

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

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***15th Annual Comprehensive  
Report 2005-2019  
to the  
Texas Water Development Board***

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**DECEMBER 1, 2020**

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# Texas Alliance for Water Conservation participants:



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Appreciation is expressed to  
***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 depends on the protection and appropriate use of our water resources.*

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# Water Conservation Demonstration Producer Board

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Glenn Schur, Chair  
Boyd Jackson, Co-Chair  
Eddie Teeter, Secretary  
Keith Phillips  
Mark Beedy  
Jeff Don Terrell  
Jody Foster  
Lanney Bennett  
Louis (Bubba) Ehrlich  
Rick Kellison (ex-officio), Project Director

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

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

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

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

## TEXAS ALLIANCE FOR WATER CONSERVATION 2019 PARTICIPANTS

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### Texas Tech University

Dr. Chuck West, Project Administrator\*  
 Mr. Rick Kellison, Project Director\*  
 Mr. Philip Brown\*  
 Dr. Phillip Johnson\*  
 Dr. Wenxuan Guo\*  
 Dr. Steve Frazee\*  
 Dr. Rudy Ritz\*  
 Ms. Samantha Borgstedt,  
 Matt Williams\*

### Texas A&M AgriLife Extension

Dr. Steven Klose  
 Mr. Jeff Pate\*  
 Dr. Will Keeling\*  
 Dr. Nithya Rajan

### High Plains Underground Water Conservation District No. 1

Mr. Jason Coleman\*  
 Mr. Keith Whitworth\*

### USDA - Natural Resources Conservation Service

Mr. Monte Dollar (retired)\*

### Producer Board Chairman

Mr. Glenn Schur\*

### Graduate Research Assistants (past and present)

Nithya Rajan  
 Swetha Dorbala  
 Morgan Newsom  
 Jarrott Wilkinson  
 Rachel Oates  
 Jennifer Zavaleta  
 Nichole Sullivan  
 Miranda Gillum  
 Mallory Newsom  
 Nellie Hill  
 Melissa Murharam  
 Sanaz Shafian  
 Victoria Xiong  
 Lisa Baxter  
 Krishna Bhandari  
 Madhav Dhakal  
 Libby Durst  
 Cassie Godwin  
 Taylor Black  
 Rebecca McCullough  
 Kathryn Radicke

\* Indicates Management Team member

### Producers of the TAWC Project (past and present)

Ronnie Aston	Jody Foster	Charles Nelson	Dan Smith
Mark Beedy	Scott Horne	Danny Nutt	Eddie Teeter
Lanney Bennett	Boyd Jackson	Keith Phillips	Jeff Don Terrell
Troy Bigham	Jimmy Kemp	Glenn Schur	Aaron Wilson
Bob Meyer	Lloyd Arthur	Blake Davis	Jerry Don Glover
Barry Evans	Randy McGee	R.N. Hopper	Jerry Brightbill
S. Clevenger			

The dedication of all these participants is gratefully acknowledged.

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

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The 2020 Covid-19 pandemic significantly delayed the collection of producer records and resulting analysis for this report. Some initial reporting to the Texas Water Development Board concerning water savings has been revised in this report to reflect more complete producer records. Additional details are provided in the appropriate sections of this report.

### Objective

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

### Background

The Texas High Plains generates a combined annual economic value of crops and livestock that exceeds \$12.0 billion (\$2.6 crops; \$9.4 livestock; USDA, National Agricultural Statistics Service, 2017). Such productivity is highly dependent on water from the Ogallala Aquifer. Groundwater supplies have been declining significantly in the South Plains region (average water level during 2007-2017 declined 8.84 feet in High Plains Underground Water Conservation District No. 1<sup>1</sup>, while costs related to pumping the water (energy, system infrastructure, maintenance) have escalated. Improved irrigation technologies including low energy precision application (LEPA) and subsurface drip irrigation (SDI) have increased irrigation efficiencies to around 95% but have not necessarily led to decreased water use. TAWC provides information on efficient irrigation systems and guidelines for matching water supply to crop needs as a means of reducing the risk of overwatering. There is increasing importance of diversifying the crop choice to include low-water demanding crops, concentrating irrigation rates onto the most profitable crops, and reducing tillage to protect soil quality.

Diversified systems include growing more than one type of crop on a farm at the same time, rotating crops on a field across years, growing minor crops for a niche market, and integrating crops and livestock. Cattle can utilize perennial and annual forages that are not irrigated or receive very low irrigation and can graze crop residue after the grain is harvested. Local supplies of by-products from processing cottonseed, corn, and sorghum for oil and ethanol provide high-protein feed to supplement local forages. Crop-livestock integrated systems reduce soil erosion and inputs of nitrogen fertilizer and pesticides while building soil health and stabilizing income (Allen et al., 2012; Johnson et al., 2013). Research on crop production, soil science, economics, and communication dynamics underpin the demonstration project. Results from the demonstration sites serve to validate the research and inform approaches to transferring technology to users.

No single technology will successfully address water conservation. Rather, the approach must be a combination of techniques, including monitoring crop needs for water and soil moisture status, precise timing and amount of irrigation, improved plant genetics, and

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<sup>1</sup> High Plains Water District 2018 Water Level Report source: <http://www.hpwd.org/reports/>

practices that reduce water demand and optimize value so that profitability is maintained or improved. Conservation of the Ogallala Aquifer will prolong the regional economic benefits of agriculture. As state and global populations increase with an increasing demand for agricultural products, the future of the Texas High Plains depends on our ability to protect and appropriately use our water resources. Nowhere is there greater opportunity to demonstrate the results of successfully meeting these challenges than in the High Plains of west Texas.

A multidisciplinary and multi-university/agency/producer team, coordinated through 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 the demonstration project conducted in Hale and Floyd Counties. A producer Board of Directors was elected to oversee all aspects of this project. The purpose of this project was to understand where and how water conservation could be achieved while maintaining acceptable levels of profitability. Results of this study assist area producers in meeting the challenges of declining water supplies and reduced pumping capacities by demonstrating various production systems and water-saving technologies. The first nine years of the Texas Alliance for Water Conservation (TAWC) project are considered Phase I of our effort to demonstrate and compare irrigation systems and crop types for agronomic and economic water use efficiencies. In Phase I, 26 producer sites were identified to represent 26 different 'points on a curve' that characterize cropping and livestock grazing system monocultures with integrated cropping systems and integrated crop/livestock approaches to agriculture in this region. All data from Phase I are contained in the Appendix section of this report.

In 2013, continuing under the infrastructure of Phase I, a new source of funding via the Texas Water Development Board for TAWC was approved by the Texas Legislature. This allowed TAWC to expand its impact area and establish Phase II during the 2014-2018 cropping seasons. In the first year, Phase II dropped four original sites and added 10 sites in six new counties, namely Bailey, Crosby, Deaf Smith, Lamb, Lubbock, and Parmer. An additional site in Castro county was added in 2015, bringing the total project area to 9 counties. The number of sites and producers varies across years as new sites are added and some of the original sites replaced. This is to facilitate the time and effort toward the new expanded area allowing focus on a larger more diverse group of agricultural producers in Phase II. Many of the additional farms were formerly participants in a Conservation Innovation Grant program funded by the United States Department of Agriculture Natural Resources Conservation Service, aimed at transferring technologies for conserving irrigation.

A key strategy of this project is that all sites are producer-owned and producer-managed. The producers make all decisions about their agricultural practices, management strategies, and marketing decisions. Thus, practices and systems at any specific site were subject to change from year to year as producers addressed changes in market opportunities, weather, commodity prices, and other factors. This project allowed us to measure, monitor, and document the effects of these decisions. The same producers did not all participate every year. A small number withdrew participation, and they were replaced in subsequent years at



the discretion of Producer Board. Nonetheless, the project provided a valuable survey of changes in agricultural practices in this region and the information to interpret what is driving these changes.

Sites were originally selected 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 represented a range from monoculture cropping practices (one type or species of annual crop at the site per year), multi-cropping systems (more than one crop species per year on a field), integrated crop and livestock systems (part of the site produced annual crops and part forage-based livestock production), and all-forage/livestock systems. Irrigation practices included subsurface drip, center pivot, furrow, and dryland systems.

It is important to note that these data and their interpretations are based on certain assumptions which are critical to objectively compare information across different sites. We adopted constants for productivity and efficiency calculations, such as pumping depth of wells, in order to make unbiased economic and agronomic comparisons (see p. 32 for detailed assumptions). Therefore, the economic data for an individual site are valid for comparisons of systems but do not represent the actual economic results of that farm. Actual economic returns for each site were calculated and confidentially shared with the individual producer but are not a part of this report. Likewise, the identity of the participating producers is not matched to the demonstration sites.

This is the sixth annual report of Phase II of TAWC and is a compendium of data over the life of the project. Data collection technologies gradually changed over time as better equipment became available and were installed. As each annual report updates 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. This report contains numerous corrections of data from previous years with all previous yearly data contained in the Appendix section of this report.

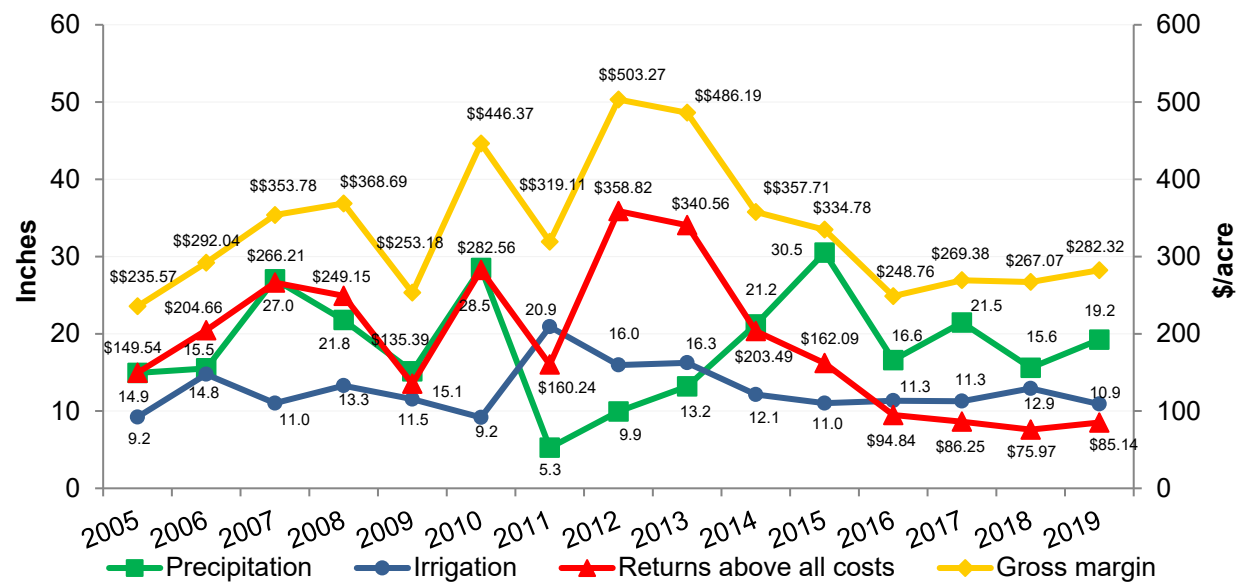
## **Overall Summary of Years 2005-2019** *Chuck West, Philip Brown (TTU)*

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With 15 years completed of this study, we see substantial annual variations in economic returns and water received from irrigation and precipitation (Figure 1). Each year's results are highly influenced by weather, availability of irrigation water, input costs, actual and anticipated prices for crops and livestock, and previous years' experiences. During the 15 years, annual precipitation ranged from 5.3 inches (2011) to 30.5 inches (2015) (Figure 1), averaging 18.4 inches, which matches the long-term mean for the region. Eight of 15 years exhibited below-average rainfall, with 2011-2013 substantially below average. Precipitation for 2019 averaged 19.3 inches across all sites, with 13.3 inches occurring from planting to approximate harvest time (May through September). May rainfall was significantly above normal, with 3.8 inches average received across all sites as compared to the Plainview long-term (1911-2019) average of 2.9 inches. June and July rainfall amounts were both slightly below average at 2.2 and 2.0 inches respectively, with August at about half and September double the long-term averages (Figure 14; Table 2; p. 23-24). Long-term average for

Plainview (1911-2019) for May through September is approximately 13 inches of total precipitation.

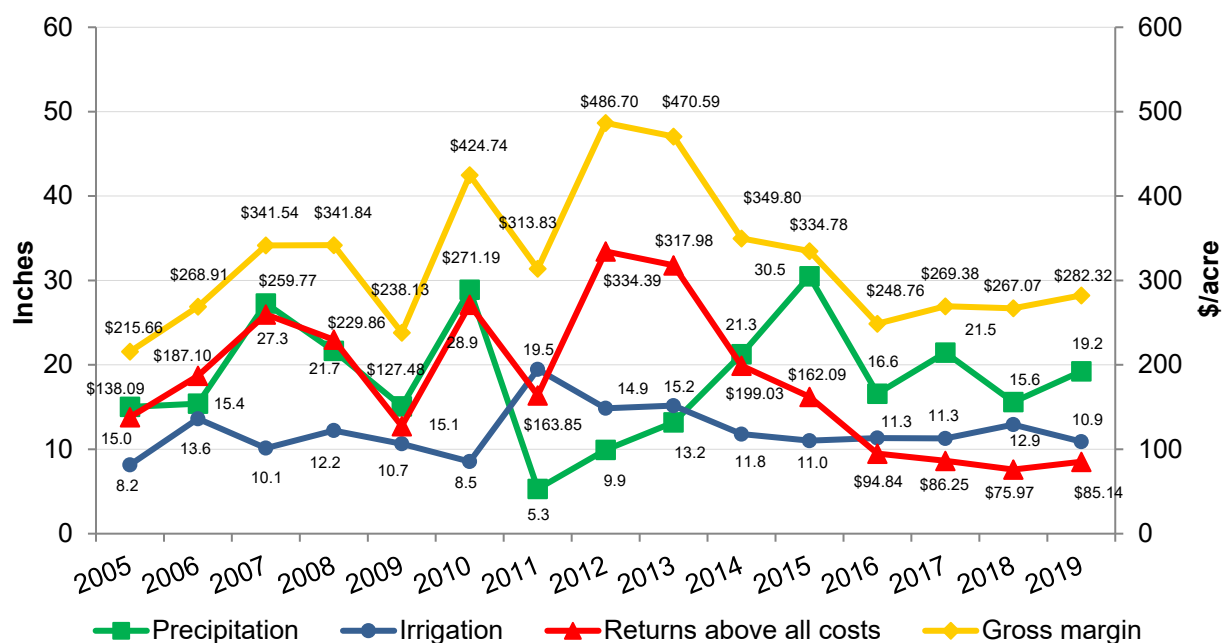
Figure 1 shows annual changes in economic returns above all costs and gross margins (red and yellow lines) in relation to precipitation and irrigation (green and blue lines). Gross margin equals total revenue less total variable costs. Returns above all costs equals gross margin less fixed costs and is the same as net returns.



**Figure 1.** Average precipitation (inches), irrigation applied (inches), returns above all costs (\$/acre), and gross margin (\$/acre) for irrigated sites only.

Amount of system irrigation averaged over 15 years on the irrigated sites was 12.8 inches, with a range of 9.2 to 20.9 inches (Figure 1). Irrigation was greatest during the dry years of 2011-2013. Average system irrigation plus average rainfall (18.4 inches) equaled 31.2 inches of water received per year. This suggests that 30-32 inches of total annual water input is a general norm for typical crop production in this region. In-season (May/planting - September/harvest) effective rainfall (considered to be 50%) for the project sites (5.1 inches in 2019) ranged from approximately 1.5 inch in 2011 to 9.6 inches in 2010, with an average of 6.2 inches in-season during 2005-2019 (Table 4). Timing of this rainfall is critical for producing a viable crop in drier years. In the six “wet” years (annual rainfall exceeding 20 inches), total rainfall plus irrigation received ranged from 32.8 to 41.5 inches. In such years, excessive rains were concentrated in particular weeks or months. This meant that irrigation was still required in the drier months of those years to make up water deficits caused by high evapotranspiration. The extremely dry year of 2011 was a test of how much irrigation could buffer against the low precipitation. System irrigation supplied 20.9 inches for a total effective water input of 22.4 inches. In 2011, irrigation rates generally were inadequate to meet crop water demand. As well outputs decline over time, the expectation is that even in less severe droughts than that of 2011, irrigation will fall short of meeting crop water demand. When all sites including the non-irrigated fields (Figure 2) are included in the

means, average irrigation applied declines from 12.8 to 12.1 inches.

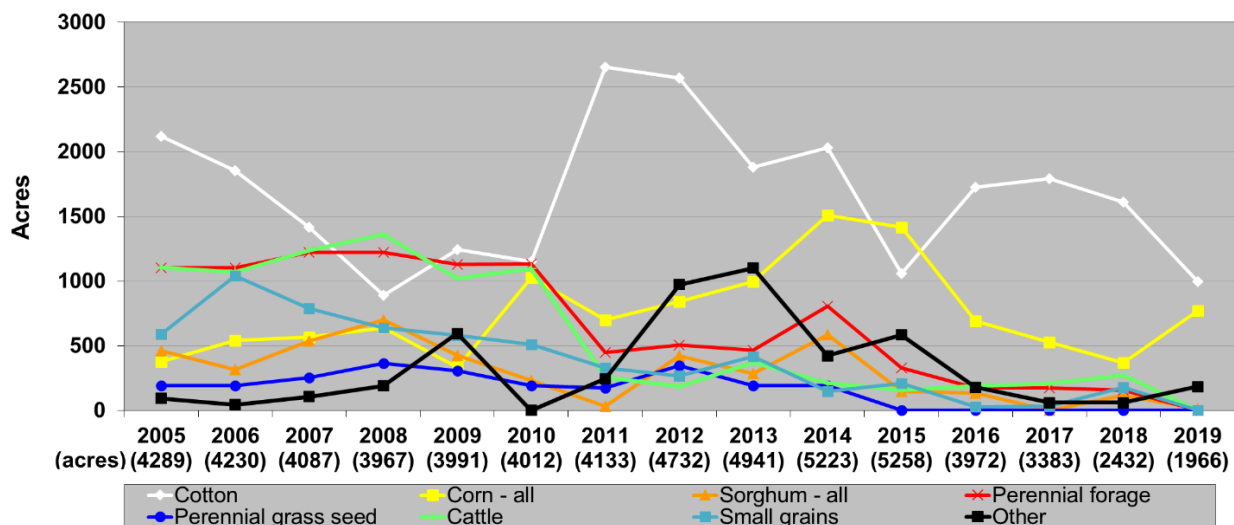


**Figure 2.** Average precipitation (inches), irrigation applied (inches), returns above all costs (\$/acre), and gross margin (\$/acre) for all sites, irrigated and dryland (there are no dryland sites after 2014).

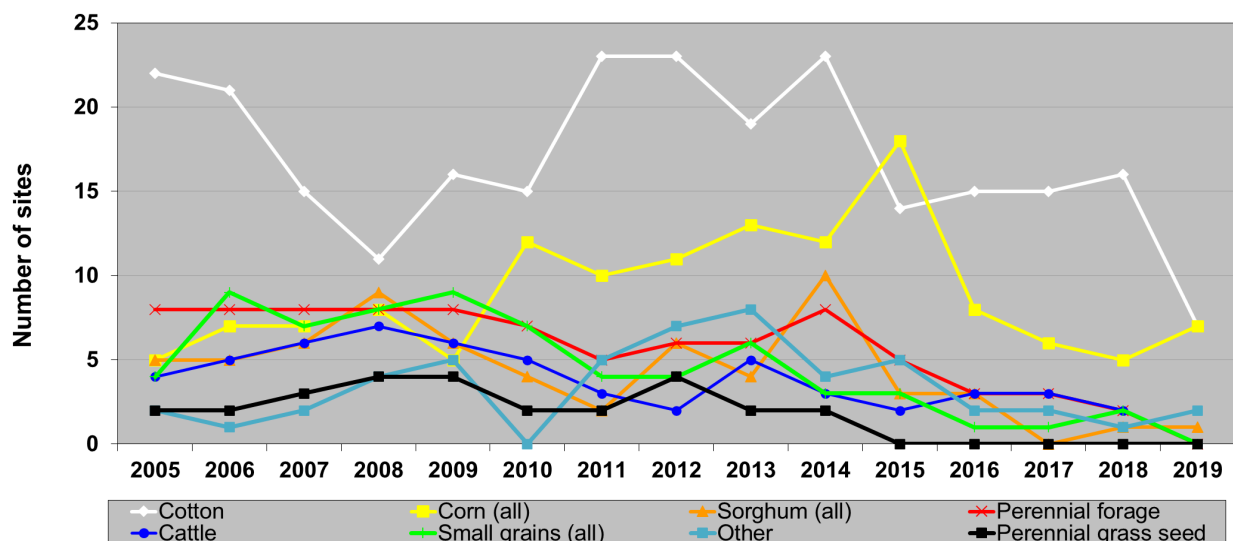
Two basic strategies can be used alone or in combination to stretch water supplies as irrigation well outputs decline: a) apply less water per acre to a level that still maintains profitable yields (70-80% of crop ET demand); and b) apply available water to fewer acres. Both approaches have merit depending on the crop species and variety, how water is allocated over the cropland, and the timing of precipitation within a year. Both strategies require careful planning and monitoring of crop water use, skills which are supported by information and web-based decision-aid tools offered by TAWC.

Yearly trends in gross margin and returns above all costs fluctuated tremendously owing to variable commodity prices and crop yields (Figures 1 and 2). The trends were essentially parallel, with the difference between them reflecting fixed costs. Closer inspection reveals that the difference more than doubled over the years from \$78/acre in 2005 to \$197/acre in 2019. Profitability in 2005 and 2009 was negatively impacted by high production costs in relation to values of crops and livestock. Low profitability during the 2011 drought reflected reduction in livestock numbers and yield losses in crops but was buffered somewhat by insurance payments. Profitability in 2014-2019 showed a continual drop from 2013, which was the one of the highest of all years. The low returns in 2014 and 2015 were attributed largely to low commodity prices, but also to decreased crop yields resulting from heavy spring rains and hail events setting back crop planting and early-fall rains hampering harvest. The late start and low fiber quality for cotton depressed prices and limited profitability. Commodity prices continued to trend low from 2016 to 2019.

Producers in the TAWC project make their own decisions each season on enterprise selection and production practices. Land use reflects current crop and livestock prices, contracts, expected profitability, water supply, and decisions to terminate leases, sell property, or retire. Therefore, the number of acres and number of sites of the enterprise choices varied over time. Figures 3 and 4 show the acreages and number of sites, respectively, that were devoted to cotton, corn, sorghum, perennial forages, cattle, small grains, and other crops. The total of enterprise acres exceeds total acres in the project in any given year because of double cropping and multi-use for livestock. The main changes in 2019 relative to 2018 were a decrease in cotton acreage and an increase in corn acreage (Figure 3), primarily due to hail induced cotton crop failures.



**Figure 3.** Number of acres of various crops and cattle enterprises. Sites were located in two counties through 2013 (Phase I) and in nine counties for Phase II (2014 and later).

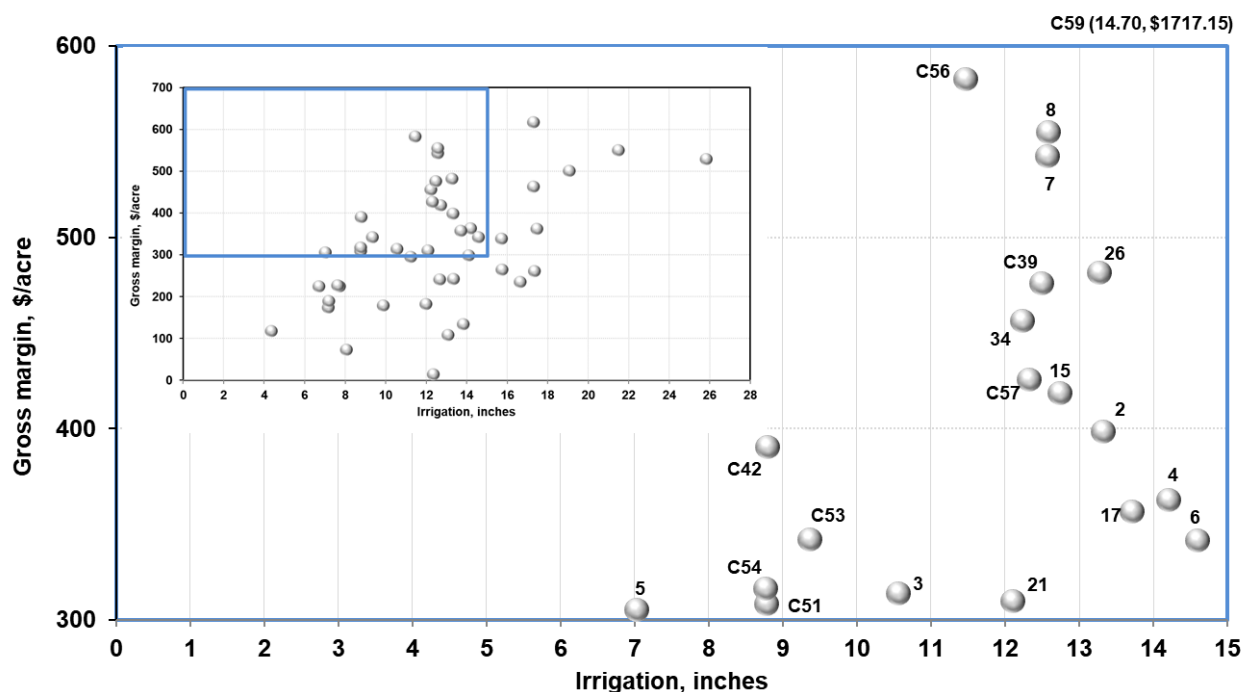


**Figure 4.** Number of sites of various crops and cattle enterprise. Sites were located, in two counties through 2013 (Phase I) and in nine counties for Phase II (2014 and later).

The trends in number of sites where different commodities were produced (Figure 4) generally followed the trends in acreage distribution (Figure 3). There was a substantial reduction in cotton sites from 2018 (16) to 2019 (7) (Figure 4), due largely to hail damage (Tables 3 & 7). Four of those sites replanted to corn, which explains the increase in corn sites. There was no perennial forage, no cattle, and no small grain sites in 2019 for project sites collected. The perennial grass seed production sites were dropped from the project after the 2014 crop year due to producer retirement (Figures 3 and 4).

### Water Use and Profitability

Profitability in relation to irrigation applied is important because of the constant need to increase water use efficiency by the crops and prolong the groundwater supply, while maintaining or even increasing profitability of agricultural production in the High Plains. To examine systems for meeting criteria of relatively low water use and high profitability, we arbitrarily selected a maximum of 15 inches of irrigation and a minimum of \$300 gross margin per acre as a desired target for performance (Figure 5). Please note that these levels were selected only to identify whether certain sites and cropping systems consistently performed to those criteria and *not* to relate system performance to pumping restrictions nor to state a minimum amount of revenue required for economic viability.



**Figure 5.** Gross margin per acre in relation to inches of applied irrigation averaged over 2005 to 2019. Each point represents one site, of which all were irrigated, averaged across all years in which they were in the project. See Table 1 for site descriptions. The large graph depicts sites which met the arbitrary criteria of relatively low irrigation and high gross margin. The insert shows all sites, except C59, which was off scale. This site produced alfalfa, provided 14.7 inches of irrigation, and grossed \$1717, averaged over 2 years for 2014 and 2015 only.

**Table 1.** Description of cropping system and current irrigation type used for sites plotted in Figure 5 which met criteria of 15 or fewer inches of irrigation and \$300 or more gross margin/acre. Descriptions of cropping systems (as categorized across years within which they appear) by site from 2005-2019 are shown. Site numbers with “C” indicate new Phase II sites from USDA CIG group.

Site	Cropping system	Irrigation type
2	Multi-crop, cotton/corn/sunflower	Subsurface drip
3	Multi-crop, cotton/grain sorghum/wheat	Mid elevation spray application
4	Multi-crop, livestock/cotton/grain sorghum/wheat/alfalfa/millet/haygrazer	Low elevation spray/Low energy precision application
5	Livestock only through 2010; Multi-crop, cotton/wheat/sunflower/millet	Low elevation spray application
6	Multi-crop, livestock, cotton/corn/wheat	Low elevation spray application
7	Continuous sideoats grama grass seed	Low elevation spray application
8	Continuous sideoats grama grass seed	Subsurface drip
15	Multi-crop, cotton/grain sorghum/corn	Subsurface drip
17	Multi-crop, livestock/cotton/corn/sunflower/perennial grass	Mid elevation spray application
21	Multi-crop, livestock, cotton/corn/small grain/forage sorghum/grass seed/hay grazer	Low energy precision application
26	Multi-crop, livestock, cotton/corn/small grains/sunflower/millet	Low elevation spray application
34	Multi-crop, cotton/corn/sunflower (3 year)	Low elevation spray application
C39	Multi-crop, cotton/corn/sorghum (3 year)	Low elevation spray/Low energy precision application
42	Cotton-monoculture (1 year)	Subsurface drip
C51	Cotton monoculture (6 year)	Subsurface drip
C53	Cotton monoculture (2 year)	Subsurface drip
C54	Cotton monoculture (2 year)	Subsurface drip
C56	Monoculture, rotation, corn/blackeye pea/corn/blackeye pea/corn (5 year)	Low elevation spray application
C57	Monoculture, corn/corn/sunflower/corn/cotton (6 year)	Low elevation spray application
C59	Alfalfa monoculture (2 year)	Subsurface drip

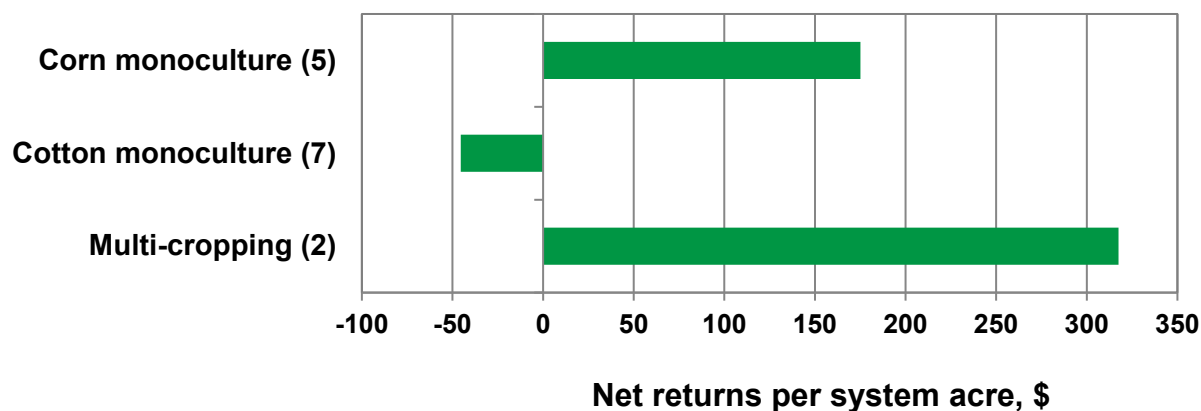
Twenty out of 48 total sites since 2005 have met the arbitrary criteria of 15 or fewer inches of irrigation and \$300 or more gross margin/acre, when averaged over 2005-2019 inclusive of years these sites were in the project (Figure 5). Seven sites that met the \$300 gross margin per acre criterion but with average irrigation over 15 inches (points located to the right of the blue insert box in Figure 5) were mostly multi-crop corn/cotton rotations, with one site being multi-crop cotton/sorghum/small grain/alfalfa and another multi-crop with cotton/grain sorghum and millet. Sites 2, 6, 15, 17, 21, 26, 34 and 39 all included corn in the

multi-crop rotations, indicating that inclusion of corn in the cropping system can result in high return at low water use, averaged over years. Site 42 was a newly added site for 2019 and met criteria with a cotton-monoculture system. Corn in sites C56 and C57 were for both grain and silage and represent 5 and 6 years of data, respectively. Sites C51 (6-year data), C53 and C54 (2-year data) were the only cotton monocultures that met the double criteria. The two sites with grass seed production (7 and 8) were the highest ranked sites during the Phase I years. The alfalfa monoculture in site C59 indicates very high potential for profitability at surprisingly low irrigation, thanks partly to timely rains.

### 2019 Project Year

Producer sites can be categorized according to type of farming system insofar as a site represents a conceptual farm. The system categories in use in 2019 were corn monoculture (five entire sites in corn only), cotton monoculture (7 entire sites in cotton only), and multi-cropping (more than one annual crop species harvested in the reporting year), in this case one corn/sorghum and one corn/cotton. Systems not occurring in years after 2012 included cow-calf pasture and dryland multi-cropping. The “Other” category is a catch-all of minor annual crops and fallowed fields whose makeup changes from year to year. In 2019, the “Other” sites consisted of approximately 184 acres of fallowed land following cotton hail out (Figure 7).

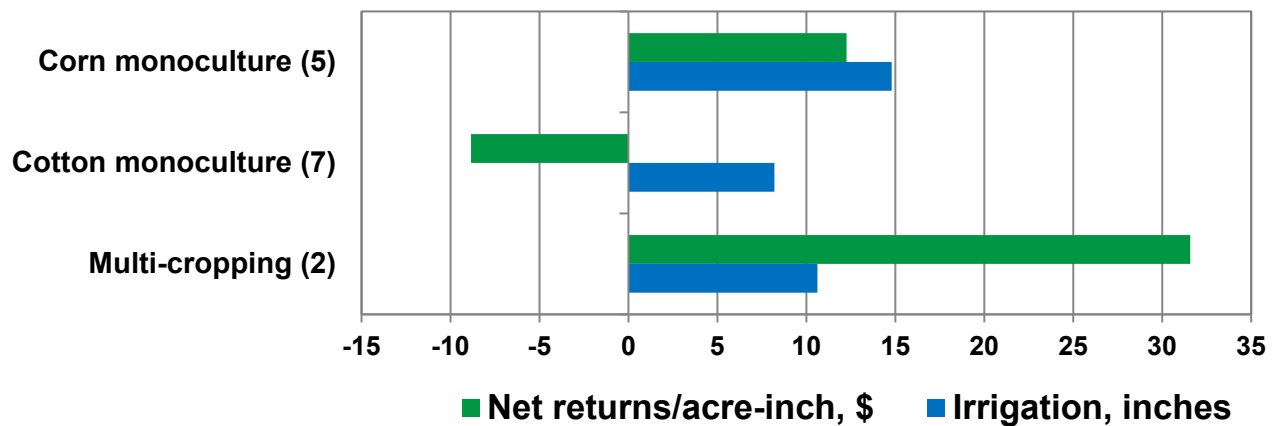
This section compares the cropping systems for net returns per system acre and per acre-inch of irrigation, and usage of irrigation and nitrogen fertilizer for 2019. Cotton commodity prices were based on \$0.68/lb, and the cotton monoculture system showed a mean net return of \$(45.48)/system acre (Figure 6). Of the seven cotton monoculture systems for 2019, four showed a net loss per system acre and three showed a net gain (Table 11, page 35). The highest-return system in 2019 was the multi-cropping system at \$317.48/system acre, followed by corn monoculture at \$175.06. Cotton monoculture showed a mean net loss of \$(45.48)/system acre (Figure 6). Site C37 had the greatest loss with \$(70.62)/system acre primarily due to hail-induced cotton crop failure and fallowing field remainder of year, while site 60 had a net gain of \$22.20/system acre (Table 11, page 35). Weather conditions in 2019 with significant hail events were a major influence on cotton yields resulting in a wide range of net returns for these systems.



**Figure 6.** Net returns per system acre for three cropping systems in 2019 with number of sites in parentheses.

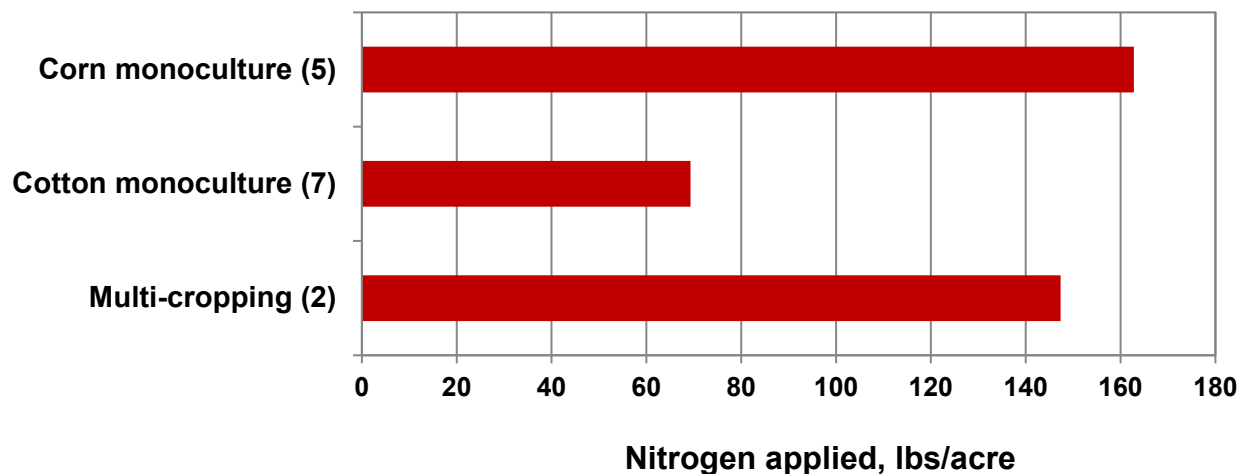


These systems were also examined in terms of net returns per acre-inch of irrigation applied (Figure 7, green bars). The multi-cropping systems had the greatest return, followed by the corn monoculture system. The blue bars in Figure 7 indicate average inches of irrigation applied per system. Cotton monoculture had the lowest application (8.2 inches) and corn had the highest (14.8 inches).



**Figure 7.** Net returns per acre-inch irrigation water (green bars), and inches of irrigation applied (blue bars), 2019 with number of sites in parentheses.

The amount of nitrogen applied in fertilizer varied across cropping system (Figure 8). Corn was greatest at 163 lbs/acre, followed by multi-cropping, and cotton monoculture, at 147 and 69 lbs/system acre, respectively (Figure 8). Commercial N fertilizer application is a major input cost and therefore greatly influences the calculation of net return.

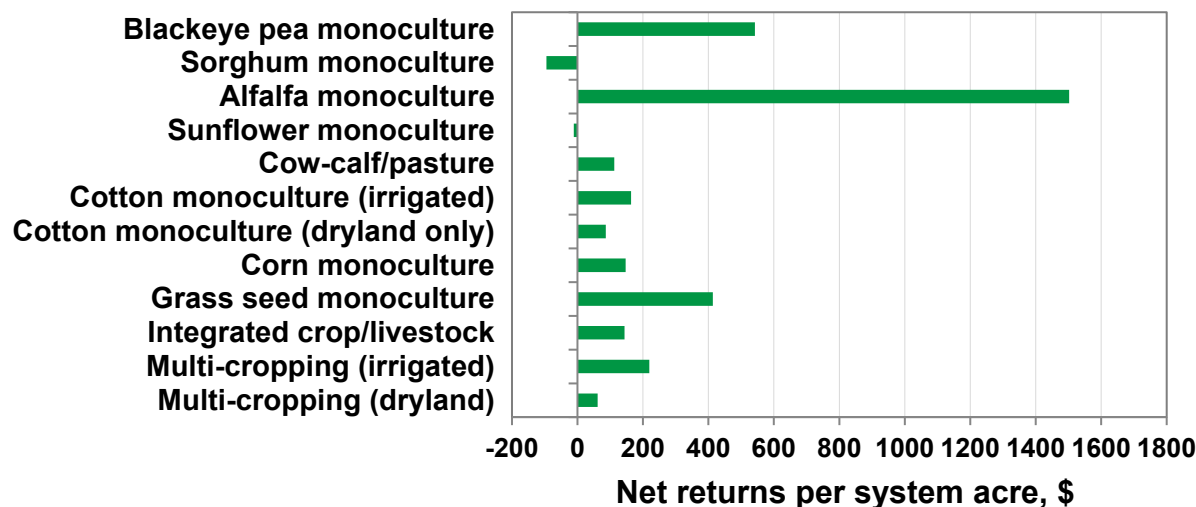


**Figure 8.** Pounds per system acre of nitrogen applied in fertilizer by cropping system, 2019 with number of sites in parentheses.



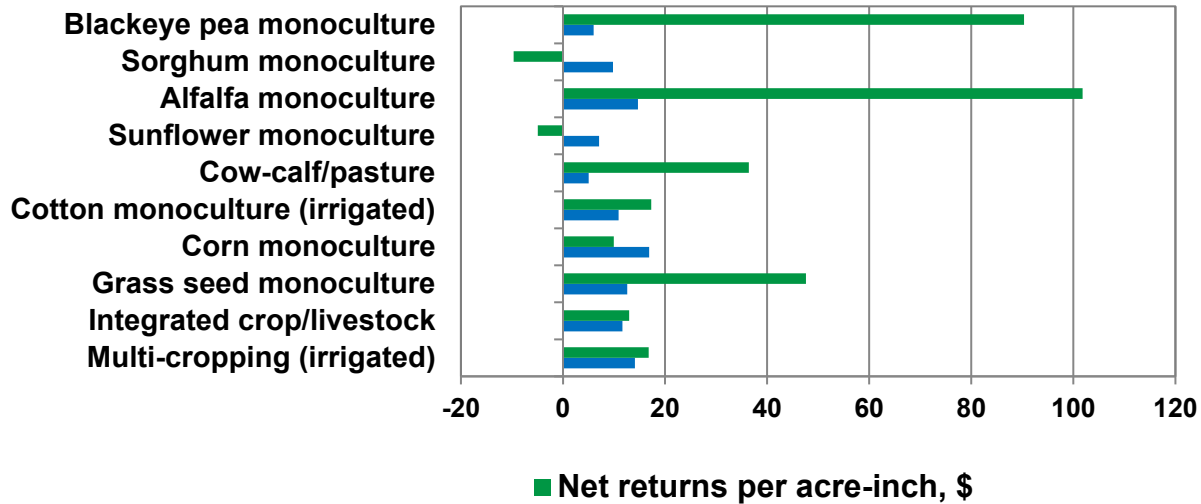
### Project years 1 through 15 (2005-2019)

Figure 9 summarizes net returns per acre by system over the life of the project so far. Not all systems were grown in all years. For example, alfalfa and blackeye pea were grown in only two years but indicates alternative crops can potentially provide significant net returns per system acre. Grass seed monoculture was the most profitable system in the long term at \$414/acre (2005-2014). While irrigated multi-cropping and cotton monoculture yielded similar average net returns per system acre (\$219 and \$164/acre, respectively), integrated crop/livestock was at \$144 and corn monoculture was \$147/system acre. Grain sorghum monoculture (one year only) showed the most negative net returns among all systems.



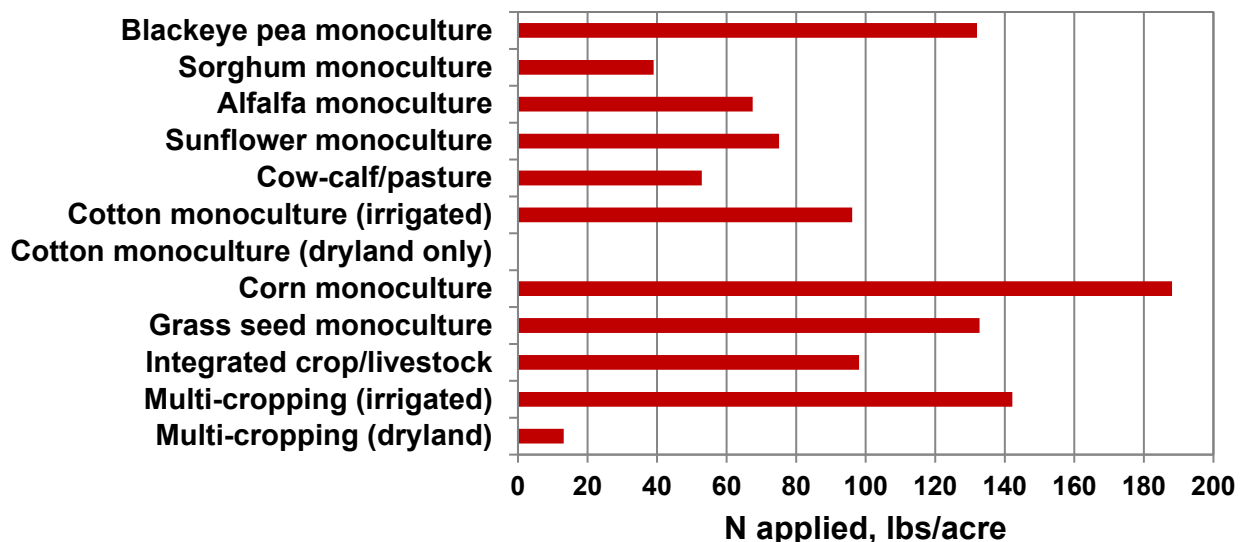
**Figure 9.** Net returns per system acre, average of 2005-2019, or for those years which those systems occurred. Data for cow-calf includes 2005-2010 data only, for alfalfa monoculture 2014-2015 only, for blackeye pea 2015 and 2017 only, sorghum monoculture in 2014 only, sunflower monoculture in 2008, 2009 and 2016 only.

Net returns per acre-inch of irrigation applied over the project life (Figure 10, green bars) were greatest for the two years of blackeye pea and the two years of alfalfa, and least for sorghum monoculture, for which the number of years of data is very limited. Net returns for irrigated cotton monoculture averaged \$17.30/acre-inch, about twice as great as the net return for corn monoculture \$9.97 (Figure 10). Corn monocultures were not present in some of the earlier years of this project and thus their means reflect fewer years. The droughts of 2011 and 2012 hit corn yields particularly hard, therefore with fewer years in the mean, the effects of drought have a proportionally greater effect on this crop's performance. Dryland systems have always had the lowest average net returns in this project. Irrigation amount applied annually (Figure 10, blue bars) was greatest for corn monoculture (16.9 inches), followed by alfalfa (14.7 inches). Irrigated cotton monoculture received about the same amount of irrigation (10.9 inches) as grass seed (12.6 inches) and the integrated crop-livestock system (11.6 inches).



**Figure 10.** Net returns per acre-inch of irrigation water (green bars), and inches of irrigation applied (blue bars), average of 2005-2019. Data for cow-calf/pasture includes 2005-2010 only, for alfalfa monoculture 2014-2015 only, 2 years for blackeye pea, 2015 and 2017, sorghum in 2014 only, sunflower in 2008, 2009 and 2016 only.

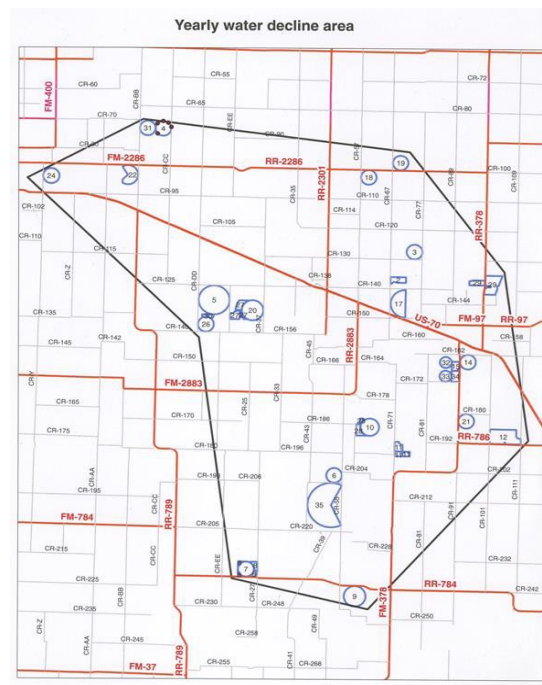
Dryland cotton and dryland multi-cropping received the least nitrogen fertilizer per system acre, followed by sorghum monoculture and cow-calf operations on perennial grass pastures (Figure 11). In contrast, corn monoculture represented the other extreme with 188 lbs N/acre. Multi-cropping systems were second highest, receiving 142 lbs N/acre. Multi-cropping systems frequently have had corn as a component increasing nitrogen input. All other systems received from about 39 to 133 lbs/acre of N.



**Figure 11.** Pounds of nitrogen per system acre applied in commercial fertilizer, average of 2005-2019. Data for cow-calf/pasture includes 2005-2010 only, for alfalfa monoculture 2014-2015 only, for blackeye pea 2015 and 2017, sorghum in 2014 only, sunflower in 2008, 2009 and 2016 only.

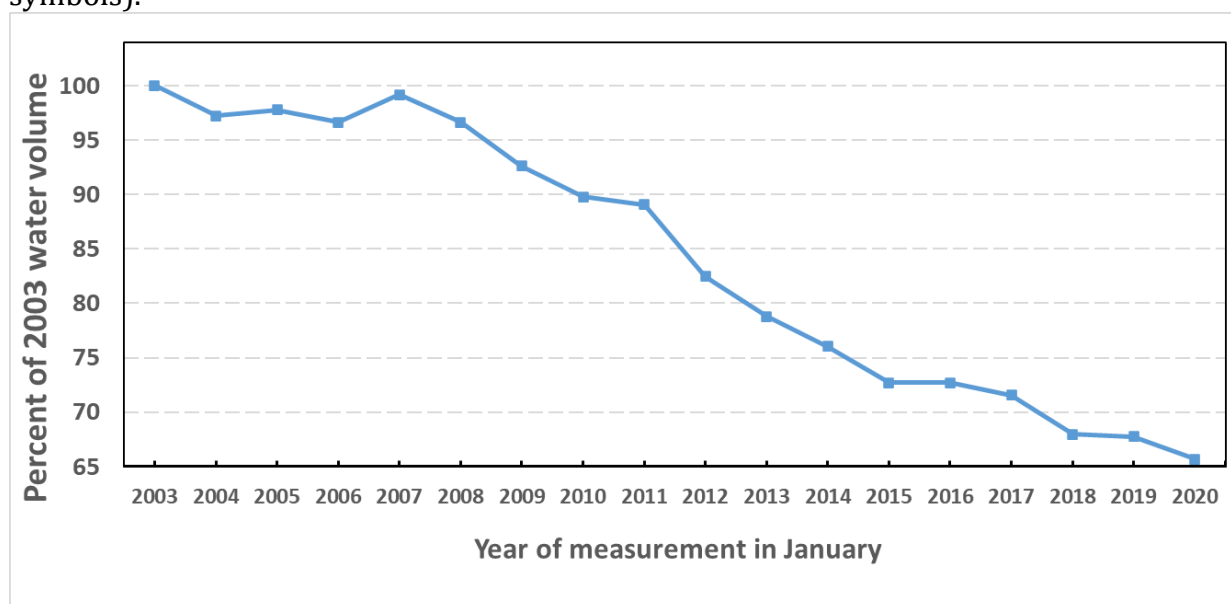
### Water Use and Efficiency Discussion

Depth to water in the Ogallala Aquifer has been monitored annually by the High Plains Underground Water Conservation District for many years. The District used those measurements and saturated thickness data to calculate the amount of water stored in an area defined by a perimeter around the TAWC producer sites taking part in Phase I in Floyd and Hale Counties (see Figure 12 for map of the perimeter). The graph in Figure 13 tracks the amounts of water storage in that area as a percentage of the 2003 measurement. The measurement time was January; therefore, the values reflect the change that occurred over the previous calendar year. Starting in 2007, water storage declined at a fairly constant rate over 8 years to 73% of the initial amount in 2003. The small decline in 2011 reflected the above-normal rainfall during 2010. Subsequently, the sharp drop at the 2012 reading was a response to the severe drought of 2011, which intensified the demand for irrigation. The high rainfall amount in 2015 reduced the amount of irrigation that year, contributing to no net change in the 2016 reading. The modest decline in the 2017 reading occurred after a year of 16.6 inches of rainfall, which was below the long-term average; however, rain events were well timed to relieve some need for irrigation. There was only a 2.1 percentage-point drop in water volume in 2019, which equals the overall annual percentage drop from 2003 to 2020.



**Figure 12.** Original TAWC project area for determining water in storage (area encompassed within solid black line; 97,900 total acres) and cooperator demonstration sites (areas in blue)

symbols).



**Figure 13.** Graph of volume of water change in percent for Hale and Floyd Counties, January 2020. The 2020 value is at 65.7% of what it was in 2003, and 2.1% points lower than 2019. Volume in 2003 was 1,748,630. Volume in January 2020 is 1,148,372.

Delivering water more precisely to the crop roots by using improved irrigation equipment, and timing that water delivery according to actual crop needs (based on monitoring soil moisture and evapotranspiration) results in conservation of the aquifer. We have calculated the amount of groundwater potentially saved for each year of the TAWC project. It is calculated as the difference between the total amount of water required to replace 100% of crop water demand and the amount which was provided by rainfall (assuming 50% effectiveness), stored soil water from before the growing season, and irrigation, summed over all sites. Details of those calculations are found in Water and Crop Use Efficiency Summaries (p. 25-30) and in Tables 3 to 6. In 2019, the amount of irrigation water potentially conserved was 2,106 acre-feet over 1,966 acres, or 15.2 inches of depth (Table 4). Over the 15 years of the project, the annual depth of water conserved averaged 12.7 inches (Table 4).

Saving water involves reducing unnecessary irrigations and targeting total water received to less than 100% crop water demand. The reason to aim short of 100% is that most crops can achieve near maximum yield when water is provided at 70-80% of crop water demand. In 2019, irrigation provided an average of 40% of crop water demand, while effective rainfall provided an additional 21%, with no soil storage collected, for a total of 62% (Table 3). Total crop water supply ranged from 43% to 88% of crop water demand among the sites that were not hailed out. Only one site received greater than 80% of crop water demand, which illustrates overall high efficiency in 2019; however, some of that low water use resulted from a relatively large number of hailed out fields. Nevertheless, continued use of the TAWC online irrigation scheduling tool and soil monitoring equipment demonstrated by this project helps maintain low irrigation inputs. See Table 6 for means of water use efficiency by crop type.

## Overall Discussion

Over 15 years of the project we have observed a number of system configurations under varied environmental conditions, irrigation technologies, and market conditions. Management is the key to how these systems behave under the extreme year to year variations. Producers make strategic and tactical production decisions to maintain economic viability and utilize available resources efficiently. Strategic decisions relate to crop and livestock enterprise selection, whether it is year to year crop selection or longer-term planning. Planting perennial grasses for seed and pasture production, integrating livestock into an operation, and the selection of irrigation technologies are examples of “strategic” decisions. “Tactical” decisions relate to enterprise management within the growing season, such as variety selection, fertilizer management, irrigation scheduling and harvest timing. There are many irrigation management technologies such as FieldNet®, SmartField™, Crop Metrics™, and AquaSpy®, which aid specifically in the tactical decision process. Over the years of the project we have provided various technologies to producers within the TAWC project. Information received from these technologies in conjunction with measurement of evapotranspiration (ET) on a field by field basis has helped producers gain insight into better irrigation management techniques. Feedback from producers who have used these technologies has helped us formulate tools to address the short-term and long-term irrigation management challenges facing the region. Continual adoption of water-saving technologies and monitoring will contribute to advances in the efficiency of water applied and amounts of water saved.

Various management tools have been developed and made freely available to producers in the region through the TAWC Solutions web site (<http://www.tawcsolutions.org>). These include an Irrigation Scheduler, Resource Allocation Analyzer, Heat Unit Calculator for corn and cotton, and a general Daily Cotton Water Use Tracker. In 2019, a Heat Unit Calculator was added to the IOS app version of the Texas Tech West Texas Mesonet (WTM) weather app in a cooperative effort between TAWC, WTM, and Plains Cotton Growers. The intent was to increase both function and coverage area available through the vast array of selectable stations on the WTM.

The dissemination of results and information from the project through various outreach efforts is an important part of the project. The TAWC Annual Winter Field Day from previous years was modified in 2015, and in 2019 we held the sixth Annual TAWC Water College event to promote education in water conservation. See page 19 for the most recent Water College program agenda.

Summer field walks were also continued to demonstrate technologies and how to schedule irrigation in relation to meeting crop needs. See Task 6 beginning on page 48 for more detailed information. These field days and field walks allow attendees to visit project sites and observe the technologies that are currently being demonstrated within the project to better manage and monitor irrigation use and timing. In addition to the field days, the project was represented at several farm shows within the region. This allowed further dissemination of findings and information related to the project concerning demonstrations and producer interaction on the management tools that are being provided on the TAWC Solutions

website. Detailed listings of donations, sponsors, outreach presentations, articles and activities are listed on pages 58-64 and beginning on p. 255 of appendix.

Texas Tech University is part of a consortium of eight universities and USDA research centers located across the Ogallala Aquifer region who received a \$10 million grant from the USDA in 2016 to conduct research and extension activities related to conserving irrigation water to prolong the profitability of agriculture (<http://ogallalawater.org>). TAWC activities are now connected to extension, information exchange, and technology transfer efforts across the region so that producers and water policymakers can access the latest developments in promoting efficient water use. This consortium will extend the visibility and geographic reach of education and technology delivered by TAWC. More details are described in the Task 8 report beginning on page 52.

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



# 6<sup>th</sup> Annual Water College



**January 23, 2020**  
**Lubbock Memorial Civic Center**  
**Lubbock, TX**

## **Morning Sessions:**

8:30 am **Registration & Visit Booths**

8:50 am **Welcome & Introductions**

*Dr. Glen Ritchie, Department Chair  
and Professor of Plant & Soil Science,  
Texas Tech University*

*Cameron Turner, Manager,  
Agricultural Water Conservation  
Program, TWDB*

9:00 am **Future Trends in World Demographics and Ag: The Effect of  
Population Changes on the American Farmer**

*Kevin Brinkley, President and CEO  
Plains Cotton Cooperative Association*

9:40 am **Using Cover Crops to Manage Soil and Weed Control While Being  
Economically Sustainable**

*Kris Verett, Lubbock Texas Producer*

10:30 am **Break & Visit Booths**

10:50 am **Real Farm Data – Using Irrigation Management Technology to  
Conserve Water and Gain Profitability**

*Lloyd Arthur, TAWC Producer  
Jeff Miller, Forefront Agronomy*

11:50 am **Update from the Texas Water Development Board**

*Brooke Paup, Texas Water  
Development Board (TWDB)*

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**Afternoon Sessions:**

12:15 pm **Lunch & Visit Booths**

12:30 pm **Keynote Address**

**Jodey Arrington**, U.S. Representative,  
District 19 Congressional District

1:30 pm **Upcoming Weather Patterns – What is in store?**

**Brian Bledsoe**, Chief Meteorologist/  
Climatologist, Colorado Springs, CO

2:00 pm **Hot Topics of Texas Water Law**

**Tiffany Dowell Lashmet J.D.**,  
Extension Specialist Agricultural Law,  
Texas A&M AgriLife Extension

2:40 pm **Break & Visit Booths**

3:10 pm **US Cotton Trust Protocol – What Farmers Need to Know**

**Ken Burton**, Executive Director of  
U.S. Cotton Trust Protocol National  
Cotton Council

3:40 pm **The Future of Cotton Genetics and Weed Control**

**Dr. Luis Herrera-Estrella**, President's  
Distinguished Professor of Plant  
Genomics and Director of the Center  
for Functional Genomics of Abiotic  
Stress, Texas Tech University

4:30 pm **Close**



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HPWD (Provided Doughnuts and Coffee)  
AgTexas (provided water)  
Indigo Ag, Inc. (Provided lunch)  
CASNR (Live Radio Coverage Sponsor)  
Texas Water Development Board (Project Sponsor)

**\*Please see Display Booth in Exhibit Hall.**

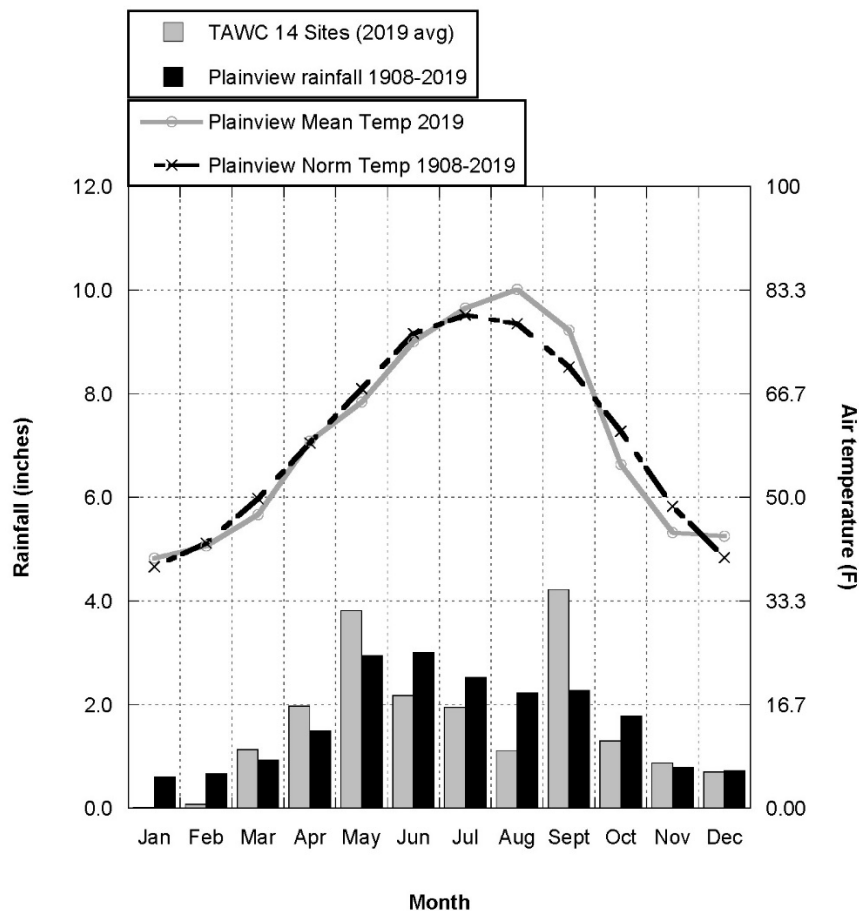
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## 2019 WEATHER DATA (SEE APPENDIX FOR 2005-2018 DATA)

The 14 active project sites received above-average rainfall in 2019 with a total mean of 19.3 inches, using Plainview, TX for the long-term average of 18.5 inches (Figure 14). Precipitation was above average for the months of March through May, and below-average for the remainder of the year except for September. Temperature tracked with the long term normal for most months, but was greatly above normal in August and September, and below normal in October and November.



**Figure 14.** Temperature (lines) and precipitation (bars) by month for 2019 near the demonstration area (Plainview, TX) compared with long term averages.

**Table 2.** Precipitation (inches) at each active site in the demonstration area during 2019.

<b>Site</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Total</b>
<b>11</b>	0.0	0.0	1.0	2.3	4.5	1.7	0.3	0.9	5.2	0.5	0.9	0.7	<b>17.9</b>
<b>21</b>	0.0	0.0	1.1	2.4	4.9	3.3	1.3	1.2	4.9	0.5	0.9	0.7	<b>21.3</b>
<b>22</b>	0.0	0.0	1.1	1.2	4.2	2.8	1.4	0.5	1.4	0.5	0.7	0.8	<b>14.7</b>
<b>32</b>	0.0	0.0	1.1	1.9	1.2	1.8	1.1	0.8	6.3	0.5	0.8	0.8	<b>16.2</b>
<b>35</b>	0.0	0.0	1.1	2.4	4.9	3.3	1.3	1.2	4.9	0.5	0.9	0.7	<b>21.3</b>
<b>C37</b>	0.0	0.1	1.1	1.6	2.5	1.8	2.2	0.3	4.1	0.7	0.7	1.3	<b>16.3</b>
<b>C38</b>	0.0	0.0	1.0	2.0	3.8	3.6	2.1	1.2	5.5	0.8	0.9	0.8	<b>21.8</b>
<b>C39</b>	0.1	0.3	1.0	0.8	2.4	1.5	2.0	1.9	0.7	3.1	0.9	0.4	<b>15.1</b>
<b>41</b>	0.0	0.0	1.1	1.8	4.0	2.1	4.5	2.1	6.0	1.1	1.1	0.7	<b>24.4</b>
<b>42</b>	0.0	0.0	1.1	1.8	4.0	2.1	4.5	2.1	6.0	1.1	1.1	0.7	<b>24.4</b>
<b>C50</b>	0.0	0.0	0.9	2.8	5.7	1.7	0.4	0.6	5.6	0.1	1.0	0.3	<b>19.0</b>
<b>C51</b>	0.0	0.0	0.9	2.8	5.7	1.7	0.4	0.6	5.6	0.1	1.0	0.3	<b>19.0</b>
<b>C57</b>	0.2	0.4	2.1	2.8	2.8	1.6	3.8	1.6	1.2	7.4	1.1	0.8	<b>25.7</b>
<b>C60</b>	0.0	0.1	1.3	1.1	2.9	1.7	2.1	0.5	1.9	1.2	0.3	0.6	<b>13.6</b>
<b>Avg</b>	<b>0.0</b>	<b>0.1</b>	<b>1.1</b>	<b>2.0</b>	<b>3.8</b>	<b>2.2</b>	<b>2.0</b>	<b>1.1</b>	<b>4.2</b>	<b>1.3</b>	<b>0.9</b>	<b>0.7</b>	<b>19.3</b>

# Water and Crop Use Efficiency Summaries

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## *Philip Brown and Chuck West*

Records collected prior to the Texas Water Development Board's (TWDB) 2020 Final Performance Measure deadline were used for reporting to the TWDB and resulted in a 1,188-acre feet water savings across the collected sites with a 53.6% water savings. However, additional site records were collected after this deadline and are included in this Annual Report of Water and Crop Use Efficiency Summaries accounting for the discrepancy in final water savings presented.

## *Total Irrigation, Crop Water Use and Water Conserved* *Definitions and Methods*

Table 3 lists information on 2019 crop water use and irrigation water conserved in the 18 fields that made up the 14 sites for which data are available. Collected data include **site**, **field**, **crop**, special harvest **status**, **irrigation type**, **acres**, **rainfall**, and **irrigation** amount for each field. From these inputs, crop water demand and use were calculated to estimate the amount of irrigation water potentially conserved; that is the amount of groundwater pumped which was less than the amount needed to meet 100% of ET replacement (crop water demand).

**Seasonal rainfall** is based on individual sites and represents an estimated 50% effective rainfall received during the growing season (approximately planting to harvest). This is the amount of rainfall contributing to plant-available water in the soil. In TAWC annual reports covering 2005 to 2013, rainfall was considered to be 70% effective to correct for estimated losses to runoff, evaporation, and deep percolation. The 2014 report revised all water use estimates from 2005-2013 to 50% effective rainfall which has now become the standard. Rain events in the High Plains tend to be high intensity, resulting in ponding and slow infiltration and therefore high evaporation losses. 50% was deemed as a more realistic effective rainfall correction factor based on the typical rain intensity for this area, and the NRCS (retired) representative recommended we adopt the 50% effective rainfall using FAO formulas (<http://www.fao.org/docrep/S2022E/s2022e08.htm>). **Total irrigation** (inches) is the total amount of irrigation applied to each individual site's crop. **Soil moisture contribution** (inches) refers to the difference between beginning and end-of-season plant-available soil water contents. Gravimetric soil water measurements are made by extracting soil with a hand corer to a maximum depth of 3 feet in 1-foot increments. Inability to punch to a depth resulted in an assumed 0% plant-available soil water content below that depth. Gravimetric soil water content was converted to plant-available water based on the site-specific soil texture, bulk density, wilting point and maximum available water capacity values from NRCS SSURGO from the USDA Natural Resources Conservation Service ([http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2\\_053627](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053627)). No gravimetric soil water measurements were made for 2019 due to limits in personnel.

**Total crop water supplied** is the sum of 50% effective rainfall, total irrigation and plant-available soil water contribution. **ET crop water demand** is the average crop water demand (inches) required for an individual crop at 100% potential ET based on crop-specific

coefficients and/or a standardized estimated season ET value based on research experience and history with crops lacking these coefficients. Use of an estimated ET value when specific crop coefficients were not available enabled calculation of the ET crop water demand (potential ET) for all sites and crops within the project. Percentages of **crop water demand provided by rainfall (50% effective), irrigation,** and plant-available **soil moisture** (when available) illustrate the breakdown of crop water supplied by each of these sources. **Total crop water demand provided by total crop water (%)** is the sum of the three sources of water.

**Total irrigation potentially conserved in acre-feet** is the total amount of irrigation water estimated to have been conserved across all irrigated project acres below the **100% season crop ET water demand**. Acre-feet was converted to inches of depth so that fields, crop types, and years involving different acreages could be compared.

### **Results and Discussion**

Total crop water supplied during the 2019 cropping year provided an average of 62% of the total crop water demand across the TAWC fields and ranged from 13 (hailed out cotton field) to 111 % (Table 3, third column from the right). Irrigation at greater than 100% crop water demand indicates excessive water application with only 1 field among the 18 total fields exceeding 100% (14 sites) in 2019, therefore considered to be over-watered. On average across all sites and irrigation systems, irrigation alone provided 40% of the total crop water demand with 21% provided by effective in-season rainfall. These variables total to the 61% crop water demand being provided by the total crop water supplied excluding soil moisture reserves. Stored plant-available soil moisture was not collected for 2019 once again, due to the difficulty in collection and lack of available personnel. The estimated total irrigation potentially conserved across the TAWC project sites totaled 2,106 acre-feet for the growing season with an average indexed depth savings of 15.2 (Table 3, last column).

Newer irrigation systems, while designed for greater efficiency of water delivery to the crop, sometimes result in excessive water being applied rather than conserving water because of lack of careful monitoring of soil and crop water status. This indicates a need for increased user awareness and education on the operation and management of advanced irrigation systems such as subsurface drip and the potential of newer technologies such as variable rate irrigation. Greater use of the TAWC online irrigation scheduling tool and new technology demonstration within this project will continue to aid in reducing over-irrigation and potentially improve water conservation.

**Table 3.** Total water use summary by individual fields across the TAWC sites in 2019.

Year	Site	Field	Crop	Status	Irrigation type	Field Acres	50% Effective season rainfall (inches)	Total irrigation (inches)	Soil moisture contribution to WUE (inches)	Total crop water supplied (inches)	ET crop water demand (inches)	Crop water demand provided by rainfall (%)	Crop water demand provided by irrigation (%)	Crop water demand provided by soil moisture (%)	Crop water demand provided by total crop water (%)	Total irrigation potentially conserved (acre-feet)	Indexed depth (inches)
2019	11	9	Grain Sorghum	Hail out*	FUR	15.0	3.4	0.00	na	3.4	26.0	13%	0%	na	13%	32.5	26.0
2019	11	13	Corn	Hail out*	SDI	80.0	3.4	8.00	na	11.4	32.0	11%	25%	na	36%	160.0	24.0
2019	21	1	Corn (W. Food)	Hail out*	LEPA	60.1	4.2	13.00	na	17.2	32.0	13%	41%	na	54%	95.2	19.0
2019	21	2	Cotton/Fallow	Hail out*	LEPA	60.6	4.2	0.00	na	4.2	20.0	21%	0%	na	21%	101.0	20.0
2019	22	1	Corn	Hail out*	LEPA	145.0	2.2	20.25	na	22.4	32.0	7%	63%	na	70%	142.0	11.8
2019	32	1	Corn		LEPA	70.0	2.0	11.75	na	13.8	32.0	6%	37%	na	43%	118.1	20.2
2019	35	6	Corn (W. Food)		SDI	76.3	8.6	15.00	na	23.6	32.0	27%	47%	na	74%	108.1	17.0
2019	35	7	Corn	Hail out*	SDI	152.7	4.9	12.00	na	16.9	32.0	15%	38%	na	53%	254.5	20.0
2019	C37	1	Cotton	Hail out*	VRI	123.0	5.4	3.25	na	8.6	20.0	27%	16%	na	43%	171.7	16.8
2019	C38	1	Cotton	Hail out*	VRI	467.0	8.4	13.80	na	22.2	20.0	42%	69%	na	111%	241.3	6.2
2019	C39	1	Cotton		LESA/LEPA	62.0	5.5	12.00	na	17.5	20.0	27%	60%	na	87%	41.3	8.0
2019	C39	2	Corn		LESA/LEPA	62.0	5.8	17.00	na	22.8	32.0	18%	53%	na	71%	77.5	15.0
2019	41	1	Cotton	Hail out*	LEPA	120.0	4.8	8.09	na	12.9	20.0	24%	40%	na	64%	119.1	11.9
2019	42	1	Cotton		SDI	122.0	8.7	8.80	na	17.5	20.0	44%	44%	na	88%	113.9	11.2
2019	C50	1	Cotton	Hail out*	LESA/VRI	120.6	3.5	7.70	na	11.2	20.0	17%	39%	na	56%	123.6	12.3
2019	C51	1	Cotton	Hail out*	SDI	45.7	4.4	9.60	na	14.0	20.0	22%	48%	na	70%	39.6	10.4
2019	C57	1	Corn (W. Food)	Hail out*	LESA	124.0	8.5	22.50	na	31.0	32.0	26%	70%	na	97%	98.2	9.5
2019	C60	1	Cotton		LESA	59.5	5.1	6.20	na	11.3	20.0	26%	31%	na	57%	68.4	13.8
<b>Average</b>							<b>5.2</b>	<b>10.5</b>			<b>25.7</b>	<b>21%</b>	<b>40%</b>	<b>na</b>	<b>62%</b>		<b>15.2</b>
<b>Total</b>						<b>1966</b>										<b>2106</b>	

\*Hail out- initial crop cotton, replanted cotton, alternative crop, or fallowed

MESA-Mid elevation spray application, LESA- Low elevation spray application, LEPA-Low energy spray application, VRI-Variable rate irrigation, SDI- Subsurface drip irrigation

Table 4 is a summary across all 15 years of the project for the sources of plant-available water. The data are based on 50% effective season rainfall, plant-available soil moisture (average, if available), and total system irrigation applied. The average total crop water demand supplied by rainfall ranged from 6.8% in 2011 receiving 5.3 inches, which was the most severe drought year in the history of the area, to 51.2% in 2010 with 28.5 inches of annual rainfall, which was the second wettest year for the project. The differences in rainfall were balanced by differences in irrigation.

**Table 4.** Amounts and percentage make-up of the sources of water contributing to total crop water use averaged across fields and calculation of amount and depth of irrigation potentially conserved for TAWC sites in 2005-2019.

Year	Field acres	Annual rainfall (inches)	Average season rainfall (50% effective-inches)	Average total system* irrigation (inches)	Average ET crop water demand (inches)	Average crop water demand provided by rainfall (%)	Crop water demand provided by soil moisture (%)	Average crop water demand provided by irrigation (%)	Average crop water demand provided by total crop water (%)	Total irrigation potentially conserved all sites (acre-feet)	Indexed depth (inches)
2005	3939	14.9	5.4	9.2	22.5	25.4	na	35.9	61.3	5,134	15.6
2006	4132	15.5	4.2	14.8	25.2	18.0	1.9	52.1	72.1	4,526	13.1
2007	4058	27.0	8.6	11.0	18.9	50.4	na	46.7	97.1	4,130	12.2
2008	3996	21.8	9.1	13.3	22.1	44.7	-6.9	49.0	87.9	4,139	12.4
2009	3861	15.1	5.4	11.5	23.6	27.0	14.7	44.8	82.2	4,365	13.6
2010	3934	28.5	9.6	9.2	21.7	51.2	-14.3	34.7	78.5	4,841	14.8
2011	4033	5.3	1.5	20.9	26.7	6.8	17.6	76.6	89.2	3,475	10.3
2012	3962	9.9	3.6	16	26.1	15.9	8.4	58.7	79.6	5,131	15.5
2013	4552	13.2	5.2	16.2	23.5	24.7	8.7	63.8	92.6	4,099	10.8
2014	5114	21.2	8.6	12.1	23.2	41.1	4.1	50.0	95.4	5,454	12.8
2015	3740	30.5	7.3	11.0	25.3	32.5	17.2	42.7	92.5	4,429	14.2
2016	2826	16.6	6.3	11.3	23.2	30.2	2.6	49.5	81.4	2,629	11.2
2017	2656	21.5	8.0	11.3	20.5	43	na	51.8	94.8	1882	8.5
2018	2434	15.6	5.4	12.9	22.1	27	na	53	80	2030	10.6
2019	1966	19.2	5.1	10.9	25.7	21	na	40	62	2106	15.2
Average		18.4	6.2	12.8	23.4	30.6	5.4	49.9	83.1	3891	12.7

\*Note average system irrigation will differ from actual field irrigation averages.

### Crop Water Use Efficiency - 2019

Table 5 lists information related to 2019 crop water use efficiency. Data include **site, field, crop, special harvest status, irrigation type, acres, harvest yield (lbs/acre), in-season irrigation (inches) and in-season total crop water supplied (inches)**, which includes in-season irrigation, plant-available soil water, and 50% in-season effective rainfall (planting to harvest) for each site, field, and crop. Crop water use efficiency is presented as **pounds**



**of harvest product** (lint, in the case of cotton) **per acre-inch of irrigation** water applied and the **pounds per acre-inch of total water** input.

**Table 5.** Crop water use efficiency summary by fields across the TAWC sites in 2019.

Year	Site	Field	Crop	Status	Irrigation type	Field Acres	Harvest yield (lbs/acre)	In-season irrigation (inches)	In-season total crop water supplied (inches)	WUE of irrigation (lbs/acre-inch)	WUE of total water (lbs/acre-inch)
2019	11	9	Grain Sorghum	Hail out*	FUR	100.8	1,800	8.2	3.4	na	530.2
2019	11	13	Corn	Hail out*	SDI	135.0	8,232	13.2	11.4	1029.0	719.6
2019	21	1	Corn (W. Food)	Hail out*	LEPA	57.7	8,848	8.9	17.2	680.6	515.9
2019	21	2	Cotton/Fallow	Hail out*	LEPA	116.6	0	11.3	4.2	na	0.0
2019	22	1	Corn	Hail out*	LEPA	116.6	9,744	10.5	22.4	481.2	435.0
2019	32	1	Corn		LEPA	116.6	8,680	7.9	13.8	738.7	629.9
2019	35	6	Corn (W. Food)		SDI	15.0	9,352	19.0	23.6	623.5	396.8
2019	35	7	Corn (W. Food)	Hail out*	SDI	80.0	5,712	13.8	16.9	476.0	338.0
2019	C37	1	Cotton	Hail out*	VRI	124.1	0	14.6	8.6	0.0	0.0
2019	C38	1	Cotton	Hail out*	VRI	54.5	573	11.5	22.2	41.5	25.9
2019	C39	1	Cotton		LESA/LEPA	54.4	1,691	11.1	17.5	140.9	96.9
2019	C39	2	Corn		LESA/LEPA	60.1	13,888	11.6	22.8	816.9	610.5
2019	41	1	Cotton	Hail out*	LEPA	60.1	403	10.9	12.9	49.8	31.3
2019	42	1	Cotton		SDI	60.6	899	11.5	17.5	102.2	51.3
2019	C50	1	Cotton	Hail out*	LESA/VRI	145.0	1,077	10.5	11.2	139.9	96.6
2019	C51	1	Cotton	Hail out*	SDI	70.0	1,075	8.2	14.0	112.0	77.1
2019	C57	1	Corn (W. Food)	Hail out*	LESA	115.0	11,592	13.2	31.0	515.2	374.3
2019	C60	1	Cotton		LESA	115.0	1,053	8.9	11.3	169.8	93.2

\*Hail out- initial crop cotton, replanted cotton, alternative crop or fallowed

Water use efficiency comparisons among crops are difficult to compare because the nature of the harvested material is different, for example, pounds of lint, grain, or forage. In Table 6 we show the average yields, irrigation supplied, total water supplied, and calculated WUE by crop type calculated on irrigation basis and total water supplied basis.

**Table 6.** Water use efficiency (WUE) based on irrigation supplied and total water supplied averaged by harvested crop type across fields in 2019.

Crop	Number of fields	Total field acres	Average Harvest yield (lbs/acre)	Average In-season irrigation (inches)	Average In-season total crop water supplied (inches)	Average WUE of irrigation (lbs/acre-inch)	Average WUE of total water (lbs/acre-inch)
Corn grain	7	770	9,506	14.9	19.9	670.1	502.5
Cotton lint	7	997	967	9.5	15.2	108.0	67.5
Grain Sorghum	1	15	1,800	0	3.4	na	530.2

### **Systems Management for Water Savings - 2019**

It should be noted that water savings can also be achieved through management of the cropping system and tillage types being implemented. There are many benefits to minimum/no-till management practices, which can conserve water and/or improve infiltration and rainfall capture as well as other agronomic benefits to the overall system and soil health.

Crop selection and planting management can also have an impact on water use. For example, in earlier years, Site 14 was a pivot field with approximately 120 acres. This site implemented a 2 in, 2 out planting scheme every year since 2014 (2 planted rows alternating with 2 fallow rows). Water is applied only over the planted rows. This results in only half of the field area being planted and irrigated. Therefore, on a land-area basis, when 8 inches of irrigation is applied to the crop rows, only 4 inches of irrigation has been applied across the system acres. This constitutes a 50% water savings to the overall cropping system. Other systems can include individual fields that have been fallowed or the integration of low water use crops such as specialty crops and perennial grasses that use less water, combined with higher water-use crops allowing a producer to concentrate more water onto a smaller high-value cropping area, but achieve water savings on the whole land area. Education/outreach components focusing on such management practices are continually being improved through the TAWC efforts.

**Table 7.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 14 producer sites in the project during 2019. (See Appendix for 2005-2018)

Site	Irrigation type	System acres	Cotton	Corn grain	Corn silage	Fallow	Grain sorghum	Seed sorghum	Forage sorghum	Alfalfa	Grass seed	Hay	Perennial forage	Cattle grazed	Wheat for grain	Wheat silage	Grazed wheat	Sunflower	Blackeye pea	Millet hay
11	FUR/SDI	95.0	95.0	80.0			15													
21	LEPA	120.7	120.7	60.1		60.6														
22	LEPA	145.0	145.0	145.0																
32	LEPA	70.0		70.0																
35	SDI	229.0	152.7	229.0																
C37	VR-LESA	123.0	123.0			123.0														
C38	VR-LESA	467.0	467.0																	
C39	LESA/LEPA	124.0		62.0																
41	LEPA	120.0	120.0																	
42	SDI	122.0	122.0																	
C50	LESA	120.6	120.6																	
C51	SDI	45.7	45.7																	
C57	LESA	124.0		124.0																
C60	LESA	59.5	59.5																	
<b>Total harvested acres 2019</b>		1966 (1966 active)	996.8	770.1		183.6	15													
<b>Total # of Harvested Sites</b>		14 (14 active)	7	7	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0

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

\*\*Red denotes field crop failure/Insurance claim, Yellow denotes original purpose altered Brown denotes fallowed, Grey denotes no producer field data for this year.

# Phase II Economic Summaries of Results from Monitoring Producer Sites in 2014-2019.

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## Phase II - Economic assumptions of data collection and interpretation

1. Although actual depth to water in wells located among the producer sites varies, a pumping depth of 303 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. Variable costs are nearly constant across irrigation systems, according to Amosson et al. (2011)<sup>2</sup>, so this assumption has negligible effect on the analysis. The estimated cost per acre-inch includes the cost of energy, repair and maintenance cost, and labor cost. The primary source of variation in variable cost from year to year is due to changes in the unit cost of energy and repair and maintenance costs.
5. Mechanical tillage operations for each individual site were accounted for with the cost of each field operation being based on typical custom rates for the region. Using custom rates avoids the variations among sites in the types of equipment owned and operated by individuals.

## Economic Term Definitions

**Gross Income** – The total revenue received per acre from the sale of production

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

**Gross Margin** – Total revenue less total variable costs

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

**Net Returns** – Gross margin less fixed costs.

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<sup>2</sup> Amosson, L. et al. 2011. Economics of irrigation systems. Texas A&M AgriLife Extension Service. B-6113.

**Phase II - Assumptions of energy costs, prices, fixed and variable costs (Tables 8-10)**

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

**Table 8.** Electricity irrigation cost parameters for Phase II 2014-2019.

<b>Item</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
Gallons per minute (gpm)	450	250	250	250	250	250
Pumping lift (feet)	303	310	313	320	325	325
Discharge pressure (psi)	15	15	15	18	18	18
Pump efficiency (%)	60	60	60	50	50	50
Motor efficiency (%)	88	88	80	80	80	80
Electricity cost per kWh	\$ 0.14	\$ 0.10	\$ 0.10	\$ 0.11	\$ 0.11	\$ 0.11
Cost of electricity per acre-inch	\$ 8.26	\$ 5.93	\$ 6.14	\$ 8.66	\$ 9.12	\$ 9.12
Cost of maint. & repairs per acre-in.	\$ 3.87	\$ 3.15	\$ 3.53	\$ 3.16	\$ 3.03	\$ 3.03
Cost of labor per acre-inch	\$ 1.10	\$ 1.10	\$ 1.10	\$ 1.10	\$ 1.12	\$ 1.12
Total cost per acre-inch	\$13.23	\$10.18	\$10.77	\$12.92	\$13.27	\$13.27

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

**Table 9.** Commodity prices for Phase II 2014-2019.

<b>Commodity</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
Cotton lint (\$/lb)	\$0.65	\$0.63	\$0.68	\$0.68	\$0.76	\$0.68
Cotton seed (\$/ton)	\$175	\$190	\$180	\$150	\$155	\$150
Grain sorghum-grain (\$/cwt)	\$7.10	\$3.45	\$3.45	\$3.45	\$3.45	\$3.45
Grain sorghum-seed (\$/lb)	-	-	-	-	-	-
Corn-grain (\$/bu)	\$5.00	\$4.76	\$4.71	\$4.71	\$4.60	\$4.60
Corn-food (\$/bu)	\$5.99	\$5.10	\$5.10	\$4.95	\$5.10	\$5.40
Barley (\$/cwt)	-	-	-	-	-	-
Wheat-grain (\$/bu)	\$6.85	\$4.25	\$4.25	\$5.25	\$4.25	\$4.25
Sorghum silage (\$/ton)	\$24.00	\$24.00	\$24.00	\$24.00	\$24.00	\$24.00
Corn silage (\$/ton)	\$30.60	\$30.60	\$30.60	\$30.60	\$37.75	\$37.75
Wheat silage (\$/ton)	\$26.59	\$26.59	\$26.59	\$26.59	\$26.59	\$26.59
Oat silage (\$/ton) -	\$14.58	\$14.58	\$14.58	\$14.58	\$14.58	\$14.58
Millet seed (\$/lb)	\$0.38	\$0.50	\$0.50	\$0.32	\$0.50	\$0.50
Sunflower (\$/lb)	\$0.38	\$0.25	\$0.25	\$0.25	\$0.25	\$0.25
Alfalfa (\$/ton)	\$264	\$205	\$140	\$130	\$140	\$140
Hay (\$/ton)	\$60	\$60	\$60	\$60	\$60	\$60
WW-BDahl hay (\$/ton)	\$40	\$40	\$40	\$40	\$40	\$40
Haygrazer (\$/ton)	\$80	\$80	\$80	\$80	\$80	\$80
Sideoats seed (\$/lb)	\$8.12	\$8.12	\$8.12	\$8.12	\$8.12	\$8.12
Sideoats hay (\$/ton)	\$35	\$35	\$35	\$35	\$35	\$35
Triticale silage (\$/ton)	\$45	\$45	\$45	\$45	\$45	\$45
Triticale forage (\$/ton)	\$140	\$140	\$140	\$140	\$140	\$140
Blackeye pea (\$/cwt)	-	\$40.00	\$40.00	\$40.00	\$40.00	\$40.00

3. Fertilizer and chemical costs (herbicides, insecticides, growth regulators, and harvest aids) are reflective of the production year; however, prices were constant across sites for the product and formulation.
4. Other variable and fixed costs are given for Phase II 2014-2019 in Table 10.

**Table 10.** Other variable and fixed costs for Phase II 2014-2019.

<b>VARIABLE COSTS</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
<i>Boll weevil assessment: (\$/ac)</i>						
Irrigated cotton	\$1.00	\$1.00	\$1.00	\$1.00	\$1.00	\$1.00
Dryland cotton	\$1.00	\$1.00	\$1.00	\$1.00	\$1.00	\$1.00
<i>Crop insurance: (\$/ac)</i>						
Irrigated cotton	\$40.00	\$40.00	\$40.00	\$40.00	\$40.00	\$40.00
Dryland cotton	\$32.00	\$32.00	\$32.00	\$32.00	\$32.00	\$32.00
Irrigated corn	\$15.50	\$15.50	\$15.50	\$15.50	\$15.50	\$15.50
Irrigated corn silage	\$15.50	\$15.50	\$15.50	\$15.50	\$15.50	\$15.50
Irrigated wheat	\$19.50	\$19.50	\$19.50	\$19.50	\$19.50	\$19.50
Irrigated sorghum grain	\$29.00	\$29.00	\$29.00	\$29.00	\$29.00	\$29.00
Dryland sorghum grain	\$16.50	\$16.50	\$16.50	\$16.50	\$16.50	\$16.50
Irrigated sorghum silage	\$29.00	\$29.00	\$29.00	\$29.00	\$29.00	\$29.00
Irrigated sunflowers	\$17.00	\$17.00	\$17.00	\$17.00	\$17.00	\$17.00
Cotton harvest – strip and module (\$/lint lb)	\$0.08	\$0.08	\$0.09	\$0.09	\$0.09	\$0.09
Cotton ginning (\$/cwt)	\$2.20	\$2.20	\$2.50	\$2.50	\$2.50	\$2.50
Bags, ties, & classing (\$/bale)	\$14.63	\$14.63	\$15.40	\$15.40	\$15.40	\$15.40
<b>FIXED COSTS</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
<i>Irrigation system:</i>						
Center pivot system	\$40.00	\$40.00	\$40.00	\$60.00	\$40.00	\$40.00
Drip system	\$75.00	\$75.00	\$75.00	\$100.00	\$75.00	\$75.00
Flood system	\$25.00	\$25.00	\$25.00	\$40.00	\$25.00	\$25.00
<i>Cash rent:</i>						
Irrigated cotton, grain sorghum, sunflower, grass, pearl millet, and sorghum silage.	\$100.00	\$100.00	\$100.00	\$130.00	\$100.00	\$100.00
Irrigated corn silage, corn grain, and alfalfa.	\$140.00	\$140.00	\$140.00	\$130.00	\$140.00	\$140.00
Dryland cropland	\$30.00	\$30.00	\$30.00	\$30.00	\$30.00	\$30.00

5. The custom tillage and harvest rates used for 2018 were based on rates reported in Texas A&M AgriLife Extension, 2017 Texas Agricultural Custom Rates, May 2017.

**Table 11.** Summary of results from monitoring 14 producer sites during 2019 (Year 15).

System	Site No.	System Acres	Irrigation Type <sup>1</sup>	System inches	Net Return/ System acre	Net Return/ inch water	Gross margin per inch irrigation
<b><i>Monoculture systems</i></b>							
Corn (Cotton hail out-replant/fallow)	21	120.7	LEPA	92.45	14.29	29.68	92.45
Corn (Cotton hail out-replant)	22	145.0	LEPA	279.75	13.81	23.69	279.75
Corn	32	70.0	LEPA	173.35	14.75	30.92	173.35
Corn (Field 7 Cotton hail out-replant)	35	70.0	SDI	117.05	9.00	26.95	117.05
Cotton (Cotton hail out/fallowed)	C37	124.0	VRI	-229.53	-70.62	0.14	-229.53
Cotton (Cotton replant)	C38	467.0	VRI	-279.08	-20.22	-6.46	-279.08
Cotton (Cotton replant)	41	120.0	LEPA	-128.14	-15.84	8.88	-128.14
Cotton	42	122.0	SDI	190.00	21.59	44.32	190.00
Cotton (Cotton replant)	C50	120.6	LESA/VRI	75.02	9.74	34.42	75.02
Cotton (Cotton replant)	C51	45.7	SDI	-84.25	-8.78	15.18	-84.25
Corn (Cotton hail out-replant)	C57	124.0	LESA	212.70	9.45	17.90	212.70
Cotton	C60	59.5	LESA	137.63	22.20	52.84	137.63
<b><i>Multi-crop systems</i></b>							
Corn/Grain Sorghum	11	95.0	FUR/SDI	6.7	243.72	36.16	69.19
Corn/Cotton	C39	120.0	LESA/LEPA	14.5	391.24	26.98	40.43

<sup>1</sup>SDI – Subsurface drip irrigation; MESA – Mid elevation spray application; LESA – Low elevation spray application; LEPA – Low energy precision application; LDN – Low drift nozzle; VRI – Variable rate irrigation; FUR – furrow irrigation; DL – dryland

**Table 12.** Summary of crop production, irrigation and economic returns within all production sites for Phase I (See Appendix for detailed list by year) and Phase II 2014-19.

Item			Average Phase I 2005-2013	Phase II 2014	Phase II 2015	Phase II 2016	Phase II 2017	Phase II 2018	Phase II 2019	2005-2019 Crop Year Average
Crop			(yrs)	(fields)	(fields)	(fields)	(fields)	(fields)	(fields)	
	Cotton									
		Lint, lbs	1,300 (9yr)	1,138 (20)	1,258 (16)	1,360 (18)	1,294 (18)	1,417 (14)	967 (7)	1,275
		Seed, tons	0.9	0.8 (20)	0.9 (16)	1.0 (18)	0.9 (18)	1.0 (14)	0.7 (7)	0.9
	Corn									
		Grain, lbs	10,680 (9yr)	11,538 (8)	10,452 (19)	9,996 (9)	11,830 (6)	11,017 (4)	9,506 (7)	10,697
		Silage, tons	26.8 (8yr)	16.4 (4)	-	22 (1)	-	22.9 (1)		25.1
	Sorghum									
		Grain, lbs	5,231 (9yr)	6,675 (7)	3,944 (3)	6,748 (1)	-	-	1,800 (1)	5,371
		Silage, tons	18.5 (5yr)	-	-	-	-	-	-	18.5
		Seed, lbs	3,507 (1yr)	-	-	-	-	-		3,507
	Wheat									
		Grain, lbs	2,458 (8yr)	1,333 (1)	3,652 (3)	-	2,400 (1)	2,760	-	2,484
		Silage, tons	8.6 (4yr)	-	-	-	-	-	-	8.6
		Hay, tons	1.5 (2yr)	-	-	-	-	-	-	1.5
	Oat									
		Silage, tons	8.7 (2yr)	-	-	-	-	-	-	8.7
		Hay, tons	1.8 (1yr)	-	-	-	-	-	-	1.8
	Barley									
		Grain, lbs	3,133 (1yr)	-	-	-	-	-	-	3,133
		Hay, tons	5.5 (1yr)	-	-	-	-	-	-	5.5
	Triticale									
		Hay, tons	3.0 (1yr)	-	-	-	-	-	-	3.0
		Silage, tons	13.3 (5yr)	-	-	-	-	-	-	13.3
	Sunflower									
		Seed, lbs	2,182 (4yr)	2,867 (4)	1,790 (3)	1,473 (2)	-	-	-	2,123
	Millet									
		Seed, lbs	2,840 (7yr)	3,800 (1)	3,350 (2)	-	6,855 (2)	-	-	3,389
	Blackeye p.									
		Bean, lbs	0	-	2,700 (1)	-	2,200 (1)	-	-	2,450
	Perennial forage									
	WW-BDahl									
		Seed, PLS lbs	58.6 (3yr)	-	-	-	-	-	-	58.6
		Hay, tons	2.5 (1yr)	-	-	-	-	-	-	2.5
	Sideoats									
		Seed, PLS lbs	257.2 (9yr)	184 (2)	-	-	-	-	-	249.9
		Hay, tons	1.7 (9yr)	1.3 (2)	-	-	-	-	-	1.7



Item			Average Phase I 2005-2013	Phase II 2014	Phase II 2015	Phase II 2016	Phase II 2017	Phase II 2018	Phase II 2019	2005-2019 Crop year average
By Crop			inches applied	inches applied	inches applied	inches applied	inches applied	inches applied	inches applied	inches applied
	Other									
Item		Hay, tons	2.3 (3yr)		-	-	-	3.7 (2)		2.6
	Alfalfa									
		Hay, tons	9.1 (9yr)	8.2 (3)	7.8 (3)	6.5 (1)	7.5 (1)	-	-	8.6
Annual forage										
	Forage sorg.									
		Hay, tons	3.5 (3yr)	5.5 (1)	-	4.1 (1)	-	1.4 (1)	-	3.6
		Seed, lbs	3,396 (1yr)	3,742 (1)		3,200 (1)				3,446
Precipitation, inches (including all sites)			16.9	21.3	30.5	16.6	21.5	15.6	19.24	18.4
By System			inches applied	inches applied	inches applied	inches applied	inches applied	inches applied		inches applied
Total irrigation water (system average)			13.6	12.1 (39)	11.0 (31)	11.3 (22)	11.3 (19)	12.9 (17)	10.9 (14)	12.8
By Crop		Primary crop	inches applied	inches applied	inches applied	inches applied	inches applied	inches applied		inches applied
	Cotton	lint	13.6	9.8 (20)	9.3 (16)	10.6 (18)	10.8 (18)	13.6 (14)	8.68 (7)	12.3
	Corn	grain	19.1	15.2 (8)	16.4 (19)	16.8 (9)	16.4 (6)	18.2 (4)	14.9 (7)	18.2
	Corn	silage	22.8	13.2 (4)	-	15 (1)	-	16.0 (1)	-	20.6
	Sorghum	grain	12.0	11.6 (7)	6.2 (3)	8.0 (1)	-	-	0 (1)	10.3
	Sorghum	silage	12.6		-	-	-	-	-	12.6
	Wheat	grain	6.4	10.5 (1)	5.3 (3)	-	7.0 (1)	9.0 (1)	-	6.9
	Wheat	silage	11.3	-	-	-	-	-	-	11.3
	Oat	silage	10.0	-	-	-	-	-	-	10.0
	Oat	hay	4.9	-	-	-	-	-	-	4.9
	Triticale	silage	10.8	-	-	-	-	-	-	10.8
	Barley	grain	12.8	-	-	-	-	-	-	12.8
	Small grain	(grazing)	0.0	16.8 (1)	-	1.2 (1)	-	3.0 (1)	-	4.0
	Small grain	(grains)	6.4	10.5 (1)	5.3 (3)	-	7.0 (1)	9.0 (1)	-	6.9
	Small grain	(silage)	10.9	-	-	-	-	-	-	10.9
	Small grain	(hay)	11.3		-	-	-	-	-	11.3
	Small grain	(all uses)	7.0	13.7 (2)	5.3 (3)	1.2 (1)	7.0 (1)	-	-	6.9
	Sunflower	seed	10.4	8.9 (4)	5.3 (3)	8.6 (2)	-	-	-	9.3
	Millet	seed	13.1	14 (1)	11 (2)	-	8.5 (2)	-	-	12.6
	Blackeye p.	bean	0	0	6.0 (1)	-	6.0 (1)	-	-	6.0
Dahl										
	Hay		3.7	-		-	-	-	-	3.7
	Seed		8.1	-		-	-	-	-	8.1
	Grazing		7.9	0 (1)	0 (1)	-	0 (1)	-	-	6.3
Sideoats										
	Seed		11.2	15.8 (2)	-	-	-	-	-	11.7
Bermuda										

Table 12 continued.

Item			Average Phase I 2005-2013	Phase II 2014	Phase II 2015	Phase II 2016	Phase II 2017	Phase II 2018	Phase II 2019	2005-2019 Crop year average
By Crop			inches applied	inches applied	inches applied	inches applied	inches applied	inches applied	inches applied	inches applied
	Grazing		7.4	-	0 (1)	-	0 (1)	-	-	6.3
<b>Other Perennial/Annuals</b>										
	Hay		9.6	5.0 (1)	-	-	-	-	-	9.1
	Grazing		5.9	8.0 (3)	0 (1)	9.6 (1)	-	-	-	5.9
<b>Perennial grasses (grouped)</b>										
	Seed		10.4	15.8 (2)	-	-	-	-	-	10.9
	Grazing		6.2	2.3 (3)	0 (2)	9.6 (1)	0 (2)	-	-	5.3
	Hay		1.2	0 (2)	-	-	-	-	-	1.0
	all uses		6.4	5.5 (5)	0 (2)	9.6 (1)	0 (2)	-	-	5.6
<b>Alfalfa</b>										
	all uses		23.2	20.1 (3)	15.3 (3)	28 (1)	15.0 (1)	-	-	22.1
<b>Income &amp; Expense, \$/system acre</b>										
<b>Projected Returns</b>			\$895.46	\$989.38	\$879.95	\$884.91	\$923.88	\$923.88	\$873.80	\$911.30
<b>Costs</b>										
	Total variable costs (all sites)		\$554.28	\$639.58	\$545.17	\$636.15	\$654.50	\$714.95	\$591.48	\$587.70
	Total fixed costs (all sites)		\$115.56	\$154.63	\$162.24	\$153.92	\$183.13	\$191.10	\$197.18	\$139.45
	Total all costs (all sites)		\$669.81	\$790.35	\$707.41	\$790.07	\$837.63	\$906.05	\$788.66	\$726.88
<b>Gross margin</b>										
	Per system acre (all sites)		\$341.05	\$349.80	\$334.78	\$248.76	\$269.38	\$267.07	\$282.32	\$323.60
	Per acre-inch irrigation water (irrigation only)		\$34.07	\$29.74	\$35.15	\$22.39	\$28.42	\$21.85	\$27.72	\$31.46
<b>Net returns over all costs</b>										
	Per system acre (all sites)		\$225.52	\$199.03	\$172.54	\$94.84	\$86.25	\$75.97	\$85.14	\$184.43
	Per acre-inch irrigation water (irrigation only)		\$21.53	\$15.79	\$17.74	\$7.49	\$8.48	\$5.73	\$4.47	\$16.90
	Per pound of nitrogen (all sites)		\$1.86	\$3.76	\$1.84	\$1.99	\$0.64	\$0.14	\$0.45	\$1.73

## Reports by Specific Task

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### TASK 2: ADMINISTRATION AND SUPPORT

#### **Annual Report ending February 29, 2020**

##### **2.1: Project Director: Rick Kellison, Project Director (TTU)**

As we say in the Texas Panhandle, from one extreme to another. So goes the 2019 growing season. April and May brought cool, wet weather and significant hailstorms which led to many producers not being able to get cotton planted then replanted. This led to many acres of alternate crops being planted including many acres of late planted corn. The tide turned in June, July and August with little to no rain fall. Many acres of early and late planted grain crops along with the cotton were adversely affected by the extended hot and dry conditions. Late September and early October brought extremely wet, cool conditions which slowed down crop maturity. We had the lack of heat unit accumulation coupled with a very early frost in mid-October. Cotton quality and quantity were adversely affected. Most producers just wanted to get this growing season in the record books.

July 9<sup>th</sup>, TAWC helped to host a Forage Field Day at the Texas Tech University research farm at New Deal. The focus was to show-case current forage research being conducted at the farm and the different management practices being used. There was very good attendance and much interest in the work being done.

On July 24<sup>th</sup> thru the 26<sup>th</sup> TAWC hosted the cotton working group from Indigo Inc. The 25<sup>th</sup> was spent exchanging information between Indigo, TAWC and Texas Tech University. Indigo is interested in developing a market for carbon and water credits to be sold to the major clothing brands. This might be an excellent opportunity to develop another revenue stream for producers. On the 26<sup>th</sup>, we took the group to the Glenn and Layton Schur farms where they were able to see the different types of irrigation delivery technologies in operation. Later that day we traveled to Lorenzo to visit the Lloyd Author Farms. Lloyd and Jeff Miller did a great job of explaining VRI irrigation technology using moisture probes, soil mapping and ET data to develop an in-season irrigation prescription. I believe Indigo may be a good partner for TAWC in the future.

On September 12<sup>th</sup>, TAWC hosted its 14<sup>th</sup> Annual Field Day at Muncy, Texas. We had approximately seventy people in attendance this year. There was an outstanding line-up of presenters with quality presentations. Many of our producers were harvesting corn and grain sorghum and not able to attend. Thanks to KFLP Radio, producers and other interested parties were able to listen to presentations live on the radio. KFLP Radio has been a great partner of TAWC's outreach efforts for the past fourteen years.

September 21<sup>st</sup>, I met with Texas Tech University President, Lawrence Schovanec and other interested parties to discuss funding options for TAWC in the future. I believe it was a very productive meeting and we decided to monitor incoming funding in early 2020 and try to develop a plan as needed. On October 24<sup>th</sup>, I had the pleasure of hosting Arun Agarwal and

two of his marketing team for a meeting in Lubbock. The purpose of this meeting was to develop a dialogue between Arun and local cotton leaders. We had producers present along with representatives from Plains Cotton Growers, Plains Cotton Co-operative Association, Texas Tech University and TAWC. It was agreed that we would work together to help bring alternate cotton marketing options to area cotton producers.

Much of December was dedicated to finalizing plans for the 2020 6<sup>th</sup> annual TAWC Water College to be held on January 23<sup>rd</sup> at the Lubbock Civic Center. Considering it was a very challenging growing season in 2019 we had excellent attendance. Many of the producers attending commented on the quality and diversity of the presentations. Congressman Jodey Arrington did an outstanding job delivering the keynote address.

The TAWC Management team developed a grant proposal for additional funding which was submitted to the Texas Water Development Board in mid-February. We are excited about the opportunity to demonstrate the impact of incorporating multi-species cover crops into exiting systems. We need to understand how this will affect water infiltration, water efficiency, soil health and the effect on profitability. On February 11<sup>th</sup> John Bender made a presentation on behalf of TAWC to the WCAC requesting consideration for additional funding in the next session of the Texas Legislature. The request for the recommendation was approved by the council.

We continue to develop a plan to work with Arun Agarwal in his effort to support producer's sustainability efforts. At this time, we are developing a MOU to define specific responsibilities of all parties involved. This partnership would offer TAWC an additional outreach opportunity to aid producers in their water conservation efforts.

We have had 12 management team meeting this quarter and I have made regular site visits.

Presentations in 2019:

07-25-19	Indigo, Overton Hotel	Lubbock, Texas
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Tours in 2019:

07-26-19	Indigo	Plainview & Lorenzo
02-27-20	TSWCR	TAWC Site Tour
02-25-20	Texas Monthly	TAWC Site Tour

## **2.2: Administrative Coordinator: (TTU)**

Year 15 main objectives for the secretarial/administrative and bookkeeping support role for the TAWC Project included the following:

Accurate Accounting of All Expenses for the Project: This included monthly reconciliations of accounts with the TTU accounting system, quarterly reconciliations of subcontractors' invoices, preparation of itemized quarterly reimbursement requests, and preparation of

Task and Expense Budgets for Year 15. The budget was balanced for this annual report and is presented in Table 13 on page 64.

Administrative Support for Special Events: Support staff continued to assist the communications director and project director with special events by processing purchase orders, procurement card orders and travel.

Ongoing Administrative Support: Daily administrative tasks included correspondence through print, telephone and e-mail; completed various clerical documents such as mileage logs, purchase orders, cost transfers, travel applications, human resource forms, and pay payroll paperwork; and other duties as requested or assigned. Prepared producer record books for individual producer records.

### *TASK 3: FARM ASSISTANCE PROGRAM*

**Annual Report ending February 29, 2020**

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

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Texas AgriLife Extension Service, FARM Assistance Subcontract with Texas Tech University

Year 15 project progress regarding task 3 in the overall project scope of work has occurred in several areas ranging from collaborating in project coordination and data organization to data collection and communication, as well as, providing additional services to the area producers in conjunction with the TAWC project. A brief summary of specific activities and results follows:

#### *Project Collaboration*

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

#### *Farm Field Records*

AgriLife Extension has taken the lead in the area of data retrieval in that FARM Assistance staff is meeting with producers multiple times each year to obtain field records and entering those records into the database. AgriLife Extension assisted many of the project participants individually with the completion of their individual site demonstration records (farm field records). Extension faculty have completed the collection, organization, and sharing of site records for all of the 2019 site demonstrations.

#### *FARM Assistance Strategic Analysis Service*

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

#### *Economic Study Papers*

Farm Assistance members completed a study poster utilizing the economic data on a site within the TAWC project. The paper examined the "Economic Comparison of Crop Row Offset and Orientation to SDI Laterals". The results of this paper were presented at the Beltwide Cotton Conference held in Austin, Texas this past January.

### **Continuing Cooperation**

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

### **Other Presentations**

Farm Assistance members made a presentation to the Castro County Ag. Conference concerning the benefit of soil moisture probes and Variable Rate Irrigation economics. A poster presentation was made to the Texas Extension Specialist Association at their annual meeting. Also, presentations were made to two local Lions Club groups concerning agricultural water savings methods. One was at Idalou and one at Ralls.

### **Field Days**

A Field Day was held in the T.A.W.C project during the 2019 growing season. The Summer Field Day was held September and hosted about 90 producers and guest. The purpose of the meeting was to allow producers outside of the project to see what takes place within the project, as well as allow producers to hear about the latest research and policy that could have an impact on their operation. Personnel from AgriLife Extension, AgriLife Research, Farm Assistance, members of industry, and Texas Tech University were involved in these field days.

### **Water College**

The Sixth Annual Water College was in held January at the Lubbock Memorial Civic Center with more than 250 attendees. F.A. members were responsible for planning, organizing, and ensuring proper flow of the event. More than 25 members of industry had booths at the event.

### **Radio Broadcasts**

Members of F.A. made more than 12 appearances on various radio stations promoting the T.A.W.C. and its events. Stations included Lubbock, Plainview, Amarillo, and Floydada.

### **TAWC Booth**

F.A. members helped man the TAWC booth, which promotes tools developed by the TAWC team and upcoming TAWC activities, at several events during the year. Those events include the Amarillo Farm and Ranch Show, Texas Cotton Ginners Meeting, High Plains Irrigation Conference, and the Texas No-Till Symposium

#### *TASK 4: ECONOMIC ANALYSIS*

**Annual Report ending February 29, 2020**

**Principal Investigator(s): Drs. Phillip Johnson and Donna Mitchell (TTU)**

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

#### *Major achievements for 2019:*

- 2019 was the 15<sup>th</sup> year of economic data collection from the project sites. Data for the 2018 production year were collected and enterprise budgets were generated.
- TAWC cooperated with the National Cotton Council in a project for the Fieldprint Calculator, which is being developed by Field-to-Market – The Keystone Alliance for Sustainable Agriculture. The Fieldprint Calculator estimates the sustainability footprint for crop production. TAWC site information for 2007 through 2018 was entered into the calculator. In August of 2017, TAWC became an affiliate member of Field to Market through Texas Tech University's College of Agricultural Sciences and Natural Resources and Dr. McCallister is currently serving a two-year term on the Field to Market Education and Outreach Committee.

#### *Grant funding received in 2019:*

- Application of the Fieldprint Calculator for Cotton Production in the Texas High Plains. Funded by the Cotton Foundation (7/14-8/19, \$36,000). PI's – Phillip Johnson and Donna McCallister. The objective of this project is to evaluate cotton production sites in the TAWC project with regard to their sustainability as measured by the Fieldprint Calculator.
- Sustaining Agriculture through Adaptive Management to Preserve the Ogallala Aquifer under a Changing Climate. Funded by USDA AFRI. PI: Chuck West. Collaborator: Donna McCallister. (3/16-2/20, \$57,160). The objective of this project is to develop best management practices and technologies, tools, and crop management practices.



- Co-PI. 2018-2019. USDA ARS OAP. “Economic Viability and Soil Health Sustainability Concerning the Use of Brackish Dockum Aquifer Irrigation Water for Crop Agriculture.” PI’s: Nathan Howell. Total Amount: \$39,000
- Economic and Policy Implications of Underground Water Use in the Southern Ogallala Region. Co-PI: Donna McCallister. 2017-2019. USDA ARS Ogallala Aquifer Program. Amount: \$45,000.
- Evaluation of Soil Conservation Practices and Integrated Advanced Irrigation Technologies on Soil Health and Water Use Efficiency. Co-PI: Donna McCallister. 2017-2019. Texas Corn Producers Board. Amount: \$36,324.
- Economic and Policy Implications of Underground Water Use in the Southern Ogallala Region. Co-PI: Donna McCallister. 2016-2018. USDA ARS Ogallala Aquifer Program. Amount: \$45,000.

**Peer-reviewed Publications during 2019:**

- Mitchell-McCallister, D.M., A. Cano, C. West. “Meta-Analysis of Water Use Efficiency in Deficit Irrigation Systems.” Irrigation Science, under review.
- Mitchell-McCallister, D.M., R.B. Williams, J. Bordovsky, J. Mustian, G. Ritchie, and K. Lewis. 2020. “Maximizing profits via irrigation timing for capacity-constrained cotton production.” Ag Water Management, 229:1-8.
- D. Rudnick, S. Irmak, C. West, J.L. Chavez, I. Kisekka, T.H. Marek, J. Schneekloth, D. Mitchell McCallister, V. Sharma, K. Djaman, J. Aguilar, M.E. Schipanski, D.H. Rogers, and A. Schlegel. 2019. “Deficit Irrigation of Maize in the High Plains Aquifer Region: A Review.” Journal of the American Water Resources Association, 1-18(35). doi: 10.1111/1752-1688.12723.

**Professional Presentations during 2019:**

- McCallister, D.M. and M. Parajulee. 2019. “The Role of IPM in Farm Sustainability.” American Chemical Society Fall 2019 National Meeting and Expo, San Diego, CA, August 25.
- McCallister, D.M., P. Johnson, and R. Kellison. “Involving Agricultural Producers in Efforts to Conserve Irrigation Water While Maintaining Economic Profitability.” 2019 Regional Engaged Scholarship Presentation, April 10, 2019, Lubbock, Texas.

- Ritz, R., C. West, and D. McCallister. "Connecting Agricultural Water Conservation Education from Students to Producers and Consumers." 2019 Regional Engaged Scholarship Presentation, April 10, 2019, Lubbock, Texas.
- McCallister, D. and Phillip Johnson. 2019. "A Fieldprint Calculator Analysis of Resource and Cost Efficiencies in the Southern High Plains." Selected Presentation at the 2019 Beltwide Cotton Conference, New Orleans, Louisiana, January 9-11.
- W. Keeling, K. Lewis, D. McCallister, W. Keeling, P. DeLaune, and J. Burke. 2019. "Economic Comparison of Cover Crop Use in Texas High Plains Cotton." Selected Presentation at the 2019 Beltwide Cotton Conference, New Orleans, Louisiana, January 9-11.
- Pate, J., D. McCallister, and W. Keeling. 2019. "Economic Analysis of Cover Crops in the Southern High Plains." Poster Presentation at the 2019 Beltwide Cotton Conference, New Orleans, Louisiana, January 9-11.

#### *Professional Meetings Attended:*

- Attended the Beltwide Cotton Conference, Jan 8-10, 2019 New Orleans
- Attended the TAWC Water College, Jan 16-17, 2019
- Attended Banker's Conference, Nov 15
- OAP Economics Spring Team Meeting May 3, 2019, Canyon
- Attended the Field to Market Summer Plenary Meeting, Chicago, IL, June 24-26
- Attended the Field to Market Fall Plenary Meeting, Indianapolis, IA, Nov 18-20
- Ogallala Water Cap Annual Meeting, Santa Fe, Nov 28-30
- OAP Economics Fall Team Meeting December 13, 2019, Canyon

#### *Graduate Students:*

- Rebecca McCullough, Ph.D. Student. Department of Agricultural and Applied Economics. Graduated August 2019.
- Yi Chen, Ph.D. Student. Department of Agricultural and Applied Economics. Expected Graduation Date: 2019.
- Lauren Worley, MS student. Department of Agricultural and Applied Economics. Expected Graduation Date: May 2021

### *TASK 5: PLANT WATER USE AND WATER USE EFFICIENCY*

**Annual Report ending February 29, 2020**

**Principal Investigator(s): Drs. Wenxuan Guo and Nithya Rajan (TTU & TAMU)**

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Task 5 has been completed.

### *TASK 6: COMMUNICATIONS AND OUTREACH*

**Annual Report ending February 29, 2020**

**Principal Investigator(s): Samantha Borgstedt, Dr. Steve Frazee, Dr. Rudy Ritz (TTU)**

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#### *Awards*

TAWC Producers Glenn Schur and Eddie Teeter were featured as Field to Market Spotlight Farmers.

Eddie Teeter was presented with the Texas Alliance for Water Conservation Producer Appreciation Award.

TAWC was selected to be a part of the 2019 Regional Engaged Scholarship Symposium held April 10 at Texas Tech University. The theme this year was “The Future of Higher Education: Redesigning Teaching, Research, and Service to Remain Relevant.” Dr. Meyers and Ritz joined several TAWC team members presenting about the TAWC project to attendees.

TAWC was selected to be included in the Texas Tech University President's Address to the university for outstanding research.

TAWC was selected to be a presenter at the High Plains Journal's Cotton U meeting held at the Amarillo Farm and Ranch Show. Cooperating consultant Jeff Miller was available to present on behalf of the TAWC at the event. He demonstrated technologies, management and results from cooperating producer Lloyd Arthur's irrigated fields in Ralls, Texas.

#### *Trade Shows, Meetings and Events Attended*

TAWC Water College - Lubbock, Texas - January 2019

Texas Soil Symposium - Lubbock, Texas - February 2019

Texas Cotton Ginners' Conference - Lubbock Civic Center - Lubbock, Texas - April 2019

Texas Tech University Earth Day – Texas Tech Campus, Lubbock, TX - April 2019  
TAWC Pasture Walk – New Deal, TX – July 2019  
Texas Wildlife Association's Annual Conference - JW Marriot in San Antonio - July 2019  
TAWC Field Day – Muncy, TX - September 2019  
Texas Tech Agricultural and Applied Economics' Bankers' Conference - Texas Tech International Cultural Center -Lubbock, Texas - November 2019  
Amarillo Farm and Ranch Show – Amarillo Civic Center – December 2019  
Cotton U – Amarillo Civic Center – December 2019

### **TAWC Field Day, and Field Tours**

TAWC hosted its 14th Annual TAWC Field Day on Thursday, September 12, from 8:00am to 2:00pm at the Floyd Co. Unity Center located in Muncy, Texas. This event was free of charge and lunch was served. CEUs were offered: 4 CCA and 3 TDA. Approximately 75 producers, researchers and industry attended. Nine industry vendors set up display/information booths. The event was live broadcasted on KFLP 900AM with presentation recordings later being aired on the station and posted on their website.

Presentations included:

- Producer Perspective: Water Management Efficiency Technologies & Cotton Sustainability
- Balancing Conservation & Property Rights: Groundwater Law & Policy Update
- Grazing Options for Rainfed and Reduced Irrigation Scenarios
- Policy Changes, Trade Wars, and Markets
- Upcoming Weather Trends and Conditions
- Texas Water Development Board Update
- Incorporating New Technologies into On Farm Research: Is this a game changer?

Preparations were made for promotion and organization of a Pasture Walk in which Dr. Chuck West and his collaborators lead an easy walk through five kinds of pastures, showing different options for grasses and legumes that work well in the region. Discussion included grazing alfalfa, efficient use of water, native and introduced grasses, methane emissions from cattle, and building soil health.

The TAWC along with Flying Y Farms hosted a kids' farm tour showing urban kids where and how their food and fiber is grown. Topics included soil health, water conservation, and seasonal growing. The 27 kids in attendance were able to plant their own seed to take home, take a tour of the farm, visualize how food is grown and watered, and eat a meal prepared with produce and eggs from the farm.

We were honored to host Indigo Ag as they visited with the TAWC about area producers' water management efforts and needs. We toured the through cooperating producers' fields

and showed those in Indigo's group the technologies and management practices being done on TAWC research field sites.

### *Outreach Materials*

Borgstedt worked with the CASNR development office to create a handout describing the TAWC project which can be used for outreach efforts. This general overview of the project is full of pictures, history and information about the project and will be used by both TAWC management team members and the CASNR development office.

USB drives were created with TAWC and TWDB logos and websites on them. These are distributed at our TAWC events.

The Water College website, [www.tawcwatercollege.com](http://www.tawcwatercollege.com), was updated with meeting details, agenda, and speaker bios.

### *2019 Water College*

TAWC Water College was held on January 24 at the Lubbock Memorial Civic Center in Lubbock Texas. This was attended by approximately 250 participants and 30 sponsor booths. Presentations from Water College were made available on TAWC's websites the day after Water College.

Press Release was sent out by Texas Tech's College of Agricultural Sciences and Natural Resources for Water College. Radio ads began to play on KFLP, KDHN and KGNC. We also had live interviews with these radio stations. Email blasts and social media campaigns were sent every week of January prior to Water College to our email members, Facebook, and twitter followers.

Water College was live broadcasted by KFLP radio with excerpts of presentations being played during broadcasts afterwards (reaching approx. 2,000 listeners per broadcast).

### *Graduate Student Assistants*

Maggie Elliot held a research study with attendees of the TAWC Water College to collect data regarding the social, ecological, and economic attributes of the idea of "sustainability." She later visited producers within the TAWC project area to better understand how they define 'sustainable agriculture'.

Maggie Elliot received the 2019 Outstanding Research Proposal at the Association for Communication Excellence (ACE) Conference in San Antonio, Texas. Maggie's research focused on exploring perceptions of sustainable textiles among producers and consumers. She is interested in defining the priorities of these two groups, and assessing how people rank statements regarding the social, ecological, and economic attributes of the idea of "sustainability."

TAWC graduate student Maggie Elliot successfully defended her thesis - Perceptions of Sustainable Textiles: A Q Methodological Approach.

### **2019 Social Media**

- 125 YouTube videos
  - 47 TAWC broadcasts on KFLP All Ag All Day
- Field Talk reaches around 2000 Class 1 farmers (those that make more than \$40,000 per year from agriculture) per airing according to AG Media Research's last survey.
- 12 electronic newsletters using MailChimp
  - 791 Facebook followers
  - 913 Twitter followers
  - 27 live Radio Appearances (KFLP, KKYN, KFLP and Fox Talk 950)

### **2019 Popular Press**

Research into water use, integration of crops, livestock - Texas Farm Bureau News, October 2019

CASNR researchers focus on improving Ogallala Aquifer water use efficiency - CASNR News Center, October 9, 2019

Purpose at Work: How Wrangler Is Creating the Next Generation of Sustainable Fashion - Sustainable Brands, October 9, 2019

Agricultural economics plays role in developing sustainable High Plains - High Plains Journal, July 10, 2019

Fountainhead Newsletter - 2nd Quarter 2019, published by the Texas Ground Water Association

Producers, researchers exploring ways to conserve Ogallala Aquifer - Lubbock A-J, June 23, 2019

Researchers in several departments within Texas Tech's College of Agricultural Sciences and Natural Resources work together to address big issues related to water. Special thanks to Texas Tech's Ag Communications Department and Dr. Darren Hudson for the collaboration of this video. <https://www.youtube.com/watch?reload=9&v=6yfNmtsrgPQ>

Students learn water efficiency with new CASNR program - Daily Toreador, April 17, 2019

Purpose at Work: How Wrangler Is Creating the Next Generation Of Sustainable Fashion - Forbes, April 16, 2019

Grow More Lint with Less Water - Progressive Farmer, March 2019

The Performance of Cover Crops in Minimally Tilled Forage-based Grazing Systems - High Plains Water Conservation Bulletin No. 12

Integrating Legumes with Grass to Improve Forage-Livestock Systems - High Plains Water Conservation Bulletin No. 13

National Wind Institute's West Texas Mesonet App Releases Updated, Enhanced Version. The app, available for Apple or Android devices, provides precise weather and agricultural information 24/7, and so much more. - Texas Tech Today, February 8, 2019

Local Muleshoe Resident to speak at the 2nd Annual Soil Health Symposium – Muleshoe journal, January 16, 2019

TAWC hosts its 5th annual Water College - Southwest Farm Press, January 18, 2019  
TTU's CASNR develops new agricultural water management certificate program - Everything Lubbock, January 10, 2019

#### *TASK 7: PRODUCER ASSESSMENT OF OPERATION*

**Annual Report ending February 29, 2020**

**Principal Investigator: Dr. Nithya Rajan (TAMU, AgriLife Research)**

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Task 7 has been completed.

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

**Annual Report ending February 29, 2020**

**Principal Investigators: Dr. Chuck West, Mr. Philip Brown (TTU)**

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The second year of a livestock grazing study was carried out at the Texas Tech New Deal research facility to generate data to be used in publications, outreach presentations, and field tours, all related to testing and demonstrating the role of forages grown for cattle as an alternative economic enterprise to annual cash crops to conserve water from the Ogallala Aquifer. The grazing trial, part of Kathryn Radicke's graduate research, compared old world bluestem pastures either with alfalfa and not receiving nitrogen fertilizer vs. bluestem with no alfalfa but receiving 60 lbs./acre of nitrogen each spring. The measurements were on steer liveweight gain, water use efficiency of forage and beef growth, and release of methane by cattle. Averaged over 2018 and 2019, the average daily gain of cattle on the alfalfa-grass treatment was 2.40 lb, while that of cattle on grass with N fertilizer was 1.95 lb. The amount of methane released per steer per day was slightly less in the alfalfa-grass pastures than in the grass pastures, and water use was the same between pasture treatment. This means that including alfalfa in the pasture made more efficient use of water for beef production, more economical beef production, and less methane production.

Work continued in our association with the USDA-NIFA funded Ogallala Coordinated Agriculture Project. The federally funded project ([www.ogallalawater.org](http://www.ogallalawater.org)) involves eight states and the USDA-ARS in the Great Plains of the U.S. The involvement of TAWC in the NIFA project consists of 1) analyzing data to test the degree to which new irrigation practices can improve crop water use efficiency and maintain profitability, and 2) extending the audience of TAWC field days and water college beyond the South Plains of Texas. In collaboration with Dr. Donna McCallister (Task 4), we conducted a meta-analysis of irrigation technologies for cotton, corn, grain sorghum, and wheat. Irrigation with pivot and subsurface drip systems resulted in the greatest and most consistent increases in water use efficiency in cotton and sorghum crops and least beneficial in wheat.

Chuck West and his graduate students presented a number of talks locally and nationally on strategies of irrigation water conservation being promoted by TAWC, and benefits of diversifying the South Plains cropping systems with high quality forages for beef production as a low-water-input method of sustaining agricultural productivity. Dr. West summarized this work for producers and irrigation service providers at the September 12 TAWC Field Day.

**Grants Funded:**

USDA-SARE. C. West. Long term agroecosystems research and adoption in the Texas Southern High Plains. \$100,000. This is a renewal grant for pasture research at the New Deal Research Field Station.



USDA-NIFA-AFRI. C. West and D. Mitchell McAlister in collaboration with 40 scientists from 8 universities and the USDA-ARS. Sustaining agriculture through adaptive management to preserve the Ogallala Aquifer. \$118,230 is the Texas Tech portion of a \$2.5 million grant in 2019, and \$75,633 in 2020.

**Presentations:**

West, C.P. 2019. Grazing options for rainfed and reduced irrigation scenarios. 2019. TAWC Annual Field Day, Sep. 12, Muncie, TX.

West, C.P., and D.M. McCallister. 2019. Irrigation technologies with potential to improve water use efficiency. Symposium: Managing Limited Water Resources In A Changing Climate. 10-13 Nov. American Society of Agronomy annual meeting, San Antonio, TX.

Kharel, G., S. Deb, C. West, and L. Slaughter. 2019. Evaluation of thermal conductivity models for semiarid pasture soils. 6-9 Jan. Annual Meetings Abstracts, Soil Science Society of America, Madison, WI.

Neupane, Jasmine, W. Guo, A. Raihan, Z. Lin, Y. Sun, C. West, and F. Zhang. 2019. Influence of soil physical properties and topography on cotton yield under different irrigation rates. Texas Tech University Graduate Student Research Poster Competition. 26 March.

West, C.P. 2019. Water decline and climatic stress impacts agricultural land use in the Texas High Plains. Symposium on After Design: Monitoring and Managing the Texas Landscape. Texas Tech University. 4-5 April.

Ritz, R., D.M. McCallister, and C. West. 2019. Connecting agricultural water conservation education from students to producers and consumers. April 10, Texas Tech University. Regional Engaged Scholarship Symposium.

Dhakal, M., C.P. West, S.K. Deb, C. Villalobos, and G. Kharel. 2019. Trade-off between forage quality improvement and crop water use for alfalfa-grass system. 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.

West, C.P., and D.M. McCallister. 2019. Irrigation technologies with potential to improve water use efficiency. 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.

Hayhoe, Katharine, Anne Stoner, and C.P. West. 2019. High-resolution climate projections for agriculture and water management. 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.

Bhattarai, B., S. Singh, C.P. West, C.L. Trostle, and G.L. Ritchie. 2019. Forage sorghum, pearl millet, and corn physiology, nutrient content, and yield under deficit irrigation. 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.

Bhattarai, B., S. Singh, C.P. West, C.L. Trostle, and G.L. Ritchie. 2019. Soil water depletion patterns and water use efficiency of forage sorghum, pearl millet, and corn under deficit irrigation. 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.

Lin, Zhe, W. Guo, Y. Sun, C.P. West, and F. Jin. 2019. Unmanned aerial systems and crop modeling for irrigation scheduling in the Southern High Plains. 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.

Radicke, Kathryn, C.P. West, and D.D. Henry. 2019. Can alfalfa in mixture with grass reduce enteric methane emissions from cattle on pasture? 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.

Radicke, Kathryn, J. Ning, C.P. West, and C.P. Brown. 2019. Assessment of drone image analysis of legume cover in pastures in relation to ground assessment. 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.

Radicke, K.L., L. Slaughter, C.P. West, B.J. Petermann, D.D. Henry. 2020. Soil health relations with greenhouse gas emissions in semi-arid pastures. Proc. American Forage Grassl. Council. 5-8 January, Greenville, SC.

### **Publications:**

Xiong, Yedan., C.P. West, C.P. Brown, and P.E. Green. 2019. Digital image analysis of old world bluestem cover to estimate canopy development. *Agron. J.* 111:1247-1253. doi:10.2134/agronj2018.08.0502

Dhakal, M., C.P. West, S.K. Deb, G. Kharel, and G.L. Ritchie. 2019. Field calibration of PR2 capacitance probe in Pullman clay-loam soil of Southern High Plains. *Agrosyst. Geosci. Environ.* 2:1-7. doi:10.2134/age2018.10.0043

Bhandari, K.B., C.P. West, D. Klein, and S. Subbiah. 2019. Essential oil composition of 'WW-B.Dahl' old world bluestem [*Bothriochloa bladhii*] grown in the Texas High Plains. *Industrial Crops Products* 133:1-9. doi:10.1016/j.indcrop.2019.03.013

Dhakal, M., C.P. West, and C. Villalobos. 2019. Establishment and stand development of alfalfa interseeded into native grass mixture: Cultivar and row spacing effects. *Crop Sci.* 59:2271-2279. doi:10.2135/cropsci2019.03.0156

Bhattarai, Bishwoyog, S. Singh, C.P. West, and R. Saini. 2019. Forage potential of pearl millet and forage sorghum alternate to corn in water limiting condition of Texas High Plains - A review. *Crop Forage Turf Management* 5:190058. doi:10.2134/cftm2019.08.0058

Dhakal, M., C.P. West, S.K. Deb, C. Villalobos, and G. Kharel. 2020. Row spacing of alfalfa interseeded into native grass pasture influences soil-plant-water relations. *Agron. J.* 112:274-287. doi:10.1002/agj2.20012

Bhandari, Krishna, C.P. West, and V. Acosta-Martinez. 2020. Assessing the role of interseeding alfalfa into grass on improving pasture soil health in semi-arid Texas High Plains. Appl. Soil Ecol. 147: Article 103399. doi:10.1016/j.apsoil.2019.103399

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

**Annual Report ending February 29, 2020**

**Principal Investigator(s): Jason Coleman and Keith Whitworth (HPWCD #1)**

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### **9.1 Equipment Procurement & Installation**

- No new equipment purchased or installed.

### **9.2 Data Collection and Processing**

- Daily rainfall was collected using tipping bucket rain gauges with Hobo data loggers.
- Daily rainfall can be seen on the HPWD.org website for 2017, 2018 and 2019.
- Daily rainfall graphed for each rain gauge.
- Daily water levels were collected with the use of pressure transducers.
- The 2019 daily water levels were added to the previous year's data, and published on the HPWD website.
- 2019 daily water levels added to previous years and graphed.
- Annual saturated thickness volume was calculated and compared to previous years.
- All equipment was monitored regularly, and maintenance preformed if needed.



<http://www.tawcsolutions.org>

## TAWC Solutions: Management tools to aid producers in conserving water

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*Rick Kellison, Jeff Pate, Philip Brown (TTU, TAMU, TTU)*

The **Texas Alliance for Water Conservation** released three web-based tools to aid producers at our February 2011 field day. Producers involved in the TAWC project had indicated the need for tools to aid them in making cropping decisions and managing these crops in season.

The **Irrigation Scheduler** is a field level, crop specific ET tool to aid producers in irrigation management. The producer can customize this tool for beginning soil moisture, effective rainfall, effective irrigation application and percent ET replacement. Users can select from a list of local weather stations that supplies the correct weather information for each field. Once the decision is made on which crop a grower plants, this tool produces an in-season, check-book style water balance output to aid in irrigation applications.

The **TAWC Resource Allocation Analyzer** provide producers with a simple, comprehensive approach to planning and managing various cropping systems. The Resource Allocation Tool is an economic based optimization model that aids producers in making decisions about different cropping systems. Based on available irrigation water, projected cost of production and expected revenue, this model will aid producers in their decisions to plant various crops.

Because of implementation of new water policy by the High Plains Underground Water Conservation District, growers need a method to determine the amount of irrigation that they were allowed to apply to each irrigated acre. The **Contiguous Acre Calculator** allows growers to project specific levels of irrigation water to be applied to various delivery systems. The tool then calculates how much water can be banked for future use. Once the growing season is completed the producer can enter actual water applied and use it for record keeping.

The **Basic Irrigation Calculator** aids producers in determining the length of time required to apply a specific amount of water by calculating the number of minutes, hours and days required to pump based on the well GPM and the number of acres being applied.

The **Contiguous Acre Calculator** was developed to aid a producer in determining the total allowable amount of irrigation water in inches that could be pumped as established by water policy from the High Plains Underground Water Conservation District.

The **Heat Unit Calculator** was developed to aid a producer in determining the total heat unit accumulation for both corn and cotton. Available sites to select from include: Amarillo, Lamesa, Lubbock, and Plainview. A cumulative heat unit calculator is provided to calculate cumulative heat units for the desired time-period.

In 2019, a Heat Unit Calculator was added to the IOS app version of the Texas Tech West Texas Mesonet (WTM) weather app in a cooperative effort between TAWC, WTM, and Plains Cotton Growers. The intent was to increase both function and coverage area available through the vast array of selectable stations on the WTM.

The **Cotton Water Use Tracker** is a generalized table provided as an estimate for water use for cotton based on weather data from the Plainview weather station from the West Texas Mesonet and an average planting date. This is not intended to replace the Irrigation Scheduling Tool but is merely intended as a quick reference for daily cotton water use.

As we move forward, we continually seek user input by providing both demonstration of new technologies and the development of new web-based decision-aid tools. These tools and demonstrations deal with our declining water resources by providing alternative management strategies and decision aids with which our producers can make better informed decisions that fit their individual needs.



We would also like to acknowledge our relationship with the Texas Tech West Texas Mesonet and appreciate their invaluable contribution of weather data which enables our ability to provide these tools at no cost to our agricultural producers.

*More detail concerning each individual program is provided on our website and in previous annual reports.*

## **2019 SUPPLEMENTARY GRANTS TO PROJECT (SEE APPENDIX FOR 2005-2018 DATA)**

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Supplementary grants and grant requests were obtained or attempted through leveraging of the base platform of TAWC and the Texas Coalition for Sustainable Integrated Systems (TeCSIS), and therefore represent added value to the overall TAWC effort.

- USDA-SARE. C. West. Long term agroecosystems research and adoption in the Texas Southern High Plains. \$100,000. This is a renewal grant for pasture research at the New Deal Research Field Station.
- USDA-NIFA-AFRI. C. West and D. Mitchell McAlister in collaboration with 40 scientists from 8 universities and the USDA-ARS. Sustaining agriculture through adaptive management to preserve the Ogallala Aquifer. \$118,230 is the Texas Tech portion of a \$2.5 million grant in 2019, and \$75,633 in 2020.
- Application of the Fieldprint Calculator for Cotton Production in the Texas High Plains. Funded by the Cotton Foundation (7/14-8/19, \$36,000). PI's – Phillip Johnson and Donna McCallister. The objective of this project is to evaluate cotton production sites in the TAWC project with regard to their sustainability as measured by the Fieldprint Calculator.
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- Co-PI. 2018-2019. USDA ARS OAP. "Economic Viability and Soil Health Sustainability Concerning the Use of Brackish Dockum Aquifer Irrigation Water for Crop Agriculture." PI's: Nathan Howell. Total Amount: \$39,000
- Economic and Policy Implications of Underground Water Use in the Southern Ogallala Region. Co-PI: Donna McCallister. 2017-2019. USDA ARS Ogallala Aquifer Program. Amount: \$45,000.
- Evaluation of Soil Conservation Practices and Integrated Advanced Irrigation Technologies on Soil Health and Water Use Efficiency. Co-PI: Donna McCallister. 2017-2019. Texas Corn Producers Board. Amount: \$36,324.
- Economic and Policy Implications of Underground Water Use in the Southern Ogallala Region. Co-PI: Donna McCallister. 2016-2018. USDA ARS Ogallala Aquifer Program. Amount: \$45,000.

**2019 DONATIONS TO PROJECT (SEE APPENDIX FOR 2005-2018 DATA)**

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***TAWC Water College, Field Day, Field Walk Sponsors***

Ag Workers Insurance	\$ 500
Alpha Capital Strategies	\$ 500
AquaSpy	\$ 500
City of Lubbock	\$ 500
City Bank	\$ 200
Cotton Inc	\$ 2,000
Diversity D	\$ 1,000
Eco-Drip	\$ 500
Equipment Supply	\$ 500
High Plains Water District	\$ 500
Hurst Farm Supply	\$ 500
Lindsay Zimmatic	\$ 500
Lindsay	\$ 500
Ogallala CAP Project	\$ 500
Pioneer Seed	\$ 2,000
Plains Cotton Growers	\$ 500
Prairie View A&M	\$ 500
South Plains Valley Irrigation	\$ 500
T-L Irrigation Company	\$ 500
Texas Ag Irrigation Assoc	\$ 500
Texas Corn Producers	\$ 1,000
Texas Sorghum Producers	\$ 200
Ag Workers Insurance	\$ 500
Total	\$14,400

**2019 VISITORS TO THE DEMONSTRATION PROJECT SITES, FIELD WALKS, FIELD DAYS, AND  
WATER COLLEGE OUTREACH EVENTS  
(SEE APPENDIX FOR 2005-2018 DATA)**

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Total Number of Visitors

500+

## 2019 PRESENTATIONS (SEE APPENDIX FOR 2005-2018 DATA)

<b>Date</b>	<b>Presentation</b>	<b>Spokesperson(s)</b>
07-25-2019	Indigo Presentation Overton Hotel-Lubbock, Texas	R. Kellison
07-26-2019	Indigo Field Tour Plainview & Lorenzo	R. Kellison, & P. Brown
02-25-2020	Texas Southwestern Cattle Raisers Association Field Tour	R. Kellison
02-25-2020	Texas Monthly Field Tour	R. Kellison

### Formal Presentations:

- McCallister, D.M. and M. Parajulee. 2019. "The Role of IPM in Farm Sustainability." American Chemical Society Fall 2019 National Meeting and Expo, San Diego, CA, August 25.
- McCallister, D.M., P. Johnson, and R. Kellison. "Involving Agricultural Producers in Efforts to Conserve Irrigation Water While Maintaining Economic Profitability." 2019 Regional Engaged Scholarship Presentation, April 10, 2019, Lubbock, Texas.
- Ritz, R., C. West, and D. McCallister. "Connecting Agricultural Water Conservation Education from Students to Producers and Consumers." 2019 Regional Engaged Scholarship Presentation, April 10, 2019, Lubbock, Texas.
- McCallister, D. and Phillip Johnson. 2019. "A Fieldprint Calculator Analysis of Resource and Cost Efficiencies in the Southern High Plains." Selected Presentation at the 2019 Beltwide Cotton Conference, New Orleans, Louisiana, January 9-11.
- W. Keeling, K. Lewis, D. McCallister, W. Keeling, P. DeLaune, and J. Burke. 2019. "Economic Comparison of Cover Crop Use in Texas High Plains Cotton." Selected Presentation at the 2019 Beltwide Cotton Conference, New Orleans, Louisiana, January 9-11.
- Pate, J., D. McCallister, and W. Keeling. 2019. "Economic Analysis of Cover Crops in the Southern High Plains." Poster Presentation at the 2019 Beltwide Cotton Conference, New Orleans, Louisiana, January 9-11.
- West, C.P. 2019. Grazing options for rainfed and reduced irrigation scenarios. 2019. TAWC Annual Field Day, Sep. 12, Muncie, TX.



- West, C.P., and D.M. McCallister. 2019. Irrigation technologies with potential to improve water use efficiency. Symposium: Managing Limited Water Resources In A Changing Climate. 10-13 Nov. American Society of Agronomy annual meeting, San Antonio, TX.
- Kharel, G., S. Deb, C. West, and L. Slaughter. 2019. Evaluation of thermal conductivity models for semiarid pasture soils. 6-9 Jan. Annual Meetings Abstracts, Soil Science Society of America, Madison, WI.
- Neupane, Jasmine, W. Guo, A. Raihan, Z. Lin, Y. Sun, C. West, and F. Zhang. 2019. Influence of soil physical properties and topography on cotton yield under different irrigation rates. Texas Tech University Graduate Student Research Poster Competition. 26 March.
- West, C.P. 2019. Water decline and climatic stress impacts agricultural land use in the Texas High Plains. Symposium on After Design: Monitoring and Managing the Texas Landscape. Texas Tech University. 4-5 April.
- Ritz, R., D.M. McCallister, and C. West. 2019. Connecting agricultural water conservation education from students to producers and consumers. April 10, Texas Tech University. Regional Engaged Scholarship Symposium.
- Dhakal, M., C.P. West, S.K. Deb, C. Villalobos, and G. Kharel. 2019. Trade-off between forage quality improvement and crop water use for alfalfa-grass system. 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.
- West, C.P., and D.M. McCallister. 2019. Irrigation technologies with potential to improve water use efficiency. 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.
- Hayhoe, Katharine, Anne Stoner, and C.P. West. 2019. High-resolution climate projections for agriculture and water management. 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.
- Bhattarai, B., S. Singh, C.P. West, C.L. Trostle, and G.L. Ritchie. 2019. Forage sorghum, pearl millet, and corn physiology, nutrient content, and yield under deficit irrigation. 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.
- Bhattarai, B., S. Singh, C.P. West, C.L. Trostle, and G.L. Ritchie. 2019. Soil water depletion patterns and water use efficiency of forage sorghum, pearl millet, and corn under deficit irrigation. 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.

- Lin, Zhe, W. Guo, Y. Sun, C.P. West, and F. Jin. 2019. Unmanned aerial systems and crop modeling for irrigation scheduling in the Southern High Plains. 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.
- Radicke, Kathryn, C.P. West, and D.D. Henry. 2019. Can alfalfa in mixture with grass reduce enteric methane emissions from cattle on pasture? 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.
- Radicke, Kathryn, J. Ning, C.P. West, and C.P. Brown. 2019. Assessment of drone image analysis of legume cover in pastures in relation to ground assessment. 10-13 Nov., San Antonio, Annual Meetings Abstracts, ASA-CSSA-SSSA, Madison, WI.
- Radicke, K.L., L. Slaughter, C.P. West, B.J. Petermann, D.D. Henry. 2020. Soil health relations with greenhouse gas emissions in semi-arid pastures. Proc. American Forage Grassl. Council. 5-8 January, Greenville, SC.

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#### **2019 RELATED NON-REFEREED PUBLICATIONS (SEE APPENDIX FOR 2005-2018 DATA)**

None

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#### **2019 RELATED REFEREED JOURNAL ARTICLES (SEE APPENDIX FOR 2005-2018 DATA)**

- Mitchell-McCallister, D.M., A. Cano, C. West. "Meta-Analysis of Water Use Efficiency in Deficit Irrigation Systems." Irrigation Science, under review.
- Mitchell-McCallister, D.M., R.B. Williams, J. Bordovsky, J. Mustian, G. Ritchie, and K. Lewis. 2020. "Maximizing profits via irrigation timing for capacity-constrained cotton production." Ag Water Management, 229:1-8.
- D. Rudnick, S. Irmak, C. West, J.L. Chavez, I. Kisekka, T.H. Marek, J. Schneekloth, D. Mitchell McCallister, V. Sharma, K. Djaman, J. Aguilar, M.E. Schipanski, D.H. Rogers, and A. Schlegel. 2019. "Deficit Irrigation of Maize in the High Plains Aquifer Region: A Review." Journal of the American Water Resources Association, 1-18(35). doi: 10.1111/1752-1688.12723.
- Xiong, Yedan., C.P. West, C.P. Brown, and P.E. Green. 2019. Digital image analysis of old world bluestem cover to estimate canopy development. Agron. J. 111:1247-1253. doi:10.2134/agronj2018.08.0502

- Dhakal, M., C.P. West, S.K. Deb, G. Kharel, and G.L. Ritchie. 2019. Field calibration of PR2 capacitance probe in Pullman clay-loam soil of Southern High Plains. *Agrosyst. Geosci. Environ.* 2:1-7. doi:10.2134/age2018.10.0043
- Bhandari, K.B., C.P. West, D. Klein, and S. Subbiah. 2019. Essential oil composition of 'WW-B.Dahl' old world bluestem [*Bothriochloa bladhii*] grown in the Texas High Plains. *Industrial Crops Products* 133:1-9. doi:10.1016/j.indcrop.2019.03.013
- Dhakal, M., C.P. West, and C. Villalobos. 2019. Establishment and stand development of alfalfa interseeded into native grass mixture: Cultivar and row spacing effects. *Crop Sci.* 59:2271-2279. doi:10.2135/cropsci2019.03.0156
- Bhattarai, Bishwoyog, S. Singh, C.P. West, and R. Saini. 2019. Forage potential of pearl millet and forage sorghum alternate to corn in water limiting condition of Texas High Plains - A review. *Crop Forage Turf Management* 5:190058. doi:10.2134/cftm2019.08.0058
- Dhakal, M., C.P. West, S.K. Deb, C. Villalobos, and G. Kharel. 2020. Row spacing of alfalfa interseeded into native grass pasture influences soil-plant-water relations. *Agron. J.* 112:274-287. doi:10.1002/agj2.20012
- Bhandari, Krishna, C.P. West, and V. Acosta-Martinez. 2020. Assessing the role of interseeding alfalfa into grass on improving pasture soil health in semi-arid Texas High Plains. *Appl. Soil Ecol.* 147: Article 103399. doi:10.1016/j.apsoil.2019.103399

## 2019 POPULAR PRESS (SEE APPENDIX FOR 2005-2018 DATA)

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- Research into water use, integration of crops, livestock - Texas Farm Bureau News, October 2019
- CASNR researchers focus on improving Ogallala Aquifer water use efficiency - CASNR News Center, October 9, 2019
- Purpose at Work: How Wrangler Is Creating the Next Generation of Sustainable Fashion - Sustainable Brands, October 9, 2019
- Agricultural economics plays role in developing sustainable High Plains - High Plains Journal, July 10, 2019
- Fountainhead Newsletter - 2nd Quarter 2019, published by the Texas Ground Water Association
- Producers, researchers exploring ways to conserve Ogallala Aquifer - Lubbock A-J, June 23, 2019

- Researchers in several departments within Texas Tech's College of Agricultural Sciences and Natural Resources work together to address big issues related to water. Special thanks to Texas Tech's Ag Communications Department and Dr. Darren Hudson for the collaboration of this video. <https://www.youtube.com/watch?reload=9&v=6yfNmtsrgPQ>
- Students learn water efficiency with new CASNR program - Daily Toreador, April 17, 2019
- Purpose at Work: How Wrangler Is Creating the Next Generation Of Sustainable Fashion - Forbes, April 16, 2019
- Grow More Lint with Less Water - Progressive Farmer, March 2019
- The Performance of Cover Crops in Minimally Tilled Forage-based Grazing Systems - High Plains Water Conservation Bulletin No. 12
- Integrating Legumes with Grass to Improve Forage-Livestock Systems - High Plains Water Conservation Bulletin No. 13
- National Wind Institute's West Texas Mesonet App Releases Updated, Enhanced Version. The app, available for Apple or Android devices, provides precise weather and agricultural information 24/7, and so much more. - Texas Tech Today, February 8, 2019
- Local Muleshoe Resident to speak at the 2nd Annual Soil Health Symposium - Muleshoe Journal, January 16, 2019
- TAWC hosts its 5th annual Water College - Southwest Farm Press, January 18, 2019
- TTU's CASNR develops new agricultural water management certificate program - Everything Lubbock, January 10, 2019

## **2019 THESIS AND DISSERTATIONS (SEE APPENDIX FOR 2005-2018 DATA)**

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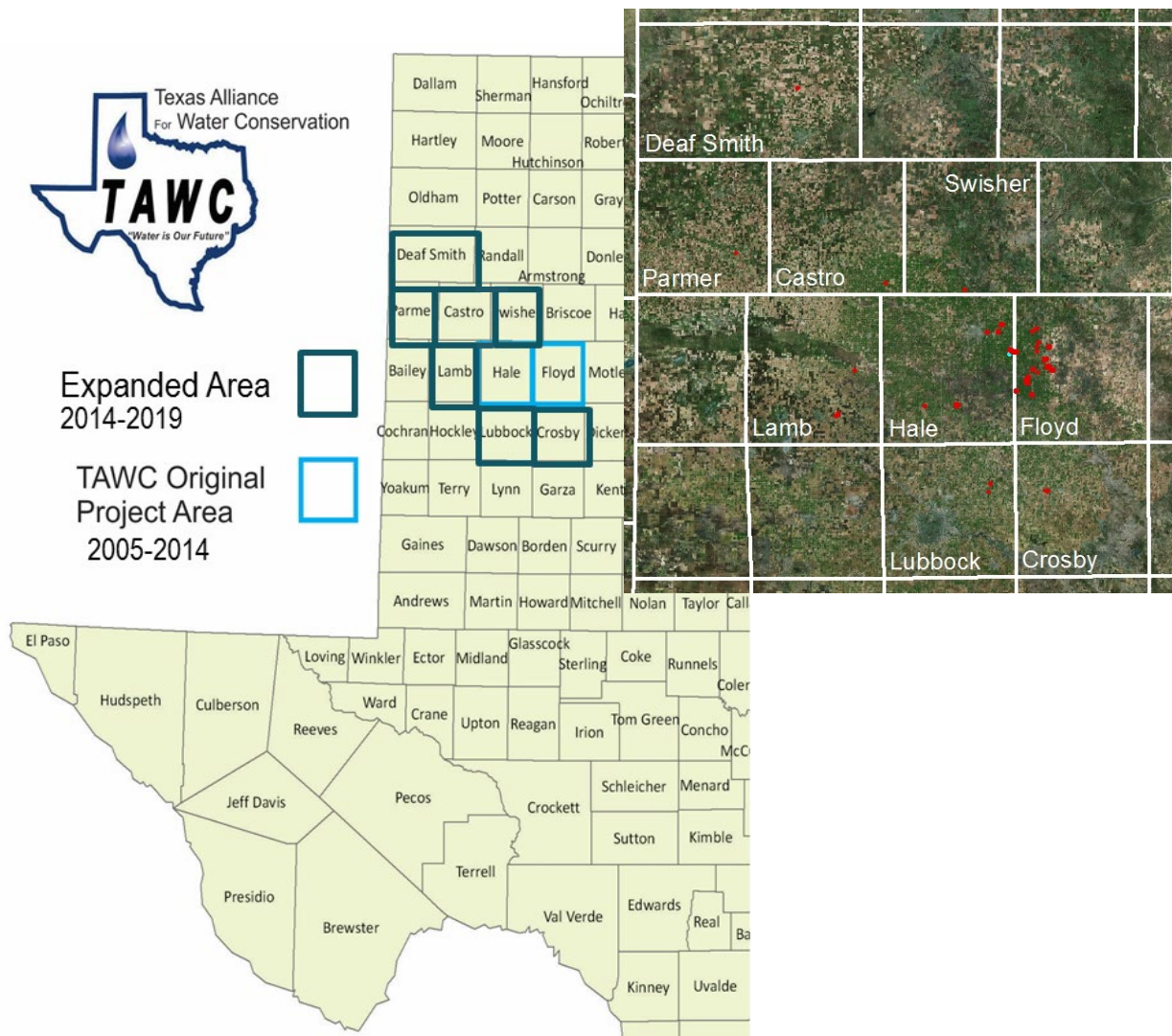
- Rebecca McCullough, Ph.D. Student. Department of Agricultural and Applied Economics. Graduated August 2019.
- Yi Chen, Ph.D. Student. Department of Agricultural and Applied Economics. Expected Graduation Date: 2019.
- Maggie Elliot, M.S. Student. Department of Agricultural Education and Communications. Perceptions of Sustainable Textiles: A Q Methodological Approach. Graduated December 2019.

## Phase II – Budget\*

**Table 13.** Task and expense budget for Phase II Year 1-6 of the demonstration project.

TWDB # 1413581688		Year 1 (10/17/13 - 02/28/15)	Year 2 (03/01/15 - 02/29/16)	Year 3 (03/01/16 - 02/28/17)	Year 4 (03/01/17 - 02/28/18)	Year 5 (03/01/18 - 02/28/19)	Year 6 (03/01/19 - 02/29/20)	
Task Budget	Task Budget*							Total Expenses
1								
2	\$1,148,395.00	135,179.51	254,325.38	276,943.98	276,429.93	232,507.21	216,692.01	1,392,078.02
3	\$571,806.00	19,180.57	79,957.17	102,051.66	65,572.52	66,258.92	87,219.31	420,240.15
4	\$469,978.00	39,467.89	47,127.42	38,833.02	55,276.58	75,767.41	67,253.51	323,725.83
5	\$360,708.00	110,849.99	82,061.04	9,547.54	62,586.64	0	0	265,045.21
6	\$582,645.00	50,867.54	110,592.85	86,776.22	96,114.08	35,479.93	30,019.88	409,850.60
7	\$27,048.00	3,000.00	6,134.03	18,539.39	0	118,987.22	107,123.94	253,784.58
8	\$181,110.00	6,671.70	25,277.96	25,184.96	14,373.65	20,493.43	0	92,001.70
9	\$258,310.00	27,058.73	14,607.22	30,578.68	24,027.33	50,414.35	3,191.13	149,877.44
<b>TOTAL</b>	<b>\$3,600,000.00</b>	<b>392,275.93</b>	<b>620,083.07</b>	<b>588,455.45</b>	<b>594,380.73</b>	<b>599,908.47</b>	<b>511,499.88</b>	<b>3,306,603.53</b>
		Year 1 (10/17/13 - 02/28/15)	Year 2 (03/01/15 - 02/29/16)	Year 3 (03/01/16 - 02/28/17)	Year 4 (03/01/17 - 02/28/18)	Year 5 (03/01/18 - 02/28/19)	Year 6 (03/01/19 - 02/29/20)	
Expense Budget	Total Budget*							Total Expenses
Salary and Wages +2%/yr	\$1,545,882.00	196,610.27	307,839.14	220,883.72	268,119.75	308,801.08	284,193.51	1,586,447.47
Fringe	\$229,910.00	30,751.67	48,664.72	30,891.06	35,696.90	38,113.88	39,031.30	223,149.53
Travel	\$106,151.00	16,152.68	24,991.40	20,933.30	21,001.11	21,467.71	15,906.27	120,452.47
Other Operating Expenses (inc. materials & supplies)	\$130,023.00	14,249.11	16,871.15	18,085.91	27,677.79	11,192.73	5,542.26	93,618.95
Capital Equipment	\$76,000.00	58,070.86	0	0	18,789.30	0	0	76,860.16
Subcontract Services	\$857,164.00	49,239.30	105,048.42	199,169.73	104,599.85	125,673.27	96,410.44	680,141.01
Technical/Hardware /Software	\$238,033.00	0.00	69,944.98	27,634.67	49,389.60	24,810.03	19,602.01	191,381.29
Tuition and Fees	\$111,337.00	7,578.05	12,123.75	23,160.74	40,027.24	39,910.35	24,335.00	147,135.13
Other Expenses (Insurance: auto, medical)	\$305,500.00	19,623.99	34,599.51	47,696.32	29,079.19	29,939.42	26,479.09	187,417.52
<b>TOTAL</b>	<b>\$3,600,000.00</b>	<b>392,275.93</b>	<b>620,083.07</b>	<b>588,455.45</b>	<b>594,380.73</b>	<b>599,908.47</b>	<b>511,499.88</b>	<b>3,306,603.53</b>

\*Numbers may not match final budget expenses exactly. TTU Accounting Services responsible for final submissions to TWDB.



**Figure 15.** Original project area and new county expansion for Phase II of the demonstration project.



## ACTIVE SITE DESCRIPTIONS (SEE APPENDIX FOR 2005-2018 DATA AND TERMINATED SITES)

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### Phase II Changes and Alterations

Phase II (See Appendix for Phase I Background) was started in 2014 with an additional 5 years of funding by the Texas Water Development Board and expanded the impact area to include a total of 8 counties in the Texas High Plains (Figure 15) with an additional county site location to be added in 2015.

Total number of Phase II acres devoted to each crop and livestock enterprise and management type in 2015 are given in Table 7. Previous year system information for both Phase I and Phase II of this project is provided in the Appendix, Tables A1-A10.

In Phase II year 1 (2014), sites 2, 3, 12 and 18 were dropped from the project, and 10 new sites in six new counties were added (Crosby, Deaf Smith, Lamb, Lubbock, Parmer, Swisher). The 10 new sites are numbered C50-C54 and C56-C60. Total net acres for the project increased from 4,962 in 2013 to 5,223 in 2014 as a result of these changes (Table A10).

In Phase II year 2 (2015), Sites 20, 27 and 29 were dropped and Sites C37, C38 and C39 were added with Site 17 dropping the perennial grass field of 112 acres from the original system acres. This resulted in a net increase in project acres from 5,223 acres in 2014 to 5,258 acres in 2015. While total sites in the project remained the same at 36, data was only collected on 31 producer sites in 2015 and the impact area covered by the project has significantly increased. As Phase II of our project outreach has expanded to include additional counties, some of the original project sites within Hale and Floyd counties are being replaced to facilitate the time and effort toward the new expanded area sites in order to focus on a broader impact area. With the addition of site 39 in Castro county the project area has increased from 2 counties in Phase I to a total of 9 counties in Phase II for 2015.

In Phase II year 3 (2016), Sites 5, 7, 8, 15, 19, 26, 30, C52 and C58 were dropped in a continued effort to reduce the number of sites in the project to a more manageable number of sites across a broader area as well as deleting sites in which the participating producer has now retired. No producer records were available for sites 34, C39, C53, C54 and C59 for 2016 though these sites remain a part of the project at the current time. The first year of data was collected for Sites C37 and C38. This resulted in a net decrease in total project acres from 5,258 acres in 2015 to 3,972 acres in 2016 with 27 total sites with producer data collected on 22 of these sites with 2,909 active acres in 2016. The total number of sites will be reduced again in 2017.

In Phase II year 4 (2017), Sites 6, 24, 28, 33, C53 and C54 were dropped in a continued effort to reduce the number of sites in the project to a more manageable number of sites across a broader area as well as deleting sites in which the participating producer has now retired or no longer able to provide field records. No producer records were available for site 34 for 2017 though this site currently remains a part of the project at the current time. This resulted in a net decrease in total project acres from 3,961 acres in 2016 to 3,383 system acres in 2017 with 2,656 active acres. Due to the loss of Sites C53 and C54 we

currently no longer have a site in Lamb county reducing the county coverage from 9 to 8 counties with a demonstration site.

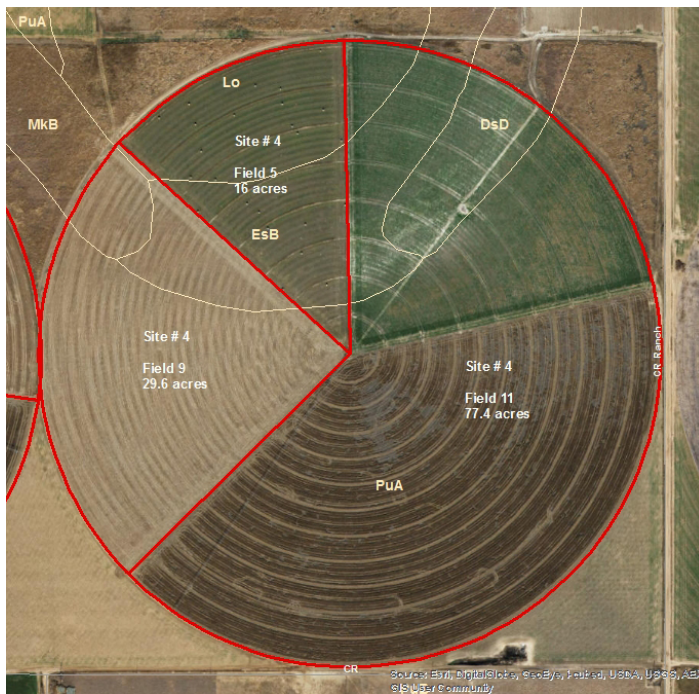
In Phase II year 5 (2018), Site 34 was dropped from project due to no records supplied by producer. No producer records were available for site 4 and 31 for 2018 though these sites remain a part of this project. This resulted in a net decrease in total project acres from 3,383 acres in 2017 to 2,432 system acres in 2018 with 2,200 active acres. Due to the loss of Sites C53 and C54 we currently no longer have a site in Lamb county reducing the county coverage from 9 to 8 counties with a demonstration site.

In Phase II year 6 (2019), several producer sites collected in past were not available for analysis that have been presented in previous years. This resulted in a net decrease in total project acres from 2,432 acres in 2018 to 1,966 active system acres in 2019. Data collection for this year (summarized in 2020) has been particularly challenging due to the Covid-19 pandemic and resulted in significant delays in data collection and reporting.

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



## SITE 4 – NO DATA FOR 2018, 2019



### **Description:**

Site acres: 123.0

### Soil types:

**PuA**-Pullman clay loam, 0 to 1%

**DsD**-Drake soils, 3 to 8%

**EsB**-Estacado loam, 1 to 3%

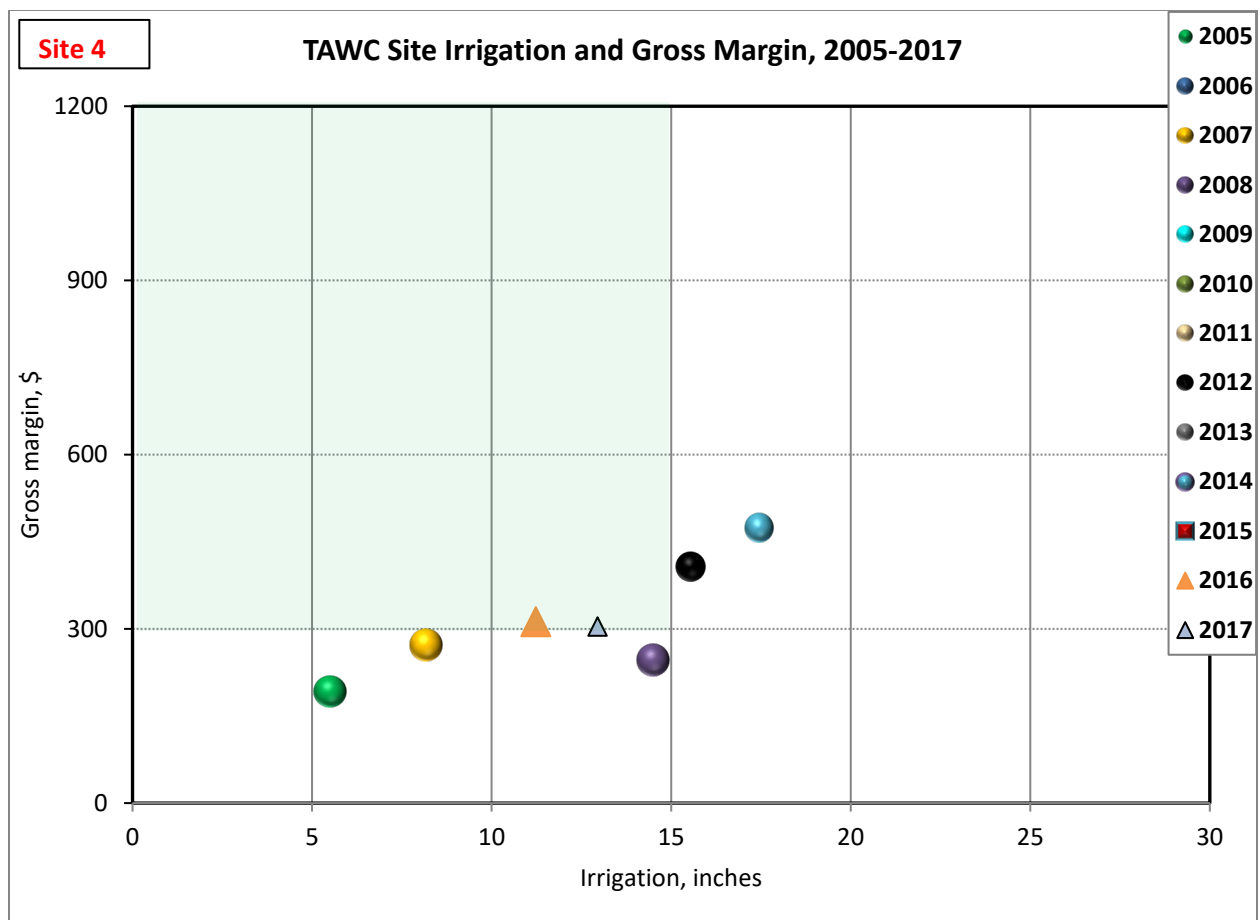
**Lo**-Lofton clay loam, 0 to 1%

### Irrigation:

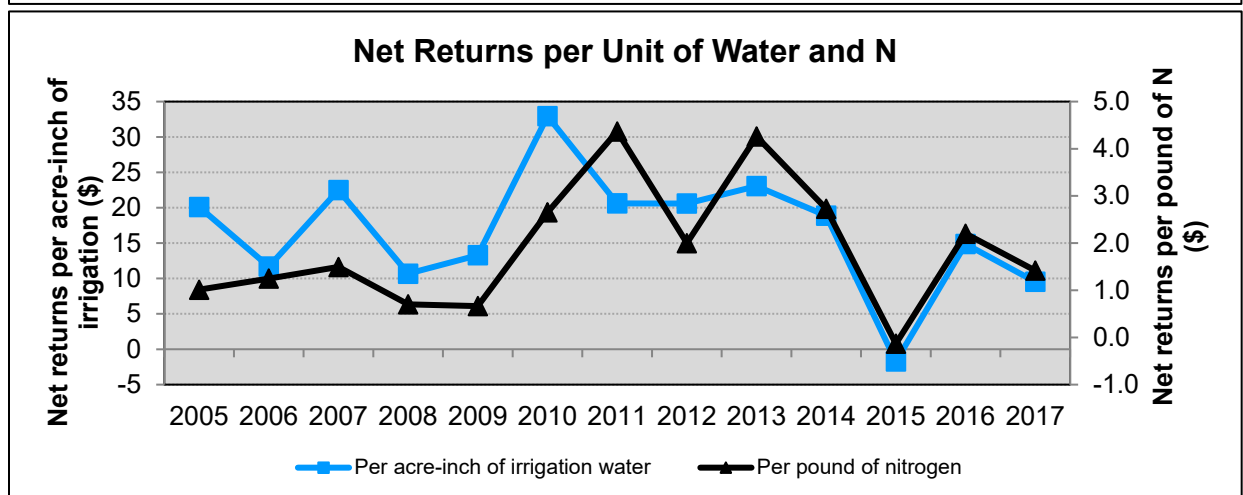
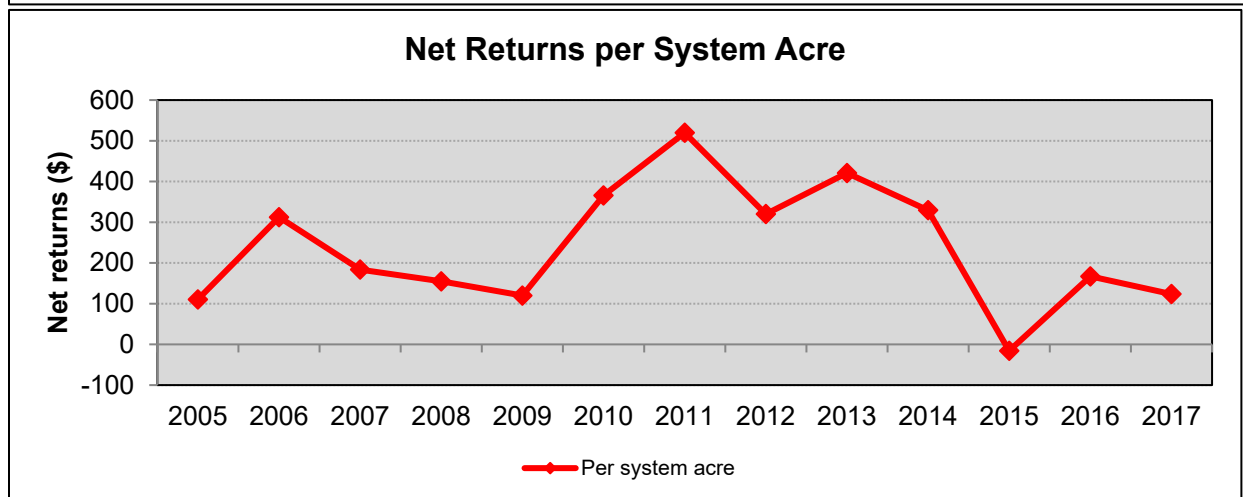
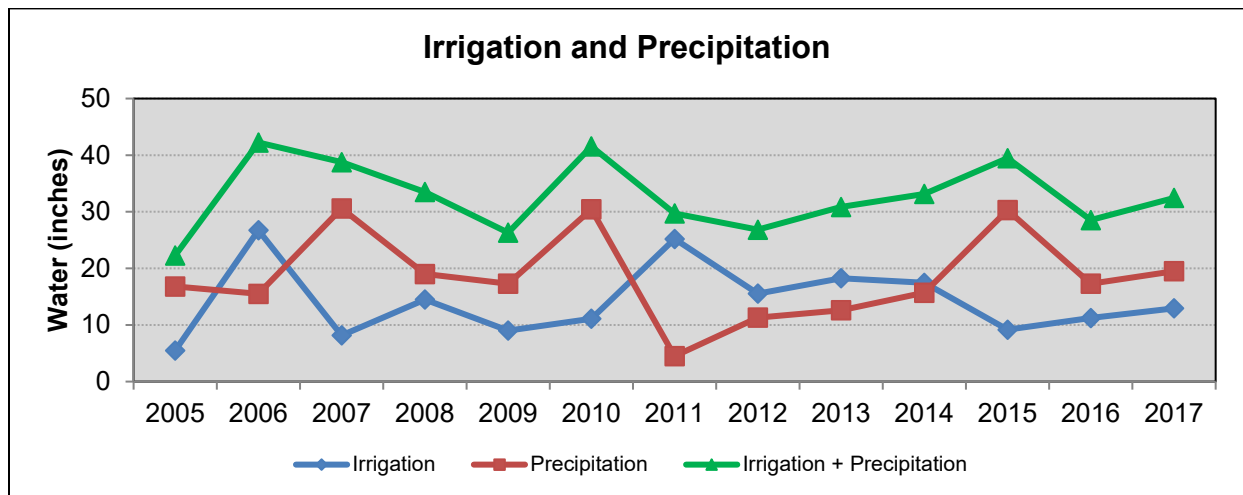
Center Pivot (LESA) 500 gpm

Number of wells: 3

Fuel Source: 1 Natural gas,



## Site 4 –No Data for 2018, 2019



**Site 4 – NO Data for 2018, 2019**



May ground prep



Hay production



Cattle grazing



Alfalfa



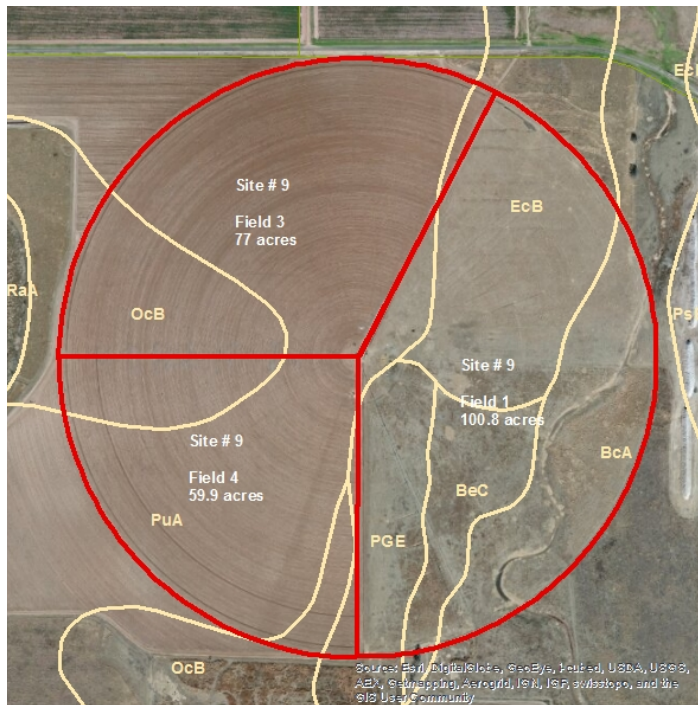
September Cotton



LEPA Irrigated wheat

Comments: In 2017 this pivot LEPA/LESA integrated crop/livestock irrigated site was planted to wheat, cotton, seed millet, and started a new planting of alfalfa in a different section of the pivot.

## SITE 9-NO DATA FOR 2019



### **Description:**

Site acres: 237.7

### Soil types:

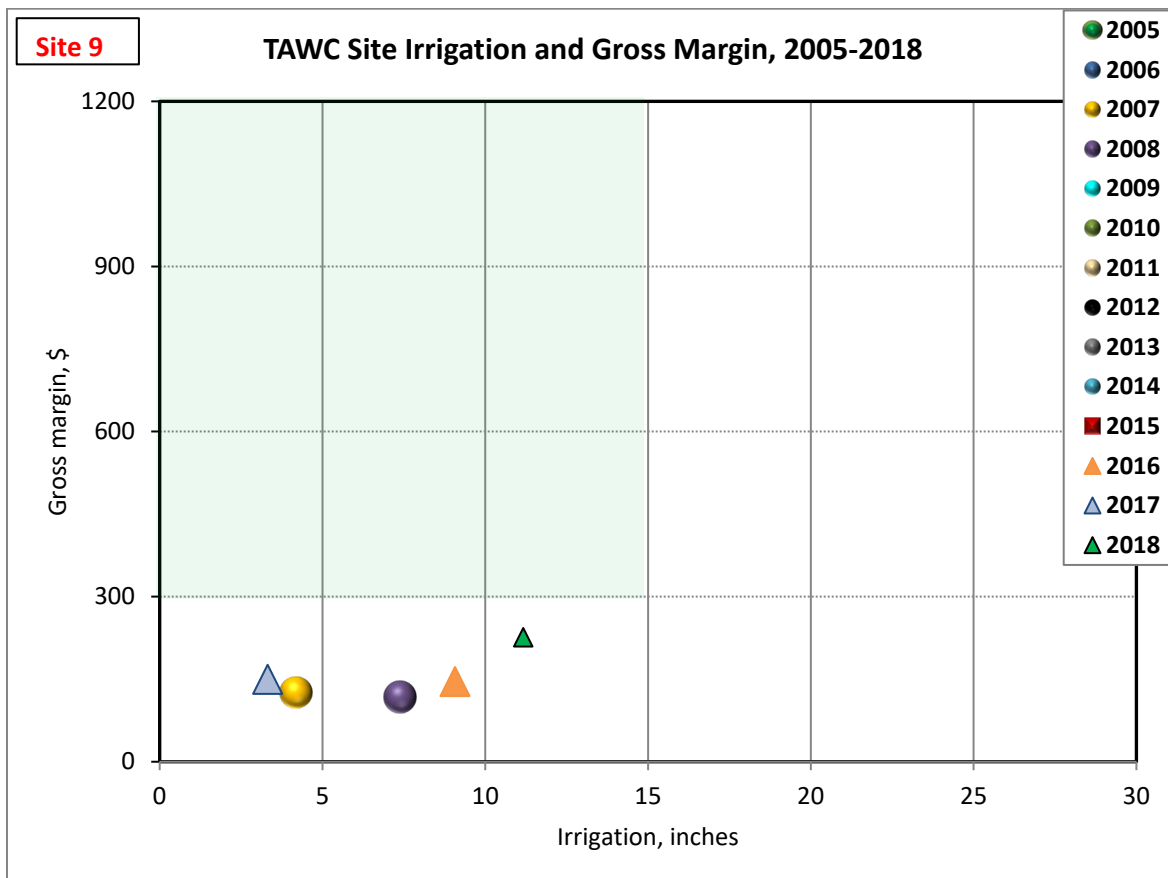
- PuA-Pullman clay loam; 0 to 1%
- OcB-Olton clay loam, 1 to 3%
- EcB-Estacado clay loam; 1 to 3%
- BcA-Bippus clay loam; 0 to 2%
- BeC-Berda loam, 3 to 5%
- PGE-Potter soil, 3 to 20%

### Irrigation:

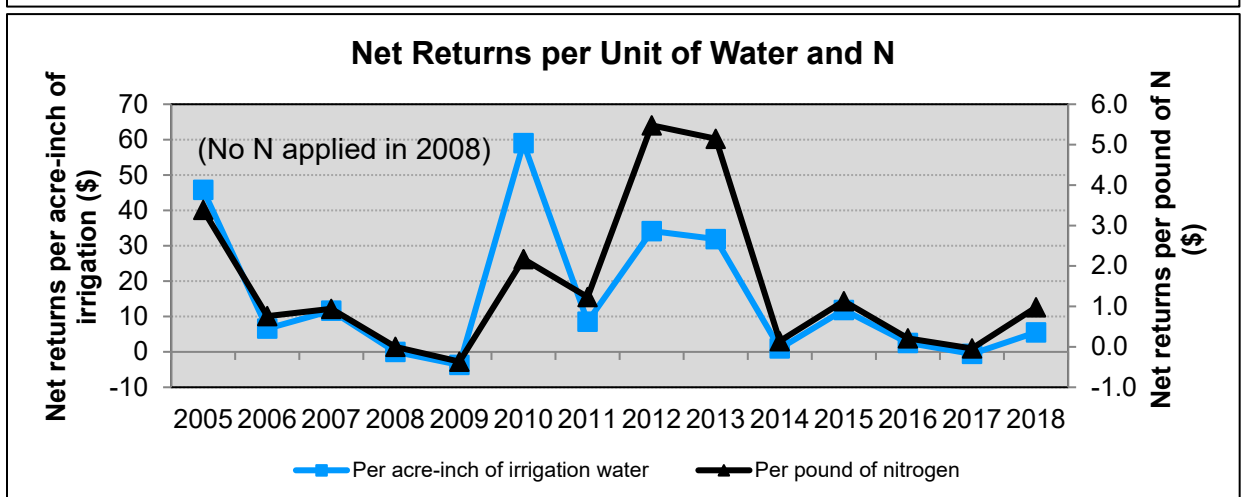
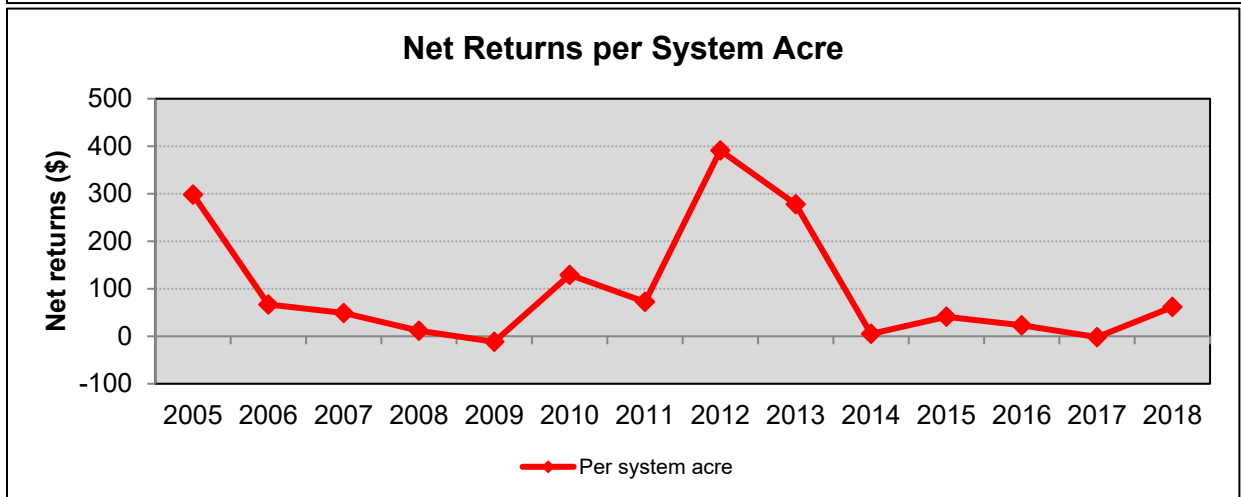
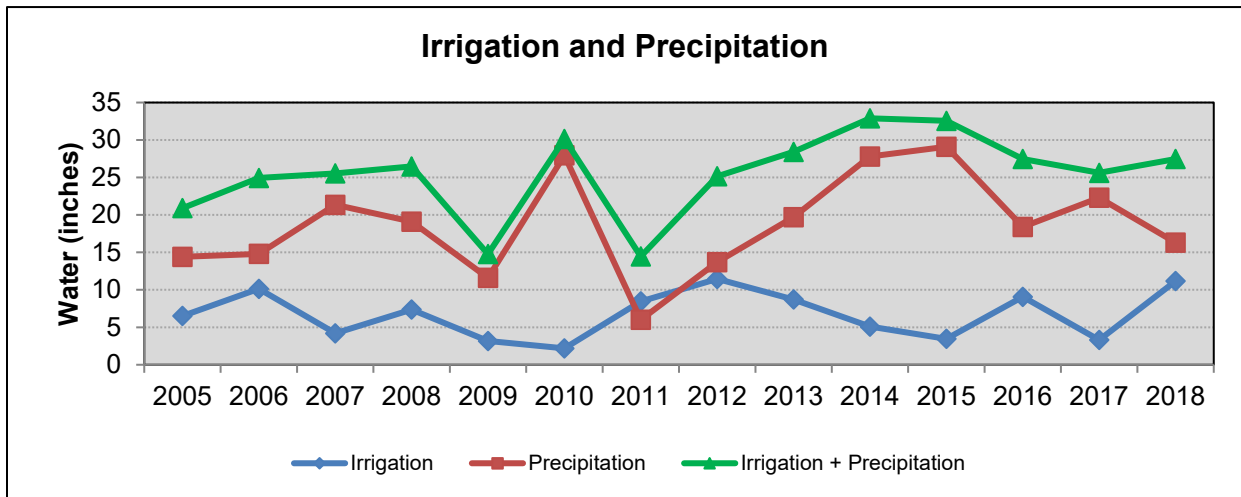
Center Pivot (MESA) 900 gpm

Number of wells: 4

Fuel Source: 2 Natural gas,  
2 Diesel



## Site 9-No Data for 2019





**Site 9-No Data for 2019**



Perennial grass



September cotton



Cow/calf grazing grass



Perennial grass for grazing



Momma cows



Cotton ready for harvest

Comments: In 2018 this pivot irrigated integrated crop/livestock site was minimum till planted to cotton. The perennial grass mix was grazed by 50 cows with 40 calves born.

[illegible]

Site acres: 173.6

PuA-Pullman clay loam; 0 to 1%

PuB-Pullman clay loam, 1 to 3%

**EcA**-Estacado clay loam; 0 to 1%

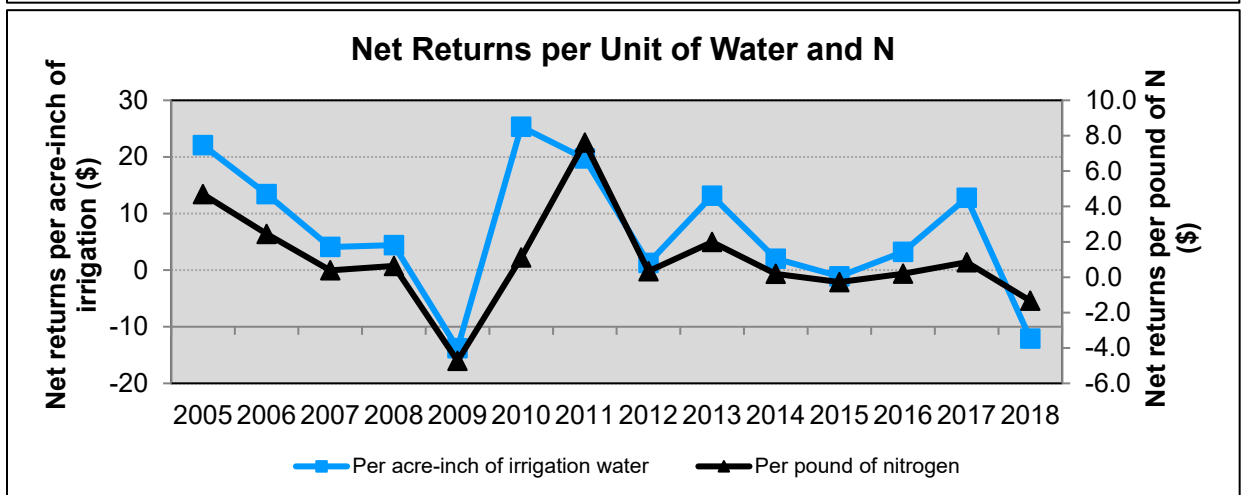
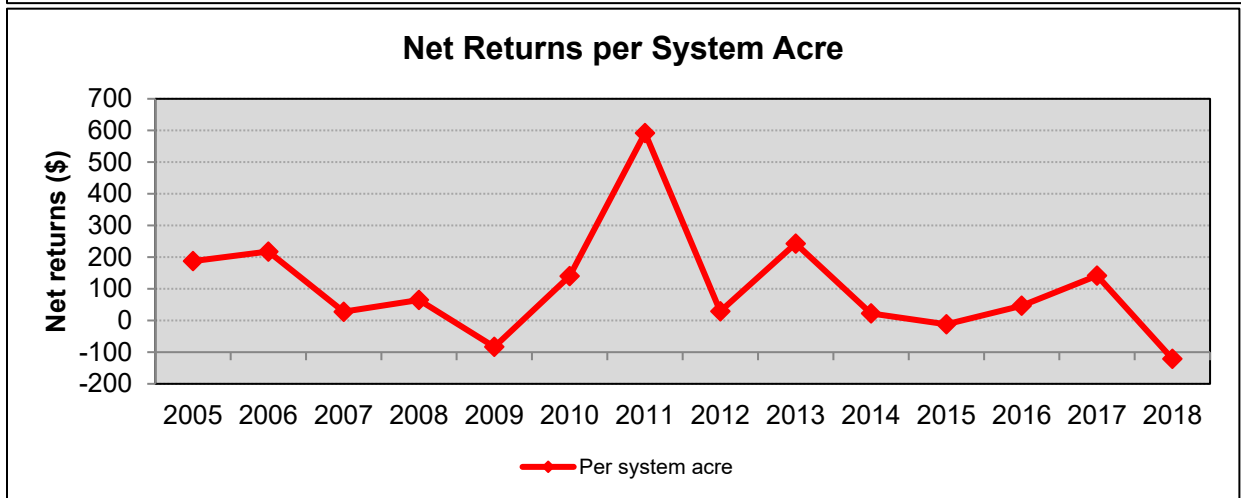
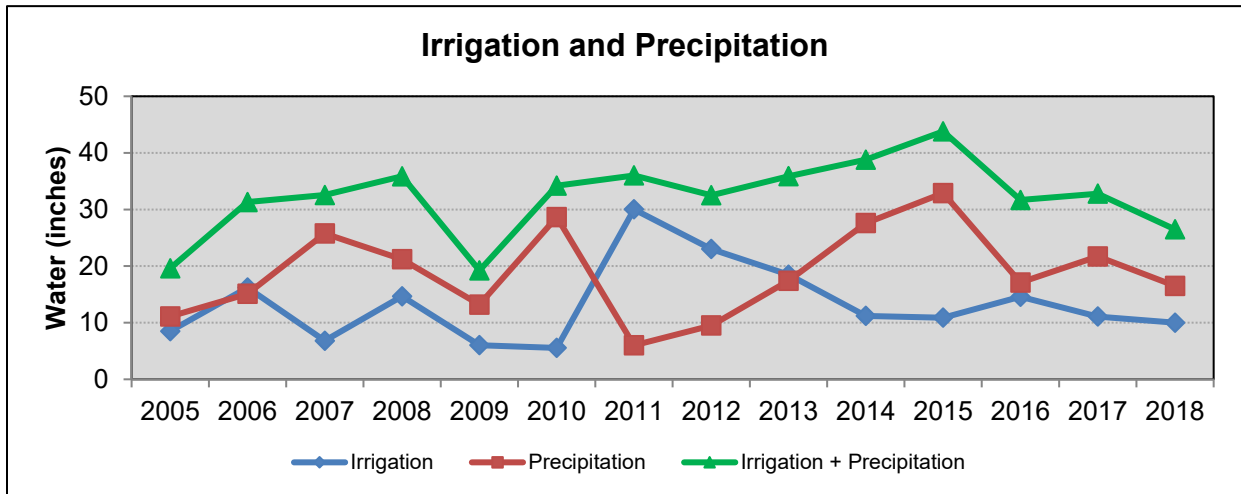
LoA-Lofton clay loam; 0 to 1%

## Center Pivot (LESA) 800 gpm

Fuel Source: Electric



## Site 10-No Data for 2019





**Site 10 -No Data for 2019**



Early May



Cow/calf pairs



Cattle grazing mixed grass



Grazing corn residue



November cotton



November cotton bales

Comments: In 2018 this pivot LESA irrigated integrated crop/livestock site was planted to minimum tillage cotton. The cotton was hailed out and replanted to forage sorghum for hay production and continued in perennial grass. The perennial grass was grazed by 34 cattle pairs for 143 days. 3.5 tons of compost was applied.

## SITE 11



### Description:

Site acres: 82.6

### Soil types:

PuA-Pullman clay loam; 0 to 1%

LoA-Lofton clay loam; 0 to 1%

EcB-Estacado clay loam; 1 to 3%

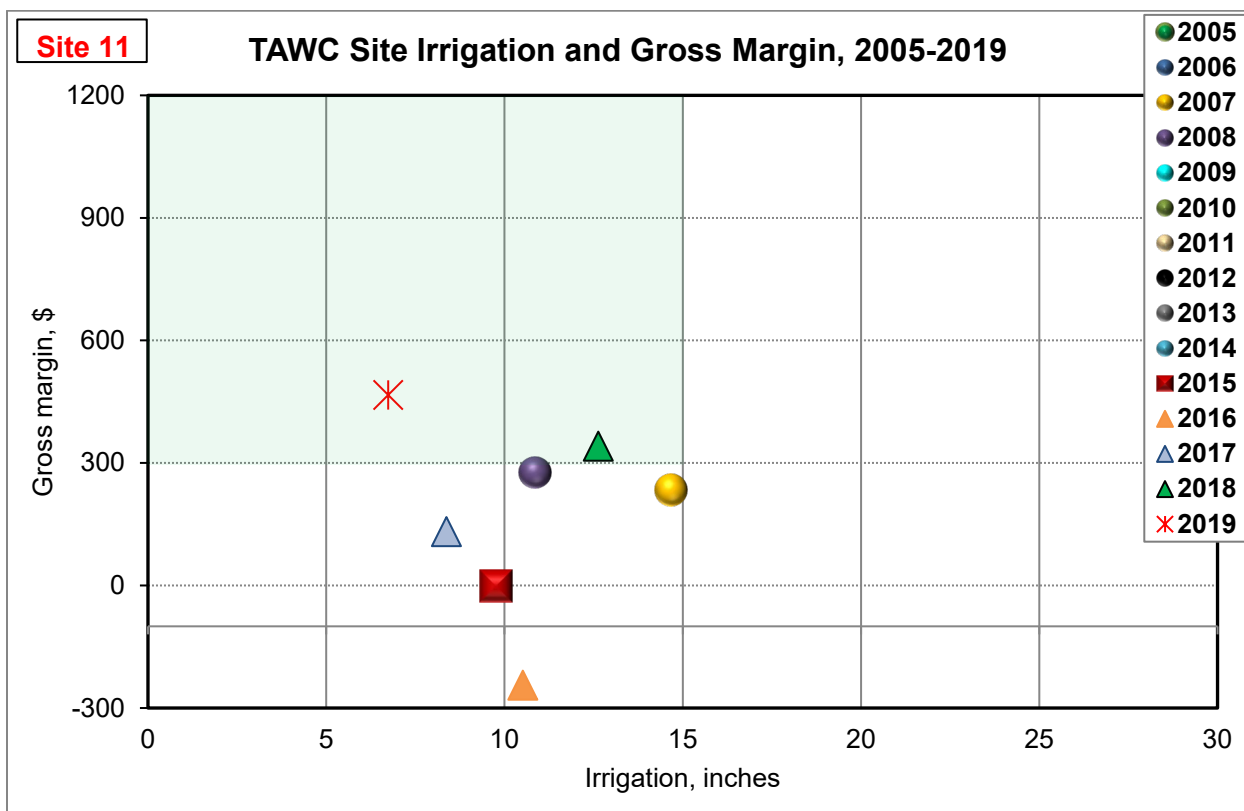
OcB-Olton clay loam; 1 to 3%

### Irrigation:

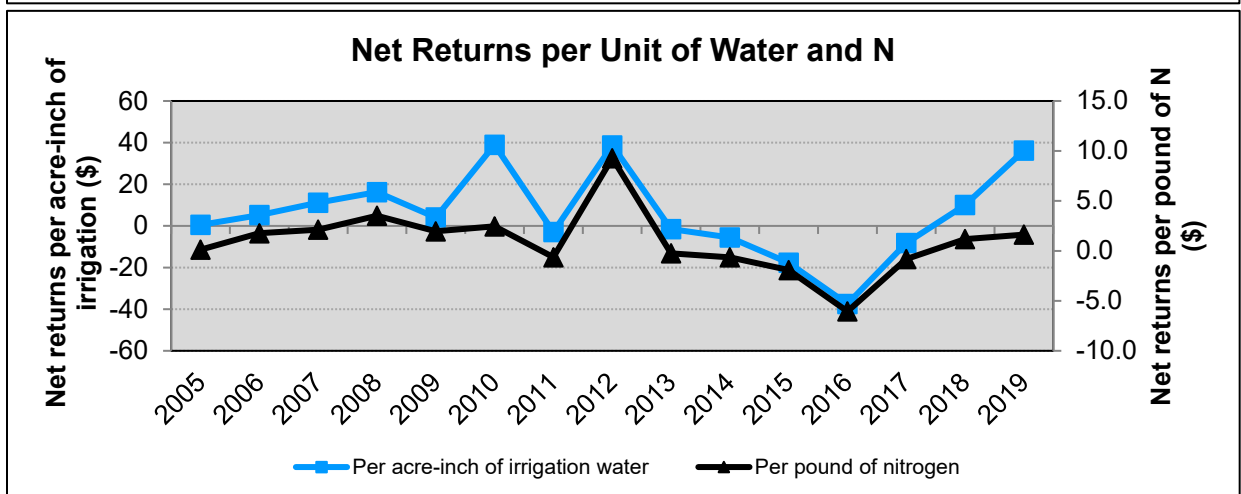
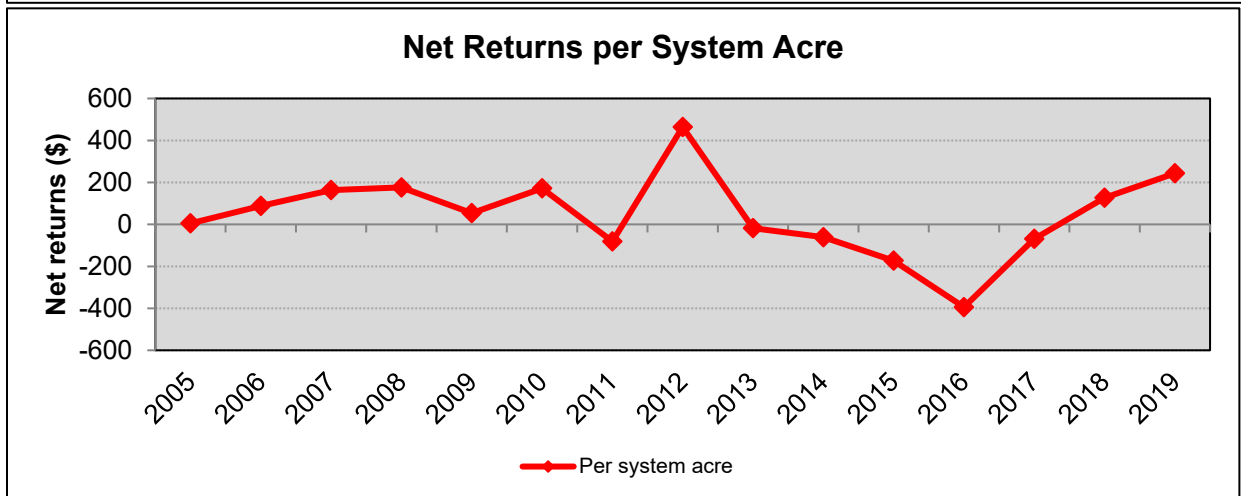
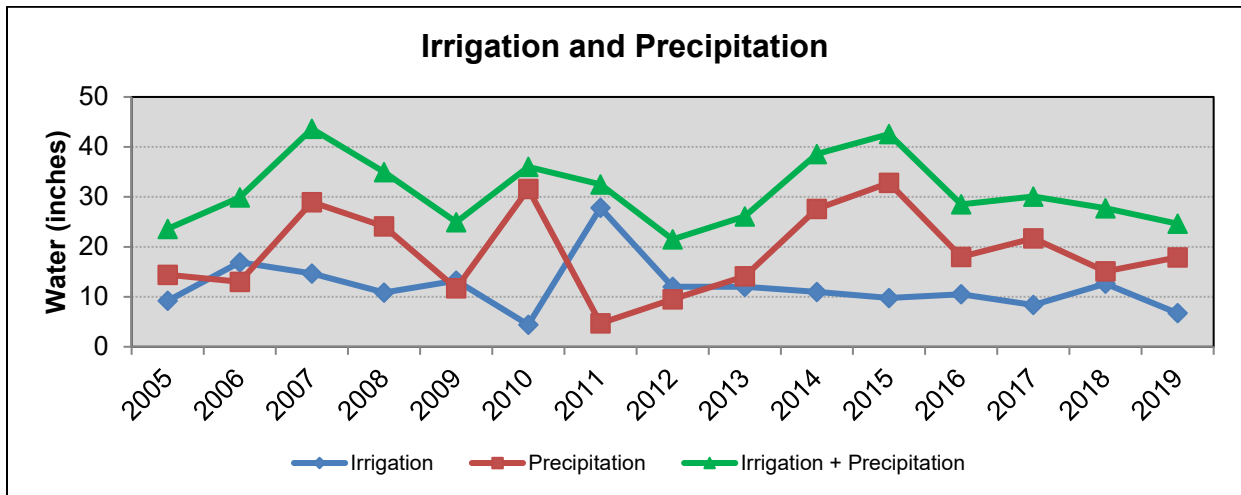
Furrow/Drip (FUR/SDI) 490 gpm

Number of wells: 1

Fuel Source: Electric



## Site 11

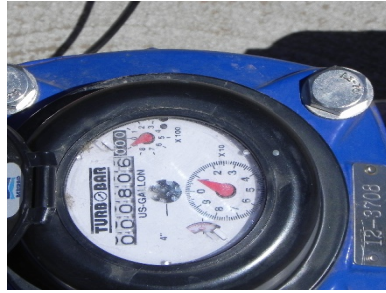




## Site 11



May dry conditions



Water meter on system



SDI filtration system



September cotton



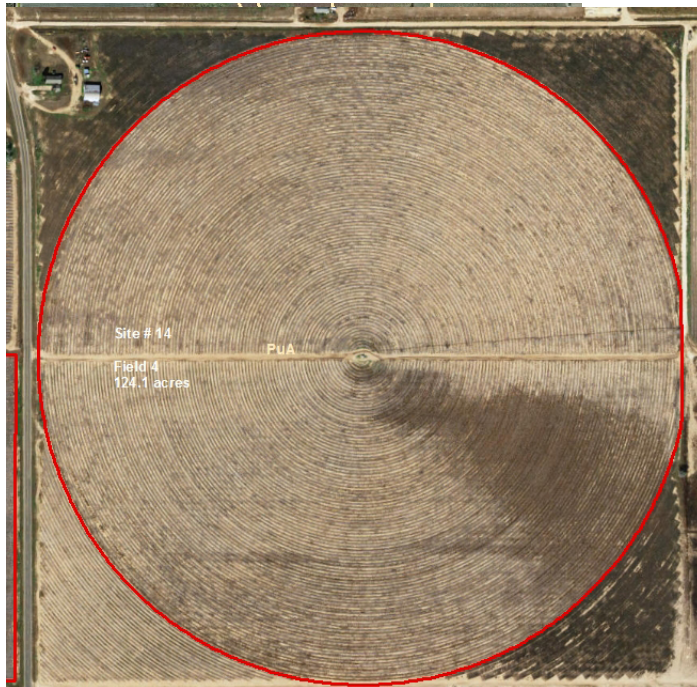
September corn



Moisture probe installation

Comments: In 2019 this SDI/FUR irrigated site was planted to cotton. The cotton crop was hauled out and field 9 with furrow irrigation was replanted to Grain Sorghum. Field 13 with SDI was replanted to corn and taken to harvest.

## SITE 14 – NO DATA COLLECTED



### **Description:**

Site acres: 124.1

Soil types:

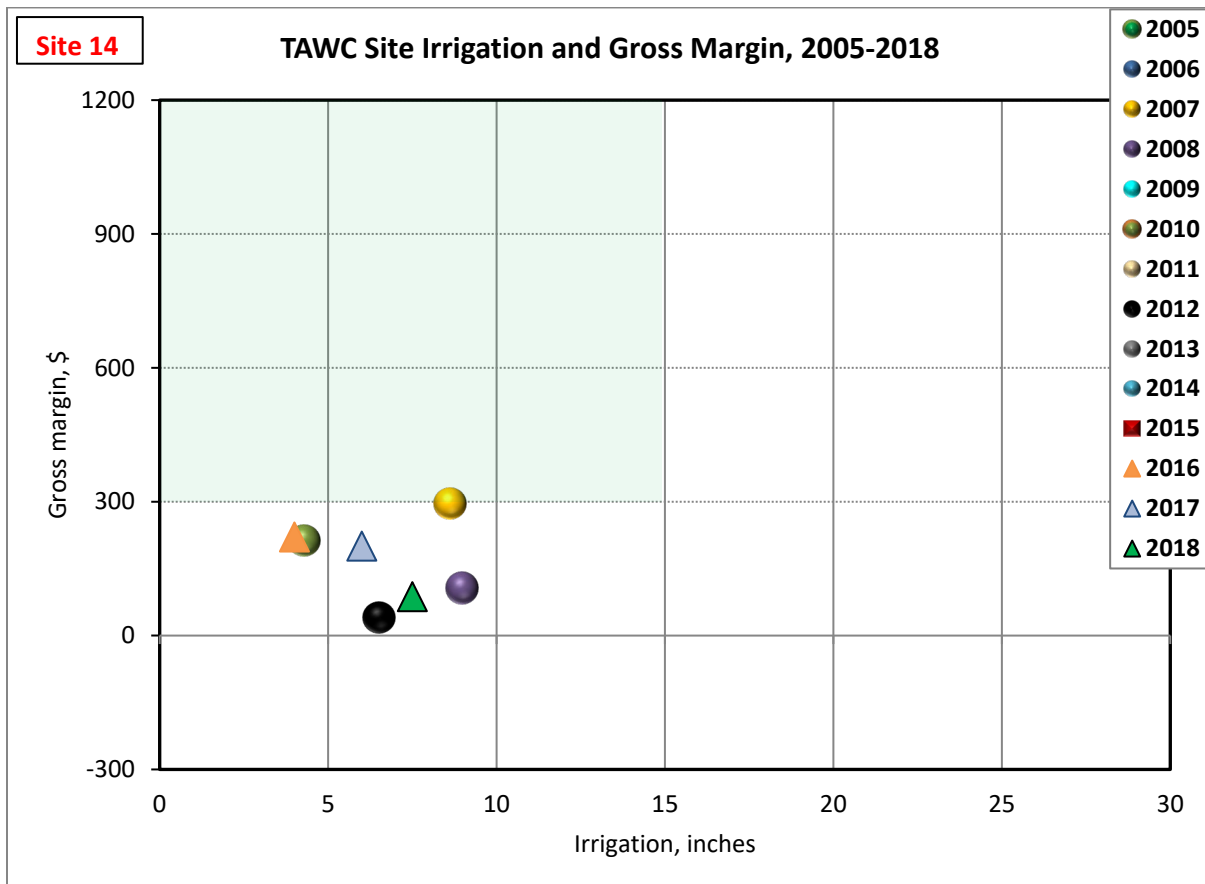
PuA-Pullman clay loam; 0 to 1%

Irrigation:

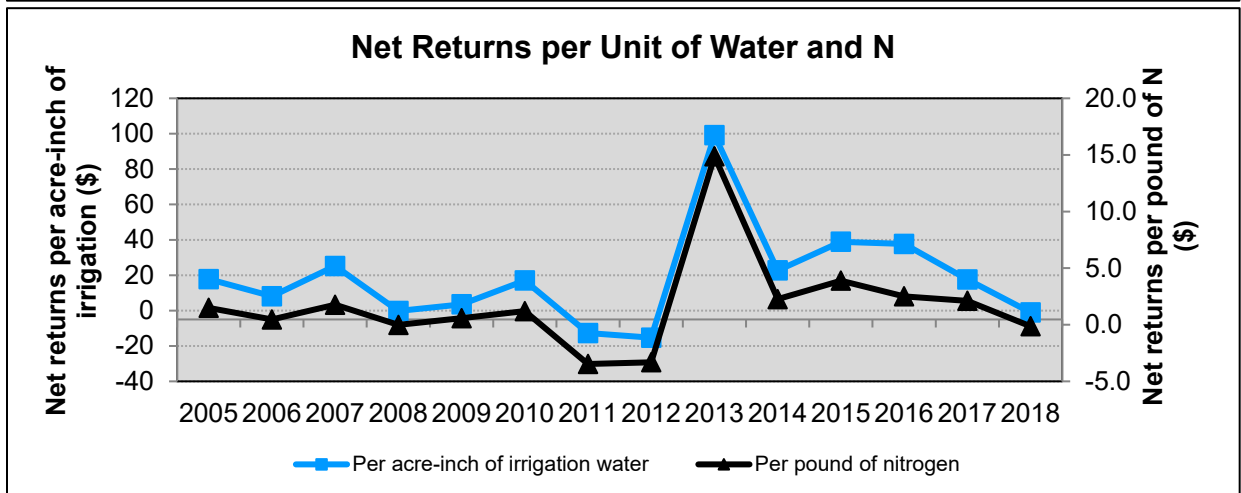
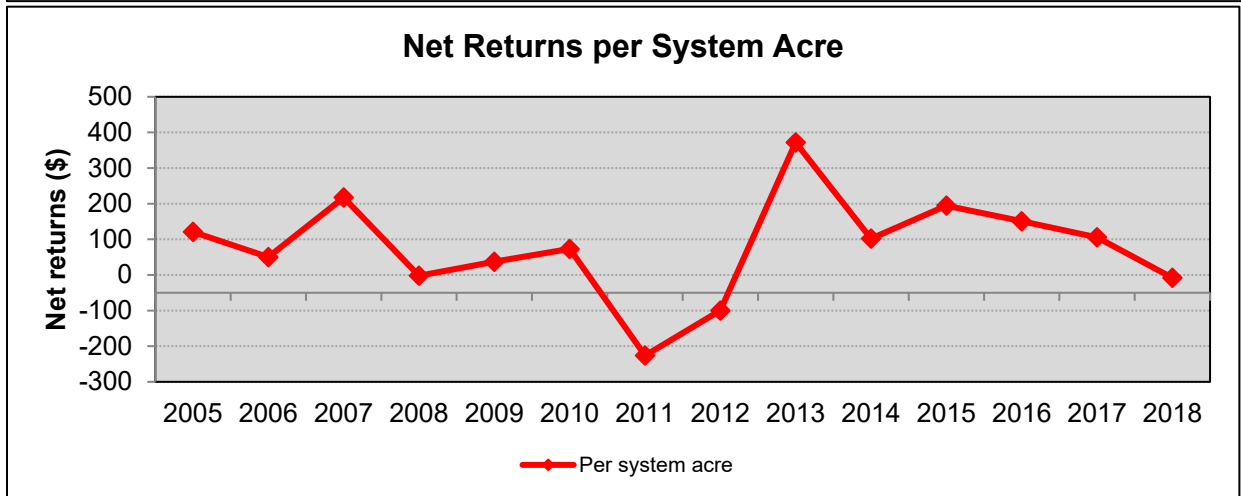
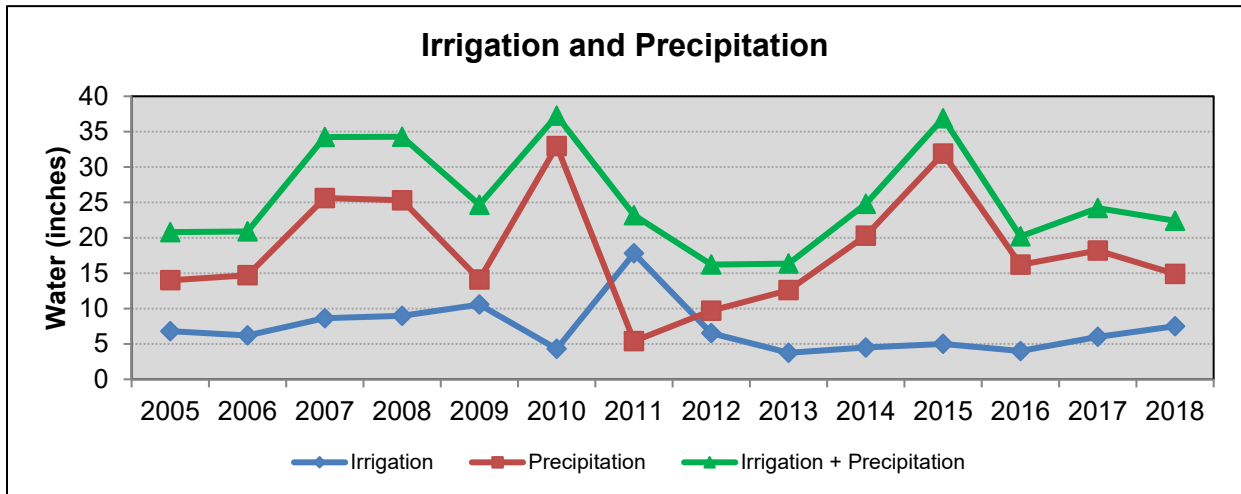
Center Pivot (LESAA) 300 gpm

Number of wells: 3

Fuel Source: Electric



## Site 14-No Data Collected





## Site 14-No Data Collected



Dry conditions March



Early June cotton



Early September cotton



Cotton planted 2 in- 2 out



Cotton ready for harvest



MESA/LEPA irrigation

Comments: In 2018 this pivot MESA/LEPA irrigated site was planted to cotton monoculture in a 2 in 2 out tillage system.

## SITE 17-NO DATA COLLECTED



### Description:

Site acres: 108.9

Soil types:

**PuA**-Pullman clay loam; 0 to 1%

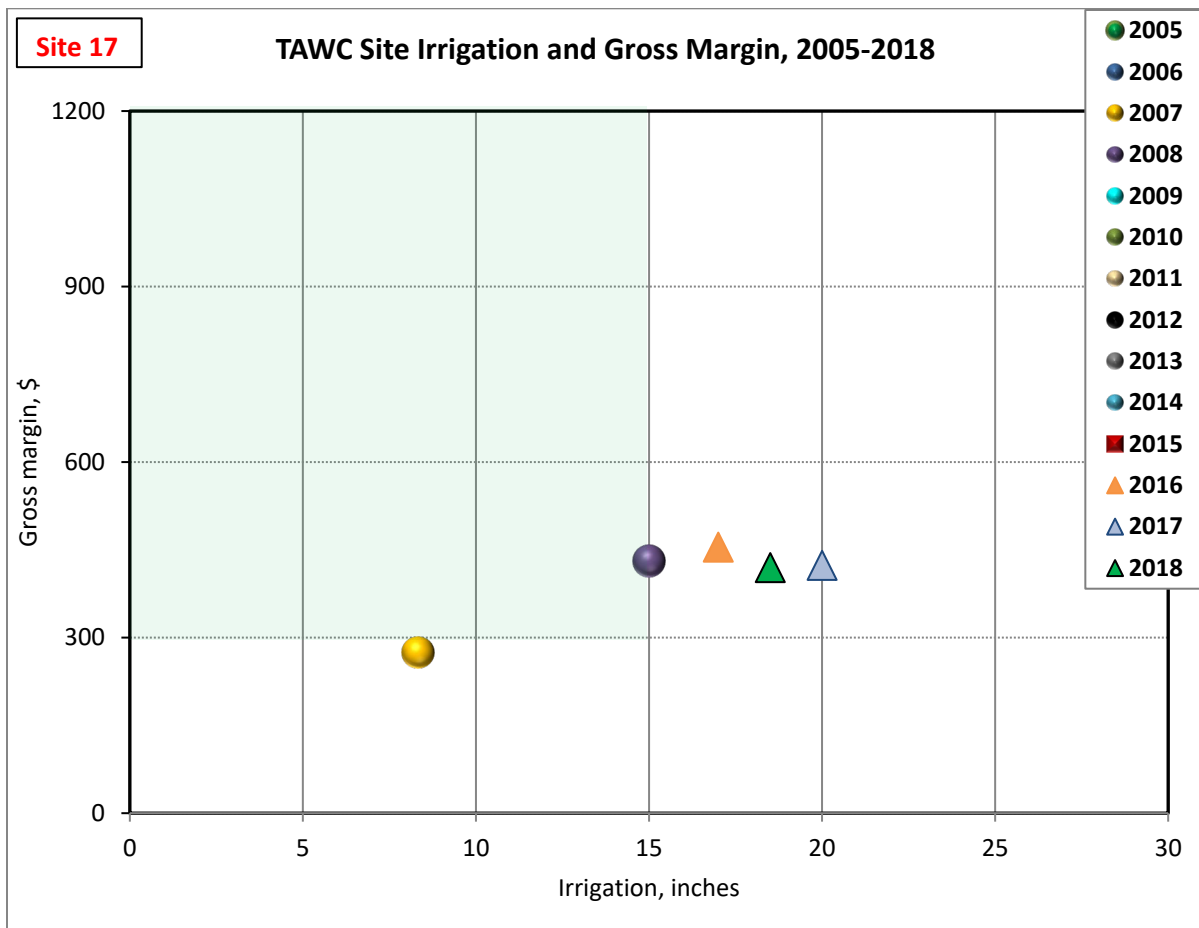
**OcB**-Olton clay loam; 1 to 3%

Irrigation:

Center Pivot (MESA) 900 gpm

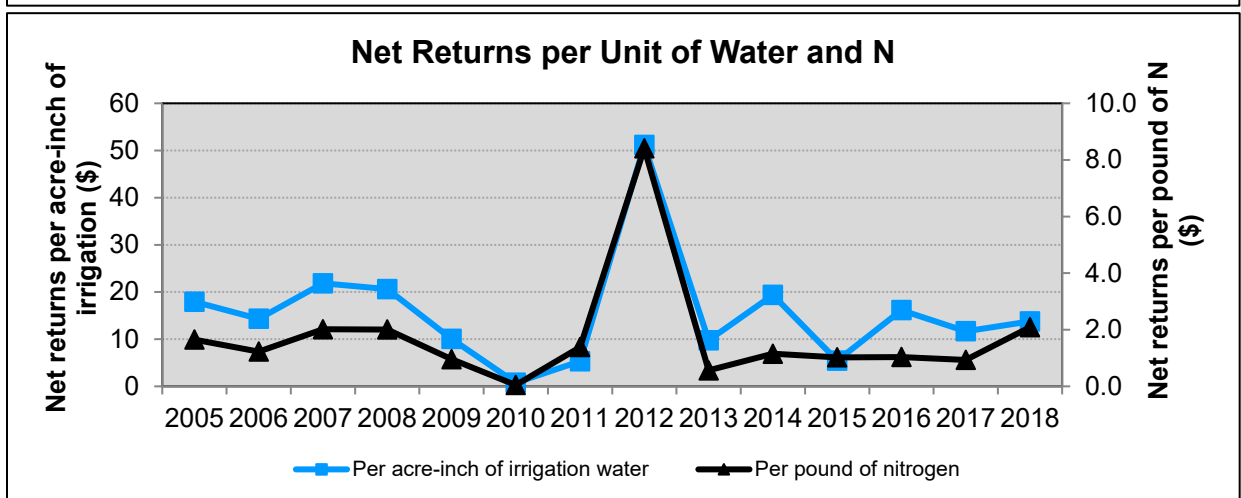
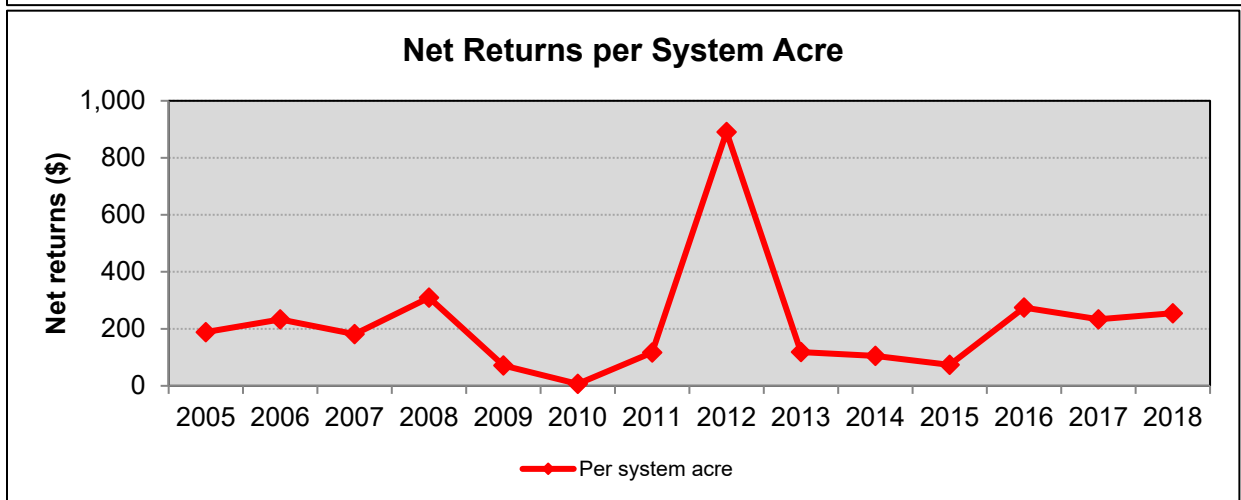
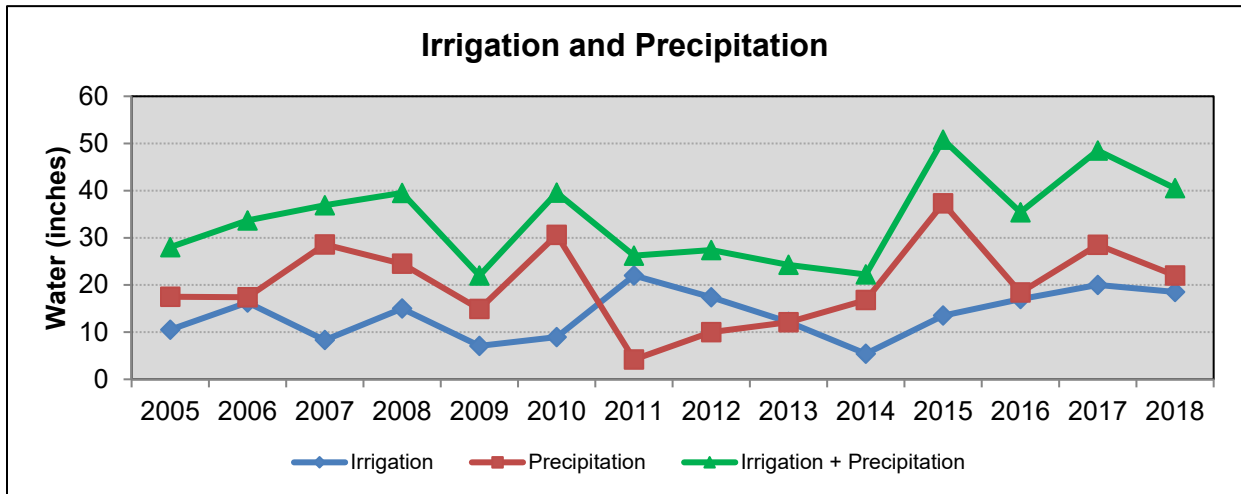
Number of wells: 8

Fuel Source: Electric





# Site 17-No Data Collected



**Site 17 – No Data Collected**



May cotton residue



W.W. B-Dahl fallowed



September corn



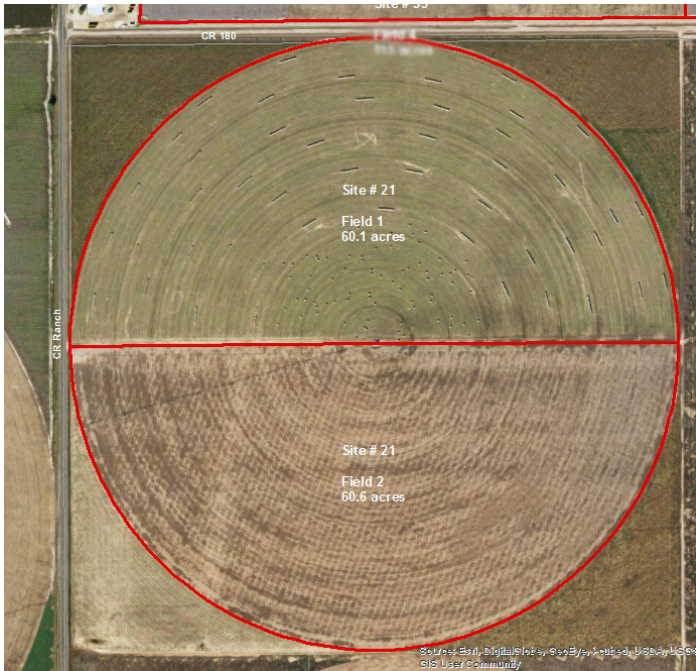
Perennial grass and corn



Corn ready for harvest

Comments: In 2018 this pivot irrigated site was planted to corn and cotton. The W.W. B-Dahl perennial grass was fallowed.

## SITE 21



### Description:

Site acres: 120.7

### Soil types:

PuA-Pullman clay loam; 0 to 1%

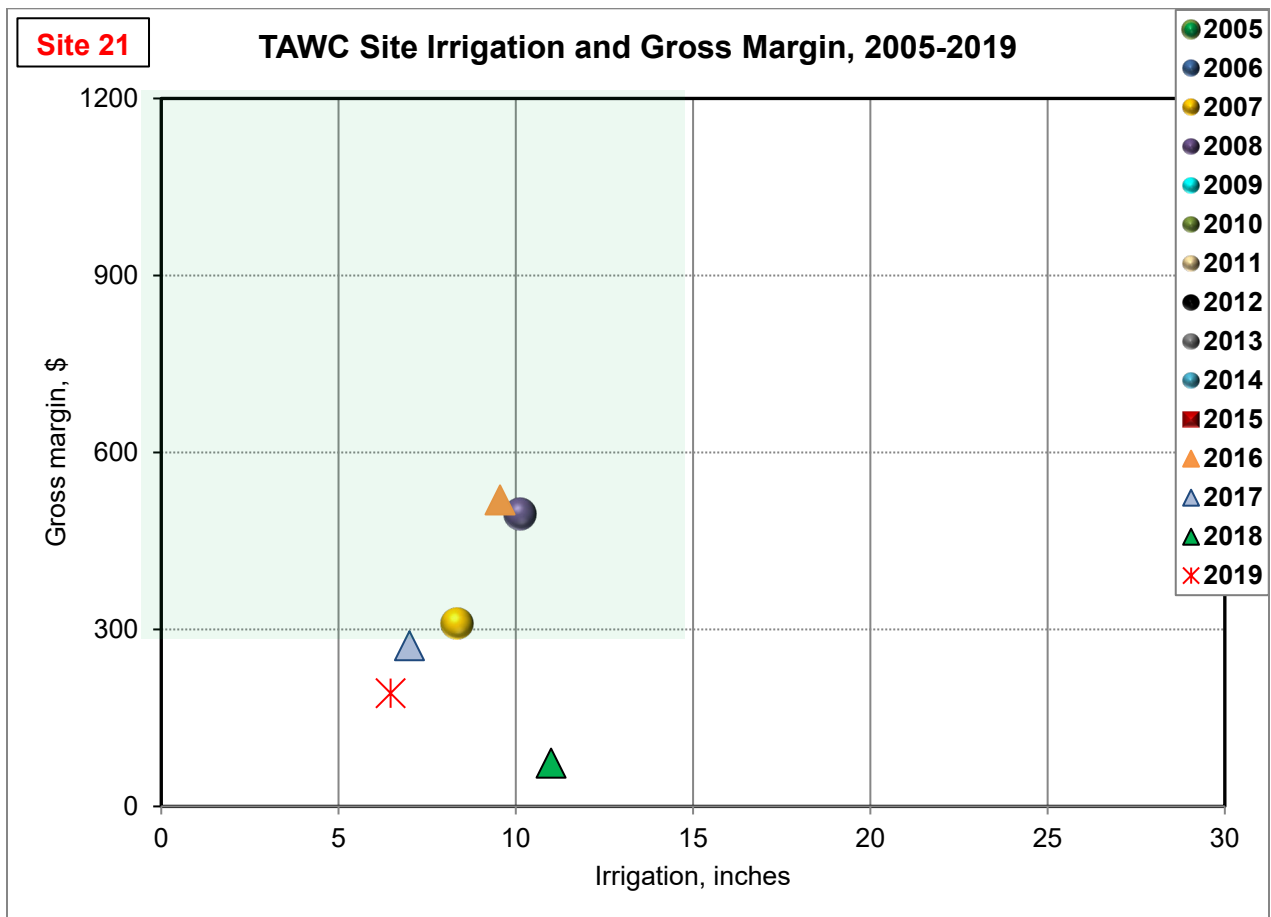
LoA-Lofton clay loam; 0 to 1%

### Irrigation:

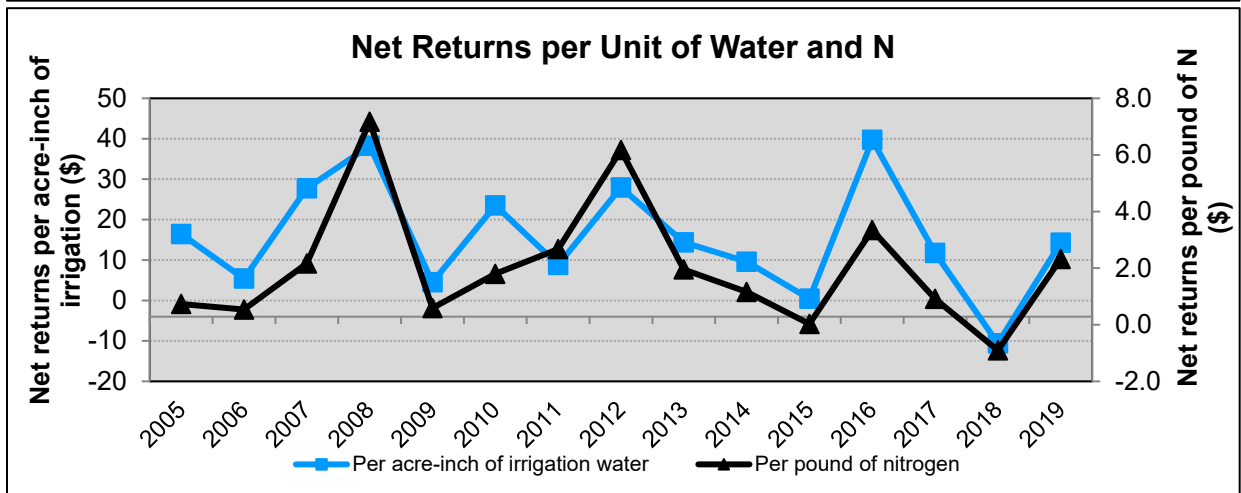
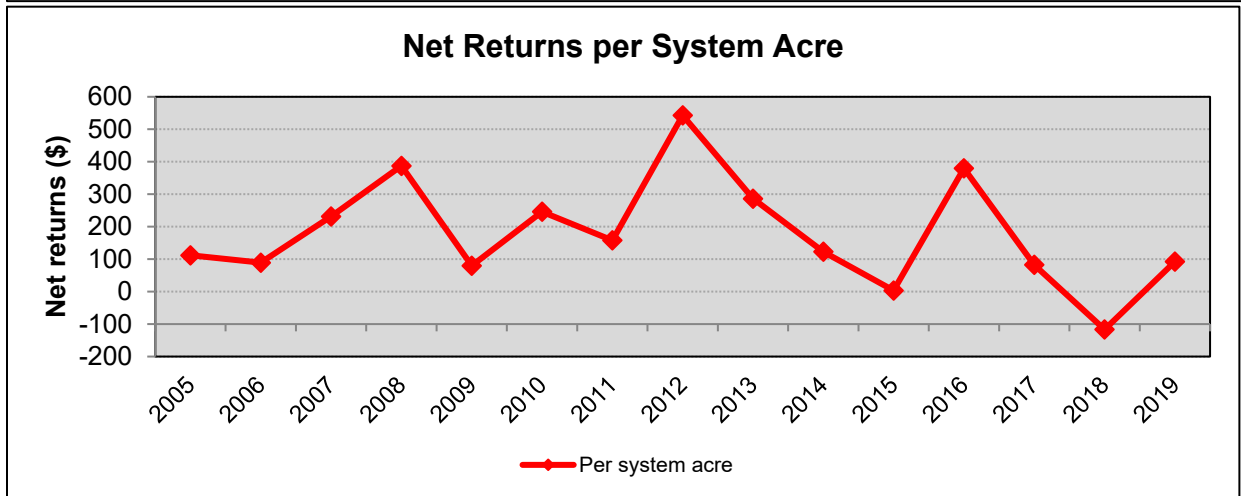
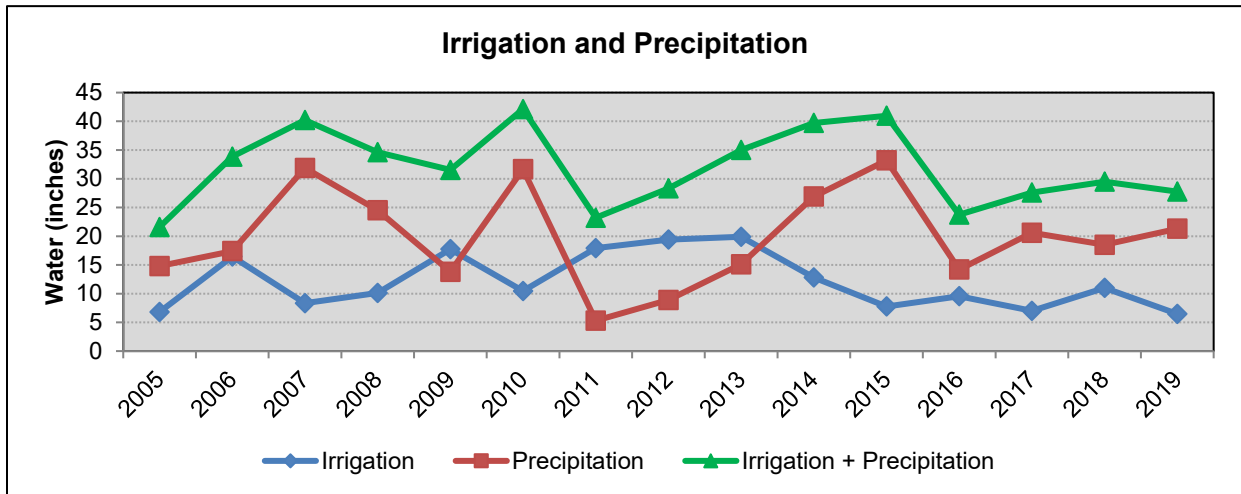
Center Pivot (LEPA) 500 gpm

Number of wells: 1

Fuel Source: Electric



## Site 21





## Site 21



May germination application



September irrigation



Cotton harvest equipment



Ready to strip



November cotton



November cotton module

Comments: In 2019 this pivot LEPA irrigated site was planted to cotton, but after hail out. Field 1 was replanted to White Food Corn and Field 2 was fallowed.

CR Fm 2286

CR

CR Eb

EsB

DsD

Lo

Site # 22

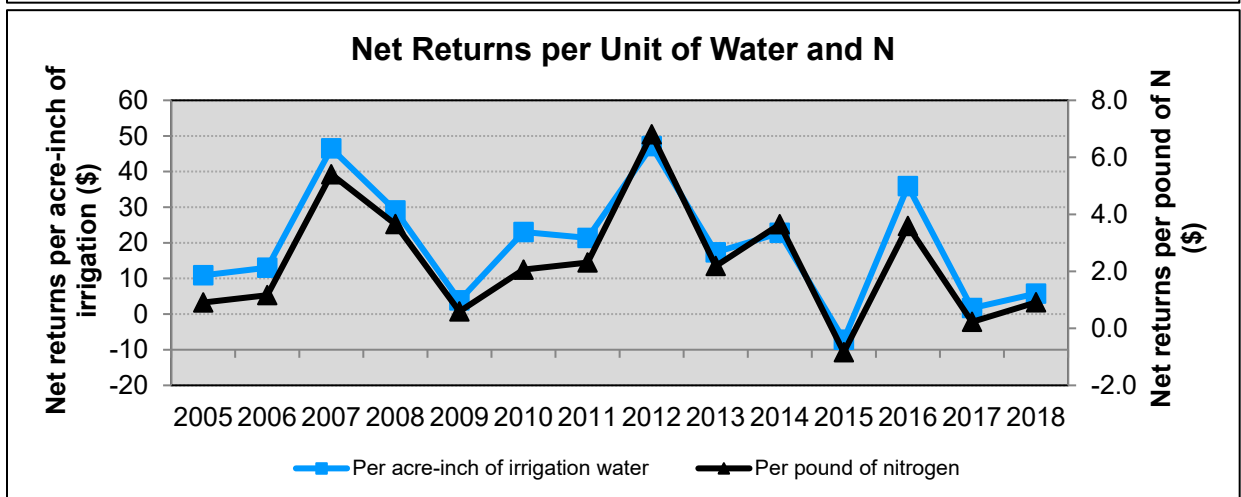
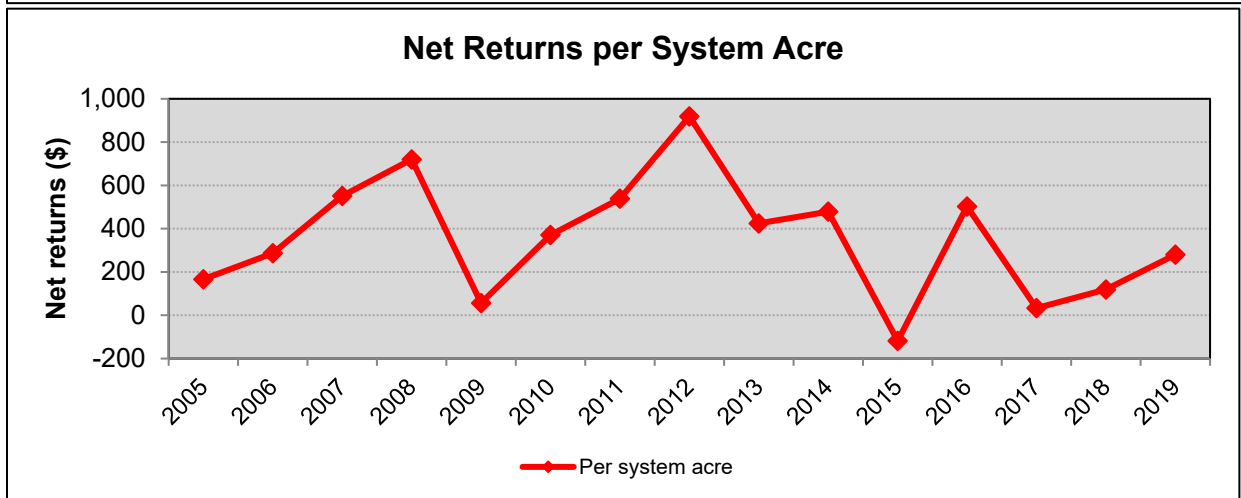
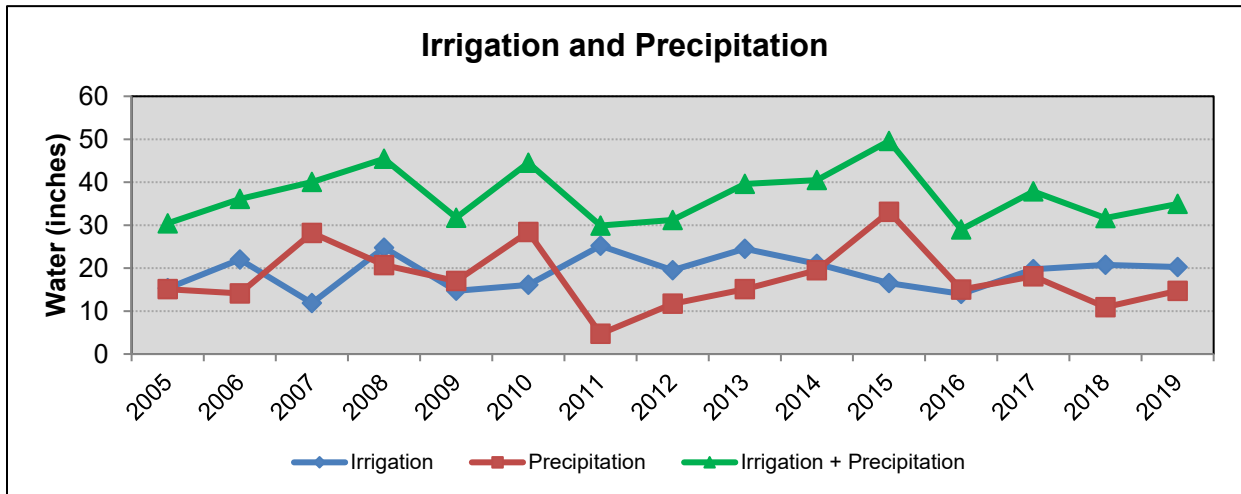
Field 3  
145 acres

Source: Esri, DigitalGlobe, GeoEye, IGN, and the GIS User Community

## Electric



## Site 22



## Site 22



May



30-inch strip till planting



September cotton



Ground preparation



November cotton harvest

Comments: In 2019 this pivot LEPA irrigated site was planted to cotton. Following hail out field was replanted to corn.



## SITE 31 – NO DATA FOR 2018 OR 2019



### Description:

Site acres: 121.9

Soil types:

PuA-Pullman clay loam, 0 to 1%

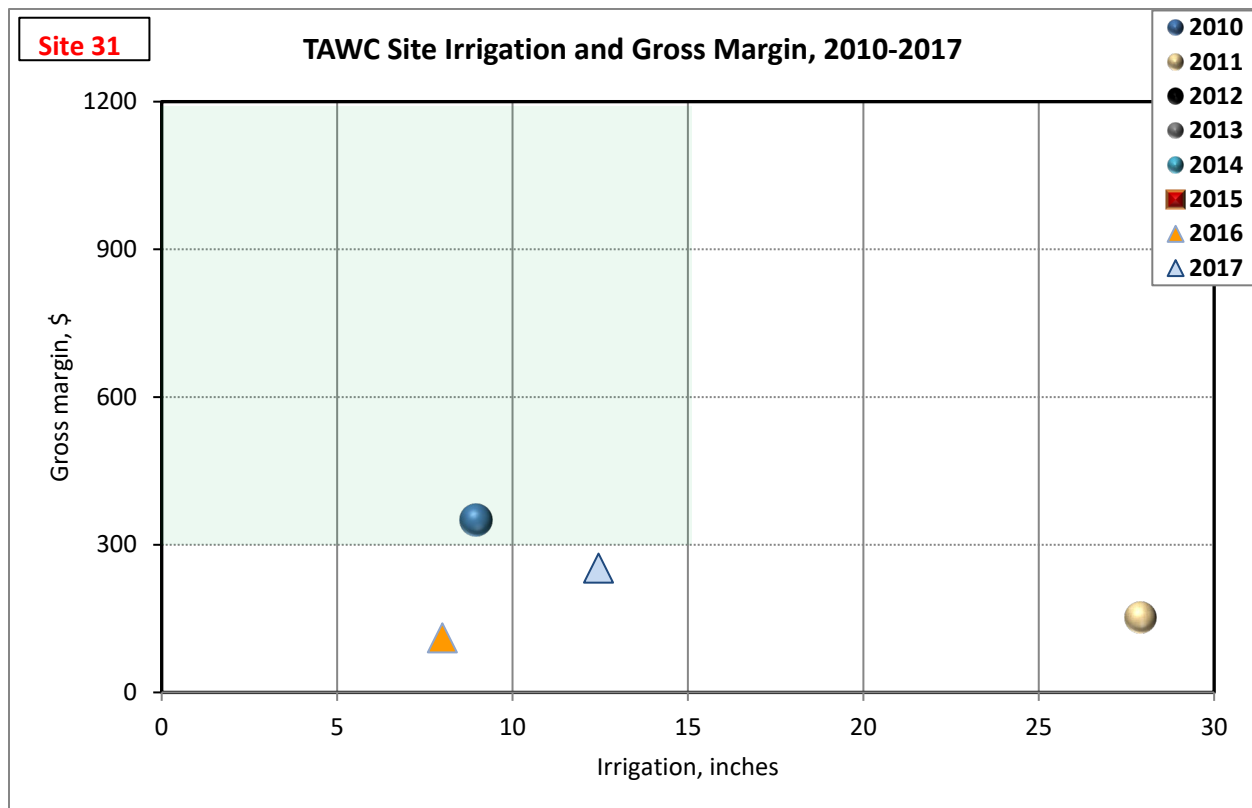
Irrigation:

Center Pivot (LEPA) 450 gpm

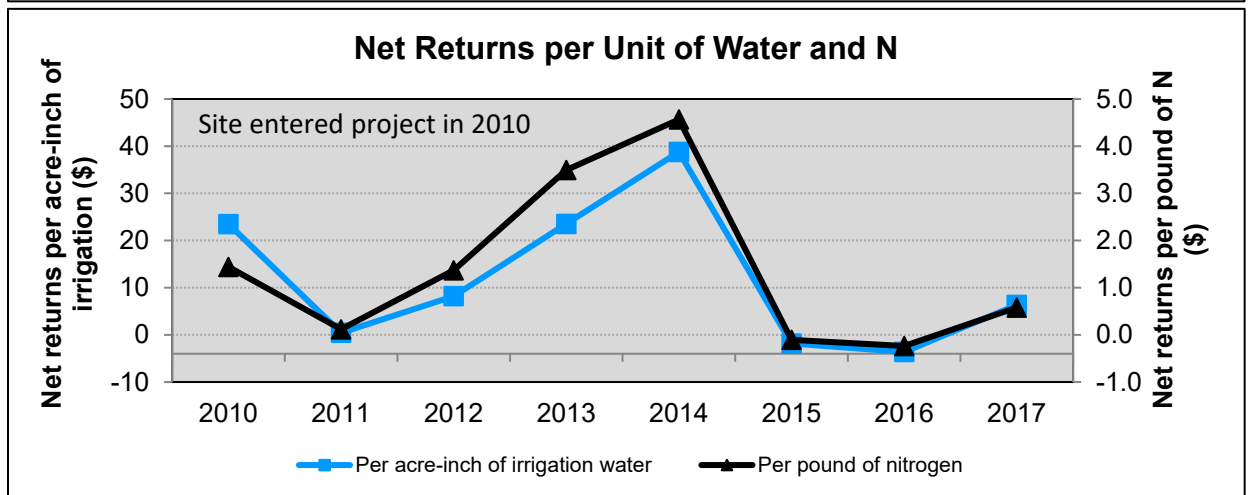
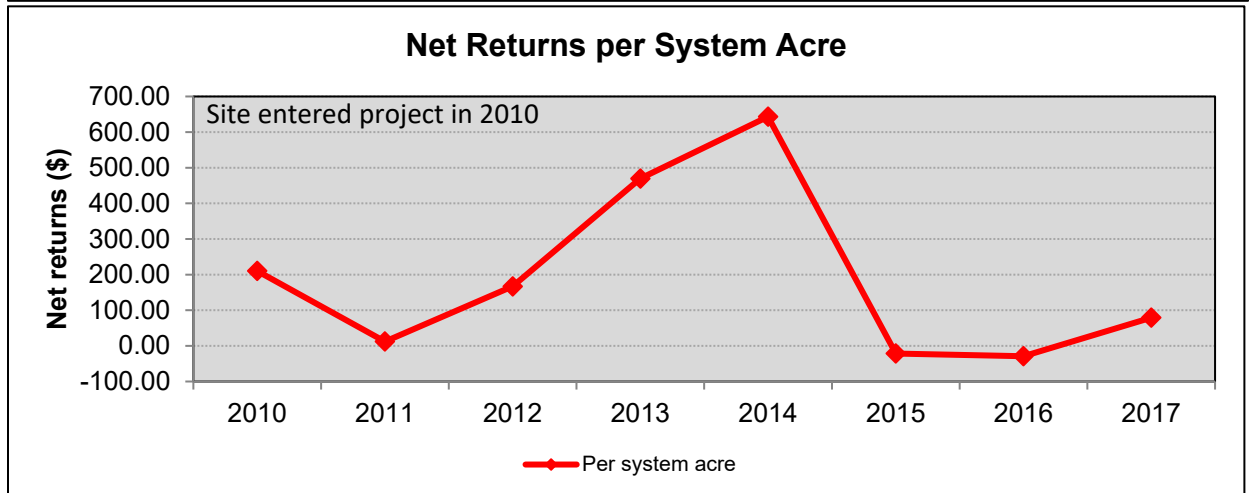
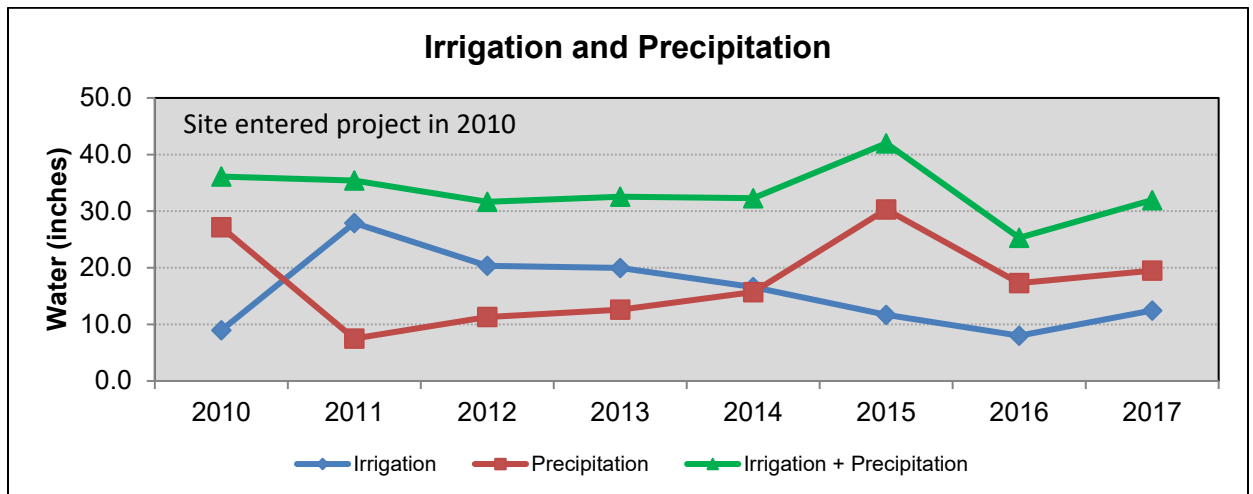
Number of wells: 2

Fuel Source:

1 Natural Gas,  
1 Electric



## Site 31 – No Data for 2018 or 2019



**Site 31 – No Data for 2018 or 2019**



May



PMDI installed on span



LEPA Irrigation head



PMDI drag line



July Grain sorghum



September cotton

Comments: In 2016 this pivot irrigated site was established as an irrigation technology site and fitted with LESA, LEPA 40, LEPA 80, LDN and PMDI technologies for demonstration and comparison. The site was planted to cotton and seed millet in 2017.

## SITE 32



### Description:

Site acres: 70

### Soil types:

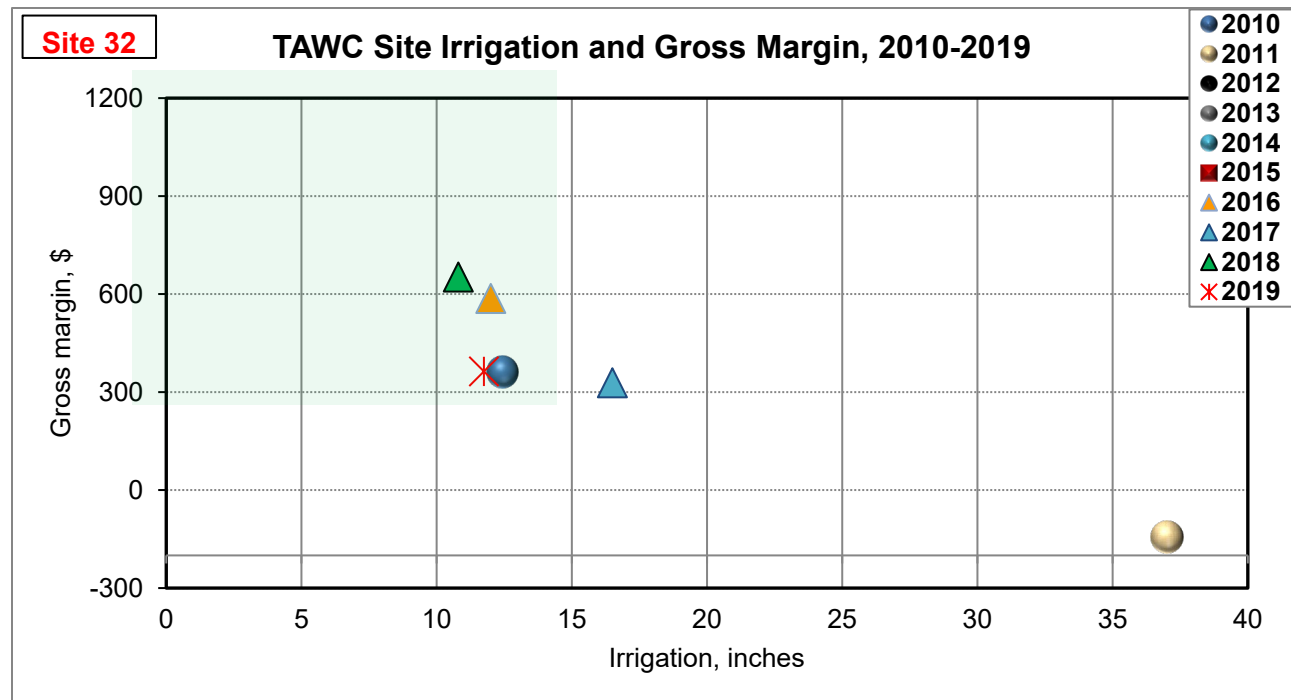
PuA-Pullman clay loam, 0 to 1%

### Irrigation:

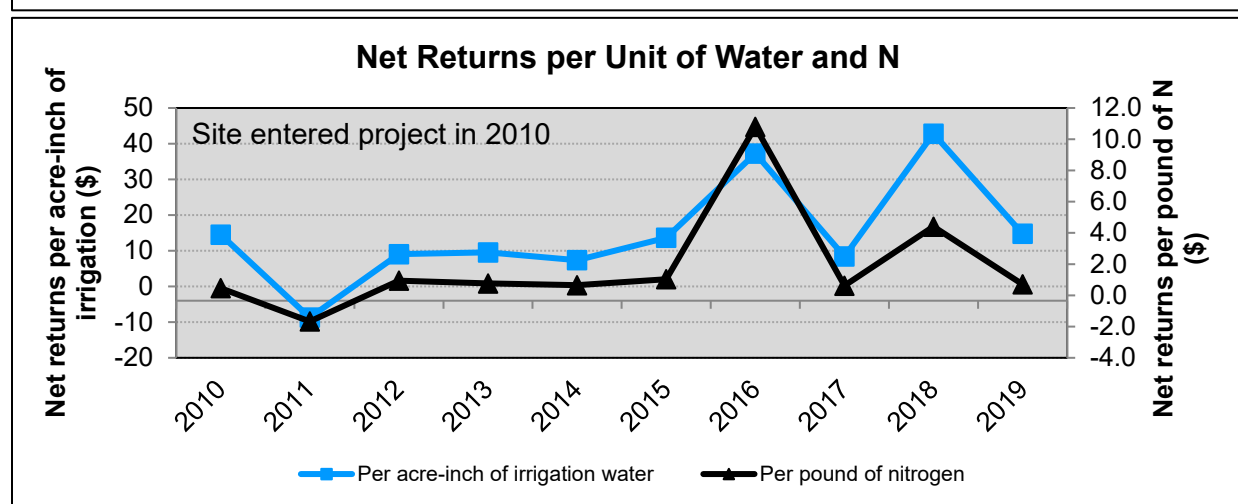
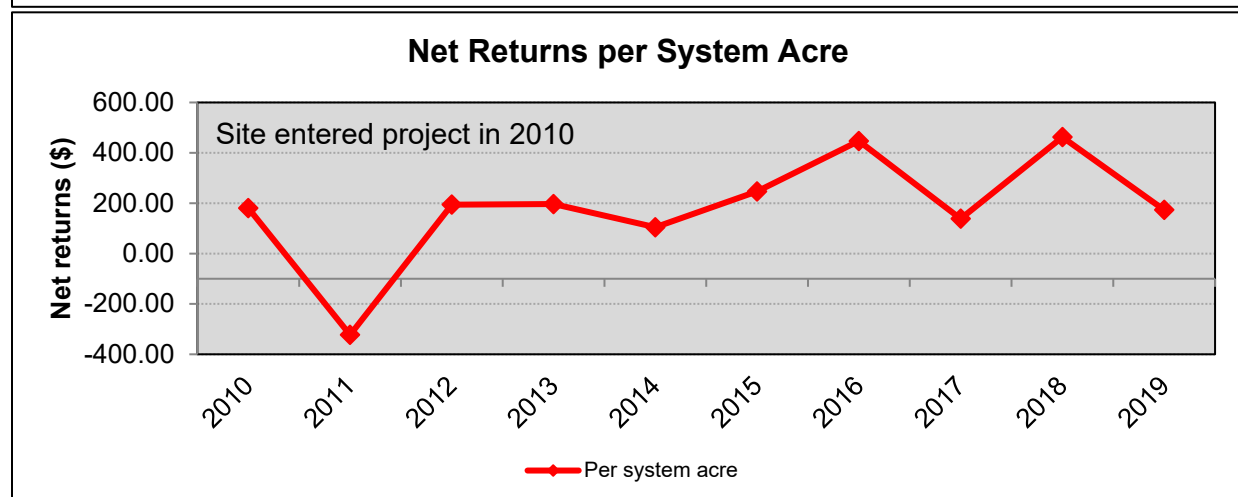
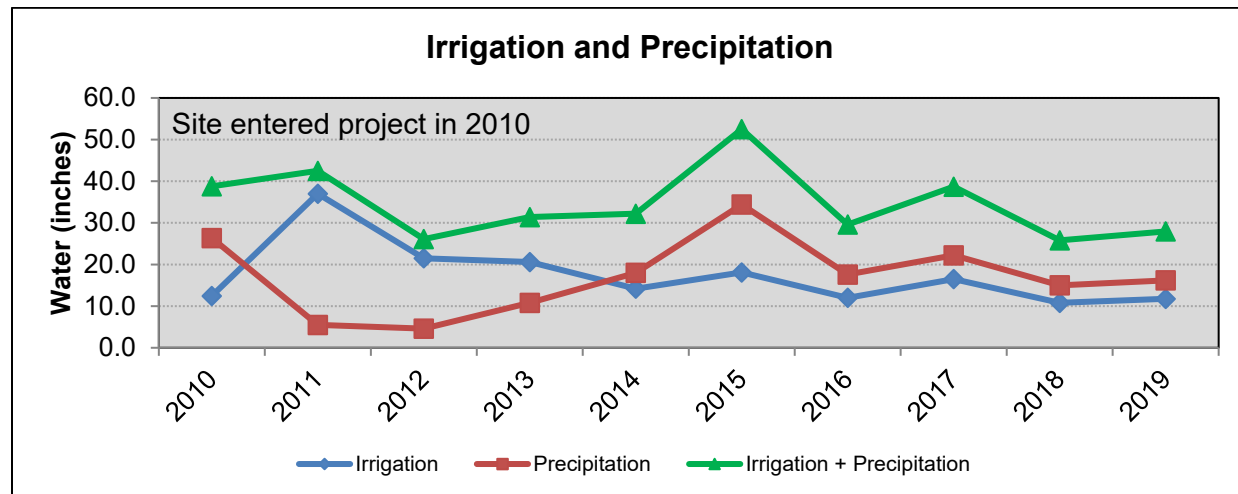
Center Pivot (LEPA) 350 gpm

Number of wells: 2

Fuel Source: Electric



## Site 32





## Site 32



March



Corn stubble



August corn

Comments: In 2019 this pivot LEPA irrigated site was vertical till planted to corn.

## SITE 35



### Description:

Site acres: 230.0

### Soil types:

**PuA**-Pullman clay loam, 0 to 1%

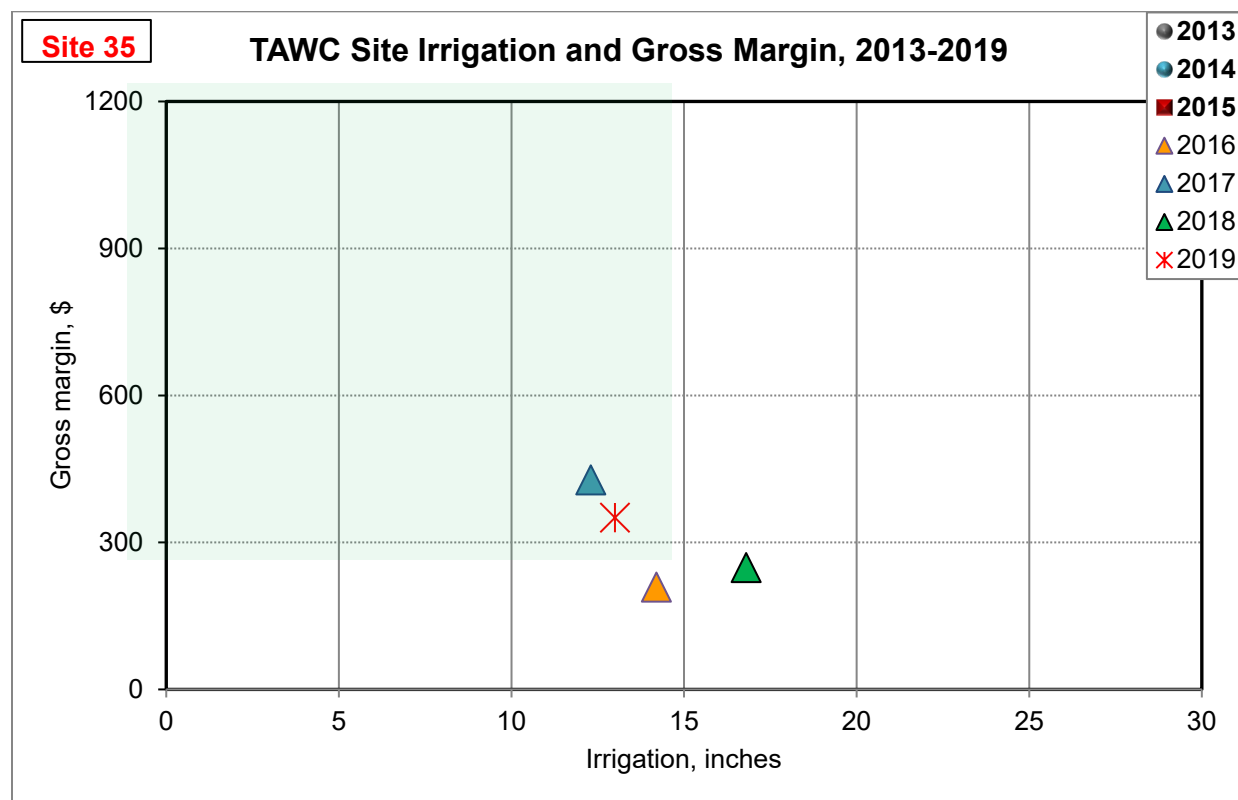
**LoA**-Lofton clay loam, 0 to 1%

### Irrigation:

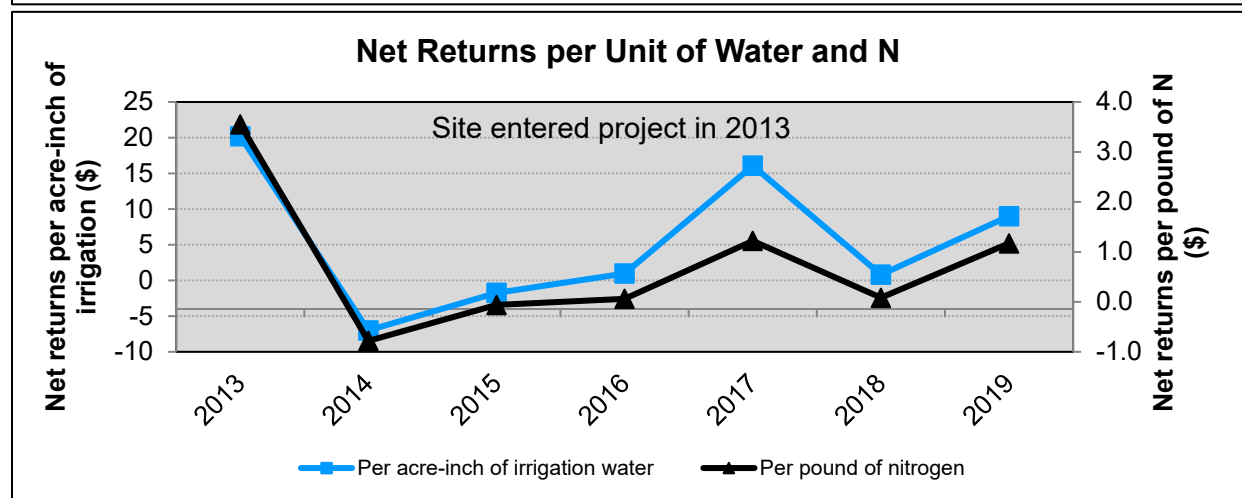
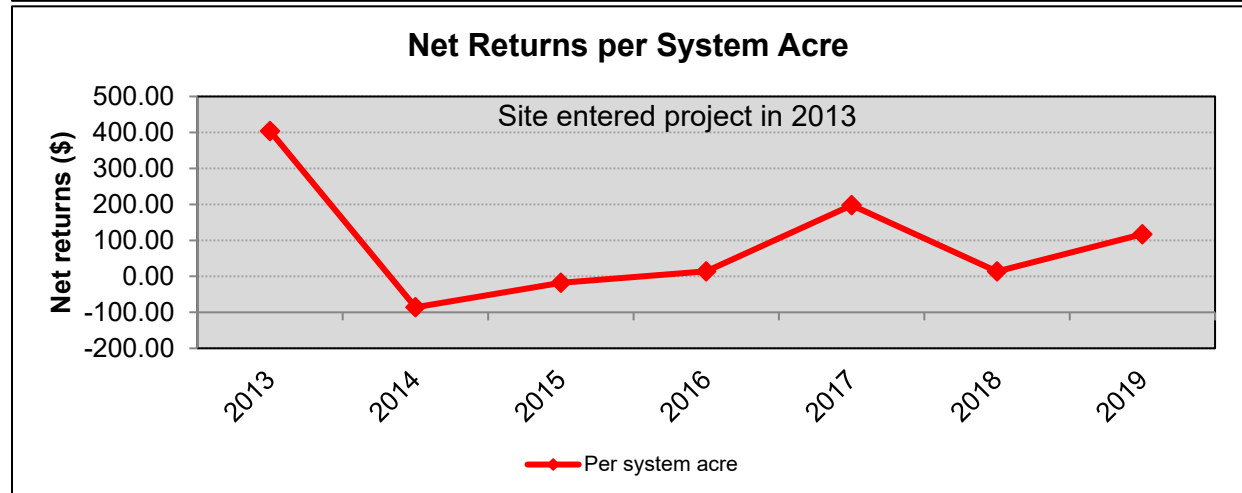
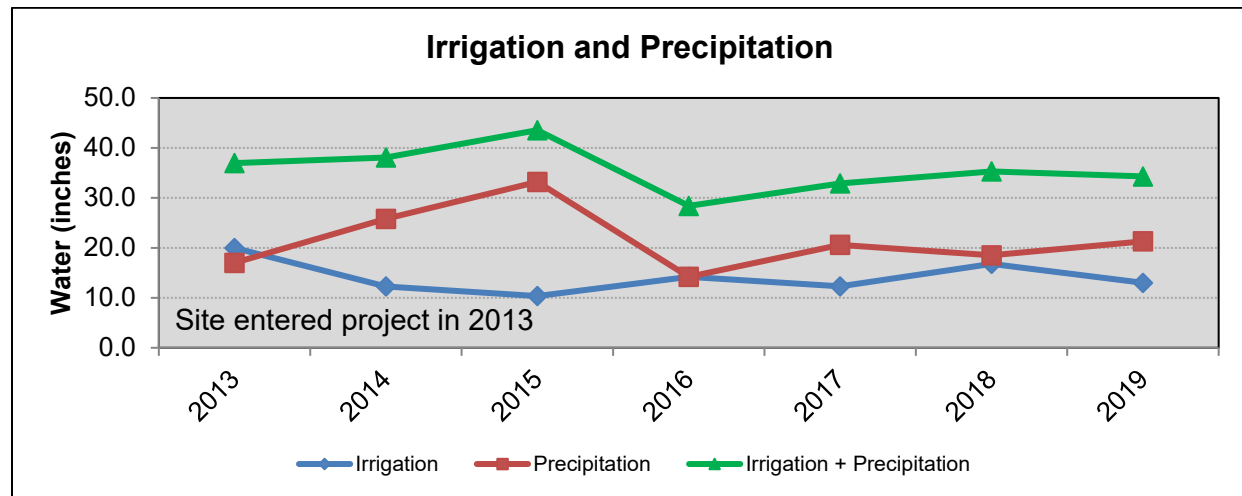
Sub-Surface Drip (SDI)  
650 gpm

Number of wells: 2

Fuel Source: Electric



## Site 35





## Site 35



May



May corn



September cotton



September corn



Corn being harvested



November cotton

Comments: In 2019 this SDI irrigated site was planted to white food corn and cotton. Following cotton hail out of field 7 corn was replanted.

## SITE C37



### Description:

Site acres: 121.1

### Soil types:

**PuA**-Pullman clay loam, 0 to 1%

**AcB**-Acuff loam, 1 to 3%

**EsB**-Estacado loam, 1 to 3%

**Mkc**-Mansker loam, 3 to 5%

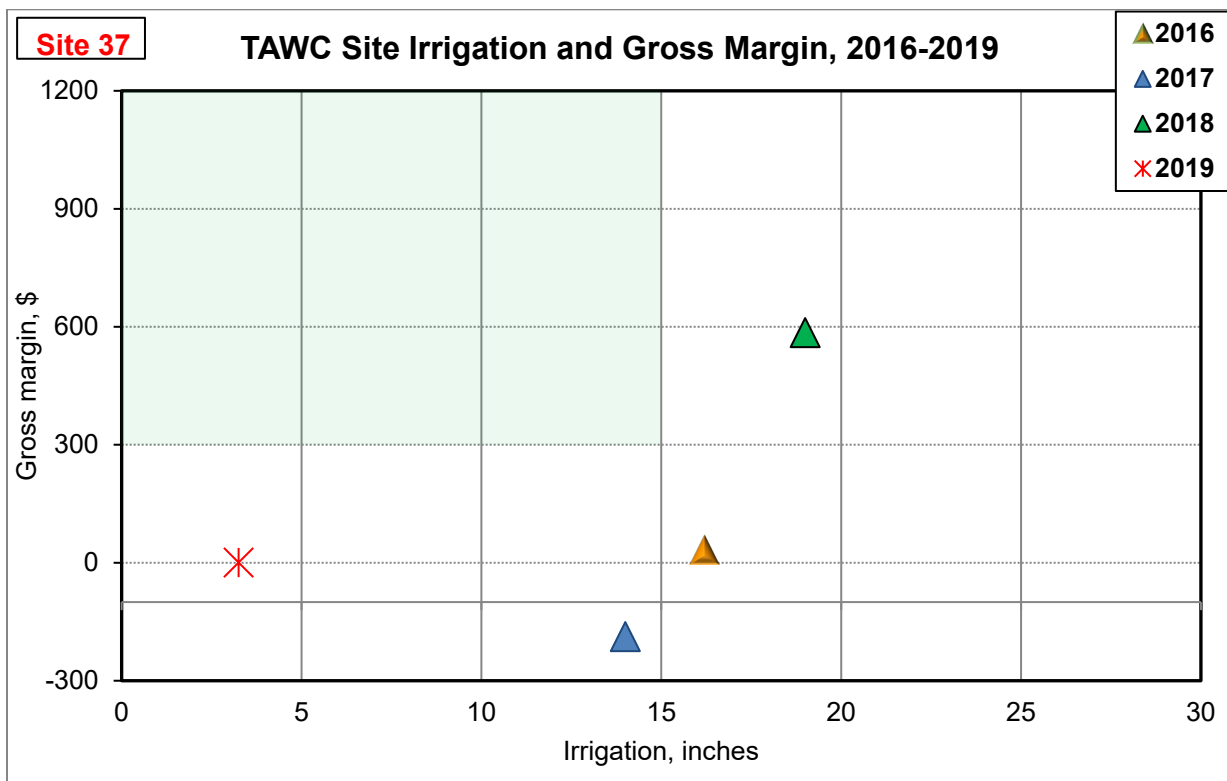
**Ra**-Randal clay, 0 to 1%

### Irrigation:

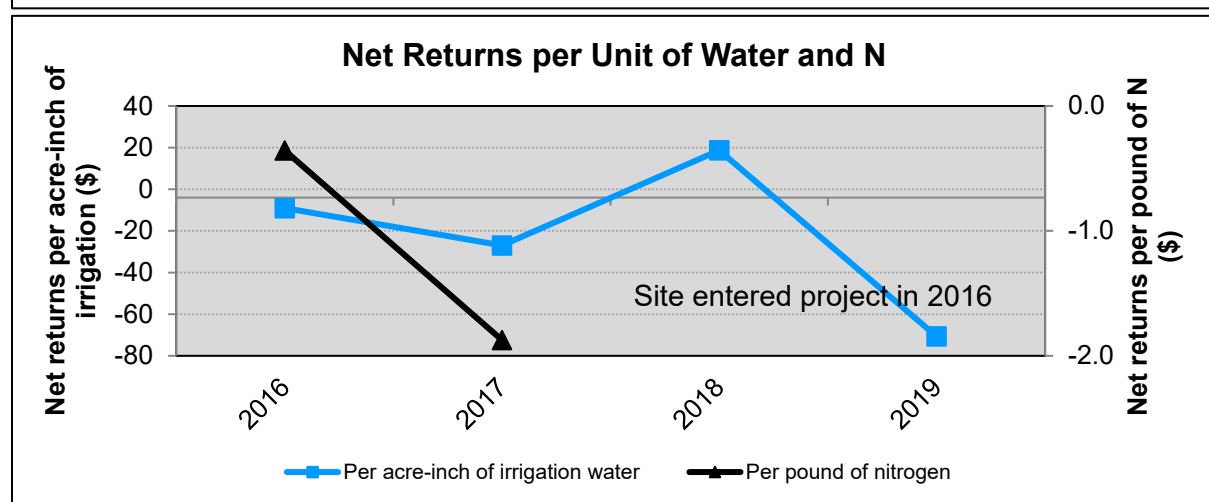
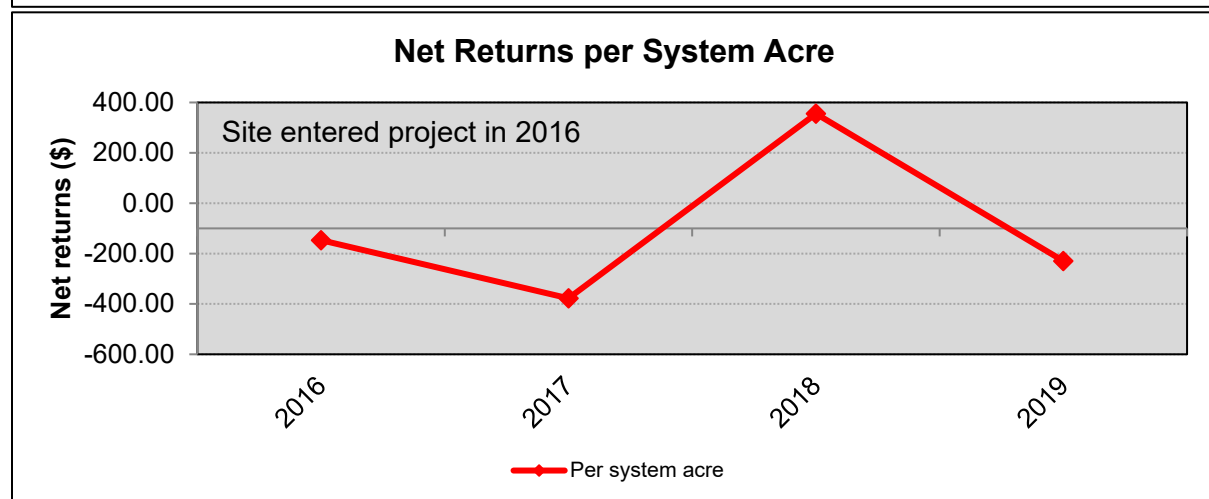
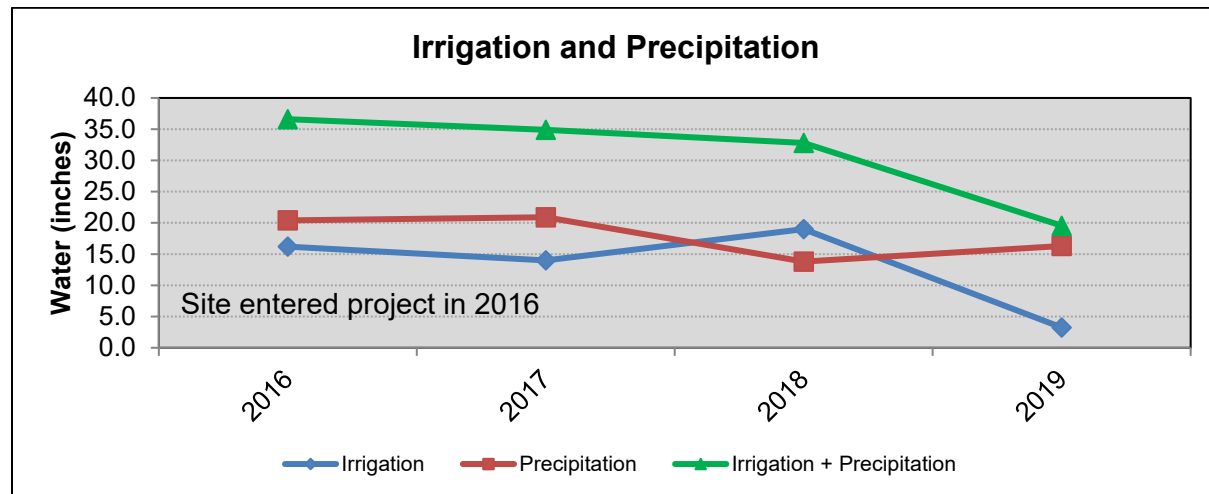
Center Pivot (VR) 450 gpm

Number of wells: 2

Fuel Source: Electric



## Site C37



**Site C37**



Variable rate valve



VRI Irrigation System



Cotton

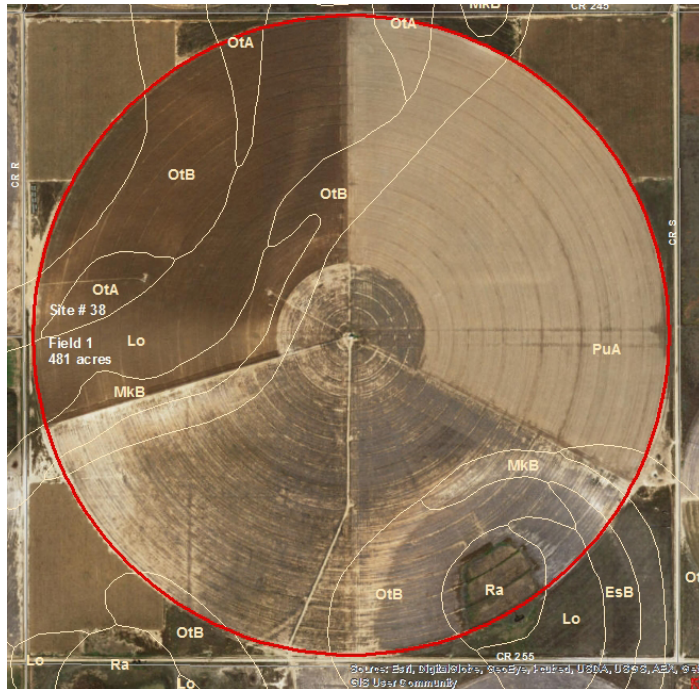


October cotton

Comments: In 2019 this site was planted to cotton on 30-inch centers utilizing a Variable Rate Irrigation (VRI) system. After being hailed out, system was fallowed for year.



## SITE C38



### Description:

Site acres: 481

### Soil types:

**PuA**-Pullman clay loam, 0 to 1%

**Lo**-Lofton clay loam, 0 to 1%

**MkB**-Mansker loam, 0 to 3%

**OtA**-Olton loam, 0 to 1%

**OtB**-Olton loam, 1 to 3%

**Ra**-Randall clay, 0 to 1%

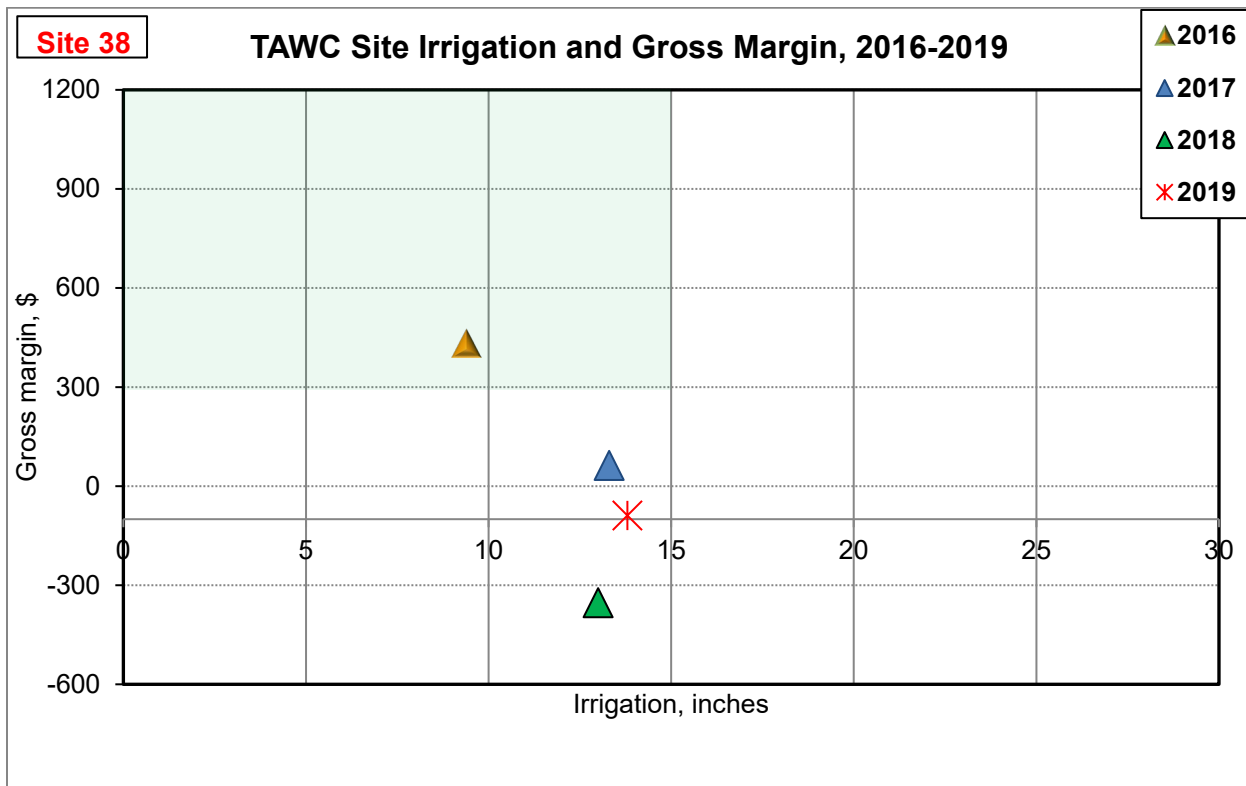
**EsB**-Estacado loam, 1 to 3%

### Irrigation:

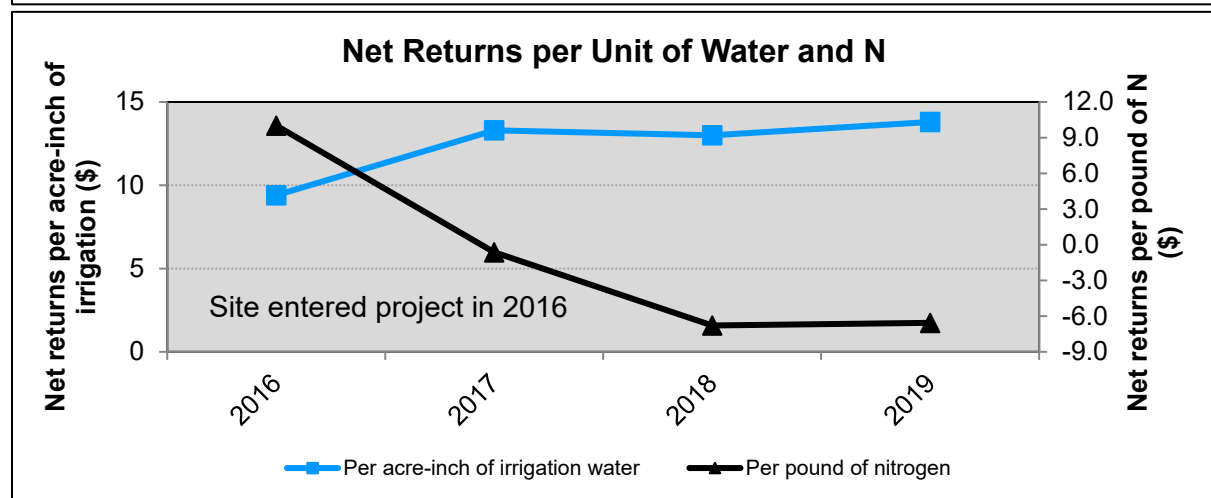
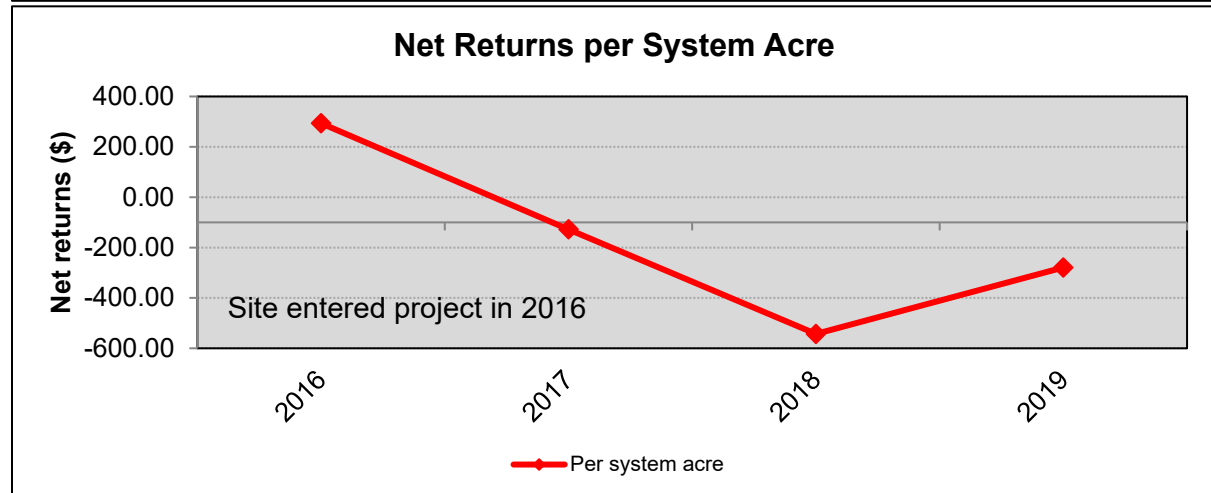
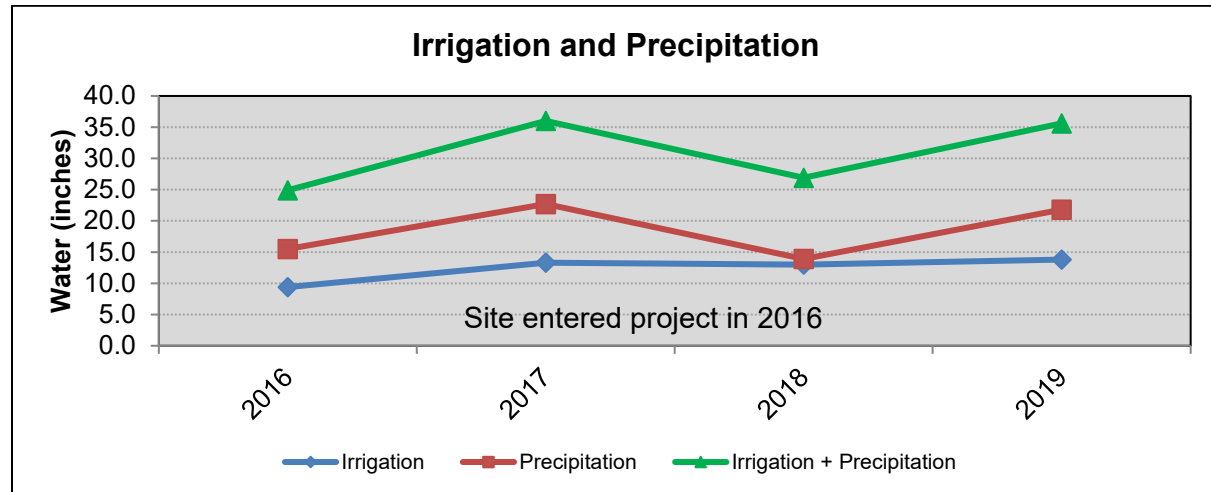
Center Pivot (VR) 750 gpm

Number of wells: 3

Fuel Source: Electricity



## Site C38



## Site C38



Irrigation nozzle



July cotton



July cotton

Comments: In 2019 this site was planted to cotton on 30-inch centers utilizing a Variable Rate Irrigation (VRI) system. It was hailed out, but replanted again to cotton.



## SITE C39



### Description:

Site acres: 120.0

### Soil types:

**PuA**-Pullman clay loam, 0 to 1%

**OcB**-Olton clay loam, 1 to 3%

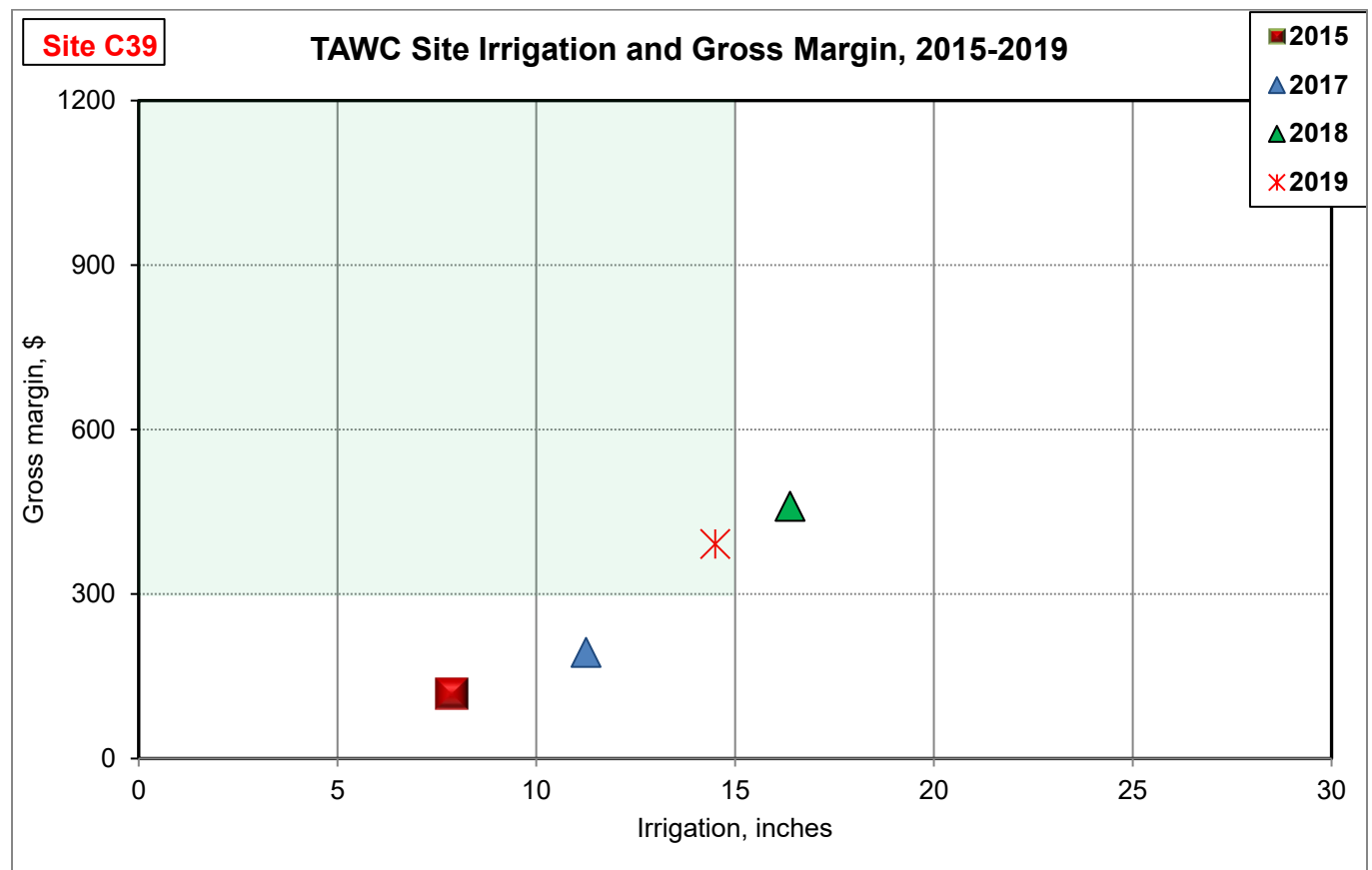
**EcB**-Estacado clay loam, 1 to 3%

### Irrigation:

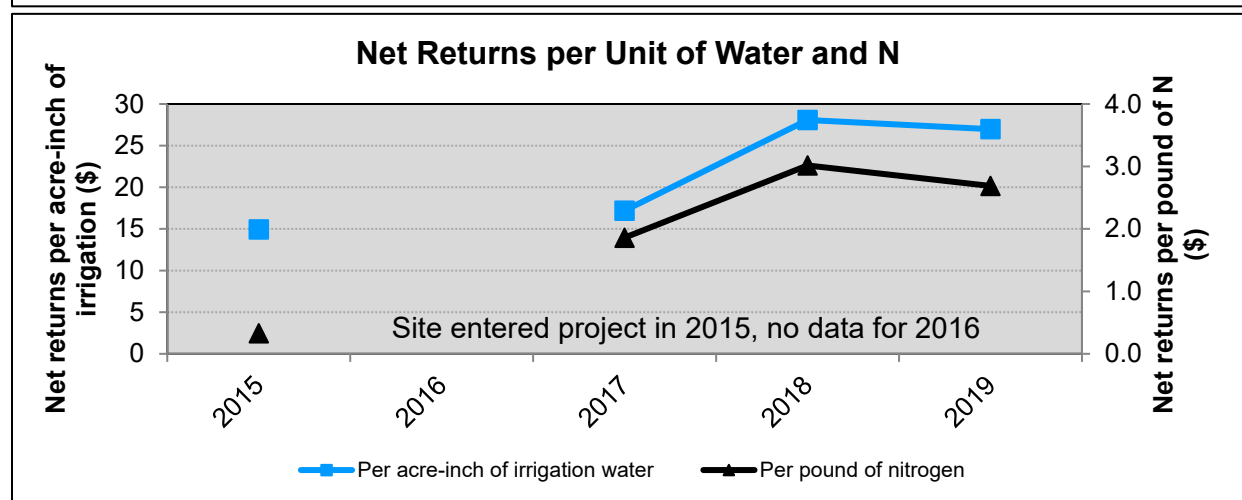
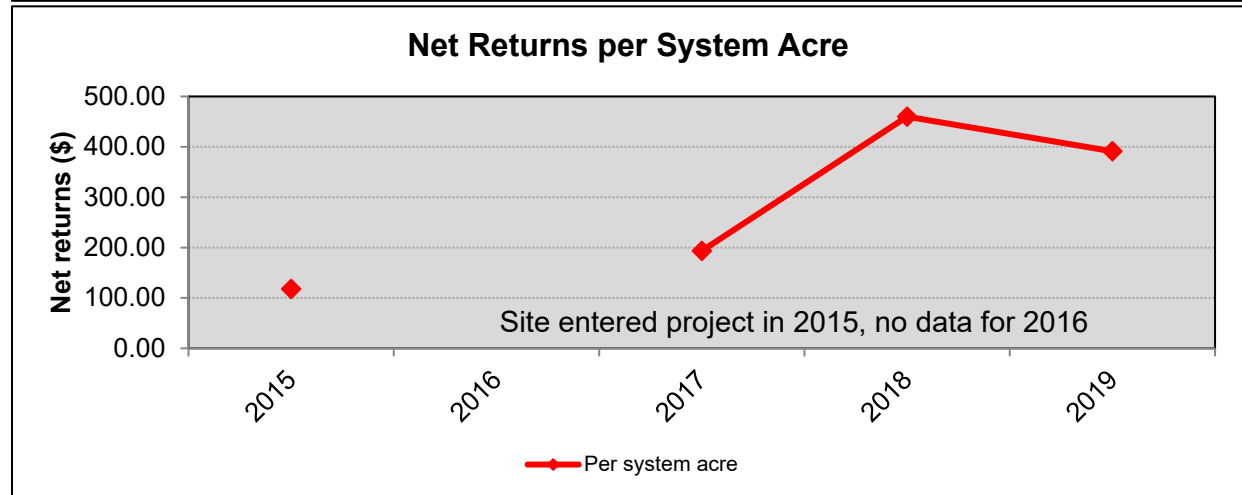
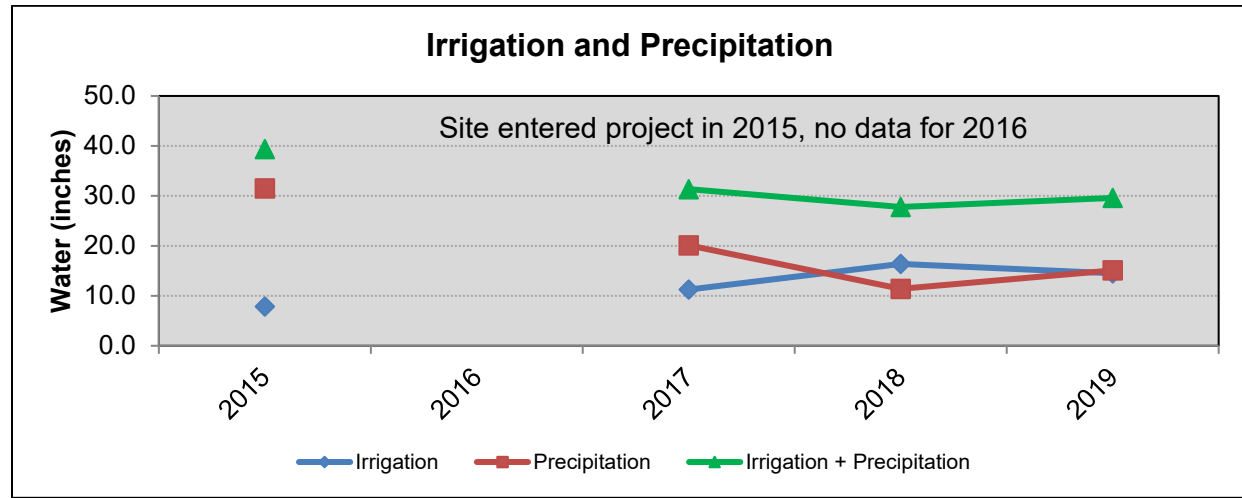
Center Pivot (LESA) 650 gpm

Number of wells: 1

Fuel Source: Electricity



## Site C39 – No Site Data for 2016



## Site C39



June corn



Fertilize injection



July cotton

Comments: In 2019 this LESA/LEPA site was planted to corn and cotton.

## SITE 41



### **Description:**

Site acres: 120.0

### Soil types:

5-Amarillo fine sandy loam, 0 to 1%

6-Amarillo fine sandy loam, 1 to 3%

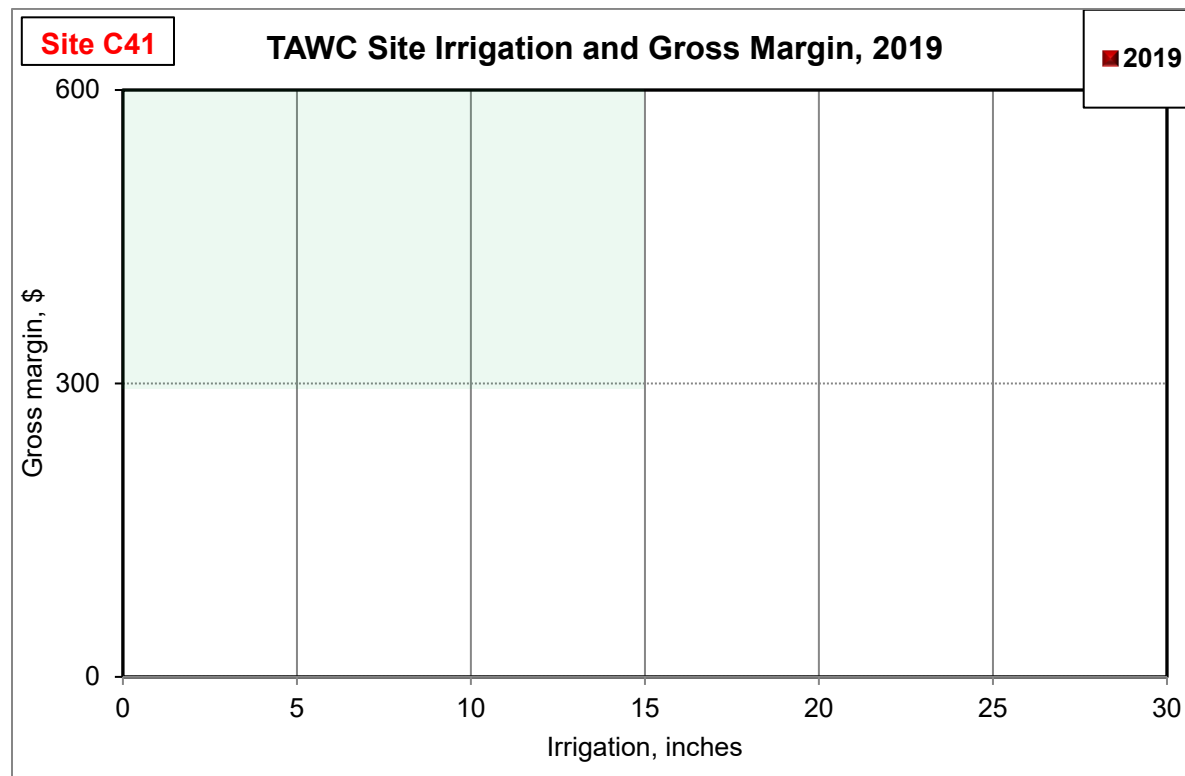
42-Randall clay

### Irrigation:

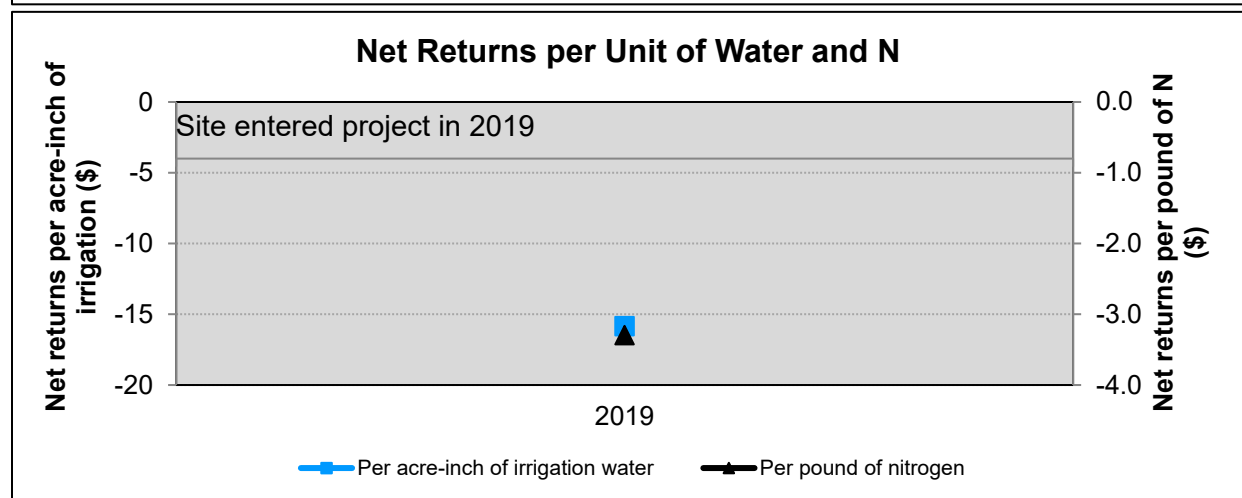
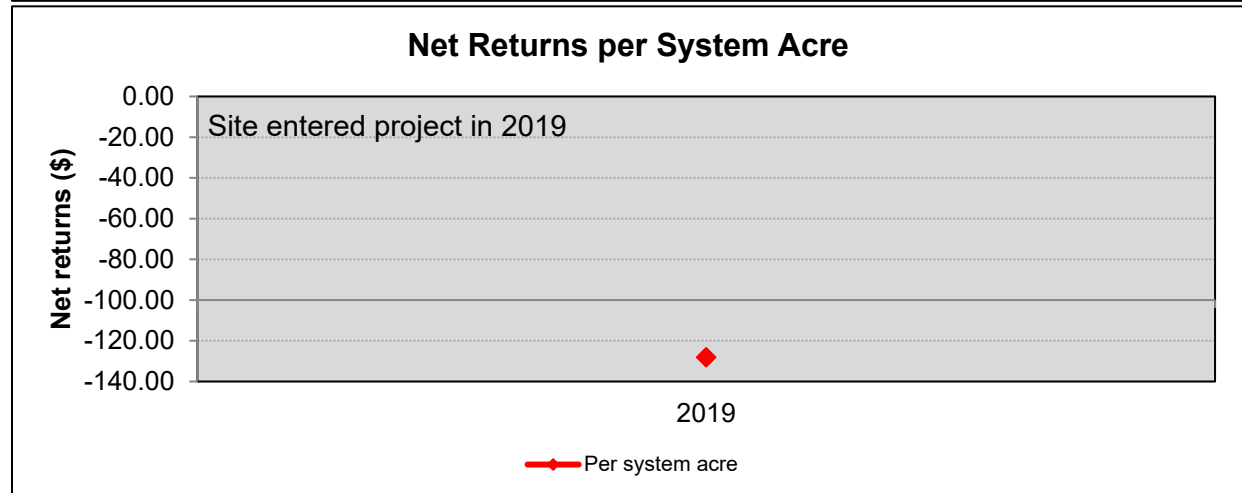
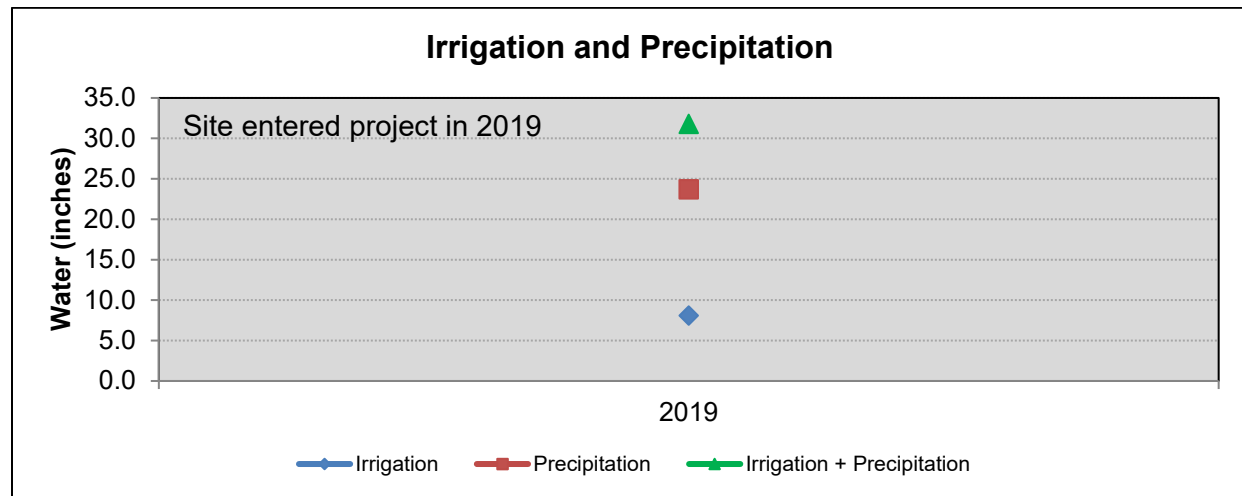
Center Pivot (LEPA) 400 gpm

Number of wells: 6

Fuel Source: Electricity



## Site 41



**Site 41**

No pics available

Comments: In 2019 this LEPA site was limit-till planted to cotton, hailed out and replanted to cotton.

## SITE 42



### **Description:**

Site acres:

122.0

Soil types:

1-Acuff loam, 0 to 1%

18-Estacado clay loam, 0 to 1%

1%

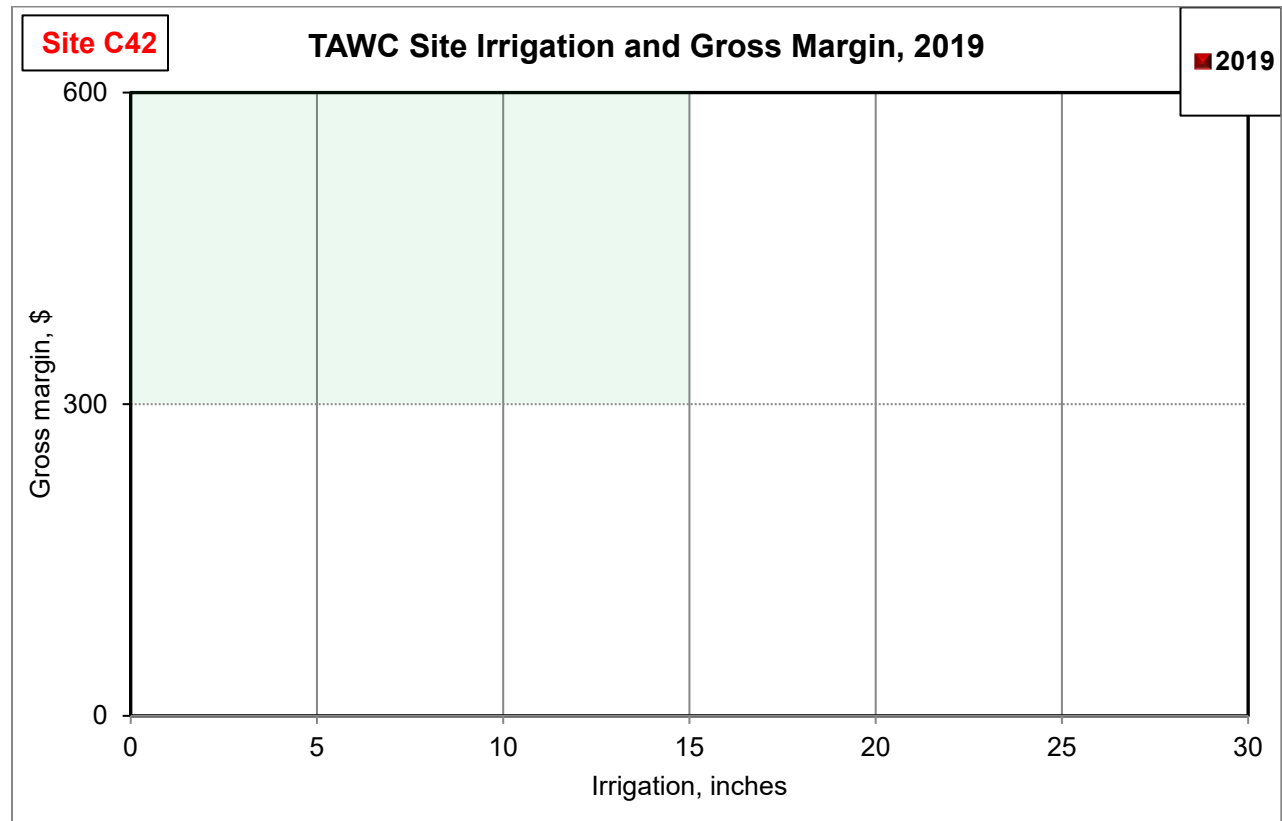
30-Olton clay loam, 0 to 1%

Irrigation:

Subsurface Drip (SDI) 450  
gpm

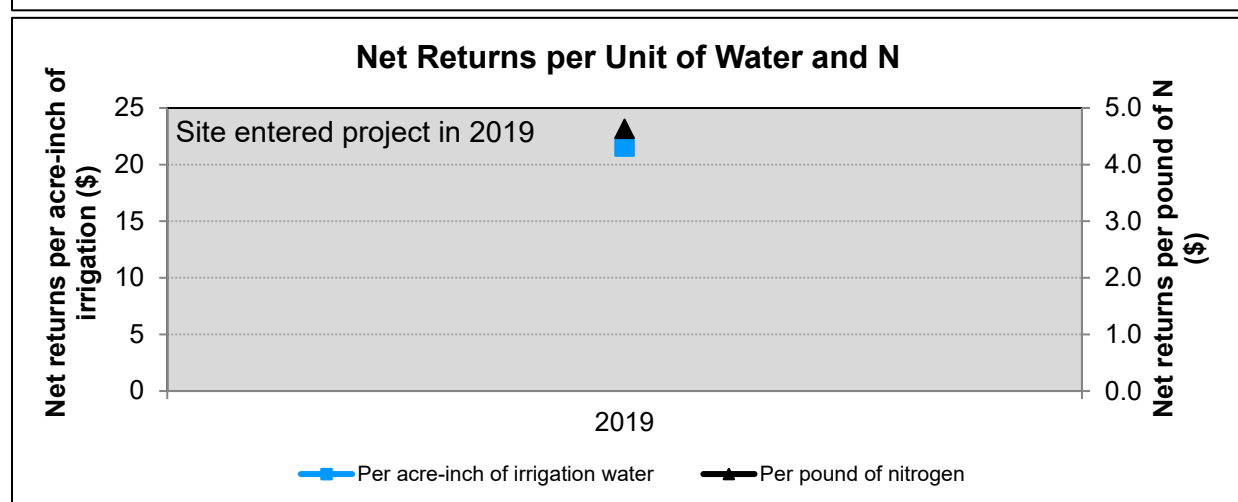
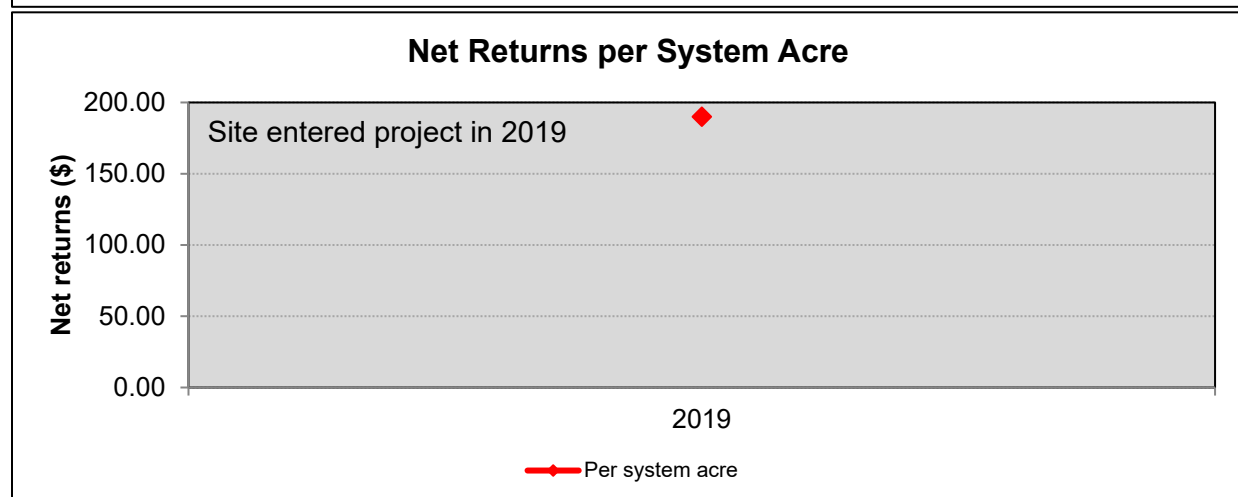
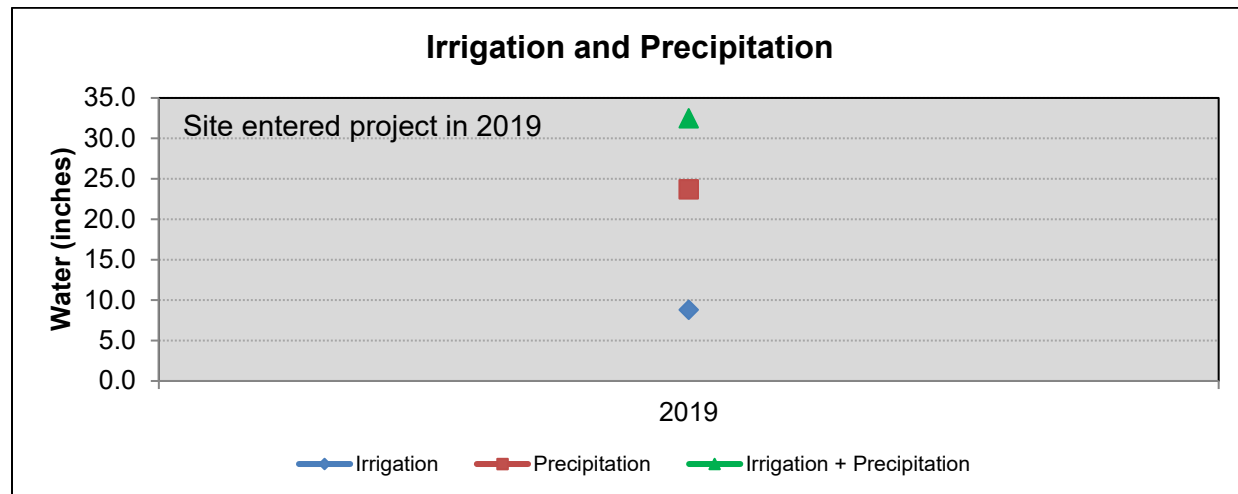
Number of wells: 3

Fuel Source: Electricity





## Site 42

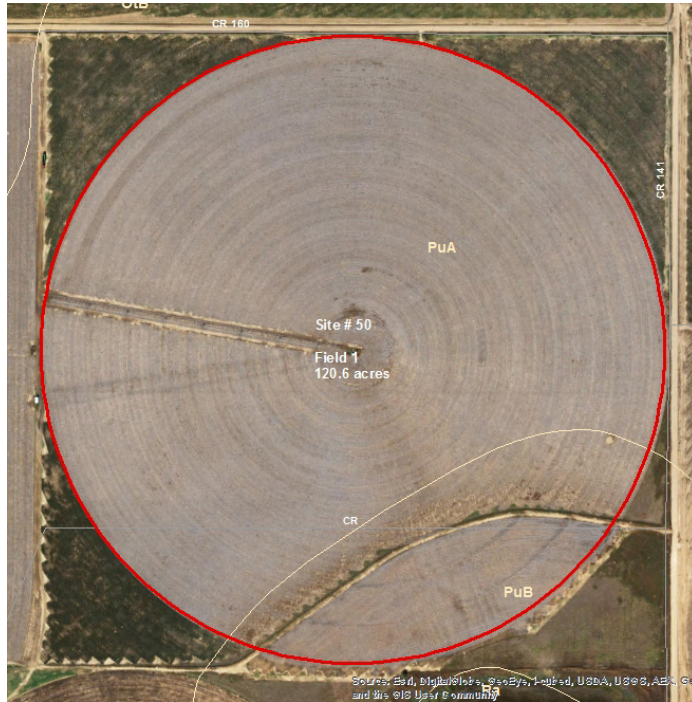


**Site 42**

No pics available

Comments: In 2019 this SDI site was limit-till planted to cotton.
---

## SITE C50



### Description:

Site acres: 120.6

### Soil types:

**PuA**-Pullman clay loam, 0 to 1%

**PuB**-Pullman clay loam, 1 to 3%

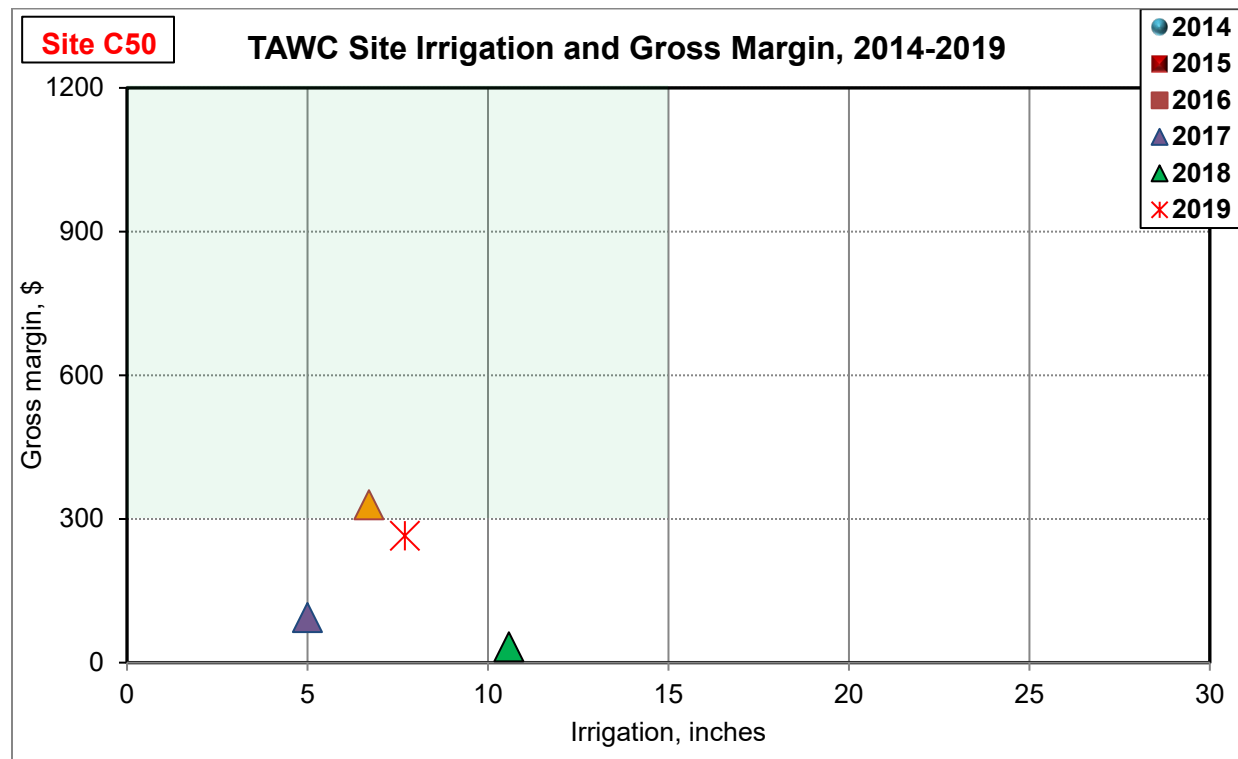
### Irrigation:

Low Elevation Spray Application  
(LESA) 265 gpm

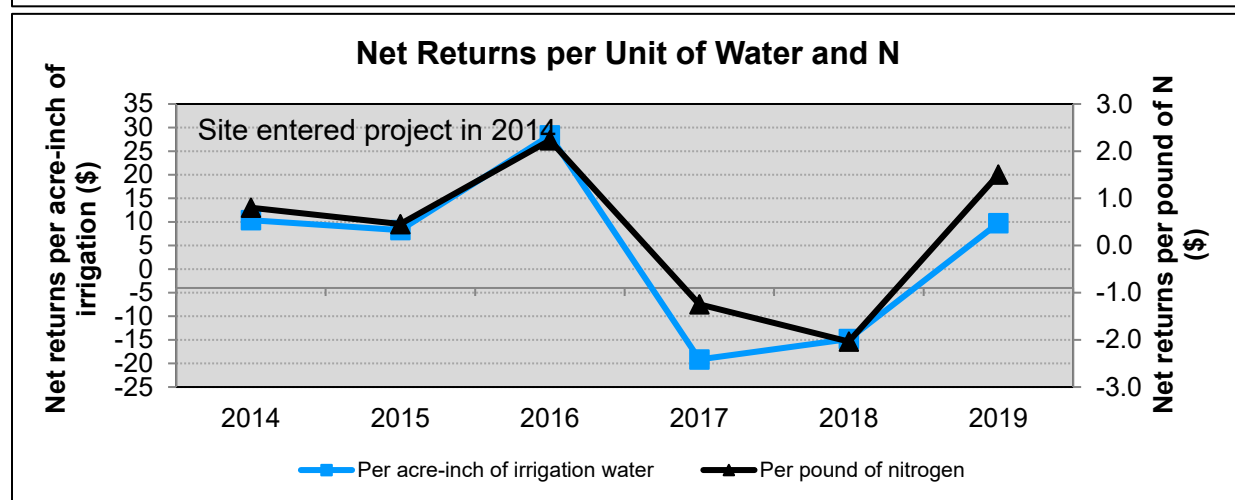
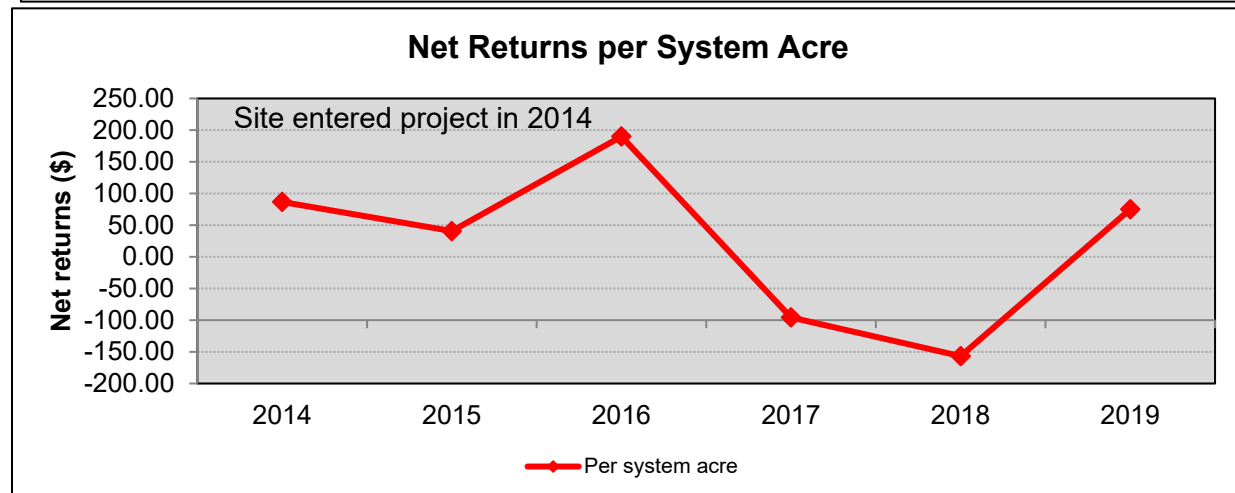
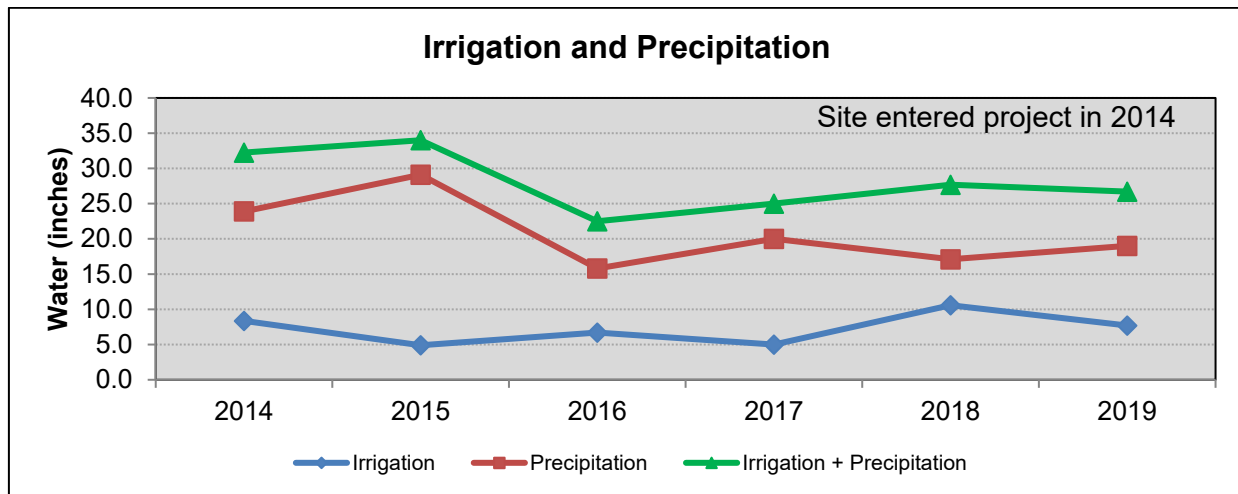
Number of wells: 1

Depth: 300 feet

Fuel Source: Natural gas



## Site C50



## Site C50



May



August cotton



October cotton



Surface turbine irrigation well

Comments: In 2019 this LESA irrigated site was planted to monoculture cotton but managed as a VRI system through speed adjustment. All crops were planted on 40-inch centers conventional tillage.

## SITE C51



### **Description:**

Site acres: 45.7

### Soil types:

OtA-Olton loam; 0 to 1%

OtB-Olton loam; 1 to 3%

### Irrigation:

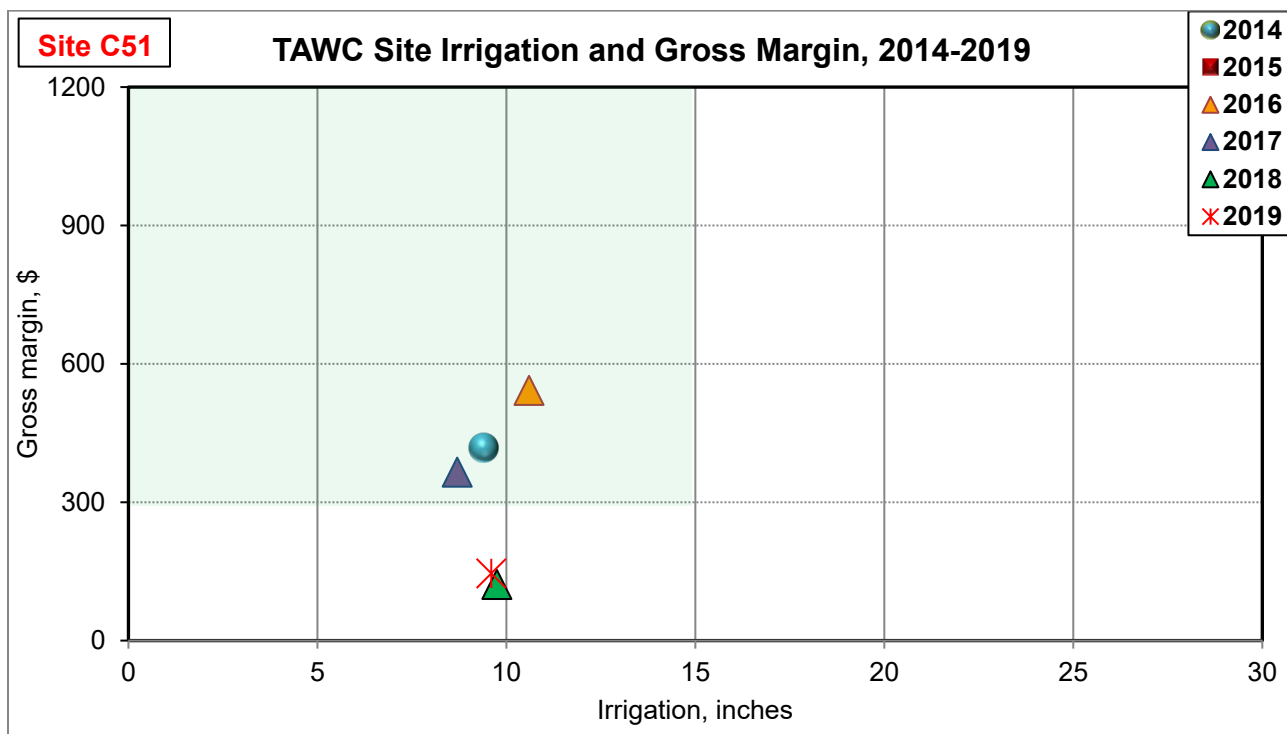
Sub-surface Drip  
(SDI)

175 gpm

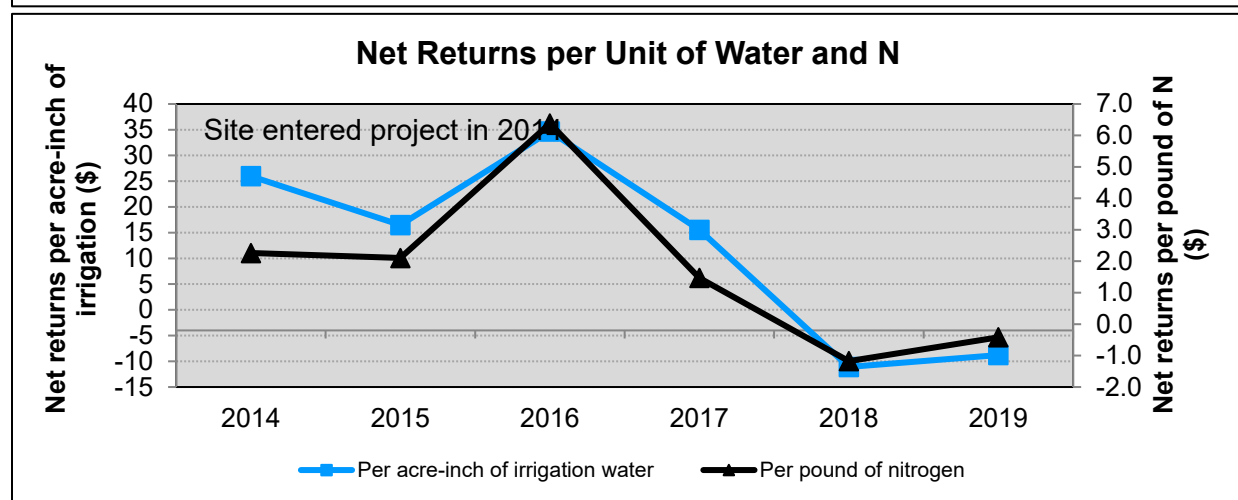
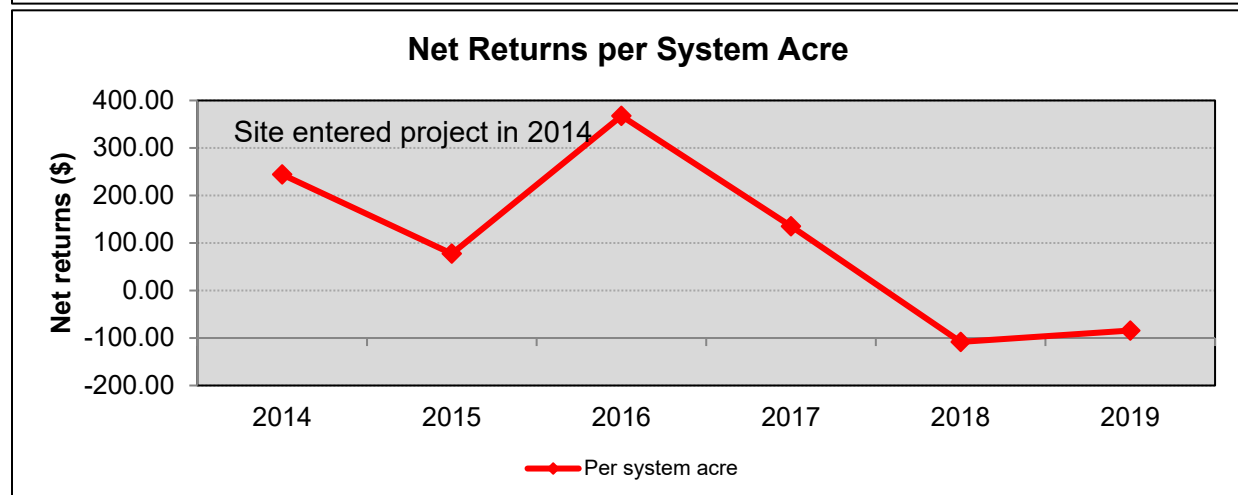
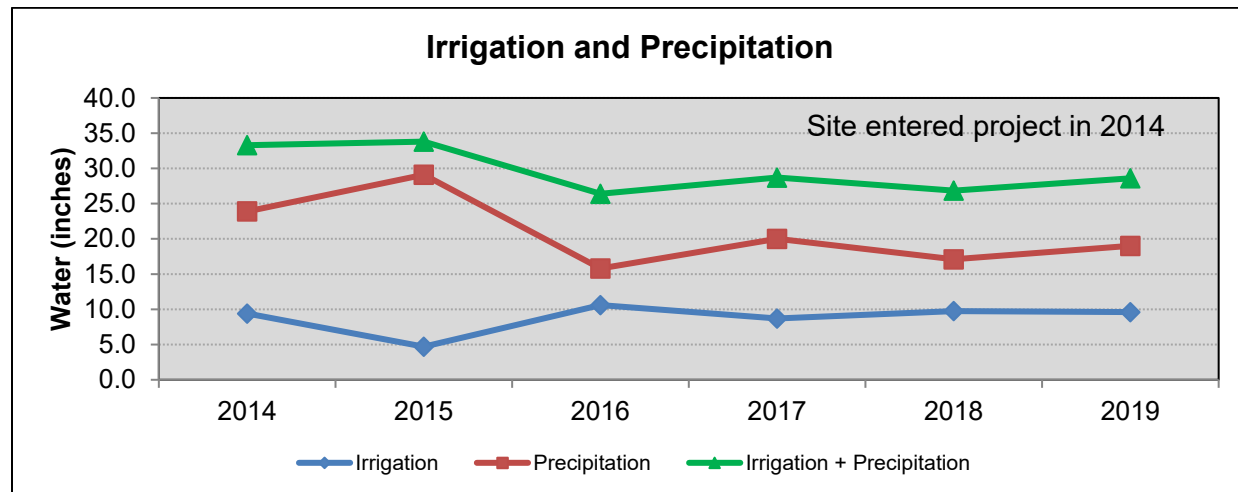
Number of wells: 1

Depth: 350 feet

Fuel Source: Natural gas



## Site C51





## Site C51



Late May planting



Furrow irrigation to establish



Early August cotton



Checking crop maturity



October cotton

Comments: In 2019 this SDI irrigated site was planted to monoculture cotton. All crops were planted on 40-inch centers. Cotton crop was hailed out initially and replanted to cotton.

SITE C56 – No DATA COLLECTED FOR 2019



**Description:**

Site acres: 40

**Soil types:**

OcA - Oilton clay loam, 0 to 1%

AcA - Acuff loam; 0 to 1%

AcB - Acuff loam; 1 to 3%

AfA - Amarillo fine sandy loam, 0 to 1%

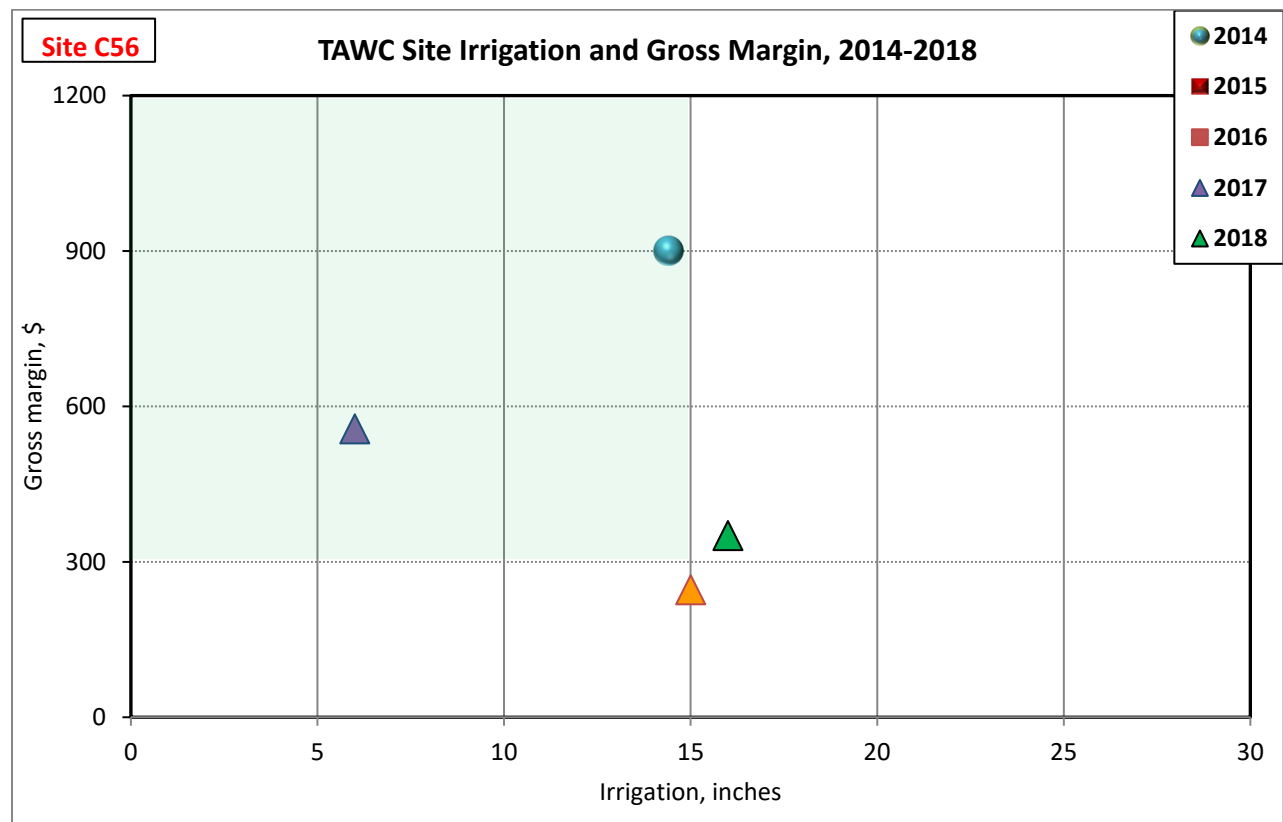
**Irrigation:**

Low Elevation Spray Application  
(LESA) 450 gpm

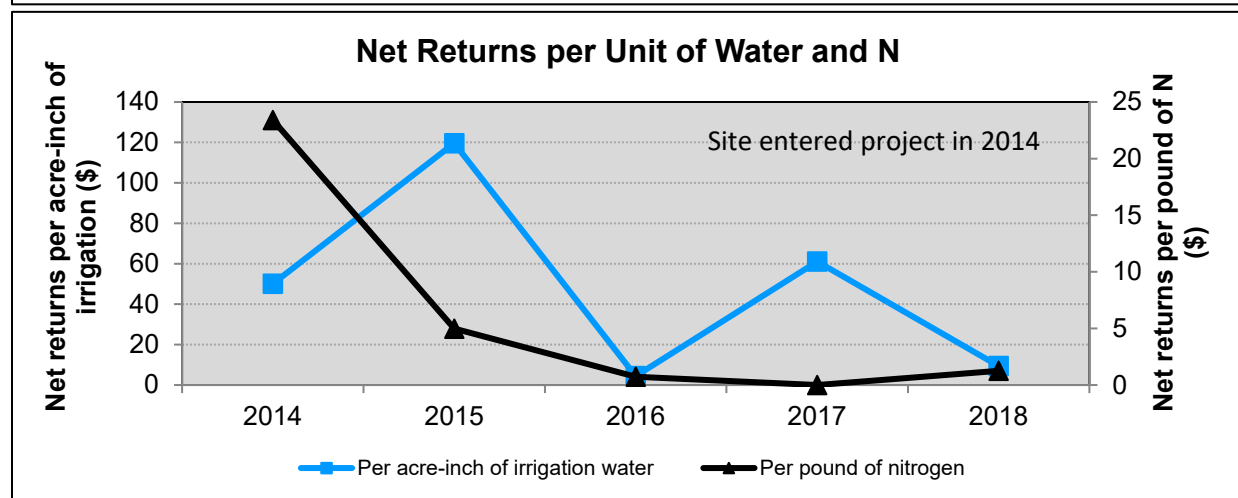
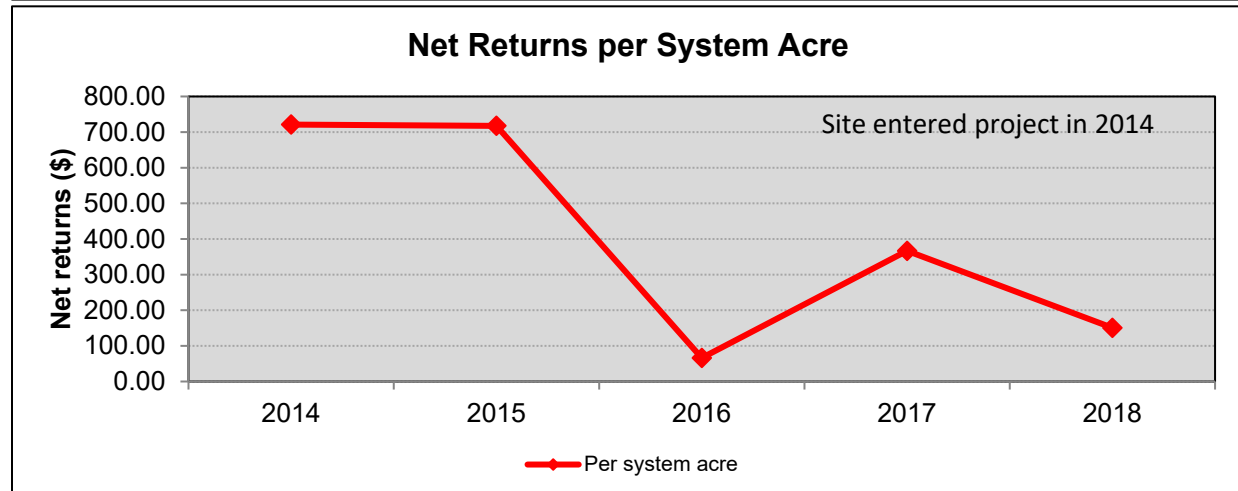
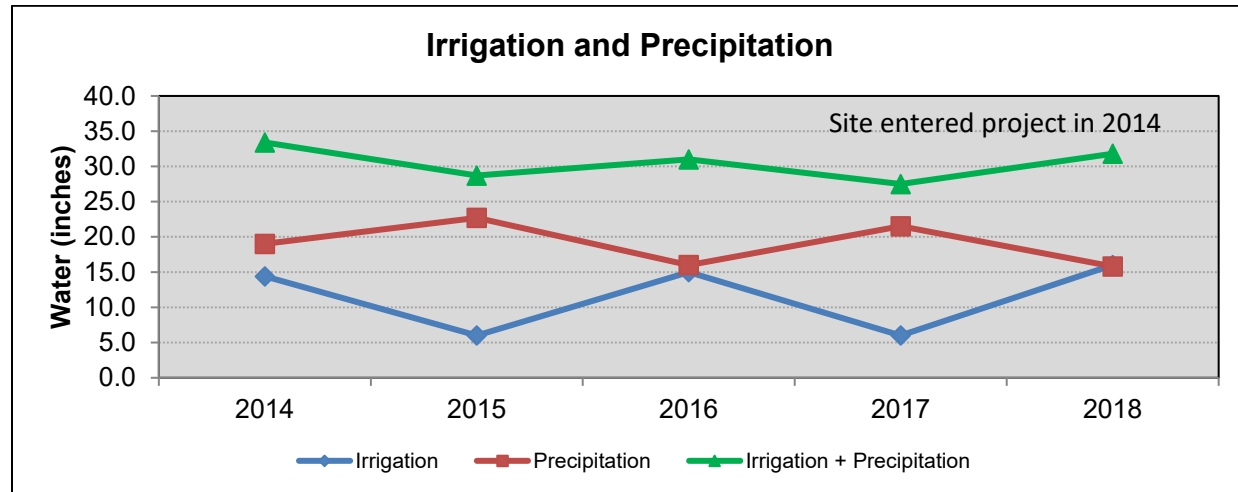
Number of wells: 3

Depth: 300 feet

Fuel Source: Electric



## Site C56 – No Data Collected for 2019



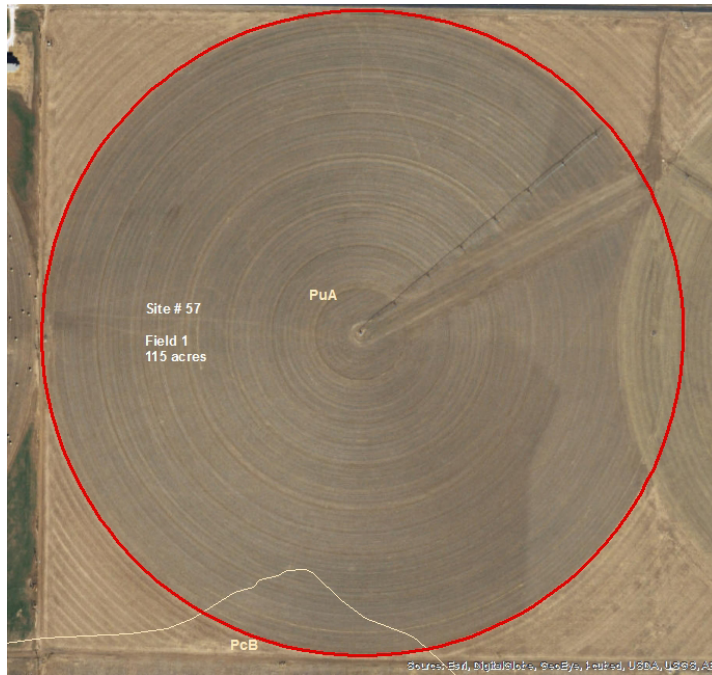
**Site C56** - No Data Collected for 2019



Early January

Comments: In 2018 this LESA irrigated site was planted to corn to be harvested as silage on 30-inch centers. No commercial fertilizer, but 4 tons of compost was applied to crop.

## SITE C57



### Description:

Site acres: 115

### Soil types:

PuA - Pullman clay loam; 0 to 1%

PcB - Pep clay loam; 1 to 3%

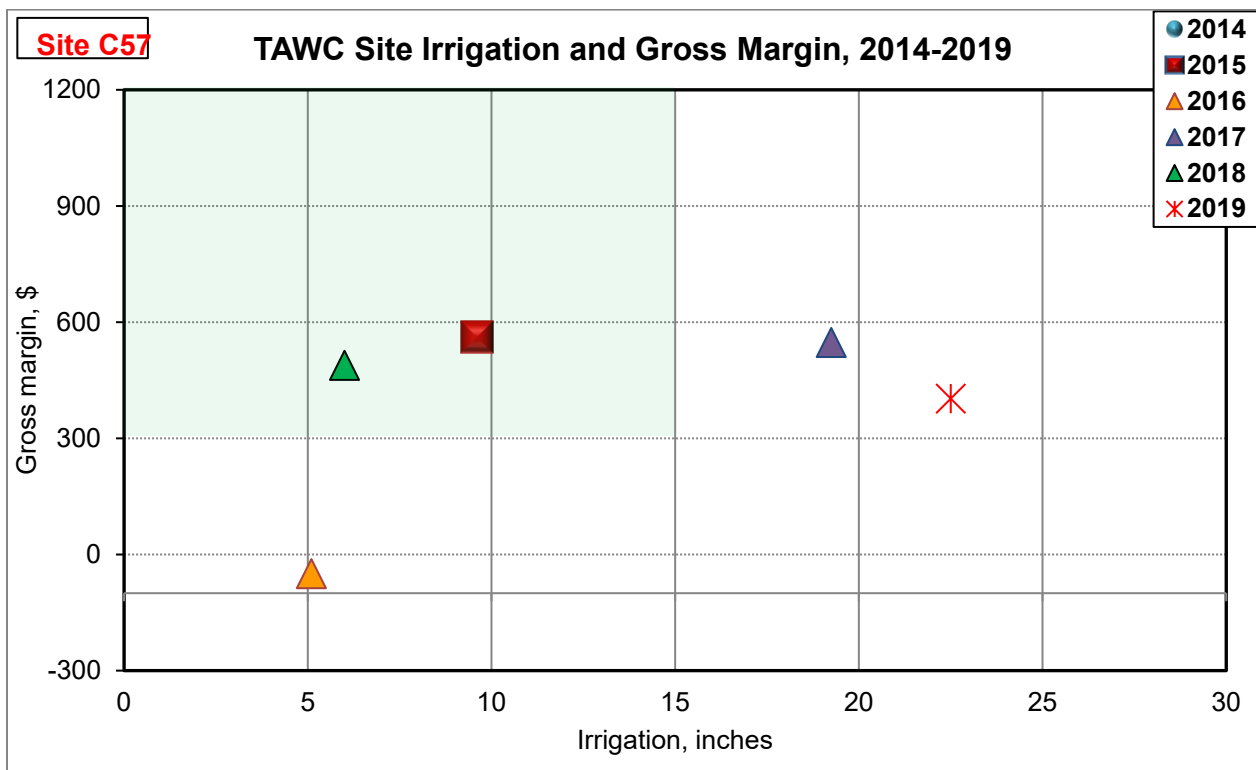
### Irrigation:

Low Elevation Spray Application  
(LESA) 750 gpm

Number of wells: 4

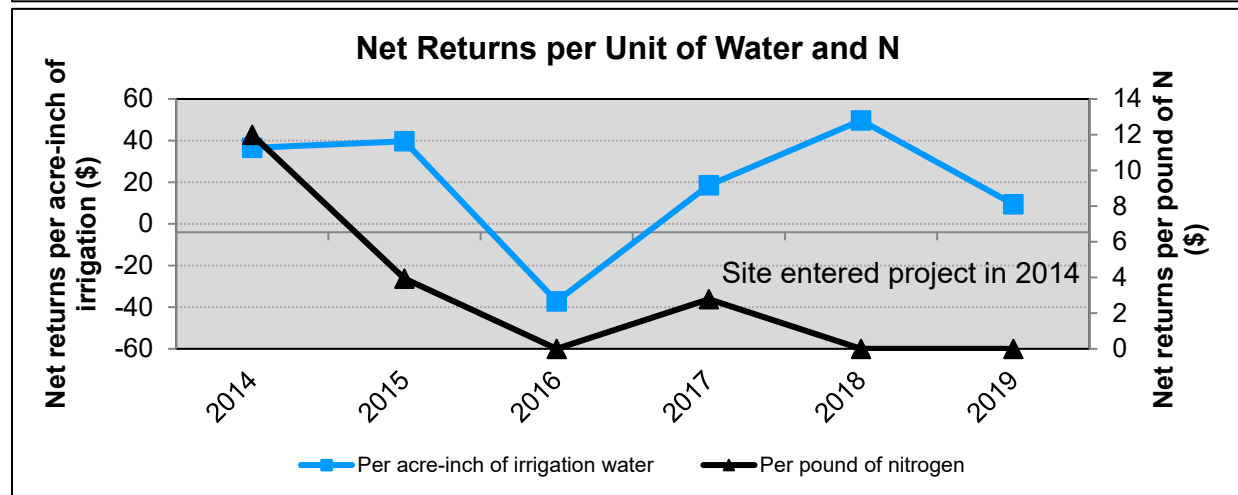
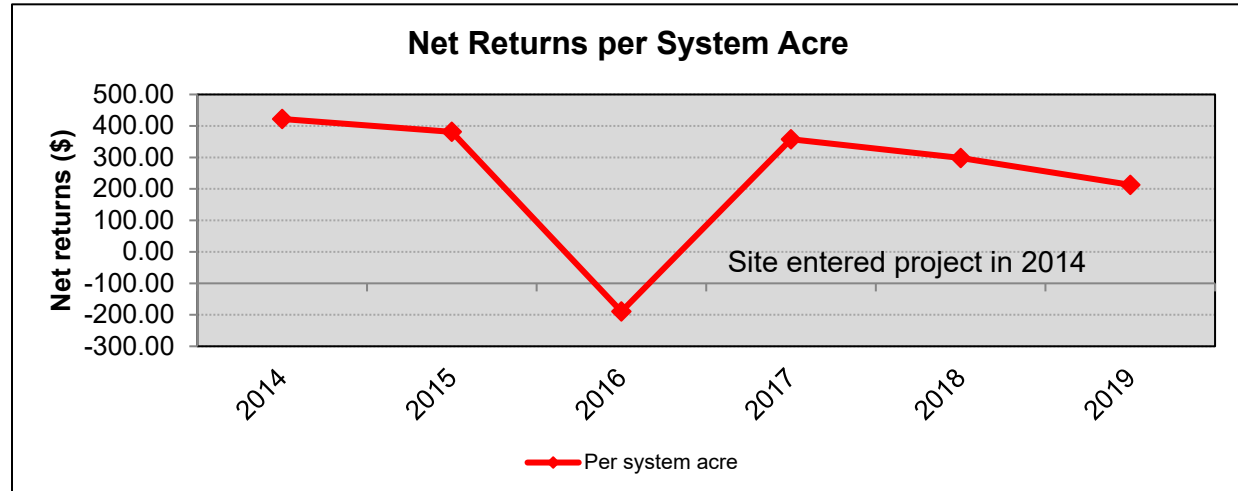
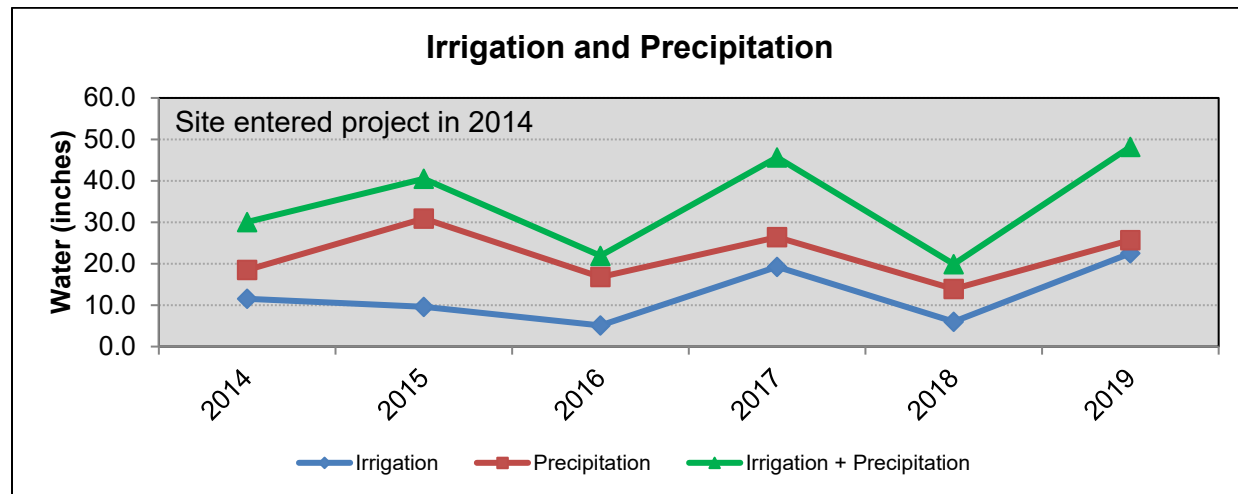
Depth: 300 feet

Fuel Source: Electric





## Site C57



## Site C57



April irrigation



July corn

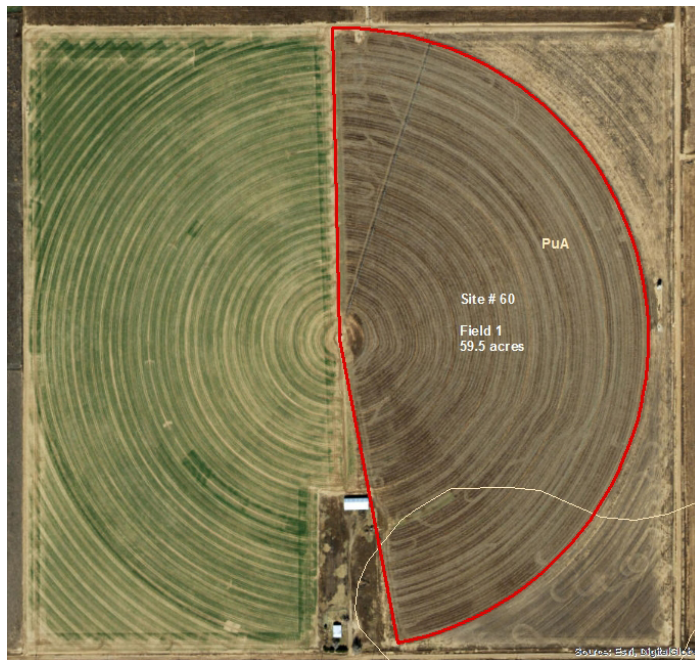


Residue following harvest

Comments: In 2019 this LESA irrigated site was planted to cotton on 30-inch centers with strip-till tillage management but hailed out and was replanted to white food corn.



## SITE C60



### **Description:**

Site acres: 59.5

### Soil types:

**PuA** - Pullman clay loam, 0 to 1%

**LoA** - Lofton clay loam, 0 to 1%

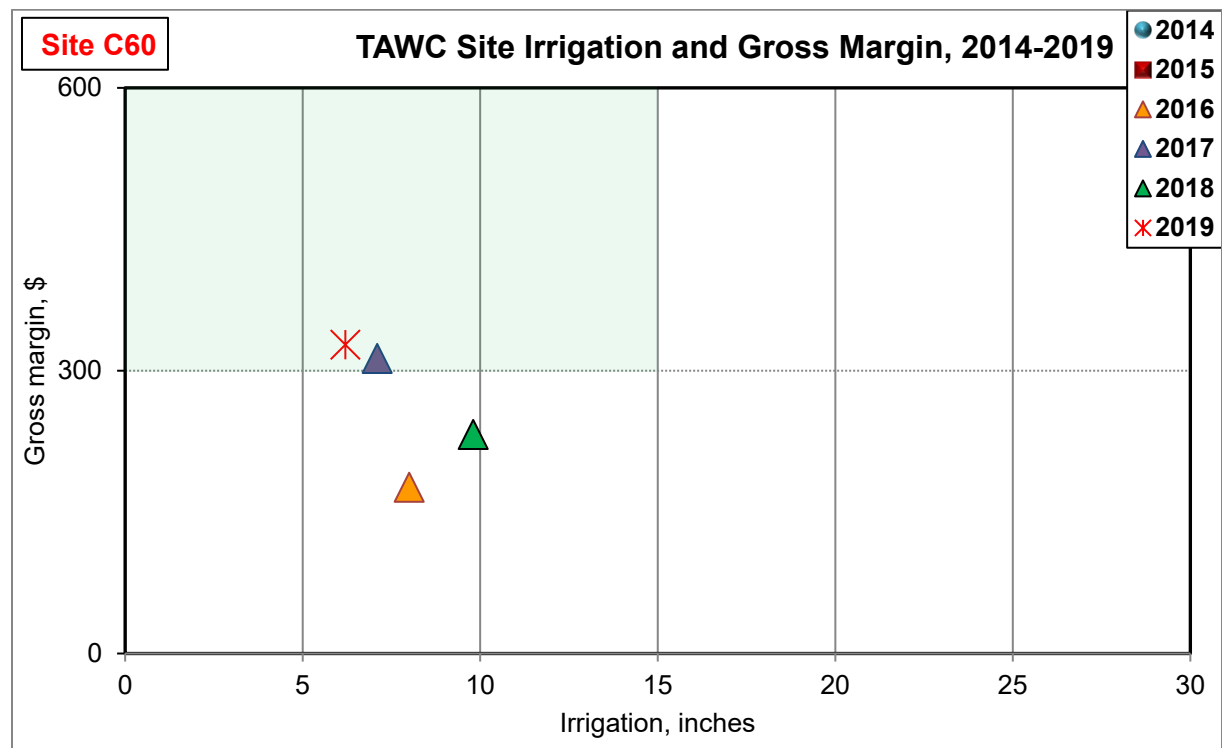
### Irrigation:

Low Elevation Spray Application  
(LESA) 290 gpm

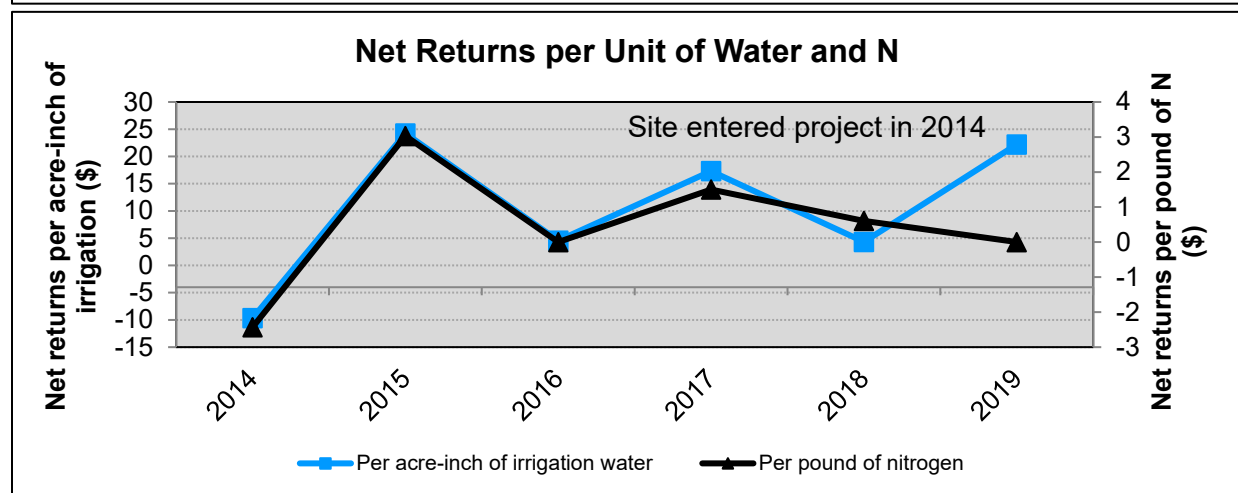
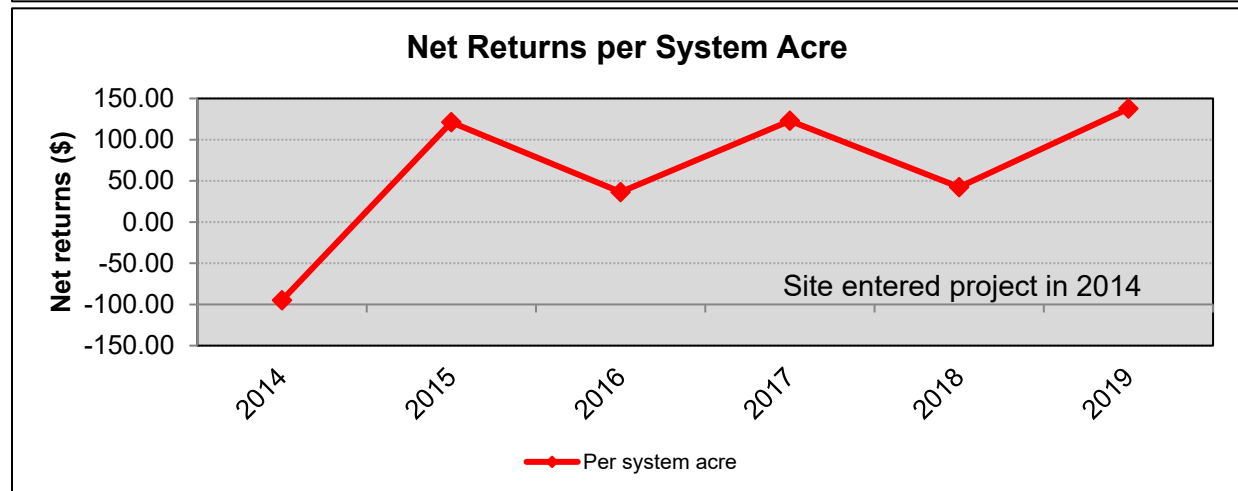
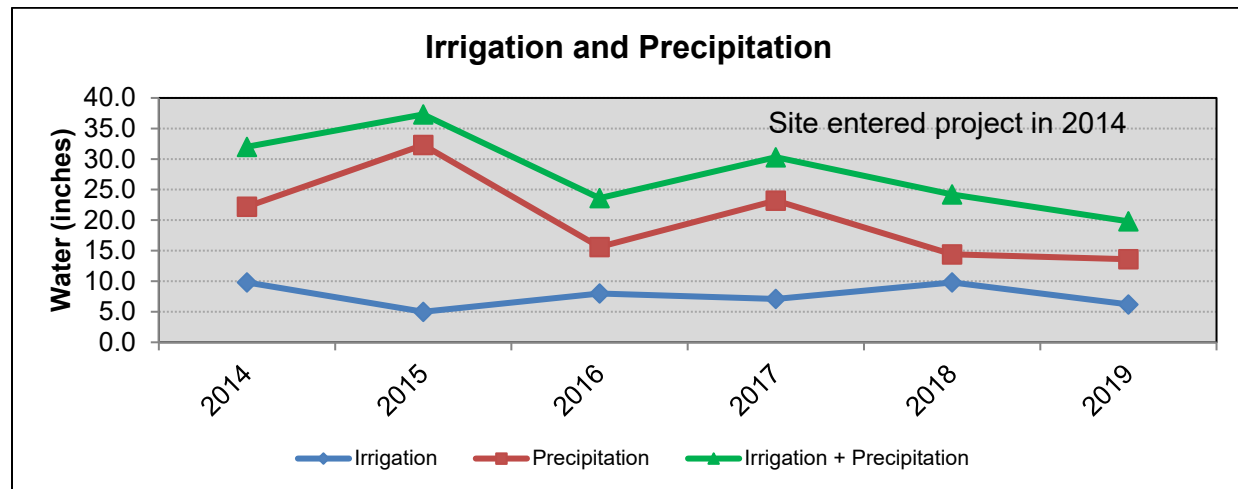
Number of wells: 3

Depth: 280 feet

Fuel Source: Electric



## Site C60



## Site C60



LESA irrigated cotton



July cotton



October

Comments: In 2019 this LESA irrigated site was planted to cotton on 30-inch spacing.

## Appendix - Archives

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### Phase I Changes and Alterations

Phase I of the TAWC program spanned a period (2005-2013) of increasing corn production in response to a growing dairy industry and U.S. policy encouraging renewable biofuels, especially ethanol. This period also encompassed wide swings in annual rainfall (5.3 to 28.5 inches) and commodity prices (\$0.54 to \$0.90 per lb. of cotton lint and \$2.89 to \$6.00 per bu. of corn). The decline in aquifer output and intense swings in prices and rainfall have driven producers to seek ways to minimize risk. This project officially began with the announcement of the grant from the Texas Water Development Board in September 2004. It was February 2005, when all contracts and budgets were finalized, and field site selections began. Also by February 2005, the Producer Board was named and functioning, and the Management Team was identified to expedite the decision-making process. The positions of project director and secretary/accountant were filled by June, 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. Soil moisture monitoring points installed, maintained and measured by the High Plains Underground Water Conservation District No. 1 were purposely located close to these sites, and global positioning system (GPS) coordinates were taken for each monitoring point. This was completed during 2005 and was operational for much of the 2005 growing season.

Total number of acres devoted to each crop and livestock enterprise and management type in 2005-2014 are given in Appendix Tables A1-A10. These sites include subsurface drip, center pivot, and furrow irrigation as well as dryland examples. It is important to note when interpreting data from Year 1 (2005), that this was an incomplete year. We were fortunate that this project made use of already existing and operating systems; thus, there was no time delay in establishment of systems. Efforts were made to locate missing information on water use while the original 26 sites were brought on-line. Such information is based on estimates as well as actual measurements during this first year and should be interpreted with caution. The resulting 2005 water use data, however, provided useful information as we began this long-term project. It is important to note that improvements were made in 2006 in calibration of water measurements and other protocols.

In year 2 (2006), site 25 was lost to the project due to a change in land ownership, but was replaced by site 27, thus the project continued to monitor 26 sites. Total acreage in 2006 was 4,230, a decline of about 60 acres. Crop and livestock enterprises on these sites and the acres committed to each use by site are given in Table A2.

In year 3 (2007), all sites present in 2006 remained in the project through 2007. Total acreage was 4,245, a slight increase over year 2 due to expansion of Site 1 (Table A3).

In year 4 (2008), 25 sites comprised 3,967 acres (Table A4). Sites 1, 13, 16, and 25 of the original sites had left the project, and sites 28 and 29 were added.

In year 5 (2009), all sites present in 2008 remained in the project. Site 30 with 21.8 acres was added. Thus, 26 total sites were present in 2009 for a total of 3,991 acres (Table A5).

In year 5 (2009), all sites present in 2008 remained in the project. Site 30 with 21.8 acres was added. Thus, 26 total sites were present in 2009 for a total of 3,991 acres (Table A5).

In year 6 (2010), three new sites were added as part of the implementation phase of the project (Table A6). These sites were designed to limit total irrigation for 2010 to no more than 15 inches. Crops grown included cotton, seed millet, and corn. The purpose of these added sites was to demonstrate successful production systems while restricting the water applied. With the addition of sites 31, 32, and 33, the project now totaled 29 sites and increased the project acreage from 3,991 acres to 4,272 acres, although data from these new sites were treated separately in this year. The new sites also increased the number of producers involved in the project by one.

In year 7 (2011), the previously mentioned implementation sites were incorporated into the whole project and no longer differentiated from other sites in management or data analysis because of changes in water policy. In addition, site 5 was converted from a livestock-only system to an annual cropping system. The site acreage declined from 626.4 to 487.6 by dropping the grassland corners but maintaining the cropping system under the center pivot. Site maps were adjusted for 2012 to reflect this change. Total acres for the project decreased from 4272 acres in 2010 to 4133 acres in 2011 as a result (Table A7).

In year 8 (2012), site 34 was added to the project (Table A8). The new 726.6 acres were partially offset by the exit of site 23 (121.1 acres). The 2012 report includes new satellite imagery of each site, and site information has been updated accordingly. As always, minor corrections to site acreages continued to occur as discrepancies are discovered. Total acres for the project increased from 4133 acres in 2011 to 4732 acres in 2012 as a result of these site changes.

In year 9 (2013), site 35 was added to the project (Table A9). The new 229.2 acres were a drip irrigated site. Total acres for the project increased from 4732 acres in 2012 to 4962 acres in 2013 as a result. Year 9 constituted the last data collection year of Phase I. A final report of Phase I was completed in 2014, and is available at <http://www.depts.ttu.edu/tawc/resources.html>.

### Acres and Crops 2005-2018

**Table A 1.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 26 producer sites in Hale and Floyd Counties during 2005.

Site	Irrigation type	Cotton	Corn grain	Corn silage	Sorghum grain	Sorghum forage	Pearl millet	Sunflower	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													
<b>Total</b>	<b>2005 acres</b>	<b>2118.3</b>	<b>203.4</b>	<b>174.1</b>	<b>209.8</b>	<b>250.3</b>	<b>45.1</b>	<b>48.8</b>	<b>82.9</b>	<b>191.8</b>	<b>829.8</b>	<b>1105.7</b>	<b>358.5</b>	<b>232.8</b>	<b>0.0</b>	<b>0.0</b>

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

**Table A 2.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 26 producer sites in Hale and Floyd Counties during 2006.

Site	Irrigation type	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												
26	PIV	62.3	62.9													
27	SDI	46.2														
<b>Total</b>	<b>2006 acres</b>	<b>1854.5</b>	<b>249.1</b>	<b>291.2</b>	<b>28.4</b>	<b>286.9</b>	<b>45.3</b>	<b>0.0</b>	<b>82.9</b>	<b>191.8</b>	<b>829.8</b>	<b>1069.6</b>	<b>588.3</b>	<b>137.0</b>	<b>115.8</b>	<b>105.7</b>

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



**Table A 3.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 26 producer sites in Hale and Floyd Counties during 2007.

Site	Irrigation type	Cotton	Corn grain	Corn silage	Sorghum grain	Sorghum forage	Pearl millet	Sunflowers	Alfalfa	Grass seed	Perennial pasture	Cattle	Wheat	Rye	Triticale	Oats
1	SDI	135.1														
2	SDI	60.9														
3	PIV	61.5				61.8							61.8			
4	PIV	65.4							13.3			109.8	109.8			
5	PIV/DRY										620.9	620.9				
6	PIV	122.9														
7	PIV									130.0						
8	SDI									61.8						
9	PIV				137.0						95.8	95.8		232.8		
10	PIV			44.5							129.1	129.1				
11	FUR	92.5														
12	DRY	151.2			132.7											
13	DRY	201.5											118.0			
14	PIV	124.2														
15	FUR	66.7			28.8											
16	PIV															
17	PIV	108.9									167.2	167.2	108.9			
18	PIV				61.5								60.7			
19	PIV	75.8					45.6									
20	PIV			117.6		115.8									233.4	
21	PIV		61.3							61.4						
22	PIV	148.7														
23	PIV		105.9													
24	PIV		129.8													
26	PIV		62.3				62.9					62.9				
27	SDI			46.2												
<b>Total</b>	<b>2007 acres</b>	<b>1415.4</b>	<b>358.5</b>	<b>208.3</b>	<b>360.0</b>	<b>177.6</b>	<b>108.5</b>	<b>0.0</b>	<b>13.3</b>	<b>253.2</b>	<b>1013.0</b>	<b>1185.7</b>	<b>459.2</b>	<b>232.8</b>	<b>233.4</b>	<b>0.0</b>

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

**Table A 4.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 25 producer sites in Hale and Floyd Counties during 2008.

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

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

**Table A 5.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 26 producer sites in Hale and Floyd Counties during 2009.

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

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

**Table A 6.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 26 producer sites in Hale and Floyd Counties during 2010.

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

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

**Table A 7.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 29 producer sites in Hale and Floyd Counties during 2011.

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

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

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

**Table A 8.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 29 producer sites in Hale and Floyd Counties during 2012.

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

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

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

**Table A 9.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 30 producer sites in Hale and Floyd Counties during 2013.

Site	Irrigation type	System acres	Cotton	Corn grain	Corn silage	Fallow	Grain sorghum	Seed sorghum	Haygrazer	Alfalfa	Grass seed	Hay	Perennial forage	Cattle grazed	Wheat for grain	Wheat silage	Grazed wheat	Sunflower	Triticale silage	Seed millet
2	SDI	60	31.5	28.4																
3	PIV	123.3	61.5				61.8													
4	PIV	123	50.5						26.8	16		16	16	26.8	26.8					29.6
5	PIV	484.1	119.4											85.8	85.8			122.9		156
6	PIV	122.7	60.6									62.1			62.1					
7	PIV	130									130	130	130							
8	SDI	61.8									61.8	61.8	61.8							
9	PIV	237.8	77				59.9						100.8	100.8						
10	PIV	173.6	42.1		87.2								44.3	44.3						
11	FUR	92.5	92.5																	
12	DRY	283.8	283.8																	
14	PIV	124.1	124.1																	
15	SDI	101.1	101.1																	
17	PIV	220.7		54.5									111.8	111.8				54.4		
18	PIV	122.2				122.2														
19	PIV	120.3	120.3																	
20	PIV	233.3	117.6		115.7														117.6	
21	PIV	122.6		61.4					61.2			61.2			61.2					
22	PIV	148.7	148.7																	
24	PIV	129.7		65.1														64.6		
26	PIV	125.2		62.2											62.9					
27	SDI	108.4	48.8		59.6															
28	SDI	51.4	51.4																	
29	DRY	221.7	221.7																	
30	SDI	21.8		21.8																
31	PIV	121.9	55.1																	66.8
32	PIV	70			70															
33	PIV	70		70																
34	PIV	726.6		241.2														485.4		
35	PIV	209.1	75	60.9			73.2													
Total acres 2013		4941.4	1882.7	665.5	332.5	122.2	194.9	0	88	16	191.8	331.1	464.7	369.5	298.8	0	0	727.3	117.6	252.4
# of sites		30	19	9	4	1	3	0	2	1	2	5	6	5	5	0	0	4	1	3

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

\*\*Red denotes field crop failure, Yellow denotes original purpose altered, brown denotes fallowed



**Table A 10.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 36 producer sites in the project during year 1 Phase II 2014.

Site	irrigation type	System acres	Cotton	Corn grain	Corn silage	Fallow	Grain sorghum	Seed sorghum	Forage sorghum	Alfalfa	Grass seed	Hay	Perennial forage	Cattle grazed	Wheat for grain	Wheat silage	Grazed wheat	Sunflower	Triticale hay	Seed millet
4	PIV	122.9	29.6				29.6	50.5	26.8	16		16	16	53.6			26.8			
5	PIV	484.1	241.8															119.4		122.9
6	PIV	122.7	62.1	60.6																
7	PIV	130									130.0	130	130							
8	SDI	61.8									61.8	61.8	61.8							
9	PIV	237.7	59.9				77.0						100.8	100.8						
10	PIV	173.6	59.2	59.2									57.7	57.7						
11	FUR	92.3	77.3				15.0													
14	PIV	124.1	124.1																	
15	SDI	101.1	101.1																	
17	PIV	220.7		54.4		111.8							111.8					54.5		
19	PIV	120.3	120.3																	
20	PIV	233.3			233.3															
21	PIV	122.0	60.6						61.4			61.4			61.4					
22	PIV	148.7		148.7																
24	PIV	129.7		64.6														65.1		
26	PIV	125.1		62.9														62.2		
27	SDI	108.4			108.4															
28	SDI	51.4	51.4																	
29	DRY	221.7	221.7																	
30	SDI	21.8	21.8																	
31	PIV	121.9	66.8				66.8													
32	PIV	70	70.0				70.0													
33	PIV	70	70.0																	
34	PIV	726.0	242.0	484.0																
35	PIV	230.2	80.5	75.0			74.7	55.1												
C50	PIV	120.6	120.6																	
C51	SDI	45.7	45.7																	
C52	PIV	135	135																	
C53	SDI	50	50																	
C54	SDI	85	85																	
C56	PIV	45			45															
C57	PIV	115			115															
C58	PIV	120								60									60	
C59	SDI	76								76										
C60	PIV	59.5					59.5													
<b>Total acres 2014</b>		<b>5223.3</b>	2196.5	1009.4	501.7	111.8	392.6	105.6	88.2	152	191.8	269.2	478.1	212.1	61.4	0	26.8	301.2	60	122.9
<b># of Sites</b>		<b>36</b>	23	8	4	1	7	2	2	3	2	4	6	3	1	0	1	4	1	1

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

\*\*Red denotes field crop failure, Yellow denotes original purpose altered, Brown denotes fallowed

**Table A 11.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 36 producer sites in the project during year 1 Phase II 2015. Sites 6, 7, 34, C37 and C38 had no data collected for 2015.

Site	Irrigation type	System acres	Cotton	Corn grain	Corn silage	Fallow	Grain sorghum	Seed sorghum	Forage sorghum	Alfalfa	Grass seed	Hay	Perennial forage	Cattle grazed	Wheat for grain	Wheat silage	Grazed wheat	Sunflower	Blackeye pea	Seed millet
4	LESA/LEPA	123.0	77.4							16					29.6		29.6			
5	LESA	484.1		122.9											119.4			85.8		156.0
6	LESA	122.7	60.6	62.1																
7	LESA	130.0																		
8	SDI	61.8																		
9	MESA	237.7	136.9										100.8	100.8						
10	LESA	173.6	59.2	59.2									57.7	57.7						
11	FUR/SDI	82.6	10	37.6			35.0													
14	MESA	124.1	62.1			62.0														
15	SDI	101.1	101.1																	
17	MESA	108.9		54.5														54.4		
19	LEPA	120.4	60.2			60.2														
21	LEPA	120.7		60.1											60.6					
22	LEPA	145.0	145.0	145.0																
24	LESA	129.7		65.1														64.6		
26	LESA	125.1		62.9																62.2
28	SDI	51.5		51.5																
30	SDI	21.8		21.8																
31	LEPA/LESA/ LDN/PMDI	121.9		66.8			55.1													
32	LEPA	70.0		70.0																
33	LEPA	70.0		70.0																
34	LESA	726																		
35	SDI	230.0		230.0																
C37	VR-LESA	121.1																		
C38	VR-LESA	481.0																		
C39	LEPA	120.0		60.0			60.0													
C50	LESA	120.6	120.6																	
C51	SDI	45.7	45.7																	
C52	LESA	130	130.0																	
C53	SDI	50	50.0																	
C54	SDI	80	80.0																	
C56	LESA	40																	40.0	
C57	LESA	115		115.0																
C58	LESA	120		60.0						60.0										
C59	SDI	93								93.0										
C60	LESA	59.5	59.5																	
Total acres 2015		5,258	1,053.3 (harvested)	1,414.5	0	122.2	150.1	0	0	169.0	0	0	158.5	158.5	209.6	0	29.6	204.8	40.0	218.2
# of Sites		36	14	18	0	2	3	0	0	3	0	0	2	2	3	0	1	3	1	2

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

\*\*Red denotes field crop failure/Insurance claim, Yellow denotes original purpose altered, Brown denotes fallowed, Grey denotes no field data for this year.

**Table A 12.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 22 producer sites in the project during year 1 Phase II 2016. Sites 34, C39, C53, C54 and C59 had no data collected for 2016.

Site	Irrigation type	System acres	Cotton	Corn grain	Corn silage	Fallow	Grain sorghum	Seed sorghum	Forage sorghum	Alfalfa	Grass seed	Hay	Perennial forage	Cattle grazed	Wheat for grain	Wheat silage	Grazed wheat	Sunflower	Blackeye pea	Seed millet
4	LESA/LEPA	123.0	26.9					50.5	29.6	16		29.6	16	29.6			29.6			
6	LESA	122.7	62.1	60.6																
9	MESA	236.9	134.0										102.9	102.9						
10	LESA	176.1	59.2	59.2									57.7	57.7						
11	FUR/SDI	93.5	93.5																	
14	MESA	124.1	124.1																	
17	MESA	108.9		108.9																
21	LEPA	121.7	121.7																	
22	LEPA	145.0	145.0																	
24	LESA	129.7		65.1														64.6		
28	SDI	51.5		51.5																
31	LEPA/LESA/ LDN/PMDI	121.9	66.8				55.1													
32	LEPA	70.0	70.0																	
33	LEPA	70.0		70.0																
34	LESA	726																		
35	SDI	230.0	115.0	115.0																
C37	VR-LESA	121.1		121.1																
C38	VR-LESA	481.0	481.0																	
C39	LEPA	120.0																		
C50	LESA	121.0	121.0																	
C51	SDI	46.0	46.0																	
C53	SDI	50																		
C54	SDI	80																		
C56	LESA	35			35.0															
C57	LESA	115																115.0		
C59	SDI	93																		
C60	LESA	59.5	59.5																	
<b>Total acres 2016</b>		3972 (2909 active)	1726.4	651.4	40.0		55.1	50.5	29.6	16	0	29.6	176.6	190.2	0	0	29.6	179.6	0	0
<b>Total # of Sites</b>		27 (22 active)	15	8	1	0	1	1	1	1	0	1	3	3	0	0	1	2	0	0

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

\*\*Red denotes field crop failure/Insurance claim, Yellow denotes original purpose altered, Brown denotes fallowed, Grey denotes no producer field data for this year.

**Table A 13.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 20 producer sites in the project during year 2017. Sites 34 had no data collected for 2017.

Site	Irrigation type	System acres	Cotton	Corn grain	Corn silage	Fallow	Grain sorghum	Seed sorghum	Forage sorghum	Alfalfa	Grass seed	Hay	Perennial forage	Cattle grazed	Wheat for grain	Wheat silage	Grazed wheat	Sunflower	Blackeye pea	Seed millet
4	LESA/LEPA	110.0	60.0							15.0		15.0	15.0	51.0	35.0		35.0			35.0
9	MESA	237.7	136.9										100.8	100.8						
10	LESA	176.1	59.2	59.2									57.7	57.7						
11	FUR/SDI	92.6	92.6																	
14	MESA	124.1	124.1																	
17	MESA	108.9		108.9																
21	LEPA	120.7	120.7																	
22	LEPA	145.0	145.0																	
31	LEPA/LESA/ LDN/PMDI	121.9	55.1																	66.8
32	LEPA	70.0		70.0																
34	LESA	726.6																		
35	SDI	230.0	115.0	115.0																
C37	VR-LESA	475.5	475.5																	
C38	VR-LESA	122.9	122.9																	
C39	LESA/LEPA	120.0	60.0	60.0																
C50	LESA	120.6	120.6																	
C51	SDI	45.7	45.7																	
C56	LESA	60.0																	60.0	
C57	LESA	115.0		115.0																
C60	LESA	59.5	59.5																	
<b>Total acres 2017</b>		3382.8 (2656 active)	1792.8	528.1						15.0		15.0	172.3	208.3	35.0		35.0		60.0	101.8
<b>Total # of Sites</b>		20 (19 active)	15	6						1		1	3	3	1		1		1	2

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

\*\*Red denotes field crop failure/Insurance claim, Yellow denotes original purpose altered, Brown denotes fallowed, Grey denotes no producer field data for this year.

**Table A 14.** Irrigation type and total acres, by site, of crops, forages, and acres grazed by cattle in 17 active of 19 producer sites in the project during year 2018. Sites 4 and 31 had no data collected for 2018.

Site	Irrigation type	System acres	Cotton	Corn grain	Corn silage	Fallow	Grain sorghum	Seed sorghum	Forage sorghum	Alfalfa	Grass seed	Hay	Perennial forage	Cattle grazed	Wheat for grain	Wheat silage	Grazed wheat	Sunflower	Blackeye pea	Millet hay
4	LESA/LEPA	110.0																		
9	MESA	235.8	135										100.8	100.8						
10	LESA	174.3	116.6						116.6			116.6	57.7	174.3			116.6			
11	FUR/SDI	95.0	95	80		15														
14	MESA	124.1	124.1																	
17	MESA	108.9	54.4	54.5																
21	LEPA	120.7	60.6									60.1			60.1					60.1
22	LEPA	145.0	145.0																	
31	LEPA/LESA/ LDN/PMDI	121.9																		
32	LEPA	70.0	70.0																	
35	SDI	230.0	115.0	115.0																
C37	VR-LESA	124.0	124.0																	
C38	VR-LESA	242.7	242.7																	
C39	LESA/LEPA	120.0	60	60																
C50	LESA	120.6	120.6																	
C51	SDI	45.7	45.7																	
C56	LESA	60.0		60																
C57	LESA	124.0	124.0																	
C60	LESA	59.5	59.5																	
Total acres 2018		2432 (2200 active)	1612.2	309.5	60	15			116.6			176.7	158.5	275.1	60.1		116.6			60.1
Total # of Sites		19 (17 active)	16	4	1	1	0	0	1	0	0	2	2	2	1	0	1	0	0	1

## Phase I Economic Summaries of Results from Monitoring Producer Sites in 2005-2013.

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### *Phase I - Economic assumptions of data collection and interpretation*

1. Although actual depth to water in wells located among the producer sites varies, a pumping depth of 303 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. Variable costs are nearly constant across irrigation systems, according to Amosson et al. (2011)<sup>3</sup>, so this assumption has negligible effect on the analysis. The estimated cost per acre-inch includes the cost of energy, repair and maintenance cost, and labor cost. The primary source of variation in variable cost from year to year is due to changes in the unit cost of energy and repair and maintenance costs.
5. Mechanical tillage operations for each individual site were accounted for with the cost of each field operation being based on typical custom rates for the region. Using custom rates avoids the variations among sites in the types of equipment owned and operated by individuals.

### *Phase I - Assumptions of energy costs, prices, fixed and variable costs* *(Tables A10-A13)*

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

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<sup>3</sup> Amosson, L. et al. 2011. Economics of irrigation systems. Texas A&M AgriLife Extension Service. B-6113.

**Table A 15.** Electricity irrigation cost parameters for 2005 through 2013.

Item	2005	2006	2007	2008	2009	2010	2011	2012	2013
Gallons per minute (gpm)	450	450	450	450	450	450	450	450	450
Pumping lift (feet)	260	250	252	254	256	285	290	300	303
Discharge pressure (psi)	15	15	15	15	15	15	15	15	15
Pump efficiency (%)	60	60	60	60	60	60	60	60	60
Motor efficiency (%)	88	88	88	88	88	88	88	88	88
Electricity cost per kWh	\$0.085	\$0.085	\$0.090	\$0.110	\$0.140	\$0.081	\$0.086	\$0.100	\$0.140
Cost of electricity per ac-inch	\$4.02	\$4.26	\$5.06	\$6.60	\$3.78	\$4.42	\$4.69	\$5.37	\$8.26
Cost of maint. & repairs per acre-inch	\$2.05	\$2.07	\$2.13	\$2.45	\$3.37	\$3.49	\$4.15	\$3.83	\$3.87
Cost of labor per acre-inch	\$0.75	\$0.75	\$0.80	\$0.90	\$0.90	\$0.90	\$0.90	\$1.00	\$1.10
Total Cost per acre-nch	\$6.82	\$7.08	\$7.99	\$9.95	\$8.05	\$8.81	\$9.74	\$10.20	\$13.23

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

**Table A 16.** Commodity prices for 2005 through 2013.

Commodity	2005	2006	2007	2008	2009	2010	2011	2012	2013
Cotton lint (\$/lb)	\$0.54	\$0.56	\$0.58	\$0.55	\$0.56	\$0.75	\$0.90	\$0.90	\$0.80
Cotton seed (\$/ton)	\$100	\$135	\$155	\$225	\$175	\$150	\$340	\$280	\$260
Grain sorghum – Grain (\$/cwt)	\$3.85	\$6.10	\$5.96	\$7.90	\$6.48	\$9.51	\$9.75	\$13.10	\$8.50
Grain sorghum – Seed (\$/lb)	-	-	-	-	-	-	-	\$0.17	-
Corn – Grain (\$/bu)	\$2.89	\$3.00	\$3.69	\$5.71	\$3.96	\$5.64	\$5.64	\$6.00	\$5.00
Corn – Food (\$/bu)	\$3.48	\$3.55	\$4.20	\$7.02	\$5.00	\$4.88	\$7.50	\$7.50	\$6.80
Barley (\$/cwt)	-	-	-	-	-	-	-	\$14.08	\$14.08
Wheat – grain (\$/bu)	\$2.89	\$4.28	\$4.28	\$7.85	\$5.30	\$3.71	\$5.75	\$6.85	\$6.85
Sorghum silage (\$/ton)	\$20.19	\$18.00	\$18.00	\$25.00	\$24.00	\$24.00	\$24.00	\$24.00	\$24.00
Corn silage (\$/ton)	\$20.12	\$22.50	\$25.00	\$25.00	\$42.90	\$43.50	\$43.50	\$43.50	\$45.00
Wheat silage (\$/ton)	\$18.63	\$22.89	\$22.89	\$29.80	\$26.59	\$26.59	\$26.59	\$26.59	\$26.59
Oat silage (\$/ton) -	\$17.00	\$17.00	-	\$14.58	-	-	-	\$14.58	\$14.58
Millet seed (\$/lb)	\$0.17	\$0.17	\$0.22	\$0.25	-	\$0.25	\$0.25	\$0.25	\$0.38
Sunflower (\$/lb)	\$0.21	\$0.21	\$0.21	\$0.29	\$0.27	-	-	\$0.39	\$0.38
Alfalfa (\$/ton)	\$130	\$150	\$150	\$160	\$160	\$185	\$350	\$350	\$250
Hay (\$/ton)	\$60	\$60	\$60	\$60	\$60	-	-	\$60	\$60
WW-BDahl hay (\$/ton)	\$65	\$65	\$90	\$90	-	\$60	\$200	\$200	\$108
Haygrazer (\$/ton)	-	\$110	\$110	\$70	\$110	\$65	\$65	\$125	\$104
Sideoats seed (\$/lb)	-	-	\$6.52	\$6.52	\$3.90	\$8.00	\$5.70	\$5.70	\$9.00
Sideoats hay (\$/ton)	-	-	\$64	\$64	\$70	\$60	\$220	\$220	\$60
Triticale silage (\$/ton)	-	-	-	-	-	-	-	\$45	\$45
Triticale forage (\$/ton)	-	-	-	-	-	-	-	\$24	\$24



3. Fertilizer and chemical costs (herbicides, insecticides, growth regulators, and harvest aids) are reflective of the production year; however, prices were constant across sites for the product and formulation.
4. Other variable and fixed costs are given for 2005 through 2013 in Table A12.

**Table A 17.** Other variable and fixed costs for 2005 through 2013.

<b>VARIABLE COSTS</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
<i>Boll weevil assessment: (\$/ac)</i>									
Irrigated cotton	\$12.00	\$12.00	\$12.00	\$1.50	\$1.00	\$1.00	\$1.00	\$1.00	\$1.00
Dryland cotton	\$6.00	\$6.00	\$6.00	\$1.50	\$1.00	\$1.00	\$1.00	\$1.00	\$1.00
<i>Crop insurance: (\$/ac)</i>									
Irrigated cotton	\$17.25	\$17.25	\$17.25	\$20.00	\$20.00	\$20.00	\$30.00	\$30.00	\$30.00
Dryland cotton	\$12.25	\$12.25	\$12.25	\$12.25	\$12.25	\$12.25	\$20.00	\$20.00	\$20.00
Irrigated corn	\$15.00	\$15.00	\$15.00	\$15.00	\$15.00	\$15.00	\$15.00	\$15.00	\$15.00
Irrigated corn silage	-	-	-	-	-	-	-	\$11.00	\$11.00
Irrigated Wheat	-	-	-	-	-	-	-	\$5.00	\$5.00
Irrigated sorghum grain	-	-	-	-	-	-	-	\$2.00	\$2.00
Dryland sorghum grain	-	-	-	-	-	-	-	\$2.00	\$2.00
Irrigated sorghum silage	-	-	-	-	-	-	-	\$2.00	\$2.00
Irrigated sunflower	-	-	-	-	-	-	-	\$5.00	\$5.00
Cotton harvest – strip and module (\$/lint lb)	\$0.08	\$0.08	\$0.08	\$0.08	\$0.08	\$0.08	\$0.08	\$0.08	\$0.08
Cotton ginning (\$/cwt)	\$1.95	\$1.75	\$1.75	\$1.95	\$1.95	\$1.95	\$1.95	\$1.95	\$2.10
Bags, ties, & classing (\$/bale)	\$17.50	\$19.30	\$17.50	\$18.50	\$18.50	\$18.50	\$18.50	\$18.50	\$18.50
<b>FIXED COSTS</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
<i>Irrigation system:</i>									
Center Pivot system	\$33.60	\$33.60	\$33.60	\$33.60	\$33.60	\$40.00	\$40.00	\$40.00	\$40.00
Drip system	\$75.00	\$75.00	\$75.00	\$75.00	\$75.00	\$75.00	\$75.00	\$75.00	\$75.00
Flood system	\$25.00	\$25.00	\$25.00	\$25.00	\$25.00	\$25.00	\$25.00	\$25.00	\$25.00
<i>Cash rent:</i>									
Irrigated cotton, grain sorghum, sun-flowers, grass, pearl millet, and sorghum silage.	\$45.00	\$45.00	\$45.00	\$75.00	\$75.00	\$100.00	\$100.00	\$100.00	\$100.00
Irrigated corn silage, corn grain, and alfalfa.	\$75.00	\$75.00	\$75.00	\$100.00	\$100.00	\$140.00	\$140.00	\$140.00	\$140.00
Dryland cropland	\$15.00	\$15.00	\$15.00	\$25.00	\$25.00	\$30.00	\$30.00	\$30.00	\$30.00

5. The custom tillage and harvest rates used for 2005 were based on rates reported in Texas A&M AgriLife Extension, 2013 Texas Agricultural Custom Rates, May 2013.

**Table A 18.** Phase I Summary of results from monitoring 26 producer sites, 2005 (Year 1).

System	Site No.	Acres	Irrigation Type <sup>1</sup>	System Inches	Net Returns/ system Acre	Net Returns/ inch water
<b><u>Monoculture systems</u></b>						
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
<b><u>Multi-crop systems</u></b>						
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/pearl millet	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/sunflower	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
<b><u>Crop-livestock systems</u></b>						
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

<sup>1</sup>SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

**Table A 19.** Phase I Summary of results from monitoring 26 producer sites, 2006 (Year 2).

System	Site No.	Acres	Irrigation type <sup>1</sup>	System inches	Net Returns/ system acre	Net Returns/ inch water	Gross margin per inch irrigation
<b><u>Monoculture systems</u></b>							
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
<b><u>Multi-crop systems</u></b>							
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/pearl millet	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
<b><u>Crop-livestock systems</u></b>							
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

<sup>1</sup>SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

**Table A 20.** Phase I Summary of results from monitoring 26 producer sites, 2007 (Year 3).

System	Site No.	Acres	Irrigation Type <sup>1</sup>	System inches	Net Returns/ system acre	Net Returns /inch water	Gross margin per inch irrigation
<b><u>Monoculture systems</u></b>							
Cotton	1	135	SDI	14.60	162.40	11.12	19.34
Cotton	2	61	SDI	12.94	511.33	39.52	48.79
Cotton	6	123	CP	10.86	605.78	55.78	63.02
Cotton	11	93	Fur	14.67	163.58	11.15	15.92
Cotton	14	124	CP	8.63	217.38	25.19	34.30
Cotton	22	149	CP	11.86	551.33	46.49	53.11
Corn	23	105	CP	10.89	325.69	29.91	37.12
Corn	24	130	CP	15.34	373.92	24.38	31.46
Perennial grass: seed and hay	7	130	CP	13.39	392.59	29.32	35.19
Perennial grass: seed and hay	8	62	SDI	15.67	292.63	18.67	26.33
<b><u>Multi-crop systems</u></b>							
Cotton/grain sorghum/wheat	3	123	CP	13.25	190.53	14.38	20.31
Cotton/grain sorghum	12	284	DL	0.00	265.71	Dryland	Dryland
Cotton/wheat	13	320	DL	0.00	105.79	Dryland	Dryland
Cotton/grain sorghum	15	96	Fur	10.50	191.68	18.26	24.92
Grain sorghum/wheat	18	122	CP	5.34	13.91	2.60	13.62
Cotton/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/per. grass: seed and hay	21	123	CP	8.35	231.60	27.75	37.16
Corn silage	27	62	SDI	13.00	194.40	14.95	24.18
<b><u>Crop-livestock systems</u></b>							
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
Per. grass, rye: stocker cattle/grain sorghum	9	237	CP	4.19	48.89	11.65	30.00
Perennial grass: cow-calf, hay/corn silage	10	174	CP	6.80	27.84	4.09	14.74
Perennial grass: cow-calf, seed, hay/cotton/wheat for grazing	17	221	CP	8.31	181.48	21.83	33.06
Pearl millet: seed, grazing/corn	26	123	CP	11.34	378.61	33.39	41.65

<sup>1</sup>SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

**Table A 21.** Phase I Summary of results from monitoring 25 producer sites, 2008 (Year 4).

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

<sup>1</sup>SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

**Table A 22.** Phase I Summary of results from monitoring 26 producer sites, 2009 (Year 5).

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

<sup>1</sup>SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

**Table A 23.** Phase I Summary of results from monitoring 26 producer sites, 2010 (Year 6).

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

<sup>1</sup>SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland



**Table A 24.** Phase I Summary of results from monitoring 29 producer sites, 2011 (Year 7).

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

<sup>1</sup>SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

**Table A 25.** Phase I Summary of results from monitoring 29 producer sites, 2012 (Year 8).

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

<sup>1</sup>SDI – Subsurface drip irrigation; CP – center pivot; Fur – furrow irrigation; DL – dryland

**Table A 26.** Phase I Summary of results from monitoring 30 producer sites, 2013 (Year 9).

System	Site No.	Acres	Irrigation Type <sup>1</sup>	System inches	Net Returns/ system acre	Net Returns /inch water	Gross margin per inch irrigation
<b><u>Monoculture systems</u></b>							
Perennial grass: seed/hay	7	130	CP/LESA	10.3	403.68	39.19	52.78
Perennial grass: seed/hay	8	61.8	SDI	14.1	983.54	69.75	82.17
Cotton	11	92.5	FUR	12.0	-18.10	-1.51	8.91
Cotton – No data	12	283.8	DL	0	0.00	Dryland	Dryland
Cotton (2 in 2 out)	14	124.1	CP/LESA	7.5	371.85	49.58	58.92
Cotton	15	101.1	SDI	17.65	858.11	48.62	58.54
Fallowed	18	122.2	CP/MESA	0	0.00	0.00	0.00
Cotton (2 in 2 out)	19	120.3	CP/LEPA	12.0	199.93	16.66	22.49
Cotton	22	148.7	CP/LEPA	24.5	424.35	17.32	23.03
Cotton	28	51.4	SDI	17.5	163.36	9.33	19.33
Cotton (failed, collected ins.)	29	221.6	DL	0	3.79	Dryland	Dryland
Corn	30	21.8	SDI	13	-30.84	-2.37	14.17
Corn	32	70	CP/LEPA	20.6	196.45	9.54	18.27
Corn	33	70	CP/LEPA	26.8	188.99	7.05	13.77
<b><u>Multi-crop systems</u></b>							
Cotton/Corn grain	2	59.9	SDI	21.0	262.95	12.54	21.79
Cotton/Grain sorghum	3	123.3	CP/MEPA	16.2	334.56	20.59	29.21
Wheat/Millet/Cotton/Sunflower	5	484.1	CP/LESA	10.3	454.87	44.37	58.03
Wheat/Cotton	6	122.7	CP/LESA	17.0	149.62	8.78	17.00
Dahl/Corn/Sunflower	17	220.7	CP/MESA	12.2	118.60	9.76	21.27
Trit silage/Corn silage/Cotton	20	233.3	CP/LEPA	27.3	704.25	25.78	31.65
Wheat/Haygrazer/Corn	21	122.6	CP/LEPA	19.9	286.14	14.38	21.16
Corn grain/Sunflower	24	129.7	CP/LESA	17.2	392.45	22.78	32.07
Wheat/Corn	26	125.1	CP/LESA	11.9	157.18	13.20	26.62
Corn silage/Cotton	27	108.4	SDI	36.3	673.31	18.55	23.98
Cotton/Seed millet	31	121.9	CP/LEPA	20.0	469.53	23.52	30.53
Corn/Sunflower	34	726.6	CP/LESA	14.1	445.30	31.58	40.94
Grain sorghum/Corn/Cotton	35	229.3	SDI	20.0	403.82	20.22	27.70
<b><u>Crop-livestock systems</u></b>							
Alfalfa/Cotton/Wheat/Seed Sorghum	4	122.9	CP/LEPA	18.3	420.87	23.05	31.01
Perennial grass: contract grazing/cotton	9	237.7	CP/MESA	8.7	277.95	31.89	47.96
Perennial grass: contract grazing/cotton	10	173.6	CP/LESA	18.5	242.86	13.14	21.80

<sup>1</sup>SDI – Subsurface drip irrigation; CP – center pivot; FUR – furrow irrigation; DL – dryland

**Table A 27.** Phase II Summary of results from monitoring 36 producer sites, 2014 (Year 1).

System	Site No.	Acres	Irrigation Type <sup>1</sup>	System inches	Net Returns /system acre	Net Returns /inch water	Gross margin per inch irrigation
<b><u>Monoculture systems</u></b>							
Perennial grass: seed/hay	7	130	CP/LESA	15.5	-63.58	-4.10	4.93
Perennial grass: seed/hay	8	61.8	SDI	16.0	22.23	1.39	12.33
Cotton (2 in 2 out)	14	124.1	CP/LESA	4.5	102.08	22.68	38.25
Cotton	15	101.1	SDI	15.2	150.58	9.89	21.39
Cotton (2 in 2 out)	19	120.3	CP/LEPA	4.3	43.82	10.31	26.77
Corn silage	20	233.3	CP/LEPA	14.2	-143.00	-10.07	2.61
Corn	22	148.7	CP/LEPA	21.0	478.71	22.80	31.37
Corn silage	27	108.4	SDI	12.7	-162.75	-12.81	4.11
Cotton	28	51.4	SDI	8.0	113.13	14.14	36.02
Cotton	29	221.7	DL	0	43.04	Dryland	Dryland
Cotton	30	21.8	SDI	13	256.73	19.75	33.21
Cotton (failed replanted grain sorghum)	32	70	CP/LEPA	14.2	104.46	7.36	20.03
Cotton	33	70	CP/LEPA	13.9	-18.75	-1.35	11.60
Cotton (1 year)	C50	120.6	CP/LESA	8.4	86.69	10.38	27.15
Cotton (1 year)	C51	45.7	SDI	9.4	244.15	25.97	44.59
Cotton (1 year)	C52	135	CP/LESA	15.5	-176.98	-11.42	-2.39
Cotton (1 year)	C53	50	SDI	8.5	108.94	12.89	33.60
Cotton (1 year)	C54	85	SDI	8.3	74.61	8.99	30.07
Corn silage (1 year)	C56	45	CP/LESA	14.4	721.08	50.08	62.58
Corn silage (1 year)	C57	115	CP/LESA	11.6	422.08	36.54	52.13
Alfalfa (1 year)	C59	76	SDI	15.1	1740.88	115.29	129.53
Grain sorghum (1 year)	C60	59.5	CP/LESA	9.8	-94.87	-9.68	4.61
<b><u>Multi-crop systems</u></b>							
Millet/Cotton/Sunflower	5	484.1	CP/LESA	12.5	410.76	32.82	44.01
Corn/Cotton	6	122.7	CP/LESA	13.5	61.24	4.55	16.41
Grain Sorghum/Cotton	11	92.3	FUR/SDI	11.0	-60.97	-5.55	8.16
Perennial grass/Corn/Sunflower	17	220.7	CP/MESA	5.4	105.17	19.38	47.00
Wheat/Haygrazer/Cotton	21	122.0	CP/LEPA	12.8	122.96	9.59	18.55
Corn grain/Sunflower	24	129.7	CP/LESA	12.7	413.56	32.47	45.04
Corn/Sunflower	26	125.1	CP/LESA	11.5	474.52	41.19	55.07
Grain sorghum/Forage Sorghum	31	121.9	CP/LEPA	16.6	643.26	38.78	47.22
Corn/Cotton	34	726.0	CP/LESA	12.6	270.78	21.43	21.50
Grain sorghum/Corn/Cotton	35	230.2	SDI	12.3	-85.97	-7.00	8.31
Triticale/Alfalfa (1 year)	C58	120	CP/LESA	16.7	399.57	24.00	33.61
<b><u>Crop-Livestock systems</u></b>							
Alfalfa/Grain Sorg./Wheat/ Haygrazer/Seed sorghum	4	122.9	CP/LEPA	17.4	329.52	18.89	27.21
Perennial grass: Contract grazing/Cotton/Grain Sorghum	9	237.7	CP/MESA	5.1	5.02	0.99	28.47
Perennial grass: Contract grazing/Corn/Cotton	10	173.6	CP/LESA	11.2	22.53	2.01	15.71

<sup>1</sup>SDI – Subsurface drip irrigation; CP – center pivot; FUR – furrow irrigation; DL – dryland

**Table A 28.** Phase II Summary of results from monitoring 32 of 36 producer sites, 2015 (Year 2).

System	Site No.	Acres	Irrigation Type <sup>1</sup>	System inches	Net Returns/ system acre	Net Returns/ inch water	Gross margin per inch irrigation
<b><u>Monoculture systems</u></b>							
Cotton (2 in 2 out)	14	124.1	MESA	5.0	194.55	38.91	52.92
Cotton	15	101.1	SDI	7.0	65.96	9.42	34.42
Cotton (2 in 2 out)	19	120.4	LEPA	4.0	-13.58	-3.40	14.12
Corn	22	145.0	LEPA	16.5	-118.51	-7.18	3.73
Corn	28	51.5	SDI	17.0	-452.80	-26.64	-13.99
Corn	30	21.8	SDI	18.0	173.18	9.62	21.57
Corn	32	70.0	LEPA	18.1	246.70	13.63	23.57
Corn	33	70.0	LEPA	19.0	185.90	9.78	19.26
Corn	35	230.0	SDI	10.4	-17.99	-1.74	19.03
Cotton	C50	120.6	LESA	4.9	40.57	8.28	36.85
Cotton	C51	45.7	SDI	4.7	77.43	16.47	53.71
Cotton	C52	130.0	LESA	12.2	163.60	13.41	24.89
Cotton	C53	50.0	SDI	10.3	223.99	21.75	38.74
Cotton	C54	80.0	SDI	9.3	207.78	22.41	41.29
Blackeye pea	C56	40.0	LESA	6.0	717.65	119.61	142.94
Corn	C57	115.0	LESA	9.6	381.32	39.72	58.47
Alfalfa	C59	93.0	SDI	14.3	1263.41	88.35	103.39
Cotton	C60	59.5	LESA	5.0	121.17	24.23	52.23
<b><u>Multi-crop systems</u></b>							
Alfalfa/Wheat/Cotton	4	123.0	LESA/LEPA	9.2	-15.82	-1.73	14.11
Wheat/Millet/Sunflower/Corn	5	484.1	LESA	10.3	541.62	52.49	66.06
Corn/Cotton	6	122.7	LESA	20.9	29.51	1.42	9.10
Grain Sorghum/Cotton/Corn	11	82.6	FUR/SDI	9.8	-172.78	-17.70	-0.08
Corn/Sunflower	17	108.9	MESA	13.5	73.67	5.45	17.30
Wheat/Corn	21	120.7	LEPA	7.7	3.34	0.43	21.14
Corn grain/Sunflower	24	129.7	LESA	14.0	121.51	8.69	20.15
Corn/Seed Millet	26	125.1	LESA	13.0	690.17	53.02	65.32
Corn/Grain Sorghum	31	121.9	LEPA/LESA/ LDN/PMDI	11.7	-21.51	-1.84	11.68
Grain Sorghum/Corn grain	C39	120.0	LEPA	10.4	-17.99	-1.74	19.03
Corn/Alfalfa	C58	120.0	LESA	18.0	492.12	27.34	37.34
<b><u>Crop-Livestock systems</u></b>							
Perennial grass: contract grazing/Cotton	9	237.7	MESA	3.5	40.98	11.86	52.37
Perennial grass: contract grazing, /Corn/Cotton	10	173.6	LESA	10.9	-12.00	-1.10	12.99

<sup>1</sup>SDI – Subsurface drip irrigation; MESA – Mid elevation spray application; LESAs – Low elevation spray application; LEPA – Low energy precision application; LDN – Low drift nozzle; FUR – furrow irrigation; DL – dryland

**Table A 29.** Phase II Summary of results from monitoring 22 of 27 producer sites, 2016 (Year 3).

System	Site No.	Acres	Irrigation Type <sup>1</sup>	System inches	Net Returns/ system acre	Net Returns/ inch water	Gross margin per inch irrigation
<b><u>Monoculture systems</u></b>							
Cotton	11	94.1	Fur/SDI	10.5	-394.15	-37.49	-23.21
Cotton (2 in 2 out)	14	124.1	MESA	4.0	150.70	37.68	55.19
Corn	17	108.9	MESA	17.0	274.71	16.16	26.75
Cotton	21	121.7	LEPA	9.6	379.57	39.72	54.38
Cotton	22	145	LEPA	14.0	502.70	35.91	45.91
Corn	28	51.5	SDI	8.0	-552.47	-69.06	-42.18
Cotton	32	70	LEPA	12.0	446.80	37.23	48.90
Corn	33	70	LEPA	20.0	95.74	4.79	13.79
Corn	C37	121.1	VRI	16.2	-147.01	-9.07	2.04
Cotton	C38	481	VRI	9.4	293.47	31.22	46.11
Cotton	C50	121	LESA	6.7	189.96	28.35	49.25
Cotton	C51	46	SDI	10.6	367.43	34.66	51.17
Corn silage	C56	40	LESA	15.0	66.18	4.41	16.41
Sunflower	C57	115	LESA	5.1	-189.61	-37.18	-9.73
Cotton	C60	59.5	LESA	8.0	36.40	4.55	22.05
<b><u>Multi-crop systems</u></b>							
Corn/Cotton	6	122.7	LESA	14.2	293.16	20.64	31.89
Corn grain/Sunflower	24	129.7	LESA	12.0	51.41	4.28	17.59
Cotton/Grain Sorghum	31	121.9	LEPA/LESA/ LDN/PMDI	8.0	-29.06	-3.63	13.87
Corn/Cotton	35	230	SDI	14.2	13.79	0.97	14.70
<b><u>Crop-Livestock systems</u></b>							
Alfalfa/Forage Sorghum/Wheat grazing/Cotton	4	123	LESA/LEPA	11.2	166.95	14.87	27.80
Perennial grass: contract grazing/Cotton	9	236.5	MESA	9.1	23.06	2.54	16.07
Perennial grass: contract grazing, /Corn/Cotton	10	176.1	LESA	14.6	46.74	3.21	13.73

<sup>1</sup>SDI – Subsurface drip irrigation; MESA – Mid elevation spray application; LESAs – Low elevation spray application; LEPA – Low energy precision application; LDN – Low drift nozzle; VRI – Variable rate irrigation; FUR – furrow irrigation; DL – dryland

**Table A 30.** Phase II Summary of results from monitoring 19 producer sites, 2017 (Year 4).

System	Site No.	System Acres	Irrigation Type <sup>1</sup>	System inches	Net Return/ System acre	Net Return/ inch water	Gross margin per inch irrigation
<b><u>Monoculture systems</u></b>							
Cotton	11	92.6	Fur/SDI	8.4	-68.93	-8.24	15.76
Cotton (2 in 2 out)	14	124.1	MESA	12.0	105.53	17.59	33.42
Corn	17	108.9	MESA	20.0	233.44	11.67	21.17
Cotton	21	120.7	LEPA	7.0	82.40	11.77	38.91
Cotton	22	145.0	LEPA	19.8	33.20	1.68	11.30
Corn	32	70.0	LEPA	16.5	138.35	8.38	19.90
Cotton	C37	475.5	VRI	14.0	-377.73	-26.98	-13.41
Cotton	C38	122.9	VRI	13.3	-127.58	-9.59	4.69
Cotton	C50	120.6	LESA/VRI	5.0	-95.75	-19.15	18.85
Cotton	C51	45.7	SDI	8.7	135.24	15.54	41.98
Blackeye pea	C56	60.0	LESA	6.0	366.54	61.09	92.76
Corn	C57	115.0	LESA	19.3	357.58	18.58	28.45
Cotton	C60	59.5	LESA	7.1	122.90	17.31	44.07
<b><u>Multi-crop systems</u></b>							
Cotton/Millet	31	121.9	LEPA/LESA/ LDN/PMDI	12.5	79.07	6.35	20.29
Corn/Cotton	35	230.0	SDI	12.3	197.76	16.08	34.78
Corn/Cotton	C39	120.0	LESA/LEPA	11.3	193.45	17.20	34.08
<b><u>Crop-Livestock systems</u></b>							
Alfalfa/Millet/Wheat grazing/Cotton	4	111.0	LESA/LEPA	13.0	123.49	9.54	23.47
Perennial grass: contract grazing/Cotton	9	236.5	MESA	3.3	-1.87	-0.56	45.28
Perennial grass: contract grazing, /Corn/Cotton	10	176.1	LESA	11.1	141.71	12.77	24.29

<sup>1</sup>SDI – Subsurface drip irrigation; MESA – Mid elevation spray application; LESAs – Low elevation spray application; LEPA – Low energy precision application; LDN – Low drift nozzle; VRI – Variable rate irrigation; FUR – furrow irrigation; DL – dryland



**Table A 31.** Phase II Summary of results from monitoring 17 active producer sites, 2018 (Year 5).

System	Site No.	System Acres	Irrigation Type <sup>1</sup>	System inches	Net Return/ System acre	Net Return/ inch water	Gross margin per inch irrigation
<b><u>Monoculture systems</u></b>							
Corn	11	95	Fur/SDI	12.6	126.82	10.04	27.00
Cotton (2 in 2 out)	14	124.1	MESA	7.5	-7.92	-1.06	11.62
Cotton	22	145.0	LEPA	20.8	119.23	5.75	14.90
Cotton	32	70.0	LEPA	10.8	462.31	42.81	60.40
Cotton	C37	124.0	VRI	19.0	355.31	18.70	30.81
Cotton	C38	242.7	VRI	13.0	-542.85	-41.76	-27.14
Cotton	C50	120.6	LESA/VRI	10.6	-156.78	-14.82	3.14
Cotton	C51	45.7	SDI	9.8	-108.22	-11.10	12.49
Corn	C56	60.0	LESA	16.0	150.65	9.42	21.92
Cotton	C57	124.0	LESA	6.0	298.31	49.72	81.39
Cotton	C60	59.5	LESA	9.8	42.37	4.32	23.71
<b><u>Multi-crop systems</u></b>							
Corn/Cotton	17	108.9	MESA	18.5	254.68	13.76	22.68
Wheat/Millet/Cotton	21	120.7	LEPA	11.0	-116.60	-10.60	6.67
Corn/Cotton	35	230.0	SDI	16.8	13.65	0.81	14.80
Corn/Cotton	C39	120.0	LESA/LEPA	16.4	459.90	28.08	39.98
<b><u>Crop-Livestock systems</u></b>							
Perennial grass: contract grazing/Cotton	9	235.8	MESA	11.2	61.61	5.52	20.24
Perennial grass: contract grazing, /Corn/Cotton	10	174.3	LESA	10.0	-120.97	-12.11	6.91

<sup>1</sup>SDI – Subsurface drip irrigation; MESA – Mid elevation spray application; LESAs – Low elevation spray application; LEPA – Low energy precision application; LDN – Low drift nozzle; VRI – Variable rate irrigation; FUR – furrow irrigation; DL – dryland

**Table A 32.** Phase I summary of crop production, irrigation, and economic returns within all production sites during 2005-2013.

Crop		2005	2006	2007	2008	2009	2010	2011	2012	2013	Crop year average
	Mean yields, per acre (only includes sites producing these crops, includes dryland) {Yield averages across harvested fields within sites}										
Cotton											
	Lint, lbs	1,117 (22)	1,379 (20)	1,518 (13)	1,265 (11)	1,223 (16)	1,261 (15)	1,166 (19)	1,299 (16)	1,470 (19)	1,300
	Seed, tons	0.80 (22)	0.95 (20)	1.02 (13)	0.86 (11)	0.81 (16)	0.83 (15)	0.77 (19)	0.92 (16)	1.0 (19)	0.9
Corn											
	Grain, lbs	12,729 (3)	8,814 (4)	12,229 (4)	10,829 (8)	12,613 (4)	12,685 (10)	6,766 (4)	7,475 (7)	11,982 (9)	10,680
	Silage, tons	30.9 (2)	28.3 (3)	27.3 (3)	-	38.3 (1)	31 (2)	20.5 (3)	6.3 (4)	32 (5)	26.8
Sorghum											
	Grain, lbs	4,147 (3)	2,987 (1)	6,459 (4)	6,345 (5)	6,907 (3)	4,556 (3)	1,196 (1)	6,358 (2)	8,124 (3)	5,231
	Silage, tons	26.0 (1)	20.4 (2)	25.0 (1)	11.3 (2)	9.975 (2)	-	-	-	-	18.5
	Seed, lbs	-	-	-	3,507 (1)	-	-	-	-	-	3,507
Wheat											
	Grain, lbs	2,034 (1)	-	2,613 (5)	4,182 (5)	2,061 (6)	2,860 (6)	3,060 (1)	2,052 (3)	798 (3)	2,458
	Silage, tons	16.1 (1)	7.0 (1)	-	7.5 (1)	3.71 (1)	-	-	-	-	8.6
	Hay, tons	-	-	-	-	2.5 (1)	-	-	-	0.5 (2)	1.5
Oat											
	Silage, tons	-	4.9 (1)	-	-	12.5 (1)	-	-	-	-	8.7
	Hay, tons	-	1.8 (1)	-	-	-	-	-	-	-	1.8
Barley											
	Grain, lbs	-	-	-	3,133 (1)	-	-	-	-	-	3,133
	Hay, tons	-	-	-	5.5 (1)	-	-	-	-	-	5.5
Triticale											
	Hay, tons	-	-	-	-	-	-	3(1)	-	-	3.0
	Silage, tons	-	21.3 (1)	17.5 (1)	-	-	13 (2)	2.5(2)	12 (1)	-	13.3
Sunflower											
	Seed, lbs	-	-	-	1,916 (2)	2,274 (4)	-	-	1903 (1)	2,635 (4)	2,182
Pearl millet for seed											
	Seed, lbs	3,876 (1)	2,488 (1)	4,002 (2)	2,097 (2)	-	-	1,800(1)	2,014 (1)	3,600 (3)	2,840
Perennial forage											
WW-BDahl											
	Seed, PLS lbs	-	-	-	30 (1)	83.14 (1)	-	-	62.8 (1)	-	58.6
	Hay, tons	-	-	-	2.5 (1)	-	-	-	-	-	2.5
Sideoats											
	Seed, PLS lbs	313 (2)	268 (2)	183.5 (3)	192.9 (3)	362 (3)	212.5 (2)	200.75 (2)	267 (2)	315 (2)	257
	Hay, tons	3.6 (2)	2.1 (2)	1.46 (3)	1.66 (3)	1.83 (3)	1.1 (2)	0.5 (2)	1.9 (2)	1.4 (2)	1.7

Crop		2005	2006	2007	2008	2009	2010	2011	2012	2013	Crop year average
Other											
	Hay, tons	-	-	-	0.11 (1)	4.3 (1)	2.4 (1)	-	-	-	2.3
Alfalfa											
	Hay, tons	8.3 (1)	9.18 (1)	4.90 (1)	12.0 (1)	9.95 (1)	9.0 (1)	10.6 (1)	8.4 (1)	9.5 (1)	9.1
<b>Annual forage</b>											
Forage sorghum											
	Hay, tons	-	-	-	-	-	-	6.8 (1)	1.9 (2)	1.7 (1)	3.5
	Seed, lbs								3,396 (1)		3,396
<b>Precipitation, inches (including all sites)</b>		15.0	15.4	27.3	21.7	15.7	28.9	5.3	10.0	13.2	16.9
<b>By System</b>		<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>
<b>Total irrigation water (system average)</b>		9.2 (26)	14.8 (26)	11.0 (25)	13.3 (23)	11.5 (24)	9.2 (24)	20.9 (27)	16.0 (26)	16.3 (29)	13.6
<b>By Crop</b>	<b>Irrigation</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>	<b>inches applied</b>
Cotton	lint	8.7 (19)	14.3 (19)	11.3 (11)	12.2 (10)	11.5 (15)	7.6 (16)	23.2 (19)	14.8 (16)	18.4 (17)	13.6
Corn	grain	17.4 (3)	21.0 (4)	12.7 (4)	22.3 (8)	20.5 (4)	13.0 (10)	21.2 (4)	22.2 (7)	22.0 (9)	19.1
Corn	silage	18.0 (2)	24.0 (3)	14.3 (3)	-	24.3 (1)	15.5 (3)	36.1 (3)	22.4 (4)	27.9 (4)	22.8
Sorghum	grain	5.3 (3)	4.2 (1)	6.6 (4)	12.3 (5)	9.4 (3)	6.1 (2)	27.8 (1)	19.7 (2)	16.9 (3)	12.0
Sorghum	silage	15.0 (1)	9.0 (1)	11.6 (1)	11.5 (1)	15.7 (1)	-	-	-	-	12.6
Wheat	grain	-	-	5.3 (3)	7.7 (4)	6.4 (5)	4.8 (3)	7.9 (2)	4.2 (3)	8.2 (5)	6.4
Wheat	silage	7.5 (1)	16.3 (1)	-	5.5 (1)	15.7 (1)	-	-	-	-	11.3
Oat	silage	-	4.3 (1)	-	-	15.7 (1)	-	-	-	-	10.0
Oat	hay	-	4.9 (1)	-	-	-	-	-	-	-	4.9
Triticale	silage	2.5 (1)	10.0 (1)	12.9 (1)	-	-	6.9 (2)	17.8 (2)	19.6 (1)	5.6 (1)	10.8
Barley	grain	-	-	-	12.8 (1)	-	-	-	-	-	12.8
Small grain	(grazing)	0.0 (1)	0.0 (1)	0.0 (1)	-	-	-	-	-	-	0.0
Small grain	(grains)	-	-	5.3 (3)	8.7 (5)	6.4 (5)	3.8 (4)	7.9 (2)	4.2 (3)	8.2 (5)	6.4
Small grain	(silage)	5.0 (1)	10.2 (3)	12.0 (1)	5.5 (1)	15.7 (1)	6.9 (2)	17.8 (2)	19.6 (1)	5.6 (1)	10.9
Small grain	(hay)	-	4.9 (1)	5.0 (1)	-	-	-	24 (1)	-	-	11.3
Small grain	(all uses)	2.5 (2)	5.9 (6)	6.0 (5)	8.2 (6)	8.0 (6)	3.6 (8)	13.9 (4)	7.2 (4)	7.8 (6)	7.0
Sunflower	seed	6.0 (1)	-	-	9.6 (2)	8.9 (4)	-	-	15.1 (1)	12.3 (4)	10.4
Millet	seed	11.5 (1)	10.2 (1)	8.1 (2)	9.6 (2)	-	9.9 (1)	14.4 (1)	22.7 (1)	18.3 (3)	13.1
<b>Dahl</b>											
	hay	6.5 (2)	-	0 (1)	4.6 (1)	-	-	-	-	-	3.7
	seed	-	-	6.1 (2)	9.4 (1)	8.5 (1)	-	-	8.2 (1)	-	8.1
	grazing	0 (1)	11.4 (2)	5.5 (2)	-	5.9 (2)	2.8 (2)	8.9 (2)	22.7 (1)	5.6 (2)	7.9
<b>Sideoats</b>											
	seed	10.5 (2)	7.8 (2)	11.9 (2)	8.0 (3)	15.3 (3)	2.8 (2)	13.6 (2)	19.0 (2)	12.2 (2)	11.2
<b>Bermuda</b>											
	grazing	-	-	3.8 (1)	6.2 (1)	5.1 (1)	0 (1)	17.1 (1)	12.0 (1)	-	7.4

Crop		2005	2006	2007	2008	2009	2010	2011	2012	2013	Crop Year Average
By Crop	Irrigation	inches applied	inches applied	inches applied	inches applied	inches applied	inches applied	inches applied	inches applied	inches applied	inches applied
Other Perennials/Annuals											
	hay	-	10.9 (3)	5.0 (1)	6.4 (2)	6.7 (2)	8.5 (1)	21.5 (2)	13.9 (2)	3.6 (1)	9.6
	grazing	1.0 (1)	3.2 (3)	4.4 (4)	7.6 (4)	3.3 (2)	7.6 (5)	16.5 (2)	4.2 (1)	5.7 (2)	5.9
Perennial grasses (grouped)											
	seed	10.5 (2)	7.8 (2)	9.0 (5)	8.6 (4)	13.6 (4)	2.8 (2)	13.6 (2)	15.4 (3)	12.2 (2)	10.4
	grazing	1.0 (3)	8.8 (4)	4.9 (4)	5.2 (3)	4.9 (4)	2.3 (4)	12.4 (3)	13.0 (2)	3.7 (3)	6.2
	hay	8.5 (4)	0 (2)	0 (4)	1.9 (4)	0 (3)	0 (2)	0 (2)	0 (2)	0 (2)	1.2
	all uses	6.7 (6)	6.6 (6)	5.2 (7)	5.2 (7)	6.5 (7)	1.9 (6)	10.0 (5)	10.6 (5)	5.1 (5)	6.4
Alfalfa											
	all uses	10.3 (1)	34.5 (1)	10.6 (1)	15.6 (1)	18.6 (1)	15.6 (1)	44.1 (1)	28.3 (1)	31.6 (1)	23.2
Income and Expense, \$/system acre											
Projected returns		\$660.53	\$773.82	\$840.02	\$890.37	\$745.82	\$961.87	\$951.66	\$1,063.98	\$1,171.08	\$895.46
Costs											
Total variable costs (all sites)		\$444.88	\$504.91	\$498.48	\$548.53	\$507.69	\$537.14	\$658.68	\$578.28	\$709.95	\$554.28
Total fixed costs (all sites)		\$77.57	\$81.81	\$81.77	\$111.98	\$110.65	\$153.55	\$149.98	\$135.53	\$137.19	\$115.56
Total all costs (all sites)		\$522.45	\$586.72	\$580.25	\$660.51	\$618.34	\$690.69	\$808.67	\$713.80	\$846.87	\$669.81
Gross Margin											
Per system acre (all sites)		\$215.66	\$268.91	\$341.54	\$341.84	\$238.13	\$424.74	\$313.83	\$469.92	\$454.90	\$341.05
Per acre-inch irrigation water (irrigated only)		\$33.51	\$22.53	\$34.01	\$31.17	\$22.95	\$71.50	\$24.76	\$32.72	\$33.45	\$34.07
Net returns over all costs											
Per system acre (all sites)		\$138.09	\$187.10	\$259.77	\$229.86	\$127.48	\$271.19	\$163.85	\$334.39	\$317.98	\$225.52
Per acre-inch of irrigation water (irrigated only)		\$21.58	\$15.88	\$24.99	\$20.89	\$9.99	\$43.71	\$10.16	\$22.89	\$23.70	\$21.53
Per pound of nitrogen (all sites)		\$1.62	\$0.81	\$2.34	\$1.48	\$0.87	\$2.40	\$1.92	\$2.51	\$2.78	\$1.86

# Terminated Site Data (2005-2016)

## SITE 1 – TERMINATED AFTER 2007



Site acres: 135.2

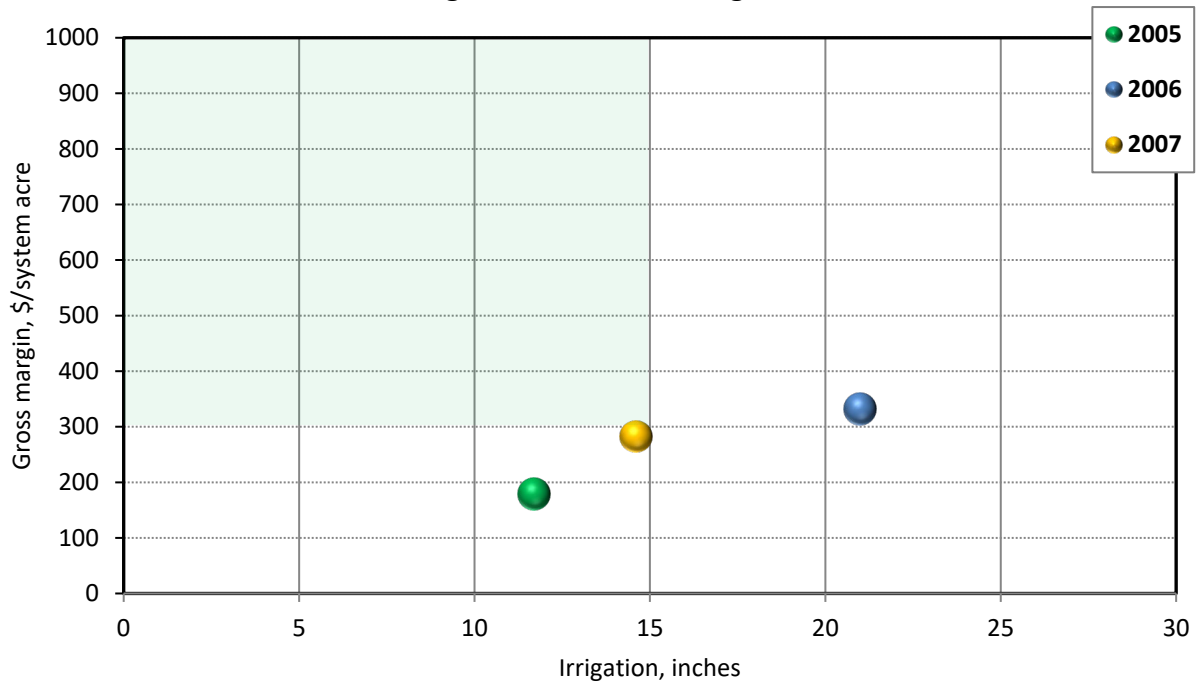
Soil types:  
PuA-Pullman clay loam, 0 to 1%

Irrigation:  
Sub-Surface Drip (SDI) 850 gpm

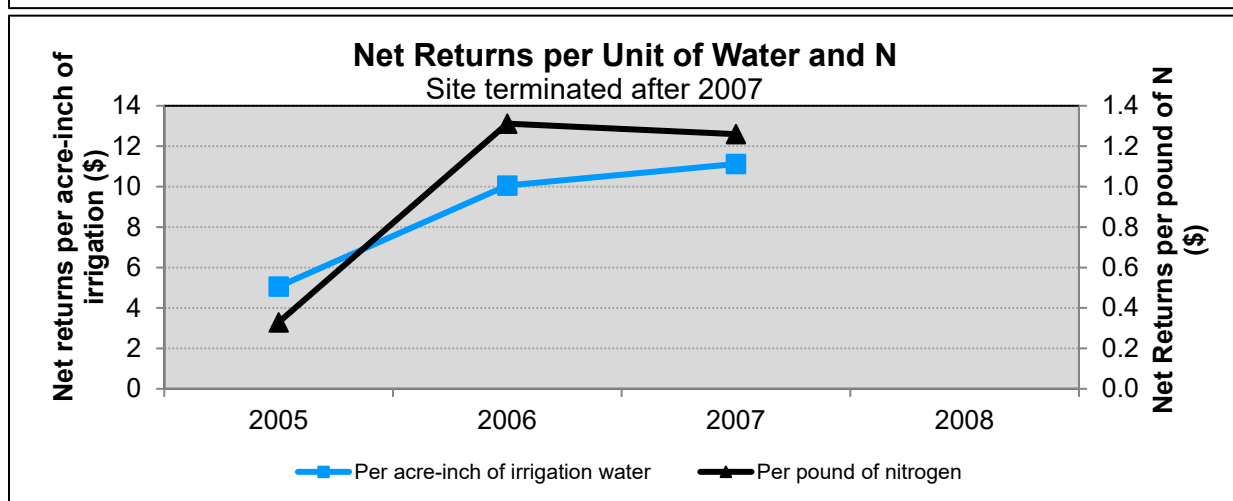
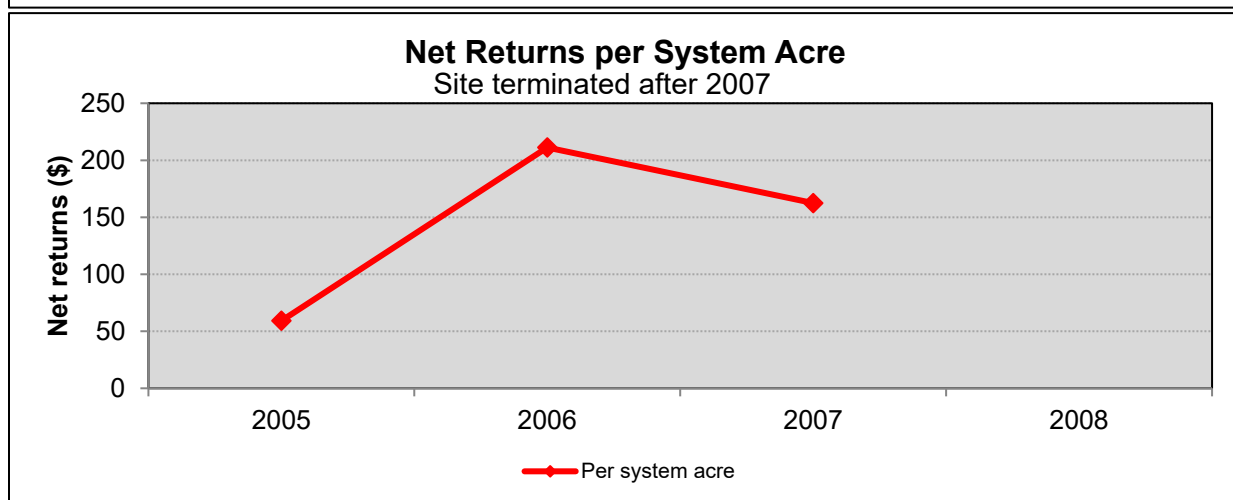
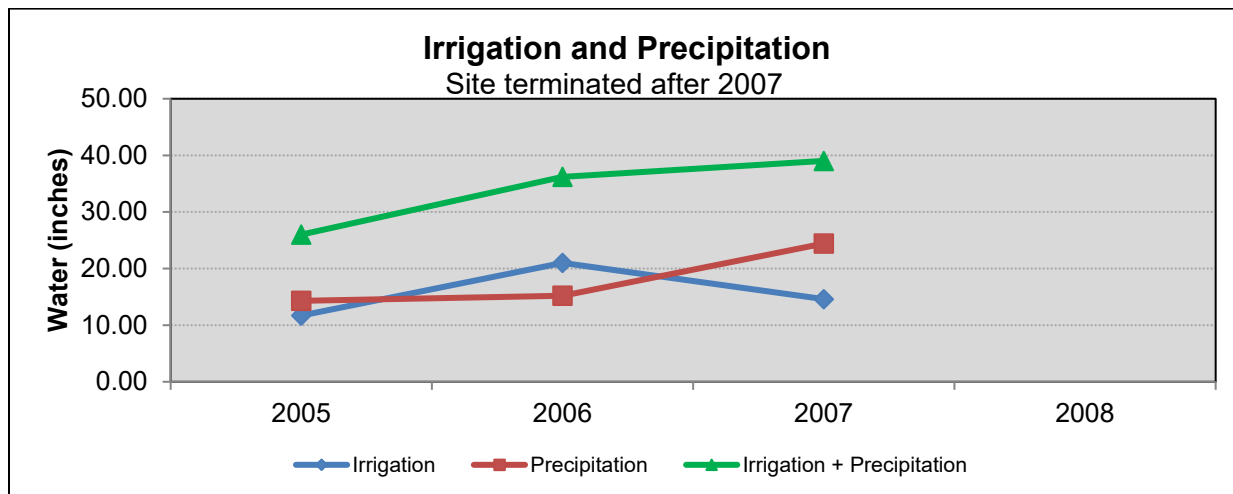
Number of wells: 2

Fuel Source: 1 Natural gas,  
1 Electric

**Site 1** TAWC Site Irrigation and Gross Margin, 2005-2007



## Site 1



## SITE 2 – TERMINATED AFTER 2013



### **Description:**

Site acres: 60

### Soil types:

**PuA**-Pullman clay loam, 0 to 1%

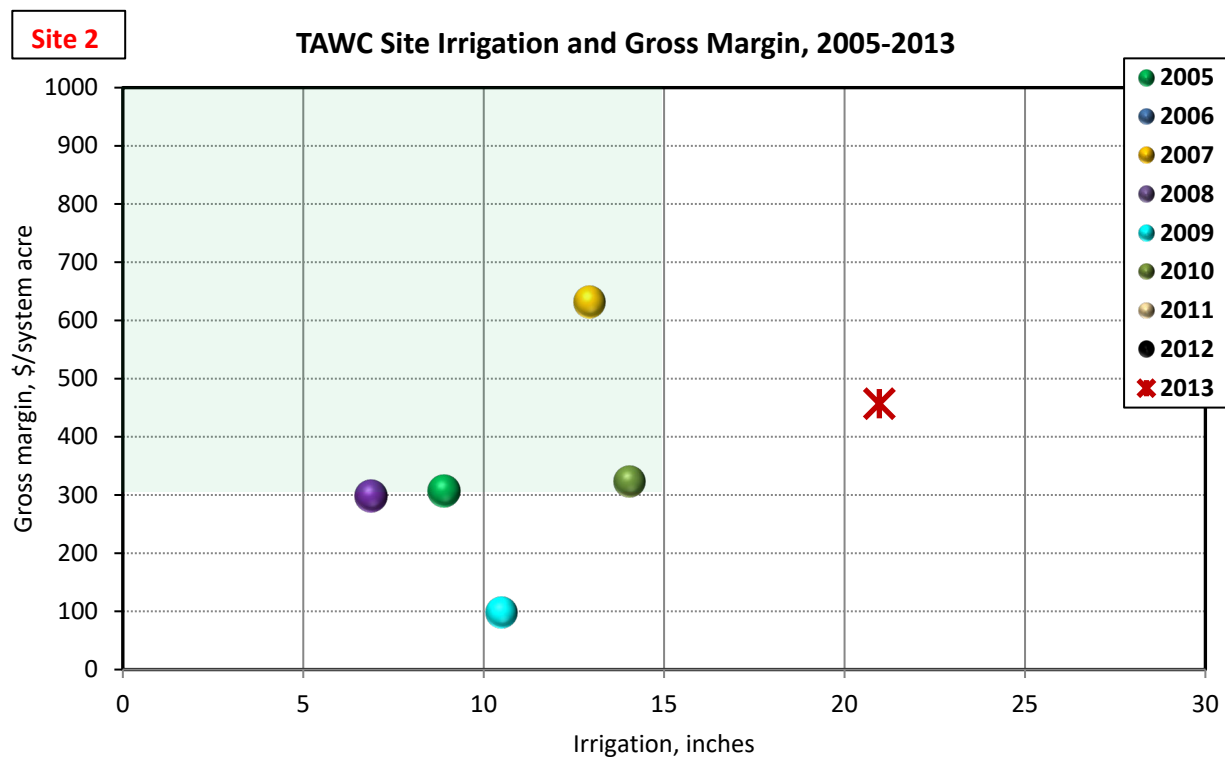
**OcB**-Olton clay loam, 1 to 3%

### Irrigation:

Sub-Surface Drip (SDI) 3600 gpm

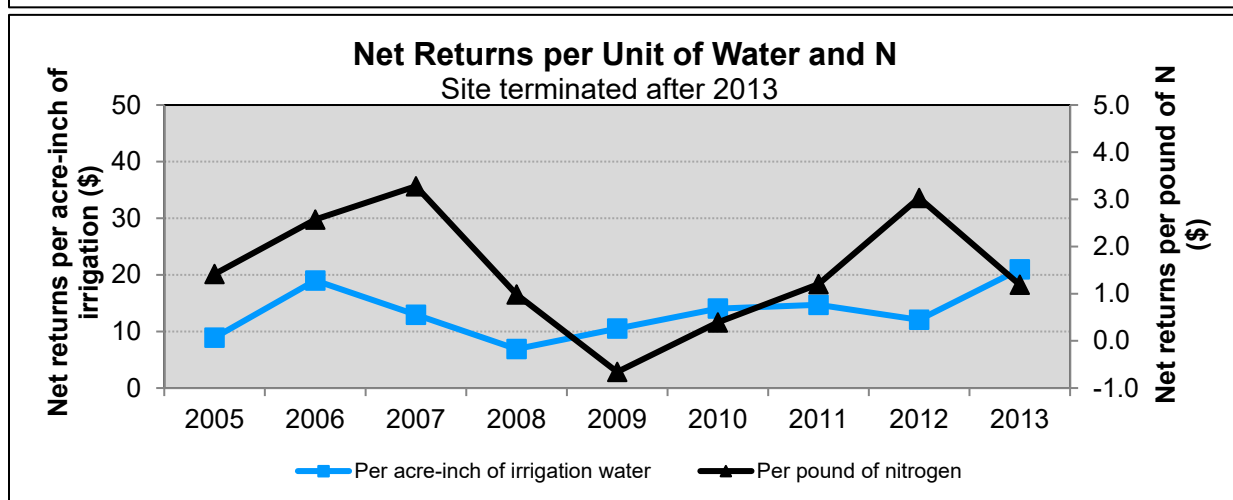
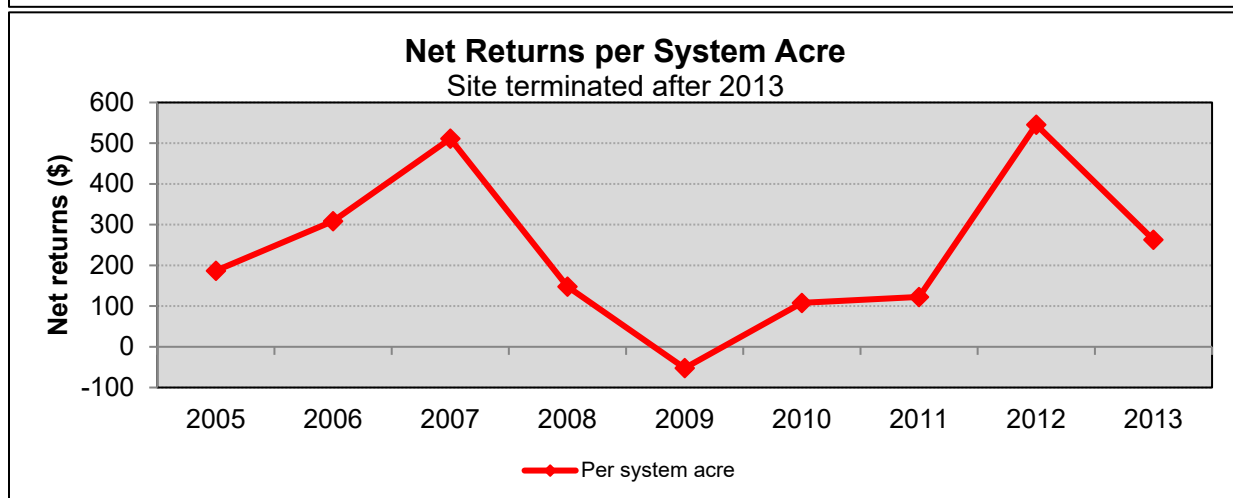
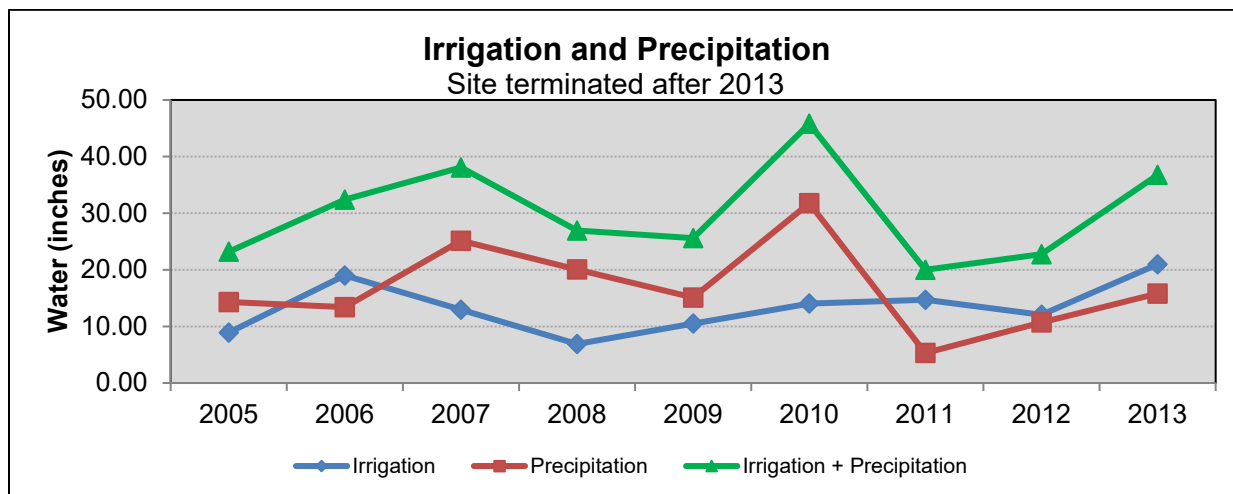
Number of wells: 2

Fuel Source: Electric

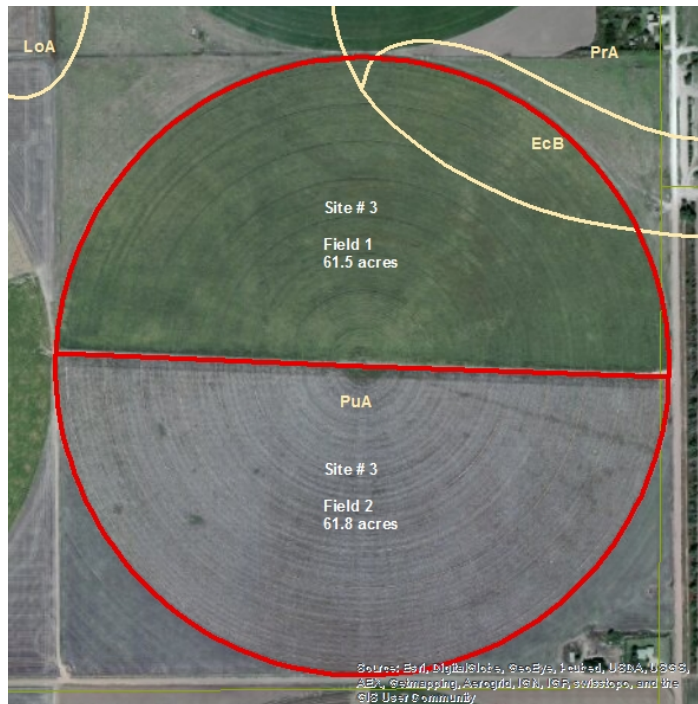




## Site 2



### SITE 3 – TERMINATED AFTER 2013



#### **Description:**

Site acres: 123.3

#### Soil types:

**PuA**-Pullman clay loam, 0 to 1%

**EcB**-Estacado clay loam; 1 to 3%

#### Irrigation:

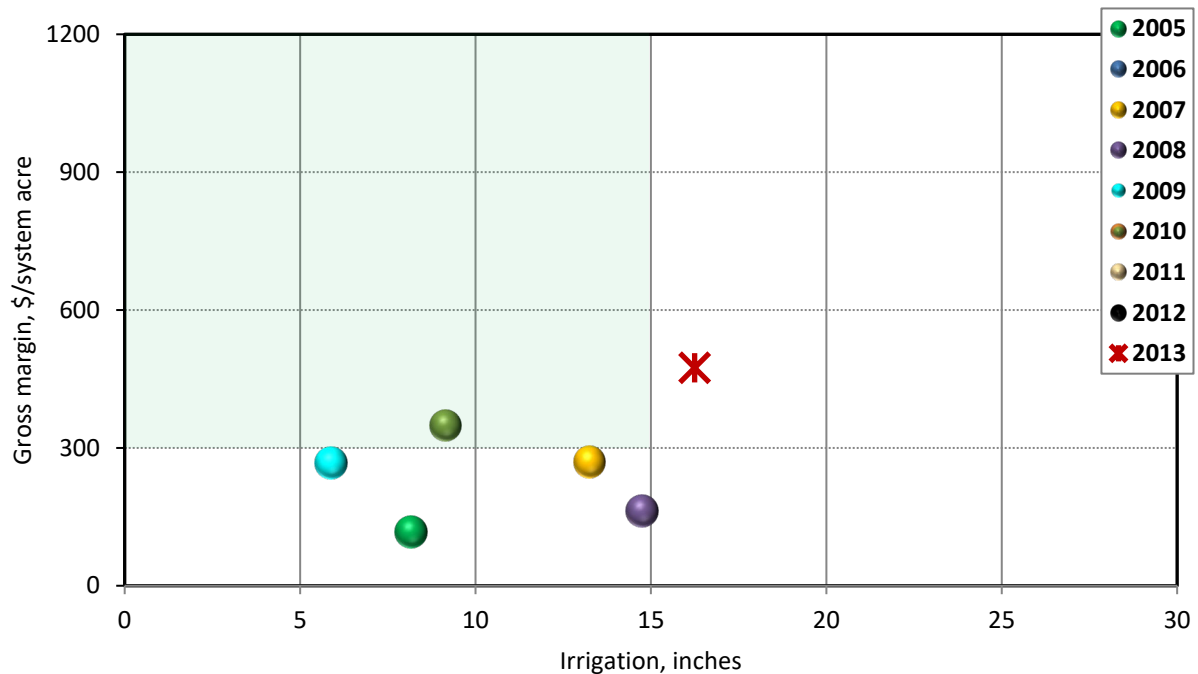
Center Pivot (MESA) 450 gpm

Number of wells: 2

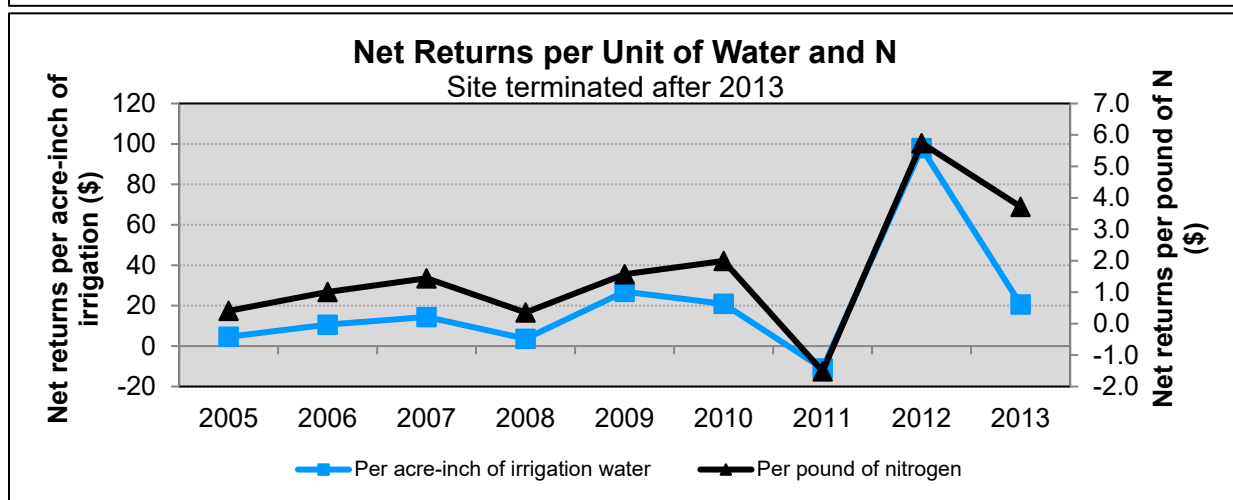
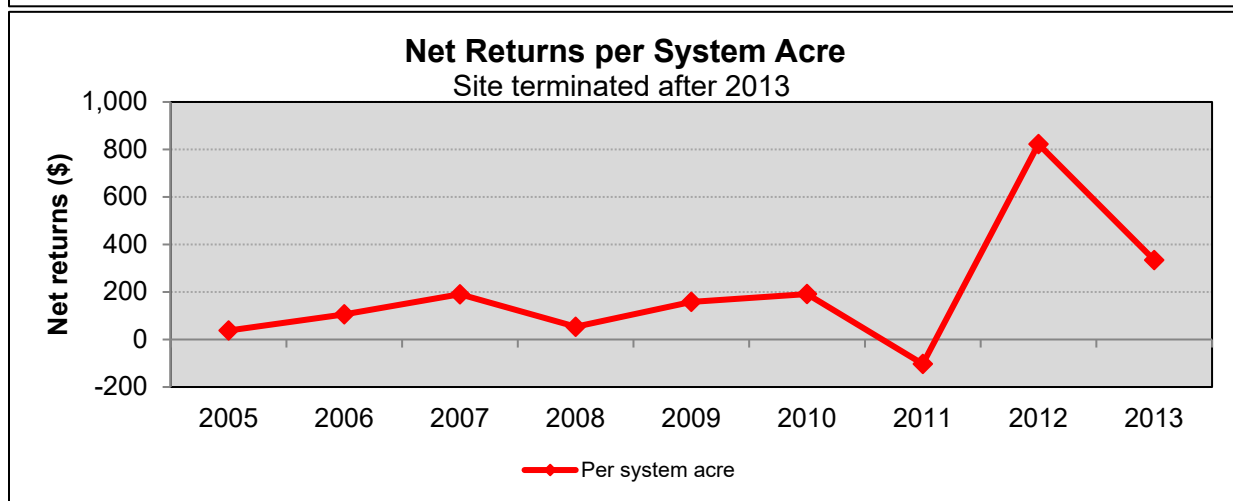
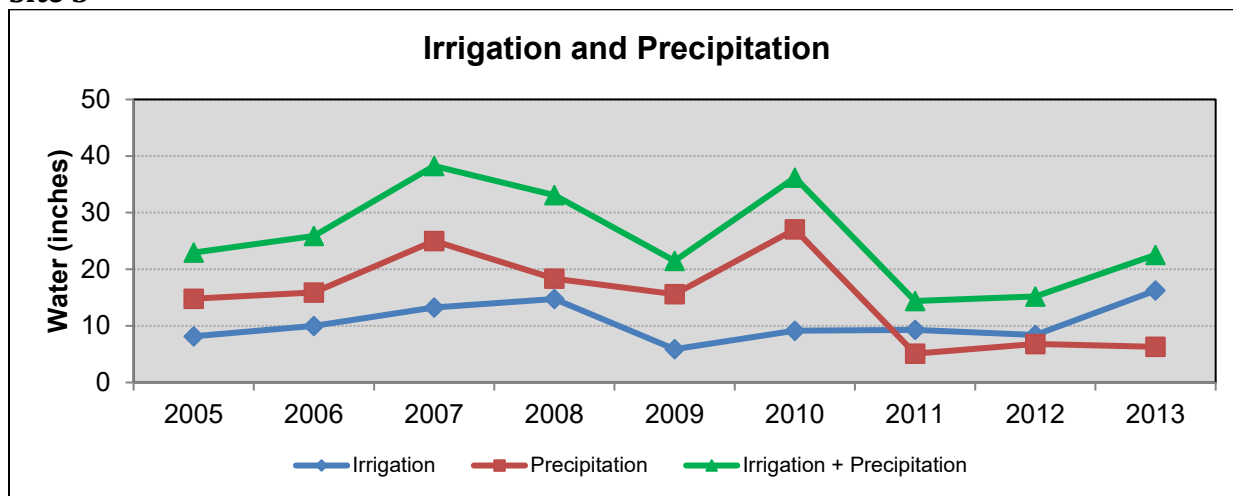
Fuel Source: 1 Natural Gas,  
1 Electric

#### **Site 3**

#### **TAWC Site Irrigation and Gross Margin, 2005-2013**



## Site 3



Site acres: 484.1

Soil types:  
BpA-Bippus loam, 0 to 1%  
MkB/MkC-Mansker loam, 0 to 3 and 3 to 5%  
OtA/OtB-Olton loam, 0 to 1% and 1 to 3%

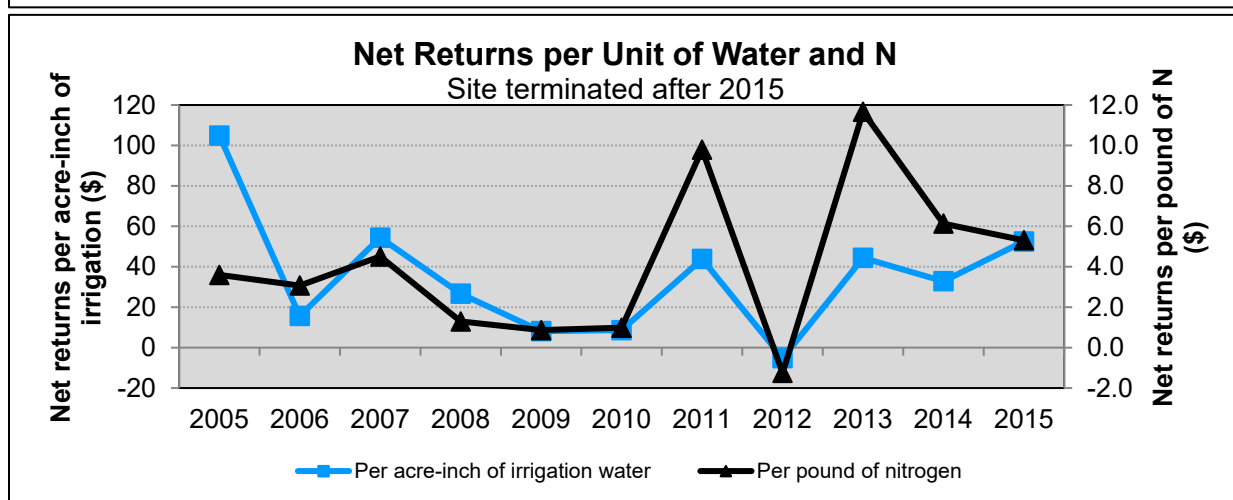
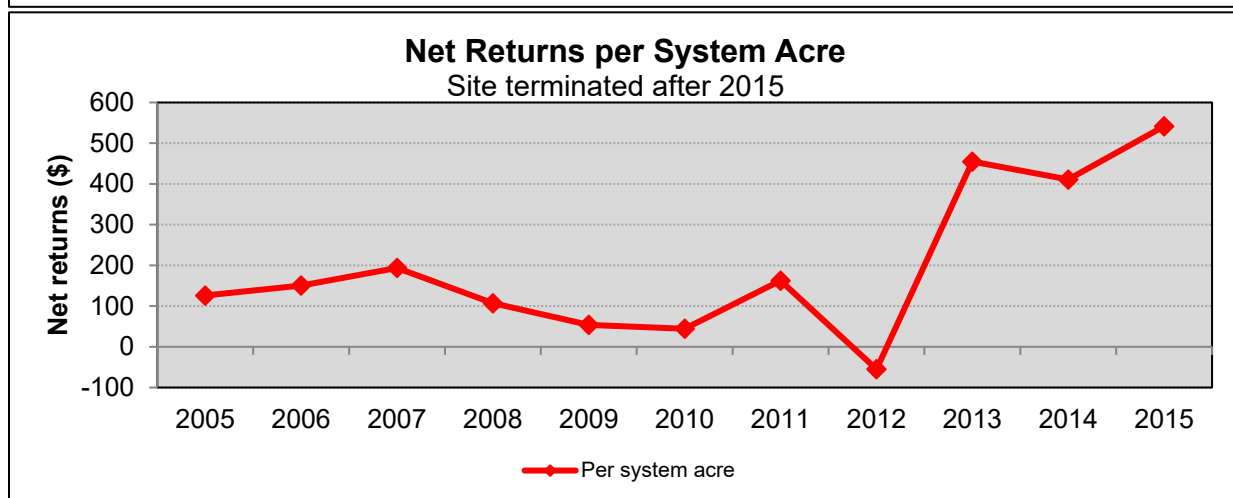
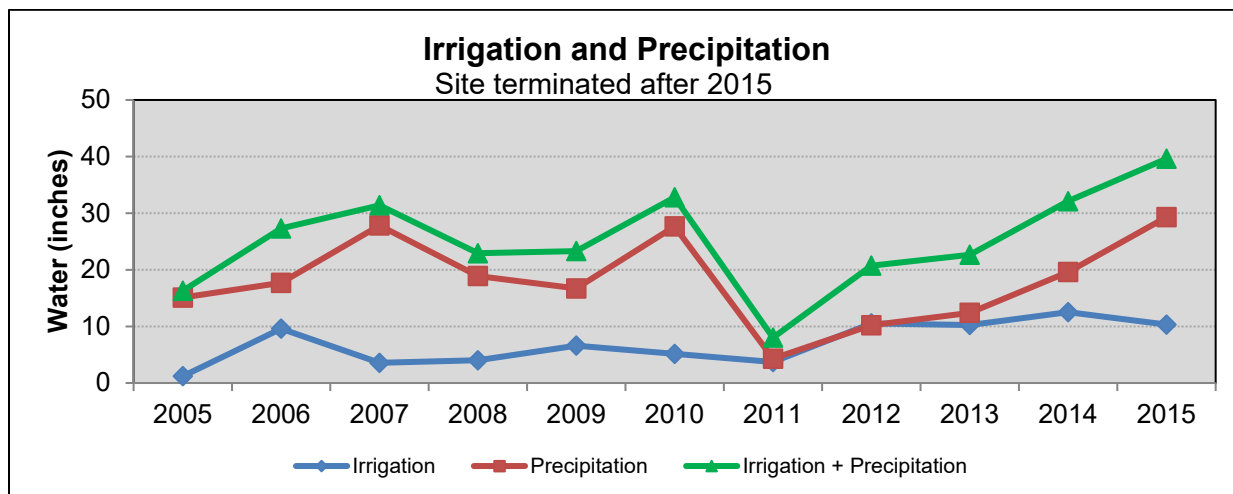
Irrigation:  
Center Pivot (MESA) 1100gpm

Number of wells: 4

Fuel Source: Electric



## Site 5



## SITE 6 - TERMINATED AFTER 2016



### **Description:**

Site acres: 122.7

### **Soil types:**

**PuA**-Pullman clay loam, 0 to 1%

**PuB**-Pullman clay loam, 1 to 3%

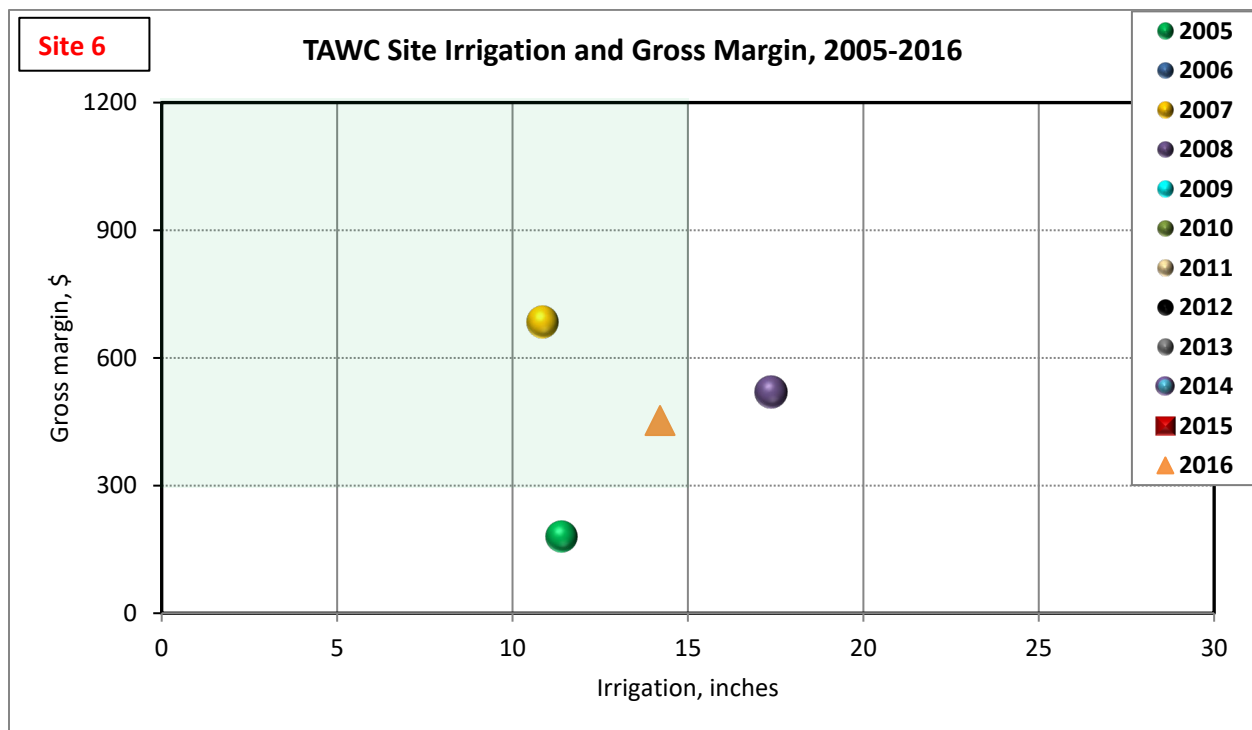
**LoA**-Lofton clay loam, 0 to 1%

### **Irrigation:**

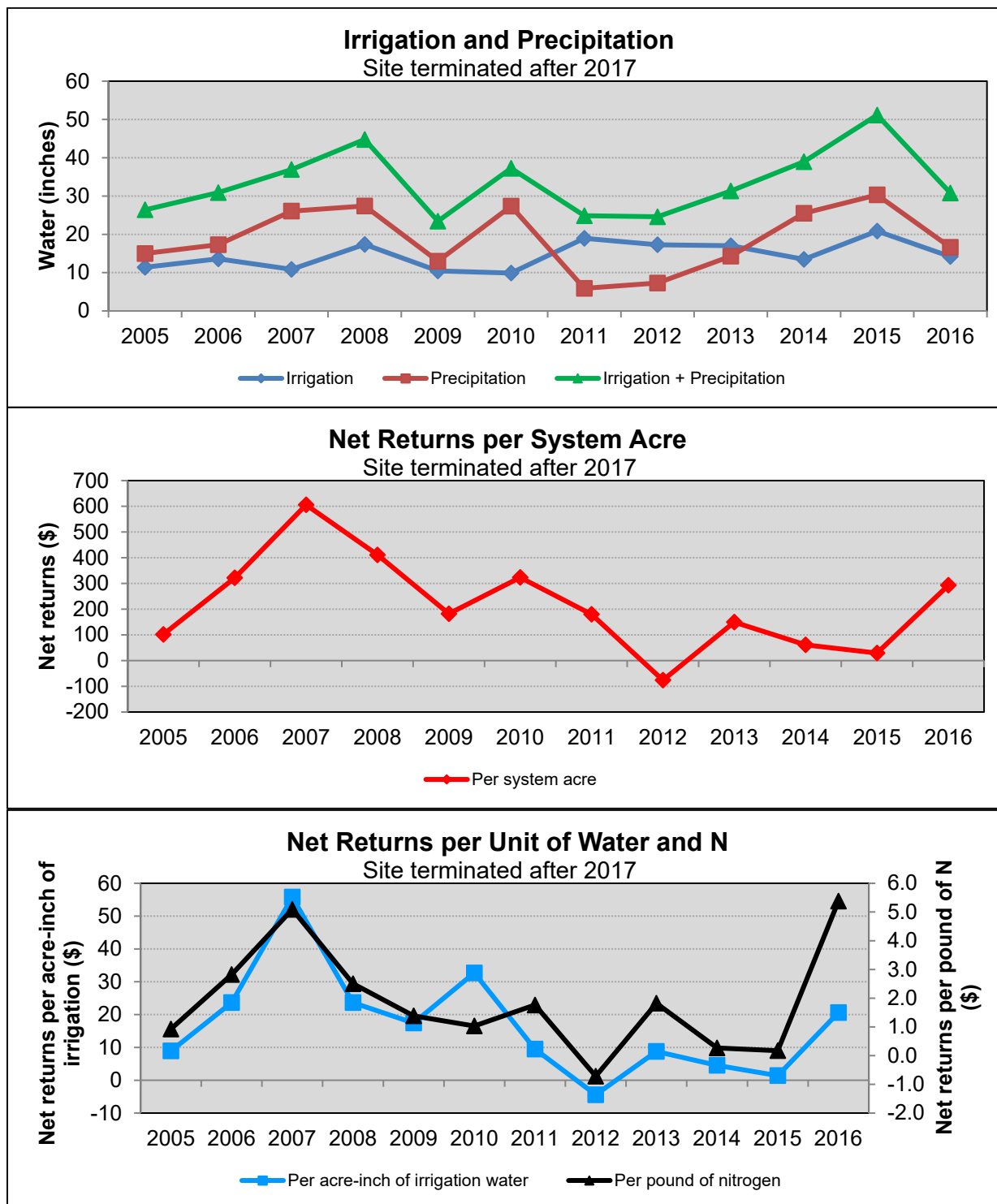
Center Pivot (LESA) 500 gpm

Number of wells: 4

Fuel Source: Natural gas



## Site 6





## SITE 7 – TERMINATED AFTER 2014



### **Description:**

Site acres: 130

### Soil types:

**PuA**-Pullman clay loam, 0 to 1%

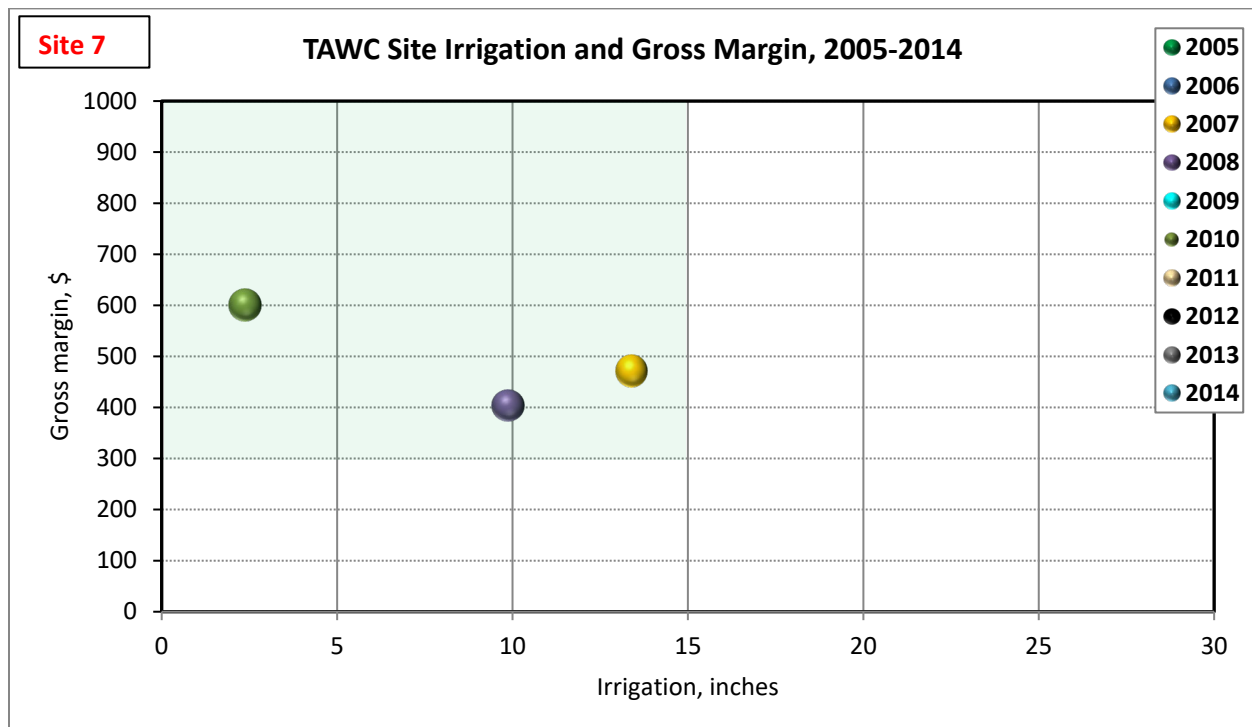
**PuB**-Pullman clay loam, 1 to 3%

### Irrigation:

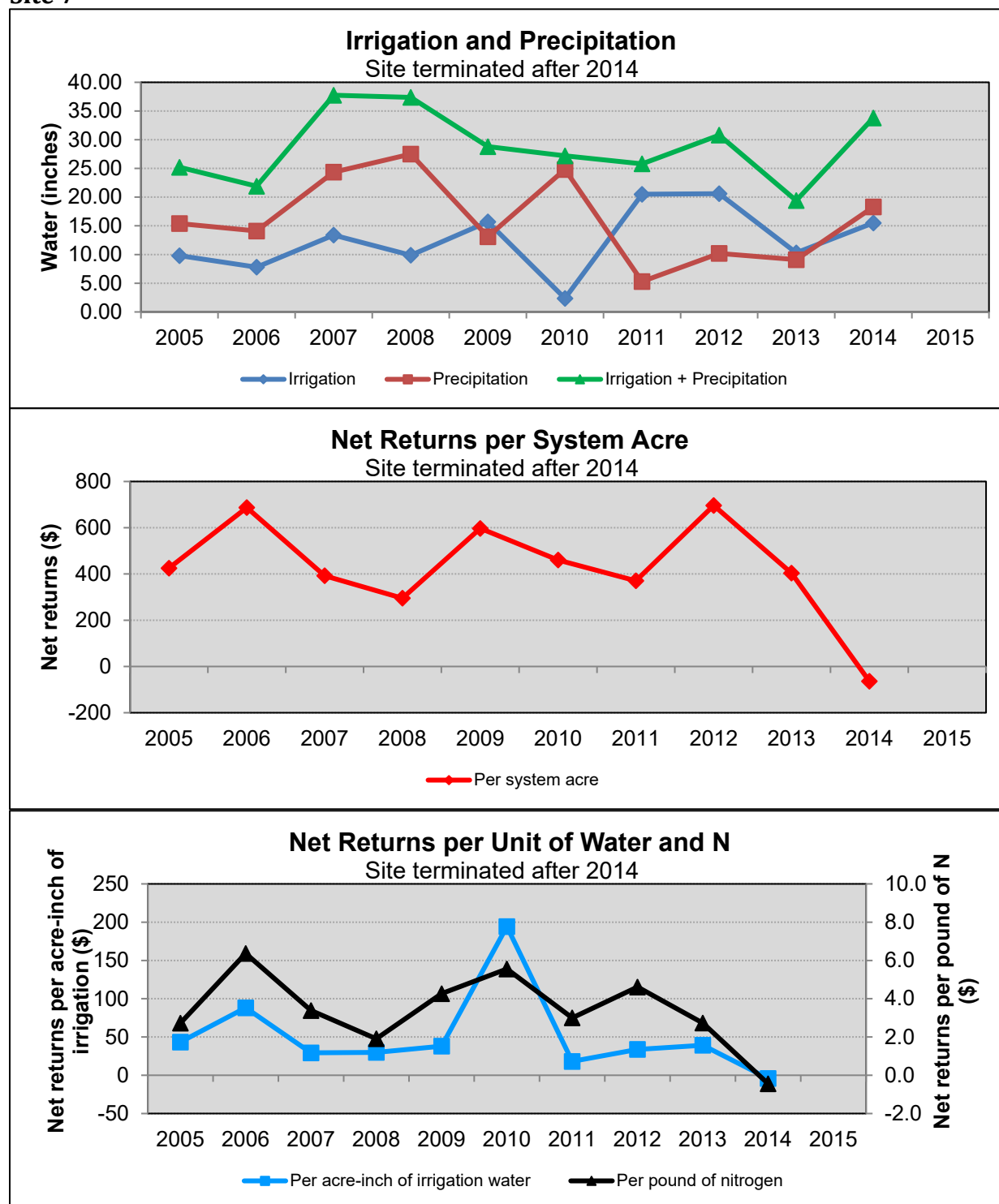
Center Pivot (LESA) 500 gpm

Number of wells: 4

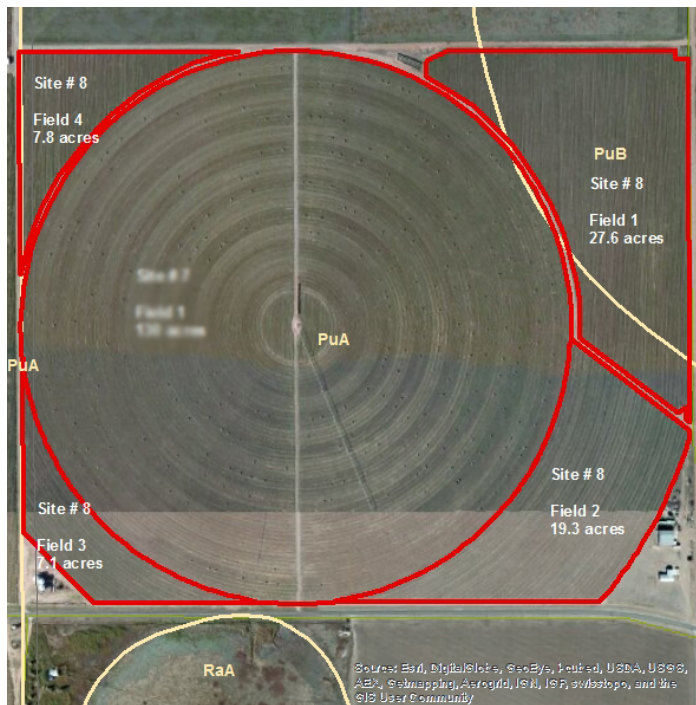
Fuel Source: Electric



## Site 7



## SITE 8 – TERMINATED AFTER 2014



### **Description:**

Site acres: 61.8

### **Soil types:**

PuA-Pullman clay loam, 0 to 1%

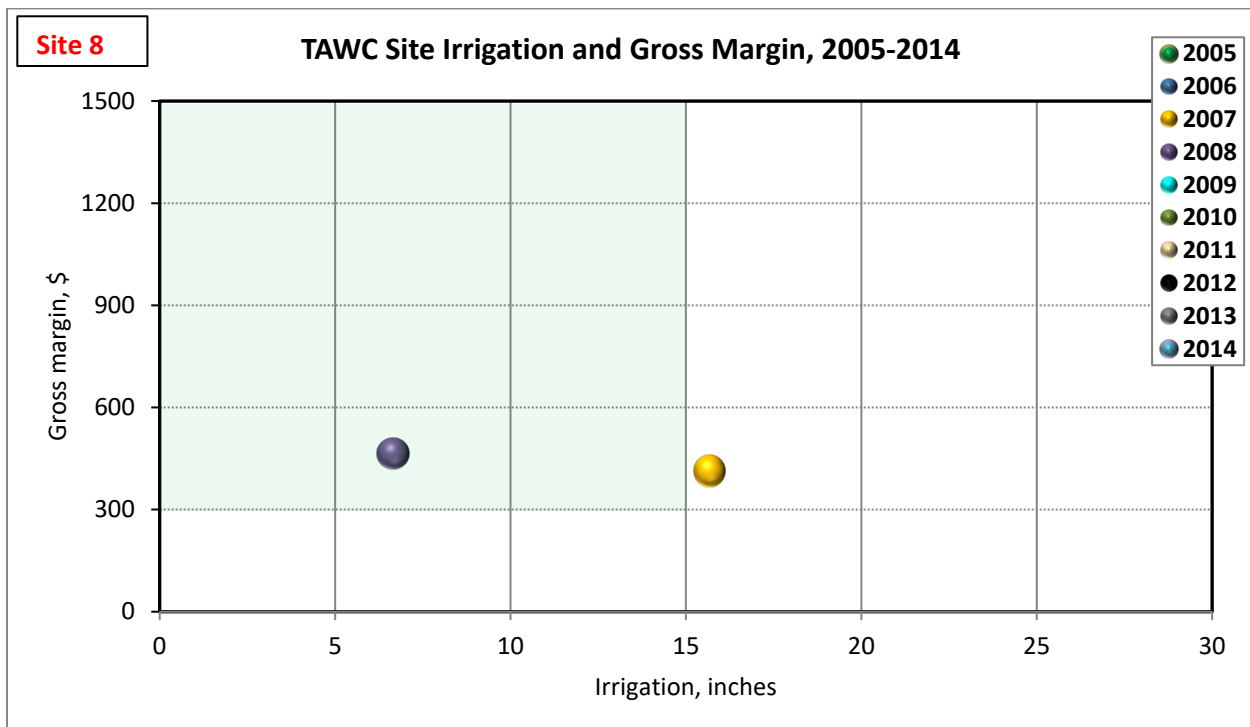
PuB-Pullman clay loam, 1 to 3%

### **Irrigation:**

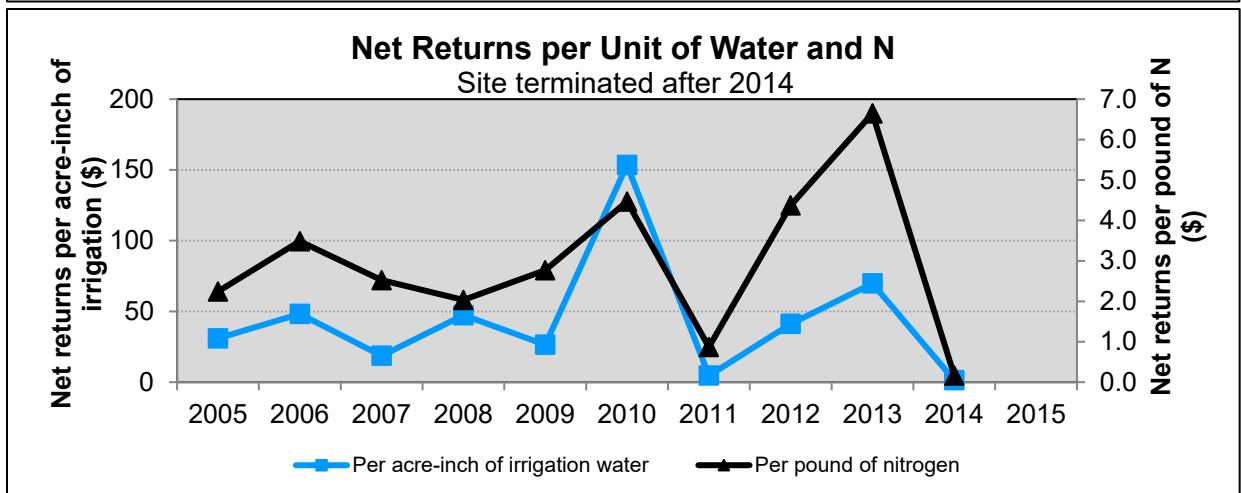
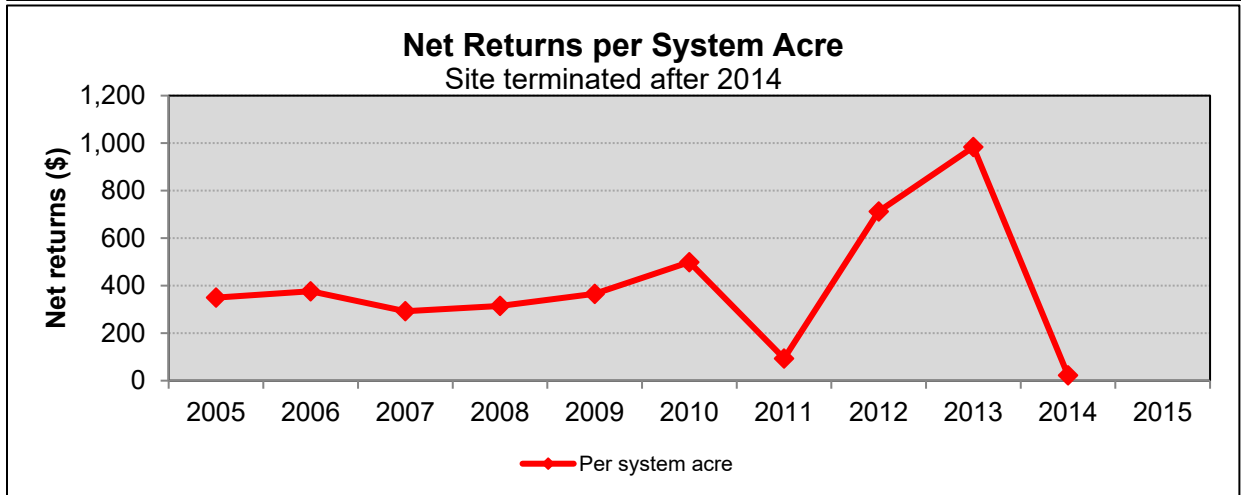
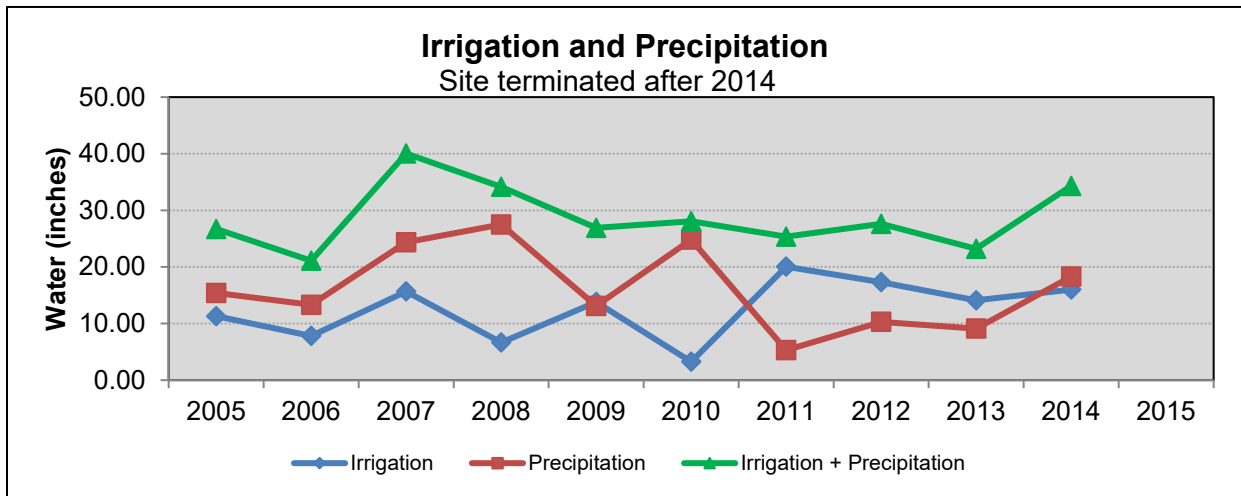
Sub-surface drip (SDI) 360 gpm

Number of wells: 4

Fuel Source: Electric



## Site 8



## SITE 12 – TERMINATED AFTER 2013



### **Description:**

Site acres: 283.8

Soil types:

**PuA**-Pullman clay loam, 0 to 1%

Irrigation:

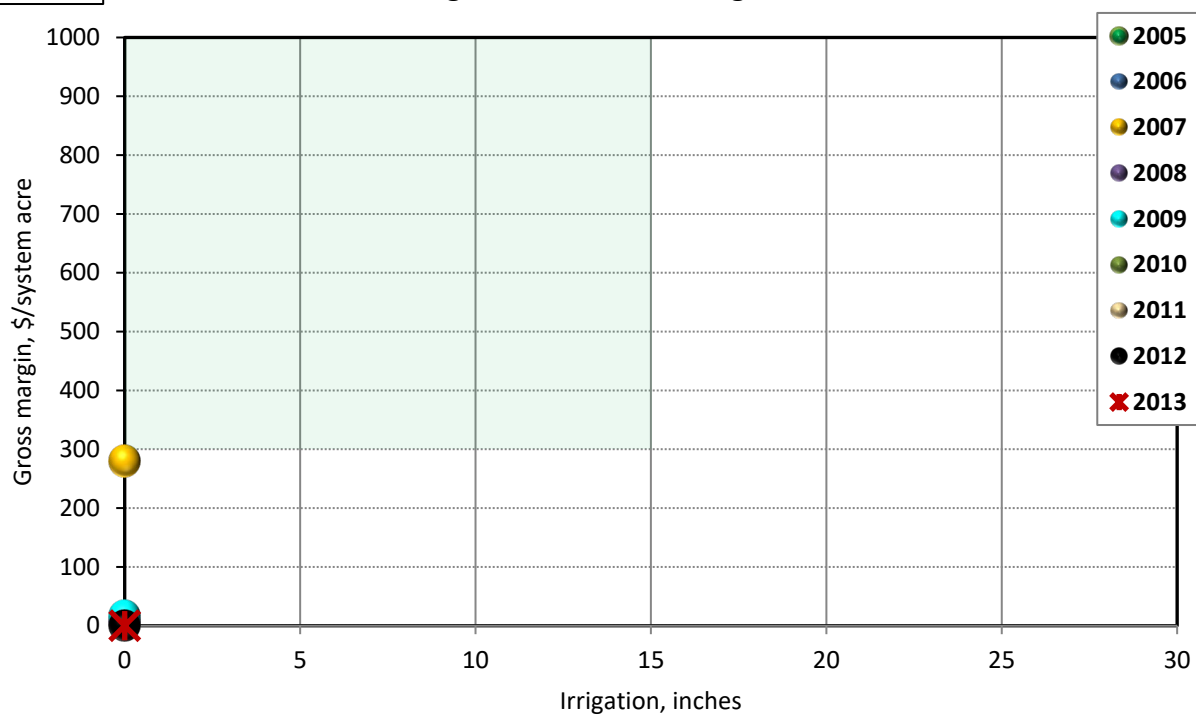
Dryland (DL) na gpm

Number of wells: na

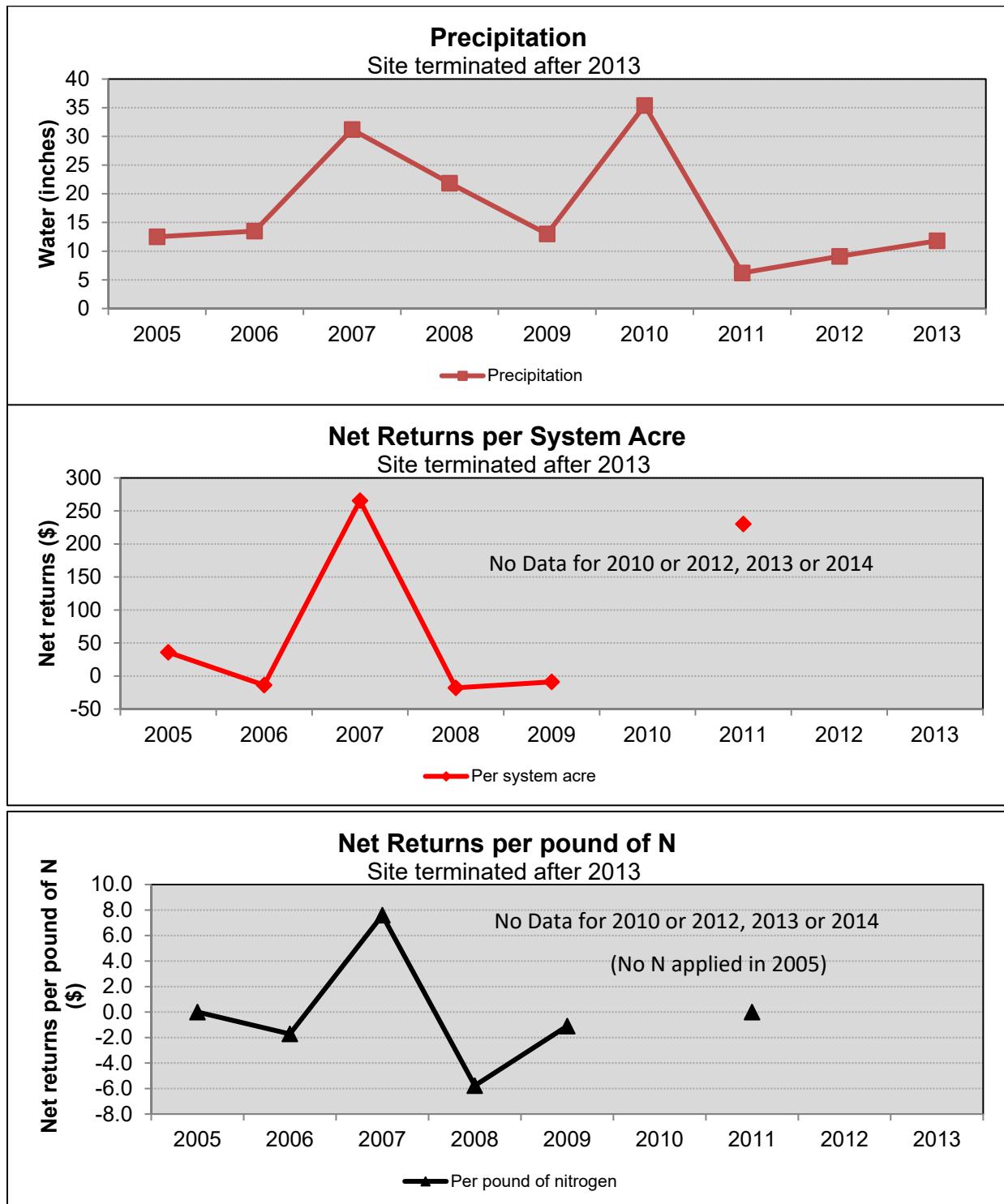
Fuel Source: na

### **Site 12**

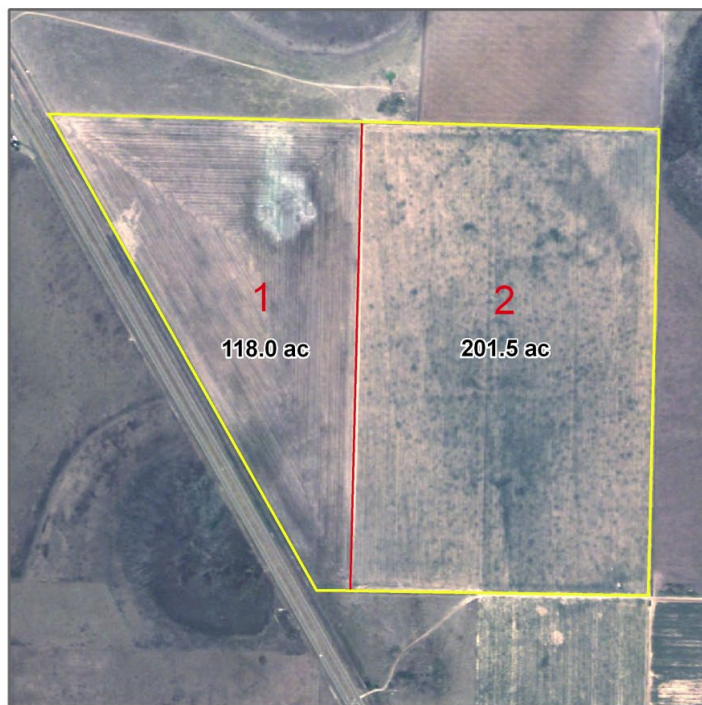
### **TAWC Site Irrigation and Gross Margin, 2005-2013**



## Site 12 - Dryland Site



### SITE 13 – TERMINATED AFTER 2007



#### **Description:**

Site acres: 319.5

Soil types:

PuA-Pullman clay loam, 0 to 1%

Irrigation:

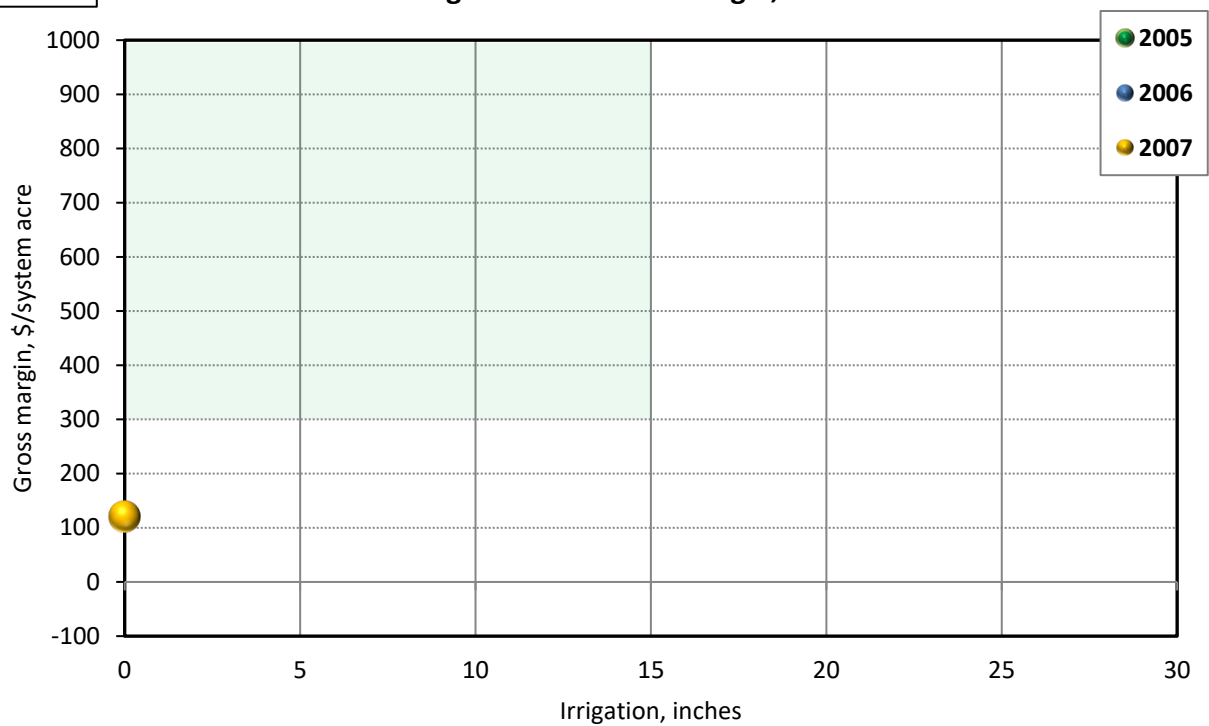
Dryland (DL) na gpm

Number of wells: na

Fuel Source: na

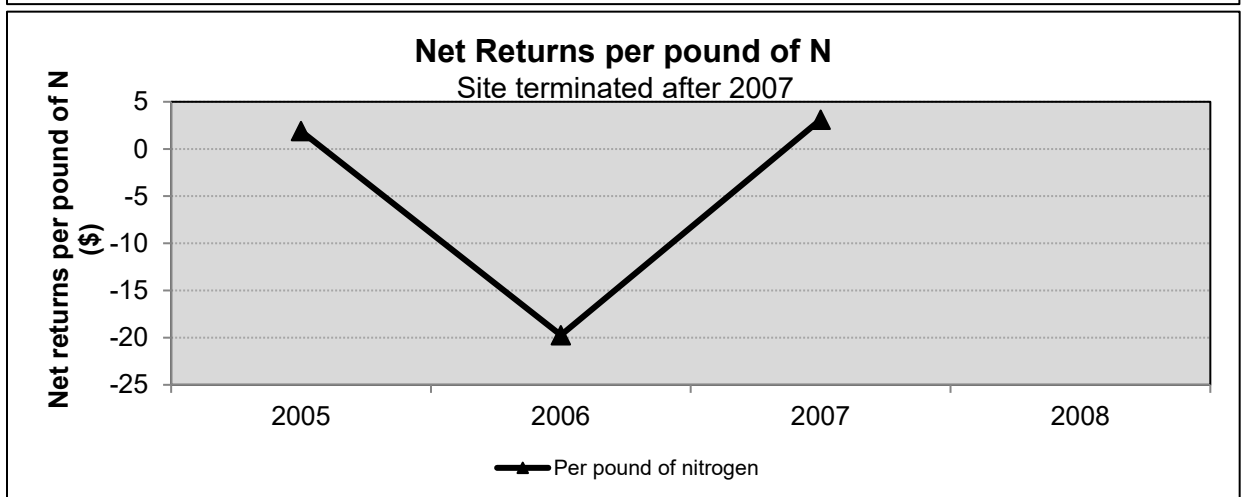
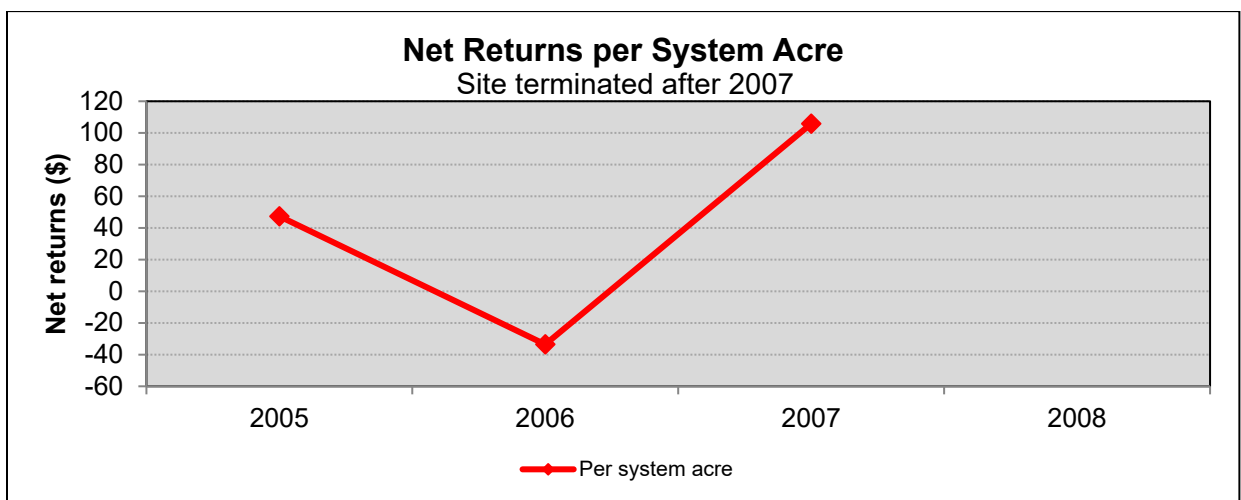
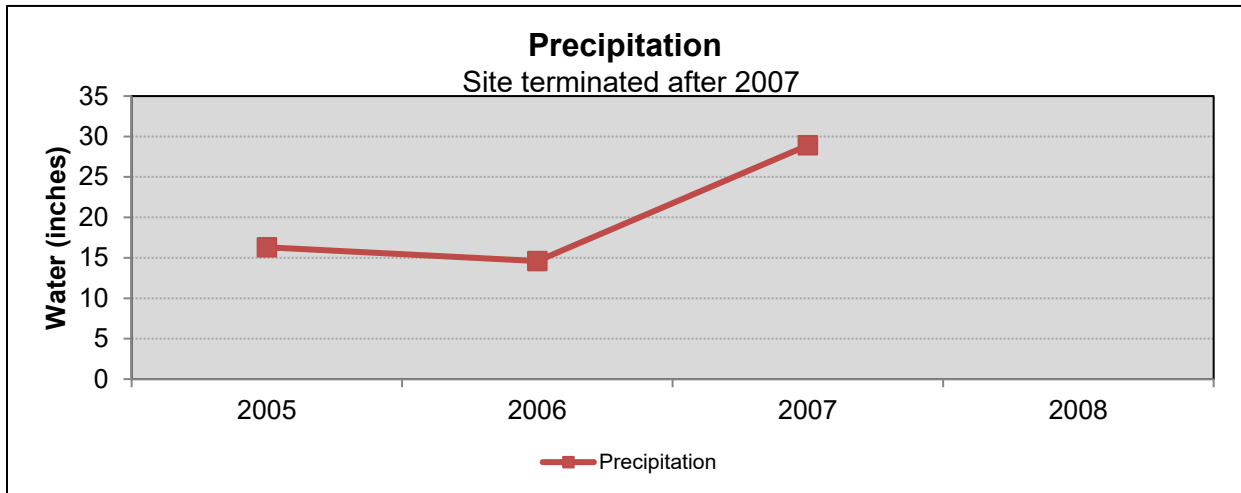
**Site 13**

**TAWC Site Irrigation and Gross Margin, 2005-2007**





## Site 13 - Dryland Site



Site # 15

Field 9  
44.4 acres

PuA

Site # 15

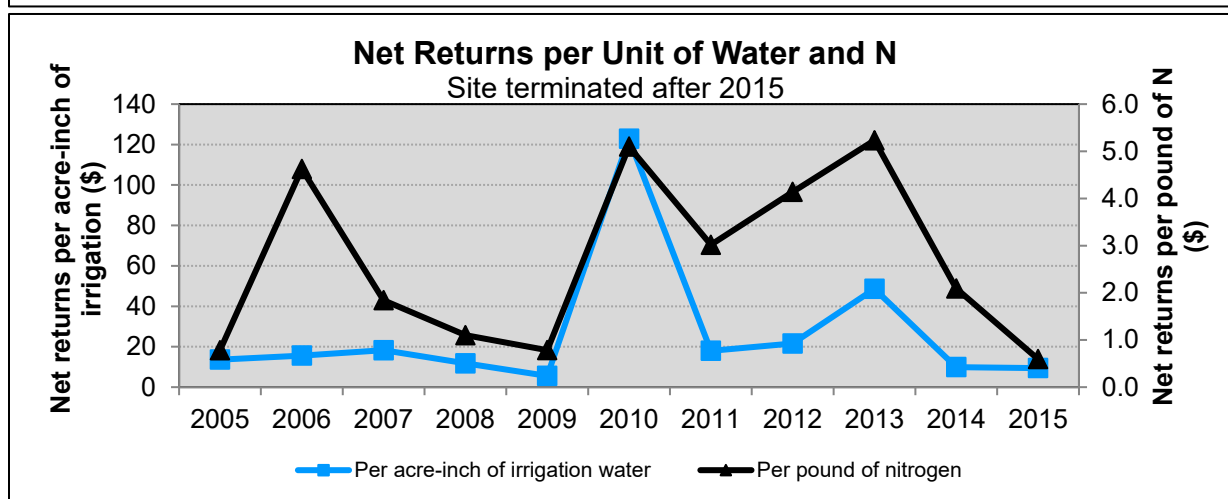
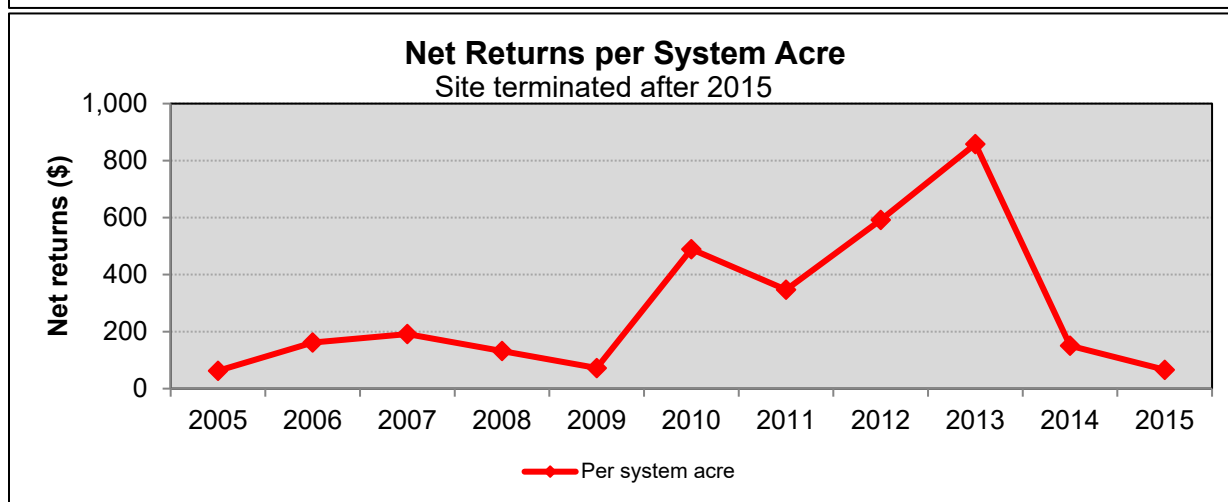
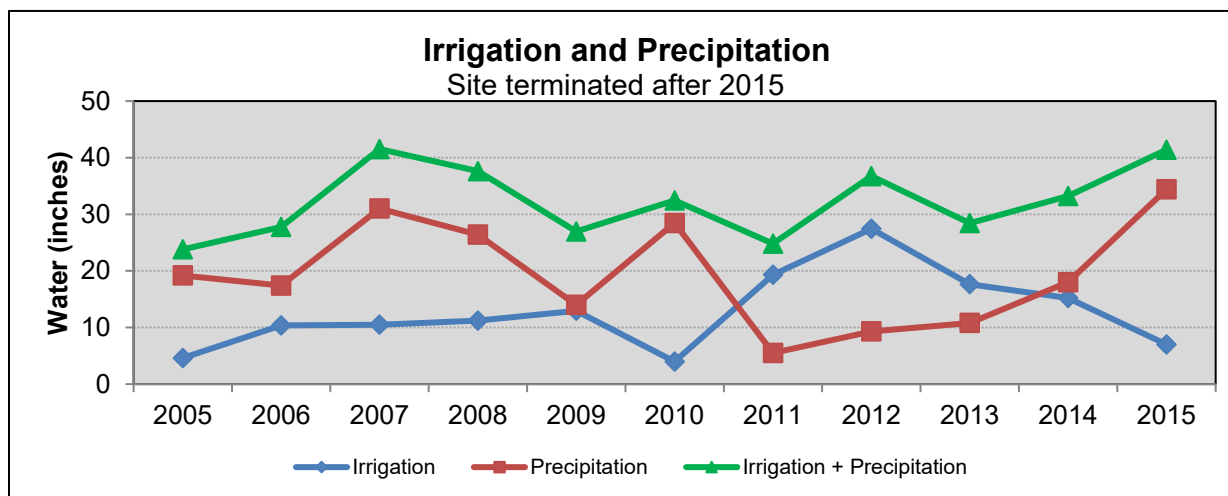
Field 8  
56.7 acres

Source: Esri, DigitalGlobe, GeoEye, Aerial, © mapping.com, Inc., GIS User Community

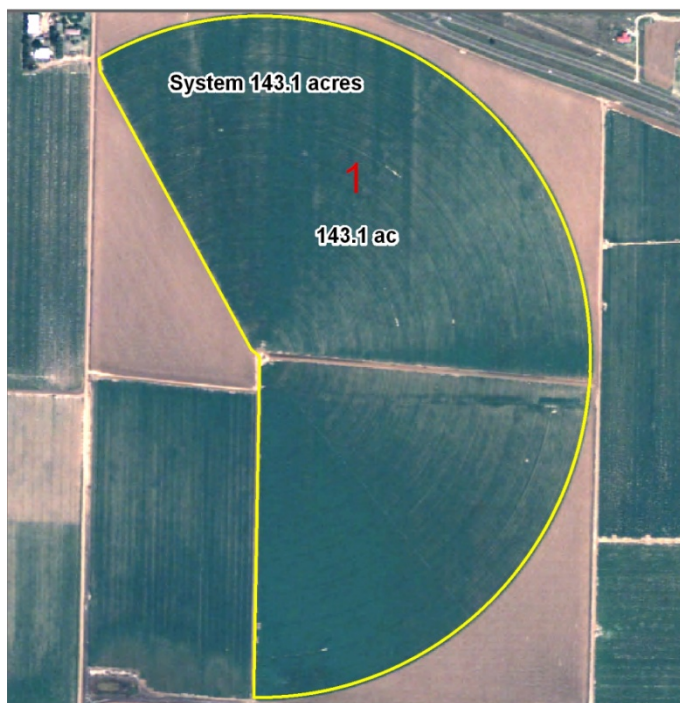
Site acres:	101.1
Soil types:	PuA-Pullman clay loam; 0 to 1%
Irrigation:	
Sub-Surface Drip (SDI)	290 gpm
Number of wells:	1
Fuel Source:	Electric



## Site 15



## SITE 16 – TERMINATED AFTER 2006



### **Description:**

Site acres: 143.1

Soil types:

**PuA**-Pullman clay loam, 0 to 1%

Irrigation:

Center Pivot (LESA) 600 gpm

Number of wells:

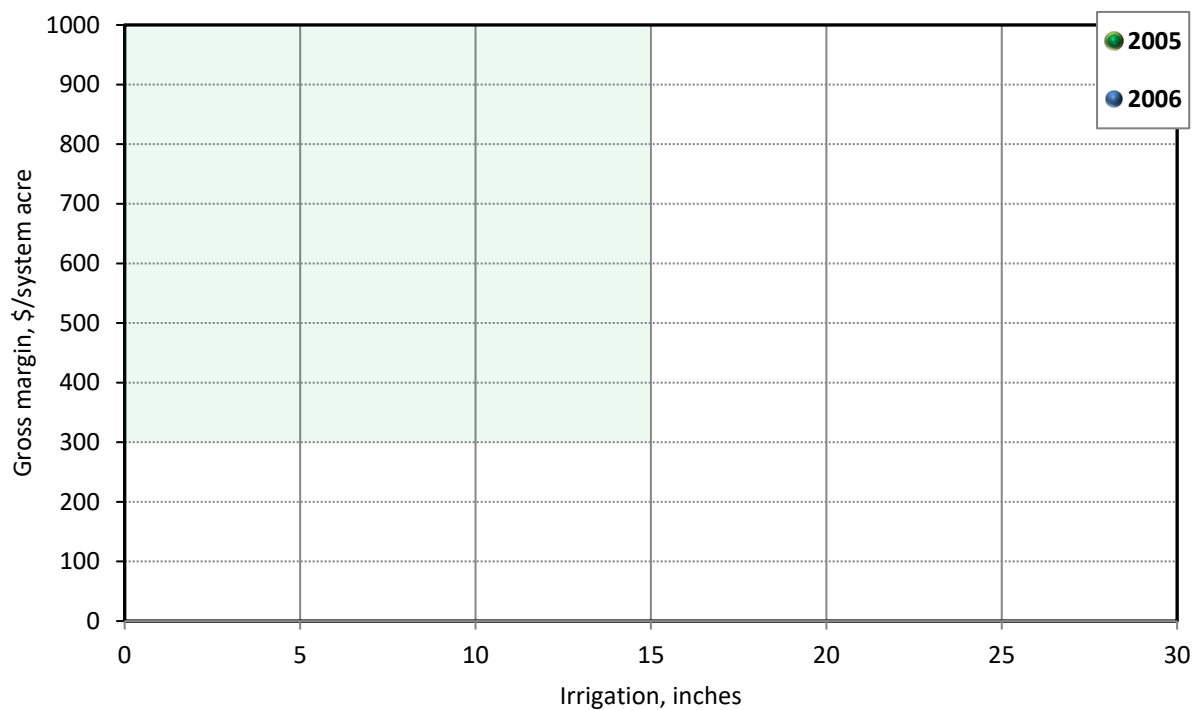
3

Fuel Source:

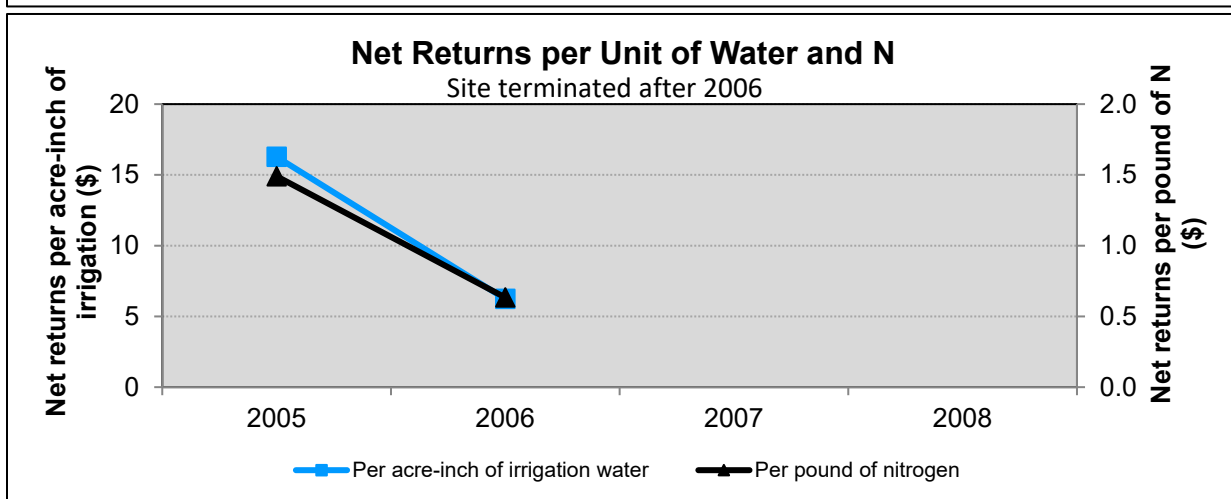
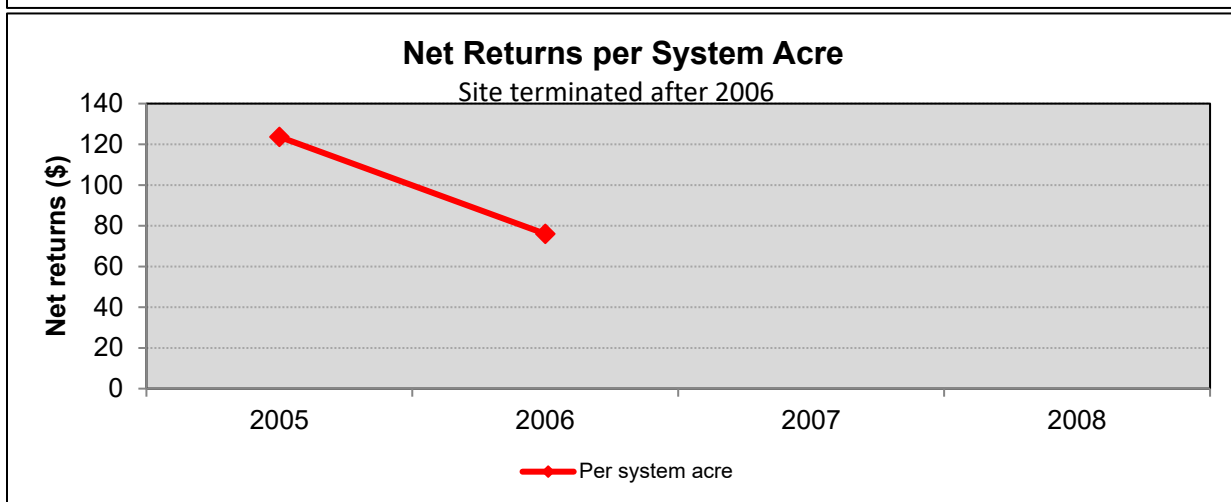
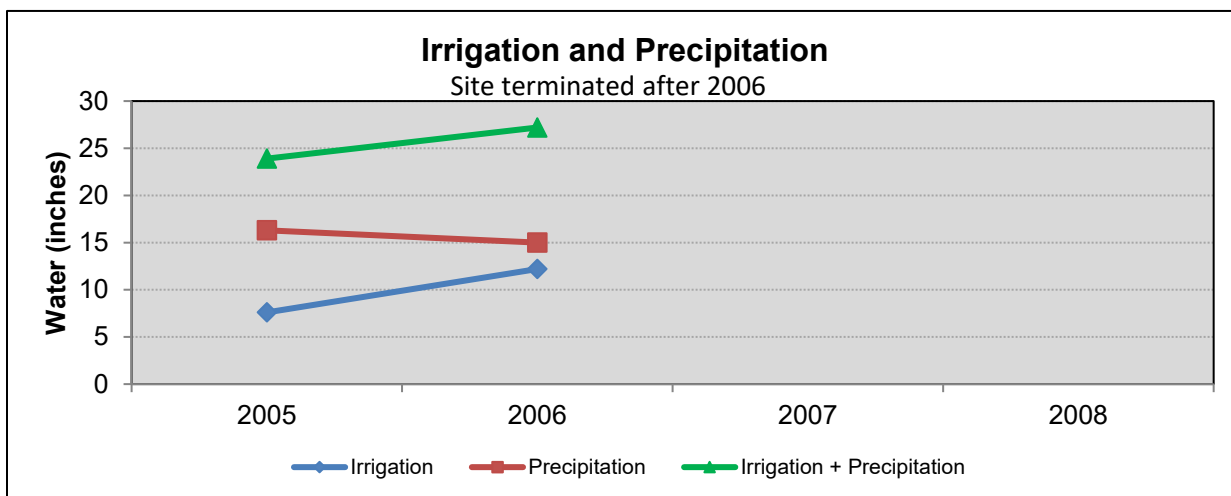
Electric

**Site 16**

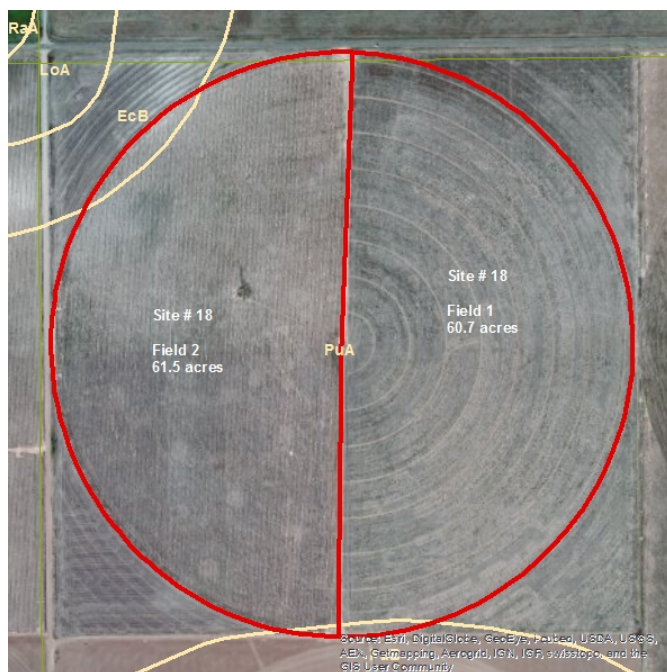
### **TAWC Site Irrigation and Gross Margin, 2005-2006**



## Site 16



## SITE 18 – TERMINATED AFTER 2013



### **Description:**

Site acres: 122.2

### **Soil types:**

**PuA**-Pullman clay loam, 0 to 1%

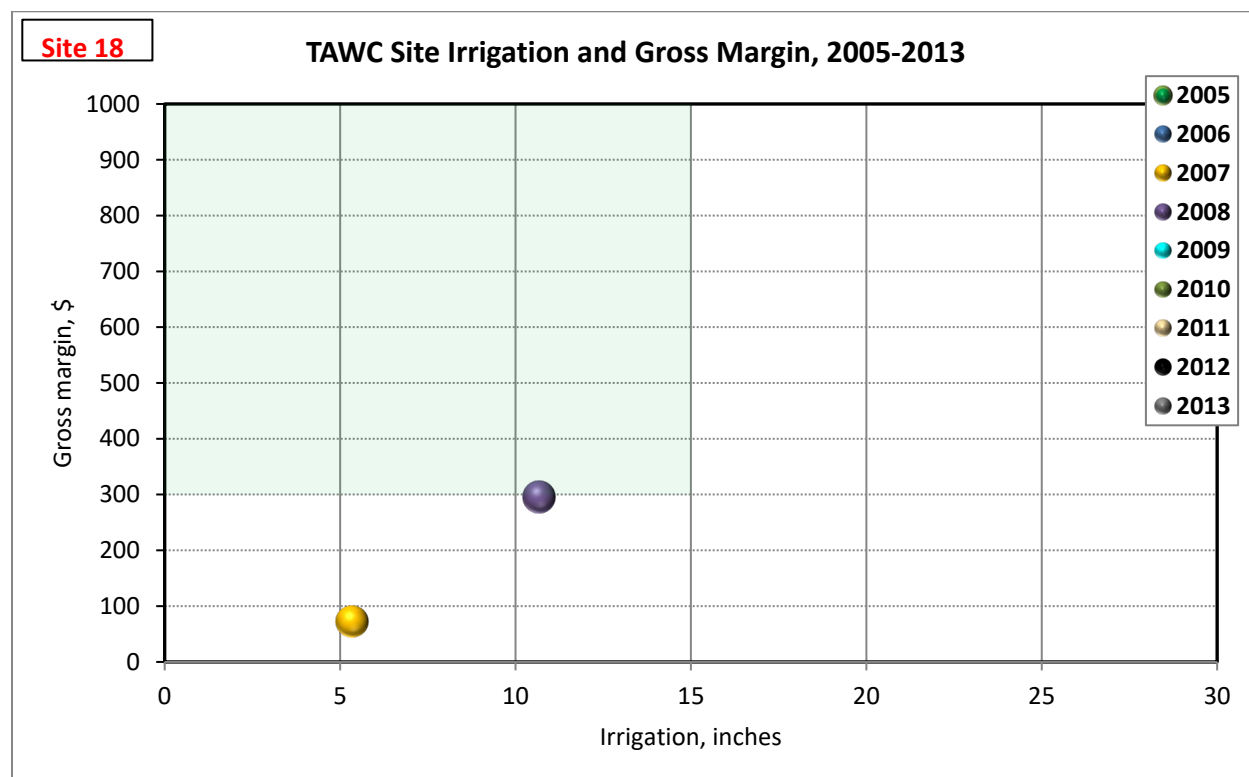
**EcB**-Estacado clay loam; 1 to 3%

### **Irrigation:**

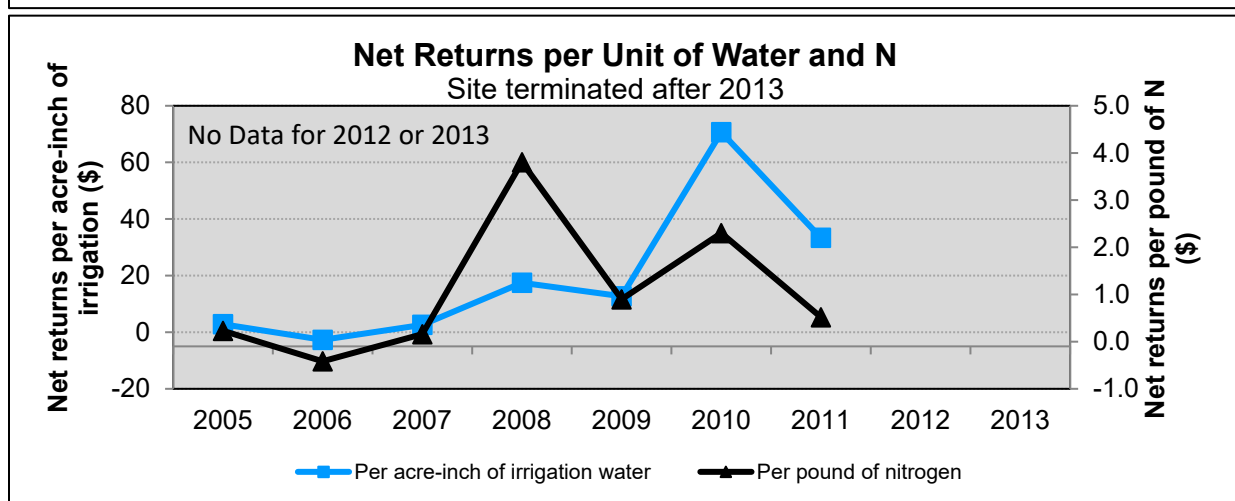
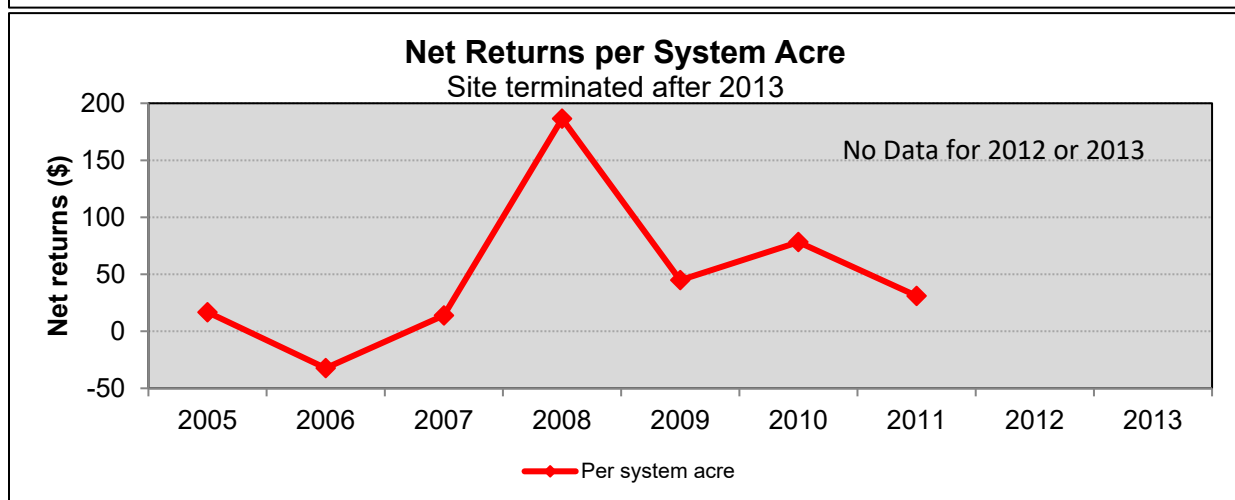
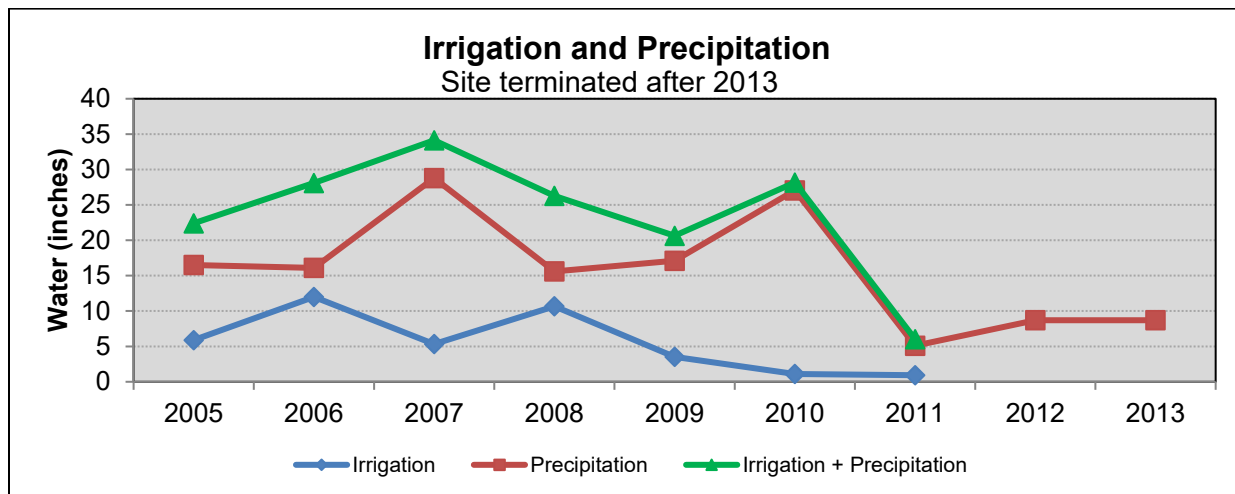
Center Pivot (LEPA) 250 gpm

Number of wells: 3

Fuel Source: Electric

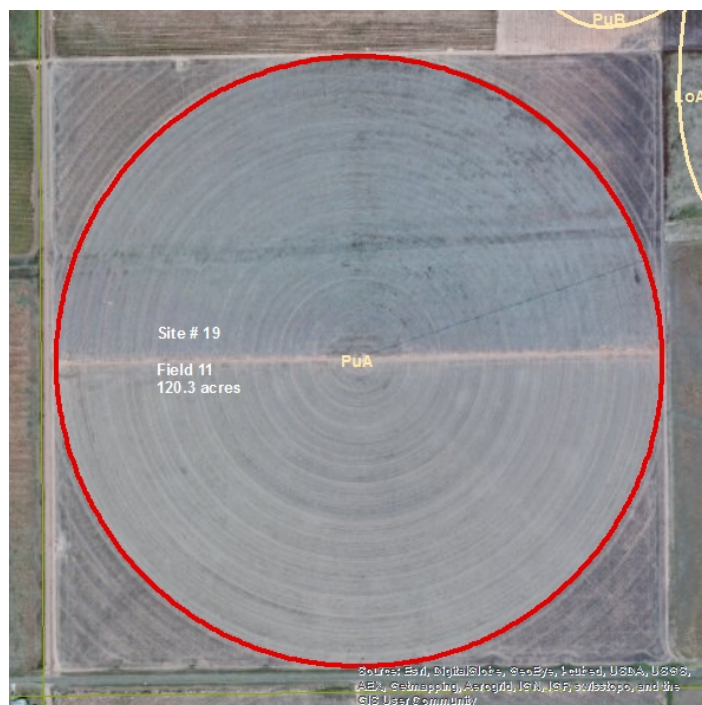


## Site 18 – Terminated 2013





## SITE 19 - TERMINATED AFTER 2015



### **Description:**

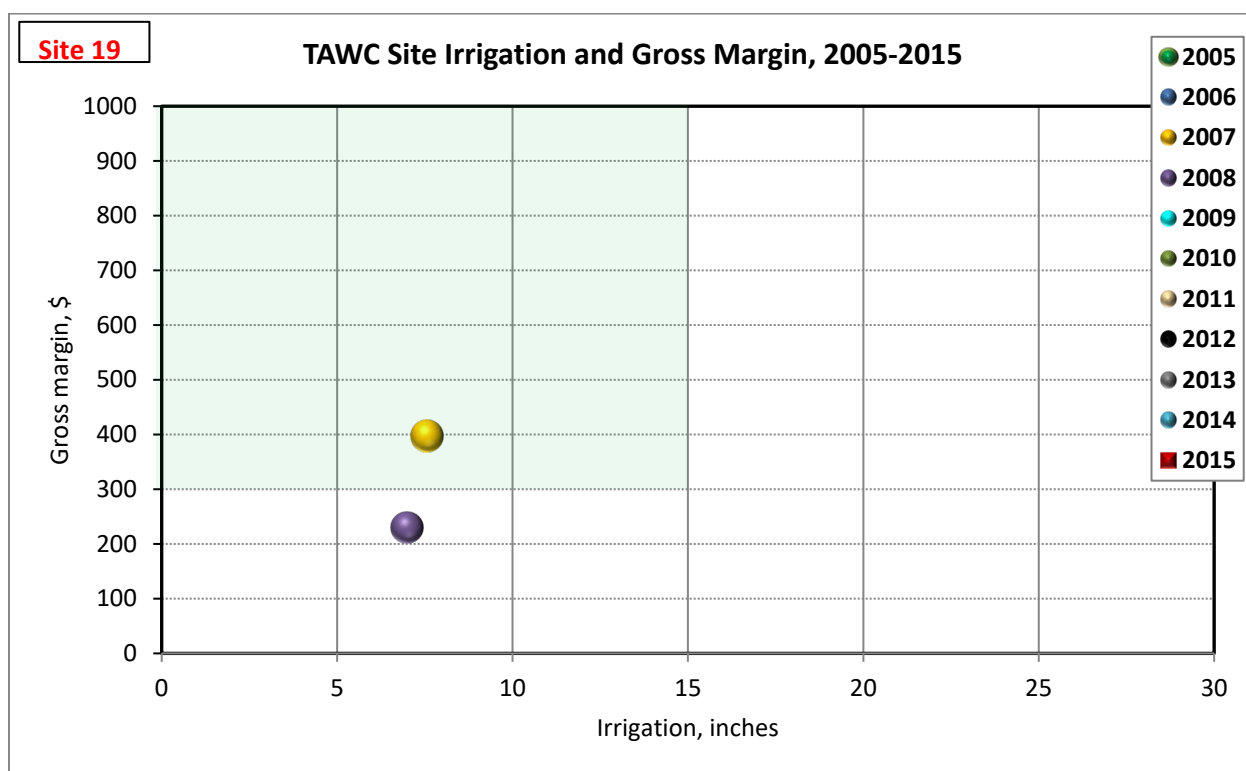
Site acres: 120.4

Soil types:  
PuA-Pullman clay loam; 0 to 1%

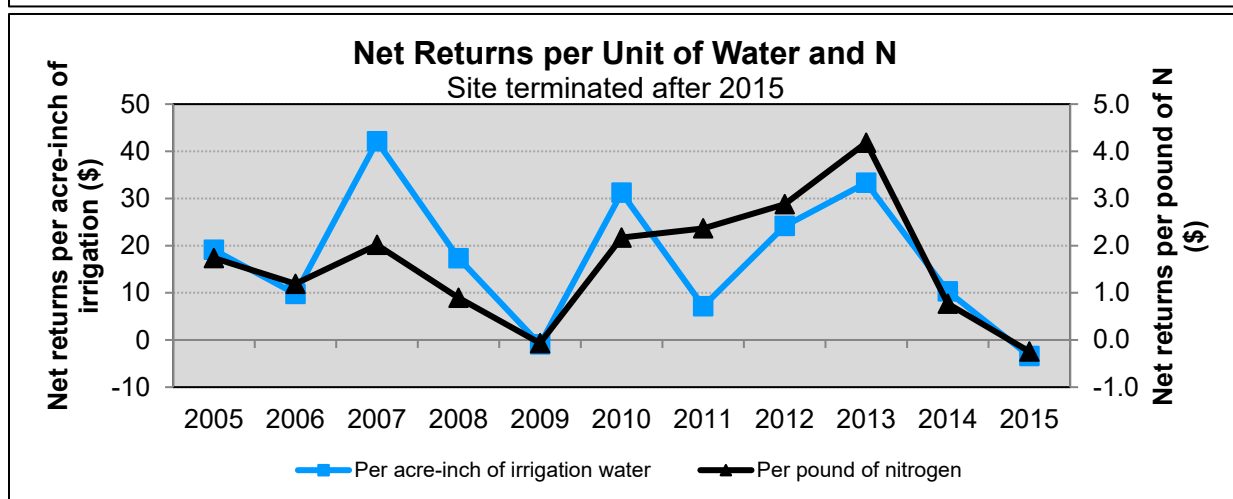
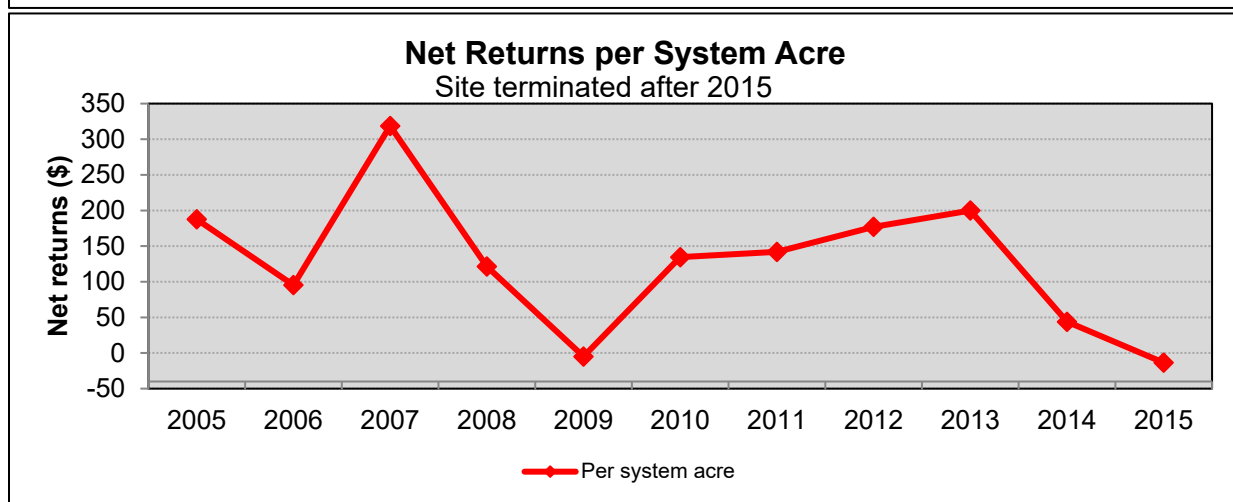
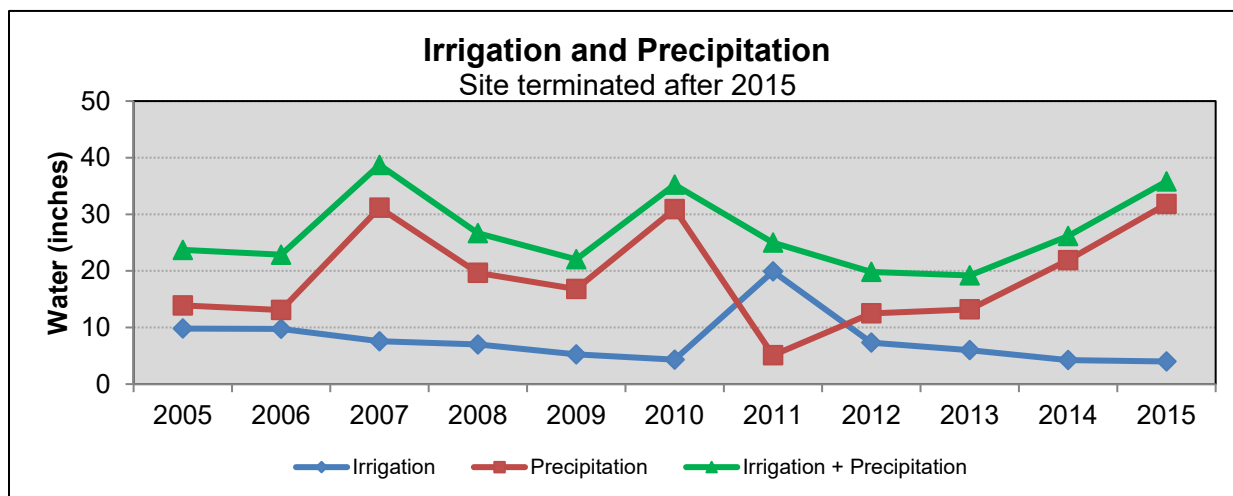
Irrigation:  
Center Pivot (LEPA) 400 gpm

Number of wells: 3

Fuel Source: Electric



## Site 19



Site # 27

Field 1  
46.2 acres

Site # 20

Field 1  
117.6 acres

PuA

OcB

LOA

RAH

Site # 27

Field 4  
13.5 acres

Site # 20

Field 2  
115.7 acres

OcB

Source: Esri, DigitalGlobe, GeoEye, Earthstar, USDA, USGS, AeroVig, Aerodyne, IGN, IGN, IGN, and the GIS User Community

Site acres: 233.3

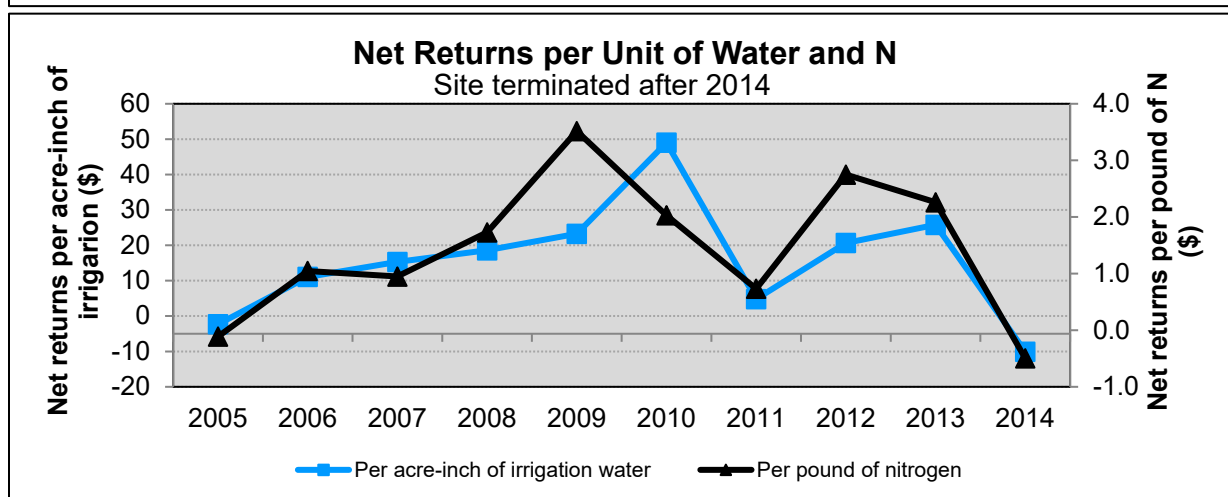
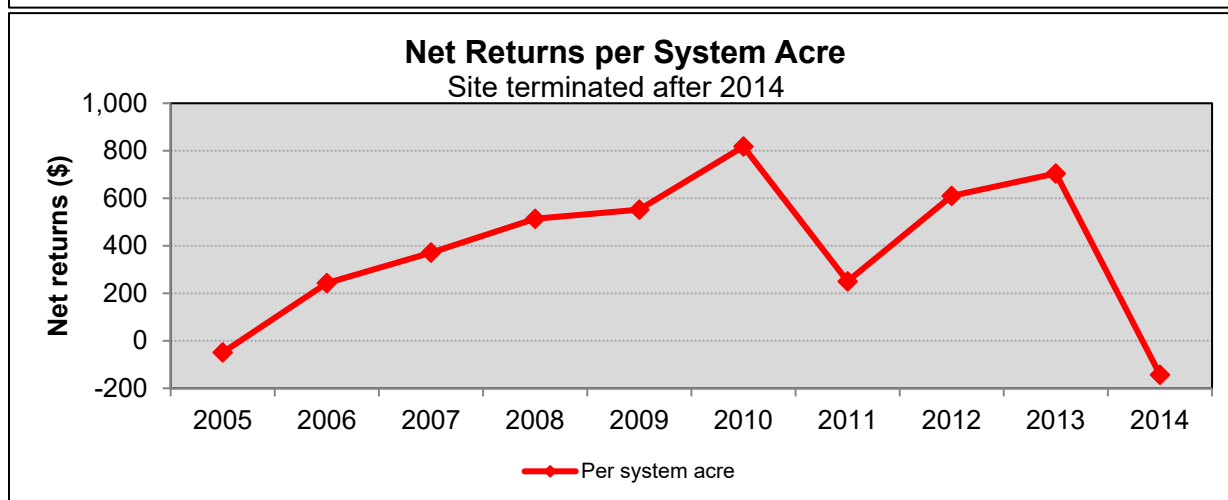
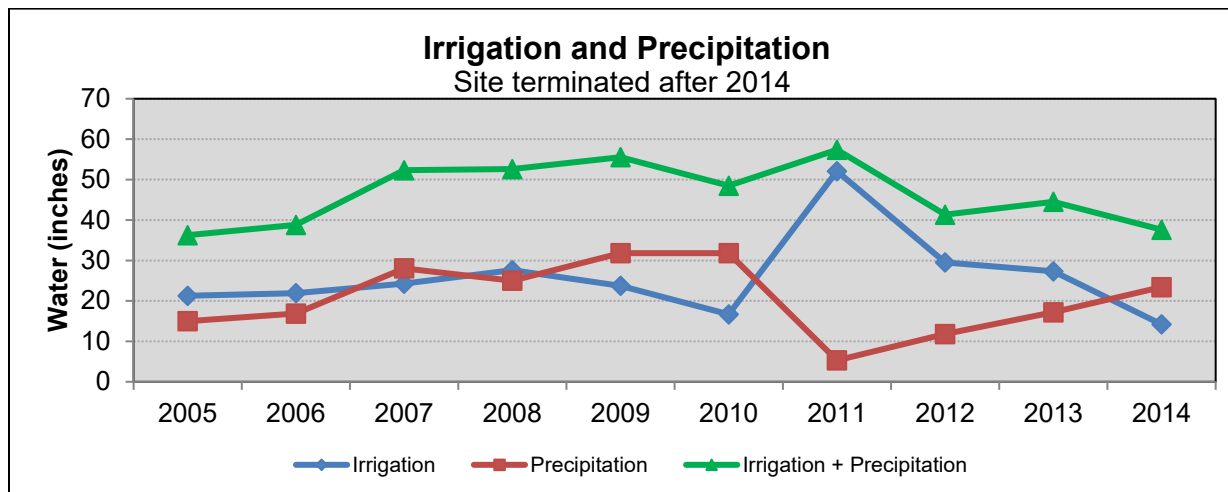
Soil types:  
PuA-Pullman clay loam; 0 to 1%  
OcB-Olton clay loam, 1 to 3%

Irrigation:  
Center Pivot (LEPA) 1000 gpm

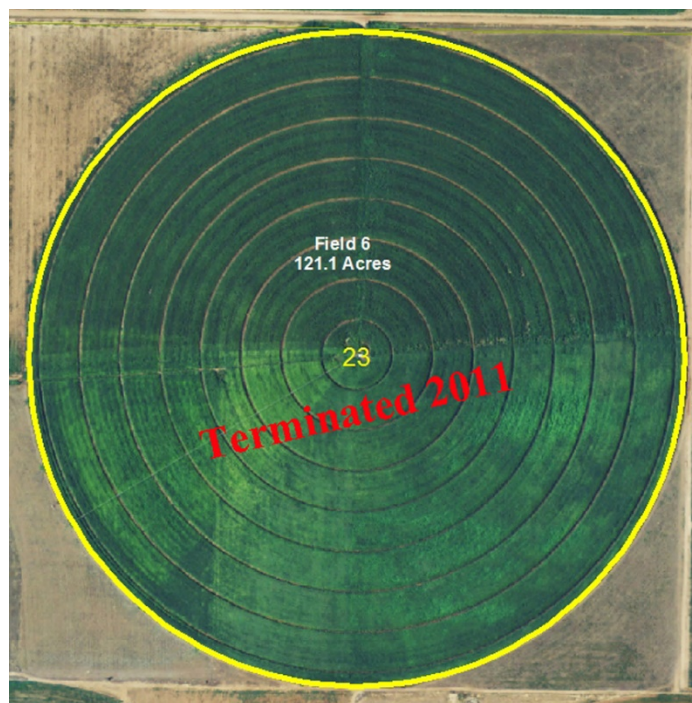
Number of wells: 3

Fuel Source: Electric





## SITE 23 – TERMINATED AFTER 2011



### **Description:**

Site acres: 122.2

### Soil types:

**PuA**-Pullman clay loam, 0 to 1%

**EcB**-Estacado clay loam; 1 to 3%

### Irrigation:

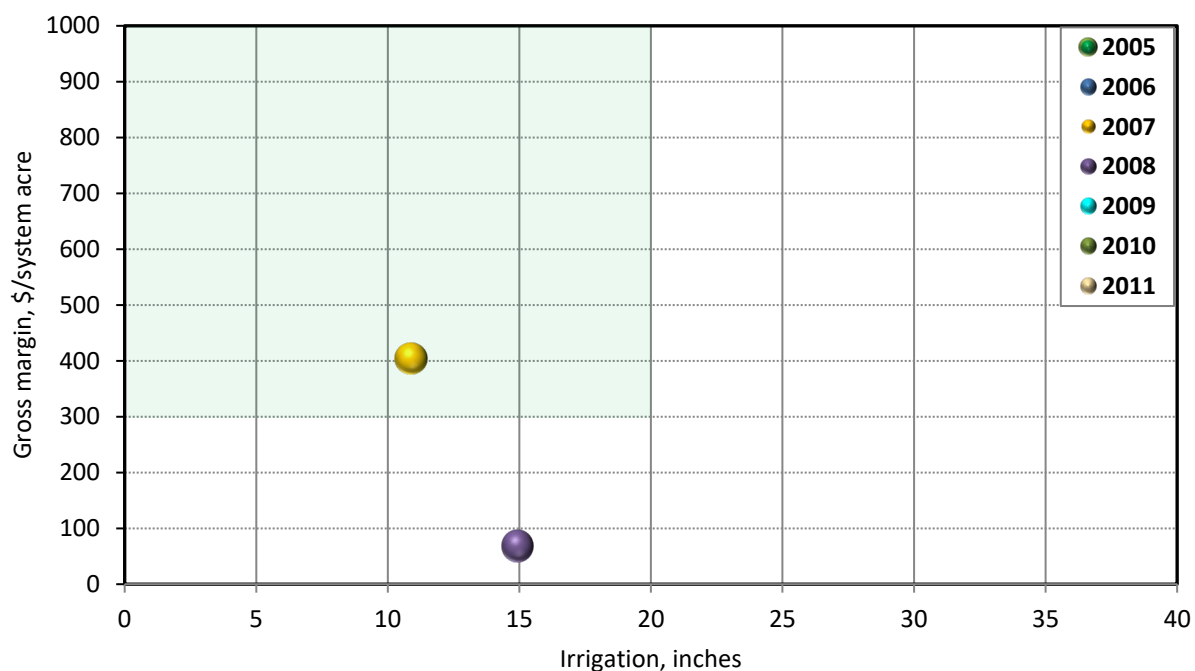
Center Pivot (LEPA) 250 gpm

Number of wells: 3

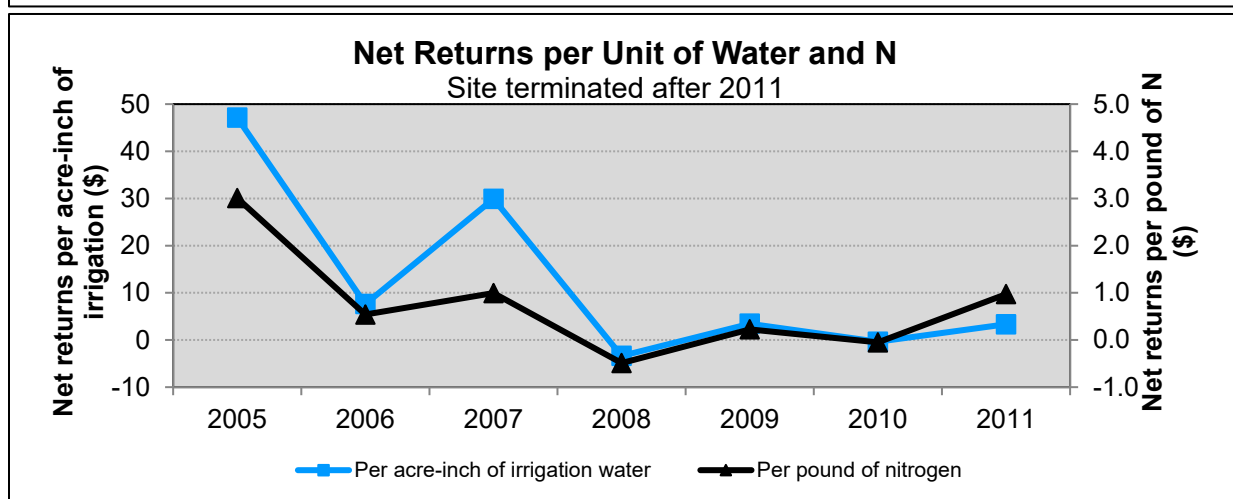
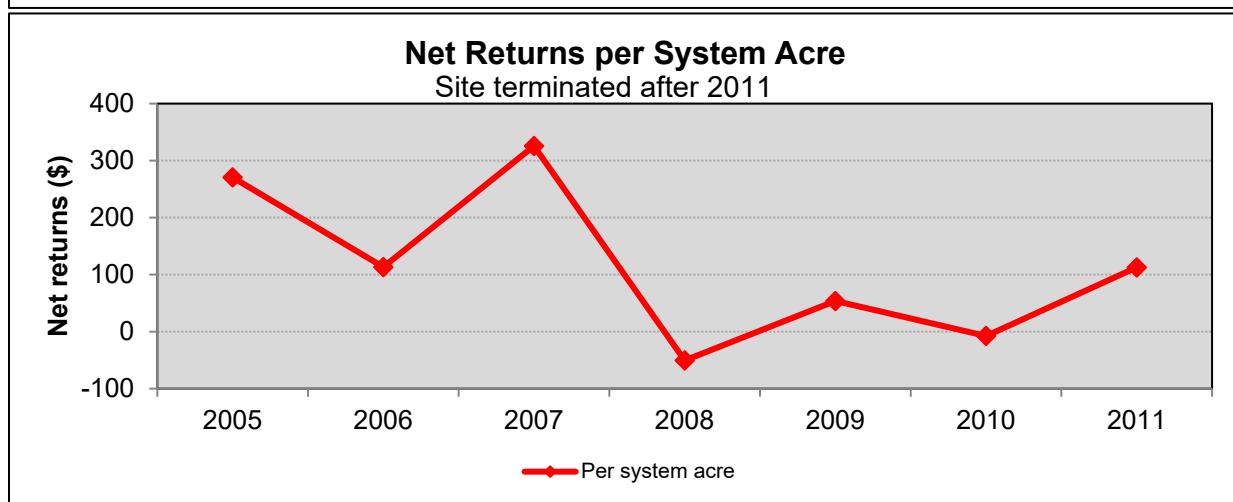
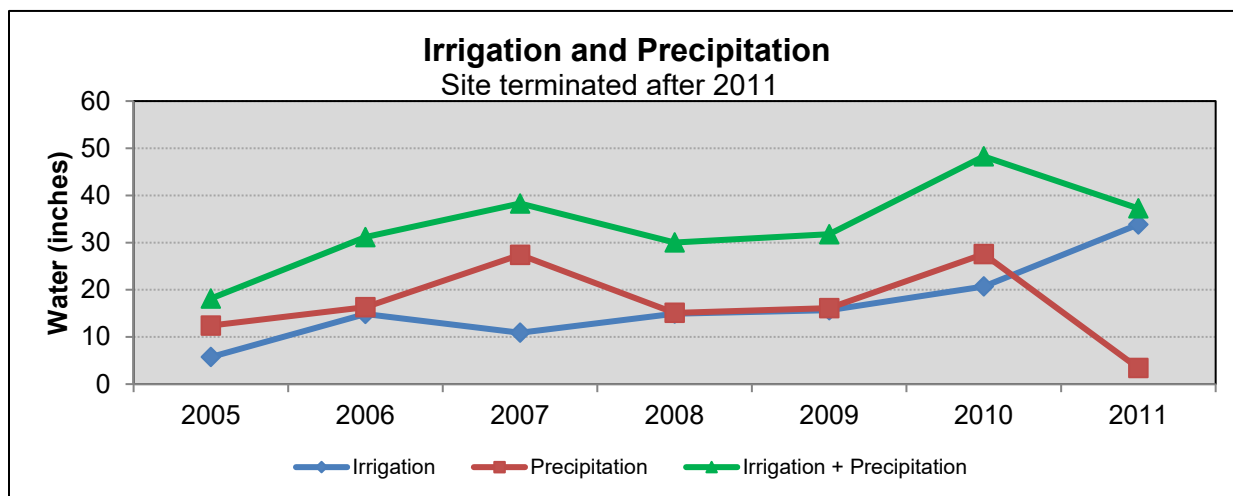
Fuel Source: Electric

### **Site 23**

### **TAWC Site Irrigation and Gross Margin, 2005-2011**



## Site 23



## SITE 24 – TERMINATED AFTER 2016



### **Description:**

Site acres: 129.7

### Soil types:

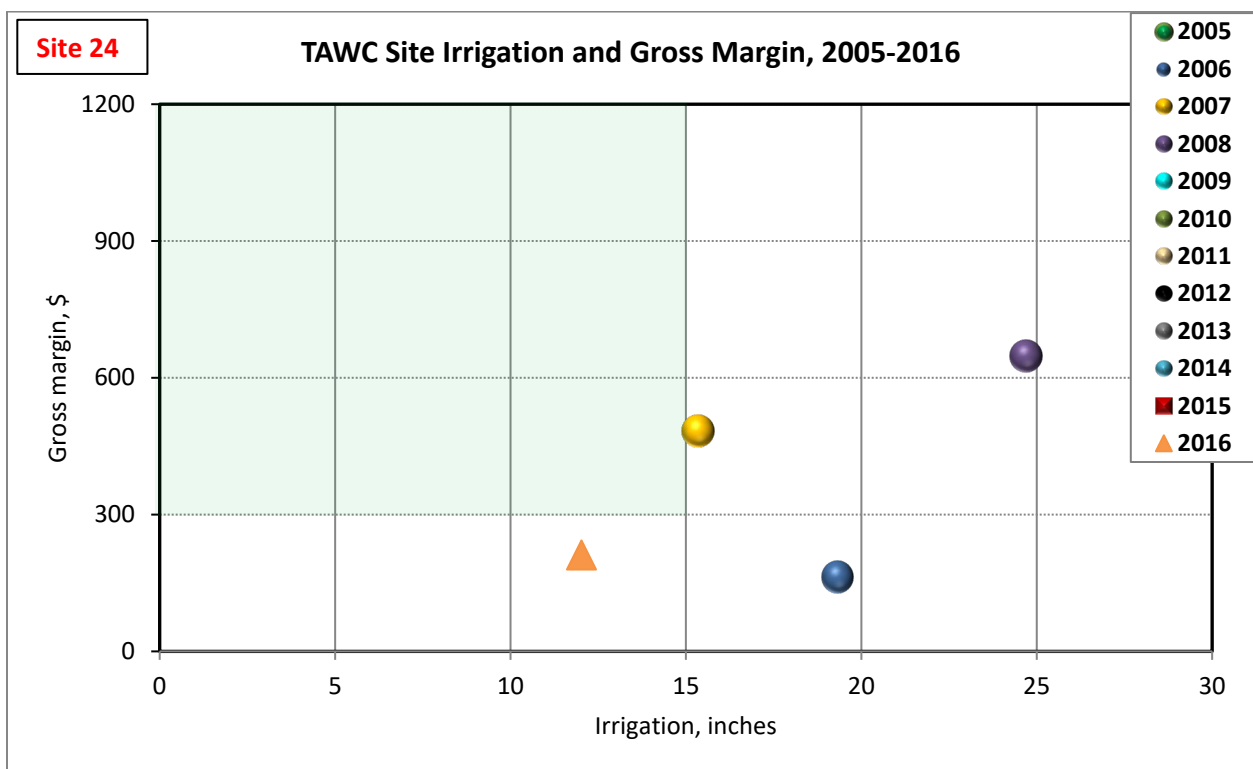
PuA-Pullman clay loam; 0 to 1%

### Irrigation:

Center Pivot (LESA) 700 gpm

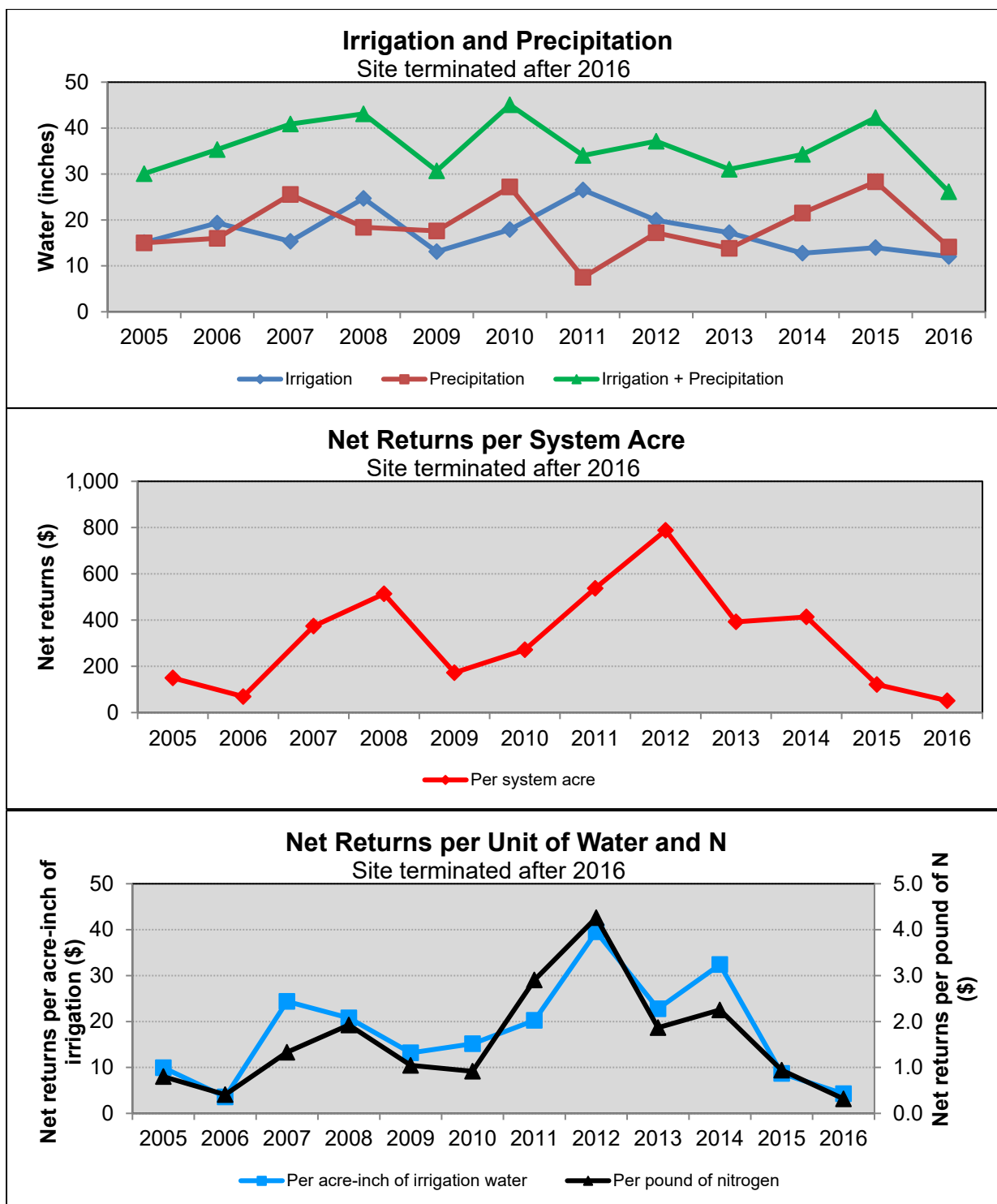
Number of wells: 1

Fuel Source: Diesel

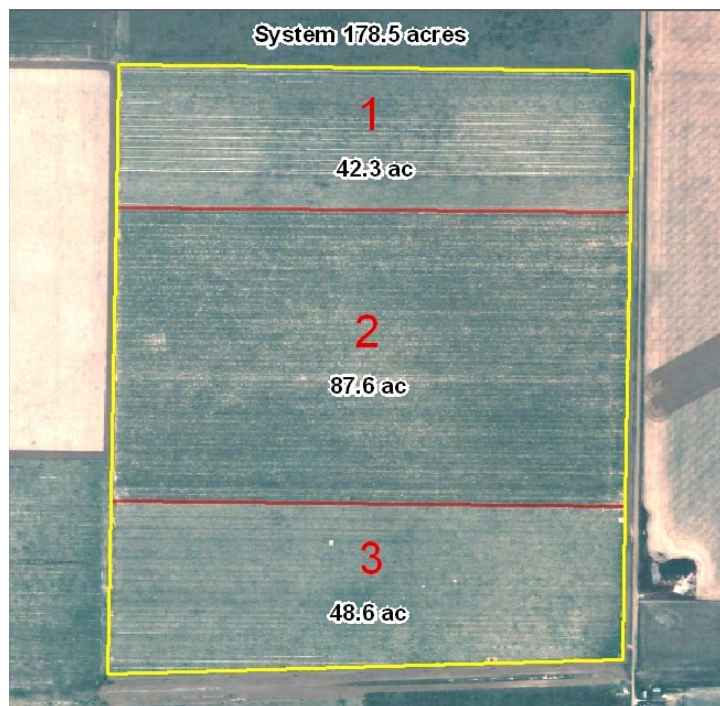




## Site 24



## SITE 25 – TERMINATED AFTER 2005



### **Description:**

Site acres: 178.5

Soil types:

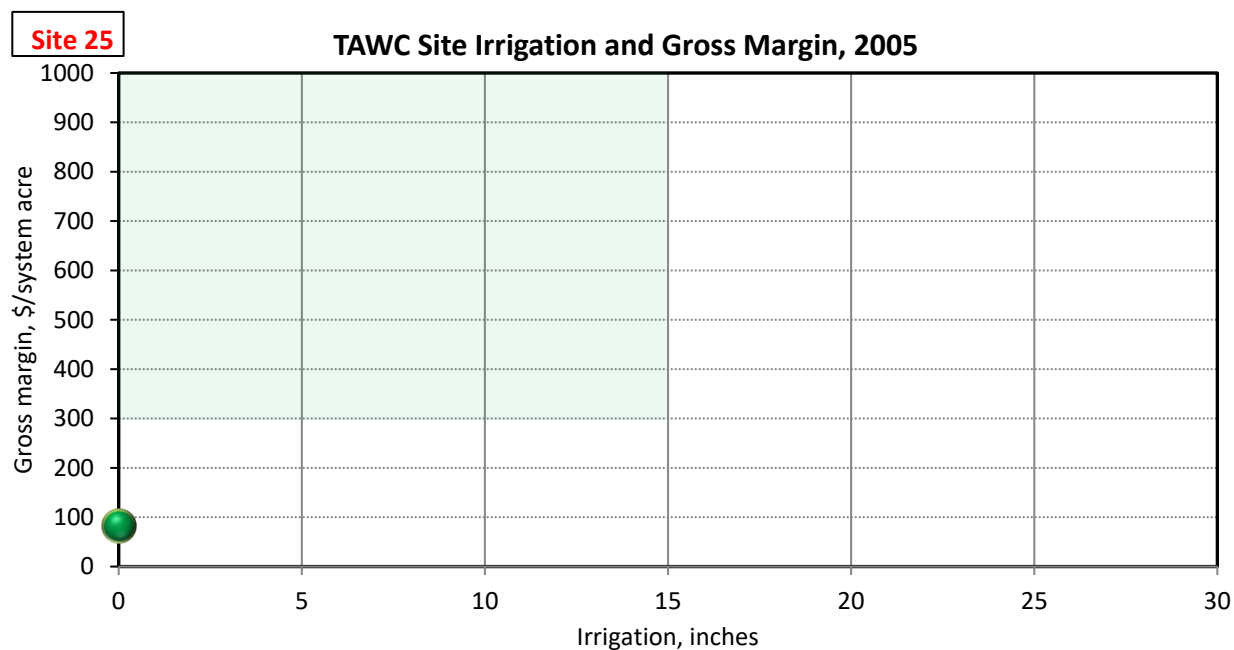
PuA-Pullman clay loam, 0 to 1%

Irrigation:

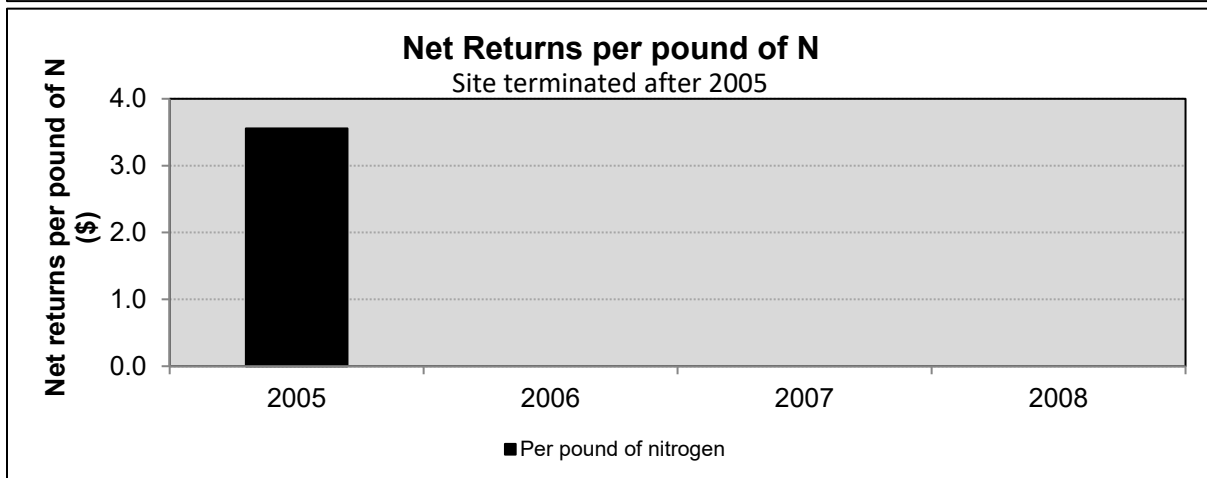
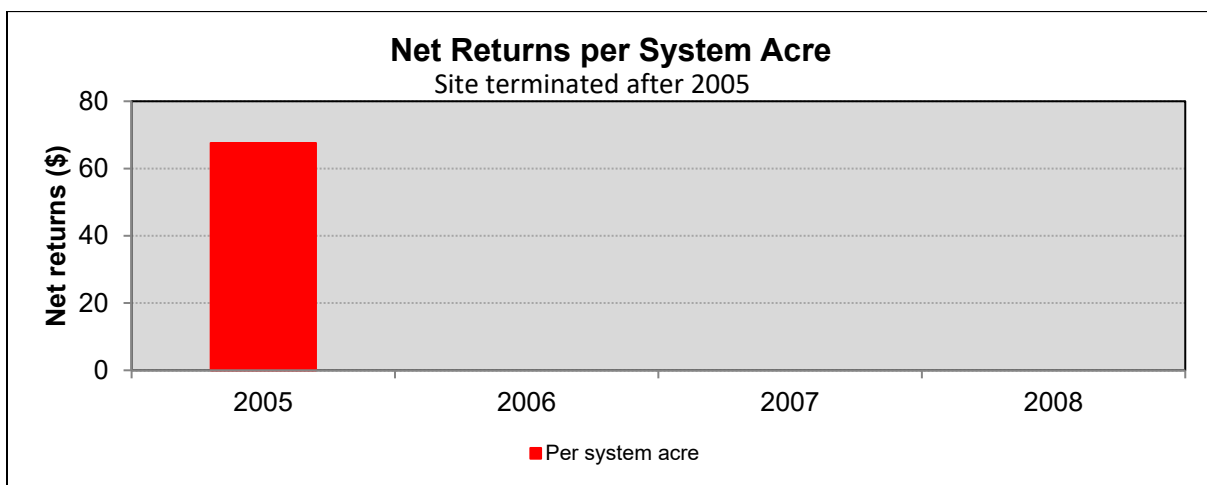
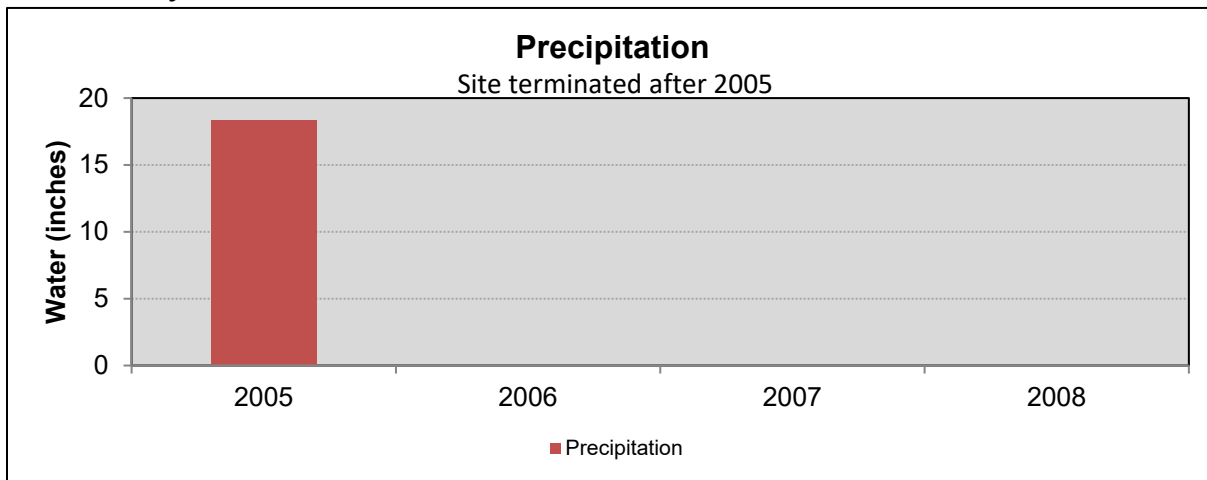
Dryland (DL) na gpm

Number of wells: na

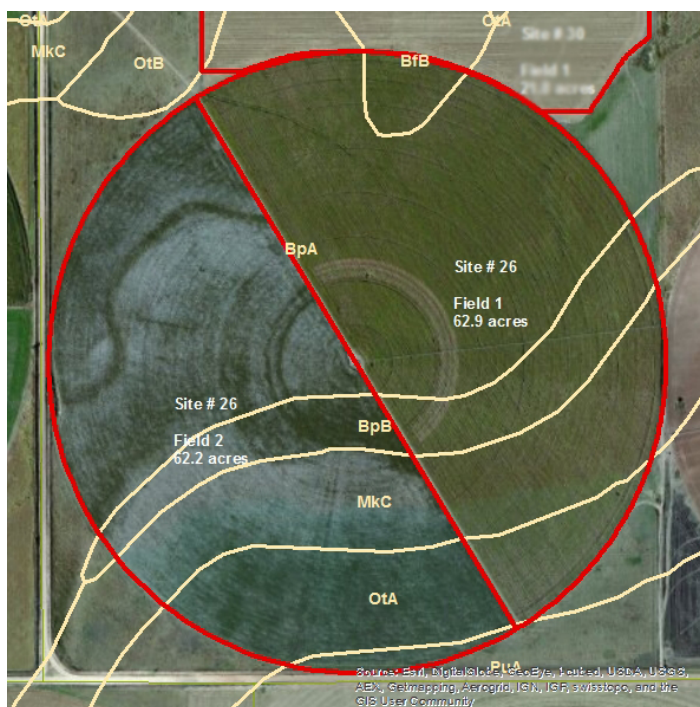
Fuel Source: na



## Site 25 - Dryland



## SITE 26 - TERMINATED AFTER 2015



### **Description:**

Site acres: 125.1

### Soil types:

BpA-Bippus loam; 0 to 1%

MkC-Mansker loam; 3 to 5%

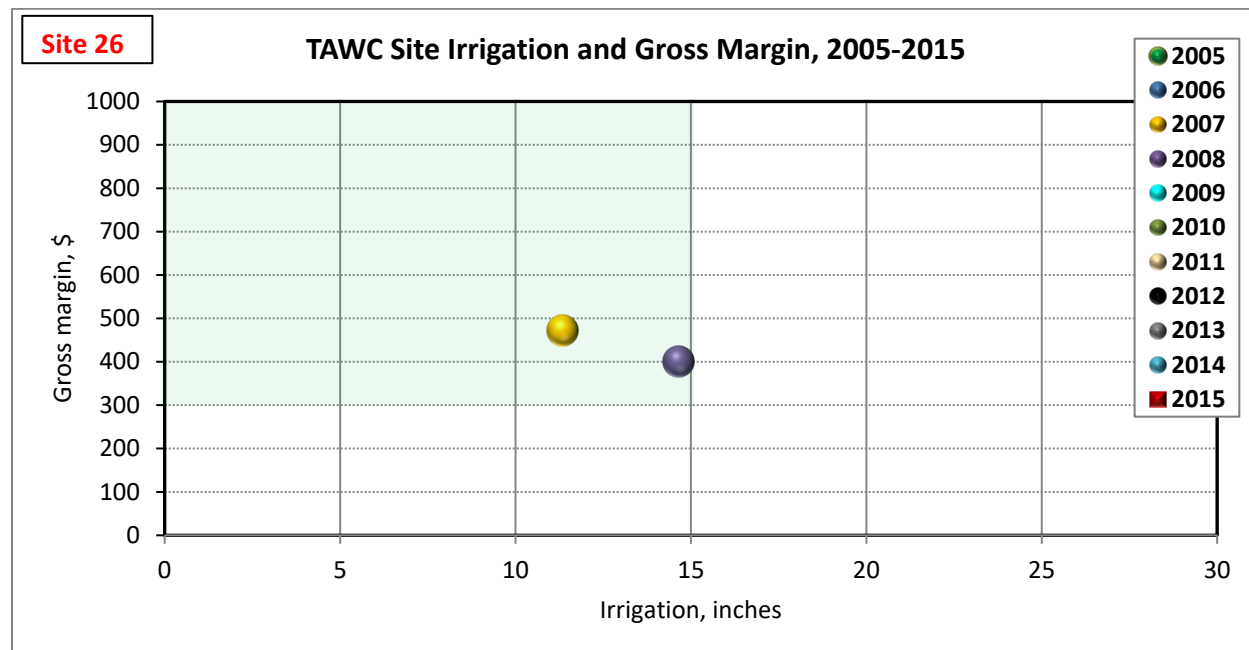
OtA-Olton loam; 0 to 1%

### Irrigation:

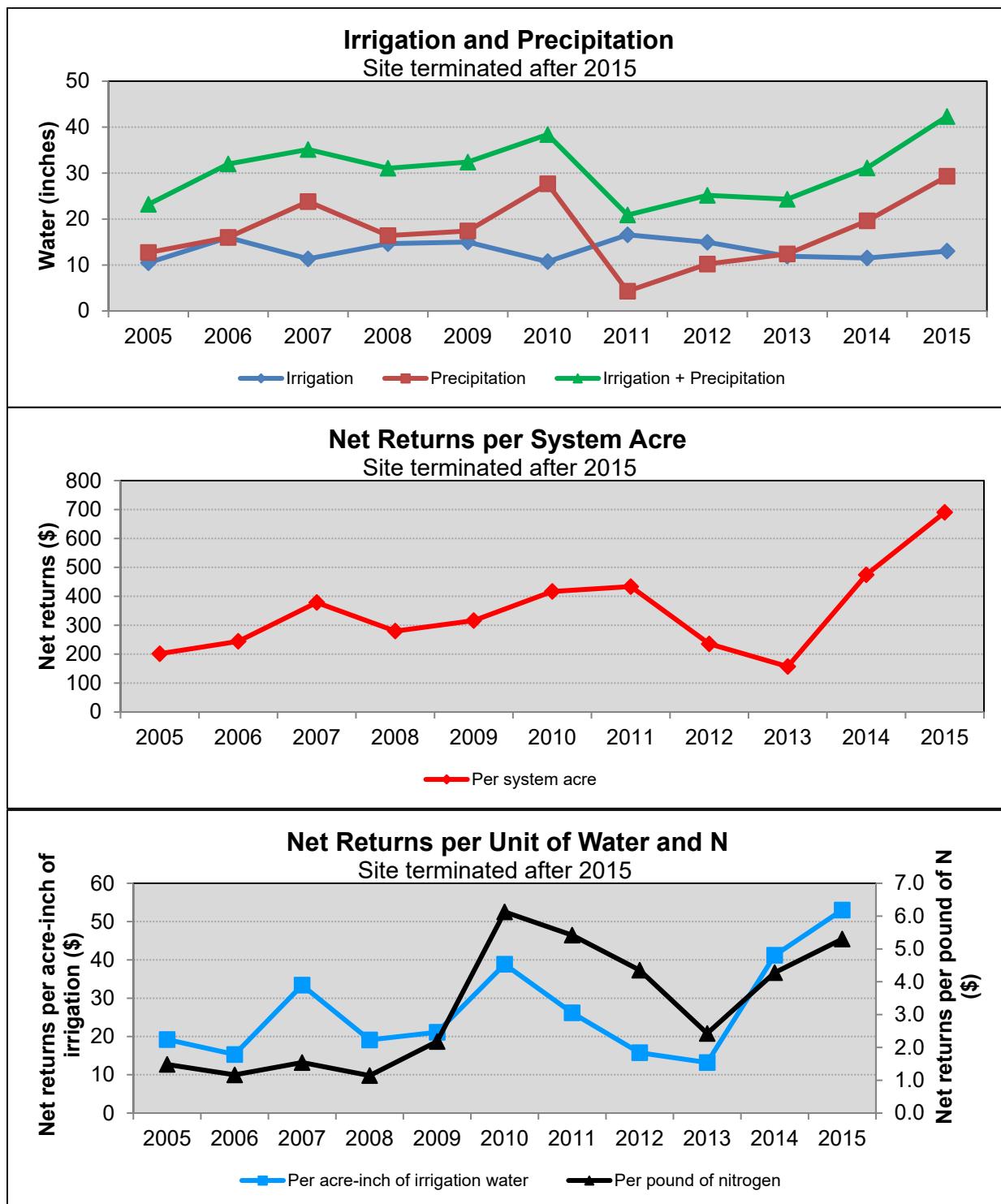
Center Pivot (LESA) 600 gpm

Number of wells: 2

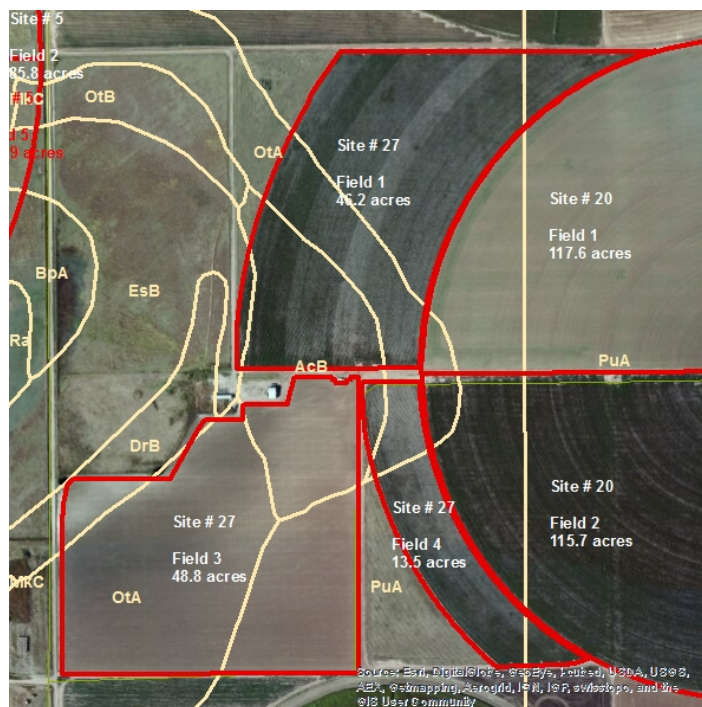
Fuel Source: 1 Electric,  
1 Diesel



## Site 26



## SITE 27 – TERMINATED AFTER 2014



### **Description:**

Site acres: 108.4

### Soil types:

PuA-Pullman clay loam; 0 to 1%

OtA-Olton loam; 0 to 1%

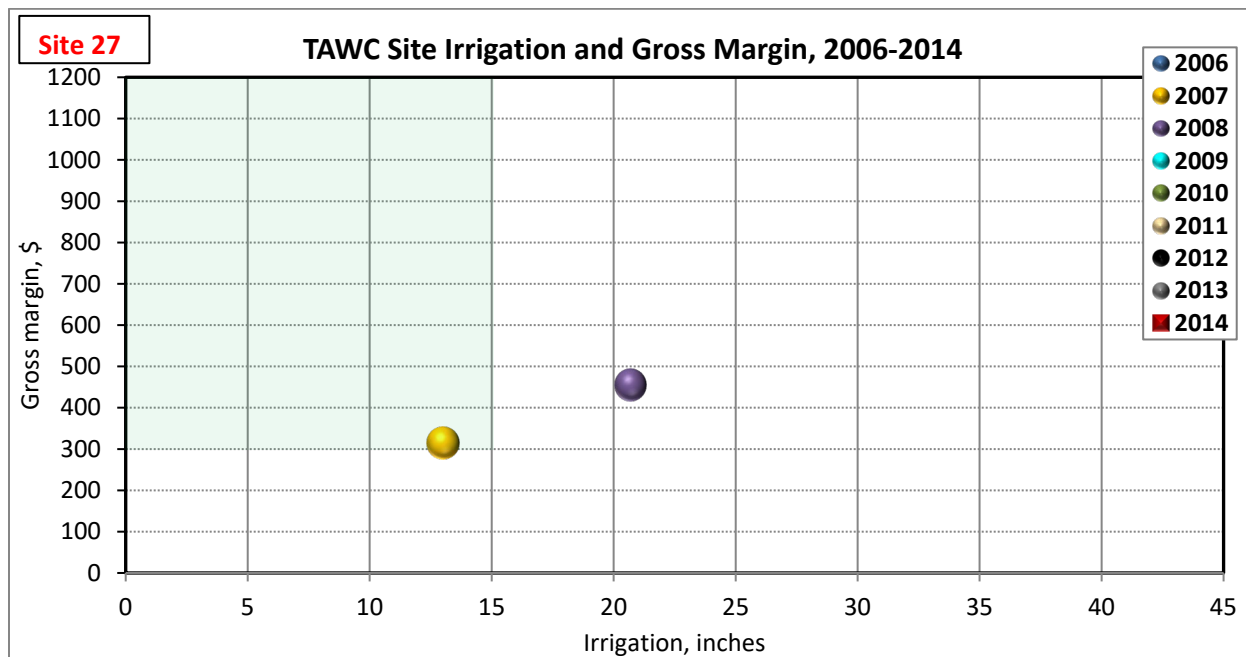
AcB-Acuff loam; 1 to 3%

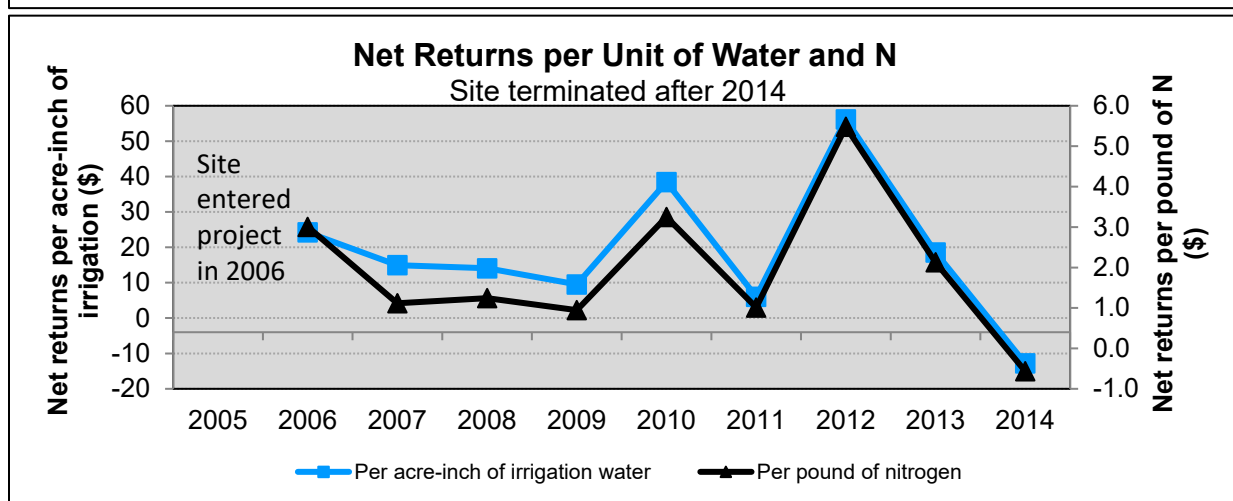
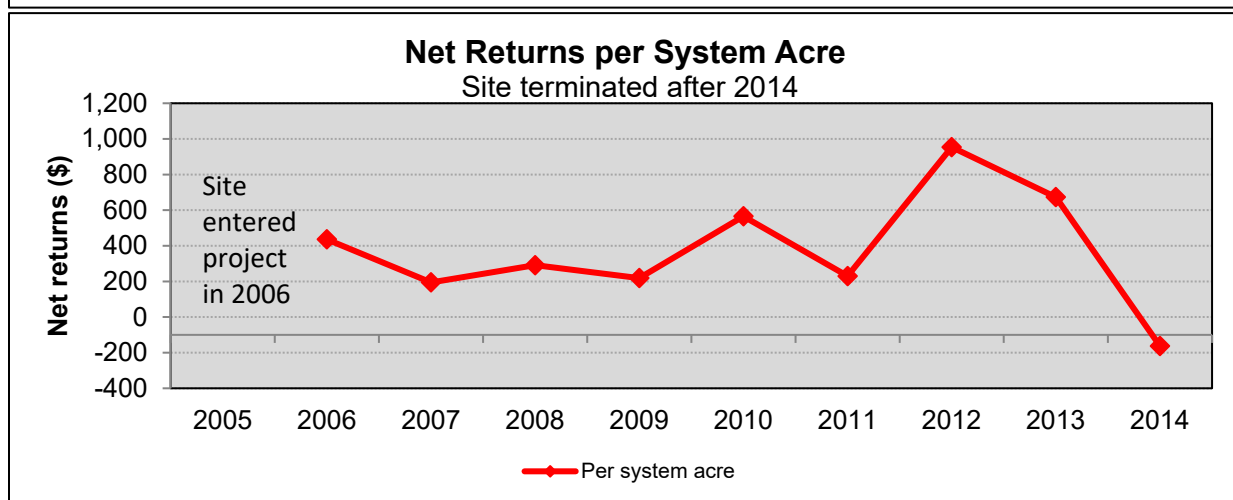
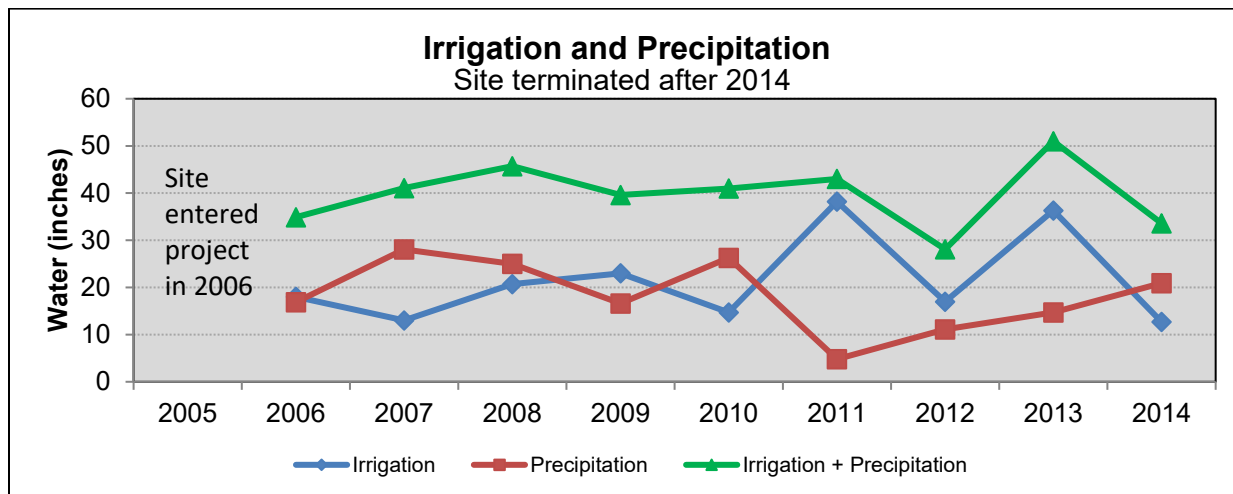
### Irrigation:

Sub-Surface Drip (SDI) 400 gpm

Number of wells: 2

Fuel Source: Electric







## SITE 28 – TERMINATED AFTER 2016



### **Description:**

Site acres: 51.5

### **Soil types:**

**PuA**-Pullman clay loam; 0 to 1%

**PuB**-Pullman clay loam; 1 to 3%

**OtA**-Olton loam; 0 to 1%

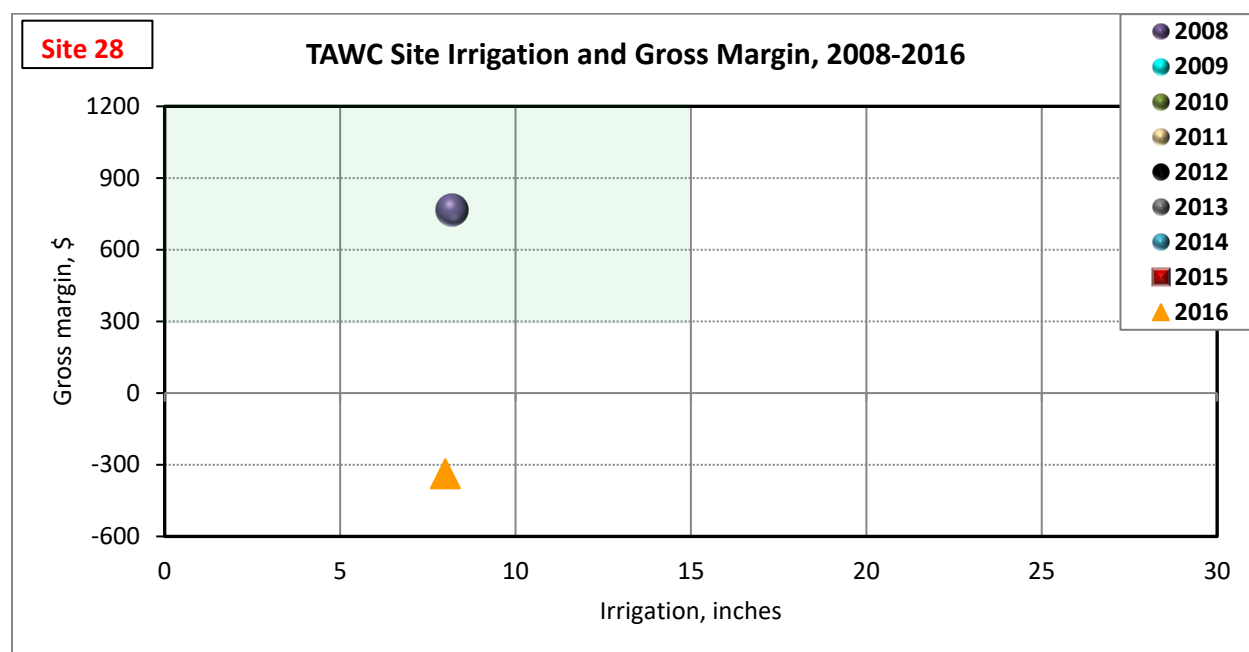
**McA**-McLean clay, 0 to 1%

### **Irrigation:**

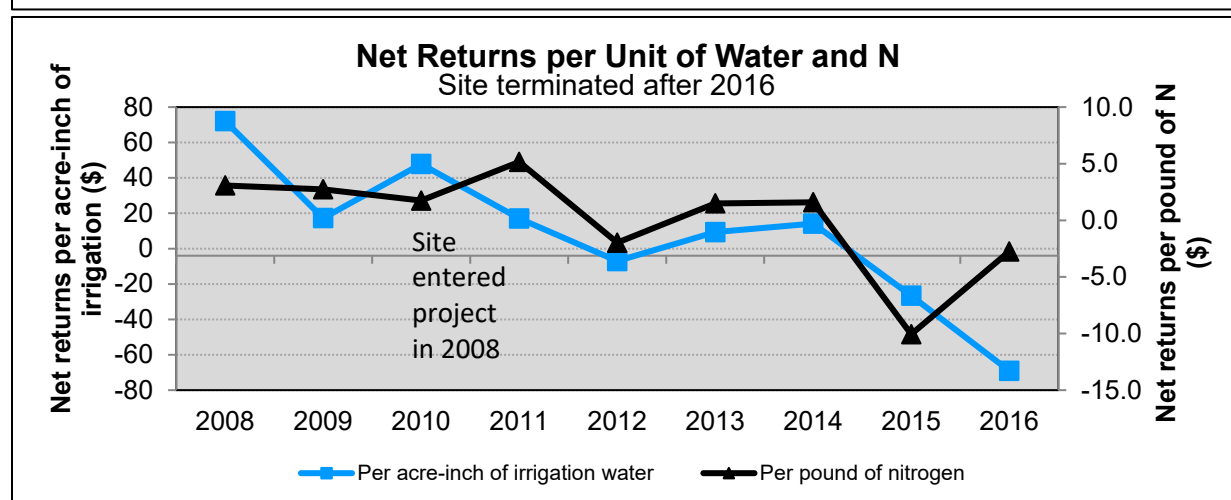
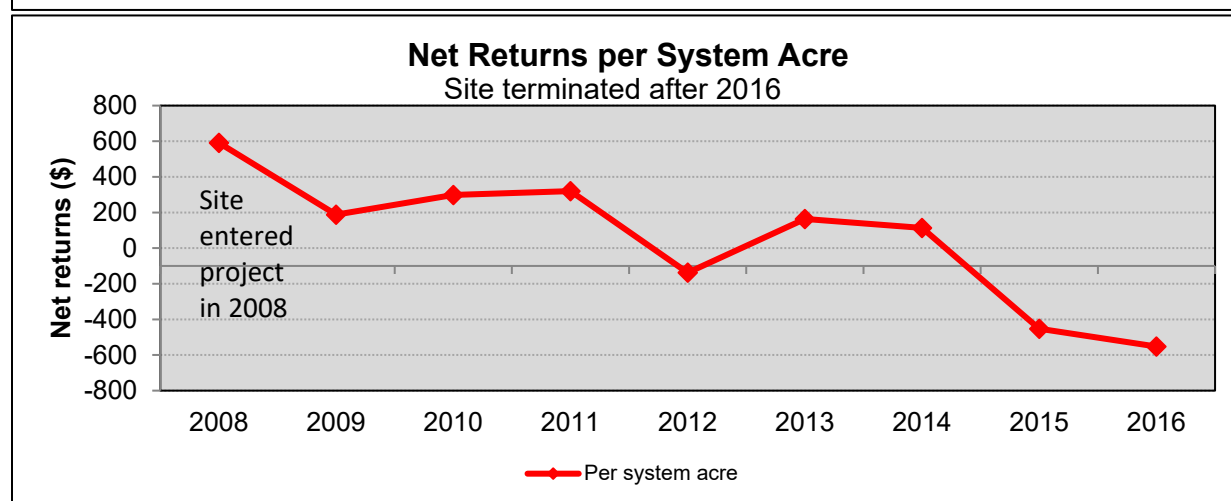
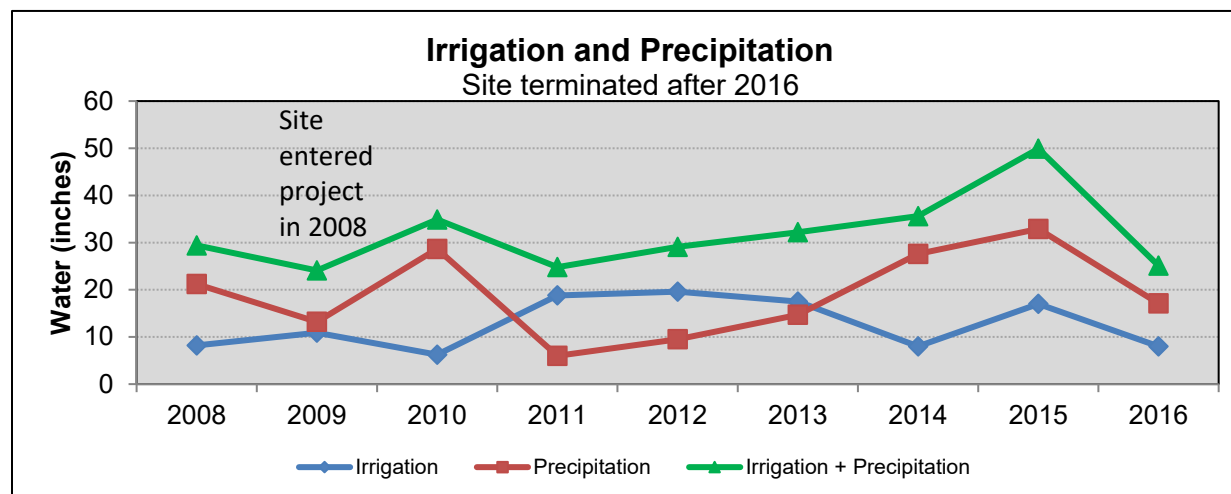
Sub-Surface Drip (SDI) 300 gpm

Number of wells: 1

Fuel Source: Electric



## Site 28



## SITE 29 – TERMINATED AFTER 2014



### **Description:**

Site acres: 221.7

### **Soil types:**

**PuA**-Pullman clay loam; 0 to 1%

**LoA**-Lofton clay loam; 0 to 1%

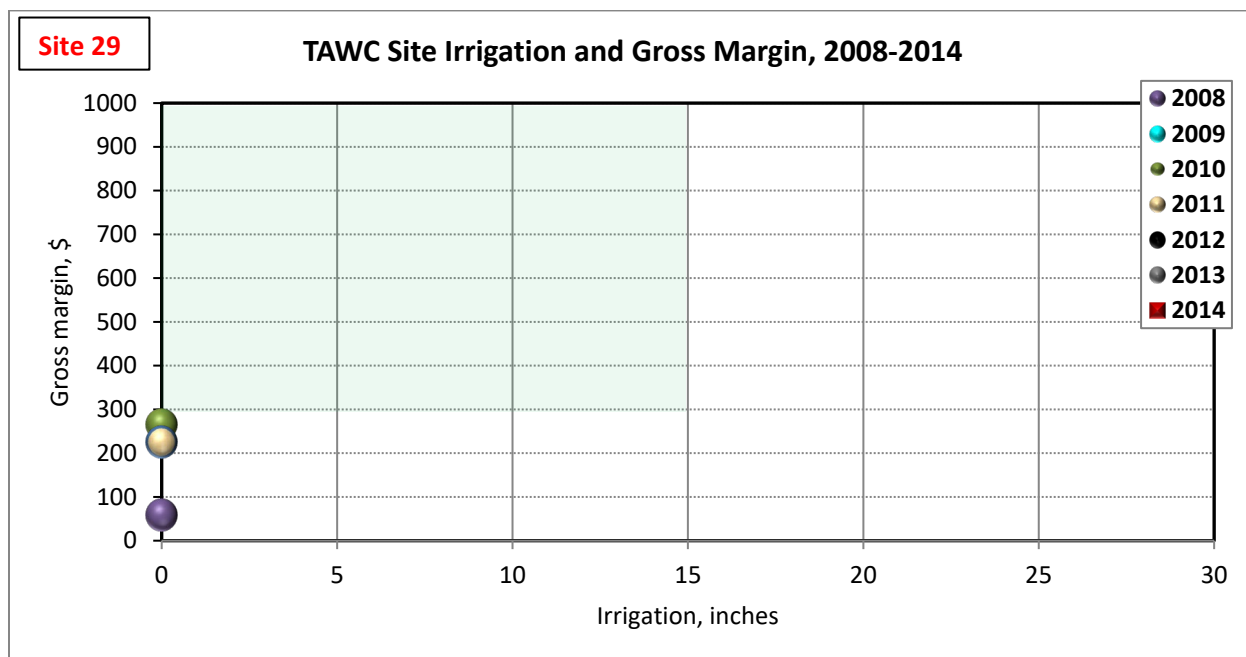
**EcB**-Estacado clay loam; 1 to 3%

### **Irrigation:**

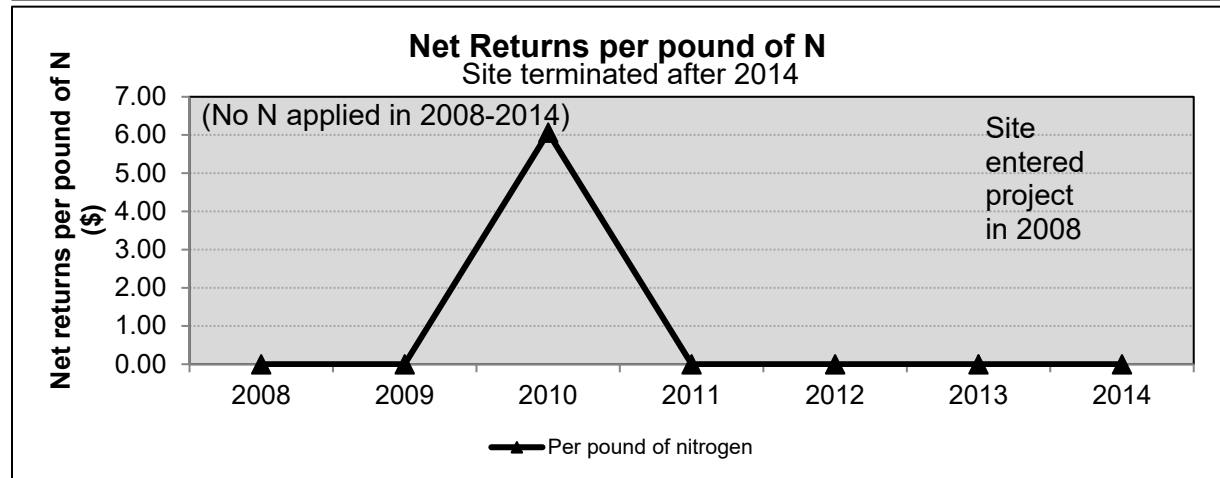
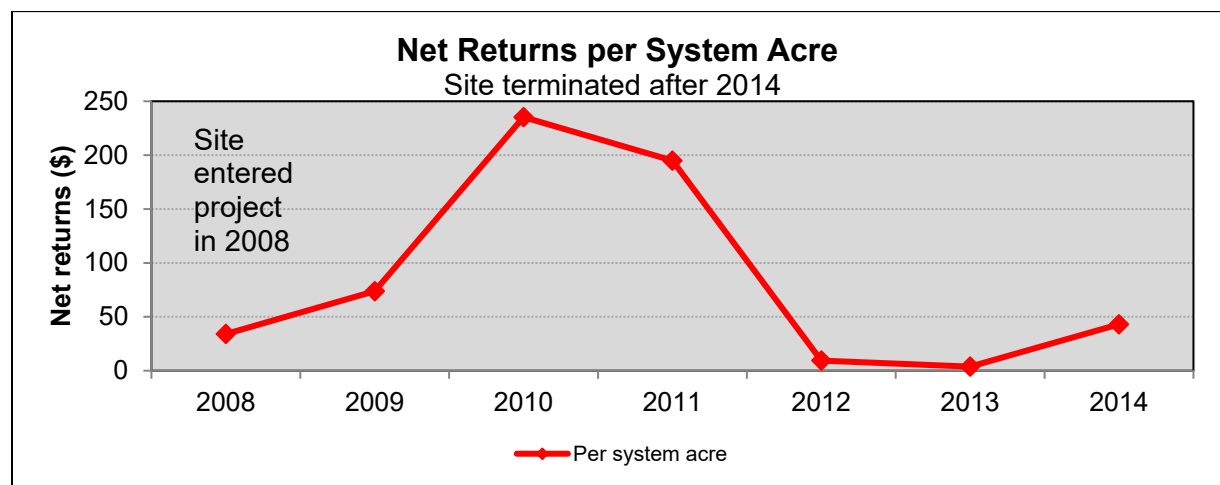
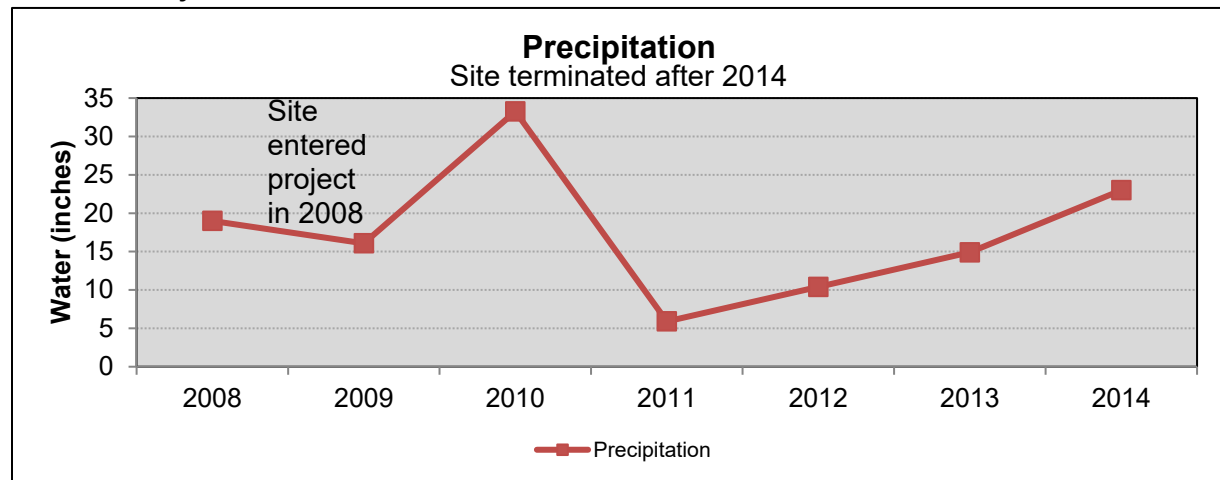
Dryland (DL) na gpm

Number of wells: na

Fuel Source: na



## Site 29 – Dryland Site



## SITE 30-TERMINATED AFTER 2015



### **Description:**

Site acres: 21.8

### Soil types:

**OtA**-Olton loam; 0 to 1%

**BpA**-Bippus loam; 0 to 1%

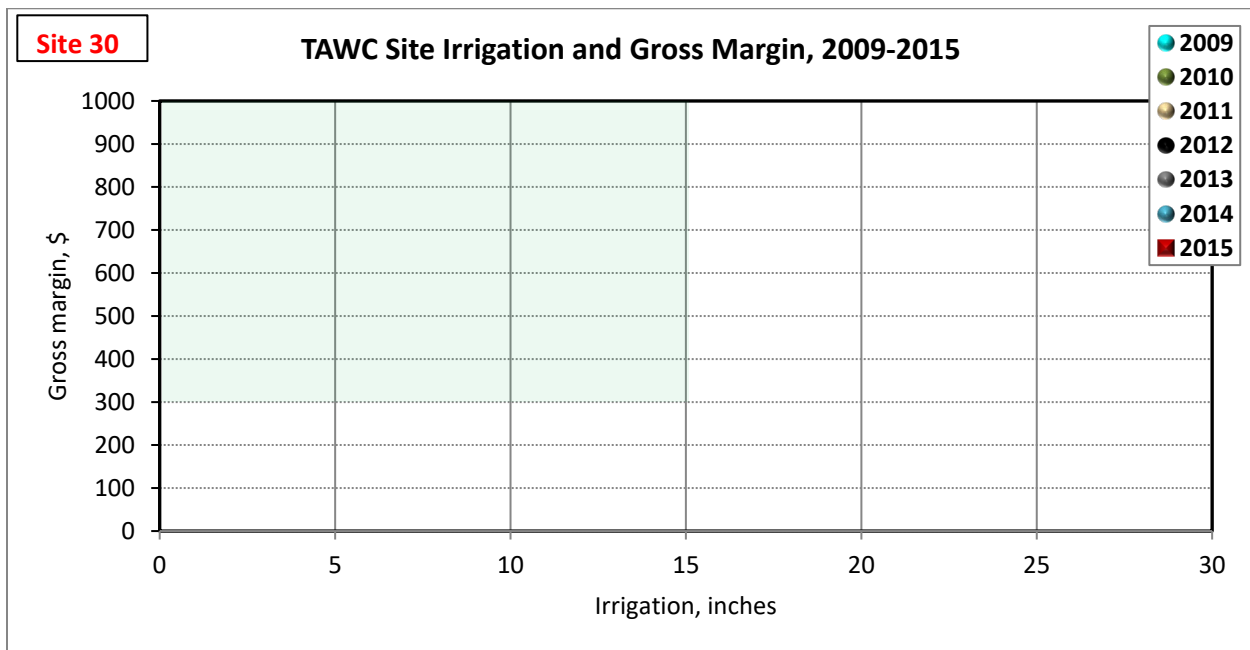
**BfB**-Bippus fine sandy loam; 1 to 3%

### Irrigation:

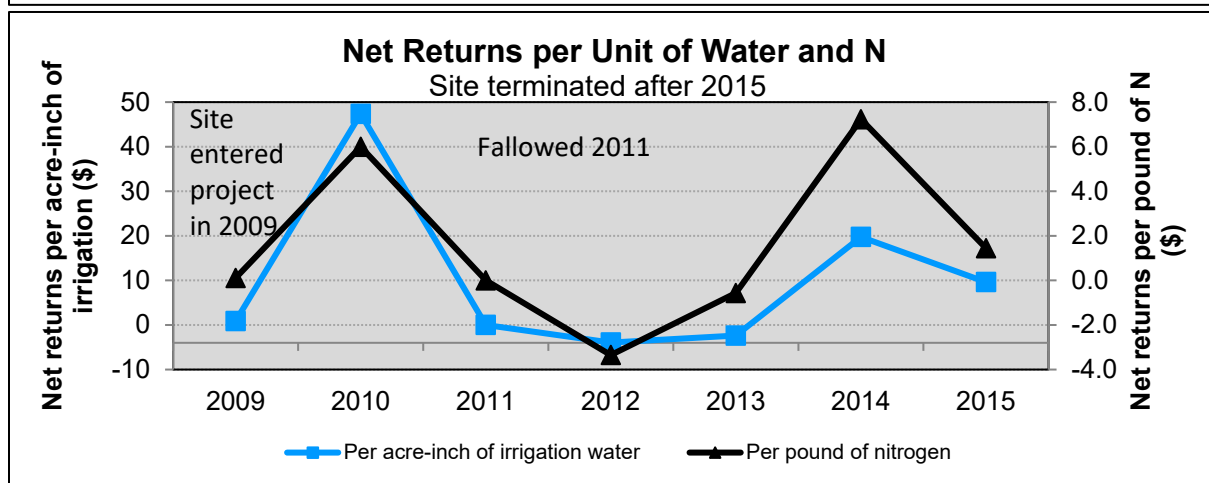
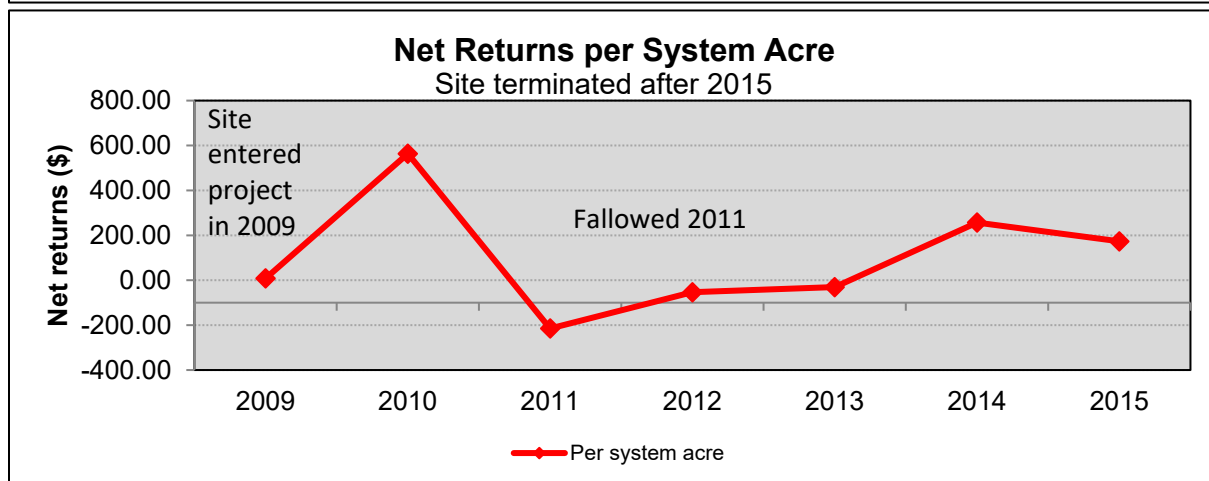
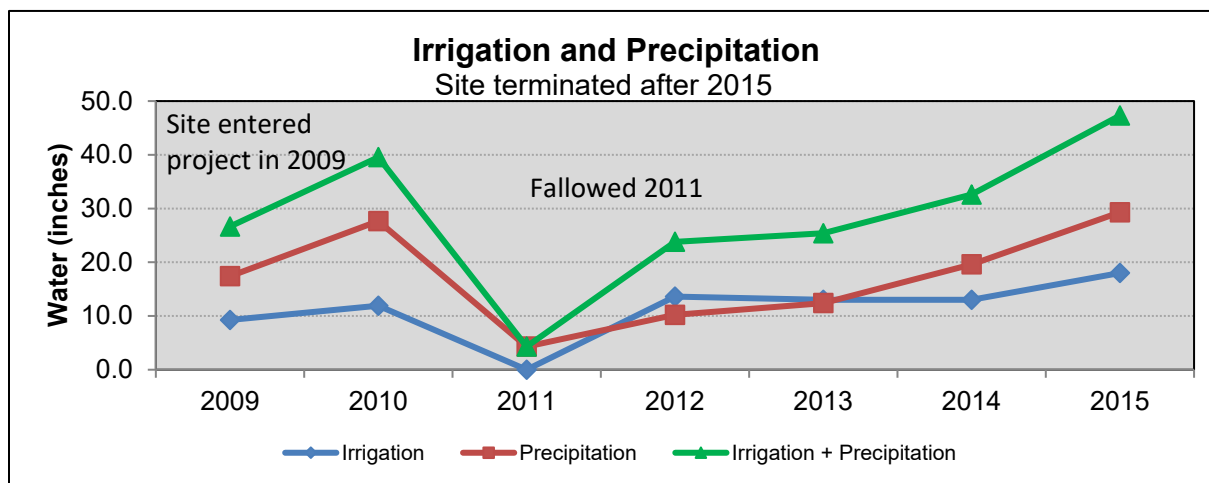
Sub-Surface Drip (SDI) 150 gpm

Number of wells: 1

Fuel Source: Electric



## Site 30





### SITE 33 – TERMINATED AFTER 2016



#### **Description:**

Site acres: 70

#### **Soil types:**

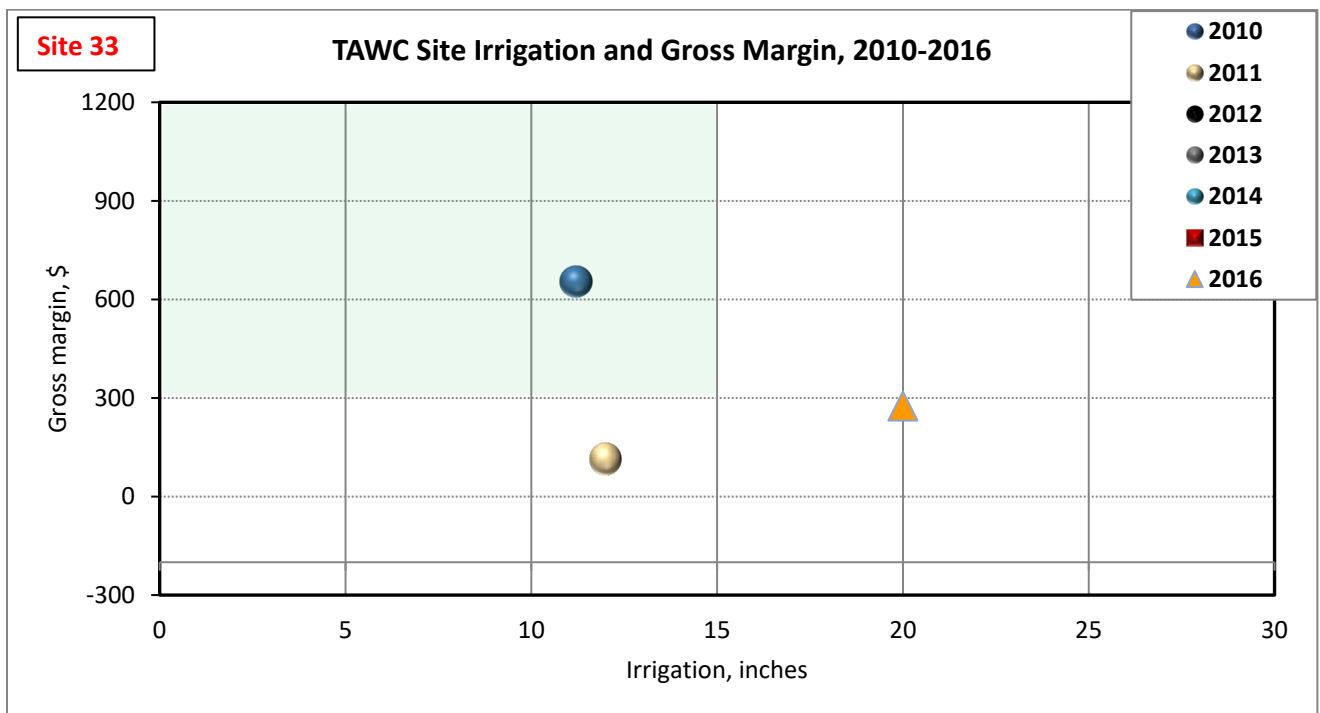
PuA-Pullman clay loam, 0 to 1%

#### **Irrigation:**

Center Pivot (LEPA) 350 gpm

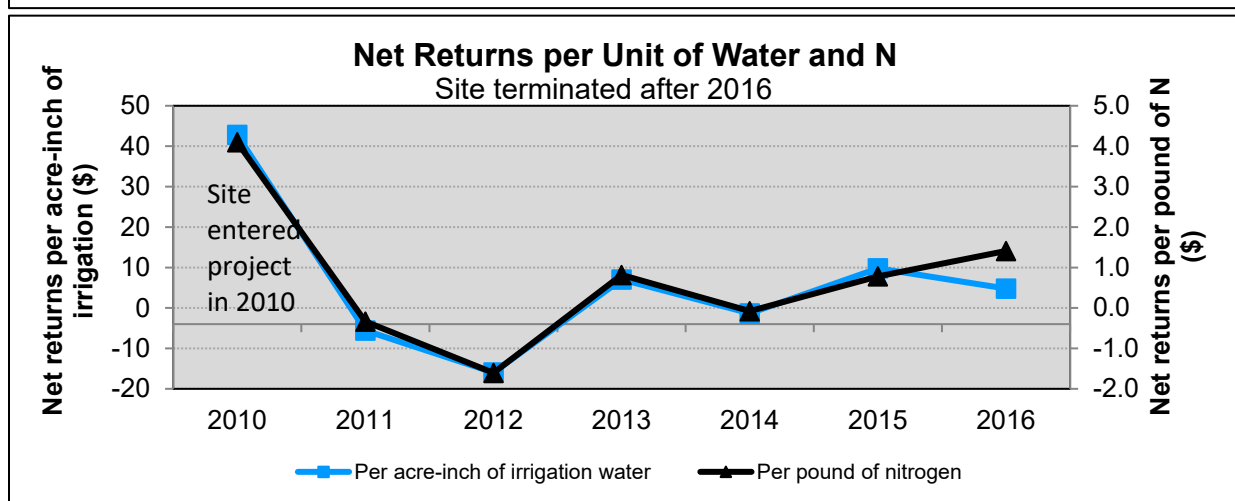
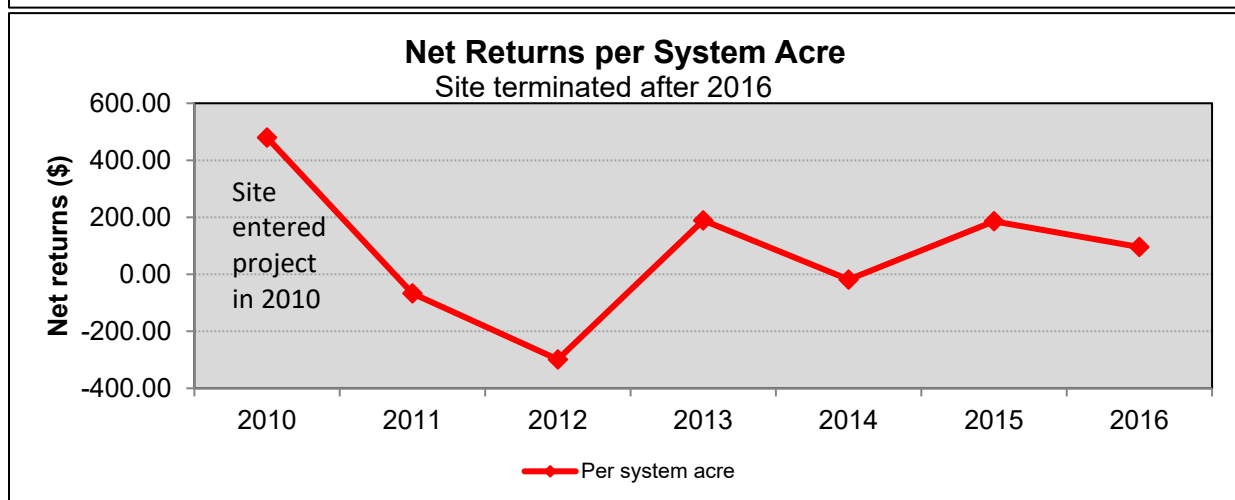
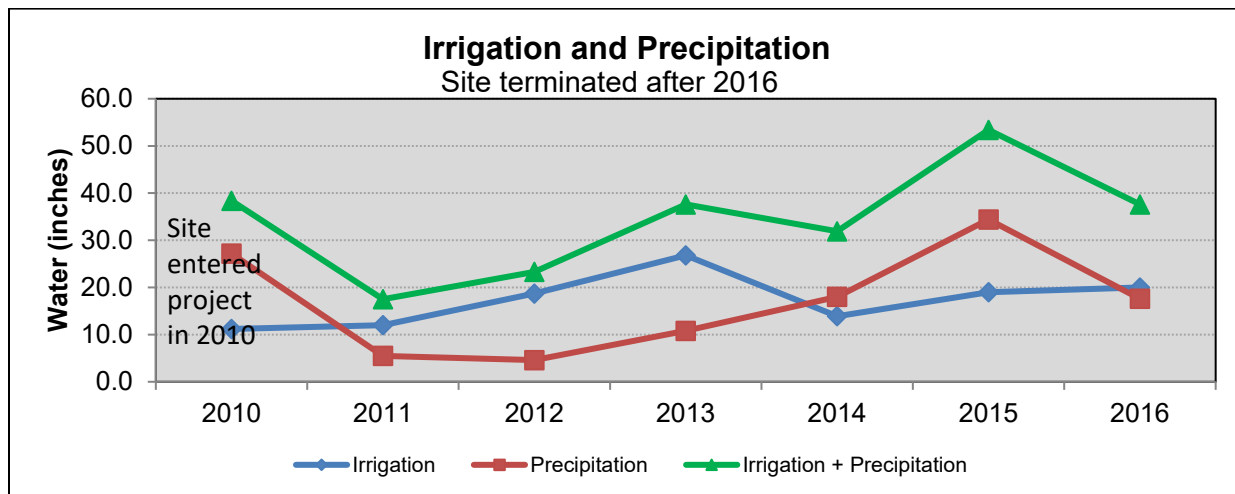
Number of wells: 2

Fuel Source: Electric





## Site 33



## SITE 34 – TERMINATED AFTER 2017



Electric

### **Description:**

Site acres: 726

### Soil types:

**PuA**-Pullman clay loam, 0 to 1%

**LoA**-Lofton clay loam, 0 to 1%

**McA**-McLean clay, 0 to 1%

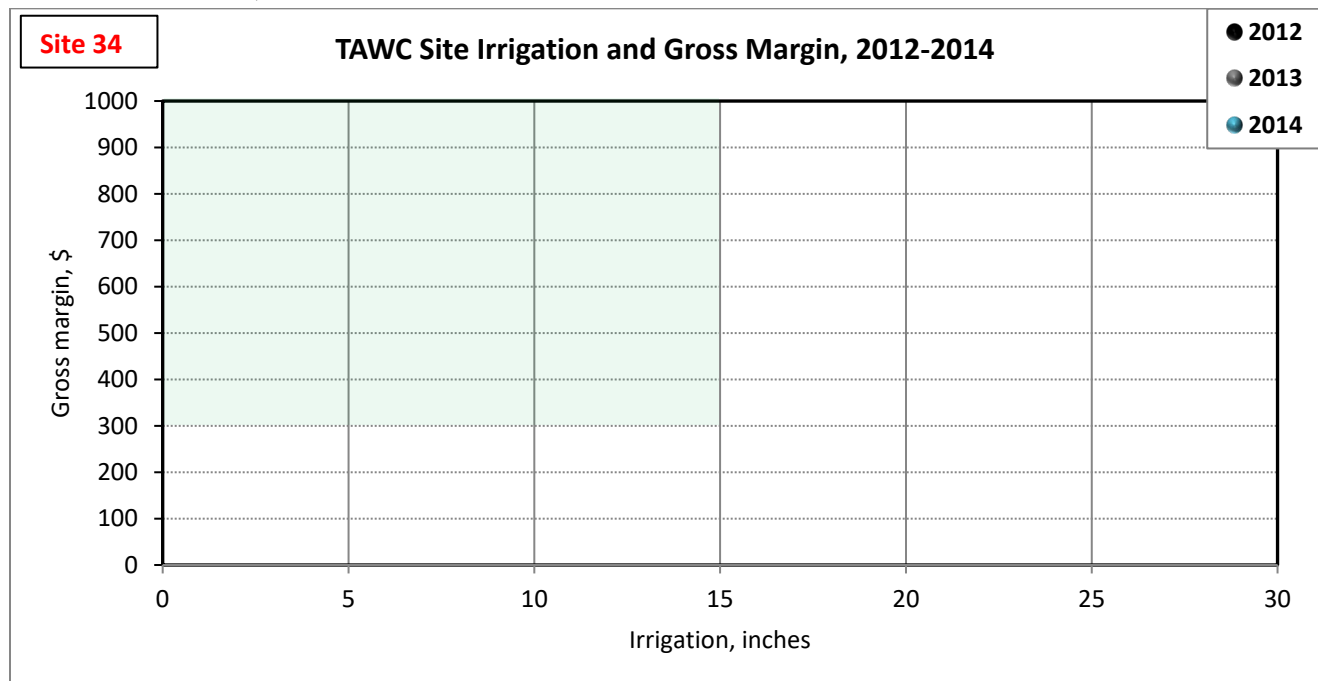
### Irrigation:

Center Pivot (LESA) 1600 gpm

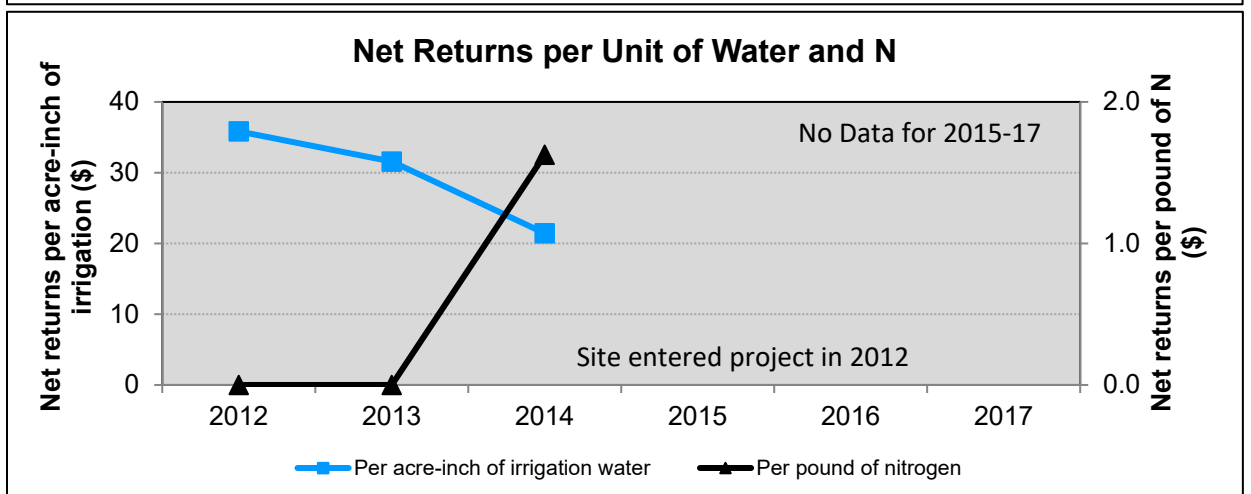
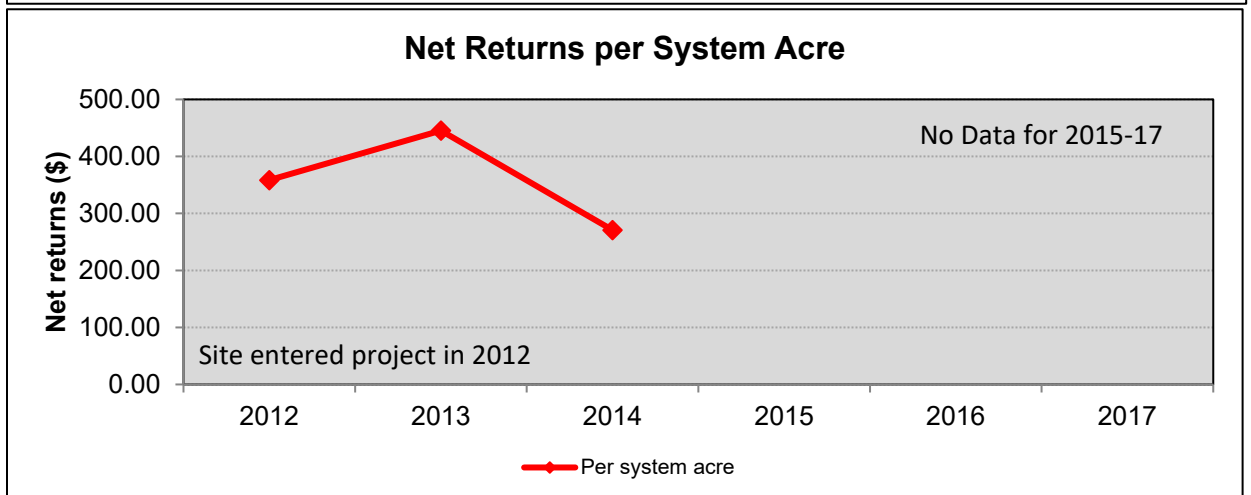
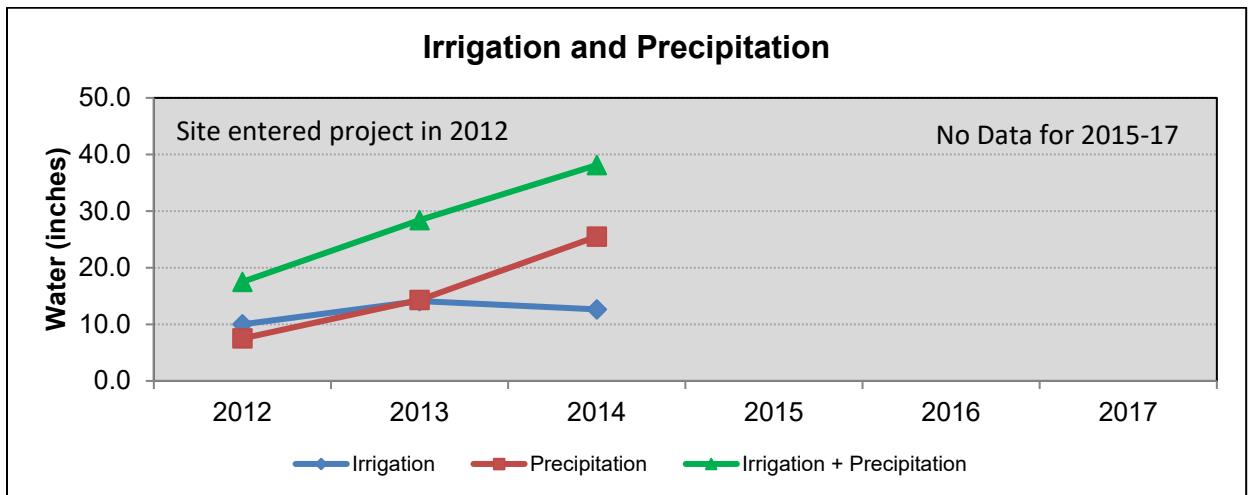
Number of wells: 2

Fuel Source:

No Site Data 2016, 2017



## Site 34

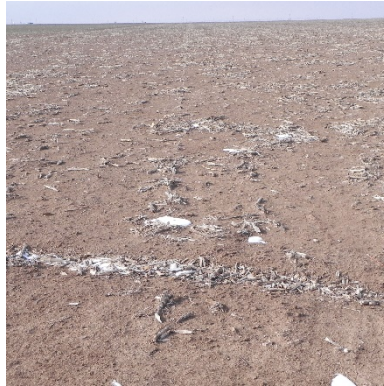


## Site 34

February snow in residue  
water



February snow no residue



Preparing to



June corn



Fertilize injection



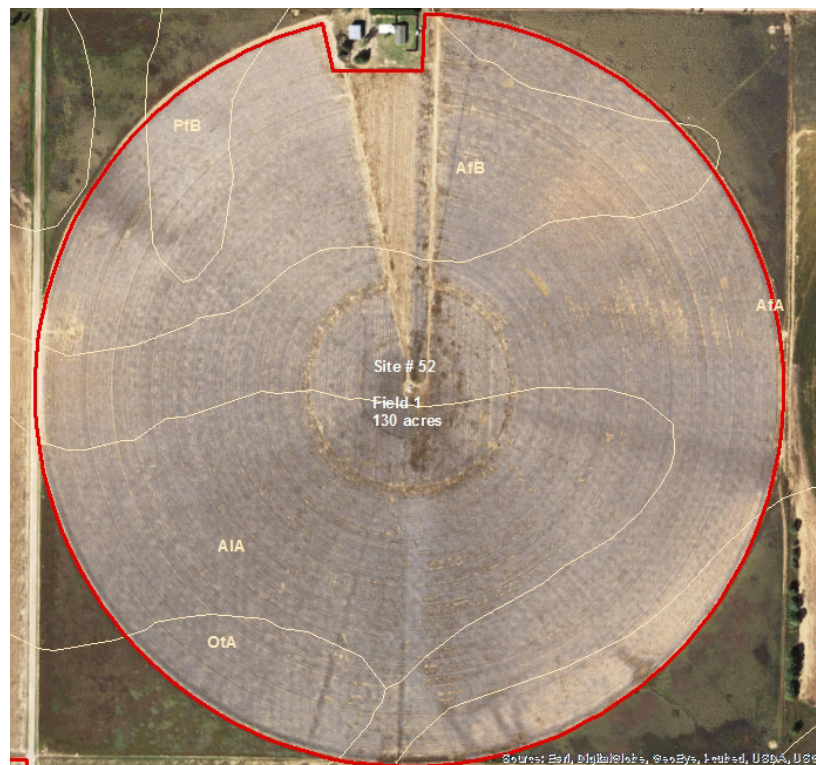
July cotton



Comments: Site dropped after multiple consecutive years of no data collection.



## SITE C52 – TERMINATED AFTER 2015



### **Description:**

Site acres: 130

### Soil types:

**AfA**-Amarillo fine sandy loam, 0 to 1%

**AfB**-Amarillo fine sandy loam; 1 to 3%

**AIA**- Acuff loam, 0 to 1%

**OtA**-Olton loam, 0 to 1%

**PfB**- Portales fine sandy loam, 1 to 3%

### Irrigation:

Low Elevation Spray

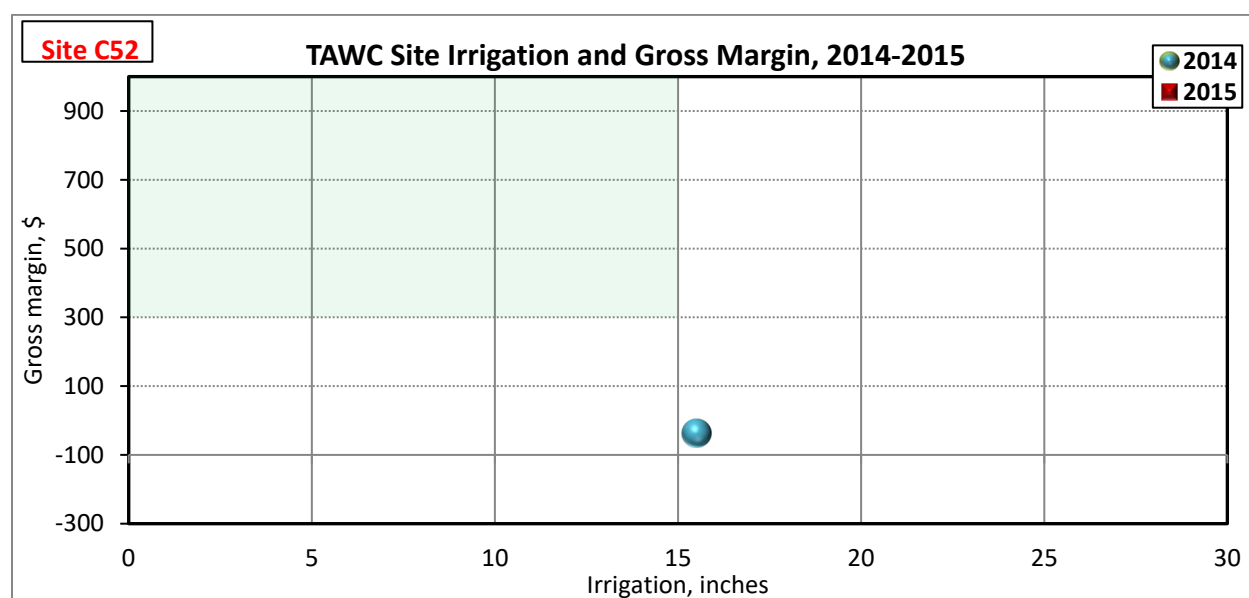
### Application

(SDI) 410 gpm

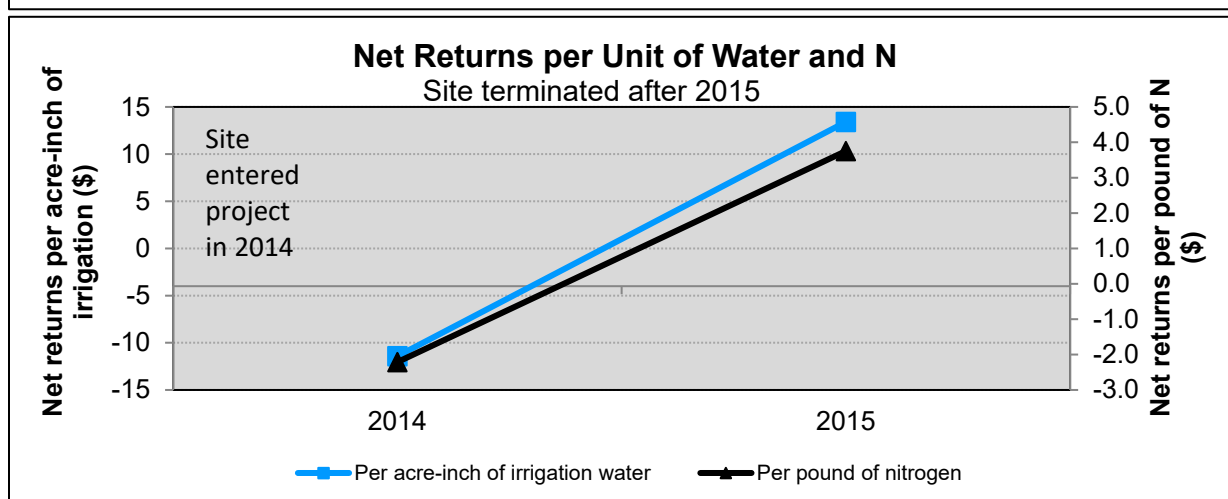
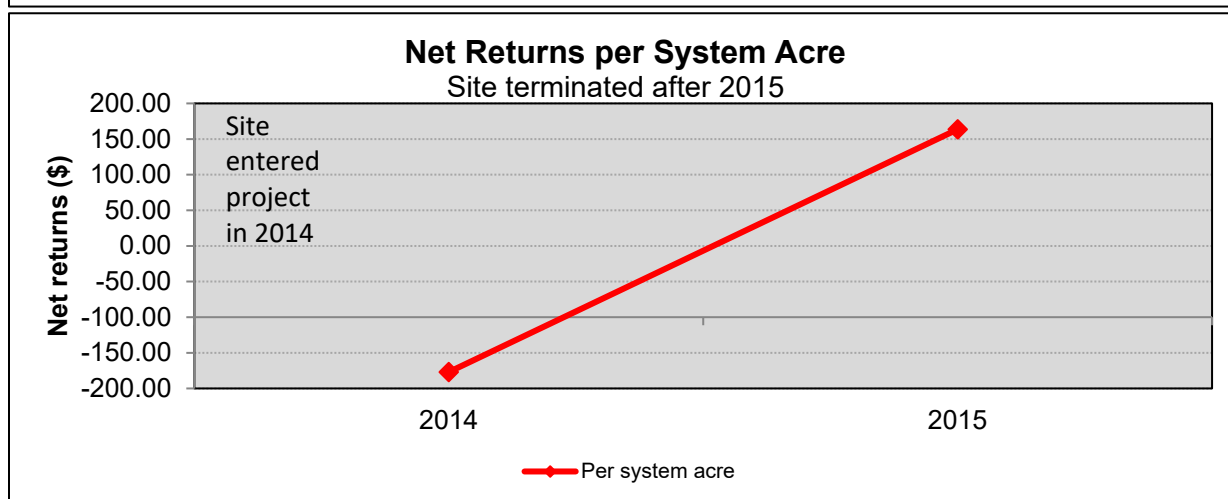
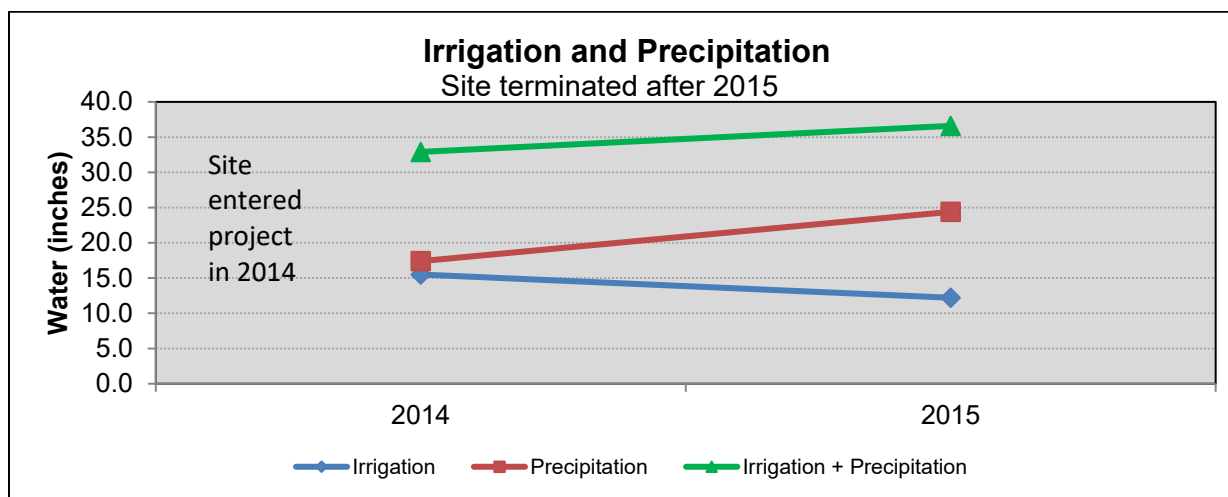
Number of wells: 3

Depth: 300 feet

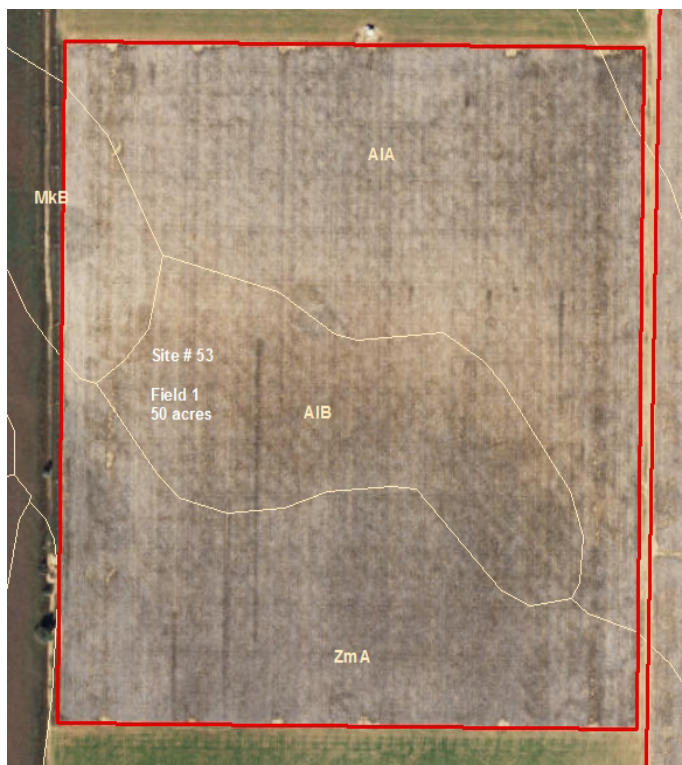
Fuel Source: Electric



## Site C52



## SITE C53 – TERMINATED AFTER 2015



### **Description:**

Site acres: 50

### Soil types:

**AIA** - Acuff loam; 0 to 1%

**AIB** - Acuff loam, 1 to 3%

**MkB** - Mansker loam 0 to 3%

**ZmA** - Zita loam, 0 to 1%

### Irrigation:

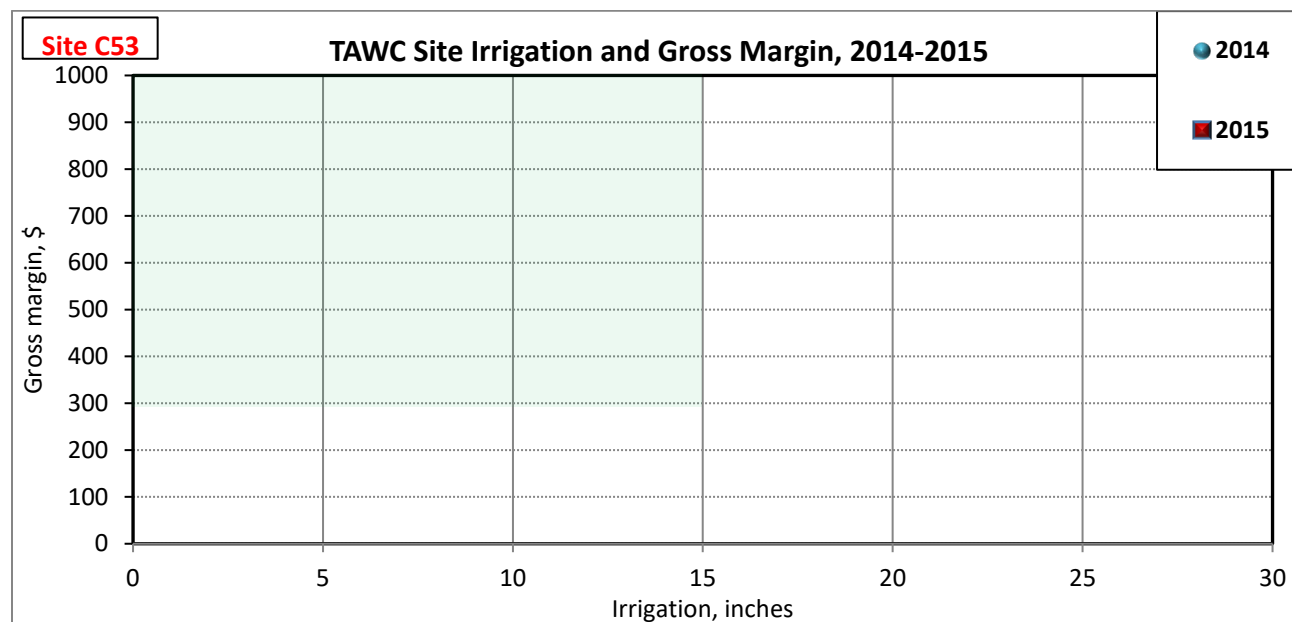
40" Sub-surface Drip

(SDI) 160 gpm

Number of wells: 3

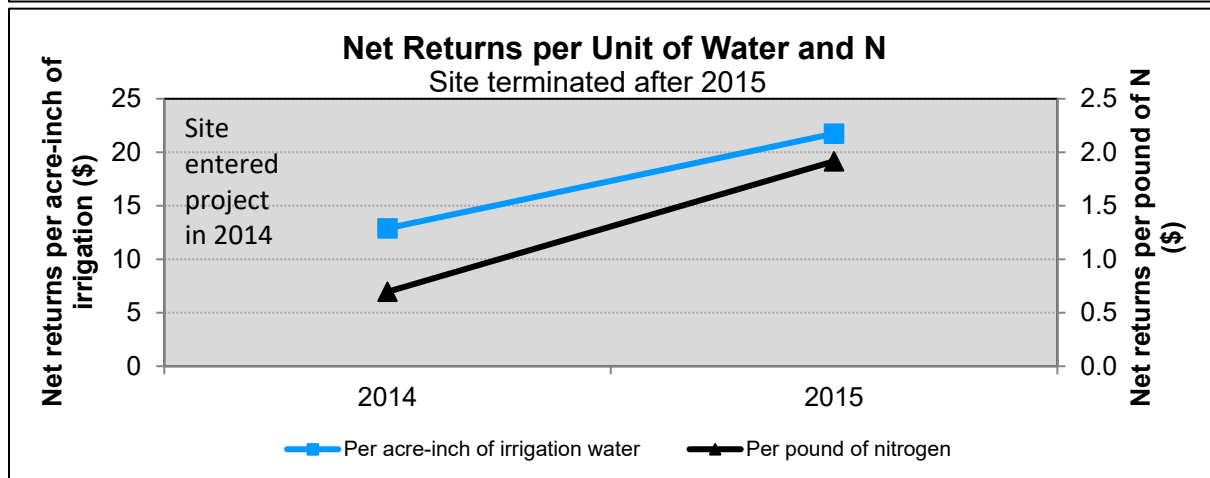
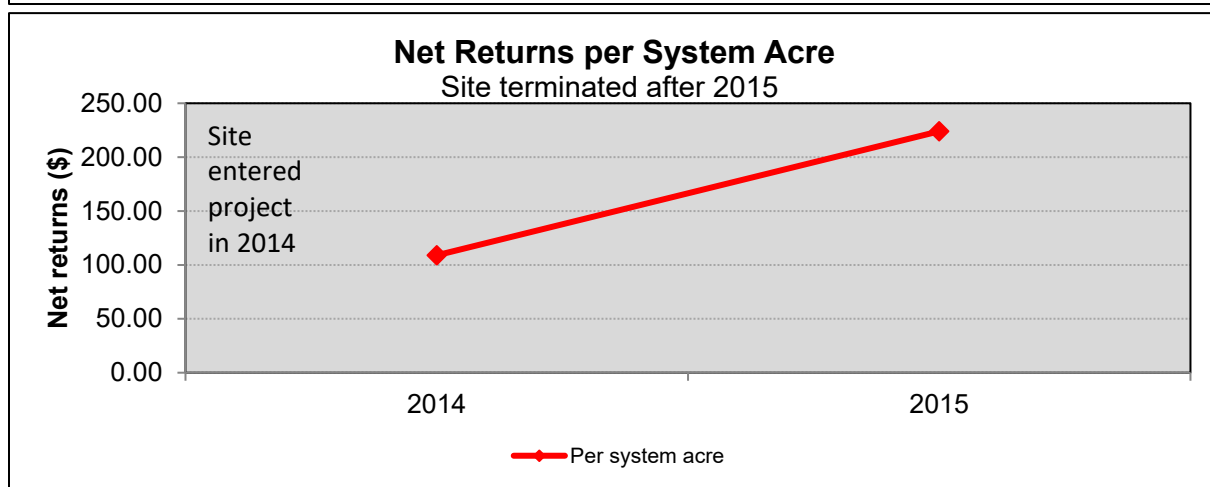
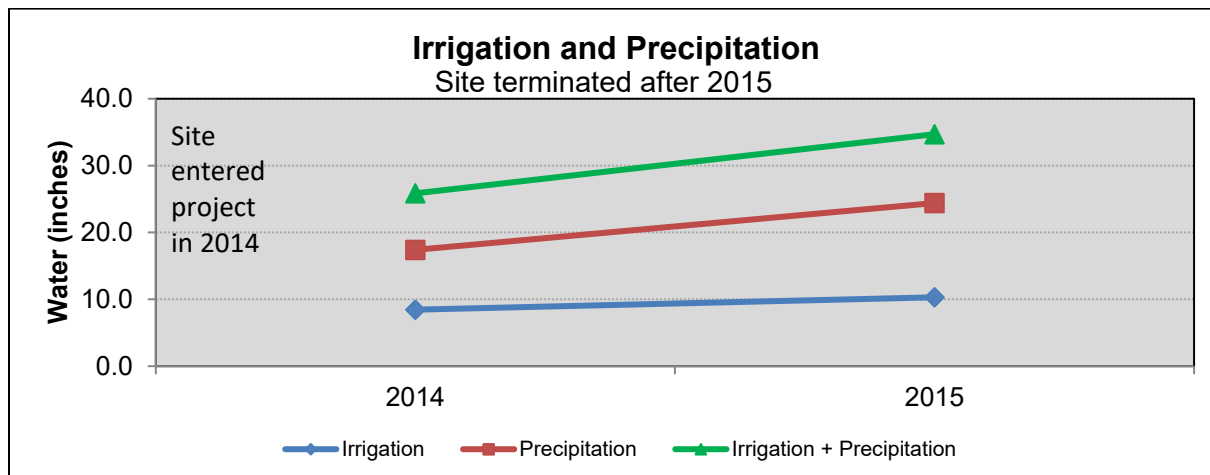
Depth: 300 feet

Fuel Source: Electric





## Site C53



## SITE C54 – TERMINATED AFTER 2016



### **Description:**

Site acres: 80

### Soil types:

**OtA** - Olton loam, 0 to 1%

**AlA** - Acuff loam, 0 to 1%

**ZmA** - Zita loam, 0 to 1%

### Irrigation:

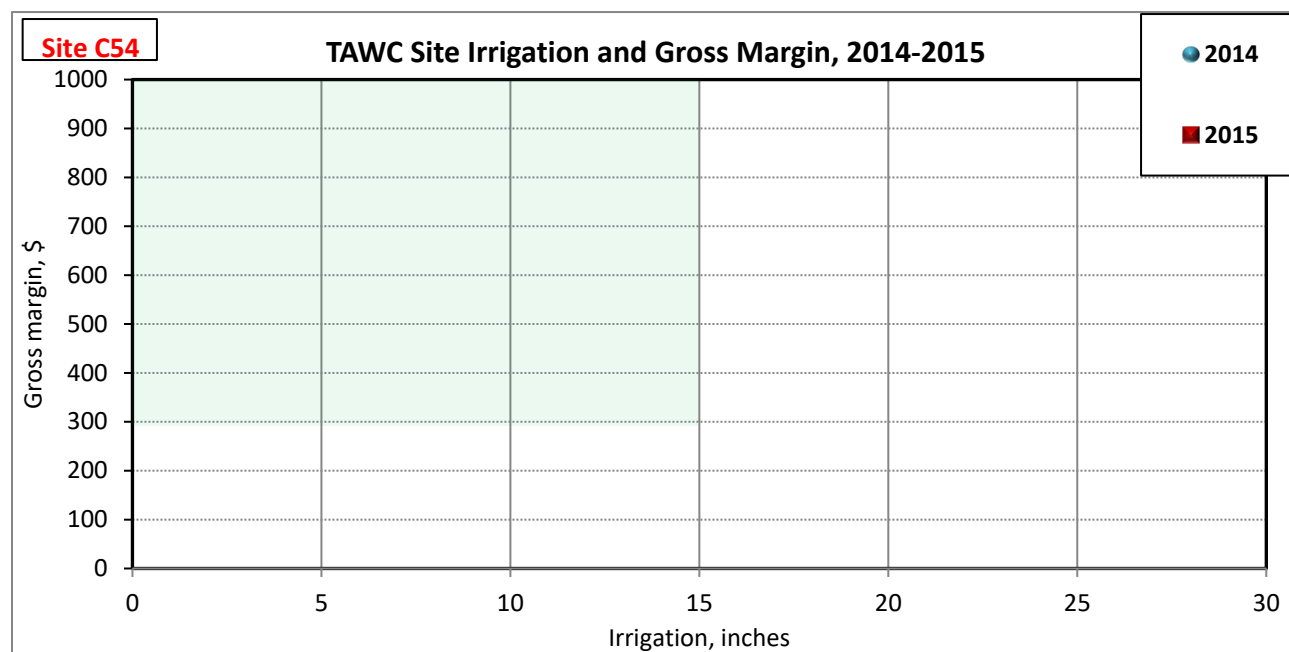
80" Sub-surface Drip

(SDI) 180 gpm

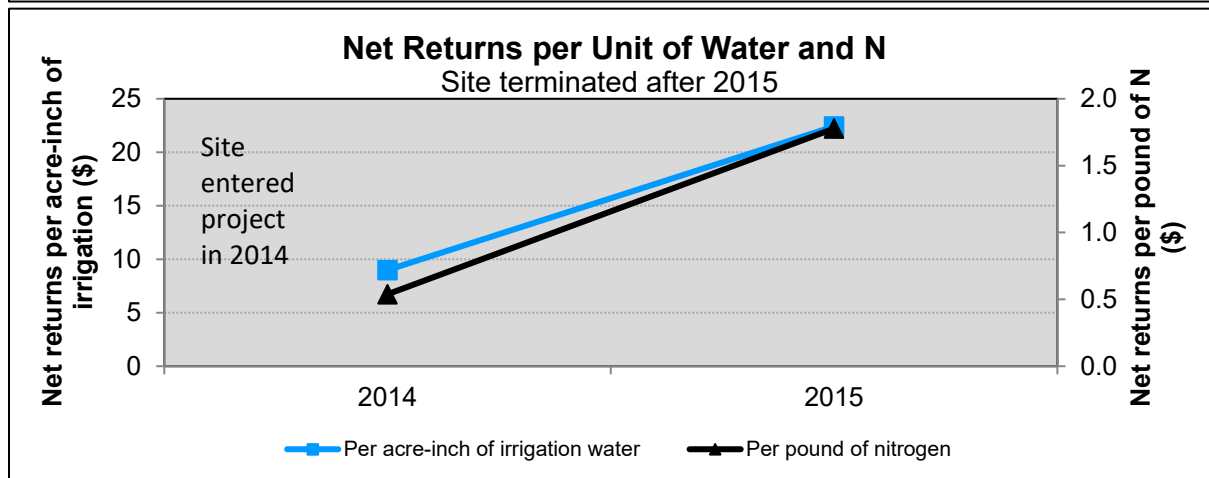
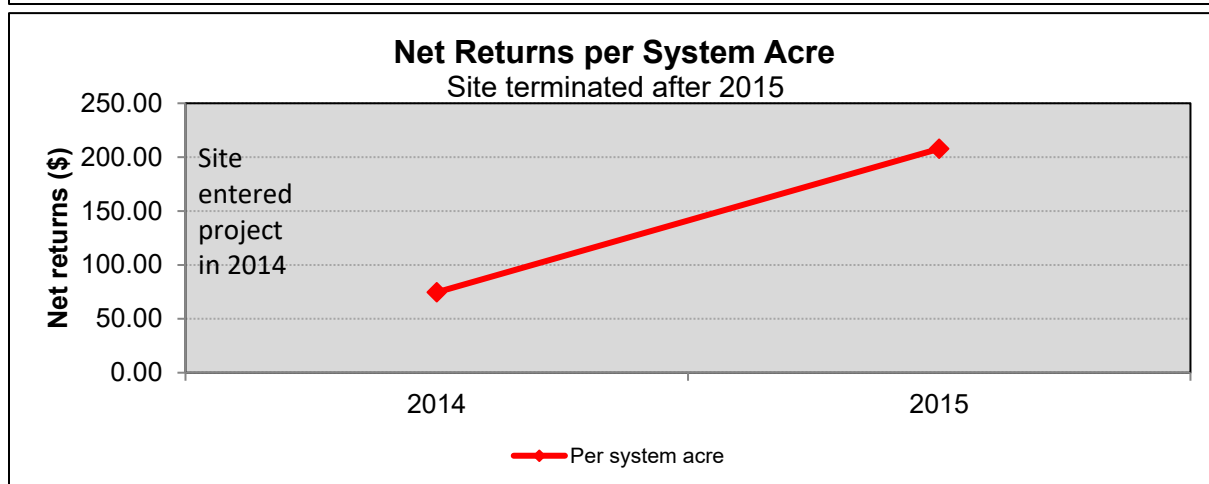
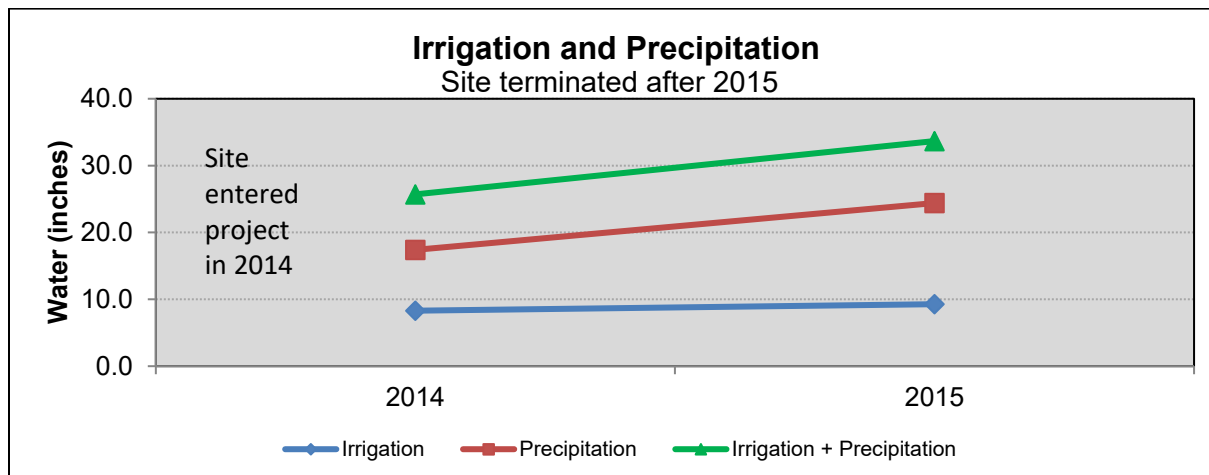
Number of wells: 2

Depth: 300 feet

Fuel Source: Electric



## Site C54



Site # 58

Field 1  
60 acres

Field 2  
60 acres

CR Fm 400

CR 50

Source: Esri, DigitalGlobe, GeoEye, AeroGRID, USDA

## Fuel Source: Electric

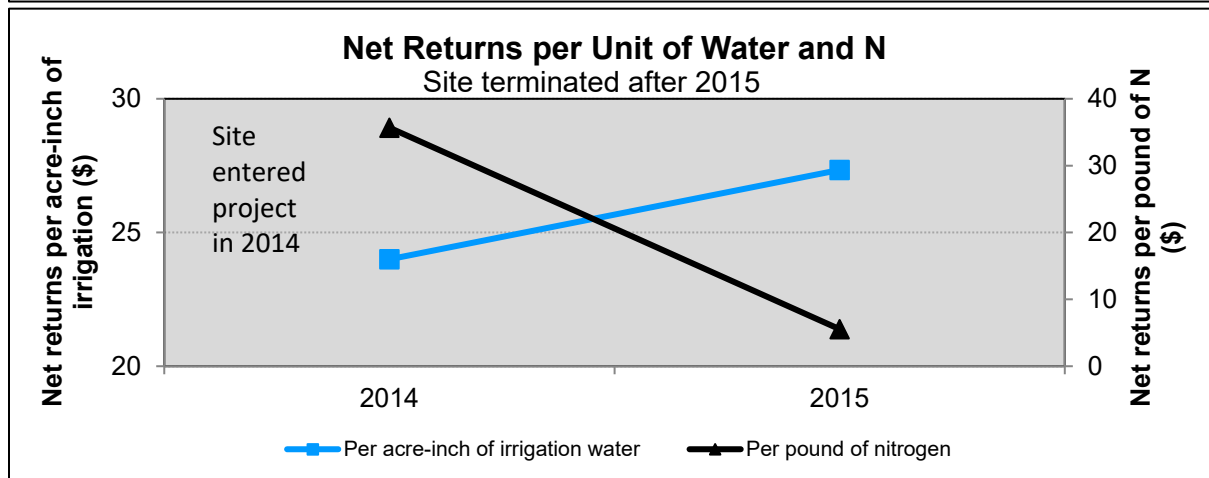
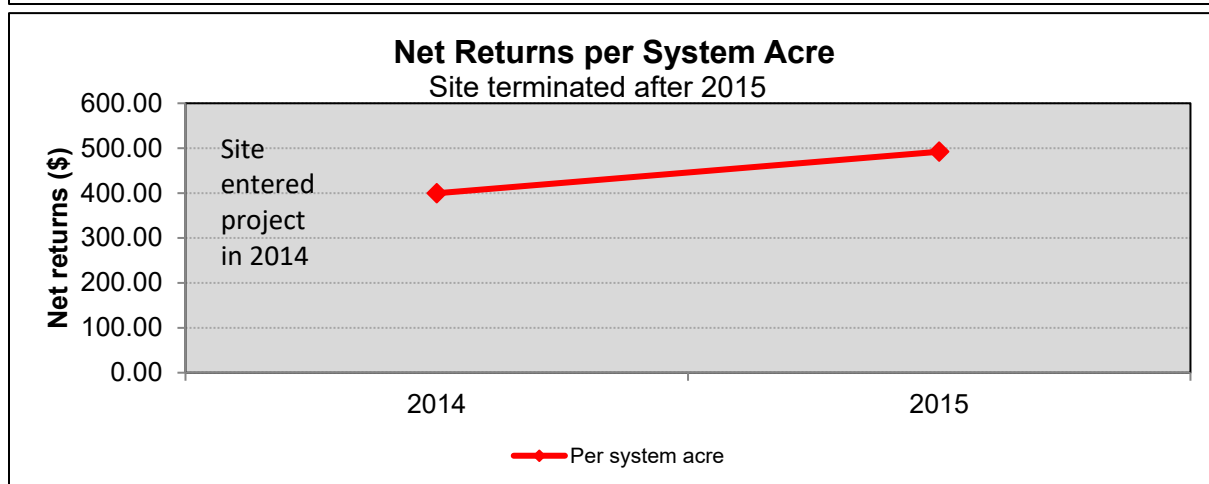
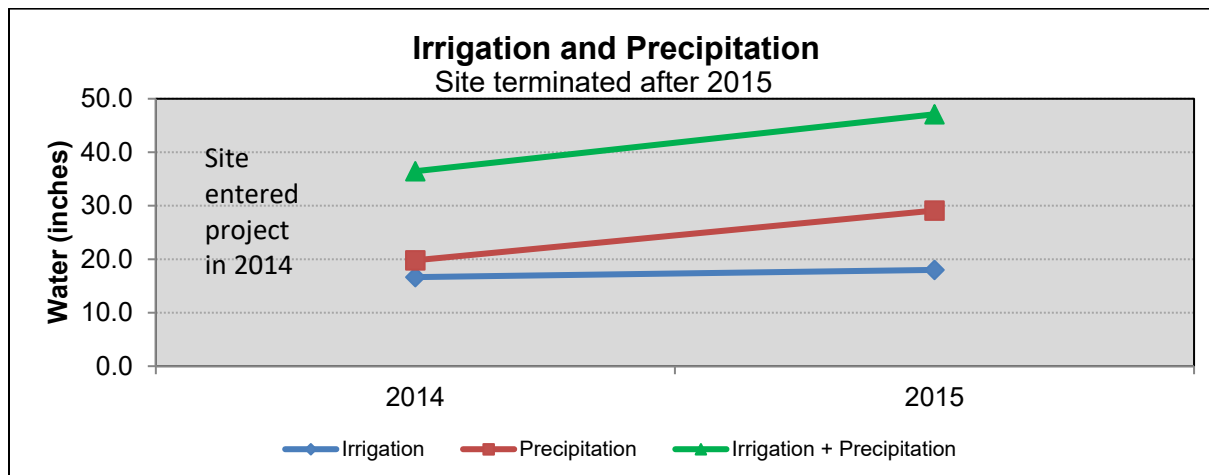
**Site C58**

**TAWC Site Irrigation and Gross Margin, 2014-2015**

Legend: 2014 (Blue circle), 2015 (Red square)

Irrigation (inches)	Gross Margin 2014 (\$)	Gross Margin 2015 (\$)
0	1000	800
5	900	700
10	800	600
15	700	500
20	600	400
25	500	300
30	200	100

## Site C58



## SITE C59 – TERMINATED AFTER 2015



### **Description:**

Site acres: 93

### Soil types:

30 - Olton clay loam, 0 to 1%

31 - Olton clay loam, 1 to 3%

41 - Pullman clay loam, 0 to 1%

### Irrigation:

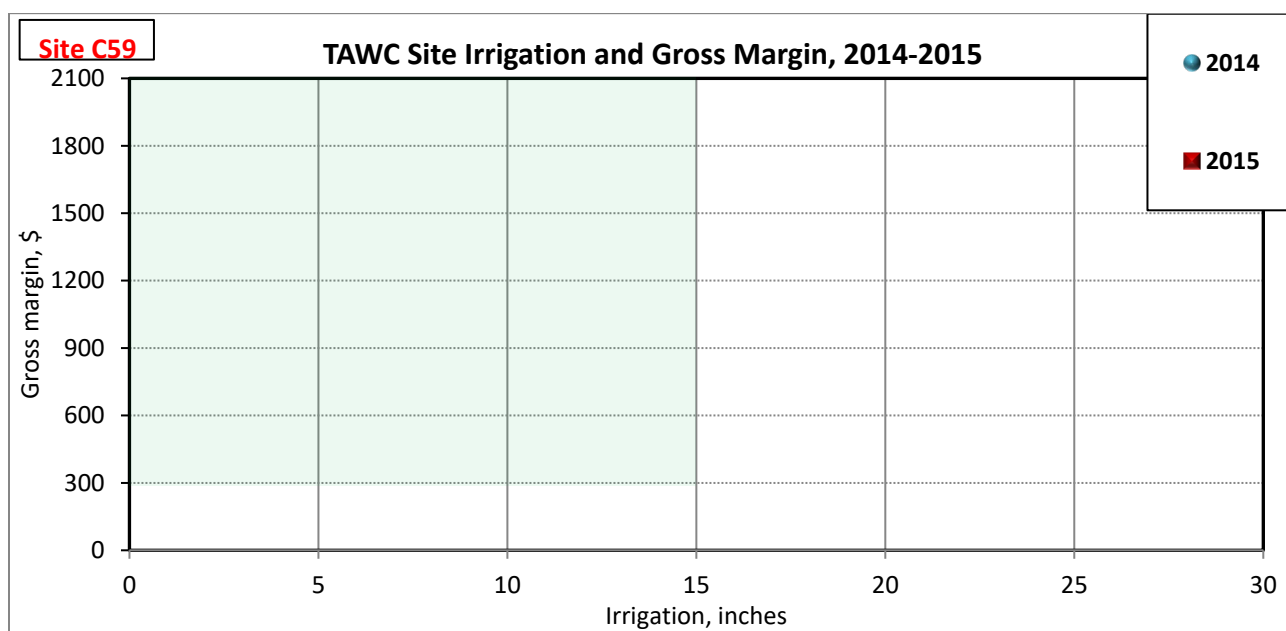
Sub-surface Drip

(SDI) 350 gpm

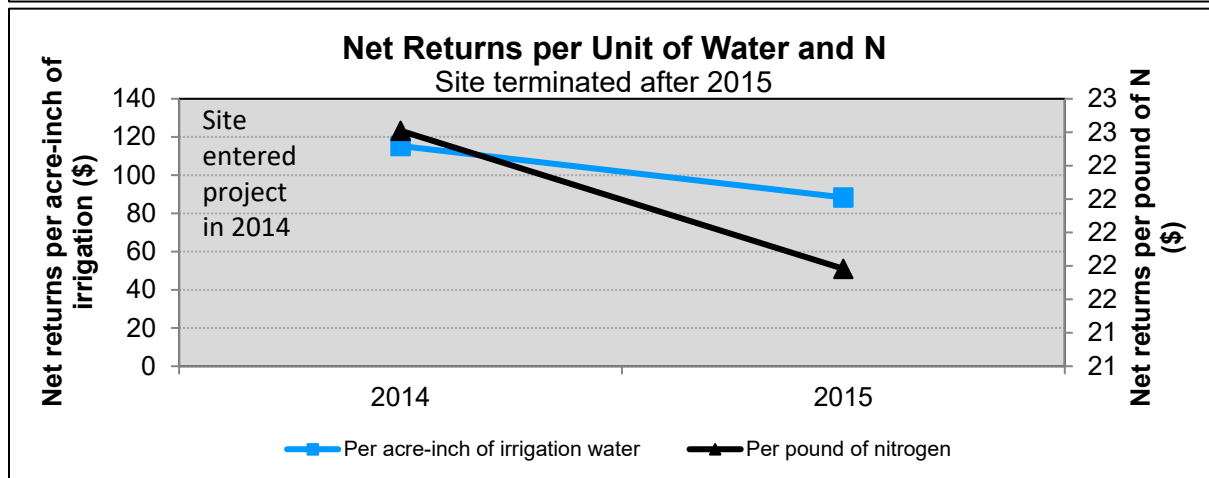
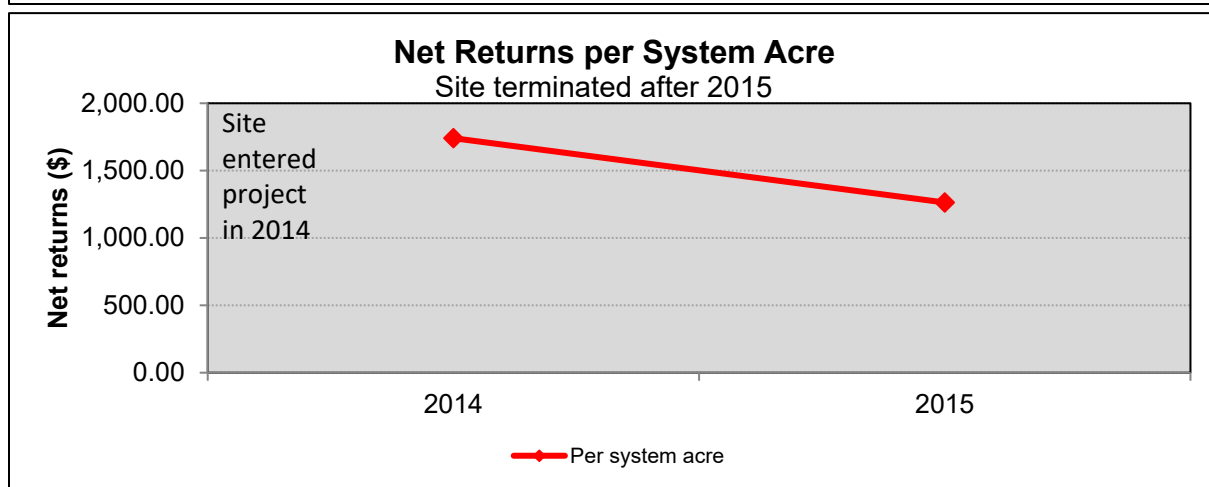
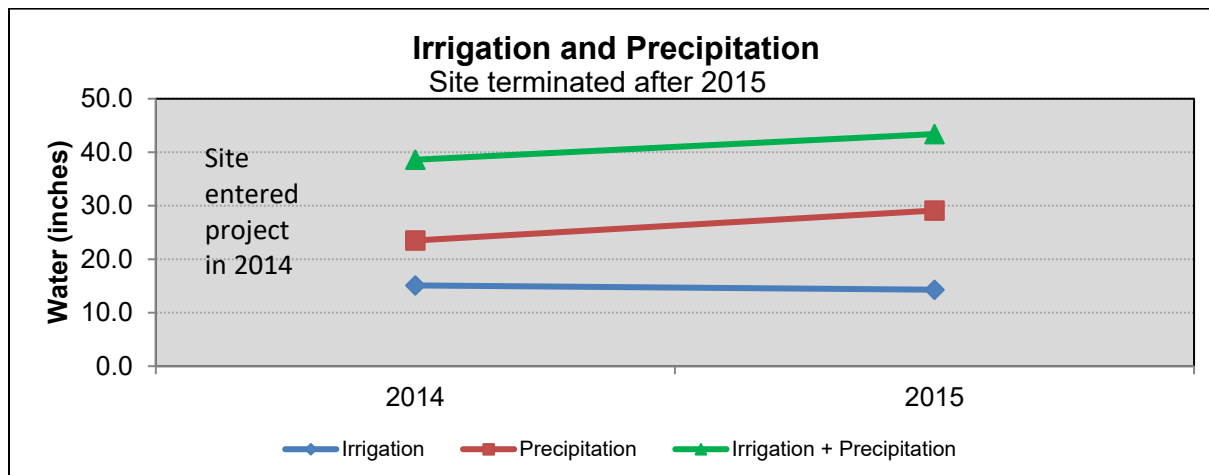
Number of wells: 2

Depth: 300 feet

Fuel Source: Electric



## Site C59



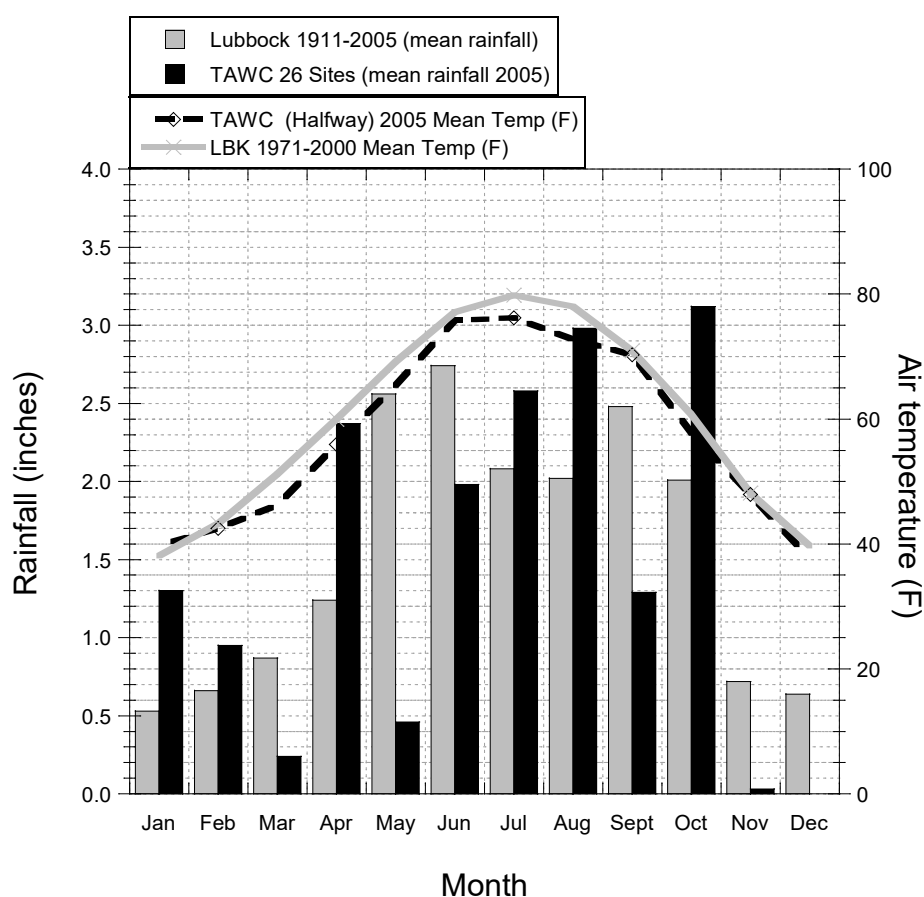


## Weather Data (Phase I - 2005-2013/Phase II - 2014-2018)

### 2005

The 2005 growing season was close to ideal in terms of temperatures and timing of precipitation. The precipitation and temperatures for this area are presented in Figure A1 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 A23, is the mean of precipitation recorded at the 26 sites during 2005, beginning in March when the sites were identified and equipped. Precipitation for January and February are amounts recorded at Halfway, TX; the nearest weather station.



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

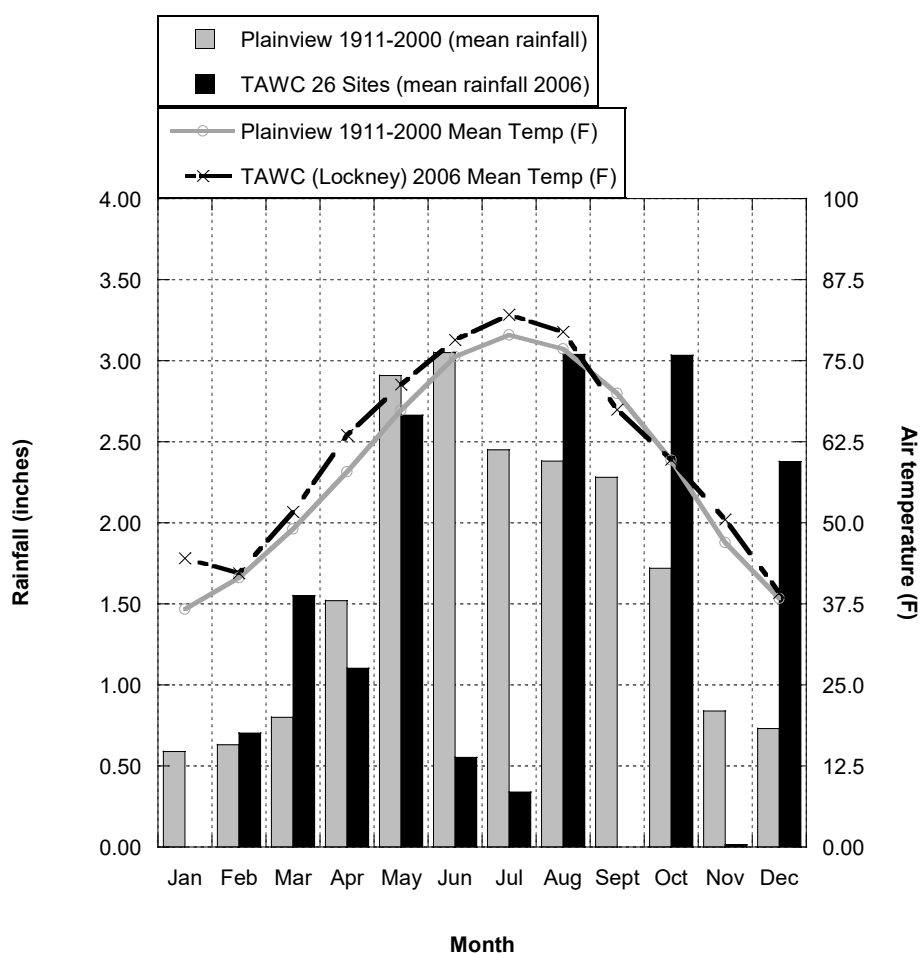
**Table A 33.** Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2005.

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

## 2006

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

Precipitation for 2006, presented in Figure A2 and Table A24, 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 A 2.** Temperature and precipitation for 2006 in the demonstration area compared with long term averages.

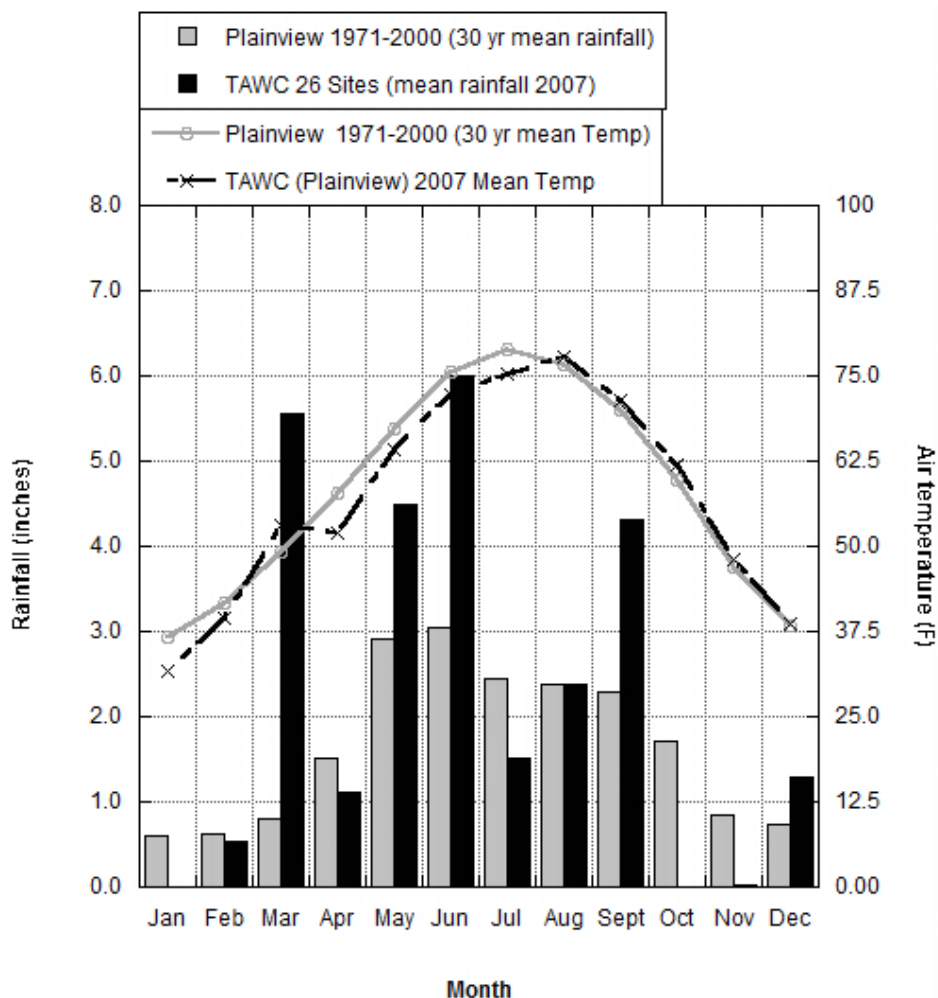
**Table A 34.** Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2006.

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

## 2007

Precipitation during 2007 totaled 27.2 inches (Table A25) and was well above the long-term mean (18.5 inches) for annual precipitation for this region. Furthermore, precipitation was generally well distributed over the growing season with early season rains providing needed moisture for crop establishment and early growth (Figure A3). Many producers took advantage of these rains and reduced irrigation until mid-season when rainfall declined. Growing conditions were excellent and there was little effect of damaging winds or hail at any of the sites. Temperatures were generally cooler than normal during the first half of the growing season but returned to normal levels by August. The lack of precipitation during October and November aided producers in harvesting crops.

Precipitation for 2007, presented in Figure A3 and Table A25, 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 A 3.** Temperature and precipitation for 2007 in the demonstration area compared with long term averages.

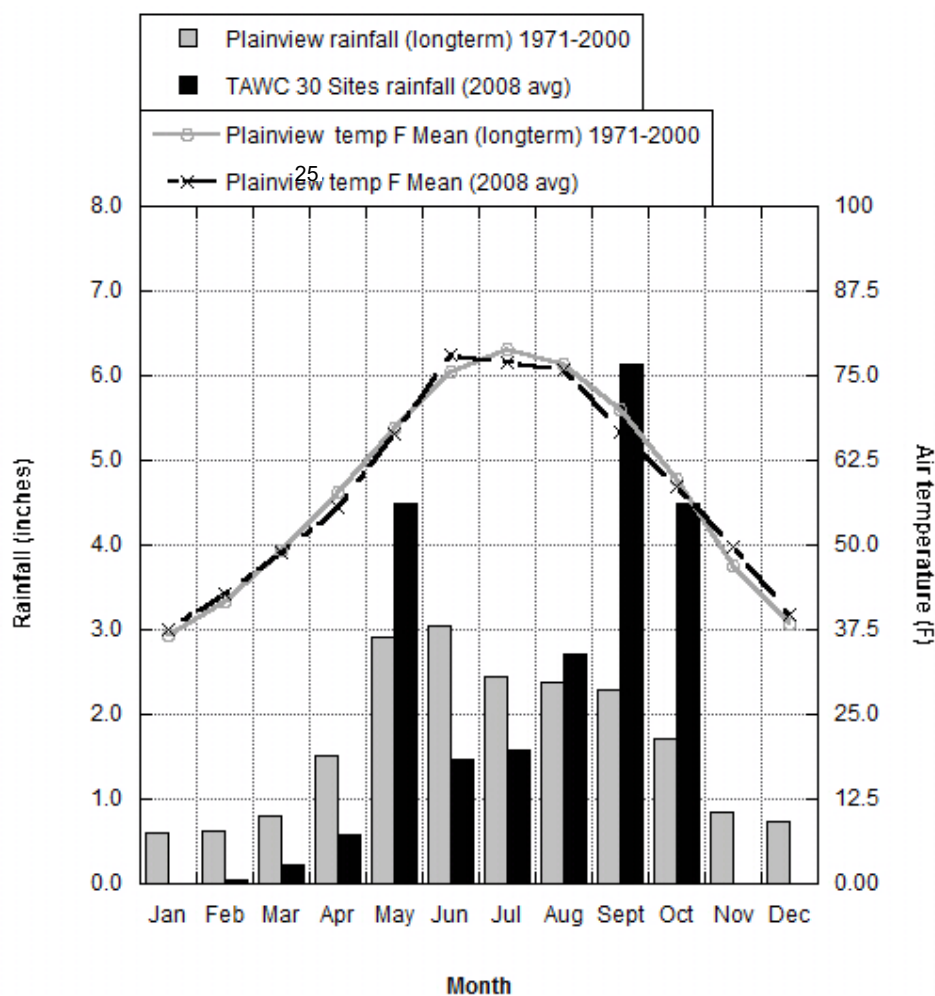
**Table A 35.** Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2007.

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

## 2008

Precipitation during 2008, at 21.6 inches, was above average for the year (Table A26). However, the distribution of precipitation was unfavorable for most crops (Figure A4). Beginning the previous autumn, little rain fell until December and then less than an inch of precipitation was received before May of 2008. Four inches was received in May, well above the average for that month. This was followed by below average rain during most of the growing season for crops. In September and October, too late for some crops and interfering with harvest for others, rain was more than twice the normal amounts for this region. Following the October precipitation, no more rain came during the remainder of the year. This drying period helped with harvest of some crops but the region entered the winter with below normal moisture.

Temperatures during 2008 were close to the long-term mean for the region (Figure A4).



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



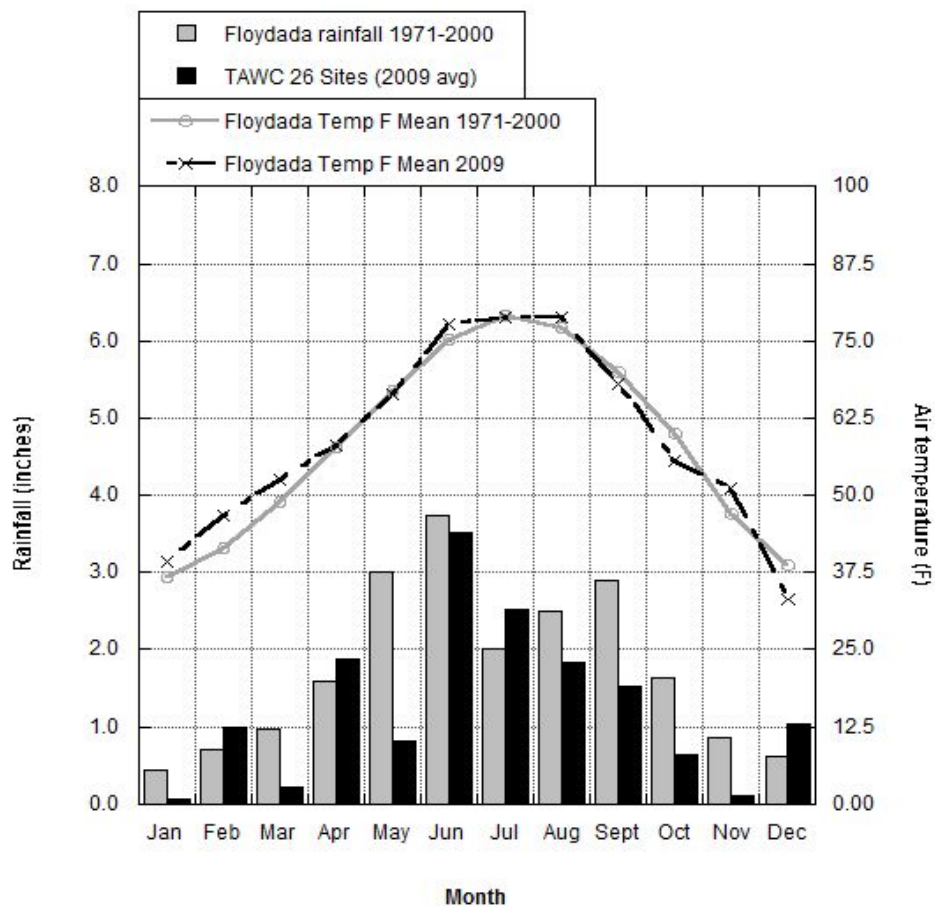
**Table A 36.** Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2008.

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

## 2009

Precipitation during 2009 totaled 15.2 inches averaged across all sites (Table A27). This was similar to precipitation in 2005 (Table A23). However, in 2005 above-average winter moisture was received followed by precipitation in April that was nearly twice the long-term mean. July, August, and October precipitation were also higher than normal in that year (Figure A5). In 2009, January began with very little precipitation that followed two months of no precipitation in the previous year (Figure A4). Thus, the growing season began with limited soil moisture. March and May saw less than half of normal precipitation. While June and July were near of slightly above normal, August, September, October and November were all below normal. December precipitation was above normal and began a period of higher than normal moisture entering 2010.

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



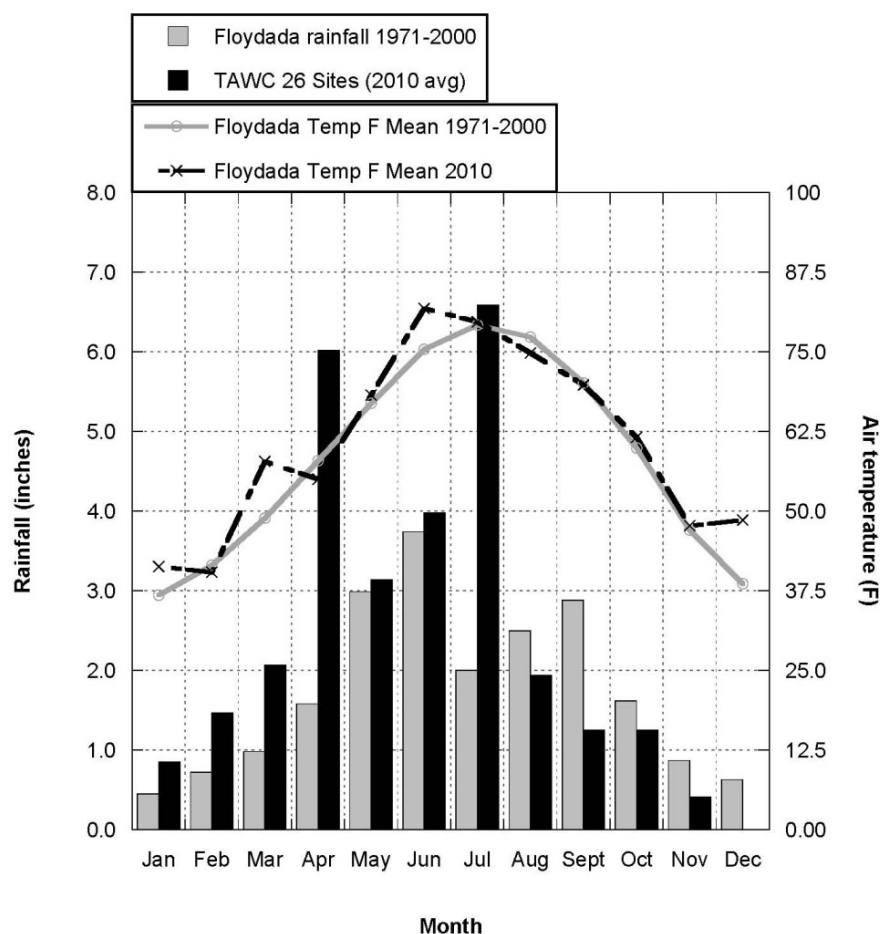
**Figure A 5.** Temperature and precipitation for 2009 in the demonstration area compared with long term averages.

**Table A 37.** Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2009.

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

## 2010

The project sites and the region received above average rainfall for the 2010 calendar year with an average of 28.9 inches measured across the project, as indicated in Table A28 and illustrated in Figure A6. Much of this rainfall came in the late winter and early spring/summer months, with above average rainfall from January through July, and significant rainfall amounts in the months of April and July. Temperatures for the year were slightly above average during the late fall and early spring months across the TAWC sites, allowing for increased soil temperatures at planting, further stabilizing the germination and early growth stages of the upcoming crops. An average of 6.0 inches fell on the project sites in April and 6.5 inches in July which when combined with the favorable conditions of the previous three months, provided ideal conditions for the 2010 summer growing season. The abnormally high rainfall continued in July and October allowing for summer crops to receive needed moisture during the final stages of production. This record high rainfall allowed some producers to achieve record yields, specifically on cotton and corn, while maintaining or decreasing their irrigation use from previous years of the project.



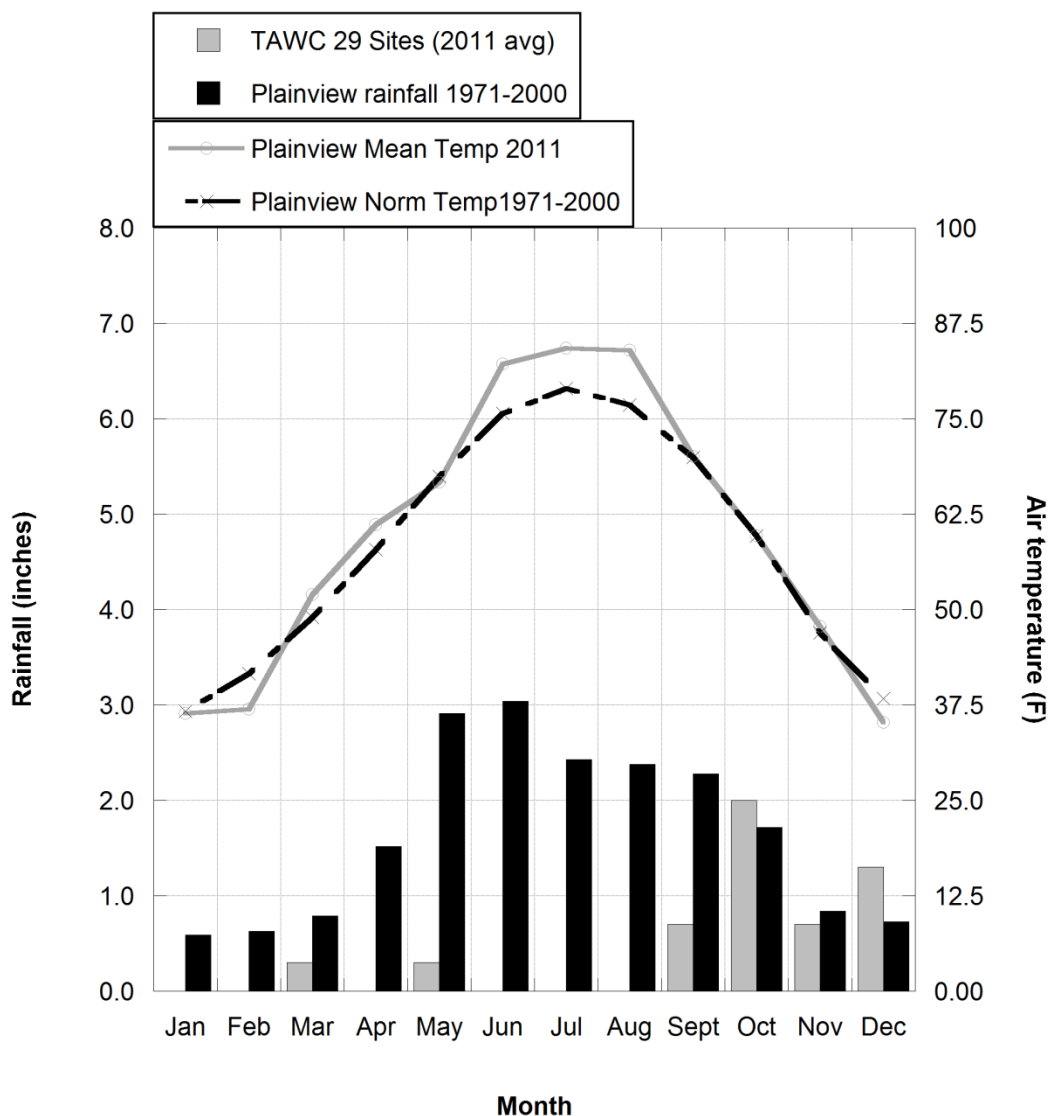
**Figure A 6.** Temperature and precipitation for 2010 in the demonstration area compared with long term averages.

**Table A 38.** Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2010.

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

## 2011

The project sites and the region received below average rainfall for the 2011 calendar year with an average of 5.3 inches (Figure A7 and Table A29), compared with a long term average of 18.5 inches. This was the worst drought the Texas High Plains had seen since the 1930's in that virtually no rainfall was received during the normal growing season. Several fields within sites recorded zero crop yields in 2011 because irrigation was insufficient to produce yields high enough to merit the harvest costs.



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

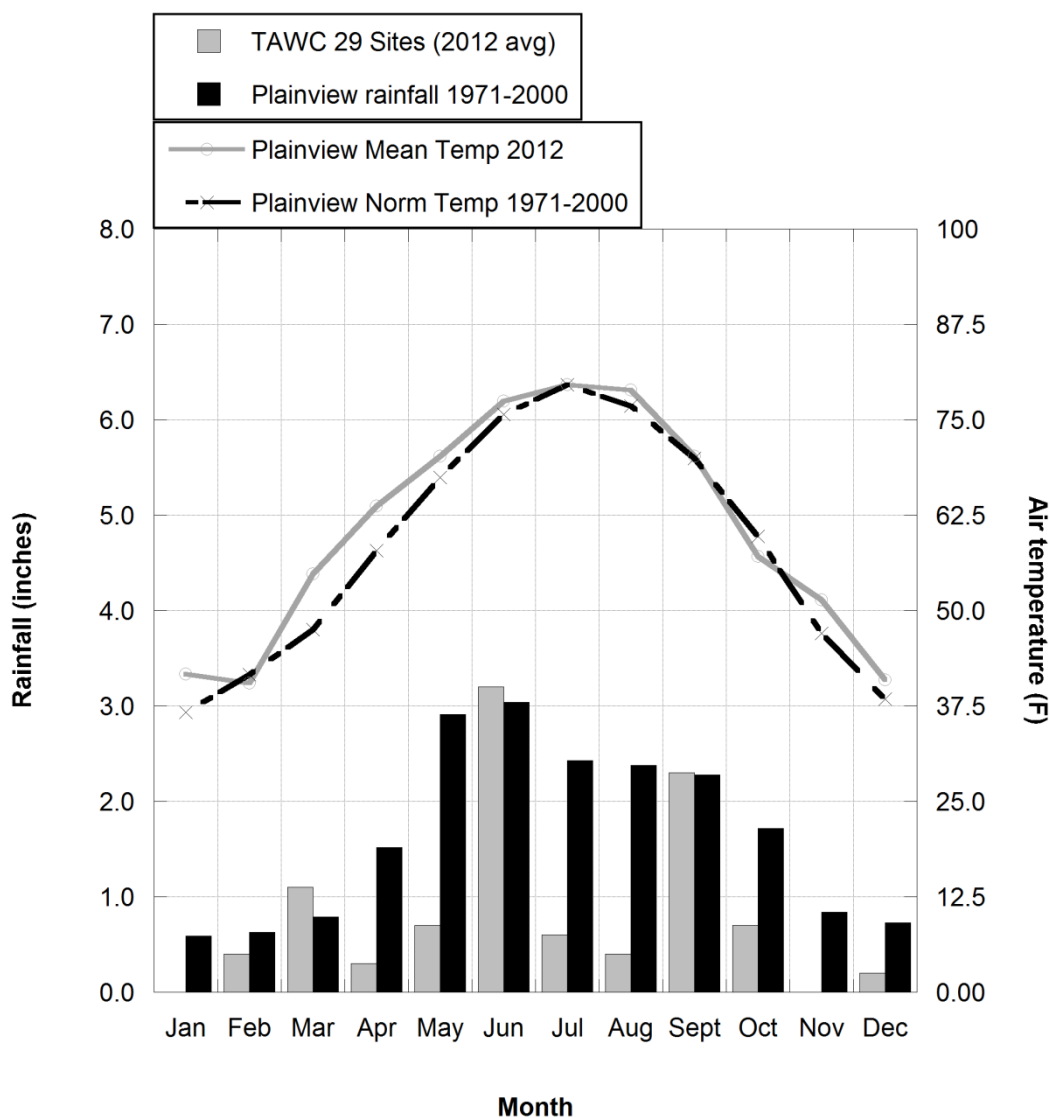
**Table A 39.** Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2011.

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



## 2012

The project sites and the region again received below average rainfall for the 2012 calendar year, with an average of 10.0 inches measured across the project (Figure A8 and Table A30). Slightly above average rainfall was received in the months of March, June and September. Mean temperatures ran slightly above normal early in the season, but were close to normal during the growing season.



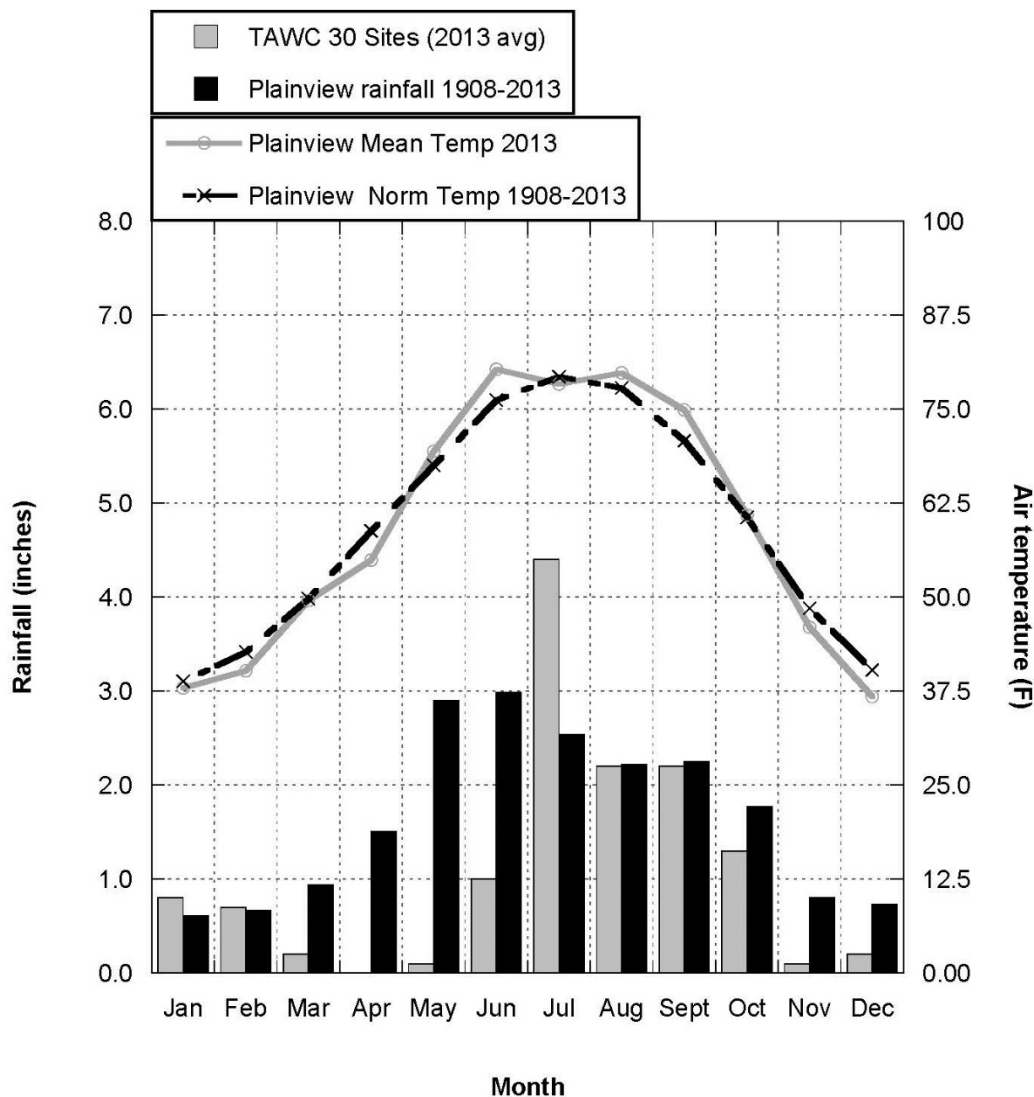
**Figure A 8.** Temperature and precipitation for 2012 in the demonstration area compared with long term averages.

**Table A 40.** Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2012.

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

## 2013

The project sites and the region again received below average rainfall for the 2013 calendar year with an average of 13.3 inches measured across the project, as indicated in Figure A9 and illustrated in Table A31. Below average rainfall was received in March through June, but nearly double average rainfall was received in July with about normal rain in August and September. Mean temperatures ran slightly above normal through the growing season with the exception of July which was about average for the long term means. As a result of the above average rainfall in July and warmer than normal temperatures, 2013 was a very good cropping year on average for the TAWC sites in the area.



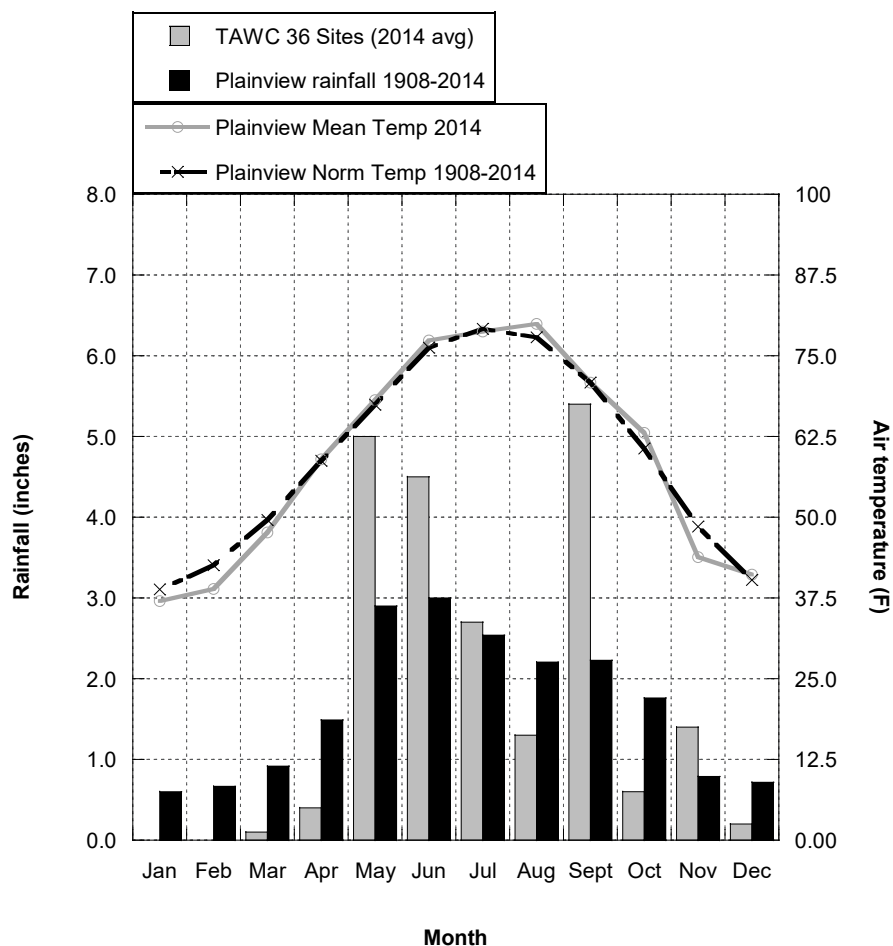
**Figure A 9.** Temperature and precipitation for 2013 in the demonstration area compared with long term averages.

**Table A 41.** Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2013.

<b>SITE</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Total</b>
<b>2</b>	1.2	0.6	0.2	0.1	0.2	1.2	4.8	2.8	2.9	1.6	0.1	0.2	15.8
<b>3</b>	0.1	0.4	0.1	0.0	0.2	0.0	3.4	0.2	1.5	0.5	0.0	0.0	6.3
<b>4</b>	0.4	0.8	0.4	0.1	0.2	0.4	5.5	1.8	1.5	1.0	0.5	0.2	12.6
<b>5</b>	1.1	1.0	0.2	0.0	0.0	0.1	4.4	1.8	2.8	0.9	0.1	0.1	12.4
<b>6</b>	0.4	0.8	0.0	0.0	0.0	1.0	4.8	2.7	2.8	1.6	0.1	0.2	14.3
<b>7</b>	0.5	0.7	0.0	0.1	0.2	1.0	3.0	1.2	1.8	0.4	0.1	0.1	9.1
<b>8</b>	0.5	0.7	0.0	0.1	0.2	1.0	3.0	1.2	1.8	0.4	0.1	0.1	9.1
<b>9</b>	1.6	0.8	0.2	0.1	0.2	2.4	6.8	3.2	2.4	1.5	0.2	0.5	19.7
<b>10</b>	1.1	1.0	0.2	0.1	0.2	1.2	5.0	4.4	2.2	1.5	0.3	0.4	17.4
<b>11</b>	1.2	0.6	0.2	0.1	0.2	1.6	4.1	2.0	2.2	1.6	0.2	0.2	14.1
<b>12</b>	0.8	0.8	0.1	0.0	0.1	2.0	3.2	0.1	2.8	1.4	0.1	0.4	11.8
<b>14</b>	0.5	0.7	0.1	0.1	0.3	0.4	4.0	2.0	2.6	1.5	0.1	0.3	12.6
<b>15</b>	0.1	0.0	0.1	0.1	0.1	1.1	2.8	2.6	2.6	1.1	0.1	0.2	10.8
<b>17</b>	1.2	0.4	0.1	0.0	0.1	1.0	4.4	2.2	2.6	1.8	0.1	0.2	14.0
<b>18</b>	0.4	0.8	0.1	0.0	0.1	0.6	3.4	0.7	1.9	0.4	0.1	0.3	8.7
<b>19</b>	1.2	0.9	0.2	0.0	0.2	2.5	4.6	1.2	2.7	1.9	0.1	0.3	15.7
<b>20</b>	1.4	0.8	0.3	0.1	0.2	1.2	5.8	4.2	2.2	1.0	0.0	0.0	17.2
<b>21</b>	1.1	0.4	0.1	0.0	0.0	1.6	3.8	3.3	3.2	1.4	0.1	0.2	15.1
<b>22</b>	1.0	1.1	0.4	0.1	0.1	1.1	6.1	0.6	2.0	2.2	0.3	0.1	15.1
<b>24</b>	1.0	0.8	0.3	0.0	0.0	0.9	6.0	1.4	1.2	2.0	0.2	0.0	13.8
<b>26</b>	1.1	1.0	0.2	0.0	0.0	0.1	4.4	1.8	2.8	0.9	0.1	0.1	12.4
<b>27</b>	0.9	0.6	0.2	0.1	0.1	1.0	5.6	2.8	2.2	1.1	0.1	0.1	14.7
<b>28</b>	1.1	1.0	0.2	0.1	0.2	1.2	5.0	4.4	2.2	1.5	0.3	0.4	17.4
<b>29</b>	1.2	1.1	0.2	0.0	0.4	1.6	3.6	2.4	2.5	1.6	0.1	0.3	14.9
<b>30</b>	1.1	1.0	0.2	0.0	0.0	0.1	4.4	1.8	2.8	0.9	0.1	0.1	12.4
<b>31</b>	0.4	0.8	0.4	0.1	0.2	0.4	5.5	1.8	1.5	1.0	0.5	0.2	12.6
<b>32</b>	0.1	0.0	0.1	0.1	0.1	1.1	2.8	2.6	2.6	1.1	0.1	0.2	10.8
<b>33</b>	0.1	0.0	0.1	0.1	0.1	1.1	2.8	2.6	2.6	1.1	0.1	0.2	10.8
<b>34</b>	0.4	0.8	0.0	0.0	0.0	1.0	4.8	2.7	2.8	1.6	0.1	0.2	14.3
<b>35</b>	1.2	1.0	0.1	0.0	0.1	1.8	5.4	2.6	3.2	1.1	0.2	0.4	17.0
<b>Average</b>	0.8	0.7	0.2	0.0	0.1	1.1	4.4	2.2	2.4	1.3	0.1	0.2	13.4

## 2014

The 36 project sites received above-average rainfall in 2014 with an overall mean of 21.7 inches, using Plainview, TX for the long-term average (Figure 12). Below-average rainfall was received in January through April. Precipitation in May, June and September was substantially above average, and occurred in relatively few heavy rain events. Such events typically lead to low efficiency of water use for crop production owing to runoff, soil-surface evaporation, and drainage below the root zone. Furthermore, the heavy May and June rains delayed planting of some crops, and crop water use for transpiration was low because crop canopies were underdeveloped. The heavy rains did help refill soil profiles that were quite depleted after the dry winter and early spring, which saved on irrigation needs during June. The September rain came while crop water needs were declining with crop maturity, so that rain had limited benefit for crop yields. Mean temperatures ran about normal through the growing season with the exception of August, which was hotter than normal. Rainfall by site (Table 2) indicated wide variation, such that some sites did not benefit from above-average precipitation.



**Figure A 10.** Temperature and precipitation for 2014 (Phase II Year 1) in the demonstration area compared with long term averages.

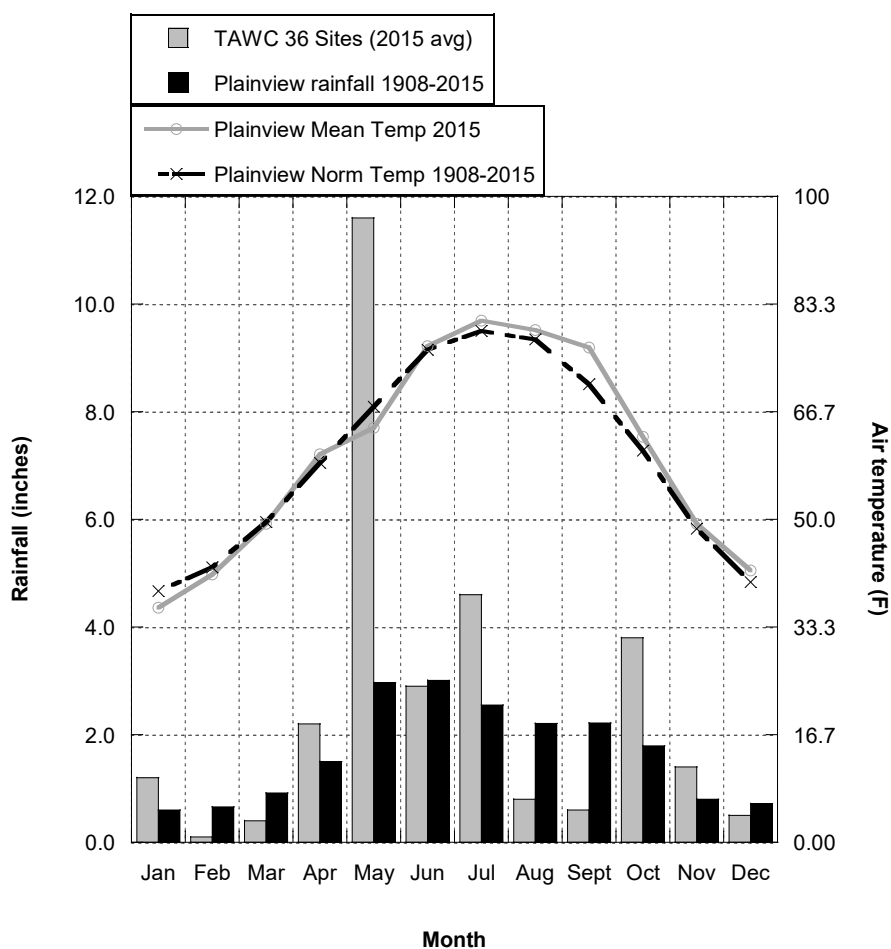
**Table A 42.** Precipitation by each site in the Demonstration Project during 2014 (Phase II Year 1).

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
4	0.0	0.0	0.2	0.8	3.0	4.1	1.8	0.1	3.9	0.6	1.0	0.2	15.7
5	0.0	0.0	0.1	0.0	6.3	4.8	2.7	0.2	3.5	0.6	1.3	0.1	19.6
6	0.0	0.0	0.1	0.3	5.4	6.7	2.8	2.2	5.3	0.6	2.0	0.1	25.5
7	0.0	0.0	0.1	0.4	4.5	3.5	2.6	1.2	3.2	0.7	1.6	0.5	18.3
8	0.0	0.0	0.1	0.4	4.5	3.5	2.6	1.2	3.2	0.7	1.6	0.5	18.3
9	0.0	0.0	0.1	0.5	8.2	4.5	3.1	1.0	6.8	0.8	2.2	0.5	27.7
10	0.0	0.0	0.2	0.5	5.3	5.5	3.0	2.5	7.6	0.7	2.2	0.1	27.6
11	0.0	0.0	0.1	0.6	5.7	5.2	3.6	2.5	7.0	0.6	2.2	0.3	27.8
14	0.0	0.0	0.2	0.6	5.1	2.4	3.0	0.6	6.4	0.7	1.2	0.1	20.3
15	0.0	0.0	0.1	0.4	5.1	4.2	3.0	0.8	3.4	0.3	0.6	0.1	18.0
17	0.0	0.0	0.2	0.5	3.7	2.6	2.2	0.8	4.8	0.4	1.4	0.2	16.8
19	0.0	0.0	0.1	0.2	6.3	5.4	3.5	0.2	4.2	0.7	1.3	0.0	21.9
20	0.0	0.0	0.1	0.5	7.9	4.7	2.4	0.5	4.9	0.5	1.7	0.2	23.4
21	0.0	0.0	0.1	0.4	5.9	3.8	3.7	3.1	6.4	0.7	2.5	0.3	26.9
22	0.0	0.0	0.2	0.5	5.3	4.8	2.2	0.2	3.8	0.8	1.5	0.2	19.5
24	0.0	0.0	0.2	0.7	5.3	5.3	2.2	0.4	4.5	0.7	2.0	0.2	21.5
26	0.0	0.0	0.1	0.0	6.3	4.8	2.7	0.2	3.5	0.6	1.3	0.1	19.6
27	0.0	0.0	0.5	0.3	7.2	4.7	2.4	0.1	4.0	0.5	1.5	0.1	21.3
28	0.0	0.0	0.2	0.5	5.3	5.5	3.0	2.5	7.6	0.7	2.2	0.1	27.6
29	0.0	0.0	0.2	0.4	6.0	4.2	2.8	1.1	5.4	0.8	2.0	0.1	23.0
30	0.0	0.0	0.1	0.0	6.3	4.8	2.7	0.2	3.5	0.6	1.3	0.1	19.6
31	0.0	0.0	0.2	0.8	3.0	4.1	1.8	0.1	3.9	0.6	1.0	0.2	15.7
32	0.0	0.0	0.1	0.4	5.1	4.2	3.0	0.8	3.4	0.3	0.6	0.1	18.0
33	0.0	0.0	0.1	0.4	5.1	4.2	3.0	0.8	3.4	0.3	0.6	0.1	18.0
34	0.0	0.0	0.1	0.3	5.4	6.7	2.8	2.2	5.3	0.6	2.0	0.1	25.5
35	0.0	0.0	0.1	0.5	5.3	6.2	3.5	1.7	5.1	0.8	2.4	0.2	25.8
C50	0.0	0.0	0.01	0.4	4.4	3.0	>	7.6	6.1	0.6	1.3	0.5	23.9
C51	0.0	0.0	0.1	0.4	4.4	3.0	>	7.6	6.1	0.6	1.3	0.5	24.0
C52	0.0	0.0	0.0	0.1	2.5	3.6	>	1.2	8.7	0.4	0.8	0.1	17.4
C53	0.0	0.0	0.0	0.1	2.5	3.6	>	1.2	8.7	0.4	0.8	0.1	17.4
C54	0.0	0.0	0.0	0.1	2.5	3.6	>	1.2	8.7	0.4	0.8	0.1	17.4
C56	0.0	0.0	0.1	0.1	3.5	5.1	>	1.8	8.4	0.0	0.0	0.0	19.0
C57	0.0	0.0	0.1	0.0	2.7	4.7	>	5.8	4.5	0.5	0.0	0.2	18.5
C58	0.0	0.0	0.02	0.2	6.2	5.0	>	1.3	5.2	0.0	1.6	0.3	19.8
C59	0.0	0.0	0.01	na	5.2	5.0	>	1.3	9.7	0.4	1.5	0.4	23.5
C60	0.0	0.0	0.2	0.8	3.5	5.0	>	5.6	4.5	0.7	1.6	0.2	22.1
Avg	0.0	0.0	0.1	0.4	5.0	4.5	2.8	1.0	5.4	0.6	1.4	0.2	21.3

> totaled with August

## 2015

The 36 project sites received above-average rainfall in 2015 with an overall mean of 30.1 inches, using Plainview, TX for the long-term average (Figure 12). This year also showed a change of +0.37-foot (4.44 inches) water level of the Ogallala as measured and reported by the High Plains Underground Water Conservation District No. 1 (published in the 2016 Water Level Report (<http://www.hpwd.org/reports/>)). This increase was an unusual occurrence given the steady decline in the aquifer observed over previous years. Precipitation in May, July, and October was substantially above average with the May rainfall being 4 times normal, resulting in flooding and difficulty in planting on time. The May and July rainfall events resulted in water saved on irrigation needs throughout the growing season. August and September were substantially below normal rainfall and required supplemental irrigation. Mean temperatures ran about normal through June but were above normal the remainder of the growing season. Rainfall by site (Table 2) indicates relative uniformity in rainfall events, though with a larger project area more variation is to be expected.



**Figure A 11.** Temperature and precipitation for 2015 (Phase II Year 2) in the demonstration area compared with long term averages.

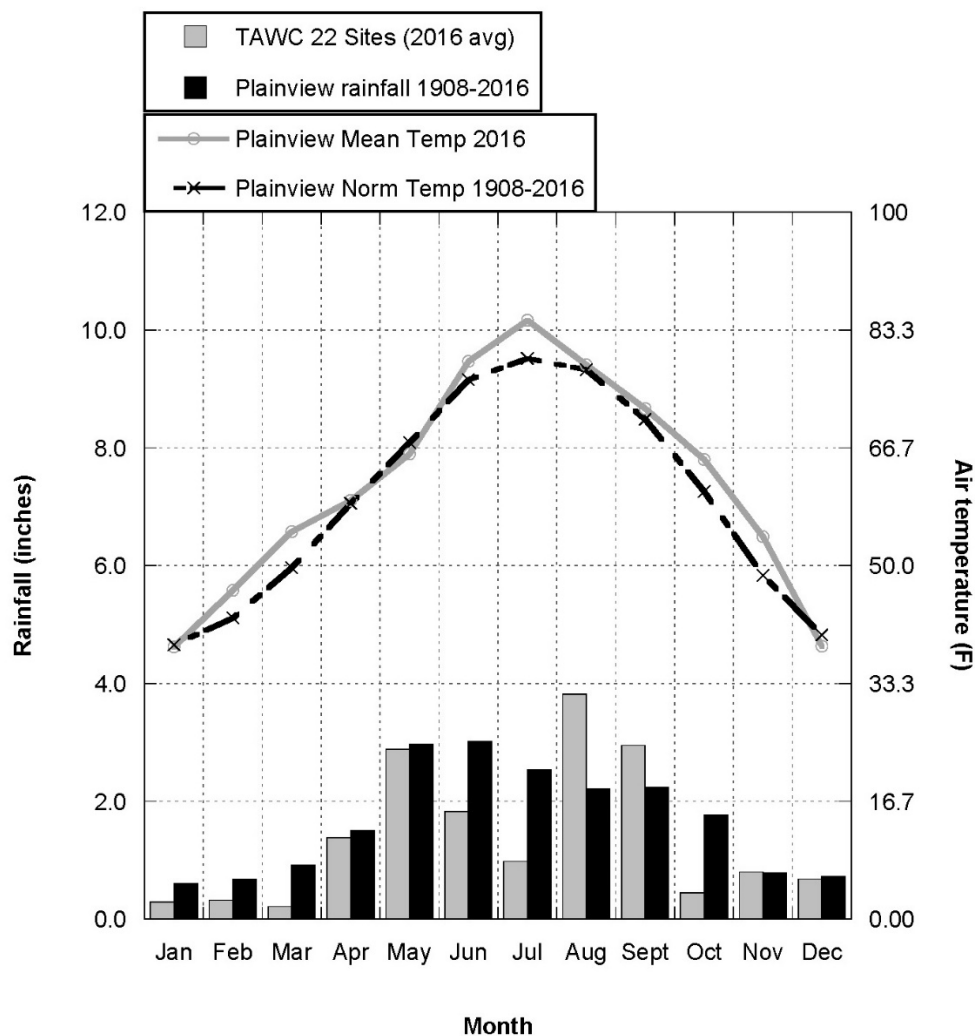


**Table A 43.** Precipitation by each site in the Demonstration Project during 2015 (Phase II Year 2).

<b>Site</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Total</b>
<b>4</b>	1.0	0.1	0.3	1.8	12.1	2.8	4.9	1.1	0.2	4.4	1.1	0.4	<b>30.2</b>
<b>5</b>	1.2	0.1	0.3	2.1	13.6	1.8	3.7	0.7	0.4	3.7	1.2	0.6	<b>29.4</b>
<b>6</b>	1.0	0.1	0.2	2.2	12.4	3.0	5.0	0.3	0.4	3.6	1.6	0.5	<b>30.3</b>
<b>7</b>	1.2	0.1	0.3	2.6	10.1	2.2	3.7	0.5	0.0	0.5	1.8	0.3	<b>23.3</b>
<b>8</b>	1.2	0.1	0.3	2.6	10.1	2.2	3.7	0.5	0.0	0.5	1.8	0.3	<b>23.3</b>
<b>9</b>	1.1	0.0	0.2	1.9	10.9	3.1	5.7	0.4	0.5	3.5	1.5	0.3	<b>29.1</b>
<b>10</b>	1.1	0.1	0.2	2.7	12.8	4.1	5.5	0.5	0.5	3.4	1.8	0.3	<b>33.0</b>
<b>11</b>	1.2	0.1	0.2	2.6	12.3	3.2	5.5	0.5	0.5	3.9	2.0	0.8	<b>32.8</b>
<b>14</b>	1.1	0.1	0.4	2.8	13.0	2.7	5.1	0.9	0.7	3.7	1.3	0.4	<b>32.2</b>
<b>15</b>	1.4	0.1	0.4	3.3	14.1	3.3	5.6	0.7	0.6	3.4	1.0	0.7	<b>34.6</b>
<b>17</b>	1.4	0.1	0.3	3.9	15.5	3.5	5.5	0.9	1.0	3.9	1.0	0.5	<b>37.5</b>
<b>19</b>	1.3	0.1	0.3	2.3	14.0	0.0	5.7	1.2	0.6	4.9	0.8	0.6	<b>31.8</b>
<b>21</b>	1.2	0.2	0.2	2.3	13.1	2.8	4.7	0.9	0.8	4.7	1.8	0.5	<b>33.2</b>
<b>22</b>	1.1	0.1	0.3	2.9	13.4	3.8	4.5	1.0	0.2	4.4	1.0	0.5	<b>33.2</b>
<b>24</b>	1.0	0.1	0.3	2.7	11.8	3.2	3.6	0.9	0.2	3.7	0.9	0.0	<b>28.4</b>
<b>26</b>	1.2	0.1	0.3	2.1	13.6	1.8	3.7	0.7	0.4	3.7	1.2	0.6	<b>29.4</b>
<b>28</b>	1.1	0.1	0.2	2.7	12.8	4.1	5.5	0.5	0.5	3.4	1.8	0.3	<b>33.0</b>
<b>30</b>	1.2	0.1	0.3	2.1	13.6	1.8	3.7	0.7	0.4	3.7	1.2	0.6	<b>29.4</b>
<b>31</b>	1.0	0.1	0.3	1.8	12.1	2.8	4.9	1.1	0.2	4.4	1.1	0.4	<b>30.2</b>
<b>32</b>	1.4	0.1	0.4	3.3	14.1	3.3	5.6	0.7	0.6	3.4	1.0	0.7	<b>34.6</b>
<b>33</b>	1.4	0.1	0.4	3.3	14.1	3.3	5.6	0.7	0.6	3.4	1.0	0.7	<b>34.6</b>
<b>34</b>	1.3	0.2	0.0	2.2	12.4	3.0	5.0	0.4	0.4	3.6	1.5	0.4	<b>30.4</b>
<b>35</b>	1.2	0.2	0.2	2.3	13.1	2.8	4.7	0.9	0.8	4.7	1.8	0.5	<b>33.2</b>
<b>C37</b>	1.8	0.1	0.2	1.7	12.3	3.4	2.0	1.1	0.7	4.8	1.5	0.2	<b>29.8</b>
<b>C38</b>	1.8	0.1	0.2	1.7	12.3	3.4	2.0	1.1	0.7	4.8	1.5	0.2	<b>29.8</b>
<b>C39</b>	1.1	0.2	0.3	1.6	7.9	1.6	8.0	2.0	0.6	5.3	2.4	0.4	<b>31.4</b>
<b>C50</b>	1.3	0.0	0.5	1.7	11.6	2.8	3.9	0.0	0.8	3.0	2.1	1.3	<b>29.0</b>
<b>C51</b>	1.3	0.0	0.5	1.7	11.6	2.8	3.9	0.0	0.8	3.0	2.1	1.3	<b>29.0</b>
<b>C52</b>	0.9	0.2	0.7	1.1	5.8	3.3	2.9	1.4	1.4	5.2	1.1	0.5	<b>24.5</b>
<b>C53</b>	0.9	0.2	0.7	1.1	5.8	3.3	2.9	1.4	1.4	5.2	1.1	0.5	<b>24.5</b>
<b>C54</b>	0.9	0.2	0.7	1.1	5.8	3.3	2.9	1.4	1.4	5.2	1.1	0.5	<b>24.5</b>
<b>C56</b>	1.6	0.3	0.8	1.1	6.8	3.4	4.6	1.8	0.5	1.4	0.3	0.2	<b>22.8</b>
<b>C57</b>	1.3	0.4	0.7	1.7	8.1	2.2	7.6	1.0	1.8	4.9	0.9	0.5	<b>31.1</b>
<b>C58</b>	1.3	0.0	0.5	1.7	11.6	2.8	3.9	0.0	0.8	3.0	2.1	1.3	<b>29.0</b>
<b>C59</b>	1.3	0.0	0.5	1.7	11.6	2.8	3.9	0.0	0.8	3.0	2.1	1.3	<b>29.0</b>
<b>C60</b>	1.4	0.1	0.7	2.2	11.6	4.2	5.2	1.3	0.3	4.1	1.1	0.0	<b>32.2</b>
<b>Avg</b>	<b>1.2</b>	<b>0.1</b>	<b>0.4</b>	<b>2.2</b>	<b>11.6</b>	<b>2.9</b>	<b>4.6</b>	<b>0.8</b>	<b>0.6</b>	<b>3.8</b>	<b>1.4</b>	<b>0.5</b>	<b>30.1</b>

## 2016

The 22 active project sites received below-average rainfall in 2016 with an overall mean of 16.6 inches, using Plainview, TX for the long-term average (Figure 14). Precipitation in January through July was below normal. With above average August and September rainfall and the warmer than average fall temperatures, heat units resulted in continued crop production and effectively saved the 2016 cotton crop. Rainfall by site (Table 2) indicates a wide range in precipitation amounts but as project area has increased more variation is to be expected.



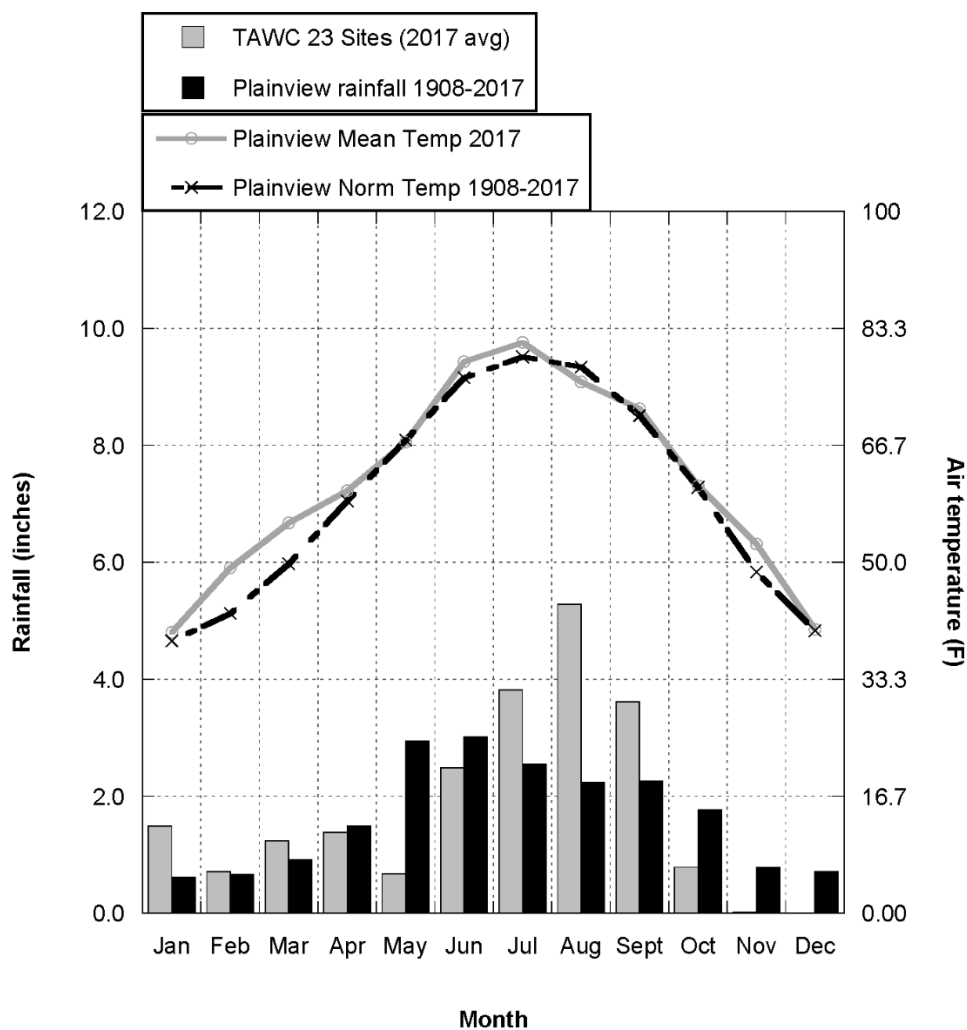
**Figure A 12.** Temperature (lines) and precipitation (bars) by month for 2016 near the demonstration area (Plainview, TX) compared with long term averages.

**Table A 44.** Precipitation (inches) by each site in the Demonstration Project during 2016 (Phase II Year 3).

<b>Site</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Total</b>
<b>4</b>	0.1	0.4	0.2	1.5	2.1	2.4	0.2	6.1	2.4	0.6	0.7	0.6	<b>17.3</b>
<b>6</b>	0.3	0.4	0.2	1.5	2.7	1.1	1.7	2.8	4.4	0.4	0.3	0.7	<b>16.6</b>
<b>9</b>	0.4	0.3	0.4	1.6	3.1	1.7	2.0	4.0	3.2	0.5	0.5	0.8	<b>18.4</b>
<b>10</b>	0.3	0.3	0.2	1.5	3.7	1.7	1.5	2.8	3.5	0.6	0.4	0.7	<b>17.1</b>
<b>11</b>	0.4	0.5	0.3	1.1	2.9	1.9	1.8	3.1	4.5	0.4	0.3	0.8	<b>18.0</b>
<b>14</b>	0.2	0.4	0.1	1.9	3.7	2.5	0.6	2.9	2.6	0.3	0.3	0.8	<b>16.2</b>
<b>17</b>	0.2	0.4	0.5	2.7	3.4	1.6	1.0	3.8	3.0	0.4	0.5	1.0	<b>18.4</b>
<b>21</b>	0.4	0.5	0.4	1.0	3.2	1.0	0.5	2.0	3.9	0.3	0.3	0.9	<b>14.2</b>
<b>22</b>	0.1	0.4	0.2	1.5	2.0	2.1	0.3	4.2	2.5	0.5	0.7	0.5	<b>15.0</b>
<b>24</b>	0.1	0.1	0.1	1.4	1.7	2.1	0.3	4.5	2.2	0.3	0.8	0.5	<b>14.1</b>
<b>28</b>	0.3	0.3	0.2	1.5	3.7	1.7	1.5	2.8	3.5	0.6	0.4	0.7	<b>17.1</b>
<b>31</b>	0.1	0.4	0.2	1.5	2.1	2.4	0.2	6.1	2.4	0.6	0.7	0.6	<b>17.3</b>
<b>32</b>	0.3	0.5	0.2	1.5	3.6	2.4	0.9	3.3	3.5	0.4	0.3	0.9	<b>17.6</b>
<b>33</b>	0.3	0.5	0.2	1.5	3.6	2.4	0.9	3.3	3.5	0.4	0.3	0.9	<b>17.6</b>
<b>35</b>	0.4	0.5	0.4	1.0	3.2	1.0	0.5	2.0	3.9	0.3	0.3	0.9	<b>14.2</b>
<b>C37</b>	0.3	0.2	0.4	1.2	4.7	2.7	0.6	4.7	3.5	0.6	1.0	0.4	<b>20.4</b>
<b>C38</b>	0.3	0.2	0.4	1.1	3.5	0.7	0.3	4.8	1.3	0.5	1.8	0.5	<b>15.5</b>
<b>C50</b>	0.8	0.3	0.0	0.8	3.3	2.1	1.8	1.6	1.7	0.8	1.5	1.0	<b>15.8</b>
<b>C51</b>	0.8	0.3	0.0	0.8	3.3	2.1	1.8	1.6	1.7	0.8	1.5	1.0	<b>15.8</b>
<b>C56</b>	0.1	0.2	0.0	0.5	1.3	1.9	1.8	5.2	3.3	0.1	1.5	0.1	<b>16.0</b>
<b>C57</b>	0.0	0.0	0.0	1.0	1.2	1.1	0.7	8.5	1.8	0.0	2.4	0.1	<b>16.8</b>
<b>C60</b>	0.0	0.1	0.2	2.5	1.6	1.5	0.9	3.8	2.8	0.5	1.4	0.4	<b>15.6</b>
<b>Avg</b>	<b>0.3</b>	<b>0.3</b>	<b>0.2</b>	<b>1.4</b>	<b>2.9</b>	<b>1.8</b>	<b>1.0</b>	<b>3.8</b>	<b>3.0</b>	<b>0.5</b>	<b>0.8</b>	<b>0.7</b>	<b>16.6</b>

## 2017

The 19 active project sites received above-average rainfall in 2017 with an overall mean of 21.7 inches, using Plainview, TX for the long-term average (Figure 14). Precipitation and temperature from January through April were above average. May and June had below average rainfall with normal temperatures and July through September had significantly higher rainfall with near normal temperatures. Rainfall by site (Table 2) indicates a normal range in precipitation.



**Figure A 13.** Temperature (lines) and precipitation (bars) by month for 2017 near the demonstration area (Plainview, TX) compared with long term averages.

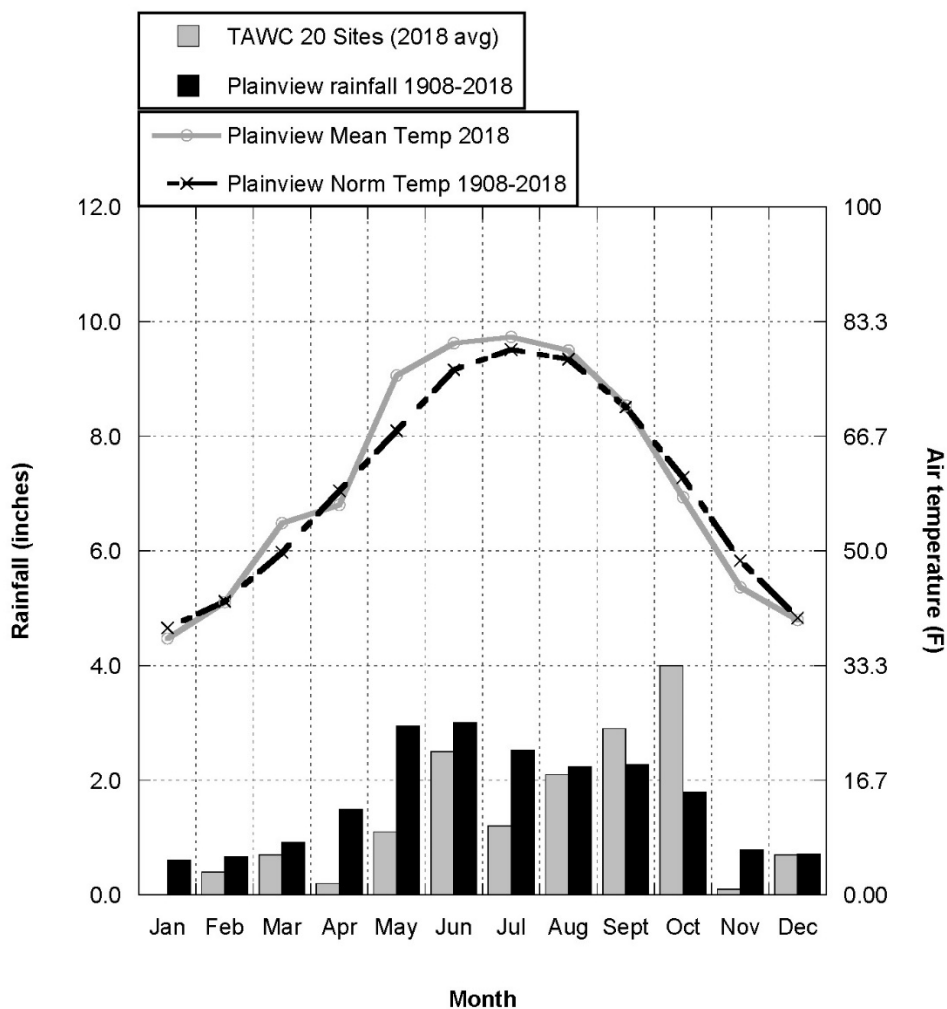
**Table A 45.** Precipitation (inches) by each site in the Demonstration Project during 2017 (Phase II Year 4).

<b>Site</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Total</b>
<b>4</b>	1.5	0.6	0.7	1.4	0.4	2.9	3.7	3.7	4.2	0.7	0.0	0.0	<b>19.8</b>
<b>9</b>	1.4	0.7	1.2	1.5	0.8	2.9	3.7	6.2	3.4	0.5	0.0	0.0	<b>22.3</b>
<b>10</b>	1.3	0.6	1.4	1.4	0.6	2.6	3.0	6.0	3.8	1.1	0.0	0.0	<b>21.8</b>
<b>11</b>	0.8	0.7	0.9	1.1	0.6	2.3	1.3	5.9	4.0	0.6	0.0	0.0	<b>18.2</b>
<b>14</b>	0.7	0.6	1.1	1.0	0.5	1.9	2.9	5.2	3.5	0.8	0.0	0.0	<b>18.2</b>
<b>17</b>	1.2	0.7	1.7	1.6	1.0	3.1	5.0	8.4	4.5	1.3	0.0	0.0	<b>28.5</b>
<b>21</b>	1.7	0.8	1.1	1.4	0.7	2.0	3.8	4.4	4.1	0.6	0.0	0.0	<b>20.6</b>
<b>22</b>	1.4	0.5	0.7	1.2	0.2	1.9	3.3	3.6	4.8	0.5	0.0	0.0	<b>18.1</b>
<b>31</b>	1.5	0.6	0.7	1.4	0.4	2.9	3.7	3.7	4.2	0.7	0.0	0.0	<b>19.8</b>
<b>32</b>	1.2	0.7	1.3	1.4	0.5	2.4	4.0	6.3	3.5	0.9	0.0	0.0	<b>22.2</b>
<b>34</b>	1.1	0.9	1.9	1.7	1.0	3.6	4.4	7.8	4.8	0.8	0.0	0.0	<b>28.0</b>
<b>35</b>	1.7	0.8	1.1	1.4	0.7	2.0	3.8	4.4	4.1	0.6	0.0	0.0	<b>20.6</b>
<b>C37</b>	1.7	0.5	0.8	1.2	0.1	2.1	4.2	6.0	3.8	0.6	0.0	0.0	<b>21.0</b>
<b>C38</b>	2.1	0.5	1.5	1.2	0.3	2.3	4.4	6.6	3.5	0.5	0.0	0.0	<b>22.9</b>
<b>C39</b>	1.4	0.6	1.7	2.3	0.4	2.5	2.3	4.8	3.3	0.8	0.0	0.0	<b>20.1</b>
<b>C50</b>	2.0	1.4	1.1	1.2	0.9	2.3	3.6	3.6	3.3	0.5	0.1	0.0	<b>20.0</b>
<b>C51</b>	2.0	1.4	1.1	1.2	0.9	2.3	3.6	3.6	3.3	0.5	0.1	0.0	<b>20.0</b>
<b>C56</b>	1.3	0.5	1.2	0.9	1.7	2.3	4.0	7.2	1.1	1.3	0.0	0.0	<b>21.5</b>
<b>C57</b>	2.1	0.5	2.8	1.0	1.3	3.0	3.6	8.1	1.8	2.3	0.0	0.0	<b>26.5</b>
<b>C60</b>	1.4	0.6	0.9	3.1	0.6	2.1	3.8	6.3	2.6	1.7	0.0	0.0	<b>23.1</b>
<b>Avg</b>	<b>1.5</b>	<b>0.7</b>	<b>1.2</b>	<b>1.4</b>	<b>0.7</b>	<b>2.5</b>	<b>3.6</b>	<b>5.6</b>	<b>3.6</b>	<b>0.9</b>	<b>0.0</b>	<b>0.0</b>	<b>21.7</b>

\*Greyed sites had no field data collected for 2017

## 2018

The 17 active project sites received below-average rainfall in 2018 with an overall mean of 15.6 inches, using Plainview, TX for the long-term average (Figure 14). Precipitation was below-average from January through August, except for an average June. Temperature was above average for most of growing season from May through August. September and October had above-average rainfall with normal temperatures and July through September had significantly higher rainfall with near normal temperatures. Rainfall by site (Table 2) indicates an average below normal range in precipitation from an average of 10.7 to a single site with 22 inches across all TAWC Sites.



**Figure A 14.** Temperature (lines) and precipitation (bars) by month for 2018 near the demonstration area (Plainview, TX) compared with long term averages.

**Table A 46.** Precipitation (inches) by each site in the Demonstration Project during 2018 (Phase II Year 4).

<b>Site</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Total</b>
<b>4</b>	0.0	0.7	0.7	0.4	1.5	3.6	1.0	1.5	2.2	4.2	0.1	0.5	<b>16.5</b>
<b>9</b>	0.0	0.3	1.0	0.3	0.9	2.3	1.5	2.1	3.1	3.9	0.1	0.9	<b>16.3</b>
<b>10</b>	0.0	0.4	0.8	0.2	1.0	3.6	0.8	1.8	3.5	3.5	0.0	0.7	<b>16.5</b>
<b>11</b>	0.0	0.4	0.8	0.3	0.6	2.3	0.1	2.5	3.7	3.5	0.1	0.9	<b>15.1</b>
<b>14</b>	0.0	0.4	0.7	0.1	0.4	3.4	1.4	1.9	3.2	2.8	0.1	0.7	<b>15.0</b>
<b>17</b>	0.0	0.6	1.0	0.2	0.8	7.4	1.3	2.5	2.5	4.8	0.1	0.8	<b>22.0</b>
<b>21</b>	0.0	0.4	1.0	0.2	1.5	2.3	1.7	3.4	3.6	3.5	0.1	0.9	<b>18.5</b>
<b>22</b>	0.0	0.7	0.1	0.0	0.8	0.4	0.3	1.5	2.2	4.2	0.1	0.4	<b>10.7</b>
<b>31</b>	0.0	0.7	0.7	0.4	1.5	3.6	1.0	1.5	2.2	4.2	0.1	0.5	<b>16.5</b>
<b>32</b>	0.0	0.4	0.8	0.2	0.7	2.9	1.7	1.6	3.0	2.8	0.0	0.9	<b>15.0</b>
<b>35</b>	0.0	0.4	1.0	0.2	1.5	2.3	1.7	3.4	3.6	3.5	0.1	0.9	<b>18.5</b>
<b>C37</b>	0.0	0.4	0.9	0.1	0.9	1.6	0.5	2.2	2.6	4.0	0.1	0.7	<b>13.9</b>
<b>C38</b>	0.0	0.4	1.0	0.0	0.3	1.4	0.3	1.7	3.4	4.6	0.1	0.8	<b>13.9</b>
<b>C39</b>	0.0	0.5	0.0	0.0	2.3	1.1	1.0	0.9	1.4	3.2	0.0	1.0	<b>11.4</b>
<b>C50</b>	0.0	0.1	0.9	0.0	1.4	2.6	1.1	1.2	3.7	5.1	0.1	0.9	<b>17.1</b>
<b>C51</b>	0.0	0.1	0.9	0.0	1.4	2.6	1.1	1.2	3.7	5.1	0.1	0.9	<b>17.1</b>
<b>C56</b>	0.0	0.2	0.3	0.7	0.7	1.0	3.9	2.3	2.8	3.9	0.1	0.1	<b>15.8</b>
<b>C57</b>	0.0	0.0	0.1	0.1	0.8	1.2	1.6	2.0	1.6	6.1	0.0	0.3	<b>13.9</b>
<b>C60</b>	0.0	0.6	0.2	0.6	1.0	2.0	0.8	2.7	2.6	3.3	0.1	0.5	<b>14.4</b>
<b>Avg</b>	<b>0.0</b>	<b>0.4</b>	<b>0.7</b>	<b>0.2</b>	<b>1.1</b>	<b>2.5</b>	<b>1.2</b>	<b>2.1</b>	<b>2.9</b>	<b>4.0</b>	<b>0.1</b>	<b>0.7</b>	<b>15.6</b>

\*Greyed sites had no field data collected for 2018



## Supplementary Grants To Project (Phase I - 2005-2013/Phase II – 2014-2018)

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Grants directly used or partially used within the TAWC project sites are listed. Other grants and grant requests are considered complementary and outside of the TAWC project, but were obtained or attempted through leveraging of the base platform of the Texas Coalition for Sustainable Integrated Systems and Texas Alliance for Water Conservation (TeCSIS) program, and therefore represents added value to the overall TAWC effort.

### 2006

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

### 2007

- Trostle, C.L., R. Kellison, L. Redmon, S. Bradbury. 2007. Adaptation, productivity, & water use efficiency of warm-season perennial grasses in the Texas High Plains. Texas Coalition, Grazing Lands Conservation Initiative, a program in which Texas State Natural Resource Conservation Service is a member. \$3,500 (funded).
- Li, Yue and V.G. Allen. 2007. Allelopathic effects of small grain cover crops on cotton plant growth and yields. USDA-SARE. Amount requested, \$10,000 (funded).
- Allen, V.G. and multiple co-authors. Crop-livestock systems for sustainable High Plains Agriculture. 2007. Submitted to the USDA-SARE program, Southeast Region, \$200,000 (funded).

### 2008

- Doerfert, D. L., Baker, M., and Akers, C. 2008. Developing Tomorrow's Water Conservation Researchers Today. Ogallala Aquifer Program Project. \$28,000 (funded).
- Doerfert, D.L., Meyers, C.. 2008. Encouraging Texas agriscience teachers to infuse water management and conservation-related topics into their local curriculum. Ogallala Aquifer Initiative. \$61,720 (funded).
- Request for federal funding through the Red Book initiatives of CASNR - \$3.5 million. Received letters of support from Senator Robert Duncan, mayors of three cities in Hale and Floyd Counties, Glenn Schur, Curtis Griffith, Harry Hamilton, Mickey Black, and the Texas Department of Agriculture.

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

## 2009

- Texas High Plains: A Candidate Site for Long-Term Agroecosystems Research. USDA-CSREES 'proof of concept' grant. \$199,937 (funded).
- Building a Sustainable Future for Agriculture. USDA-SARE planning grant, \$15,000 (funded).
- Maas, S., A. Kemanian, & J. Angerer. 2009. Pre-proposal was submitted to Texas AgriLife Research for funding research on irrigation scheduling to be conducted at the TAWC project site.
- Maas, S., N. Rajan, A.C. Correa, & K. Rainwater. 2009. Proposal was submitted to USGS through TWRI to investigate possible water conservation through satellite-based irrigation scheduling.
- Doerfert, D. 2009. Proposal was submitted to USDA ARS Ogallala Aquifer Initiative.

## 2010

- Kucera, J.M., V. Acosta-Martinez, V. Allen. 2010. Integrated Crop and Livestock Systems for Enhanced Soil C Sequestration and Biodiversity in Texas High Plains. Southern SARE grant. \$159,999 (funded with ~15% applied directly to TAWC project sites).
- Calvin Trostle, Rick Kellison, Jackie Smith. 2010. Perennial Grasses for the Texas South Plains: Species Productivity and Irrigation Response, \$10,664 (2 years).

## 2011

- Johnson, P., D. Doerfert, S. Maas, R. Kellison & J. Weinheimer. 2011. The Texas High Plains Initiative for Strategic and Innovative Irrigation Management and Conservation. USDA-NRCS Conservation Innovation Grant. Joint proposal with North Plains Groundwater Conservation District. \$499,848 (funded).
- Allen, V. 2011. Long-Term Agroecosystems Research and Adoption in the Texas Southern High Plains. Southern SARE grant. \$110,000 (funded).
- Maas, S. 2011. Auditing Irrigation Systems in the Texas High Plains. Texas Water Development Board. \$101,049 (funded).

- Maas, S. and co-authors. 2011. Development of a Farm-Scale Irrigation Management Decision-Support Tool to Facilitate Water Conservation in the Southern High Plains. USDA-NIFA. \$500,000 requested.
- Trostle, C. 2011. Dryland reduced Tillage/No Tillage Cropping Sequences for the Texas South Plains. \$4,133 (funded from Texas State Support Committee, Cotton, Inc.,).

## 2012

- Allen, V. 2012. Long-Term Agroecosystems Research and Adoption in the Texas Southern High Plains. Southern SARE grant. \$110,000 (continued funding).
- Trojan, S. and co-authors. 2012. Adapting to drought and dwindling groundwater supply by integrating cattle grazing into High Plains row-cropping systems. USDA-NRCS Conservation Innovation Grant. \$348,847 requested.
- Trostle, C. 2012. Dryland reduced tillage/no tillage cropping sequences for the Texas South Plains. \$8,500 (funded from Texas Grain Sorghum Association).
- Trostle, C. 2012. Dryland reduced tillage/no tillage cropping sequences for the Texas South Plains. \$35,500 (funded from USDA Ogallala Aquifer Project).
- West, C. 2012. Calibration and validation of ALMANAC model for growth curves of warm-season grasses under limited water supply. USDA-ARS USDA Ogallala Aquifer Project. \$76,395 (funded).

## 2013

- West, C. 2013. Long-term agroecosystems research and adoption in the Texas Southern High Plains. Southern SARE grant. \$100,000 (funded).

## 2014

- West, C.P. 2014. Long-term agroecosystems research and adoption in the Texas Southern High Plains. Southern SARE grant. \$100,000. (Funded)
- West, C.P. 2014. Improving water productivity and new water management strategies to sustain rural economies. Ogallala Aquifer Program (USDA-ARS). \$20,000. (Funded)

## 2015

- USDA-SARE. C. West. Long term agroecosystems research and adoption in the Texas Southern High Plains. \$100,000. This is a renewal grant for pasture research at the New Deal Research Field Station.
- USDA-NIFA-AFRI. C. West in collaboration with 40 scientists from 8 universities and the USDA-ARS. Sustaining Agriculture through Adaptive Management to Preserve the Ogallala Aquifer under a Changing Climate. \$218,000 is the Texas Tech portion of a \$2.5 million grant, to be renewed at that level for an additional 3 years.
- USDA Southern SARE Graduate Student Grant Program. L. Baxter (West advisee), and C.P. West. Evaluation of winter annual cover crops under multiple residue managements: Impacts on land management, soil water depletion, and cash crop productivity. \$9,511.

## 2016

- USDA-SARE. C. West. Long term agroecosystems research and adoption in the Texas Southern High Plains. \$100,000. This is a renewal grant for pasture research at the New Deal Research Field Station.
- USDA-NIFA-AFRI. C. West and D. Mitchell McAlister in collaboration with 40 scientists from 8 universities and the USDA-ARS. Sustaining agriculture through adaptive management to preserve the Ogallala Aquifer. \$218,000 is the Texas Tech portion of a \$2.5 million grant.
- CH Foundation. C. West and C. Villalobos Improving grassland quality with drought-tolerant alfalfa. \$71,018 2016-2018.
- USDA-SARE. C. West and L. Baxter. Evaluation of winter annual cover crops under multiple residue managements: Impacts on land management, soil water depletion, and cash crop productivity.
- Application of the Fieldprint Calculator for Cotton Production in the Texas High Plains. Funded by the Cotton Foundation (7/14-8/16, \$36,000). PI – Phillip Johnson. The objective of this project is to evaluate cotton production sites in the TAWC project with regard to their sustainability as measured by the Fieldprint Calculator.
- An Economic Analysis to Determine the Feasibility of Groundwater Supplementation from the Dockum Aquifer. Funded by the High Plains Underground Water District. Co-PIs – Donna Mitchell and Phillip Johnson. (7/15- 6/16, \$10,000). The objective of this project is to evaluate the economic feasibility of using water from the Dockum aquifer for crop production in the Texas High Plains.

- Sustaining Agriculture through Adaptive Management to Preserve the Ogallala Aquifer under a Changing Climate. Funded by USDA AFRI. PI: Chuck West. Collaborator: Donna Mitchell. (3/16-2/20, \$57,160). The objective of this project is to develop best management practices and technologies, tools, and crop management practices across all states that access the Ogallala aquifer.

## 2017

- USDA-SARE. C. West. Long term agroecosystems research and adoption in the Texas Southern High Plains. \$100,000. This is a renewal grant for pasture research at the New Deal Research Field Station.
- USDA-NIFA-AFRI. C. West and D. Mitchell McAlister in collaboration with 40 scientists from 8 universities and the USDA-ARS. Sustaining agriculture through adaptive management to preserve the Ogallala Aquifer. \$218,000 is the Texas Tech portion of a \$2.5 million grant.
- CH Foundation. C. West and C. Villalobos Improving grassland quality with drought-tolerant alfalfa. \$71,018 2016-2018.
- USDA-SARE. C. West and L. Baxter. Evaluation of winter annual cover crops under multiple residue managements: Impacts on land management, soil water depletion, and cash crop productivity. \$9, 511.
- Application of the Fieldprint Calculator for Cotton Production in the Texas High Plains. Funded by the Cotton Foundation (7/14-8/16, \$64,000). PI's – Phillip Johnson and Donna McCallister. The objective of this project is to evaluate cotton production sites in the TAWC project with regard to their sustainability as measured by the Fieldprint Calculator.
- Sustaining Agriculture through Adaptive Management to Preserve the Ogallala Aquifer under a Changing Climate. Funded by USDA AFRI. PI: Chuck West. Collaborator: Donna Mitchell. (3/16-2/20, \$57,160). The objective of this project is to develop best management practices and technologies, tools, and crop management practices.
- Economic and Policy Implications of Underground Water Use in the Southern Ogallala Region. Co-PI: Donna McCallister. 2017-2019. USDA ARS Ogallala Aquifer Program. Amount: \$180,000.
- Evaluation of Soil Conservation Practices and Integrated Advanced Irrigation Technologies on Soil Health and Water Use Efficiency. Co-PI: Donna McCallister. 2017-2019. Texas Corn Producers Board. Amount: \$36,324.

- Economic and Policy Implications of Underground Water Use in the Southern Ogallala Region. Co-PI: Donna McCallister. 2016-2018. USDA ARS Ogallala Aquifer Program. Amount: \$180,000.

## 2018

- USDA-SARE. C. West. Long term agroecosystems research and adoption in the Texas Southern High Plains. \$100,000. This is a renewal grant for pasture research at the New Deal Research Field Station.
- USDA-NIFA-AFRI. C. West and D. Mitchell McAlister in collaboration with 40 scientists from 8 universities and the USDA-ARS. Sustaining agriculture through adaptive management to preserve the Ogallala Aquifer. \$246,636 is the Texas Tech portion of a \$2.5 million grant in 2018.
- USDA-SARE. C. West and Kathryn Radicke. Effects of cumulative cattle trampling on soil bulk density on an annual forage crop pasture. USDA Southern Regional Sustainable Agriculture Research and Education (SARE). \$10,144.
- Application of the Fieldprint Calculator for Cotton Production in the Texas High Plains. Funded by the Cotton Foundation (7/14-8/16, \$36,000). PI's – Phillip Johnson and Donna McCallister. The objective of this project is to evaluate cotton production sites in the TAWC project with regard to their sustainability as measured by the Fieldprint Calculator.
- Sustaining Agriculture through Adaptive Management to Preserve the Ogallala Aquifer under a Changing Climate. Funded by USDA AFRI. PI: Chuck West. Collaborator: Donna McCallister. (3/16-2/20, \$57,160). The objective of this project is to develop best management practices and technologies, tools, and crop management practices.
- Economic and Policy Implications of Underground Water Use in the Southern Ogallala Region. Co-PI: Donna McCallister. 2017-2019. USDA ARS Ogallala Aquifer Program. Amount: \$45,000.
- Evaluation of Soil Conservation Practices and Integrated Advanced Irrigation Technologies on Soil Health and Water Use Efficiency. Co-PI: Donna McCallister. 2017-2019. Texas Corn Producers Board. Amount: \$36,324.
- Economic and Policy Implications of Underground Water Use in the Southern Ogallala Region. Co-PI: Donna McCallister. 2016-2018. USDA ARS Ogallala Aquifer Program. Amount: \$45,000.

# Donations to Project

## (Phase I - 2005-2013/Phase II - 2014-2018)

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### 2005

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



### 2008

July 31, 2008 Field Day sponsors:

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

### 2010

February 3, 2010 Field Day sponsors:

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

August 10, 2010 Field Day sponsors:

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

### 2011

February 24, 2011 Field Day sponsors:

Texas Corn Producers Board	\$500.00
West Texas Guar, Inc.	\$500.00



Texas Grain Sorghum Producers	\$500.00
Happy State Bank	\$500.00
August 4, 2011 Field Day sponsors:	
Texas Corn Producers Board	\$500.00
City Bank	\$500.00
Texas Grain Sorghum Producers	\$500.00
AquaSpy, Inc.	\$250.00
NetaFim USA	\$200.00
Panhandle-Plains Land Bank Association, FLCA	\$ 50.00

## 2012

August 4, 2012 Field Day sponsors:	
Texas Corn Producers Board	\$500.00
City Bank	\$500.00
Texas Grain Sorghum Producers	\$500.00
AquaSpy, Inc.	\$250.00
NetaFim USA	\$200.00
Panhandle-Plains Land Bank Association, FLCA	\$ 50.00
January 17, 2013 Field Day sponsors:	
Texas Corn Producers Board	\$500.00
Plains Cotton Growers	\$250.00
Grain Sorghum Producers	\$250.00
Ronnie Aston	\$500.00
Ag Tech	\$250.00
Diversified Sub-Surface Irrigation	\$500.00

## 2013

August 15, 2013 Field Day sponsors:	
Texas Corn Producers Board	\$ 500.00
Texas Grain Sorghum Producers	\$ 250.00
Plains Cotton Growers	\$ 250.00
United Sorghum Check-Off Program	\$ 250.00
Dupont-Pioneer	\$ 800.00
AquaSpy	\$ 250.00
Eco-Drip	\$ 250.00
Hurst Farm Supply	\$ 800.00
Bayer Crop Science	\$ 800.00
Total	\$4,150.00

## 2014

AquaSpy	\$ 250.00
Bayer CropScience	\$ 800.00
Bamert Seed	\$ 250.00
Texas Corn Producers	\$ 500.00

DSI Drip Irrigation	\$ 500.00
Helena Chemical	\$ 500.00
Hurst Farm Supply	\$ 500.00
Plains Cotton Growers	\$ 250.00
National Sorghum Check-Off Program	\$ 250.00
Texas Grain Sorghum Producers	\$ 250.00
<b>Total</b>	<b>\$4,050.00</b>

## 2015

### **TAWC Water College Sponsors**

Bayer	\$ 2,000.00
Cotton Inc.	\$ 2,000.00
Sorghum Checkoff	\$ 2,000.00
Eco-Drip	\$ 2,000.00
DuPont Pioneer	\$ 2,000.00
Texas Corn Producers	\$ 1,000.00
Texas Sorghum Producers	\$ 1,000.00
AgTexas	\$ 1,000.00
AAEC	\$ 500.00
Hurst Farm Supply	\$ 500.00
Lubbock Electric	\$ 250.00
Plains Cotton Growers	\$ 500.00
Diversity D	\$ 250.00
Zimmatic	\$ 250.00
Watermaster Irrigation	\$ 250.00
Capital Farm Credit	\$ 250.00
<b>Total</b>	<b>\$15,750.00</b>

### **TAWC Field Day Sponsors**

Plains Land Bank	\$ 250.00
Sorghum Checkoff	\$ 250.00
Eco-Drip	\$ 250.00
Texas Corn Producers	\$ 250.00
Texas Sorghum Producers	\$ 250.00
Hurst Farm Supply	\$ 250.00
Plains Cotton Growers	\$ 250.00
Netafim	\$ 250.00
AquaSpy	\$ 250.00
<b>Total</b>	<b>\$ 2,250.00</b>

## 2016

### TAWC Water College, Field Day, Field Walk Sponsors

Bayer	\$2,000
Cotton Inc.	\$2,000
Pioneer	\$2,000
Texas Corn Producers	\$1,000
Diversity D	\$1,000
Americot	\$ 500
Capital Farm Credit	\$ 500
Hurst Farm Supply	\$ 500
Dow	\$ 500
Equipment Supply	\$ 500
TX Grain Sorghum	\$ 500
Plains Cotton Growers	\$ 500
Zimmatic	\$ 500
Texas Department of Agriculture	No Charge
EcoDrip	\$ 500
First Bank & Trust	\$ 500
City Bank Texas	\$ 500
Prosperity Bank	\$ 500
Ag Workers	\$ 500
Toro	\$ 500
HPUWD	\$ 500
Sorghum Checkoff	\$ 500
AquaSpy	\$ 500
Valley Irrigation	\$ 500
TX Panhandle Organics	\$ 500
AgTexas	\$ 250
<b>Total</b>	<b>\$17,750.00</b>

## 2017

### TAWC Water College, Field Day, Field Walk Sponsors

Cotton Inc.	\$ 2,000
Bayer	\$ 2,000
Pioneer	\$ 2,000
Diversity D	\$ 1,000
Texas Corn Producers	\$ 1,000
Capital Farm Credit	\$ 500
Hurst Farm Supply	\$ 500
Dow	\$ 500
Equipment Supply	\$ 500
TX Grain Sorghum	\$ 500
Plains Cotton Growers	\$ 500
Zimmatic	\$ 500
EcoDrip	\$ 500
First Bank & Trust	\$ 500
City Bank Texas	\$ 500
Prosperity Bank	\$ 500
Ag Workers	\$ 500

Toro	\$ 500
HPUWD	\$ 500
Sorghum Checkoff	\$ 500
AquaSpy	\$ 500
Valley Irrigation	\$ 500
TX Panhandle Organics	\$ 500
AgTexas	\$ 250
<b>Total</b>	<b>\$17,250</b>

## 2018

### *TAWC Water College, Field Day, Field Walk Sponsors*

CASNR Dean's Office	\$ 4,000
Cotton Inc.	\$ 2,000
Dow/Pioneer	\$ 2,000
Diversity D	\$ 1,000
Texas Corn Producers	\$ 1,000
Forefront Agronomy	\$ 500
Hurst Farm Supply	\$ 500
Equipment Supply	\$ 500
Plains Cotton Growers	\$ 500
Lindsay Sales & Service	\$ 500
EcoDrip	\$ 500
First Bank & Trust	\$ 500
WaterMaster	\$ 500
Ag Precision Supply	\$ 500
Farmers Edge	\$ 500
Miller Chemical	\$ 500
Water by GMX	\$ 500
HPUWD	\$ 500
AquaSpy	\$ 500
South Plains Valley Irrigation	\$ 500
Trellis	\$ 500
T-L Irrigation	\$ 500
Browning Seed	\$ 500
City of Lubbock	\$ 500
Nachurs	\$ 500
Ogallala CAP Project	\$ 500
Capital Farm Credit	\$ 200
City Bank	\$ 200
TX Grain Sorghum	\$ 200
<b>Total</b>	<b>\$21,100</b>

## Visitors to the Demonstration Project Sites, Field Walks, Field Days, and Water College Outreach Events (Phase I - 2005-2013/Phase II - 2014-2018)

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### 2005

Total Number of Visitors	190
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### 2006

Total Number of Visitors	282
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### 2007

Total Number of Visitors	176+
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### 2008

Total Number of Visitors	153+
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### 2009

Total Number of Visitors	126+
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### 2010

Total Number of Visitors	120+
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### 2011

Total Number of Visitors	175+ +
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### 2012

Total Number of Visitors	200 +
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### 2013

Total Number of Visitors	230+
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### 2014

Total Number of Visitors	270+
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### 2015

Total Number of Visitors	350+
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### 2016

Total Number of Visitors	400+
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2017

Total Number of Visitors

475+

2018

Total Number of Visitors

475+

## Presentations

### (Phase I - 2005-2013/Phase II - 2014-2018)

#### 2005

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

#### 2006

<b><u>Date</u></b>	<b><u>Presentation</u></b>	<b><u>Spokesperson(s)</u></b>
24-26 Jan	Lubbock Southwest Farm & Ranch Classic	Kellison
6-Feb	Southern Region AAAE Conference: <i>The value of water: Educational programming to maximize profitability and decrease water consumption</i> (poster presentation), Charlotte, NC	M. Norton/Doerfert
7-Feb	Radio Interview	Kellison/Baker
2-Mar	South Plains Irrigation Management Workshop	Trostle/Kellison/Orr
30-Mar	Forage Conference	Kellison/Allen/Trostle
19-Apr	Floydada Rotary Club	Kellison
20-Apr	Western Region AAAE Conference: <i>Conservation outreach communications: A framework for structuring conservation outreach campaigns</i> (poster presentation), Boise, ID	M. Coutts/Doerfert

27-Apr	ICASALS Holden Lecture: <i>New Directions in Groundwater Management for the Texas High Plains</i>	Conkwright
18-May	Annual National AAAE Conference: <i>The value of water: Educational programming to maximize profitability and decrease water consumption</i> (poster presentation), Charlotte, NC	M. Norton/Doerfert
18-May	Annual National AAAE Conference: <i>Conservation outreach communications: A framework for structuring conservation outreach campaigns</i> (poster presentation), Charlotte, NC	M. Coutts/Doerfert
15-Jun	Field Day @ New Deal Research Farm	Kellison/Allen/Craddock/Doerfert
21-Jul	Summer Annual Forage Workshop	Trostle
27-Jul	National Organization of Professional Hispanic NRCS Employees annual training meeting, Orlando, FL	Craddock (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

<b><u>Date</u></b>	<b><u>Presentation</u></b>	<b><u>Spokesperson(s)</u></b>
11-Jan	Management Team meeting (Dr. Jeff Jordan, Advisory Council in attendance)	
23—25 Jan	2007 Southwest Farm & Ranch Classic, Lubbock, TX	Kellison/Doerfert
6-Feb	Cow/Calf Beef Producer Meeting at Floyd County Unity Center	Allen
8-Feb	Management Team meeting	
13-Feb	Grower meeting, Clarendon, TX	Kellison
26-Feb	Silage workshop, Dimmitt, TX	
8-Mar	Management Team meeting	
21-Mar	Silage Workshop, Plainview, TX	Kellison/Trostle
22-Mar	Silage Workshop, Clovis, NM	Kellison/Trostle
30-Mar	Annual Report review meeting w/Comer Tuck, Lubbock, TX	



2-Apr	TAWC Producer meeting, Lockney, TX	
11-Apr	Texas Tech Cotton Economics Institute Research/Extension Symposium	Johnson
12-Apr	Management Team meeting	
21-Apr	State FFA Agricultural Communications Contest, Lubbock, TX (100 high school students)(mock press conf. based on TAWC info)	Johnson
7-May	The Lubbock Round Table meeting	Kellison
9-May	Area 7 FFA Convention, Texas State University, San Marcos, TX (distributed 200 DVD and info sheets)	Baker
10-May	Management Team meeting	
12-May	RoundTable meeting, Lubbock Club	Allen
15—17-May	21st Biennial Workshop on Aerial Photog., Videography, and High Resolution Digital Imagery for Resource Assessment: <i>Calibrating aerial imagery for estimating crop ground cover</i> , Terre Haute, IN	Rajan
30-May	Rotary Club (about 100 present)	Allen
7-Jun	Lubbock Economic Development Association	Baker
14-Jun	Management Team meeting	
18-Jun	Meeting with Senator Robert Duncan	Kellison
10-Jul	Management Team meeting	
24—26-Jul	Universities Council on Water Resources (UCOWR)/National Institutes for Water Resources (NIWR) Annual Conference: <i>Political and civic engagement of agriculture producers who operate in selected Idaho and Texas counties dependent on irrigation</i> , Boise, ID	Doerfert
30-Jul—3-Aug	Texas Vocational Agriculture Teachers' Association Annual Conference, Arlington, TX (distributed 100 DVDs)	Doerfert
9-Aug	Management Team meeting	
10-Aug	Texas South Plains Perennial Grass Workshop, Teeter Farm & Muncy Unity Center	Kellison/Trostle
13—15-Aug	International Symposium on Integrated Crop-Livestock Systems conference, Universidade Federal do Parana in Curitiba, Brazil	(Presentation made on behalf of Allen)
13—14-Aug	2007 Water Research Symposium: <i>Comparison of water use among crops in the Texas High Plains estimated using remote sensing</i> , 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: <i>Overview and Initial Progress of the Texas Alliance for Water Conservation Project</i>	Kellison
8-Oct	Plant & Soil Science Departmental Seminar: <i>Estimating ground cover of field crops using multispectral medium, resolution satellite, and high resolution aerial imagery</i>	Rajan
11-Oct	Management Team meeting	

4—8-Nov	American Society of Agronomy Annual meetings: <i>Using remote sensing and crop models to compare water use of cotton under different irrigation systems</i> (poster presentation), New Orleans, LA	Rajan
4—8-Nov	American Society of Agronomy Annual meetings: <i>Assessing the crop water use of silage corn and forage sorghum using remote sensing and crop modeling</i> , 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: <i>Considering conservation outreach through the framework of behavioral economics: a review of literature</i> (poster presentations), Albuquerque, NM	M. Findley/Doerfert
12—15-Nov	American Water Resources Association annual meeting: <i>How do we value water? A multi-state perspective</i> (poster presentation), Albuquerque, NM	L. Edgar/Doerfert
16-Nov	Water Conservation Advisory Council meeting, Austin, TX	Allen
19-Nov	Plant & Soil Science Departmental Seminar: <i>Finding the legume species for West Texas which can improve forage quality and reduce water consumption</i>	Cui
27—29-Nov	Amarillo Farm Show, Amarillo, TX	Doerfert/Leigh/Kellison
2—4-Dec	Texas Water Summit, San Antonio, TX	Allen
13-Dec	Management Team meeting	

## 2008

<u>Date</u>	<u>Presentation</u>	<u>Spokesperson(s)</u>
8-11-Jan	Beltwide Cotton Conference Proceedings: <i>Energy Analysis of Cotton Production in the Southern High Plains of Texas</i> , Nashville, TN	Johnson/Weinheimer
10-Jan	Management Team meeting	
1-Feb	Southwest Farm and Ranch Classic, Lubbock	Kellison
14-Feb	Management Team meeting (Weinheimer presentation)	
14-Feb	TAWC Producer Board meeting	Kellison
5-Mar	Floydada Rotary Club	Kellison
13-Mar	Management Team meeting	
25-Mar	National SARE Conference: New American Farm Conference: <i>Systems Research in Action</i> , Kansas City, MO	Allen
27-Mar	Media training for TAWC Producer Board	Doerfert/Kellison
Apr	Agricultural Economics Seminar: <i>Transitions in Agriculture</i> , Texas Tech University	Weinheimer
10-Apr	Management Team meeting	
5-May	Pasture and Forage Land Synthesis Workshop: <i>Integrated forage-livestock systems research</i> , Beltsville, MD	Allen
8-May	Management Team meeting	

9-Jun	Walking tour of New Deal Research farm	Allen/Kellison/Li/Cui/Craddock
10-12-Jun	Forage Training Seminar: <i>Agriculture and land use changes in the Texas High Plains</i> , Cropland Genetics, Amarillo	Allen
12-Jun	Management Team meeting	
14-Jul	Ralls producers	Kellison
14-Jul	Water and the AgriScience Fair Teacher and Student Workshops	Kellison/Brown/Craddock
15-Jul	Pioneer Hybrids Research Directors	Kellison
20-23-July	9 <sup>th</sup> International Conference on Precision Agriculture, Denver, CO	Rajan
31-Jul	TAWC Field Day	all
8-Aug	TAWC Producer Board meeting	
12-Aug	Pioneer Hybrids Field Day	Kellison
9-Sep	Texas Ag Industries Association, Lubbock regional meeting	Allen
11-Sep	Management Team meeting	
16-Sep	Mark Long, TDA President, Ben Dora Dairies, Amherst, TX	Kellison/Trostle/ Craddock
5-9-Oct	American Society of Agronomy Annual meeting, Houston	Rajan
8-Oct	American Society of Agronomy Annual meeting, Houston	Maas
15-Oct	State Energy Conservation Office (SECO) meeting	
16-Oct	Management Team meeting	
17-Oct	Thesis defense: <i>A Qualitative Investigation of the Factors that Influence Crop Planting and Water Management in West Texas.</i>	Leigh
20-Oct	Farming with Grass conference, Soil and Water Conservation Society, Oklahoma City, OK	Allen
23-Oct	Thesis defense: <i>Farm Level Financial Impacts of Water Policy on the Southern Ogallala Aquifer</i>	Weinheimer
13-Nov	Management Team meeting (Weinheimer presentation)	
17-20-Nov	American Water Resources Association Conference: <i>Farm-based water management research shared through a community of practice model</i> , New Orleans, LA	Leigh
17-20-Nov	American Water Resources Association Conference: <i>The critical role of the community coordinator in facilitating an agriculture water management and conservation community of practice</i> , New Orleans, LA	Wilkinson
17-20-Nov	American Water Resources Association Conference: <i>An exploratory analysis of the rural population and their attitudes toward water management and conservation</i> (poster presentation), New Orleans, LA	Newsom
17-20-Nov	American Water Resources Association Conference: <i>Developing tomorrow's water researchers today</i> (poster presentation), New Orleans, LA	C. Williams
19-Nov	TTU GIS Open House	Barbato
Dec	Panhandle Groundwater District: <i>Farm Level Financial Impacts of Water Policy on the Southern Ogallala Aquifer</i> , White Deer, TX	Johnson/Weinheimer
2-4-Dec	Amarillo Farm Show	Doerfert
3-Dec	Dr. Todd Bilby, Ellen Jordan, Nicholas Kenny, Dr. Amosson (discussion of water/crops/cattle), Amarillo	Kellison

6-Dec	Lubbock RoundTable	Kellison
6-7-Dec	Meeting regarding multi-institutional proposal to target a future USDA RFP on water management, Dallas	Doerfert
11-Dec	Management Team meeting	
12-Dec	Olton CO-OP Producer meeting	Kellison
19-Dec	TAWC Producer meeting	Kellison/Schur/ Cradduck/Weinheimer

## 2009

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

9-Jul	Management Team meeting	
27-31-Jul	Texas Agriscience Educator Summer Conference, Lubbock	Doerfert/Jones
6-Aug	Management Team meeting	
17-19-Aug	TAWC NRCS/Congressional tour and presentations, Lubbock, New Deal & Muncy	TAWC participants
27-Aug	Panhandle Association of Soil and Water Conservation Districts	Kellison
10-Sep	Management Team meeting	
8-Oct	Management Team meeting	
9-Oct	Presentation to visiting group from Colombia, TTU campus, Lubbock	Kellison
13-Oct	Briscoe County Field day, Silverton, TX	Kellison
1-5-Nov	Annual Meetings of the American Society of Agronomy, oral presentations: <i>Evapotranspiration of Irrigated and Dryland Cotton Fields Determined Using Eddy Covariance and Penman-Monteith Methods</i> , and <i>Relation Between Soil Surface Resistance and Soil Surface Reflectance</i> , poster presentation: <i>Variable Rate Nitrogen Application in Cotton Using Commercially Available Satellite and Aircraft Imagery</i> ," Pittsburgh, PA	Maas/Rajan
10-12-Nov	Cotton Incorporated Precision Agriculture Workshop: <i>Biomass Indices</i> , Austin, TX	Rajan/Maas
12-Nov	Management Team meeting	
Dec	United Farm Industries Board of Directors: <i>Irrigated Agriculture</i> , Lubbock	Johnson/Weinheimer
Dec	Fox 34 TV interview, Ramar Communications, Lubbock	Allen
1-3-Dec	Amarillo Farm Show, Amarillo	Doerfert/Jones/Oates/ Kellison
3-Dec	Management Team meeting	
10-Dec	TAWC Producer Board meeting, Lockney	Kellison/Weinheimer/Maas
14-Dec	Round Table meeting with Todd Staples, Lubbock, TX	Kellison
12-18-Dec	Fall meeting, American Geophysical Union: <i>Vegetation cover mapping at multiple scales using MODIS, Landsat, RapidEye, and Aircraft imageries in the Texas High Plains</i> , San Francisco, CA	Rajan/Maas

## 2010

<u>Date</u>	<u>Presentation</u>	<u>Spokesperson(s)</u>
4-7-Jan	Beltwide Cotton Conference: <i>Energy and Carbon: Considerations for High Plains Cotton</i> , New Orleans, LA	Yates/Weinheimer
14-Jan	TAWC Management Team meeting	
3-Feb	TAWC Farmer Field Day, Muncy, TX	TAWC participants
6-9-Feb	Southern Agricultural and Applied Economics Association annual meeting: <i>Macroeconomic Impacts on Water Use in Agriculture</i> , Orlando, FL	Weinheimer
9-11-Feb	Southwest Farm & Ranch Classic (TAWC booth), Lubbock	Doerfert/Jones/Frederick

10-Feb	Southwest Farm & Ranch Classic, Lubbock	Kellison/Yates/Trostle/Maas
11-Feb	TAWC Management Team meeting	
9-March	TAWC Producer Board Meeting, Lockney	TAWC participants
11-March	TAWC Management Team meeting	
31-March	Texas Tech Forage Class	Kellison
8-April	TAWC Management Team meeting	
13-April	Matador Land & Cattle Co., Matador, TX	Kellison
13-May	TAWC Management Team meeting	
10-June	TAWC Management Team meeting	
30-June	TAWC Grower Technical Working Group meeting, Lockney	Glodt/Kellison
8-July	TAWC Management Team meeting	
9-July	Southwest Council on Agriculture annual meeting, Lubbock	Doerfert/Sell/Kellison
15-July	Universities Council on Water Resources (UCOWR): <i>Texas Alliance for Water Conservation: An Integrated Approach to Water Conservation</i> , Seattle, WA	Weinheimer
25-27-July	American Agricultural Economics Association annual meeting: <i>Carbon Footprint: A New Farm Management Consideration on the Southern High Plains</i> , Denver, CO	Weinheimer
27-July	Tour for Cotton Incorporated group, TAWC Sites	Kellison/Maas
August	Ag Talk on FOX950 am radio show	Weinheimer
10-Aug	TAWC Field day, Muncy, TX	TAWC participants
12-Aug	TAWC Management Team meeting	
30-Aug	Tour/interviews for SARE film crew, TTU campus, New Deal and TAWC Sites	TAWC participants
9-Sept	TAWC Management Team meeting	
14-Sept	Floyd County Farm Tour, Floydada, TX	Kellison
14-Oct	TAWC Management Team meeting	
27-Oct	Texas Agricultural Lifetime Leadership Class XII	Kellison
31-Oct—3-Nov	Annual Meetings of the American Society of Agronomy: <i>Carbon fluxes from continuous cotton and pasture for grazing in the Texas High Plains</i> , Long Beach, CA	Rajan/Maas
31-Oct—3-Nov	Annual Meetings of the American Society of Agronomy: <i>Closure of surface energy balance for agricultural fields determined from eddy covariance measurements</i> , Long Beach, CA	Maas/Rajan
8-Nov	Fox News interview	Kellison
8-Nov	Fox 950 am radio interview	Doerfert
9-Nov	Texas Ag Industries Association Regional Meeting, Dumas, TX	Kellison
18-Nov	TAWC Management Team meeting	
19-Nov	North Plains Water District meeting, Amarillo, TX	Kellison/Schur
1-3-Dec	Amarillo Farm & Ranch Show (TAWC booth), Amarillo	Doerfert/Zavaleta/Graber

9-Dec	TAWC Management Team meeting	
12-18-Dec	American Geophysical Union fall meeting: <i>Vegetation cover mapping at multiple scales using MODIS, Landsat, RapidEye, and Aircraft imageries in the Texas High Plains</i> , San Francisco, CA	Rajan/Maas

## 2011

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

30-Mar	West Texas Mesonet (Wes Burgett), TTU Reese Center, Lubbock, TX	Kellison/Brown/Maas/Rajan /Weinheimer
31-Mar—1-Apr	Texas Cotton Ginners Show (TAWC booth), Lubbock, TX	Doerfert/Graber/Sullivan
13-Apr	USDA-ARS/Ogallala Aquifer project (David Brauer), Lubbock, TX	Kellison/TAWC participants
13-Apr	KJTV-Fox 34 Ag Day news program: <i>TAWC introduces solution tools for producers</i> , Lubbock, TX	Weinheimer
14-Apr	TAWC Management Team meeting	
18-Apr	KJTV-Fox 34 Ag Day news program: <i>Cotton overwhelmingly king this year on South Plains</i> , Lubbock, TX	Boyd Jackson
18-Apr	KJTV-Fox 34 Ag Day news program: <i>Specialty, rotation crops not popular this growing season</i> , Lubbock, TX	Trostle
12-May	TAWC Management Team meeting	
17-May	KJTV-Fox 34 Ag Day news program: <i>Tools available to maximize irrigation efficiency</i> , Lubbock, TX	Kellison
18-May	Floydada Rotary Club, Floydada, TX	Kellison
9-Jun	TAWC Management Team meeting	
29-Jun—2-Jul	Joint meetings of the Western Agricultural Economics Association/Canadian Agricultural Economics Society: <i>Evaluating the Implications of Regional Water Management Strategies: A Comparison of County and Farm Level Analysis</i> , Banff, Alberta, Canada	Weinheimer
12-14-Jul	UCOWR/NIWR Conference: <i>Texas Alliance for Water Conservation: An Innovative Approach to Water Conservation: An Overview</i> , Boulder, CO	Kellison
12-14-Jul	UCOWR/NIWR Conference: <i>Sunflowers as an Alternative Irrigated Crop on the Southern High Plains</i> , Boulder, CO	Pate
12-14-Jul	UCOWR/NIWR Conference: <i>Economic Considerations for Water Conservation: The Texas Alliance for Water Conservation</i> , Boulder, CO	Weinheimer
12-14-Jul	UCOWR/NIWR Conference: <i>Determining Crop Water Use in the Texas Alliance for Water Conservation Project</i> , Boulder, CO	Maas
12-14-Jul	UCOWR/NIWR Conference: <i>What We Know About Disseminating Water Management Information to Various Stakeholders</i> , Boulder, CO	Doerfert
12-14-Jul	UCOWR/NIWR Conference: <i>Assessment of Improved Pasture Alternatives on Texas Alliance for Water Conservation</i> , Boulder, CO	Kellison
12-14-Jul	UCOWR/NIWR Conference: <i>Integrating forages and grazing animals to reduce agricultural water use</i> , Boulder, CO	Brown
21-Jul	TAWC Management Team meeting	
4-Aug	KXDJ-FM news radio interview	Weinheimer
4-Aug	TAWC Field Day, Muncy, TX	TAWC participants
11-Aug	TAWC Management Team meeting	
1-Sep	KJTV-Fox 34 Ag Day news program: <i>High Plains producers struggling to conserve water in drought</i> , Lubbock, TX	Boyd Jackson



5-Sep	KJTV-Fox 34 Ag Day news program: <i>New ideas, concepts emerging from surviving historic drought</i> , Lubbock, TX	Kellison
8-Sep	TAWC Management Team meeting (Brown presentation)	
29-Sep	Texas & Southwestern Cattle Raiser Association Fall meeting, Lubbock, TX	Kellison
13-Oct	TAWC Management Team meeting (Maas presentation)	
16-19-Oct	Annual Meetings of the American Society of Agronomy: <i>Satellite-based irrigation scheduling</i> , San Antonio, TX	Maas/Rajan
16-19-Oct	Annual Meetings of the American Society of Agronomy: <i>Comparison of carbon, water and energy fluxes between grassland and agricultural ecosystems</i> , San Antonio, TX	Maas/Rajan
16-19-Oct	Annual Meetings of the Soil Science Society of America: <i>CO<sub>2</sub> and N<sub>2</sub>O Fluxes in Integrated Crop Livestock Systems</i> (poster presentation), San Antonio, TX	Lisa Fultz/Marko Davinic/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: <i>Dynamics of Soil Aggregation and Carbon in Long-Term Integrated Crop-Livestock Agroecosystems in the Southern High Plains</i> (poster presentation), San Antonio, TX	Lisa Fultz/Marko Davinic/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: <i>Long-Term Integrated Crop-Livestock Agroecosystems and the Effect on Soil Carbon</i> (poster presentation), San Antonio, TX.	Lisa Fultz/Marko Davinic/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: <i>Soil Microbial Dynamics in Alternative Cropping Systems to Monoculture Cotton in the Southern High Plains</i> , San Antonio, TX.	Marko Davinic/Lisa Fultz/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: <i>Soil Fungal Community and Functional Diversity Assessments of Agroecosystems in the Southern High Plains</i> , San Antonio, TX.	Marko Davinic/Lisa Fultz/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: <i>Aggregate Stratification Assessment of Soil Bacterial Communities and Organic Matter Composition: Coupling Pyrosequencing and Mid-Infrared Spectroscopy Techniques</i> , San Antonio, TX.	Marko Davinic/Lisa Fultz/Jennifer Moore-Kucera
6-10-Nov	47 <sup>th</sup> Annual American Water Resources Association: <i>The Use of Communication Channels Including Social Media Technology by Agricultural Producers and Stakeholders in the State of Texas</i> , Albuquerque, NM	Doerfert/Graber
6-10-Nov	47 <sup>th</sup> Annual American Water Resources Association: <i>What We Know About Disseminating Water Management Information to Various Stakeholders</i> , Albuquerque, NM	Doerfert, et al.
6-10-Nov	47 <sup>th</sup> Annual American Water Resources Association: <i>The Water Management and Conservation Instructional Needs of Texas Agriculture Science Teachers</i> , Albuquerque, NM	Doerfert/Sullivan
6-10-Nov	47 <sup>th</sup> Annual American Water Resources Association: <i>The Attitudes and Opinions of Agricultural Producers Toward Sustainable Agriculture on the High Plains of Texas</i> , Albuquerque, NM	Doerfert, et al.
6-10-Nov	47 <sup>th</sup> Annual American Water Resources Association: <i>The Issues That Matter Most to Agricultural Stakeholders: A Framework for Future Research</i> (poster presentation), Albuquerque, NM	Sullivan/Doerfert, et al.
10-Nov	TAWC Management Team meeting	
18-Nov	39 <sup>th</sup> Annual Bankers Agricultural Credit Conference, Lubbock, TX	Kellison
22-Nov	KJTV 950 AM AgTalk radio interview	Trostle
29-Nov—1-Dec	Amarillo Farm Show (TAWC booth), Amarillo, TX	Doerfert/Graber/Sullivan/Kellison

		/Borgstedt
7-Dec	Plainview Lions Club, Plainview, TX	Kellison
8-Dec	TAWC Management Team meeting	
13-Dec	Channel Bio Water Summit (TAWC booth), Amarillo, TX	Borgstedt/Sullivan/Graber

## 2012

<u>Date</u>	<u>Presentation</u>	<u>Spokesperson(s)</u>
6-Mar	Lubbock Kiwanis Club	Kellison
7-Mar	Monthly Management Team Meeting	Kellison
23-Mar	New Mexico Ag Bankers Conference	Kellison, Klose
3-Apr	AgriLife Extension Meeting	Kellison
12-Apr	Monthly Management Team Meeting	Kellison
10-May	Monthly Management Team Meeting	Kellison
10-May	Carillon Center	Kellison
11-May	Tours-Comer Tuck with the Texas Water Development Board	Kellison
14-May	Tours-Farm Journal Media	Kellison
17-May	Tours-Secretary of State Group	Kellison
14-June	Monthly Management Team Meeting	Kellison
19-June	Lloyd Author Farm	Kellison
20-June	Blake Davis Farm	Kellison
21-June	Glenn Schur Farm	Kellison
10-July	Tours-Justin Weinheimer	Kellison
12-July	Texas Agricultural Coop Council	Kellison
12-July	Texas Independent Ginners Conference	Kellison
18-July	Monthly Management Team Meeting	Kellison
16-Aug	Monthly Management Team Meeting	Kellison
5-Sep	Leadership Sorghum Class 1	Kellison
20-Sep	Monthly Management Team Meeting	Kellison
18-Oct	Monthly Management Team Meeting	Kellison
24-Oct	Texas Agriculture Lifetime Leadership	Kellison

30-Oct	Special Management Team Meeting	Kellison
8-Nov	Monthly Management Team Meeting	Kellison
27-28-Nov	Amarillo Farm & Ranch Show	Borgstedt/Doerfert/Kellison
13-Dec	Monthly Management Team Meeting	Kellison
16-18-Nov	48 <sup>th</sup> Annual American Water Resources Association conference	Doerfert/Kellison/P. Johnson/Maas
20-Nov	Special Management Team Meeting	Kellison
3-Jan	KFLP Radio	Kellison
7-9-Jan	Beltwide Cotton Conference	Doerfert
15-Jan	Fox 950 AM	Doerfert
4-Feb	Texas Seed Trade Association	Kellison
14-Feb	Monthly Management Team meeting	Kellison
21-Mar	Monthly Management Team meeting	Kellison
29-30-Mar	Texas Gin Association Convention	Borgstedt/Doerfert
11-Apr	Monthly Management Team meeting	Kellison

### 2013

<u>Date</u>	<u>Presentation</u>	<u>Spokesperson(s)</u>
7-10-Jan. 2013	Field evaluation of a remote sensing based irrigation scheduling tool Beltwide Cotton Conference San Antonio, TX	Rajan, Maas
13-Mar.	John Deere Crop Sense capacitance probe use by TAWC – Lubbock, TX	Pate
2 Apr.	Southern Pasture Forage Crop Improvement Conference, Overton, TX	West, Brown
26-Apr.	Data plans for the initiative for strategic and innovative irrigation management and conservation. presented at the Water Management and Conservation: Database Workshop – Lubbock, TX	Kellison, Johnson
8-May	TAWC Update and Highlights – For D-2 County Agents – Lubbock, TX	Pate
5-Jun.	Radio Interview – Field Walk Update – KFLP	Pate
3-Jul.	Radio Interview – Field Walk Update – KFLP	Pate
19-Jul.	Texas Southwestern Cattle Raisers Association, Lubbock, TX	Kellison
22-Jul.	TAWC and Its Purpose – 4-H Ag. Ambassadors – Lubbock, TX	Pate

9-Aug.	Radio Interview – Field Walk Update – KFLP	Pate
13-Aug.	High Plains Water District board of directors – Lubbock, TX	Kellison
19-Sept.	International Grasslands Conference – Sydney, Australia	Kellison, Brown
25-Sept.	TAWC update and highlights – Monsanto headquarters – St. Louis, Mo.	Pate
26- Sept.	Wayland Baptist University class – Lockney, TX	Kellison
2-Oct.	Congressman Frank Lucas – Lubbock, TX	West, Kellison
7-Oct.	TAIA Annual Meeting	Kellison
9-Oct.	Congressman Mike Conway	West, Kellison
10-Oct.	TAWC Field Walk – Lockney, TX	Kellison
2 Nov.	Am. Soc. Agronomy, Tampa, FL. Modeling Old World bluestem grass	West, Xiong
14-15-Dec.	Remote sensing based water management from the watershed to the field level. CIMMYT and the Gates Foundation- Mexico City	Maas, Rajan
14-15-Dec.	Remote sensing based soil moisture detection. Abstracts, Workshop “Beyond Diagnostics: Insights and Recommendations from Remote Sensing.” CIMMYT and the Gates Foundation- Mexico City	Shafian, Maas
7-Jan. 2014	Sorghum U – Levelland, TX	Kellison
7 Jan. 2014	Fieldprint Calculator: A measurement of agricultural sustainability in the Texas High Plains Beltwide Cotton Conference, New Orleans	Stokes, Johnson, Robertson, Underwood
7-Jan. 2014	Poster- LEPA vs. LESA Irrigation – Beltwide Cotton Conference – New Orleans, La.	Pate, Yates
16-Jan. 2014	TWDB Director Bech Bruun & staff – Lubbock, TX	Kellison
28-Jan. 2014	Randall County Producers	Kellison
12-Feb. 2014	Texas Panhandle-High Plains Water Symposium	Kellison
13 Feb. 2014	Nebraska Independent Crop Consultants Assoc. annual meeting. Talk on TAWC	West
24-Feb. 2014	TWDB Directors-Lubbock, TX	Kellison

## 2014

<u>Date</u>	<u>Presentation</u>	<u>Spokesperson(s)</u>
1/6/2014	Beltwide Cotton conference, New Orleans, LA	A. Attia/N. Rajan

1/7/2014	Sorghum U, Levelland, TX	Rick Kellison
1/16/2014	TWDB Director Bech Bruun and staff, Lubbock, TX	Rick Kellison
1/28/2014	Texas Panhandle-High Plains Water Symposium, Amarillo, TX	Rick Kellison
2/2-4/2014	Annual Meeting Southern Branch American Society of Agronomy Dallas, TX	S. Sharma/ N. Rajan/S. Maas
2/2-4/2014	Annual Meeting Southern Branch American Society of Agronomy, Dallas, TX	S. Sharma/ N. Rajan/S. Maas
2/13/2014	Nebraska Independent Crop Consultants Assoc., Nebraska City, NE	Chuck West
2/25/2014	Texas Water Development Board, Lubbock, TX	Rick Kellison
3/11/2014	Plainview Producer Meeting, Plainview, TX	Rick Kellison
4/1/2014	Cotton Irrigation Meeting, Plainview, TX	Jeff Pate
4/2/2014	Doug Shaw, TWDB, Lubbock, TX	Rick Kellison
4/23/2014	Region O Water Planning Committee, Lubbock, TX	R. Kellison/C. West
5/6/2014	Lions Club Meeting, Idalou, TX	Jeff Pate
5.6.2014	Texas Tech Climate Science Center Seminar series, Lubbock, TX	Chuck West
5/15/2014	TAWC Field Walk, Lockney, TX	Rick Kellison
5/19/2014	Texas Water Summit, TAMEST, Austin, TX	Chuck West
6/17/2014	North Central Coordinating Committee-31, Grand Rapids, MI	Chuck West
6/24/2014	Brownfield Chamber of Commerce, Brownfield, TX	Rick Kellison
8/5/2014	Stronger Economies Together, Littlefield, TX	Jeff Pate
8/12/2014	Radio Interview 950 AM, Lubbock, TX	Rick Kellison
9/29/2014	Texas Speaker of the House Joe Straus & Texas Rep. John Frullo, Lubbock, TX	Rick Kellison
11/2-5/2014	ASA-CSSA-SSSA Annual Meeting, Long Beach, CA	S. Sharma/ N. Rajan/S. Maas
11/2-5/2014	ASA-CSSA-SSSA Annual Meeting, Long Beach, CA	S. Sharma/ N. Rajan/S. Maas
12/11/2014	Olton Co-op grain Winter Meeting, Olton, TX	Jeff Pate
12/15- 19/2014	AGU Fall Meeting, San Francisco, CA	S. Shafian, S. Maas
12/16/2014	Swisher County Producer Meeting, Tulia, TX	Rick Kellison
12/23/2014	Texas Representative Dustin Burrows, Lubbock, TX	Rick Kellison

## 2015

<b>Date</b>	<b>Presentation</b>	<b>Spokesperson(s)</b>
2/15/2015	Agriculture and Climate Change. Amsterdam, Netherlands	S. Angadi, C. West
3/3/2015	HPACC, Lubbock, TX	R. Kellison
3/11/2015	Marketing 101, Muncy, TX	J. Pate
3/12/2015	Ogallala Aquifer Program, Manhattan, KS	Y. Xiong, C. West
3/18/2015	Farm Budgeting, Lubbock, TX	J. Pate
3/19/2015	Nebraska Water Symposium, Lincoln, Nebraska	R. Kellison, G. Schur
4/8/2015	Briscoe County Ag Days, Silverton, TX	R. Kellison
4/17/2015	Kingpins 2029, Amsterdam	R. Kellison
5/2015	National AAAE Research Conference, San Antonio, TX	L. Durst, C. Myers
5/18/2015	World Environ. Water Resources Conference, Austin, TX	C. West, R. Kellison
7/9/2015	Texas Tech TeCSIS Field Day, New Deal, TX	C. West, P. Brown, R. Kellison, V. Allen
8/3/2015	Nebraska Water Balance Field Day, Sutherland, Nebraska	R. Kellison
8/17/2015	Texas Soil and Water, Lubbock, TX	R. Kellison
8/19/2015	Floydada Rotary Club, Floydada, TX	R. Kellison
11/15-18/2015	ASA-CSSA-SSSA Annual Meeting, Minneapolis, MN	C. West, P. Brown
11/15-18/2015	ASA-CSSA-SSSA Annual Meeting, Minneapolis, MN	S. Sharma, S. Maas
11/15-18/2015	ASA-CSSA-SSSA Annual Meeting, Minneapolis, MN	S. Sharma, N. Rajan, S. Maas
11/15-18/2015	ASA-CSSA-SSSA Annual Meeting, Minneapolis, MN	N. Rajan, S. Sharma, K.D. Casey, S. Maas
11/15-18/2015	ASA-CSSA-SSSA Annual Meeting, Minneapolis, MN	N. Rajan, S. Sharma, S. Maas
1/12/2016	Crop Profitability, Lubbock, TX	J. Pate
1/19/2016	Crop Profitability, Lubbock, TX	J. Pate
1/22/2016	Crop Profitability, Lubbock, TX	J. Pate
2/17/2016	Regional SCS Group Presentation, PYCO, Lubbock, TX	P. Brown

## 2016

<u>Date</u>	<u>Presentation</u>	<u>Spokesperson(s)</u>
1/5-6/2016	Beltwide Cotton Conference, New Orleans, Louisiana	D. Mitchell and J. Pate
1/10-13/2016	American and Forage and Grassland Council Annual Conference Baton Rouge, LA (3 presentations)	L. Baxter, C.P. West
2/25/2016	HPPAC Conference, Lubbock, TX	R. Kellison
3/30/2016	USDA CIG Presentation	R. Kellison
7/19-23/2016	American Society of Animal Science Western Section Joint Meeting	J.D. Sugg, et. al.
8/02/2016	H2O for Texas (Senator Charles Perry), Lubbock, TX	R. Kellison
2016	Lamesa Rotary Club, Lamesa, TX	D. Mitchell
2016	Annual Meeting ASA, CSSA and SSSA Madison, WI	Y. Xiong, C.P. West and T. McLendon
2016	Annual Meeting ASA, CSSA and SSSA Madison, WI	K. Bhandari , C.P. West et. al.
2016	Annual Meeting ASA, CSSA and SSSA Madison, WI (2 presentations)	L. Baxter , C.P. West et. al.
11/17/2016	TTU Class Presentation, Lubbock, TX	R. Kellison
1/5-6/2017	Economic Poster, Beltwide Cotton Conference, Dallas	J. Pate, D. Mitchell and W. Keeling
1/5-6/2016	Beltwide Cotton Conference, New Orleans, Louisiana	D. Mitchell and J. Pate
1/5-7/2017	Southern Agricultural Economics Association Annual Meeting, San Antonio, Texas	D. Mitchell, R.B. Williams and P. Johnson
1/5-7/2017	Southern Agricultural Economics Association Annual Meeting, San Antonio, Texas	D. Mitchell and John Robinson
1/5-7/2017	Southern Agricultural Economics Association Annual Meeting, San Antonio, Texas	Y. Gao, R.B. Williams and D. Mitchell

## Formal Presentations:

- Baxter, L.L., C.P. West. 2016. Comparison of productivity, efficiency, and profitability of grass-only and grass-legume beef stocker grazing systems in the Southern High Plains. American and Forage and Grassland Council Annual Conference, 10-13 January, Baton Rouge.
- Baxter, L.L., and C.P. West. 2016. Comparison of traditional and novel non-destructive techniques for assessment of botanical composition in grass-legume pastures. American and Forage and Grassland Council Annual Conference, 10-13 January, Baton Rouge.
- Baxter, L.L., and C.P. West. 2016. Comparison of productivity and efficiency of grass-only and grass-legume beef stocker grazing systems in the Southern High Plains. In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI.
- Baxter, L.L., and C.P. West. 2016. Developing novel non-destructive sampling techniques for assessing botanical composition in grass-legume pastures. In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI.
- Sugg, J.D., P.R. Campanili, C.P. West, L.L. Baxter, J.O. Sarturi, and S.J. Trojan. 2016. Evaluation of *Eragrostis tef* (Zucc.) as a forage option for grazing beef cattle in the Southern High Plains. Proc. Am. Soc. Anim. Sci. Western Section, Am. Dairy Sci. Assoc., and Canadian Soc. Anim. Sci. Joint Annual Meeting, 19-23 July, Salt Lake City, UT.
- Xiong, Y., C.P. West, and T. McLendon. 2016. Fractionating rainfall into vegetative interception and soil infiltration in perennial grassland. In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI.
- Bhandari, K., C.P. West, S.D. Longing, D.M. Klein and V. Acosta-Martinez. 2016. Arthropod community composition of 'WW-B.Dahl' Old World bluestem pasture systems. In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI.
- Mitchell, D. and J. Pate. 2016. "Profitability of 2 and 2 Production Systems." Poster Presentation at the *2016 Beltwide Cotton Conference, New Orleans, Louisiana*.
- Mitchell, D. R.B. Williams, and P. Johnson. 2016. "An Economic Analysis to Determine the Feasibility of Groundwater Supplementation from the Dockum Aquifer." Selected Presentation at the *2016 Southern Agricultural Economics Association Annual Meeting, San Antonio, Texas*.



Mitchell, D. and John Robinson. 2016. "Structural Changes in U.S. Cotton Supply." Selected Presentation at the *2016 Beltwide Cotton Conference, New Orleans, Louisiana*.

Mitchell, D. and John Robinson. 2016. "Structural Changes in U.S. Cotton Supply." Selected Presentation at the *2016 Southern Agricultural Economics Association Annual Meeting, San Antonio, Texas*.

Gao, Y, R.B. Williams, and D. Mitchell. 2016. "Cap and Trade Markets for Groundwater: Efficiency and Distributional Effects of the Permit Allocation Mechanism." Selected Presentation at the *2016 Southern Agricultural Economics Association Annual Meeting, San Antonio, Texas*.

## 2017

<u>Date</u>	<u>Presentation</u>	<u>Spokesperson(s)</u>
3/01/2017	Oklahoma Irrigation Conference, Altus, OK	R. Kellison
4/03/2017	Texas Tech University (Ag. Communications), Lubbock, TX	R. Kellison
8/01/2017	U.S. House Ag Committee, San Angelo, TX	R. Kellison
8/22/2017	Commissioner Sid Miller, Lubbock, TX	R. Kellison
8/23/2017	Bayer Brands Tour, Lubbock, TX	R. Kellison
12/07/207	Swisher County Extension Ag Tour, Tulia, TX	R. Kellison

### **Formal Presentations:**

West, C.P. 2017. Linking climate to groundwater conservation. Climate Outlook Forum: Managing Risk and Thinking Ahead. 26 April, Clovis, NM. USDA-ARS Southwest Climate Hub, Las Cruces, NM.

West, C.P. 2017. Water footprints in High Plains agriculture. Texas Tech Climate Science Center, Science by the Glass, May 9. <https://www.youtube.com/watch?v=cxIW1J2h2q4>

West, C., D. Malinowski, and T. McLendon. 2017. Responses of grassland communities to climate changes in Texas and Oklahoma. Proceedings of 71st Southern Pasture and Forage Crop Improvement Conference, p. 9-20. June 5-7, Knoxville, TN. <http://agrilifecd.n.tamu.edu/spfcic/files/2013/02/Proceedings-71st-SPFCIC.pdf>

- West, C.P. 2017. Strategies for economical conservation of irrigation in the Great Plains. New Mexico State University Research Center Agricultural Field Day, Clovis, NM. Aug. 9. Clovis, NM.
- West, C.P., R. Kellison, C.P. Brown, J. Pate, and D. McCallister. 2017. Stretching the supply of groundwater and making it pay in the Texas South Plains. West Central Research and Extension Center Field Day, Aug. 24. North Platte, NE.
- Baxter, L.L., and C.P. West. 2017. Comparison of productivity and efficiency of grass-only and grass-legume beef stocker grazing systems in the Southern High Plains. Presented at: American Forage and Grassland Conference, Roanoke, VA. 24 Jan.
- Baxter, L.L., and C.P. West. 2017. Evaluation of winter annual cover crops under multiple residue managements: Impacts on soil water depletion and cash-crop productivity. Poster presented at: American Forage and Grassland Conference, Roanoke, VA. 24 Jan.
- Baxter, L.L., and C.P. West. 2017. Comparison of traditional and novel non-destructive sampling techniques for site-specific assessment of botanical composition in grass-legume pastures. Poster presented at: American Forage and Grassland Conference, Roanoke, VA. 23 Jan.
- Bhandari, K., C.P. West, S.D. Longing, and V. Acosta-Martinez. 2017. Arthropod and soil microbial community composition of 'WW-B.Dahl' Old World bluestem pasture systems. Presented at: American Forage and Grassland Council, Roanoke, VA. 23 Jan.
- Xiong, Y., C.P. West. 2017. Comparison of ALMANAC and APSIM for simulating Old World bluestem growth. Presented at: American Forage and Grassland Council, Roanoke, VA. 23 Jan.
- Baxter, L.L., and C.P. West. 2017. Comparison of productivity and efficiency of grass-only and grass-legume beef stocker grazing systems in the Southern High Plains. Presented at: Southern Branch of the American Society of Agronomy, Mobile, AL. 6 Feb.
- West, C.P., L.L. Baxter, C.P. Brown, and P.E. Green. 2017. Water use for beef production on pastures in West Texas. Universities Council on Water Resources, annual meeting, June 12-14. Fort Collins, CO.

- Kharel, Geeta, S.K. Deb, and C.P. West. 2017. Evaluation of different models for estimating the hydraulic parameters and thermal conductivity of pasture unsaturated soils. In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI.
- Bhandari, K., C.P. West, S. Longing, and V. Acosta-Martinez. 2017. Arthropod and soil microbial community size and composition of native and introduced pastures. In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI.
- Xiong, Y., and C.P. West. 2017. ALMANAC and APSIM models for simulating old world bluestem growth and water use under limited irrigation. In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI.
- Rocateli, A.C., and C.P. West. 2017. Introducing grazeable summer cover crops to wheat systems in the Southern Great Plains. In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI.
- Neupane, J., W. Guo, Abir Raihan, Zhe Lin, and C.P. West. 2017. Cotton growth variability in relation to topography and soil physical properties in the High Plains. In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI.
- Florence, Kason, L. Baxter, L. Slaughter, and C. West. 2017. Managing winter annual cover crops for increased productivity and soil health. Poster for SARE James Harrison Hill, Sr. Young Scholar Enhancement Grant. August meeting of USDA-Southern SARE Administrative Council meeting. <http://www.southernsare.org/Grants/Types-of-Grants/James-Harrison-Hill-Sr.-Young-Scholar-Enhancement-Grant-Program/2017-Young-Scholar-Enhancement-Grant-Projects>
- West, C., J. Aguilar, and D. Rudnick. 2017. Boosting producer learning, exchange and adoption of water use efficient technologies: Strategies from the High Plains/Ogallala region. Climate Learning Network/ANREP Community Science Initiative. Nov. 2, 2017. [www.climatewebinars.net/webinars](http://www.climatewebinars.net/webinars).
- Black, T., D. McCallister and P. Johnson. 2018. Fieldprint Calculator: A Measurement of Environmental and Economic Sustainability Performance of Agricultural Systems in the Southern High Plains. Selected Presentation at the 2018 Beltwide Cotton Conference, San Antonio, Texas, January 3-5.
- Black, T., P. Johnson and D. McCallister. 2018. An Evaluation of Production, Costs, and Sustainability on Crop Production in the Southern High Plains. Selected Presentation at the 2018 Beltwide Cotton Conference, San Antonio, Texas, January 3-5.

- McCallister, D., A. Cantu, C. West, D. Rudnick. 2017. Effects of Irrigation Technology and Management on WUE and Crop Yield: A Meta-Analysis. Presentation at the 2017 Universities Council on Water Resources (UCOWR) Annual Meeting, Ft. Collins, Colorado, June 13-15.
- West, C.P., R. Kellison, C.P. Brown, J. Pate, and D. McCallister. 2017. Stretching the supply of groundwater and making it pay in the Texas South Plains. West Central Research and Extension Center Field Day, Aug. 24. North Platte, NE.
- McCallister, D.M., R.B. Williams, D. Hudson, and P. Johnson. 2017. Policy Implications for Sustainable Development in Uzbekistan. Presentation at The 2<sup>nd</sup> International Conference on Natural Resource Management in Public Policy, Oct. 18-20, Wuhan, Hubei Province, China.
- Durst, L., Meyers, C., Irlbeck, E., & Ritz, R. (2017, May). *Adoption of water conservation practices in irrigation management: An application of the Theory of Planned Behavior in the Texas High Plains*. Paper presented at the National AAAE Research Conference, San Luis Obispo, CA. \*Distinguished Manuscript Award
- Dobelbower, S., & Meyers, C. (2017, September). *Back to school: The development of an educational event to encourage adoption of irrigation management practices*. Refereed poster session presented at the Western Region meeting of the American Association of Agricultural Education, Fort Collins, CO.
- Godwin, C., Meyers, C., Dobelbower, S., Irlbeck, E., & Ritz, R. (2017, September). *A case study of the Texas Alliance for Water Conservation's communication efforts*. Refereed poster session presented at the Western Region meeting of the American Association of Agricultural Education, Fort Collins, CO.
- Dobelbower, S., & Meyers, C. (2017, September). *An evaluation of attendees' satisfaction with topics presented at an educational water conservation event*. Refereed poster session presented at the Western Region meeting of the American Association of Agricultural Education, Fort Collins, CO.
- Durst, L., Dobelbower\*, S., & Meyers, C. (2017, September). *The relationship between familiarity with the Texas Alliance for Water Conservation and use of water conservation behaviors*. Refereed poster session presented at the Western Region meeting of the American Association of Agricultural Education, Fort Collins, CO.

## 2018

<u>Date</u>	<u>Presentation</u>	<u>Spokesperson(s)</u>
12-07-2017	Swisher County Extension Field, Tulia, TX	R. Kellison
04-12-2018	Dean Bill Brown, Lubbock, TX	R. Kellison
06-05-2018	Natural Resource Committee, Canyon, TX	R. Kellison
09-14-2018	BCI Tour, Lubbock, TX	R. Kellison
10-26-2018	BASF Tour, Lubbock, TX	R. Kellison
10-26-2018	Texas Lyceum Panel, Lubbock, TX	R. Kellison
11-29-2018	Nigerian Delegation, Lubbock, TX	R. Kellison, P. Brown

### **Formal Presentations:**

Bernadt, T., D. Brown, D. Dubois, B. Fuchs, W. Hargrove, S. Hermitte, A. Kremen, M. Shafer, C. Steele, R. Steele, C. Turner, and C. West. 2018. Regional drought early warning, impact, and assessment for water and agriculture in the Rio Grande basin, 2016-2017. Annual Meeting American Meteorological Society, Austin, TX.

McCallister, D., A. Cano, C. West, and D. Rudnick. 2018. A meta-analysis on the impact of irrigation technology on cotton yield and WUE. Beltwide Cotton Conference, Cotton Economics and Marketing Conference, San Antonio, TX, 3-5 January.

Chen, Y., D. McCallister, C.P. West, L.L. Baxter, C.P. Brown, and P.E. Green. 2018. Economic evaluation of integrating legume and beef production on low-water-input systems. Southern Section of Am. Soc. Agric. Econ. 2-6 February, Jacksonville, FL.

West, C.P. 2018. Water footprint of stocker beef production. Annual meeting of the American Society of Animal Science. 9-12 July, Vancouver, BC.

Dhakai, M., and C.P. West. 2018. Can interseeded alfalfa deplete water in semiarid grassland? Abstract for International Aridlands Conference, 13-14 August, Lubbock, TX.

Kharel, Geeta, S.K. Deb, and C.P. West. 2018. Evaluation of different models for quantifying water retention and thermal properties of semi-arid pasture soils land. Abstract for International Aridlands Conference, 13-14 August, Lubbock, TX.

- Raihan, Abir, W. Guo, S. Deb, Zhe Zhu, J. Neupane, Zhe Lin, Yazhou Sun, and C.P. West. 2018. Application of unmanned aerial systems for estimating soil water content in the Southern High Plains. Abstract for International Aridlands Conference, 13-14 August, Lubbock, TX.
- Neupane, Jasmine, W. Guo, F. Zhang, S. Deb, Z. Lin, A. Raihan, Y. Sun, and C.P. West. 2018. Irrigation rates, soil physical properties and topography effects on cotton yield in the Southern High Plains. Abstract for International Aridlands Conference, 13-14 August, Lubbock, TX.
- Sun, Yazhou., W. Guo, D.C. Weindorf, F. Sun, S.K. Deb, Z. Lin, J. Neupane, A. Raihan, C.P. West. 2018. Identifying soil properties using proximal sensors in the Southern High Plains. International Aridlands Conference, Aug, 13, 2018, Lubbock, TX.
- Otuya, R.K., L.C. Slaughter, C. West, V. Acosta-Martinez, and S.K. Deb. 2018. Effects of compost manure on soil microbial communities and soil health in a semi-arid improved pasture ecosystem. Abstract for International Aridlands Conference, 13-14 August, Lubbock, TX.
- West, C.P. 2018. Role of grasslands and cattle in conversion of irrigated cropland to dryland agriculture. Leu Distinguished Lecture Series, Nebraska Center for Grassland Studies. Nov. 12., Lincoln, NE.
- Baker, C., D. McCallister, P. Johnson, and J. Bordovsky. 2018. "Economic Analysis on the Timing of Cotton Irrigation with Variable Seasonal Irrigation Capacities in the Texas South Plains." Poster Presentation at the 2018 Texas Tech University 10<sup>th</sup> Annual Undergraduate Research Conference
- R.B. Williams, E. Segarra, D. Bian, and D. McCallister. 2018. "Impacts of Agricultural Productivity Enhancements and Time Value of Money on Groundwater Extraction." Western Social Science Association, San Antonio, Texas, April 4-7.
- McCallister, D. and P. Johnson. 2019. "A Fieldprint Calculator Analysis of Resource and Cost Efficiencies in the Southern High Plains." Proceedings of the 2019 Annual Beltwide Cotton Conference, January 10, New Orleans, LA.
- Pate, J., D. McCallister, and W. Keeling. 2019. "Economic Analysis of Cover Cropps in the Southern High Plains." Proceedings of the 2019 Annual Beltwide Cotton Conference, Poster Presentation, January 9, New Orleans, LA.
- W. Keeling, D. McCallister, K. Lewis, W. Keeling, P. DeLaune, and J. Burke. 2019. "Economic Comparison of Cover Crop Use in Texas High Plains Cotton." Proceedings of the 2019 Annual Beltwide Cotton Conference, January 10, New Orleans, LA.

## **Related Non-Refereed Publications**

### **(Phase I - 2005-2013/Phase II – 2014-2018)**

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- Rajan, N., and S. J. Maas. 2007. Comparison of water use among crops in the Texas High Plains estimated using remote sensing. Abstracts, 2007 Water Research Symposium, Socorro, NM.
- Rajan, N., and S. J. Maas. 2007. Calibrating aerial imagery for estimating crop ground cover. In R. R. Jensen, P. W. Mausel, and P. J. Hardin (ed.) Proc., 21st Biennial Workshop on Aerial Photog., Videography, and High Resolution Digital Imagery for Resource Assessment, Terre Haute, IN. 15-17 May. 2007. ASPRS, Bethesda, MD.
- Allen, V.G., D. Philipp, W. Craddock, P. Brown, and R. Kellison. 2007. Water dynamics in integrated crop-livestock systems. Proc. Simpósio Internacional em Integração Lavoura-Pecuária. 13, 14, and 15 August, 2007. Curitiba, Parana, Brazil.
- Acosta-Martínez, V., G. Burow, T.M. Zobeck, and V. Allen. 2007. Soil microbial diversity, structure and functioning under alternative systems compared to continuous cotton. Annual meeting of the American Society of Agronomy, New Orleans, LA. Nov. 4-8, 2007.
- Deycard, Victoria N., Wayne Hudnall, Vivien G. Allen. 2007. Soil sustainability as measured by carbon sequestration using carbon isotopes from crop-livestock management systems in a semi-arid environment. Annual meeting of the American Society of Agronomy, New Orleans, LA. Nov. 4-8, 2007.
- Doerfert, D., V. Allen, W. Craddock, and R. Kellison. 2007. Forage sorghum production in the Southern Plains Region. Texas Alliance for Water Conservation, Summary of Research. Vol. 1, No. 1. Texas Tech Univ., Lubbock, TX.
- Leigh, K., D. Doerfert. 2008. Farm-based water management research shared through a community of practice model. 44<sup>th</sup> Annual American Water Resources Association (AWRA) Conference, New Orleans, LA.
- Rajan, N., and S. J. Maas. 2008. Acclimation of crops to soil water availability. Abstracts, Annual Meetings, Amer. Soc. Agronomy. 5-9 October, Houston, TX. (CD-ROM)
- Maas, S. J., and N. Rajan. 2008. Estimating plant transpiration and soil evaporation using remote sensing. Abstracts, Annual Meetings, Amer. Soc. Agronomy. 5-9 October, Houston, TX. (CD-ROM)
- Rajan, N., and S. J. Maas. 2008. Comparison of PVI and NDVI for estimating crop ground cover for precision agriculture applications. In Proc., 9th International Conference on Precision agriculture. 20-23 July, Denver, CO. (CD-ROM)

- Robertson, G. P., V. G. Allen, G. Boody, E. R. Boose, N. G. Creamer, L. E. Drinkwater, J. R. Gosz, L. Lynch, J. L. Havlin, L. E. Jackson, S. T.A. Pickett, L. Pitelka, A. Randall, A. S. Reed, T. R. Seastedt, R. B. Waide, and D. H. Wall. 2008. Long-Term Agricultural Research: A Research, Education, and Extension Imperative. *BioScience* 58(7):604-645.
- Johnson, J., P. Johnson, E. Segarra and D. Willis. 2009. Water conservation policy alternatives for the Ogallala Aquifer in Texas. *Water Policy*. 11: (2009) 537-552.
- Weinheimer, J., and P. Johnson. 2009. Energy and Carbon. Considerations for High Plains cotton. 2010 Beltwide Cotton Conference. January 2010, New Orleans, LA.
- Yates, J., J. Pate, J. Weinheimer, R. Dudensing, and J. Johnson. 2010. Regional economic impact of irrigated versus dryland agriculture in the Texas High Plains. Beltwide Cotton Conference. January, New Orleans, LA.
- Weinheimer, J., N. Rajan, P. Johnson, and S.J. Maas. 2010. Carbon footprint: A new farm management consideration in the Southern High Plains. Selected paper, Agricultural & Applied Economics Association Annual Meeting. July 25-27, Denver, CO.
- Weinheimer, J. 2010. Texas Alliance for Water Conservation: An integrated approach to water conservation. Universities Council on Water Resources. July, Seattle, WA.
- Doerfert, D.L., L. Graber, D. Meyers, and E. Irlbeck. 2012. Traditional and social media channels used by Texas agricultural producers. Proceedings of the 2012 American Association for Agricultural Education (AAAE) Research Conference, Ashville, NC.
- Doerfert, D., R. Kellison, P. Johnson, S. Maas, and J. Weinheimer. 2012. Crop production water management tools for West Texas farmers. Paper to be presented at the 2012 American Water Resources Association (AWRA) Annual Conference, November, Jacksonville, FL.
- Maas, S. 2012. Combining remote sensing and crop modeling: It's like baking a cake. Abstracts, Annual Meetings of the American Society of Agronomy, October, Cincinnati, OH. (abstract) CD-ROM.
- Rajan, N., and S. J. Maas. 2012. Inter-annual variation in carbon dioxide and water fluxes from a grazed pasture in the semi-arid Texas High Plains. Abstracts, Annual Meetings, Amer. Soc. Agronomy. October, Cincinnati, OH. (abstract) CD-ROM.
- Rajan, N., M. Roy, S. J. Maas and F.M. Padilla. 2012. Soil background effects on reflectance-based estimates of leaf area index of cotton. Abstracts, Annual Meetings, Amer. Soc. Agronomy. October, Cincinnati, OH. (abstract) CD-ROM.



- Maas, S., and N. Rajan. 2012. Spectral Crop Coefficient Approach: Its Development and Validation. Proceedings, 2012 UCOWR/NIWR Annual Conference, 17-19 July 2012, Santa Fe, NM. (abstract)
- Rajan, N., and S. Maas. 2012. Comparison of the Spectral Crop Coefficient and Standard Crop Coefficient Approaches. Proceedings, 2012 UCOWR/NIWR Annual Conference, 17-19 July 2012, Santa Fe, NM. (abstract).
- Doerfert, D., R. Kellison, R., S. Maas, P. Johnson, and J. Weinheimer. 2012. Crop production water management tools for west texas farmers. 48<sup>th</sup> annual American Water Resources Association (AWRA) conference in Jacksonville, FL, November 2012.
- Doerfert, D. 2012. The Texas Alliance for Water Conservation: An integrated water resources management model for agriculture. 48<sup>th</sup> annual American Water Resources Association (AWRA) conference in Jacksonville, FL, November, 2012
- Doerfert, D., and Rutherford, T. Use of multi-user virtual environments (MUVES) for training purposes. 48<sup>th</sup> annual American Water Resources Association (AWRA) conference in Jacksonville, FL, November, 2012
- Graber, L., D. Doerfert, C.A. Meyers, and E.G. Irlbeck. 2012. Traditional and social media channels used by Texas agricultural producers. Proceedings of the American Association of Agricultural Education (AAAE) Western Region Conference, Bellingham, WA.
- Maas, S., and N. Rajan. Remote sensing based water management from the watershed to the field level. Workshop "Beyond Diagnostics: Insights and Recommendations from Remote Sensing." CIMMYT, Gates Foundation, 14-15 Dec 2013, Mexico City.
- Shafian, S., and S. Maas. Remote sensing based soil moisture detection. Abstracts, Workshop "Beyond Diagnostics: Insights and Recommendations from Remote Sensing." CIMMYT, Gates Foundation, 14-15 December 2013, Mexico City. (Invited)
- West, C.P., C.P. Brown, and V.G. Allen. 2013. Integrated crop/forage/livestock systems for the Texas High Plains. 67th Southern Pasture and Forage Crop Improvement Conference. 22-24 Apr., 2013, Tyler, Texas.
- Mitchell, D., P. Johnson, V. Allen, and C. Zilverberg. 2013. Integrating cotton and beef production in the Texas Southern High Plains: A simulation approach. Abstract for Southern Agric. Econ. Assoc., February 2-5, 2013, Orlando, FL.
- Mitchell, D., and P. Johnson. 2013. Economic impacts of the 2011 drought on the Southern High Plains. Abstract for Am. Agric. Econ. Assoc., August 4-6, 2013, Washington, DC.

- Stokes, K., P. Johnson, B. Robertson, and B. Underwood. 2014. FieldPrint Calculator: A measurement of agricultural sustainability in the Texas High Plains. 2014 Beltwide Cotton Conferences Proceedings, pg. 406-412. January 4-7, 2014, New Orleans, LA.
- Gillum, M. and P. Johnson. 2015. Fieldprint Calculator: Results from the Texas High Plains. 2015 Beltwide Cotton Conferences Proceedings, in press. Selected for presentation at the 2015 Beltwide Cotton Conference. Co-sponsored by the National Cotton Council and the Cotton Foundation, January 5-7, 2015, San Antonio, TX.
- Xiong, Y., C.P. West, and C.P. Brown. 2014. Digital image analysis of Old World bluestem canopy cover and leaf area. In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI.
- West, C.P., S.J. Maas, R. Kellison, C.P. Brown, S. Borgstedt, P.N. Johnson, D.L. Doerfert, J. Pate, and J. Yates. 2014. Promoting conservation of irrigation water in the Texas High Plains. In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI.
- West, C. 2014. Regional Opportunities and Challenges: High Plains. D. Reible (ed.). p. 36-39. 2014 Texas Water Summit Report: Securing our Economic Future. The Academy of Medicine, Engineering, and Science of Texas (TAMEST), Austin, TX. Available at: <http://www.tamest.org/publications/event-publications.html>.
- West, C., R. Kellison, C.P. Brown, S.J. Maas, S. Borgstedt, P.N. Johnson, J. Pate. 2014. TAWC 2013 Annual report to Texas Water Development Board.
- West, C., R. Kellison, C.P. Brown, S.J. Maas, S. Borgstedt, P.N. Johnson, J. Pate. 2014. TAWC 2004-2013 Phase I Final report to Texas Water Development Board.
- Pate, Jeff, and Donna Mitchell: "Profitability of 2 and 2 Skip-Row Planted Cotton". Poster presented in the Economics and Marketing Session at the 2015 Beltwide Cotton Conferences, January 2015, New Orleans, LA. Published in 2015 Proceedings.
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## Phase I - Budget

**Table A 47.** Final task and expense budget for Phase I Years 1-9 of the demonstration project.

2005-358-014		Year 1 (9/22/04 - 1/31/06)	Year 2 (2/01/06 - 2/28/07)	Year 3 (3/01/07 - 2/29/08)		Year 4 (3/01/08 - 2/28/09)	Year 5 (03/01/09 - 2/28/10)	Year 6 03/01/10 - 2/28/11	Year 7 03/01/11 - 2/29/12	Year 8 03/01/12 - 2/28/13	Final Year 03/01/13 - 4/30/14	
Task Budget	Task Budget*	revised	revised									Total Expenses
1	4,537	4,537	0	0		0	0	0	0	0	0	4,537
2	2,561,960	216,966	335,319	317,317		299,727	249,163	299,550	296,282	249,082	371,233	2,631,949
3	675,402	21,112	33,833	80,984		61,455	56,239	28,122	46,033	145,566	200,675	674,017
4	610,565	52,409	40,940	46,329		53,602	64,124	43,569	117,206	118,858	60,525	597,564
5	376,568	42,428	40,534	47,506		38,721	51,158	27,835	29,231	45,096	55,092	377,601
6	568,773	54,531	75,387	71,106		60,257	39,595	60,473	52,444	56,865	97,256	567,913
7	306,020	37,014	22,801	30,516		25,841	11,497	14,302	34,398	87,024	13,269	262,197
8	334,692	44,629	43,089	41,243		43,927	42,084	42,984	37,157	38,169	5,948	339,229
9	623,288	145,078	39,011	35,656		82,844	52,423	65,785	32,971	76,416	110,886	627,160
10	162,970	0	0	0		0	0	86,736	55,871	0	0	142,607
TOTAL	6,224,775	618,702	630,914	670,657		666,374	566,283	669,355	701,594	817,075	914,885	6,224,775
		Year 1 (09/22/04 - 01/31/06)	Year 2 (02/01/06 - 02/28/07)	Year 3 (3/01/07 - 2/29/08)		Year 4 (3/01/08 - 2/28/09)	Year 5 (03/01/09 - 2/28/10)	Year 6 03/01/10 - 2/28/11	Year 7 03/01/11 - 2/29/12	Year 8 03/01/12 - 2/28/13	Final Year 03/01/12 - 4/30/14	Total Expenses
Expense Budget	Total Budget*											
Salary and Wages <sup>1</sup>	2,524,172	230,611	304,371	302,411		301,933	259,929	293,198	307,459	300,033	288,676	2,588,620
Fringe <sup>2</sup> (20% of Salary)	370,655	28,509	34,361	36,263		40,338	37,180	43,410	42,061	32,852	35,536	330,219
Insurance	186,600	13,634	26,529	25,302		25,942	21,508	23,294	24,918	17,554	25,126	204,096
Tuition and Fees	199,922	8,127	16,393	21,679		18,502	13,277	9,828	21,803	35,299	34,565	179,473
Travel	158,482	14,508	25,392	14,650		15,556	16,579	12,329	19,127	17,148	30,752	166,041
Capital Equipment	154,323	23,080	13,393	448		707	18,668	95,993	(146)	0	5,842	157,983
Expendable Supplies	105,455	14,277	16,100	12,205		18,288	8,614	4,802	8,265	21,058	73,705	163,314
Subcon	1,758,667	212,718	103,031	161,540		183,125	131,627	115,587	131,779	335,505	353,396	1,697,245
Technical/Computer	61,364	9,740	3,879	16,225		430	7,990	11,857	10,550	0	0	74,671
Communications	270,192	25,339	41,374	35,497		23,062	14,448	18,300	45,344	17,002	22,315	242,681
Reproduction (see comm)												0
Vehicle Insurance	2,000	0	397	235		187	194	114	130	222	0	1,479
Producer Compensation	57,450	0	0	0		0	0	0	39,225	0	0	39,225
Overhead	375,493	38,160	45,694	44,202		38,302	36,270	40,644	51,079	40,403	44,972	379,726
Profit												
TOTAL	6,224,775	618,702	630,914	670,657		666,374	566,283	669,355	701,594	817,075	914,885	6,224,775

## Phase I - Cost Sharing

**Table A 48.** Final cost sharing figures for TTU, Texas A&M AgriLife, and HPUWCD for Phase I Years 1-9 of the demonstration project.

### Cost Sharing Balance Summary (estimated)

Budget	Total Cost Share Budgeted	Actual Funds Contributed	Balance
TTU		958,073.61	
TAMU		417,512.95	
HPUWCD		200,053.70	
TOTAL	1,300,000.00	1,575,640.26	(-275,640.26)

Expense Categories	Total Expense Budget	Actual Funds Contributed	Balance
Salary & Wages		350,471.81	
Overhead		607,601.80	
SubCon - TAMU		417,512.95	
\$25,000/yr - HPUWCD		200,053.70	
TOTAL	1,300,000.00	1,575,640.26	(-275,640.26)