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USDA ARS United States Department of Agriculture Agricultural Research Service

NRCS Natural Resources Conservation Service

Producers of Hale & Floyd Counties

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

3rd Annual Report to the Texas Water Development Board

Texas Alliance For Water Conservation

TAWC

"Water is Our Future"

JUNE 18, 2008

FARM Assistance Planning Solutions

AgriLIFE EXTENSION Texas A&M System

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High Plains Underground Water Conservation District #1

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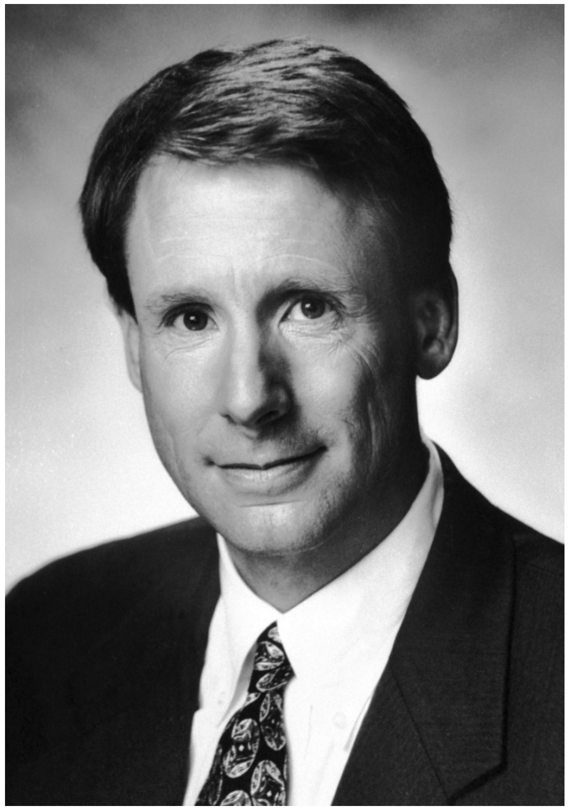

Senator Robert Duncan

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

Elected April 2, 2007

	will serve through the year
Glenn Schur, Chair	2008
Boyd Jackson, Co-Chair	2008
Brian Teeple, Secretary	2008
Keith Phillips	2007
Mark Beedy	2007
Jeff Don Terrell	2007
Jody Foster	2007
Lanney Bennett	2009
Eddie Teeter	2009
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.

TEXAS ALLIANCE FOR WATER CONSERVATION PARTICIPANTS

Texas Tech University
Rick Kellison, Project Director*
Dr. Vivien Gore Allen*
Dr. Matt Baker*
Ms. Lucia Barbato*
Mr. Philip Brown
Dr. David Doerfert*
Dr. Phil Johnson*
Dr. Stephan Maas*
Dr. Eduardo Segarra*
Mr. Tom Sell*
Ms. Angela Beikmann,*
  Secretary/Bookkeeper

Texas AgriLife Extension
Dr. Steven Klose*
Mr. Jeff Pate*
Dr. Calvin Trostle*
Mr. Jay Yates*

Texas AgriLife Research
Dr. Robert Lascano

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

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
Dr. Will Cradduck

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

* 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 rapidly escalating 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. Twenty-six 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 and communities.

REPORT OF THE FIRST THREE 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 26 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 and 2007.

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

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

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

	2005	2006	2007
Cotton lint ($/lb)	$0.54	$0.56	$0.58
Cotton seed ($/ton)	$100.00	$135.00	$155.00
Grain Sorghum – Grain ($/cwt)	$3.85	$6.10	$5.96
Corn – Grain ($/bu)	$2.89	$3.00	$3.69
Corn – Food ($/bu)	$3.48	$3.55	$4.20
Wheat – Grain ($/bu)	$2.89	$4.28	$4.28
Sorghum Silage ($/ton)	$20.19	$18.00	$18.00
Corn Silage ($/ton)	$20.12	$22.50	$25.00
Wheat Silage ($/ton)	$18.63	$22.89	$22.89
Oat Silage ($/ton)	-	$17.00	$17.00
Millet Seed ($/lb)	$0.17	$0.17	$0.22
Sunflowers ($/lb)	$0.21	$0.21	$0.21
Alfalfa ($/ton)	$130.00	$150.00	$150.00
Hay ($/ton)	$60.00	$60.00	$60.00
WWB Dahl Hay ($/ton)	$65.00	$65.00	$90.00
Hay Grazer ($/ton)	-	$110.00	$110.00
Sideoats Seed ($/lb)	-	-	$6.52
Sideoats Hay ($/ton)	-	-	$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, 2006 and 2007 in Table 3.

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

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

5. The custom tillage and harvest rates used for 2005 were based on rates reported in USDA-NASS, 2004 Texas Custom Rates Statistics, Bulletin 263, September 2005. The custom rates used for 2006 were 115% of the reported 2004 rates to reflect increased cost of operation due to rising fuel prices and other costs while 2007 rates were 120% of the 2006 rates.

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 Fig. 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.

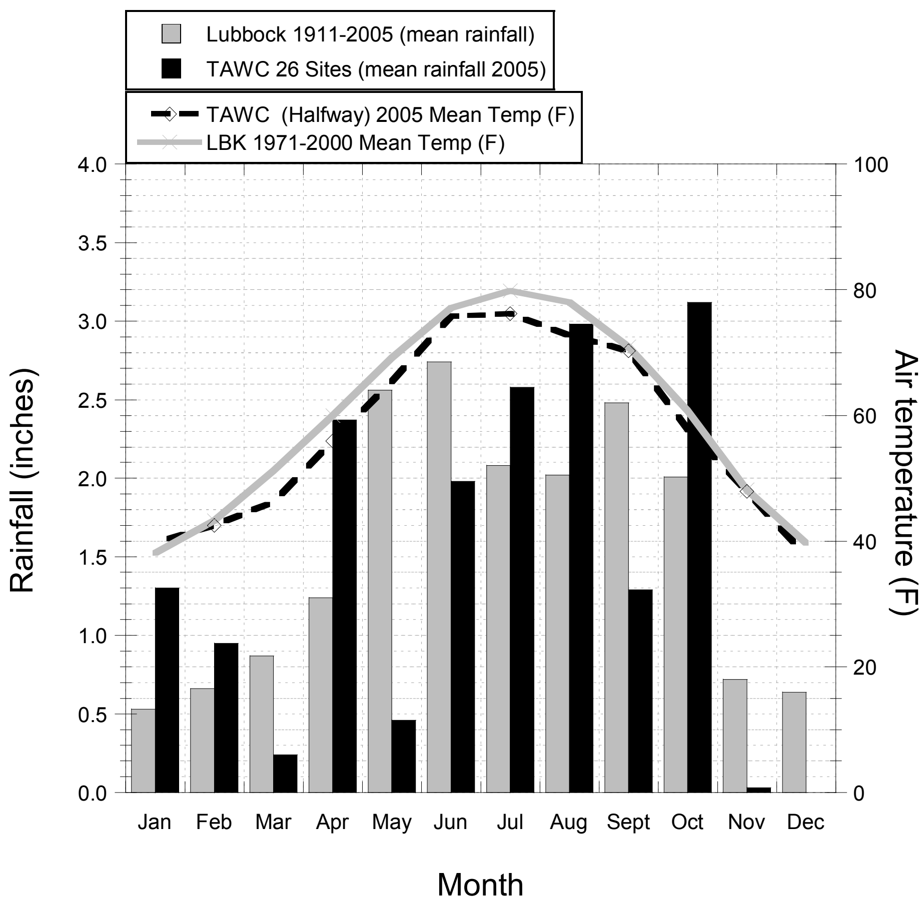

Figure 1. Temperature and precipitation for 2005 in the demonstration area compared with long term averages.

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 Fig. 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.

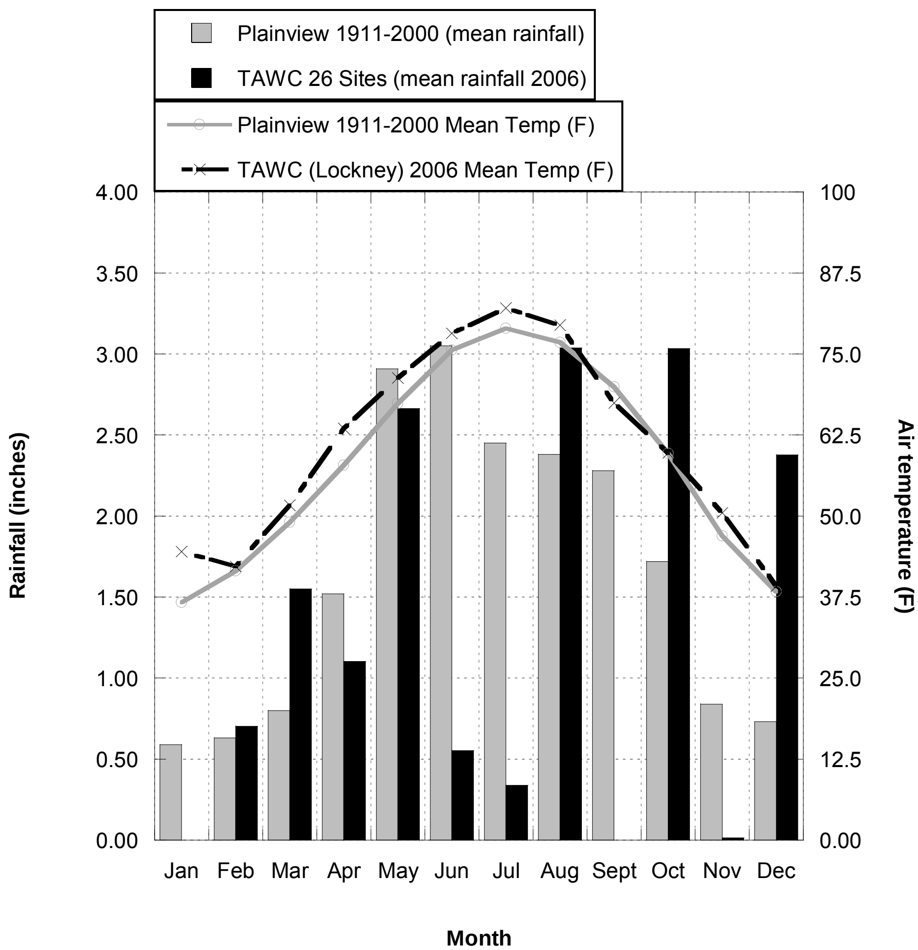

Figure 2. Temperature and precipitation for 2006 in the demonstration area compared with long term averages.

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 (Fig. 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 Fig. 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.

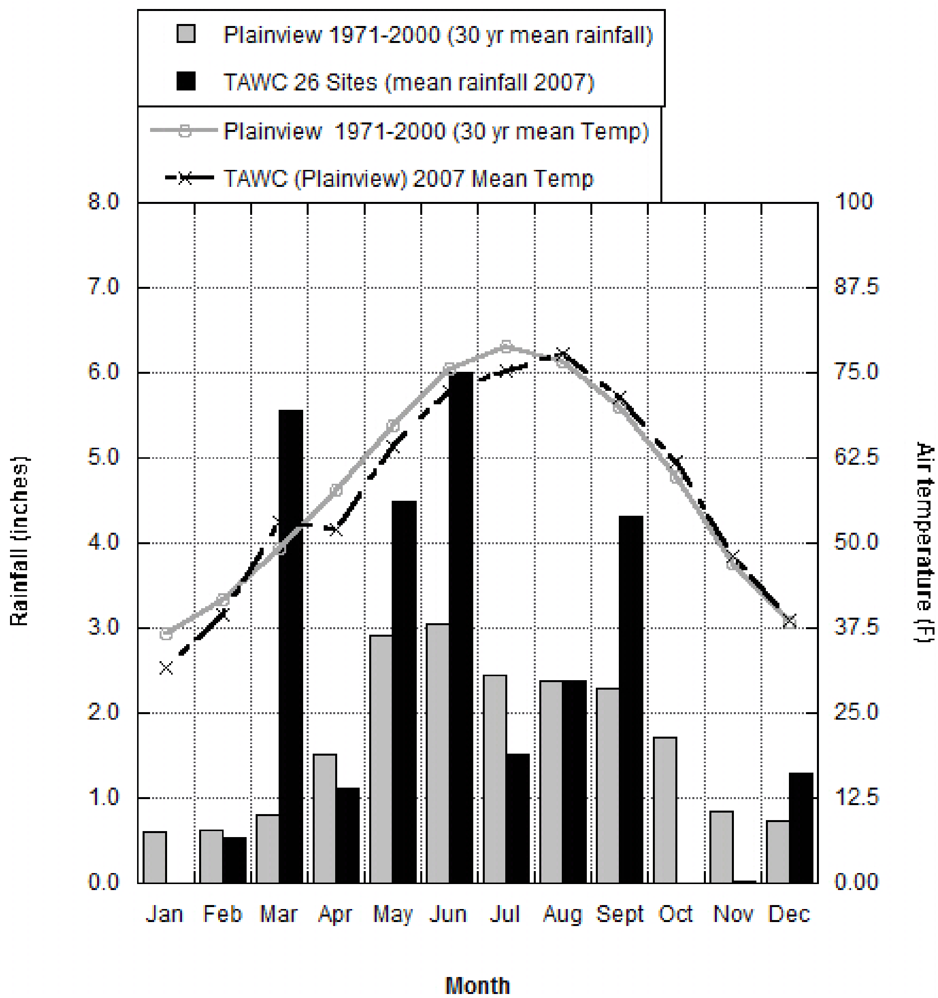

Figure 3. Temperature and precipitation for 2007 in the demonstration area compared with long term averages.

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

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. Amount requested, $10,000 (funded).

2008

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

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

DONATIONS TO PROJECT

2005

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

VISITORS TO THE DEMONSTRATION PROJECT SITES

2005

Total Number of Visitors	190

2006

Total Number of Visitors	282

2007

Dr. Jeff Jordan	*1*
South Plains Perennial Grass Workshop participants	*32*
Dr. Burns and Dr. Misra	*2*
Dr. Darrell Dromgoole	*1*
Total Number of Visitors	36

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	

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.

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.

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.

Refereed Journal Articles

Acosta-Martinez, V., T. M. Zobeck, and V. Allen. 2004. Soil microbial, chemical and physical properties in continuous cotton and integrated crop-livestock systems. Soil 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)

Popular Press

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

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

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

Foster, Jerod. 2007. Learning to Conserve. *Archways* Vol. 2 No. 1: 6-9.

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

THESIS AND DISSERTATIONS

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

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

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

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

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

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

Deycard, Victoria Nicole. 2008. Comparison of Soil Sustainability Measured by Carbon Sequestration using Carbon Isotopes from Cotton (Gossypium hirsutum) – Forage – Integrated Management Systems. M.S. Thesis, Texas Tech University, Lubbock.

IN PRESS

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1. Acosta-Martinez, V., T. M. Zobeck, and Vivien Allen. 2004. Soil microbial, chemical and physical properties in continuous cotton and integrated crop-livestock systems. Soil Sci. Soc. Am. J. 68:1875-1884.

2. 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).

3. 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.

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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 (Fig. 4). Many of these sites were located in close

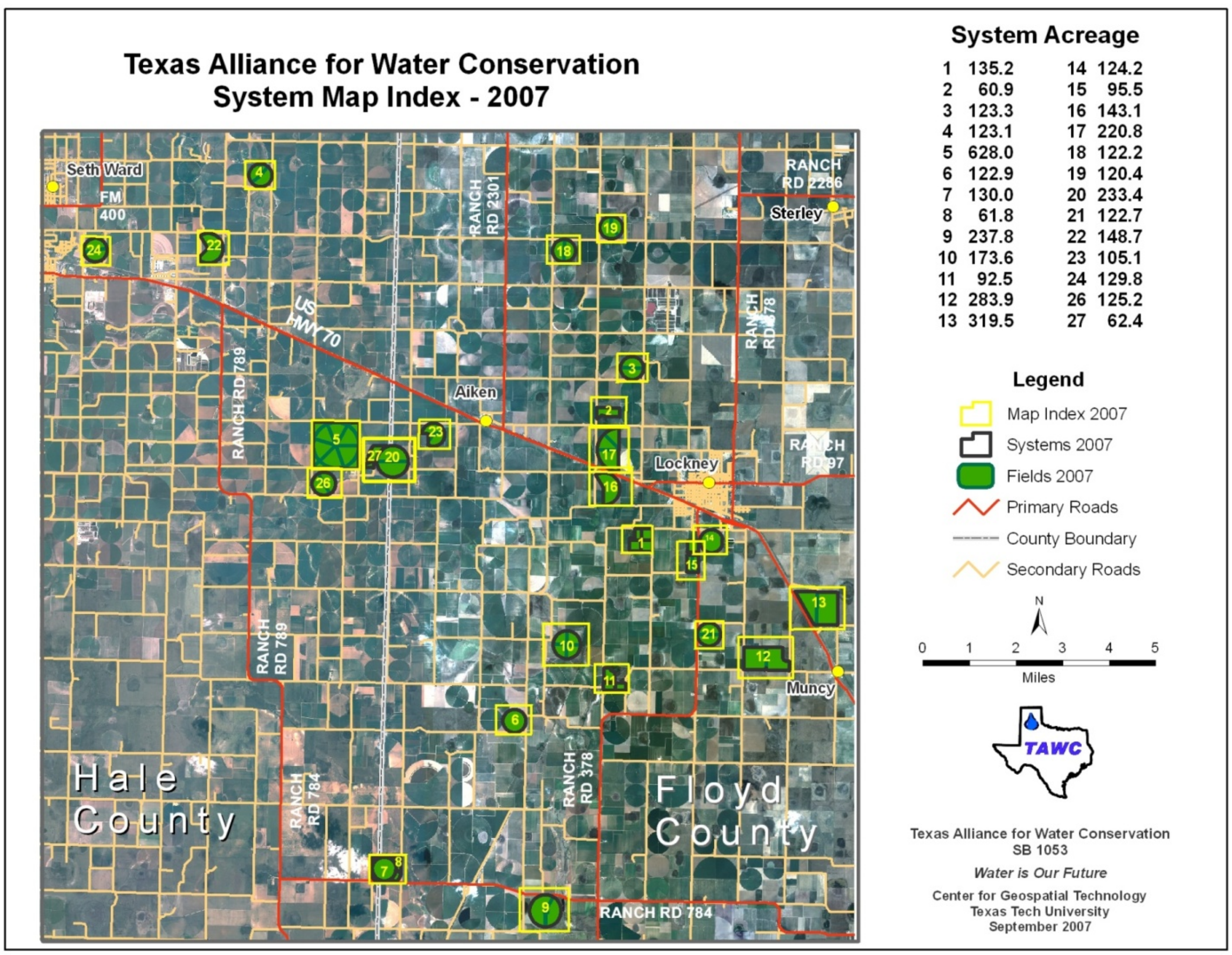


Figure 4. System map index for 2007 (Year 3).

proximity to soil moisture monitoring points maintained by the High Plains Underground Water Conservation District No. 1 (Fig. 5). 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.

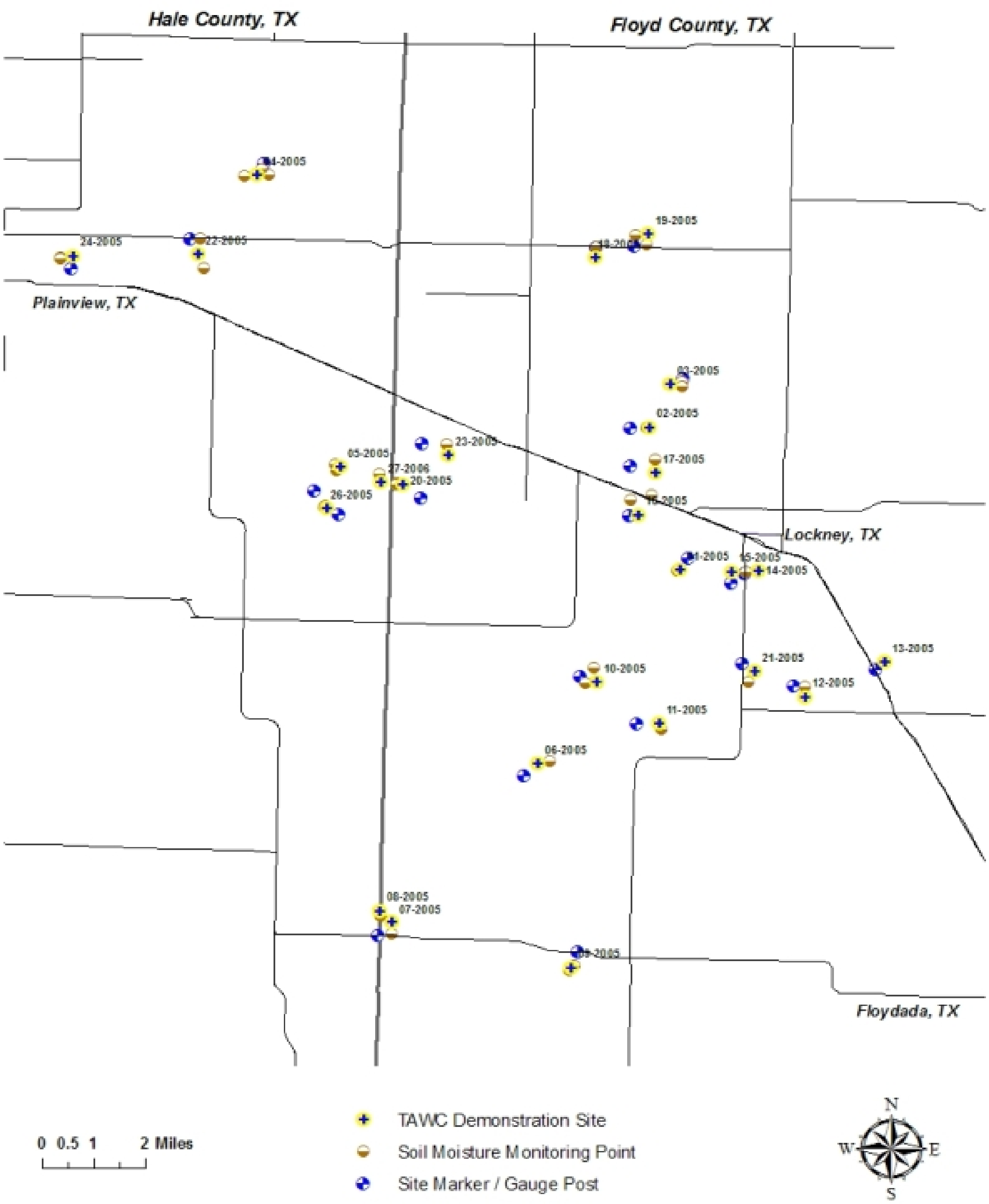


Figure 5. Location of soil moisture monitoring points in each of the 26 sites in the Demonstration project.

Total number of acres devoted to each crop and livestock enterprise and management type in 2005, 2006 and 2007 are given in Tables 7, 8 and 9. 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

Table 7. Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 26 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

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 8.

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.

Table 8. Irrigation type and total acres, by site, of crops, forages and acres grazed by cattle in 26 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

All numbers in this report continue to be checked and verified. THIS REPORT SHOULD BE CONSIDERED A DRAFT AND SUBJECT TO FURTHER REVISION. However, each year's annual report reflects completion and revisions made to previous 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 the first 3 years follow and are presented by site.

Table 9. Irrigation type and total acres, by site, of crops, forages and acres grazed by cattle in 26 producer systems in Hale and Floyd Counties during 2007.

TAWC 2007 CROP ACRES - ACRES MAY OVERLAP DUE TO MULTIPLE CROPS PER YEAR, GRAZING, AND OVERLAPPING CATEGORIES.

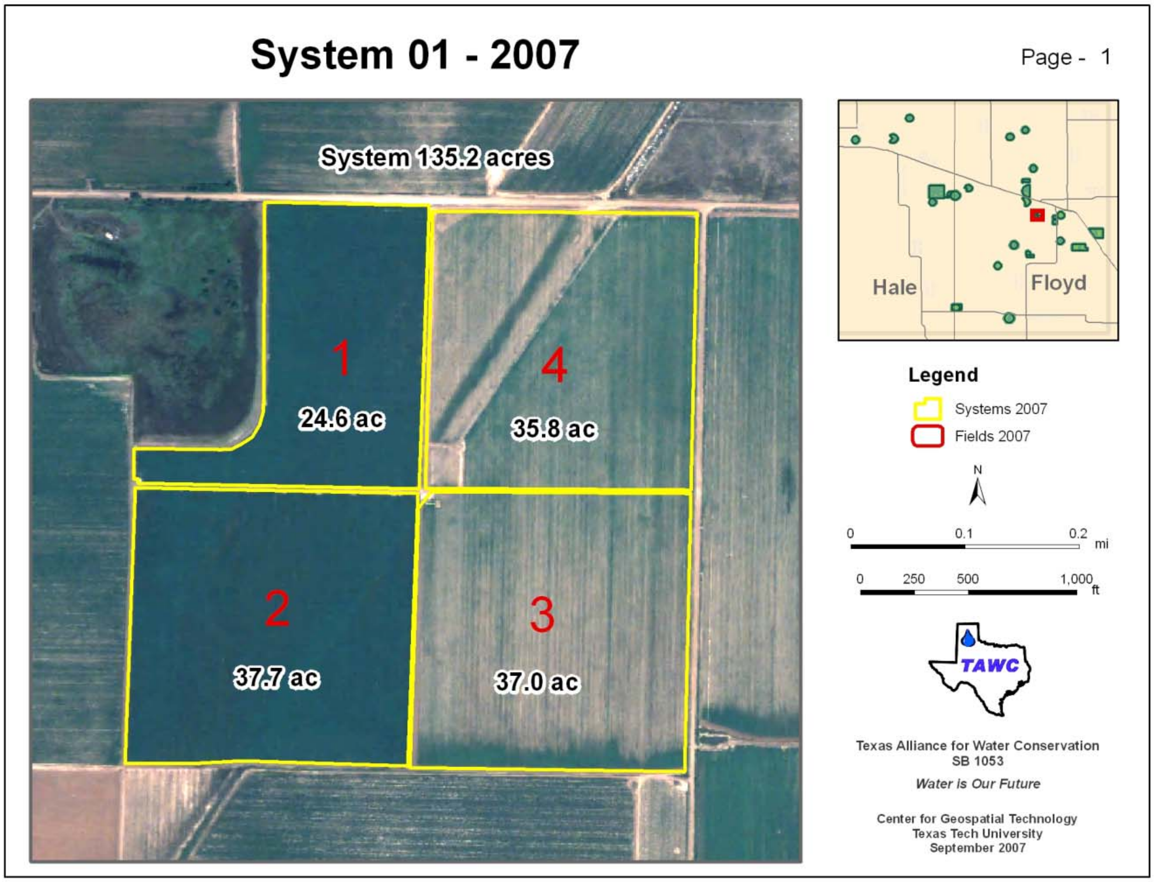
Site	irrigation type	cotton	corn grain	corn silage	sorghum grain	sorghum silage	pearl millet	alfalfa	grass seed	perennial pasture	cattle	wheat for grain	wheat for grazing	rye interseeded for grazing	triticale
1	SDI	135.2													
2	SDI	60.9													
3	PIV	61.5			61.8							61.8			
4	PIV	65.4						13.3		13.3	109.8	44.4	65.4		
5	PIV/DRY									620.9	620.9				
6	PIV	122.9													
7	PIV								130.0	130.0					
8	SDI								61.8	61.8					
9	PIV				137.0					95.8	95.8			95.8	
10	PIV			44.5					42.7	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														
17	PIV	108.9							111.9	111.9	220.8		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	61.4					
22	PIV	148.7													
23	PIV		105.2												
24	PIV		129.8												
25	DRY														
26	PIV		62.9				62.3				62.3				
27	SDI			46.2											
Total 2007 acres		**1415.4**	**359.2**	**208.3**	**421.8**	**115.8**	**107.9**	**13.3**	**407.8**	**1224.2**	**1238.7**	**284.9**	**174.3**	**95.8**	**233.4**
Number of sites		**13**	**4**	**3**	**5**	**1**	**2**	**1**	**5**	**8**	**6**	**4**	**2**	**1**	**1**
Site	irrigation type	cotton	corn grain	corn silage	sorghum grain	sorghum silage	pearl millet	alfalfa	grass seed	perennial pasture	cattle	wheat for grain	wheat for grazing	rye interseeded for grazing	triticale

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

Table 10. Crops, forage, and livestock present on the 26 producer sites in the Demonstration Project in 2005, 2006 and 2007.

site	cotton	corn grain	corn silage	sorghum grain	sorghum forage	pearl millet	sunflowers	alfalfa	grass seed	perennial pasture	cattle	wheat	rye	triticale	oats
1	2005, 2006, 2007														
2	2005, 2006, 2007														
3	2005, 2006, 2007			2005, 2007								2007			
4	2005, 2006, 2007				2006			2005, 2006, 2007			2007	2006, 2007			
5								2005, 2006		2005, 2006, 2007	2005, 2006, 2007				
6	2005, 2006, 2007										2005	2005			
7									2005, 2006, 2007						
8									2005, 2006, 2007						
9	2005, 2006			2007						2005, 2006, 2007	2005, 2006, 2007		2005, 2006, 2007		
10	2005		2007		2006					2005, 2006, 2007	2005, 2006, 2007				2006
11	2005, 2006, 2007														
12	2005, 2006, 2007			2007	2005							2006, 2007			
13	2005, 2006, 2007											2005, 2006, 2007			
14	2005, 2006, 2007														
15	2005, 2006, 2007			2006, 2007											
16	2005, 2006														
17	2005, 2006, 2007		2005, 2006							2005, 2006, 2007	2006, 2007	2006, 2007			
18	2005, 2006			2005, 2007	2006							2007			2006
19	2005, 2006, 2007					2005, 2006, 2007									
20			2005, 2006, 2007		2005, 2006, 2007							2005		2006, 2007	
21	2005, 2006	2006, 2007							2007		2006	2006			
22	2005, 2006, 2007	2005, 2006													
23	2005, 2006	2006, 2007					2005								
24	2005, 2006	2005, 2007	2006												
25	2005			2005											
26	2005, 2006	2005, 2006, 2007				2007					2007				
27	2006		2007												
Total 2005	22	3	2	3	2	1	1	2	2	4	4	3	1	0	0
Total 2006	21	4	3	1	4	1	0	2	2	4	5	5	1	1	2
Total 2007	13	4	3	5	1	2	0	1	3	4	6	6	1	1	0

● 2005 ● 2006 ● 2007



System 1

<u>Crops</u>

2007
Field 1: Cotton
Field 2: Cotton
Field 3: Cotton
Field 4: Cotton

2006
Field 1: Cotton
Field 2: Cotton
Field 3: Cotton
Field 4: Cotton

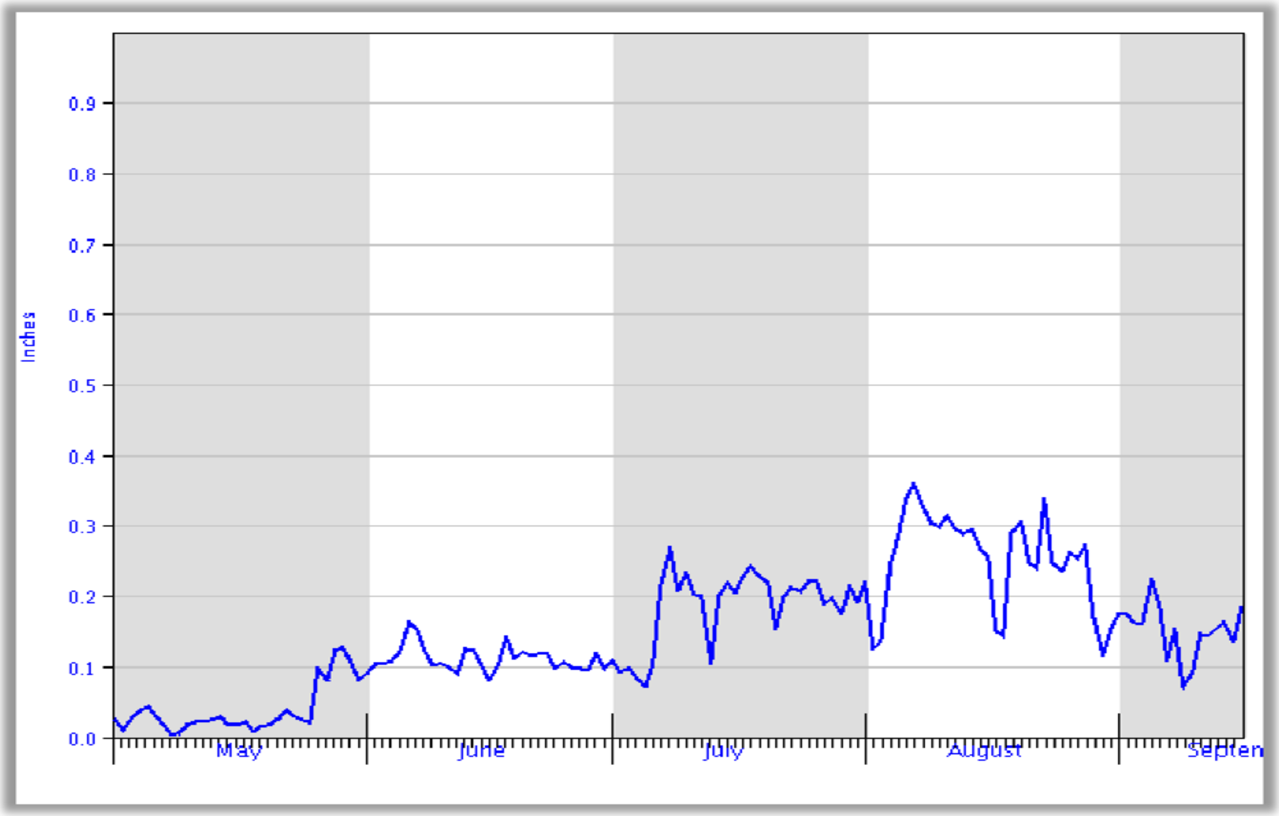
2005
Field 1: Cotton
Field 2: Cotton

<u>Irrigation</u>

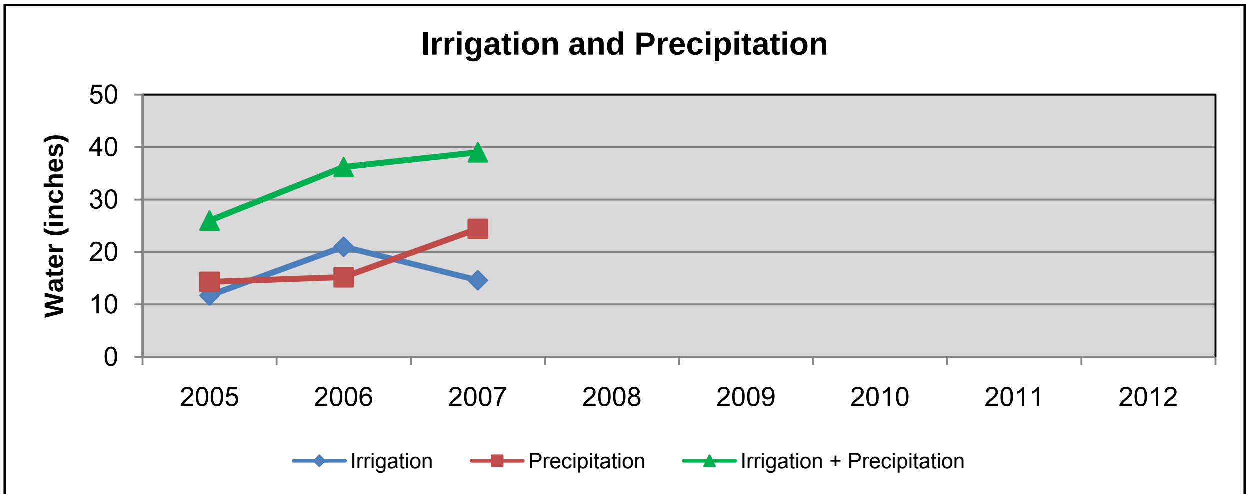
Type: Sub-surface Drip (SDI)
(Field 1 and 2 installed prior to 2004 crop year;
Field 3 and 4 installed prior to 2006 crop year)
Pumping capacity, gal/min: 850
Fuel source: 1 Electric
1 Natural Gas

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

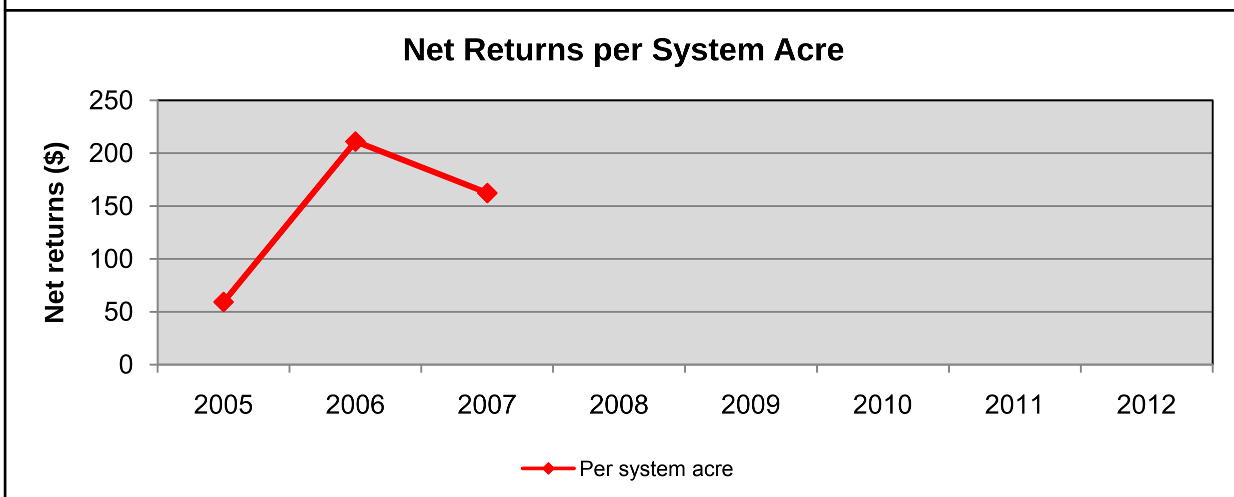
SITE 1 -1
South Plains Cotton ET
Planted May 1, 2007 Total ET Demand 20.18"



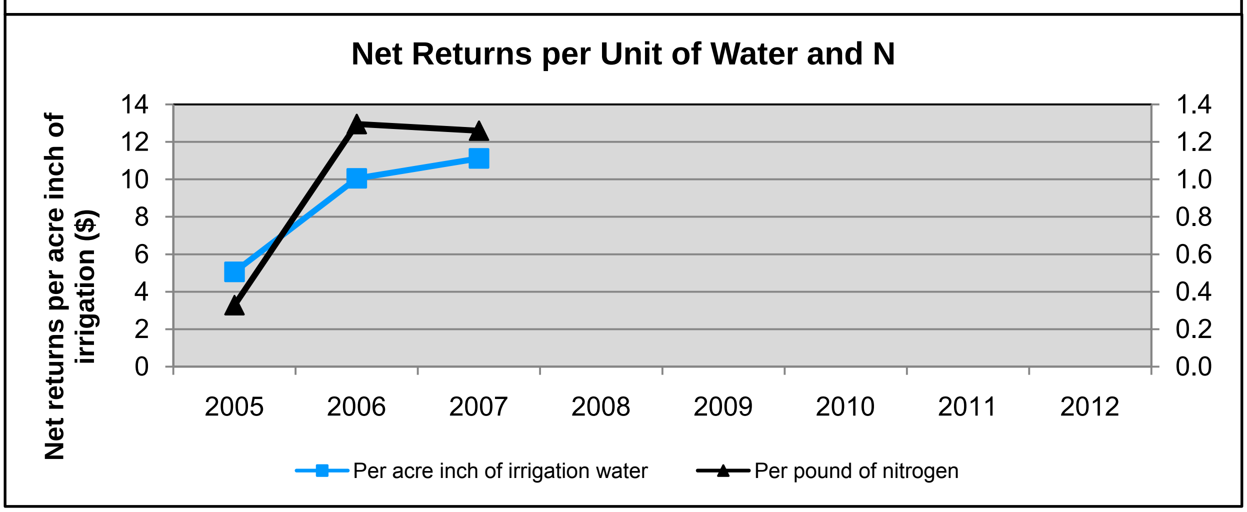
System 1



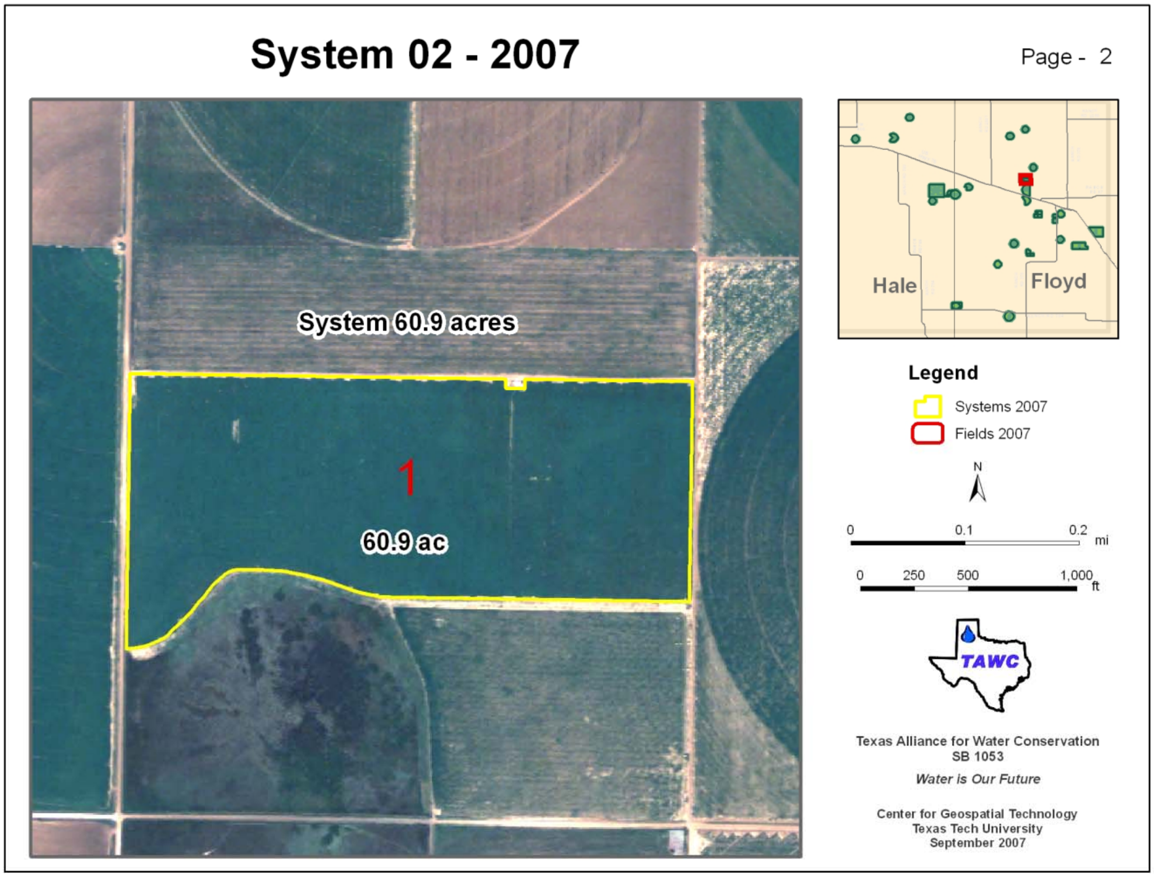
Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation



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



Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
14
12
10
8
6
4
2
0
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen

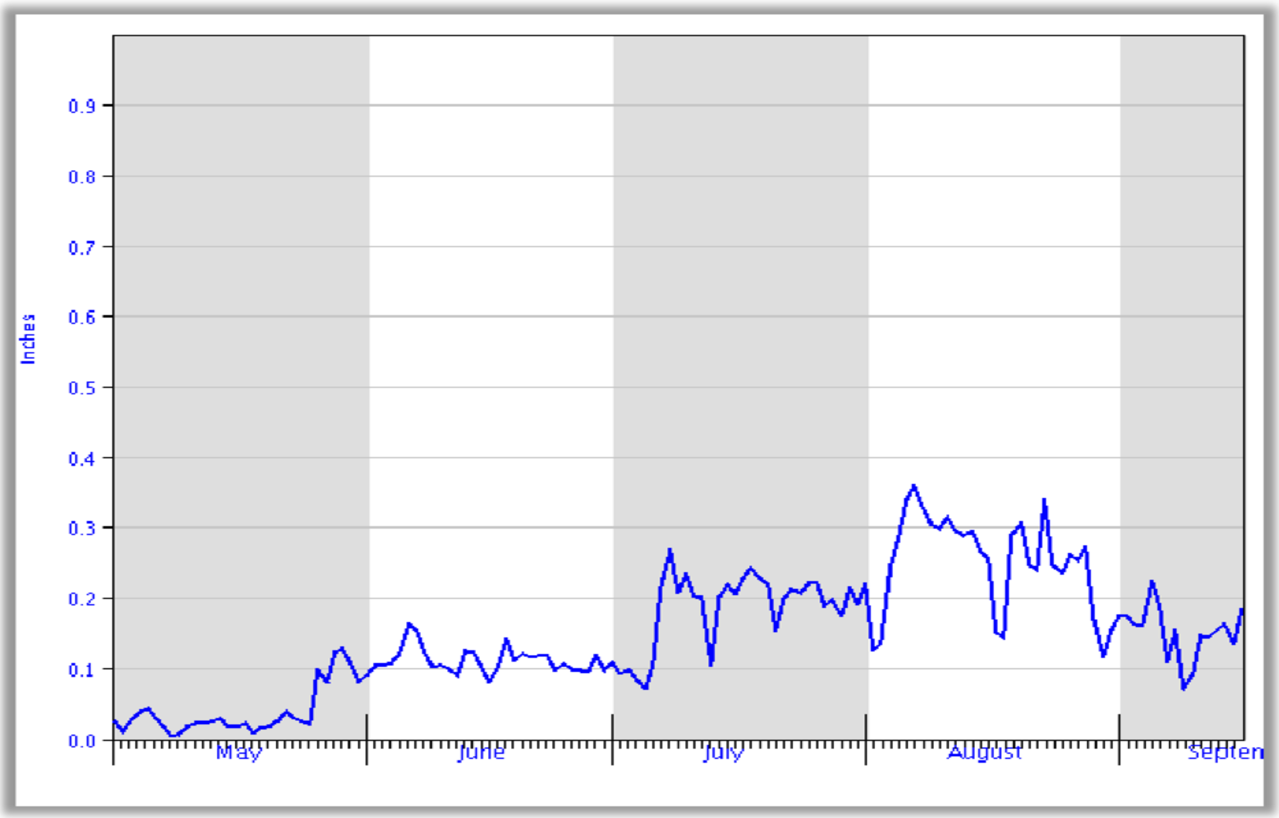


SYSTEM 2

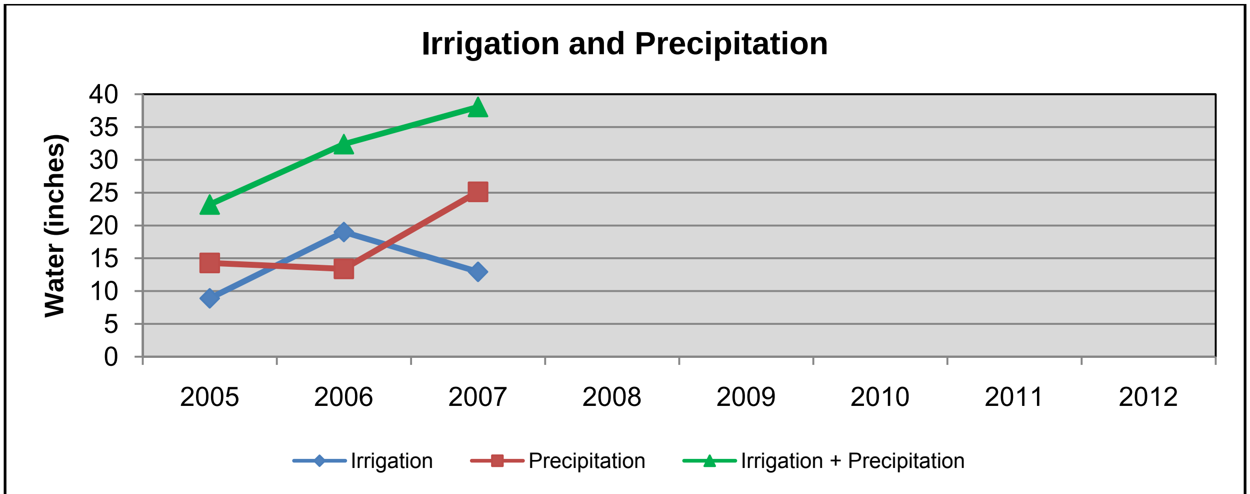
Crops	Irrigation	
2007	Type:	Sub-surface Drip
Field 1: Cotton		(SDI, installed prior to 2004 crop year)
	Pumping capacity, gal/min:	360
2006	Number of wells:	2
Field 1: Cotton	Fuel source:	Electric
2005		
Field 1: Cotton		

Comments: Drip irrigated cotton system, conventional tillage, planted on thirty-inch centers. This was the fourth growing season for this farm to be in drip.

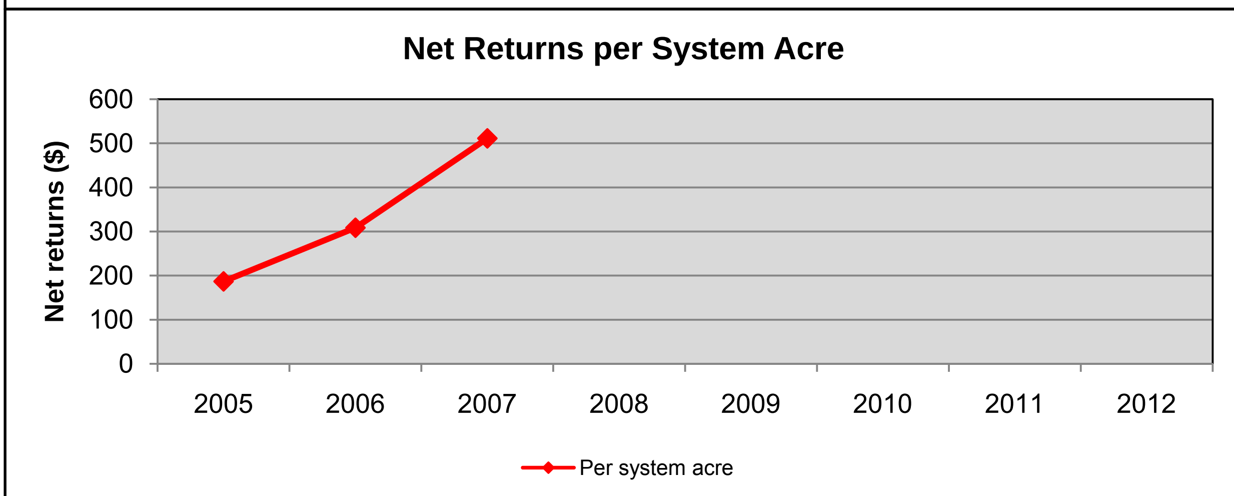
SITE 2 -1
South Plains Cotton ET
Planted May 3, 2007 Total ET Demand 20.09"



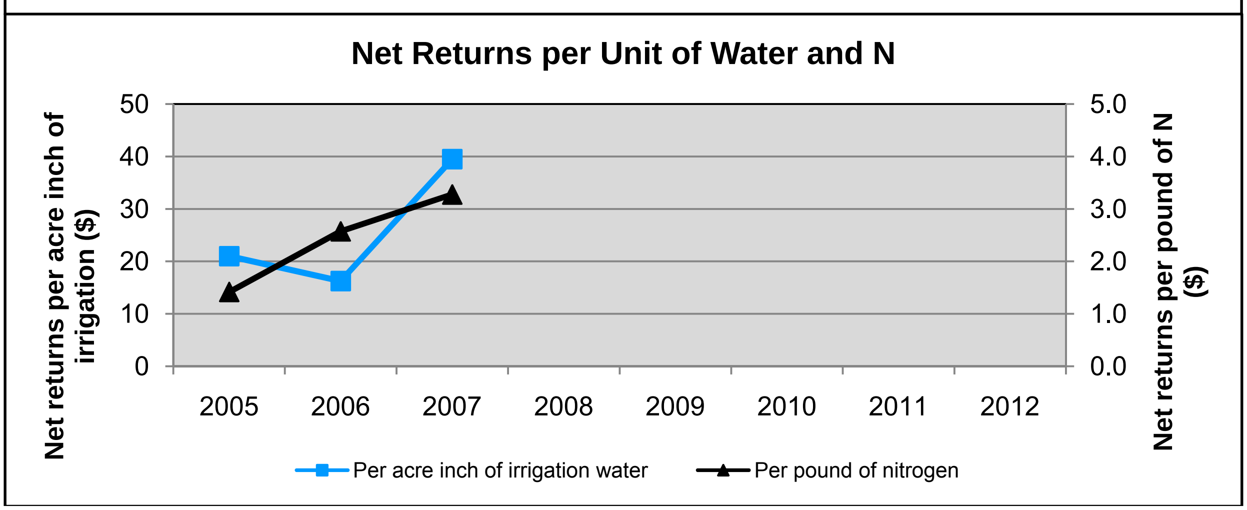
System 2



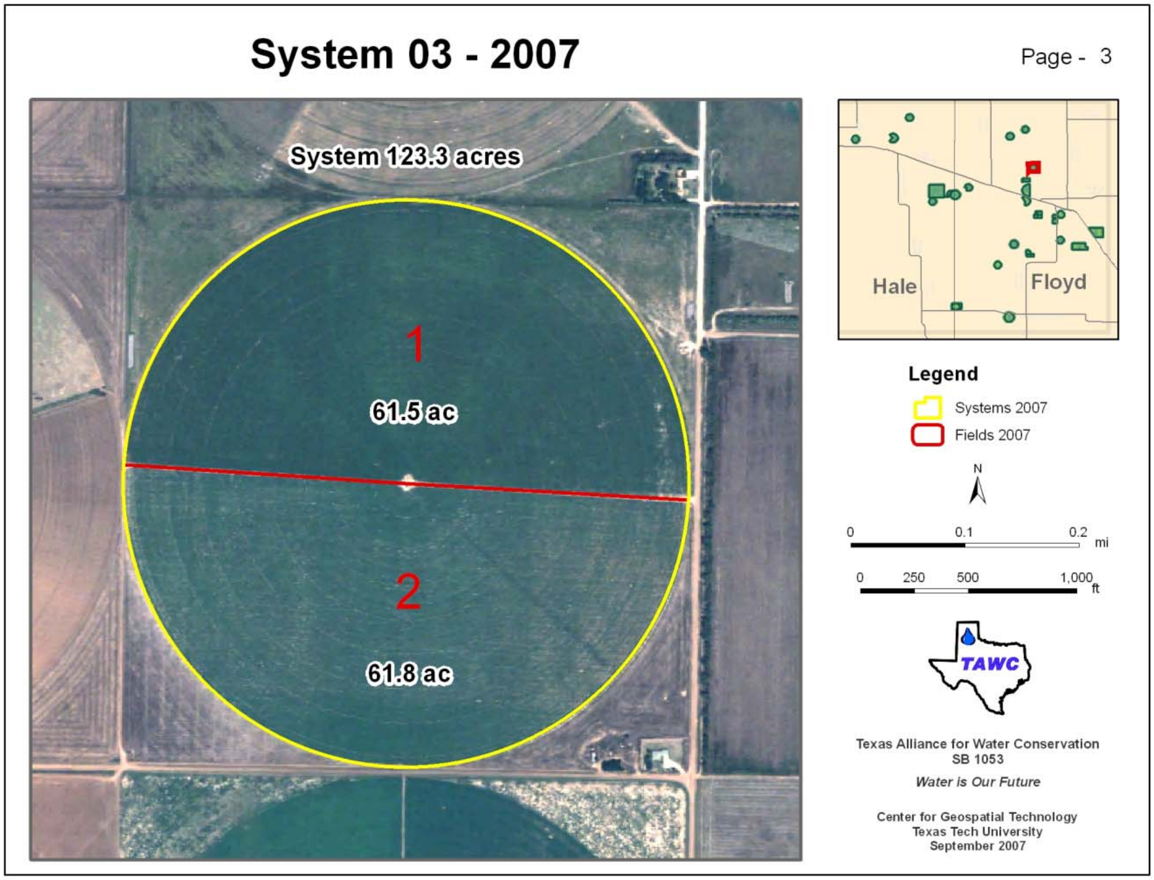
Irrigation and Precipitation
Water (inches)
0
5
10
15
20
25
30
35
40
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation



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



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



SYSTEM 3

<u>Crops</u>

2007

Field 1: Cotton following Wheat cover crop

Field 2: Wheat for grain followed by Grain Sorghum

2006

Field 1: Cotton

Field 2: Cotton

2005

Field 1: Grain Sorghum

Field 2: Cotton

<u>Irrigation</u>

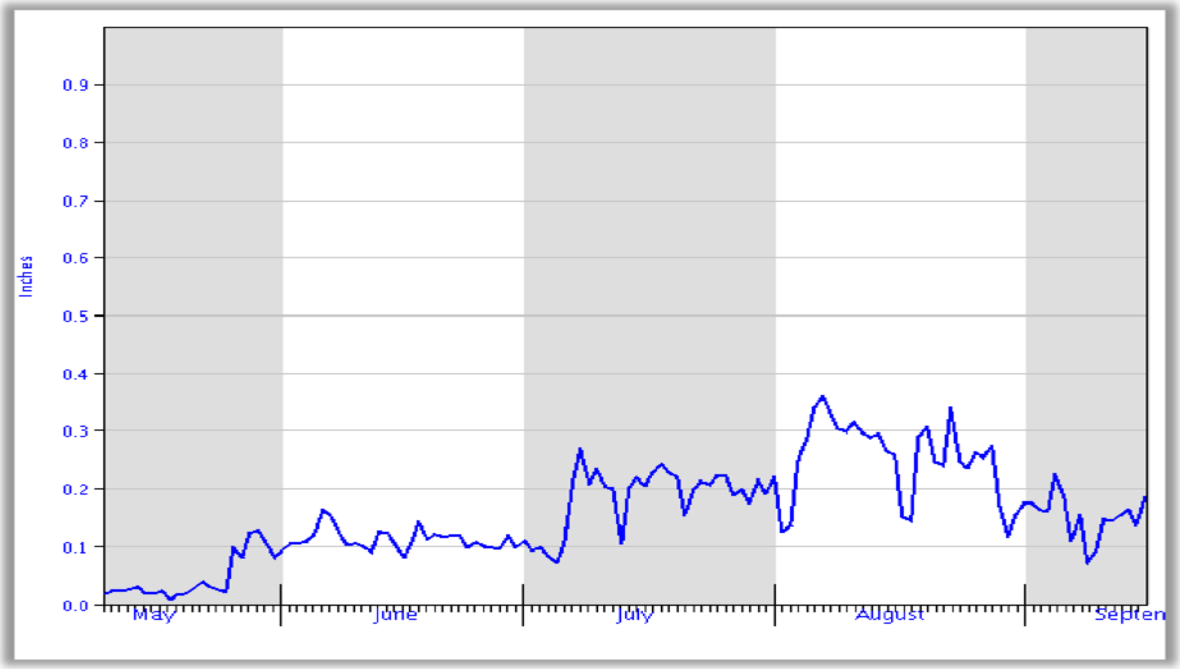
Type:	Center Pivot (MESA)
Pumping capacity, gal/min:	450
Number of wells:	2
Fuel source:	1 natural gas; 1 electric



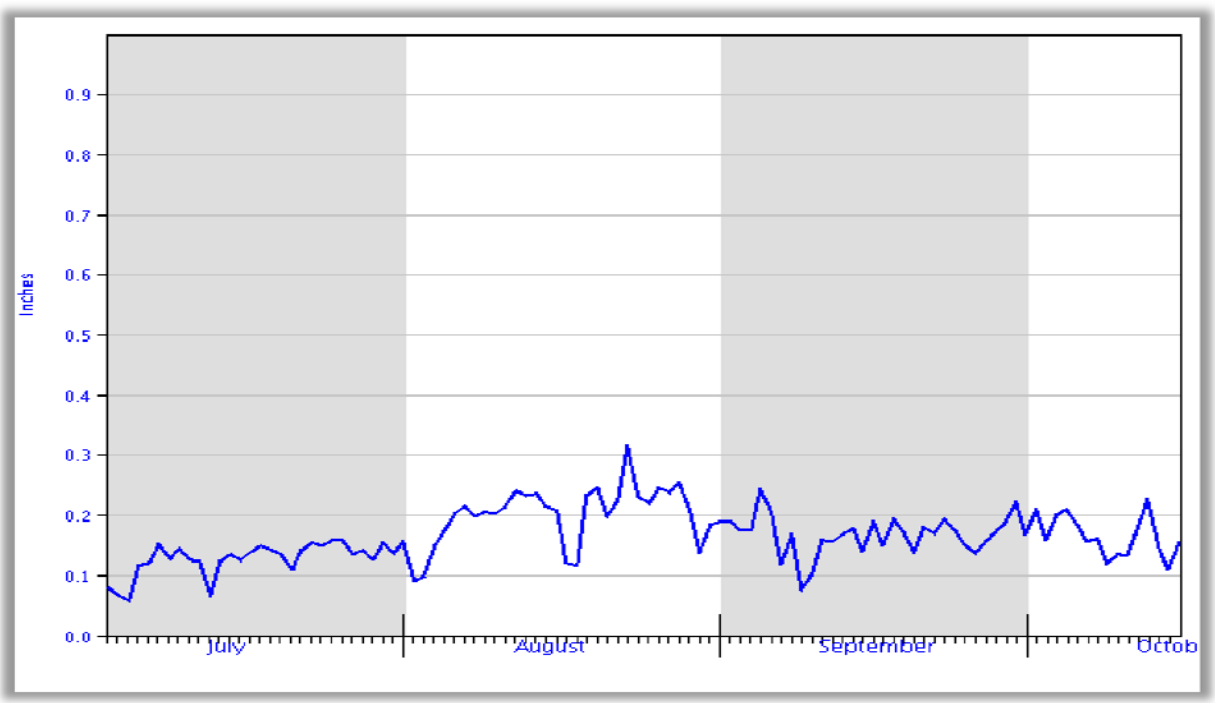



Comments: This is a pivot irrigated system, conventional tillage, and is planted on forty-inch centers. One-half in cotton, the other half planted to wheat then double cropped to grain sorghum.

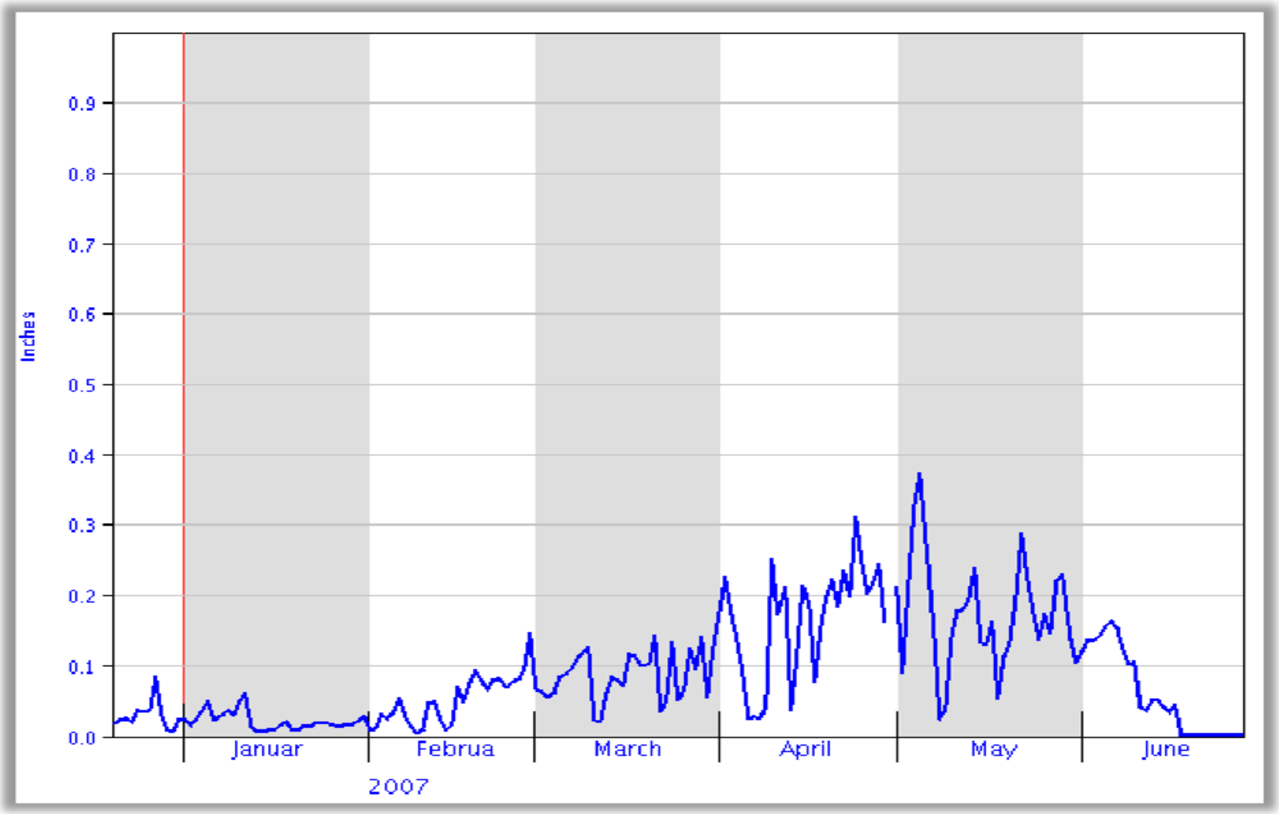
SITE 3 -1
South Plains Cotton ET
Planted May 10, 2007 Total ET Demand 19.91"



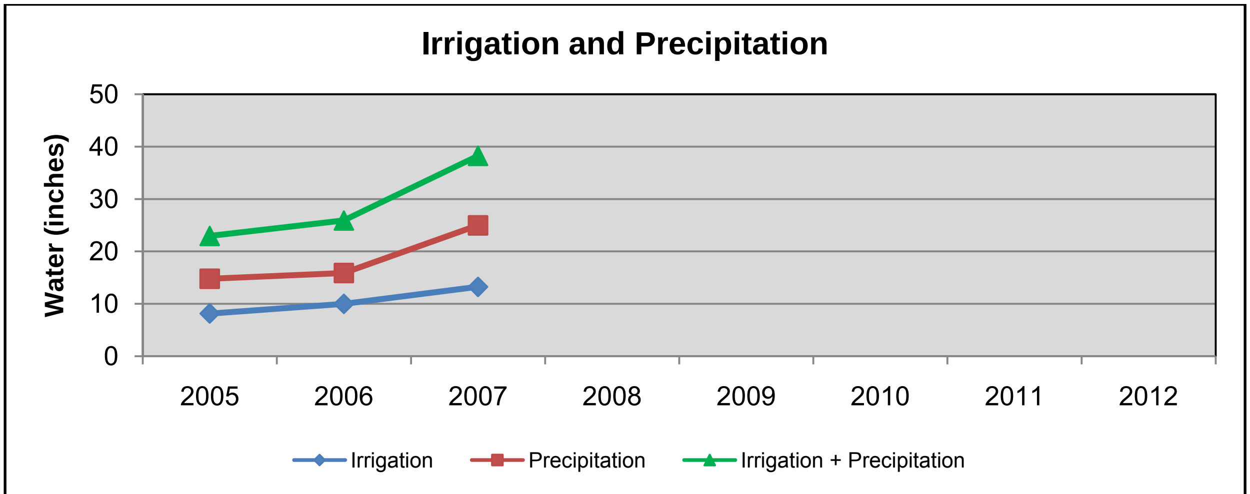
SITE 3 - 2
South Plains Sorghum ET
Planted July 3, 2007 Total ET Demand 17.76"

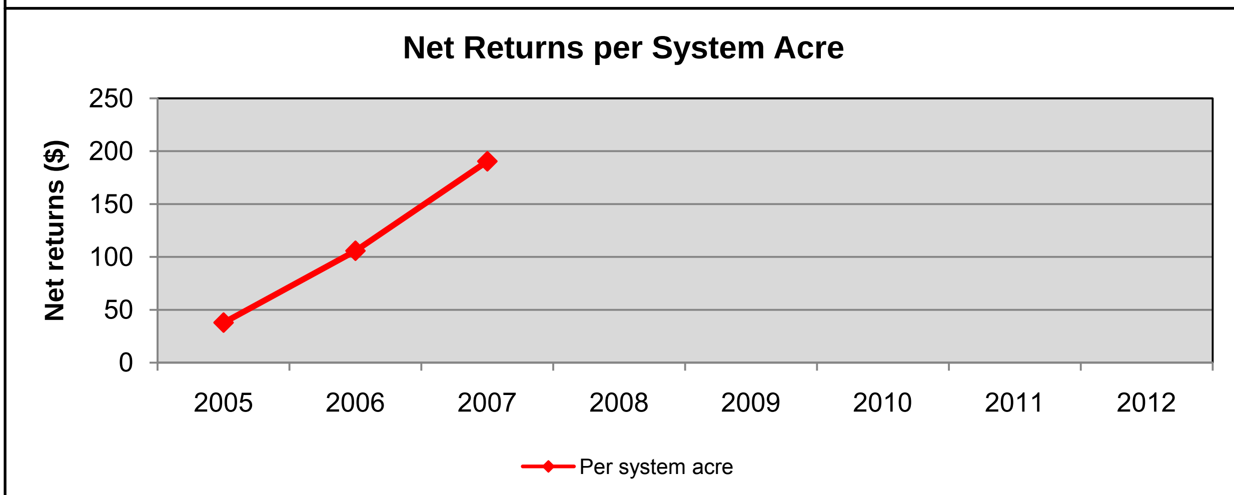


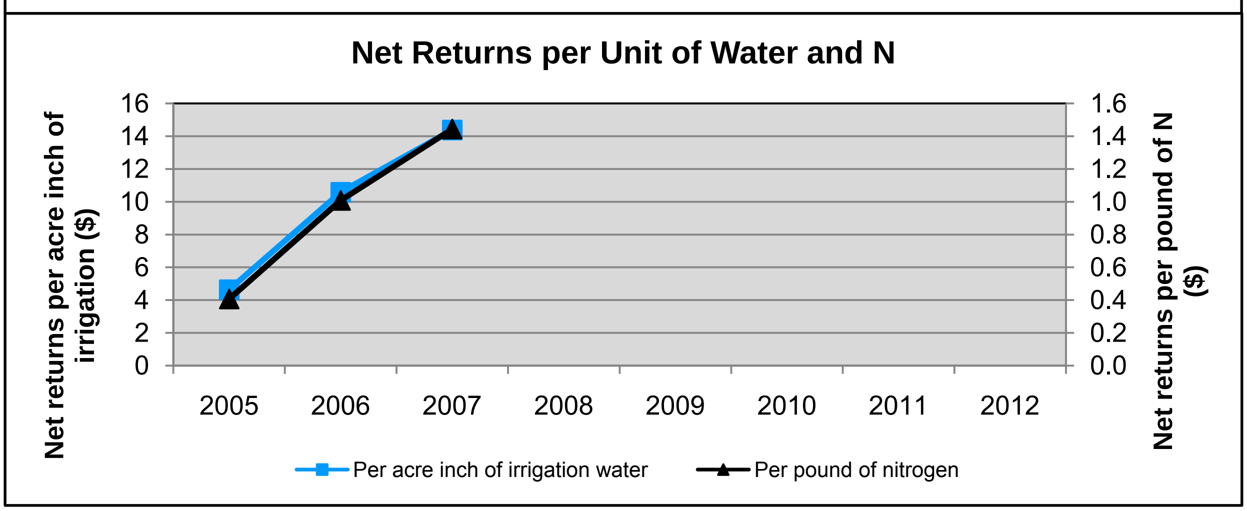
SITE 3 - 2
South Plains Wheat ET
Planted December 20, 2006 Total ET Demand 16.47"

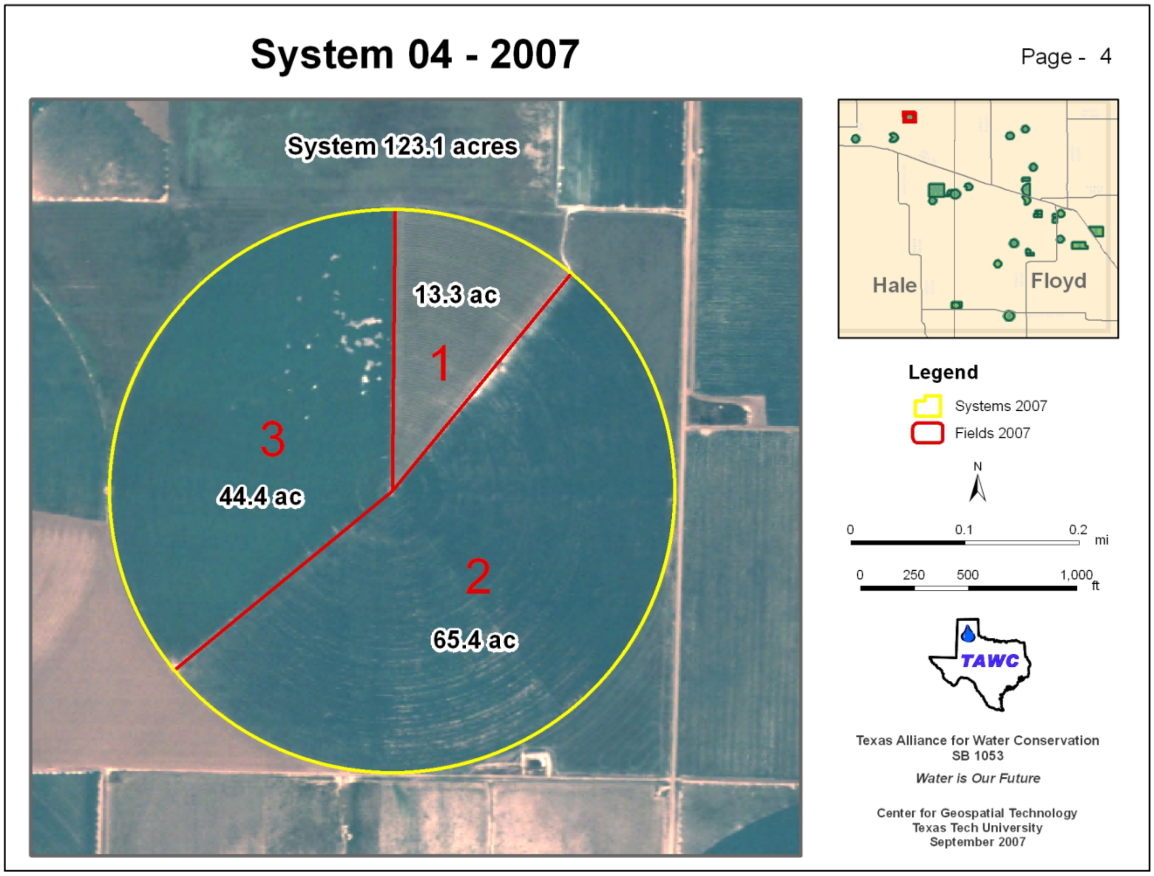


System 3


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


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


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
16
14
12
10
8
6
4
2
0
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen



SYSTEM 4

Livestock
2007: Cow-calf
2006: None
2005: None

Irrigation

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

Crops

2007
Field 1: Alfalfa for hay
Field 2: Wheat for grazing (winter-spring) and cover crop; followed by Cotton
Field 3: Wheat for grain, followed by Wheat for grazing (fall-winter)

2006
Field 1: Alfalfa for hay
Field 2: Wheat for silage, followed by Forage Sorghum for silage and hay
Field 3: Cotton

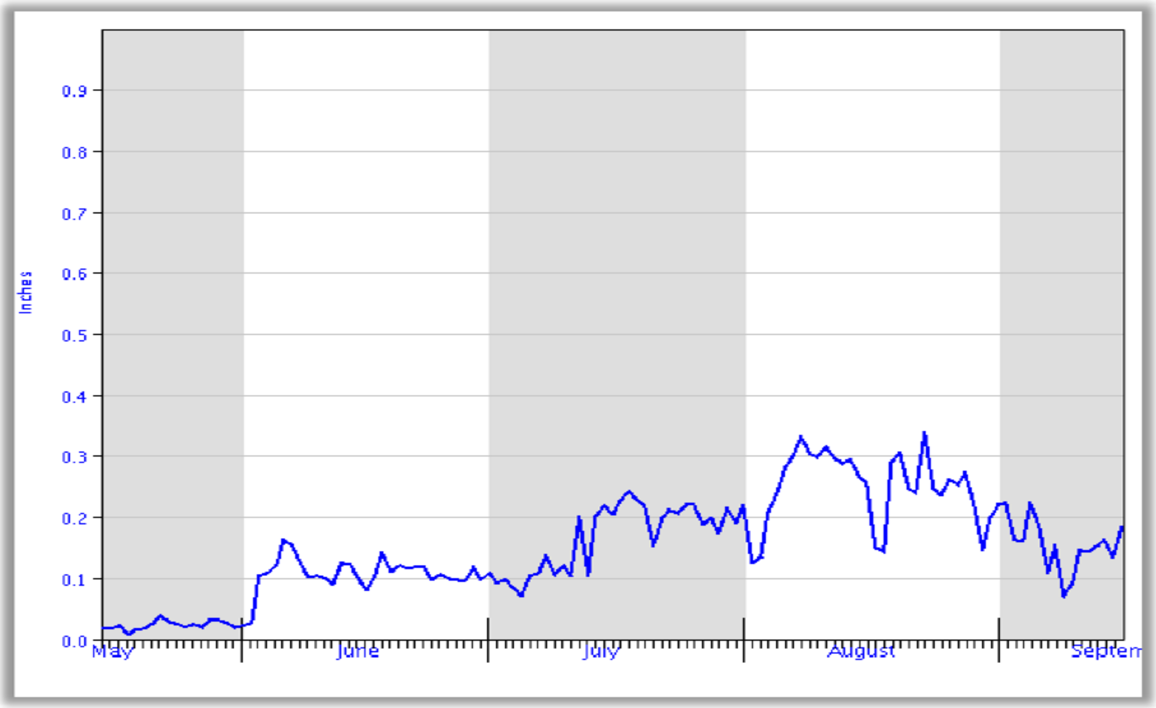
2005
Field 1: Alfalfa for hay
Field 2: Cotton following wheat cover crop
Field 3: Cotton following wheat cover crop



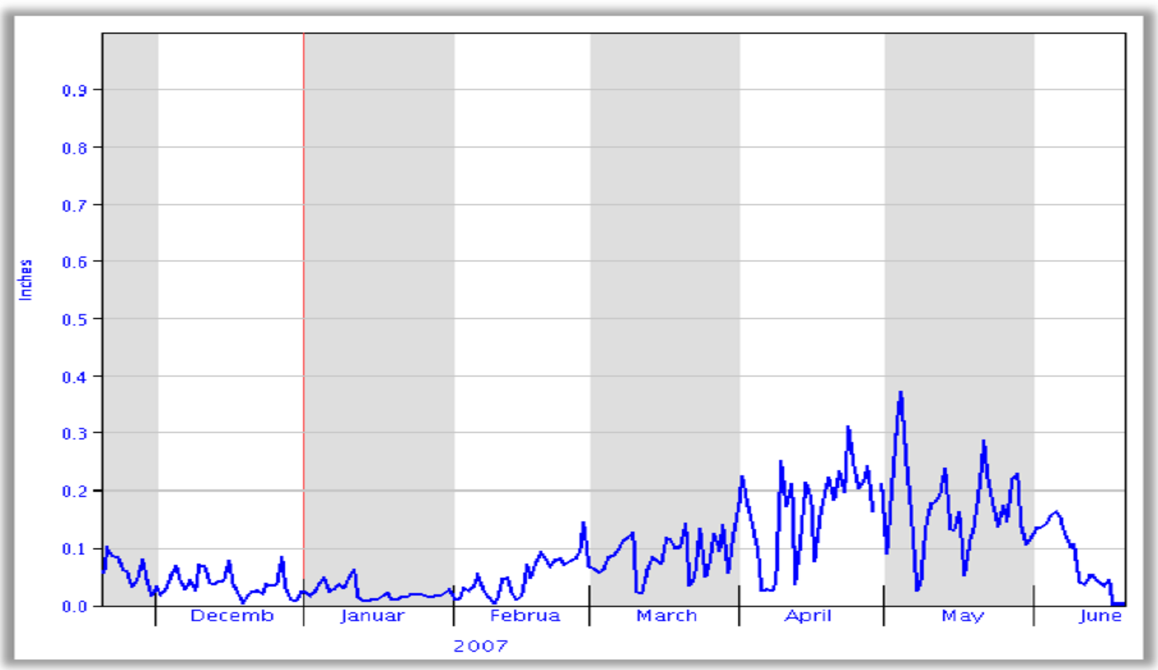



Comments: Pivot irrigated system, conventional tillage, and cotton is planted on forty-inch centers. Field 1 is planted to alfalfa and the hay is used in this producer's cow/calf operation. Field 2 was planted to wheat, grazed and terminated for cotton. Field 3 was planted to wheat for harvest.

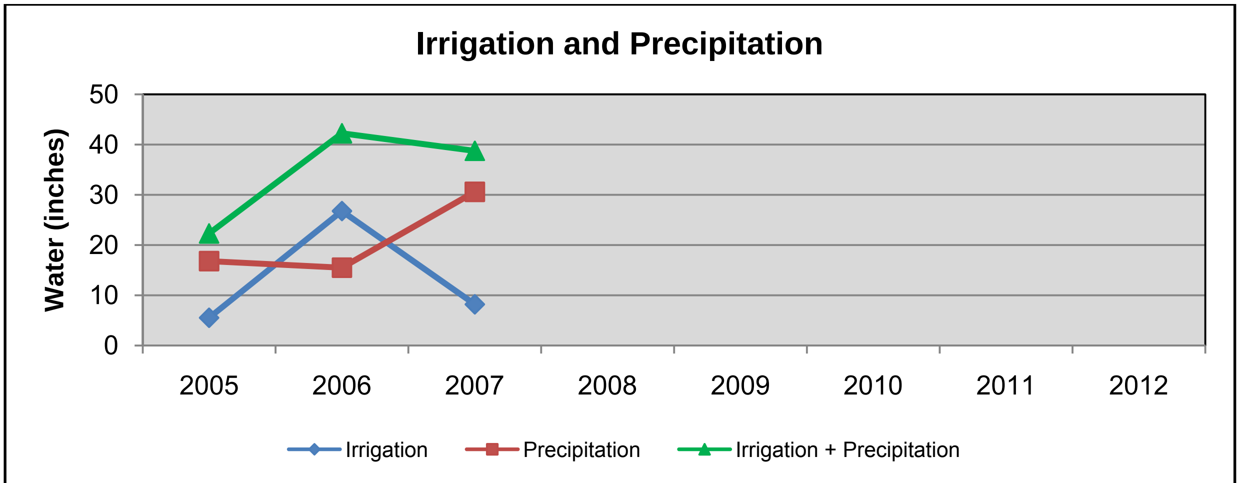
SITE 4 - 2
South Plains Cotton ET
Planted May 14, 2007 Total ET Demand 19.83"

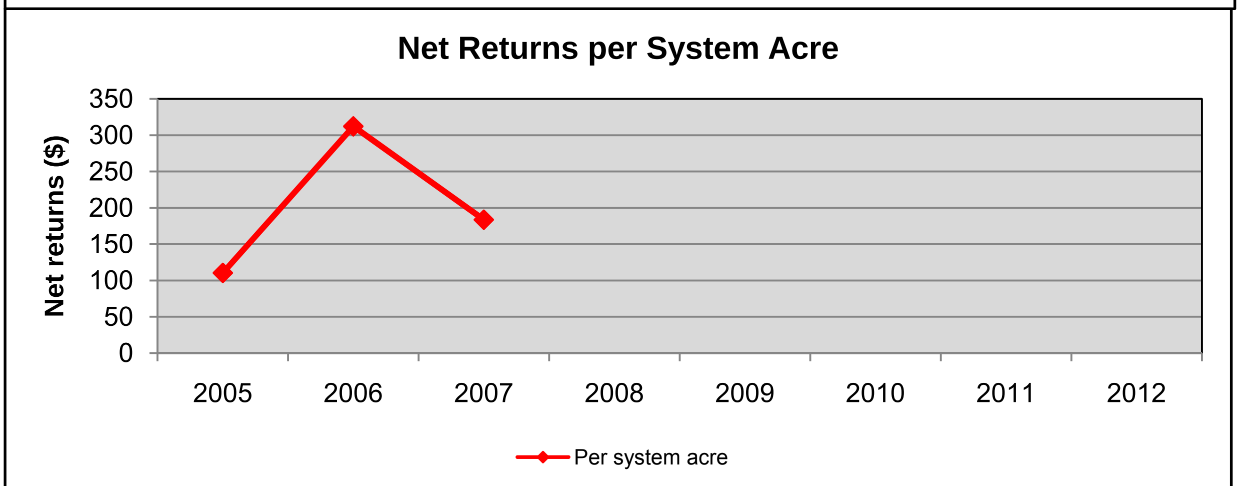


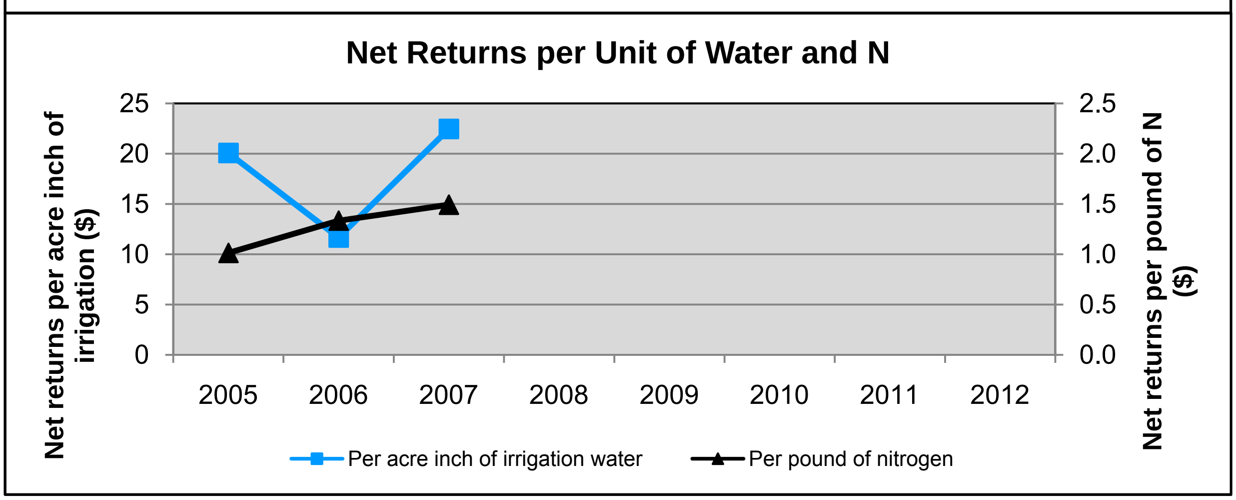
SITE 4 - 3
South Plains Wheat ET
Planted November 15, 2006 Total ET Demand 17.82

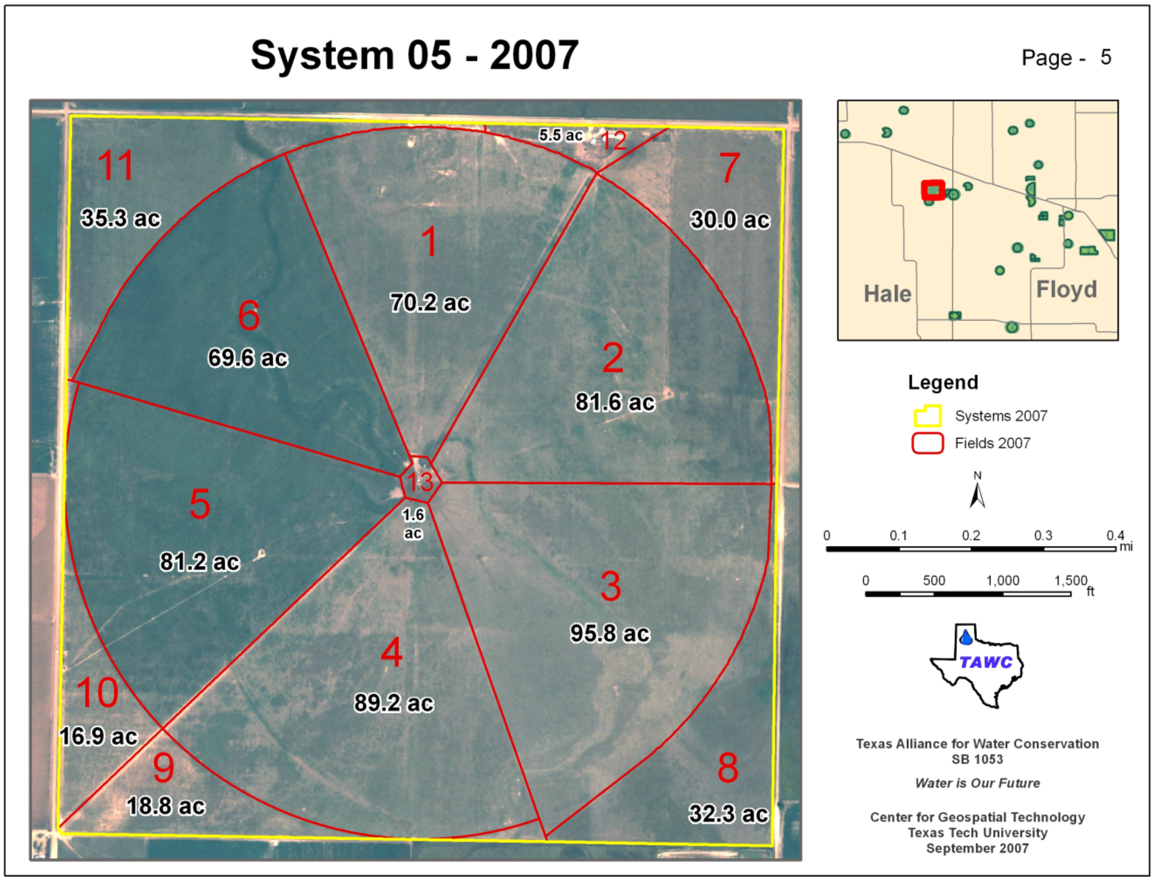


System 4


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


Net Returns per System Acre
Net returns ($)
350
300
250
200
150
100
50
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
25
20
15
10
5
0
2.5
2.0
1.5
1.0
0.5
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen



System 5

<u>Livestock</u>
2007: Cow-calf
2006: Cow-calf
2005: Cow-calf

<u>Irrigation</u>

Type:	Center Pivot (MESA)
Pumping capacity, gal/min:	1100
Number of wells:	4
Fuel source:	electric

<u>Crops - Irrigated</u>

2007
Field 1: Klein/Plains/Dahl/Blue grama/Buffalograss mixture for grazing
Field 2: Plains/Blue grama/Klein mixture for grazing
Field 3: Plains/Klein/Blue grama/Dahl mixture for grazing
Field 4: Plains/Blue grama/Klein mixture for grazing
Field 5: Plains/Klein/Blue grama mixture for grazing
Field 6: Dahl/Green sprangletop/Plains mixture for grazing and hay

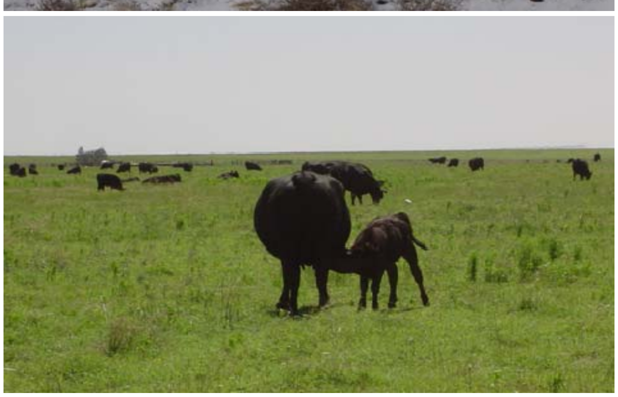
2006
Field 1: Klein/Plains/Dahl/Blue grama/Buffalograss mixture for grazing
Field 2: Plains/Blue grama/Klein mixture for grazing

Field 3: Plains/Klein/Blue grama/Dahl mixture for grazing and hay
Field 4: Plains/Blue grama/Klein mixture for grazing
Field 5: Plains/Klein/Blue grama mixture for grazing
Field 6: Alfalfa/Plains/blue grama/klein mixture for grazing

2005
Field 1: Klein/Plains/Dahl/Blue grama/Buffalograss mixture for grazing
Field 2: Plains/Blue grama/Klein mixture for grazing
Field 3: Plains/Klein/Blue grama mixture for grazing
Field 4: Plains/Blue grama/Klein mixture for grazing
Field 5: Plains/Klein/Blue grama mixture for grazing
Field 6: Alfalfa/Plains/blue grama/klein mixture for grazing

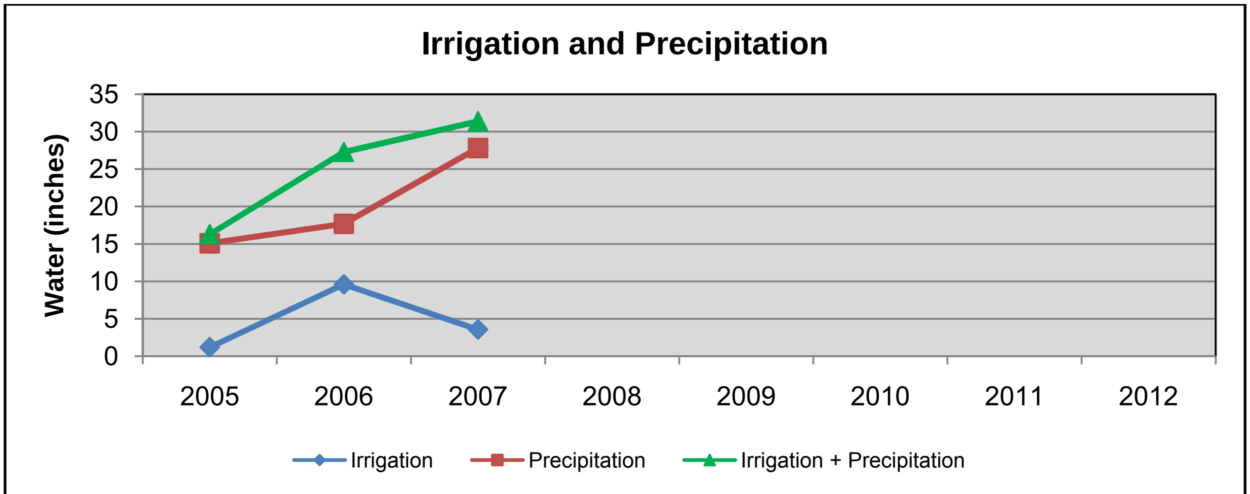
Crops - Dryland
2007, 2006, 2005
Field 7: Plains/blue grama mixture for grazing
Field 8: Plains/blue grama/sand dropseed/buffalograss mixture for grazing
Field 9: Plains/blue grama mixture for grazing
Field 10: Plains/blue grama mixture for grazing
Field 11: Plains/blue grama mixture for grazing
Fields 12 and 13: Pens and barns

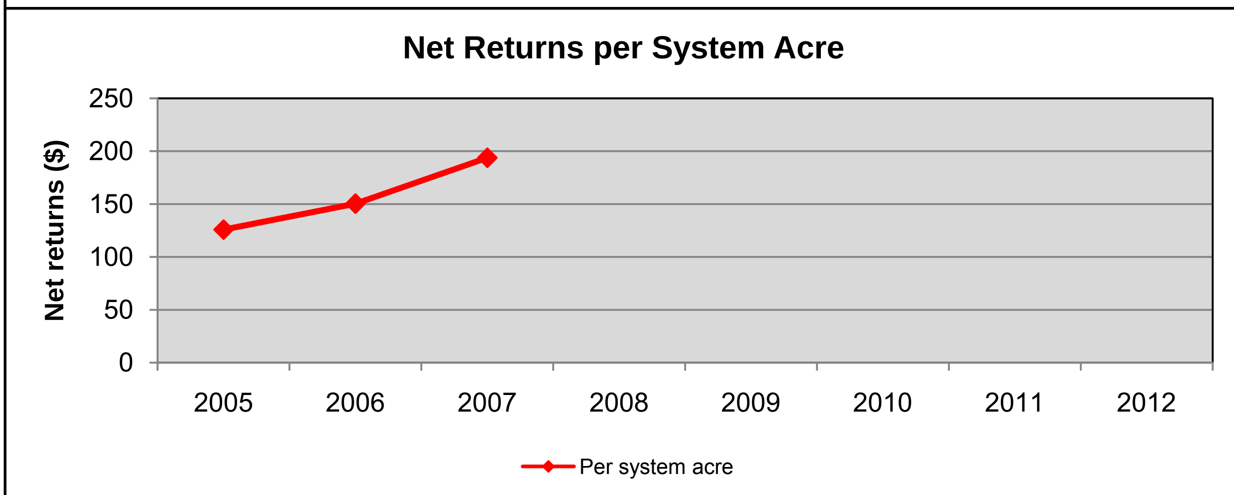


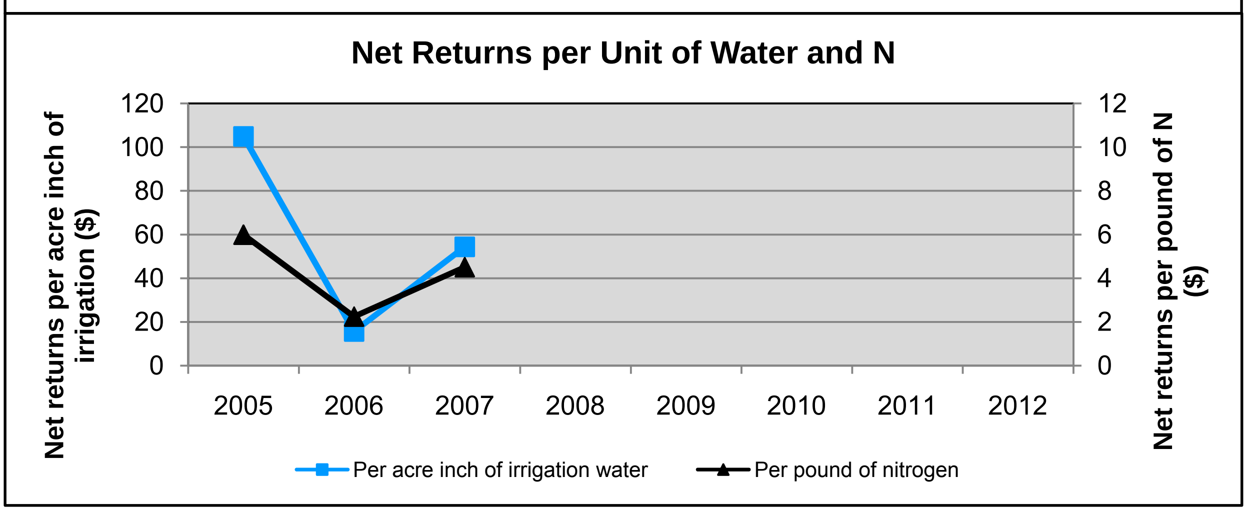


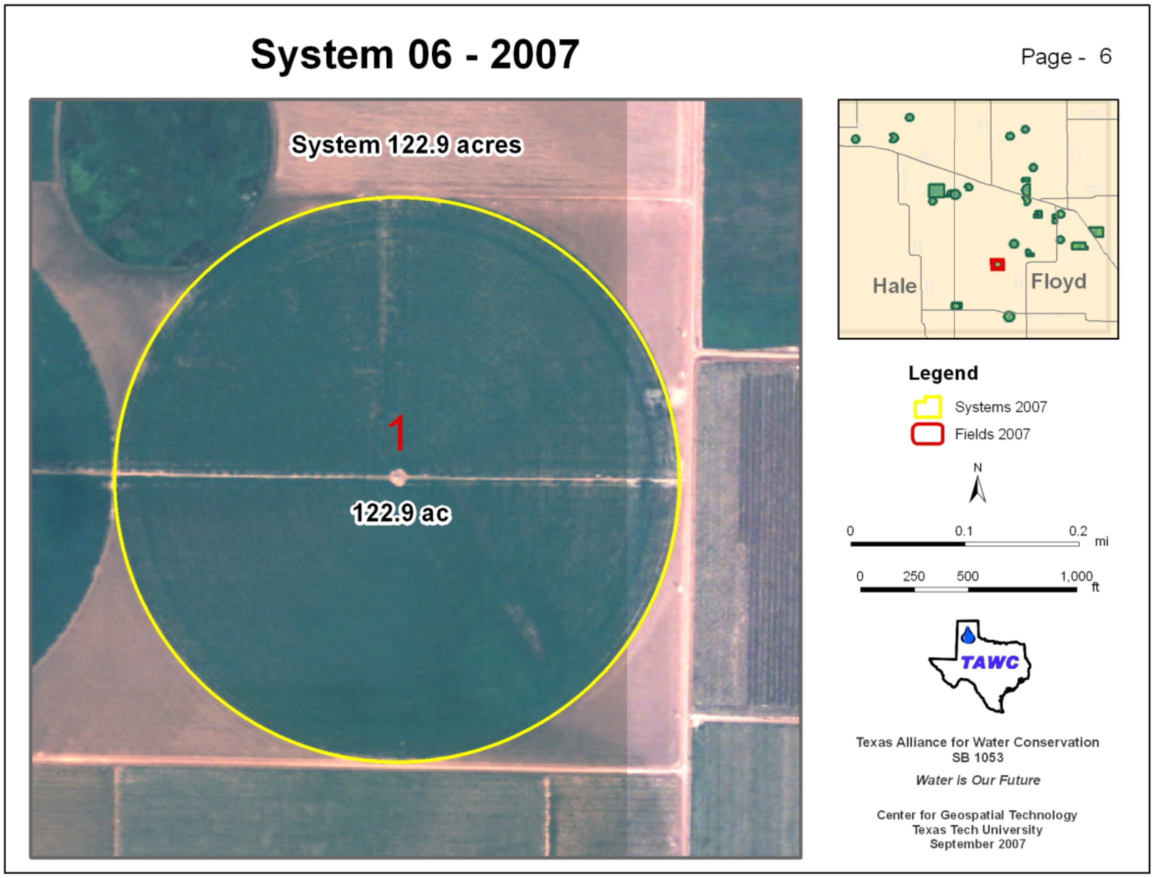

Comments: This is a commercial, spring calving cow/calf operation. The 494.7 acres of irrigated grass is broken into six cells. This producer usually moves all cattle off site in early winter after the calves are weaned. Cows will calve on wheat and are then moved back on site.

System 5


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


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


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
120
100
80
60
40
20
0
2005
2006
2007
2008
2009
2010
2011
2012
12
10
8
6
4
2
0
Net returns per pound of N ($)
Per acre inch of irrigation water
Per pound of nitrogen



System 6

<u>Livestock</u>
2007: none
2006: none
2005: stocker steers

<u>Irrigation</u>

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

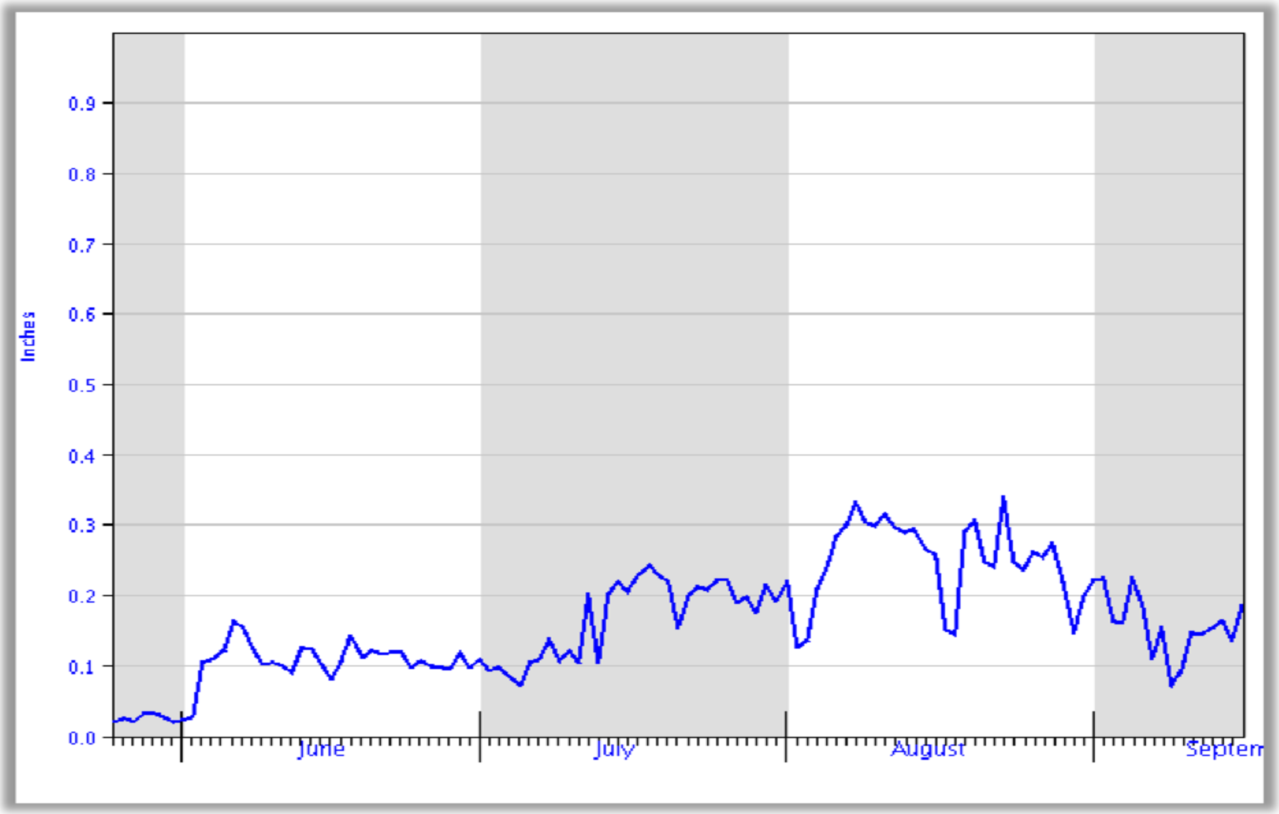
<u>Crops</u>
2007
Field 1: Cotton

2006
Field 1: Cotton

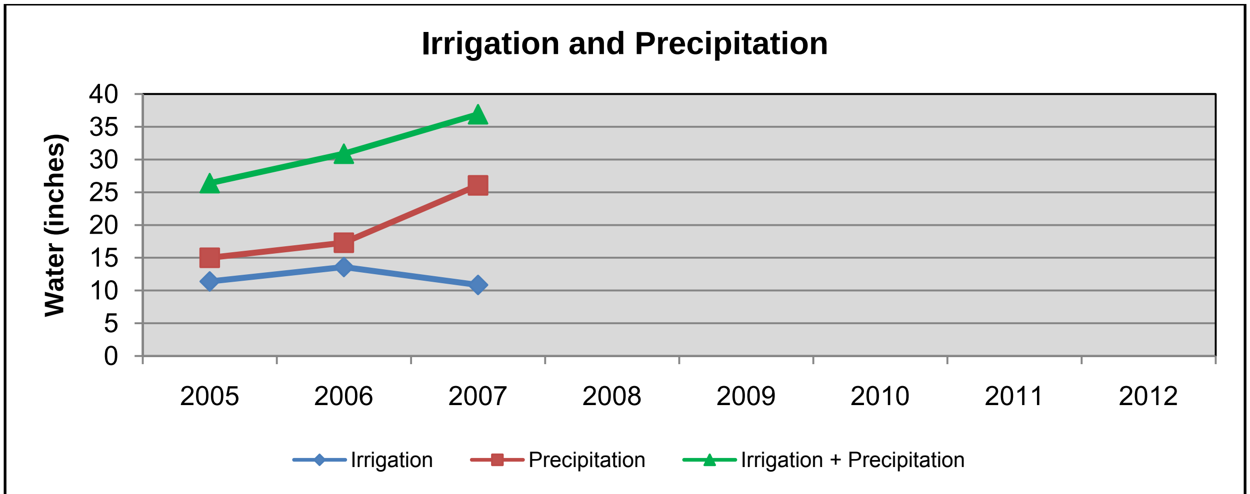
2005
Field 1: Wheat for grazing and cover followed by Cotton

Comments: This is a pivot irrigated cotton system, conventional tillage, and planted on forty-inch centers.

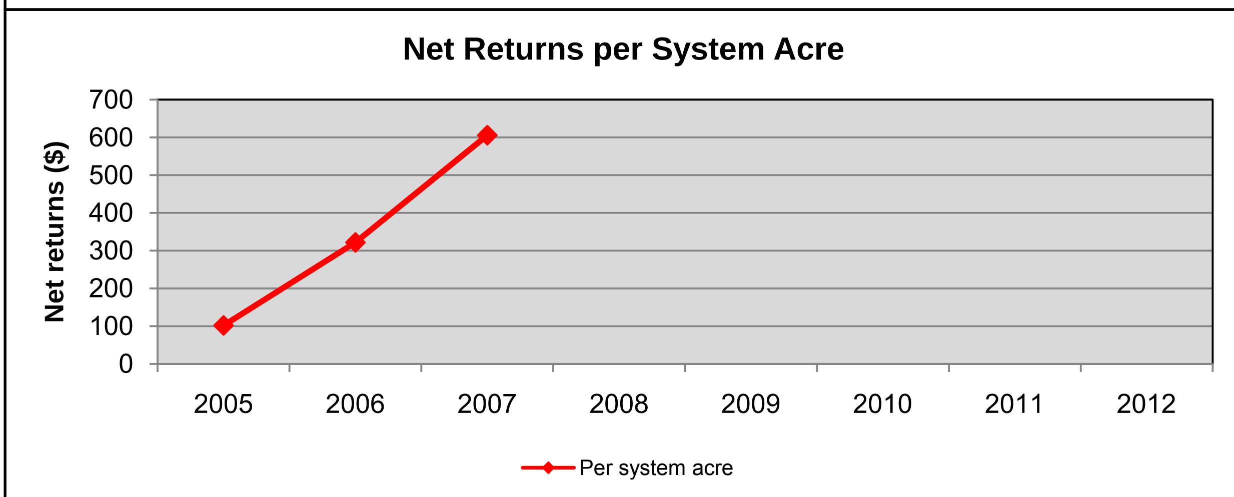
SITE 6 - 1
South Plains Cotton ET
Planted May 25, 2007 Total ET Demand 19.59"



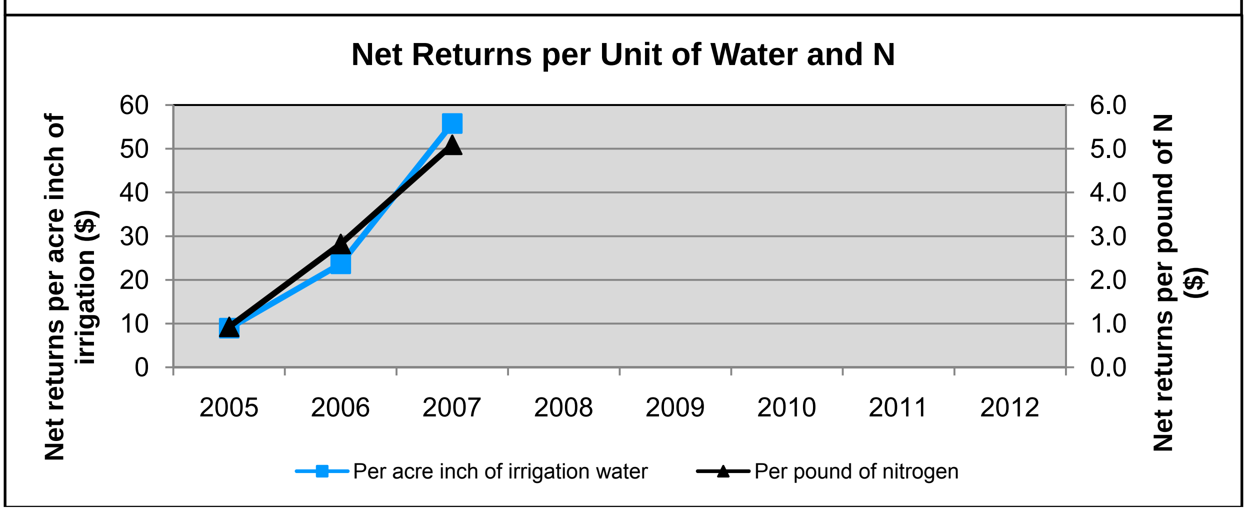
System 6



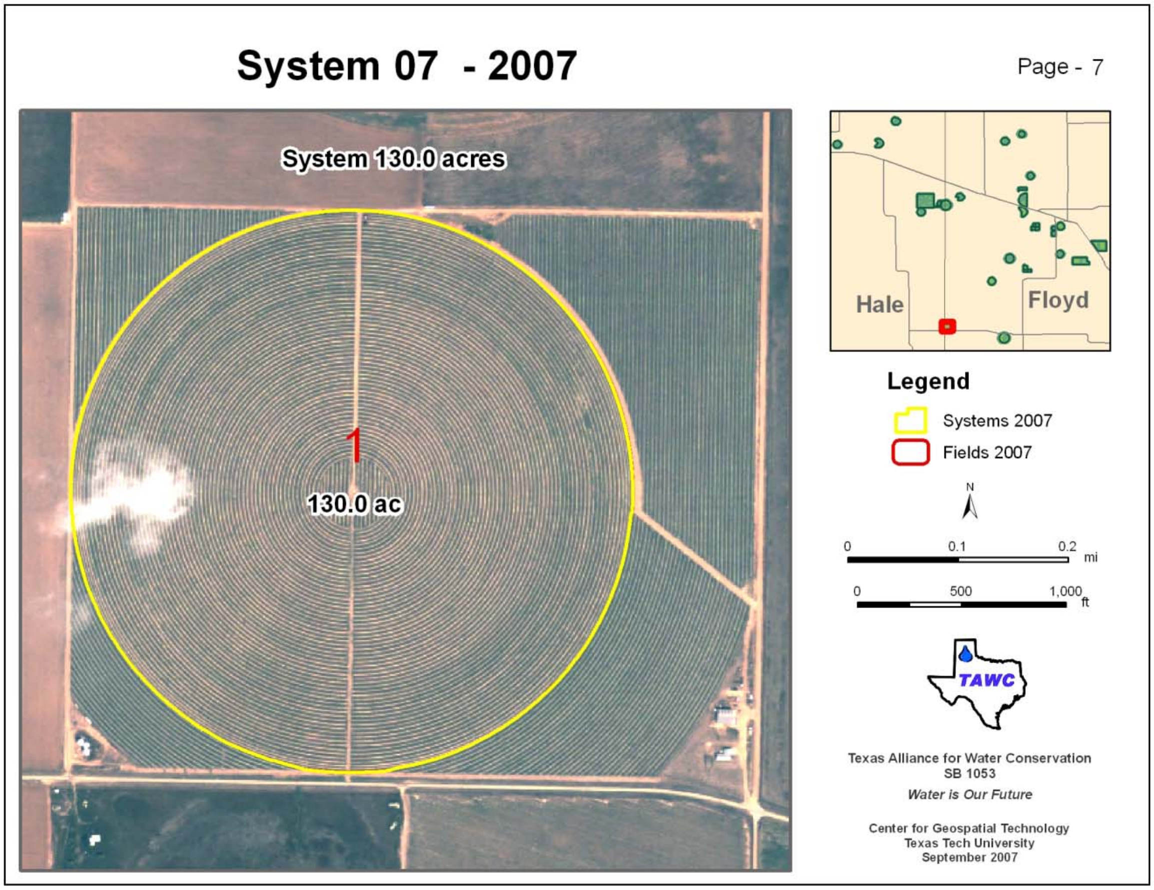
Irrigation and Precipitation
Water (inches)
40
35
30
25
20
15
10
5
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation



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



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



SYSTEM 7

<u>Crops</u>

2007

Field 1: Sideoats grama for seed and hay

<u>Irrigation</u>

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

2006

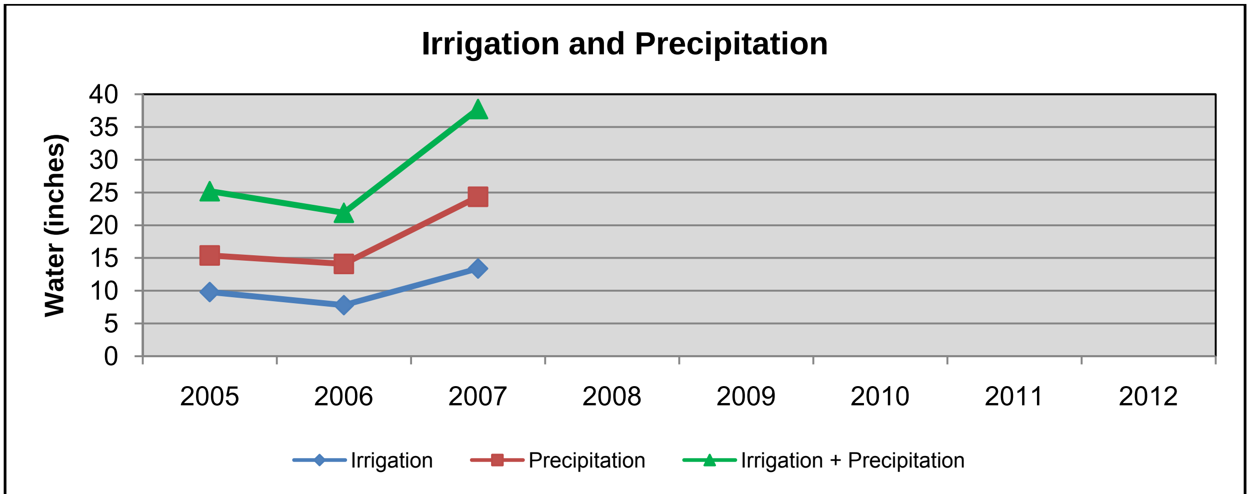
Field 1: Sideoats grama for seed and hay

2005

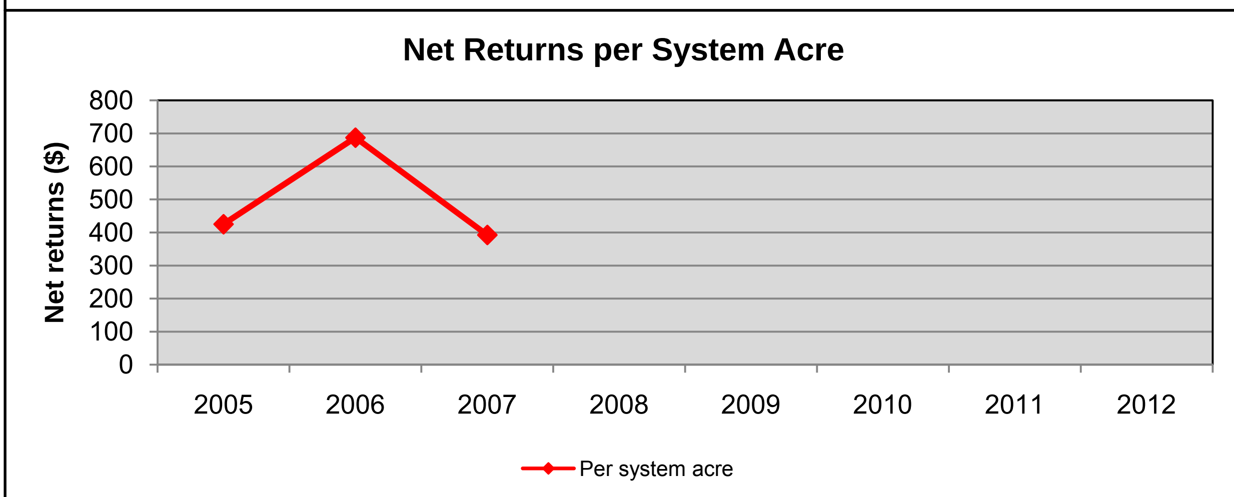
Field 1: Sideoats grama for seed and hay

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

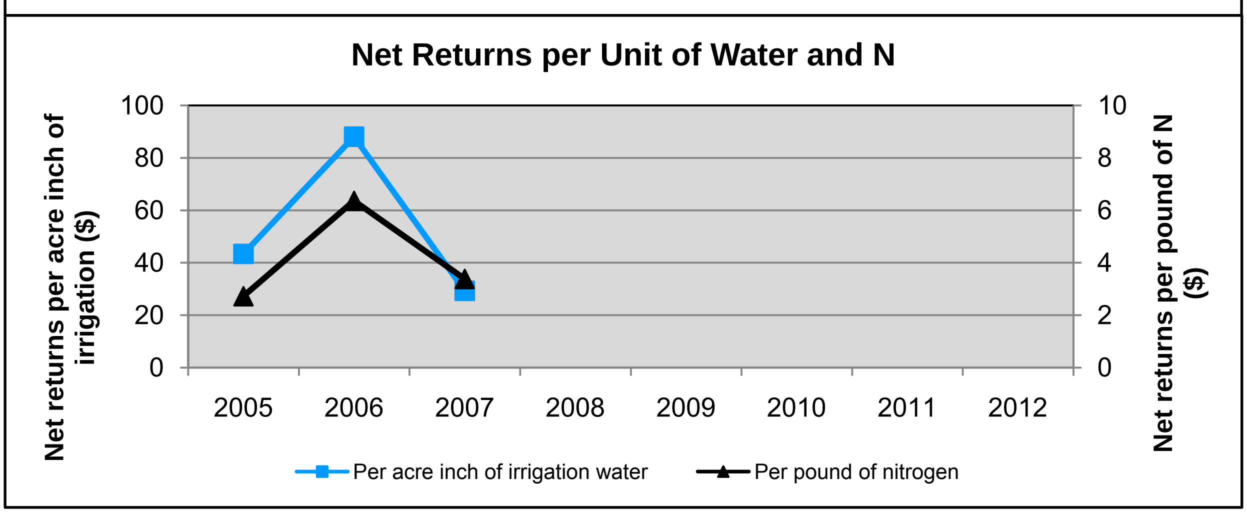
System 7



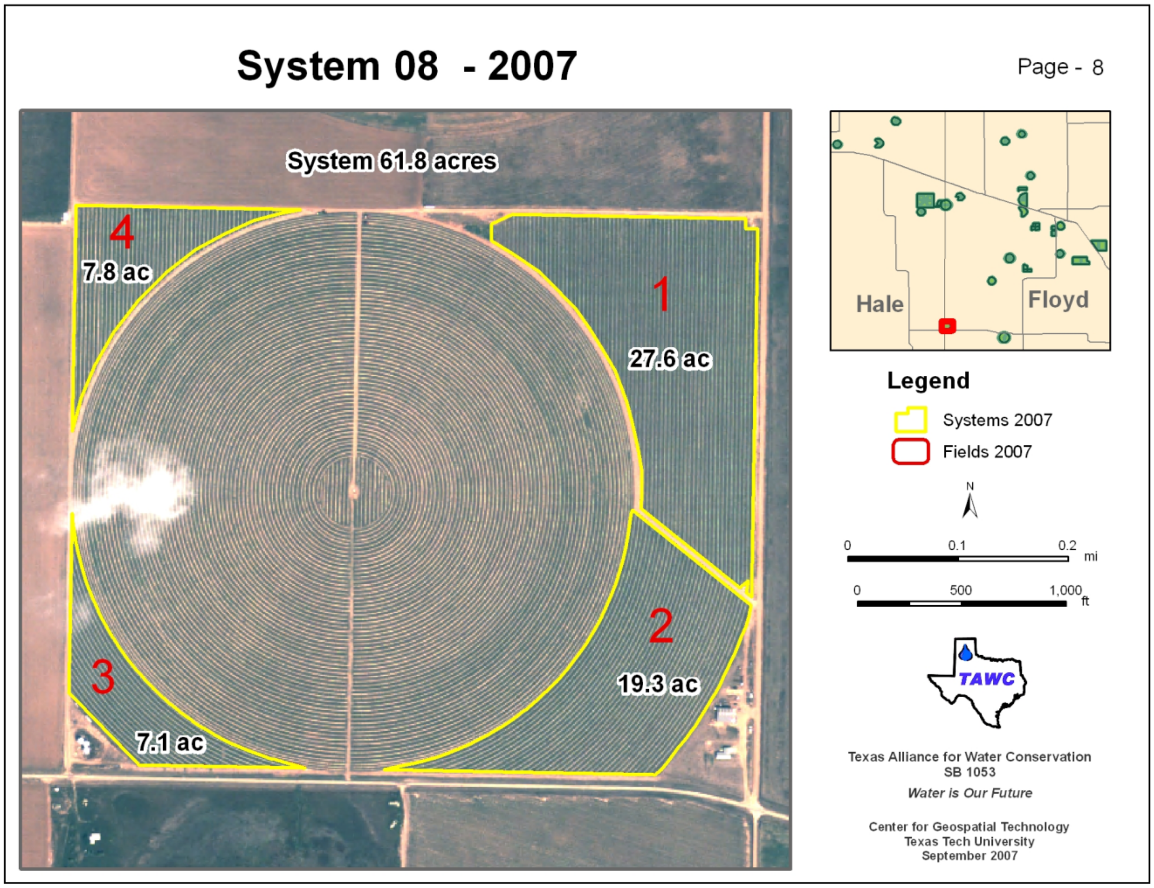
Irrigation and Precipitation
Water (inches)
40
35
30
25
20
15
10
5
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
800
700
600
500
400
300
200
100
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre



Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
100
80
60
40
20
0
Net returns per pound of N ($)
10
8
6
4
2
0
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen



SYSTEM 8

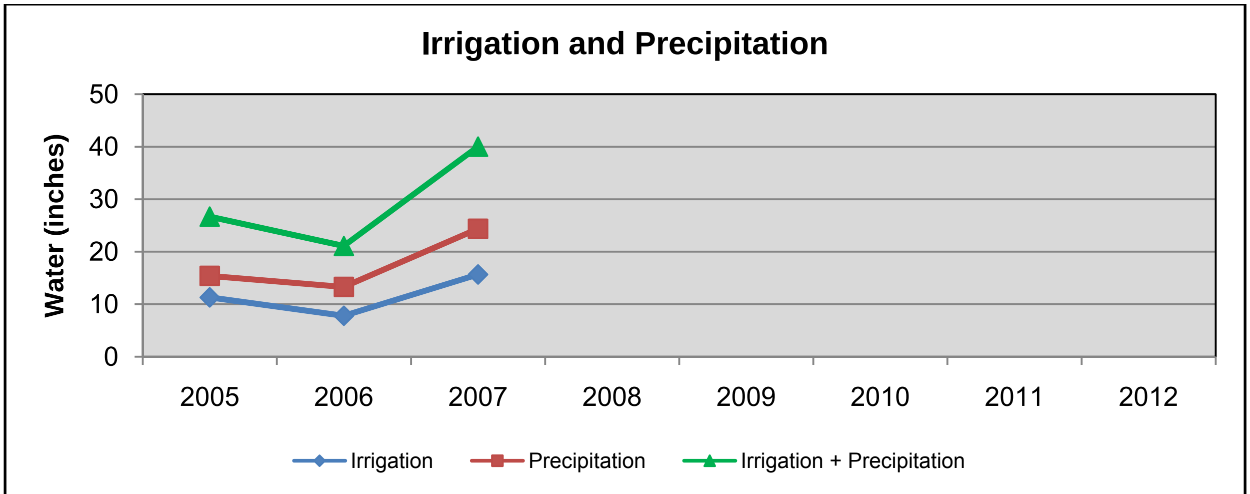
Crops	Irrigation	
2007	Type:	Sub-surface Drip (SDI)
Field 1,2,3,4: Sideoats grama for seed and hay	Pumping capacity, gal/min:	360
	Number of wells:	4
	Fuel source:	electric

2006
Field 1,2,3,4: Sideoats grama for seed and hay

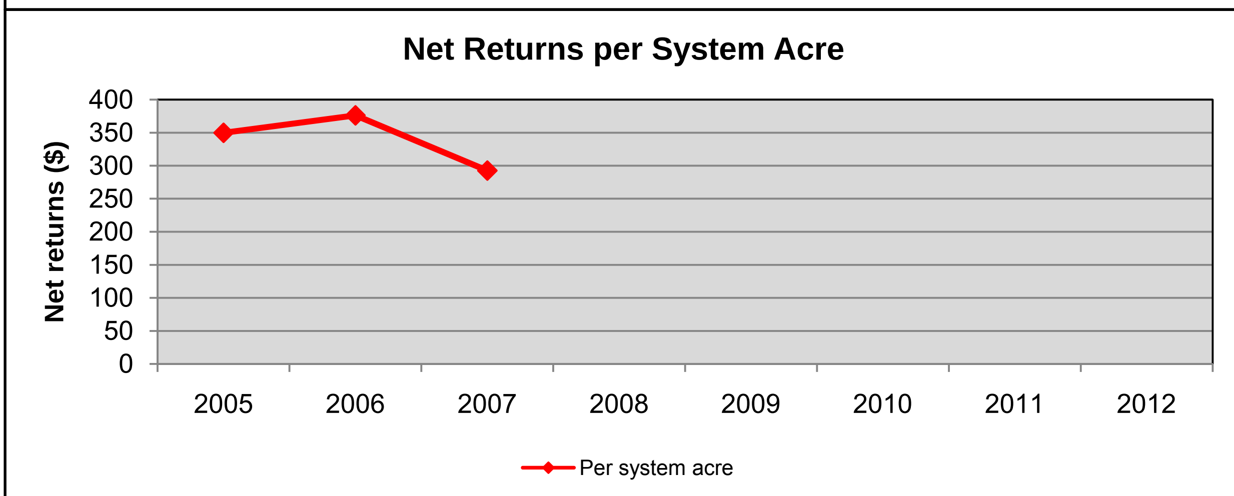
2005
Field 1,2,3,4: Sideoats grama for seed and hay

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

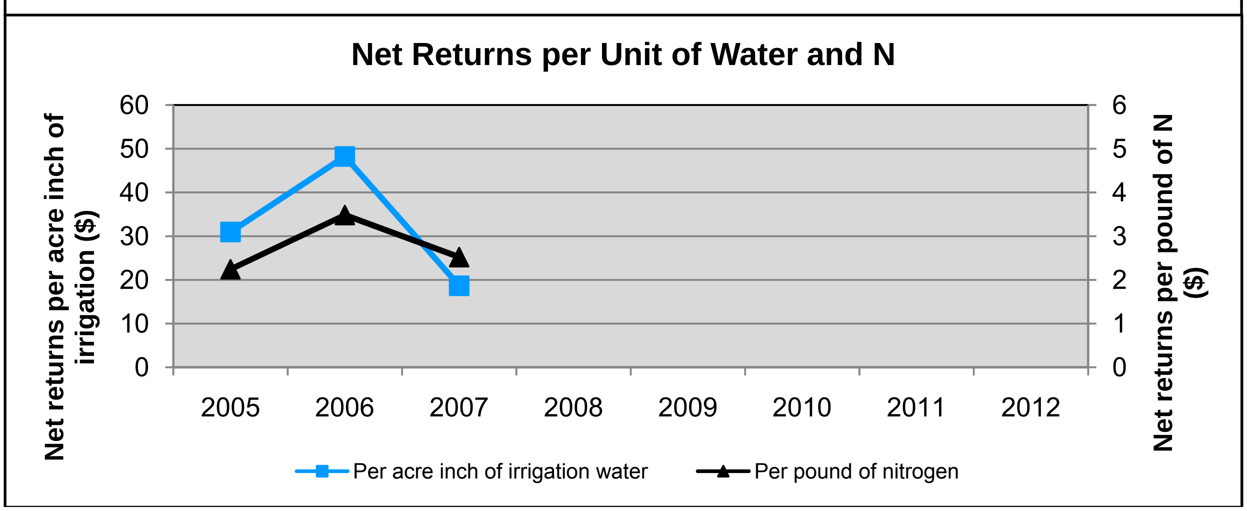
System 8



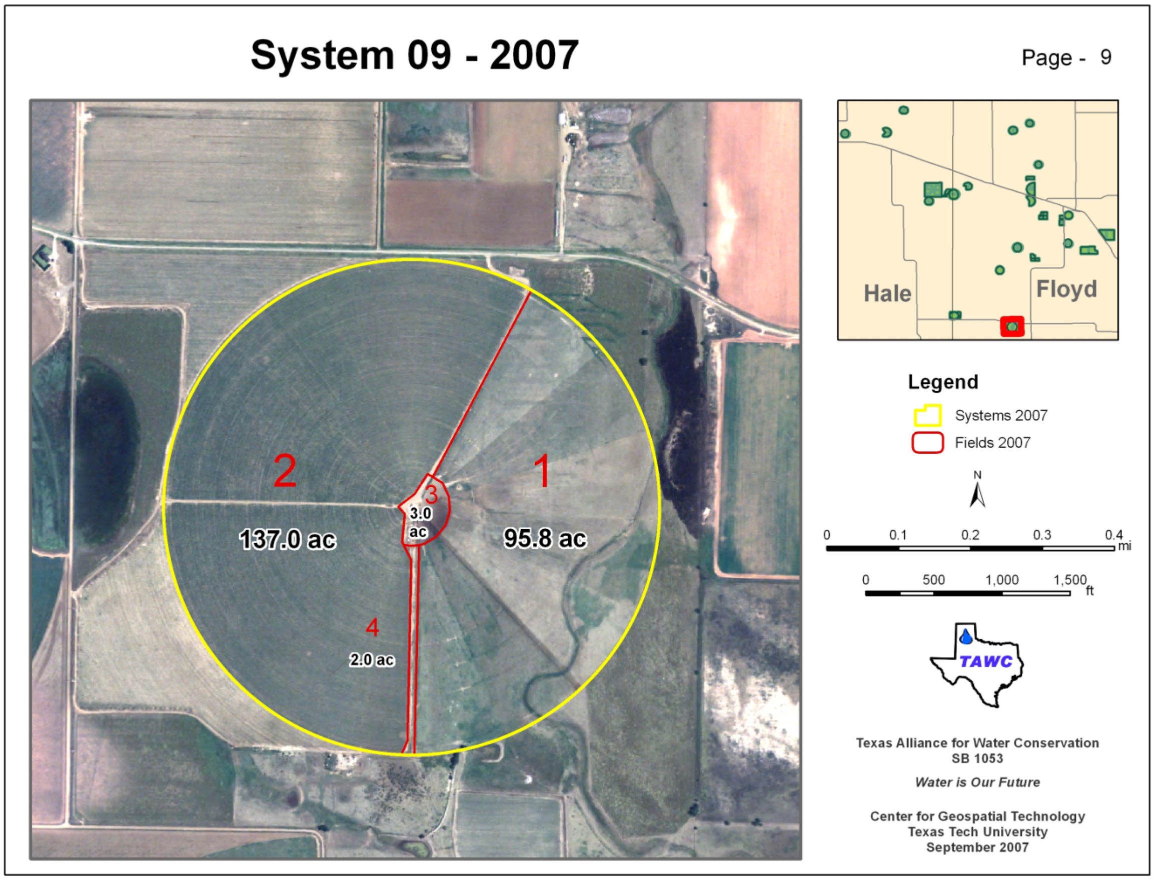
Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
400
350
300
250
200
150
100
50
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre



Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
60
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
6
5
4
3
2
1
0
Net returns per pound of N ($)
Per acre inch of irrigation water
Per pound of nitrogen



SYSTEM 9

<u>Livestock</u>
2007: stocker heifers
2006: stocker steers
2005: stocker steers

<u>Irrigation</u>

Type:	Center Pivot (MESA)
Pumping capacity, gal/min:	1100
Number of wells:	4
Fuel source:	3 natural gas; 1 diesel

<u>Crops</u>

2007
Field 1: Klein/buffalo/Blue grama/ annual forb mix interseeded with Rye for grazing
Field 2: Grain Sorghum following Rye cover crop. Cotton was planted first; lost to hail. Replanted to Grain Sorghum.

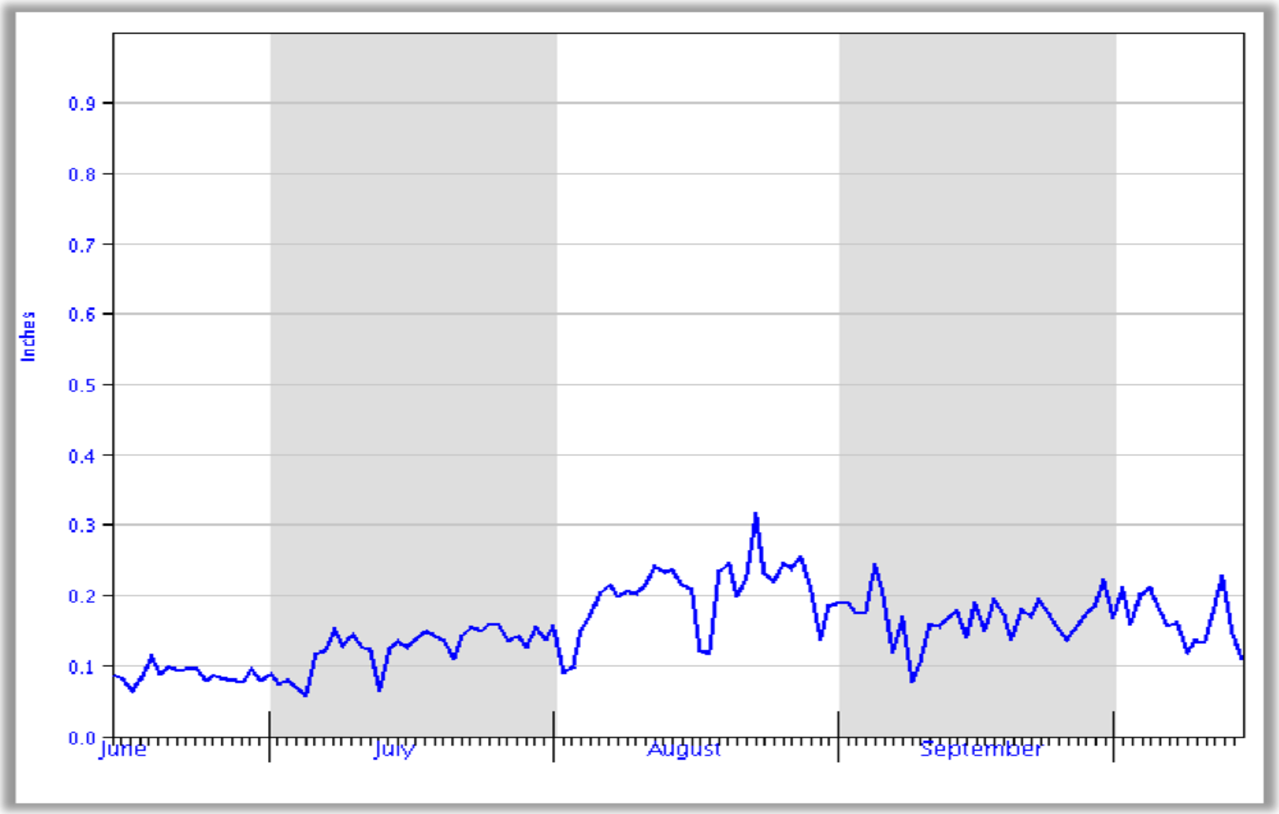
2006
Field 1: Klein/buffalo/blue grama/ annual forb mix interseeded with Rye for grazing
Field 2: Cotton following Rye cover crop

2005
Field 1: Klein/buffalo/blue grama/ annual forb mix interseeded with Rye for grazing
Field 2: Rye for grazing and cover crop followed by Cotton

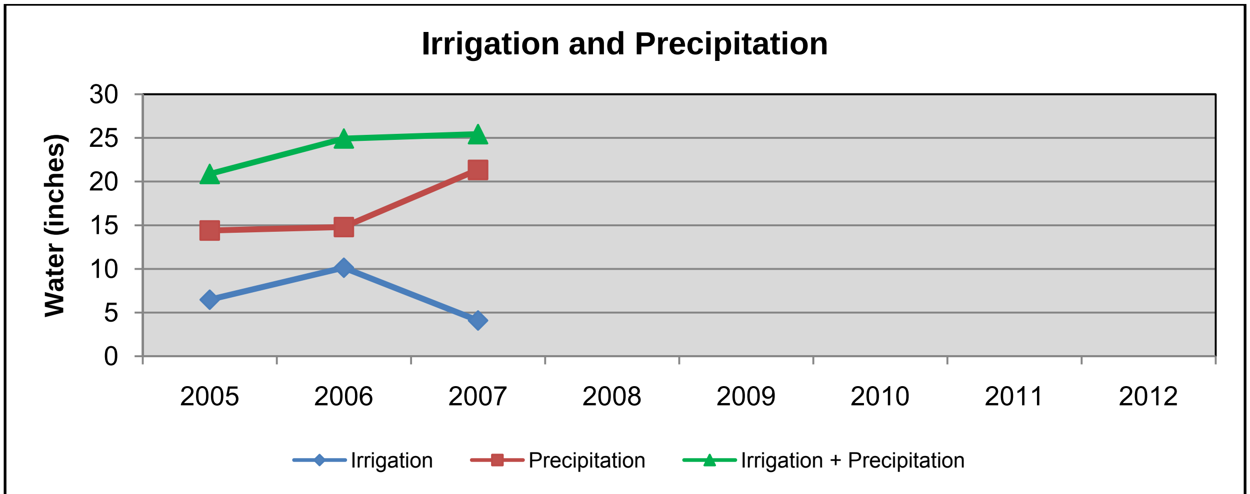



Comments: This is a no-till, pivot irrigated cotton/grass/livestock system. Field 2 is planted to cotton and after harvest is planted to rye for grazing. After being grazed the rye is terminated and then planted to cotton. This year the cotton was lost to hail and replanted to grain sorghum. The grass is also interseed with rye for fall and winter grazing. This producer uses this system for a stocker operation.

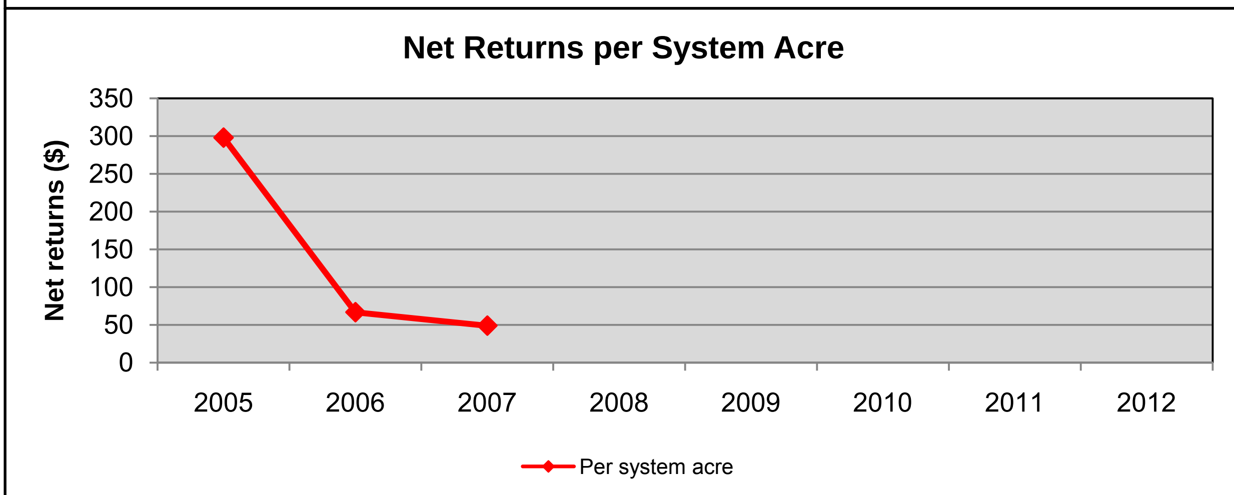
SITE 9 - 2
South Plains Sorghum ET
Planted June 15, 2007 Total ET Demand 19.27



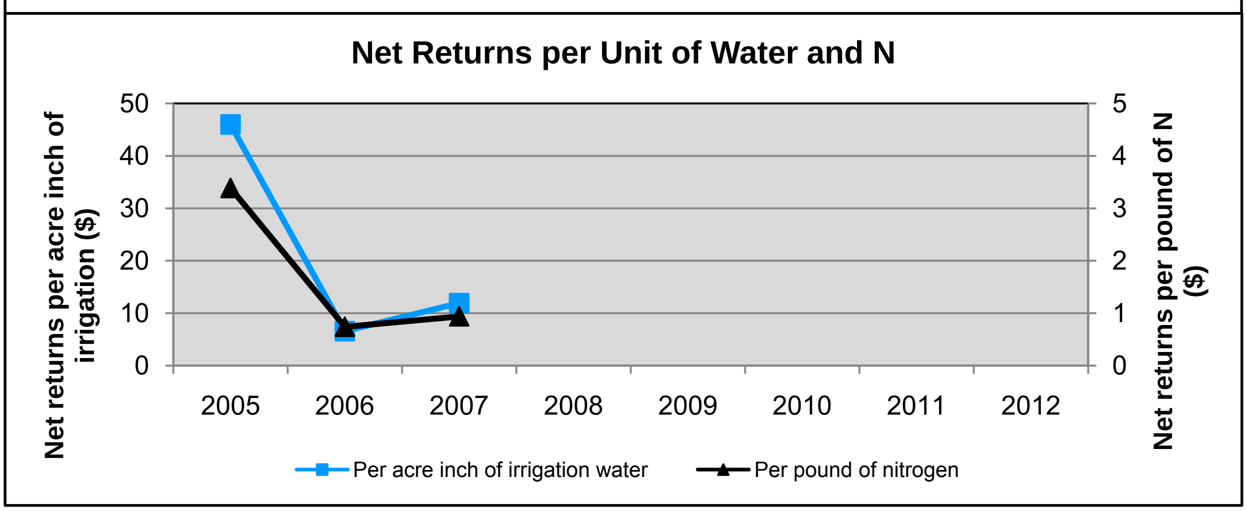
System 9



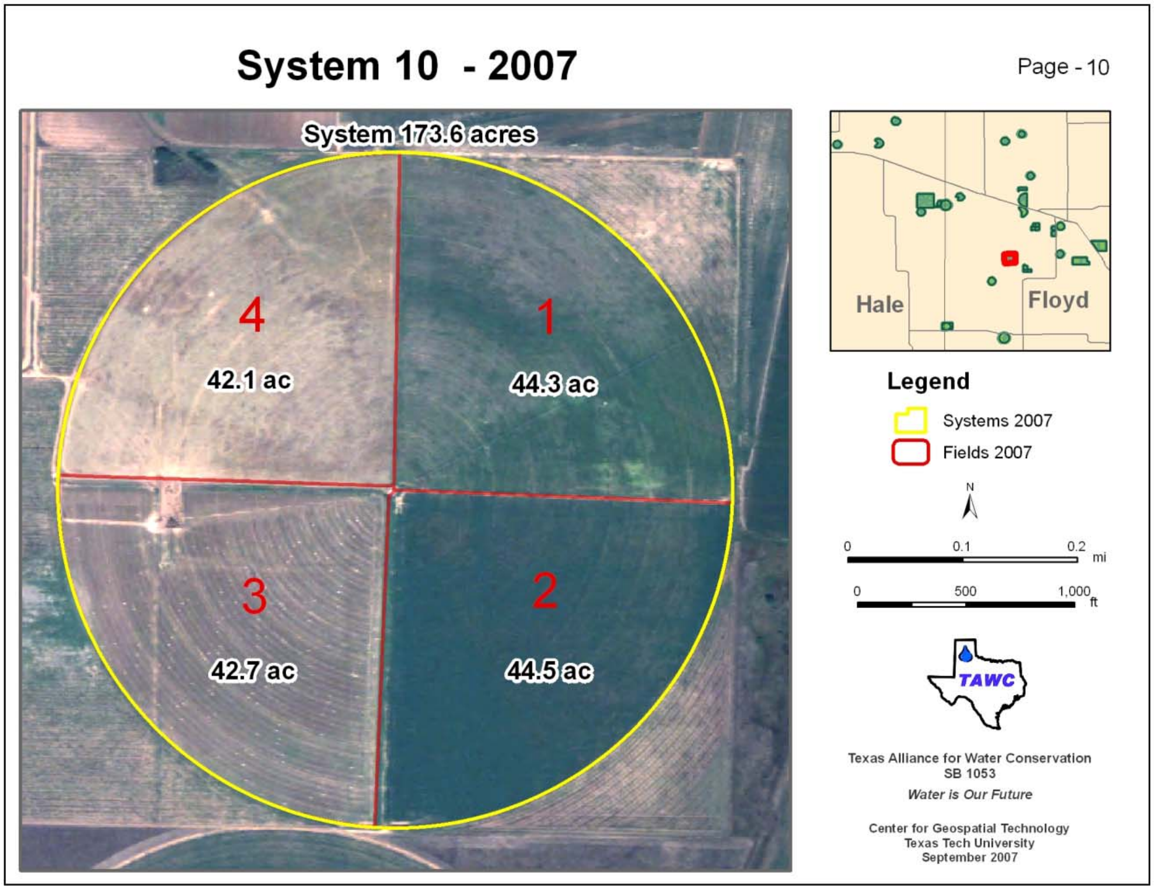
Irrigation and Precipitation
Water (inches)
30
25
20
15
10
5
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
350
300
250
200
150
100
50
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre



Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
50
40
30
20
10
0
5
4
3
2
1
0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen



SYSTEM 10

Livestock

2007: Cow-calf
2006: Cow-calf
2005: Cow-calf

Irrigation

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

Crops

2007

Field 1: Dahl for grazing
Field 2: Corn for silage following Wheat cover crop
Field 3: Dahl for grazing and seed
Field 4: Bermudagrass for grazing

2006

Field 1: Dahl for grazing
Field 2: Oats for hay followed by Forage Sorghum for hay
Field 3: Dahl for grazing
Field 4: Bermudagrass for grazing and hay

2005

Field 1: Dahl planted, no grazing this year
Field 2: Cotton
Field 3: Dahl for grazing and hay
Field 4: Bermudagrass planted, some grazing

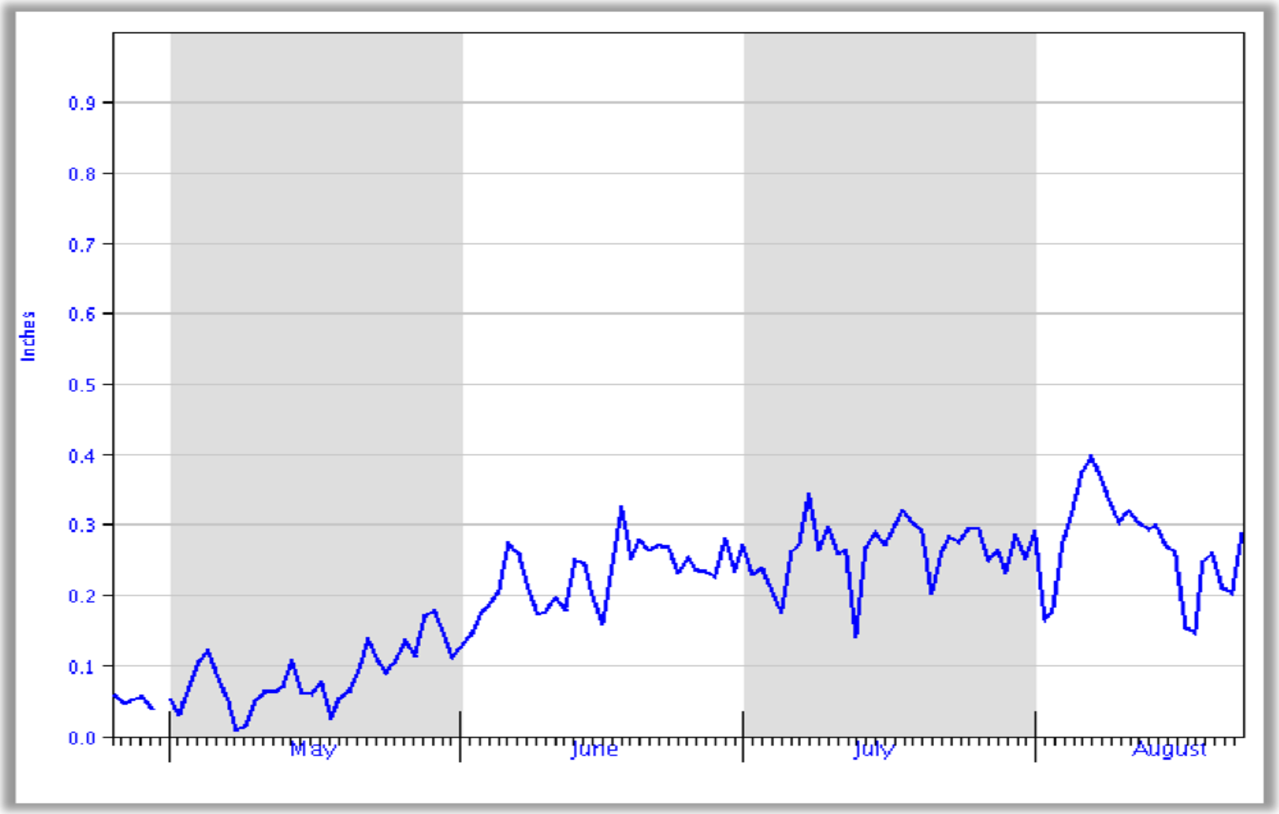



Comments: This is a four cell, pivot irrigated forage/livestock system. Two of the cells are planted to Old-World bluestem and one cell is planted to bermudagrass. The fourth cell has been planted to corn for silage and then to wheat for grazing and then harvested for grain. This producer runs a registered cow/calf program.

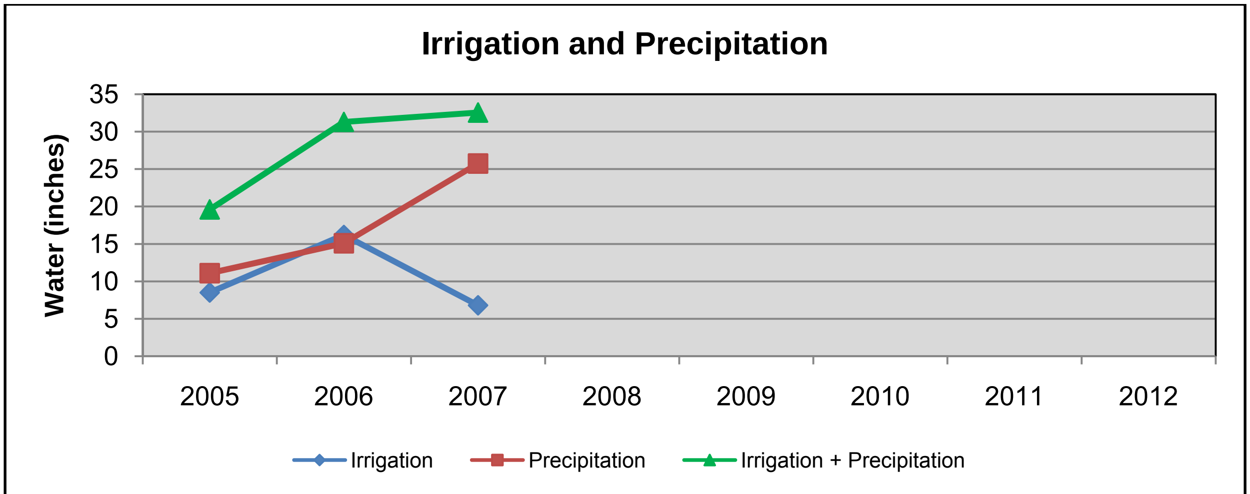
SITE 10 - 2

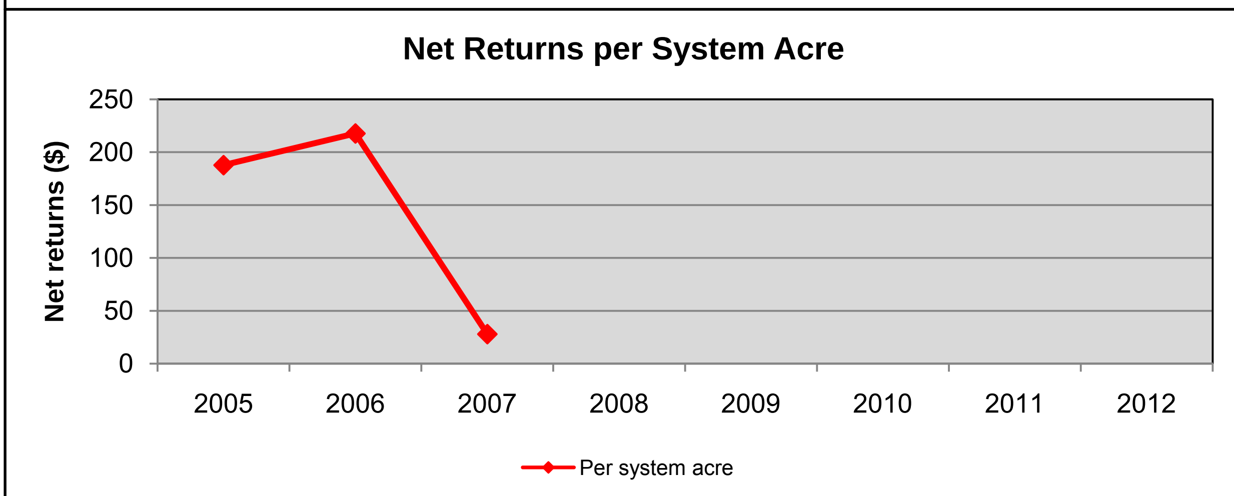
South Plains Corn Silage ET

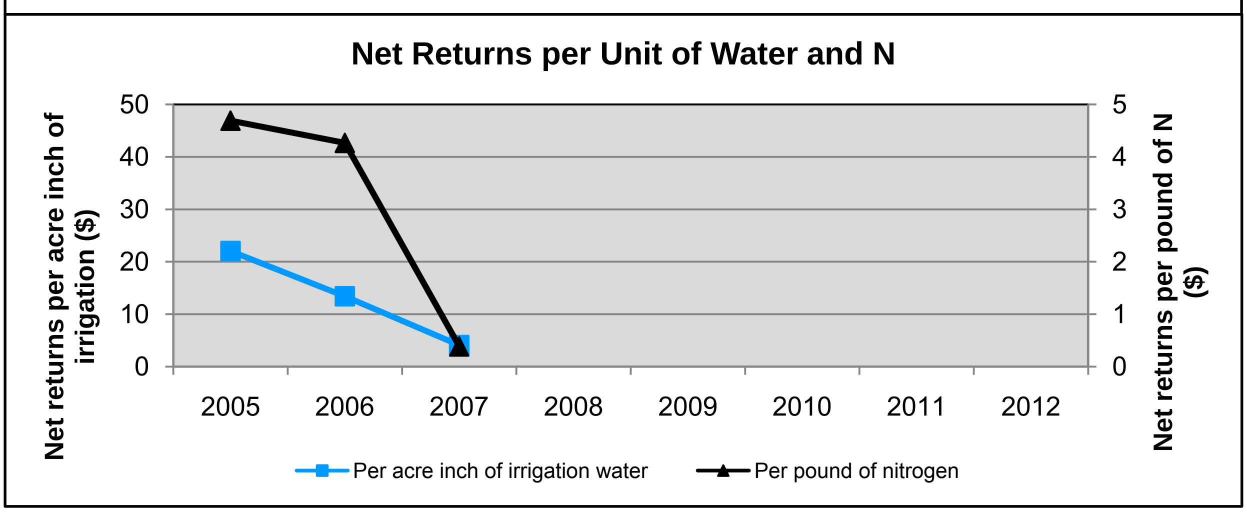
Planted April 15, 2007 Total ET Demand 24.56

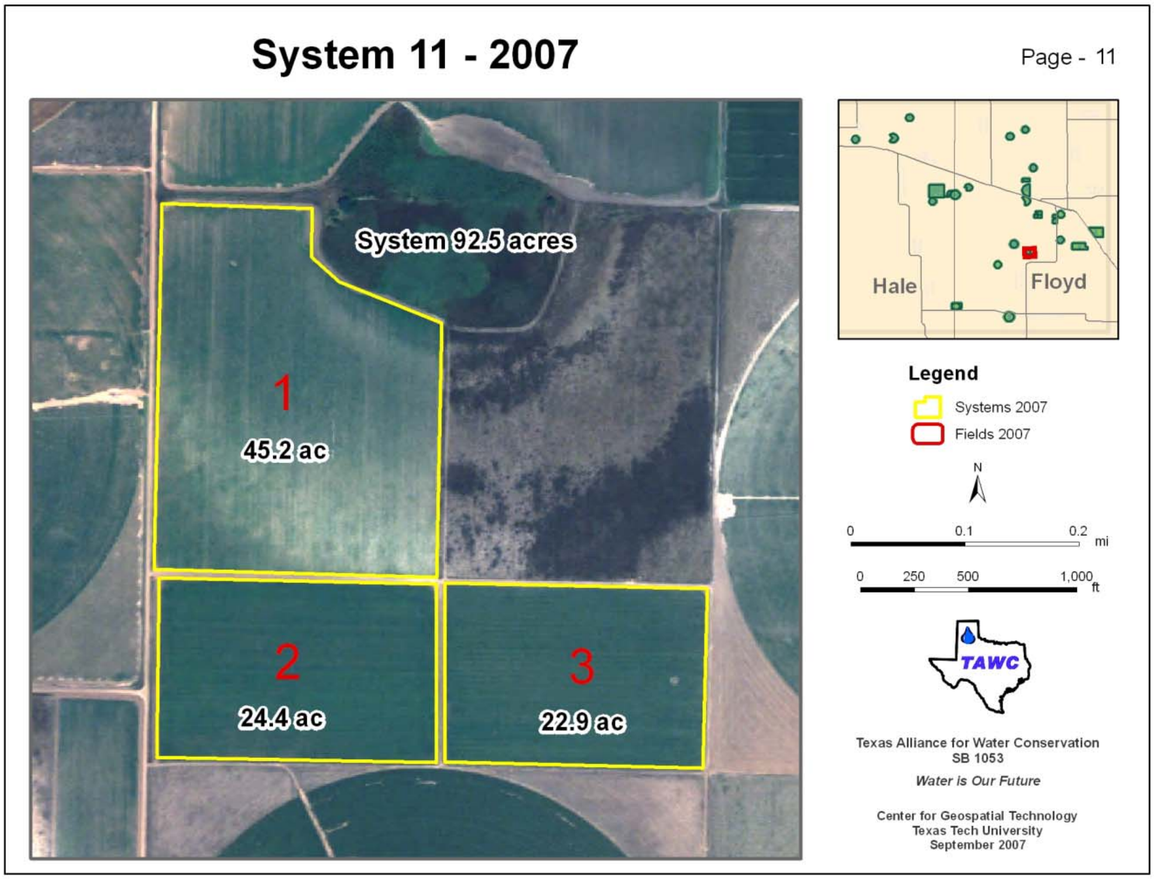


System 10


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


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


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
50
40
30
20
10
0
5
4
3
2
1
0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen



SYSTEM 11

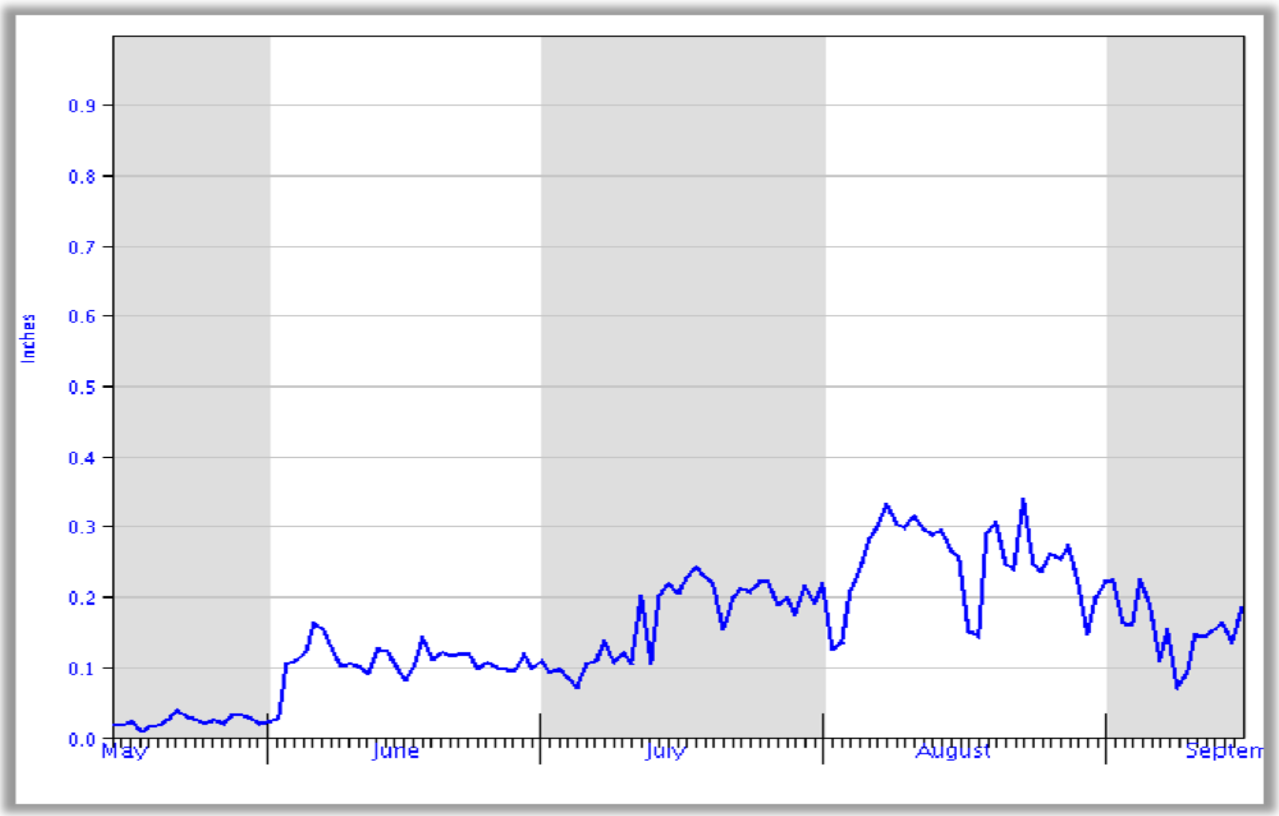
<u>Crops</u>		<u>Irrigation</u>	
2007		Type:	Furrow
Field 1:	Cotton	Pumping capacity, gal/min:	490
Field 2:	Cotton	Number of wells:	1
Field 3:	Cotton	Fuel source:	electric

2006
Field 1: Cotton
Field 2: Cotton
Field 3: Cotton

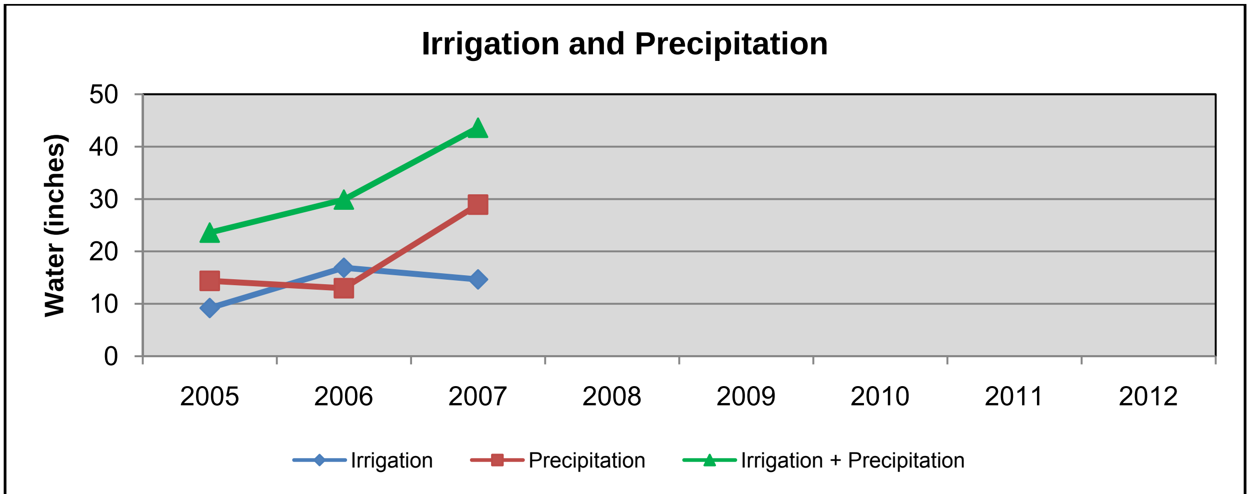
2005
Field 1: Cotton following wheat cover crop
Field 2: Cotton
Field 3: Cotton

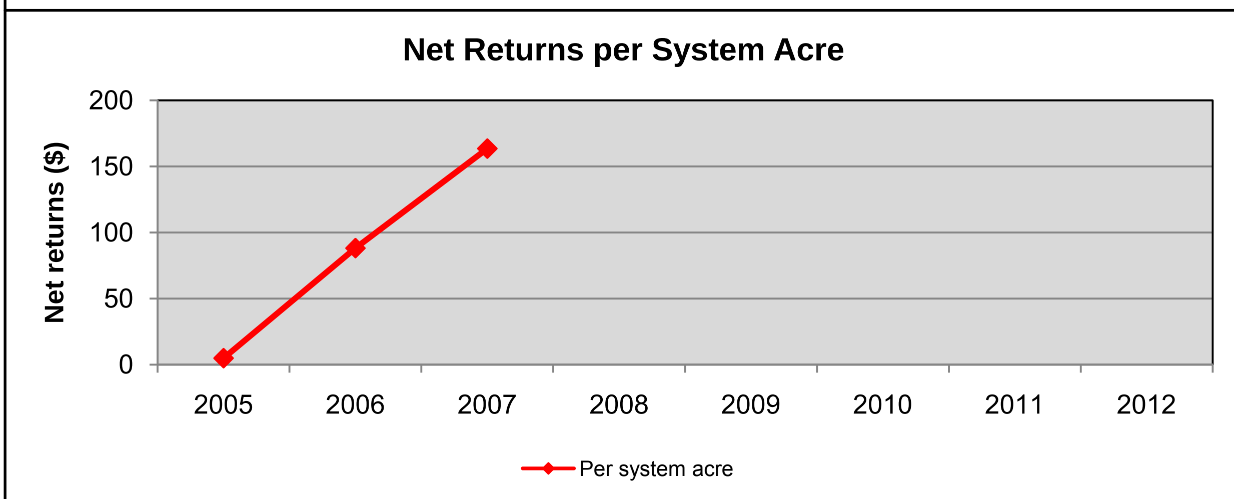
Comments: This is a flood irrigated cotton system under conventional tillage and planted on forty-inch centers.

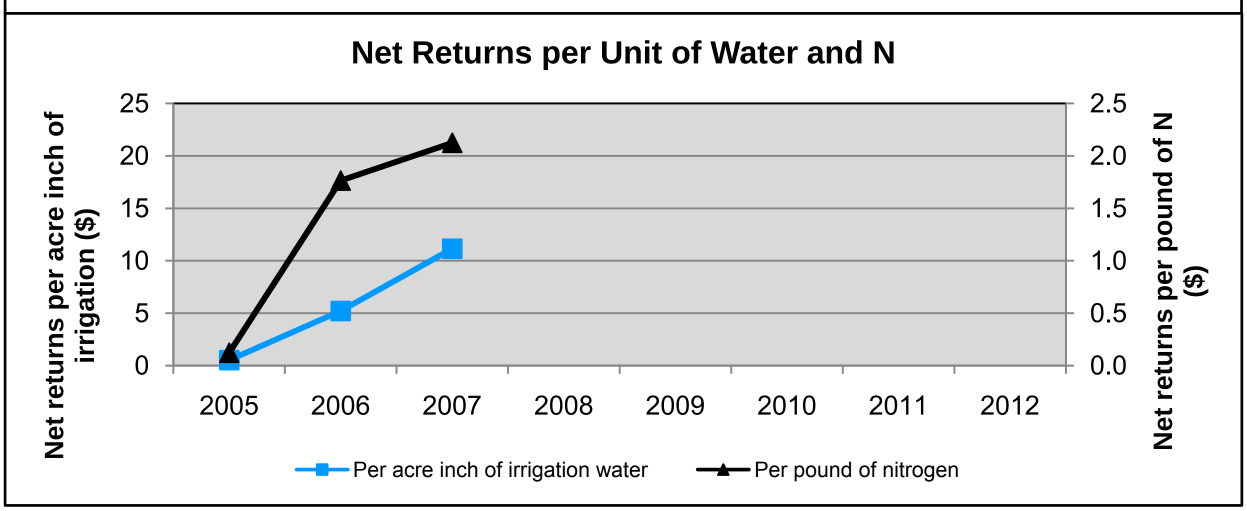
SITE 11 - 2
South Plains Cotton ET
Planted May 15, 2007 Total ET Demand 19.86"

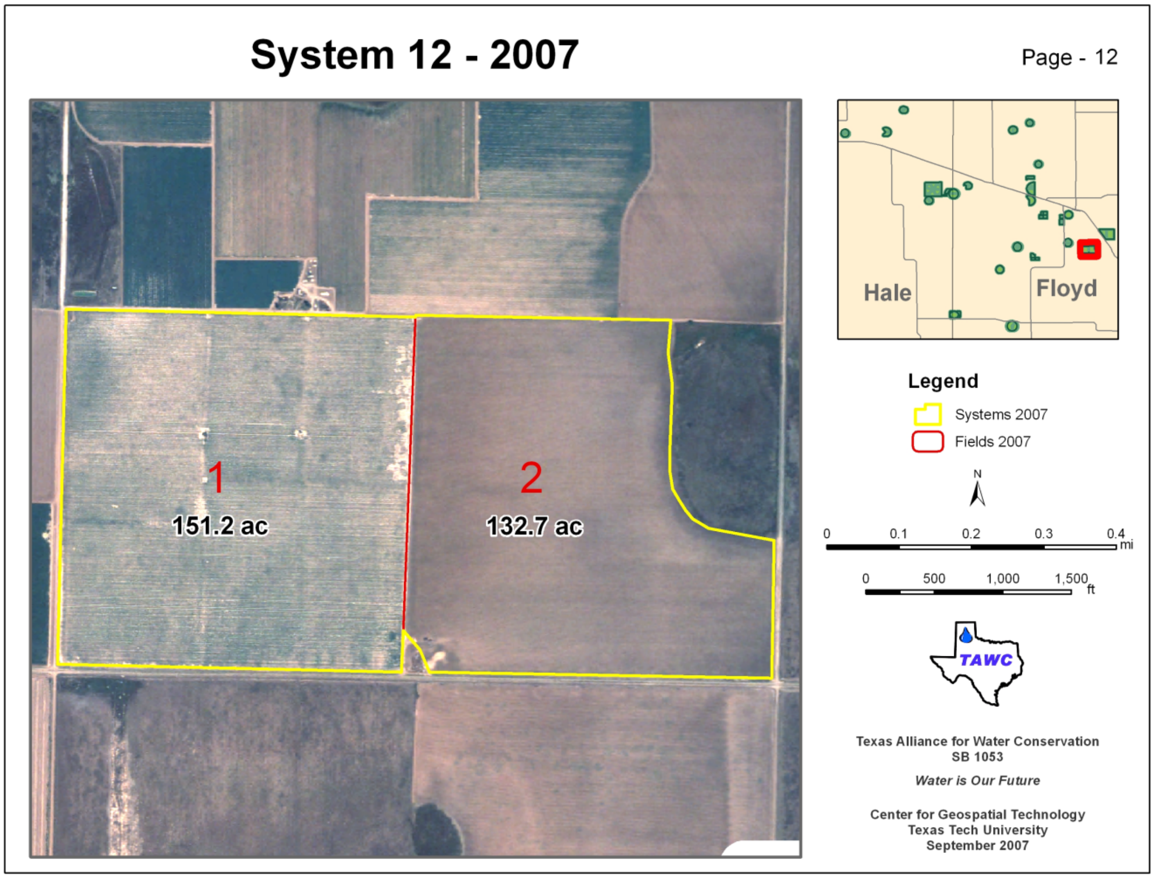


System 11


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


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


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
25
20
15
10
5
0
2.5
2.0
1.5
1.0
0.5
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen



SYSTEM 12

Crops	Irrigation
2007	Type: Dryland

Field 1: Cotton
Field 2: Grain Sorghum following Wheat cover crop

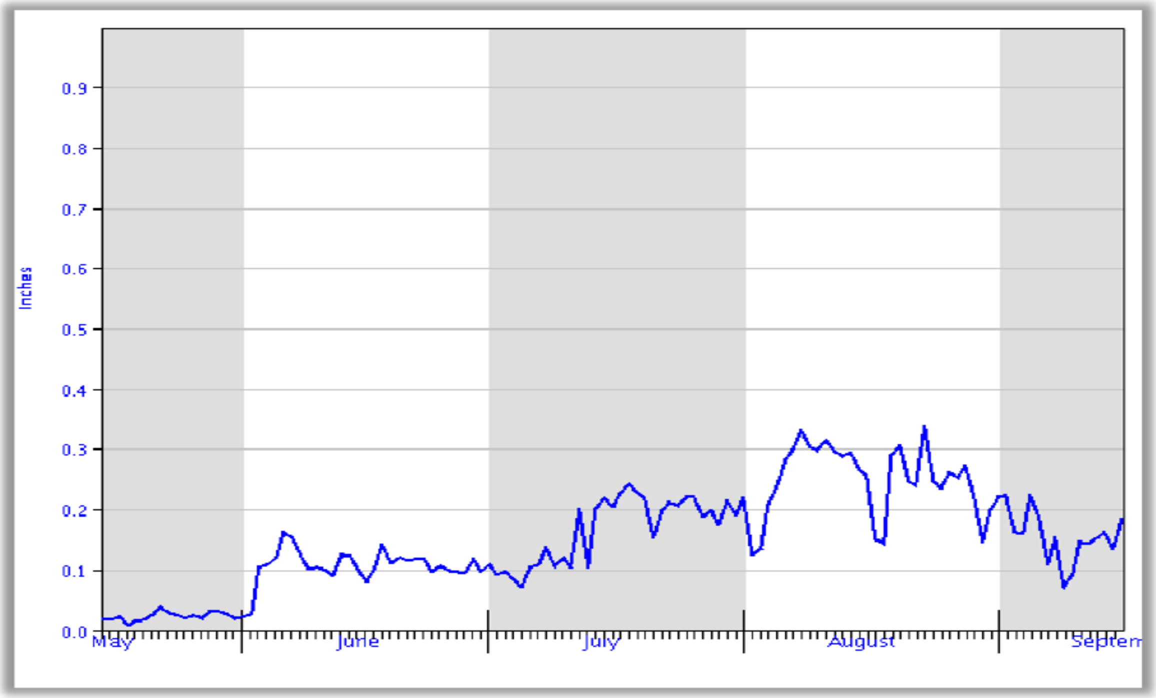
2006
Field 1: Wheat for grain
Field 2: Cotton following previous year cover of Forage Sorghum

2005
Field 1: Cotton following wheat cover crop
Field 2: Forage Sorghum for cover following Wheat

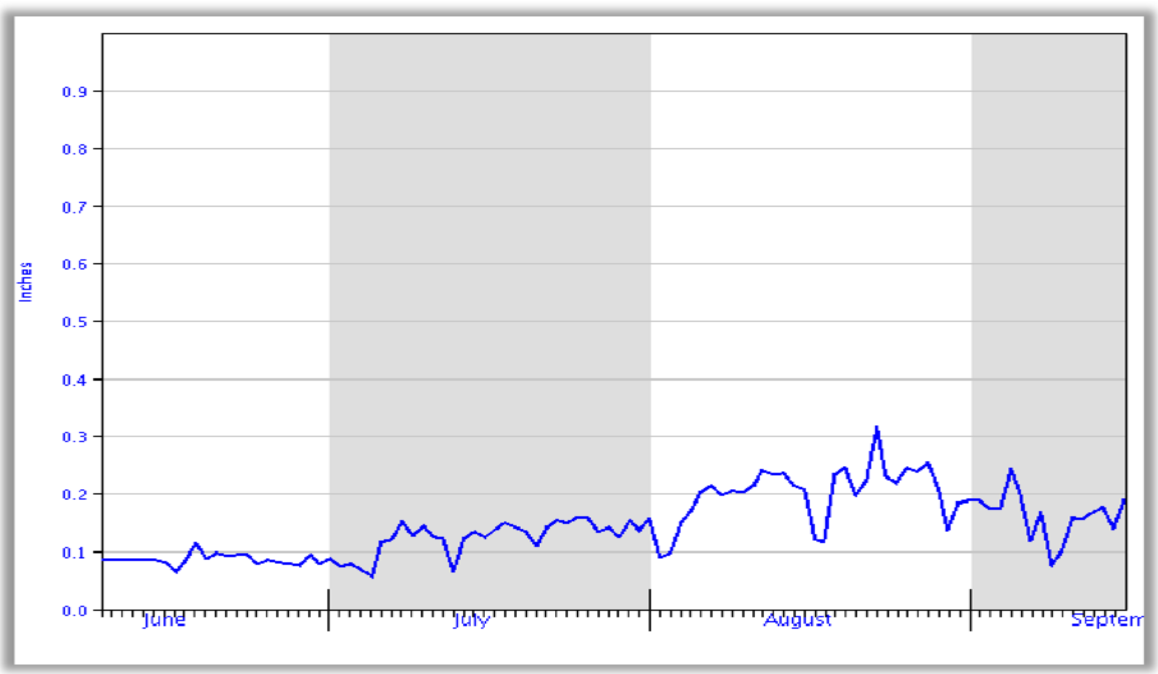



Comments: This dryland system uses cotton, grain sorghum and small grains in rotation. Grain sorghum was planted on old cotton ground then wheat was planted following grain sorghum harvest. Cotton was planted on the balance of the acres.

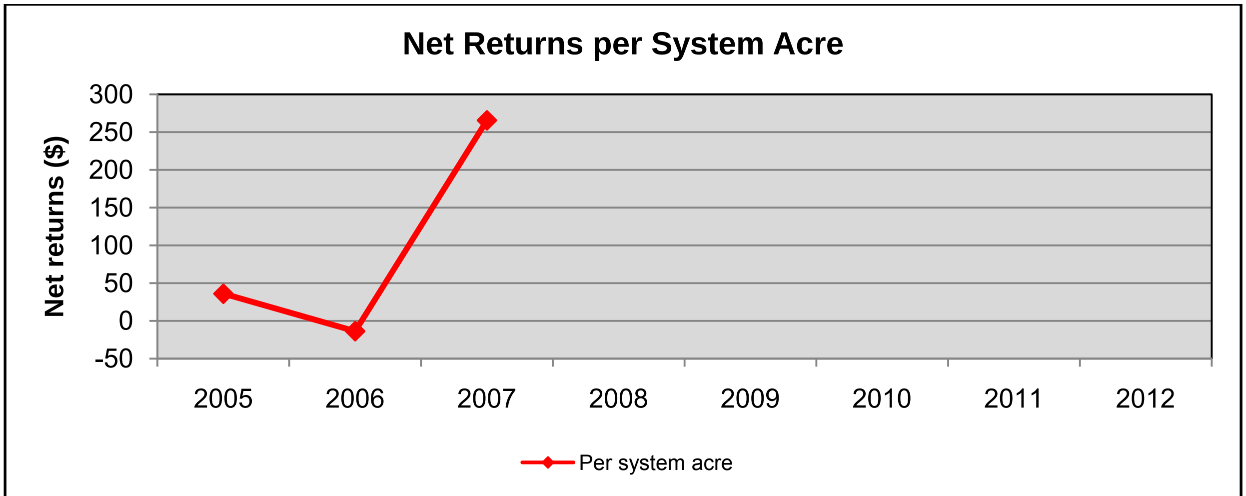
SITE 12 - 1
South Plains Cotton ET
Planted May 15, 2007 Total ET Demand 19.86"

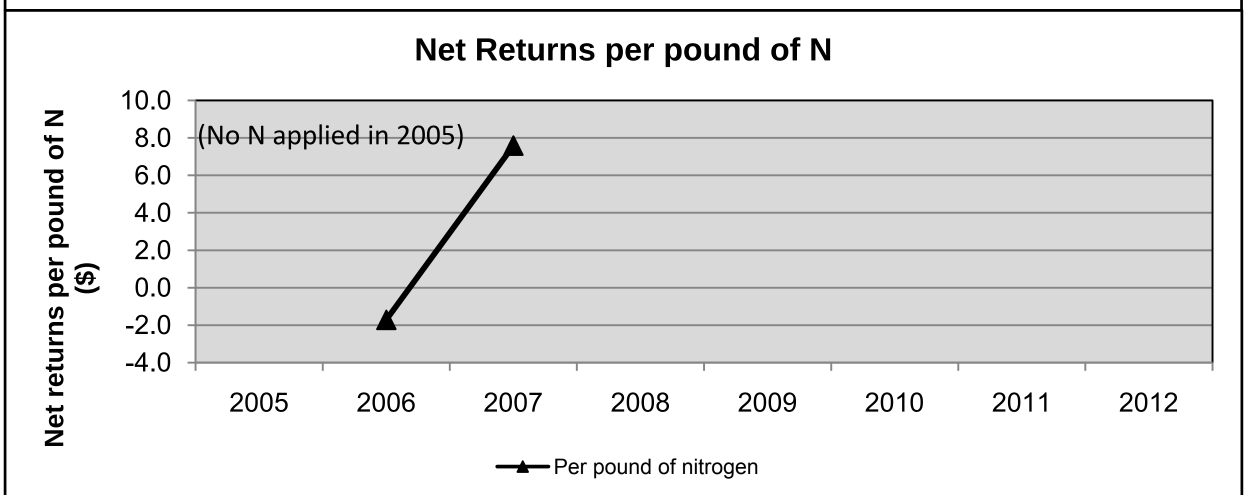


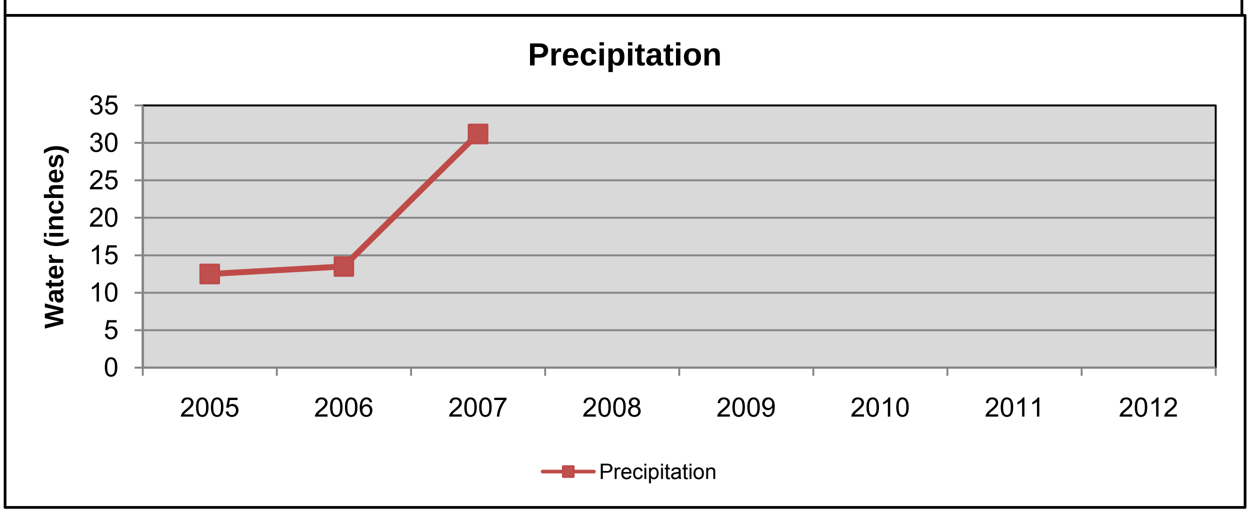
SITE 12 - 2
South Plains Sorghum ET
Planted June 9, 2007 Total ET Demand 19.75"

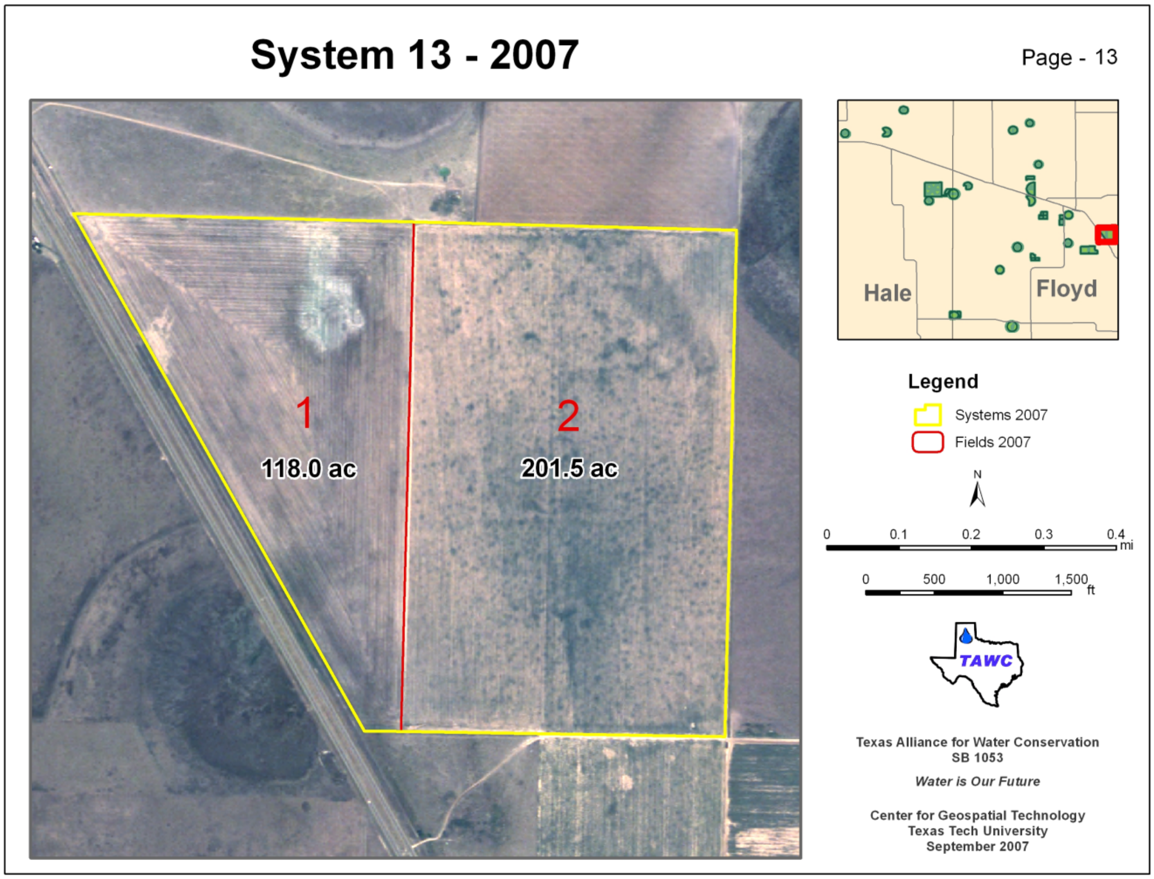


System 12


Net Returns per System Acre
Net returns ($)
300
250
200
150
100
50
0
-50
2005
2006
2007
2008
2009
2010
2011
2012
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
(No N applied in 2005)
2005
2006
2007
2008
2009
2010
2011
2012
Per pound of nitrogen


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



System 13

Crops	Irrigation
2007	Type: Dryland

Field 1: Wheat for grain
Field 2: Cotton following Wheat cover crop

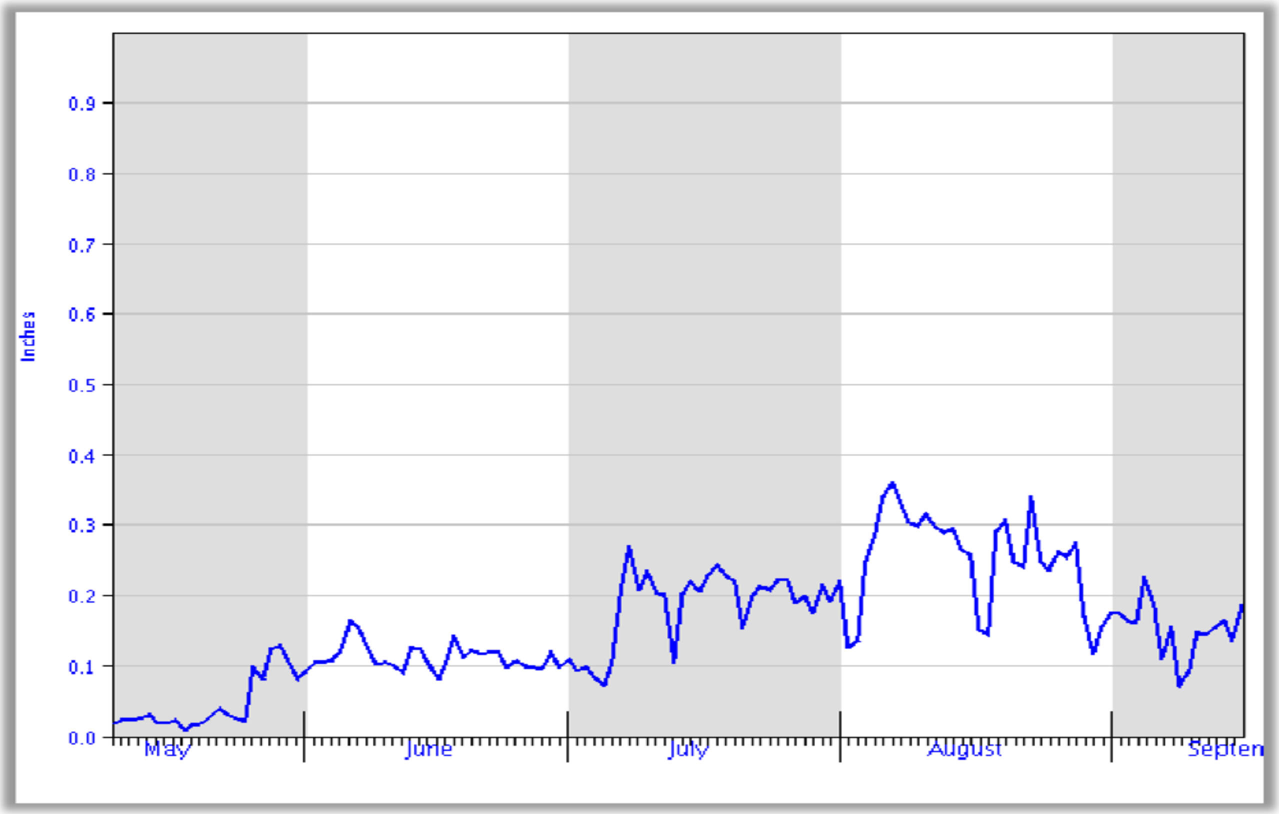
2006
Field 1: Cotton following previous year's cover of Wheat stubble
Field 2: Cotton following lost Wheat to drought

2005
Field 1: Wheat for grain
Field 2: Cotton following previous year's cover of Wheat stubble

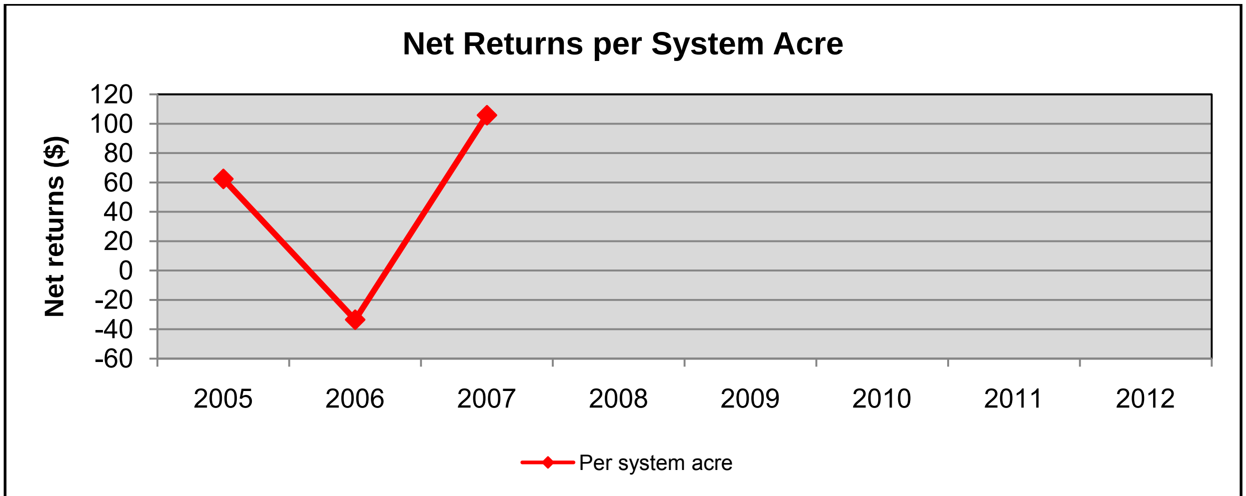



Comments: This dryland site uses cotton and small grains in rotation. Cotton is planted on forty-inch centers under limited tillage. Small grains are drilled after cotton harvest.

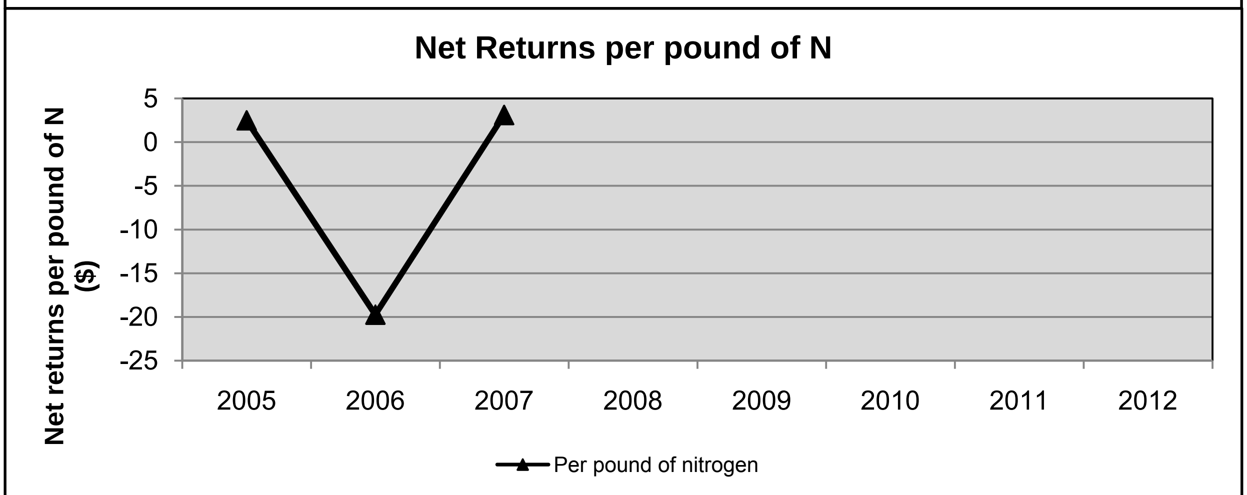
SITE 13 - 1
South Plains Cotton ET
Planted May 10, 2007 Total ET Demand 19.91"



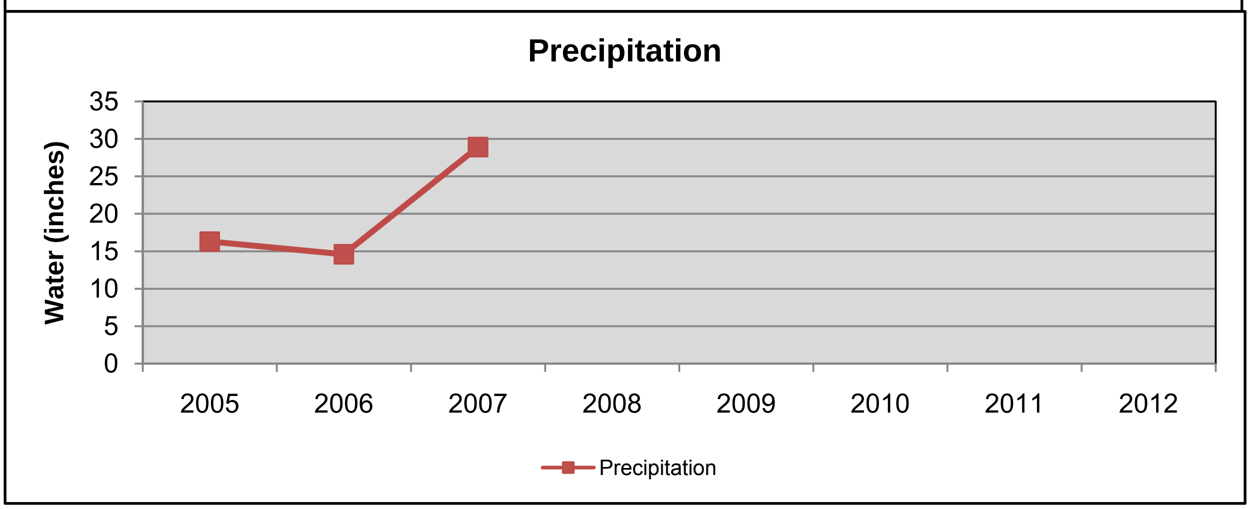
System 13



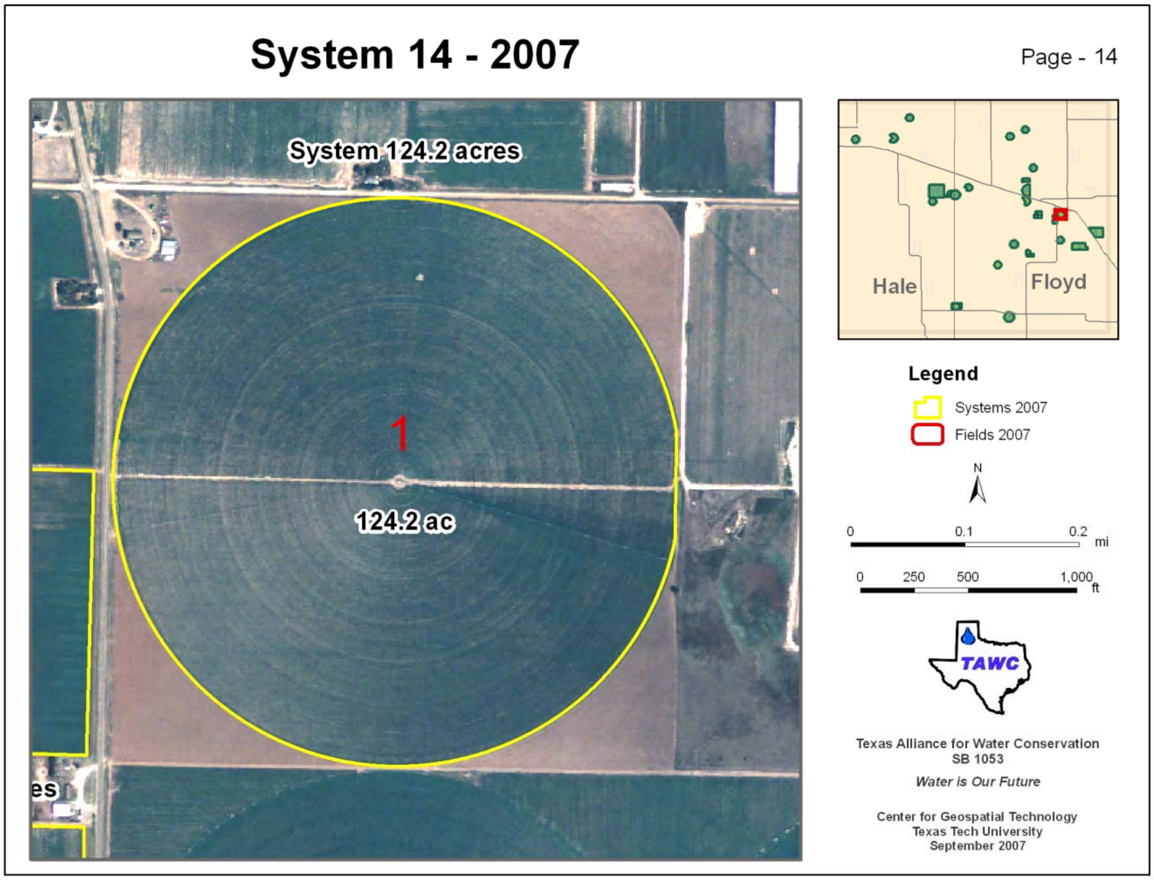
Net Returns per System Acre
Net returns ($)
120
100
80
60
40
20
0
-20
-40
-60
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre



Net Returns per pound of N
Net returns per pound of N ($)
5
0
-5
-10
-15
-20
-25
2005
2006
2007
2008
2009
2010
2011
2012
Per pound of nitrogen



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



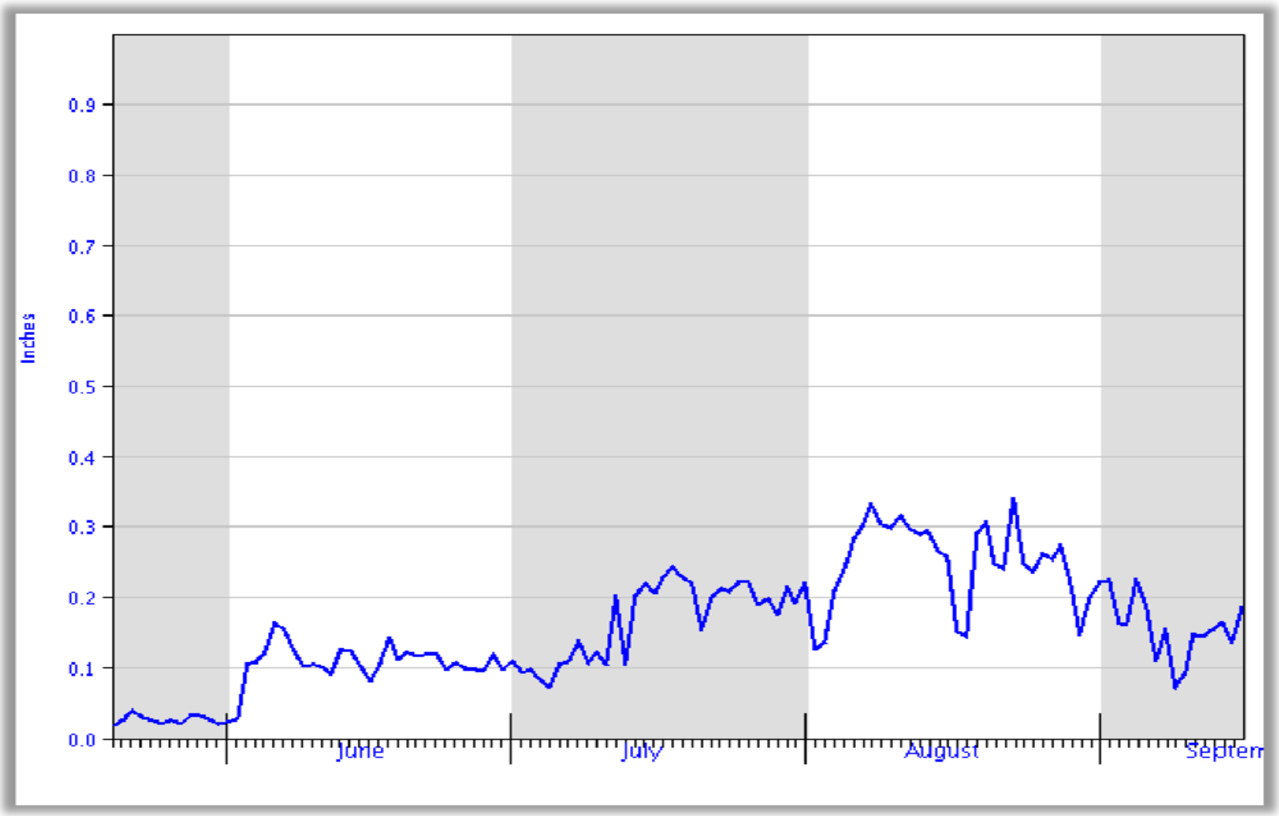
SYSTEM 14

Crops	Irrigation	
2007	Type:	Center pivot (LEPA)
Field 1: Cotton	Pumping capacity, gal/min:	300
	Number of wells:	3
2006	Fuel source:	electric
Field 1: Cotton		
2005		
Field 1: Cotton		

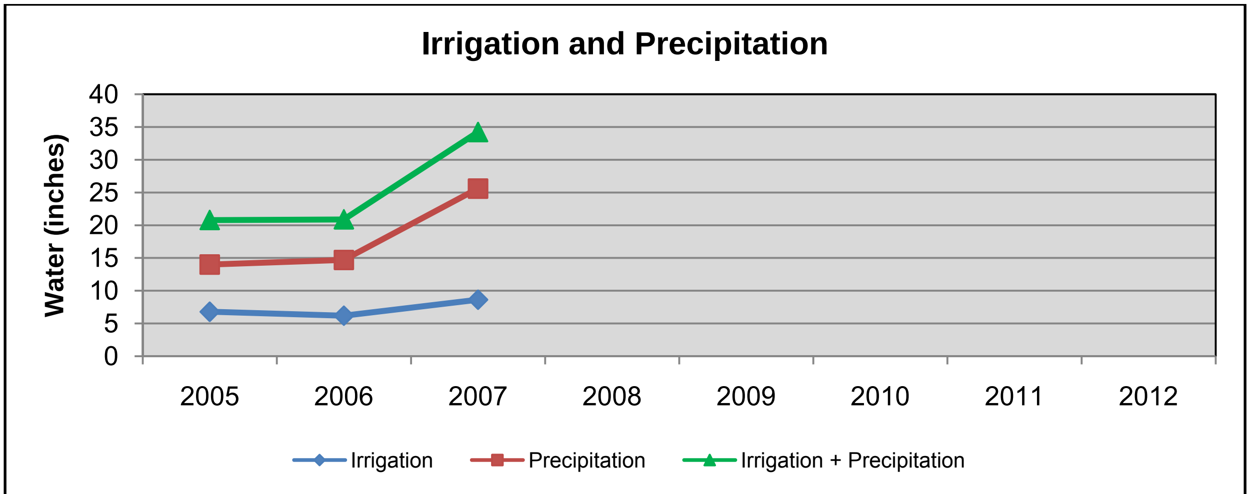


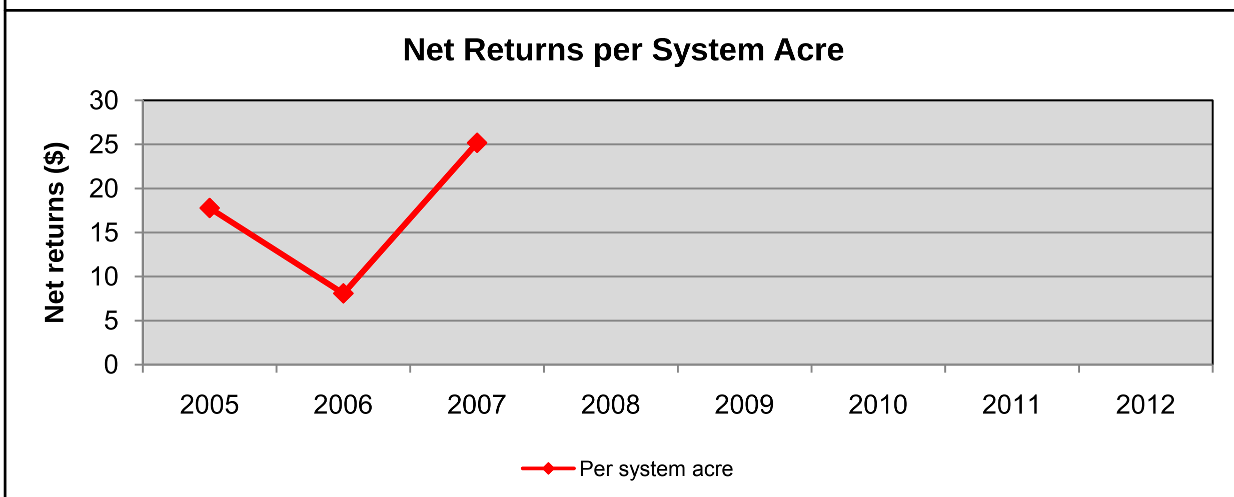

Comments: This is a pivot irrigated site with limited water available. The producer uses conventional tillage and plants on forty-inch centers.

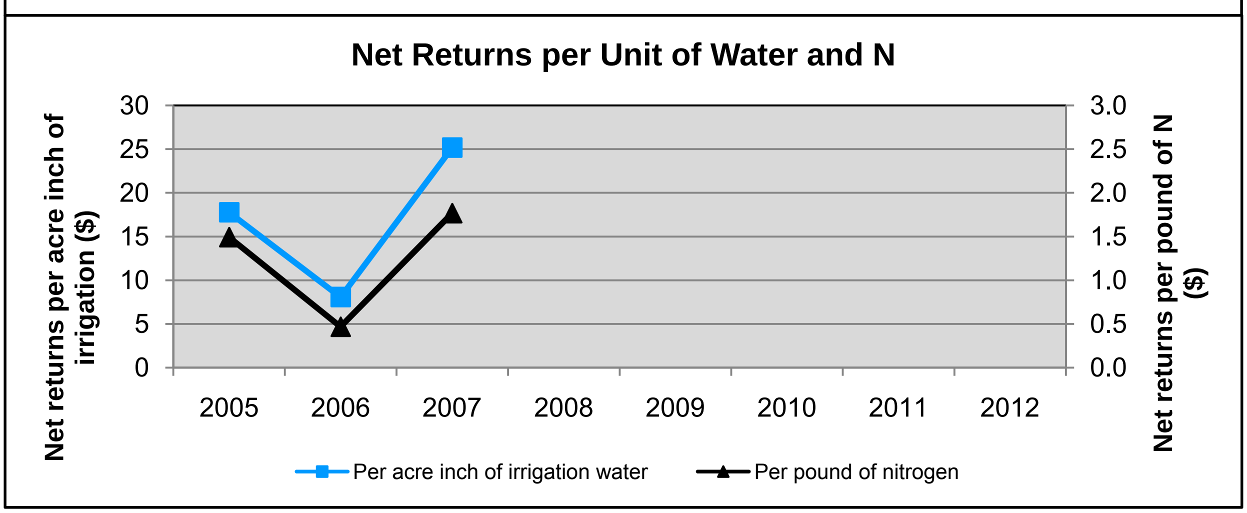
SITE 14 - 1
South Plains Cotton ET
Planted May 20, 2007 Total ET Demand 19.72"

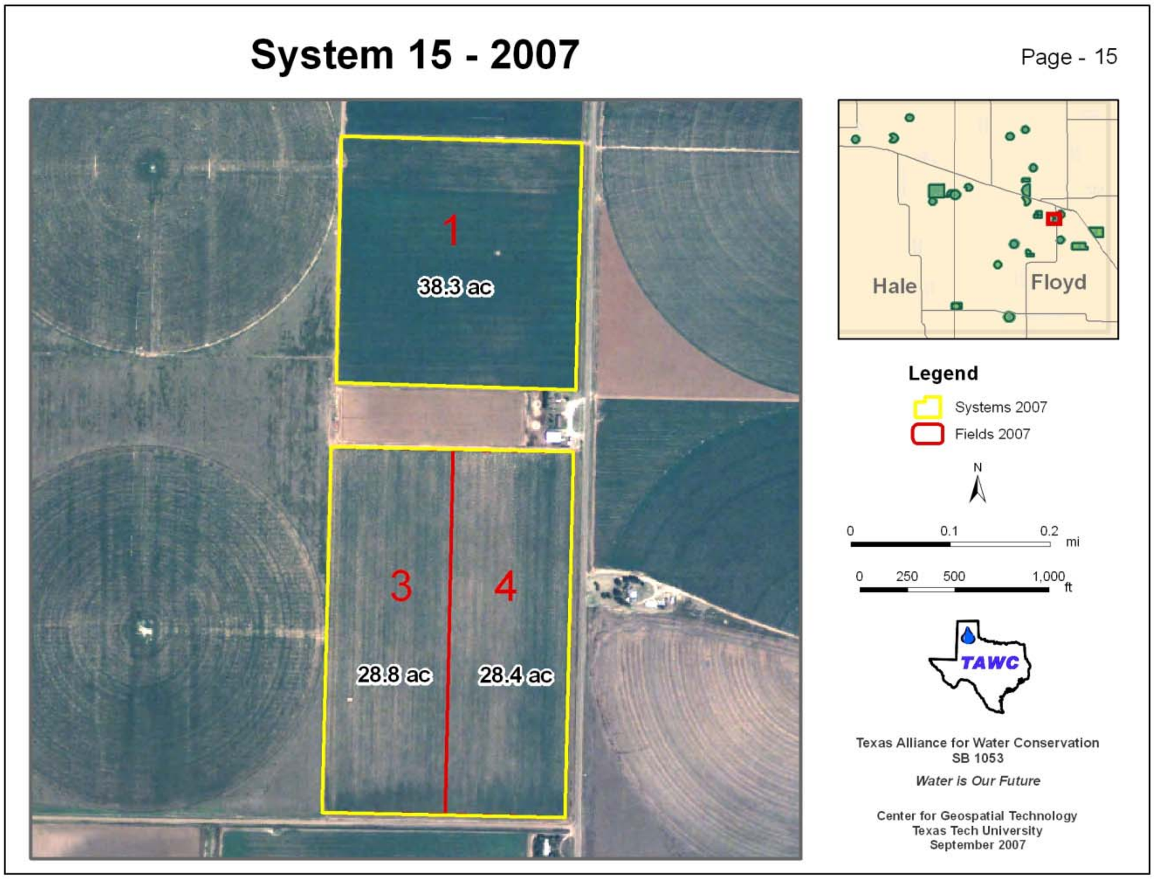


System 14


Irrigation and Precipitation
Water (inches)
0
5
10
15
20
25
30
35
40
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
0
5
10
15
20
25
30
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
0
5
10
15
20
25
30
Net returns per pound of N ($)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen



System 15

<u>Crops</u>

2007
Field 1: Cotton
Field 3: Grain Sorghum
Field 4: Cotton

2006
Field 1: Cotton
Field 3: Cotton
Field 4: Grain Sorghum

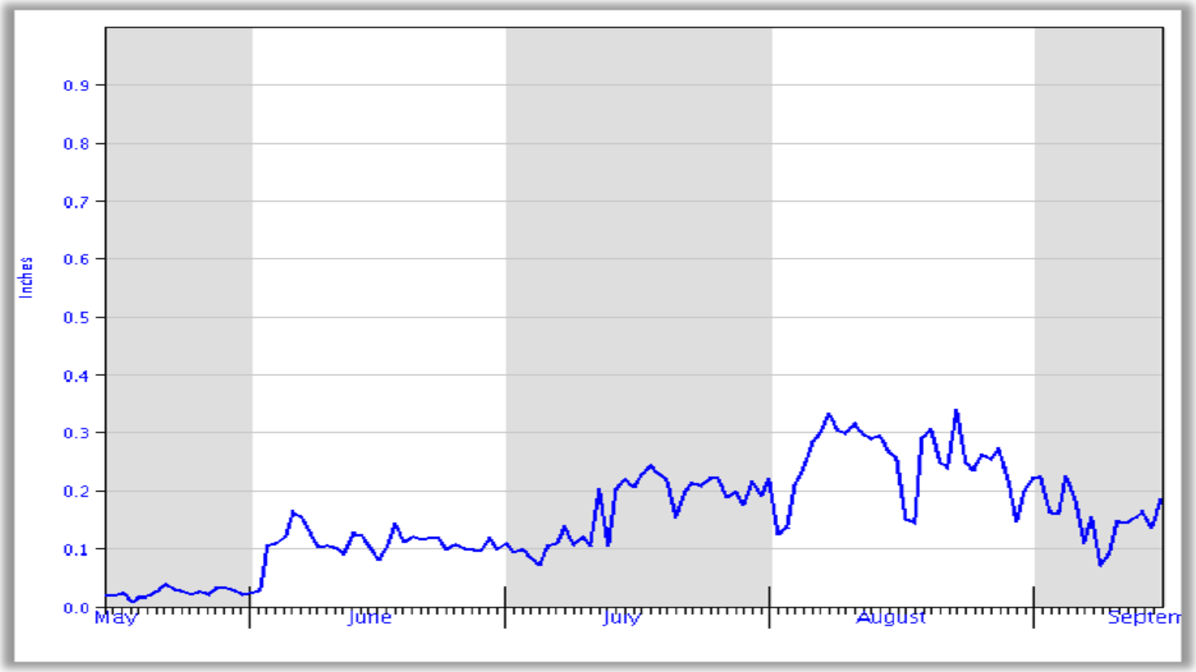
2005
Field 1: Cotton
Field 2: Cotton

Irrigation	
Type:	Furrow
Pumping capacity, gal/min:	290
Number of wells:	1
Fuel source:	natural gas

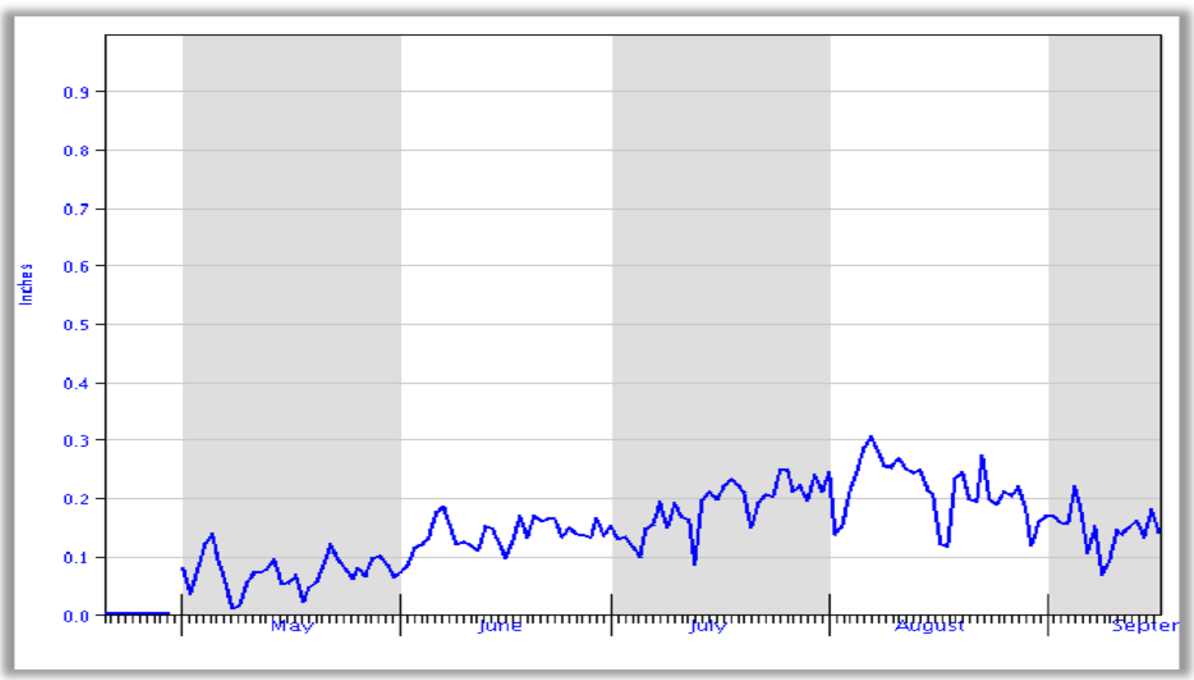



Comments: This flood irrigated cotton site added grain sorghum in 2006. He uses conventional tillage by relisting his beds each growing season and plants on forty-inch centers.

SITE 15 - 1
South Plains Cotton ET
Planted May 14, 2007 Total ET Demand 19.83"

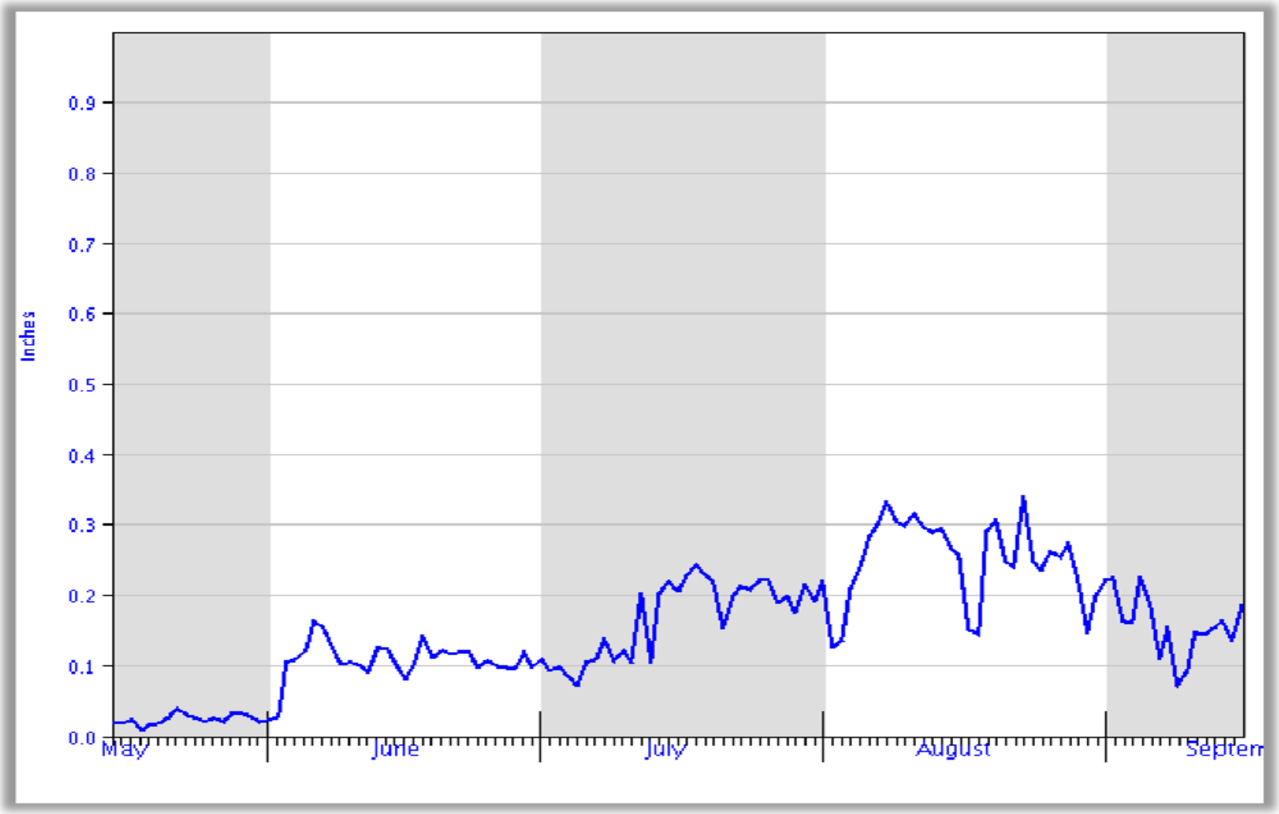


SITE 15 - 3
South Plains Sorghum ET
Planted April 20, 2007 Total ET Demand 18.27"

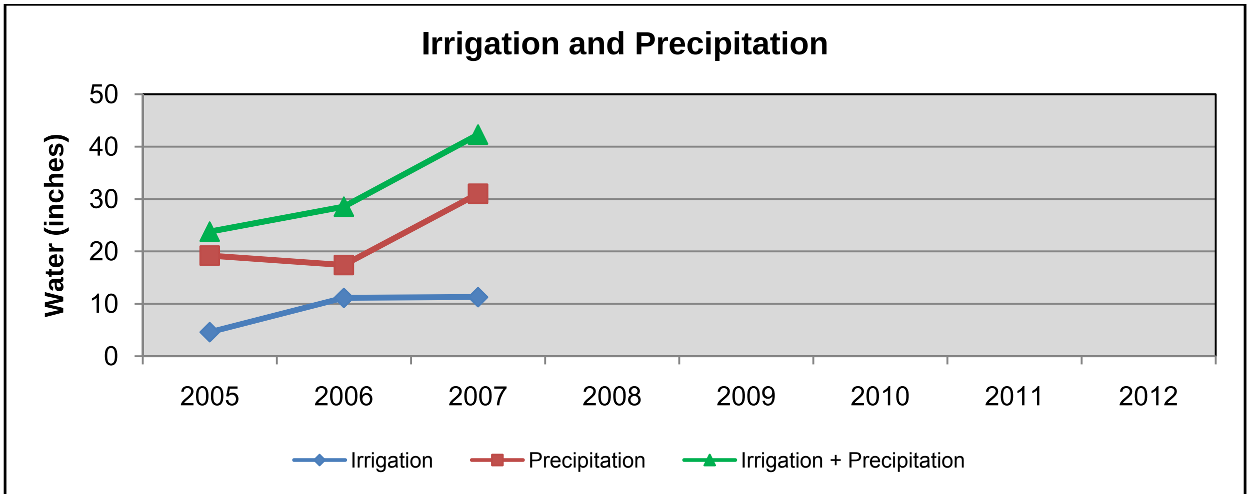


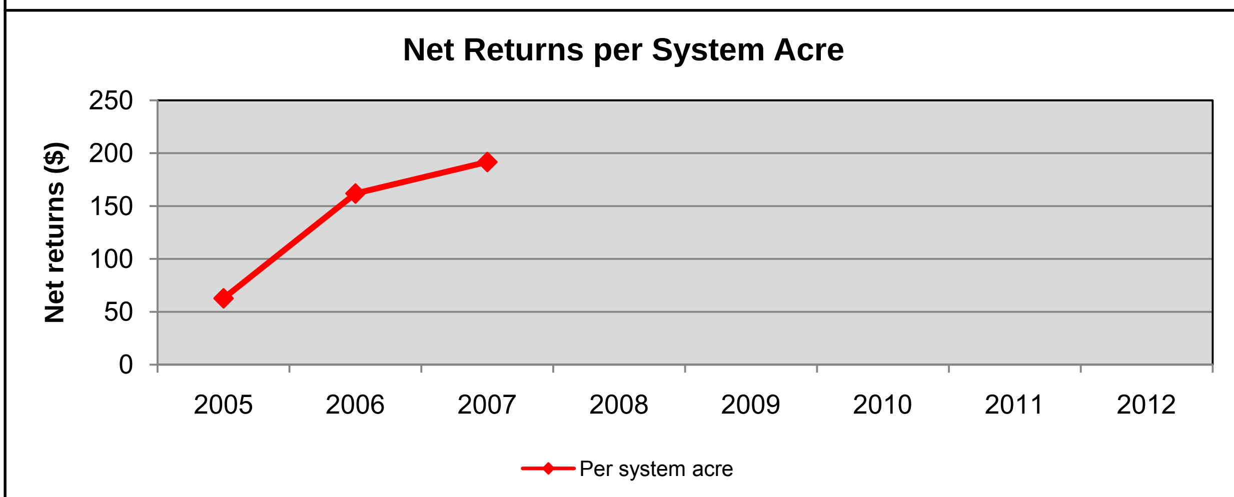
SITE 15 - 4
South Plains Cotton ET
Planted May 14, 2007

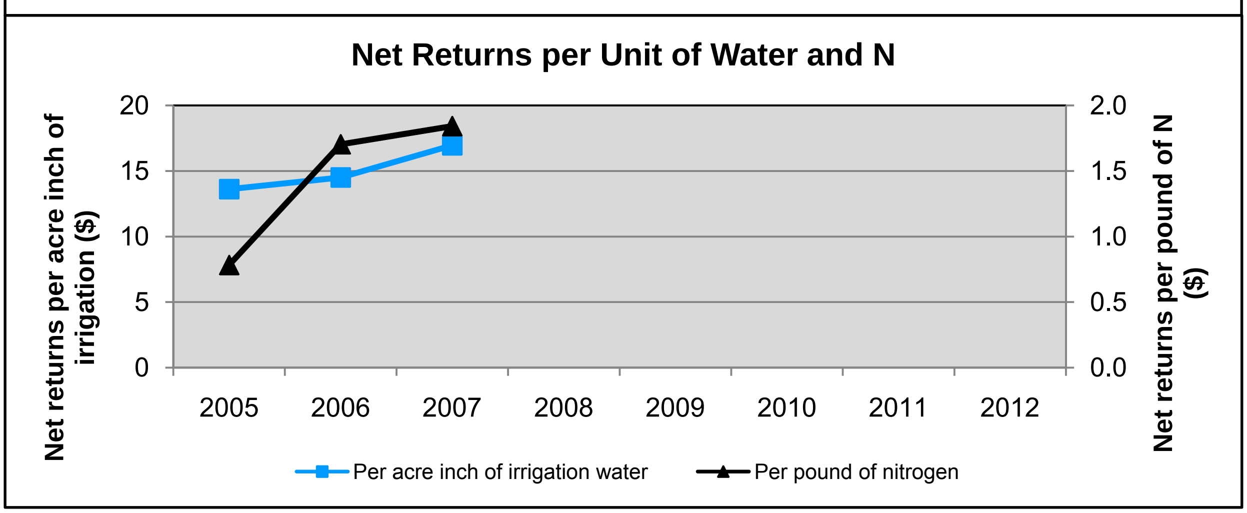
Total ET Demand 19.83"

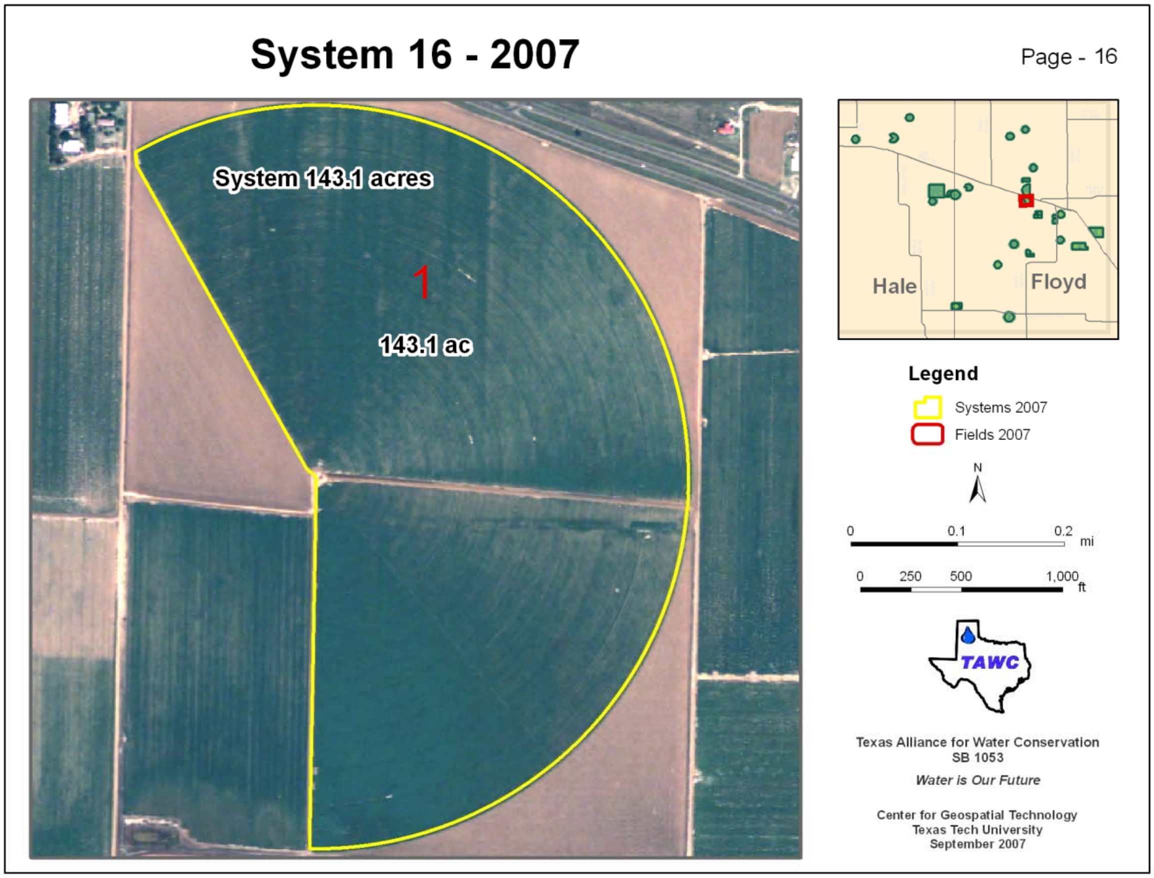


System 15


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


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


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
20
15
10
5
0
2005
2006
2007
2008
2009
2010
2011
2012
2.0
1.5
1.0
0.5
0.0
Net returns per pound of N ($)
Per acre inch of irrigation water
Per pound of nitrogen



SYSTEM 16

Crops
2007
Field 1: Cotton following Wheat cover crop

2006
Field 1: Cotton

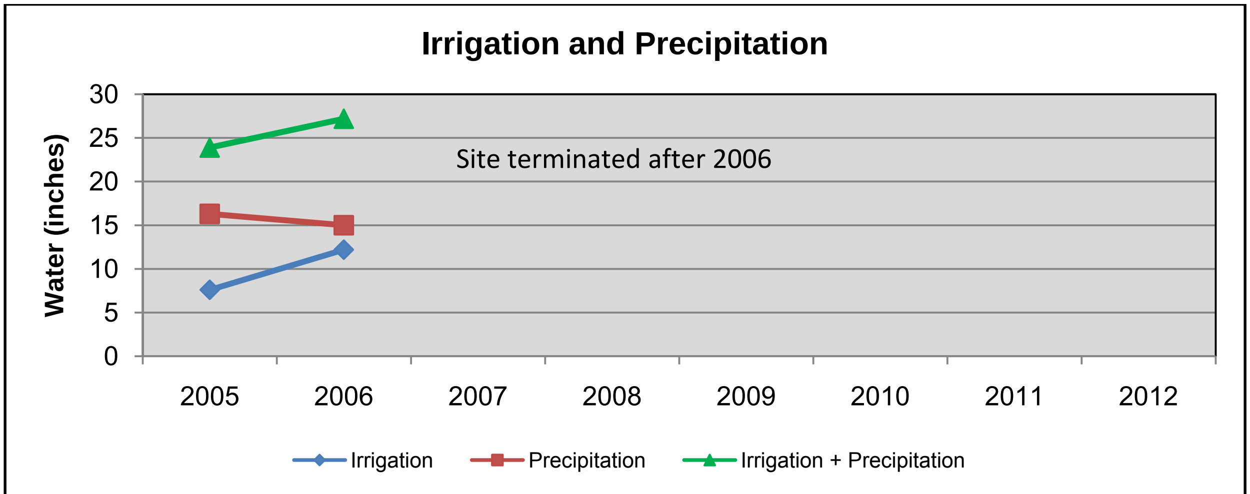
2005
Field 1: Cotton

Irrigation	
Type:	Center pivot (LESA)
Pumping capacity, gal/min:	600
Number of wells:	3
Fuel source:	electric

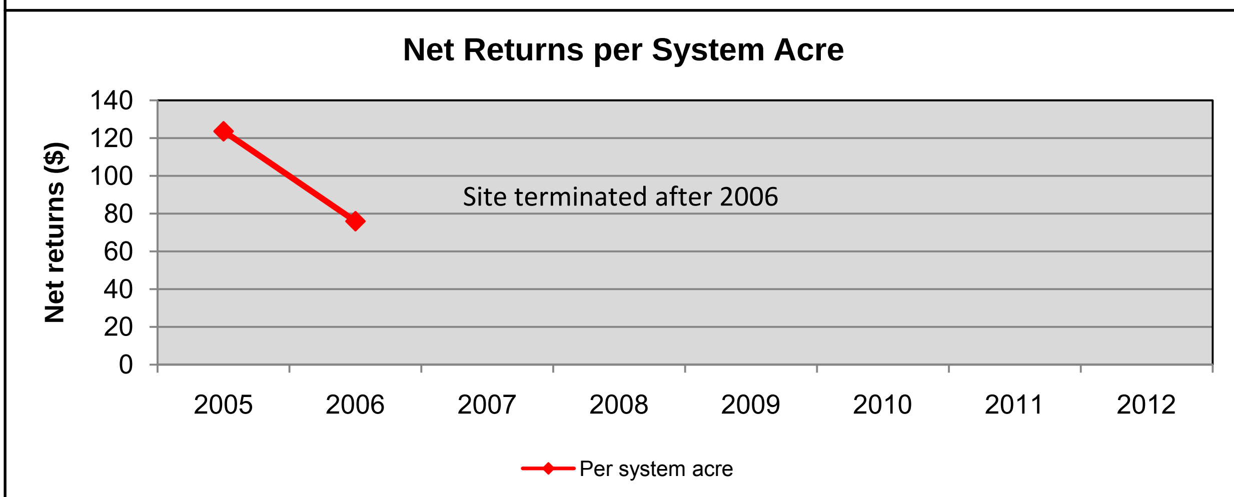



Comments: This pivot irrigated cotton site uses conventional tillage and plants on forty-inch centers.

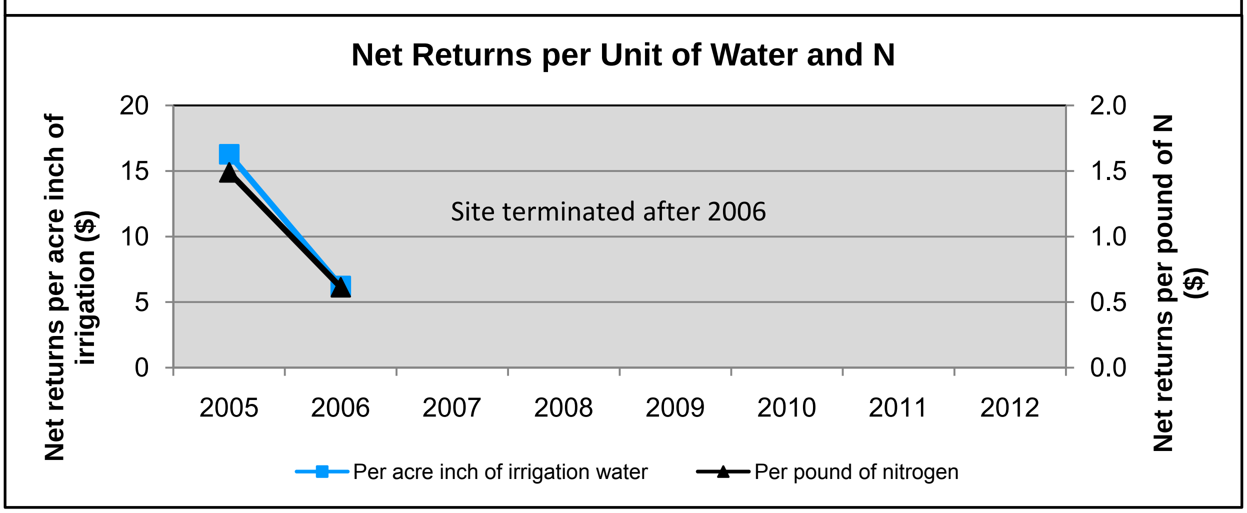
System 16



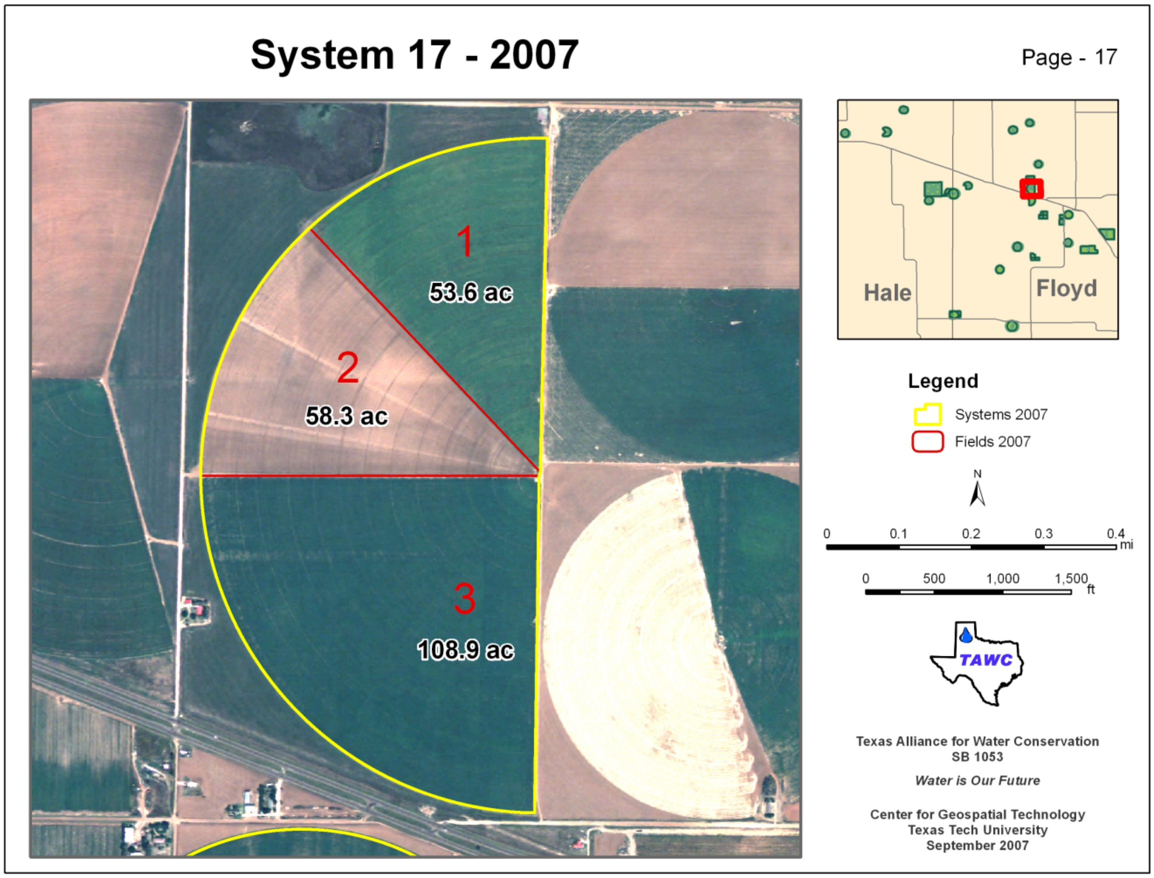
Irrigation and Precipitation
Water (inches)
30
25
20
15
10
5
0
Site terminated after 2006
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
140
120
100
80
60
40
20
0
Site terminated after 2006
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre



Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
20
15
10
5
0
2.0
1.5
1.0
0.5
0.0
Net returns per pound of N ($)
Site terminated after 2006
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen



System 17

Livestock
2007: Cow-calf
2006: Cow-calf
2005: none

Irrigation

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

Crops - Irrigated

2007
Field 1: WW-B. Dahl grass for grazing and seed
Field 2: WW-B. Dahl grass for grazing, hay & seed est. following Oat cover crop
Field 3: Wheat for grazing and cover followed by Cotton

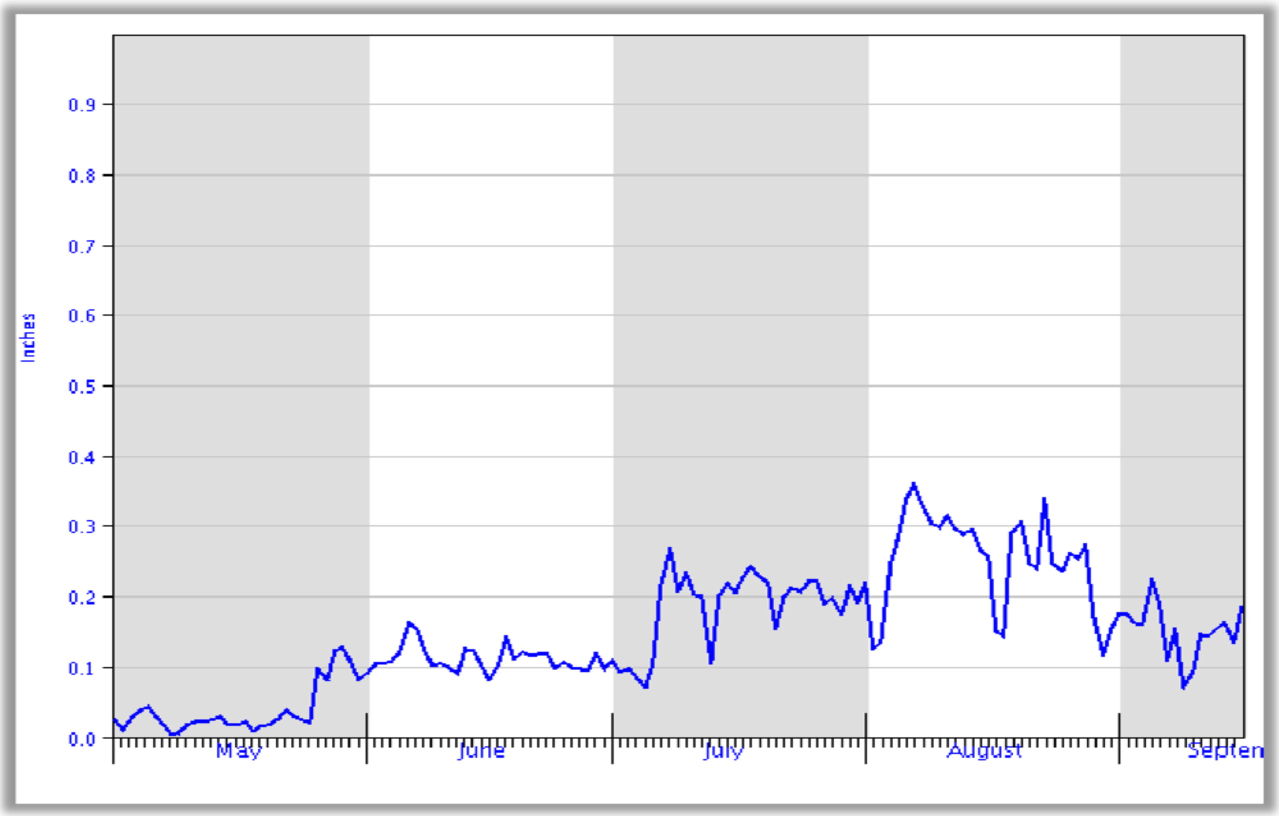
2006
Field 1: WW-B. Dahl grass for grazing and hay
Field 2: Wheat for grazing and cover followed by Cotton
Field 3: Corn for silage, followed by Wheat for grazing and cover

2005
Field 1: WW-B. Dahl grass for hay
Field 2: Corn for silage, followed by wheat for grazing and cover
Field 3: Cotton following cover crop of Wheat

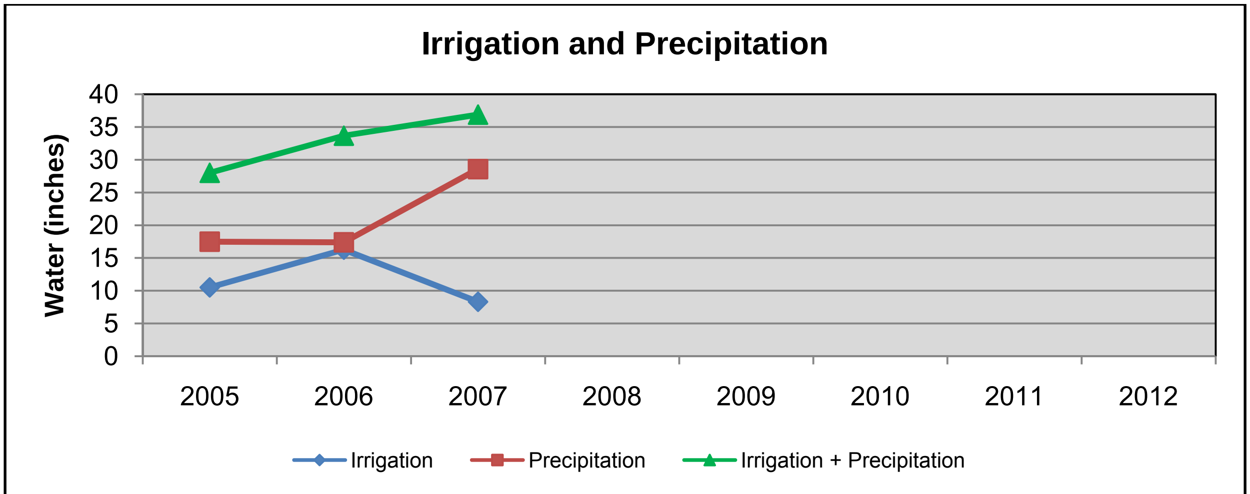


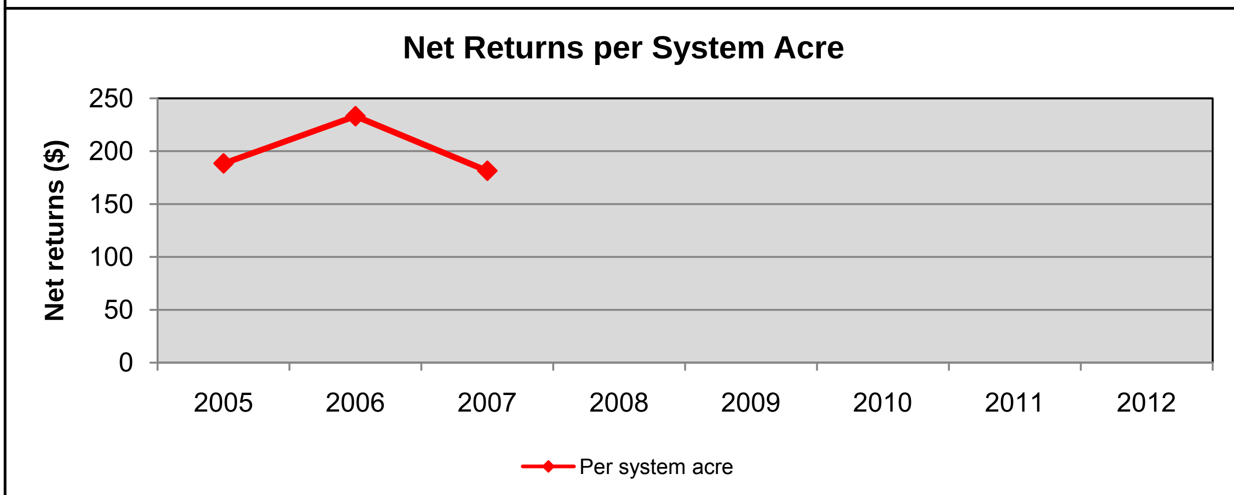

Comments: This is a cotton, silage corn, and old-world bluestem site using pivot irrigation. Wheat is planted after corn harvest, and the wheat is terminated where cotton is no-till planted the following year. Corn is planted on twenty-inch centers on clean tilled ground. The old-world bluestem is used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

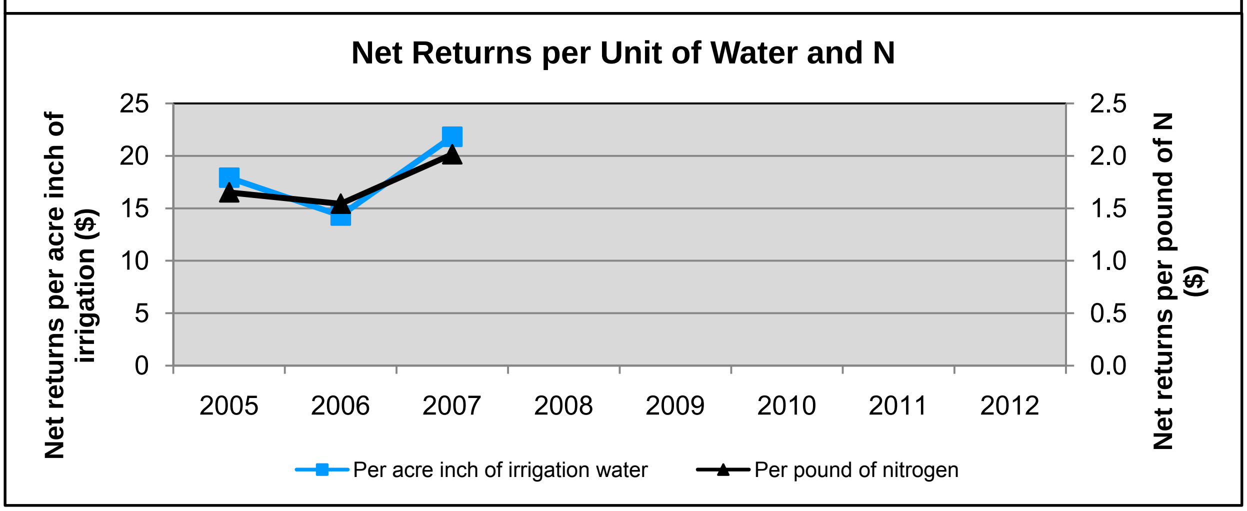
SITE 17-3
South Plains Cotton ET
Planted May 2, 2007 Total ET Demand 20.08"

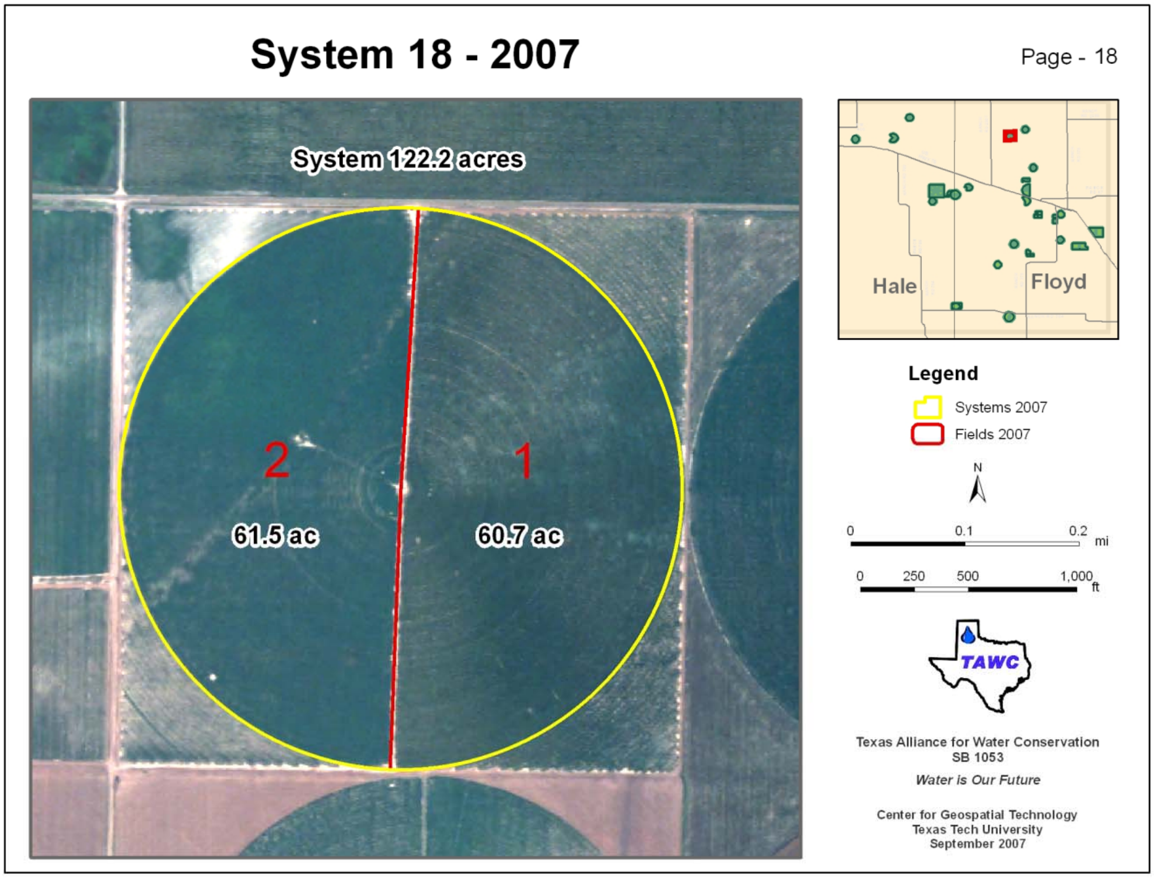


System 17


Irrigation and Precipitation
Water (inches)
40
35
30
25
20
15
10
5
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation


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


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
25
20
15
10
5
0
2.5
2.0
1.5
1.0
0.5
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen



SYSTEM 18

<u>Crops</u>

2007
Field 1: Wheat for grain
Field 2: Grain Sorghum

<u>Irrigation</u>	
Type:	Center pivot (LEPA)
Pumping capacity, gal/min:	250
Number of wells:	3
Fuel source:	electric

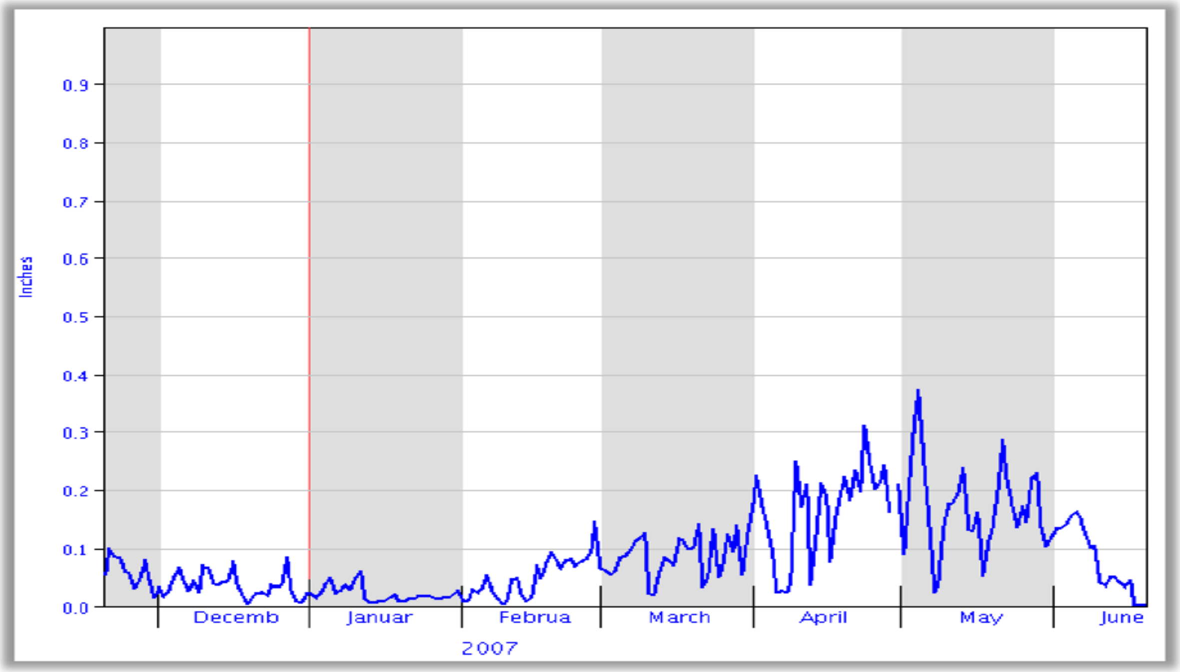
2006
Field 1: Cotton
Field 2: Oats for silage followed by Forage Sorghum for hay

2005
Field 1: Cotton
Field 2: Grain Sorghum

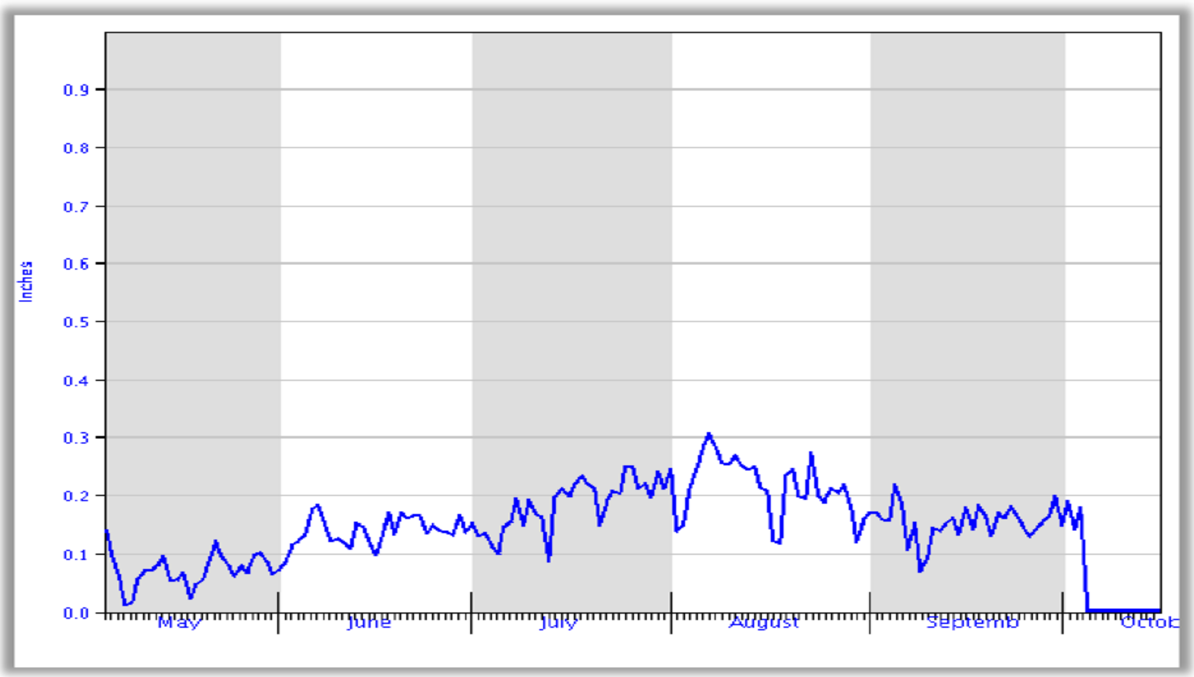



Comments: This is a pivot irrigated site with limited irrigation. Wheat was drilled following cotton in 2006 and taken to grain harvest. Grain sorghum was drilled no-till into forage sorghum residue and harvested for grain.

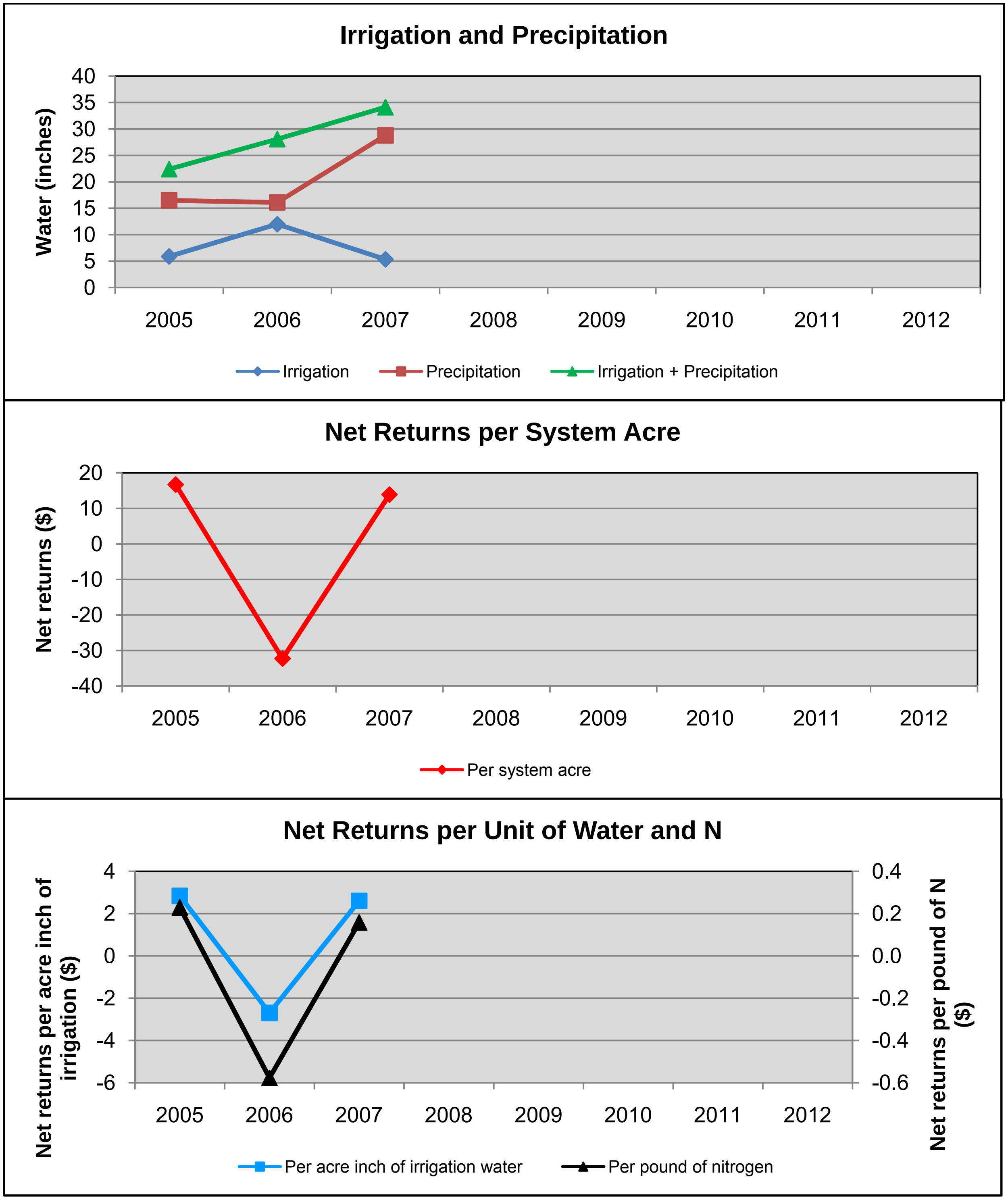
SITE 18 - 1
South Plains Wheat ET
Planted November 15, 2006 Total ET Demand 18.03"

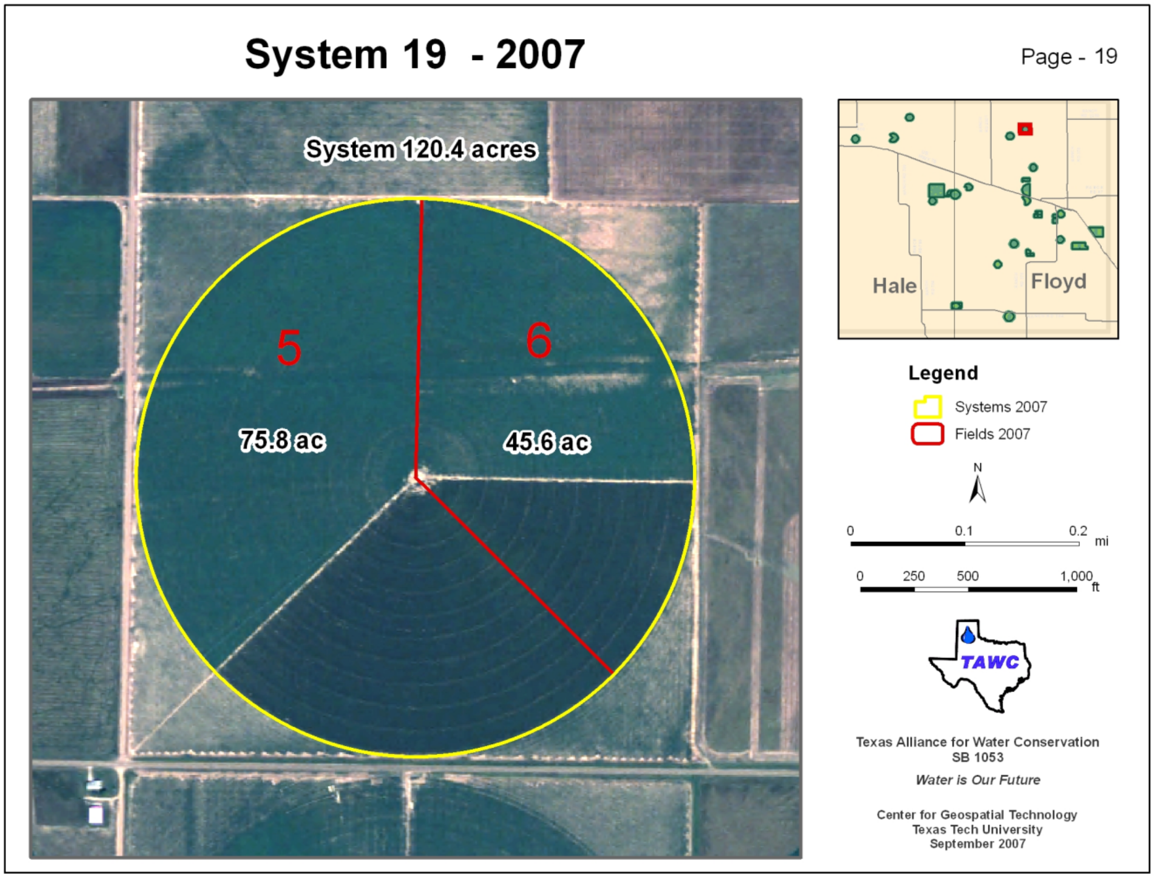


SITE 18 - 2
South Plains Sorghum ET
Planted May 5, 2007 Total ET Demand 22.58



System 18


Irrigation and Precipitation
Water (inches)
40
35
30
25
20
15
10
5
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation
Net Returns per System Acre
Net returns ($)
20
10
0
-10
-20
-30
-40
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre
Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
4
2
0
-2
-4
-6
0.4
0.2
0.0
-0.2
-0.4
-0.6
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen



System 19

<u>Crops</u>

2007
Field 5: Cotton
Field 6: Pearl Millet for seed

2006
Field 3: Pearl Millet for seed
Field 4: Cotton

2005
Field 1: Cotton
Field 2: Pearl Millet for seed

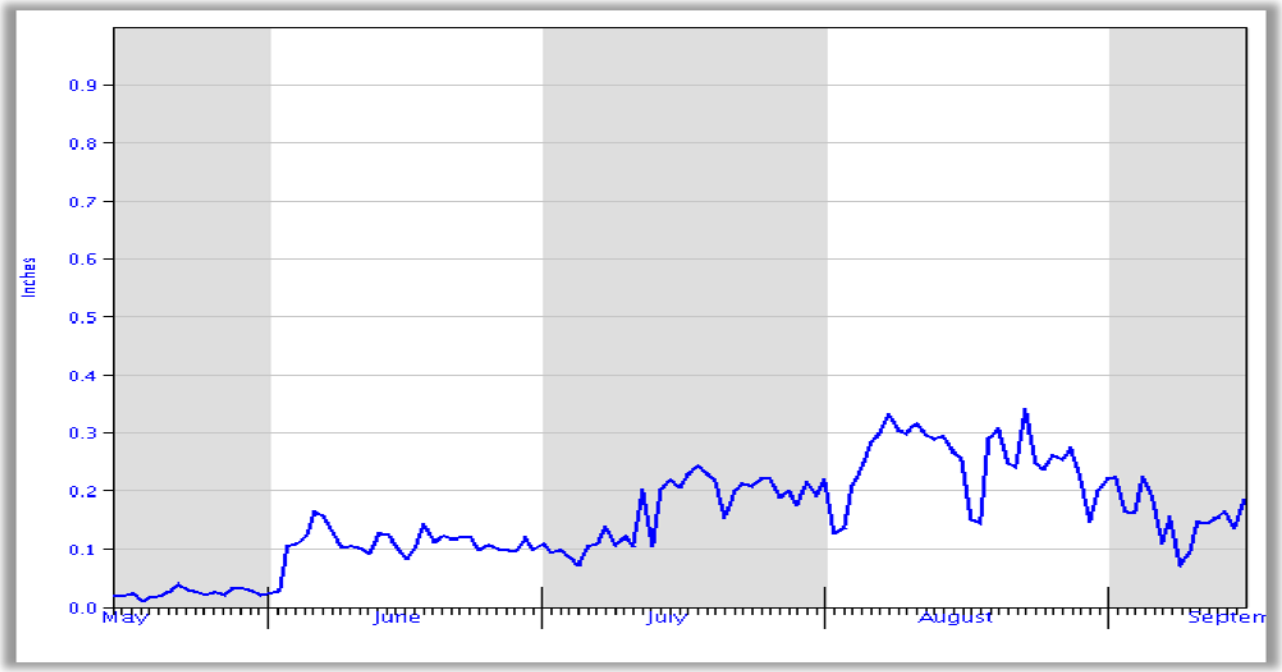
<u>Irrigation</u>

Type:	Center pivot (LEPA)
Pumping capacity, gal/min:	400
Number of wells:	3
Fuel source:	electric

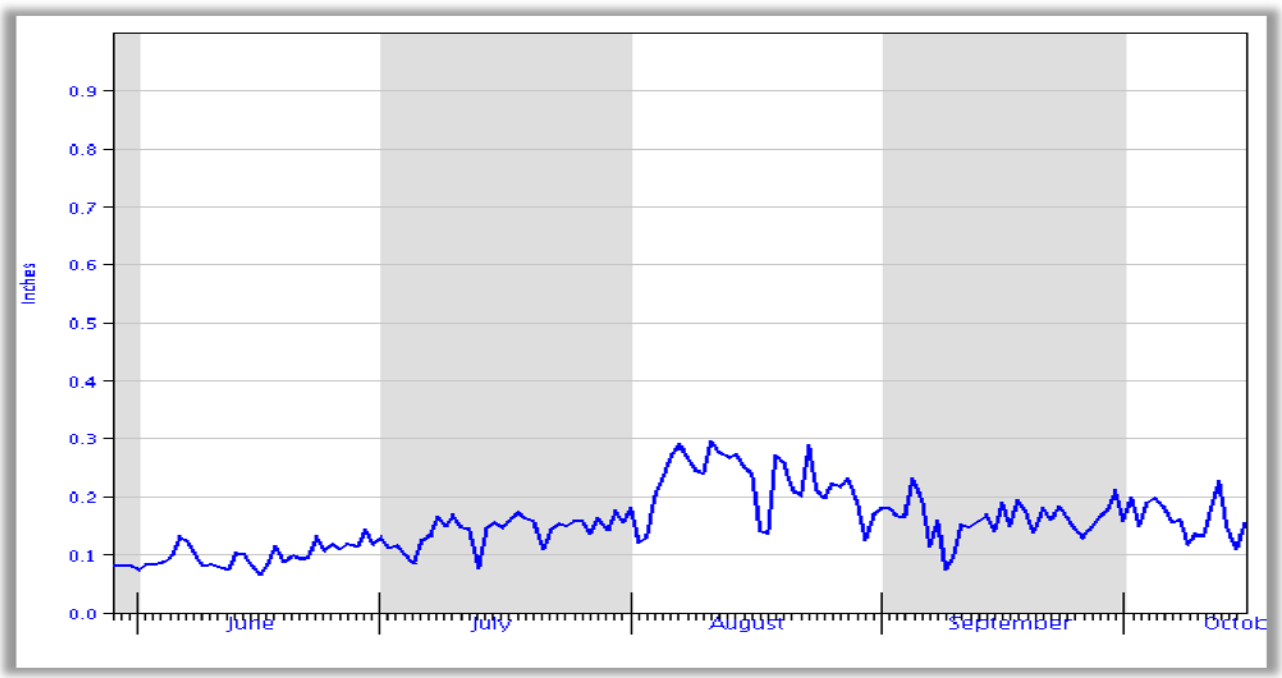



Comments: This is a pivot irrigated cotton and seed millet site. The seed millet comprises one-third of the system and is rotated around the circle. One-third of the cotton is planted following seed millet and one-third following cotton. This producer uses conventional tillage and plants on forty-inch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

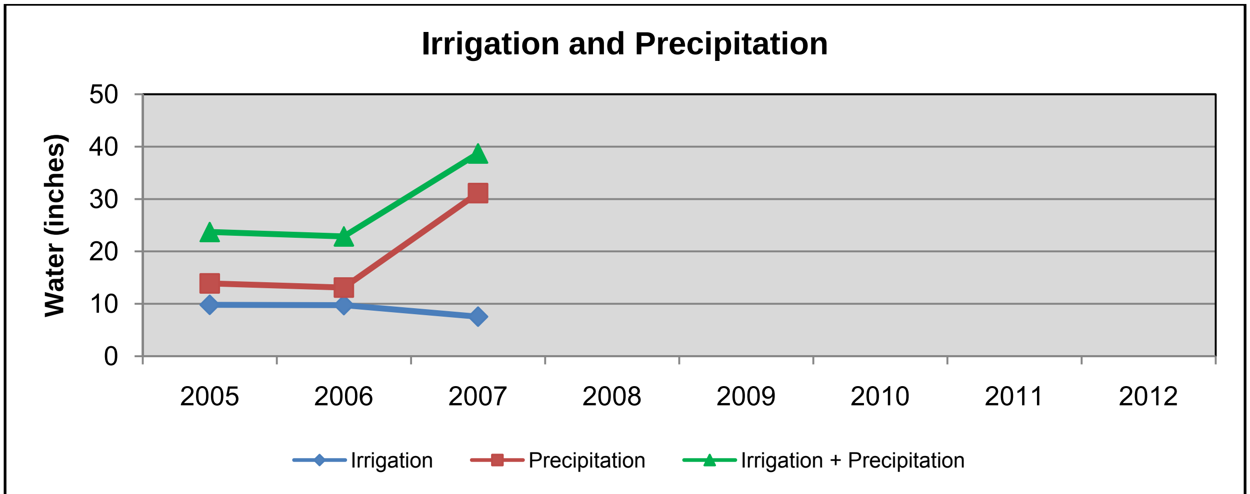
SITE 19 - 5
South Plains Cotton ET
Planted May 15, 2007 Total ET Demand 19.86"

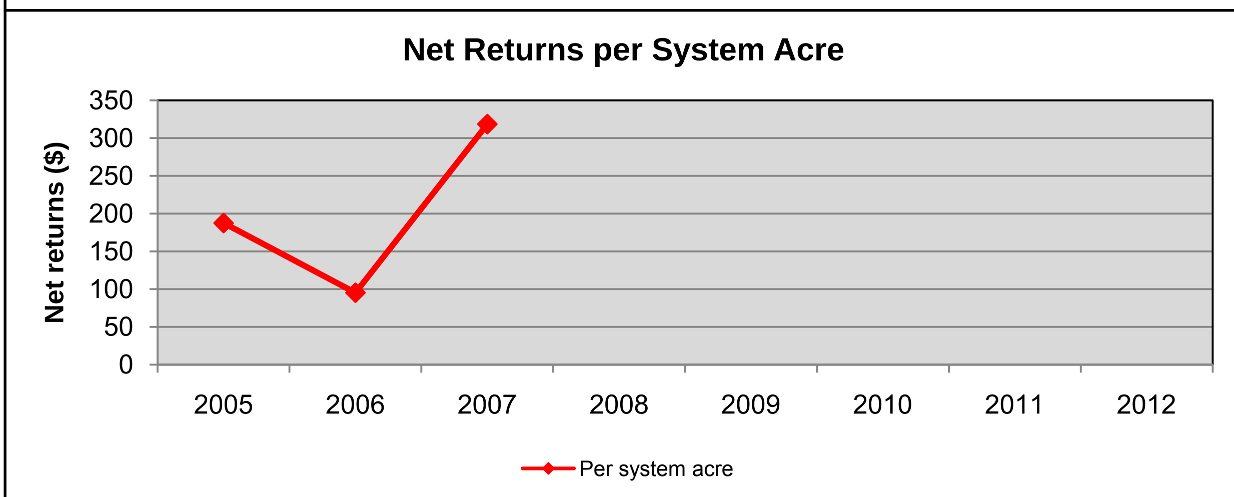


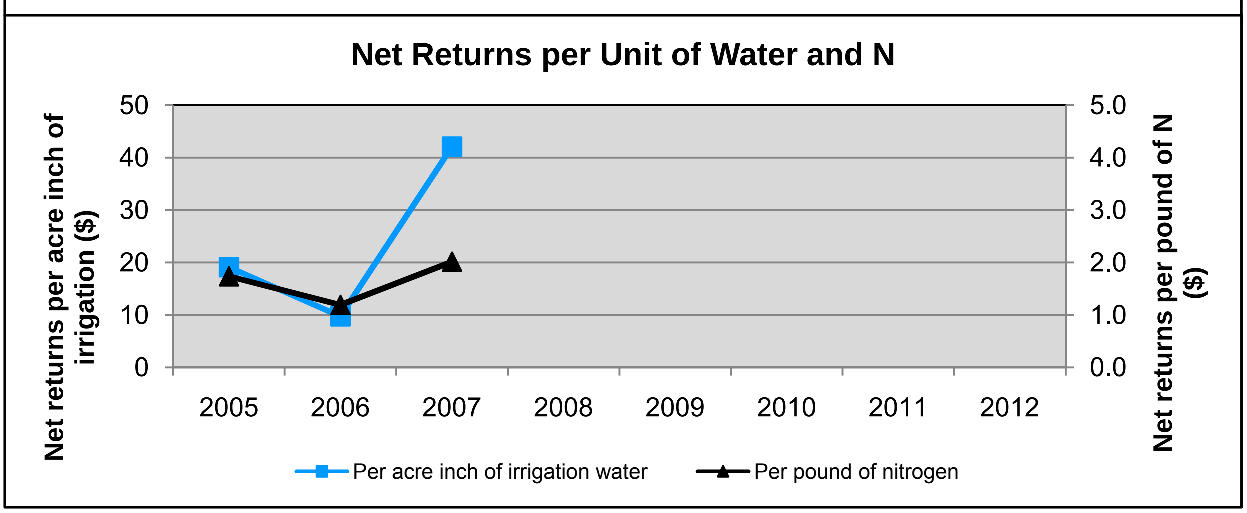
SITE 19 - 6
Millet (Sorghum Coefficient) ET
Planted May 29, 2007 Total ET Demand 20.97"

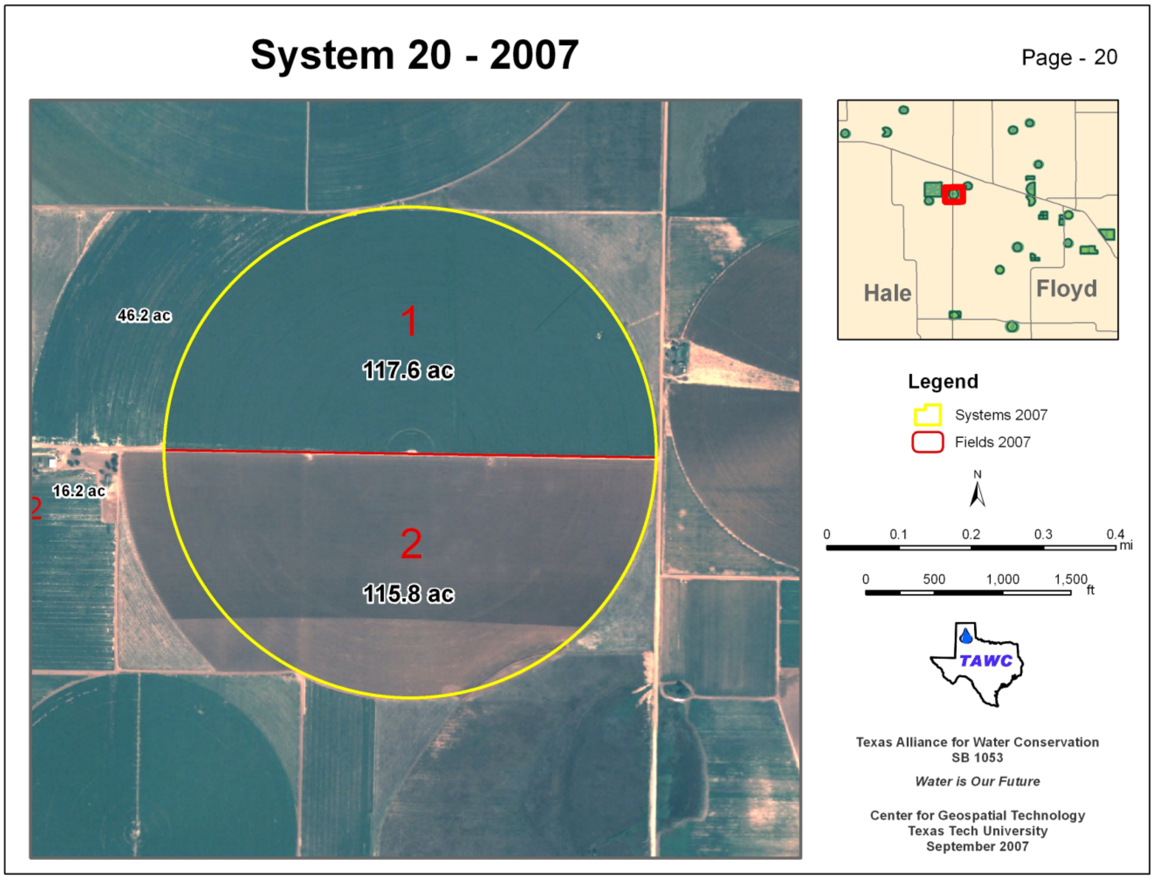


System 19


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


Net Returns per System Acre
Net returns ($)
350
300
250
200
150
100
50
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


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



System 20

Crops	Irrigation	
2007	Type:	Center pivot (LEPA)
Field 1: Triticale for silage, followed by Corn for silage	Pumping capacity, gal/min:	1300
	Number of wells:	3
	Fuel source:	electric

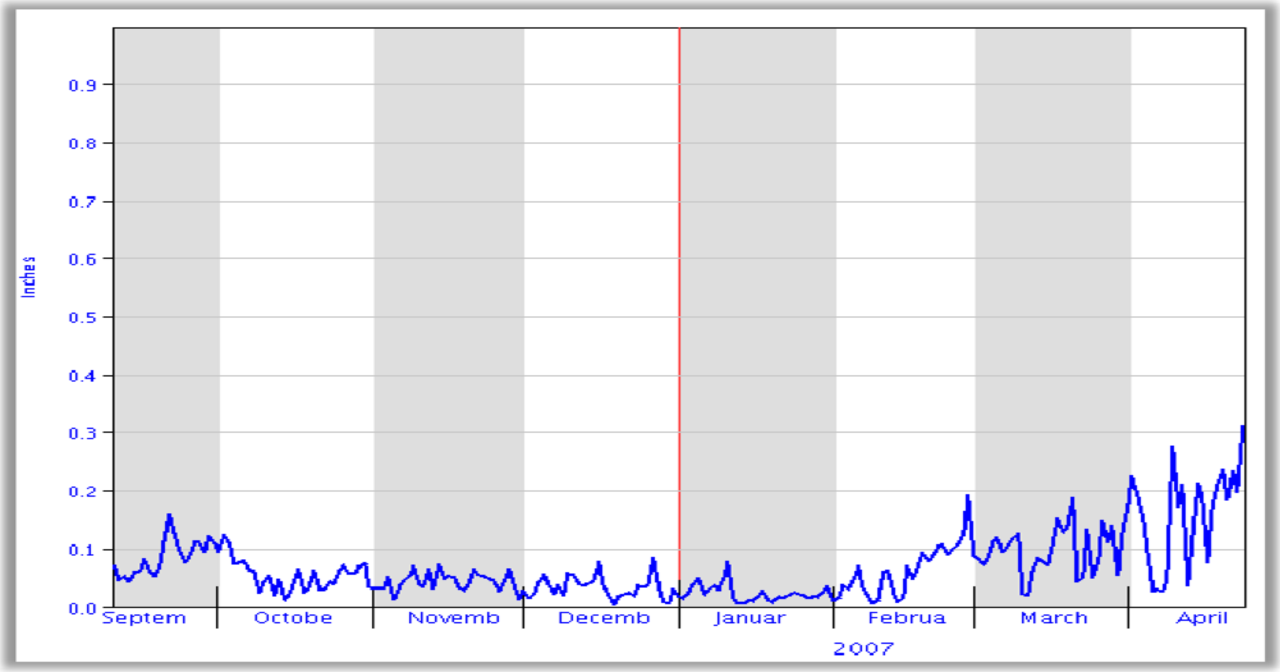
Field 2: Triticale for silage,
followed by Forage Sorghum for silage

2006
Field 1: Corn for silage
Field 2: Triticale for silage followed by Forage Sorghum for silage

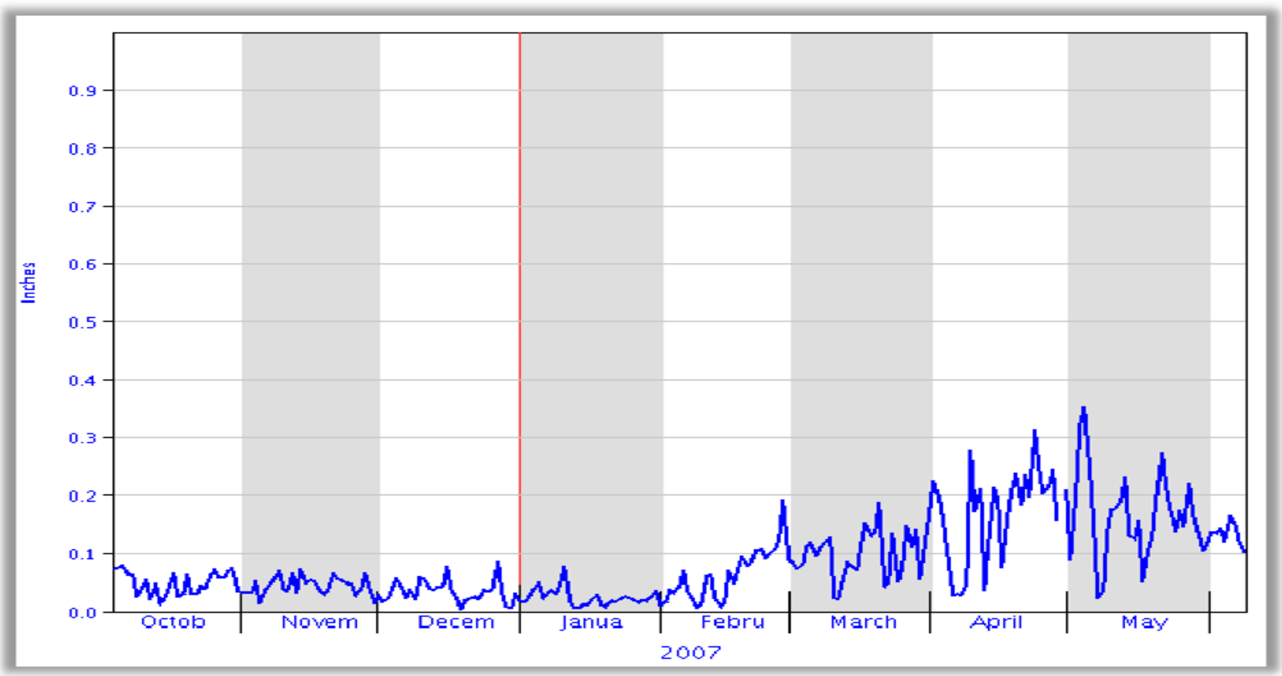
2005
Field 1: Wheat for silage followed by Forage Sorghum for silage
Field 2: Corn for silage

Comments: This is a corn, forage sorghum and triticale site with all crops harvested for silage. Triticale is broadcast planted following corn harvest and forage sorghum is planted no-till on twenty-inch centers following harvest. Corn is planted on twenty-inch centers with conventional tillage.

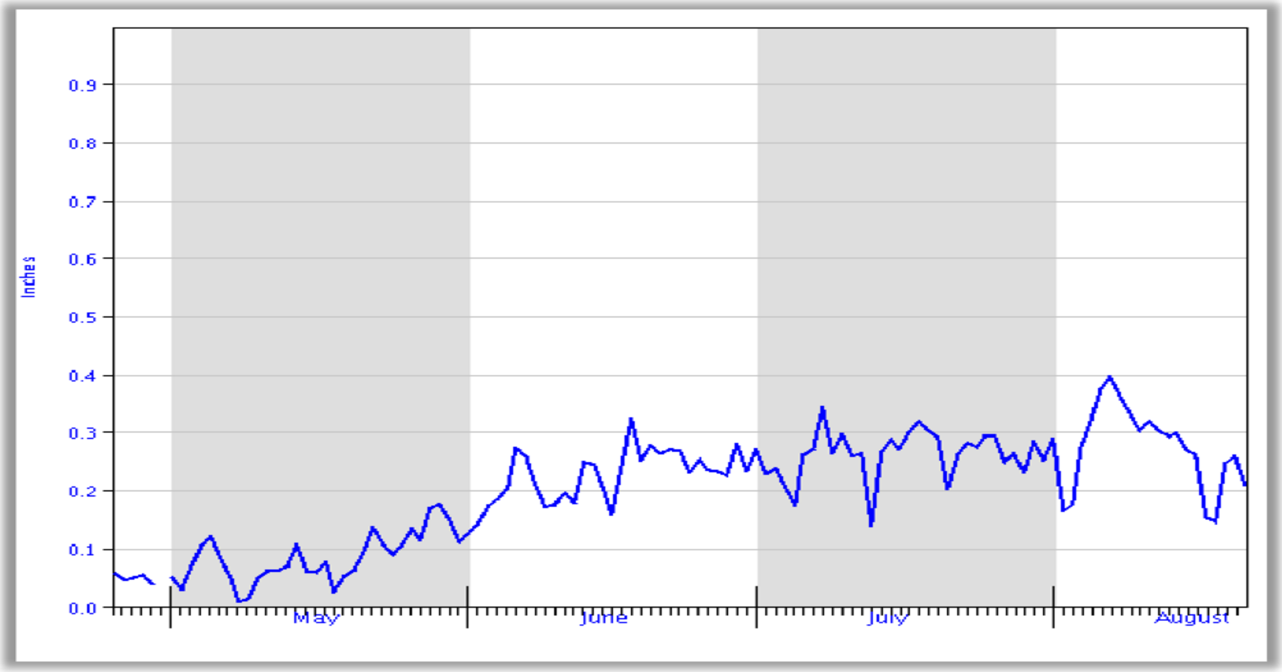
SITE 20 - 1
South Plains Triticale Silage ET
Planted September 9, 2006 Total ET Demand 13.79



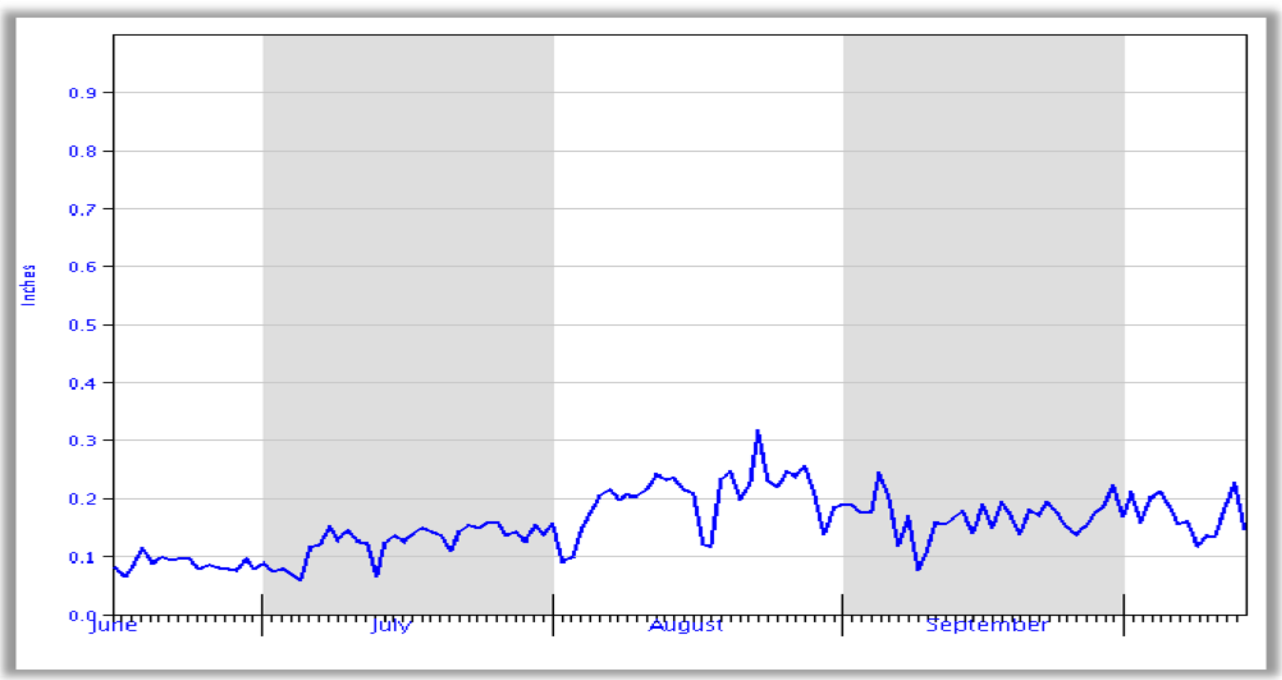
SITE 20 - 2
South Plains Triticale Silage ET
Planted October 4, 2006 Total ET Demand 19.42"



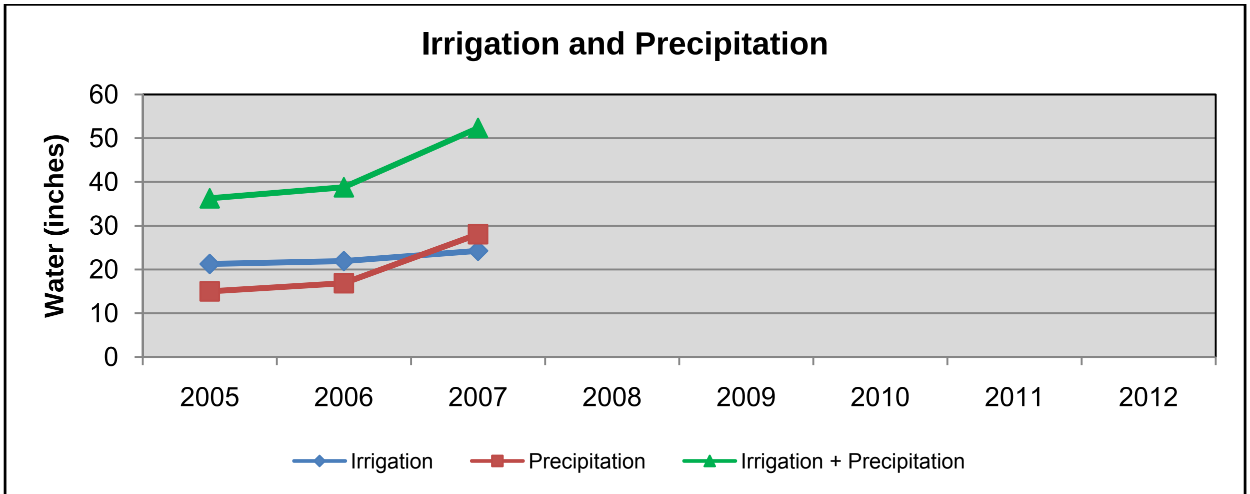
SITE 20 - 1
South Plains Corn Silage ET
Planted April 25, 2007 Total ET Demand 23.15



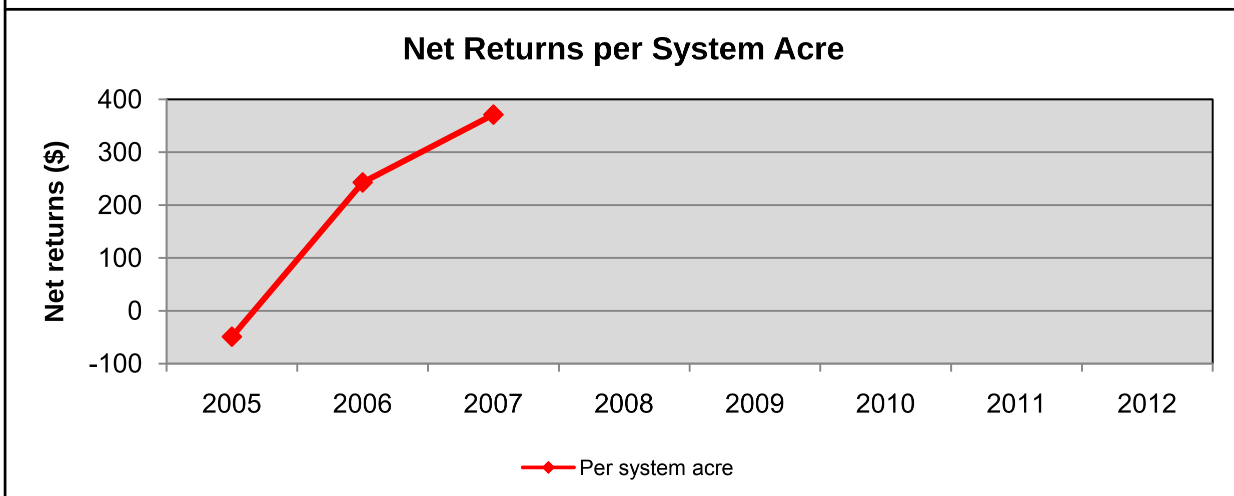
SITE 20 - 2
South Plains Sorghum Silage ET
Planted June 15, 2007 Total ET Demand 18.7"



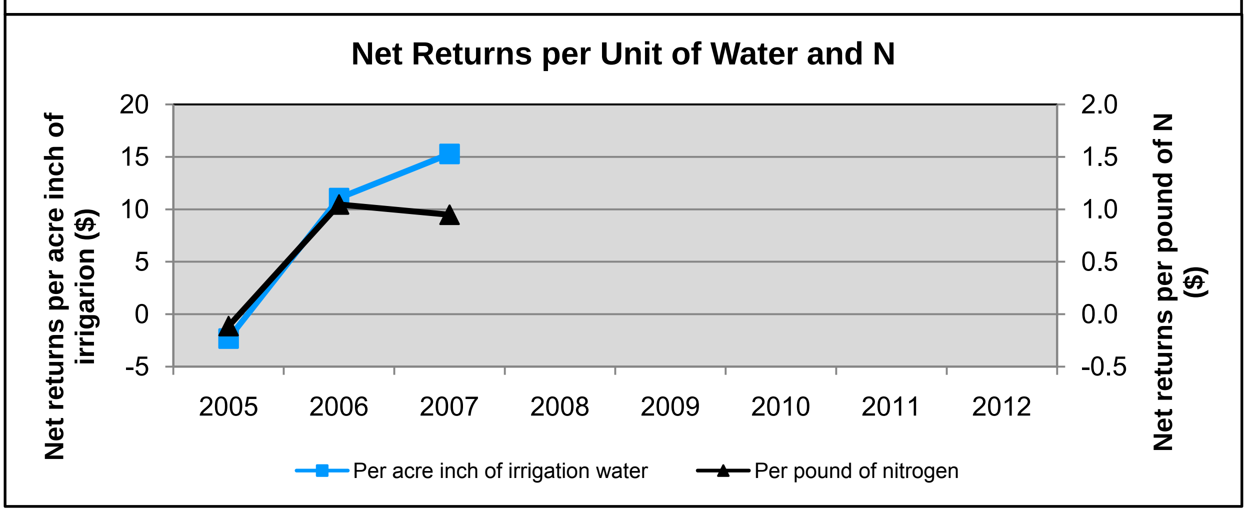
System 20



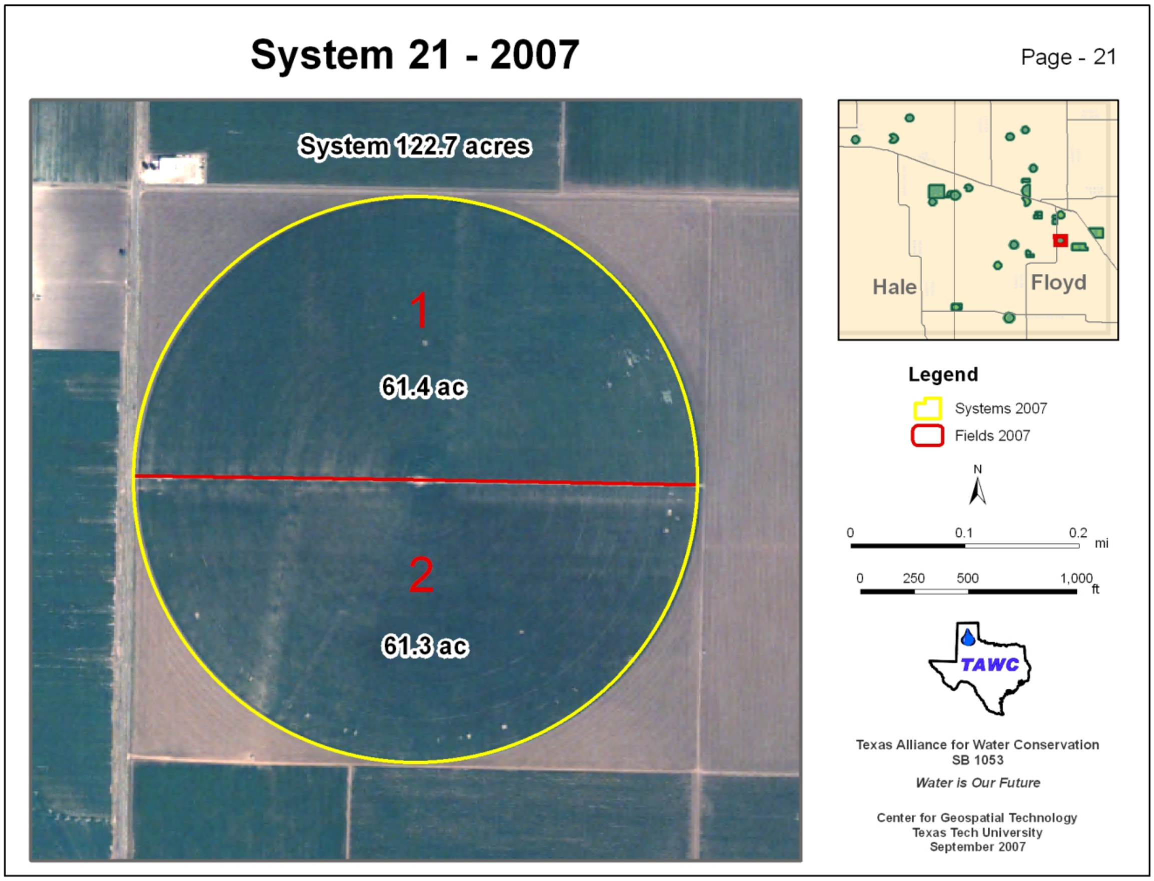
Irrigation and Precipitation
Water (inches)
60
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation



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



Net Returns per Unit of Water and N
Net returns per acre inch of irrigarion ($)
20
15
10
5
0
-5
2.0
1.5
1.0
0.5
0.0
-0.5
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen



System 21

Livestock		Irrigation	
2007:	none	Type:	Center pivot (LEPA)
2006:	Stocker steers	Pumping capacity, gal/min:	500
2005:	none	Number of wells:	1
		Fuel source:	electric

Crops

2007
Field 1: Sideoats grama grass for seed and hay
Field 2: Corn for grain

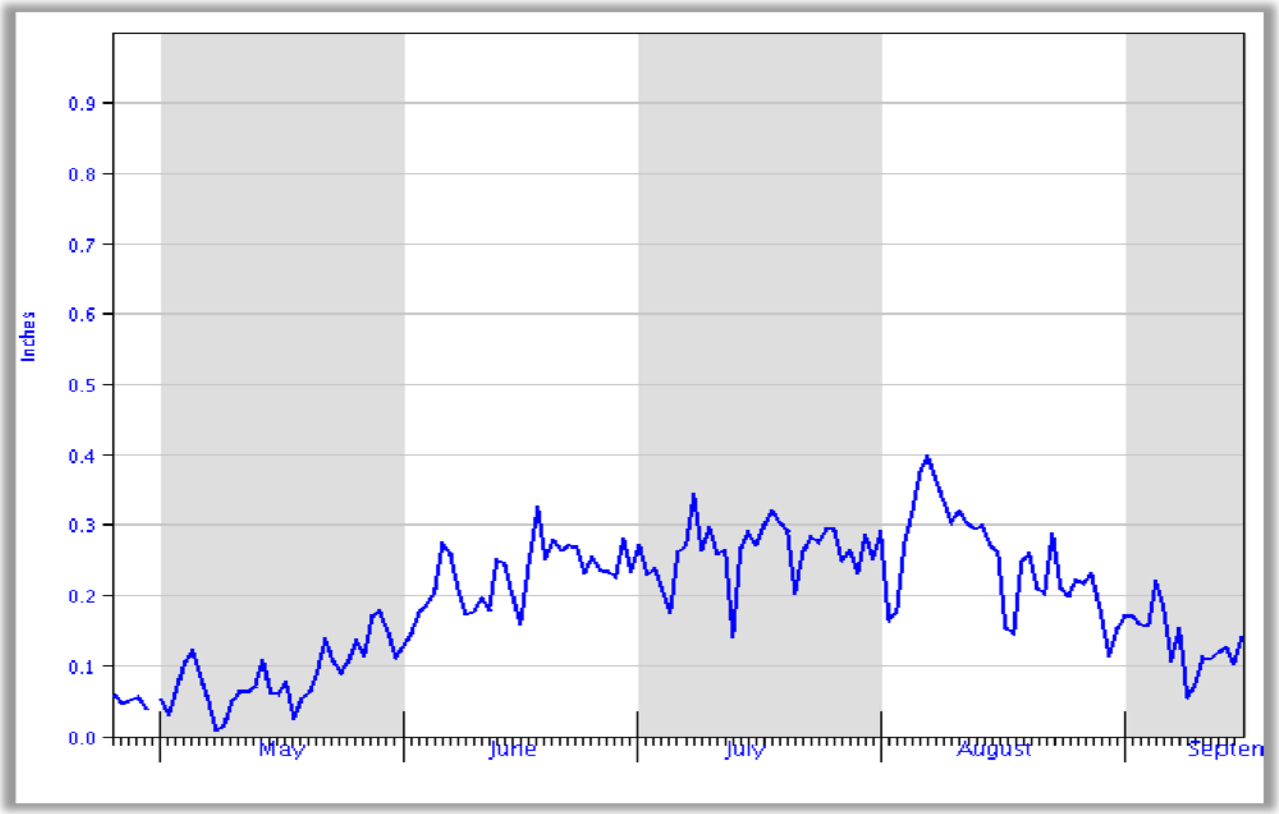
2006
Field 1: Corn for grain
Field 2: Wheat for grazing and cover followed by Cotton

2005
Field 1: Cotton
Field 2: Cotton

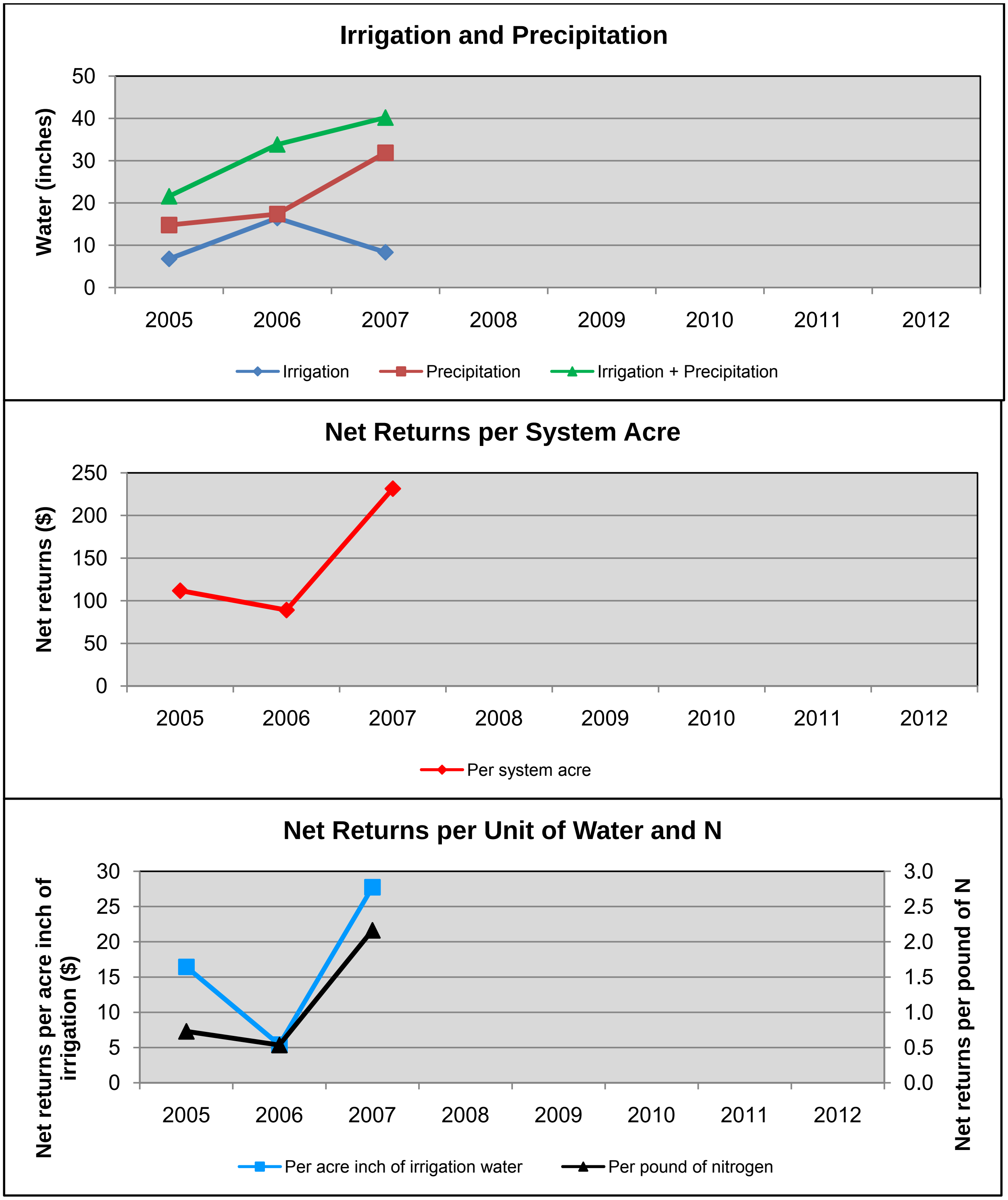



Comments: This is a pivot irrigated corn and side-oats grama site. Following corn harvest in 2007 barley was drilled on one-half of the pivot. The barley will be harvested for seed in 2008.

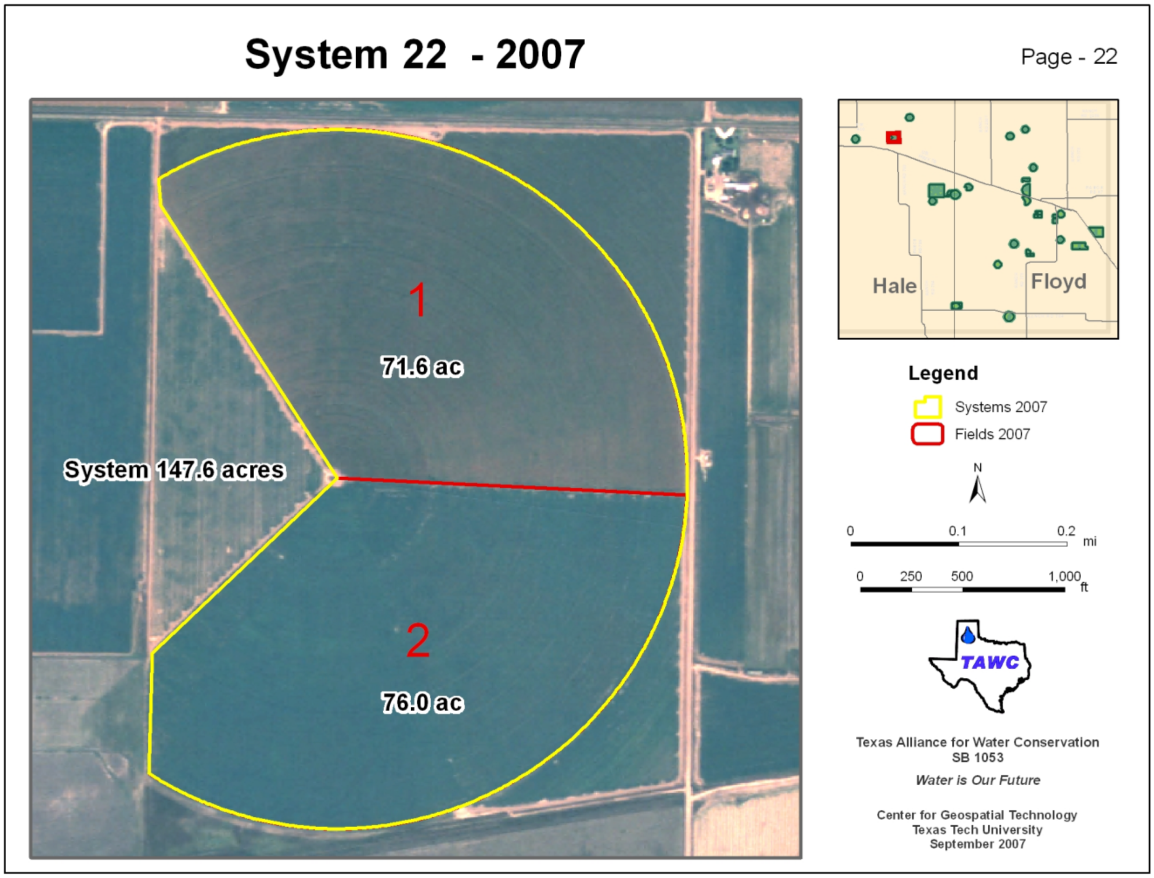
SITE 21 - 2
South Plains Corn ET
Planted April 25, 2007 Total ET Demand 27.25



System 21



Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation
Net Returns per System Acre
Net returns ($)
250
200
150
100
50
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre
Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
30
25
20
15
10
5
0
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Net returns per pound of N
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen



System 22

<u>Crops</u>

2007

Field 1: Cotton following Wheat cover crop
Field 2: Cotton

2006

Field 1: Cotton
Field 2: Corn for grain

2005

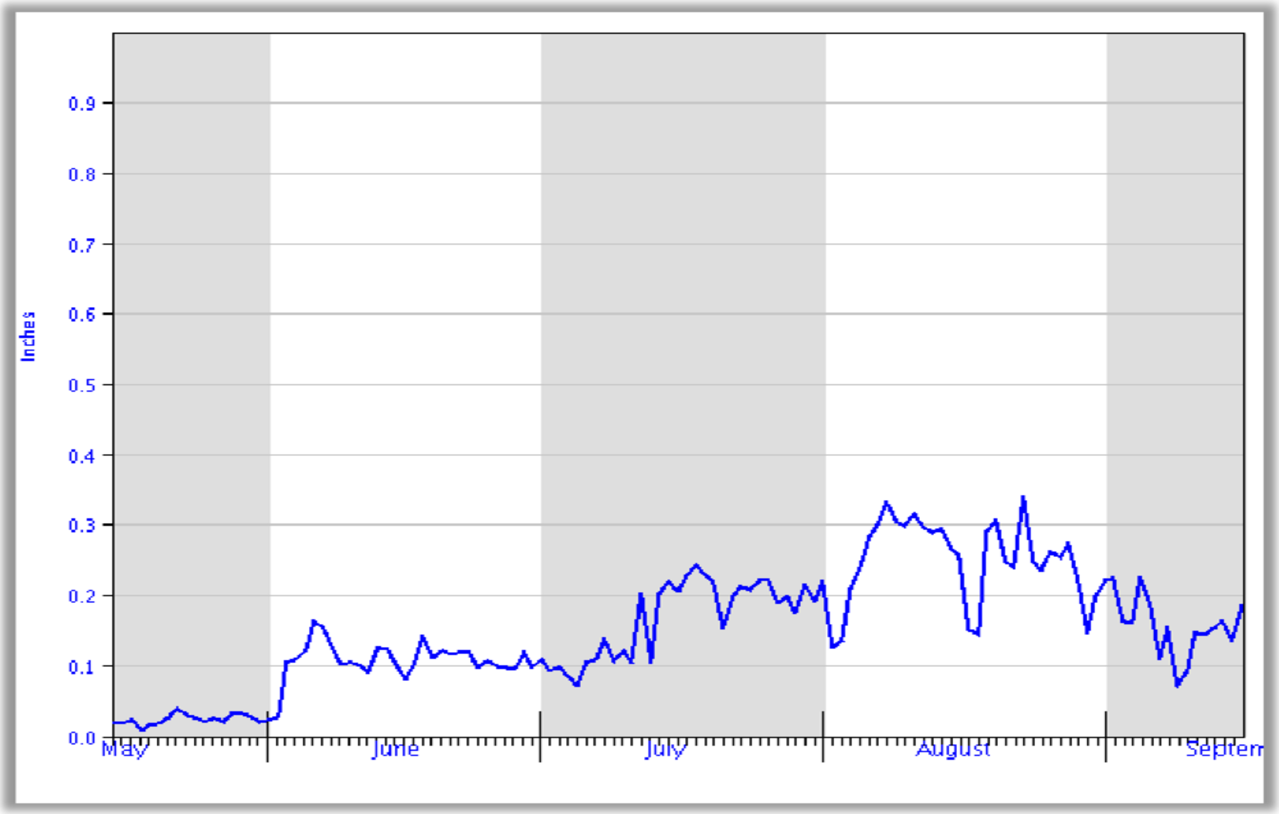
Field 1: Corn for grain
Field 2: Cotton

<u>Irrigation</u>

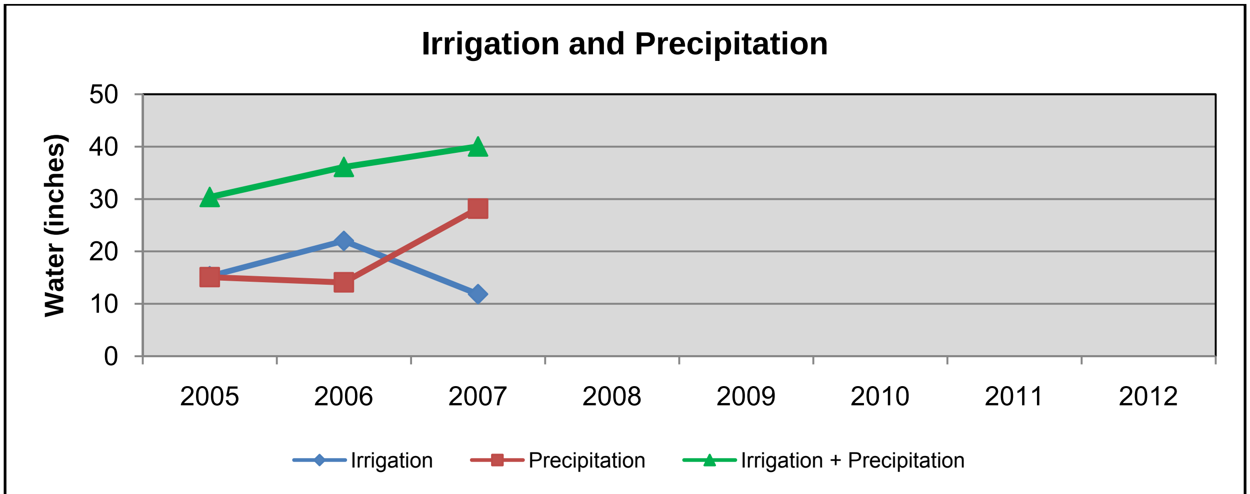
Type:	Center pivot (LEPA)
Pumping capacity, gal/min:	800
Number of wells:	4
Fuel source:	electric

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

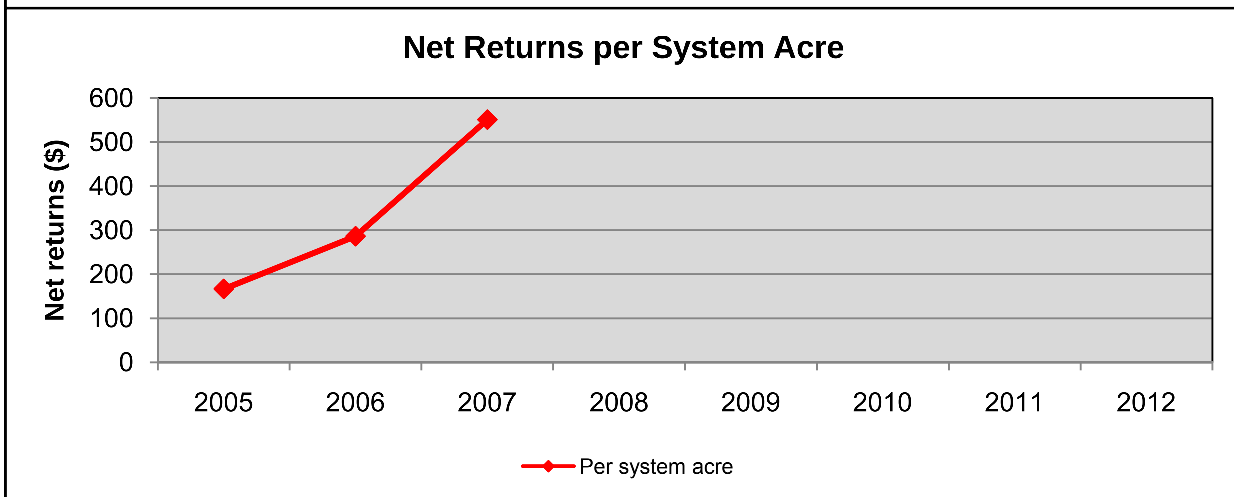
SITE 22 - 1
South Plains Cotton ET
Planted May 15, 2007 Total ET Demand 19.83



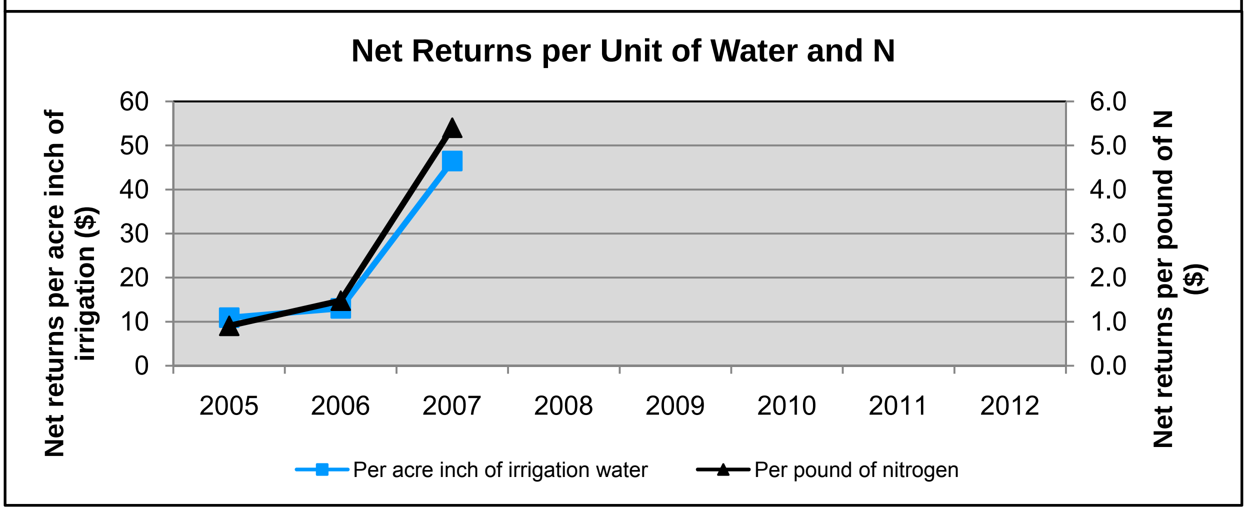
System 22



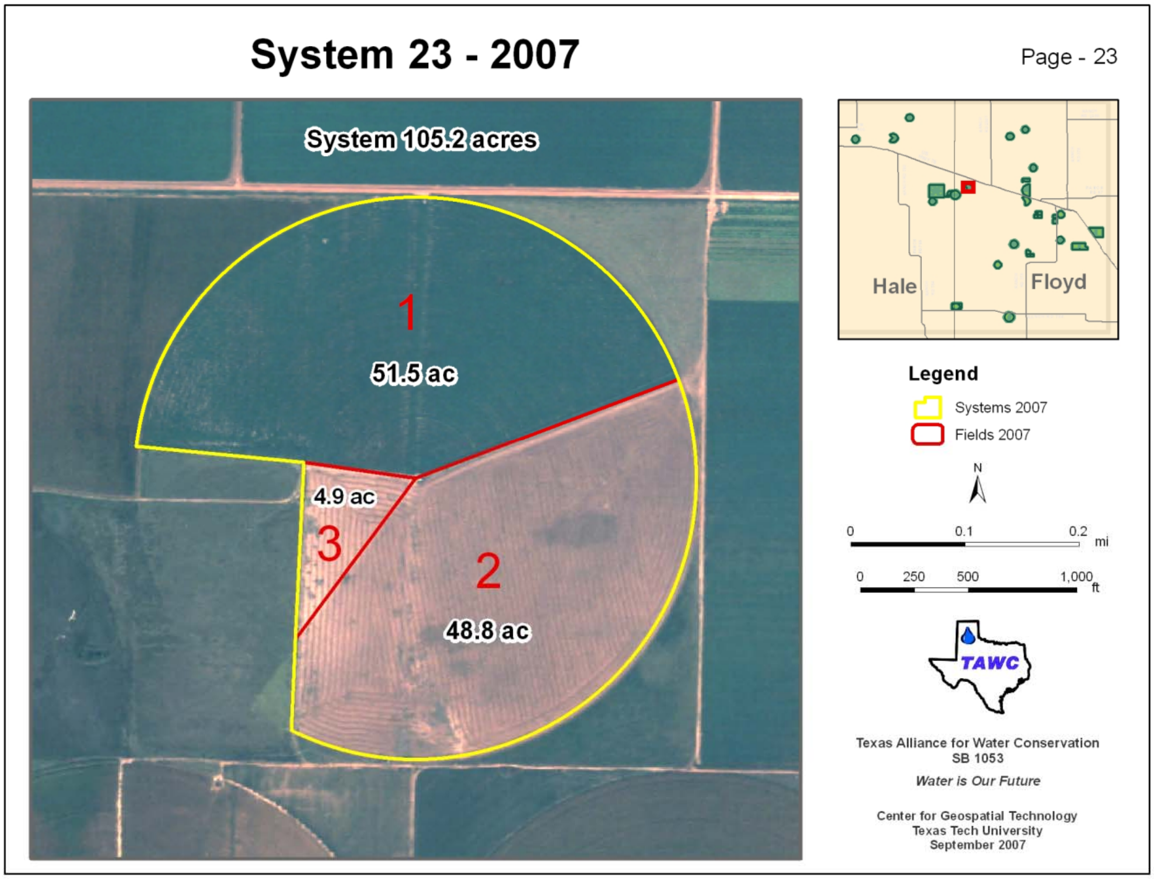
Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation



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



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



System 23

Crops	Irrigation	
2007	Type:	Center pivot (LESA)
Field 1: Corn for grain	Pumping capacity, gal/min:	800
Field 2: Corn for grain	Number of wells:	2
Field 3: Corn for grain	Fuel source:	1 natural gas; 1 diesel

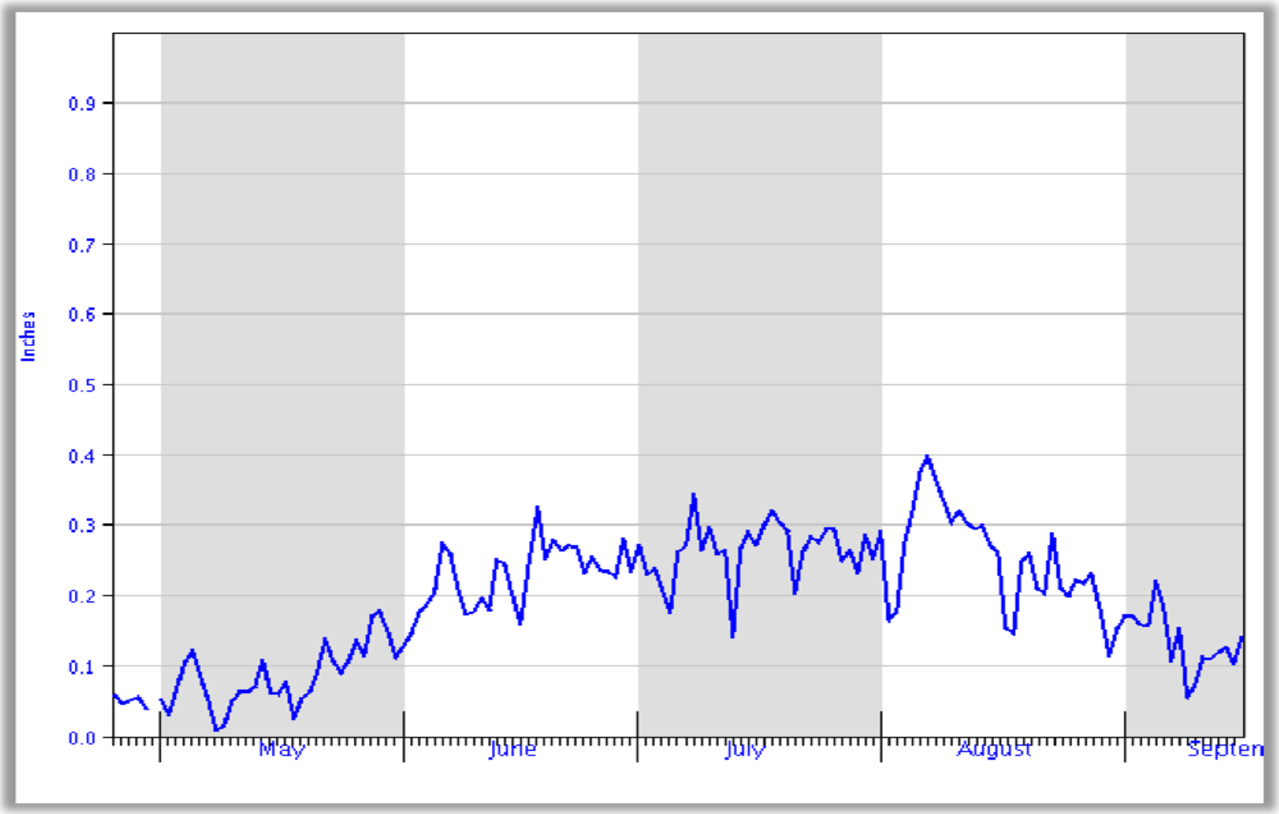
2006
Field 1: Cotton
Field 2: Corn for grain
Field 3: Cotton

2005
Field 1: Cotton
Field 2: Sunflowers for seed
Field 3: Sunflowers for seed

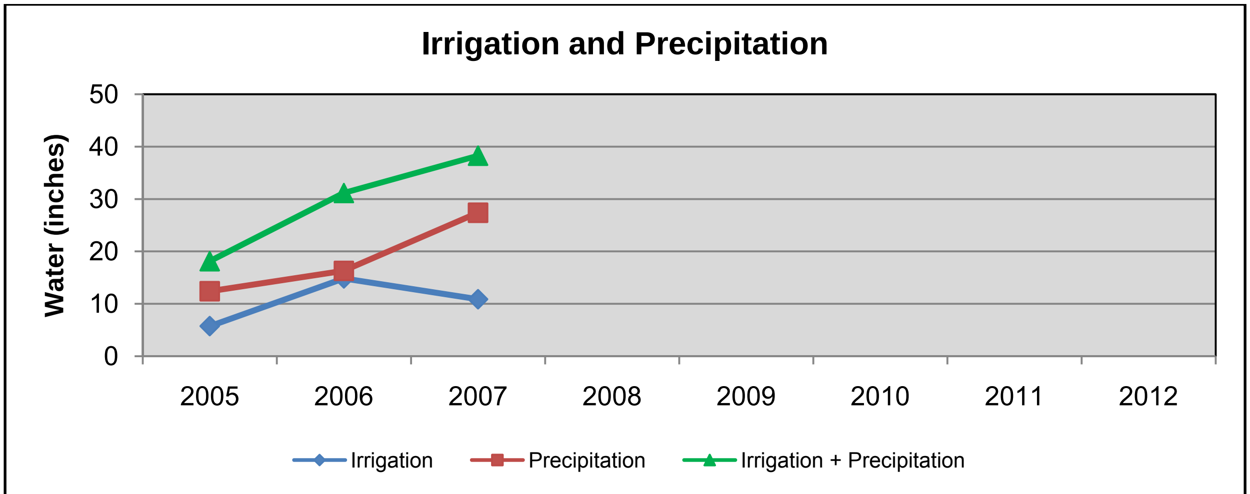


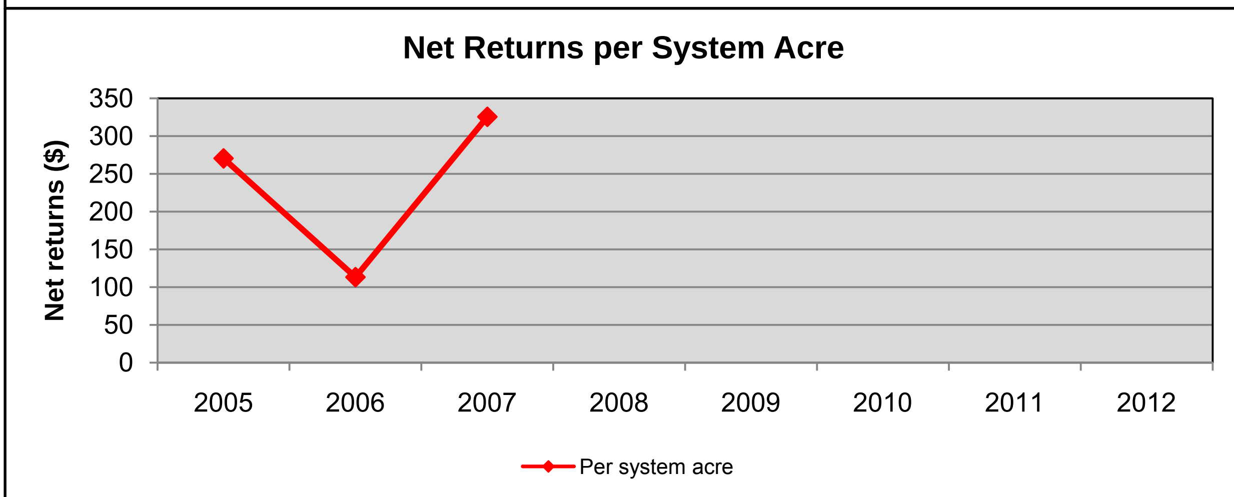

Comments: This has been a pivot irrigated corn and cotton system. In 2007 the entire pivot was planted to food corn on twenty-inch centers.

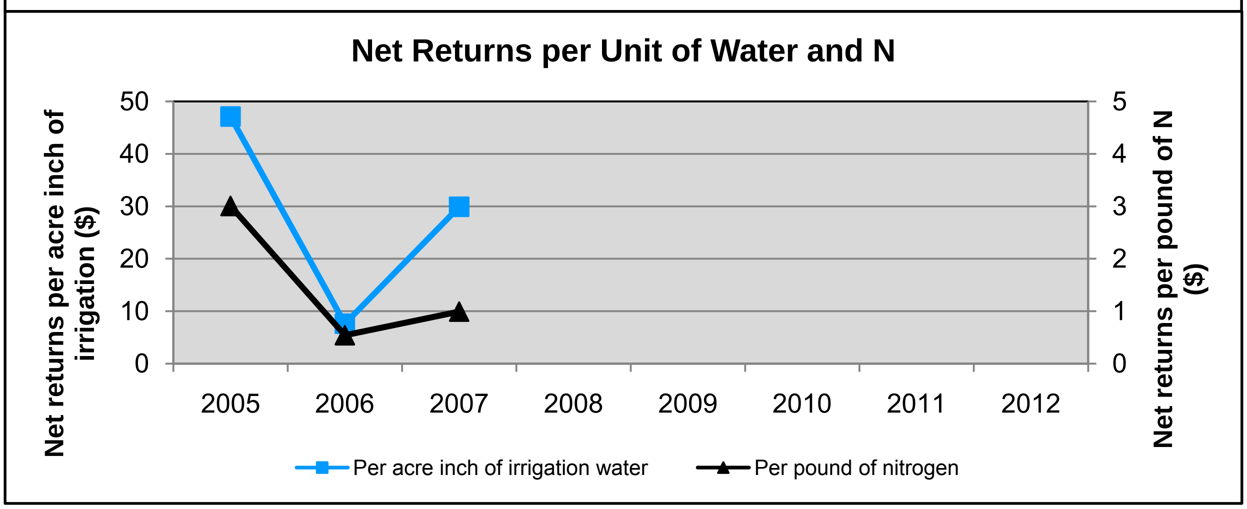
SITE 23 - 1
South Plains Corn ET
Planted April 26, 2007 Total ET Demand 27.20"

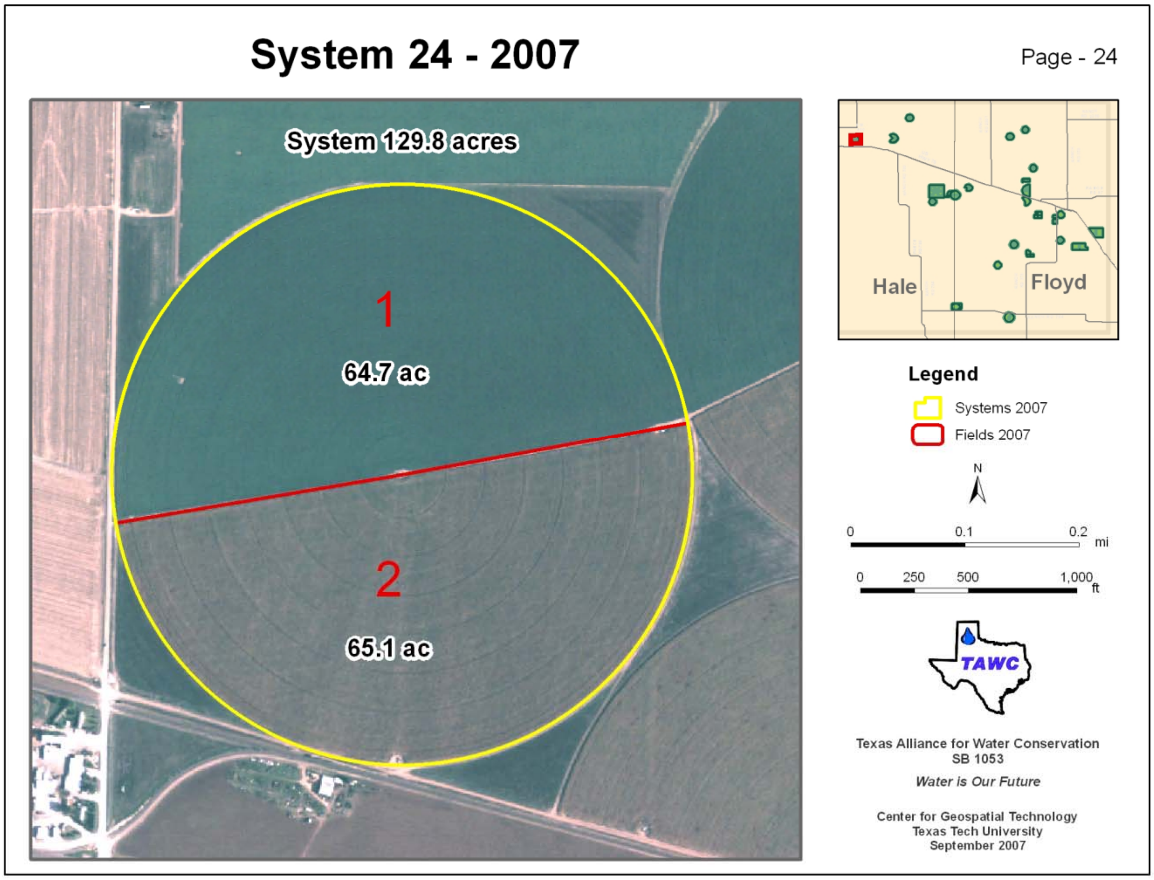


System 23


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


Net Returns per System Acre
Net returns ($)
350
300
250
200
150
100
50
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
50
40
30
20
10
0
5
4
3
2
1
0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen



System 24

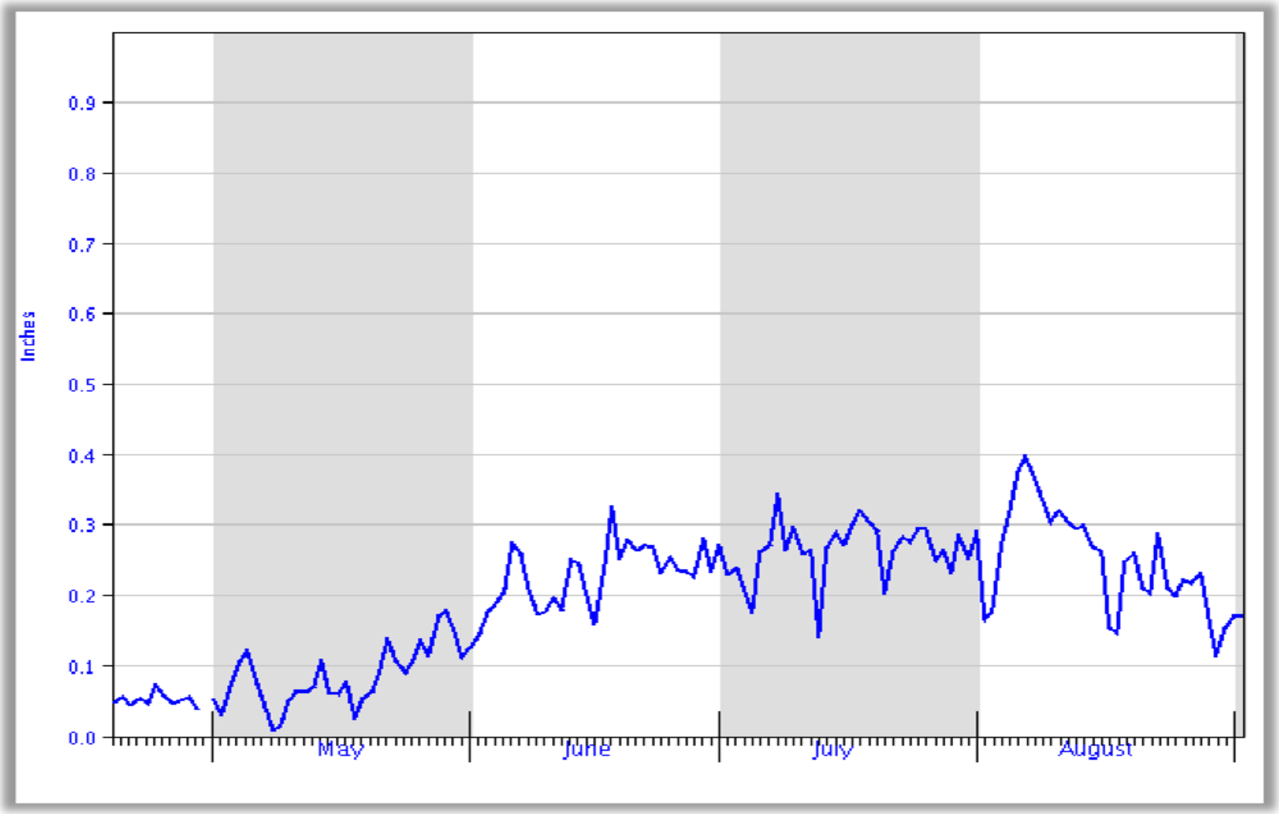
Crops	Irrigation	
2007	Type:	Center pivot (LESA)
Field 1: Corn for grain	Pumping capacity, gal/min:	700
Field 2: Corn for grain	Number of wells:	1
	Fuel source:	diesel

2006
Field 1: Corn for silage
Field 2: Cotton

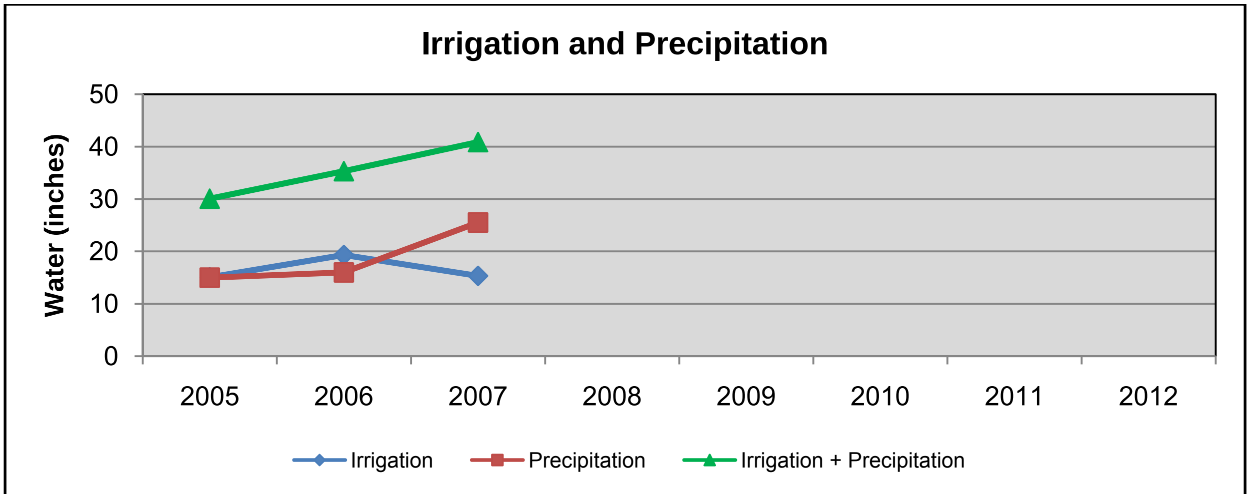
2005
Field 1: Cotton
Field 2: Corn for grain

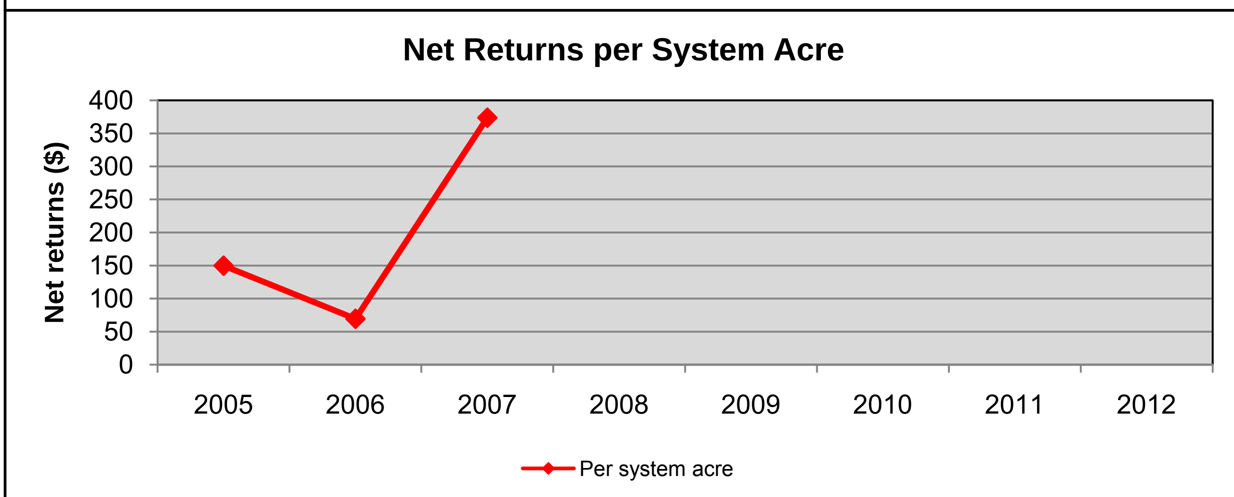
Comments: This has been a corn and cotton system using pivot irrigation. In 2007 white food corn was planted on twenty-inch centers on the entire pivot using conventional till.

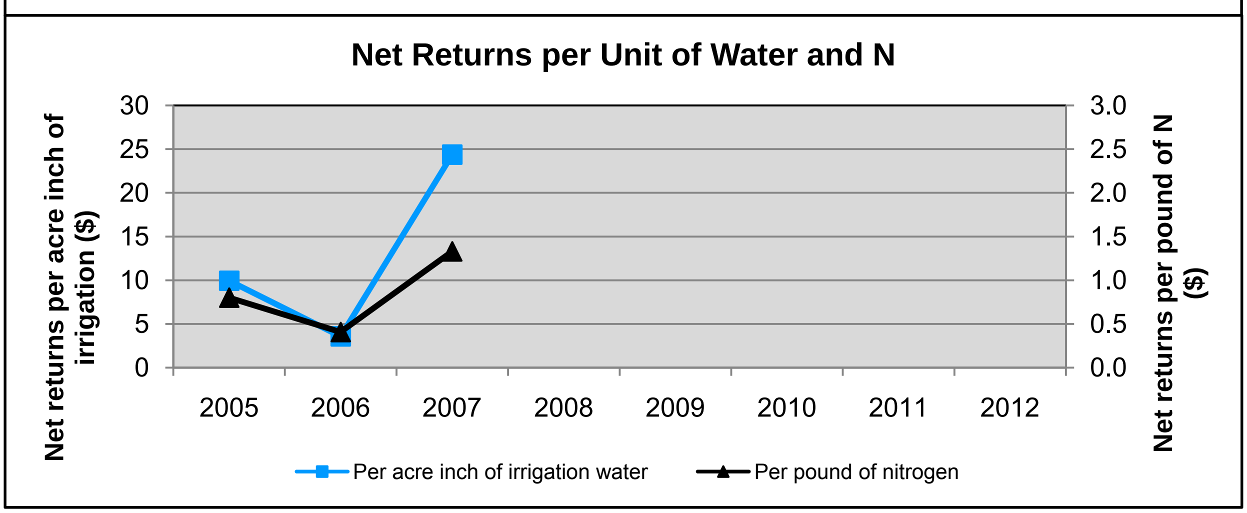
SITE 24 - 1
South Plains Corn ET
Planted April 19, 2007 Total ET Demand 27.03"

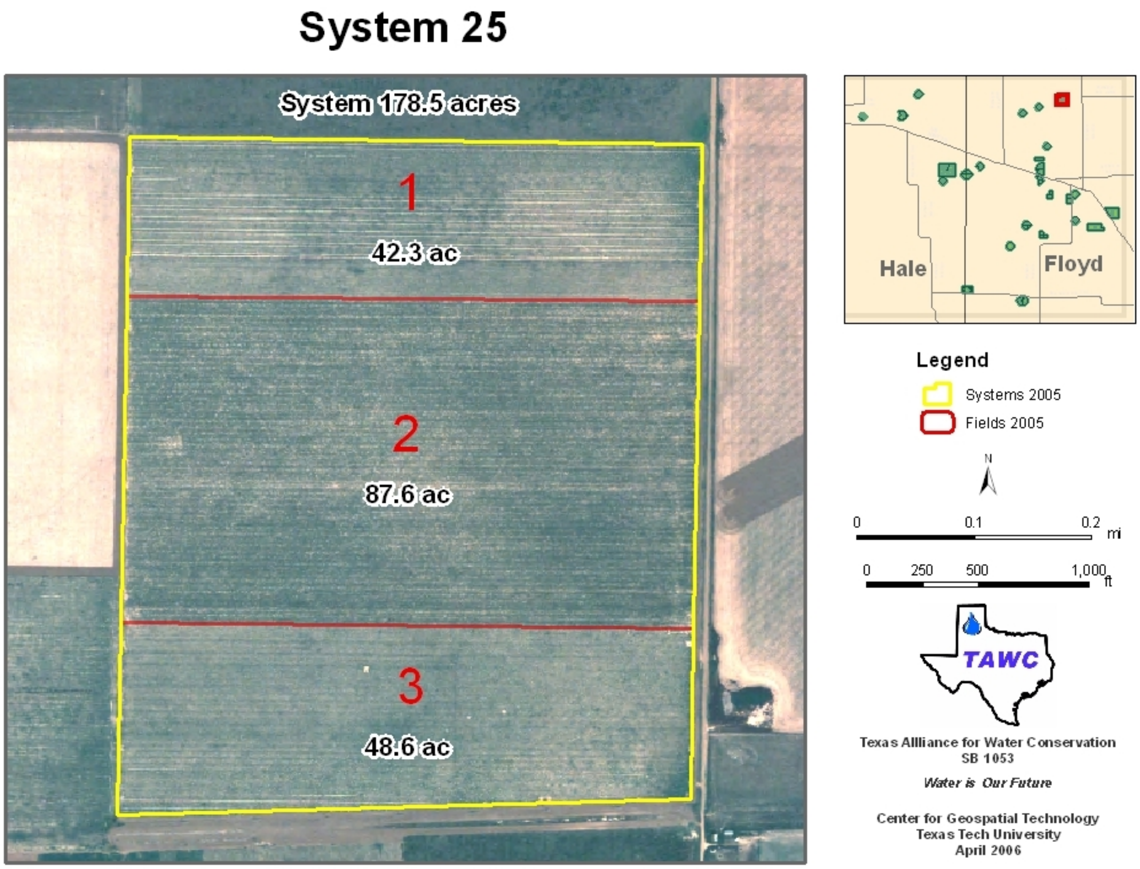


System 24


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


Net Returns per System Acre
Net returns ($)
400
350
300
250
200
150
100
50
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
30
25
20
15
10
5
0
2005
2006
2007
2008
2009
2010
2011
2012
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Net returns per pound of N ($)
Per acre inch of irrigation water
Per pound of nitrogen



SYSTEM 25

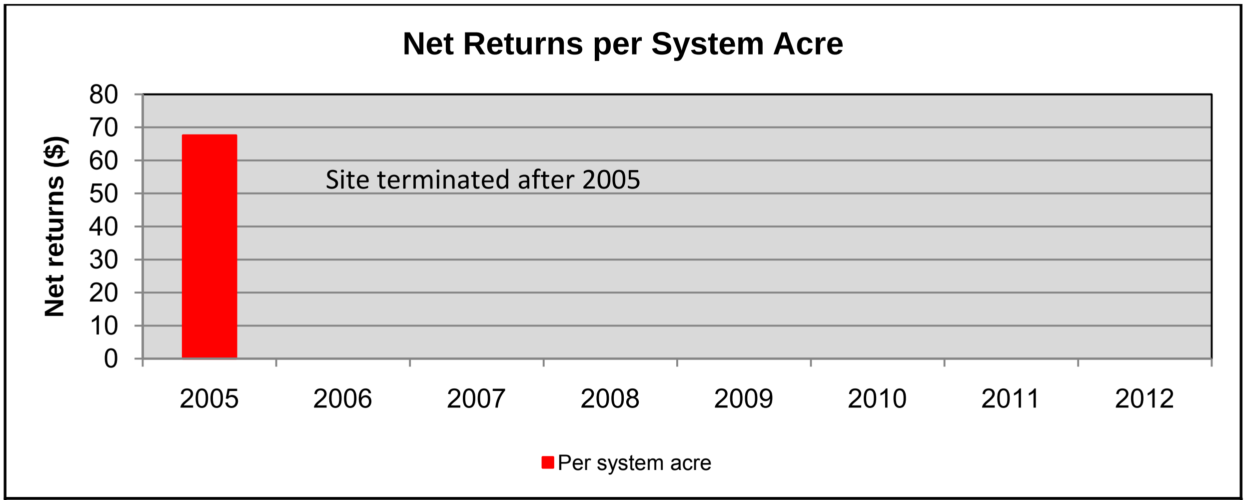
<u>Crops</u>
2006
Site terminated in 2006.

2005
Field 1: Cotton
Field 2: Grain Sorghum
Field 3: Cotton

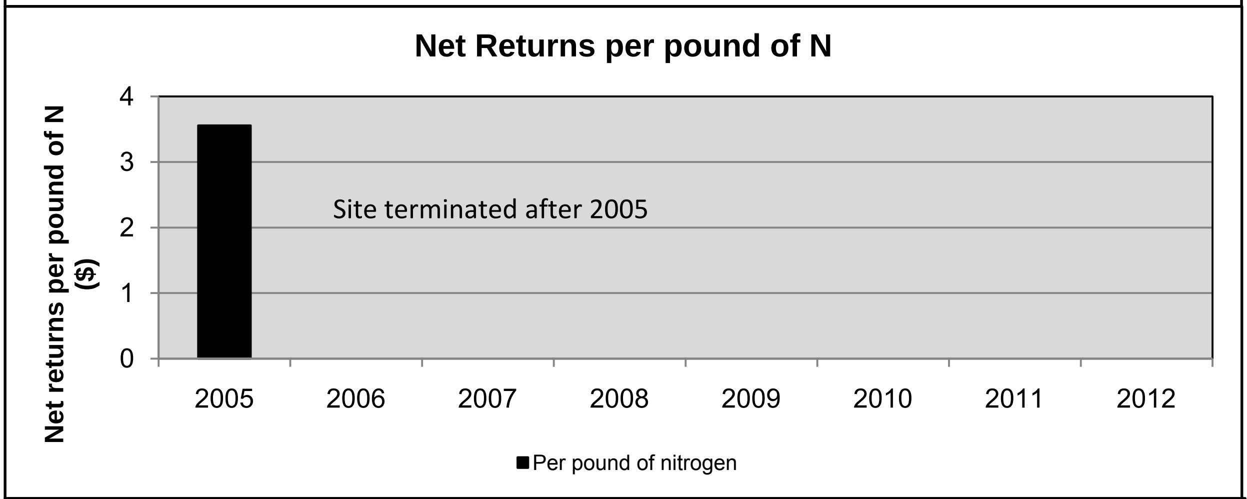
<u>Irrigation</u>
Type: Dryland

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.

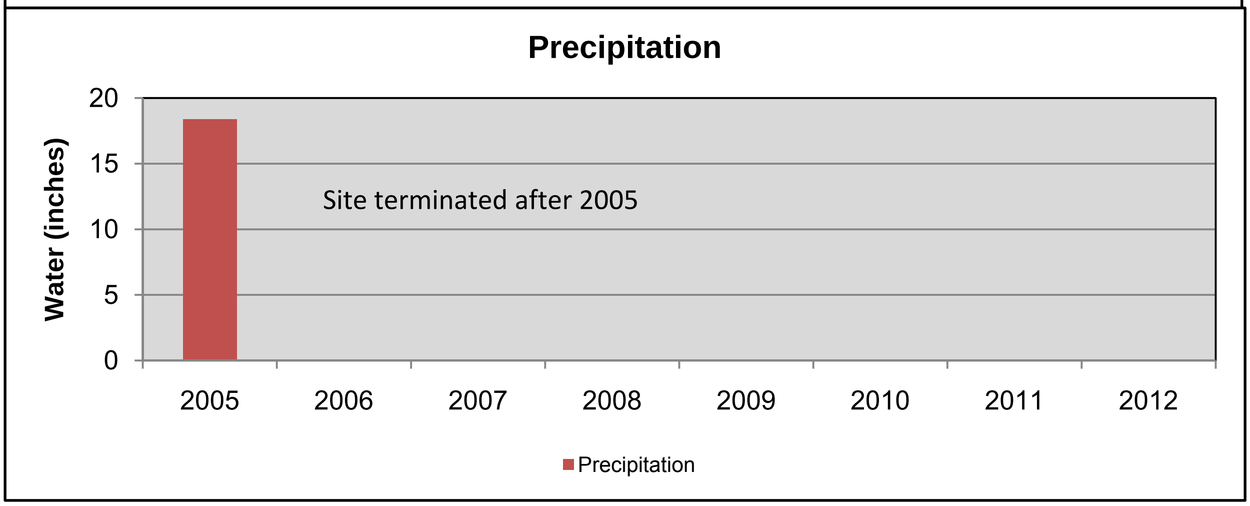
System 25



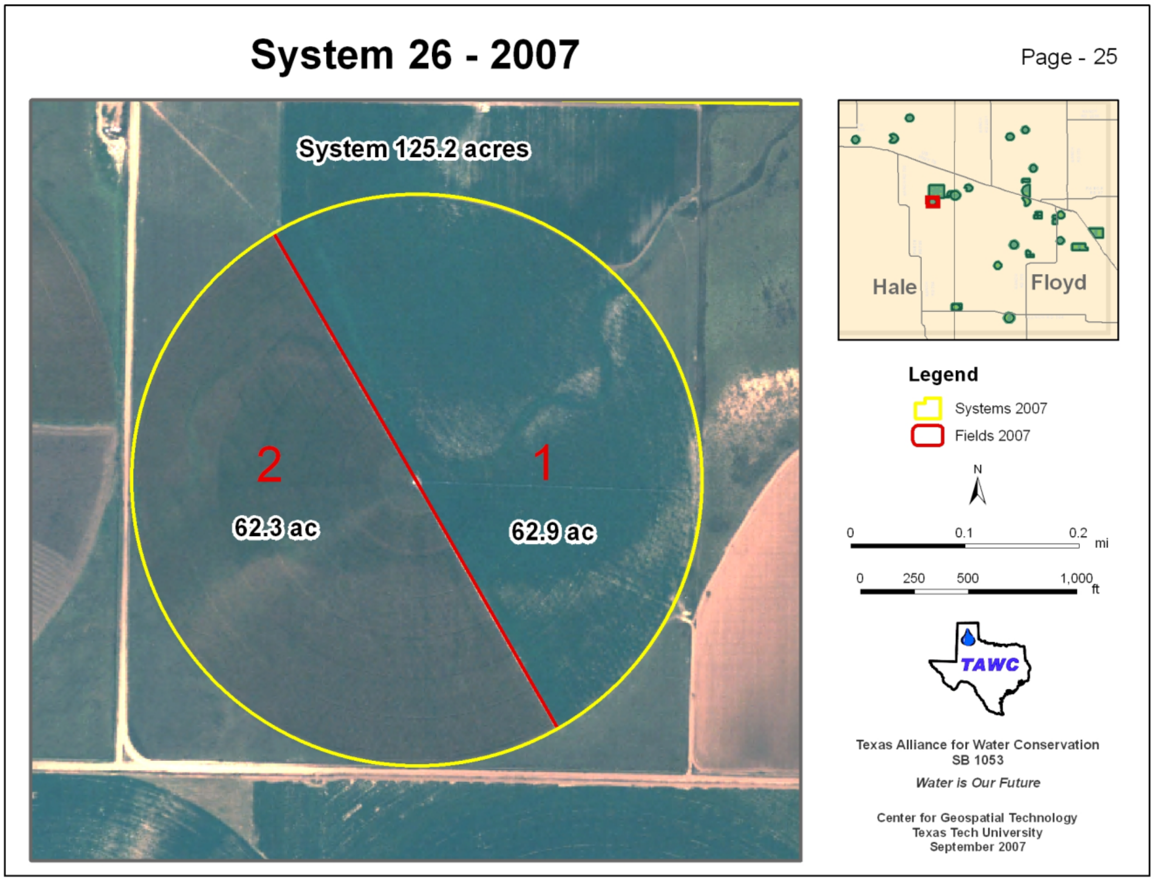
Net Returns per System Acre
Net returns ($)
80
70
60
50
40
30
20
10
0
Site terminated after 2005
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre



Net Returns per pound of N
Net returns per pound of N ($)
4
3
2
1
0
Site terminated after 2005
2005
2006
2007
2008
2009
2010
2011
2012
Per pound of nitrogen



Precipitation
Water (inches)
20
15
10
5
0
Site terminated after 2005
2005
2006
2007
2008
2009
2010
2011
2012
Precipitation



System 26

<u>Livestock</u>
2007: Cow-calf
2006: None
2005: None

<u>Irrigation</u>

Type:	Center pivot (LESA)
Pumping capacity, gal/min:	600
Number of wells:	2
Fuel source:	1 electric, 1 diesel

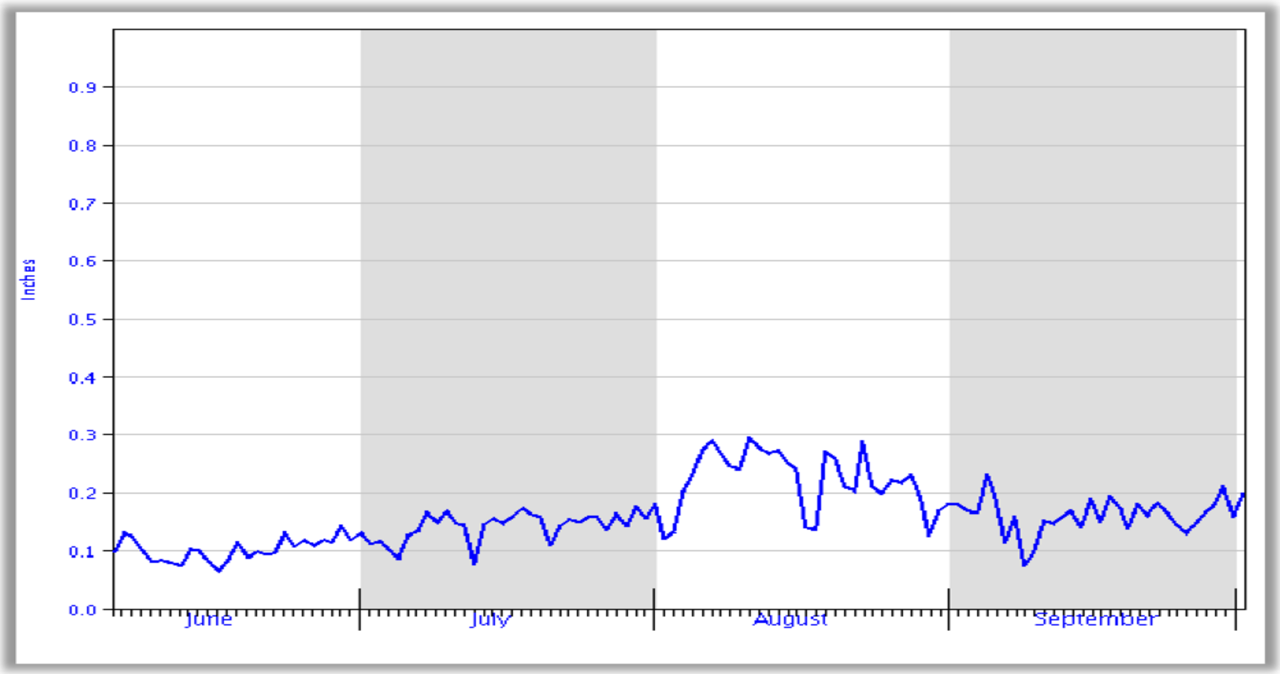
<u>Crops</u>
2007
Field 1: Corn for grain
Field 2: Pearl Millet for seed and grazing of residue

2006
Field 1: Corn for grain
Field 2: Cotton

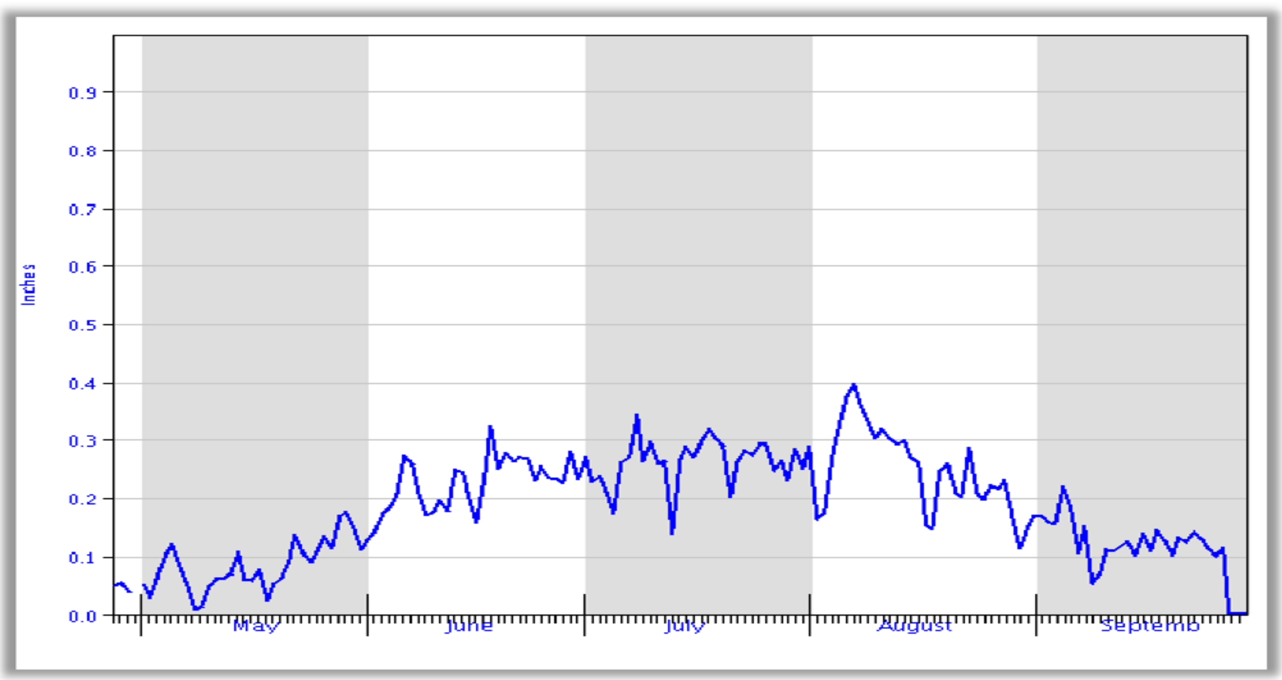
2005
Field 1: Cotton
Field 2: Corn for grain

Comments: This is a corn and seed millet pivot irrigated site. Seed millet was planted on twenty-inch centers following 2006 corn. Corn is planted on twenty-inch centers with both crops using conventional tillage.

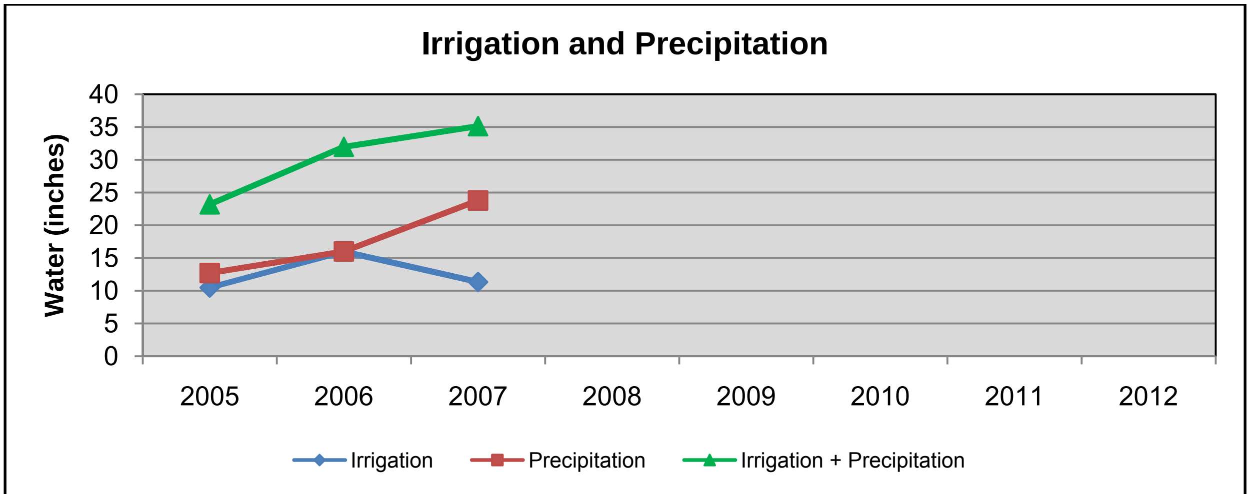
SITE 26 - 1
Millet (Sorghum Coefficient) ET
Planted June 5, 2007 Total ET Demand 18.89"



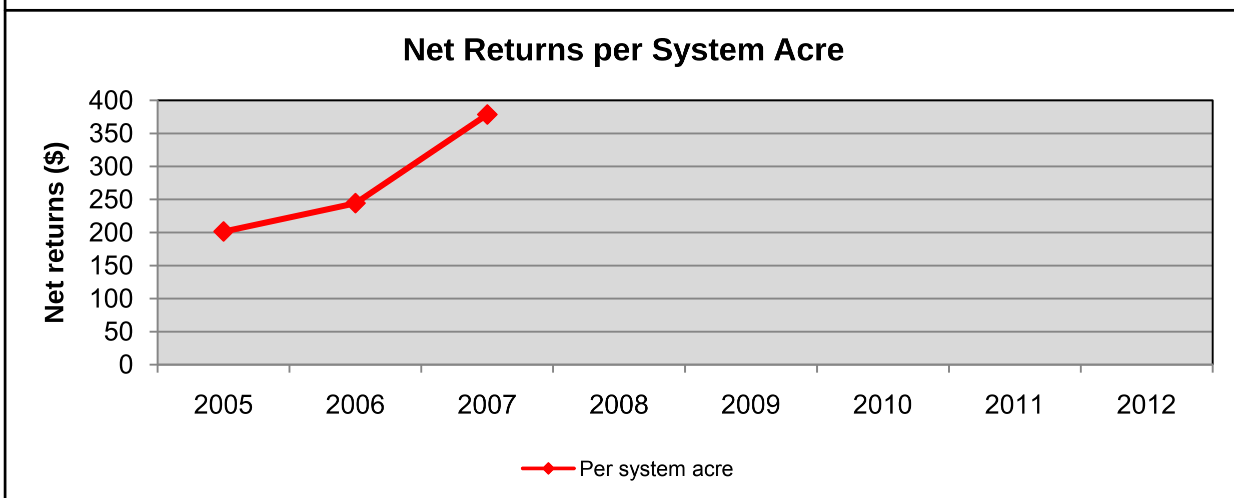
SITE 26 - 2
South Plains Corn ET
Planted April 27, 2007 Total Et Demand 27.65



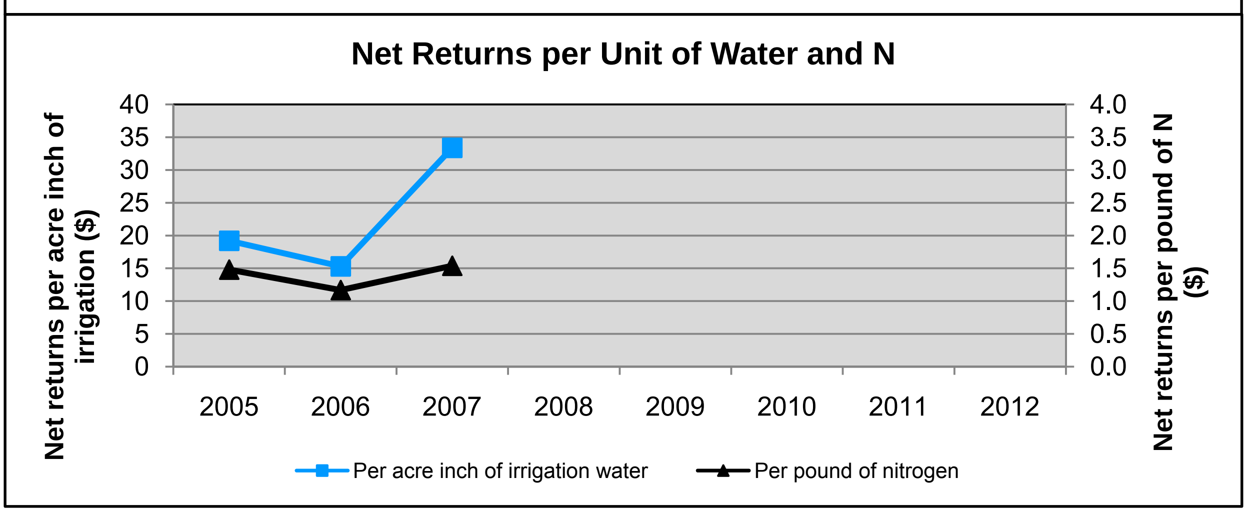
System 26



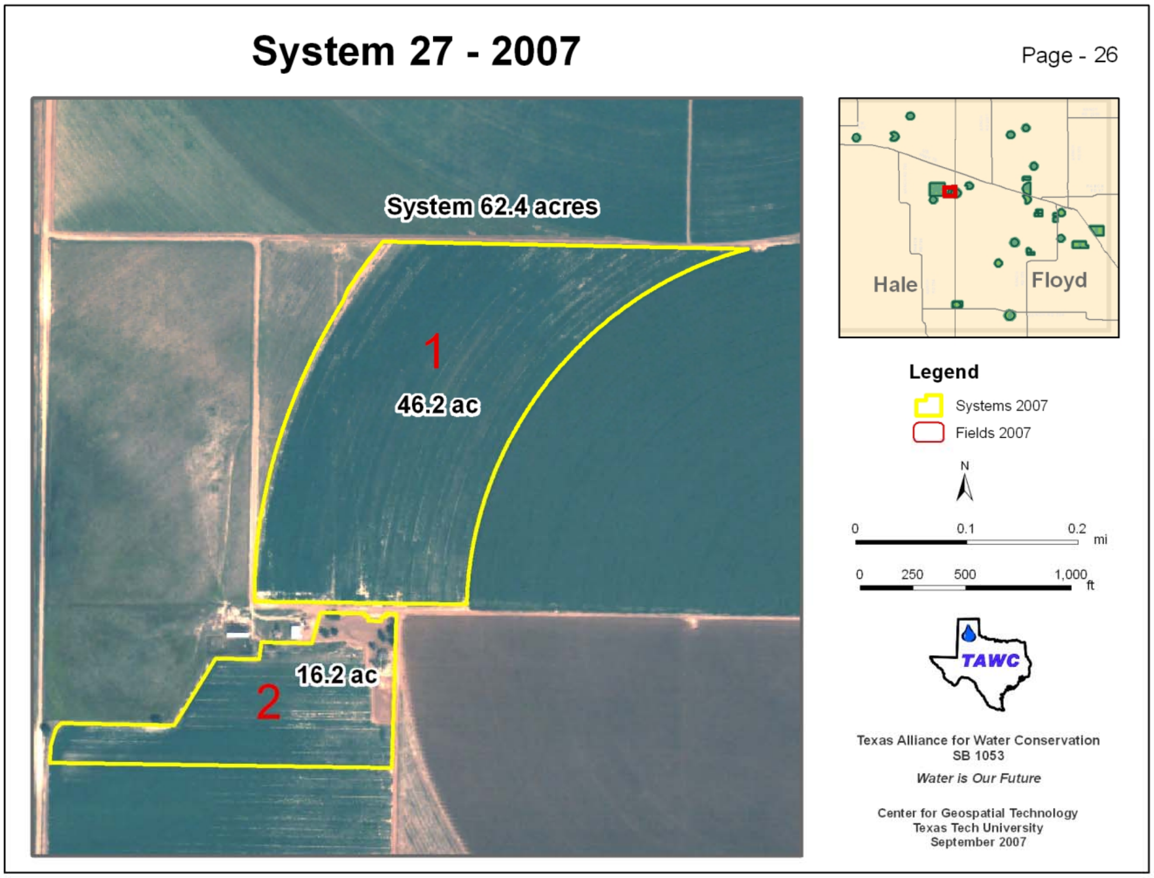
Irrigation and Precipitation
Water (inches)
40
35
30
25
20
15
10
5
0
2005
2006
2007
2008
2009
2010
2011
2012
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
400
350
300
250
200
150
100
50
0
2005
2006
2007
2008
2009
2010
2011
2012
Per system acre



Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
Net returns per pound of N ($)
40
35
30
25
20
15
10
5
0
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen



SYSTEM 27

<u>Crops</u>

2007

Field 1: Corn for silage

Field 2: Cotton following Wheat cover crop

<u>Irrigation</u>

Type:	Sub-surface Drip
	(SDI, installed prior to 2006 crop year)
Pumping capacity, gal/min:	750
Number of wells:	2
Fuel source:	Electric

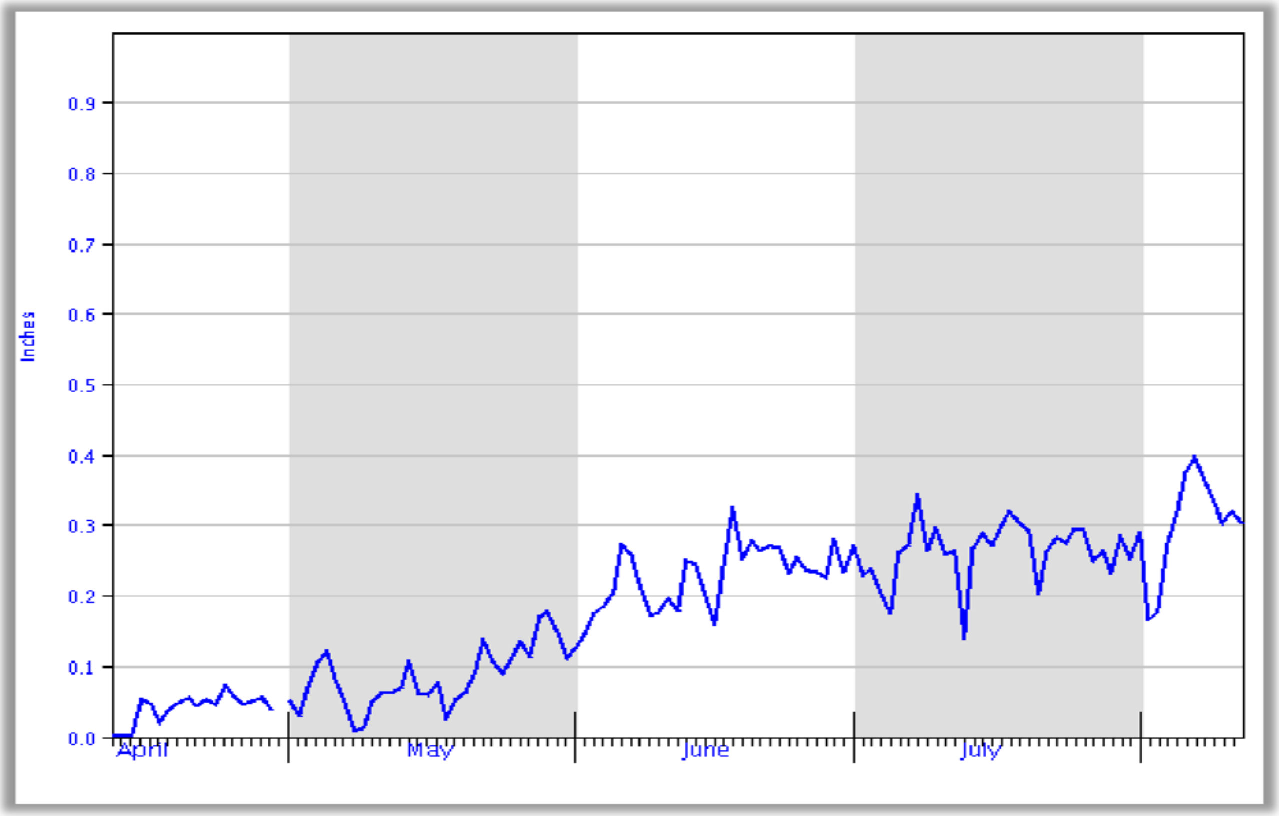
2006

Field 1: Cotton following Wheat cover crop

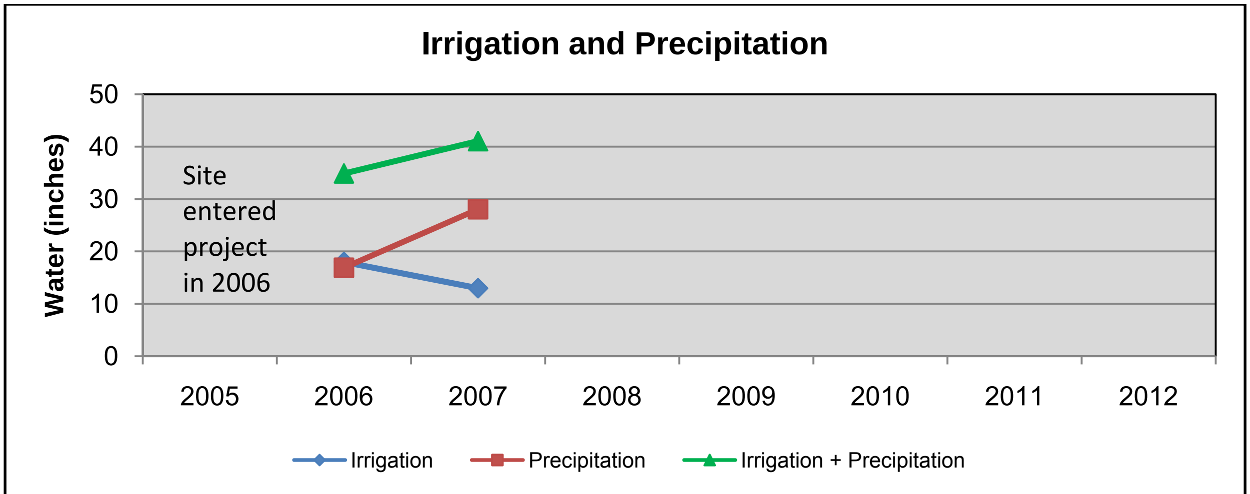


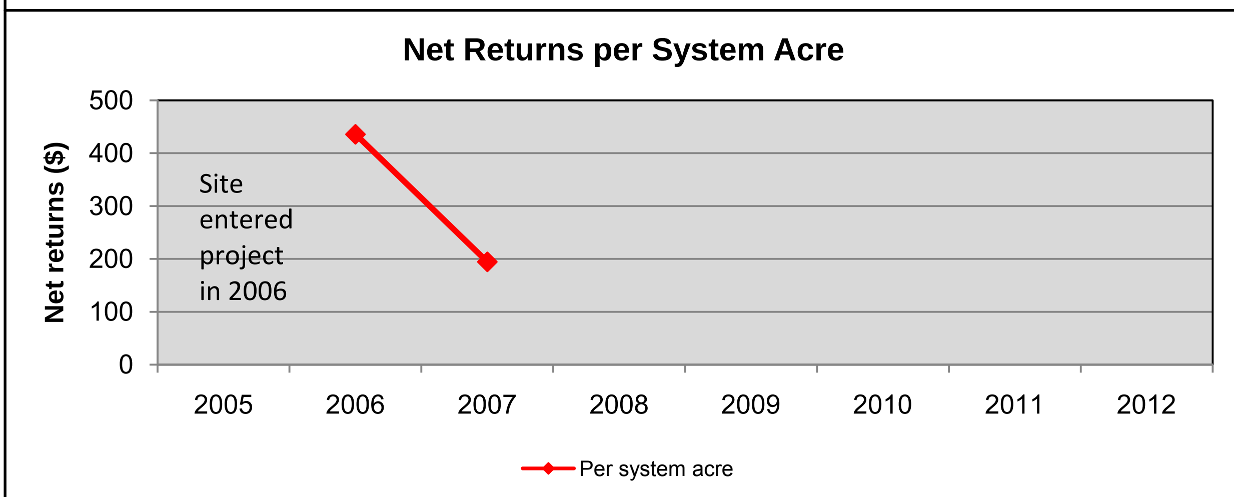

Comments: This is a new site using drip irrigation. Corn was planted on twenty-inch centers using conventional tillage.

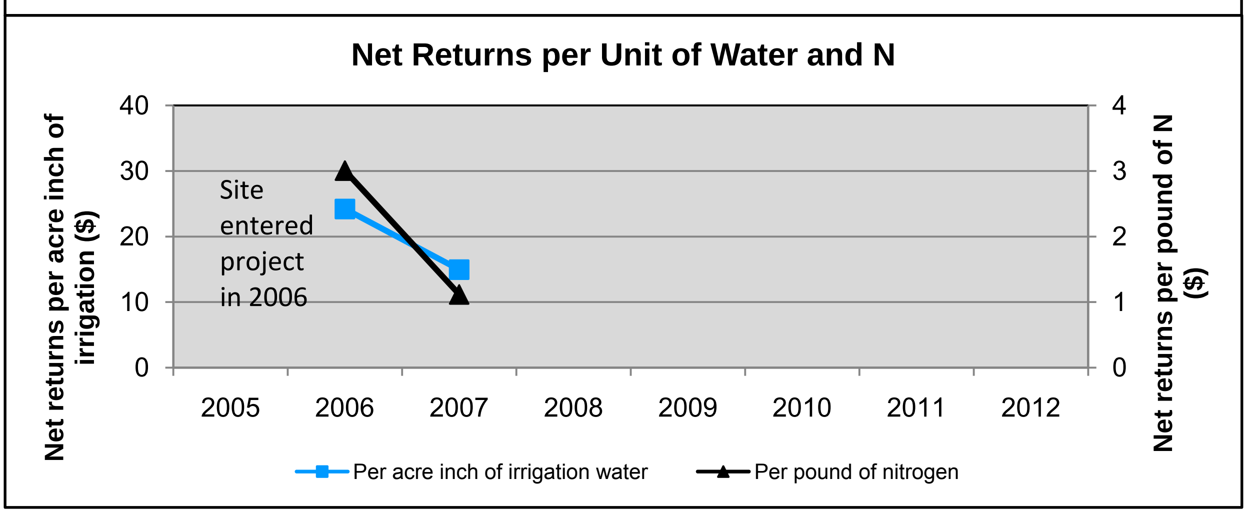
SITE 27 - 1
South Plains Corn Silage ET
Planted April 12, 2007 Total ET Demand 21.68'



System 27


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


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


Net Returns per Unit of Water and N
Net returns per acre inch of irrigation ($)
40
30
20
10
0
Net returns per pound of N ($)
4
3
2
1
0
Site entered project in 2006
2005
2006
2007
2008
2009
2010
2011
2012
Per acre inch of irrigation water
Per pound of nitrogen

Site Data

Site 1 Description						
	Total system acres:					
		2005:	62.3			
		2006:	135.1			
		2007	135.1			
	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:	35.8			
		Major soil type:				
			Pullman clay loam, 0 to 1% slope			
Item				2005	2006	2007
Crops						
	Field No. 1					
	Cotton					
			Tillage system	Conventional	Limit-till	Conventional
			Cover crop	None	None	None
			Variety	'FM 960BR'	'FM 960B2R'	'FM 960B2R'
			Row spacing, inches	40	40	40
		Yield/acre				
			Lint, lb	2,024	1,751	1,374
			Lint, lbs/inch irrigation water	173	83	94
			Lint, lbs/inch total water	78	48	35
			Seed, tons	1.44	1.26	0.96
			Pounds water/lb of lint	2,905	4,676	6,430
	Field No. 2					
	Cotton					
			Tillage system	Conventional	Limit-till	Conventional
			Cover crop	None	None	None
			Variety	'D&PL 444BG/RR'	'FM 960B2R'	'FM 960B2R'
			Row spacing, inches	40	40	40
		Yield/acre				
			Lint, lb	1,480	1,751	1,374
			Lint, lbs/inch irrigation water	126	83	94
			Lint, lbs/inch total water	57	48	35
			Seed, tons	1.01	1.26	0.96
			Pounds water/lb of lint	3,973	4,676	6,430
	Field No. 3					
	Cotton					
			Tillage system	-	Conventional	Conventional
			Cover crop	-	None	None
			Variety	-	'Stoneville 4554 B2RF'	'FM 960B2R'
			Row spacing, inches	-	40	40
		Yield/acre				
			Lint, lb	-	1,648	1,374
			Lint, lbs/inch irrigation water	-	78	94
			Lint, lbs/inch total water	-	46	35
			Seed, tons	-	1.18	0.96
			Pounds water/lb of lint	-	4,968	6,430
	Field No. 4					
	Cotton					
			Tillage system	-	Conventional	Conventional
			Cover crop	-	None	None
			Variety	-	'Stoneville 4554 B2RF'	'FM 960B2R'
			Row spacing, inches	-	40	40
		Yield/acre				
			Lint, lb	-	1,648	1,374
			Lint, lbs/inch irrigation water	-	78	94
			Lint, lbs/inch total water	-	46	35
			Seed, tons	-	1.18	0.96
			Pounds water/lb of lint	-	4,968	6,430

Site 1, continued

Item	2005	2006	2007
Fertilizer			
lbs/system acre			
Nitrogen	180	163	128.89
Phosphorus (P_2O_5) [1]	62	5.76	3.55
Potassium (K_2O)	trace	1.0	0.59
Zinc	3.5	0	0
Water use, inches			
Irrigation			
By field			
Field 1	11.7	21	14.6
Field 2	11.7	21	14.6
Field 3	-	21	14.6
Field 4	-	21	14.6
By system	11.7	21	14.6
Precipitation	14.3	15.2	24.4
Total system (irrigation + precipitation)	26.0	36.2	39.0
Income and Expense, $/system acre			
Projected returns	1,016.58	1,113.78	945.86
Costs			
Total variable costs	837.38	782.60	663.46
Total fixed costs	120.00	120.00	120.00
Total all costs	957.38	902.60	783.46
Net returns			
Per system acre	59.20	211.18	162.40
Per acre inch of irrigation water	5.06	10.06	11.12
Per pound of Nitrogen	0.33	1.30	1.26
Gross margin			
Per system acre	179.20	331.18	282.40
Per acre inch of irrigation water	15.32	15.77	19.34

[1] Phosphorus was applied through subsurface drip irrigation.

				2005	2006	2007
Site 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			
Item				2005	2006	2007
Crops						
	Field No. 1					
	Cotton					
			Tillage system	Conventional	Conventional	Conventional
			Cover crop	None	None	None
			Variety	'981 Fibermax LL' '9058 Flex'	'9963 B2 Flex'	'9058 Flex'
			Row spacing, inches	30	30	30
		Yield/acre				
			Lint, lb	1,455	1,966	2,287
			Lint, lbs/inch irrigation water	163	103	177
			Lint, lbs/inch total water	63	61	60
			Seed, tons	1.20	1.40	1.49
			Pounds water/lb of lint	3,607	3,728	3,765
Fertilizer						
		lbs/system acre				
			Nitrogen	132	120	156
			Phosphorus (P_2O_5)	40	0	53
			Potassium (K_2O)	0	0	9
			Other	0	0	0
Water use, inches						
	Irrigation					
		By field				
			Field 1	8.9	19.0	12.9
		By system		8.9	19.0	12.9
	Precipitation			14.3	13.4	25.1
	Total system (irrigation + precipitation)			23.2	32.4	38.1
Income and Expense, $/system acre						
	Projected returns			924.43	1,289.28	1556.96
	Costs					
		Total variable costs		617.49	860.57	925.63
		Total fixed costs		120.00	120.00	120.00
		Total all costs		737.49	980.57	1045.63
	Net returns					
		Per system acre		186.94	308.71	511.33
		Per acre inch of irrigation water		21.00	16.25	39.52
		Per pound of Nitrogen		1.42	2.57	3.28
	Gross margin					
		Per system acre		306.94	428.71	631.33
		Per acre inch of irrigation water		34.49	22.56	48.79

Site 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	

Item				2005	2006	2007
Crops						
	Field No. 1					
	Grain sorghum					
			Tillage system	Conventional	-	-
			Variety	‘DeKalb 40Y’	-	-
			Row spacing, inches	40	-	-
		Yield/acre				
			Grain, lbs	4,567	-	-
			Grain, lbs/inch irrigation water	609	-	-
			Grain, lbs/inch total water	205	-	-
			Pounds water/lb of grain	1,104	-	-
	Field No. 1					
	Cotton					
			Tillage system	-	Limit-till	Limit-till
			Cover crop	-	None	Wheat
			Variety	-	‘Nexgen 1553’	'FM 9058'
			Row spacing, inches	-	40	40
		Yield/acre				
			Lint, lb	-	915	1,801
			Lint, lbs/inch irrigation water	-	91	157
			Lint, lbs/inch total water	-	35	49
			Seed, tons	-	0.66	1.17
			Pounds water/lb of lint	-	6,405	4,582
	Field No. 2					
	Cotton					
		Tillage system		Conventional	Limit-till	-
		Cover crop		None	None	-
		Variety		‘Nexgen 1553’	‘BW 50R’	-
		Row spacing, inches		40	40	-
		Yield/acre				
			Lint, lbs	1,106	1,188	-
			Lint, lbs/inch irrigation water	136	119	-
			Lint, lbs/inch total water	47	46	-
			Seed, tons	0.87	0.83	-
			Pounds water/lb lint	4,693	4,932	-
	Field No. 2 (double croppped in 2007)					
	Wheat					
			Tillage system	-	-	Limit-till
			Variety	-	-	Tascosa
			Row spacing, inches	-	-	9
			Grain, lbs	-	-	1,812
			Grain, lbs/inch irrigation water	-	-	268
			Grain, lbs/inch total water	-	-	94
			Pounds water/lb of grain	-	-	2,403
	Field No. 2 (double croppped in 2007)					
	Grain sorghum					
			Tillage system	-	-	Limit-till
			Variety	-	-	DeKalb 40Y
			Row spacing, inches	-	-	40
		Yield/acre				
			Grain, lbs	-	-	2,862
			Grain, lbs/inch irrigation water	-	-	347
			Grain, lbs/inch total water	-	-	138
			Pounds water/lb of grain	-	-	1,639

Site 3, continued

Item				2005	2006	2007
Fertilizer						
		lbs/system acre				
			Nitrogen	93	105	132
			Phosphorus (P_2O_5)	0	51	16
			Potassium (K_2O)	0	0	0
			Other	0	0	0
Water use, inches						
	Irrigation					
		By field				
			Field 1	7.5	10	11.5
			Field 2 (2007 wheat)	8.8	10	6.8
			Field 2 (2007 grain sorghum)	-	-	8.2
		By system		8.2	10	13.2
	Precipitation			14.8	15.9	25.0
	Total system (irrigation + precipitation)			23.0	25.9	38.2
Income and Expense, $/system acre						
	Projected returns			431.77	689.44	761.97
	Costs					
		Total variable costs		315.37	505.05	492.84
		Total fixed costs		78.60	78.60	78.60
		Total all costs		393.97	583.65	571.44
	Net returns					
		Per system acre		37.80	105.79	190.53
		Per acre inch of irrigation water		4.64	10.58	14.38
		Per pound of Nitrogen		0.41	1.01	1.44
	Gross margin					
		Per system acre		116.40	184.39	269.13
		Per acre inch of irrigation water		14.28	18.44	20.31

Site 4 Description						
	Total system acres:		123.1			
	Field No. 1:	Acres:	13.3			
		Major soil type:				
			Estacado clay loam; 1 to 3% slope			
			Drake soils; 3 to 8% 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			
Item				2005	2006	2007
Crops						
	Field No. 1					
	Alfalfa					
			Variety	'Pioneer'	'Pioneer'	'Pioneer'
		Yield/acre				
			Hay, tons	8.3	9.18	4.90
			Hay, lbs/inch irrigation water	1612	532	928
			Hay, lbs/inch total water	613	367	238
			Pounds total water/pound alfalfa hay	369	616	950
	Field No. 2 (double cropped in 2007 with wheat for grazing)					
	Cotton					
			Tillage system	Conventional	-	Limit-till
			Cover crop	Wheat	-	Wheat
			Variety	'Fibermax 989'	-	'FM 989 RR'
			Row spacing, inches	40	-	40
		Yield/acre				
			Cows and bull grazing wheat, animal-days	-	-	39.95
			Calves, lbs. of gain	-	-	98.4
			Lint, lb	1,201.9	-	1,674.8
			Lint, lbs/inch irrigation water	240	-	186
			Lint, lbs/inch total water	55	-	42
			Seed, tons	0.93	-	1.09
			Pounds water/lb lint	4,102	-	5,346
	Field No. 2 (double-cropped in 2006)					
	Wheat					
			Tillage system	-	Conventional	-
			Variety	-	'Jagalene'	-
			Row spacing, inches	-	8	-
		Yield/acre				
			Wheatlage, tons	-	6.98	-
			Wheatlage, lbs/inch irrigation water	-	856	-
			Wheatlage, lbs/inch total water	-	580	-
			Pounds total water/pound wheatlage	-	126	-
	Field No. 2 (double-cropped in 2006)					
	Forage Sorghum					
			Tillage system	-	No-till into wheat	-
			Cover crop	-	Wheat	-
			Variety	-	'Surpass'	-
			Row spacing, inches	-	7	-
		Yield/acre				
			Silage, tons	-	14.4	-
			Hay, tons (6.12 bales @ 1,175lb/bale)	-	3.6	-
			Forage, lbs/inch irrigation water	-	2,250	-
			Forage, lbs/inch total water	-	1,213	-
			Pounds water/pound forage (as fed)	-	149	-
	Field No. 3					
	Cotton					
			Tillage system	Limit-till	Limit-till	-
			Cover crop	Wheat	None	-
			Variety	'PayMaster 2226'	'FM 989 RR'	-
			Row spacing, inches	40	40	-
		Yield/acre				
			Lint, lb	873	1,806	-
			Lint, lbs/inch irrigation water	182	111	-
			Lint, lbs/inch total water	40	57	-
			Seed, tons	0.74	1.27	-
			Pounds of water/lb of cotton lint	5,593	3,982	-

Site 4, continued

Item				2005	2006	2007
	Field No. 3					
	Wheat					
			Tillage system	-	-	Limit-till
			Variety	-	-	TAM 111
			Row spacing, inches	-	-	7
			Cows and bull grazing wheat, animal-days	-	-	39.95
			Calves, lbs. of gain	-	-	98.4
			Grain, lbs	-	-	4,595
			Grain, lbs/inch irrigation water	-	-	735
			Grain, lbs/inch total water	-	-	213
			Pounds water/lb of grain	-	-	1,060
Fertilizer						
		lbs/system acre				
			Nitrogen	109	234	123
			Phosphorus (P_2O_5)	71	55	71
			Potassium (K_2O)	0	4	8
			Sulfur	0	6.8	32
Water use, inches						
	Irrigation					
		By field				
			Field 1	10.3	34.5	10.6
			Field 2 (2006 wheat)	5.0	16.3	9.0
			Field 2 (2006 forage sorghum)	-	16.0	-
			Field 3	4.8	16.3	6.3
		By system		5.5	26.8	8.2
	Precipitation, annual			16.8	15.5	30.6
	Total system (irrigation + precipitation)			22.3	42.3	38.8
Income and Expense, $/system acre						
	Projected returns			727.99	984.83	871.86
	Costs					
		Total variable costs		535.72	590.66	599.59
		Total fixed costs		81.80	81.84	88.55
		Total all costs		617.52	672.50	688.14
	Net returns					
		Per system acre		110.47	312.33	183.72
		Per acre inch of irrigation water		20.08	11.67	22.47
		Per pound of Nitrogen		1.01	1.33	1.49
	Gross margin					
		Per system acre		192.27	394.17	272.27
		Per acre inch of irrigation water		34.96	14.73	33.30

Site 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			
	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			
			Pens and barns			
Item				2005	2006	2007
Crops						
	Crop/Livestock system					
			Bull calves, head/system acre	0.2134	0.2325	0.2229
			Heifer calves, head/system acre	0.1672	0.1672	0.1768
			Grass hay, tons	0	0.25	0.18
	Field No.s 1, 2, 3, 4, 5, Irrigated grass					
			Varieties	see site summary		
	Field No. 6, Irrigated grass					
			Varieties	see site summary		
	Field No.s 7, 8, 9, 10, 11, Dryland grass					
			Varieties	see site summary		

Site 5, continued

Item				2005	2006	2007
Fertilizer						
		lbs/system acre				
			Nitrogen	21	67	43
			Phosphorus (P_2O_5)	57	16	20
			Potassium (K_2O)	0	0	0
			Sulphur	10	27	24
Water use, inches						
	Irrigation					
		By system		1.2	9.6	3.6
	Precipitation			15.1	17.7	27.8
	Total system (irrigation + precipitation)			16.3	27.3	31.4
Income and Expense, $/system acre						
	Projected returns			279.80	378.29	374.53
	Costs					
		Total variable costs		89.52	163.44	116.33
		Total fixed costs		64.39	64.39	64.39
		Total all costs		153.91	227.83	180.72
	Net returns					
		Per system acre		125.89	150.46	193.81
		Per acre inch of irrigation water		104.91	15.67	54.38
		Per pound of Nitrogen		5.99	2.25	4.51
	Gross margin					
		Per system acre		190.28	214.85	258.20
		Per acre inch of irrigation water		158.57	22.38	72.45

Site 6 Description						
	Total system acres:		122.9			
Irrigated						
	Field No. 1:	Acres:	122.9			
		Major soil type:				
			Pullman clay loam, 0 to 1%slope			
Item				2005	2006	2007
Livestock						
		Stocker steers, gain/system, lbs		477	0	0
Crops						
	Field No. 1					
	Cotton					
			Tillage system	Conventional	Conventional	Conventional
			Cover crop	wheat (grazed)	none	none
			Variety	'Stoneville 2448'	'Stoneville 4554-B2RF'	'Nexgen 5065'
			Row spacing, inches	40	40	40
		Yield/acre				
			Lint, lb	1,216	1,530	2,023
			Lint, lbs/inch irrigation water	107	113	186
			Lint, lbs/inch total water	46	50	55
			Seed, tons	0.97	0.98	1.31
			Pounds of water/lb lint	4,910	4,568	4,128
Fertilizer						
		lbs/system acre				
			Nitrogen	110	114	119
			Phosphorus (P_2O_5)	24	52	23
			Potassium (K_2O)	0	0	0
			Other	0	0	0
Water use, inches						
	Irrigation					
		By field				
			Field 1	11.4	13.6	10.9
		By system		11.4	13.6	10.9
	Precipitation			15.0	17.3	26.1
	Total system (irrigation + precipitation)			26.4	30.9	36.9
Income and Expense, $/system acre						
	Projected returns			758.20	988.99	1,377.10
	Costs					
		Total variable costs		577.69	588.60	692.72
		Total fixed costs		78.60	78.60	78.60
		Total all costs		656.29	667.20	771.32
	Net returns					
		Per system acre		101.91	321.79	605.78
		Per acre inch of irrigation water		8.94	23.66	55.78
		Per pound of Nitrogen		0.93	2.82	5.09
	Gross margin					
		Per system acre		180.51	400.39	684.38
		Per acre inch of irrigation water		15.83	29.44	63.02

Site 7 Description						
	Total system acres:		130.0			
	Field No. 1:	Acres:	130.0			
		Major soil type:				
			Pullman clay loam; 0 to 1%slope			
Item				2005	2006	2007
Crops						
	Field No. 1					
	Sideoats grama					
			Variety	'Haskell'	'Haskell'	'Haskell'
			Row spacing	40	40	40
		Yield/acre				
			Seed, lb	300	300	197
			Hay, tons	3.5	2.89	1.91
			Seed, lbs/inch irrigation water	31	38	15
			Seed, lbs/inch total water	12	14	5
			Pounds water/lb of seed	18,997	16,510	43,338
Fertilizer						
		lbs/system acre				
			Nitrogen	156	108	116
			Phosphorus (P_2O_5)	56	56	60
			Potassium (K_2O)	0	0	0
			Sulphur	8	8	6
Water use, inches						
	Irrigation					
		By field				
			Field 1	9.8	7.8	13.4
		By system		9.8	7.8	13.4
	Precipitation			15.4	14.1	24.4
	Total system (irrigation + precipitation)			25.2	21.9	37.8
Income and Expense, $/system acre						
	Projected returns			1,328.48	1,760.10	1,406.94
	Costs					
		Total variable costs		824.55	994.14	935.75
		Total fixed costs		78.60	78.60	78.60
		Total all costs		903.15	1,072.74	1,014.35
	Net returns					
		Per system acre		425.33	687.36	392.59
		Per acre inch of irrigation water		43.40	88.12	29.32
		Per pound of Nitrogen		2.73	6.36	3.38
	Gross margin					
		Per system acre		503.93	765.96	471.19
		Per acre inch of irrigation water		51.42	98.20	35.19

Site 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			

Item				2005	2006	2007
Crops						
	Field No. 1, 2, 3, 4					
	Sideoats grama					
			Variety	'Haskell'	'Haskell'	'Haskell'
			Row spacing	40	40	40
		Yield/acre				
			Seed, lb	325	235	206
			Hay, tons	3.7	1.36	1.98
			Seed, lbs/inch irrigation water	29	30	13
			Seed, lbs/inch total water	12	11	5
			Pounds water/lb of seed	18,580	20,306	43,884
Fertilizer						
		lbs/system acre				
			Nitrogen	156	108	116
			Phosphorus (P_2O_5)	56	56	60
			Potassium (K_2O)	0	0	0
			Sulphur	8	8	6
Water use, inches						
	Irrigation					
		By field				
			Field 1, 2, 3, 4	11.3	7.8	15.7
		By system		11.3	7.8	15.7
	Precipitation			15.4	13.3	24.4
	Total system (irrigation + precipitation)			26.7	21.1	40.0
Income and Expense, $/system acre						
	Projected returns			1,229.02	1,297.04	1,209.79
	Costs					
		Total variable costs		759.13	800.68	797.16
		Total fixed costs		120.00	120.00	120.00
		Total all costs		879.13	920.68	917.16
	Net returns					
		Per system acre		349.89	376.36	292.63
		Per acre inch of irrigation water		30.96	48.25	18.67
		Per pound of Nitrogen		2.24	3.48	2.52
	Gross margin					
		Per system acre		469.89	496.36	412.63
		Per acre inch of irrigation water		41.58	63.64	26.33

Site 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			
			Pens and Feed Alley			
Item				2005	2006	2007
Crops						
	Field No. 1					
	Pasture					
			Variety	Kleingrass/buffalograss	Kleingrass/buffalograss	Kleingrass/buffalograss
			Interseeded	Elbon rye	Elbon rye	Elbon rye
		Yield/acre				
			Grazing, gain (cwt)	4.01	3.73	4.22
			Hay, tons	0.66	0	0
			Hay, lbs/inch irrigation water	880	-	-
			Hay, lbs/inch total water	83	-	-
			Pounds water/lb of hay	2,724	-	-
	Field No. 2					
	Cotton					
			Tillage system	No-till	No-till	-
			Cover crop	Rye, for grazing	Rye, no grazing	-
			Variety	'FiberMax 989 BR'	'FM 989 B2R'	-
			Row spacing, inches	40	40	-
		Yield/acre				
			Lint, lb	1,394	1,154	-
			Lint, lbs/inch irrigation water	137	66	-
			Lint, lbs/inch total water	57	36	-
			Seed, tons	0.85	0.87	-
			Pounds water/lb of lint	3,991	6,350	-
	Field No. 2					
	Grain sorghum					
			Tillage system	-	-	No-till
			Cover crop	-	-	Rye, no grazing
			Variety	-	-	Elbon
			Row spacing, inches	-	-	40
		Yield/acre				
			Grain, lbs	-	-	8,225
			Grain, lbs/inch irrigation water	-	-	2131
			Grain, lbs/inch total water	-	-	326
			Pounds water/lb of grain	-	-	693
Fertilizer						
		lbs/system acre				
			Compost, tons/acre[2]	3	3	3 (Field 2 only)
			Nitrogen	88	90	52
			Phosphorus (P_2O_5)	88	90	52
			Potassium (K_2O)	88	90	52
			Sulphur	21	21	12
Water use, inches						
	Irrigation					
		By field				
			Field 1	1.5	0	4.7
			Field 2	10.2	17.6	3.9
		By system		6.5	10.1	4.1
	Precipitation			14.4	14.8	21.4
	Total system (irrigation + precipitation)			20.9	24.9	25.4

Site 9, continued

Item			2005	2006	2007
Income and Expense, $/system acre					
	Projected returns		732.28	493.00	341.93
	Costs				
		Total variable costs	357.19	349.26	216.09
		Total fixed costs	76.95	76.95	76.95
		Total all costs	434.14	426.21	293.04
	Net returns				
		Per system acre	298.14	66.79	48.89
		Per acre inch of irrigation water	46.00	6.59	11.93
		Per pound of Nitrogen	3.39	0.74	0.94
	Gross margin				
		Per system acre	375.09	143.74	125.84
		Per acre inch of irrigation water	57.88	14.18	30.71
	[2]Compost provided 88 lbs of N in 2005, 90 lbs of N in 2006, and 52 lbs of N in 2007 plus all other nutrients.				

Site 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			
Item				2005	2006	2007
Crops						
	Livestock			Cow-calf	Cow-calf	Cow-calf
	Field No. 1					
	Grass (established in 2005)					
			Variety	‘WW-B. Dahl’	‘WW-B. Dahl’	‘WW-B. Dahl’
		Yield/acre				
			Grazed, animal days	0	77.95	78.86
	Field No. 2					
	Cotton					
			Tillage system	Conventional	-	-
			Cover crop	None	-	-
			Variety	‘FM 832LL’	-	-
			Row spacing, inches	40	-	-
		Yield/acre				
			Lint, lb	1,535	-	-
			Lint, lbs/inch irrigation water	128	-	-
			Lint, lbs/inch total water	66	-	-
			Seed, tons	1.05	-	-
			Pounds water/lb of lint	3,403	-	-
	Field No. 2 (double cropped in 2006)					
	Oats					
			Variety	-	Troy	-
			Row spacing, inches	-	7, cross-seeded	-
		Yield/acre				
			Hay, tons	-	1.79	-
			Hay, lbs/inch irrigation water	-	731	-
			Hay, lbs/inch total water	-	149	-
			Pounds water/lb of hay	-	787	-
	Field No. 2 (double cropped in 2006)					
	Haygrazer					
			Variety	-	?	-
			Row spacing, inches	-	7	-
		Yield/acre				
			Hay, tons	-	2.20	-
			Hay, lbs/inch irrigation water	-	267	-
			Hay, lbs/inch total water	-	183	-
			Pounds water/lb of hay	-	1,236	-
	Field No. 2					
	Corn					
			Tillage system	-	-	Conventional
			Cover crop	-	-	Wheat
			Variety	-	-	Pioneer
			Row spacing, inches	-	-	20
		Yield/acre (as ensiled)				
			Silage, tons	-	-	32.00
			Silage, lbs/inch irrigation water	-	-	4,089
			Silage, lbs/inch total water	-	-	1,546
			Pounds water/lb of silage	-	-	146

Site 10, continued

Item				2005	2006	2007
	Field No. 3					
	Old World Bluestem					
			Variety	'WW-B. Dahl'	'WW-B. Dahl'	'WW-B. Dahl'
		Yield/acre				
			Grazed, animal days	125.29	80.87	81.81
			Grass seed, PLS lbs.	-	-	5.35
			Hay, tons	2.03	0	0
			Hay, lbs/inch irrigation water	677	-	-
			Hay, lbs/inch total water	237	-	-
			Pounds water/lb of hay	953	-	-
	Field No. 4					
	Bermudagrass (seeded in 2005)					
			Variety	'Giant' and 'common'	'Giant' and 'common'	'Giant' and 'common'
		Yield/acre				
			Grazed, animal days	127.08	82.03	82.98
			Hay, tons	0	1.80	0
			Hay, lbs/inch irrigation water	-	257	-
			Hay, lbs/inch total water	-	124	-
			Pounds water/lb of hay	-	1,828	-
Fertilizer						
		lbs/system acre				
			Nitrogen	40	51	72
			Phosphorus (P_2O_5)	0	0	13
			Potassium (K_2O)	0	0	0
			Other	0	0	0
Water use, inches						
	Irrigation					
		By field				
			Field 1	6	13.2	3.8
			Field 2 (2006 oats)	12	4.9	15.7
			Field 2 (2006 forage sorghum)	-	16.5	-
			Field 3	6	16.1	3.8
			Field 4	10	14.0	3.8
		By system		8.5	16.2	6.8
		Precipitation		11.1	15.1	25.8
		Total system (irrigation + precipitation)		19.6	31.3	32.6
Income and Expense, $/system acre						
	Projected returns			503.21	460.47	248.34
	Costs					
		Total variable costs		228.32	164.16	148.13
		Total fixed costs		87.17	78.60	72.37
		Total all costs		315.49	242.76	220.5
	Net returns					
		Per system acre		187.72	217.71	27.84
		Per acre inch of irrigation water		22.06	13.43	4.09
		Per pound of Nitrogen		4.69	4.27	0.39
	Gross margin					
		Per system acre		274.89	296.31	100.21
		Per acre inch of irrigation water		32.31	18.28	14.74

				2005	2006	2007
Site 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			
Item				2005	2006	2007
Crops						
	Field No. 1					
	Cotton					
			Tillage system	Conventional	Conventional	Conventional
			Cover crop	none	none	none
			Variety	'ADF 3511'	'FM 989 RR'	'FM 9058'
			Row spacing, inches	40	40	40
		Yield/acre				
			Lint, lb	724	1,123	1,252
			Lint, lbs/inch irrigation water	79	66	85
			Lint, lbs/inch total water	31	38	29
			Seed, tons	0.58	0.81	0.81
			Pounds water/lb of lint	7,374	6,021	7,880
	Field No. 2					
	Cotton					
			Tillage system	Conventional	Conventional	Conventional
			Cover crop	none	none	none
			Variety	'ADF 3511'	'NexGen 2448 RR'	'FM 9058'
			Row spacing, inches	40	40	40
		Yield/acre				
			Lint, lb	724	1,110	1,167
			Lint, lbs/inch irrigation water	79	66	80
			Lint, lbs/inch total water	31	37	27
			Seed, tons	0.58	0.80	0.84
			Pounds water/lb of lint	7,374	6,095	8,453
	Field No. 3					
	Cotton					
			Tillage system	Conventional	Conventional	Conventional
			Cover crop	none	none	none
			Variety	'ADF 3511'	'NexGen 2448 RR'	'FM 9058'
			Row spacing, inches	40	40	40
		Yield/acre				
			Lint, lb	724	790	1,130
			Lint, lbs/inch irrigation water	79	47	77
			Lint, lbs/inch total water	31	26	26
			Seed, tons	0.58	0.57	0.81
			Pounds water/lb of lint	7,374	8,563	8,730
Fertilizer						
		lbs/system acre				
			Nitrogen	40	50	77
			Phosphorus (P_2O_5)	45	25	0
			Potassium (K_2O)	0	0	0
			Sulphur	10	0	0
Water use, inches						
	Irrigation					
		By field				
			Field 1	9.2	16.9	14.7
			Field 2	9.2	16.9	14.7
			Field 3	9.2	16.9	14.7
		By system		9.2	16.9	14.7
	Precipitation			14.4	13.0	29.0
	Total system (irrigation + precipitation)			23.6	29.9	43.6

Site 11, continued

Item		2005	2006	2007
Income and Expense, $/system acre				
Projected returns		461.24	681.64	822.95
Costs				
	Total variable costs	386.35	523.45	589.37
	Total fixed costs	70.00	70.00	70.00
	Total all costs	456.35	593.45	659.37
Net returns				
	Per system acre	4.89	88.19	163.58
	Per acre inch of irrigation water	0.53	5.22	11.15
	Per pound of Nitrogen	0.12	1.76	2.12
Gross margin				
	Per system acre	74.89	158.19	233.58
	Per acre inch of irrigation water	8.14	9.36	15.92

				2005	2006	2007
Site 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			
Item				2005	2006	2007
Crops						
	Field No. 1					
	Cotton					
			Tillage system	No-till	-	Conventional
			Cover crop	Wheat	-	None
			Variety	'PayMaster 2266'	-	'FM 9058'
			Row spacing, inches	40	-	40
		Yield/acre				
			Lint, lb	615	-	1238
			Lint, lbs/inch irrigation water	dryland	-	dryland
			Lint, lbs/inch total water	49	-	40
			Seed, tons	0.47	-	0.80
			Pounds water/lb of lint	4,597	-	5,704
	Field No. 1					
	Wheat					
			Tillage system	-	No-till	-
			Cover crop	-	wheat	-
			Variety	-	Tam 202	-
			Row spacing, inches	-	7	-
		Yield/acre				
			Grain, lbs	-	0	-
			Grain, lbs/inch irrigation water	-	dryland	-
			Grain, lbs/inch total water	-	0	-
			Pounds water/lb of grain	-	0	-
	Field No. 2					
	Wheat/Forage sorghum					
			Tillage system	No-till	-	-
			Cover crop		-	-
			Variety		-	-
			Row spacing, inches	40	-	-
		Yield/acre				
			Forage, lb	0	-	-
			Forage, lbs/inch irrigation water	dryland	-	-
			Forage, lbs/inch total water	0	-	-
			Pounds water/lb of forage	0	-	-
	Field No. 2					
	Cotton					
			Tillage system	-	Limit-till	-
			Cover crop	-	Sorghum stubble	-
			Variety	-	'PayMaster 2266'	-
			Row spacing, inches	-	40	-
		Yield/acre				
			Lint, lb	-	0	-
			Lint, lbs/inch irrigation water	-	dryland	-
			Lint, lbs/inch total water	-	0	-
			Seed, tons	-	0	-
			Pounds water/lb of lint	-	0	-
	Field No. 2					
	Grain Sorghum					
			Tillage system	No-till	-	Conventional
			Cover crop		-	Wheat
			Variety		-	87G57 Pioneer
			Row spacing, inches	40	-	40
		Yield/acre				
			Grain, lbs	0	-	2,909
			Grain, lbs/inch irrigation water	dryland	-	dryland
			Grain, lbs/inch total water	0	-	93
			Pounds water/lb of grain	0	-	2,426

Site 12, continued

Item				2005	2006	2007
Fertilizer						
		lbs/system acre				
			Nitrogen	0	8	35
			Phosphorus (P_2O_5)	0	25	9
			Potassium (K_2O)	0	0	0
			Other	0	0	0
Water use, inches						
	Irrigation					
		By field				
			Field 1	Dryland	Dryland	Dryland
			Field 2	Dryland	Dryland	Dryland
		By system		Dryland	Dryland	Dryland
	Precipitation			12.5	13.5	31.21
	Total system (irrigation + precipitation)			12.5	13.5	31.21
Income and Expense, $/system acre						
	Projected returns			198.49	71.56	529.70
	Costs					
		Total variable costs		154.50	70.28	248.99
		Total fixed costs		7.99	15.00	15.00
		Total all costs		162.49	85.28	263.99
	Net returns					
		Per system acre		36.00	-13.72	265.71
		Per acre inch of irrigation water		Dryland	Dryland	Dryland
		Per pound of Nitrogen			-1.72	7.59
	Gross margin					
		Per system acre		43.99	1.28	280.71
				Dryland	Dryland	Dryland

Site 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			
Item				2005	2006	2007
Crops						
	Field No. 1					
	Wheat					
			Tillage system	Conventional	-	Limit-till
			Cover crop	None	-	None
			Variety	Tam111	-	Tam 202
			Row spacing, inches	7	-	7
		Yield/acre				
			Grain, lbs	2,034	-	1,920
			Grain, lbs/inch irrigation water	dryland	-	dryland
			Grain, lbs/inch total water	125	-	66
			Pounds water/lb of grain	1,812	-	3,405
	Field No. 1					
	Cotton					
			Tillage system	-	Limit-till	-
			Cover crop	-	2005 wheat stubble	-
			Variety	-	NG 3350 RF	-
			Row spacing, inches	-	40	-
		Yield/acre				
			Lint, lb	-	187	-
			Lint, lbs/inch irrigation water	-	dryland	-
			Lint, lbs/inch total water	-	13	-
			Seed, tons	-	0.12	-
			Pounds water/lb of lint	-	17,657	-
	Field No. 2					
	Cotton					
			Tillage system	Conventional	Limit-till	Limit-till
			Cover crop	None	Wheat	Wheat
			Variety	‘HS2326’	'NG 3350 RF'	‘Paymaster HS 2326’
			Row spacing, inches			
		Yield/acre				
			Lint, lb	602	187	648
			Lint, lbs/inch irrigation water	dryland	dryland	dryland
			Lint, lbs/inch total water	37	13	22
			Seed, tons	0.45	0.12	0.72
			Pounds water/lb of lint	6,124	17,657	10,087
	Field No. 2					
	Wheat					
			Tillage system	-	Crop lost	-
			Cover crop	-	to drought	-
			Variety	-	Tam 111	-
			Row spacing, inches	-	7	-
		Yield/acre				
			Grain, lbs	-	-	-
			Grain, lbs/inch irrigation water	-	-	-
			Grain, lbs/inch total water	-	-	-
			Pounds water/lb of grain	-	-	-
Fertilizer						
		lbs/system acre				
			Nitrogen	25	17	34
			Phosphorus (P_2O_5)	0	0	0
			Potassium (K_2O)	0	0	0
			Other	0	0	0

Site 13, continued

Item				2005	2006	2007
Water use, inches						
	Irrigation					
		By field				
			Field 1	Dryland	Dryland	Dryland
			Field 2	Dryland	Dryland	Dryland
		By system		Dryland	Dryland	Dryland
	Precipitation			16.3	14.6	28.9
	Total system (irrigation + precipitation)			16.3	14.6	28.9
Income and Expense, $/system acre						
	Projected returns			265.97	54.35	266.42
	Costs					
		Total variable costs		203.60	72.90	145.63
		Total fixed costs		15.00	15.00	15.00
		Total all costs		218.60	87.90	160.63
	Net returns					
		Per system acre		47.37	-33.55	105.79
		Per acre inch of irrigation water		Dryland	Dryland	Dryland
		Per pound of Nitrogen		1.89	-19.74	3.11
	Gross margin					
		Per system acre		62.37	-18.55	120.79
				Dryland	Dryland	Dryland

Site 14 Description						
	Total system acres:		124.2			
	Field No. 1:	Acres:	124.2			
		Major soil type:				
			Pullman clay loam; 0 to 1%slope			
Item				2005	2006	2007
Crops						
	Field No. 1					
	Cotton					
			Tillage system	Conventional	Conventional	Conventional
			Cover crop	None	None	None
			Variety	'Fibermax 960 RR'	'Paymaster 2266'	'FM 9058'
				'Paymaster 2266'		
			Row spacing, inches	40	40	40
		Yield/acre				
			Lint, lb	1,004	768	1,296
			Lint, lbs/inch irrigation water	148	124	150
			Lint, lbs/inch total water	48	37	38
			Seed, tons	0.76	0.59	0.84
			Pounds water/lb of lint	4,685	6,151	5,974
Fertilizer						
		lbs/system acre				
			Nitrogen	81	107	123
			Phosphorus (P_2O_5)	77	25	52
			Potassium (K_2O)	0	0	0
			Sulphur	21	0	0
Water use, inches						
	Irrigation					
		By field				
			Field 1	6.8	6.2	8.6
		By system		6.8	6.2	8.6
	Precipitation			14.0	14.7	25.6
	Total system (irrigation + precipitation)			20.8	20.9	34.2
Income and Expense, $/system acre						
	Projected returns			621.42	509.82	882.37
	Costs					
		Total variable costs		421.91	381.14	586.39
		Total fixed costs		78.60	78.60	78.60
		Total all costs		500.51	459.74	664.99
	Net returns					
		Per system acre		120.91	50.08	217.38
		Per acre inch of irrigation water		17.78	8.08	25.19
		Per pound of Nitrogen		1.49	0.47	1.77
	Gross margin					
		Per system acre		199.51	128.68	295.98
		Per acre inch of irrigation water		29.34	20.75	34.30

Site 15 Description					
Total system acres:		95.5			
Field No. 1:	Acres:	38.3			
	Major soil type:				
		Pullman clay loam; 0 to 1% slope			
Field No. 2:	*2005 only, split into fields 3 and 4 for 2006*				
	Acres:	57.2			
	Major soil type:				
		Pullman clay loam; 0 to 1% slope			
Field No. 3:	*2006 -2007 only*				
	Acres:	28.8			
	Major soil type:				
		Pullman clay loam; 0 to 1% slope			
Field No. 4:	*2006 -2007 only*				
	Acres:	28.4			
	Major soil type:				
		Pullman clay loam; 0 to 1% slope			

Item			2005	2006	2007
Crops					
Field No. 1					
Cotton					
		Tillage system	Conventional	Conventional	Limit-till
		Cover crop	None	None	None
		Variety	‘Paymaster 2326’	‘FM 960 RR’	‘FM 9058’
		Row spacing, inches	40	40	40
	Yield/acre				
		Lint, lb	378	1,328	1,492
		Lint, lbs/inch irrigation water	82	94	108
		Lint, lbs/inch total water	16	42	33
		Seed, tons	0.54	0.86	0.97
		Pounds water/lb of lint	14,259	5,365	6,792
Field No. 2					
Cotton					
		Tillage system	Conventional	-	-
		Cover crop	None	-	-
		Variety	‘Paymaster 2280’	-	-
		Row spacing, inches	40	-	-
	Yield/acre				
		Lint, lb	911	-	-
		Lint, lbs/inch irrigation water	198	-	-
		Lint, lbs/inch total water	38	-	-
		Seed, tons	0.76	-	-
		Pounds water/lb of lint	5,908	-	-
Field No. 3					
Cotton					
		Tillage system	-	Conventional	-
		Cover crop	-	None	-
		Variety	-	‘FM 960 RR’	-
		Row spacing, inches	-	40	-
	Yield/acre				
		Lint, lb	-	1,487	-
		Lint, lbs/inch irrigation water	-	105	-
		Lint, lbs/inch total water	-	47	-
		Seed, tons	-	1.03	-
		Pounds water/lb of lint	-	4,790	-
Field No. 3					
Grain sorghum					
		Tillage system	-	-	Limit-till
		Cover crop	-	-	None
		Variety	-	-	‘Frontier 305’
		Row spacing, inches	-	-	40
	Yield/acre				
		Grain, lbs	-	-	7,235
		Grain, lbs/inch irrigation water	-	-	1,096
		Grain, lbs/inch total water	-	-	165
		Pounds water/lb of grain	-	-	1,176

Site 15, continued

Item				2005	2006	2007
	Field No. 4					
	Grain sorghum					
			Tillage system	-	Conventional	-
			Cover crop	-	None	-
			Variety	-	'DK 40 Y'	-
			Row spacing, inches	-	40	-
		Yield/acre				
			Grain, lbs	-	3,023	-
			Grain, lbs/inch irrigation water	-	720	-
			Grain, lbs/inch total water	-	140	-
			Pounds water/lb of grain	-	1,616	-
	Field No. 4					
	Cotton					
			Tillage system	-	-	Limit-till
			Cover crop	-	-	None
			Variety	-	-	'FM 9058'
			Row spacing, inches	-	-	40
		Yield/acre				
			Lint, lb	-	-	1,258
			Lint, lbs/inch irrigation water	-	-	99
			Lint, lbs/inch total water	-	-	29
			Seed, tons	-	-	0.81
			Pounds water/lb of lint	-	-	7,862
Fertilizer						
		lbs/system acre				
			Nitrogen	80	95	104
			Phosphorus (P_2O_5)	48	21	32
			Potassium (K_2O)	0	0	0
			Zinc	20	0	0
Water use, inches						
	Irrigation					
		By field				
			Field 1	4.6	14.1	13.8
			Field 2	4.6	-	-
			Field 3	-	14.1	6.6
			Field 4	-	4.2	12.7
		By system		4.6	11.2	11.3
	Precipitation			19.2	17.4	31.02
	Total system (irrigation + precipitation)			23.8	28.6	42.3
Income and Expense, $/system acre						
	Projected returns			517.14	692.32	791.57
	Costs					
		Total variable costs		384.49	460.43	529.89
		Total fixed costs		70.00	70.00	70.00
		Total all costs		454.49	530.43	599.89
	Net returns					
		Per system acre		62.65	161.89	191.68
		Per acre inch of irrigation water		13.62	14.51	16.96
		Per pound of Nitrogen		0.78	1.70	1.84
	Gross margin					
		Per system acre		132.65	231.89	261.68
		Per acre inch of irrigation water		28.84	20.79	23.15

Site 16 Description					
Total system acres:		143.1			
Field No. 1:	Acres:	143.1			
	Major soil type:				
		Pullman clay loam; 0 to 1% slope			
Item			2005	2006	2007
Crops					
Field No. 1					SITE TERMINATED
Cotton					
		Tillage system	Conventional	Conventional	
		Cover crop	None	None	
		Variety	‘FM 958’	‘FM 958’	
		Row spacing, inches	40	40	
	Yield/acre				
		Lint, lb	1,347	1,175	
		Lint, lbs/inch irrigation water	177	96	
		Lint, lbs/inch total water	56	43	
		Seed, tons	0.95	0.76	
		Pounds water/lb of lint	4,014	5,234	
Fertilizer					
	lbs/system acre				
		Compost, tons/acre[1]	0	3	
		Nitrogen	83	124	
		Phosphorus (P_2O_5)	26	90	
		Potassium	0	90	
		Sulphur	1.8	21	
Water use, inches					
Irrigation					
	By field				
		Field 1	7.6	12.2	
	By system		7.6	12.2	
Precipitation			16.3	15.0	
Total system (irrigation + precipitation)			23.9	27.2	
Income and Expense, $/system acre					
Projected returns			821.74	761.36	
Costs					
	Total variable costs		619.46	606.75	
	Total fixed costs		78.60	78.60	
	Total all costs		698.06	685.35	
Net returns					
	Per system acre		123.68	76.01	
	Per acre inch of irrigation water		16.27	6.23	
	Per pound of Nitrogen		1.49	0.61	
Gross margin					
	Per system acre		202.28	154.61	
	Per acre inch of irrigation water		26.62	12.67	

[1]Compost provided 90 lbs of N and all other nutrients in 2006.

Site 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			
Item				2005	2006	2007
Livestock						
	cow/calf			None	yes	yes
Crops						
	Field No. 1					
	Old world bluestem					
			Variety	'WW-B. Dahl'	'WW-B. Dahl'	'WW-B. Dahl'
		Yield/acre				
			Grazed, animal days	0	261.87	122.38
			Grass seed, PLS lbs.	-	-	7.91
			Hay, tons	5.91	1.08	0
			Hay, lbs/inch irrigation water	1713	393	0
			Hay, lbs/inch total water	484	94	0
			Pounds water/lb of hay	467	2,398	#DIV/0!
	Field No. 2					
	Corn					
			Tillage system	Conventional	-	-
			Cover crop	None	-	-
			Variety	'NC + 1717'	-	-
			Row spacing, inches	20	-	-
		Yield/acre				
			Silage, tons (as ensiled)	31.8	-	-
			Silage, lbs/inch irrigation water	4,000	-	-
			Silage, lbs/inch total water	1,904	-	-
			Pounds water/lb of silage	119	-	-
	Field No. 2					
	Cotton					
			Tillage system	-	Conventional	-
			Cover crop	-	Wheat	-
			Variety	-	'FM 960 B2R'	-
			Row spacing, inches	-	20	-
		Yield/acre				
			Lint, lbs	-	1,834	-
			Lint, lbs/inch irrigation water	-	109	-
			Lint, lbs/inch total water	-	54	-
			Seed, tons	-	1.26	-
			Pounds water/lb of lint	-	4,218	-
	Field No. 2					
	Old world bluestem					
			Variety	-	-	'WW-B. Dahl'
		Yield/acre				
			Grazed, animal days	-	-	72.16
			Grass seed, PLS lbs.	-	-	8.94
			Hay, tons (30 acres only)	-	-	0.54
			Hay, lbs/inch irrigation water	-	-	173
			Hay, lbs/inch total water	-	-	31
			Pounds water/lb of hay	-	-	7,296

Site 17, continued

Item			2005	2006	2007
	Field No. 3				
	Cotton (double cropped with wheat for grazing in 2007)				
		Tillage system	Conventional	-	Limit-till
		Cover crop	Wheat	-	Wheat
		Variety	'FiberMax 960 B2R'	-	'FiberMax 9058'
		Row spacing, inches	30	-	30
	Yield/acre				
		Grazing on wheat cover crop, animal-days	none	-	27.48
		Lint, lb	1,658	-	1,526
		Lint, lbs/inch irrigation water	176	-	162
		Lint, lbs/inch total water	62	-	40
		Seed, tons	0.21	-	0.99
		Pounds water/lb of lint	3,669	-	5,637
	Field No. 3				
	Corn (double cropped with non-irrigated TAM 105 wheat for grazing in 2006)				
		Tillage system	-	Limit-till	-
		Cover crop	-	None	-
		Variety	-	'NC+7117'	-
		Row spacing, inches	-	20	-
	Yield/acre				
		Grazed, animal days	-	122.73	-
		Silage, tons (as ensiled)	-	29.09	-
		Silage, lbs/inch irrigation water	-	2,731	-
		Silage, lbs/inch total water	-	1,503	-
		Pounds water/lb of silage	-	150	-
Fertilizer					
	lbs/system acre				
		Nitrogen	114	151	90
		Phosphorus (P_2O_5)	31	8	38
		Potassium (K_2O)	0	0	0
		Sulfur (S)	0	0	7
Water use, inches					
	Irrigation				
	By field				
		Field 1	6.9	5.5	8.3
		Field 2	15.9	16.8	6.3
		Field 3	9.4	21.3	9.5
	By system		10.51	16.28	8.3
	Precipitation		17.5	17.4	28.6
	Total system (irrigation + precipitation)		28.0	33.7	36.9
Income and Expense, $/system acre					
	Projected returns		762.52	708.89	760.38
	Costs				
	Total variable costs		487.61	382.33	485.50
	Total fixed costs		86.47	93.40	93.40
	Total all costs		574.08	475.73	578.90
	Net returns				
	Per system acre		188.44	233.16	181.48
	Per acre inch of irrigation water		17.93	14.33	21.83
	Per pound of Nitrogen		1.65	1.54	2.02
	Gross margin				
	Per system acre		274.91	326.56	274.88
	Per acre inch of irrigation water		26.16	20.06	33.06

Site 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			
Item				2005	2006	2007
Crops						
	Field No. 1					
	Grain sorghum					
			Tillage system	Conventional	-	-
			Cover crop	None	-	-
			Variety	'DeKalb 404'	-	-
			Row spacing, inches	40	-	-
		Yield/acre				
			Grain, lbs	5115	-	-
			Grain, lbs/inch irrigation water	1,705	-	-
			Grain, lbs/inch total water	262	-	-
			Pounds water/lb of grain	862	-	-
	Field No. 1					
	Cotton					
			Tillage system	-	Conventioinal	-
			Cover crop	-	None	-
			Variety	-	'AFD 3511 RR'	-
			Row spacing, inches	-	40	-
		Yield/acre				
			Lint, lb	-	879	-
			Lint, lbs/inch irrigation water	-	66	-
			Lint, lbs/inch total water	-	30	-
			Seed, tons	-	0.62	-
			Pounds water/lb of lint	-	7,586	-
	Field No. 1					
	Wheat					
			Tillage system	-	-	Limit-till
			Cover crop	-	-	none
			Variety	-	-	TAM 111
			Row spacing, inches	-	-	40
		Yield/acre				
			Grain, lbs	-	-	1,499
			Grain, lbs/inch irrigation water	-	-	500
			Grain, lbs/inch total water	-	-	47
			Pounds water/lb of grain	-	-	4,795
	Field No. 2					
	Cotton					
			Tillage system	Conventional	-	-
			Cover crop	No	-	-
			Variety	'AFD 3511 RR'	-	-
			Row spacing, inches	40	-	-
		Yield/acre				
			Lint, lb	992	-	-
			Lint, lbs/inch irrigation water	113	-	-
			Lint, lbs/inch total water	39	-	-
			Seed, tons	0.83	-	-
			Pounds water/lb of lint	5,757	-	-
	Field No. 2 (double cropped in 2006)					
	Oats					
			Tillage system	-	Limit-till	-
			Variety	-	Magnum	-
		Yield/acre				
			Silage, tons	-	4.88	-
			Silage, lbs/inch irrigation water	-	2,270	-
			Silage, lbs/inch total water	-	790	-
			Pounds water/lb of silage	-	286	-

Site 18, continued

Item				2005	2006	2007
	Field No. 2 (double cropped in 2006)					
	Forage Sorghum					
			Tillage system	-	Drilled	-
			Cover crop	-	Oat stubble	-
			Variety	-		-
			Row spacing, inches	-	8	-
		Yield/acre				
			Hay, tons	-	1.43	-
			Hay, lbs/inch irrigation water	-	454	-
			Hay, lbs/inch total water	-	199	-
			Pounds water/lb of hay	-	1,135	-
	Field No. 2					
	Grain sorghum					
			Tillage system	-	-	Limit-till
			Cover crop	-	-	none
			Variety	-	-	'Frontier 647'
			Row spacing, inches	-	-	40
		Yield/acre				
			Grain, lbs	-	-	7,515
			Grain, lbs/inch irrigation water	-	-	982
			Grain, lbs/inch total water	-	-	206
			Pounds water/lb of grain	-	-	1,097
Fertilizer						
		lbs/system acre				
			Nitrogen	73	56	88
			Phosphorus (P_2O_5)	8	8.3	5
			Potassium (K_2O)	0	0	0
			Sulphur	7	6.8	0
Water use, inches						
	Irrigation					
		By field				
			Field 1	3	13.4	3.0
			Field 2 (2006 oats)	8.75	4.3	7.7
			Field 2 (2006 forage sorghum)	-	6.3	-
		By system		5.9	12.0	5.3
	Precipitation			16.5	16.1	28.8
	Total system (irrigation + precipitation)			22.4	28.1	34.1
Income and Expense, $/system acre						
	Projected returns			400.54	406.79	278.56
	Costs					
		Total variable costs		305.20	360.50	205.83
		Total fixed costs		78.60	78.60	58.82
		Total all costs		383.80	439.10	264.65
	Net returns					
		Per system acre		16.74	-32.31	13.91
		Per acre inch of irrigation water		2.84	-2.69	2.60
		Per pound of Nitrogen		0.23	-0.58	0.16
	Gross margin					
		Per system acre		95.34	46.29	72.73
		Per acre inch of irrigation water		16.18	3.86	13.62

Site 19 Description						
	Total system acres:		120.4			
	Field No. 1:	*2005 only*				
		Acres:	75.3			
		Major soil type:				
			Pullman clay loam; 0 to 1%slope			
	Field No. 2:	*2005 only*				
		Acres:	45.1			
		Major soil type:				
			Pullman clay loam; 0 to 1%slope			
	Field No. 3:	*2006 only*				
		Acres:	45.3			
		Major soil type:				
			Pullman clay loam; 0 to 1%slope			
	Field No. 4:	*2006 only*				
		Acres:	75.1			
		Major soil type:				
			Pullman clay loam; 0 to 1%slope			
	Field No. 5:	*2007 only*				
		Acres:	75.8			
		Major soil type:				
			Pullman clay loam; 0 to 1%slope			
	Field No. 6:	*2007 only*				
		Acres:	45.6			
		Major soil type:				
			Pullman clay loam; 0 to 1%slope			

Item				2005	2006	2007
Crops						
	Field No. 1					
	Cotton					
			Tillage system	Conventional	-	-
			Cover crop	None	-	-
			Variety	'AFD 3511'	-	-
			Row spacing, inches	40		
		Yield/acre				
			Lint, lb	948	-	-
			Lint, lbs/inch irrigation water	108	-	-
			Lint, lbs/inch total water	42	-	-
			Seed, tons	0.71	-	-
			Pounds water/lb of lint	5,415		
	Field No. 2					
	Pearl millet					
			Tillage system	Conventional	-	-
			Cover crop	None	-	-
		Variety		Seed millet	-	-
			Row spacing, inches	40	-	-
		Yield/acre				
			Seed, lb	3,876	-	-
			Seed, lbs/inch irrigation water	337	-	-
			Seed, lbs/inch total water	153	-	-
			Pounds water/lb of seed	1,482	-	-
	Field No. 3					
	Pearl millet					
			Tillage system	-	Conventional	-
			Cover crop	-	None	-
			Variety	-	Seed Millet	-
			Row spacing, inches	-	40	-
		Yield/acre				
			Seed, lb	-	2,488	-
			Seed, lbs/inch irrigation water	-	244	-
			Seed, lbs/inch total water	-	107	-
			Pounds water/lb of seed	-	2,118	-

Site 19, continued

Item				2005	2006	2007
	Field No.4					
	Cotton					
			Tillage system		Conventional	
			Cover crop		None	
			Variety		‘FM 960 BR’	
			Row spacing, inches		40	
		Yield/acre				
			Lint, lb	-	931	-
			Lint, lbs/inch irrigation water	-	98	-
			Lint, lbs/inch total water	-	41	-
			Seed, tons	-	0.71	-
			Pounds water/lb of lint	-	5,493	-
	Field No. 5					
	Cotton					
			Tillage system	-	-	Conventional
			Cover crop	-	-	None
			Variety	-	-	‘FM 9058’
			Row spacing, inches			40
		Yield/acre				
			Lint, lb	-	-	1,348
			Lint, lbs/inch irrigation water	-	-	172
			Lint, lbs/inch total water	-	-	35
			Seed, tons	-	-	0.88
			Pounds water/lb of lint			6,542
	Field No. 6					
	Pearl millet					
			Tillage system	-	-	Conventional
			Cover crop	-	-	None
		Variety		-	-	Seed millet
			Row spacing, inches	-	-	40
		Yield/acre				
			Seed, lb	-	-	3,706
			Seed, lbs/inch irrigation water	-	-	533
			Seed, lbs/inch total water	-	-	97
			Pounds water/lb of seed	-	-	2,325
Fertilizer						
		lbs/system acre				
			Nitrogen	108	80	158
			Phosphorus (P_2O_5)	0	0	65
			Potassium (K_2O)	0	0	0
			Other	0	0	0
Water use, inches						
	Irrigation					
		By field				
			Field 1	8.8	-	-
			Field 2	11.5	-	-
			Field 3	-	10.2	-
			Field 4	-	9.5	-
			Field 5	-	-	7.8
			Field 6	-	-	7.0
		By system		9.8	9.8	7.6
	Precipitation			13.9	13.1	31.2
	Total system (irrigation + precipitation)			23.7	22.9	38.7
Income and Expense, $/system acre						
	Projected returns			611.44	543.76	879.57
	Costs					
		Total variable costs		345.86	369.88	482.36
		Total fixed costs		78.00	78.60	78.60
		Total all costs		423.86	448.48	560.96
	Net returns					
		Per system acre		187.58	95.28	318.61
		Per acre inch of irrigation water		19.12	9.76	42.10
		Per pound of Nitrogen		1.74	1.19	2.02
	Gross margin					
		Per system acre		265.58	173.88	397.21
		Per acre inch of irrigation water		27.07	17.81	52.49

Site 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			
Item				2005	2006	2007
Crops						
	Field No. 1					
	Wheat/forage sorghum double cropped					
			Tillage system	Conventional	-	-
			Variety, wheat	'Weather Master'	-	-
			Variety, forage sorghum	'DeKalb 5907'	-	-
			Row spacing, inches	20	-	-
		Yield/acre (as ensiled)				
			Wheat silage, tons	16.1	-	-
			Sorghum silage, tons	26.0	-	-
			Silage, lbs/inch irrigation water	3,742	-	-
			Silage, lbs/inch total water	2,245	-	-
			Pounds water/lb of silage	101	-	-
	Field No. 1					
	Corn					
			Tillage system	-	Conventional	-
			Cover crop	-	None	-
			Variety	-	'Pioneer 32B33'	-
			Row spacing, inches	-	20	-
		Yield/acre (as ensiled)				
			Silage, tons	-	29.54	-
			Silage, lbs/inch irrigation water	-	2,382	-
			Silage, lbs/inch total water	-	1,417	-
			Pounds water/lb of silage	-	160	-
	Field No. 1					
	Triticale/ corn double-cropped					
			Tillage system	-	-	Conventional
			Cover crop	-	-	Corn stubble
			Variety, triticale	-	-	'Slick Trit'
			Variety, corn	-	-	'Pioneer 31G65'
			Row spacing, inches	-	-	20
		Yield/acre, (as ensiled)				
			Triticale silage, tons	-	-	13
			Corn silage, tons	-	-	30
			Silage, lbs/inch irrigation water	-	-	3,656
			Silage, lbs/inch total water	-	-	1,667
			Pounds water/lb of silage	-	-	136
	Field No. 2					
	Corn, followed by triticale					
			Tillage system	Conventional	-	-
			Variety	'Pioneer 32B29'	-	-
			Row spacing, inches	20	-	-
		Yield/acre (as ensiled)				
			Corn silage, tons	30	-	-
			Silage, lbs/inch irrigation water	3,000	-	-
			Silage, lbs/inch total water	1,714	-	-
			Pounds water/lb of silage	132	-	-
	Field No. 2					
	Triticale/ forage sorghum double-cropped					
			Tillage system	-	Limit-till	Conventional
			Cover crop	-	Corn stubble	Sorghum stubble
			Variety, triticale	-	'Slick Trit'	'Slick Trit'
			Variety, forage sorghum	-	'DeKalb 5909 '	'DeKalb 5909 '
			Row spacing, inches	-	20	20
		Yield/acre, (as ensiled)				
			Triticale silage, tons	-	21.3	22
			Sorghum silage, tons	-	26.4	25
			Silage, lbs/inch irrigation water	-	5,021	3,754
			Silage, lbs/inch total water	-	2,659	1,770
			Pounds water/lb of silage	-	85	128

Site 20, continued

Item				2005	2006	2007
Fertilizer						
		lbs/system acre				
			Nitrogen	436	232	391
			Phosphorus (P_2O_5)	127	46	138
			Potassium (K_2O)	71	0	0
			Zinc	24	0	0
Water use, inches						
	Irrigation					
		By field				
			Field 1 (2007 triticale)	22.5	24.8	9.3
			Field 1 (2007 corn)	-	-	14.3
			Field 2 (2006 triticale)	20	10.0	13.5
			Field 2 (2006 forage sorghum)	-	9.0	11.6
		By system		21.3	21.9	24.274
	Precipitation			15.0	16.88	28.1
	Total system (irrigation + precipitation)			36.3	38.8	52.3
Income and Expense, $/system acre						
	Projected returns			715.09	757.29	1054.72
	Costs					
		Total variable costs		654.87	405.90	574.98
		Total fixed costs		109.44	108.60	108.60
		Total all costs		764.31	514.50	683.58
	Net returns					
		Per system acre		-49.22	242.79	371.14
		Per acre inch of irrigation water		-2.32	11.07	15.29
		Per pound of Nitrogen		-0.11	1.05	0.95
	Gross margin					
		Per system acre		60.22	351.39	479.74
		Per acre inch of irrigation water		2.83	16.03	19.76

				2005	2006	2007
Site 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			
Item				2005	2006	2007
Crops						
	Cattle, stocker steers, contract grazing			None	Yes	None
	Field No. 1					
	Cotton					
			Tillage system	Conventional	-	-
			Cover crop	None	-	-
			Variety	'DP 444 BF/RR'	-	-
			Row spacing, inches	40	-	-
		Yield/acre				
			Lint, lb	1,279	-	-
			Lint, lbs/inch irrigation water	188	-	-
			Lint, lbs/inch total water	59	-	-
			Seed, tons	0.79	-	-
			Pounds water/lb of lint	3,819	-	-
	Field No. 1					
	Corn					
		Tillage system		-	Conventional	-
			Cover crop	-	None	-
			Variety	-	'Pioneer 34K77'	-
			Row spacing, inches	-	40	-
		Yield/acre				
			Grain, lbs	-	6982	-
			Grain, lbs/inch irrigation water	-	382	-
			Grain, lbs/inch total water	-	196	-
			Pounds water/lb of grain	-	1,156	-
	Field No. 1					
	Sideoats grama					
			Variety			"Haskell"
			Row spacing			40
		Yield/acre				
			Seed, pls lb			147.6
			Hay, tons			0.49
			Seed, lbs/inch irrigation water			23
			Seed, lbs/inch total water			4
			Pounds water/lb of seed			58,873
	Field No. 2					
	Wheat					
	Cotton					
			Tillage system	Conventional	Conventional	-
			Cover crop	None	Wheat	-
			Variety	'FM 960 RR/BR'	'FM 960 RR BR'	-
			Row spacing, inches	40	40	-
		Yield/acre				
			Wheat, animal days	-	31.81	-
			Cotton			
			Lint, lb	1,228	1,201	-
			Lint, lbs/inch irrigation water	181	82	-
			Lint, lbs/inch total water	57	100	-
			Seed, tons	0.82	0.88	-
			Pounds water/lb of lint	3,978	6,026	-

Site 21, continued

Item				2005	2006	2007
	Field No. 2					
	Corn					
		Tillage system		-		Conventional
			Cover crop	-		None
			Variety	-		Food corn
			Row spacing, inches	-		40
		Yield/acre				
			Grain, lbs	-		9,670
			Grain, lbs/inch irrigation water	-		953
			Grain, lbs/inch total water	-		230
			Pounds water/lb of grain	-		983
Fertilizer						
		lbs/system acre				
			Nitrogen	153	166	107
			Phosphorus (P_2O_5)	15	26	52
			Potassium (K_2O)	0	0	0
			Sulphur	11	0	0
Water use, inches						
	Irrigation					
		By field				
			Field 1	6.8	18.3	6.6
			Field 2	6.8	14.6	10.2
		By system		6.8	16.5	8.3
	Precipitation			14.8	17.4	31.9
	Total system (irrigation + precipitation)			21.6	33.9	40.2
Income and Expense, $/system acre						
	Projected returns			757.28	626.15	667.85
	Costs					
		Total variable costs		566.88	458.53	357.65
		Total fixed costs		78.60	78.60	78.60
		Total all costs		645.48	537.13	436.25
	Net returns					
		Per system acre		111.80	89.02	231.60
		Per acre inch of irrigation water		16.44	5.41	27.74
		Per pound of Nitrogen		0.73	0.54	2.16
	Gross margin					
		Per system acre		190.40	167.62	310.20
		Per acre inch of irrigation water		28.00	10.19	37.16

Site 22 Description

Total system acres: 147.6

Field No. 1: Acres: 71.6
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

Item	2005	2006	2007
Crops			
Field No. 1			
Corn			
Tillage system	Conventional	-	-
Cover crop	None	-	-
Variety	‘Pioneer 33M54’	-	-
Row spacing, inches	40	-	-
Yield/acre			
Grain, lbs	13,204	-	-
Grain, lbs/inch irrigation water	695	-	-
Grain, lbs/inch total water	387	-	-
Pounds water/lb of grain	584	-	-
Field No. 1			
Cotton			
Tillage system	-	Conventional	Conventional
Cover crop	-	None	Wheat
Variety	-	‘PM 2266’	'FM958 LL'
Row spacing, inches	-	30	30
Yield/acre			
Lint, lb	-	2,181	1,966
Lint, lbs/inch irrigation water	-	124	166
Lint, lbs/inch total water	-	69	49
Seed, tons	-	1.42	1.28
Pounds water/lb of lint	-	3,287	4,608
Field No. 2			
Cotton			
Tillage system	Conventional	-	Conventional
Cover crop	None	-	None
Variety	‘Paymaster 2266’	-	'FM958 LL'
Row spacing, inches	40	-	30
Yield/acre			
Lint, lb	1,177	-	1,880
Lint, lbs/inch irrigation water	100	-	159
Lint, lbs/inch total water	44	-	47
Seed, tons	0.94	-	1.22
Pounds water/lb of lint	5,169	-	4,817
Field No. 2			
Corn			
Tillage system	-	Conventional	-
Cover crop	-	None	-
Variety	-	‘Pioneer 33M54’	-
Row spacing, inches	-	30	-
Yield/acre			
Grain, lbs	-	11,156	-
Grain, lbs/inch irrigation water	-	426	-
Grain, lbs/inch total water	-	277	-
Pounds water/lb of grain	-	817	-
Fertilizer			
Compost, tons/acre	0	1.5	2
Nitrogen [1]	184	194	102
Phosphorus (P_2O_5)	110	45	60
Potassium (K_2O)	15	45	60
Sulphur	8	10.5	20

Site 22, continued

Item	2005	2006	2007
Water use, inches			
Irrigation			
By field			
Field 1	19.0	17.6	11.9
Field 2	11.8	26.2	11.9
By system	15.3	22.0	11.9
Precipitation	15.1	14.1	28.2
Total system (irrigation + precipitation)	30.4	36.1	40.1
Income and Expense, $/system acre			
Projected returns	706.62	1,034.25	1,211.60
Costs			
Total variable costs	461.39	669.27	581.67
Total fixed costs	78.60	78.60	78.60
Total all costs	539.99	747.87	660.27
Net returns			
Per system acre	166.63	286.38	551.33
Per acre inch of irrigation water	10.90	13.00	46.49
Per pound of Nitrogen	0.91	1.48	5.41
Gross margin			
Per system acre	245.23	364.98	629.93
Per acre inch of irrigation water	16.04	16.57	53.11

[1]Compost provided 45 lb of N and all other nutrients in 2006, and 60 lbs of N and all other nutrients in 2007

Site 23 Description						
	Total system acres:		105.2			
	Field No. 1:	Acres:	51.5			
		Major soil type:				
			Pullman clay loam; 0 to 1%slope			
	Field No. 2:	Acres:	48.8			
		Major soil type:				
			Pullman clay loam; 0 to 1%slope			
	Field No. 3:	Acres:	4.9			
		Major soil type:				
			Pullman clay loam; 0 to 1%slope			
Item				2005	2006	2007
Crops						
	Field No. 1					
	Cotton					
			Tillage system	‘Conventional’	‘Conventional’	-
			Cover crop	None	None	-
			Variety	‘Americot 427R’	‘Americot 427R’	-
			Row spacing, inches	40	20	-
		Yield/acre				
			Lint, lb	1,205	1,343	-
			Lint, lbs/inch irrigation water	219	115	-
			Lint, lbs/inch total water	67	48	-
			Seed, tons	0.87	0.88	-
			Pounds water/lb of lint	3,360	4,715	-
	Field No. 2					
	Sunflowers					
			Tillage system	Conventional	-	-
			Cover crop	None	-	-
			Variety	‘Blacks’	-	-
			Row spacing, inches	20	-	-
		Yield/acre				
			Seed, lb	2,857	-	-
			Seed, lbs/inch irrigation water	476	-	-
			Seed, lbs/inch total water	155	-	-
			Pounds water/lb of seed	1,457	-	-
	Field No. 1					
	Corn					
			Tillage system	-	-	Conventional
			Cover crop	-	-	None
			Variety	-	-	'Pioneer 36V10'
			Row spacing, inches	-	-	20
		Yield/acre				
			Grain, lbs	-	-	12,722
			Grain, lbs/inch irrigation water	-	-	1,168
			Grain, lbs/inch total water	-	-	332
			Pounds water/lb of grain	-	-	681
	Field No. 2					
	Corn					
			Tillage system	-	Conventional	Conventional
			Cover crop	-	None	None
			Variety	-		'Pioneer 36V10'
			Row spacing, inches	-	20	20
		Yield/acre				
			Grain, lbs	-	8,800	12,722
			Grain, lbs/inch irrigation water	-	484	1,168
			Grain, lbs/inch total water	-	255	332
			Pounds water/lb of grain	-	887	681
Fertilizer						
	Compost, tons/acre[1]			0	1.5	2
		Nitrogen		90	209	328
		Phosphorus (P_2O_5)		0	45	30
		Potassium (K_2O)		0	45	30
		Sulphur		0	12.5	25

Site 23, continued

Item				2005	2006	2007
Water use, inches						
	Irrigation					
		By field				
			Field 1	5.5	11.7	10.9
			Field 2	6.0	18.2	10.9
		By system		5.7	14.9	10.9
	Precipitation			12.4	16.3	27.4
	Total system (irrigation + precipitation)			18.1	31.2	38.3
Income and Expense, $/system acre						
	Projected returns			669.15	718.70	954.14
	Costs					
		Total variable costs		319.93	526.85	549.85
		Total fixed costs		78.60	78.60	78.60
		Total all costs		398.53	605.45	628.45
	Net returns					
		Per system acre		270.62	113.25	325.69
		Per acre inch of irrigation water		47.12	7.62	29.91
		Per pound of Nitrogen		3.01	0.54	0.99
	Gross margin					
		Per system acre		349.22	191.85	404.29
		Per acre inch of irrigation water		60.81	12.91	37.12

[1] Compost provided 45 lbs of N and all other nutrients in 2006, and 30 lbs of N and all other P and K in 2007.

Site 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			
Item				2005	2006	2007
Crops						
	Field No. 1					
	Cotton					
			Tillage system	Conventional	-	-
			Cover crop	None	-	-
			Variety	'PM 2280 BR'	-	-
			Row spacing, inches	30	-	-
		Yield/acre				
			Lint, lb	989	-	-
			Lint, lbs/inch irrigation water	105	-	-
			Lint, lbs/inch total water	41	-	-
			Seed, tons	0.88	-	-
			Pounds water/lb of lint	5,580	-	-
	Field No. 1					
	Corn - Silage					
			Tillage system	-	Conventional	-
			Cover crop	-	None	-
			Variety	-	Pioneer 33V62	-
			Row spacing, inches	-	20	-
		Yield/acre				
			Silage, ton (as ensiled)	-	26.2	-
			Silage, lb/inch irrigation water	-	2,031	-
			Silage, lbs/inch total water	-	1,254	-
			Pounds water/lb of silage	-	180	-
	Field No. 1					
	Corn - Grain					
			Tillage system	-	-	Conventional
			Cover crop	-	-	None
			Variety	-	-	'Pioneer 33V62'
			Row spacing, inches	-	-	20
		Yield/acre				
			Grain, lb	-	-	13,660
			Grain, lbs/inch irrigation water	-	-	890
			Grain, lbs/inch total water	-	-	334
			Pounds water/lb of grain	-	-	677
	Field No. 2					
	Corn					
			Tillage system	Conventional	-	Conventional
			Cover crop	None	-	None
			Variety	'Pioneer 33V62'	-	'Pioneer 33V62'
			Row spacing, inches	20	-	20
		Yield/acre				
			Grain, lb	12,139	-	13,660
			Grain, lbs/inch irrigation water	586	-	890
			Grain, lbs/inch total water	340	-	334
			Pounds water/lb of grain	665	-	677
	Field No. 2					
	Cotton					
			Tillage system	-	Conventional	-
			Cover crop	-	None	-
			Variety	-	FM 9060 Flex and FM 9063B2Flex	-
			Row spacing, inches	-	20	-
		Yield/acre				
			Lint, lb	-	1,160	-
			Lint, lbs/inch irrigation water	-	90	-
			Lint, lbs/inch total water	-	40	-
			Seed, tons	-	0.85	-
			Pounds water/lb of lint	-	5,635	-

Site 24, continued

Item				2005	2006	2007
Fertilizer						
		lbs/system acre				
			Nitrogen	187	170	281
			Phosphorus (P_2O_5)	58	0	78
			Potassium (K_2O)	0	0	0
			Other	0	0	0
Water use, inches						
	Irrigation					
		By field				
			Field 1	9.4	25.8	15.3
			Field 2	20.7	12.9	15.3
		By system		15.1	19.3	15.3
	Precipitation			15.0	16.0	25.5
	Total system (irrigation + precipitation)			30.1	35.3	40.9
Income and Expense, $/system acre						
	Projected returns			686.63	676.57	1024.50
	Costs					
		Total variable costs		443.10	513.61	541.98
		Total fixed costs		93.66	93.65	108.60
		Total all costs		536.76	607.26	650.58
	Net returns					
		Per system acre		149.87	69.31	373.92
		Per acre inch of irrigation water		9.95	3.59	24.38
		Per pound of Nitrogen		0.80	0.41	1.33
	Gross margin					
		Per system acre		243.53	162.96	482.52
		Per acre inch of irrigation water		16.16	8.43	31.46

Site 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			
Item				2005	2006	2007
Crops					SITE TERMINATED	SITE TERMINATED
	Field No. 1					
	Cotton					
			Tillage system	Limit-till		
			Cover crop	None		
			Variety	'PM 2326 RR'		
			Row spacing, inches	40		
		Yield/acre				
			Lint, lb	676		
			Lint, lbs/inch irrigation water	dryland		
			Lint, lbs/inch total water	37		
			Seed, tons	0.58		
			Pounds water/lb of lint	6,156		
	Field No. 2					
	Grain sorghum					
			Tillage system	Limit-till		
			Cover crop	None		
			Variety	'DeKalb 39Y'		
			Row spacing, inches	40		
		Yield/acre				
			Grain, lbs	2,758		
			Grain, lbs/inch irrigation water	dryland		
			Grain, lbs/inch total water	150		
			Pounds water/lb of grain	1,509		
	Field No. 3					
	Cotton					
			Tillage system	Limit-till		
			Cover crop	None		
			Variety	'PM 2326 RR'		
			Row spacing, inches	40		
		Yield/acre				
			Lint, lb	676		
			Lint, lbs/inch irrigation water	dryland		
			Lint, lbs/inch total water	37		
			Seed, tons	0.58		
			Pounds water/lb of lint	6,156		
Fertilizer						
		lbs/system acre				
			Nitrogen	19		
			Phosphorus (P_2O_5)	0		
			Potassium (K_2O)	0		
			Other	0		
Water use, inches						
	Irrigation			Dryland		
		By field				
			Field 1	Dryland		
			Field 2	Dryland		
		By system		Dryland		
	Precipitation			18.4		
	Total system (irrigation + precipitation)			18.4		
Income and Expense, $/system acre						
	Projected returns			267.30		
	Costs					
		Total variable costs		184.71		
		Total fixed costs		15.00		
		Total all costs		199.71		
	Net returns					
		Per system acre		67.59		
		Per acre inch of irrigation water		dryland		
		Per pound of Nitrogen		3.56		
	Gross margin					
		Per system acre		82.59		
				Dryland		

Site 26 Description						
	Total system acres:		125.2			
	Field No. 1:	Acres:	62.9			
		Major soil type:				
			Bippus loam; 0 to 3%slope			
			Mansker loam, 3 to 5%slope			
	Field No. 2:	Acres:	62.3			
		Major soil type:				
			Bippus loam; 0 to 3%slope			
			Mansker loam, 3 to 5%slope			
Item				2005	2006	2007
Crops						
	Cattle contract grazing, dry cows			No	No	Yes
	Field No. 1					
	Cotton					
			Tillage system	Limit-till	-	-
			Cover crop	None	-	-
			Variety	'PM 2379 RR'	-	-
			Row spacing, inches	40	-	-
		Yield/acre				
			Lint, lb	1,213	-	-
			Lint, lbs/inch irrigation water	143	-	-
			Lint, lbs/inch total water	57	-	-
			Seed, tons	0.93	-	-
			Pounds water/lb of lint	3,953	-	-
	Field No. 1					
	Corn					
			Tillage system	-	Conventional	-
			Cover crop	-	None	-
			Variety	-	'Pioneer 3362'	-
			Row spacing, inches	-	20	-
		Yield/acre				
			Grain, lbs	-	9,717	-
			Grain, lbs/inch irrigation water	-	456	-
			Grain, lbs/inch total water	-	260	-
			Pounds water/lb of grain	-	868	-
	Field No. 1					
	Pearl millet					
			Tillage system	-	-	Conventional
			Cover crop	-	-	None
		Variety		-	-	Seed millet
			Row spacing, inches	-	-	20
		Yield/acre				
			Cattle grazing residue, animal-days	-	-	42.98
			Seed, lb	-	-	3,507
			Seed, lbs/inch irrigation water	-	-	379
			Seed, lbs/inch total water	-	-	106
			Pounds water/lb of seed	-	-	2,131
	Field No. 2					
	Corn					
			Tillage system	Conventional	-	Conventional
			Cover crop	None	-	None
			Variety	'Pioneer 3362'	-	'Pioneer 33B10'
			Row spacing, inches	20	-	20
		Yield/acre				
			Grain, bu	12,588	-	12,864
			Grain, lbs/inch irrigation water	1007	-	956
			Grain, lbs/inch total water	500	-	345
			Pounds water/lb of grain	453	-	655
	Field No. 2					
	Cotton					
			Tillage system	-	Limit-till	-
			Cover crop	-	None	-
			Variety	-	'PM 2379 RR'	-
			Row spacing, inches	-	20	-
		Yield/acre				
			Lint, lb	-	2,112	-
			Lint, lbs/inch irrigation water	-	199	-
			Lint, lbs/inch total water	-	79	-
			Seed, tons	-	1.37	-
			Pounds water/lb of lint	-	2,848	-

Site 26, continued

Item	2005	2006	2007
Fertilizer			
lbs/system acre			
Compost, tons/acre [1]	0	1.5	0.75 (on Field 1 only)
Nitrogen	136	209	246
Phosphorus (P_2O_5)	48	45	11
Potassium (K_2O)	0	45	11
Sulfur	0	10.7	3
Water use, inches			
Irrigation			
By field			
Field 1	8.5	21.3	9.3
Field 2	12.5	10.6	13.5
By system	10.5	16.0	11.3
Precipitation	12.7	16.0	23.8
Total system (irrigation + precipitation)	23.2	32.0	35.1
Income and Expense, $/system acre			
Projected returns	779.52	969.66	880.9
Costs			
Total variable costs	484.55	631.6	408.62
Total fixed costs	93.53	93.67	93.67
Total all costs	578.08	725.27	502.29
Net returns			
Per system acre	201.44	244.39	378.61
Per acre inch of irrigation water	19.20	15.30	33.39
Per pound of Nitrogen	1.48	1.17	1.54
Gross margin			
Per system acre	294.97	338.06	472.28
Per acre inch of irrigation water	28.12	21.16	41.65

[1] Compost provided 45 lbs. of N in 2006 and 11 lbs of N plus all other nutrients in 2006 and 2007.

Site 27 Description						
	Total system acres:		62.4			
	Field No. 1:	Acres:	46.2			
		Major soil type:				
			Pullman clay loam; 0 to 1%slope			
	Field No. 2:	Acres:	16.2			
		Major soil type:				
			Pullman clay loam; 0 to 1%slope			
Item				2005	2006	2007
Crops				ENTERED PROJECT		
	Field No. 1			IN YEAR 2		
	Cotton					
			Tillage system	-	Limit-till	-
			Cover crop	-	Wheat	-
			Variety	-	'BW 4630'	-
			Row spacing, inches	-	40	-
		Yield/acre				
			Lint, lb	-	2,240	-
			Lint, lbs/inch irrigation water	-	124	-
			Lint, lbs/inch total water	-	64	-
			Seed, tons	-	1.46	-
			Pounds water/lb of lint	-	3,522	-
	Field No. 1					
	Corn - Silage					
			Tillage system	-	-	Conventional
			Cover crop	-	-	None
			Variety	-	-	'Pioneer 31G71'
			Row spacing, inches	-	-	20
		Yield/acre				
			Silage, ton (as ensiled)	-	-	36
			Silage, lb/inch irrigation water	-	-	5,538
			Silage, lbs/inch total water	-	-	1,754
			Pounds water/lb of silage	-	-	129
Fertilizer						
		lbs/system acre				
			Nitrogen		145	174
			Phosphorus (P_2O_5) [1]		5.8	60
			Potassium (K_2O)		1	0
			Other		0	0
Water use, inches						
	Irrigation					
		By field				
			Field 1		18.00	13.0
		By system			18.00	13.0
	Precipitation				16.88	28.1
	Total system (irrigation + precipitation)				34.88	41.1
Income and Expense, $/system acre						
	Projected returns				1,450.96	900.00
		Costs				
			Total variable costs		895.02	585.60
			Total fixed costs		120.00	120.00
			Total all costs		1,015.02	705.60
		Net returns				
			Per system acre		435.94	194.40
			Per acre inch of irrigation water		24.22	14.95
			Per pound of Nitrogen		3.01	1.12
	Gross margin					
		Per system acre			555.94	314.40
		Per acre inch of irrigation water			30.89	24.18
	[1] Phosphorus was applied through subsurface drip irrigation.					

OVERALL SUMMARY OF YEARS 1—3

A key defining characteristic of this demonstration project is the fact that producers make the decisions on cropping and livestock practices. We simply document what these decisions are, the impact that they have on water use, and on the economic returns. This also provides a way to monitor over time what changes are occurring in crop and livestock enterprise decisions in this 2-county area.

Cropping and Livestock Trends. With 3 years of data, certain trends and changes in land-use in this area are beginning to emerge. When the numbers of sites that include each different enterprise are plotted across the three years, the most dramatic change is the decline in sites that included cotton (Fig. 6). This decline in cotton is apparent not only as a

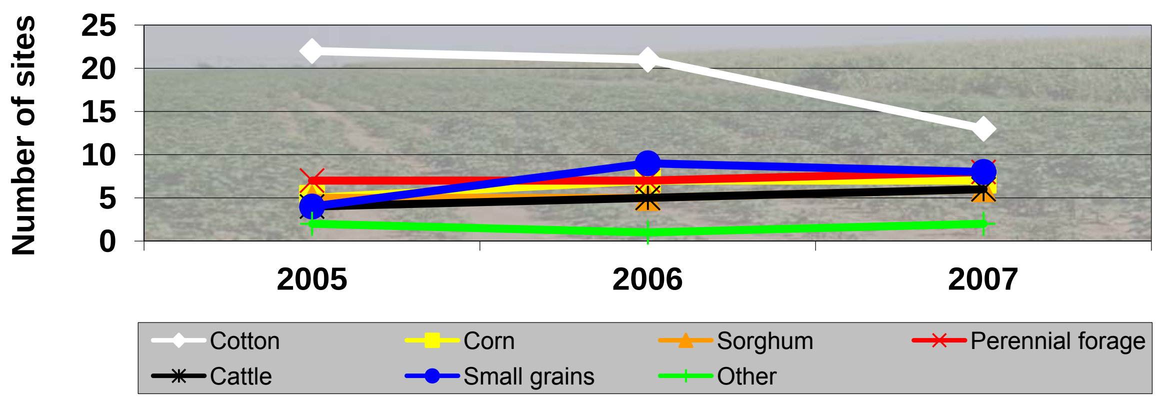


Figure 6. Number of systems (sites) that include cotton, corn, sorghum, perennial forages, cattle, small grains, and other crops within the 26 producer systems located in Hale and Floyd Counties.

change in numbers of sites, but it is also evident in the change in total acres within the overall project area on which cotton was planted (Fig. 7 and 8) and represents a decline of about 25% (Fig. 8 and 9). Thus, this change is due to both a reduction in sites and a reduction in acres within sites. Between 2006 and 2007, two sites that had been cotton monocultures diversified their systems to include either corn or grain sorghum. One site that had been a cotton/corn system became a cotton monoculture and five sites that had

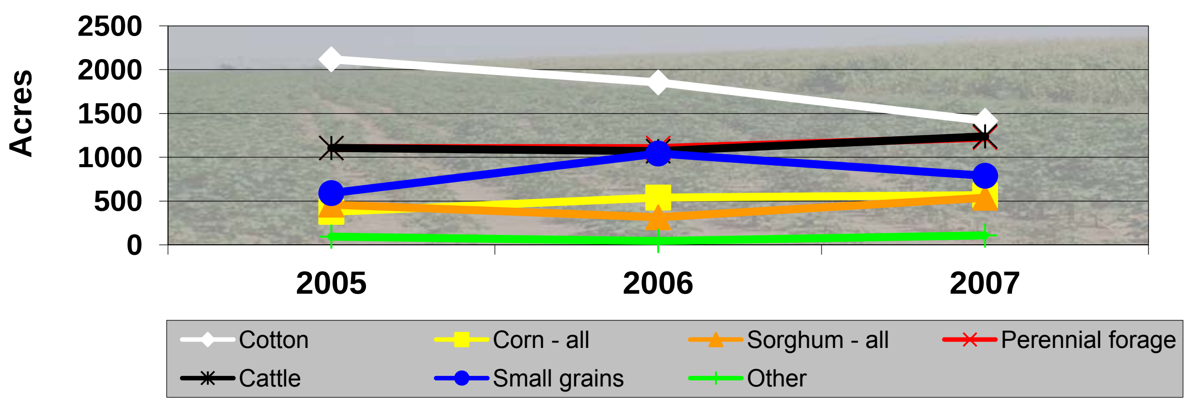


Figure 7. Number of acres that include cotton, corn, sorghum, perennial forages, cattle, small grains and other crops within the 26 producer systems located in Hale and Floyd Counties.

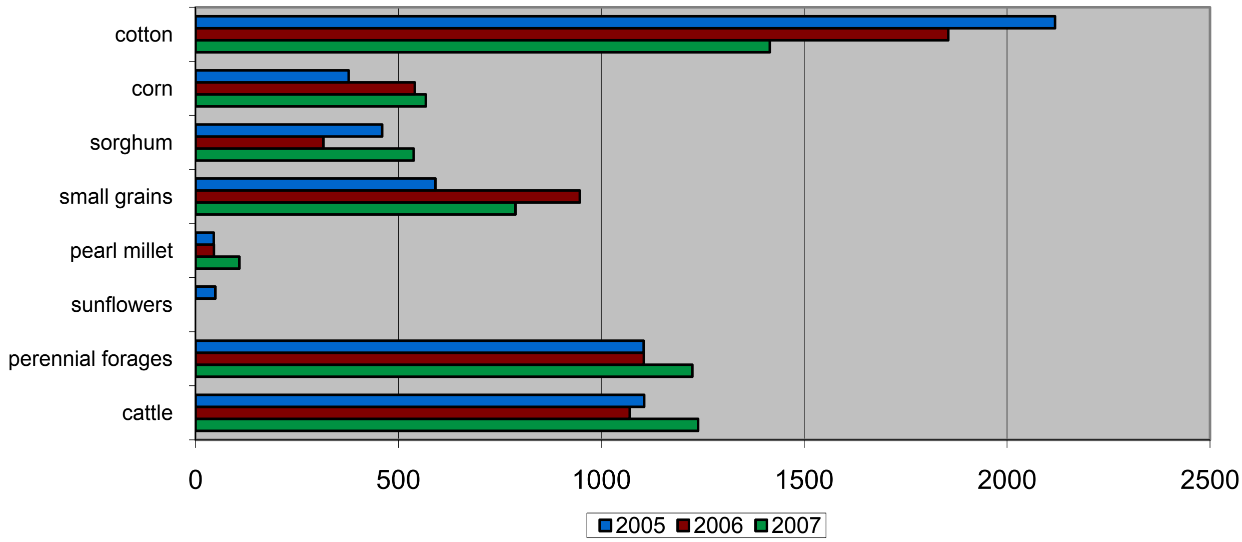


Figure 8. Total number of acres planted to cotton, corn, sorghum, small grains, pearl millet sunflowers, perennial forages and acres grazed by cattle in 26 producer systems in Hale and Floyd Counties.

previously included cotton in their integrated system, dropped cotton and added other crops, forages, and/or livestock.

Other changes in cropping and livestock systems were more subtle but the second largest shifts in producer decisions were to include and/or increase acres of both corn and small grains (Fig. 6, 7, 8 and 9). Small grain acres and numbers of sites that included small grains were larger in 2006 than in 2007 but both years increased over 2005. Compared with year 1, small grain acres increased over 50% while corn acreage increased by about 50%. Number of acres committed to corn has increased in each year but between 2006 and 2007, the increase came largely from expansion of acres within systems already growing corn. Two sites that had previously grown both cotton and corn became corn monocultures in 2007 (Table 13). In 2007, more of the corn crop was harvested as grain, compared with either previous year, while corn for silage decreased in 2007, compared with 2006.

While pearlmillet acres more than doubled between 2005 and (Fig. 8 and 9), this represents an actual increase in acres from 45 in 2005 to 108 acres in 2007. Only one site grew pearlmillet in 2005. A second site was added in 2007.

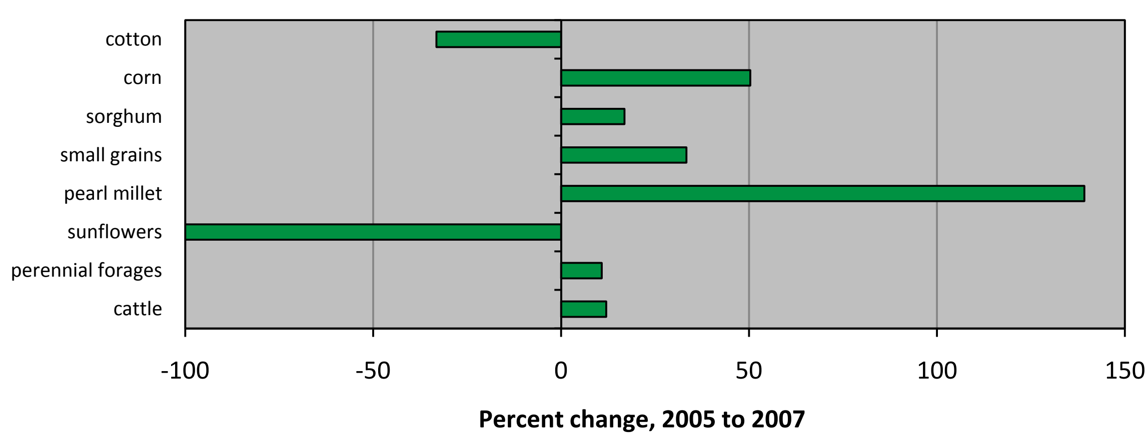


Figure 9. Percent change of acres within crop categories, 2005 to 2007. 2005 is baseline.

Table 11. Summary of results from monitoring 26 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 12. Summary of results from monitoring 26 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 13. Summary of results from monitoring 26 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/pearl millet	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
Pearl millet: 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

Sorghum for grain and for silage has increased slightly (Fig. 8 and 9) with acres of sorghum harvested for grain about double the number of acres in previous years. However, sorghum harvested for silage has declined (Tables 7, 8 and 9). This is of concern because much data exists demonstrating that selected varieties of sorghum for silage rival corn in both quality and yield while requiring as little as half of the irrigation water and increasing profitability (Bean and McCollum, 2006). This relationship was also observed at Site No. 20 within the Demonstration project in 2006 (Fig. 10) where sorghum produced only a slightly lower yield with less than half the irrigation water and about twice the profitability as was achieved with corn for silage. During 2007, yield and profitability of sorghum silage was similar to that achieved in 2006 but about 2.5 inches more irrigation water (11.6 vs 9 inches) was applied during 2007 than in 2006 (Fig. 11) in spite of the higher rainfall in 2007. As was observed for sorghum, yield of triticale was similar between the two years but irrigation applied was also somewhat higher in 2007 than 2006 and again, profitability declined. On the other hand, corn yield was also similar between these two years but

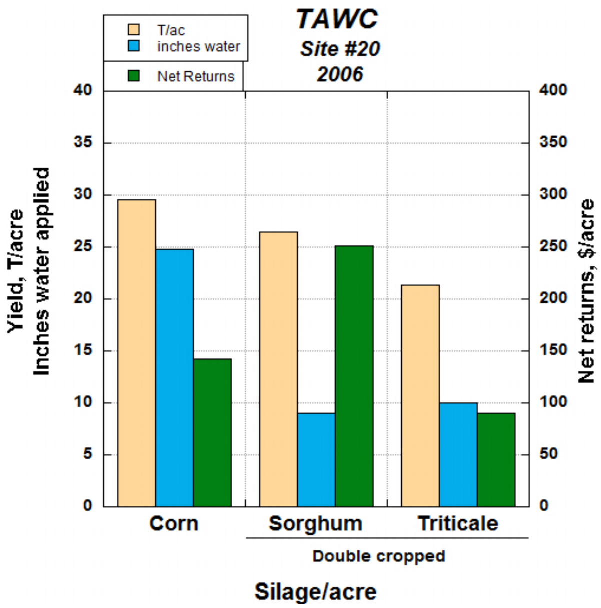


Figure 10. Yield, irrigation applied, and net returns per acre of corn, triticale, and sorghum silages in 2006. Sorghum and triticale were double-cropped.

irrigation water was reduced from 24.8 inches in 2006 to 14.3 inches in 2007 and profitability for corn silage more than doubled.

Several things are important to note about these data. In 2007, when total water applied to corn and the early crop of triticale grown for silage is compared with the total water applied to the double-cropped sorghum and triticale for silage, the amount is similar at about 24 inches. Likewise, when net returns from these crop combinations are totaled, they are similar at about $380/acre. Total tonnage of forage harvested for corn plus triticale was about 43 t/acre while total tonnage of sorghum and triticale was about 47 t/acre. Thus, risk becomes a key question. The risk of growing corn in this environment is greater than the risk of growing sorghum. In fact, 2006 and 2007 represent two extremes in weather with the first a hot and exceptionally dry year and the other a year of cooler growing conditions and precipitation of nearly 10 inches above normal. Corn profitability and irrigated water demands differed greatly between the two years while sorghum differed little. The risk of a successful corn crop is considerably higher than the risk of a successful sorghum crop.

Site No. 20 received 16.9 vs 28.1 inches of precipitation in 2006 and 2007, respectively, with more favorable distribution over the growing season in 2007 than 2006. Data from this site suggest that more water was applied to sorghum and triticale in 2007 than was required by these crops and that the additional water did not contribute to increased profitability. Sorghum is widely recognized as a drought tolerant crop and this was evident under the hot and dry conditions experienced during 2006. On the other hand, irrigation water applied to corn was adjusted downward in response to the precipitation received in 2007 and was reflected in the greater profitability for this crop. Furthermore, temperatures during the growing season in 2007 were generally lower than in 2006 which likely further favored growth of corn. Such favorable conditions for corn production are not typical of the southern High Plains. It is very unlikely that across most years, corn for

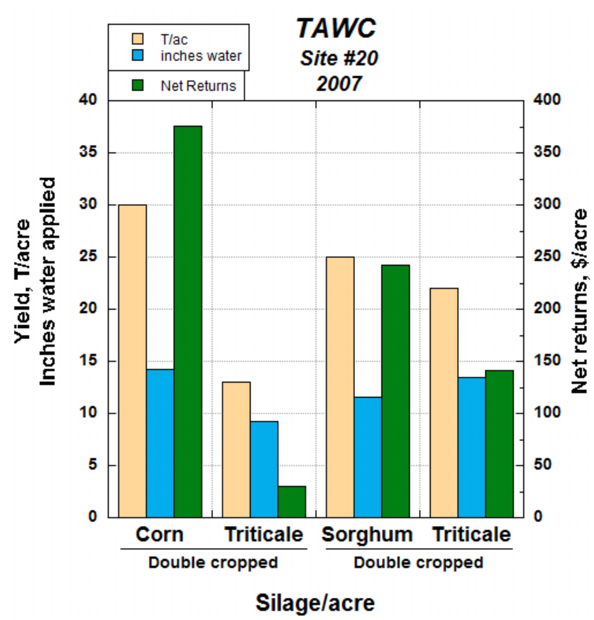


Figure 11. Yield, irrigation applied, and net returns per acre of corn, triticale and sorghum silages in 2007. Corn and triticale, and sorghum and triticale were double-cropped.

grain or for silage can be produced with less than 15 inches of irrigation water as was accomplished at Site 20 during 2007. While timing of precipitation and irrigation events are critical to interpreting crop growth responses, these data strongly suggest that with greater understanding of crop water demands, residual soil moisture, and accurate accounting of effective rainfall, irrigation water can be saved and profitability can be increased.

Numbers of sites that include forages and cattle have increased in each year as well as the total numbers of acres and total numbers of cattle (Fig. 6, 7, 8 and 9). Total acres established in perennial grasses are second only to cotton within the project area. Additionally, the number of sites and total acres established in perennial grasses for grass seed production has also increased from two sites in 2005 with a total of 191 acres to 5 sites in 2007 with a total of 408 acres (Table 7, page 35 and Table 9, page 37).

Water Use and Profitability. Excluding dryland acres, the systems represented in this Demonstration project have averaged 9.2, 14.8, and 10.9 inches of supplemental irrigation water per system acre, annually, for 2005, 2006, and 2007 respectively (Table 14). Averaged over the three years, irrigation water applied to individual system components has ranged from 7.5 inches for perennial grasses to 17 and 18.2 inches applied to corn for grain and silage, respectively (Table 14). Cotton is intermediate at about 11 inches. Water use on small grains varied greatly and has ranged from 4.3 to 11.9. Because of differences in small grain species and intended uses, these numbers require more years of monitoring to see valid patterns emerge. Variation within all categories is large and offers opportunities to compare management strategies with water use and crop profitability for improved water conservation.

Net returns per acre inch of irrigation water in 2007 was greater for the all-forage/livestock system than any other system (Fig. 12). This system also used the lowest total amount of supplemental water for any of the irrigated systems. Cotton monoculture used less water and returned more dollars of profit per unit of water invested than corn monoculture, even in this cooler and wetter year. Integrated crop and livestock systems required less supplemental water and were slightly more profitable per acre inch of irrigation than integrated cropping systems without livestock.

Water and nitrogen use are closely related. Also, nitrogen fertilizer costs are rising rapidly and nitrogen fertilizer manufacturing is one of the most energy expensive inputs in agriculture. In 2007, the livestock system, integrated livestock/cropping systems and multi-cropping systems required less nitrogen fertilizer than the monocultures (Fig. 13). Corn monocultures used nearly three times more nitrogen than any other system.

Net returns above all costs of production was highest for cotton grown in monoculture at over $400 per acre (Fig. 14). Monoculture corn and grass seed production were similar in profitability. As has been shown with research, short-term profitability must be balanced with long-term ability to sustain resource use and optimum, sustainable profits may differ greatly from maximum profits that are achieved with non-sustainable depletion of natural resources.

Table 14. Overall summary of crop production, irrigation, and economic returns within 26 production sites in Hale and Floyd Counties during 2005, 2006 and 2007.

Item	2005	2006	2007	3-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)	1,338
Seed, tons	0.80 (22)	0.95 (20)	1.02 (13)	0.92
Corn				
Grain, lbs	12,729 (3)	8,814 (4)	12,229 (4)	11,257
Silage, tons	30.9 (2)	28.3 (3)	27.3 (3)	28.8
Sorghum				
Grain, lbs	4,147 (3)	2,987 (1)	6,459 (4)	4,531
Silage, tons	26.0 (1)	20.4 (2)	25.0 (1)	23.8
Wheat				
Grain, lbs	2,034 (1)	-	2,613 (5)	2,324
Silage, tons	16.1 (1)	7.0 (1)	-	11.6
Oat				
Silage, tons	-	4.9 (1)	-	4.9
Hay, tons	-	1.8 (1)	-	1.8
Triticale				
Silage, tons	-	21.3 (1)	17.5 (1)	19.4
Pearl millet for seed				
Seed, lbs	3,876 (1)	2,488 (1)	4,002 (2)	3,455
Perennial grass for seed				
Seed, PLS lbs	313 (2)	268 (2)	96 (5)	226
Alfalfa				
Hay, tons	8.3 (1)	9.18 (1)	4.90 (1)	7.46
Precipitation, inches (including all sites)	**14.9**	**15.5**	**27.0**	**19.2**
Irrigation applied, inches (not including dryland)				
By system				
Total irrigation water (system average)	9.2 (26)	14.8 (26)	11.1 (25)	11.7
By crop				
Cotton	8.7 (19)	14.3 (19)	11.3(11)	11.4
Corn grain	17.4 (3)	21.0 (4)	12.5 (4)	17.0
Corn silage	18.0 (2)	24.0 (3)	12.6 (3)	18.2
Sorghum grain	7.5 (1)	4.2 (1)	6.6 (4)	6.1
Sorghum silage	15.0 (1)	12.5 (2)	13.5 (1)	13.7
Wheat grain	-	-	5.3 (3)	5.3
Wheat silage	7.5 (1)	16.3 (1)	-	11.9
Oat silage	-	4.3 (1)	-	4.3
Oat hay	-	4.9 (1)	-	4.9
Triticale silage	-	10.0 (1)	12.9 (1)	11.5
Small grain grazing	0.5 (3)	0.8 (2)	0.8 (3)	0.7
Perennial grasses	6.5 (6)	8.8 (6)	7.1 (7)	7.5
Alfalfa	10.3 (1)	34.5 (1)	10.6 (1)	18.5
Income and Expense, $/system acre				
Projected returns	660.53	773.82	840.02	758.12
Costs				
Total variable costs (all sites)	444.88	504.91	498.48	482.75
Total fixed costs (all sites)	77.57	81.81	81.77	80.38
Total all costs (all sites)	522.45	586.72	580.25	563.14
Gross margin				
Per system acre (all sites)	215.66	268.91	341.54	275.37
Per acre inch irrigation water (irrigated only)	33.52	22.46	33.96	29.98
Net returns over all costs				
Per system acre (all sites)	138.09	187.10	259.77	194.99
Per acre inch of irrigation water (irrigated only)	21.58	15.83	24.94	20.79
Per pound of nitrogen (all sites)	1.72	0.75	2.34	1.60

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

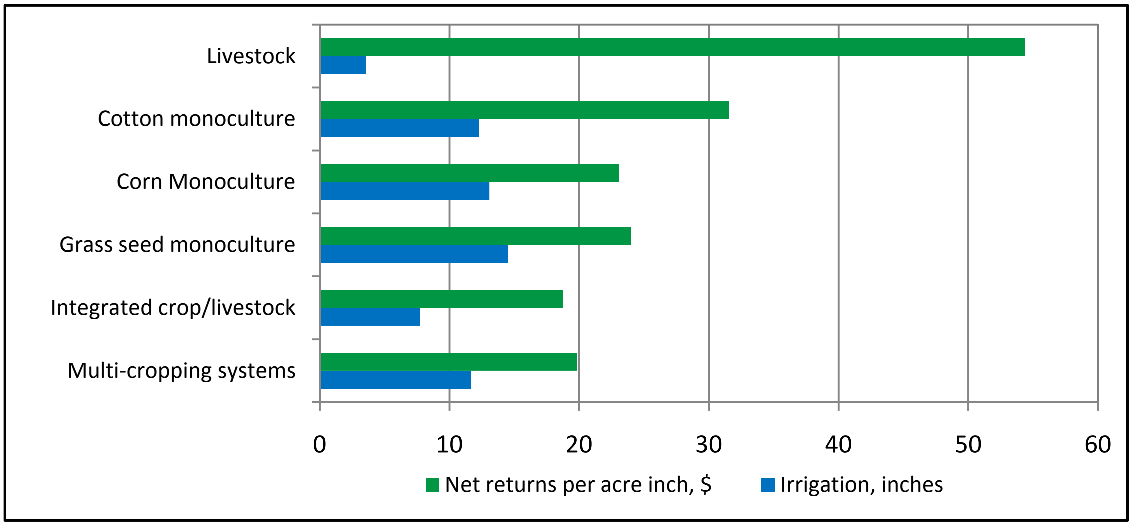


Figure 12. Net returns per acre inch irrigation water, and inches of irrigation applied, 2007.

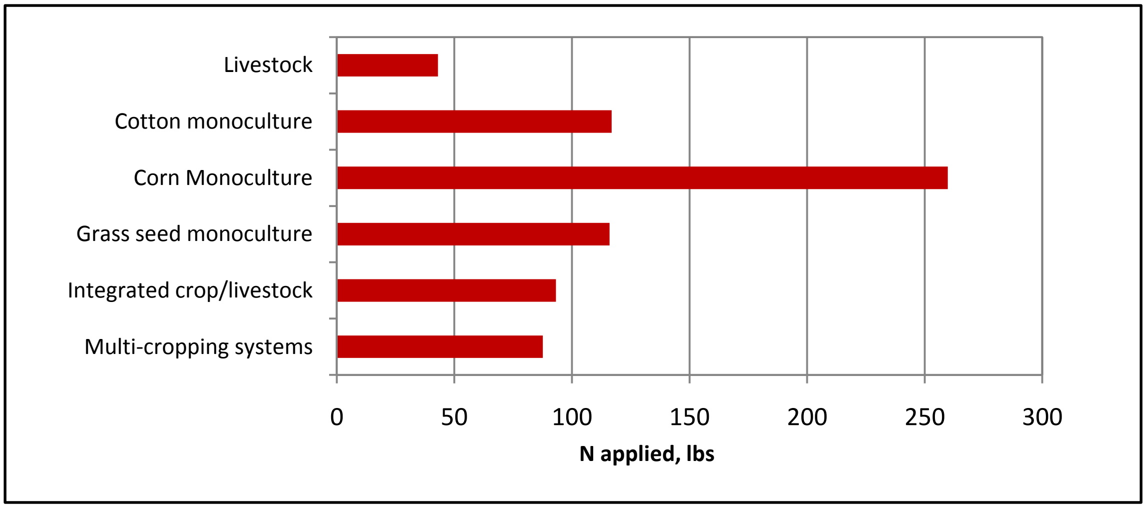


Figure 13. Pounds of nitrogen applied in fertilizer, 2007.

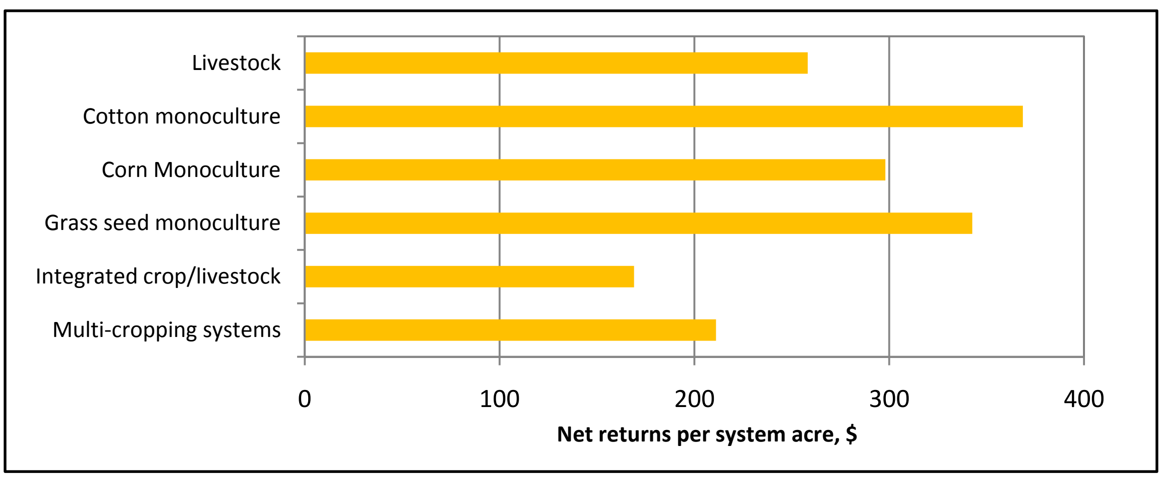


Figure 14. Net returns per system acre, 2007.

As a measure of change in irrigation use and profitability, the per system acre mean for each system was averaged across all systems for irrigation water applied and net returns above all costs of production. This was done for each of the 3 years where dryland systems were included (Fig. 15) and excluded(Fig. 16). Comparing these two graphs, mean precipitation differs slightly due to the differences in rainfall measured at each site. Whether dryland sites are included or not, profitability has increased each year averaged across all sites, almost doubling between 2005 and 2007. Irrigation water applied was higher in 2006 than in the other years reflecting the high temperatures and unfavorable distribution of precipitation experienced in that year. When only irrigated sites were included, irrigation water applied in 2007 was higher than that of 2005 in spite of the generally more favorable growing conditions (Fig. 16). This increased water applied likely reflects at least in part the shift in cropping away from cotton and the increase in acres devoted to crops with higher water requirements (Tables 7, 8 and 9; Figure 8).

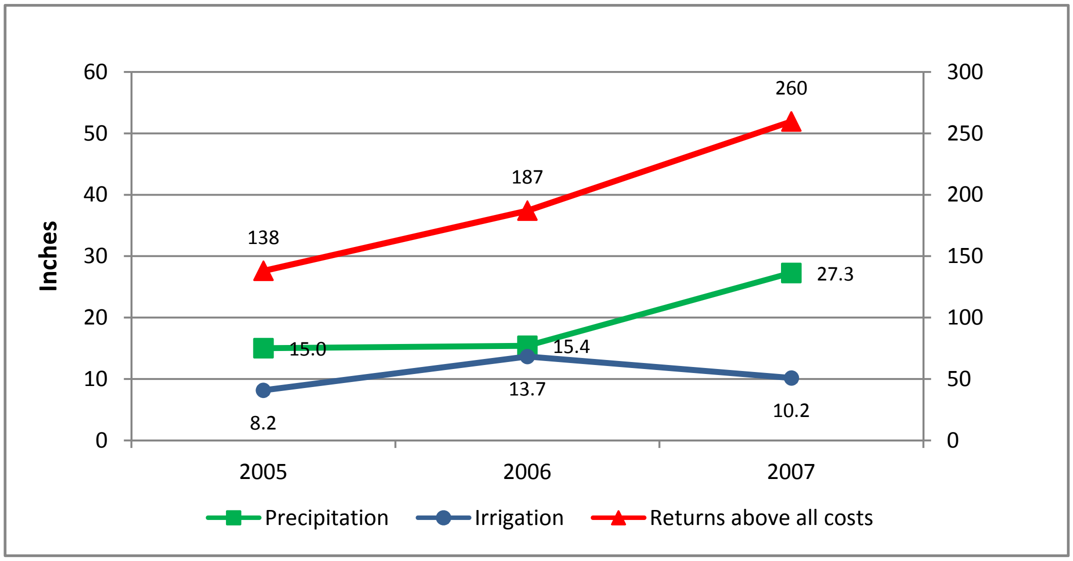


Figure 15. Average precipitation, irrigation, and returns above all costs for all sites in the TAWC project, including dryland sites.

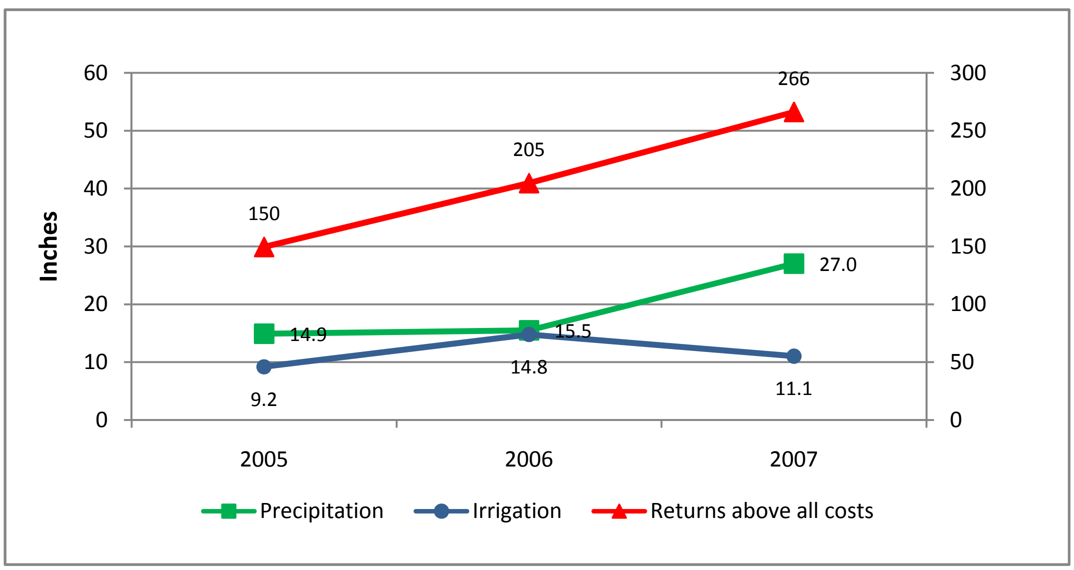


Figure 16. Average precipitation, irrigation, and returns above all costs for all sites in the TAWC project, <u>excluding</u> dryland sites.

As a further indicator of trends in water use and profitability, the total area and data from all systems was combined to provide an estimate of how this 2-county landscape might function as an integrated landscape composed of the mosaic of agricultural systems represented in the Demonstration project. Thus, the irrigation water use and net returns over all costs of production per system acre were multiplied by the total number of acres within each system. These numbers were then divided by the total number of acres within the demonstration project to provide an estimate of water use and profitability per acre on a landscape basis. This provides a weighted average that accounts for the variation in size of each individual site as it contributes to the overall landscape. In general, the trends for irrigated water use and profitability were similar to those observed when calculated by per system acre (Fig. 17 and 18).

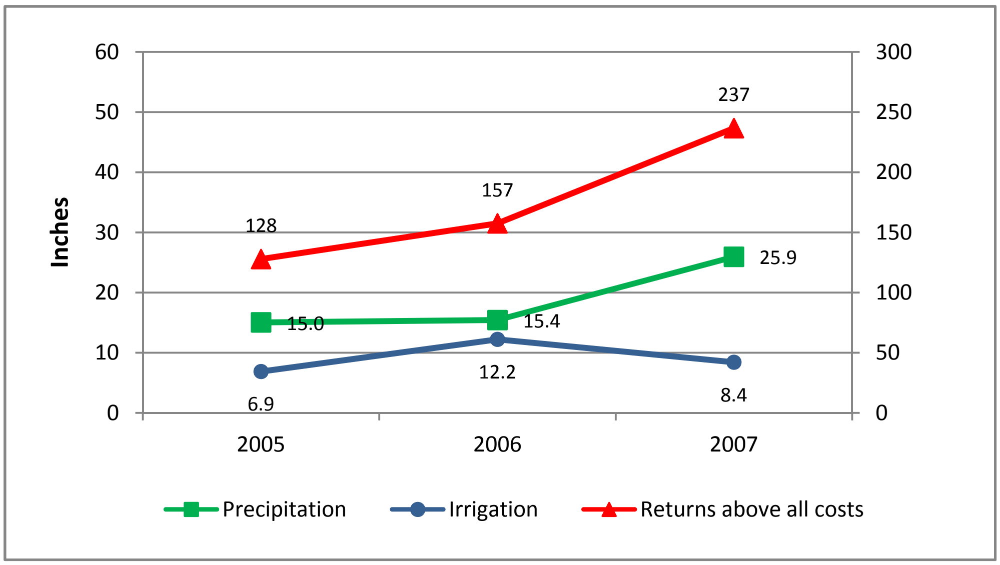


Figure 17. Average precipitation across all sites and average irrigation and returns above all costs for all acres in the TAWC project, including dryland sites.

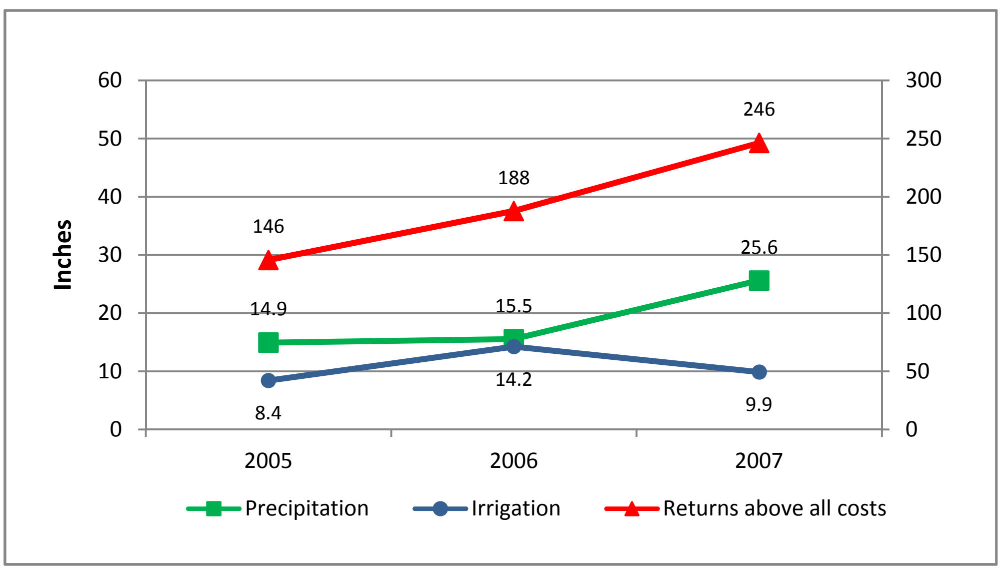


Figure 18. Average precipitation across all sites and average irrigation and returns above all costs for all acres in the TAWC project, without dryland sites.

On a landscape basis, total irrigated water applied averaged over the 3 years was 9 inches compared with a mean of 10.6 inches when calculated on a system mean basis. The practical interpretation of this, based on 3 years of data, is that if these counties produced the crops and livestock currently produced by the sites in the demonstration project and if the individual crop and livestock enterprises are in similar proportions across the counties as they are within the demonstration sites, and included the same proportion of dryland acres, these counties could produce an average income of $175 per acre above all costs of production with an average of 9 inches of supplemental irrigation water applied.

There is of course a great deal of variation among the different crop and livestock components and irrigation strategies. As we further develop the information coming from this project, we will increasingly be able to identify those systems, system components, and management practices that can maximize profit and minimize irrigation use. It should be possible to move both profitability and water demand in increasingly favorable directions, and to do this on a landscape basis. Variation due to weather will continue to cause large differences among years but by increasing conservation in favorable years and sustaining production in years of low precipitation, regional stability should be improved.

Results of year 1, 2 and 3 are summarized in Tables 11, 12, 13 and 14 for the 26 systems being monitored. It is important to understand that these systems are compared on a basis that equalizes those factors that are not unique to the system and that do not influence the systems results. (see Assumptions, page 12) These factors include depth to water, prices paid for fertilizers and pesticides, and other factors that vary among locations but do not reflect the functioning of the particular system. Thus, results of these analyses do not reflect the profitability of the individual site under the specific conditions and marketing opportunities of the individual system. This does, however, allow us to make comparisons among systems that are not biased by individual variability. This allows us to see how the system functions per se.

The 2005 growing season in Hale and Floyd Counties was near ideal in terms of precipitation amount and distribution. Harvest conditions were excellent for the cotton crop. Dryland systems benefited likely from soil moisture stored from the previous high-rainfall year as well as the timely rains that occurred during the growing season. The 2006 growing season was characterized by one of the most severe and extended drought periods on record for this region. Pumping of water reached near capacity levels. Total seasonal rainfall was similar between the two years but distribution during the growing season differed dramatically. The 2007 growing season returned to near ideal conditions with cooler than normal temperature in the early part of the season and favorable amount and distribution of precipitation that was nearly 10 inches above normal.

Net returns per system acre have increased each year but gross margin per acre inch of irrigation water and net returns per inch of irrigation water applied was lower in 2006 than in either 2005 or 2007 reflecting the severe growing conditions in 2006 (Table 14). Net returns per pound of nitrogen fertilizer invested was greater in 2007 than in either of the two previous years, likely representing greater nitrogen use efficiency due to the additional moisture. The differences between these three years underscore the importance of multiple years of observation but some patterns are beginning to emerge. It will take additional years of data to begin to understand how these systems function over a range of environmental conditions. Several systems were influenced by planting costs incurred in 2005 for crops or forages that were not harvested or grazed until 2006, thus, influencing the profitability of these systems in 2005. Most of these systems are now fully operational but other systems are changing as producers make operational decisions. This is what was intended and provides a truly unique ability to monitor what is happening on the Texas High Plains. Decisions for planting in late 2006 and during 2007 were influenced by the relative prices for cotton, corn grain, cattle, water availability, and loan potentials. This large demonstration project is an absolutely one-of-a-kind chance to measure and interpret what changes are happening and to understand the dynamics of these systems such that practices that conserve water and remain economically viable can be identified and translated to other locations.

Reports by Specific Task

Task 2: Project Administration

2.1 Project Director: Rick Kellison. The growing conditions for the 2007 season were near perfect in the demonstration area. We started the growing season with exceptional soil moisture conditions. Rainfall throughout the first two thirds of the season were timely and of adequate amounts with cooler than normal temperatures. This reduced the amount of irrigations needed for corn and grain sorghum. During the last one third of the growing season rainfall declined and in conjunction with an excellent fall allowed our cotton crop to mature to one of the best we have ever seen. Very rarely do we see excellent grain yields and cotton yields the same year. We were also fortunate to have very little adverse weather in the demonstration area.

I did not conduct as many site tours this year as in previous years. In July Dr. Matt Baker and I hosted Duane Toenges for a tour of local dairies. This gave me an opportunity to visit with several dairy owners about the possibility of using forage sorghum instead of corn for silage production. Dr. John Burns and Dr. Sukant Misra toured the demonstration area November 15th. On November 31st Dr. Darrell Dromgoole, Dr. Calvin Trostle and Jeff Pate toured all of the TAWC sites. During this tour we discussed the possibility for all AgriLife Extension agents to have the opportunity for a site tour in 2008. On January 15th AgriLife Extension and TAWC hosted Sarah Hamm for a meeting and tour.

On February 13th I was asked to speak to a group of approximately eighty-five producers at a grower meeting in Clarendon, Texas. TAWC, Texas AgriLife Extension and New Mexico State University hosted two silage workshops in March of 2007. The first workshop was held in Plainview, Texas on March 21st and the second was held on March 22nd in Clovis, New Mexico. I had the opportunity to make a presentation at both workshops explaining TAWC efforts to create an awareness of more water efficient crops for silage production. The Lubbock Round Table asked me to make a presentation explaining our project on May 2nd. On August 10th TAWC and AgriLife Extension hosted our second South Plains Perennial Grass workshop. We had attendance from as far away as Vernon and Hereford. We helped host the Cattle Feeds and Mixing Program on August 23rd. I made a presentation to the Texas Ag Chemical Conference on October 5th with approximately two hundred in attendance. This year I have made three presentations to various classes on the Texas Tech campus.

Dr. Vivien Allen and I met with Senator Robert Duncan in June to deliver a copy of our annual report and to discuss findings from the TAWC demonstration sites. He stated he was pleased with the progress of the project and that we were getting meaningful information. I also delivered copies of our annual report to Dean Marvin Cepica and Dr. Tom Thompson.

We completed our first Summary of Research, Forage Sorghum Production in the Southern Plains Region. This summary has been distributed to dairies, seed companies, consultants and growers in the Panhandle area. The response has been very good with some seed companies requesting additional copies for distribution to their growers. Dr. Bruce Maunder and Dr. Jeff Dahlberg with the National Grain Sorghum Producers have reviewed our Summary of Research and agreed with the information. They voiced a willingness to work with us in the future.

On April 2nd Glenn Schur was elected as Chairman of our Floyd and Hale County Producer Board. Following the producer board meeting a general meeting was held for all producers involved in the TAWC project. Justin Weinheimer and Scott Orr made presentations and answered questions. The sixteen producers present were given an opportunity to review a draft of the annual report and make suggestions and corrections.

In 2007 we held our management team meeting on the second Thursday of each month and have had excellent attendance. I have visited each of the demonstration sites on a regular basis and recorded pictures of the different stages of the crops.

2.2 Secretary/Bookkeeper: Angela Beikmann. *(three-quarter time position).* Year 3 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 3 of the project. Future budget needs were discussed with task leaders and communicated with appropriate university personnel. A formal budget change was constructed for subcontractor TCE and has been implemented for Year 4. This budget change did not affect any bottom-line total amounts for task, expense or project budgets.

Administrative Support for Special Events. Correspondence was created and mailed regarding a Producer's meeting held on April 2, 2007. Draft copies of the 2nd Annual Report were printed and sent to this meeting for producer perusal before final printing of the report.

Assistance was provided to the database management team to set up meetings with certain task leaders to evaluate the functionality of the web-based database, specifically specialized reports.

Ongoing Administrative Support. Quarterly reports have been assembled and forwarded to TWDB. These quarterly reports, dated May 31, 2007, August 31, 2007, November 30, 2007 and February 29, 2008, coincide with quarterly reimbursement requests submitted by TTU.

Summary of Research, Volume 1, Number 1 was printed and mailed to 275+ dairies and seed companies in this region. Mailing list for dairies in this region was obtained from the Southwest Dairy Association. Additional copies of the Research Summary have been mailed or delivered to others as requested; remaining copies are being stored in the TAWC office for personal distribution at events.

Proposal for additional funding was produced for presentation to Senator Robert Duncan.

Management Team meeting minutes have been recorded and transcribed for each meeting. These meetings were held on February 8, March 8, April 12, May 10, June 14, July 10, August 9, September 20, October 11, November 8, and December 13, 2007, and January 10 and February 14, 2008. Separate "progress report" meeting was held with Comer Tuck on November 9. Plans are underway for a Field Day to be held on July 31, 2008.

Formatting changes for Year 3 Annual Report were made with the help of Dr. Will

Cradduck. These changes include the creation of an appendix where data for all years for each site will be reported in spreadsheet and graph format. A template was created for each site description page that is based on a spreadsheet format.

Additional copies of *Hay & Forage Grower* and *Archways* magazines were obtained for individual distribution. These publications each contain articles highlighting the TAWC project. Pictures from the project were forwarded to Sorghum Grower's Association for an article they are producing.

System maps for 2007 were obtained from Lucia Barbato. These maps were bound and distributed to management team members.

Several meetings were held throughout the year with the database/website team. Procedures for uploading/updating data spreadsheets and picture links have been obtained from the database team, who also provided hands-on training and continue to provide functional/maintenance support.

Procurement and installation of additional lettering on producer site signs was completed with the help of Dr. Will Cradduck.

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

2.3 Database team, SQL database development, TAWC research enterprise website development: Lucia Barbato, Paul Braden.

Overview. Over the course of this project the team consisted of Paul Braden (undergraduate and graduate student), Swetha Dorbala (graduate student), Kiran Masapari (research associate), and Lucia Barbato from the TTU Center for Geospatial Technology (CGST).

For the 2007-2008 project year the Database team consisted of Paul Braden and Lucia Barbato. Ms. Barbato served as project manager and provided GIS mapping and GIS database development. Mr. Braden served as SQL database and web developer. Paul graduated with his Masters Degree in December 2007; however, he continues to provide support from Houston to address any issues identified in the website.

The Database team joined the TAWC project on July 5, 2005. In 2005 the database team efforts included completing a user needs assessment and developing a prototype database design using SQL Server 2000. The design concept was initiated for the website to access the database. In 2006 the data dictionary was finalized and fully implemented in SQL. Significant progress was made with the SQL database and website development. In 2007 the database was substantially completed and rolled out for use by researchers.

The first mission of the Database team was to develop a SQL database and a website to support data entry, management and reporting of results from researchers involved in the project. During this year the database team worked closely with several members of the Texas Alliance for Water Conservation research team to finalize the website. The database team initiated collaboration with the following TAWC researchers: Rick Kellison, Dr. Vivien Allen, Dr. Will Cradduck, Dr. David Doerfort, Dr. Steve Maas, Jay Yates, Justin Weinheimer, Jeff Pate, Kati Leigh (graduate student), Monty Dollar, and Scott Orr.

The data managed via the website includes cattle, crop, climate, economic, soil and system information that are stored in the SQL database. The website is in use by TAWC researchers who are actively entering, editing and sharing data. The current versions of the SQL database and the TAWC Research Enterprise Website are considered complete in terms of software development. The SQL database and website are complete. It is anticipated that maintenance of the website and SQL database will be required if any changes are desired in the future

The second mission of the Database team was to develop a GIS database from which maps of the TAWC producer systems could be created. GIS technology was used to produce map books for use by researchers and producers for 2005, 2006 and 2007. Maps were also developed for the annual reports. The GIS database is managed by the CGST and is available for other researchers to use. It is also anticipated that GIS mapping to reflect updates of the producer systems, fields and acreages will continue throughout the project. Also the calculation of system and field acreages from GIS is expected to continue.

Database and Website Accomplishments. In 2007 the SQL database was migrated from SQL 2000 to the TTU SQL2005 cluster. As with the previous database it is backed up with daily incremental changed and weekly full backups for 30 days. This upgrade updated the database software at no cost to the project. It also facilitated the management of the SQL database by the TTU Technical Operations Sever Management team.

Efforts were made throughout the year to make the website more user-friendly as researchers began entering and editing data. The website evolved from an alpha release to a beta release to a full implementation.

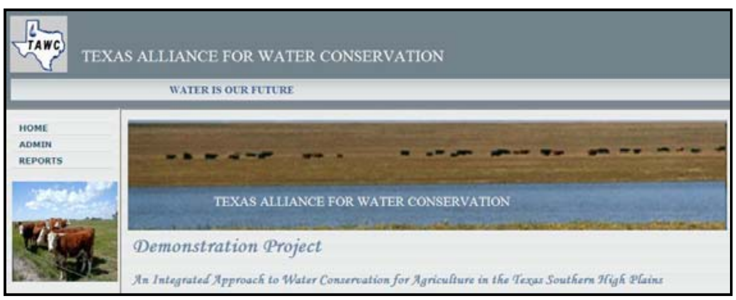


Figure 19. TAWC Research Website home page and navigation.

A significant development was incorporating security access to the TAWC internal research enterprise website. The website is secured by a multi-level security access system. The website is accessible only by log in and password and by permission from the project management and leadership. Users are granted permission from the project management and leadership as needed. Researchers are provided access to enter and edit data in their respective research areas, while anyone with access to the website has access to the reports from all research areas. To further protect the data special procedures were done to ensure that the internal research website was not registered with search engines.

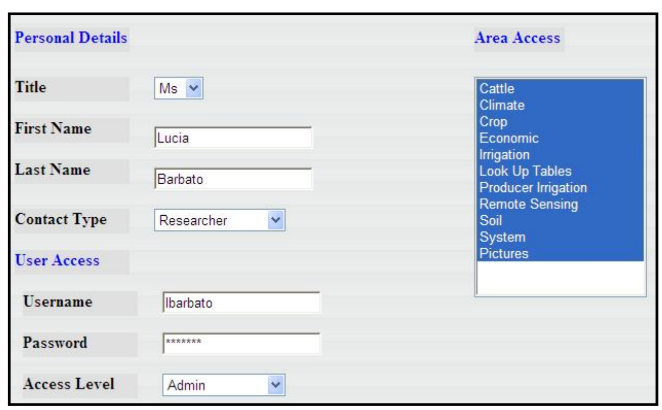


Figure 20. Security access categories available for web administration.

Another important development was the creation of the data upload capability. This allowed researchers with pre-existing data in Excel spreadsheets to automatically upload data to the TAWC

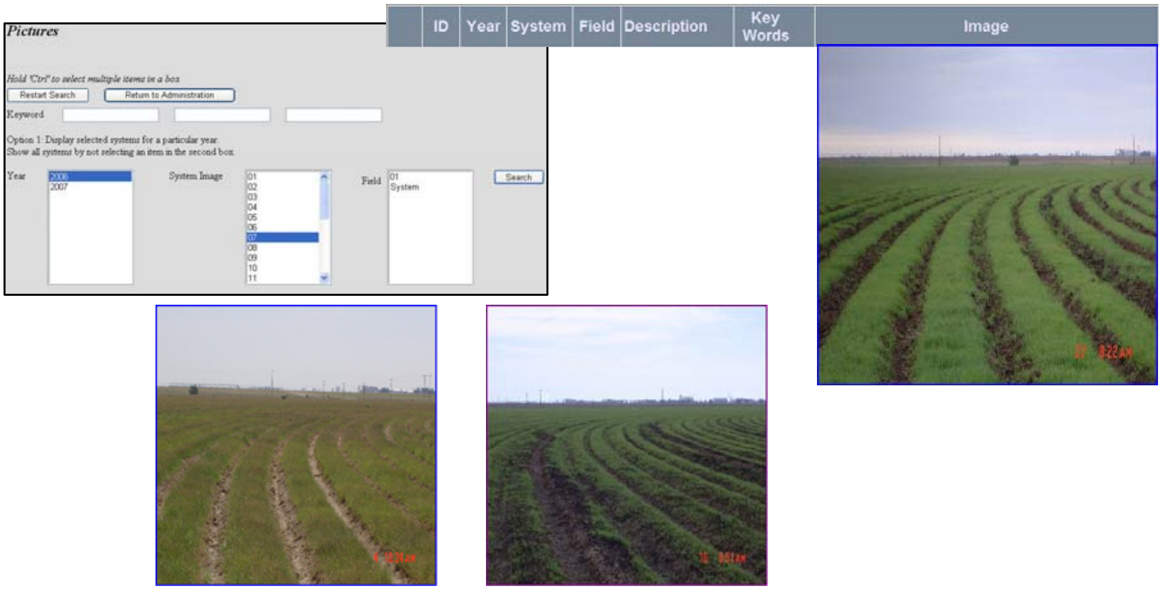


Figure 21. Photograph query and management system.

database with requiring duplicate data entry. Training meetings were conducted with researchers and administrators (Dr. Maas, Phil Brown, Will Cradduck, and Angela Beikmann) who desired this capability. The datasets benefiting from the upload capability include Agriculture Remote Sensing Estimates, soil, irrigation, and photographs.

An organizational structure was developed for storing hundreds of photographs taken at the study sites. This structure was designed to facilitate sharing hundreds of photographs through the TAWC web site. Training meetings were conducted with Rick Kellison and Angela Beikmann to finalize the data structure and procedures to upload photographs into the SQL database. Instructions were provided that documented the photograph upload procedure as well as to allow descriptions and key works to be assigned to each photograph. All photographs that have been uploaded into the database

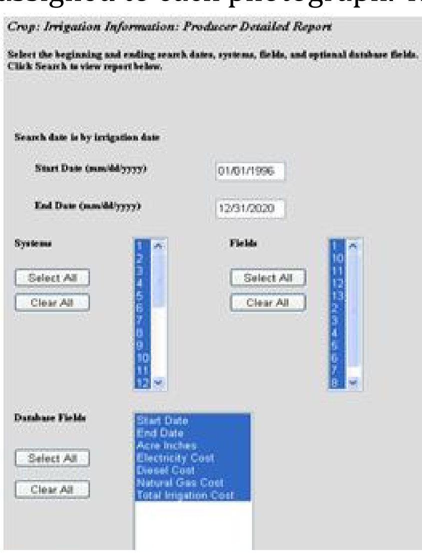


Figure 22. Example report query for Crop Planted Information.

Crop: Irrigation Information: Producer Detailed Report

ID	System	Field	Start Date	End Date	Acre Inches	Electric Cost
6	1	1	01/31/2006	01/31/2006	1.500	
7	1	1	02/15/2006	02/15/2006	1.500	
8	1	1	03/01/2006	03/01/2006	1.500	
9	1	1	03/08/2006	03/08/2006	1.500	
10	1	1	04/13/2006		1.500	
11	1	1	04/19/2006		1.500	
12	1	2	04/03/2006		1.500	
13	1	2	04/08/2006		1.500	
14	1	2	05/28/2006		0.750	
15	1	2	05/30/2006		1.500	
16	1	2	06/08/2006		1.500	
62	2	1	07/04/2007	07/10/2007	1.200	
63	2	1	07/11/2007	07/17/2007	1.200	
64	2	1	07/18/2007	07/28/2007	1.500	

Figure 23. Example report results for selection database fields of the Crop Planted Report.

are available to view and download from the TAWC research website. An addition to the website functionality was the capability to search photographs using up to three keywords. For example, all photographs taken of cotton for selected systems and fields can be queried.

Table 15. TAWC reports available on the Research Website.

Data Category	Available Reports on Website
Cattle	Dry Cows Finishing Cattle Growing Heifers, Bulls and Steers Lactating Cows Mature Bulls Stocker Cattle Wintering Pregnant Cows Supplemental Feed Veterinary Treatment
Climate	Mesonet Station Mesonet Data Monitoring Station Degree Days Precipitating Event
Crop	Agricultural Remote Sensing Daily Estimates Agricultural Remote Sensing Seasonal Biomass Clippings Biomass Measurements Crop Labor Costs Crop Planted Fertilizer Information Harvest Yield Irrigation Information HPWD Irrigation Information Producer Irrigation Type Irrigation Water Use Efficiency Mechanical Operations Pesticide Information Tillage Type
Economic	Farm Assist Economic Summary Ag Eco Seasonal Irrigation Cost
Look Up Table	Application Method Information Breed Information Crop Varieties Veterinary Products Information Pesticide Description Information
Soil	Soil Sample Information Soil Moisture Sample Annual Erosion
System	System Information Field Information

A series of meetings between the Database team, project management and researchers were conducted to review the website. The meetings involved the database team, Rick Kellison, Dr. Mass and Nithya Rajan, Scott Orr, Jeff Pate, Monty Dollar, Justin Weinheimer, and Jay Yates. These meetings also encouraged the use of the website to enter as much data as possible to test the functionality as well as the data needs of the researchers. As a result of these meetings significant redesign and restructuring of the cattle, crop, climate, soil and economic database tables and associated webpages took place.

The website was demonstrated at a TAWC Management Team meeting with data that had been entered by researchers. By the end of the year the data entry functionality and testing of the website and SQL database was completed. The functionality to edit and update data was also completed.

Database Reports. The reporting functionality of the website allows ad hoc, push-button access to all categories of data. These reports allow researchers to view data entered into the database.

The following detailed database reports are available to TAWC researchers. The reports reflect the current status of the data entered in the database.

GIS Accomplishments. The addition of producer system 27 to the project required incorporating it into the GIS database as well as the SQL database and website. The GIS databases for the 2006 and 2007 TAWC producer systems were completed. These databases were used to create maps of each producer field which were compiled into a map book. Also included in the map books are two index maps of the project area. A set of 50 map books for 2007 were delivered to the project management team, researchers and producers. The maps were also made available via the TAWC Research Website and for the annual report. The 2008 GIS database is nearly completed. The maps and database will be completed upon final producer planting decisions. It is anticipated that GIS mapping to reflect updates of the producer systems, fields and acreages will continue throughout the project.

System Codes and Acreage. A benefit of the GIS is the ability to calculate acreage for the fields and system areas for each producer site. The acreages are included in each map as well as in the annual update of the System Codes spreadsheet. The System Codes spreadsheet updates the producer system numbers, field numbers, acreage, field irrigation type and field descriptions. Whenever the geometry of a producer field is changed, the field number is incremented in the System Codes spreadsheet. This will prevent erroneous comparison of results between fields with differing acreages. Only fields that maintain their original geometry maintain the same field number and are available for comparison in the database reports. Updates to the System Codes spreadsheet and calculation of system and field acreages from GIS are expected to continue throughout the project.

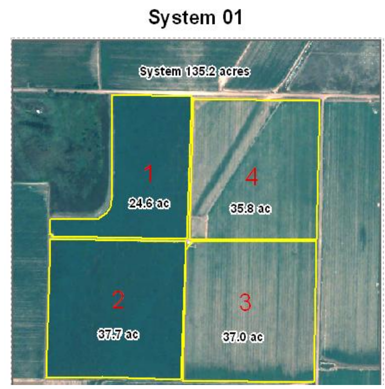


Figure 24. Example GIS map of a TAWC system.

Table 16. Example of TAWC system codes provided to researchers.

System Codes - 2006							
Producer System Name	**Irrig. Type**	**System**	**Field**	**Field Desc**	**System Crop Acres GIS**	**Field Acres GIS**	**Comments**
Jeff Don Terrell#1-	SDI (drip)	2	-	Single Drip	60.9	60.9	
Keith Phillips		3	-		123		
	pivot		1	North Half		61.5	
	pivot		2	South Half		61.8	
Glen Schur		4	-		123.1		
	pivot		1	North-east		13.3	
	pivot		2	South east		65.4	
	pivot		3	North-west		44.4	

Documentation. The following documents have been completed and delivered to project management:

- User Needs assessment (49 pages): The user needs assessment and analysis describes the data requirements to design and develop a database for the TAWC project. The information in this report is based upon the responses provided by the principal researchers during a series of interviews designed to assess user needs.

- Draft Production Database Design and Data Dictionary (86 pages): Details the draft production procedures and table designs and structures implemented in the SQL database.

- Final Production Database Design and Data Dictionary (113 pages): Details the final production procedures and table designs and structures implemented in the SQL database

- Database Upload Procedures (24 pages): This document describes the process to upload researcher's data from Excel spreadsheets to the TAWC research website.

- DataUploadTemplate.xls: This spreadsheet template supports researchers needing to upload their data to the SQL database.

- Programmer Manual: This document describes the ASP.Net 2003 with C# software framework used to develop the TAWC research website.

- TAWC User Manual: This document describes how to successfully input and edit records in the TAWC research website. Also included in this document are the instructions on how to add, edit or delete a producer, system or site, or a field to the database.

Recommendations. The website which accesses the SQL database is stored on a separate web server. The web server is used by the Center for Geospatial Technology for multiple projects and is not dedicated for the TAWC project. It is recommended that a web server be purchased for dedicated use for the TAWC project with a direct connection to the SQL cluster within a year or two when the current server is expected to be removed from service.

TASK 3: FARM ASSISTANCE PROGRAM

Dr. Steven Klose
Jeff Pate
Jay Yates

Year 3 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 TCE 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. Considerable progress was made in planning and coordinating data collection with new project leader, Phil Johnson, in Agricultural Economics at Texas Tech. Together we developed plans for what data to collect, how it will be collected, how it is stored, and how our two tasks will handle data sharing. Further progress was made in communicating and coordinating database needs with the project database team. TCE has taken the lead in the area of data retrieval in that FARM Assistance staff are meeting with producers three times per year to obtain field records and entering those records into the database. TCE assisted many of the project participants individually with the completion of their individual site demonstration records (farm field records). TCE faculty has completed the collection, organization, and sharing of site records for most of the 2007 site demonstrations.

FARM Assistance Strategic Analysis Service. Demonstrator participation in the formal FARM Assistance service is growing. As is typical with the FARM Assistance service, participants need re-assurance that the process does not require an overwhelming commitment of time or data. An assurance of their confidentiality is also needed to secure their cooperation and commitment TCE faculty have completed whole farm strategic analysis for several producers, and have secured other participants committed to the analysis. To secure cooperation TCE has promoted the service through numerous phone calls, e-mails, and personal visit contacts with project 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 2006 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. 2007 analysis will be completed this summer, as yield data has only recently been finalized for the 2007 crop.

Irrigation Comparison. Farm Assistance members completed and reported on a comparison of irrigation water usage from 2006 to 2007 on various sites within the demonstration project. This report was given at the November management team meeting with the audience consisting of all management team members as well a representative of the Texas Water Development Board.

TASK 4: ECONOMIC ANALYSIS

Dr. Phillip Johnson
Dr. Eduardo Segarra
Justin Weinheimer

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. A 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

- 2007 represented the third year of data collection from project sites. Data for the 2007 production year have been compiled and enterprise budgets have been complied.

- A presentation was made at the Texas Tech Cotton Economics Institute Research/Extension Symposium on April 11, 2007. Attendees at the Symposium were Texas Cooperative Extension personal and representatives of commodity groups, government agencies and state legislative representatives. The presentation gave an overview of the project and discussed certain findings and issues from the 2006 results. This presentation was also given at the May TAWC management team meeting.

- Justin Weinheimer presented a paper titled "Energy Analysis of Cotton Production in the Southern High Plains of Texas" at the 2008 Beltwide Cotton Conferences held in January 2008 at Nashville, TN. The paper presented an energy evaluation of cotton production under the various irrigation systems in the TAWC project for 2006. This analysis will be expanded to include all years of the study and additional crops.

Energy Analysis of Cotton Production in the Southern High Plains of Texas

Justin Andrew Weinheimer and Phillip N. Johnson
Department of Agricultural and Applied Economics
Texas Tech University
Lubbock, TX

Abstract

The cotton producing region of the Southern High Plains of Texas is an input intensive agricultural region. The use of irrigation, fertilizer, and other inputs makes this region a large consumer of both direct and indirect energy. Increasing energy costs have affected farm profitability and are predicted to increase in the future. Energy consumption from fossil fuels either directly through fuel consumption in mechanical operations and irrigation application or indirectly through the production of fertilizer and chemicals varies greatly at the farm level based on irrigation systems, crop selection, and management decisions. The objective of this study was to evaluate energy use in irrigated cotton production systems on the Southern High Plains of Texas. Results indicate that in terms of energy use efficiency the subsurface drip irrigation system (SDI) was the most efficient. The low energy spray application pivot system (LESA) was the most efficient with regard to profitability per unit of water applied.

Introduction

Energy from fossil fuels is a major input in agricultural production on the Southern High Plains of Texas (SHP). The region is characterized by the intensive use of inorganic fertilizers, pesticides and irrigation; which are inputs that are dependent on fossil fuels. The global dynamics of fossil fuel energy costs have significantly affected the input costs of crop production in the region and will be a major factor affecting production costs in the future.

Energy costs have been increasing faster than other input costs. Over the past 10 years, prices of diesel fuel and natural gas have increased at an annual rate of 8.2% and 8.3%, respectively (Energy Information Administration, 2007). Over the same period, the annual increase in the Index of Prices Paid for Agricultural Production Items was 2.8% (NASS, various issues). Although increasing fuel prices have affected producers across the nation, irrigated farmers on the SHP face the situation of reliance on energy to pump irrigation water in addition to other energy intensive inputs. Input costs for fuel and energy related inputs for cotton production in the region increased at a 12% annual rate between 1995 and 2005, while the cost of non-energy related inputs increased at a 4% annual rate (Johnson, Yates and Smith, 2006).

While there is some literature on how different agricultural systems consume energy, the specific needs of the producers in the SHP must be addressed in accordance with their dependence upon primary inputs such as irrigation. It is crucial to understand and analyze the potential of sustainable agricultural systems in this region and comprehend how they may aid in the conservation of energy while maintaining yields, socioeconomic levels, and profits. The objective of this study was to measure the use of energy for cotton production in the SHP region. Specifically, energy budgets were prepared to measure energy use for cotton production across different irrigation systems using data from the Texas Alliance for Water Conservation project (TAWC, 2007)

Methods and Materials

Energy inputs can be categorized as direct, indirect, and embedded. Use of fuel for irrigation and mechanical operations is considered a direct energy input. Inputs that require energy or fossil fuel for manufacture of fertilizers, commonly nitrogen fertilizer, and chemicals represent indirect energy inputs into the production process. Embedded energy is categorized as energy required in manufacturing capital assets used on the farm, such as machinery, equipment, and irrigation systems. In this study, only direct and indirect energy are considered.

There are several methods of analyzing energy in agricultural production systems including statistical, input-output analysis, and process analysis (Fluck and Baird 1980). Each is either considered a measure of efficiency, how well energy is converted, or intensity which involves a macro-analysis of the industry as a whole. Both the process method and the input-output analysis are generally applied to the study of energy efficiency, while the statistical method is used to measure energy use intensity. Bullard et al. (1976) indicated that the process analysis is more suited to specific processes, products or manufacturing chains in which the flow of goods and services can be easily traced. In this study the process analysis method was chosen due to the suitability of this method to farm level analysis of production systems. This method is preferred when there is sufficient data available to fully understand the farm practices, operational methods, input quantities, and yield characteristics over several crops and or systems.

Energy coefficients (expressed as mega-joules/unit, see Appendix) were established for all inputs, and calculated based on the quantity of inputs used. Energy budgets were developed so that the amount of energy required by each system can be compared with profitability, production practice, and cropping system. The energy coefficients for the various inputs were obtained from a number of sources which included: Pimentel (1980), Fluck and Baird (1980), and Green (1987).

The data available for this study encompasses all aspects of the production model through individual producer records. The Texas Alliance for Water Conservation project has gathered data from 26 sites in Floyd and Hale Counties of Texas for the 2006 crop year (TAWC, 2007). Data for this study was from 25 cotton fields (1,603 acres) on 21. The cotton production systems analyzed were under irrigation systems that included subsurface drip (SDI), low energy precision application pivot (LEPA), mid-elevation spray application pivot (MESA), low elevation spray application pivot (LISA), and conventional furrow irrigation (CF).

The direct energy values are the summation of energy consumed in field operations, harvest, processing, and irrigation. In the case of field operations and harvest, the direct energy values represent the amount of diesel fuel consumed in the various mechanical operations. Processing or ginning includes the electricity and fuel used to transport and gin the seed cotton. Energy used in irrigation was calculated assuming electricity as the primary fuel source. Indirect energy calculations consisted of the energy used to manufacture and transport production inputs such as fertilizer and chemicals including harvest aids, herbicides, insecticides and seed production. The energy coefficients, particularly those for nitrogen fertilizer, are primarily driven by the amount of natural gas required in the production process.

Discussion and Results

The results of the energy analysis are summarized in Table 1. The values shown are weighted means by acres for each type of irrigation system. It is important to note that the focus of this study was to understand the energy

Table 1. Energy Summary by Irrigation System

	SDI	LEPA	MESA	LESA	CF
Yield (bale per acre)	3.89	2.39	2.58	3.04	2.48
Acre Inches Applied	19.92	11.35	14.48	12.77	15.71
Lbs per acre inch	93.71	101.18	85.54	114.05	75.64
Acres	242.20	394.00	318.60	488.90	159.60
Observations	6.00	5.00	4.00	7.00	5.00
	--------------------------------(MJ)---------------------------------				
Direct Energy per acre	5560.53	3501.50	3954.80	4058.71	4276.30
Indirect Energy per acre	5949.59	4834.58	5081.27	6438.01	3401.53
Total Energy per acre	11510.12	8336.08	9036.07	10496.72	7677.83
Energy per bale	2958.82	3485.54	3501.24	3458.33	3102.13
Energy per $ Gross Margin	28.88	36.68	38.59	33.65	32.75
Energy per $ Gross Revenue	9.42	11.03	11.09	11.09	9.88

efficiency, not total consumption, of different types of irrigation systems. In this particular case the efficiency measures are in three categories; 1) energy consumed to produce one bale of cotton, 2) energy consumed to generate one dollar of gross revenue, and 3) the energy consumed to generate on dollar of gross margin.

The SDI system had a yield of 3.89 bales per acre which was the highest across irrigation systems. However, irrigation water applied for the SDI system was also the highest at 19.92 acre inches. Water use efficiency as measured by pounds of lint per acre inch applied varied from 114.05 lbs per acre inch for the LESA system to 75.64 lbs per acre inch for the CF system. While the SDI system had the highest yield, its water use efficiency was third highest at 93.71 lbs per acre inch. The LESA system had the highest water use efficiency while the CF system had the lowest water use efficiency.

Total energy used varied from a high of 11510.82 MJ per acre for the SDI system to 7677.83 MJ for the CF system. The SDI system had the highest level of direct energy use at 5560.53 MJ which was related to the level of water applied at 19.92 acre inches and the harvest and processing of 3.89 bales per acre. The LESA system had the highest level of indirect energy use at 6438.01 MJ which was related to higher levels of fertilizer application. The results indicate that the SDI and CF systems were the most efficient in terms of energy use per bale, 2958.82 MJ and 3102.13 MJ, respectively. The pivot systems (LEPA, MESA and LESA) were similar with a range of 3458.33 MJ to 3501.24 MJ per bale.

Energy use per dollar of gross revenue followed the same relationship as energy use per bale, with the SDI and CF systems being the most efficient at 9.42 MJ and 9.88 MJ per dollar of gross revenue, respectively. The pivot systems had a very small range from 10.92 MJ per dollar of gross revenue for the MESA system to 11.09 MJ per dollar of gross revenue for the LESA system.

Energy use per dollar of gross margin was 28.89 MJ for the SDI system, which was the lowest across all systems irrigation systems. The CF and LESA systems used 32.75 MJ and 33.65 MJ to generate a dollar of gross margin, respectively. The LEPA and MESA systems were least efficient with respect to energy use per dollar of gross margin. Gross margin which is gross revenues less variable expenses takes into account the costs of production inputs. Using gross margin as a measure of energy use efficiency reflects the efficiency of energy use from both direct and indirect sources to generate profitability. Additionally, the SDI system and CF system were the most efficient with respect to energy use efficiency as measured by yield and gross revenue.

Table 2 presents an economic summary for each irrigation system. The SDI system had the highest gross revenue, gross margin, and net returns, which is primarily due to the SDI system having the highest lint yield at 3.89 bales per acre. However, the LESA system had the highest profitability per acre inch of water applied with $24.42 of gross margin per acre inch and $18.27 of net returns per acre inch. This compares to the SDI system of $20.00 of gross margin per acre inch and $13.98 of net returns per acre inch. The CF system had the lowest profitability per acre inch at $14.93 of gross margin per acre inch and $10.47 of net returns per acre inch.

Table 2. Economic Summary by Irrigation System

	SDI	LEPA	MESA	LESA	CF
	------------------------($/Acre)--------------------------				
Gross Revenue	1222.23	755.84	814.45	946.14	776.89
Pre Harvest Cost	420.77	302.85	332.77	339.49	309.09
Harvest Cost	388.48	215.33	237.51	283.06	222.79
Interest Cost	14.41	10.37	10.01	11.63	10.59
Total Variable Cost	823.65	528.55	580.29	634.18	542.47
Gross Margin	398.57	227.29	234.15	311.96	234.43
Fixed Cost	120.00	78.60	78.60	78.60	70.00
Total Cost	943.65	607.15	658.89	712.78	612.47
Net Returns	278.57	148.69	155.55	233.36	164.43
Gross Margin per Acre Inch Applied	20.00	20.03	16.17	24.42	14.93
Net Returns per Acre Inch Applied	13.98	13.11	10.74	18.27	10.47

Conclusions

Since only one year's data (2006) was analyzed, it is difficult to draw any definitive conclusions for the analysis. However, there are some interesting results that can be discussed. The SDI system was the most efficient with regard to energy use, however; the SDI system used the greatest amount of total energy. The CF system was the second most efficient system with respect to energy use, which was surprising given that the CF system is considered to be the least efficient with regard to water application efficiency. The center pivot systems (LEPA, MESA and LESA) were very similar with regard to energy use efficiency. However, the LESA system was the most efficient of the three with regard to energy use efficiency per dollar of gross margin.

The LESA system had the highest water use efficiency with regard to gross margin and net return per acre inch of water applied. The SDI system had the highest yields, but also had the highest amount of water applied. From a profitability standpoint the SDI system gave the highest total returns, however; its water use efficiency per dollar of return was not as good as the LESA system.

Yield levels for each system are an important variable in all aspects of the analysis. All calculations in this study are based on input quantity applied or consumed. In this respect, the more input applied the more potential output was produced. There is a direct correlation between total energy used and yield, thus comparisons between systems was based on energy efficiency and not the quantities of inputs or production.

Data from the Texas Alliance for Water Conservation project is available for 2005 and will be available for 2007. Further analysis is planned to look at the three years 2005, 2006 and 2007 with regard to energy use efficiency in cotton production across the irrigation systems.

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Appendix

Mega joule (MJ) – a joule is defined as a metric (SI) unit of work or energy. One mega joule, MJ, is one million joules.

The following table represents several common conversion factors and measurements related to the joule.

Common Conversions and Measurements of the Mega joule

Energy Measurement	Btu	MJ
1 Kilowatt hour of electricity	3,412	3.6
1 Gallon of Gasoline	115,400	131.9
1 Gallon of Diesel	128,700	135.8
1 Gallon of LP Gas	83,500	88.1
1 Mcf of Natural Gas	1,031,000	1,008.0
1 Barrel of Crude Oil	5,535,600	5,840.0

TASK 5: PLANT WATER USE AND WATER USE EFFICIENCY

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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 first two 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, the remotely sensed GC values for each field were used in a mathematical model to simulate the GC of the vegetation on each day of the growing season. Daily weather data used in running the model simulations were obtained from the West Texas Mesonet station at Lockney. In Step 3, potential evapotranspiration (PET) was estimated for each day of the growing season from the Lockney weather data. 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 17 lists the satellite data acquisition dates for 2006 and 2007. In 2006, CWU estimates were based on 8 Landsat-5 TM images. During 2007, we ordered an additional 5 Landsat-7 ETM+ images of the study region from 2006. Due to a mechanical problem with the ETM+ sensor, gaps in the image data were present. However, some usable image data could be identified in the ETM+ imagery for most fields in the project. With this larger collection of Landsat-5 and Landsat-7 imagery, we went back and re-calculated CWU for 2006 for fields in the project. These re-calculated CWU values will be presented in this report for comparison with results from 2007.

Due to cloudy conditions, we acquired only 3 usable Landsat-5 images in 2007. However, these were supplemented by 6 Landsat-7 ETM+ images in 2007. Clouds prevented successful image acquisition by either satellite in June of 2007. In order to provide additional remote sensing coverage of the fields in the project, airborne multispectral imagery was acquired 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 25). TTAMRSS imaging flights are summarized in Table 18. Two flights were specifically made in June 2007 to fill the gap in the satellite image acquisitions.

Table 17. Acquisition dates for Landsat-5 Thematic Mapper (TM) and Landsat-7 Thematic Mapper + (ETM+) imagery.

Year	Landsat-5 TM	Landsat-7 ETM+
2006	13 May 29 May 30 June 16 July 01August 18 September 04 October 20 October	8 July 09August 25August 10 September 26 September
2007	29 March 19 July 5 September	22 April 24 May 27 July 12 August 28 August 13 September

Table 18. Acquisition dates for TTAMRSS.

Year	Date
2006	28 Aug
2007	8 June 21 June 10 July 9 Aug 14 Aug

The satellite and airborne imagery was used to estimate crop GC in the project fields using the procedure previously developed based on the Perpendicular Vegetation Index. An example of a GC map produced for one of the fields in the project based on Landsat imagery is shown in Figure 26. Similar GC maps produced using TTAMRSS imagery are shown in Figure 27. Due to the greater surface resolution for the TTAMRSS imagery (approximately 2 m) compared to the Landsat imagery (30 m), more detail in the variation in crop GC is visible in the airborne imagery. For the purpose of estimating CWU in this project, average values of GC were calculated on the field-scale from the satellite or airborne image data.

Figure 25. Components of TTAMRSS. (A) Cessna Skyhawk aircraft; (B) System monitor; (C) View of underside of aircraft showing cameras; (D) Computer.

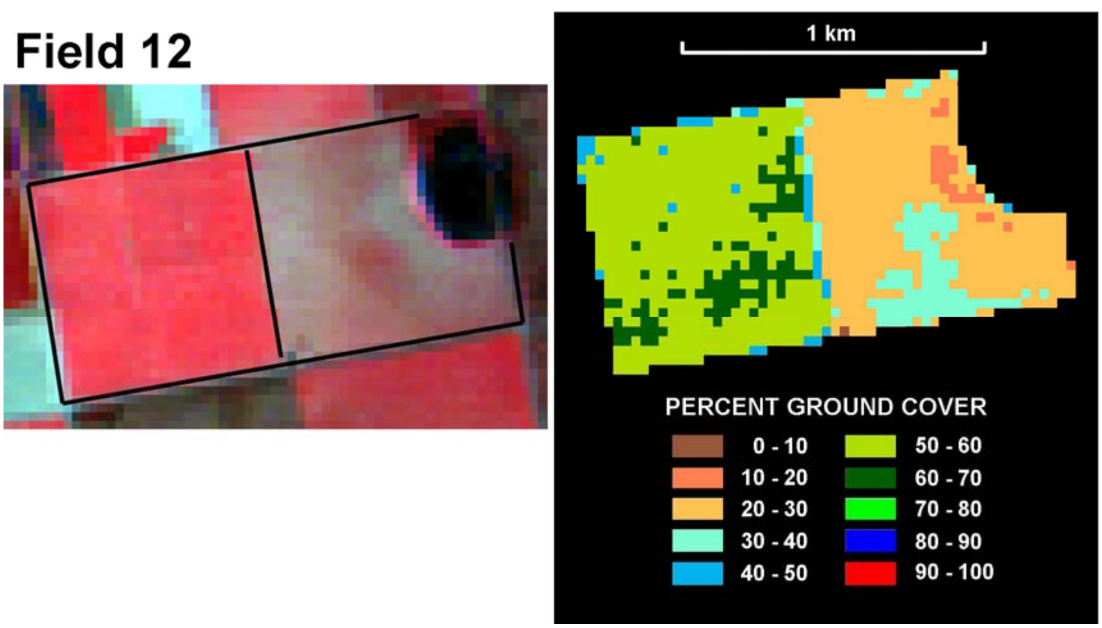

Figure 26. (Left) Landsat image (displayed like a standard aerial IR photo) showing Field 12 in 2007; left portion of field is dryland cotton, while right portion of field is dryland grain sorghum. (Right) Ground cover map constructed for the two fields.

As in 2006, ground-based measurements of crop GC were obtained at several times during the growing season for testing the estimates of GC derived from the remote sensing observations (see Figure 28). Two articles were published describing the procedure used for estimating GC from remote sensing image data:

- 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.

- 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.

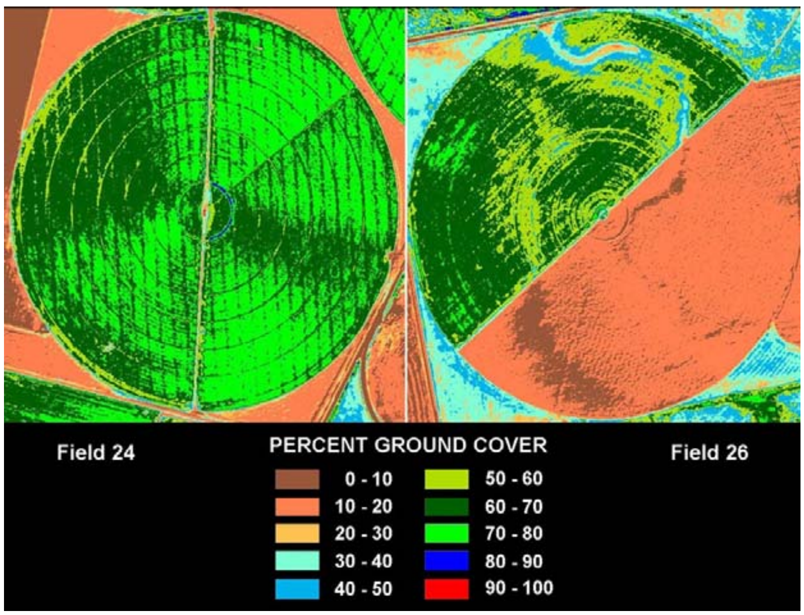

Figure 27. GC maps constructed for Fields 24 and 26 using TTAMRSS imagery.

As in previous years of the project, a crop growth model was used to simulate GC on each day of the growing season based on daily weather data and the estimates of GC determined from the remote sensing imagery. This was done so that a value of crop GC could be produced for each day of the growing season. An example of such a simulation is presented in Figure 29. Since remote sensing imagery of the project fields was acquired fairly regularly using the three remote sensing systems (Landsat-5, Landsat-6, and TTAMRSS), consistent simulations of GC could be made. The daily values of GC from the simulations represent the spectral crop coefficient Ksc used in estimating daily CWU.

Figure 28. Nithya Rajan collecting overhead photos in Field 24 for determining GC.

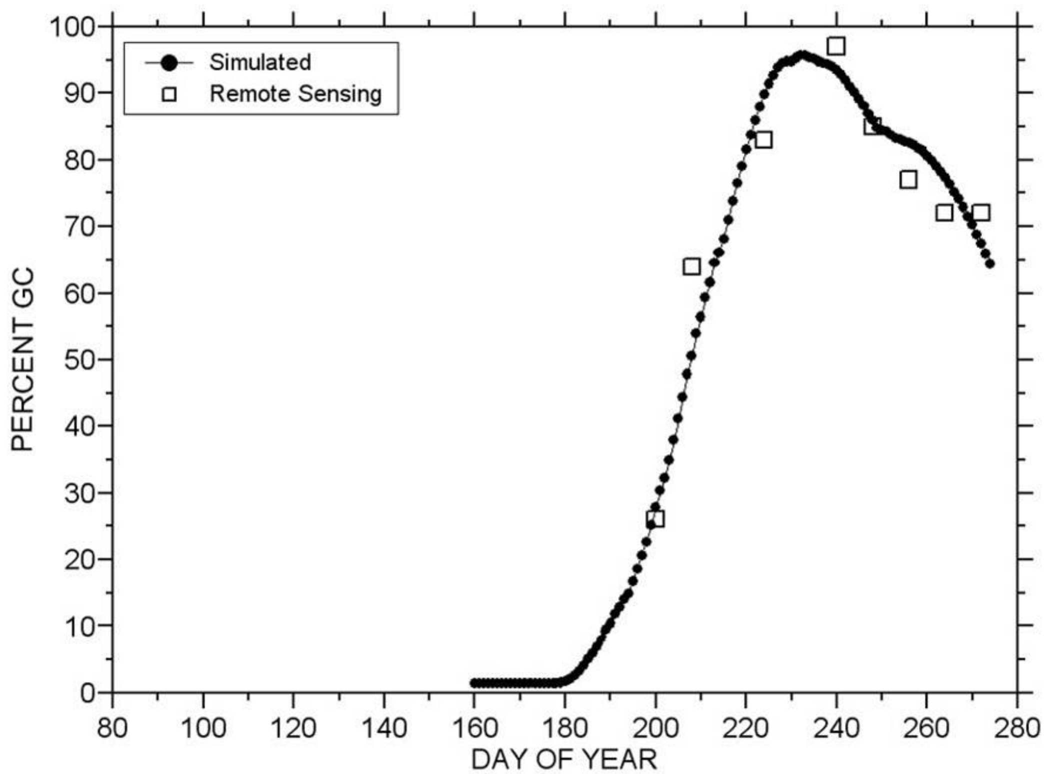

Figure 29. Daily GC Simulation for Field 20-2.

GC (or Ksc) curves generated from remote sensing data for corn and cotton fields in 2007 are presented in Figures 30 and 31. Note that the magnitude and shape of each curve tends to be unique for a given field.

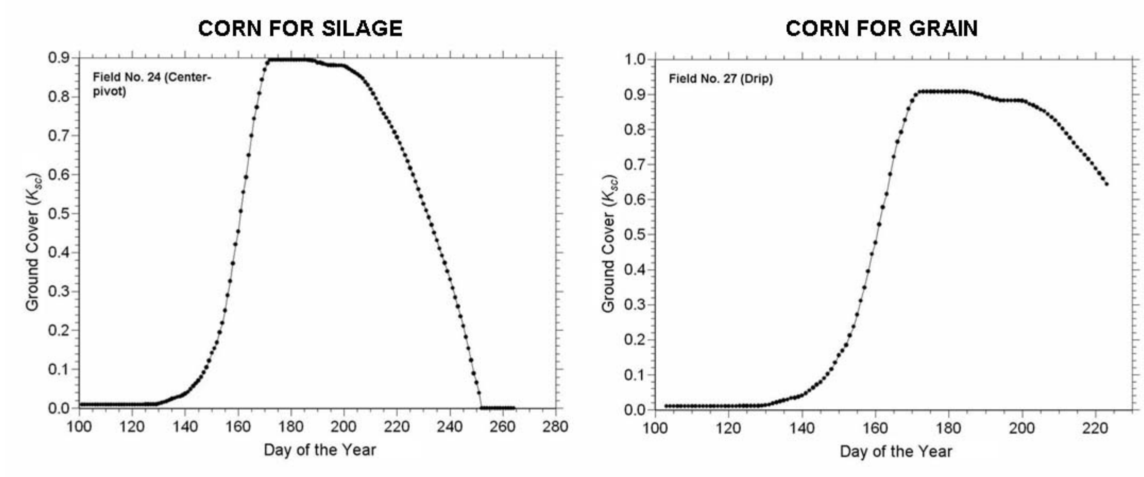

Figure 30. GC (Ksc) curves for corn fields 24 and 27 in 2007. Corn in Field 24 was harvested for grain, while the corn in Field 27 was cut for silage.

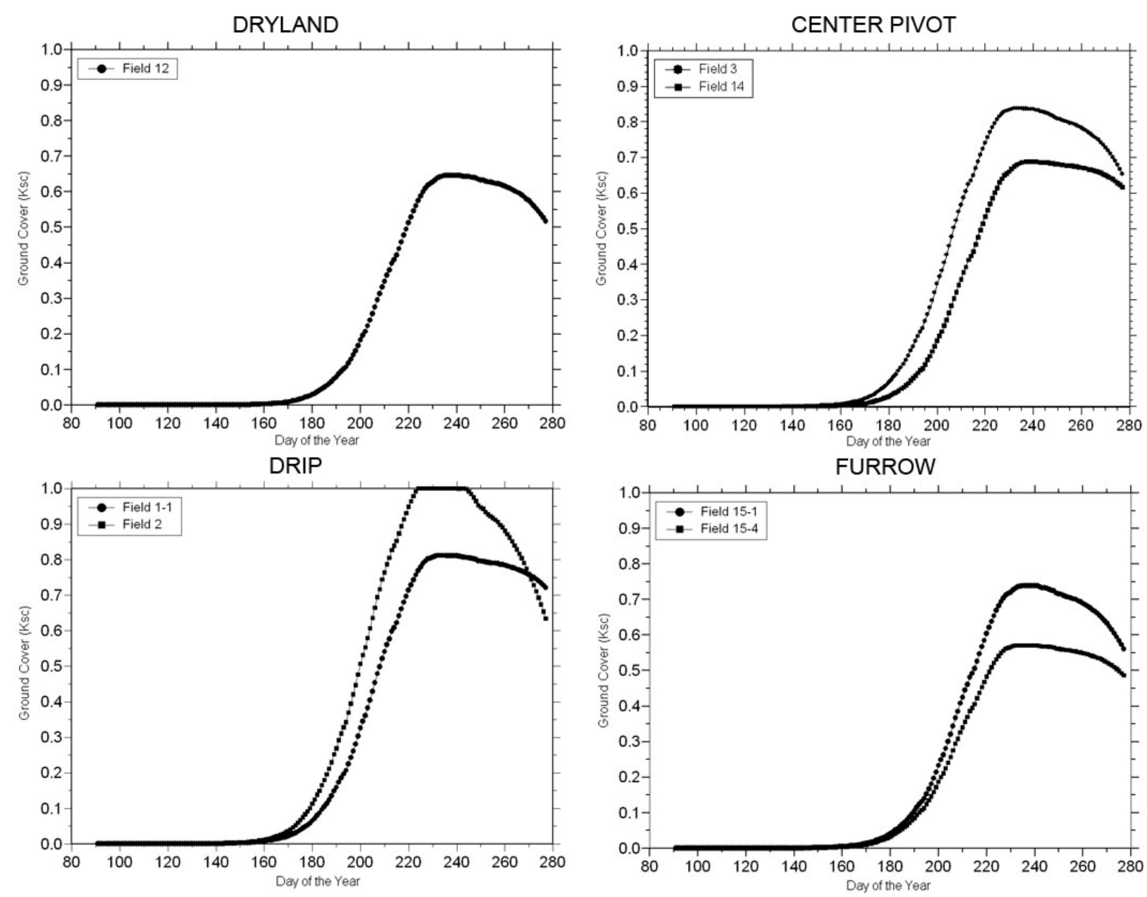

Figure 31. GC (Ksc) curves for cotton fields with various types of irrigation in 2007.

Daily CWU for the four corn fields in the TAWC Project in 2007 estimated using the spectral crop coefficient approach are plotted in Figure 32, along with estimates of crop evapotranspiration (ETc) determined using the standard FAO-56 crop coefficient approach. Recall that CWU represents the water actually used by the crop, and does not include evaporation from the soil surface, as in the case of ETc. The biggest difference in the results from the two methods is early in the growing season, where values of ETc include substantial amounts of soil evaporation. Since the corn in this project was fully irrigated, values of CWU approach the values of ETc in mid-season, suggesting that the corn was growing under near-ideal conditions (which is assumed for ETc). Late in the growing season, some differences appear in the plots of CWU and ETc for given fields (particularly Field 24).

Corresponding results are presented in Figures 33-36 for cotton. All show differences early in the growing season associated with the presence of soil evaporation in ETc. However, many plots show differences between CWU and ETc at other times during the growing season. These differences are related to the field-to-field differences in how the cotton crops grew. Since most of the cotton fields were deficit-irrigated, their water use was below the levels dictated by ideal conditions (as in the case of ETc).

Figure 33 shows results for center-pivot irrigated cotton fields in 2007. Both fields exhibited high water use in mid-season, but also continued to use water late in the growing season, probably because water was available in the soil from above-normal rains during the year. Figure 34 shows results for the one dryland cotton field in the study in 2007. Mid-season water use was considerably below that suggested by the regular Kc approach, as should be expected for a non-irrigated crop. However, soil moisture from rains allowed substantial water use late in the growing season. Figure 35 shows results for the furrow-irrigated cotton in 2007. Most estimates of CWU for these fields were considerably below the values of ETc calculated for the fields. In fact, CWU for these furrow-irrigated fields was similar to the results presented for the dryland cotton field in Figure 34, suggesting that the above-normal rainfall allowed non-irrigated fields to perform as well as the furrow irrigated fields. This might be expected, since furrow irrigation is one of the least efficient forms of irrigation. Figure 36 shows results for the drip-irrigated cotton fields in 2007. Mid-season CWU was near the values expected under ideal conditions (as in the case of ETc), but again CWU late in the growing season was augmented by available soil moisture from rains.

There was one forage sorghum field (Field 20-2) in the TAWC Project in 2007. Daily CWU estimated for this field using the Ksc approach is shown in Figure 37. The variation in daily CWU was qualitatively similar to that for other crops in the Project. As with the cotton crops, CWU late in the growing season was relatively high, sustained by soil moisture accumulated from rain earlier in the growing season. Values of ETc were not determined for this field, since a standard crop coefficient curve was not available specifically for forage sorghum in this region. Corresponding results are presented in Figure 38 for the one millet field in the Project in 2007.

Fig. 8. Comparison of crop water use estimated by spectral and regular crop coefficient approaches for corn fields for the 2007 growing season.

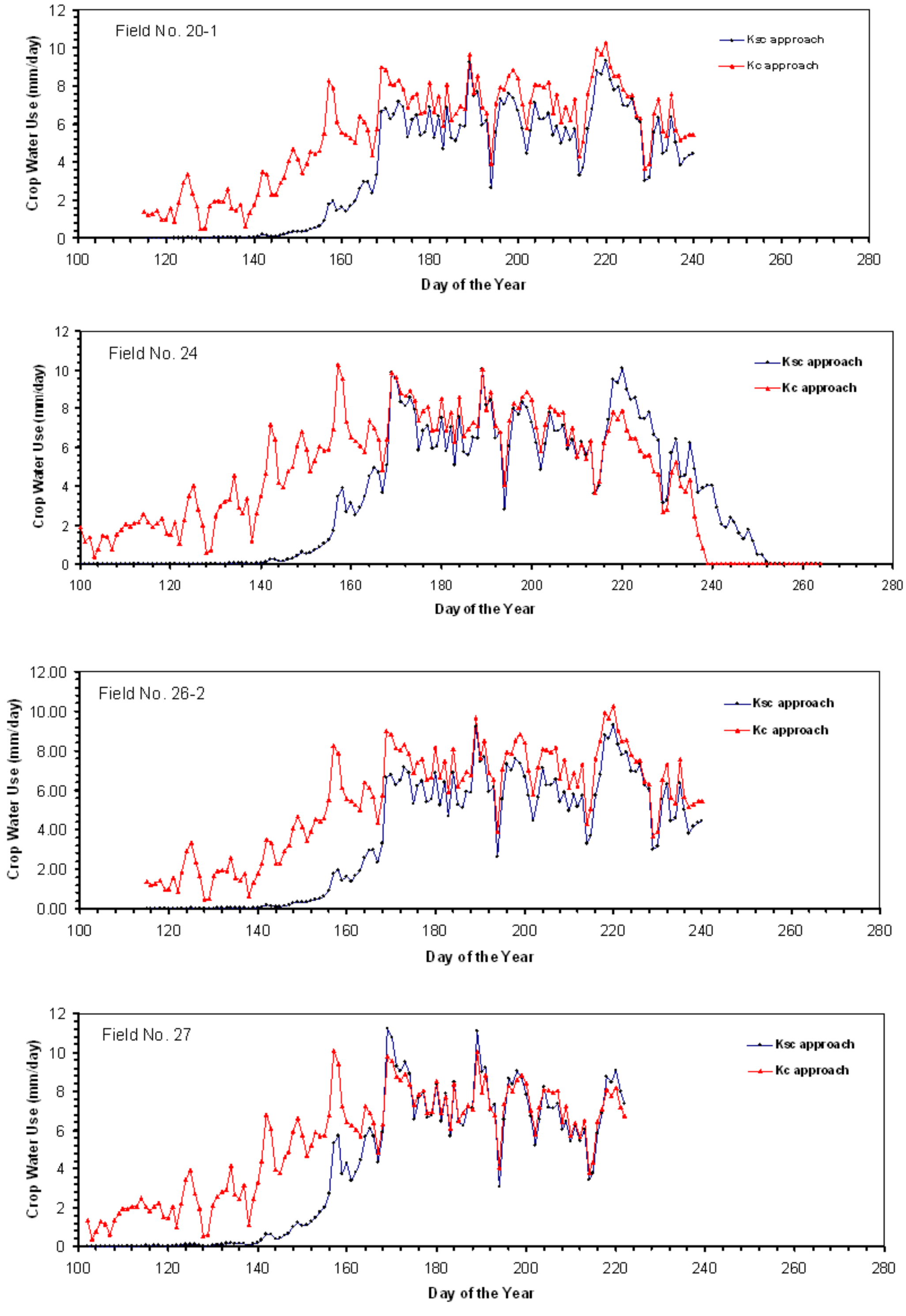

Figure 32. Comparison of crop water use estimated by spectral and regular crop coefficient approaches for corn fields for the 2007 growing season.

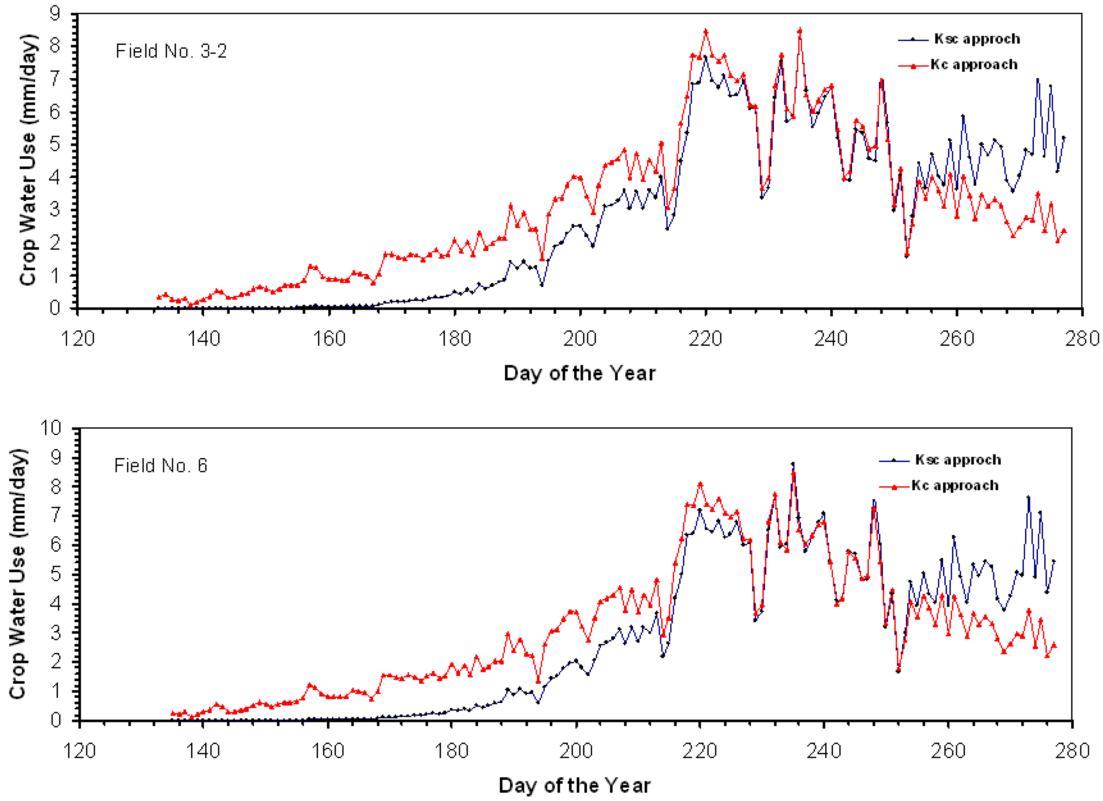

Figure 33. Comparison of crop water use estimated by spectral and regular crop coefficient approaches for center-pivot cotton fields for the 2007 growing season.

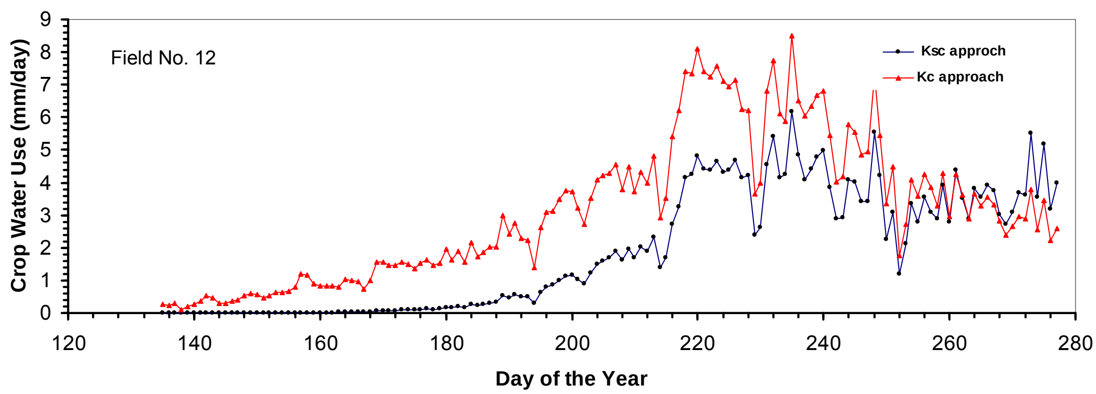

Figure 34. Comparison of crop water use estimated by spectral and regular crop coefficient approaches for dryland cotton for the 2007 growing season.

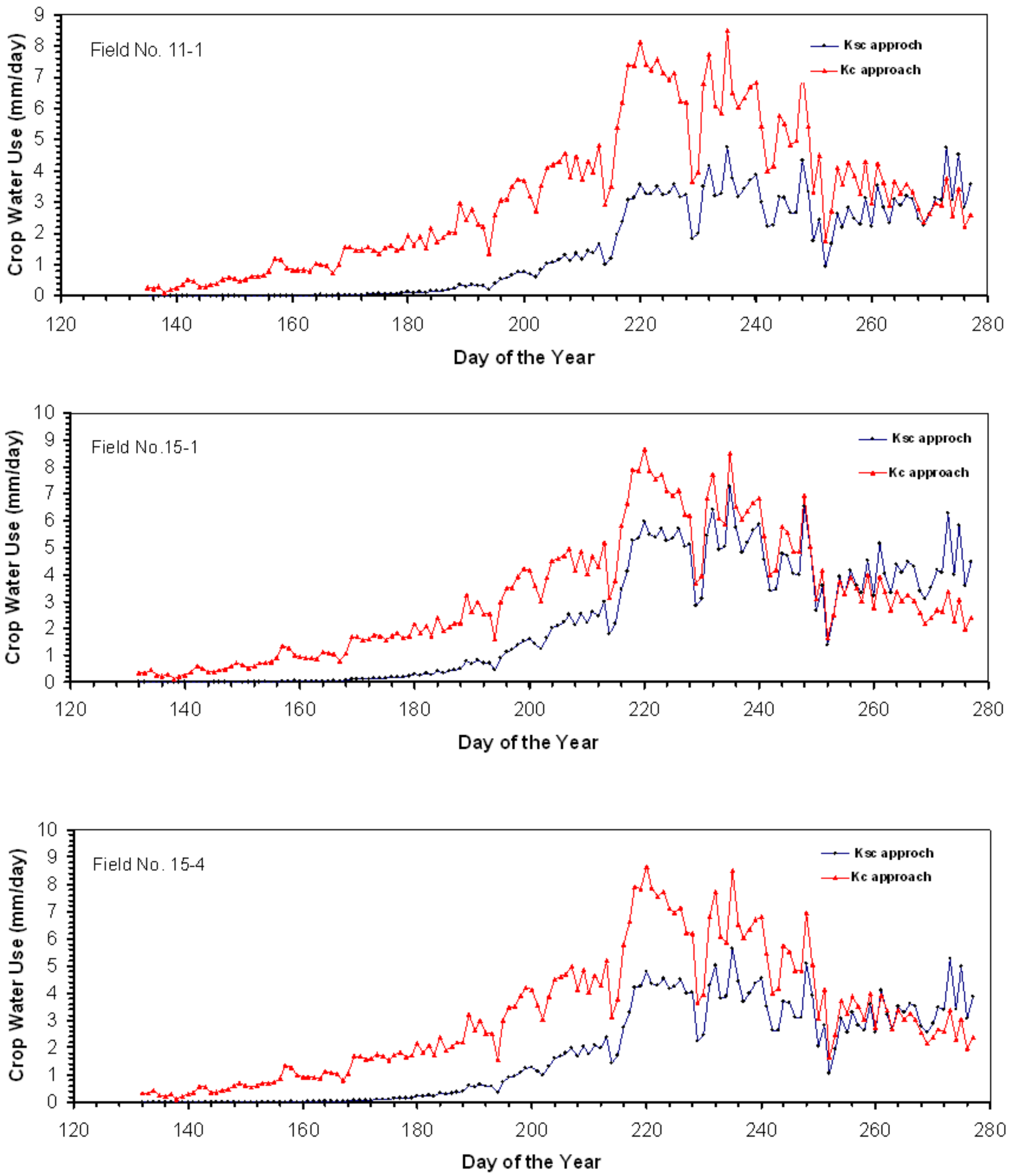

Figure 35. Comparison of crop water use estimated by spectral and regular crop coefficient approaches for furrow-irrigated cotton fields for the 2007 growing season.

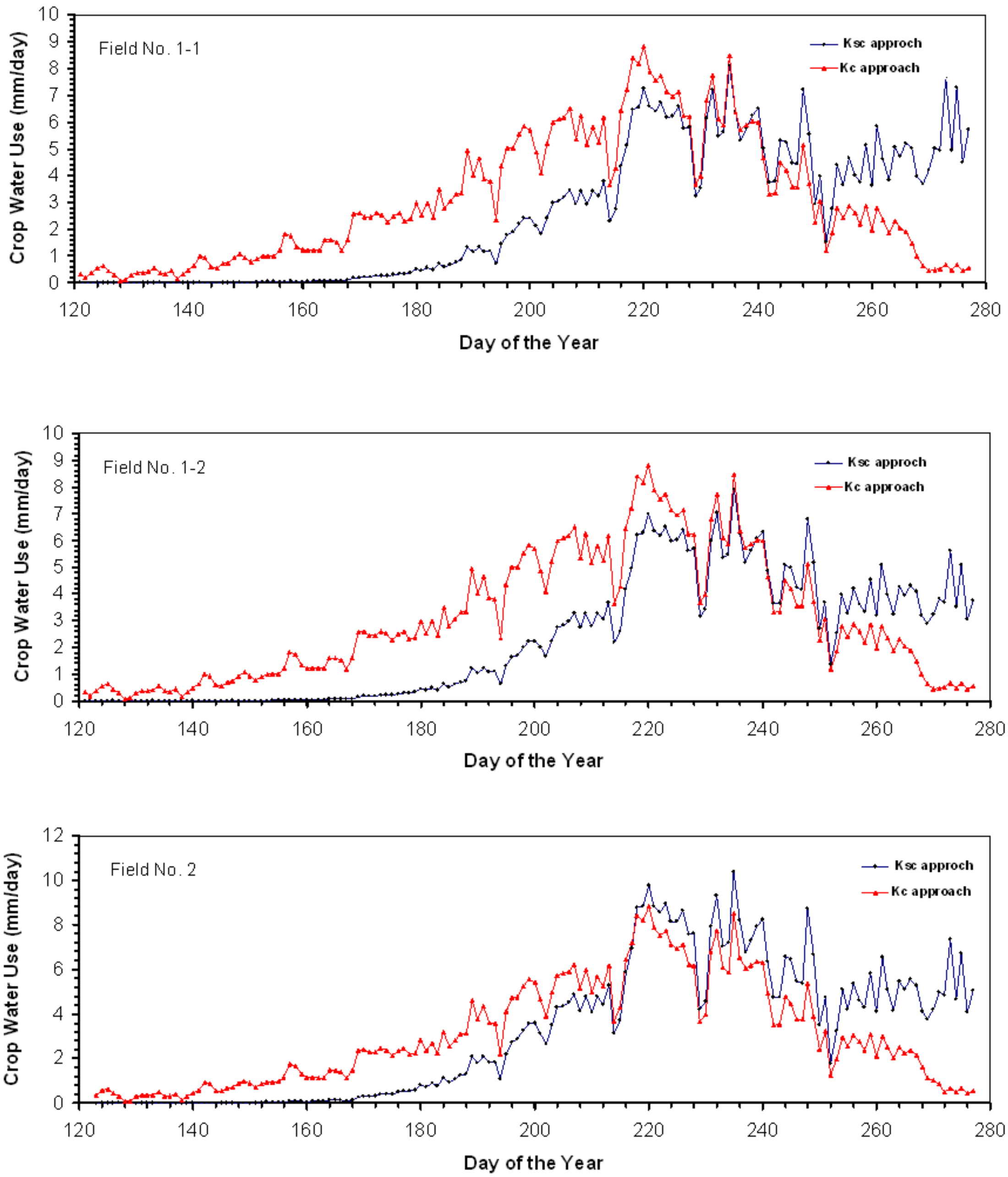

Figure 36. Comparison of crop water use estimated by spectral and regular crop coefficient approaches for drip-irrigated cotton fields for the 2007 growing season.

Figure 39 shows daily CWU estimated for grain sorghum fields in the Project in 2007. Fields 15-3 and 18-2 were irrigated, so the levels of CWU were relatively high over the growing season. Field 12 was dryland sorghum, and never developed a dense crop canopy (see Figure 26). Thus, CWU for this crop was relatively low, particularly late in the growing season.

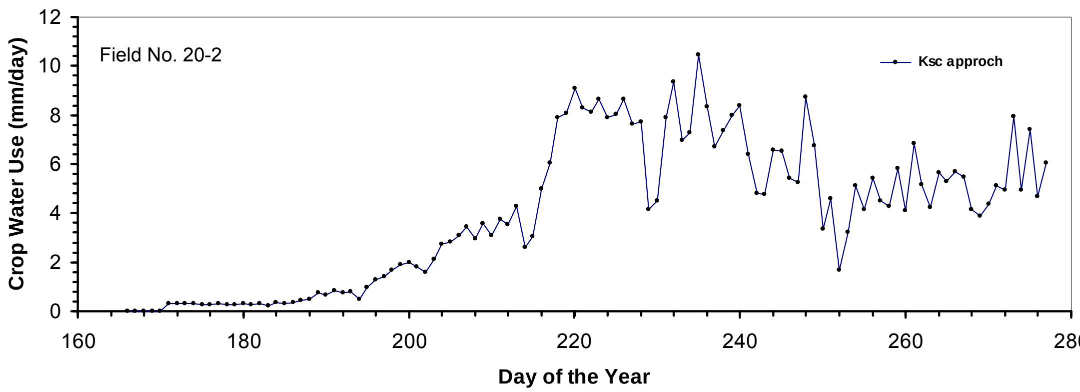

Figure 37. Crop water use estimated by spectral crop coefficient approach for Field No. 20-2 (Forage Sorghum) for the 2007 growing season.

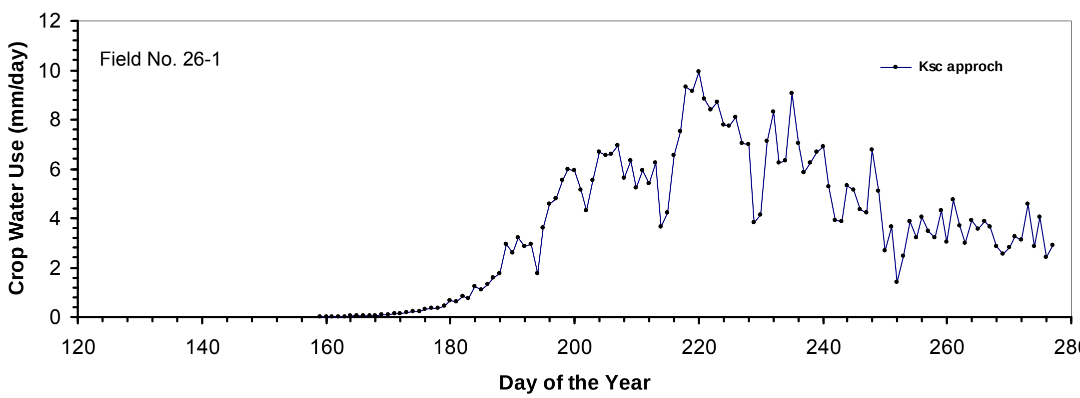

Figure 38. Comparison of crop water use estimated by spectral and regular crop coefficient approach for Field No. 26-1 (Millet) for the 2007 growing season.

During the 2007 growing season, measurements of actual crop evapotranspiration were made on selected fields using two mobile eddy covariance (EC) systems (Figure 40). Measurements of crop evapotranspiration, corrected for soil evaporation, can be compared to the estimates of CWU obtained for fields in the Project as a test of the accuracy of the spectral crop coefficient approach. An example is presented in Figure 41, which shows estimates of CWU determined using the Ksc method compared to actual measurements of crop evapotranspiration (corrected for soil evaporation) from the mobile EC systems. There was good agreement between the two sets of data. Figure 42 compares all the EC measurements obtained during the 2007 growing season with their corresponding CWU estimates made using the Ksc approach. There is good agreement between the two sets of data, with the estimated CWU explaining over 80% of the variation in the observed EC evapotranspiration values. Thus, it is suggested that CWU estimates obtained using the remote sensing-based spectral crop coefficient approach are a reasonable representation of the actual crop water use by the various crops in this project.

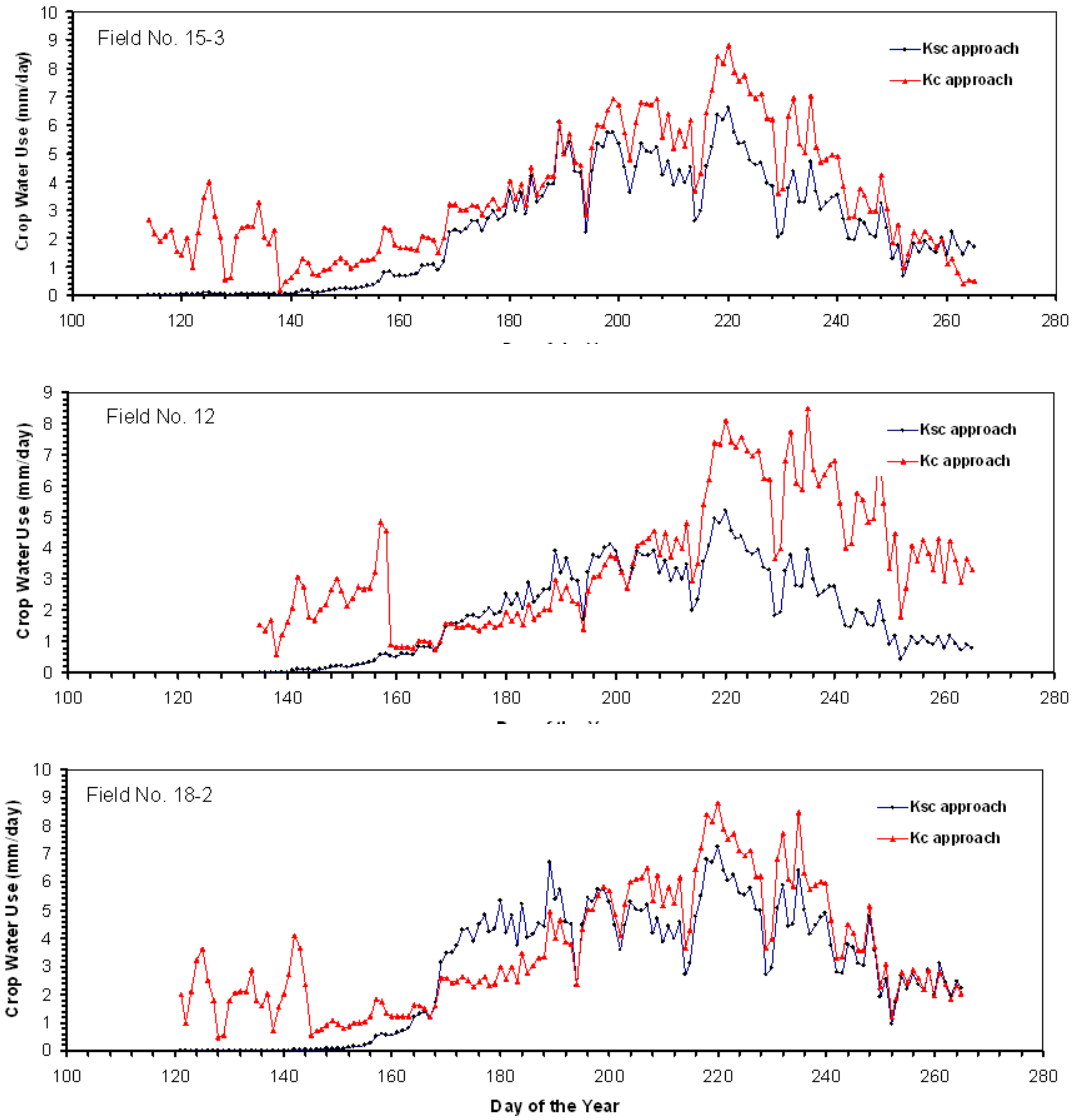

Figure 39. Comparison of crop water use estimated by spectral and regular crop coefficient approaches for grain sorghum fields for the 2007 growing season.

The daily values of CWU determined for fields in the Project can be summed over the growing season to produce estimates of seasonal CWU. These were determined for the fields crops in 2007 and, as previously mentioned, were re-calculated for the 2006 growing season. This allowed comparisons between the two years, between different types of irrigation, and between different crops. Differences in seasonal CWU between 2006 and 2007 were primarily related to differences in the amounts of rainfall received in those two years. Monthly rainfall values are compared for 2006 and 2007 in Fig. 43.

Figure 40. Mobile eddy covariance system located at Field 2.

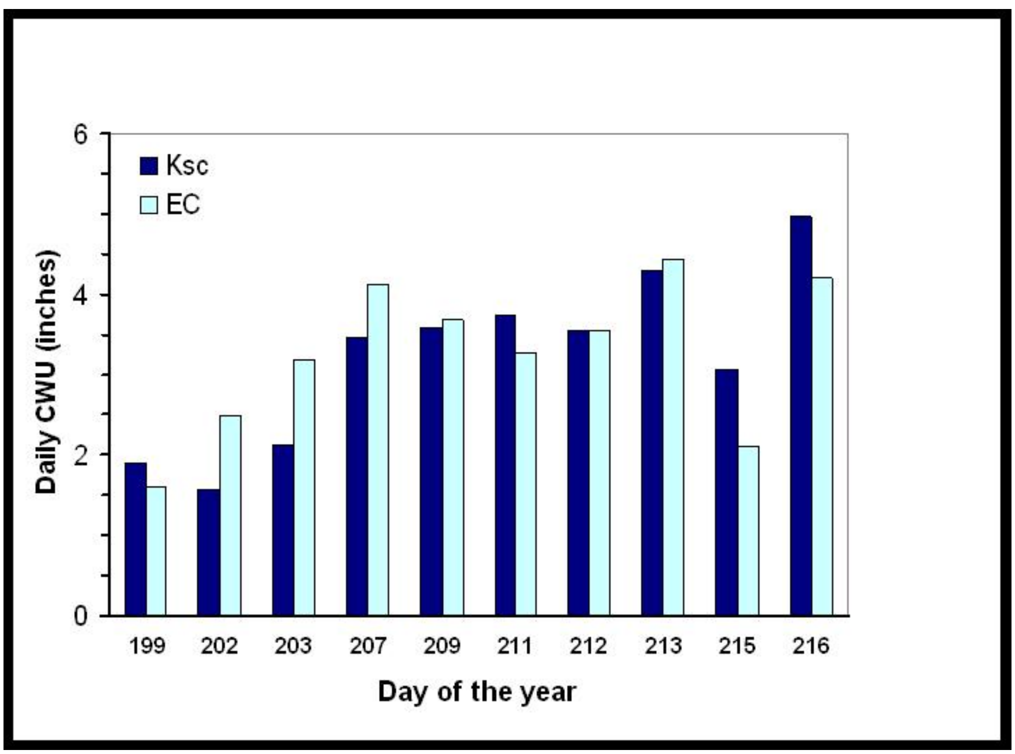

Figure 41. Comparison of CWU estimated for Field 20-2 (forage sorghum) using the Ksc approach with actual measurements of crop evapotranspiration (corrected for soil evaporation) obtained from eddy covariance (EC) measurements on that field.

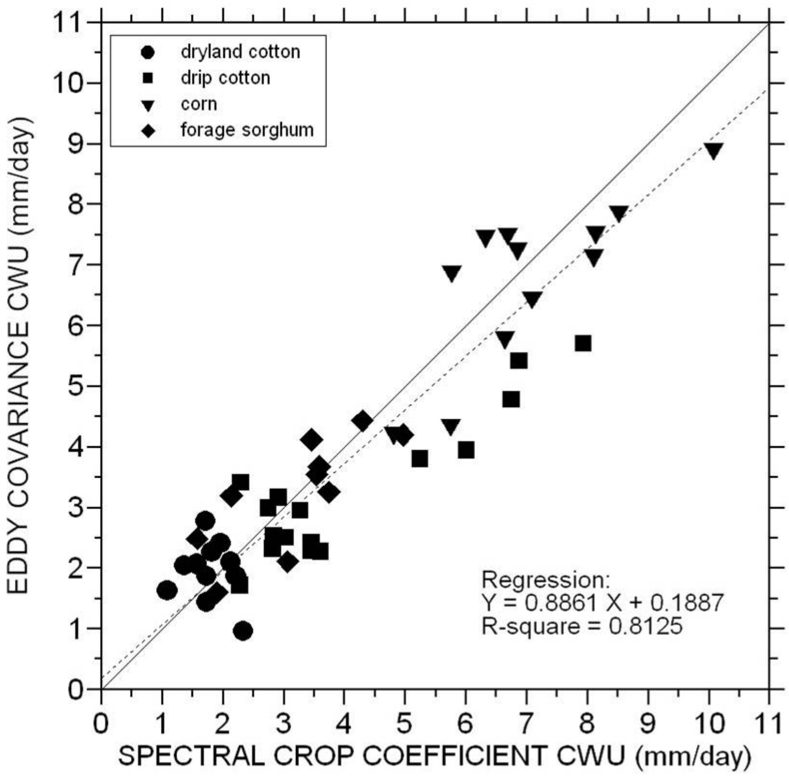

Figure 42. Comparison of daily CWU estimated using the Ksc approach with actual measurements made using the mobile eddy covariance systems.

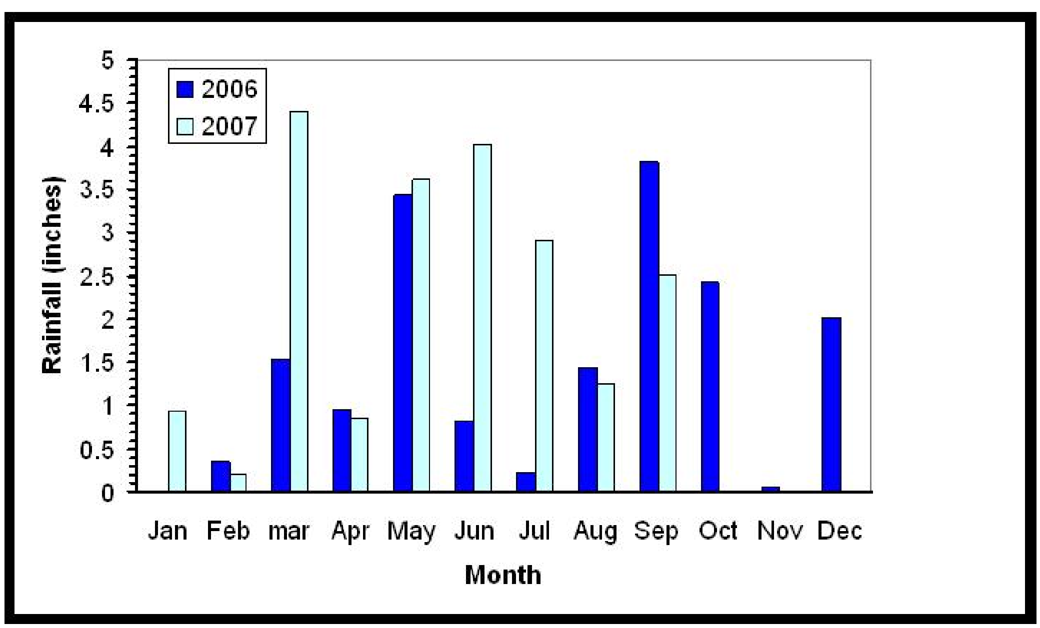

Figure 43. Monthly rainfall received at the Lockney Mesonet station in 2006 and 2007.

Figure 44 summarizes the seasonal CWU for fields in the Project that were planted to the same crop in both 2006 and 2007. Seasonal CWU for the center-pivot irrigated corn fields (Fields 20-1 and 24) and the drip-irrigated cotton fields (Fields 1-1, 102, and 2) was greater in 2006 than in 2007, even though rainfall was greater in 2007 than in 2006. This is most likely because these fields were fully irrigated, so there was no extra benefit of rainfall in 2007. Since 2007 was more humid than 2006, potential evapotranspiration (PET) was greater in 2006, so more water was transpired by the fully irrigated crops in 2006. For deficit-irrigated crops, like center-pivot cotton (Fields 3-2 and 6) and furrow-irrigated cotton (Field 15-1), the additional rainfall in 2007 allowed for higher seasonal CWU for those crops in that year. The same is true for the dryland cotton (Field 12-1), where increased rainfall in 2007 led to increased seasonal CWU. These results emphasize the importance of rainfall in the production of dryland and deficit-irrigated crops in this region. They also suggest that fully irrigated crops, like corn, may receive little benefit from enhanced seasonal rainfall.

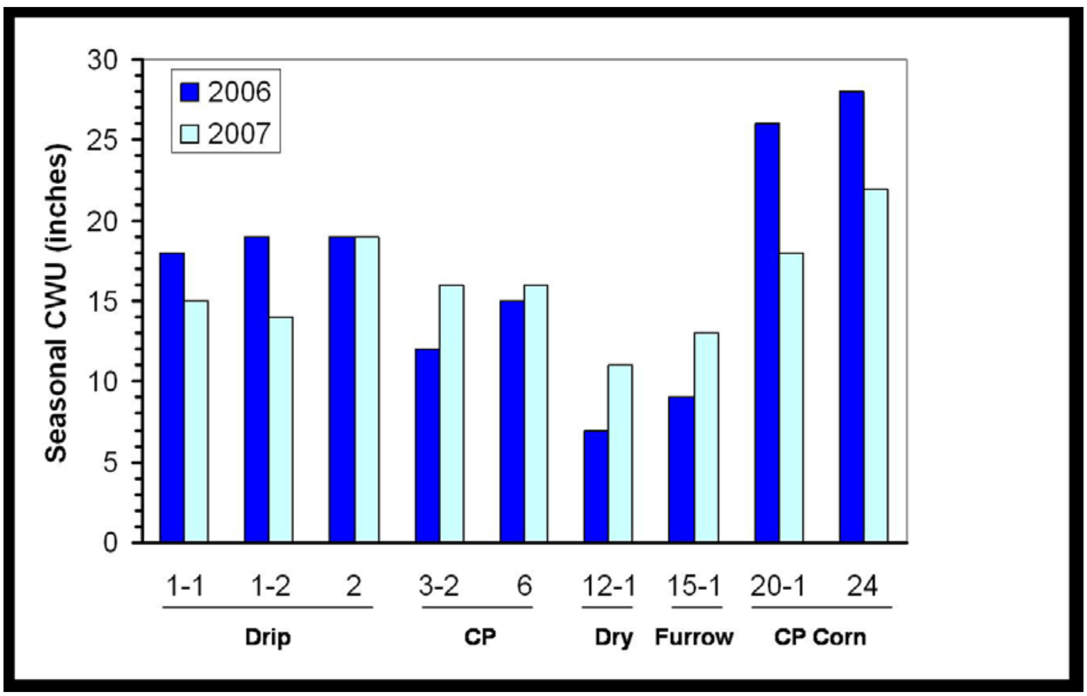

Figure 44. Seasonal CWU for fields planted to the same crop in 2006 and 2007.

Figure 45 shows the seasonal CWU for the four corn and two forage sorghum fields for the 2006 growing season. Two complete forage sorghum crops were obtained from Field 4-1, so the CWU for each crop is treated separately. Corresponding results for the 2007 growing season are presented in Fig. 46. In 2007, there was only one forage sorghum field in the Project. Average seasonal CWU by crop from Figures 45 and 46 are compared in Fig. 47. As suggested in Fig. 44, CWU for fully irrigated corn appears to have been greater in 2006 than in 2007, while CWU for forage sorghum appears to be similar for the two years. While the number of fields in this sample is relatively small, the results in Fig. 47 suggest that, on average, forage sorghum tends to use less water than corn in producing a crop.

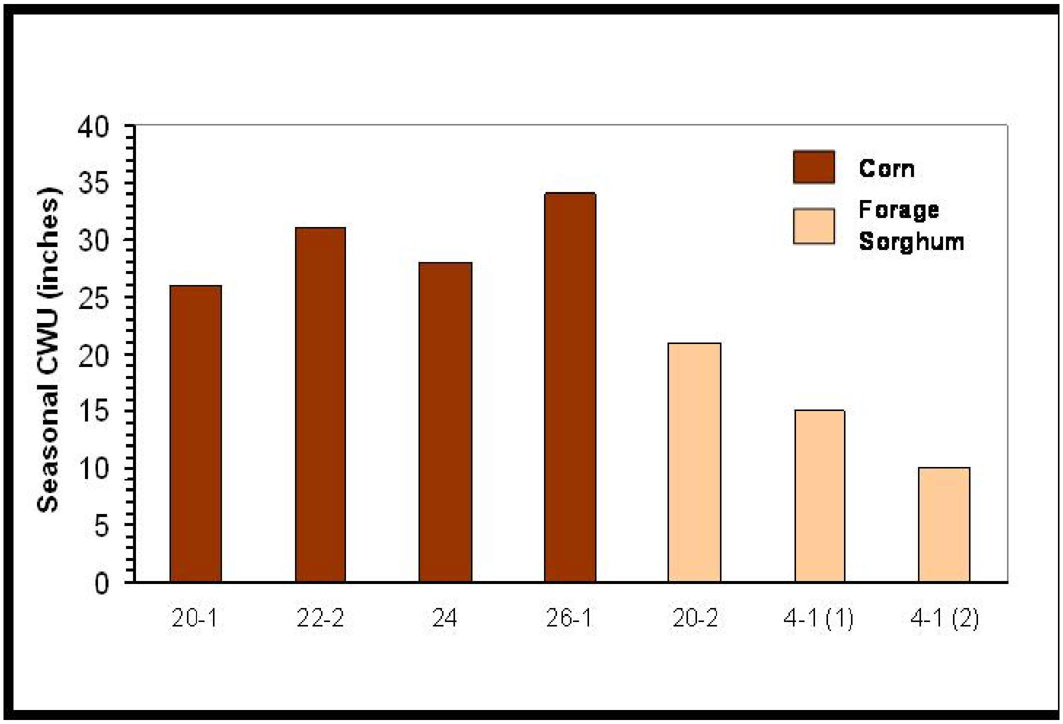

Figure 45. Seasonal CWU for the four corn and two forage sorghum fields for 2006.

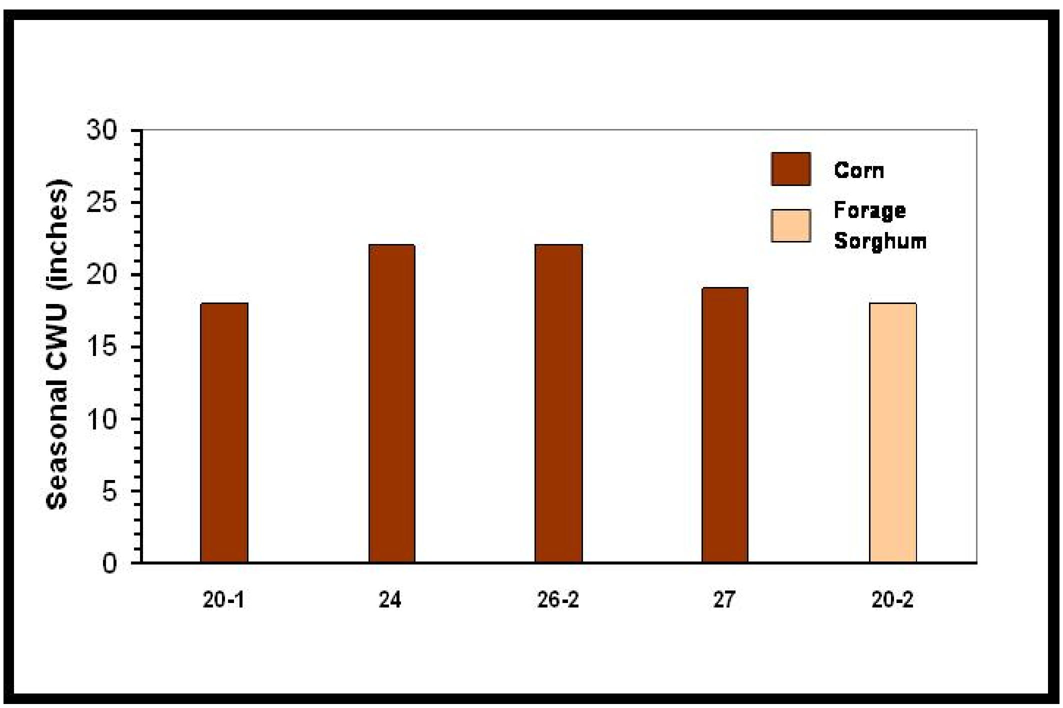

Figure 46. Seasonal CWU for the four corn and one forage sorghum field for 2007.

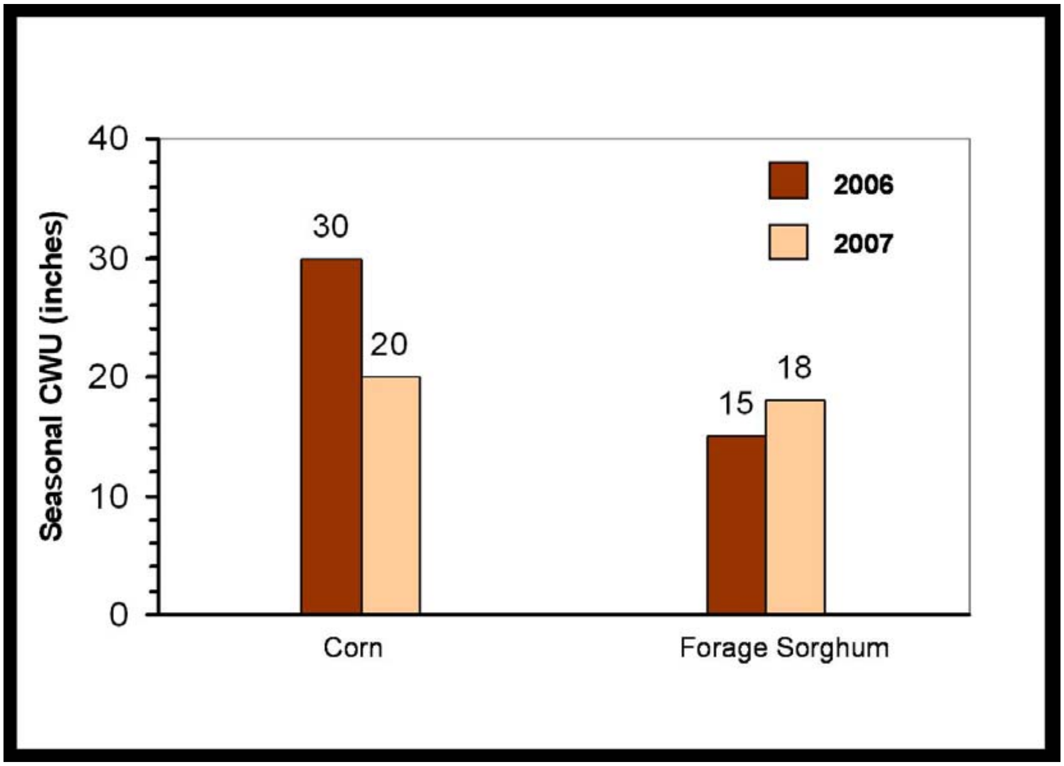

Figure 47. Average seasonal CWU for corn and forage sorghum.

Figure 48 shows the seasonal CWU for cotton averaged according to irrigation type for 2006, estimated using the spectral crop coefficient (Ksc) approach and the standard crop coefficient (Kc) method. Since the Kc method assumes that the crop is well-watered, the values of seasonal CWU are approximately the same for the different irrigation types. The values developed from the Ksc approach, however, reflect the differences among the irrigation types. Corresponding results are presented in Fig. 49 for 2007. Since 2007 was a rainy year, the normally deficit-irrigated cotton was able to utilize extra soil moisture, so that its CWU was the same as the well-watered drip-irrigated cotton. The extra rainfall also allowed the dryland cotton to perform as well as the furrow-irrigated cotton.

Figure 50 summarizes the average seasonal CWU by crop for 2006 and 2007. Of these five field crops, corn consistently used the most water. Forage sorghum and millet had similar average values of CWU over the two years. On average, cotton and grain sorghum used the least water. This is in part because of the use of deficit irrigation in producing these crops, and because some cotton and grain sorghum fields were dryland.

In summary, after two intensive years of study, recognizable patterns in relative water use are beginning to appear for the various crops in the TAWC Project. The spectral crop coefficient approach, which is based on actual observations of the individual fields using remote sensing, appears to do a good job of discriminating differences in CWU among crops, irrigation practices, and individual fields. Comparisons of CWU estimated using the spectral crop coefficient approach with actual measurements made using eddy covariance indicate that this method of estimating CWU appears to be accurate.

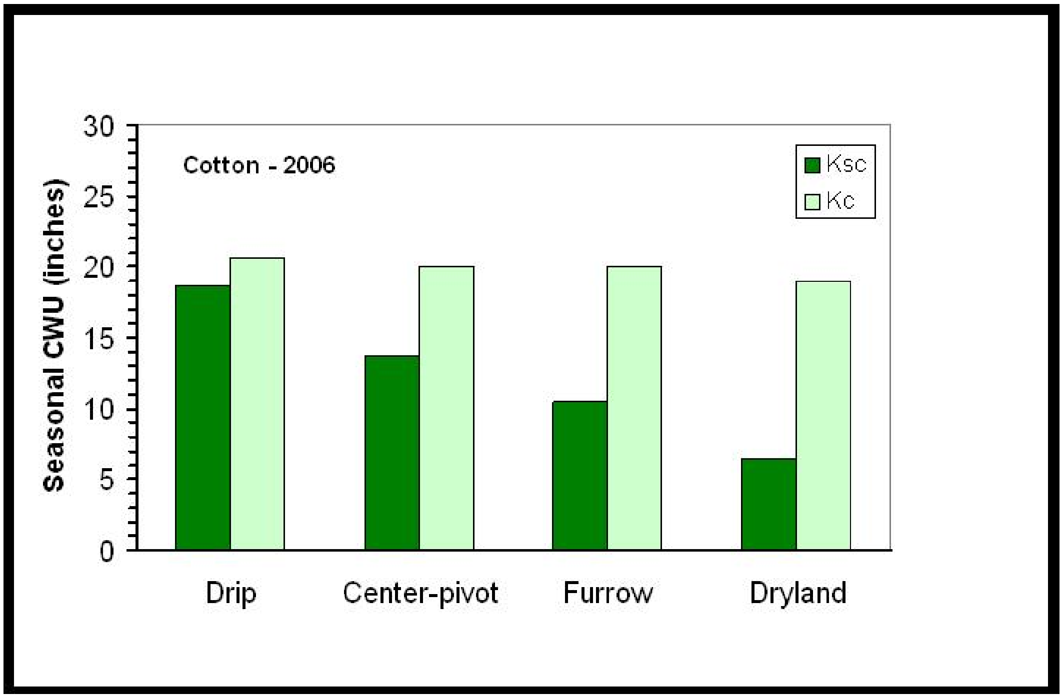

Figure 48. Seasonal CWU for cotton averaged according to irrigation type for 2006, estimated using the spectral crop coefficient (Ksc) approach and the standard crop coefficient (Kc) method.

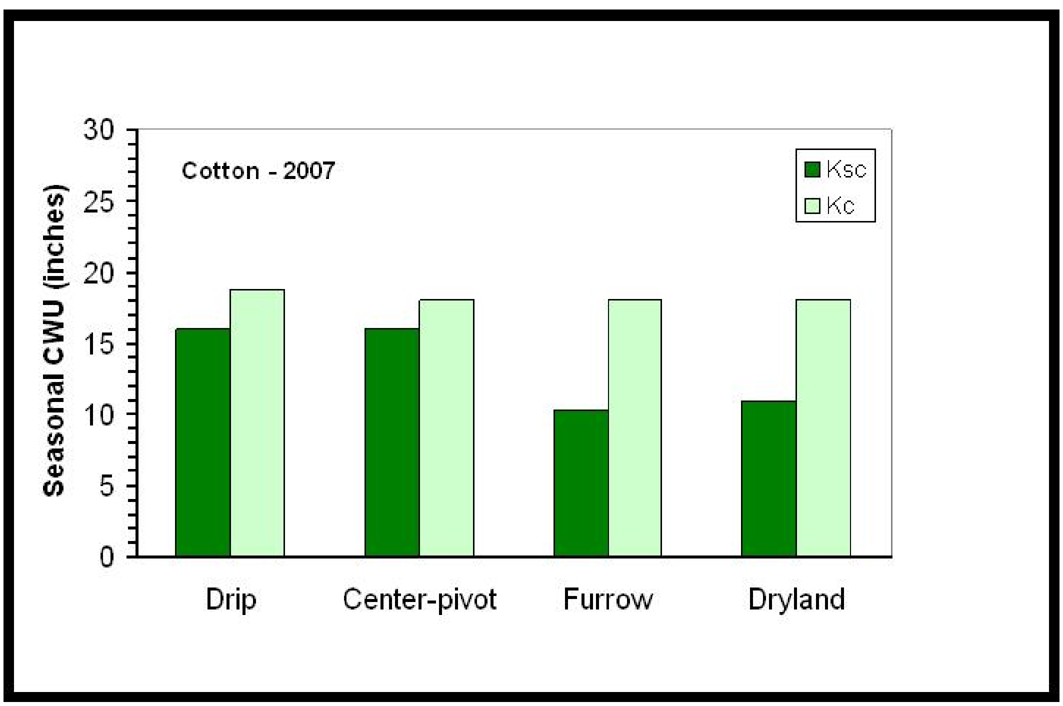

Figure 49. Same as Fig. 48, except for 2007.

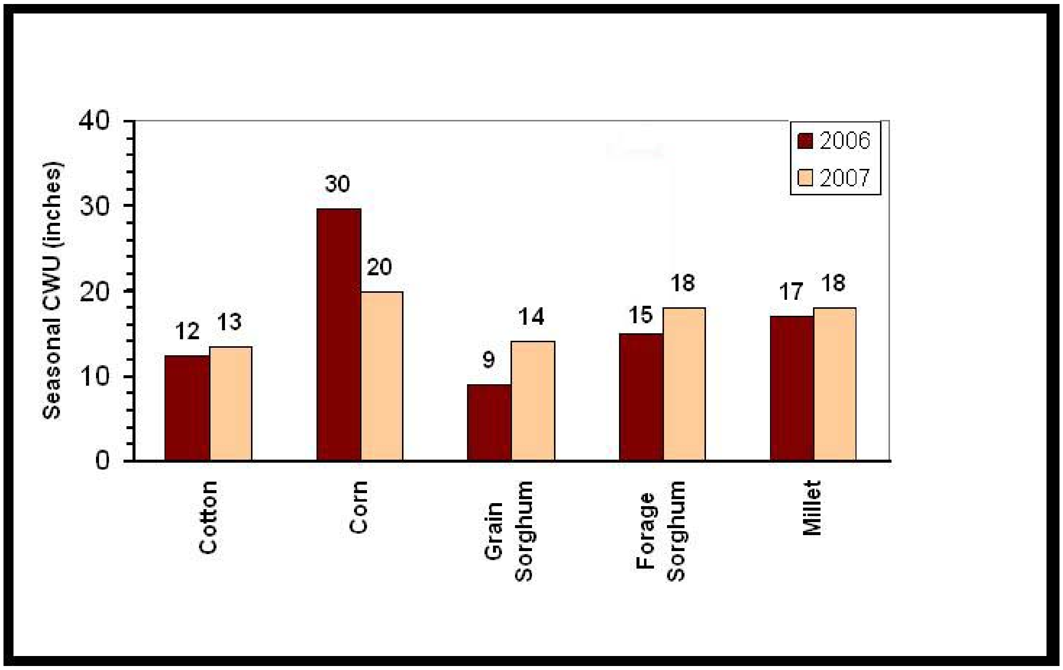

Figure 50. Average seasonal CWU by crop for 2006 and 2007.

TASK 6: COMMUNICATIONS AND OUTREACH

Dr. Mathew Baker
Dr. David Doerfert
Jurahee Jones
Katie Leigh

During this past year, several activities were designed and implemented towards the goal of creating a community of practice around agricultural water conservation. These efforts focused on increasing the awareness of the project, its vision, and the project-related activities to audiences within and beyond the geographic scope of the project. In addition, 2007 activities were designed and conducted to develop the project's first farm field school to be conducted in July 2008. 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.

Accomplishments

- Producer workshops were continued in 2007 with a Cow-Calf Management workshop being held on February 6, 2007 at the Unity Center in Floyd County. Approximately 45 individuals attended the workshop. The workshop was broadcast live on KLFP in Floydada. Participants received notebooks that contained and organized materials discussed during the workshop.

  Workshops on silage management were also conducted in Plainview (March 21) and Clovis, NM (March 22). Participants also received notebooks that contained and organized materials discussed during the workshop.

  A Forage Perennial Grass workshop (which included species selection, management & cattle utilization) was conducted on August 10th. The event was also documented with photographs and video footage.

- A *Summary of Research* series was begun with the project and has been well received with several hundreds of copies being distributed in just a few months. The purpose of this series is to provide a single, comprehensive point of information for producers that highlight findings from the project while enriching with additional information that will facilitate a producer's decision making processes.

  The initial volume centered on the economic and water-saving benefits of forage sorghum silage that was revealed through research conducted at TAWC site #20. The resulting 16-page summary highlighted these results while providing producers with additional management-related information that may be needed to convert their production system to this crop. Summaries being planned for 2008 will focus on perennial grasses and energy consumption.

- Efforts were made to have a presence of the project at major producer gatherings. During 2007, a booth was created and used at two regional producer shows: the Southwest Farm and Ranch Classic (January 2007, Lubbock) and the Amarillo Farm & Ranch Show (November 2007, Amarillo). The booth was staffed throughout the show hours to provide information and respond to questions from those that stop at the booth. Combined attendance at these two shows exceeded 5,000. Project descriptions and summaries of research were distributed to attendees. More than 120 names and addresses were collected for the purpose of sending personal invitations to the 2008 project field day tentatively scheduled for July 2008.
- Project-related presentations were made at (1) the 2007 Southwest Farm and Ranch Classic (January 2007, Lubbock); (2) Area 7 FFA Convention (May 2007, San Marcos); (3) State FFA Agricultural Communications CDE event (April, 2007, Lubbock).
- The project 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). In addition, project-related stories were released through Texas Tech's *Vistas* magazine and the University's home page.
- In addition to the aforementioned activities:
    - Drs. David Lawver and Carlos Villalobos provided TAWC-related information to a group of 28 ranchers in Parral, Mexico.
    - Additional funding has been secured ($28,000) through the Ogallala Aquifer Initiative to encourage agriscience teachers and FFA members to examine water-related topics as potential projects for the Agri-Science fair competition. The goal 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 2008 Texas FFA Convention.
    - On July 23-25, Dr. Matt Baker, Rick Kellison and Kent Lewis (Lamb County – Texas Cooperative Extension Agent) toured regional dairies w/ Duane Tonges from AgCert. During the tour, the TAWC representatives explored opportunities w/regional dairy producers on the topics of water conservation and forage sorghums vs. alfalfa production and carbon credits for composting.
    - 100 TAWC DVDs were distributed at the Texas Vocational Agriculture Teachers' Association Annual Conference in Arlington, TX, July 30-August 3. The purpose was to begin informing teachers about the project in preparation for future educational activities.
    - A copy of the TAWC DVD to 17 new doctoral students who were on campus August 14-17 for educational training. This dissemination helped to create awareness of the project beyond the borders of Texas as these students were

from across the U.S. and Canada—from California to Canada to the Rio Grande Valley to Indianapolis.

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

Accomplishments: Communications Planning

- Initial discussions were held with Monica Hightower, President of Cornerstone Education Group about the creation of a second DVD for the project. This new DVD will highlight the project activities and accomplishments to-date and would be ready for release in 2008. Filming began during the summer months and will conclude in March 2008.
- Photo documentation of field sites has continued with 10 visits since the last annual report. Additional project photos were taken during tours of the project sites and at various related events.
- Three years of project photographs have been uploaded to the internal project website with keywords to facilitate searches by other project participants.
- The external website was updated throughout the year with event news and project-related publications. Media and educator sections of the web site are being constructed for a May 2008 release.
- 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.

Accomplishments: Research

- Dr. David Doerfert co-authored two project-related research posters that were presented at the American Water Resources Association (AWRA) annual meeting in Albuquerque, NM in November. The posters are titled *Considering Conservation Outreach through the Framework of Behavioral Economics: A Review of Literature* and *How Do We Value Water? A Multistate Perspective*.
- Dr. David Doerfert met with representatives from the University of Florida and Oklahoma State Universities in Dallas on November 16-18, 2007 to begin efforts that would secure funding to expand the social science research efforts of the TAWC project. Plans are to submit an integrated research, Extension, and education proposal to USDA (April 2008) and a social psychology proposal to the National Science Foundation (January 2009). Researchers from other universities are being considered for the NSF proposal.
- Drs. Vivien Allen, Matt Baker, Eduardo Segarra, and Mr. Phil Brown published a symposium paper in the *Agronomy Journal* titled: Integrated Irrigated Crop-Livestock Systems in Dry Climates. This seminal article provided anecdotal evidence supporting importance that the TAWC community of practice will have on regional water use.
- Two project-related research studies were completed as student thesis/dissertation.

1. A master's student thesis was completed on the water conservation attitudes and behaviors of a growing rural population segment in West Texas — the small acreage hobby farmer (also known as ruralpolitans). The correlational research study used a mailed questionnaire to collect data from 151 rural area residents in Hale, Floyd, and Lubbock counties. The thesis is available electronically at: http://etd.lib.ttu.edu/theses/available/etd-07072007-182151/ Findings indicated that

    - This population segment believes that everyone needs to conserve water and they feel personally responsible to help conserve water in their community.
    - Responses represented a paradox in that while respondents believe that water conservation should be paramount to society, they also believe that individual autonomy in how water should be used is important.
    - There are potentially four unique segments within this population that may have independent views on water use and regulation.

2. Study #2 was a dissertation of a doctoral student entitled: *Political and Civic Engagement of Agriculture Producers Who Operate in Selected Idaho and Texas Counties Dependent on Irrigation* (see abstract posted below). The dissertation is available electronically at: http://etd.lib.ttu.edu/theses/available/etd-07112007-100717/. Data from this study was used in a paper authored by the doctoral student and Drs. Matt Baker, James Smith, David Doerfert and Phil Kelly (Boise State University) at the joint University Council on Water Resources/National Institute for Water Resources Annual Conference, Boise, Idaho.

Public policy is something that affects all citizens that are governed by the civilization that they live within. We in the United States of America have elected to establish and maintain a system of government called a Democratic Republic. This system relies on the adherence to a set of premises as a basis of policy development and implementation. The first of these is that no policy may contradict that of a higher governing authority. In our country the highest governing authority and ideal is prescribed by the Constitution of the United States.

The constitution among other things maintains that the wishes of the majority may not violate the rights of the minority. This is largely the motivation that results in a rather lengthy process that takes place to the end of a policy being implemented. Early phases of the process are commonly initiated as a result of some form of public discontent over an issue. When sufficient attention is drawn to this discontent the investigative phase of policy development will begin.

This study was conducted to ascertain the scope and extent to which professional agriculture producers in selected counties of Idaho and Texas *engage in processes that influence the crafting of public policy. The predominant criterion for selecting the counties of interest was the extent that irrigation water was relied upon for production. In accordance with focusing on counties that are highly watered, the survey instrument specifically inquired of historic producer action pursuant to water policy development.*

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

Accomplishments

- Four farmer-oriented workshops (see below) were conducted by the project during 2007. For three of the workshops, 3-ring binders were created with handouts from the various speakers. A format for the binder was developed that was consistent with the brand image created for the project. In designing these binders, a vision of creating a library of topics help to guide the final product
    - A Cow-Calf Management workshop was held on Tuesday, February 6 at the Unity Center in Floyd County. Approximately 40 individuals attended the workshop.
    - Silage Management workshops were held on March 21st at the Hale County Extension office in Plainview, TX and March 22nd at the New Mexico State University Extension office in Clovis, NM. Approximately 50 individuals attended the workshops.
    - A Forage Perennial Grass workshop (which included species selection, management & cattle utilization) was conducted outside at the grass trials site on August 10th.

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.

Accomplishments

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

TASK 7: INITIAL FARMER/PRODUCER ASSESSMENT OF OPERATIONS

Dr. Calvin Trostle

7.1 Support to Producers

Visited with eleven producers during 2007 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. Provided crop information to at least 28 producers (TAWC cooperators and others) in the demonstration area.

As noted in previous reports in accord with Task 7 objectives there were several producer questions that were raise which were addressed. The following interests among producers were common in 2007:

1. *What crop, forage, livestock, irrigation, and economic information do you need to make improvements in your farming operation?*
   Which forage sorghums would be appropriate for marketing to dairies?
   How much less water is required for forage sorghum vs. corn silage. This was addressed in great part through the 2007 TAWC publication headed by Doerfert, Bean, and others on silage.
   Strategies to maximize small grains forage production for silage including approximate projection of forage yields if crop was harvested for silage rather than taken to grain.
   Several producers in the TAWC demonstration area included grain sorghum production in their 2007 cropping due to favorable prices. Production information made available in the area as well as the September farm tour included tips on increasing irrigation efficiency.

2. *What production practices or diversification have you considered trying in your operation? (With the availability of FARM Assistance producers will have a better opportunity to gauge the economic effects of changes in practices.)*
   Adding grain sorghum
   Due to the hopefully temporary diversion of many producers throughout the region to interest in producing cash crops interest in perennial grasses has declined for the time, but once the new economics of production are understood and/or cash crop prices decline, I believe the interest in perennial grasses will resume.
   Strategies to spread water use among different crops under the same pivot, a strategy that was discussed during the March sorghum workshop in Floydada.

3. *What ideas do you have for reducing water use on your farm that you believe you could incorporate without reducing profitability?*
   Area growers were tempted into growing corn in 2007 due to high early season rainfall and increased cash prices. This made some producers lose site of

irrigation availability or potentially and grossly overestimate corn yield potential with the current moisture regimes.

4. *What improvements in irrigation efficiency do you believe you could make in your operation?*
   Evaluate potential use of irrigation scheduling based on crop water demand. This topic is being addressed statewide by the Texas Agricultural Irrigation Association with assistance from the Texas Water Resources Institute. Future programs in the TAWC demonstration area will include the information developed.

5. *What types of crop, livestock, and irrigation demonstrations in the Lockney area would you like to see that might help you consider long-term sustainable options for your operation?*
   Small grains silage yields among types and varieties
   More results from the Lockney grass trial—two cuts for the 2007 cropping season are reported in conjunction with this report for Task 7.

7.2 Field Demonstrations

1. Small Grains Forage Trial
   Harvest of two-date (mid-September & late October plantings) irrigated triticale and wheat variety trial for silage. The primary objective is to evaluate different varieties of these small grains for forage production, water use efficiency, and economic value for dairies. Little difference was found among wheat and triticale varieties as a whole suggesting that producer management would be more important than variety selection. Fall 2006 seedings to repeat this trial were implemented north of Lockney, but poor stand and geese feeding damage, led to loss of sufficient stand to preclude meaningful harvest results. Though limited harvest did occur, the variability of the data was too great to be meaningful (Phillips farm).
   A new trial was started Oct. 31 to provide data to the area from a trial at the Texas A&M Center at Lubbock where we could keep up with the plot maintenance better since we could not find a suitable cooperator within the demonstration area for Fall 2007.

2. Lockney Range Grass & Irrigation Trial
   See the report on pages 249 – 252.

Opportunities to Expand TAWC Objectives

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

Leverage of funding: Received $3,500 from the Texas State NRCS agriculture grazing lands initiative to assist with startup costs at a sister perennial grass trial site to be located in Terry Co. on a more sandy soil than what is found at the Lockney site. A cooperator has been identified with land and irrigation southeast of Brownfield to expand the Lockney trial site to land that is sandier.

An application was made to the Texas State NRCS GLCI program for start up funding, and this grant was funded at $3,500.

Educational Outreach

Grain sorghum production discussed at Hale-Swisher Co. crops meeting Feb. 7th, as well as implications of bioenergy in West Texas and the amount of grain and water that may be required to supply regional ethanol plants. Grain sorghum production was also the subject of a grain sorghum mini-workshop in Floydada on March 20th.

Assisted in planning and participated in two silage workshops in Plainview (March 21) and Clovis, NM (March 22). Spoke on the ensiling process addressed common mistakes in silage packing and the effects on spoilage and waste.

Organized and conducted a field tour of the grass trial plots at Lockney in conjunction with J.D. Ragland, Floyd Co. Extension agent. The tour was conducted Friday, August 10th, with about 30 attending, including grass producers from as far away as Hereford and Abilene. This educational opportunity was used as a county extension agent training program. Subsequent educational programs after the field plot tour included beef cattle production and pasture management discussion by Dr. Ted McCollum, Texas Cooperative Extension beef cattle specialist.

Discussed wheat grain production for area producers August 10th at Muncy.

Spoke to 40 producers and industry personnel during the Floyd Co. farm tour in September about grain sorghum production. Producers see the value of grain sorghum in the area for rotations and also as a more water-use efficient crop than corn.

Existing TCE publications and reports were provided in the TAWC target area to at least 28 producers.

SUMMARY OF RESEARCH

Texas Alliance for Water Conservation, Box 42122, Lubbock, Texas 79409-2122
Phone: (806) 742-2744 Fax: (806) 742-0988 Web address: www.depts.ttu.edu/tawc

The TAWC project was made possible through a grant from the Texas Water Development Board

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.

Perennial grass trial plots near Lockney, Texas.

With the help of several grass and producer experts individual varieties of eight different species (13 varieties in all) were selected for testing near Lockney on an Acuff silty clay loam soil. The replicated field set up was located near an irrigation well head on a pivot corner for access to irrigation. Seed industry and producer assistance was received from Nick Bamert, Bamert Seed Company, Muleshoe; Dan Ryan (deceased), Frontier Hybrids, Abernathy; local NRCS staff; and Rick Kellison, Vivien Allen, and Charles Nelson, producers/TAWC collaborators.

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).

Project Initiation

Initial seeding of ten grass species and varieties occurred April 1-3, 2006 three miles south of Lockney. A Tye drill with a grass seed attachment was used to plant three strips for each grass 10' X 75'. Goals of the 2006 season were to first get the grasses established and harvest only if sufficient growth warranted. Three bermudagrass species (two seeded, one sprigged by hand) were added to the test May 26. Seeding rates followed local NRCS suggested guidelines. Broadcast P (30 lbs. phosphate equivalent) and N (30 lbs. urea-N per acre) were applied. Weeds were hoed by hand as needed.

Weather conditions were severely limiting in 2006, but most grasses were well established by the end of the season. Irrigation levels were not implemented in 2006 rather all area were irrigated equally to ensure establishment.

Establishment ratings were conducted in 2006 to ascertain which grasses most rapidly achieve ground cover (Table 1).

Grass Species Stand Establishment

Kleingrass received an excellent stand establishment rating only 5 weeks after seeding. Other grasses, not surprisingly, took much longer to germinate and establish in the field. These included buffalograss and all three old world bluestems. Quick establishment may not necessarily be the hallmark, however, of good long-term perennial grasses. Subsequent ratings to the end of the 2006 season noted the gradual establishment of most species though Indiangrass was poor (Table 1).

Due to a poor initial stand, Wrangler seeded bermudagrass was reseeded in May 2007, and WW-B Dahl old-world bluestem was thickened up with more seed due to weed seed contamination and poor germination. The original supply of WW-B Dahl was infested with Rhodesgrass, and this grass will be rogued from test plots for years to come if it persists in the field. Consistent with local understanding, Spar old world bluestem, which is normally seeded in the region, did establish more easily than WW-B Dahl.

Table 1. Perennial grass trial yield results for July and November 2007 cuttings, Lockney, Texas. Due to high rainfall through June no irrigation treatments were implemented until late July after the first cutting.

Seeding, 1-3 April 2006

Entry	Perennial Grass Species	Variety	Stand† 5/10/06	Stand† 6/6/06	Stand† 9/19/06	Stand† 10/31/07	Summer Yields Lbs./A 7/9-10/07	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
1	Buffalograss	Plains	0.5	3.2	2.8	4.3	1,156	0	689	698	1,854
								1	502		
								2	901		
2	Sideoats Grama	Haskell	2.3	4.7	4.3	3.0	3,539	0	2,736	2,817	6,357
								1	2,529		
								2	3,188		
3	Blue Grama	Hatchita	2.5	3.8	3.7	3.4	2,954	0	3,200	3,223	6,176
								1	3,251		
								2	3,217		
4	NRCS Natives Blend	3 Grasses‡	2.3	5.0	4.3	2.9	3,233	0	2,342	2,642	5,875
								1	2,496		
								2	3,089		
5	Switchgrass	Alamo	1.8	2.7	1.3	2.5	2,790	0	8,049	7,633	10,423
								1	6,937		
								2	7,913		
6	Kleingrass	Selection 75	5.0	5.0	5.0	4.8	2,044	0	5,719	6,201	8,245
								1	6,721		
								2	6,164		
7	Old World Bluestem	Spar	2.0	3.3	3.5	4.9	3,209	0	4,795	5,631	8,840
								1	6,249		
								2	5,848		
8	Old World Bluestem	WW-B Dahl§	0.7	0.7	2.0	3.9	2,420	0	6,653	6,793	9,214
								1	7,826		
								2	5,901		
9	Old World Bluestem	Caucasian	0.0	0.4	1.0	4.6	3,406	0	5,203	4,852	8,258
								1	4,895		
								2	4,458		
12	Indiangrass	Cheyenne	0.7	1.7	0.0	1.2	1,177	0	2,356	2,208	3,386
								1	2,162		
								2	2,107		

Seeding/Sprigging, 26 & 30 May 2006

Entry	Perennial Grass Species	Variety	Stand† 5/10/06	Stand† 6/6/06	Stand† 9/19/06	Stand† 10/31/07	Summer Yields Lbs./A 7/9-10/07	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 sprigged	N/A	3.3	4.3	5.0	4,549	0	5,330	5,626	10,175
								1	5,371		
								2	6,177		
11	Bermudagrass	Giant/Common (1:1 ratio,) seeded¶	N/A	0.2	2.5	5.0	4,113	0	4,712	5,187	9,300
								1	5,401		
								2	5,447		
13	Bermudagrass	Wrangler seeded¶	N/A	0.0	0.5	4.4	977	0	2,850	3,408	4,385
								1	4,001		
								2	3,373		
		Trial Averages	1.8	2.6	2.7	3.9	2,736	0	4,109	4,378	7,114
								1	4,414		
								2	4,300		

	Stand† 5/10/06	Stand† 6/6/06	Stand† 9/19/06	Stand† 10/31/07	Summer Yields Lbs./A 7/9-10/07	Yield @ Irrigation Lbs./A 11/2-7/07
P-Value (Variety)	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
P-Value (Irrigation)						0.2862
P-Value (Variety X Irrigation)						0.4296
Fisher's Protected Least Significant Diff. (0.10)¤	1.0	0.9	1.0	0.5	723	668
Coefficient of Variation, CV (%)	85.4	71.6	63.0	30.9	43.2	48.5

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

^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.)

§Dahl OWB overseeded Spring 2007

¶Wrangler reseeded Spring 2007

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

2007—Rain and Initial Yields

The entire 2007 'cropping' season for the perennial grasses was characterized by a cumulative rainfall of over 15" through the end of June, about double of normal (Table 2). No irrigation treatments were initiated until after a first cut was taken (10' X 75' strips) are reported as 'dryland' or 'Level 0' irrigation for the July 9-10, 2007 harvest. Irrigation was applied only twice the rest of the season creating only 1" and 2" differential among irrigation treatments.

Table 2. Rainfall and irrigation levels on perennial grass trial, Lockney, TX, 2007. Minimal irrigation was applied due to high rainfall received through June.

2007 Lockney Rainfall	Monthly Rainfall (inches)	Cumulative 2008 Total (inches)	Irrigation Levels (inches)			Irrigation Date
			Level 0	Level 1	Level 2	
January	0.31	0.31	D			
February	0.10	0.41	R			
March	3.87	4.28	Y			
April	0.74	5.02	L			
May	4.03	9.05	A			
June	6.58	15.63	N			
July	1.39	17.02	D	1.0	2.0	July 31
August	1.26	18.28	"	1.0	2.0	Aug. 24
September	3.49	21.77	"			
October	0.16	21.93	"			
November	0.01	21.94	Harvest Nov. 2-7, 2008			
December	1.06	23.00				

Grasses which yielded well in the July 2007 harvest included sideoats grama, Ozark sprigged bermudagrass, and a simple 1:1 mix of seeded Giant/common bermudagrass. Most of the forages yielded better in the second half of the season. Top yields came from switchgrass, WW-B Dahl, and Kleingrass. This is particularly impressive for WW-B Dahl which started with a thin stand. Five grasses performed excellent for yields over the full season including switchgrass, Ozark bermudagrass, Giant/common bermudagrass, WW-B Dahl, Spar. Low yielding grasses to date include buffalograss, Indiangrass, and the reseeded Wrangler bermudagrass. Statistically significant yields differences were found among most grasses not irrigation or (variety X irrigation).

The importance and the value of a project like this is that it may take 5 years or more to fully evaluate forage productivity. Some grasses may start early and fast, but other grasses may in time surpass the total forage production. In subsequent seasons it is expected that up to 8 irrigations may be applied to the selected treatments. For the time being, however, little difference was found in yields between irrigation levels though that is expected to change in future reporting.

Education Outreach

As noted before, this project has generated more advanced interest from producers than any other project I have been affiliated with in nearly 10 years in the Texas High Plains. Two field tours have been held to date at the site (over 55 attending). Rick Kellison and Eddie Teeter report frequent inquiries.

2008 Cultural Practices

The trial will be fertilized with P and N prior to spring green up. We expect to initiate one irrigation sometime in March, then beginning in likely mid/late April institute twice monthly irrigations. The goal remains to have a minimum of six years' of data for this project on behalf of TAWC cooperators.

Research conducted by Calvin Trostle, Texas AgriLife Extension Service agronomist, Lubbock with TAWC director assistance from Rick Kellison.

The Texas Alliance for Water Conservation (TAWC) is the effort of individuals and organizations with a mission to conserve water for future generations by collaborating to identify those agricultural production practices and technologies that, when integrated across farms and landscapes, will reduce the depletion of ground water while maintaining or improving agricultural production and economic opportunities. Collaborating partners include the Producers of Hale and Floyd Counties, Texas, Texas Tech University, AgriLife Extension Service, High Plains Underground Water Conservation District No. 1, USDA Natural Resource Conservation Service, USDA ARS Cropping Systems Research Laboratory, FARM Assistance, and the AgriLife Experiment Station.

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, 6 included livestock in 2007. This compares with 5 sites in 2006 and 4 sites in 2005. Thus, within these sites, 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. 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 2007 by site is provided below.

Site 4: This is the first 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 spring of 2007, cattle grazed wheat in Field 2. Wheat provided both grazing and a cover crop prior to planting cotton. In the fall of 2007, cattle grazed wheat in Field 3. Field 3 produced a wheat grain crop during the spring of this year and was ungrazed. Wheat was replanted into Field 3 in the fall and was then grazed.

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 2007, cattle remained on site but had access to sorghum and millet stubble 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 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. This site is a cross-bred stocker cattle operation with occasional hay harvested if there is excess forage. 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 and is overseeded each year in autumn with annual rye. Stocker cattle (heifers in 2007) 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 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. If grazing is not needed, hay is harvested. Seed are also harvested from the Dahl old world bluestem as an additional cash crop for this system. Livestock income is calculated as contract grazing based on grazing days. Although there is a cover crop included in Field 2, this has not grazed by cattle.

Site 17. This is a cross-bred cow-calf system. There is a frequent turnover of cattle in this system as they are bought and sold. With no distinct breeding season, calves are marketed when they reach an appropriate weaning weight for sale. Excess forage is harvested as hay and Dahl was harvested for seed in autumn. The wheat cover crop in Field 3 is grazed by these cattle as well as the perennial warm-season Dahl old world bluestem in Fields 1 and 2. These cattle also graze forages off site generally in fall through mid-winter when grazing crop residues. Economic analysis is based on contract grazing and numbers of grazing days. 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.

Site 26. This site provided contract grazing for dry cows from Site 5 during late fall and winter of 2007. This site has not previously included livestock. Pearlmillet residue in Field 1 provided this grazing opportunity and economics was 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.

Evaluation of producer sites for wildlife habitat of selected species, and observation of presence of wildlife species

Objectives. The overall objective of the TAWC project is to observe how producers use their water, and to identify practices that use less water and make more money. The presence and potential presence of wildlife may play an ever increasing role in economic viability of farming and ranching. Activities such as hunting and wildlife watching are becoming more popular in the region. Land prices in the nearby Rolling Plains are often based more on hunting potential than agricultural use, and hunting leases are as much or more lucrative than leases for agricultural use. With the right wildlife habitat, hunting or similar leases may provide additional income for landowners and operators in this area.

Five wildlife species were chosen because they were native to the region, their potential economic and aesthetic impact on the land, and the availability of habitat models applicable to the species and area. These are lark bunting (*Calamospiza melanocorys*), northern bobwhite quail (*Colinus virginianus*), eastern cottontail rabbit (*Sylvilagus floridanus*), black-tailed prairie dog (*Cynomys ludovicianus*), and pronghorn antelope (*Antilocapra americana*).

Much of this report will read similarly to that in the 2006 Annual Report, since objectives and methods have not changed. Data presented here is for 2007 only, please see the 2006 Annual Report for 2006 data and explorations of theoretical sites and resulting habitat. Much new data, findings, results, and conclusions are included here on various aspects of wildlife habitat and observations of wildlife presence and habits in the area.

Methods. Each site was evaluated using a wildlife Habitat Suitability Index (HSI) for each species. Wildlife HSIs are models used to determine the potential for wildlife habitat under a variety of conditions. These habitat models have been published by the U.S. Fish and Wildlife Service. These models are not based on actual wildlife presence, but on conditions that make the area favorable or unfavorable for specific wildlife species. Each model was designed to be applicable to its specific species in a geographic region that includes the southern High Plains. In general, the models are based on land use and cover type classification, management, vegetation, soil type, and degree of interspersion of specific wildlife requirements.

Cover types on each site were determined based on descriptions in U.S. Fish and Wildlife Service 103 ESM. Soil type and slope were determined from the USDA Soil Survey data, and verified in the field. Cropping and management practices were determined by observing field operations on a regular basis, and by interviews with producers. Botanical composition on perennial pastures was determined using the step-point method, walking transects in each field. Transects were followed using a GPS unit to maintain straight lines and uniform coverage. Canopy height measurements of vegetation were taken at 4 points around a central point. Each central point represented about 20 acres. The central points were placed randomly in vegetation representative of the area. Canopy heights were noted for grass, herbaceous, and woody growth at each site. Visual estimations of all vegetation parameters were also done to augment and verify actual measurements.

HSI calculations were completed using assumptions published with the corresponding HSI model, and assumptions may vary from one species to the next. Most HSI are based on the most limiting factors required by that species, and may not evaluate all actual requirements. Minimum acres required for habitat were ignored for all models, in order to evaluate other factors. For instance, pronghorn antelope require 11.8 sq miles as a minimum habitat area. It is also assumed that pronghorn obtain adequate free water from playas in the area. The other 4 species generally obtain adequate water from their diet and dew, but adequate water may be limiting in very dry years. HSI calculations are based only on conditions with the study area, and may be increased or very occasionally decreased by the surrounding environment.

Results. Habitat suitability index values range from 0 to 1, with 0 not providing at least one essential component of habitat for the specific animal species, and 1 providing all of the essential components required by that species. Sites were evaluated for wildlife habitat in Jan.-Feb. 2007 (Table 19) and July 2007 (Table 20). These HSI values very closely resemble each other, and also are similar to values for 2006. Very few changes were noted.

The most significant changes were increased HSI's at sites 17 and 21, where cropland for annual crops was converted to perennial grass crops. This is very important to note, because the difference between annual and perennial crops are the most important factor for the wildlife habitats evaluated in this geography. Perennial vegetation is the basis for wildlife habitat, and annual vegetation only plays a smaller supporting role for food availability. Land use changes drastically affect wildlife habitat when perennial vegetation is established on, or removed from the land.

Many of the wildlife species require some type of perennial vegetation, primarily for winter food and year-round cover. This is especially true for lark bunting and quail. Therefore, those sites with only annual crops are severely limited in the amount of habitat they offer. Many of the producer sites have HSI values of 0. These are primarily sites devoted to annual plants and that have no perennial vegetation. However, this is without considering nearby habitat. If a cropped area provided winter food for quail in the form of waste grain, and a neighboring farm provided the necessary winter cover, then this cropped field is actually an essential component of the quail habitat.

There is a practical limit to how far wildlife will travel to find components of their habitat that meet their requirements. This is a factor in many of the HSI models. Therefore, farms that have smaller fields and are more diverse in vegetation types will have higher HSI values.

It may also be noted that very few sites, even those with perennial vegetation, had a high HSI for quail or antelope. This is because, according to the HSI model, quail habitat must have some type of woody cover, and pronghorn require woody vegetation such as sage for winter food. There is very little woody cover in the project area, and none within any of the project sites.

However, it has been observed that bobwhite quail are present in the project area, and intermittently on project sites. Although the quail model we are using suggests that quail habitat does not exist without some type of woody cover, observations in the field tend to suggest this is not true. In the geography of the project, quail appear to use any substantial persistent herbaceous vegetation for cover, and do not appear to need the presence of woody cover. This may be a behavioral adaptation of quail specific to the project area due to the scarcity of woody plants and may not be observed elsewhere. This requires further investigation and may provide evidence for adapting the quail habitat model to include other acceptable cover types.

Wildlife Observations

A number of resident wildlife are present on or near project sites, and their presence has been recorded and their behavior has been observed whenever possible. Migratory birds have been observed in the project area and on several sites, including sandhill cranes, northern pintail ducks, mallard ducks, long-billed curlew, cattle egrets, and others.

Table 19. Wildlife Habitat Suitability Indices (HSI)[1] of 26 producer sites in winter 2006 – 2007.

System	Site No.	Acres	Lark Bunting	Bobwhite Quail	Cottontail Rabbit	Black-Tailed Prairie Dog	Pronghorn Antelope
			HSI				
Single crop							
Cotton	1	135.1	0	0	0	0	0.10
Cotton	2	60.9	0	0	0	0	0.10
Cotton	3	123.3	0	0	0	0	0.10
Cotton	6	122.9	0	0	0	0	0.10
Cotton	11	92.5	0	0	0	0	0.10
Cotton	14	124.2	0	0	0	0	0.10
Cotton	16	143.1	0	0	0	0	0.10
Cotton	27	46.2	0	0	0	0	0.10
Multiple crop							
Cotton/wheat	12	283.9	0	0	0	0	0.10
Cotton/wheat	13	319.5	0	0	0	0	0.10
Cotton/grain sorghum	15	95.5	0	0	0	0	0.10
Cotton/oat silage/for. sorgh. hay/wheat	18	122.2	0	0	0	0	0.10
Cotton/pearl millet	19	120.4	0	0	0	0	0.10
Corn/sorg./trit. silages	20	233.4	0	0	0	0	0.10
Cotton/corn/wheat for stocker cattle	21	122.7	0	0	0	0	0.10
Cotton/corn	22	148.7	0	0	0	0	0.10
Cotton/corn	23	105.1	0	0	0	0	0.10
Cotton/corn for silage	24	129.8	0	0	0	0	0.10
Cotton/corn	26	125.2	0	0	0	0	0.10
Perennial vegetation as part of system							
Alfalfa for hay/cotton/ wheat:cow-calf, grain, silage	4	123.1	0	0	0.10	0	0.13
Perr. grass: cow-calf, hay	5	628.0	0.67	0	0.67	0.36	0.10
Perennial grass: seed, hay	7	130.0	0.87	0	0.51	0.82	0.10
Perennial grass: seed, hay	8	61.8	0.87	0	0.51	0.82	0.10
Perr. grass, rye: stocker cattle/cotton	9	237.8	0.37	0	0.15	0.23	0.10
Perr. grass: cow-calf, hay/ oats and forage sorghum hay	10	173.6	0.65	0	0.47	0.65	0.10
Perr. grass: cow-calf, hay/cotton/ corn silage/wheat for cow-calf	17	220.8	0.20	0	0.21	0.24	0.10

[1] A HSI of 0 does not meet the basic requirements of that species. A HSI of 1 fully meets all habitat requirements of that species. HSI models used were published by the US Fish and Wildlife Service.

Ducks and curlews are usually associated with playas, and sandhill cranes are often associated with fields where corn was grown the previous summer, and in wheat fields, where they can cause considerable damage. Common residents are often observed such as field larks, blackbirds, various sparrow species, kildeer, and others.

Table 20. Wildlife Habitat Suitability Indices (HSI)[2] of 26 producer sites in summer 2007.

System	Site No.	Acres	Lark Bunting	Bobwhite Quail	Cottontail Rabbit	Black-Tailed Prairie Dog	Pronghorn Antelope
			HSI				
Single crop							
Cotton	1	135.2	0	0	0	0	0.10
Cotton	2	60.9	0	0	0	0	0.10
Cotton	6	122.9	0	0	0	0	0.10
Cotton	11	92.5	0	0	0	0	0.10
Cotton	14	124.2	0	0	0	0	0.10
Cotton	16	143.1	0	0	0	0	0.10
Cotton	22	148.7	0	0	0	0	0.10
Corn	23	105.1	0	0	0	0	0.10
Corn	24	129.8	0	0	0	0	0.10
Multiple crop							
Cotton/grain sorghum/wheat	3	123.3	0	0	0	0	0.10
Cotton/grain sorghum	12	283.9	0	0	0	0	0.10
Cotton/wheat	13	319.5	0	0	0	0	0.10
Cotton/grain sorghum	15	95.5	0	0	0	0	0.10
Grain sorghum/wheat	18	122.2	0	0	0	0	0.10
Cotton/pearl millet	19	120.4	0	0	0	0	0.10
Corn/sorghum/triticale silages	20	233.4	0	0	0	0	0.10
Corn/pearl millet	26	125.2	0	0	0	0	0.10
Cotton/corn silage	27	62.4	0	0	0	0	0.22
Perennial vegetation as part of system							
Alfalfa for hay/cotton/wheat:cow-calf, grain	4	123.1	0	0	0.10	0	0.13
Perennial grass: cow-calf, hay	5	628.0	0.82	0	0.52	0.55	0.10
Perennial grass: seed, hay	7	130.0	0.84	0	0.57	0.53	0.10
Perennial grass: seed, hay	8	61.8	0.84	0	0.57	0.53	0.10
Perr. grass, rye: stocker cattle/grain sorghum	9	237.8	0.36	0	0.17	0.24	0.10
Perennial grass: cow-calf, seed/corn silage	10	173.6	0.64	0	0.57	0.42	0.23
Perennial grass: cow-calf, seed, hay/cotton/ wheat for grazing	17	220.8	0.41	0	0.39	0.21	0.10
Perennial grass: seed, hay/corn	21	122.7	0.24	0	0.21	0.47	0.10

[2] A HSI of 0 does not meet the basic requirements of that species. A HSI of 1 fully meets all habitat requirements of that species. HSI models used were published by the US Fish and Wildlife Service.

Pheasant are often observed near and in areas bordering on playas where vegetation cover is tall and dense. Predatory birds are often observed over and around perennial vegetation, including primarily northern harrier hawks, red-tailed hawks. Occasionally burrowing owls and short-eared owls have also been observed. Red-wing blackbirds have been observed in large numbers in and around triticale crops. This crop appears to attract them, and even before seed filling and maturity. Turkey presence has been noted occasionally in the area, and on one site. Lark bunting has not been observed in the area, but is known to exist in the project area. The project is in both the winter and summer ranges of the lark bunting.

Small mammals observed include primarily jack rabbits and cottontail rabbits, the jackrabbits being associated with perennial grass fields, and the cottontails associated with a cover of persistent vegetation. Signs of coyote presence are observed regularly on many sites, and occasionally animals have been sighted. Various field mice are often observed, but as with small birds, visual identification is difficult. High presence of predatory birds and coyotes suggests small mammal populations in areas of persistent vegetation are quite significant. Signs of raccoon presence has been noted on one site, possibly because of more constant and high water use on the site resulted in a more reliable source of water for the raccoon. Black-tailed prairie dogs are known to exist in the area, but are generally suppressed and are not common. No signs have been noted on any sites in the project.

Large mammals are not common, but are present in the project area. Both mule deer and whitetail deer have been seen in the area, but not on any sites in the project. Mule deer are regarded to be more prevalent than white-tail by local residents. Pronghorn antelope are not known in the area, but are common to the northwest within 150 miles. As the HSI model suggests, they seem to prefer larger areas of uninterrupted grassland and shrubland.

Regular observations of wildlife in the project sites and project area suggest that their presence is both more common and more diverse than what is commonly perceived.

Conclusion

In general, those sites with perennial vegetation had higher HSI values, and should provide better wildlife habitat. The sites that had HSI values of 0 still may be of some value to wildlife, but lack all the components for a complete habitat for the animals. Sites and areas with perennial vegetation provide permanent homes for wildlife, while those sites with cultivation are only used by wildlife if they are close enough to areas of permanent vegetation. Sites with some component of perennial vegetation may show the most promise for additional income from recreational activities such as wildlife hunting and watching. Further investigation of wildlife presence, wildlife habitat, and potential for wildlife habitat is important for both the wildlife in the area and potential profitability from wildlife-based enterprises.

Task 9: Equipment, Site Instrumentation, and Data Collection for Water Monitoring

Jim Conkwright
Scott Orr

9.1 Equipment Procurement & Installation

Primary System. The following equipment is installed and is operating on site:

- Electromagnetic flow meters,
- Pressure transducers,
- Data logging controllers with communication capabilities,
- Digital compass units have been installed at selected sites.

Secondary System. The following equipment has been installed and is operating on site:

- Tipping bucket rain gauges,
- Temperature Sensors,
- HPWD Manual read rain gauges.

Soil Moisture Site Install. Neutron probe access sites have been installed at each location. Several locations have multiple probe access sites. New sites have been added as needed.

Water Metering & Atmospheric Install. Primary and secondary systems have been installed at each irrigated site. Non-irrigated sites have been equipped with manual HPWD read rain gauges only. Water well level recorders / telemetry systems have been procured and installed at 10 well sites. The Et weather station is operational.

9.2 Data Collection & Processing

Data collection and site monitoring. Initial site information consisting of irrigation application method, operational flows and pressure, acres, crop, irrigation well (size, fuel type, number) and soil classifications have been recorded. Sites equipped with electronic sensors are currently collecting data. Data is being transmitted and logged every 24 hours. Soil moisture data is being collected on schedule. Water well levels at selected sites are being logged and data telemetered to HPWD. Water level data has been retrieved from loggers and is being analyzed. Each location equipped with electronic monitoring devices is being visited on a regular basis for calibration and maintenance.

Data Processing. Data collected is being processed for preparation into the annual report to the TWDB. The water use efficiency estimations for year 3 of the project are being finalized for inclusion in the annual report.

Summary

Primary and secondary systems located at each site are functioning. Water level monitoring is ongoing. Data collection for year 3 has been completed and reports are being finalized. Preparations for year four of the project are underway.

Table 21. Irrigation, PET, and production by site (2007).

System	Field	Crop	Application Method	Acres	Acre Inch ET Crop Water Demand	Acre Inch Irrigation Applied	Acre Inch Total Crop Water (Soil, Irrigation, Precip)	% Of ET Provided To Crop From Irrigation	% Of ET Provided To Crop From Total Water	Yield Per Acre Lbs.	Yield Per Acre Inch Of Irrigation (lbs.)	Yield Per Acre Inch Of Total Water (lbs.)
1	***1***	Cotton	SDI	135.2	20.18	14.64	27.67	73%	137%	NA	NA	NA
2	***1***	Cotton	SDI	60.9	20.09	12.94	29.22	64%	145%	1,280	99	44
3	***1***	Cotton	MESA	61.5	19.91	11.5	31.95	58%	160%	1,801	157	56
3	***2***	Sorghum	MESA	61.8	17.76	8.24	27.90	46%	157%	2,862	347	103
3	***2***	Wheat	MESA	61.8	16.47	6.75	9.70	41%	59%	1,812	268	187
4	***1***	Alfalfa	LESA	13.3	NA	10.56	24.58	NA	NA	9,800	928	399
4	***2***	Cotton	LESA	65.4	19.83	9	21.09	45%	106%	1,672	186	79
4	***3***	Wheat	LESA	44.4	17.82	6.25	5.97	35%	34%	4,636	742	777
5	***1***	Grass	MESA	628	NA	4.59	26.76	NA	NA	NA	NA	NA
6	***1***	Cotton	LESA	122.9	19.59	10.86	27.10	55%	138%	1,341	123	49
7	***1***	Grass	LESA	130	NA	13.39	29.64	NA	NA	3,828	286	129
7	***1***	Seed	LESA	130	NA	13.39	29.64	NA	NA	197	15	7
8	***1***	Grass	SDI	61.8	NA	15.67	31.42	NA	NA	3,960	253	126
8	***1***	Seed	SDI	61.8	NA	15.67	31.42	NA	NA	206	13	7
9	***1***	Rye	MESA	95.8	NA	4.65	20.35	NA	NA	NA	NA	NA
9	***2***	Sorghum	MESA	137	19.27	3.86	20.13	20%	104%	5,250	1,360	9
10	***1***	Grass	LESA	44.3	NA	3.75	28.08	NA	NA	NA	NA	NA
10	***2***	Corn Silage	LESA	44.5	24.56	15.65	31.72	64%	129%	64,000	4,089	2,018
10	***3***	Grass Seed	LESA	42.7	NA	3.75	28.08	NA	NA	72	19	3
10	***4***	Grass	LESA	42.1	NA	3.75	28.08	NA	NA	NA	NA	NA
11	***1***	Cotton	Furrow	92.5	19.86	14.67	37.25	74%	188%	1,209	82	32
12	***1***	Cotton	Dryland	151.2	19.86	DRY	23.18	0%	117%	1,237	0	53
12	***2***	Sorghum	Dryland	132.7	19.75	DRY	21.16	0%	107%	2,909	0	137
13	***1***	Cotton	Dryland	319.5	19.91	DRY	15.28	0%	77%	1,792	0	117
14	***1***	Cotton	MESA	124.2	19.72	8.63	19.83	44%	101%	1,205	140	61
15	***1***	Cotton	Furrow	38.3	19.83	13.78	33.23	75%	168%	1,492	108	45
15	***3***	Sorghum	Furrow	28.8	18.27	6.6	20.31	36%	111%	7,135	1,081	351
15	***4***	Cotton	Furrow	28.4	19.83	12.72	26.90	64%	136%	1,258	99	47
16	***1***	Cotton	LESA	143.1	NA	8.72	18.89	NA	NA	NA	NA	NA
17	***2***	Grass Hay	MESA	58.3	NA	6.25	23.57	NA	NA	2,100	336	89
17	***2***	Grass Seed	MESA	58.3	NA	6.25	17.32	NA	NA	5	1	0.29
17	***3***	Cotton	MESA	108.9	20.08	9.45	25.99	47%	129%	1,526	161	59
18	***1***	Wheat	MESA	60.7	18.03	3	18.37	17%	102%	1,500	500	82
18	***2***	Sorghum	MESA	61.5	22.58	7.65	24.45	34%	108%	7,703	1,007	315
19	***5***	Cotton	LEPA	75.8	19.86	7.84	20.52	39%	103%	1,345	172	66
19	***6***	Millet Seed	LEPA	45.6	20.97	6.95	19.72	33%	94%	4,200	604	213
20	***1***	Triticale Silage	LEPA	117.6	13.79	9.26	17.83	67%	129%	26,000	2,808	1,458
20	***2***	Triticale Silage	LEPA	115.8	19.42	13.45	22.55	69%	116%	44,000	3,271	1,951
20	***1***	Corn Silage	LEPA	117.6	23.15	14.26	27.47	62%	119%	60,000	4,208	2,185
20	***2***	Sorghum Silage	LEPA	115.8	19.42	11.59	27.00	60%	139%	50,000	4,314	1,852
21	***1***	Grass	LEPA	61.4	NA	6.55	24.62	NA	NA	203	31	8
21	***2***	Corn	LEPA	61.3	27.25	10.15	26.14	37%	96%	9,717	957	372
22	***1***	Cotton	LEPA	147.6	19.83	11.86	23.48	60%	118%	1,661	140	71
23	***1***	Corn	LESA	100.3	27.2	10.89	27.84	40%	102%	12,760	1,172	458
24	***1***	Corn	LESA	129.8	27.03	15.34	28.72	57%	106%	13,660	890	476
26	***1***	Millet Seed	LESA	62.9	19.89	9.25	26.83	47%	135%	3,507	379	638
26	***2***	Corn	LESA	62.3	27.65	13.45	24.51	49%	89%	12,864	956	525
27	***1***	Corn Silage	SDI	46.2	21.68	13	28.50	60%	131%	72,000	5,538	2,527

Explanation of Table: Estimated Volume of Irrigation Conserved (Tables 22 and 23)

Description
The estimated volume of supplemental irrigation actually applied as compared to the total estimated amount of water needed (demanded) by the crop based upon ET. The difference between the amount of irrigation applied and the amount demanded by the crop could theoretically be categorized as water conserved if demand exceeded irrigation applied.

ET Demand Acre Feet per Acre
Estimated water demand based upon crop specific ET.
(Inches per acre of estimated ET / 12)
**Actual crop water demand can be affected by many factors, including soil moisture available, health of the crop, and likely by plant populations and crop variety traits. These factors are not taken into account by ET models. The actual crop water use may be somewhat less than the predicted value due to less than optimal field conditions.*

Percentage of ET Provided to Crop from Irrigation Acre Feet per Acre
The amount of estimated water demanded by the crop which was provided by irrigation expressed as a percentage of total irrigation applied.
(Estimated ET / Irrigation applied)

Potential Irrigation Conservation Acre Feet per Acre
Acre feet of irrigation that was not applied to satisfy total estimated ET demand which could theoretically be categorized as water conserved.
(ET demand – irrigation applied)

Percentage of Potential Irrigation Conservation Acre Feet per Acre
Acre feet of irrigation that was not applied to satisfy total estimated ET demand which could theoretically be categorized as water conserved expressed as a percentage.

Total Acre Feet of Irrigation Potentially Conserved
Total acre feet of irrigation not applied to the sum field acres to satisfy total estimated ET which could theoretically be categorized as water conserved.

Table 22. Total irrigation potentially conserved (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/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			**48.96**	**85.86**		**44.74**		**1706.00**

Table 23. Total irrigation potentially conserved (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/ACRE	ACRE FEET/ACRE	ACRE FEET
2007	1	1	135.2	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	122.9	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	151.2	0.00	1.66	0%	0.00	100%	0.00
2007	12	2	132.7	0.00	1.65	0%	0.00	100%	0.00
2007	13	1	319.5	0.00	1.66	0%	0.00	100%	0.00
2007	14	1	124.2	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	143.1	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	108.9	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	117.6	0.77	1.15	67%	0.38	33%	44.39
2007	20	2	115.8	1.12	1.62	69%	0.50	31%	57.61
2007	20	1	117.6	1.19	1.93	62%	0.74	38%	87.12
2007	20	2	115.8	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	147.6	0.99	1.65	60%	0.66	40%	98.03
2007	23	1	100.3	0.91	2.27	40%	1.36	60%	136.32
2007	24	1	129.8	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				37.39	58.36		26.45		2,114

Explanation of Table: Estimated Volume of Total Water Conserved (Tables 24 and 25)

<u>Description</u>
The estimated volume of total water available and utilized as compared to the total estimated amount of water needed (demanded) by the crop based upon ET. The difference between the amount of total water available and the amount demanded by the crop could theoretically be categorized as water conserved if demand exceeded total available water.

<u>ET Demand Potential Use Total Acre Feet</u>
Estimated total water demand based upon crop specific ET.
(Acre feet per acre of estimated ET demand x total acres)
*Actual crop water demand can be affected by many factors, including soil moisture available, health of the crop, and likely by plant populations and crop variety traits. These factors are not taken into account by ET models. The actual crop water use may be somewhat less than the predicted value due to less than optimal field conditions.

<u>Available Water Total Acre Feet</u>
The total amount of available water consisting of effective precipitation, irrigation applied and soil moisture content.
(Acre feet total water available x total acres)

<u>Percentage of Potential Use</u>
Percentage difference between ET demand and total available water.
A positive percentage indicates more water available than utilized while a negative percentage indicates demand exceeded available.
(ET demand / Available Water) This value is calculated for only those sites that have the ET potential use and available water consisting of rain, irrigation, and soil moisture data available.

<u>Potential Water Demand Conserved Total Acre Feet</u>
The difference between total available and ET demand.
A negative number indicates more water available than utilized while a positive number indicates demand exceeded total water available.
(ET Demand – Available water) This value is calculated for only those sites that have the ET potential use and available water consisting of rain, irrigation, and soil moisture data available.

<u>Potential Water Demand Conserved</u>
The total percentage of water that could theoretically be categorized as water conserved. A negative number indicates more water was available or supplied than the crop demanded during the growing season.
(100% - Percentage of Potential Use) This value is calculated for only those sites that have the ET potential use and available water consisting of rain, irrigation, and soil moisture data available.

Table 24. Potential water demand conserved (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 25. Potential Water Demand Conserved (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%**

Statement of Factors Affecting Irrigation Water Savings

The district 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.

Brief Synopsis of Year 3 Irrigation

Year 3 of the demonstration project began with above average rainfall preceding the planting of summer crops. Few producers applied irrigation prior to crop seeding. The majority of irrigation applications began the second and third week of July.
Varying precipitation events continued throughout the growing season. Crop growing conditions were extremely favorable as a majority of producers were able to adequately supplement precipitation with irrigation at appropriate timing intervals. Soil moisture was maintained at above average levels during the season supplying crop water demand between precipitation and irrigation intervals.
The need for irrigation was greatly reduced during year three hence a large reduction in total irrigation hours was documented. Total crop water availability exceeded the demand of crops at many sites.

BUDGET

Table 26. Task and expense budget for 2005 (Year 1), 2006 (Year 2) and 2007 (Year 3).

2005-358-014 Task	Task Budget	Year 1 (9/22/04 - 1/31/06) *revised*	Year 2 (2/01/06 - 2/28/07) *revised*	Year 3 (3/01/07 - 2/29/08)
1	5,450.00	4,537.11	-	-
2	2,667,550.00	216,356.08	335,696.85	317,316.66
3	675,402.00	21,111.97	33,832.60	80,983.55
4	610,565.00	52,409.10	40,940.08	46,328.71
5	371,359.00	42,427.73	40,533.84	47,506.26
6	633,173.00	54,530.50	75,387.27	71,106.29
7	306,020.00	37,013.79	22,801.48	30,516.07
8	334,692.00	44,628.53	43,062.62	41,243.29
9	620,564.00	145,078.00	39,010.61	35,656.24
TOTAL	6,224,775.00	618,092.81	631,265.35	670,657.07

Expense	Expense Budget	Year 1 (09/22/04 - 1/31/06)	Year 2 (2/01/06 - 2/28/07)	Year 3 (3/01/07 - 2/29/08)
Salary and Wages [1]	2,126,064.00	230,131.35	300,530.73	298,105.60
Fringe[2] (20% of Salary)	288,379.00	29,304.43	35,534.29	37,264.74
Insurance	313,514.00	13,318.05	26,528.94	25,301.90
Tuition and Fees	200,514.00	8,126.78	16,393.00	21,679.18
Travel	150,000.00	14,508.18	24,391.85	14,649.80
Capital Equipment	76,554.00	22,958.77	13,392.67	447.89
Expendable Supplies	381,035.00	14,397.82	16,119.54	12,205.01
Subcon	1,741,376.00	212,360.28	103,388.58	161,540.03
Technical/Computer	190,400.00	9,740.00	3,860.00	16,225.00
Communications	365,000.00	25,339.15	45,040.39	38,800.63
Vehicle Insurance	5,000.00	-	397.06	235.00
Overhead	386,939.00	37,908.00	45,688.30	44,202.29
TOTAL	6,224,775.00	618,092.81	631,265.35	670,657.07

Cost Sharing

Table 27. Cost share figures for TTU, AgriLife (TCE) and HPUWCD for 2005 (Year 1), 2006 (Year 2) and 2007 (Year 3).

	Total Cost Share	Year 1 (05)	Year 2 (06)	Year 3 (FY07)	Year 4 (FY08)	Year 5 (FY09)	Year 6 (FY10)	Year 7 (FY11)	Year 8 (FY12)	Balance
TTU	1,026,840.00	51,824.77	60,218.17	56,022.06	-	-	-	-	-	858,775.00
AgriLife (TCE)	423,892.00	40,944.88[*]	45,109.49[†]	28,678.71	-	-	-	-	-	309,158.92
HPUWCD	200,000.00	0.00	50,000.00	25,000.00	-	-	-	-	-	125,000.00
TOTAL	1,650,732.00	92,769.65	155,327.66	109,700.77	-	-	-	-	-	1,292,933.92

[*] Includes cost share amounts from September 22, 2004 through December 31, 2005.
[†] Includes cost share amounts from January 1, 2006 through August 31, 2006.

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