
# AU TAPS

**TESTING AG PERFORMANCE SOLUTIONS**

# REPORT 2024

*The impact of agronomic and economic practices on crop yield, input use efficiency, and profitability evaluated through a team competition*

AUBURN AGRICULTURE

extension ALABAMA A&M & AUBURN UNIVERSITIES

Alabama Agricultural Experiment Station AT AUBURN UNIVERSITY

**TABLE OF CONTENTS**


2024 Testing Ag Performance Solutions (TAPS) Core Team ........ 3
Acknowledgment ........ 3
Mission Statement ........ 3
EXECUTIVE SUMMARY ........ 4
1. PROGRAM OVERVIEW ........ 5
2. MANAGEMENT OPTIONS AVAILABLE TO THE TEAMS ........ 6
3. TIMELINE OF ACTIVITIES ........ 8
4. EQUIPMENT AND TECHNOLOGY ........ 8
5. GROWING CONDITIONS ........ 9
6. DESCRIPTION OF AWARDS ........ 10
7. PARTICIPANTS ........ 10
8. PARTNERS AND SPONSORS ........ 11
9. DECISIONS MADE BY THE 2024 TAPS TEAMS ........ 11
9.1 Competition Data ........ 11
9.2 Agronomic Decisions ........ 11
10. RESULTS ........ 14
10.1 Grain Yield ........ 14
10.2 Input Use Efficiency ........ 15
10.3 ECOMONIC DECISIONS ........ 17
10.3.1 Net Returns ........ 18
10.3.2 Marketing ........ 20
CONCLUSIONS ........ 22
FUNDING ........ 23
REFERENCE ........ 23
APPENDIX ........ 24
Appendix A ........ 24
Appendix B ........ 25

**2024 Testing Ag Performance Solutions (TAPS) Core Team**

Brenda Ortiz
TAPS project coordinator
Professor and Precision Ag. Specialist
Auburn University
Email: bortiz@auburn.edu
Phone: (334) 844-5534

Andrew Sparks
Associate Director of Ag Research, EV Smith Research and Extension Center
Auburn University
Email: ajs0015@auburn.edu
Phone: 334-749-3353

Eros Francisco
Extension Specialist in Grain Crops Agronomy
Auburn University
Email: ezf0034@auburn.edu
Phone: (334) 844-5450

Wendiam Sawadgo
Extension Economist
Auburn University
Email: wendiam@auburn.edu
Phone: (334) 844-4800

Adam Rabinowitz
Extension Specialist in Agricultural Economics
Auburn University
Email: adam.rabinowitz@auburn.edu
Phone: (334) 844-5620

Emmanuel Abban-Baidoo
Research Scholar
Auburn University
Email: eza0077@auburn.edu
Phone: (334) 844-4133

**Acknowledgment**

The success of the TAPS program at Auburn University, Alabama, results from the dedicated efforts of numerous individuals and collaborators. We sincerely thank our colleagues at E. V. Smith Research and Extension Center – Farm Service Unit for their dedication and commitment to implementing this project on the ground. Additionally, we want to thank our colleagues at Auburn University College of Agriculture, for their support of this project. Special thanks to our collaborators at the Universities of Florida, Nebraska, Kansas, and Colorado for their guidance and support in aligning this project with the broader goals of sustainable and precision agriculture. Appreciation is also extended to the graduate students and visiting research scholars in the CSES Precision Agriculture Laboratory, field assistants, industry collaborators, and participating farmers for their invaluable contributions.

**Mission Statement**

The mission of TAPS is to engage farmers, crop consultants, scientists, extension personnel, students, personnel from governmental agencies (e.g. NRCS and USDA), and industry representatives in a collaborative and innovative effort to advance agriculture in Alabama and beyond. By exchanging knowledge, adopting cutting-edge technologies, fostering partnerships, and implementing best management practices, TAPS aims to provide effective solutions to achieve long-term productivity, sustainability, and profitability in farm operations.

**Goals and Objectives**

This project aimed to demonstrate the role of crop management practices and the use of decision-support tools and solutions to increase crop yield, profitability, and input use efficiency. This project also explored the role of crop marketing strategies and crop insurance on profitability and risk management. Teams comprised of farmers and crop consultants manage plots planted with corn by choosing among various crop management practices, decision support tools, and economic strategies. Teams competed for the input use efficiency and net return awards. It is expected that sharing the results of this project with the team members, other farmers, and practitioners, may lead to knowledge sharing and adoption of solutions that will increase profitability and environmental sustainability.


**EXECUTIVE SUMMARY**

The TAPS program in Alabama completed its inaugural year at the E.V. Smith Research and Extension Center (EVS) in Shorter, Alabama. The project, which centers around a competitive framework, provided participants with an opportunity to explore and implement innovative crop management practices for corn production. Eight teams, consisting of farmers and crop consultants, participated in this year's competition. Team members represented seven counties: Autauga, Dallas, Henry, Lee, Macon, Pike, and Talladega.

Management decisions, including the choice of corn hybrid, seeding rate, nitrogen source, nitrogen rate and timing, irrigation rate and timing, and insurance selection were evaluated for their impact on yield, profitability, and input use efficiency. Results demonstrated significant variability in profitability, input use efficiency, and yield outcomes, highlighting opportunities for optimizing resource use and maximizing productivity. One of the project's core objectives is to encourage knowledge-sharing among participants, fostering collaboration and the adoption of sustainable agricultural practices. At the end of the 2024 competition, farmers, extension specialists, industry representatives, sponsors, and other stakeholders gathered to learn the outcomes of the competition. Participants were awarded in two categories: Team with Highest Net Return and High Input Use Efficiency.



The TAPS program wishes to acknowledge the support of the Alabama Agricultural Experiment Station at Auburn University, and the funding received from the Wheat and Feed Grain Committee of the Alabama Farmers Federation and Alabama Soil and Water Conservation Committee to execute this project. In addition, recognition goes to the Economic Development Partnership of Alabama organization for the monetary support provided to the 2024 TAPS winners. The TAPS team appreciates all the private companies who provided time, effort, technology, and technical assistance to support the 2024 TAPS program.


Continuation of this program and the impacts represented in learning and networking opportunities and advancements in agricultural innovation rely on your participation. We are looking forward to the new learning opportunities the next 2025 growing season will provide.

Sincerely,
*The TAPS Team*

## 1. PROGRAM OVERVIEW

The Testing Agricultural Performance Solutions (TAPS) program aimed to demonstrate the impact of various crop management practices on crop yield, input use efficiency, and profitability. This innovative program evaluated critical agronomic decisions, including hybrid selection, seeding rate, nitrogen source, nitrogen application rate and timing, irrigation rate and timing, crop insurance, and marketing strategies (Fig. 1). By analyzing the outcomes of these decisions, participants assessed the impact of their management practices and benchmarked their performance against profitable and environmentally sustainable standards. Teams were able to access numerous tools and solutions available through private companies. Testing those solutions through the competition might increase their adoption at the farm level.

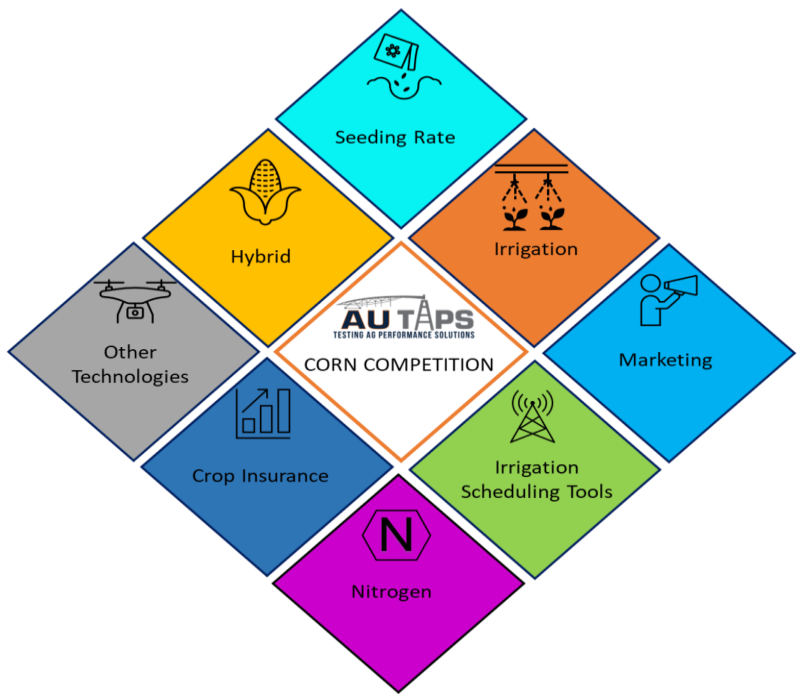


**Figure 1**. 2024 TAPS crop management choices.

During the first year of TAPS, Qualtrics surveys were used before planting, and before side-dress nitrogen application to collect the crop management decisions made by each team. From June to July, the TAPS coordinator used text messages to communicate with teams on a daily or weekly basis to collect information related to irrigation decisions. A report with all the management strategies performed up to the side-dress nitrogen applications was prepared for each team and sent by email. Pictures documenting crop growth progression, along with weekly rainfall records, were also shared with the teams.

The project was established at the E.V. Smith Research and Extension Center, Farm Services Unit, in Shorter, AL, with eight teams (A-H), comprising farmers, crop consultants, and extension specialists. Each team was responsible for independently managing three plots of 0.8 acres each (Fig. 2). Due to the relatively uniform conditions of the field allocated for this project, the team plots were randomized across the field (referred to as the TAPS Field). The project was conducted at the Gin-east field of the Farm Services Unit (32º 26’ 17” N, 85º 54’ 42” W) with soil types ranging from silty clay loam to Clay Loam texture. The

TAPS field, planted with corn, was irrigated with a Center Pivot Irrigation System with Variable Rate Irrigation (VRI) technology. As part of the competition, a control treatment, known as Team H, was included. Team H received only 13 lbs N/ac at planting, serving as a benchmark for evaluating nitrogen use efficiency among the competing teams. This control team provided a reference for assessing the environmental and economic impacts of nitrogen management strategies.

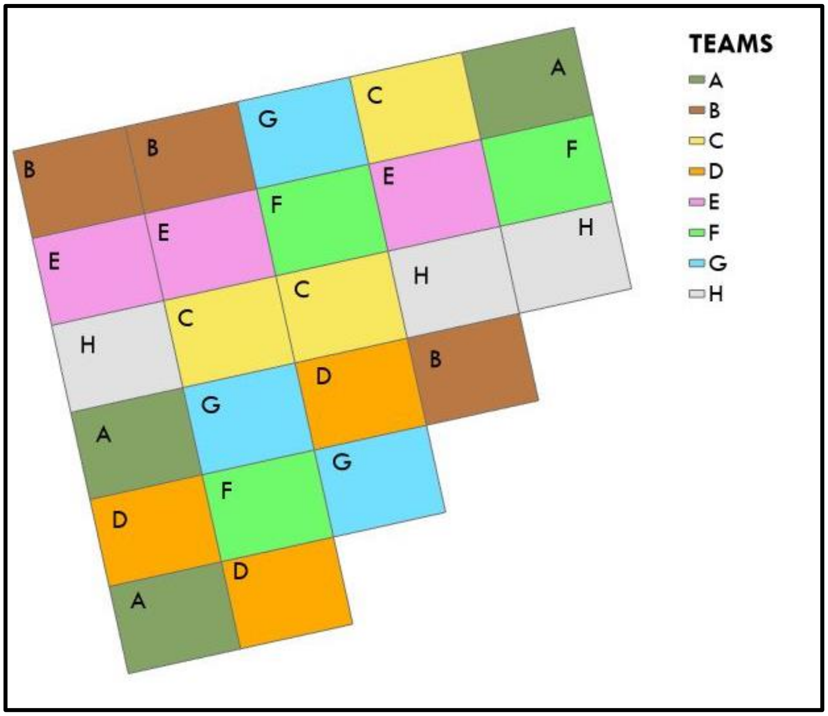


**Figure 2**. 2024 Plots layout. Each team was assigned three randomized plots of 0.8 acres each, which they independently managed according to their management choices.

## 2. MANAGEMENT OPTIONS AVAILABLE TO THE TEAMS

**2.1 Hybrid Selection (decision type #1) and Seeding Rate (decision type #2).** Teams were required to select their corn hybrid and seeding rate. The six corn hybrids available in the competition included DKC68-35 (118 RM), DKC67-44 (117 RM), DKC63-57 (113 RM), Croplan 5893 (118 RM), Croplan 5678 (116 RM), PIO18-47VYHR (118 RM), and DynaGro 58VC65 (118 RM). Teams chose the corn hybrid from these options as well as the seeding rate of their preference.

**2.2 Crop Insurance (decision #3).** Prior to planting, teams were required to select a crop insurance package from the following four options:

1. Revenue Protection (RP), specifying the level of coverage in percentage,
2. Revenue Protection with Harvest Price Exclusion (RP-HPE),
3. Yield Protection (YP) with buy-up coverage, and
4. Yield Protection using either Optional Units (OU) or Enterprise Units (EU).

**2.3. Nitrogen Management (decision #4).** Teams were asked to select from various nitrogen management options such as nitrogen source, rate, and time of application. The maximum and total amount of nitrogen each team could apply during the growing season was 300 lbs N/ac. Four choices regarding nitrogen application source were available: liquid Ammonium Polyphosphate (APP) 11-37-0 (planting), granular

NPK 19-19-19 (planting), liquid Urea Ammonium Nitrate (UAN) 28-0-0-5 (at and after side-dress application), and granular Urea – 40% (side-dress). Teams were also allowed to apply nitrogen at three different times during the growing season: at plating, at the V6 growth stage (side-dress application), and at the V10 growth stage. To provide a unique insight into how effectively nitrogen inputs (source, rate, and timing of application) are utilized, indices such as Nitrogen Use Efficiency (NUE), Agronomic Efficiency of Nitrogen (AEN), Nitrogen Recovery Efficiency (NRE), Nitrogen Intensification Performance Index (NIPI), and Nitrogen Uptake (NU) were used to estimate nitrogen input use efficiencies. The equation for calculating these indices can be found in Appendix B. These metrics provide valuable insights into nitrogen input efficiency, crop response, and environmental sustainability. Team H, serving as the control with only 13 lbs N/ac applied, represents the baseline nitrogen uptake ($NU_{Control}$) and Yield ($Y_{Control}$) without fertilizer, making it essential for comparison with fertilized plots (Team Plots A-G). Nitrogen Uptake (NU) measured the total nitrogen absorbed by the crop's aboveground biomass, while AEN evaluated the increase in grain yield per unit of nitrogen applied. NRE quantified the percentage of applied nitrogen recovered by the crop. NUE provided a broader perspective on grain yield per unit of nitrogen applied. NIPI assessed the relative gains in yield and nitrogen uptake between fertilized and control plots. These indices collectively emphasize the importance of efficient nitrogen management to balance productivity and sustainability in crop production.

**2.4. Water Management (decision #5).** The TAPS field was irrigated using a center pivot irrigation system with variable rate irrigation (VRI) capabilities. Teams were responsible for selecting their preferred tools for irrigation scheduling. The available options for soil sensors were: AquaSpy®, Sentek (distributed by Simplot Smart Farm), and Trellis (soil water tension sensor). In addition, an irrigation scheduling phone App (Smart Irrigation CropFit App) that uses crop evapotranspiration-based soil water balance was also available as an option among the irrigation scheduling tools (https://smartirrigationapps.org/cropfit-app/). The teams also had access to real-time weather data recorded by a weather station installed near the field, as well as an automatic rain gauge located at one of the field's boundaries, which recorded both irrigation and rainfall. During June and July, the teams were contacted weekly by text messages to provide their irrigation recommendations. If necessary, irrigation was applied two times per week. Irrigation depth per application could be as much as 1.0 inches, in increments of 0.05 inches. If teams chose to apply 1.0 inch of water in a single irrigation event, the rate was split in half and the pivot was run twice consecutively. The center pivot irrigation system at the TAPS field consists of seven spans, each equipped with VRI capabilities. The VRI applies different irrigation rates using the zone control method, and specifically for this system, a different rate could be prescribed every half-span. To understand how effectively irrigation water is utilized, two indices; Irrigation Water Use Efficiency (IWUE) and Crop Water Productivity (CWP) were used to estimate water use efficiencies. The equation for calculating these indices can be found in Appendix B. IWUE measures grain yield per inch of irrigation water applied. It evaluates how effectively irrigation water contributes to grain yield. IWUE is crucial for assessing water use in a region where irrigation management can significantly impact crop performance. CWP measures total biomass produced per inch of water (irrigation + rainfall). It focuses on total biomass rather than grain yield alone and reflects the efficiency of water use for overall crop growth.

**2.5. Grain Marketing (decision #6)**. The TAPS teams planned to evaluate choices related to crop marketing selection made by the participants. Although in the end this decision was not offered to the teams, two marketing options were considered: 1) Forward contacting and 2) Hedge to arrive.

**2.6. 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 entire TAPS field. The competition teams freely made choices, as they sought to be the most profitable, efficient, and highest-yielding Team. The TAPS team did the physical management of all plots (e.g., operation of machinery, fertilizer and irrigation application, collection of tissue samples, harvesting, etc.).

## 3. TIMELINE OF ACTIVITIES

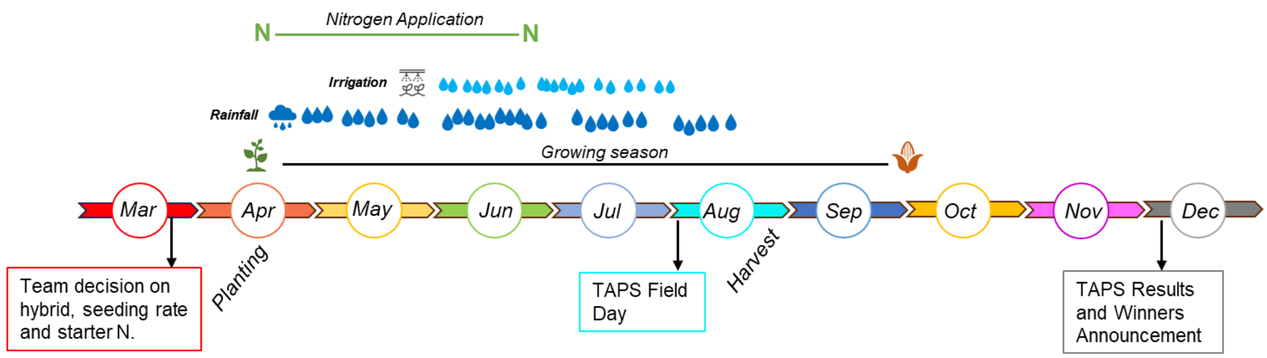


**Figure 3**. 2024 TAPS timeline of crop management practices and associate project activities.

## 4. EQUIPMENT AND TECHNOLOGY


**Figure 4**. Technologies and services used by Teams for decision-making.

One of the primary goals of the competition is to equip farmers, crop consultants, and extension personnel with commercial tools and solutions that can enhance crop management efficiency and profitability. By allowing teams to test these solutions on a small scale with minimal risk of yield losses, the competition provides a platform for evaluating their benefits, accelerating the learning process, and encouraging adoption.

In this inaugural year, teams had access to advanced technologies, including irrigation scheduling tools, in-season nitrogen recommendation platforms, and drone imagery. These tools were intended to raise awareness among participants about their practical use and to help them evaluate their financial and conservation value for their operations. Additionally, while the teams did not operate the farming equipment used to apply inputs on the plots, they were exposed to various Precision Agriculture Technologies. This provided valuable insights into the benefits of variable rate application methods and how teams can apply these technologies to their farming operations. A list of technologies used for the 2024 TAPS competition can be found in Appendix A.

## 5. GROWING CONDITIONS

The project site is located in a region with a humid subtropical climate, with most precipitation occurring in the winter and variable rainfall during the summer. Although the soil survey information provided by NRCS characterizes the predominant soil type of the project site as Altavista silt loam (USDA-NRCS. 2024), soil texture analysis from soil samples collected at the site indicated soil texture ranges from silty clay loam to clay loam. The corn was planted on April 18, 2024, reached silking around July 4$^{th}$, and showed early signs of physiological maturity in early August (Fig. 5).

The rainfall recorded from planting to harvest was 26 inches, however, the rainfall was not well distributed to meet the corn water requirement throughout the growing period. Sparse rainfall events were recorded in May (7.4 inches) and June (6.1 inches), suggesting the need for irrigation to supplement the daily crop water needs. During the first 15 days in July, the sparse rainfall recorded was 1.9 inches; however, during the second half of the month, the cumulative rainfall recorded was 6.8 inches. The ambient temperature, minimum and maximum temperatures, increased from May to August. In May, the maximum ambient temperature recorded was 84.8 $^{o}$F, and in August it was 94.5$^{o}$F.

To ensure adequate potassium for early crop development, 200 lbs of potash (0-0-60) per acre was applied during field preparation. During the growing season, sulfur was introduced as part of the nitrogen fertilization strategy, incorporated through UAN (28-0-0-5S) and granular urea, with sulfur contributing approximately 10% of the total nitrogen applied as Urea. This approach supported nitrogen and sulfur synergy, crucial for plant protein synthesis and metabolic functions. Zinc was applied (equivalent to 0.5 lbs. of actual zinc) during the herbicide application to mitigate potential micronutrient deficiencies. No fungicides were applied during the growing period.

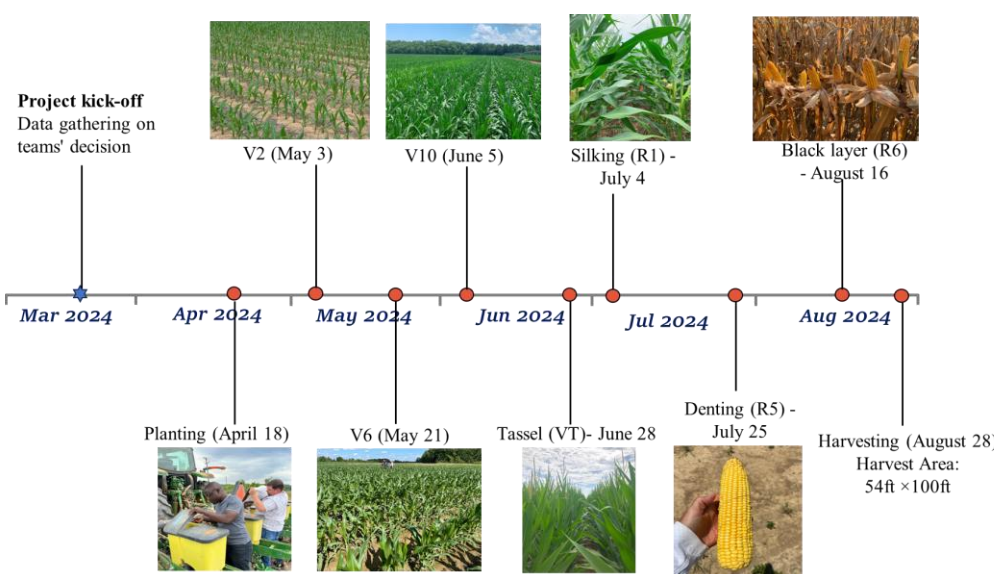


**Figure 5**. Sequence and dates of the major corn growth stages recorded from the TAPS plots from planting to harvest.

## 6. DESCRIPTION OF AWARDS

The competition had four cash awards:

1. Highest Net Return
2. Highest Input Use Efficiency (First placed)
3. Highest Input Use Efficiency (Second placed)
4. Highest Input Use Efficiency (Third placed)

The award was presented as a large-sized ceremonial check to the winners. Each award is described in detail below.

***Highest Net Return Award*** – The Award recognizes the team achieving the greatest net return per acre. Net return is calculated as the difference between total revenue and total costs. Since all teams operate under identical conditions and events, their individual management decisions ultimately determine their net return. Total revenue includes the income from bushels sold (calculated as bushels times the price received), plus all government payments, insurance indemnities, and any gains or losses from futures contracts. The average per-acre revenue is determined by dividing the total revenue by the number of acres. Total costs reflect all expenses incurred during the season as a result of each team's management decisions. Because all teams have the same number of acres, the team with the highest net return per acre (Figure 12) earns the Highest Net Return Award.

***Highest Input Use Efficiency Award*** – These awards recognize teams with the highest performance in input use efficiency, evaluated using weighted composite indices for Nitrogen Use Efficiency (NUE), Water Use Efficiency (IWUE), Agronomic Efficiency (AE), Crop Water Productivity (CWP), and Gran Yield. Each of the five variables was assigned an equal weight of 20% to calculate the Total Weighted Score. The Total Weighted Score was the sum of the weighted averages of the five variables for each team. Equations for the estimation of these variables can be found in Appendix B.

## 7. PARTICIPANTS

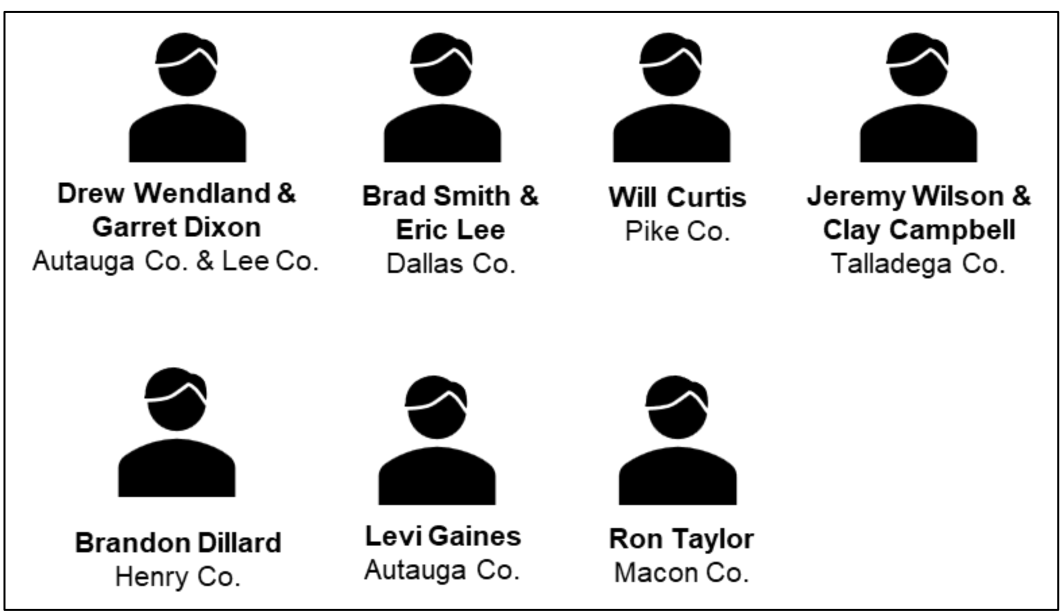


**Figure 6**. Participants for the AU-TAPS competitions in Alabama

## 8. PARTNERS AND SPONSORS


**Figure 7**. 2024 TAPS sponsors and partners. Funding to implement and execute the project and award the winner, as well as contributions including seed, technology, equipment installation, access to novel tools, and time, were received.

## 9. DECISIONS MADE BY THE 2024 TAPS TEAMS

The teams were responsible for making pre-planting and in-season crop management and economic decisions. Some of the decisions were submitted by the participants via Qualtrics surveys and others via text messages to the TAPS project coordinator. The decisions and resulting outcomes are summarized below.

### 9.1 Competition Data

In winter 2024 and early Spring, soil sampling on the TAPS field was done by Green Point Ag and SouthGen to assess soil nutrient levels and made recommendations for macro-nutrient application. Variable rate application of Lime, DAP 18-46-0, and MOP 0-0-60 was done before planting. This information was provided to the teams before planting. Leaf tissue samples were collected during the growing season and at harvest to measure nitrogen in the tissue and the grain. Drone images were collected in-season by SouthGen.

### 9.2 Agronomic Decisions

Teams were responsible for making six crop management and economic decisions. Frequent communications between the participants and the TAPS coordinating team were required to ensure the plots were managed according to the team's recommendations. The agronomic decisions made by the teams are summarized in Table 1.

***Hybrid Selection (decision type #1) and Seeding Rate (decision type #2).*** Although seven different hybrids from four major seed companies were offered to the teams, only four different hybrids were chosen by the teams for the competition. Five teams (B, C, E, F, and H) selected the same hybrid, DKC68-35 (Table 1). The DKC67-44 and DKC63-57 were chosen by Team D, and A, respectively, and Team G chose the

DynaGro 58VC65 hybrid. The seeding rates selected by the teams ranged from 27,500 to 36,000 seeds/acre. All the plots were planted on April 18th, 2024.

***Crop Insurance (decision #3).*** Four different crop insurance packages were offered to the teams. Team A chose Yield Protection with buy-up coverage. Teams B, C, and D selected Revenue Protection, specifying coverage levels in 5% increments from 50% to 85%. Teams E, F, and G chose Yield Protection with catastrophic coverage only.

***Nitrogen Management (decision #4).*** The total nitrogen fertilizer applied by the teams, excluding the control (Team H), ranged from 211 to 310 lbs N/ac (Table 1). On average, the Teams applied 25% of the total nitrogen at planting, except Team A which applied 60% of the nitrogen at planting. At the V6-growth stage (side-dress nitrogen application), most teams applied 36% of the total nitrogen except Team F which applied 74% of the remaining nitrogen as side-dress, and Team A which chose not to apply any nitrogen. All teams except Team F chose to apply nitrogen at the V10 growth stage, with rates that corresponded to 23% to 62% of the total nitrogen (Table 1). Teams A, B, F, and G chose to apply the fertilizer APP 11-37-0 at planting, however, because some of the rates selected were high and the application of the product was expensive, the TAPS teams decided to apply a maximum rate of 30 lbs N/ac using 11-37-0 and the remaining nitrogen was applied using UAN – 28% 23 days after planting (May 11, 2024) which corresponded with the V2 growth stage (Table 1). Teams C, D, and E chose granular NPK 19-19-19 as their starter N source, which was applied six days after planting. The control plots, Team H, only received 13 lbs N/ac of 11-37-0 and no additional nitrogen fertilizer was applied throughout the growing season. All teams except Team A, applied nitrogen at the V6 growth stage. Teams B, F, and G chose UAN – 28% as their nitrogen source, and Teams C, D, and E chose Urea – 40% (Table 1). The third nitrogen application was done using UAN – 28%. Nitrogen recommendations for the final application were provided by Sentinel Fertigation, and teams were given the option to adjust their rates based on these recommendations. The Teams decided not to modify their choices. The summary of nitrogen management decisions is shown in Table 1. Leaf tissue samples were collected on May 21 (V5 growth stage) and June 3 (V10 growth stage), while crop biomass and grain samples were collected at harvest. These samples were analyzed for nitrogen content, and the data collected at harvest was used to estimate crop nitrogen uptake. Due to differences in nitrogen source, rate, and timing of application as chosen by the teams, different equipment was utilized for the nitrogen application. The liquid application of 11-37-0 at planting was done using the LMC 6-row coulter applicator attached to the planter. At the V6 growth stage, the coulter applicator was upgraded with the 360 Y-DROP® Sidedress system to increase the liquid nitrogen application efficiency. A Chandler fertilizer spreader, 54 feet wide, was used for the granular Urea application. A John Deere R4030 sprayer, 60 feet wide, outfitted with 42 inches drops was used for the liquid UAN 28% application at the V10 growth stage. A detailed list of all Precision Agriculture technologies used for input applications is provided in Appendix A.

***Water Management (decision #5).*** Due to issues with the variable rate irrigation system, irrigation only began on June 13, 2024. The final irrigation event took place on July 19, 2024, as frequent rainfall events in late July and the first week of August reduced the need for additional irrigation. Corn reached physiological maturity around the first week of August 2024. When irrigation was prescribed by the teams during weeks with significant rainfall, either irrigation was not applied, or the irrigation rate was adjusted based on the rainfall amount. Seasonal irrigation totals ranged from 5.6 to 8.2 inches (Table 1). Among the irrigation scheduling tools selected, we reported that Teams A, D, and G used the Smart Irrigation CropFit App, Teams B and E used the AquaSpy® sensor, and Teams C and F utilized the Sentek soil sensor. The TAPS coordinating team recognizes the need for additional training on the use of irrigation scheduling tools in future years to ensure that farmers and consultants can fully leverage these tools and adjust irrigation effectively. Figure 8 illustrates the various irrigation rates prescribed by the teams and applied using the variable rate irrigation system.

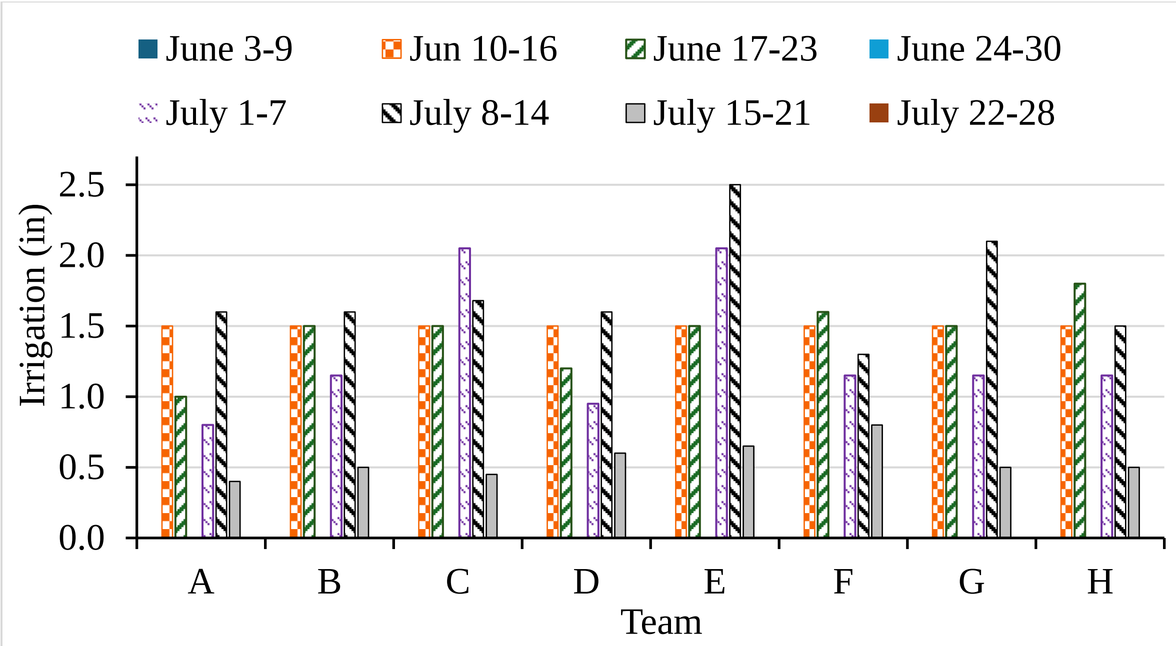


**Figure 8**. Weekly irrigation rates prescribed by the Teams in the competition.

**Table 1**. Summary of selected agronomic input as chosen by Teams.

| Team ID | Corn Hybrid | Seeding Rate (1,000/ac) | Nitrogen Fertilization* April 18 (APP) | April 24 (NPK) | May 11 (UAN) | May 24 (UAN) | May 31 (Urea) | June 13 (UAN) | Total | Irrigation (in) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | (Lbs. N/ac) | | | | | | | |
| A | DKC63-57 | 30 | 40 | 0 | 113 | 0 | 0 | 101 | 254 | 5.8 |
| B | DKC68-35 | 35 | 13 | 0 | 0 | 80 | 0 | 154 | 247 | 6.3 |
| C | DKC68-35 | 36 | 0 | 60 | 0 | 0 | 120 | 122 | 302 | 7.2 |
| D | DKC67-44 | 32 | 0 | 50 | 0 | 0 | 100 | 101 | 251 | 5.6 |
| E | DKC68-35 | 36 | 0 | 100 | 0 | 139 | 0 | 71 | 310 | 8.2 |
| F | DKC68-35 | 34 | 40 | 0 | 30 | 202 | 0 | 0 | 272 | 6.4 |
| G | DynaGro 58VC65 | 27.5 | 40 | 0 | 62 | 53 | 0 | 56 | 211 | 6.8 |
| H** | DKC68-35 | 34 | 13 | 0 | 0 | 0 | 0 | 0 | 13 | 6.5 |

*APP – Ammonium Polyphosphate applied at planting; UAN – Urea Ammonium Nitrate; NPK – 19-19-19; Urea – 40%N. Note: The corn crop was planted on April 18, 2024.
** Control nitrogen treatment.

## 10. RESULTS

### 10.1 Grain Yield

Most Teams achieve grain yields of above 150 bu/ac with nitrogen application between 200 – 300 lbs/ac and irrigation ranging from 5.5 – 8 inches. The grain yield data should be carefully analyzed, especially if the interest is to compare among the teams as there are differences in corn hybrids, seeding rates, irrigation rates, nitrogen sources, rates, and timing of application. Preliminary data analyses showed that nitrogen management explained 50% of the variability in yield while irrigation only explained 15%. The variations in yield among Teams suggested possible interactions among hybrid type, nitrogen source, as well as the nitrogen rate and timing of application. One example of the possible influence of corn hybrid genetics was observed when the crop management strategies of Teams E and G were compared. Team E chose to plant the DCK68-35 with a seeding rate of 36,000 seeds/acre and Team G selected the DynaGro 58VC65 with a seeding rate of 27,500 seeds/acre. The total nitrogen rate applied by Team G was 32% lower than Team E; however, the yield of Team G was only 8.6 bu/ac lower than Team E. Because four teams planted the corn hybrid DKC68-35 and the seeding rates were similar, some basic comparisons among teams B, C, E, and F could be done (Figure 9). Team F achieved the highest yield among all the teams, with a total nitrogen rate close to the average nitrogen applied by all teams. However, 70% of Team F's nitrogen was applied during the side-dress application (Table 1). Team E recorded the second-highest yield but applied the highest rates of both nitrogen and water among all teams. Teams C and E achieved corn yields of 174 bu/ac and 184 bu/ac, respectively with Team C applying only 10 lbs N/ac lower than Team E but using different sources of nitrogen (Table 1). In summary, the teams with the highest yields were F, E, and G (Fig. 9) respectively. These results highlight the key role of hybrid selection, nitrogen management, and irrigation in maximizing grain yield while also emphasizing opportunities to optimize input efficiency.

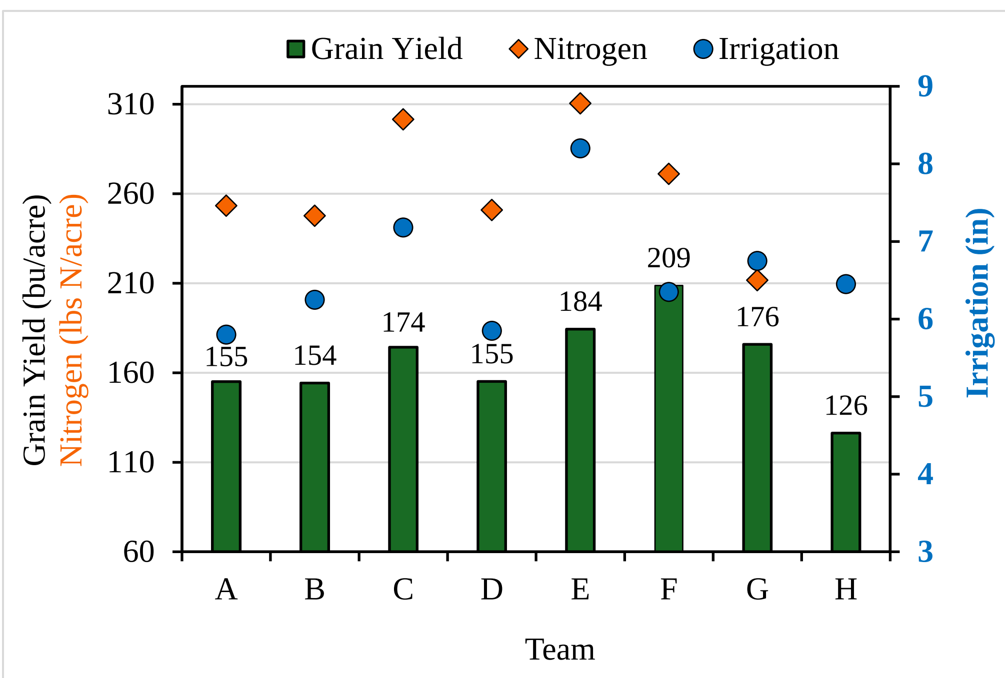


**Figure 9**. Grain yield differences among the 2024 TAPS teams and their total nitrogen and irrigation management decisions.

### 10.2 Input Use Efficiency

The Nitrogen Intensification Performance Index (NIPI) (Lo et al., 2019), was used to quantify nitrogen use efficiency as shown in Table 2. This index compares the effect of nitrogen on grain yield relative to a control treatment, serving as a baseline to measure the impact of additional nitrogen fertilizer. The competition control treatment, Team H, applied only 13 lbs N/ac and produced 126.3 bu/ac. Team F demonstrated the highest nitrogen efficiency with an NIPI of 0.23 (Figures 10, Table 2), applying 271 lbs N/ac and 6.4 inches of irrigation water to achieve a yield of 209 bu/ac. This team exclusively used liquid nitrogen forms, with 70% of the total nitrogen applied during side-dress. The Agronomic Efficiency of Nitrogen (AEN) measures the yield increase per pound of nitrogen applied. Team F produced 4,614 lbs/ac more than the control, resulting in an AEN of 17 lbs grain/lb N, significantly higher than the competition average of 9.0 lbs grain/lb N (excluding the control). The teams with the highest AEN values were F, E, and C, respectively. However, when nitrogen use was evaluated using Nitrogen Use Efficiency (NUE) (yield achieved compared to total nitrogen applied), the top-performing teams were G, F, and B, respectively (Table 2).

Irrigation Water Use Efficiency (IWUE) evaluates yield relative to irrigation water applied. Team F achieved the highest IWUE of 727 lbs grain/inch water, far exceeding the overall average of 387.5 lbs grain/inch water (excluding Team H). The top-performing teams for IWUE were F, G, and E (Table 2). Regarding the Crop Water Productivity Index (CWP), which considers the crop yield per unit of total water used (irrigation + rainfall), the teams with the highest CWP values were F, G, and B, respectively (Table 3).

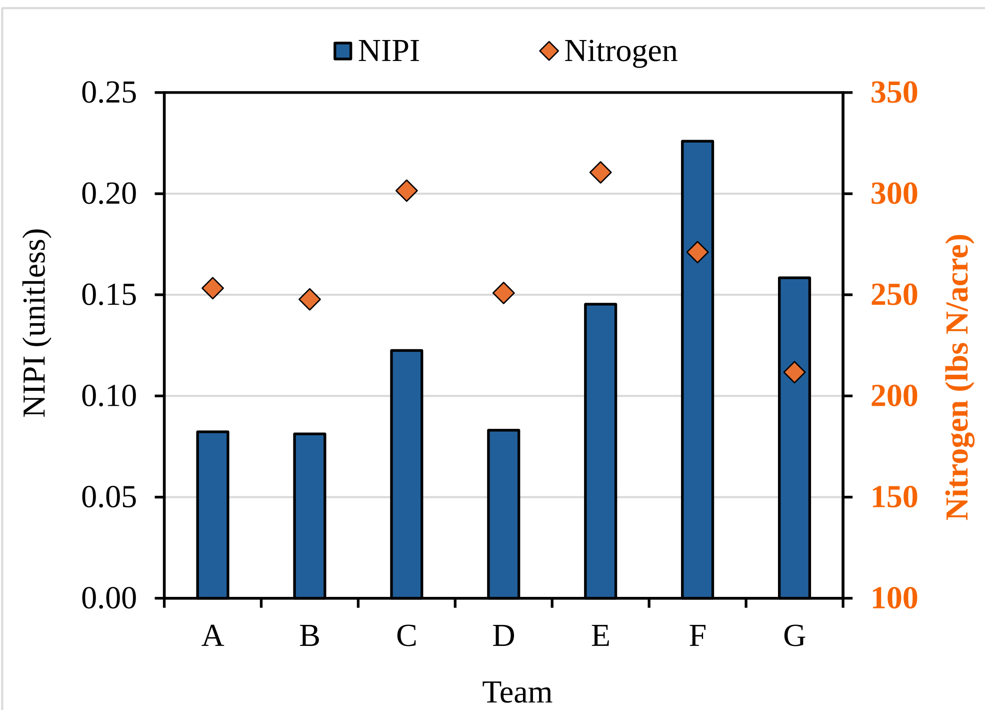


**Figure 10**. Team differences in the Nitrogen Intensification Performance Index (NIPI) and the total nitrogen rates.

**Table 2**. Summary of results from the 2024 TAPS competition

| Team ID | Grain Yield* (Bu/acre) | Gross Revenue ($/ac) | Marginal Cost ($/ac) | Net Return ($/ac) | AEN** (lbs/lbs) | NRE** (%) | IWUE** (lbs/in) | NIPI** (unitless) |
|---|---|---|---|---|---|---|---|---|
| A | 155.0 | 550.4 | 422.3 | 128 | 6.4 | 38.2 | 277.4 | 0.082 |
| B | 154.3 | 547.7 | 412.4 | 135.3 | 6.3 | 44.6 | 250.6 | 0.081 |
| C | 174.3 | 618.7 | 479.5 | 139.1 | 8.9 | 35.3 | 374.1 | 0.122 |
| D | 155.1 | 550.7 | 405.5 | 145.3 | 6.4 | 34.0 | 275.9 | 0.083 |
| E | 184.4 | 654.6 | 537.4 | 117.2 | 10.5 | 44.6 | 396.6 | 0.145 |
| F | 208.7 | 741.1 | 476.8 | 264.3 | 17.0 | 65.4 | 727.0 | 0.226 |
| G | 175.8 | 624.2 | 417.1 | 207.1 | 13.1 | 49.1 | 410.8 | 0.158 |
| H | 126.3 | 448.5 | 232 | 216.5 | 0.0 | 0.0 | 0.0 | 0.00 |

* Yield reported at 15.5% grain moisture content
**AEN – Agronomic Efficiency of Nitrogen; NRE – Nitrogen Recovery Efficiency; IWUE – Irrigation Water Use Efficiency; NIPI – Nitrogen Intensification Performance Index.

**Table 3**. Team differences in the efficiency of nitrogen, irrigation, and total water use.

| Team ID | Total N (lbs/acre) | Irrigation (in) | Total Biomass (lbs/ac) | Grain N Uptake (lbs/ac) | Stover N Uptake (lbs/ac) | Total N Uptake (lbs/ac) | NUE* (lbs/lbs) | CWP* (lbs/in) | Test Weight** (lbs/bu) |
|---|---|---|---|---|---|---|---|---|---|
| A | 253.3 | 5.8 | 18078 | 159.6 | 80.5 | 240.1 | 34.3 | 1129.9 | 58.3 |
| B | 247.7 | 6.3 | 18662 | 167.4 | 86.7 | 254.0 | 34.9 | 1134.4 | 60.0 |
| C | 301.5 | 7.2 | 19342 | 178.9 | 71.1 | 250.0 | 32.4 | 1112.9 | 60.2 |
| D | 250.9 | 5.9 | 16409 | 157.2 | 71.5 | 228.8 | 34.6 | 1022.4 | 59.8 |
| E | 310.5 | 8.2 | 20841 | 196.6 | 85.4 | 282.1 | 33.3 | 1132.7 | 59.8 |
| F | 271.1 | 6.4 | 24319 | 224.4 | 96.4 | 320.8 | 43.1 | 1469.4 | 60.2 |
| G | 211.7 | 6.8 | 19872 | 169.4 | 77.9 | 247.3 | 46.5 | 1172.4 | 59.5 |
| H | 13.2 | 6.5 | 14409 | 110.0 | 33.5 | 143.5 | 0.0 | 865.4 | 56.1 |

*NUE – Nitrogen Use Efficiency; CWP – Crop Water Productivity. Biomass, yield, and N uptake values are based on samples collected at harvest. Note: the yield on this table is reported in Lbs./acre as these values were used to the efficiency indices presented in this table. ** Grain moisture at 15.5%

## 10.3 ECOMONIC DECISIONS

Teams carefully selected Multi-Peril Crop Insurance (MPCI) policies to align with their risk management strategies. The options included Revenue Protection (RP), Revenue Protection with Harvest Price Exclusion (RP-HPE), and Yield Protection (YP). RP policies offered protection against lost revenue due to a decline in price and/or USDA RMA-covered yield loss, with coverage levels ranging from 50% to 85% of the defined Actual Production History (APH) yield, in increments of 5%. Additionally, RP guaranteed the higher of the projected or harvest price as part of the revenue guarantee. YP policies focused solely on protection against USDA RMA-covered yield loss, with coverage levels between 50% and 85%, and price protection ranging from 55% to 100% of the projected price. Catastrophic coverage (CAT) was also available under YP, covering 50% of the APH yield and 55% of the projected price.

Among the competitors, most teams prioritized minimizing cost by selecting YP at the CAT level, priced at just $0.655 per acre. Three teams opted for RP, balancing moderate coverage with cost. Two of the teams that selected RP chose 50% coverage at a cost of $11.24, while the third team chose RP at 70% coverage and a cost of $26.86 per acre. Higher coverage, while at a higher premium, does ensure more comprehensive protection against price and yield variability, showcasing a preference for higher financial security. The premium costs of the chosen policies were included in the teams' marginal costs, and any indemnities were factored into their revenues.

Overall, the diverse selection of policy options reflects a range of risk management strategies aimed at balancing costs and yield or revenue protection (Table 4).

**Table 4**. Crop Insurance Premiums by Coverage Level and Policy Type.

| | Premium per acre | | |
|---|---|---|---|
| Coverage Level | RP (Revenue Protection) | RP-HPE (Revenue Price - Harvest Price Exclusion) | YP (Yield Protection) |
| CAT | - | - | $0.655 |
| 50% | $11.24 | $10.18 | $9.60 |
| 55% | $14.33 | $12.88 | $12.07 |
| 60% | $16.82 | $14.98 | $14.01 |
| 65% | $22.60 | $19.78 | $18.61 |
| 70% | $26.86 | $23.15 | $21.80 |
| 75% | $35.88 | $30.74 | $28.90 |
| 80% | $50.83 | $43.61 | $41.11 |
| 85% | $74.04 | $63.63 | $60.21 |

All coverage options, except CAT, are shown based on a 100% projected price.

The Teams had access to soil analysis reports and were required to make strategic agronomic decisions such as:
Corn Hybrid Selection: Teams selected hybrids from options listed in Table 5, which ranged in cost from $244.00/bag (Dekalb 69-19) to $308.09/bag (Dekalb 67-44). Their choices influenced not only seed costs but also yield potential and disease resistance.

Seeding Rates: Decisions on seeding density directly impacted total seed costs and yield outcomes, with the per-seed cost detailed in Table 5.

**Table 5**. Corn Hybrid Costs.

| Corn Hybrid | Per Bag (80K seeds) | Per 1,000 Seeds |
|---|---|---|
| Croplan 5678 | $281.16 | $3.51 |
| Croplan 5893 | $280.00 | $3.50 |
| Dekalb 67-44 | $308.09 | $3.85 |
| Dekalb 68-35 | $302.72 | $3.78 |
| Dekalb 69-19 (replacing 63-57) | $244.00 | $3.05 |
| DynaGro 58VC65 | $301.90 | $3.77 |
| Pioneer 1847 | $267.88 | $3.35 |

Nitrogen Fertilizer Management: Teams selected from options such as 19-19-19 at $645/ton, 28-0-0-5 at $375/ton, Urea (40%) at $425/ton and 11-37-0 at $695/ton, as shown in Table 3. Decisions were made carefully considering both the cost per pound of nitrogen and the timing of application to optimize nitrogen efficiency and maximize the yield response while controlling costs. In addition to the fertilizer costs, each application included a sprayer application of $3.20 per trip, as listed in Table 6.

**Table 6.** Nitrogen Fertilizer Costs.

| Starter Nitrogen Fertilizer | Per Ton | Per Gallon | $/lb. |
|---|---|---|---|
| 19-19-19 (replacing 17-17-17) | $645.00 | | $0.32 |
| 28-0-0-5 | $375.00 | $2.083 | |
| Urea (40%) | $425.00 | | $0.21 |
| 11-37-0 | $695.00 | $4.16 | |

Irrigation Management: Teams determined irrigation needs based on soil analysis and weather conditions, balancing the operational cost of $9.00/inch of water applied (Table 7).

**Table 7.** Irrigation and Application Costs.

| Inputs | Unit | Cost |
|---|---|---|
| Irrigation operations | in | $9.00 |
| Sprayer application | trip | $3.20 |

### 10.3.1 Net Returns

Profitability refers to the ability of a business or activity to generate financial gain. In the context of crop production, it measures how efficiently a farm converts its costs (such as seeds, fertilizers, irrigation, and labor) into income from selling the crops. We do not calculate profitability for this competition because we have not estimated total cost of production. Instead, we focus on net returns, which represents the amount of revenue that can be allocated to additional costs that are not estimated. Net return is thus calculated as:

$$\text{Net Return} = \text{Gross Revenue} - \text{Marginal Cost}$$

A higher net return indicates that the farm has more residual revenue remaining to allocate to other costs of production not included in the marginal cost calculation.

The Marginal Cost is calculated by summing all input costs per acre that are related to the team decisions. This includes expenses for crop insurance, seeding, fertilizer, irrigation, and sprayer applications. In this context, only costs that can differ between teams are computed as follows:

Marginal Cost = Sum of all team decision input costs (per acre)

The Gross Revenue is determined by adding the revenue from crop sales per acre to any additional sources, such as crop insurance indemnity payments, if applicable:

Gross Revenue=Revenue from Crop Sale (per acre) + Crop Insurance Indemnity (if applicable)

Revenue from crop sales was determined based on the marketing decisions of the teams discussed in the next section. The performance of teams is depicted in terms of Gross Revenue and Marginal Cost in Figure 11 and Net Returns in Figure 12, highlighting the degree of variation in results. Team F stands out with the highest gross revenue ($741.08 per acre) and a moderate marginal cost ($476.80), resulting in the highest net return ($264.28). Similarly, Team E demonstrates strong gross revenue ($654.58 per acre); however, its high marginal cost ($537.35) reduces its profitability, leading to a net return of $117.23. Team C exhibits a balanced performance with gross revenue of $618.67 and a marginal cost of $479.54, yielding a net return of $139.13.

These findings underscore the importance of optimizing input costs to maximize net return and, ultimately, profitability in crop production.

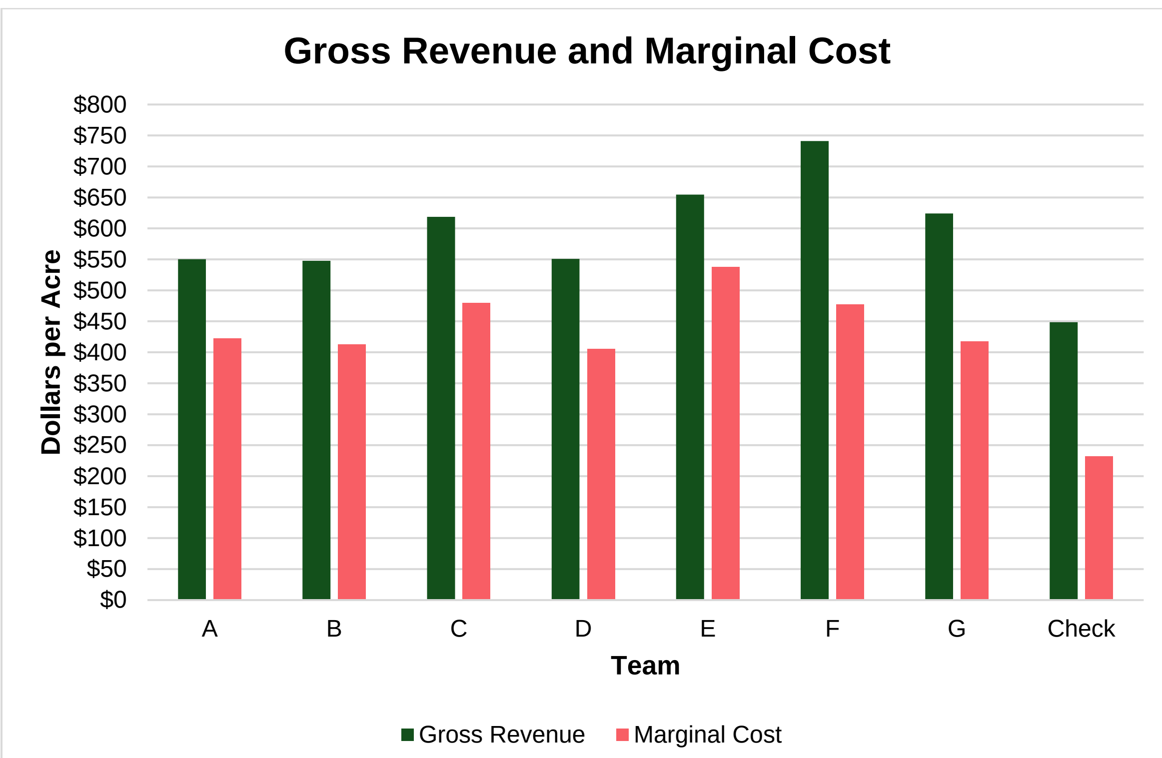


**Figure 11.** Gross Revenue and Marginal Cost

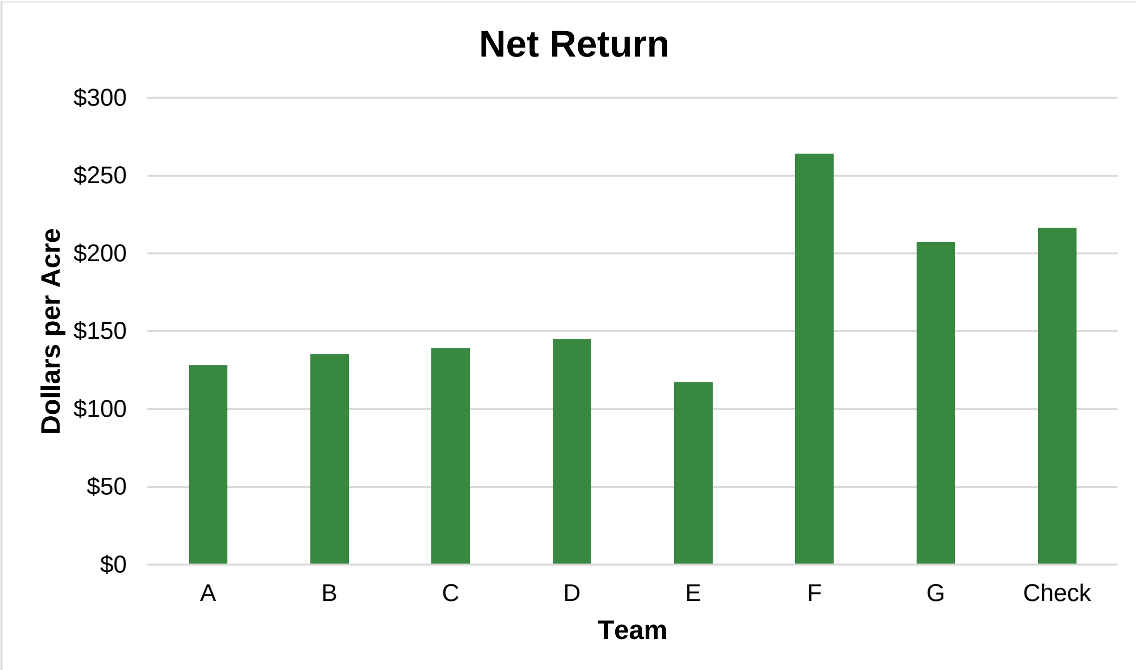


**Figure 12.** Net Return

### 10.3.2 Marketing

During the 2024 competition year there were no marketing decisions made by teams. All corn was sold at harvest based on the local cash price at the Agrex Inc., Montgomery elevator. Harvest occurred on August 28, 2024, when the local cash price, including basis, was $3.55 per bushel.

Alternative marketing options might have provided opportunities to secure a different price, thus we evaluated a hypothetical marketing performance of the teams based on three distinct scenarios, considering two marketing plans and a best-case “crystal ball” scenario. The marketing plans simulated that Teams sold 1/3 of their insured production on the first trading day of each month from April to June for delivery at harvest. The strategies analyzed were forward contracts, where the price is locked in advance, and hedge-to-arrive (HTA) contracts, where only the futures component is locked in while the basis is determined at harvest. The "crystal ball" scenario assumes that teams perfectly forecasted their production and marketed all of it at the highest available price during the growing season.

The basis improved from -$0.25 to -$0.10 between June and August, making the HTA strategy more advantageous in terms of the final price. The crystal ball scenario indicated that if all production had been marketed on May 13 using an HTA contract, the final price would have reached $4.72 per bushel.

Figure 13 illustrates the average prices achieved by teams A through G under four different marketing strategies, including Actual (harvest) Price, Forward Contract Marketing Plan, HTA Marketing Plan, and Crystal Ball simulations. Teams B, C, and D achieved higher average prices due to their selection of higher crop insurance coverage. This was because the higher crop insurance would have allowed them to sell a greater portion of their harvested grain in the pre-harvest period, at a higher price point. The harvest price was $3.55, while the highest price of $4.72 was recorded on May 13, 2024. The average price during the April-June period was $4.31.

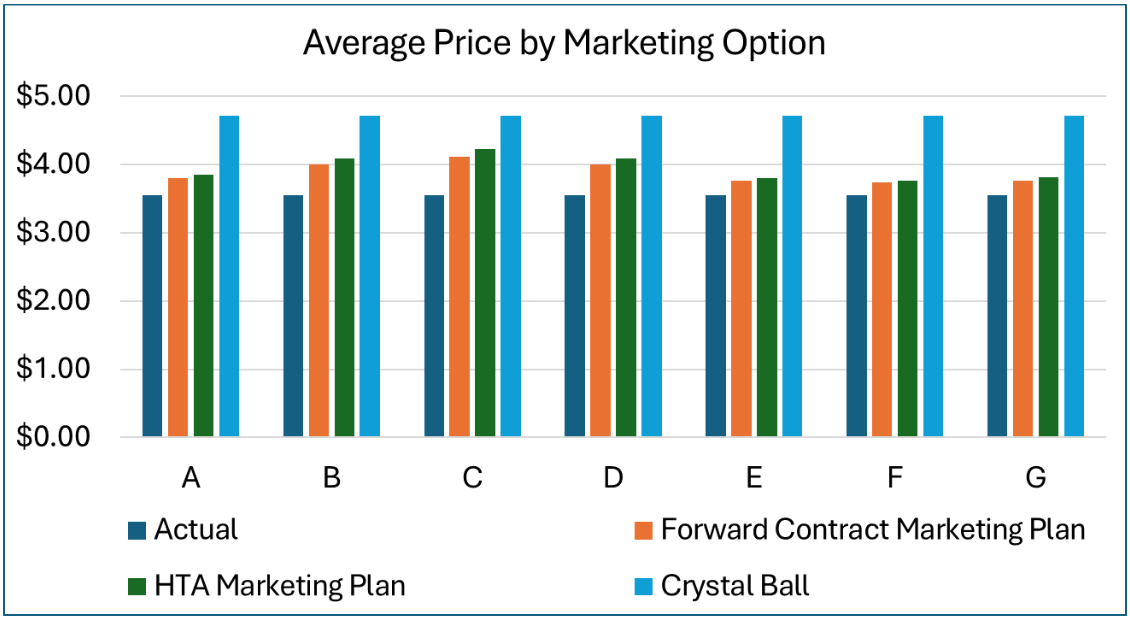


**Figure 13.** Average Price by Marketing Option

For marketing purposes, we assumed 1,000 acres of production. Figure 14 illustrates revenue differences based on actual yield harvested for 1,000 acres for teams A through G. This highlights the significant impact of both yield variations and marketing strategies on total revenue. On average, the Forward Contract marketing plan would have increased teams' revenues by $56,000 and the HTA by $67,000. Teams that would have effectively combined higher yields with strategic marketing approaches achieved greater revenue growth compared to marketing all production at harvest.

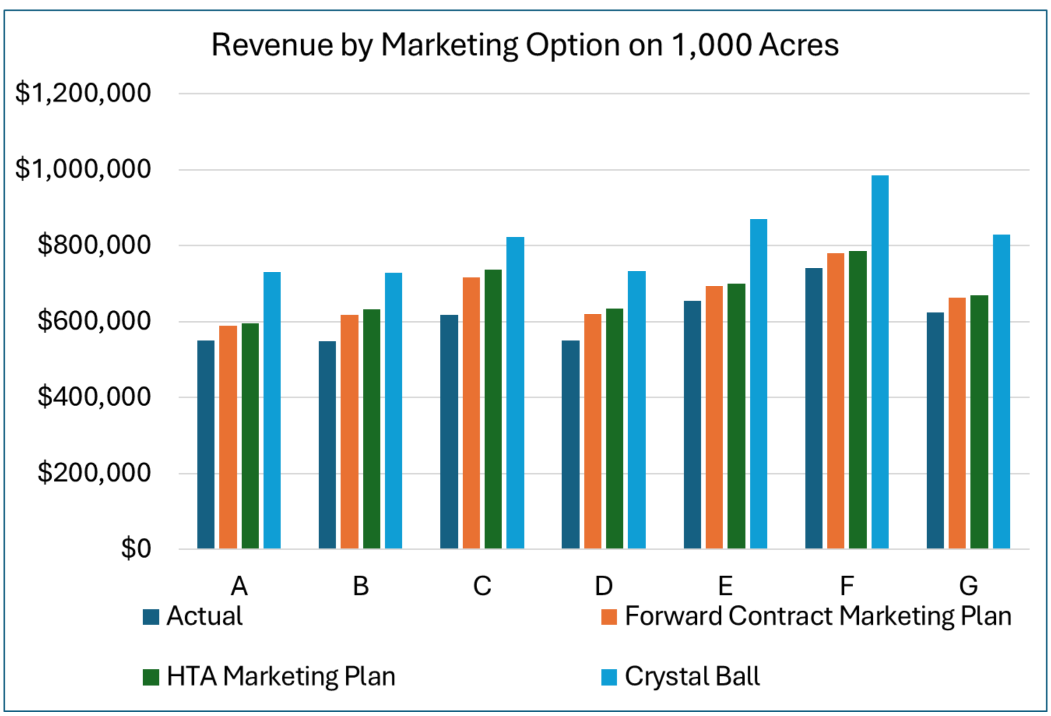


**Figure 14.** Revenue by Marketing Option on 1,000 acres

Figure 15 shows net returns based after subtracting marginal costs from the total revenue under each marketing option. Team F consistently comes out on top, having successfully managed yield growth with decision costs. The Forward Contract and HTA marketing plan options do provide opportunities for increased net returns, as shown by the relative improvement in performance of team C under these scenarios.

Overall findings from this marketing simulation emphasize the importance of pairing yield optimization with effective marketing strategies to maximize net returns and profitability, demonstrating the substantial financial benefits of adopting a time-driven marketing plan.

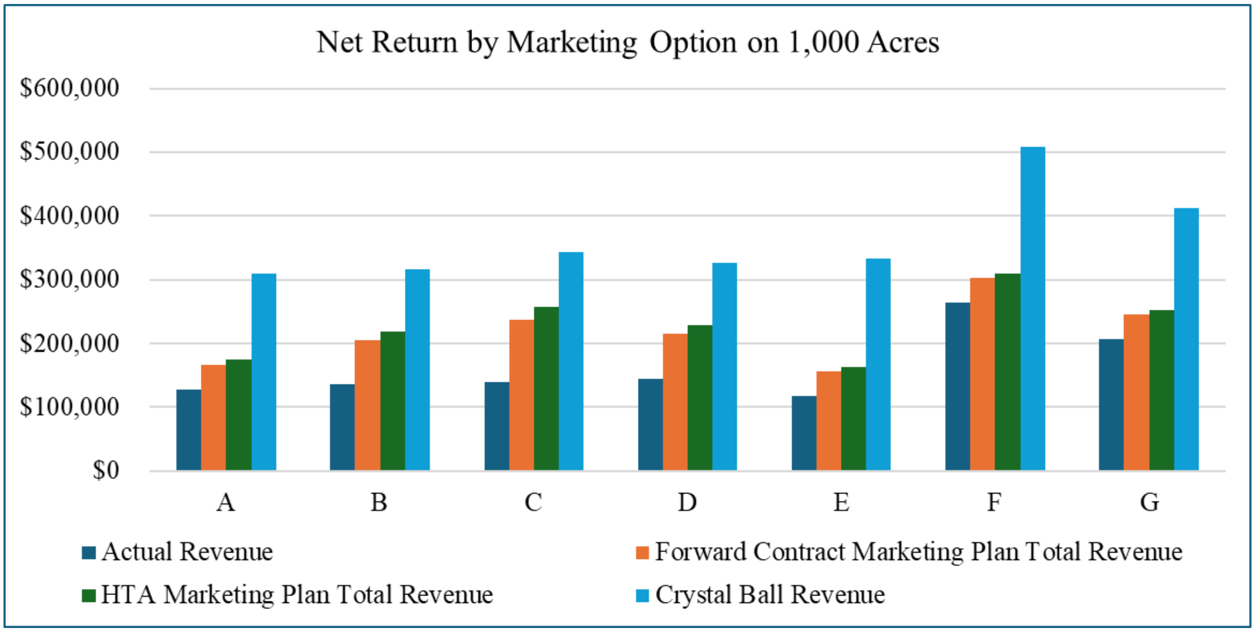


**Figure 15.** Net Return by Marketing Option on 1,000 acres

## CONCLUSIONS

The inaugural year of the TAPS project in Alabama provided numerous opportunities to collaborate with farmers, crop consultants, and industry representatives in testing different crop management strategies, economic decisions, and technological solutions to advance agricultural production. While challenges arose during the implementation of a project of this scale for the first time, the lessons learned will inform improvements for next year's competition. As we look ahead to future competitions and the expansion of TAPS, our focus remains on leveraging the wealth of data generated to uncover better practices and implement cutting-edge ideas and technologies. The TAPS coordinating team deeply appreciates everyone who participated, supported, or engaged with the program. Congratulations to all involved in this year's success, especially the 2024 winners.

We welcome innovative ideas to enhance the project's impact and effectiveness. If you have a solution, tool, or concept that could be evaluated in next year's competition, we encourage you to share it with us. We extend our heartfelt thanks to the farmers and consultants who participated in the competition and to the personnel of the E.V. Smith Research and Extension Center – Farm Services Unit for their dedicated support. Our gratitude also goes to the private companies that provided technology or services to the TAPS project and to the students; undergraduate, graduate, visiting scholars, and research scholars whose collaboration made this project possible. This project could not have succeeded without your valuable contributions.

## FUNDING

The TAPS program was established through the commitment and support of our participants, partners, and sponsors (Figures 6 and 7). The 2024 competitions were funded by grants from the Wheat and Feed Grain Committee of ALFA and the Alabama Soil and Water Conservation Committee. Partial funding was also provided by the USDA-NRCS Conservation Innovation Grant under award number USDA-NR203A750013G016. Recognition of the 2024 TAPS winners was generously supported by the Economic Development Partnership of Alabama.

### REFERENCE

Lo, R. A., et al. (2019). Nitrogen Intensification Performance Index: A metric for nitrogen use efficiency. Agronomy Journal, 111(3), 123-132.

USDA-NRCS. (2024). Altavista silt loam soil classification report.

## APPENDIX

## Appendix A

**Table 8.** List of technologies used for the 2024 TAPS competition.

| Agronomic Practice | Equipment /Technology | Representative |
|---|---|---|
| Planting | John Deere 1700 six-row planter | SunSouth |
| | Planter retrofitted with Precision Planting Technology | |
| | * vSet Select | |
| | * vDrive | Vantage South |
| | * Delta Force | |
| | * Smart Firmer | |
| | 20\|20 Display | |
| Nitrogen application | LMC coulter for liquid application | |
| | Chandler spreader, 54 feet wide | |
| | InCommand 1200 (Ag Leader) display | InformedAG |
| | 360 Y-Drop | Vantage South |
| | John Deere, 4640 display-Gen4 (side-dress liquid application) | |
| | TeeJeet rate controller | |
| | John Deere R4030 sprayer, 60 feet | SunSouth |
| | John Deere 2630 display-Gen3 | |
| | In-season nitrogen recommendations and fertigation | Sentinel Fertigation |
| Irrigation | Valley Center Pivot Irrigation System with VRI - Zone control | Reid Bros Irrigation |
| Irrigation Scheduling | AquaSpy sensor | TriGreen |
| | Trellis soil water tension sensor | Trellis |
| | Senstek sensor | Simplot |
| | SmartIrrigation CropFit App | UGA |
| Crop Scouting | Drone imagery | SouthGen |
| Harvest | John Deere six-row grain combine | SunSouth |

**Appendix B**

***Equations for Estimation of Variables***

$$\text{N Uptake (lbs/ac)} = \frac{N_{Conc.}\ (\%) \times \text{Biomass (lbs/ac)}}{100}$$

$$\text{NUE (lbs/lbs)} = \frac{\text{Yield (lbs/ac)}}{\text{TN (lbs/ac)}}$$

$$\text{NRE (\%)} = \frac{NU_{Fert}\ \text{(lbs/ac)} - NU_{Control}\ \text{(lbs/ac)}}{\text{TN (lbs/ac)}} \times 100$$

$$\text{AEN (lbs/lbs)} = \frac{Y_{Fert}\ \text{(lbs/ac)} - Y_{Control}\ \text{(lbs/ac)}}{\text{TN (lbs/ac)}}$$

$$\text{NIPI} = \frac{((Y_{Fert} - Y_{Control}) \div Y_{Control})}{(ANU_{Control} + TN) \div ANU_{Control}}$$

$$\text{IWUE (lbs/in)} = \frac{\text{Yield (lbs/ac)}}{\text{Total Irrigation (in)}}$$

$$\text{CWP (lbs/in)} = \frac{\text{Total Biomass (lbs/ac)}}{\text{Irrigation (in) + Rainfall (in)}}$$

Where;
$Y_{Fert.}$ = Yield with fertilizer.
$Y_{Control}$ = Yield without fertilizer
$N_{Conc.}$ = Nitrogen concentration in the aboveground biomass
TN = Total nitrogen applied by the team.
$NU_{Fert}$ = Nitrogen uptake in the aboveground biomass with fertilizer
$NU_{Control}$ = Nitrogen uptake in the aboveground biomass without fertilizer
ANU = Aboveground nitrogen uptake in pounds/acre.
$ANU_{control}$ = Aboveground nitrogen uptake in pounds/acre estimated for the control treatment.