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

12th Annual Comprehensive Report 2005-2016

to the

Texas Water Development Board

Texas Alliance For Water Conservation

TAWC

"Water is Our Future"

NOVEMBER 1, 2017

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

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 2016 PARTICIPANTS

Texas Tech University
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Mr. Rick Kellison, Project Director*
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Dr. Phillip Johnson*
Dr. Wenxuan Guo*
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Texas Department of Agriculture
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* 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		

The dedication of all these participants is gratefully acknowledged.

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

Objective

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

Background

The Texas High Plains generates a combined annual economic value of crops and livestock that exceeds $9.9 billion ($2.4 crops; $7.5 livestock; Texas Agricultural Statistics, Texas Department of Agriculture, 2012). Such productivity is highly dependent on water from the Ogallala Aquifer. Groundwater supplies have been declining significantly in the South Plains region (average depth to water during 2006-2016 declined 9.29 feet in High Plains Underground Water Conservation District No. 1[1], 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 over 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 risk. 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 that include both crops and livestock have long been known for complementary effects that increase productivity. Research conducted at Texas Tech over the past 15 years has shown that an integrated cotton/forage/beef cattle system, compared with a continuous cotton monoculture, lowered irrigated water use by about 25%, increased profitability per unit of water invested, diversified income sources, reduced soil erosion, reduced nitrogen fertilizer use by about 40%, and decreased needs for other chemicals, while maintaining similar cotton yields per acre between the two systems (Allen et al., 2005; 2012). Profitability was found to be similar for the integrated system as compared to the cotton monoculture system (Johnson et al., 2013). Furthermore, soil health was improved, more carbon was sequestered, and soil microbial activities were higher in the integrated system compared with the cotton monoculture (Acosta-Martinez et al., 2004; 2008; 2010). This and other research on crop production, agricultural climatology, economics, and communication dynamics provided basic information for designing the demonstration project. Results from the demonstration sites serve to validate the research and inform approaches to current and future research.

No single technology will successfully address water conservation. Rather, the approach must be an integration of agricultural systems, best irrigation technologies, improved plant genetics, and management strategies that reduce water demand, optimize water use and value, and maintain an appropriate level of productivity and profitability. Water

[1] High Plains Water District 2016 Water Level Report source: http://www.hpwd.org/reports/

conservation must become both an individual goal and a community ethic. Educational programs are needed at all levels to raise awareness of the necessity for water conservation to 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, and indeed the State of Texas and the world, depends on our ability to protect and appropriately use our water resources. Nowhere is there greater opportunity to demonstrate the implications of successfully meeting these challenges than in the High Plains of west Texas.

A multidisciplinary and multi-university/agency/producer team, coordinated though Texas Tech University, assembled during 2004 to address these issues. In September of 2004 the project *'An Integrated Approach to Water Conservation for Agriculture in the Texas Southern High Plains'* was approved by the Texas Water Development Board and funding was received in February 2005 to begin 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 vary 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 Incentive 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. 30 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 third 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 2005-2016 *Chuck West, Philip Brown (TTU)*

Sites 34, C39, C53, C54 and C59 (totaling 1,069 acres) had no data collected in 2016 due to various circumstances and are not included in these summaries; however, they currently remain a part of the project. With 12 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 12 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. Seven of 12 years exhibited below-average rainfall, with 2011-2013 substantially below average. Precipitation for 2016 averaged 16.6 inches across all sites, with 12.5 inches occurring from May through September, which agrees with the long-term average over those months; however, June and July were substantially below and August and September were above long-term average (Figure 14; Table 2; p. 20-21).

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.

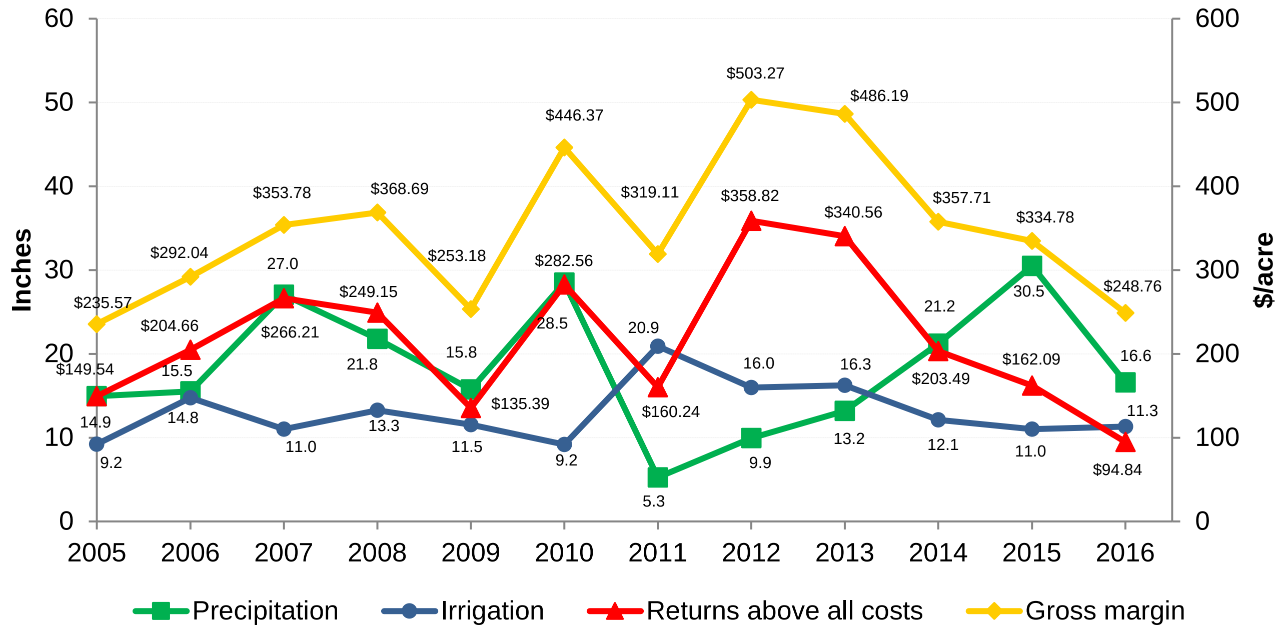

Figure 1. Average precipitation (inches), irrigation applied (inches), returns above all costs ($/acre), and gross margin ($/acre) for irrigated sites only.

Amount of system irrigation averaged over 12 years on the irrigated sites was only 13.0 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 31.4 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-September) rainfall ranged from approximately 3 inches in 2011 to 19 inches in 2010, with an average of 12.5 inches per year during 2005-2016. Timing of this rainfall is critical for producing a viable crop in drier years. In the four "wet" years (rainfall exceeding 20 inches), total water received ranged from 33.1 to 41.0 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. Irrigation supplied 20.9 inches for a total water input of 26.2 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 13.0 to 12.3 inches.

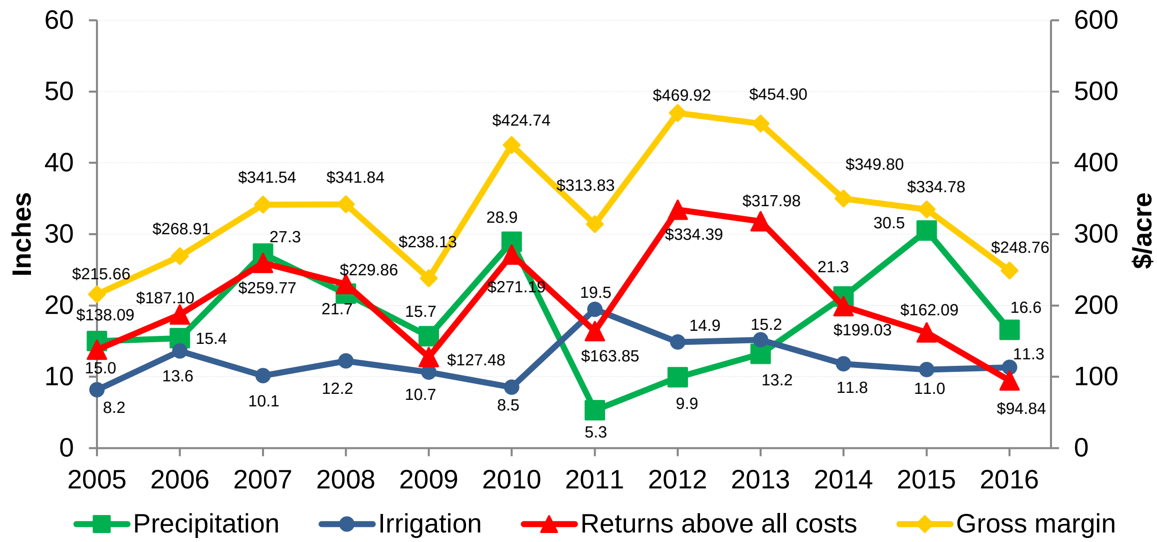

Figure 2. Average precipitation (inches), irrigation applied (inches), returns above all costs ($/acre), and gross margin ($/acre) for all sites, irrigated and dryland (there are no dryland sites after 2014).

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 doubled over the years from $77/acre in 2005 to $154/acre in 2016. 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 2014-2016 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 setting back crop planting and early-fall rains hampering harvest. The favorable August-September rains and warmer than normal and dry October in 2016 benefited crop yields; however, depressed commodity prices limited profitability.

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 2016 relative to 2015 were increased cotton and decreased corn acreage (Figure 3).

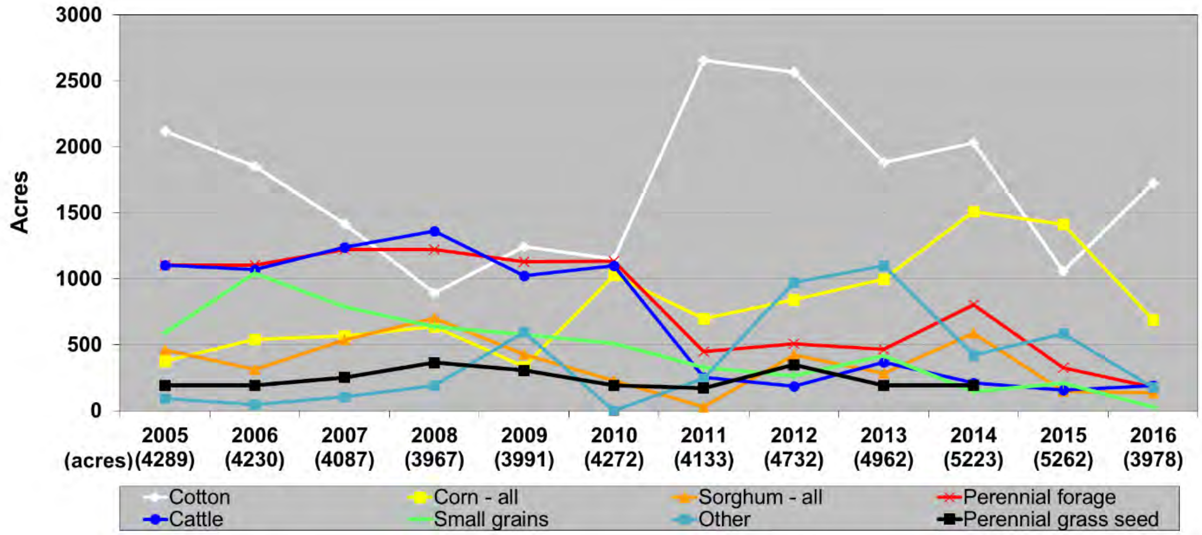

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Figure 3. Number of acres of various crops and cattle enterprises. Sites were located in two counties through 2013 (Phase I) and in nine counties for Phase II (2014 and later).

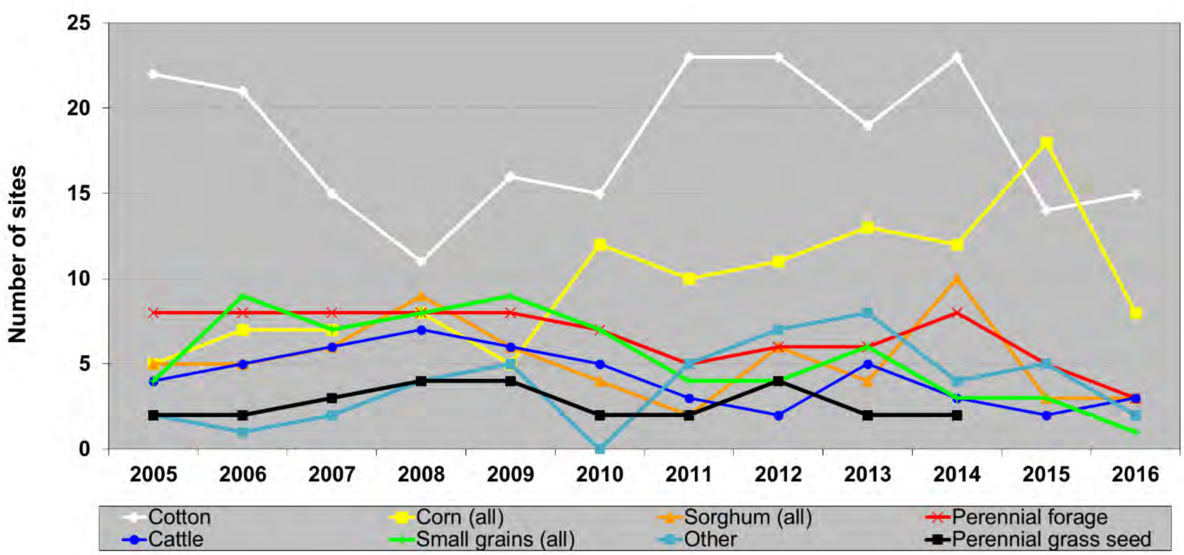


Figure 4. Number of sites of various crops and cattle enterprise. Sites were located, in two counties through 2013 (Phase I) and in nine counties for Phase II (2014 and later).

The trends in number of sites where different commodities were produced (Figure 4) generally followed the trends in acreage distribution (Figure 3). 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.

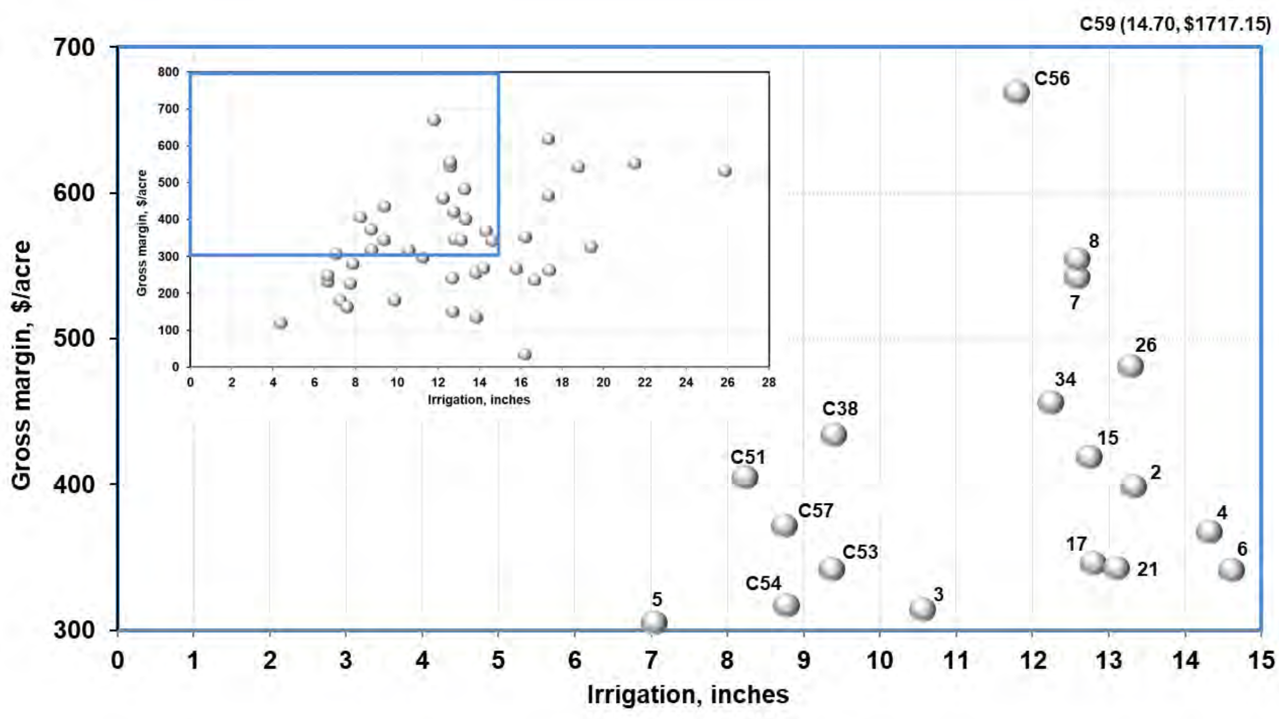


Figure 5. Gross margin per acre in relation to inches of applied irrigation averaged over 2005 to 2016. Each point represents one site, of which all were irrigated, averaged across all years in which they were in the project. See Table 1 for site descriptions. The main graph depicts sites which met the arbitrary criteria of relatively low irrigation and high gross margin. The insert shows all sites. Site C59, not shown because it was off scale, had $1717 gross margin with 14.7 inches of irrigation averaged over 2 years.

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 2005-2016 are shown. Site numbers with "C" indicate new Phase II sites.

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/Low energy spray 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
C38	Cotton monoculture (1 year)	Variable rate/Low elevation spray application
C51	Cotton monoculture (3 year)	Subsurface drip
C53	Cotton monoculture (2 year)	Subsurface drip
C54	Cotton monoculture (2 year)	Subsurface drip
C56	Monoculture, rotation, corn/blackeye pea/corn (3 year)	Low elevation spray application
C57	Monoculture, corn/corn/sunflower (3 year)	Low elevation spray application
C59	Alfalfa monoculture (2 year)	Subsurface drip

Nineteen 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 2005-2016 inclusive to 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, 17, 21, 26, and 34 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. Corn in sites C56 and C57 were for silage, and only represent 2 years of data. Sites C51, 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.

2016 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 2016 were corn monoculture (entire site in corn only), cotton monoculture (entire site in cotton only), alfalfa monoculture (entire site in alfalfa only), sorghum monoculture (entire site in grain sorghum), integrated crop/livestock (site included cattle on pasture plus an annual crop and/or hay), multi-cropping (more than one annual crop species harvested in the reporting year). Systems not occurring in years after 2012 included cow-calf pasture and dryland multi-cropping. A site categorized in one system is re-categorized each year that the crop choice changes. The "Other" category is a catch-all of minor annual crops and fallow whose makeup changes from year to year. In 2016, grain sorghum acreage declined because of concern over the previous year's infestations by sugarcane aphid.

In 2016, corn monoculture accounted for 23% of the 22 sites from which yield data were collected, while integrated crop/livestock occupied 14%, cotton monoculture occupied 41%, multi-cropping occupied 18%, and other monoculture (sunflower) 4%. Sunflower and corn composed one of the multi-cropping sites. Various combinations of alfalfa, grain sorghum, forage sorghum, grazed wheat, grazed kleingrass/buffalograss and WW-B.Dahl old world bluestem and cotton constituted the three integrated crop/livestock sites.

This section compares the cropping systems for net returns per acre and per acre-inch of irrigation, and usage of irrigation and nitrogen fertilizer for 2016. Low commodity prices in 2016 continued to drive lower net returns as compared to the peak years of 2012 and 2013 (Figures 1 and 2). For the systems that have been monitored over many years, the highest-return system in 2016 was cotton monoculture, followed by multi-cropping and integrated crop/livestock (Figure 6). Continuous corn and sunflower monoculture had negative returns per acre.

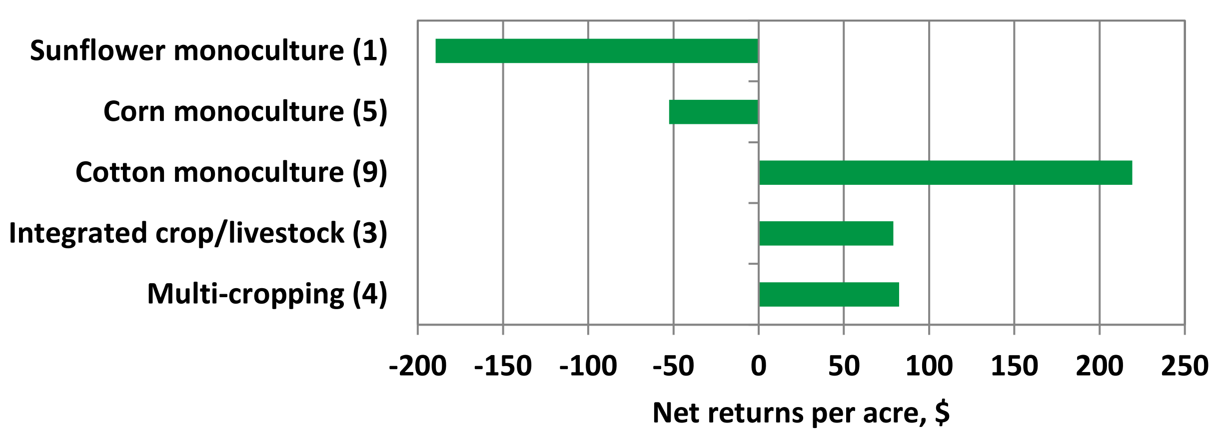


Figure 6. Net returns per acre for five cropping systems in 2016 with number of sites in parentheses.

These systems were also examined in terms of net returns per acre-inch of irrigation applied (Figure 7, green bars). Sunflower monoculture and corn monoculture were negative, while cotton monoculture had the greatest returns, and integrated crop/livestock and multi-cropping had lower positive returns. The blue bars in Figure 7 indicate average inches of irrigation applied per system. Sunflower monoculture had the lowest application (6.0 inches) and corn monoculture had the highest (15.5 inches).

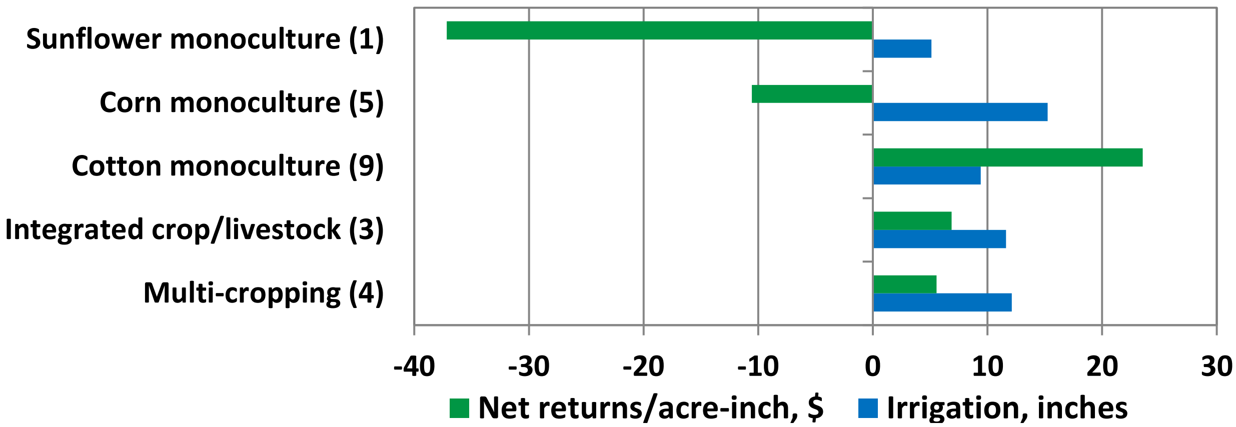


Figure 7. Net returns per acre-inch irrigation water (green bars), and inches of irrigation applied (blue bars), 2016 with number of sites in parentheses.

The amount of nitrogen applied in fertilizer varied across cropping system (Figure 8). Corn monoculture, integrated crop/livestock, and multi-cropping had the highest application rates of nitrogen (N) fertilizer at 207, 142 and 141 lbs/system acre, respectively (Figure 8). The lowest N applied was to the cotton monoculture at 72 lbs/system acre. The significance of N fertilizer application is that it constitutes a major input cost and therefore greatly influences the calculation of net return.

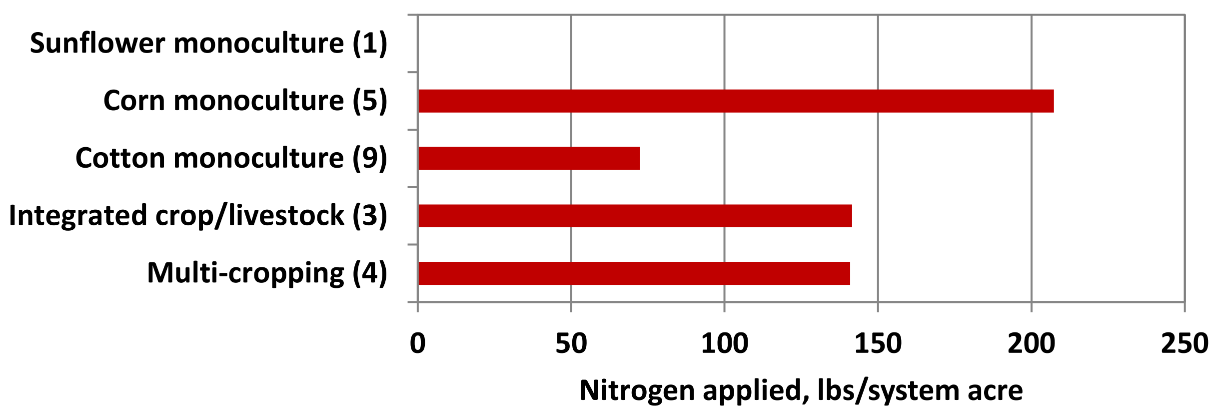


Figure 8. Pounds per system acre of nitrogen applied in fertilizer by cropping system, 2016 with number of sites in parentheses.

Project years 1 through 12 (2005-2016)

Figure 9 summarizes net returns per acre by system over the life of the project so far. Note the extremely high value for alfalfa monoculture, which benefited from timely late-spring rains in 2014-2015. Similarly, blackeye pea exhibited high return with only one year's data. Apart from those two newer crops in the project, grass seed monoculture was the most profitable system in the long term at $376/acre (2005-2014). While irrigated multi-cropping and cotton monoculture yielded similar average net returns per acre ($222 and $206/acre, respectively), integrated crop/livestock was at $163 and corn monoculture was around $134/acre. Grain sorghum monoculture (one year only) showed the most negative net returns among the systems.

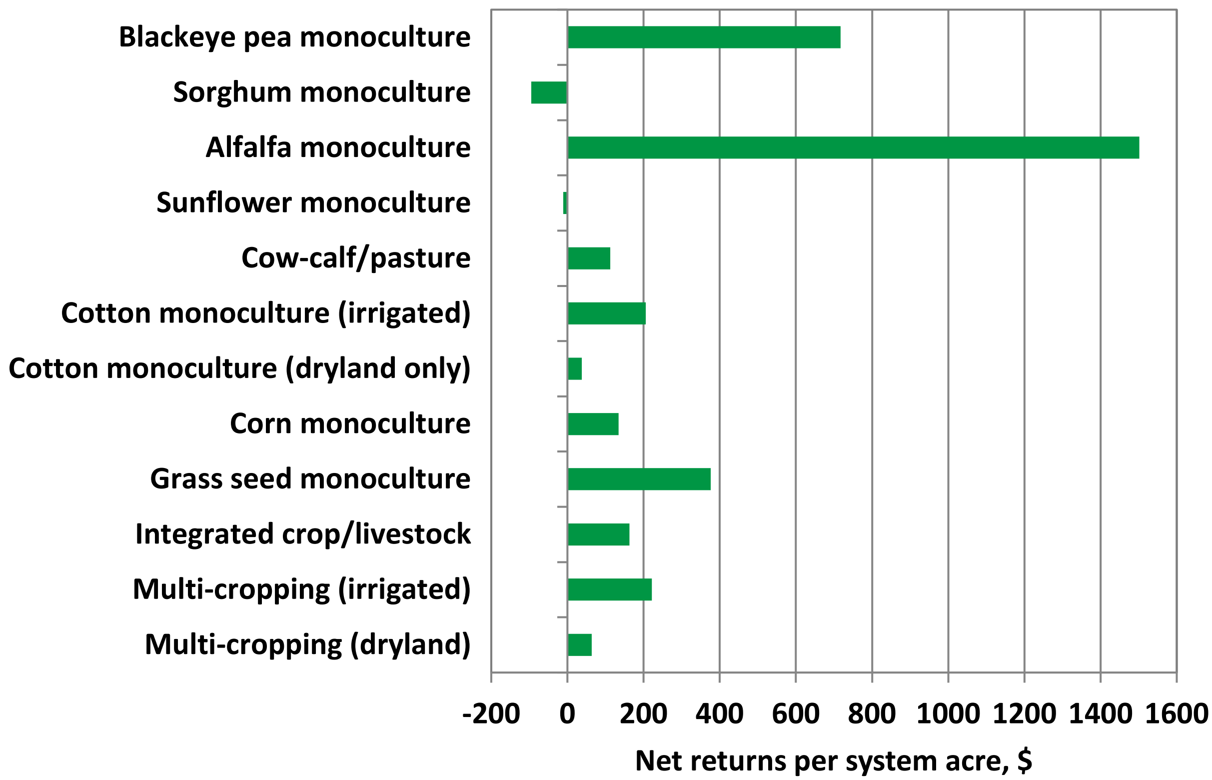


Figure 9. Net returns per system acre, average of 2005-2016, or for those years which those systems occurred. Data for cow-calf includes 2005-2010 data only, for alfalfa monoculture 2014-2015 only, for blackeye pea 2015 only, sorghum monoculture in 2014 only, sunflower monoculture in 2008, 2009 and 2016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

Net returns per acre-inch of irrigation applied over the project life (Figure 10, green bars) were greatest for the single year 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 $21.87/acre-inch, about twice as great as the net return for corn monoculture ($9.42). 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 (17.2 inches), followed by alfalfa (14.7 inches). Irrigated cotton monoculture received about the same amount of irrigation (11.1 inches) as grass seed (11.4 inches) and the integrated crop-livestock system (11.9 inches).

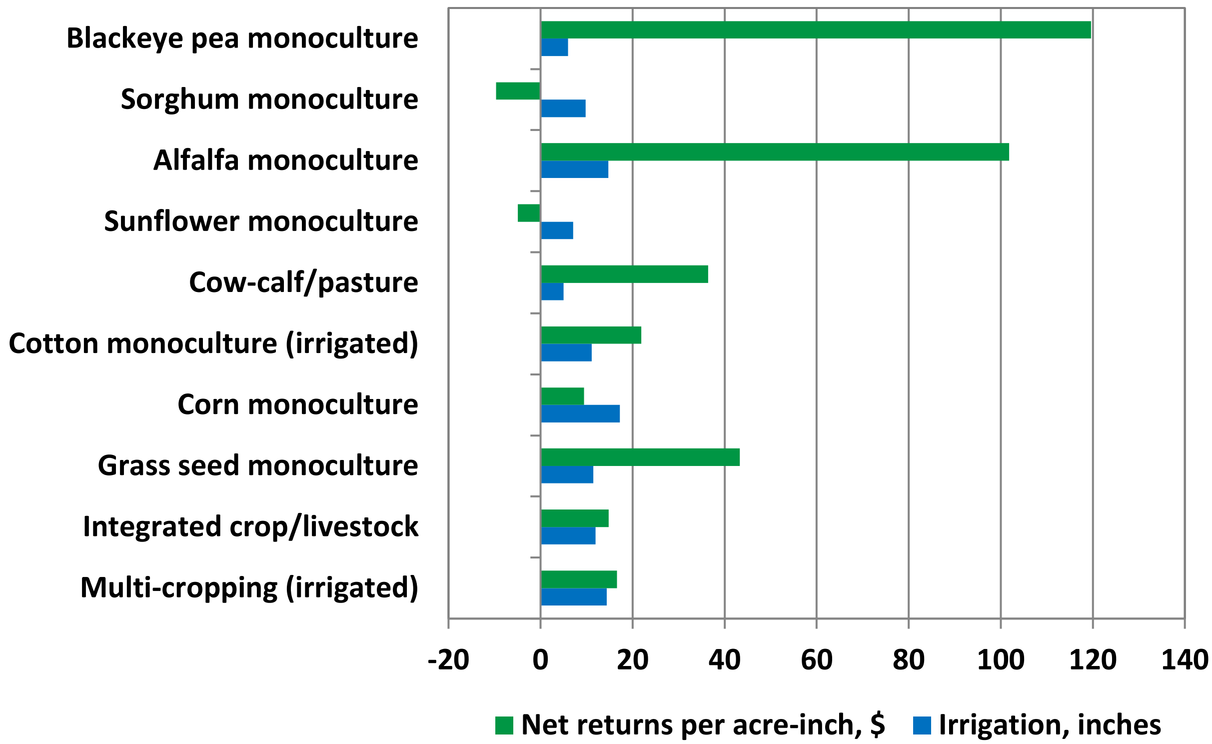


Figure 10. Net returns per acre-inch of irrigation water (green bars), and inches of irrigation applied (blue bars), average of 2005-2016. Data for cow-calf/pasture includes 2005-2010 only, for alfalfa monoculture 2014-2015 only, for blackeye pea 2015 only, sorghum in 2014 only, sunflower in 2008, 2009 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 196 lbs N/acre. Blackeye pea was second highest, receiving 144 lbs N/acre. All other systems received from about 67 to 132 lbs/acre of N.

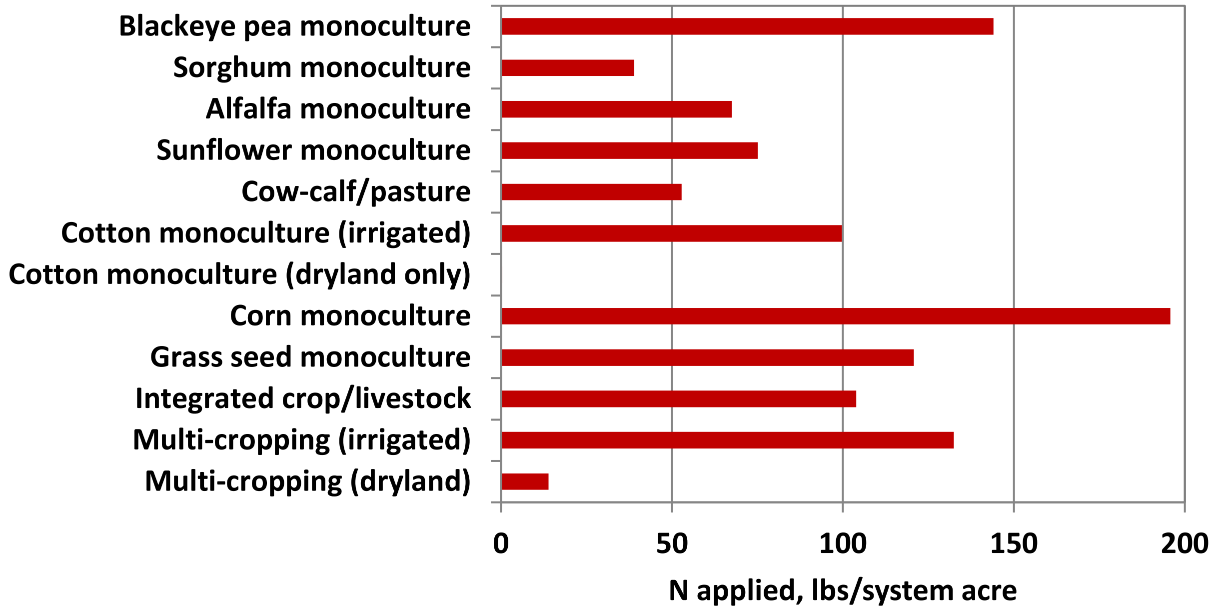


Figure 11. Pounds of nitrogen per system acre applied in fertilizer, average of 2005-2016. Data for cow-calf/pasture includes 2005-2010 only, for alfalfa monoculture 2014-2015 only, for blackeye pea 2015 only, sorghum in 2014 only, sunflower in 2008, 2009 and 2016 only.

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 so as to relieve some need for irrigation. It is possible that implementation of more efficient irrigation management during 2016 and a reduction in corn acreage also contributed to the slower decline in groundwater; however, the data are inadequate to evaluate that impact.

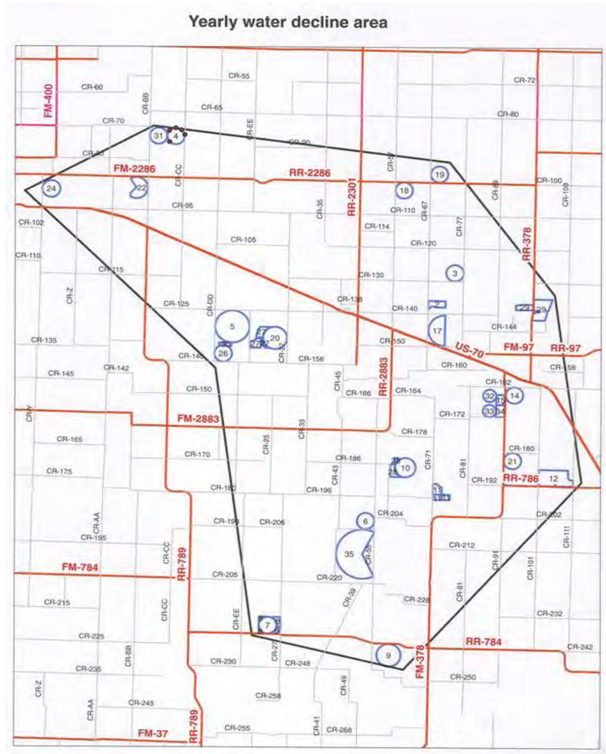


Figure 12. Original TAWC project area for determining water in storage (area encompassed within solid black line; 97,900 total acres) and cooperator demonstration sites (areas in blue symbols).

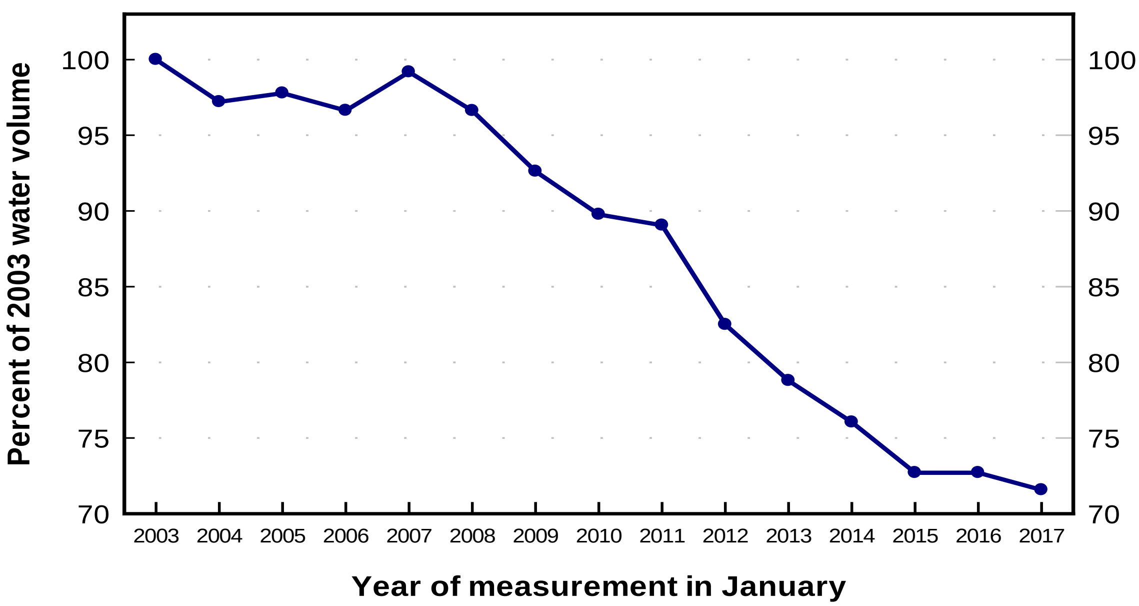


Figure 13. Change in water storage in TAWC project area from 2003 to 2017 expressed as percentage of the volume in 2003 (1,748,630 acre-feet).

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. 22-28) and in Tables 3-6. In 2016, the amount of irrigation water potentially conserved was 2,696 acre-feet over 2909 acres, or 11.1 inches of depth (Table 3). Over the 12 years of the project, the depth of water conserved averaged 13.0 inches per year (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 2016, irrigation provided an average of 50% of crop water demand, while effective rainfall provided 30%, and soil storage 3%, for a total of 83%. Total crop water supply ranged from 54% to 143% of crop water demand among the sites. Breaking that down by irrigation delivery system, the LEPA system provided an average of 83%, subsurface drip 79%, LESA 79%, MESA 86%, furrow 83%, and variable rate irrigation (VRI) 80%. Irrigation types did not vary much in the percentage of crop water demand provided, suggesting that producers managed water use fairly well on a per-site basis. The occurrence of seven sites out of 22 that exceeded receiving 86% of crop water demand illustrates room for further improvements in conserving water. Greater use of the TAWC online irrigation scheduling tool and equipment demonstrated by this project can help reduce irrigation needs. See Table 6 for means of water use efficiency by crop type.

Overall Discussion

Over 12 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™ and AquaSpy®, which aid specifically in the tactical decision process. We have provided some of these technologies to producers within the TAWC project. Information received from these technologies in conjunction with measurement of evapotranspiration (ET) on a field by field basis has helped producers gain insight into better irrigation management techniques. Feedback from producers who have used these technologies has helped us formulate tools to address the short-term and long-term irrigation management challenges facing the region. Continual adoption of water-saving 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 Scheduling Tool, Resource Allocation Analyzer, Heat Unit Calculator for corn and cotton, and a general Daily Cotton Water Use Tracking tool.

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 2016 we held the Second Annual TAWC Water College event to promote education in water conservation. See page 19 for the most recent Water College program agenda.

Field walks were also continued at a participating farm in June-September to demonstrate how to schedule irrigation in relation to meeting crop needs and the performance of a technology called precision mobile drip irrigation (PMDI). See Task 6 beginning on page 43 for more detailed information. These field days allowed attendees to visit several project sites and observe the technologies that are currently being demonstrated within the project to better manage and monitor irrigation use and timing. 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 outreach presentations, articles and activities are listed on pages 54-56 and beginning on 243 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 46.

The long-term ability of this project to observe and monitor a variety of crop and integrated crop/livestock systems under various environmental conditions is now allowing us to provide valuable information on irrigation management and water conservation techniques to producers in the area. The management of the Ogallala water resource is critical to the continued economic success of agriculture in the region. Producers face many technical, 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.

TAWC Water College

January 20, 2016
Bayer Museum of Agriculture, 1121 Canyon Lake Drive,
Lubbock, TX (3 TDA CEU's, 3.25 IA CEU's, 6.0 CCA CEU's)

8:15 am Registration & Refreshments

8:35 am Welcome & Introductions - ***Cameron Turner, Team Lead for Agricultural Water Conservation Programs, Texas Water Development Board***

8:45 am Nebraska Water "What's the Right Thing to Do" - ***Roric Paulman, Paulman Farms***

9:30 am Grain Sorghum Management Options - ***Brent Bean, Agronomist Sorghum Checkoff***

10:20 am Texas Water Development Board Update - ***Bech Bruun, Chairman Texas Water Development Board***

11:00 am Understanding ET and "How to Use the Data" - ***Bob Glodt, Crop Consultant Specialist***

12:30 pm Water Cotton "Know When to Hold'em and Know When to Fold'em" - ***Dr. Kater Hake, Vice President Agricultural and Environmental Research, Cotton Incorporated***

1:15 pm Weather and Climate Outlook - ***Brian Bledsoe, Consultant and Chief Meteorologist***

1:45 pm Corn Management Options - ***Cody Daft, Agronomist Pioneer Hi-Bred***

2:45 pm "Texas Agriculture Matters" TDA Policy Update - ***Sid Miller, Commissioner Texas Department of Agriculture***

3:15 pm Cotton Management Options - ***Craig Bednarz, Scientist Bayer Crop Science***

4:05 pm Closing Remarks

Thanks to our Sponsors: Bayer Crop Science, Sorghum Checkoff, Cotton Inc., DuPont Pioneer, Eco-Drip,
Texas Sorghum Producers, Texas Corn Producers, AgTexas Farm Credit, Plains Cotton Growers, Capital Farm Credit, Diversity D Irrigation Services, Zimmatic Irrigation Services, Hurst Farm Supply, High Plains Underground Water District, Growers Source, Dow AgroSciences, Netafim, Dragon-Line, AquaSpy, Valley, Nelson TomCar, Texas Department of Agriculture

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

2016 Weather data (See Appendix for 2005-2015 data)

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.

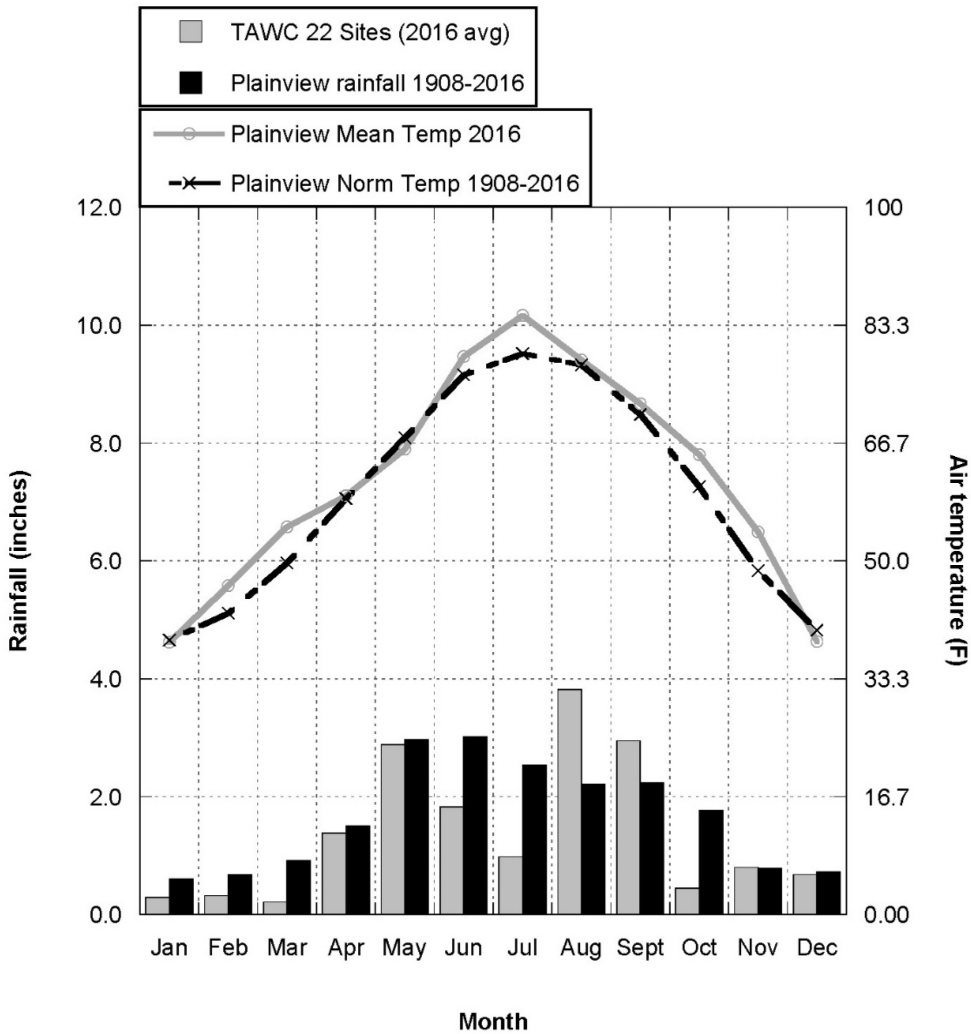


Figure 14. Temperature (lines) and precipitation (bars) by month for 2016 near the demonstration area (Plainview, TX) compared with long term averages.

Table 2. Precipitation (inches) at each site in the demonstration area during 2016.

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

Water and Crop Use Efficiency Summaries

Philip Brown and Chuck West

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

Table 3 lists information on 2016 crop water use and irrigation water conserved in the 37 fields that made up the 22 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 in 2016 were 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 Soil Conservation Service (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053627).

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 2016 cropping year, which includes total irrigation, 50% effective seasonal rainfall and plant-available soil moisture (where available), provided an average of 81% of the total crop water demand and ranged from 29 to 166% (Table 3, second column from the right). The range among sites was 54 to 143%. Irrigation at greater than 100% crop water demand indicated excessive water application with 6 fields among the 36 fields (22 sites). On average across all sites and irrigation systems, irrigation alone provided 50% of the total crop water demand with 30% provided by rainfall and approximately 3% provided by the stored plant available soil moisture. These variables total to approximately 83% of the crop water demand being provided by the total crop water supplied. Stored plant-available soil moisture was likely underestimated due to inability to collect gravimetric samples from all sites, leaving large data gaps for this cropping year. In addition, some rainfall events in 2016 were less extreme and likely provided greater than the 50% effective rainfall standard used in our calculations. The estimated total irrigation potentially conserved across the TAWC project sites totaled 2,696 acre-feet for the growing season. The average depth of irrigation water conserved was 13.05 inches.

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 2016.

Year	Site	Field	Crop	Status	Irrigation type	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)
2016	4	5	Alfalfa	Hay	LEPA	16.0	6.9	28.0		34.9	40.0	17	70	na	87	16.0	12.0
2016	4	8	Grain sorghum	Seed	LEPA	50.5	6.9	11.3	0.0	18.2	26.0	25	40	0	65	70.3	16.7
2016	4	9	Wheat	Grazed	LESA	29.6	5.2	1.2		6.4	11.7	44	10	na	55	25.9	10.5
2016	4	9	Forage sorghum	Double crop	LESA	29.6	4.5	3.5		8.0	28.0	16	13	na	29	60.4	24.5
2016	4	10	Cotton		LESA	26.9	7.5	8.3	0.0	15.8	19.0	40	44	0	83	24.0	10.7
2016	6	9	Corn		LESA	60.6	6.3	18.0	0.0	24.3	32.0	20	56	0	76	70.7	14.0
2016	6	10	Cotton		LESA	62.1	6.6	10.5	0.0	17.1	19.0	35	55	0	90	44.0	8.5
2016	9	3	Grass	Grazed	MESA	102.5	7.0	0.0		7.0	15.0	72	0	na	72	83.3	9.8
2016	9	2	Cotton		MESA	134.0	7.4	16.0	2.0	25.4	19.0	39	84	11	133	33.5	3.0
2016	10	6	Grass	Grazed	LESA	57.7	6.6	9.6		16.2	9.8	67	98	na	166	0.7	0.2
2016	10	7	Cotton		LESA	59.2	7.0	14.0	2.0	23.0	19.0	37	74	11	121	24.6	5.0
2016	10	8	Corn		LESA	59.2	6.6	20.0	-1.5	25.1	32.0	20	63	-5	78	59.2	12.0
2016	11	2	Cotton	Hail damage	SDI	24.4	7.8	13.0	-2.0	18.8	19.0	41	68	-11	99	12.2	6.0
2016	11	3	Cotton	Hail damage	SDI	22.9	7.8	13.0	-2.0	18.8	19.0	41	68	-11	99	11.5	6.0
2016	11	5	Cotton	Hail damage	FUR	46.8	7.8	8.0	0.0	15.8	19.0	41	42	0	83	42.9	11.0
2016	14	4	Cotton	2 in, 2 out	MESA	124.1	6.1	8.0	-2.0	12.1	19.0	32	42	-11	64	113.8	11.0
2016	17	5	Corn		MESA	54.5	6.3	16.0	6.0	28.3	32.0	20	50	19	88	72.7	16.0
2016	17	6	Corn		MESA	54.4	7.7	18.0	-2.0	23.7	32.0	24	56	-6	74	63.5	14.0
2016	21	1	Cotton		LEPA	61.1	5.4	10.8	2.0	18.2	19.0	28	57	11	96	42.0	8.3
2016	21	2	Cotton		LEPA	60.6	5.4	8.3	2.0	15.7	19.0	28	43	11	82	54.3	10.8
2016	22	1	Cotton		LEPA	145.0	6.1	14.0	1.0	21.1	19.0	32	74	5	111	60.4	5.0
2016	24	1	Sunflower		LESA	64.6	5.2	6.0		11.2	22.0	24	27	na	51	86.1	16.0
2016	24	2	Corn		LESA	65.1	5.4	18.0		23.4	32.0	17	56	na	73	76.0	14.0

Table 3. Continued

Year	Site	Field	Crop	Status	Irrigation type	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)
2016	28	1	Corn		SDI	51.5	6.6	8.0		14.6	32.0	20	25	na	45	103.0	24.0
2016	31	1	Cotton		LEPA	66.8	7.0	8.0		15.0	19.0	37	42	na	79	61.2	11.0
2016	31	2	Grain sorghum		LEPA	55.1	6.9	8.0	-4.0	10.9	26.0	27	31	-15	42	82.7	18.0
2016	32	1	Cotton		LEPA	70.0	6.2	12.0	1.5	19.7	19.0	32	63	8	103	40.8	7.0
2016	33	1	Corn		LEPA	70.0	6.9	20.0		26.9	32.0	21	63	Na	84	70.0	12.0
2016	35	1	Corn		SDI	115.0	6.0	17.0	0.0	23.0	32.0	19	53	0	72	143.8	15.0
2016	35	2	Cotton		SDI	115.0	5.5	11.4	0.0	16.9	19.0	29	60	0	89	72.8	7.6
2016	37	1	Corn		VRI	121.1	5.3	16.2	4.0	25.5	32.0	17	51	13	80	159.4	15.8
2016	38	1	Cotton		VRI	481.0	4.6	9.4	1.0	15.0	19.0	24	49	5	79	384.8	9.6
2016	C50	1	Cotton		LESA	121.0	5.6	6.7	0.0	12.3	19.0	29	35	0	65	124.0	12.3
2016	C51	1	Cotton		SDI	46.0	4.1	10.6		14.7	19.0	21	56	Na	77	32.2	8.4
2016	C56	1	Corn	Silage	LESA	40.0	6.5	15.0		21.5	32.0	20	47	Na	67	56.7	17.0
2016	C57	1	Sunflower		LESA	115.0	6.8	5.1		11.9	22.0	31	23	Na	54	162.0	16.9
2016	C60	1	Cotton	Replanted	LESA	59.5	5.7	8.0	5.5	19.2	19.0	30	42	29	101	54.5	11.0
Average							**6.3**	**11.6**			**23.2**	**30**	**50**	**2.6**	**81**		
Total						**2909**										**2696**	

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 12 years of the project of the sources of plant-available water. The data are based on 50% effective season rainfall, plant-available soil moisture, and total 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 28.9 inches of annual rainfall, which was the second wettest year. 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 and calculation of amount and depth of irrigation potentially conserved for TAWC sites in 2005-2016.

page	Project acres	Annual rainfall (inches)	Average season rainfall (50% effective-inches)	Average total 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	15.0	5.4	8.2	22.5	25.4	na	35.9	61.3	5,134	15.6
2006	4132	15.4	4.2	13.2	25.2	18.0	1.9	52.1	72.1	4,526	13.1
2007	4058	27.3	8.6	8.9	18.9	50.4	na	46.7	97.1	4,130	12.2
2008	3996	21.7	9.1	11.3	22.1	44.7	-6.9	49.0	87.9	4,139	12.4
2009	3861	15.7	5.4	10.5	23.6	27.0	14.7	44.8	82.2	4,365	13.6
2010	3934	28.9	9.6	7.9	21.7	51.2	-14.3	34.7	78.5	4,841	14.8
2011	4033	5.3	1.5	19.0	26.7	6.8	17.6	76.6	89.2	3,475	10.3
2012	3962	9.9	3.6	13.8	26.1	15.9	8.4	58.7	79.6	5,131	15.5
2013	4552	13.2	5.2	14.6	23.5	24.7	8.7	63.8	92.6	4,099	10.8
2014	5114	21.3	8.6	11.5	23.2	41.1	4.1	50.0	95.4	5,454	12.8
2015	3740	30.5	7.3	11.1	25.3	32.5	17.2	42.7	92.5	4,429	14.2
2016	2909	16.6	6.3	11.6	23.2	30.2	2.6	49.5	81.4	2,696	11.1
Average		**18.4**	**6.2**	**11.8**	**23.5**	**30.7**	**5.4**	**50.4**	**84.2**	**4,368**	**13.05**

Crop Water Use Efficiency - 2016

Table 5 lists information related to 2016 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 2016.

Year	Site	Field	Crop	Status	Irrigation type	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)
2016	4	5	Alfalfa	Hay	LEPA	16.0	13,000	28.0	34.9	464.3	372.5
2016	4	8	Grain sorghum	Seed	LEPA	50.5	3,200	11.3	18.2	283.2	175.8
2016	4	9	Wheat	Grazed	LESA	29.6		1.2	6.4	0.0	0.0
2016	4	9	Forage sorghum	Hay	LESA	29.6	8,100	3.5	8.0	2314.3	1008.1
2016	4	10	Cotton		LESA	26.9	1,246	8.3	15.8	150.1	78.8
2016	6	9	Corn		LESA	60.6	11,200	18.0	24.3	622.2	460.1
2016	6	10	Cotton		LESA	62.1	1,550	10.5	17.1	147.6	90.8
2016	9	3	Grass	Grazed	MESA	102.5		0.0	7.0	na	0.0
2016	9	2	Cotton		MESA	134.0	1,486	16.0	25.4	92.9	58.6
2016	10	6	Grass	Grazed	LESA	57.7		9.6	16.2	0.0	0.0
2016	10	7	Cotton		LESA	59.2	1,360	14.0	23.0	97.1	59.1
2016	10	8	Corn		LESA	59.2	12,222	20.0	25.1	611.1	487.9
2016	11	2	Cotton	Hail damage	SDI	24.4	752	13.0	18.8	57.8	39.9
2016	11	3	Cotton	Hail damage	SDI	22.9	752	13.0	18.8	57.8	39.9
2016	11	5	Cotton	Hail damage	FUR	46.8	545	8.0	15.8	68.1	34.4
2016	14	4	Cotton	2 in, 2 out	MESA	124.1	1,405	8.0	12.1	175.6	115.9
2016	17	5	Corn		MESA	54.5	12,152	16.0	28.3	759.5	430.2
2016	17	6	Corn		MESA	54.4	11,984	18.0	23.7	665.8	506.7
2016	21	1	Cotton		LEPA	61.1	2,111	10.8	18.2	196.4	116.3
2016	21	2	Cotton		LEPA	60.6	1,435	8.3	15.7	173.9	91.7
2016	22	1	Cotton		LEPA	145.0	2,048	14.0	21.1	146.3	97.1
2016	24	1	Sunflower		LESA	64.6	1,650	6.0	11.2	275.0	147.3
2016	24	2	Corn		LESA	65.1	12,320	18.0	23.4	684.4	526.5
2016	28	1	Corn		SDI	51.5	2254	8.0	14.6	281.8	154.9
2016	31	1	Cotton		LEPA	66.8	1,408	8.0	15.0	176.0	93.9
2016	31	2	Grain sorghum		LEPA	55.1	6,748	8.0	10.9	843.5	619.1
2016	32	1	Cotton		LEPA	70.0	1,670	12.0	19.7	139.2	85.0
2016	33	1	Corn		LEPA	70.0	10,080	20.0	26.9	504.0	375.4
2016	35	1	Corn		SDI	115.0	8,680	17.0	23.0	510.6	377.4
2016	35	2	Cotton		SDI	115.0	1,603	11.4	16.9	140.6	94.9
2016	37	1	Corn		VRI	121.1	9,072	16.2	25.5	560.0	355.8
2016	38	1	Cotton		VRI	481.0	1,425	9.4	15.0	151.6	95.3
2016	C50	1	Cotton		LESA	121.0	1,220	6.7	12.3	182.1	99.2
2016	C51	1	Cotton		SDI	46.0	1,521	10.6	14.7	143.5	103.8
2016	C56	1	Corn	Silage	LESA	40.0	44,000	15.0	21.5	2933.3	2044.1
2016	C57	1	Sunflower		LESA	115.0	1,295	5.1	11.9	253.9	109.3
2016	C60	1	Cotton	Replanted	LESA	59.5	951	8.0	19.2	118.9	49.7

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 supply basis.

Table 6. Water use efficiency (WUE) based on irrigation supplied and total water supplied averaged by crop type in 2016.

Crop	Number of fields	Total 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)
Alfalfa forage	1	16.0	13,000	28.0	34.9	464.3	372.5
Corn grain	9	651.4	9,996	16.8	23.8	577.7	408.3
Corn silage	1	40	44,000	15.0	21.5	2,933.3	2,044.1
Cotton lint	18	1726.4	1,360	10.6	17.5	134.2	80.2
Grain sorghum	1	55.1	6,748	8.0	10.9	843.5	619.1
Forage sorghum	1	29.6	8,100	3.5	8.0	2,314.3	1,008.1
Seed sorghum	1	50.5	3,200	11.3	18.2	283.2	175.8
Sunflower	2	179.6	1,473	5.6	11.5	264.5	128.3

Systems Management for Water Savings - 2016

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. Site 34 (no producer records in 2016) implements many of these practices, and this producer shares his experience and success with other area producers at a field day he promotes on his own farm each year.

Crop selection and planting management can also have an impact on water use. For example, Site 14 is a pivot field with approximately 120 acres. This site implemented a 2 in, 2 out planting scheme in 2014, 2015, and 2016 (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. 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 and in 2016 resulted in much greater than average WUE for cotton. 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 22 active producer sites in the project during 2016. (See Appendix for 2005-2015)

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	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																	
Total acres 2016		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
Total # of Sites		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.

Phase II Economic Summaries of Results from Monitoring Producer Sites in 2014-2016.

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)[2], 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.

[2] 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 2014-2016.

Item	2014	2015	2016
Gallons per minute (gpm)	450	250	250
Pumping lift (feet)	303	310	313
Discharge pressure (psi)	15	15	15
Pump efficiency (%)	60	60	60
Motor efficiency (%)	88	88	80
Electricity cost per kWh	$ 0.14	$ 0.10	$ 0.10
Cost of electricity per acre-inch	$ 8.26	$ 5.93	$ 6.14
Cost of maint. & repairs per acre-in.	$ 3.87	$ 3.15	$ 3.53
Cost of labor per acre-inch	$ 1.10	$ 1.10	$ 1.10
Total cost per acre-inch	$13.23	$10.18	$10.77

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

Table 9. Commodity prices for Phase II 2014-2016.

Commodity	2014	2015	2016
Cotton lint ($/lb)	$0.65	$0.63	$0.68
Cotton seed ($/ton)	$175	$190	$180
Grain sorghum – Grain ($/cwt)	$7.10	$3.45	$3.45
Grain sorghum – Seed ($/lb)	-	-	-
Corn-grain ($/bu)	$5.00	$4.76	$4.71
Corn-food ($/bu)	$5.99	$5.10	$5.10
Barley ($/cwt)	-	-	-
Wheat – grain ($/bu)	$6.85	$4.25	$4.25
Sorghum silage ($/ton)	$24.00	$24.00	$24.00
Corn silage ($/ton)	$30.60	$30.60	$30.60
Wheat silage ($/ton)	$26.59	$26.59	$26.59
Oat silage ($/ton) -	$14.58	$14.58	$14.58
Millet seed ($/lb)	$0.38	$0.50	$0.50
Sunflower ($/lb)	$0.38	$0.25	$0.25
Alfalfa ($/ton)	$264	$205	$140
Hay ($/ton)	$60	$60	$60
WW-BDahl hay ($/ton)	$40	$40	$40
Haygrazer ($/ton)	$80	$80	$80
Sideoats seed ($/lb)	$8.12	$8.12	$8.12
Sideoats hay ($/ton)	$35	$35	$35
Triticale silage ($/ton)	$45	$45	$45
Triticale forage ($/ton)	$140	$140	$140
Black Eyed Peas ($/cwt)	-	$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 2014-2016 in Table 10.

Table 10. Other variable and fixed costs for Phase II 2014-2016.

VARIABLE COSTS	2014	2015	2016
Boll weevil assessment: ($/ac)			
Irrigated cotton	$1.00	$1.00	$1.00
Dryland cotton	$1.00	$1.00	$1.00
Crop insurance: ($/ac)			
Irrigated cotton	$40.00	$40.00	$40.00
Dryland cotton	$32.00	$32.00	$32.00
Irrigated corn	$15.50	$15.50	$15.50
Irrigated corn silage	$15.50	$15.50	$15.50
Irrigated wheat	$19.50	$19.50	$19.50
Irrigated sorghum grain	$29.00	$29.00	$29.00
Dryland sorghum grain	$16.50	$16.50	$16.50
Irrigated sorghum silage	$29.00	$29.00	$29.00
Irrigated sunflowers	$17.00	$17.00	$17.00
Cotton harvest – strip and module ($/lint lb)	$0.08	$0.08	$0.09
Cotton ginning ($/cwt)	$2.20	$2.20	$2.50
Bags, ties, & classing ($/bale)	$14.63	$14.63	$15.40

FIXED COSTS	2014	2015	2016
Irrigation system:			
Center pivot system	$40.00	$40.00	$40.00
Drip system	$75.00	$75.00	$75.00
Flood system	$25.00	$25.00	$25.00
Cash rent:			
Irrigated cotton, grain sorghum, sun-flower, grass, pearl millet, and sorghum silage.	$100.00	$100.00	$100.00
Irrigated corn silage, corn grain, and alfalfa.	$140.00	$140.00	$140.00
Dryland cropland	$30.00	$30.00	$30.00

5. The custom tillage and harvest rates used for 2016 were based on rates reported in Texas A&M AgriLife Extension, 2016 Texas Agricultural Custom Rates, May 2016.

Table 11. Summary of results from monitoring 22 of the 27 producer sites during 2016 (Year 12).

System	Site No.	Acres	Irrigation Type[1]	System inches	$/system acre	$/inch water	Gross margin per inch irrigation
Monoculture systems							
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
Multi-crop systems							
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
Crop-Livestock systems							
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

[1]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 2014-16.

Item			**Average Phase I 2005-2013**	**Phase II 2014**	**Phase II 2015**	**Phase II 2016**	**2005-2016 Crop Year Average**
Crop							
	Cotton						
		Lint, lbs	1,300	1,138 (20)	1,258 (16)	1,360 (18)	1,288
		Seed, tons	0.9	0.8 (20)	0.9 (16)	1.0 (18)	0.9
	Corn						
		Grain, lbs	10,680	11,538 (8)	10,452 (19)	9,996 (9)	10,676
		Silage, tons	26.8	16.4 (4)	-	22 (1)	25.3
	Sorghum						
		Grain, lbs	5,231	6,675 (7)	3,944 (3)	6,748 (1)	5,371
		Silage, tons	18.5	-	-	-	18.5
		Seed, lbs	3,507	-	-	-	3,507
	Wheat						
		Grain, lbs	2,458	1,333 (1)	3,652 (3)	-	2,465
		Silage, tons	8.6	-	-	-	8.6
		Hay, tons	1.5	-	-	-	1.5
	Oat						
		Silage, tons	8.7	-	-	-	8.7
		Hay, tons	1.8	-	-	-	1.8
	Barley						
		Grain, lbs	3,133	-	-	-	3,133
		Hay, tons	5.5	-	-	-	5.5
	Triticale						
		Hay, tons	3.0	-	-	-	3.0
		Silage, tons	13.3	-	-	-	13.3
	Sunflower						
		Seed, lbs	2,182	2,867 (4)	1,790 (3)	1,473 (2)	2,123
	Pearl millet for seed						
		Seed, lbs	2,840	3,800 (1)	3,350 (2)	-	3,003
Perennial forage							
	WW-BDahl						
		Seed, PLS lbs	58.6	-	-	-	58.6
		Hay, tons	2.5	-	-	-	2.5
	Sideoats						
		Seed, PLS lbs	257.2	184 (2)	-	-	249.9
		Hay, tons	1.7	1.3 (2)	-	-	1.7
	Other						
		Hay, tons	2.3		-	-	2.3
	Alfalfa						
		Hay, tons	9.1	8.2 (3)	7.8 (3)	6.5 (1)	8.7
Annual forage							
	Forage sorg.						
		Hay, tons	3.5	5.5 (1)	-	4.1 (1)	4.0
		Seed, lbs	3,396	3,742 (1)		3,200 (1)	3,446
Precipitation, inches (including all sites)			16.9	21.3	30.5	16.6	18.4
By System			**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**
Total irrigation water (system average)			13.6	12.1(39)	10.3 (31)	11.7 (22)	13.0
By Crop		**Primary crop**	**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**
	Cotton	lint	13.6	9.8 (20)	9.3 (16)	10.6 (18)	12.6
	Corn	grain	19.1	15.2 (8)	16.4 (19)	16.8 (9)	18.4
	Corn	silage	22.8	13.2 (4)	-	15 (1)	21.1
	Sorghum	grain	12.0	11.6 (7)	6.2 (3)	8.0 (1)	11.2

Table 12 continued.

Item			Average Phase I 2005-2013	Phase II 2014	Phase II 2015	Phase II 2016	2005-2016 Crop year average
By Crop			**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**
	Sorghum	silage	12.6		-	-	12.6
	Wheat	grain	6.4	10.5 (1)	5.3 (3)	-	6.7
	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)	3.6
	Small grain	(grains)	6.4	10.5 (1)	5.3 (3)	-	6.7
	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)	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)	-	13.0
Dahl							
	Hay		3.7	-		-	3.7
	Seed		8.1	-		-	8.1
	Grazing		7.9	0 (1)	0 (1)	-	6.3
Sideoats							
	Seed		11.2	15.8 (2)	-	-	11.7
Bermuda							
	Grazing		7.4	-	0 (1)	-	6.3
Other Perennial/Annuals							
	Hay		9.6	5.0 (1)	-	-	9.1
	Grazing		5.9	8.0 (3)	0 (1)	9.6 (1)	5.9
Perennial grasses (grouped)							
	Seed		10.4	15.8 (2)	-	-	10.9
	Grazing		6.2	2.3 (3)	0 (2)	9.6 (1)	5.7
	Hay		1.2	0 (2)	-	-	1.0
	all uses		6.4	5.5 (5)	0 (2)	9.6 (1)	6.1
Alfalfa							
	all uses		23.2	20.1 (3)	15.3 (3)	28 (1)	22.7
			Income & Expense, $/system acre				
Projected Returns			$895.46	$989.38	$826.62		$897.64
Costs							
	Total variable costs (all sites)		$554.28	$639.58	$512.13		$558.20
	Total fixed costs (all sites)		$115.56	$154.63	$152.41		$122.46
	Total all costs (all sites)		$669.81	$790.35	$664.53		$680.29
Gross margin							
	Per system acre (all sites)		$341.05	$349.80	$314.49		$339.43
	Per acre-inch irrigation water (irrigation only)		$34.07	$29.74	$33.03		$33.58
Net returns over all costs							
	Per system acre (all sites)		$225.52	$199.03	$162.09		$217.35
	Per acre-inch irrigation water (irrigation only)		$21.53	$15.79	$16.66		$20.57
	Per pound of nitrogen (all sites)		$1.86	$3.76	$1.84		$2.04

Reports by Specific Task

TASK 2: ADMINISTRATION AND SUPPORT

Annual Report ending February 28, 2017

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

The 2016 growing season started out very dry with little to no precipitation until mid-May. Most areas of the South Plains region received good rain events since mid-May, with some concerns about preventing planting for cotton. After our good mid-May rains, the weather turned off very hot and dry for the region. Early planted corn had some pollination problems because of very hot temperatures in August. The dryland cotton was a mixed bag this year with some fields holding up well and others not harvested because of a lack of moisture. Late August and early September brought very heavy rains over most of the South Plains. In most cases rains like this lead to immature cotton and low-quality grades. Many producers were able to harvest their highest yields ever in 2016. This outstanding cotton crop is just what producers needed and it has allowed the cotton support infrastructure to do very well also. 2016 will go down in the record books as one of the best cotton crops in the South Plains at something north of 5.1 million bales on reduced acres. Not only did we have record yields, we had outstanding quality as well. Yield, quality and an unexpected small price rally may have saved the day for most producers in this region. Along with a great cotton crop in 2016, we have had above average rainfall in January and February and we hope this weather pattern will continue for a great growing season in 2017.

Our first 2016 summer Field Walk was held at Glenn Schur's farm, site 31 where we are comparing five different irrigation delivery systems. Moisture probes were also installed in each treatment to compare the differences in soil water movement. We also flew this site with a drone to be able to show the difference in the soil wetting patterns. Yield data were also collected in each treatment.

Our 2016 Field Day was to be held at the Bob Glodt Farm, but had to be moved because of rain. Attendees would have had the opportunity to view several different varieties of cotton with four different irrigation levels. There were side-by-side comparisons at 90, 60, 30 percent of potential ET and rain-fed only. We moved the field day to the Ollie Liner Center in Plainview. We had approximately eighty-five people in attendance.
TAWC hosted our third Water College on January 18, 2017 at the Lubbock Civic Center. The change in venue from previous years allowed us to expand our trade show segment. We had over twenty companies participating at the Water College. I met with the different commodity groups and sponsors to determine the best group of speakers to convey our message. There were approximately two hundred in attendance along with the twenty-one vendors. The date for our 2018 Water College has been set for January 24, 2018.

The proposal to carry TAWC into the 2020's is complete and we will be presenting it to Chancellor Robert Duncan in March. Provost Mike Galyean and Dr. Steve Fraze have reviewed our proposal and are in support of our effort.

We had twelve management team meetings in 2016 and I made regular sites visits..

Presentations during this year:

08-02-2016	H2O for Texas (Senator Charles Perry)	Lubbock, Texas
11-7-2016	Texas Tech Classroom presentation	Lubbock, Texas

Tours this year:

07-21-2016	CO-OP Group	Hale, County
08-16-2016	National Cotton Council	Hale & Floyd Counties

2.2: Administrative Coordinator: (TTU)

Due to medical conditions, Christy Barbee was forced to take permanent disability and leave the project. Lori Walraven assumed the main bookkeeping support role and all other duties have been taken on by other TAWC personnel.

Year 12 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 12. The budget was balanced for this annual report and is presented in Table 13 on page 57.

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 28, 2017

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

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

Year 12 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 producers' 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 meets 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 2016 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 profitability of irrigated cotton grown using soil moisture probes. The results of this paper were presented at the Beltwide Cotton Conference held in Dallas, Texas in January, 2017.

Continuing Cooperation

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

Other Presentations

Farm Assistance members made a presentation to agricultural extension economists concerning the growth and development of the TAWC over the past 10 years. A poster presentation was made to the Texas Extension Specialist Association at their annual meeting. A presentation was given at the annual Water College over Economic Value of Irrigation at Differing Levels of Evapotranspiration.

Field Walks

Five Field Walks were held in the growing season at one site. The purpose of these Field Walks was to make producers aware of irrigation timing practices using various soil moisture probes. These probes were located on-site and allowed attendees to see them in operation during various stages of growth of corn, cotton, and grain sorghum. The participation was so encouraging that similar events are planned for 2017.

Field Days

A Field Day was held on August 31 in Plainview. The purposes of the meeting were 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 impact their operations. Personnel from AgriLife Extension, AgriLife Research, Farm Assistance, the High Plains Water District, and Texas Tech University were involved in these field days.

Water College

The Third Annual Water College was held January 18 at the Lubbock Memorial Civic Center with more than 170 attendees. Farm Assistance members gave a presentation over Economic Value of Irrigation at Differing Levels of Evapotranspiration. More than 20 members of industry had booths at the event.

Radio Broadcasts

Members of Farm Assistance made more than 10 appearances on various radio stations promoting the TAWC and its events. Stations covered Lubbock, Plainview, Amarillo, and Floydada.

Awards

In December, TAWC was awarded the National Water and Energy Conservation Award from the Irrigation Association. Three members traveled to Las Vegas, Nevada to receive this prestigious award.

TASK 4: ECONOMIC ANALYSIS

Annual Report ending February 28, 2017

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

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 2016:

- 2016 was the 12th year of economic data collection from the project sites. Data for the 2015 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 2015 was entered into the calculator.

Grant funding received in 2016:

- 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.

Peer-reviewed Publications during 2016:

- Williams, R.B., R. Al-Hmoud, E. Segarra, and D. Mitchell. 2016. "An Estimate of the Shadow Price of Water in the Southern Ogallala Aquifer." Journal of Water Resource and Protection 9(3):289-304.

- Opheim, T.L., West, C.P., Carpio, C.E., Mitchell, D.M., Johnson, P.N., and Trojan, S.J. 2016. "The relationships between Crop Water Use and finishing performance of beef steers fed diets containing corn or sorghum distillers coproducts." Under Review.

Professional Presentations during 2016:

1. Mitchell, D. and J. Pate. 2016. "Profitability of 2 and 2 Production Systems." Poster Presentation at the *2016 Beltwide Cotton Conference, New Orleans, Louisiana.*

2. 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.*

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

4. 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.*

5. 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.*

Informal Presentations during 2016:

- Lamesa Rotary Club

Graduate Students:

- Taylor Black. M.S. Student. Department of Agricultural and Applied Economics. Expected Graduation Date: 2017.
- Rebecca McCullough, Ph.D. Student. Department of Agricultural and Applied Economics. Expected Graduation Date: 2019.

TASK 5 & 7: PLANT WATER USE AND WATER USE EFFICIENCY

Annual Report ending February 28, 2017

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

We developed a web-interface Google Map's JavaScript API for the advanced irrigation-scheduling tool. A user can identify and draw the boundaries of their fields. It allows users to store field boundary and the corresponding location data in the database within the application. Users can specify any numerical values in the designated input fields, then actually draw the boundaries of their field on a map. The program then identifies the chosen weather from the Texas Tech Mesonet website and creates a database of reference ET. This is then multiplied by a crop coefficient to estimate the irrigation demand. We also developed a procedure to adjust the crop coefficient with Landsat satellite data.

Historical Mesonet weather data have been obtained from the National Wind Institute at Texas Tech University. Accumulated growing degree days (heat units) and maximum water use will be incorporated in the current irrigation scheduling tool and in a mobile phone app. Current improvement in interface is being tested on an open source server program. This will be transferred to a GoDaddy site after initial testing is completed.

A new research program on precision water management has been initiated. This research focuses on optimized water allocation based on variability patterns of soil physical properties, topography, and historical yield. Variable rate irrigation based on within-field variability in soil physiochemical properties and plant growth conditions has great potential to further increase crop water use efficiency. This study is conducted in a commercially managed field approximately 30 miles north of Lubbock. Soil sensing technologies such as Veris mapping system will be used to measure soil spatial physiochemical properties as a reference layer for water requirements. Topographic properties will be derived from elevation data collected by Real Time Kinematic (RTK) GPS systems. Research will also address the application of Unmanned Aerial Systems (UAS) with sensors to detect plant stress and water status in plants and soil at fine scale. Imagery data together with soil physiochemical data and topography will be used to develop management zones for variable rate irrigation both spatially and temporally. Variable rate irrigation will be demonstrated in commercially managed agricultural fields with center pivot irrigation systems.

TASK 6: COMMUNICATIONS AND OUTREACH

Annual Report ending February 28, 2017

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

Awards

Irrigation Association Award – Agriculture Category

Trade Shows, Meetings and Events Attended

High Plains Irrigation Conference - Amarillo Civic Center - Amarillo, Texas - February 2016

Water Advancement, Technology, Training and Strategy (WATTS) Conference - Lubbock Civic Center - Lubbock, Texas - March 2016

High Plains Association of Crop Consultants meeting - Shiner's Building - Lubbock Texas - March 2016

Texas Cotton Ginners' Conference - Lubbock Civic Center - Lubbock, Texas - April 2016

Texas Environmental Excellence Awards Banquet - Austin Convention Center - Austin Texas - May 2016

Texas Tech Agricultural and Applied Economics' Bankers' Conference - Texas Tech International Cultural Center -Lubbock, Texas - November 2016

West Texas Chemical Conference - August 2016

TAWC Field Walk

On July 7, a field walk was held on TAWC site 31 demonstrating five different pivot irrigation nozzles. There were over 35 in attendance. This was advertised by live radio spots airing on KFLP, Fox Talk 950, KFYO and KDHN. Two email blasts were also sent to out to our 400+ distribution list.

August 2016 TAWC Field Day

Arrangements were made for the August 31 Field Day. Fudruckers was contacted for catering. Facilities were rented including: tent, chairs, PA system, tables and portable bathrooms. The Ollie Liner Center in Plainview, Texas was contacted as a backup plan in case of bad weather.

Five hundred save-the-date cards were printed and distributed throughout co-ops, gins, coffee shops, and farm dealerships. An email blast (sent to 400+) and letters of invitation (sent to 200+) were sent out. Facebook and Twitter were also used as an outlet to advertise the field day. A total of 13 live radio appearances were made on KDHN, KFYO and Fox Talk 950. Radio ads were also run through 10 days prior to the event.
The Field Day was moved to the Ollie Liner Center in Plainview, Texas, because of rain.

About 95 producers, industry, and crop consultants attended the meeting.

Outreach Materials

1,750 save-the-date cards were printed and distributed for our Forage & Livestock Field Day, September meeting and Water College.

Over 1,000 personal invite letters were printed and distributed for our Forage & Livestock Field Day, September meeting and Water College.

A new pull-up display was created that we now use at meetings and trade shows when the full display is not needed.

USB drives were created with TAWC and TWDB logos and websites on them. These have uploaded on them the TAWC project overview and Phase 1 research summary. These are distributed at our TAWC events.

The Water College website, www.tawcwatercollege.com, was updated with meeting details, agenda, and speaker bios.

YouTube videos were created including Glenn Schur describing research being done on TAWC Site 31. Drone footage taken of the site was incorporated into the video. Borgstedt also put together a YouTube video displaying how to use the TAWC online ET tool.

2016 Water College

Approximately 220 attended the 3rd Annual Water College held at the Bayer Crop Science Agricultural Museum in Lubbock, Texas. Two television stations, KFLP, Fox Talk 950 and the Lubbock Avalanche Journal all covered the event. 16 companies sponsored the event and had booths.

Field Talks running on KFLP focused on promoting Water College prior to the event. Excerpts from speakers' presentations from Water College were used for the segments after the event. Evaluations from Water College were analyzed and all results were combined into one document to be used for future meeting planning. About 90 evaluations were collected. Borgstedt posted Water College presentations on www.tawcwatercollege.com and www.tawc.us.

December 2016 Preparation for 2017 Water College: 500 save-the-date cards for 2016 TAWC Water College were distributed to local farm supply stores and gins. Final preparations were made for the TAWC Water College. Radio advertisements were arranged on KKYN, KFLP, KFYO and Fox Talk 950 prior to the event. Main Street was contacted and confirmed for catering. Meeting room details were confirmed with the Lubbock Civic Center. Borgstedt finalized sponsors and vendors that required booth space for the event. Borgstedt also updated www.tawcwatercollege.com with 2017 meeting information. Hotel arrangements were made at the Overton for all presenters requiring overnight stay. Meal and meeting arrangements were made at the Tech Club for the presenter appreciation dinner.

Graduate Student Assistants

Cassie Godwin graduated in December of 2016. She successfully defended her thesis "A Case Study of the Texas Alliance for Water Conservation's Communication Efforts." Sinclaire Dobelbower began working as our graduate assistant in September 2016 and continues to be with us through May 2018.

- 94 YouTube videos
- 52 TAWC Field Talk radio segments airing every Wednesday on KFLP All Ag All Day
- 12 electronic newsletters using MailChimp
- 500 Facebook followers
- 605 Twitter followers
- 2 Television Appearances
- 37 live Radio Appearances (KFLP, KKYN, KFLP and Fox Talk 950)

TASK 7: PRODUCER ASSESSMENT OF OPERATION

Annual Report ending February 28, 2017

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

Task 7 report is combined with Task 5 in this 2015 report because of their combined efforts.

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

Annual Report ending February 28, 2017

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

Several forage and livestock research trials were carried out at the Texas Tech New Deal research facility to generate data that were used in publications, outreach presentations, field tours, and to expand capabilities of the TAWC online tools.

Chuck West, Philip Brown and graduate students carried out the third year of a three-year steer grazing trial at the New Deal Research Field Station comparing pastures containing only grass versus pastures containing grass and alfalfa, a high quality legume forage. Total precipitation at the Station in Nov. 2015-Oct. 2016 was 15.2 inches (long-term average is 18.5 inches), and April-September (pasture growing season) precipitation was 12.1 inches (long-term average is 13.2 inches). The Old World bluestem grass growing alone received 8.0 inches of irrigation, and that growing with alfalfa received 7.5 inches. Alfalfa growing with tall wheatgrass received 10.2 inches. We normally target irrigation levels in April-September to not exceed 12 inches for alfalfa-tall wheatgrass pastures and 9 inches for the Old World bluestem pastures, with or without alfalfa. The amount of rain + irrigation during April-September is targeted at 22 to 25 inches; in 2016 rain + irrigation ranged from 19.6 to 22.3 inches. Averaged over 3 years (2014-2016), we applied 8.0 inches to grass-alone and 6.9 inches to grass-legume. Results indicate that the 9 and 12-inch targets are reasonable and easy to attain if grazing-season rainfall is a little less than average (as in 2016) or above average (as in 2014 and 2015). In comparison to TAWC producer sites, the amount of irrigation applied to cotton averages around 12 inches and for corn around 18 inches.

Averaged over 3 years, cattle average daily gain was 1.74 lbs. for grass-alone and 2.06 lbs. for grass-legume systems. Season-long weight gain per acre was 118 lbs. for grass-alone vs. 188 lbs. for grass-legume. Season-long weight gain per acre was 118 lbs. for grass-alone vs. 188 lbs. for grass-legume. The productive advantage of the grass-legume system was due to a combination of exposure to high-quality legumes and a greater number of days in native grass mix compared with the grass-only system. The novel part of the grass-legume system was the inclusion of the alfalfa-tall wheatgrass mixture, which served as a supplemental protein bank in small acreage. This component was grazed for around 2 days per week and boosted protein intake over the grass alone. The principal forage quality component that explained the greater productivity of steers on the grass-legume system was that it averaged 14.4% crude protein content vs. only 7.0% for grass-alone. The take-home message is that boosting forage quality while keeping water inputs low boosts the sustainability of water use in a beef grazing system. This linkage between forage quality and efficiency of water use is a novel contribution of this research.

Graduate student Lisa Baxter received a grant from the USDA-SARE graduate student program titled "Evaluation of winter annual cover crops under multiple residue management: Impacts on land management, soil water depletion, and cash crop productivity." The winter cover crops were planted in October of 2015, consisting of burr clover, hairy vetch, rye, wheat, and a rape-kale mixture. They were rotated to a summer crop of teff grass to test for soil water depletion. Teff forage yields and summer soil water content was not affected by previous winter crop types. This trial is being repeated in 2017. Yedan (Victoria) Xiong continued her doctoral research in 2016 to enhance the ALMANAC and APSIM plant growth models to predict canopy leaf area, light interception, and forage growth as a function of water supply, canopy cover, and grazing vs. hay harvest. Calibrations resulted in improved simulations for grass productivity. These models will be used to predict grass yield as affected by water supply, from which cattle stocking rates can be calculated.

Graduate student Krishna Bhandari characterized insect populations in the OWB grass-only system and the grass-legume system for cattle horn flies and other insects to test whether OWB deters potentially harmful insects. This is in response to casual observations by producers that cattle harbor fewer flies when grazing WW-B.Dahl OWB. On seven observation dates across 2015 and 2016, there was a small but statistically nonsignificant trend toward fewer flies on cattle grazing OWB alone. The most dramatic effect of OWB on insects was the virtually complete absence of fire ants and harvester ants in soil where OWB was grown. This observation strongly supports earlier published accounts that OWB is a strong fire-ant deterrent, a very undesirable pest in pastures. The numbers of beneficial insects such as ladybird beetles and pollinators were generally greater in pastures containing alfalfa.

Graduate student Madhav Dhakal initiated in October 2015 a study in which diverse types of alfalfa varieties were sod-seeded into six existing stands of native grasses. The objective was to identify planting densities and growth types of alfalfa which, once established, could provide a high-protein component of native grass pasture without competing too much for soil water. The main point is to test how well alfalfa can improve nutritional quality of perennial grass pastures under dryland conditions to provide a valuable grazing forage for producers who have to convert to dryland production while trying to minimize profit losses.

Grant proposals were funded for continued funding from USDA-SARE and USDA-NIFA-AFRI to enhance the efforts of TAWC (see list below). The NIFA-funded project (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. The well-documented success of the TAWC program is what brought us in as collaborators with the other institutions.

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. $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.

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.

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

Annual Report ending February 28, 2017

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

9.1 Equipment Procurement & Installation

- New steel post and hardware was purchased to relocate the tipping bucket rain gauges.
- Six new water level transducers, with telemetry, were purchased to replace the damaged and ageing equipment.

9.2 Data Collection and Processing

- Daily rainfall was collected using 22 tipping bucket rain gauges with Hobo data loggers.
- Compiled the 2016 daily rainfall into an Excel spreadsheet.
- All water level transducers were downloaded, graphed and published on the HPWD website.
- Six new water level transducers were installed in the first part of June. These call in each morning and the water levels can be seen on the HPWD.org website.
- All equipment was monitored regularly and maintenance preformed if needed.

http://www.tawcsolutions.org

TAWC Solutions: Management tools to aid producers in conserving water

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

The **TAWC Resource Allocation Analyzer** provide producers with a simple, comprehensive approach to planning and managing various cropping systems. The Resource Allocation Tool is an economic based optimization model that aids producers in making decisions about different cropping systems. Based on available irrigation water, projected cost of production and expected revenue, this model will aid producers in their decisions to plant various crops.
Because of implementation of new water policy by the High Plains Underground Water Conservation District, growers need a method to determine the amount of irrigation that they were allowed to apply to each irrigated acre. The **Contiguous Acre Calculator** allows growers to project specific levels of irrigation water to be applied to various delivery systems. The tool then calculates how much water can be banked for future use. Once the growing season is completed the producer can enter actual water applied and use it for record keeping.

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** tool 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** tool 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.

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.

2016 Supplementary Grants to Project (See Appendix for 2005-2015 data)

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. $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.

2016 Donations to project (See Appendix for 2005-2015 data)

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
Total	**$17,750.00**

2016 Visitors to the Demonstration Project sites, Field Walks, Field Days, and Water College Outreach Events (See Appendix for 2005-2015 data)

Total Number of Visitors	400+

2016 Presentations (See Appendix for 2005-2015 data)

Date	Presentation	Spokesperson(s)
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

2016 Related Non-refereed Publications (See Appendix for 2005-2015 data)

Pate, Jeff, Donna Mitchell and Will Keeling: “Economic Advantages of Soil Moisture Probes on the Texas Southern High Plains”. Poster presented in the Economics and Marketing Session at the 2017 Beltwide Cotton Conferences, January 2017, Dallas, TX. Published in 2017 Proceedings.

2016 Related Refereed Journal Articles (See Appendix for 2005-2015 data)

Williams, R.B., R. Al-Hmoud, E. Segarra, and D. Mitchell. 2016. “An Estimate of the Shadow Price of Water in the Southern Ogallala Aquifer.” Journal of Water Resource and Protection, 9(3):289-304.

Opheim, T.L., West, C.P., Carpio, C.E., Mitchell, D.M., Johnson, P.N., and Trojan, S.J. 2016. "The relationships between crop water use and finishing performance of beef steers fed diets containing corn or sorghum distillers coproducts." Under Review.

2016 Popular Press (See Appendix for 2005-2015 data)

TAWC Water College Wednesday in Lubbock. – Fox 34, January 2016. http://www.fox34.com/story/31000868/tawc-water-college-wednesday-in-lubbock

Water College features ag commissioner, TWDB chair – Plainview Daily Herald, January 21, 2016. http://www.myplainview.com/agriculture/article_fb9915ae-bbb3-11e5-8518-6f36ab361974.html

TAWC Improves Water Management Through Education - PCCA Commentator, Winter 2016. https://www.pcca.com/Publications/Commentator/2016/Winter/page06.asp

Texas Alliance for Water Conservation Water College set for Jan. 20 – Texas Tech Today, January 2016. http://today.ttu.edu/posts/2015/12/texas-alliance-for-water-conservation-water-college

Ag. Commissioner Miller among speakers set for water conservation event in Lubbock Miller to speak at conservation event – Lubbock Avalanche-Journal, January 14, 2016. http://lubbockonline.com/local-news/2016-01-14/ag-commissioner-miller-among-speakers-set-water-conservation-event-lubbock#.VqfpVporL0M

Agriculture commissioner seeks federal disaster declaration for Goliath-hurt livestock producers - Lubbock Avalanche Journal, January 20, 2016. http://m.lubbockonline.com/local-news/2016-01-20/agriculture-commissioner-seeks-federal-disaster-declaration-goliath-hurt#gsc.tab=0

Aquifer levels up for first time in a decade - Lubbock Avalanche Journal, May 14, 2016. http://lubbockonline.com/filed-online/2016-05-14/aquifer-levels-first-time-decade#.V07mKpErLRZ

Texas Tech part of consortium studying sustainability of Ogallala Aquifer - CASNR News Center, March 2016. http://www.depts.ttu.edu/agriculturalsciences/news/?p=6662

Tech researchers take part in sustainability study of Ogallala Aquifer - Fox 34 News, March 24, 2016. http://www.fox34.com/story/31561952/tech-researchers-take-part-in-sustainability-study-of-ogallala-aquifer

Tech collaborates with other universities to examine sustainability of Ogallala Aquifer - Lubbock Avalanche – Journal, March 24, 2016. http://m.lubbockonline.com/filed-online/2016-03-24/tech-collaborates-other-universities-examine-sustainability-ogallala-aquifer#gsc.tab=0

Farmers Teaching Farmers How to Manage Water Like Money – Sustainable Agriculture Research & Education, July 2016. http://www.southernsare.org/Educational-Resources/Topic-Rooms/Water-Conservation-on-the-High-Plains/Sustainable-High-Plains-Contents/Water-Conservation/Texas-Alliance-for-Water-Conservation

Texas Tech agricultural communications project aims to develop critical thinkers – CASNR News Center, March 2016. http://www.depts.ttu.edu/agriculturalsciences/news/?p=6707

Water, energy conservation award goes to Texas Alliance for Water Conservation – CASNR News Center, August 18, 2016 http://www.depts.ttu.edu/agriculturalsciences/news/?p=6832

West Coast cotton farmers catch glimpse of area crops- Lubbock A-J, Tuesday, Aug 16, 2016, By JOSIE MUSICO http://m.lubbockonline.com/local-news/2016-08-16/west-coast-cotton-farmers-catch-glimpse-area-crops#gsc.tab=0

TAWC brings home National Water & Energy Conservation Award – Texas Tech CASNR News

CASNR, TAWC researchers tenaciously battle to slow decline of Ogallala Aquifer -Texas Tech CASNR News

Water, energy conservation award goes to Texas Alliance for Water Conservation – Texas Tech CASNR News

2016 Theses and Dissertations (See Appendix for 2005-2015 data)

Godwin, Cassie. 2016. "A Case Study of the Texas Alliance for Water Conservation's Communication Efforts." M.S. Thesis, Texas Tech University, Lubbock, TX.

Phase II - Budget

Table 13. Task and expense budget for Phase II Year 1-3 of the demonstration project.

TWDB # 1413581688		Year 1	Year 2	Year 3	
		(10/17/13 - 02/28/15)	(03/01/15 - 02/29/16)	(03/01/16 - 02/28/17)	
Task Budget	**Task Budget***				**Total Expenses**
1					
2	$1,148,395.00	135,179.51	254,325.38	276,943.98	666,448.87
3	$571,806.00	19,180.57	79,957.17	97,051.66	196,189.40
4	$469,978.00	39,467.89	47,127.42	38,833.02	125,428.33
5	$360,708.00	110,849.99	82,061.04	9,547.54	202,428.33
6	$582,645.00	50,867.54	110,592.85	86,776.22	248,226.61
7	$27,048.00	3,000.00	6,134.03	18,539.39	27,673.42
8	$181,110.00	6,671.70	25,277.96	25,184.96	57134.62
9	$258,310.00	27,058.73	14,607.22	30,578.68	72244.63
TOTAL	$3,600,000.00	392,275.93	620,083.07	583,455.45	1,595,804.45
		Year 1	**Year 2**	**Year 3**	
		(10/17/13 - 02/28/15)	(03/01/15 - 02/29/16)	(03/01/16 - 02/28/17)	
Expense Budget	**Total Budget***				**Total Expenses**
Salary and Wages +2%/yr	$1,545,882.00	196,610.27	307,839.14	220,833.72	725,283.13
Fringe	$229,910.00	30,751.67	48,664.72	30,891.06	110,307.45
Travel	$106,151.00			20,933.30	20,933.30
Other Operating Expenses (inc. materials & supplies	$130,023.00	16,152.68	24,991.4	18,085.91	59,229.99
Capital Equipment	$76,000.00	14,249.11	16,871.15	0	31,120.26
Subcontract Services	$857,164.00	58,070.86	0	199,169.73	257,240.59
Technical/Hardware /Software	$238,033.00	49,239.30	105,048.42	27,643.67	181,931.39
Tuition and Fees	$111,337.00		69,944.98	23,160.74	93,105.72
Other Expenses (Insurance: auto, medical)	$305,500.00	7,578.05	12,123.75	47,696.32	67,398.12
TOTAL	$3,600,000.00	392,275.93	620,083.07	588,455.45	1,525,615.65

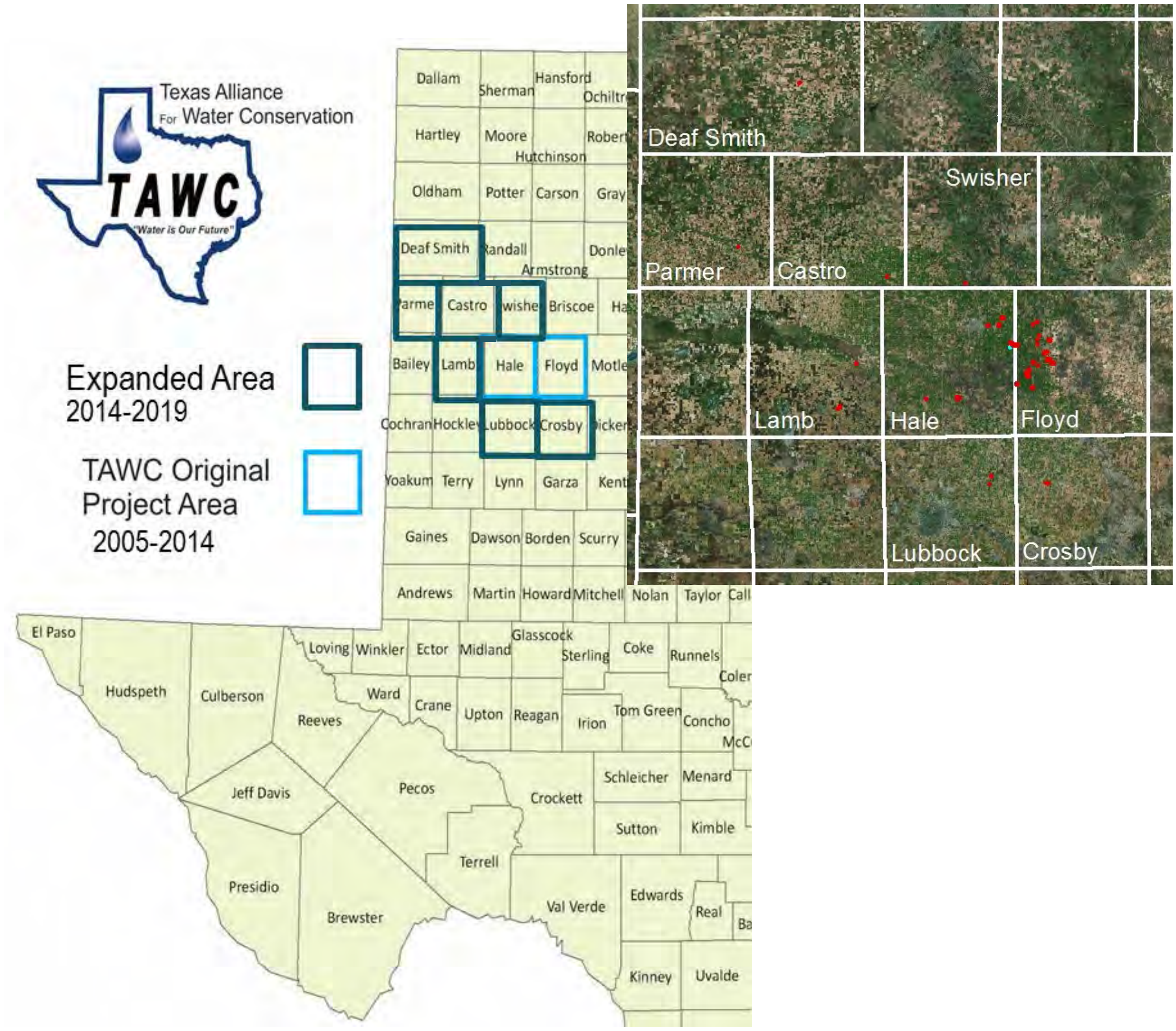


Figure 15. Original project area and new county expansion for Phase II of the demonstration project.

SITE DESCRIPTIONS (SEE APPENDIX FOR 2005-2015 DATA AND TERMINATED SITES)

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.

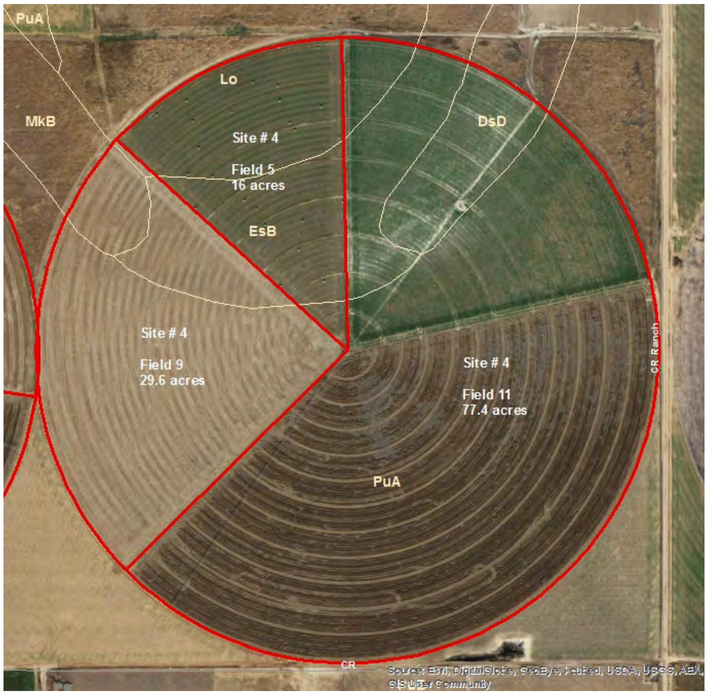
In Phase II year 1 (2014), sites 2, 3, 12 and 18 were dropped from the project, and 10 new sites in six new counties were added (Crosby, Deaf Smith, Lamb, Lubbock, Parmer, Swisher). The 10 new sites are numbered C50-C54 and C56-C60. Total net acres for the project increased from 4,962 in 2013 to 5,223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

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



Description:

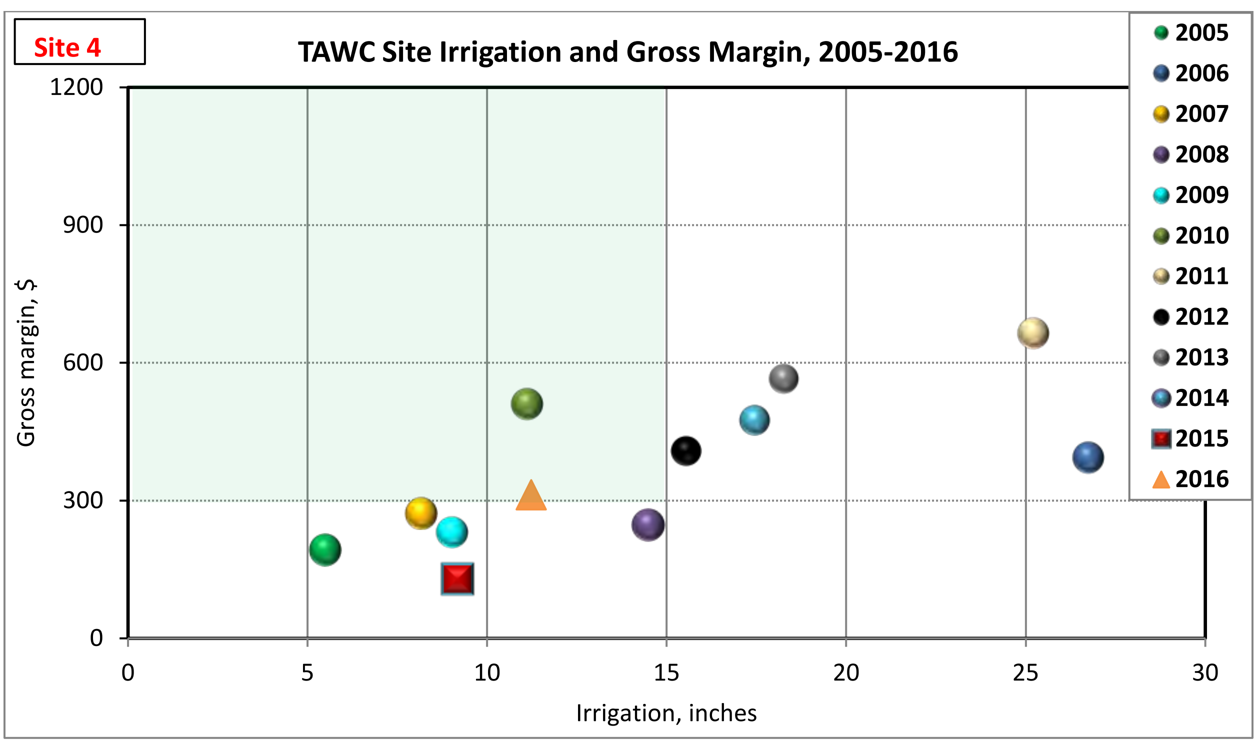
Site acres: 123.0

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%

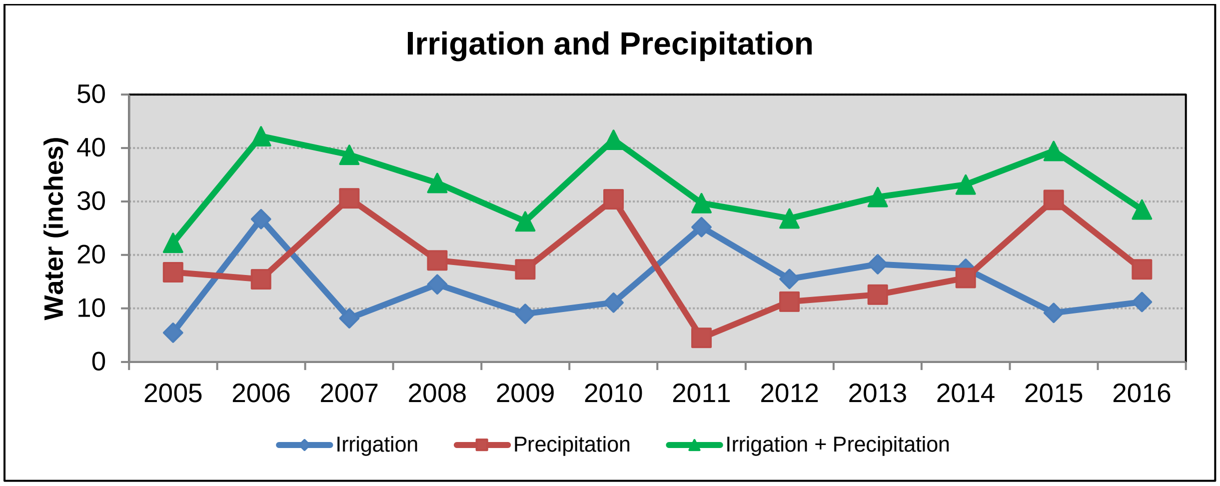
Irrigation:
Center Pivot (LESA) 500 gpm

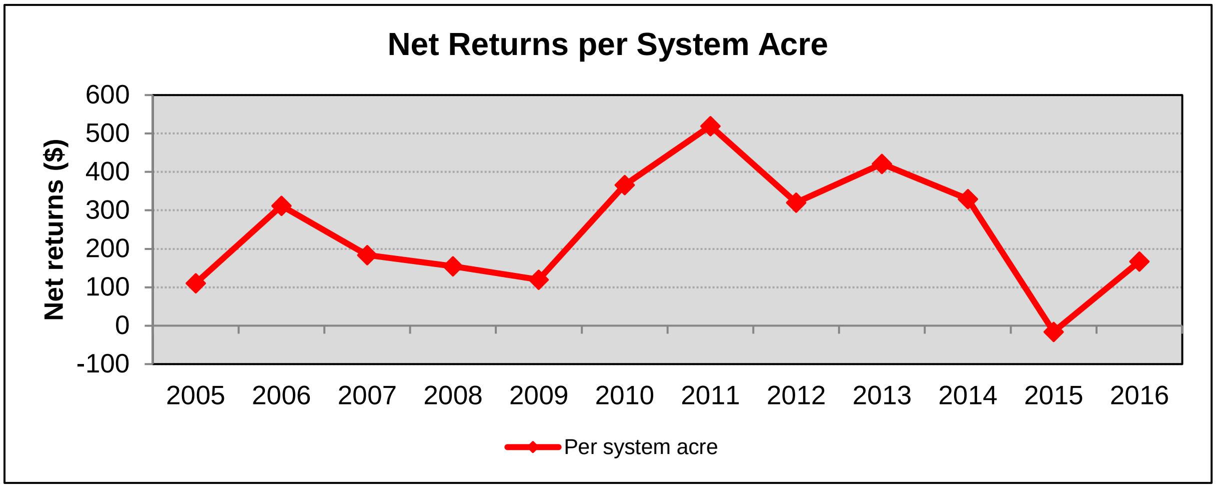
Number of wells: 3

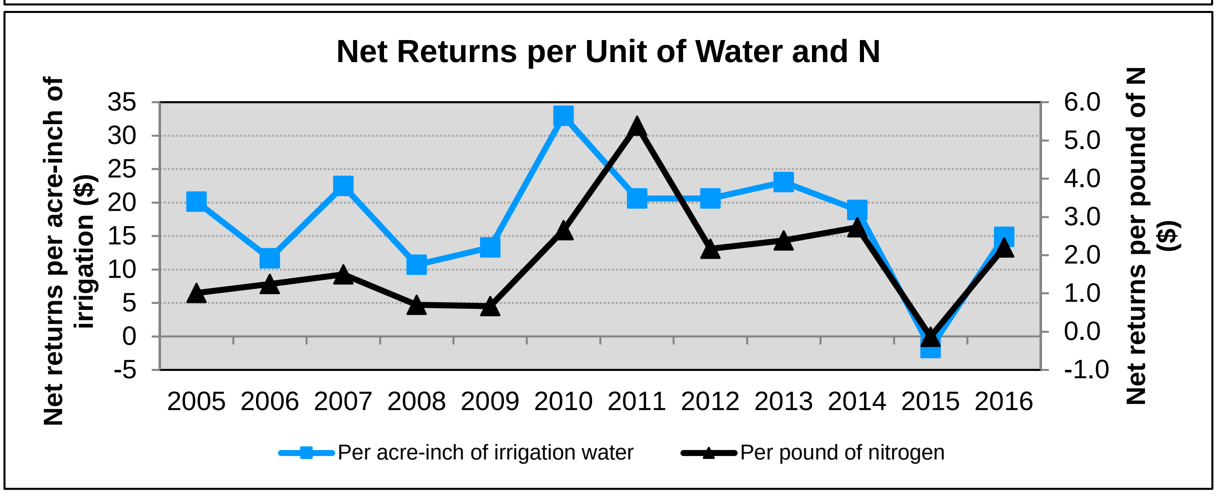
Fuel Source: 1 Natural gas,



Site 4


Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Irrigation
Precipitation
Irrigation + Precipitation

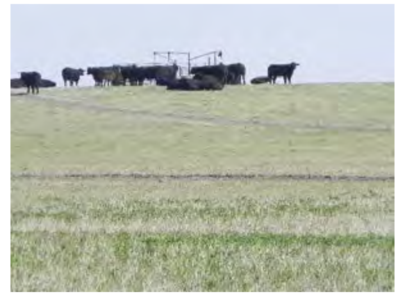

Net Returns per System Acre
Net returns ($)
600
500
400
300
200
100
0
-100
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
35
30
25
20
15
10
5
0
-5
Net returns per pound of N ($)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site 4


May ground prep


Hay production


Cattle grazing


Alfalfa


September Cotton


LEPA Irrigated wheat

Comments: In 2016 this pivot LEPA/LESA integrated crop/livestock irrigated site was planted to wheat, cotton, seed sorghum, forage sorghum and continued with alfalfa.

SITE 6

Description:

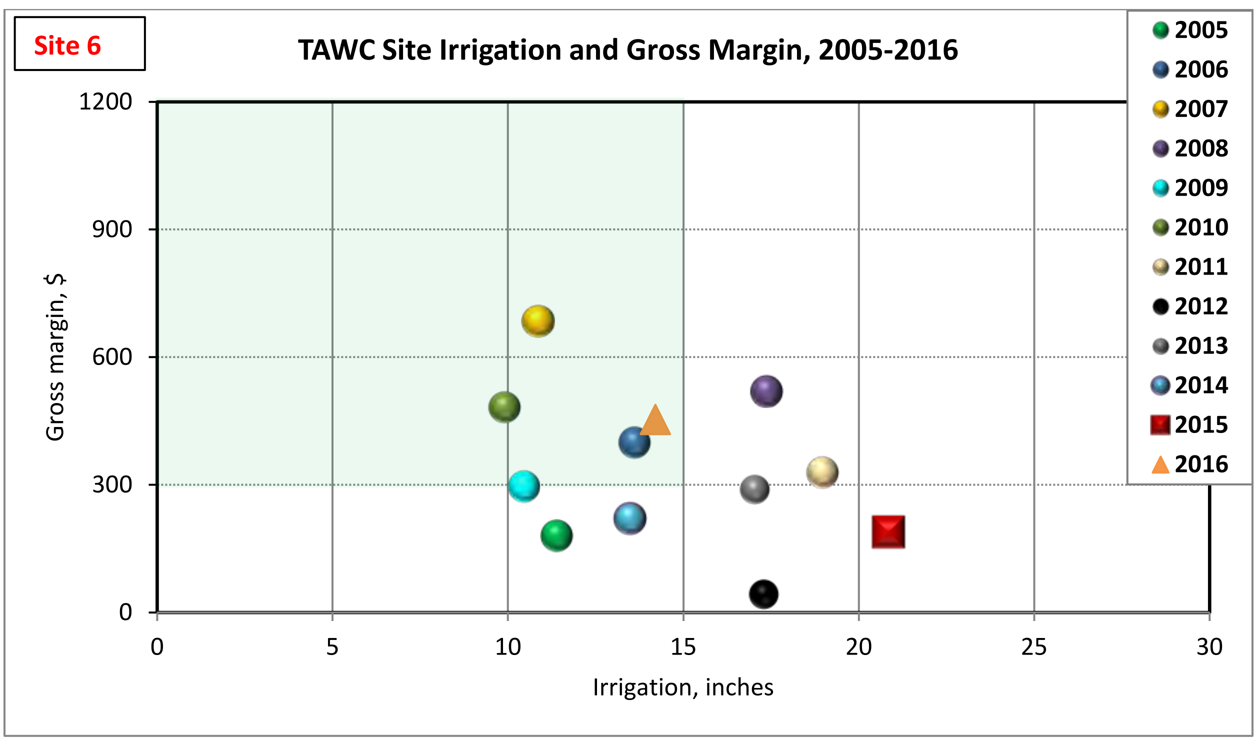
Site acres: 122.7

Soil types:
- PuA-Pullman clay loam, 0 to 1%
- PuB-Pullman clay loam, 1 to 3%
- LoA-Lofton clay loam, 0 to 1%

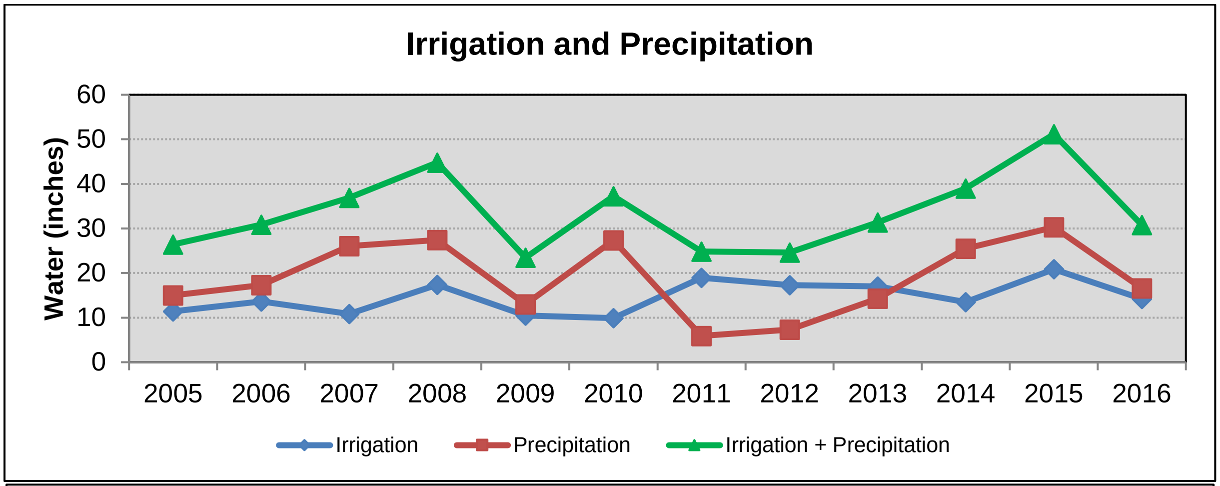
Irrigation:
- Center Pivot (LESA) 500 gpm

Number of wells: 4

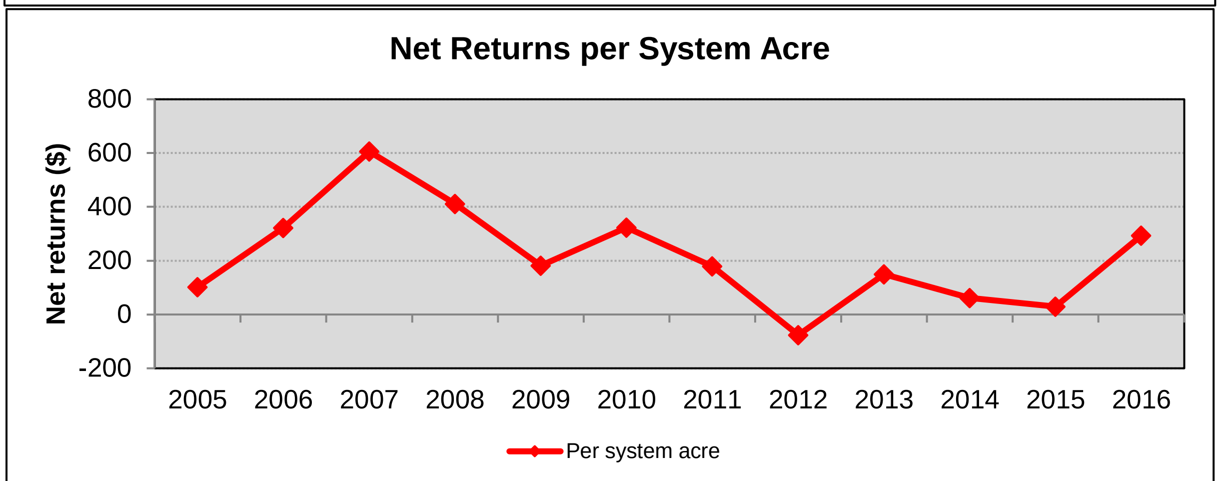
Fuel Source: Natural gas



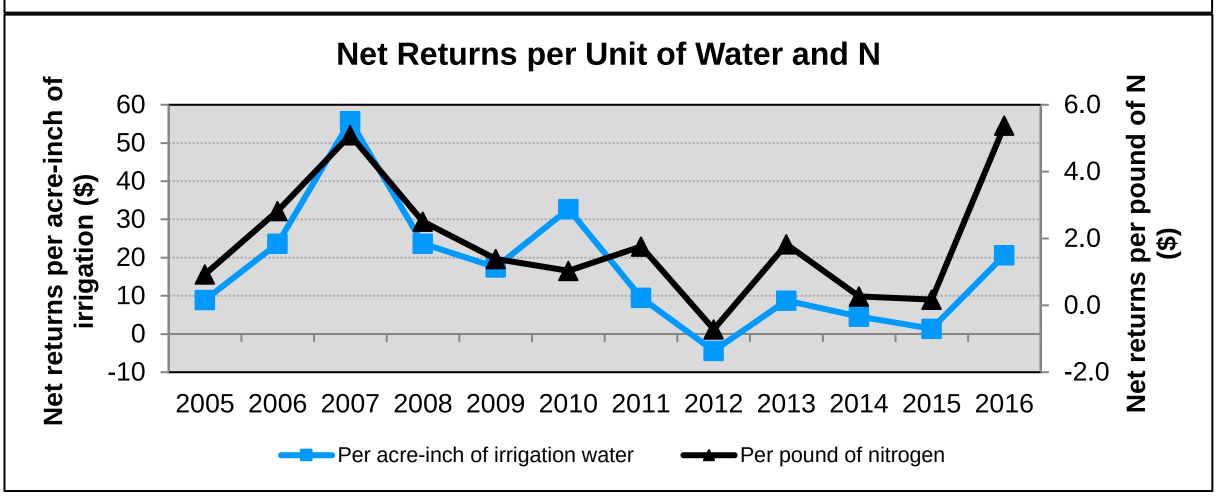
Site 6



Irrigation and Precipitation
Water (inches)
60
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
800
600
400
200
0
-200
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
60
50
40
30
20
10
0
-10
6.0
4.0
2.0
0.0
-2.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site 6


March cotton residue


September corn harvest


Irrigated cotton


Irrigating corn


September corn


Harvested corn

Comments: In 2016 this pivot irrigated site was planted to corn and cotton. The corn was planted strip-till and the cotton was planted conventional.

SITE 9

Description:

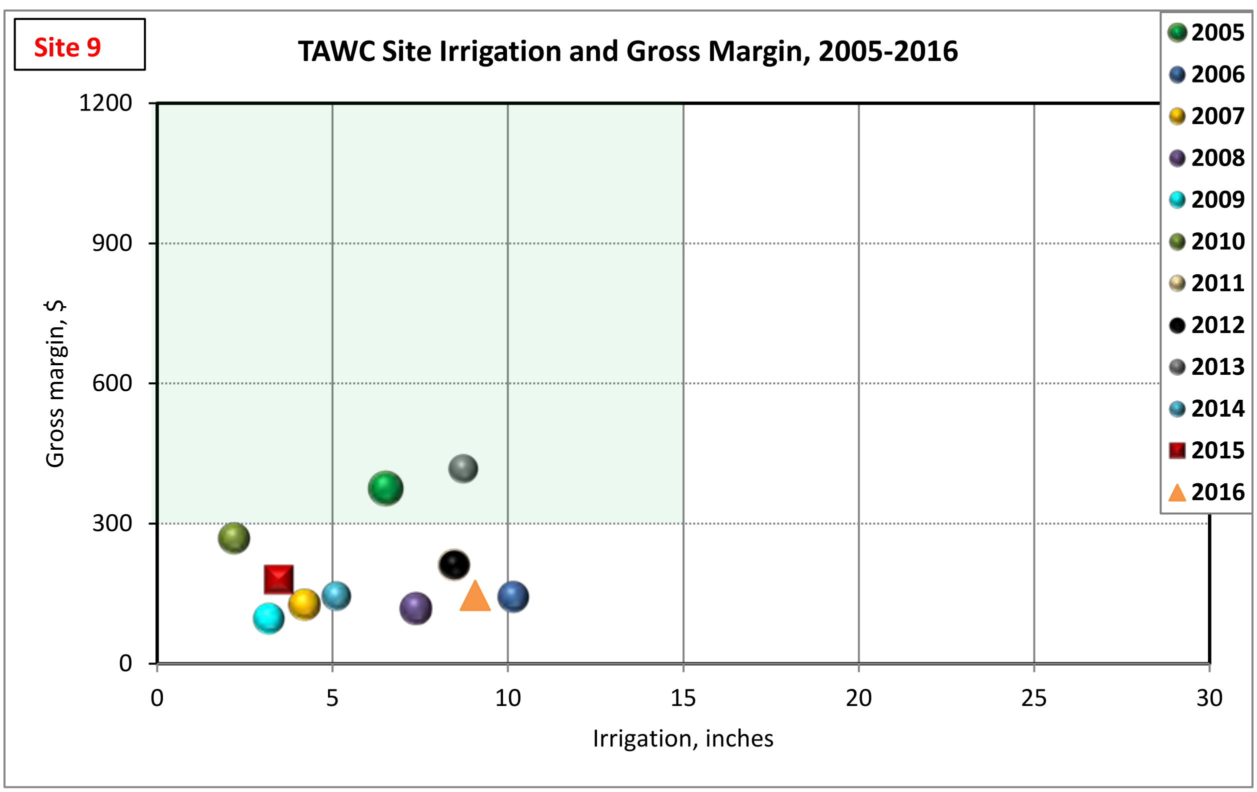
Site acres: 237.7

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%

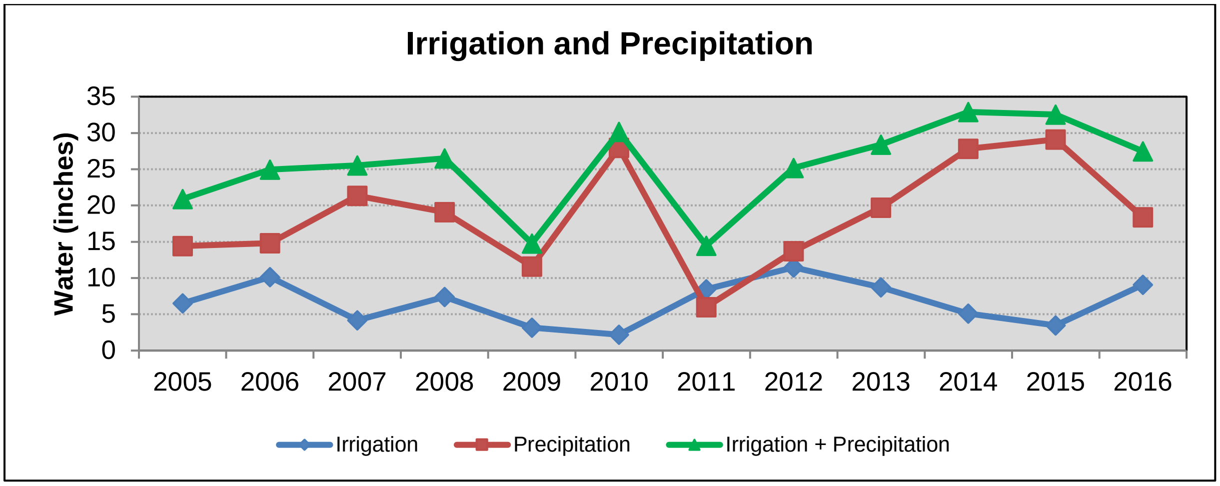
Irrigation:
Center Pivot (MESA) 900 gpm

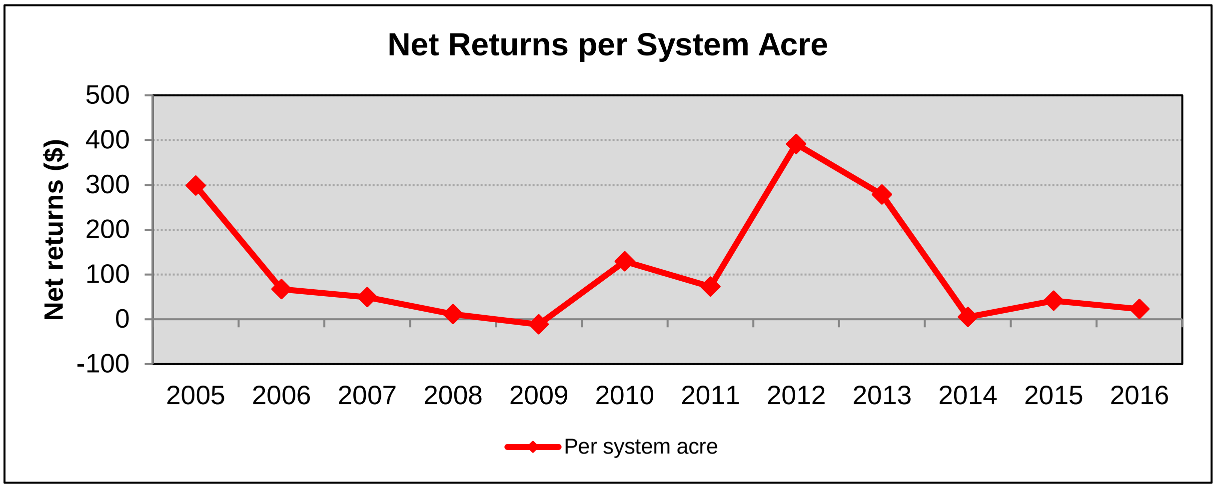
Number of wells: 4

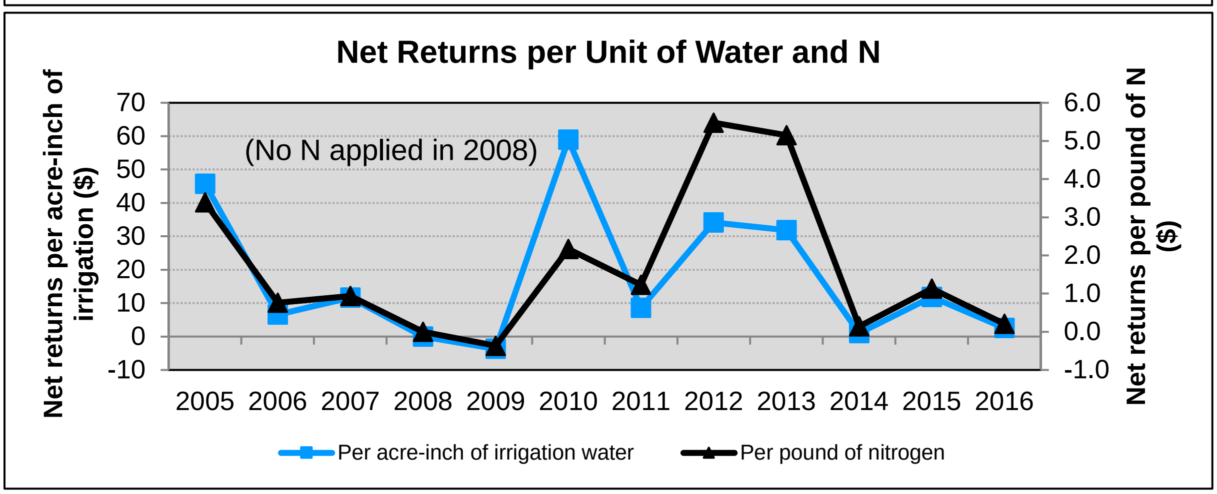
Fuel Source: 2 Natural gas,
2 Diesel



Site 9


Irrigation and Precipitation
Water (inches)
35
30
25
20
15
10
5
0
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
500
400
300
200
100
0
-100
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
70
60
50
40
30
20
10
0
-10
(No N applied in 2008)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
Net returns per pound of N ($)
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site 9

Perennial grass

September cotton

Cow/calf grazing grass

Perennial grass for grazing

Momma cows

Cotton ready for harvest

Comments: In 2016 this pivot irrigated integrated crop/livestock site was planted to cotton. The perennial grass mix was grazed by cows with calves.

SITE 10

Description:

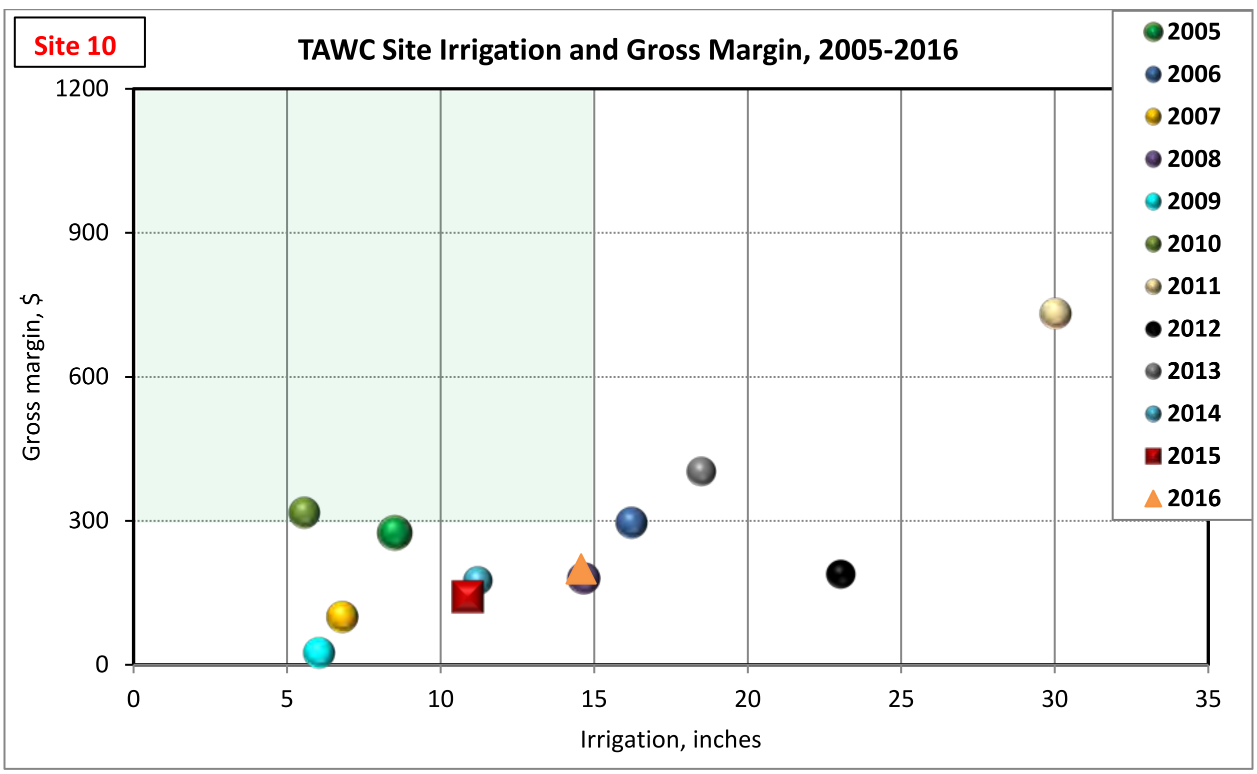
Site acres: 173.6

Soil types:
- 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%

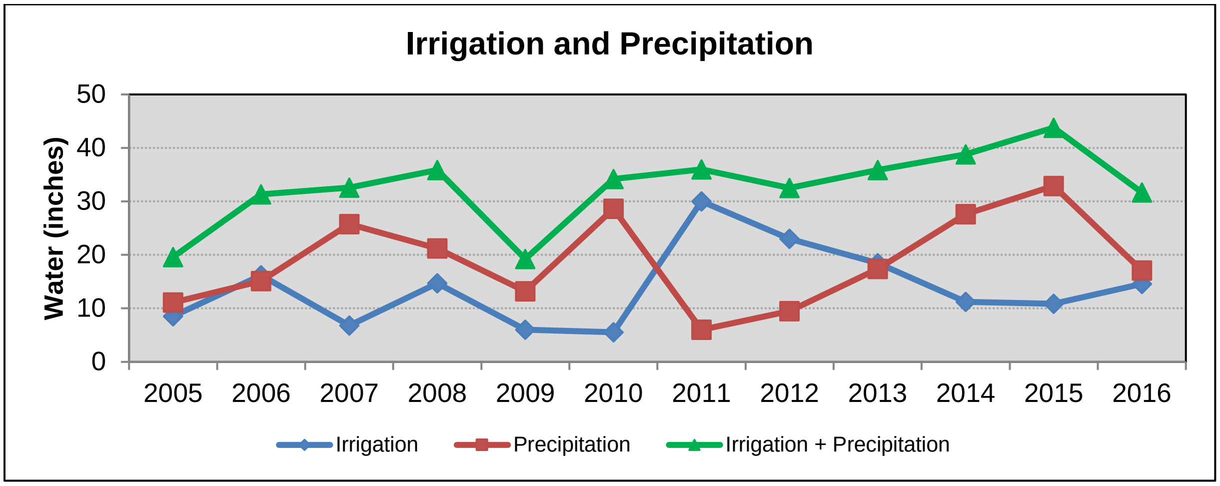
Irrigation:
Center Pivot (LESA) 800 gpm

Number of wells: 2

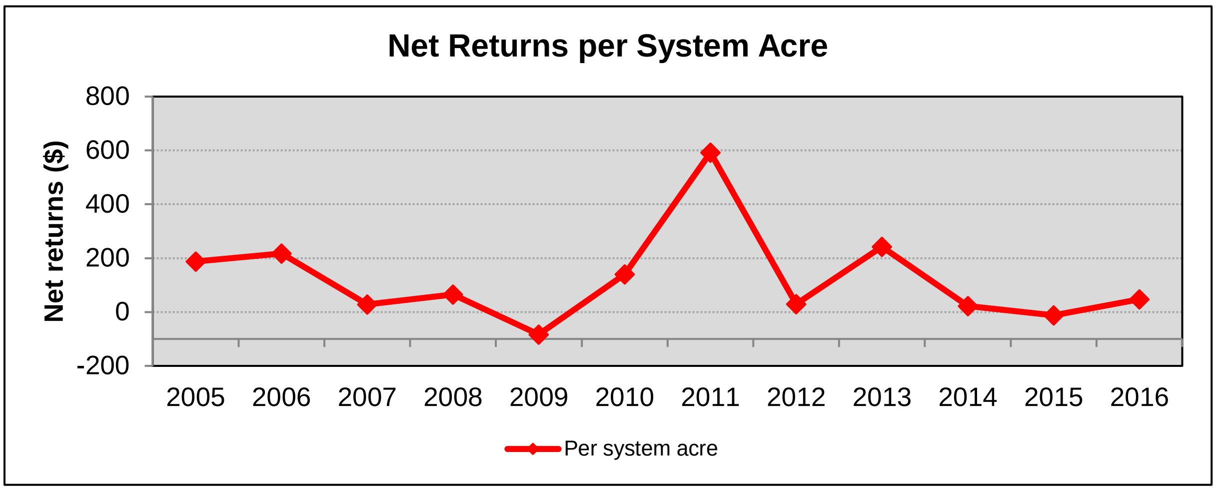
Fuel Source: Electric



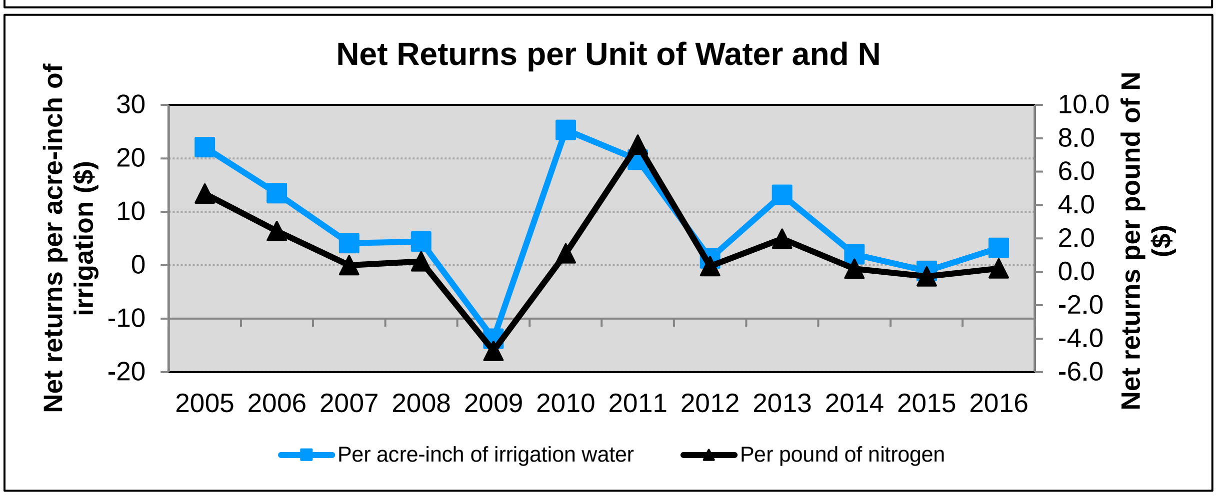
Site 10



Irrigation and Precipitation
Water (inches)
0
10
20
30
40
50
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
-200
0
200
400
600
800
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
-20
-10
0
10
20
30
Net returns per pound of N ($)
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
8.0
10.0
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Per acre-inch of irrigation water
Per pound of nitrogen

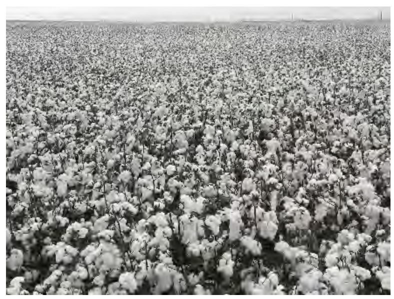
Site 10


Early May


Cow/calf pairs


Cattle grazing mixed grass


Grazing corn residue


November cotton


November cotton bales

Comments: In 2016 this pivot LESA irrigated integrated crop/livestock site was planted to conventional tillage corn and cotton and continued in perennial grass. The perennial grass and corn residue was grazed.

SITE 11

Description:

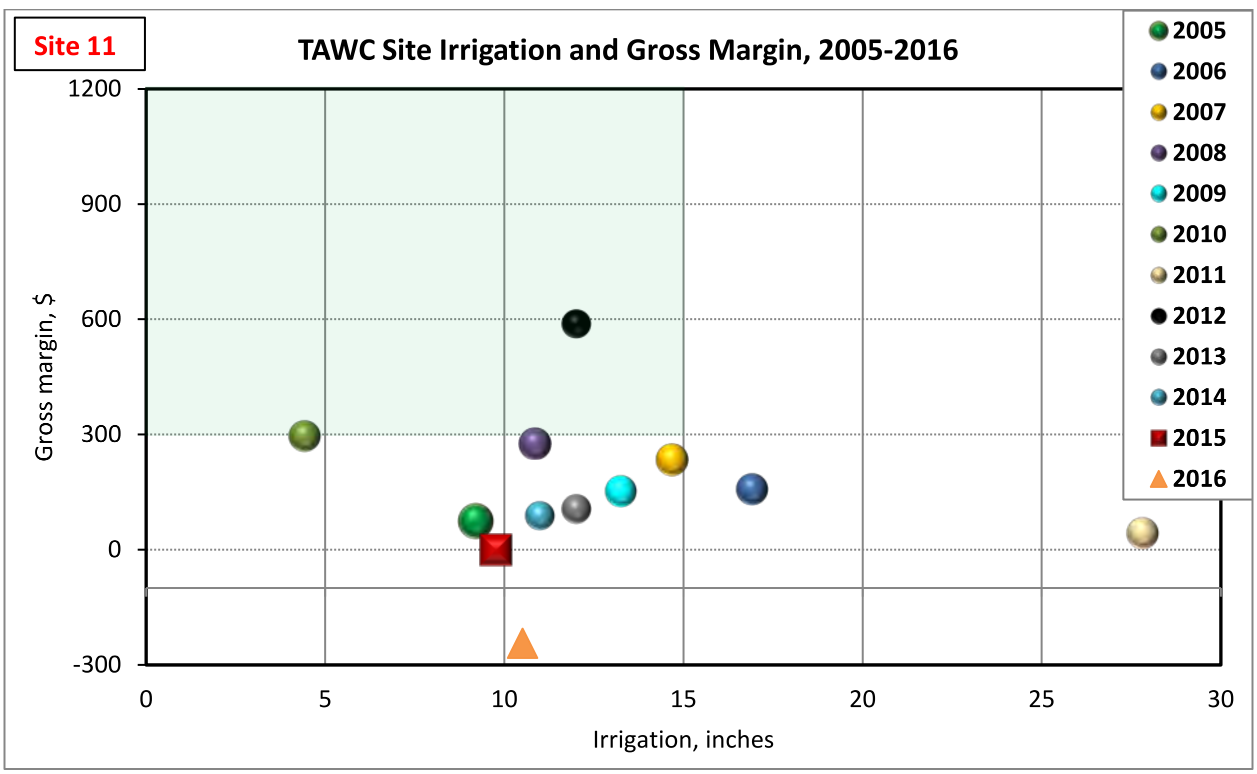
Site acres: 82.6

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%

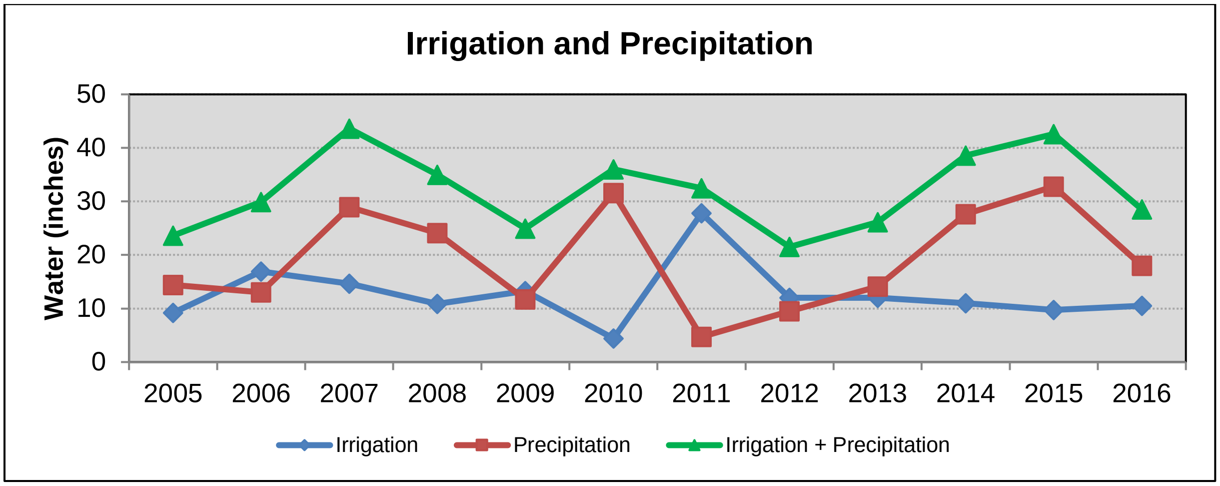
Irrigation:
- Furrow/Drip (FUR/SDI) 490 gpm

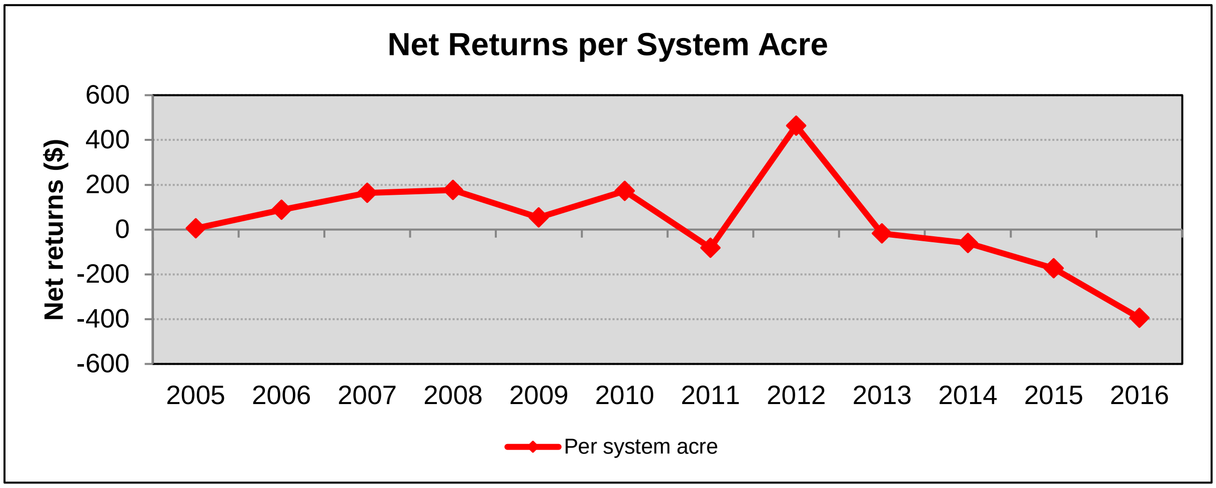
Number of wells: 1

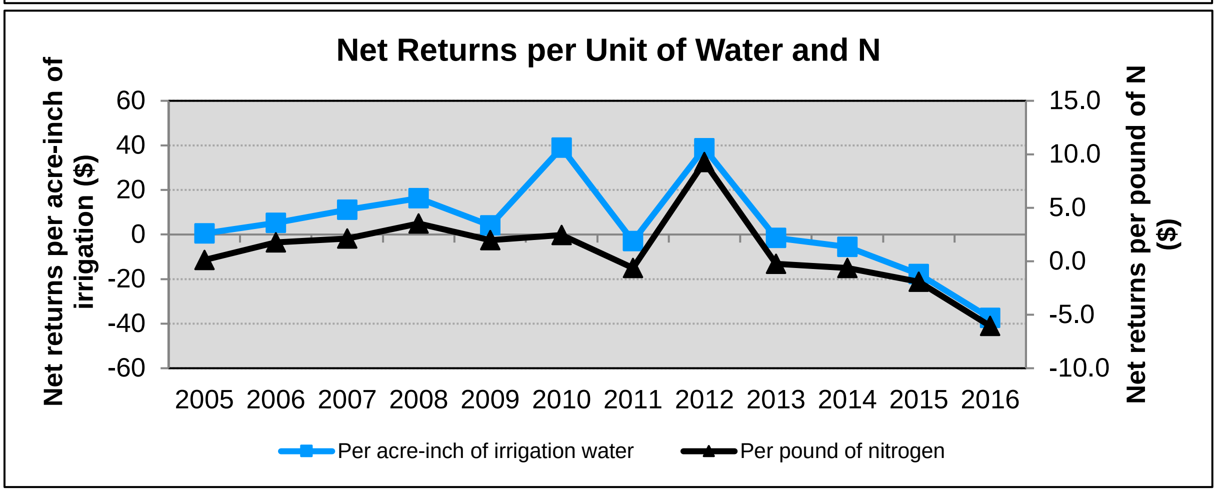
Fuel Source: Electric



Site 11


Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
600
400
200
0
-200
-400
-600
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
60
40
20
0
-20
-40
-60
15.0
10.0
5.0
0.0
-5.0
-10.0
Net returns per pound of N ($)
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site 11

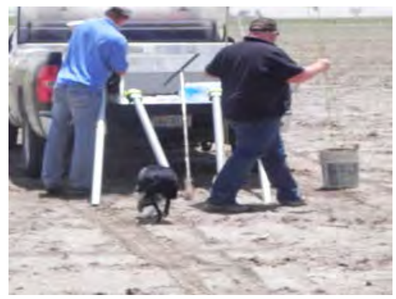
May dry conditions

Water meter on system

SDI filtration system

September cotton

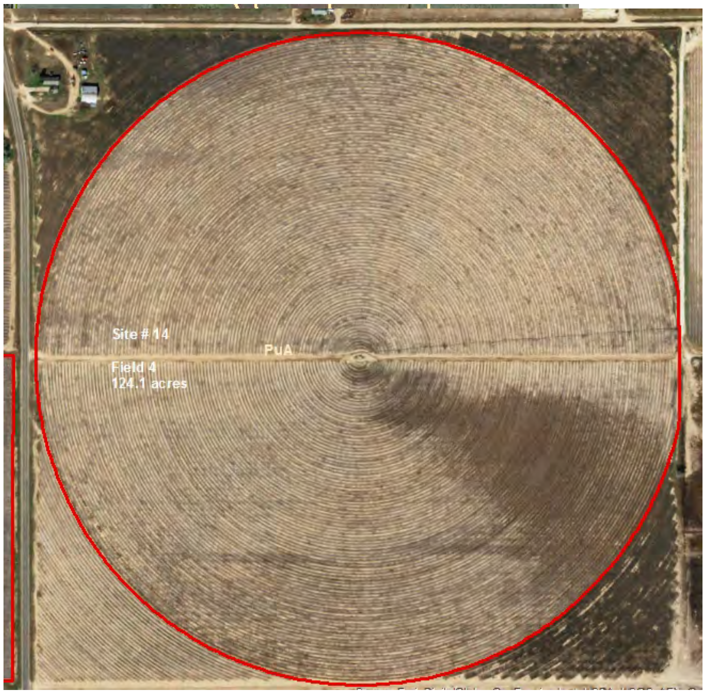
September corn



Moisture probe installation

Comments: In 2016 this SDI/FUR irrigated site was planted to cotton. The cotton was planted on 40-inch centers under conventional tillage.

SITE 14



Description:

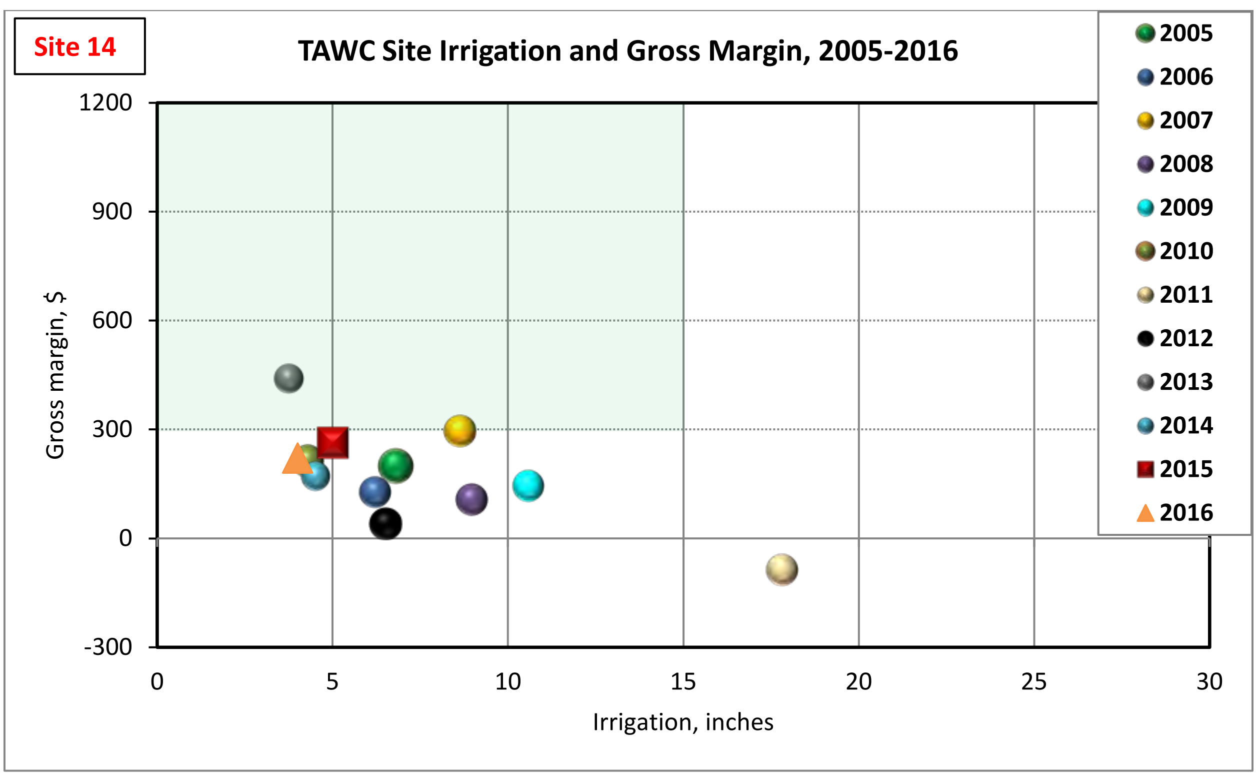
Site acres: 124.1

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

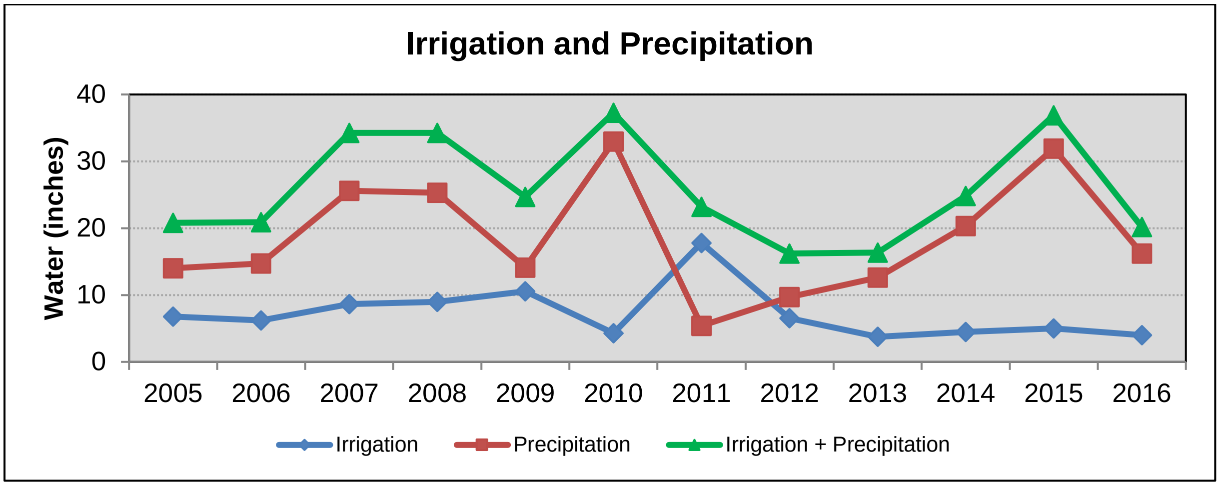
Irrigation:
Center Pivot (LESAA) 300 gpm

Number of wells: 3

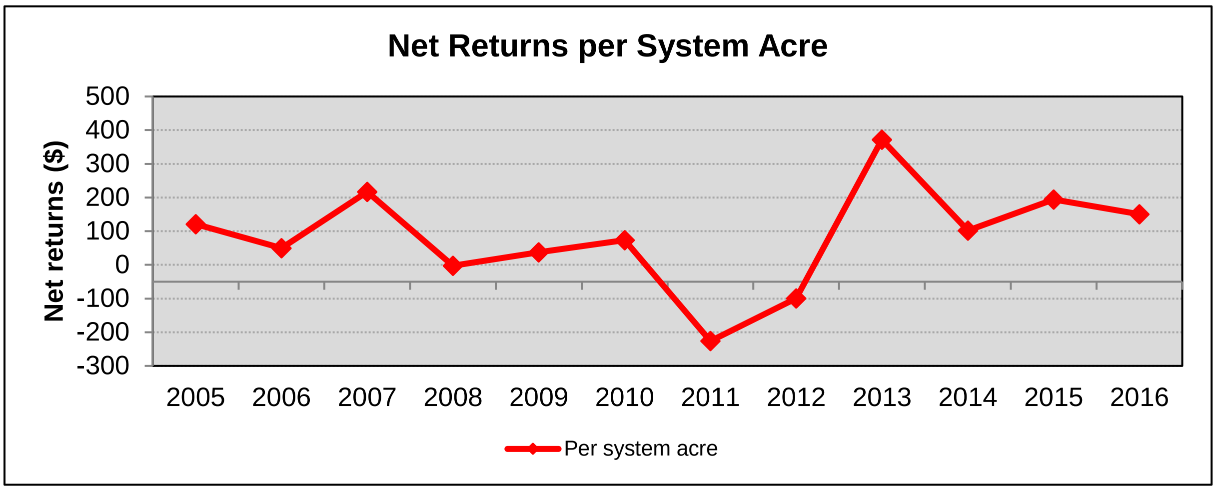
Fuel Source: Electric



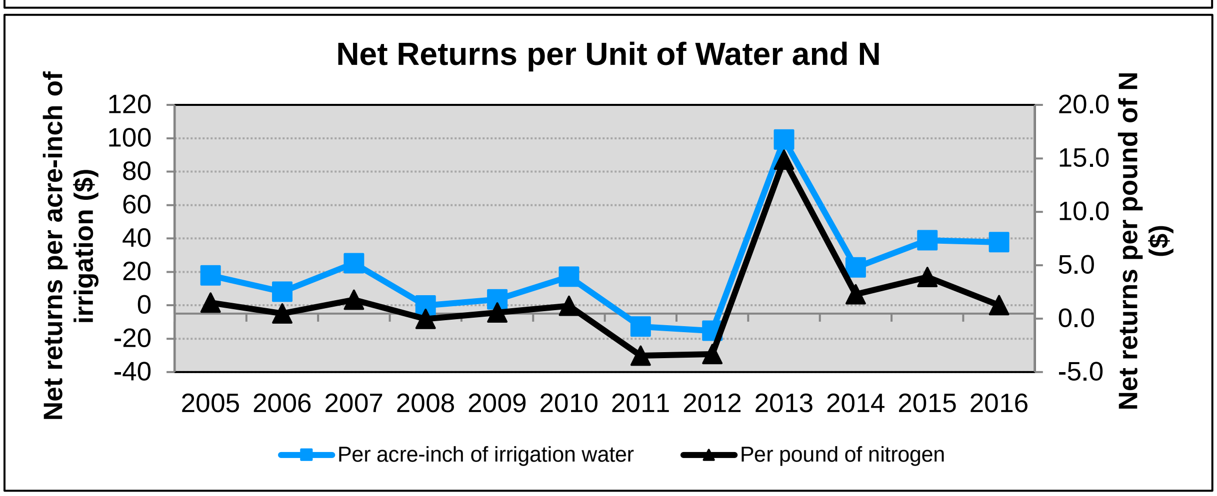
Site 14



Irrigation and Precipitation
Water (inches)
40
30
20
10
0
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
500
400
300
200
100
0
-100
-200
-300
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
120
100
80
60
40
20
0
-20
-40
20.0
15.0
10.0
5.0
0.0
-5.0
Net returns per pound of N ($)
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site 14


Dry conditions March


Early June cotton


Early September cotton


Cotton planted 2 in- 2 out


Cotton ready for harvest


MESA/LEPA irrigation

Comments: In 2016 this pivot MESA/LEPA irrigated site was planted to cotton monoculture in a 2 in 2 out tillage system.

SITE 17

Description:

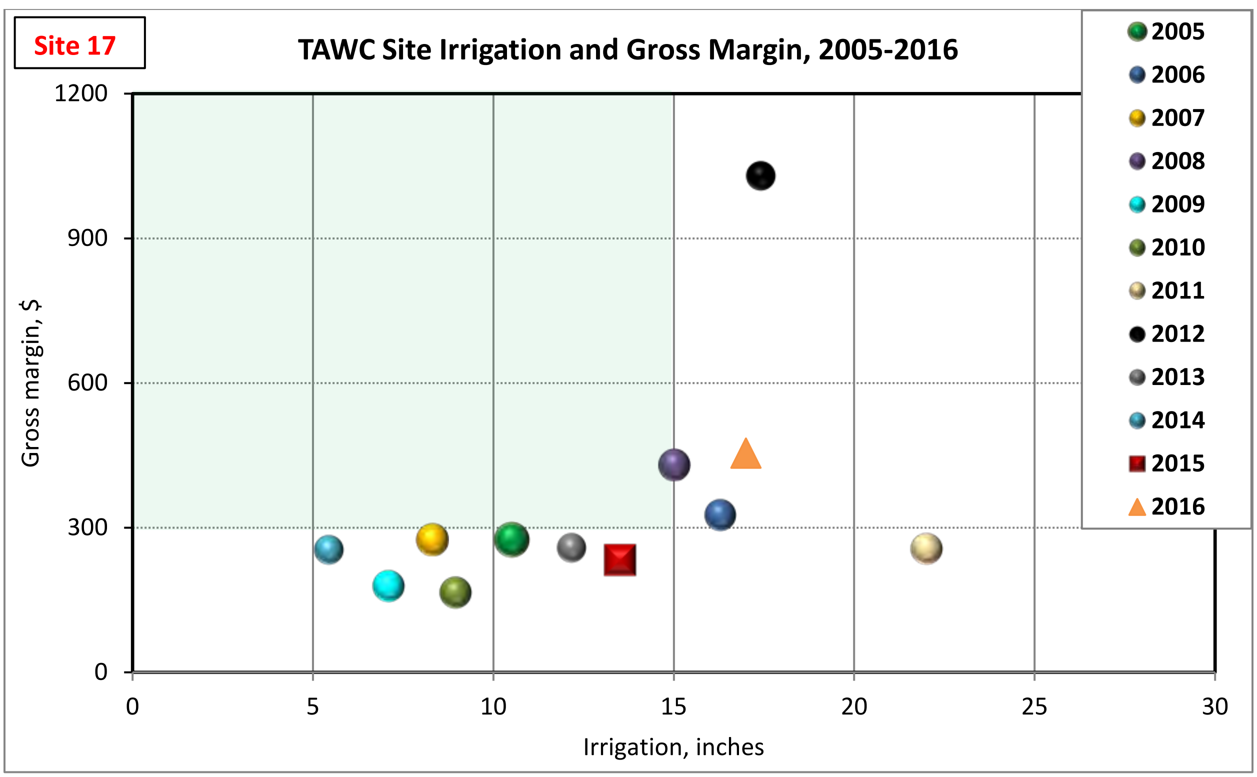
Site acres: 108.9

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

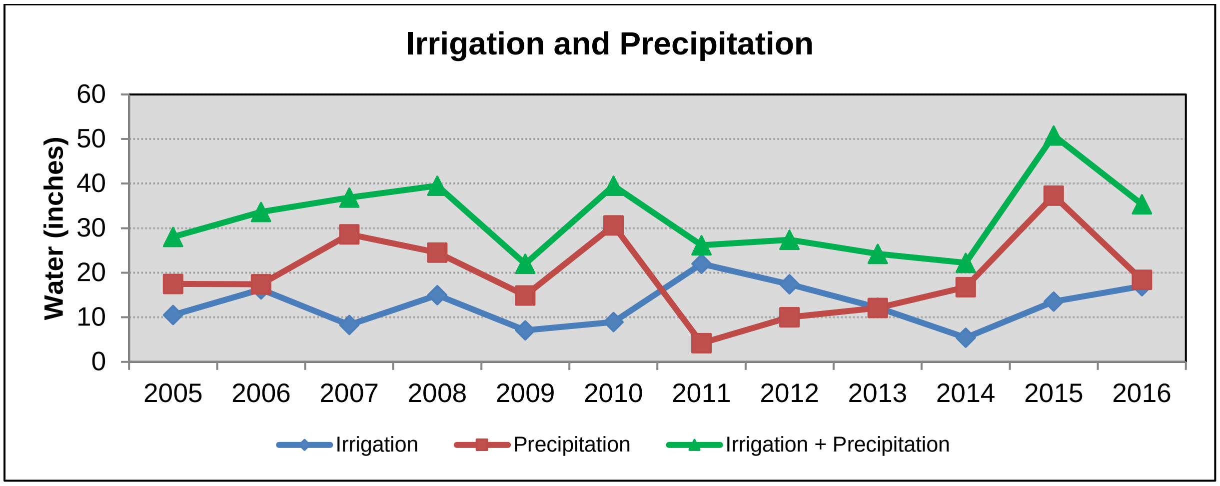
Irrigation:
Center Pivot (MESA) 900 gpm

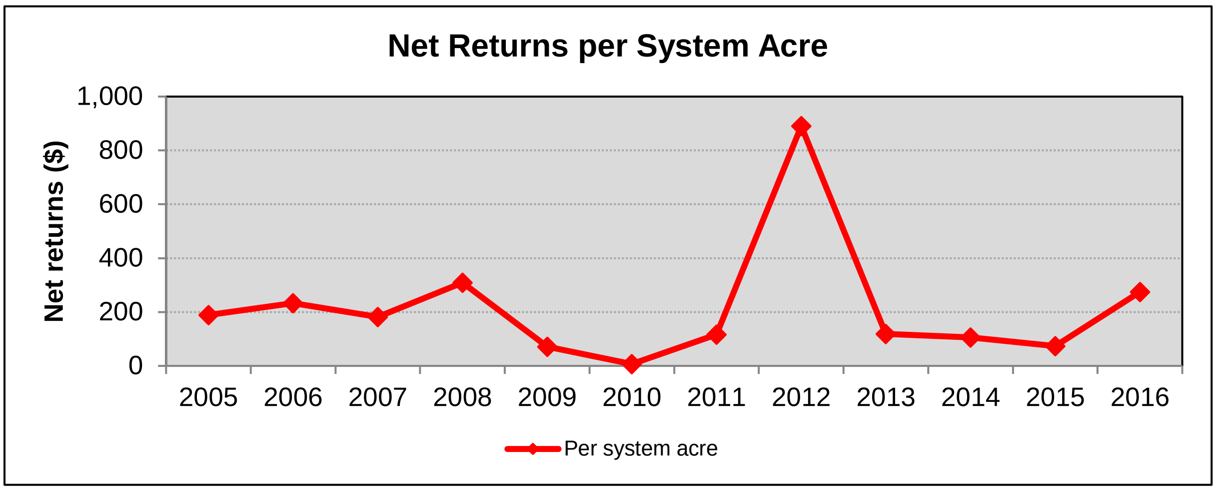
Number of wells: 8

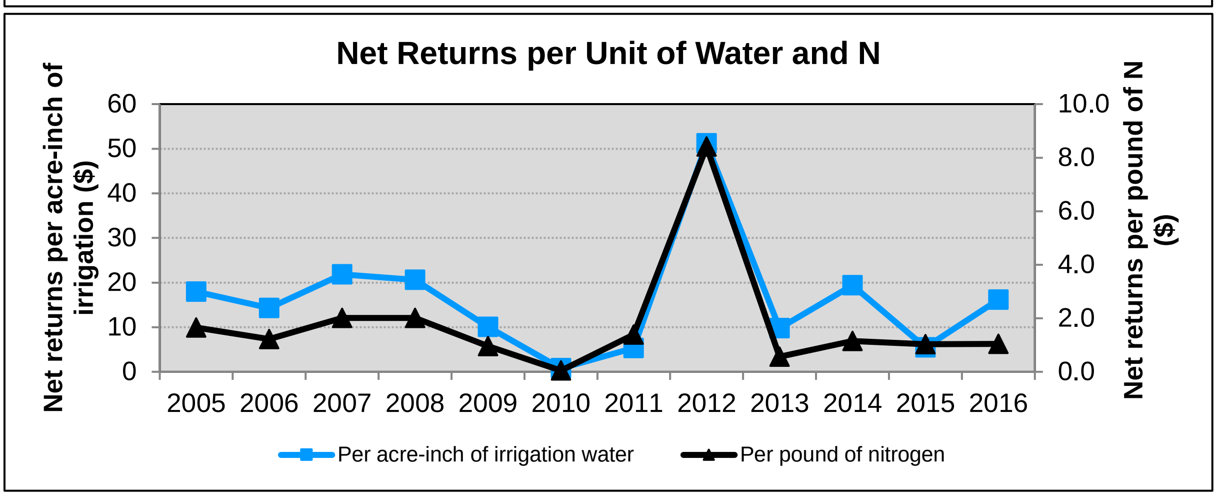
Fuel Source: Electric



Site 17


Irrigation and Precipitation
Water (inches)
60
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
1,000
800
600
400
200
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
60
50
40
30
20
10
0
Net returns per pound of N ($)
10.0
8.0
6.0
4.0
2.0
0.0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site 17


May cotton residue


Sept. W.W. B-Dahl pasture


September corn


Perennial grass and corn


Dahl hay


Corn ready for harvest

Comments: In 2016 this pivot irrigated site was planted to yellow corn. The W.W. B-Dahl perennial grass was not grazed but baled for hay.

SITE 21

Description:

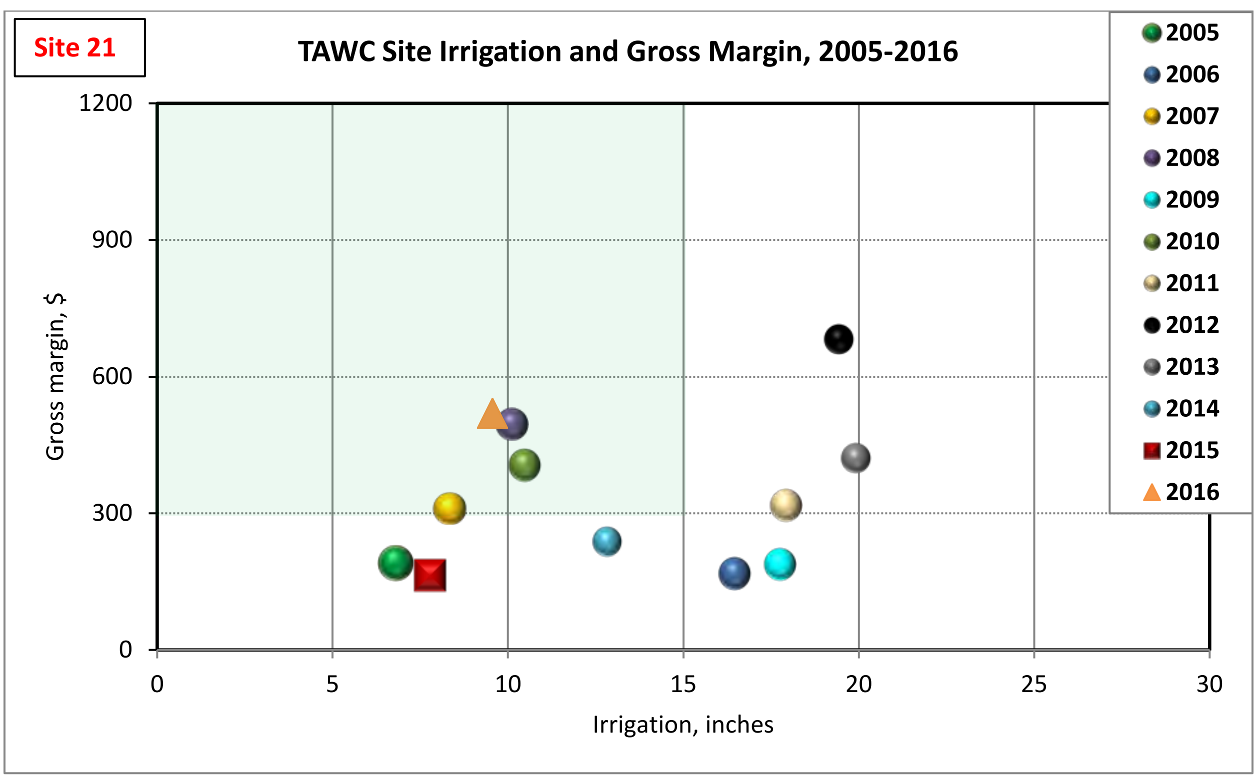
Site acres: 120.7

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

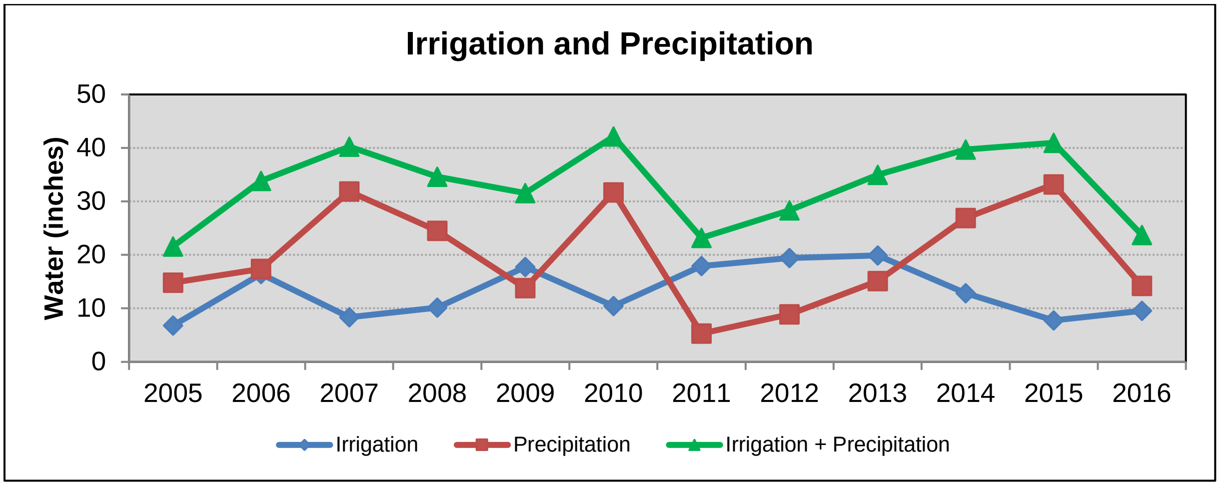
Irrigation:
Center Pivot (LEPA) 500 gpm

Number of wells: 1

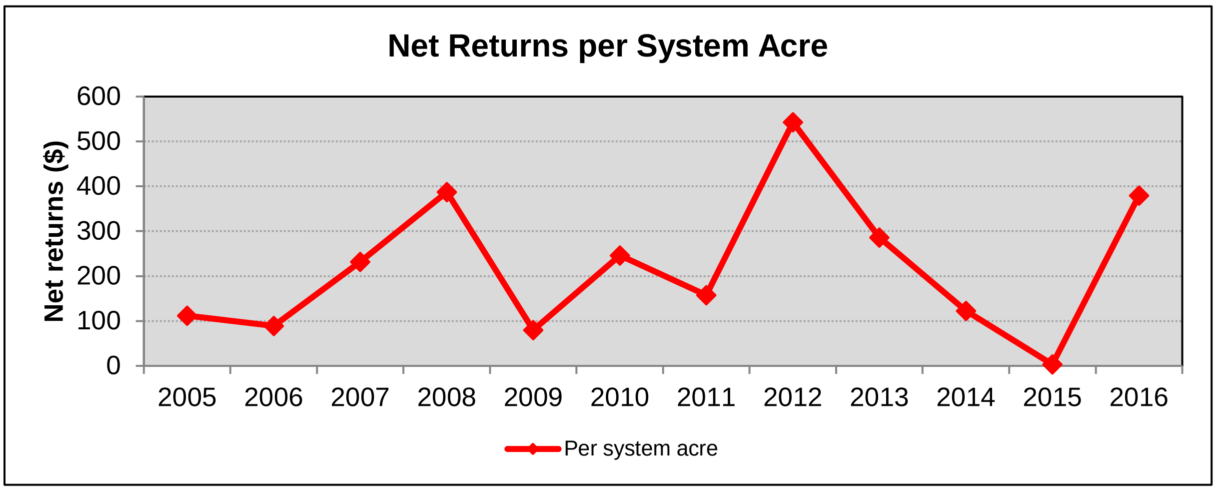
Fuel Source: Electric



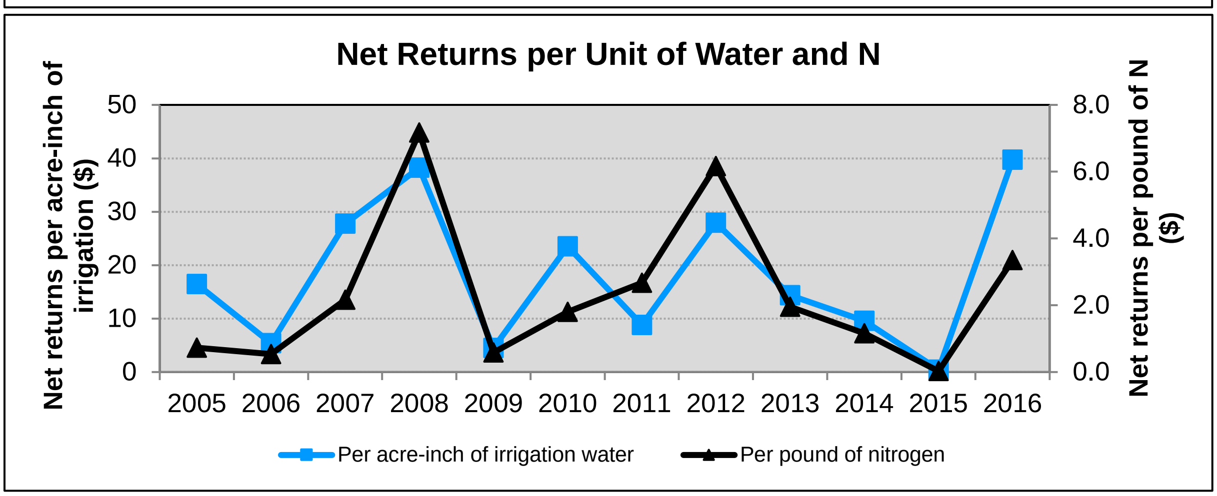
Site 21



Irrigation and Precipitation
Water (inches)
0
10
20
30
40
50
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
0
100
200
300
400
500
600
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
0
10
20
30
40
50
Net returns per pound of N ($)
0.0
2.0
4.0
6.0
8.0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site 21

May germination application

September irrigation

Cotton harvest equipment

Ready to strip

November cotton

November cotton module

Comments: In 2016 this pivot LEPA irrigated site was planted to cotton 40 inch conventional tillage.

SITE 22

Description:

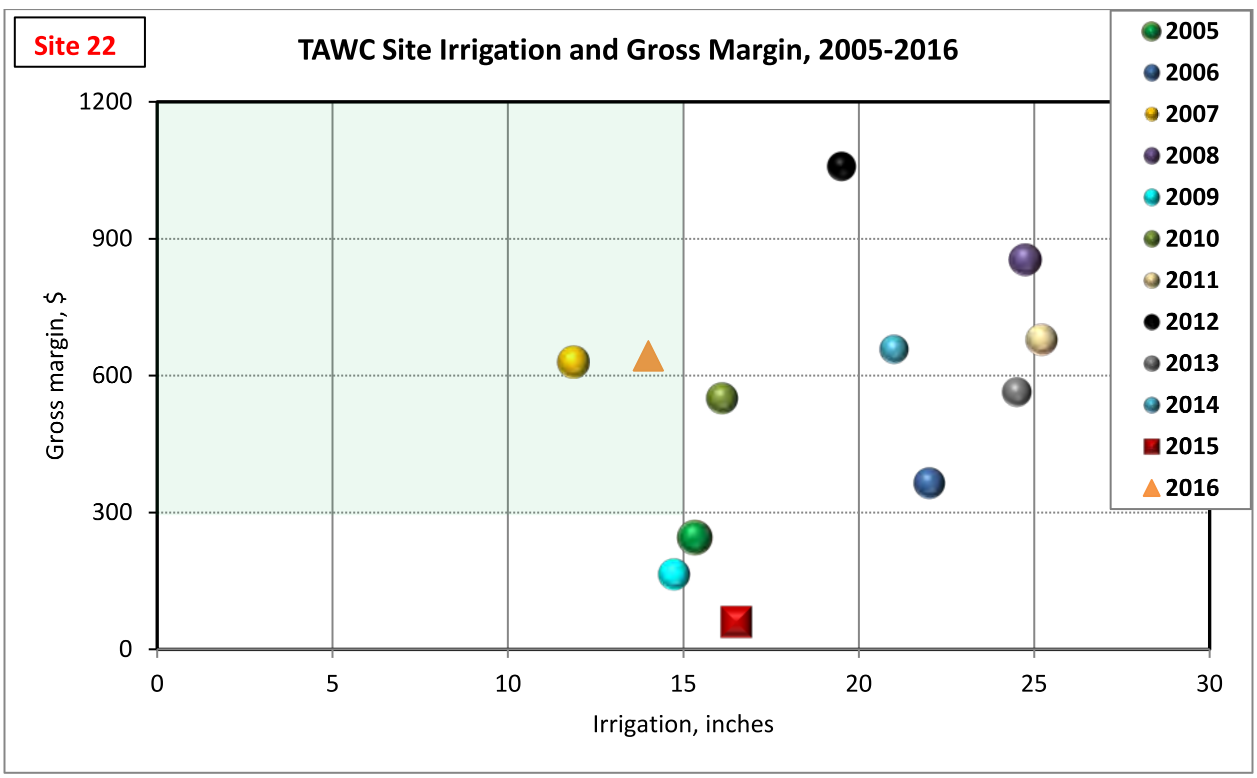
Site acres: 145.0

Soil types:
PuA-Pullman clay loam; 0 to 1%
EsB-Estacado loam; 1 to 3%

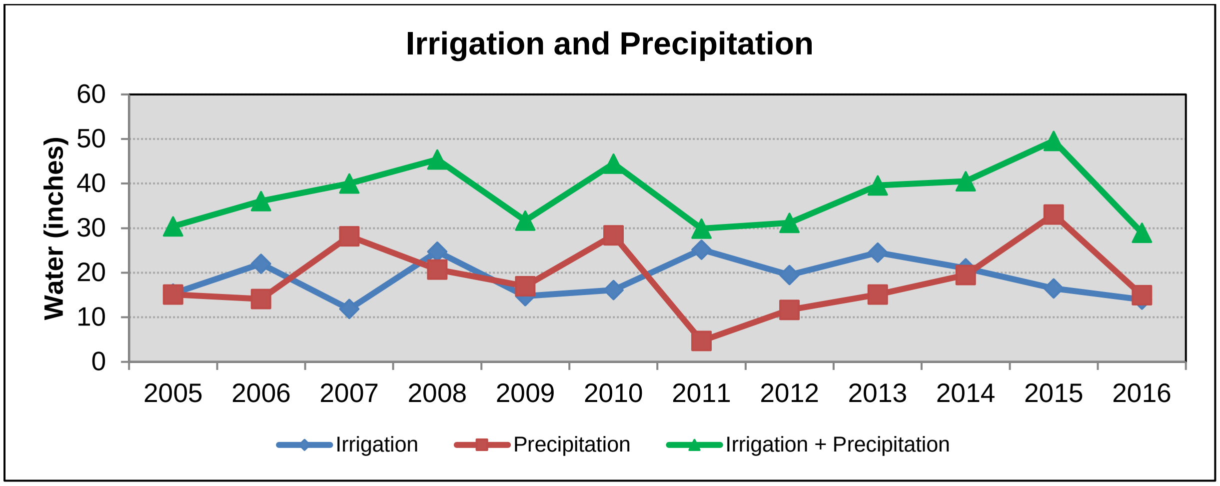
Irrigation:
Center Pivot (LEPA) 800 gpm

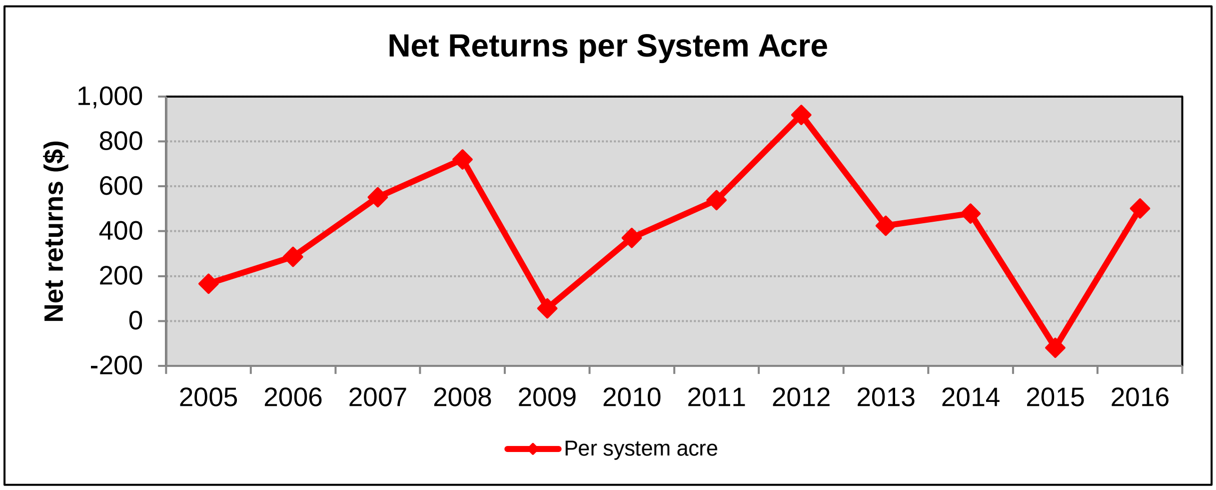
Number of wells: 4

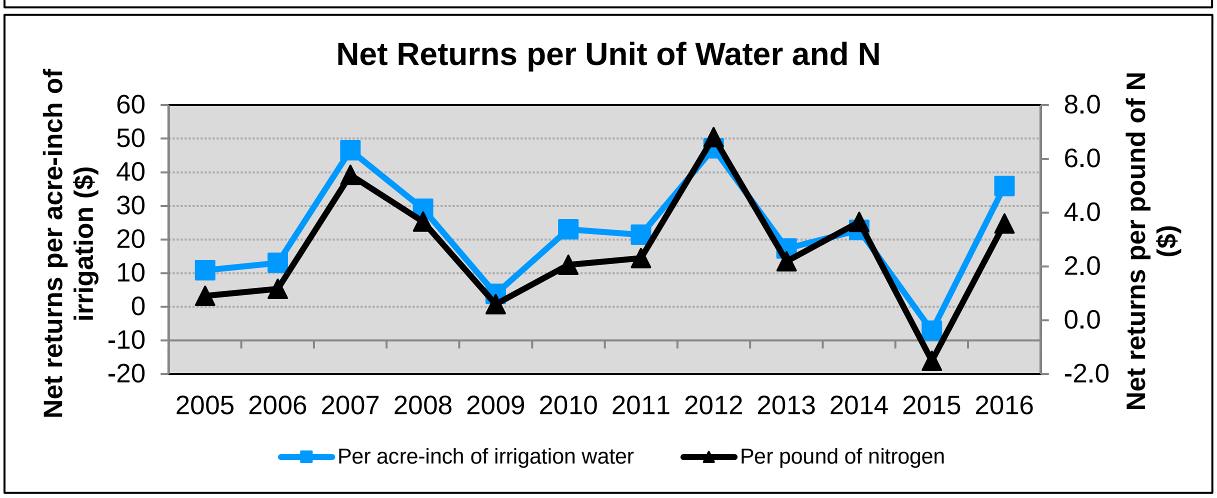
Fuel Source: Electric



Site 22


Irrigation and Precipitation
Water (inches)
60
50
40
30
20
10
0
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
1,000
800
600
400
200
0
-200
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
60
50
40
30
20
10
0
-10
-20
8.0
6.0
4.0
2.0
0.0
-2.0
Net returns per pound of N ($)
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site 22


May


30-inch strip till planting

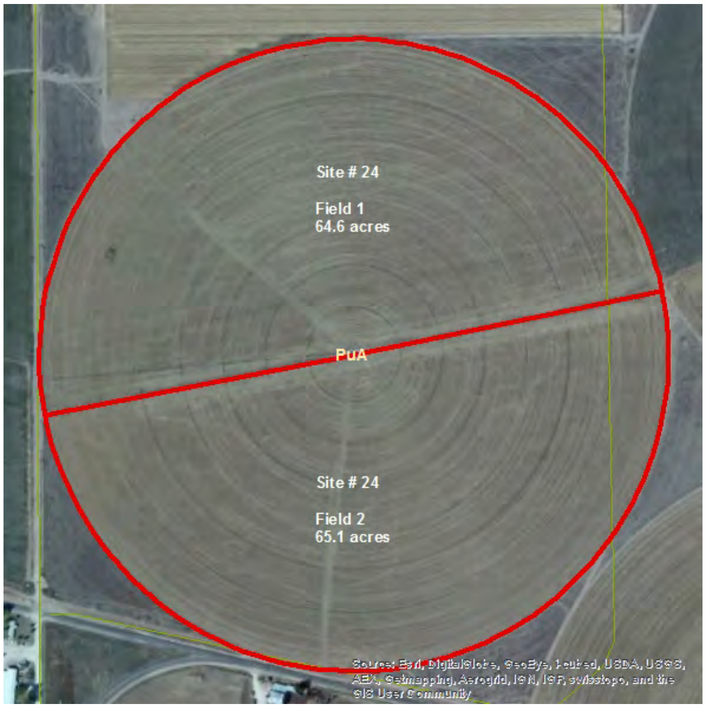

September cotton


Ground preparation


November cotton harvest

Comments: In 2016 this pivot LEPA irrigated site was planted to cotton. The cotton was planted on 30-inch centers.

Site 24



Description:

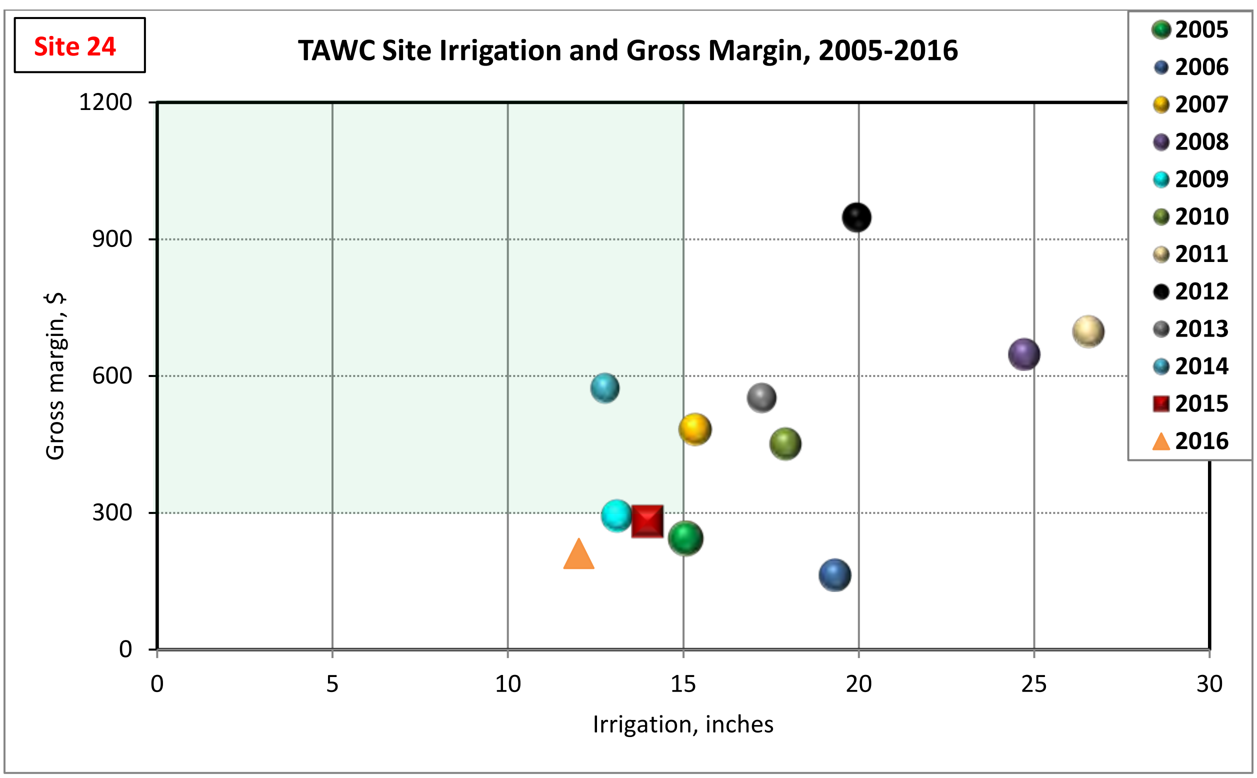
Site acres: 129.7

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

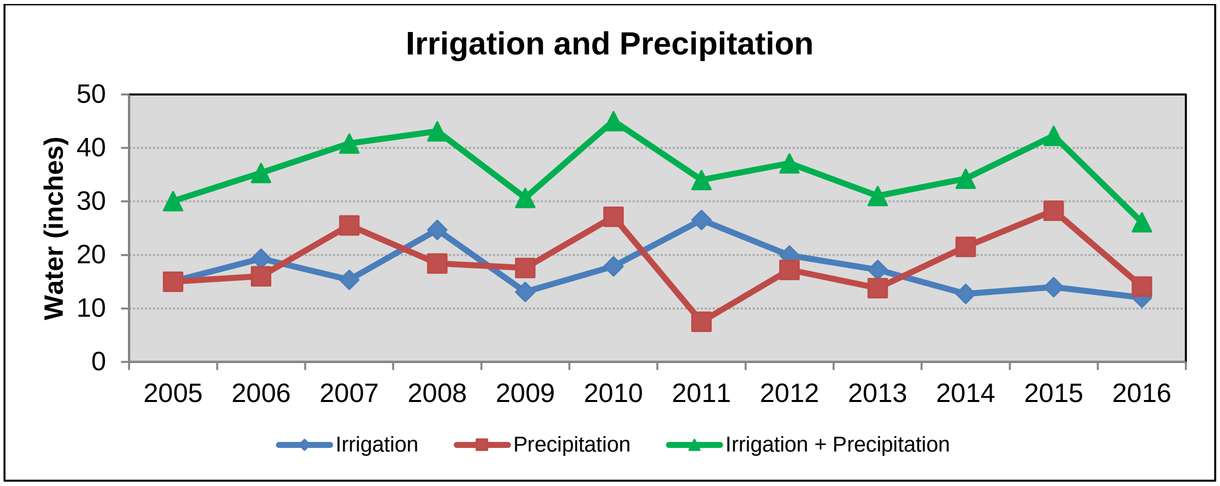
Irrigation:
Center Pivot (LESA) 700 gpm

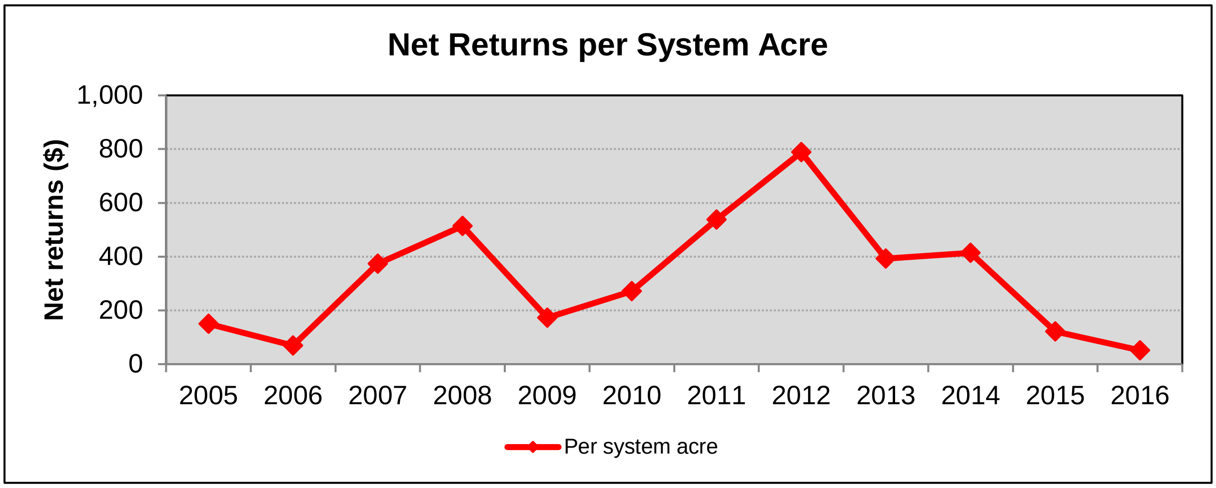
Number of wells: 1

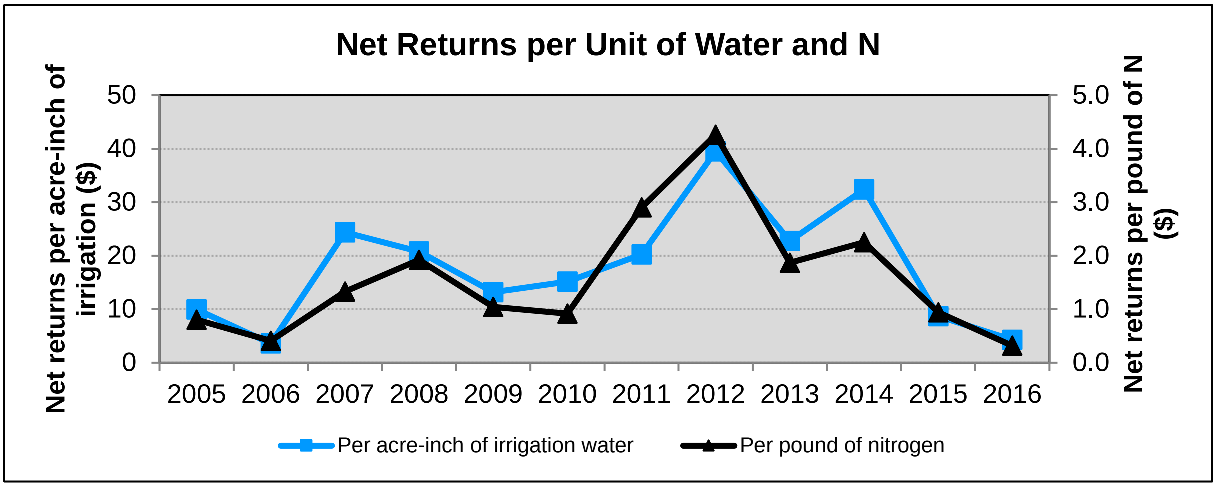
Fuel Source: Diesel



Site 24


Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
1,000
800
600
400
200
0
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
50
40
30
20
10
0
5.0
4.0
3.0
2.0
1.0
0.0
Net returns per pound of N ($)
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site 24

May

Sunflower field

Sunflower head

September corn

Corn harvest

Corn Harvester

Comments: In 2016 this pivot LESA irrigated site was planted to food corn and sunflower on 30 inch centers with the sunflower being strip till.

SITE 28

Description:

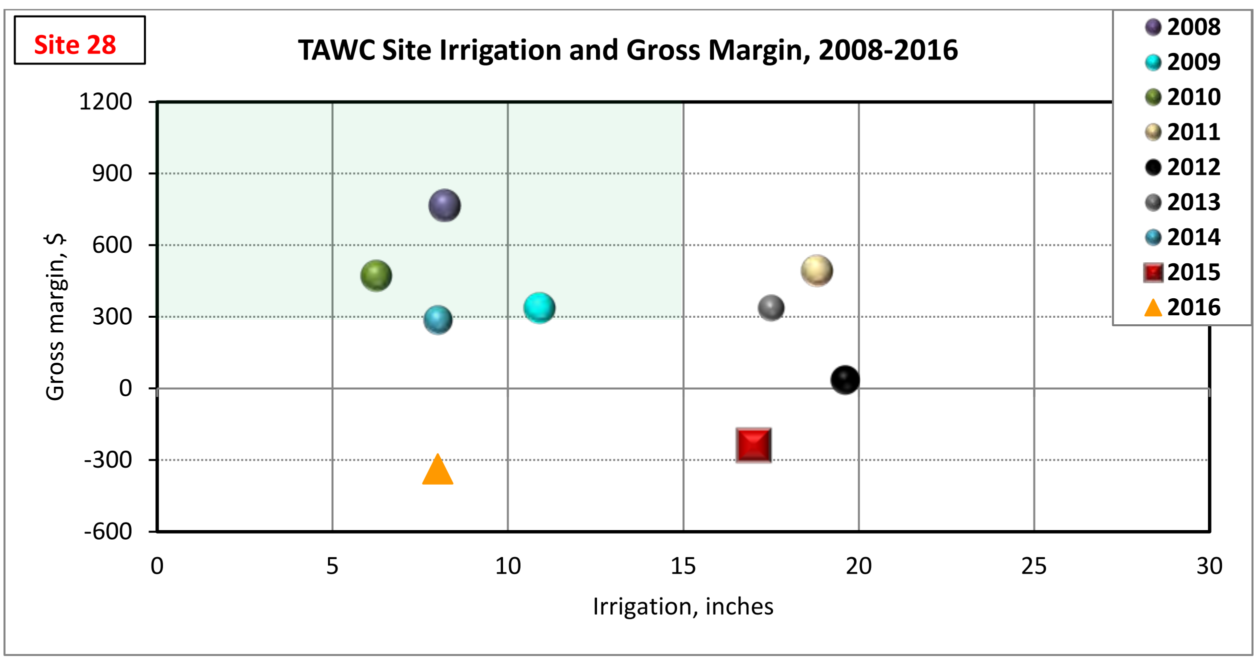
Site acres: 51.5

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%

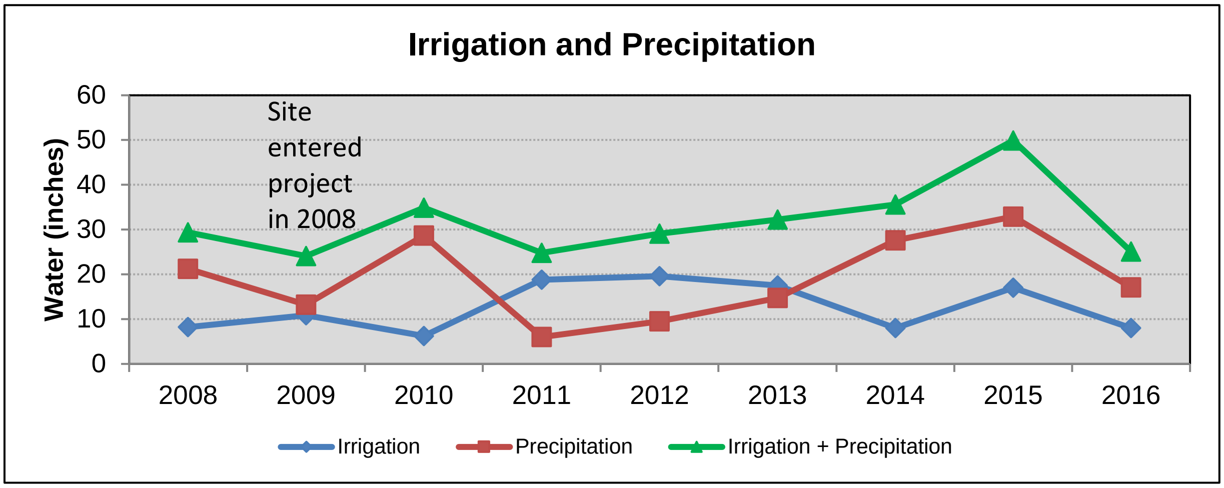
Irrigation:
Sub-Surface Drip (SDI) 300 gpm

Number of wells: 1

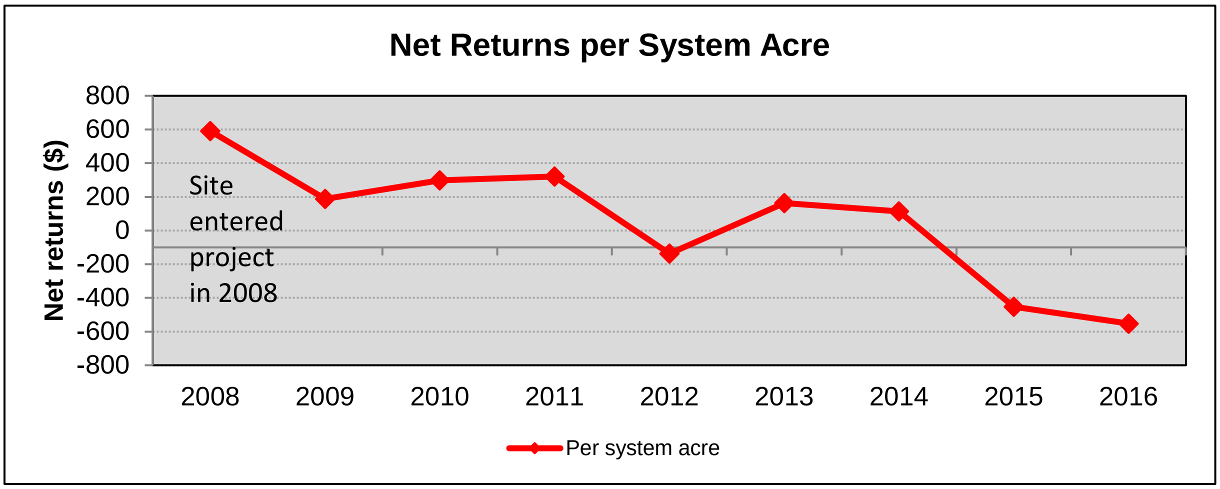
Fuel Source: Electric



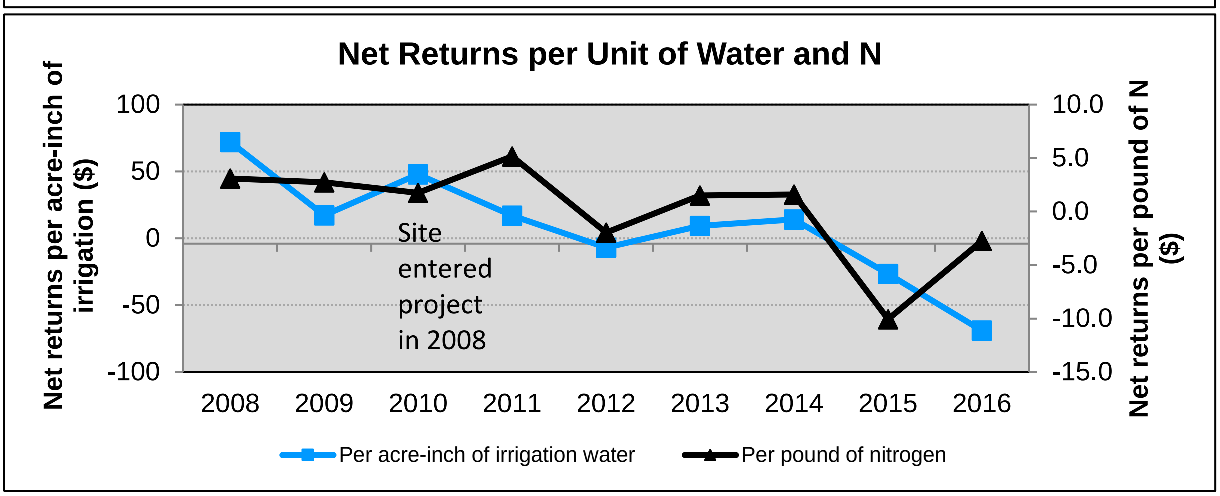
Site 28



Irrigation and Precipitation
Water (inches)
60
50
40
30
20
10
0
Site entered project in 2008
2008
2009
2010
2011
2012
2013
2014
2015
2016
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
800
600
400
200
0
-200
-400
-600
-800
Site entered project in 2008
2008
2009
2010
2011
2012
2013
2014
2015
2016
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
100
50
0
-50
-100
Net returns per pound of N ($)
10.0
5.0
0.0
-5.0
-10.0
-15.0
Site entered project in 2008
2008
2009
2010
2011
2012
2013
2014
2015
2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site 28


May


Drip flush valve


September corn

Comments: In 2016 this SDI irrigated site was planted to corn. The corn was planted on 40-inch centers with conventional tillage.

SITE 31

Description:

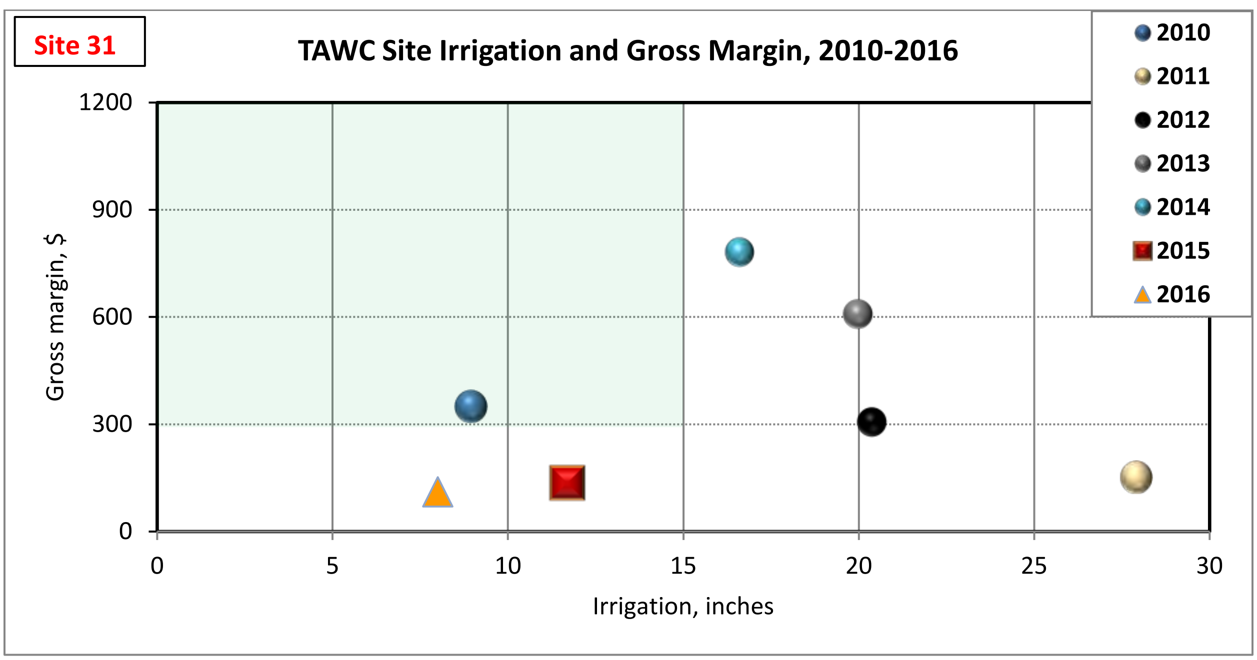
Site acres: 121.9

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

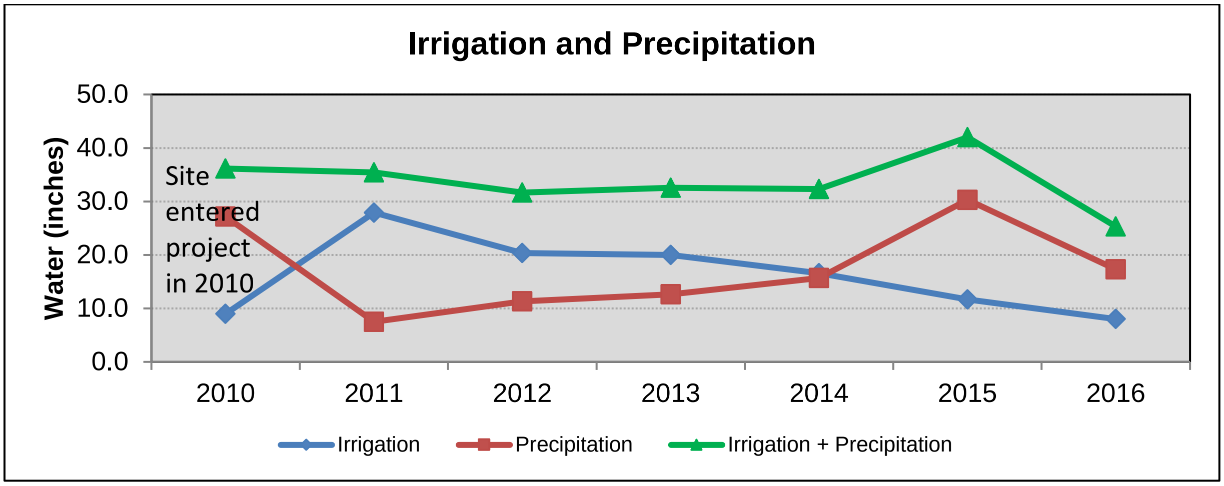
Irrigation:
Center Pivot (LEPA) 450 gpm

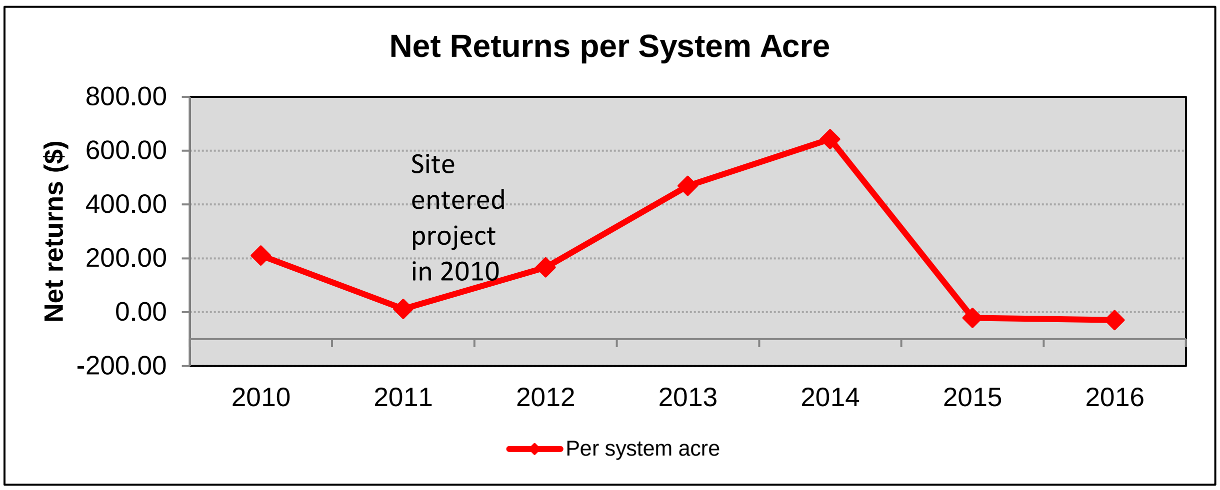
Number of wells: 2

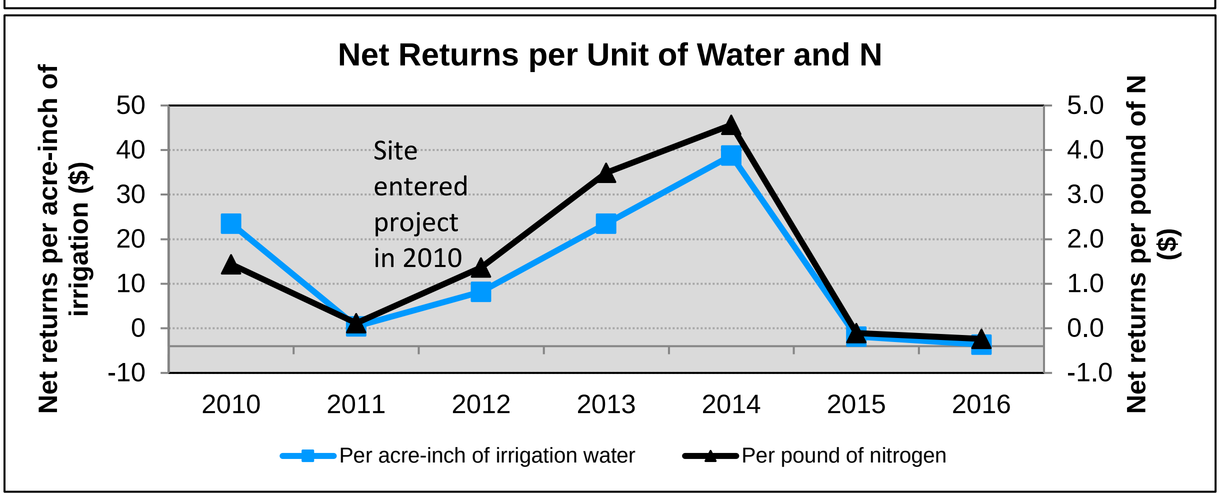
Fuel Source: 1 Natural Gas, 1 Electric



Site 31


Irrigation and Precipitation
Water (inches)
50.0
40.0
30.0
20.0
10.0
0.0
Site entered project in 2010
2010
2011
2012
2013
2014
2015
2016
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
800.00
600.00
400.00
200.00
0.00
-200.00
Site entered project in 2010
2010
2011
2012
2013
2014
2015
2016
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
50
40
30
20
10
0
-10
Net returns per pound of N ($)
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
Site entered project in 2010
2010
2011
2012
2013
2014
2015
2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site 31


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 grain sorghum.

SITE 32

Description:

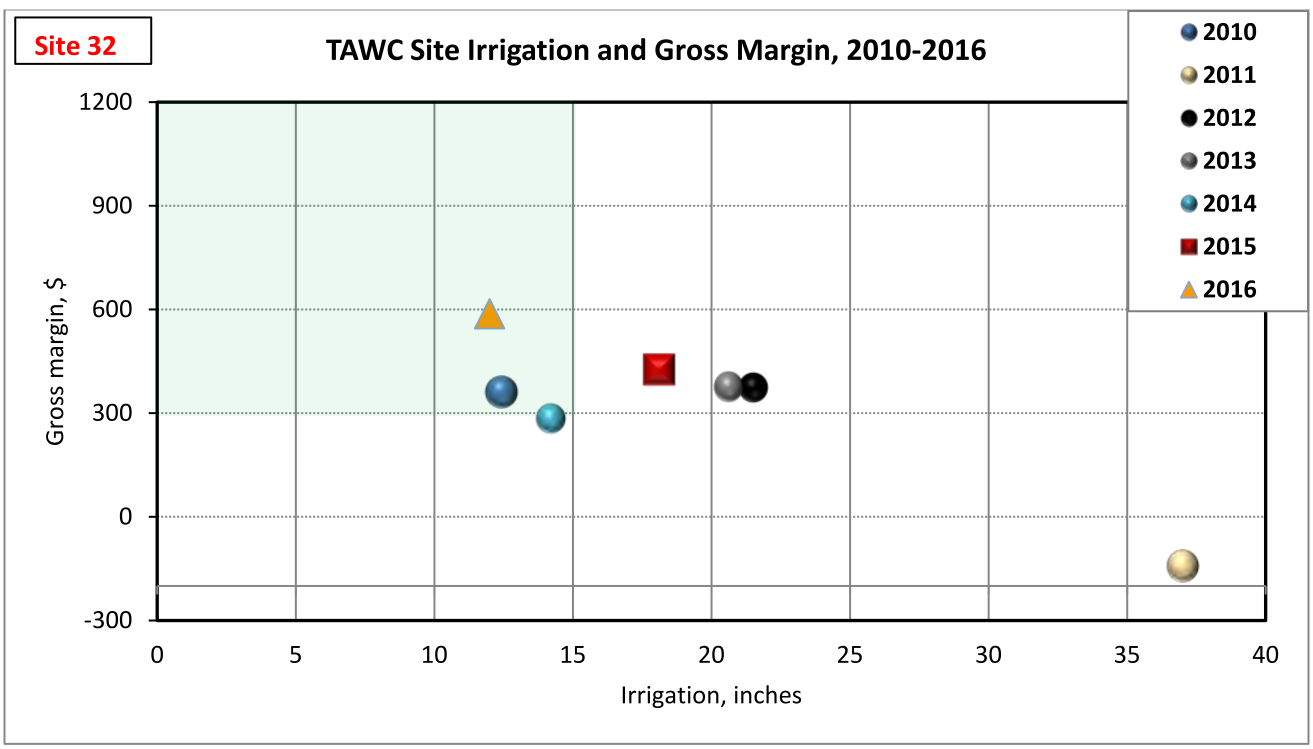
Site acres: 70

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

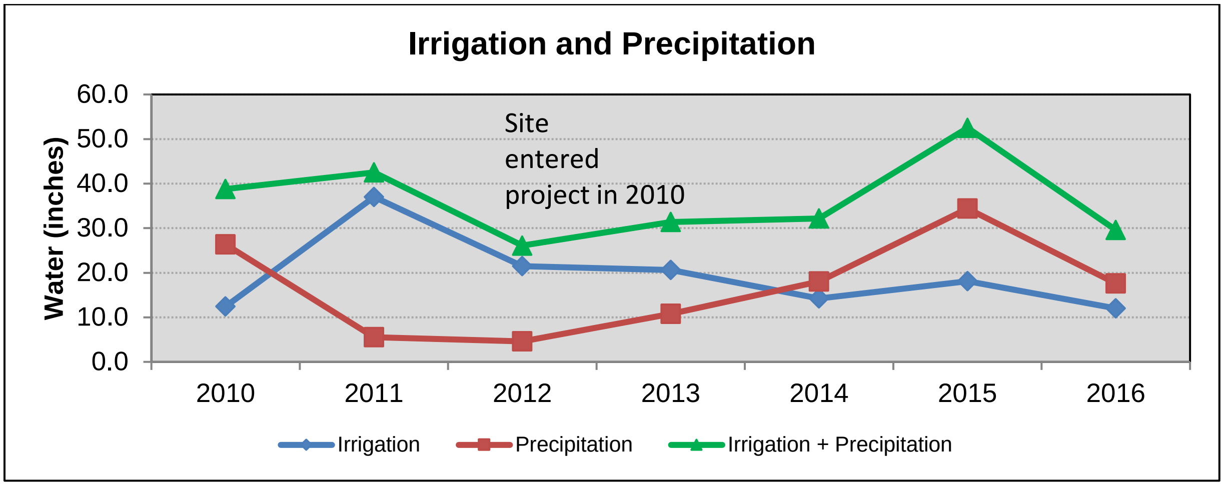
Irrigation:
Center Pivot (LEPA) 350 gpm

Number of wells: 2

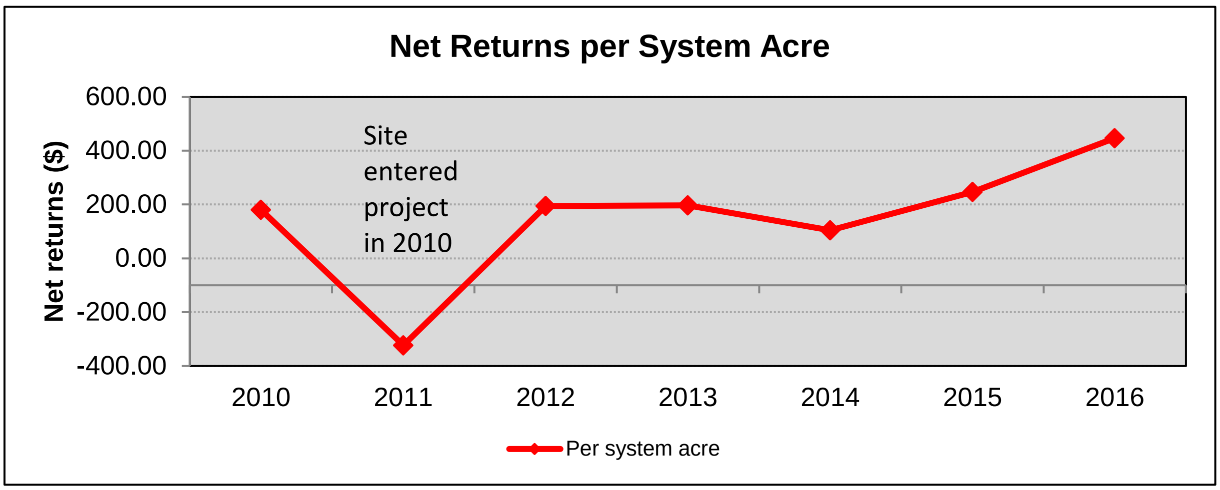
Fuel Source: Electric



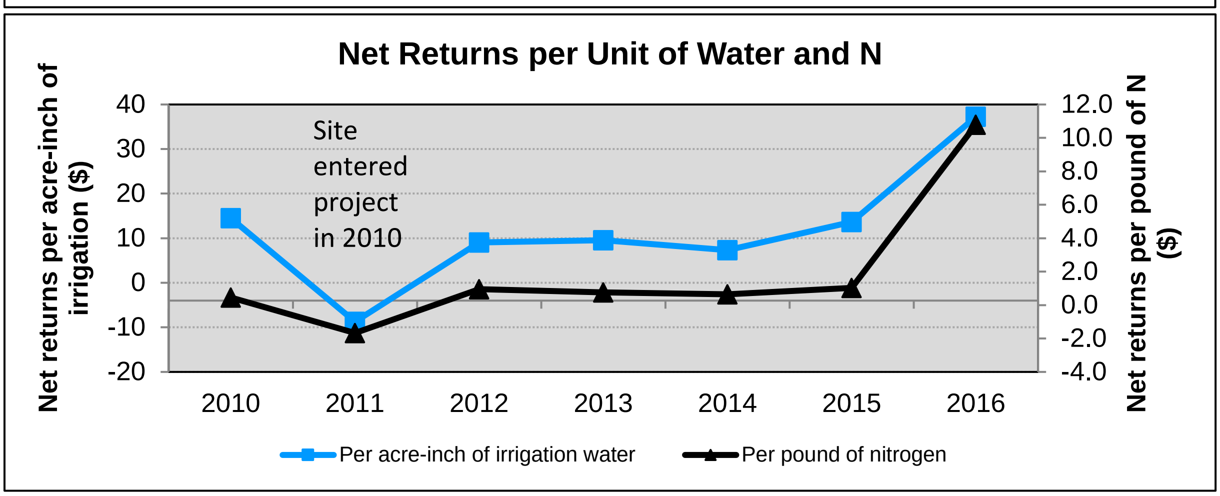
Site 32



Irrigation and Precipitation
Water (inches)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Site entered project in 2010
2010
2011
2012
2013
2014
2015
2016
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
600.00
400.00
200.00
0.00
-200.00
-400.00
Site entered project in 2010
2010
2011
2012
2013
2014
2015
2016
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
40
30
20
10
0
-10
-20
Net returns per pound of N ($)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
Site entered project in 2010
2010
2011
2012
2013
2014
2015
2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site 32

March

Corn stubble

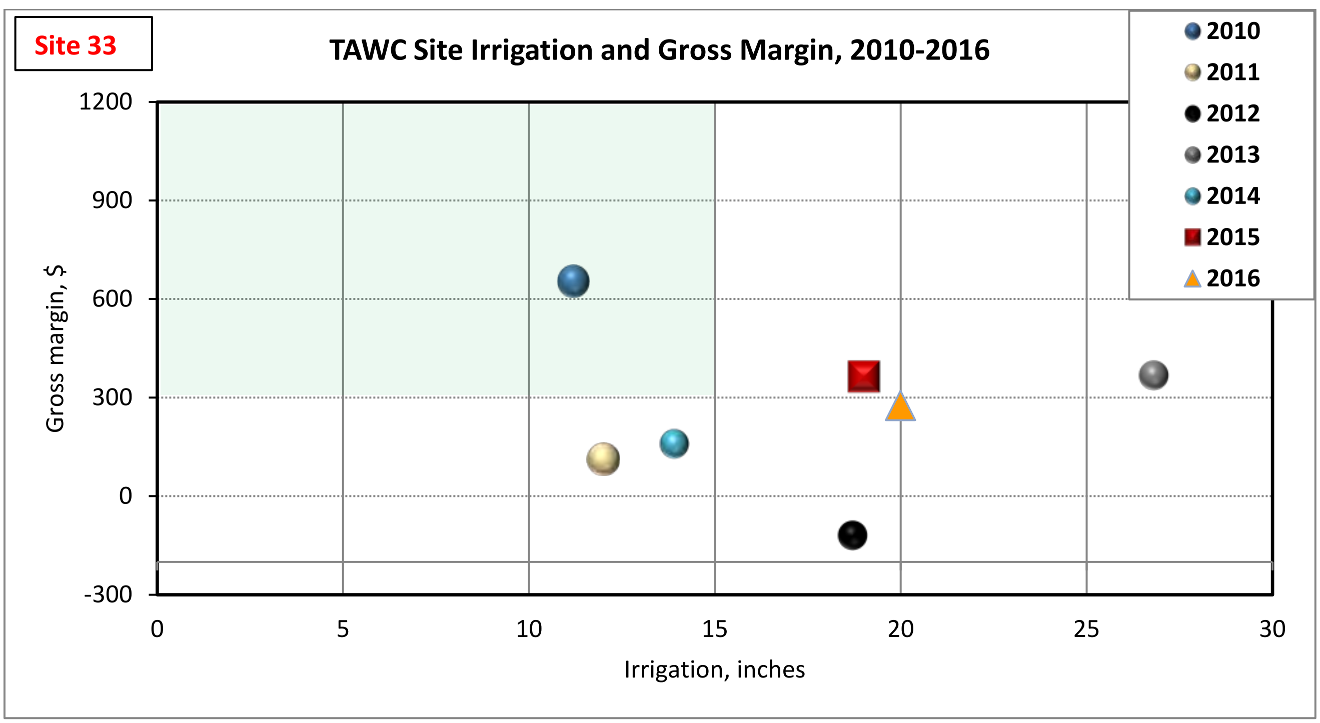
September cotton

Comments: In 2016 this pivot LEPA irrigated site was strip till planted to cotton through corn stubble.

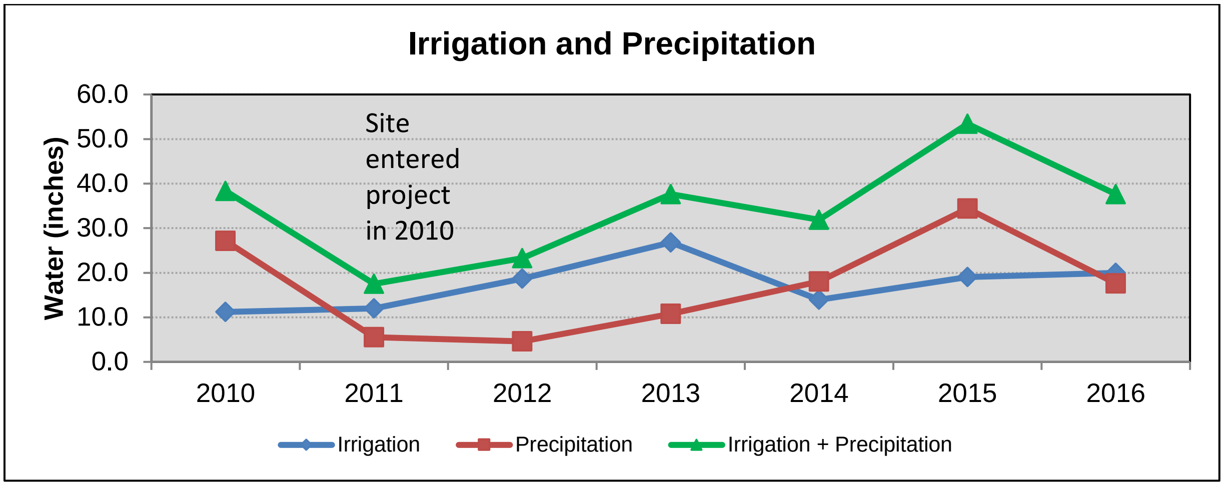
SITE 33

Description:

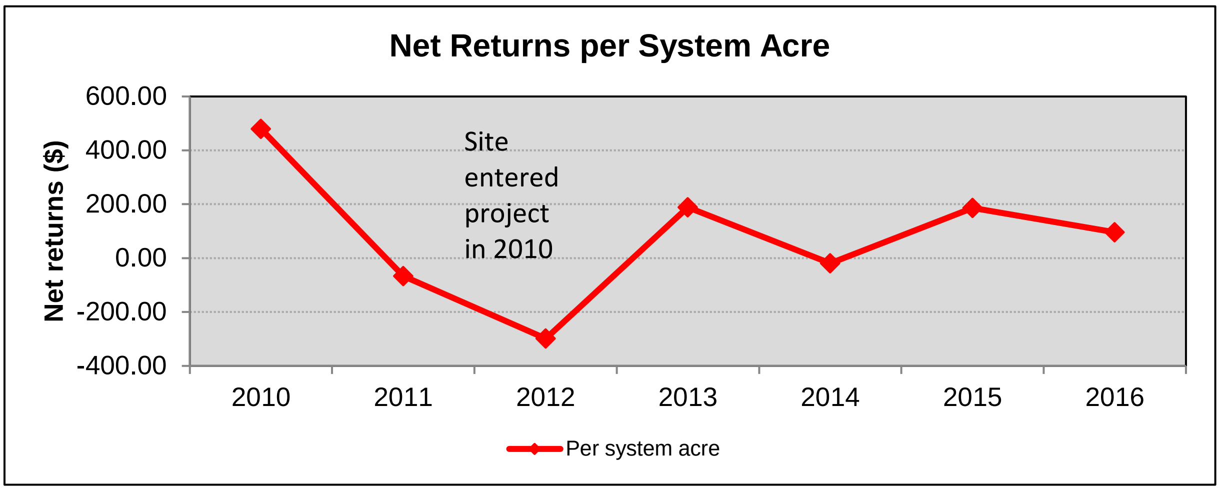
Site acres:	70
Soil types:	
PuA-Pullman clay loam, 0 to 1%	
Irrigation:	
Center Pivot (LEPA)	350 gpm
Number of wells:	2
Fuel Source:	Electric



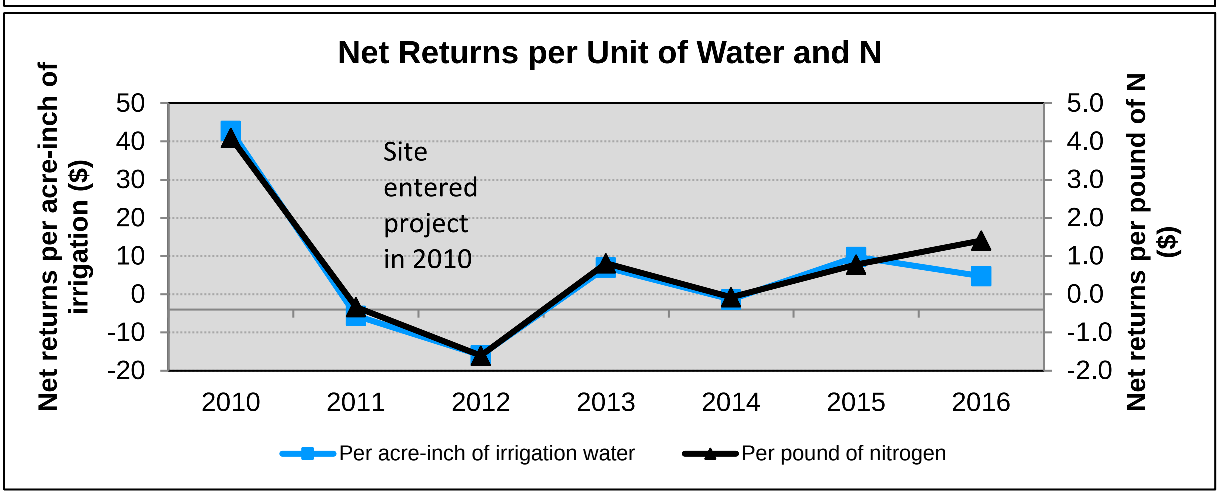
Site 33



Irrigation and Precipitation
Water (inches)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Site
entered
project
in 2010
2010
2011
2012
2013
2014
2015
2016
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
600.00
400.00
200.00
0.00
-200.00
-400.00
Site
entered
project
in 2010
2010
2011
2012
2013
2014
2015
2016
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
50
40
30
20
10
0
-10
-20
Net returns per pound of N ($)
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
Site
entered
project
in 2010
2010
2011
2012
2013
2014
2015
2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site 33

March

Early September corn

Late October residue

Comments: In 2016 this pivot LEPA irrigated site was planted to conventional corn on 40 inch centers.

SITE 34

Description:

Site acres: 726

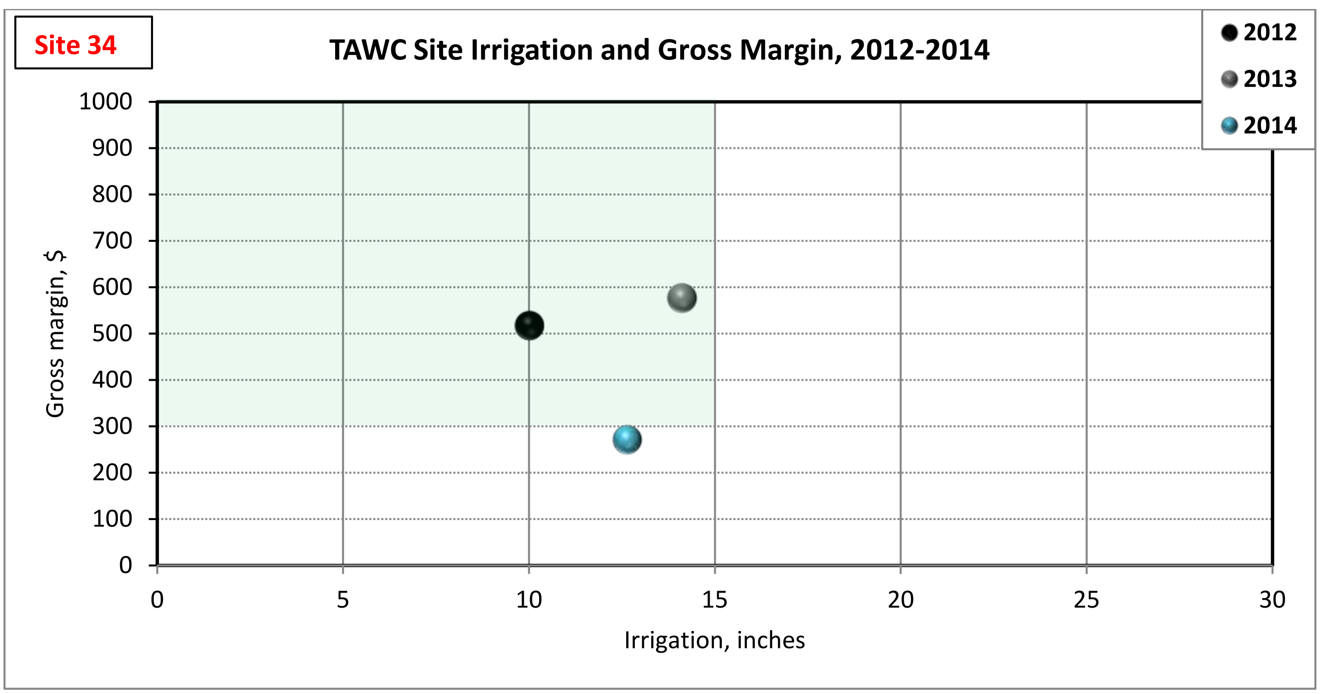
Soil types:
- PuA-Pullman clay loam, 0 to 1%
- LoA-Lofton clay loam, 0 to 1%
- McA-McLean clay, 0 to 1%

Irrigation:
- Center Pivot (LESA) 1600 gpm

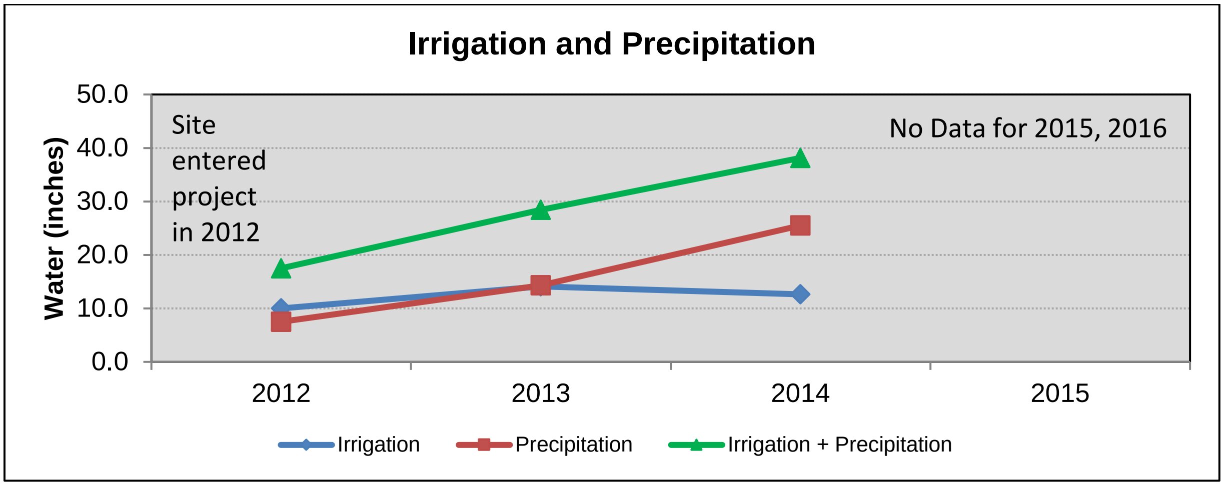
Number of wells: 2

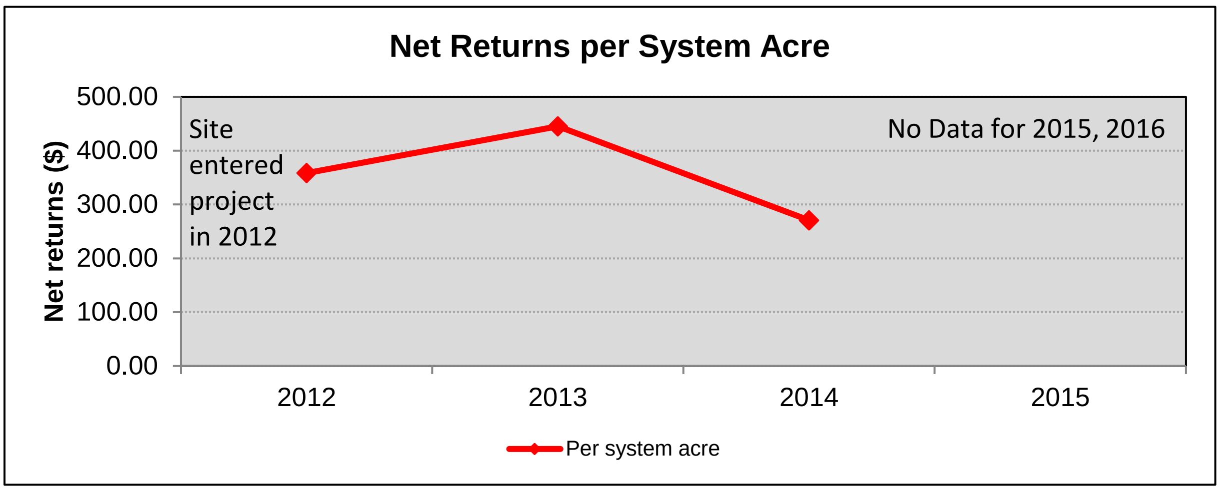
Fuel Source: Electric

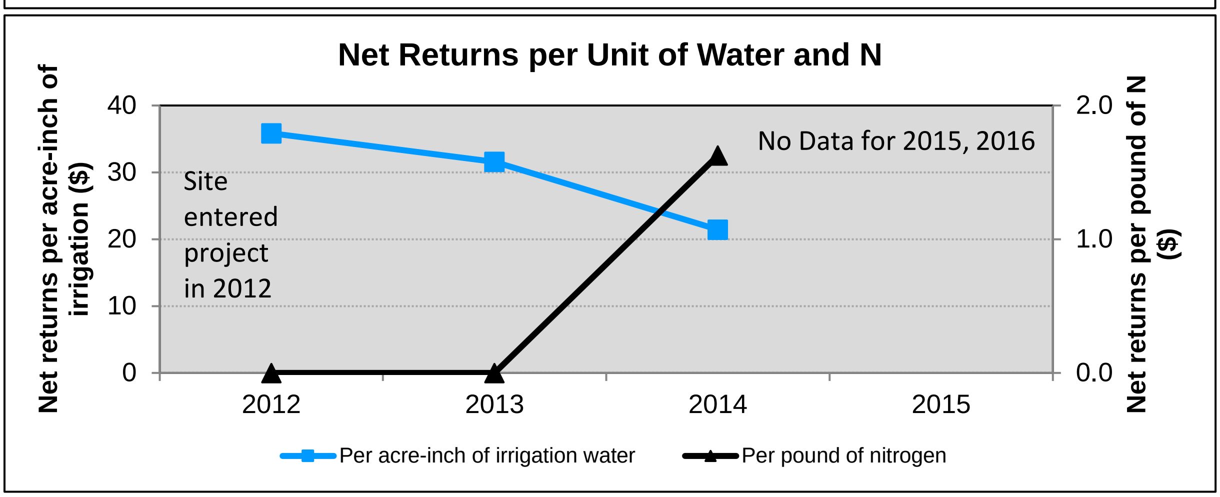
No Site Data 2016



Site 34 – No Site Data for 2016







Site 34


February snow in residue


February snow no residue


Preparing to water


June corn


Fertilize injection


July cotton

Comments: No crop information was collected in 2016.

SITE 35

Description:

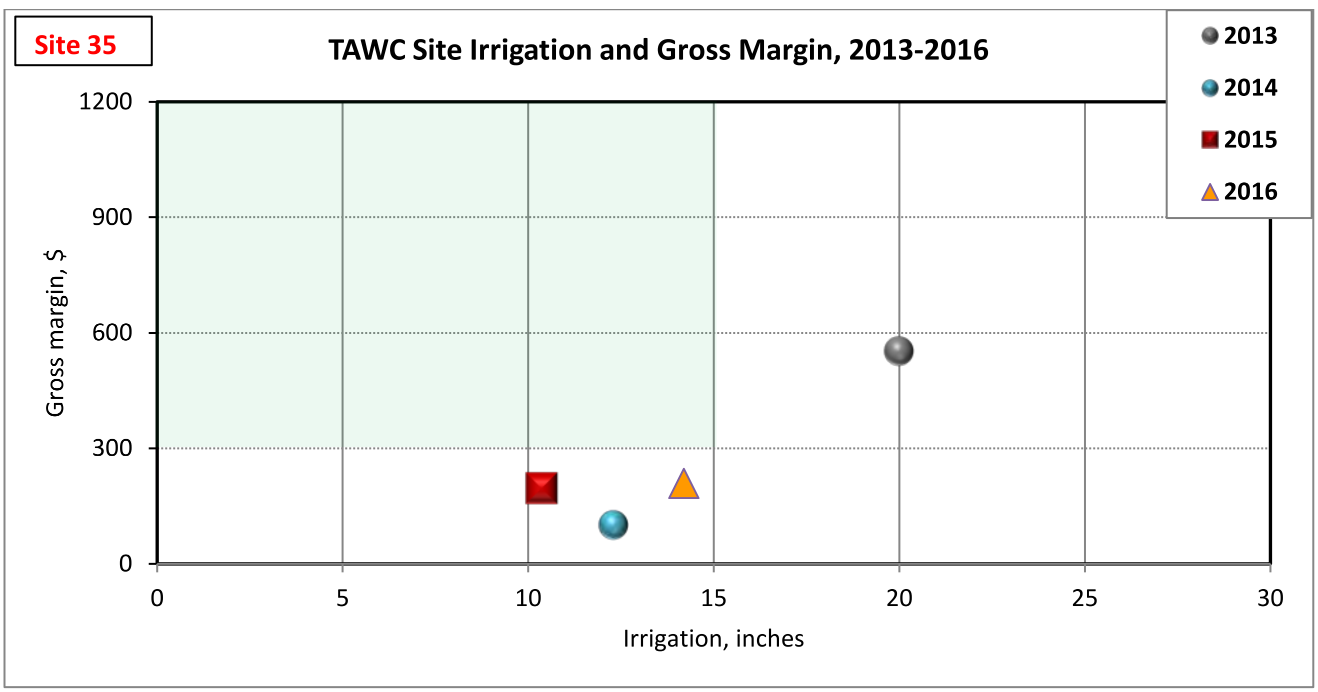
Site acres: 230.0

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

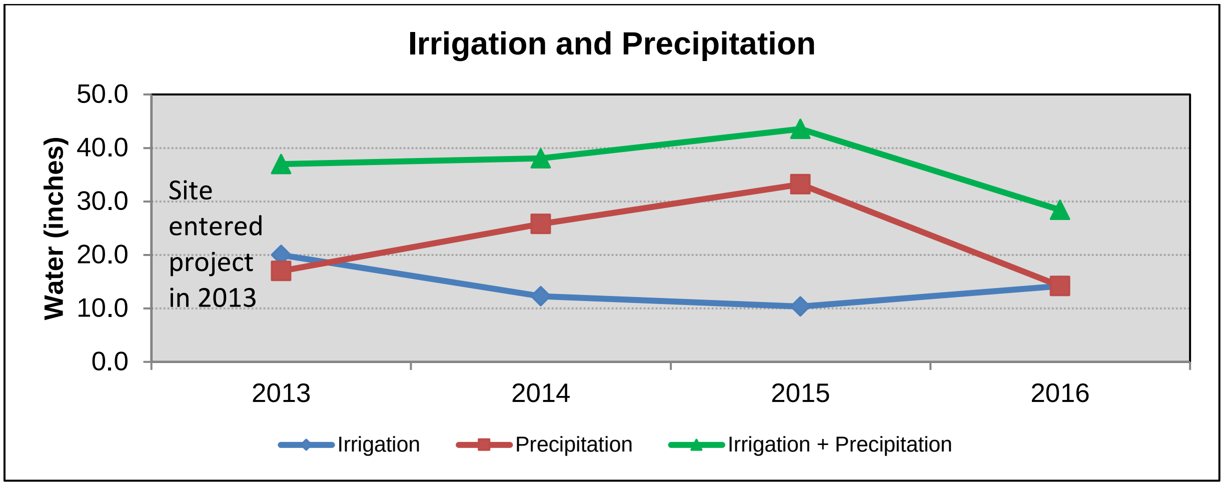
Irrigation:
Sub-Surface Drip (SDI)
650 gpm

Number of wells: 2

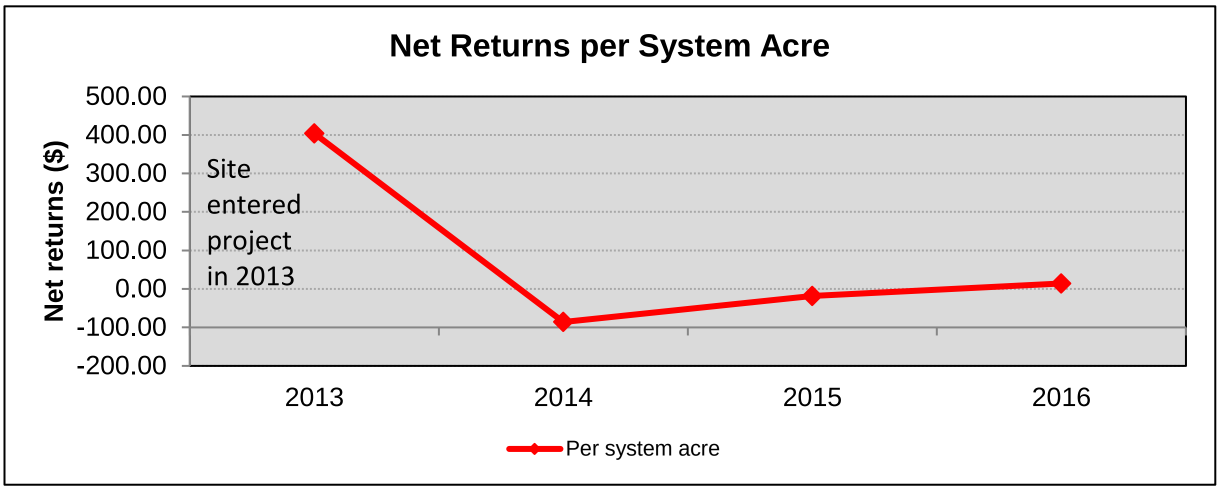
Fuel Source: Electric



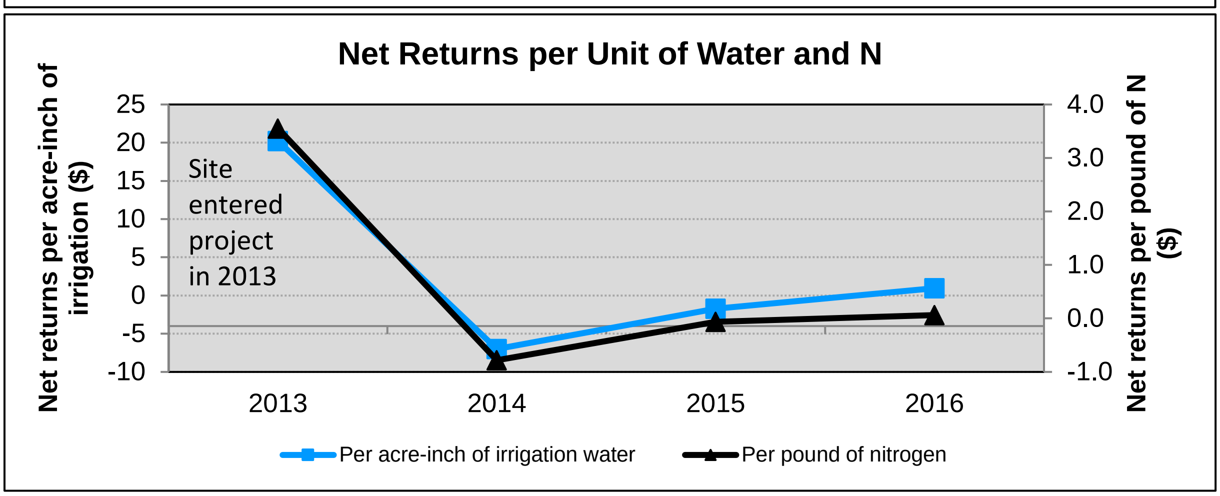
Site 35



Irrigation and Precipitation
Water (inches)
50.0
40.0
30.0
20.0
10.0
0.0
Site entered project in 2013
2013
2014
2015
2016
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
500.00
400.00
300.00
200.00
100.00
0.00
-100.00
-200.00
Site entered project in 2013
2013
2014
2015
2016
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
25
20
15
10
5
0
-5
-10
4.0
3.0
2.0
1.0
0.0
-1.0
Net returns per pound of N ($)
Site entered project in 2013
2013
2014
2015
2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site 35


May


May corn


September cotton


September corn


Corn being harvested


November cotton

Comments: In 2016 this SDI irrigated site was planted to corn and cotton. All crops were planted on 40-inch centers with conventional tillage.

SITE C37

Description:

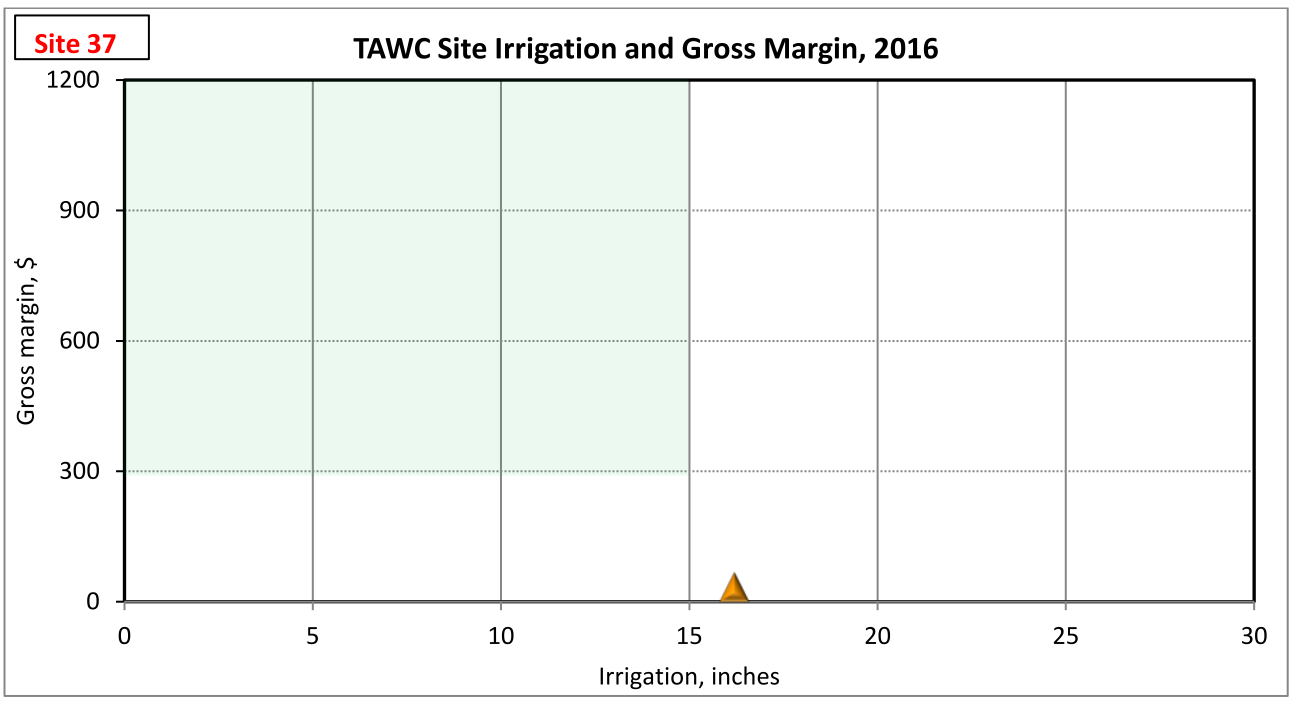
Site acres:	121.1

Soil types:

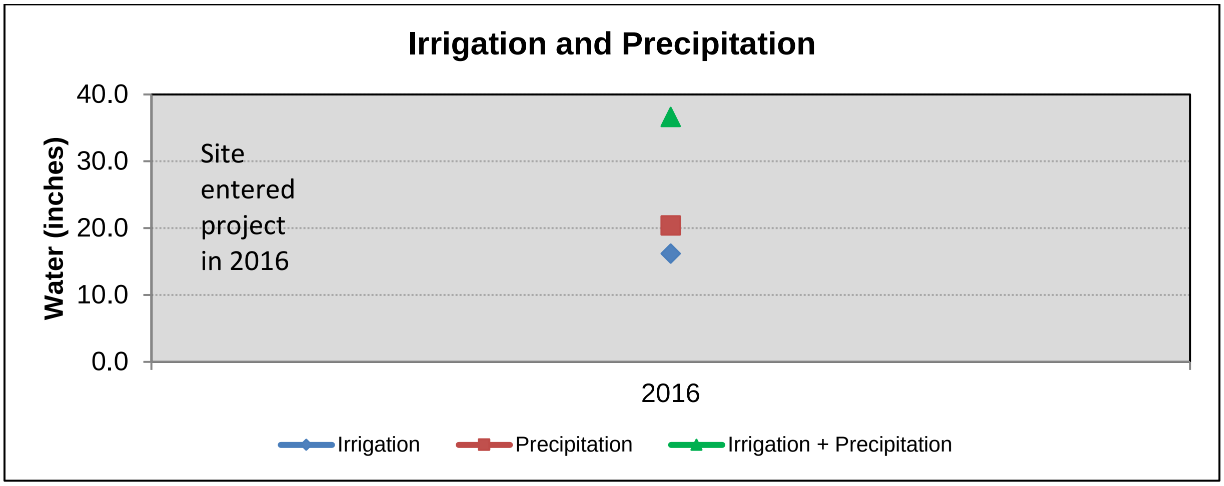
- PuA-Pullman clay loam, 0 to 1%
- AcB-Acuff loam, 1 to 3%
- EsB-Estacado loam, 1 to 3%
- Mkc-Mansker loam, 3 to 5%
- Ra-Randal clay, 0 to 1%

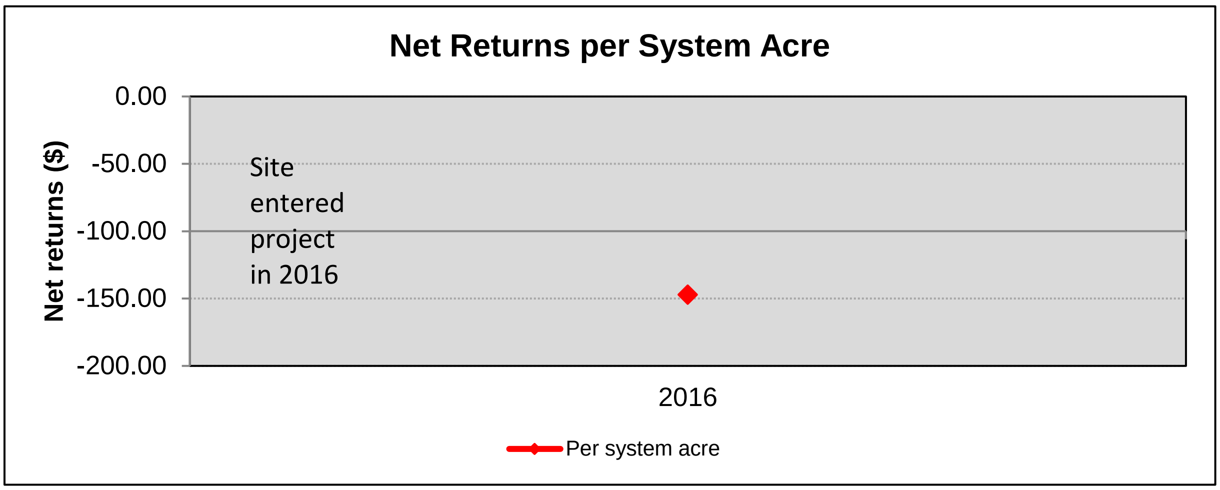
Irrigation:

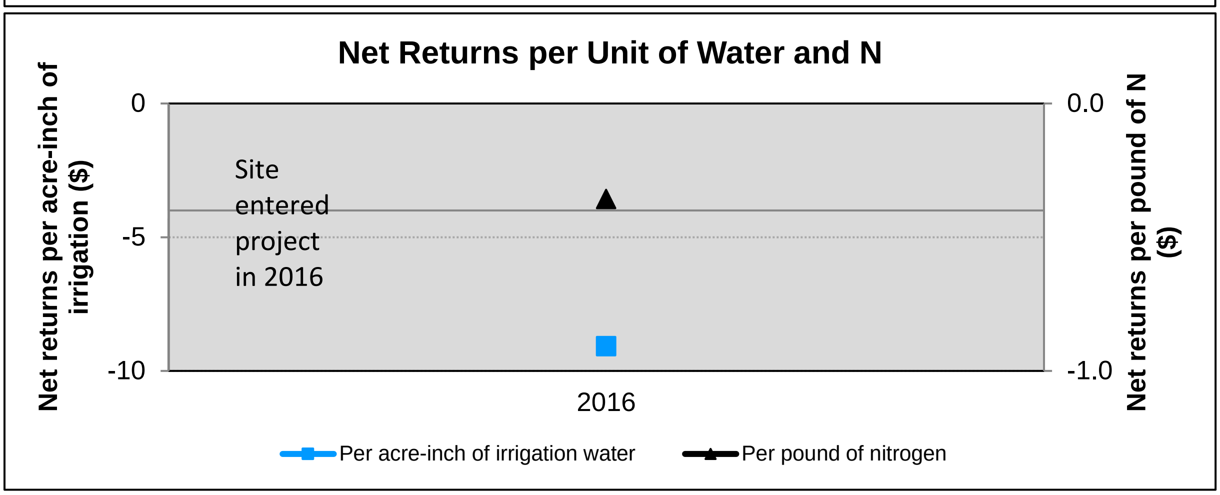
Center Pivot (VR)	450 gpm
Number of wells:	2
Fuel Source:	Electric



Site C37


Irrigation and Precipitation
Water (inches)
40.0
30.0
20.0
10.0
0.0
Site entered project in 2016
2016
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
0.00
-50.00
-100.00
-150.00
-200.00
Site entered project in 2016
2016
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
0
-5
-10
Net returns per pound of N ($)
0.0
-1.0
Site entered project in 2016
2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site C37


Variable rate valve


VRI Irrigation System

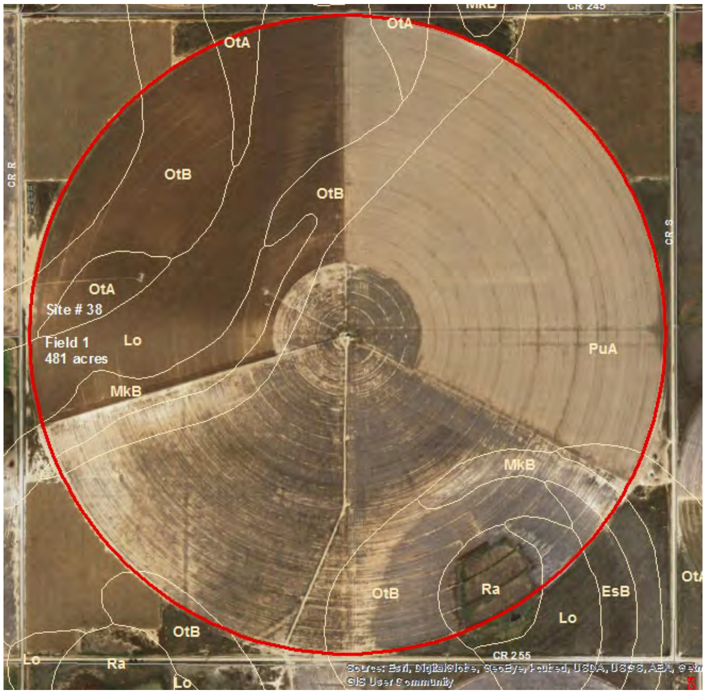

Preparing to water


June corn


Fertilize injection

Comments: In 2016 this site was planted to corn on 30-inch centers utilizing a Variable Rate Irrigation (VRI) system.

Site C38



Description:

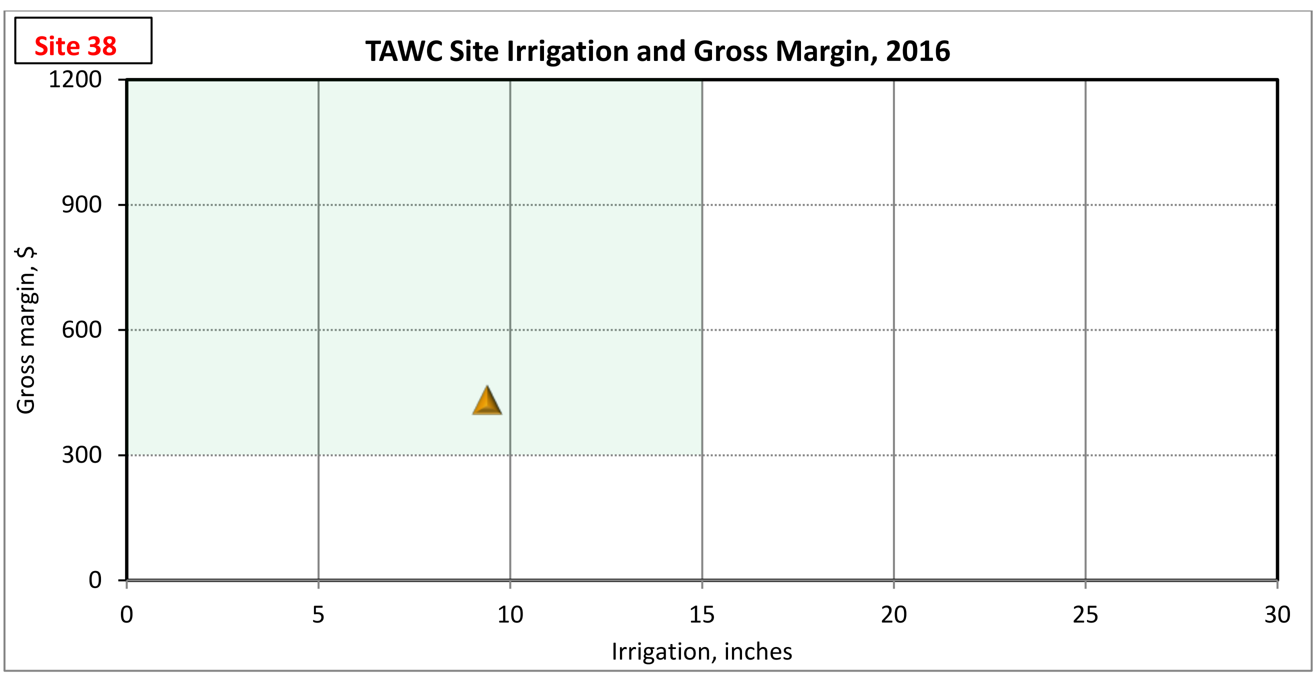
Site acres: 481

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%

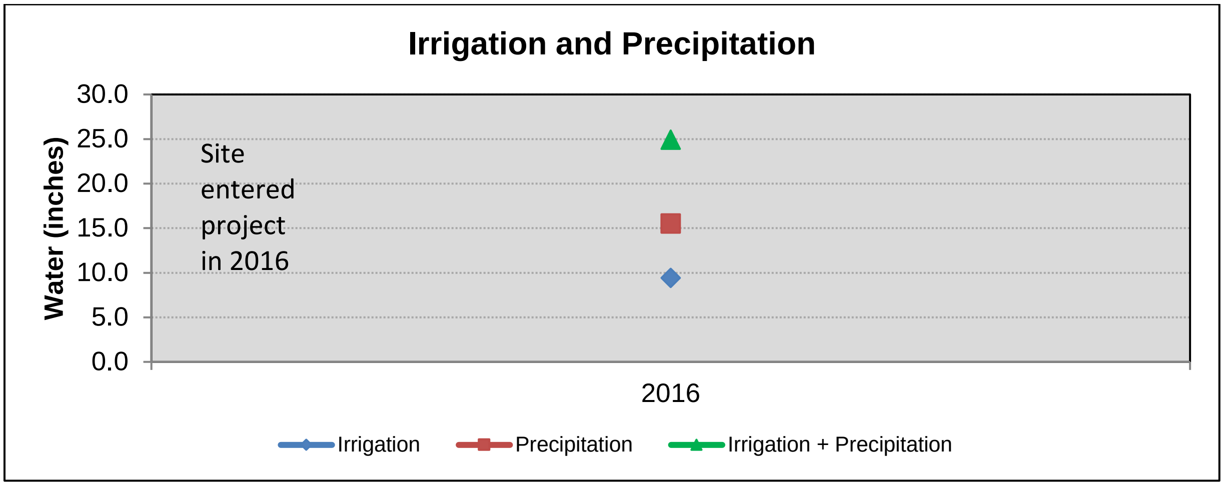
Irrigation:
Center Pivot (VR) 750 gpm

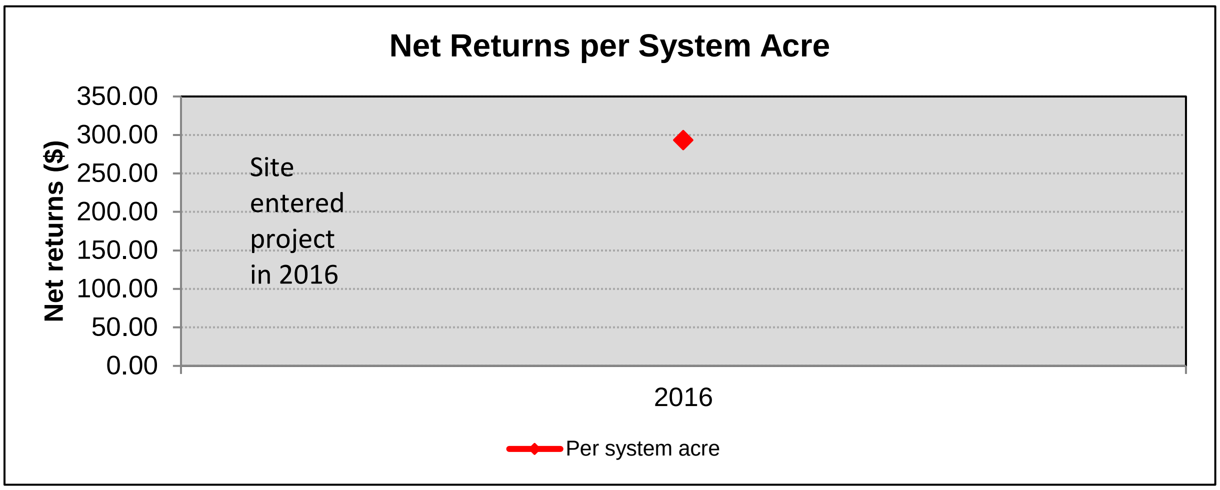
Number of wells: 3

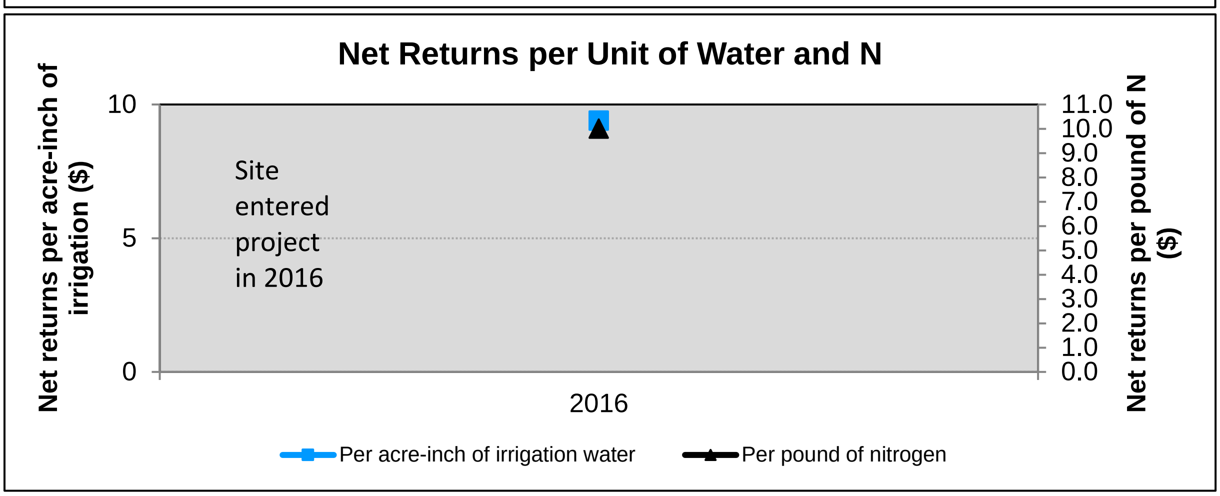
Fuel Source: Electricity



Site C38


Irrigation and Precipitation
Water (inches)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Site entered project in 2016
2016
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Site entered project in 2016
2016
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
10
5
0
Site entered project in 2016
2016
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Net returns per pound of N ($)
Per acre-inch of irrigation water
Per pound of nitrogen

Site C38


Irrigation nozzle

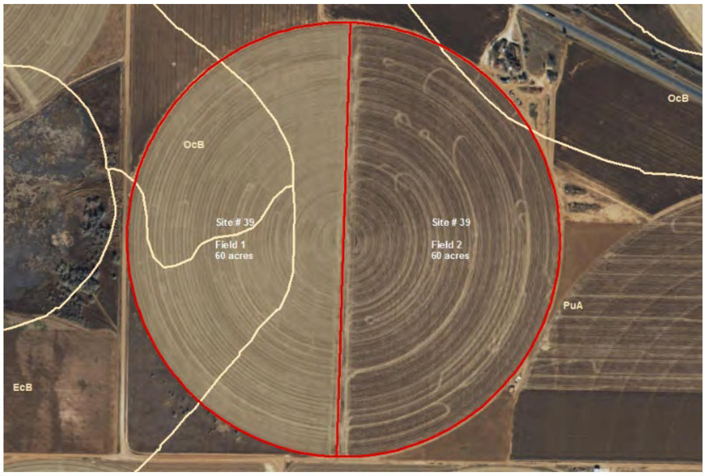

July cotton


July cotton

Comments: In 2016 this site was planted to cotton on 30-inch centers utilizing a Variable Rate Irrigation (VRI) system.

Site C39

Description:



Site acres: 120.0

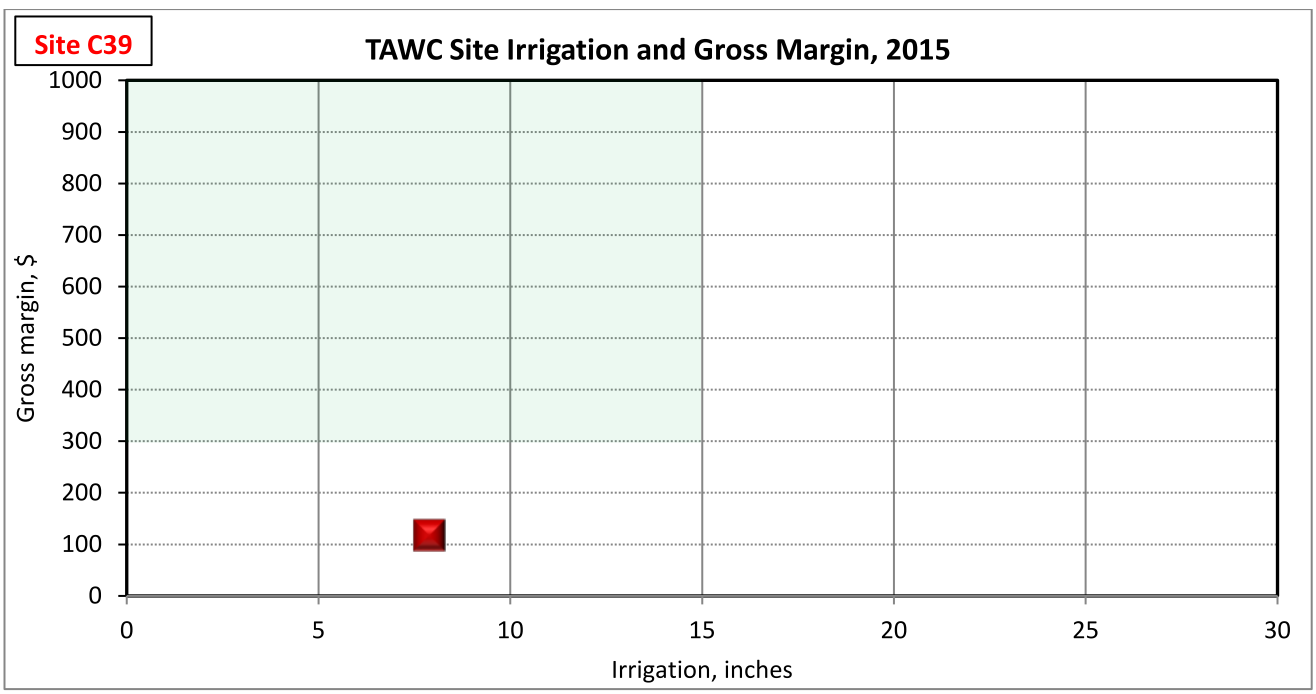
Soil types:
- PuA-Pullman clay loam, 0 to 1%
- OcB-Olton clay loam, 1 to 3%
- EcB-Estacado clay loam, 1 to 3%

Irrigation:
Center Pivot (LESA) 650 gpm

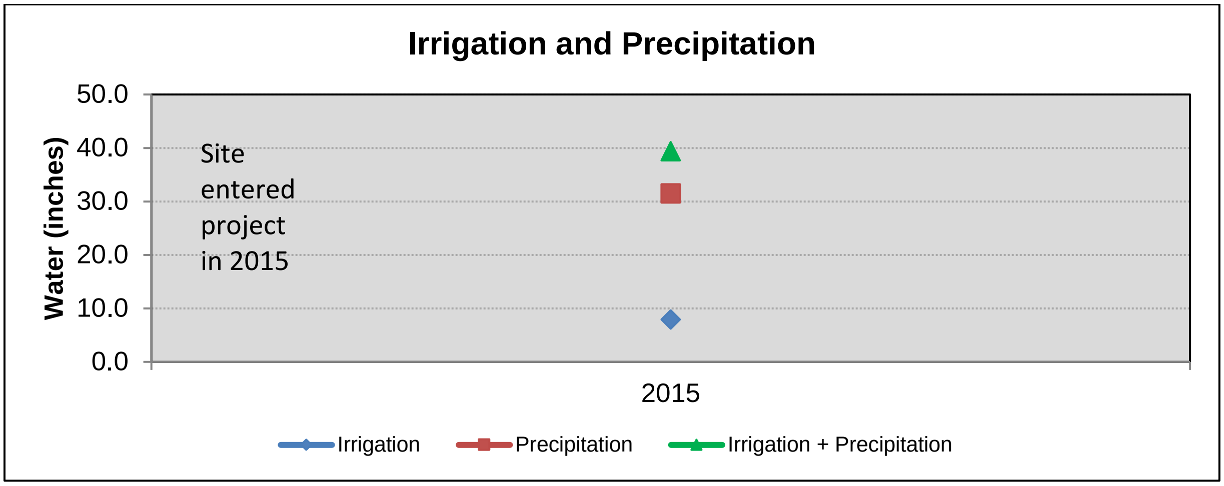
Number of wells: 1

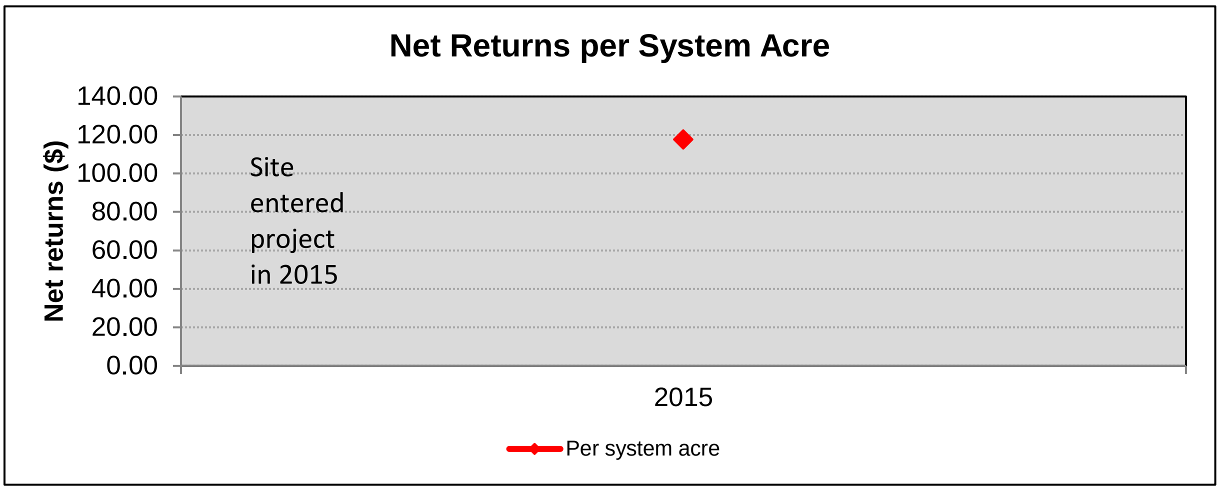
Fuel Source: Electricity

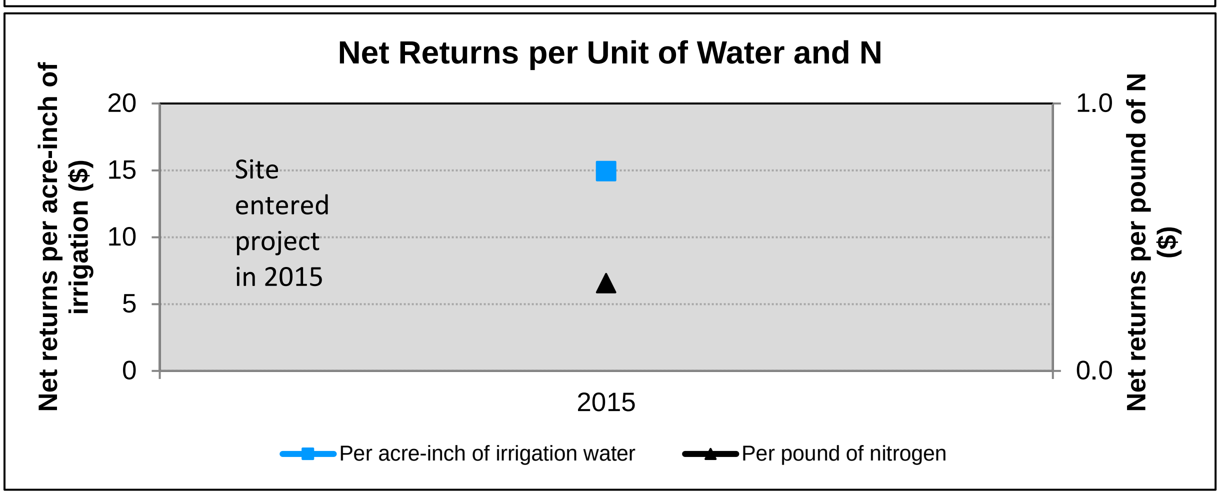
No Site Data for 2016



Site C39 – No Site Data for 2016







Site C39

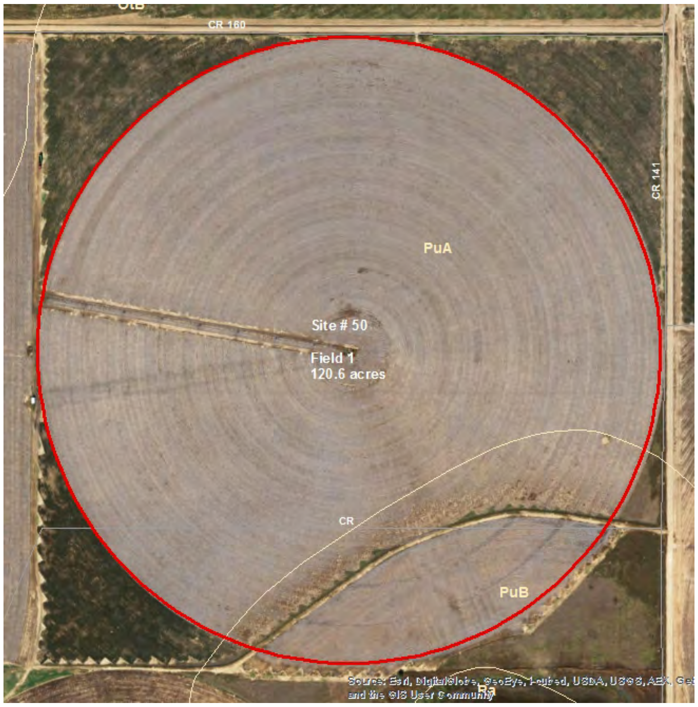
June corn

Fertilize injection

July cotton

Comments: No data was collected for this site in 2016.

Site C50



Description:

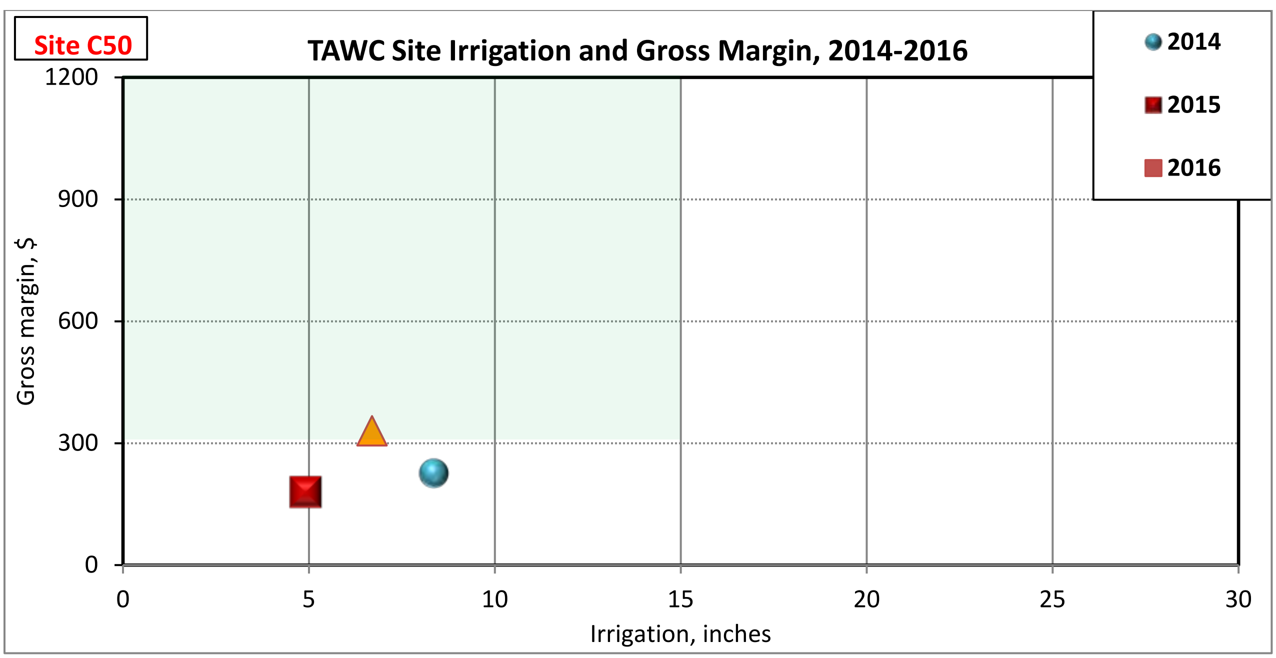
Site acres: 120.6

Soil types:
PuA-Pullman clay loam, 0 to 1%
PuB-Pullman clay loam, 1 to 3%

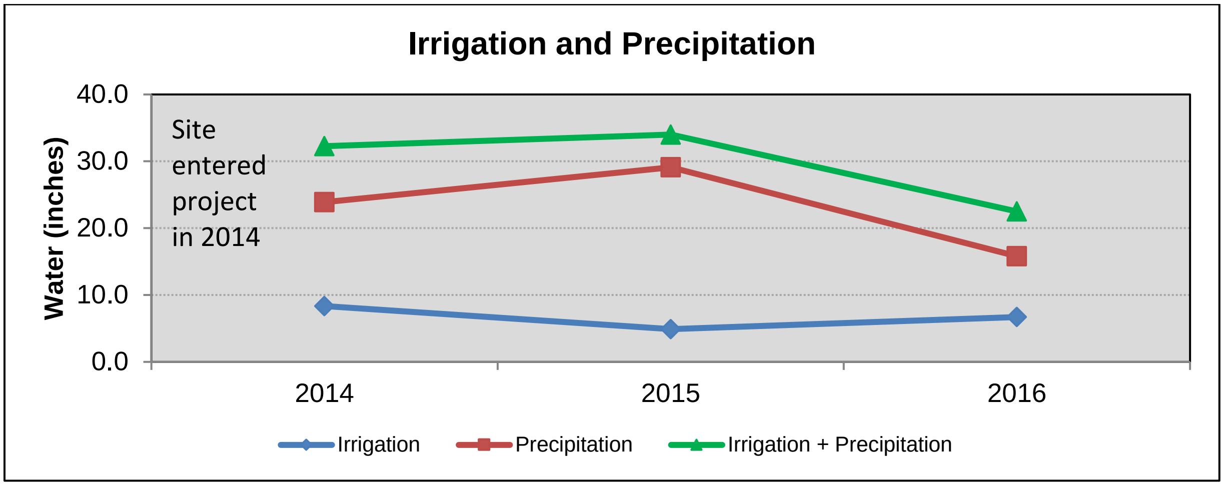
Irrigation:
Low Elevation Spray Application (LESA) 265 gpm

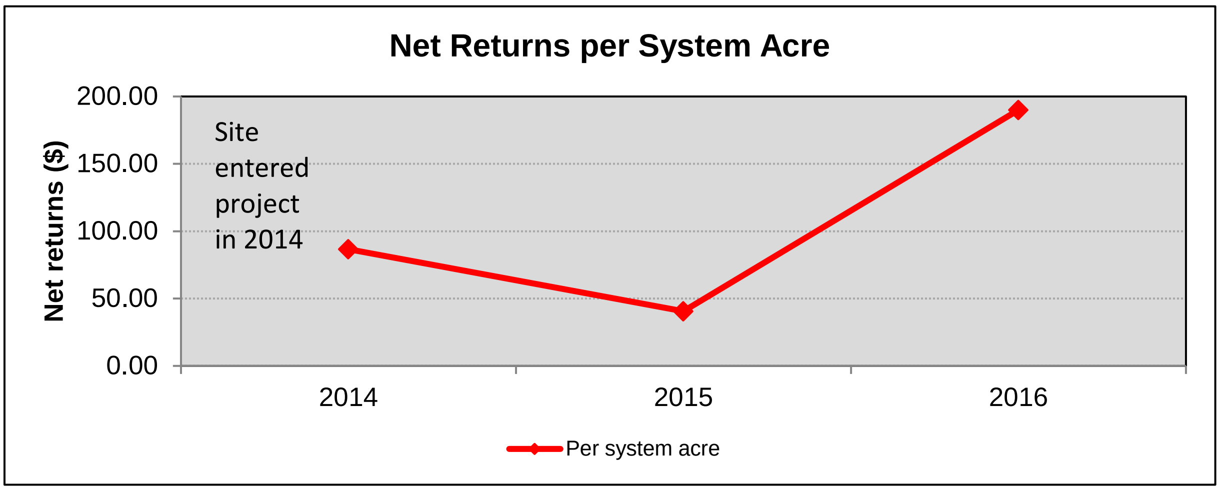
Number of wells: 1
Depth: 300 feet

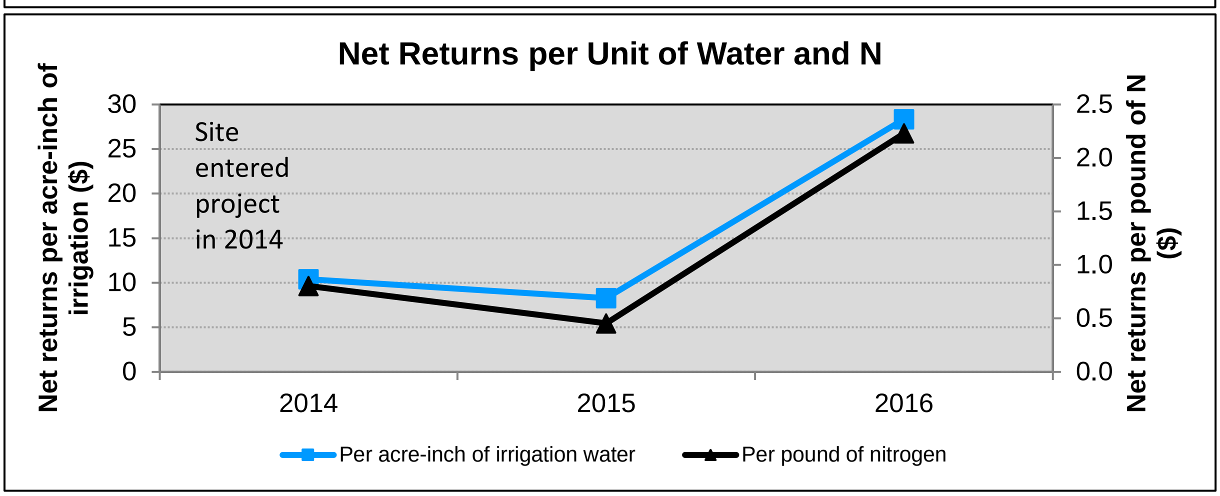
Fuel Source: Natural gas



Site C50


Irrigation and Precipitation
Water (inches)
40.0
30.0
20.0
10.0
0.0
Site entered project in 2014
2014
2015
2016
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
200.00
150.00
100.00
50.00
0.00
Site entered project in 2014
2014
2015
2016
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
30
25
20
15
10
5
0
Net returns per pound of N ($)
2.5
2.0
1.5
1.0
0.5
0.0
Site entered project in 2014
2014
2015
2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site C50


May


August cotton


October cotton


Surface turbine irrigation well

Comments: In 2016 this LESA irrigated site was planted to monoculture cotton. 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%

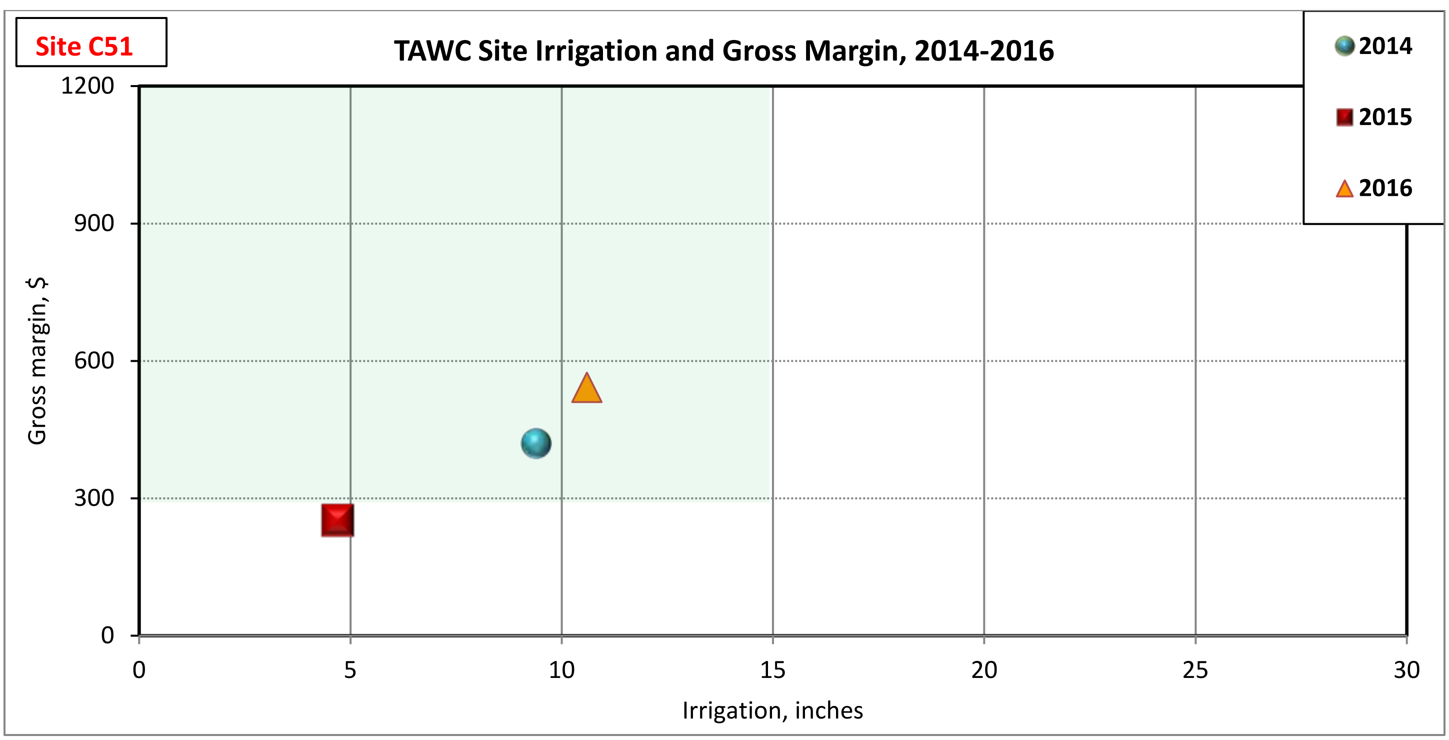
Irrigation:

Sub-surface Drip (SDI) 175 gpm

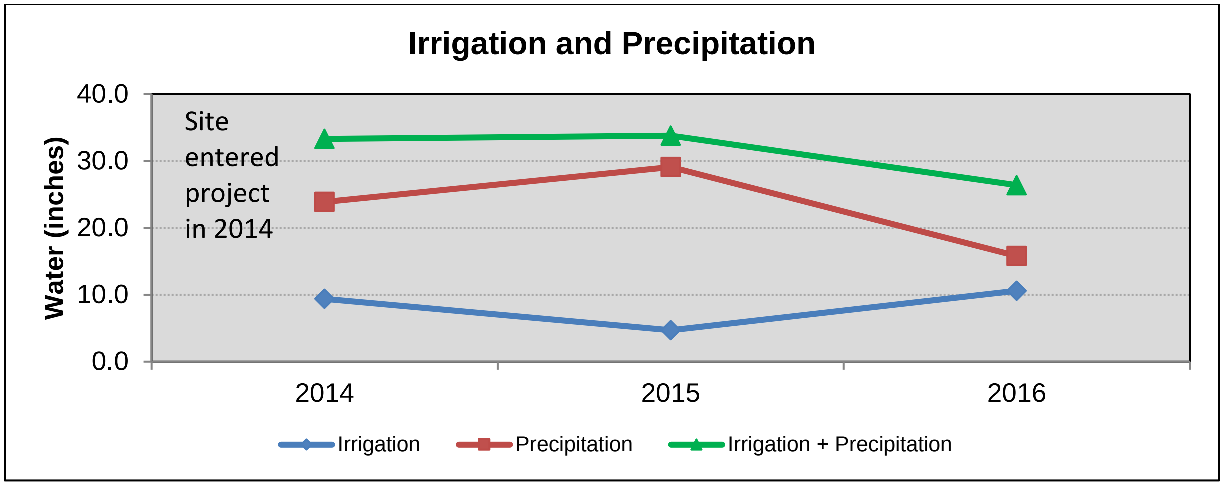
Number of wells: 1

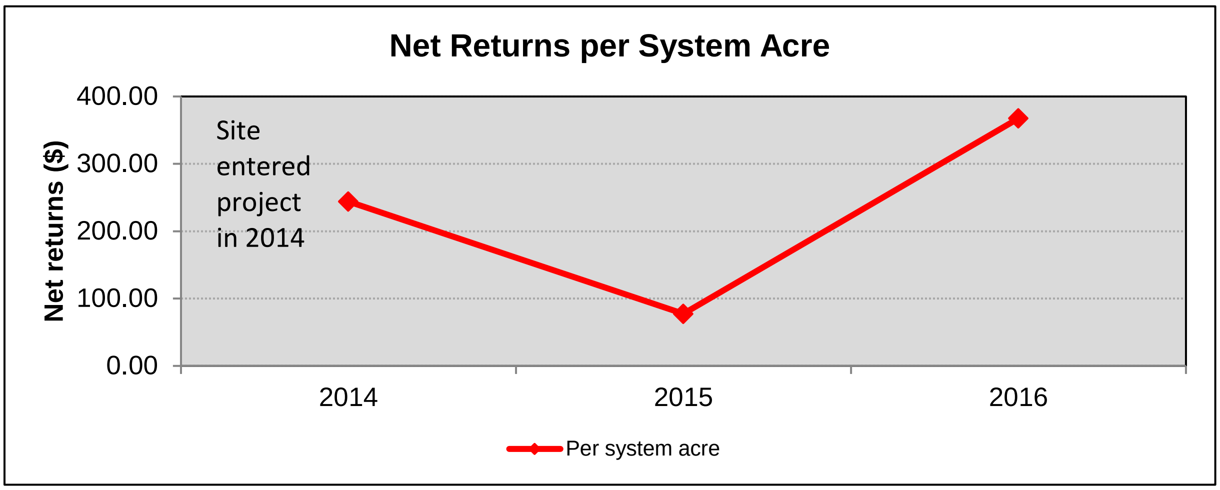
Depth: 350 feet

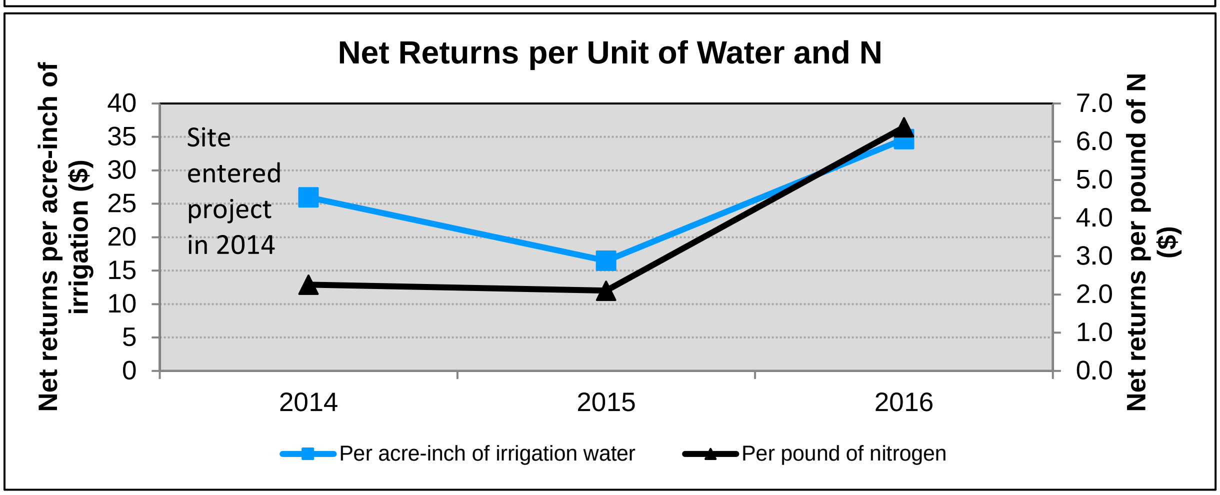
Fuel Source: Natural gas



Site C51


Irrigation and Precipitation
Water (inches)
40.0
30.0
20.0
10.0
0.0
Site entered project in 2014
2014
2015
2016
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
400.00
300.00
200.00
100.00
0.00
Site entered project in 2014
2014
2015
2016
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
40
35
30
25
20
15
10
5
0
Net returns per pound of N ($)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Site entered project in 2014
2014
2015
2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site C51


Late May planting


Furrow irrigation to establish

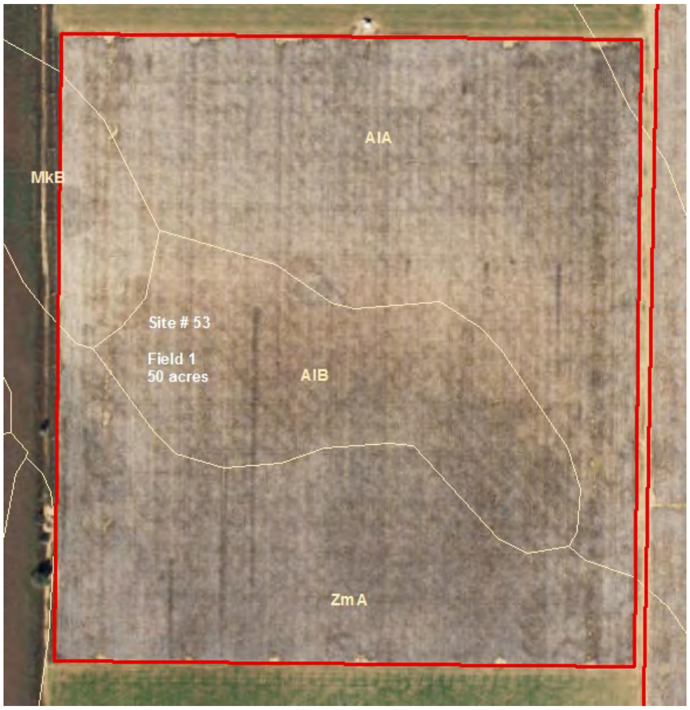

Early August cotton


Checking crop maturity


October cotton

Comments: In 2016 this SDI irrigated site was planted to monoculture cotton. All crops were planted on 40-inch centers.

SITE C53



Description:

Site acres: 50

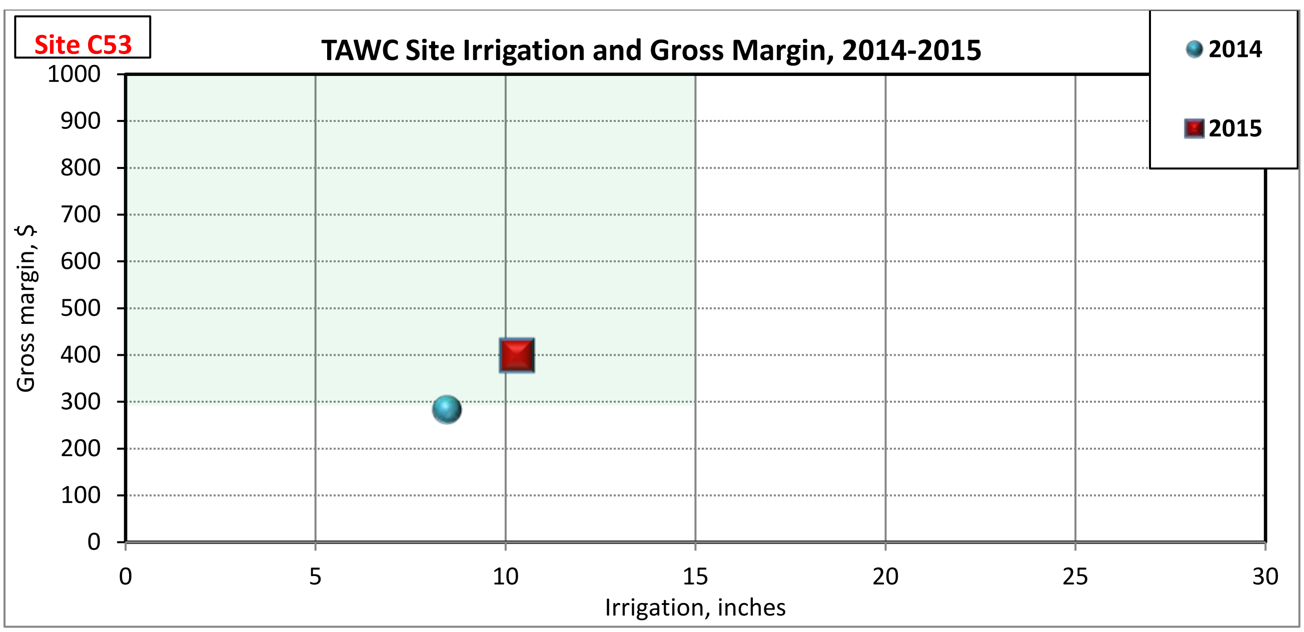
Soil types:
- AlA - Acuff loam; 0 to 1%
- AlB - Acuff loam, 1 to 3%
- MkB - Mansker loam 0 to 3%
- ZmA - Zita loam, 0 to 1%

Irrigation:
40" Sub-surface Drip (SDI) 160 gpm

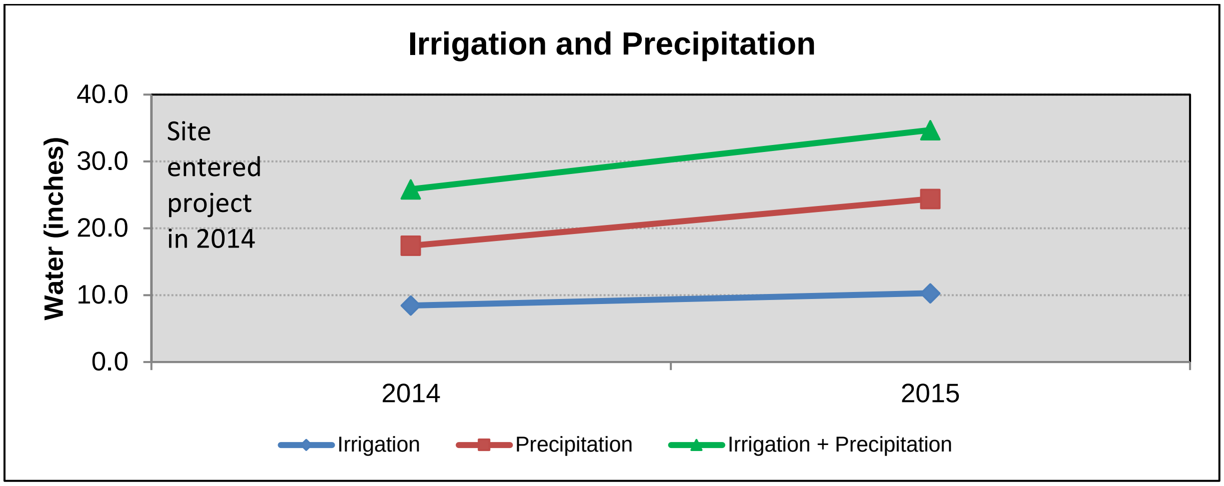
Number of wells: 3
Depth: 300 feet

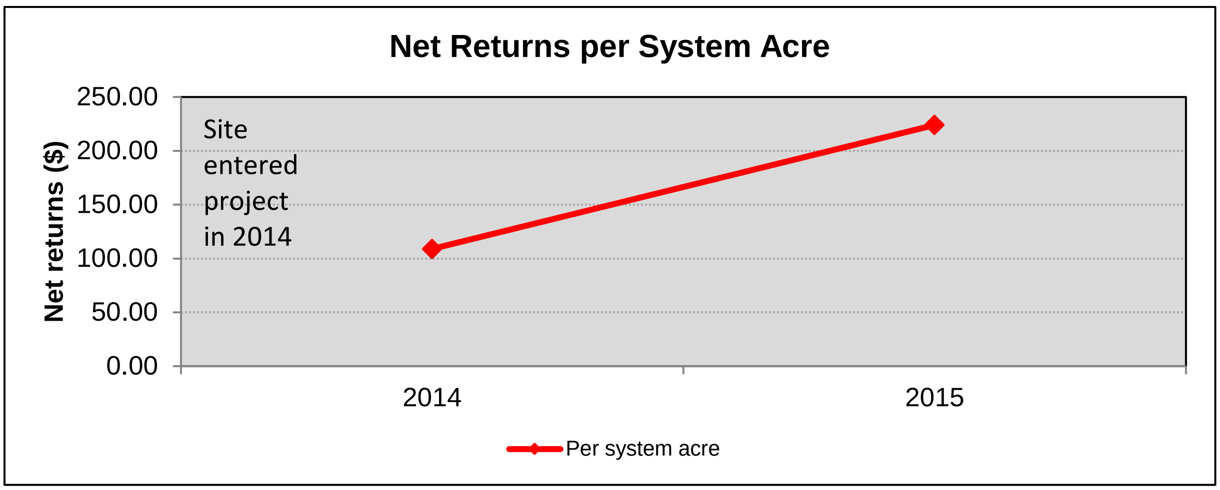
Fuel Source: Electric

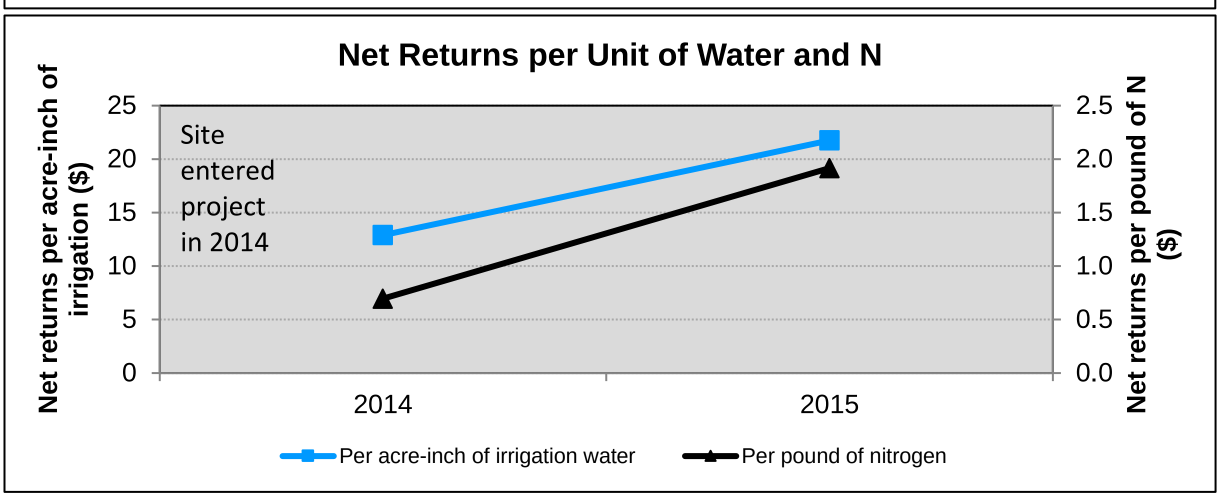
No Site Data for 2016



Site C53 – No Site Data for 2016







Site C53

Residue from previous year

Valve bank with air relief

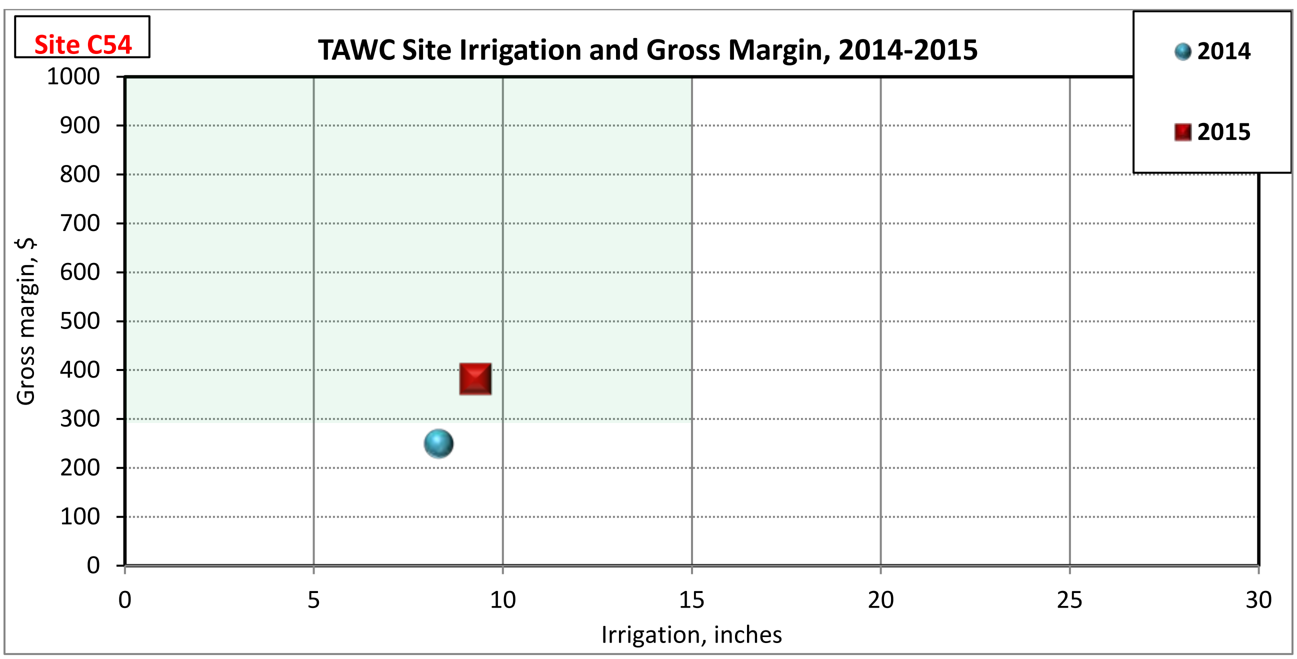
Comments: In 2016 no data was collected.

Site C54

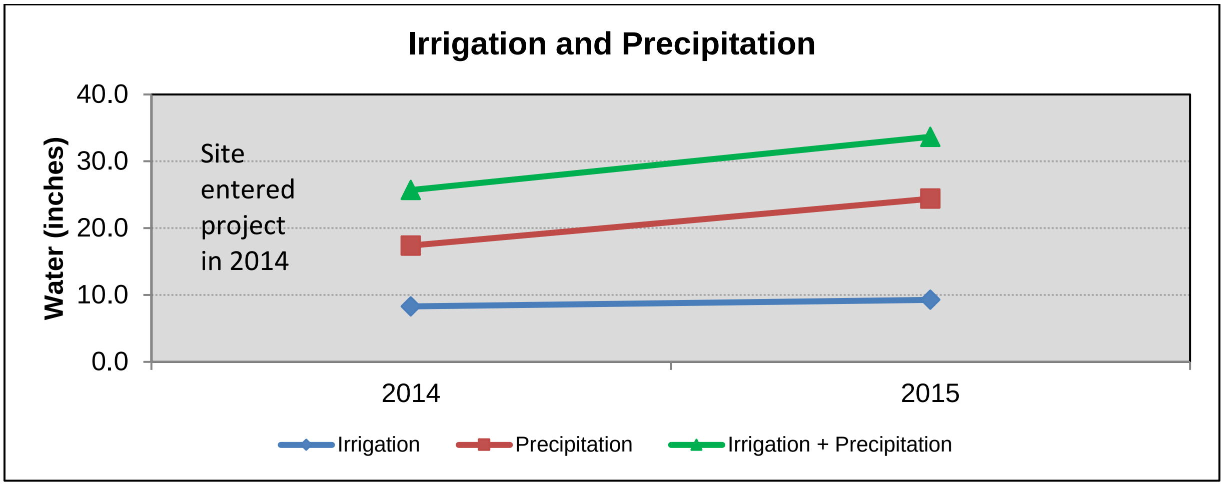
Description:

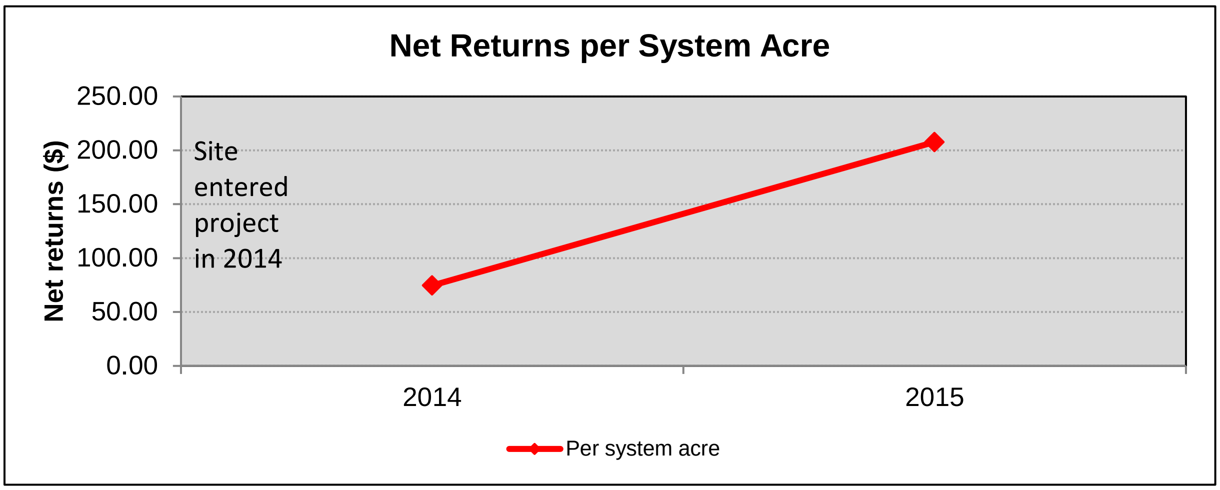
Site acres:	80
Soil types:	
OtA - Olton loam, 0 to 1%	
AlA - Acuff loam, 0 to 1%	
ZmA - Zita loam, 0 to 1%	
Irrigation:	
80" Sub-surface Drip (SDI)	180 gpm
Number of wells:	2
Depth:	300 feet
Fuel Source:	Electric

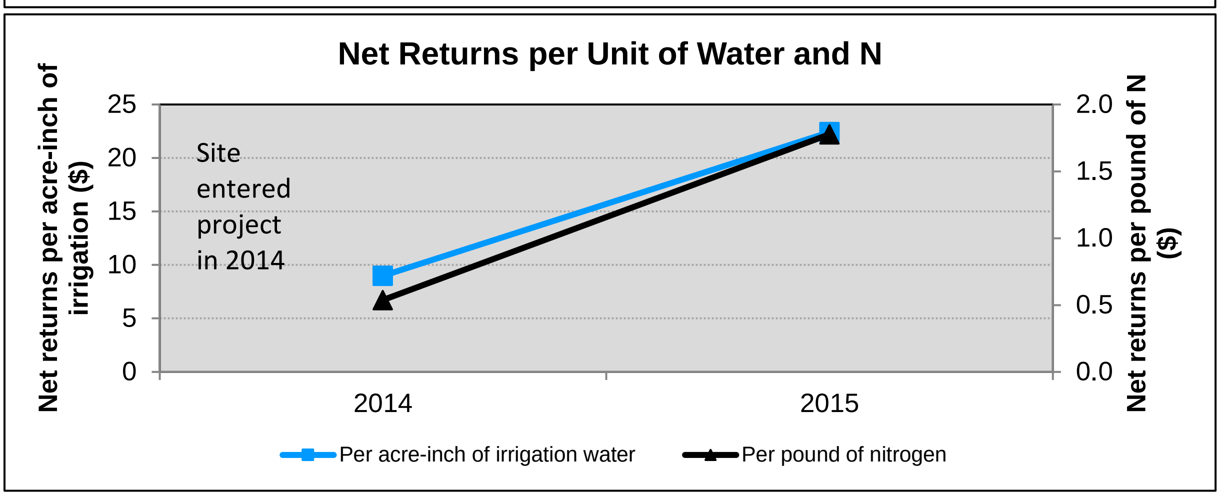
No Site Data for 2016



Site C54 – No Site Data for 2016







Site C54

Late May

Meter on SDI drip system

Comments: In 2016 no data was collected.

Site C56

Description:

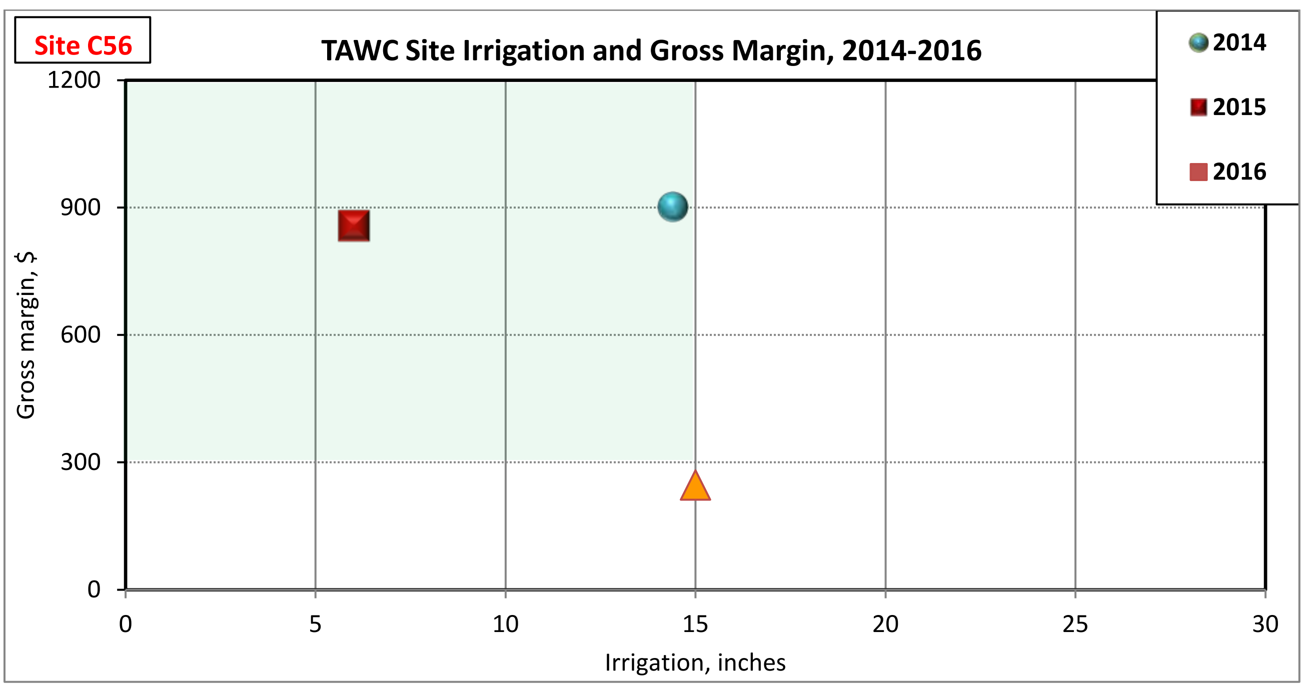
Site acres: 40

Soil types:
- OcA - Olton 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%

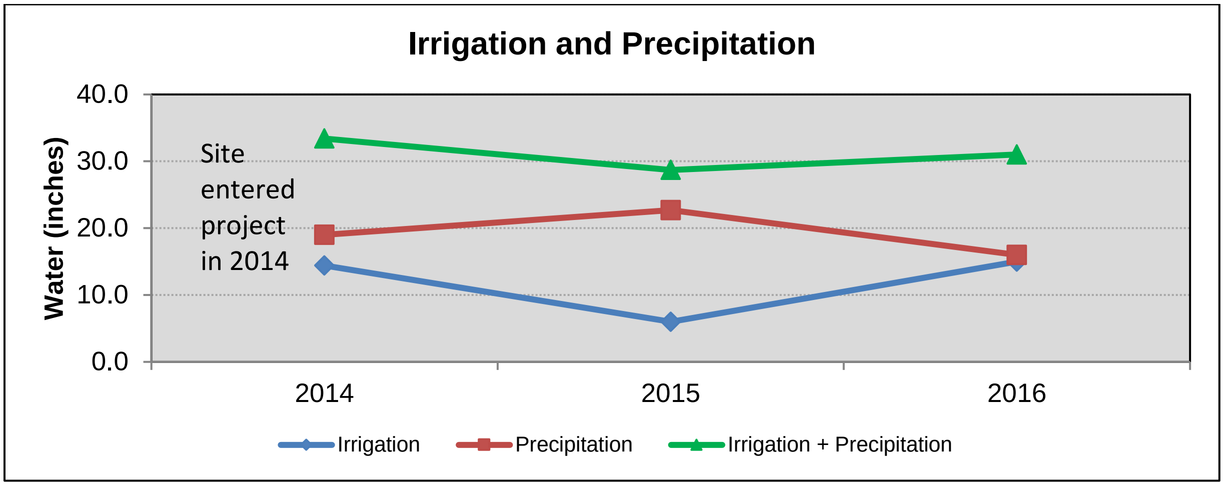
Irrigation:
Low Eleveation Spray Application (LESA) 450 gpm

Number of wells: 3
Depth: 300 feet

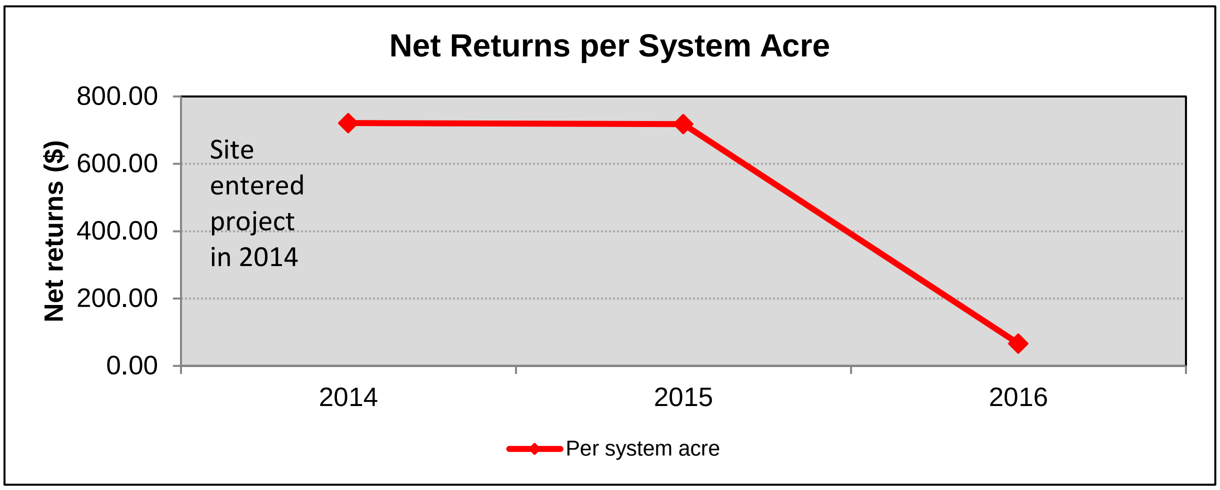
Fuel Source: Electric



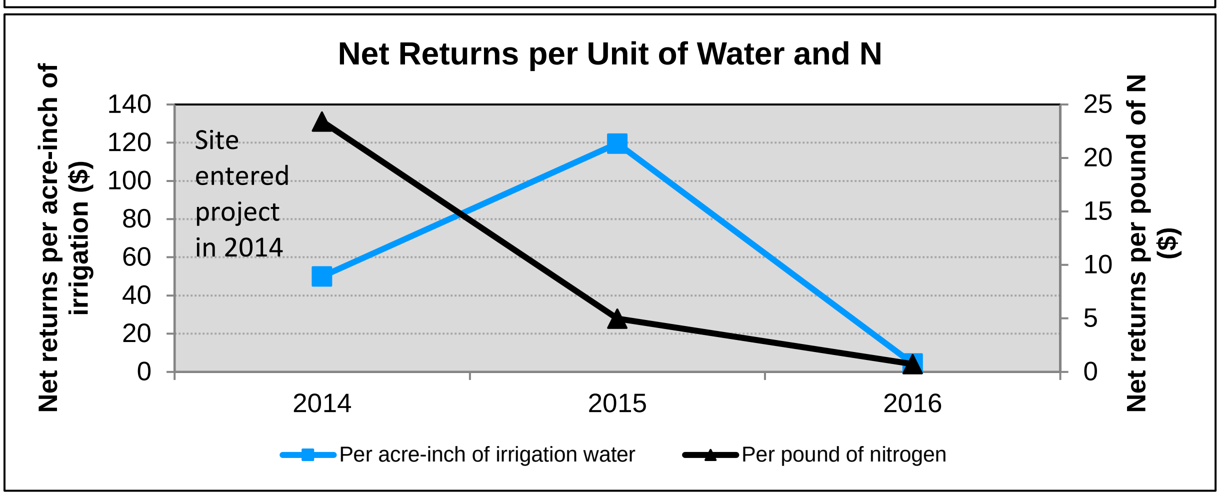
Site C56



Irrigation and Precipitation
Water (inches)
40.0
30.0
20.0
10.0
0.0
Site entered project in 2014
2014
2015
2016
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
800.00
600.00
400.00
200.00
0.00
Site entered project in 2014
2014
2015
2016
Per system acre



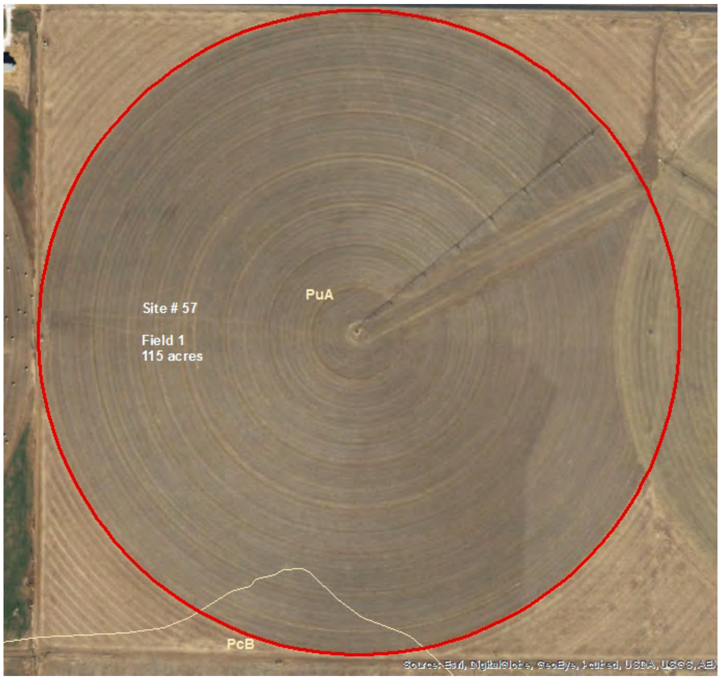
Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
140
120
100
80
60
40
20
0
Net returns per pound of N ($)
25
20
15
10
5
0
Site entered project in 2014
2014
2015
2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site C56

Early January

Comments: In 2016 this LESA irrigated site was planted to corn on 30-inch centers with strip-till tillage.

Site C57



Description:

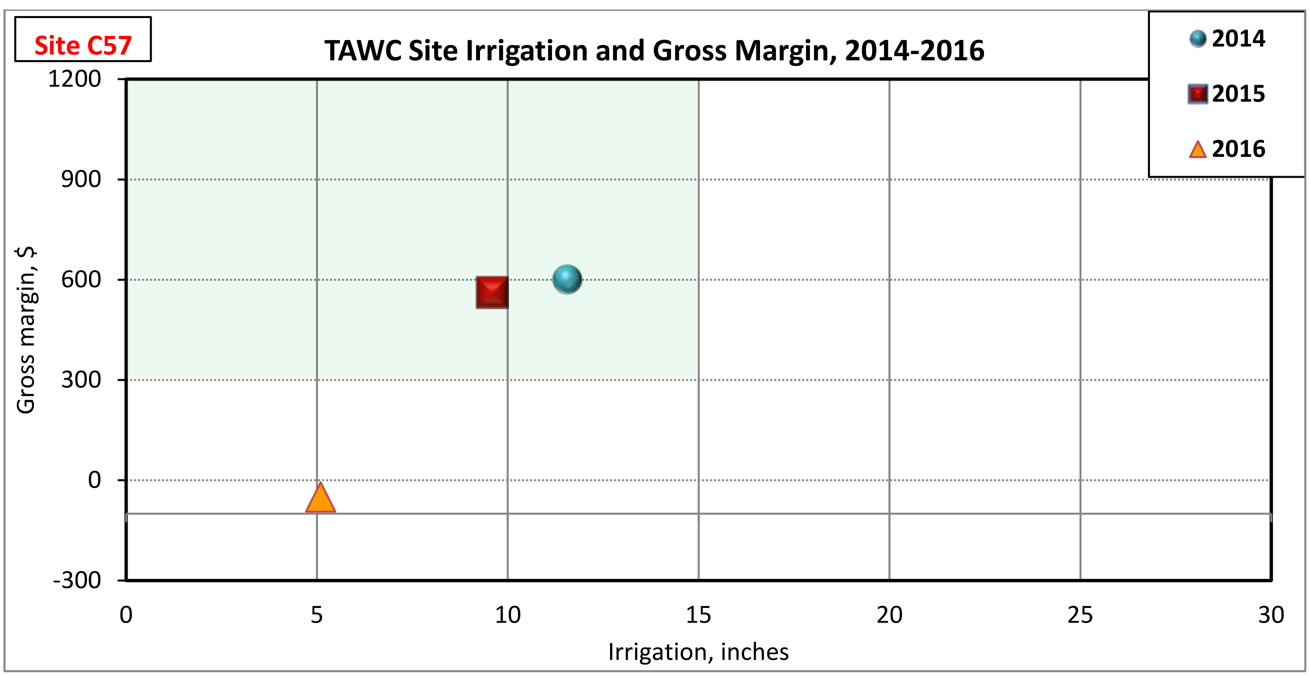
Site acres: 115

Soil types:
PuA - Pullman clay loam; 0 to 1%
PcB - Pep clay loam; 1 to 3%

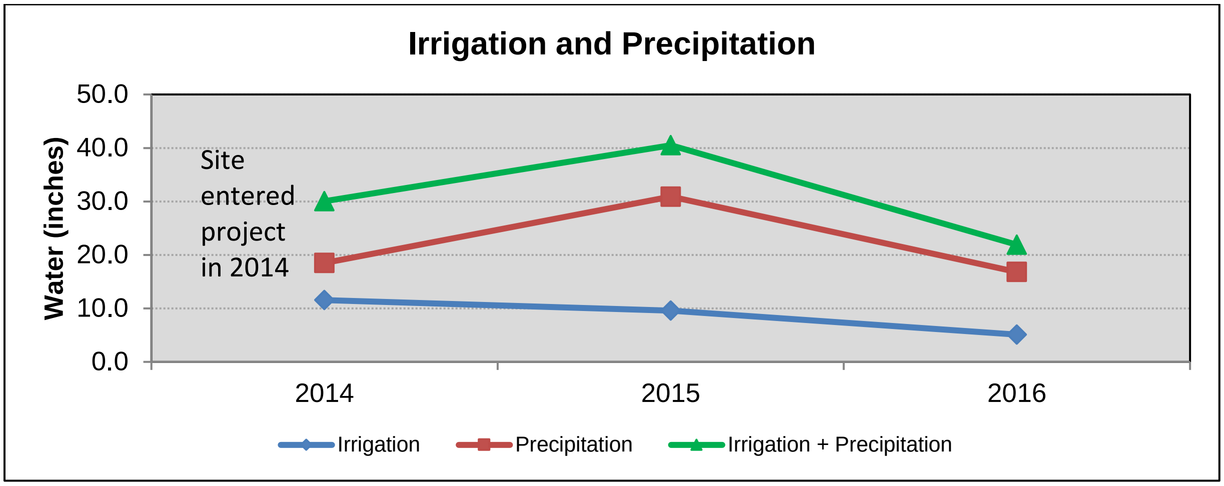
Irrigation:
Low Eleveation Spray Application (LESA) 750 gpm

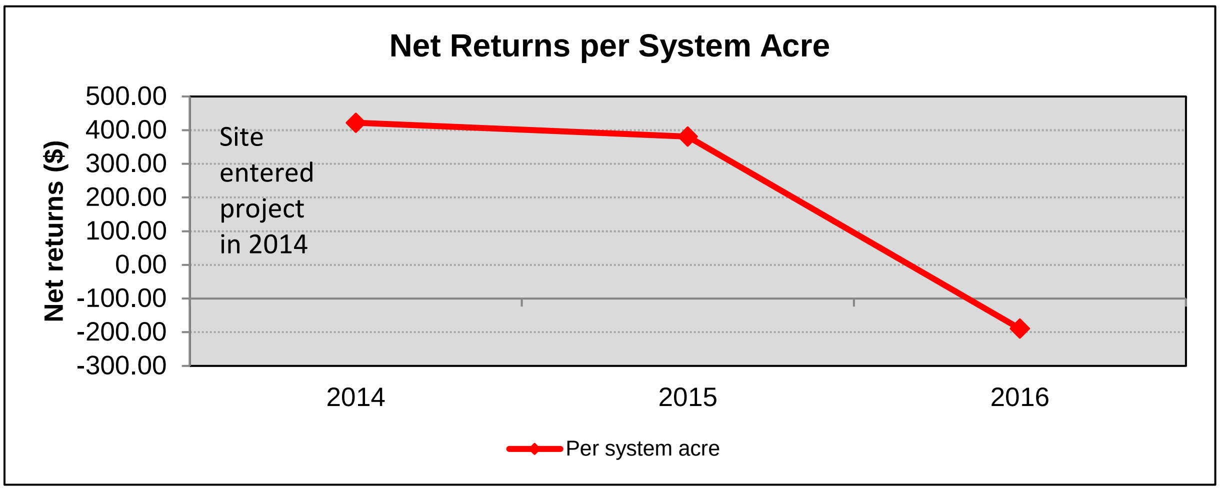
Number of wells: 4
Depth: 300 feet

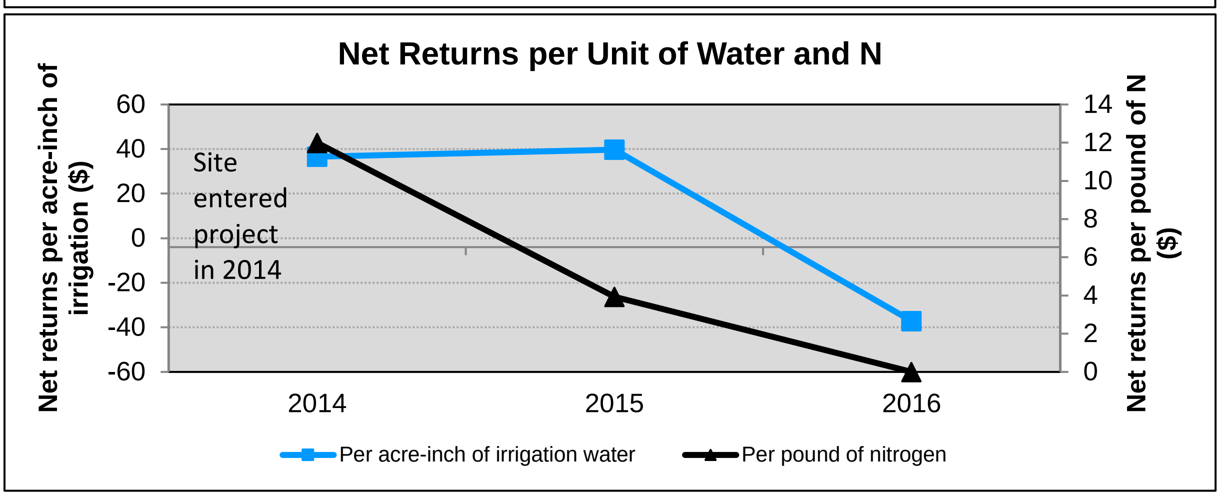
Fuel Source: Electric



Site C57


Irrigation and Precipitation
Water (inches)
50.0
40.0
30.0
20.0
10.0
0.0
Site entered project in 2014
2014
2015
2016
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
500.00
400.00
300.00
200.00
100.00
0.00
-100.00
-200.00
-300.00
Site entered project in 2014
2014
2015
2016
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
60
40
20
0
-20
-40
-60
Net returns per pound of N ($)
14
12
10
8
6
4
2
0
Site entered project in 2014
2014
2015
2016
Per acre-inch of irrigation water
Per pound of nitrogen

Site C57


March


Sunflower


Sunflower

Comments: In 2016 this LESA irrigated site was planted to sunflower on 30-inch centers with strip-till tillage.

SITE C59

Description:

Site acres: 93

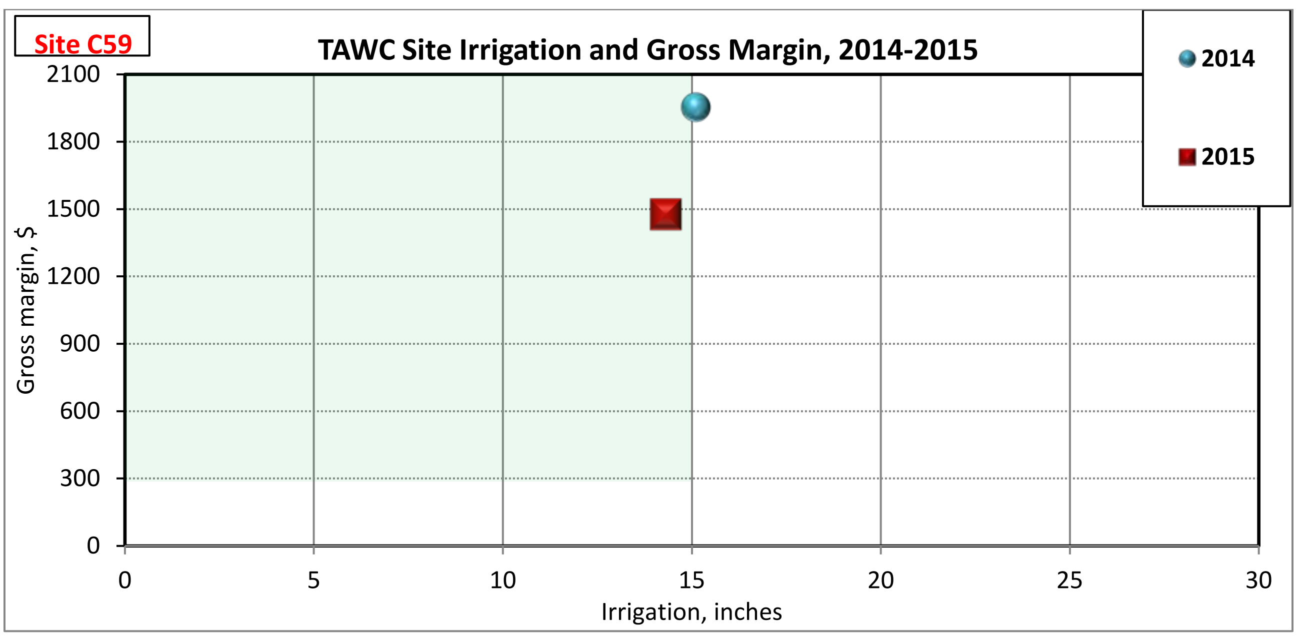
Soil types:
- 30 - Olton clay loam, 0 to 1%
- 31 - Olton clay loam, 1 to 3%
- 41 - Pullman clay loam, 0 to 1%

Irrigation:
Sub-surface Drip (SDI) 350 gpm

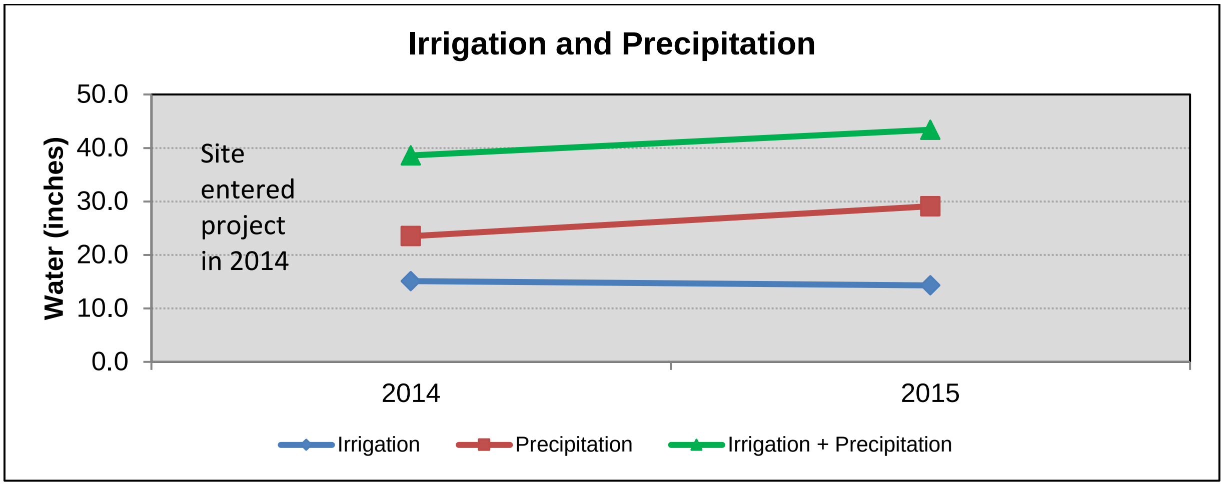
Number of wells: 2
Depth: 300 feet

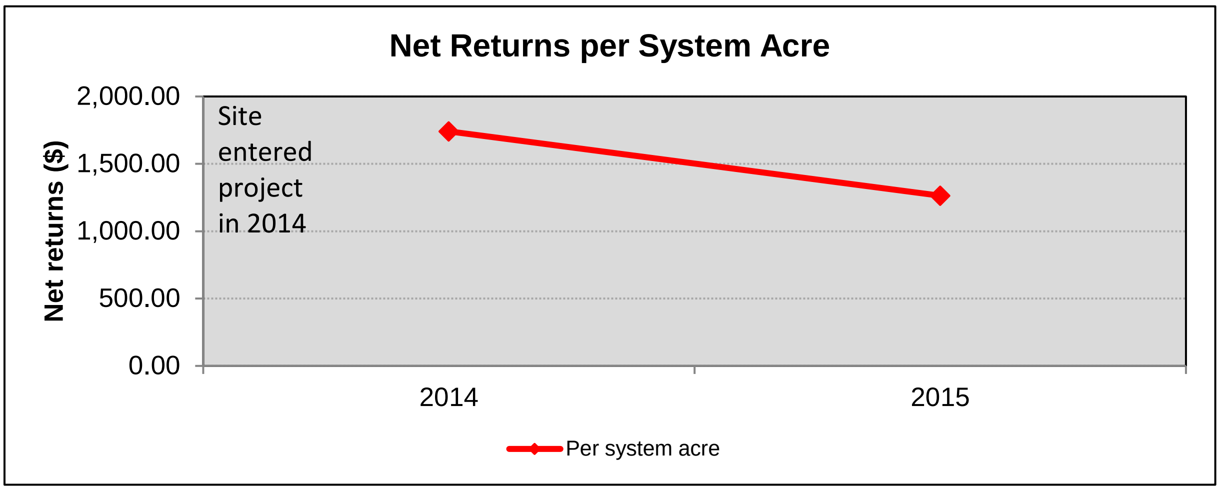
Fuel Source: Electric

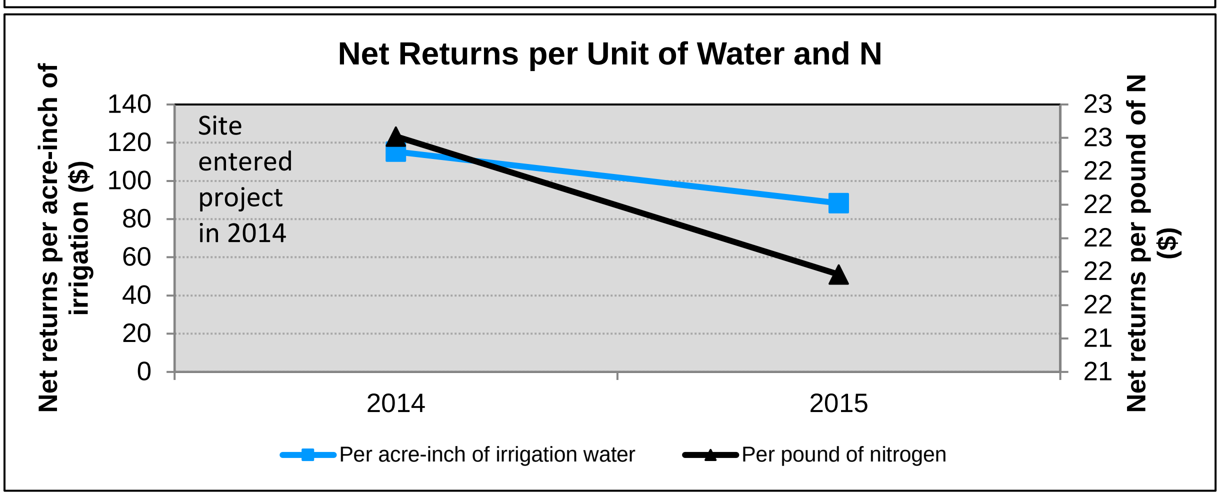
No Site Data for 2016



Site C59 – No Site Data for 2016







Site C59

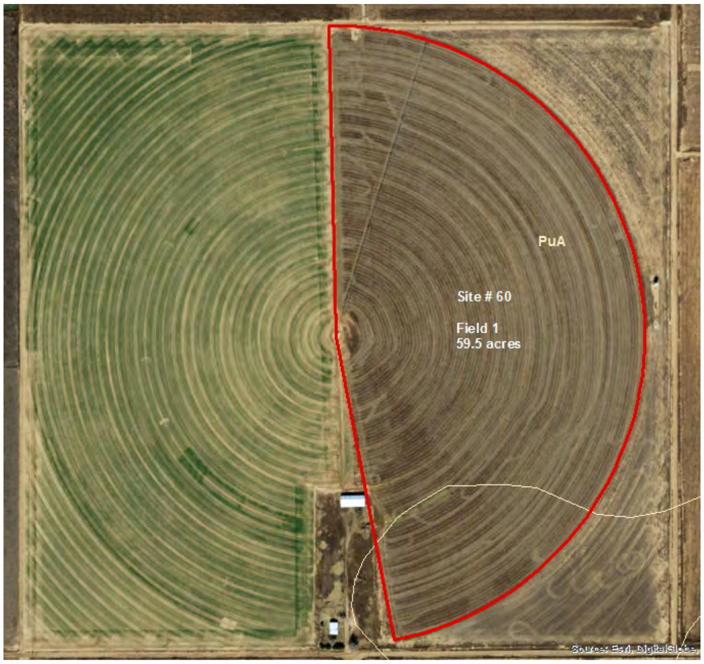
May alfalfa over drip

August alfalfa ready for harvest

Alfalfa field following hay

Comments: In 2016 this SDI irrigated site had no data collected.

SITE C60



Description:

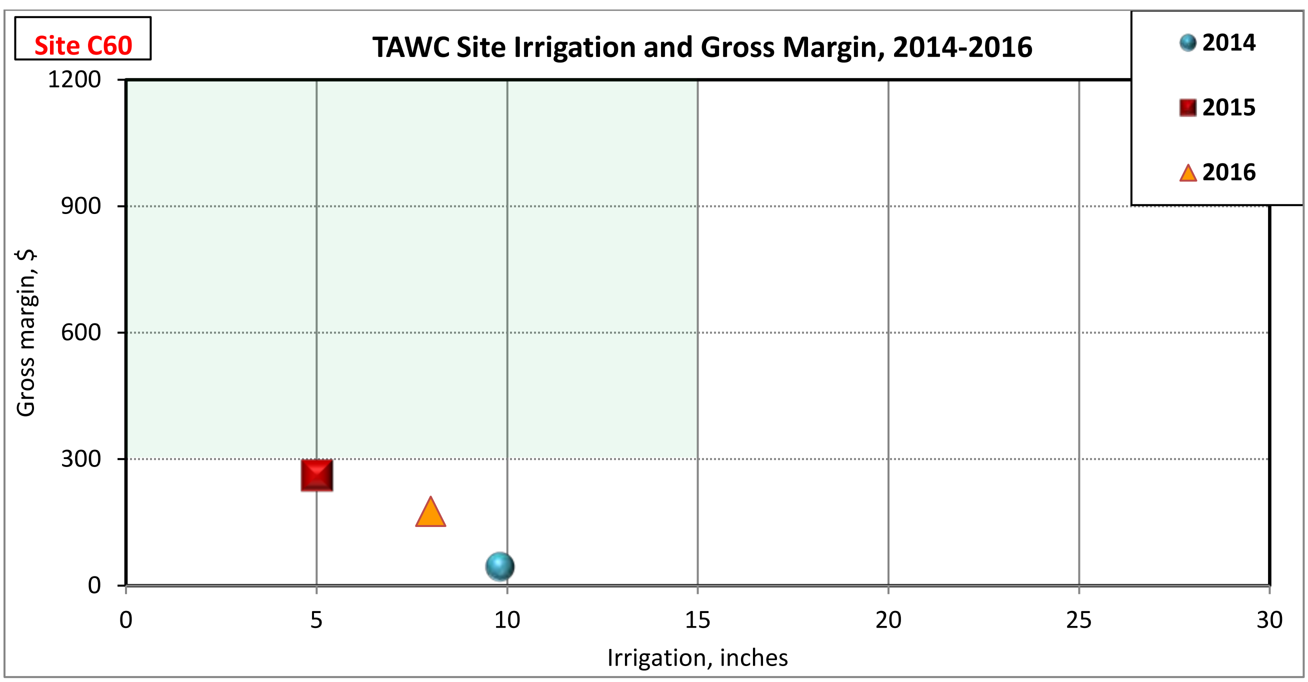
Site acres: 59.5

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

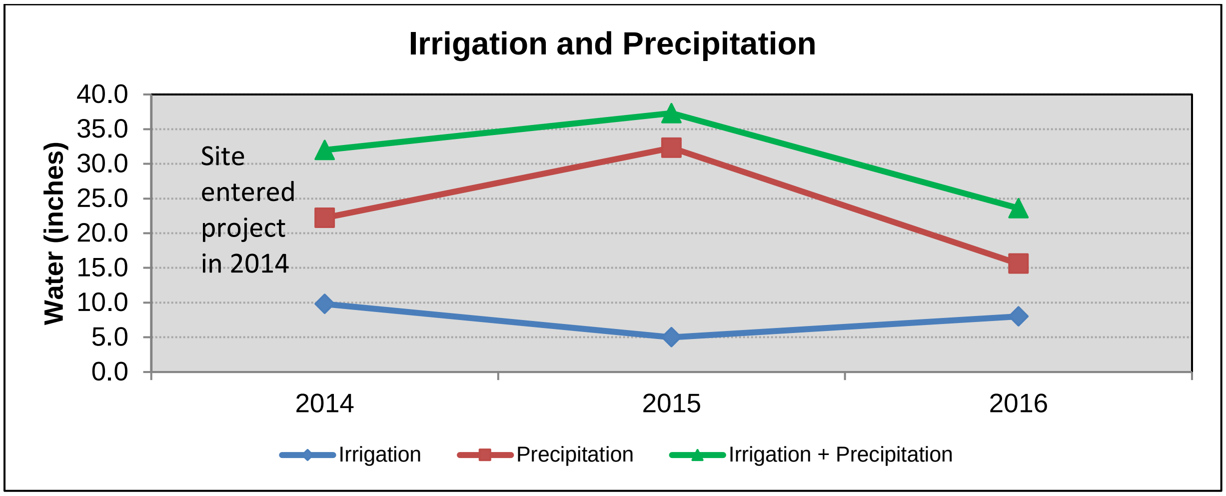
Irrigation:
Low Elevation Spray Application (LESA) 290 gpm

Number of wells: 3
Depth: 280 feet

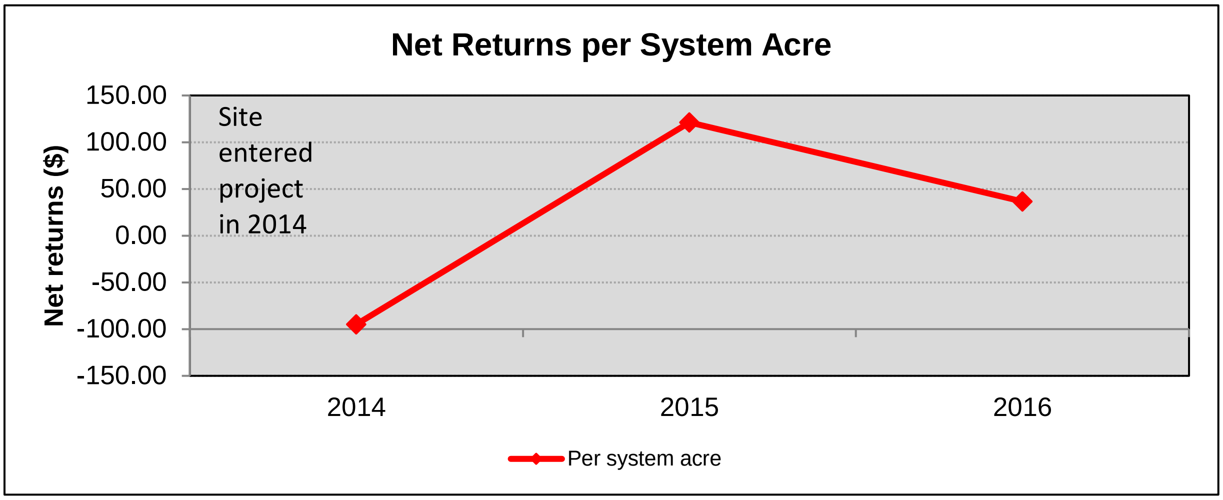
Fuel Source: Electric



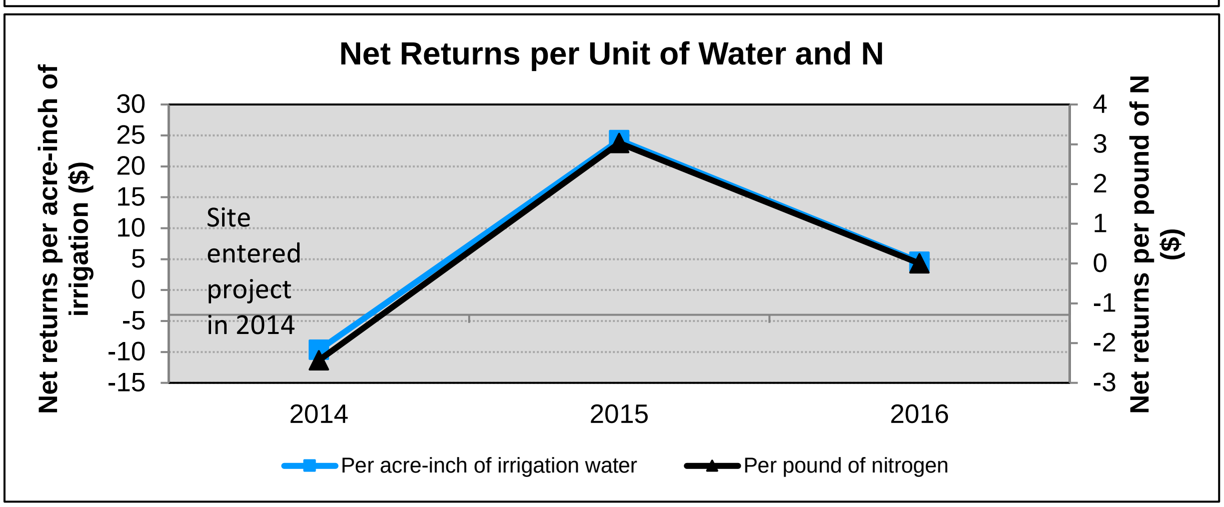
Site C60



Irrigation and Precipitation
Water (inches)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Site entered project in 2014
2014
2015
2016
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
150.00
100.00
50.00
0.00
-50.00
-100.00
-150.00
Site entered project in 2014
2014
2015
2016
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
30
25
20
15
10
5
0
-5
-10
-15
Site entered project in 2014
2014
2015
2016
Net returns per pound of N ($)
4
3
2
1
0
-1
-2
-3
Per acre-inch of irrigation water
Per pound of nitrogen

Site C60


LESA irrigated cotton


July cotton


October

Comments: In 2016 this LESA irrigated site was planted to cotton.

Appendix - Archives

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 2005-2014

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													
Total	**2005 acres**	**2118.3**	**203.4**	**174.1**	**209.8**	**250.3**	**45.1**	**48.8**	**82.9**	**191.8**	**829.8**	**1105.7**	**358.5**	**232.8**	**0.0**	**0.0**

PIV = pivot irrigation SDI = subsurface drip irrigation FUR = furrow irrigation DRY = dryland, no irrigation (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														
Total	**2006 acres** **1854.5**	**249.1**	**291.2**	**28.4**	**286.9**	**45.3**	**0.0**	**82.9**	**191.8**	**829.8**	**1069.6**	**588.3**	**137.0**	**115.8**	**105.7**	

PIV = pivot irrigation SDI = subsurface drip irrigation FUR = furrow irrigation DRY = dryland, no irrigation (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	135.2														
2	SDI	60.9														
3	PIV	61.5				61.8							61.8			
4	PIV	65.4							13.3			109.8	109.8			
5	PIV/DRY										620.9	620.9				
6	PIV	122.9														
7	PIV									130.0						
8	SDI									61.8						
9	PIV				137.0						95.8	95.8		232.8		
10	PIV			44.5							129.1	129.1				
11	FUR	92.5														
12	DRY	151.2			132.7											
13	DRY	201.5											118.0			
14	PIV	124.2														
15	FUR	66.7			28.8											
16	PIV	143.1														
17	PIV	108.9									167.2	167.2	108.9			
18	PIV				61.5								60.7			
19	PIV	75.8					45.6									
20	PIV			117.6		115.8									233.4	
21	PIV		61.3							61.4						
22	PIV	148.7														
23	PIV		105.2													
24	PIV		129.8													
26	PIV		62.3				62.9					62.9				
27	SDI	16.2		46.2												
Total	**2007 acres**	**1574.7**	**358.6**	**208.3**	**360.0**	**177.6**	**108.5**	**0.0**	**13.3**	**253.2**	**1013.0**	**1185.7**	**459.2**	**232.8**	**233.4**	**0.0**

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

Table 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																		
15	FUR	95.5	67.1													28.4					
17	PIV	220.8		108.9								111.9		111.9	220.8				108.9		
18	PIV	122.2	61.5			60.7											60.7				
19	PIV	120.4	75.0							45.4											
20	PIV	233.4				117.6		115.8					117.6			233.4					
21	PIV	122.7							61.3			61.4	122.7	61.4						61.3	
22	PIV	148.7		148.7																	
23	PIV	105.1	60.5		44.6																
24	PIV	129.8		129.8																	
26	PIV	125.2		40.4			22.5			62.3					125.2				125.2		
27	SDI	108.5	46.2	62.3																	
28	SDI	51.5		51.5																	
29	DRY	221.6	117.3												104.3			104.3			
Total 2008 acres		**3967.4**	**890.8**	**616.1**	**105.5**	**350.4**	**22.5**	**267.0**	**61.3**	**107.7**	**13.3**	**365.1**	**569.3**	**1224.2**	**1340.5**	**412.2**	**60.7**	**148.7**	**234.1**	**61.3**	**143.2**
# of sites		**25**	**11**	**8**	**2**	**5**	**1**	**2**	**1**	**2**	**1**	**4**	**7**	**8**	**7**	**5**	**1**	**2**	**2**	**1**	**3**
Site	**irrigation type**	**total acres (no overlap)**	**cotton**	**corn grain**	**sunflowers**	**grain sorghum**	**grain sorghum for seed**	**grain sorghum for silage**	**forage sorghum for hay**	**pearl millet for seed**	**alfalfa**	**grass seed**	**hay**	**perennial pasture**	**cattle**	**wheat for grain**	**wheat for silage**	**wheat for grazing**	**grazing of crop residue**	**barley for seed**	**fallow or pens/facilities**

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

Table 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													
Total acres 2014		**5223.3**	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
# of Sites		36	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.

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

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)[3], 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.

[3] Amosson, L. et al. 2011. Economics of irrigation systems. Texas A&M AgriLife Extension Service. B-6113.

Table A 12. 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 13. 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 14. Other variable and fixed costs for 2005 through 2013.

VARIABLE COSTS	2005	2006	2007	2008	2009	2010	2011	2012	2013
Boll weevil assessment: ($/ac)									
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	$1.00
Crop insurance: ($/ac)									
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

FIXED COSTS	2005	2006	2007	2008	2009	2010	2011	2012	2013
Irrigation system:									
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
Cash rent:									
Irrigated cotton, grain sorghum, sun-flowers, grass, pearl millet, and sorghum silage.	$45.00	$45.00	$45.00	$75.00	$75.00	$100.00	$100.00	$100.00	$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 15. Summary of results from monitoring 26 producer sites in 2005 (Year 1).

System	Site No.	Acres	Irrigation Type[1]	System Inches	$/system Acre	$/inch water
Monoculture systems						
Cotton	1	61	SDI	11.7	84.02	7.19
Cotton	2	68	SDI	8.9	186.94	21
Cotton	14	125	CP	6.8	120.9	17.91
Cotton	16	145	CP	7.6	123.68	16.38
Cotton	21	123	CP	6.8	122.51	18.15
Cotton	11	95	Fur	9.2	4.39	0.48
Cotton	15	98	Fur	4.6	62.65	13.62
Multi-crop systems						
Cotton/grain sorghum	3	125	CP	8.3	37.79	4.66
Cotton/grain sorghum	18	120	CP	5.9	16.75	2.84
Cotton/grain sorghum	25	179	DL	0	67.58	na
Cotton/forage sorghum	12	250	DL	0	36	na
Cotton/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
Crop-livestock systems						
Cotton/wheat/stocker cattle	6	123	CP	11.4	162.63	9.04
Cotton/grass/stocker cattle	9	237	CP	6.5	298.14	46.17
Cotton/grass/cattle	10	175	CP	8.5	187.72	22.06
Forage/beef cow-calf	5	630	CP	1.23	125.89	93.34
Forage/Grass seed	7	61	SDI	9.8	425.32	37.81
Forage/Grass seed	8	130	CP	11.3	346.9	35.56

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

Table A 16. Summary of results from monitoring 26 producer sites in 2006 (Year 2).

System	Site No.	Acres	Irrigation type[1]	System inches	$/system acre	$/inch water	Gross margin per inch irrigation
Monoculture systems							
Cotton	1	135	SDI	21	225.9	10.76	15.77
Cotton	2	61	SDI	19	308.71	16.25	22.56
Cotton	27	46	SDI	18	417.99	23.22	29.89
Cotton	3	123	CP	10	105.79	10.58	18.44
Cotton	6	123	CP	13.6	321.79	23.64	29.42
Cotton	14	124	CP	6.2	44.81	7.2	19.84
Cotton	16	143	CP	12.2	71.08	5.81	8.43
Cotton	11	93	Fur	16.9	88.18	5.22	9.37
Multi-crop systems							
Cotton/grain sorghum	15	96	Fur	11.2	161.89	14.51	20.78
Cotton/forage sorghum	12	284	DL	0	-13.72	na	na
Cotton/forage sorghum /oats	18	122	CP	12	-32.31	-2.69	3.86
Cotton/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
Crop-livestock systems							
Cotton/stocker cattle	21	123	CP	16.4	94.94	5.79	10.22
Cotton/grass/stocker cattle	9	237	CP	10.6	63.29	6.26	13.87
Cotton/corn silage /wheat/cattle	17	221	CP	13	242.21	14.89	20.64
Forage/beef cow-calf	5	628	CP	9.6	150.46	15.62	22.31
Forage/beef cow-calf	10	174	CP	16.1	217.71	13.52	18.4
Forage/Grass seed	7	130	CP	7.8	687.36	88.69	98.83
Forage/Grass seed	8	62	SDI	10.1	376.36	48.56	64.05

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

Table A 17. Summary of results from monitoring 26 producer sites in 2007 (Year 3).

System	Site No.	Acre s	Irrigation Type[1]	System inches	$/system acre	$/inch water	Gross margin per inch irrigation
Monoculture systems							
Cotton	1	135	SDI	14.60	162.40	11.12	19.34
Cotton	2	61	SDI	12.94	511.33	39.52	48.79
Cotton	6	123	CP	10.86	605.78	55.78	63.02
Cotton	11	93	Fur	14.67	163.58	11.15	15.92
Cotton	14	124	CP	8.63	217.38	25.19	34.30
Cotton	22	149	CP	11.86	551.33	46.49	53.11
Corn	23	105	CP	10.89	325.69	29.91	37.12
Corn	24	130	CP	15.34	373.92	24.38	31.46
Perennial grass: seed and hay	7	130	CP	13.39	392.59	29.32	35.19
Perennial grass: seed and hay	8	62	SDI	15.67	292.63	18.67	26.33
Multi-crop systems							
Cotton/grain sorghum/wheat	3	123	CP	13.25	190.53	14.38	20.31
Cotton/grain sorghum	12	284	DL	0.00	265.71	Dryland	Dryland
Cotton/wheat	13	320	DL	0.00	105.79	Dryland	Dryland
Cotton/grain sorghum	15	96	Fur	10.50	191.68	18.26	24.92
Grain sorghum/wheat	18	122	CP	5.34	13.91	2.60	13.62
Cotton/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
Crop-livestock systems							
Wheat: cow-calf, grain/cotton/alfalfa hay	4	123	CP	8.18	183.72	22.47	33.30
Perennial grass: cow-calf, hay	5	628	CP	3.56	193.81	54.38	72.45
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

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

Table A 18. Summary of results from monitoring 25 producer sites in 2008 (Year 4).

System	Site No.	Acres	Irrigation Type[1]	System inches	$/system acre	$/inch water	Gross margin per inch irrigation
Monoculture Systems							
Sunflowers	2	60.9	SDI	6.89	147.83	21.46	43.23
Perennial grass: seed and hay	7	130.0	CP	9.88	295.43	29.90	40.89
Perennial grass: seed and hay	8	61.8	SDI	6.65	314.74	47.33	69.89
Cotton	14	124.2	CP	8.97	-2.12	-0.24	11.87
Corn	22	148.7	CP	24.75	720.10	29.09	34.49
Corn	24	129.8	CP	24.70	513.54	20.79	26.20
Corn	28	51.5	SDI	8.20	591.15	72.09	93.43
Multi-crop systems							
Cotton/Wheat/Grain sorghum	3	123.3	CP	14.75	53.79	3.65	11.01
Cotton/Corn	6	122.9	CP	17.35	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
Crop-Livestock systems							
Wheat: cow-calf, grain/cotton/alfalfa hay	4	123.1	CP	14.51	154.85	10.68	17.00
Perennial grass: cow-calf, hay	5	628	CP	4.02	107.14	26.65	49.02
Perennial Grass: stocker cattle/Cotton	9	237.8	CP	7.26	11.63	1.60	16.25
Perennial grass: cow-calf, hay/Grass seed/Corn	10	173.6	CP	14.67	64.80	4.42	0.00
Perennial grass: cow-calf, seed, hay/cotton/wheat for grazing	17	220.8	CP	15.00	309.34	20.62	28.68
Pearl millet: seed, Grain sorghum/Corn: grazing, hay	26	125.2	CP	14.65	279.69	19.09	27.36

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

Table A 19. Summary of results from monitoring 26 producer sites in 2009 (Year 5).

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

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

Table A 20. Summary of results from monitoring 26 producer sites in 2010 (Year 6).

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

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

Table A 21. Summary of results from monitoring 29 producer sites in 2011 (Year 7).

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

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

Table A 22. Summary of results from monitoring 29 producer sites in 2012 (Year 8).

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

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

Table A 23. Summary of results from monitoring 30 producer sites in 2013 (Year 9).

System	Site No.	Acres	Irrigation Type[1]	System inches	$/system acre	$/inch water	Gross margin per inch irrigation
Monoculture systems							
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
Multi-crop systems							
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
Crop-livestock systems							
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

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

Table A 24. Phase II Summary of results from monitoring 36 producer sites during 2014 (Year 1).

System	Site No.	Acres	Irrigation Type[1]	System inches	$/system acre	$/inch water	Gross margin per inch irrigation
Monoculture systems							
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
Multi-crop systems							
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
Crop-Livestock systems							
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

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

Table A 25. Phase II Summary of results from monitoring 32 of 36 producer sites during 2015 (Year 2).

System	Site No.	Acres	Irrigation Type[1]	System inches	$/system acre	$/inch water	Gross margin per inch irrigation
Monoculture systems							
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
Multi-crop systems							
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
Crop-Livestock systems							
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

[1]SDI – Subsurface drip irrigation; MESA – Mid elevation spray application; LESA – Low elevation spray application; LEPA – Low energy precision application; LDN – Low drift nozzle; FUR – furrow irrigation; DL – dryland

Table A 26. 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
Annual forage											
Forage sorghum											
	Hay, tons	-	-	-	-	-	-	6.8 (1)	1.9 (2)	1.7 (1)	3.5
									3,396 (1)		3,396
Precipitation, inches (including all sites)		15.0	15.4	27.3	21.7	15.7	28.9	5.3	10.0	13.2	16.9
By System		**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**
Total irrigation water (system average)		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
By Crop	**Irrigation**	**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**	**inches applied**
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
Dahl											
	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
Sideoats											
	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
Bermuda											
	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 (2005-2014)

Site 1 – Terminated 2007

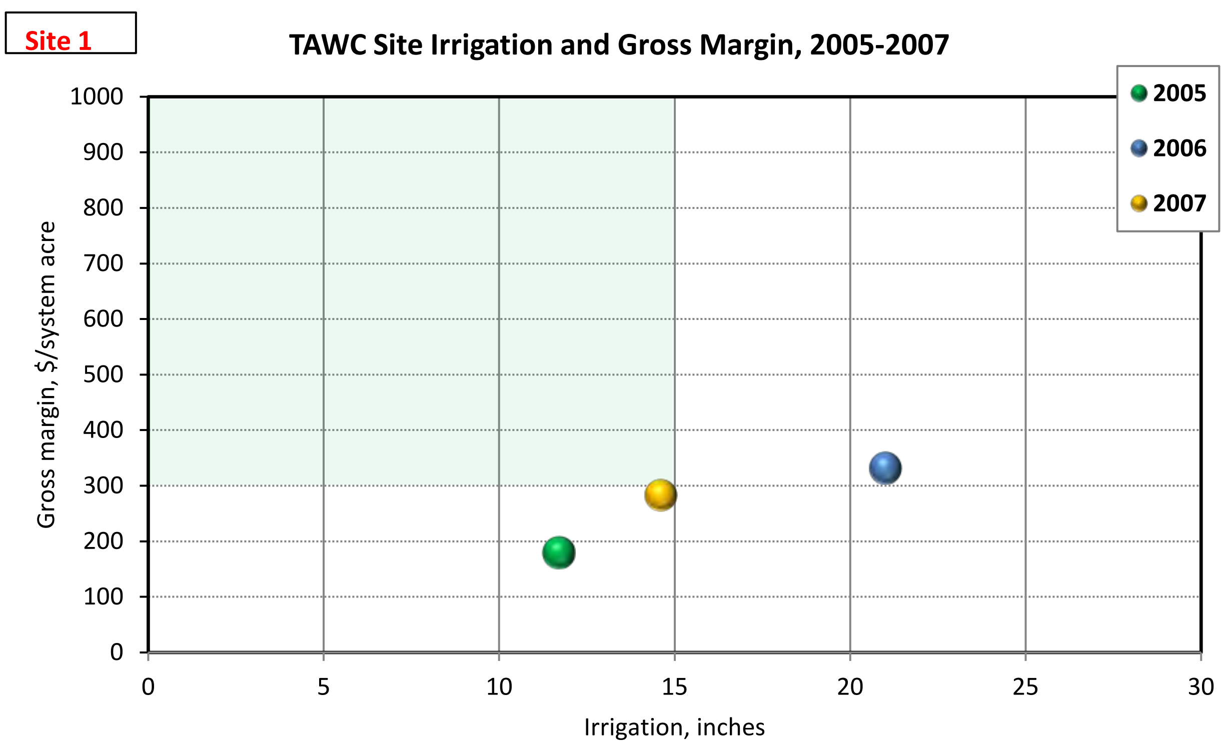
Site acres: 135.2

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

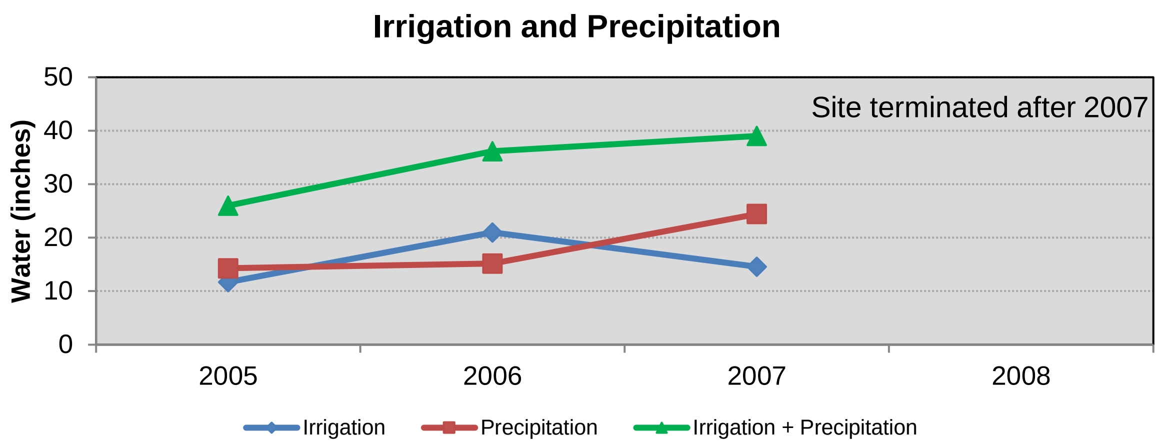
Irrigation:
Sub-Surface Drip (SDI) 850 gpm

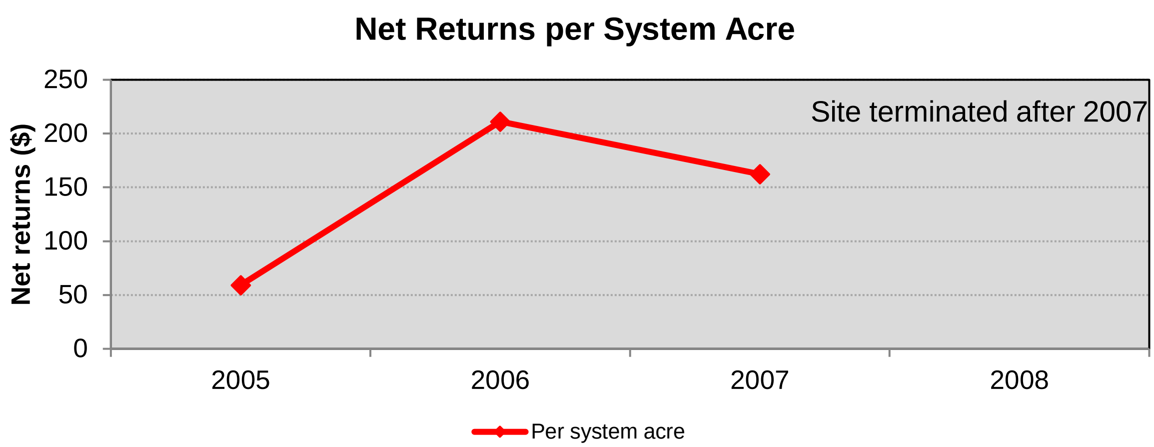
Number of wells: 2

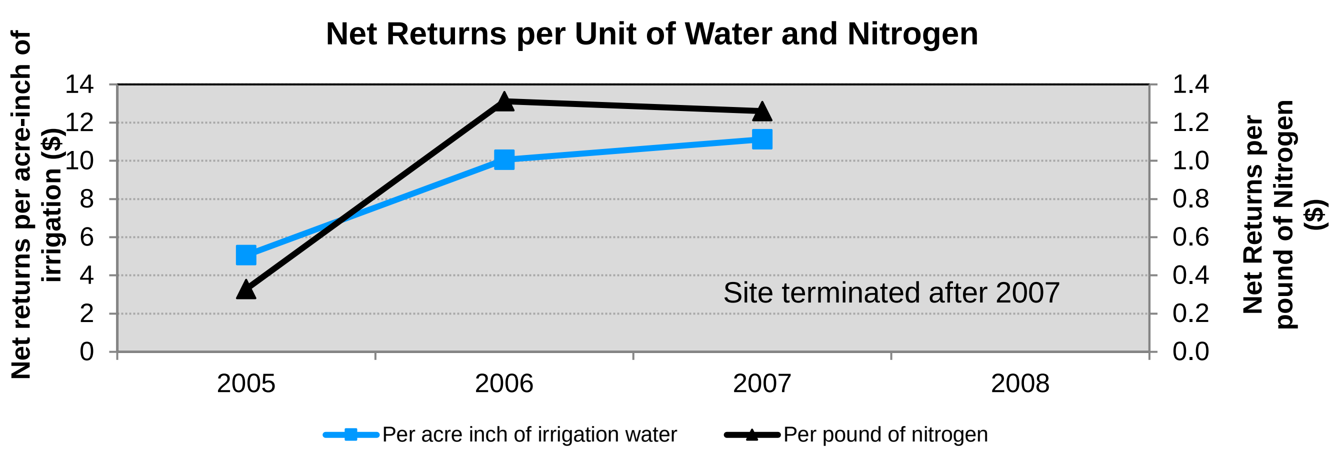
Fuel Source: 1 Natural gas,
1 Electric



Site 1


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


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


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

SITE 2 – TERMINATED 2013

Description:

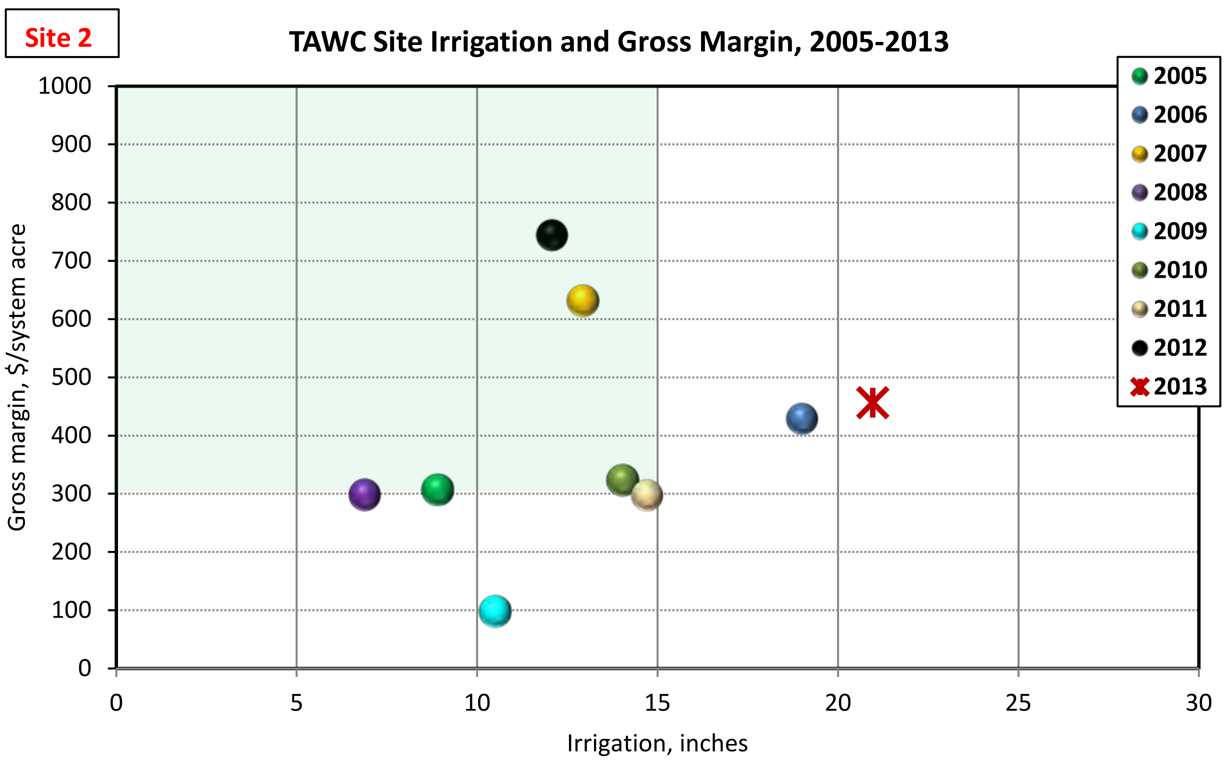
Site acres: 60

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

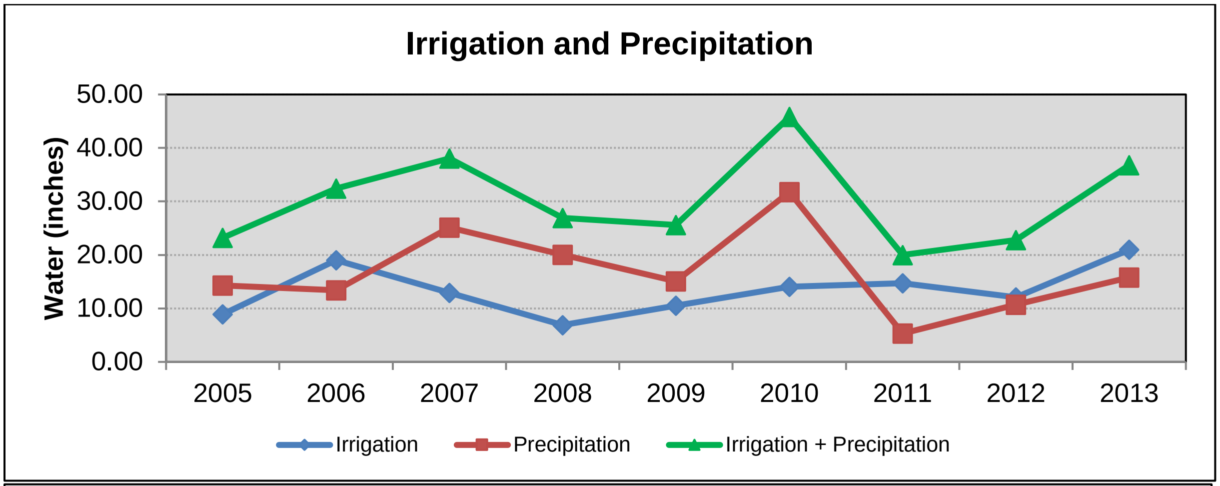
Irrigation:
Sub-Surface Drip (SDI) 3600 gpm

Number of wells: 2

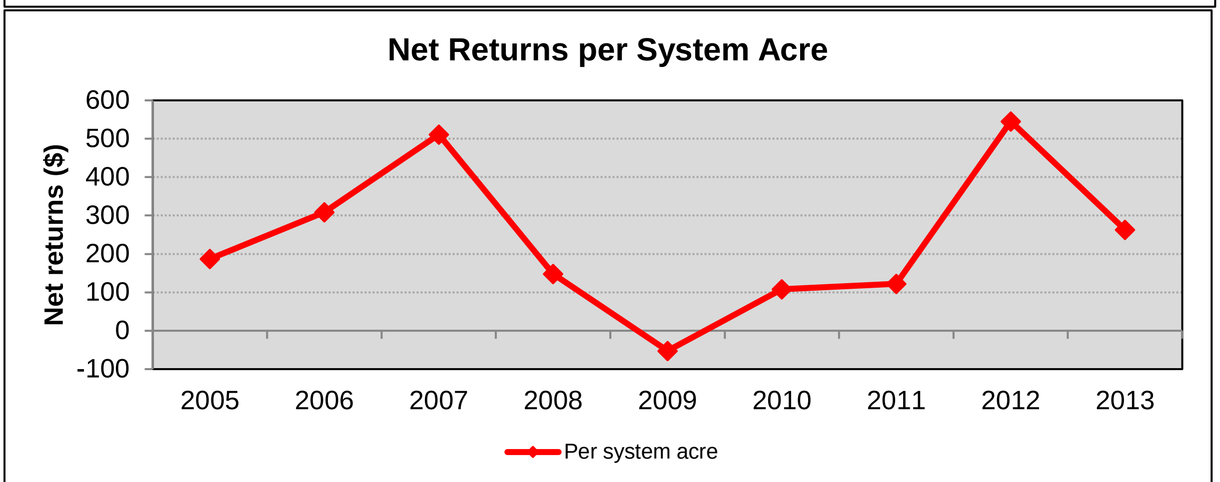
Fuel Source: Electric



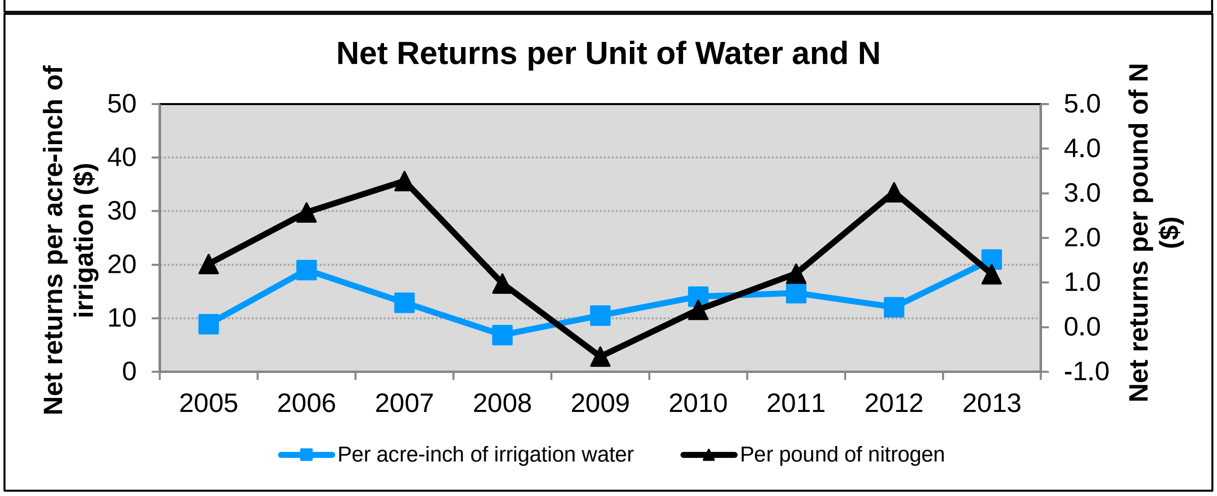
Site 2



Irrigation and Precipitation
Water (inches)
50.00
40.00
30.00
20.00
10.00
0.00
2005
2006
2007
2008
2009
2010
2011
2012
2013
Irrigation
Precipitation
Irrigation + Precipitation

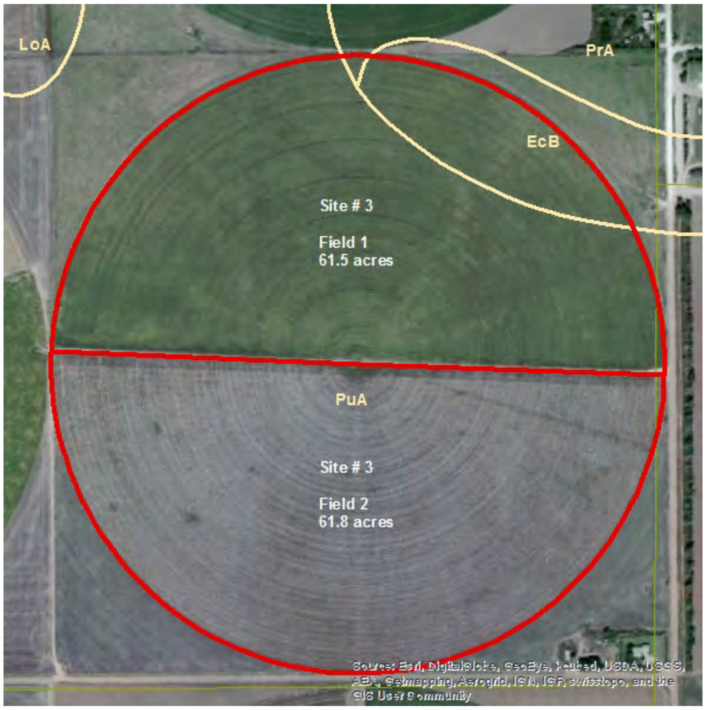


Net Returns per System Acre
Net returns ($)
600
500
400
300
200
100
0
-100
2005
2006
2007
2008
2009
2010
2011
2012
2013
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
Net returns per pound of N ($)
Per acre-inch of irrigation water
Per pound of nitrogen

SITE 3 – TERMINATED 2013



Description:

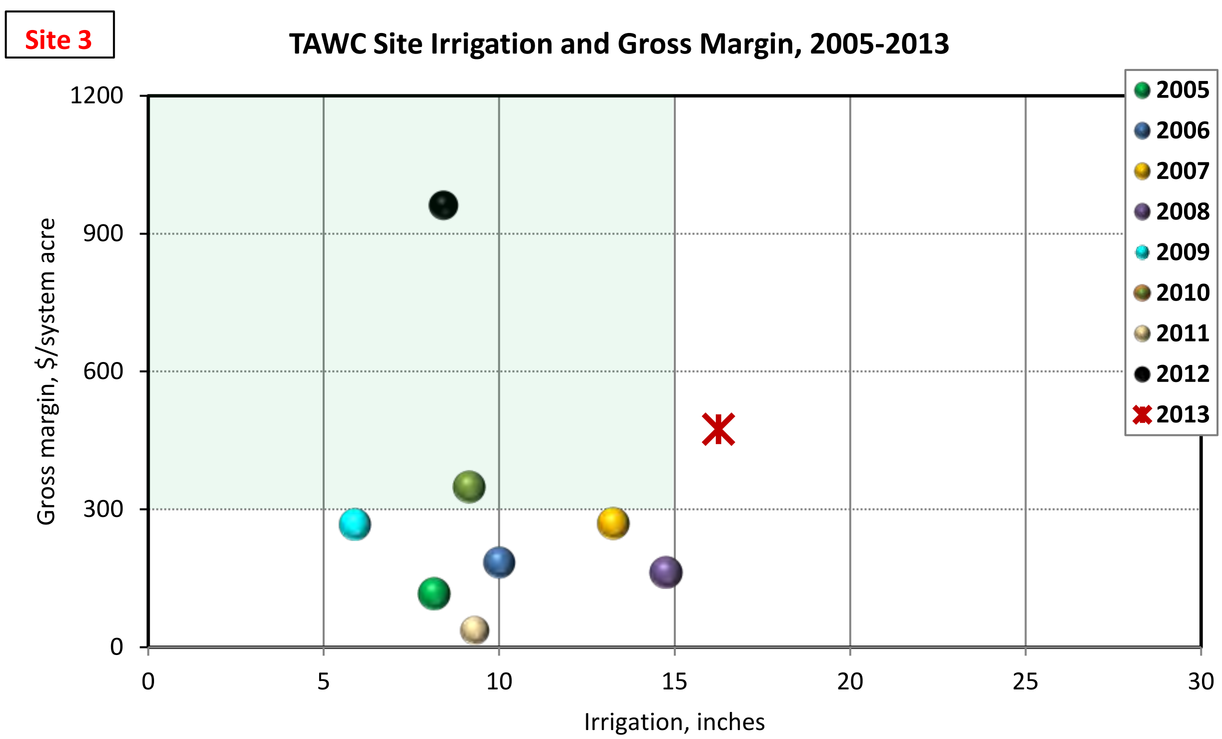
Site acres: 123.3

Soil types:
PuA-Pullman clay loam, 0 to 1%
EcB-Estacado clay loam; 1 to 3%

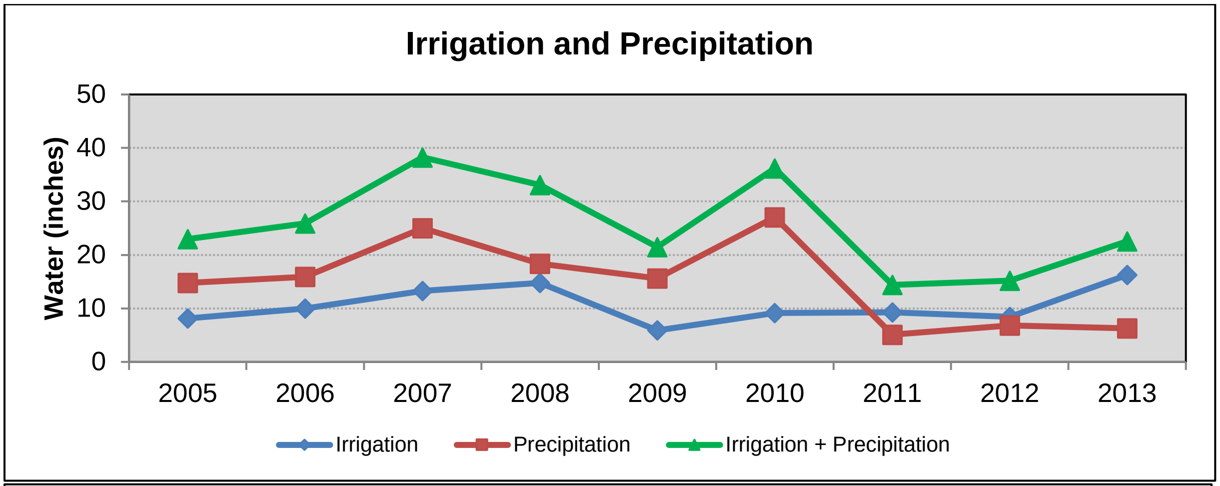
Irrigation:
Center Pivot (MESA) 450 gpm

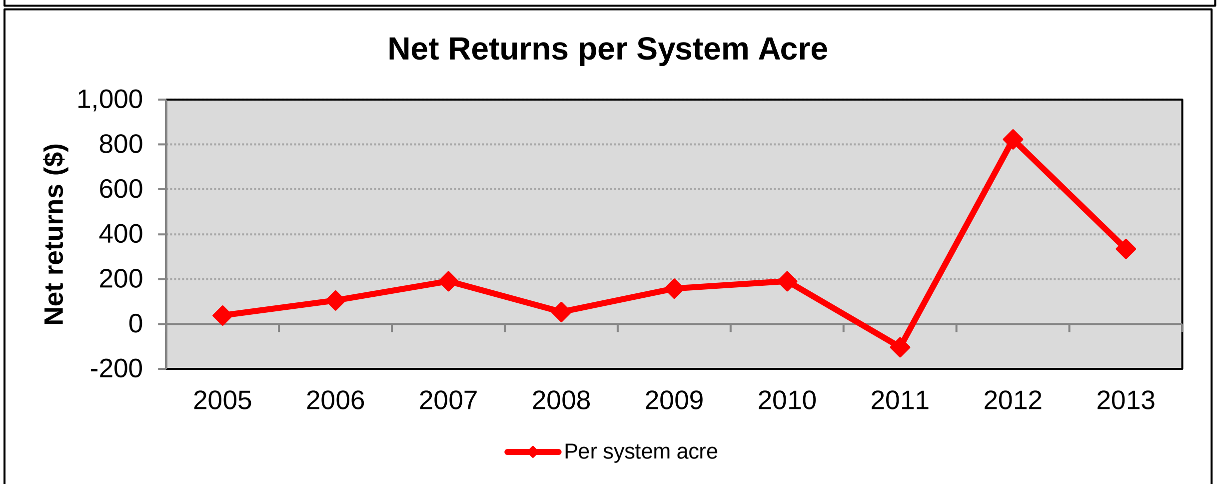
Number of wells: 2

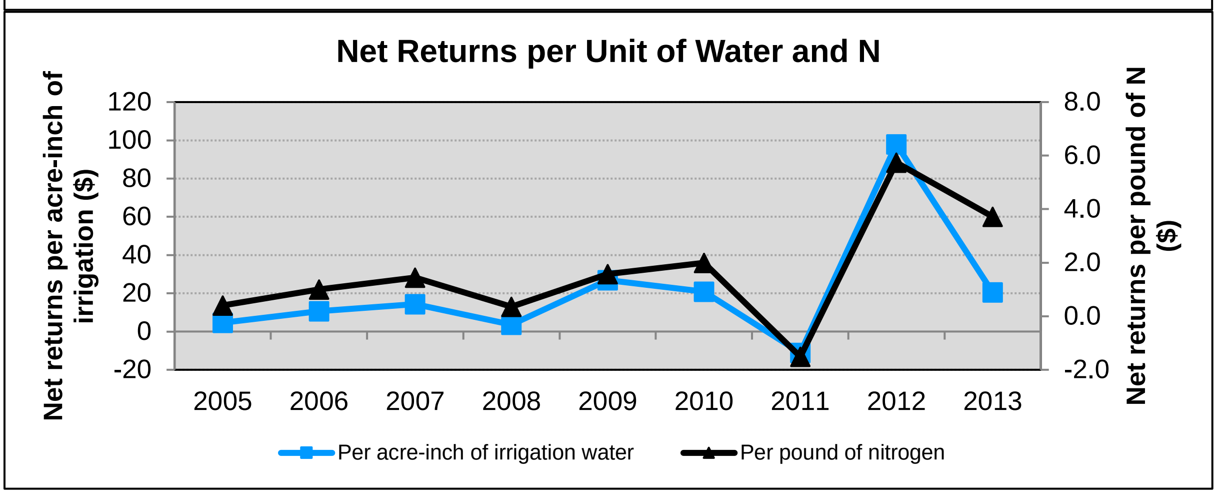
Fuel Source: 1 Natural Gas,
1 Electric



Site 3


Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
1,000
800
600
400
200
0
-200
2005
2006
2007
2008
2009
2010
2011
2012
2013
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
120
100
80
60
40
20
0
-20
8.0
6.0
4.0
2.0
0.0
-2.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
2013
Per acre-inch of irrigation water
Per pound of nitrogen

Site 5 - Terminated 2015

Description:

Site acres: 484.1

Soil types:

BpA-Bippus loam, 0 to 1%

MkB/MkC-Mansker loam, 0 to 3 and 3 to 5%

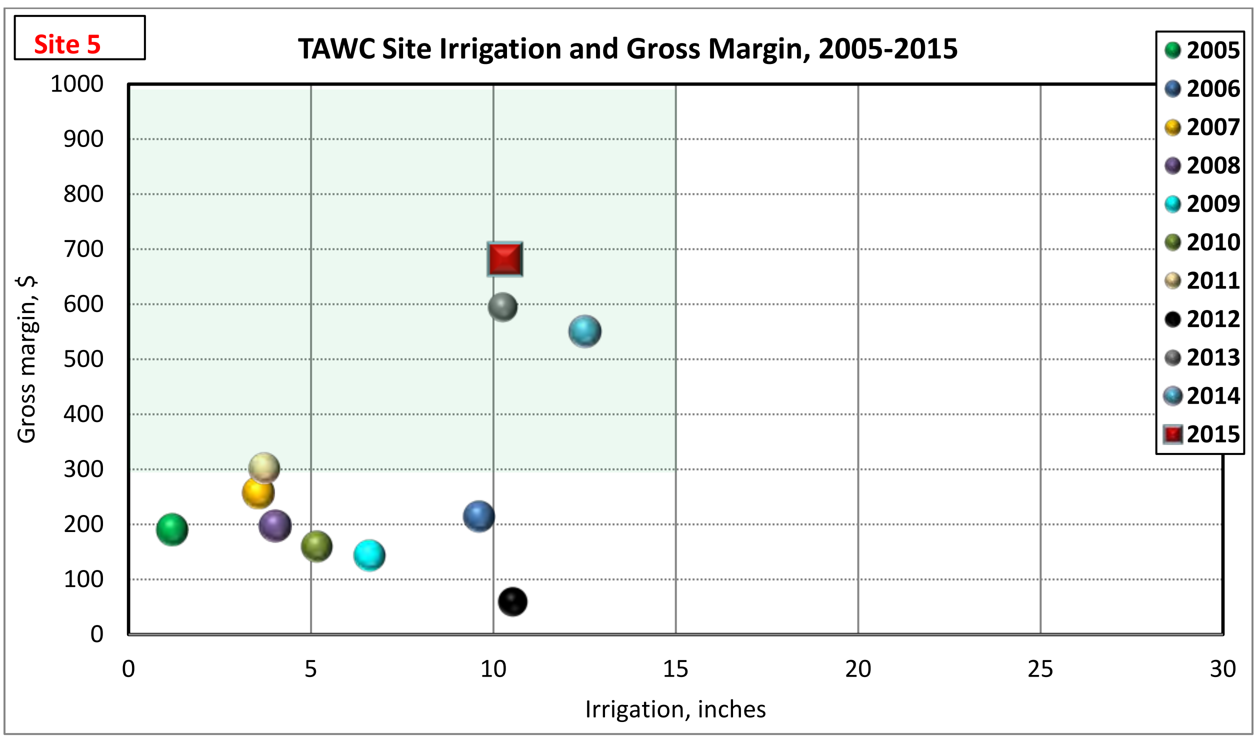
OtA/OtB-Olton loam, 0 to 1% and 1 to 3%

Irrigation:

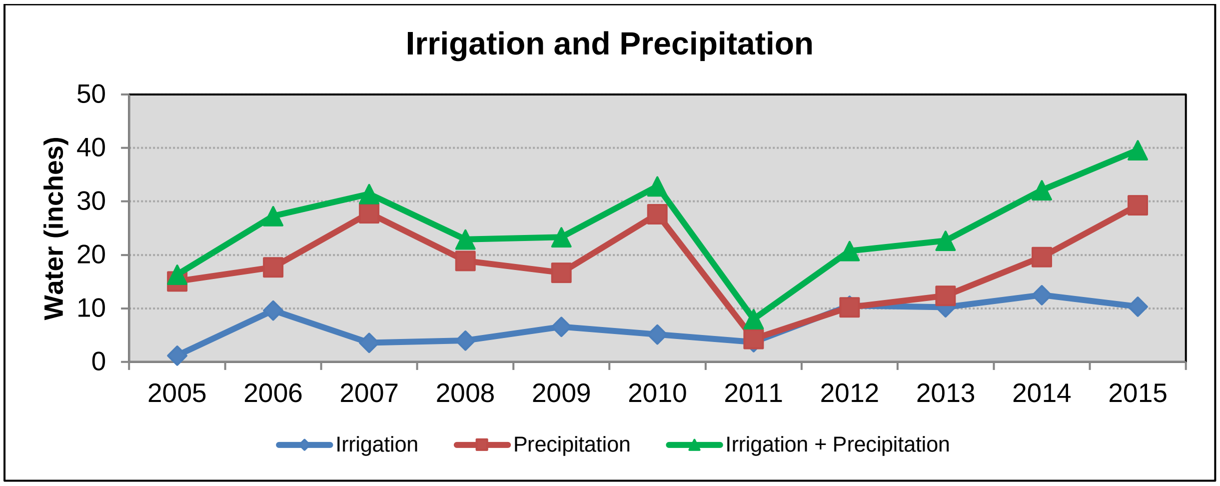
Center Pivot (MESA) 1100gpm

Number of wells: 4

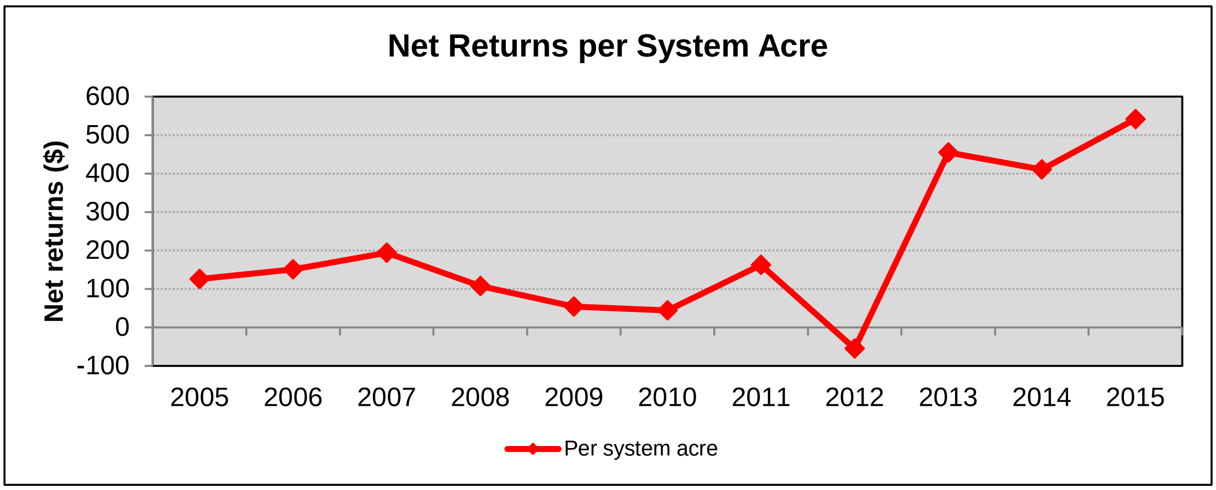
Fuel Source: Electric



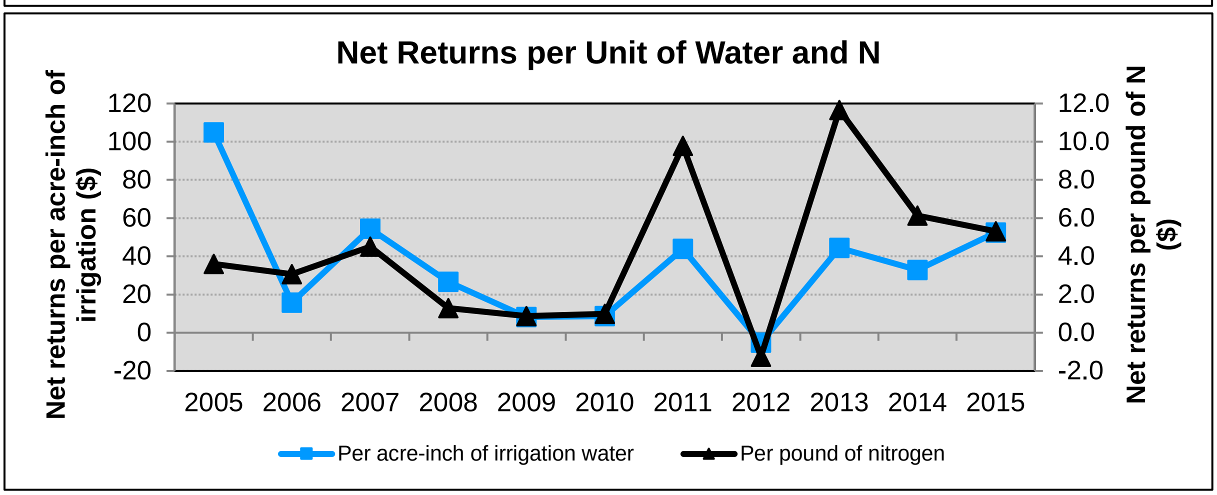
Site 5



Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
600
500
400
300
200
100
0
-100
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
120
100
80
60
40
20
0
-20
12.0
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Per acre-inch of irrigation water
Per pound of nitrogen

Site 7 – Terminated 2014

Description:

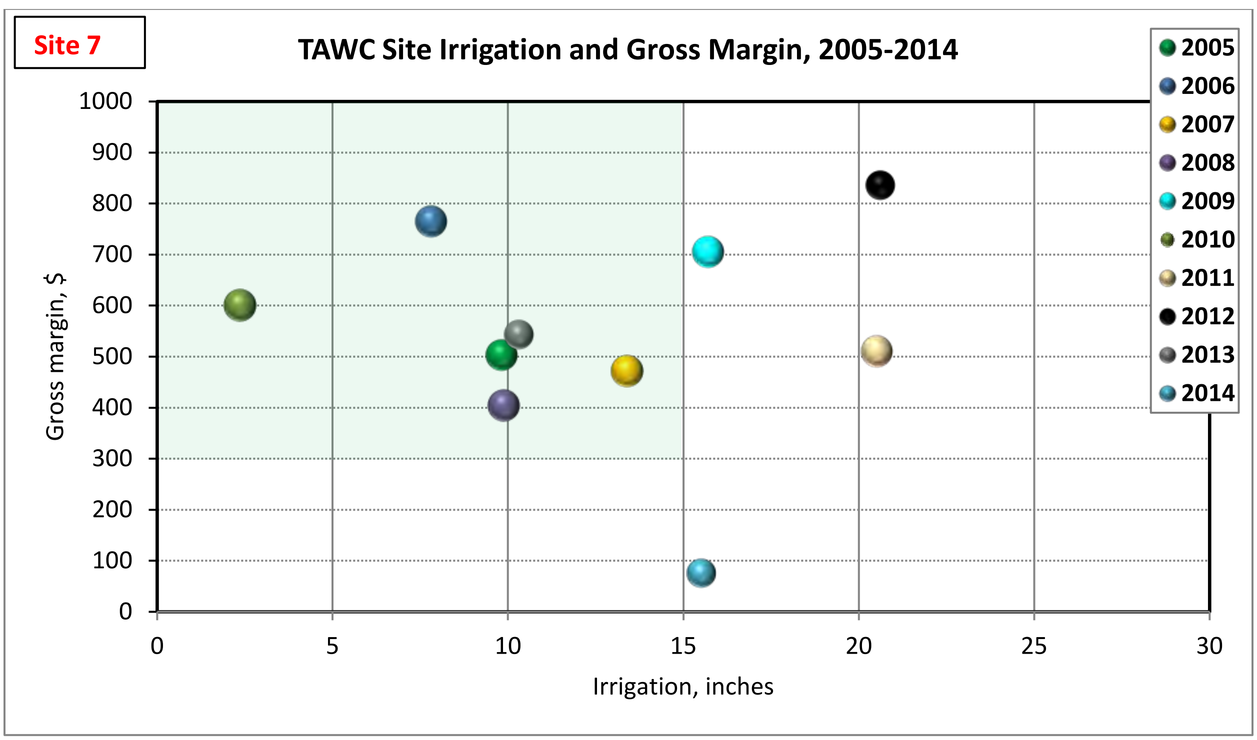
Site acres: 130

Soil types:
PuA-Pullman clay loam, 0 to 1%
PuB-Pullman clay loam, 1 to 3%

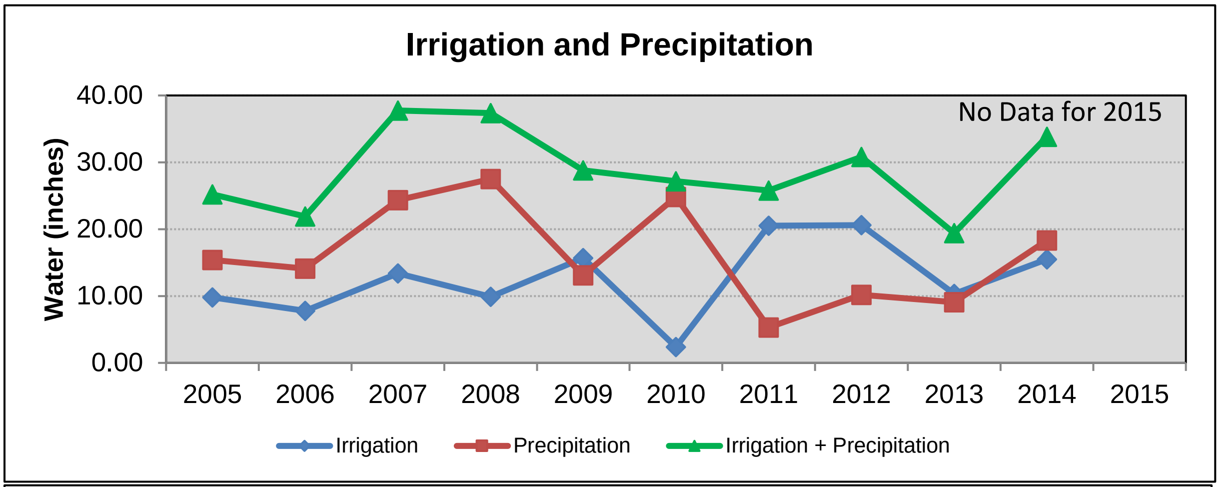
Irrigation:
Center Pivot (LESA) 500 gpm

Number of wells: 4

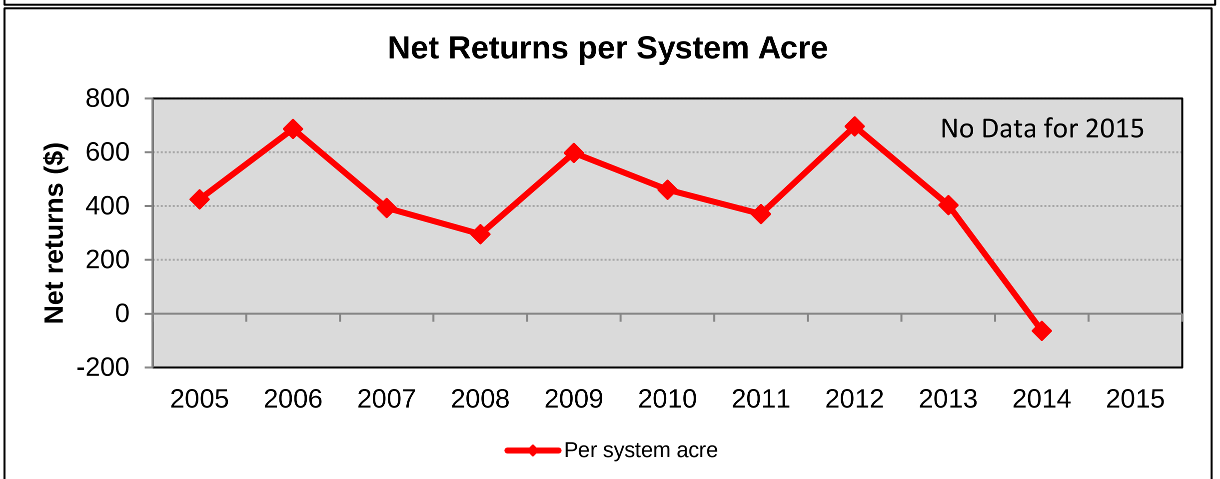
Fuel Source: Electric



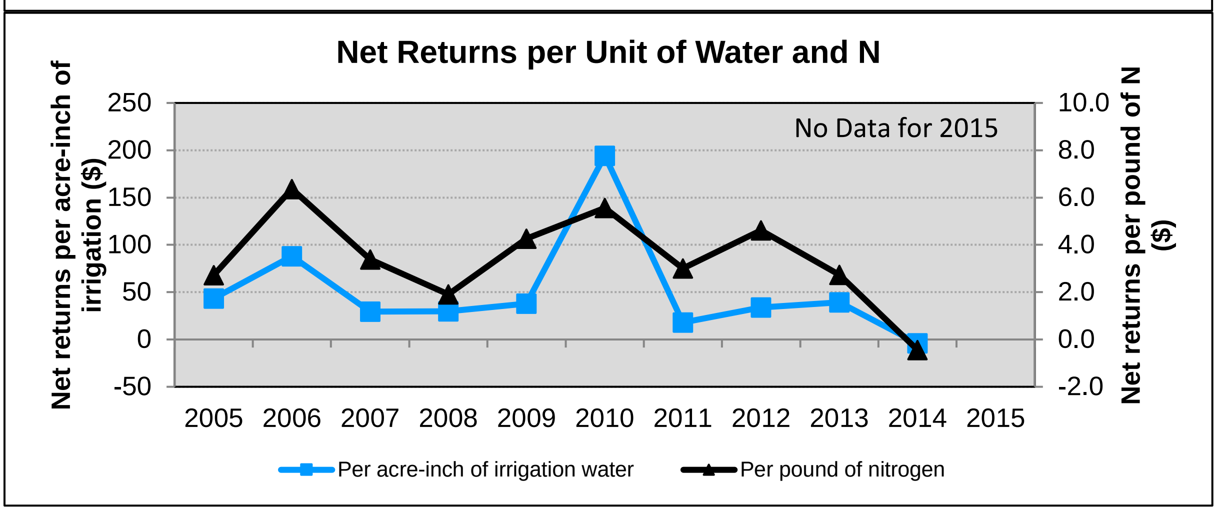
Site 7



Irrigation and Precipitation
No Data for 2015
Water (inches)
40.00
30.00
20.00
10.00
0.00
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Irrigation
Precipitation
Irrigation + Precipitation

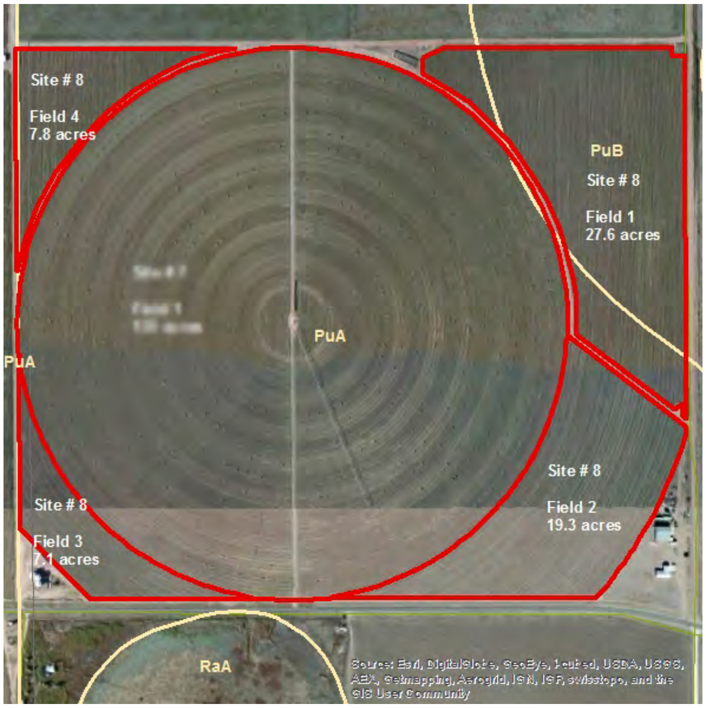


Net Returns per System Acre
No Data for 2015
Net returns ($)
800
600
400
200
0
-200
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Per system acre



Net Returns per Unit of Water and N
No Data for 2015
Net returns per acre-inch of irrigation ($)
250
200
150
100
50
0
-50
Net returns per pound of N ($)
10.0
8.0
6.0
4.0
2.0
0.0
-2.0
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Per acre-inch of irrigation water
Per pound of nitrogen

SITE 8 – TERMINATED 2014



Description:

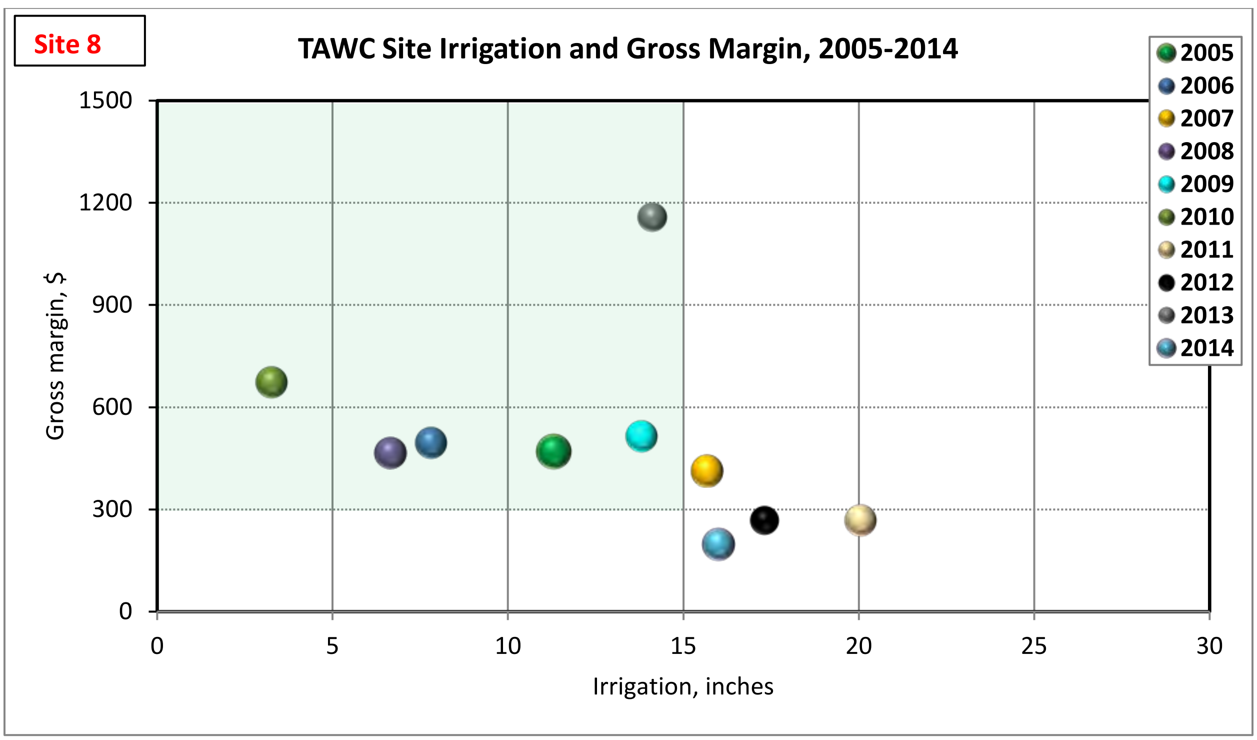
Site acres: 61.8

Soil types:
PuA-Pullman clay loam, 0 to 1%
PuB-Pullman clay loam, 1 to 3%

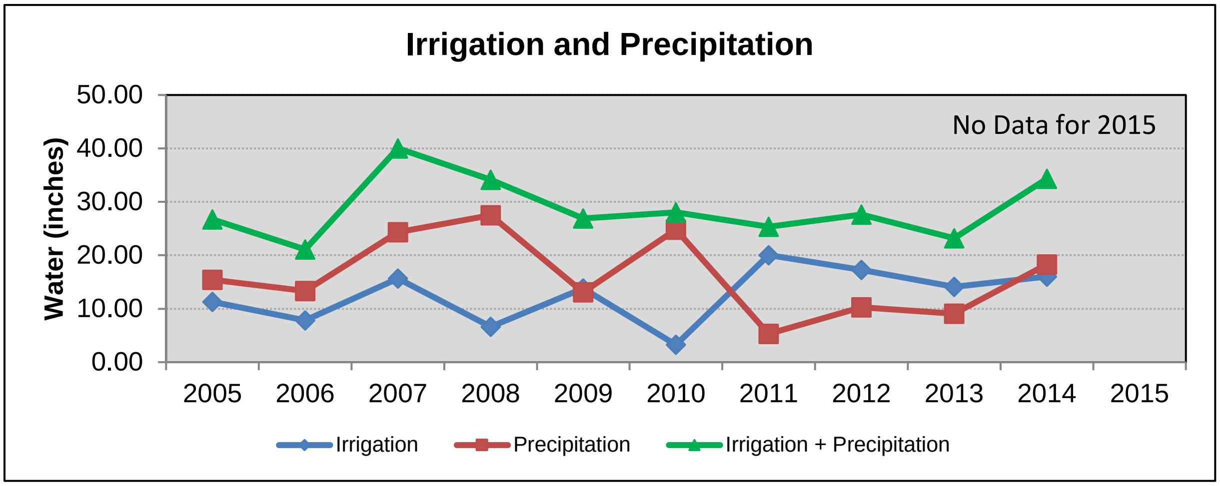
Irrigation:
Sub-surface drip (SDI) 360 gpm

Number of wells: 4

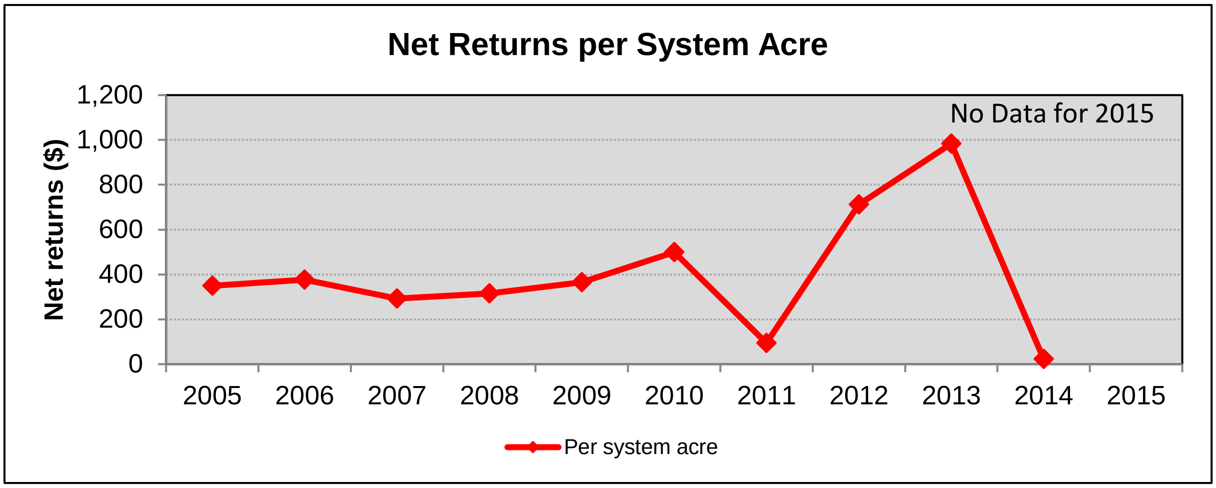
Fuel Source: Electric



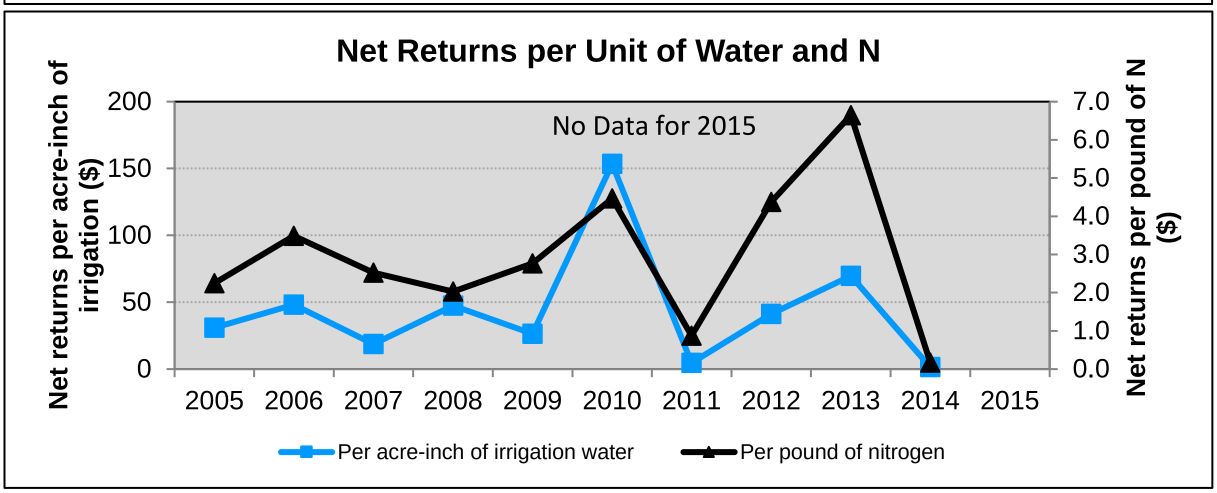
Site 8



Irrigation and Precipitation
No Data for 2015
Water (inches)
50.00
40.00
30.00
20.00
10.00
0.00
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Irrigation
Precipitation
Irrigation + Precipitation

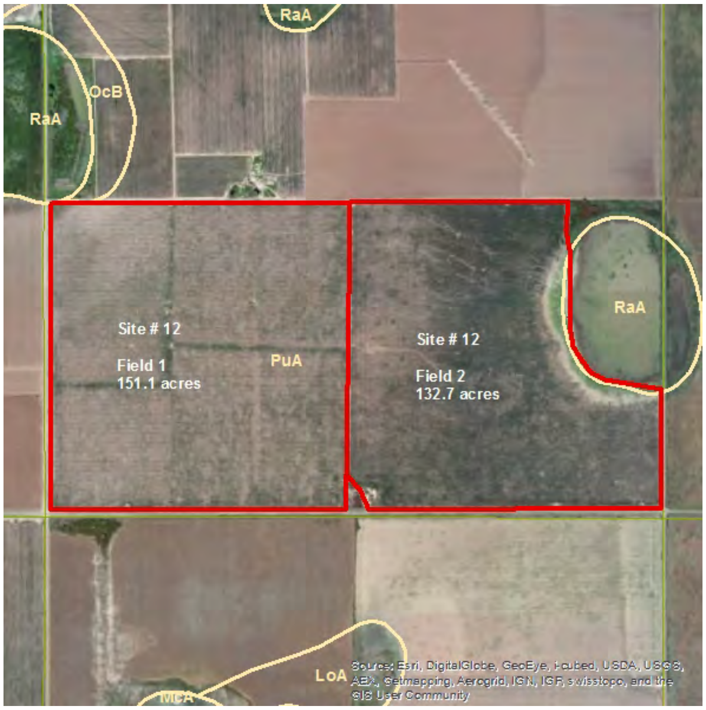


Net Returns per System Acre
No Data for 2015
Net returns ($)
1,200
1,000
800
600
400
200
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Per system acre



Net Returns per Unit of Water and N
No Data for 2015
Net returns per acre-inch of irrigation ($)
200
150
100
50
0
Net returns per pound of N ($)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Per acre-inch of irrigation water
Per pound of nitrogen

SITE 12 – TERMINATED 2013



Description:

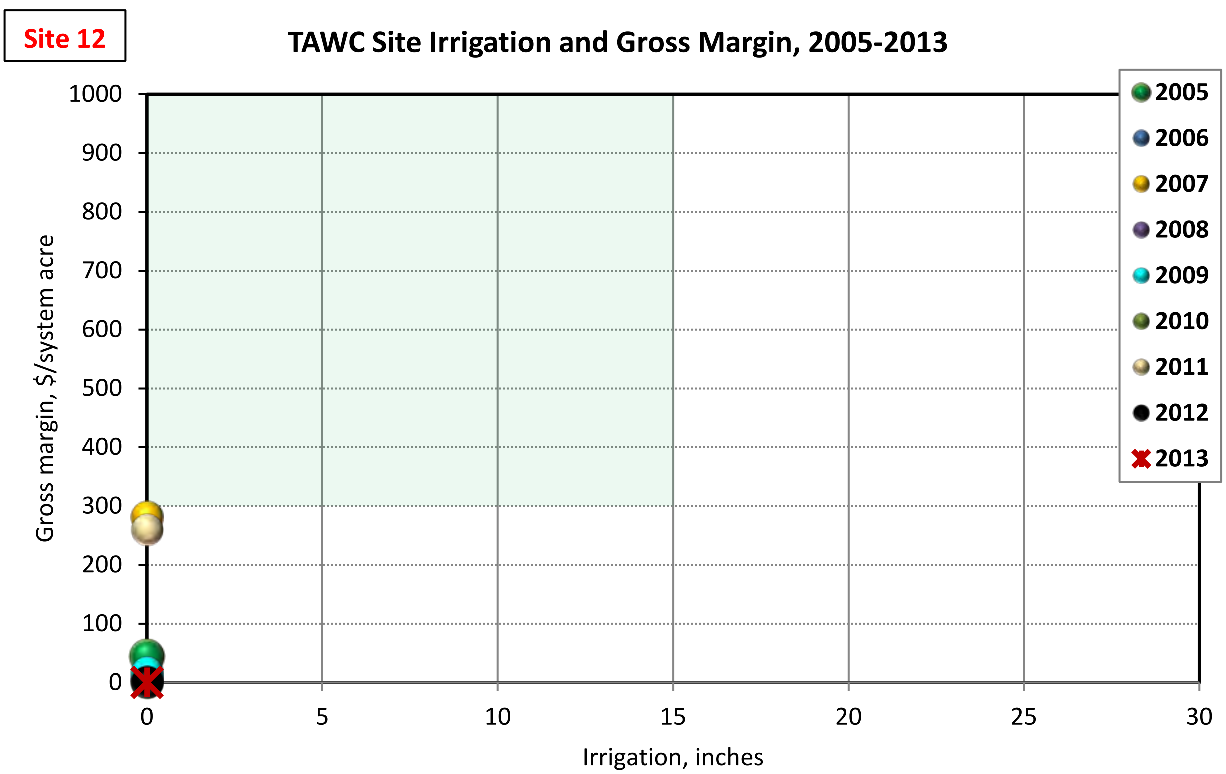
Site acres: 283.8

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

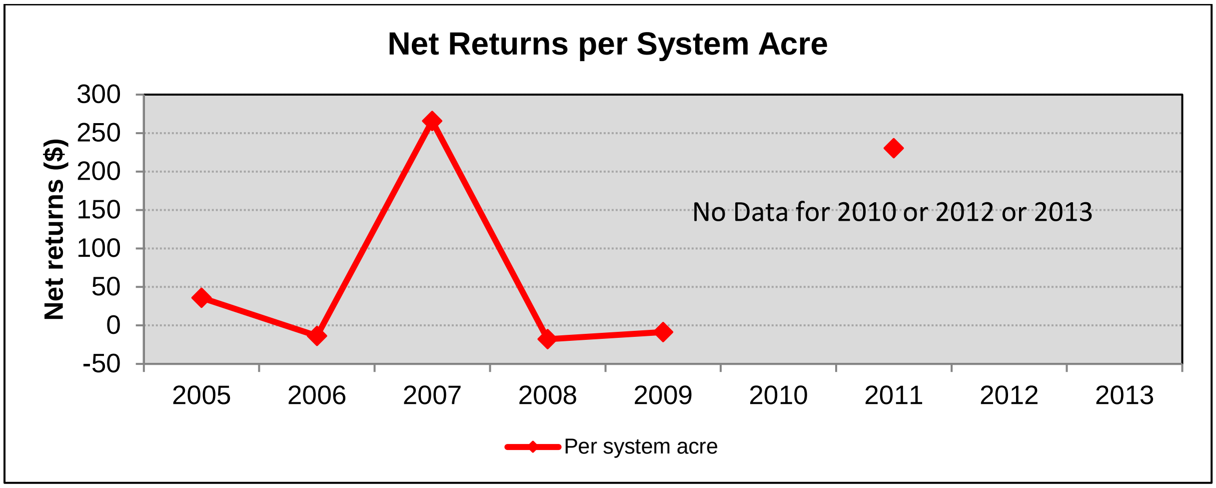
Irrigation:
Dryland (DL) na gpm

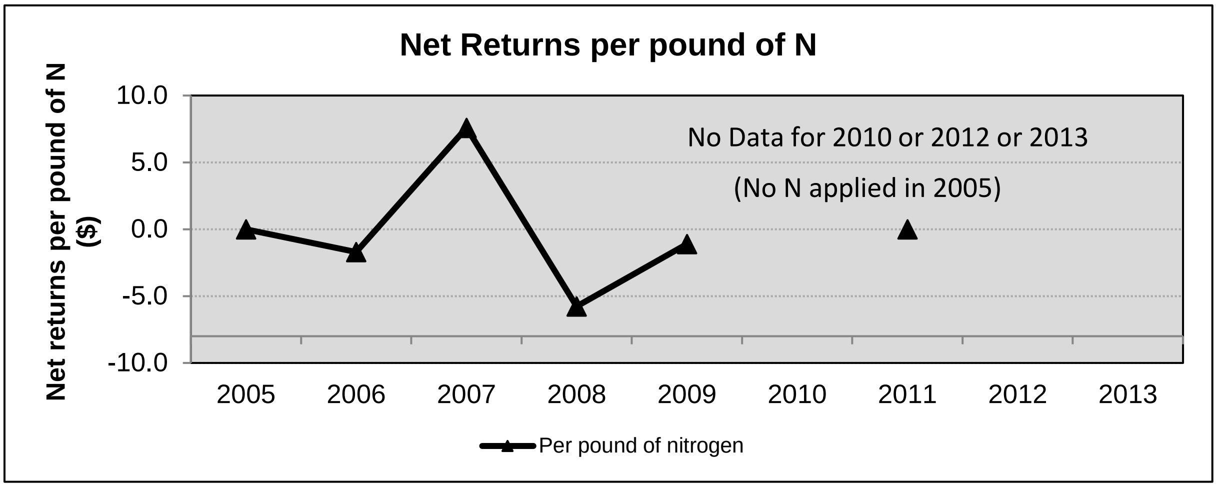
Number of wells: na

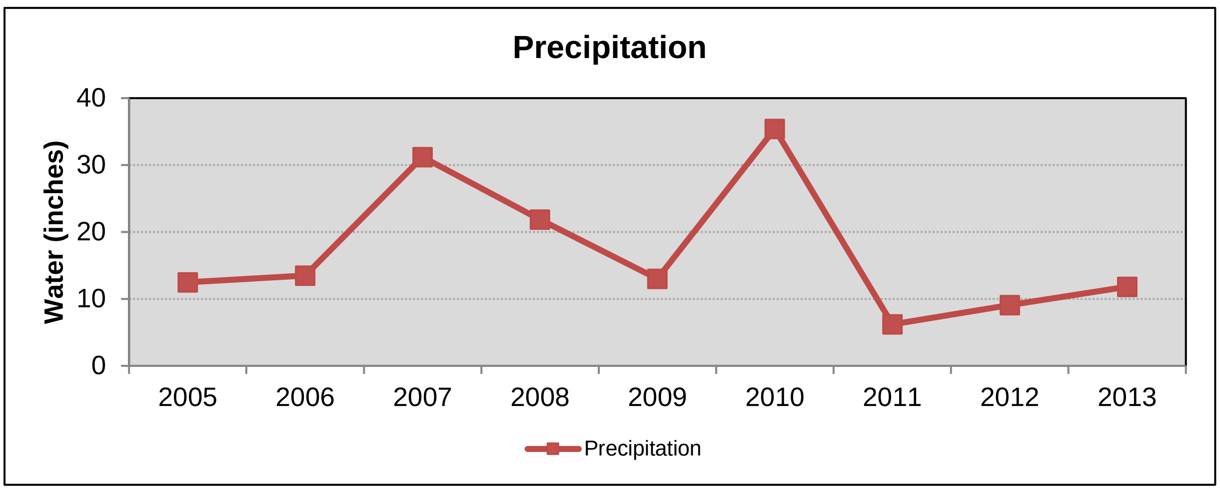
Fuel Source: na



Site 12 – Dryland Site







Site 13 – Terminated 2007

Description:

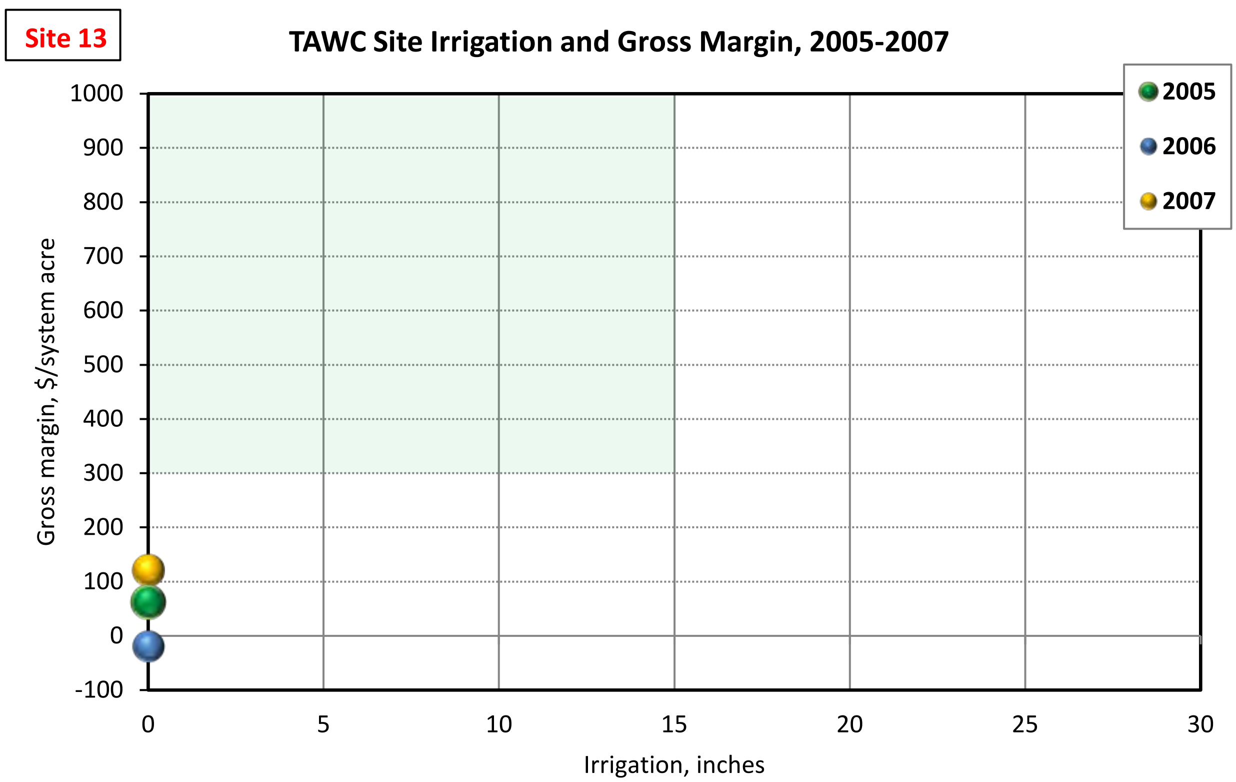
Site acres: 319.5

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

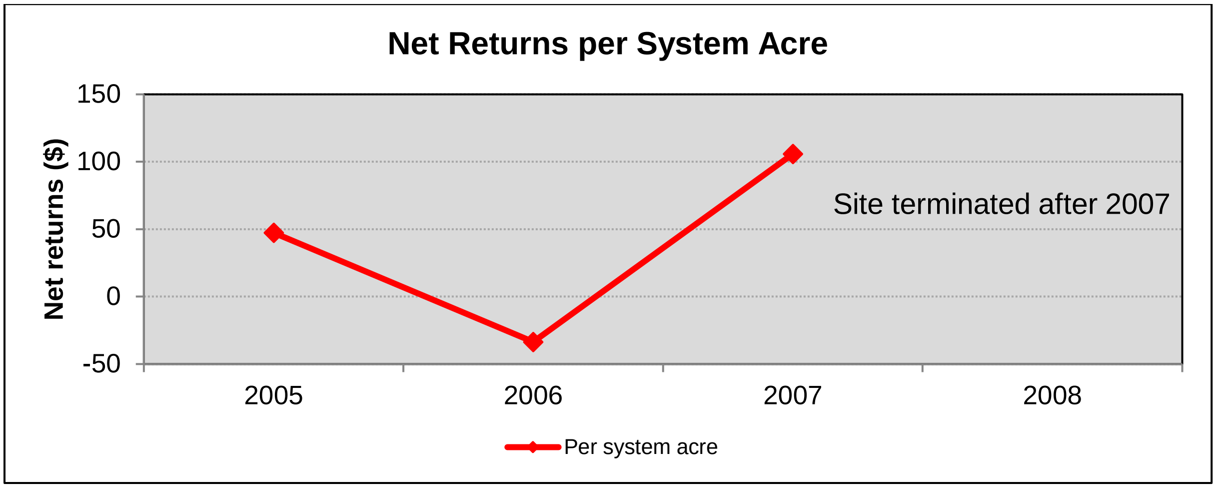
Irrigation:
Dryland (DL) na gpm

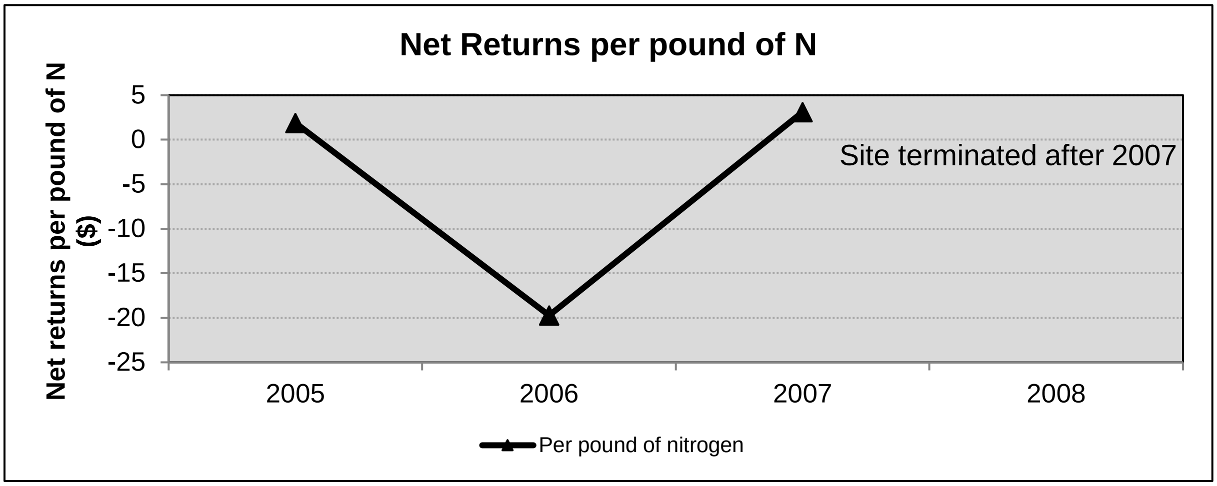
Number of wells: na

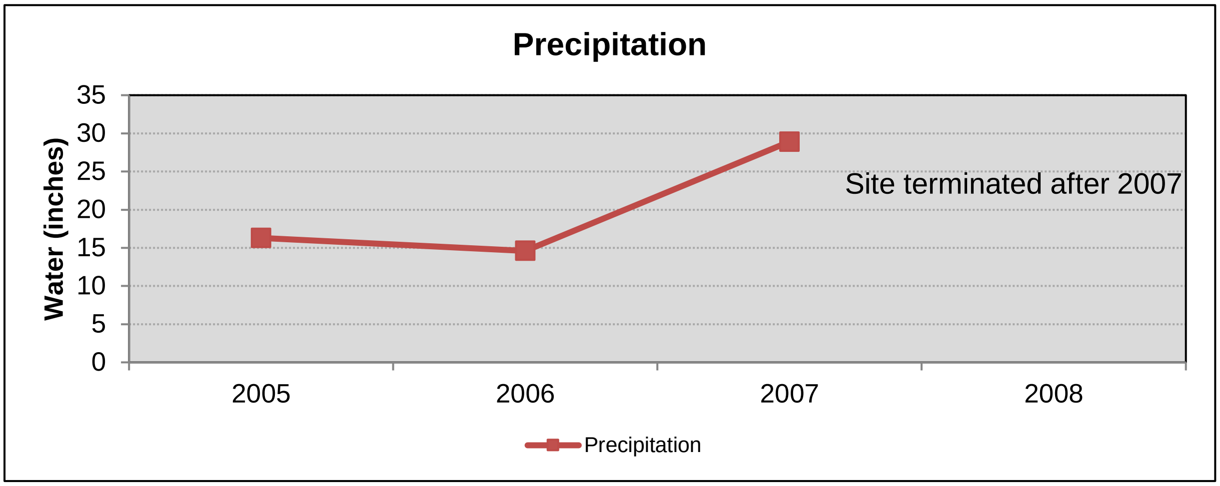
Fuel Source: na



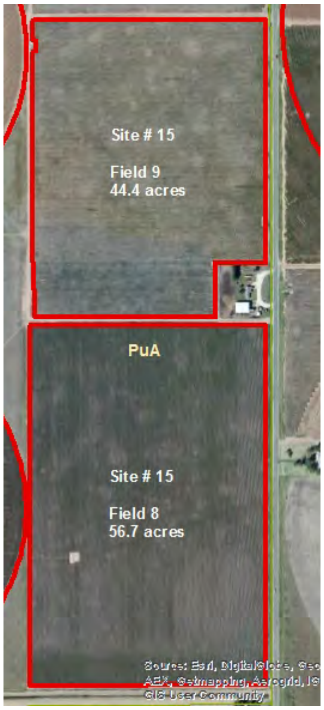
Site 13 – Dryland Site







Site 15 – Terminated 2015



Description:

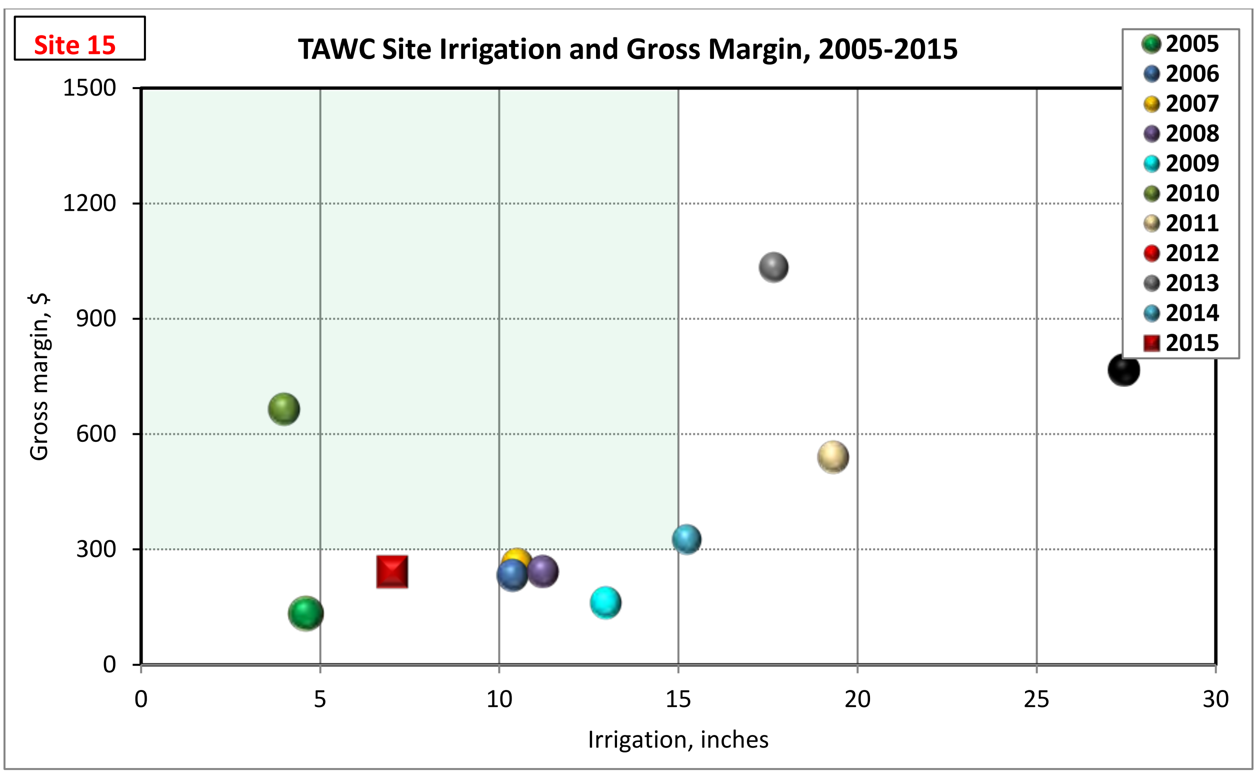
Site acres: 101.1

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

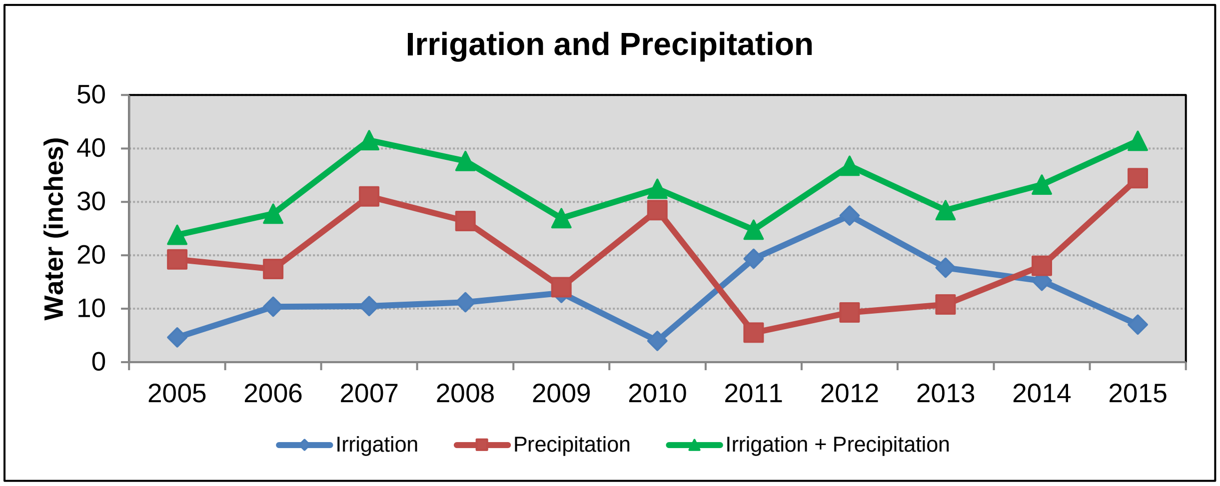
Irrigation:
Sub-Surface Drip (SDI) 290 gpm

Number of wells: 1

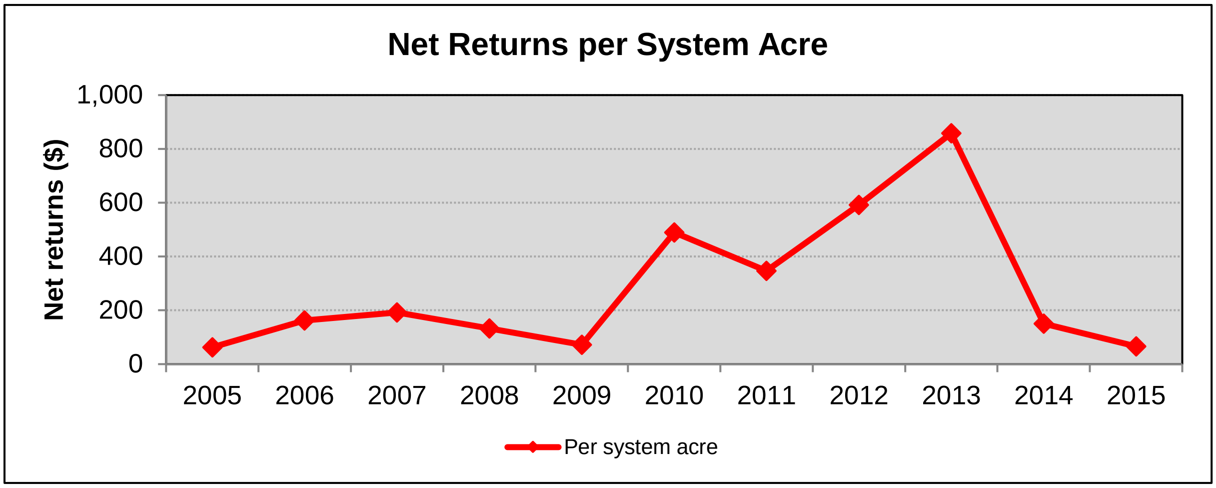
Fuel Source: Electric



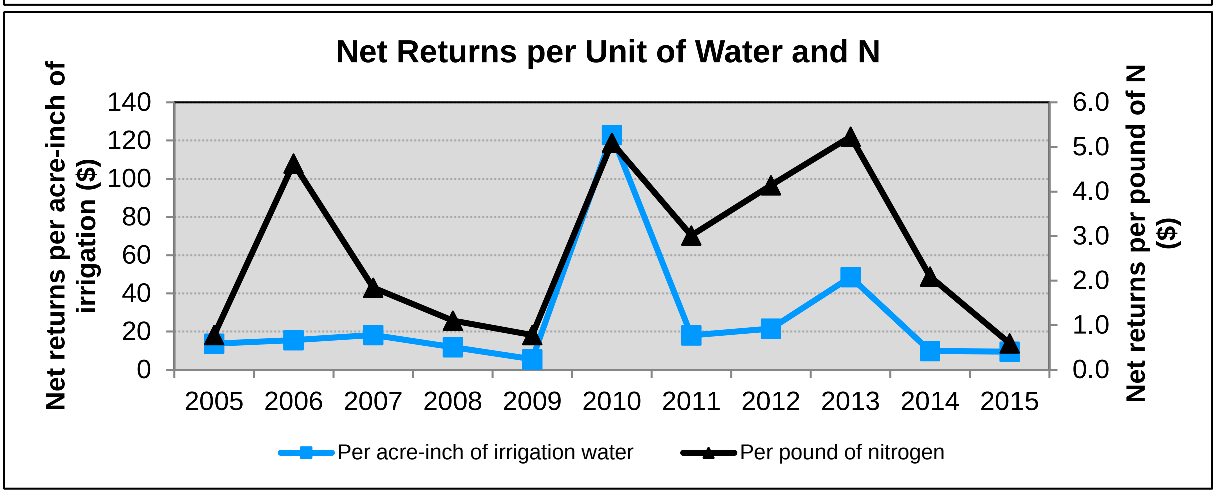
Site 15



Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Irrigation
Precipitation
Irrigation + Precipitation

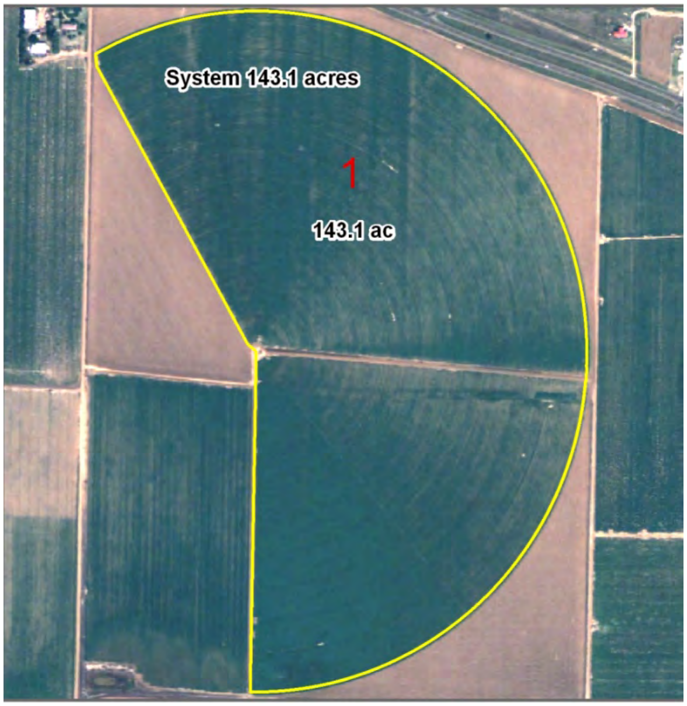


Net Returns per System Acre
Net returns ($)
1,000
800
600
400
200
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
140
120
100
80
60
40
20
0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Per acre-inch of irrigation water
Per pound of nitrogen

SITE 16 – TERMINATED 2006



Description:

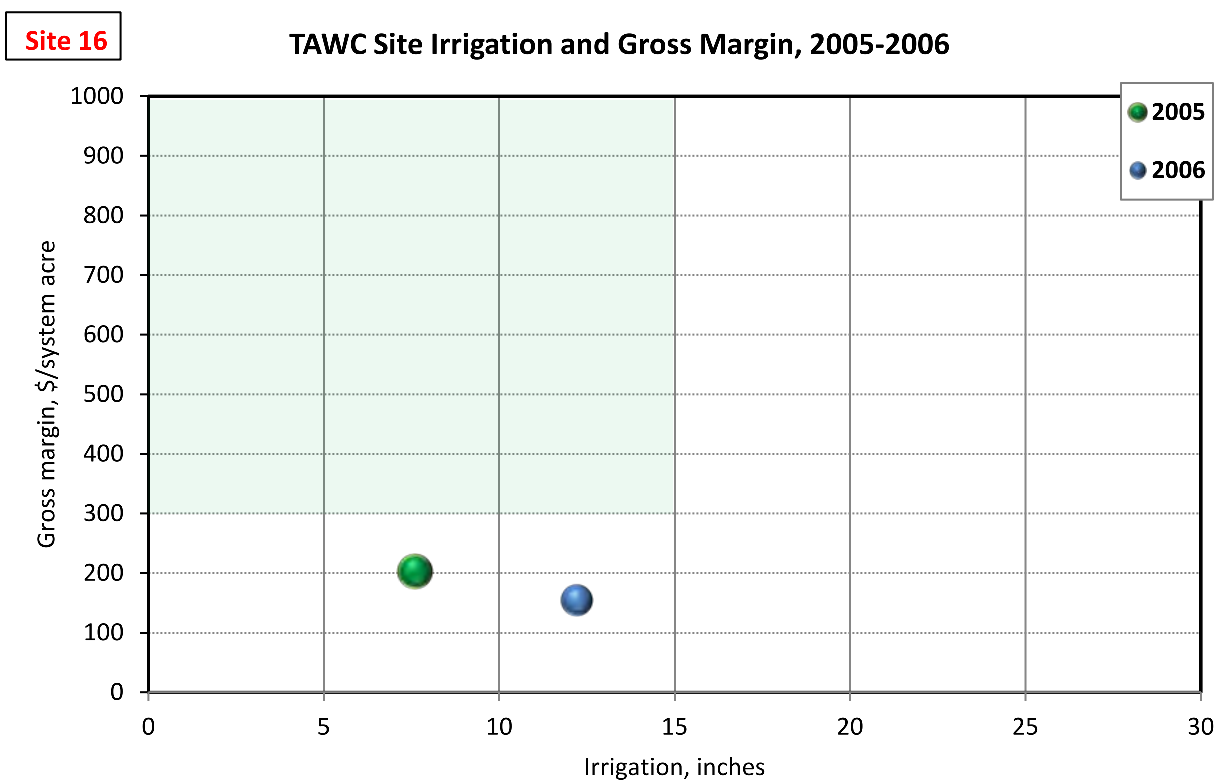
Site acres: 143.1

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

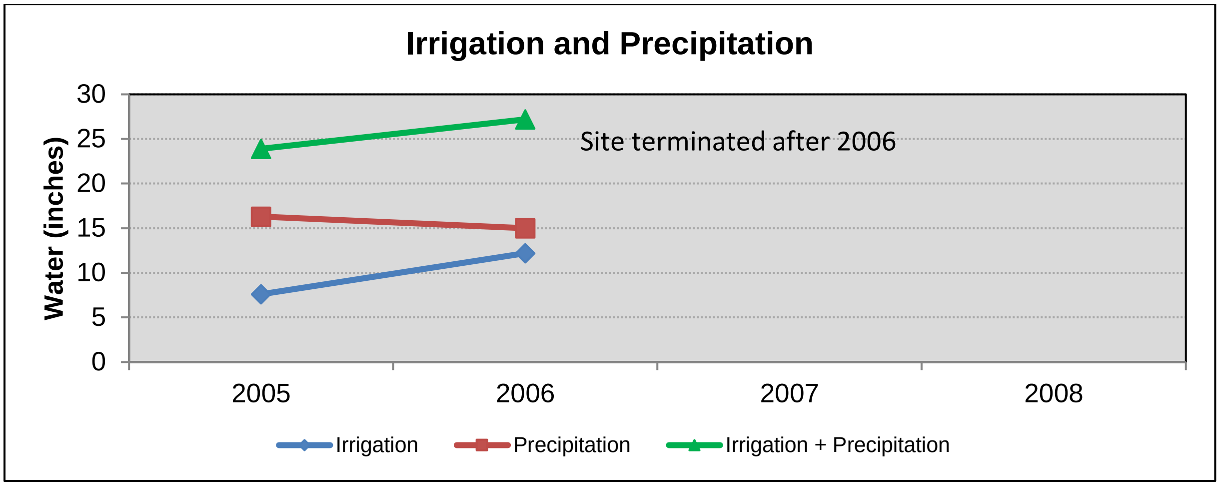
Irrigation:
Center Pivot (LESA) 600 gpm

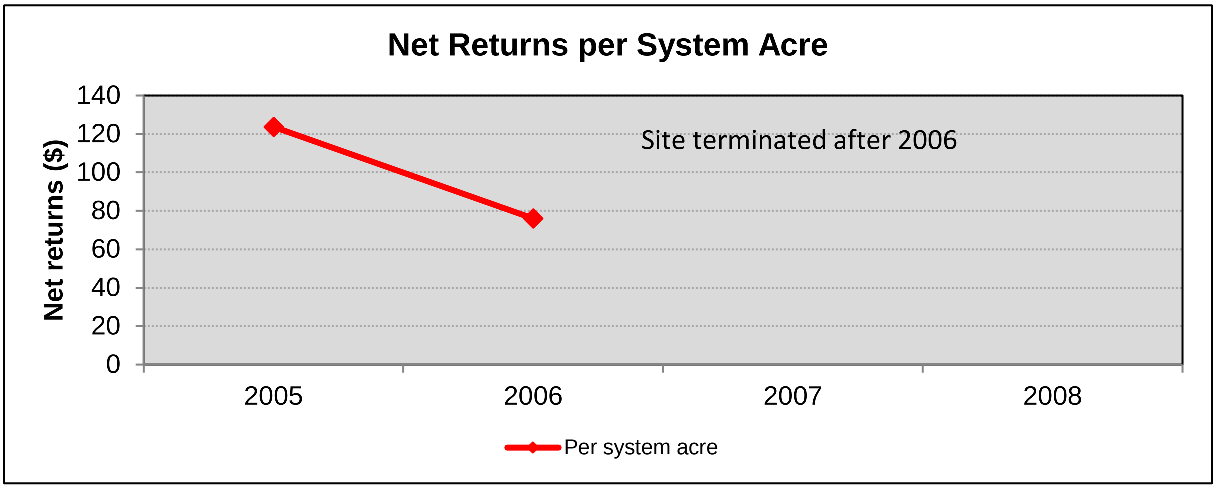
Number of wells: 3

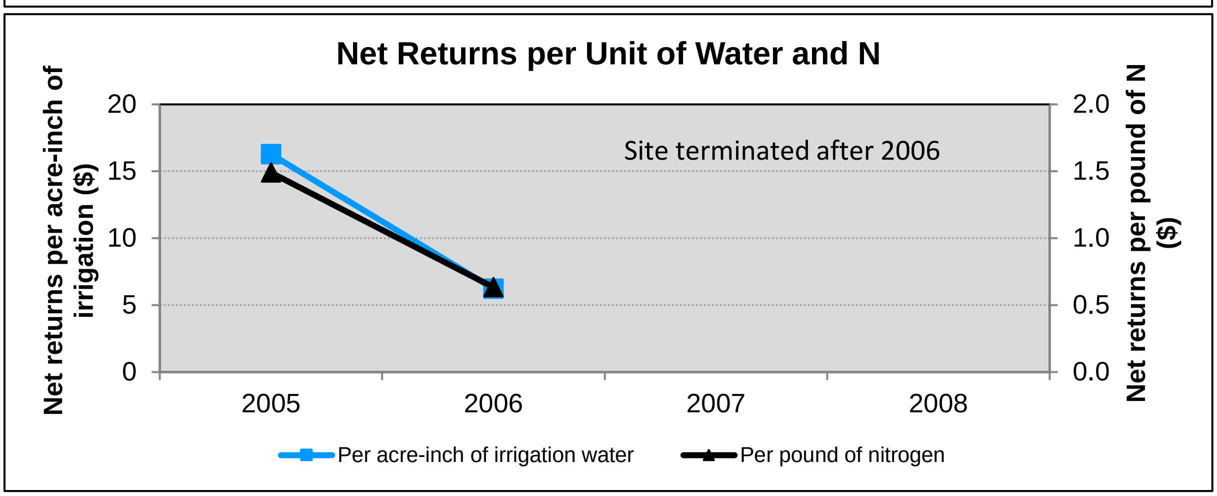
Fuel Source: Electric



Site 16


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


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


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

Site 18 – Terminated 2013

Description:

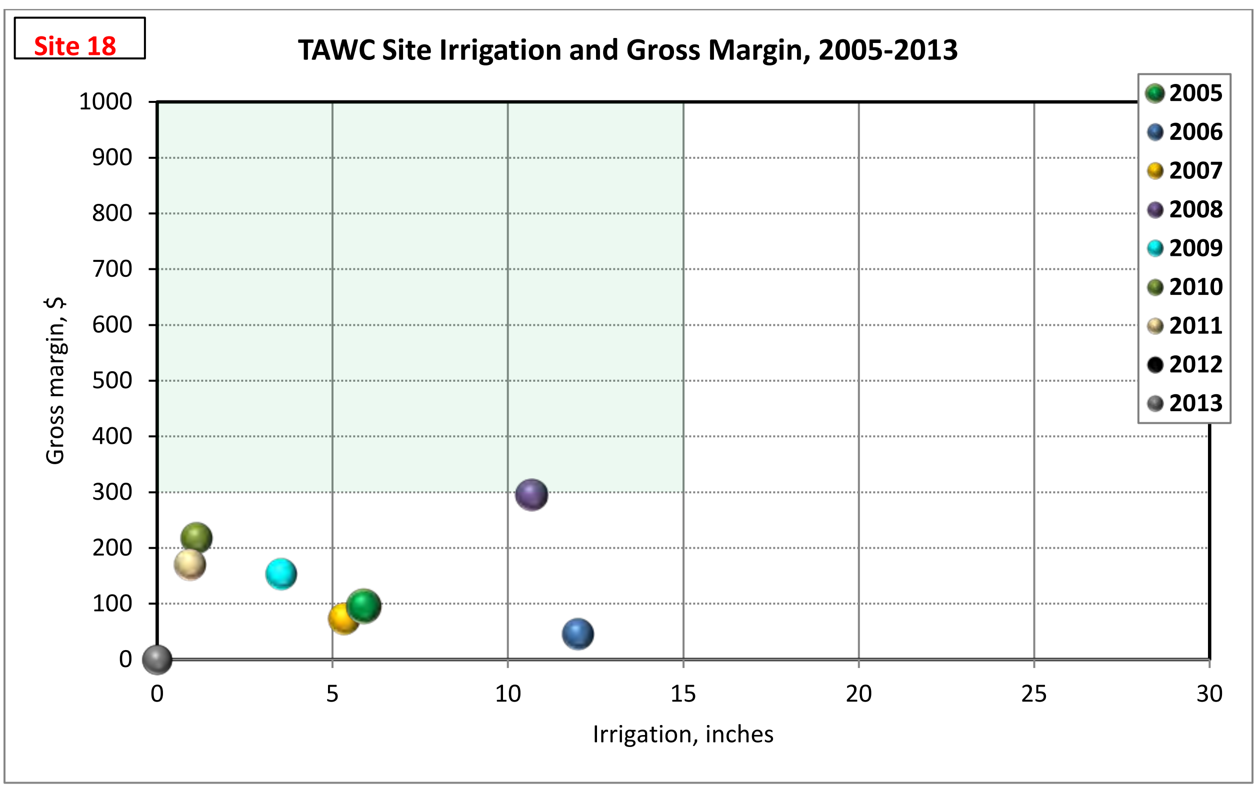
Site acres: 122.2

Soil types:
PuA-Pullman clay loam, 0 to 1%
EcB-Estacado clay loam; 1 to 3%

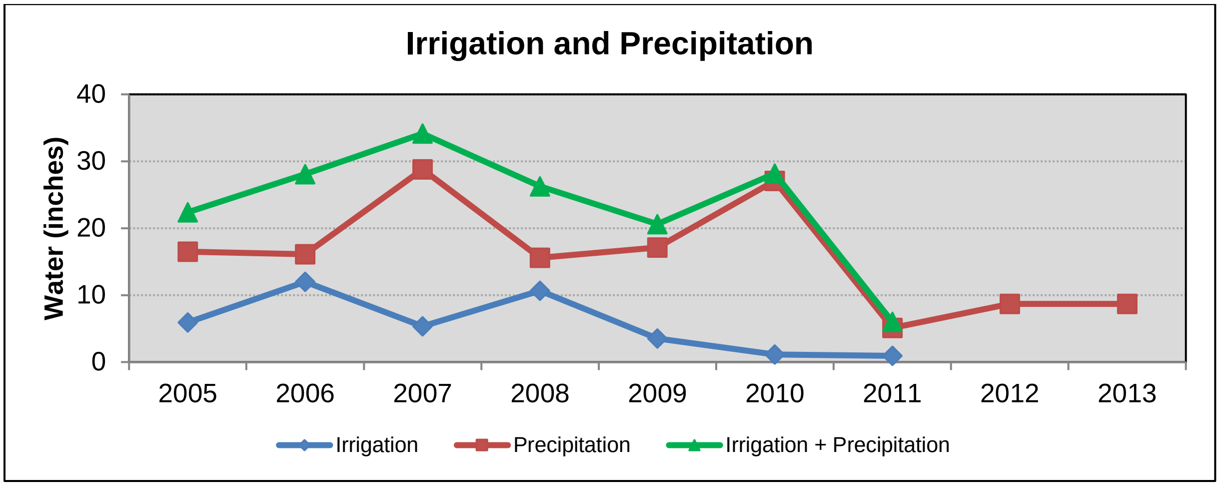
Irrigation:
Center Pivot (LEPA) 250 gpm

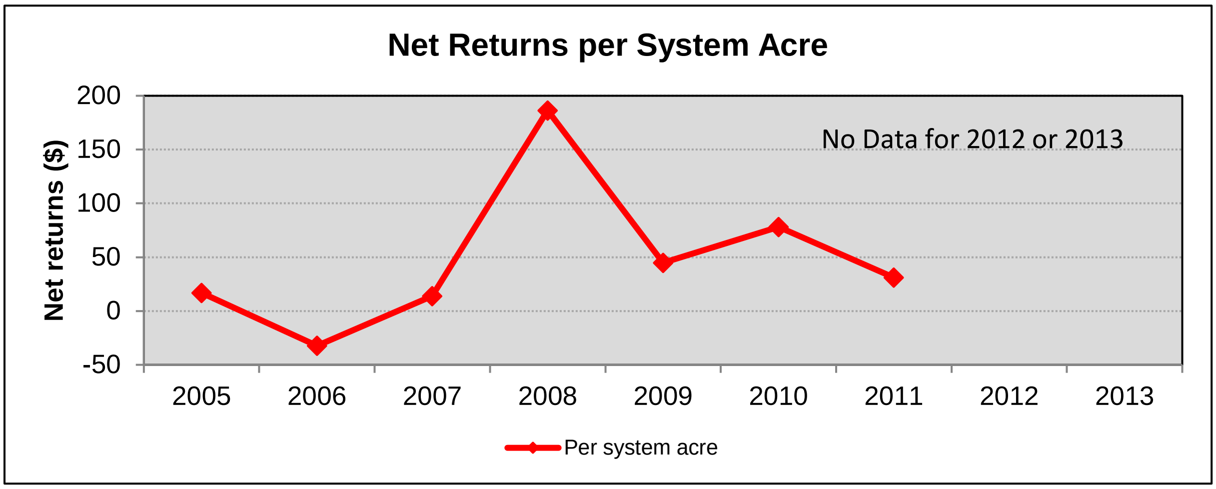
Number of wells: 3

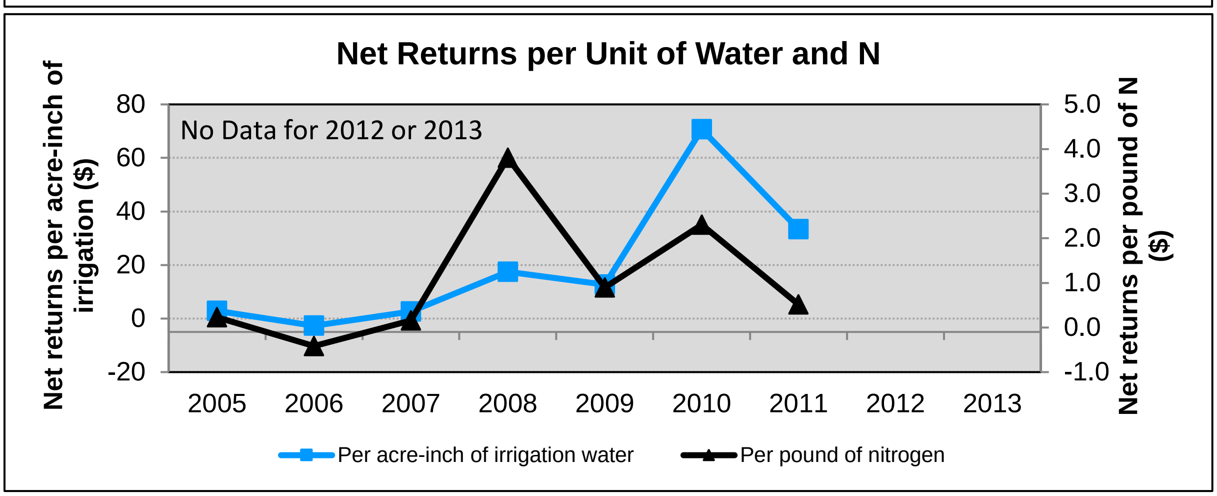
Fuel Source: Electric



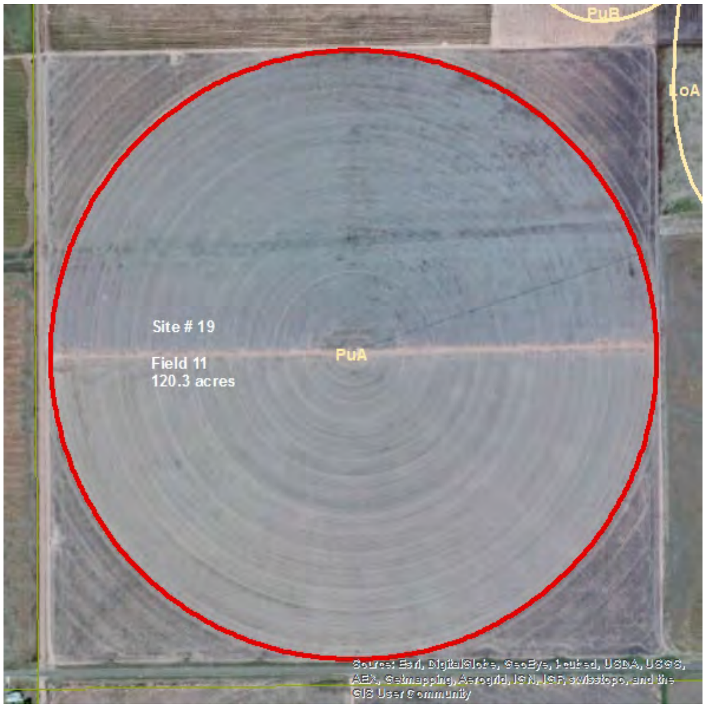
Site 18 – Terminated 2013







SITE 19 - TERMINATED 2015



Description:

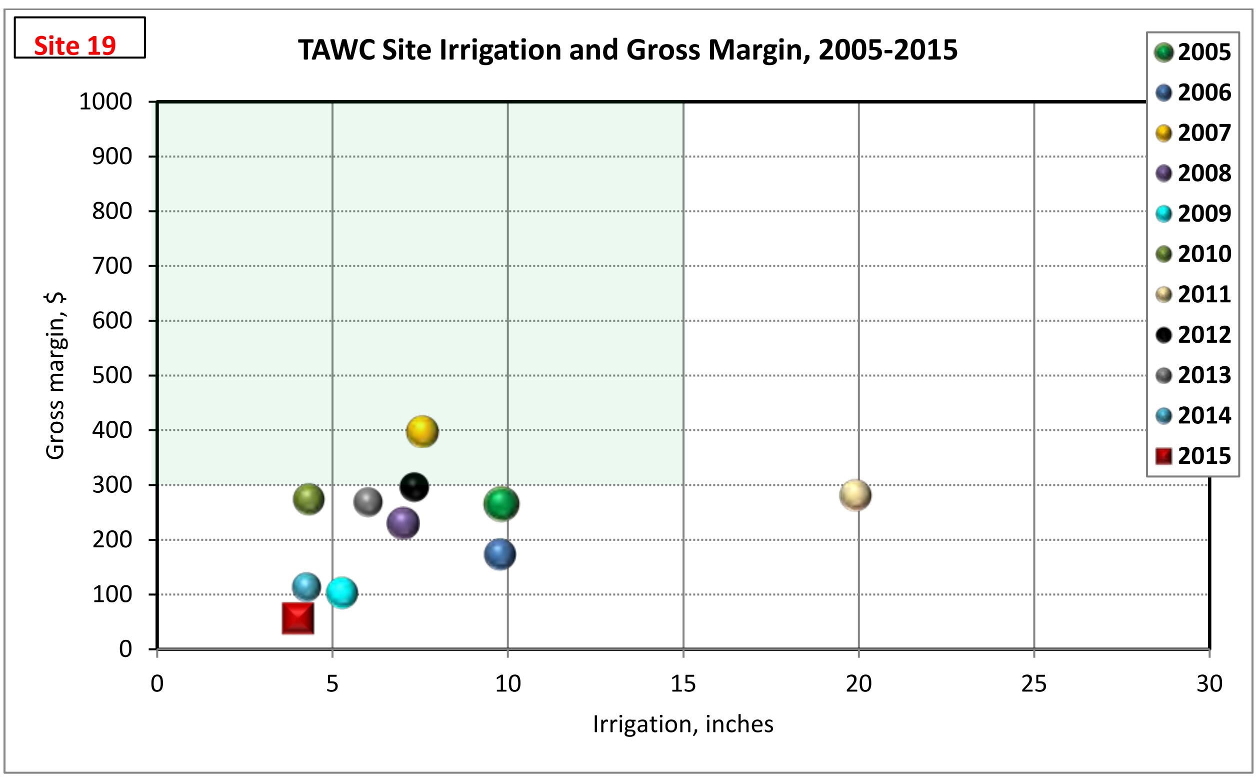
Site acres: 120.4

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

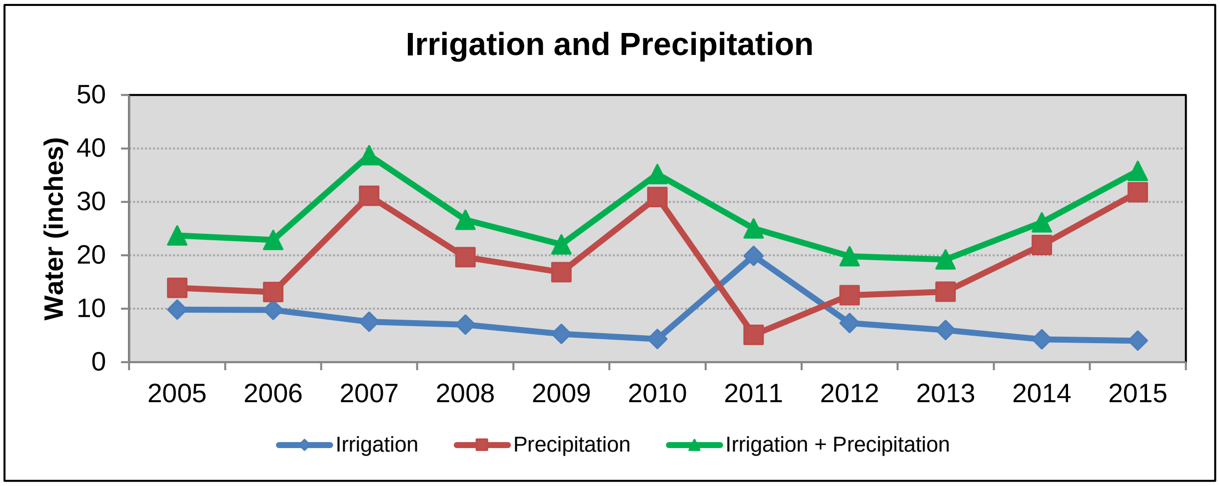
Irrigation:
Center Pivot (LEPA) 400 gpm

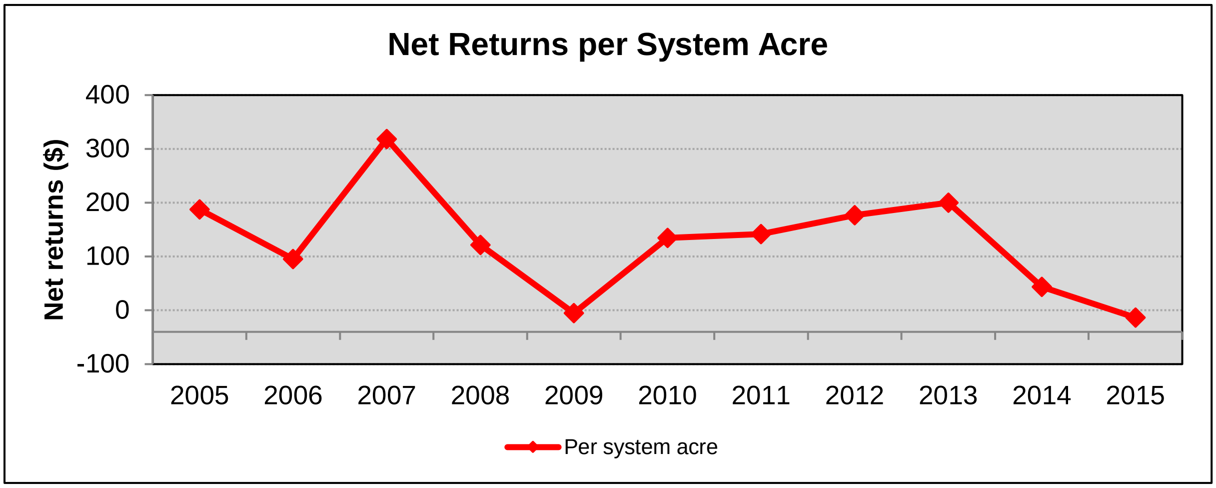
Number of wells: 3

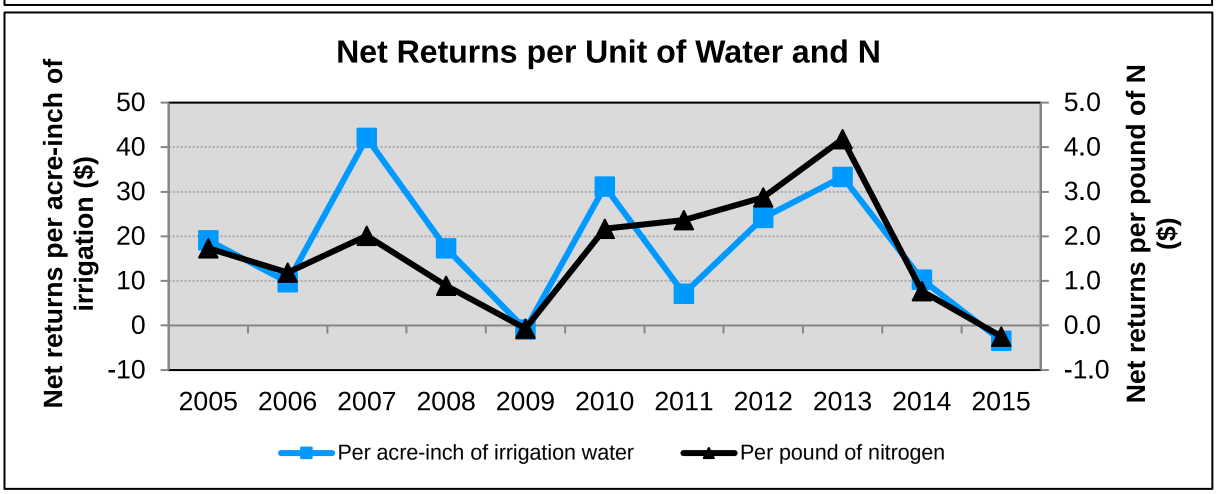
Fuel Source: Electric



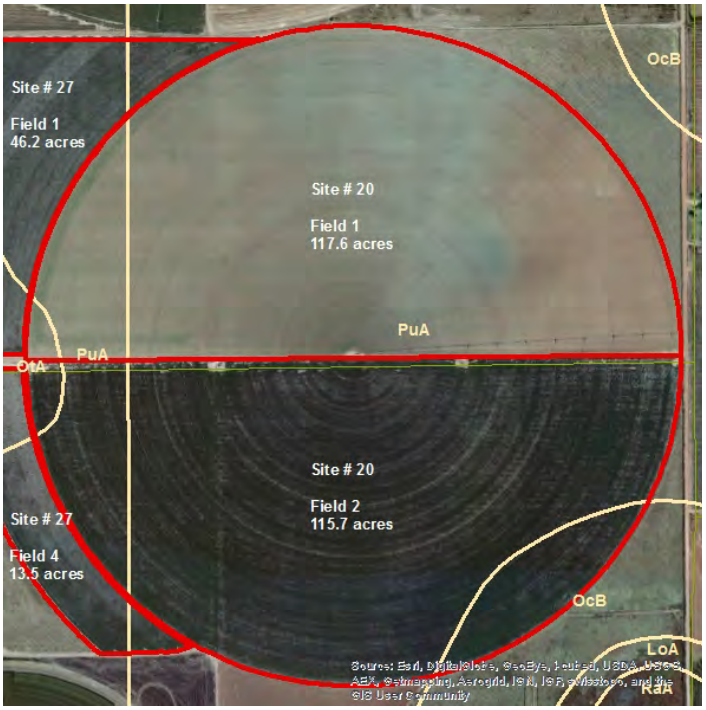
Site 19


Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
400
300
200
100
0
-100
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
50
40
30
20
10
0
-10
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Per acre-inch of irrigation water
Per pound of nitrogen

SITE 20 - TERMINATED 2014



Description:

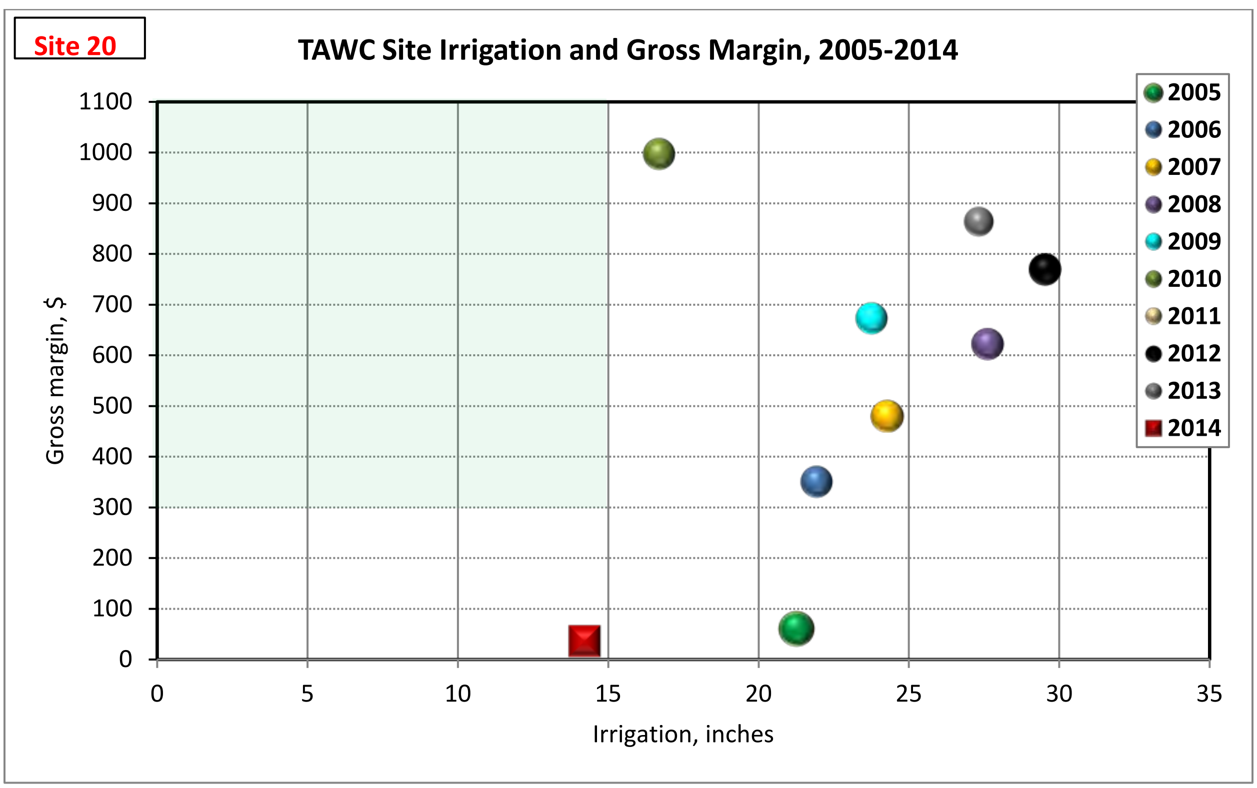
Site acres: 233.3

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

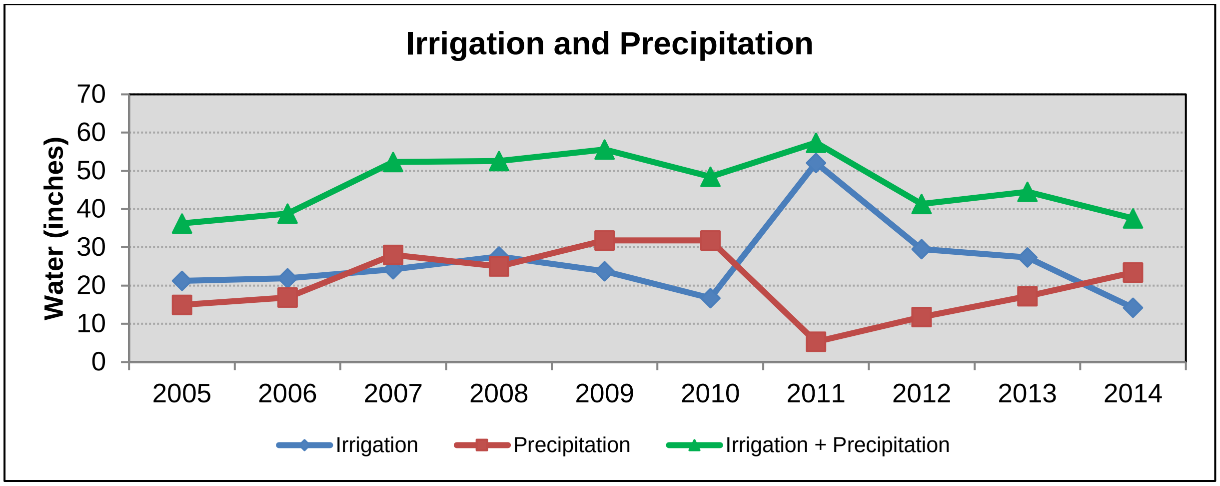
Irrigation:
- Center Pivot (LEPA) 1000 gpm

Number of wells: 3

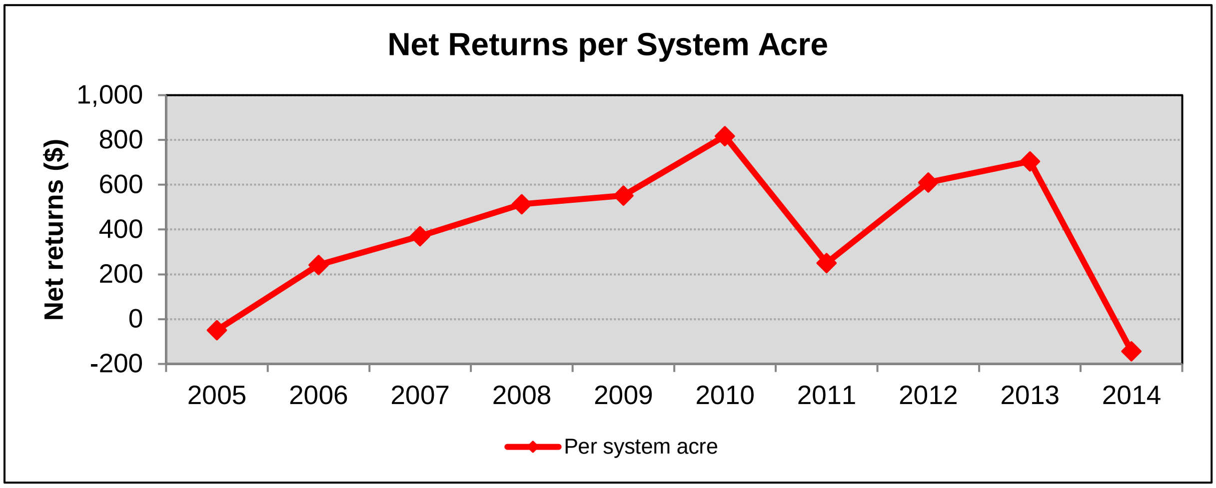
Fuel Source: Electric



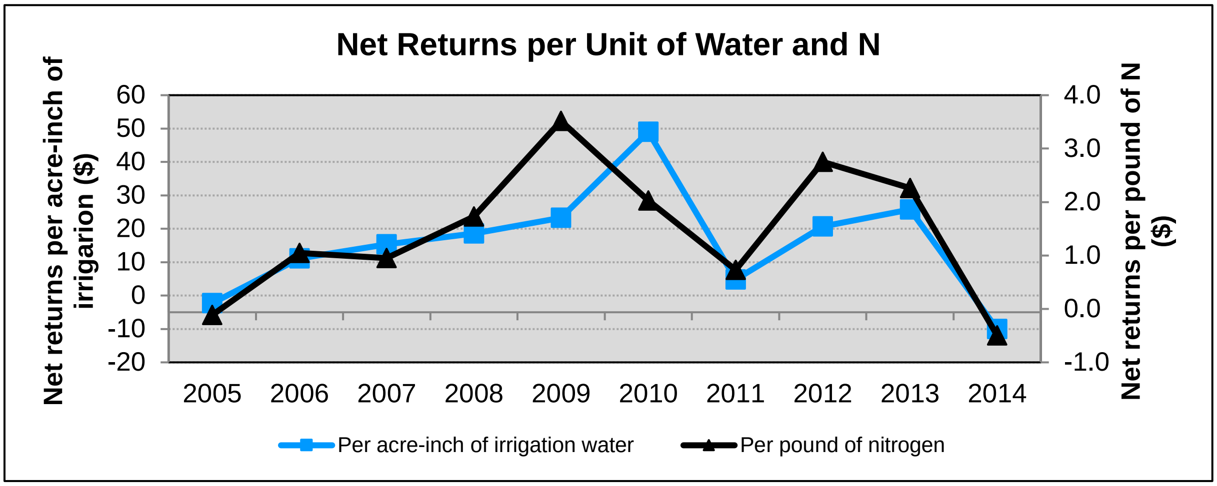
Site 20



Irrigation and Precipitation
Water (inches)
70
60
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Irrigation
Precipitation
Irrigation + Precipitation

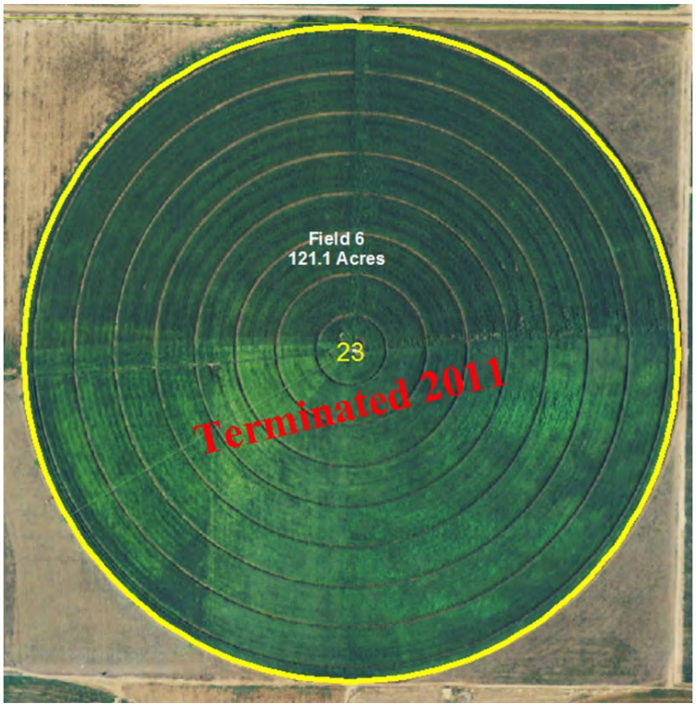


Net Returns per System Acre
Net returns ($)
1,000
800
600
400
200
0
-200
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigarion ($)
60
50
40
30
20
10
0
-10
-20
4.0
3.0
2.0
1.0
0.0
-1.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Per acre-inch of irrigation water
Per pound of nitrogen

SITE 23 – TERMINATED 2011



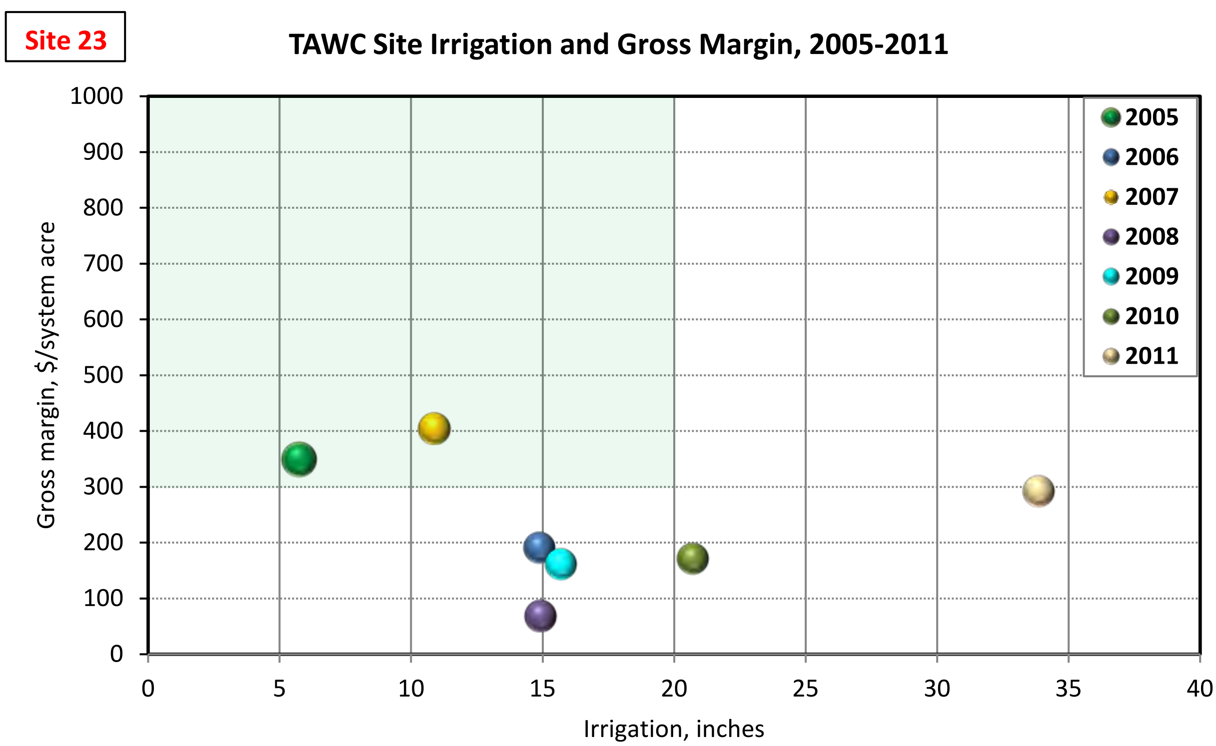
Description:

Site acres: 122.2

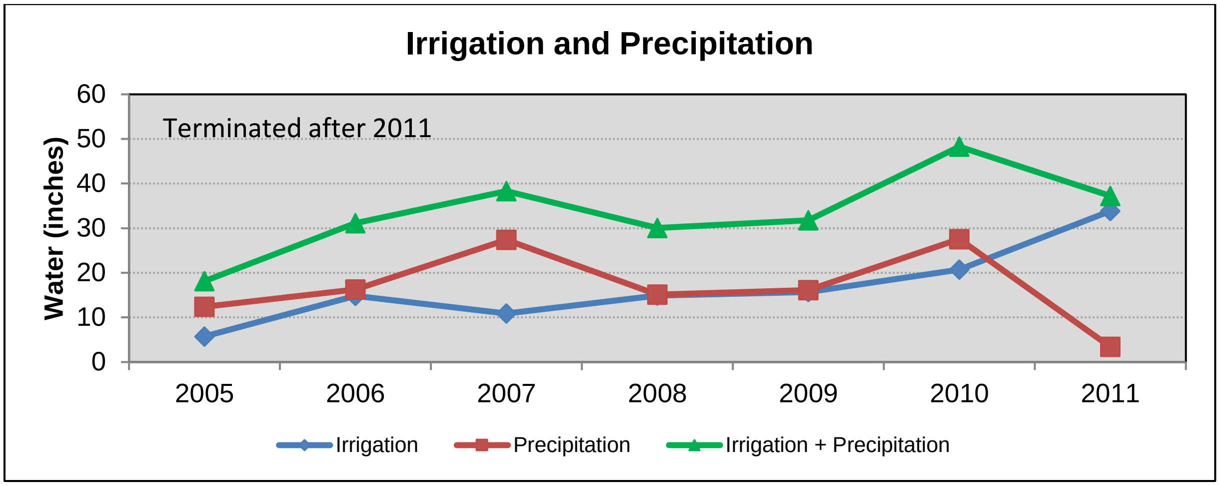
Soil types:
- PuA-Pullman clay loam, 0 to 1%
- EcB-Estacado clay loam; 1 to 3%

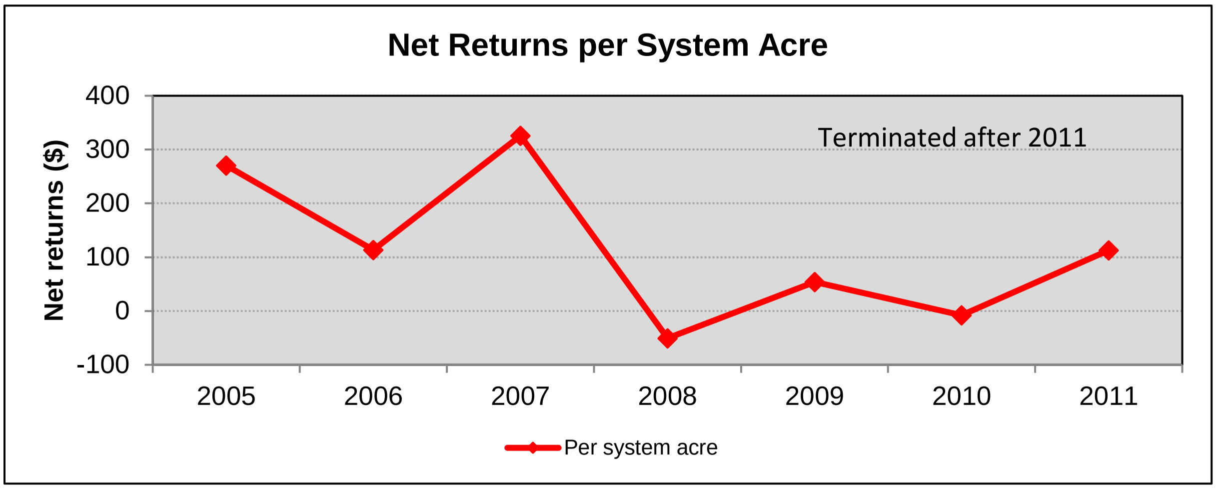
Irrigation:
- Center Pivot (LEPA) 250 gpm
- Number of wells: 3

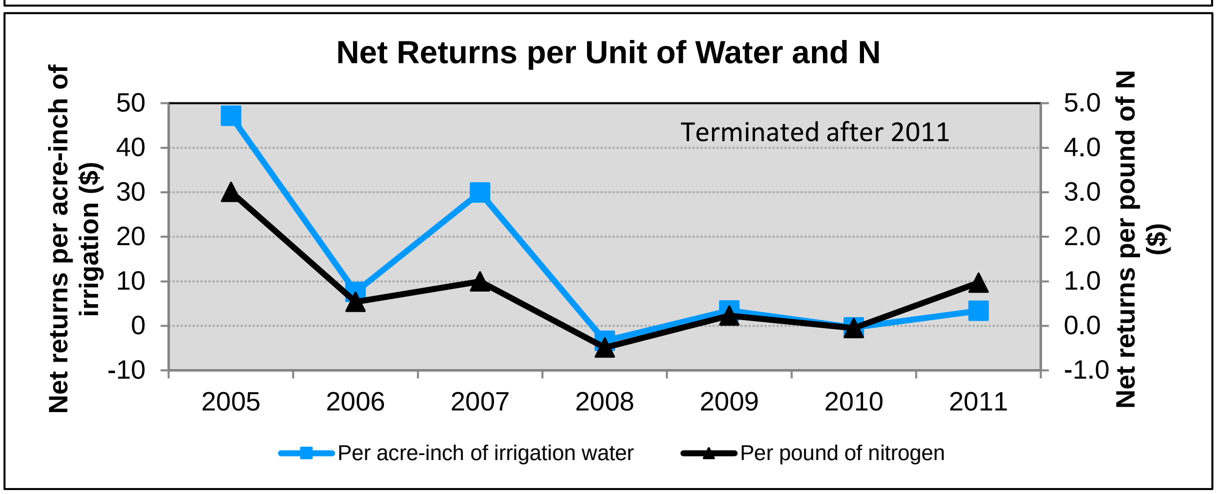
Fuel Source: Electric



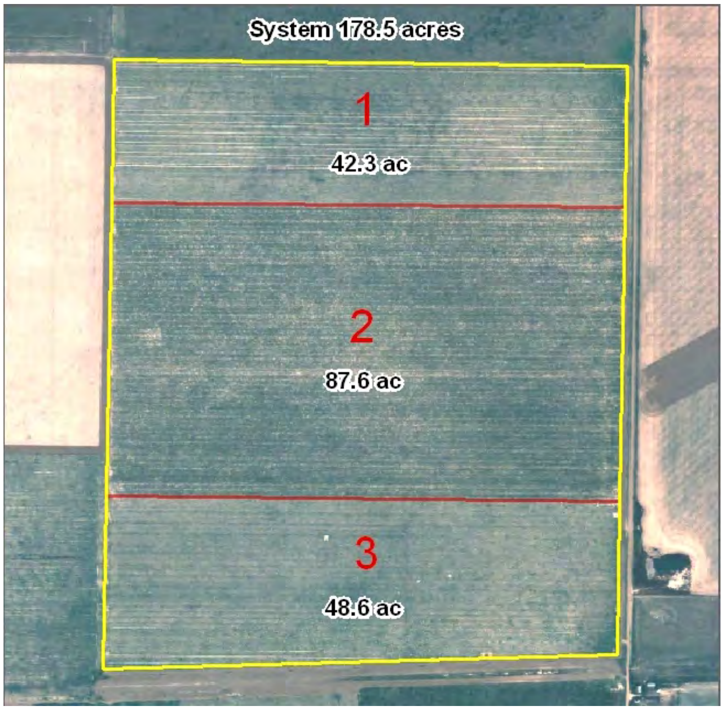
Site 23


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


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


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

SITE 25 – TERMINATED 2005



Description:

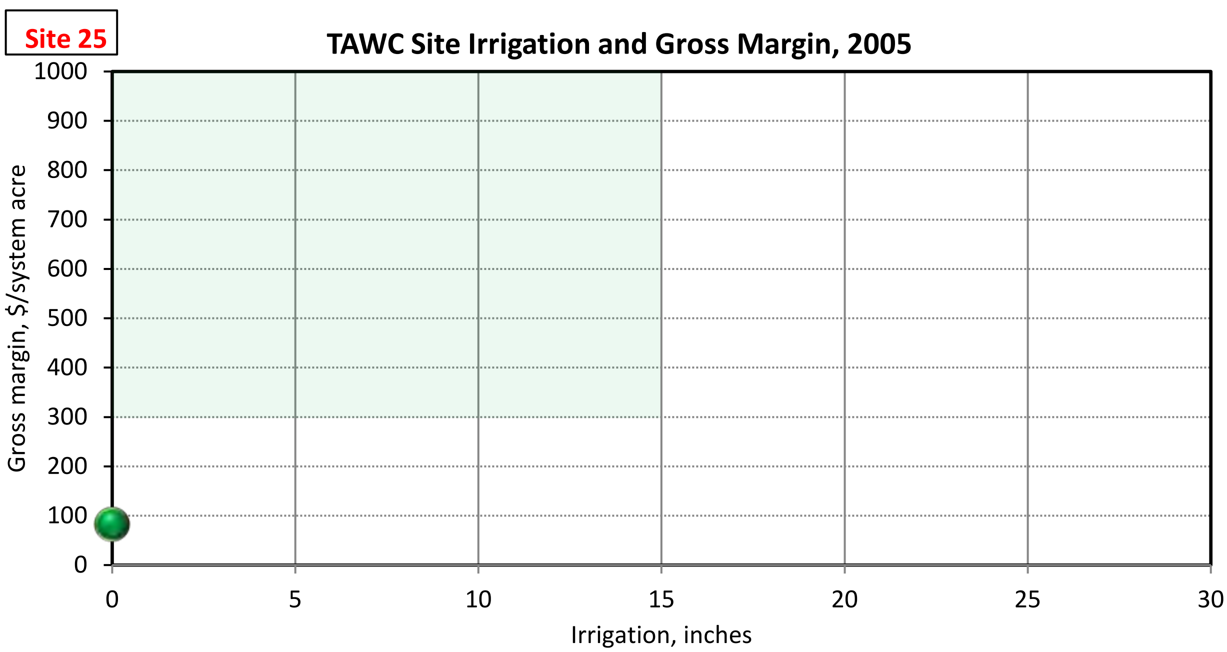
Site acres: 178.5

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

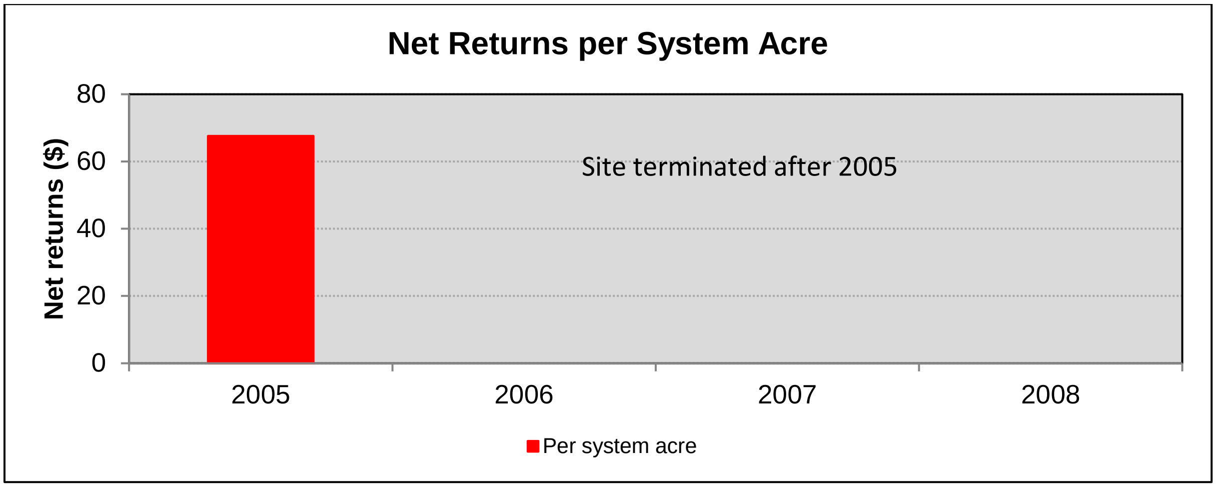
Irrigation:
Dryland (DL) na gpm

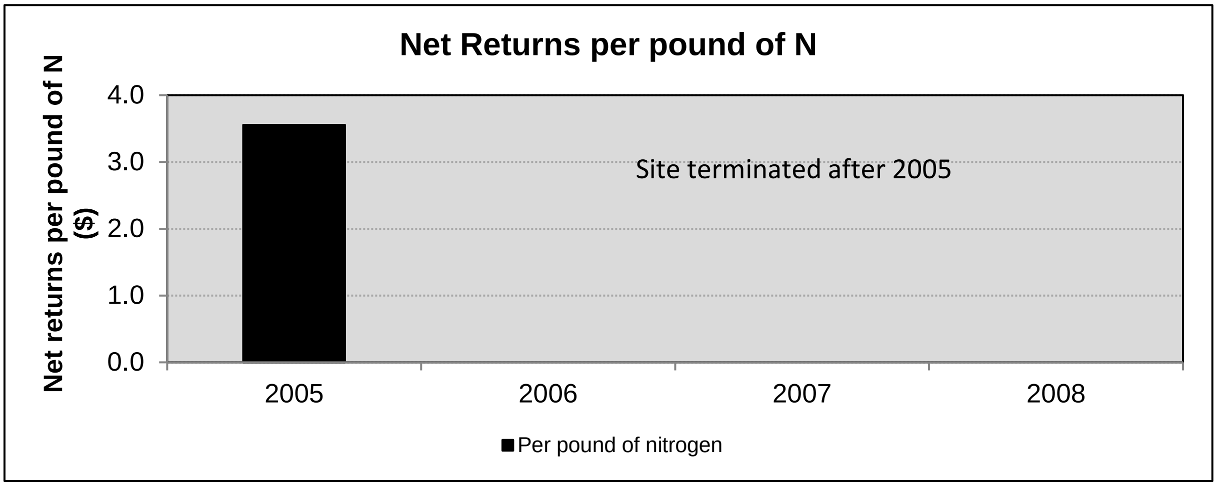
Number of wells: na

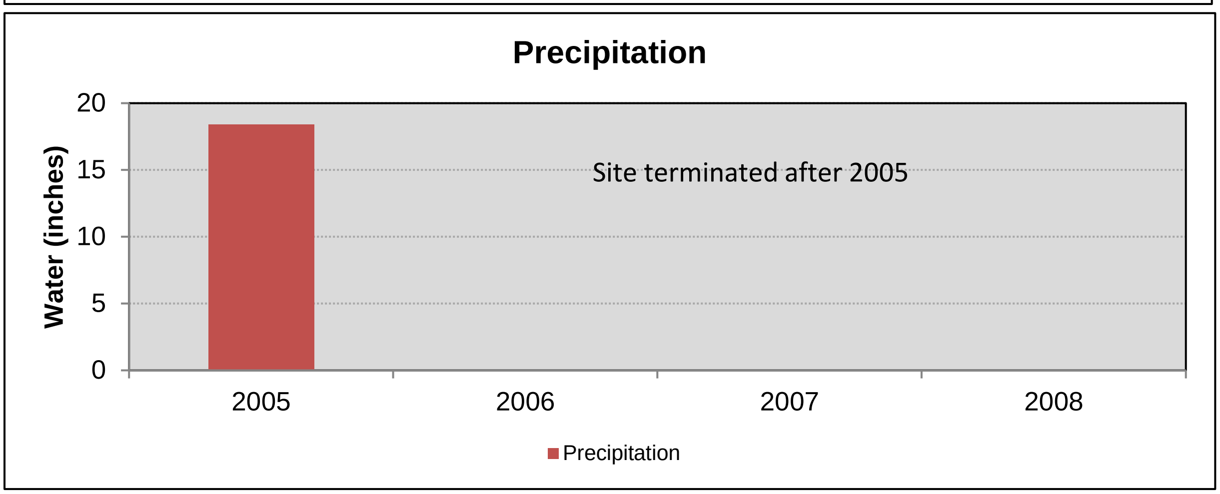
Fuel Source: na



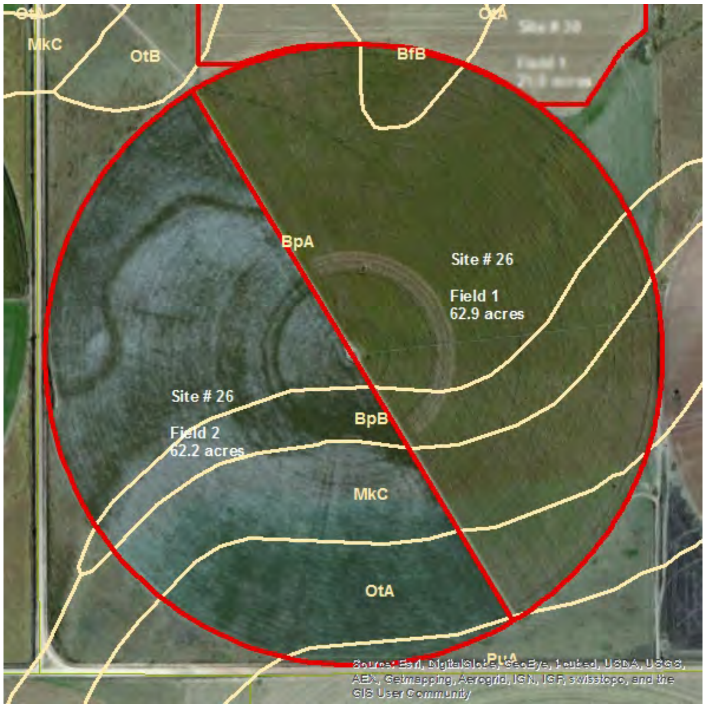
Site 25 - Dryland







SITE 26 - TERMINATED 2015



Description:

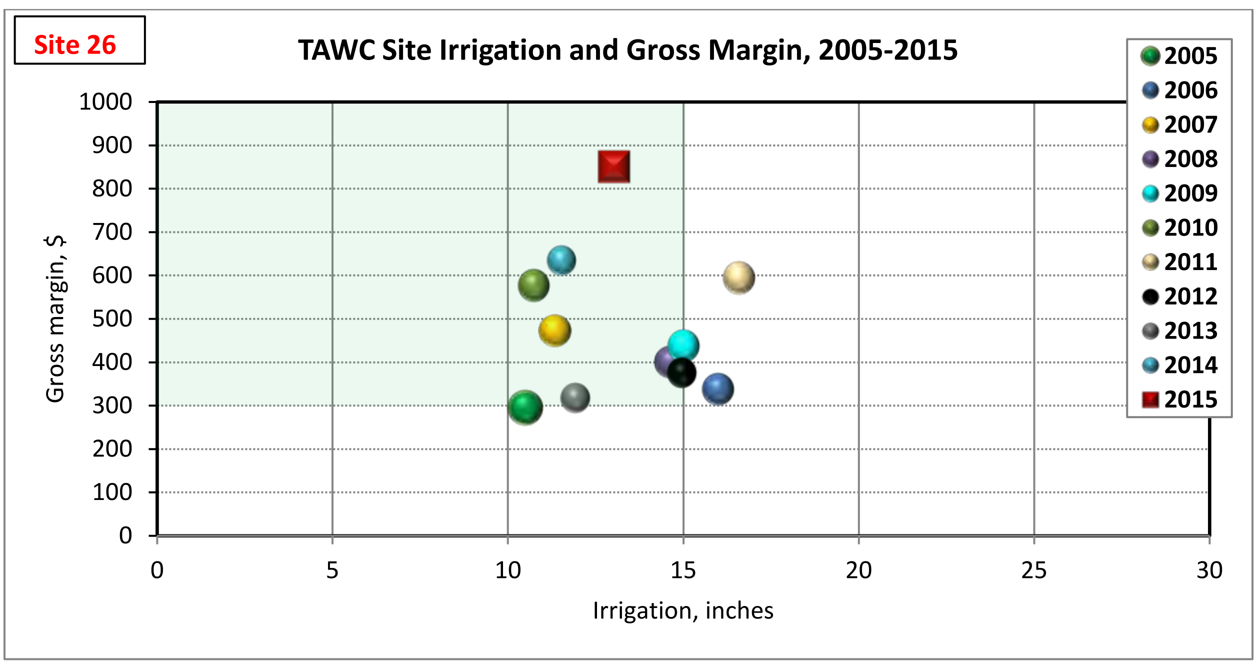
Site acres: 125.1

Soil types:
BpA-Bippus loam; 0 to 1%
MkC-Mansker loam; 3 to 5%
OtA-Olton loam; 0 to 1%

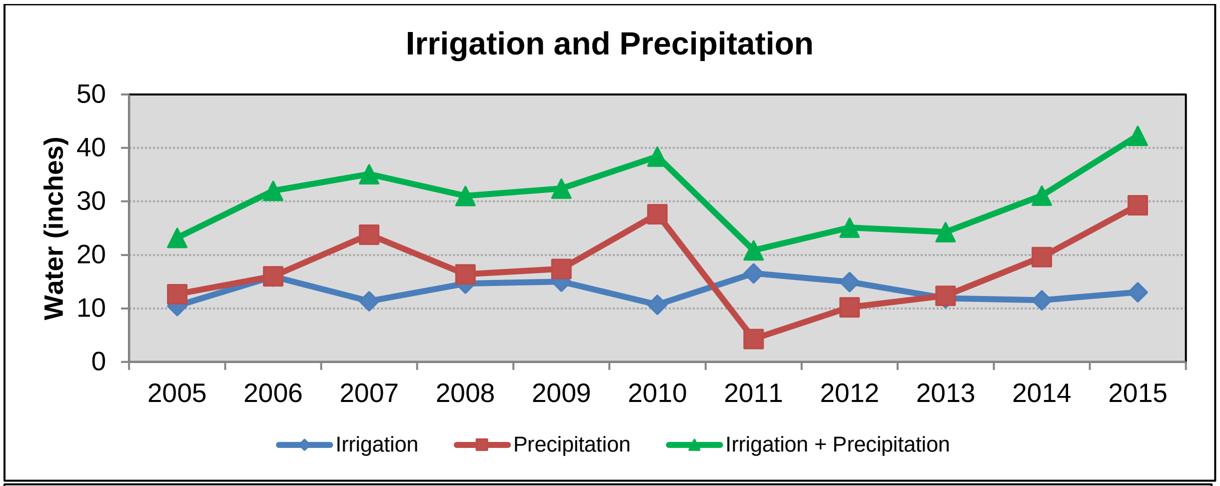
Irrigation:
Center Pivot (LESA) 600 gpm

Number of wells: 2

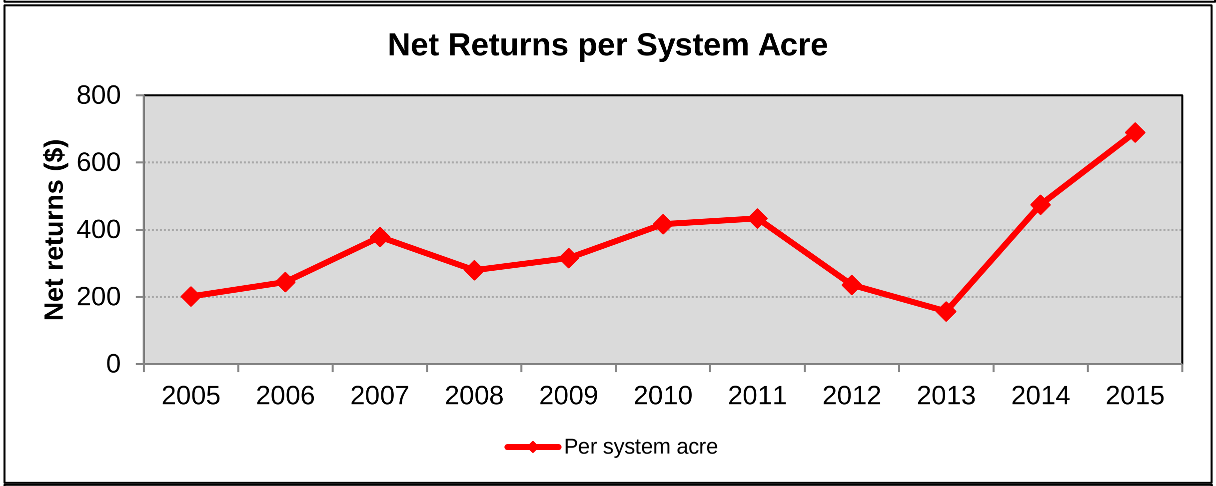
Fuel Source: 1 Electric,
1 Diesel



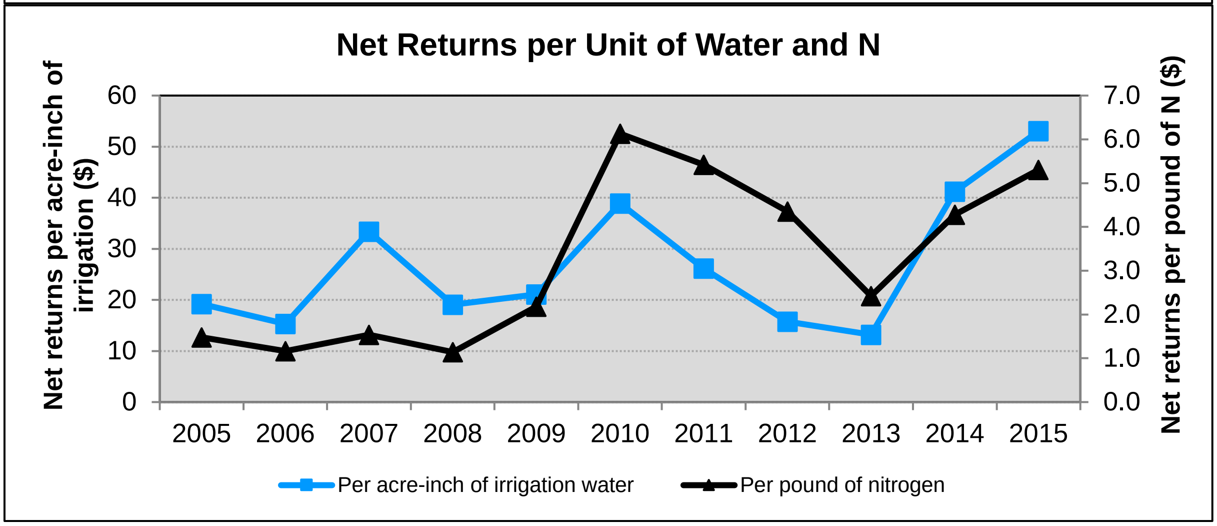
Site 26



Irrigation and Precipitation
Water (inches)
50
40
30
20
10
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Irrigation
Precipitation
Irrigation + Precipitation

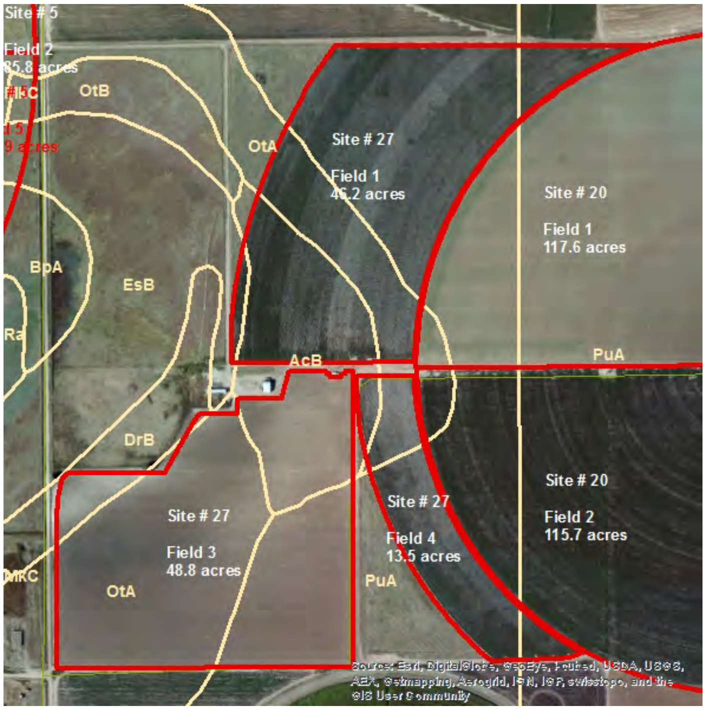


Net Returns per System Acre
Net returns ($)
800
600
400
200
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
60
50
40
30
20
10
0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Net returns per pound of N ($)
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Per acre-inch of irrigation water
Per pound of nitrogen

SITE 27 - TERMINATED 2014



Description:

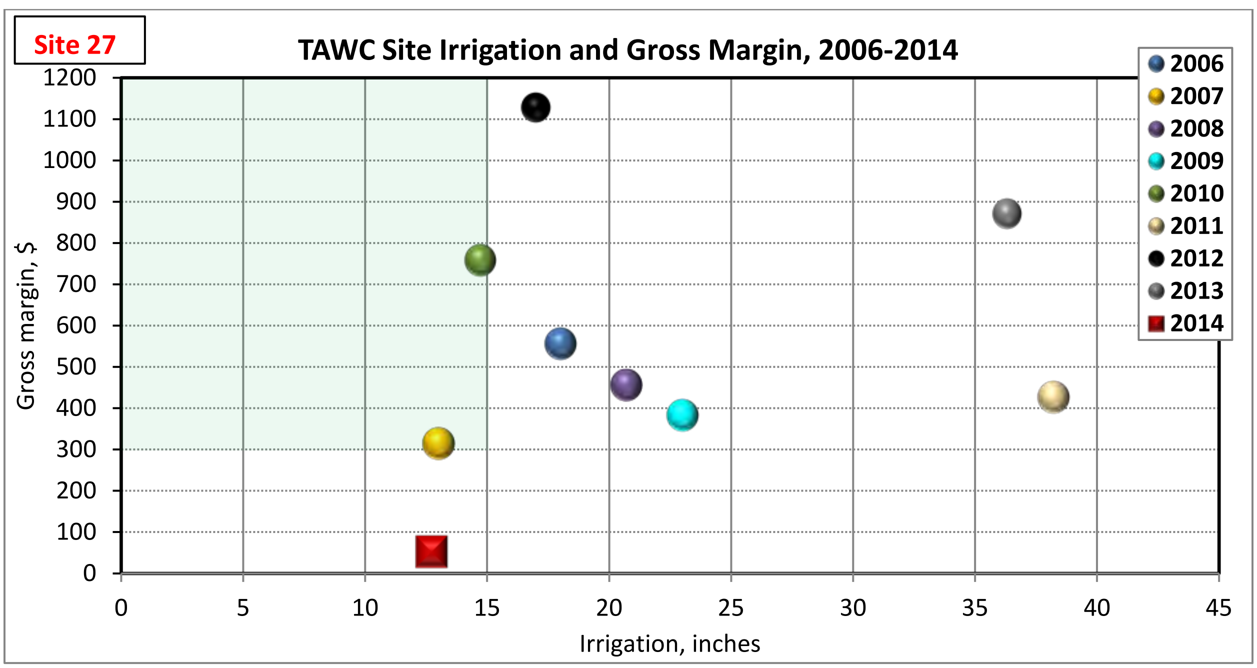
Site acres: 108.4

Soil types:
- PuA-Pullman clay loam; 0 to 1%
- OtA-Olton loam; 0 to 1%
- AcB-Acuff loam; 1 to 3%

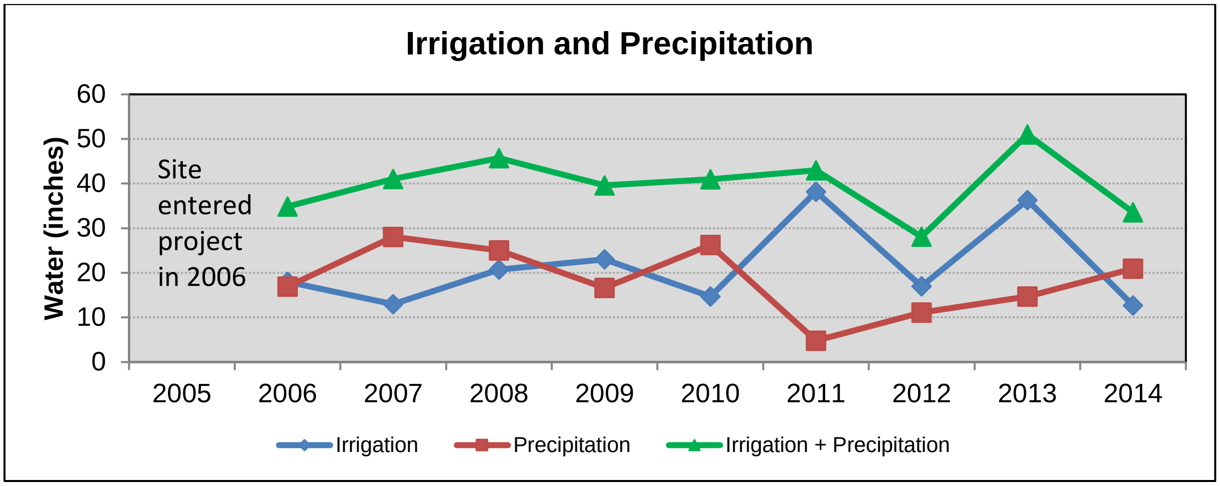
Irrigation:
Sub-Surface Drip (SDI) 400 gpm

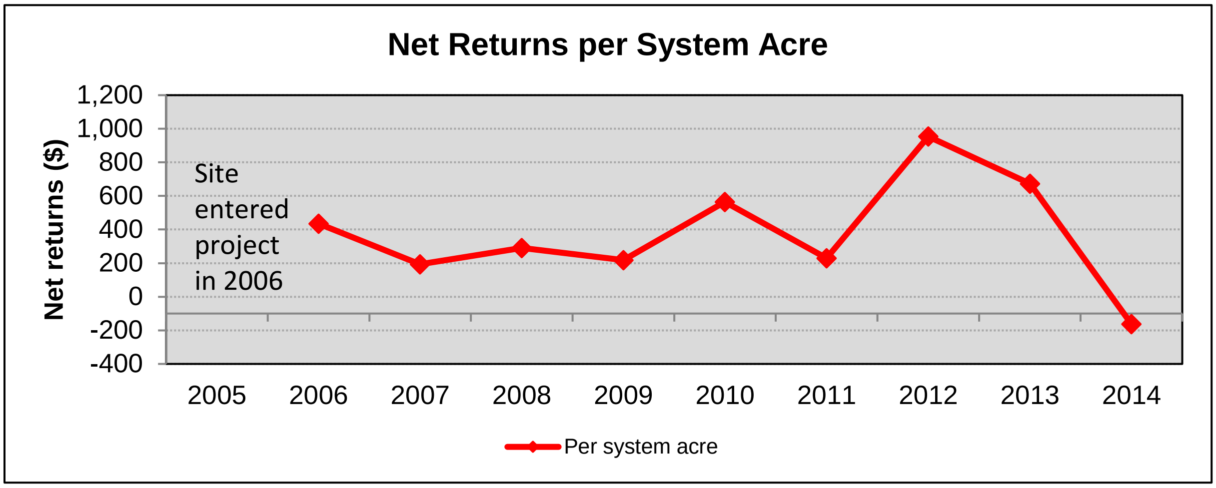
Number of wells: 2

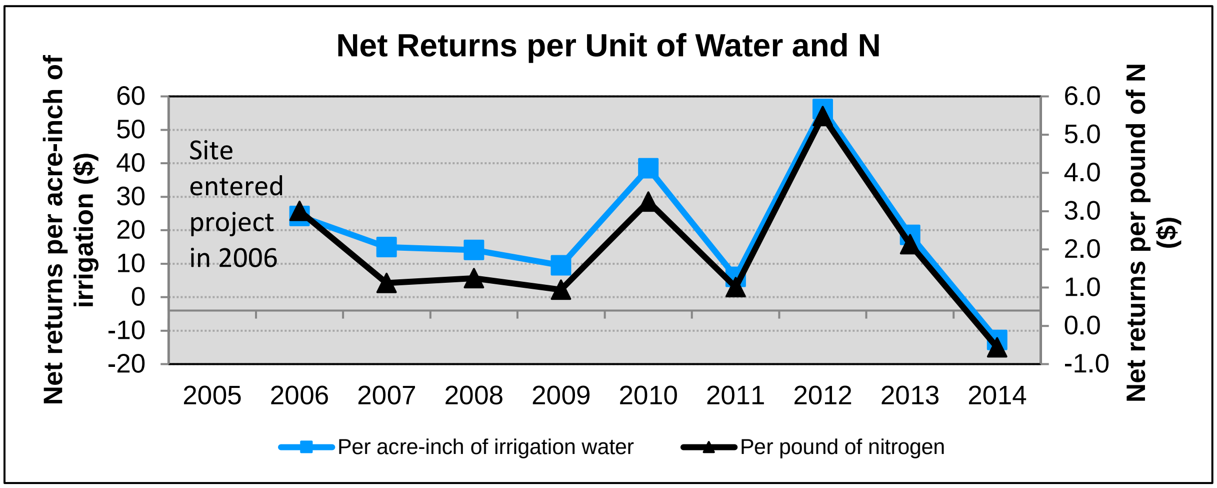
Fuel Source: Electric



Site 27


Irrigation and Precipitation
Water (inches)
60
50
40
30
20
10
0
Site entered project in 2006
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
1,200
1,000
800
600
400
200
0
-200
-400
Site entered project in 2006
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
60
50
40
30
20
10
0
-10
-20
Net returns per pound of N ($)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
Site entered project in 2006
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Per acre-inch of irrigation water
Per pound of nitrogen

SITE 29 – TERMINATED 2014

Description:

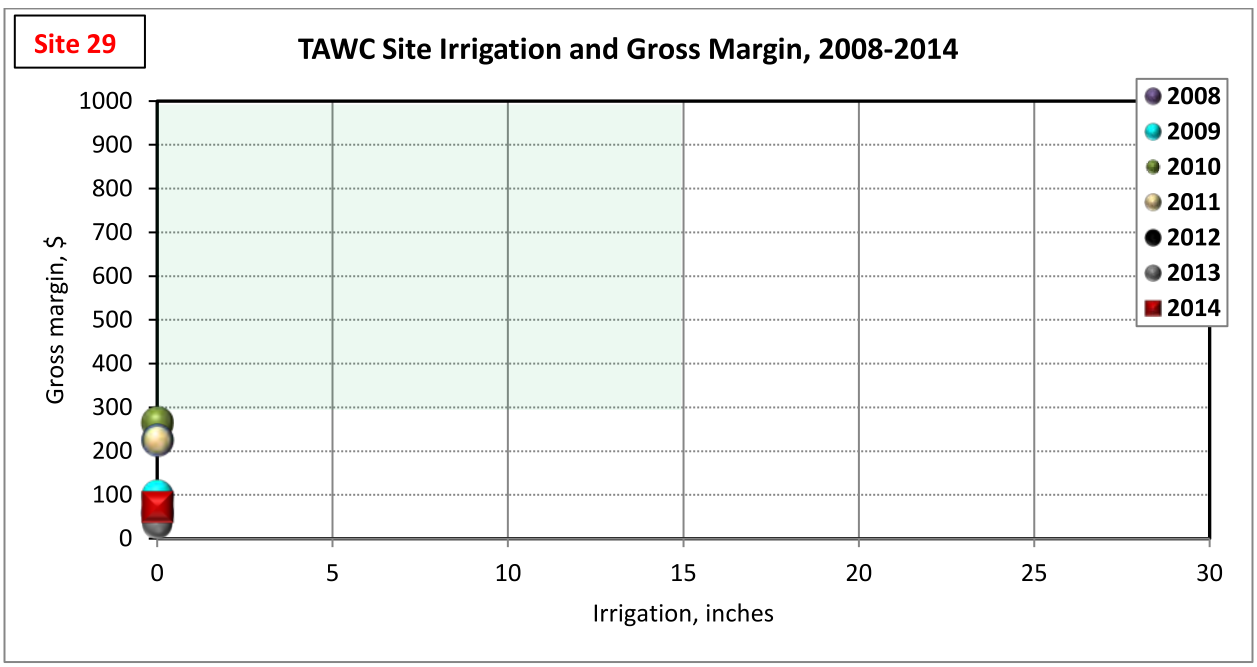
Site acres: 221.7

Soil types:
- PuA-Pullman clay loam; 0 to 1%
- LoA-Lofton clay loam; 0 to 1%
- EcB-Estacado clay loam; 1 to 3%

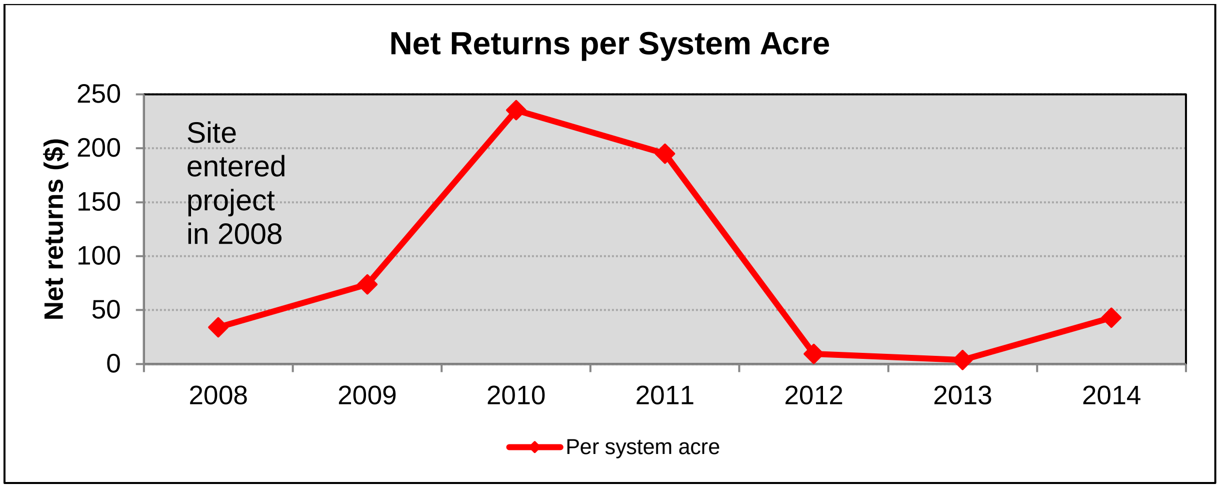
Irrigation:
Dryland (DL) na gpm

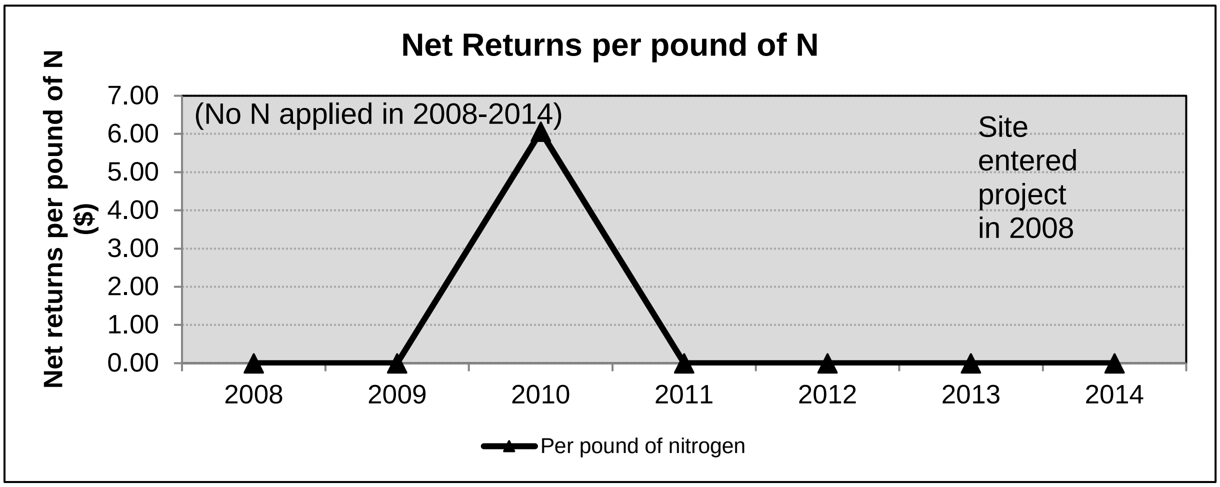
Number of wells: na

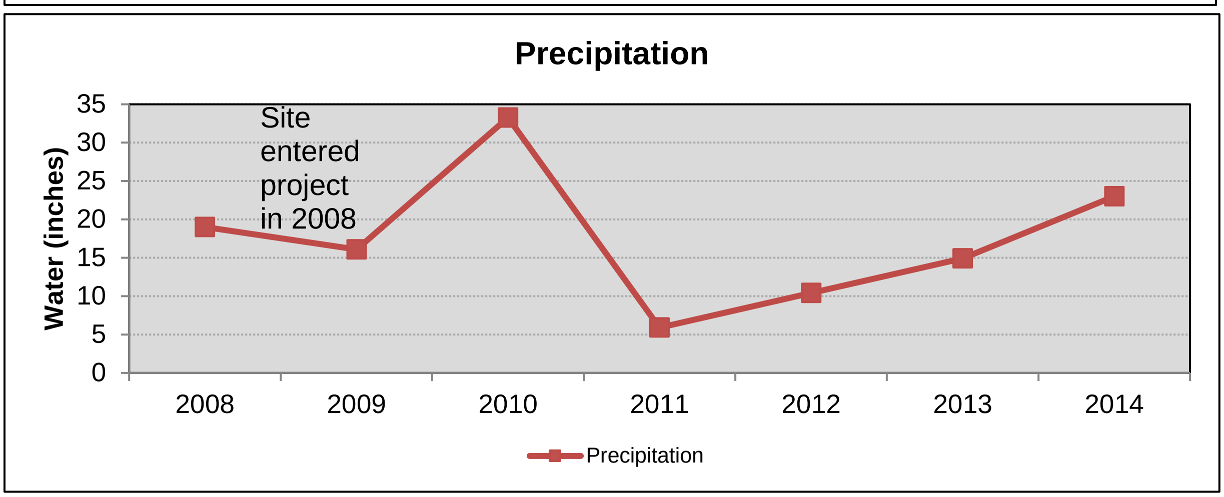
Fuel Source: na



Site 29 – Dryland Site







SITE 30-TERMINATED 2015

Description:

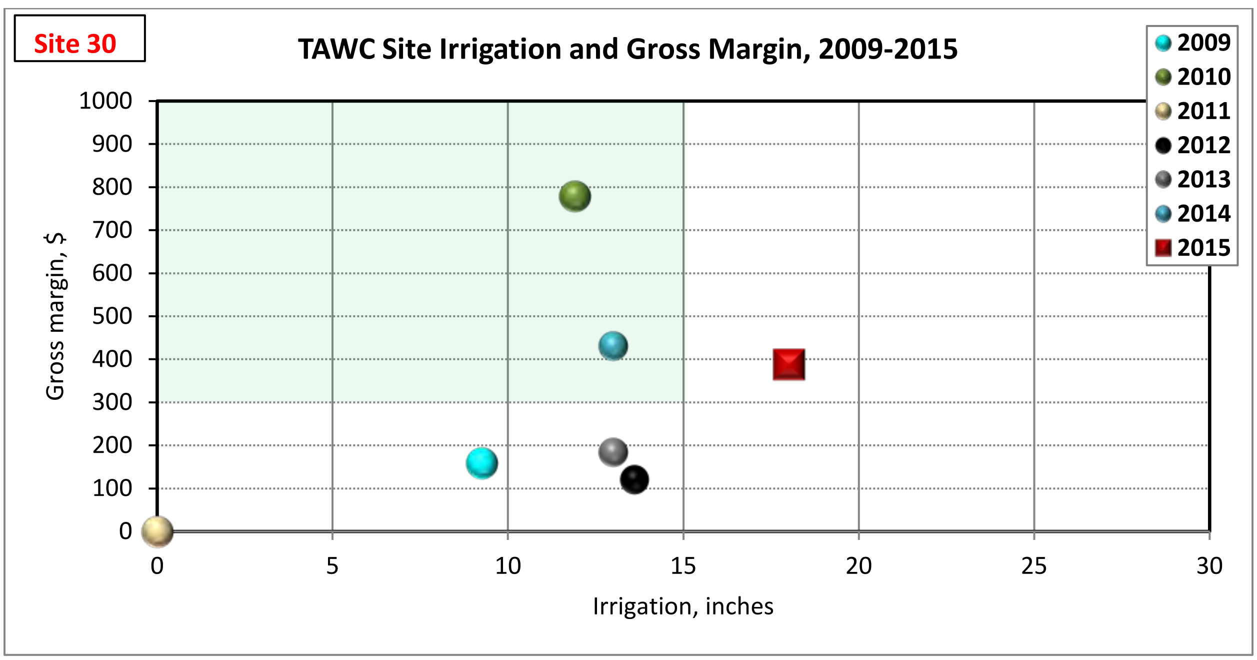
Site acres: 21.8

Soil types:
- OtA-Olton loam; 0 to 1%
- BpA-Bippus loam; 0 to 1%
- BfB-Bippus fine sandy loam; 1 to 3%

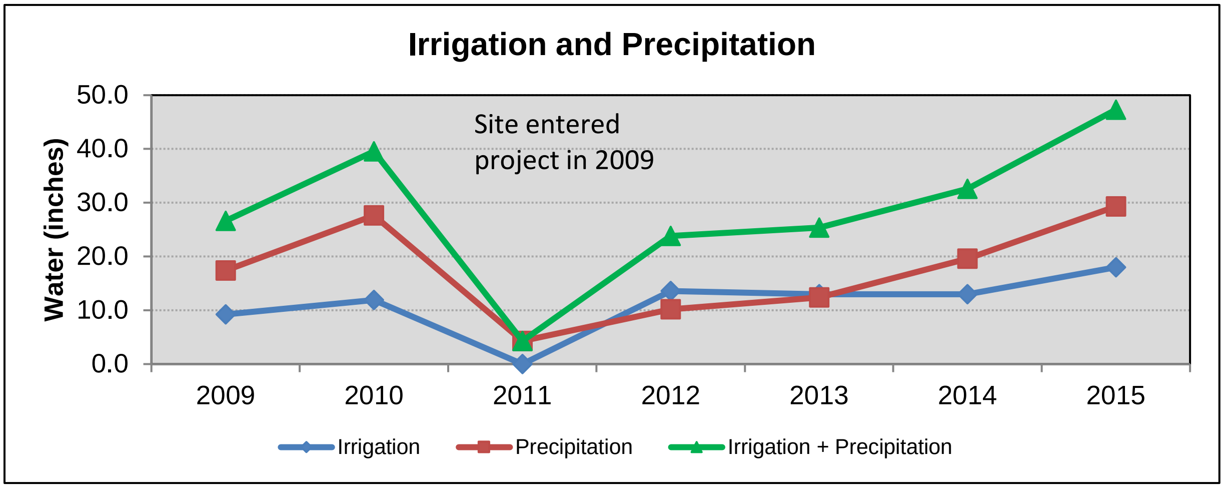
Irrigation:
Sub-Surface Drip (SDI)150 gpm

Number of wells: 1

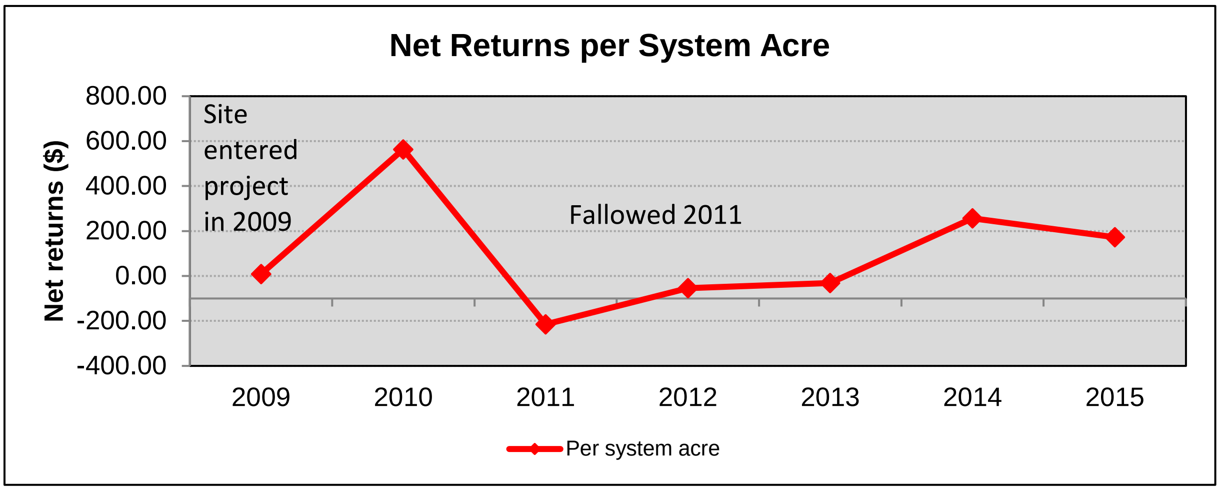
Fuel Source: Electric



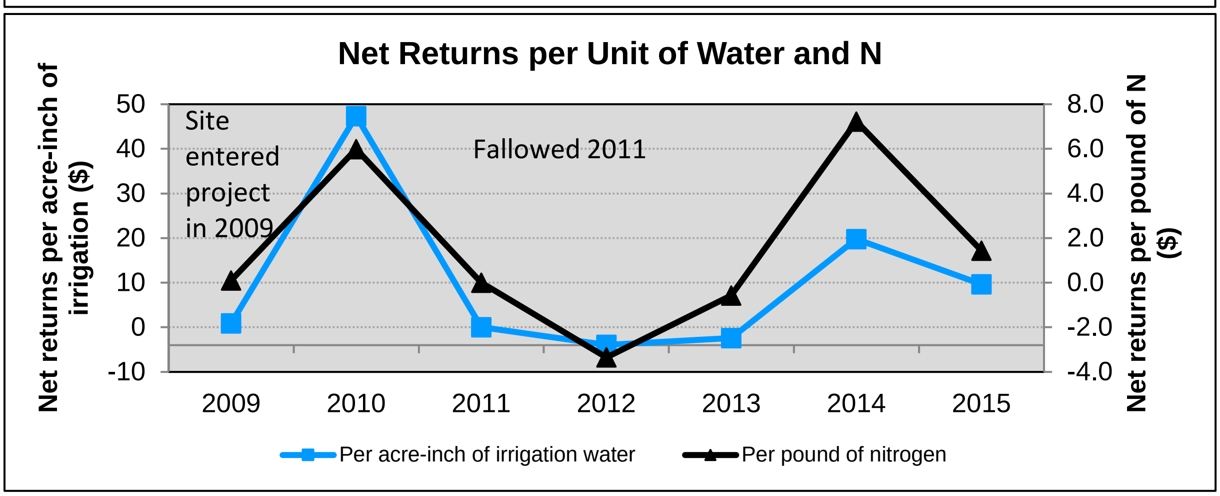
Site 30



Irrigation and Precipitation
Water (inches)
50.0
40.0
30.0
20.0
10.0
0.0
Site entered project in 2009
2009
2010
2011
2012
2013
2014
2015
Irrigation
Precipitation
Irrigation + Precipitation

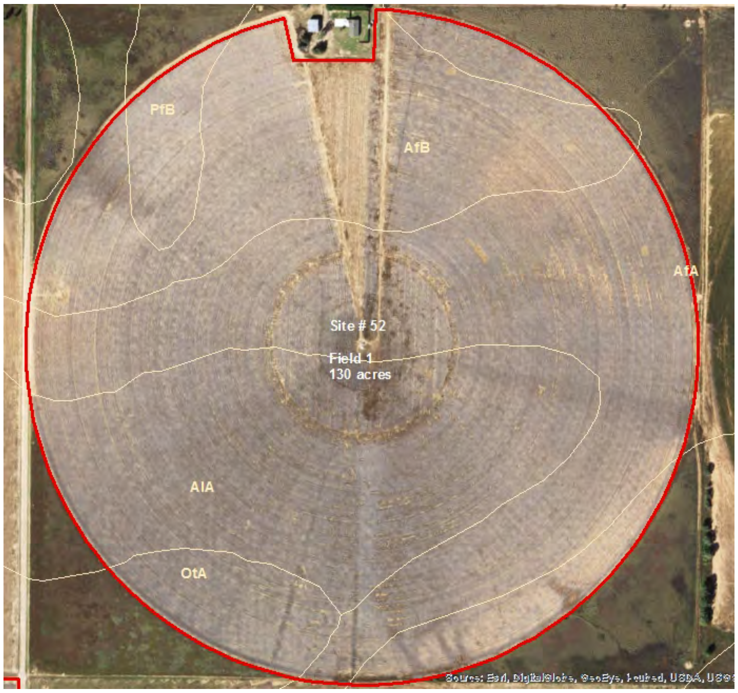


Net Returns per System Acre
Net returns ($)
800.00
600.00
400.00
200.00
0.00
-200.00
-400.00
Site entered project in 2009
Fallowed 2011
2009
2010
2011
2012
2013
2014
2015
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
50
40
30
20
10
0
-10
Net returns per pound of N ($)
8.0
6.0
4.0
2.0
0.0
-2.0
-4.0
Site entered project in 2009
Fallowed 2011
2009
2010
2011
2012
2013
2014
2015
Per acre-inch of irrigation water
Per pound of nitrogen

Site C52 – Terminated 2015



Description:

Site acres: 130

Soil types:

AfA-Amarillo fine sandy loam, 0 to 1%

AfB-Amarillo fine sandy loam; 1 to 3%

AlA- Acuff loam, 0 to 1%

OtA-Olton loam, 0 to 1%

PfB- Portales fine sandy loam, 1 to 3%

Irrigation:

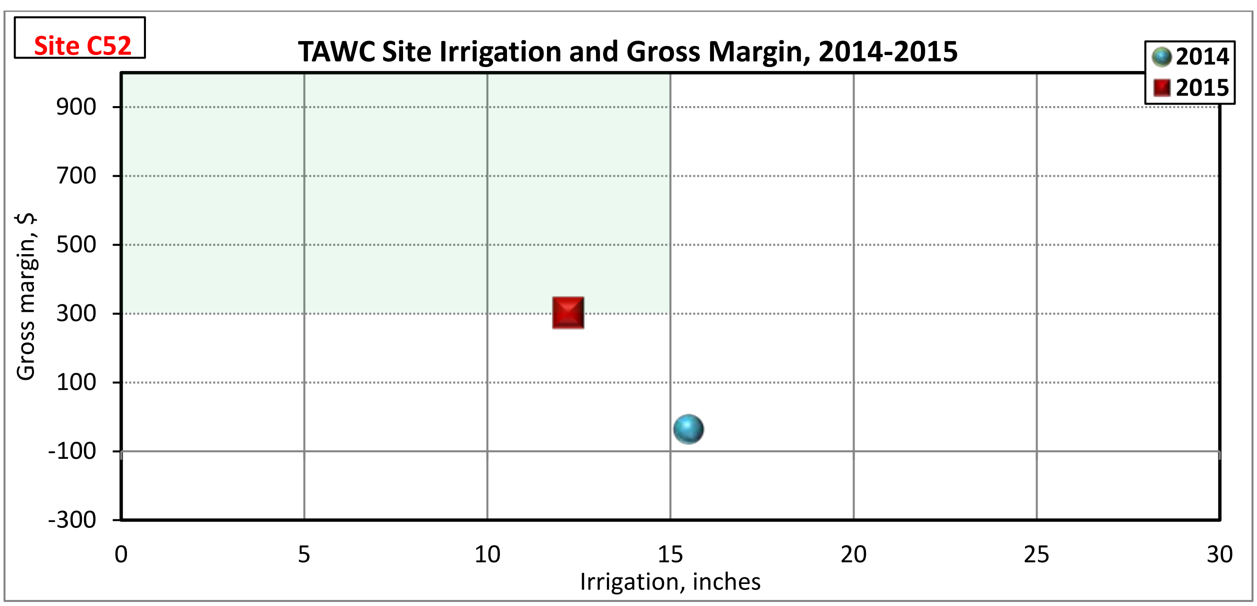
Low Elevation Spray Application

(SDI) 410 gpm

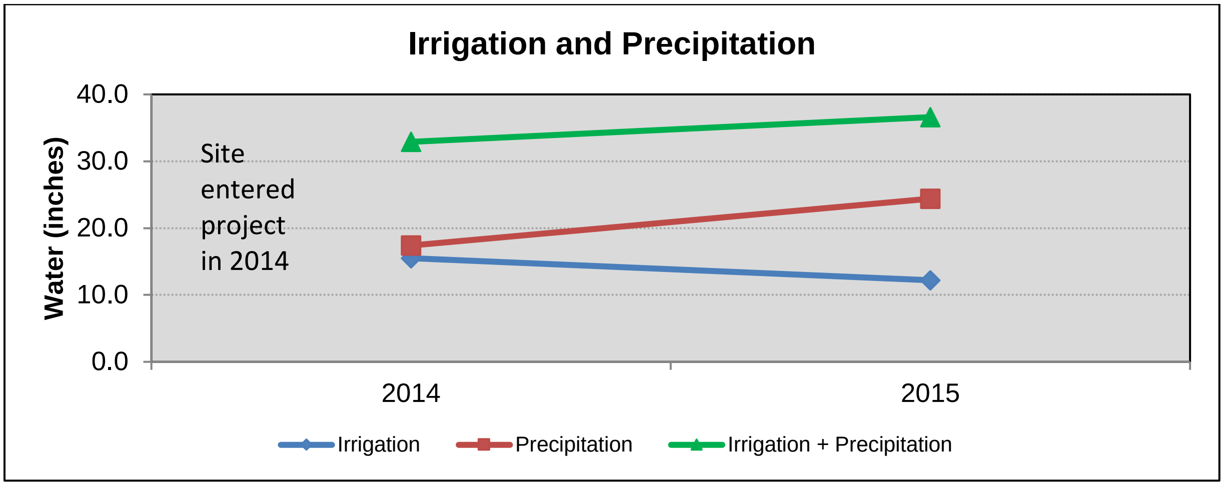
Number of wells: 3

Depth: 300 feet

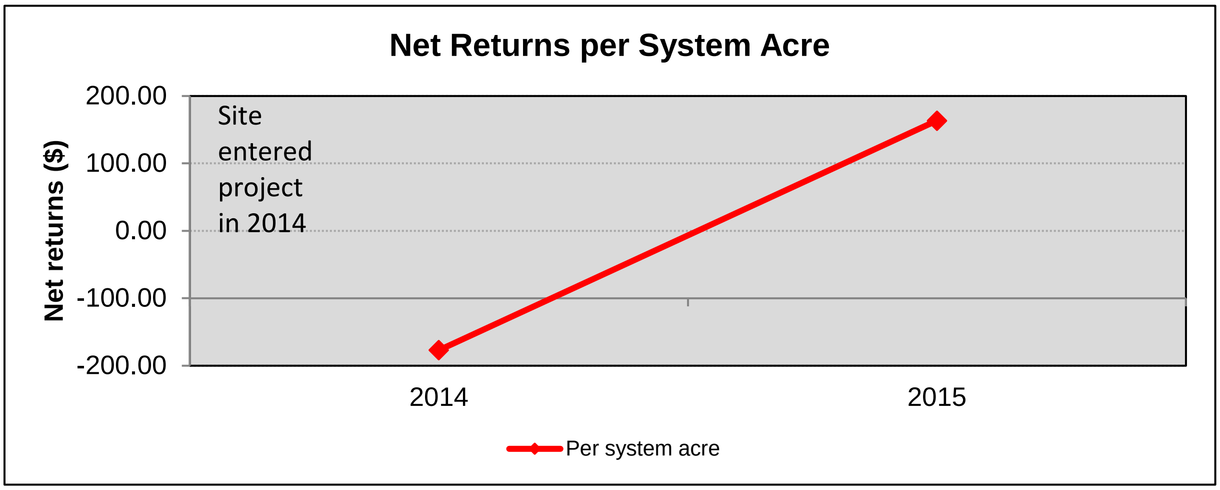
Fuel Source: Electric



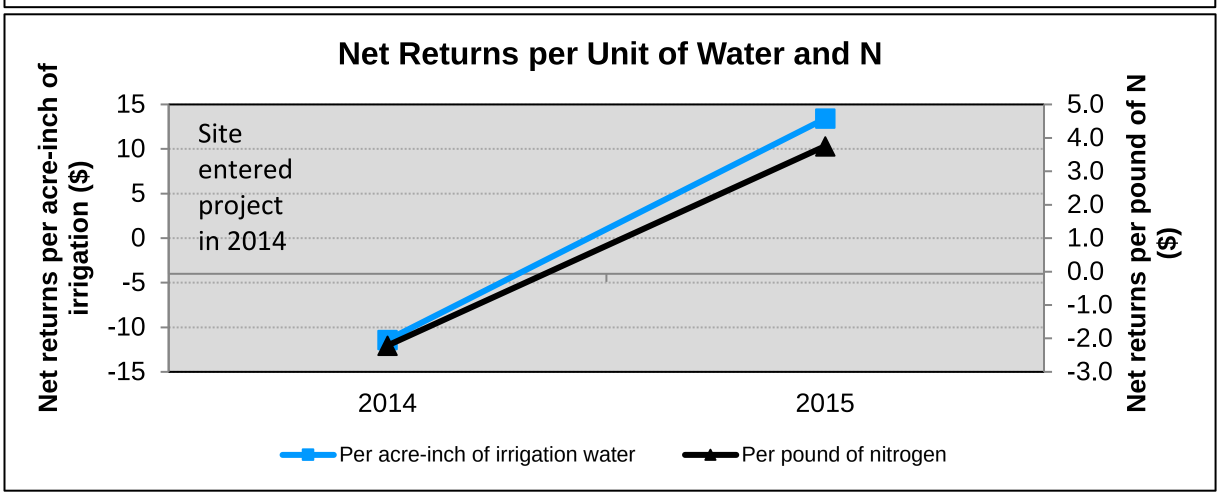
Site C52



Irrigation and Precipitation
Water (inches)
40.0
30.0
20.0
10.0
0.0
Site entered project in 2014
2014
2015
Irrigation
Precipitation
Irrigation + Precipitation



Net Returns per System Acre
Net returns ($)
200.00
100.00
0.00
-100.00
-200.00
Site entered project in 2014
2014
2015
Per system acre



Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
15
10
5
0
-5
-10
-15
Net returns per pound of N ($)
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
Site entered project in 2014
2014
2015
Per acre-inch of irrigation water
Per pound of nitrogen

SITE C58 – TERMINATED 2015

Description:

Site acres: 120.0

Soil types:
- 30 - Olton clay loam, 0 to 1%
- 41 - Pullman clay loam, 0to 1%
- 46 - Zita loam, 0 to 1%

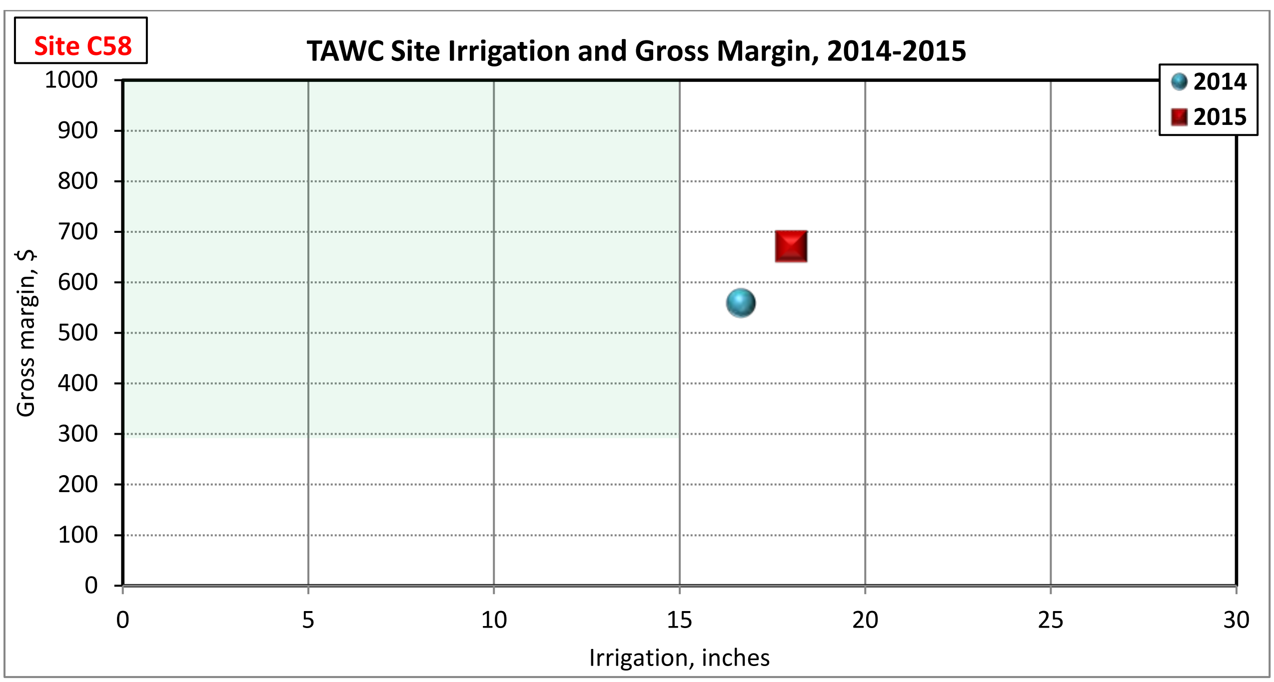
Irrigation:
Low Elevation Spray Application (LESA) 450 gpm

Number of wells: 2

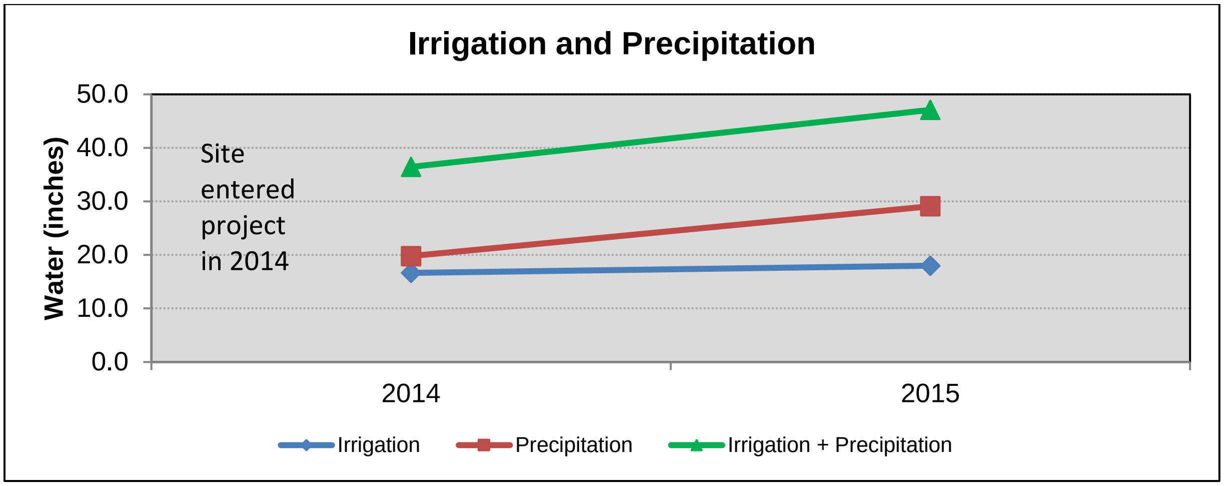
Depth: 300 feet

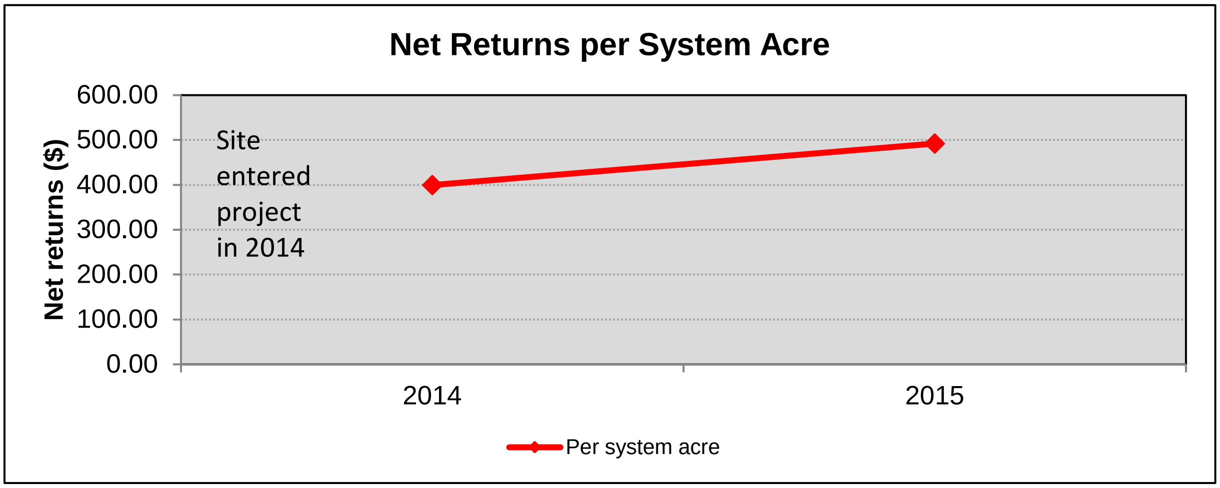
Fuel Source: Electric

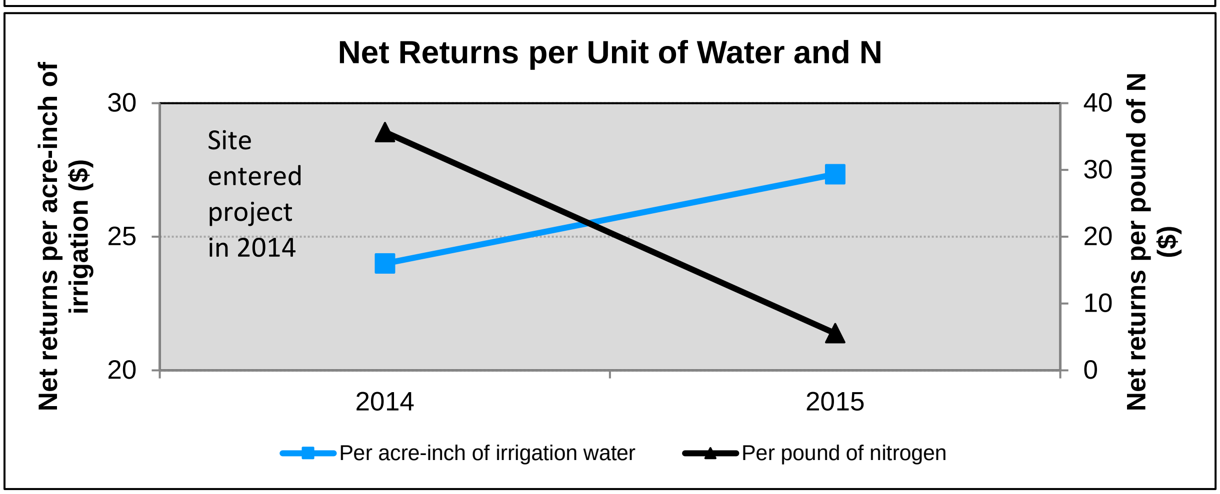
Site C58



Site C58


Irrigation and Precipitation
Water (inches)
50.0
40.0
30.0
20.0
10.0
0.0
Site entered project in 2014
2014
2015
Irrigation
Precipitation
Irrigation + Precipitation


Net Returns per System Acre
Net returns ($)
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Site entered project in 2014
2014
2015
Per system acre


Net Returns per Unit of Water and N
Net returns per acre-inch of irrigation ($)
30
25
20
Net returns per pound of N ($)
40
30
20
10
0
Site entered project in 2014
2014
2015
Per acre-inch of irrigation water
Per pound of nitrogen

Weather Data (Phase I - 2005-2013/Phase II – 2014-2015)

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.

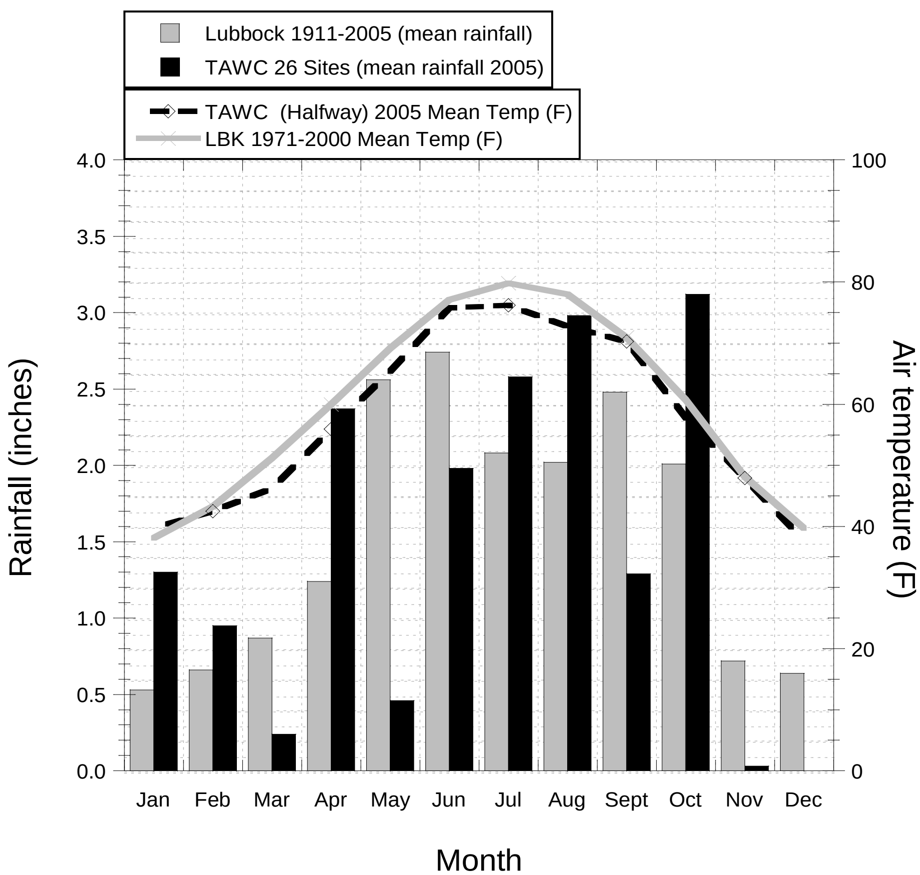


Figure A 1. Temperature and precipitation for 2005 in the demonstration area compared with long term averages.

Table A 27. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2005.

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

2006

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

Precipitation for 2006, presented in Figure 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.

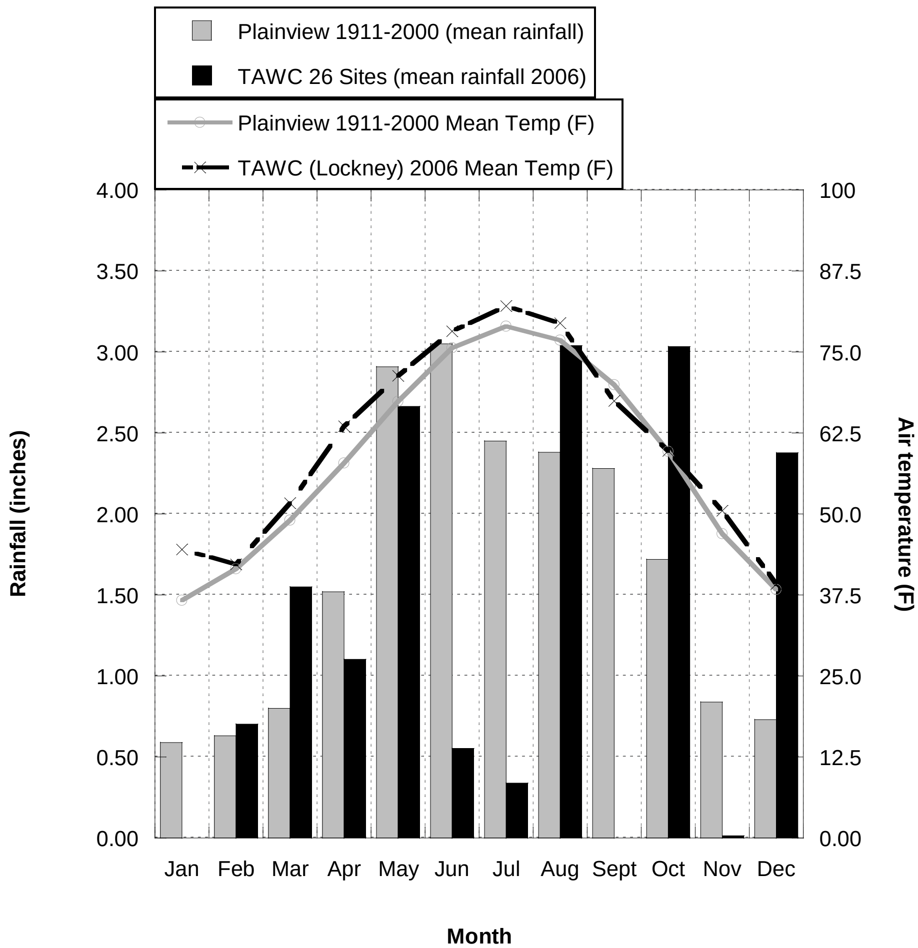


Figure A 2. Temperature and precipitation for 2006 in the demonstration area compared with long term averages.

Table A 28. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2006.

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

2007

Precipitation during 2007 totaled 27.2 inches (Table 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.

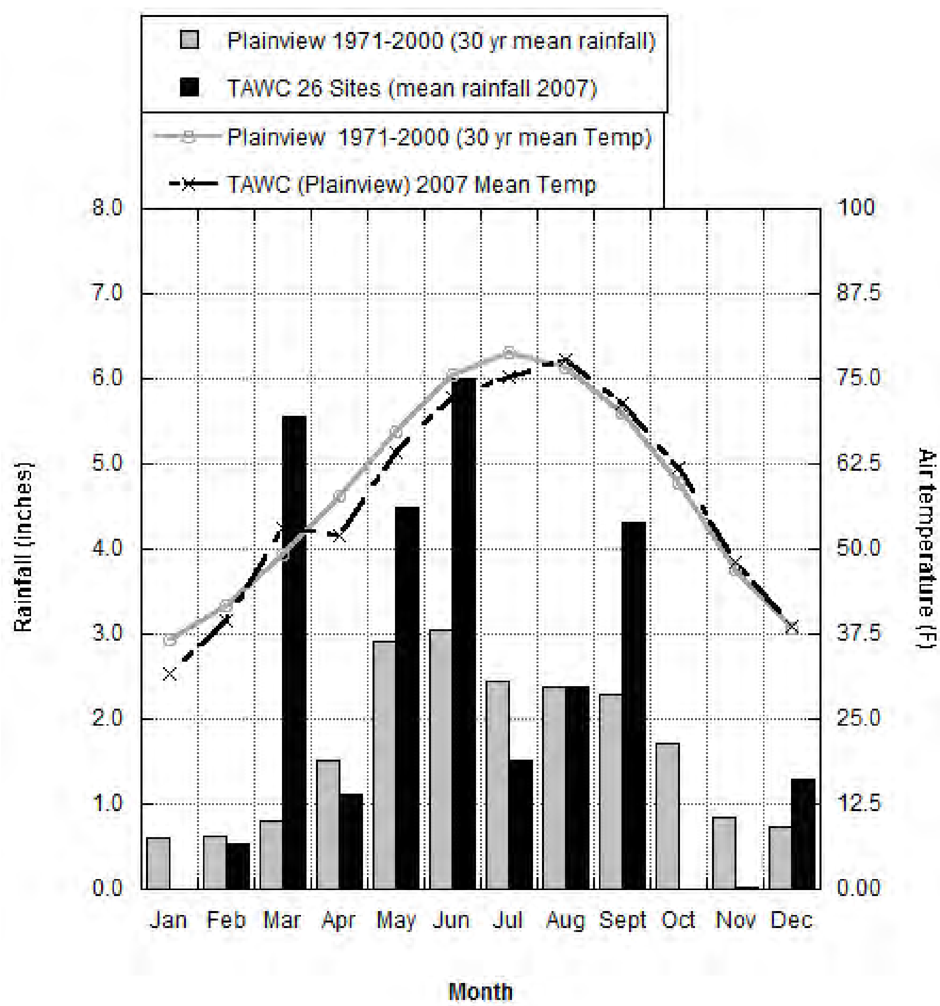


Figure A 3. Temperature and precipitation for 2007 in the demonstration area compared with long term averages.

Table A 29. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2007.

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

2008

Precipitation during 2008, at 21.6 inches, was above average for the year (Table 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).

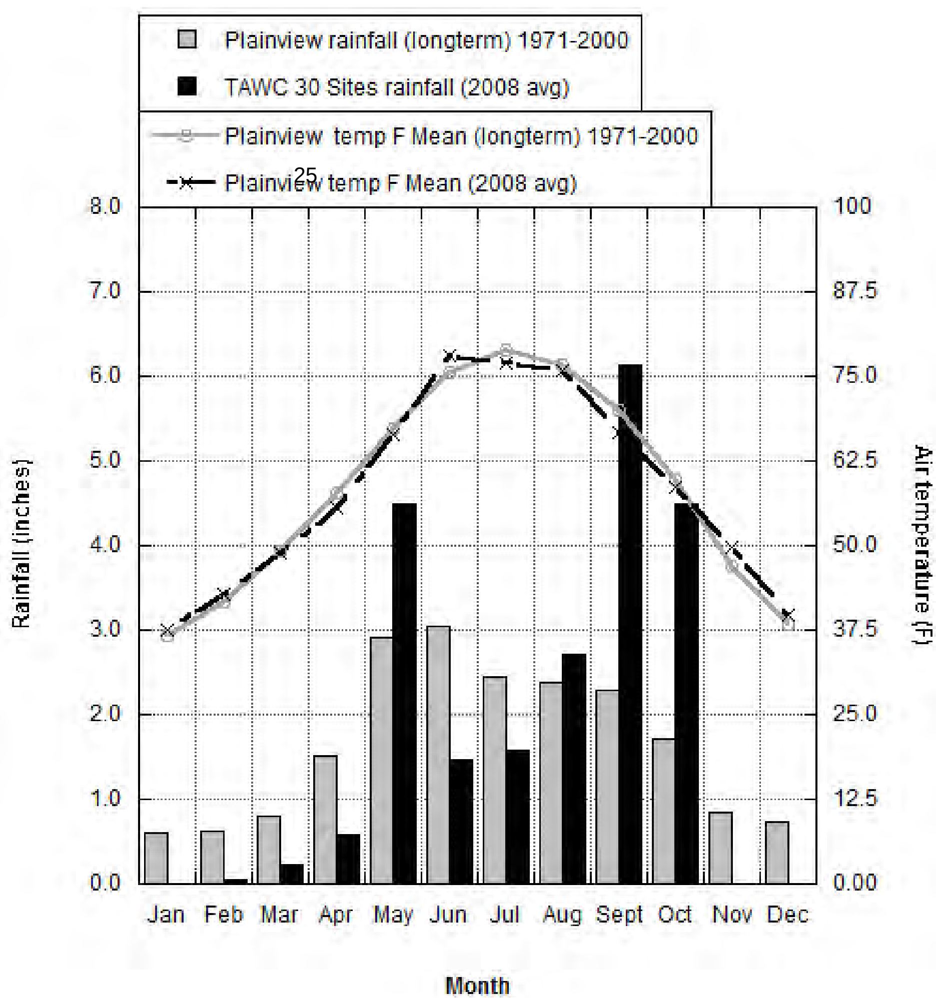


Figure A 4. Temperature and precipitation for 2008 in the demonstration area compared with long term averages.

Table A 30. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2008.

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

2009

Precipitation during 2009 totaled 15.2 inches averaged across all sites (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.

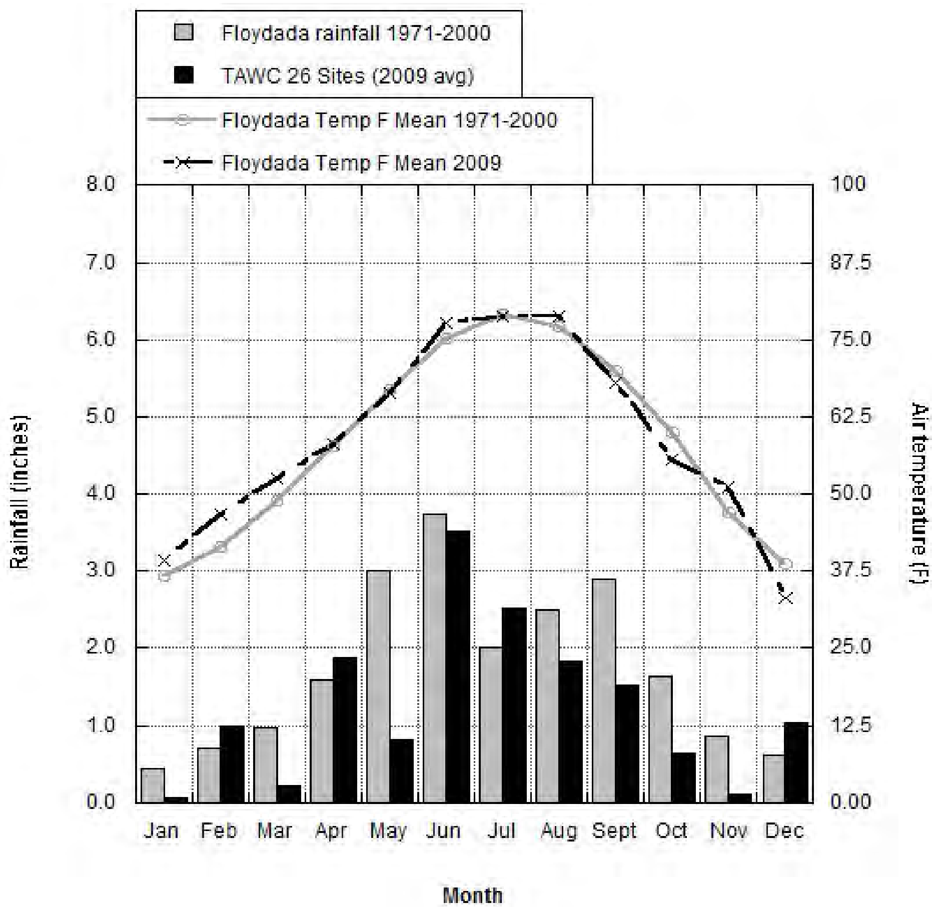


Figure A 5. Temperature and precipitation for 2009 in the demonstration area compared with long term averages.

Table A 31. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2009.

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

2010

The project sites and the region received above average rainfall for the 2010 calendar year with an average of 28.9 inches measured across the project, as indicated in Table 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.

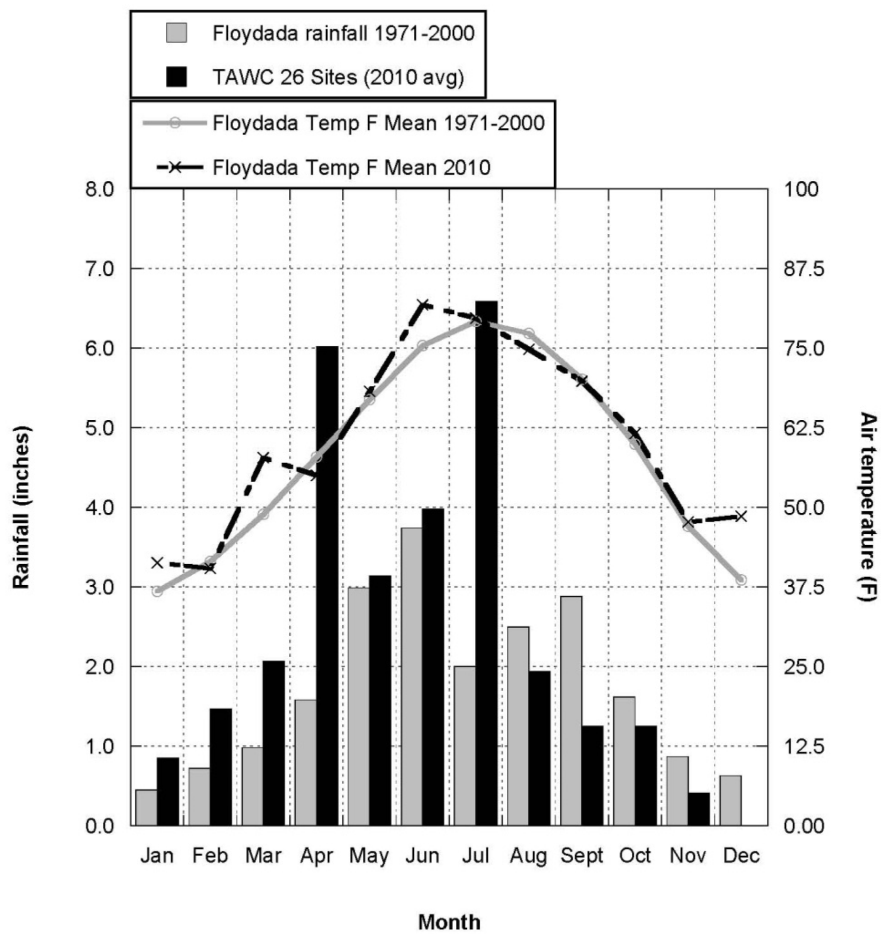


Figure A 6. Temperature and precipitation for 2010 in the demonstration area compared with long term averages.

Table A 32. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2010.

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

2011

The project sites and the region received below average rainfall for the 2011 calendar year with an average of 5.3 inches (Figure 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.

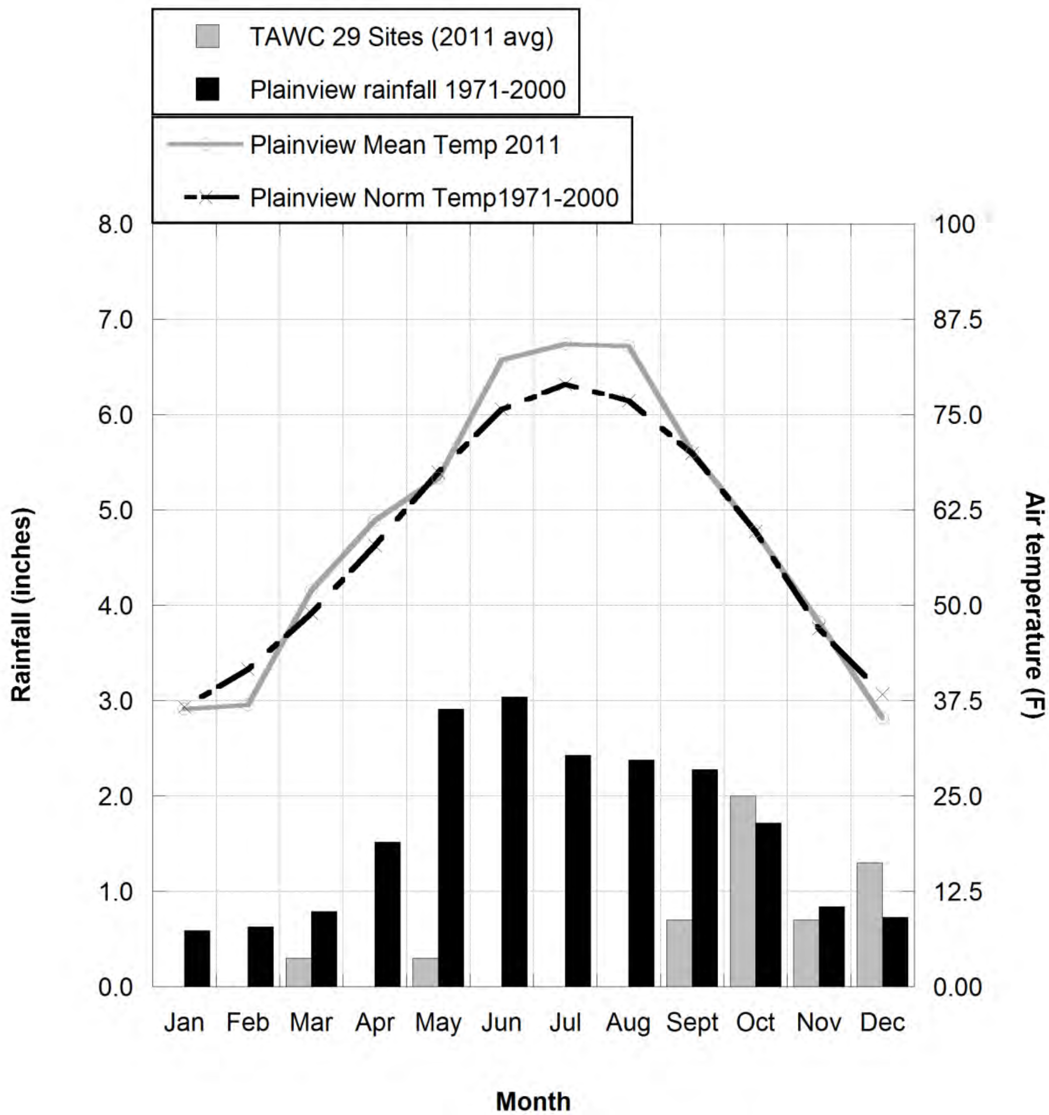


Figure A 7. Temperature and precipitation for 2011 in the demonstration area compared with long term averages.

Table A 33. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2011.

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

2012

The project sites and the region again received below average rainfall for the 2012 calendar year, with an average of 10.0 inches measured across the project (Figure 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.

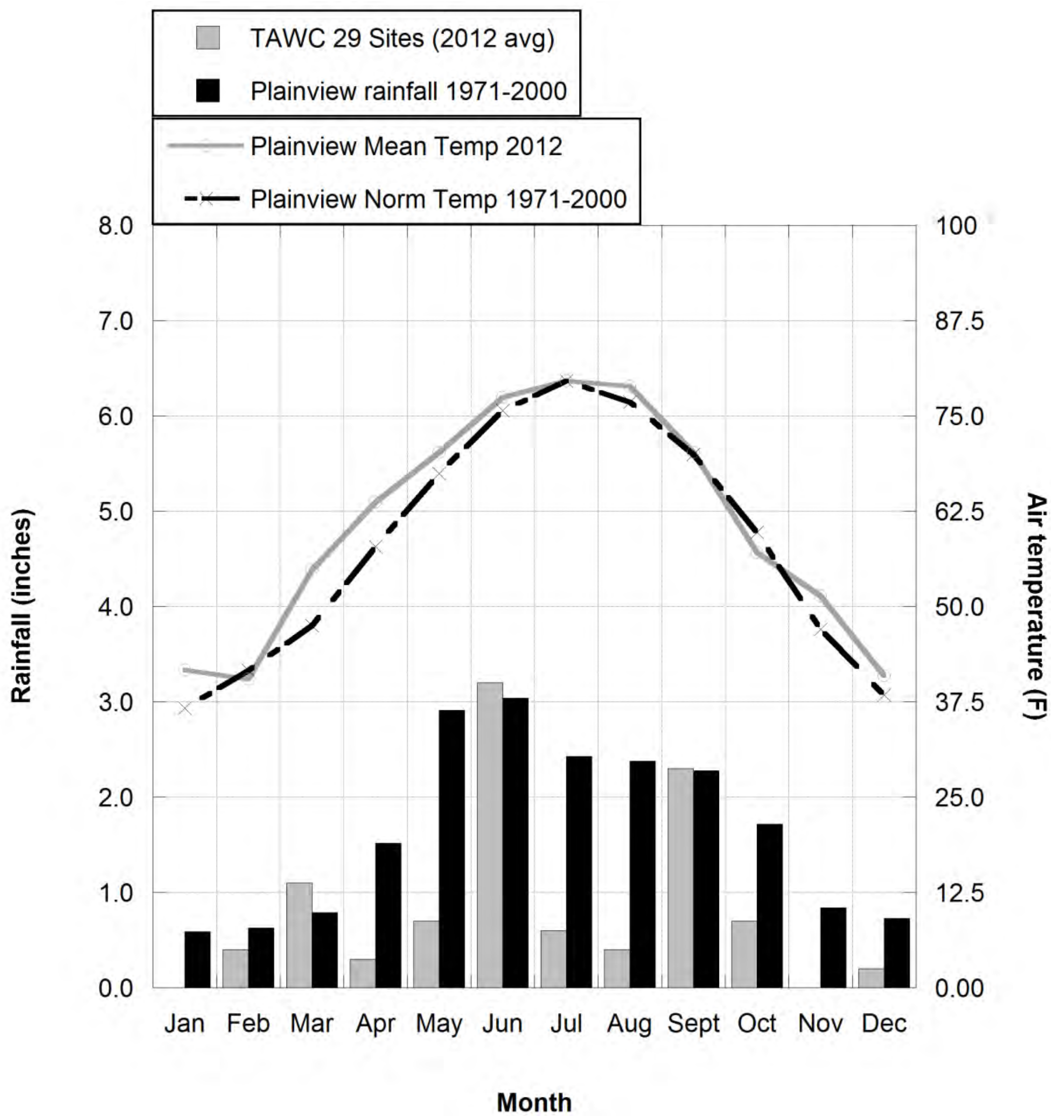


Figure A 8. Temperature and precipitation for 2012 in the demonstration area compared with long term averages.

Table A 34. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2012.

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

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.

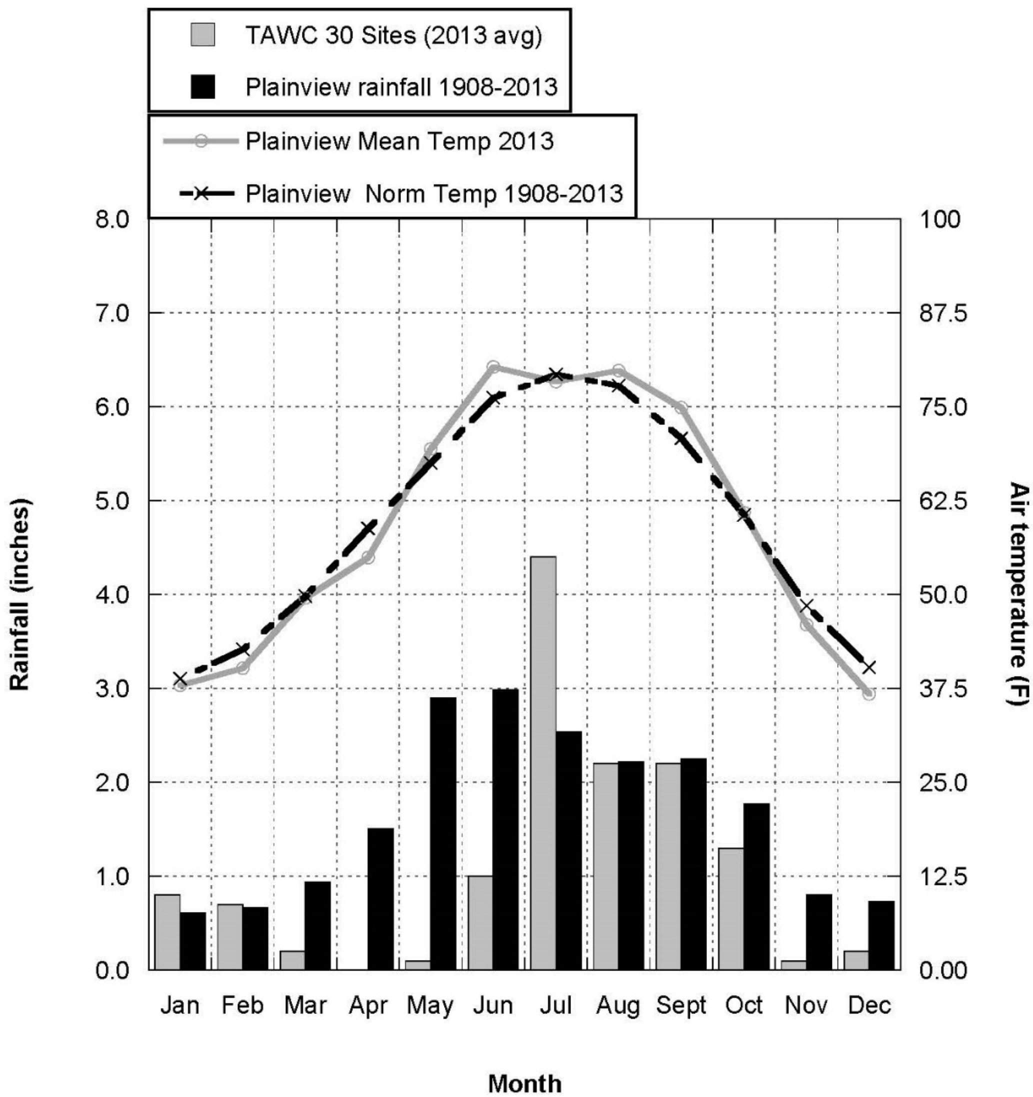


Figure A 9. Temperature and precipitation for 2013 in the demonstration area compared with long term averages.

Table A 35. Precipitation by each site in the Demonstration Project in Hale and Floyd Counties during 2013.

SITE	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2	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
3	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
4	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
5	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
6	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
7	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
8	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
9	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
10	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
11	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
12	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
14	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
15	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
17	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
18	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
19	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
20	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
21	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
22	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
24	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
26	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
27	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
28	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
29	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
30	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
31	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
32	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
33	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
34	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
35	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
Average	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.

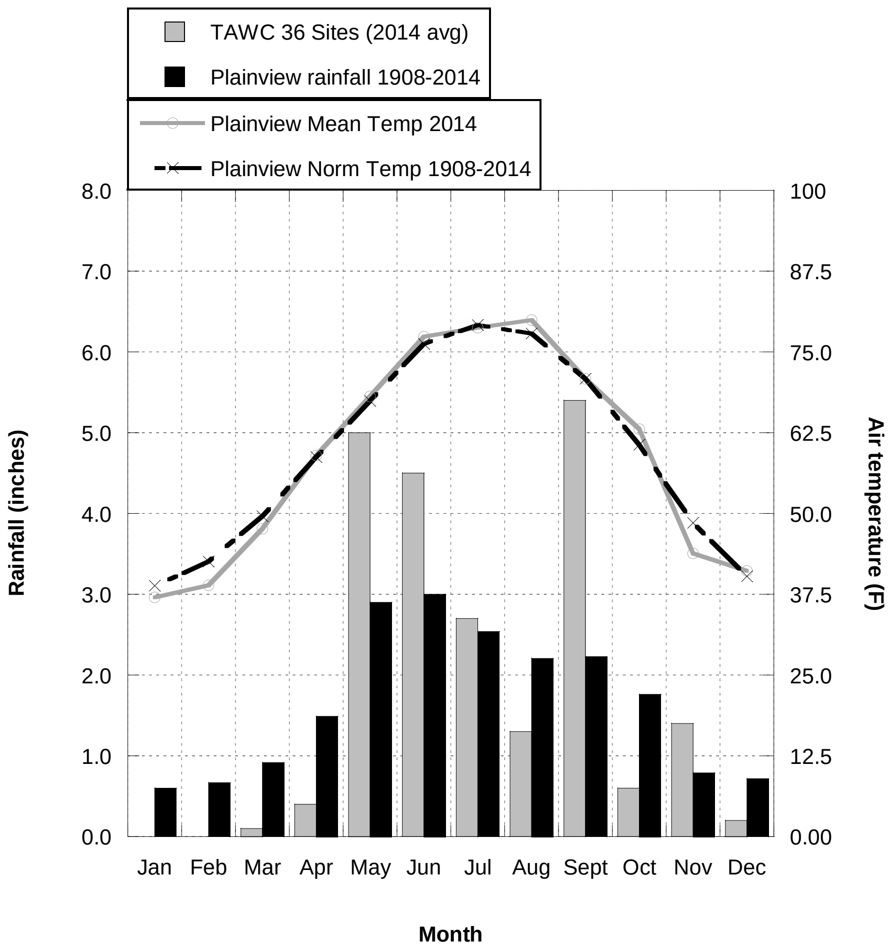


Figure A 10. Temperature and precipitation for 2014 (Phase II Year 1) in the demonstration area compared with long term averages.

Table A 36. 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 WEATHER DATA (SEE APPENDIX FOR 2005-2014 DATA)

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.

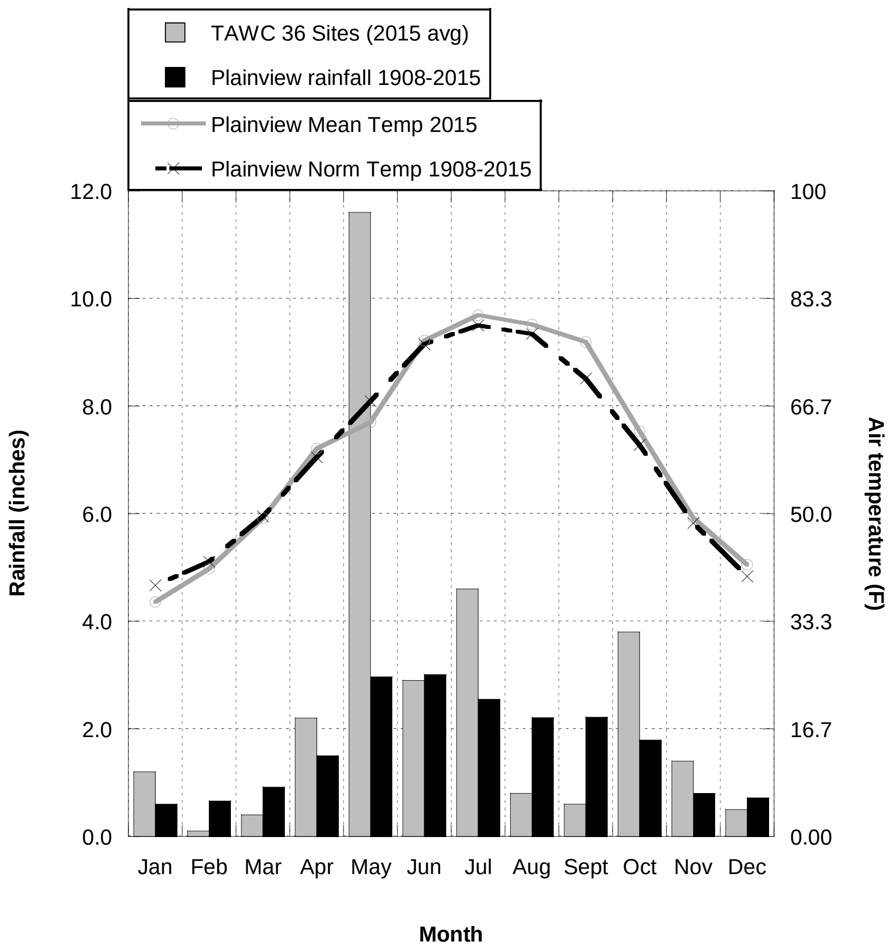


Figure A 11. Temperature and precipitation for 2015 (Phase II Year 2) in the demonstration area compared with long term averages.

Table A 37. Precipitation by each site in the Demonstration Project during 2015 (Phase II Year 2).

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

Supplementary Grants To Project
(Phase I - 2005-2013/Phase II – 2014-2015)

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

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.

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

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 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.

Donations to Project
(Phase I - 2005-2013/Phase II – 2014-2015)

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
Total	**$4,050.00**

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
Total	**$15,750.00**

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
Total	**$ 2,250.00**

Visitors to the Demonstration Project Sites, Field Walks, Field Days, and Water College Outreach Events
(Phase I - 2005-2013/Phase II – 2014-2015)

2005

Total Number of Visitors 190

2006

Total Number of Visitors 282

2007

Total Number of Visitors 176+

2008

Total Number of Visitors 153+

2009

Total Number of Visitors 126+

2010

Total Number of Visitors 120+

2011

Total Number of Visitors 175+ +

2012

Total Number of Visitors 200 +

2013

Total Number of Visitors 230+

2014

Total Number of Visitors 270+

2015

Total Number of Visitors 350+

Presentations
(Phase I - 2005-2013/Phase II – 2014-2015)

2005

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

2006

Date	Presentation	Spokesperson(s)
24-26 Jan	Lubbock Southwest Farm & Ranch Classic	Kellison
6-Feb	Southern Region AAAE Conference: The *value of water: Educational programming to maximize profitability and decrease water consumption* (poster presentation), Charlotte, NC	M. Norton/Doerfert
7-Feb	Radio Interview	Kellison/Baker
2-Mar	South Plains Irrigation Management Workshop	Trostle/Kellison/Orr
30-Mar	Forage Conference	Kellison/Allen/Trostle
19-Apr	Floydada Rotary Club	Kellison

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

2007

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

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

8-Oct	Plant & Soil Science Departmental Seminar: *Estimating ground cover of field crops using multispectral medium, resolution satellite, and high resolution aerial imagery*	Rajan
11-Oct	Management Team meeting	
4—8-Nov	American Society of Agronomy Annual meetings: *Using remote sensing and crop models to compare water use of cotton under different irrigation systems* (poster presentation), New Orleans, LA	Rajan
4—8-Nov	American Society of Agronomy Annual meetings: *Assessing the crop water use of silage corn and forage sorghum using remote sensing and crop modeling*, New Orleans, LA	Rajan
7—9-Nov	National Water Resources Association Annual Conference, Albuquerque, NM	Bruce Rigler (HPUWCD #1)
8-Nov	Management Team meeting (Comer Tuck in attendance)	
12—15-Nov	American Water Resources Association annual meeting: *Considering conservation outreach through the framework of behavioral economics: a review of literature* (poster presentations), Albuquerque, NM	M. Findley/Doerfert
12—15-Nov	American Water Resources Association annual meeting: Ho*w do we value water? A multi-state perspective* (poster presentation), Albuquerque, NM	L. Edgar/Doerfert
16-Nov	Water Conservation Advisory Council meeting, Austin, TX	Allen
19-Nov	Plant & Soil Science Departmental Seminar: *Finding the legume species for West Texas which can improve forage quality and reduce water consumption*	Cui
27—29-Nov	Amarillo Farm Show, Amarillo, TX	Doerfert/Leigh/Kellison
2—4-Dec	Texas Water Summit, San Antonio, TX	Allen
13-Dec	Management Team meeting	

2008

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

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

Dec	Panhandle Groundwater District: *Farm Level Financial Impacts of Water Policy on the Southern Ogallala Aquifer,* White Deer, TX	Johnson/Weinheimer
2-4-Dec	Amarillo Farm Show	Doerfert
3-Dec	Dr. Todd Bilby, Ellen Jordan, Nicholas Kenny, Dr. Amosson (discussion of water/crops/cattle), Amarillo	Kellison
6-Dec	Lubbock RoundTable	Kellison
6-7-Dec	Meeting regarding multi-institutional proposal to target a future USDA RFP on water management, Dallas	Doerfert
11-Dec	Management Team meeting	
12-Dec	Olton CO-OP Producer meeting	Kellison
19-Dec	TAWC Producer meeting	Kellison/Schur/ Cradduck/Weinheimer

2009

Date	**Presentation**	**Spokesperson(s)**
15-Jan	Management Team meeting	
21-Jan	Caprock Crop Conference	Kellison
27-29 Jan	Southwest Farm & Ranch Classic (TAWC booth), Lubbock	Doerfert/Jones/Wilkinson/ Williams
27-Jan	Southwest Farm & Ranch Classic: *Managing Wheat for Grain*, Lubbock	Trostle
27-Jan	Southwest Farm & Ranch Classic: *2009 Planting Decisions – Grain Sorghum and Other Alternatives*, Lubbock	Trostle
28-Jan	Southwest Farm & Ranch Classic: *Profitability Workshop*, Lubbock	Yates/Pate
Feb	Floyd County crop meetings, Muncy	Trostle
Feb	Hale County crop meetings, Plainview	Trostle
12-Feb	Management Team meeting	
17-Feb	Crops Profitability workshops, AgriLife Extension and Research Center, Lubbock	Yates/Trostle
5-Mar	Crops Profitability workshops, AgriLife Extension and Research Center, Lubbock	Yates/Trostle
12-Mar	Management Team meeting	
1-Apr	Texas Tech Cotton Economics Institute Research Institutes 9th Annual Symposium (CERI): *Water Policy Impacts on High Plains Cropping Patterns and Representative Farm Performance*, Lubbock	Johnson/Weinheimer
9-Apr	Management Team meeting	
15-Apr	Texas Tech Forage Class	Kellison
21-Apr	Presentation to High Plains Underground Water District Board of Directors	Kellison
14-May	Management Team meeting	
27-May	Consortium for Irrigation Research and Education conference, Amarillo	Kellison

11-Jun	Management Team meeting	
22-24-Jun	Joint Meeting of the Western Society of Crop Science and Western Society of Soil Science: *Evaluation of the bare soil line from reflectance measurements on seven dissimilar soils* (poster presentation), Ft. Collins, CO	Rajan
26-Jun	Western Agricultural Economics Association: *Economics of State Level Water Conservation Goals*, Kauai, HI	Weinheimer/Johnson
7-Jul	Universities Council of Water Resources: *Water Policy in the Southern High Plains: A Farm Level Analysis*, Chicago, IL	Weinheimer/Johnson
9-Jul	Management Team meeting	
27-31-Jul	Texas Agriscience Educator Summer Conference, Lubbock	Doerfert/Jones
6-Aug	Management Team meeting	
17-19-Aug	TAWC NRCS/Congressional tour and presentations, Lubbock, New Deal & Muncy	TAWC participants
27-Aug	Panhandle Association of Soil and Water Conservation Districts	Kellison
10-Sep	Management Team meeting	
8-Oct	Management Team meeting	
9-Oct	Presentation to visiting group from Colombia, TTU campus, Lubbock	Kellison
13-Oct	Briscoe County Field day, Silverton, TX	Kellison
1-5-Nov	Annual Meetings of the American Society of Agronomy, oral presentations: *Evapotranspiration of Irrigated and Dryland Cotton Fields Determined Using Eddy Covariance and Penman-Monteith Methods,* and *Relation Between Soil Surface Resistance and Soil Surface Reflectance,* poster presentation: *Variable Rate Nitrogen Application in Cotton Using Commercially Available Satellite and Aircraft Imagery,"* Pittsburgh, PA	Maas/Rajan
10-12-Nov	Cotton Incorporated Precision Agriculture Workshop: *Biomass Indices*, Austin, TX	Rajan/Maas
12-Nov	Management Team meeting	
Dec	United Farm Industries Board of Directors: *Irrigated Agriculture,* Lubbock	Johnson/Weinheimer
Dec	Fox 34 TV interview, Ramar Communications, Lubbock	Allen
1-3-Dec	Amarillo Farm Show, Amarillo	Doerfert/Jones/Oates/ Kellison
3-Dec	Management Team meeting	
10-Dec	TAWC Producer Board meeting, Lockney	Kellison/Weinheimer/Maas
14-Dec	Round Table meeting with Todd Staples, Lubbock, TX	Kellison
12-18-Dec	Fall meeting, American Geophysical Union: *Vegetation cover mapping at multiple scales using MODIS, Landsat, RapidEye, and Aircraft imageries in the Texas High Plains,* San Francisco, CA	Rajan/Maas

2010

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

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

2011

Date	**Presentation**	**Spokesperson(s)**
13-Jan	High Plains Irrigation Conference	Kellison
13-Jan	TAWC Management Team meeting	
18-Jan	Fox Talk 950 AM radio interview	Doerfert/Graber/Sullivan
24-Jan	Wilbur-Ellis Company	Kellison
25-Jan	Caprock Crop Conference	Kellison
4-Feb	KJTV-Fox 34 Ag Day news program: *TAWC rep discusses optimal irrigation, Field Day preview*, Lubbock, TX	Glodt
6-8-Feb	American Society of Agronomy Southern Regional Meeting: *Seasonal Ground Cover for Crops in The Texas High Plains*, Corpus Christi, TX	Maas/Rajan
7-Feb	KJTV-Fox 34 Ag Day news program: *Risk management specialist gives best marketing options for your crop*, Lubbock, TX	Yates
8-Feb	KJTV-Fox 34 Ag Day news program: *Producer Glenn Schur shares his water conservation tips*, Lubbock, TX	Schur
8-10-Feb	Southwest Farm & Ranch Classic (TAWC booth), Lubbock, TX	Doerfert/Graber/Sullivan

9-Feb	Southwest Farm & Ranch Classic: *Managing Warm Season Annual Forages on the South Plains*, Lubbock, TX	Trostle
9-Feb	KJTV-Fox 34 Ag Day news program: *Rep of the HPWD discusses possible water restrictions*, Lubbock, TX	Carmon McCain
10-Feb	Hale County Crops meeting, Plainview, TX	Trostle
17-Feb	TAWC Management Team meeting	
23-Feb	Pioneer Hybrids	Kellison
24-Feb	2011 Production Agriculture Planning Workshop, Muncy, TX	TAWC participants
25-Feb	KJTV-Fox 34 Ag Day news program: *Producers gain knowledge about water conservation at TAWC Field Day*, Lubbock, TX	Doerfert
4-Mar	Texas Tech Forage class	Kellison
10-Mar	TAWC Management Team meeting (Maas presentation)	
30-Mar	West Texas Mesonet (Wes Burgett), TTU Reese Center, Lubbock, TX	Kellison/Brown/Maas/Rajan /Weinheimer
31-Mar—1-Apr	Texas Cotton Ginners Show (TAWC booth), Lubbock, TX	Doerfert/Graber/Sullivan
13-Apr	USDA-ARS/Ogallala Aquifer project (David Brauer), Lubbock, TX	Kellison/TAWC participants
13-Apr	KJTV-Fox 34 Ag Day news program: *TAWC introduces solution tools for producers*, Lubbock, TX	Weinheimer
14-Apr	TAWC Management Team meeting	
18-Apr	KJTV-Fox 34 Ag Day news program: *Cotton overwhelmingly king this year on South Plains*, Lubbock, TX	Boyd Jackson
18-Apr	KJTV-Fox 34 Ag Day news program: *Specialty, rotation crops not popular this growing season*, Lubbock, TX	Trostle
12-May	TAWC Management Team meeting	
17-May	KJTV-Fox 34 Ag Day news program: *Tools available to maximize irrigation efficiency*, Lubbock, TX	Kellison
18-May	Floydada Rotary Club, Floydada, TX	Kellison
9-Jun	TAWC Management Team meeting	
29-Jun—2-Jul	Joint meetings of the Western Agricultural Economics Association/Canadian Agricultural Economics Society: *Evaluating the Implications of Regional Water Management Strategies: A Comparison of County and Farm Level Analysis,* Banff, Alberta, Canada	Weinheimer
12-14-Jul	UCOWR/NIWR Conference: *Texas Alliance for Water Conservation: An Innovative Approach to Water Conservation: An Overview,* Boulder, CO	Kellison
12-14-Jul	UCOWR/NIWR Conference: *Sunflowers as an Alternative Irrigated Crop on the Southern High Plains*, Boulder, CO	Pate
12-14-Jul	UCOWR/NIWR Conference: *Economic Considerations for Water Conservation: The Texas Alliance for Water Conservation,* Boulder, CO	Weinheimer
12-14-Jul	UCOWR/NIWR Conference: *Determining Crop Water Use in the Texas Alliance for Water Conservation Project*, Boulder, CO	Maas

12-14-Jul	UCOWR/NIWR Conference: *What We Know About Disseminating Water Management Information to Various Stakeholders*, Boulder, CO	Doerfert
12-14-Jul	UCOWR/NIWR Conference: *Assessment of Improved Pasture Alternatives on Texas Alliance for Water Conservation,* Boulder, CO	Kellison
12-14-Jul	UCOWR/NIWR Conference: *Integrating forages and grazing animals to reduce agricultural water use*, Boulder, CO	Brown
21-Jul	TAWC Management Team meeting	
4-Aug	KXDJ-FM news radio interview	Weinheimer
4-Aug	TAWC Field Day, Muncy, TX	TAWC participants
11-Aug	TAWC Management Team meeting	
1-Sep	KJTV-Fox 34 Ag Day news program: *High Plains producers struggling to conserve water in drought*, Lubbock, TX	Boyd Jackson
5-Sep	KJTV-Fox 34 Ag Day news program: *New ideas, concepts emerging from surviving historic drought,* Lubbock, TX	Kellison
8-Sep	TAWC Management Team meeting (Brown presentation)	
29-Sep	Texas & Southwestern Cattle Raiser Association Fall meeting, Lubbock, TX	Kellison
13-Oct	TAWC Management Team meeting (Maas presentation)	
16-19-Oct	Annual Meetings of the American Society of Agronomy: *Satellite-based irrigation scheduling*, San Antonio, TX	Maas/Rajan
16-19-Oct	Annual Meetings of the American Society of Agronomy: *Comparison of carbon, water and energy fluxes between grassland and agricultural ecosystems*, San Antonio, TX	Maas/Rajan
16-19-Oct	Annual Meetings of the Soil Science Society of America: *CO2 and N2O Fluxes in Integrated Crop Livestock Systems* (poster presentation), San Antonio, TX	Lisa Fultz/Marko Davinic/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: *Dynamics of Soil Aggregation and Carbon in Long-Term Integrated Crop-Livestock Agroeceosystems in the Southern High Plains* (poster presentation), San Antonio, TX	Lisa Fultz/Marko Davinic/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: *Long-Term Integrated Crop-Livestock Agroecosystems and the Effect on Soil Carbon* (poster presentation), San Antonio, TX.	Lisa Fultz/Marko Davinic/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: *Soil Microbial Dynamics in Alternative Cropping Systems to Monoculture Cotton in the Southern High Plains*, San Antonio, TX.	Marko Davinic/Lisa Fultz/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: *Soil Fungal Community and Functional Diversity Assessments of Agroecosystems in the Southern High Plains*, San Antonio, TX.	Marko Davinic/Lisa Fultz/Jennifer Moore-Kucera
16-19-Oct	Annual Meetings of the Soil Science Society of America: *Aggregate Stratification Assessment of Soil Bacterial Communities and Organic Matter Composition: Coupling Pyrosequencing and Mid-Infrared Spectroscopy Techniques*, San Antonio, TX.	Marko Davinic/Lisa Fultz/Jennifer Moore-Kucera
6-10-Nov	47th Annual American Water Resources Association: *The Use of Communication Channels Including Social Media Technology by Agricultural Producers and Stakeholders in the State of Texas*, Albuquerque, NM	Doerfert/Graber

6-10-Nov	47th Annual American Water Resources Association: *What We Know About Disseminating Water Management Information to Various Stakeholders*, Albuquerque, NM	Doerfert, et al.
6-10-Nov	47th Annual American Water Resources Association: *The Water Management and Conservation Instructional Needs of Texas Agriculture Science Teachers*, Albuquerque, NM	Doerfert/Sullivan
6-10-Nov	47th Annual American Water Resources Association: *The Attitudes and Opinions of Agricultural Producers Toward Sustainable Agriculture on the High Plains of Texas*, Albuquerque, NM	Doerfert, et al.
6-10-Nov	47th Annual American Water Resources Association: *The Issues That Matter Most to Agricultural Stakeholders: A Framework for Future Research* (poster presentation), Albuquerque, NM	Sullivan/Doerfert, et al.
10-Nov	TAWC Management Team meeting	
18-Nov	39th Annual Bankers Agricultural Credit Conference, Lubbock, TX	Kellison
22-Nov	KJTV 950 AM AgTalk radio interview	Trostle
29-Nov—1-Dec	Amarillo Farm Show (TAWC booth), Amarillo, TX	Doerfert/Graber/Sullivan/Kellison /Borgstedt
7-Dec	Plainview Lions Club, Plainview, TX	Kellison
8-Dec	TAWC Management Team meeting	
13-Dec	Channel Bio Water Summit (TAWC booth), Amarillo, TX	Borgstedt/Sullivan/Graber

2012

Date	**Presentation**	**Spokesperson(s)**
6-Mar	Lubbock Kiwanis Club	Kellison
7-Mar	Monthly Management Team Meeting	Kellison
23-Mar	New Mexico Ag Bankers Conference	Kellison, Klose
3-Apr	AgriLife Extension Meeting	Kellison
12-Apr	Monthly Management Team Meeting	Kellison
10-May	Monthly Management Team Meeting	Kellison
10-May	Carilllon Center	Kellison
11-May	Tours-Comer Tuck with the Texas Water Development Board	Kellison
14-May	Tours-Farm Journal Media	Kellison
17-May	Tours-Secretary of State Group	Kellison
14-June	Monthly Management Team Meeting	Kellison
19-June	Lloyd Author Farm	Kellison

20-June	Blake Davis Farm	Kellison
21-June	Glenn Schur Farm	Kellison
10-July	Tours-Justin Weinheimer	Kellison
12-July	Texas Agricultural Coop Council	Kellison
12-July	Texas Independent Ginners Conference	Kellison
18-July	Monthly Management Team Meeting	Kellison
16-Aug	Monthly Management Team Meeting	Kellison
5-Sep	Leadership Sorghum Class 1	Kellison
20-Sep	Monthly Management Team Meeting	Kellison
18-Oct	Monthly Management Team Meeting	Kellison
24-Oct	Texas Agriculture Lifetime Leadership	Kellison
30-Oct	Special Management Team Meeting	Kellison
8-Nov	Monthly Management Team Meeting	Kellison
27-28-Nov	Amarillo Farm & Ranch Show	Borgstedt/Doerfert/Kellison
13-Dec	Monthly Management Team Meeting	Kellison
16-18-Nov	48th Annual American Water Resources Association conference	Doerfert/Kellison/P. Johnson/Maas
20-Nov	Special Management Team Meeting	Kellison
3-Jan	KFLP Radio	Kellison
7-9-Jan	Beltwide Cotton Conference	Doerfert
15-Jan	Fox 950 AM	Doerfert
4-Feb	Texas Seed Trade Association	Kellison
14-Feb	Monthly Management Team meeting	Kellison
21-Mar	Monthly Management Team meeting	Kellison
29-30-Mar	Texas Gin Association Convention	Borgstedt/Doerfert
11-Apr	Monthly Management Team meeting	Kellison

2013

Date	Presentation	Spokesperson(s)
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

Date	Presentation	Spokesperson(s)
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

Date	Presentation	Spokesperson(s)
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

Related Non-Refereed Publications
(Phase I - 2005-2013/Phase II – 2014-2015)

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

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

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

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

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

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

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

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. 48th 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. 48th 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. 48th 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.

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Phase I - Budget

Table A 38. Final task and expense budget for Phase I Years 1-9 of the demonstration project.

2005-358-014		Year 1	Year 2	Year 3		Year 4	Year 5	Year 6	Year 7	Year 8	Final Year	
		(9/22/04 - 1/31/06)	(2/01/06 - 2/28/07)	(3/01/07 - 2/29/08)		(3/01/08 - 2/28/09)	(03/01/09 - 2/28/10)	03/01/10 - 2/28/11	03/01/11 - 2/29/12	03/01/12 - 2/28/13	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	**Year 2**	**Year 3**		**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Final Year**	
Expense Budget	**Total Budget***	(09/22/04 - 01/31/06)	(02/01/06 - 02/28/07)	(3/01/07 - 2/29/08)		(3/01/08 - 2/28/09)	(03/01/09 - 2/28/10)	03/01/10 - 2/28/11	03/01/11 - 2/29/12	03/01/12 - 2/28/13	03/01/12 - 4/30/14	**Total Expenses**
Salary and Wages [1]	2,524,172	230,611	304,371	302,411		301,933	259,929	293,198	307,459	300,033	288,676	2,588,620
Fringe[2] (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 39. 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)