the total irrigated acres within the contiguous land area. Upon entering these two pieces of information, the producer can select from the current or future HPWD contiguous inches per acre limits from a drop down box (HPWD Contiguous In./Ac. Limit) and the maximum inches per irrigated acre allowed will be calculated based on the limit selected. This allows the producer to view how the future restrictions would affect the maximum inches per irrigated acre allowed. If the producer has banked water (water allowed not used from one of the previous 3 years) he may enter this amount which will be added to the maximum inches per acre allowed for that crop production year.

The 2nd or lower part of the calculator is a water allocation calculator for irrigated systems within the contiguous acres that allow the producer to distribute the maximum inches per acre allowed across irrigated systems within the contiguous land area. This portion of the calculator allows a producer to first enter the number of irrigation systems within a specific contiguous land area. This will expand data entry fields to the number of systems requested, allowing the producer to enter the gpm, irrigated acres within each zone or pivot and target inches desired for each individual irrigated system. The producer may enter various scenarios for each system varying the amount of inches of water to view how the water may be distributed to maximize or minimize the designated water amount on any given system as well as view any bankable or “carry forward water” remaining. If the calculator detects an error such as maximum water allowed or number of irrigated acres exceeded the program will give a “red flag” error notification which will allow the producer to correct the offending issue. Once all data entry values have been entered correctly “OK” will display at the bottom of the calculator and no red flag warnings will be visible. If there is any unused water remaining of the total allowed, this amount will display in the “Bankable Water/Contig. Ac.” box at the bottom of the calculator.

Information obtained from this two-part tool include the maximum inches/irrigated acre allowed, hours and days required to pump the target inches of water, bankable water for carry forward and the ability to distribute the allowed water among irrigated systems based on the HPWD total acre inches allowed. In addition the producer may use the tool to try varying scenarios to distribute the allowed water based on the crops within each system.

> *We are continually striving to improve the accuracy, usability and performance of these programs. Through your feedback and assistance we can be proactive in addressing the needs of the Texas High Plains. This program has been created through the efforts of many involved in this project including Texas Tech University, Texas A&M AgriLife Research and Extension, USDA-ARS/NRCS, High Plains Underground Water District No. 1, Producers of Hale and Floyd Counties and the Texas Water Development Board.*

We must work together to solve the growing issues faced by agriculture today and tomorrow because ‘Water is Our Future’.

Disclaimer: Neither the programmers nor the Texas Alliance for Water Conservation and its affiliated institutions are to be held responsible for the information generated from these programs and tools.

BUDGET

Table 37. Task and expense budget for years 1-8 of the demonstration project.

2005-358-014		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	
		(9/22/04 - 1/31/06)	(2/01/06 - 2/28/07)	(3/01/07 - 2/29/08)	(3/01/08 - 2/28/09)	(03/01/09 - 2/28/10)	03/01/10 - 2/28/11	03/01/11 - 2/29/12	03/01/12 - 2/28/13	
Task Budget	**Task Budget***	*revised*	*revised*							**Total Expenses**
1	4,537	4,537	0	0	0	0	0	0	0	4,537
2	2,561,960	216,966	335,319	317,317	299,727	249,163	299,550	296,282	249,082	2,260,760
3	675,402	21,112	33,833	80,984	61,455	56,239	28,122	46,033	145,566	473,342
4	610,565	52,409	40,940	46,329	53,602	64,124	43,569	117,206	118,858	537,038
5	376,568	42,428	40,534	47,506	38,721	51,158	27,835	29,231	45,096	322,509
6	568,773	54,531	75,387	71,106	60,257	39,595	60,473	52,444	56,865	470,657
7	306,020	37,014	22,801	30,516	25,841	11,497	14,302	34,398	87,024	248,929
8	334,692	44,629	43,089	41,243	43,927	42,084	42,984	37,157	38,169	333,281
9	623,288	145,078	39,011	35,656	82,844	52,423	65,785	32,971	76,416	516,274
10	162,970	0	0	0	0	0	86,736	55,871	0	142,607
TOTAL	6,224,775	618,702	630,914	670,657	666,374	566,283	669,355	701,594	817,075	5,309,890

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	
Expense Budget	**Total Budget***	(09/22/04 - 01/31/06)	(02/01/06 - 02/28/07)	(3/01/07 - 2/29/08)	(3/01/08 - 2/28/09)	(03/01/09 - 2/28/10)	03/01/10 - 2/28/11	03/01/11 - 2/29/12	03/01/12 - 2/28/13	**Total Expenses**
Salary and Wages [1]	2,524,172	230,611	304,371	302,411	301,933	259,929	293,198	307,459	300,033	2,299,944
Fringe[2] (20% of Salary)	370,655	28,509	34,361	36,263	40,338	37,180	43,410	42,061	32,852	294,974
Insurance	186,600	13,634	26,529	25,302	25,942	21,508	23,294	24,918	17,554	178,680
Tuition and Fees	199,922	8,127	16,393	21,679	18,502	13,277	9,828	21,803	35,299	144,908
Travel	158,482	14,508	25,392	14,650	15,556	16,579	12,329	19,127	17,148	135,289
Capital Equipment	154,323	23,080	13,393	448	707	18,668	95,993	(146)	0	152,141
Expendable Supplies	105,455	14,277	16,100	12,205	18,288	8,614	4,802	8,265	21,058	103,610
Subcon	1,758,667	212,718	103,031	161,540	183,125	131,627	115,587	131,779	335,505	1,343,849
Technical/Computer	61,364	9,740	3,879	16,225	430	7,990	11,857	10,550	0	60,671
Communications	270,192	25,339	41,374	35,497	23,062	14,448	18,300	45,344	17,002	220,366
Reproduction (see comm)										0
Vehicle Insurance	2,000	0	397	235	187	194	114	130	222	1,479
Producer Compensation	57,450	0	0	0	0	0	0	39,225	0	39,225
Overhead	375,493	38,160	45,694	44,202	38,302	36,270	40,644	51,079	40,403	334,754
Profit										
TOTAL	6,224,775	618,702	630,914	670,657	666,374	566,283	669,355	701,594	817,075	5,309,890

COST SHARING

Table 38. Cost sharing figures for Texas Tech University, Texas A&M AgriLife, and High Plains Underground Water Conservation District for years 1-8 of the demonstration project.

Cost Sharing Balance Summary (estimated)

Budget	**Total Cost Share Budgeted**	***Actual Funds Contributed***	***Balance***
TTU		885,990.99	
TAMU		356,012.33	
HPUWCD		200,053.70	
TOTAL	1,100,000.00	1,442,057.02	(-342,057.02)

Expense Categories	**Total Expense Budget**	***Actual Funds Contributed***	***Balance***
Salary & Wages		350,471.81	
Overhead		535,519.18	
SubCon - TAMU		356,012.33	
$25,000/yr - HPUWCD		200,053.70	
TOTAL	1,100,000.00	1,442,057.02	(-342,057.02)