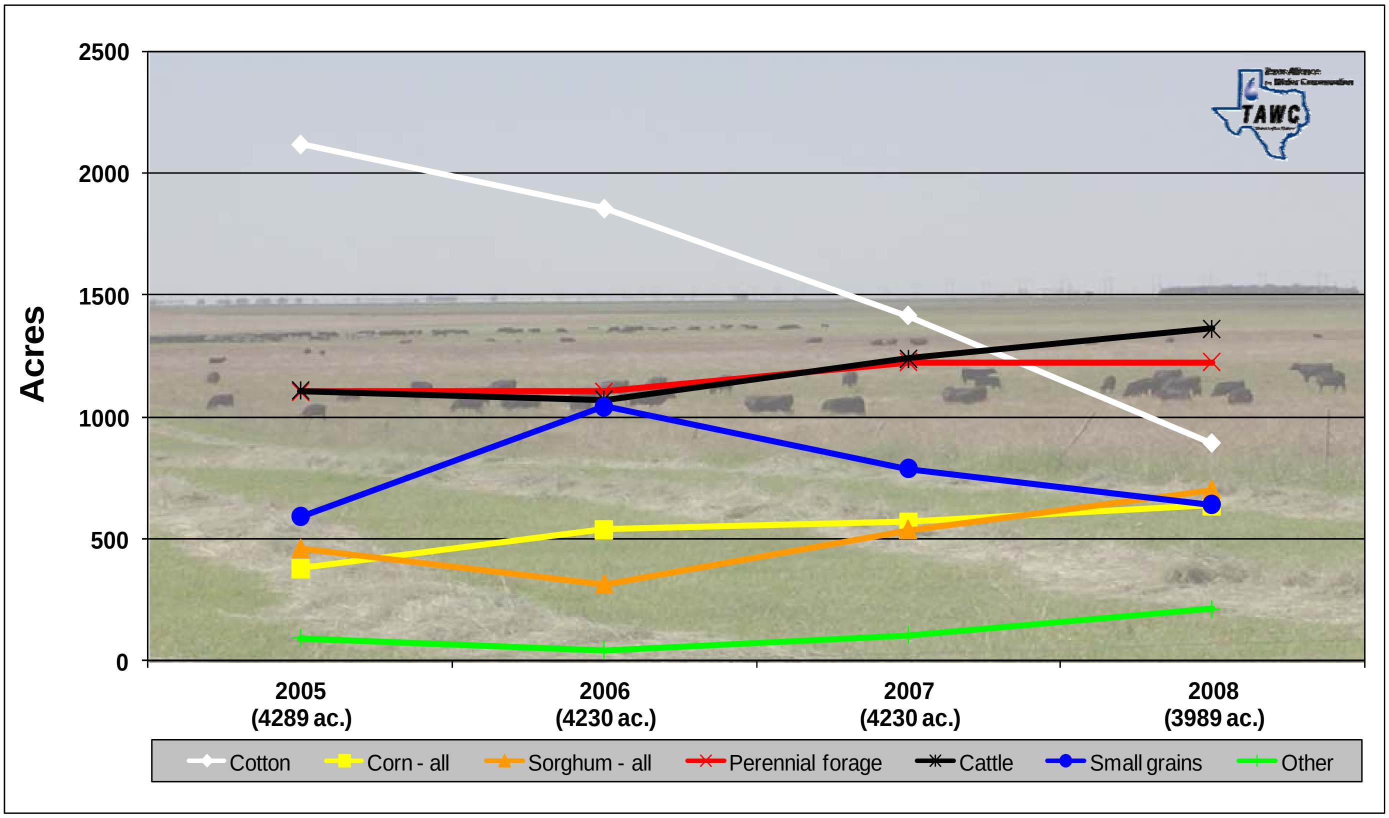
4TH ANNUAL REPORT

TO THE

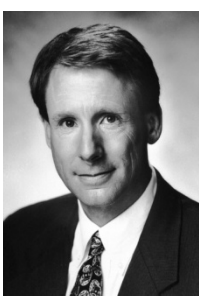
TEXAS WATER DEVELOPMENT BOARD



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

June 18, 2009

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

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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 Manager serves in an *ex officio* capacity on the Producer Board. Meetings of the Producer Board of Directors are on an as need basis to carry out the responsibilities of the project and occur at least 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 Participants

Texas Tech University
Rick Kellison, Project Director*
Dr. Vivien Gore Allen*
Mr. Philip Brown
Dr. David Doerfert*
Dr. Phil Johnson*
Dr. Stephan Maas*
Dr. Eduardo Segarra*
Mr. Tom Sell*
Ms. Angela Beikmann,*
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Texas AgriLife Extension
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Mr. Jeff Pate*
Dr. Calvin Trostle*
Mr. Jay Yates*

High Plains Underground Water Conservation District #1
Mr. Jim Conkwright*
Mr. Scott Orr*
Caleb Jenkins

USDA - Natural Resource Conservation Service
Mr. Monty Dollar (retired)*

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

Producer Board Chairman
Mr. Glenn Schur*

Post Doctoral Fellow
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Dr. Nithya Rajan
Dr. Justin Weinheimer

Graduate Research Assistants
Rebekka Martin (completed 2005)
Pamela Miller (completed 2006)
Nithya Rajan (completed 2007)
Paul Braden (completed 2007)
Jurahee Jones (completed 2007)
Justin Weinheimer (completed 2008)
Katie Leigh (completed 2008)
Swetha Dorbala
Song Cui
Yue Li
Cody Zilverberg
Heather Jones
Morgan Newsom

* Indicates Management Team member

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

Background

The Texas High Plains currently generates a combined annual economic value of crops and livestock that exceeds $5.6 billion ($1.1 crops; $4.5 livestock; TASS, 2004) but is highly dependent on water from the Ogallala Aquifer. Ground water supplies are declining in this region (TWDB, 2007) while costs of energy required to pump water are escalating. Improved irrigation technologies including low energy precision application (LEPA) and sub-surface 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 fuels, 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. Increasing grain prices, fertilizer costs, and uncertain energy costs are driving changes in this region as well as increasing water scarcity.

Diversified systems that include both crops and livestock have long been known for complimentary effects that increase productivity. Research conducted at Texas Tech over the past 10 years has shown that an integrated cotton/forage/beef cattle system, compared with a 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). At cotton yields average for irrigated cotton in the region, profitability was greater for the integrated system than a cotton monoculture. 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). This ongoing replicated research provided originally 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 state and global populations increase with an increasing demand for agricultural products, the future of the Texas High Plains, and indeed the State of Texas and the world depends on our ability to protect and appropriately use our water resources. Nowhere is there greater opportunity to demonstrate the implications of successfully meeting these challenges than in the High Plains of west Texas.

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.

OBJECTIVE

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

REPORT OF THE FIRST FOUR YEARS

In the first year of any demonstration or research project, the data should be interpreted with caution. As systems are begun and data collection is initiated, there are also many factors that do not function as they will over more time when everything becomes a mature system with data gathering techniques well developed. For each added year of reporting, some data will be missing because there is only a partial years 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, integrated cropping systems, integrated crop and livestock systems, 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 involved 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.

The assumptions necessary for system comparisons are elaborated below.

ASSUMPTIONS OF DATA COLLECTION AND INTERPRETATION

1. Although actual depth to water in wells located among the 26 sites varies, a pumping depth of 260 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.

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 ASSUMPTIONS

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

Table 1. Electricity irrigation cost parameters for 2005, 2006, 2007 and 2008.

	2005	2006	2007	2008
Gallons per minute (gpm)	450	450	450	450
Pumping lift (feet)	260	250	252	254
Discharge Pressure (psi)	15	15	15	15
Pump efficiency (%)	60	60	60	60
Motor Efficiency (%)	88	88	88	88
Electricity Cost per kWh	$0.085	$0.09	$0.11	$0.14
Cost of Electricity per Ac. In.	$4.02	$4.26	$5.06	$6.60
Cost of Maintenance and Repairs per Ac. In.	$2.05	$2.07	$2.13	$2.45
Cost of Labor per Ac. In.	$0.75	$0.75	$0.80	$0.90
Total Cost per Ac. In.	$6.82	$7.08	$7.99	$9.95

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

Table 2. Commodity prices for 2005, 2006, 2007 and 2008.

	2005	2006	2007	2008
Cotton lint ($/lb)	$0.54	$0.56	$0.58	$0.55
Cotton seed ($/ton)	$100.00	$135.00	$155.00	$225.00
Grain Sorghum – Grain ($/cwt)	$3.85	$6.10	$5.96	$7.90
Corn – Grain ($/bu)	$2.89	$3.00	$3.69	$5.71
Corn – Food ($/bu)	$3.48	$3.55	$4.20	$7.02
Wheat – Grain ($/bu)	$2.89	$4.28	$4.28	$7.85
Sorghum Silage ($/ton)	$20.19	$18.00	$18.00	$25.00
Corn Silage ($/ton)	$20.12	$22.50	$25.00	$25.00
Wheat Silage ($/ton)	$18.63	$22.89	$22.89	$29.80
Oat Silage ($/ton)	-	$17.00	$17.00	-
Millet Seed ($/lb)	$0.17	$0.17	$0.22	$0.25
Sunflowers ($/lb)	$0.21	$0.21	$0.21	$0.29
Alfalfa ($/ton)	$130.00	$150.00	$150.00	$160.00
Hay ($/ton)	$60.00	$60.00	$60.00	$60.00
WWB Dahl Hay ($/ton)	$65.00	$65.00	$90.00	$90.00
Hay Grazer ($/ton)	-	$110.00	$110.00	$70.00
Sideoats Seed ($/lb)	-	-	$6.52	$6.52
Sideoats Hay ($/ton)	-	-	$64.00	$64.00

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

4. Other variable and fixed costs are given for 2005 through 2008 in Table 3.

Table 3. Other variable and fixed costs for 2005, 2006, 2007 and 2008.

	2005	2006	2007	2008
VARIABLE COSTS				
Boll weevil assessment: ($/ac)				
Irrigated cotton	$12.00	$12.00	$12.00	$1.50
Dryland cotton	$6.00	$6.00	$6.00	$1.50
Crop insurance ($/ac)				
Irrigated cotton	$17.25	$17.25	$17.25	$20.00
Dryland cotton	$12.25	$12.25	$12.25	$12.25
Irrigated corn	$15.00	$15.00	$15.00	$15.00
Cotton harvest – strip and module ($/lint lb)	$0.08	$0.08	$0.08	$0.08
Cotton ginning ($/cwt)	$1.95	$1.75	$1.75	$1.95
Bags, Ties, & Classing ($/480 lb bale)	$17.50	$19.30	$17.50	$18.50
FIXED COSTS				
Irrigation system:				
Center Pivot system	$33.60	$33.60	$33.60	$33.60
Drip system	$75.00	$75.00	$75.00	$75.00
Flood system	$25.00	$25.00	$25.00	$25.00
Cash rent:				
Irrigated cotton, grain sorghum, sunflowers, grass, millet, and sorghum silage.	$45.00	$45.00	$45.00	$75.00
Irrigated corn silage, corn grain, and alfalfa.	$75.00	$75.00	$75.00	$100
Dryland cropland	$15.00	$15.00	$15.00	$25

5. The custom tillage and harvest rates used for 2005 were based on rates reported in USDA-NASS, <u>2004 Texas Custom Rates Statistics,</u> 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.

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 4, is the actual mean of precipitation recorded at the 26 sites during 2005 but begins in March when the sites were identified and equipped. Precipitation for January and February are amounts recorded at Halfway, TX; the nearest monitoring site.

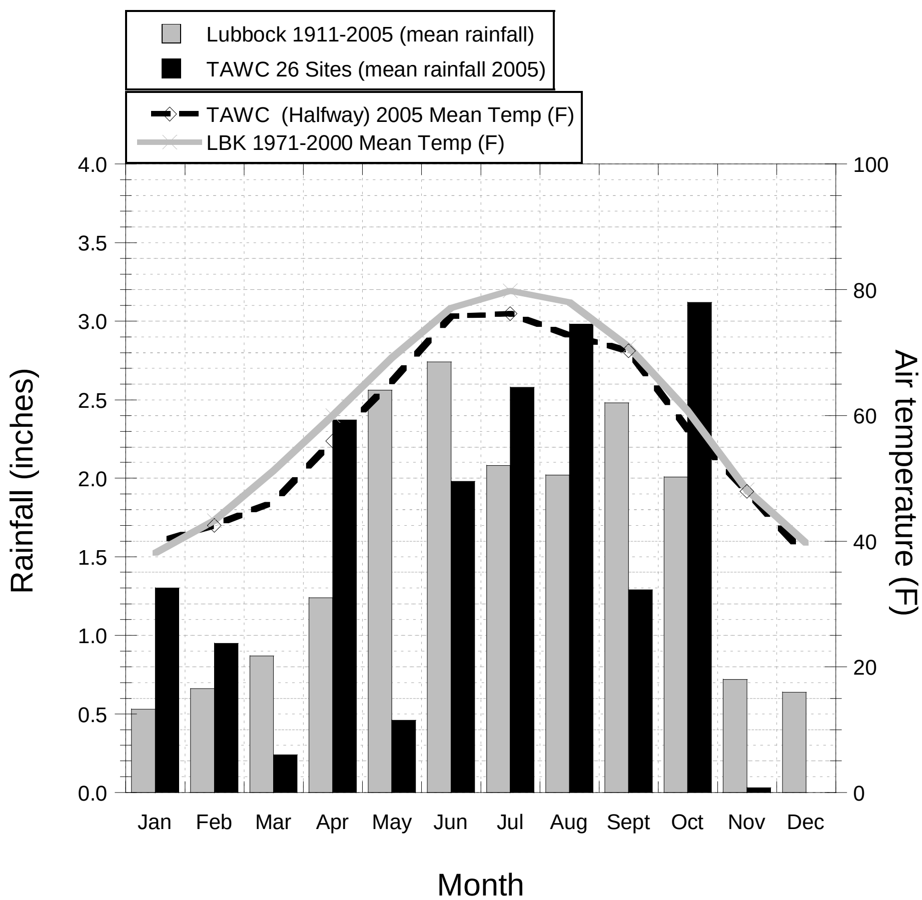

Figure 1. Temperature and precipitation for 2005 in the demonstration area compared with long term averages.

Table 4. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2005.

SITE	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
01	0	0	0.4	1.3	0.2	1.7	2.2	2.4	2	4.1	0	0	14.3
02	0	0	0.4	1.8	0.5	1.4	2.4	3.6	0.8	3.4	0	0	14.3
03	0	0	0.7	2	0.6	1.4	2.5	4	0.4	3.2	0	0	14.8
04	0	0	0.6	8	0.3	1.4	2.2	3.2	0.1	1	0	0	16.8
05	0	0	0.6	2.9	0.4	1.5	3.2	4.2	0.6	1.7	0	0	15.1
06	0	0	0.5	1.5	0.4	3	2.4	1	2	4.2	0	0	15
07	0	0	0.5	1.5	0.6	2.6	2.4	1.5	3.3	3	0	0	15.4
08	0	0	0	1.5	0.6	2.6	2.4	1.5	3.3	3	0	0	14.9
09	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
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
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	0.0	0.2	2.4	0.5	2.0	2.6	3.0	1.3	3.1	0.0	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 5, 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.

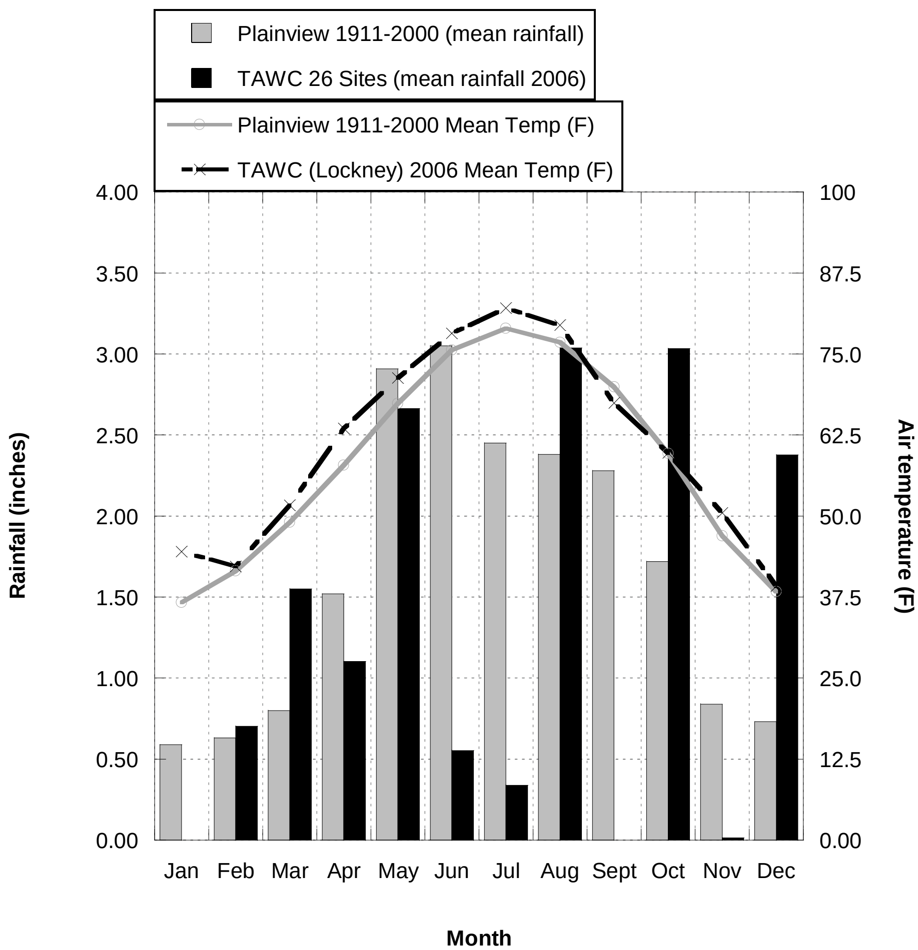

Figure 2. Temperature and precipitation for 2006 in the demonstration area compared with long term averages.

Table 5. 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
01	0	0.9	1.7	1.2	2.6	0.5	0.55	2.3	0	2.87	0	2.6	15.22
02	0	0.8	1.9	1.1	1.9	0.2	0	2.6	0	3.05	0	1.8	13.35
03	0	0.6	1.5	0.9	2.6	0.7	0.22	3	0	3.14	0	3.2	15.86
04	0	0.5	1.4	1.1	2.7	0.2	0.4	3.8	0	2.56	0	2.8	15.46
05	0	0.7	1.4	1.8	3.2	0.4	0.57	4	0	2.78	0	2.8	17.65
06	0	0.7	1.5	0.8	3	0.4	0.2	5.4	0	2.6	0	2.7	17.3
07	0	0.5	1.3	0.9	1.92	0.5	0.33	3.8	0	2.75	0	2.1	14.1
08	0	0.5	1.3	0.9	1.92	0.5	0.33	3	0	2.75	0	2.1	13.3
09	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
12	0	0.8	1.4	0.8	2.2	0.9	0.2	1.9	0	3.3	0	2	13.5
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	14.7
15	0	1.4	2.2	1.4	2.8	0.4	0	2	0	4.4	0.1	2.6	17.3
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	0.7	1.6	1.1	2.7	0.6	0.3	3.0	0.0	3.0	0.0	2.4	15.40

2007

Precipitation during 2007 totaled 27.2 inches (Table 6) 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 6, 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.

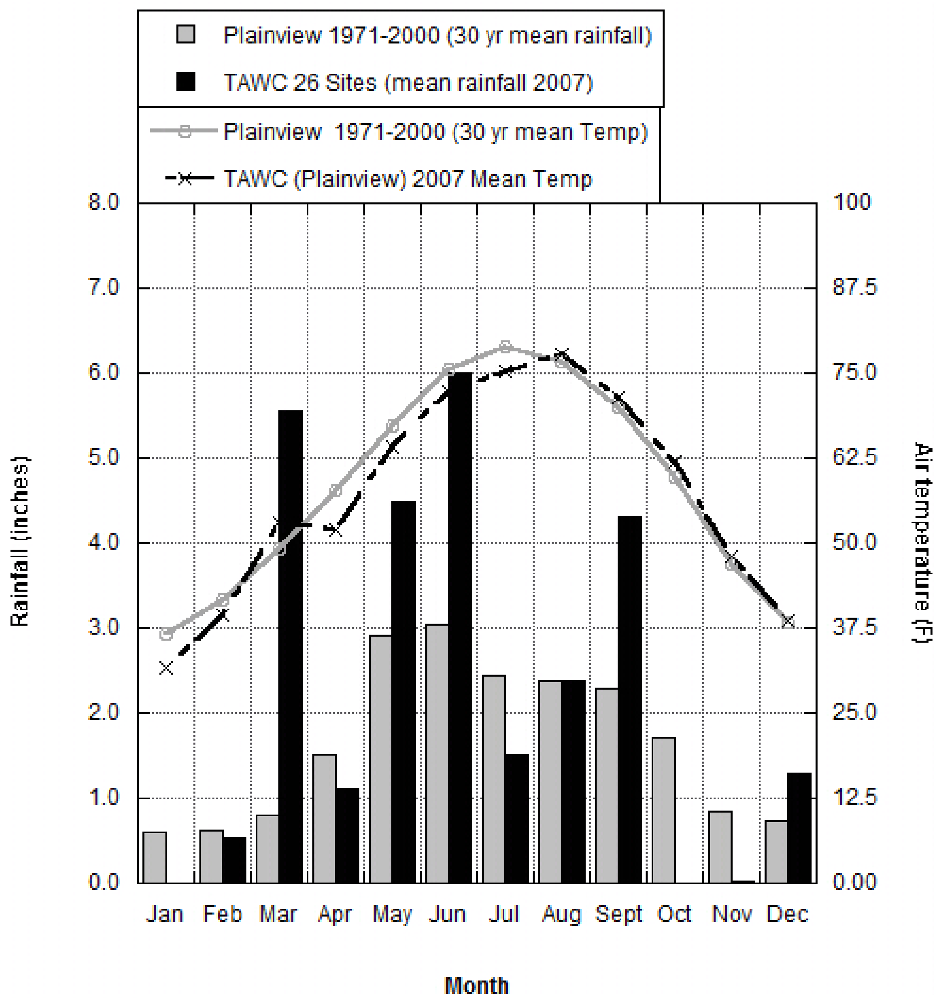

Figure 3. Temperature and precipitation for 2007 in the demonstration area compared with long term averages.

Table 6. 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
01	0	0.74	5.4	0.8	4.92	4.75	0.71	2.3	3.6	0	0	1.2	24.42
02	0	0.52	3.7	0.8	2.86	6.93	1.32	3	4.8	0	0	1.2	25.13
03	0	0.47	4.8	0.9	2.74	6.88	1.41	2.4	4.4	0	0	1	25
04	0	0.29	7.6	0.9	3.53	6.77	4	1.5	5	0	0	1	30.59
05	0	0.72	6	1.1	5.09	7.03	0.79	1.2	4.7	0	0	1.2	27.83
06	0	0.46	6	0.7	5.03	5.43	0.54	2	4.5	0	0	1.4	26.06
07	0	0.9	6.4	1	5.4	4.12	0.74	1.2	3.2	0	0	1.4	24.36
08	0	0.9	6.4	1	5.4	4.12	0.74	1.2	3.2	0	0	1.4	24.36
09	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	27.4
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	23.8
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	0.5	5.6	1.1	4.5	6.0	1.5	2.4	4.3	0.0	0.0	1.3	27.2

2008

Precipitation during 2008, at 21.6 inches, was above average for the year (Table 7). 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. Over 4 inches of precipitation 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 many 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).

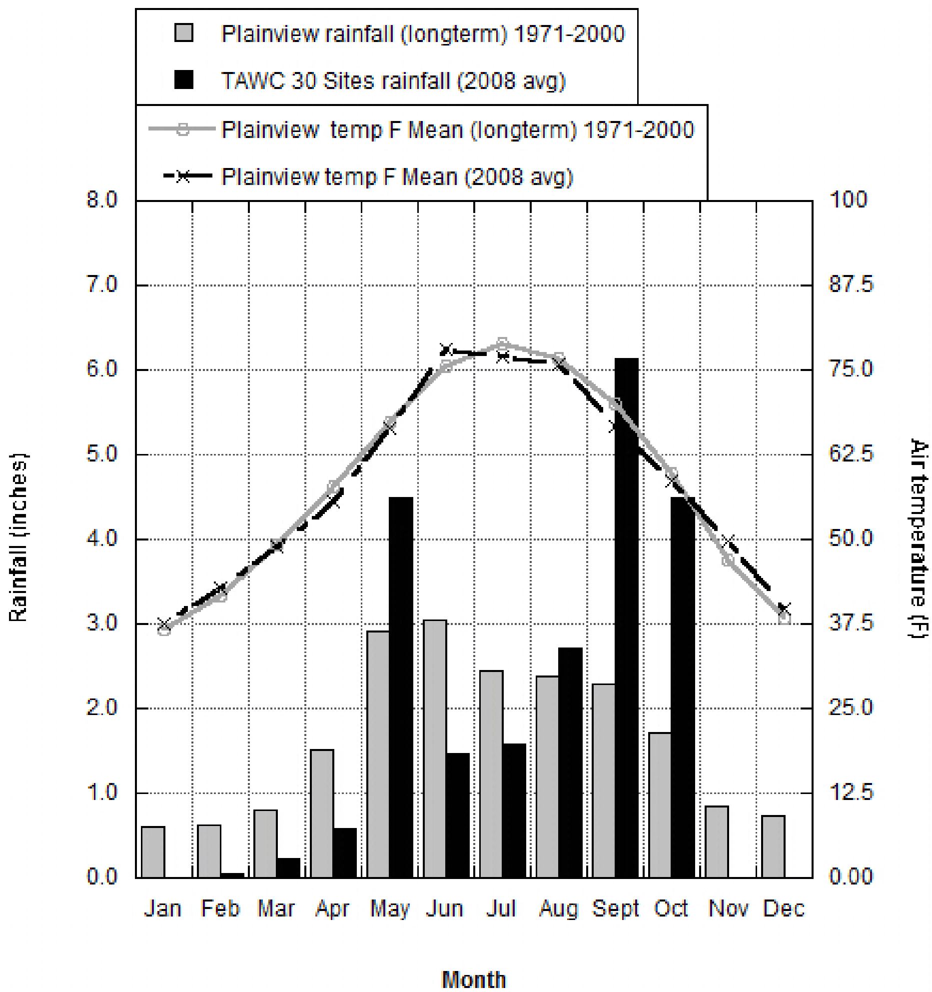

Figure 4. Temperature and precipitation for 2008 in the demonstration area compared with long term averages.

Table 7. 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	Year Total
2	0	0	0.2	0.8	4.75	1.7	1	2.1	5.4	4.1	0	0	20.05
3	0	0	0.2	0.5	4.5	1.1	0.95	2	4.7	4.4	0	0	18.35
4	0	0	0.4	0.6	4	2.9	1.1	4.1	3	2.9	0	0	19
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	21.85
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	19.65
20	0	0	0.4	0.5	5	1.9	1.4	4.8	6.8	4.2	0	0	25
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
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
Average	0.00	0.04	0.22	0.58	4.48	1.48	1.59	2.71	6.07	4.46	0.00	0.00	21.62

Supplementary Grants to Project

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. $10,000 (funded).

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

2008

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

Doerfert, D.L., and 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, Micky 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

Allen, V.G. 2009. Building a sustainable future for agriculture. USDA-SARE planning grant. $15,000 (funded).

Allen, V.G., Song Cui, Rick Kellison, and Phil Brown. 2009. 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. $63,349 (funded).

Allen, V.G., S. Maas, D. Doerfert, R. Kellison and multiple co-authors. 2009. The Texas High Plains: A Candidate Site for Long-term Agroecosystem Research and Education. USDA-CSREES AFRI LTAR program. $199,937 (pending).

Maas, S., Allen, V., Johnson, P., Doerfert, D., Kellison, R., et al. 2009. Development of a cropping system strategic decision tool (CSSDT) for the Texas high plains. EPA/CSREES. $454,000 (pending).

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
Agricultural Workers Mutual Auto Insurance Co.	$250
City Bank	$250
Accent Engineering & Logistics, Inc.	$100
Bamert Seed Co.	$100
Floyd County Supply	$100
Plainview Ag Distributors, Inc.	$100
Production-Plus+	$100

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

Dr. Tony Allan	Michael Dolle	Lendan Morin
Kelly Attebury	Dr. Darrell Dromgoole	Justin Odom
JR Bell	Sen. Robert Duncan	Marcy Pena
Brian Borchardt	Larry Ferguson	David Peterson
Rex Borchardt	Dennis Gehler	Matt Pierce
Mary Lou Bradley	David Gibson	Koby Reed
Minnie Lou Bradley	Jerry Grainer	Jerry Riney
Josh Brooks	Sarah Hamm	Clar Schacht
Dr. Mark Brown	Joe Heflin	Greg Sokora
Mike Buxkemper	Dr. Wayne Hudnall	JD Terrell
Jim Bob Clary	Dr. David Kemp	Warren Thetford
Rodney Collins	Dr. Gary Lacefield	Dr. Dan Undersander
Bobby Cox	David Lawver	Steve Verett
Leigh Cranmer	Tim Lust	Cheramie Viator
Gerald Crenwelge	Tommy Maeker	Ross Wilson
Jeff Dahlberg	Dr. Jett Major	Aaron Winn
JO Dawdy	Gerald McMasters	Chris Winn
Robert R. Dobos	Jack Moreman	

PRESENTATIONS

2005

Date	Presentation	Spokesperson
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
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
27-Apr	ICASALS Holden Lecture: "New Directions in Groundwater Management for the Texas High Plains"	Conkwright
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	Calibrating aerial imagery for estimating crop ground cover. 21st Biennial Workshop on Aerial Photog., Videography, and High Resolution Digital Imagery for Resource Assessment, 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	
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	Comparison of water use among crops in the Texas High Plains estimated using remote sensing. 2007 Water Research Symposium, 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	Using remote sensing and crop models to compare water use of cotton under different irrigation systems (poster). Accepted for presentation at the Annual Meetings, Amer. Soc. Agronomy. New Orleans, LA	Rajan
4-8 Nov	Assessing the crop water use of silage corn and forage sorghum using remote sensing and crop modeling. Accepted for presentation at the Annual Meetings, Amer. Soc. Agronomy. 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, Albuquerque, NM (2 poster presentations)	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)
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
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, "Texas Alliance for Water Conservation," 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, New Orleans (paper/posters presentations)	Doerfert/Leigh/ Newsom/Wilkinson/ Williams
19-Nov	TTU GIS Open House	Barbato
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

RELATED 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, Verónica, Gloria Burow, Ted M. Zobeck, and Vivien 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.

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)

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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 Sci. Soc. Am. J. 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. Agron. J. 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 Sci. Soc. Amer. 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. Agron. J. 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. Agric. Ecosystems Environ. 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 & Biochemistry, doi:10.1016/j.soilbio.2008.07.022

Maas, S.J., and N. Rajan. 2008. Estimating ground cover of field crops using medium-resolution multispectral satellite imagery. Agronomy Journal 100(2), 320-327.

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.

Allen, V.G., T. Sell, R.L. Kellison, P.N. Johnson, and P. Brown. 2008. Grassland environments: Factors driving change. J. Soil Water Conserv.

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

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SITE DESCRIPTIONS

BACKGROUND

This project officially began with the announcement of the grant in September, 2004. However, it was February, 2005, before all of the contracts and budgets were finalized and actual field site selection could begin. By February, 2005, the Producer Board had been named and was functioning and the Management Team had been 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 5). Many of these sites were located in close proximity to soil moisture monitoring points maintained by the High Plains Underground Water Conservation District No. 1 (Figure 6). Personnel with the High Plains Underground Water Conservation District No. 1, under the direction of Scott Orr, began immediately to install and test the site monitoring equipment. This was completed during 2005 and was in place for most of the growing season.

Total number of acres devoted to each crop and livestock enterprise and management type in 2005, 2006, 2007 and 2008 are given in Tables 8, 9, 10 and 11. 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 the information to fill gaps that occur due to the time it took to bring these 26 sites on-line but information in regard to water use is based on estimates as well as actual measurements during this first year and should be interpreted with caution. However, it provided useful information as we began this long-term project. It is also important to note that the first year of any project is unlikely to resemble closely any following year because of all the factors involved in start-up and calibration of measurement techniques. This is always the case. As we entered year 2, we were positioned to collect increasingly meaningful data and all sites were complete.

In year 2, Site No. 25 was lost to the project due to a change in ownership of the land. However, Site 27 was added, thus, the project continued to monitor 26 sites. Total acreage in 2006 was 4,230, a difference of about 60 acres between the two years. Crop and livestock enterprises on these sites and the acres committed to each use by site is given in Table 9.

In year 3, all sites present in 2006 remained in the project through 2007. Total acreage was 4,245, a slight increase over year 2 due to expansion of the area in Site No. 1.

In year 4, 26 sites included 2989 acres (Table 11). Sites 1, 13, 16, and 25 of the original sites had left the project with sites 28 and 29 added since the project began.

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 reflect completion and revisions made to previous year's 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 1-4 follow and are presented by site.

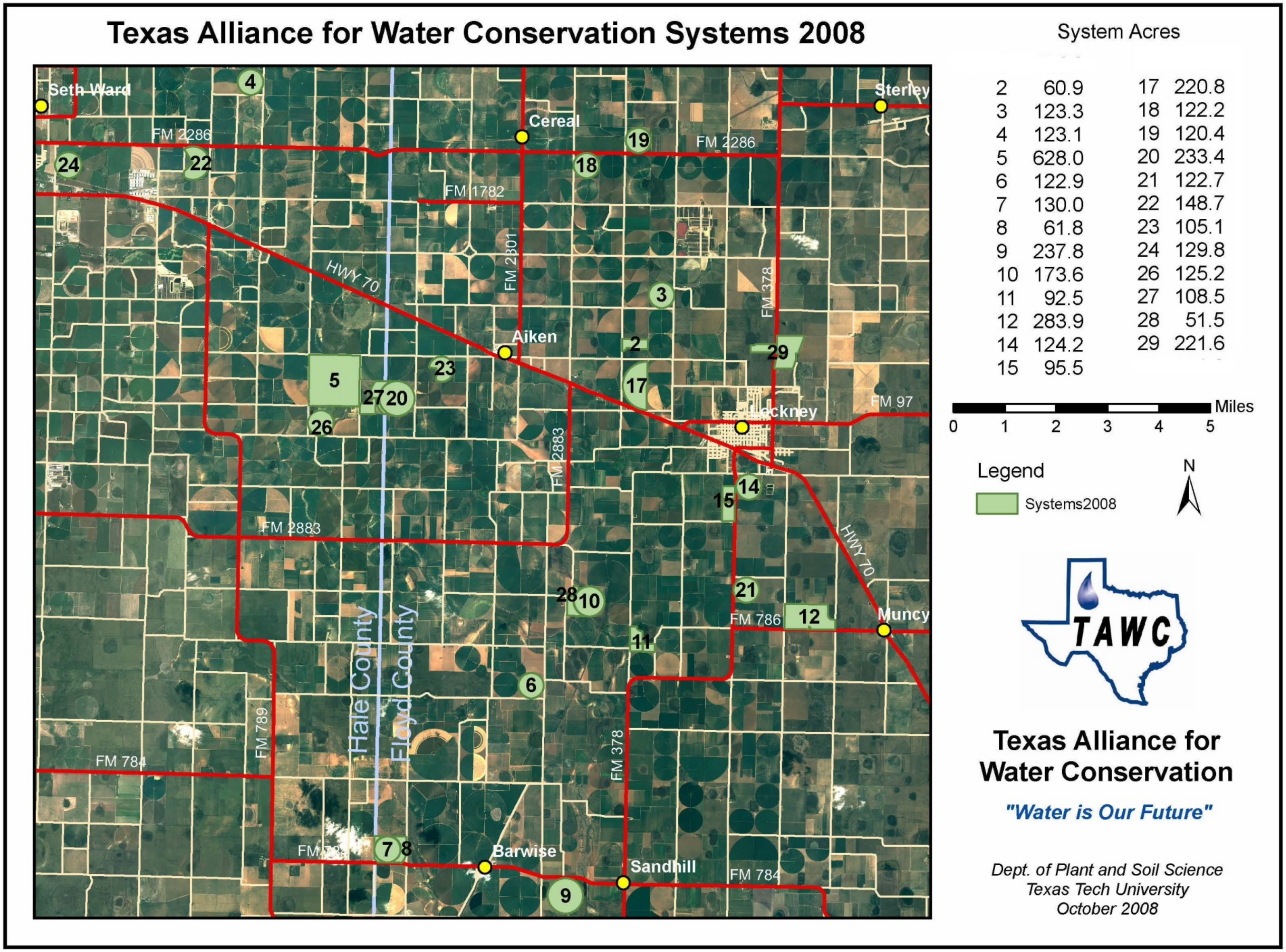


Figure 5. System map index for 2008 (Year 4).

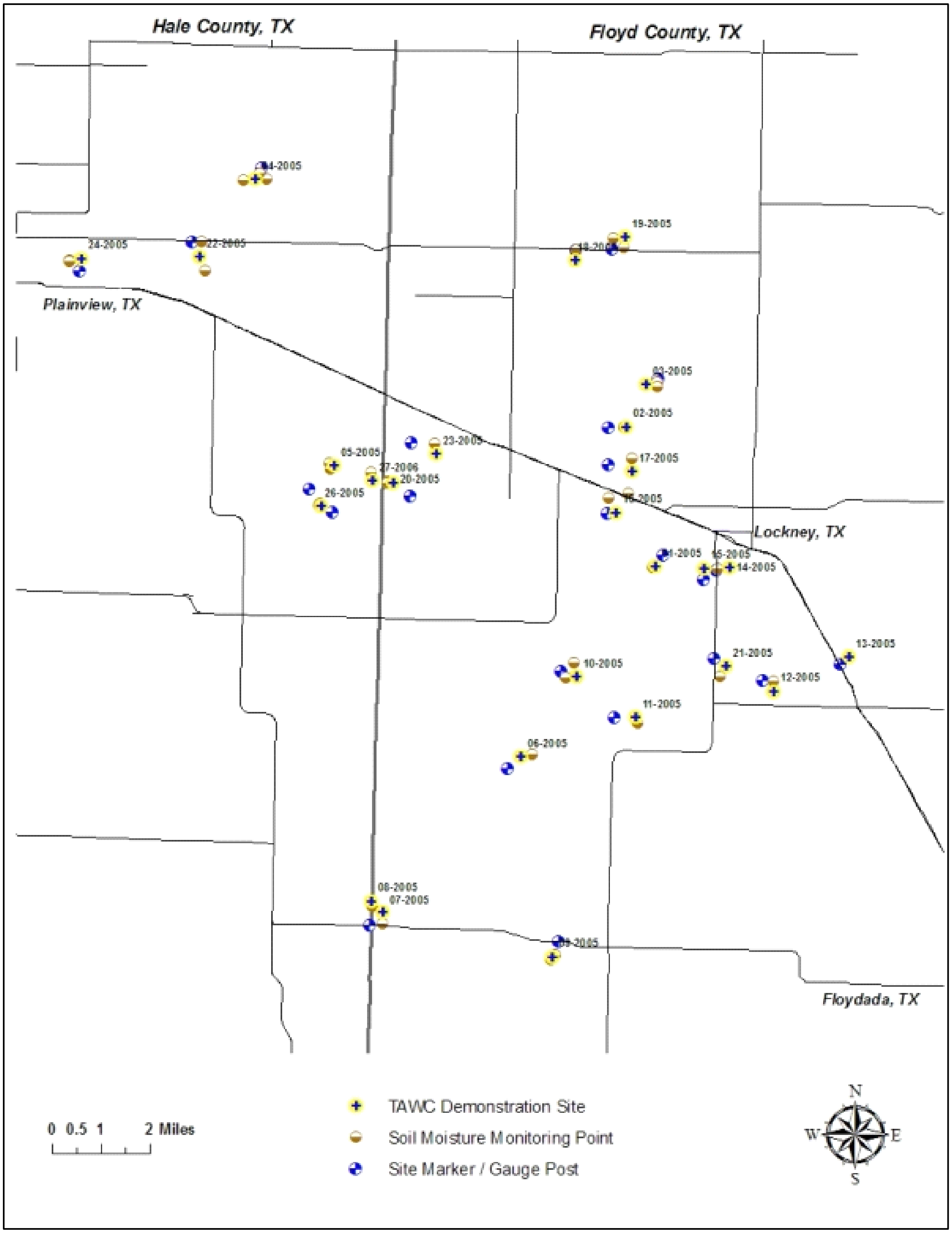


Figure 6. Location of soil moisture monitoring points of 26 sites in the Demonstration project.

Table 8. Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in producer systems in Hale and Floyd Counties during 2005.

TAWC 2005 CROP ACRES - ACRES MAY OVERLAP DUE TO MULTIPLE CROPS PER YEAR AND GRAZING

Site	irrigation type	cotton	corn grain	corn silage	sorghum grain	sorghum forage	pearl millet	sunflowers	alfalfa	grass seed	perennial pasture	cattle	wheat	rye	triticale	oats
1	SDI	62.3														
2	SDI	60.9														
3	PIV	61.8			61.5											
4	PIV	109.8							13.3							
5	PIV/DRY								69.6		551.3	620.9				
6	PIV	122.9										122.9	122.9			
7	PIV									130.0						
8	SDI									61.8						
9	PIV	137.0									95.8	232.8		232.8		
10	PIV	44.5									129.1	129.1				
11	FUR	92.5														
12	DRY	151.2				132.7										
13	DRY	201.5											118.0			
14	PIV	124.2														
15	FUR	95.5														
16	PIV	143.1														
17	PIV	108.9		58.3							53.6					
18	PIV	61.5			60.7											
19	PIV	75.3					45.1									
20	PIV			115.8		117.6							117.6			
21	PIV	122.7														
22	PIV	72.7	76.0													
23	PIV	51.5						48.8								
24	PIV	64.7	65.1													
25	DRY	90.9			87.6											
26	PIV	62.9	62.3													
27	SDI	n/a														
Total 2005 acres		**2118.3**	**203.4**	**174.1**	**209.8**	**250.3**	**45.1**	**48.8**	**82.9**	**191.8**	**829.8**	**1105.7**	**358.5**	**232.8**	**0.0**	**0.0**

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

Table 9. Irrigation type and total acres, by site, of crops, forages and acres grazed by cattle in producer systems in Hale and Floyd Counties during 2006.

TAWC 2006 CROP ACRES - ACRES MAY OVERLAP DUE TO MULTIPLE CROPS PER YEAR AND GRAZING

Site	irrigation type	cotton	corn grain	corn silage	sorghum grain	sorghum forage	pearl millet	sunflowers	alfalfa	grass seed	perennial pasture	cattle	wheat	rye	triticale	oats
1	SDI	135.2														
2	SDI	60.9														
3	PIV	123.3														
4	PIV	44.4				65.4			13.3				65.4			
5	PIV/DRY								69.6		551.3	620.9				
6	PIV	122.9														
7	PIV									130.0						
8	SDI									61.8						
9	PIV	137.0									95.8	95.8		137.0		
10	PIV					44.5					129.1	129.1				44.5
11	FUR	92.5														
12	DRY	132.7											151.2			
13	DRY	118.0											201.5			
14	PIV	124.2														
15	FUR	67.1			28.4											
16	PIV	143.1														
17	PIV	58.3		108.9							53.6	162.5	108.9			
18	PIV	60.7				61.2										61.2
19	PIV	75.1					45.3									
20	PIV			117.6		115.8									115.8	
21	PIV	61.3	61.4									61.3	61.3			
22	PIV	72.7	76													
23	PIV	51.5	48.8													
24	PIV	65.1		64.7												
25	DRY	n/a														
26	PIV	62.3	62.9													
27	SDI	46.2														
Total 2006 acres		**1854.5**	**249.1**	**291.2**	**28.4**	**286.9**	**45.3**	**0.0**	**82.9**	**191.8**	**829.8**	**1069.6**	**588.3**	**137.0**	**115.8**	**105.7**

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

Table 10. Irrigation type and total acres, by site, of crops, forages and acres grazed by cattle in producer systems in Hale and Floyd Counties during 2007.

TAWC 2007 CROP ACRES - ACRES MAY OVERLAP DUE TO MULTIPLE CROPS PER YEAR AND GRAZING

Site	irrigation type	cotton	corn grain	corn silage	sorghum grain	sorghum forage	pearl millet	sunflowers	alfalfa	grass seed	perennial pasture	cattle	wheat	rye	triticale	oats
1	SDI	135.2														
2	SDI	60.9														
3	PIV	61.5				61.8							61.8			
4	PIV	65.4							13.3			109.8	109.8			
5	PIV/DRY										620.9	620.9				
6	PIV	122.9														
7	PIV									130.0						
8	SDI									61.8						
9	PIV				137.0						95.8	95.8		232.8		
10	PIV			44.5							129.1	129.1				
11	FUR	92.5														
12	DRY	151.2			132.7											
13	DRY	201.5											118.0			
14	PIV	124.2														
15	FUR	66.7			28.8											
16	PIV	143.1														
17	PIV	108.9									167.2	167.2	108.9			
18	PIV				61.5								60.7			
19	PIV	75.8					45.6									
20	PIV			117.6		115.8									233.4	
21	PIV		61.3							61.4						
22	PIV	148.7														
23	PIV		105.2													
24	PIV		129.8													
25	DRY	n/a														
26	PIV		62.3				62.9					62.9				
27	SDI	16.2		46.2												
Total 2007 acres		**1574.7**	**358.6**	**208.3**	**360.0**	**177.6**	**108.5**	**0.0**	**13.3**	**253.2**	**1013.0**	**1185.7**	**459.2**	**232.8**	**233.4**	**0.0**

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

Table 11. Irrigation type and total acres, by site, of crops, forages and acres grazed by cattle in producer systems 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	pearlmillet 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	pearlmillet 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

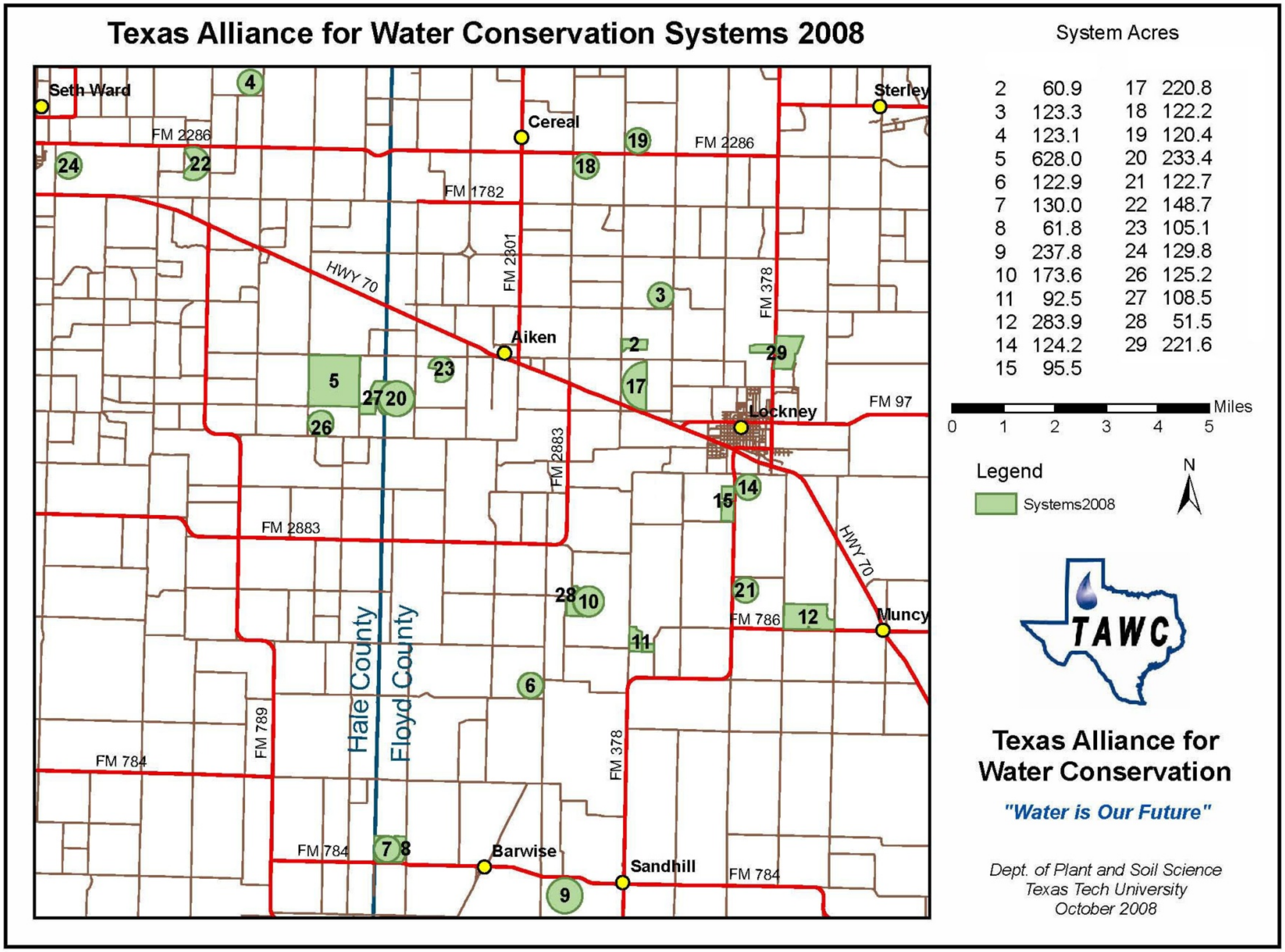
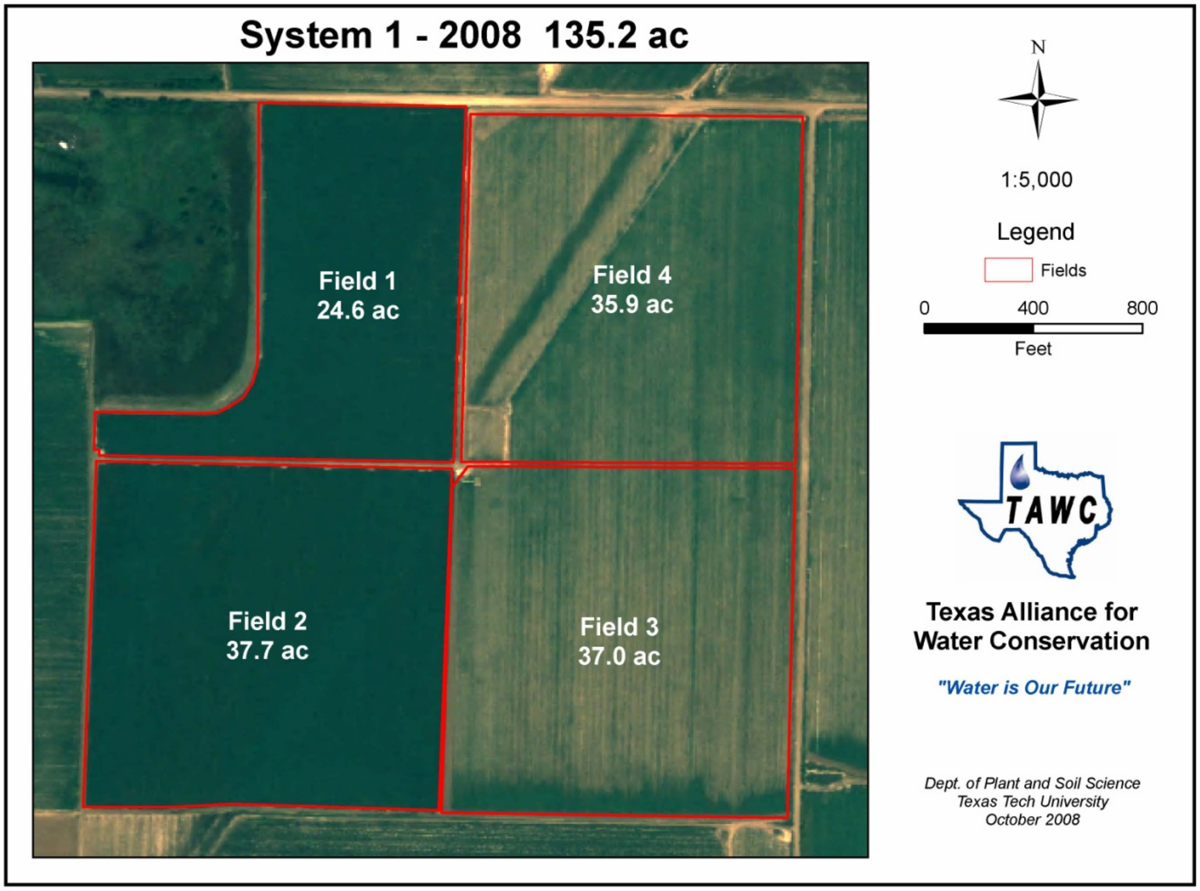


Figure 7. Systems map for 2008 (Year 4).



System 1 Description

Total system 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: Sub-surface 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

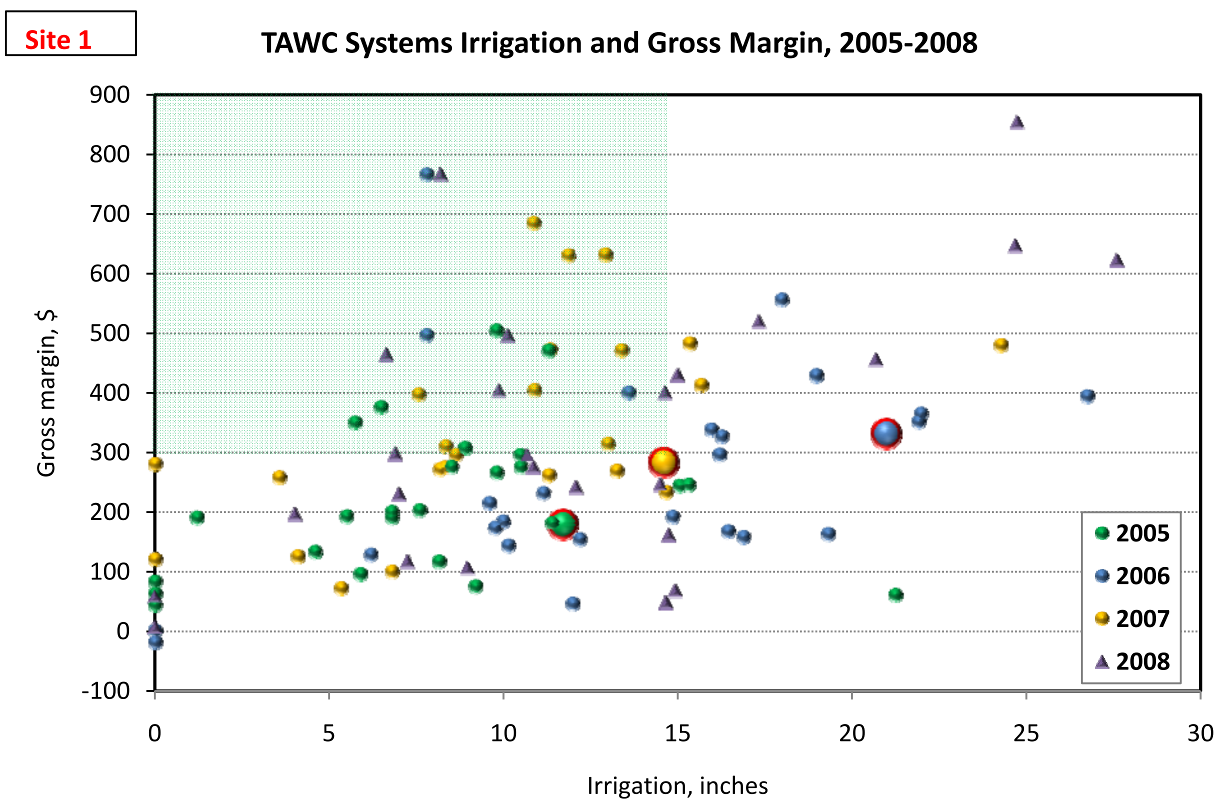
Number of wells: 2

Fuel source: Electric
Natural gas

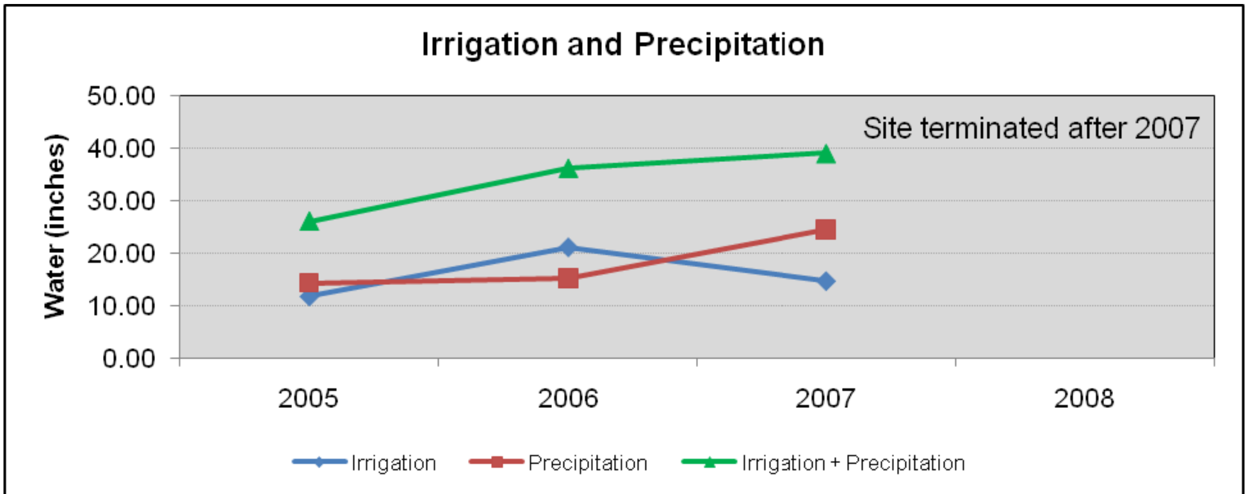
Comments: Drip irrigation cotton system, conventional tillage and plants on forty-inch centers.

System 1

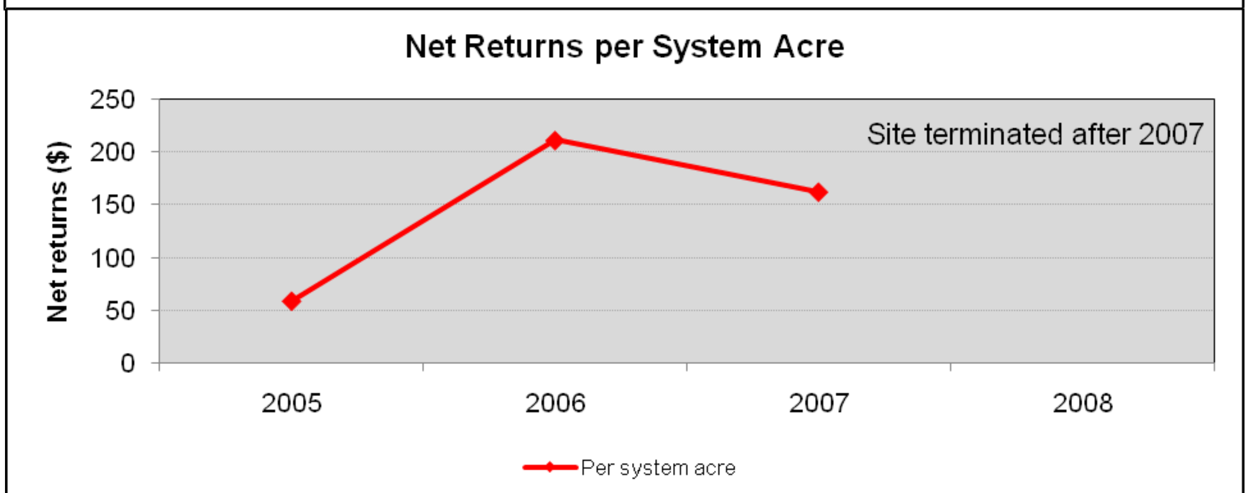
	Field 1	Field 2	Field 3	Field 4
2005	Cotton	Cotton		
2006	Cotton	Cotton	Cotton	Cotton
2007	Cotton	Cotton	Cotton	Cotton
2008	Site terminated in 2008			



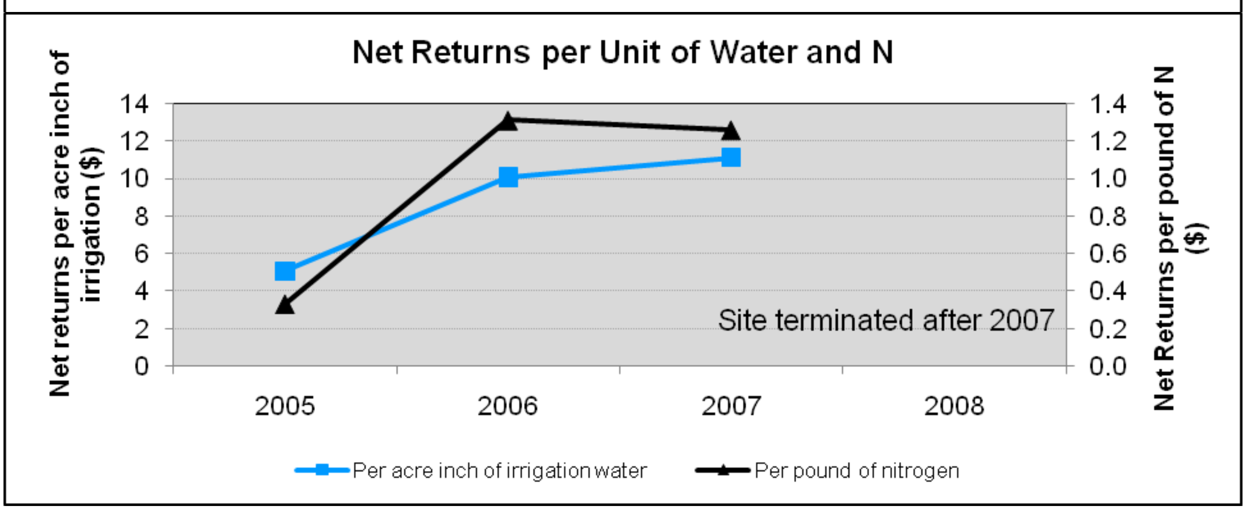
Site 1



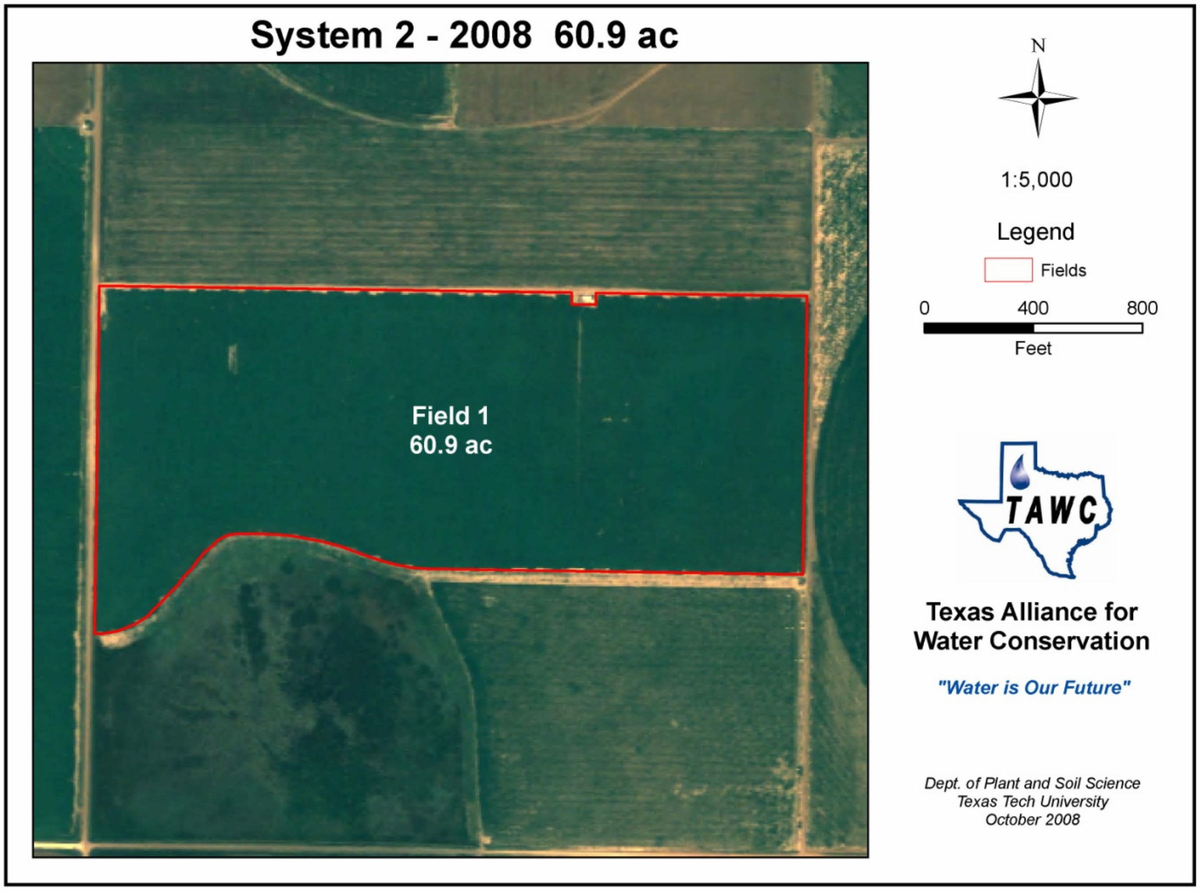
Irrigation and Precipitation
Water (inches)
50.00
40.00
30.00
20.00
10.00
0.00
Site terminated after 2007
2005
2006
2007
2008
Irrigation
Precipitation
Irrigation + Precipitation



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



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



System 2 Description

Total system acres: 60.9

Field No. 1 Acres: 60.9
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

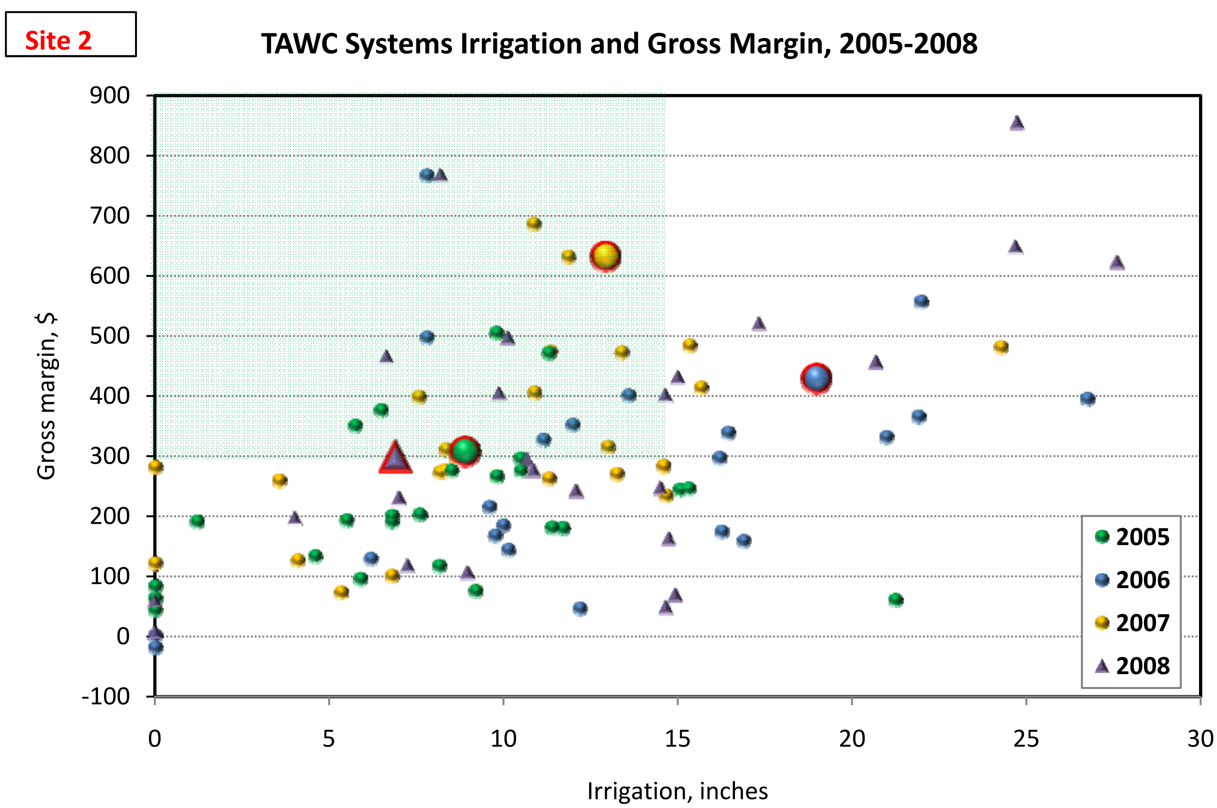
Number of wells: 2

Fuel source: Electric

Comments: This drip irrigated site was planted to sunflowers on thirty inch centers. The previous three years cotton was planted on this site.

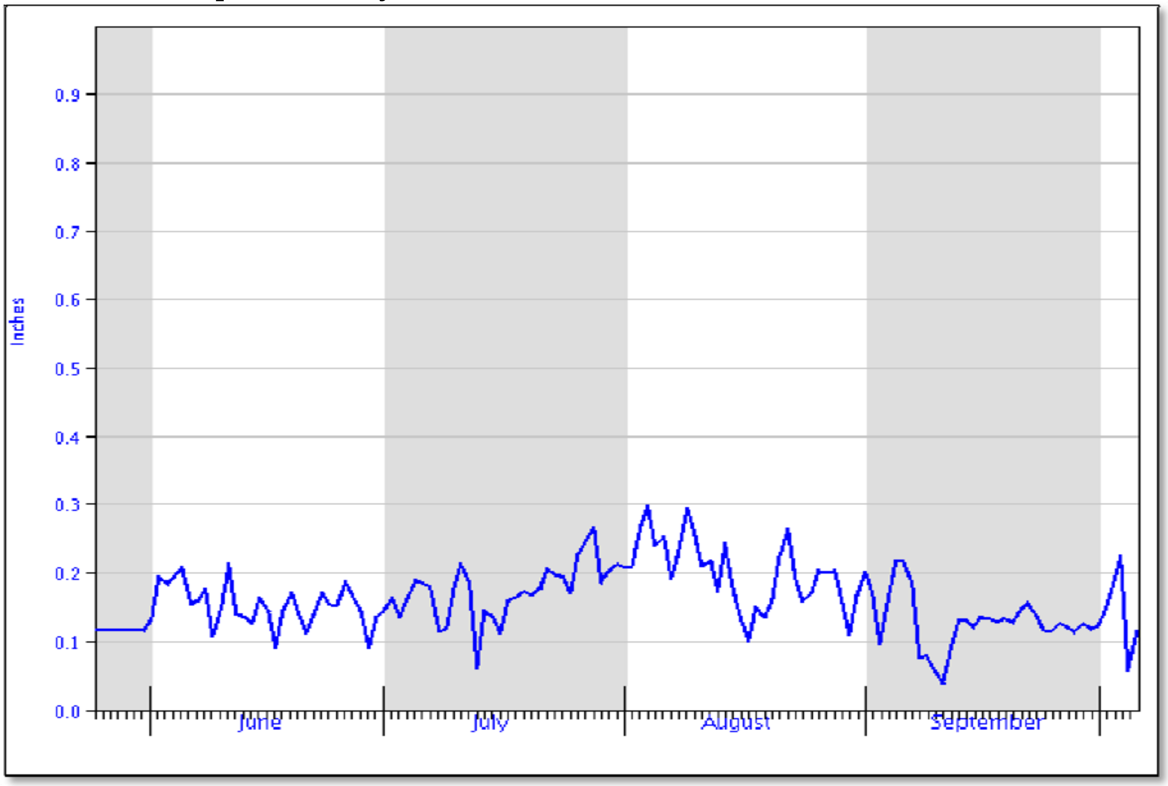
System 2

	Livestock	Field 1
2005	None	Cotton
2006	None	Cotton
2007	None	Cotton
2008	None	Sunflowers



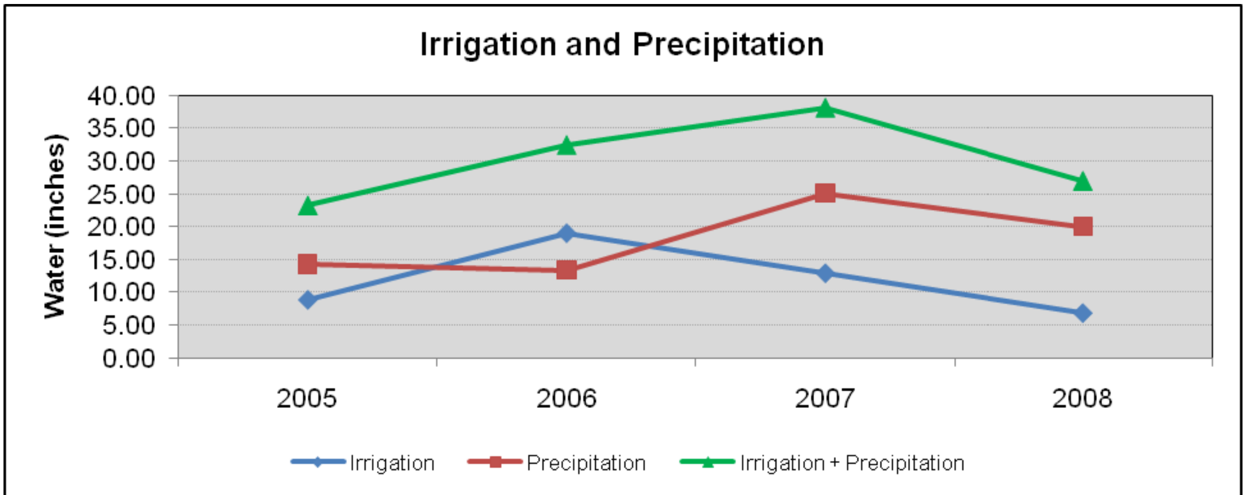
Site 2 Field 1

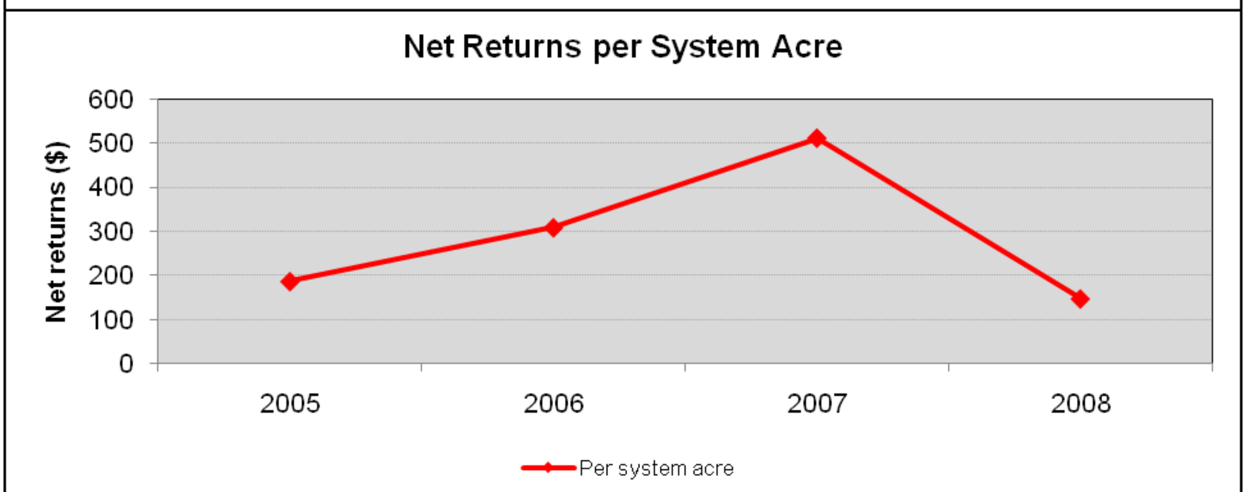
Sunflowers planted May 25 **Total ET Demand 23.23"**

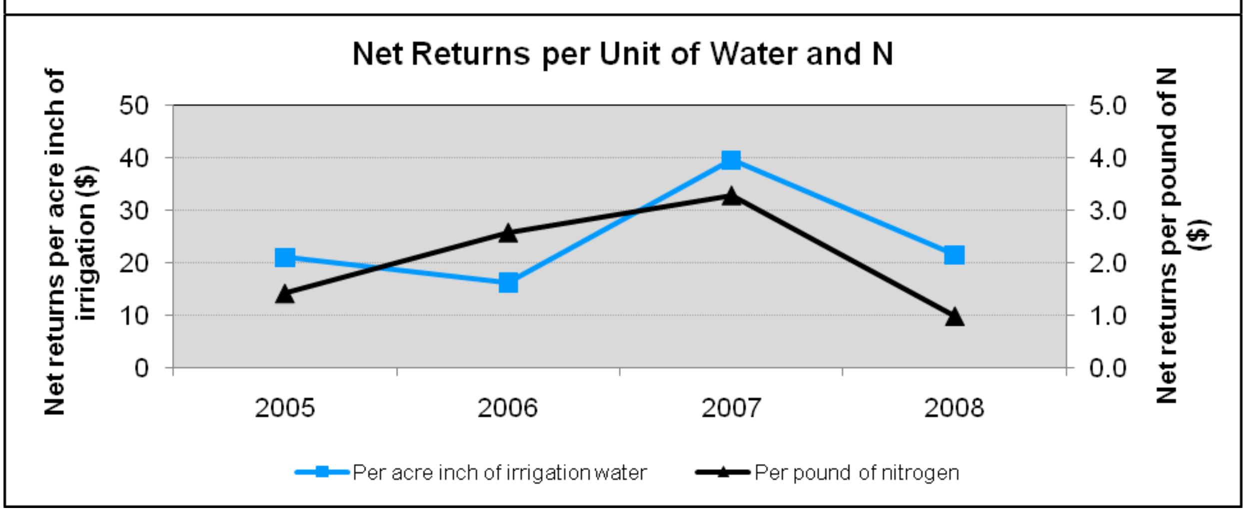


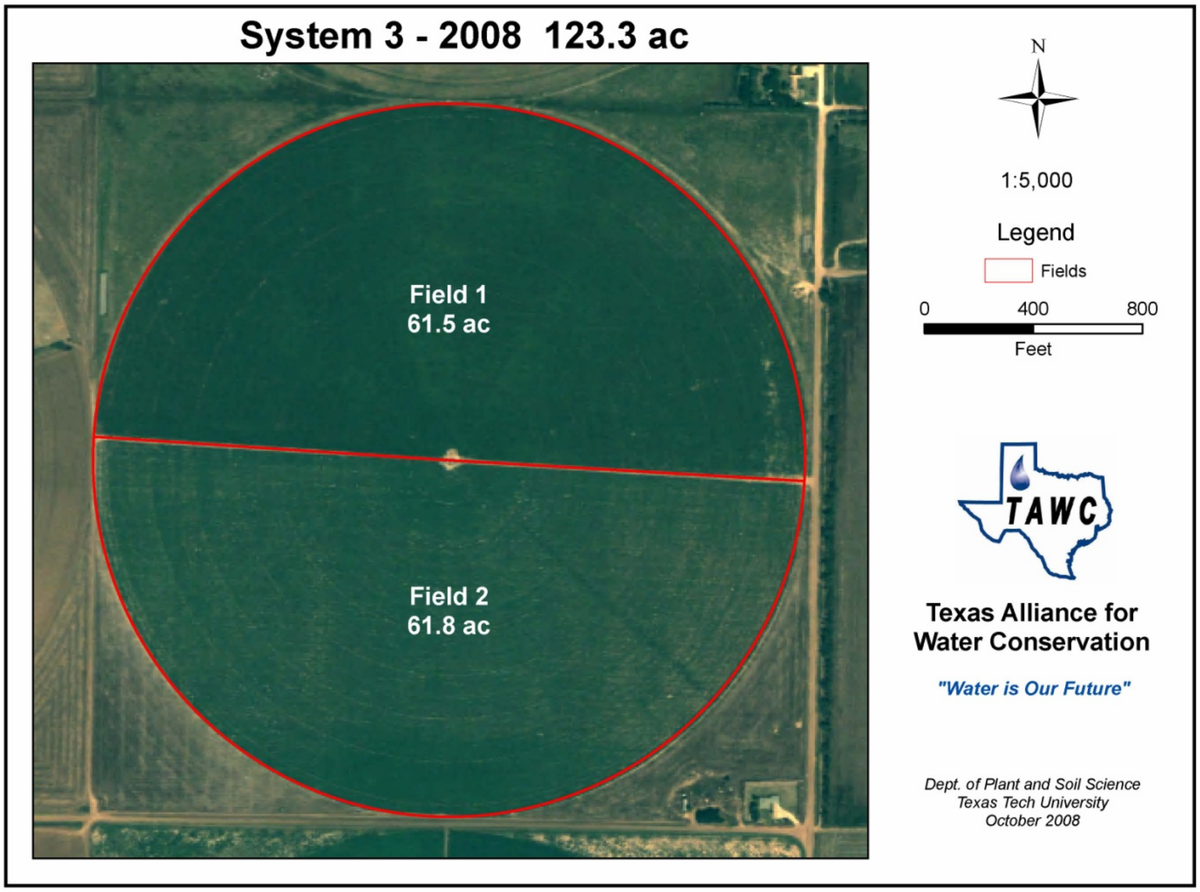
Site 2 Field 1, August 2008

Site 2


Irrigation and Precipitation
Water (inches)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
2005
2006
2007
2008
Irrigation
Precipitation
Irrigation + Precipitation


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


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



System 3 Description

Total system acres: 123.3

Field No. 1 Acres: 61.5
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 2 Acres: 61.8
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Center Pivot (MESA)

Pumping capacity, gal/min: 450

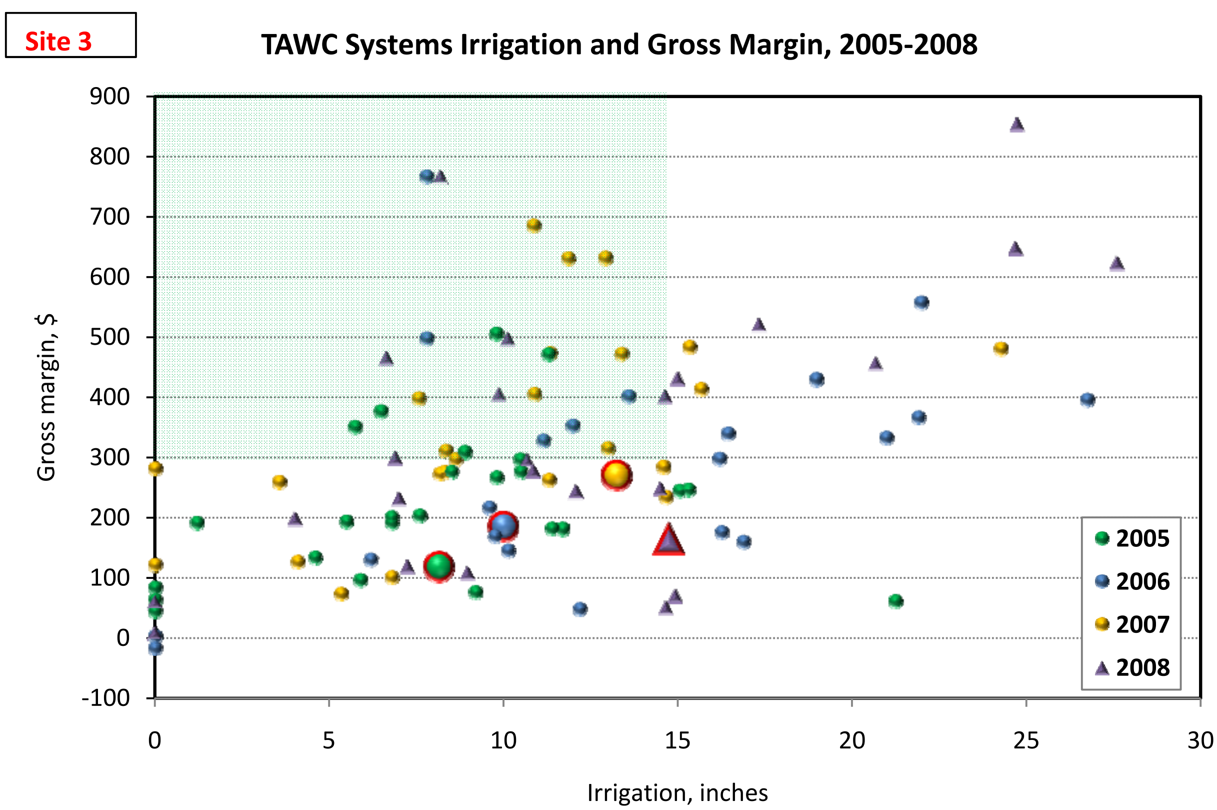
Number of wells: 2

Fuel source: 1 Natural gas
1 Electric

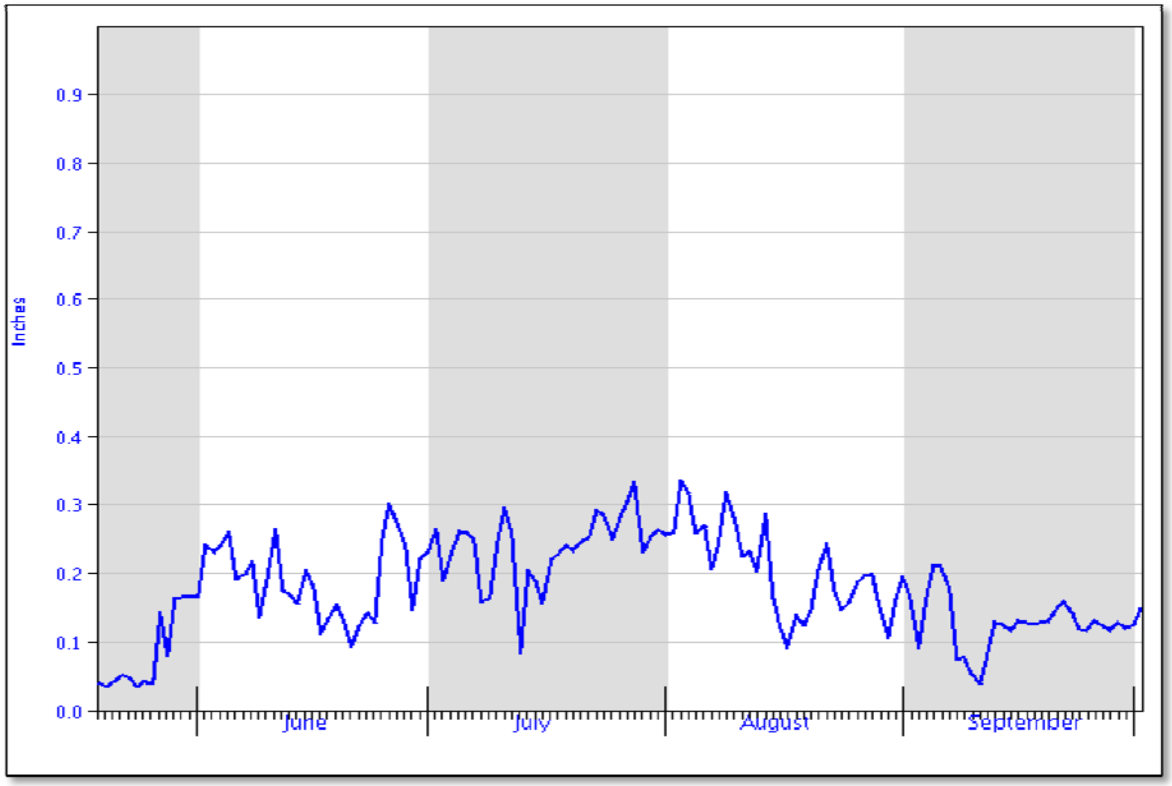
Comments: This is a pivot irrigated system, conventional tillage, and is planted on forty-inch centers, one-half in cotton, the other half planted to wheat then double cropped to grain sorghum.

System 3

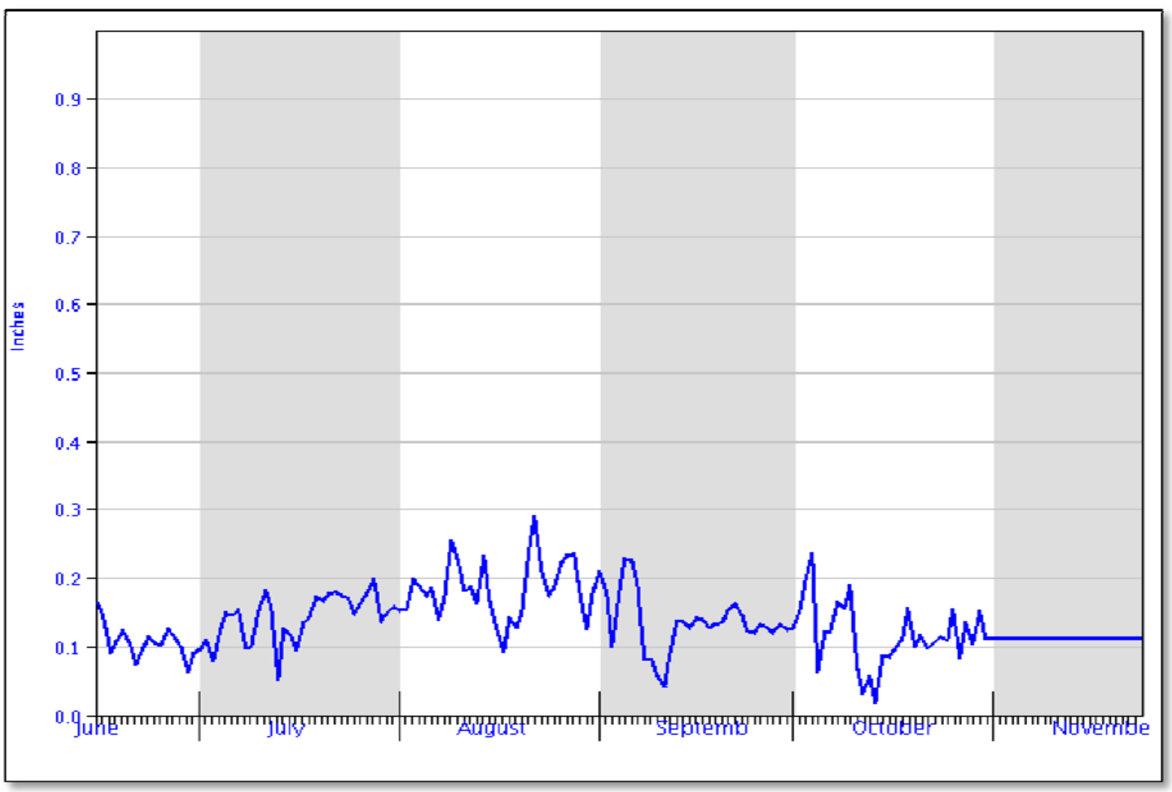
	Livestock	Field 1	Field 2
2005	None	Grain Sorghum	Cotton
2006	None	Cotton	Cotton
2007	None	Cotton following Wheat cover crop	Wheat for grain followed by Grain Sorghum
2008	None	Wheat for grain followed by Grain Sorghum	Cotton



Site 3 Field 1
Cotton planted May 19 **Total ET Demand 24.22"**



Site 3 Field 2
Sorghum planted June 15 **Total ET Demand 22.01"**



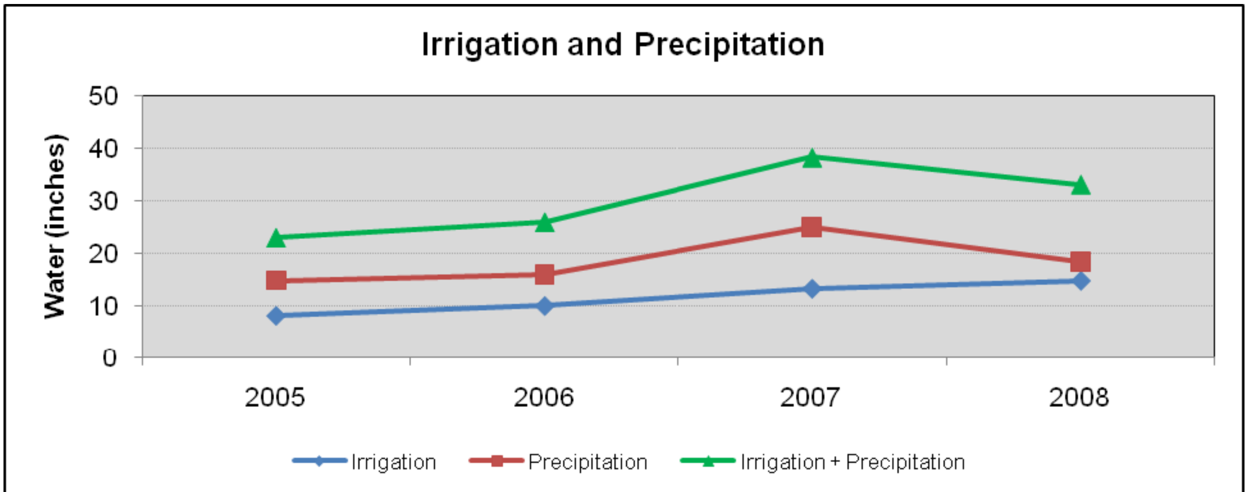

Site 3 Field 1, April 2008


Site 3 Field 1, October 2008

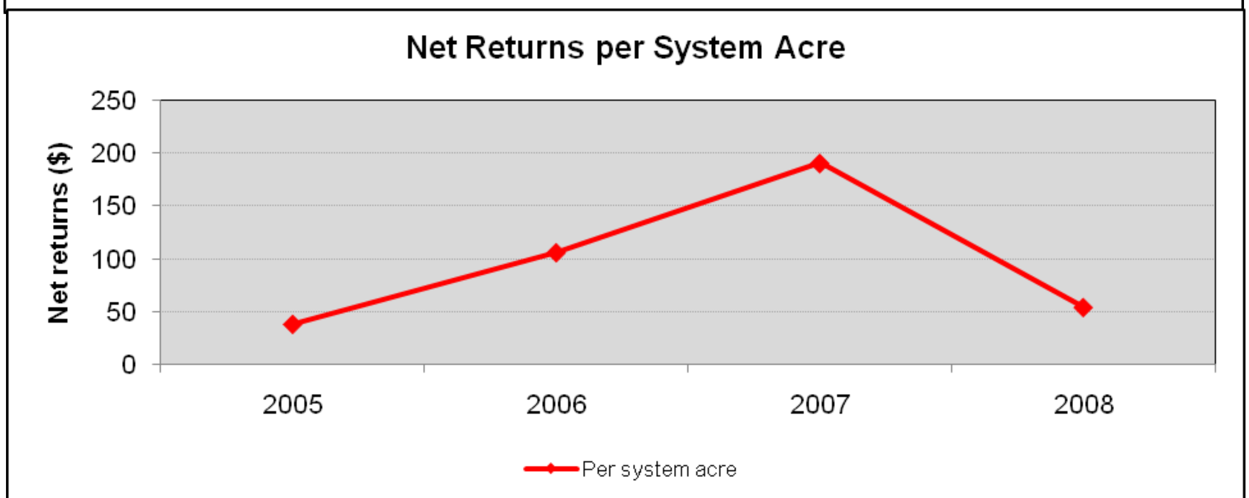

Site 3 Field 2, June 2008


Site 3 Field 2, November 2008

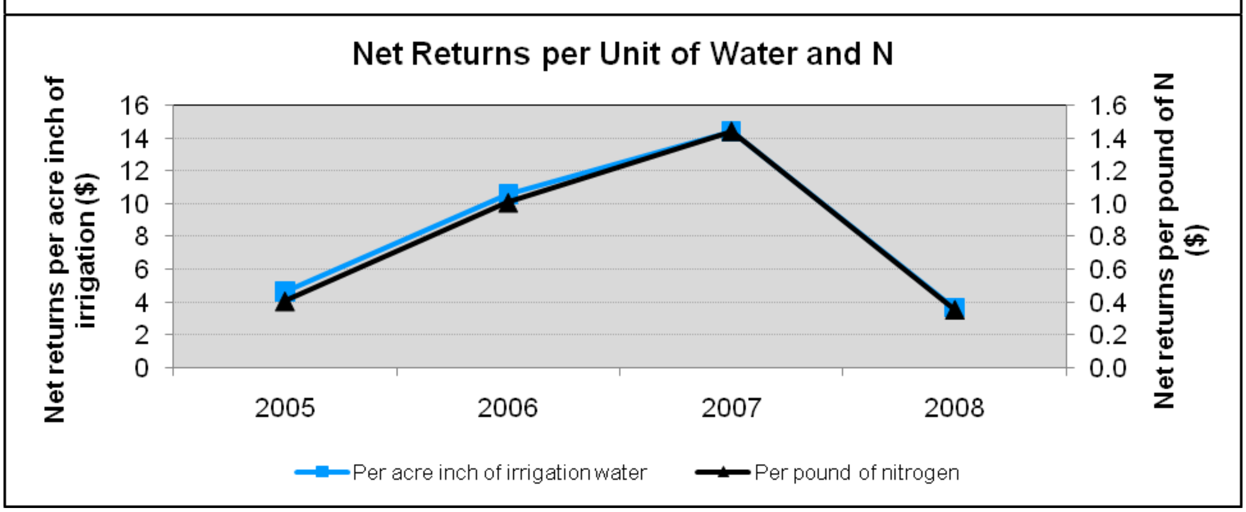
Site 3



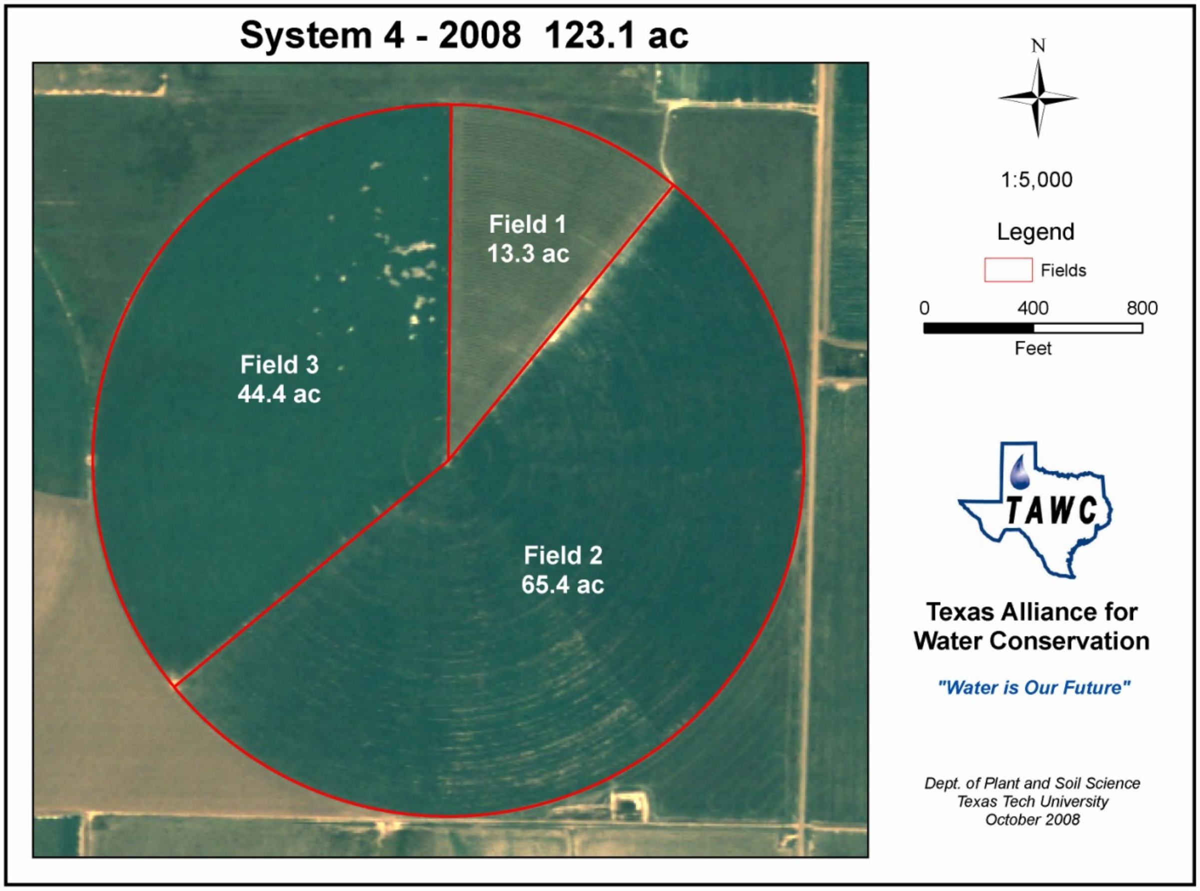
Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
Irrigation
Precipitation
Irrigation + Precipitation



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



Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
16
14
12
10
8
6
4
2
0
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
Per acre inch of irrigation water
Per pound of nitrogen



System 4 Description

Total system acres:	123.1
Field No. 1 Acres:	13.3
Major soil type:	Estacado clay loam, 1 to 3% slope
Field No. 2 Acres:	65.4
Major soil type:	Pullman clay loam, 0 to 1% slope
Field No. 3 Acres:	44.4
Major soil type:	Pullman clay loam, 0 to 1% slope

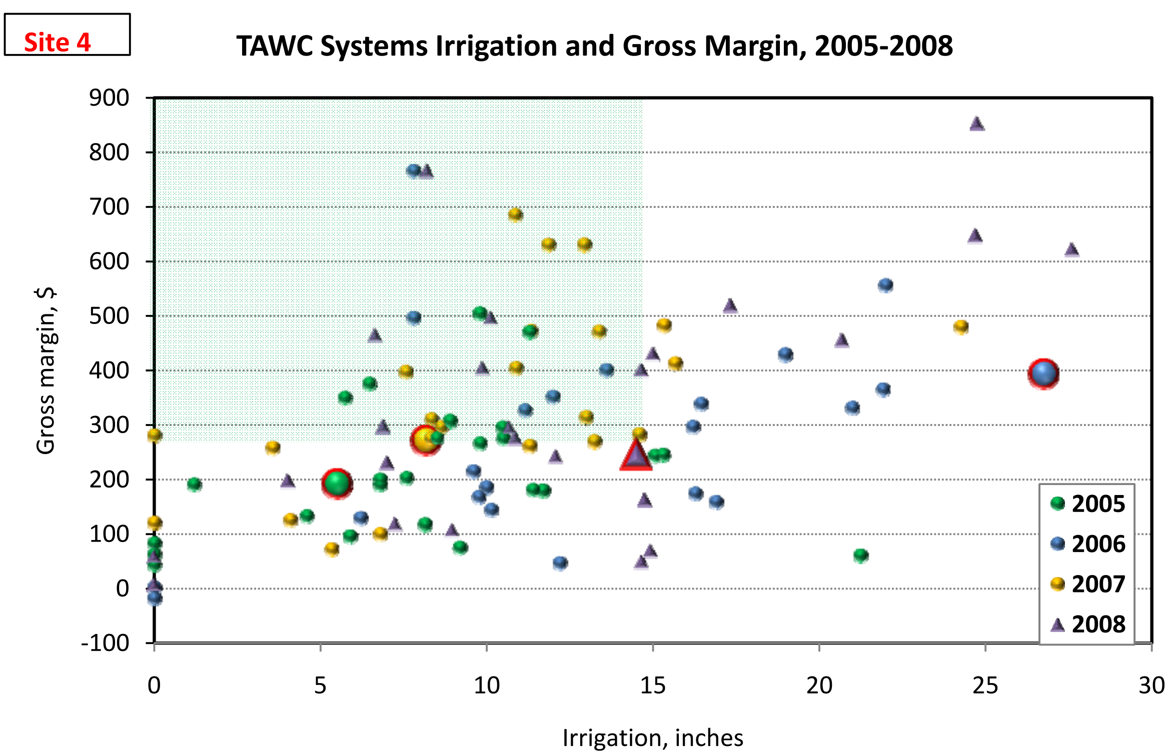
Irrigation

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

Comments: Pivot irrigated system, conventional tillage, and cotton is planted on forty-inch centers. Field 1 is planted to alfalfa and the hay is used in this producer's cow/calf operation. Field 2 was planted to grain sorghum and this field was planted to wheat.

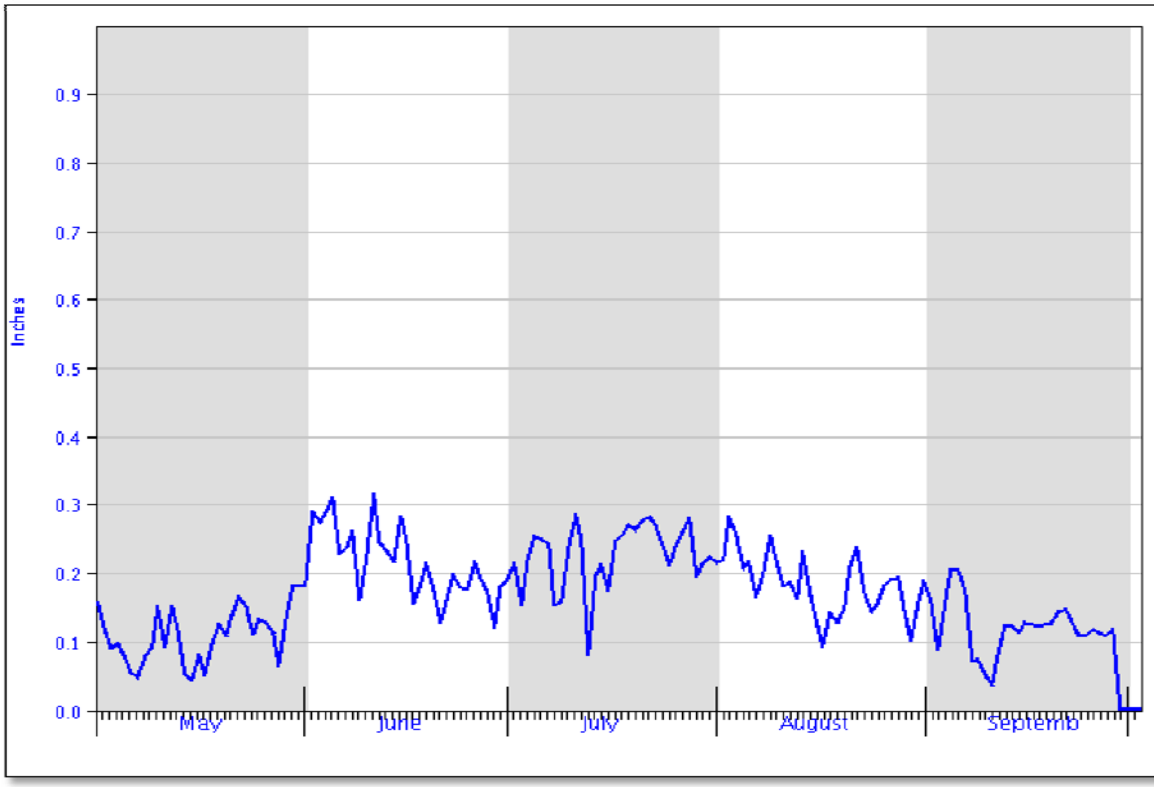
System 4

	Livestock	Field 1	Field 2	Field 3
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



Site 4 Field 2

Sorghum planted May 1 **Total ET Demand 26.01"**

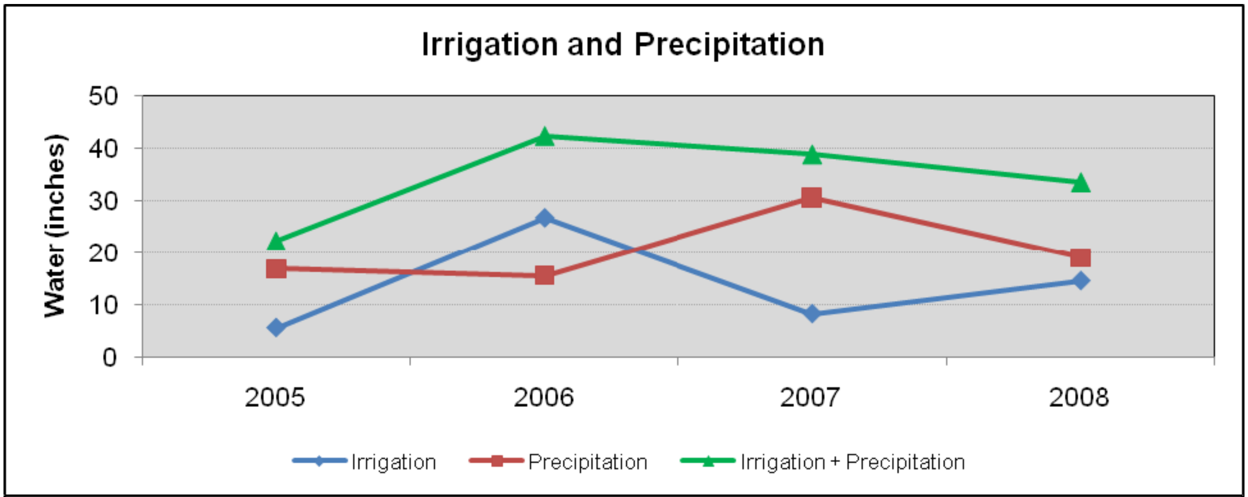


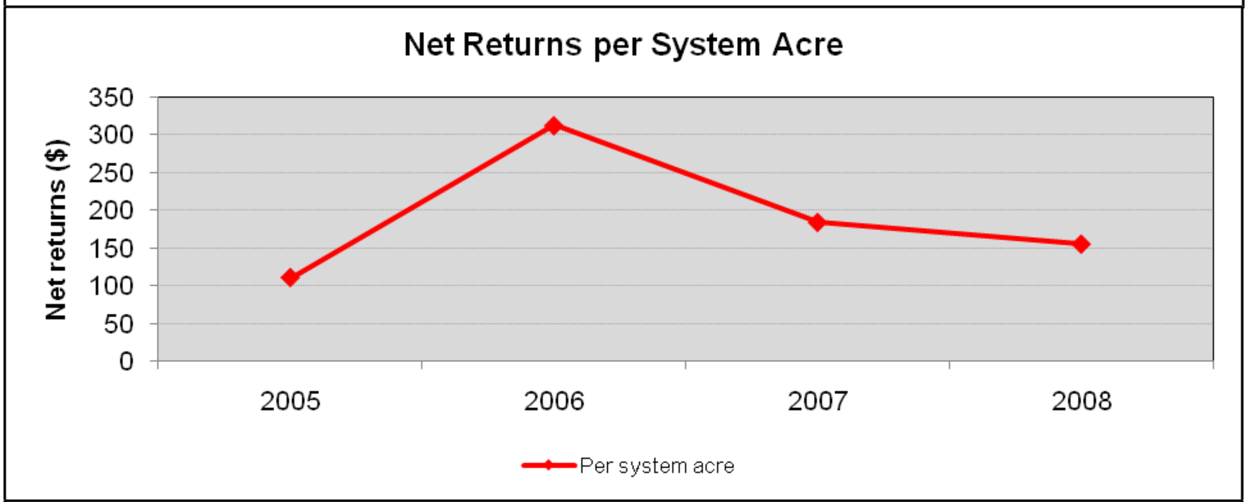
Site 4 Field 1, September 2008

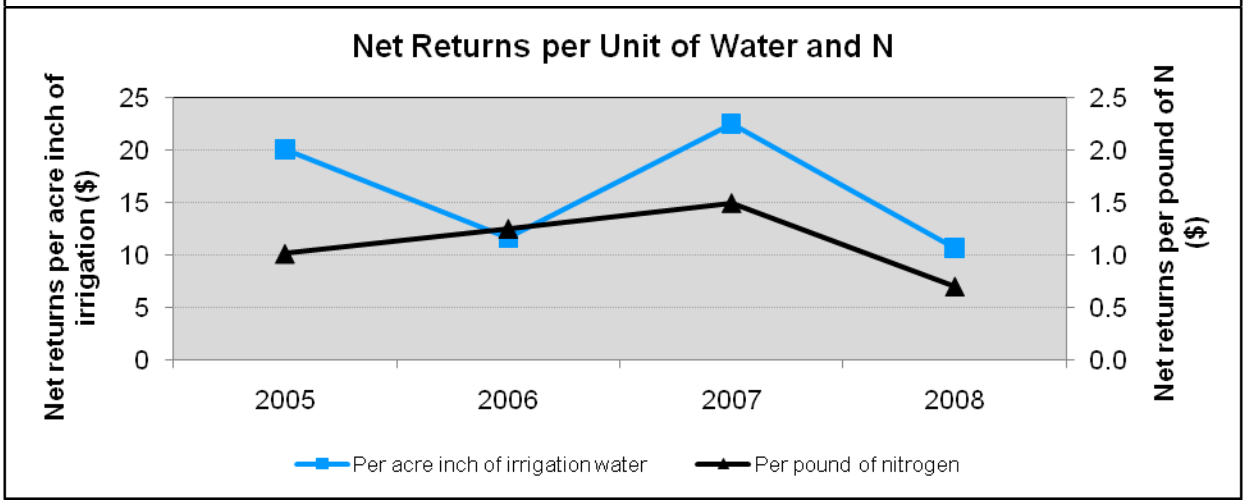
Site 4 Field 2, September 2008

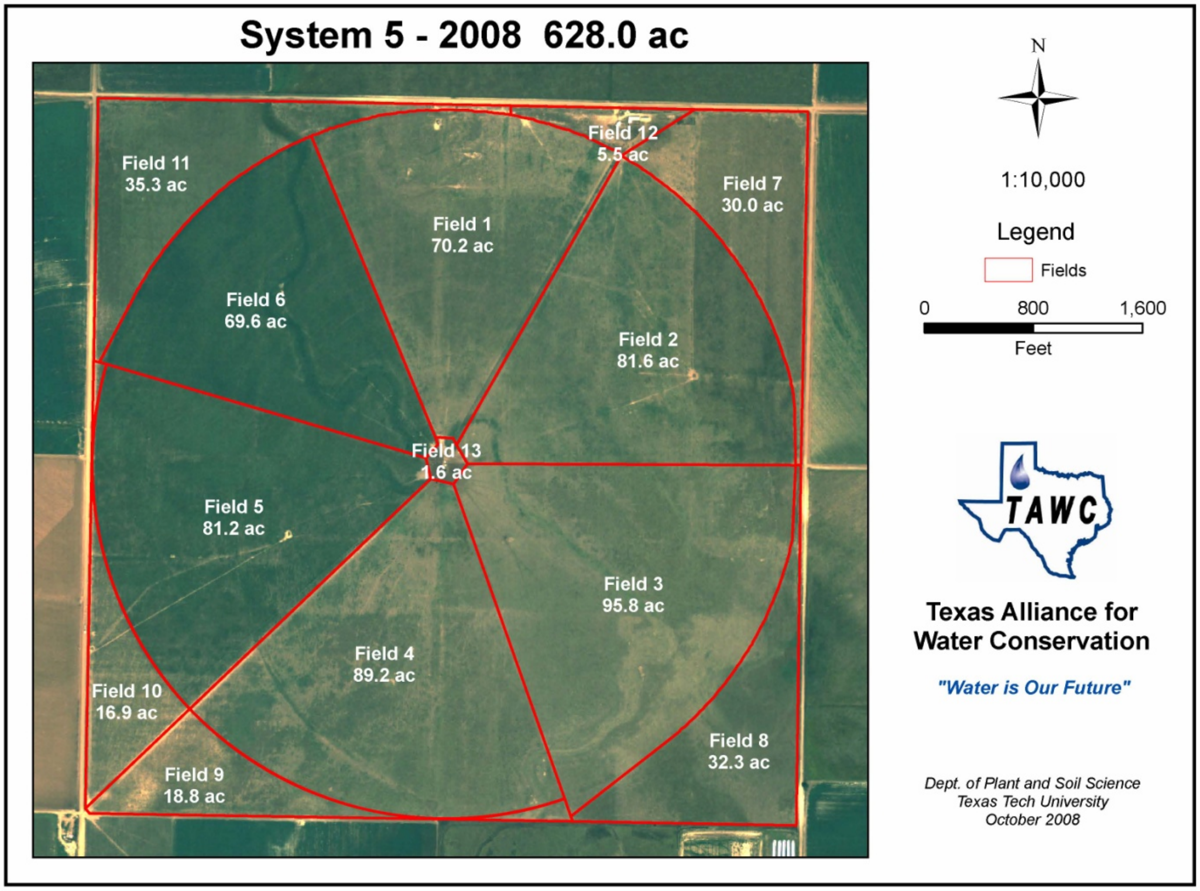
Site 4 Field 3, May 2008

Site 4


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


Net Returns per System Acre
Net returns ($)
0
50
100
150
200
250
300
350
2005
2006
2007
2008
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
0
5
10
15
20
25
Net returns per pound of N ($)
0.0
0.5
1.0
1.5
2.0
2.5
2005
2006
2007
2008
Per acre inch of irrigation water
Per pound of nitrogen



System 5 Description

Total system acres: 628.0
(487.6 irrigated; 133.3 dryland, 7.1 facilities)

IRRIGATED

Field No. 1 Acres: 70.2
Major soil type: Bippus loam, 0 to 1% slope
Mansker loam, 0 to 3% slope

Field No. 2 Acres: 81.6
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. 3 Acres: 95.8
Major soil type: Bippus loam, 0 to 1% slope

Field No. 4 Acres: 89.2
Major soil type: Bippus loam, 0 to 1% slope
Olton loam, 0 to 1 and 1 to 3% slope

Irrigation

Type: Center Pivot (MESA)

Pumping capacity, gal/min: 1100

Number of wells: 4

Fuel source: Electric

Field No. 5 Acres:	81.2
Major soil type:	Olton loam, 0 to 1% slope Bippus loam, 0 to 1% slope Mansker loam, 0 to 3% slope
Field No. 6 Acres:	69.6
Major soil type:	Bippus loam, 0 to 1% slope

DRYLAND

Field No. 7 Acres:	30.0
Major soil type:	Pullman clay loam, 0 to 1% slope
Field No. 8 Acres:	32.3
Major soil type:	Bippus loam, 0 to 1% slope Randall clay Estacado loam, 1 to 3% slope
Field No. 9 Acres:	18.8
Major soil type:	Olton loam, 1 to 3% slope Mansker loam, 3 to 5% slope Bippus fine sandy loam, overwash, 1 to 3% slope
Field No. 10 Acres:	16.9
Major soil type:	Olton loam, 0 to 1% slope Pullman clay loam, 0 to 1% slope
Field No. 11 Acres:	35.3
Major soil type:	Bippus loam, 0 to 1% slope
Field No. 12 and 13 Acres:	7.1
Major soil type:	Pens and barns

Comments: This is a commercial, spring calving cow/calf operation. The 494.7 acres of irrigated grass is broken into six cells. This producer usually moves all cattle off site in early winter after the calves are weaned. Cows will calve on wheat and are moved back on site.

System 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

System 5 ***Crops - Dryland***

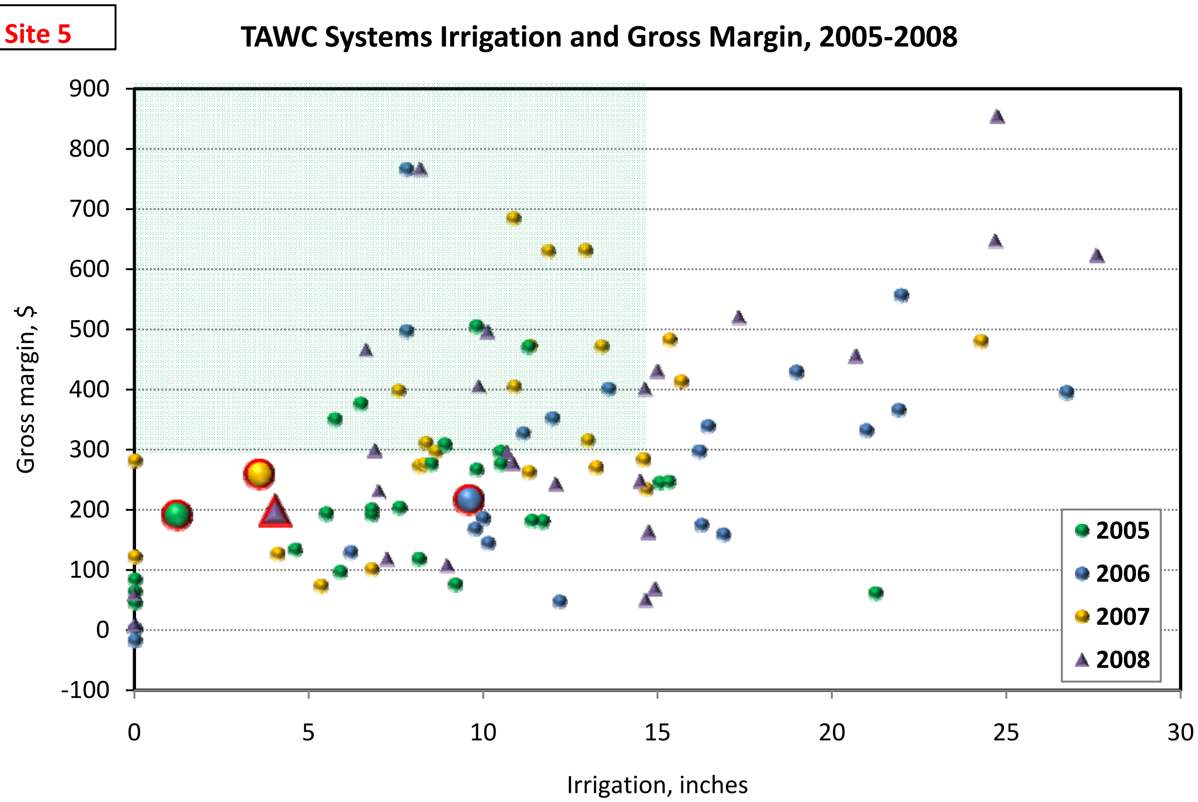
	Field 7	Field 8	Field 9	Field 10	Field 11	Fields 12 and 13
2005	Plains/Blue grama mixture for grazing	Plains/Blue grama/Sand dropseed/Buffalograss mixture for grazing	Plains/Blue grama mixture for grazing	Plains/Blue grama mixture for grazing	Plains/Blue grama mixture for grazing	Pens and barns
2006	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

Site 5, March 2008

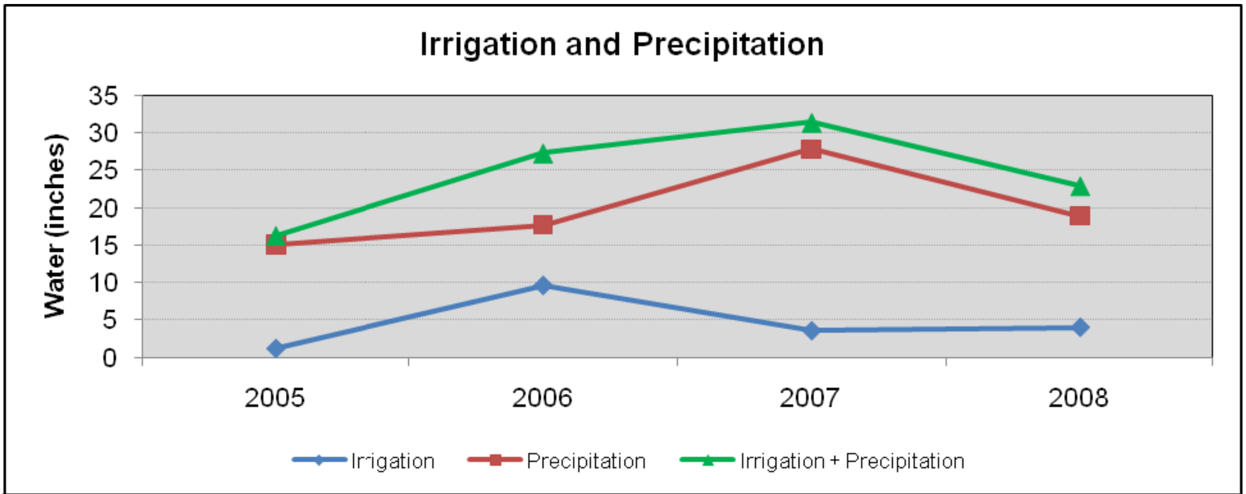
Site 5, August 2008

Site 5, August 2008

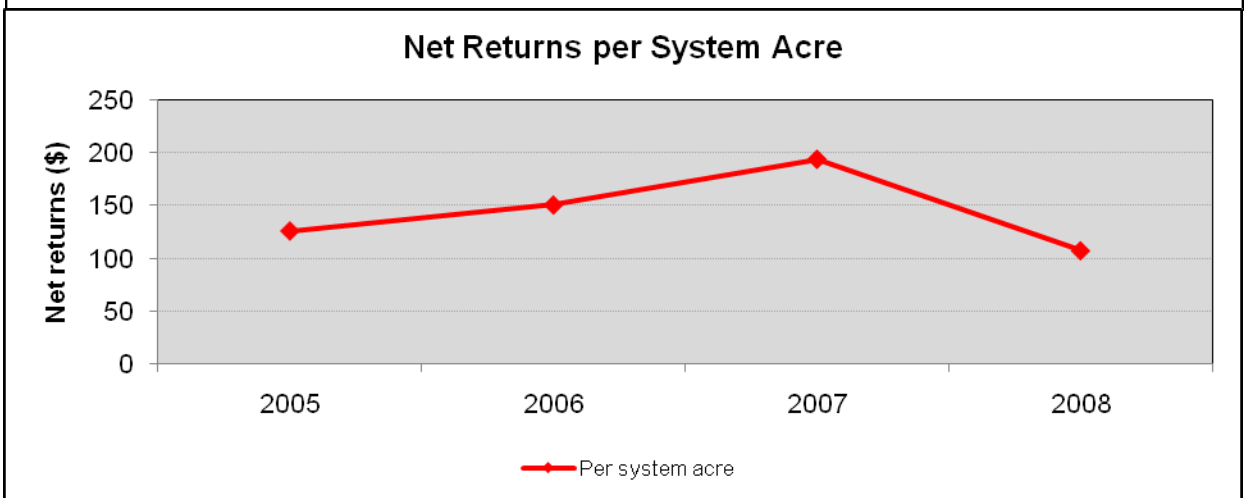
Site 5



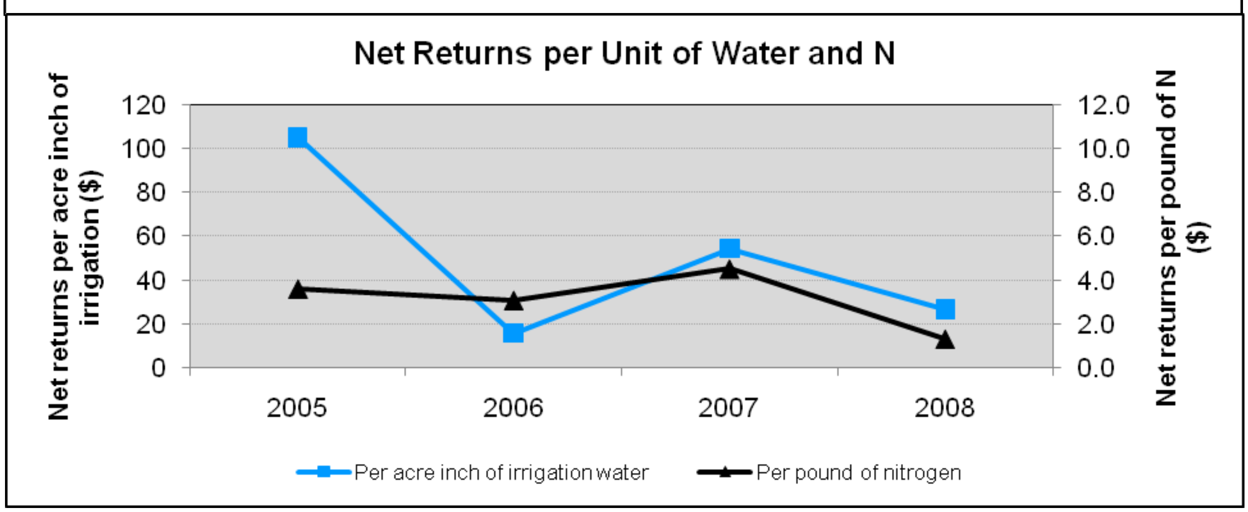
Site 5



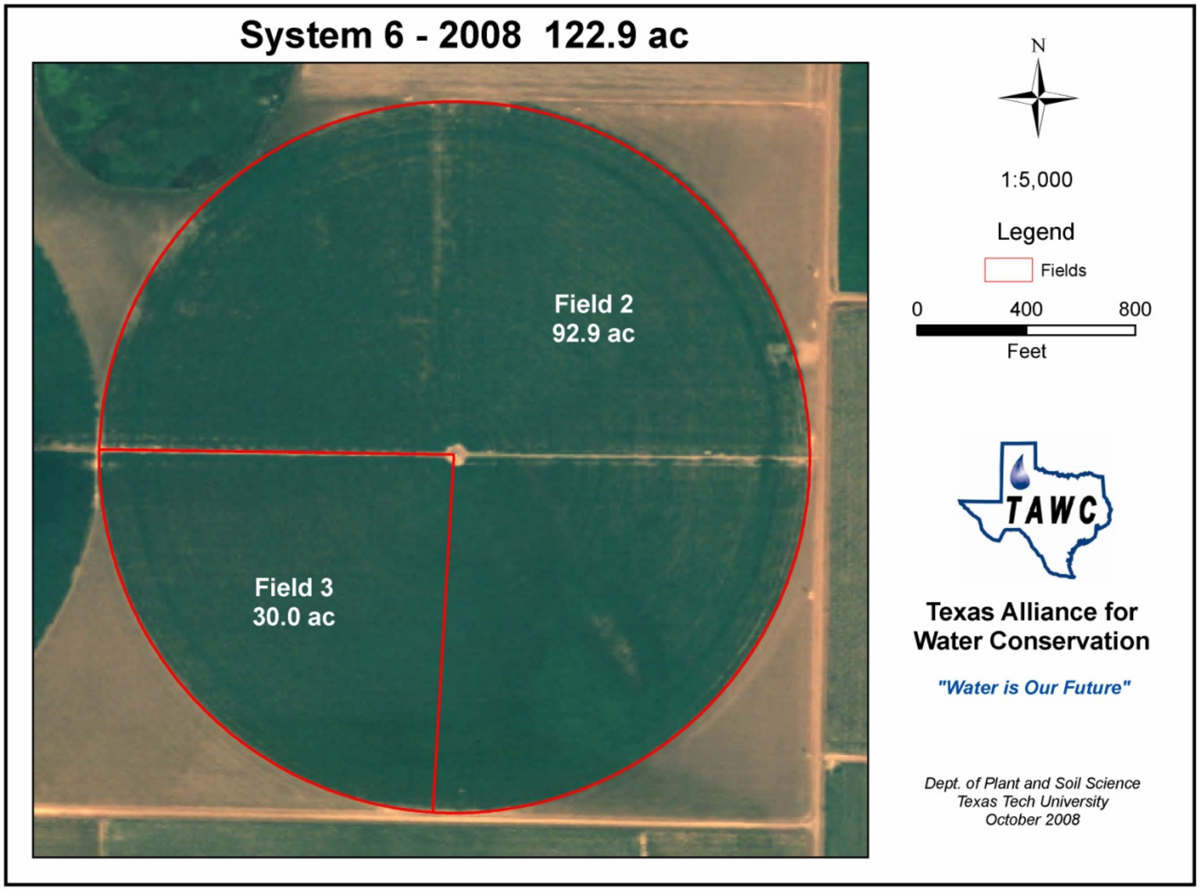
Irrigation and Precipitation
Water (inches)
35
30
25
20
15
10
5
0
2005
2006
2007
2008
Irrigation
Precipitation
Irrigation + Precipitation



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



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



System 6 Description

Total system acres: 122.9

Field No. 2 Acres: 92.9
Major soil type: Pullman clay loam, 0 to 1% slope

Field No. 3 Acres: 30.0
Major soil type: Pullman clay loam, 0 to 1% slope

Irrigation

Type: Center Pivot (LESA)

Pumping capacity, gal/min: 500

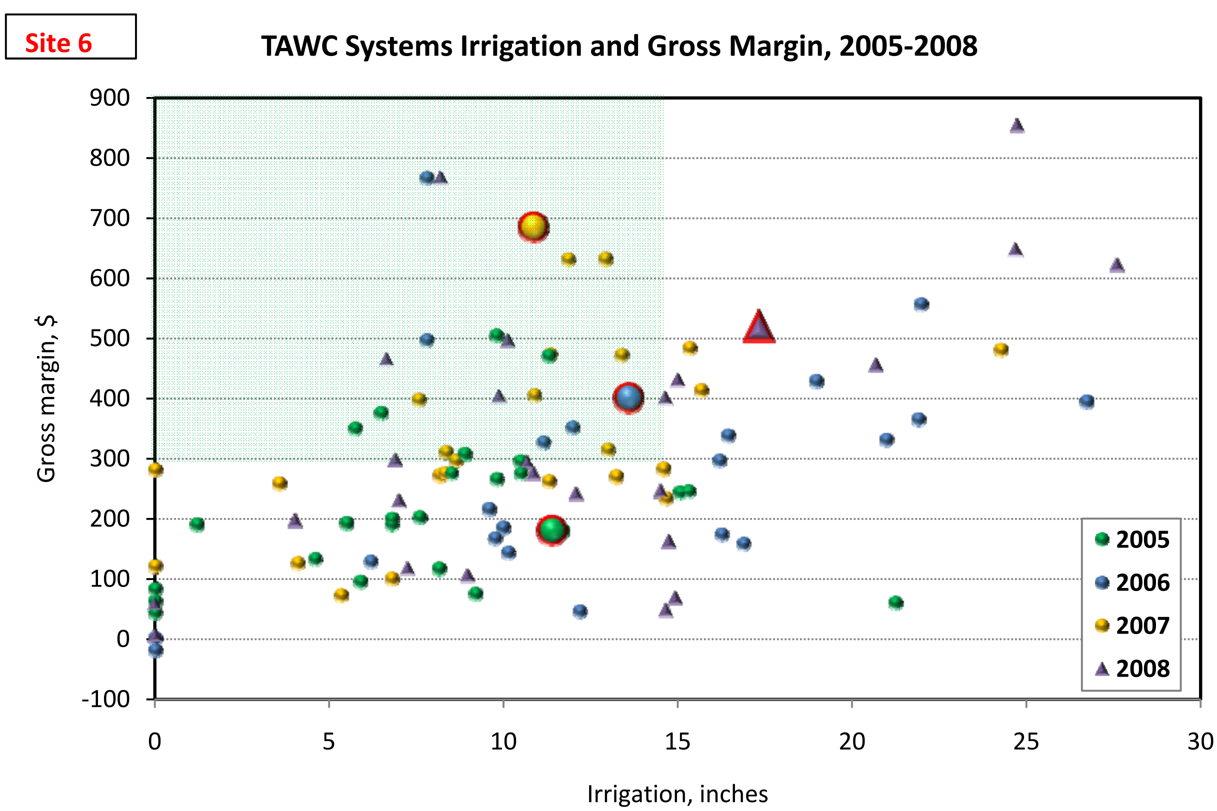
Number of wells: 4

Fuel source: Natural gas

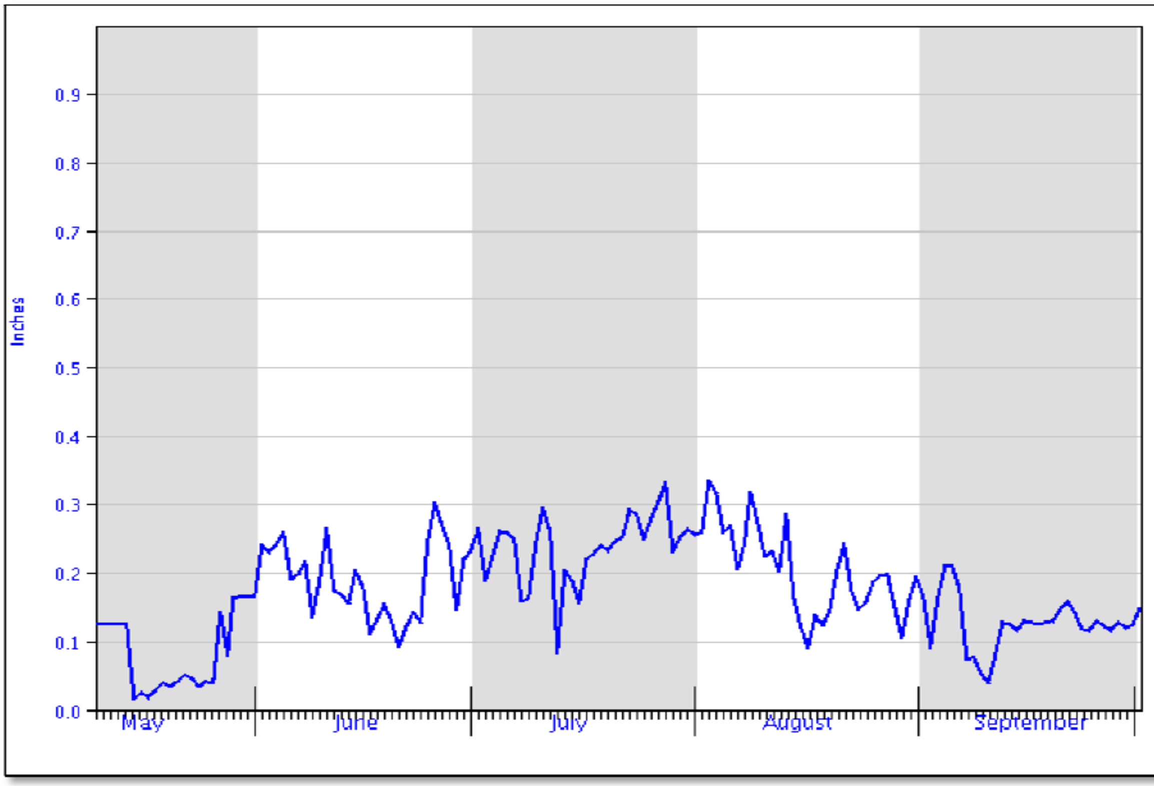
Comments: This is the first year for corn to be included in this system. One-fourth of this system was planted to corn and three-fourths planted to cotton on forty-inch centers with conventional tillage.

System 6

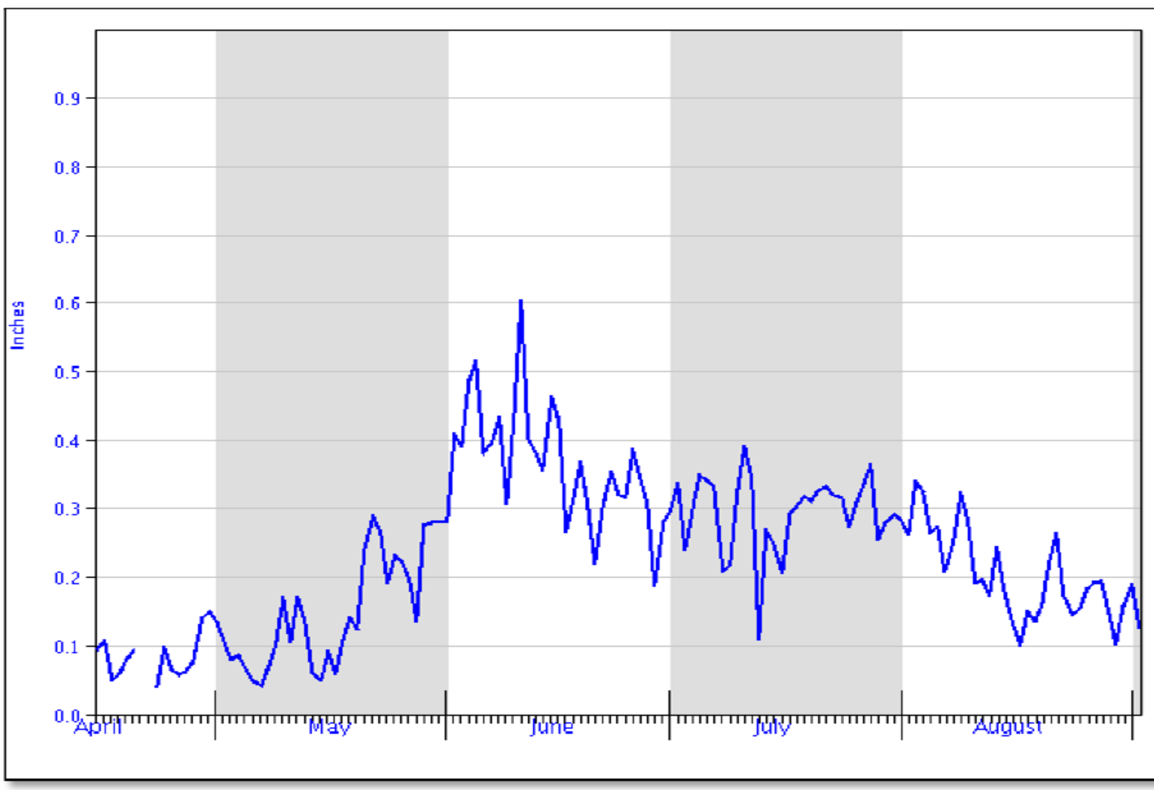
	Livestock	Field 1	Field 2	Field 3
2005	Stocker steers	Wheat for grazing and cover followed by Cotton		
2006	None	Cotton		
2007	None	Cotton		
2008	None	Split into Fields 2 and 3	Cotton	Corn for grain



Site 6 Field 2
Cotton planted May 10 **Total ET Demand 24.89"**



Site 6 Field 3
Corn planted April 15 **Total ET Demand 32.19"**



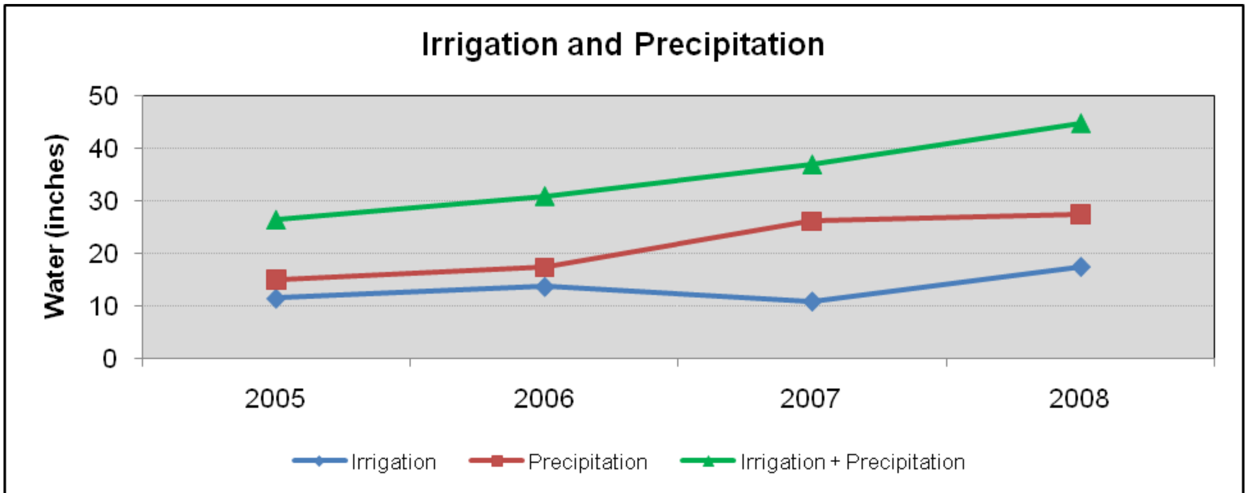
Site 6 Field 2, June 2008

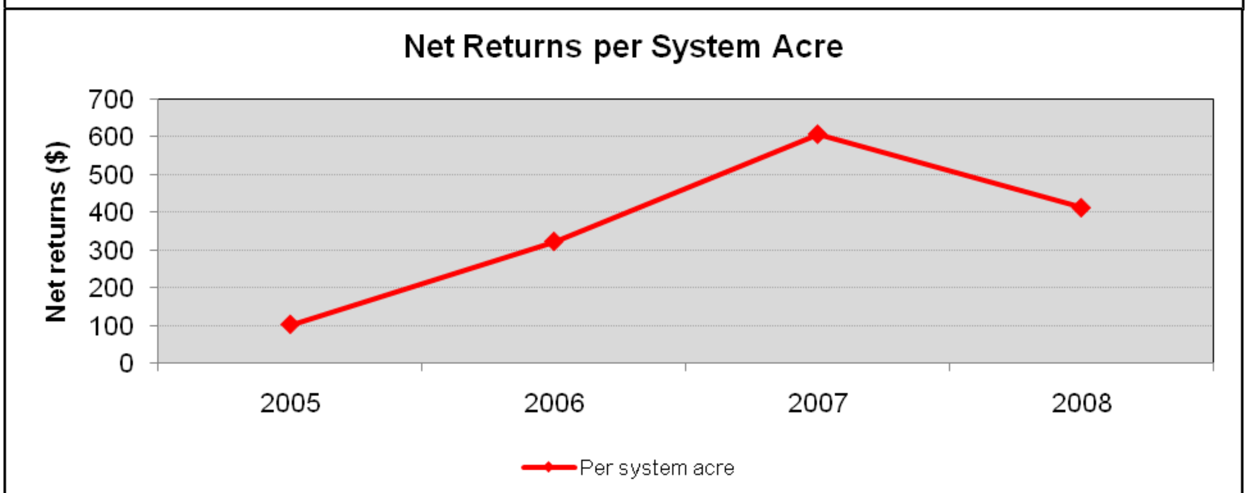
Site 6 Field 2, November 2008

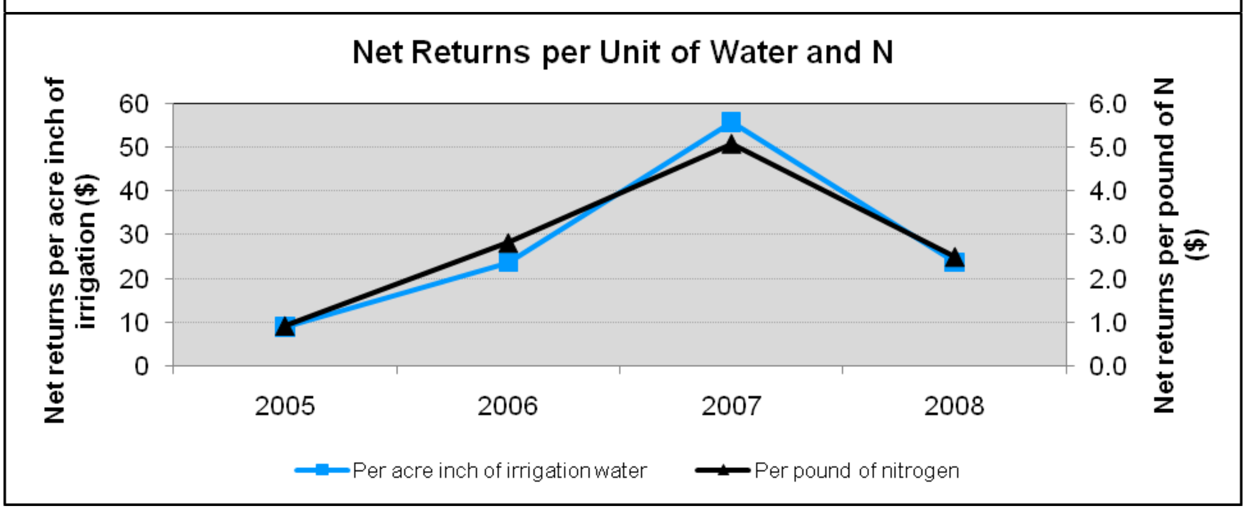
Site 6 Field 3, June 2008

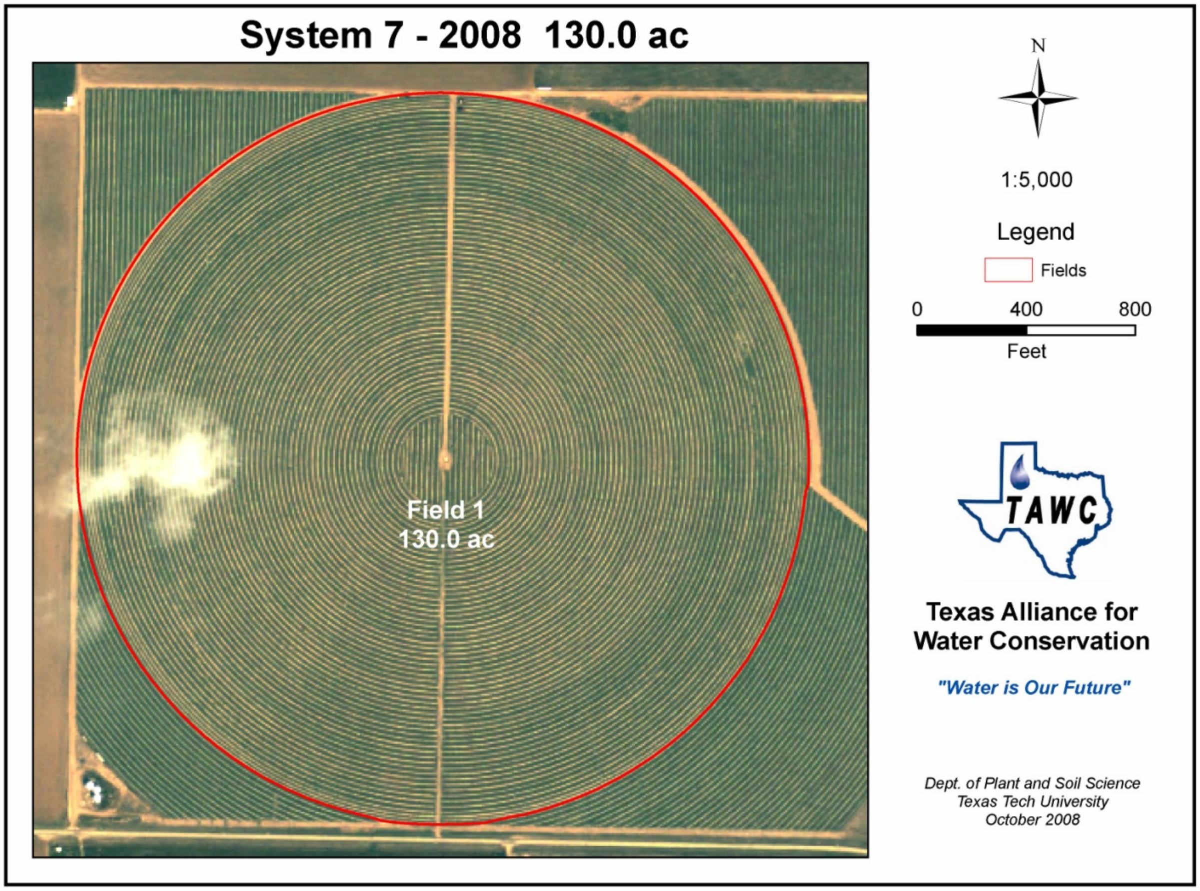
Site 6 Field 3, October 2008

Site 6


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


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


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



System 7 Description

Total system 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

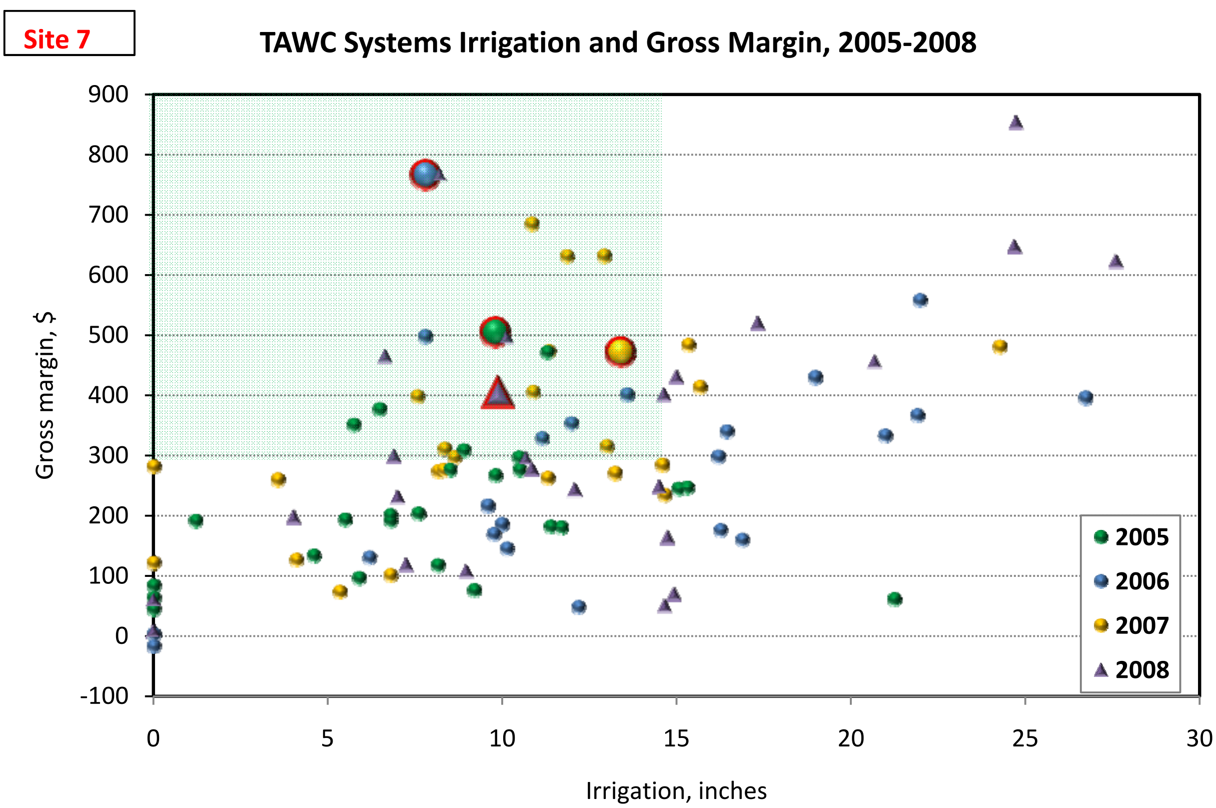
Number of wells: 4

Fuel source: Electric

Comments: This is a pivot irrigated circle of side-oats grama grown for seed production and the grass residue is baled for hay and sold. This field was established fourteen years ago.

System 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

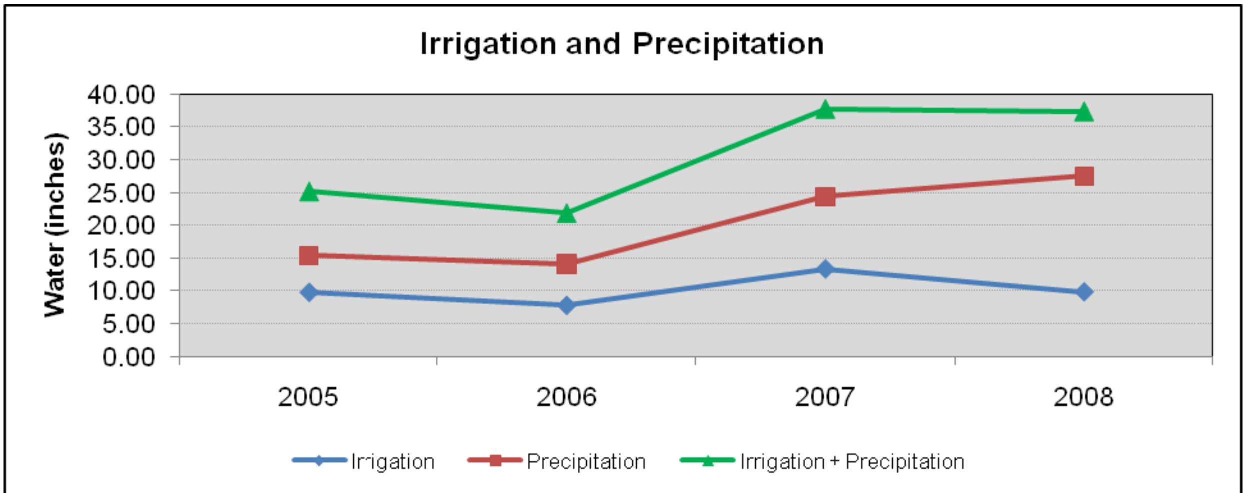


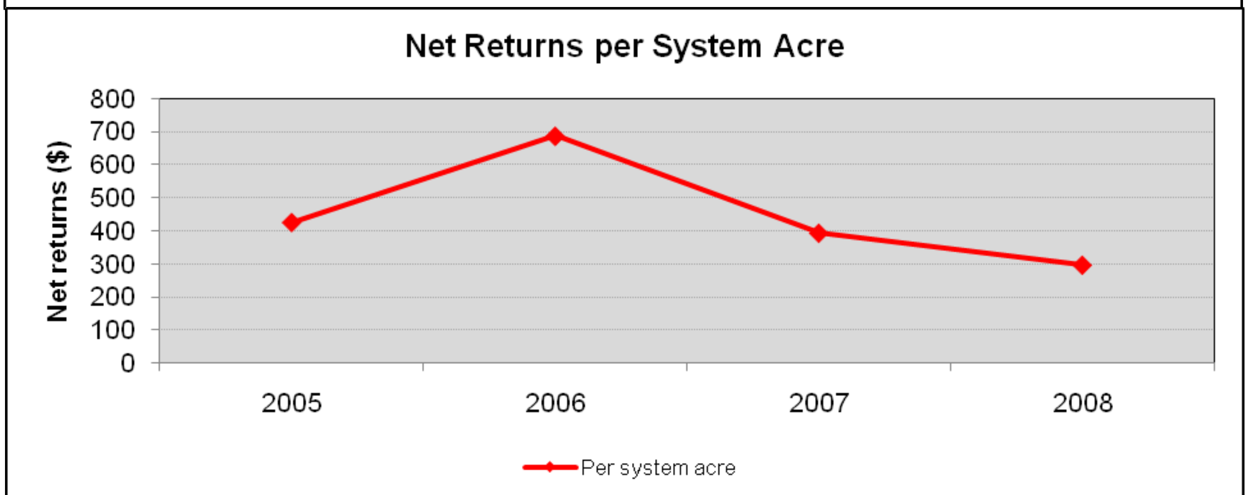
Site 7 Field 1, July 2008

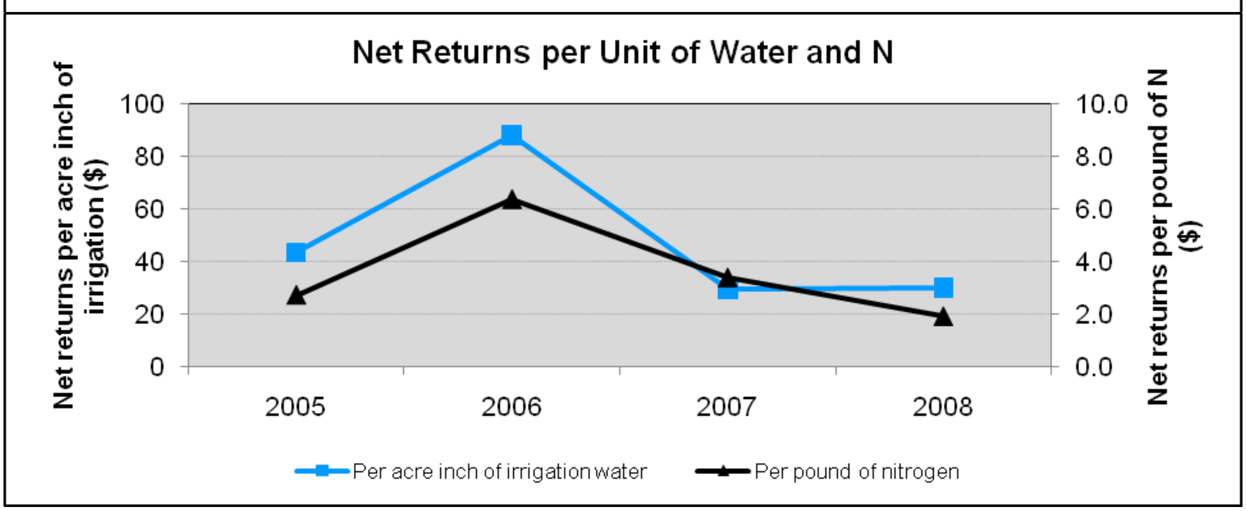
Site 7 Field 1, September 2008

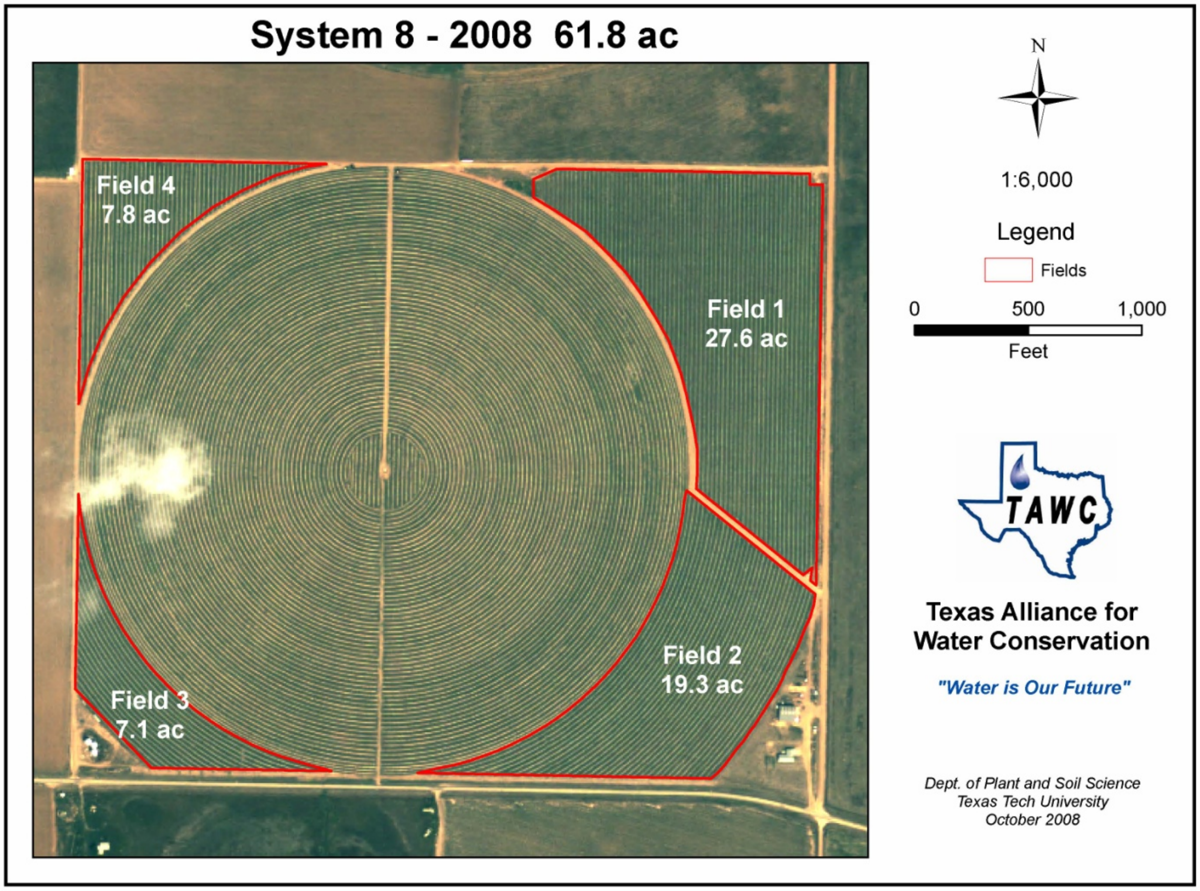
Site 7 Field 1, September 2008

Site 7


Irrigation and Precipitation
Water (inches)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
2005
2006
2007
2008
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
800
700
600
500
400
300
200
100
0
2005
2006
2007
2008
Per system acre


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



System 8 Description

Total system 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

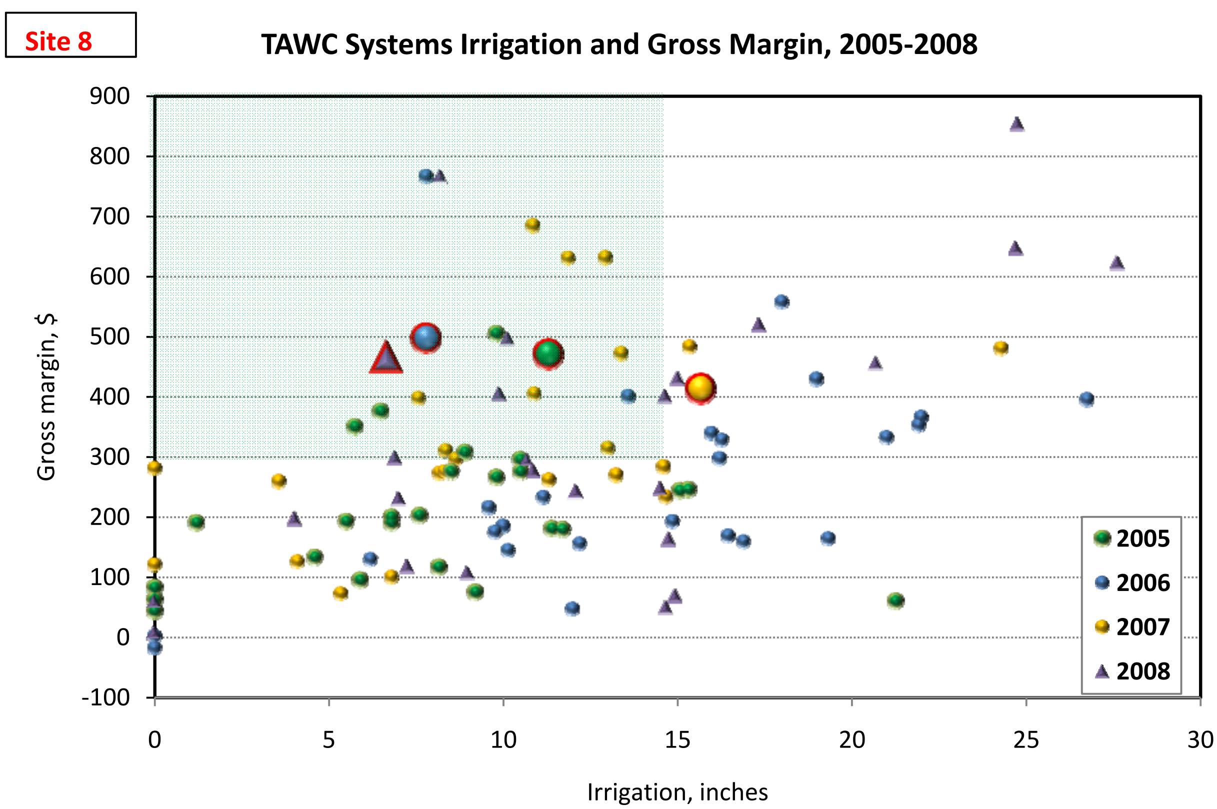
Number of wells: 4

Fuel source: Electric

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

System 8

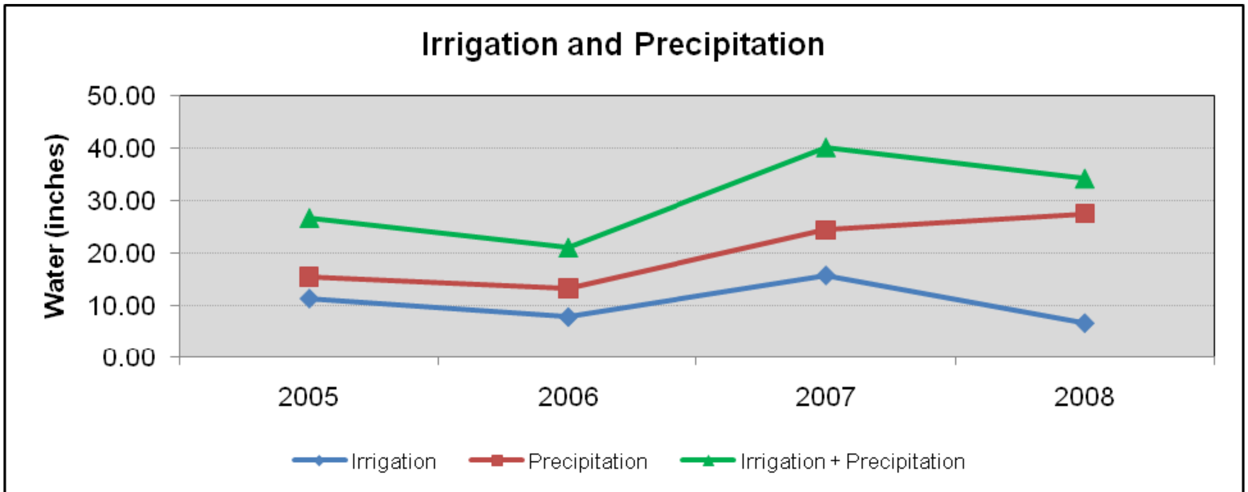
	Livestock	Field 1	Field 2	Field 3
2005	None	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay
2006	None	Sideoats grama for seed and hay	Sideoats grama for seed and hay	Sideoats grama for seed and hay
2007	None	Sideoats grama for seed and hay	Sideoats grama 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

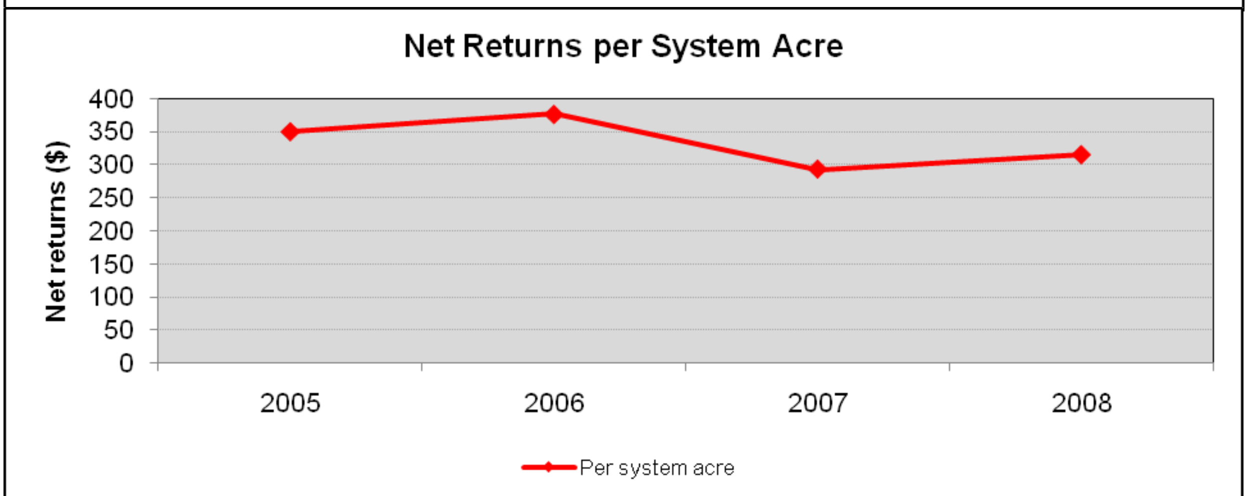


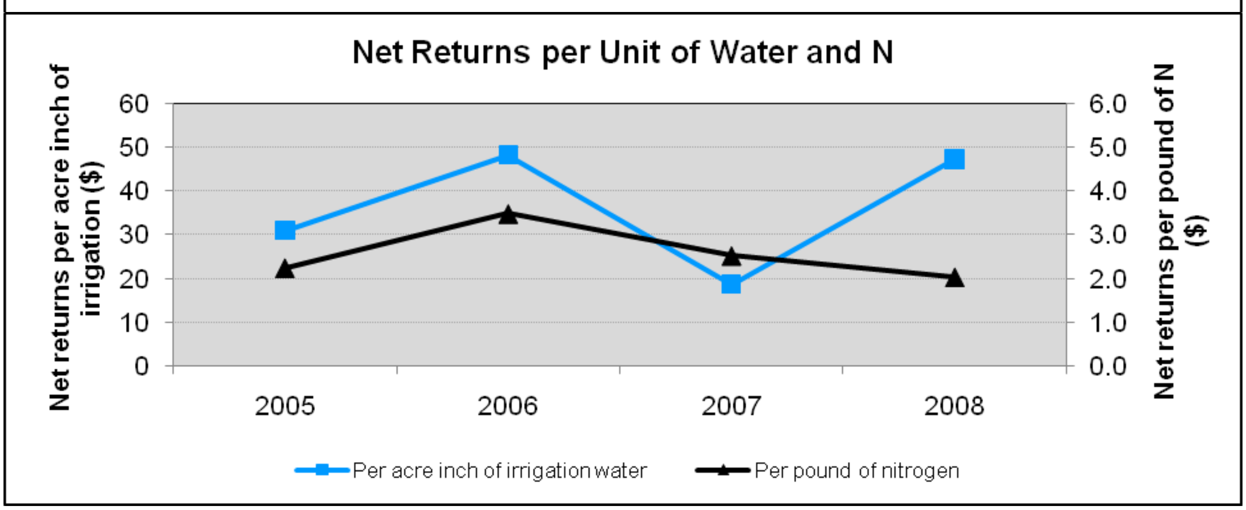
Site 8, July 2008

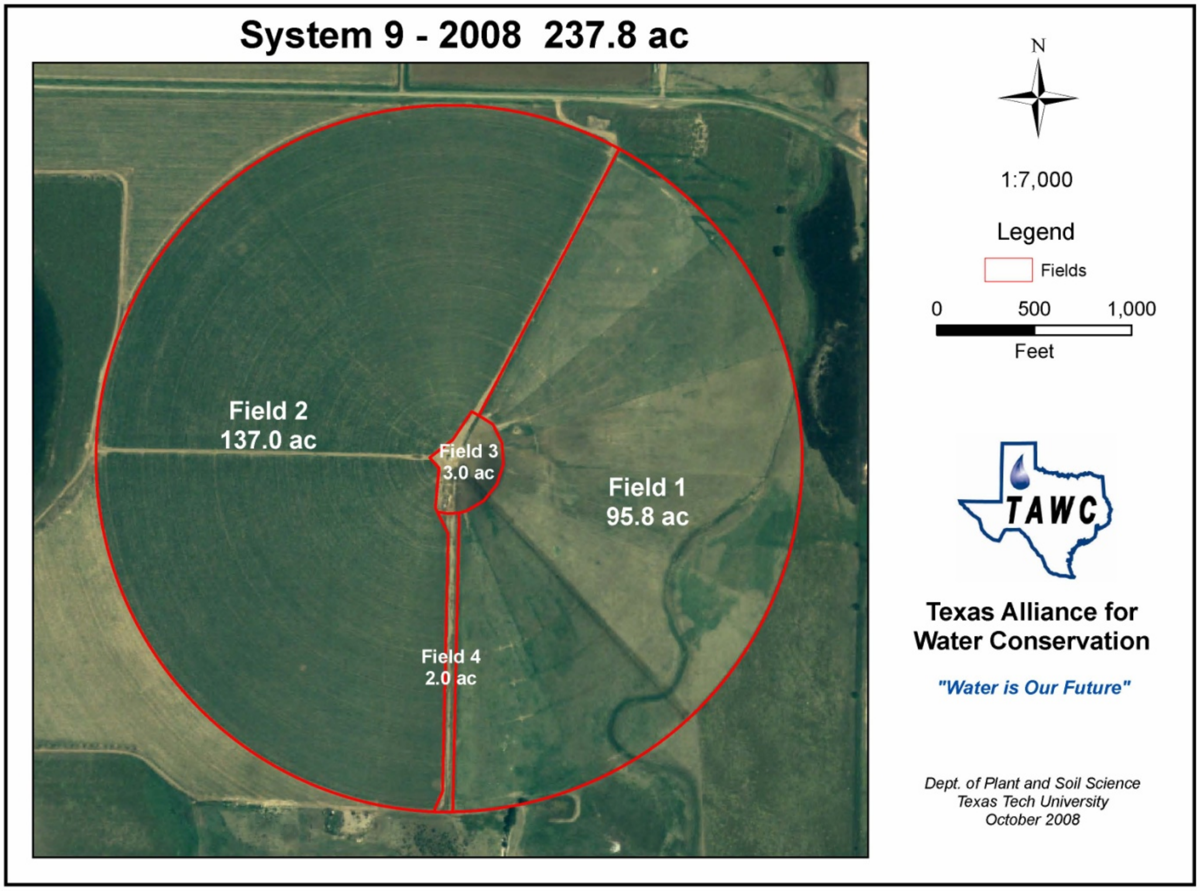
Site 8, September 2008

Site 8


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


Net Returns per System Acre
Net returns ($)
400
350
300
250
200
150
100
50
0
2005
2006
2007
2008
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
2005
2006
2007
2008
Per acre inch of irrigation water
Per pound of nitrogen



System 9 Description

Total system acres: 237.8
(232.8 in production, 5.0 pens and feed alley)

Field No. 1 Acres: 95.8
Major soil type: Mixed shallow soils

Field No. 2 Acres: 137.0
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 3 and 4
Acres: 5.0
Major soil type: Pens and Feed Alley

Irrigation

Type: Center Pivot (MESA)

Pumping capacity, gal/min: 900

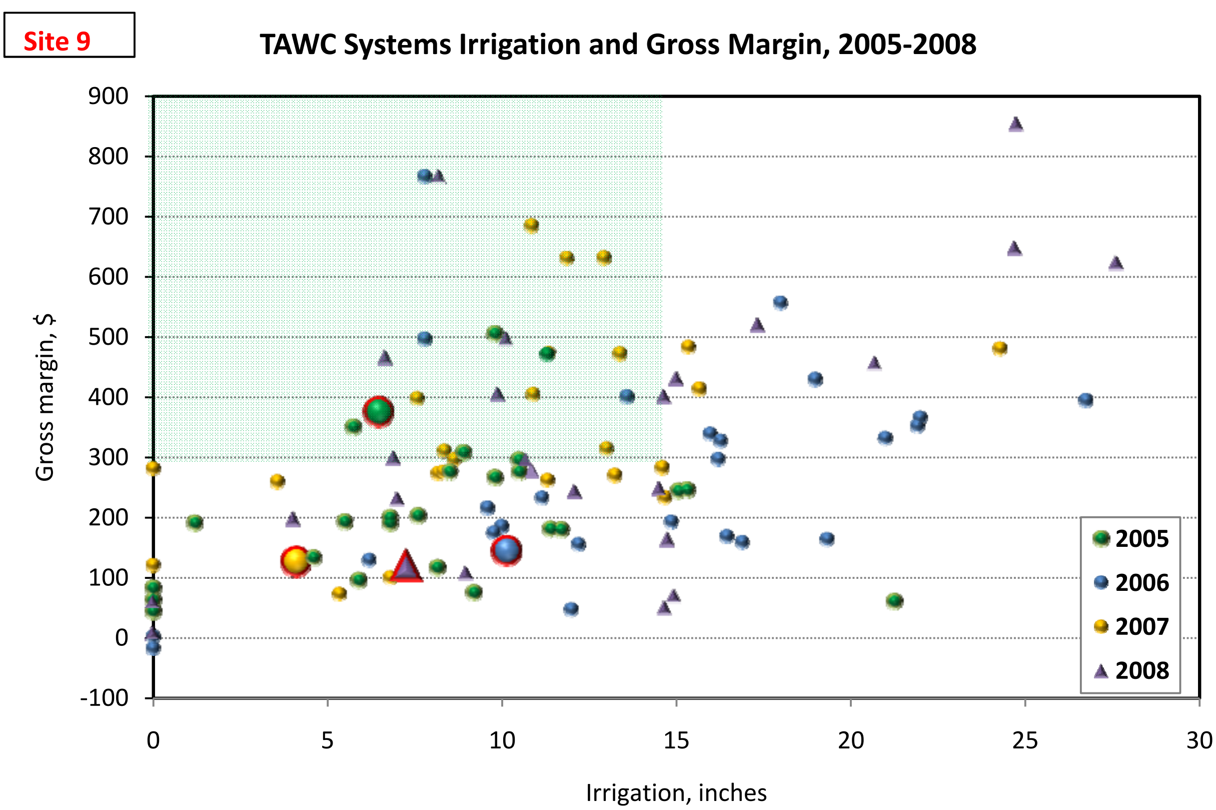
Number of wells: 4

Fuel source: 2 Natural gas
2 Diesel

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

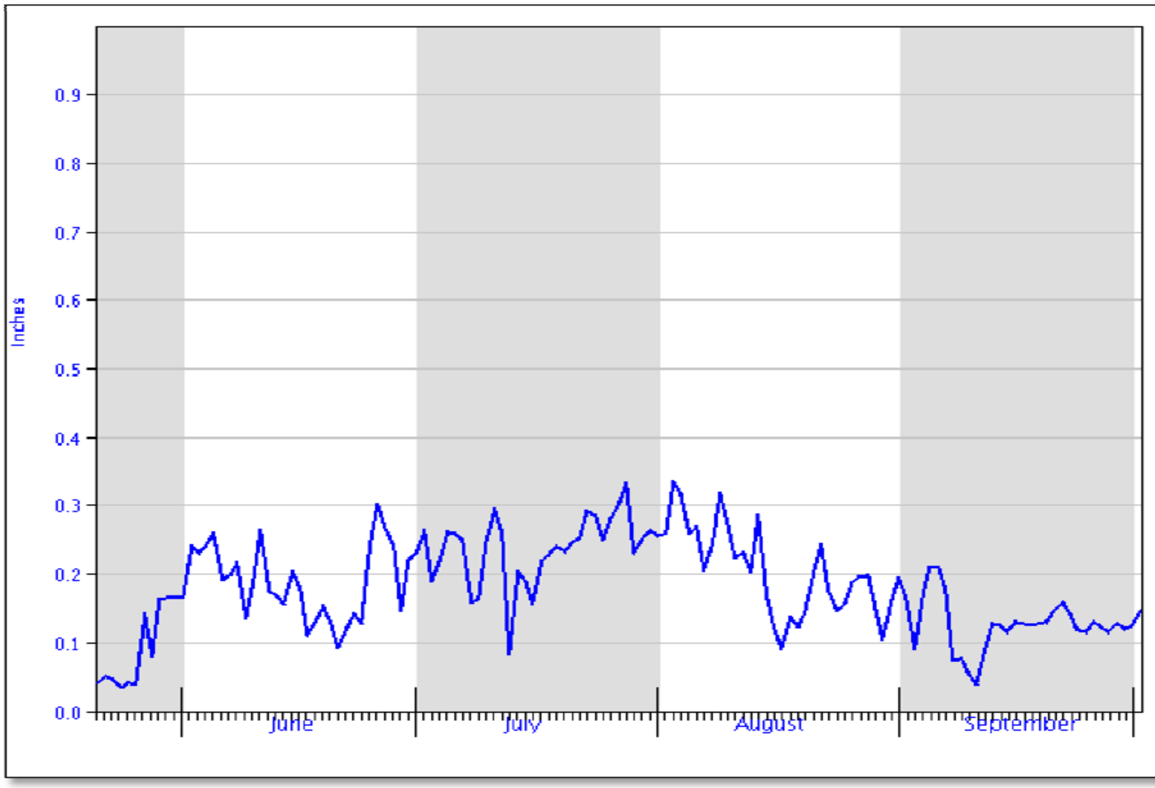
System 9

	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



Site 9 Field 2

Cotton planted May 21 **Total ET Demand 24.15"**



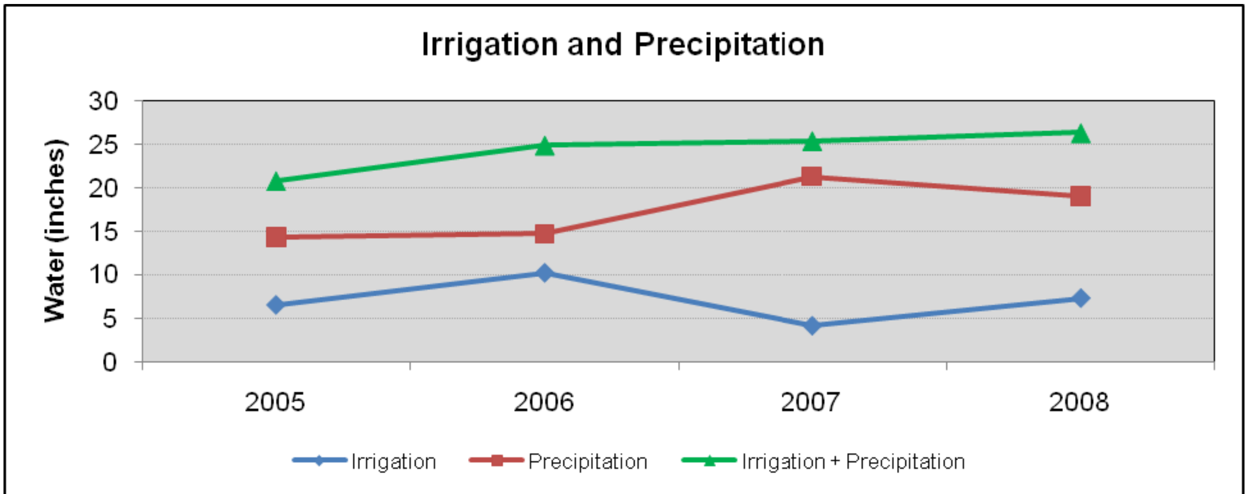
Site 9 Field 1, April 2008

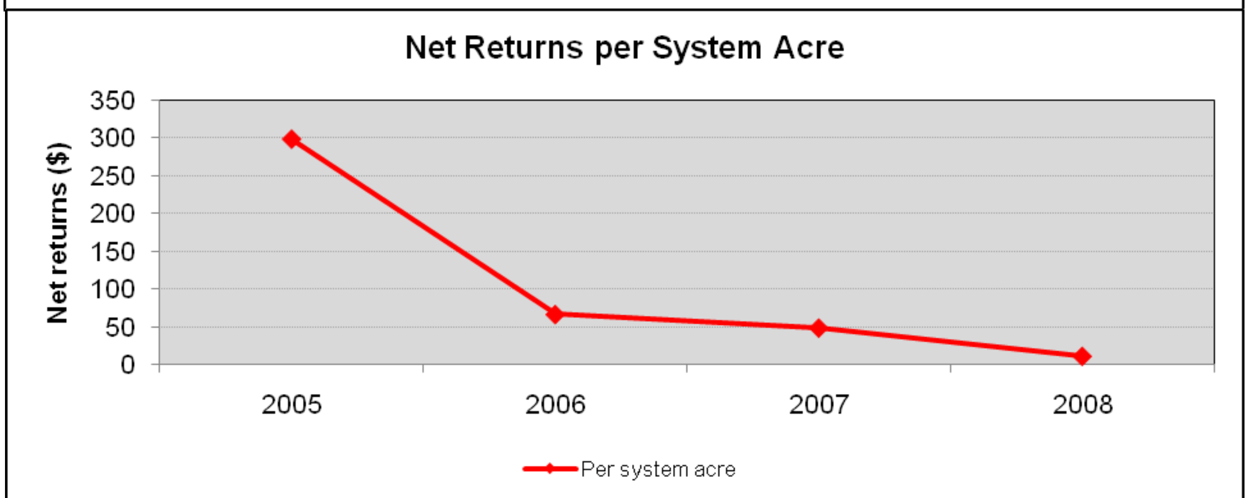
Site 9 Field 1, May 2008

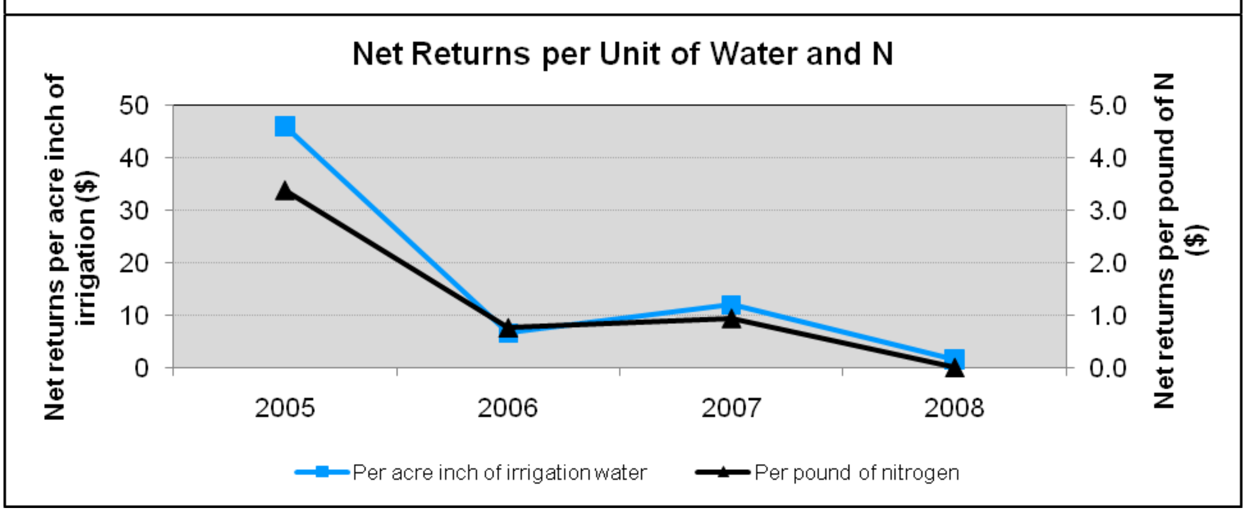
Site 9 Field 2, July 2008

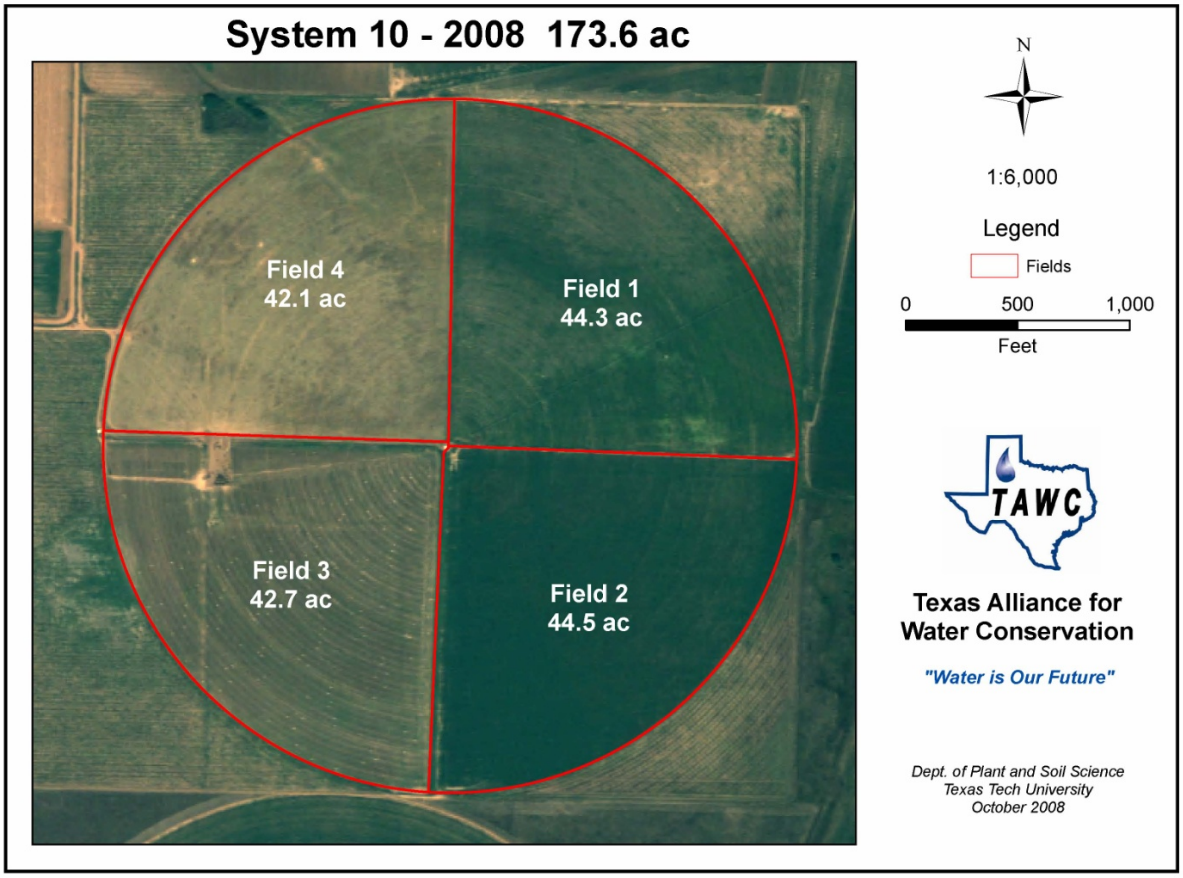
Site 9 Field 2, October 2008

Site 9


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


Net Returns per System Acre
Net returns ($)
0
50
100
150
200
250
300
350
2005
2006
2007
2008
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
Per acre inch of irrigation water
Per pound of nitrogen



System 10 Description

Total system 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. 2 Acres: 44.5
Major soil type: Pullman clay loam; 0 to 1% slope
Estacado clay loam; 0 to 1% slope

Field No. 3 Acres: 42.7
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 4 Acres: 42.1
Major soil type: Pullman clay loam; 0 to 1 and 1 to 3% slope
Lofton clay loam; 0 to 1% slope

Irrigation

Type: Center Pivot (LESA)

Pumping capacity, gal/min: 800

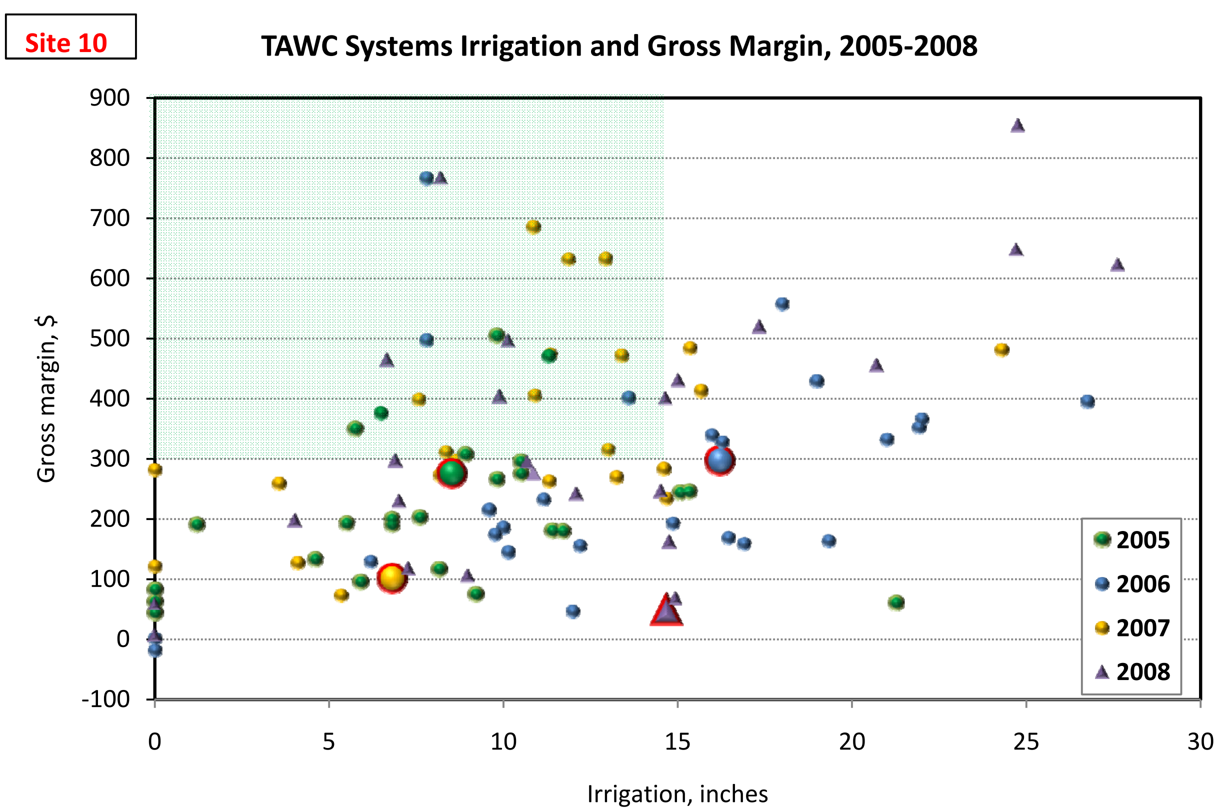
Number of wells: 2

Fuel source: Electric

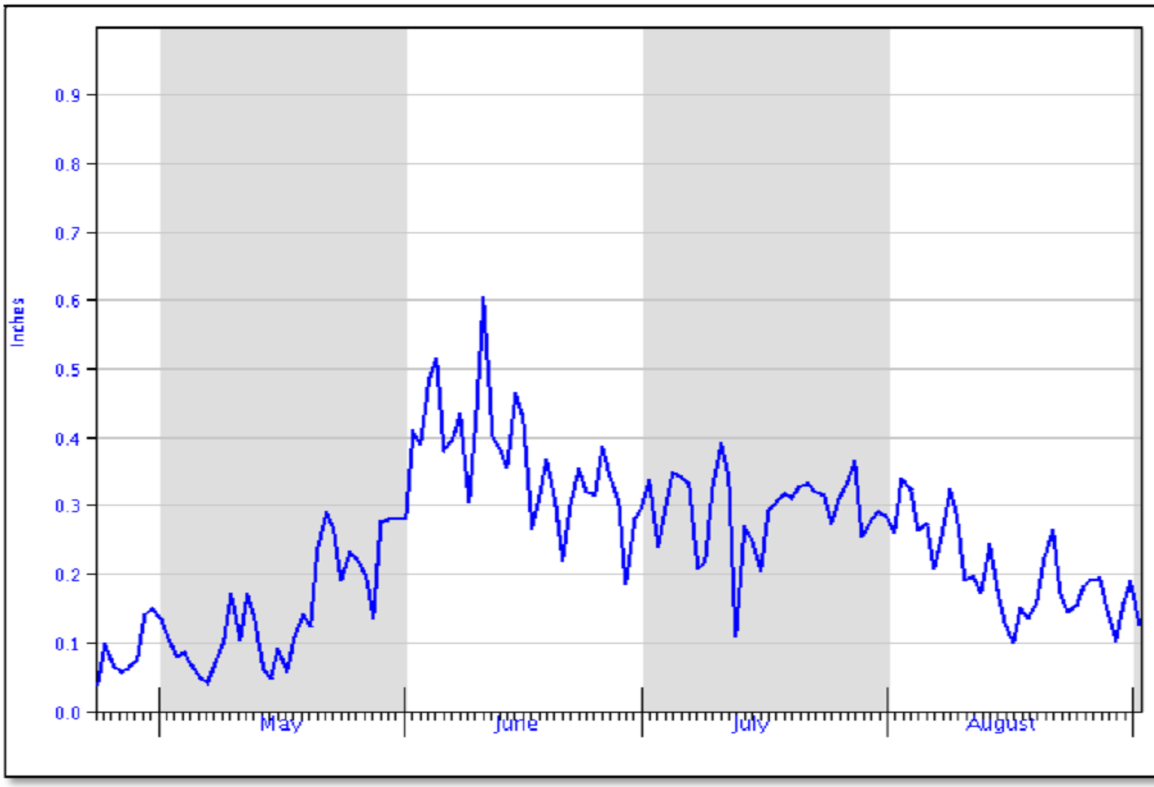
Comments: This is a four cell, pivot irrigated forage/livestock system. Two of the cells are planted to Old-World bluestem and one cell is planted to Bermuda grass. The fourth cell was planted to wheat and then double-cropped to corn for grain.

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



Site 10 Field 2
Corn planted April 15 **Total ET Demand 31.08"**



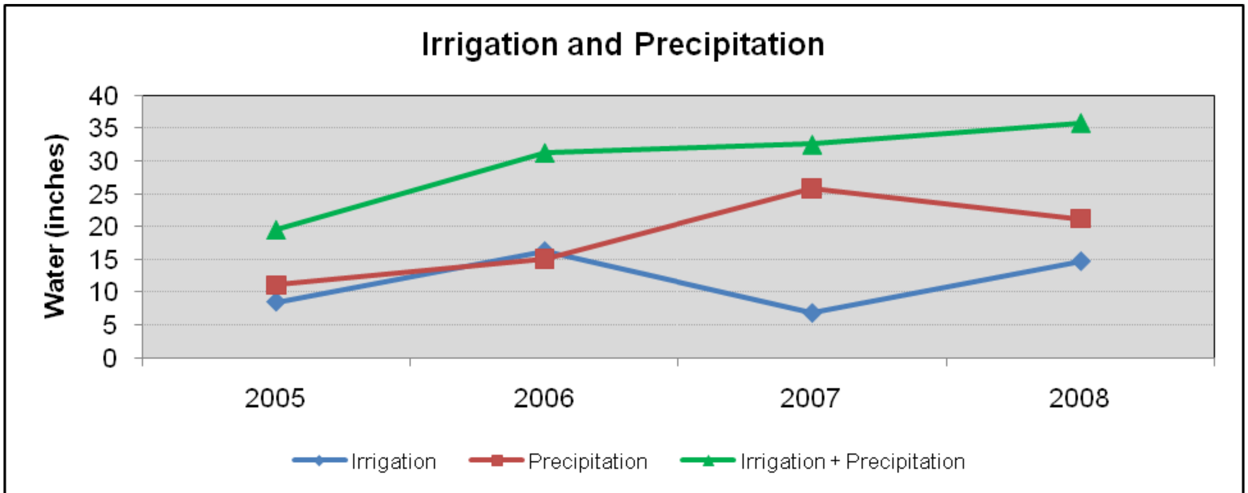
Site 10 Field 1, July 2008

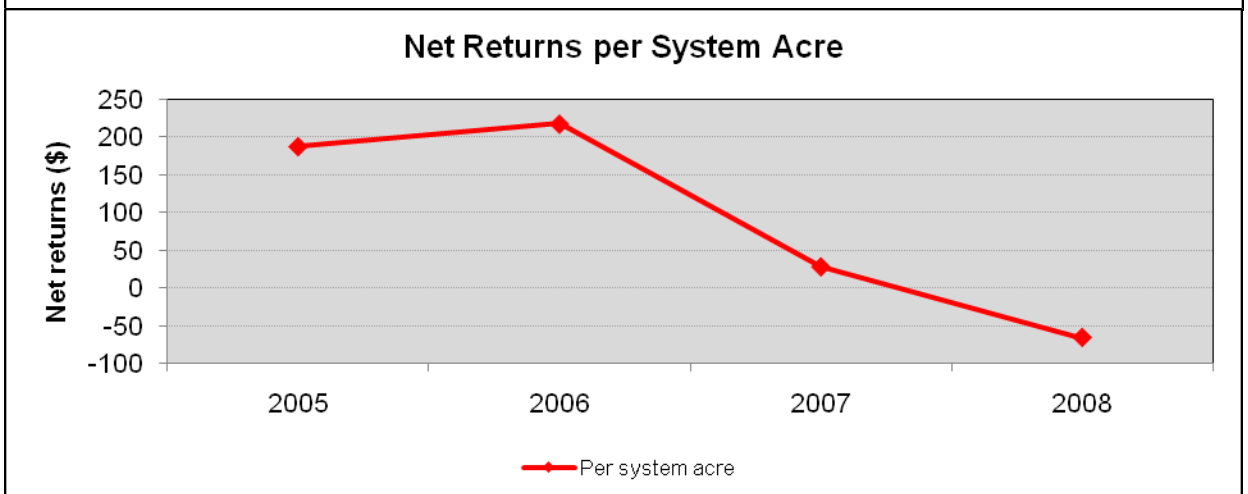
Site 10 Field 2, July 2008

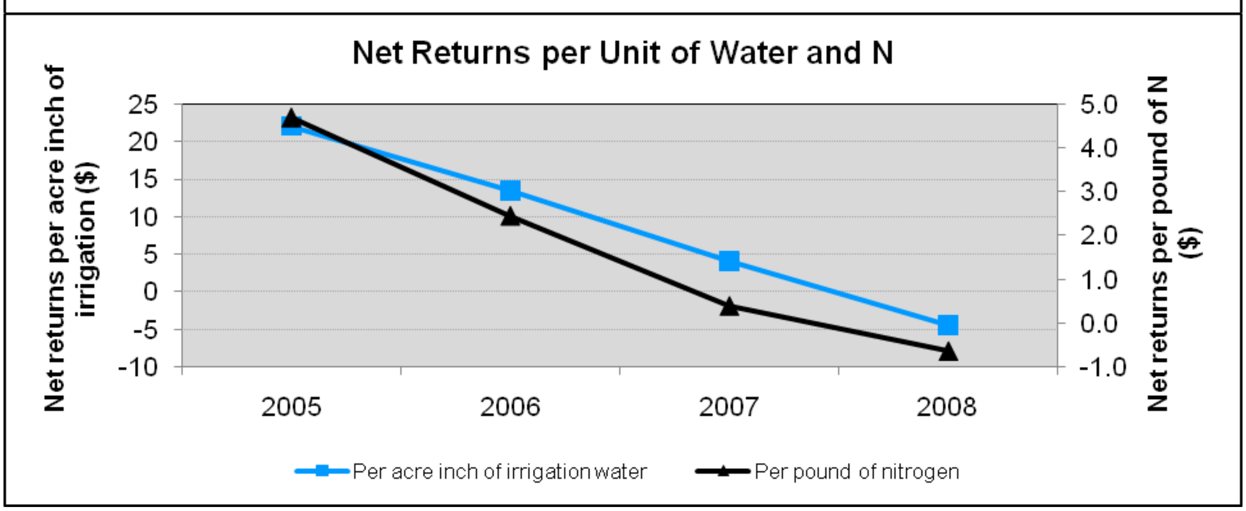
Site 10 Field 3, August 2008

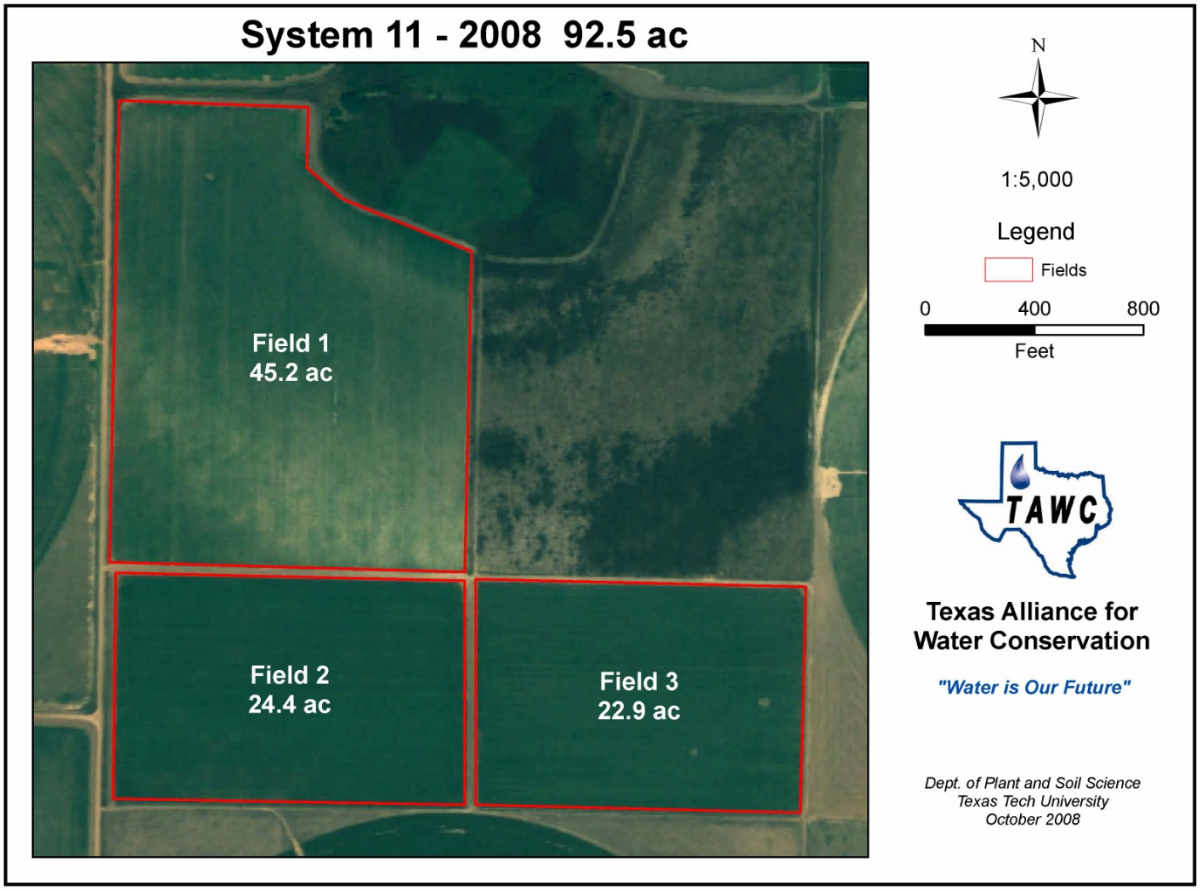
Site 10 Field 4, August 2008

Site 10


Irrigation and Precipitation
Water (inches)
40
35
30
25
20
15
10
5
0
2005
2006
2007
2008
Irrigation
Precipitation
Irrigation + Precipitation


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


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



System 11 Description

Total system acres:	92.5
Field No. 1 Acres:	45.2
Major soil type:	Lofton clay loam; 0 to 1% slope Olton clay loam; 1 to 3% slope
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

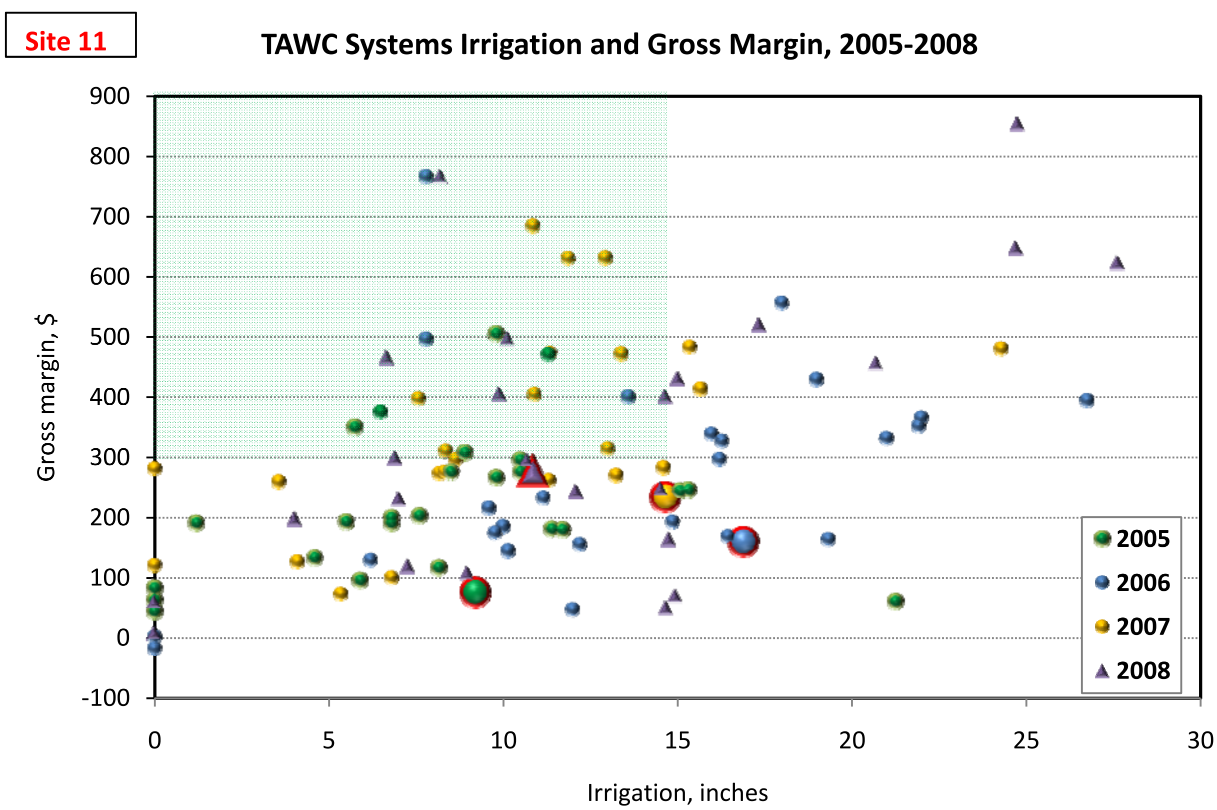
Irrigation

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

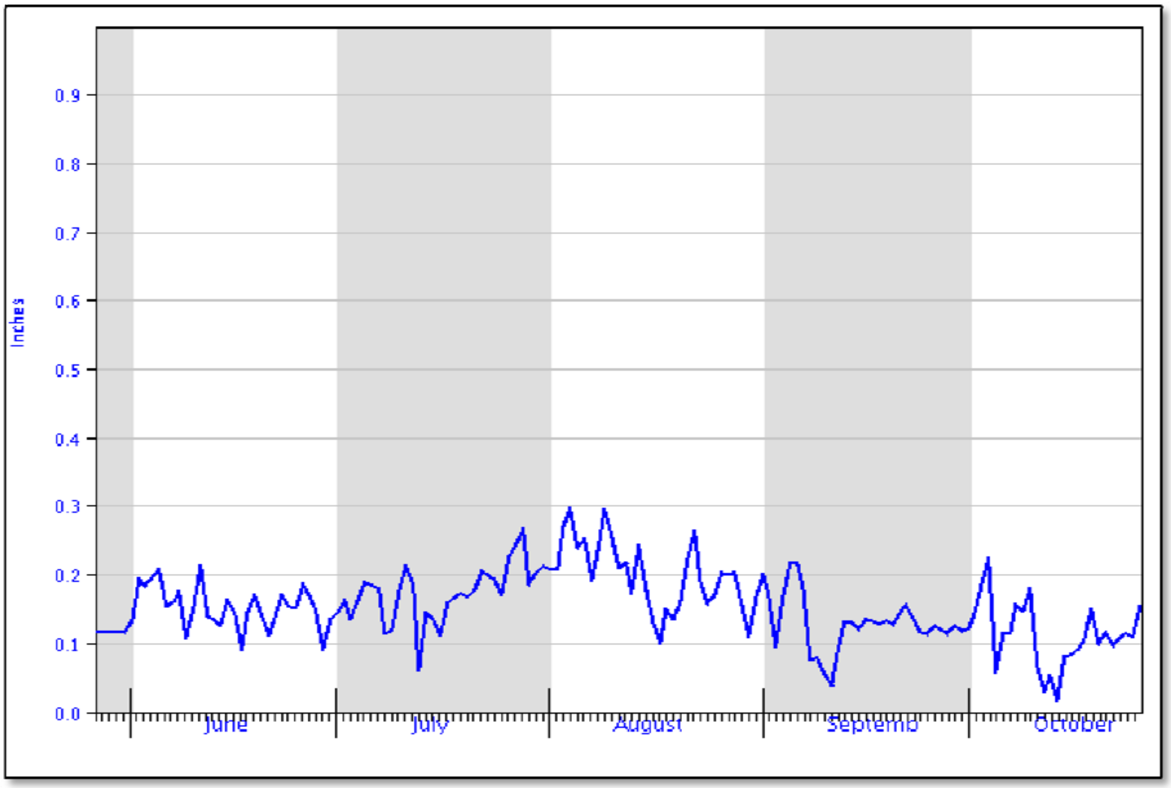
Comments: This is a flood irrigated cotton/grain sorghum system under conventional tillage and planted on forty-inch centers.

System 11

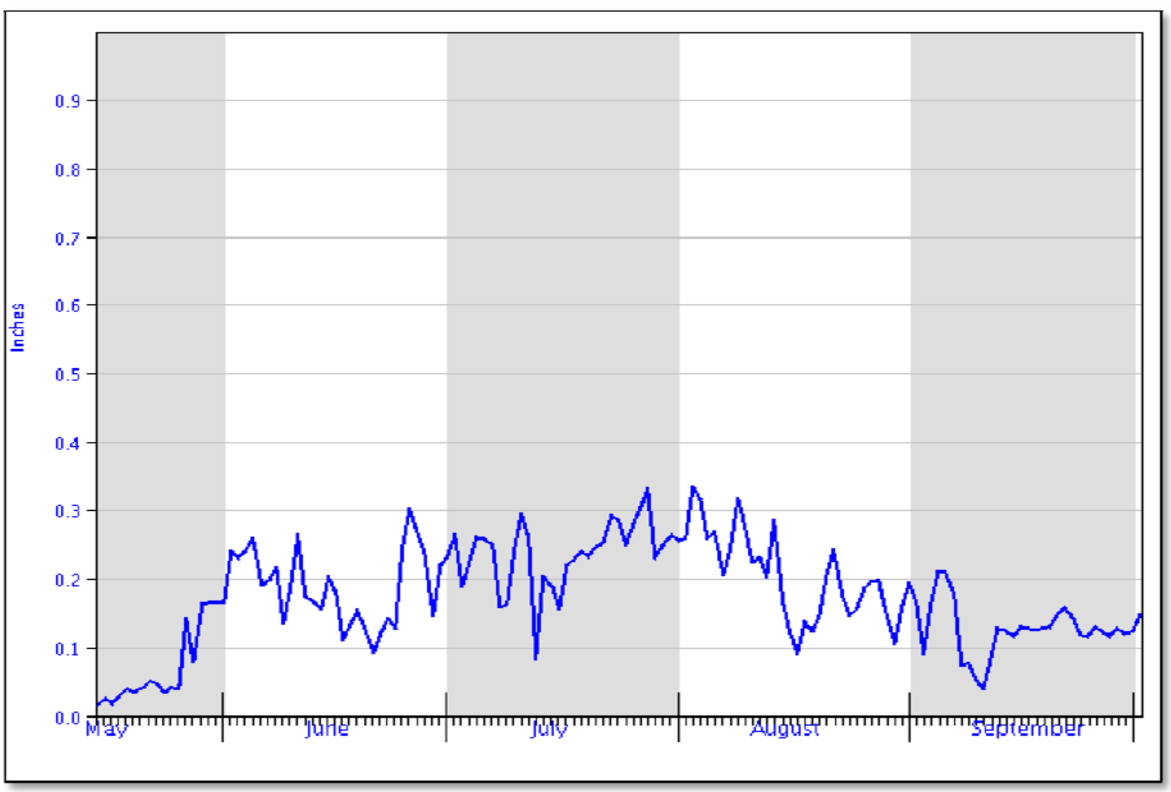
	Livestock	Field 1	Field 2	Field 3
2005	None	Cotton following Wheat cover crop	Cotton	Cotton
2006	None	Cotton	Cotton	Cotton
2007	None	Cotton	Cotton	Cotton
2008	None	Grain Sorghum	Cotton	Cotton



Site 11 Field 1
Sorghum planted May 27 **Total ET Demand 23.1"**

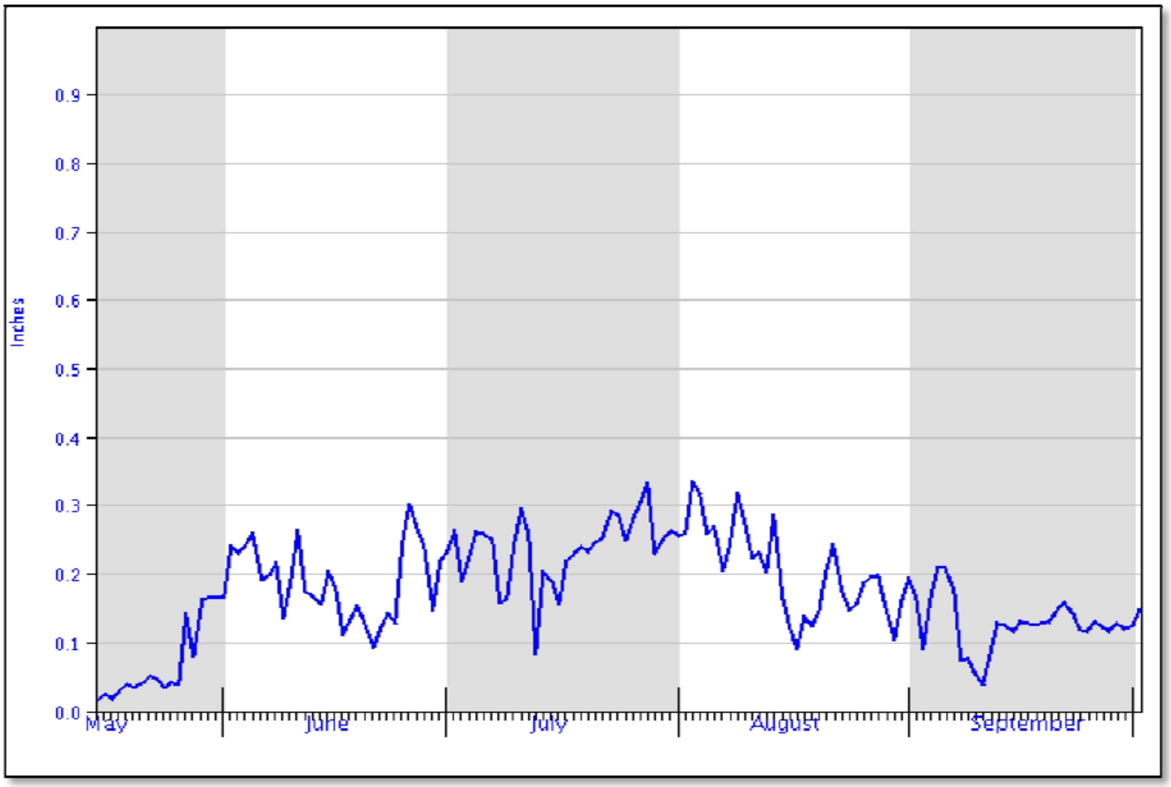


Site 11 Field 2
Cotton planted May 15 **Total ET Demand 24.29"**



Site 11 Field 3

Cotton planted May 15 **Total ET Demand 24.29"**

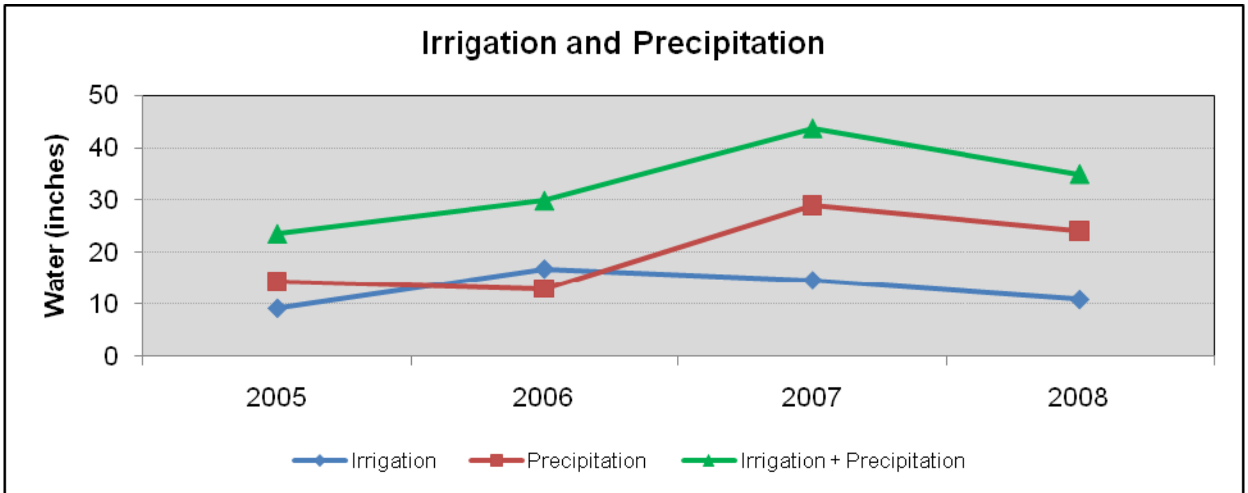


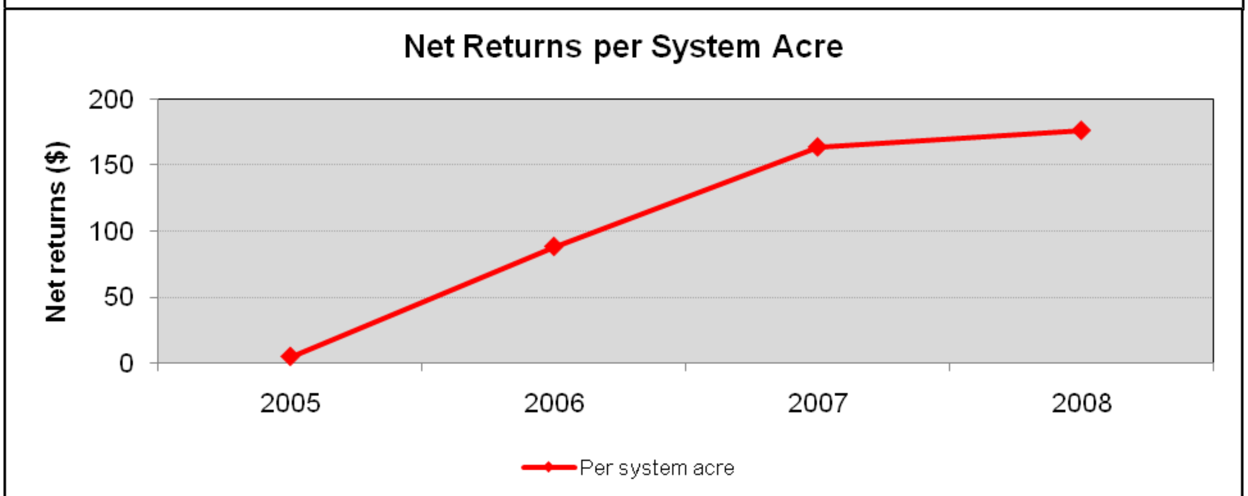
Site 11 Field 1, August 2008

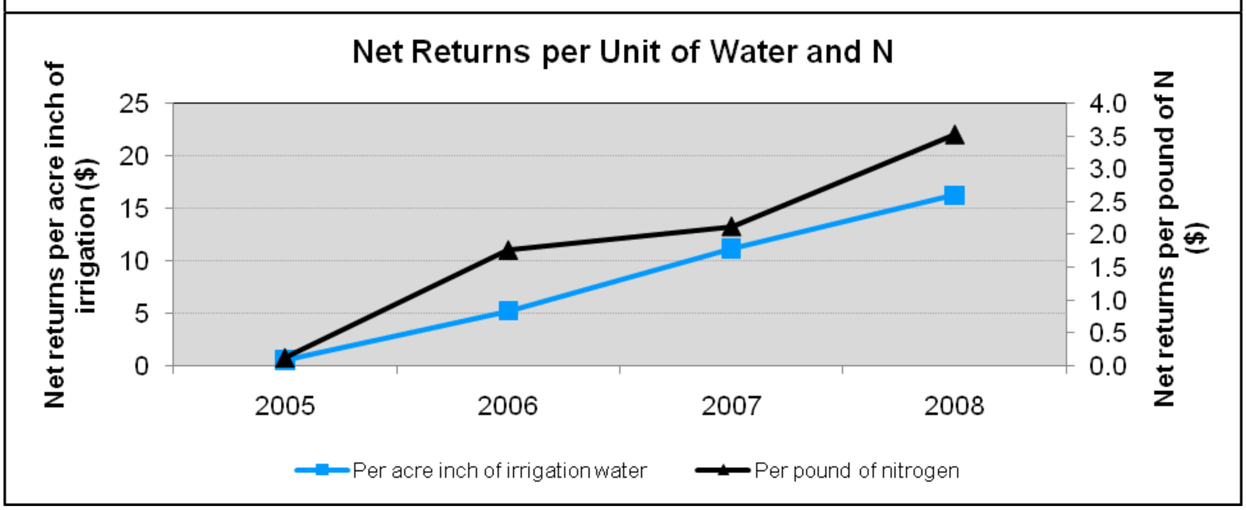
Site 11 Field 2, August 2008

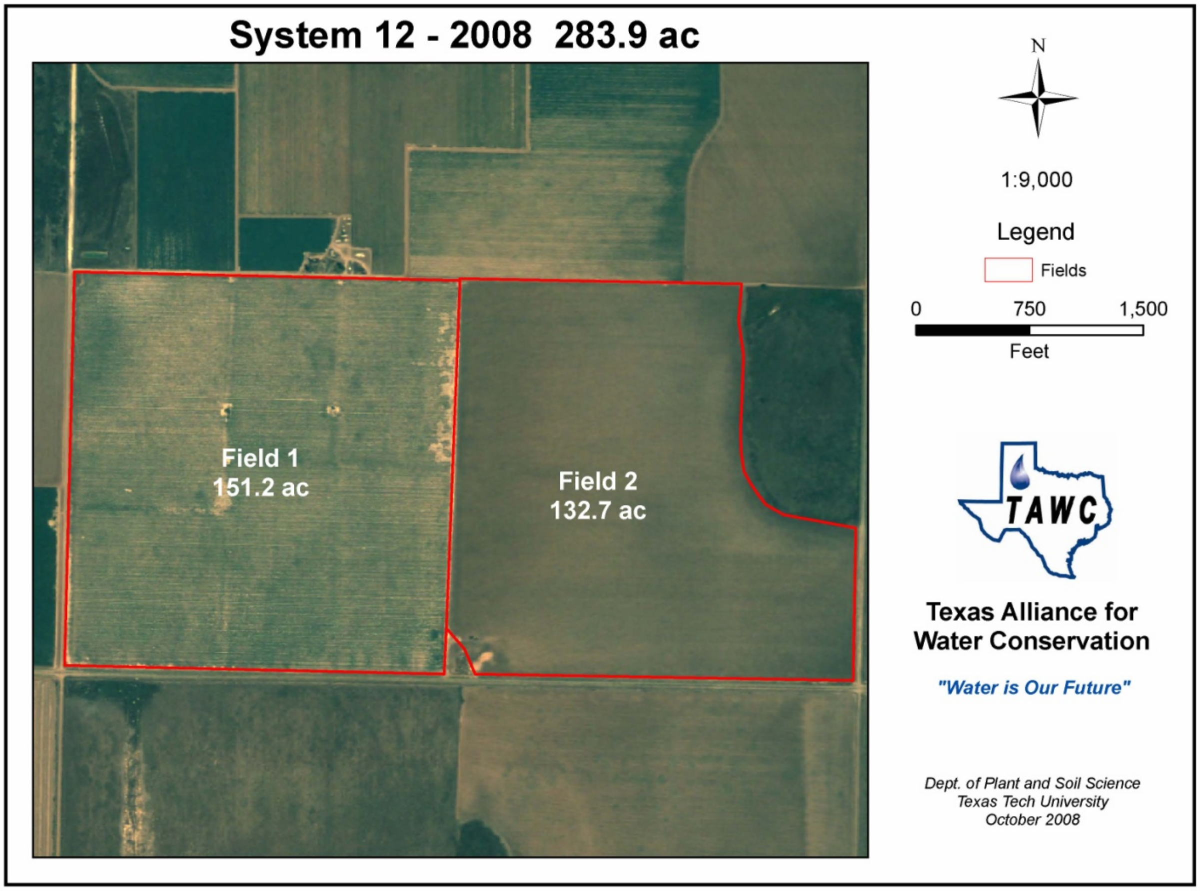
Site 11 Field 3, October 2008

Site 11


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


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


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
25
20
15
10
5
0
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
Per acre inch of irrigation water
Per pound of nitrogen



System 12 Description

Total system acres: 283.9

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

<u>Irrigation</u>

Type: Dryland

Pumping capacity, gal/min:

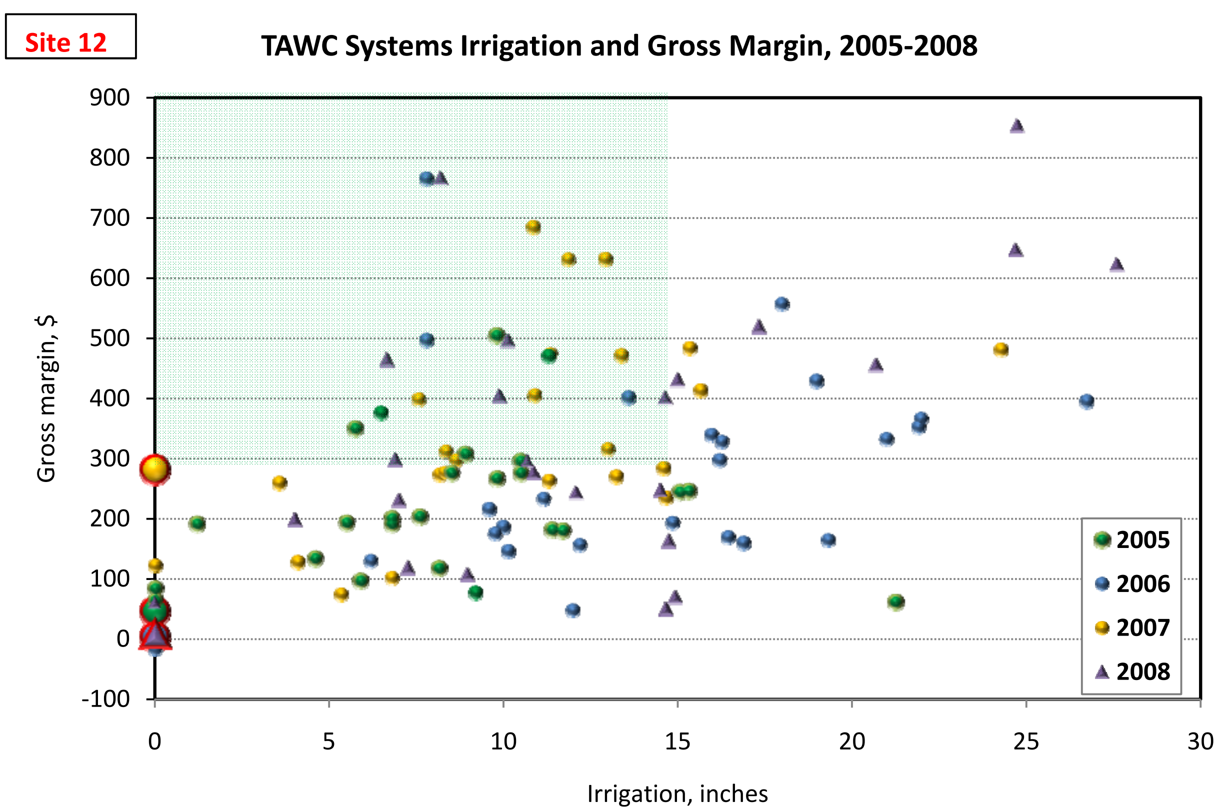
Number of wells:

Fuel source:

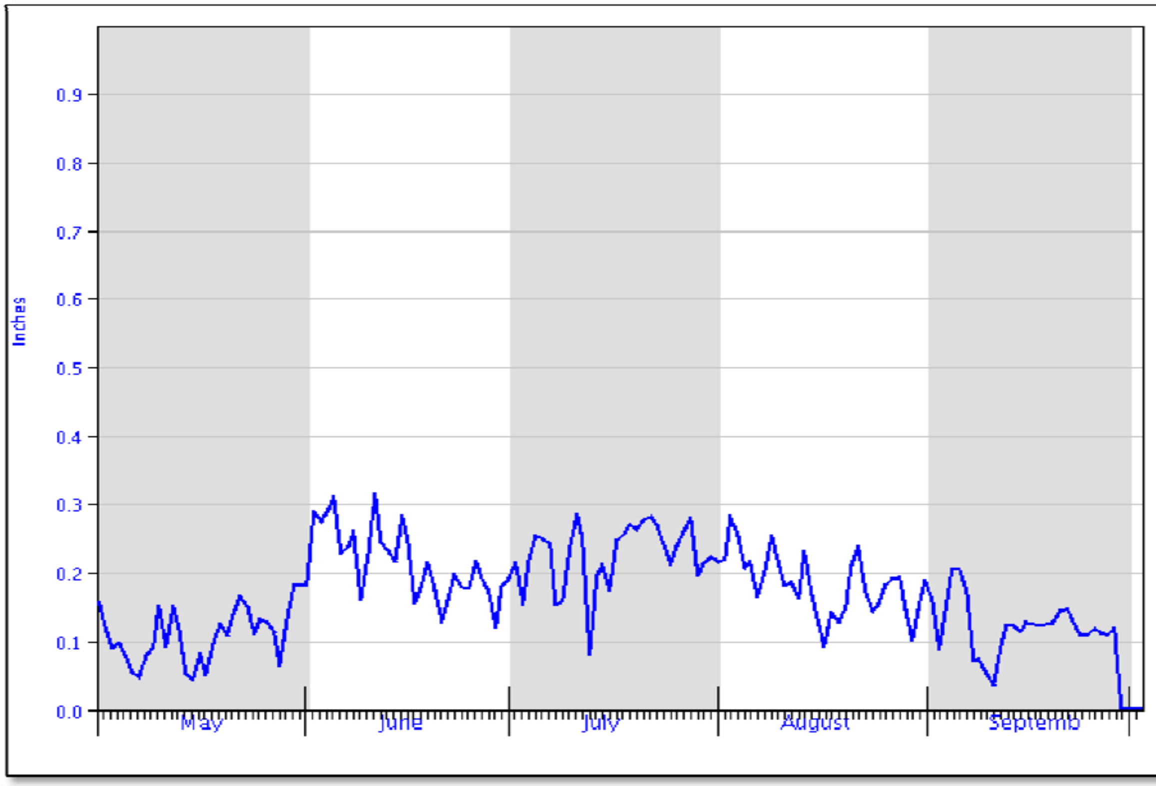
Comments: This dryland system uses cotton, grain sorghum and small grains in rotation. Grain sorghum was planted on old cotton ground then wheat was planted following grain sorghum harvest. Cotton was planted on the balance of the acres.

System 12

	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



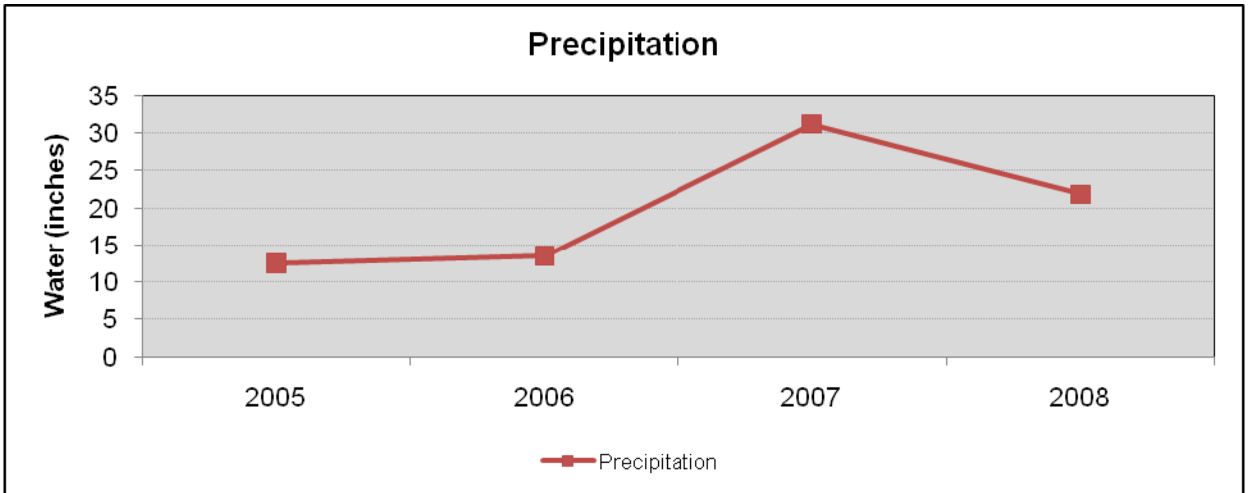
Site 12 Field 1
Sorghum planted May 1 **Total ET Demand 26.01”**

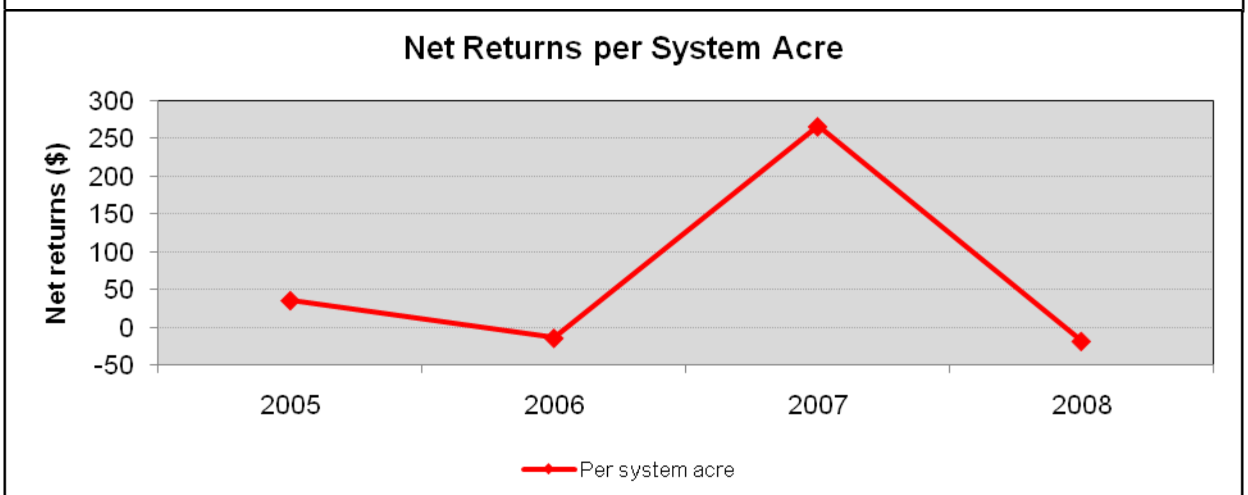


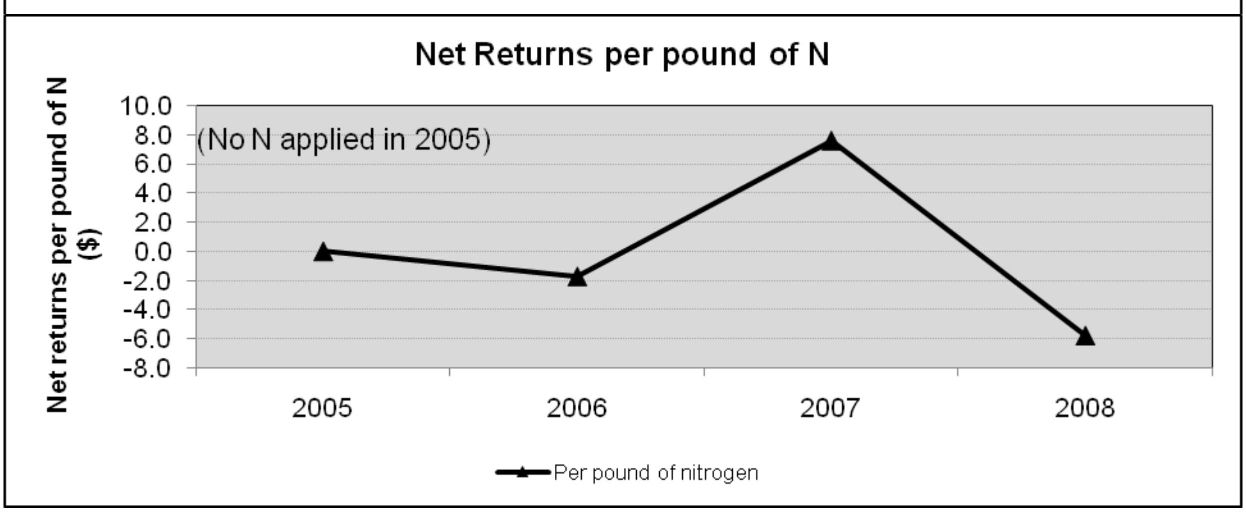
Site 12 Field 1, October 2008

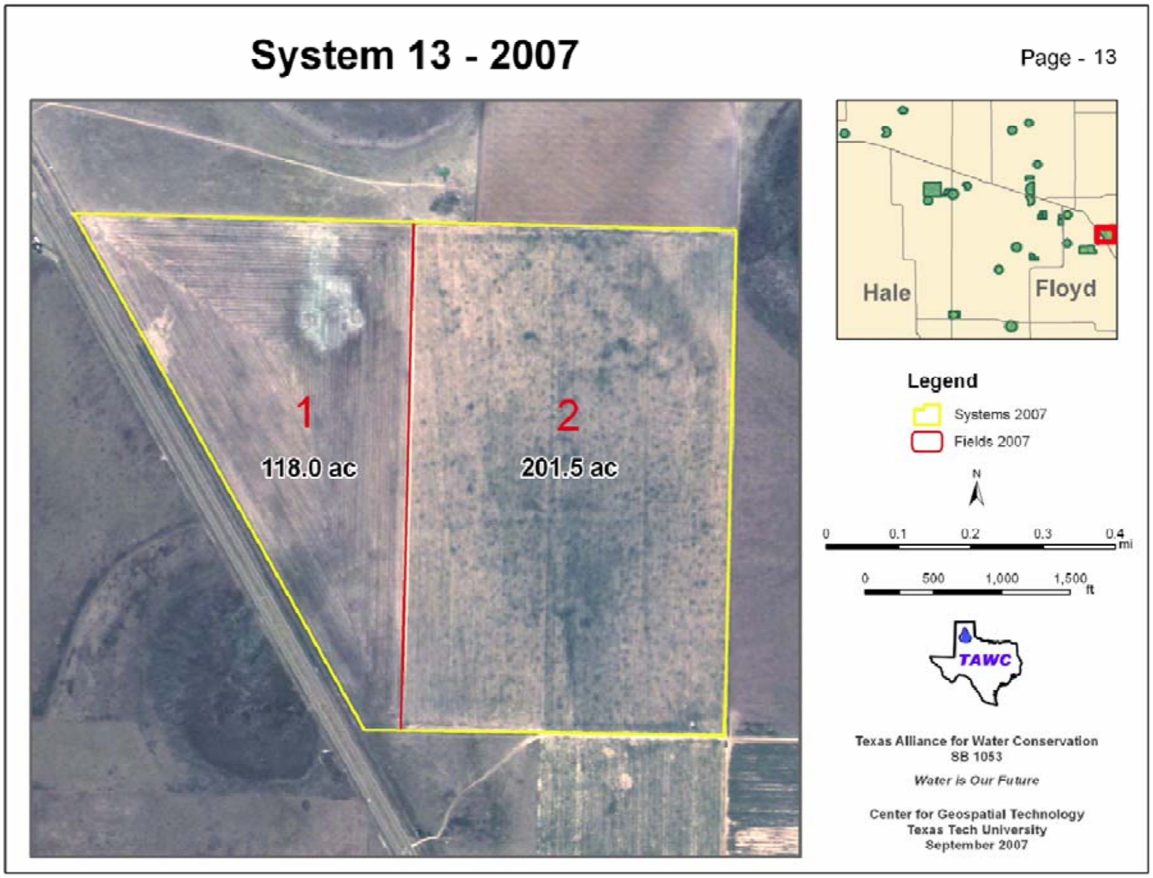
Site 12 Field 2, May 2008

Site 12


Precipitation
Water (inches)
35
30
25
20
15
10
5
0
2005
2006
2007
2008
Precipitation


Net Returns per System Acre
Net returns ($)
300
250
200
150
100
50
0
-50
2005
2006
2007
2008
Per system acre


Net Returns per pound of N
Net returns per pound of N ($)
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
(No N applied in 2005)
2005
2006
2007
2008
Per pound of nitrogen



System 13 Description

Total system 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:

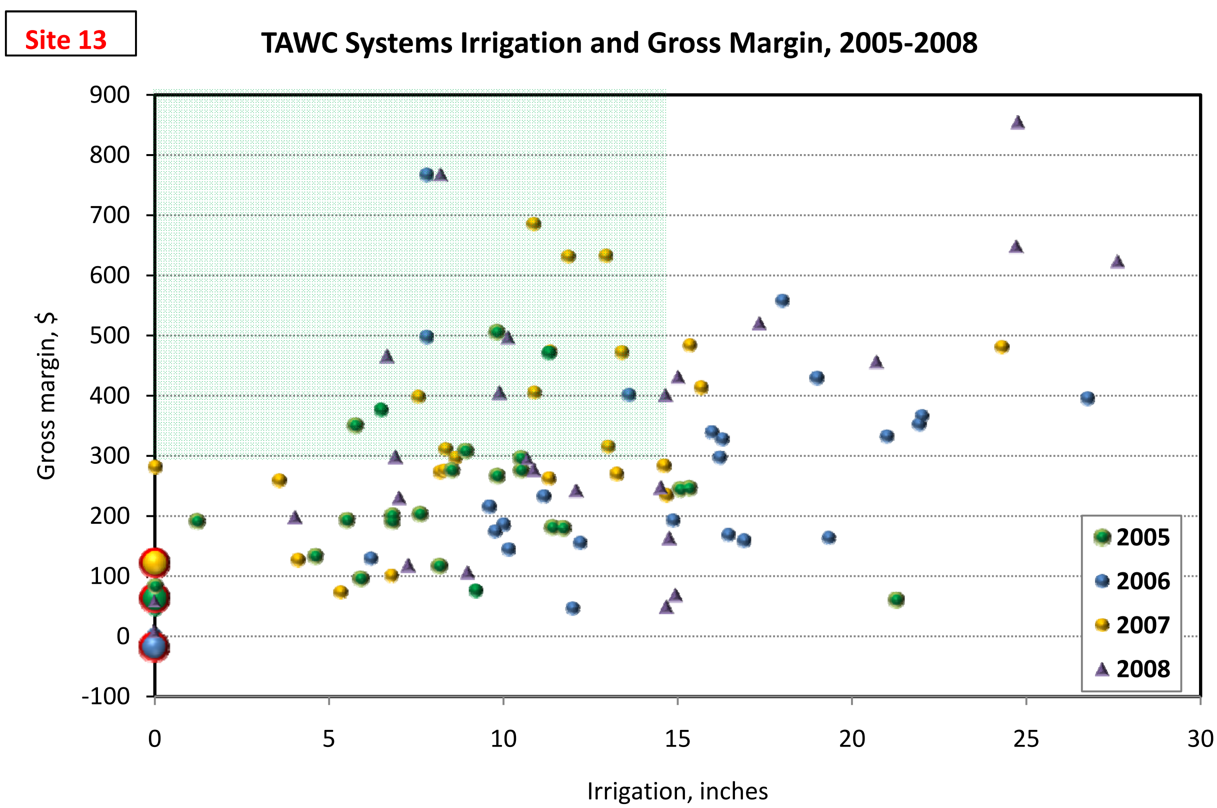
Number of wells:

Fuel source:

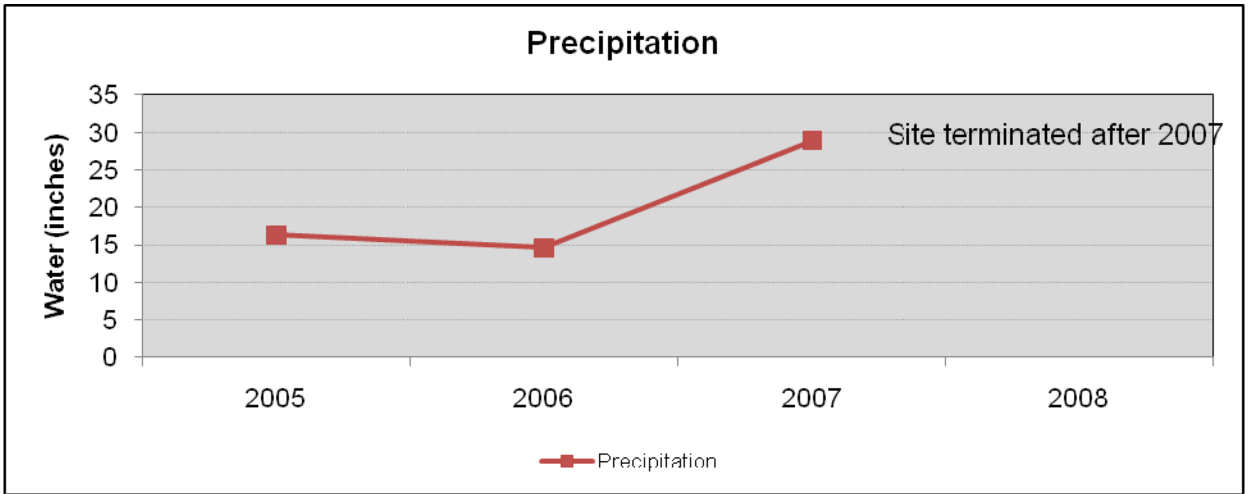
Comments: This dryland site uses cotton and small grains in rotation. Cotton is planted on forty-inch centers under limited tillage. Small grains are drilled after cotton harvest.

System 13

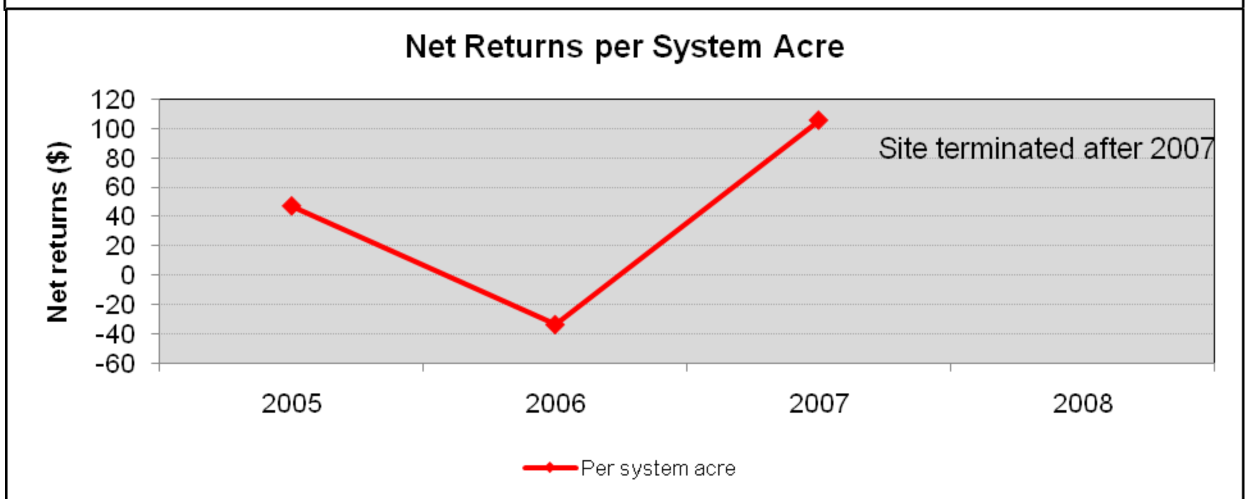
	Livestock	Field 1	Field 2
2005	None	Wheat for grain	Cotton following previous year's cover of Wheat stubble
2006	None	Cotton following previous year's cover of Wheat stubble	Wheat lost to drought
2007	None	Wheat for grain	Cotton following Wheat cover crop
2008	Site terminated for 2008		



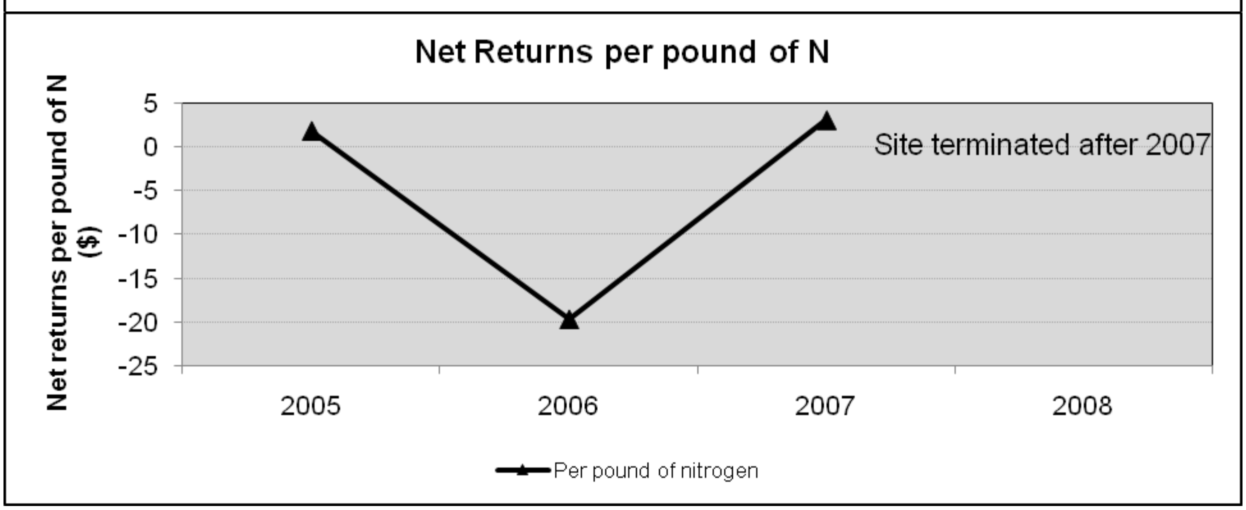
Site 13



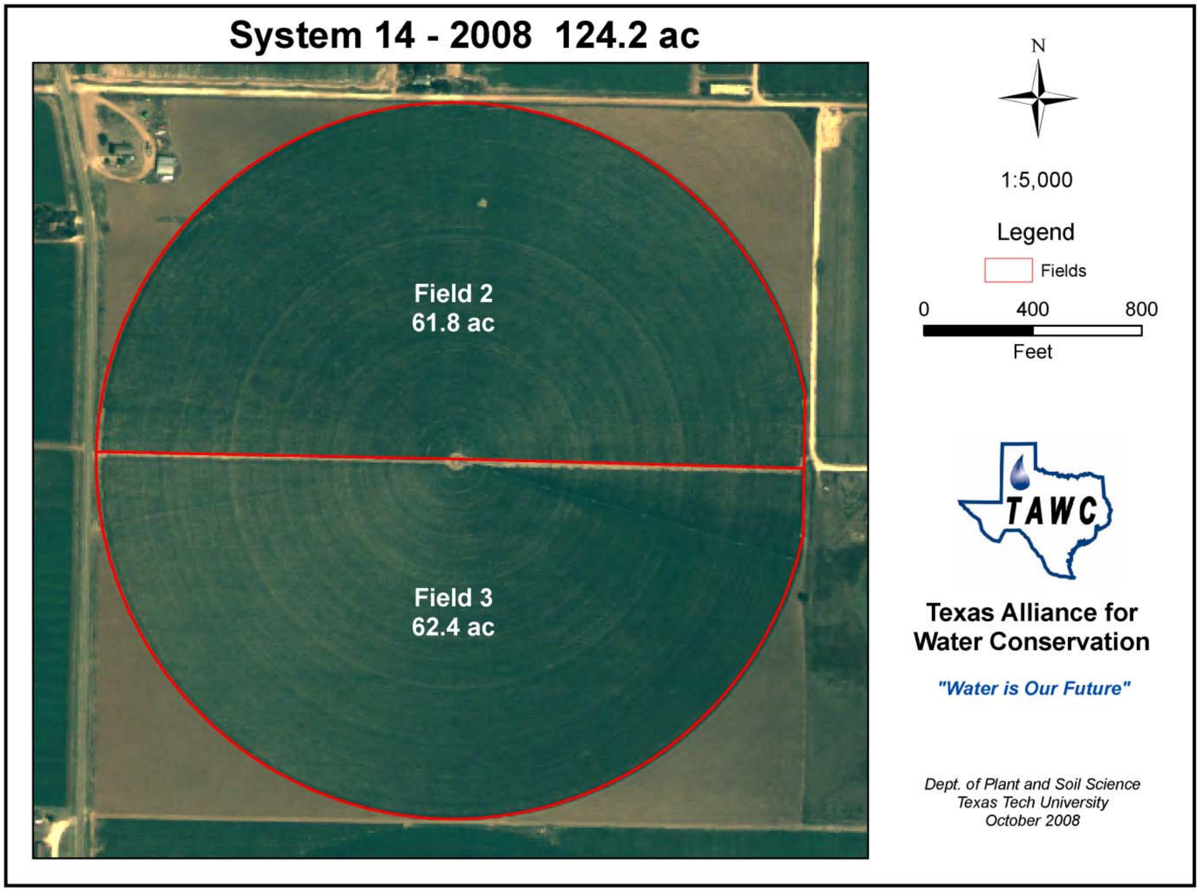
Precipitation
Water (inches)
35
30
25
20
15
10
5
0
2005
2006
2007
2008
Site terminated after 2007
Precipitation



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



Net Returns per pound of N
Net returns per pound of N ($)
5
0
-5
-10
-15
-20
-25
2005
2006
2007
2008
Site terminated after 2007
Per pound of nitrogen



System 14 Description

Total system acres: 124.2

Field No. 2 Acres: 61.8
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

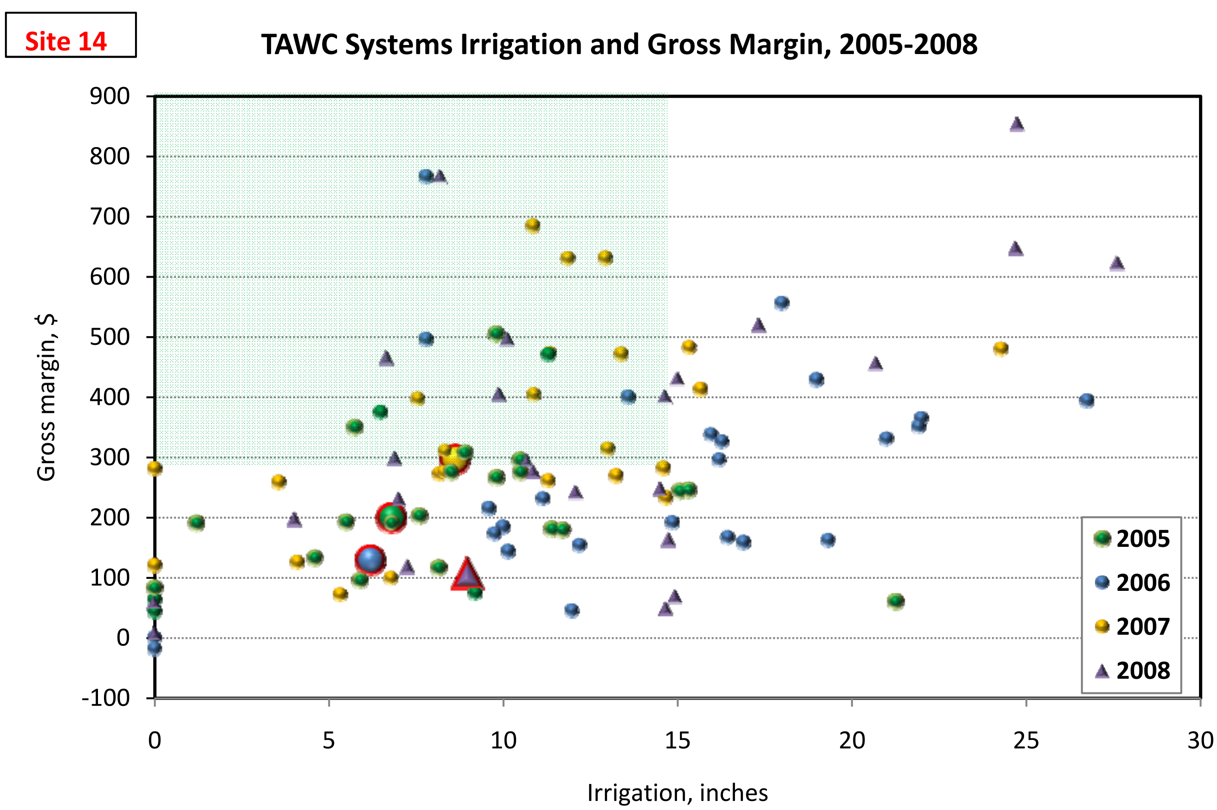
Number of wells: 3

Fuel source: Electric

Comments: This is a pivot irrigated site with limited irrigation water available. The producer uses conventional tillage on forty-inch centers.

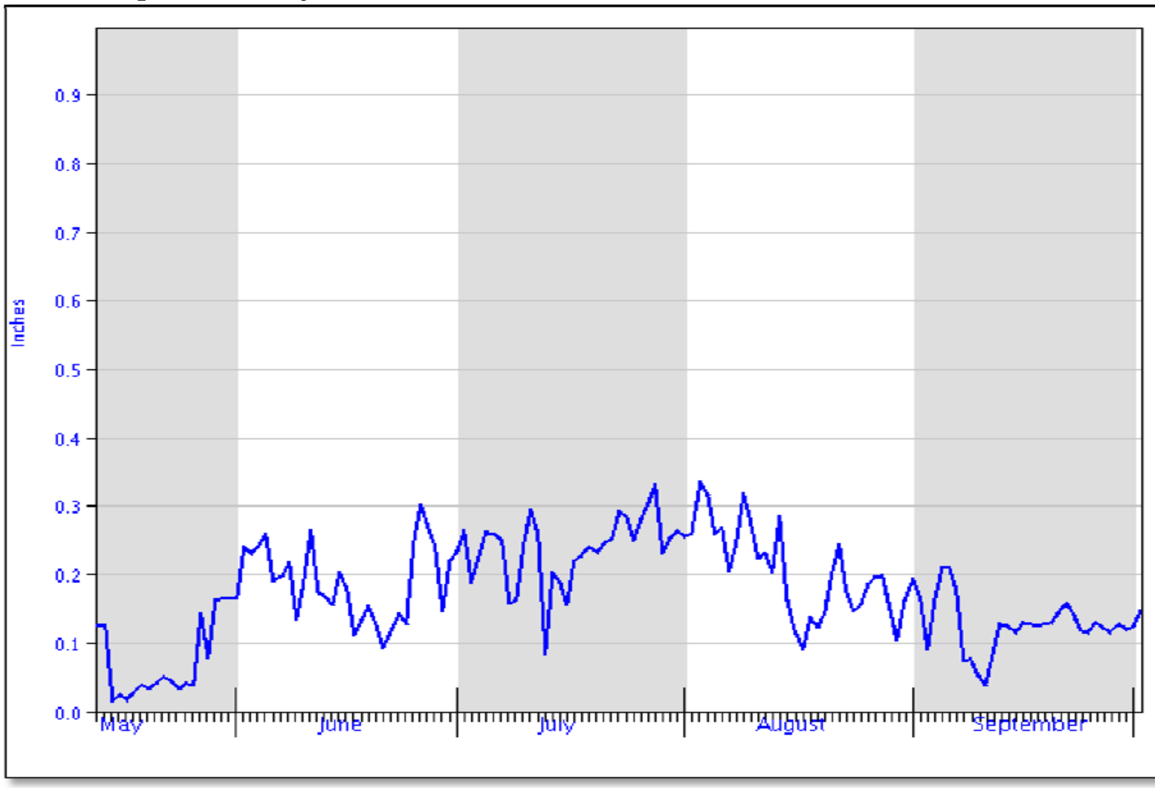
System 14

	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



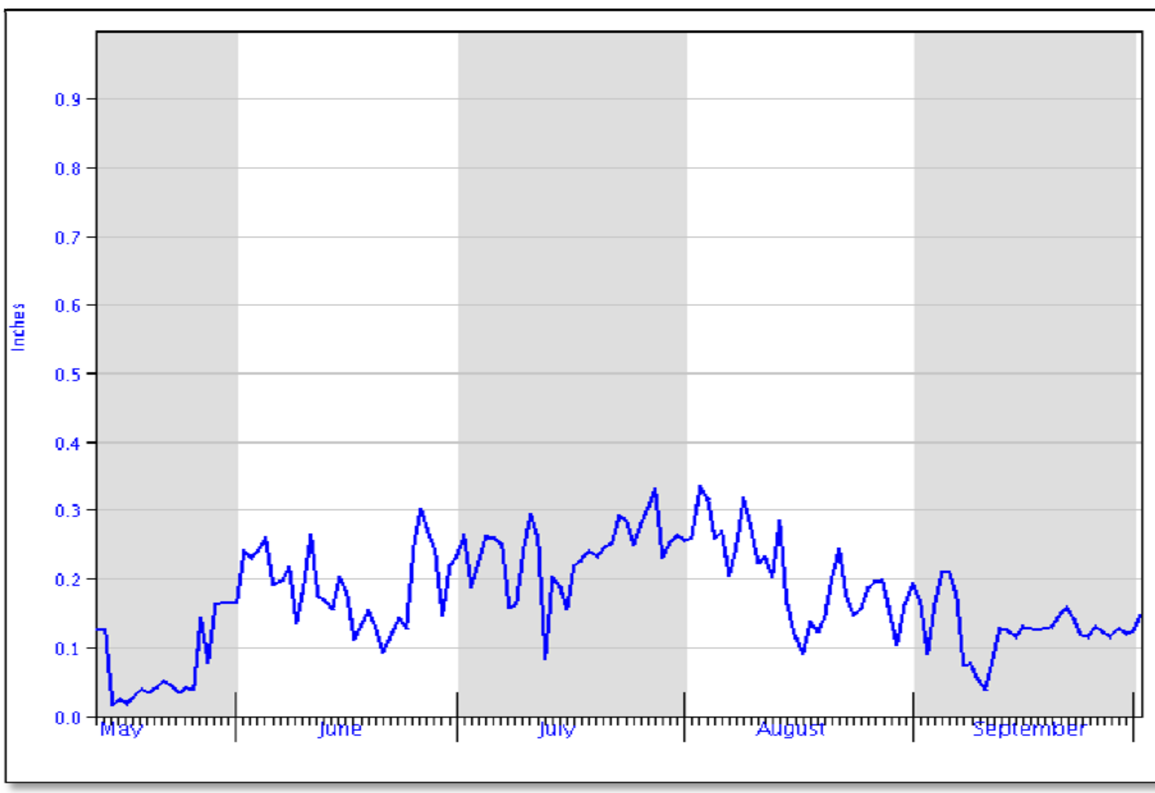
Site 14 Field 2

Cotton planted May 13 **Total ET Demand 24.53”**



Site 14 Field 3

Cotton planted May 13 **Total ET Demand 24.53”**

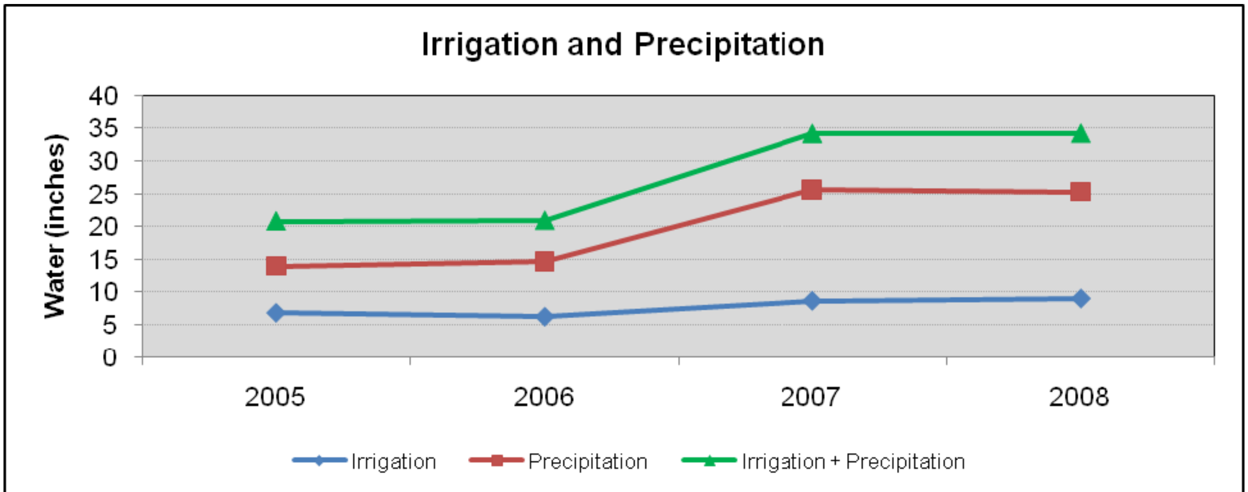


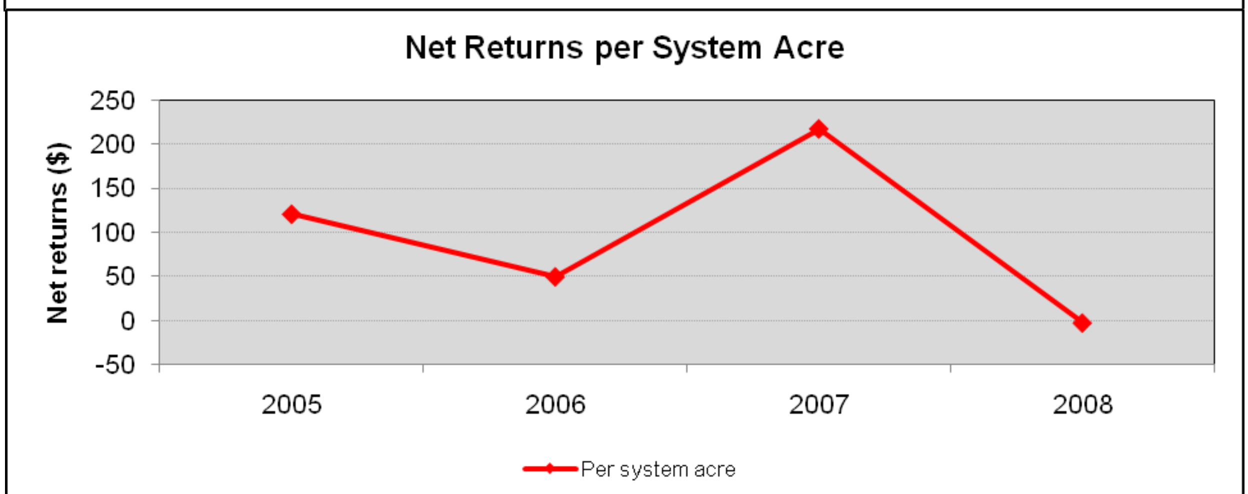
Site 14 Field 2, September 2008

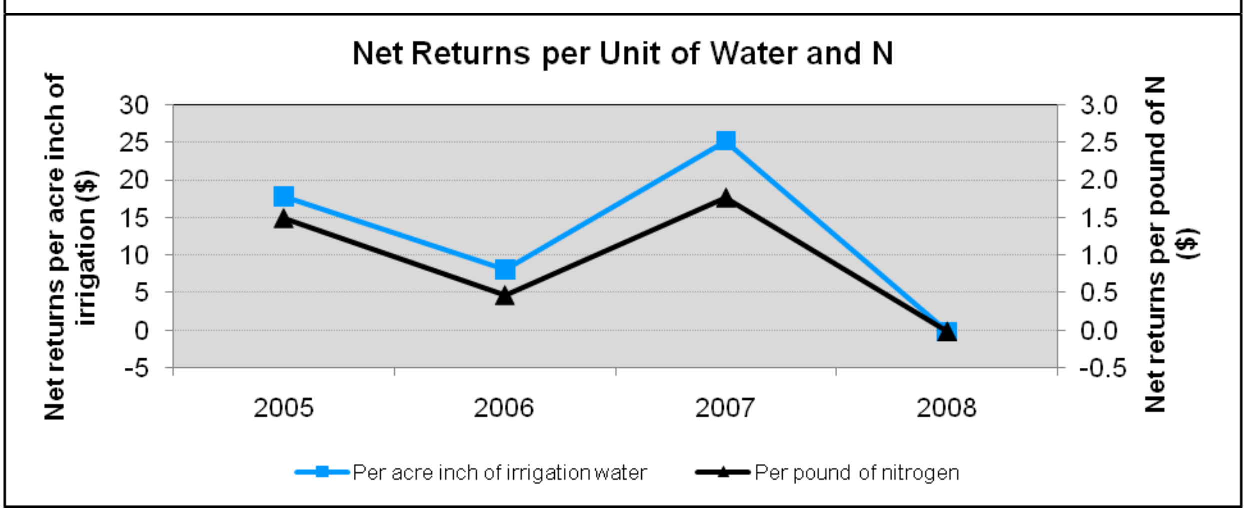
Site 14 Field 2, November 2008

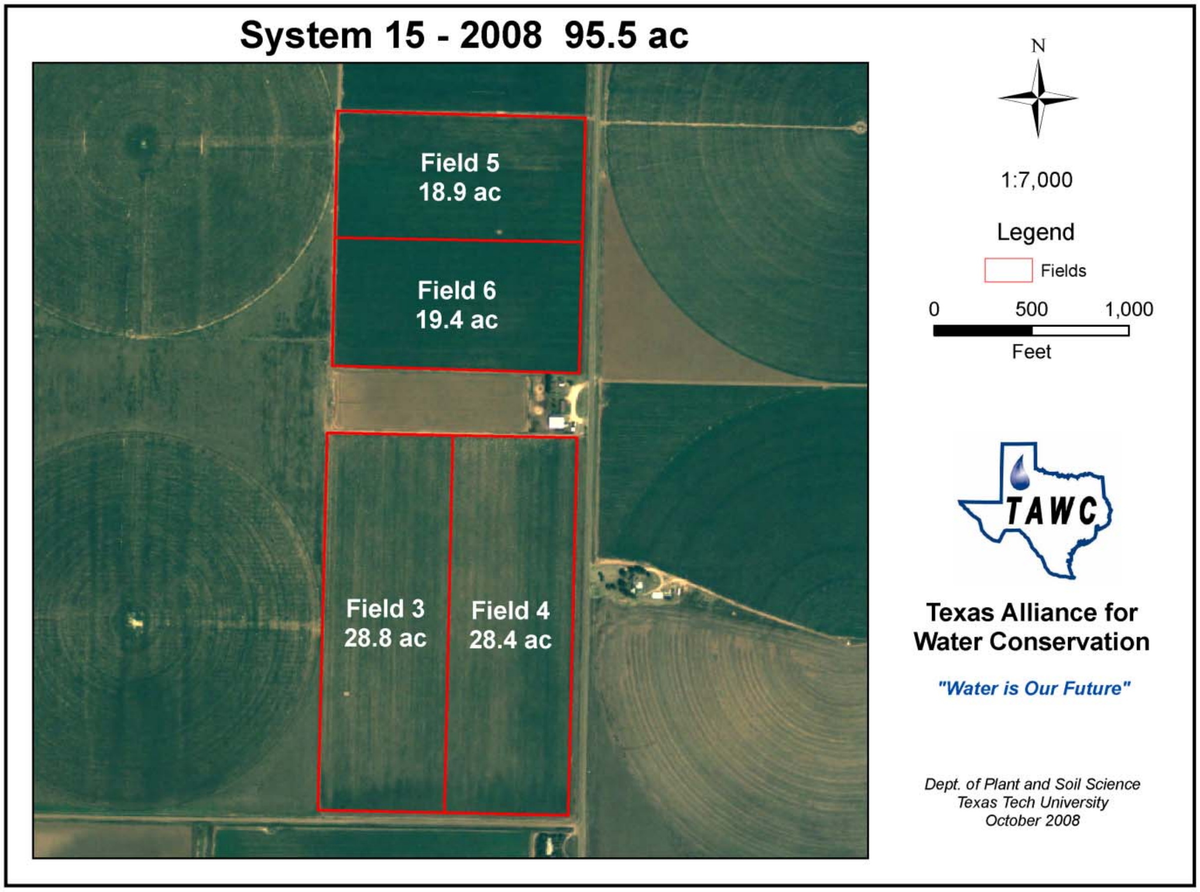
Site 14 Field 3, September 2008

Site 14


Irrigation and Precipitation
Water (inches)
40
35
30
25
20
15
10
5
0
2005
2006
2007
2008
Irrigation
Precipitation
Irrigation + Precipitation


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


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
30
25
20
15
10
5
0
-5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
Net returns per pound of N ($)
2005
2006
2007
2008
Per acre inch of irrigation water
Per pound of nitrogen



System 15 Description

Total system acres: 95.5

Field No. 3	*2006-2008*
Acres:	28.8
Major soil type:	Pullman clay loam; 0 to 1% slope
Field No. 4	*2006-2008*
Acres:	28.4
Major soil type:	Pullman clay loam; 0 to 1% slope
Field No. 5	*2008 only*
Acres:	18.9
Major soil type:	Pullman clay loam; 0 to 1% slope
Field No. 6	*2008 only*
Acres:	19.4
Major soil type:	Pullman clay loam; 0 to 1% slope

Irrigation

Type:	Furrow Fields 3 and 4 Subsurface Drip Fields 5 and 6
Pumping capacity, gal/min:	290
Number of wells:	1
Fuel source:	Natural gas

System 15

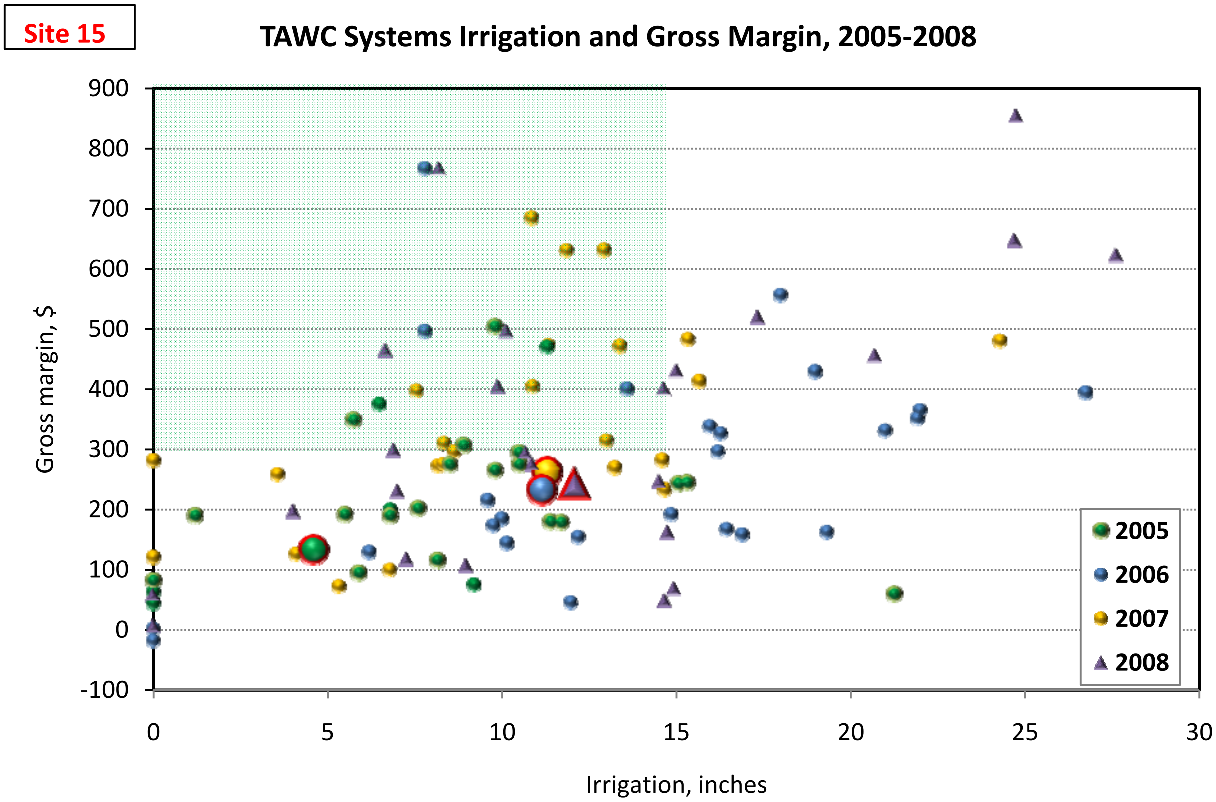
	Livestock	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6
2005	None	Cotton	Cotton				
2006	None	Cotton	Split into Fields 3 and 4	Cotton	Grain Sorghum		
2007	None	Cotton	Split into Fields 3 and 4	Grain Sorghum	Cotton		
2008	None	Split into Fields 5 and 6	Split into Fields 5 and 6	Cotton	Wheat harvested, volunteer Wheat for cover crop, replanted to Wheat	Cotton	Cotton


Site 15 Field 3, April 2008


Site 15 Field 4, June 2008

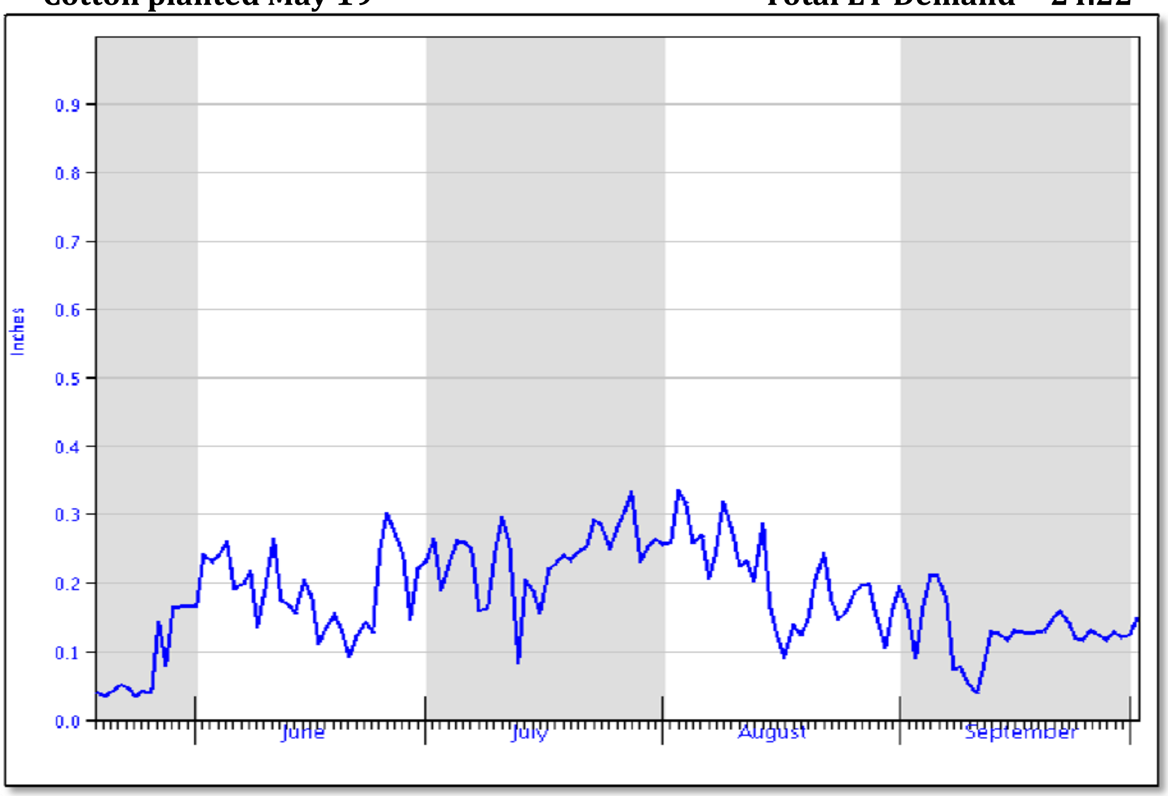

Site 15 Field 6, November 2008

Comments: Twenty acres of this flood irrigated system was converted to drip irrigation this year. This is a cotton/wheat/grain sorghum site with conventional tillage and planted on forty-inch centers.

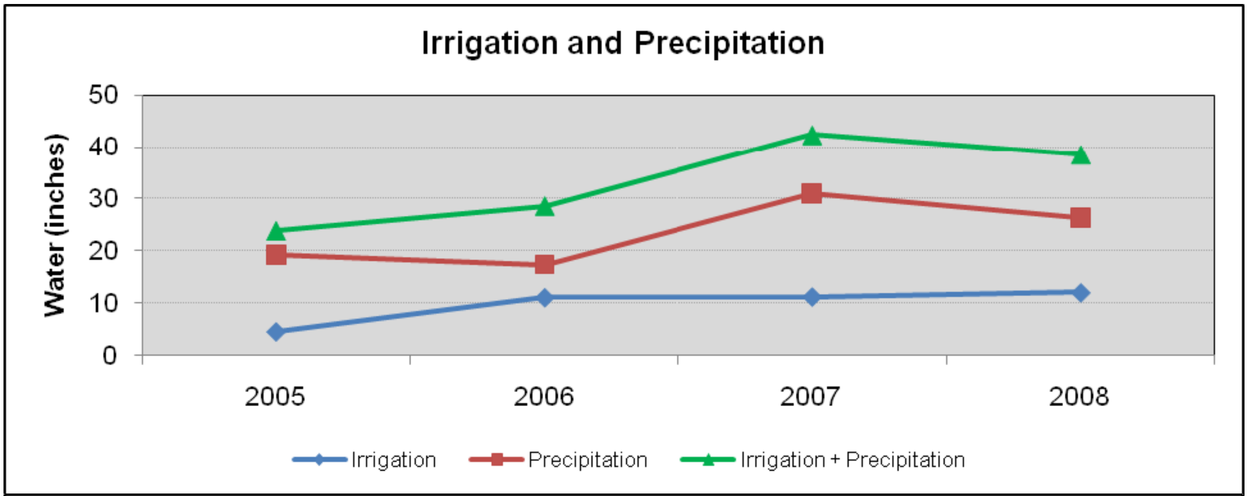


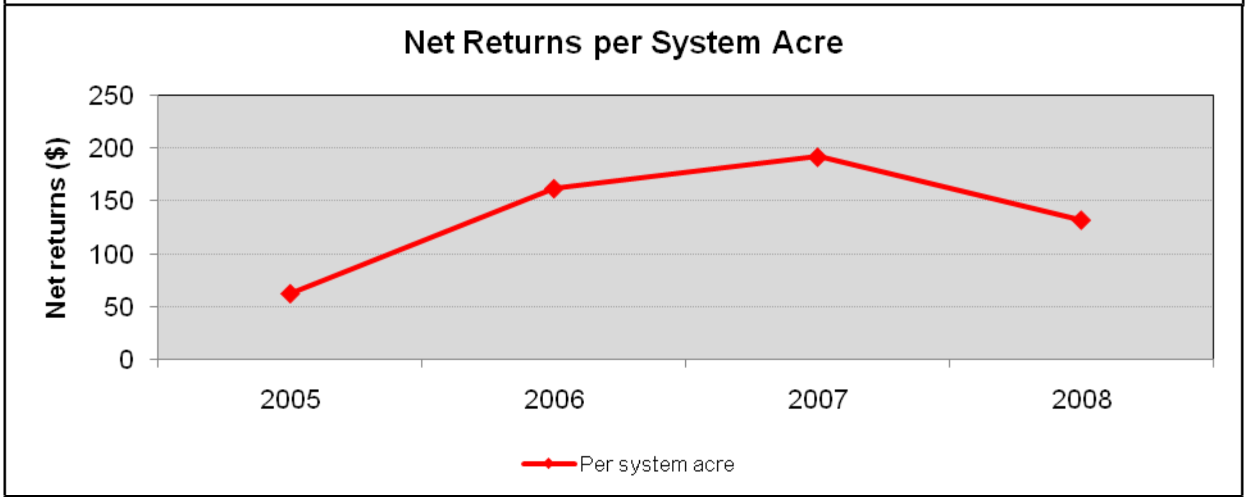
Site 15 Field 6

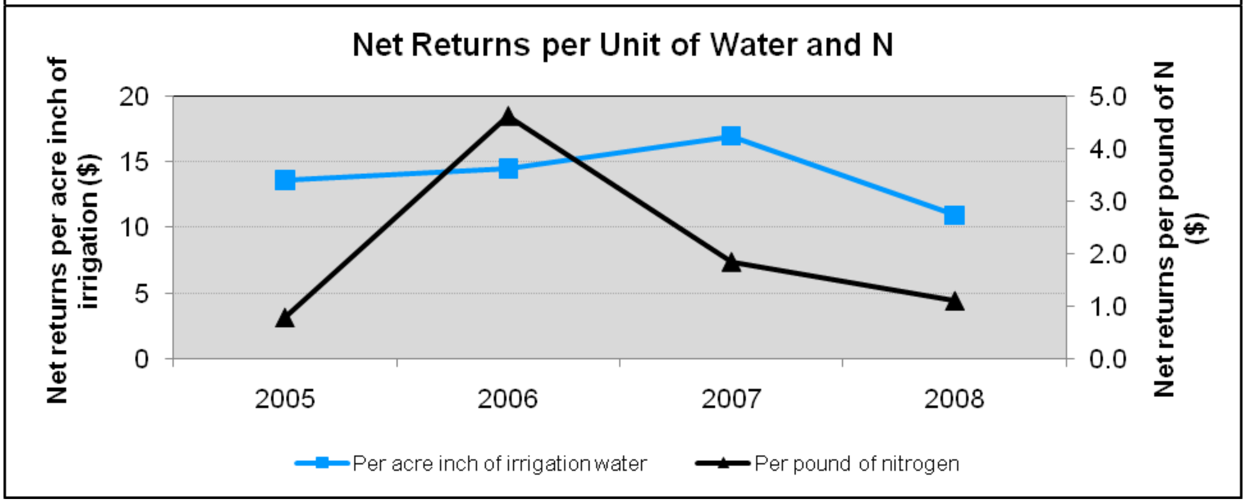
Cotton planted May 19 **Total ET Demand 24.22"**

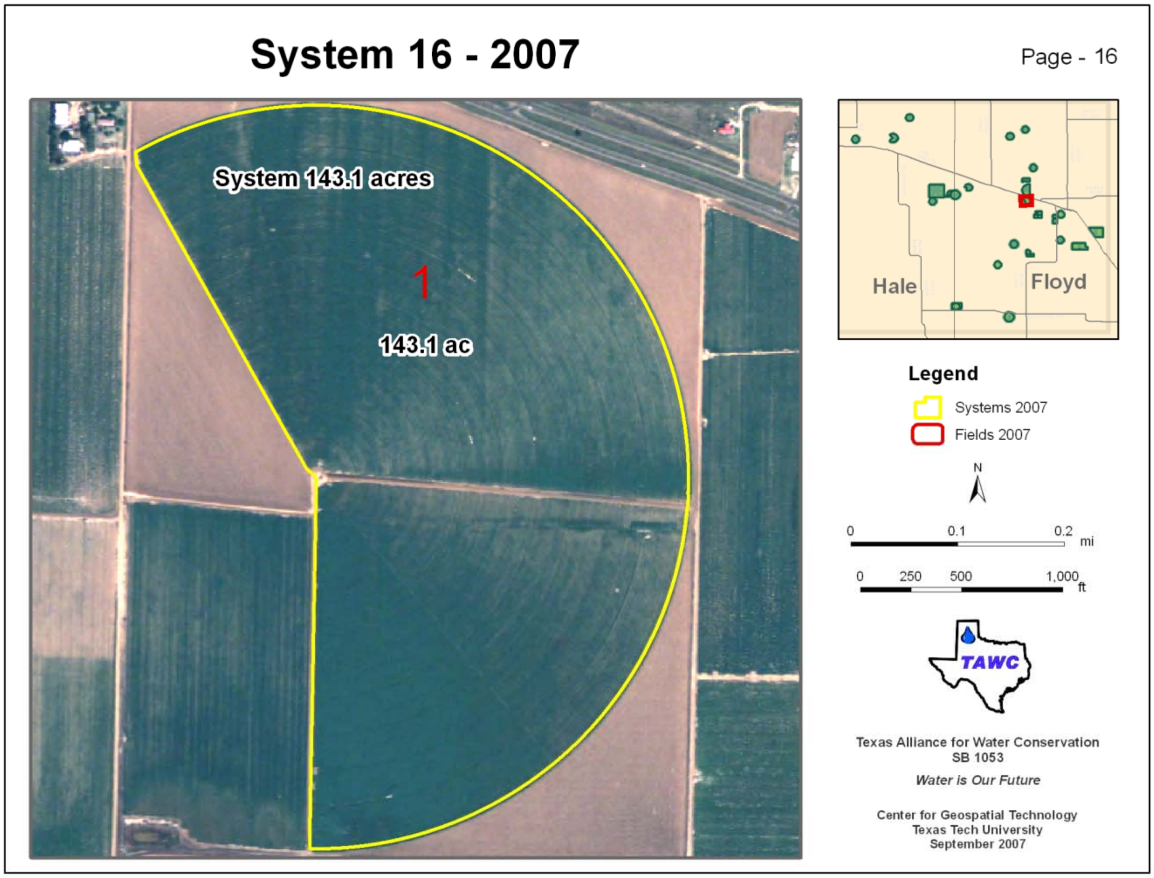


Site 15


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


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


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



System 16 Description

Total system 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

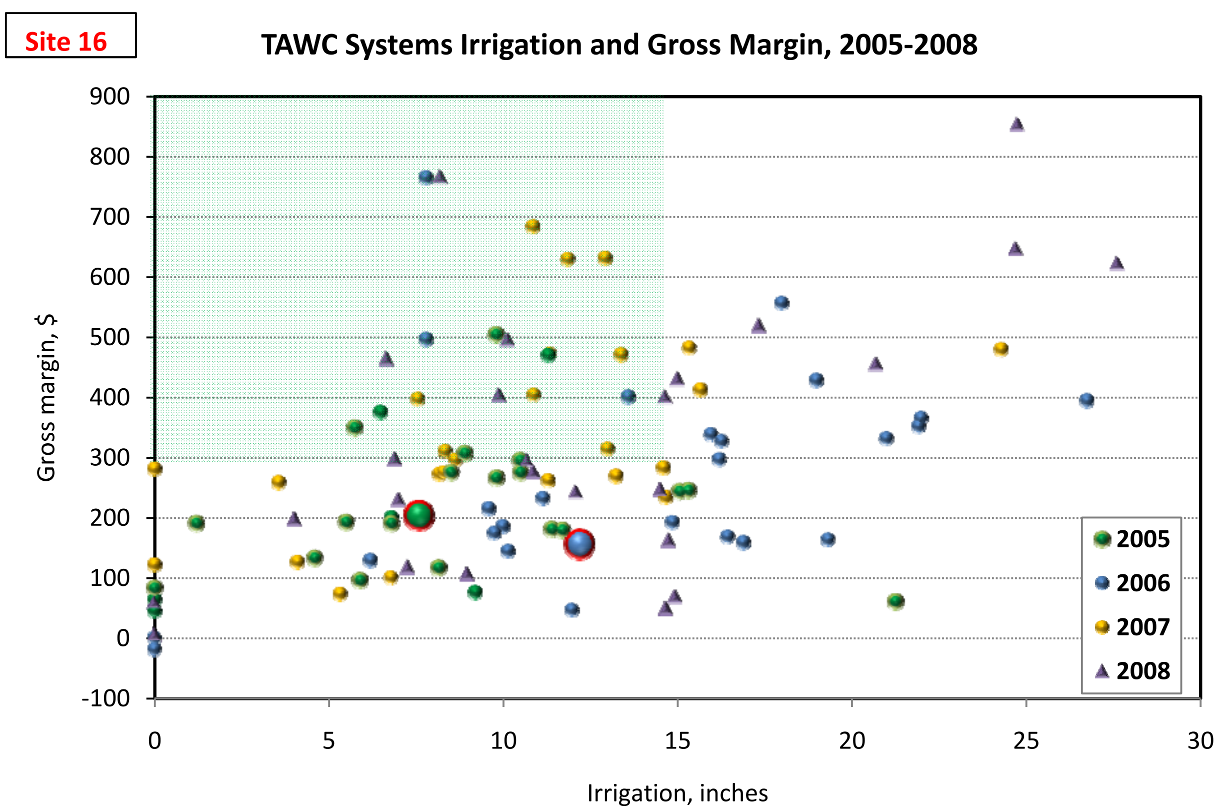
Number of wells: 3

Fuel source: Electric

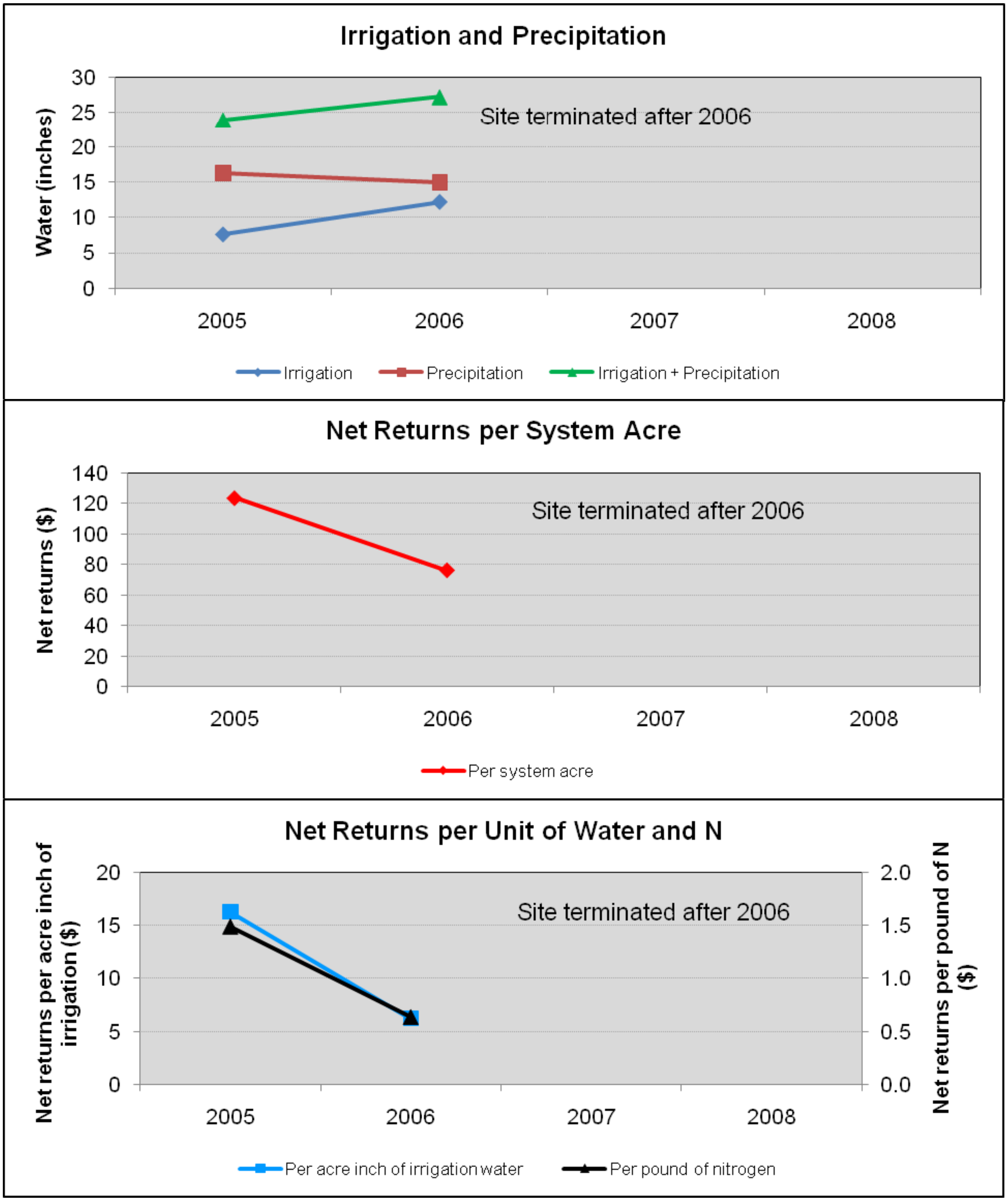
Comments: This pivot irrigated cotton site uses conventional tillage and plants on forty-inch centers.

System 16

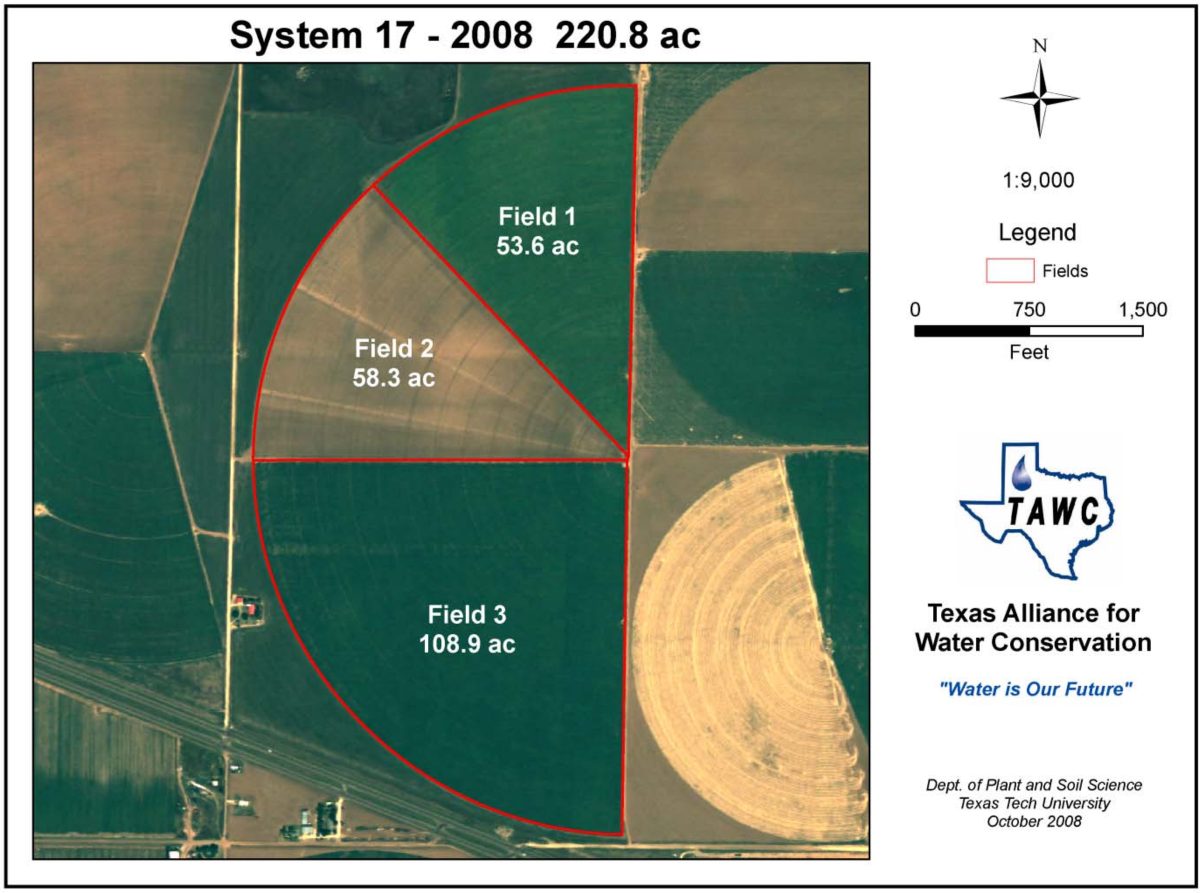
	Livestock	Field 1
2005	None	Cotton
2006	None	Cotton
2007	Site terminated for 2007	
2008		



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
2.0
1.5
1.0
0.5
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
Site terminated after 2006
Per acre inch of irrigation water
Per pound of nitrogen



System 17 Description

Total system acres: 220.8

Field No. 1 Acres: 53.6
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 2 Acres: 58.3
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 3 Acres: 108.9
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Center Pivot (MESA)

Pumping capacity, gal/min: 900

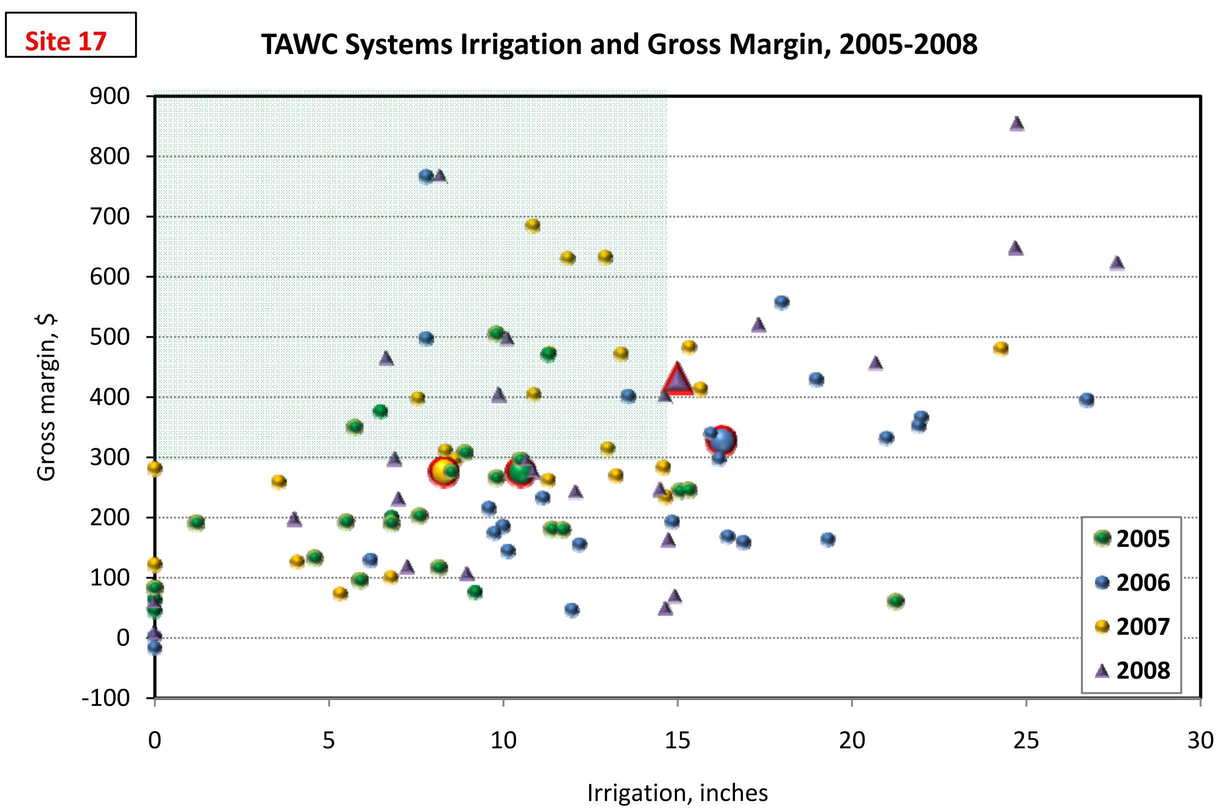
Number of wells: 8

Fuel source: Electric

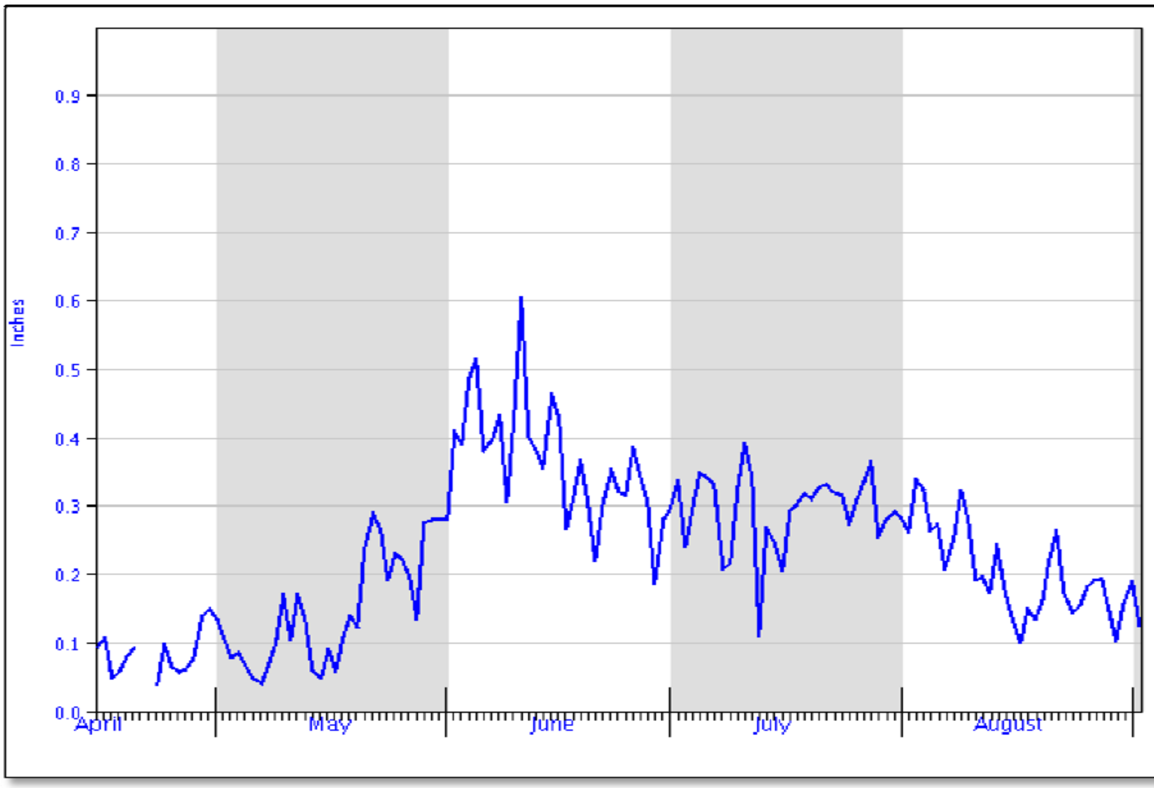
Comments: This is a cotton, food corn, and Old World bluestem site using pivot irrigation. Wheat is planted after corn harvest, and the wheat is terminated then cotton is no-till planted the following year. Corn is planted on twenty-inch centers on clean tilled ground. The Old-world bluestem is used for grazing and/or hay and seed production.

System 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



Site 17 Field 3
Corn planted April 15 **Total ET Demand 32.19"**



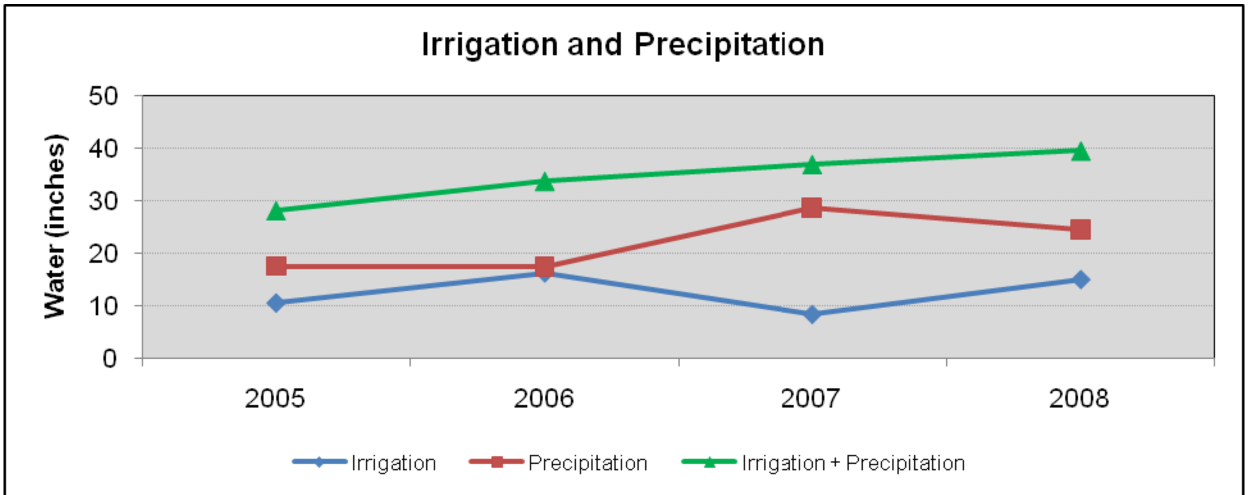
Site 17 Field 1, August 2008

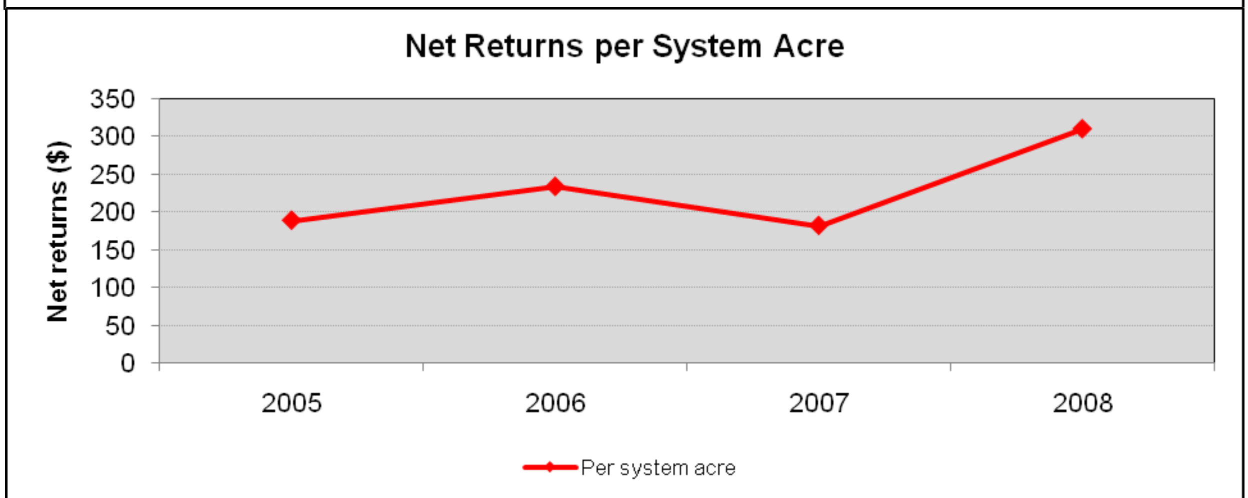
Site 17 Field 2, August 2008

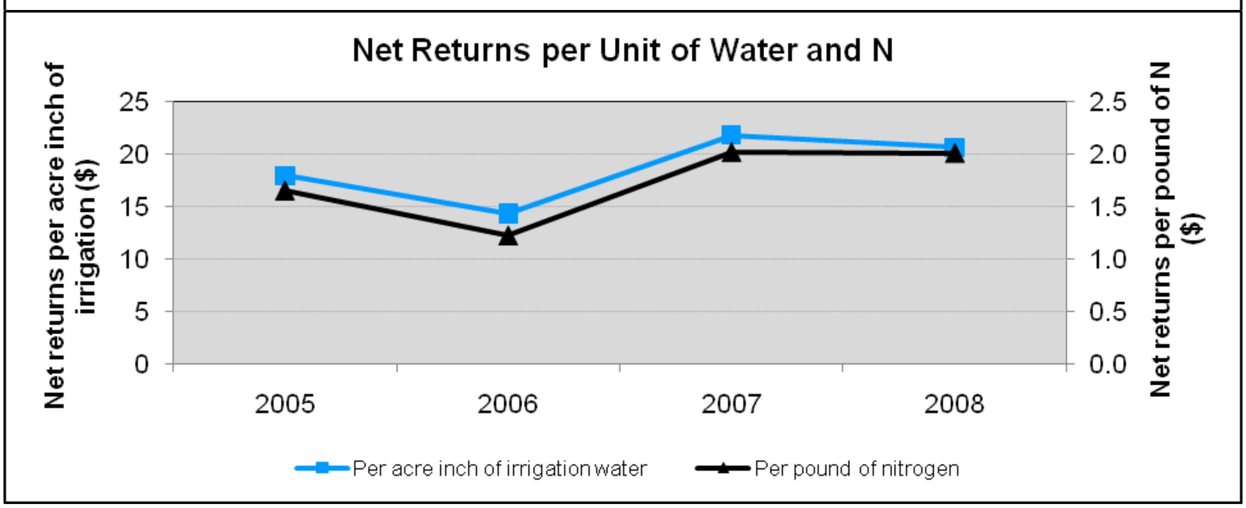
Site 17 Field 3, April 2008

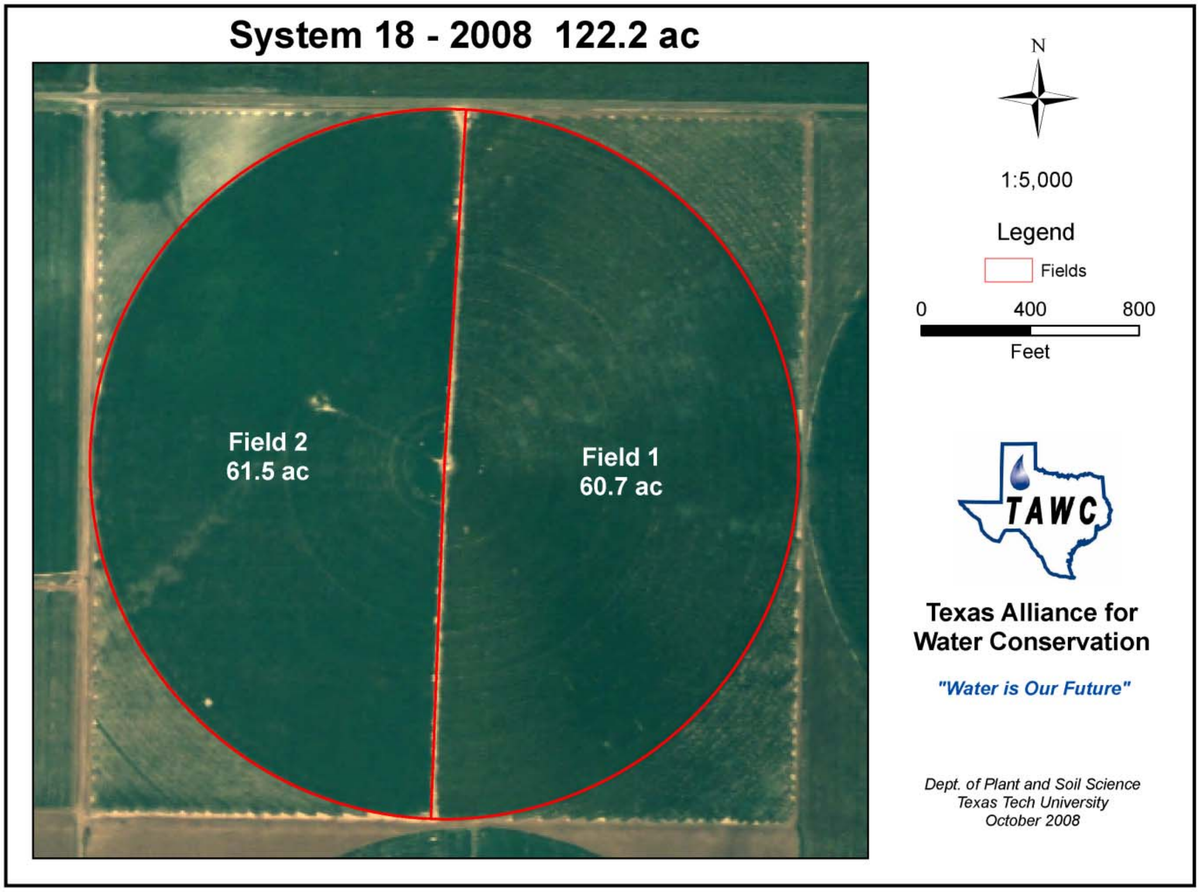
Site 17 Field 3, June 2008

Site 17


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


Net Returns per System Acre
Net returns ($)
350
300
250
200
150
100
50
0
2005
2006
2007
2008
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
25
20
15
10
5
0
2.5
2.0
1.5
1.0
0.5
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
Per acre inch of irrigation water
Per pound of nitrogen



System 18 Description

Total system acres: 122.2

Field No. 1 Acres: 60.7
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 2 Acres: 61.5
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Center Pivot (LEPA)

Pumping capacity, gal/min: 250

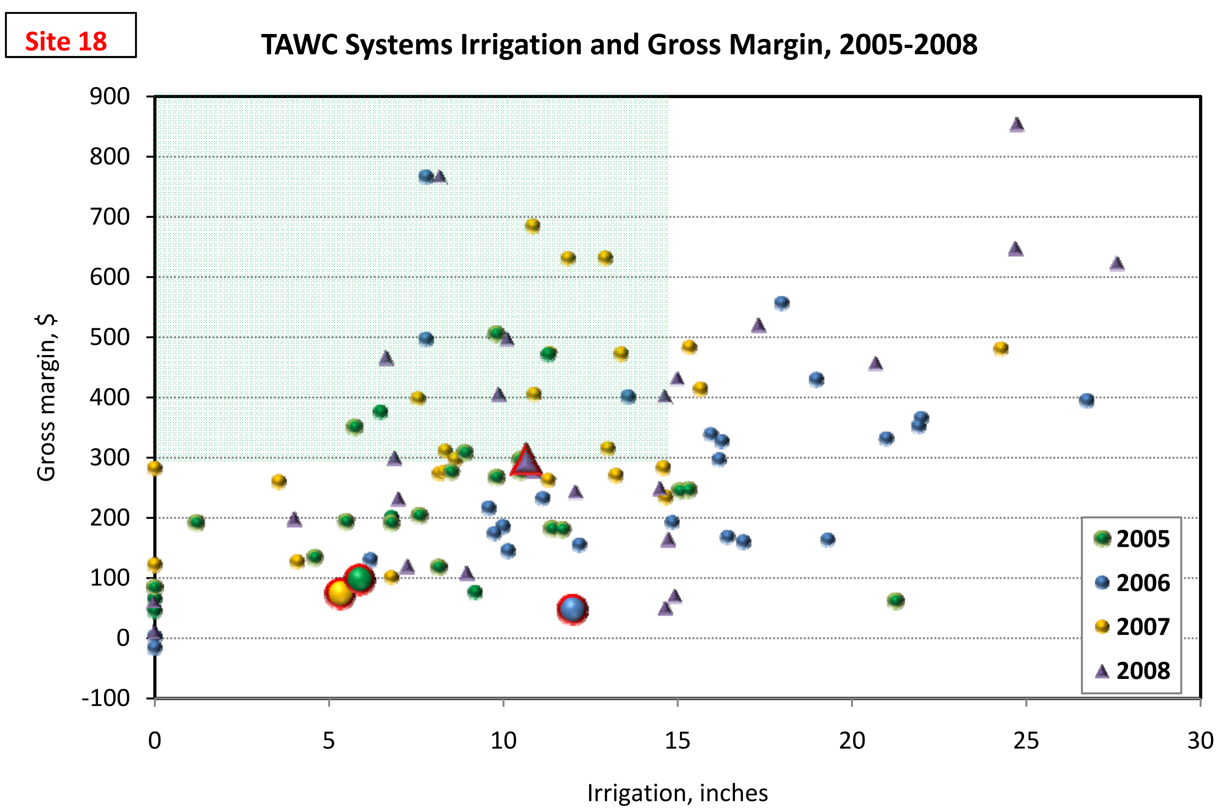
Number of wells: 3

Fuel source: Electric

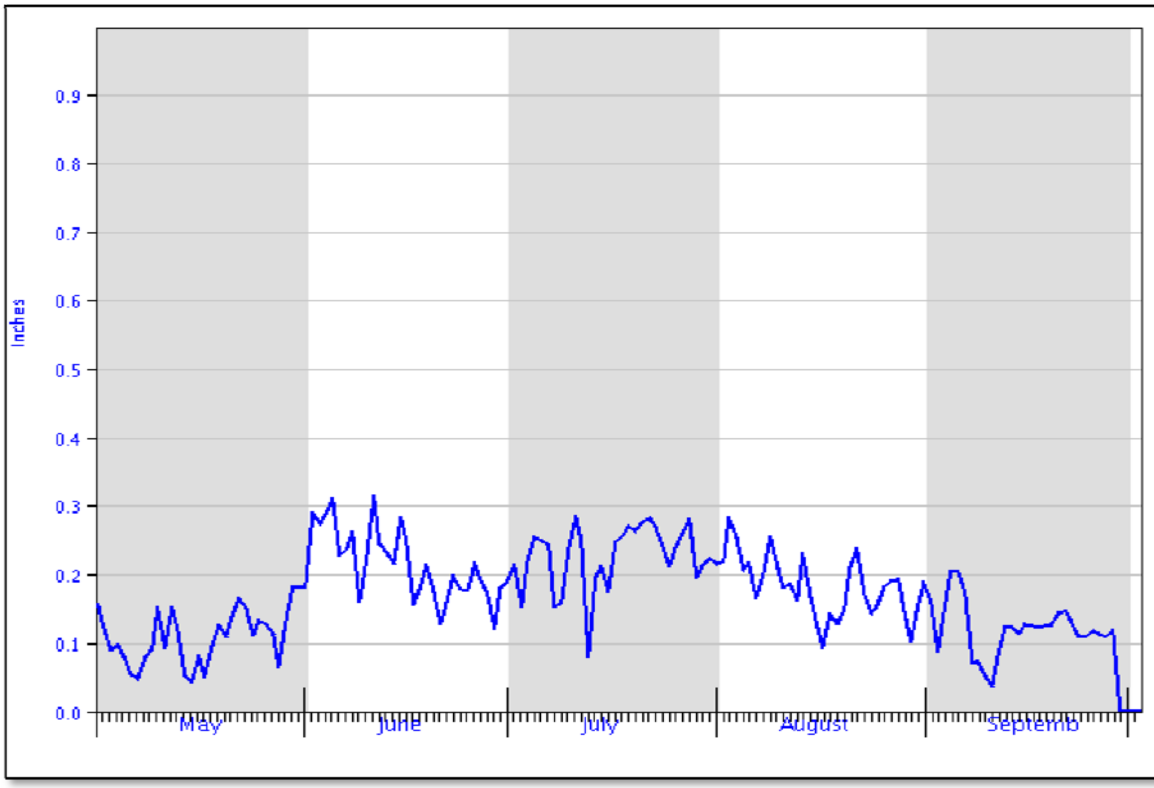
Comments: This is a pivot irrigated site with limited irrigation. Grain sorghum, cotton and wheat are planted on a rotational basis.

System 18

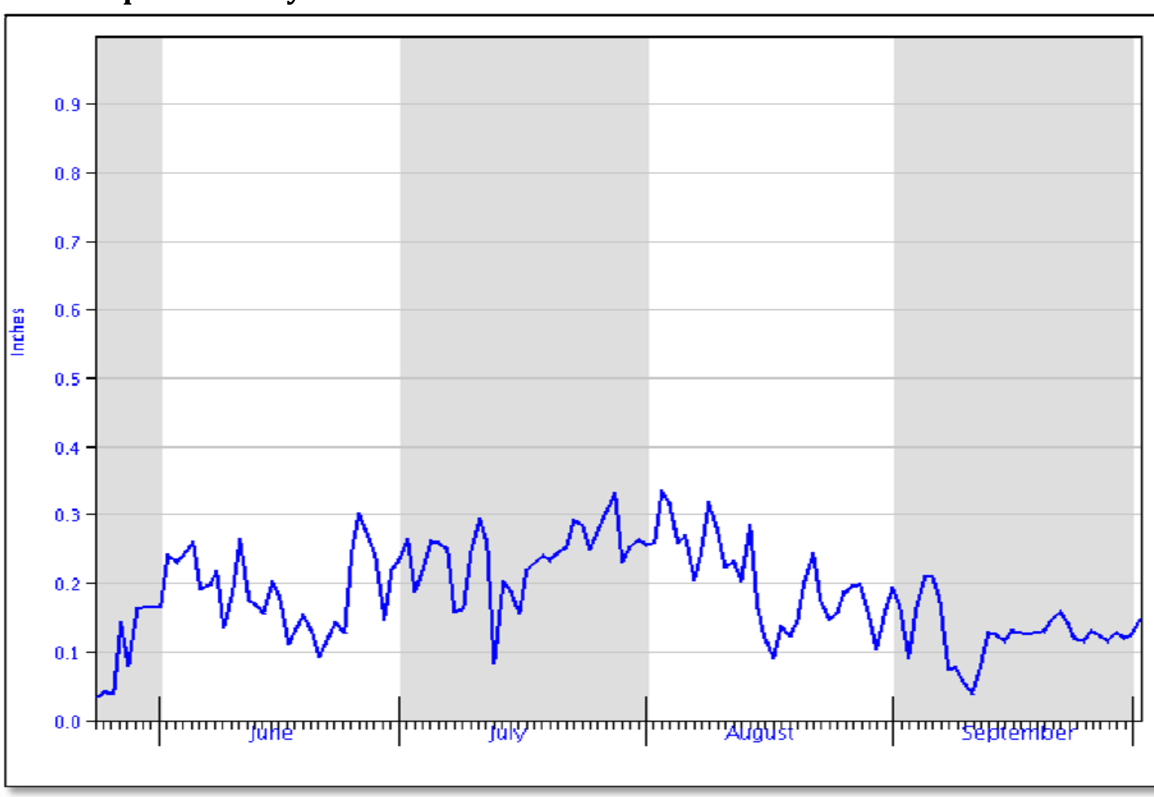
	Livestock	Field 1	Field 2
2005	None	Cotton	Grain Sorghum
2006	None	Cotton	Oats for silage followed by Forage Sorghum for hay
2007	None	Wheat for grain	Grain Sorghum
2008	None	Wheat for silage followed by Grain Sorghum	Cotton



Site 18 Field 1
Sorghum planted May 1 **Total ET Demand 26.01"**



Site 18 Field 2
Cotton planted May 15 **Total ET Demand 25.20"**

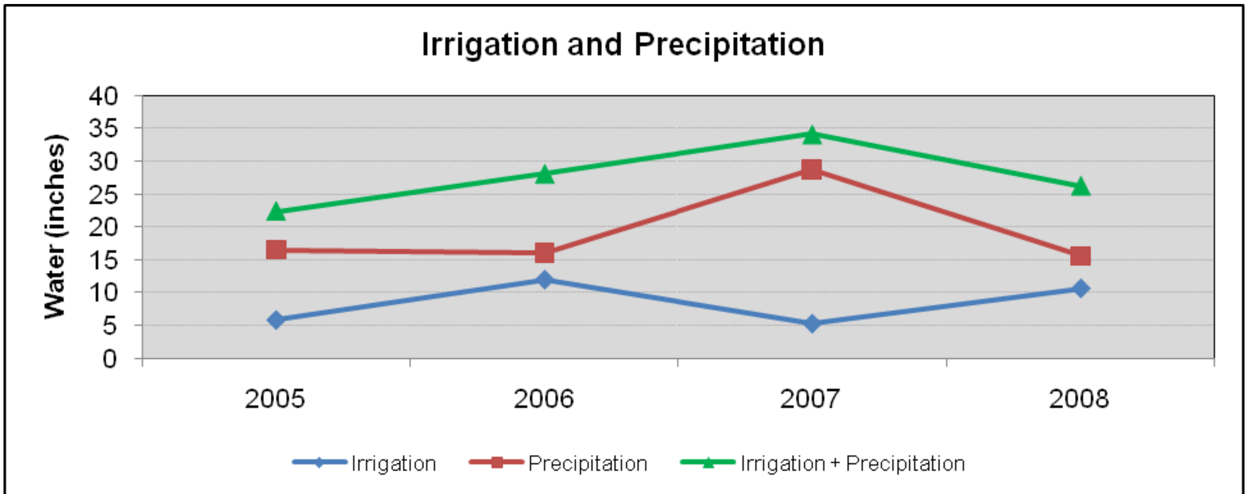


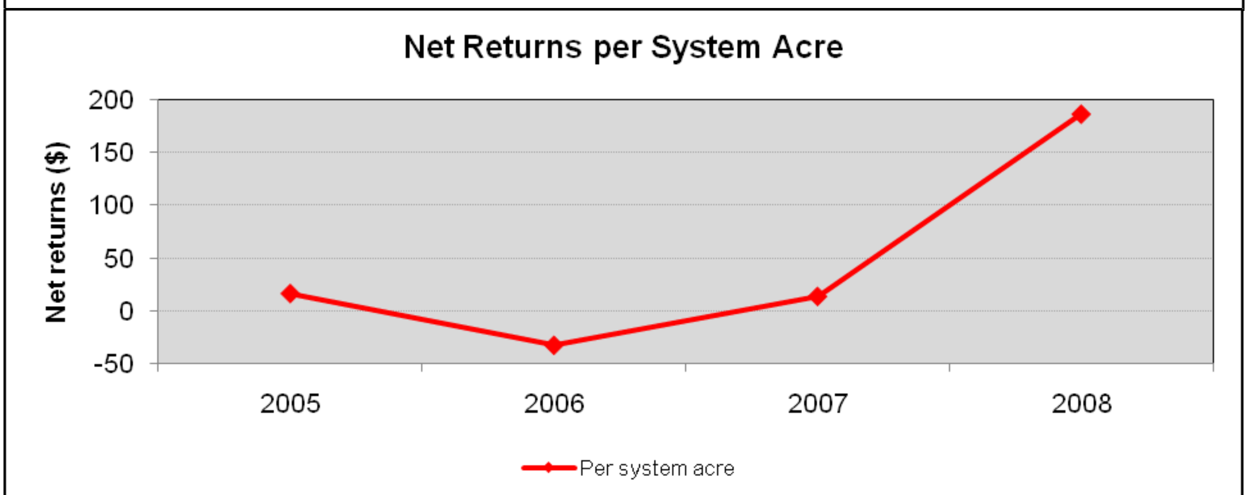

Site 18 Field 1, April 2008

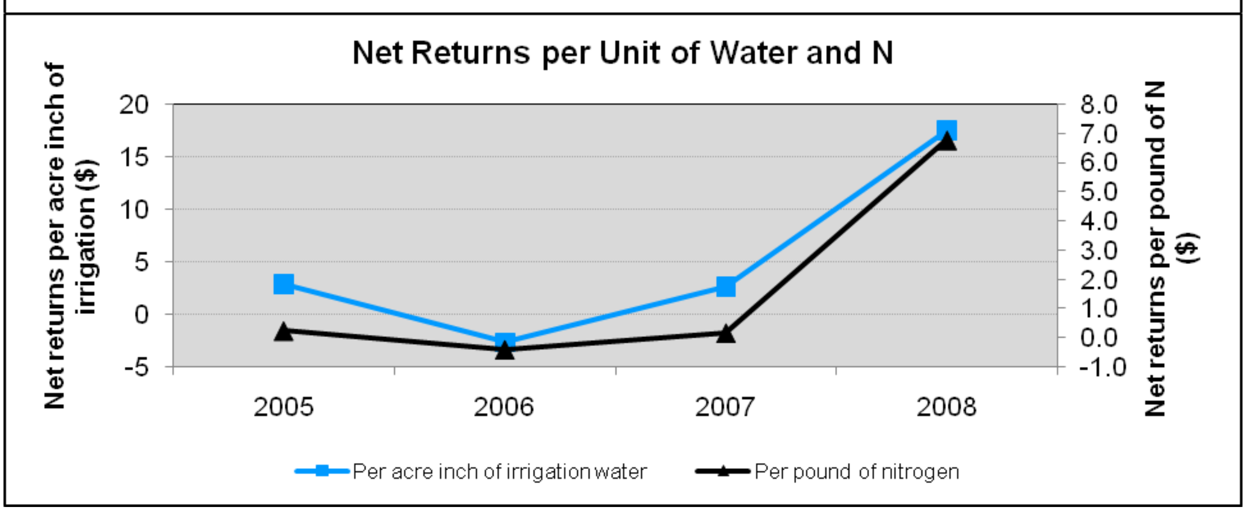

Site 18 Field 1, October 2008

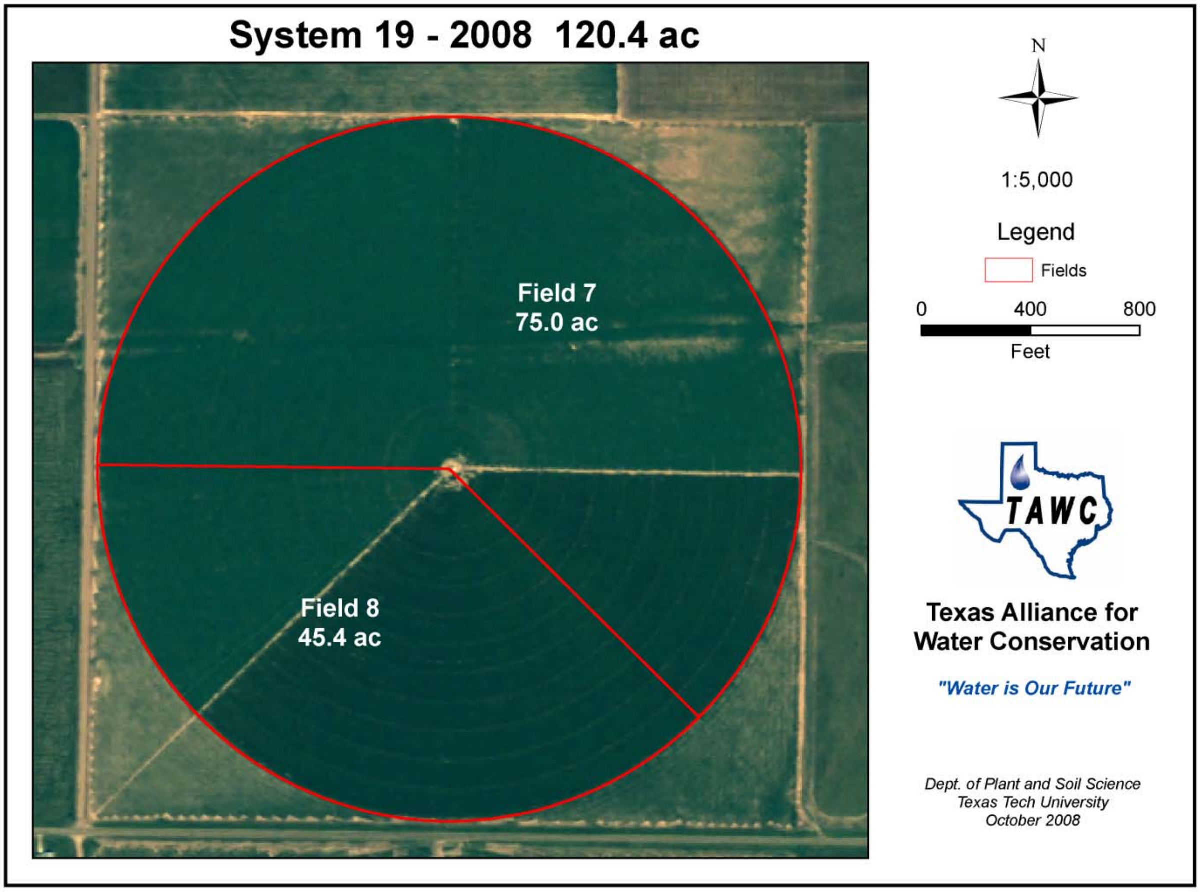

Site 18 Field 2, October 2008

Site 18


Irrigation and Precipitation
Water (inches)
40
35
30
25
20
15
10
5
0
2005
2006
2007
2008
Irrigation
Precipitation
Irrigation + Precipitation


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


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
20
15
10
5
0
-5
2005
2006
2007
2008
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
Net returns per pound of N ($)
Per acre inch of irrigation water
Per pound of nitrogen



System 19 Description

Total system acres: 120.4

Field No. 7 Acres: 75.0
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 8 Acres: 45.4
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

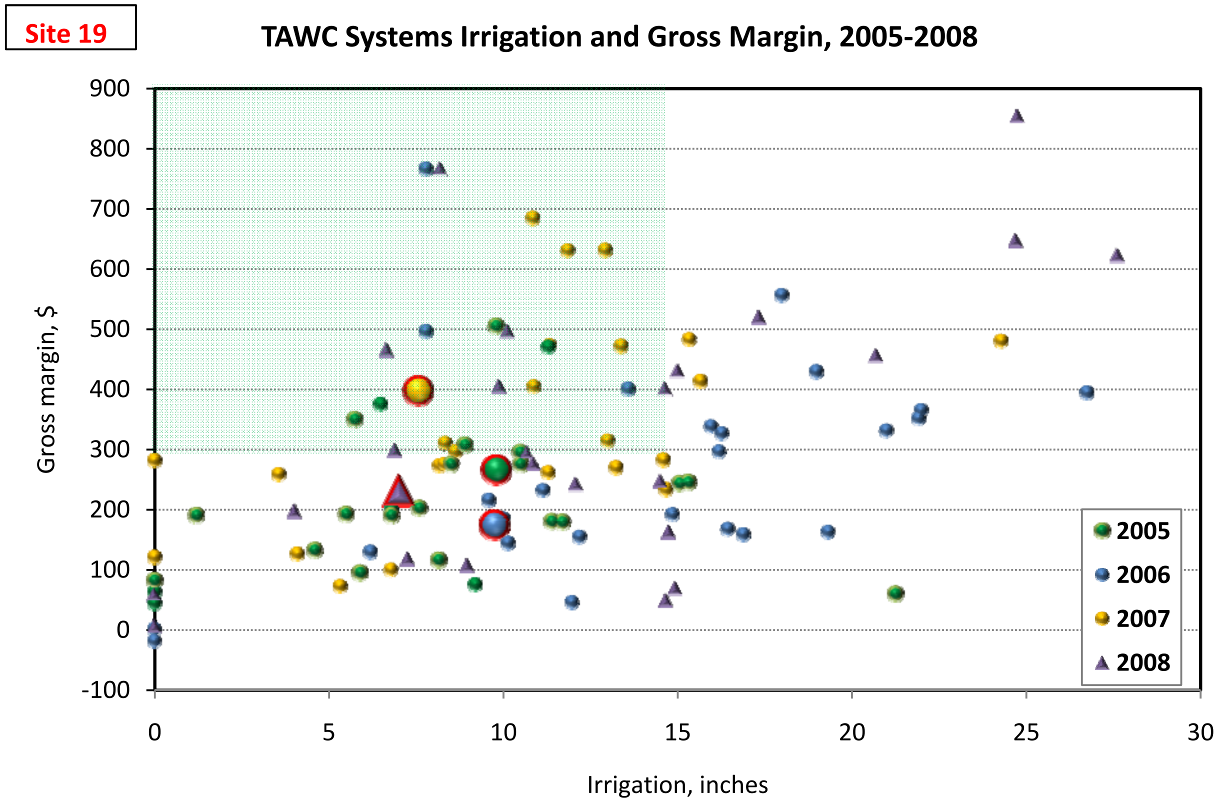
Comments: This is a pivot irrigated cotton and seed millet site. The seed millet comprises one-third of the system and is rotated around the circle. One-third of the cotton is planted following seed millet and one-third following cotton. This producer uses conventional tillage and plants on forth-inch centers.

System 19

	Livestock	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7	Field 8
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

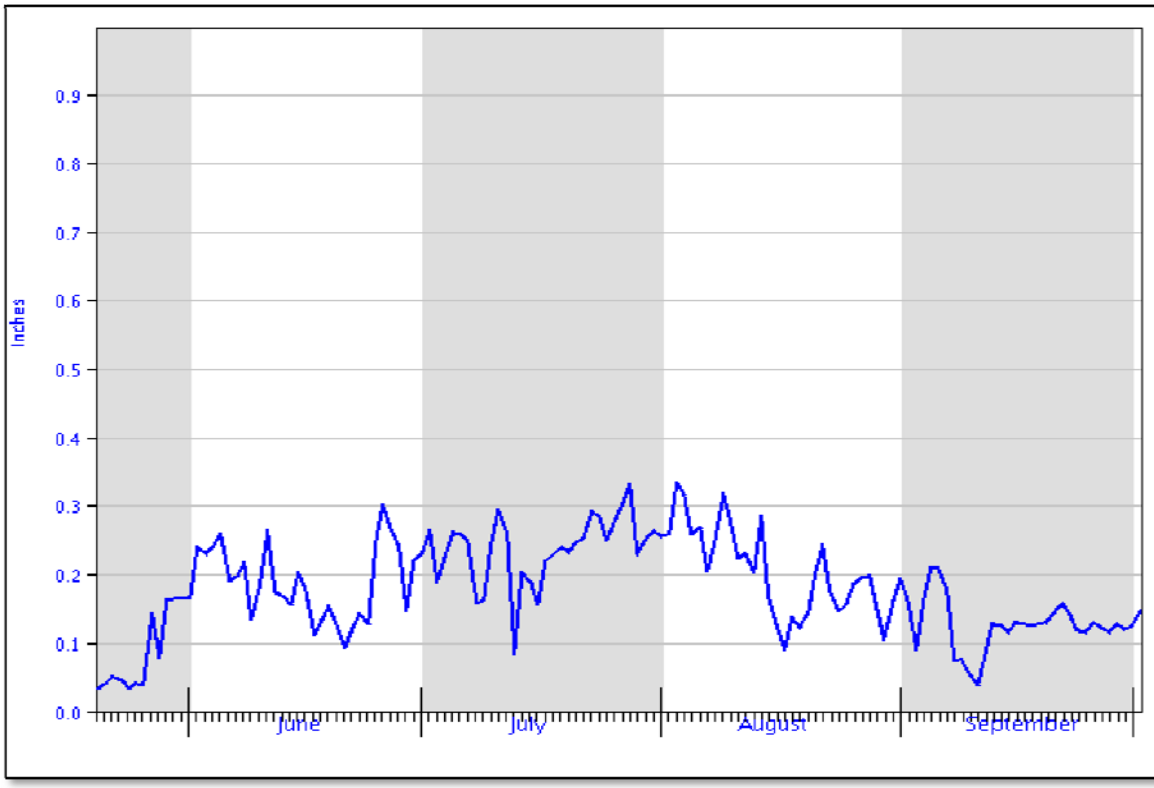
Site 19 Field 7, September 2008

Site 19 Field 8, August 2008

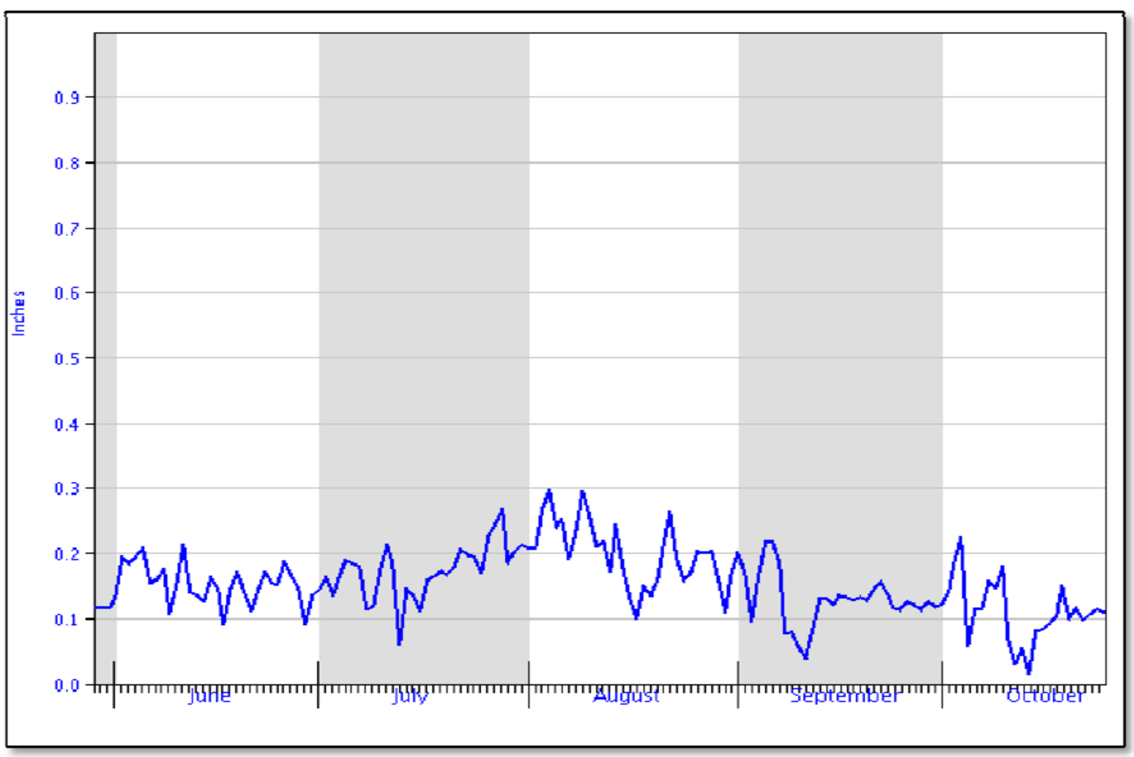


Site 19
TAWC Systems Irrigation and Gross Margin, 2005-2008
Gross margin, $
900
800
700
600
500
400
300
200
100
0
-100
0
5
10
15
20
25
30
Irrigation, inches
2005
2006
2007
2008

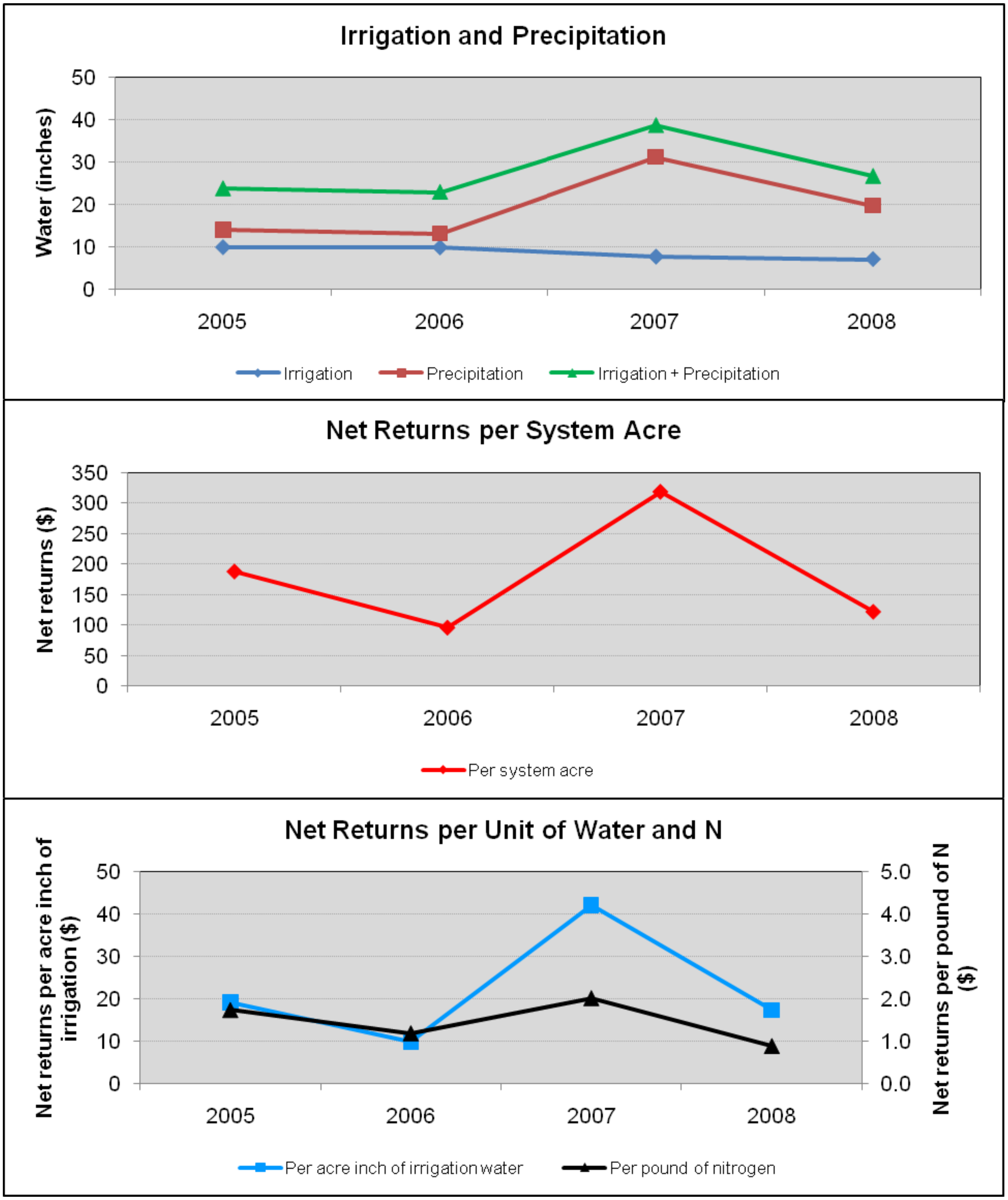
Site 19 Field 7
Cotton planted May 20 **Total ET Demand 24.18"**



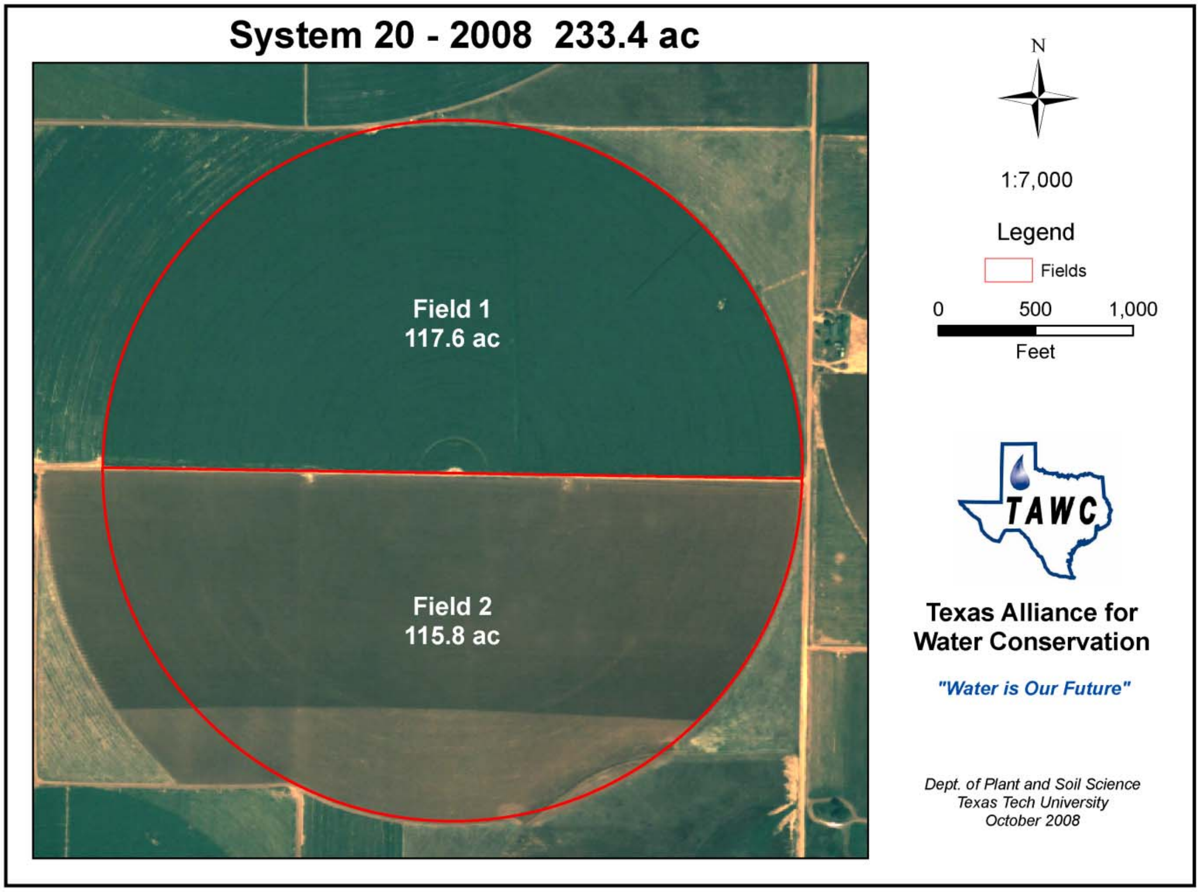
Site 19 Field 8
Millet planted May 29 **Total ET Demand 22.77"**



Site 19



Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
Irrigation
Precipitation
Irrigation + Precipitation
Net Returns per System Acre
Net returns ($)
350
300
250
200
150
100
50
0
2005
2006
2007
2008
Per system acre
Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
50
40
30
20
10
0
5.0
4.0
3.0
2.0
1.0
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
Per acre inch of irrigation water
Per pound of nitrogen



System 20 Description

Total system acres: 233.4

Field No. 1 Acres: 117.6
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 2 Acres: 115.8
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Center Pivot (LEPA)

Pumping capacity, gal/min: 1000

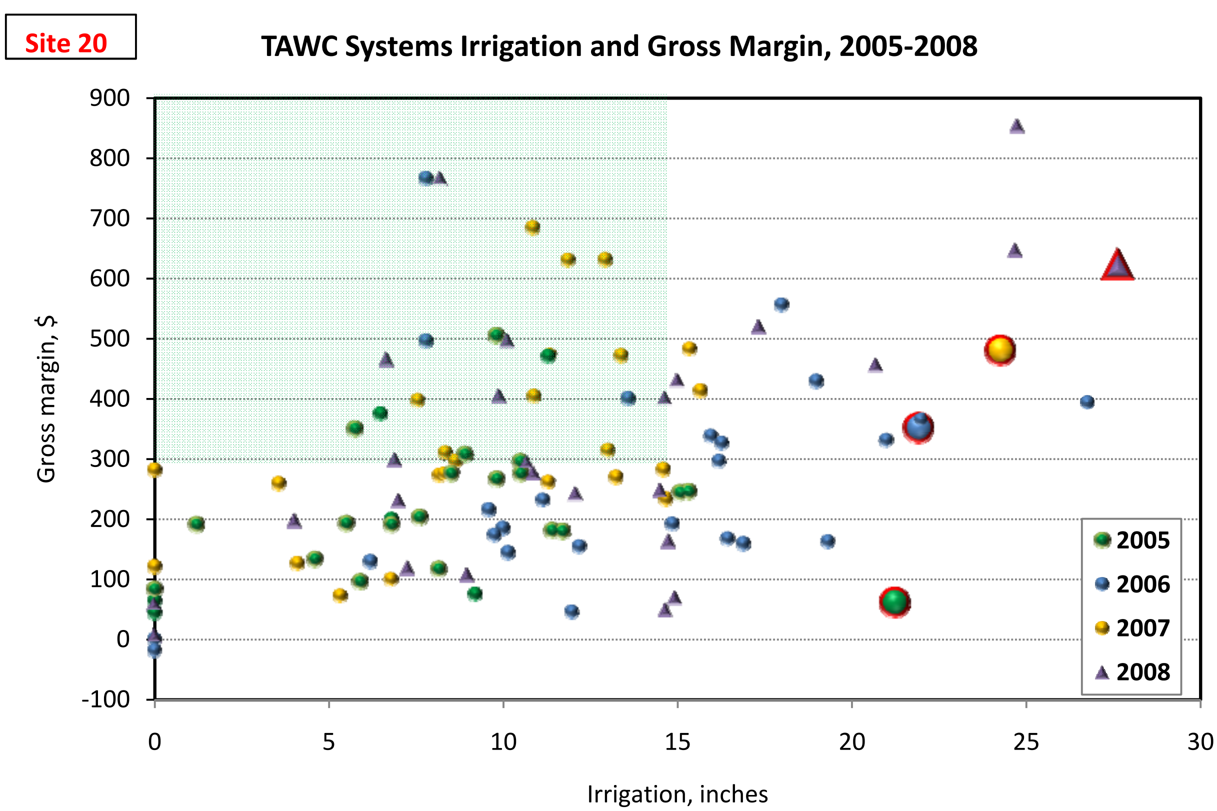
Number of wells: 3

Fuel source: Electric

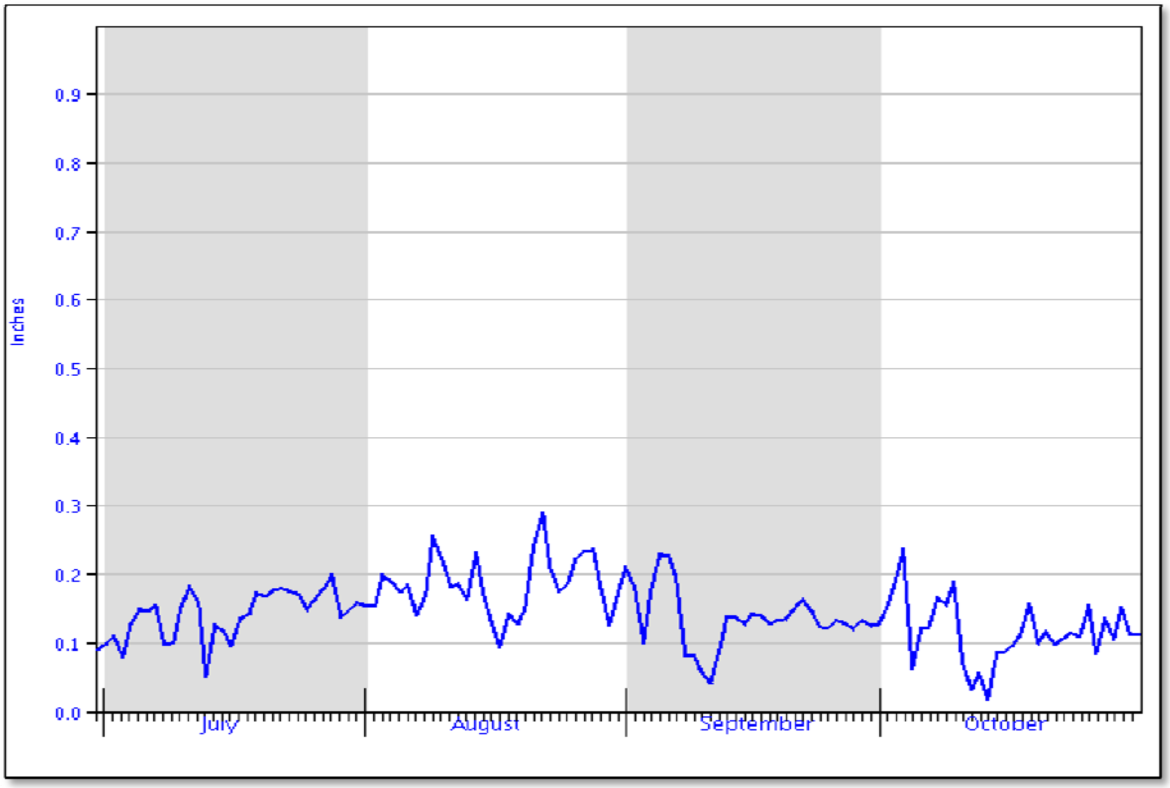
Comments: Both fields in this system were planted to wheat for grain this year. After wheat harvest both fields were planted to grain sorghum on twenty-inch centers. Field 1 was cut for silage and field 2 was harvested for grain.

System 20

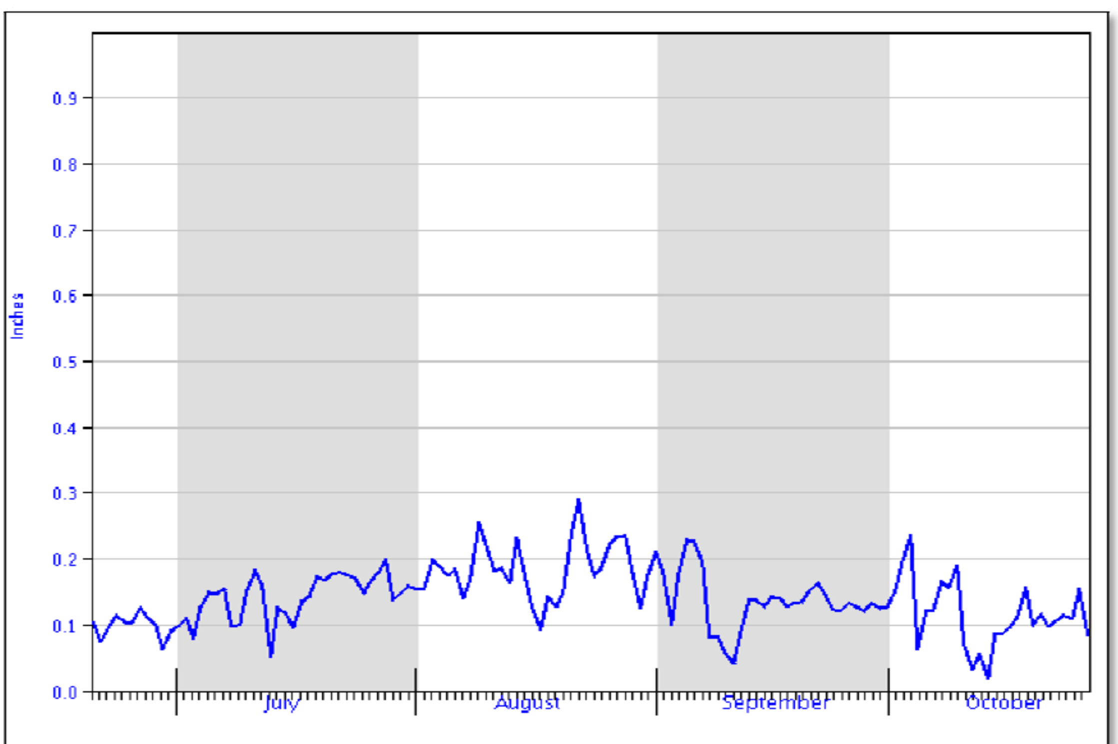
	Livestock	Field 1	Field 2
2005	None	Wheat for silage followed by Forage Sorghum for silage	Corn for silage
2006	None	Corn for silage	Triticale for silage followed by Forage Sorghum for silage
2007	None	Triticale for silage, followed by Corn for silage	Triticale for silage, followed by Forage Sorghum 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



Site 20 Field 1
Sorghum planted June 30 **Total ET Demand 17.7"**



Site 20 Field 2
Sorghum planted June 20 **Total ET Demand 18.1"**



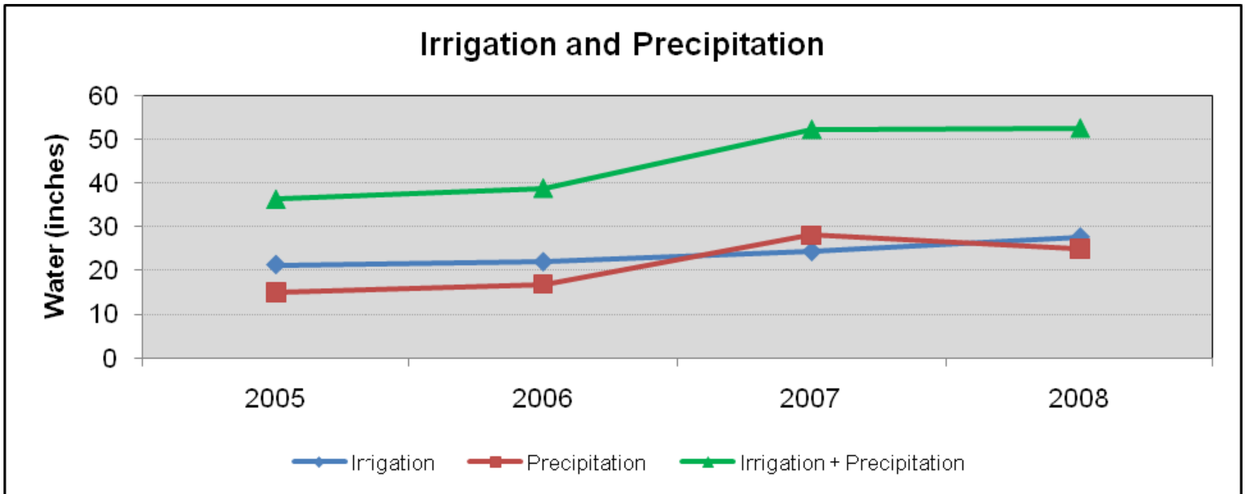

Site 20 Field 1, February 2008

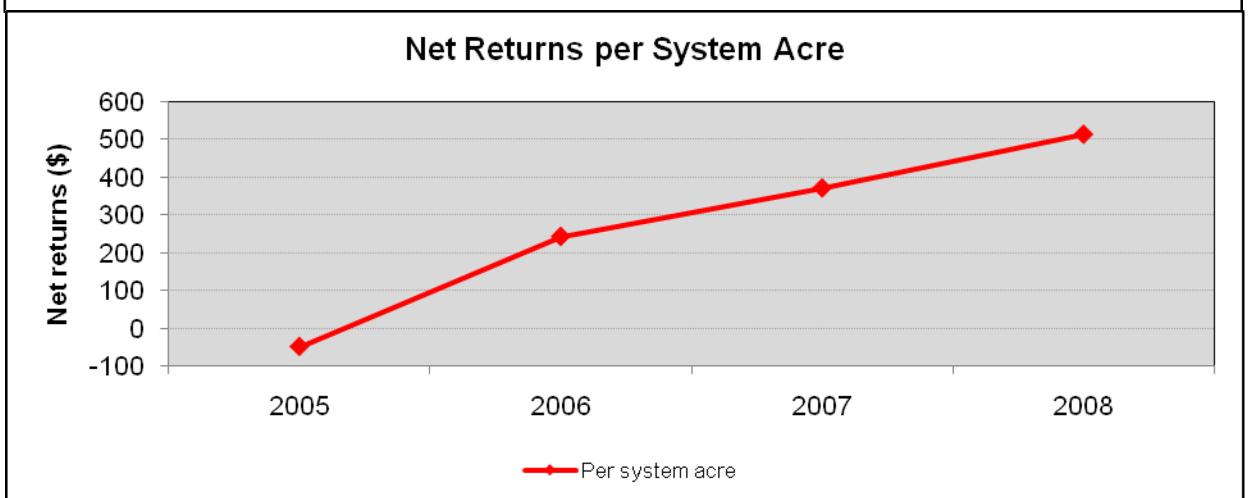

Site 20 Field 1, June 2008

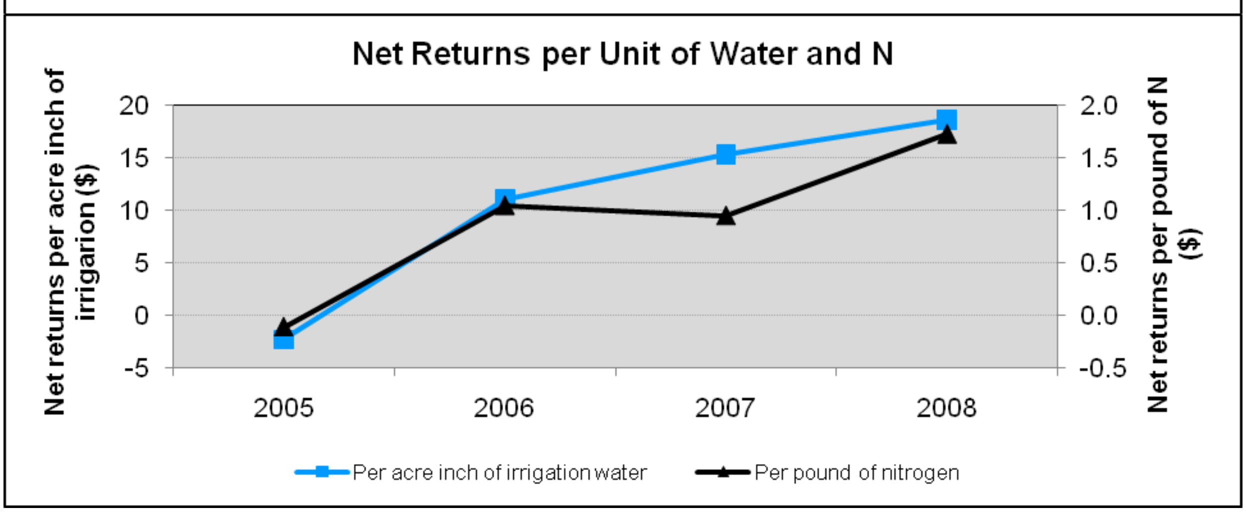

Site 20 Field 1, July 2008

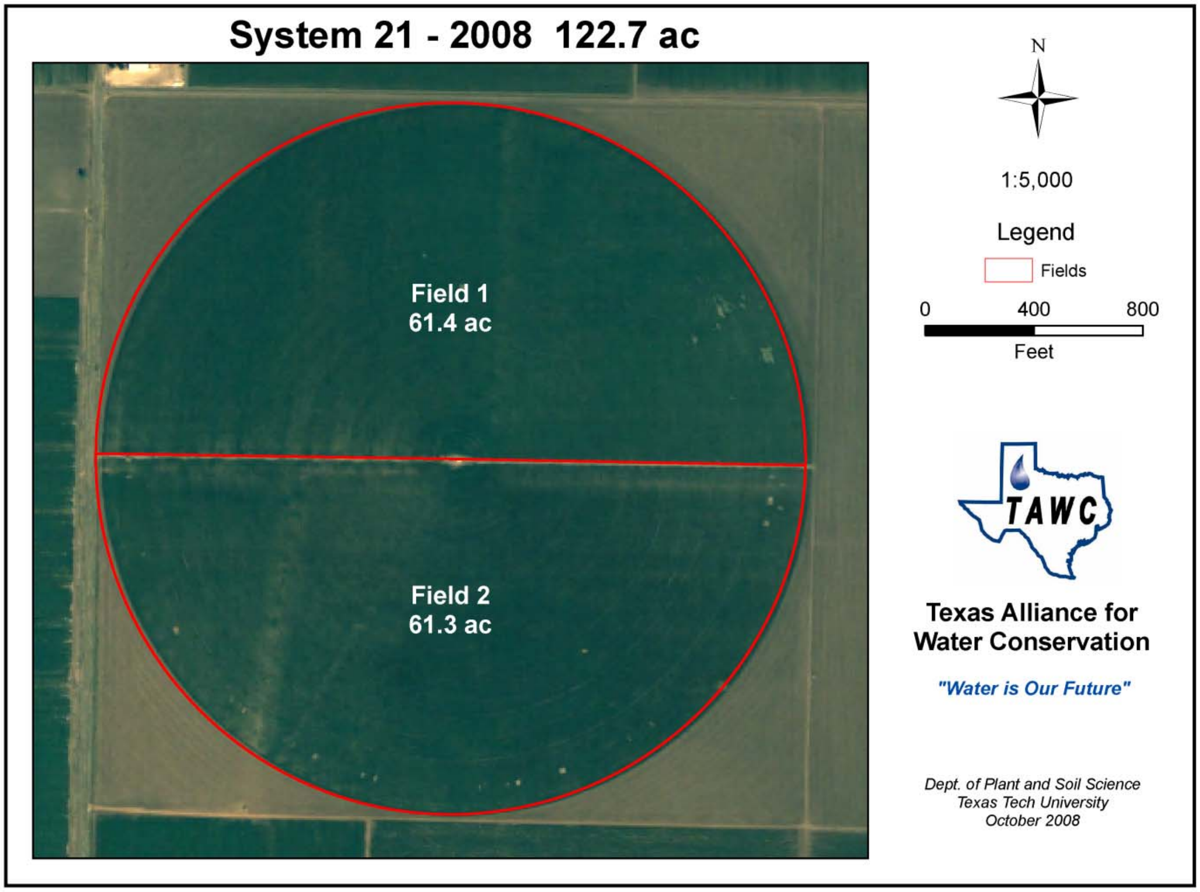

Site 20 Field 2, October 2008

Site 20


Irrigation and Precipitation
Water (inches)
60
50
40
30
20
10
0
2005
2006
2007
2008
Irrigation
Precipitation
Irrigation + Precipitation


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


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



System 21 Description

Total system acres: 122.7

Field No. 1 Acres: 61.4
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 2 Acres: 61.3
Major soil type: Pullman clay loam

Irrigation

Type: Center Pivot (LEPA)

Pumping capacity, gal/min: 500

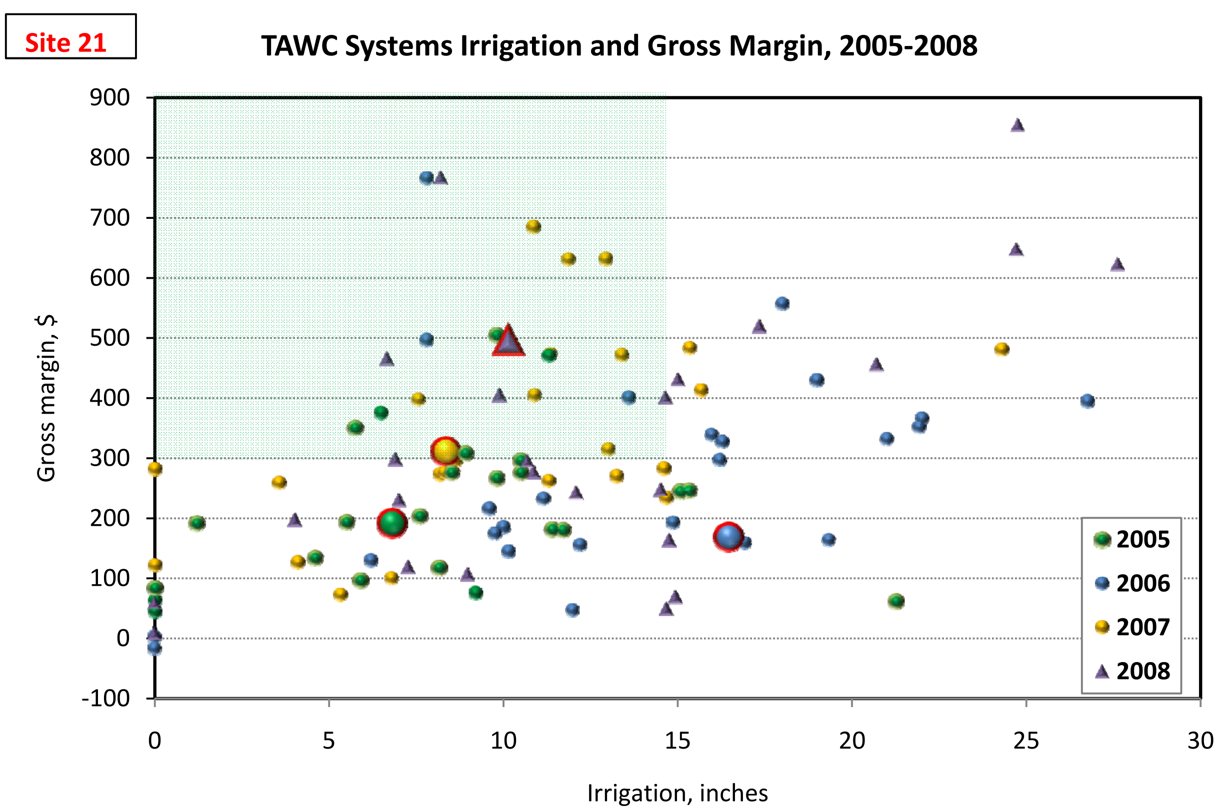
Number of wells: 1

Fuel source: Electric

Comments: This is a pivot irrigated site with one-half planted to side-oats grama harvested for seed with the grass residue baled and sold. In 2008 the other half was planted to barley for seed production then double cropped to forage sorghum for hay production.

System 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

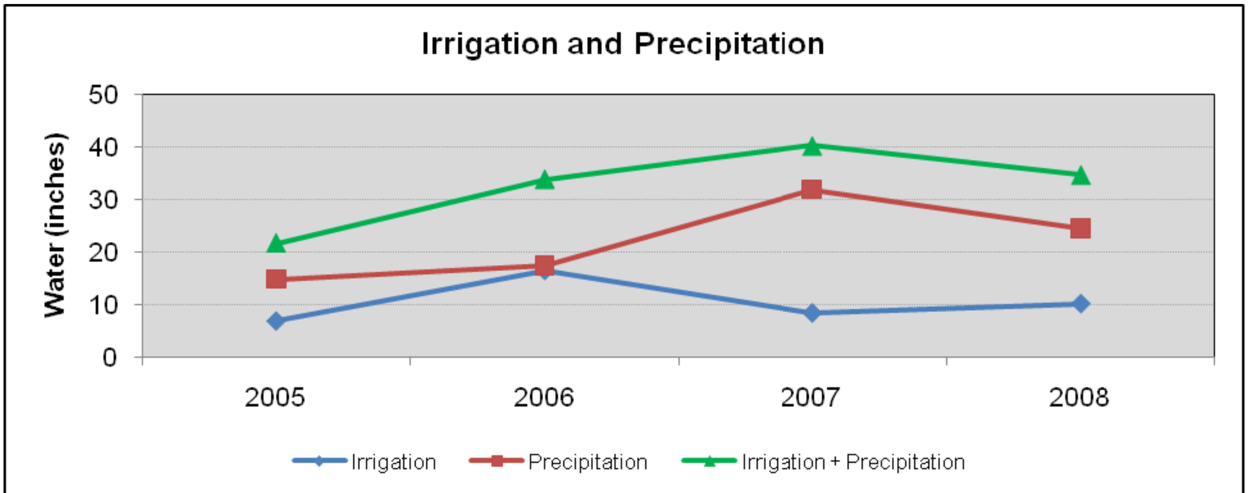


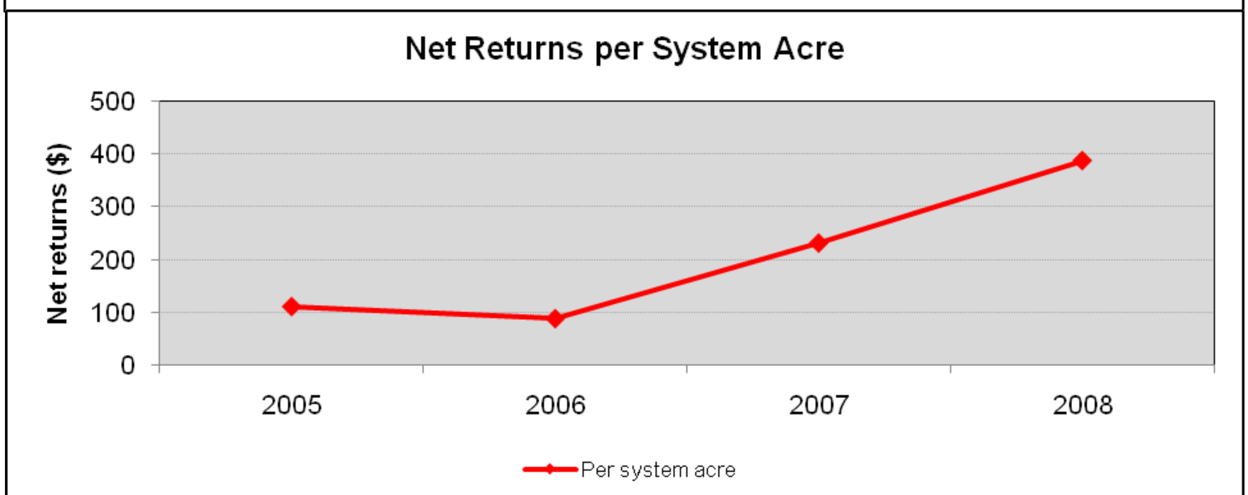
Site 21 Field 1, September 2008

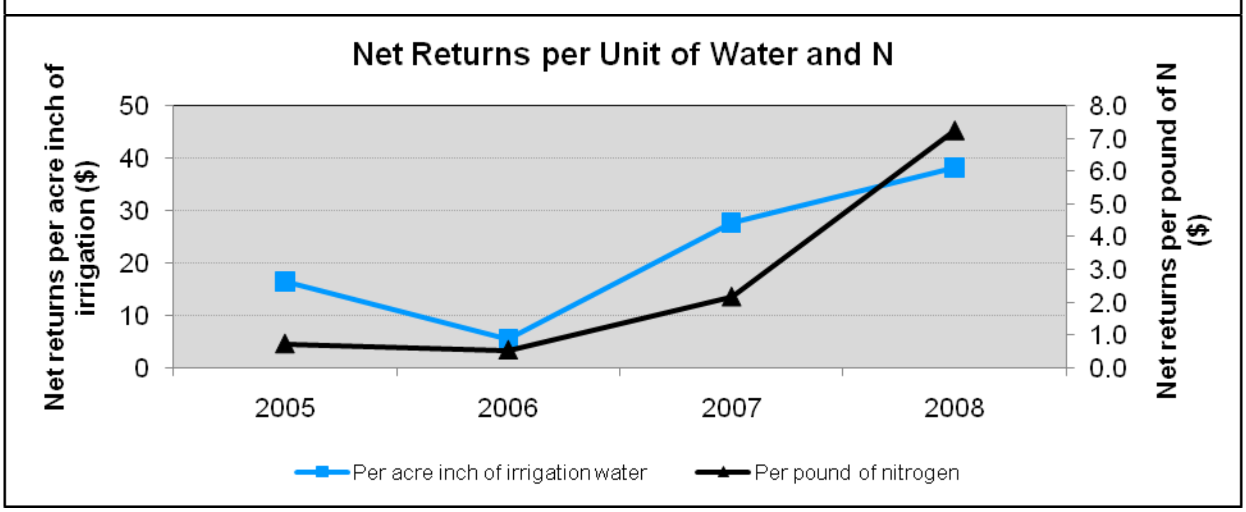
Site 21 Field 2, April 2008

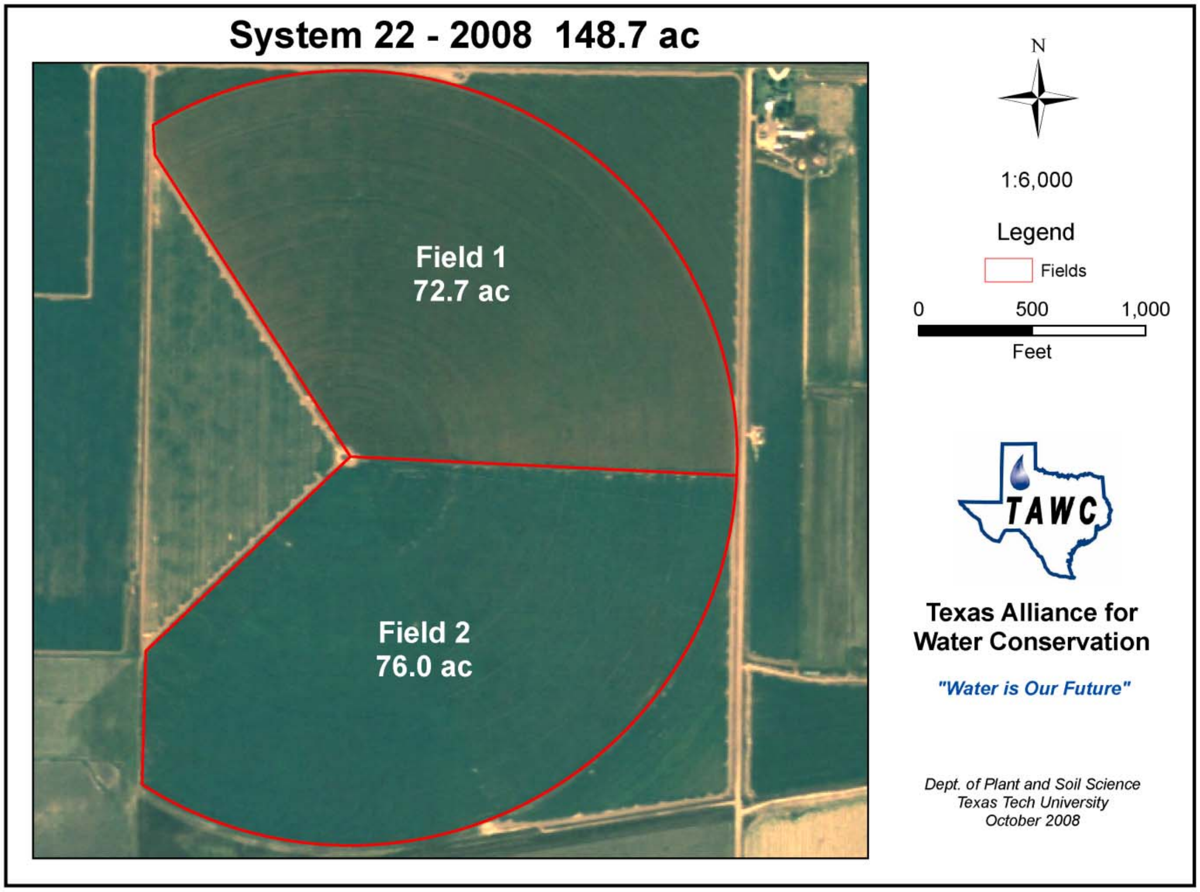
Site 21 Field 2, July 2008

Site 21


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


Net Returns per System Acre
Net returns ($)
0
100
200
300
400
500
2005
2006
2007
2008
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
6.0
7.0
8.0
2005
2006
2007
2008
Per acre inch of irrigation water
Per pound of nitrogen



System 22 Description

Total system acres: 148.7

Field No. 1 Acres: 72.7
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 2 Acres: 76.0
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Center Pivot (LEPA)

Pumping capacity, gal/min: 800

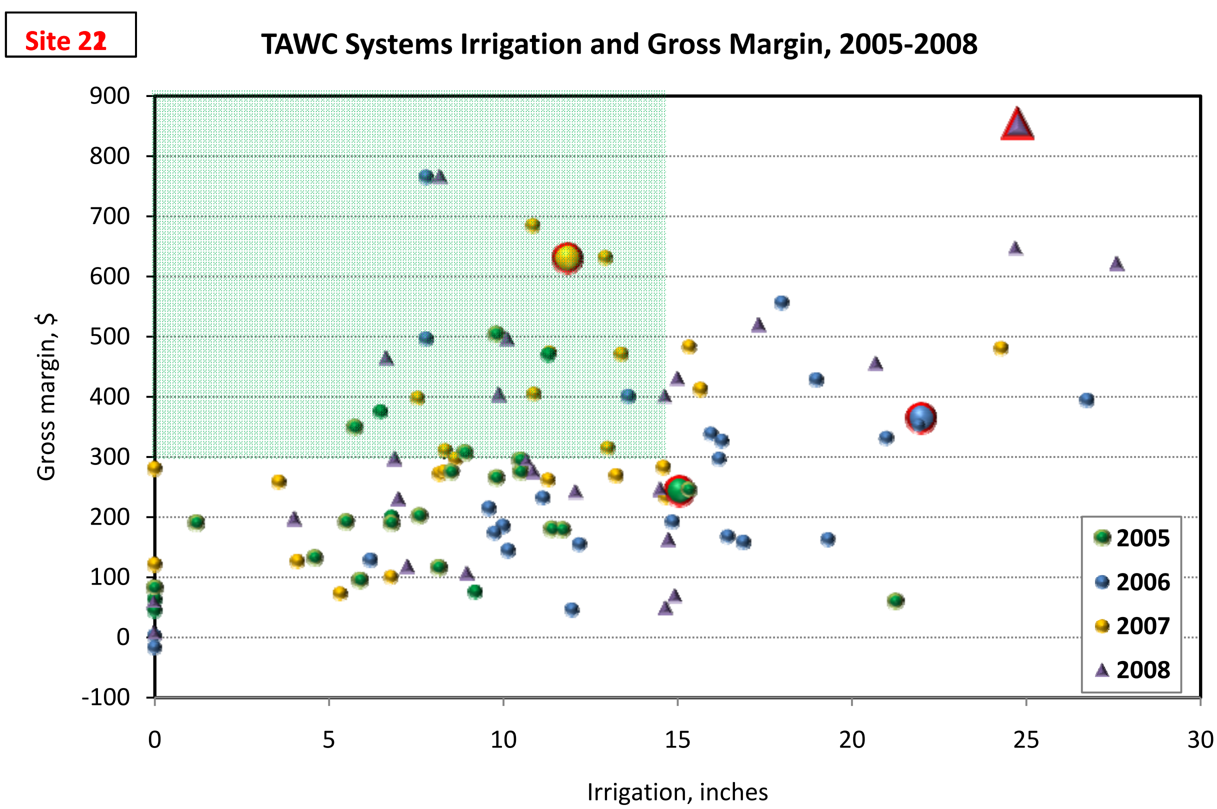
Number of wells: 4

Fuel source: Electric

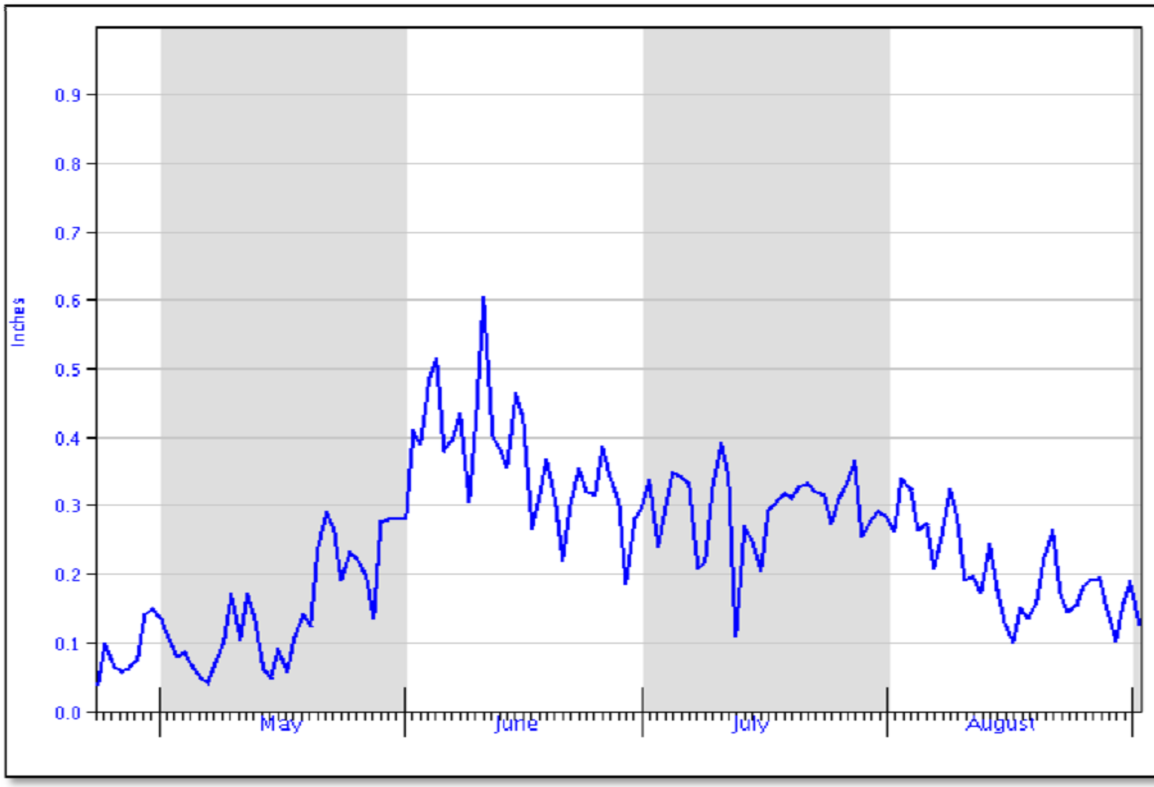
Comments: This is a pivot irrigated corn and cotton system. In 2008 both fields were planted to corn with conventional tillage. In 2007 both fields were planted to cotton on thirty-inch centers.

System 22

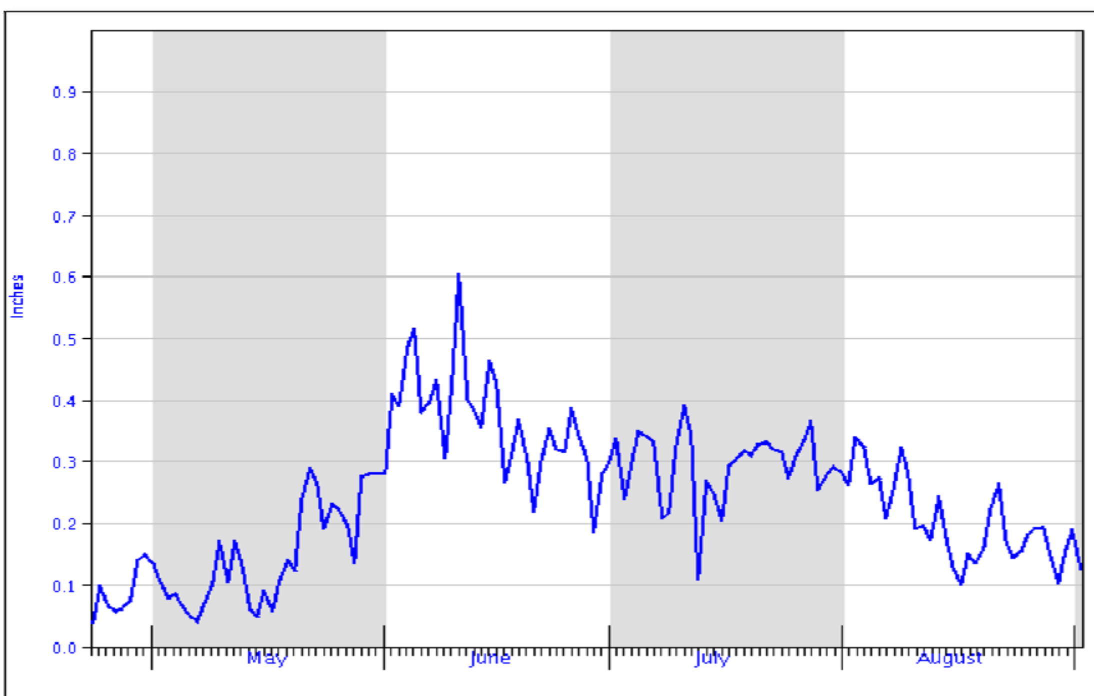
	Livestock	Field 1	Field 2
2005	None	Corn for grain	Cotton
2006	None	Cotton	Corn for grain
2007	None	Cotton following Wheat cover crop	Cotton
2008	None	Corn for grain	Corn for grain



Site 22 Field 1
Corn planted April 23 **Total ET Demand 31.72"**



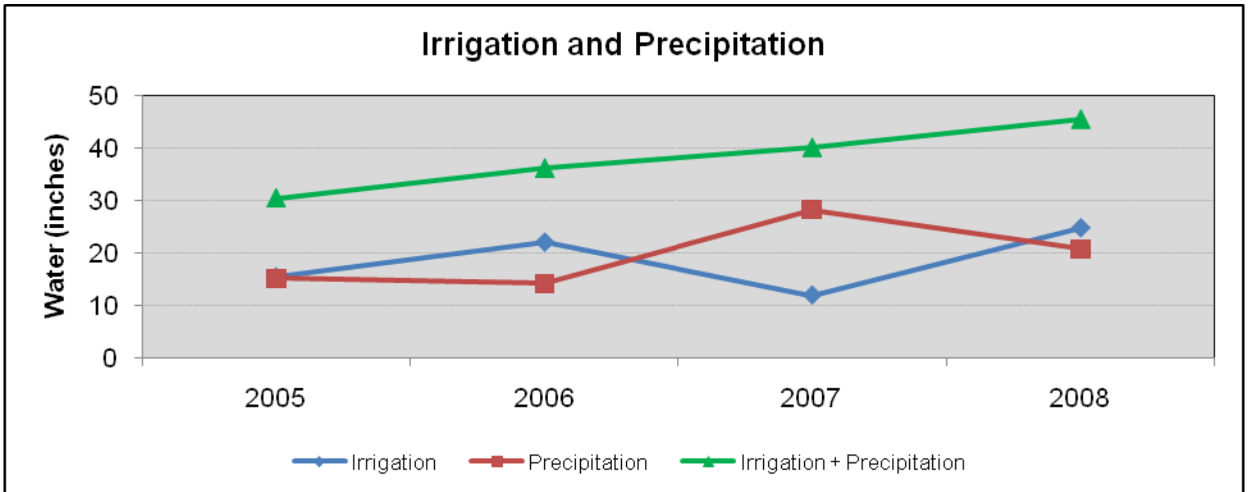
Site 22 Field 2
Corn planted April 23 **Total ET Demand 31.72"**

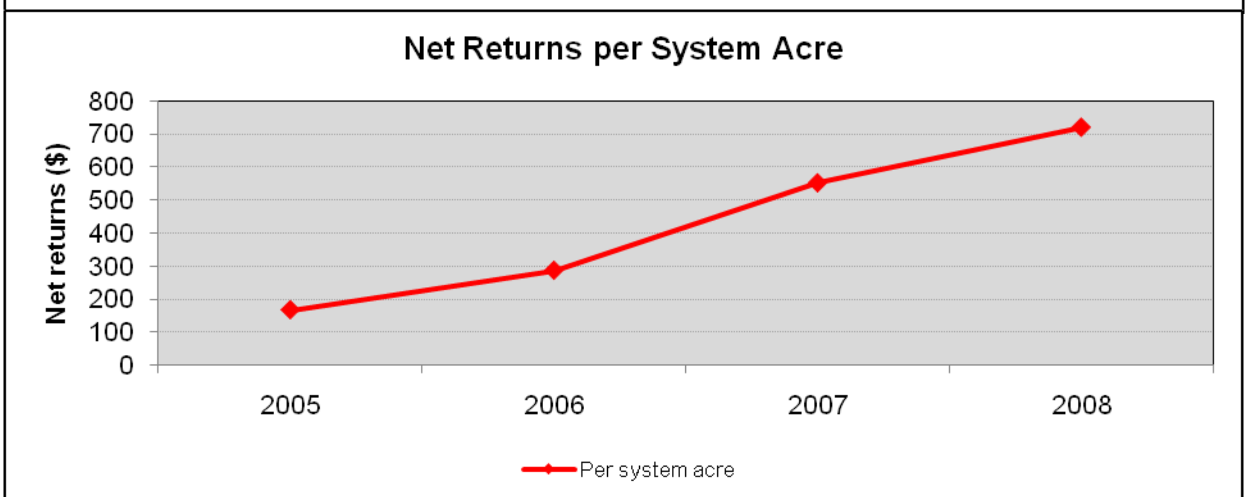


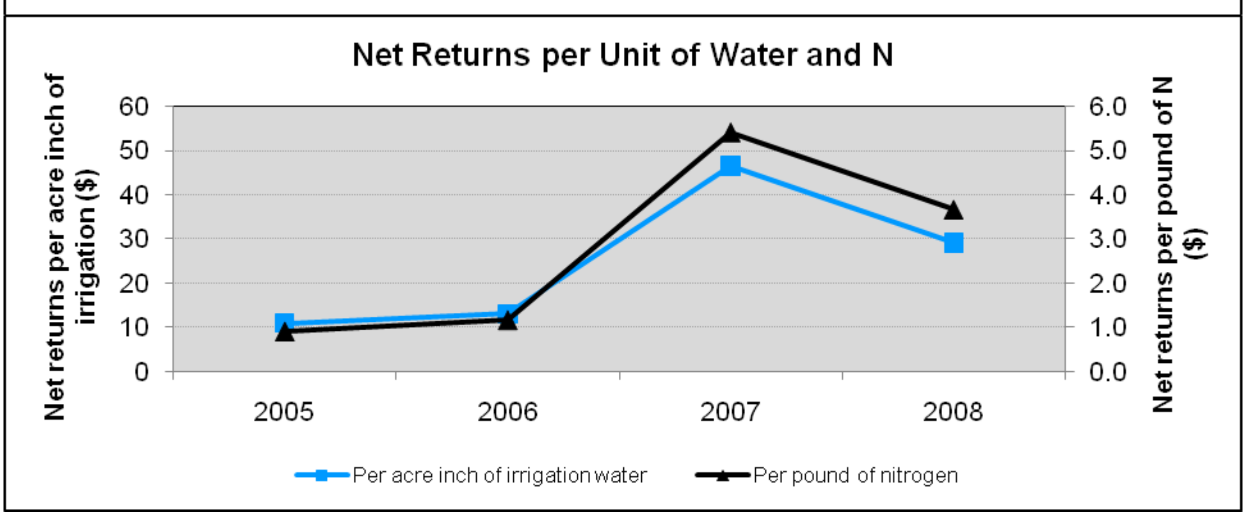
Site 22 Field 1, September 2008

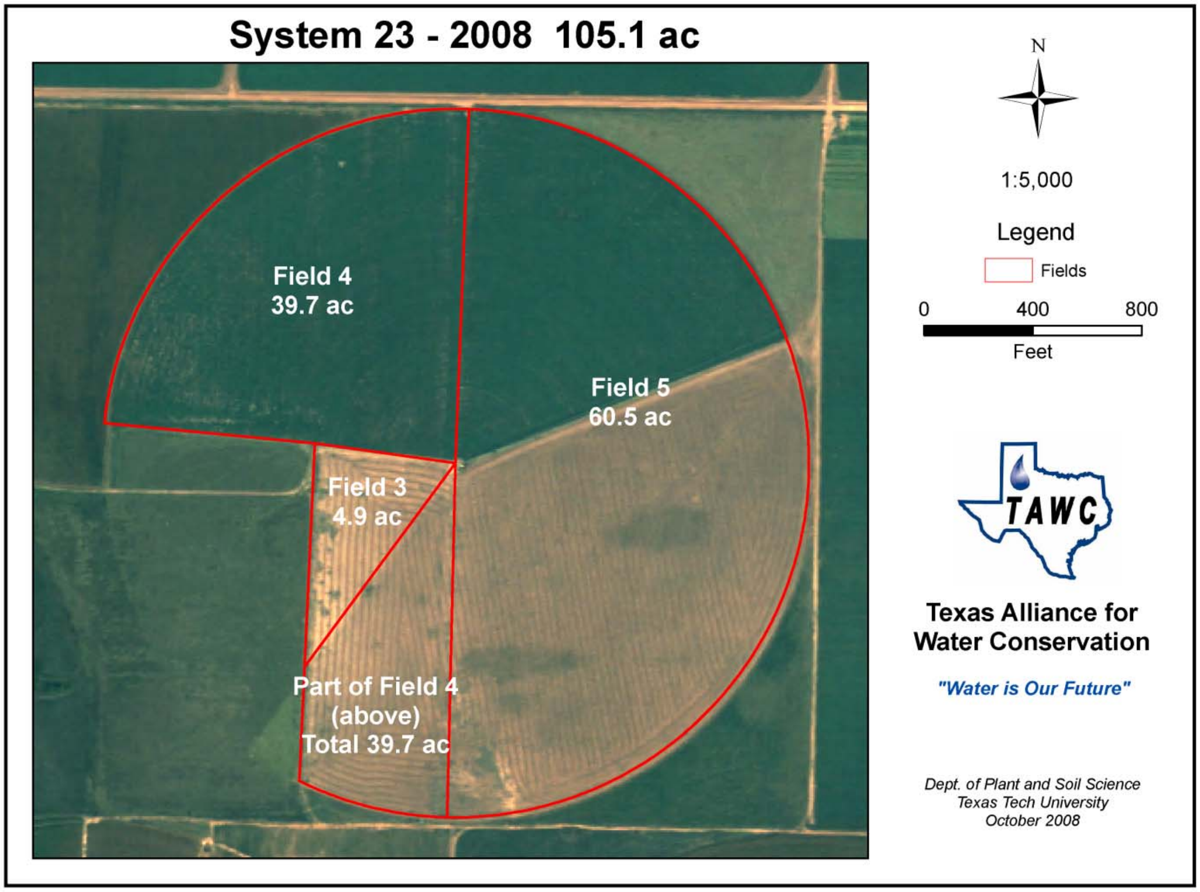
Site 22 Field 2, September 2008

Site 22


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


Net Returns per System Acre
Net returns ($)
0
100
200
300
400
500
600
700
800
2005
2006
2007
2008
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
Per acre inch of irrigation water
Per pound of nitrogen



System 23 Description

Total system acres: 105.1

Field No. 3 Acres: 4.9
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 4 Acres: 39.7
Major soil type: Pullman clay loam; 0 to 1% slope

Field No. 5 Acres: 60.5
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Center Pivot (LESA)

Pumping capacity, gal/min: 800

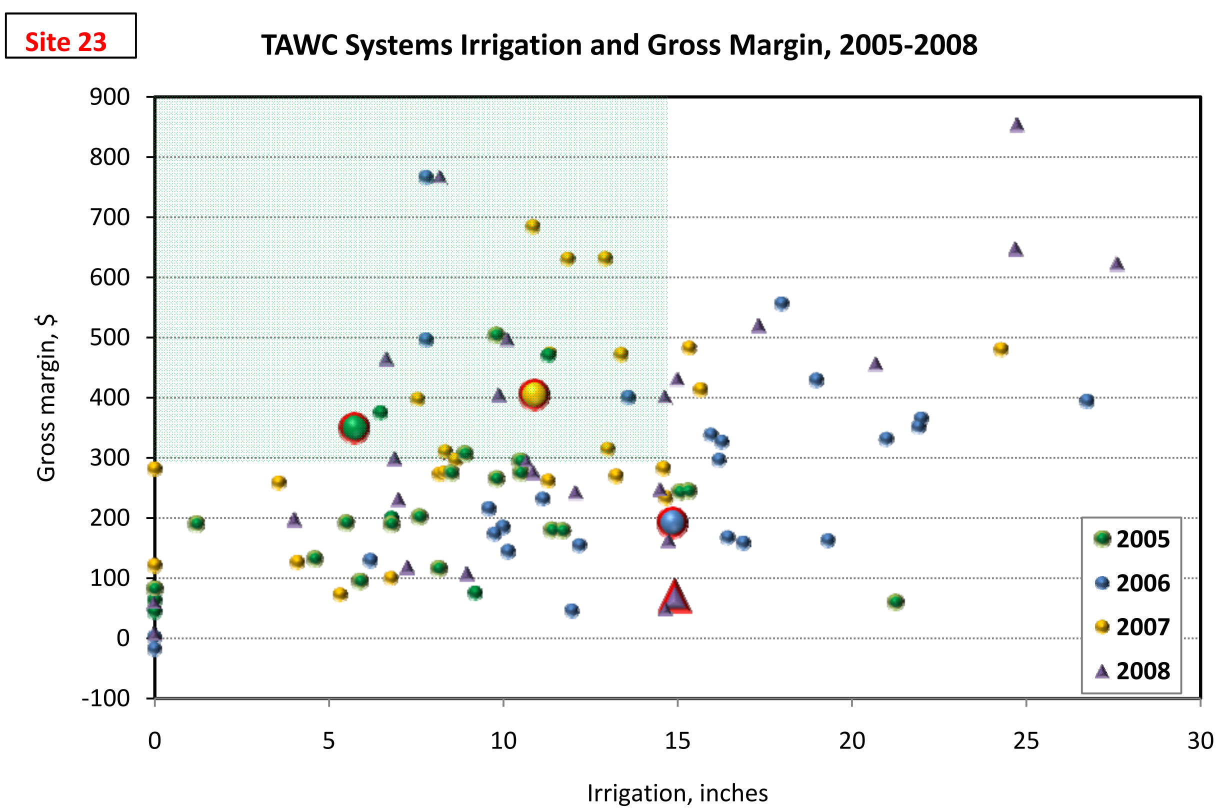
Number of wells: 2

Fuel source: Natural gas

Comments: This pivot irrigated site has been a corn/cotton system in the past. In 2008 sunflowers were planted followed by wheat in the fall the balance of the pivot was planted to cotton on thirty-inch centers.

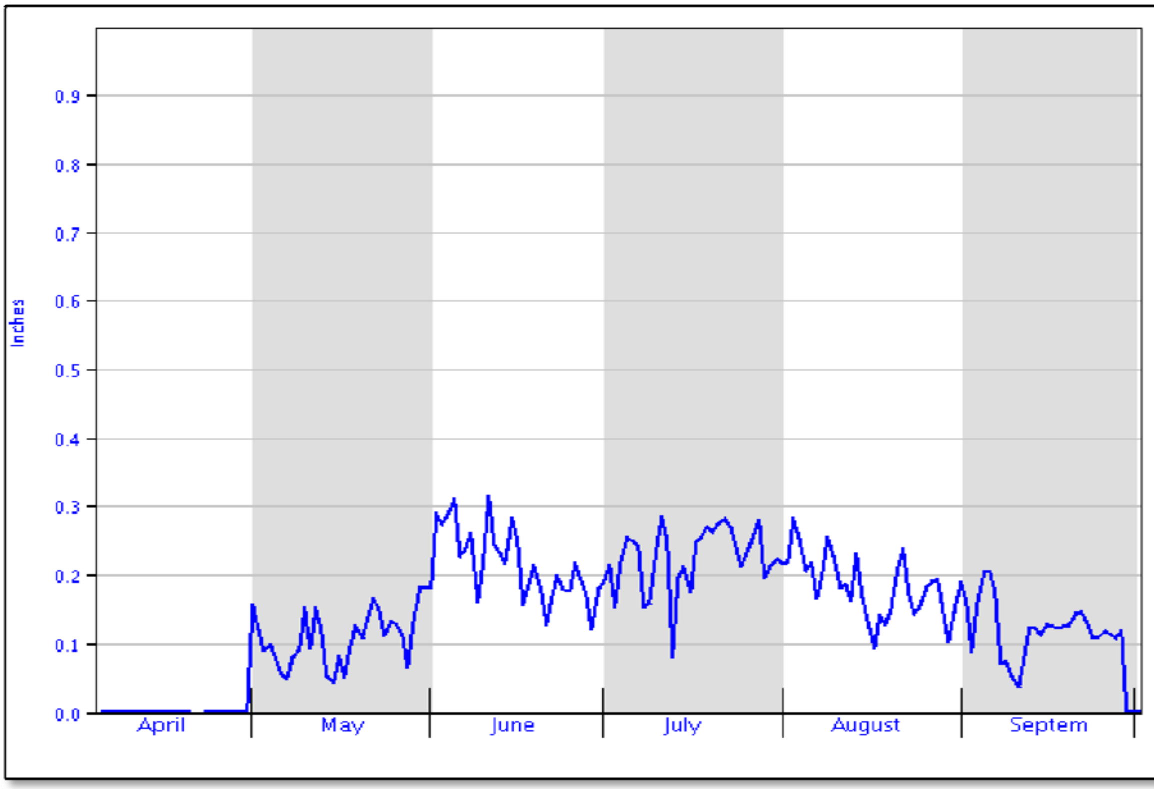
System 23

	Livestock	Field 1	Field 2	Field 3	Field 4	Field 5
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



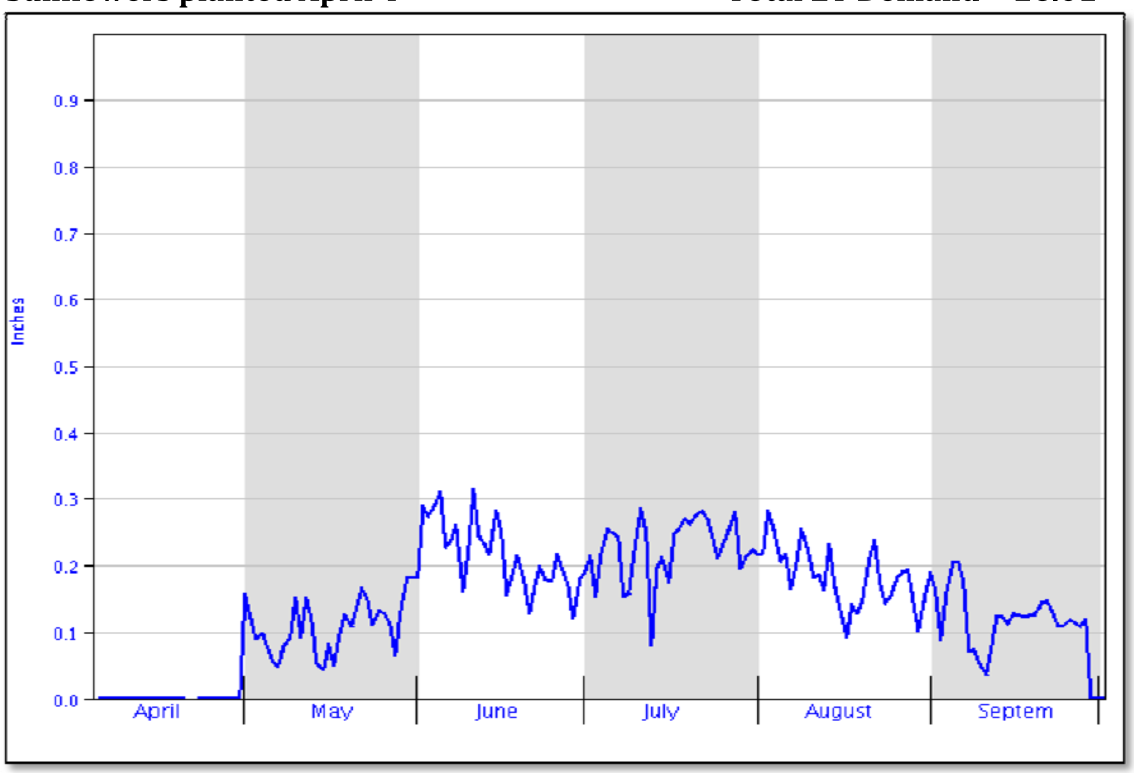
Site 23 Field 3

Sunflowers planted April 4 **Total ET Demand 26.01"**

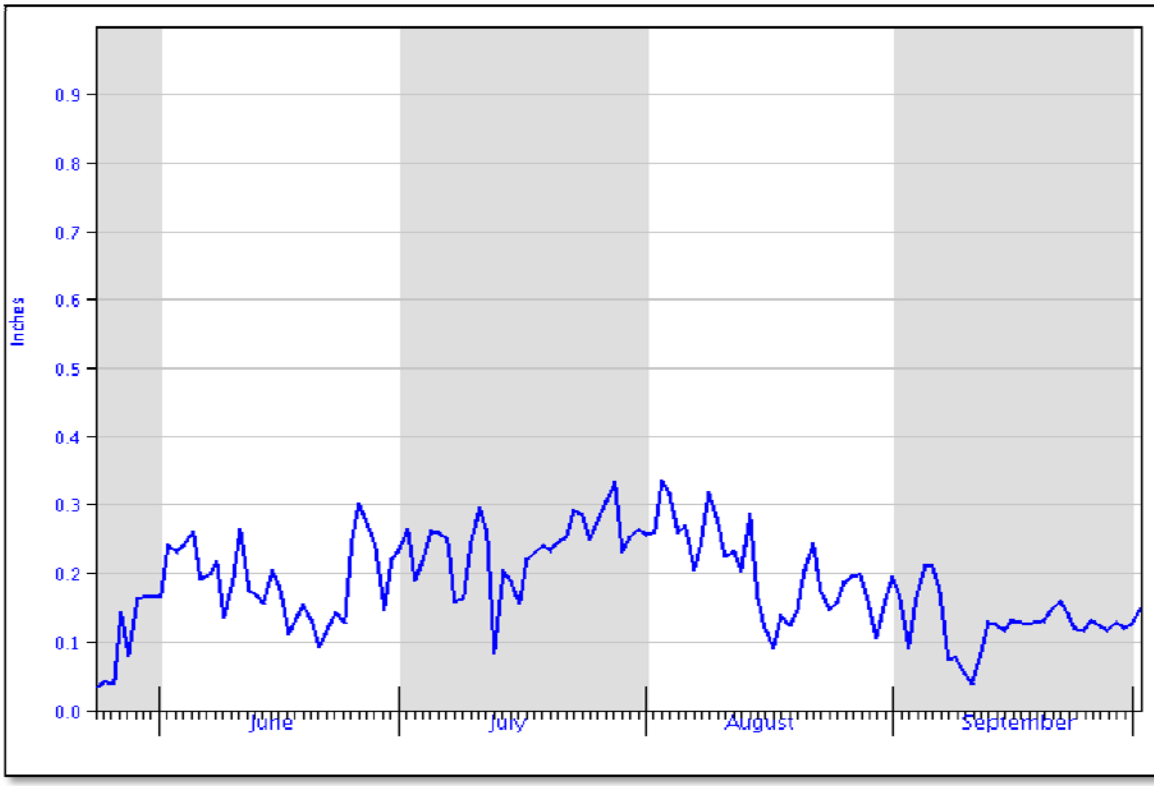


Site 23 Field 4

Sunflowers planted April 4 **Total ET Demand 26.01"**



Site 23 Field 5
Cotton planted May 24 **Total ET Demand 25.62”**

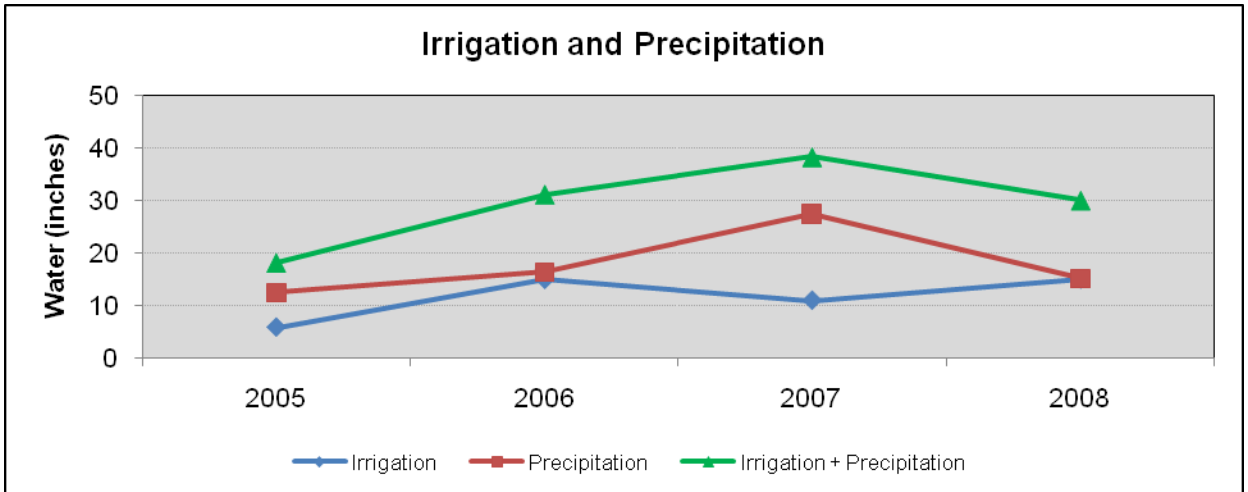


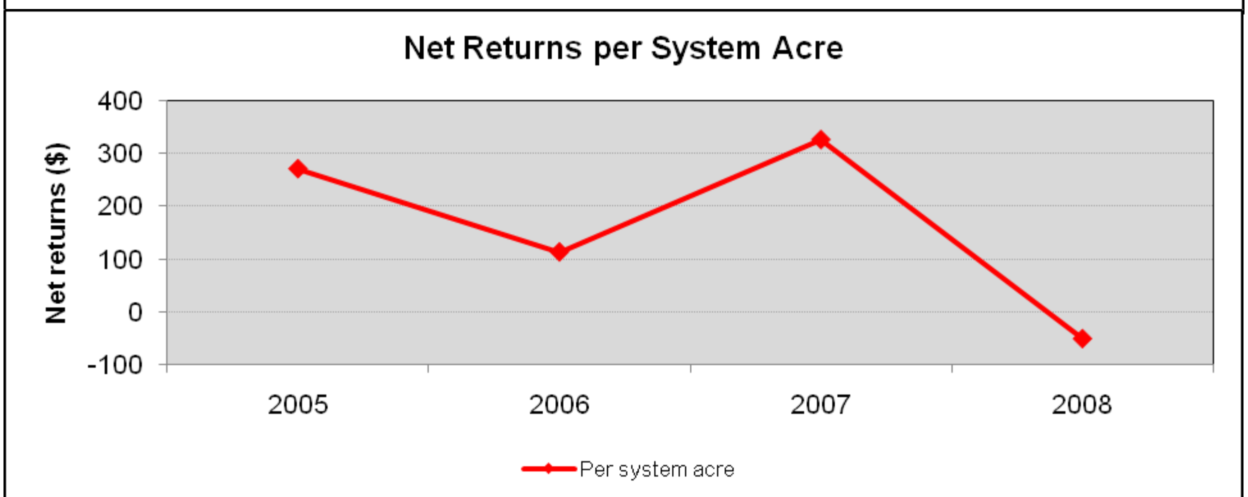
Site 23 Field 3, June 2008

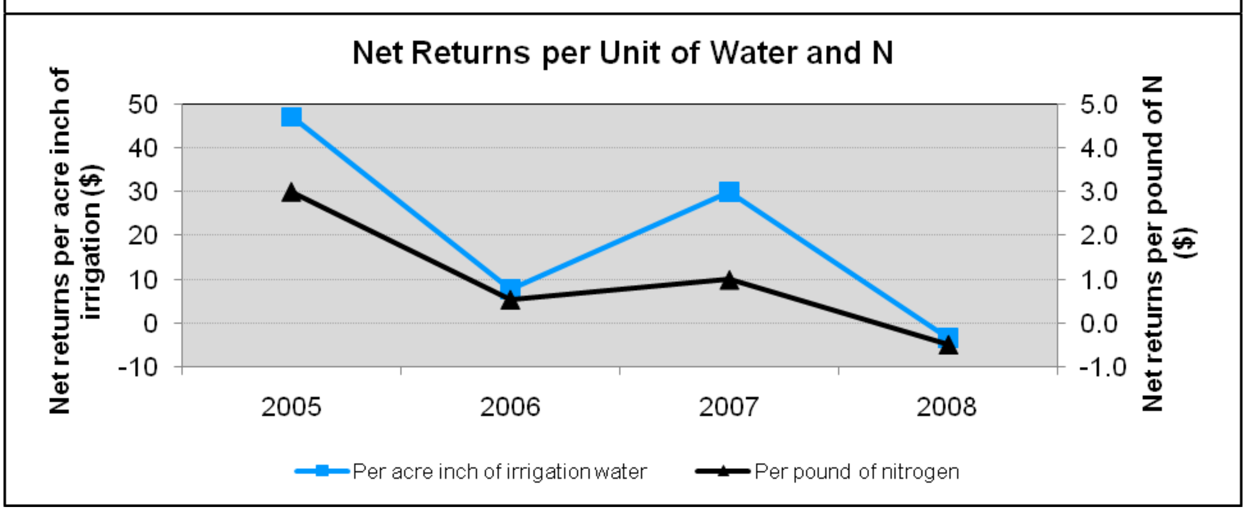
Site 23 Field 4, June 2008

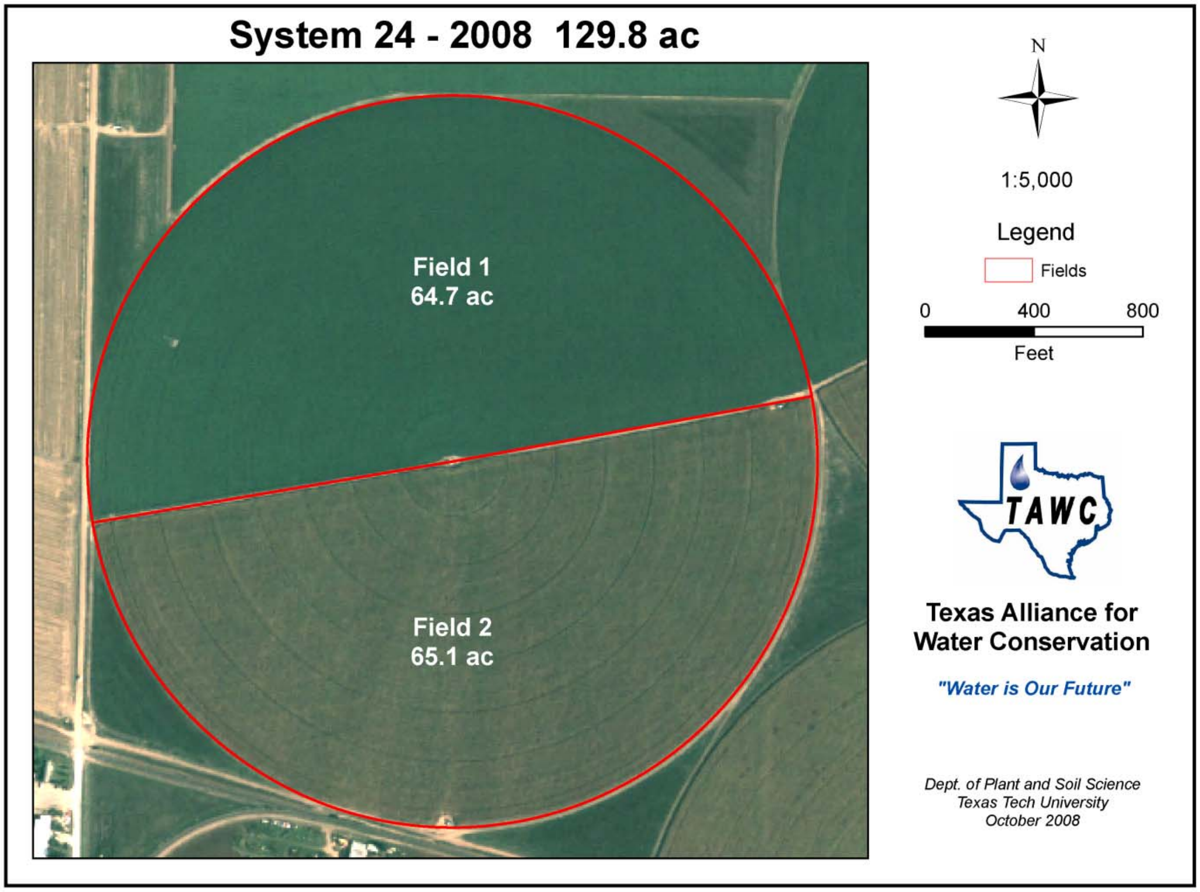
Site 23 Field 5, November 2008

Site 23


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


Net Returns per System Acre
Net returns ($)
400
300
200
100
0
-100
2005
2006
2007
2008
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
2005
2006
2007
2008
Per acre inch of irrigation water
Per pound of nitrogen



System 24 Description

Total system acres: 129.8

Field No. 1 Acres: 64.7
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

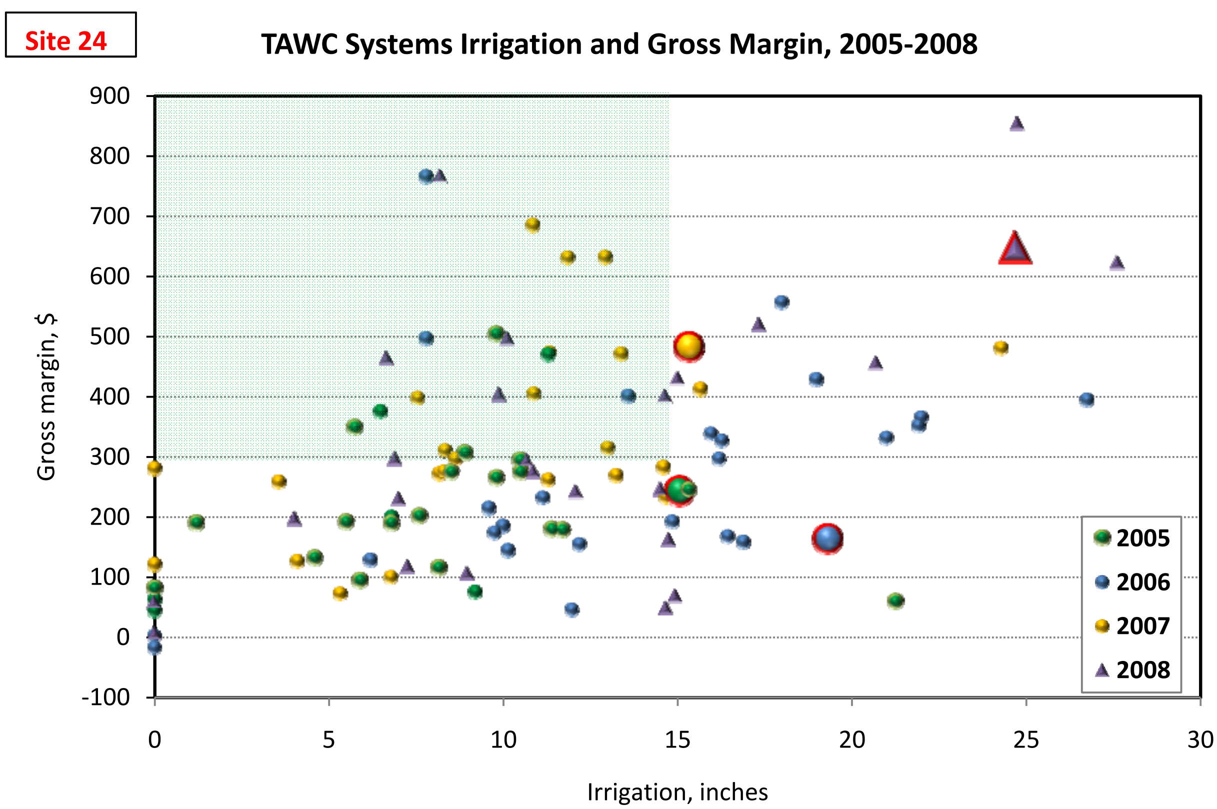
Number of wells: 1

Fuel source: Diesel

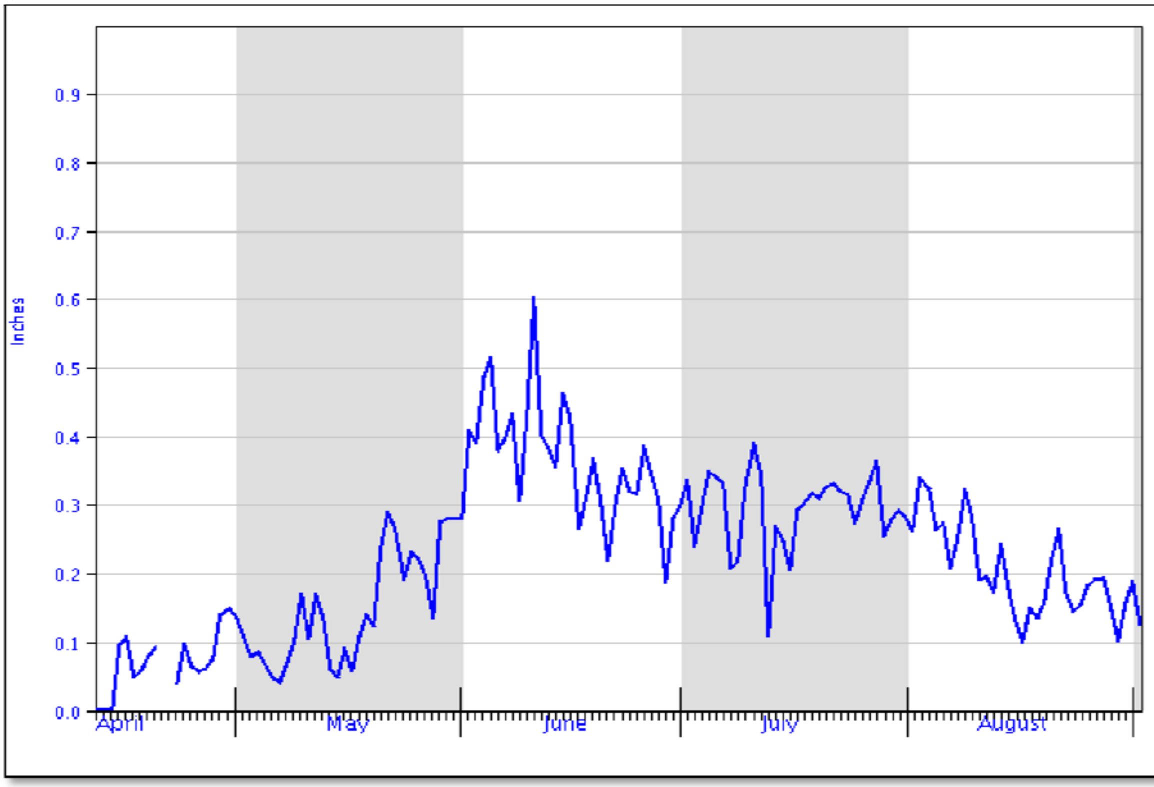
Comments: This has been a corn/cotton pivot irrigated system using conventional tillage. In 2007 and 2008 both fields were planted to white food corn on twenty-inch centers.

System 24

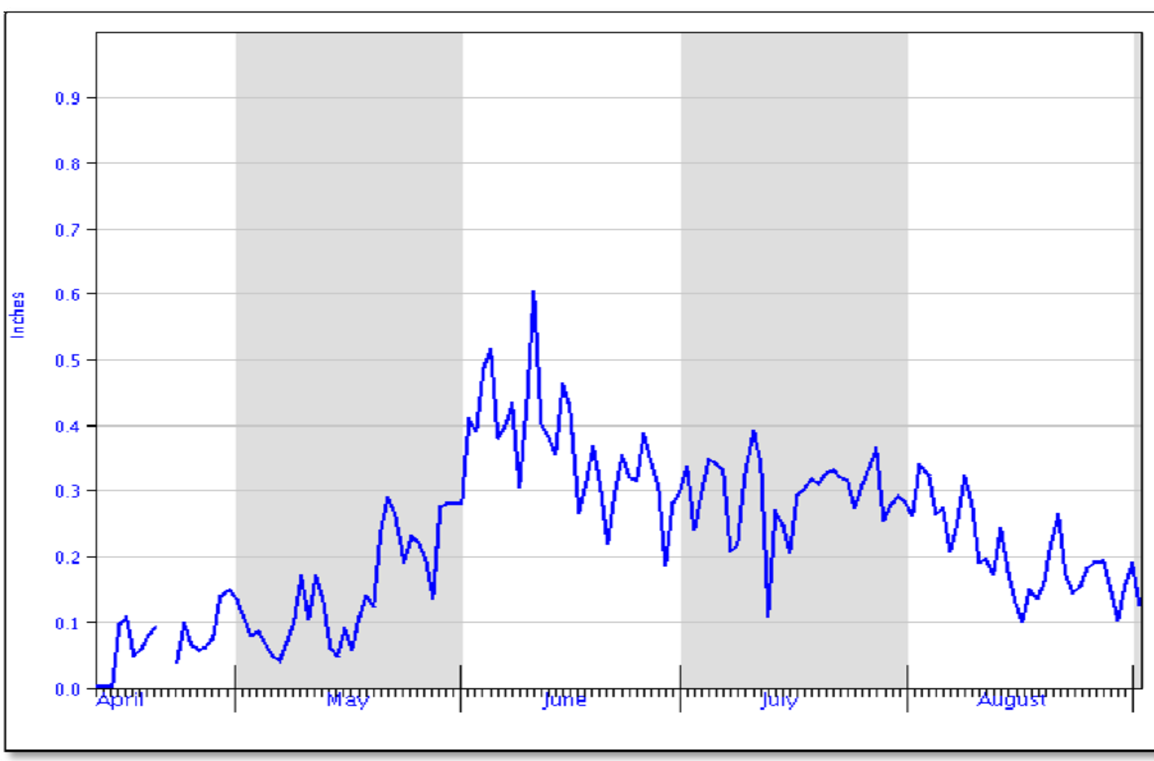
	Livestock	Field 1	Field 2
2005	None	Cotton	Corn for grain
2006	None	Corn for grain	Cotton
2007	None	Corn for grain	Corn for grain
2008	None	Corn for grain	Corn for grain



Site 24 Field 1
Corn planted April 12 **Total ET Demand 32.19"**



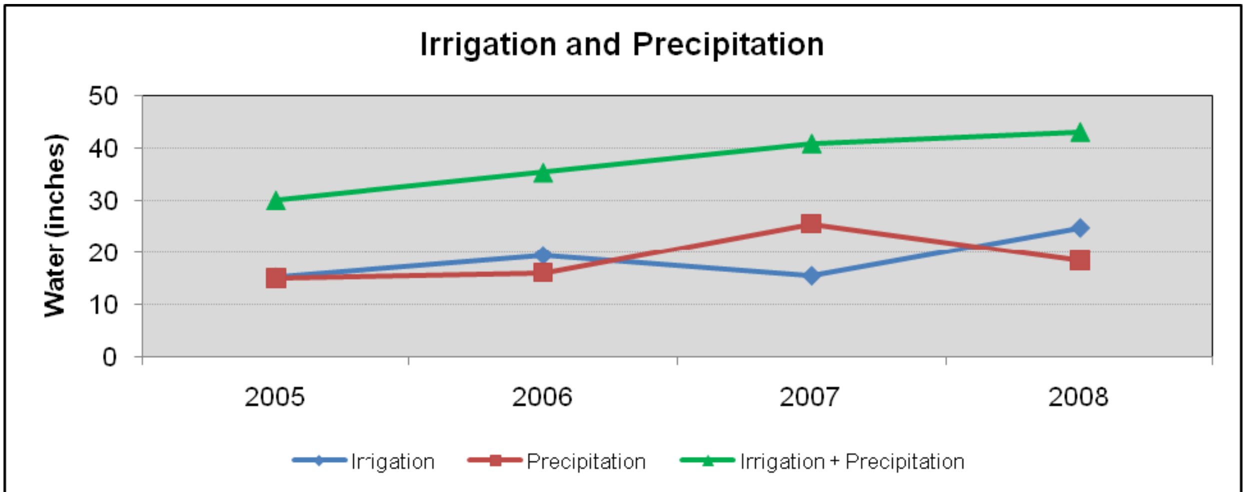
Site 24 Field 2
Corn planted April 12 **Total ET Demand 32.19"**

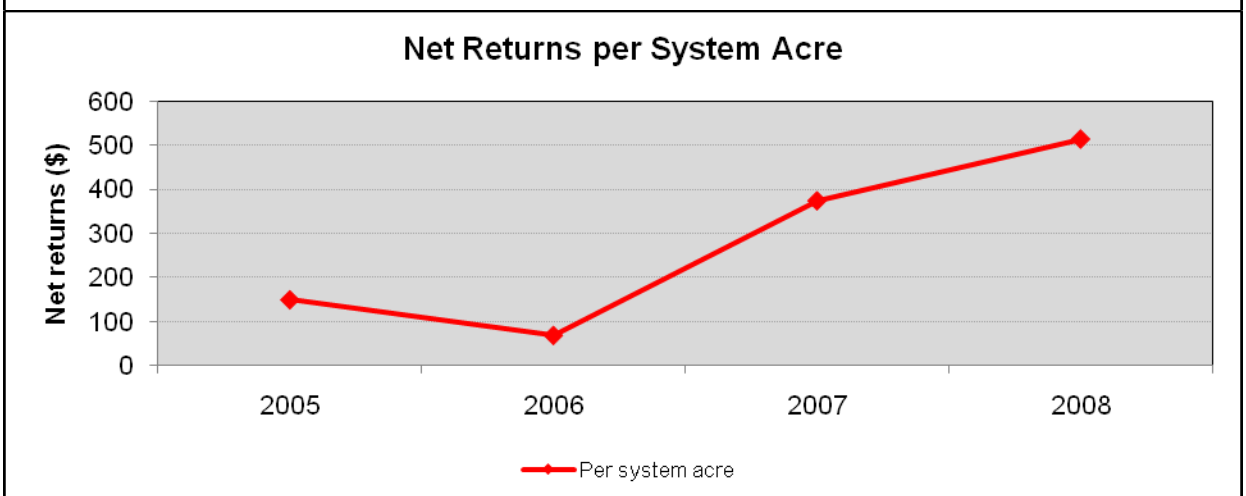


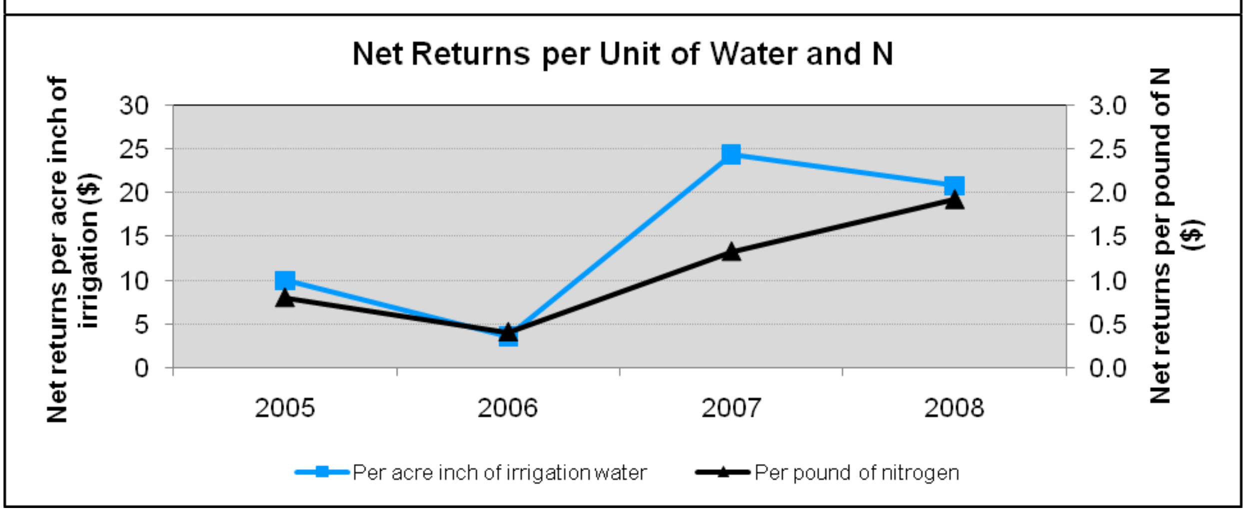

Site 24 Field 1, September 2008

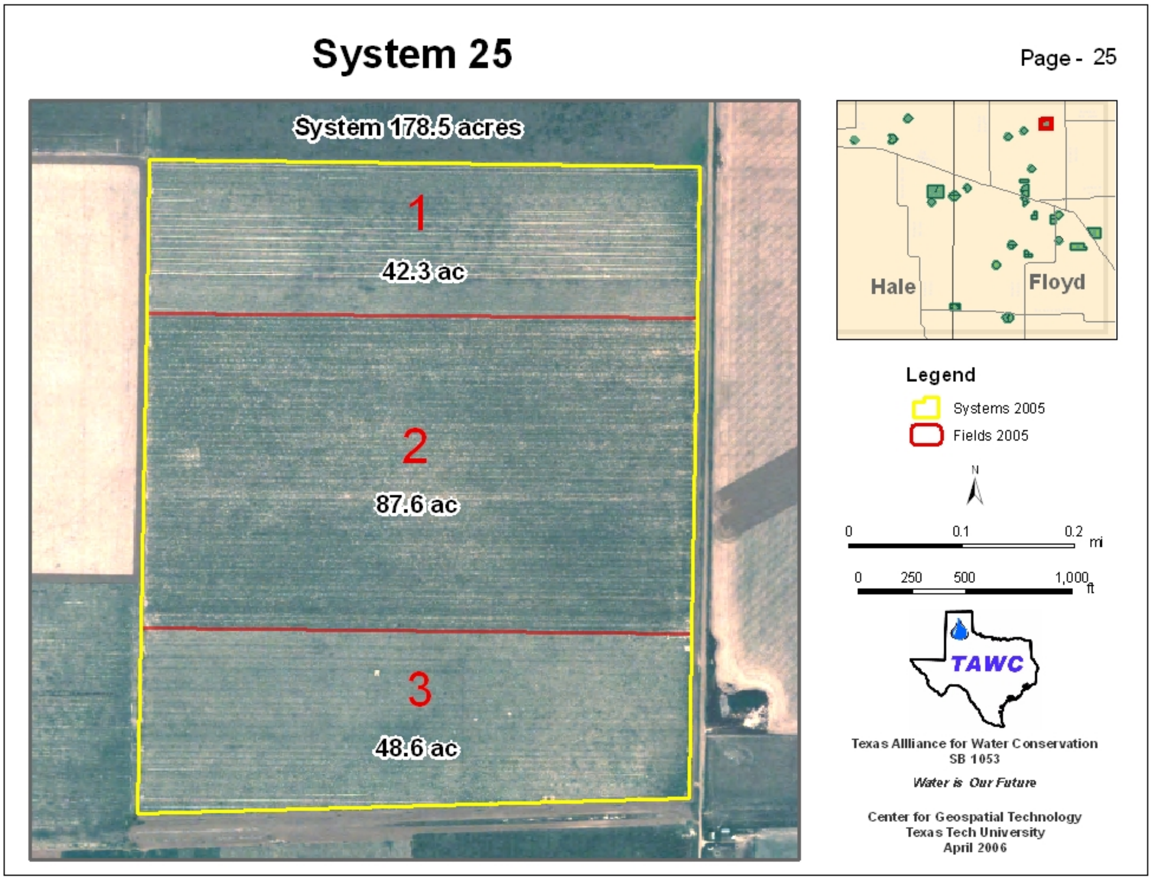

Site 24 Field 2, September 2008

Site 24


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


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


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
0
5
10
15
20
25
30
Net returns per pound of N ($)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
2005
2006
2007
2008
Per acre inch of irrigation water
Per pound of nitrogen



System 25 Description

Total system 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:

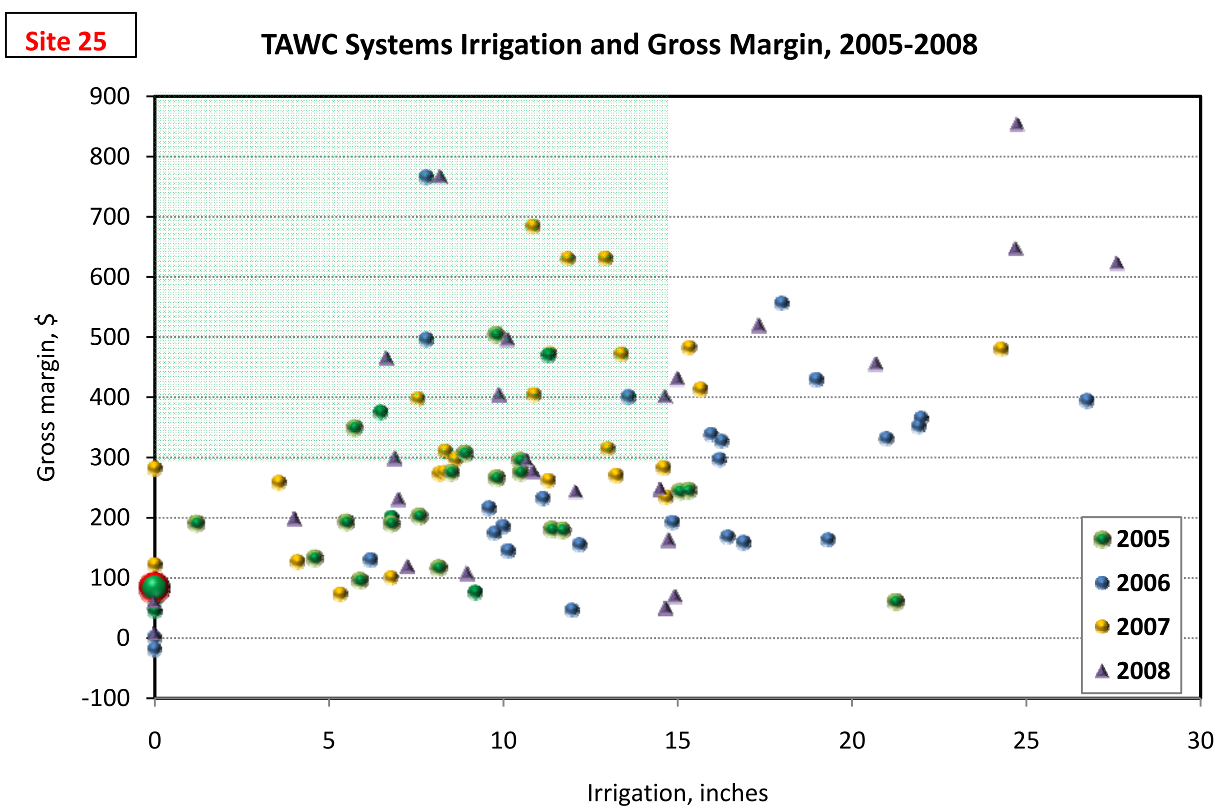
Number of wells:

Fuel source:

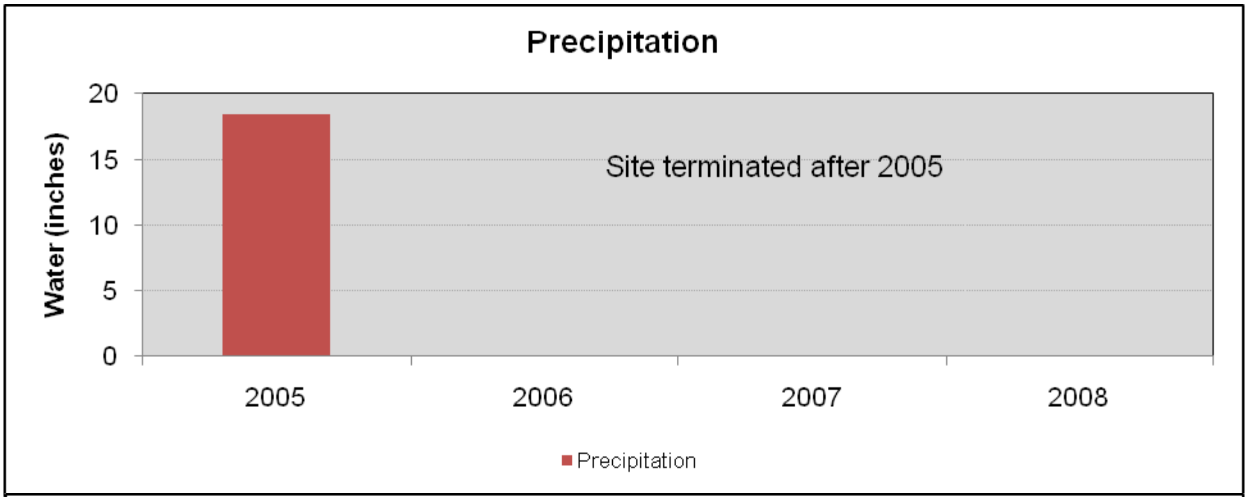
Comments: At this dryland site cotton and grain sorghum are grown in rotation. The cotton is planted in standing grain sorghum stalks. Cotton and grain sorghum are planted on forty-inch centers.

System 25

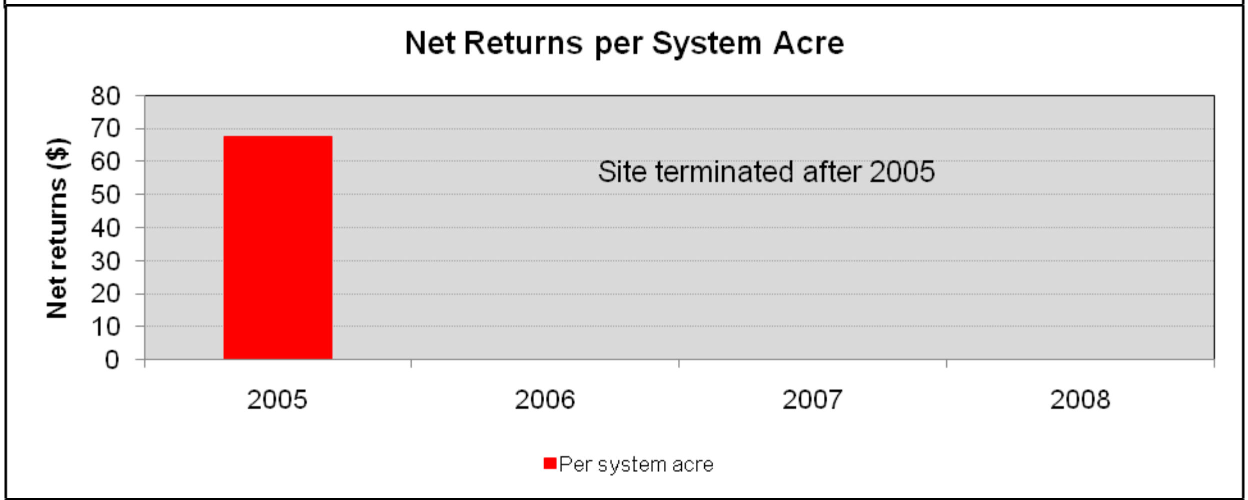
	Livestock	Field 1	Field 2	Field 3
2005	None	Cotton	Grain Sorghum	Cotton
2006	Site terminated in 2006			
2007				
2008				



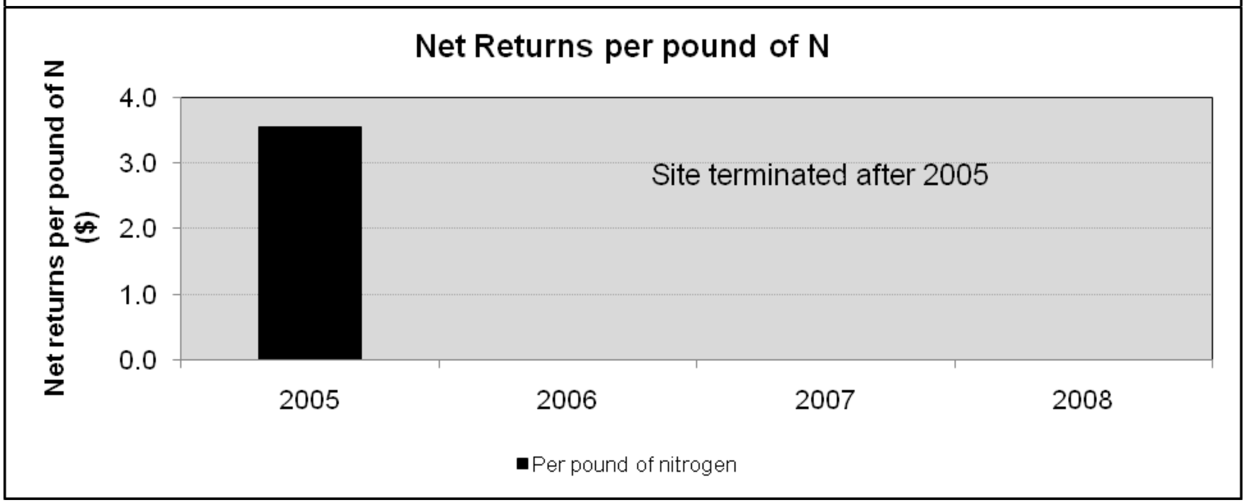
Site 25



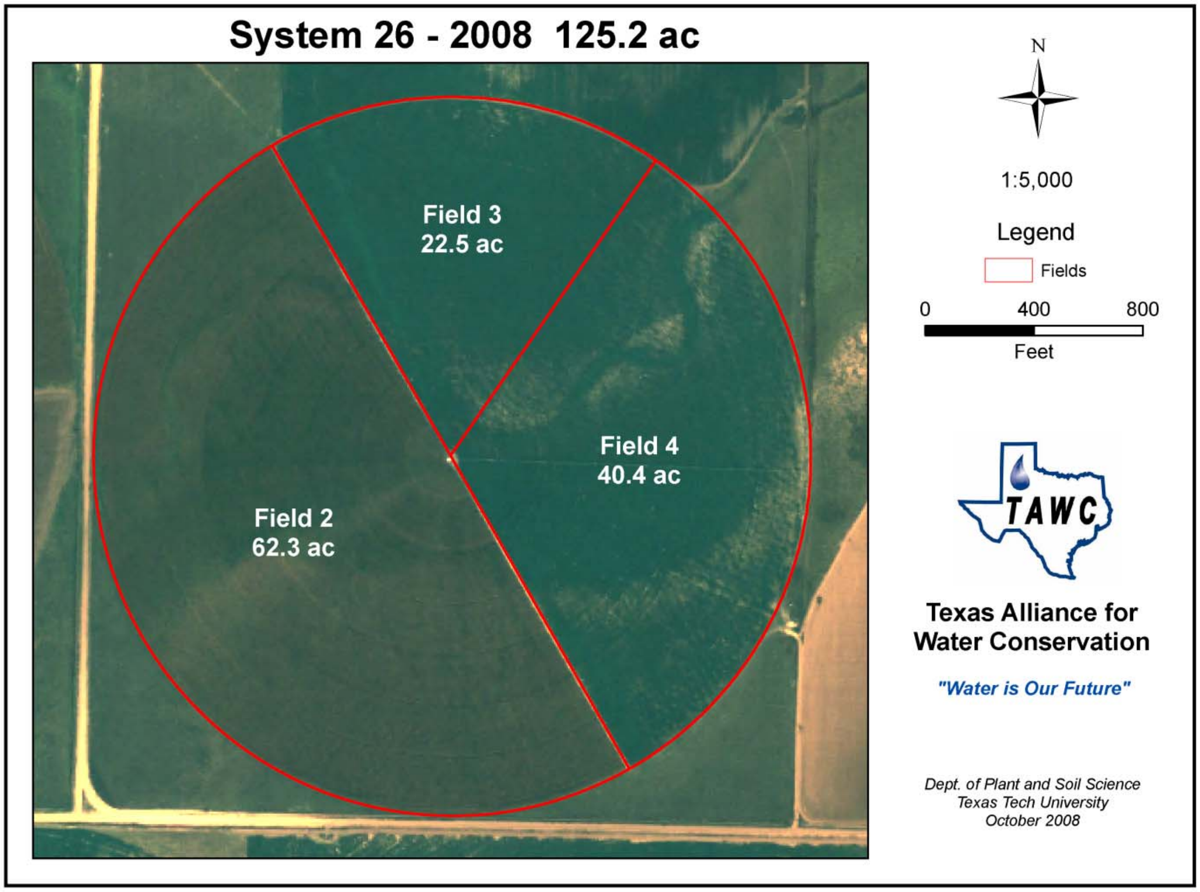
Precipitation
Water (inches)
20
15
10
5
0
Site terminated after 2005
2005
2006
2007
2008
Precipitation



Net Returns per System Acre
Net returns ($)
80
70
60
50
40
30
20
10
0
Site terminated after 2005
2005
2006
2007
2008
Per system acre



Net Returns per pound of N
Net returns per pound of N ($)
4.0
3.0
2.0
1.0
0.0
Site terminated after 2005
2005
2006
2007
2008
Per pound of nitrogen



System 26 Description

Total system acres: 125.2

Field No. 2 Acres: 62.3
Major soil type: Bippus loam; 0 to 3% slope
Mansker loam; 3 to 5% slope

Field No. 3 Acres: 22.5
Major soil type: Bippus loam; 0 to 3% slope
Mansker loam; 3 to 5% slope

Field No. 4 Acres: 40.4
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

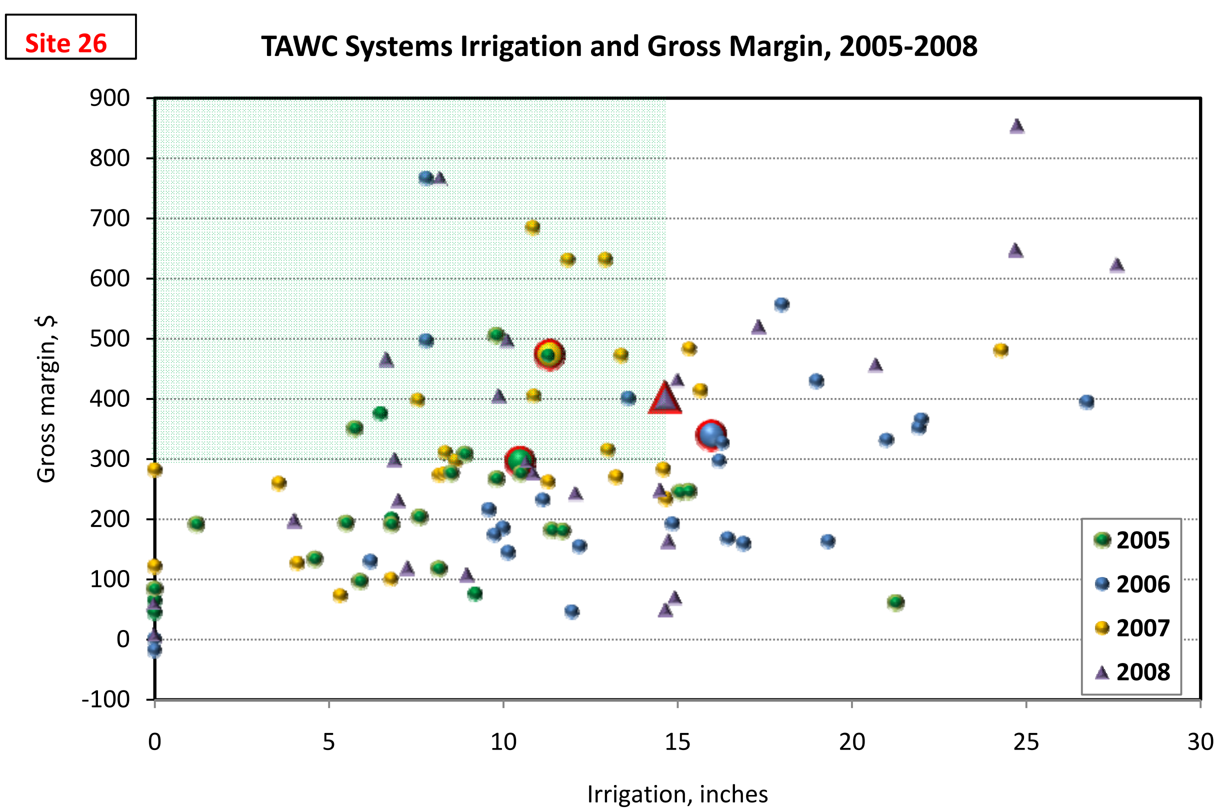
Number of wells: 2

Fuel source: 1 Electric
1 Diesel

Comments: This is a corn/seed millet/seed grain sorghum pivot irrigated site. Because of a poor stand on a portion of field 1 the seed grain sorghum was replanted to corn, thus creating fields 3 and 4.

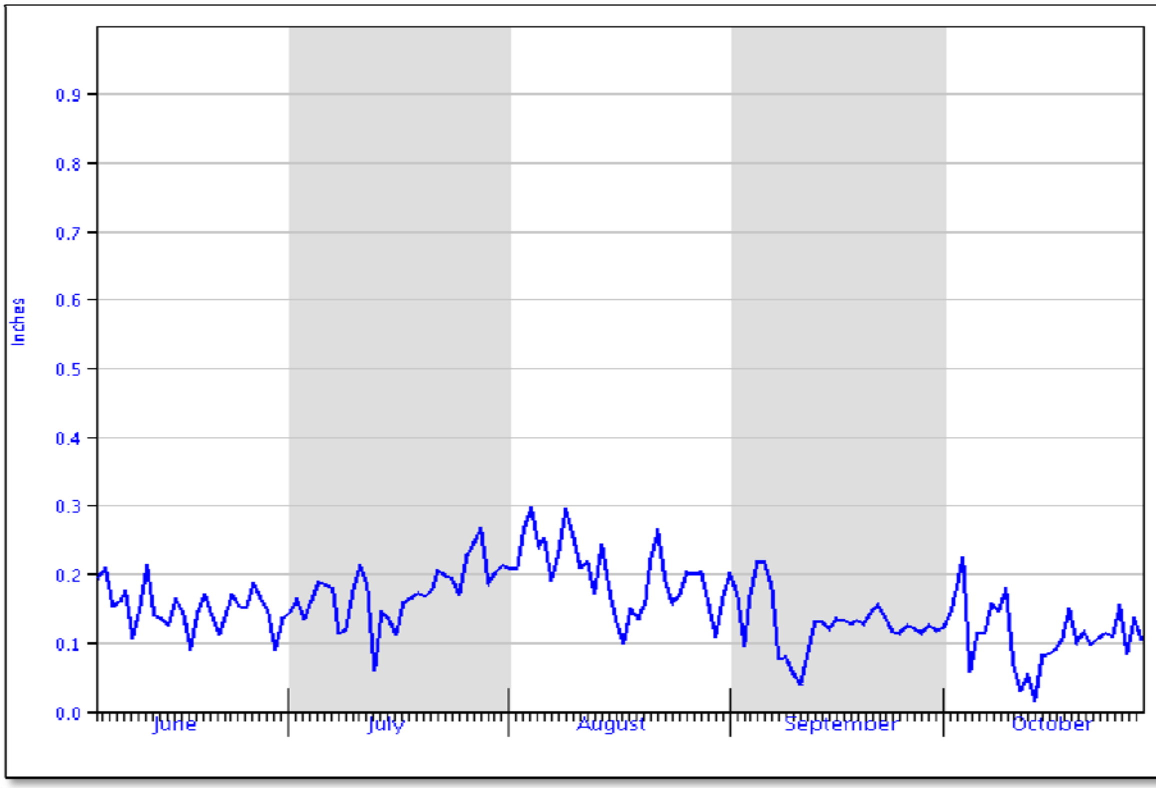
System 26

	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



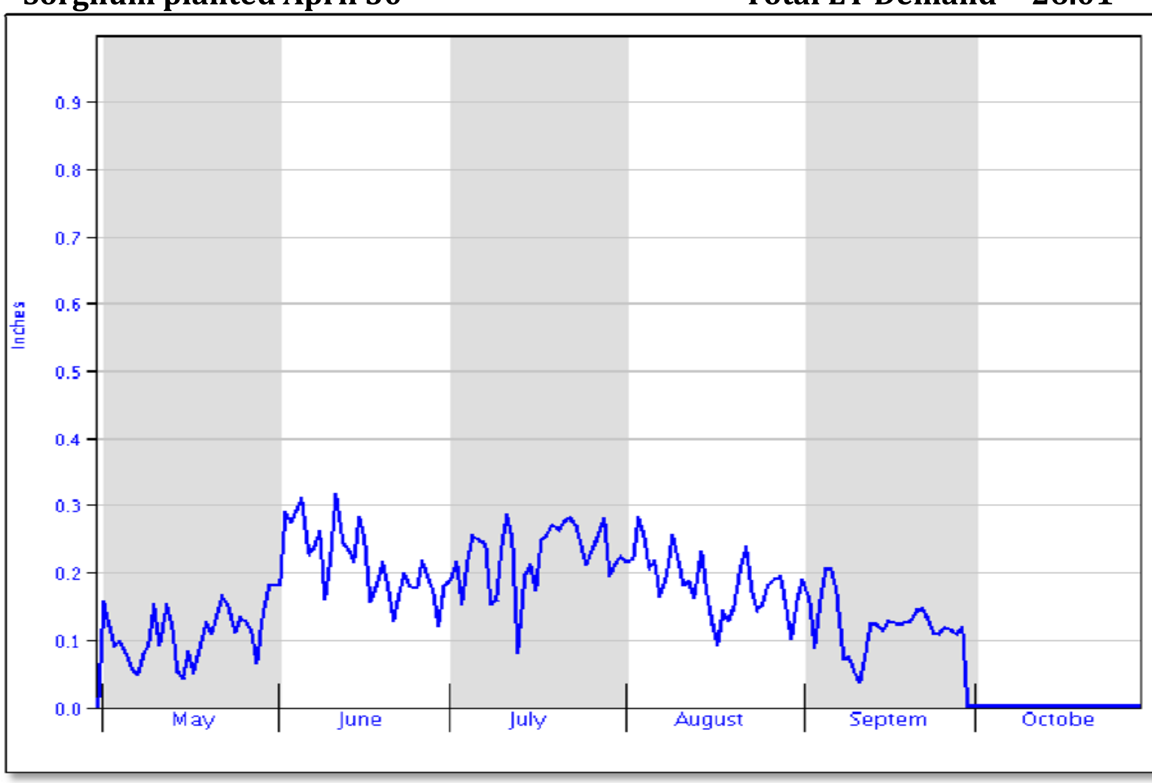
Site 26 Field 2

Millet planted June 4 **Total ET Demand 22.41”**

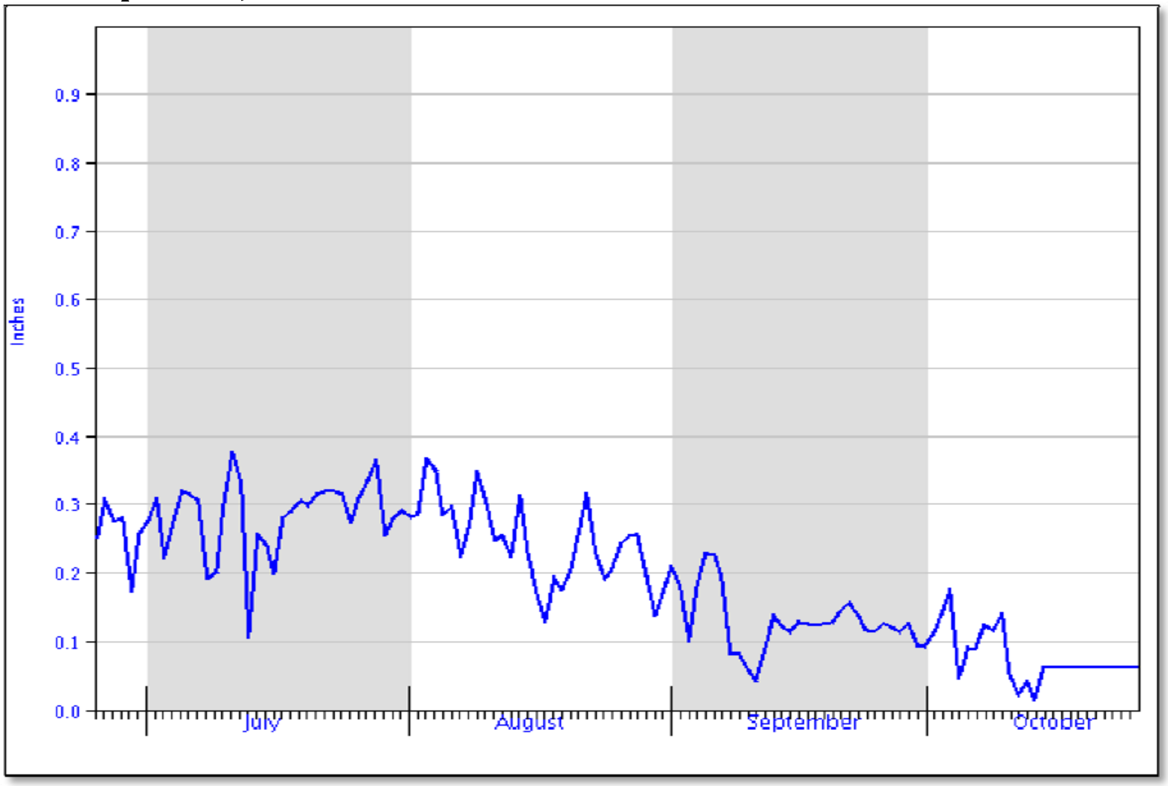


Site 26 Field 3

Sorghum planted April 30 **Total ET Demand 26.01”**



Site 26 Field 4
Corn planted June 25 **Total ET Demand 23.61"**

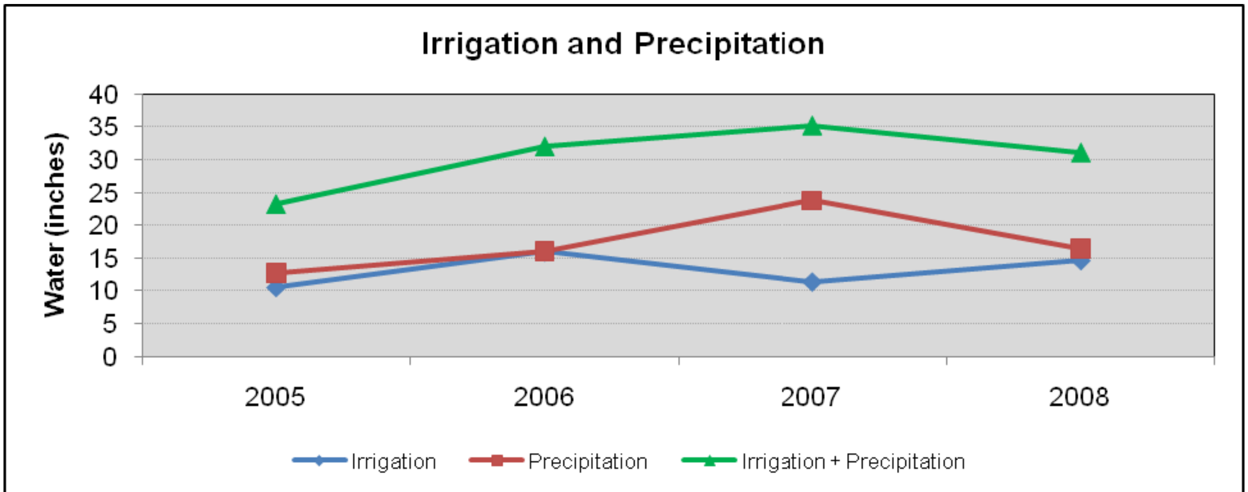


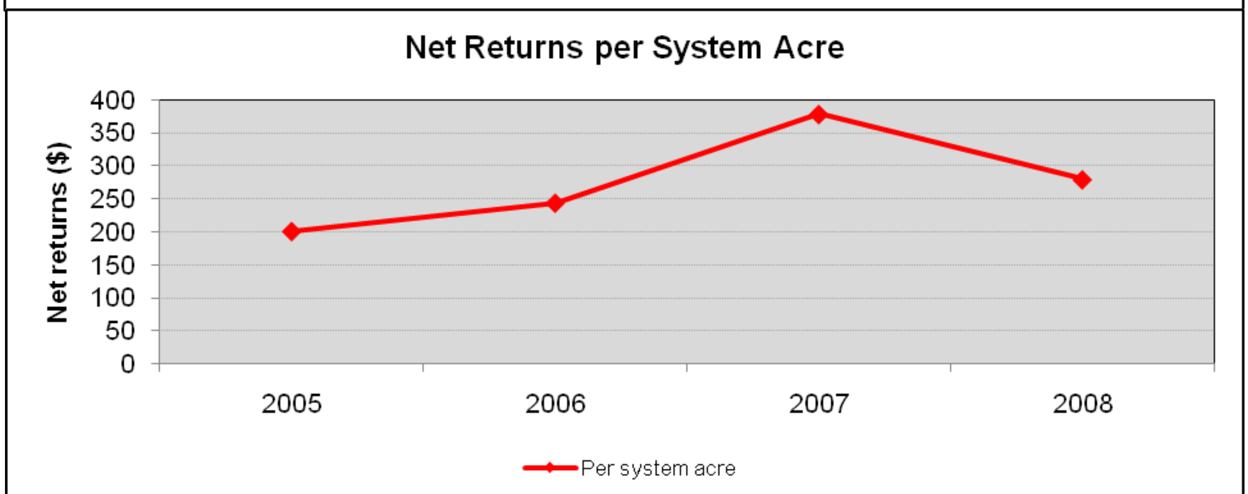
Site 26 Field 2, August 2008

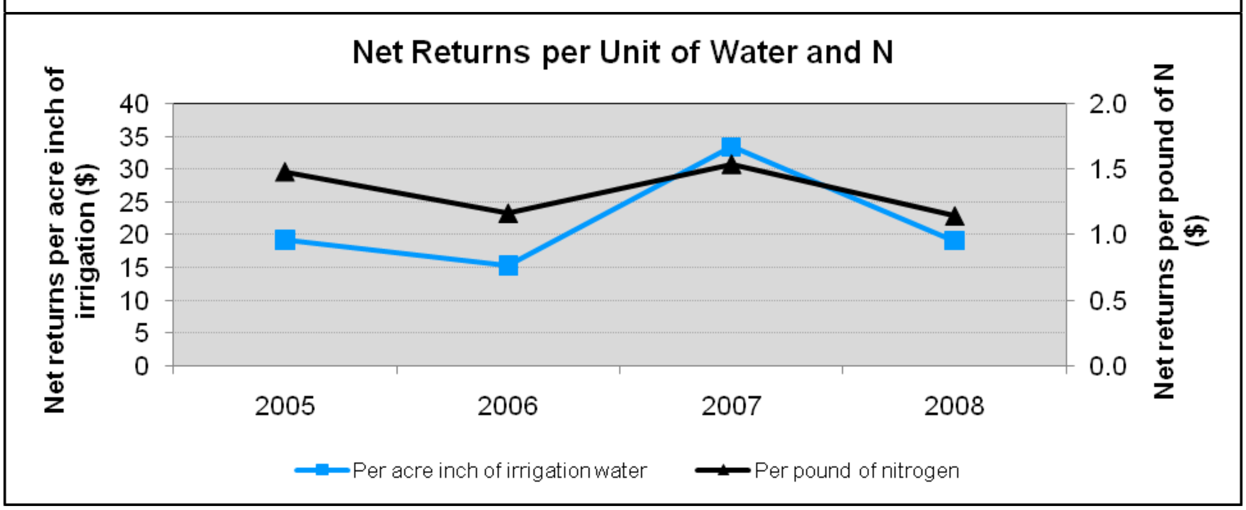
Site 26 Field 3, September 2008

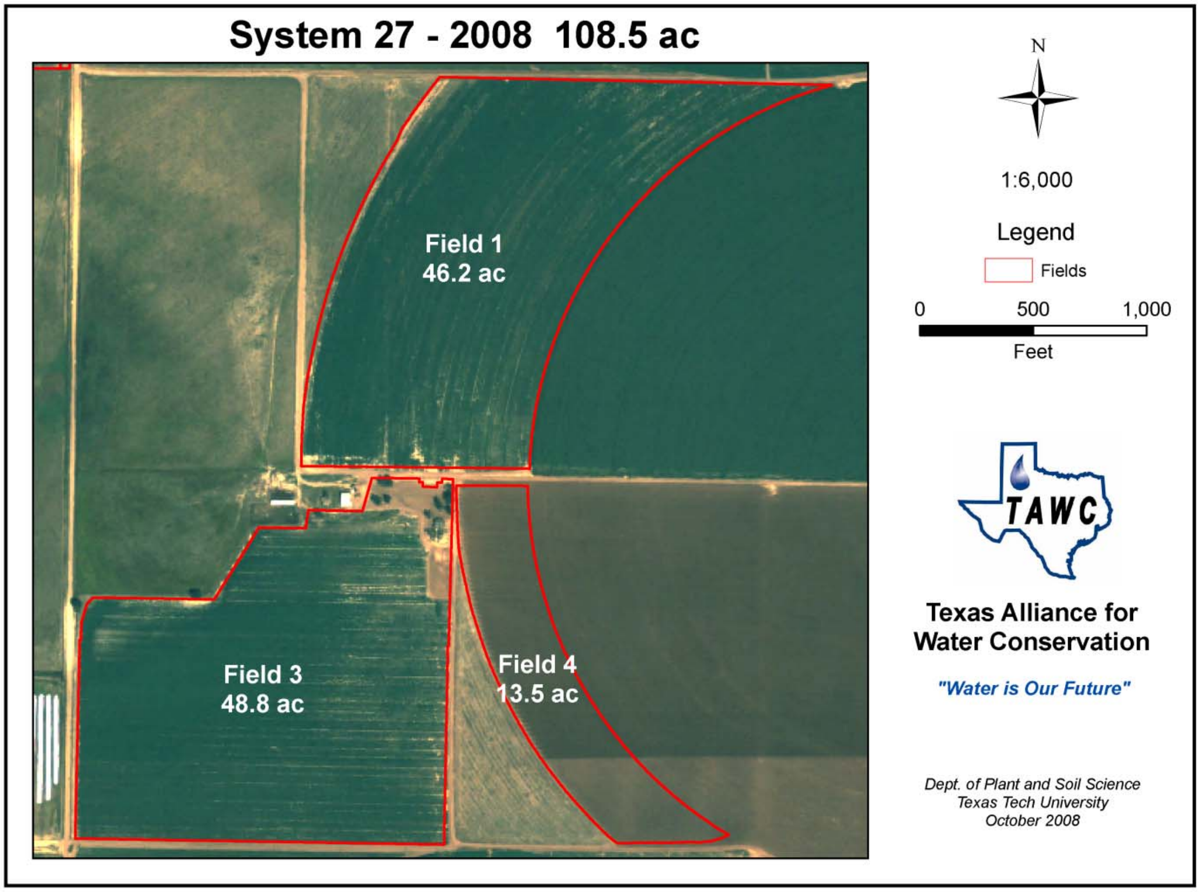
Site 26 Field 4, November 2008

Site 26


Irrigation and Precipitation
Water (inches)
0
5
10
15
20
25
30
35
40
2005
2006
2007
2008
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
0
50
100
150
200
250
300
350
400
2005
2006
2007
2008
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
0
5
10
15
20
25
30
35
40
Net returns per pound of N ($)
0.0
0.5
1.0
1.5
2.0
2005
2006
2007
2008
Per acre inch of irrigation water
Per pound of nitrogen



System 27 Description

Total system acres: 108.5

Field No. 1 Acres: 46.2
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: Sub-surface Drip
(SDI, installed prior to 2006 crop year)
Pumping capacity,
gal/min: 400

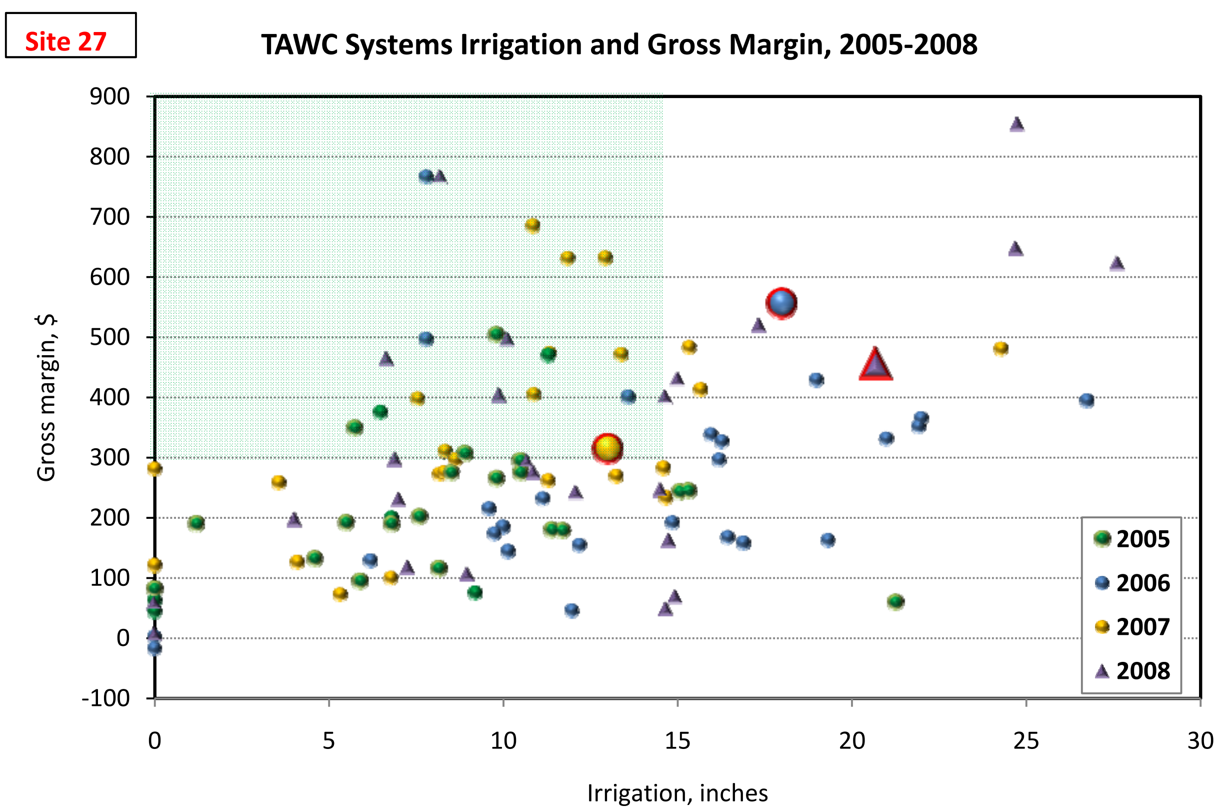
Number of wells: 2

Fuel source: Electric

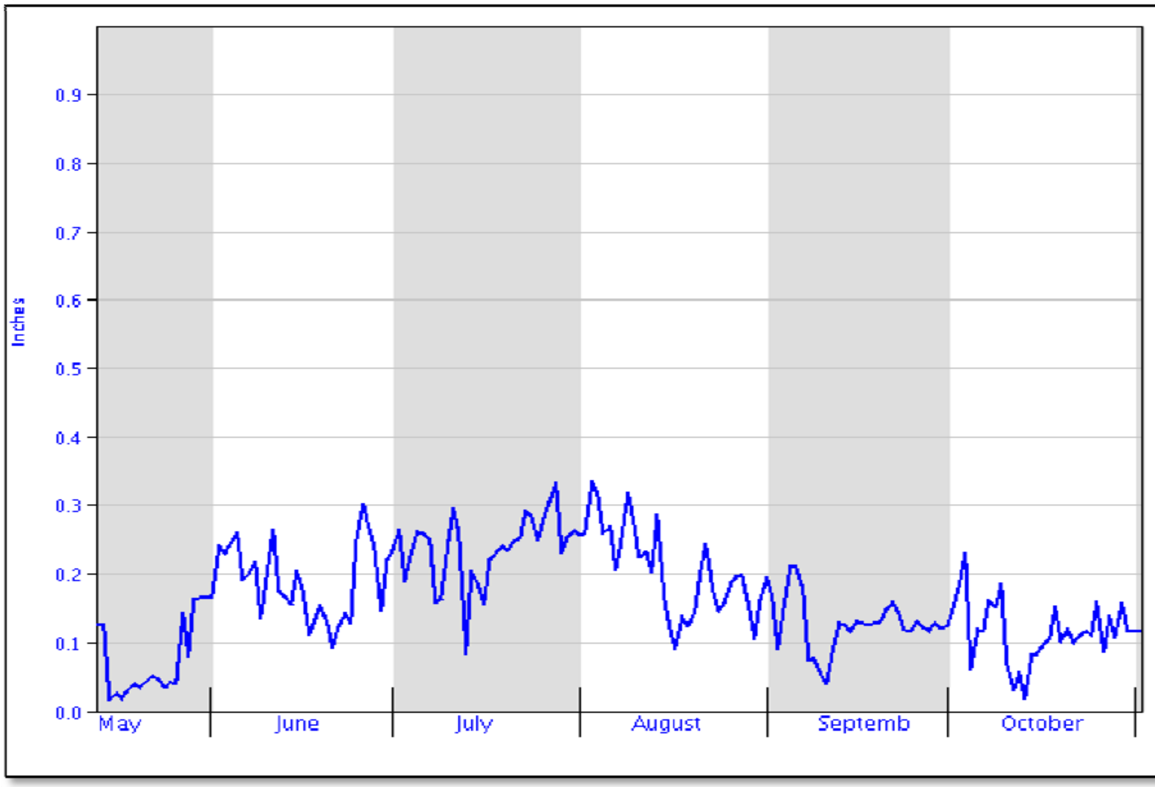
Comments: This is the second year for this cotton/corn drip irrigated site. Corn is planted on twenty-inch centers with cotton planted on forty-inch centers and conventional tillage.

System 27

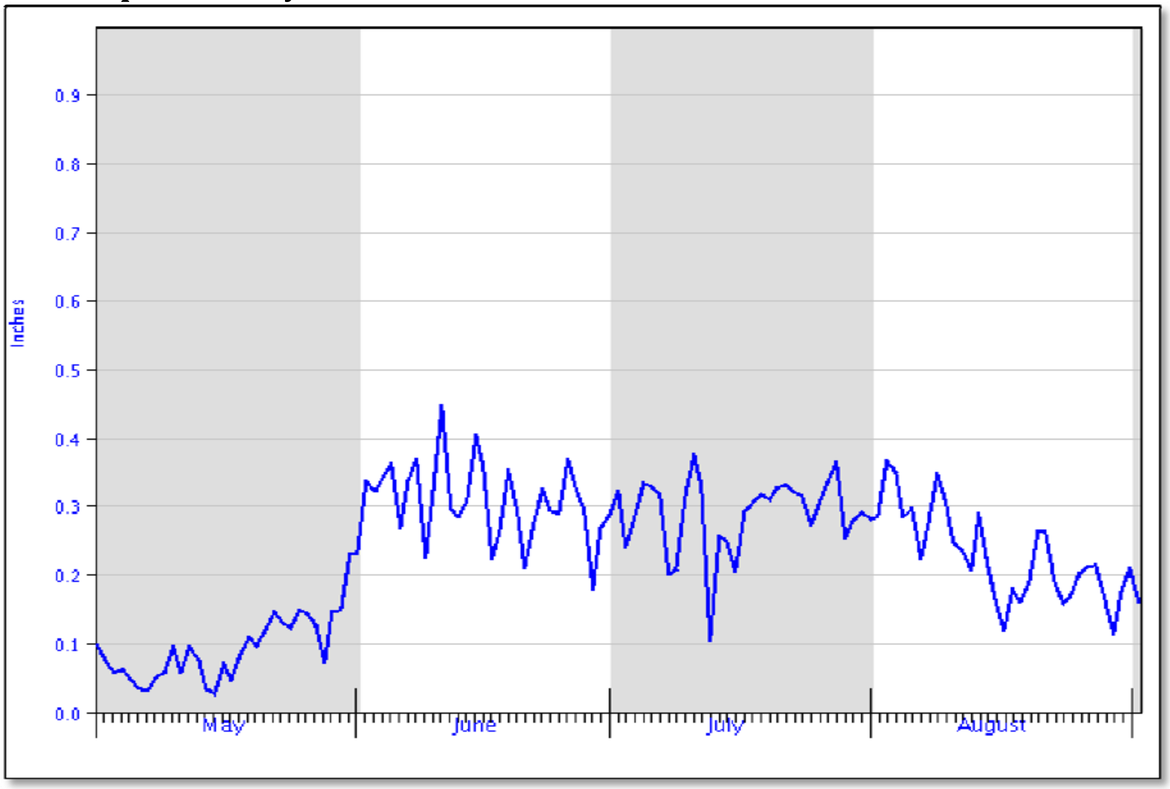
	Livestock	Field 1	Field 2	Field 3	Field 4
2005	Entered project in Year 2				
2006	None	Cotton following Wheat cover crop			
2007	None	Corn for silage	Cotton following Wheat cover crop		
2008	None	Cotton following wheat cover crop	Additional acres added to create Field 3	Corn for grain	Corn for grain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



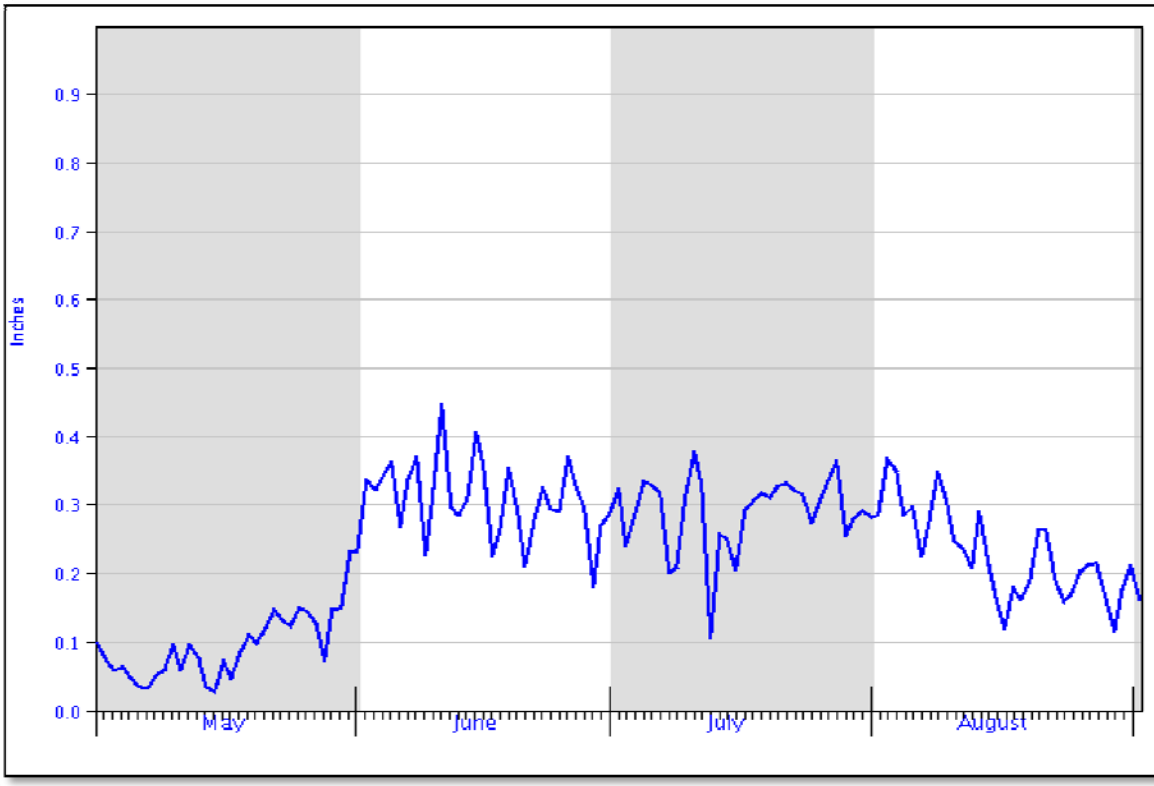
Site 27 Field 1
Cotton planted May 13 **Total ET Demand 28.06"**



Site 27 Field 3
Corn planted May 1 **Total ET Demand 28.22"**



Site 27 Field 4
Corn planted May 1 **Total ET Demand 28.22"**

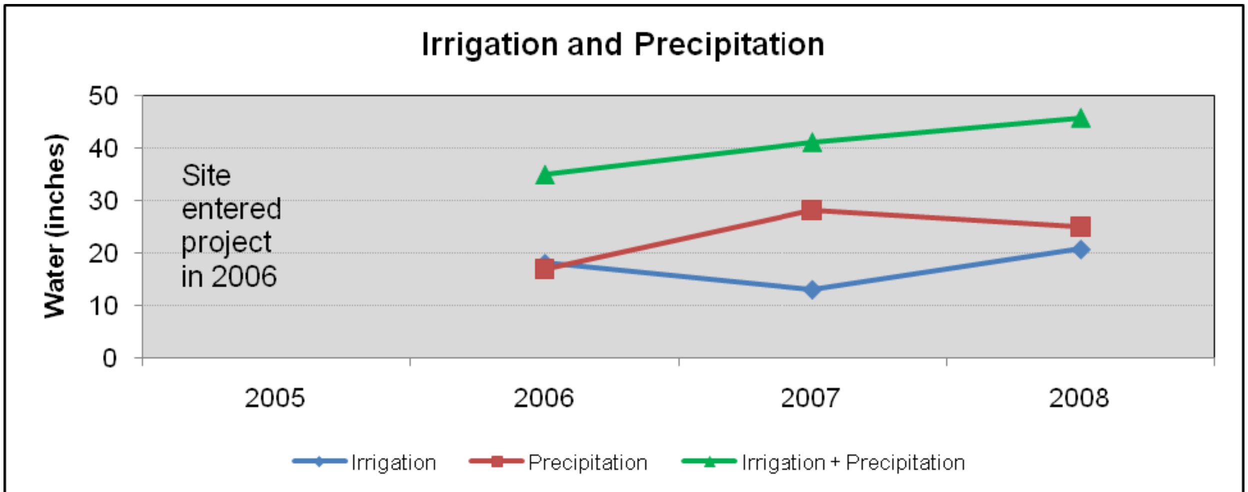


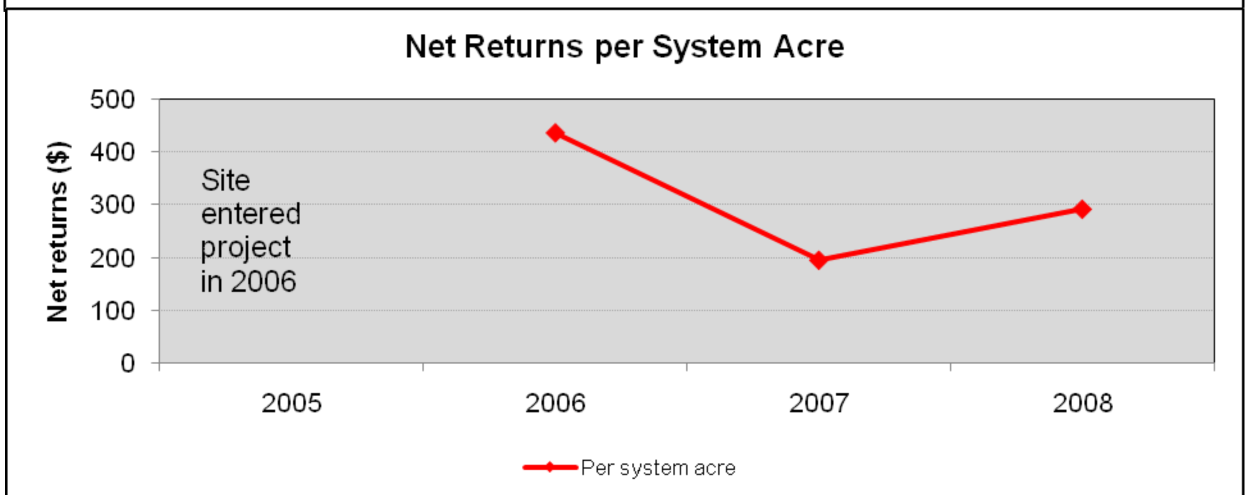
Site 27 Field 1, July 2008

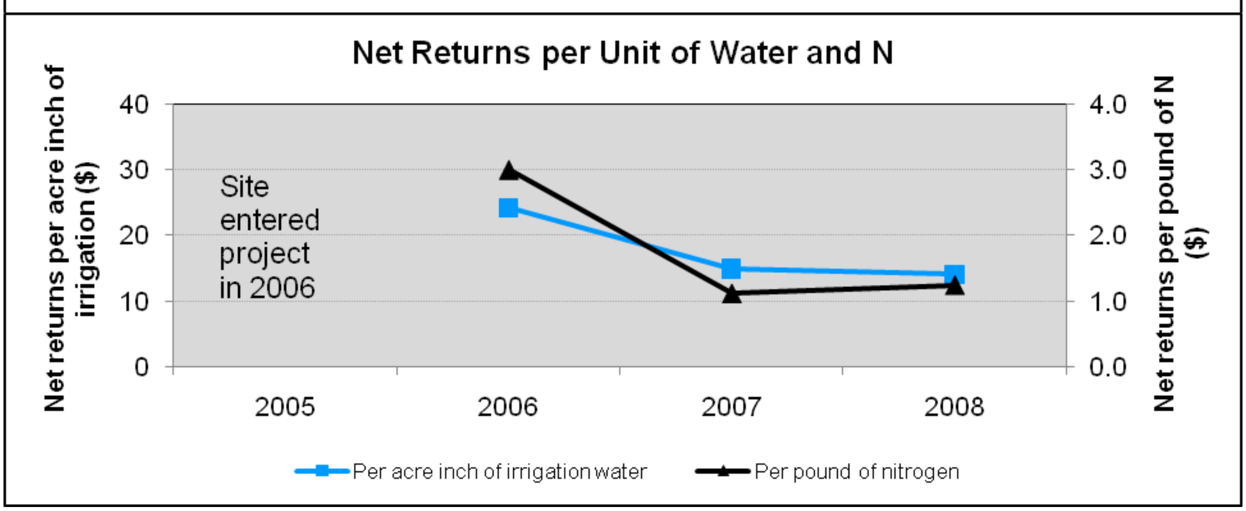
Site 27 Field 3, August 2008

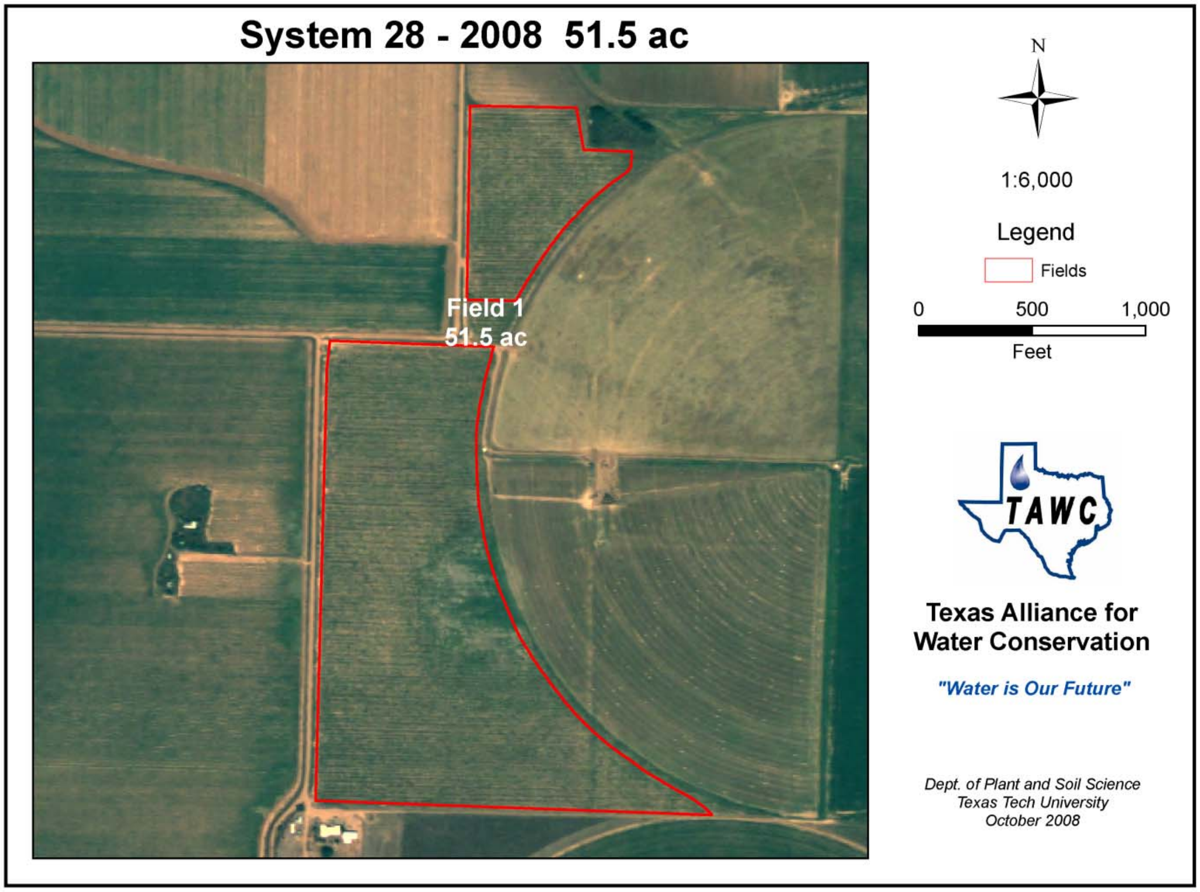
Site 27 Field 4, June 2008

Site 27


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


Net Returns per System Acre
Net returns ($)
500
400
300
200
100
0
Site entered project in 2006
2005
2006
2007
2008
Per system acre


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



System 28 Description

Total system acres: 51.5

Field No. 1 Acres: 51.5
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Sub-surface Drip (SDI)

Pumping capacity, gal/min: 300

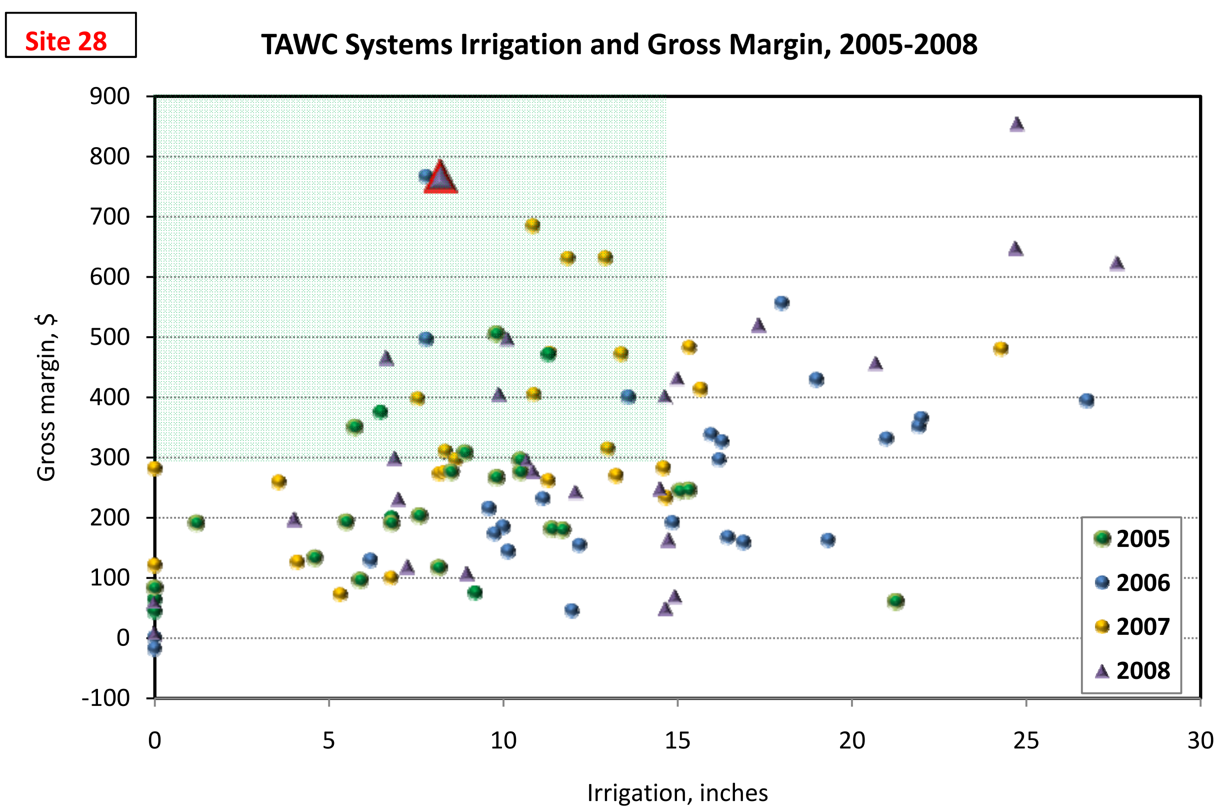
Number of wells: 1

Fuel source: electric

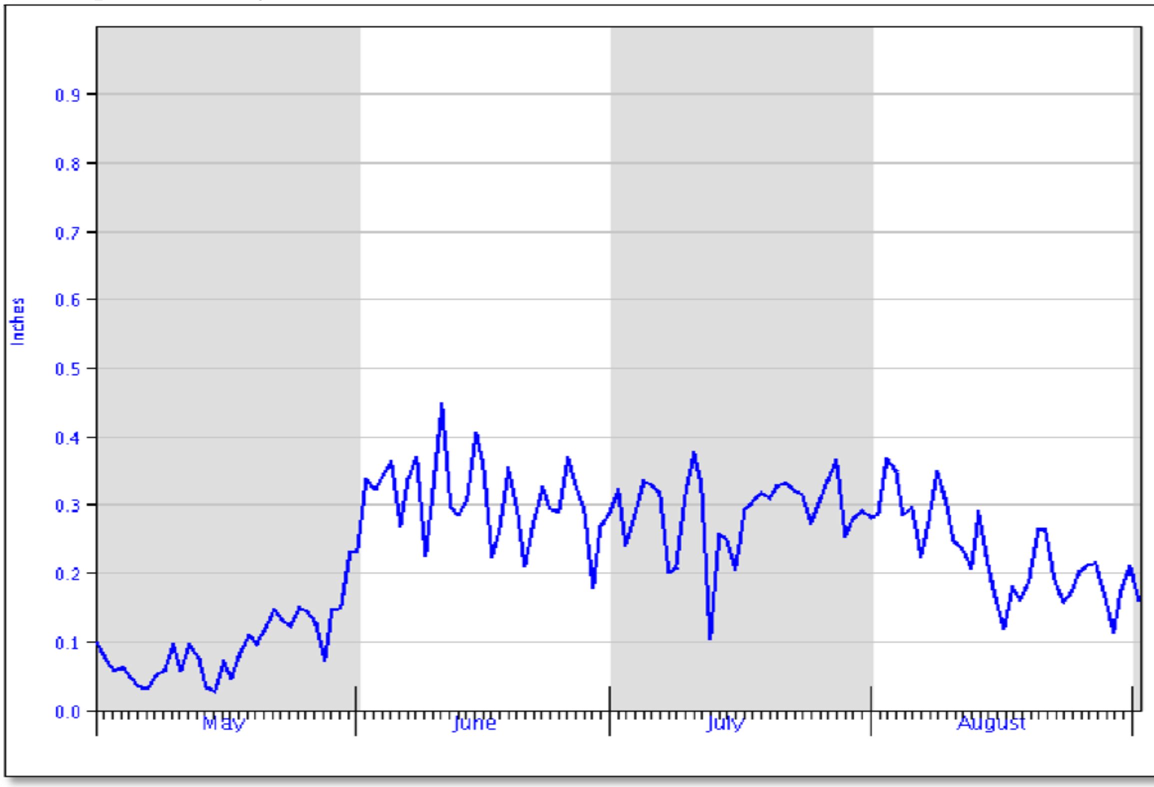
Comments: This is a new drip irrigated site using conventional tillage planted to corn in 2008.

System 28

	Livestock	Field 1
2005	Entered project in Year 4	
2006		
2007		
2008	None	Corn for grain

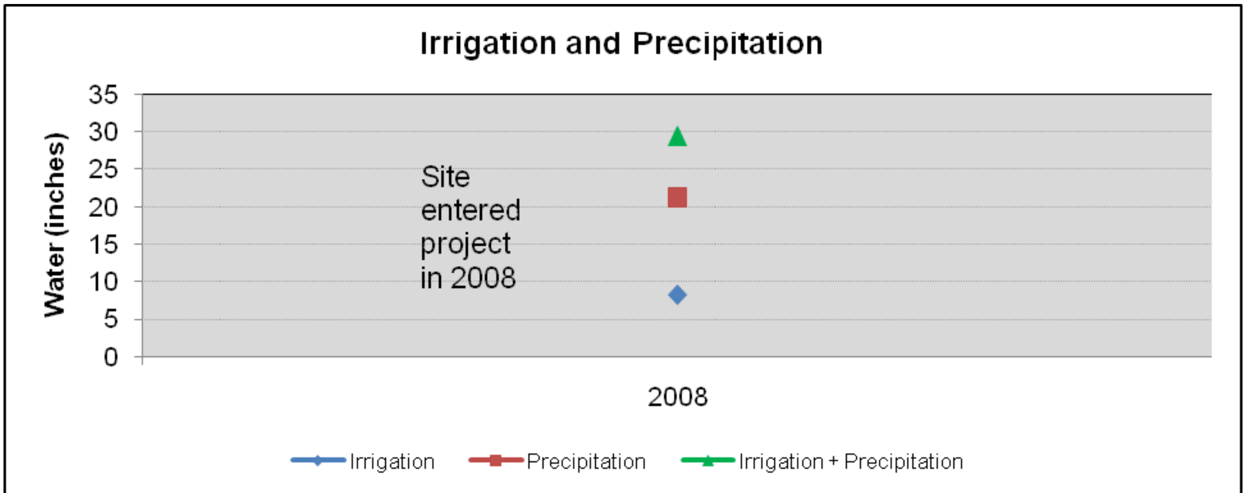


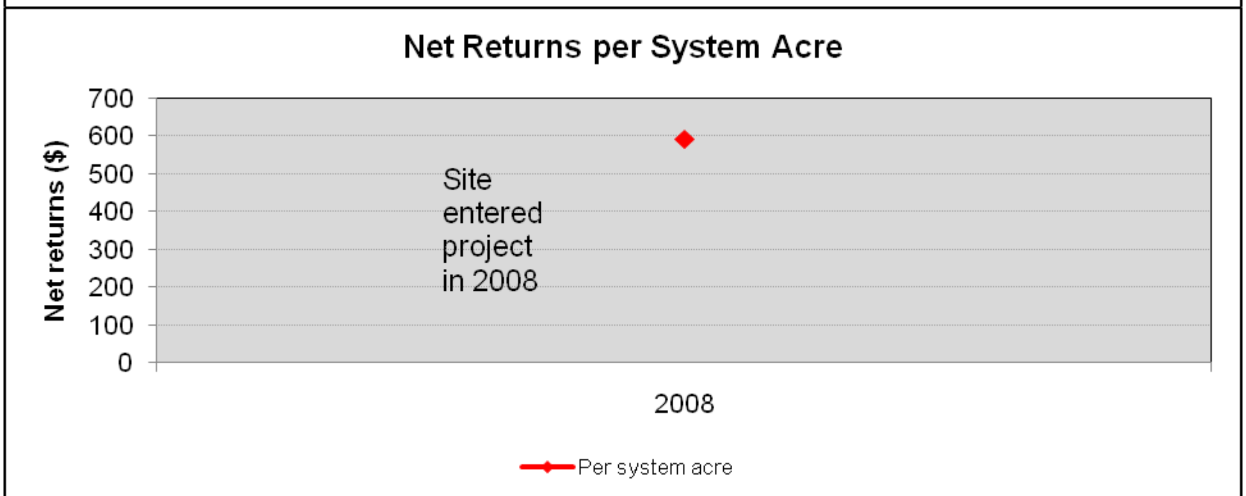
Site 28 Field 1
Corn planted May 1 **Total ET Demand 28.22"**

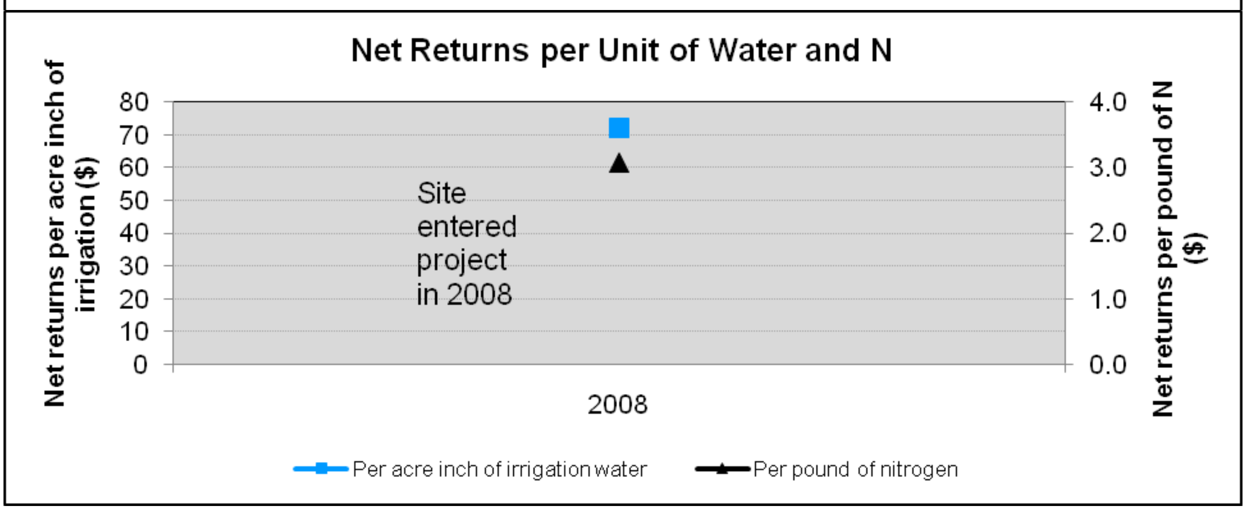


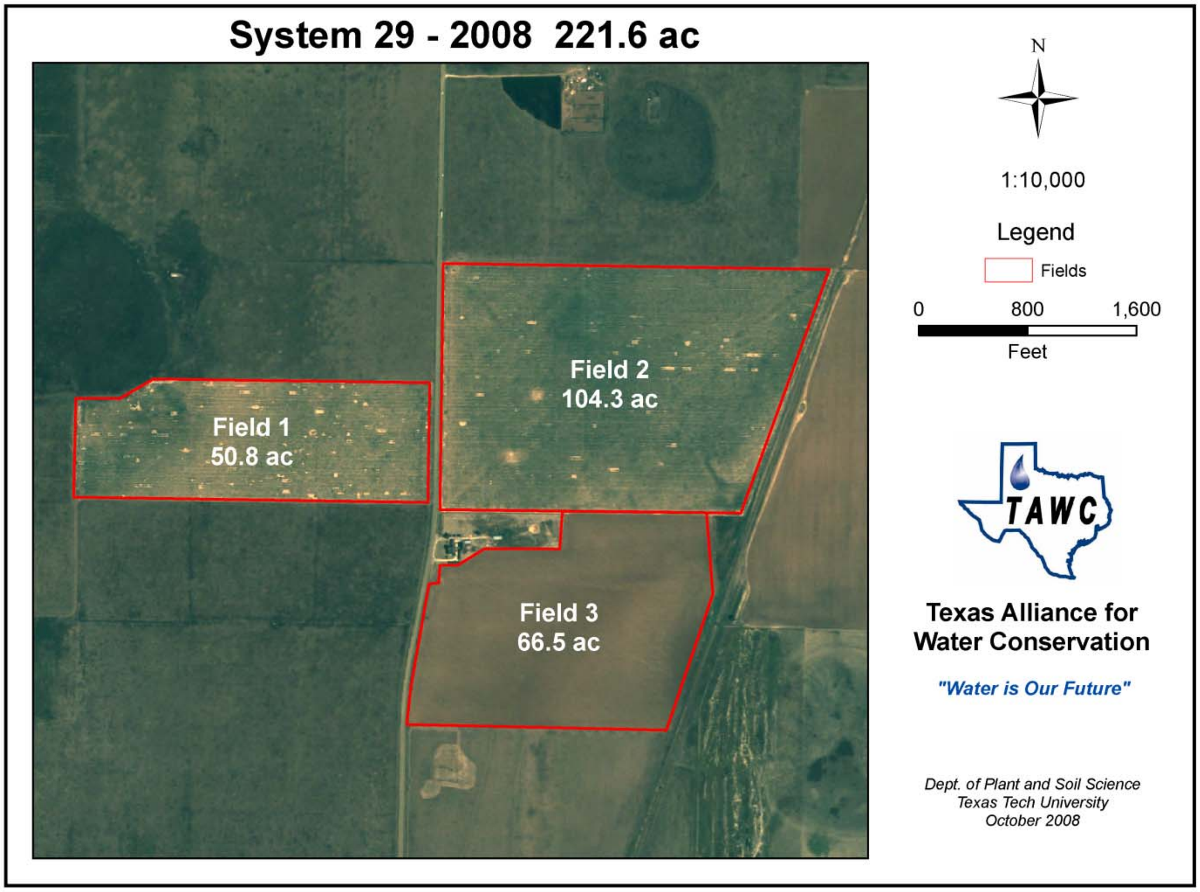
Site 28 Field 1, July 2008

Site 28


Irrigation and Precipitation
Water (inches)
35
30
25
20
15
10
5
0
Site entered project in 2008
2008
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
700
600
500
400
300
200
100
0
Site entered project in 2008
2008
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
80
70
60
50
40
30
20
10
0
4.0
3.0
2.0
1.0
0.0
Net returns per pound of N ($)
Site entered project in 2008
2008
Per acre inch of irrigation water
Per pound of nitrogen



System 29 Description

Total system acres: 221.6

Field No. 1 Acres: 50.8
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: 66.5
Major soil type: Pullman clay loam; 0 to 1% slope

Irrigation

Type: Dryland

Pumping capacity, gal/min:

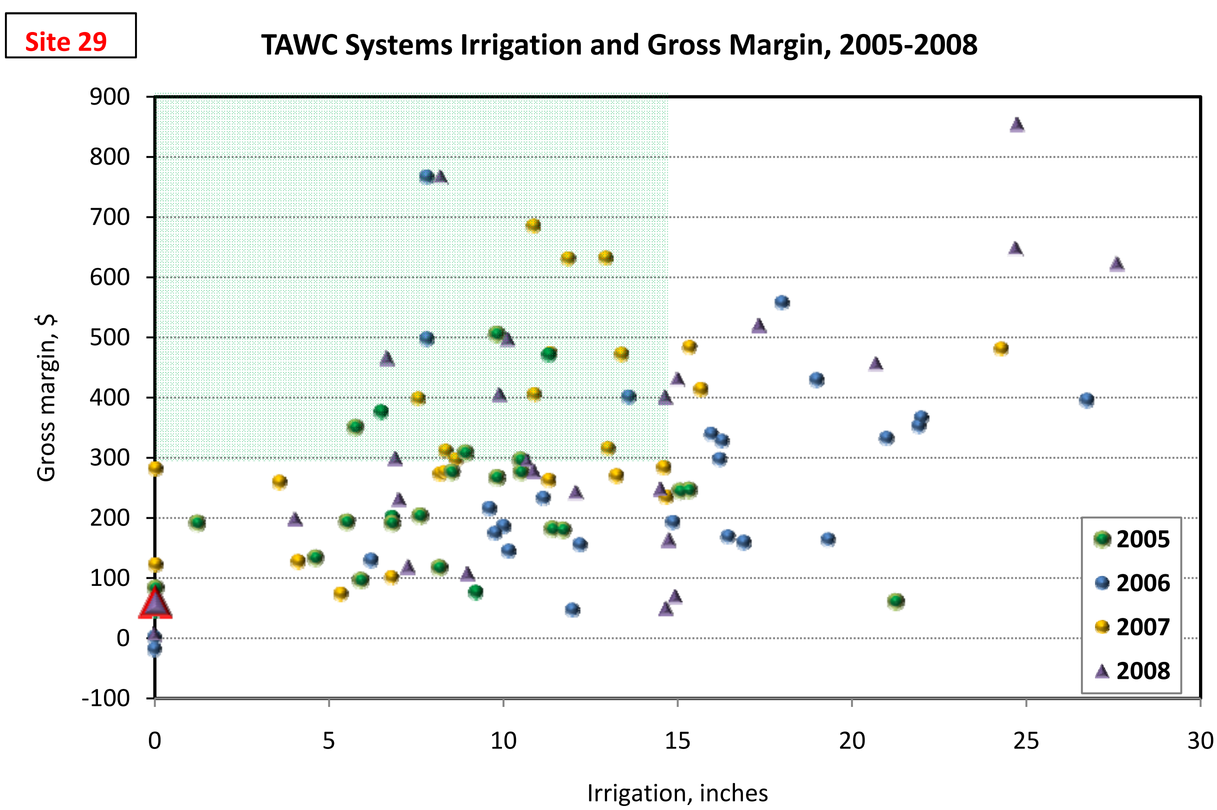
Number of wells:

Fuel source:

Comments: This is a conventional till dryland site. A cotton/wheat rotation program is used.

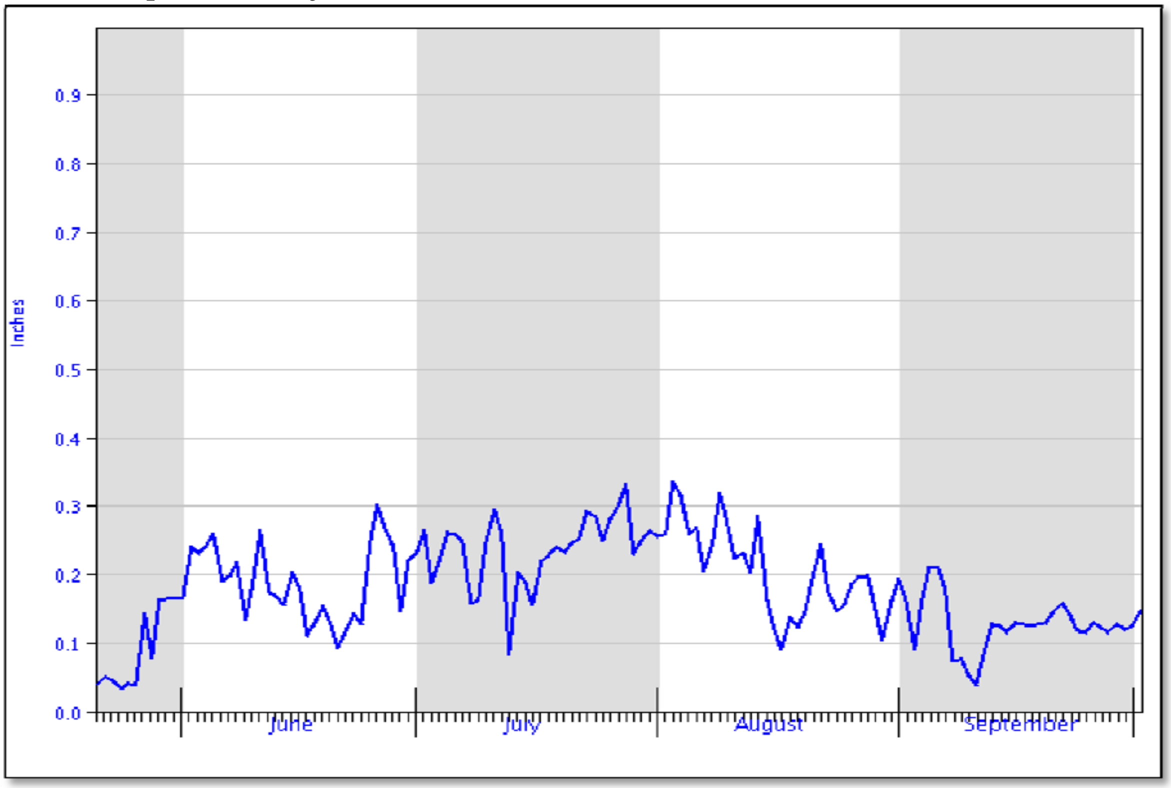
System 29

	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



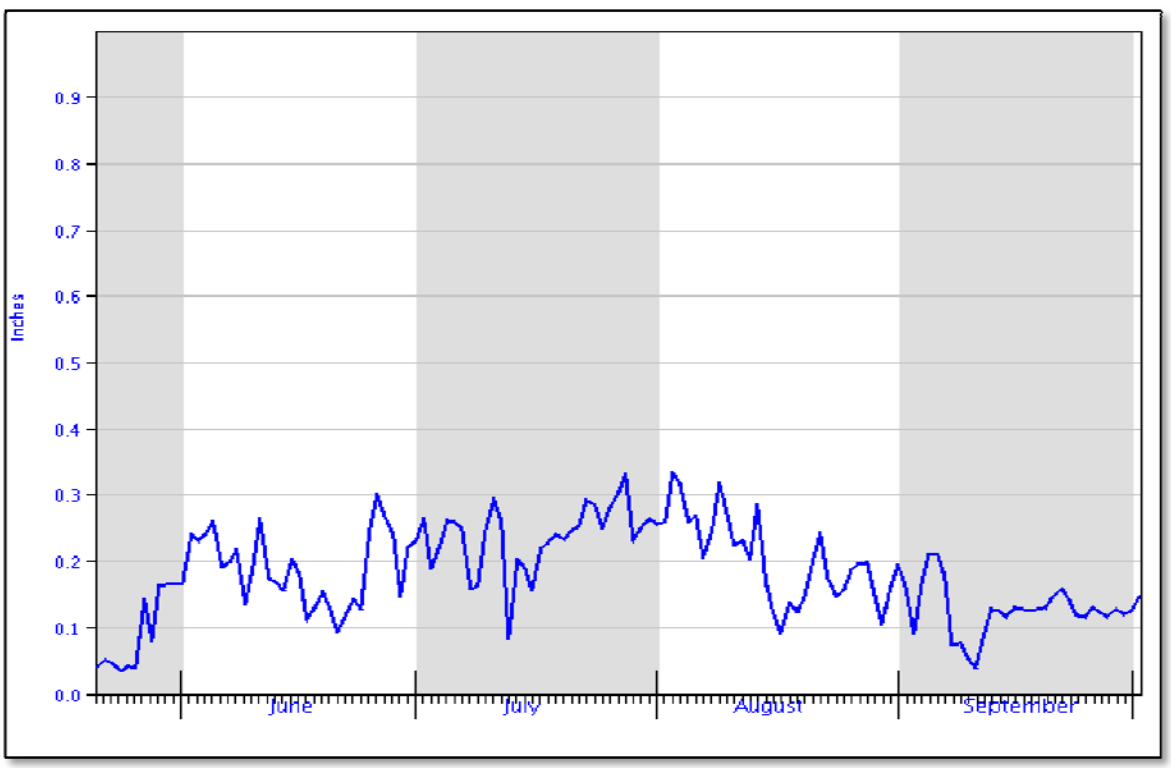
Site 29 Field 1

Cotton planted May 21 **Total ET Demand 24.15”**



Site 29 Field 3

Cotton planted May 21 **Total ET Demand 24.15”**

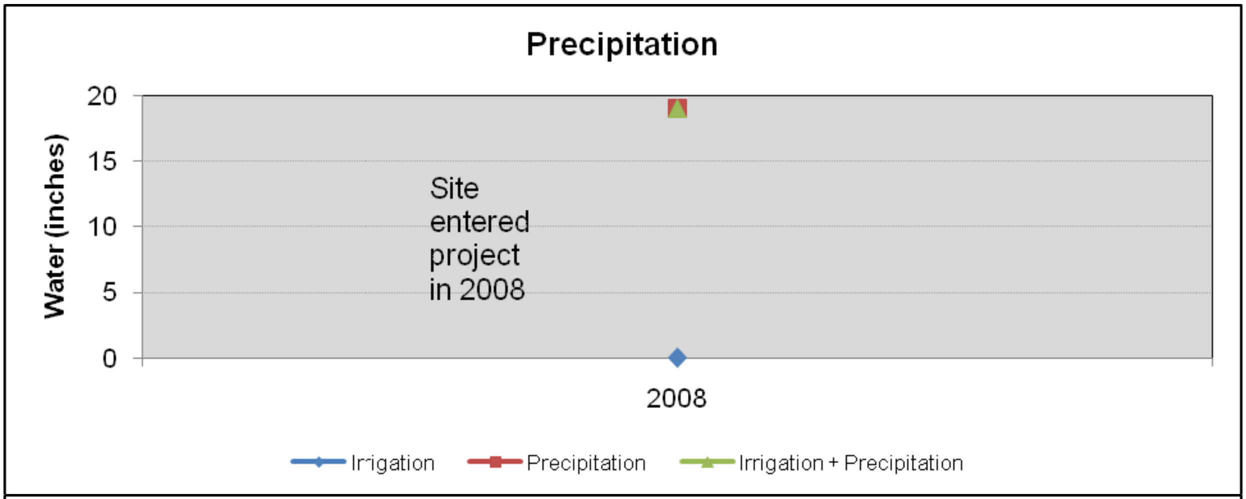


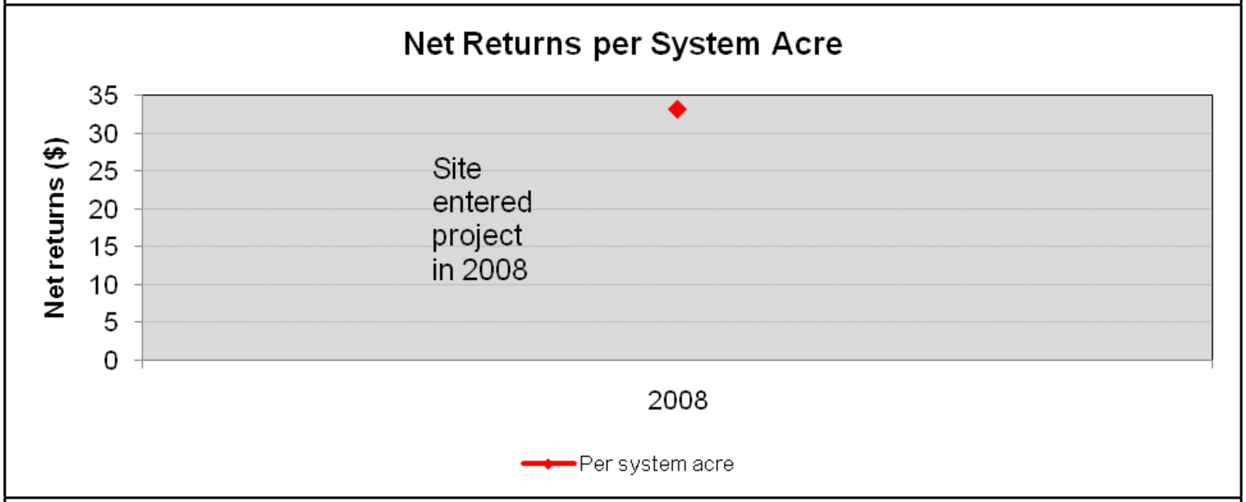
Site 29 Field 1, August 2008

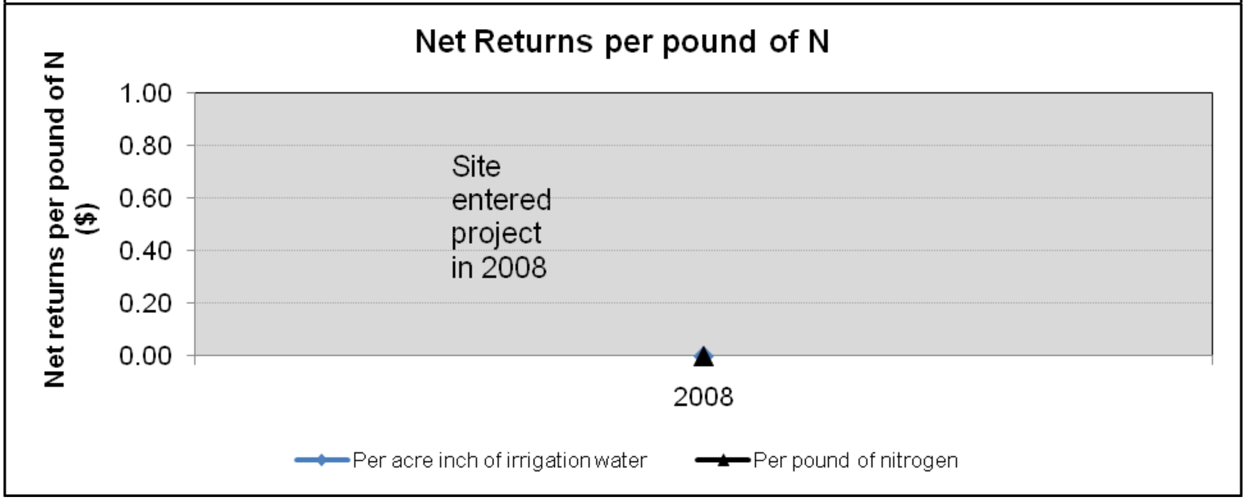
Site 29 Field 2, May 2008

Site 29 Field 3, August 2008

Site 29


Precipitation
Water (inches)
20
15
10
5
0
Site entered project in 2008
2008
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
35
30
25
20
15
10
5
0
Site entered project in 2008
2008
Per system acre


Net Returns per pound of N
Net returns per pound of N ($)
1.00
0.80
0.60
0.40
0.20
0.00
Site entered project in 2008
2008
Per acre inch of irrigation water
Per pound of nitrogen

Overall Summary of Years 1—4

A key defining characteristic of this demonstration project is the fact that producers make all decisions on cropping and livestock practices. We simply document what these decisions are, the impact that they have on water use, and their effects on the economic returns. Through the knowledge thus gained, we are identifying those systems and system components and management strategies that are returning the most revenue per acre and per unit of water invested. We do, however, attempt to provide these and other producers with the best information available on management and marketing opportunities, technologies for water conservation, and conservation of other resources. This is being done through a series of workshops, field days, and other communication strategies. It is also accomplished through a continuing search for new technologies that a producer could incorporate to conserve water if they desire to do so. Such information is shared with the Producer Board of Directors and with individuals that have an expressed interest in learning more about such techniques. It is our objective to provide producers with the best information possible on which they can base their decisions but the decision belongs to the producer.

With water scarcity an increasing reality and regulation of water use a probability in the near future, the information emerging from this demonstration is suggesting how systems can be designed and managed to remain profitable at water use levels well within anticipated regulated water use amounts. Such information is imperative to the survival of an economically viable agriculture – not only in the Texas High Plains but anywhere water is limiting.

Through the data generated from these producer managed sites, it is now possible also to identify other relationships including economic returns to specific inputs such as nitrogen fertilizer. The information collected from these sites is also allowing us to examine energy balance and the energy economics of these systems. We anticipate that with additional grant opportunities, these sites will provide valuable information on carbon balance, carbon sequestration, and other environmental impacts of these systems.

Cropping and Livestock Trends

By monitoring the cropping decisions made by producers in the project, changes in agricultural land use are emerging. These sites are providing a reasonable sample of the crop and livestock enterprise decisions in this 2-county area.

Two major changes have occurred in land use during the past 4 years. When the project began, cotton was the dominant land use within these systems. However, over these 4 years, cotton has declined in each year, both in terms of total acres planted and sites including cotton within the system (Figs. 8 and 9). Cotton is no longer the dominant land use.

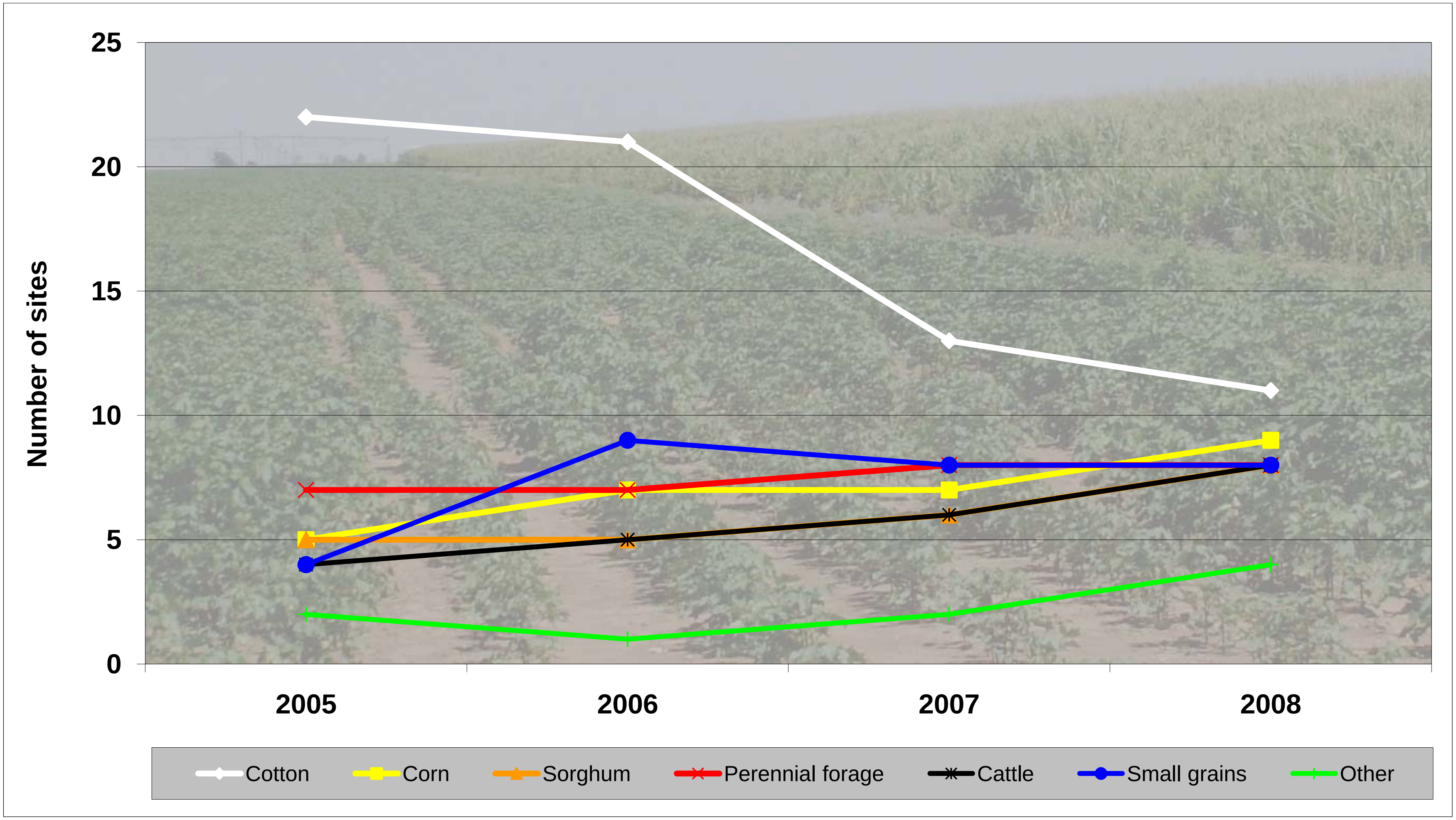


Figure 8. Number of systems (sites) that include cotton, corn, sorghum, perennial forages, cattle, small grains, and other crops within the producer systems located in Hale and Floyd Counties.

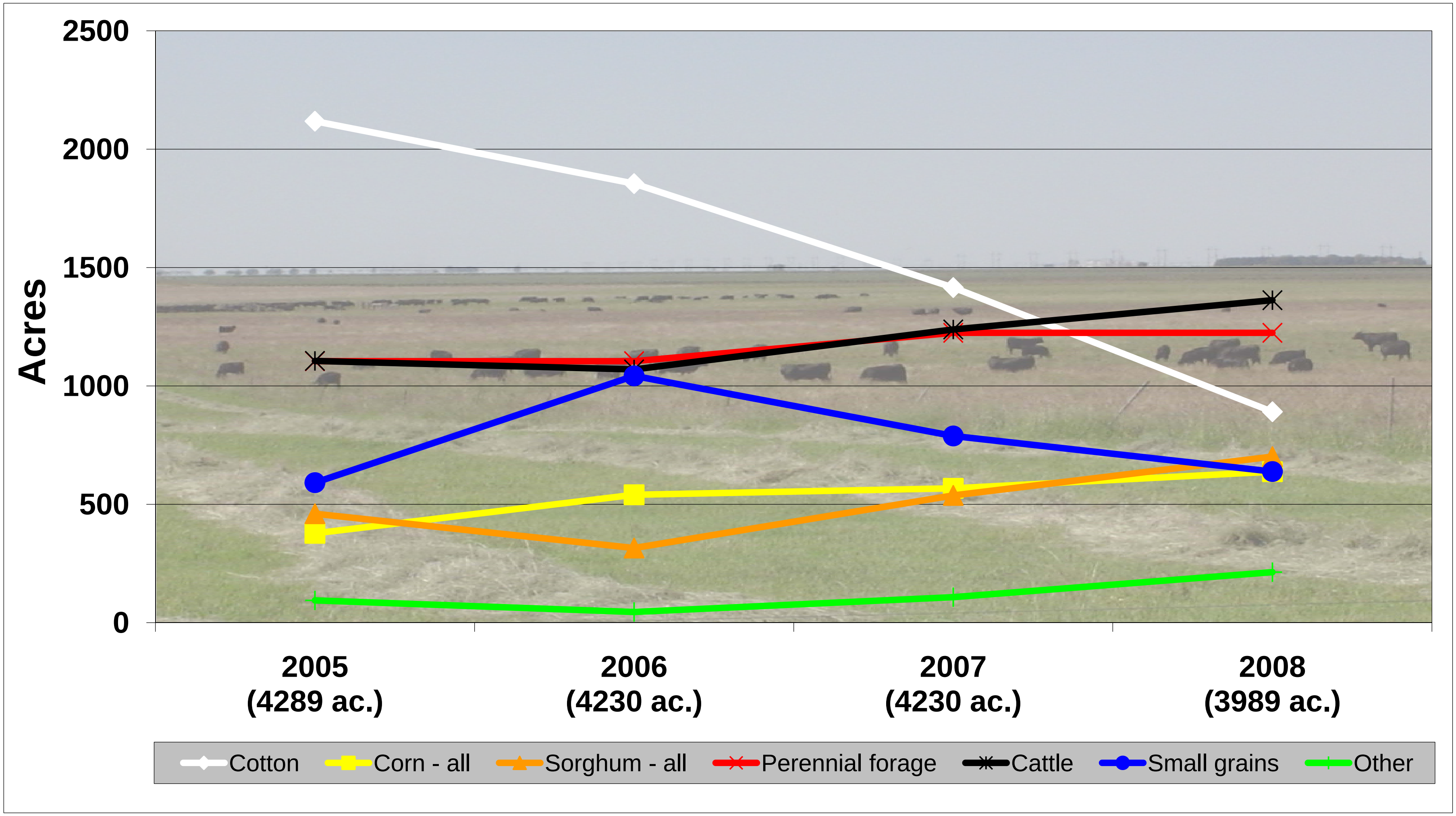


Figure 9. Number of acres that include cotton, corn, sorghum, perennial forages, cattle, small grains and other crops within the producer systems located in Hale and Floyd Counties.

The second major change is that grassland acres now occupy more area than any other land use. Grassland acres represent livestock grazing, hay production and grass seed enterprises. This is of particular interest because none of these grassland acres are in the Conservation Reserve Program (CRP). Thus, the decision to put land in grass is based on factors other than this key government program. Undoubtedly, both water and economic returns are influencing these decisions. Furthermore, about 36% of the sites in this project are on leased land. Sites that currently include perennial forages are predominantly on sites owned by the producer (6 of 8 total sites) rather than on leased land (2 sites). Conversion of crop land to perennial forages for livestock grazing is a long-term commitment and involves infrastructure such as fencing, watering, and livestock handling facilities not required on cropland. Such expansion is more likely to occur on land owned than on leased land unless there is a long-term commitment in the lease agreement.

With the increase in grain prices in the recent past, the number of sites that have included corn within their system has almost doubled (Figs. 8 and 9). The total number of acres in corn has also increased. While price, market uncertainties, and high water demands for corn may limit further expansion of this cropping choice, during the years of this project, this crop has generally been profitable.

Other changes in cropping and livestock patterns are more subtle reflecting year-to-year changes in opportunities.

Water Use and Profitability

With 4 years of data, it is now possible to see certain patterns emerging and to examine systems in terms of their total water use vs. profitability. This is important both because of the basic need to conserve the water resource and because of anticipated regulation of water use. For the purposes of examining systems for meeting criteria of limited water use while maintaining profitability, we arbitrarily selected a maximum of 15 inches of irrigation water and a minimum of $300 gross margin as the desired target area for system performance. Please note that these numbers are selected only to begin this process and do not represent either the anticipated pumping limitation or the minimum amount of revenue required for agriculture to remain viable. This is simply a beginning point as we begin to understand what these limits may ultimately be and to see if a pattern in systems emerges for meeting these criteria.

Thirteen of the 29 sites examined were able to meet this target in at least 1 of the four years. Note that some of these sites do not represent the entire 4 years of the project but are included in this first examination of the data. These sites represent a range of cropping and livestock practices and, thus far, no particular pattern of irrigation system or agricultural enterprise has emerged.

Target water use: **15 inches or less**
Target profitability: **$300 or more gross margin**

Sites hitting the target in 4 of 4 years:

The only site that used less than 15 inches of irrigation water and exceeded $300 gross margin in all 4 years is site 7 (page 71). This site produces sideoats grama for seed and hay and uses a center pivot irrigation system to deliver water.

Sites hitting the target in 3 of 4 years:

Site 2 was a monoculture cotton system in years 1 to 3 and became a monoculture sunflower system in year 4 (2008; page 45). The irrigation system at this site is a subsurface drip system. This site met or exceeded the criteria in all years except for 2006 (year 3) when water use exceeded the target by about 5 inches. Gross margin was close to the $300 minimum in years 1 and 4. In year 2 (2007) this site exceeded $600 in gross margin and used less than 15 inches of irrigation water.

Site 8 produces sideoats grama for seed and hay and is irrigated with a subsurface drip system (page 75). This site produced between $400 and $500 per acre in gross margin in all years but water use slightly exceeded 15 inches in year 3.

Site 26 also hit or exceeded the target in 3 of the 4 years but slightly exceeded water use in 2006 (year 2; page 150). Gross margin was at or above $300 in all years. Site 26 was an integrated cropping system in years 1 and 2 and became an integrated cropping and cow-calf system in years 3 and 4. This system is irrigated by center pivot.

Sites hitting the target in 2 of 4 years:

Site 6 produced cotton in year 1 with stocker steers grazing wheat prior to the cotton crop (page 64). In years 2 and 3, cotton was grown as a monoculture system. In year 4, part of the area was converted to corn for grain while the remainder continued in cotton production. The criteria for water use and profitability were met by this system in years 2 and 3. Year 1 was well below 15 inches of water use but was less than $200 in gross margin. Year 4 exceeded $500 in gross margin but water use exceeded the 15-inch maximum target. Site 6 is irrigated by center pivot.

Site 21 uses center pivot irrigation. In year 1, cotton was grown in monoculture. In year 2, stocker steers grazed wheat that provided a cover crop prior to planting cotton on one–half of the circle while the remaining half was planted to corn (page 128). In years 3 and 4, one half of the circle was used to produce sideoats grama for seed and hay. Corn for grain was grown on the remaining half in year 3 while barley for seed followed by forage sorghum for hay was grown on this half in year 4. The target for water use and profitability were met by this site in years 3 and 4. In year 1, only about 7 inches of water was applied but gross margin was about $200 per acre. In year 2 with the inclusion of corn, water use exceeded the 15 inch target for this system and profitability was less than $200 gross margin per acre.

Site 23 is an integrated cropping system that included cotton/sunflowers in year 1, cotton/corn in year 2, corn only in year 3, and cotton/sunflowers in year 4 (page 137). Irrigation is supplied by a center pivot system. This system was at or below the target water use in all years but was above the $300 gross margin per acre target only in years 1 and 3.

Sites hitting the target in 1 of 4 years:

Site 9 is an integrated crop and livestock system that uses center pivot irrigation (page 77). This system produced stocker cattle in years 1 to 3 and included cows and calves in year 4. Perennial pastures are a mix of warm season grasses overseeded in most years with rye for additional grazing. Cotton was the cropping component in years 1, 2, and 4 with grain sorghum grown in year 3. A rye cover crop preceded the crop in years 1 to 3 and was used for cover and for additional grazing. This site met the criteria for water and profitability in year 1. In all other years, water use was well below the 15-inch maximum but profitability was between $100 to $200 gross margin per acre.

Site 15 began as a 2-field monoculture cotton site (page 102). For years 2 and 3, field 2 was split into a 2-paddock crop rotation with cotton and grain sorghum. In year 4, cotton and wheat were grown in these two respective fields. Cotton remained the crop in field 1 although this area was physically split into two fields in year 4. Water use by this system was below the 15-inch maximum in all 4 years. Profitability, however, only reached the $300 gross margin target in year 4. However, in years 2 and 3, profitability was over $200 gross margin per acre.

Site 19 is a center pivot irrigated system that grows cotton and pearlmillet for seed. This site was well below the 15-inch irrigation target in all years and exceeded the $300 gross margin target in year 3 (page 118). Gross margin was above $200 per acre in years 1 and 4 and was slightly less than $200 per acre in year 2.

Site 22 is irrigated by a center pivot system that included a cotton/corn for grain crop rotation in years 1 and 2 (page 132). In year 3 it became an all cotton system and in year 4 it became an all corn system. The only year that this site met the targets for water use and profitability was year 3 – the year that it grew cotton as a single crop. Gross margin for this year exceeded $600 per acre and water use was below the 15-inch target. The shift to corn in year 4 resulted in an increase in gross margin to over $800 per acre but water use was about 25 inches. In the 2 years that this site used a corn-cotton rotation, water use exceeded the 15-inch maximum (only slightly in year 1) while profitability was below the target in year 1 but was above the target in year 2.

Site 27 entered the project in year 2, thus, only 3 years of data are available. This site produced cotton in year 2, cotton and corn for silage in year 3 and cotton and corn from grain in year 4 and is irrigated by a sub surface drip system (page 155). Only year 4 met the targets for water use and profitability. Years 2 and 3 exceeded water use targets but profitability was above $400 gross margin per acre.

Site 28 entered the project in year 4 so only 1 year of observation is available (page 160). This site was a monoculture corn for grain site irrigated by sub-surface drip. Data from this site indicated water use well below the target level with profitability above $700 gross margin per acre. More years of observation are needed to see if these outstanding results are repeatable.

Meeting the Targets for Water Use

Averaged over all irrigated sites and all 4 years of the project, only 12.1 inches of irrigation have been applied (Table 16). This is well within the 15" target for potential water limitation for this region. However, individual sites varied within this target.

Looking only at water use during the 4 years of this project, 15 sites have never exceeded the target of 15 inches for maximum water use. Of these 15 sites, 10 have been in the project the entire 4 years, 2 were in the project for 3 years, and only 3 have had only 1 year of observation.

Nine additional sites exceeded 15 inches in only 1 of the 4 years and all but one of these sites has been in the project the entire 4 years with the remaining site included for 3 of the 4 years.

Adding all of the individual years of site observation together for these 24 sites gives 84 years of individual observations. For these sites, the 15-inch maximum was exceeded in only 9 times. Thus, these 24 sites in the Demonstration Project are meeting the objectives for water use about 89% of the time! While targets for profitability were not always met by these sites, it is anticipated that with the knowledge being gained and advances in technology, profit margins can be increased in many of these systems.

One additional site met the target in 2 of 4 years with the 2 years that exceeded this limit only doing so by a small amount of additional water.

For the four remaining sites, 2 exceeded the 15-inch limit by a large amount in all 4 years. One site exceeded the limit in 3 of 4 years, while the remaining site exceeded the 15-inch maximum in 2 of the 3 years of observation.

It is important to understand why sites use both more and less water for irrigation. Site 20 (page 123) exceeded 20 inches of water use in all four years. This system uses center pivot irrigation and grows corn, small grains, and forage sorghums primarily for silage but some grain and hay. Gross margins have been above the $300 per acre target in 3 of the 4 years but in year 1, gross margin was negative for this site.

Site 22 met the targets for water use and profit in 1 of the 4 years and was close to this in a second year (see above and see page 132). However, in years 1 and 4 water use exceeded 20 inches but profitability was above the $300 target for gross margin. This corn/cotton rotation system became a corn only system in year 4, the year of highest water use but also the year of greatest profitability.

Site 24 was a corn/cotton rotation in years 1 and 2 and became a corn for grain monoculture in years 3 and 4 (page 142). With the shift to corn only, profitability increased in both years while water use increased only in year 4. Water use was close to the target level for years 1 and 3 but was almost 20 inches in year 2 and approached 25 inches in year 4.

Site 27 entered the project in year 2 and is an integrated cropping system. This site is irrigated by sub-surface drip. Cotton only was produced in year 2 with this system becoming a cotton/corn system in years 3 and 4 (page 155). Water use was within target levels in year 3 but was around 20 inches in years 2 and 4. Thus, changes in cropping sequences do not explain the water use patterns for this system. Profitability exceeded the $300 gross margin target in all 3 years.

Discussion

The sideoats grama grass seed monoculture systems have been consistently the most successful in meeting both the water and profitability criteria. This has been observed under both center pivot and sub-surface drip irrigation. However, along with these systems, a cotton monoculture, an integrated cropping system that included grass seed with either corn or barley for seed production, and an integrated crop (pearlmillet and grain sorghum for seed and corn for grain)/cow-calf system also are among the most successful in meeting the water and profitability standards.

Systems that met the criteria in 1 or 2 years did so when they included:

- Cotton as a monoculture
- Integrated system including grass seed/corn or barley
- Integrated system including cotton/sunflowers
- Corn monoculture
- Integrated corn/cow-calf system
- Integrated cotton/wheat system
- Integrated cotton/corn grain system

Our observations for all-livestock/forage systems are limited to site 5. This site has averaged less than 4 inches of irrigation water applied over the 4 years of this project. From a water use and profitability perspective, this site is likely the most sustainable in the long run. Profitability has generally been between $200 to $300 gross margin per acre.

While dryland systems obviously met the criteria for water conservation, profitability of these systems never met the arbitrary $300 gross margin target. This may not be an appropriate target to these systems or for other systems. What defines a sustainable level of profit for an individual or a region can vary depending on many different circumstances. Dry land systems returned some level of profit in year 1 (Table 12) but lost money in year 2 (Table 13). They became profitable again in year 3 (Table 14) but in year 4 (Table 15), one site lost money while the other returned a profit. Dryland farming involves a high level of risk with its dependence on vagrancies of weather. It is probable that an irrigated component of otherwise dryland systems could buffer these systems and provide more flexibility while reducing total system water use.

Table 12. Summary of results from monitoring producer sites during 2005 (Year 1).

System	Site No.	Acres	Irrigation Type[1]	System Inches	$/system Acre	$/inch water
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
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
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 13. Summary of results from monitoring producer sites during 2006 (Year 2).

System	Site No.	Acres	Irrigation type[1]	System inches	$/system acre	$/inch water	Gross margin per inch irrigation
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
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
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 14. Summary of results from monitoring producer sites during 2007 (Year 3).

System	Site No.	Acres	Irrigation Type[1]	System inches	$/system acre	$/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
Corn silage	27	62	SDI	13.00	194.40	14.95	24.18
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	11.30	191.68	16.96	23.15
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	27.74	37.16
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
Perr. grass, rye: stocker cattle/grain sorghum	9	237	CP	4.10	48.89	11.93	30.71
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 15. Summary of results from monitoring producer sites during 2008 (Year 4).

System	Site No.	Acres	Irrigation Type[1]	System inches	$/system acre	$/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	17.34	411.02	23.70	29.97
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	-18.72	Dryland	Dryland
Cotton/Wheat	15	95.5	Fur/SDI				
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	38.23	48.95
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	33.15	Dryland	Dryland
Crop-Livestock systems							
Wheat: cow-calf, grain/cotton/alfalfa hay	4	123.1	CP	14.51	154.85	10.67	16.99
Perennial grass: cow-calf, hay	5	628	CP	5.18	95.22	18.38	35.74
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	-66.00	-4.50	3.34
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

Thus, it appears that agriculture in the Texas High Plains has opportunities for diversity, profitability, and water conservation at least to a 15-inch maximum use. While examples of cotton and corn monocultures met these criteria, the greater number of systems doing so was integrated either in cropping rotations or crop and livestock systems. Simply integrating systems with either cropping rotation and or livestock is not a viable approach however. The components that make up these systems are going to dictate the outcome and our challenge is to identify the best array of component parts and the proportions and combinations that are best able to achieve our goals. Furthermore, many more systems met the criteria for the 15-inch pumping maximum and with refining of the systems components and/or improved technologies and management, may well meet the needs for both water conservation and profitability. Furthermore, what defines a sustainable level of profit for an individual or a region can vary depending on many different circumstances. Management is key to the way these systems behave. As we gain a greater understanding of the impact of the management strategies employed by these producers, it is very likely that we can make substantial progress toward water conservation and profitability.

Table 16. Overall summary of crop production, irrigation, and economic returns within production sites in Hale and Floyd Counties during 2005, 2006, 2007 and 2008.

Item		2005	2006	2007	2008	Crop year Average
Mean Yields, per acre (only includes sites producing these crops, includes dryland)						
Cotton						
	Lint, lbs	1,117 (22) [1]	1,379 (20)	1,518 (13)	1,265 (11)	1,312.00
	Seed, tons	0.80 (22)	0.95 (20)	1.02 (13)	0.86 (11)	0.91
Corn						
	Grain, lbs	12,729 (3)	8,814 (4)	12,229 (4)	10,829 (8)	11,150.25
	Silage, tons	30.9 (2)	28.3 (3)	27.3 (3)	-	28.83
Sorghum						
	Grain, lbs	4,147 (3)	2,987 (1)	6,459 (4)	6,345 (5)	4,984.50
	Silage, tons	26.0 (1)	20.4 (2)	25.0 (1)	11.3 (2)	20.68
	Seed, lbs				3507 (1)	3,507.00
Wheat						
	Grain, lbs	2,034 (1)	-	2,613 (5)	38.25 (4)	2,824.00
	Silage, tons	16.1 (1)	7.0 (1)	-	7.5 (1)	10.20
Oat						
	Silage, tons	-	4.9 (1)	-	-	4.90
	Hay, tons	-	1.8 (1)	-	-	1.80
Barley						
	Grain, lbs	-	-	-	3133 (1)	3,133.00
	Hay, tons	-	-	-	5.5 (1)	5.50
Triticale						
	Silage, tons	-	21.3 (1)	17.5 (1)	-	19.40
Sunflower						
	Seed, lbs	-	-	-	1916 (2)	1,916.00
Pearl millet for seed						
	Seed, lbs	3,876 (1)	2,488 (1)	4,002 (2)	2,097 (2)	3,115.75
Perennial grass						
Dahl						
	Seed, PLS lbs	-	-	-	30 (1)	30.00
	Hay, tons	-	-	-	2.5 (1)	2.50
SideOats						
	Seed, PLS lbs	313 (2)	268 (2)	96 (5)	192.9 (4)	217.48
	Hay, tons	-	-	-	1.66 (3)	1.66
Other						
	Hay, tons	-	-	-	0.11 (1)	0.11
Alfalfa						
	Hay, tons	8.3 (1)	9.18 (1)	4.90 (1)	12.0 (1)	8.60
Precipitation, inches (including all sites)		14.9	15.5	27.0	21.8	19.82
Irrigation applied, inches (not including dryland)						
By System						
Total irrigation water (system average)		9.2 (26)	14.8 (26)	11.1 (25)	13.3 (23)	12.10
By Crop (Primary Crop)						
Cotton		8.7 (19)	14.3 (19)	11.3 (11)	12.2 (10)	11.63
Corn grain		17.4 (3)	21.0 (4)	12.5 (4)	21.7 (8)	18.15
Corn silage		18.0 (2)	24.0 (3)	12.6 (3)	-	18.20
Sorghum grain		7.5 (1)	4.2(1)	6.6 (4)	12.3 (5)	7.65
Sorghum silage		15.0 (1)	12.5 (2)	13.5 (1)	11.5 (1)	13.13
Wheat grain		-	-	5.3 (3)	7.68 (4)	6.49
Wheat silage		7.5 (1)	16.3 (1)	-	5.5 (1)	9.77
Oat silage		-	4.3 (1)	-	-	4.30
Oat hay		-	4.9 (1)	-	-	4.90
Triticale silage		-	10.0 (1)	12.9 (1)	-	11.45
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)	7.00
Small Grain (silage)		7.5 (1)	10.2 (3)	12.9 (1)	5.5 (1)	9.03
Small Grain (hay)		-	4.9 (1)	-	-	4.90
Small Grain (all uses)		5.2 (5)	7.3 (10)	7.44(11)	8.2 (6)	7.04
Sunflower seed		-	-	-	9.6 (2)	9.60
Millet seed		-	-	-	9.6 (2)	9.60
Dahl						
hay		-	-	-	4.65 (1)	4.65
seed					9.4 (1)	9.40
Sideoats						
seed		-	-	-	8.0 (3)	8.00
Bermuda						
grazing		-	-	-	6.2 (1)	6.20
Other Perennials						
hay		-	-	-	4.02 (1)	4.02
grazing					5.5 (1)	5.50
Perennial grasses						
Seed		-	-	-	8.35 (4)	8.35
Grazing		-	-	-	5.85 (2)	5.85
Hay		-	-	-	4.33(2)	4.33
All Uses		6.5 (6)	8.8 (6)	7.1 (7)	6.7 (8)	7.28
Alfalfa		10.3 (1)	34.5 (1)	10.6 (1)	15.6 (1)	17.75
Income and Expense, $/system acre						
Projected returns		660.53	773.82	840.02	885.14	789.88
Costs						
	Total variable costs (all sites)	444.88	504.91	498.48	548.53	499.20
	Total fixed costs (all sites)	77.57	81.81	81.77	111.98	88.28
	Total all costs (all sites)	522.45	586.72	580.25	660.51	587.48
Gross margin						
	Per system acre (all sites)	215.66	268.91	341.54	336.61	290.68
	Per acre inch irrigation water (irrigated only)	33.52	22.46	33.96	30.72	30.17
Net returns over all costs						
	Per system acre (all sites)	138.09	187.10	259.77	224.59	202.39
	Per acre inch of irrigation water (irrigated only)	21.58	15.83	24.94	19.63	20.50
	Per pound of nitrogen (all sites)	1.62	0.81	2.34	1.62	1.60

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

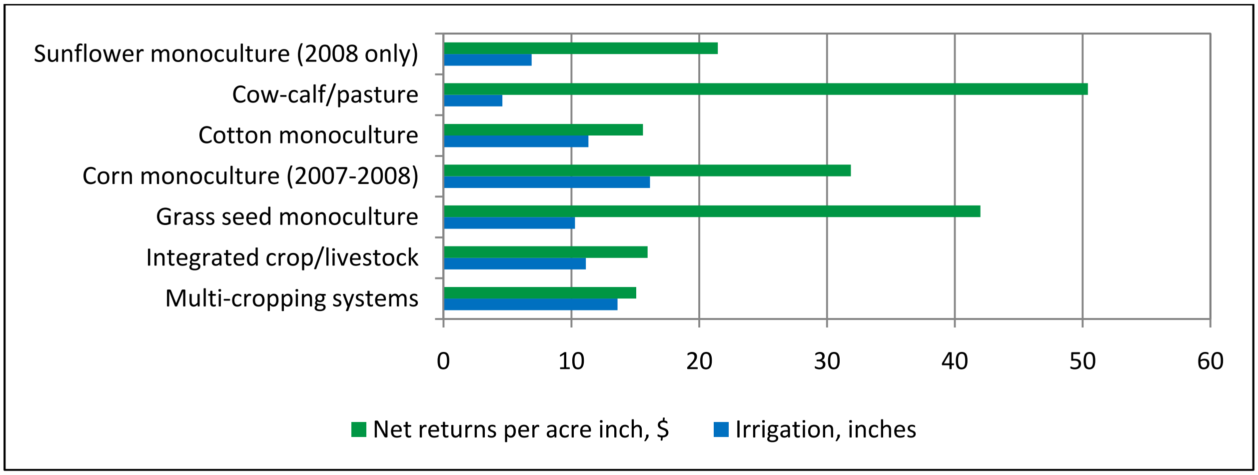


Figure 10. Net returns per acre inch irrigation water, and inches of irrigation applied, average of 2005-2008

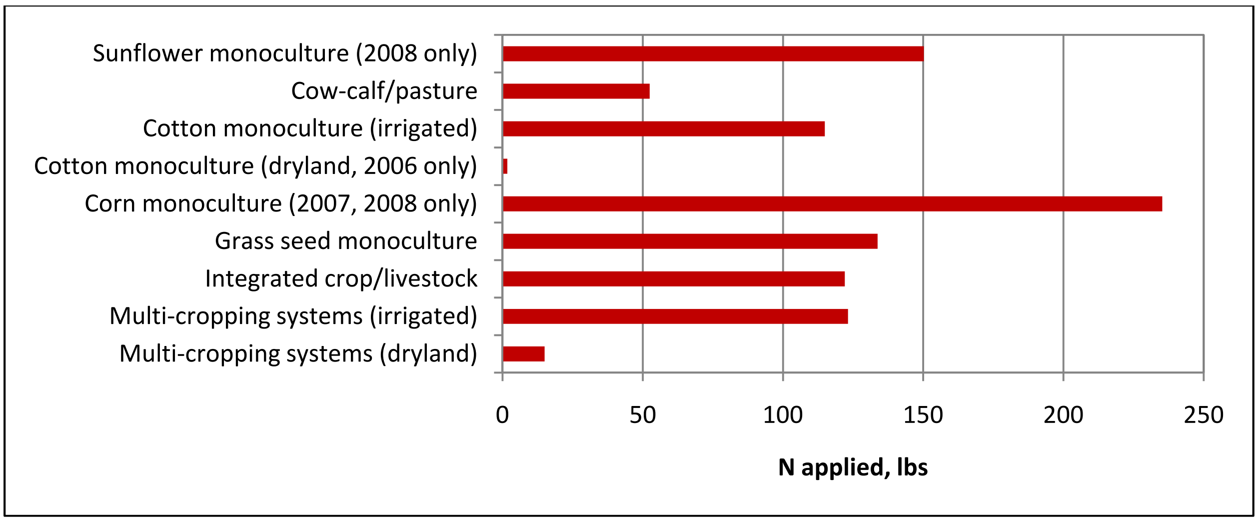


Figure 11. Pounds of nitrogen applied in fertilizer, average of 2005-2008.

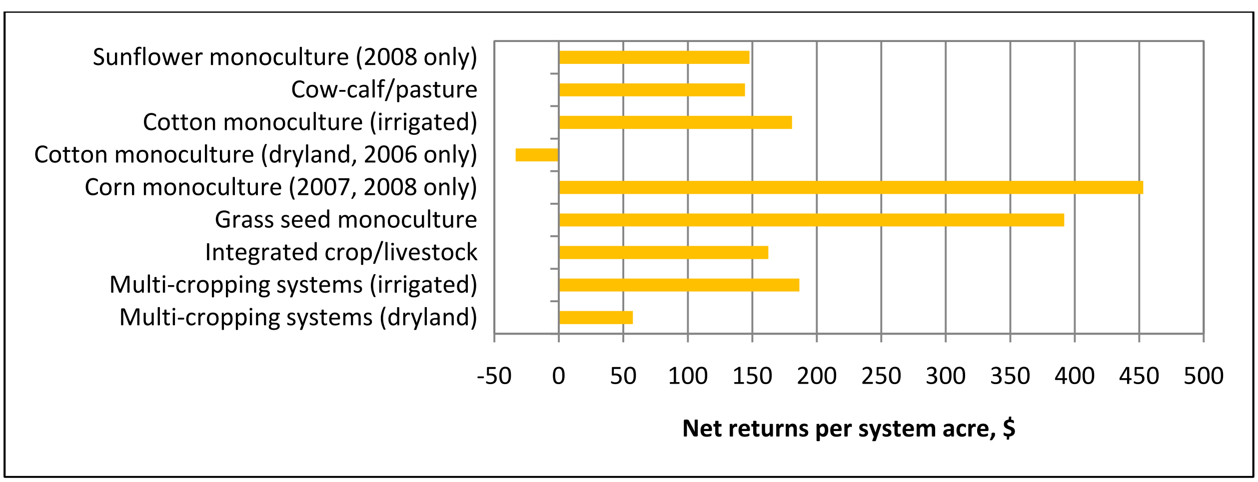


Figure 12. Net returns per system acre, average of 2005-2008.

Reports by Specific Task

Task 2: Project Administration

2.1 Project Director: Rick Kellison.

The 2008 growing season offered very different challenges as compared to the two previous years. The season started out extremely dry and very windy then finished the growing season much wetter and cooler than normal. Dry and windy conditions early in the growing season made it almost impossible to start a dryland crop. The irrigated producers had very high irrigation demands during very critical growth stages of their crops, especially the grain crops. The fall brought well above normal rainfall in September and October with very little heat unit accumulation. These weather conditions delayed crop maturity and harvest. One interesting observation was the indication of fields that had been irrigated too late in the growing season and the delayed maturity of these crops. In spite of this challenging year, our yields as a whole were better than we expected.

On March 31, 2008 I had the opportunity to meet with Senator Robert Duncan. The objective of this meeting was to report to Senator Duncan the progress of the TAWC demonstration project and plans for the future, both opportunities and challenges. We discussed the objectives that had been accomplished to date and the possible directions we should take in the future. We also discussed the upcoming field day. Senator Duncan stated that he was pleased with the progress of the TAWC project to date.

On July 31, 2008 Texas Alliance for Water Conservation hosted their first field day at the Floyd County Unity Center in Muncy, Texas. There were approximately one hundred people in attendance. We were able to assemble an outstanding group of speakers and panel members. Four producer sites were visited on our bus tour with the producers explaining specific information concerning their demonstration site. After our noon meal, Senator Robert Duncan gave the key note address.

Producer Board meetings were held on March 27, August 8, and October 25, 2008.

All TAWC producers met on December 19, 2008, when we presented the first three years of data collected from the TAWC demonstration. We presented crop water use for each crop and type of delivery system used. Also, a comparison of crop yields based on volume of irrigation water available, delivery system and amount and timing of fertilizer applied was discussed. Data was presented on a crop and system basis. Producers were requested to share ideas for future direction on TAWC.

Six TAWC site tours were given for 2008 and included visitors such as Dr. Dan Undersander, Dr. Gary Lacefield, Dennis Gehler, Minnie Lou Bradley, Jack Moreman, Jerry Grainer, Cheramie Viator, Mary Lou Bradley, Dr. Tony Allan and Dr. David Kemp.

At least eight TAWC presentations were given during 2008, to groups such as the Floydada Rotary Club, Ralls producers, Water and AgriScience Fair participants, Pioneer Hybrids Research directors and field day participants, Lubbock RoundTable and Olton CO-OP producers.

We have held eleven management team meetings this year. I have made frequent site visits throughout this past year.

2.2 Secretary/Bookkeeper: Angela Beikmann. *(three-quarter time position).* Year 4 main objectives for the secretarial and bookkeeping support role for the TAWC project include the following.

Accurate Accounting of All Expenses for the Project.

This 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 4 of the project. A budget change was constructed for subcontractor High Plains Underground Water Conservation District #1 and has been implemented for Year 4. This budget change does not affect any bottom-line total amounts for task, expense or project budgets. Preparation for a formal TAWC budget amendment request for the remaining years of the project is underway.

Administrative Support for Special Events.

A Field Day event was held on July 31, 2008 at Muncy, Texas. Pre-event planning, securing of services and other preparations were completed. Attended the Field Day event to assist in registration, clean up and any other tasks as requested. Post-event responsibilities included handling sponsors' contributions towards the costs of the event. Ongoing support for research team and special events, projects or other special requests continues as needed.

Ongoing Administrative Support.

Access database was created to integrate several mailing lists into one, organized list. This primary mailing list will aid in the completion of future mass mailing projects and tasks.

A binder for each TAWC producer was organized with the help of Justin Weinheimer. These binders are used by the producers to categorize their records, and assist the research team in acquiring useful data.

Executive Summary was compiled and forwarded to TWDB. This report summarizes the results of the first three years of the TAWC project and was also shared with others as requested.

Quarterly reports have been assembled and forwarded to TWDB. These quarterly reports, dated June 30, 2008, August 31, 2008, November 30, 2008 and February 28, 2009, coincide with quarterly reimbursement requests submitted by TTU.

Management Team meeting minutes have been recorded and transcribed for each meeting. These meetings were held on March 13, April 10, May 8, June 12, August 14, September 11, October 16, November 20, December 11, 2008, and January 15 and February 12, 2009.

Formatting changes for Year 4 Annual Report were made with the help of Dr. Will Cradduck, Dr. Vivien Allen and Phil Brown. These changes will focus mainly on re-formatting each site description page to include a graph and table unique to each system. Other graphs throughout the report will include 3-year averages as well as individual year information.

Daily administrative tasks include many clerical procedures and documents pertaining to a business/education setting.

TASK 3: FARM ASSISTANCE PROGRAM

Dr. Steven Klose
Jeff Pate
Jay Yates

Year 4 project progress regarding task 3 in the overall project scope of work 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 three times per 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 most of the 2008 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 the confidentiality of personal data is protected. Extension faculty have completed whole farm strategic analysis 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 offered to demonstrators as a service is helpful to both the individual as well as the long-term capacities of the project, the essential analysis of the financial performance of the individual sites continues. FARM Assistance faculty completed and submitted economic projections and analysis of each site based on 2007 demonstration data. These projections will serve as a baseline to for future site and whole farm strategic analysis, as well as providing a demonstration of each site's financial feasibility and profitability. 2008 analysis will be completed this summer, as yield data has only recently been finalized for the 2008 crop.

Focus Papers

Farm Assistance members completed two focus papers utilizing the economic data on five sites within the TAWC project The first paper compared sideoats grama grass grown under subsurface drip irrigation to a sideoats field grown under center pivot irrigation. The second paper compared three cotton sites. One site utilized flood irrigation, another utilized center pivot irrigation and a third site utilized subsurface drip irrigation. The purpose of these focus papers was to show the economic viability of each type of irrigation practice when utilized on different crops.

Continuing Cooperation

Farm Assistance members also cooperated with Texas Tech doctorial candidate, Justin Weinheimer, in contacting project producers, as well as furnishing historical yields that will aid Mr. Weinheimer in the economic modeling portion of his dissertation. Meetings between Mr. Weinheimer and project producers were held in conjunction with field record collection so as to minimize the interruption of field activities of the cooperating producers.

FARM Assistance Focus

AgriLIFE EXTENSION
Texas A&M System

Furrow, Pivot, and SDI Irrigation Illustration For Cotton in the Southern High Plains

Jeff Pate
Jay Yates
Mac Young
Steven Klose
Greg Kaase

FARM Assistance Focus 2009-1
January 2009

Department of Agricultural Economics
Texas AgriLife Extension Service
Texas A&M University System
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FARM Assistance

The increasing regional demand for water coupled with the ongoing needs of irrigated agriculture has spurred an interest in evaluating water conservation practices.

Conservation of the Ogallala Aquifer, the primary source for water in the Southern High Plains, is being headlined because of substantial depletion of underground reserves. The increasing regional demand for water coupled with the ongoing needs of irrigated agriculture has spurred an interest in evaluating water conservation practices. As a result, water use demonstrations on irrigated crops have been established. In this illustration three irrigation methods are examined: traditional furrow, center pivot, and subsurface drip. Illustrating the economic viability of the site demonstrations allows for an evaluation of the viability of differing irrigation practices in the search for more efficient water delivery systems.

The Texas Alliance of Water Conservation (TAWC) project is a multi-faceted effort among the Texas Water Development Board, Texas Tech University, Texas AgriLife Extension Service, Texas AgriLife Research, the United States Department of Agriculture, the High Plains Underground Water Conservation District #1, and the producers of Floyd and Hale counties. It is designed to demonstrate water conservation methods while maintaining or improving agricultural production and economic opportunities within communities. The project focuses on maximizing the efficiency of irrigation water pumped from Ogallala Aquifer, while also looking at methods which allow for water conservation with a minimum economic impact to producers. The Texas AgriLife Extension Service (Extension) conducts the economic analyses of demonstration results, evaluating the potential impact of adopting alternative water conserving technologies. Extension works individually with agricultural producers using the Financial And Risk Management (FARM) Assistance financial planning model to analyze the impact and cost-effectiveness of the alternative irrigation technologies.

In 2007, furrow, center pivot, and subsurface drip irrigation (SDI) demonstrations, in association with the TAWC project were examined to illustrate potential water application and irrigation costs scenarios in cotton production (Table 1). The following analysis evaluates the potential financial incentives for using these three irrigation technologies.

Assumptions

Table 1 provides the basic water use and irrigation cost assumptions for cotton irrigation. For the purpose of illustrating the different technologies, three demonstration sites were used, including a 135.1-acre SDI site (Site 1), a 124.2-acre pivot site (Site 14), and 66.7-acre furrow site (Site 15). Production costs were derived from custom rates and estimates of per acre overhead charges from the three individual sites. They are assumed to be typical for the region and were not changed for analysis purposes. These assumptions are intended to make the illustration relevant to a wide range of producers in the Southern High Plains area.

The analysis consists of three separate demonstration sites located in close proximity to one

Table 1

Demo Site	Irrigation Method	Acres	Acre Inches Applied	Irrigation Costs per Acre	Irrigation Costs Per Acre Inch	Yields per Acre (lbs.)	Yields Per Acre Inch (lbs.)
1	SDI	135.10	14.64	$191.97	$13.11	1374	93.85
14	Pivot	124.20	8.63	$102.50	$11.88	1296	150.17
15	furrow	66.70	13.33	$131.52	$9.87	1392	104.43

Table 2: 10 - Year Average Financial Indicators Per Acre For Cotton.

Demo Site	Irrigation Method	Projected Yield 2008-16	10 - Year Averages Per Year: Total Cash Receipts	Total Cash Costs	Net Cash Farm Income	Prob Net Cash Income <0 (%)	Avg. Annual Operating Expenses/Receipts
1	SDI	1390	$1,133.00	$1,111.00	$22.00	52.6	0.98
14	Pivot	1000	$1,047.00	$921.00	$126.00	47.3	0.88
15	Furrow	900	$821.00	$993.00	-$172.00	79.5	1.21

another. No difference in soil types, rainfall and management practices were associated within these three sites. As a result, the three trials represent a relatively controlled experiment for comparison purposes. This comparison is a case study example illustrating results of these sites. Site 1 assumes an overhead irrigation cost of $75.00/acre/year for the SDI, site 14 has a cost of $33.60/acre/year for the center pivot, and site 15 has a cost of $25/acre/year for its system. The system cost for the SDI site is assumed to have been installed using the EQIP cost share program, which is a standard practice in the study area. For the current analysis, no other major differences were assumed for the sites.

For each 10-year outlook projection, commodity price trends follow projections provided by the Food and Agricultural Policy Research Institute (FAPRI, at the University of Missouri) with costs adjusted for inflation over the planning horizon. Demonstration findings suggest a range of possible yields based on varying management practices and production conditions. Each 10-year outlook includes this yield risk as well a price risk.

Results

Irrigation costs and yields per acre inch for 2007 are compared in Table 1. These results show that the costs for the SDI (Site 1) were $13.11 per acre inch, including the system cost, as compared to $11.88 per acre inch for the pivot (Site 14) and $9.87 per acre inch for the furrow irrigated (Site 15). Yields were 93.85 pounds per acre inch for the SDI (Site 1), 150.17 pounds per acre inch for the pivot (Site 14), and 104.43 pounds per acre inch for the furrow site (Site 15).

Comprehensive projections for 2007, including price and yield risk for each irrigation method, are illustrated in Table 2 and Figures 1-3. Table 2 presents the average outcomes for selected financial projections, while the graphical presentations illustrate the full range of possibilities for net cash farm income. Cash receipts average $1,133/acre for the SDI (Site 1), $1,047/acre for the pivot (Site 14), and $821/acre for furrow (Site 15) over the 10-year period. While 2007 produced unusually good yields, the long-term expectations for furrow irrigated yields remain the lowest of the three irrigation systems. Average cash costs range from $1,111/acre for the SDI (Site1) to $921/acre for the pivot (Site 14) to $993/acre for the furrow (Site 15). It should also be noted that no direct or counter cyclical payments are included for any of the sites.
Average Net Cash Farm Income (NCFI) is the highest for the pivot (Site 14) at $126/acre, the SDI site is next at $22/acre, and is lowest for the furrow (Site 15) is -$172/acre (Table 2; Figures 1-3). NCFI decreases for all three sites from 2007 to 2008 due to a sharp rise in fuel and fertilizer costs. NCFI then generally increases the remainder of the ten-year projection period for the SDI and pivot sites. All three scenarios reflect significant

levels of risk (Figures 1-3). Risk projections also indicate a 52.6% or less chance of a negative NCFI for Site 1, compared to 47.3% for Site 14 and 79.5% for Site 15 (Table 2).

Summary

The case study results of comparing irrigation methods for cotton illustrate a variation of possible water application rates and irrigation costs. Two of the system demonstrations reported here, SDI (Site 1) and the Pivot (Site 14), illustrate a profitable use of modern technology in irrigation cotton production. However, the furrow site (Site 15) reflects a net loss per acre with furrow irrigation. It is important to note that the advantages and disadvantages of various irrigation systems will vary by crops, soil types, and seasons.

Figure 2. Projected Variability in Net Cash Farm Income per Acre for Cotton, Pivot.

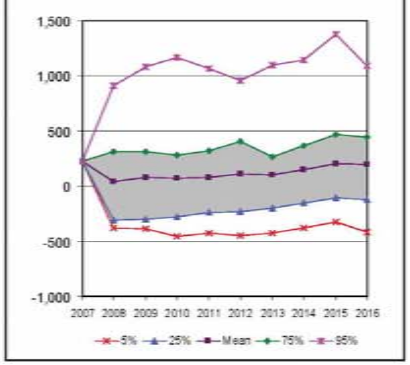


Figure 1. Projected Variability in Net Cash Farm Income per Acre for Cotton, SDI.

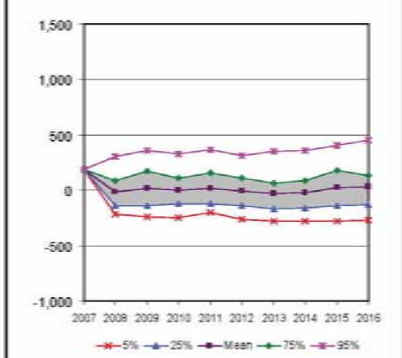
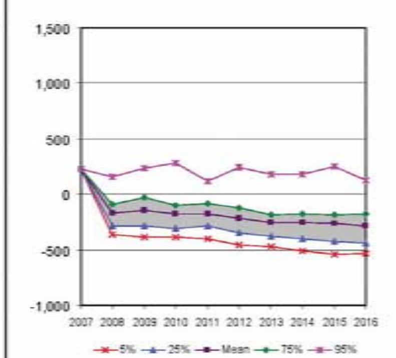


Figure 3. Projected Variability in Net Cash Farm Income per Acre for Cotton, Flood .



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FARM Assistance Focus

AgriLIFE EXTENSION
Texas A&M System

Pivot vs. SDI Irrigation Illustration for Side Oats Grama in the Southern High Plains

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FARM Assistance Focus 2009-2
January 2009

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farmassistance.tamu.edu

An increasing regional demand for water coupled with the ongoing needs of irrigated agriculture has spurred an interest in evaluating water conservation practices.

The overall demand for water in the Southern High Plains is being pressured by a substantial depletion of underground reserves. An increasing regional demand for water coupled with the ongoing needs of irrigated agriculture has spurred an interest in evaluating water conservation practices. As a result, water use demonstrations on irrigated crops, such as subsurface drip irrigation and pivot irrigation have been established. Illustrating the economic viability of the site demonstrations allows for an evaluation of the viability of differing irrigation practices in the search for more efficient water delivery systems.

The Texas Alliance of Water Conservation (TAWC) project is a multi-faceted effort among the Texas Water Development Board, Texas Tech University, Texas AgriLife Extension Service, Texas AgriLife Research, the United States Department of Agriculture, the High Plains Underground Water Conservation District #1, and the producers of Floyd and Hale counties. It is designed to demonstrate water conservation methods while maintaining or improving agricultural production and economic opportunities within communities. The project focuses on maximizing the efficiency of irrigation water pumped from the Ogallala Aquifer, while also looking at methods which allow for water conservation with a minimum economic impact to producers. The Texas AgriLife Extension Service (Extension) conducts the economic analyses of demonstration results, evaluating the potential impact of adopting alternative water conserving technologies. Extension works individually with agricultural producers using the Financial And Risk Management (FARM) Assistance financial planning model to analyze the impact and cost-effectiveness of the alternative irrigation technologies.

In 2007, center pivot irrigation technology was compared to subsurface drip irrigation (SDI) demonstrations associated with the TAWC project to illustrate potential water application and irrigation costs scenarios in sideoats grama production (Table 1). The following analysis evaluates the potential financial incentives for using these two irrigation technologies.

Assumptions

Table 1 provides the basic water use and irrigation cost assumptions for side oats irrigation. For the purpose of illustrating the two different technologies, two demonstration sites were used, including a 130-acre pivot site (Site 7) and 61.8-acre SDI site (Site 8). Production costs were derived from custom rates and estimates of per acre overhead charges from the two individual sites. They are assumed to be typical for the region and were not changed for analysis purposes. These assumptions are intended to make the illustration relevant to a wide range of producers in the Southern High Plains area.

The analysis consists of two separate demonstration sites located adjacent to one another on the same farm. No difference in soil types, rainfall and management practices were associated within these

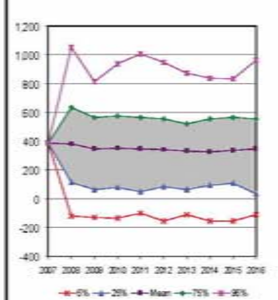
Table 1: Side Oats Grama Irrigation Application and Cost Information Per Acre in 2007.

Demo Site	Irrigation Method	Acres	Acre Inches Applied	Irrigation Costs Per Acre	Irrigation Costs Per Acre Inch	Yields Per Acre (lbs.)	Yields Per Acre Inch (lbs.)
7	Pivot	130.00	13.39	$140.59	$10.50	197	14.71
8	SDI	61.80	15.67	$202.20	$12.90	206	13.15

Table 2: 10-Year Average Financial Indicators Per Acre for Side Oats Grama.						
Demo Site	Irrigation Method	Total Cash Receipts	Total Cash Costs	Net Cash Farm Income	Prob Net Cash Income <0 (%)	Average Annual Operating Expenses/Receipts
7	Pivot	$1,656.00	$1,308.00	$348.00	15.40	0.81
8	SDI	$1,598.00	$1,358.00	$240.00	24.90	0.87

two sites. As a result, the two sites are a relatively controlled experiment for comparison purposes. This comparison is a case study example illustrating results of these sites. The first site (7), assumes a center pivot overhead cost of $33.60/acre/year and the SDI site (8) cost is $75.00/acre/year based on typical costs and useful life of the systems. The system cost for the SDI site is assumed to have been installed using the EQIP cost share program, which is a standard practice in the study area. For the current analysis, no other major differences were assumed for the sites.

Figure 1. Projected Variability in Net Cash Farm Income per Acre for Side Oats Grama, Pivot Irrigation



For each 10-year outlook projection, commodity price trends follow projections provided by the Food and Agricultural Policy Research Institute (FAPRI, at the University of Missouri) with costs adjusted for inflation over the planning horizon. Demonstration findings suggest a range of possible yields based on varying management practices and production conditions. Each 10-year outlook includes this yield risk as well a price risk.

Results

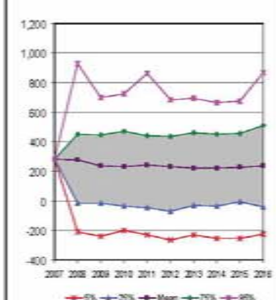
Irrigation costs and yields per acre inch for 2007 are compared in Table 1. These results show that the costs for the pivot (Site 7) were $10.50 per acre inch, including the system cost, as compared to $12.90 per acre inch for the SDI (Site 8). Yields were 14.71 pounds per acre inch for the pivot (Site7) and 13.15 pounds per acre inch for the SDI (Site 8).

Comprehensive projections, including price and yield risk for each irrigation method, are illustrated in Table 2 and Figures 1-2.

Table 2 presents the average outcomes for selected financial projections, while the graphical presentations illustrate the full range of possibilities for net cash farm income. Cash receipts average $1,656/acre for the pivot (Site 7) and $1,598/acre for the SDI (Site 8) over the 10-year period. Average cash costs range from $1,308/acre for the pivot (Site 7) to $1,358/acre for SDI (Site 8).

Average Net Cash Farm Income (NCFI) is the highest for the pivot (Site 7) at $348/acre while the SDI (Site 8) is $240/acre (Table 2; Figures 1-2). NCFI decreases slightly for both sites

Figure 2. Projected Variability in Net Cash Farm Income per Acre for Side Oats Grama, SDI



from 2007 to 2008 due to increases in fuel and fertilizer costs, then flattening in the later years. Both scenarios reflect significant levels of risk (Figures 1-2). Risk projections also indicate a 15.4% or less chance of a negative NCFI for Site 7, compared to 24.9% for Site 8 (Table 2).

Summary

The case study results of comparing irrigation methods for side oats grama illustrate a variation of possible water application rates and irrigation costs. Demonstration results vary little due to similarities in yields and management practices. Site 7 demonstrates a profitable use of center pivot sprinkler technology in grass seed and hay production. However, site 8 demonstrates, that even with the use of SDI technology, production is not increased enough to offset the higher cost of the SDI system in this case study. These two demonstrations provide a unique and site specific comparison of center pivot vs. SDI irrigation systems for the 2007 crop season. It is important to note that the advantages and disadvantages of various irrigation systems will vary by crops, soil types, and seasons.

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TASK 4: ECONOMIC ANALYSIS

Dr. Phillip Johnson
Dr. Eduardo Segarra
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Cody Zilverberg

Objective. The economic assessment will evolve over time with the integration of the demonstration project; allowing baseline data to be developed for both economic and agronomic analysis. As joint effort between the Texas Agri-Life, Texas A&M University and the Texas Tech University Department of Agricultural and Applied Economics (AAEC) will develop and maintain detailed records of inputs and production (costs and returns) on each farm production scenario using enterprise budgets developed from producer field records and the Texas Agri-Life's FARM-Assistance program. These records will provide the base data for determining the economic impact of observed technologies for producers and water utilization.

Achievements

- 2008 represented the fourth year of data collection form the project sites. Data for the 2008 production year have been complied and enterprise budgets have been generated.
- A set of farm level economic forecasting models was developed to better understand how a typical commercial agricultural operation deals with declining or restricted water resources which dictate enterprise selection and financial stability. These models and results are summarized in the following section titled Farm Level Financial Impacts of Water Policy, A Floyd County Farm Study. This unique study allowed the interaction of producers and agricultural leaders to cooperate in the development of modeling assumptions and characteristics.
- In correlation with the Task objectives, data analysis is an ongoing goal throughout the production year. As summarized in the TAWC Profitability Summary, the economics of various crop production systems were compiled to understand how certain agronomic systems consistently remain profitable while utilizing water resources to maximize agronomic and financial potential.
- Presentations made in 2008:
  - High Plains Underground Water Conservation District #1, "Farm Level Financial Impacts of Water Policy"
  - Panhandle Groundwater Conservation District, "Farm Level Economics and Water Conservation"
    - TAWC Producer Meeting, "Economic Modeling Summary"

TAWC Site Profitability Evaluation

2005-2007

This evaluation was conducted to identify the sites and or crops within the TAWC which have consistently produced the highest returns per acre while utilizing irrigation water efficiently. Due to the challenges faced in irrigated agriculture, it is important to identify specific cropping patterns, agronomic systems, or management characteristics which could allow commercial agricultural producers to reach profitability in the field while at the same time using their water resources efficiently.

To achieve the goals set forth by the project, two primary resources should be utilized efficiently, land and irrigation water. The economic comparison is based on Gross Margin (gross revenue less cash expenses) and provides two separate yet linked values:

(1) Gross margin per acre of crop land (returns to land), and

(2) Gross margin per acre inch of irrigation water applied (returns to irrigation).

While each value has its importance and application, the sites and or crops which are generating high returns to both land and irrigation are of primary interest. Table 17 gives the sites which had the highest gross margin per acre and the highest gross margin per acre inch of irrigation water applied. Data for the 27 sites in the TAWC project were averaged for the years 2005, 2006 and 2007, and ranked for gross margin per acre and gross margin per acre inch of irrigation. The 7 sites shown in Table 17 were in the “Top 10” for each criterion.

The results shown in Table 17 indicate that there is no “silver bullet” to achieve high returns for land and irrigation. The sites represent a variety of crops, cropping patterns and irrigation technologies. Three sites were monoculture cropping systems: sites 7 and 8 were monoculture grass seed (Sideoats Grama), and site 2 was monoculture cotton. Four sites had some type of cotton/grain rotation. Drip, LESA, and LEPA irrigation technologies are all represented in the top sites which indicate that irrigation management is more important than the type of irrigation system used.

Table 17. Sites in the Top 10 for Gross Margin per Acre and Gross Margin per Acre Inch of Irrigation for the Years 2005, 2006 and 2007.

Site	Irrigation Applied	Gross Margin Per Acre	Gross Margin Per Acre Inch	Irrigation Technology	Crop or Rotation [1]		
	Ac In/Ac	*$/Ac*	*$/Ac In*		*2005*	*2006*	*2007*
2	13.6	455.70	35.30	DRIP	CT	CT	CT
6	12.0	421.80	36.10	LESA	CT/WH	CT	CT
7	10.3	580.40	61.60	LESA	GS	GS	GS
8	11.6	459.60	43.90	DRIP	GS	GS	GS
22	16.4	413.40	28.60	LEPA	CT/CR	CT/CR	CT
23	10.5	315.10	36.90	LESA	CT/SF	CT/CR	CR
26	12.6	368.40	30.30	LESA	CT/CR	CT/CR	CR

[1] Abbreviation: CT – Cotton, WH – Wheat, GS – Grass Seed, CR – Corn, and SF - Sunflowers

Average irrigation applied over the three years ranged from 10.3 to 16.4 acre inches. Site 22 which had the highest irrigation applied of 16.4 acre inches was in a corn/cotton rotation. Sites 7 and 8 which were in monoculture grass seed (Sideoats Grama) had the lowest and third lowest irrigation levels and were the top sits with respect to gross margin per acre inch of irrigation. Grass seed production represents a high value specialty crop that has the potential to be very profitable with low levels of irrigation. The other five sites were in more traditional cropping patterns with all but one having some rotation that included cotton and grain crops.

The diversity of crops, cropping patterns and irrigation systems in the top sites indicates that management is a key factor in determining profitability. It is important to note with respect to the level of irrigation water applied that with proper management (even under limited resource availability) it is possible to maintain or increase profitability. The question becomes what types of management techniques and practices are represented in the most profitable and efficient production systems? The results from this evaluation dovetail into two of the three goals for the project over the next year with regard to irrigation management and water/nutrition management.

Farm Level Financial Impacts of Water Policy – A Floyd County Farm Study

The agricultural economy of the Texas High Plains relies heavily on irrigation water pumped from the Ogallala Aquifer. The Texas High Plains region produces 83% and 65% of the state's irrigated cotton and corn production, respectively. Irrigation withdrawals have exceeded recharge in the Southern Ogallala for many years and have led to the exhaustion of the aquifer in some areas and threaten to produce noticeable economic, social, and agronomic impacts on the regional and state economy. The Texas Legislature has shown a strong commitment towards increasing water conservation efforts through water policy implementation.

Past studies have analyzed the effects of various water policies at the regional level on water conservation, agricultural income and the regional economy. This study evaluated the response of an 1800 acre representative farm (95% irrigated and 5% dryland) in the Texas High Plains to the implementation of a water policy which restricts the amount of irrigation water available such that 50% of the current saturated thickness must remain in 50 years (50/50 water policy). Debates over the proper level of management intervention or type of policy are intense; however, for the purposes of this study the 50/50 water policy was evaluated due to its previous implementation by the Panhandle Groundwater Conservation District located in the northeastern Texas Panhandle.

Non-linear dynamic optimization methods integrated with a stochastic simulation model were used to estimate crop and enterprise selection, change in cash positions, and probability of financial viability for the representative farm over a 10-year time horizon. The models were run under a baseline scenario with no water policy intervention and a scenario with the 50/50 water policy irrigation restriction for four levels of initial saturated thickness (120ft, 100ft, 80ft, and 60ft). A comparison of the results from the two scenarios allowed the evaluation of farm level affects of the implementation of the 50/50 water policy.

The first stage of the analysis consisted of the estimation of enterprise levels on the representative farm using dynamic optimization models (solved using GAMS) with an objective to maximize the net present value of net returns reflecting the optimal usage of resources and available enterprises. The models incorporated non-linear enterprise production functions relative to irrigation levels which allowed for the adjustment of irrigation levels within an enterprise or between enterprises to meet specified water availability within each scenario. The results of the optimization models estimated a decision path over the 10-year time horizon based on mean input and output parameters. The results of the optimization models were used in a financial simulation model (solved using Simitar®) that incorporated empirical multivariate stochastic distributions of both price and yield to estimate the probabilities associated with certain financial indicators to evaluate financial viability for the representative farm over the time horizon.

Results for the optimization models indicated that sprinkler irrigated cotton and dryland sorghum were the predominant crops which maximized net returns per acre under both the baseline and 50/50 water policy models. The effect of the 50/50 water policy on water conservation and net income was most pronounced on the higher initial saturated thickness scenarios. Shifts toward dryland production were already occurring without water policy intervention at the lower saturated thickness scenarios. The probability of negative net cash income and cumulative ending cash reserves increased for all saturated thickness scenarios under the 50/50 water policy, with the greatest impacts being on the moderate to high saturated thickness levels. The results indicate that the 50/50 water policy will have the most detrimental economic impacts on moderate to high levels of water availability; however, the greatest water savings at the lowest costs were also realized for these scenarios.

Task 5: Plant Water Use and Water Use Efficiency

Dr. Stephan Maas
Dr. Nithya Rajan

The objective of this task is to estimate the actual amount of water used by crop, grassland, and pasture vegetation in the growth process. This quantity is called the daily crop water use (CWU), and can be accumulated over the growing season to estimate the total water used in growing a crop, grassland, or pasture. CWU does not include water lost from the field through soil evaporation, runoff, or deep percolation. CWU can be compared to the water applied to the field, either through irrigation and/or precipitation, to estimate the efficiency of water application in producing a crop.

As in the previous years of this project, daily CWU was estimated in a four-step process. In Step 1, Landsat images containing the study region were analyzed to determine ground cover (GC) in each study field. GC is indicative of the amount of living vegetation in a field. In Step 2, values of GC values for each field were determined for each day of the growing season. In 2008, a sufficient number of Landsat images could be obtained so that daily values were estimated using linear interpolation between satellite acquisitions. In Step 3, potential evapotranspiration (PET) was estimated for each day of the growing season from weather data observed at the West Texas Mesonet station at Lockney. In the final step, PET was multiplied by GC for each day of the growing season to determine daily CWU for each field in the project. In this procedure, GC is also referred to as a "spectral crop coefficient" (Ksc). This procedure is mechanistically similar to estimating crop evapotranspiration (ETc) using the standard FAO-56 crop coefficient approach, where an empirically determined crop coefficient (Kc) is multiplied by reference evapotranspiration (ET0) calculated for a "reference crop" surface (a well-watered, uniform short grass) from observed weather data. While Kc is specific to a given crop, it is not specific to a given field. Thus, estimates of ETc represent evapotranspiration under ideal conditions (a uniform, unstressed crop), and does not account for differences in crop growth from field to field. In contrast, the value of GC used in estimating CWU in this task comes from actual observations of crop growth in a given field, so the value of CWU for a given crop varies from field to field based on the variations in actual growing conditions.

Table 18 lists the satellite data acquisition dates for 2008. Due to favorable sky conditions, practically every Landsat-5 and Landsat-7 image during the growing season provided usable data for estimating crop GC.

Airborne multispectral imagery was also acquired in 2008 using TTAMRSS (the Texas Tech Airborne Multispectral Remote Sensing System). This system was flown aboard a Cessna Model 172 Skyhawk aircraft in cooperation with South Plains Precision Ag (see Figure 13). TTAMRSS imaging flights are summarized in Table 19. An example of TTAMRSS imagery is presented in Figure 14. Due to the abundance of Landsat images, it was not necessary to use TTAMRSS imagery for estimating CWU. However, the TTAMRSS imagery was used to demonstrate the ability to generate high spatial resolution maps of crop GC for fields in the TAWC Project. These maps are capable of showing detailed variations in GC across fields. Such information could be useful in crop management applications.

Table 18. Acquisition dates in 2008 for Landsat-5 Thematic Mapper (TM) and Landsat-7 Enhanced Thematic Mapper + (ETM+) imagery.

Landsat-5 TM	Landsat-7 ETM+
18 May	11 June
3 June	27 June
19 June	15 September
5 July	1 October
21 July	17 October
6 August	
22 August	
7 September	
23 September	
9 October	
25 October	

Table 19. Acquisition dates for TTAMRSS in 2008.

Date
31 July

Examples of high resolution GC maps produced from TTAMRSS imagery are presented in Figures 15-17. Figure 15 presents the GC map for Field 1 constructed using the aerial image data acquired on 31 July 2008. The GC of Fields 1-1 and 1-2 (planted to corn) was more spatially uniform as compared to Fields 1-3 and 1-4 (planted to cotton), which showed more variation in GC across the fields. Higher spatial variation in GC within the cotton fields suggests that these fields might be candidates for site-specific crop management. Of interest in the GC map is the linear feature oriented northeast to southwest supporting enhanced crop growth, as indicated by the higher GC values. This feature is associated with an abandoned railroad right-of-way running through the field. Although this feature in the past had been leveled, it still influences the growth of the crop and can be readily visualized in the GC map. Figure 16 shows the GC map constructed for Field 11 (which has three sections) using aerial image data from 31 July 2008. The GC of Field 11-1 (grain sorghum) showed wide variations in ground cover ranging from 19 to 73%. Although both Fields 11-2 and 11-3 were planted to furrow irrigated cotton, the GC map shows the cotton in Field 11-2 had a denser canopy compared to the cotton grown in 11-3. The feature along the northeast border of Field 11-1 is an ephemeral lake (a "playa lake"). At the time of the image acquisition, the lakebed was dry but supported a dense growth of natural vegetation. Figure 17 shows the GC map for Field 22, which is a center-pivot irrigated cotton field. The GC of Field 22 was uniform as in the cases of Fields 1-1 and 1-2, with an average GC of approximately 75%. The corners on the north side of Field 22 represent furrow-irrigated cotton, which the GC map shows had a lower GC compared to the center-pivot irrigated cotton in the main field.

Figure 13. Components of TTAMRSS. (A) Cessna Skyhawk aircraft; (B) System monitor; (C) View of underside of aircraft showing cameras; (D) computer.

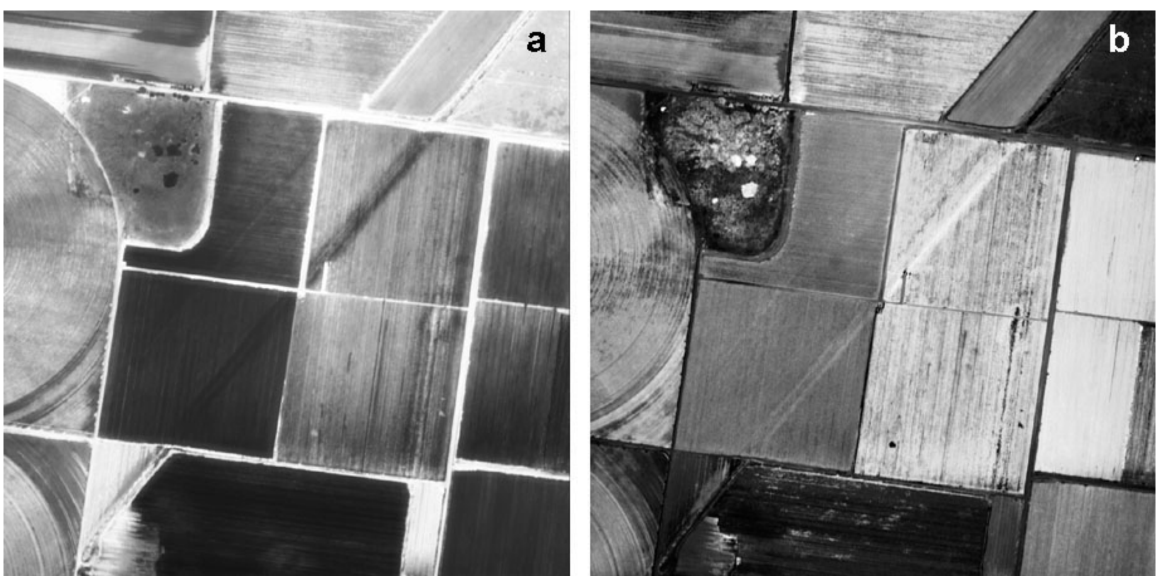

Figure 14. High resolution aerial imagery of Field 1 acquired using TTAMRSS imagery in the (a) red spectral band and (b) near-infrared spectral band.

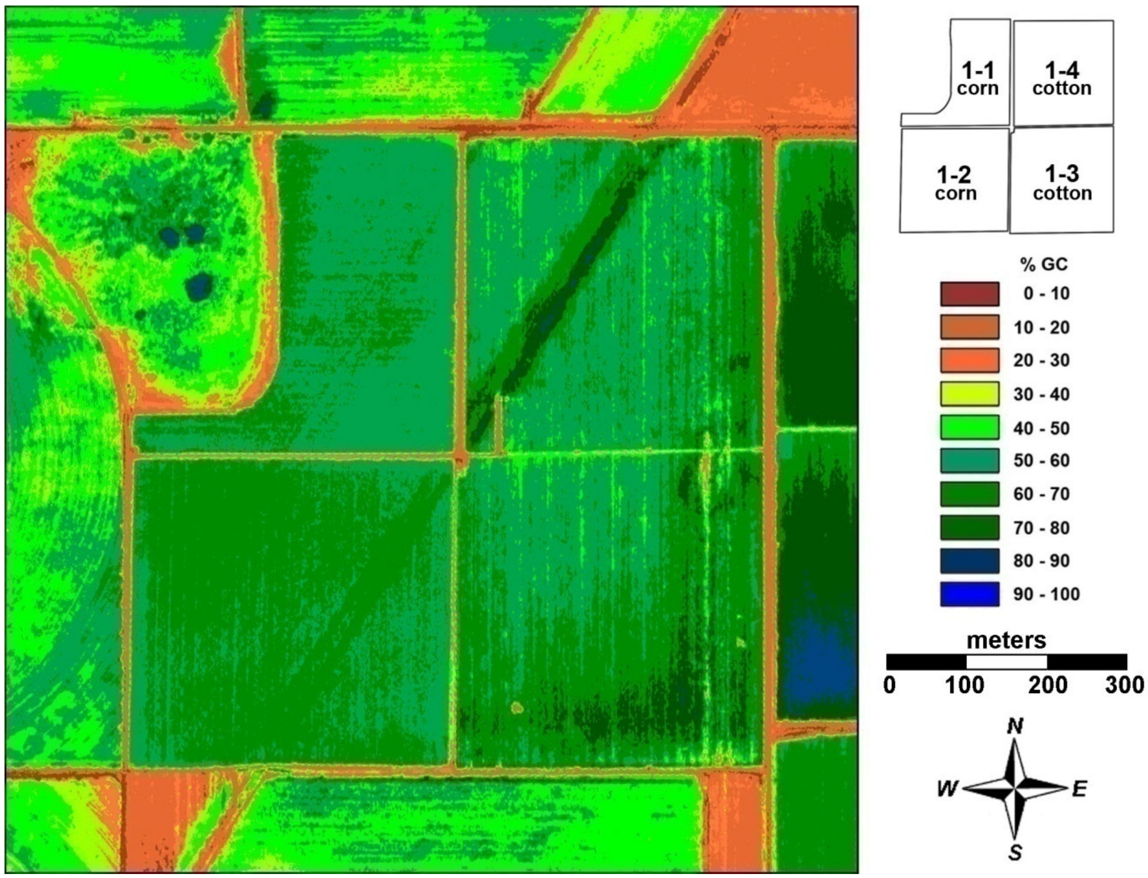

Figure 15. High resolution GC map constructed for Field 1 using TTAMRSS imagery.

Ground cover maps like those presented in Figs. 15, 16, and 17 could be of use in many crop management applications where vegetation index-based maps are currently used. A major advantage of these GC maps over vegetation index maps such as NDVI is that the GC map can provide an absolute measure of the state of the crop at any point in the field. Vegetation index maps can only describe the relative spatial variation in crop canopy density. Another advantage of GC maps is that, since they show an absolute measurement of crop status, one can directly compare results derived from multi-temporal images. This is because the GC maps constructed using this procedure implicitly include the corrections for factors that affect image DC values, such as atmospheric clarity. GC maps provide a description of the spatial variation in crop canopy density that is more easily understood by users (such as farmers) than vegetation index or "crop vigor" maps.

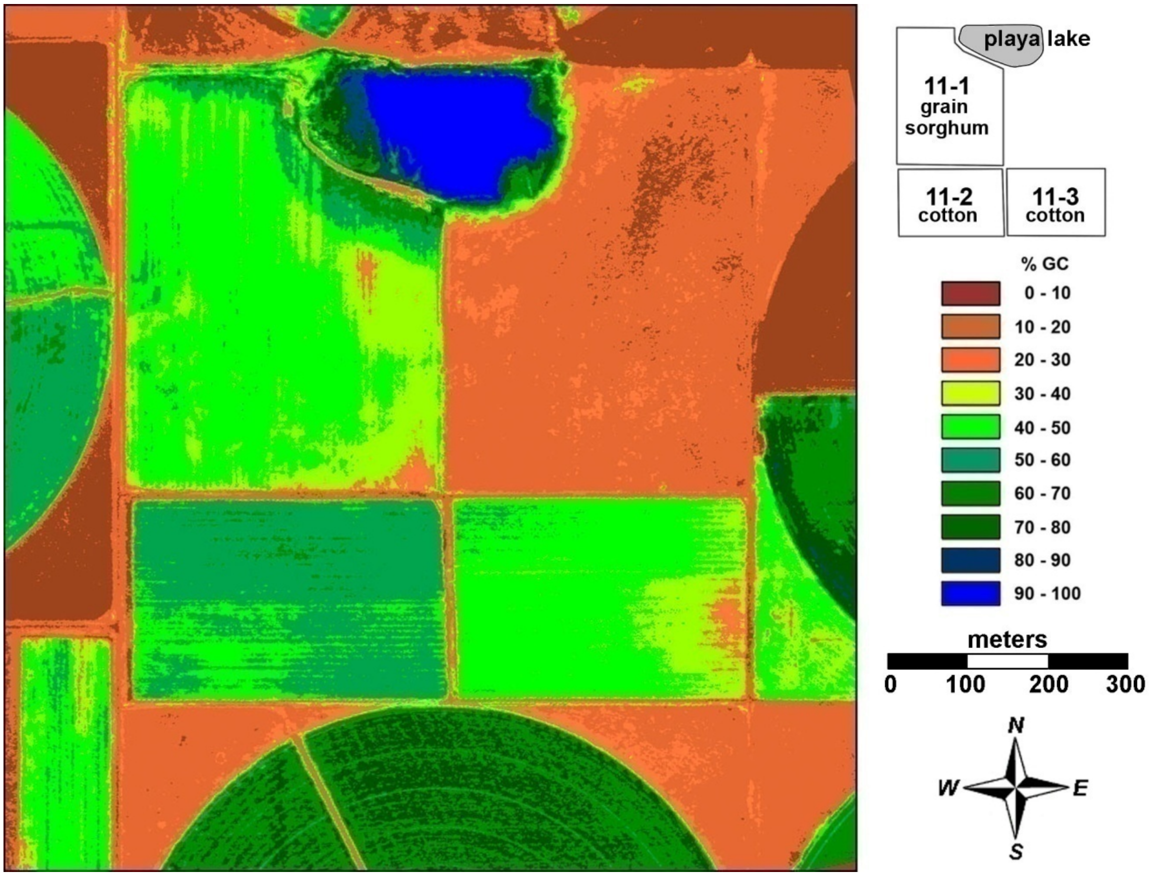

Figure 16. High resolution GC map constructed for Field 11 using TTAMRSS imagery.

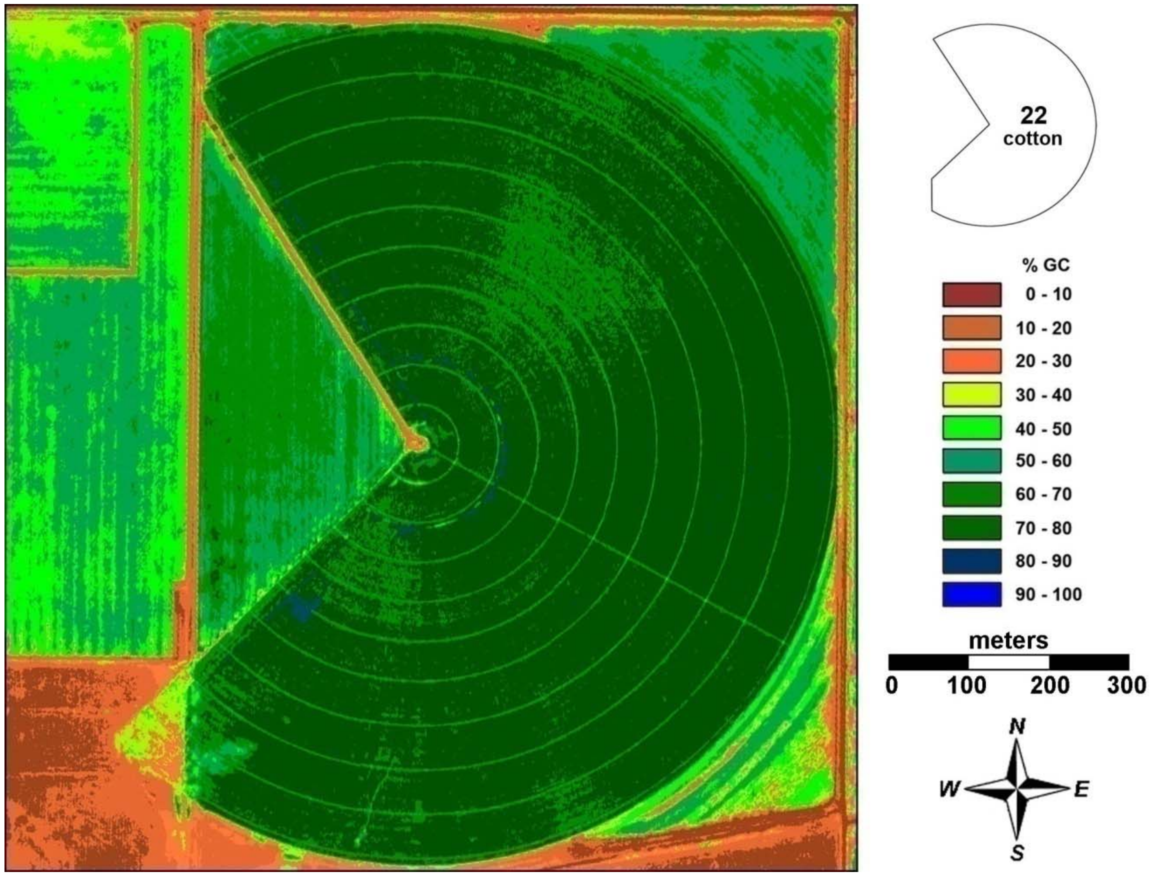

Figure 17. High resolution GC map constructed for Field 22 using TTAMRSS imagery.

Values of crop GC estimated from TTAMRSS high resolution imagery were compared against corresponding ground-based measurements of crop GC made within fields in the TAWC Project. This provides a test of how accurate the GC maps constructed from the TTAMRSS imagery are. Data from both 2007 and 2008 were used in this analysis. Results of this test are presented in Figure 18. The least-squares linear regression fit to the points in this figure has the equation,

$$GC_{EST} = 1.0014 GC_{OBS} + 1.7272$$

The correlation coefficient is 0.9873, indicating that this regression explained almost 99% of the total variance among the points. A Student's *t* test indicated that the slope of the regression line is not significantly different from 1 (t = -1.55, 21 df, α= 0.05) and the intercept of the regression line is not significantly different from 0 (t= 1.44, 21 df, α = 0.05). This suggests that there is no difference between the regression line and the 1:1 line. The calculated value of the AAE is 2.61, suggesting that the values of GC estimated using the procedure described in this study were on average within 3% of their actual values. These results suggest that the GC maps produced using TTAMRSS imagery are accurate representations of crop conditions in the observed fields.

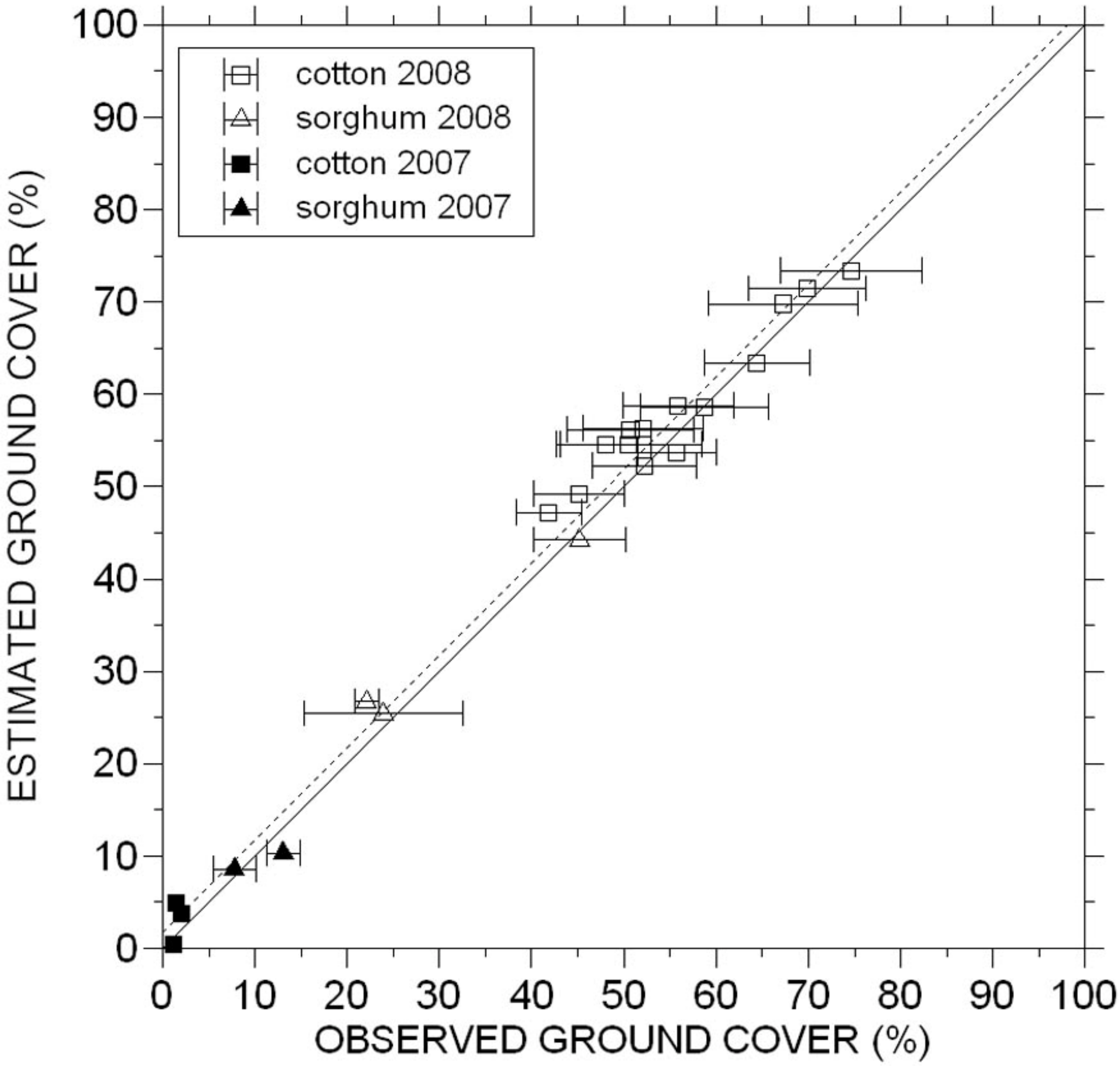

Figure 18. GC estimated from TTAMRSS imagery plotted versus corresponding ground-based measurements of GC. Dashed line represents the least-squares linear regression fit ($GC_{EST} = 1.0014GC_{OBS} + 1.7272$, $r^2 = 0.9873$) to the set of points, while the solid line represents the 1:1 line. Horizontal bars represent the mean observed value plus or minus one standard deviation.

Estimates of seasonal crop water use (CWU) for field crops in the 2008 study determined using the spectra crop coefficient method are presented in Table 20. Estimates of CWU for cotton fields in the study are compared in Figure 19. Corresponding results for corn and sorghum are presented in Figures 20 and 21. CWU estimates for all fields are compared in Figure 22.

Table 20. Seasonal crop water use for field crops in 2008.

Field No	Irrigation	Crop	CWU (mm/season)	CWU (inches/season)
1-1	Drip	Corn	573.72	22.59
1-2	Drip	Corn	679.23	26.74
1-3	Drip	Cotton	478.86	18.85
1-4	Drip	Cotton	452.81	17.83
2	Drip	Sunflower	514.01	20.24
3-1	Center-pivot	Sorghum	291.83	11.49
3-2	Center-pivot	Cotton	414.04	16.3
4-2	Center-pivot	Sorghum	625.68	24.63
6-2	Center-pivot	Cotton	404.10	15.94
6-3	Center-pivot	Corn	767.49	30.22
9-2	Center-pivot	Cotton	228	9.02
11-1	Furrow	Sorghum	274.03	10.79
11-2	Furrow	Cotton	359.51	14.15
11-3	Furrow	Cotton	352.21	13.87
12-1	Dryland	Sorghum	281.95	11.1
14-2	Center-pivot	Cotton	378.22	14.89
14-3	Center-pivot	Cotton	420.57	16.56
15-3	Furrow	Cotton	367.599	14.47
15-5	Drip	Cotton	581.9	22.9
15-6	Furrow	Cotton	362.58	14.27
17-3	Center-pivot	Corn	611.02	24.06
18-1	Center-pivot	Sorghum	190.54	7.5
18-2	Center-pivot	Cotton	408.81	16.09
19-7	Center-pivot	Cotton	322.52	12.7
20-1	Center-pivot	Sorghum	328.55	12.94
20-2	Center-pivot	Sorghum	233.12	9.18
22-1	Center-pivot	Corn	666.75	26.25
22-3	Center-pivot	Corn	701.01	27.60
23-4	Center-pivot	Sunflower	515.54	20.3
23-5	Center-pivot	Cotton	609.47	23.99
24-1	Center-pivot	Corn	653.48	25.73
24-2	Center-pivot	Corn	678.23	26.7
26-3	Center-pivot	Sorghum	625.42	24.62
26-4	Center-pivot	Corn	392.47	15.45
27-1	Drip	Cotton	542.27	21.35
28	Furrow	Corn	728.7	28.69
29-1	Dryland	Cotton	215.56	8.49
29-3	Dryland	Cotton	228.04	8.98
30	Furrow	Corn	687.12	27.05

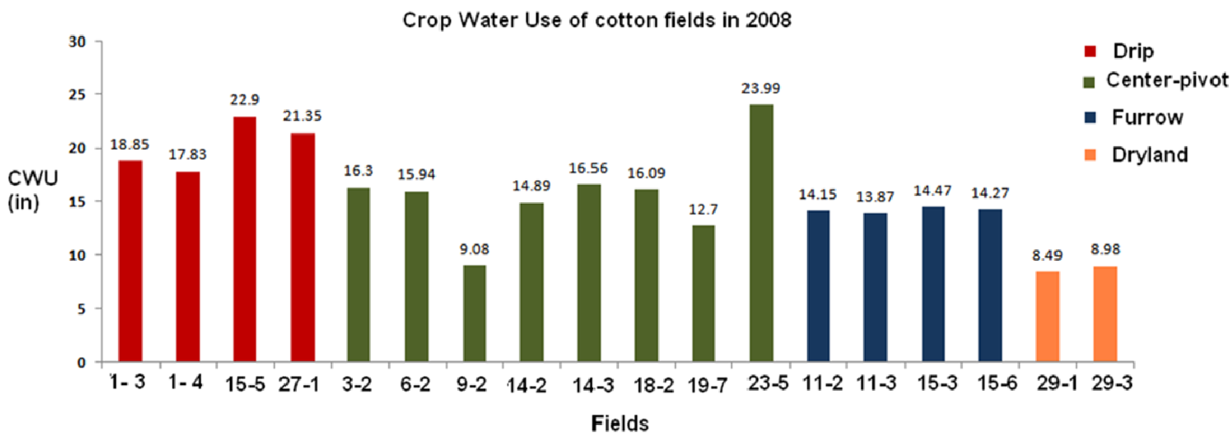

Figure 19. Seasonal average crop water use (CWU) for cotton fields under different irrigation systems.

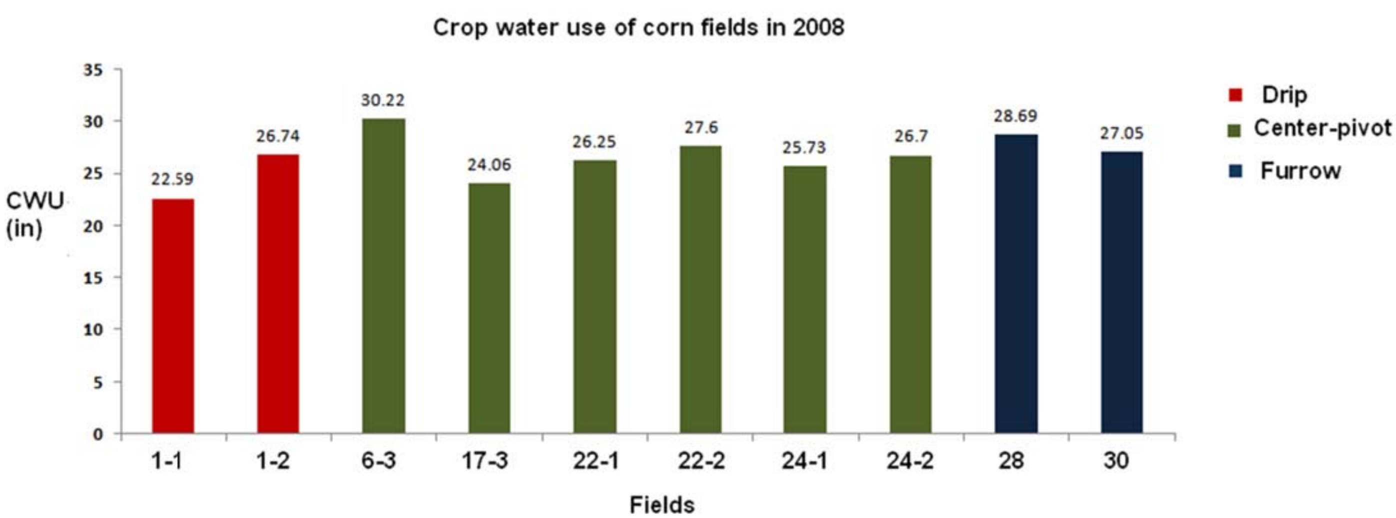

Figure 20. Seasonal average crop water use (CWU) of corn fields under different irrigation systems.

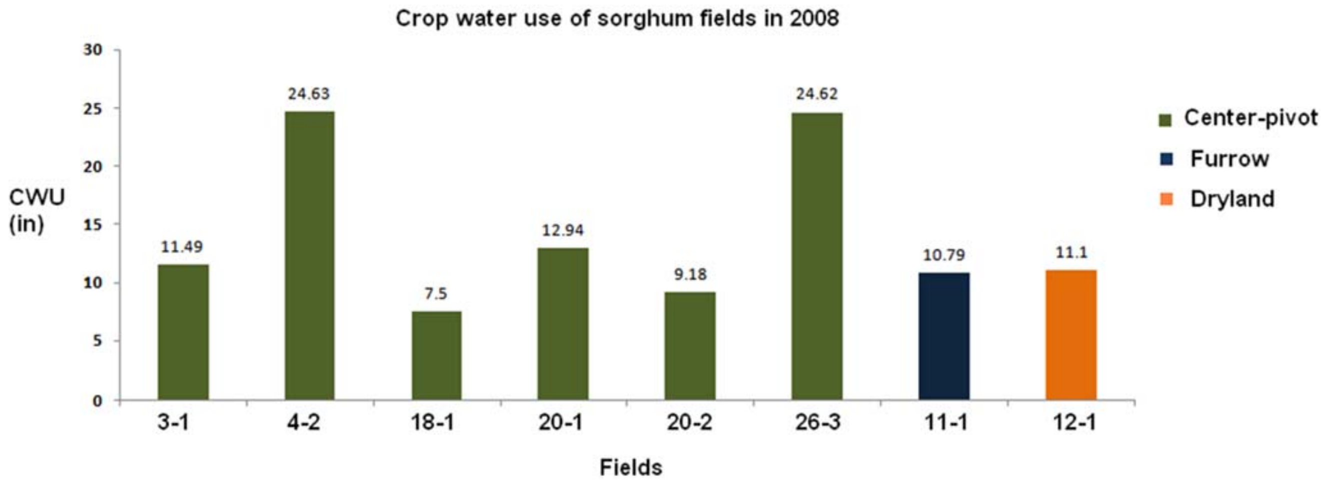

Figure 21. Seasonal average crop water use (CWU) of sorghum fields under different irrigation systems.

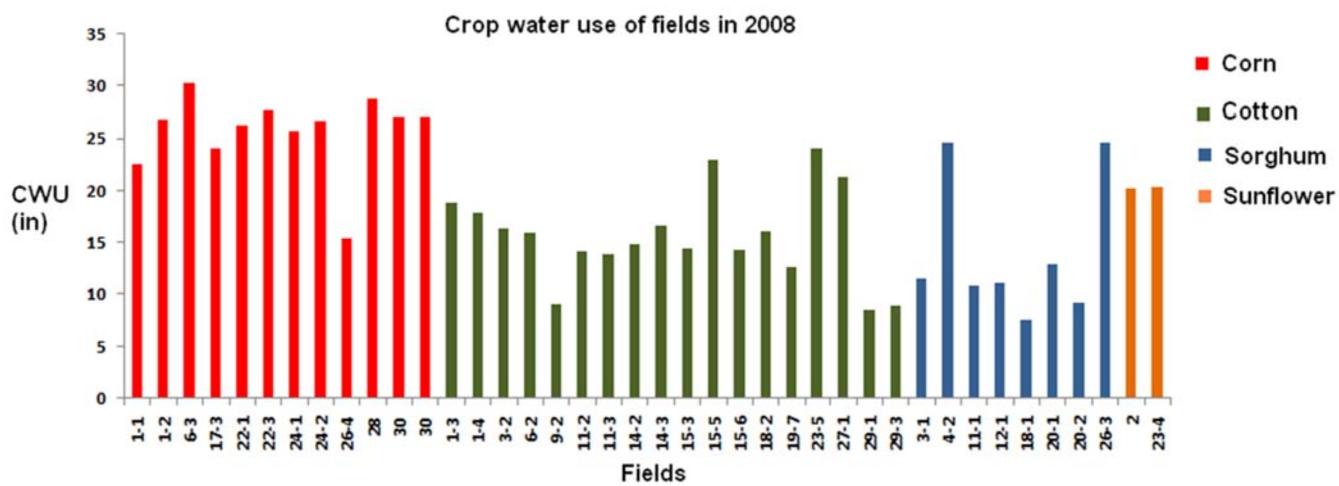

Figure 22. Seasonal crop water use (CWU) of fields in 2008.

Accumulation of CWU data from several years of project study allows the analysis of various relationships between CWU and other agronomic factors. An example is shown in Figure 23, where farmer-reported cotton yields for various fields in the TAWC Project are plotted versus corresponding values of seasonal CWU determined using the spectral crop coefficient approach. This analysis used data from the 2006 and 2007 cropping seasons. As indicated in the figure, the data from both years can be fit by a single regression line with the equation,

$$Yield = 108(CWU) + 156$$

This relationship explains over 60% of the variation in the data. The analysis shows that there is a consistent, strong relationship between the yield of the crop and the amount of water used by the crop during the growing season. This is in agreement with studies conducted by other researchers, which indicate that there should be a linear relationship between crop yield and crop water use.

The relationship between yield and irrigation applied is not as good. Figure 24 shows farmer-reported cotton yields from the 2006 growing season plotted against irrigation applied. There is considerably more scatter in the data, and the regression line between yield and irrigation does not fit as well. In this case, the regression explains only 27% of the variation between yield and irrigation. Thus, irrigation applied is not as good a predictor of yield as is CWU.

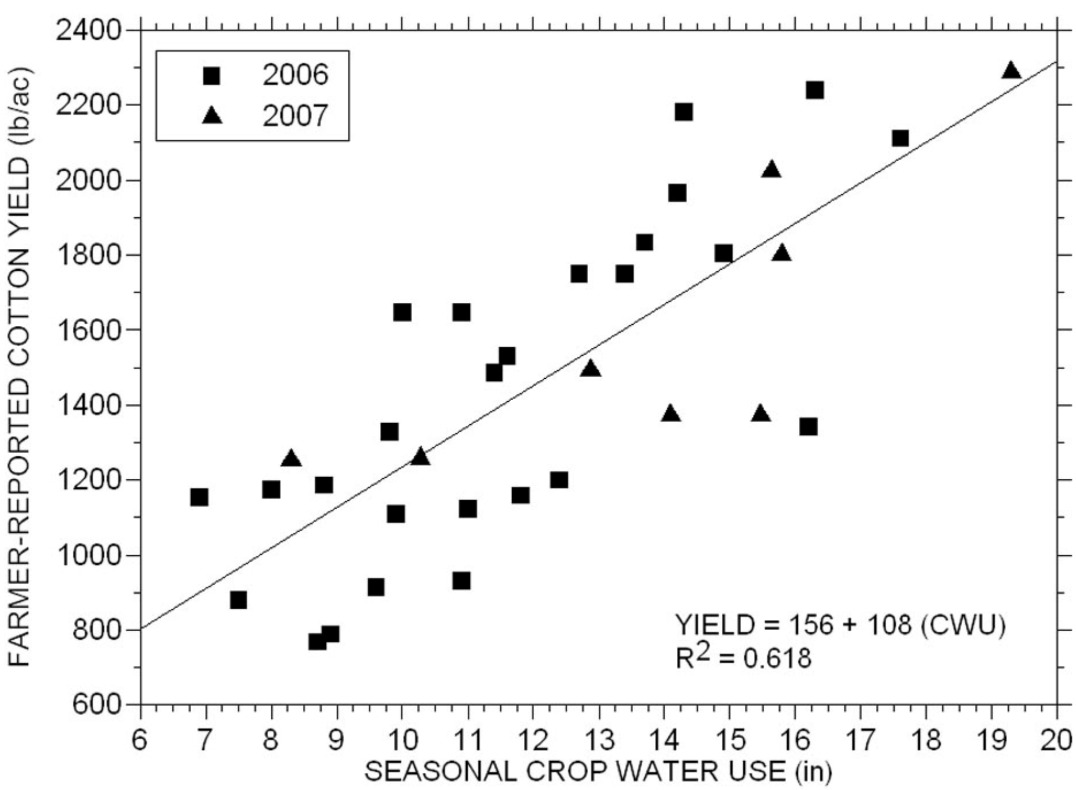

Figure 23. Relationship between farmer-reported cotton yields in 2006 and 2007 and corresponding values of seasonal crop water use.

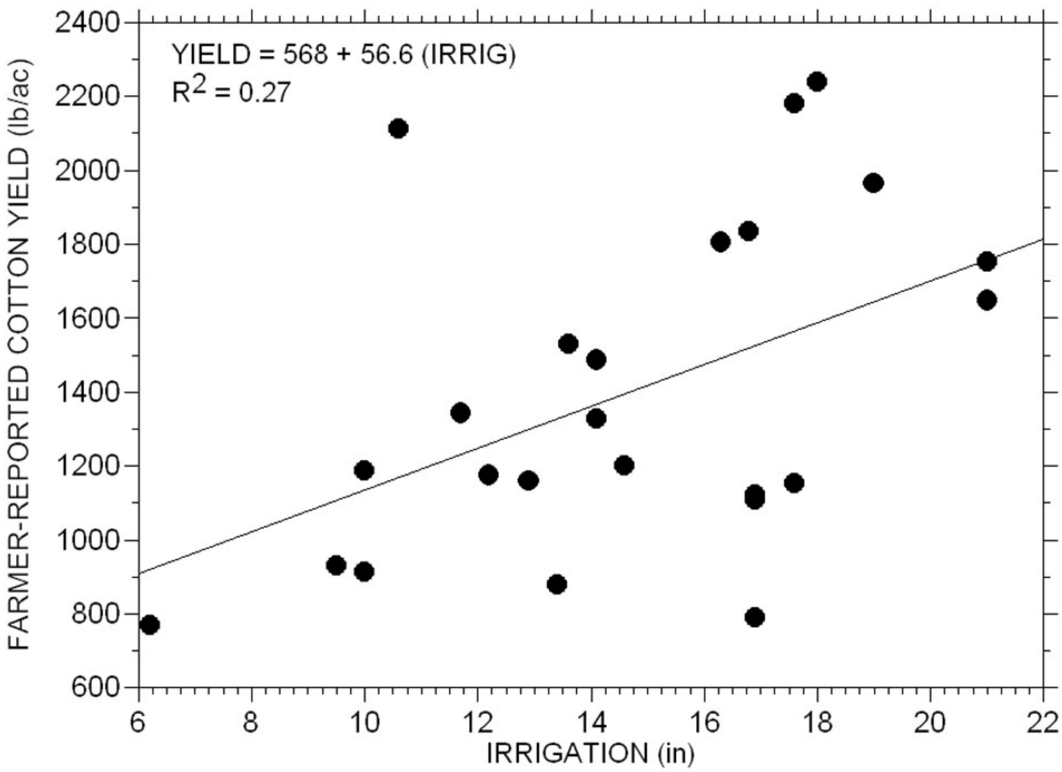

Figure 24. Relationship between farmer-reported cotton yields in 2006 and corresponding values of irrigation applied.

PUBLICATIONS RELATED TO TAWC

Rajan, N., and S.J. Maas. 2009. Mapping crop ground cover using airborne multispectral digital imagery. *Precision Agriculture* (In press).

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)

PRESENTATIONS RELATED TO TAWC

Maas, S.J. "Estimating plant transpiration and soil evaporation using remote sensing." Annual Meetings, Amer. Soc. Agronomy. 8 October 2008, Houston, TX.

Rajan, N. 2008. “Acclimation of crops to soil water availability.” Annual Meetings, American Society of Agronomy. 5-9 October, Houston, TX.

Rajan, N. 2008. “Comparison of PVI and NDVI for estimating crop ground cover for precision agriculture applications.” 9th International Conference on Precision agriculture. 20-23 July, Denver, CO.

TASK 6: COMMUNICATIONS AND OUTREACH

Dr. David Doerfert
Katie Leigh
Morgan Newsom

During this past year, several activities were designed and implemented towards the goal of creating a community of practice around agricultural water conservation. This past year also saw the beginnings of a transition of sort moving the TAWC communications and outreach activities from awareness building to activities that will facilitate the adoption of the research results and best practices produced during the past four years of the project. The most visible highlight of the year was the Farmer Field day conducted in July. Less visible was the research completed that increased our understanding of producer decision-making processes related to water. A second study that examines the importance of trust in the information seeking and dissemination of the project information saw the collection of data during 2008 and with results ready in 2009. 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.*

6.1 — Accomplishments

Farmer Field Day (July 31, 2008)

A significant investment of time and resources was spent on planning and implementing a Farmer Field day that was held on July 31, 2008. More than 100 producers and agricultural leaders attended the field day. Dr. David Doerfert and Katie Leigh, TAWC Communications Graduate Assistant, were responsible for the majority of the preparation activities.

On the day of the event, additional graduate students from the Department of Agricultural Education and Communications (Jarrott Wilkinson, Claire Williams, and Morgan Newsom) assisted with set-up, registration, refreshments, filming (digital and video) of the event, and other activities related to the event. More specifically, the planning activities of the field day included the following tasks.

- Developed and finalized a program for the field day program
- Secured speakers for program topics that included individual presentations and panel discussions
- Secured meeting location, food services, and local transportation between field sites.
- Developed and disseminating promotional materials including flyers, press releases, and on-air radio presentations. Press releases were sent to media outlets in West Texas, Oklahoma, Kansas, Colorado, and New Mexico. Flyers were sent to

county and regional offices of Extension, NRCS, and SCS agencies as well as to area agribusiness locations.

- Individual invitations were created and mailed to early 150 producers who signed up at the TAWC booth during the recent Amarillo and Lubbock farm shows.
- Developed and assembled a field day notebook for all participants.
- A new TAWC DVD was created that highlights the project activities and accomplishments to-date. Site filming began early in 2008 with work completed in time for distribution at the 2008 Farmer Field Day.

Informational Items Created & Disseminated

The initial *Summary of Research* was completed for the TAWC project on the first topic of forage sorghum silage*.* The summary highlighted the water conserving and economic findings of this crop in the TAWC project. The summary also include research findings from outside the TAWC project as well as best production practices that have been published. The initial printing of 500 copies was distributed and an additional 1,000 were subsequently printed.

Additional information pieces created prior to the Field Day were summaries of: (a) perennial grass variety trials, (b) the use of SmartCrop™ Systems in the TAWC project, (c) an overview of the first three years of the project, and (d) an overview of the 2008 Farm Bill components related to conservation and energy. Each of these items were included in the Farmer Field Day notebooks and distributed at the area farm and ranch shows.

Presentations and Project Promotions

Efforts were made to have a TAWC project presence at major producer gatherings. During 2008, a booth was created and used at two regional producer shows: the Southwest Farm and Ranch Classic (February 2008, Lubbock) and the Amarillo Farm & Ranch Show (December 2008, Amarillo). The booth was staffed throughout the show hours to provide information and respond to questions from those that stopped at the booth. Combined attendance at these two shows exceeded 3,000. Project descriptions and summaries of research were distributed to attendees.

To attract additional producers to the TAWC booth during the area farm and ranch shows, two 24" x 30" charts of project research results were created and displayed at the front of the booth for discussion with attendees. In further increase traffic to the booth, ads were designed and placed in three agriculture magazines (*The High Plains Journal*, *The Farmer-Stockman*, and *Western Dairy Business*). Based on the data collected during the shows, the charts were effective traffic-creating devices while the ads were not.

Project-related presentations continued in 2008 with presentations being made at Southwest Farm and Ranch Classic in February and the State FFA Convention in Lubbock in July. The project also continues to take advantage of opportunities to discuss the project through the various broadcast, print, and electronic media. During the past year, broadcast interviews were conducted with FOX34 (TV), local news radio (AM 1420 and AM 950).

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 past four years, additional communication planning and research activities were conducted during the past year to achieve the desired future outcomes. The items that were accomplished are listed below.

6.2a — Accomplishments: *Communications Planning*

Media training was conducted for the TAWC Producer Board members on March 27, 2008. The reason for this training is that these producers are the most likely sources for media interviews. The design of this training was to help them understand the best techniques to use during interviews based on the variety of media they may encounter.

Photo documentation of the individual field sites continued with five visits during 2008. 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 Day.

To help manage as well as share the thousands of photographs that have been taken over the previous years, the photographs have been uploaded to the internal project website with keywords to facilitate searches by other project participants.

The external TAWC project website was updated throughout the year with event news and project-related publications. Resources for the media professionals were constructed for the web site and released in May 2008. Included in the section are press releases, a photo gallery, project overview footage, and contact information for project leaders.

Finally, a clipping service was hired to help the project monitor the extent and type of print media coverage on the TAWC project. A content analysis is planned for 2009 with the results being used to further shape communication planning efforts.

6.2b — Accomplishments: *Research*

Dr. David Doerfert co-authored a research manuscript and three project-related research posters that were presented at the American Water Resources Association (AWRA) annual meeting in New Orleans in November. The presentations were:

- Leigh, K., & Doerfert, D.L. (2008). Farm-based water management research shared through a community of practice model. *Paper presented at the 44th Annual American Water Resources Association (AWRA) Conference*, New Orleans, LA.
- Wilkinson, J., & Doerfert, D.L. (2008). The critical role of the community coordinator in facilitating an agriculture water management and conservation community of practice. *Poster presented at the 44th Annual American Water Resources Association (AWRA) Conference*, New Orleans, LA.
- Newsom, M., Doerfert, D.L., & Carr, J. (2008). An exploratory analysis of the ruralpolitan population and their attitudes toward water management and

conservation. *Poster presented at the 44th Annual American Water Resources Association (AWRA) Conference*, New Orleans, LA.

- Williams, C., Doerfert, D.L., Baker, M., & Akers, C. (2008). Developing tomorrow's water researchers today. *Poster presented at the 44th Annual American Water Resources Association (AWRA) Conference*, New Orleans, LA.

One project-related research study was completed this past year as student thesis (second project thesis will be completed in 2009). Katie Leigh completed her research thesis titled *A Qualitative Investigation of the Factors that Influence Crop Planting and Water Management in West Texas*. For this study, Katie interviewed the members of the TAWC Producer Board about the factors they consider when making annual cropping decisions. Leigh found that producers lack factual information about their available water resources and are making annual production decisions based on perceptions and personal memories of well performance. The thesis can be accessed at http://etd.lib.ttu.edu/theses/available/etd-10312008-095820/.

In addition to the research that was completed, additional project-related research funding was sought during the past year. Drs. David Doerfert and Courtney Meyers secured funding through the Ogallala Aquifer Initiative to encourage Texas agriscience teachers infuse water management and conservation-related topics into their local curriculum ($61,720). The goal of this project is to increase water research awareness in students and teachers while encouraging the development of future water researchers. The majority of the activity will occur as part of the 2009 Texas Agriscience Teacher Conference in Lubbock.

Dr. Doerfert also met with representatives from six universities in Dallas on November 7-9, 2008 to begin efforts that would secure funding to expand the social science research efforts of the TAWC project including research on community of practice effectiveness. Outcome of the meeting will lead to a multi-institutional proposal to target a future USDA RFP on water management.

6.3 *Creation of longitudinal education efforts that include, but are not limited to, Farmer Field Schools and curriculum materials.*

6.3 — Accomplishments

Today's students will be tomorrow's water conservation practitioners and researchers. As such, providing information to educators to help shape this desired future are of value to the sustainable success of the TAWC project. As a start pointing, four lesson plans created and posted to the TAWC website under a separate "For Educators" section on the website to help high school agriscience teachers to incorporate water conservation material into their local curriculum. In addition, links to five websites with educational material was posted to the web site section. The goal for 2009 is to increase the amount of educational resources available through the project web site. The following were created and/or posted to the TAWC web site in 2008.

Lesson Plans

- Groundwater Basics (*included lesson plan, teacher manual, student manual, groundwater handout and PowerPoint presentation*)
- Irrigation Systems (*included lesson plan, center pivot handout, surface irrigation handout, and subsurface drip handout*)
- Technology Advances for Conserving Water in Agriculture (*included lesson plan, teacher manual, student manual, SmartCrop™ handout and PowerPoint presentation*)
- Sustainable Agriculture in the Southern High Plains (*included lesson plan, teacher manual, and student manual*)

Online Water Education Resources

- U.S. Geological Survey Water Resources *Information for Students and Teachers provides information on many aspects of water, along with pictures, data, maps, and an interactive center where you can give opinions and test your water knowledge. Links to other helpful web sites are also available.*
- U.S. Geological Survey *Water resources provides general information over varying water topics such as Groundwater, Surface Water, Water Quality, Water Use, etc. These information pages can be used as background information when teaching students about different aspects of water.*
- "Water IQ: Know your water" *is a multifaceted educational campaign targeting businesses and 1.5 million consumers. Water IQ challenges people to learn more about their natural water source and how wise, efficient daily water-use habits can make it last, especially during a drought. This site provides Water IQ Quizzes and general educational tips and resources.*
- The Groundwater Foundation *is a nonprofit organization dedicated to educating and motivating people to care for and about groundwater. This site provides student activities, games, and puzzles as well as sample activities and educational games for the classroom.*
- The Environmental Science Institute at the University of Texas in Austin *has developed a web site that provides information on Groundwater, Hydrology, Ecosystems, People and water, and K-12 Educational Resources that parallel these areas. Supportive classroom and laboratory*

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.*

<u>6.4 — Accomplishments</u>

- Timely quarterly reports and project summaries were provided as requested.

TASK 7: INITIAL FARMER/PRODUCER ASSESSMENT OF OPERATIONS

Dr. Calvin Trostle

7.2 Upon completion of the initial assessment of producers' needs, appropriate farm demonstrations will be outlined for the Lockney area in collaboration with the Producer Advisory Board...Additional demonstrations will replace completed tasks based on feedback from producers further into the project. Field demonstrations will be coordinated by Calvin Trostle, and each of these sites will serve as a focal point for educational programs, Farm Field School activities, etc.

Support to Producers.

Visited with ten producers during 2008 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 2008 centered on how to respond to the high price of grains and other crops going in to the 2008 cropping season, especially for corn and grain sorghum. Sorghum prices in particularly were sharply higher than previous record grain sorghum prices

Field Demonstrations.

A) Lockney & Brownfield Range Grass & Irrigation Trial

See the supplemental Task 7 report on the existing Lockney perennial grass trial as well as the newly established Terry Co. test site.

B) Small Grains Forage Trial

In response to producer questions and interest in small grains and wheat production, a 40 entry wheat variety trial was seeded at the R.N. Hopper farm at the southern edge of the TAWC site in Floyd Co. Due to wheat prices and the potential to use wheat in order to reduce summer irrigation, this test site was added as part of the greater Texas High Plains uniform wheat variety trials.

Opportunities to Expand TAWC Objectives.

Project awareness: Commented on project on four different radio programs, answered producers phone calls, and information and the approach that the TAWC project is taking has helped shape at least four other programs and Extension activities in the Texas South Plains.

Leverage of funding: 1) Received State of Texas NRCS Conservation grant to help establish the Brownfield grass trial site ($2,500). 2) received two-year federal Ogallala Aquifer Project (OAP) in support of perennial grass trial sites ($12,500).

Educational Outreach.

Participated in 3 county Extension meetings covering the TAWC demonstration area in 2008, including Muncy, September 3.

Met with Ben Dora dairy staff in Lamb County with Rick Kellison to discuss potential water savings by using forage sorghum rather than corn silage (September).

Existing TCE publications and reports were provided in the TAWC target area to at least 9 producers.

Support to Overall Project.

Activities include attending five monthly management team meetings and/or Producer Advisory Board meetings.

Texas Alliance for Water Conservation Perennial Grass Species Trial

Project Overview

Beginning in 2005 TAWC participants frequently discussed the slow but steady trend of producers converting cropland back into permanent grassland. Some of this land could very well seek to irrigate perennial grasses if that would be a more efficient and profitable use of groundwater resources. The Lockney trial site was initiated in 2006, and a second site was initiated in Terry Co. as an outreach of the TAWC project into surrounding areas.

As noted in previous reports the primary objective is to determine which perennial grass species and varieties are adapted to the region and productive under conditions ranging from dryland to ~1" irrigation per week (mid-April to early October).

Lockney Site

Irrigation was implemented as noted in Table 21 with an annual rainfall of 16.6". Irrigation was applied using a measured flow rate to apply the desired number of gallons per plot area.

Table 21. Lockney perennial grass trial rainfall and irrigation, 2008.

2008 Lockney Rainfall	Monthly Rainfall	Cumulative 2008 Total	Irrigation Levels (inches)		
Month	*(inches)*	*(inches)*	*Level 0*	*Level 1*	*Level 2*
January	0.0	0.0	DRYLAND		
February	0.4	0.4			
March	0.0	0.4			
April	0.3	0.7		1.0	2.0
May	4.1	4.8			
June	2.2	7.0		2.0	4.0
July	0.8	7.8		2.0	4.0
August	2.0	9.8		1.0	2.0
September	4.1	13.9			
October	2.6	16.5			
November	0.1	16.6			
December	0.0	16.6			

Yield data for 2008 as well as a 2-year summary is listed in Table 22 including the August 13-14 harvest for yield. Stockpiled forage from the end of the season will be added to the annual total once data processing is complete. Wrangler bermudagrass was dropped from the study due to poor growth and excessive weed contamination originating from the seed.

The trial grass yield by species ranged from 1,515 lbs./A (buffalograss) to over 17,000 lbs./A (Alamo switchgrass), with WWB Dahl & Caucasian old world bluestems and Kleingrass yielding over 10,000 lbs./A (trial average ~8,000 lbs./A when averaged across

Table 22. Perennial grass trial yield results for 2007-2008 cuttings, Lockney, Texas. Irrigation levels in 2008 peaked at 10% (Level 2). Table does not reflect additional data from stockpiled forage, 2008. Trial was established in April, 2006.

Entry	Perennial Grass Species	Variety	Total for July & Nov. 2007 Clippings	Irrigation Level^	Yield @ Irrigation Lbs./A 8/13-14/08	Avg. Yield all Irrigation Levels 2008	Average All Irrig. Levels Lbs./A 2007-2008	Avg. 2-Year Total Yield all Irrig 2007-2008
1	Buffalograss	Plains	2,551	0	1,464	1,515	1,077	2,033
				1	1,459		980	
				2	1,623		1,262	
2	Sideoats Grama	Haskell	9,174	0	3,941	5,175	3,339	7,174
				1	5,147		3,838	
				2	6,435		4,811	
3	Blue Grama	Hatchita	9,399	0	4,063	4,144	3,631	6,771
				1	3,950		3,600	
				2	4,418		3,818	
4	NRCS Natives Blend	3 Grasses‡	8,517	0	3,622	5,993	2,982	7,255
				1	7,098		4,797	
				2	7,260		5,174	
5	Switchgrass	Alamo	18,056	0	15,975	17,265	12,012	17,661
				1	17,751		12,344	
				2	18,070		12,991	
6	Kleingrass	Selection 75	14,447	0	8,708	10,391	7,214	12,419
				1	11,228		8,975	
				2	11,237		8,700	
7	Old World Bluestem	Spar	14,471	0	5,719	8,919	5,257	11,695
				1	8,764		7,507	
				2	12,274		9,061	
8	Old World Bluestem	WW-B Dahl§	16,007	0	8,813	11,637	7,733	13,822
				1	12,565		10,196	
				2	13,533		9,717	
9	Old World Bluestem	Caucasian	13,110	0	8,252	10,874	6,728	11,992
				1	11,271		8,083	
				2	13,099		8,778	
12	Indiangrass	Cheyenne	5,594	0	5,284	6,485	3,820	6,039
				1	7,159		4,660	
				2	7,011		4,559	

Entry	Perennial Grass Species	Variety	Total for July & Nov. 2007 Clippings	Irrigation Level^	Yield @ Irrigation Lbs./A 11/2-7/07		Average All Irrig. Levels Lbs./A 11/2-7/07	Average for Season Lbs./A 11/2-7/07
10	Bermudagrass	Ozark	15,801	0	7,805	6,281	6,568	11,041
		sprigged		1	5,713		5,542	
				2	5,324		5,750	
11	Bermudagrass	Giant/Common	14,486	0	6,905	8,218	5,808	11,352
		(1:1 ratio,)		1	8,796		7,099	
		seeded¶		2	8,954		7,201	
		Trial Averages	11,801	**0**	6,713	8,075	5,514	9,938
				1	8,408		6,468	
				2	9,103		6,819	
P-Value (Variety)					<0.0001			
P-Value (Irrigation)					<0.0001			
P-Value (Variety X Irrigation)					0.1008			
Fisher's Protected Least Significant Diff. (0.10)¤					1,429			
Coefficient of Variation, CV (%)					55.4			

^Due to high early season rainfall, irrigation was applied only on 31 July and 24 August (1" each for '1'; 2" for '2').

‡50% Hatchita, 40% Haskell, 10% green sprangletop (Natural Resources Conservation Service blend for Floyd Co.).

¤Values in the same column that differ by more the PLSD are not statistically/significantly different at the 90% confidence level.

Wrangler bermuda grass was deleted from the trial due to poor stand which has become weedy.

all irrigation levels. For all grasses, the dryland grass production level averaged 5,500 lbs./A., and 6” and 12” of supplemental irrigation increased forage yields about 1,000 and 1,300 lbs./A respectively, a yield increase that would not be justified. As a class the old world bluestems (WWB Dahl, Caucasian, and Spar) were far superior to other grasses in taking advantage of supplemental irrigation.

Two-year average yields demonstrated the similar results as the 2008 results alone (Table 22). Alamo switchgrass clearly is producing the most forage or biomass to date, and the old world bluestems and Kleingrass next in order of forage production. Two-year bermudagrass yields are also solid (11,000 lbs./A). Noting strictly dryland performance, the same grasses are also outperforming, and the familiar native grasses such as sideoats grama and blue grama are not yielding competitively although they may be hardier in the worst of drought years and/or have higher quality forage.

Terry County Grass Species Stand Establishment

Similar to the trial at Lockney, TAWC determined that an area of prime interest in perennial grasses and the potential to convert irrigated agriculture back to dryland centered on the highly sandy soils of the southwest South Plains. With slight modification of the grasses planted at Lockney, we prepared land at Mike Timmons farm east of Brownfield. Grasses were seeded in late May once irrigation was available (about six weeks later than desired). Establishment ratings were tracked (Table 23), but the

Table 23. Initial stand ratings of perennial grass trial establishment, Terry County, Texas 2008. Trial site was infested with pigweed, which precluded full establishment and re-seeding will occur in 2009.

Entry	Perennial grass species	Variety	Stand Rating‡	
			7/9/08	11/5/08
1	Buffalograss	Plains	0.5	0.1
2	Sideoats grama	Haskell	1.2	0.9
3	Blue grama	Hatchita	1.0	0.7
4	Natives Blend	Terry Co. NRCS Mix†	2.0	1.4
5	Switchgrass	Alamo	1.0	0.7
6	Kleingrass	Selection 75	2.3	2.8
7	Old world bluestem	Spar	1.0	1.8
8	Old world bluestem	WW-B Dahl	0.3	0.8
9	Old world bluestem	Caucasian	0.7	1.0
10	Bermudagrass	Ozark sprigged	Not yet sprigged	
11	Bermudagrass	Giant/Common,1:1 (seeded)	Not yet seeded	
12	Dahl OWB for overseeing	Yellow sweet clover	Legume not seeded	
13	Dahl OWB for overseeing	Alfalfa	Legume not seeded	
14	Dahl OWB for overseeing	Overton 18 rose clover	Legume not seeded	
15	Dahl OWB for overseeing	Hairy vetch	Legume not seeded	

†Mix of bristlegrass, sideoats grama, Blackwell switchgrass, and sand lovegrass.

‡0 = none, 1 = poor, 2 = fair, 3 = good, 4 = very good, 5 = excellent

irrigation input flared a tremendous weed problem particularly with pigweed (carelessweed). Rescue options were limited due to a winegrape vineyard immediately to the west. Banvel and atrazine was applied mid-season to try to knock the weeds back and the trial site was mowed.

Bermudagrass as well as the interseeding of four different legumes into stands of WWB Dahl old world bluestem were delayed until 2009.

In spite of the weed pressure, and similar to the Lockney trial establishment in 2006, Kleingrass achieved a good stand, and Spar OWB a fair stand at the end of the season. Like Lockney, these two grasses again highlighted ease of establishment, which is important to producers. All other grasses failed to establish well, and would generally be considered a failure were it not for the weed problems. The test site will be over seeded for all grasses in April 2009.

Education Outreach

One educational program was hosted at the Lockney grass trial site in 2008 for a local tour. Additional tour stops are anticipated for 2009. A fall tour stop for the Terry County crop tour was planned for the Brownfield site, but was canceled due to a lack of stand.

TASK 8: INTEGRATED CROP/FORAGE/LIVESTOCK SYSTEMS AND ANIMAL PRODUCTION EVALUATION

Dr. Vivien Allen
Dr. Will Cradduck
Song Cui

Descriptions of sites that include livestock

Of the 26 sites in the demonstration project in 2008, 6 included livestock. This compares with 6 sites in 2007, 5 sites in 2006 and 4 sites in 2005. Thus, within these sites, at least one additional location has been added each year. All sites within the demonstration project involving livestock are exclusively beef cattle. These sites include both stocker and cow-calf systems. Of the 8 sites with cattle in 2008, 7 were cow-calf systems and one was stocker cattle. Based on observations of this region and data in the Texas Agricultural Statistics, an increase in beef cattle grazing systems appears to be representative of trends in this region. Specific information for 2008 by site is provided below.

Site 4. This is the second year that cattle have been included in this site. This site includes a registered Limousin cow-calf herd that spends only a part of its time within this defined system area. Cattle are primarily maintained off site, thus, the grazing days provided by this system are accounted for and the value of the livestock grazing is calculated as contract grazing. In the autumn of 2008, cattle grazed wheat in part of Field 3. In reality, the grazing on this site is part of a larger grazing system for the registered Limousin herd that includes primarily perennial warm season grasses, and the alfalfa hay harvested from the site is used exclusively as supplemental winter feed for these cattle.

Site 5. This is a purebred Angus cow-calf system that spends most of its time within the system area. Cattle have generally calved off site on wheat pasture before entering this system. During the fall of 2008, cattle remained on site as in 2007, and also as in 2007 had access to corn, sorghum and millet stubble on adjoining farms, in combination with continued grazing of the perennial pastures. In previous years, cattle moved off site to graze corn stover during winter. This system does not contain a cropping component but hay is harvested if there is excess forage. The area under the center-pivot is divided into six sections and each year for the last several years, one of these sections has been renovated to improve forage production. In the year of renovation, this section is harvested for hay. This hay is stored and fed for supplemental winter feed to the cow herd. This system is evaluated as an intact grazing system with the off-site grazing for stover or wheat pasture during winter handled as contract grazing. Calves are weaned in early autumn. Steer calves are considered 'sold' by the pound at weaning about October while heifers are kept on-site within the system. Heifers are 'sold' as yearlings at 12 to 15 months as breeding stock 'by the head.' In actual fact, this producer retains steer calves past weaning and though feedlot finishing. These calves graze crop residues and wheat pasture as available until entering the feedlot for finishing. They are sorted into size groups and enter the finishing phase based on their size. Carcass data is collected and selection of cow and bull genetics is targeted to feedlot performance and carcass merit of the calves. The genetics of this herd has been steadily improved over the past years by extensive use of artificial insemination

(AI) to known sires for carcass merit improvement. However, for the purposes of calculating economic return to this system for the Demonstration project, these steer calves are considered sold at weaning based on current market prices to approximate the marketing strategies most commonly practiced.

Site 9. In the past, this site has been a cross-bred stocker cattle operation with occasional hay harvested if there is excess forage. However, for 2008, the site supplied grazing for cow-calf pairs, and excess forage was allowed to accumulate due to a relatively low stocking rate. This may have been beneficial for the primarily warm-season perennial grasses due to intensive stocking rates in previous years. Cattle are concentrated on Field 1 which is divided into seven cells for rotational stocking. This field is a base of perennial grasses including kleingrass, buffalograss, blue grama and annual forbs. There was not any overseeding with rye done in autumn of 2007 or autumn of 2008 as had been done in previous years. Historically, stocker cattle enter the system when rye is available for grazing, usually in fall. They graze-out rye and continue to graze the spring growth of perennial warm-season grasses. When light cattle are bought, they remain in the system until sold in late summer (August/September). If heavier cattle are bought initially, there may be two different groups of animals that graze each year. The rye cover crop sometimes used in Field 2 offers limited grazing opportunities in some years depending on rainfall and growth of the forage. Economics are calculated as contract grazing.

Site 10. This four-field system includes two fields of WW-B. Dahl old world bluestem, one field of bermudagrass and a final field used variously for cropping. The system provides a small part of the summer grazing required for registered SimmiAngus and ChiAngus cow-calf herds. Different parts of the herd are moved on and off the system as needed, and it generally provides a place for grazing of pairs and calving of older cows. If grazing is not needed, hay is harvested. A late summer hay harvest was taken on field 3, WW-B. Dahl, in 2008. Seed are also harvested from the Dahl old world bluestem as an additional cash crop for this system, but no seed were harvested in 2008. Due to the continual movement of cattle on and off the site, livestock income is calculated as contract grazing based on grazing days. Field 2 is generally intensively cropped, often double-cropped, but is not used for grazing. Some years it may be planted to forage sorghum and harvested for hay, and then will be used as supplemental winter feed for the cow herd.

Site 17. This is a cross-bred cow-calf system. Cows spend the majority of the year on site, and also graze wheat grazing planted in the corners by the site or in Field 3, a playa lake bottom adjacent to the site, and corn stover residue in field 3, as in 2008, or fields nearby as in past years. Excess forage from WW-B. Dahl on field 1 and 2 is harvested as hay in some years, and both fields were harvested for seed in autumn 2008. Fields 1 and 2 provide the majority of the grazing for the cows and calves. These cattle also graze forages off site generally in fall through mid-winter when grazing crop residues. Cattle are supplemented in winter with cotton burrs and hay harvested from the site. For 2008, economic analysis was similar to site 5, collecting costs of maintaining the cattle on site and adding a standard contract grazing fee for when the cattle grazed off site. Field 2 was established in Dahl in 2007 and with Dahl establishment costs included, this field netted more than $50 per acre in the establishment year though grazing, hay production and seed harvest in this year. This is quite important because this shows that establishment of warm-season grasses can be quick and profitable in the first year under the right conditions.

Site 26. This site provided contract grazing for dry cows from Site 5 during late fall and winter of 2008. This was the second year this site has included livestock grazing. Pearlmillet residue in Field 2 and seed sorghum residue in field 3 along with corn stover in field 4 provided grazing for the dry cows in 2008. Economics were calculated on a contract grazing basis.

Site 30. This site is adjacent to sites 5 and 26, and this is the first year for this farm to be included in the TAWC project. In 2008, corn stover on this drip-irrigated site provided grazing for dry cows. In 2007, before the farm was included in the project, it provided grazing for dry cows from site 5 on sorghum residue. Economics were calculated on a contract grazing basis.

Site 29. This is the first year for this farm to be included in the TAWC project. It is a dryland farm, and field 2 was planted to wheat in 2008, and grazed by stocker cattle in autumn and winter of 2008. This is the only site in the project to have stocker cattle in 2008. Economics were calculated on a contract grazing basis.

Sites 6 and 21. In previous years, these two sites provided grazing of wheat cover crops prior to cotton production. No grazing occurred at these sites in 2007 or 2008.

<u>Dr. Will Cradduck</u>

All livestock sites are visited on a regular basis to verify presence of livestock, document grazing and management practices, and to observe grazing resource utilization and operation of the systems. Dr. Cradduck met with researchers to discuss cattle management and nutrition in the TTU Forages Research Program, closely related to the TAWC project.

Winter 2007-2008 vegetation data was collected for wildlife habitat evaluation on January 29 and 31, 2008. Each site was evaluated for potential habitat for bobwhite quail, lark bunting, eastern cottontail, black-tailed prairie dog, and pronghorn antelope, using models published by the U.S. Fish and Wildlife Service. Up to 22 variables were calculated from vegetation data for entry into the five models. Field work and data entry was completed to calculate habitat indices for all sites for winter 2007-2008. Collection and analysis of summer 2008 field data was also completed. Documentation of vegetation and cropping practices and management to evaluate sites for wildlife habitat was taken periodically. Evaluation of all project sites for potential wildlife habitat continues.

Multiple trips were made to the project area with the GPS unit to map changes and additions to the systems for 2008. New fields were mapped and the data was corrected using desktop software. The new fields were drawn in ArcMap and shapefiles were delivered to team members that require them. Dr. Cradduck attended two courses in GIS training on June 9, 10 and June 16, 17, 18 to prepare for maintenance and production of map information for the TAWC project. Design of new map books for 2008 was completed. GPS software was updated for use on and with the GPS unit in preparation for mapping site changes in 2009.

Mapped the Exactrix fertilizer trial on Producer Site 17 with the GPS unit, and then used desktop GIS software to produce an accurate graph of the trial that was delivered to Management Team Members at the May Management Team meeting.

Dr. Cradduck helped coordinate the purchase of the SmartCrop Systems and monitored a test unit for ease of operation for several weeks. Details of the SmartCrop System were discussed with Mr. Tommy Martin from Accent Engineering and Mr. Rick Kellison on May 1. On May 9, details of the SmartCrop system operation and installation and crop and system monitoring were discussed with Mr. Tommy Martin and Mr. Jeff McNeill from Accent Engineering and Mr. Scott Orr. On July 21, Dr. Cradduck met with Dr. James Mahan and discussed implementation and introduction to producers of the SmartCrop technology. On July 23, a meeting was held with the producers in the project that had SmartCrop units installed on their farms to discuss how to use information from the SmartCrop Systems to make irrigation decisions. Dr. Cradduck offered support by monitoring, maintaining, and troubleshooting installations of the SmartCrop systems on producer sites. At the August 8 Producer Board meeting, Dr. Cradduck demonstrated the use of the SmartCrop systems. At the end of the 2008 growing season, all sensors were removed for harvest and because plants had reached dormancy for winter. Planning continues for implementing SmartCrop systems in the 2009 growing season.

Along with Dr. Justin Weinheimer, Dr. Cradduck helped to begin to evaluate individual components of the grazing and cropping systems on each site, and determine how they contribute to the whole system. Evaluation of TAWC data from past years and evaluation of the individual components of each system and how they affect profitability and water conservation was examined.

Dr. Cradduck worked extensively on data organization and graphing for the Annual Report to the Texas Water Development Board, including graphs for each site and many overall graphs and tables. Verification of data and details for sites that include livestock budgets and other sites was completed with the help of Dr. Weinheimer and Dr. Phil Johnson.

In conjunction with Mr. Rick Kellison and Dr. Vivien Allen, a number of producers were consulted about forage and livestock questions and concerns, including how to optimize and design grazing, feeding, and production systems to meet the different objectives of the producers. For example, a producer from Slaton was advised on selecting a perennial grass to seed for grazing.

Dr. Cradduck assisted in several outreach efforts, including the Pioneers in Agriculture Series tour of the New Deal farm, "Forages: Back to the Future" on June 9, a tour the New Deal Forage Research projects by a group of high school agricultural science teachers on July 14, a small tour of livestock and forage industry individuals to select sites in the project on June 24, the TAWC Field Day on July 31 which included presenting information to the group about perennial warm-season grasses, a tour of TAWC project sites and New Deal forage research for Dr. Tony Allan on September 25, and a talk entitled "Grassland environments: Factors driving change" at the Farming with Grass conference hosted by the Soil and Water Conservation Society in Oklahoma City, OK on October 20. Dr. Cradduck also assisted Ms. Lucia Barbato in creation of a display of two posters, and Mr. Warren Thedford with Precision Brush Control in creation of a display of various aerial photos showing irrigation water challenges.

Dr. Cradduck met with Mr. Rick Kellison, Dr. Calvin Trostle and Mr. Mark Long of Ben Dora Dairies to discuss water challenges and forage solutions at his dairy on September 16th.

Two high school students were assisted in September on a project to set up and run a greenhouse experiment to evaluate biomass production at different root temperatures.

Dr. Cradduck attended the TAWC Producer meeting in Lockney on October 15. On December 11, a meeting was held to discuss data presentation to producers. As a result of this meeting, the data was organized and a presentation was prepared to present data from the project to producers. This presentation was given on December 19. In response to this presentation, several interested producers requested to discuss individual site data.

Several management team meetings were attended and updates were given on this task at those meetings.

Dr. Vivien Allen

Several grant proposals are either submitted or are in various stages of preparation. They include:

1. USDA-SARE planning grant – funded.
2. Request for Federal Funding through the Red Book initiatives of CASNR - $3.5 million. Have received letters of support from Senator Duncan, mayors of 3 cities in Hale and Floyd Counties, Glen Schur, Curtis Griffith, Harry Hamilton, Micky Black, and the Texas Dept of Agriculture.
3. Prepared request for $10 Million through the Stimulus monies at the request of the Dean's Office.
4. Beginning work on proposal to CSREES for 'proof of concept' grant. This involves many individuals. Steve Maas is leading the research component, David Doerfert is leading the outreach component, and Rick, Glen and Dr. Allen are working on the overall structure of the proposal.

TASK 9: EQUIPMENT, SITE INSTRUMENTATION, AND DATA COLLECTION FOR WATER MONITORING

Jim Conkwright
Scott Orr
Caleb Jenkins

9.1 Equipment Procurement & Installation

Primary System

The following equipment is installed and operating on site:
Electromagnetic flow meters,
Pressure transducers,
Netirrigate monitoring and control systems replaced NTE monitoring systems.

Secondary System

The following equipment is operating on site:
Tipping bucket rain gauges,
Temperature Sensors,
HPWD Manual read rain gauges.

Soil Moisture Site Install

Neutron probe access sites are located at each site. Overall there are 25 demonstration sites and a total of 45 moisture probe access locations. Multiple access points are required due to cropping pattern fluctuations.

9.2 Data Collection & Processing

Data collection and site monitoring

Changes in site information consisting of irrigation application method, system parameters, acres, crop, pump plants (size, fuel type, number), are being documented as needed.

Sites equipped with electronic sensors are currently collecting data. Irrigation data is transmitted every 15 minutes to the Netirrigate website.

Soil moisture data is being collected upon crop seeding and termination.

Water well level recorders at selected sites are logging data on 30 minute intervals and telemetered to HPWD.

Each location equipped with electronic monitoring devices is visited on a regular basis for performance evaluation.

Data Processing

Accumulate data is processed to establish water use efficiency of each crop and crop ET relationships for inclusion into the annual TAWC report. Initial data processing now occurs automatically on the Netirrigate website.

Summary

The Netirrigate data telemetry systems are superior to the previous data collection system. These new automated devices are allowing the project to analyze data in greater detail. Monitoring systems now allow staff to examine irrigation data on 15 minute intervals versus 24 hour intervals and create customized reports based upon various data query. Additionally, producers now have instant feedback to current water use and historical water use by accessing the Netirrigate website.

Cropping pattern changes are monitored closely as field boundary changes necessitate additional Neutron soil moisture access tube installation and fluctuations in crop acreages.

Statement of Factors Affecting Irrigation Water Savings

The High Plains Underground Water Conservation District No. 1 has an excellent long standing reputation educating constituents on the importance of water conservation. The district has for many years worked with irrigated agriculture by supplying timely information to positively impact the management of water resources. For many years district cooperative projects have involved the measurement of actual on farm irrigation applications. The resulting water use efficiency and irrigation data are returned to cooperators in order to benefit their water management decisions.

Through many years of experience performing on farm irrigation audits the district has determined that there are many factors which affect water use. The district must weigh these factors when accounting for the effectiveness of its own conservation projects. Although not all inclusive, estimated water savings must be tempered with these factors in mind.

The factors have been:

- The ability or inability of producers to supply irrigation water to meet total crop water demand. The majority of producers in this district can only supplement precipitation;
- The fluctuating amount of precipitation received from one growing season to the next;
- The timeliness of precipitation;
- The cost of pumping underground water;
- Water quality which may limit amount of water applied to crops;
- Culturally historic and traditional practices which may or may not foster a willingness to accept change;
- Current crop prices and the decision to alter irrigation practices to supply a particular market;
- Consciousness of water conservation while participating in conservation oriented projects;
- Continuing or consistent use of conservation practices after project conclusion and district presence is less frequent.

Water Use Efficiency Synopsis

The percentage of total crop water demand replaced by irrigation increased by 12% compared to 2007. Theoretical total irrigation conservation in 2008 was 286 acre feet less than 2007. This is predominately due to an acreage increase in higher water demanding crops and to a lesser extent the timing of beneficial precipitation events.

Year 4 of the demonstration project began with average rainfall preceding the planting of summer crops. This in comparison to year 3 of the project when above average rainfall was received prior to seeding. Initial irrigation demand for year 4 was greater during the month of April in comparison to 2007 when heavy water demand predominately began in July. Total 2008 pumping hours for all sites was 15% greater than 2007. Congruently, in season precipitation was 15% less in 2008 compared to 2007. The bulk of year 4 precipitation occurred at season end during crop maturity which had both positive and negative affects upon yields hence affecting water use efficiency as well.

Precipitation timing is but one factor which affected irrigation application totals for 2008. Year 4 of the project indicated a greater demand for irrigation due to an increased acreage in higher water demanding crops. Irrigated corn and sorghum acreages increased to their highest point since the project began. Conversely cotton which requires less water was at its lowest acreage point since project inception. In addition to these cropping pattern changes, an increase in winter crop acreage or double cropping was also greater in 2008.

Table 24. Potential irrigated water conserved by various cropping and livestock systems in Hale and Floyd Counties (2006).

Year	Site Number	Acres	Irrigation Applied	ET Demand	Percentage of ET Provided To Crop From Irrigation	Potential Irrigation Conservation	Percentage of Potential Irrigation Conservation	Total Irrigation Potentially Conserved
			ACRE FEET/ACRE	ACRE FEET/ACRE	%	ACRE FEET/ACRE	%	ACRE FEET
2006	1-1,2,3,4	135.2	1.75	2.39	73%	0.64	27%	87.09
2006	2-1	60.9	1.58	2.37	67%	0.79	33%	48.06
2006	3-1,2	61.5	0.83	4.66	18%	3.83	82%	235.32
2006	4-1	61.8	2.88	NA	NA	NA	NA	NA
2006	4-2	61.8	1.33	2.19	61%	0.86	39%	52.92
2006	4-2	13.3	1.35	8.05	17%	6.70	83%	89.08
2006	4-3	65.4	1.35	1.61	84%	0.26	16%	16.96
2006	5-1,2..13	44.4	0.80	NA	NA	NA	NA	NA
2006	6-1	628	1.13	0.47	244%	-0.67	-144%	-420.16
2006	7.00	122.9	0.65	NA	NA	NA	NA	NA
2006	8-1,2,3,4	130	0.84	NA	NA	NA	NA	NA
2006	9-1	130	NA	NA	NA	NA	NA	NA
2006	9-2	61.8	1.46	5.31	28%	3.84	72%	237.62
2006	10-1,2,3,4	61.8	1.33	NA	NA	NA	NA	NA
2006	11-1,2,3	95.8	1.41	2.29	61%	0.88	39%	84.70
2006	12-1	137	NA	NA	NA	NA	NA	NA
2006	13-1	44.3	NA	NA	NA	NA	NA	NA
2006	14-1	44.5	0.52	6.67	8%	6.15	92%	273.57
2006	15-1,3	42.7	1.17	3.72	32%	2.55	68%	108.83
2006	15-4	42.1	0.35	1.32	27%	0.97	73%	40.84
2006	16-1	92.5	1.02	3.48	29%	2.46	71%	227.46
2006	17-1	151.2	0.46	NA	NA	NA	NA	NA
2006	17-2	132.7	1.40	1.05	134%	-0.35	-34%	-46.52
2006	17-3	319.5	1.78	1.03	172%	-0.74	-72%	-237.51
2006	18-1	124.2	1.12	1.17	95%	0.05	5%	6.74
2006	18-2	38.3	0.53	NA	NA	NA	NA	NA
2006	18-2	28.8	0.36	NA	NA	NA	NA	NA
2006	19-3	28.4	0.85	3.30	26%	2.45	74%	69.50
2006	19-4	143.1	0.79	1.25	63%	0.46	37%	66.37
2006	20-1	53.6	2.07	3.88	53%	1.82	47%	97.33
2006	20-2	58.3	0.83	3.40	24%	2.57	76%	149.92
2006	20-2	58.3	0.75	3.47	22%	2.72	78%	158.73
2006	21-1	108.9	1.52	1.74	88%	0.21	12%	23.34
2006	21-2	60.7	1.21	2.40	51%	1.19	49%	71.99
2006	22-1	61.5	1.47	2.82	52%	1.35	48%	82.80
2006	22-2	75.8	2.19	3.07	71%	0.89	29%	67.38
2006	23-1	45.6	0.97	2.65	37%	1.68	63%	76.44
2006	23-2	117.6	1.51	1.29	117%	-0.22	-17%	-26.10
2006	24-1	115.8	1.08	1.32	82%	0.24	18%	27.93
2006	24-2	117.6	2.15	1.55	138%	-0.60	-38%	-70.27
2006	26-1	115.8	1.77	1.72	103%	-0.05	-3%	-6.01
2006	26-2	61.4	0.89	2.40	37%	1.52	63%	93.16
2006	27-1	61.3	1.50	1.80	83%	0.30	17%	18.51
TOTALS			**41.10**	**85.84**		**44.74**		**1706.00**
TOTAL/AVERAGE			**1.28**	**2.68**		**1.40**		

Table 25. Potential irrigated water conserved by various cropping and livestock systems in Hale and Floyd Counties (2007).

Year	System	Field	Acres	Irrigation Applied	ET Demand	Percentage of ET Provided To Crop From Irrigation	Potential Irrigation Conservation	Percentage of Potential Irrigation Conservation	Total Irrigation Potentially Conserved
				ACRE FEET/ACRE	ACRE FEET/ACRE	%	ACRE FEET/ACRE	%	ACRE FEET
2007	*1*	*1*	135	1.22	1.68	73%	0.46	27%	62.42
2007	*2*	*1*	60.9	1.08	1.67	64%	0.60	36%	36.29
2007	*3*	*1*	61.5	0.96	1.66	58%	0.70	42%	43.10
2007	*3*	*2*	61.8	0.69	1.48	46%	0.79	54%	49.03
2007	*3*	*2*	61.8	0.56	1.37	41%	0.81	59%	50.06
2007	*4*	*1*	13.3	0.88	NA	NA	NA	NA	NA
2007	*4*	*2*	65.4	0.75	1.65	45%	0.90	55%	59.02
2007	*4*	*3*	44.4	0.52	1.49	35%	0.96	65%	42.81
2007	*5*	*1*	628	0.38	NA	NA	NA	NA	NA
2007	*6*	*1*	123	0.91	1.63	55%	0.73	45%	89.41
2007	*7*	*1*	130	1.12	NA	NA	NA	NA	NA
2007	*7*	*1*	130	1.12	NA	NA	NA	NA	NA
2007	*8*	*1*	61.8	1.31	NA	NA	NA	NA	NA
2007	*8*	*1*	61.8	1.31	NA	NA	NA	NA	NA
2007	*9*	*1*	95.8	0.39	NA	NA	NA	NA	NA
2007	*9*	*2*	137	0.32	1.61	20%	1.28	80%	175.93
2007	*10*	*1*	44.3	0.31	NA	NA	NA	NA	NA
2007	*10*	*2*	44.5	1.30	2.05	64%	0.74	36%	33.04
2007	*10*	*3*	42.7	0.31	NA	NA	NA	NA	NA
2007	*10*	*4*	42.1	0.31	NA	NA	NA	NA	NA
2007	*11*	*1*	92.5	1.22	1.66	74%	0.43	26%	40.01
2007	*12*	*1*	151	0.00	1.66	0%	0.00	100%	0.00
2007	*12*	*2*	133	0.00	1.65	0%	0.00	100%	0.00
2007	*13*	*1*	320	0.00	1.66	0%	0.00	100%	0.00
2007	*14*	*1*	124	0.72	1.64	44%	0.92	56%	114.78
2007	*15*	*1*	38.3	1.15	1.65	75%	0.50	25%	19.31
2007	*15*	*3*	28.8	0.55	1.52	36%	0.97	64%	28.01
2007	*15*	*4*	28.4	1.06	1.65	64%	0.59	36%	16.83
2007	*16*	*1*	143	0.73	NA	NA	NA	NA	NA
2007	*17*	*1*	53.6	0.69	NA	NA	NA	NA	NA
2007	*17*	*2*	58.3	0.52	NA	NA	NA	NA	NA
2007	*17*	*2*	58.3	0.52	NA	NA	NA	NA	NA
2007	*17*	*3*	109	0.79	1.67	47%	0.89	53%	96.47
2007	*18*	*1*	60.7	0.25	1.50	17%	1.25	83%	76.03
2007	*18*	*2*	61.5	0.64	1.88	34%	1.24	66%	76.52
2007	*19*	*5*	75.8	0.65	1.66	39%	1.00	61%	75.93
2007	*19*	*6*	45.6	0.58	1.75	33%	1.17	67%	53.28
2007	*20*	*1*	118	0.77	1.15	67%	0.38	33%	44.39
2007	*20*	*2*	116	1.12	1.62	69%	0.50	31%	57.61
2007	*20*	*1*	118	1.19	1.93	62%	0.74	38%	87.12
2007	*20*	*2*	116	0.97	1.62	60%	0.65	40%	75.56
2007	*21*	*1*	61.4	0.55	NA	NA	NA	NA	NA
2007	*21*	*2*	61.3	0.85	2.27	37%	1.43	63%	87.35
2007	*22*	*1*	148	0.99	1.65	60%	0.66	40%	98.03
2007	*23*	*1*	100	0.91	2.27	40%	1.36	60%	136.32
2007	*24*	*1*	130	1.28	2.25	57%	0.97	43%	126.45
2007	*26*	*1*	62.9	0.77	1.66	47%	0.89	53%	55.77
2007	*26*	*2*	62.3	1.12	2.30	49%	1.18	51%	73.72
2007	*27*	*1*	46.2	1.08	1.81	60%	0.72	40%	33.42
TOTALS				**26.97**	**58.37**		**26.45**		**2,114**
TOTAL/AVERAGE				**0.79**	**1.72**		**0.78**		

Table 26. Potential irrigated water conserved by various cropping and livestock systems in Hale and Floyd Counties (2008).

Year	System	Field	Acres	Irrigation Applied	ET Demand	Percentage of ET Provided To Crop From Irrigation	Potential Irrigation Conservation	Percentage of Potential Irrigation Conservation	Total Irrigation Potentially Conserved
				ACRE FEET/ACRE	ACRE FEET/ACRE	%	ACRE FEET/ACRE	%	ACRE FEET
2008	1	1	24.6	2.13	1.97	108%	-0.16	-8%	-4.02
2008	1	2	37.7	2.13	1.97	108%	-0.16	-8%	-6.16
2008	1	3	37	0.61	2.02	30%	1.41	70%	52.14
2008	1	4	35.9	0.61	2.02	30%	1.41	70%	50.59
2008	2	1	60.9	0.57	1.94	30%	1.36	70%	82.93
2008	3	1	61.5	0.48	NA	NA	NA	NA	NA
2008	3	1	61.5	0.84	1.83	46%	1.00	54%	61.24
2008	3	2	61.8	1.14	2.02	56%	0.88	44%	54.28
2008	4	1	13.3	1.30	NA	NA	NA	NA	NA
2008	4	2	65.4	1.59	2.17	73%	0.58	27%	37.93
2008	4	3	44.4	0.63	NA	NA	NA	NA	NA
2008	5	1	70.2	0.53	NA	NA	NA	NA	NA
2008	5	2	81.6	0.45	NA	NA	NA	NA	NA
2008	5	3	95.8	0.31	NA	NA	NA	NA	NA
2008	5	4	89.2	0.31	NA	NA	NA	NA	NA
2008	5	5	81.2	0.53	NA	NA	NA	NA	NA
2008	5	6	69.6	0.53	NA	NA	NA	NA	NA
2008	6	3	30.1	1.31	2.68	49%	1.37	51%	41.36
2008	6	2	92.9	1.49	2.07	72%	0.59	NA	NA
2008	7	1	130	0.82	NA	NA	NA	NA	NA
2008	7	1	130	0.82	NA	NA	NA	NA	NA
2008	8	1	61.8	0.55	NA	NA	NA	NA	NA
2008	8	1	61.8	0.55	NA	NA	NA	NA	NA
2008	9	2	137	0.73	2.01	36%	1.28	64%	175.82
2008	9	1	95.8	0.46	NA	NA	NA	NA	NA
2008	10	1	44.3	0.27	NA	NA	NA	NA	NA
2008	10	2	44.5	0.30	NA	NA	NA	NA	NA
2008	10	2	45.5	2.82	2.59	109%	-0.23	-9%	-10.35
2008	10	3	42.7	0.50	NA	NA	NA	NA	NA
2008	10	3	43.7	0.50	NA	NA	NA	NA	NA
2008	10	4	42.1	0.51	NA	NA	NA	NA	NA
2008	11	1	45.1	0.91	1.93	47%	1.02	NA	NA
2008	11	2	47.3	0.91	2.02	45%	1.12	55%	52.94
2008	12	1	151.2	NA	2.17	NA	NA	NA	NA
2008	12	1	132.7	NA	NA	NA	NA	NA	NA
2008	14	2	61.8	0.75	2.04	37%	1.30	63%	80.13
2008	14	3	62.4	0.75	2.04	37%	1.30	63%	80.91
2008	15	5	18.8	0.70	2.02	35%	1.32	65%	24.82
2008	15	6	19.4	0.70	2.02	35%	1.32	65%	25.61
2008	17	1	53.6	0.77	NA	NA	NA	NA	NA
2008	17	1	53.6	0.77	NA	NA	NA	NA	NA
2008	17	2	58.3	0.80	NA	NA	NA	NA	NA
2008	17	2	58.3	0.80	NA	NA	NA	NA	NA
2008	17	3	109	1.73	2.68	64%	0.95	36%	103.91
2008	18	1	60.7	0.46	NA	NA	NA	NA	NA
2008	18	1	60.7	0.46	2.17	21%	1.71	79%	103.75
2008	18	2	61.5	0.86	2.10	41%	1.24	59%	76.11
2008	19	8	45.4	0.51	1.90	27%	1.39	73%	62.92
2008	19	7	74.9	0.63	2.02	31%	1.39	69%	103.92
2008	20	2	115.8	0.96	1.51	64%	0.55	36%	63.40
2008	20	1	117.7	1.33	1.48	90%	0.15	10%	17.36
2008	20	2	115.8	1.16	NA	NA	NA	NA	NA
2008	20	1	117.7	1.15	NA	NA	NA	NA	NA
2008	21	1	61.4	0.63	NA	NA	NA	NA	NA
2008	21	1	61.4	0.63	NA	NA	NA	NA	NA
2008	21	2	61.3	1.06	NA	NA	NA	NA	NA
2008	21	2	61.3	1.06	NA	NA	NA	NA	NA
2008	22	1	72.8	2.06	2.64	78%	0.58	22%	42.28
2008	22	2	76	2.06	2.64	78%	0.58	22%	44.14
2008	23	3	4.9	1.03	2.17	47%	1.14	53%	5.60
2008	23	4	28.8	1.03	2.17	47%	1.14	53%	32.90
2008	23	5	71.4	1.41	2.14	66%	0.73	34%	52.06
2008	24	1	64.7	2.06	2.68	77%	0.62	23%	40.38
2008	24	2	65.1	2.06	2.68	77%	0.62	23%	40.63
2008	26	4	40.5	1.55	1.97	79%	0.42	21%	17.08
2008	26	3	22.5	1.25	2.17	58%	0.91	42%	20.55
2008	26	2	62.3	1.09	1.87	59%	0.77	41%	48.18
2008	27	1	46.2	1.30	2.34	55%	1.04	45%	48.13
2008	27	3	48.8	2.04	2.35	87%	0.31	13%	15.13
2008	27	4	13.5	2.04	2.35	87%	0.31	13%	4.19
2008	28	1	51.5	0.68	2.35	29%	1.67	71%	85.92
2008	29	1	50.8	NA	2.01	NA	NA	NA	NA
2008	29	2	104.3	NA	NA	NA	NA	NA	NA
2008	29	3	66.6	NA	2.01	NA	NA	NA	NA
Totals				**48.83**	**83.74**		**34.93**		**1828.71**
Total/Average				**1.25**	**2.15**		**0.90**		

Table 27. Potential water demand conserved by various cropping and livestock systems in Hale and Floyd Counties (2006).

Year	Site Number	Acres	ET Demand Potential Use	Available Water Rain/Irrig/Soil	Percentage of Potential Use	Potential Water Demand Conserved	Potential Water Demand Conserved
			TOTAL ACRE FEET	TOTAL ACRE FEET	%	TOTAL ACRE FEET	%
2006	1-1,2,3,4	135.20	323.69	304.92	94%	18.77	6%
2006	2-1	60.90	144.49	127.05	88%	17.43	12%
2006	3-1,2	123.30	286.57	161.05	56%	125.52	44%
2006	4-1	13.30	NA	51.66	NA	NA	NA
2006	4-2	65.40	135.32	116.90	86%	18.42	14%
2006	4-2	65.40	107.09	112.38	105%	-5.29	-5%
2006	4-3	44.40	105.52	85.10	81%	20.42	19%
2006	5-1,2..13	628.00	NA	825.77	NA	NA	NA
2006	6-1	122.90	292.09	203.09	70%	89.00	30%
2006	7.00	130.00	NA	132.33	NA	NA	NA
2006	8-1,2,3,4	61.80	NA	72.28	NA	NA	NA
2006	9-1	95.80	NA	NA	NA	NA	NA
2006	9-2	137.00	328.00	219.66	67%	108.34	33%
2006	10-1,2,3,4	173.60	NA	383.71	NA	NA	NA
2006	11-1,2,3	92.50	219.46	185.93	85%	33.53	15%
2006	12-1	151.20	NA	NA	NA	NA	NA
2006	13-1	203.70	NA	NA	NA	NA	NA
2006	14-1	124.20	296.63	102.05	34%	194.58	66%
2006	15-1,3	67.10	158.97	125.87	79%	33.10	21%
2006	15-4	28.40	55.71	29.96	54%	25.75	46%
2006	16-1	143.10	321.74	212.66	66%	109.08	34%
2006	17-1	53.60	NA	63.96	NA	NA	NA
2006	17-2	58.30	138.71	106.88	77%	31.82	23%
2006	17-3	108.90	329.60	264.26	80%	65.34	20%
2006	18-1	60.70	145.33	99.47	68%	45.85	32%
2006	18-2	61.50	NA	54.20	NA	NA	NA
2006	18-2	61.50	NA	35.72	NA	NA	NA
2006	19-3	45.30	93.73	47.09	50%	46.64	50%
2006	19-4	75.10	179.18	81.64	46%	97.54	54%
2006	20-1	117.60	208.05	311.59	150%	-103.54	-50%
2006	20-2	115.80	198.50	136.07	69%	62.44	31%
2006	20-2	115.80	202.46	121.82	60%	80.64	40%
2006	21-1	61.40	188.96	112.83	60%	76.13	40%
2006	21-2	61.30	145.59	101.96	70%	43.63	30%
2006	22-1	72.70	173.21	134.58	78%	38.63	22%
2006	22-2	76.00	233.07	178.18	76%	54.88	24%
2006	23-1	51.40	120.79	74.98	62%	45.81	38%
2006	23-2	48.80	151.77	90.26	59%	61.51	41%
2006	24-1	64.70	152.80	106.51	70%	46.29	30%
2006	24-2	65.10	182.77	160.82	88%	21.95	12%
2006	26-1	62.90	199.34	129.69	65%	69.65	35%
2006	26-2	62.30	147.60	123.42	84%	24.18	16%
2006	27-1	46.20	110.46	102.19	93%	8.26	7%
TOTALS		**4214.10**	**6077.18**	**4470.86**	**73.55**	**1606.32**	**26%**

Table 28. Potential water demand conserved by various cropping and livestock systems in Hale and Floyd Counties (2007).

Year	System	Field	Acres	ET Demand Potential Use	Available Water Rain/Irrig/Soil	Percentage of Potential Use	Potential Water Demand Conserved	Potential Water Demand Conserved
				TOTAL ACRE FEET	TOTAL ACRE FEET	%	TOTAL ACRE FEET	%
2007	1	1	135.2	227.36	311.70	137%	-84.34	-37%
2007	2	1	60.9	101.96	148.28	145%	-46.32	-45%
2007	3	1	61.5	102.04	163.75	160%	-61.71	-60%
2007	3	2	61.8	91.46	143.69	157%	-52.23	-57%
2007	3	2	61.8	84.82	49.96	59%	34.87	41%
2007	4	1	13.3	NA	27.24	NA	NA	NA
2007	4	2	65.4	108.07	114.94	106%	-6.87	-6%
2007	4	3	44.4	65.93	22.09	34%	43.85	66%
2007	5	1	628	NA	1400.28	NA	NA	NA
2007	6	1	122.9	200.63	277.55	138%	-76.91	-38%
2007	7	1	130	NA	321.12	NA	NA	NA
2007	7	1	130	NA	321.12	NA	NA	NA
2007	8	1	61.8	NA	161.82	NA	NA	NA
2007	8	1	61.8	NA	161.82	NA	NA	NA
2007	9	1	95.8	NA	162.42	NA	NA	NA
2007	9	2	137	220.00	229.83	104%	-9.83	-4%
2007	10	1	44.3	NA	103.64	NA	NA	NA
2007	10	2	44.5	91.08	117.61	129%	-26.53	-29%
2007	10	3	42.7	NA	99.90	NA	NA	NA
2007	10	4	42.1	NA	98.50	NA	NA	NA
2007	11	1	92.5	153.09	287.12	188%	-134.03	-88%
2007	12	1	151.2	250.24	292.07	117%	-41.83	-17%
2007	12	2	132.7	218.40	233.99	107%	-15.59	-7%
2007	13	1	319.5	530.10	406.83	77%	123.27	23%
2007	14	1	124.2	204.10	205.27	101%	-1.17	-1%
2007	15	1	38.3	63.29	106.06	168%	-42.77	-68%
2007	15	3	28.8	43.85	48.73	111%	-4.88	-11%
2007	15	4	28.4	46.93	63.65	136%	-16.72	-36%
2007	16	1	143.1	NA	225.26	NA	NA	NA
2007	17	1	53.6	NA	110.52	NA	NA	NA
2007	17	2	58.3	NA	114.53	NA	NA	NA
2007	17	2	58.3	NA	84.15	NA	NA	NA
2007	17	3	108.9	182.23	235.90	129%	-53.67	-29%
2007	18	1	60.7	91.20	92.92	102%	-1.71	-2%
2007	18	2	61.5	115.72	125.33	108%	-9.60	-8%
2007	19	5	75.8	125.45	129.62	103%	-4.17	-3%
2007	19	6	45.6	79.69	74.94	94%	4.75	6%
2007	20	1	117.6	135.14	174.72	129%	-39.58	-29%
2007	20	2	115.8	187.40	217.60	116%	-30.19	-16%
2007	20	1	117.6	226.87	269.16	119%	-42.29	-19%
2007	20	2	115.8	187.40	260.50	139%	-73.10	-39%
2007	21	1	61.4	NA	125.95	NA	NA	NA
2007	21	2	61.3	139.20	133.51	96%	5.70	4%
2007	22	1	147.6	243.91	288.74	118%	-44.83	-18%
2007	23	1	100.3	227.35	232.70	102%	-5.35	-2%
2007	24	1	129.8	292.37	310.67	106%	-18.29	-6%
2007	26	1	62.9	104.26	140.65	135%	-36.40	-35%
2007	26	2	62.3	143.55	127.27	89%	16.28	11%
2007	27	1	46.2	83.47	109.71	131%	-26.24	-31%
TOTALS			**4765.20**	**5368.57**	**6147.06**	**115%**	**-778.46**	**-15%**

Table 29. Potential water demand conserved by various cropping and livestock systems in Hale and Floyd Counties (2008).

Year	System	Field	Acres	ET Demand Potential Use	Available Water Rain/Irrig/Soil	Percentage of Potential Use	Potential Water Demand Conserved	Potential Water Demand Conserved
				TOTAL ACRE FEET	TOTAL ACRE FEET	%	TOTAL ACRE FEET	%
2008	1	1	24.60	48.40	77.96	161%	-29.56	-61%
2008	1	2	37.70	74.17	119.48	161%	-45.30	-61%
2008	1	3	37.00	74.56	60.83	82%	13.72	18%
2008	1	4	35.90	72.34	59.03	82%	13.31	18%
2008	2	1	60.90	117.89	104.02	88%	13.87	12%
2008	3	1	61.50	NA	63.60	NA	NA	NA
2008	3	1	61.50	112.80	66.33	59%	46.47	41%
2008	3	2	61.80	124.73	95.77	77%	28.97	23%
2008	4	1	13.30	NA	36.38	NA	NA	NA
2008	4	2	65.40	141.75	163.34	115%	-21.59	-15%
2008	4	3	44.40	NA	47.40	NA	NA	NA
2008	5	1	70.20	NA	104.66	NA	NA	NA
2008	5	2	81.60	NA	115.33	NA	NA	NA
2008	5	3	95.80	NA	121.83	NA	NA	NA
2008	5	4	89.20	NA	113.37	NA	NA	NA
2008	5	5	81.20	NA	121.60	NA	NA	NA
2008	5	6	69.60	NA	104.23	NA	NA	NA
2008	6	3	30.10	80.74	75.73	94%	5.02	6%
2008	6	2	92.90	192.69	250.52	130%	-57.83	-30%
2008	7	1	130.00	NA	229.26	NA	NA	NA
2008	7	1	130.00	NA	229.26	NA	NA	NA
2008	8	1	61.80	NA	93.78	NA	NA	NA
2008	8	1	61.80	NA	93.78	NA	NA	NA
2008	9	2	137.00	275.71	284.17	103%	-8.46	-3%
2008	9	1	95.80	NA	154.92	NA	NA	NA
2008	10	1	44.30	NA	65.49	NA	NA	NA
2008	10	2	44.50	NA	41.16	NA	NA	NA
2008	10	2	45.50	117.85	181.69	154%	-63.84	-54%
2008	10	3	43.70	NA	30.60	NA	NA	NA
2008	10	3	43.70	NA	41.15	NA	NA	NA
2008	10	4	42.10	NA	72.37	NA	NA	NA
2008	11	1	45.10	86.82	96.55	111%	-9.73	-11%
2008	11	2	47.30	95.74	101.25	106%	-5.50	-6%
2008	12	1	151.20	327.73	154.92	47%	172.80	53%
2008	12	1	132.70	NA	77.63	NA	NA	NA
2008	14	2	61.80	126.33	111.36	88%	14.97	12%
2008	14	3	62.40	127.56	112.44	88%	15.12	12%
2008	15	5	18.80	37.94	31.54	83%	6.41	17%
2008	15	6	19.40	39.16	32.54	83%	6.61	17%
2008	17	1	53.60	NA	79.02	NA	NA	NA
2008	17	1	53.60	NA	79.02	NA	NA	NA
2008	17	2	58.30	NA	117.89	NA	NA	NA
2008	17	2	58.30	NA	117.89	NA	NA	NA
2008	17	3	109.00	292.39	288.19	99%	4.21	1%
2008	18	1	60.70	NA	71.01	NA	NA	NA
2008	18	1	60.70	131.57	71.01	54%	60.56	46%
2008	18	2	61.50	129.15	101.72	79%	27.43	21%
2008	19	8	45.40	86.15	65.50	76%	20.65	24%
2008	19	7	74.90	150.92	114.66	76%	36.27	24%
2008	20	2	115.80	174.67	228.95	131%	-54.29	-31%
2008	20	1	117.70	173.61	221.33	127%	-47.72	-27%
2008	20	2	115.80	NA	224.85	NA	NA	NA
2008	20	1	117.70	NA	300.23	NA	NA	NA
2008	21	1	61.40	NA	89.62	NA	NA	NA
2008	21	1	61.40	NA	89.62	NA	NA	NA
2008	21	2	61.30	NA	122.25	NA	NA	NA
2008	21	2	61.30	NA	122.25	NA	NA	NA
2008	22	1	72.80	192.43	229.70	119%	-37.27	-19%
2008	22	2	76.00	200.89	239.80	119%	-38.90	-19%
2008	23	3	4.90	10.62	11.65	110%	-1.03	-10%
2008	23	4	28.80	62.42	68.50	110%	-6.07	-10%
2008	23	5	71.40	152.44	192.60	126%	-40.16	-26%
2008	24	1	64.70	173.56	193.26	111%	-19.70	-11%
2008	24	2	65.10	174.63	194.46	111%	-19.83	-11%
2008	26	4	40.50	79.68	99.44	125%	-19.76	-25%
2008	26	3	22.50	48.77	46.80	96%	1.97	4%
2008	26	2	62.30	116.35	95.37	82%	20.97	18%
2008	27	1	46.20	108.03	112.24	104%	-4.21	-4%
2008	27	3	48.80	114.76	159.49	139%	-44.73	-39%
2008	27	4	13.50	31.75	44.12	139%	-12.38	-39%
2008	28	1	51.50	121.11	105.04	87%	16.07	13%
2008	29	1	50.80	102.24	47.16	46%	55.08	54%
2008	29	2	104.30	NA	115.60	NA	NA	NA
2008	29	3	66.60	134.03	61.83	46%	72.21	54%
Totals			4772.60	5237.08	8659.35		64.80	

Table 30. Water Use Efficiency (WUE) by various cropping and livestock systems in Hale and Floyd Counties (2008).

Year	System	Field	Crop	Acres	R1 Soil Moisture	R2 Soil Moisture	Soil Moisture Contribution to WUE	Acre Inch Irrigation Applied	Effective Rainfall	Total Crop Water Inches Per Acre	Yield Lb/Ac.	Yield Per Acre Inch Of Irrigation (lbs.)	Yield Per Acre Inch Of Total Water (lbs.)
2008	1	1	Corn	24.6	9.95	10.09	-0.14	25.57	12.6	38.03	NA	NA	NA
2008	1	2	Corn	37.7	9.95	10.09	-0.14	25.57	12.6	38.03	NA	NA	NA
2008	1	3	Cotton	37	9.95	10.09	-0.14	7.27	12.6	19.73	NA	NA	NA
2008	1	4	Cotton	35.9	9.95	10.09	-0.14	7.27	12.6	19.73	NA	NA	NA
2008	2	1	Sunflowers	60.9	9.28	6.71	2.58	6.89	11.03	20.50	2,370.00	343.98	115.63
2008	3	1	Wheat	61.5	1.66	4.22	-2.56	5.76	9.21	12.41	995.10	172.76	80.19
2008	3	1	Sorghum	61.5	4.22	10.55	-6.33	10.06	9.21	12.94	5,170.73	513.99	399.50
2008	3	2	Cotton	61.8	4.65	8.94	-4.29	13.68	9.21	18.60	1,495.16	109.30	80.40
2008	4	1	Alfalfa	13.3	6.70	2.48	4.23	15.58	13.02	32.83	22,340.00	1,433.89	680.55
2008	4	2	Sorghum	65.4	9.26	8.14	1.12	19.05	9.8	29.97	7,411.69	389.07	247.29
2008	4	3	Wheat	44.4	2.40	6.89	-4.49	7.5	9.8	12.81	4,838.80	645.17	377.72
2008	5	1	Grass	70.2	7.38	9.03	-1.65	6.31	13.23	17.89	N/A	NA	NA
2008	5	2	Grass	81.6	7.38	9.03	-1.65	5.38	13.23	16.96	N/A	NA	NA
2008	5	3	Grass	95.8	7.38	9.03	-1.65	3.68	13.23	15.26	N/A	NA	NA
2008	5	4	Grass	89.2	7.38	9.03	-1.65	3.67	13.23	15.25	14,932.60	4,068.83	979.12
2008	5	5	Hay	81.2	7.38	9.03	-1.65	6.39	13.23	17.97	13,593.30	2,127.28	756.40
2008	5	6	Hay	69.6	7.38	9.03	-1.65	6.39	13.23	17.97	11,651.40	1,823.38	648.35
2008	6	3	Corn	30.1	5.05	5.40	-0.35	15.7	14.84	30.19	14,108.00	898.60	467.31
2008	6	2	Cotton	92.9	5.05	5.40	-0.35	17.87	14.84	32.36	1,724.00	96.47	53.28
2008	7	1	Grass Seed	130	6.67	10.09	-3.42	9.88	14.7	21.16	200.00	20.24	9.45
2008	7	1	Hay	130	6.67	10.09	-3.42	9.88	14.7	21.16	2,550.00	258.10	120.50
2008	8	1	Grass Seed	61.8	6.47	9.61	-3.14	6.65	14.7	18.21	226.00	33.98	12.41
2008	8	1	Hay	61.8	6.47	9.61	-3.14	6.65	14.7	18.21	2,745.00	412.78	150.74
2008	9	2	Cotton	137	6.28	3.23	3.05	8.75	13.09	24.89	771.00	88.11	30.98
2008	9	1	Grass	95.8	3.43	2.89	0.54	5.5	13.37	19.41	N/A	NA	NA
2008	10	1	Grass	44.3	9.78	6.80	2.98	3.28	11.48	17.74	NA	NA	NA
2008	10	2	Wheat	44.5	2.55	6.50	-3.95	3.57	11.48	11.10	3,640.00	1,019.61	327.93
2008	10	2	Corn	45.5	4.81	7.19	-2.37	38.81	11.48	47.92	6,800.00	175.21	141.91
2008	10	3	Grass	42.7	1.16	7.32	-6.16	5.98	11.48	11.30	NA	NA	NA
2008	10	3	Hay	43.7	1.16	7.32	-6.16	5.98	11.48	11.30	NA	NA	NA
2008	10	4	Grass	42.1	9.78	6.80	2.98	6.17	11.48	20.63	NA	NA	NA
2008	11	1	Sorghum	45.1	6.51	5.27	1.24	10.86	13.58	25.68	7,866.00	724.31	306.31
2008	11	2	Cotton	47.3	6.51	5.27	1.25	10.86	13.58	25.69	1,224.07	112.71	47.66
2008	12	1	Sorghum	151.2	6.52	6.45	0.08	N/A	12.22	12.30	No hvst	No hvst	No hvst
2008	12	1	Wheat	132.7	1.32	6.52	-5.20	N/A	12.22	7.02	No hvst	No hvst	No hvst
2008	14	2	Cotton	61.8	6.06	6.50	-0.44	8.97	13.09	21.62	1,082.00	120.62	50.04
2008	14	3	Cotton	62.4	6.06	6.50	-0.44	8.97	13.09	21.62	1,082.00	120.62	50.04
2008	15	5	Cotton	18.8	5.40	7.51	-2.11	8.38	13.86	20.13	943.00	112.53	46.85
2008	15	6	Cotton	19.4	5.40	7.51	-2.11	8.38	13.86	20.13	943.00	112.53	46.85
2008	17	1	Grass	53.6	3.23	7.89	-4.66	9.26	13.09	17.69	N/A	N/A	N/A
2008	17	1	Grass Seed	53.6	3.23	7.89	-4.66	9.26	13.09	17.69	424.20	45.81	23.98
2008	17	2	Grass	58.3	5.94	4.31	1.63	9.55	13.09	24.27	N/A	N/A	N/A
2008	17	2	Grass Seed	58.3	5.94	4.31	1.63	9.55	13.09	24.27	520.97	54.55	21.47
2008	17	3	Corn	109	7.29	9.40	-2.11	20.75	13.09	31.73	11,021.72	531.17	347.39
2008	18	1	Wheat	60.7	5.66	7.62	-1.96	5.5	10.5	14.04	14,827.02	2,695.82	1,056.22
2008	18	1	Sorghum	60.7	5.66	7.62	-1.96	5.5	10.5	14.04	3,706.76	673.96	264.05
2008	18	2	Cotton	61.5	6.69	7.70	-1.00	10.35	10.5	19.85	1,450.23	140.12	73.07
2008	19	8	Millet Seed	45.4	8.83	10.43	-1.61	6.14	12.78	17.31	2,558.00	416.61	147.75
2008	19	7	Cotton	74.9	8.57	10.51	-1.94	7.53	12.78	18.37	982.12	130.43	53.46
2008	20	2	orghum Silag	115.8	7.17	9.25	-2.08	11.53	14.28	23.73	34,000.00	2,948.83	1,433.05
2008	20	1	Sorghum	117.7	2.24	9.89	-7.64	15.93	14.28	22.57	8,200.00	514.75	363.39
2008	20	2	Wheat	115.8	2.12	7.03	-4.91	13.93	14.28	23.30	6,000.00	430.73	257.51
2008	20	1	Wheat	117.7	4.78	2.24	2.54	13.79	14.28	30.61	5,220.00	378.54	170.53
2008	21	1	Grass Seed	61.4	3.87	7.66	-3.78	7.51	13.79	17.52	173.60	23.12	9.91
2008	21	1	Hay	61.4	3.87	7.66	-3.78	7.51	13.79	17.52	4,800.00	639.15	274.04
2008	21	2	Grass Seed	61.3	7.73	10.33	-2.61	12.75	13.79	23.93	3,148.00	246.90	131.54
2008	21	2	Hay	61.3	7.73	10.33	-2.61	12.75	13.79	23.93	3,148.00	246.90	131.54
2008	22	1	Corn	72.8	9.62	8.62	1.00	24.75	12.11	37.86	13,048.00	527.19	344.61
2008	22	2	Corn	76	9.62	8.62	1.00	24.75	12.11	37.86	13,048.00	527.19	344.61
2008	23	3	Sunflowers	4.9	9.72	3.91	5.81	12.3	10.43	28.54	1,643.00	133.58	57.57
2008	23	4	Sunflowers	28.8	9.72	3.91	5.81	12.3	10.43	28.54	1,643.00	133.58	57.57
2008	23	5	Cotton	71.4	9.72	4.65	5.07	16.87	10.43	32.37	1,050.00	62.24	32.44
2008	24	1	Corn	64.7	7.72	9.17	-1.46	24.7	12.6	35.84	11,312.00	457.98	315.58
2008	24	2	Corn	65.1	7.72	9.17	-1.46	24.7	12.6	35.84	11,312.00	457.98	315.58
2008	26	4	Corn	40.5	8.30	8.72	-0.43	16.8	11.34	27.71	8,133.00	484.11	293.46
2008	26	3	Sorghum	22.5	6.78	8.22	-1.43	15.05	11.34	24.96	4,533.00	301.20	181.63
2008	26	2	Millet Seed	62.3	0.68	6.78	-6.10	13.13	11.34	18.37	2,798.00	213.10	152.31
2008	27	1	Cotton	46.2	9.25	8.94	0.31	15.56	13.28	29.15	1,903.00	122.30	65.28
2008	27	3	Corn	48.8	8.66	7.22	1.44	24.5	13.28	39.22	13,900.00	567.35	354.41
2008	27	4	Corn	13.5	8.66	7.22	1.44	24.5	13.28	39.22	13,900.00	567.35	354.41
2008	28	1	Corn	51.5	8.66	7.22	1.44	8.2	14.84	24.48	11,800.00	1,439.02	482.11
2008	29	1	Cotton	50.8	2.20	4.36	-2.16	N/A	13.3	11.14	707.00	NA	63.46
2008	29	2	Fallow	104.3	0.00	0.00	0.00	N/A	13.3	13.30	N/A	NA	NA
2008	29	3	Cotton	66.6	2.20	4.36	-2.16	N/A	13.3	11.14	707.00	NA	63.46

Table 31. Evapotranspiration (ET) by various cropping and livestock systems in Hale and Floyd Counties (2008).

Year	System	Field	Crop	Application Method	Acres	Acre Inch Irrigation Applied	Total Crop Water Inches Per Acre	Acre Inch ET Crop Water Demand	% Of ET Provided To Crop From Irrigation	% Of ET Provided To Crop From Total Water	Yield Lb/Ac.	Yield Per Acre Inch Of Irrigation (lbs.)	Yield Per Acre Inch Of Total Water (lbs.)
2008	1	1	Corn	SDI	24.6	25.57	38.03	23.61	108%	161%	NA	NA	NA
2008	1	2	Corn	SDI	37.7	25.57	38.03	23.61	108%	161%	NA	NA	NA
2008	1	3	Cotton	SDI	37	7.27	19.73	24.18	30%	82%	NA	NA	NA
2008	1	4	Cotton	SDI	35.9	7.27	19.73	24.18	30%	82%	NA	NA	NA
2008	2	1	Sunflowers	SDI	60.9	6.89	20.50	23.23	30%	88%	2,370.00	343.98	115.63
2008	3	1	Wheat	MESA	61.5	5.76	12.41	NA	NA	NA	995.10	172.76	80.19
2008	3	1	Sorghum	MESA	61.5	10.06	12.94	22.01	46%	59%	5,170.73	743.99	525.85
2008	3	2	Cotton	MESA	61.8	13.68	18.60	24.22	56%	77%	1,495.16	84.47	66.11
2008	4	1	Alfalfa	LESA	13.3	15.58	32.83	NA	NA	NA	22,340.00	1,433.89	680.55
2008	4	2	Sorghum	LESA	65.4	19.05	29.97	26.01	73%	115%	7,411.69	389.07	247.29
2008	4	3	Wheat	LESA	44.4	7.5	12.81	NA	NA	NA	4,838.80	645.17	377.72
2008	5	1	Grass	MESA	70.2	6.31	17.89	NA	NA	NA	N/A	NA	NA
2008	5	2	Grass	MESA	81.6	5.38	16.96	NA	NA	NA	N/A	NA	NA
2008	5	3	Grass	MESA	95.8	3.68	15.26	NA	NA	NA	N/A	NA	NA
2008	5	4	Grass	MESA	89.2	3.67	15.25	NA	NA	NA	14,932.60	4,068.83	979.12
2008	5	5	Hay	MESA	81.2	6.39	17.97	NA	NA	NA	13,593.30	2,127.28	756.40
2008	5	6	Hay	MESA	69.6	6.39	17.97	NA	NA	NA	11,651.40	1,823.38	648.35
2008	6	3	Corn	LESA	30.1	15.7	30.19	32.19	49%	94%	14,108.00	898.60	414.45
2008	6	2	Cotton	LESA	92.9	17.87	32.36	24.89	72%	130%	1,724.00	96.47	47.61
2008	7	1	Grass Seed	LESA	130	9.88	21.16	NA	NA	NA	200.00	20.24	9.45
2008	7	1	Hay	LESA	130	9.88	21.16	NA	NA	NA	2,550.00	258.10	120.50
2008	8	1	Grass Seed	SDI	61.8	6.65	18.21	NA	NA	NA	226.00	33.98	12.41
2008	8	1	Hay	SDI	61.8	6.65	18.21	NA	NA	NA	2,745.00	412.78	150.74
2008	9	2	Cotton	MESA	137	8.75	24.89	24.15	36%	103%	771.00	88.11	30.98
2008	9	1	Grass	MESA	95.8	5.5	19.41	NA	NA	NA	N/A	NA	NA
2008	10	1	Grass	LESA	44.3	3.28	17.74	NA	NA	NA	NA	NA	NA
2008	10	2	Wheat	LESA	44.5	3.57	11.10	NA	NA	NA	3,640.00	1,019.61	260.37
2008	10	2	Corn	LESA	45.5	38.81	47.92	31.08	125%	154%	6,800.00	201.12	148.48
2008	10	3	Grass	LESA	42.7	5.98	11.30	NA	NA	NA	NA	NA	NA
2008	10	3	Hay	LESA	43.7	5.98	11.30	NA	NA	NA	NA	NA	NA
2008	10	4	Grass	LESA	42.1	6.17	20.63	NA	NA	NA	NA	NA	NA
2008	11	1	Sorghum	Furrow	45.1	10.86	25.68	23.10	47%	111%	7,866.00	340.52	274.08
2008	11	2	Cotton	Furrow	47.3	10.86	25.69	24.29	45%	106%	1,224.07	50.39	42.66
2008	12	1	Sorghum	DRY	151.2	N/A	12.30	26.01	NA	47%	No hvst	No hvst	No hvst
2008	12	1	Wheat	DRY	132.7	N/A	7.02	NA	NA	NA	No hvst	No hvst	No hvst
2008	14	2	Cotton	MESA	61.8	8.97	21.62	24.53	37%	88%	1,082.00	120.62	42.95
2008	14	3	Cotton	MESA	62.4	8.97	21.62	24.53	37%	88%	1,082.00	120.62	42.95
2008	15	5	Cotton	SDI	18.8	8.38	20.13	24.22	35%	83%	943.00	112.53	39.79
2008	15	6	Cotton	SDI	19.4	8.38	20.13	24.22	35%	83%	943.00	112.53	39.79
2008	17	1	Grass	MESA	53.6	9.26	17.69	NA	NA	NA	N/A	N/A	N/A
2008	17	1	Grass Seed	MESA	53.6	9.26	17.69	NA	NA	NA	424.20	45.81	19.63
2008	17	2	Grass	MESA	58.3	9.55	24.27	NA	NA	NA	N/A	N/A	N/A
2008	17	2	Grass Seed	MESA	58.3	9.55	24.27	NA	NA	NA	520.97	54.55	18.48
2008	17	3	Corn	MESA	109	20.75	31.73	32.19	64%	99%	11,021.72	531.17	347.39
2008	18	1	Wheat	MESA	60.7	5.5	14.04	NA	NA	NA	14,827.02	2,695.82	1,056.22
2008	18	1	Sorghum	MESA	60.7	5.5	14.04	26.01	21%	54%	3,706.76	673.96	264.05
2008	18	2	Cotton	MESA	61.5	10.35	19.85	25.2	41%	79%	1,450.23	140.12	73.07
2008	19	8	Millet Seed	LEPA	45.4	6.14	17.31	22.77	27%	76%	2,558.00	416.61	147.75
2008	19	7	Cotton	LEPA	74.9	7.53	18.37	24.18	31%	76%	982.12	130.43	53.46
2008	20	2	orghum Silag	LEPA	115.8	11.53	23.73	18.1	64%	131%	34,000.00	2,948.83	1,275.05
2008	20	1	Sorghum	LEPA	117.7	15.93	22.57	17.7	90%	127%	8,200.00	514.75	321.50
2008	20	2	Wheat	LEPA	115.8	13.93	23.30	NA	NA	NA	6,000.00	430.73	228.66
2008	20	1	Wheat	LEPA	117.7	13.79	30.61	NA	NA	NA	5,220.00	378.54	155.59
2008	21	1	Grass Seed	LEPA	61.4	7.51	17.52	NA	NA	NA	173.60	23.12	8.49
2008	21	1	Hay	LEPA	61.4	7.51	17.52	NA	NA	NA	4,800.00	639.15	234.65
2008	21	2	Grass Seed	LEPA	61.3	12.75	23.93	NA	NA	NA	3,148.00	246.90	117.15
2008	21	2	Hay	LEPA	61.3	12.75	23.93	NA	NA	NA	3,148.00	246.90	117.15
2008	22	1	Corn	LEPA	72.8	24.75	37.86	31.72	78%	119%	13,048.00	527.19	325.37
2008	22	2	Corn	LEPA	76	24.75	37.86	31.72	78%	119%	13,048.00	527.19	325.37
2008	23	3	Sunflowers	LESA	4.9	12.3	28.54	26.01	47%	110%	1,643.00	133.58	57.57
2008	23	4	Sunflowers	LESA	28.8	12.3	28.54	26.01	47%	110%	1,643.00	133.58	57.57
2008	23	5	Cotton	LESA	71.4	16.87	32.37	25.62	66%	126%	1,050.00	62.24	32.44
2008	24	1	Corn	LESA	64.7	24.7	35.84	32.19	77%	111%	11,312.00	457.98	315.58
2008	24	2	Corn	LESA	65.1	24.7	35.84	32.19	77%	111%	11,312.00	457.98	315.58
2008	26	4	Corn	LESA	40.5	16.8	27.71	23.61	71%	117%	8,133.00	438.44	276.03
2008	26	3	Sorghum	LESA	22.5	15.05	24.96	26.01	58%	96%	4,533.00	301.20	181.63
2008	26	2	Millet Seed	LESA	62.3	13.13	18.37	22.41	59%	82%	2,798.00	213.10	152.31
2008	27	1	Cotton	SDI	46.2	15.56	29.15	28.06	55%	104%	1,903.00	122.30	57.51
2008	27	3	Corn	SDI	48.8	24.5	39.22	28.22	87%	139%	13,900.00	567.35	322.06
2008	27	4	Corn	SDI	13.5	24.5	39.22	28.22	87%	139%	13,900.00	567.35	322.06
2008	28	1	Corn	SDI	51.5	8.2	24.48	28.22	29%	87%	11,800.00	1,439.02	482.11
2008	29	1	Cotton	DRY	50.8	N/A	11.14	24.15	NA	46%	707.00	NA	63.46
2008	29	2	Fallow	DRY	104.3	N/A	13.30	NA	NA	NA	N/A	NA	NA
2008	29	3	Cotton	DRY	66.6	N/A	11.14	24.15	NA	46%	707.00	NA	63.46

BUDGET

Table 32. Task and expense budget for years 1-4 of the demonstration project.

2005-358-014		**Year 1**	**Year 2**	**Year 3**	**Year 4**		
		(9/22/04 - 1/31/06)	(2/01/06 - 2/28/07)	(3/01/07 - 2/29/08)	(3/01/08 - 2/28/09)	Total expenses	Remaining balance
Task Budget	**Task Budget**	***revised***	***revised***				
1	5,450.00	4,537.11	0.00	0.00	0.00	4,537.11	912.89
2	2,667,550.00	216,356.08	335,696.85	317,316.66	299,727.29	1,169,096.88	1,498,453.12
3	675,402.00	21,111.97	33,832.60	80,983.55	61,454.67	197,382.79	478,019.21
4	610,565.00	52,409.10	40,940.08	46,328.71	53,602.21	193,280.10	417,284.90
5	371,359.00	42,427.73	40,533.84	47,506.26	38,720.76	169,188.59	202,170.41
6	633,173.00	54,530.50	75,387.27	71,106.29	60,256.73	261,280.79	371,892.21
7	306,020.00	37,013.79	22,801.48	30,516.07	25,840.97	116,172.31	189,847.69
8	334,692.00	44,628.53	43,062.62	41,243.29	43,927.47	172,861.91	161,830.09
9	620,564.00	145,078.00	39,010.61	35,656.24	82,843.74	302,588.59	317,975.41
TOTAL	6,224,775.00	618,092.81	631,265.35	670,657.07	666,373.84	2,586,389.07	3,638,385.93

Expense Budget	**Total Budget**	**Year 1** (09/22/04 - 01/31/06)	**Year 2** (02/01/06 - 02/28/07)	**Year 3** (3/01/07 - 2/29/08)	**Year 4** (3/01/08 - 2/28/09)	Total expenses	Remaining balance
Salary and Wages [1]	2,126,064.00	230,131.35	300,530.73	298,105.60	296,943.73	1,125,711.41	1,000,352.59
Fringe[2] (20% of Salary)	288,379.00	29,304.43	35,534.29	37,264.74	42,029.11	144,132.57	144,246.43
Insurance	313,514.00	13,318.05	26,528.94	25,301.90	25,941.96	91,090.85	222,423.15
Tuition and Fees	200,514.00	8,126.78	16,393.00	21,679.18	18,502.12	64,701.08	135,812.92
Travel	150,000.00	14,508.18	24,391.85	14,649.80	15,556.35	69,106.18	80,893.82
Capital Equipment	76,554.00	22,958.77	13,392.67	447.89	706.91	37,506.24	39,047.76
Expendable Supplies	381,035.00	14,343.97	16,119.54	12,205.01	18,288.43	60,956.95	320,078.05
Subcon	1,741,376.00	212,360.28	103,388.58	161,540.03	183,125.44	660,414.33	1,080,961.67
Technical/Computer	190,400.00	9,740.00	3,860.00	16,225.00	430.00	30,255.00	160,145.00
Communications	365,000.00	25,339.15	45,040.39	38,800.63	26,360.63	135,540.80	229,459.20
Reproduction (incl under comm)						0.00	
Vehicle Insurance	5,000.00	0.00	397.06	235.00	187.00	819.06	4,180.94
Overhead	386,939.00	37,961.85	45,688.30	44,202.29	38,302.16	166,154.60	220,784.40
Profit							
TOTAL	6,224,775.00	618,092.81	631,265.35	670,657.07	666,373.84	2,586,389.07	3,638,385.93

Cost Sharing

Table 33. Cost share figures for TTU, AgriLife (TAMU) and HPUWCD for years 1-4 of the demonstration project.

Budget	Total Cost Share Budgeted	Actual Funds Contributed	Balance
TTU	1,026,840.00	510,509.44	516,330.56
TCE	423,892.00	152,468.02	271,423.98
HPUWCD	200,000.00	100,000.00	100,000.00
TOTAL	1,650,732.00	762,977.46	887,754.54

Expense Categories	TTU	TAMU	HPUWCD	TOTAL	Actual Funds Contributed	Balance
Salary & Wages	269,665.00			269,665.00	154,429.92	115,235.08
Fringe	53,934.00			53,934.00	46,650.70	7,283.30
Overhead	703,241.00			703,241.00	309,428.82	393,812.18
SubCon - TAMU		423,892.00		423,892.00	152,468.02	271,423.98
$25,000/year - HPUWCD			200,000.00	200,000.00	100,000.00	100,000.00
TOTAL	1,026,840.00	423,892.00	200,000.00	1,650,732.00	762,977.46	887,754.54

Task Categories	TTU	TAMU	HPUWCD	TOTAL	Actual Funds Contributed	Balance
Task 1 - TTU	872.00			872.00	-	872.00
Task 2 - TTU	328,513.00			328,513.00	257,147.86	71,365.14
Task 3 - TCE		326,820.73		326,820.73	117,552.84	209,267.89
Task 4 - TTU	84,936.00			84,936.00	-	84,936.00
Task 5 - TTU	49,923.00			49,923.00	-	49,923.00
Task 6 - TTU	352,327.00			352,327.00	157,031.80	195,295.20
Task 7 - TCE		97,071.27		97,071.27	34,915.18	62,156.09
Task 8 - TTU	210,269.00			210,269.00	96,329.78	113,939.22
Task 9 - HPUWCD			200,000.00	200,000.00	100,000.00	100,000.00
TOTAL	1,026,840.00	423,892.00	200,000.00	1,650,732.00	762,977.46	887,754.54

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