UNL TAPS
TESTING AG PERFORMANCE SOLUTIONS

Farm Management Competitions Report

2023

USDA United States Department of Agriculture
Natural Resources Conservation Service

EXTENSION

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Acknowledgement

The TAPS program is successful in large part due to the contributions of many affiliates. We greatly appreciate each of these people for their assistance with the program. Contributing members from across the University of Nebraska's system bring a wealth of knowledge and support, as well as cohorts from the TAPS programs in Oklahoma and Colorado. We would also like to thank our summer field assistants, Ceiden Childears and Brian Odle.

Mission Statement

To fully engage agriculturalists, scientists, educators, students, and industry in an innovative endeavor, to TAP into the University of Nebraska's potential to facilitate and create an environment for all stakeholders to work together in finding solutions through innovation, entrepreneurialism, technological adoption, new managerial applications, improved techniques and cutting edge methodologies for farms, farm businesses, and farm families to maintain profitability, sustainability, and productivity.

EXECUTIVE SUMMARY

The Testing Ag Performance Solutions (TAPS) program has completed another successful year and looks forward to a promising future on the horizon.

In the seventh year, seven TAPS competitions were facilitated across four different sites in Nebraska, Colorado, and Oklahoma. The West Central Research, Extension & Education Center (WCREEC) in North Platte, NE, facilitated four contests: Sprinkler Irrigated Corn, Subsurface Drip Irrigated (SDI) Corn, Sprinkler Irrigated Popcorn, and Grain Sorghum located near Grant, NE, results of which are found in this report. The fifth contest, Winter Wheat held at the High Plains Ag Lab in Sidney, NE, was implemented by Panhandle Research, Extension & Education Center (PREEC) personnel and concluded its fourth year in 2023. Oklahoma State University (OSU) administered a Sprinkler Irrigated Cotton competition. A new Sprinkler Irrigated Corn competition was started by counterparts at Colorado State University near Fort Collins, CO. The results of the PREEC, OSU and CSU affiliate competitions will be reported separately at www.taps.unl.edu/reports.

The WCREEC competitions had more than 150 participants. Contestants represented five states: Nebraska, Colorado, Kansas, Iowa, and Michigan, and two overseas countries: France and Luxembourg. Teams were comprised of many different agriculture sector members, including producers, government agency employees, college students, high school agricultural education students, and more, involving both first-time and returning participants.

Among the opportunities on the horizon, funding was received from the Nebraska Department of Environment and Energy (NDEE) and the Nebraska Association for Resources Districts (NARD) to develop a virtual TAPS platform and curriculum to be used in high school ag programs across Nebraska.

The development of a TAPS Soybean Competition, supported by the Nebraska Soybean Board, will debut in 2024 facilitated at the Eastern Nebraska Research, Extension and Education Center near Mead, NE.

UNL was also among five states included in a Technical Agreement from the USDA's Natural Resources Conservation Service (NRCS) to fund the development and growth of TAPS and Master Irrigator programs in Nebraska, Colorado, Kansas, Oklahoma, and Texas.

Dr. Daran Rudnick has taken a position with Kansas State University to develop TAPS competitions in the water short region of western Kansas. With loss comes opportunity though with Dr. Chris Proctor having been appointed to serve in an interim position to fill the void created by Daran's departure.

It is with sincere appreciation that we recognize those who support the TAPS program, including producers, commodity boards, ag service providers and businesses, regulatory agencies, financial institutions, as well as many other organizations and personnel. This innovative and award-winning program continues to connect industry knowledge and Extension research to the firsthand experiences of growers by fostering relationships among all stakeholders in crop production.

The TAPS program specifically wishes to recognize the monetary sponsorship from the Nebraska Corn Board, Sorghum Checkoff, Nebraska Sorghum Board, Zangger Popcorn Hybrids, the USDA-NRCS Conservation Innovation Grant (CIG) and the Irrigation Innovation Consortium. In addition, the TAPS team appreciates the multitude of various organizations and entities who have provided time, effort, resources, technology, technical assistance, and innovative approaches to help deliver the TAPS program.

We hope you continue to be a part of the program, as it continues to provide opportunities to learn, network, and advance.

Sincerely,

The TAPS Team

PROGRAM OVERVIEW

The four TAPS competitions facilitated at UNL's WCREEC in North Platte, NE, are the focus of this report. The competitions include the 7th annual Sprinkler Irrigated Corn competition, the 6th annual Sorghum competition, the 5th annual Subsurface Drip Irrigated (SDI) Corn competition and the 1st annual Sprinkler Irrigated Popcorn competition. The sprinkler irrigated corn and popcorn competitions were facilitated under a Zimmatic variable rate center pivot irrigation system and the SDI corn competition was held on a field equipped with an Eco-Drip irrigation system, all located in North Platte, NE. The sorghum competition consisted of an irrigated portion and a dryland portion. The sorghum competition was relocated to the Henry J. Stumpf International Wheat Center near Grant, NE. The irrigated sorghum was facilitated under a Valley pivot irrigation system, while the dryland was located southeast of the pivot on the dryland field. The sprinkler irrigated corn competition included 38 teams, while the popcorn competition had 13 teams and the SDI corn competition had 16 teams. The sorghum competition had 18 teams participate. In each competition, there is a control, Farm 9, which did not receive any irrigation or Nitrogen (N) and was used to determine the efficiency of the competing teams. Each team was randomly assigned an experiment-sized plot replicated three times within the respective competition areas, totaling less than one-half of an acre per team, referred to as a TAPS "farm". University personnel managed the competition plots under the supervision of the TAPS team. A modified University of Nebraska ag budget was used to estimate costs on a per acre basis. Yields and costs from each "farm" were scaled to represent 3,000 acres for the sprinkler irrigated corn competition, 1,000 acres for the SDI corn competition and 130 acres for the popcorn competition. In the sorghum competition, participants made decisions on both dryland and irrigated fields. The yields and costs from both fields for each "farm" were scaled using a weighted average equal to 750 acres of dryland production and 250 acres of irrigated production. This "farm" scale provided opportunity and motivation for competitors to develop strategies for marketing grain and to consider the impact their decisions would have on a full-scale operation. These farm sizes are consistent with modern-sized farming operations, providing cognition of the effects even small decisions have on productivity and profitability.

Decisions that participants were required to make varied in each competition. The sprinkler corn competition had the original six decisions as in the past as shown below in Figure 1. In a change from previous years, the sprinkler irrigated corn competition was planted into a cereal rye cover crops following soybeans, rather than directly into soybean residue, but this did not change the management decisions. In the SDI competition, participants had the opportunity to make the same seven decisions as last year, which included the standard six as well as insecticides. In the inaugural year of the popcorn competition, participants made six decisions, differing from other competitions, which included crop insurance, seeding rate, irrigation, nitrogen, fungicide, and marketing. In the sorghum competition, participants made five decisions with the exclusion of the irrigation decision. These decisions have a direct effect on productivity, efficiency, and profitability.

Figure 1. Each competition had a unique set of decisions to make in managing their crop in 2023.

Hybrid Selection (decision type #1) and Seeding Rate (decision type #2*)* – In all competitions, except popcorn, teams were required to select their own seed hybrid. Every team among all competitions selected their seeding rate. District Sales Managers (DSMs) of multiple seed companies (Arrow, Beck's, Channel, Dekalb, DynaGro, Fontanelle, Hoegemeyer, Pioneer, and Seitec) provided hybrid and seeding rate recommendations, which included 38 corn and 15 sorghum hybrids. These recommendations were based on location, production history, and characteristics of the field used in the competition. While each team had the option of selecting a DSM recommended hybrid, they were also free to select and use their own seed hybrid. In the popcorn competition, all plots were planted with ZX-62 from Zangger Popcorn Hybrids. In addition, all participants were asked to specify seeding rate. Participants who selected a recommended hybrid were provided seed by the respective DSM, otherwise participants provided the seed. The sprinkler and SDI corn competitions were harvested when the majority of hybrids reached a 17% moisture content, consistent with the maximum moisture content elevators allow at harvest. The sorghum competition was harvested when the majority of hybrids reached 16% moisture content. Popcorn was harvested when the majority of the field reached 15% moisture. Corn farms were charged a drying fee of $0.04 per bushel for each percentage point above 15.5% moisture content. Sorghum farms were also charged a drying fee of $0.04 per bushel for each percentage point above 14% moisture at harvest. Popcorn was charged a drying fee of $0.0007 per point per pound for moisture over 15%. This ensured that all yields were measured equally for each team.

Crop Insurance (decision type #3*)* – Participants in all competitions were required to select a multi-peril crop insurance (MPCI) package from the following three options: Revenue Protection (RP), Revenue

Protection with Harvest Price Exclusion (RP-HPE), or Yield Protection (YP), using either Optional Units (OU) or Enterprise Units (EU). The available levels of coverage were 65, 70, 75, 80, or 85%. The premium rates were quoted by Farm Credit Services for the relevant competition areas in North Platte and Grant, NE. Due to the risk involved in borrowing funds to cover operating costs, a minimum level of 65% MPCI was required.

Nitrogen Management (decision type #4) – Participants were able to select the amount of pre-plant and/or in-season (via side-dress and/or fertigation) Nitrogen (N) fertilizer in the form of UAN 32%. All plots and competitions received a baseline of 5 gallons/acre of in-furrow starter fertilizer (10-34-0) at time of planting. Pre-plant N was available in all competitions and was applied using a double-coulter liquid applicator at about 1.0-inch depth at a distance of 5 inches on both sides of the planted row. Side-dress N fertilizer was also available in all competitions and was applied at the ground surface neighboring each crop row using 360° Y-Drop (360° Yield Center, Morton, IL). Fertigation opportunities were available in the corn and popcorn competitions. In the sprinkler corn and popcorn competition, fertigation was applied through the center pivot using a variable rate injection pump (Agri-Inject, Yuma, CO) that maintained proper concentrations, as the irrigation system flow rate changed. In the SDI competitions, fertigation was completed using a constant rate injection pump. Maximum application of N was limited to a total of 180 pounds/acre for pre-plant, 180 pounds/acre for side-dress, and 30 pounds/acre for each fertigation event. Pre-plant, side-dress (V4-V6), and five fertigation events (V9, V12, VT/R1, R2, and R3) were available to the sprinkler and SDI corn participants, whereas popcorn participants had pre-plant, side-dress and three fertigation events (V12, VT/R1 and R2) available. Sorghum participants were only given nitrogen application opportunities at pre-plant and side-dress. An application cost of $8.50/acre, which did not include the cost of the fertilizer, was charged for pre-plant and side-dress operations, and $1.25/acre for each fertigation application.

Irrigation Management (decision type #5) – The pivot irrigation system was operated every Monday and Thursday throughout the growing season for sprinkler irrigated corn and popcorn competitions. Participants had until 10 AM on the day of irrigation to submit their decision via their password protected online portal. If participants failed to indicate their intent to irrigate by 10 AM, irrigation was not applied. Irrigation depth per application could be as much as 1.0-inch, in intervals of 0.05 inches. The SDI system was operated likewise, every Monday and Thursday throughout the growing season for the SDI corn competition. Participants had until 8 AM to submit their irrigation decision via their password protected online portal. Similarly, if participants failed to indicate intent to irrigate by 8 AM, irrigation was not applied for that event. Irrigation per application was as much as 1.0-inch, in increments of 0.25 inches. If participants chose over 0.5 inches, then the irrigation event occurred over a 48-hour period, due to the capacity of the irrigation system. Sorghum participants did not make irrigation decisions, instead all plots were irrigated with the same amount of water at the discretion of university officials.

Grain Marketing (decision type #6) – The option to market grain was available to participants in all competitions from April 1 through November 30. Participants in the sprinkler corn, SDI corn and sorghum competitions had five different methods to sell their grain. These five options were: 1) spot or cash sales, 2) forward contracts, 3) basis contracts, 4) simple hedge to arrive, and 5) hedging with futures contracts. As a farm management competition using the market to speculate was not allowed. In the popcorn competition, participants had a simulated production contract with AK Acres Popcorn of Imperial, NE.

Participants could choose to sell a percentage of their production using the Chicago Board of Trade's December 2023 futures price and then a multiplier of 3.8 was used to determine the final price per pound.

Insecticide (decision type #7) – In the SDI corn competition, participants were able to make choices that impact insect pest management at two points during the competition: 1) during hybrid selection, based on the Bt trait package for that hybrid, and 2) whether or not to apply a foliar spray of insecticide at VT, with a choice between three insecticide products and rates including: 1) Vantacor at 0.87 or 2.5 fl oz/ac, 2) Hero at 2.6 or 6.1 fl oz/ac and 3) Brigade at 2.1 or 6.4 fl oz/ac.

Insect management could have included a variety of pests, but based on local pest pressure history, western bean cutworm was the most likely economically threatening insect. For the foliar insecticide choice, insect monitoring (collection of moths from a black light trap located at WCREEC) and scouting data (inspection of corn plants for the presence of western bean cutworm eggs and larvae) was provided by the entomology research team. Due to a hailstorm at tassel which removed up to 50% of the leaf area, the insecticide option was suspended for the 2023 competition.

Products were to be applied with a drone or spray boom at approximately 95% tasseling. The entomology research team would have gathered data approximately 28 days after insecticide applications to measure survival of western bean cutworm caterpillars and ear feeding injury to the crop.

Fungicide (decision type #8) – In the popcorn competition, participants had the opportunity to choose if their plots received a fungicide application. Scouting was conducted 7 days prior to VT to determine initial disease severity in each plot and data was provided to participants by the plant pathology research team. Participants had the option to make a Priaxor fungicide application at a rate of 4 oz/ac at VT or forgo treatment. Disease severity for southern rust, gray leaf spot, and northern corn leaf blight was assessed by estimating the percent leaf area covered with lesions throughout the entire plot at 14 (R2-R3), 28 (R3-R4), and 42 (R5-R6) days after treatment applications.

Other Management Decisions – All other management decisions, (e.g., tillage practices, residue management, etc.), were determined and executed by the TAPS team and were uniformly applied to the study area. Three plots per team were randomized and managed identically with their chosen decisions. Each team freely made choices in their competition's decision areas, as they sought to be the most profitable, efficient, and highest yielding farm. As noted, the TAPS team did the physical management of all farms (e.g., operation of machinery, irrigation systems, application of chemicals, and harvesting). Participants, however, were encouraged to actively observe their plots, install additional data collecting technology, and collect any additional data from their plots throughout the growing season, but at their own expense. No other inputs (e.g., fertilizers, additives, amendments, operations, sprays, etc.) were permitted.

TIMELINE

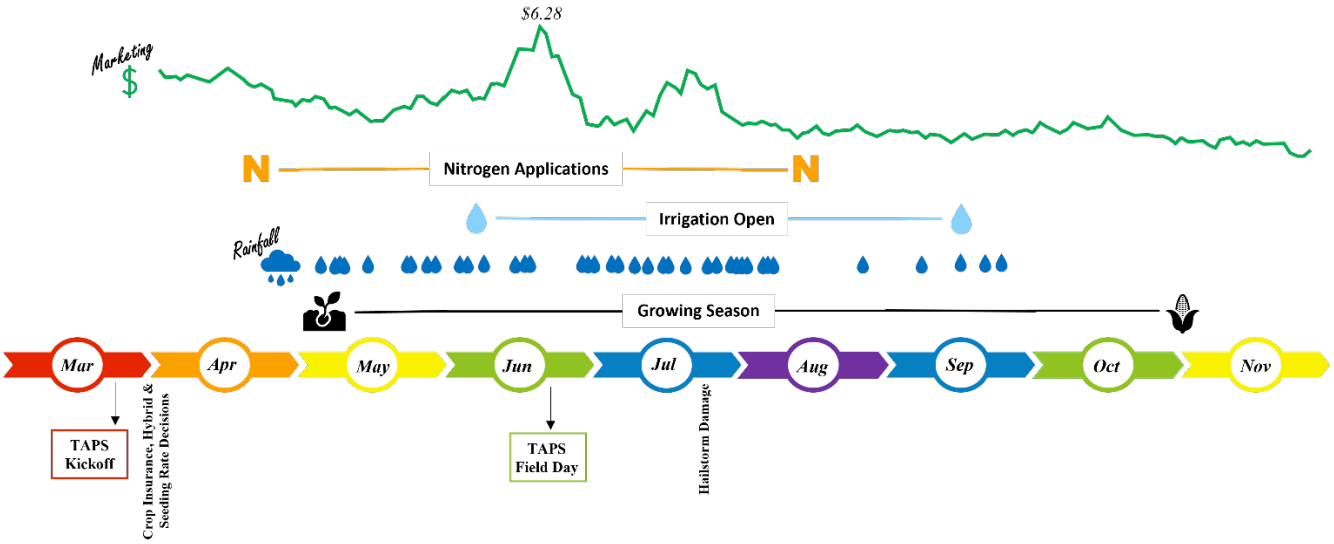

Figure 2. A brief look at the 2023 competition timeline, including marketing conditions and rainfall activity among the decision making and events.

TECHNOLOGY

Figure 3. Participants were given the opportunity to use over ten technology companies' services, as well as being provided with a plethora of other data and research results.

One of the primary goals of the TAPS program is to provide contestants with an opportunity to use innovative technology and services in a financially risk-free environment. These innovations include equipment, ideas, strategies, new methods, etc. The core concept is for all involved to identify methods, technologies, and/or strategies that might bring financial and/or conservational value to their own

operation(s) and to others who learn from them. Participants were provided access to a variety of technology, ideas, and methods that are designed to help inform production and marketing decisions. The technology provided included in-field and edge-of-field instrumentation, imagery products, sophisticated crop management models, and more. In addition, contestants had access to several agricultural services and recommendations provided by commercial soil labs, DSMs, and others.

GROWING CONDITIONS

North Platte has a semi-arid climate with the majority of annual precipitation occurring between late-April and mid-October. The predominant soil type at the North Platte site is Cozad silt loam with approximately 1.5 inches/feet of lab-estimated plant available water (i.e., difference between field capacity and permanent wilting point). The 2023 growing season received 16.55 inches from May 1st to September 30th. As compared to the previous six years of TAPS competitions, this rainfall amount was more than the average of 14.45 inches in the same time period. In 2023 the months of June, July, and August averaged maximum daily temperatures of 85.8°F. For the first time in the history of the TAPS program, the North Platte, NE, plots were measurably affected by severe weather on July 22 including hail and wind.

DESCRIPTION OF AWARDS

Each competition had three cash awards, 1) Most Profitable Farm, $1,500, 2) Highest Input Use Efficiency, $1,500, and 3) Greatest Grain Yield, $250-$500, adjusted based on profitability. Along with the monetary award, all winners also received a plaque, an oversized keepsake check, and a TAPS apparel item. Each award is described in detail below:

1. Most Profitable Award – Profit is the difference between total revenue minus total cost. Since each competitor is operating under identical conditions and events, it is the individual actions of the competitor that determines profit. Total revenue is obtained by bushels sold times the prices received, plus all government payment, insurance indemnities, and any gain/loss incurred from using futures contracts. The average per acre revenue is the total revenue divided by acres. Costs included fixed costs (in this case those incurred by the University), and variable expenses were those incurred during the season through the execution of the competitor's individual management decisions. Together these represent total cost. Since all farms in any one competition have the same number of acres, the farm with the most per acre profit is the most profitable.

2. Highest Input Use Efficiency Award – Efficiency was assessed using the Water-Nitrogen Intensification Performance Index (WNIPI, Lo et al., 2019) for the sprinkler corn, popcorn and SDI corn competitions and the Nitrogen Intensification Performance Index (NIPI, Lo et al., 2019) for the sorghum competition. The WNIPI and NIPI metrics were calculated as follows:

$$WNIPI = \frac{\left(\frac{Y_{Farm} - Y_{Control}}{Y_{Control}}\right)}{\left(\frac{ET_{Control} + I_{Farm}}{ET_{Control}}\right) \times \left(\frac{ANU_{Control} + N_{Farm}}{ANU_{Control}}\right)}$$

where, "Control" is a farm managed by UNL that receives no irrigation or N fertilizer (except for 10-34-0 at planting) and "Farm" referenced in the equation for yield, irrigation and N is the farm

managed by the participants. "Y" is yield in bushels/acre, “ET” is seasonal evapotranspiration in inch acre/acre, “I” is seasonal irrigation in inch acre/acre, “N” is total seasonal applied nitrogen in pounds/acre, and “ANU” is aboveground nitrogen uptake in pounds/acre. The farm with the highest value was determined the winner.

For the sorghum competition this was modified to not include the water portion of the formula since all farms in the irrigated portion received the same amount of irrigation water.

$$NIPI = \frac{\left(\frac{Y_{Farm} - Y_{Control}}{Y_{Control}}\right)}{\left(\frac{ANU_{Control} + N_{Farm}}{ANU_{Control}}\right)}$$

3. Greatest Grain Yield Award – The cash prize for Greatest Grain Yield was adjusted by the winner’s percentage of total possible profit. Total possible profit was the range of difference between the most and least profitable farms.

PARTICIPANTS

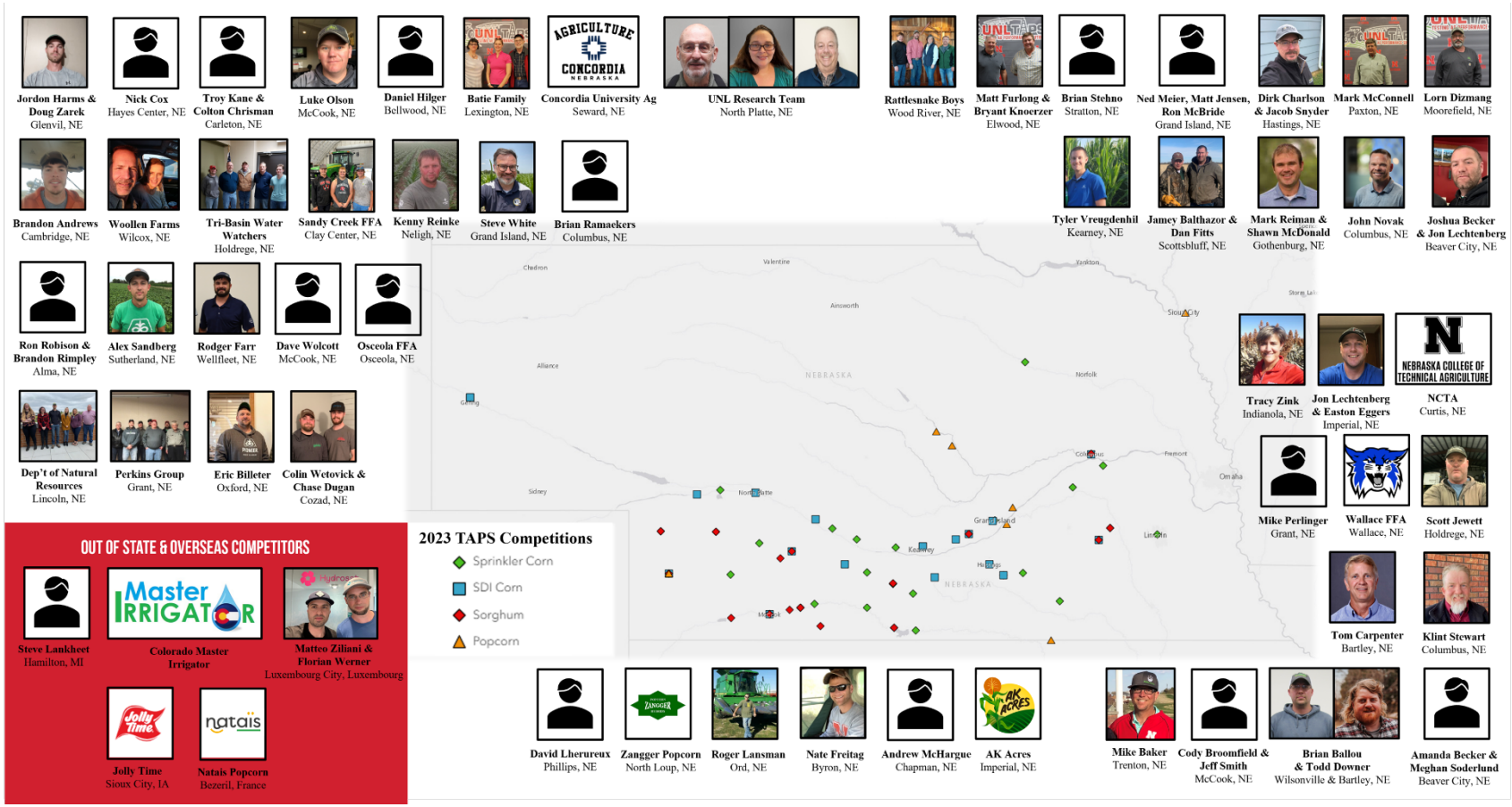

Figure 4. Location of the 2023 TAPS Farm Management Competition participants for the TAPS competitions administered in North Platte and Grant, Nebraska.

PARTNERS & SPONSORS

Figure 5. The TAPS program has seen continued success due to its partners and sponsors. Whether donating technology and time to install equipment, supplying seed, or making monetary donations, every one of these entities is greatly appreciated.

Popcorn Competition

The inaugural year of the popcorn competition consisted of 13 teams. There were 11 people who participated from across Nebraska, Iowa and one team from France. One of the 13 teams, Farm 9, was the control farm used for determining efficiency.

Field Design

Each team was assigned three randomized plots, Figure 6, located at the intersection of Highway 83 and State Farm Road in North Platte, NE.

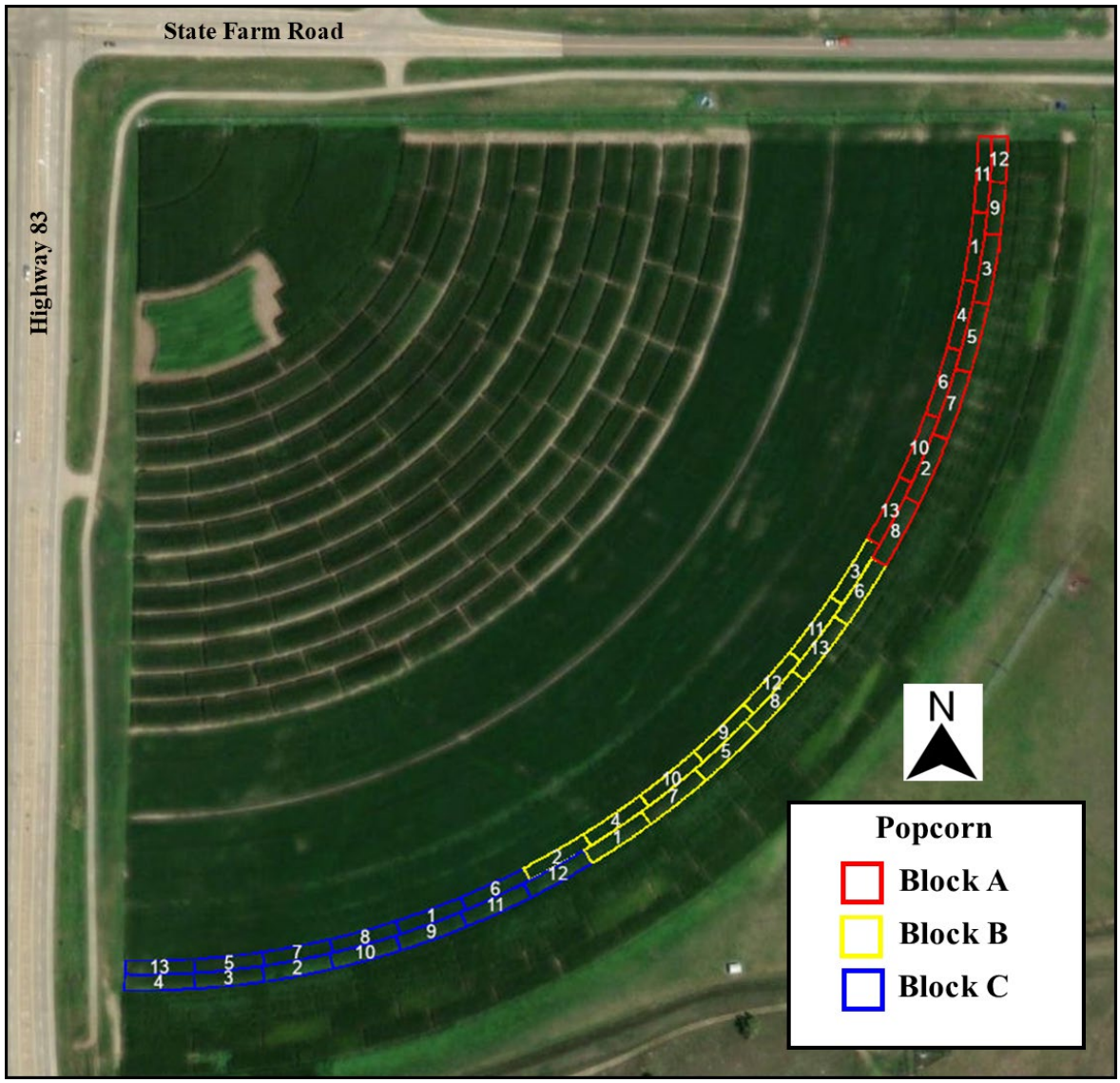

Figure 6. Plot layout for the 2023 popcorn competition held at the West Central Research, Extension, & Education Center in North Platte, NE. Each team was assigned a randomized plot located in blocks A, B, and C.

Competition Data

In mid-March, aggregate soil samples were taken throughout the TAPS competition fields. Ward Laboratories in Kearney, NE analyzed the samples, and the results (Table 1) were provided to participants ahead of the first decision deadlines.

Table 1. Soil sample results provided by Ward Laboratories in Kearney, NE for the popcorn competition field.

Sample ID	Soil pH	Modified WDRF	Soluble Salts 1:1	Excess Lime	Organic Matter	KCl Nitrate	Depth	Method	-Ammonium Acetate-				M-3	---------DTPA---------				Hot Water Boron	CaNO3 Chloride	Sum of Cations	% Base ----Saturation----				
Lab No.	1:1	BpH	mmho/cm	Rating	LOI-%	ppm N	Nitrate Lbs N/A	Phosphorus ppm P	K ppm	Ca ppm	Mg ppm	Na ppm	Sulfate ppm S	Zn ppm	Fe ppm	Mn ppm	Cu ppm	ppm B	ppm Cl	me/100g	H	K	Ca	Mg	Na
BLOCK A							0 - 8 in	M-3																	
33229	7.6		0.17	NONE	2.6	13.1	31	128	447	1679	271	26	14.2	2.02	3.0	1.6	0.27			11.9	0	10	70	19	1
BLOCK A							8 - 32 in																		
33230						5.1	37																		
BLOCK B							0 - 8 in	M-3																	
33231	7.5		0.20	NONE	2.6	10.9	26	46	377	1639	257	19	12.4	0.81	3.5	2.2	0.20			11.4	0	8	72	19	1
BLOCK B							8 - 32 in																		
33232						6.4	46																		
BLOCK C							0 - 8 in	M-3																	
33233	8.1		0.22	NONE	2.3	12.7	30	19	349	2503	252	17	14.8	1.36	5.0	2.5	0.27			15.6	0	6	80	13	0
BLOCK C							8 - 32 in																		
33234						4.2	30																		

Due to the hail damage that occurred on July 22nd, leaf tissue samples were not collected from the popcorn competition.

Participant Decisions

Participants were responsible for making six economic and production management decisions, including insurance coverage, seeding rate, fungicide, nitrogen and irrigation amount and timing, and marketing. All decisions were submitted by participants via the TAPS online password protected portal that time-stamped all decisions. The decisions and resulting outcomes are summarized below.

Agronomic Decisions

All agronomic decisions made by each team are shown in Table 2. Unlike other competitions, the participants in the popcorn competition did not make the hybrid decision. All plots were planted with Zangger Popcorn Hybrids' Variety ZX-62. In order to understand and evaluate agronomic input variation effects it was important to control the hybrid variable. Participants did select the seeding rate. Farm 11 had the lowest seeding rate at 28,000 seeds/acre (Table 2, Column 2). The highest seeding rate was 37,000 seeds/acre planted by Farm 5.

The total N fertilizer applied, not including the control, ranged from 50 to 225 pounds/acre (Table 2, Column 9). On average, 44% of N was applied at pre-plant, 31% as side-dress, and the remaining 25% was applied over the three fertigation options with 11%, 8%, and 6% applied on July 20, August 2 and 9, respectively.

The teams were given the option to irrigate, starting June 15, with one farm, Farm 8, choosing to irrigate that day. Irrigation concluded September 14, although the last irrigation decision in the popcorn competition was made on September 7 by Farm 5. Teams were allowed to irrigate twice a week. Three irrigations were cancelled due to rainfall events, one each in June, August, and September. Excluding the control, seasonal irrigation ranged from 0.0 inches, Farm 11, to 10.8 inches, Farm 1, with an average of 6.48 inches (Table 2, Column 10). These totals do include the water that was applied during fertigation operations also.

Participants had the opportunity to make a fungicide application to manage various diseases in-season. Initial disease assessment took place on July 18th to determine disease severity in each plot for fungicide decisions. Initial ratings indicated <1% disease severity in all plots for Bacterial Leaf Streak (BSL), Holcus Spot, Common Rust (CR), Gray Leaf Spot (GLS), and Northern Corn Leaf Blight (NCLB). Based on initial assessments, four teams, Farms 1, 2, 5 and 10, decided to apply Priaxor® at a rate of 4 oz/ac with a product cost of $18 per acre on July 28th at tassel (VT) (Table 2, Column 3).

While four teams decided to apply foliar fungicides, all plots were rated for consistency. Follow-up disease assessment ratings were collected 35 and 54 days after treatment (DAT). The following diseases were assessed at both rating times following fungicide applications: Tar Spot (TS), BLS, GLS, NCLB, Goss's Wilt (GW), CR, and Southern Rust (SR). Disease severity ranged from 0% or trace amounts to as high as 7% leaf area impacted at 35 DAT across all diseases assessed.

Environmental conditions including heat stress, hail, and natural plant senescence made it difficult to assess disease severity at the second rating time. Therefore, disease severity ranged from 0% or trace amounts to as high as 8% leaf area impacted at 54 DAT across all diseases assessed. BLS and GW, both bacterial diseases, consistently had the highest disease severity of all diseases assessed at both rating times. The only fungal disease with higher than 0% disease severity was GLS ranging from 0% or trace amounts to 2% leaf area impacted at both rating times. Priaxor® fungicide is labeled for managing certain fungal pathogens but not bacterial pathogens. Conclusions can be made that disease pressure of fungal pathogens was low in these plots regardless of if a foliar fungicide was used or not.

Table 2. Summary of select agronomic inputs from the 2023 TAPS popcorn competition.

			Nitrogen Fertilizer						
Farm	**Seeding Rate**	**Fungicide**	**Apr 28**	**Jun 27**	**Jul 20**	**Aug 02**	**Aug 09**	**Total**	****Irrigation**
#	**(1,000/ac)**	**Product & Rate (oz/ac)**	**---------- (lbs/ac) ----------**						**(in)**
1	34	Priaxor - 4	50	120	0	0	0	170	10.80
2	33	Priaxor - 4	70	30	30	0	0	130	5.77
3	34	-	67.5	22.5	7.5	5	10	112.5	9.49
4	32	-	90	60	20	0	0	170	7.71
5	37	Priaxor - 4	30	0	0	30	30	90	6.44
6	34	-	101.25	33.75	11.25	7.5	15	168.75	9.66
7	32	-	0	50	30	30	30	140	5.70
8	34	-	135	45	15	10	20	225	9.78
*9	34	-	0	0	0	0	0	0	0.00
10	34	Priaxor - 4	43	45	20	15	0	123	5.37
11	28	-	50	0	0	0	0	50	0.00
12	34	-	43	45	20	15	0	123	2.87
13	34	-	43	45	20	15	0	123	4.12

* Control

** "Irrigation" includes both irrigation and water applied with fertigation applications.

Economic Decisions

Teams were required to select a multi-peril crop insurance (MPCI) policy, either revenue protection (RP), yield protection (YP), or revenue protection with harvest price exclusion (RP-HPE). These policies were all offered at 65, 70, 75, 80 and 85% levels of coverage. There were no hail or wind insurance options available. Six teams chose to purchase RP policies, five farms went with RP-HPE, and one chose YP policies (Figure 7). All but one of the competing teams selected Enterprise Units (EU). Chosen by three teams, RP-EU at 70% was the most common selection. The average cost across all competitors was $15.07/acre. The least expensive policy was RPHPE-EU at 65% coverage ($4.47/acre), selected by Farm 5. The most expensive was RP-EU at 85% coverage ($48.50/acre), chosen by Farm 7.

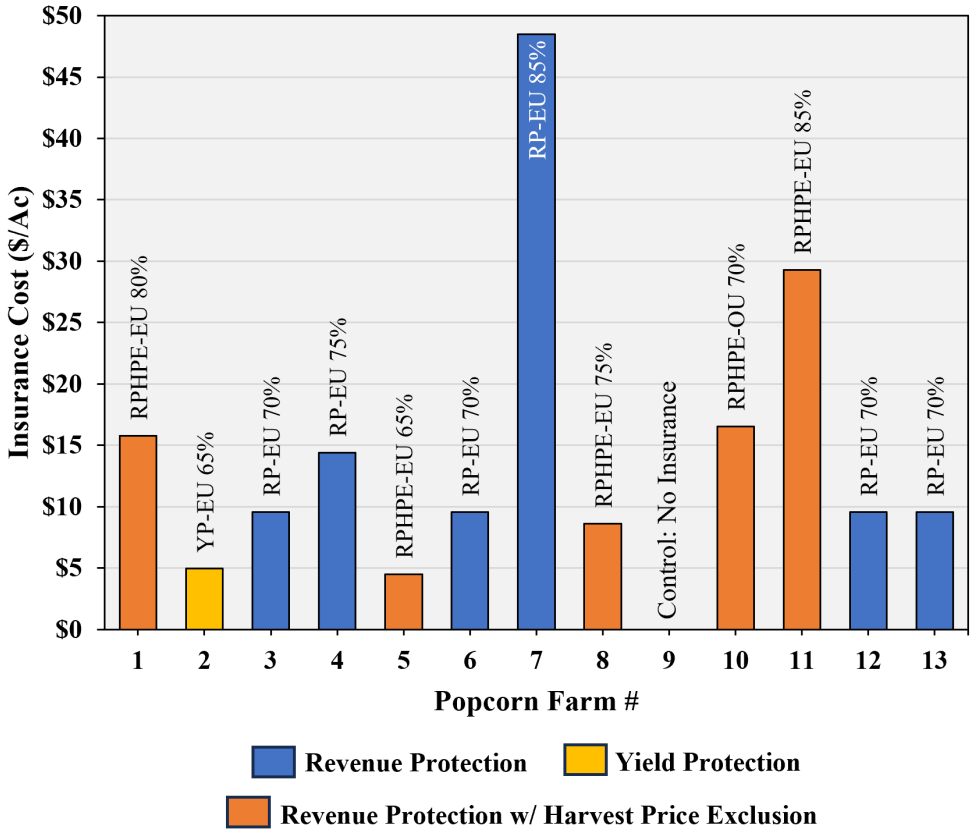

Figure 7. Insurance cost ($/acre) for the individual popcorn competition teams. Policies offered included Revenue Protection (RP), Revenue Protection with Harvest Price Exclusion (RP-HPE), and Yield Protection (YP) with either Optional Units (OU) or Enterprise Units (EU).

Participants had a production contract with AK Acres Popcorn out of Imperial, NE. The participants had from April 1 to November 30 to market their grain using the Chicago Board of Trade (CBOT) December 2023 (DEC23) futures price. As typical to the popcorn industry, a multiplier of 3.8 (.038 in equation) was used to calculate the final price into cents per pound.

Four teams chose not to fulfill any of their production contracts during the season, therefore it was sold at the end of the competition using the November 30 (DEC 2023) futures price of $4.77/bushel or just over $0.18/pound. Any unsold grain after the close of the competition was charged a handling fee of $0.05/bushel or $0.000758/pound (given industry standard of 66 pounds/bushel). The highest price attained by any farm was $6.20/bushel or $0.24/pound, Farm 4, but the team had only chosen to sell 10% of their production at that time. Due to the hail event and lower yields, insurance indemnity payments did

come into effect for ten of the thirteen farms (Figure 8). The additional revenue increased their average market value drastically. Between the marketing decisions and insurance payments, the average price received ranged from a low of just less than $0.19/pound, Farm 13, to a high of $0.46/pound by Farm 11 due to a large insurance indemnity payment. This is despite the production all being sold at the end of the competition with an imposed sales penalty. The average price per pound received for all teams, except the control, was $0.28/pound.

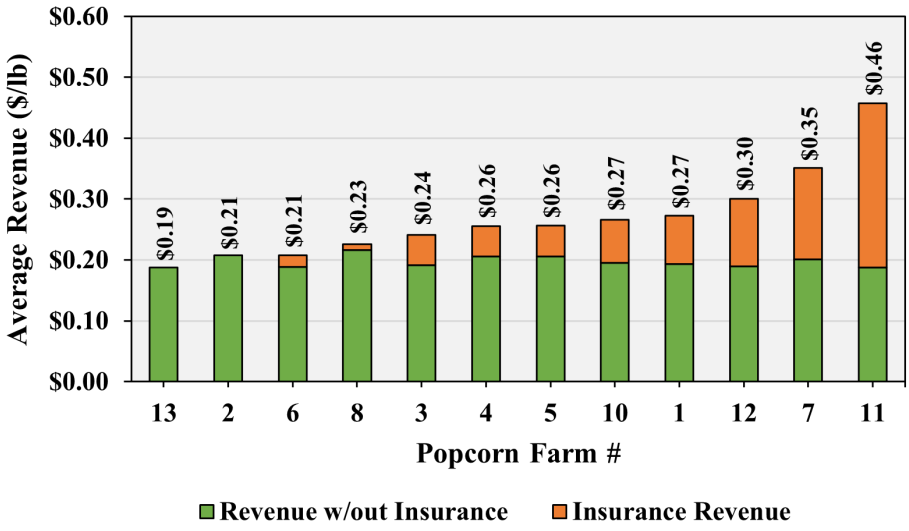

Figure 8. Average revenue received ($/pound) for the individual popcorn competition teams.

Results and Rankings

Grain Yield

With the hail damage that the popcorn plots received, all of the grain yields for the popcorn competition fell well below the APH of 7,000 pounds/acre (Table 3, Column 2). The farms ranged from 2,409 pounds/acre, Farm 9, to 5,982 pounds/acre, Farm 8. Excluding the control plot, the average yield was 4,482 pounds/acre. Figure 9A shows a significant grain yield response to total N fertilizer, which explained 84% of the yield variability. Grain yield also had a strong response to irrigation, explaining 78.5% of yield variability (Figure 9B).

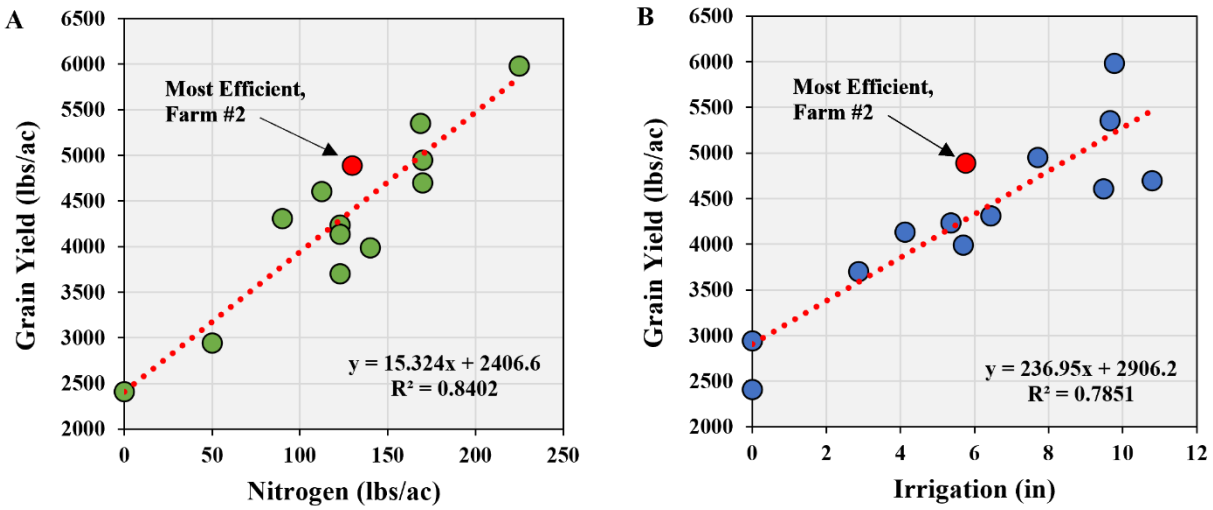

Figure 9. Popcorn grain yield response to seasonal total nitrogen fertilizer (A) and irrigation (B) at the WCREEC in North Platte, NE. The most efficient farm as measured by the Water Nitrogen Intensification Performance Index (WNIPI) is denoted in red.

Input Use Efficiency

The Water Nitrogen Intensification Performance Index (WNIPI, Lo et al., 2019), was used to quantify input use efficiency and is reported in the last column in Table 3. It compares the effect of N and irrigation input on grain yield with respect to a control treatment. The control is a baseline and is used to measure the effect of any added water or N fertilizer. The contest control was Farm 9, which had no added N or irrigation and produced 2,409 pounds/acre. Farm 2 had the highest efficiency with a WNIPI of 0.2752 (Figure 10 and Table 3, Column 8). This farm applied 130 pounds of N/acre and 5.77 inches of irrigation water resulting in a yield of 4,888 pounds/acre. Agronomic Efficiency (AE) measures the effect each added pound of N has in terms of pounds of popcorn. Farm 2 yielded 2,479 pounds/acre more than the control. When the yield difference is divided by the amount of applied N fertilizer, 130 pounds/acre, the AE is calculated to be 19.1 pounds of grain for every pound of N fertilizer applied (Table 3, Column 6). This is higher than the average of 15.2 pounds of grain/pound of N of all other farms, except the control farm. Irrigation Water Use Efficiency (IWUE) is measured in a similar manner, except pounds of N are replaced with inches/acre of applied water (Table 3, Column 7). Farm 2's IWUE was calculated to be 429.6 pounds of grain per inch of water. The overall average was 332.1 pounds of grain per inch of water excluding the control and Farm 11 which did not apply any irrigation water.

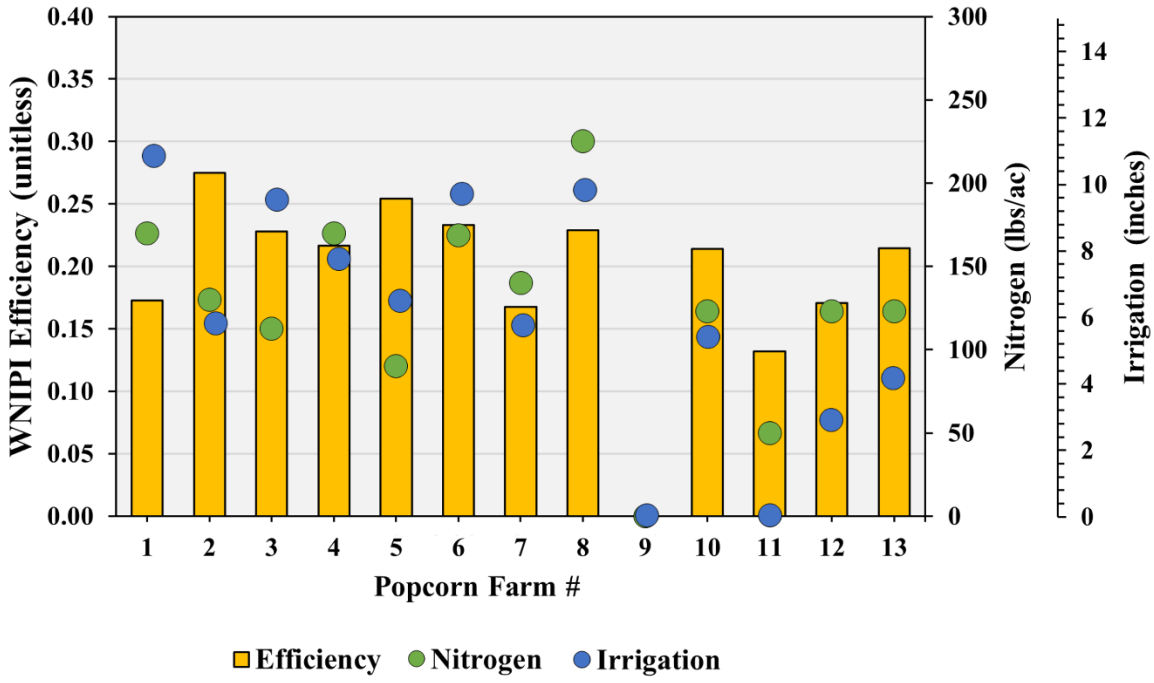

Figure 10. Input use efficiency (WNIPI) compared against irrigation (inches) and N fertilizer (lbs/acre) in the popcorn competition.

Profitability

Profitability is derived as total revenue minus total cost. Revenue was found by adding the total value of each market transaction with any government payments, insurance indemnities, and/or losses. Costs were based on the stated expenses each competition was assigned. Most of these costs were fixed on a per acre basis and are common among all farms. However, some costs e.g., grain hauling, fertilizer and water use, insecticide application, were based on a fixed per unit cost and varied by individual decisions. Since all farms are identical in cost structure, physical attributes, and revenue opportunity it is the choices they make and the resulting outcome of those choices that drive the difference in profitability.

Revenue ranged from a low of $0.19/pound, Farm 13, to a high of $0.46/pound, Farm 11 (Table 3, Column 3). Aside from the control, the lowest cost per pound was achieved by Farm 8 at $0.19/pound, and the highest cost per pound was Farm 11 at $0.30/pound (Table 3, Column 4).

With revenue and cost considered at the per acre level, Farm 11 was the most profitable with $476/acre profit, which was $91/acre more than that of the second place team, Farm 7, which earned $385/acre (Figure 11). Farms 3, 6, 12 and 13 were UNL plots with lower than recommended rates of nitrogen and irrigation water applications to determine production functions in Figure 9 and may not reflect the anticipated profitability of actual popcorn production.

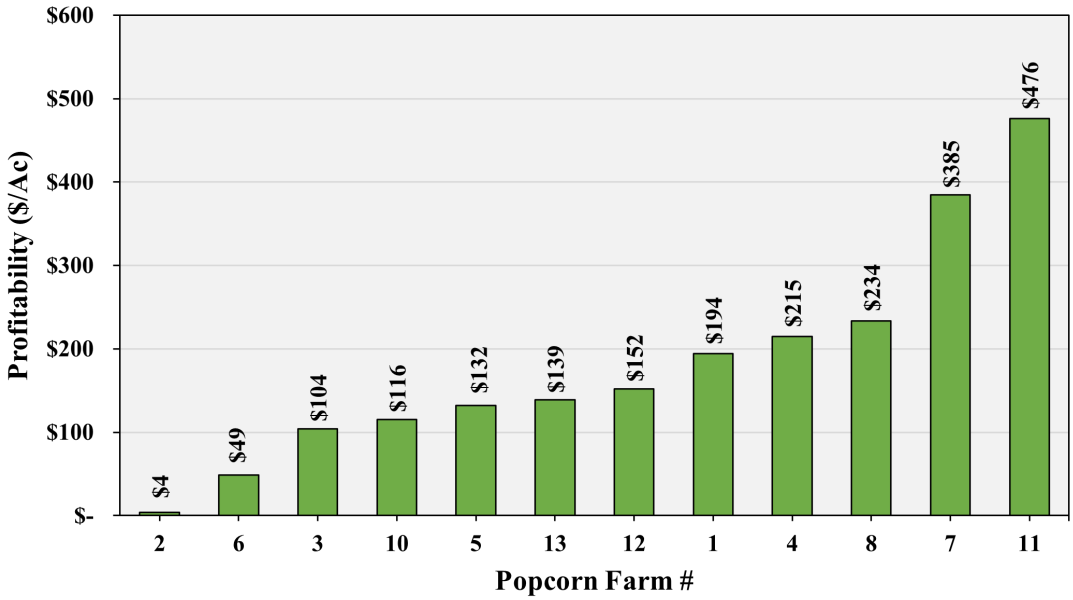

Figure 11. Profit per acre received for the individual popcorn competition teams.

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Table 3: Summary of results from the 2023 TAPS Popcorn competition.

Farm #	Grain Yield** (lbs/ac)	Revenue ($/lb)	Cost ($/lb)	Profit ($/ac)	AE (lbs/lbs)	IWUE (lbs/in)	WNIPI (unitless)
1	4,698	$0.27	$0.23	$194	13.5	211.9	0.173
2	4,888	$0.21	$0.21	$4	19.1	429.6	0.275
3	4,605	$0.24	$0.22	$104	19.5	231.4	0.228
4	4,950	$0.26	$0.21	$215	14.9	329.6	0.217
5	4,308	$0.26	$0.23	$132	21.1	294.9	0.254
6	5,352	$0.21	$0.20	$49	17.4	304.8	0.233
7	3,988	$0.35	$0.25	$385	11.3	276.9	0.168
8	5,982	$0.23	$0.19	$234	15.9	365.5	0.229
9	2,409	-	-	-	-	-	-
10	4,236	$0.27	$0.24	$116	14.9	340.4	0.214
11	2,942	$0.46	$0.30	$476	10.7	-	0.132
12	3,699	$0.30	$0.26	$152	10.5	449.8	0.171
13	4,134	$0.27	$0.24	$139	14.0	418.9	0.215

*Control **Reported as 14.0% grain moisture content

AE - Agronomic Efficiency (yield increase over the control plot, pounds of grain/pounds of N applied)

IWUE - Irrigation Water Use Efficiency (yield increase over the control plot, pounds of grain/inches of water applied)

WNIPI - Water-Nitrogen Intensification Performance Index

AWARD RECIPIENTS

Photo 1. The ***Greatest Grain Yield Award*** (among eligible teams) was won by Roger Lansman (pictured on the right), Farm 4, of Ord, NE with a yield of 4,950 pounds/acre. Lansman planted 32,000 seeds/acre.

Photo 2. The ***Highest Input Use Efficiency Award*** was presented to Nate Freitag, Farm 2, of Byron, NE. He planted a seeding rate of 33,000 seeds/acre and applied 130 pounds/acre of N and 5.77 inches/acre of irrigation water with a final yield of 4,888 pounds/acre.

Photo 3. AK Acres, Farm 11, from Imperial, NE, won the ***Most Profitable Award***. The team planted 28,000 seeds/acre. They applied 50 pounds of N and chose to not irrigate, which led to a yield of 2,942 pounds/acre. The team's choice in purchasing a Revenue Protection with Harvest Price Exclusion insurance policy with 85% coverage, which resulted in a large indemnity payment, was the driving factor in winning the most profitable award in the popcorn competition.

Additional Data

Although standability and popping quality were not taken into consideration for the results of the TAPS popcorn competition this data is valuable to popcorn growers and therefore can be found below (Table 4).

The standability (Table 4, Column 10) is a ranking on a scale of 1 to 10, with 10 being all plants standing at time of harvest. The standard popcorn industry kernel size is reported as how many kernels are in 10 grams (Table 4, Column 11). The Metric Weight to Volume Test (MWVT) used the industry standard Cretors MWVT popper with 250 grams of popcorn grain popped with 100 grams of oil.

The data in Table 4 suggests that the TAPS popcorn on average had a lower expansion by 2 to 3 points than expected, likely due to the hail damage to the crop. The control had the lowest yield, highest kernels per 10 grams and lowest expansion which is expected from a highly stressed field (no nitrogen or water, and hail damage). There is a high correlation between the kernel size or density and yield, meaning the higher the yield the larger the kernel size typically was which was also expected with the stress of the hail damage.

Table 4. Summary of select agronomic inputs & results from the 2023 TAPS popcorn competition.

			Nitrogen Fertilizer								
Farm	**Yield**	****Irrigation**	**Apr 28**	**Jun 27**	**Jul 20**	**Aug 02**	**Aug 09**	**Total**	**Standability**	**Kernels/ 10 grams**	**MWVT Expansion**
#	**(lbs/ac)**	**(in)**	**---------- (lbs/ac) ----------**						**Scale 1-10**		
1	4,698	10.80	50	120	0	0	0	170	8.83	66	44.0
2	4,888	5.77	70	30	30	0	0	130	8.17	66	45.8
3	4,605	9.49	67.5	22.5	7.5	5	10	112.5	7.20	67	44.3
4	4,950	7.71	90	60	20	0	0	170	9.17	66	44.8
5	4,308	6.44	30	0	0	30	30	90	8.07	70	44.5
6	5,352	9.66	101.25	33.75	11.25	7.5	15	168.75	9.67	64	44.3
7	3,988	5.70	0	50	30	30	30	140	7.33	68	44.2
8	5,982	9.78	135	45	15	10	20	225	9.33	64	45.0
*9	2,409	0.00	0	0	0	0	0	0	4.00	80	43.0
10	4,236	5.37	43	45	20	15	0	123	6.50	67	44.3
11	2,942	0.00	50	0	0	0	0	50	5.50	73	45.0
12	3,699	2.87	43	45	20	15	0	123	5.50	70	44.3
13	4,134	4.12	43	45	20	15	0	123	7.23	69	44.2

* Control ** "Irrigation" includes both irrigation and water applied with fertigation applications.

Sprinkler Corn Competition

This year 38 teams competed in the sprinkler corn competition, including more than 80 participants from throughout Nebraska, Colorado, Kansas and Michigan, as well as an international team from the country of Luxembourg. Within the 38 teams, there were nine that were non-competitive entities, along with the control, Farm 9, used for determining efficiency and other UNL farms for benchmarking UNL recommendations and research. To incorporate a new cropping system practice into the sprinkler corn competition, a cereal rye cover crop was drilled on October 6 following soybean harvest and terminated on May 4 using glyphosate.

Field Design

As in past years, each team was assigned three randomized plots, Figure 11, located at the intersection of Highway 83 and State Farm Road in North Platte, NE.

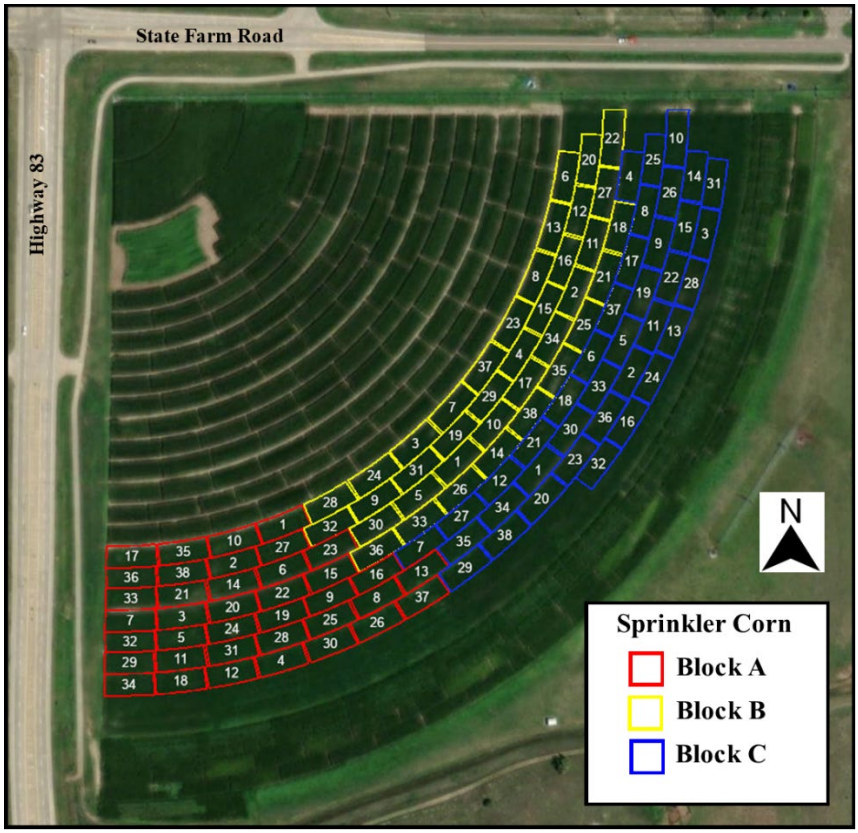

Figure 12. Layout for the sprinkler corn competition held at the WCREEC in North Platte, NE. Each team was assigned a randomized plot in blocks A, B, and C.

Competition Data

In mid-March, aggregate soil samples were taken throughout the TAPS competition fields. Ward Laboratories in Kearney, NE analyzed the samples, and the results (Table 5) were provided to participants ahead of the first decision deadlines.

Table 5. Soil sample results provided by Ward Laboratories in Kearney, NE for the sprinkler corn competition field.

Sample ID / Lab No.	Soil pH 1:1	Modified WDRF BpH	Soluble Salts 1:1 mmho/cm	Excess Lime Rating	Organic Matter LOI-%	KCl Nitrate ppm N	Depth / Nitrate Lbs N/A	Method / Phosphorus ppm P	-Ammonium Acetate- K ppm	Ca ppm	Mg ppm	Na ppm	M-3 Sulfate ppm S	DTPA Zn ppm	Fe ppm	Mn ppm	Cu ppm	Hot Water Boron ppm B	CaNO3 Chloride ppm Cl	Sum of Cations me/100g	% Base Saturation H	K	Ca	Mg	Na
BLOCK A							0 - 8 in	M-3																	
33229	7.6		0.17	NONE	2.6	13.1	31	128	447	1679	271	26	14.2	2.02	3.0	1.6	0.27			11.9	0	10	70	19	1
BLOCK A							8 - 32 in																		
33230						5.1	37																		
BLOCK B							0 - 8 in	M-3																	
33231	7.5		0.20	NONE	2.6	10.9	26	46	377	1639	257	19	12.4	0.81	3.5	2.2	0.20			11.4	0	8	72	19	1
BLOCK B							8 - 32 in																		
33232						6.4	46																		
BLOCK C							0 - 8 in	M-3																	
33233	8.1		0.22	NONE	2.3	12.7	30	19	349	2503	252	17	14.8	1.36	5.0	2.5	0.27			15.6	0	6	80	13	0
BLOCK C							8 - 32 in																		
33234						4.2	30																		

On July 17th, leaf tissue samples were collected to measure tissue nitrogen. Plant maturity for the plots averaged VT. Samples were processed and analyzed at Ward Laboratories in Kearney. The results were made available to participants via their TAPS online portal prior to the remaining two fertigation opportunities.

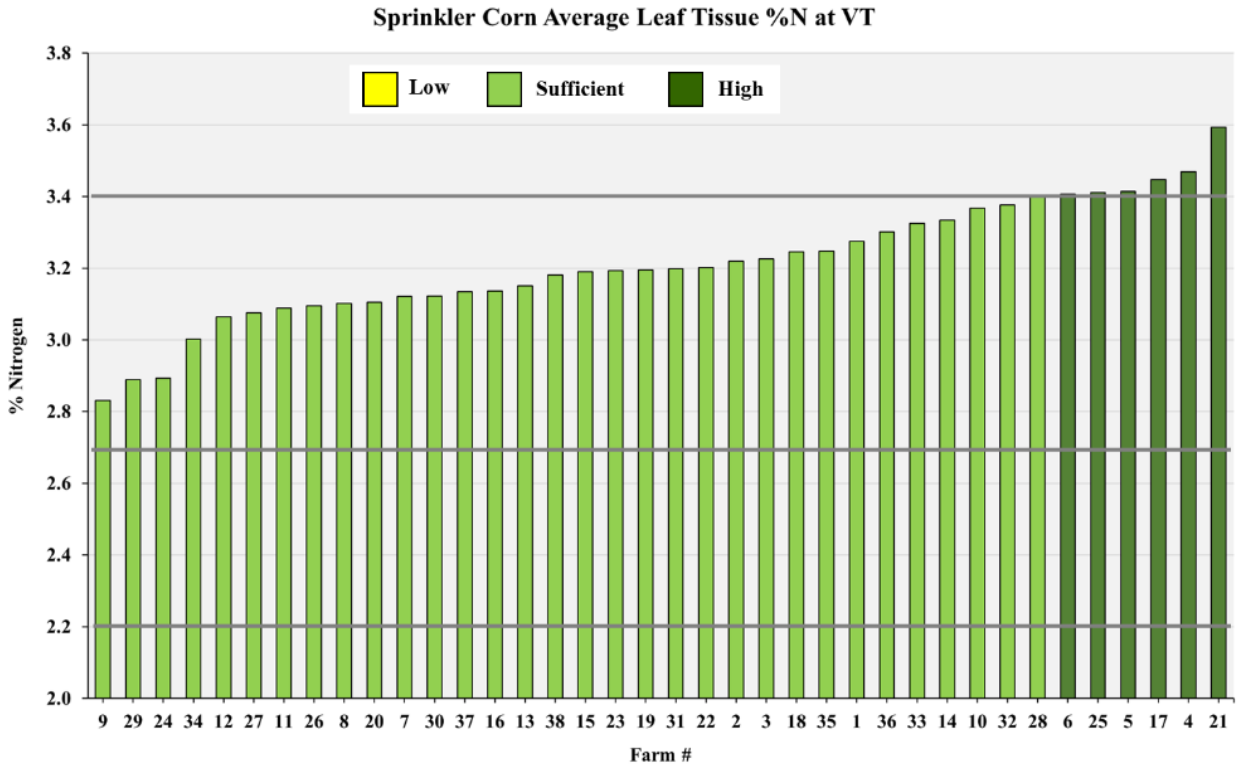

Figure 12. Average leaf tissue nitrogen for the sprinkler irrigated corn competition at VT growth stage.

Participant Decisions

Participants were responsible for making six economic and production management decisions, including multi-peril crop insurance (MPCI) coverage, hybrid type, seeding rate, nitrogen and irrigation amount and

timing, and grain marketing. All decisions were submitted by participants via the TAPS online password protected portal that time-stamped all decisions. The decisions and resulting outcomes are summarized below.

Agronomic Decisions

Agronomic decisions made by each team are shown in Table 6. Fifteen different corn hybrids were selected from five seed companies (Table 1, Column 2). Seven hybrids were selected by more than one team: Pioneer P1366AML, Pioneer P1185AM, Pioneer P1170AM, Channel 214-78DGVT2PRIB, Dekalb DKC64-65RIM, Dekalb DKC61-41 and Dekalb DKC59-82RIB. Pioneer P1366AML was the most popular hybrid used by thirteen teams. One team selected a hybrid from LG Seeds, which was not a sponsoring company and 3 hybrids, Pioneer P14830AML, Pioneer P1742Q and Dekalb DKC70-27, were not on the sponsoring companies' recommended list. These hybrids were therefore supplied to the competition by the participant. Fontanelle 14DT602-TRERIB, chosen by Farm 26, had the lowest cost at $262/bag, while Pioneer P14830AML, chosen by Farm 8, had the highest cost at $345/bag. Farm 20 had the lowest seeding rate at 28,000 seeds/acre and planted hybrid Pioneer P1366AML. The highest seeding rate of 36,000 seeds/acre was planted by both Farms 15 and 29 with the same hybrid, Pioneer P1185AM (Table 6, Column 3).

Total N fertilizer applied, excluding the control, ranged from 90 to 300 pounds/acre (Table 6, Column 11). On average, 31% of N was applied at pre-plant, 32% as a side-dress, and the remaining 37% was applied over the five fertigation options with 9%, 11%, 11%, 4% and 2% applied on June 29, July 5 and 20, August 2 and 9, respectively.

The irrigation season started June 15 and concluded on September 14. Teams were allowed to irrigate twice a week. Three irrigations were cancelled due to rainfall events, one each in June, August, and September. Excluding the control, seasonal irrigation ranged from 0.00 inches, Farms 16, 22 and 30 to 13.67 inches, Farm 15, while the average applied per farm was 6.20 inches (Table 6, Column 12). Irrigation totals do include the water applied during fertigation operations.

Table 6: Summary of select agronomic inputs from the 2023 TAPS sprinkler corn competition.

Farm #	Hybrid Name	Seeding Rate (1,000/ac)	Nitrogen Fertilizer (lbs/ac) Apr 27	Jun 6	Jun 29	Jul 5	Jul 20	Aug 2	Aug 9	Total	**Irrigation (in)
1	Channel 214-78DGVT2PRIB	32	180	0	0	0	0	0	0	180	9.75
2	Pioneer P1366AML	34	0	15	30	30	30	0	0	105	1.96
3	Channel 214-78DGVT2PRIB	30	50	150	20	20	20	10	0	270	13.29
4	Dekalb DKC59-82RIB	34	150	50	20	20	20	0	0	260	1.63
5	Dekalb DKC64-65RIB	33	70	60	30	30	0	0	0	190	2.39
6	Pioneer P1366AML	34	45	60	30	30	30	0	0	195	6.96
7	Pioneer P1185AM	34	0	55	0	30	30	0	0	115	4.24
8	Pioneer P14830AML	32	75	100	0	30	30	30	0	265	12.11
*9	Pioneer P1366AML	34	0	0	0	0	0	0	0	0	0.00
10	Pioneer P1185AM	33	50	165	10	0	10	0	10	245	0.33
11	Pioneer P1185AM	32	35	40	0	30	30	0	0	135	4.34
12	Channel 214-78DGVT2PRIB	34	80	50	25	25	25	30	30	265	11.92
13	Pioneer P1170AM	32	50	50	20	20	20	20	10	190	10.35
14	Channel 213-19VTPRIB	34	40	50	20	25	25	0	0	160	2.28
15	Pioneer P1185AM	36	40	75	30	30	30	20	0	225	13.67
16	Dekalb DKC64-65RIB	33	100	0	0	0	0	0	0	100	0.00
17	Dekalb DKC59-82RIB	34	100	0	30	30	0	0	0	160	7.34
18	Pioneer P1170AM	32	0	60	30	30	30	0	0	150	8.16
19	Pioneer P1742Q	34	150	30	30	30	0	0	0	240	4.64
20	Pioneer P1366AML	28	0	0	30	30	30	0	0	90	0.00
21	Dekalb DKC61-41	33	0	100	0	30	25	25	0	180	9.40
22	Pioneer P1366AML	34	60	92	0	0	0	0	0	152	0.00
23	Pioneer P1366AML	31.5	0	75	25	0	30	25	20	175	9.40
24	Dekalb DKC70-27	32	100	0	0	0	30	30	0	160	3.14
25	Fontanelle 11DT591	33.5	30	90	0	15	15	0	30	180	6.24
26	Fontanelle 14DT602-TRERIB	34	60	100	0	0	0	0	0	160	7.00
27	Pioneer P1563AML	31.5	150	40	15	15	15	0	0	235	8.43
28	Dekalb DKC61-41RIB	31	0	110	0	30	0	15	0	155	5.83
29	Pioneer P1185AM	36	100	50	30	30	30	30	30	300	10.10
30	LG Seed 59C72	32	120	80	0	0	0	0	0	200	0.00
31	Pioneer P1170AM	32	0	100	30	30	30	20	0	210	9.92
32	Pioneer P1366AML	34	45	60	30	30	30	0	0	195	5.46
33	Pioneer P1366AML	34	45	60	30	30	30	0	0	195	1.96
34	Pioneer P1366AML	34	45	60	30	30	30	0	0	195	1.96
35	Pioneer P1366AML	34	45	60	30	30	30	0	0	195	8.46
36	Pioneer P1366AML	34	45	60	30	30	30	0	0	195	7.76

37	Pioneer P1366AML	34	45	60	30	30	30	0	0	195	6.81
38	Pioneer P1366AML	34	45	60	30	30	30	0	0	195	11.16

*Control ** "Irrigation" includes both irrigation and water applied with fertigation applications.

Economic Decisions

Teams were required to select a multi-peril crop insurance (MPCI) policy, either revenue protection (RP), yield protection (YP), or revenue protection with harvest price exclusion (RP-HPE). These policies were all offered at the 65, 70, 75, 80 and 85% levels of coverage. There were no additional hail or wind insurance options available. Twenty-nine teams chose RP policies, seven went with RP-HPE policies and one selected a YP policy (Figure 13). Of all the competitors only one used Optional Units (OU), Farm 12, while the others all opted for Enterprise Units (EU). Thirteen teams used RP-EU at 70% coverage, the most widely used policy. The average cost across all competitors was $11.93/acre. The least expensive policy was RPHPE-EU at 65% coverage ($3.51/acre), selected by Farms 7, 13, 18 and 20. The most expensive was RP-EU at 85% coverage ($41.35/acre), Farms 10 and 29.

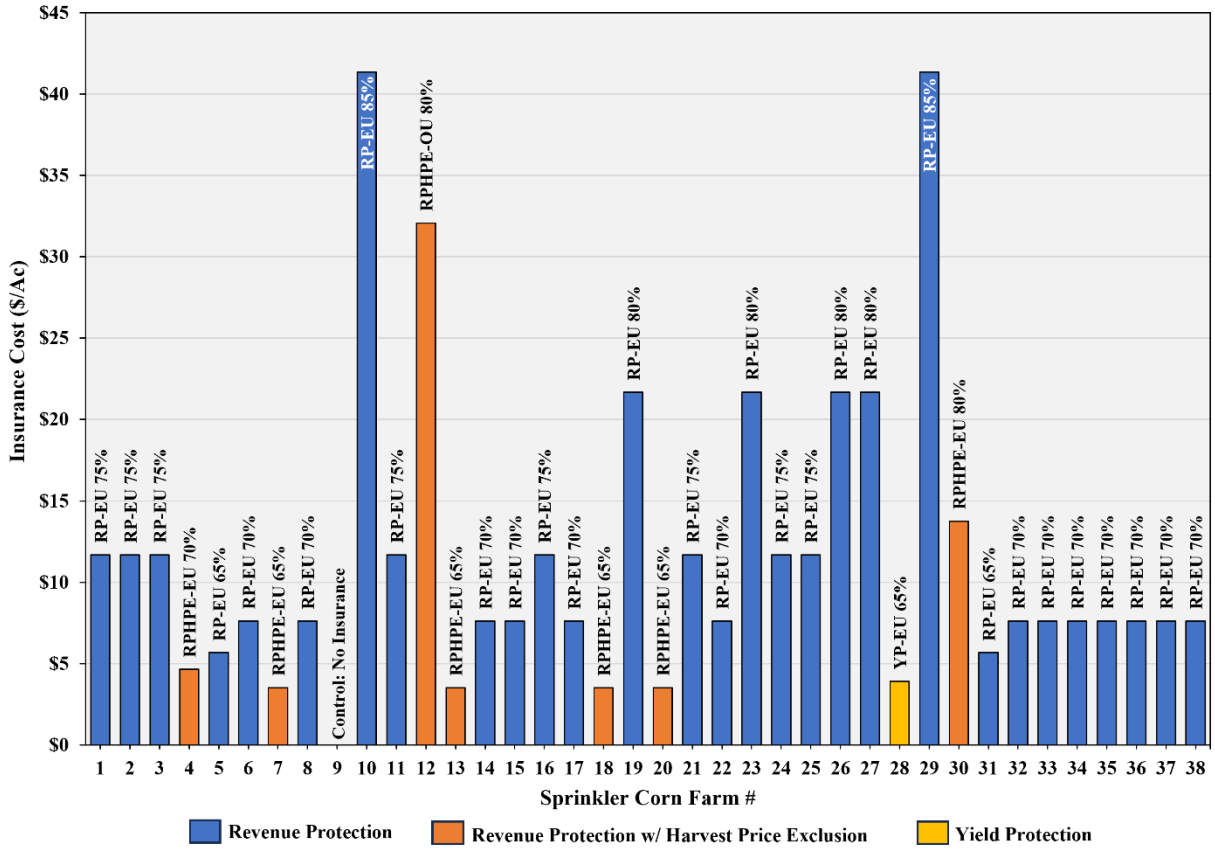

Figure 13. Insurance cost ($/acre) for the individual sprinkler irrigated corn competition teams. Policies offered included Revenue Protection (RP), Revenue Protection with Harvest Price Exclusion (RP-HPE), and Yield Protection (YP) with either Optional Units or Enterprise Units.

Closely tied to insurance is the risk related to forward pricing and sales of grain. Contestants are encouraged to take advantage of seasonal price trends and events that often make early season marketing such as forward contracting, hedging, basis contracts and hedge-to-arrive tools economically advantageous. They are however limited to market only expected production, represented by trend adjusted Average Production History (APH). These four tools and spot cash sales had to be completed during the time period of April 1 through November 30.

The 2023 marketing year saw prices decrease considerably from the previous year, by an average of approximately $1.23/bushel with inflation and world economic conditions and the supply of corn demand for US corn lower compared to last year. Fall prices, as most often occurs, ended up being lower than the predicted spring price. The seasonal price variation, however, did follow a normal marketing year with higher cash prices observed during the early part of the season. There were ample opportunities to market production as reflected by the varying average prices per bushel received by the competitors.

The marketing decisions led to average prices received from $4.47 to $8.38/bushel (Figure 14). Farm 10, whose grain was all sold at the end of the season and received an indemnity payment due to the crop insurance the team selected, achieved the highest average price per bushel of the season. Fourteen teams chose not to sell any of their production during the season, therefore it was sold at the end of the competition on November 30 at $4.47/bushel. Any unsold grain after the close of the competition incurred a $0.05/bushel handling fee. If a team sold more grain than was produced, those bushels were bought back at the $4.47/bushel price, along with a penalty of $0.10/bushel transaction fee. Thirty-three teams received indemnity payments based on their low yields and their crop insurance selection. This additional revenue ultimately increased their average market value drastically.

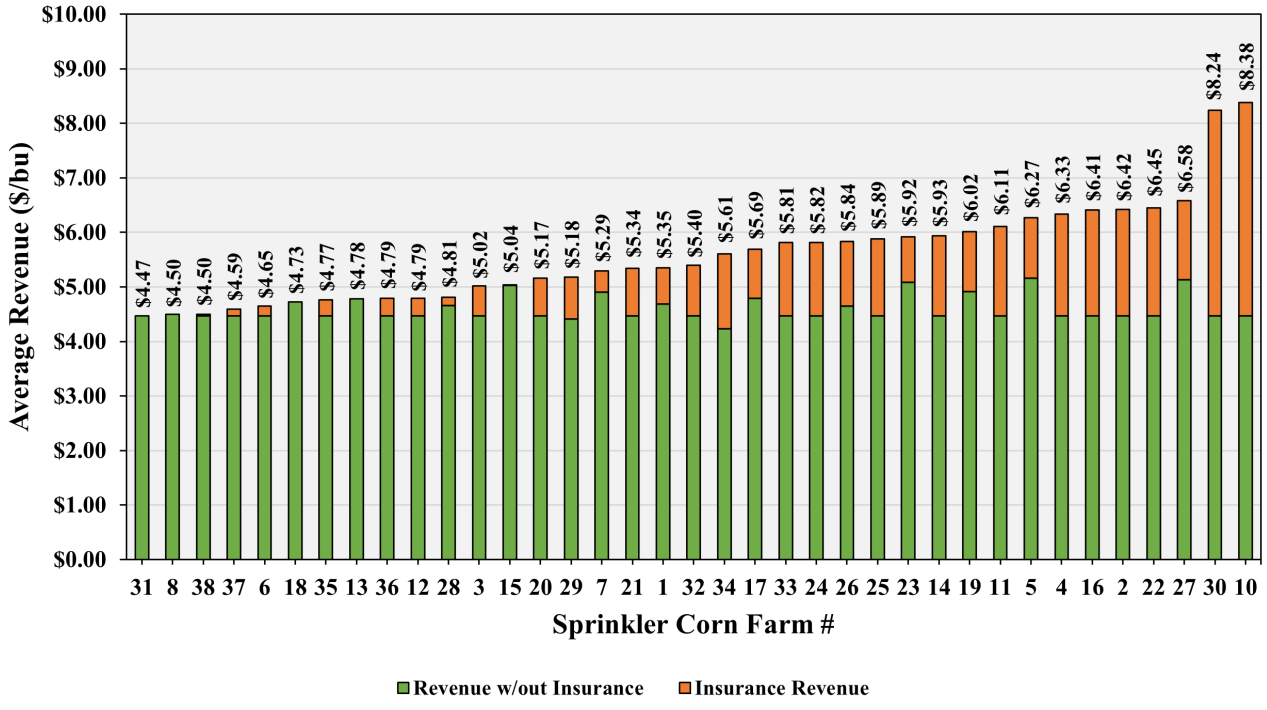

Figure 14. Average revenue received ($/bushel) for the individual sprinkler irrigated corn competition teams.

Results and Rankings

Grain Yield

As a result of the hail event on July 22, the grain yields for the competition were substantially lower than past years. The grain yields for the competition averaged 171.7 bushels/acre, which was about 58 bushels/acre less than the APH of 230 bushels/acre (Table 7, Column 2). Not a single team had an average yield that exceeded the field's APH. Excluding the control, the farms ranged from 125.7 bushels/acre, Farm 30, to 212.2 bushels/acre, Farm 12. Figure 15A shows the relationship between grain yield and total N fertilizer applied. The measure of correlation, the R-squared value of 16%, indicates that N had a limited effect on explaining yield variations. On the other hand, grain yield was more strongly correlated to irrigation where it explained 83% of yield variability (Figure 15B). Farm 12 that achieved the highest yield of 212.2 bushels/acre applied 11.92 inches of applied water, which was 3.76 inches more than the most efficient farm, Farm 18, and Farm 12 applied 265 pounds of nitrogen which was 115 pounds more than Farm 18 even with a similar yield of 205.1 bushels/acre.

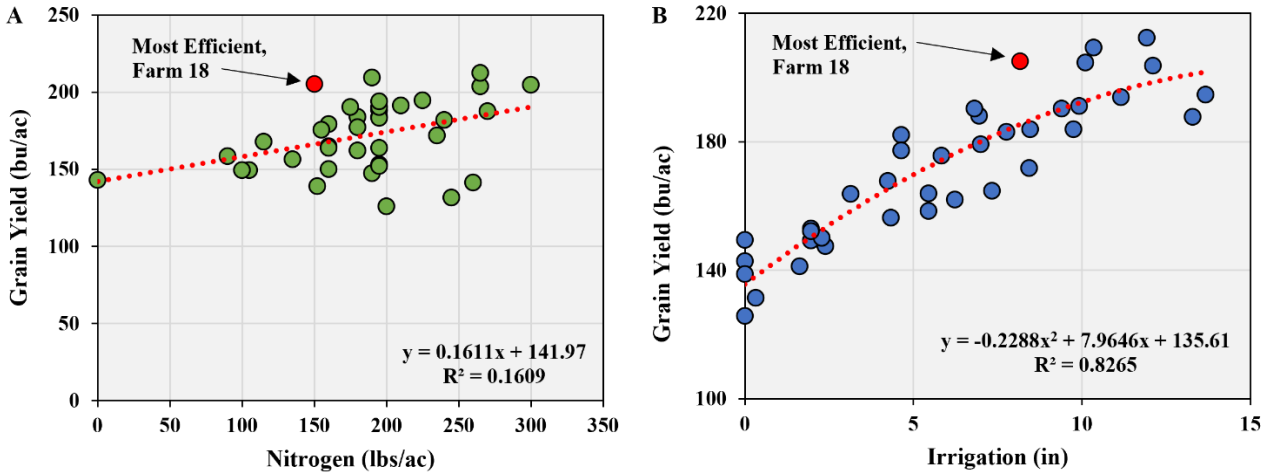

Figure 15. Sprinkler corn grain yield response to seasonal total nitrogen fertilizer (A) and irrigation (B) at the WCREEC in North Platte, NE. The most efficient farm as measured by the Water Nitrogen Intensification Performance Index (WNIPI) is denoted in red.

Input Use Efficiency

The Water Nitrogen Intensification Performance Index (WNIPI, Lo et al., 2019), was used to quantify input use efficiency and is reported in Figure 16. It compares the effect of N and irrigation input on grain yield with respect to the control farm. The control is used to measure the effect on yield of any added water or N fertilizer. The control had no added N or irrigation and yielded 142.8 bushels/acre. Farm 18 had the highest WNIPI score of 0.136 and therefore was the most N and water efficient (Table 7, Column 8). This farm applied 150 pounds of N/acre and 8.16 inches of water, resulting in a yield of 205.1 bushels/acre, which was the third highest yield in the competition. Agronomic Efficiency (AE) measures the effect each pound of N fertilizer adds in terms of bushels (Table 7, Column 6). Farm 18 yielded 62.3 bushels/acre more than the control. When the yield difference is divided by the amount of additional applied N fertilizer, 150 pounds/acre, the AE is calculated to be 0.42 bushel per acre increase per pound of N. This is over double the competition average of 0.16 bushels/pound of N of all other farms, except the control farm. Irrigation Water Use Efficiency (IWUE) is measured in a similar manner, except that N is replaced with applied water (Table 7, Column 7). Farm 18's IWUE was calculated to be 7.64 bushels/acre-inch. The average was 3.58 bushels/acre-inch, for those teams that chose to irrigate.

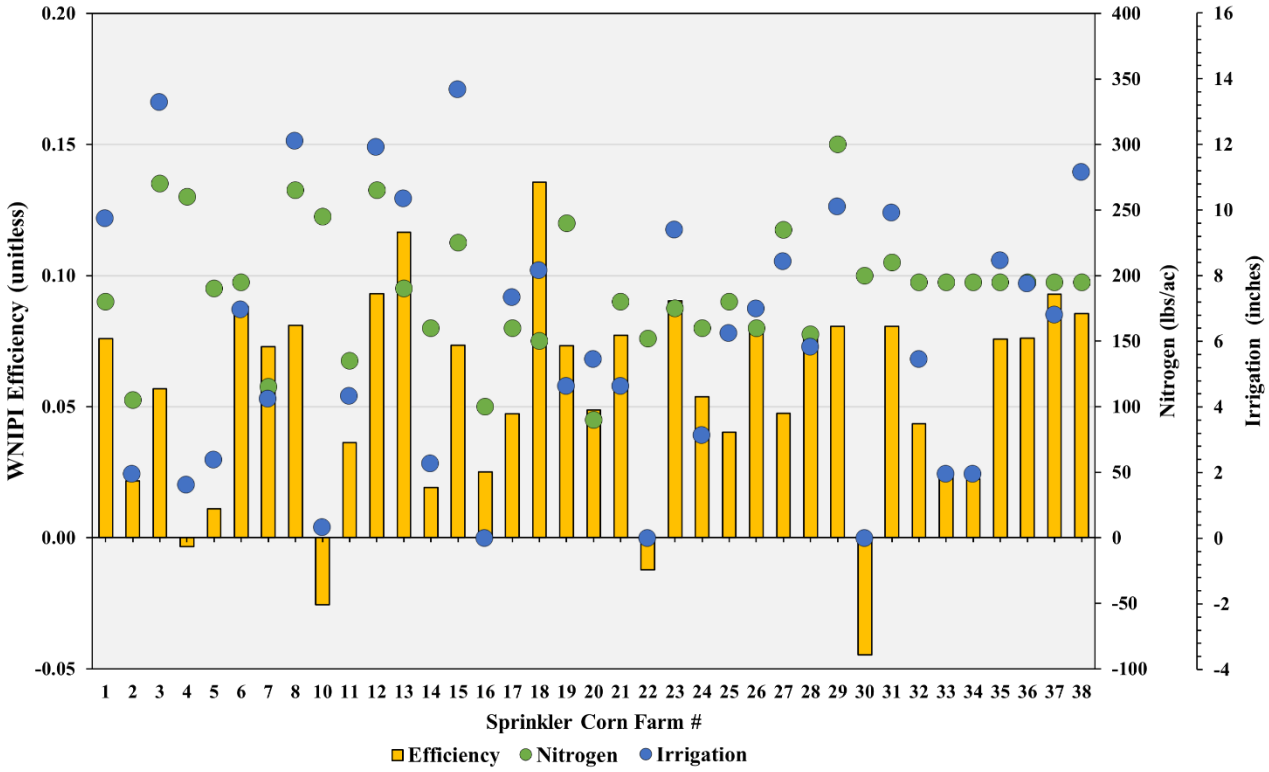

Figure 16. Input use efficiency (WNIPI) compared against irrigation (inches) and N fertilizer (lbs/acre) in the sprinkler corn competition.

Profitability

Profitability is derived as total revenue minus total cost. Revenue was found by adding the total value of each market transaction with any government payments, insurance indemnities, and/or losses. Costs were based on the stated expenses each competition was assigned. Most of these costs were fixed on a per acre basis and are common among all farms. However, some costs e.g., grain hauling, fertilizer and water use, insecticide application, were based on a fixed per unit cost and varied by individual management decisions. Since all farms are identical in cost structure, physical attributes, and revenue opportunity it is the choices made and the resulting outcome of those choices that drive the difference in profitability.

Revenue per bushel ranged from a low of $4.47/bushel, Farm 31, to a high of $8.38/bu, Farm 10 (Table 7, Column 3). Aside from the control, the lowest cost per acre was achieved by Farm 20 at $913/acre (Table 7, Column 4). The highest cost per acre was Farm 29 at $1,167/acre.

Only nine of the teams were profitable due to the hail damage's effect on productivity. With revenue and cost considered, Farm 23 was the most profitable with $91/acre profit, $42/acre more than the second ranked team, Farm 10 (Figure 17). The combination of the team's low cost per bushel, along with the high revenue per acre including an insurance indemnity payment, resulted in winning the top award.

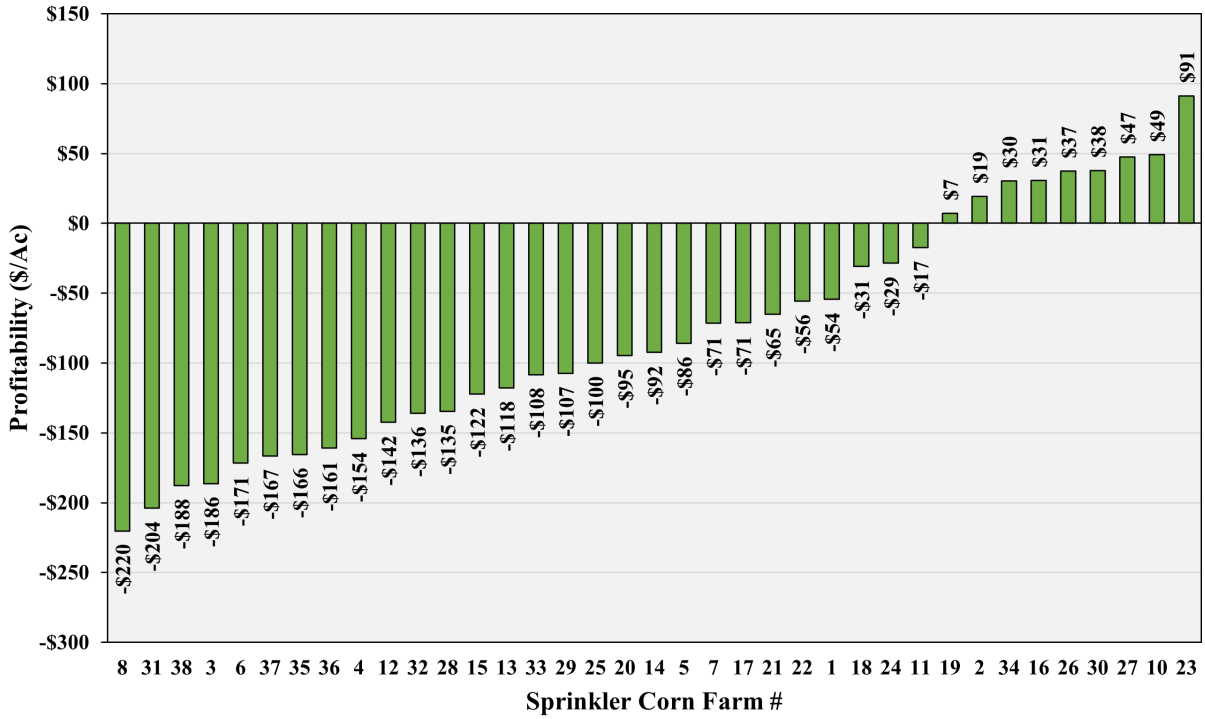

Figure 17. Profit per acre received for the individual sprinkler irrigated corn competition teams.

Table 7: Summary of results from the 2023 TAPS sprinkler corn competition.

Farm #	Grain Yield ** (bu/ac)	Revenue ($/bu)	Cost ($/ac)	Profit ($/ac)	AE (bu/lbs)	IWUE (bu/ac-in)	WNIPI (Unitless)
1	183.8	$5.35	$1,038	-$54	0.23	4.21	0.076
2	149.2	$6.42	$939	$19	0.06	3.27	0.022
3	187.7	$5.02	$1,129	-$186	0.17	3.38	0.057
4	141.1	$6.33	$1.048	-$154	-0.01	-1.02	-0.003
5	147.4	$6.27	$1,011	-$86	0.02	1.93	0.011
6	188.1	$4.65	$1,046	-$171	0.23	6.51	0.088
7	167.8	$5.29	$960	-$71	0.22	5.90	0.073
8	203.6	$4.50	$1,136	-$220	0.23	5.02	0.081
*9	142.8	-	-	-	-	-	-
10	131.4	$8.38	$1,052	$49	-0.05	-34.50	-0.026
11	156.4	$6.11	$973	-$17	0.10	3.13	0.036
12	212.2	$4.79	$1,159	-$142	0.26	5.83	0.093
13	209.2	$4.78	$1,118	-$118	0.35	6.41	0.116
14	150.0	$5.93	$982	-$92	0.04	3.16	0.019
15	194.6	$5.04	$1,102	-$122	0.23	3.79	0.073
16	149.4	$6.41	$927	$31	0.07	-	0.025
17	164.6	$5.69	$1,008	-$71	0.14	2.97	0.047
18	205.1	$4.73	$1,000	-$31	0.42	7.64	0.136
19	182.0	$6.02	$1,087	$7	0.16	8.45	0.073
20	158.5	$5.17	$913	-$95	0.17	2.87	0.049
21	177.2	$5.34	$1,012	-$65	0.19	7.41	0.077
22	138.8	$6.45	$950	-$56	-0.03	-	-0.012
23	190.2	$5.92	$1,035	$91	0.27	5.05	0.090
24	163.7	$5.82	$981	-$29	0.13	6.67	0.054
25	161.9	$5.89	$1,053	-$100	0.11	3.07	0.040
26	179.2	$5.84	$1,009	$37	0.23	5.21	0.080
27	171.8	$6.58	$1,083	$47	0.12	3.44	0.047
28	175.6	$4.81	$979	-$135	0.21	5.62	0.076
29	204.6	$5.18	$1,167	-$107	0.21	6.12	0.081
30	125.7	$8.24	$998	$38	-0.09	-	-0.045
31	191.0	$4.47	$1,058	-$204	0.23	4.87	0.081
32	163.9	$5.40	$1,020	-$136	0.11	3.86	0.044
33	153.0	$5.81	$997	-$108	0.05	5.19	0.025
34	152.1	$5.61	$997	$30	0.05	4.73	0.022
35	183.9	$4.77	$1,042	-$166	0.21	4.85	0.076
36	183.0	$4.79	$1,037	-$161	0.21	5.19	0.076
37	190.2	$4.59	$1,040	-$167	0.24	6.96	0.093
38	193.7	$4.50	$1,060	-$188	0.26	4.56	0.086

*Control **Reported as 15.5% grain moisture content.

AE - Agronomic Efficiency (yield increase over the control plot, bushels of grain/pounds of N applied)

IWUE - Irrigation Water Use Efficiency (yield increase over the control plot, bushels of grain/inches of water applied)

WNIPI - Water-Nitrogen Intensification Performance Index

AWARD RECIPIENTS

Photo 4. The ***Greatest Grain Yield Award*** was won by Tom Carpenter of Bartley, NE, Farm 12, with a yield of 212.2 bushels/acre. Carpenter planted Channel 214-78DGVT2PRIB at a population density of 34,000 seeds/acre.

Photo 5. The ***Highest Input Use Efficiency Award*** was won by Perkins Group, Farm 18. The team included Brent Gloy, Bruce Young, Curt Richmond, Jeremy Hagan, Nick Turner, Pat McGreer, Shawn Turner, Ted Tietjen, and Troy Kemling. The team planted Pioneer P1170AM at 32,000 seeds/acre. They applied 150 pounds of N and 8.16 inches of irrigation, which led to a yield of 205.1 bushels/acre.

Photo 6. The ***Most Profitable Award*** was won by Kenny Reinke of Neligh, NE, Farm 23. He planted Pioneer P1366AML at 31,500 seeds/acre. Kenny applied 175 pounds of N and 9.40 inches of irrigation, which led to a yield of 190.2 bushels/acre. The combination of the his low cost per bushel, along with the high revenue per acre including an insurance indemnity payment, resulted in winning the top award. Pictured is Tyler (L) and Kenny Reinke (R).

Subsurface Drip Irrigated Corn Competition

This year 16 teams competed in the Subsurface Drip Irrigated (SDI) corn competition, including more than 30 participants from across Nebraska. One of the 16 teams, Farm 9, was the control farm used for determining efficiency.

Field Design

Each team was assigned three randomized plots, Figure 18, located south of the WCREEC office, southwest of Highway 83 and State Farm Road intersection in North Platte, NE.

Figure 18. Plot layout for the 2023 SDI corn competition held at the West Central Research, Extension, & Education Center in North Platte, NE. Each team had a randomized plot located in blocks A, B, and C.

Competition Data

In mid-March, aggregate soil samples were taken throughout the TAPS competition fields. Ward Laboratories in Kearney, NE analyzed the samples, and the results (Table 8) were provided to participants ahead of the first decision deadlines.

Table 8. Soil sample results provided by Ward Laboratories in Kearney, NE for the SDI corn competition field.

Sample ID / Lab No.	Soil pH 1:1	Modified WDRF BpH	Soluble Salts 1:1 mmho/cm	Excess Lime Rating	Organic Matter LOI-%	KCl Nitrate ppm N	Depth / Nitrate Lbs N/A	Method / Phosphorus ppm P	-Ammonium Acetate- K ppm	Ca ppm	Mg ppm	Na ppm	M-3 Sulfate ppm S	DTPA Zn ppm	Fe ppm	Mn ppm	Cu ppm	Hot Water Boron ppm B	CaNO3 Chloride ppm Cl	Sum of Cations me/100g	% Base Saturation H	K	Ca	Mg	Na
BLOCK A							0 - 8 in	M-3																	
33235	7.9		0.21	NONE	3.0	10.5	25	158	356	1445	179	12	8.1	1.47	3.1	0.9	0.16			9.7	0	9	75	15	1
BLOCK A							8 - 32 in																		
33236						4.3	31																		
BLOCK B							0 - 8 in	M-3																	
33237	7.7		0.17	NONE	3.3	9.2	22	158	349	1308	170	10	7.6	1.45	2.4	0.9	0.16			8.9	0	10	74	16	0
BLOCK B							8 - 32 in																		
33238						4.0	29																		
BLOCK C							0 - 8 in	M-3																	
33239	7.6		0.17	NONE	3.1	13.5	32	199	365	1492	178	15	9.0	1.90	3.3	1.1	0.21			9.9	0	9	75	15	1
BLOCK C							8 - 32 in																		
33240						4.8	34																		

On July 17th, leaf tissue samples were collected to measure tissue nitrogen. Plant maturity for the plots averaged VT. Samples were processed and analyzed at Ward Laboratories in Kearney. The results (Figure 19) were made available to participants via their TAPS online portal prior to the remaining two fertigation opportunities.

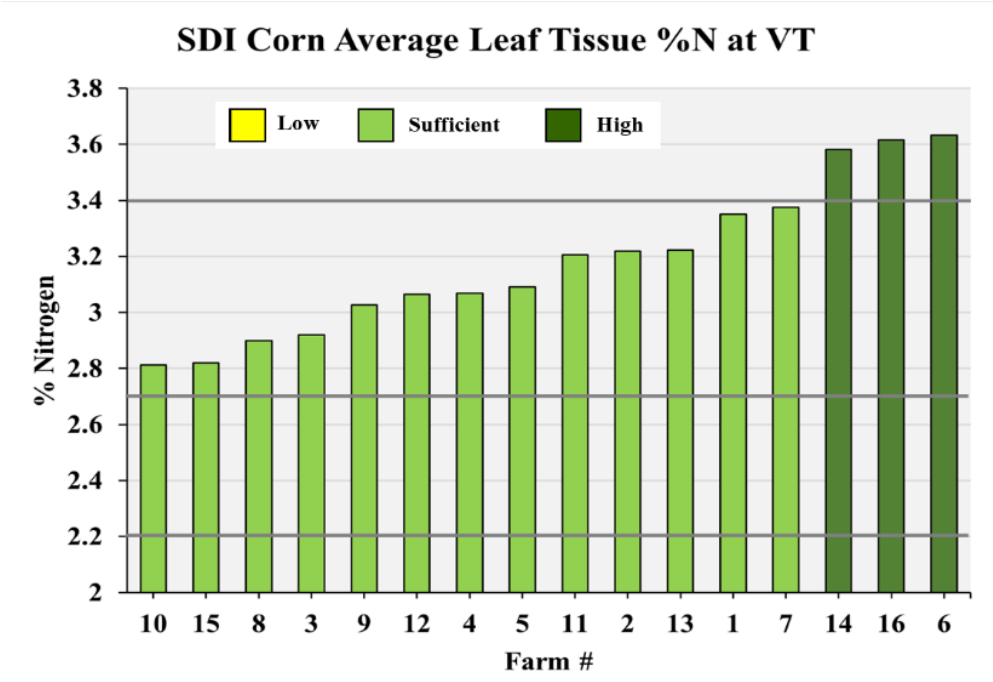

Figure 19. SDI Corn competition average leaf tissue results for nitrogen at VT growth stage.

Participant Decisions

Participants were responsible for making economic and production management decisions, including insurance coverage, hybrid type, seeding rate, insecticide, nitrogen and irrigation quantity and timing, and marketing. All decisions were submitted by participants via the TAPS online password protected portal that time-stamped all decisions. The decisions and resulting outcomes are summarized below.

Agronomic Decisions

Agronomic decisions made by each team are shown in Table 9. Twelve corn hybrids were selected from seven seed companies (Table 9, Column 2). Three teams selected Pioneer P1366AML, three teams chose Dekalb DKC62-89RIB, while all other hybrids were only chosen once by the ten remaining teams. Two hybrids, Pioneer P14830AML, Farm 8, and P1742Q, Farm 13, were not on the sponsoring companies' recommended list and therefore were provided by the competitors. Seitec 6423VT2Pro, Farm 12, had the lowest cost at $269/bag and Pioneer P14830AML, Farm 8, had the highest cost at $345/bag. Farm 10 planted the fewest seeds per acre at a rate of 30,000 seeds/acre and planted Pioneer P1366AML (Table 10, Column 3). The highest seeding rate was 35,000 planted by Farm 1 with Channel 213-19VT2PRIB.

The total N fertilizer applied, not including the control, ranged from 140 to 260 pounds/acre (Table 9, Column 11). On average, 29% of N was applied at pre-plant, 19% as side-dress, and the remaining 52% was applied over the five fertigation opportunities with 11%, 13%, 12%, 8.5% and 7.5% applied on June 28, July 5 and 19, August 2 and 9, respectively.

The teams were given the opportunity to irrigate, starting June 15. However, the first irrigation was not initiated until June 19 by Farms 1, 2, 3, and 5. Irrigation concluded September 14. Excluding the control, seasonal irrigation ranged from 1.75 inches, Farm 16, to 13.25 inches, Farm 8, with an average of 7.61 inches (Table 9, Column 12). Irrigation totals include the water applied during fertigation operations also.

For the second consecutive year, SDI corn plots were scouted for Western Bean Cutworm (WBC) by the entomology department at WCREEC. Prior to the hail event, the WBC flight was under the threshold for treatment. Following that event, numbers continued to decline eliminating the need to apply insecticides for WBC and therefore the decision was suspended.

Table 9. Summary of select agronomic inputs from the 2023 TAPS SDI corn competition.

Farm #	Hybrid Name	Seeding Rate (1,000/ac)	Nitrogen Fertilizer (lbs/ac) Apr 28	Jun 06	Jun 28	Jul 05	Jul 19	Aug 02	Aug 09	Total	**Irrigation (in)
1	Channel 213-19VT2PRIB	35	90	30	20	25	25	25	25	240	9.00
2	Channel 214-78DGVT2P	32	180	0	0	0	0	0	0	180	9.75
3	Pioneer P1563AML	32	0	0	30	30	30	30	30	150	6.00
4	Pioneer P1366AML	34	0	60	30	30	30	30	30	210	8.75
5	Pioneer P1185AM	32	40	40	30	30	30	20	20	210	12.25
6	Dekalb DKC62-89RIB	33	80	60	30	30	30	0	0	230	2.35
7	Dekalb DKC62-89RIB	33	100	0	0	30	30	30	30	220	7.30
8	Pioneer P14830AML	34	100	40	20	30	20	30	20	260	13.25
*9	Pioneer P1366AML	34	0	0	0	0	0	0	0	0	0.00
10	Pioneer P1366AML	30	0	50	25	30	30	30	20	185	7.25
11	Dekalb DKC64-65RIB	34	0	60	20	20	20	20	20	160	6.25
12	Seitec 6423VT2Pro	32.5	50	0	30	30	30	0	0	140	8.60
13	Pioneer P1742Q	34	0	60	20	20	20	0	20	140	6.05
14	Fontanelle 11DT-591	32	90	0	30	30	30	0	0	180	10.60
15	Becks 6241Q	33	60	0	25	30	30	30	0	175	5.05
16	Dekalb DKC62-89	33.5	60	150	0	0	0	0	0	210	1.75

* Control ** "Irrigation" includes both irrigation and water applied with fertigation applications.

Economic Decisions

Teams were required to select a multi-peril crop insurance (MPCI) policy, either revenue protection (RP), yield protection (YP), or revenue protection with harvest price exclusion (RP-HPE). These policies were all offered at the 65, 70, 75, 80 and 85% levels of coverage. There were no additional hail or wind insurance options available. Seven teams chose to purchase RP policies, five farms selected an RP-HPE policy, with the final three teams choosing YP policies (Figure 20). All 15 competing teams selected to be insured with Enterprise Units (EU). Three teams had RP-EU at the 75% level, which was the most common selection. The average cost across competitors was $10.69/acre. The least expensive policy was RPHPE-EU at 70% coverage ($4.84/acre), selected by Farm 3. The most expensive was YP-EU at 85% coverage ($26.48/acre), chosen by Farm 1.

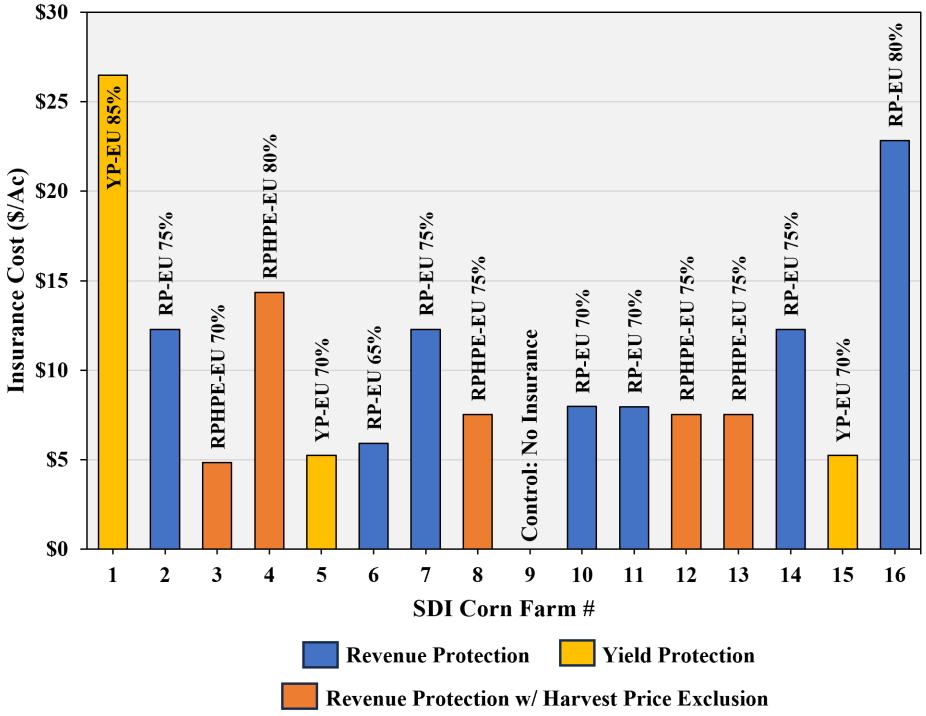

Figure 20. Insurance cost ($/acre) for the individual SDI corn competition teams. Policies offered included Revenue Protection (RP), Revenue Protection with Harvest Price Exclusion (RP-HPE), and Yield Protection (YP) with either Optional Units (OU) or Enterprise Units (EU).

Closely tied to insurance is the risk related to forward pricing and sales of grain. Contestants are encouraged to take advantage of seasonal price trends and events that often make early season marketing such as forward contracting, hedging, basis contracts and hedge-to -arrive tools economically advantageous. They are however limited to market only expected production, represented by trend adjusted Average Production History (APH). These four tools and spot cash sales must be done during the time period of April 1 through November 30.

The 2023 marketing year saw prices decrease considerably from the previous year, by an average of approximately $1.23/bushel with inflation and world economic conditions and the supply of corn demand for US corn lower compared to last year. Fall prices, as most often occurs, ended up being lower than the predicted spring price. The seasonal price variation, however, did follow a normal marketing year with high cash prices observed during the early part of the season. There were ample opportunities to market production as reflected by the varying average prices per bushel received by the competitors.

Five teams chose not to sell any of their production during the season, therefore it was sold at the end of the competition at the November 30 price of $4.47/bushel. Any unsold grain after the close of the competition incurred a charge of $0.05/bushel. If a team sold more grain than was produced, those bushels were bought back at the $4.47/bushel price, along with a penalty of $0.10/bushel. Six teams chose to sell all or a part of their production using forward or cash sales throughout the season. The other five teams used a combination of marketing methods. Seven teams received an insurance indemnity payment due to low yields and their selection of crop insurance, which ultimately increased their revenue (Figure 21). These marketing decisions and insurance indemnity payments led to the average price received ranging from a low of $4.42/bushel, Farm 14, to a high of $6.87/bushel, Farm 12. Farm 12, who used one futures contract and then sold grain using HTA contracts, and an end of season cash sale, received the highest price of the season. The average price per bushel received across the competition was $5.32/bushel.

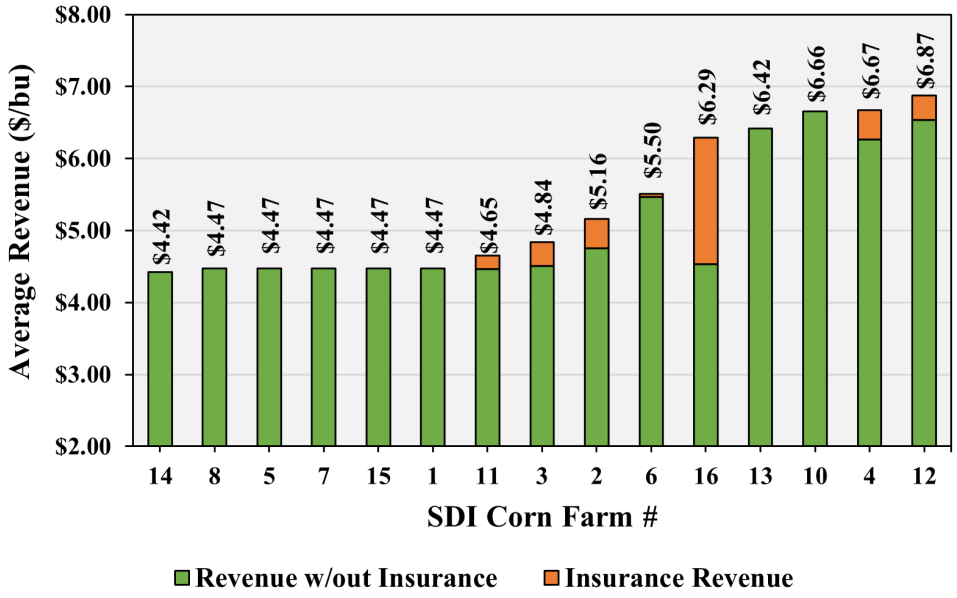

Figure 21. Average revenue received ($/bushel) for the individual SDI corn competition teams.

Results and Rankings

Grain Yield

With the hail damage grain yields for the SDI competition were substantially lower than in the past with the average of 213.2 bushels/acre (Table 10, Column 2). Except for the control, the farms ranged from 178.0 bushels/acre, Farm 16, to 238.9 bushels/acre, Farm 8, which put all of them below the APH of 250 bushels/acre. Figure 22A shows a weak grain yield response to total N fertilizer, however, that response is mostly driven by the control treatment (i.e., zero N fertilizer). With a low R-squared value, very little response in yield was attributed to nitrogen application. Whereas, grain yields had a strong response to irrigation, with a linear explanation of 65% of its yield variability (Figure 22B).

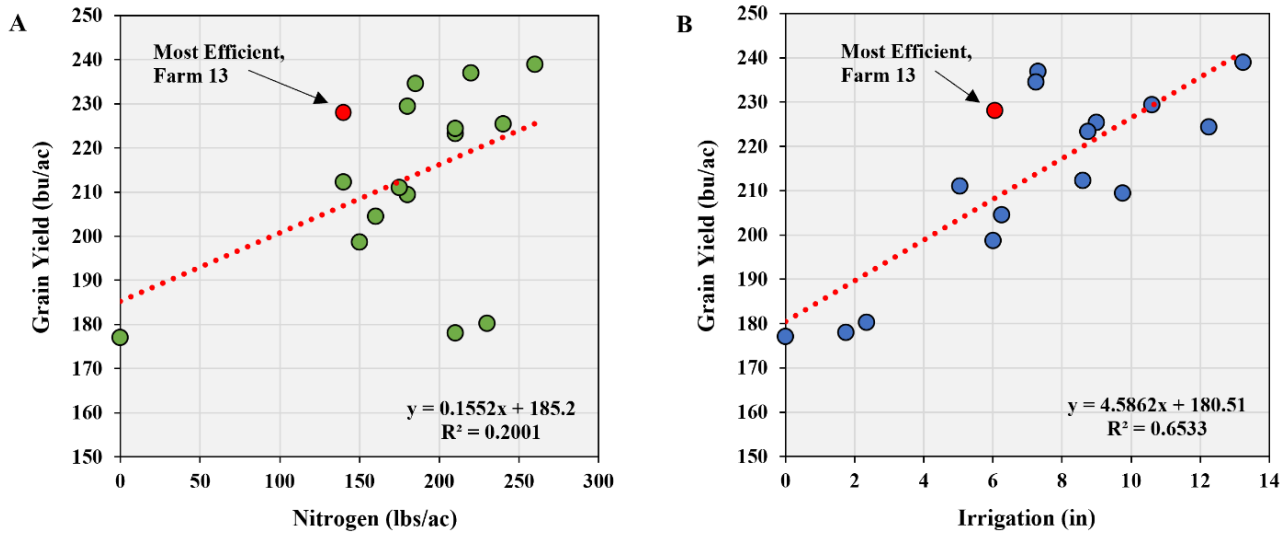

Figure 22. SDI corn grain yield response to seasonal total nitrogen fertilizer (A) and irrigation (B) at the WCREEC in North Platte, NE. The most efficient farm as measured by the Water Nitrogen Intensification Performance Index (WNIPI) is denoted in red.

Input Use Efficiency

The Water Nitrogen Intensification Performance Index (WNIPI, Lo et al., 2019), was used to quantify input use efficiency and is reported in the last Column in Table 10. It compares the effect of N and irrigation input on grain yield with respect to a control treatment. The control is a baseline and is used to measure the effect of any added water or N fertilizer. The control was Farm 9, which had no added N or irrigation and produced 177.1 bushels/acre. Farm 13 had the highest efficiency with a WNIPI of 0.112. This farm applied 140 pounds of N/acre and 6.05 inches of irrigation resulting in a yield of 228.1 bushels/acre. The Agronomic Efficiency (AE) measures the effect each added pound of N has on yield in terms of bushels. Farm 13 yielded 51 bushels/acre more than the control. When the yield difference is divided by the amount of applied N fertilizer, 140 pounds/acre, the AE is calculated to be 0.36 bushels for every pound of N fertilizer applied (Table 10, Column 6). This is more than the average of 0.21 bushels/pound of N of all other farms, except the control farm. Irrigation Water Use Efficiency (IWUE) was measured in a similar manner, replacing pounds of N with inches/acre of applied water (Table 10, Column 7). Farm 13's IWUE was calculated to be 8.4 bushels/inch. The overall average was 2.5 bushels/inch.

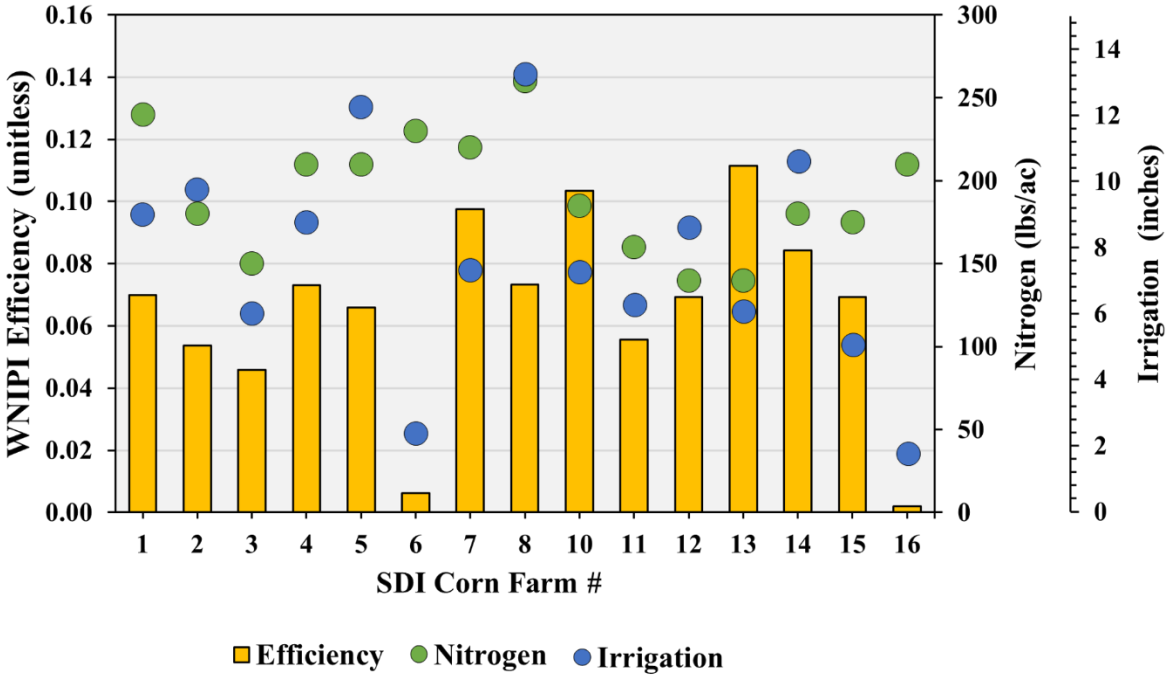

Figure 23. Input use efficiency (WNIPI) compared against irrigation (inches) and N fertilizer (lbs/acre) in the SDI corn competition.

Profitability

Profitability is derived as total revenue minus total cost. Revenue was found by adding the total value of each market transaction with any government payments, insurance indemnities, and/or losses. Costs were based on the stated expenses each competition was assigned. Most of these costs were fixed on a per acre basis and are common among all farms. However, some costs e.g., grain hauling, fertilizer and water use, insecticide application, were based on a fixed per unit cost and varied by individual participant choices. Since all farms are identical in cost structure, physical attributes, and revenue opportunity it is the choices made and the resulting outcome of those choices that drive the difference in profitability.

Revenue ranged from a low of $4.42/bushel, Farm 14, to a high of $6.87/bushel, Farm 12 (Table 10, Column 3). The lowest cost per acre, aside from the Control, was achieved by Farm 3 at $1,012/acre (Table 10, Column 4). The highest cost per acre was Farm 8 at $1,199/acre.

With revenue and cost considered, Farm 10 was the most profitable per acre, with $491/acre profit. This was $65/acre more than that of the second place team, Farm 12 (Figure 24). The cost per acre for the winning farm was $1,070, similar to the average for the competition, but when combined with the highest revenue per acre and the third place yield it led them to win the Most Profitable Award.

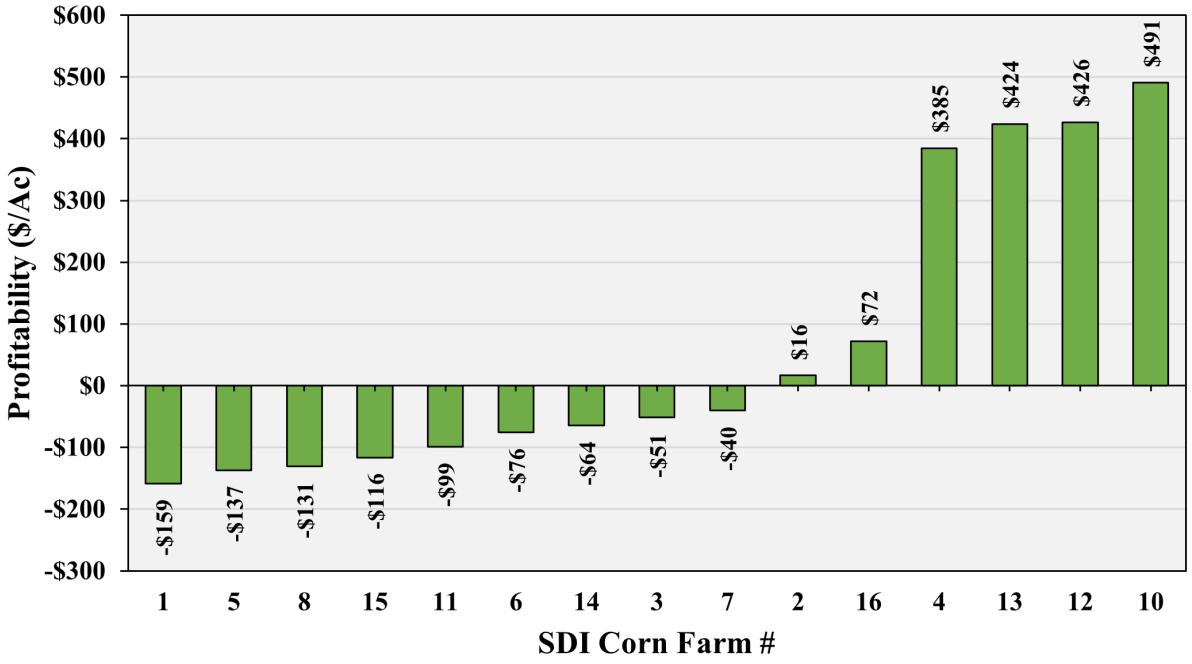

Figure 24. Profit per acre received for the individual SDI corn competition teams.

Table 10: Summary of results from the 2023 TAPS SDI corn competition.

Farm #	Grain Yield** (bu/ac)	Revenue ($/bu)	Cost ($/ac)	Profit ($/ac)	AE (bu/lbs)	IWUE (bu/ac-in)	WNIPI (unitless)
1	225.4	$4.47	$1,167	-$159	0.20	5.4	0.070
2	209.4	$5.16	$1,065	$16	0.18	3.3	0.054
3	198.7	$4.84	$1,012	-$51	0.14	3.6	0.046
4	223.3	$6.67	$1,105	$385	0.22	5.3	0.073
5	224.3	$4.47	$1,140	-$137	0.23	3.9	0.066
6	180.2	$5.50	$1,068	-$76	0.01	1.3	0.006
7	236.9	$4.47	$1,099	-$40	0.27	8.2	0.098
8	238.9	$4.47	$1,199	-$131	0.24	4.7	0.073
9	177.1	-	-	-	-	-	-
10	234.5	$6.66	$1,070	$491	0.31	7.9	0.104
11	204.5	$4.65	$1,049	-$99	0.17	4.4	0.056
12	212.3	$6.87	$1,033	$426	0.25	4.1	0.069
13	228.1	$6.42	$1,041	$424	0.36	8.4	0.112
14	229.4	$4.42	$1,078	-$64	0.29	4.9	0.084
15	211.0	$4.47	$1,060	-$116	0.19	6.7	0.069
16	178.0	$6.29	$1,047	$72	0.00	0.5	0.002

*Control **Reported as 15.5% grain moisture content

AE - Agronomic Efficiency (yield increase over the control plot, bushels of grain/pounds of N applied)

IWUE - Irrigation Water Use Efficiency (yield increase over the control plot, bushels of grain/inches of water applied)

WNIPI - Water-Nitrogen Intensification Performance Index

AWARD RECIPIENTS

Photo 7. The ***Greatest Grain Yield Award*** was won by Lorn Dizmang of Dizmang Ag, Farm 8, of Moorefield, NE with a yield of 238.9 bushels/acre. Dizmang planted Pioneer P14830AML at 34,000 seeds/acre.

Photo 8. The ***Highest Input Use Efficiency Award*** was won by the Rattlesnake Boys, Farm 13, of Wood River, NE. The team included Jay Johnson (R), Kevin Harsch (L) and Amy Harsch (Center), and Jeremy Gewecke (not pictured). They planted Pioneer P1742Q at a seeding rate of 34,000 seeds/acre and applied 140 pounds/acre of N and 6.05 inches/acre of irrigation water with a final yield of 228.1 bushels/acre.

Photo 9. The ***Most Profitable Award*** was won by Jamey Balthazor (L) and Dan Fitts (R), Farm 10, from Scottsbluff, NE. The group planted Pioneer P1366AML at 30,000 seeds/acre. They applied 185 pounds of N and 7.25 inches of irrigation water, which led to a yield of 234.5 bushels/acre. The team's average revenue of $6.72/bushel combined with their yield was the driving factor in winning the top award in the 2023 SDI Corn competition.

Sorghum Competition

This year 18 teams competed in the sorghum competition, including 31 participants from across Nebraska, as well as Kansas. One of the 18 teams, Farm 9, was the control farm used for determining efficiency. The sorghum competition included both an irrigated and dryland portion for the third year in a row. This year's competition was facilitated near Grant, NE at the Henry J. Stumpf International Wheat Center.

Field Designs

Each team was assigned three randomized plots in both irrigated and dryland fields, Figures 25 and 26. The irrigated field is located north of Highway 61 and the Henry J. Stumpf International Wheat Center. The dryland field is located just southeast of the pivot competition.

Figure 25. Farm layout for the 2023 irrigated sorghum competition held at the Henry J. Stumpf International Wheat Center near Grant, NE. Each team was assigned three randomized plots.

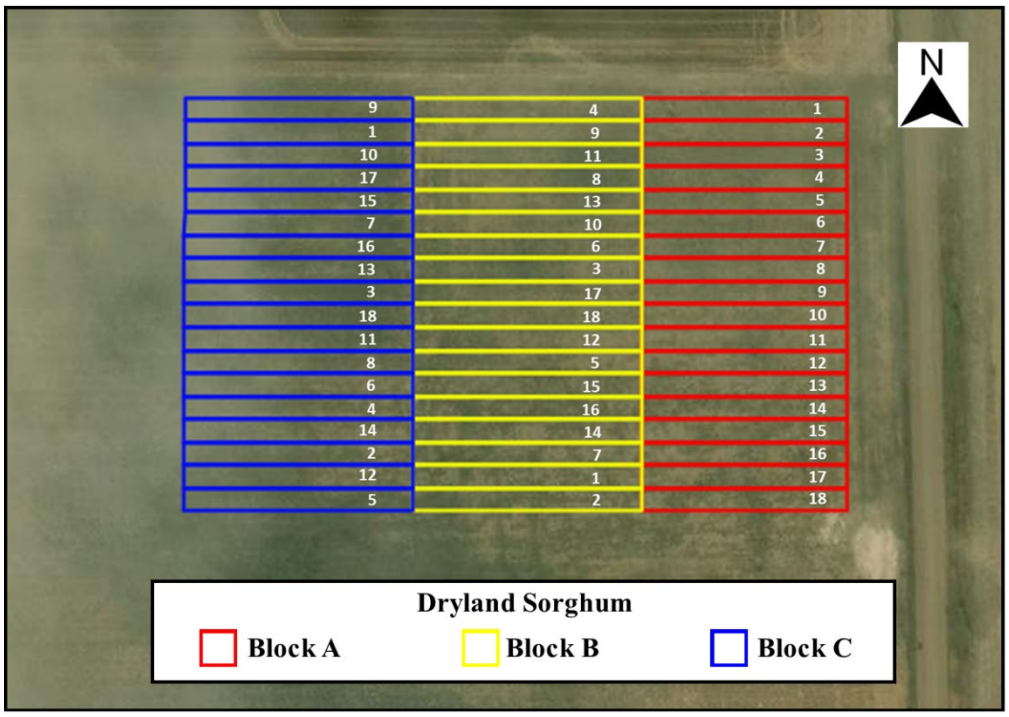

Figure 26. Farm layout for the 2023 dryland sorghum competition held at the Henry J. Stumpf International Wheat Center near Grant, NE. Each team was assigned three randomized plots.

Competition Data

In mid-March, aggregate soil samples were taken throughout the TAPS competition fields. Ward Laboratories in Kearney, NE analyzed the samples, and the results were provided to participants ahead of the first decision deadlines.

Table 11. Soil sample results provided by Ward Laboratories in Kearney, NE for the irrigated and dryland sorghum competition fields.

Sample ID / Lab No.	Soil pH 1:1	Modified WDRF BpH	Soluble Salts 1:1 mmho/cm	Excess Lime Rating	Organic Matter LOI-%	KCl Nitrate ppm N	Depth / Nitrate Lbs N/A	Method / Phosphorus ppm P	-Ammonium Acetate- K ppm	Ca ppm	Mg ppm	Na ppm	M-3 Sulfate ppm S	——DTPA—— Zn ppm	Fe ppm	Mn ppm	Cu ppm	Hot Water Boron ppm B	CaNO3 Chloride ppm Cl	Sum of Cations me/100g	% Base ----Saturation---- H	K	Ca	Mg	Na
STUMPF PIVOT 2							0 - 8 in	M-3																	
47981	6.3	6.8	0.19	NONE	2.4	7.4	18	21	359	1322	230	17	8.5	1.02	25.5	13.6	0.27			11.9	20	8	55	16	1
STUMPF PIVOT 2							8 - 36 in																		
47982						19.9	167																		
STUMPF DRYLAND 4							0 - 8 in	M-3																	
47983	7.1		0.21	NONE	2.1	4.0	10	32	273	2134	248	4	7.7	0.42	21.5	11.2	0.27			13.5	0	5	79	15	0
STUMPF DRYLAND 4							8 - 36 in																		
47984						7.1	59																		

Participant Decisions

Competitors made five economic and production management decisions, including insurance coverage, hybrid type, seeding rate, nitrogen amount and timing, and marketing. Due to plot layout and field space availability, participants were not able to make the irrigation decisions. All decisions were submitted by participants via the TAPS online password protected portal that time-stamped all decisions. The decisions and resulting outcomes are summarized below.

Agronomic Decisions

In the irrigated portion of the competition, eight sorghum hybrids were selected from six seed companies (Table 12, Column 2). One hybrid, Pioneer 85P58, chosen by Farms 7, 8 and 15, was not on the sponsoring companies' recommended list and was therefore provided by the competitors. Channel 6B95 was the participant favorite, planted by half of the farms. Dekalb DKS28-05, selected by Farm 12, was the least expensive at $0.138/1,000 seeds and Pioneer 85P58, chosen by Farms 7, 8 and 15, was the costliest at $0.261/1,000 seeds. The lowest seeding rate, 70,000 seeds/acre, was planted by Farms 5 and 17 with Channel 6B95. The highest seeding rate, 100,000 seeds/acre, was planted by Farms 12 and 15 with Dekalb DKS28-05 and Pioneer 85P58, respectively (Table 12, Column 3).

In the dryland portion of the competition, eleven sorghum hybrids were selected from six seed companies (Table 13, Column 2). Three hybrids, Dekalb DKS29-95, Fontanelle C4126 and Pioneer 88P71, were not on the sponsoring companies' recommended lists and were therefore provided by the competitor. Channel 6B55, Pioneer 87P10 and Channel 6B95 were commonly used, each was planted by three farms. Fontanelle C4126, selected by Farm 11, was the least expensive at $0.110/1,000 seeds. DynaGro M60GB31, chosen by Farm 16, was the costliest at $0.236/1,000 seeds. The lowest seeding rate, 40,000 seeds/acre, was planted by Farm 7 with Dekalb DKS29-95. The highest seeding rate, 80,000 seeds/acre, was planted by Farm 15 with Pioneer 88P71 (Table 13, Column 3).

While each team was able to select their nitrogen management on both the irrigated and dryland fields the options were limited to a maximum of 180 pounds/acre of N at pre-plant and an additional 180 pounds/acre of N applied via side-dress with no fertigation applications offered. The sorghum competition followed a rotation of winter wheat that did not yield well, therefore the fields both had a higher-than-normal amount of residual N (Table 11). The pounds of N fertilizer applied per farm to the irrigated plots, not including the control, ranged from 0 to 200 pounds/acre (Table 12, Column 6), and averaged 100 pounds/acre. Forty-three percent of the fertilizer applied to the irrigated plots was done as a pre-plant application, with the other fifty-seven percent applied via side-dress. The pounds of N fertilizer applied per farm to the dryland plots, not including the control, ranged from 0 to 125 pounds/acre (Table 13, Column 6), and averaged 70 pounds/acre. Forty-one percent of the total fertilizer applied to the dryland plots was done as a pre-plant application with the remaining fifty-two percent applied via a side-dress application.

Irrigated sorghum plots were intended to be fully irrigated to university standards, but due to mechanical issues and limitations of the well in mid-August this was not possible. Therefore, all irrigated sorghum plots received a total of 4.55 inches throughout the season. The first irrigation was on May 25th and the final irrigation, with lower application amount, occurred September 12th.

Table 12. Summary of select agronomic inputs from the 2023 TAPS irrigated sorghum competition.

Farm #	Hybrid Name	Seeding Rate (1,000/ac)	Nitrogen Fertilizer Jun 20 (lbs/ac)	Nitrogen Fertilizer Jul 14 (lbs/ac)	Nitrogen Fertilizer Total (lbs/ac)
1	Pioneer 86P20	75	75	125	200
2	Channel 6B95	90	80	90	170
3	Channel 6B95	75	20	35	55
4	Channel 6B95	85	0	90	90
5	Channel 6B95	70	80	80	160
6	Channel 6B95	85	75	50	125
7	Pioneer 85P58	80	0	40	40
8	Pioneer 85P58	90	80	25	105
*9	Channel 6B95	85	0	0	0
10	Fontanelle G4815	80	0	25	25
11	Channel 6B95	93.4	40	0	40
12	Dekalb DKS28-05	100	50	0	50
13	Channel 6B95	90	0	0	0
14	Dekalb DKS38-16	90	80	0	80
15	Pioneer 85P58	100	30	150	180
16	DynaGro M60GB31	80	80	60	140
17	Channel 6B95	70	50	150	200
18	Arrow AS292	85	0	50	50

*Control

Table 13. Summary of select agronomic inputs from the 2023 TAPS dryland sorghum competition.

Farm #	Hybrid Name	Seeding Rate (1,000/ac)	Nitrogen Fertilizer Jun 20 (lbs/ac)	Nitrogen Fertilizer Jul 13 (lbs/ac)	Nitrogen Fertilizer Total (lbs/ac)
1	Pioneer 87P10	47	60	40	100
2	Channel 6B55	55	50	70	120
3	Channel 6B55	52	55	0	55
4	Dekalb DKS28-05	45	0	60	60
5	Pioneer 87P10	45	60	60	120
6	Channel 6B95	42	65	0	65
7	Dekalb DKS29-95	40	0	40	40
8	Pioneer 87P10	50	60	15	75
*9	Channel 6B95	65	0	0	0
10	Fontanelle G4815	45	0	15	15
11	Fontanelle C4126	55	40	30	70
12	Dekalb DKS28-05	57	35	0	35
13	Channel 6B95	60	0	0	0
14	Dekalb DKS38-16	60	0	75	75
15	Pioneer 88P71	80	0	125	125
16	DynaGro M60GB31	50	40	20	60
17	Channel 6B55	50	25	100	125
18	Arrow AS292	50	0	50	50

*Control

Economic Decisions

Teams were required to select a multi-peril crop insurance (MPCI) policy, either revenue protection (RP), yield protection (YP), or revenue protection with harvest price exclusion (RP-HPE). These policies were all offered at the 65, 70, 75, 80 and 85% levels of coverage. There were no additional hail or wind insurance options available. Separate policies were required for dryland and irrigated acres. For the irrigated farms, twelve teams chose to purchase RP policies, four farms went with RP-HPE and one chose YP policies (Figure 27). Fifteen of the teams purchased Enterprise Units (EU) with the other two selecting Optional Units (OU). Seven teams chose RP-EU at 65% coverage, the most common selection. The average cost per acre across all competitors for the irrigated portion was $13.29/acre. The least expensive policy was YP-EU at 65% coverage ($6.27/acre), selected by Farm 4. The most expensive policy was RPHPE-EU at 85% coverage ($34.58/acre), chosen by Farm 17. Thirteen dryland farms selected RP policies, two others went with RP-HPE and the remaining two chose YP policies. All the teams purchased coverage at the EU classification. The average cost per acre for the dryland competitors was $13.25/acre. The least expensive policy was YP-EU at 65% coverage ($6.63/acre), selected by Farm 4. The most expensive was RP-EU at 85% coverage ($32.80/acre), chosen by Farm 11.

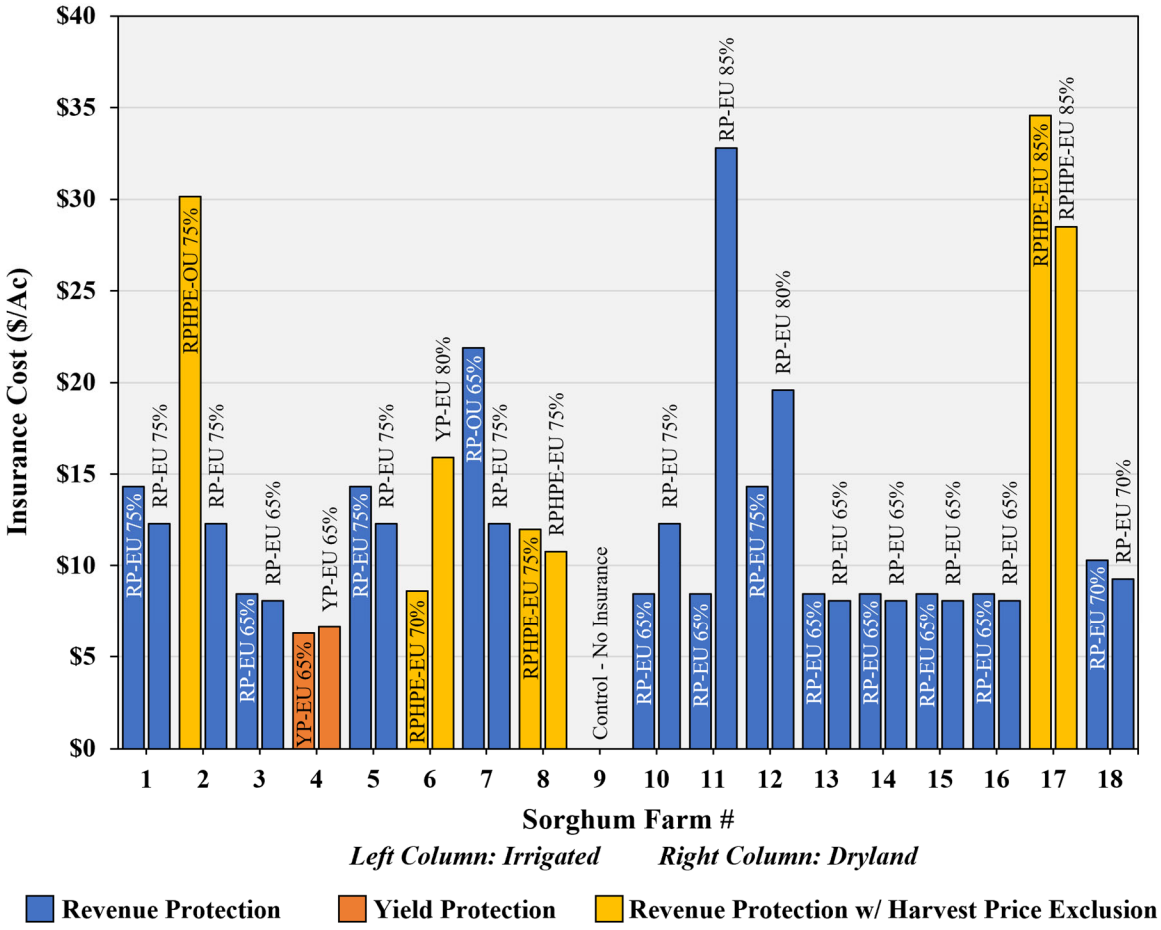

Figure 27. Insurance cost ($/acre) for the individual sorghum competition teams. Policies offered included Revenue Protection (RP), Revenue Protection with Harvest Price Exclusion (RP-HPE), and Yield Protection (YP) with either Optional Units (OU) or Enterprise Units (EU). The yellow and blue bars represent Yield Protection and Revenue Protection, respectively.

Closely tied to insurance is the risk related to forward pricing and sales of grain. Contestants are encouraged to take advantage of seasonal price trends and events that often make early season marketing such as forward contracting, hedging, basis contracts and hedge-to -arrive tools economically advantageous. They are however limited to market only expected production, represented by trend adjusted Average Production History (APH). These four tools and spot cash sales had to be done during the time period of April 1 through November 30.

Grain sorghum prices historically follow the corn market. Sorghum is usually sold at a discount relative to corn. This crop does not have a futures market and cross hedges using corn futures.

Fall prices, as most often occurs, ended up being lower than the predicted spring price. The seasonal price variation, however, did follow a normal marketing year with high cash prices observed during the early part of the season. There were ample opportunities to market production as reflected by the varying average prices per bushel received by the competitors. The highest forward contract price in the competition was from Farm 7 in June for $5.42/bushel.

Ten teams relied on the TAPS team to market their entire crop, sold on the last day of the competition, November 30, at $4.52/bushel. Any unsold grain after the close of the competition incurred a sales fee of $0.05/bushel. Four teams sold all their production on the last day of the competition without incurring a sales fee of $4.52/bushel. Three teams chose to sell part, or all their production using a forward contract in mid-June and early-July when prices were higher. These teams received the highest price per bushel by doing so. Two of these three teams used a combination of a forward contract and a cash sale. Only one team opted to forward price grain by using a basis contract. When a team sold more grain than was produced, those bushels were bought back at the $4.52/bushel price, with an added penalty of $0.10/bushel for transaction costs. Ten teams received indemnity payments based on their low yields and their crop insurance selection. Five teams received indemnity payments for their irrigated and dryland production and five teams received indemnity payments just on their irrigated production. This additional revenue ultimately increased their average market value. The marketing decisions and insurance payments led to average prices ranging from $4.30/bushel, Farm 4, to $7.54/bushel, Farm 18 (Figure 28). Farm 18, which used a cash sale on November 30 had the largest insurance indemnity payment, which resulted in the highest average price of the season at $7.54/bushel. The average price per bushel received for all teams was $5.06bushel.

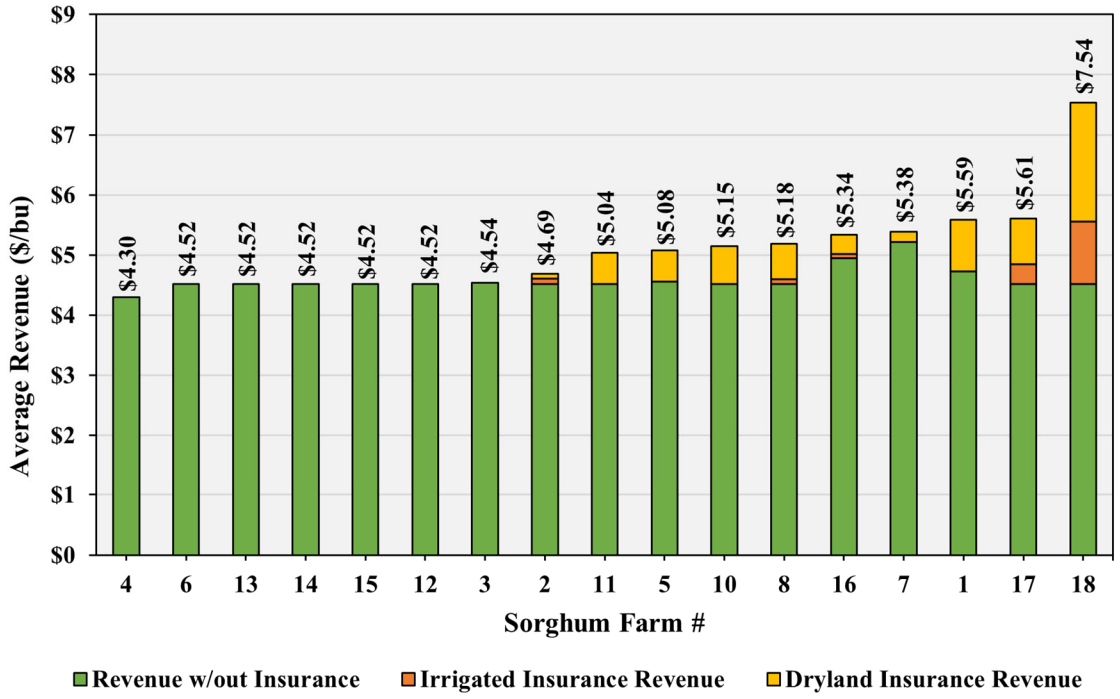

Figure 28. Revenue received ($/bushel) for the individual sorghum competition teams.

Results and Rankings

Grain Yield

Sorghum grain yields were calculated for each field type and then calculated for the 250 acres of irrigated production and 750 acres of dryland production to determine the competition results. The irrigated yields ranged from a low of 81.6 bushels/acre, Farm 18, to a high of 145.6 bushels/acre, Farm 1 (Table 14, Column 2). Excluding the control, the average irrigated yield was 125.6 bushels/acre. One team, Farm 1, yielded slightly more than the irrigated field's APH of 145 bushels/acre. The dryland yields ranged from 37.3 bushels/acre, Farm 18, to a high of 81.4 bushels/acre, Farm 12 (Table 15, Column 2). Excluding the control, the average dryland yield was 62.1 bushels/acre. One team, Farm 12, exceeded the dryland field's APH of 75 bushels/acre. The relationships between dryland and irrigated grain yields versus season total N fertilizer are shown in Figure 29. Grain yield had a weak response to N fertilizer under irrigation with an R-squared value of 0.1186 and an even weaker relationship existed under dryland conditions with an R-squared value of 0.0014. Based on the number of simulated acres for the competition, 250 irrigated and 750 dryland, the combined weighted yield averages for the competition ranged from 48.4 bushels/acre, Farm 18, to 97.0 bushels/acre, Farm 12.

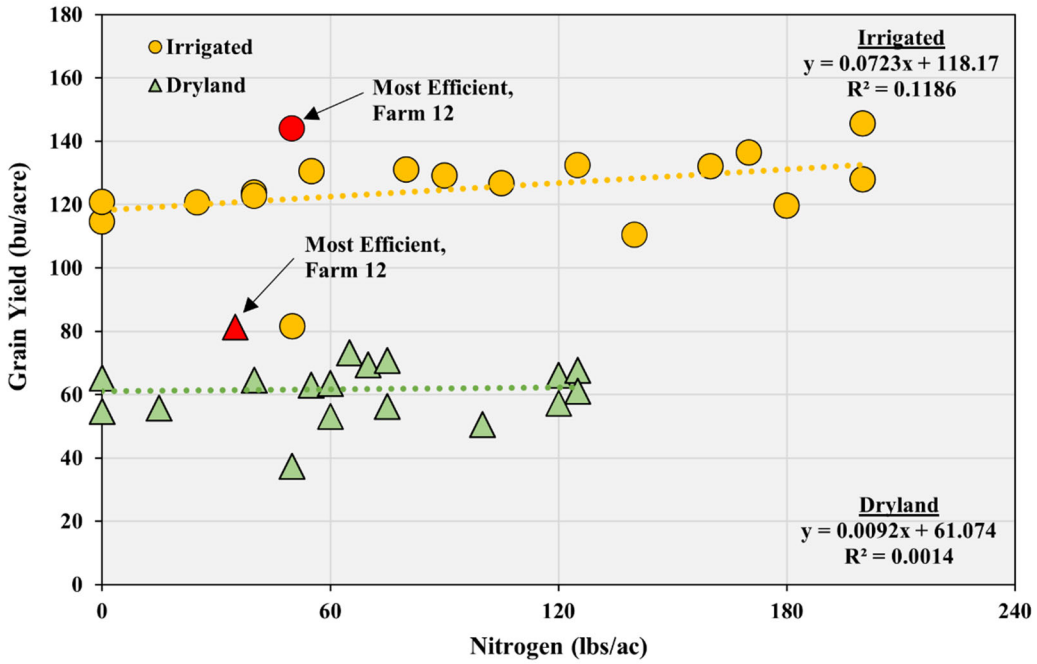

Figure 29. Dryland and irrigated sorghum grain yield response to seasonal nitrogen fertilizer. The most efficient farm as measured by the Nitrogen Intensification Performance Index (NIPI) is denoted in red.

Input Use Efficiency

Since participants did not make the irrigation decisions, water was not a factor in the efficiency award. The Nitrogen Intensification Performance Index (NIPI) (Lo et al., 2019) was used to quantify input use efficiency related to N and is reported in the last column in Tables 14, 15 and 16. It compares the effect of N on grain yield with respect to a control treatment. The baseline is used to measure the effect of any added N fertilizer. The control, Farm 9, in both portions of the competition, with no added N produced 114.6 and 54.6 bushels/acre of sorghum for the irrigated and dryland farms, respectively.

In the irrigated portion, Farm 12 had the highest efficiency with a NIPI of 0.223. This farm applied 50 pounds of N/acre, resulting in a yield of 144.0 bushels/acre. Farm 12 yielded 29.4 bushels/acre more than the control. When the yield difference is divided by the amount of additional applied N fertilizer, 50 pounds/acre, the AE is calculated to be 0.588. This is much higher compared to the average of 0.123 of the other farms that applied N fertilizer.

In the dryland portion, Farm 12 had the highest efficiency with a NIPI of 0.358. This farm applied 35 pounds of N/acre, resulting in a yield of 81.4 bushels/acre. Agronomic Efficiency (AE) measures the effect each added pound of N has in terms of bushels. Farm 12 yielded 26.8 bushels/acre more than the control. When the yield difference is divided by the amount of additional applied N fertilizer, 35 pounds/acre, the AE is calculated to be 0.766. This is much higher than the average of 0.124 of the other farms that applied N fertilizer.

When the efficiency results are multiplied by the weighted average of 250 acres irrigated production and 750 acres dryland production, Farm 12 easily won the efficiency award with a combined NIPI of 0.324 (Table 16, Column 6 and Figure 30), almost double the yield response to N as that of the second-place team, Farm 6.

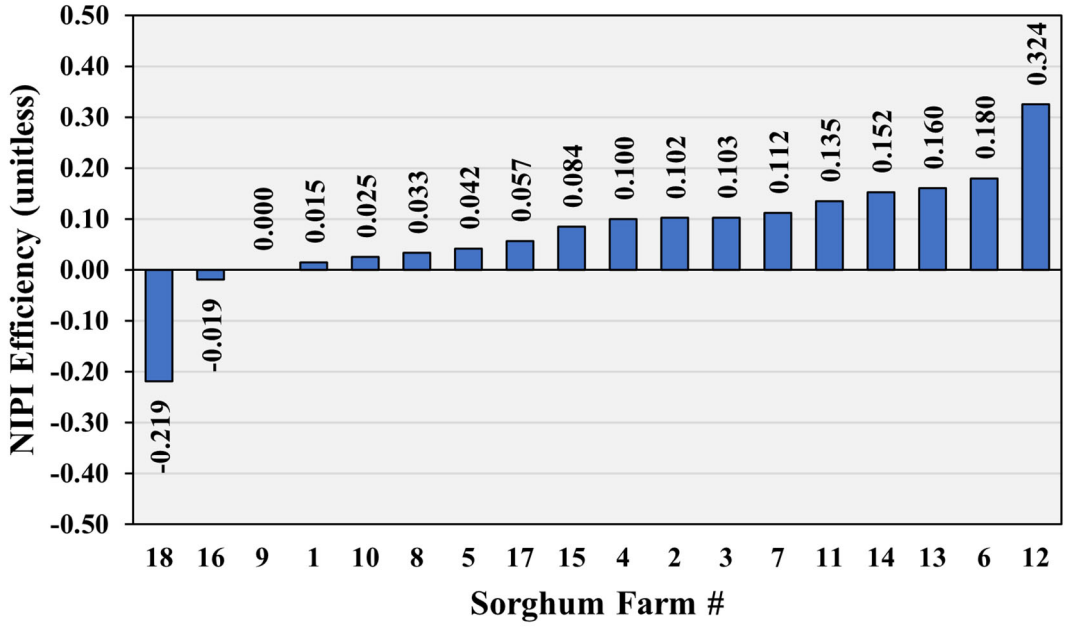

Figure 30. Input use efficiency (NIPI) for the sorghum competition, based on weighted averages from dryland and irrigated sorghum results.

Profitability

Profitability is derived as total revenue minus total cost. Revenue was found by adding the total value of each market transaction with any government payments, insurance indemnities, and/or losses. Costs were based on the stated expenses each competition was assigned. Most of these costs were fixed on a per acre basis and are common among all farms. However, some costs e.g., grain hauling, fertilizer use, insecticide application, were based on a fixed per unit cost and varied by individual choices. Since all farms are identical in cost structure, physical attributes, and revenue opportunity it is the choices made and the resulting outcomes of those choices that drive the difference in profitability.

Revenue per bushel ranged from a low of $4.30/bushel, Farm 4, to a high of $7.54/bushel, Farm 18 (Table 16, Column 3). The lowest cost per acre, excluding the control, was achieved by Farm 13 at $379/acre (Table 16, Column 4), and the highest cost per acre was Farm 17 at $508/acre.

With revenue and cost considered on a per acre basis, Farm 12 earned the award for profitability with $22/acre profit (Table 16, Column 5, and Figure 31). The cost per acre for the winning farm was $417/acre (Table 17, Column 4), which was lower than the competition average of $440/acre. The revenue per bushel sold for the winning team was $4.52/bushel, which was lower than the average of $5.06/bushel for the competition, but when combined with the higher yields that resulted in the highest revenue per acre minus the lowest per acre costs this leads Farm 12 to win the Most Profitable Award.

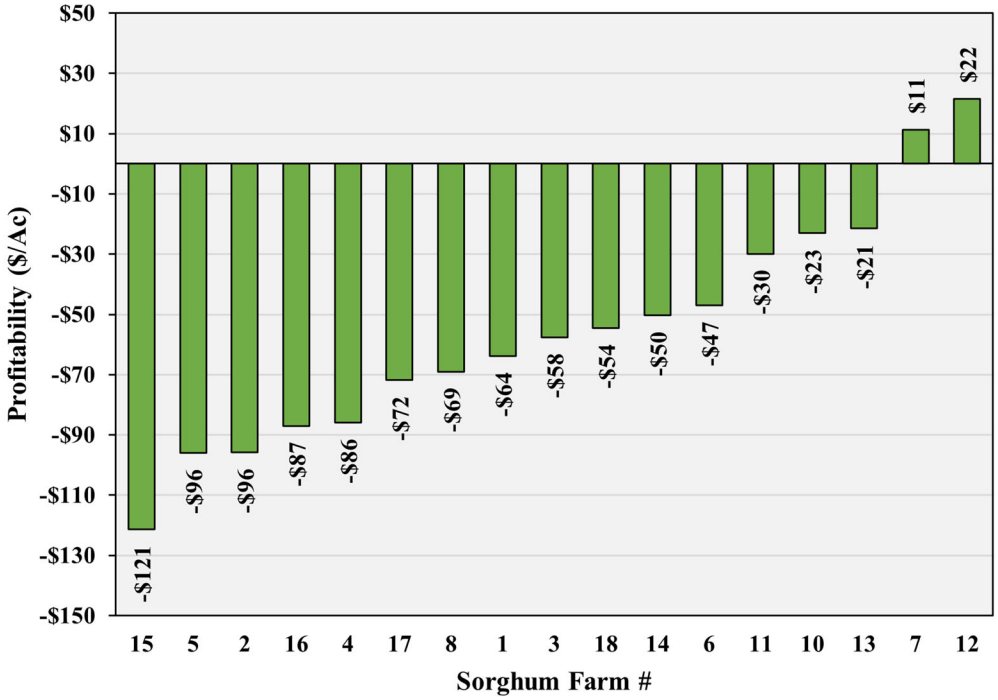

Figure 31. Profit per acre received for the individual sorghum competition teams.

Table 14: Summary of results from the irrigated portion of the 2023 TAPS sorghum competition.

Farm #	Irrigated Grain Yield** (bu/ac)	Irrigated Revenue ($/bu)	Irrigated Cost ($/ac)	Irrigated Profit ($/ac)	Irrigated NIPI (unitless)
1	145.6	$4.72	$684	$4	0.169
2	136.4	$4.74	$685	-$39	0.126
3	130.6	$4.54	$582	$11	0.120
4	129.1	$4.30	$597	-$42	0.100
5	132.2	$4.56	$658	-$55	0.104
6	132.5	$4.52	$632	-$33	0.113
7	122.7	$5.22	$581	$59	0.063
8	126.8	$4.71	$627	-$30	0.081
*9	114.6	-	-	-	-
10	120.6	$4.52	$548	-$3	0.048
11	123.8	$4.52	$567	-$8	0.071
12	144.0	$4.52	$573	$77	0.223
13	120.9	$4.52	$531	$16	0.055
14	131.1	$4.52	$591	$1	0.116
15	119.7	$4.52	$676	-$134	0.029
16	110.4	$5.11	$641	-$77	-0.026
17	128.0	$5.51	$705	-$23	0.073
18	81.6	$7.04	$575	-$5	-0.250

*Control **Reported as 14% grain moisture content.

NIPI - Nitrogen Intensification Performance Index

Table 15: Summary of results from the dryland portion of the 2023 TAPS sorghum competition.

Farm #	Dryland Grain Yield** (bu/ac)	Dryland Revenue ($/bu)	Dryland Cost ($/ac)	Dryland Profit ($/ac)	Dryland NIPI (unitless)
1	50.5	$6.42	$411	-$86	-0.037
2	66.2	$4.66	$423	-$115	0.094
3	63.0	$4.54	$366	-$80	0.097
4	63.5	$4.30	$374	-$101	0.100
5	57.3	$5.48	$424	-$110	0.022
6	73.2	$4.52	$382	-$52	0.202
7	64.5	$5.49	$359	-$4	0.128
8	56.3	$5.54	$394	-$82	0.017
*9	54.6	-	-	-	-
10	55.7	$5.60	$342	-$30	0.017
11	69.4	$5.35	$409	-$37	0.156
12	81.4	$4.52	$365	$3	0.358
13	65.3	$4.52	$329	-$34	0.195
14	70.7	$4.52	$387	-$68	0.165
15	67.6	$4.52	$422	-$117	0.103
16	53.1	$5.49	$382	-$90	-0.017
17	61.1	$5.81	$442	-$88	0.051
18	37.3	$7.95	$367	-$71	-0.208

*Control **Reported as 14% grain moisture content.
NIPI - Nitrogen Intensification Performance Index

Table 16: Summary of data from the 2023 TAPS sorghum competition based on the weighted average of irrigated and dryland acres.

Farm #	Combined Grain Yield** (bu/ac)	Combined Revenue ($/bu)	Combined Cost ($/ac)	Combined Profit ($/ac)	Combined NIPI (unitless)
1	74.3	$5.59	$479	-$64	0.015
2	83.7	$4.69	$489	-$96	0.102
3	79.9	$4.54	$420	-$58	0.103
4	79.9	$4.30	$429	-$86	0.100
5	76.0	$5.08	$482	-$96	0.042
6	88.0	$4.52	$445	-$47	0.180
7	79.1	$5.38	$414	$11	0.112
8	73.9	$5.18	$452	-$69	0.033
*9	69.6	-	-	-	-
10	71.9	$5.15	$393	-$23	0.025
11	83.0	$5.04	$448	-$30	0.135
12	97.0	$4.52	$417	$22	0.324
13	79.2	$4.52	$379	-$21	0.160
14	85.8	$4.52	$438	-$50	0.153
15	80.6	$4.52	$486	-$121	0.084
16	67.4	$5.34	$447	-$87	-0.020
17	77.8	$5.61	$508	-$72	0.057
18	48.4	$7.54	$419	-$54	-0.219

*Control **Reported as 14% grain moisture content.
NIPI - Nitrogen Intensification Performance Index

AWARD RECIPIENTS

Photo 10. All three awards, ***Greatest Grain Yield***, ***Highest Input Use Efficiency and Most Profitable Farm,*** were won by Brandon Rimpley & Ron Robison (not pictured), Farm 12, of Holdrege and Alma, NE, respectively. They chose to plant Dekalb DKC28-05 in both fields, at a population of 57,000 seeds/acre for dryland and 100,000 seeds/acre for irrigated. Brandon & Ron applied 35 pounds/acre of N to the dryland plots and 50 pounds/acre of N to the irrigated plots. The award winning weighted average yield of 97 bushels/acre combined with the average revenue per bushel of $4.52 earned them the top award.

CONCLUSION

At the close of the 2023 season, it is evident that this year's competitions have provided another year of valuable data, experiences, and interactions for competitors, industry and service providers, researchers, students, supporters, and others. The real-world environment of TAPS provides education only learned by application. This year's challenge focused on a declining market and the experience of a damaging weather event. The outcomes of the competitions allow competitors to benchmark and reflect on their use of available information, effectiveness and performance of innovative technologies, management practices, and strategies used during the season. As we prepare for future competitions and the expansion of TAPS, we hope to maintain a focus on expanding our efforts to understand the wealth of data and use it more powerfully building toward the discovery of better practices, and the application of latest ideas and technologies. The TAPS team greatly appreciates all who take part, follow, support, or engage with this program. We extend our congratulations to everyone involved in this year's success and applaud the 2023 winners.

As another year concludes, we would also like to acknowledge Tracy Zink of Indianola, NE, who was selected to receive this year's "Outstanding TAPS Advocate Award." This annual award honors a person, group, or business, who advocates for the TAPS program, either behind the scenes or publicly. Since the moment Tracy heard about the TAPS program, she has not only chosen to participate but also to share what she has learned, invited others to join the program and promoted TAPS across many avenues that she engages in across the state and nationally. Thank you, Tracy!

The success of the TAPS program in the time ahead is reliant on all those who are a part of it today. If you are not continuously preparing for the future by being engaged in the present, you will likely be disappointed by the future when it arrives. New competitions and new ways to make them better are being planned here in Nebraska and other parts of the country, as well as efforts on the horizon for a virtual TAPS program with implementation of TAPS into high school ag courses. We are excited to see where the future takes the program, and look forward to new collaborators, supporters, competitors, and followers. Thank you for being a part of this program and we look forward to what we believe is a bright future.

SUPPORT

The TAPS program continues to be successful due to the commitment and support provided by our participants, partners, and sponsors (Figures 1 and 2). The 2023 competitions were supported through the following grants: USDA-NRCS Conservation Innovation Grant under award number NR203A750013G011, Nebraska Corn Board under award number 88-R-1819-10, National Sorghum Checkoff under award number CI010-23, the Nebraska Sorghum Board, the Irrigation Innovation Consortium and Zangger Popcorn Hybrids.

REFERENCES

Lo, T., Rudnick, D.R., Burr, C.A., Stockton, M.C., & Werle, R. (2019). Approaches to evaluating grower irrigation and fertilizer nitrogen amount and timing. *Agricultural Water Management*. 213: 693-706.

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