2012 North Plains Research Field 12-200 Limited Irrigation Corn Production Study

with Summary Commentary

by

Thomas Marek, Qingwu Xue, Wenwei Xu, Jake Becker, G.J. Michels,

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The North Plains Research Field
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&
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Front cover picture:
Rain storm at sunset (royalty free).

Report compiled and edited by Thomas Marek.

Table of Contents

List of Figures

List of Tables

Abbreviations

bu - bushels

bu/ac – bushels per acre

CP1 - center pivot #1

ET - evapotranspiration

ETc - crop ET

GDD - growing degree day

gpm/ac – gallons per minute per acre (a water to land application capacity term)

GPS - global positioning system

lb/ac – pounds per acre

LESA – low elevation, sprinkler application

NDVI - Normalized Difference Vegetative Index

NPGCD – North Plains Groundwater Conservation District (Hdqtrs. at Dumas, Texas)

NPET – North Plains Evapotranspiration Network (northern part of TXHPET)

NPRF – North Plains Research Field

PAW - plant available water

TWDB - Texas Water Development Board

TXHPET - Texas High Plains Evapotranspiration Network

USDA-ARS – Unites States Department of Agriculture-Agricultural Research Service

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Executive Summary

2012 represented the third sequential year of research regarding the limited irrigation 12-200 corn production assessment study at the North Plains Research Field (NPRF) with the yield results being improved from that of the 2011 season but less than of the 2010 season. The study's purpose was to evaluate the field based potential of producing 200 bushels of grain corn using only 12 pumped inches of irrigation water per acre. The 12 inches was strict criteria for the study and every effort was made to get the corn crop to the pollination stage before expenditure of the 12 inches should the season be void of ample or distributed rainfall. The resultant study data was to subsequently be used to evaluate the feasibility of sustainable production and to address the economics of the production practice for producers should the effort ever be put into regulation. Overall, the study was conducted as a potential strategy in irrigation reduction and water conservation efforts within the North Plains Groundwater Conservation District (NPGCD) boundary.

As in the previous two years, three commercially available corn hybrids thought to be top producing hybrids were evaluated in the study and all hybrids were consistent with prior year's selection unless the corn seed was no longer available in which case a very similar hybrid from the same seed company was used. This was the case for the Monsanto corn hybrid. The 2012 year study's cultural practice was also improved with the use of a new strip tillage implement procured by the NPGCD and provided to the NPRF. The unit allowed for less tillage operations and for an improved soil moisture retention approach derived from retained surface residue. It also allowed the study to be conducted on flat ground rather than beds; thus retaining more pre-season moisture as compared to a clean tillage production practice.

Initially, it was outlined in the project that a seasonal rainfall of 10.5 inches was to be required to provide the total water necessary for 200 bushel per acre (11,200 #/ac) production level based on a corn production function derived within the area. Total seasonal rainfall in 2012 amounted to 5.97 inches from May 1 to September 30. This amount was 66 percent more than received in 2011 but only 39 percent of the rainfall received in 2010. Even though increased rainfall fell in 2012 as compared to 2011, only six rainfall events above a 0.5 inch level occurred during the entire growing season at the NPRF site.

2012 yield results were significantly higher than that of 2011 but only averaged approximately 100 bushels per acre (5,600 #/ac) for all of the hybrids. The 2012 yield levels fell well short of the study target. In addition, the yields generally did not agree well with the extrapolated corn production function derived by Marek (2006).

As in prior years, supporting plant growth and status characterization data was acquired throughout the course of the study. Plant population, biomass, initial and concluding soil profile moisture levels were recorded. Irrigation scheduling was conducted as in prior years with an advanced research scheduler developed by Marek (2004). Selected portions of the study supporting data and discussion are contained within this report. New computer capable and controlled equipment obtained by Texas A&M AgriLife, the NPGCD and borrowed from the USDA-ARS during the course of this study significantly assisted in the efficiency of implementation of study operations in 2012 and is greatly appreciated.

The 3 year 12-200 study effort at the NPRF site gained valuable data regarding previously unknown data portions of the corn production function for the region. (Nationally, there appears more interest in this type work with the recent nationwide droughts.) In addition much characterization information regarding the specific varieties was gathered and can potentially be related to other “families of corn hybrids” and to those being developed. For instance, the data gathered indicated that one of the varieties had a pronounced tendency to be a “better” forage variety than a grain producing variety.

The 2012 NPRF effort involved many scientific and supporting personnel from the Texas A&M AgriLife-Amarillo unit research programs of agricultural engineering, agronomy, corn breeding, crop physiology, entomology and agricultural economics as well as agricultural engineering and remote sensing programs from the USDA-ARS at Bushland, Texas. Additionally, a regional crop consultant provided supplemental imagery data over the study site.

Year 2012 NPRF Study Outreach: The 2012 North Plains Research Field Ag Day event was conducted in conjunction with the 200-12 NPGCD producer based corn demonstration effort in the summer (August 23, 2012). The event was headquartered at the NPRF and had excellent turnout and producer attendance. The event included touring the NPRF study and selected other studies and subsequently then the Harold Grall demonstration study (north of Dumas, Texas) near (SW) the research field. 2012 project visibility was publicized by Kirk Welch (NPGCD), and Kay Ledbetter (Texas A&M AgriLife) as well as through area media outlets. Project data was discussed and a study video was made regarding this and other corn efforts at the NPRF and was available on the front page of the Texas AgriLife Research agency website providing high visibility of the study in early 2012.

In summary of the three year effort, this study essentially represents a probability based assessment of rainfall with adequate distribution that must occur, preferably during the growth periods prior to pollination, to allow the maximum flexibility in irrigation scheduling in the later stages of the growing season. The probability of receiving the nominal 10.5 inches amount of rainfall that is required to meet the total crop water needed for 200 bushel production is unlikely and is discussed within the report. The economic impact to producers of implementing a rigid water reduction measure to only 12 inches for producers is also discussed. Assumptions of the economic analysis are included and as producer costs vary across the Texas Panhandle, the Texas A&M AgriLife Extension Service corn production budget values were used as the basis for evaluation. In summary, the consequence of a rigid irrigation restriction could have significant economic impact to producers, assuming that more irrigation capacity is available.

In addition, the true need of addressing water conservation and irrigation reduction issues before a crisis status is attained cannot be overstated. In that view, the study is viewed as a success and certainly worthwhile in terms of the data that was gained and the management items recognized by the parties involved. Selected examples of these recognitions during the course of this study are:

1) that drought based events are part of the rainfall probability distribution function and they can and do in fact occur and can have significant consequence to corn production levels,
2) that when these probability based extreme events occur on a broad enough acreage basis, corn prices tend to spike, sometimes most dramatically and can even rise to unprecedented or even record levels,
3) that the irrigation depth per application generally should be increased to the point that application runoff either does not occur or is minimal (in terms of applied water advancing forward of the application device) to reduce soil evaporation losses (but should be limited to depleted water within the soil root zone profile),
4) manage upper soil profile cracking to the degree possible with irrigation applications and allow for maximum opportunity regarding rapid infiltration potential should large rainfall events occur,
5) implement a delayed corn planting date to shift the peak corn ET requirement and to take advantage of reduced ET requirements typical in the early fall period,
6) the probability of receiving adequate rainfall to produce 200 bu/ac to augment the 12 inches off irrigation water is less than 50% on an annual basis, and
7) the economic implication of reducing production potential for growers that have access to adequate irrigation capacity can be substantial.

This multi-year effort exhibited a significant team effort of many individuals associated with Texas A&M AgriLife Research, the USDA-ARS (Bushland) and was supported in part by Texas A&M AgriLife Research, the NPGCD Board of Directors, the USDA-ARS Water Management Unit and the Ogallala Aquifer Program, and the Texas Corn Producers Board. Thanks of gratitude are extended to each agency and the respective supporting personnel associated with the effort. Real world exposure and training of the agricultural sciences to several young individuals (potentially our future scientists) was accomplished during the course of this study.

This study effort exhibited explicitly the potential range of climatic conditions that can and do occur and the subsequent consequences warranted thereof. The policy and regulatory insight towards both the cost to producers and benefit to water conservation cannot be overstated. The data derived from this and other type similar research and demonstration efforts strongly support sensible groundwater regulation and rules of water conservation management, not only for the region but throughout the western United States.

This report concludes the 3 year NPRF study effort but implicit and analogously managed research based irrigation studies will continue in 2013 and 2014 at the NPRF funded by Texas A&M AgriLife Research, the USDA-ARS Ogallala Aquifer Program and potentially the North Plains Groundwater Conservation District as well as other organizations and commercial industries. Thanks are extended to the NPGCD Board for promoting irrigation based research, demonstration and conservation programs as “Water is the key to life” in the Texas Panhandle. The droughts of 2011 and 2012 strongly reminded both the citizens and policy makers of Texas of that perspective as water and its adequacy for the future is now the number one priority in the current Texas legislative session.

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Introduction

In 2010, the agricultural sector in the Texas Panhandle region known as the Texas Water Development Board's Region A (TWDB, 2010 - see Figure 1) used approximately 88% of the entire total water resource (PWPG, 2010), which is virtually derived entirely from the Ogallala Aquifer. The agricultural water use estimate for 2010 was 1.47 million ac-ft, with irrigation accounting for 97 percent or 1.43 million ac-ft. Recently, revised agricultural water use in the 2016 regional plan estimate that amount to be 1.55 million ac-ft primarily due to new land that has come into irrigated production. Of that amount, corn irrigation is now responsible for over 60% or 912,202 ac-ft of use and is the largest water user of the irrigation sector (Marek, et al., 2012). Irrigation is currently practiced on 533,158 acres of corn annually within Region A with an average irrigation application per acre of 20.53 inches (Marek et al., 2012).

Given that production level and recently record or near record corn prices, corn evapotranspiration (ET_c) demands computed from the North Plains Evapotranspiration (ET) Network (NPET, Marek et al., 1996; TXHPET, Porter et al., 2007) indicate that full crop water demands are unable to be met by most irrigated producers. Reasoning for this is the depleting and reduced well capacity and exasperated by the recent drought conditions in the North Plains

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Groundwater Conservation District (NPGCD-headquartered in Dumas, Texas), particularly in the northwestern part of the District within the counties of Dallam, Hartley, Sherman, and Moore. Thus, the reason of evaluation of this limited water research study at the North Plains Research Field (NPRF- see figure 1 and Figure 2) with the latest commercially available genetically improved varieties.

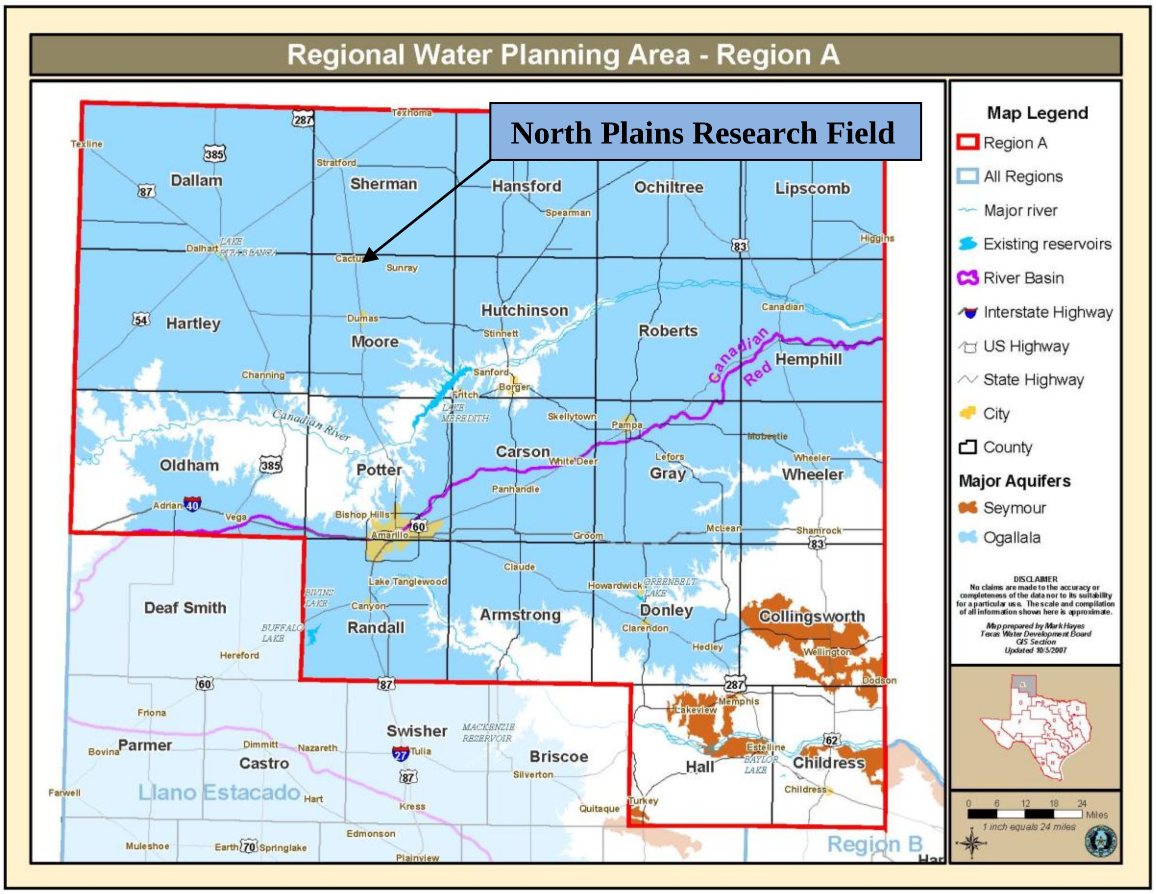

Figure 1. The Texas Panhandle water planning area defined as Region A. (TWDB, 2010).

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Figure 2. North Plains Research Field headquarters facility (1998). (Photo courtesy of Thomas Marek).

Objective

The objective of this project was to assess the potential and feasibility of producing 200 bushel per acre corn yield on up to 12 inches of pumped irrigation water. This production target was based on an extrapolated total water production function derived from data compiled from area research and producer data (see figure 3) by Marek and Cox (2008) and which assumed a fixed grain yield (threshold) point of 10.5 inches of total water (value provided by Howell, personal comm., USDA-ARS, Bushland, Texas). It was originally undetermined as to what the slope of the function was at lower water levels given the lack of controlled research data studies within the region. Production data incurred in 2011 and 2012 provided some insight as to aspects of that concern.

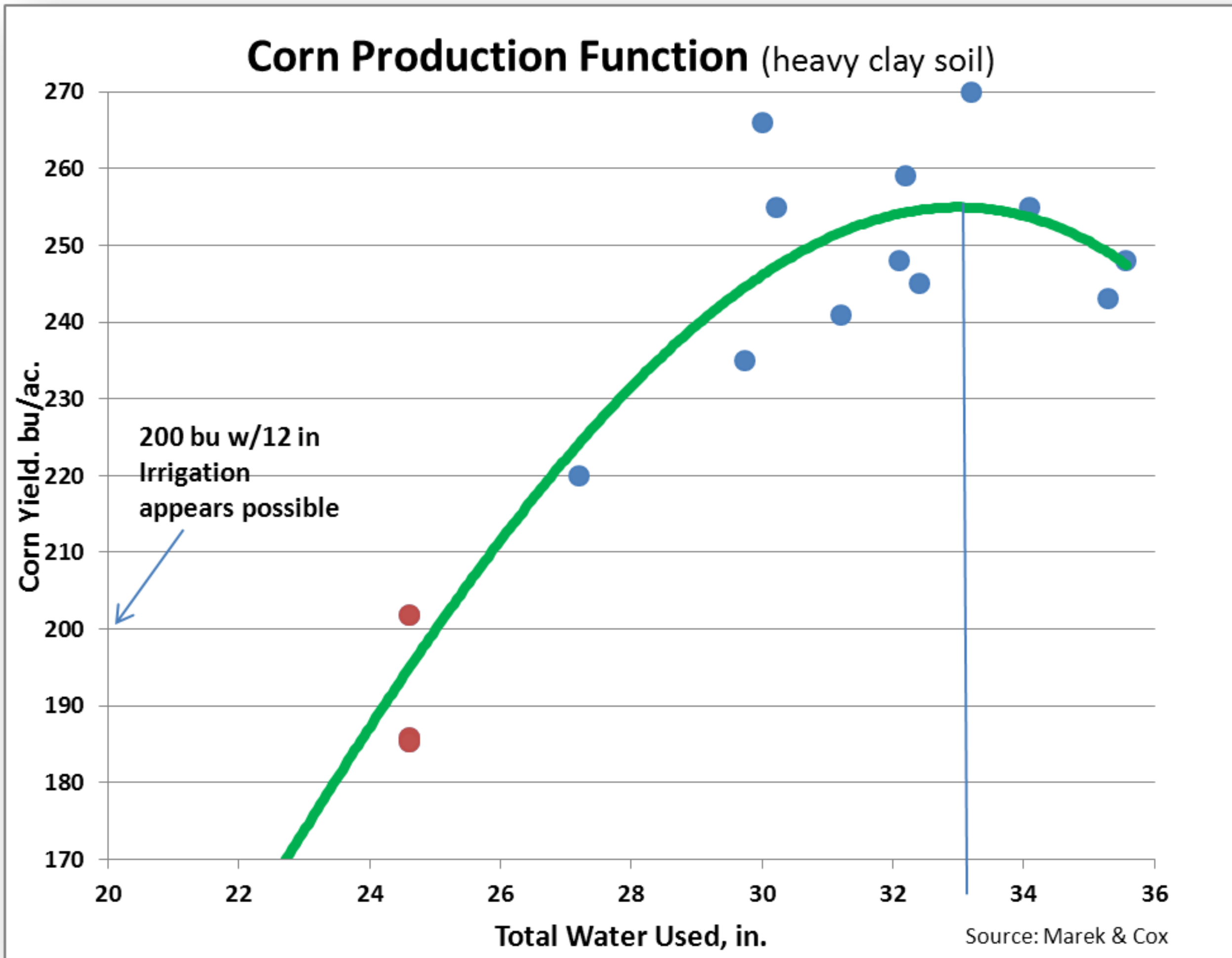

Figure 3. Generalized corn production function – NPRF area. (Marek and Cox, 2008).

Irrigation Approach and Study Activity

This study was to utilize the North Plains Evapotranspiration (ET) Network (NPET, Marek et al., 1996) to schedule a limited irrigation level (as compared to full or 100% corn ET requirement). The study was to address and represent a potential production level based on a declining well capacity condition common to much of the Texas High Plains. Irrigation events for all plots were targeted to be initiated when soil profile plant available water (PAW) reached the 50 percent availability level. Plant available water is defined as the range of soil water holding capacity between 1/3 bar and 15 bars (typically referred to field capacity and wilting point, respectively). Each seasonal irrigation application was targeted to be from 1.25 to 1.5 inches (in depth). Initial irrigation event(s) were to occur anytime following planting to ensure a suitable stand density. The total water pumped and applied to the experimental area was to be limited to a seasonal "pumped" level of 12 inches per acre. From prior data, the application efficiency from the low elevation, sprinkler nozzles (LESA) was assumed to be 90%.

The protocol of this study was to be accomplished by utilizing an experimental protocol that was scientifically based. The revised and implemented project scope included one irrigation level and represented a substantially lower irrigation level than generally practiced within the region by producers. Three commercial corn seed varieties were to be planted at four different nominal planting populations of 20,000, 24,000, 28,000 and 32,000 seeds per acre. The plots were to be of moderately large treatment size, per desire of the NPGCD Board, with the dimensions of 30 feet wide by 300 feet long. Each treatment was to be replicated four times in a completely randomized manner to increase the power of test regarding the varietal differences.

Research PI personnel involved in the 2012 effort were Thomas Marek, Qingwu Xue, Wenwei Xu, Jerry Michels, John Sweeten, Terry Howell and Prasanna Gowda. Additional support technicians and student workers participated at routine and selected times and as necessary to gather the respective disciplinary data of the project and included Tommy Moore, Curtis Schwertner, Erica Cox, and Jake Becker.

Data assessments were to include pre-planting and post-harvest soil moisture and fertility, irrigation records, in-season moisture profiling, ET_c (crop ET or water use) and rainfall, crop physiology, insect monitoring with control events and economic parameters.

Wenwei Xu was responsible for the varietal selections. The pre-planting and post-harvest soil moisture assessments were performed by Qingwu Xue and his respective support staff. The pre and post season fertility assessments were performed by Jake Becker. The irrigation applications and records were determined and retained by Thomas Marek and Erica Cox. Irrigation applications were conducted by Thomas Marek, Tommy Moore, Curtis Schwertner and Erica Cox. In-season moisture profiling was also monitored by an AquaSpy™ sensor, although it was not used in the scheduling of events. The crop physiology study aspects were performed by Qingwu Xue and his support staff. Modified corn ET_c values and effective rainfall records were determined by Thomas Marek, Terry Howell and Erica Cox. Insect monitoring and control determinations were performed by Jerry Michels. 2012 economic parameters were recorded by Thomas Marek and Erica Cox and the project feasibility analysis was performed by Steve Amosson, Thomas Marek and Bridget Guerrero.

Other tasks and activities included seed procurement and acquisition, tillage, fertility, planting, analysis/results computations, preparation, presentation and report compilation and editing. Seed procurement was conducted by Wenwei Xu and Thomas Marek. Fertilizer application and tillage was coordinated by Thomas Marek, Jake Becker and Tommy Moore. Study planting was performed by Thomas Marek, Tommy Moore, Curtis Schwertner, Jake Becker, Qingwu Xue, Gautam Pradhan, Kyle Reinart and Preston Sirmon in 2012. Hand harvesting and processing were conducted by Qingwu Xue and the crop physiology crew. Field plot harvesting using a small plot Massey Ferguson plot mapping combine was conducted by Jake Becker. Field plot harvesting was again not conducted with a JD 9500™ yield mapping combine in 2012 as production levels were far too low for an adequate processed sample size; thus, only hand samples were appropriate given the variable ear and kernel plus cob size in 2012. The 2012 analysis and results were performed by the respective principal and disciplinary scientific members involved in the project.

Outreach activities were planned into the study annually. A summer Ag Day function was scheduled to occur at the NPRF regarding outcome of the study results and a nearby NPGCD counterpart demonstration study in 2012. Study visibility through media outlets was conducted in 2012 and the NPRF had a record number of visits from seed company and commodity personnel.

As scheduled, tasks and activities went as outlined within the responsible disciplines. Study results are scheduled to be presented to the NPGCD Board by Thomas Marek and Qingwu Xue on February 12th, 2013 in Dumas, Texas. This 2012 annual report was compiled and edited by Thomas Marek and represents data contributions from the entire 2012 multi-disciplinary project member team from Texas AgriLife and the USDA-ARS.

Methodology

The 2012 test plots were established and irrigated using a center pivot sprinkler system with a capacity of near 7.0 gpm/ac at the North Plains Research Field near Etter, TX (36° 00′ N. latitude, 101° 59′ W. longitude, 3,618 feet elevation). Initial irrigations were applied at a uniform level for the study and had a nominal targeted trigger level of 50 percent PAW. Adjustment to the amount applied varied as the dryness of the soil profile conditions warranted and mitigated by the planned number of events working against the 12 inch irrigation limit.

Three commercial varieties of corn seed were flat planted in rows spaced 30 inches apart in plots measuring 30 feet wide by 300 feet long (MOA contract requirement). The 2012 varieties were Monsanto™ DK67-88, Pioneer™ P31G96, and Pioneer™ P33D49. Each variety was planted using a new JD™ planter at the four targeted planting populations of 20k, 24k, 28k and 32k plants per acre. Plots were located in a corn-wheat rotation sequence of the NPRF and as such were located within the east NPRF center pivot system (known as CP1) following a limited water wheat crop. The plots in 2012 were arranged in spans five, six and seven of the southwest quarter of CP1. To minimize plot wheel-trafficking in 2012 during planting and provide for improved water management, plots were laid out within a quarter circle with planting completed in a single pass, changing treatment boxes at each ½ width (6 row) plot. This process required more study personnel but with the aid of a multiple variety seed box carrier (as in 2011), field compaction was greatly reduced as compared to the first planting effort in 2010. In addition with the use of GPS guided tractor, the plots were planted on flat ground (versus bedded) and in the circular plots. All plot planting was conducted in a serpentine manner using a 6 row planter with adjoining passes to establish the respective 12 row plot width.

In total there were 48 plots established for this three commercial variety study (see Figure 4). Each plot was designed with an end buffer length of at least 100 feet from the center pivot field midline road. Plots were located in the interior of the field to utilize the inner and outer edges of the field as a buffer from edge effects of wind, sensible heat, blowing dust, etc. Outer edge buffers were established at least 15 feet for each plot. Plot replications were statistically arranged in a completely randomized design layout, as in prior years. Each plot was also buffered by 15 feet from the wheel tracks within each center pivot span. All plots were strip tilled, flat planted in a circular layout to minimize runoff and cross treatment transfer of any waters from adjacent plots. The target planting date was May 10th to be comparable to that of the 2010 and the 2011 effort. The study plots were planted on May 7 and 8, 2012. Soil moisture conditions were much better than those in 2011 as a significant rainfall event accounted for filling much of the profile as shown in Figure 1. (Soil profile moisture status was validated prior to planting by soil sampling).

One non-governing fertility strategy was used for all test plots, which consisted of the fertility target levels of 117.7 lb/ac nitrogen and 50.6 lb/ac phosphorus. Fertilizer was applied by the new strip-till applicator equipment pre-plant using the GPS guidance system. (After some initial adjustments on guidance sensitivity controls, accuracy was generally controlled to 1 inch. Irrigation events were scheduled using a research based irrigation scheduler that utilized the North Plains ET Network's daily corn ET values derived from the Etter location, computed effective rainfall, soil profile parameters and stress based crop indices. Weed control was achieved by pre-season and post- planting herbicides. The pre-emerge herbicide application consisted of Bicep Lite II Magnum @ 1.25 qt/A, Balance Flexx @ 3 oz/A, Medal II @ 0.8 pt/A and glyphosate @ 1.5 pt/A. Two post season herbicide applications were made: May 11 – glyphosate @ 40 oz/A plus Sharpen @ 2 oz/A, and June 11 – Option @ 1.5 oz/A, Status @ 8 oz/A, plus glyphosate @ 1.5 pt/A. Plots were harvested using both a hand sampling of 20 (consecutive) plants per plot (and with a two-row small plot combine but again in 2012 due to the problems of small and variable ear length and cob diameter, this data is not considered adequately representative and is not reported. The 20 ears sampling protocol duplicated the 2011 sampling number and was double that of the 2010 sampling number to obtain a representative yield sample given the stressed conditions and lower yield values.

<u>Dates of 2012 NPRF 12-200 study field activities were as follows</u>:

Strip-till fertilizer application: March 28, 2012
Field plot layout: May 6, 2012
Planting: May 7 & 8, 2012
Pre-emerge herbicide application: May 5, 2012
Post herbicide applications: May 11 and June 11, 2012
In-season fertilizer applications: July 6, 2012
Hand harvesting: September 21, 2012
Field harvesting (plot combine): September 30, 2012

Span	Plot #	Random #	Variety X & Rep Y	"Variety"	"Population"	"Rep"	"Drive"	"Driven"	Layer Color Code	Autocad Color Code
Span 4; Ring	4–1			"V"	"P"	"R"				
Span 4; Ring 1	4–2									
Span 4; Ring 2	4–3									
Span 4; Ring 2	4–4									
Span 4; Ring 3	4–5									
Span 4; Ring 3	4–6									
Span 4; Ring 4	4–7									
Span 4; Ring 4	4–8									
Span 4; Ring 5	4–9									
Span 4; Ring 5	4–10			"V"	"P"	"R"				
Span 5; Ring 1	5–1	34	V3P2R3	PIO-33D49	24K	3	26	28		206
Span 5; Ring 1	5–2	26	V1P2R3	DKC67-88	24K	3	26	28		162
Span 5; Ring 1	5–3	27	V1P3R3	DKC67-88	28K	3	30	28		150
Span 5; Ring 2	5–4	14	V1P2R2	DKC67-88	24K	2	26	28		162
Span 5; Ring 2	5–5	45	V3P1R4	PIO-33D49	20K	4	14	18		208
Span 5; Ring 2	5–6	48	V3P4R4	PIO-33D49	32K	4	22	18		201
Span 5; Ring 3	5–7	1	V1P1R1	DKC67-88	20K	1	14	18		168
Span 5; Ring 3	5–8	32	V2P4R3	PIO-31G96	32K	3	22	18		81
Span 5; Ring 3	5–9	33	V3P1R3	PIO-33D49	20K	3	14	18		208
Span 5; Ring 4	5–10	28	V1P4R3	DKC67-88	32K	3	22	18		151
Span 5; Ring 4	5–11	2	V1P2R1	DKC67-88	24K	1	26	28		162
Span 5; Ring 4	5–12	16	V1P4R2	DKC67-88	32K	2	22	18		151
Span 5; Ring 5	5–13	41	V2P1R4	PIO-31G96	20K	4	14	18		88
Span 5; Ring 5	5–14	39	V1P3R4	DKC67-88	28K	4	30	28		150
Span 5; Ring 5	5–15	13	V1P1R2	DKC67-88	20K	2	14	18		168
Span 6; Ring 1	6–1	36	V3P4R3	PIO-33D49	32K	3	22	18		201
Span 6; Ring 1	6–2	35	V3P3R3	PIO-33D49	28K	3	30	28		200
Span 6; Ring 1	6–3	38	V1P2R4	DKC67-88	24K	4	26	28		162
Span 6; Ring 1	6–4	29	V2P1R3	PIO-31G96	20K	3	14	18		88
Span 6; Ring 2	6–5	11	V3P3R1	PIO-33D49	28K	1	30	28		200
Span 6; Ring 2	6–6	15	V1P3R2	DKC67-88	28K	2	30	28		150
Span 6; Ring 2	6–7	21	V3P1R2	PIO-33D49	20K	2	14	18		208
Span 6; Ring 2	6–8	31	V2P3R3	PIO-31G96	28K	3	30	28		80
Span 6; Ring 3	6–9	40	V1P4R4	DKC67-88	32K	4	22	18		151
Span 6; Ring 3	6–10	12	V3P4R1	PIO-33D49	32K	1	22	18		201
Span 6; Ring 3	6–11	7	V2P3R1	PIO-31G96	28K	1	30	28		80
Span 6; Ring 3	6–12	44	V2P4R4	PIO-31G96	32K	4	22	18		81
Span 6; Ring 4	6–13	22	V3P2R2	PIO-33D49	24K	2	26	28		206
Span 6; Ring 4	6–14	6	V2P2R1	PIO-31G96	24K	1	26	28		84
Span 6; Ring 4	6–15	20	V2P4R2	PIO-31G96	32K	2	22	18		81
Span 6; Ring 4	6–16	25	V1P1R3	DKC67-88	20K	3	14	18		168
Span 6; Ring 5	6–17	18	V2P2R2	PIO-31G96	24K	2	26	28		84
Span 6; Ring 5	6–18	10	V3P2R1	PIO-33D49	24K	1	26	28		206
Span 6; Ring 5	6–19	17	V2P1R2	PIO-31G96	20K	2	14	18		88
Span 6; Ring 5	6–20	43	V2P3R4	PIO-31G96	28K	4	30	28		80
Span 7; Ring 1	7–1	3	V1P3R1	DKC67-88	28K	1	30	28		150
Span 7; Ring 1	7–2	9	V3P1R1	PIO-33D49	20K	1	14	18		208
Span 7; Ring 1	7–3	30	V2P2R3	PIO-31G96	24K	3	26	28		84
Span 7; Ring 1	7–4	46	V3P2R4	PIO-33D49	24K	4	26	28		206
Span 7; Ring 1	7–5	5	V2P1R1	PIO-31G96	20K	1	14	18		88
Span 7; Ring 2	7–6	42	V2P2R4	PIO-31G96	24K	4	26	28		84
Span 7; Ring 2	7–7	23	V3P3R2	PIO-33D49	28K	2	30	28		200
Span 7; Ring 2	7–8	24	V3P4R2	PIO-33D49	32K	2	22	18		201
Span 7; Ring 2	7–9	8	V2P4R1	PIO-31G96	32K	1	22	18		81
Span 7; Ring 2	7–10	37	V1P1R4	DKC67-88	20K	4	14	18		168
Span 7; Ring 3	7–11	19	V2P3R2	PIO-31G96	28K	2	30	28		80
Span 7; Ring 3	7–12	4	V1P4R1	DKC67-88	32K	1	22	18		151
Span 7; Ring 3	7–13	47	V3P3R4	PIO-33D49	28K	4	30	28		200
Span 7; Ring 3	7–XU	0	0	XU						252
Span 7; Ring 3	7–XU	0	0	XU						252
Span 7; Ring 4	7–16			**Not there are 8 XU plots @80' each after plot 7–13 of the 12/200 study.						
Span 7; Ring 4	7–17									
Span 7; Ring 4	7–18									
Span 7; Ring 4	7–19									
Span 7; Ring 4	7–20									
Span 7; Ring 5	7–21									
Span 7; Ring 5	7–22									
Span 7; Ring 5	7–23									
Span 7; Ring 5	7–24									
Span 7; Ring 5	7–25									

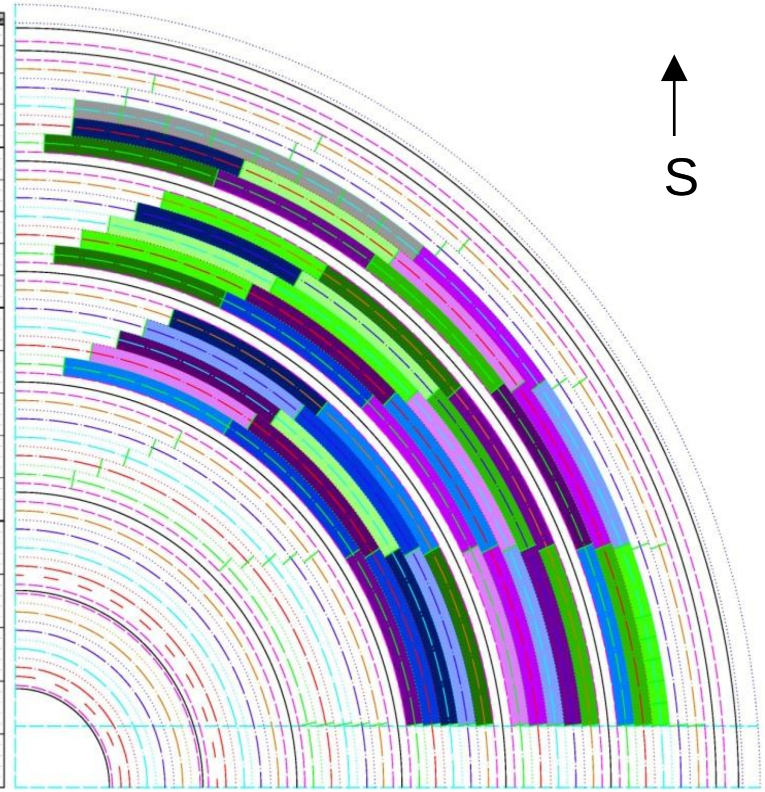

Figure 4. 2012 NPRF 12-200 study plot layout within CP1-(SW quadrant) (Source: T. Marek).

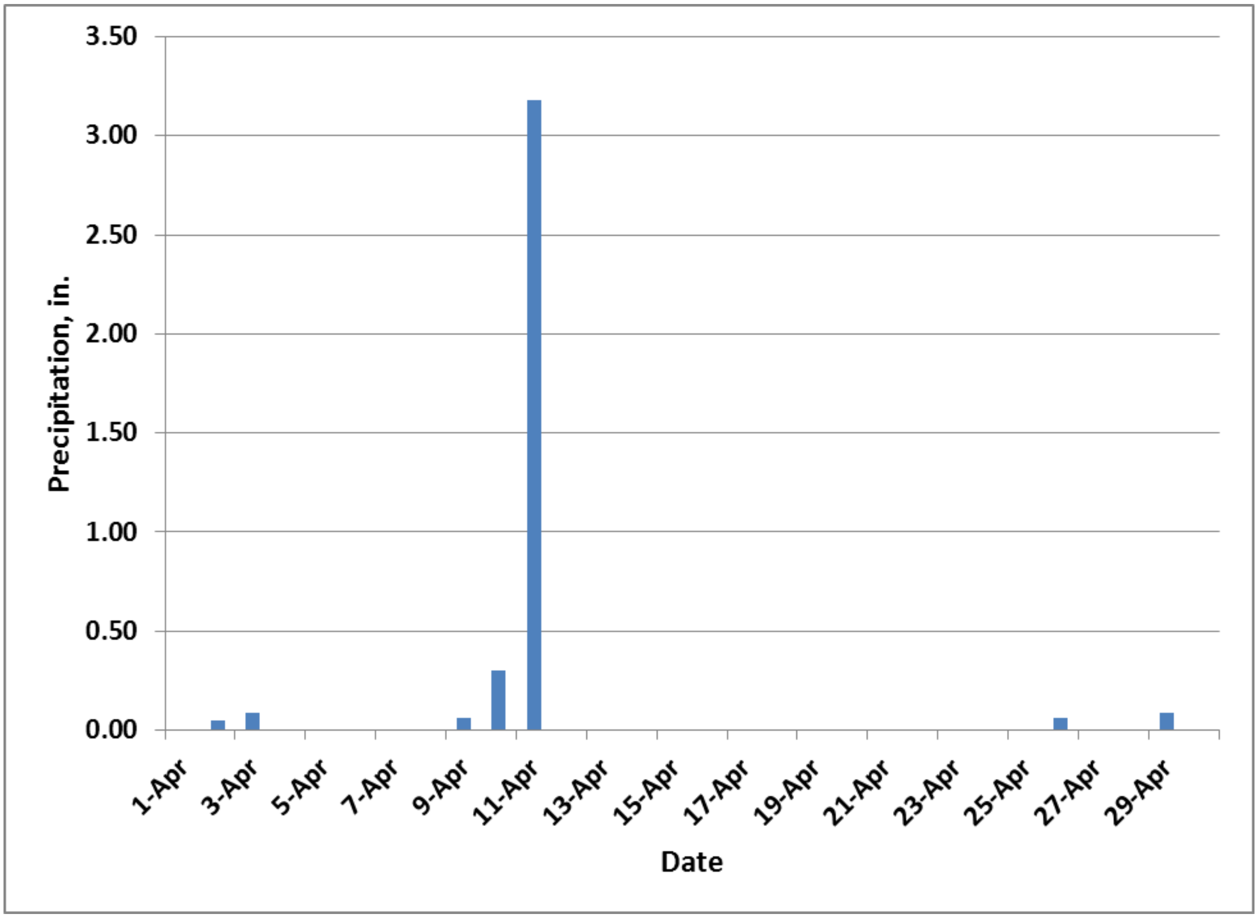

Figure 5. 2012 North Plains Research Field April precipitation events.

2012 Data and Results Discussion

<u>Yield</u>

The 2012 NPRF limited water corn yields and characteristics are presented Table 1 based on the hand harvesting of 20 plants per plot and adjusted for actual plant population. Included are the corn densities and harvest index for each of the study treatments. The amount of irrigation pumped during the 2012 growing season was 12.07 inches with an assumed effective applied irrigation amount of 10.86 inches based on an overall average seasonal application efficiency of 90%. Total rainfall recorded during the course of the corn growing season totaled 4.41 inches, with a computed effective seasonal rainfall amount of only 0.52 inches. Figure 6 indicates the distribution of precipitation received at the NPRF during the spring and summer of 2012. Total plot crop water utilized in 2012 ranged from 21.5 to 22.3 inches. The three commercial variety yield values (designated by three green dots in graph) indicate as to where the 2012 study yields "fell" in relation for the northern Texas High Plains crop production function in figure 7. A graphical comparison of the yields is provided in figure 8.

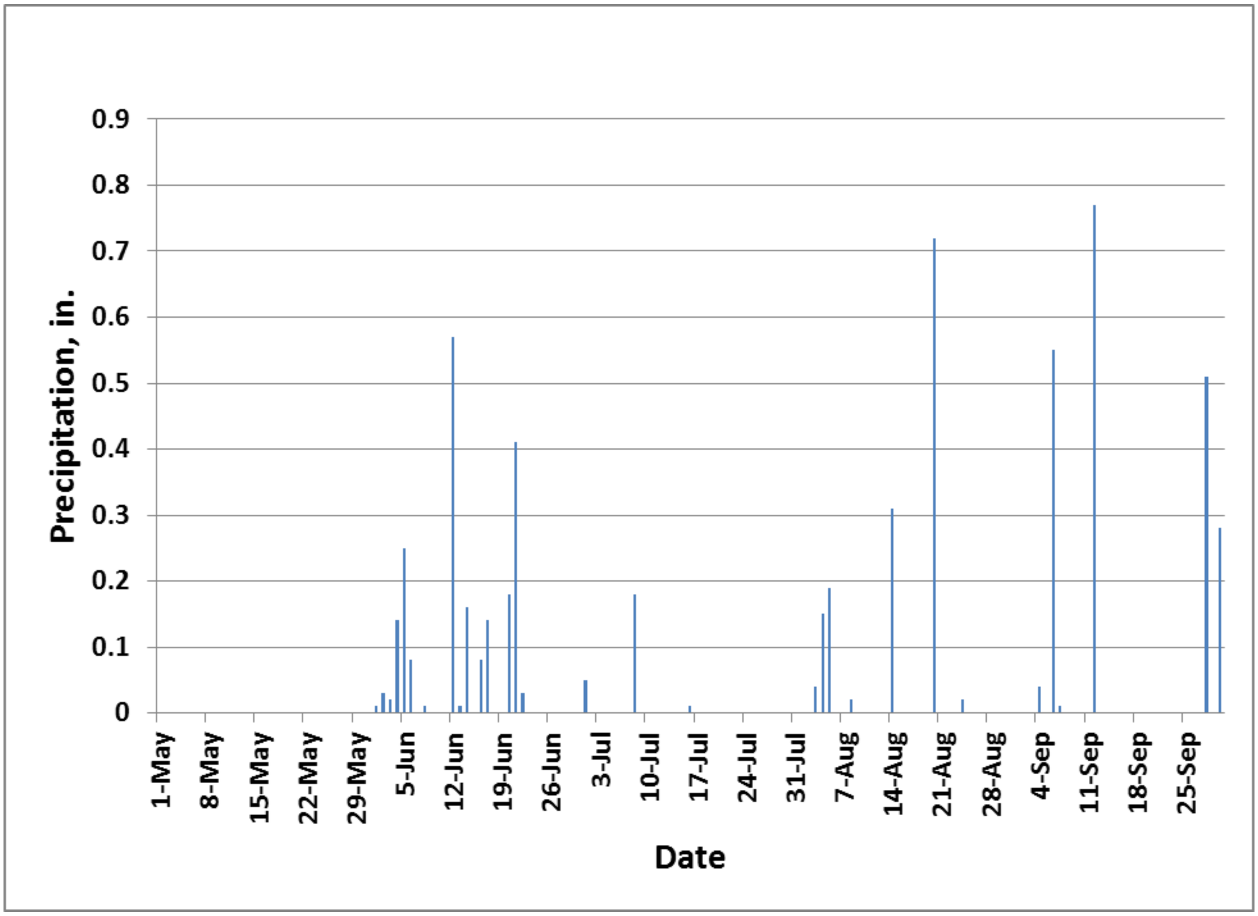

Figure 6. Precipitation graph for the 2012 corn growing season at the NPRF.

The three (green color) mid level points from the 2012 yields to the generalized corn production function does not fall on the function line well and fell substantially below the function line. This was not expected and can be possibly attributed to several factors, given the distribution of seasonal conditions and rainfall distribution. First, the available soil profile moisture was adequate at planting but the high wind conditions quickly dried out the upper 2 inches of the soil and an irrigation had to be used to get the corn up and growing. Once the emergence goal was accomplished, the corn used water within the soil profile to growth rapidly (see Figure 12). This rapid growth was reflected in the crop staging records, as reflected in Table 6. Given the 2012 yield results, this "unregulated" early plant growth may not be desired and will be discussed later.

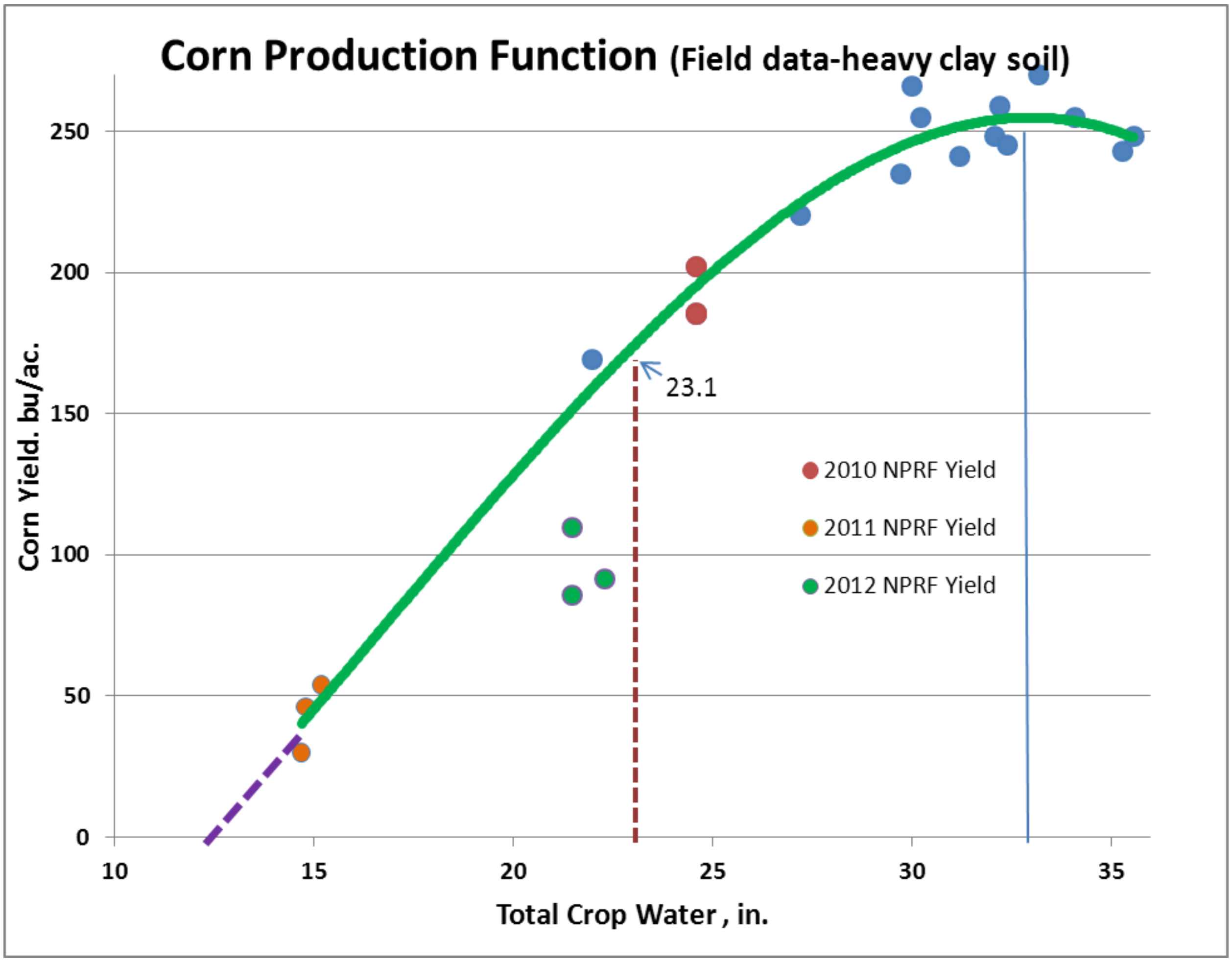

Figure 7. Updated generalized NPRF area corn production function with 2010, 2011 and 2012 12-200 data – (Marek and Cox, 2012).

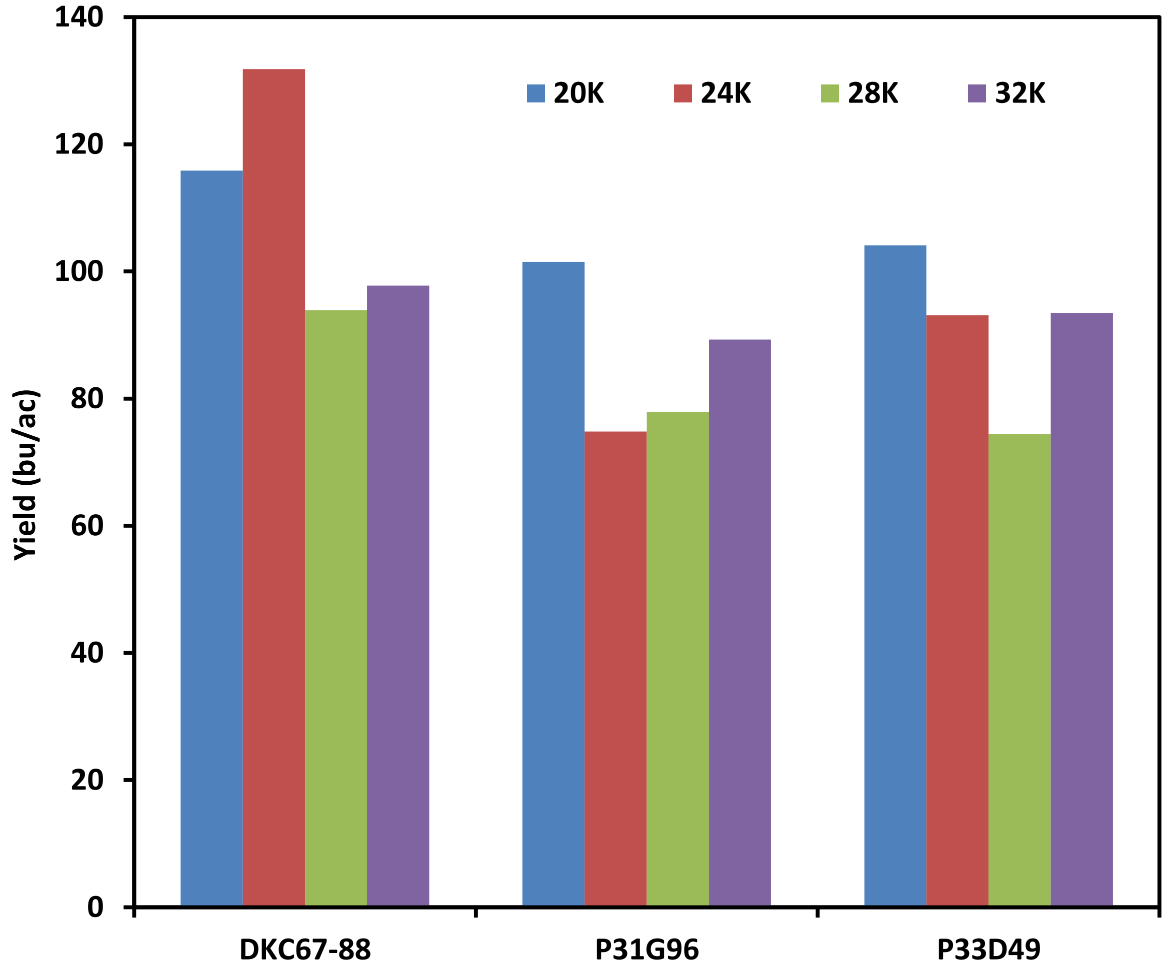

Figure 8. Comparison of the 2012 NPRF 12-200 study hybrid yields.

2012 Water use efficiency (WUE), biomass, harvest index (HI) and yield components

Since rainfall was substantially limited in both May and July of 2012 and the 12 inches of irrigation was expended during the season the plants experienced moderate to severe water and heat stresses during the grain filling period. As a result, water use efficiency (WUE) values were generally lower than expected (see Table 1) except for the Monsanto variety. The Monsanto variety had highest average yield. Among the yield components, the highest yield was associated with more kernel weight per plant. For example, the DKC67-88 variety accounted for 17% and 37% more yield over the Pioneer varieties (see Table 1).

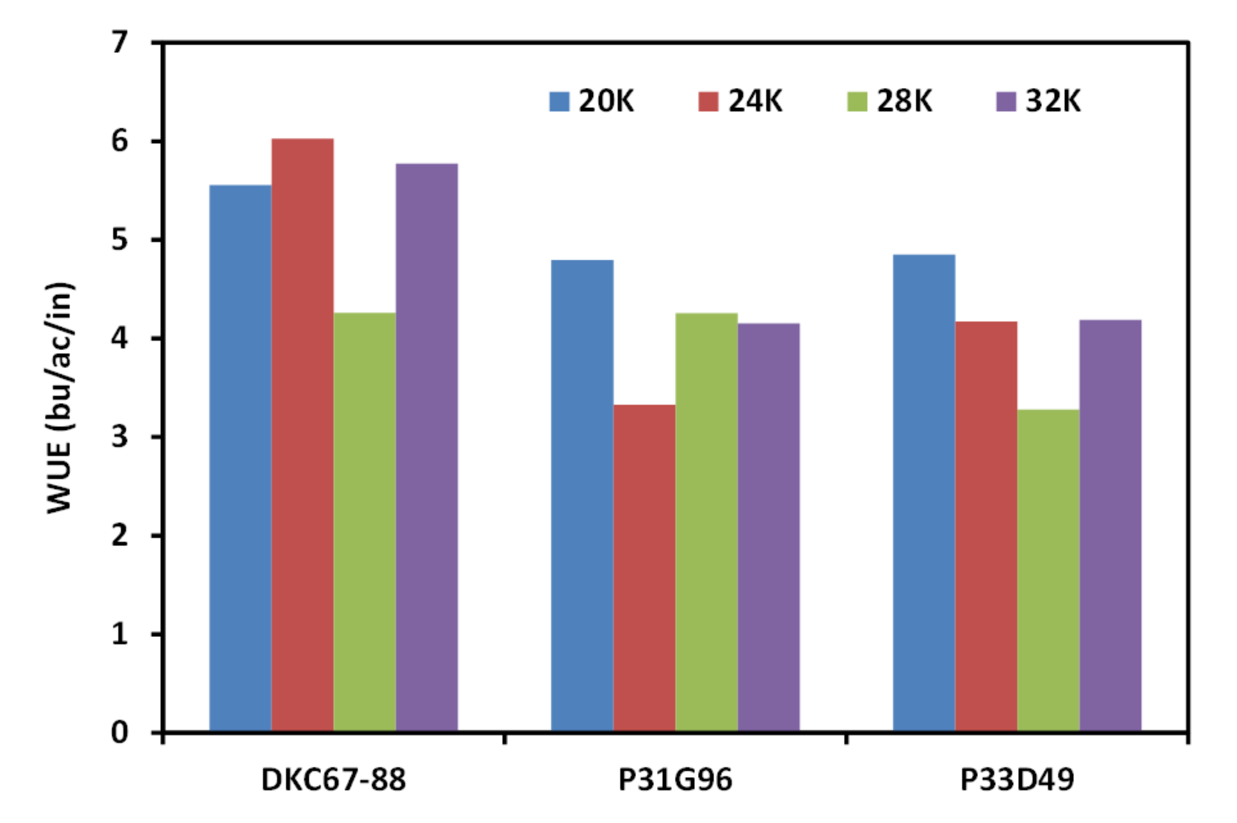

Figure 9. Comparison of the 2012 NPRF 12-200 study water use values.

Table 1. Yield components for three hybrids at four planting densities under the limited irrigation 12-200 study at the NPRF, Etter, Texas.

Hybrid	Planting density (PD)	Yield	ETc	WUE	Biomass	HI	Test weight	Kernel numbers		Kernel mass
	plants/ac	bu/ac	in	bu/ac/in	Mg/ha		lb/bu	no./m^2	no./plant	mg/kernal
DKC67-88	20,000	115.9	20.6	5.56	14.06	0.432	58.9	2839.1	533.5	213.3
	24,000	131.8	21.8	6.03	15.79	0.442	58.7	3329.4	538.5	212.2
	28,000	93.9	22.1	4.26	13.59	0.367	58.0	2375.9	335.1	210.2
	32,000	97.8	21.5	5.78	14.39	0.332	58.3	2135.7	395.9	183.7
	Mean	**109.8**	**21.5**	**5.41**	**14.46**	**0.393**	**58.5**	**2670.0**	**450.7**	**204.8**
P31G96	20,000	101.5	21.0	4.80	13.14	0.410	60.4	2755.2	524.9	193.5
	24,000	74.8	22.5	3.33	10.14	0.392	59.9	2361.4	403.5	168.2
	28,000	77.9	21.0	4.26	11.78	0.339	60.1	2352.8	340.0	170.2
	32,000	89.3	21.5	4.15	12.40	0.380	60.2	2778.6	366.8	170.0
	Mean	**85.9**	**21.5**	**4.13**	**11.86**	**0.380**	**60.1**	**2562.0**	**408.8**	**175.5**
P33D49	20,000	104.1	21.6	4.85	12.80	0.431	59.7	3348.7	639.3	164.8
	24,000	93.1	22.3	4.17	11.38	0.429	58.2	3227.3	536.1	151.1
	28,000	74.4	22.7	3.28	11.06	0.351	58.4	2821.2	394.7	139.5
	32,000	93.5	22.4	4.19	12.93	0.380	57.7	3498.3	432.8	141.8
	Mean	**91.3**	**22.3**	**4.12**	**12.04**	**0.398**	**58.5**	**3223.9**	**500.7**	**149.3**
LSD (0.05)	**Hybrid**	**17.2**	**NS**	**0.73**	**1.70**	**NS**	**0.8**	**427.2**	**75.3**	**20.5**
	PD	**NS**	**NS**	**0.84**	**NS**	**0.032**	**0.9**	**NS**	**87.0**	**NS**

Notes: DKC67-88(Monsanto hybrid); P31G96 and P33D49 (Pioneer hybrids); Yield is based on 15.5% moisture; Biomass and harvest index are determined by hand-harvesting; ET_c is computed from planting to one week after harvest; NS: Not significant (P>0.05).

Precipitation

A large rainfall occurred early in the spring season in 2012 prior to planting as illustrated in figure 5. The delayed planting day of this study as compared to the areas typical planting date of mid-April again was deemed a benefit in reducing seasonal ET for the 2012 test. It was surmised in this study that one could reduce seasonal ET_c by shifting the classical July 4 pollination period. (The downside risk is that of a early freeze and the corn not being adequately mature for harvest.) Thus, a postponed planting normally shifts the ET_c demand curve past the normal pollination period (with high ET_c demands) and with higher heat unit generation, respectively. In effect in 2012 the shifted conditions were not as effective as in 2010 due to differing precipitation distribution from that of the 2010 year. Seasonal rainfall that occurred at the NPRF is presented in figure 6. As in prior years, in the research based irrigation scheduler, not all rainfall was utilized or attributed to ET_c for irrigation scheduling purposes. (Note: rainfall intensity effect within the events is ignored). Small rainfall events were not counted as contributing to soil moisture storage and were considered as only offsetting the day of occurrence ET_c demand for that day and were reflected in the vapor pressure suppression of the following day's ET_c value. Table 2 and table 3 indicate the daily values of 2012 NPRF precipitation and the monthly and average monthly values, respectively. No rain was received in May and virtually no rain occurred in July. Total seasonal rainfall in 2012 amounted to 5.97 inches from May 1 to September 30. This amounted to only 57% of the "average" amount needed according to prior production requirements. (The probability of receiving the 10.5 inches will be discussed in the summary section). A graphical comparison of the 2012 monthly values and the longer term average is provided in figure 10.

Table 2. 2012 precipitation recorded at NPRF, Etter, Texas. (Source: TXHPET).

2012												
ETTER PRECIPITATION												
DAY	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
1						0.01	0.05					
2				0.05		0.03						
3				0.09		0.02		0.04				
4						0.14		0.15	0.04			
5						0.25		0.19				
6						0.08			0.55			
7		0.01							0.01			
8						0.01	0.18	0.02				
9		0.05		0.06								
10		0.05	0.09	0.30								
11			0.01	3.18								
12						0.57			0.77	0.04		
13						0.01				0.26		
14						0.16		0.31				0.19
15												
16						0.08	0.01					
17		0.05				0.14						
18		0.01										
19												
20			0.11			0.18		0.72				
21			0.83			0.41						
22			0.25			0.03						
23												
24								0.02				
25												
26				0.06								
27												
28									0.51			
29				0.09								
30									0.28			
31												
Total	0.00	0.17	1.29	3.83	0.00	2.12	0.24	1.45	2.16	0.30	0.00	0.19
Yr. To Date	0.00	0.17	1.46	5.29	5.29	7.41	7.65	9.10	11.26	11.56	11.56	11.75

Table 3. Monthly NPRF total precipitation for 2012 and long-term average for Etter, Texas. (Sources: TXHPET and NPRF).

Month	**2012**	**Average 1964-2012**
January	0.00	0.28
February	0.17	0.32
March	1.29	0.85
April	3.83	1.25
May	0.00	1.96
June	2.12	2.53
July	0.24	2.15
August	1.45	2.20
September	2.16	1.56
October	0.30	1.22
November	0.00	0.56
December	0.19	0.40
Totals	**11.75**	**15.28**

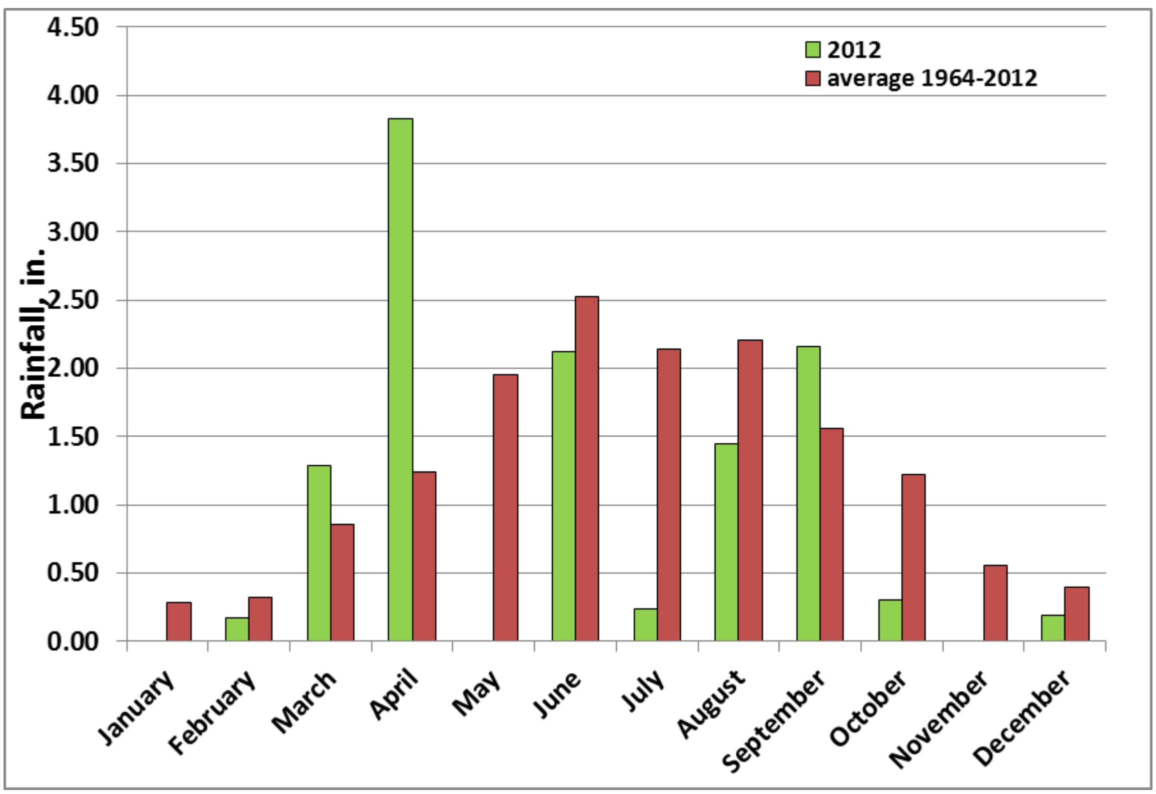

Figure 10. NPRF monthly average and 2012 precipitation totals reflecting the contribution to production.

ETc or Crop Evapotranspiration

The 2012 cumulative corn ET (100% level) was estimated to be 32.41 inches for late planted corn. Long term NPRF average cumulative corn ET (100% level) is 34.88 inches. This indicated that 2012 was a less demanding year overall at the NPRF site than the average year, and the daily ET values in Figure 11 support that position. However, it can readily be seen that the early part of the season was substantially higher in ETc and the reason for the rapid depletion of soil profile moisture. The computed (and staged adjusted) ET_c requirement for this stress-based NPRF study was 21.77 inches but could not be met in 2012 due to the lack of the average 10.5 inches of rainfall. It is noted that around day 177 (the last week of June that the data is correct and a cool front moved through the area but it effectively did little to overcome the progressive above normal ETc encountered before corn pollination in 2012. Post pollination ETc's were at normal or near it.

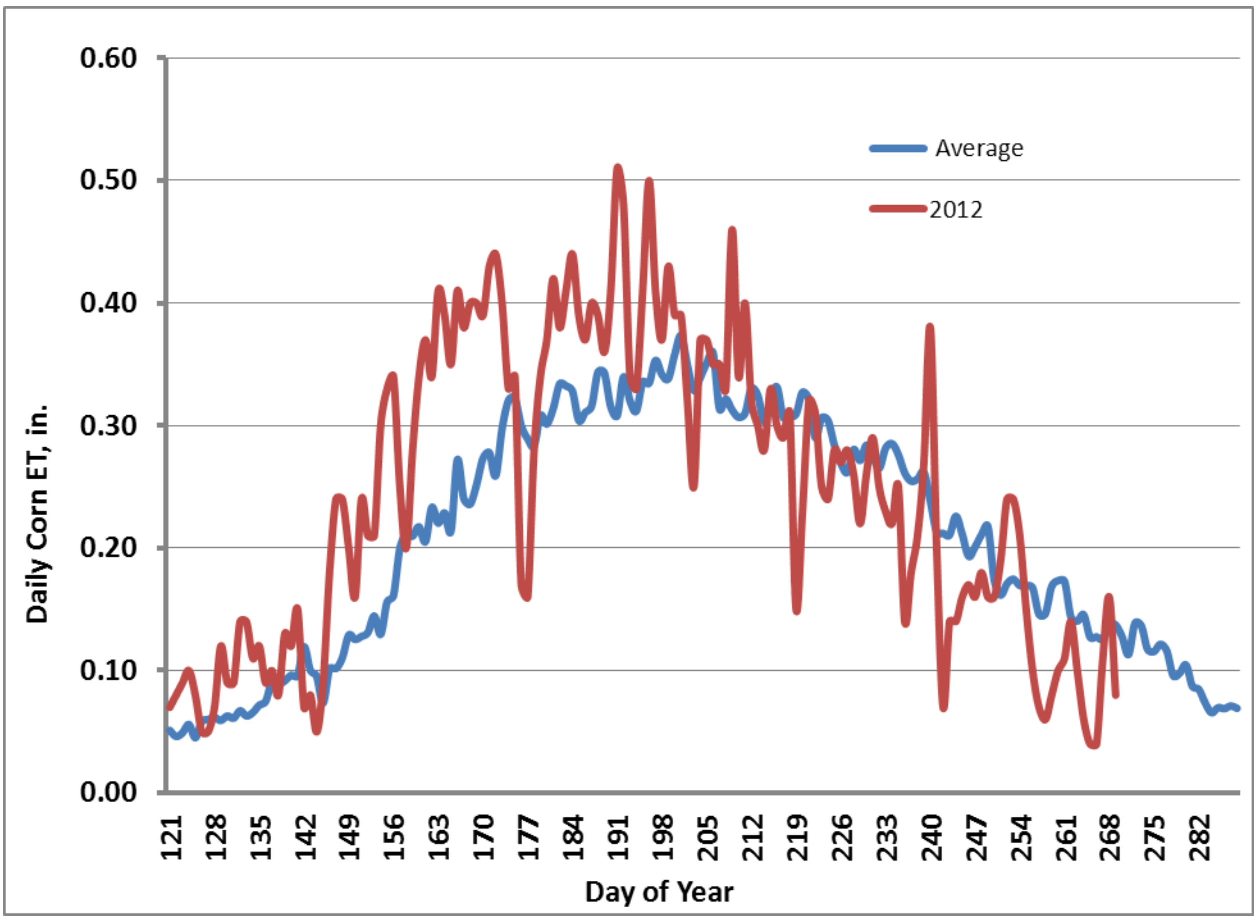

Figure 11. Comparison of 2012 daily corn ET to the average daily corn ET at the NPRF.

Irrigation Scheduling

Irrigation scheduling events occurred at the NPRF for this study on the following dates in Table 4. The initial irrigation was necessary to water the crop up after the planting operation which dried out faster than normal due to the windy conditions. (This is reflected in the higher ETc demand as seen in Figure 11.)

Table 4. 2012 NPRF 12-200 irrigation application dates and amounts.

Date	Irrigation Amount (inches)
5/14/2012	1.03
5/23/2012	1.21
6/14/2012	1.42
7/1/2012	1.70
7/6/2012	1.42
7/13/2012	1.42
7/18/2012	1.42
7/26/2012	1.42
8/9/2012	1.03
Total	**12.07**

After analysis of the pre and post soil moisture samplings of the study, the research irrigation scheduler agreed well with the total water values used over the growing season. Figure 12 illustrates the modeled soil profile moisture conditions of the 2012 study. Note in figure 12 that the corn crop was managed to deplete all of the plant available water within the soil profile and effectively did so. Also note that by July 1, the majority of the soil profile moisture was utilized in July due to the lack of rain.

The scheduler used in this study estimated an average irrigation application efficiency of 90%. The 2012 wind and heat conditions were significantly high and sustained as compared to "average or normally expected" seasonal conditions.

Additionally, due to the intense conditions of 2012, irrigation amounts applied were generally larger per application than in normal production years and are indicated in Table 4. This was done to infiltrate more water into the profile per application as the upper soil profile cracked.

Field observations in 2012 indicate that the irrigation applications had no more than a 2 foot wetting advance (runoff) ahead of the sprinkler nozzles throughout any of the season, reflecting the "dryness" of the upper profile.

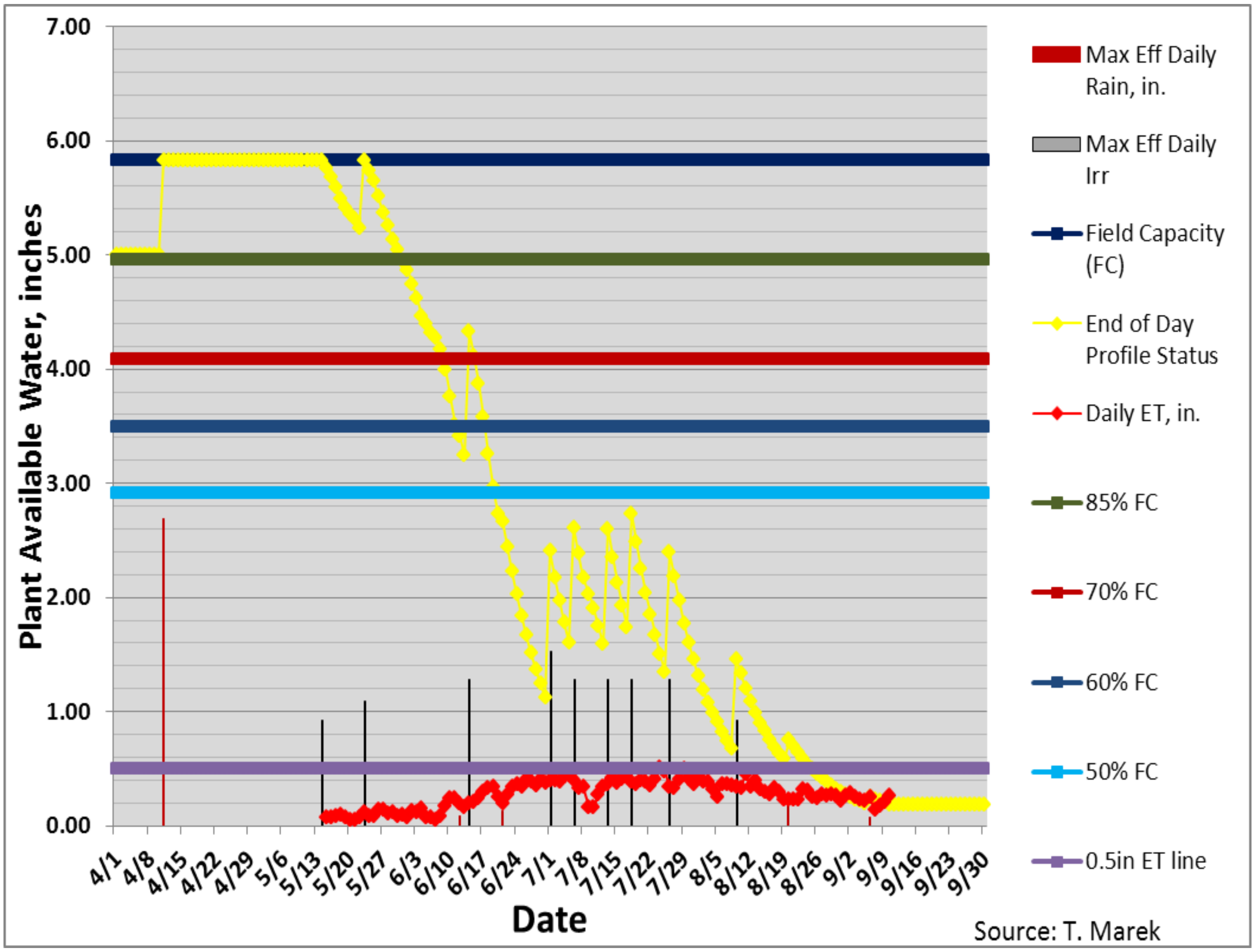

Figure 12. Research based irrigation scheduler used in the 2012 12-200 study (Marek, 2011).

Plant Populations

Plant populations established in this study were targeted at 20k, 24k, 28k and 32k seeds per acre, as in previous years. In general, the corn population was generally within three to five percent than the targeted planting density (table 5). The new planter with much improved seed size handling capability and with per row monitoring features provided by the NPGCD worked extremely well. (Given the box(s) change at each mid-plot stop, 40 to 50 feet is suggested as an adequate plot length if planter unit priming is not engaged at each plot end. If planter box priming is implemented (with some seed being wasted in the process), a 25 to 30 foot length run was tested in another research study and worked well for multiple plot populations.)

In general, all the three hybrids appeared to respond to planting density. The higher levels tended to provide increased yield as witnessed by the increasing line-of-best-fit linear trendlines in Figure 13.

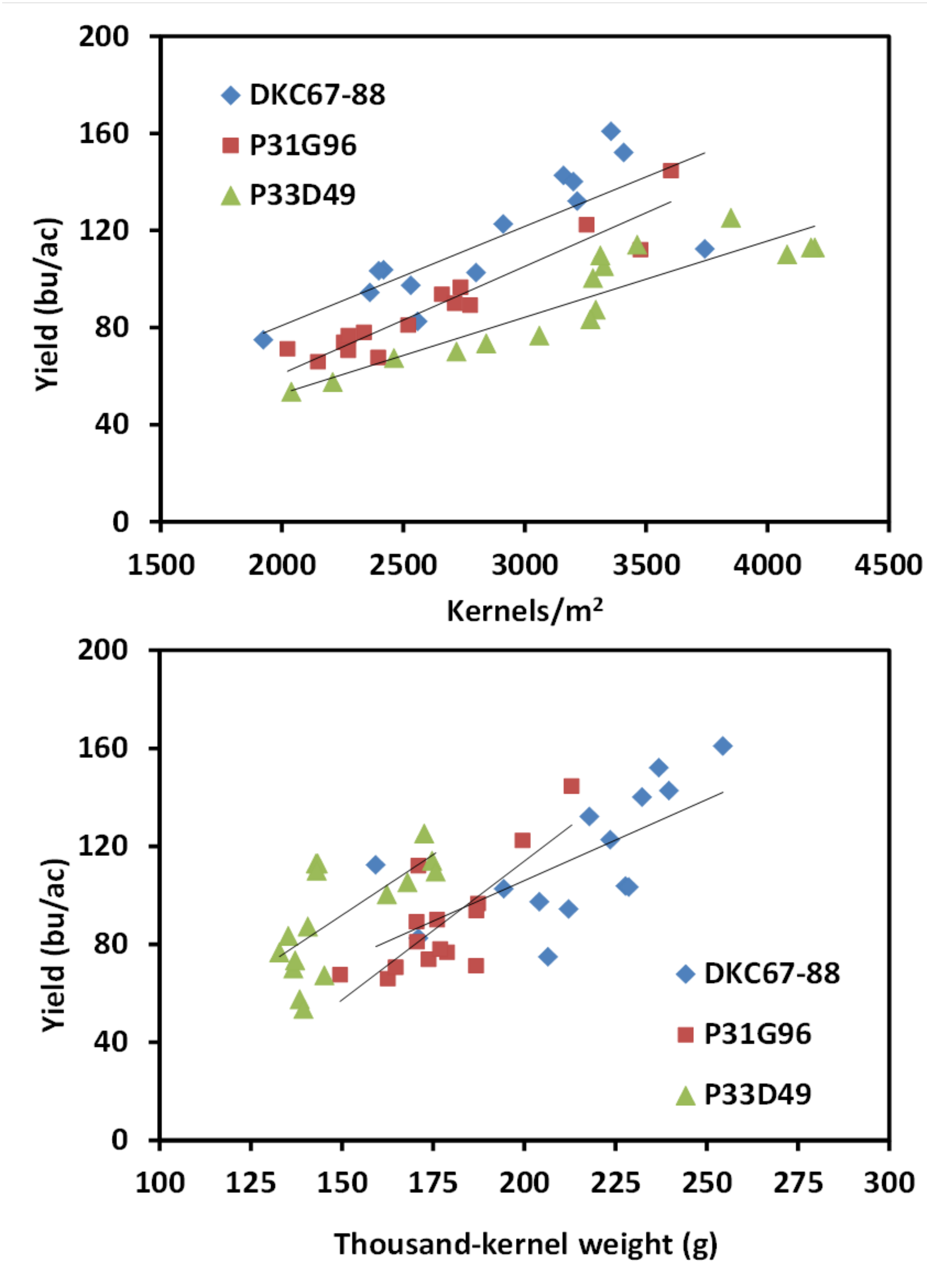

Figure 13. Yield versus kernel comparisons of 12-200 NPRF study in 2012.

Table 5. 2012 stand count (plants/ac) of three corn hybrids at four planting densities in 12-200 NPRF study, Etter, Texas.

Hybrid	Target	Actual	% Target
	plants/ac	plants/ac	
DKC67-88	20,000	21,562	108
	24,000	25,047	104
	28,000	28,749	103
	32,000	32,778	102
P31G96	20,000	21,090	105
	24,000	23,740	99
	28,000	27,987	100
	32,000	30,709	96
P33D49	20,000	21,235	106
	24,000	24,502	102
	28,000	28,858	103
	32,000	32,887	103

Crop Staging

A comparison of the North Plains Evapotranspiration Network (NPET) crop growth and stage model was compared against the actual average development of the three varieties of the study and is presented in table 6. While there were deviating differences from each stage comparatively, the total difference between the observed and NPET models resulted in a net difference of 5 days being overestimated by the NPET model. This is not surprising as again adequate controlled NPET research data for multiple planting dates is limited or nonexistent and had to be estimated during the NPET modeling development process in the past during initial network development. Even so, the corn crop advanced ("raced") ahead the NPET modeled stages possibly due to the higher available air temperatures due to the later planting. In the pre-pollination period, the crop was ahead by five days and post-pollination by as much as 21 days. (Eight days are subtracted from the days shifted due to the NPET model planting date used.) Day length is also known to be contributing factor in this growth stage difference.

Table 6. Comparison of NPET corn growth model versus average observed crop stages in 2012.

Crop Stage	**GDD of NPET model**	**GDD of NPRF observed**	**DAYS SHIFTED (Observed from NPET Model)**
seeded	200	125	-8
emerged	350	277	-4
4-leaf	515	332	-4
4-leaf	675	396	
6-leaf	850	547	-11
8-leaf	975	708	-13
10-leaf	1135	882	-11
12-leaf	1295	1114	-10
14-leaf	1500	1330	-8
tassel	1575	1353	-9
silk	1820	1457	-9
blister	2050	1610	-23
milk	2275	1873	-17
dough	2500	2027	-19
dent	2750	2144	-22
1/2 mat.	3000	2537	-29
blk lyr	3400	3065	-26
harvest	3800		

Entomology

In the summer of 2012, the Texas AgriLife Research Entomology Program at Amarillo was responsible for monitoring the Etter 12-200 corn project for insect and mite pests. The pests monitored were Western corn rootworm, Southwestern corn borer, Western bean cutworm, corn earworm, and spider mites. A Research Assistant from Bushland assessed the plots on a routine basis. Throughout the season, no significant pest infestations were found that required a control action.

Remote Imagery

While not required as an objective part of the study but included for potential comparisons to 2010 and 2011, a set of images were acquired by a crop consultant (Olan Moore, Olton, Texas) of the 2012 NPRF plots in late season and graciously forwarded to the study team. For comparison, the left side of the photos contains another NPRF study (lateral move sprinkler system that has 100, 75 and 50% ET corn treatments) in 2012 (lower portion of Figure 14). In Figure 14, a darker blue color of a pixel illustrates greater wetness. In Figure 15 of the NIR (near infrared red) image, a darker red color of a pixel illustrates greater green coloring of the crop canopy- somewhat indicating the health and condition of the crop. Figure 16 presents the image in grayscale and with this resolution (from a relatively high acquisition altitude of ~9500 feet) the plot alleys can still be seen. Lastly, in Figure 17, an indexed band of the red band divided by the green band yields similar but differential detection capabilities on a pixel based scale (as compared to Figure 14) and it is these types of analysis which are being evaluated and pursued by associated remote sensing personnel whereby potential detection of crop and production conditions are detected before they are visible to personnel on the ground.

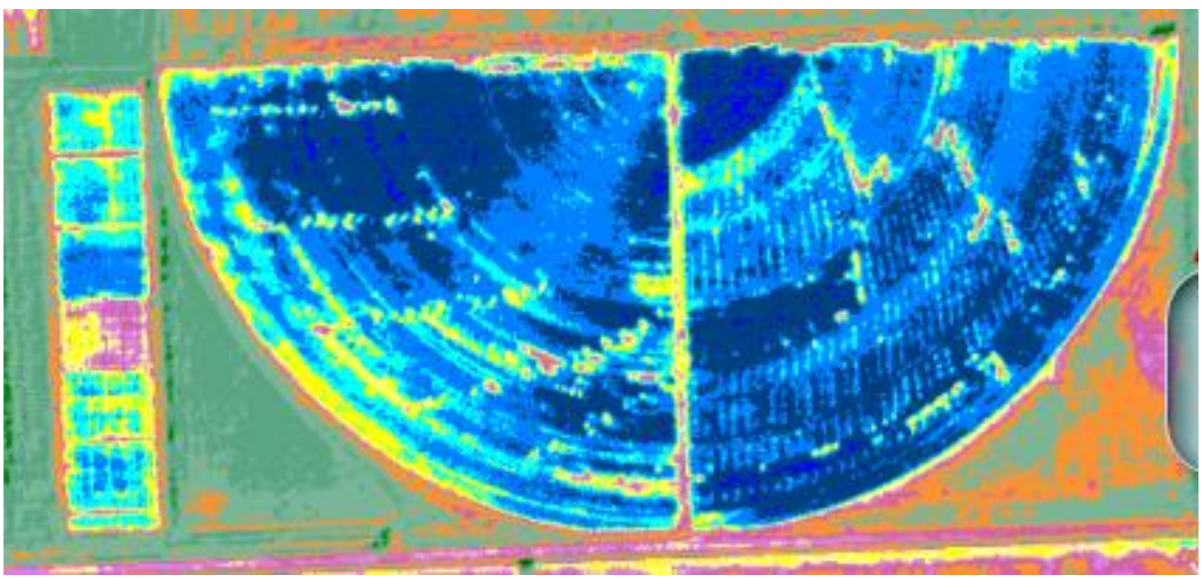

Figure 14. Remote sensing image of the 2012 NPRF 12-200 study. (Source: Courtesy of Olan Moore)

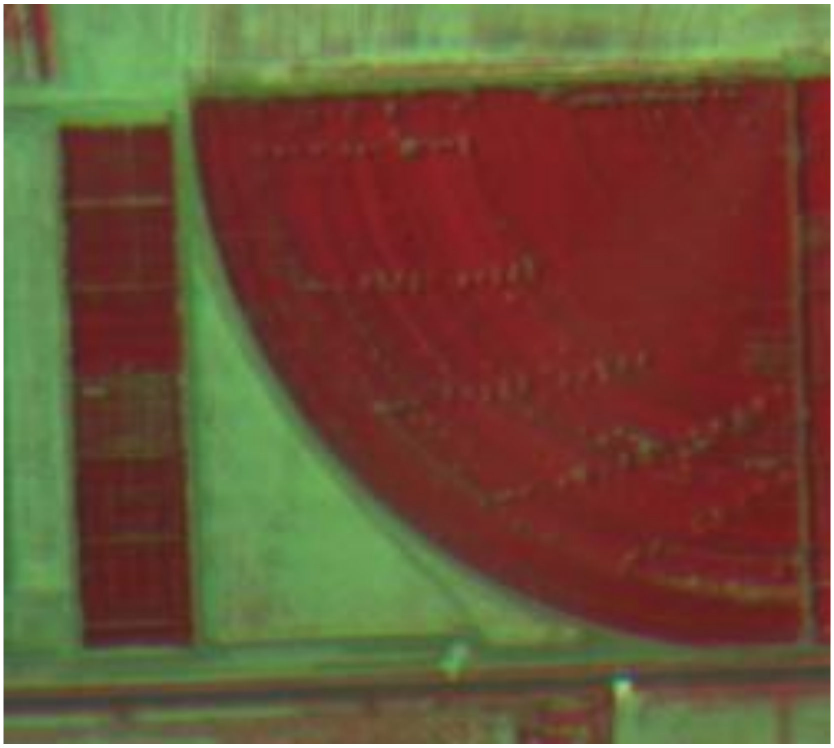

Figure 15. Landsat remote sensing NIR image of the 2012 12-200 study at the NPRF.

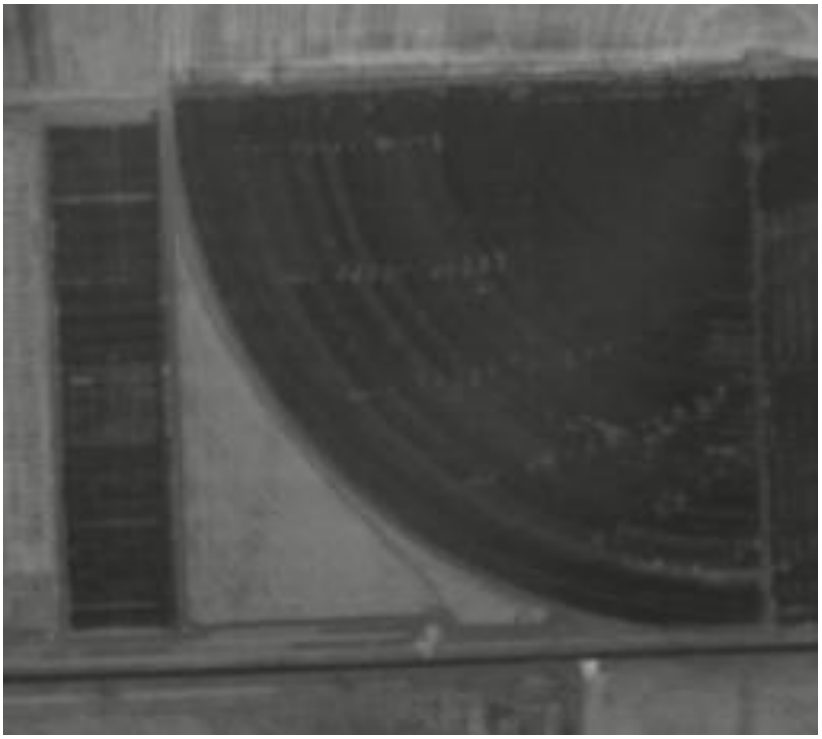

Figure 16. Grayscale image of the 2012 12-200 study at the NPRF with 1.2 m resolution. (Source: Courtesy of Olan Moore).

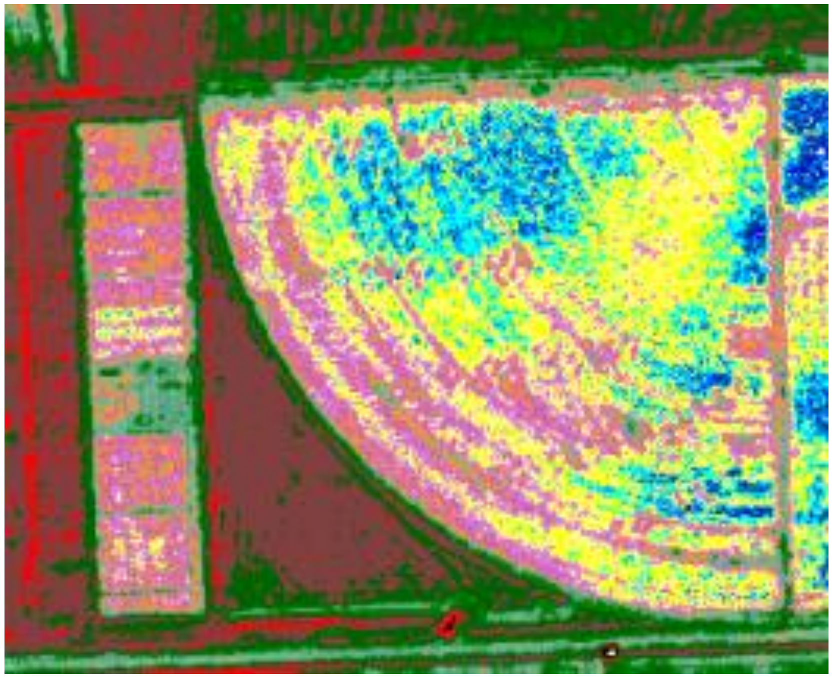

Figure 17. Color image (Red/Green) of the 2012 12-200 study at the NPRF (Source: Courtesy of Olan Moore).

As stated in a prior report, this type data effort and analysis may hold future promise in providing insight into problem areas and also for a categorical corn line or trait approach regarding differences from a remote sensing perspective that is currently unknown and unavailable.

2012 Conclusions

This limited irrigation water 12-200 North Plains Research Field (NPRF) corn production study in 2012 again fell well short of the targeted production of 200 bushels of corn in 2012 using three commercially available varieties. Yield results indicated that all of the varieties fell short of 200 bushels/acre target due to the lack of rainfall of 2012. The yields in 2012 were not only low but the production results generally disagreed with the extrapolated corn production function derived from several years of NPRF area research and producer based data at near full total water use levels. The reasoning of this deviation is that too much unrestricted early season plant growth occurred when soil profile water was available and thus too much biomass was produced given the lack of rain in May and July. This is witnessed in the harvest index. The 2012 effort suggests that this unrestricted growth has to be controlled to be more effectively utilized in a total seasonal balance approach regarding biomass production and grain yield. There are differing ways to address this crop restraint going forward such as potentially using an early season growth regulator(s) and/or selecting hybrids that, for instance, have a lower ear height which is known among breeders (and others) to reduce biomass level. These type characteristics have been witnessed in the Texas A&M corn breeding nurseries and can have a dramatic impact and range within the inbred lines and germplasm available today. The possible use of a shorter maturity variety may also return a lower biomass. Thus, the value of these type programs is obvious going forward as we address future water reducing research efforts.

Planting populations for each variety was tested from 20K to 32K seeds per acre in 4K increments and did not result in any significant yield differences in 2012. Certainly at the low production levels, the use of high plant population rate has no production advantage.

Varietal performance characteristics regarding harvest index indicate that water use efficiency (WUE) was largely determined by yield, and treatments with higher yields had higher WUE values. For the three hybrids, DKC67-88 had the higher WUE (5.4 bu/ac/in) than P31G96 and P33D49 (4.1 bu/ac/in). Among the 4 planting densities, the lower planting densities of 20,000 and 24,000 had higher WUE. Among the yield components, both kernel numbers and kernel weight were highly associated with high yields. The results of this study indicated that maintaining adequate biomass during grain filling is important for higher yield under limited irrigation conditions. Insect pest populations recorded in 2012 warranted no control measures.

Crop growth stages of each of the varieties were monitored and indicated that the three varieties performed similarly. Differences noted occurred mainly with the later season periods of crop development, coinciding with the most stressed stages.

The 2012 season experienced moderately low precipitation during the season, and thus significantly altered the project yields but provided valuable corn production data (with additional needed). The mean targeted amount of total water of 24 to 25 inches was not attained in 2012 due to the lack of rainfall, even with the entire 12 inches of irrigation water utilized.

This study effort has significant application and economic implication to future corn production and impact regarding regional water planning and groundwater regulation. Low rainfall conditions can and do exist in the probability distribution and in fact do occur as was experienced in 2011 and 2012.

Study Commentary: Discussion and Recommendations

From harvest based data of this 12-200 study, a smaller plot size is effectively warranted from a scientific data acquisition viewpoint as this level of plot size does not add to data knowledge or concept based information, which is the true desire and main objective of research activity as opposed to larger demonstration studies, such as conducted by the NPGCD. It is also recommended that the later planting date period of May 1st to May 15th and possibly later- (although currently there is little to no scientific data published to support a robust ETc analysis) be implemented in future years of this study to: 1) primarily reduce the amount of seasonal ET the varieties are subjected to, 2) alter the pollination period past the typical July 4th period, potentially reducing overall ET_c, and 3) evaluate shorter season varieties as to their performance characteristics in reduced ET and yield potential. Hand harvest is the preferred method of performance for determining the true yield and grain characteristics of this and similar research studies. (It is recognized that for large plot number studies, this may not be feasible and plot combine yields would have to be used.) It is again reiterated from previous years that this research was not designed to be a grain harvesting or loss study but rather a concept based production study. Low and lower levels of production potential can be characteristic of small cob diameter, smaller cob length, various kernel size and weights when evaluating multiple maturity hybrids and (shelling and airflow) adjustment of either plot or in particular production sized combines is not feasible. When possible in research, both methods should be employed.

In essence, this 12-200 study's objective goal depends greatly and effectively on the probability based occurrence of rainfall to meet the crops total water demand based on a currently known corn production function. This regional based function indicates that a mean 10.5 inches have to occur and have to be in a distribution that benefits seasonal crop growth. For purposes of this section, April rainfall is included and September is not (in actuality September rainfall would come too late for any tangible contribution to yield as compared to stored moisture from the month of April). An expected probability of 10.5 inches of rainfall can be determined from the following table based on 30 years of monthly records from the National Climatic Data Center, a part of the National Oceanic & Atmospheric Administration for Dumas, Texas. Thus, there is <u>less than a 50% probability</u> that 10.5 inches of total rainfall will occur each growing season on the average. In the three years of this test, 10.5 inches was received only 33% of the time but the expected percentage is again nearer to 50% of the time. (The way to read Table 7 is the probability level that precipitation will be equal to or less that the amount indicated i.e. there is only a 25% probability that 3.22 inches will occur on the average in the month of May). This informational value to both producer and policy makers is that production based on probability is statistically sounder than production based on averages.

Table 7. 12-200 corn season monthly precipitation probabilities for Dumas, Texas based on 1981-2010 records. (Source: NCDC-NOAA, 2013)

Month	**Probability level**		
	0.25 level	**0.50 level**	**0.75 level**
April	1.17	2.17	2.82
May	1.34	2.16	3.22
June	0.91	2.10	4.25
July	1.52	2.42	4.36
August	0.60	1.19	2.40
Seasonal Total	**5.54**	**10.04**	**17.05**

The final task of this project was to assess the economic implications of the NPRF 12-200 effort. To that address, an economic assessment using the 2013 Texas A&M AgriLife Extension Service Crop Budget for sprinkler irrigated corn production in District 1 (northern Texas High Plains) (Texas A&M Extension Service, 2013) was used as the basis of evaluation. It is recognized that these values may or may not represent the actual conditions of individual producers but it does provide a documented basis for economic evaluation purposes. A copy of the 2013 D1 Extension sprinkler irrigated corn budget sheets is provided in Appendix 3.

In the Extension budget, a yield of 225 bu./ac is assumed given the currently available irrigation water sources and capacity for producers. Therefore, a reduction in yield of 25 bu/ac would be surrendered by the producer if the 12-200 yield target was achieved. It is recognized that a 50 bu/ac difference may be a more appropriate reduction value in the central and northwest Texas corn producing counties. Nonetheless, certain input costs would be reduced with the limited irrigation. These would include fuel, fertilizer, reduced pumping and associated reduction in pumping plant wear, operating interest, possibly seed reduction, and potentially crop insurance. Insurers and the RMA are currently evaluating whether sufficient data exists regarding limited water and crop yield functions for statistically sound reductions in insurance coverage. (There appears to be insufficient available data to date regarding this interest according to the senior author.)

A partial budget analysis comparing the projected 2013 Extension corn budget with the 12-200 budget is presented in Table 8. In this analysis, it is assumed seed cost and operating interest are reduced 12%, fertilizer 20%, irrigation fuel & irrigation lube, maintenance and repair 45.4% and harvest & haul 40 cents/bu. on the reduced yield. Costs per acre are estimated to fall $143.38 by adopting the 12-200 production system while the reduction in yield (25 bu.) decrease gross revenues $162.50. Therefore, *net returns* per acre decrease $19.12/acre from the adoption of the 12-200 system.

Table 8. Partial budget for 12-200 production compared to the 2013 Texas High Plains Extension corn budget.

POSITIVE IMPACTS	$ / acre	NEGATIVE IMPACTS	$ / acre
Added Returns:		**Added Costs:**	
None		None	
Reduced Costs:		**Reduced returns:**	
Seed (12% less)	$12.59	25 bu. @ 6.50	$162.50
Fertilizer (20% less)	$34.13		
Irrigation Fuel (45.4% less)	$44.00		
Irrigation Repair (45.4% less)	$40.40		
Harvest & Haul (25 bu. less)	$10.00		
Operating Interest (12% less)	$2.26		
TOTAL POSITIVE IMPACTS	$143.38	**TOTAL NEGATIVE IMPACTS**	$162.50

Thus on a 125 center pivot, the estimated loss in net returns would be $2,390 ($19.12 X 125). This analysis should be considered a best case scenario. As indicated previously, the result will vary by location and management expertise. For example, if a producer with normal rainfall applies 22 acre-inches typically (as is assumed in the Extension budget) and produces 250 bu., the economic impact becomes more significant. The loss in *net return* increases from $19.13/ac to $171.62/ac ($19.12 + 25 bu. additional loss times the corn price of $6.50/bu. – additional harvest expense @ 40 cents/bu.) or $21,452.50 for a 125 acre circle. It should be noted that as corn prices fall the relative loss in net returns decreases, conversely, as corn price rises so does the difference in net returns.

Finally, this analysis only addresses the impact on annual net returns and does not take into account the value of the water saved (104 acre-feet or 34 million gallons/125 acre circle) for future production and/or the resultant increase in future land value from having that additional water available.

2012 Outreach Activities

The main event was the 2012 North Plains Research Field Ag Day event that was conducted in conjunction with the 200-12 NPGCD producer based corn demonstration effort in the summer (August 23, 2012). The event was headquartered at the NPRF and had excellent turnout and producer attendance. The event included touring the NPRF study and selected other studies and subsequently then the Harold Grall (north of Dumas, Texas) study near (SW) the research field. Project visibility was publicized by Kirk Welch (NPGCD), and Kay Ledbetter (Texas A&M AgriLife) as well as area media outlet personnel.

The following publicity and publications were conducted in 2012 regarding this study.

http://today.agrilife.org/2012/08/09/corn-irrigation-field-days-set-in-the-northern-panhandle-aug-21-24/

http://today.agrilife.org/2011/09/27/new-agrilife-research-germplasm-irrigation-management-make-a-difference-in-corn-production/

http://farmfutures.com/story-boost-corn-per-acre-output-texas-research-0-55131

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Appendix 1.

2012 Study and Outreach

Figure A- 1. 2012 corn ears of the 32K population plots (Pioneer 31G96) in the NPRF test.

Figure A- 2. 2012 corn ears of 20K population (Pioneer 33D49) in the NPRF test.

Figure A- 3. Dr. Xue's crew biomass sampling at the NPRF. (L to R: Dr. Baozhen Hao, Cole Pope, Ray Pergrem, Chance Reynolds, Dr. Gautam Pradhan and Bella Porras). (Photo by Qingwu Xue).

Figure A- 4. Another biomass sampling event at the NPRF. (L to R:, Change Reynolds, Ray Pergrem, Bella Porras and Cole Pope)-(Photo by Qingwu Xue).

Figure A- 5. Oblique view of 2012 12-200 study plots bordered by buffer corn region. (Photo by Thomas Marek).

Figure A- 6. 2012 view of stacked plot ends in CP#1 at the NPRF (Photo by Thomas Marek).

Figure A- 7. Picture of field road to be used after rainfall just prior to 2102 Corn Ag Day event. (Field tour was conducted as scheduled by packing the road but required the use of tractors for trailers carrying attendees to avoid getting stuck.)-(Photo by Thomas Marek).

Figure A- 8. Picture of plot damage due to a late season determined micro-burst in 12-200 field just prior to NPRF Ag Day. (Photo by Thomas Marek)

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Figure A- 9. NPRF tour stop at the 2012 NPRF Ag Day. (Photo by Thomas Marek)

Figure A- 10. 2012 12-200 ear exhibition of the three hybrids used. (Photo by Thomas Marek)

Figure A- 11. 200-12 gathering at the Harold Grall farm near the NPRF as part of the 2012 Ag Day program. (Photo by Kay Ledbetter).

Figure A- 12. 2012 NPRF Ag Day luncheon sponsored jointly by The North Plains Groundwater District and the Texas Corn Producer Board. Note NPGCD Board president Gene Born, manager Steve Walthour and board member Harold Grall attending function at the left front table. (Photo by Thomas Marek)

Figure A- 13. Another photo of luncheon attendees at the NPRF in 2012. (Photo by Thomas Marek)

Figure A- 14. 2012 NPRF Ag Day luncheon program speaker Dr. John Sweeten briefing group on the Texas A&M AgriLife name change. (Photo by Thomas Marek)

Figure A- 15. Jake Becker cutting NPRF corn plots in 2012 utilizing combine provided through our cooperative partners of the USDA-ARS water management unit. (Photo by Thomas Marek)

Figure A- 16. Majestic picture of sun setting below one of the NPRF sprinkler irrigation system as the summer season came to a close in 2012. (Photo by Thomas Marek, 2012)

Appendix 2.
Summary of Project Outreach

Outreach was a major objective of this effort and the following prior year publicity attributes documentation to that effort. Thanks are extended to Mrs. Kay Ledbetter of Texas A&M AgriLife Research-Amarillo for her unit based efforts for many of the following articles and dissemination to media outlets.

2010

The following publicity and publications were conducted in 2010 regarding this study.

http://today.agrilife.org/2010/09/08/agrilife-research-conducts-trials-to-reach-maximum-yield-with-limited-water-goal-200-bushels-of-corn-with-only-12-inches-irrigation/

http://today.agrilife.org/2011/09/27/new-agrilife-research-germplasm-irrigation-management-make-a-difference-in-corn-production/

Presentation of project activities at the 2010 NPRF Corn Field Day, August 25th, 2010.

Results of the 2010 NPRF 12-200 study were presented at multi-county meetings in January, 2011 by Texas A&M AgriLife extension personnel attended by approximately 600 producers.

2011

The following publicity and publications were conducted in 2011 regarding this study.

Presentation of project activities at the 2011 NPRF Corn Field Day, August 25th, 2011.

Kay Ledbetter and Marek, Thomas. 12-200 Corn (video). 12-200Corn-YouTube.mov.
http://www.youtube.com/watch?v=FJ7nPuFANGA&list=UUinY8T54MdMTuFXJk63JOFw&index=14&feature=plpp_video

News and briefs plus stories of this study and integrated NPRF irrigation work in were as follows under three principal topics:

A) AgriLife Research project shows maximum irrigation and plant populations not necessary for corn
B) New AgriLife Research germplasm, irrigation management make a difference in corn production, and
C) Irrigation meetings planned across the northern Panhandle in August.

Available at:

http://farmfutures.com/story.aspx/boost-corn-per-acre-output-texas-research-17/55131

http://farmprogress.com/prairie-farmer-story-boost-corn-per-acre-output-texas-research-8-55131

http://amarillo.com/news/local-news/2011-10-14/genetic-research-gives-corn-farmers-kernel-hope#.Tw8Oy6Xe0XE

http://www.texasdairy.com/archives/1110.htm#Growing_corn_on_limited_water_is_future_possibility_with_germplasm_technology

http://www.hpj.com/archives/2011/oct11/oct10/0929IrrigationManagementsr.cfm

http://ebionews.com/news-center/research-frontiers/ag-bio-a-bio-agriculture/44867-new-agrilife-research-germplasm-irrigation-management-make-a-difference-in-corn-production.html

http://m.southwestfarmpress.com/grains/new-agrilife-research-germplasm-irrigation-management-make-difference-corn-production

http://www.seeddaily.com/reports/Germplasm_irrigation_management_make_a_difference_in_corn_production_999.html

http://www.soyatech.com/news_story.php?id=25395

http://www.innovations-report.com/html/reports/agricultural_sciences/agrilife_research_germplasm_irrigation_management_182921.html

http://www.connectamarillo.com/news/story.aspx?id=668095&list=195070#.Tw8R4uzcwno

http://www.sciencedaily.com/releases/2011/09/110927124659.htm

http://www.eurekalert.org/pub_releases/2011-09/taac-nar092711.php - this link alone has had 1,359,883 page views alone – according to Vocus Public Relations.

http://www.redorbit.com/news/science/1112390296/new-agrilife-research-germplasm-irrigation-management-make-a-difference-in-corn-production/ - this link has had 11,370,408 page views and 1,898,857 unique visitors, also according to Vocus Public Relations.

Marek, Thomas, Wenwei Xu, Qingwu Xue, Jerry Michels and Brent Bean. 2011. Potential to Produce 200 Bushels of Corn on 12 Inches of Irrigation Water. Amarillo AREC Fact sheet.

Marek, T., W. Xu, Q. Xue, J. Michels, and B. Bean. 2011. Potential to produce 200 bushels of corn on 12 inches of irrigation water. North Plains Water News, Spring 2011

Results were also presented at multi-county meetings in January, 2012 by extension personnel attended by approximately 600 producers.

Appendix 3.

2013 Texas A&M Extension Service BT Corn for Grain, Sprinkler Irrigated, (Natural Gas)

Table 4.A Estimated costs and returns per Acre
Bt Corn for Grain, Sprinkler Irrigated, (NG)
2013 Projected Costs and Returns per Acre

ITEM	UNIT	PRICE	QUANTITY	AMOUNT	YOUR FARM
		dollars		dollars	
INCOME					
corn	bu.	6.50	225.0000	1462.50	________

TOTAL INCOME				1462.50	________
DIRECT EXPENSES					
SEED					
seed - Bt corngr.	bags	265.00	0.3800	100.70	________
INSECTICIDE					
miticide	acre	20.60	1.0000	20.60	________
HERBICIDE					
herb - corn pre	acre	16.87	1.0000	16.87	________
herb -corn post	acre	15.25	1.0000	15.25	________
FERTILIZER					
fert(N) - ANH3	lb.	0.50	126.0000	63.00	________
fert(P) - liquid	lb.	0.91	60.0000	54.60	________
fert(N) - liquid	lb.	0.68	78.0000	53.04	________
CUSTOM					
fert appl - ANH3	acre	10.00	1.0000	10.00	________
crop consultant	acre	7.00	1.0000	7.00	________
harv & haul - corn	bu.	0.40	225.0000	90.00	________
CROP INSURANCE					
corn - irrigated	acre	26.70	1.0000	26.70	________
OPERATOR LABOR					
Implements	hour	10.70	0.2925	3.13	________
Tractors	hour	10.70	0.3965	4.24	________
HAND LABOR					
Implements	hour	10.70	0.1527	1.63	________
IRRIGATION LABOR					
Center Pivot	hour	10.70	1.4080	15.06	________
DIESEL FUEL					
Tractors	gal	3.95	2.1861	8.63	________
GASOLINE					
Self-Propelled Eq.	gal	3.52	2.0100	7.07	________
NATURAL GAS					
Center Pivot	Mcf	4.40	22.0000	96.80	________
REPAIR & MAINTENANCE					
Implements	Acre	5.61	1.0000	5.61	________
Tractors	Acre	4.80	1.0000	4.80	________
Self-Propelled Eq.	Acre	0.16	1.0000	0.16	________
Center Pivot	ac-in	4.04	22.0000	88.88	________
INTEREST ON OP. CAP.	Acre	11.28	1.0000	11.28	________

TOTAL DIRECT EXPENSES				705.09	________
RETURNS ABOVE DIRECT EXPENSES				757.40	________
FIXED EXPENSES					
Implements	Acre	8.61	1.0000	8.61	________
Tractors	Acre	6.75	1.0000	6.75	________
Self-Propelled Eq.	Acre	0.24	1.0000	0.24	________
Center Pivot	Acre	35.56	1.0000	35.56	________

TOTAL FIXED EXPENSES				51.17	________

TOTAL SPECIFIED EXPENSES				756.26	________
RETURNS ABOVE TOTAL SPECIFIED EXPENSES				706.23	________
ALLOCATED COST ITEMS					
cash rent - corn	acre	140.00	1.0000	140.00	________
RESIDUAL RETURNS				566.23	________

Projections for Planning Purposes Only.

Information presented is prepared solely as a general guide & not intended to recognize or predict the costs & returns from any one operation.
Developed by Texas AgriLife Extension Service.

Table 4.B Estimated resource use and costs for field operations, per Acre
Bt Corn for Grain, Sprinkler Irrigated, (NG)
2013 Projected Costs and Returns per Acre

OPERATION/ OPERATING INPUT	SIZE/ UNIT	TRACTOR SIZE	PERF RATE	TIMES OVER	MTH	TRACTOR COST DIRECT	TRACTOR COST FIXED	EQUIP COST DIRECT	EQUIP COST FIXED	ALLOC LABOR HOURS	ALLOC LABOR COST	OPERATING INPUT AMOUNT	OPERATING INPUT PRICE	OPERATING INPUT COST	TOTAL COST
						------------dollars-----------					dollars		-------dollars--------		
chisel		125	0.099	1.00	Feb	4.21	2.36	0.69	1.12	0.219	2.34				10.74
disc	offset	100	0.078	1.00	Mar	2.73	1.57	1.54	2.18	0.173	1.85				9.89
fert appl - ANH3	acre			1.00	Mar							1.0000	10.00	10.00	10.00
fert(N) - ANH3	lb.											126.0000	0.50	63.00	63.00
corn - irrigated	acre											1.0000	26.70	26.70	26.70
sweep plow		150	0.065	1.00	Apr	2.74	1.11	0.85	1.21	0.143	1.53				7.46
planter		75	0.152	1.00	May	3.74	1.69	2.51	4.08	0.305	3.26				15.32
seed - Bt corngr.	bags											0.3800	265.00	100.70	100.70
crop consultant	acre											1.0000	7.00	7.00	7.00
herb - corn pre	acre											1.0000	16.87	16.87	16.87
fert(P) - liquid	lb.											60.0000	0.91	54.60	54.60
Center Pivot	ac-in			2.00	May			25.32	35.56	0.192	2.05	3.0000			62.93
herb -corn post	acre			1.00	May							1.0000	15.25	15.25	15.25
Center Pivot	ac-in			4.00	Jun			50.64		0.384	4.10	6.0000			54.74
fert(N) - liquid	lb.											78.0000	0.68	53.04	53.04
Pickup Truck	3/4 ton		0.006	20.00	Jun			7.24	0.24						7.48
Center Pivot	ac-in			4.00	Jul			50.64		0.384	4.10	6.0000			54.74
miticide	acre			1.00	Aug							1.0000	20.60	20.60	20.60
Center Pivot	ac-in			1.00	Aug			16.88		0.128	1.36	2.0000			18.24
Center Pivot	ac-in			1.00	Aug			8.44		0.064	0.68	1.0000			9.12
Center Pivot	ac-in			1.00	Aug			16.88		0.128	1.36	2.0000			18.24
Center Pivot	ac-in			2.00	Sep			16.88		0.128	1.36	2.0000			18.24
harv & haul - corn	bu.			1.00	Sep							225.0000	0.40	90.00	90.00
TOTALS						13.44	6.75	198.53	44.41	2.249	24.07			457.76	744.97
INTEREST ON OPERATING CAPITAL															11.28
UNALLOCATED LABOR															0.00
TOTAL SPECIFIED COST															756.26

Projections for Planning Purposes Only.

Appendix 4. Publication citation.

This report may be referenced as follows:

Marek, Thomas, Qingwu Xue, Wenwei Xu, Jake Becker, G.J. Michels, T.A. Howell, P. Gowda, S.H. Amosson, Bridget Guerrero, P.D. Colaizzi and J.M. Sweeten. 2013. 2012 North Plains Research Field 12-200 Limited Irrigation Corn Production Study. Texas A&M AgriLife Research at Amarillo. AREC 2013-05. 72p.