EC 3061

UNL TAPS
TESTING AG PERFORMANCE SOLUTIONS

Farm Management Competitions Report

2021

WCREEC

North Platte, NE

USDA
United States Department of Agriculture
Natural Resources Conservation Service
N
EXTENSION

taps.unl.edu

West Central Research and Extension Center
University of Nebraska–Lincoln
402 West State Farm Road
North Platte, NE 69101

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.

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EXECUTIVE SUMMARY

"It's when ordinary people rise above the expectations and seize the opportunity that milestones truly are reached," stated Mike Huckabee, past governor of Arkansas. We appreciate all those who seized the opportunity to help the Testing Ag Performance Solutions (TAPS) program reach its 5-year milestone. As we move to embark on the future, we look forward to even greater success. The TAPS roadmap for the future focuses on continuing to enhance the Extension experience by facilitating deeper levels of engagement among stakeholders, private industry, and University.

In the fifth year, TAPS competitions included six contests at three different sites in Nebraska and Oklahoma. The West Central Research, Extension & Education Center (WCREEC) in North Platte, NE, included three contests: Sprinkler Irrigated Corn, Subsurface Drip Irrigated (SDI) Corn, and Grain Sorghum, results of which are found in this report. The fourth 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 second year in August. The remaining two contests were administered by Oklahoma State University (OSU) and included Sprinkler Irrigated Corn and Cotton. The results of the PREEC and OSU affiliate competitions are reported separately at www.taps.unl.edu/reports.

The WCREEC competitions had more than 120 participants with 32 sprinkler irrigated corn teams, 16 SDI corn teams, and 16 sorghum teams this year. Contestants represented three states: Nebraska, Colorado, and Kansas. Teams were comprised of many different agriculture sector members, including producers, government agency employees, college students, high school agricultural education teachers, and more, embracing both first-time and returning participants.

It is difficult to adequately recognize the many individuals, businesses, and organizations that uplift and help maintain the TAPS program. Support has been widespread, 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 personal experiences of growers by fostering relationships among all stakeholders in crop production. The TAPS program provides these opportunities through interaction between producers, industry, government, and university personnel, among others.

The TAPS program specifically wishes to recognize the monetary sponsorship from the Nebraska Corn Board, Sorghum Checkoff, Nebraska Sorghum Board, and the USDA-NRCS Conservation Innovation Grant (CIG). 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 are enthusiastic about what lies ahead. We look forward to setting out the path for more competitions, connections, and learning opportunities, and celebrating more milestones down the road.

Sincerely,

TAPS Team

PROGRAM OVERVIEW

The three TAPS competitions facilitated at the WCREEC in North Platte, NE are the focus of this report. The competitions include the 5th annual Sprinkler Irrigated Corn competition, the 4th annual Sorghum competition, and the 3rd annual Subsurface Drip Irrigated (SDI) corn competition. The sprinkler irrigated corn competition was facilitated under a Zimmatic by Lindsay, Variable Rate Center Pivot and the SDI corn competition was held on a field equipped with an Eco-Drip system. In a change from previous years, the sorghum competition consisted of an irrigated portion and a dryland portion. The irrigated sorghum was facilitated under a Zimmatic linear irrigation system, while the dryland was located south of WCREEC at the dryland farm. The sprinkler irrigated corn competition included 32 teams, while the sorghum and SDI competitions each had 16 teams. In each competition there is a Control, Farm 9, which did not receive any irrigation or Nitrogen and was used to determine the efficiency of the competing teams. Each team was randomly assigned a set of three experiment-sized plots within the respective competition areas, totaling less than one-half of an acre per team. University personnel managed the competition plots under the supervision of the TAPS leadership team. A modified University of Nebraska budget was used to capture costs, as based on a per acre basis. Yields and costs from each "farm" were amplified to represent 3,000 acres for the sprinkler irrigated corn competition and 1,000 acres for both the sorghum and SDI competitions. This magnification provided ample opportunity and motivation for competitors to develop strategies to market grain and consider the impact their decisions would have on a full-scale operation. These farm sizes are consistent with modern-sized farming operations and therefore enhance recognition of the effects even small decisions have on productivity and profitability.

In both corn competitions, participants controlled six decision types, as did the sorghum competition with the exclusion of the irrigation decision, which will be further discussed later in the report. These decisions have a direct effect on productivity, efficiency, and profitability.

Figure 1. The six management decisions made by TAPS competitors in the 2021 corn competitions. Sorghum competitors made all but the irrigation decision.

Hybrid Selection
(decision type #1)
and Seeding Rate
(decision type #2)

Each team was required to select their own seed hybrid and seeding rate. District Sales Manager/s (DSM/s) of multiple seed companies (Arrow, Big Cob, Channel, Dekalb, Fontanelle, Hoegemeyer, Pioneer, Seitec, and Stine) provided hybrid and seeding rate recommendations, which included 37 corn and 16 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. Participants were also asked to specify seeding rate, regardless of the hybrid chosen. Participants who selected a recommended hybrid were provided seed by the respective DSM, otherwise participants provided the needed 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. 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. This ensured that all yields were measured equally for each contestant.

Crop Insurance
(decision type #3)

Participants were required to select a multi-peril crop insurance 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) referred to as Alt 1 and Alt 2, respectively. The available levels of coverage were 65, 70, 75, 80, or 85%. The premium rates were specifically provided by Farm Credit Services for the competition area in North Platte, NE. Due to the risk involved in borrowing funds to cover operating costs, a minimum level of 65% multi-peril crop insurance was required. This minimum level of crop insurance also allows all participants to market the majority of their production before harvest.

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 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 and 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 competitions. In the sprinkler corn 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-season N was also available to the SDI plots 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 (i.e., total possible fertigation amount was 120 pounds/acre). Pre-plant, side-dress (V4-V6), and four fertigation events (V9, V12, VT/R1, and R2) were available to the corn participants, whereas pre-plant and side-dress events were available to the sorghum participants. An application cost of $7.00/acre, which did not include the cost of the fertilizer, was charged for pre-plant and side-dress operations, and $1.00/acre for each fertigation application.

Irrigation Management
(decision type #5)

The pivot irrigation system was operated every Monday and Thursday throughout the growing season. 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. 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, again in increments of 0.05 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.

Grain Marketing
(decision type #6)

The option to market grain was available to participants in all competitions from April 1 through November 30. Each team had five different avenues to sell their grain. These five options were: 1) spot or cash sales, 2) forward contracts, 3) basis contracts with delivery at harvest, 4) simple hedge to arrive, and 5) hedging with futures contracts. Since this is a farm management contest, using the market to speculate was not allowed.

Other Management Decisions

All other management decisions, (e.g., pesticide use, tillage practices, residue management, etc.), were determined and executed by the TAPS team. Each contest was managed uniformly with scientific precision, as plots were randomized and managed identically within each contest on a continuous site, except for the six decision areas. Each team freely made choices in the decision areas, as they sought to be the most profitable, efficient, and highest yielding farm. As noted, the TAPS production team did

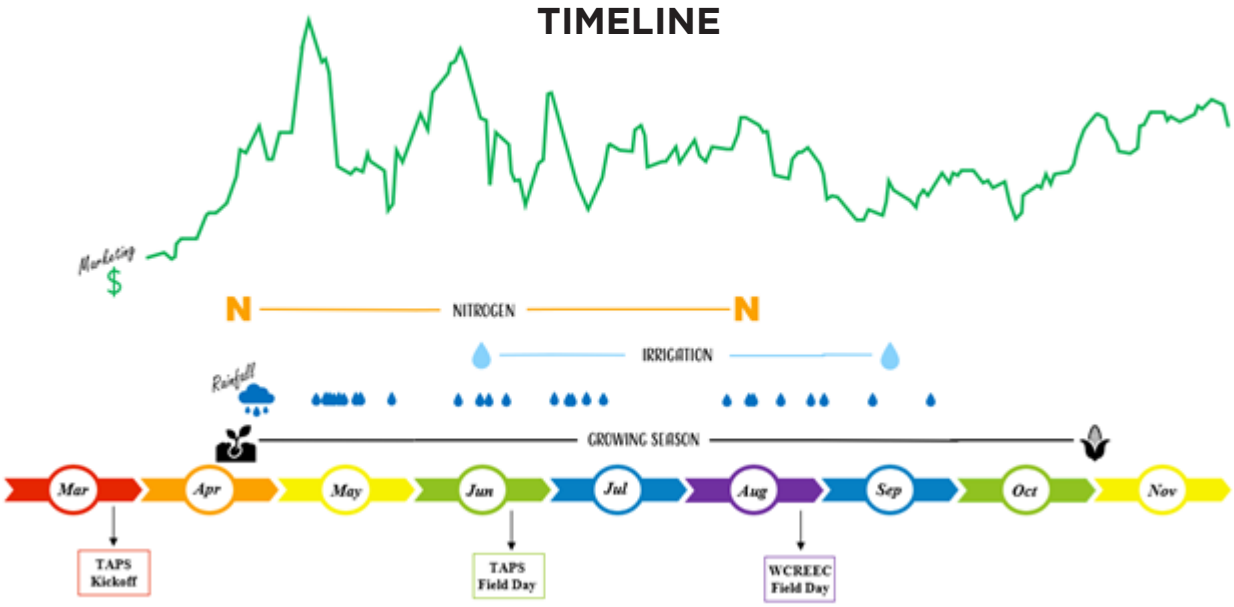

Figure 2. A brief look at the 2021 competition timeline, including marketing conditions and rainfall activity among the decision making and events.

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.

TECHNOLOGY

One of the primary goals of the TAPS program is to provide contestants 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 site is a 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 2021 growing season received 14.45 inches from May 1st to September 30th. As compared to the previous four years of TAPS competitions, this rainfall amount was less than the average of 15.81", but much higher than the 8.95" received in 2020 and less than the 21.2" received in 2019. Furthermore, the months of June, July, and August in 2021 averaged maximum daily temperatures of 74.7°F which was cooler than the 2020 average of 88.8°F for the same time period. The only wind or hail event the plots received was on July 9th with high winds.

Figure 3. Participants were given the opportunity to use over 15 technology companies' services, as well as provided a plethora of other data and research results.

DESCRIPTION OF AWARDS

Each competition had three cash awards, 1) Most Profitable Farm, $2,000, 2) Highest Input Use Efficiency, $1,000, and 3) Greatest Grain Yield, $500, adjusted by profitability score. All awards included a plaque, an oversized keepsake check, and a TAPS apparel item. Each award is described in detail below:

1. Most Profitable – Profit is the difference between total revenue minus total cost. The average per acre yield from each team's three plots was multiplied by their average market price and total number of acres; any government payments and insurance indemnities were then added to get total revenue. Costs were based on both fixed costs, as shown in the beginning budget, and variable expenses incurred during the season through the execution of their management decisions, which, when totaled, represented total cost. However, the costs of technology (e.g., sensors, imagery, and data collection) were not included in the profit equation. Since all farms in any one contest had the same number of acres, the farm with the most per acre profit was the most profitable.

2. Highest Input Use Efficiency was assessed using the Water-Nitrogen Intensification Performance Index (WNIPI, Lo et al., 2019) for the sprinkler and subsurface drip irrigated 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:

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

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

where, "Control" is a farm managed by UNL that receives no irrigation or N fertilizer (except for 10-34-0 at planting), "ET" is seasonal evapotranspiration, "I" is seasonal irrigation, "N" is total seasonal applied nitrogen, and "ANU" is aboveground nitrogen uptake. 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.

3. Greatest Grain Yield Award – 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

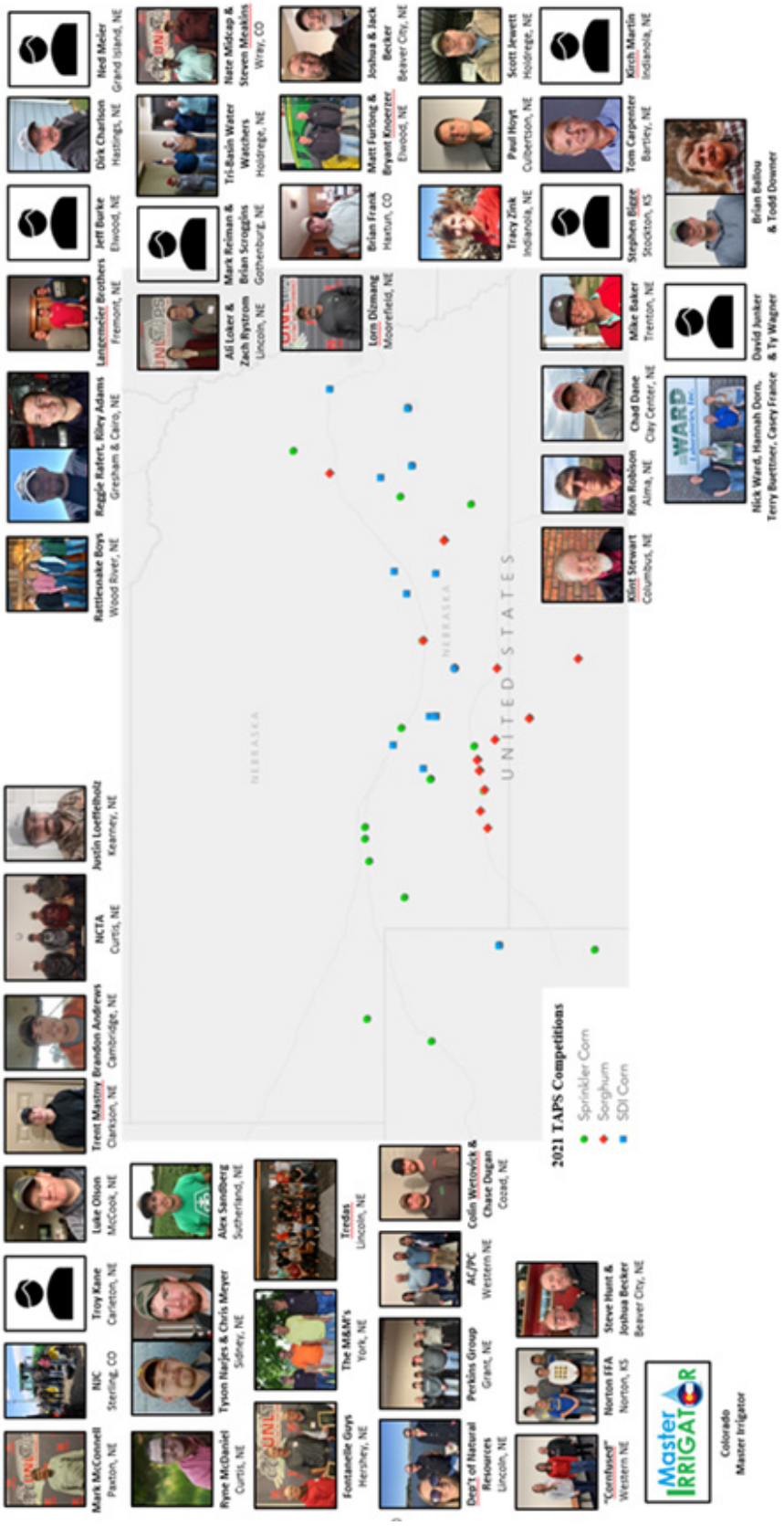

Figure 4. Location of the 2021 TAPS Farm Management Competition participants for the TAPS competitions administered in North Platte, Nebraska at WCREEC.

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.

Sprinkler Corn Competition

In the 5th year of the sprinkler corn competition, 32 teams competed, including over 60 participants from throughout Nebraska, Colorado, and Kansas. In addition to the competitors, there were eight non-competitive entities, along with the control farm used for determining contestant efficiency and UNL farms for benchmarking UNL recommendations and research.

FIELD DESIGN

As in past years, each team had three randomized plots, Figure 6, located at the intersection of Highway 83 and State Farm Road in North Platte, NE.

PARTICIPANT DECISIONS

Participants were responsible for making economic and production management decisions, including multi-peril crop insurance coverage, hybrid type, seeding rate, nitrogen and irrigation amount and timing, and grain marketing. All decisions were submitted via forms on the TAPS website, through an online password protected portal that time-stamped all decisions. Participant selections are summarized below.

Agronomic Decisions

Agronomic decisions made by each team are shown in Table 1, below. Thirteen different corn hybrids were selected from eight seed companies (Table 1, Column 2). Five hybrids were selected by more than one team: Pioneer P1089AM, Pioneer P1082AM, Pioneer P1366AML, Pioneer P1197AM, and Fontanelle 11D637. Pioneer 1366AML was used by ten teams, which made it the most used hybrid in the competition. One selected hybrid was from a company other than those providing seed, Golden Harvest G10L16-3220A. The Stine 9734-G variety had the lowest cost at $185 per bag, while Channel 214-22STXRIB had the highest cost at $285 per bag. Farm 4 had the lowest seeding rate at 24,000 seeds/acre and planted hybrid Pioneer P1089AM. The highest seeding rate of 35,000 seeds/acre was planted by Farm 2 with hybrid Pioneer P1082AM (Table 1, Column 3).

Total N fertilizer applied, excluding the control (Farm 9), ranged from 120 to 290 pounds/acre (Table 1, Column 10). On average, 30% of N was applied at pre-plant, 24% as a side-dress, and the remaining 46% was applied over the four fertigation options with 12%, 12%, 15%, and 8% applied on July 1, 22, August 2, and 11, respectively.

The irrigation season started June 17 and concluded on September 13. Teams were allowed to irrigate twice a week, except for the week of July 12,

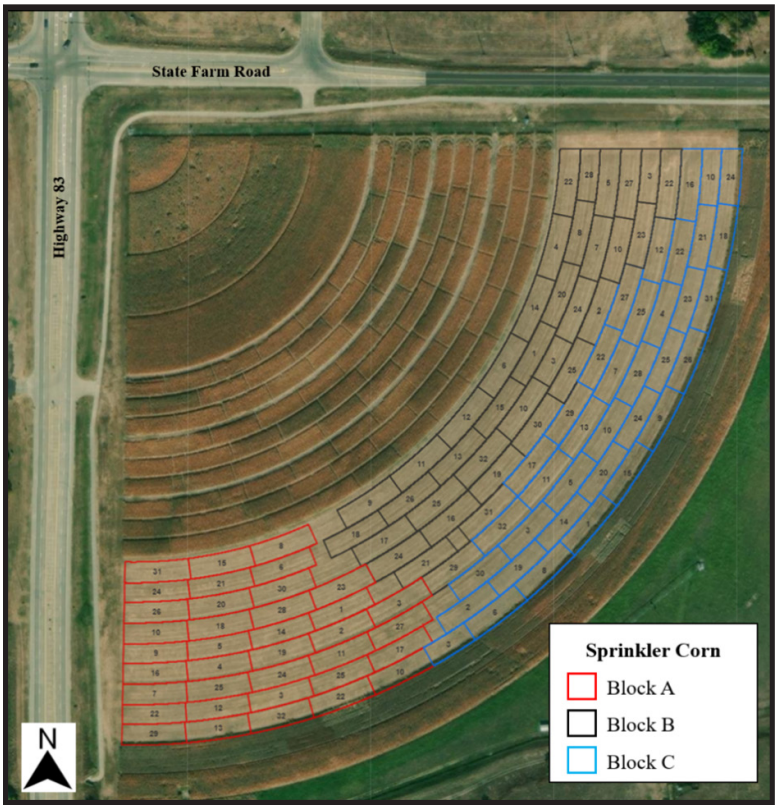

Figure 6. Farm numbers for the 2021 Sprinkler Corn Farm Management Competition held at the WCREEC in North Platte, NE. Each team was assigned a randomized plot in blocks A, B, and C.

due to pivot maintenance. Fortunately, 2.2" of rainfall occurred during that period. Excluding the control (Farm 9), seasonal irrigation ranged from 1.45 (Farm 28) to 15.26 inches (Farm 26), while the average irrigation applied per farm was 7.23 inches (Table 1, Column 11).

Table 1: Summary of select agronomic inputs from the 2021 TAPS sprinkler corn competition.

Farm	Hybrid	Seeding Rate	Nitrogen Fertilizer							Irrigation
			May 3	Jun 18	Jul 01	Jul 22	Aug 2	Aug 11	Total	
#	Name	(1,000/ac)	---------- (lbs/ac) ----------							(in)
1	Pioneer P1089AM	31	100	0	30	30	30	0	190	10.70
2	Pioneer 1082AM	35	70	100	0	15	0	0	185	6.16
3	Pioneer 1366AML	34	60	92	0	0	0	0	152	0.00
4	Pioneer P1089AM	24	0	0	30	30	30	30	120	6.96
5	Fontanelle 12DT370	32	0	160	0	20	20	0	200	9.52
6	Pioneer 1197AM	34.5	30	40	30	30	30	0	160	4.95
7	Big Cob 15-H64	29	80	0	30	30	30	30	200	9.91
8	Pioneer P1082AM	32	70	0	30	30	30	0	160	2.95
*9	Pioneer 1366AML	34	0	0	0	0	0	0	0	0.00
10	Pioneer 1366AML	34	45	30	30	0	30	0	135	9.83
11	Channel 214-22STXRIB	32.5	80	30	30	30	20	20	210	4.00
12	Pioneer 1366AML	32	100	0	30	30	30	30	220	9.61
13	Pioneer P1082AM	31	30	90	30	30	30	30	240	13.51
14	Pioneer 1197AM	32	60	60	0	30	30	30	210	1.95
15	Pioneer P1082AM	32.5	40	60	25	20	20	10	175	6.44
16	Pioneer P1089AM	33	55	0	30	30	30	30	175	8.26
17	Channel 207-42VT2	33	100	100	25	25	20	20	290	7.05
18	Fontanelle 11D637	33.5	40	100	0	0	25	0	165	4.76
19	Golden Harvest G10L16-3220A	34	120	0	0	30	30	20	200	3.49
20	Pioneer 1089AM	33	50	50	0	30	30	30	190	5.90
21	Stine 9734-G	34	60	0	30	30	30	30	180	5.26
22	Pioneer 1366AML	34	45	30	30	0	30	0	135	12.29
23	Pioneer 1366AML	34	70	70	30	30	30	30	260	10.31
24	Pioneer 1366AML	34	45	30	30	0	30	0	135	8.43
25	Pioneer 1366AML	34	45	30	30	0	30	0	135	9.33
26	Pioneer P1082	32	60	0	30	30	30	30	180	15.26
27	Dekalb DKC61-41 RIB	30	20	50	30	30	30	30	190	6.26
28	Pioneer P1082AM	30.5	0	40	30	30	30	0	130	1.45
29	Fontanelle 11D637	32	60	30	0	0	30	0	120	7.82
30	Pioneer P0622AML	32	30	50	30	30	30	30	200	7.26
31	Pioneer P1366AML	34	45	0	30	0	30	0	105	9.83
32	Pioneer P1366AML	34	45	30	30	0	30	0	135	9.83

*Control

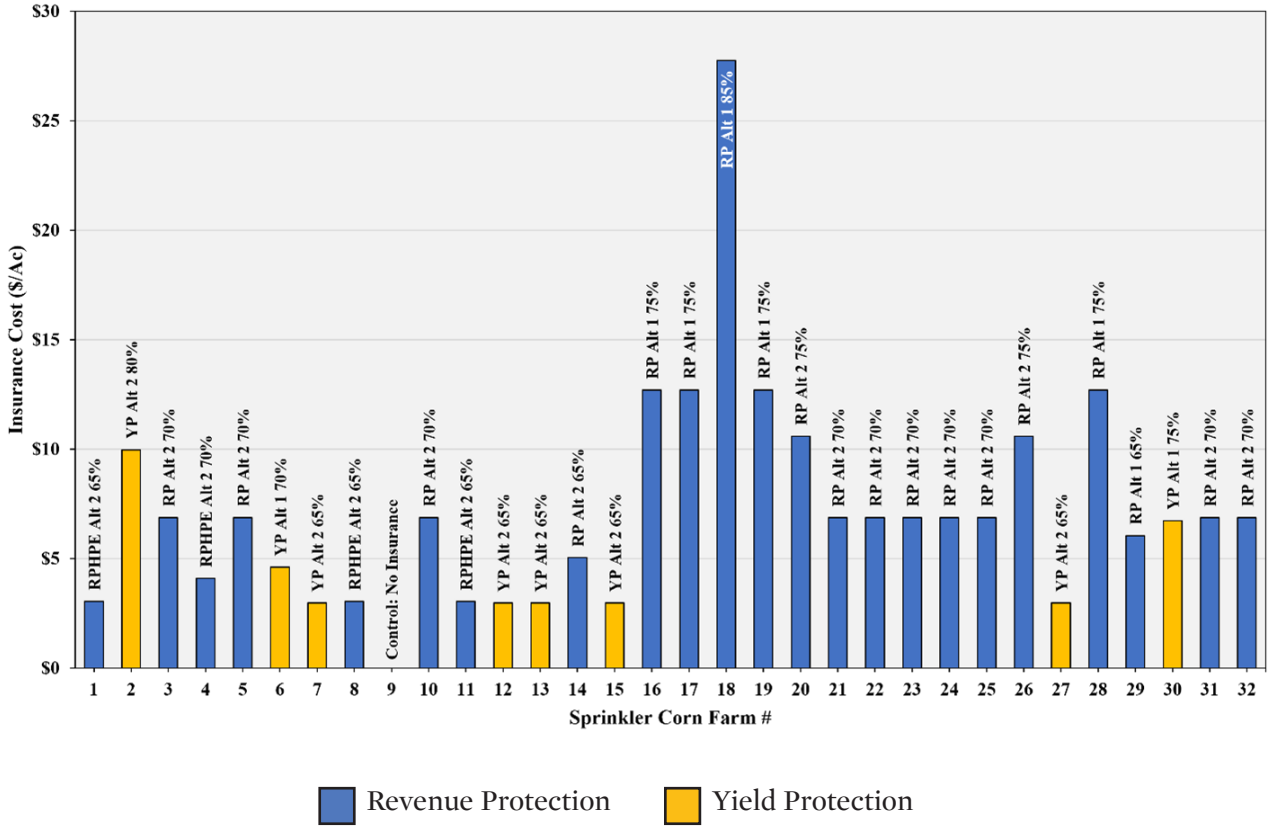

Figure 7. Insurance cost ($/acre) for the individual sprinkler irrigated corn competition teams. Policies offered included Revenue Protection (RP), Revenue Protection with Harvest Price Exclusion (RP-HPE), and Yield Protection (YP) with either Optional Units (Alt 1) or Enterprise Units (Alt 2).

Economic Decisions

Participants were required to select a multi-peril crop insurance policy with at least 65% coverage. There were no hail or wind insurance options available. Twenty teams chose to purchase Revenue Protection (RP) policies, four farms went with Revenue Protection with Harvest Price Exclusion (RP-HPE) and eight chose Yield Protection (YP) policies (Figure 7). Of the teams, eight used Optional Units (Alt 1), while the other 23 teams purchased Enterprise Units (Alt 2). Chosen by ten teams, RP-Alt 2 at 70% coverage was the most common selection. The average cost across all competitors was $7.38/acre. The least expensive policy was YP-Alt 2 at 65% coverage ($2.98/acre), selected by Farms 7, 12, 13, 15, and 27. The most expensive was RP-Alt 1 at 85% coverage ($27.76/acre), Farm 18.

Contestants could market expected production, trend adjusted Average Production History (APH), from April 1 through November 30. There were five methods allowed for selling grain: 1) forward contracting, 2) basis contracting, 3) hedge-to-arrive contracting, 4) hedge using futures contracting, and 5) cash sales. The 2021 marketing year had prices increase considerably from the previous year, due to the large amount of export activity. Stored crop grain cash prices were much higher than the December futures prices, and December futures never reached the highs of the May and July futures prices. The seasonal price variation, however, did follow a normal marketing year with high cash prices observed during the early summer.

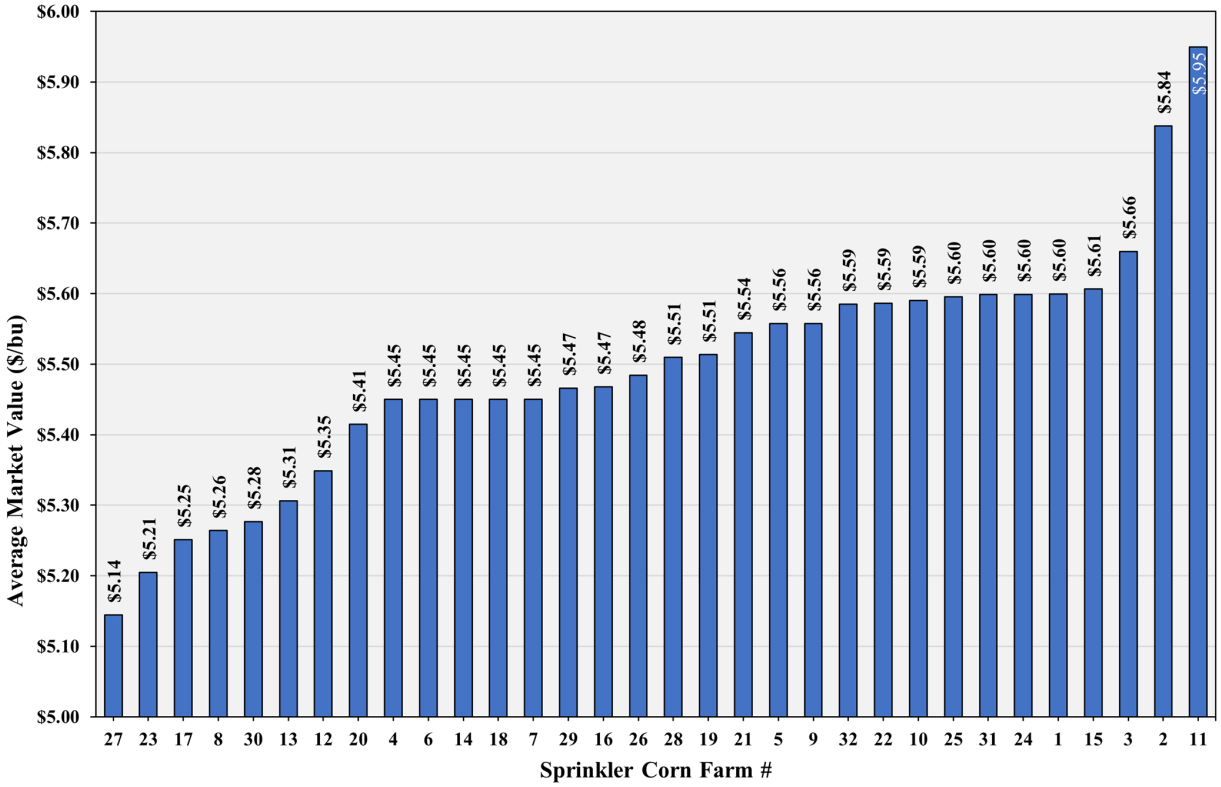

Figure 8. Average market value received ($/bushel) for the individual sprinkler irrigated corn competition teams.

The marketing decisions led to average prices received from $5.14 to $5.95/bushel (Figure 8). Farm 11, who sold all their grain using a spot cash sale on the last day of marketing, November 30, received the highest average price of the season at $5.95/bushel. Four 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 $5.50/bushel. Any unsold grain after the close of the competition were charged $0.05/bushel, making the net $5.45/bushel for unsold grain. The average price per bushel received for all 32 teams was $5.49. The highest average and overall average for the competition were more than a dollar per bushel higher than in 2020.

RESULTS AND RANKINGS

Grain Yield

Although the sprinkler corn grain yields averaged more than the 2020 competition, the greatest grain yield was less than last year's award winner. The grain yields for the competition averaged 221 bushels/acre, which was below the field's APH of 240 bushels/acre (Table 2, Column 2). Eleven teams had an average yield that exceeded the field's APH, including Farms 2, 5, 7, 13, 15, 22, 23, 26, 27, 29, and 32. Excluding control Farm 9, the farms ranged from 152 bushels/acre (Farm 3) to 274 bushels/acre (Farms 7 & 13). Figure 9A shows the relationship between grain yield and total N fertilizer. This response was weak and highly influenced by the control farm. On the other hand, grain yield had a strong response to irrigation with seasonal irrigation explaining 72% of yield variability (Figure 9B).

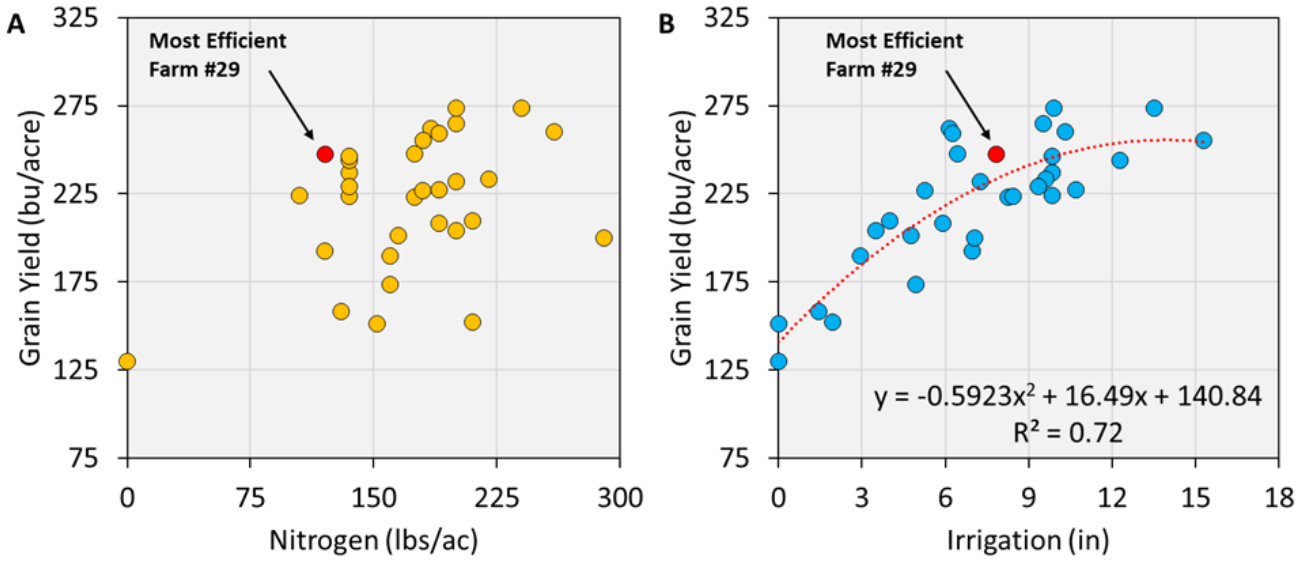

Figure 9. Sprinkler corn grain yield response to seasonal total nitrogen fertilizer (A) and irrigation (B) at the WCREEC in North Platte, NE. The most efficient farm as measured by the Water Nitrogen Intensification Performance Index (WNIPI) is denoted in red.

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 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 Farm 9 had no added N or irrigation and yielded 130 bushels/acre. Farm 29 had the highest WNIPI score at 0.286 and was therefore the most N and water efficient. This farm applied 120 pounds of N/acre and 7.82 inches of irrigation water, resulting in a yield of 248 bushels/acre. Agronomic Efficiency (AE) measures the effect each added pound of N has in terms of bushels. Farm 29 yielded 118 bushels/acre more than the control Farm 9. When the yield difference is divided by the amount of additional applied N fertilizer, 120 pounds/acre, the AE is calculated to be 0.98 bu increase per lb of N. This is much higher compared to the average of 0.55 bushels/pound of N of all other farms, except the control farm. Irrigation Water Use Efficiency (IWUE) is measured in a similar manner, except N is replaced with applied water. Farm 29's IWUE was calculated to be 15 bushels/acre-inch. The overall average was 13.3 bushels/acre-inch.

Profitability

Profitability in the TAPS competition is derived from the same formula as it is in any operation, total revenue minus total cost equals profit. The average yield from each team's plots was multiplied by their average market price and any government payments, insurance indemnities, and/or losses were then equated into this value to get total revenue. Costs were based

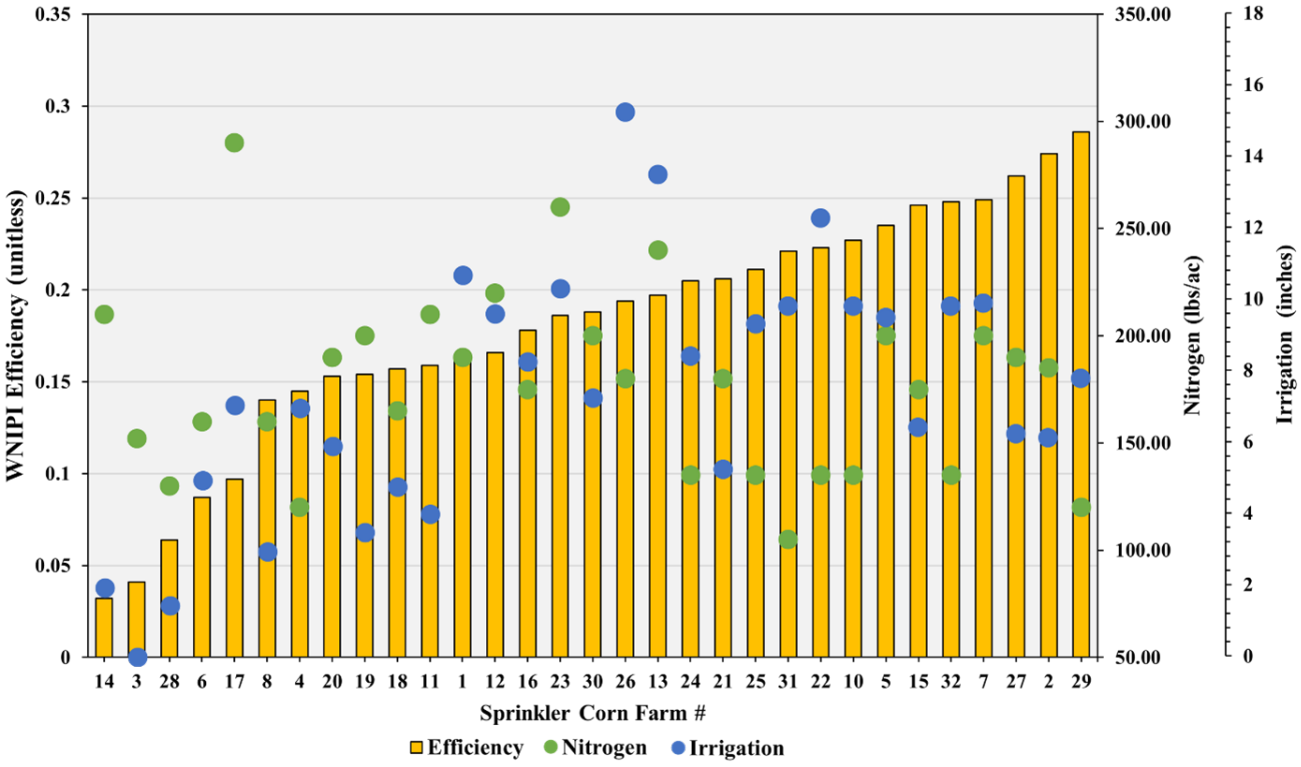

Figure 10. Input use efficiency (WNIPI) compared against irrigation (inches) and N fertilizer (lbs/acre) in the sprinkler corn competion.

on both fixed costs, as shown in the beginning budget, and variable expenses incurred during the season through the execution of their management decisions, which, when totaled, represented total cost. However, the costs of technology (e.g., sensors, imagery, and data collection) were not included in the profit equation. Since all farms had the same number of acres, the farm with the most profit per acre was the most profitable.

Revenue ranged from a low of $5.14/bushel, Farm 27, to a high of $5.95/bu, Farm 11 (Table 2, Column 3). The lowest cost per acre was achieved by Farm 3 at $588/acre (Table 2, Column 4) and the highest cost per acre was Farm 11 at $871/acre.

Table 2: Summary of data from the 2021 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	227	$5.60	$676	$528	0.51	9.1	0.164
2	262	$5.84	$736	$795	0.71	21.5	0.274
3	152	$5.66	$588	$185	0.14	0.00	0.041
4	193	$5.45	$655	$385	0.52	9.0	0.145
5	265	$5.56	$749	$721	0.67	14.2	0.235
6	174	$5.45	$689	$248	0.27	8.8	0.087
7	274	$5.45	$752	$729	0.72	14.5	0.249
8	190	$5.26	$683	$316	0.37	20.3	0.140
*9	130	$5.56	$593	$127	-	-	-
10	237	$5.59	$750	$573	0.79	10.9	0.227
11	210	$5.95	$871	$378	0.38	20.0	0.159
12	233	$5.35	$742	$496	0.47	10.7	0.166
13	274	$5.31	$803	$645	0.60	10.7	0.197
14	152	$5.45	$685	$136	0.10	11.3	0.032
15	248	$5.61	$757	$631	0.67	18.3	0.246
16	223	$5.47	$728	$481	0.53	11.3	0.178
17	200	$5.25	$808	$235	0.24	9.9	0.097
18	202	$5.45	$735	$354	0.43	15.0	0.157
19	204	$5.51	$694	$427	0.37	21.3	0.154
20	208	$5.41	$715	$402	0.41	13.3	0.153
21	227	$5.54	$728	$529	0.54	18.4	0.206
22	244	$5.59	$765	$594	0.84	9.3	0.223
23	260	$5.21	$753	$545	0.50	12.6	0.186
24	224	$5.60	$741	$508	0.69	11.1	0.205
25	229	$5.60	$740	$539	0.73	10.6	0.211
26	256	$5.48	$784	$619	0.70	8.2	0.194
27	259	$5.14	$729	$604	0.68	20.6	0.262
28	158	$5.51	$667	$206	0.22	19.6	0.064
29	248	$5.47	$715	$631	0.98	15.1	0.286
30	232	$5.28	$733	$491	0.51	14.0	0.188
31	224	$5.60	$740	$511	0.89	9.6	0.221
32	247	$5.59	$752	$621	0.86	11.9	0.248

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

With revenue and cost considered, Farm 2 earned the award for profitability with $795/acre profit, $67/acre more than the 2nd ranked team (Figure 11). Although the team ranked fourth in yield, the 12 bushel per acre difference did not matter because they had the second highest price received per bushel at $5.84, which resulted in the highest profit per acre at $795.

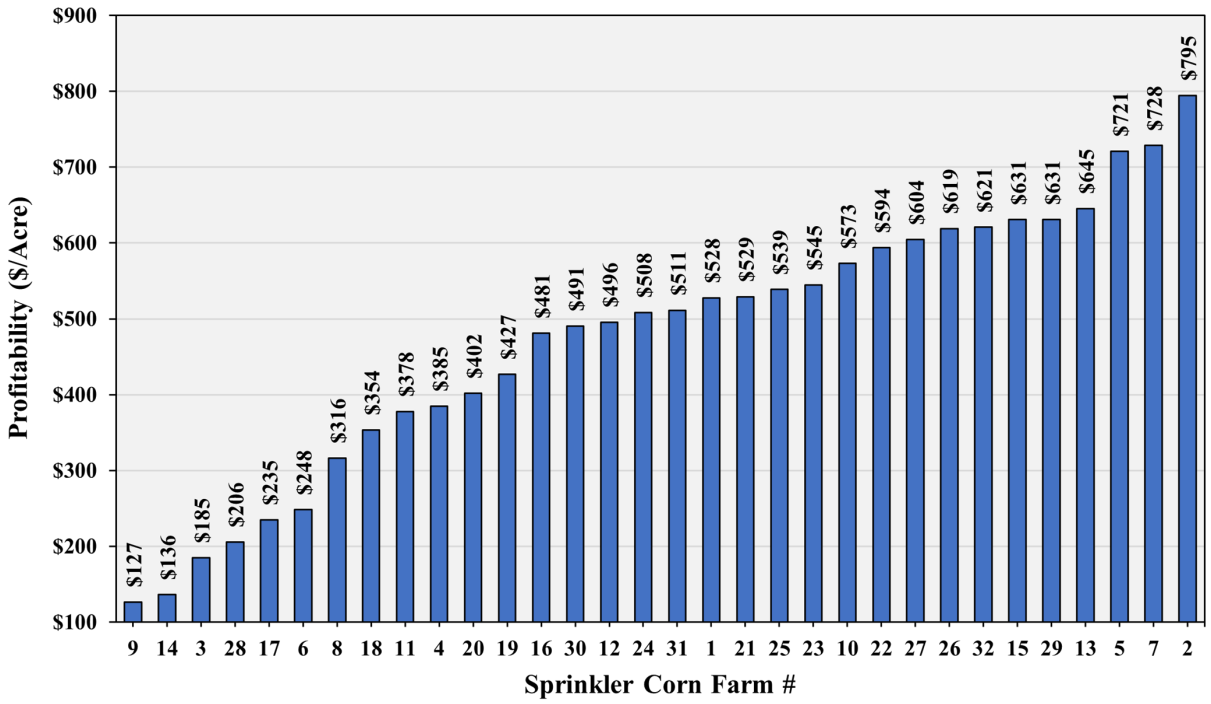

Figure 11. Profit per acre received for the individual sprinkler irrigated corn competition teams.

Photo 1. The ***Greatest Grain Yield Award*** was a tie at 274 bushels/acre. The teams that won were Luke Olson of McCook, NE (Farm 13) (pictured on left) and the Beaver City team (Farm 7) with Joshua Becker (pictured on right, left side) and Steve Hunt (not pictured) of Beaver City, NE. Olson planted Pioneer 1082AM at 31,000 seeds/acre and the Beaver City team planted Big Cob 15-H64 at 29,000 seeds/acre.

Photo 2. The ***Highest Input Use Efficiency Award*** was presented to Norton FFA from Norton, KS (Farm 29), coached by Instructor Caroline Howsden. The team planted Fontanelle 11D637 at a seeding rate of 32,000 seeds/acre and applied 120 pounds/acre of N and 7.82 inches/acre of irrigation water.

Photo 3. The Waters R Us team from Lincoln, NE (Farm 2), won the ***Most Profitable Award***. The team included Alexa Davis, Kent Zimmerman, and Elizabeth Esseks (not pictured). The group planted Pioneer P1082AM at 35,000 seeds/acre. They applied 185 pounds of N and 6.16 inches of irrigation water, which led to a yield of 262 bushels/acre. The combination of the group's fourth place yield and average revenue of $5.84/bushel were the main factors in winning the top award in the 2021 Sprinkler Corn competition.

SDI Corn Competition

In the 3rd year of the Subsurface Drip Irrigated (SDI) corn competition, 16 teams competed. There were 35 people who participated from across Nebraska and Colorado. One of the 16 teams, Farm 9, was the control farm used for determining contestant efficiency.

FIELD DESIGN

As in the past, each team had three randomized plots, Figure 12, located south of the WCREEC office, southwest of the Highway 83 and State Farm Road intersection in North Platte, NE.

PARTICIPANT DECISIONS

Participants were responsible for making economic and production management decisions, including insurance coverage, hybrid type, seeding rate, nitrogen and irrigation amount and timing, and marketing. These decisions were submitted via a form through an online password protected portal that time-stamped all decisions. The decisions participants selected are summarized below.

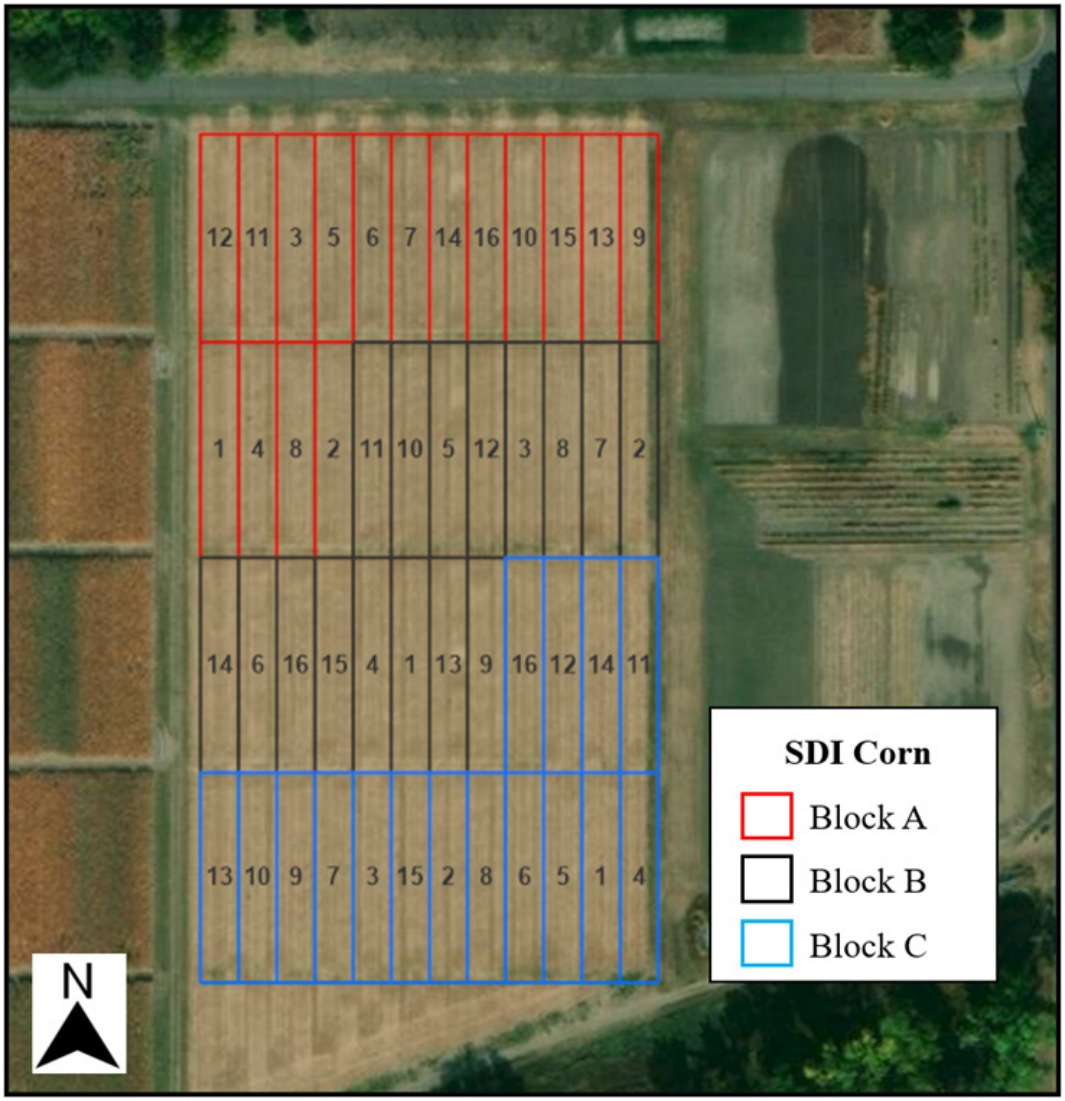

Figure 12. Plot layout for the 2021 SDI Corn Farm Management Competition held at the West Central Research, Extension, & Education Center in North Platte, NE. Each team had a randomized plot located in blocks A, B, and C.

Agronomic Decisions

All agronomic decisions made by each team are shown in Table 3, below. Ten different corn hybrids were selected from six seed companies (Table 3, Column 2). Six teams selected Pioneer P1366AML, two teams chose Channel 216-36VT2, while all other hybrids were only chosen by one team. Pioneer 1197AM had the lowest cost at $224 per bag and Channel 215-75VTPRIB had the highest cost at $275 per bag. For seeding rate, Farm 5 had the lowest rate at 28,000 seeds/acre and planted hybrid Big Cob 14-33 (Table 3, Column 3). The highest seeding rate was 34,500 planted by Farms 11 and 13 with hybrids Dekalb DKC62-89RIB and Channel 216-36VT2, respectively.

The total N fertilizer applied, not including the control (Farm 9), ranged from 0 to 260 pounds/acre (Table 3, Column 10). On average, 29% of N was applied at pre-plant, 24% sidedress, and the remaining 47% was applied over the four fertigation options with 12%, 13%, 13%, and 9% applied on June 30, July 14, 28 and August 11, respectively.

The teams were given the option to irrigate, starting June 17 and concluding September 16. Excluding the control (Farm 9), seasonal irrigation ranged from 0 (Farm 15) to 17.7 inches (Farm 3), with an average of 7.91 inches (Table 3, Column 11). The average depth of irrigation per event, excluding fertigation, was 0.73 inches.

Table 3. Summary of select agronomic inputs from the 2021 TAPS SDI corn competition.

			Nitrogen Fertilizer							
Farm	**Hybrid**	**Seeding Rate**	**Apr 27**	**Jun 21**	**Jun 30**	**Jul 14**	**Jul 28**	**Aug 11**	**Total**	**Irrigation**
#	**Name**	**(1,000/ac)**	**----------**	**----------**	**----------**	**(lbs/ac)**	**----------**	**----------**		**(in)**
1	Pioneer P1366AML	34	45	30	30	30	0	0	135	6.00
2	Pioneer P1572AM	33	0	120	20	30	25	0	195	7.10
3	Pioneer P1082AM	32	100	80	20	20	20	20	260	17.70
4	Channel 216-36VT2	33	0	0	30	30	30	30	120	6.60
5	Big Cob 14-33	28	80	0	30	30	30	30	200	10.20
6	Seitec 6433 G2Pro	32.5	60	0	25	25	25	0	135	9.35
7	Pioneer 1366AML	30	110	0	30	0	30	30	200	7.15
8	Pioneer 1366AML	33	0	80	30	30	30	15	185	9.10
*9	Pioneer 1366AML	34	0	0	0	0	0	0	0	0.00
10	Pioneer 1366AML	33	30	50	0	0	25	25	130	7.00
11	Dekalb DKC62-89RIB	34.5	100	0	30	30	25	25	210	4.05
12	Hoegemeyer 8447AM	34	90	0	30	30	30	0	180	7.35
13	Channel 216-36VT2	34.5	0	65	0	30	30	20	145	8.50
14	Pioneer 1366AML	31	60	100	30	30	15	15	250	16.90
15	Pioneer 1197AM	30	0	0	0	0	0	0	0	0.00
16	Channel 215-75VTPRIB	33	62	77	0	15	15	15	184	1.60

* Control

Economic Decisions

Participants were required to select a multi-peril crop insurance policy with at least 65% coverage. There were no hail or wind insurance options available. Eight teams chose to purchase Revenue Protection (RP) policies, two farms went with Revenue Protection with Harvest Price Exclusion (RP-HPE), and five chose Yield Protection (YP) policies (Figure 13). Of the 15 competing teams, only three teams used Optional Units (Alt 1), while the other 12 teams purchased Enterprise Units (Alt 2). Chosen by three teams, RP-Alt 2 at 70% coverage was the most common selection. The average cost across all competitors was $8.38 /acre. The least expensive policy was YP-Alt 2 at 65% coverage ($2.98/acre), selected by Farms 3, 5, and 16. The most expensive was RP-Alt 1 at 80% coverage ($23.42/acre), Farm 15.

Contestants could market expected production, trend adjusted Average Production History (APH), from April 1 through November 30. There were five methods allowed for selling grain: 1) forward contracting, 2) basis contracting, 3) hedge-to-arrive contracting, 4) hedge using futures contracting, and 5) cash sales. The 2021 marketing year had prices increase considerably from the previous year, due to the large amount of export activity. Stored crop grain cash prices were much higher than the December futures prices, and December futures never reached the highs of the May and July futures prices. The seasonal price variation, however, did follow a normal marketing year with high cash prices observed during the early summer. Seven 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 $5.50/bushel. Any unsold grain after the close of the competition was charged $0.05/bushel, making the net $5.45/bushel for unsold grain. Seven teams chose to sell using a combination of two methods, while one team used three methods, and one team used four methods. These marketing decisions led to the aver-

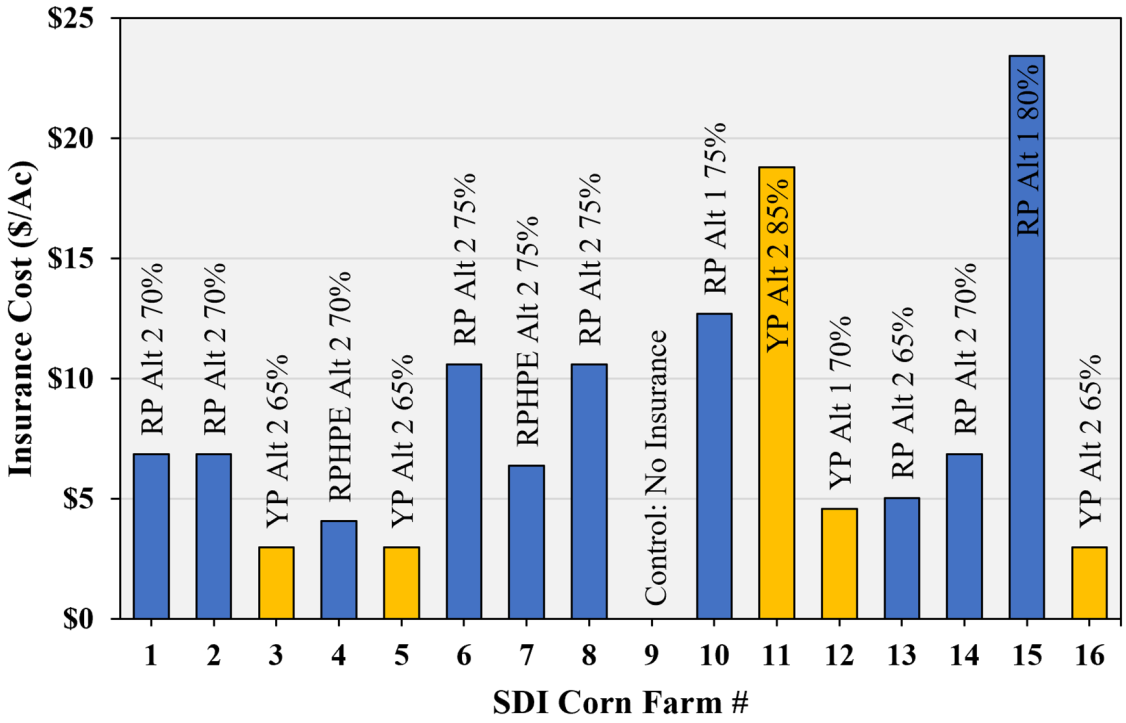

Figure 13. Insurance cost ($/acre) for the individual SDI corn competition teams. Policies offered included Revenue Protection (RP), Revenue Protection with Harvest Price Exclusion (RP-HPE), and Yield Protection (YP) with either Optional Units (Alt 1) or Enterprise Units (Alt 2).

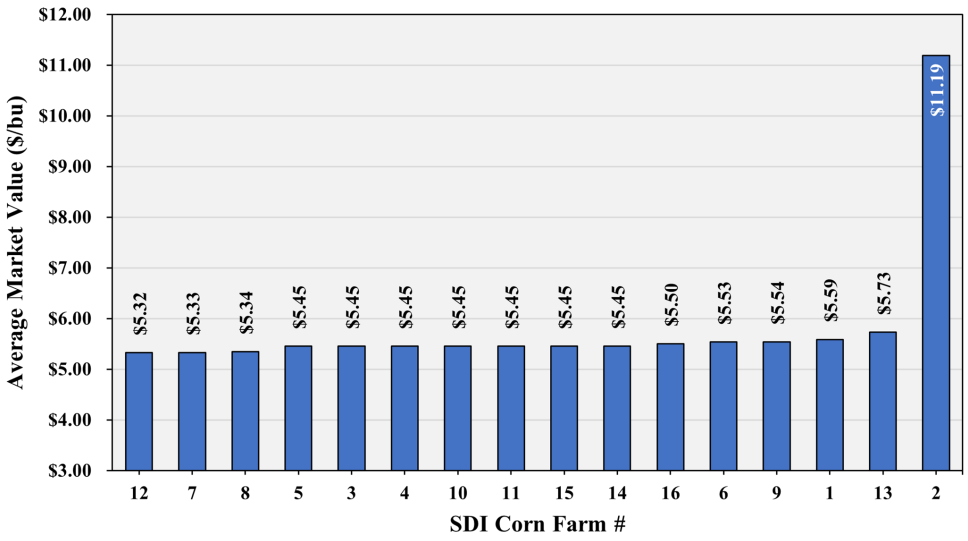

Figure 14. Average market value received ($/bushel) for the individual SDI corn competition teams.

age price received ranging from a low of $5.32/bushel to a high of $11.19/bushel (Figure 14). Farm 2, who used multiple futures contracts and then sold grain using a basis contract and spot cash sale, received the highest price of the season at $11.19/bushel. The average price per bushel received for all teams was $5.83.

RESULTS AND RANKINGS

Grain Yield

The SDI corn farm grain yields averaged more than the previous year, with the greatest grain yield exceeding last year's award winner by over 25 bushels/acre. The grain yields for the SDI competition this year averaged 259.5 bushels/acre (Table 4, Column 2), which exceeded the field's APH of 240 bushels/acre. Only three of the teams fell short of meeting the field's APH (Farms 9, 15, and 16). Except for the control Farm 9, the farms ranged from 146 bushels/acre (Farm 15) to 311 bushels/acre (Farms 3 and 6). Figure 15A shows a slight grain yield response to total N fertilizer, however, that response is mostly driven by the control treatment (i.e., zero N fertilizer). Whereas, grain yield had a strong diminishing response to irrigation, explaining 88% of yield variability (Figure 15B). Using the equation below, the estimated optimal irrigation

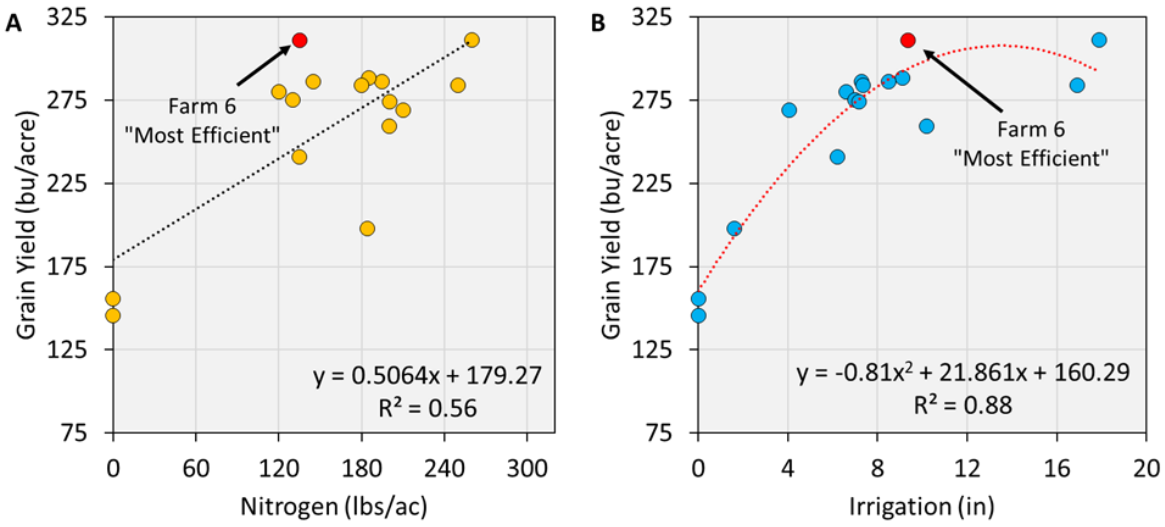

Figure 15. SDI corn grain yield response to seasonal total nitrogen fertilizer (A) and irrigation (B) at the WCREEC in North Platte, NE. The most efficient farm as measured by the Water Nitrogen Intensification Performance Index (WNIPI) is denoted in red.

amount was 13.5 inches, but visually yield peaked around 10 inches.

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 4. 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 155.8 bushels/acre. The farm with the highest efficiency for this year with a WNIPI of 0.366 was Farm 6. This farm applied 135 pounds of N/acre and 9.35 inches of irrigation water resulting in a yield of 311 bushels/acre. Agronomic Efficiency (AE) measures the effect each added pound of N has in terms of bushels. Farm 6 yielded 155.4 bushels/acre more than the control Farm 9. When the yield difference is divided by the amount of additional applied N fertilizer, 135 pounds/acre, the AE is calculated to be 1.15. This is much higher compared to the average of 0.65 bushels/pound of N of all other farms, except the control farm. On average, Farm 6 produced 1.15 bushels for every pound of N fertilizer applied. Irrigation Water Use Efficiency, (IWUE), is measured in a similar manner, except pounds of N are replaced with acre-inches of applied water. Farm 6's IWUE was calculated to be 16.6 bushels/acre-inch. The overall average was 14.5 bushels/acre-inch.

Profitability

Profitability in the TAPS competition is derived from the same formula as it is in any operation, total revenue minus total cost equals profit. The average yield from each team's three plots was multiplied by their average market price; any government payments, insurance indemnities, and/or losses were then equated into this value to get total revenue. Costs were based on both fixed costs, as shown in the beginning budget, and variable expenses incurred during the season through the execution of their management decisions, which, when totaled, repre-

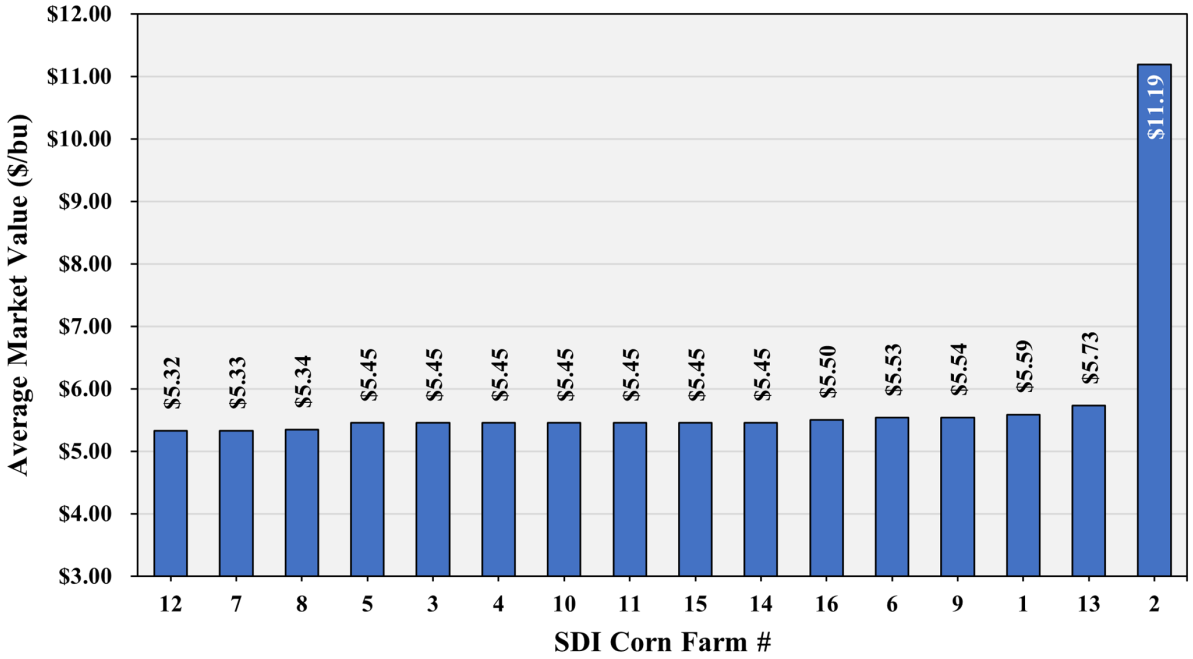

Figure 16. Input use efficiency (WNIPI) compared against irrigation (inches) and N fertilizer (lbs/acre) in the SDI corn competition.

Table 4: Summary of data from the 2021 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	241	$5.59	$841	$506	0.63	13.8	0.225
2	286	$11.19	$899	$2304	0.67	17.9	0.275
3	311	$5.45	$996	$700	0.60	8.7	0.198
4	280	$5.45	$859	$666	1.03	18.8	0.340
5	259	$5.45	$904	$509	0.52	10.1	0.194
6	311	$5.53	$877	$846	1.15	16.6	0.366
7	274	$5.33	$854	$608	0.59	16.6	0.248
8	289	$5.34	$901	$641	0.72	14.6	0.269
9	156	$5.54	$706	$157	-	-	-
10	275	$5.45	$848	$651	0.92	17.0	0.311
11	269	$5.45	$882	$583	0.54	27.9	0.261
12	284	$5.32	$880	$632	0.71	17.4	0.282
13	286	$5.73	$887	$751	0.90	15.3	0.305
14	284	$5.45	$978	$571	0.51	7.6	0.172
15	146	$5.45	$703	$90	0.00	0.0	-0.066
16	201	$5.50	$826	$281	0.25	28.4	0.116

*Control **Reported as 15.5% grain moisture content

sented total cost. However, the costs of technology (e.g., sensors, imagery, and data collection) were not included in the profit equation. Since all farms had the same number of acres, the farm with the most per acre profit was the most profitable.

Revenue ranged from a low of $5.32/bushel, Farm 12, to a high of $11.19/bushel, Farm 2 (Table 4, Column 3). The top farm had revenue in excess of $2,000/acre. Farm 2 captured an average price of $11.19/bushel, almost double the next best price of $5.73/bushel (Farm 13). The lowest cost per acre was achieved by Farm 15 at $703/acre (Table 4, Column 4) and the highest cost per acre was Farm 3 at $996/acre.

With revenue and cost considered, Farm 2 earned the award for profitability with $2,304/acre profit, nearly three times that of the second place team (Farm 6), which earned $846/acre (Figure 17). The cost per acre for the winning farm was $899, which was above the average of $865 for the competition. The average price received per bushel sold was over $5.00/bushel more than the second place team, thus having a huge impact on profit.

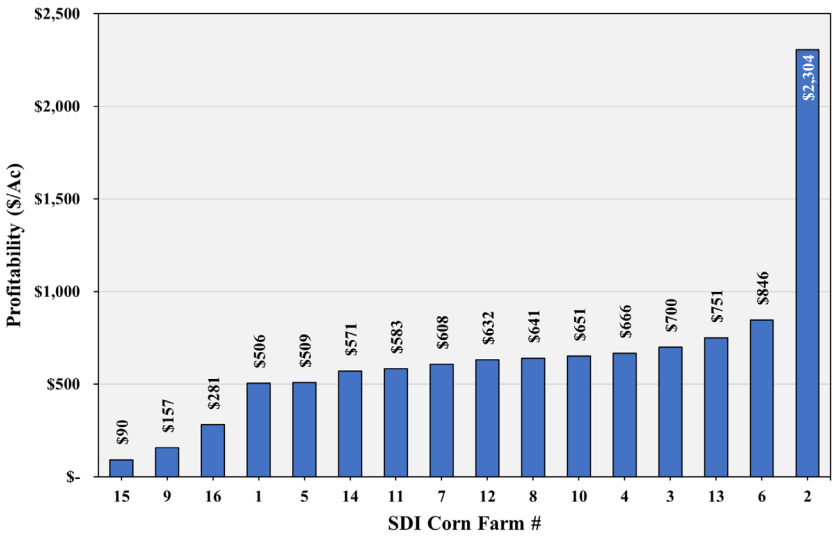

Figure 17. Profit per acre received for the individual SDI corn competition teams.

Photo 4. The ***Greatest Grain Yield Award*** was a tie at 311 bushels/acre. The teams that won were Dizmang Ag (Farm 3) of Moorefield, NE (pictured to the right, left side) and the team made up of Matt Furlong and Bryant Knoerzer (Farm 6) of Bertrand and Elwood, NE, respectively (pictured below). Dizmang planted Pioneer P1082AM at 32,000 seeds/acre.

Photo 5. The ***Highest Input Use Efficiency Award*** was presented to the team made up of Matt Furlong and Bryant Knoerzer (Farm 6) of Bertrand and Elwood, NE, respectively. The team planted Seitec 6433G2Pro at a seeding rate of 32,500 seeds/acre and applied 135 pounds/acre of N and 9.35 inches/acre of irrigation water with a final yield of 311 bu/ac.

Photo 6. The Rattlesnake Boys (Farm 2) from Wood River, NE, won the ***Most Profitable Award***. The team included Kevin (pictured left) and Amy Harsch, Jay Johnson (pictured left, center), and Jeremy Gewecke. The group planted Pioneer P1572AM at 33,000 seeds/acre. They applied 195 pounds of N and 7.10 inches of irrigation water, which led to a yield of 286 bushels/acre. The group's average revenue of $11.19/bushel was the driving factor in winning the top award in the 2021 SDI Corn competition.

Sorghum Competition

The 2021 sorghum competition, in its 4th year, had 16 teams, including 25 people from Nebraska, as well as Kansas. One of the 16 teams, Farm 9, was the control farm used for determining contestant efficiency. The sorghum competition was revised this year to include both an irrigated and dryland portion.

FIELD DESIGNS

This year with the revised format, each team had three randomized plots in the irrigated sorghum field, Figure 18, and the dryland sorghum field, Figure 19. The irrigated field is located west of Highway 83 just south of State Farm Road, and the dryland field is located east of the highway and south 3 miles from the Highway 83 and State Farm Road intersection, both in North Platte, NE.

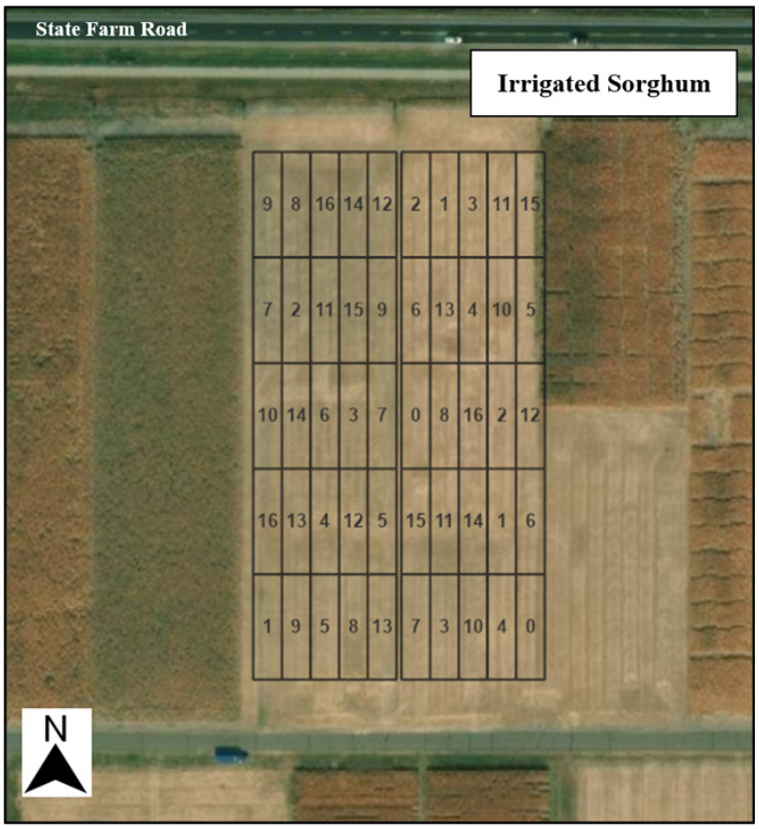

Figure 18. Farm layout for the 2021 Irrigated Sorghum Farm Management Competition held at the WCREEC in North Platte, NE. Each team was assigned three randomized plots.

Figure 19. Farm layout for the 2021 Dryland Sorghum Farm Management Competition held southeast of the WCREEC in North Platte, NE. Each team was assigned three randomized plots.

PARTICIPANT DECISIONS

Participants were responsible for making economic and production management decisions, including insurance coverage, hybrid type, seeding rate, nitrogen amount and timing, and marketing. Since the linear irrigation system was not equipped with variable rate sprinklers, participants were not required to make the irrigation decisions for the irrigated cropland portion since all plots were irrigated the same, at the discretion of university officials. The decisions were submitted

via a form through an online password protected portal that time-stamped all decisions, which are summarized below.

Agronomic Decisions

In the irrigated portion of the competition, ten sorghum hybrids were selected from six seed companies (Table 5, Column 2), including four hybrids that were not included on the recommended list of hybrids from sponsoring companies. Channel 6B95 was the participant favorite, planted by six of the 16 farms. Fontanelle G6008 had the lowest cost per bag at $100 and the High Protein 732 Trial Seed had the highest cost per bag at $210. The lowest seeding rate, 55,000 seeds/acre, was planted by Farm 13 with the Hoegemeyer H6064 hybrid, which also calculated to be the lowest cost/acre selection. The highest seeding rate, 115,000 seeds/acre, was planted by Farm 16 with hybrid Pioneer 85P58 (Table 5, Column 3).

In the dryland portion of the competition, 11 sorghum hybrids were selected from five seed companies (Table 6, Column 2), including four hybrids that were not included on the recommended list of hybrids from sponsoring companies. Pioneer 86P20 was the participant favorite, planted by three of the 16 farms. The Fontanelle hybrids had the lowest cost per bag at $100 and the High Protein 732 Trial Seed had the highest cost per bag at $210. The lowest seeding rate, 40,000 seeds/acre, was planted by Farms 7 and 13 with the Channel 6B95 and Pioneer 86P20 hybrids, respectively. Farm 4, who planted 50,000 seeds/acre of Dekalb 28-05, had the lowest cost/acre at $6.30. The highest seeding rate, 65,000 seeds/acre, was planted by Farms 6 and 9 with hybrid Channel 6B60 and Channel 6B95, respectively (Table 6, Column 3).

Participants selected their nitrogen management on both irrigated and dryland fields. The options included up to 120 pounds/acre at pre-plant and/or side-dress. There were no fertigation applications offered. The total N fertilizer applied to the irrigated plots, not including the control Farm 9, ranged from 45 to 260 pounds/acre (Table 5, Column 6) with an average of 150 pounds/acre. Half of the total fertilizer applied to the irrigated plots was done as pre-plant and the other half through side-dress application. The total N fertilizer applied to the dryland plots, not including the control Farm 9, ranged from 33 to 180 pounds/acre (Table 6, Column 6) with an average of 108 pounds/acre. Sixty percent of the total fertilizer applied to the dryland plots was done as pre-plant with the other 40 percent applied via side-dress application.

As previously mentioned, participants did not make irrigation decisions on the irrigated portion of the sorghum competition, as in the past. Instead, all plots in the irrigated portion received the same irrigation treatments throughout the season, determined by university officials. Therefore, all irrigated sorghum plots received a total of 9.05 inches throughout the season. The first irrigation was on June 17th and the final on August 31st.

Economic Decisions

Participants were required to select a multi-peril crop insurance policy with at least 65% coverage for both the dryland and irrigated crops. There were no hail or wind insurance options available. In the irrigated portion, six teams chose to purchase Revenue Protection (RP) policies, three farms went with Revenue Protection with Harvest Price Exclusion (RP-HPE) and six chose Yield Protection (YP) policies (Figure 20). Of the 15 competing teams, six teams used Optional Units (Alt 1), while the other nine teams purchased Enterprise Units (Alt 2). Chosen by three teams, YP-Alt 2 at 65% coverage was the most common selection. The average cost across all competitors for the irrigated portion was $10.00/acre. The least expensive policy was YP-Alt 2 at 65% coverage ($5.81/acre), selected by Farms 5, 10, and 11. The most expensive was RP-Alt 1 at 80% coverage ($28.18/acre), Farm 3. In the dryland portion, seven teams chose to purchase Revenue Protection (RP) policies, three farms went with Revenue Protection with Harvest Price Exclu-

Table 5. Summary of select agronomic inputs from the 2021 TAPS irrigated sorghum competition.

Farm #	Hybrid Name	Seeding Rate (1,000/ac)	Nitrogen Fertilizer Apr 30 (lbs/ac)	Nitrogen Fertilizer Jul 14 (lbs/ac)	Nitrogen Fertilizer Total (lbs/ac)
1	Channel 6B95	65	45	0	45
2	High Protein 732	85	60	50	110
3	Pioneer 86P20	75	65	65	130
4	Dekalb 38-16	100	80	80	160
5	Channel 6B95	72.5	125	135	260
6	Channel 6B95	95	100	50	150
7	Channel 6B95	65	60	150	210
8	Channel 6B60	96	90	90	180
*9	Channel 6B95	85	0	0	0
10	Channel 6B95	98	70	60	130
11	Channel 7B20	90	40	80	120
12	Fontanelle G6008	100	40	120	160
13	Hoegemeyer H6064	55	85	30	115
14	Dekalb 45-23	90	70	90	160
15	Fontanelle G6008	100	80	60	140
16	Pioneer 85P58	115	120	60	180

*Control

Table 6. Summary of select agronomic inputs from the 2021 TAPS dryland sorghum competition.

Farm #	Hybrid Name	Seeding Rate (1,000/ac)	Nitrogen Fertilizer May 4 (lbs/ac)	Nitrogen Fertilizer Jul 13 (lbs/ac)	Nitrogen Fertilizer Total (lbs/ac)
1	Fontanelle 4815	60	33	0	33
2	High Protein 732	50	60	50	110
3	Pioneer 86P20	60	45	45	90
4	Dekalb 28-05	50	45	60	105
5	Dekalb 38-16	45.3	110	0	110
6	Channel 6B60	65	80	30	110
7	Channel 6B95	40	60	120	180
8	Dekalb 28-05	50	60	60	120
*9	Channel 6B95	65	0	0	0
10	Pioneer 86P20	45	70	40	110
11	Channel 7B20	50	25	65	90
12	Fontanelle G4815	52	40	40	80
13	Pioneer 86P20	40	85	30	115
14	Dekalb 29-95	45	60	50	110
15	Fontanelle G6008	60	80	60	140
16	Pioneer 85P58	55	120	0	120

*Control

sion (RP-HPE) and five chose Yield Protection (YP) policies (Figure 20). Of the 15 competing teams, seven teams used Optional Units (Alt 1), while the other eight teams purchased Enterprise Units (Alt 2). The average cost across all competitors for the dryland portion was $10.45/acre. The least expensive policy was YP-Alt 2 at 65% coverage ($6.96/acre), selected by Farms 10, and 11. The most expensive was RP-Alt 1 at 75% coverage ($16.50/acre), by Farms 3 and 4.

Contestants could market expected production, trend adjusted Average Production History (APH), from April 1 through November 30. There were five methods allowed for selling grain: 1) forward contracting, 2) basis contracting, 3) hedge-to-arrive contracting, 4) hedge using futures contracting, and 5) cash sales. While grain sorghum prices historically follow the corn market with sorghum usually sold at a discount relative to corn, a premium has been observed, due to increased export demand primarily driven by the Chinese market. Grain sorghum does not have a futures market and requires using corn contracts to cross hedge. The 2021 marketing year had prices increase considerably from the previous year, due to the large amount of export activity. Stored crop grain cash prices were much higher than the December futures prices, and December futures never reached the highs of the May and July futures prices. The highest forward contract price in the competition was from Farm 16 in June for $6.55/bushel.

Three teams relied on their entire crop selling on the last day of competition at the closing price of $5.93/bushel on November 30. Any unsold grain was charged $0.05/bushel; therefore, these teams received a net of $5.88/bushel. Six teams chose just one of the five marketing methods to sell their commodity. Four teams chose to sell using a combination of two methods with

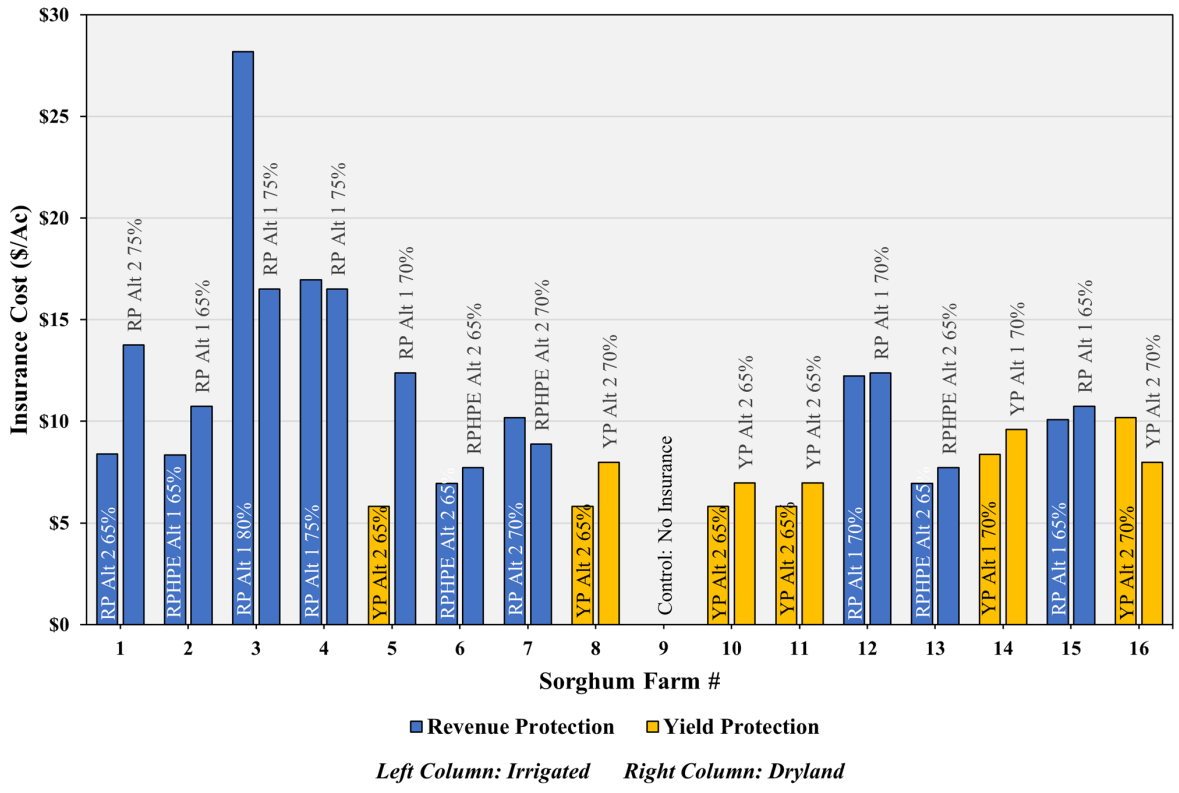

Figure 20. Insurance cost ($/acre) for the individual sorghum competition teams. Policies offered included Revenue Protection (RP), Revenue Protection with Harvest Price Exclusion (RP-HPE), and Yield Protection (YP) with either Optional Units (Alt 1) or Enterprise Units (Alt 2). The yellow and blue bars represent Yield Protection and Revenue Protection, respectively.

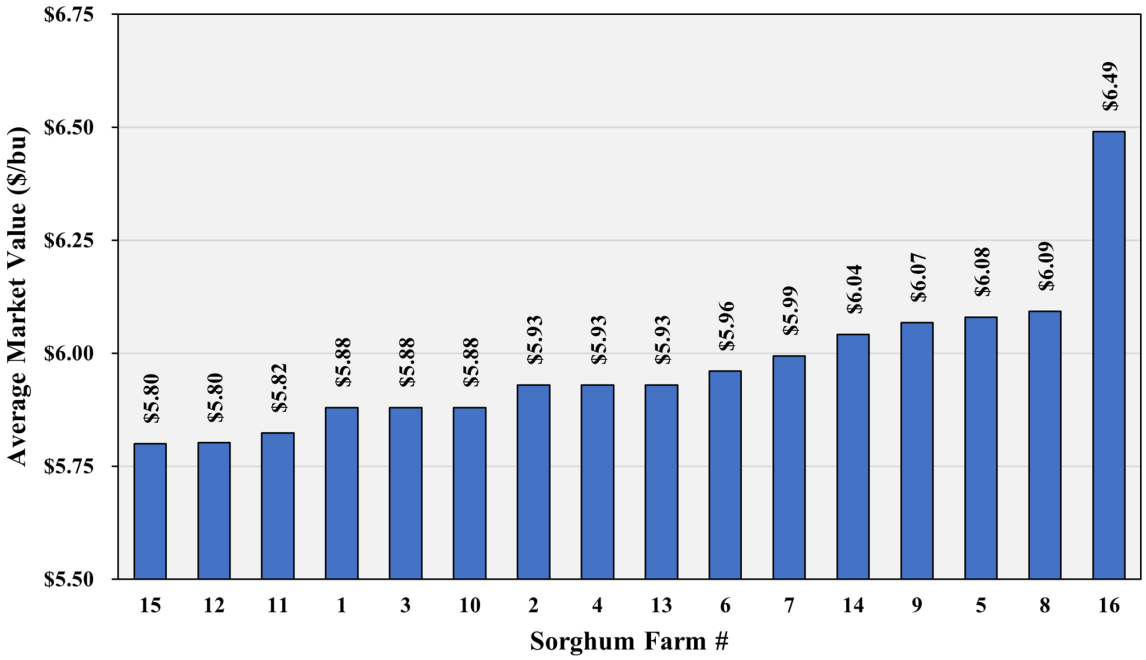

Figure 21. Average market value received ($/bushel) for the individual sorghum competition teams.

three of those involving cash sales on the final day. One team used three methods, and the remaining team used four methods, including a final sell of unsold grain by the TAPS organizers. These marketing decisions led to average prices received from $5.80 to $6.49/bushel (Figure 21). Farm 16, who used a combination of basis contracts, forward contracts, and a final cash sale on November 29, received the highest average price of the season at $6.49/bushel. The average price per bushel received for all teams was $5.97.

RESULTS AND RANKINGS

Grain Yield

Sorghum grain yields were calculated for each field and then figured for the 750 acres of dryland production and 250 acres of irrigated production to determine the competition results. Grain yields were greater under irrigated as compared to dryland. The irrigated yields ranged from a low of 139 bushels/acre, Farm 2,

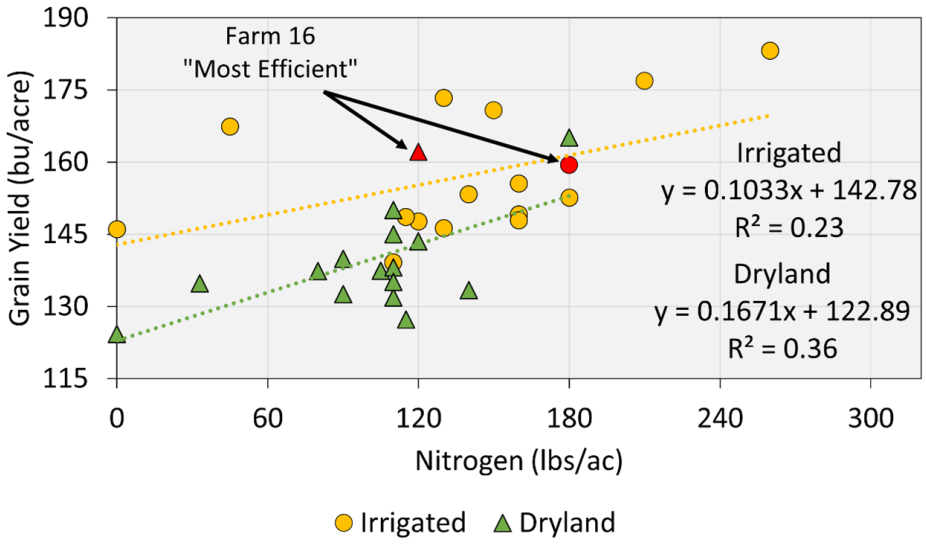

Figure 22. Dryland and irrigated sorghum grain yield response to seasonal nitrogen fertilizer at the WCREEC in North Platte, NE. The most efficient farm as measured by the Nitrogen Intensification Performance Index (NIPI) is denoted in red.

to a high of 183 bushels/acre, Farm 5 (Table 7, Column 2). Excluding the control, the average irrigated yield was 158 bushels/acre. Seven of the 16 farms exceeded the irrigated field's APH of 155 bushels/acre. The dryland yields ranged from a low of 124 bushels/acre, Farm 9, to a high of 165 bushels/acre, Farm 7 (Table 7, Column 3). Excluding the control, the average dryland yield was 141 bushels/acre. All 16 farms exceeded the dryland field's APH of 100 bushels/acre. Based on the 750 acres of dryland and 250 acres of irrigated production, the combined (i.e., farm average) competition yields ranged from 130 bushels/acres, Farm 9, to 168 bushels/acre, Farm 7. There was a weak observed relationship between grain yield and N fertilizer regardless of watering regime (i.e., dryland vs irrigated). Nitrogen fertilizer was applied, on average, at higher rates under irrigated than dryland settings. However, the increase in yields from dryland to irrigated was primarily attributed to the addition of water (e.g., irrigation) rather than the observed increase in N fertilizer use.

Input Use Efficiency

Due to the alteration of the sorghum competition, water was not used as 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 Table 7. It compares the effect of N on grain yield with respect to a control treatment. The control is a baseline and is used to measure the effect of any added N fertilizer. The controls, Farm 9 in both portions of the competition, had no added N and produced 124 and 146 bushels/acre of sorghum for the dryland and irrigated farms, respectively.

In the dryland portion, Farm 16 had the highest efficiency with a NIPI of 0.137. This farm applied 120 pounds of N/acre, resulting in a yield of 162 bushels/acre. Agronomic Efficiency (AE) measures the effect each added pound of N has in terms of bushels. Farm 16 yielded 38 bushels/acre more than the control Farm 9. When the yield difference is divided by the amount of additional applied N fertilizer, 120 pounds/acre, the AE is calculated to be 0.32. This is double that of the average of 0.16 bushels/pound of N of all other farms except the control farm. Therefore, on average, Farm 16 produced 0.32 bushels for every pound of N fertilizer applied.

In the irrigated portion, Farm 1 had the highest efficiency this year with a NIPI of 0.113. This farm applied just 45 pounds of N/acre, resulting in a yield of 167 bushels/acre. Farm 1 yielded 21 bushels/acre more than the control

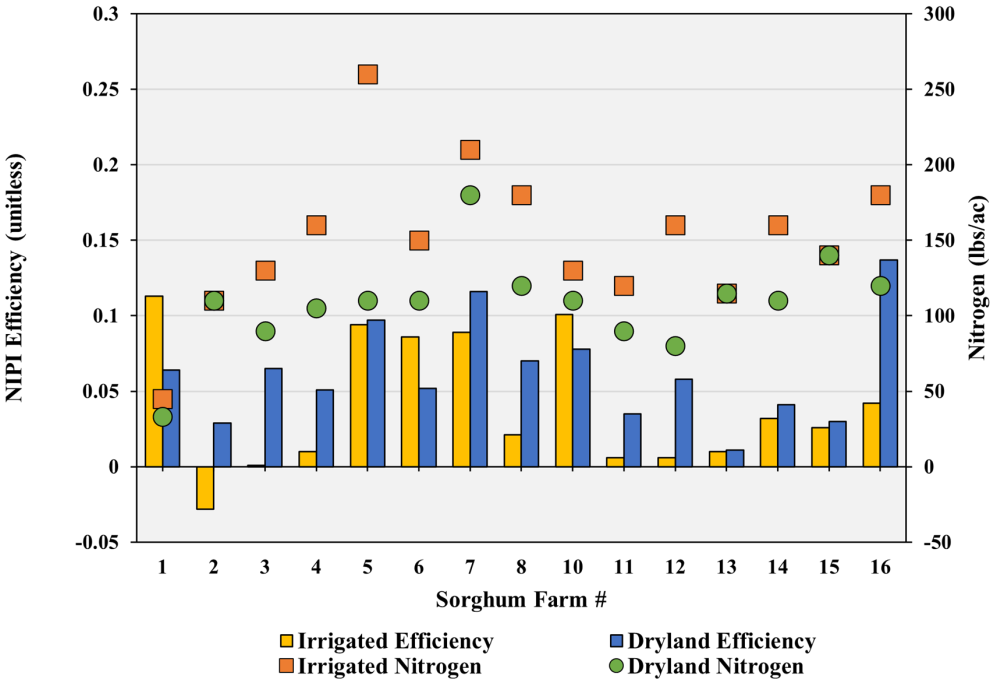

Figure 23. Input use efficiency (NIPI) compared against N fertilizer (lbs/acre) in each portion of the sorghum competition.

Farm 9. When the yield difference is divided by the amount of additional applied N fertilizer, 45 pounds/acre, the AE is calculated to be 0.47. This is much higher compared to the average of 0.09 bushels/pound of N of all other farms except the control farm. Therefore, on average, Farm 1 produced 0.47 bushels for every pound of N fertilizer applied.

When the efficiency results are multiplied by the weighted average of 750 acres dryland production and 250 acres irrigated production, Farm 16 won the efficiency award with a combined NIPI of 0.113.

Profitability

Profitability in the TAPS competition is derived from the same formula as it is in any operation, total revenue minus total cost equals profit. The average yield from each team's three plots was multiplied by their average market price; any government payments, insurance indemnities, and/or losses were then equated into this value to get total revenue. Costs were based on both fixed costs, as shown in the beginning budget, and variable expenses incurred during the season through the execution of their management decisions, which, when totaled, represented total cost. However, the costs of technology (e.g., sensors, imagery, data collection) were not included in the profit equation. Since all farms had the same number of acres, the farm with the most per acre profit was the most profitable.

Revenue ranged from a low of $5.80/bushel, Farms 12 and 15, to a high of $6.49/bushel, Farm 16 (Table 7, Column 5). The lowest cost per acre was achieved by Farm 9 at $314/acre (Table 7, Column 6), and the highest cost per acre was Farm 7 at $403/acre.

With revenue and cost considered, Farm 16 earned the award for profitability with $655/acre profit, $51/bushel more than the 2nd ranked team (Figure 24). The cost per acre for the winning farm was $393, which was above the competition average of $377. The revenue per bushel sold for the winning team was $6.49/bushel, which was $0.40/bushel more than the second place team, thus having an impact on profit, when combined with the higher yields achieved.

Table 7: Summary of data from the 2021 TAPS sorghum competition.

Farm #	Irrigated Grain Yield** (bu/ac)	Dryland Grain Yield** (bu/ac)	Combined Grain Yield* (bu/ac)	Revenue ($/bu)	Cost ($/ac)	Profit ($/ac)	Combined NIPI (unitless)
1	167	135	143	$5.88	$344	$497	0.076
2	139	132	134	$5.93	$388	$404	0.015
3	146	140	142	$5.88	$387	$445	0.049
4	149	137	140	$5.93	$385	$448	0.041
5	183	150	158	$6.08	$385	$578	0.097
6	171	138	146	$5.96	$380	$491	0.061
7	177	165	168	$5.99	$403	$604	0.109
8	153	144	146	$6.09	$382	$507	0.057
*9	146	124	130	$6.07	$314	$473	-
10	173	145	152	$5.88	$378	$516	0.084
11	148	133	136	$5.82	$367	$427	0.028
12	148	137	140	$5.80	$375	$437	0.045
13	149	127	133	$5.93	$376	$411	0.011
14	156	135	140	$6.04	$383	$464	0.039
15	153	133	138	$5.80	$388	$414	0.029
16	159	162	162	$6.49	$393	$655	0.113

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

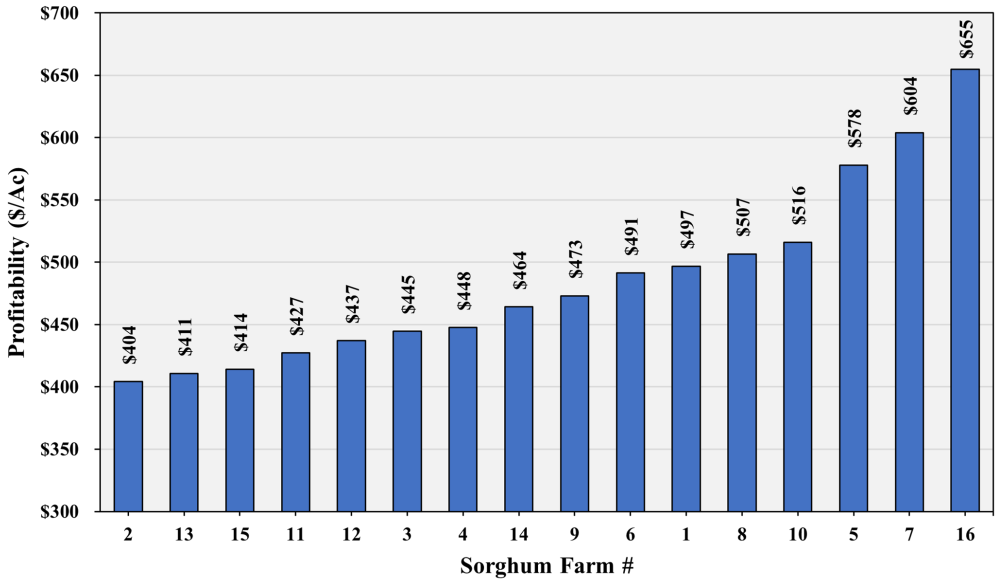

Figure 24. Profit per acre received for the individual sorghum competition teams.

AWARD RECIPIENTS

Photo 7. The ***Greatest Grain Yield Award*** of 168 bushels/acre was grown by Tom Carpenter (Farm 7) of Bartley, NE. He chose to plant Channel 6B95 at a population of 40,000 and 65,000 seeds/acre in his dryland and irrigated plots, respectively.

Photo 8. Chad Dane (Farm 16) from Clay Center, Nebraska, won the ***Highest Input Use Efficiency Award***, as well as the ***Most Profitable Award***. Chad (pictured on the left) planted Pioneer 85P58 at 55,000 seeds/acre and 115,000 seeds/acre for dryland and irrigated, respectively. He applied 120 pounds of N to dryland and 180 pounds to irrigated. Chad's dryland plot yielded 162 bushels/acre while his irrigated yielded 159 bushels/acre. Chad's average revenue of $6.49/bushel was the driving factor in winning the top award in the 2021 sorghum competion.

CONCLUSION

This milestone year has once again provided a wealth of data, as well as interaction among competitors, industry and ag service providers, researchers, and others. Like any agriculture operation, the participants were subjected to varying environmental and marketing conditions in 2021. The outcomes of the competitions allow competitors to benchmark and reflect on their use of available information, the effectiveness and performance of new technologies, management practices, and strategies used during the season. As the roadmap for the future is planned, the plethora of data will continue to build toward the discovery of better practices, and the application of new ideas and technologies. The TAPS team greatly appreciates all who take part in this program, from participants to the partners and sponsors. We extend our congratulations to everyone involved in this year's success and applaud the 2021 winners.

As another year concludes, we would also like to acknowledge Curtis Scheele, who was selected to receive the "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. We are grateful for Curtis' years of participating in the TAPS program, but even more appreciative of the time and effort he takes to share the findings of the competitions, as an employee of the USDA-NRCS. Thank you, Curtis!

The roadmap of the TAPS program's future is focused on growth, while still providing the same experiential learning experience, as in the past. New competitions are being planned for other locations in Nebraska, as well as other universities creating their own programs based on the TAPS model. We are excited to see where the next five years leads the program, and we look forward to all of you joining us.

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 2021 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 CI016-21, and the Nebraska Sorghum Board.

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