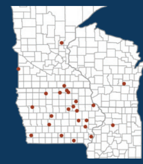
PRACTICAL FARMERS OF IOWA
COOPERATORS' PROGRAM Farmer-Led Research

EXPERIMENT



2025

Can We Reduce N Rates to Corn and Improve ROI?

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In a Nutshell:

- Twenty-four farmers performed 27 replicated strip trials testing their typical nitrogen (N) rate against that rate reduced by an amount of their choosing.
- 10 of the 24 farmers also compared their typical and reduced N rate application against a control with no N applied.
- Farmers chose to test N reductions ranging from 10-100 lb N/ac (reducing 10-62% of typical rate).
- Most farms have routinely used cover crops in the past five years (24), while some used a diversified crop rotation (2), applied manure (6), or incorporated grazing (2). Farms were predominantly in no-till with some occasionally including strip-till.

Key Findings:

- All sites experienced above-average temperatures in early spring (March-April) and again in early Fall (September-November).
- Most sites shifted to wetter-than-average conditions beginning in mid- to late July, with cumulative precipitation remaining above the 30-year average through August and into early fall.
- Nineteen of the 27 trials potentially saved money when reducing their N rates.

Aerial shot of N-rate strips in Kyle Spowart's field highlighting visual differences between nitrogen treatments. Photo taken July 2025.

Cooperators

Fred Abels (Holland, IA)
Alec Amundson (Osage, IA)
Jon Bakehouse (Hastings, IA)
Sam Bennett (Galva, IA)
Vaughn Borchardt (Fenton, IA)
Emery Davis (Solon, IA)
Michael Fosdick (Sperry, IA)
Robert Harvey (Redfield, IA)
Joshua Hiemstra (Brandon, WI)
Trent Johnson & Chad Olsen (Hendricks, MN)
Keaton Krueger (Ogden, IA)
Scott Lightly (Oakland, MN)
Adam Mayer (Saint Ansgar, IA)
Ross McCaw (Marengo, IA)
Ben Offenburger (Chariton, IA)
Lucas Olen (Mora, MN)
Matt Ollendieck (La Porte City, IA)
Jerry Ouverson (Fertile, IA)
Kevin Prevo (Bloomfield, IA)
Don Putz (Cedar Falls, IA)
Jeff Schmitt (Holy Cross, IA)
Larry Schott (Riverside, IA)
Kyle Spowart (Tripoli, IA)
Chris Von Holten (Walnut, IL)

Funding

FFAR

BACKGROUND

The 2025 round of nitrogen fertilizer rate trials builds on key questions first explored when the project began in 2022: Can farmers reduce nitrogen (N) rates while maintaining corn yields and profitability? [1], [2], [3]. The current set of trials, initiated in 2024 in preparation for the 2025 growing season, involved farmers across Iowa, Illinois, Minnesota and Wisconsin. Most participating farmers reported using soil-health promoting practices for at least five years. Using replicated strip-trial designs, they compared yields, financial outcomes and greenhouse gas emissions at their typical N rate with outcomes at a reduced rate of their choosing. A major intent of the project is to encourage farmers to test N rates outside of their usual comfort zones.

As in the 2024 growing season, the 2025 trials included strips receiving no applied nitrogen (0) to serve as a true control [3]. This zero-nitrogen benchmark improves understanding of how much yield comes from soil-supplied N versus fertilizer inputs. Including the 0N treatment also strengthens the experiment by helping farmers better interpret the effects of their typical and reduced N rates [4].

If farmers maintain yields and/or reduce costs at the lower N rate, these findings may build confidence to reduce – or at least reevaluate – their fertilizer rates in the future. Conversely, if reducing N results in lower yields and reduced profitability, farmers still gain valuable information: they can be more confident that their current N rate is appropriate for their farm. However, adoption of long-term soil health–building practices may create opportunities to safely reduce N rates in the future. “I need proof to make an educated decision in regards to nitrogen applications”, said Jeff Schmitt at the onset of the trial.

METHODS

Design

Cooperating farms in 2025 were located across Iowa (19), Illinois (1), Minnesota (3) and Wisconsin (1). All treatments were applied at least four times, resulting in a total of at least eight strips in each farmer’s trial (**Figures 1 and 2**).

Fifteen farmers used two-treatments:

1. Typical – Their typical N fertilizer rate applied to a corn crop.
2. Reduced – An N fertilizer rate less than the typical rate.

Seven farmers used three treatments:

1. Typical – Their typical N fertilizer rate applied to a corn crop.
2. Reduced – An N fertilizer rate less than the typical rate.
3. 0N – No applied N fertilizer or manure

Two farmers tested both designs, running two different trials on their farms.

	TYPICAL	REDUCED	REDUCED	TYPICAL	REDUCED	TYPICAL	TYPICAL	REDUCED
STRIP	1	2	3	4	5	6	7	8
REP	1		2		3		4	

FIGURE 1. An example of a farmer’s treatment layout testing two nitrogen (N) fertilizer treatments for this trial. In 2025 strips were averaged 29 feet wide and 1,305 feet long, resulting in an average strip size of 0.85 acres.

Measurements

Farmers recorded the timing, type (chemical, organic), amount of N applied, and price per unit of N for each treatment. Corn yields were measured and reported by each farmer, along with the percent moisture of the harvested grain. All yields were converted to 15.5% moisture for this report. Additionally, most farmers reported approximate prices received per bushel of corn.

Data analysis

Note that more details on data analysis can be found in the Appendix Y. Detailed Methods section at the end of this report.

Weather

To provide context for the results, weather data was downloaded from the National Aeronautics and Space Administration (NASA) Prediction of Worldwide Energy Resources (POWER) project (https://power.larc.nasa.gov/) for each farmer’s trial.

Yields

For both the two-treatment and three-treatment (0N) designs, yield differences at each trial were assessed for statistical significance using a statistical model. The model tested for the effect of the N treatment, while accounting for possible natural yield gradients in the field and, in some cases, missing data. Significance was assigned using 95% confidence level threshold, meaning we are 95% sure the differences observed were ‘real’.

Finances

Nitrogen prices depend on several factors including the form of N, the timing of the purchase and the location of the purchase. Similarly, the price received for corn fluctuates throughout the year. Due to this variation, as well as the limited control farmers have over the price paid for N and the price received for corn, we used three price scenarios to compare financial outcomes of the typical and reduced N treatments: best-case savings, midpoint savings, and worst-case savings (**Table 1**). Using the data provided by the farmers, we took the lowest and highest farmer reported prices for the N source they adjusted to create their two rate treatments, and the lowest and highest reported prices received for corn – these values were used to construct the price scenarios.

A partial budget using a given price scenario was performed for each treatment. Costs were estimated as the amount of N applied in that treatment multiplied by the assumed N cost, which depended on the scenario (**Table 1**). If the yields of each treatment were statistically different, each treatment’s yields were used for corn revenue calculations. If there was no statistical difference in treatment yields, the overall mean yield for the trial was used for corn revenue calculations. Partial net revenue for each treatment was calculated by subtracting the costs (N applied multiplied by N cost) from the revenue (yield multiplied by corn price). The difference between partial net revenues for the ‘reduced’, ‘typical’ and ‘zero’ treatments were calculated and reported. A positive value therefore represents financial savings at the reduced N rate. This process was done separately for the three price scenarios.

	TYPICAL	REDUCED	0N	REDUCED	0N	TYPICAL	0N	REDUCED	TYPICAL	TYPICAL	0N	REDUCED
STRIP	1	2	3	4	5	6	7	8	9	10	11	12
REP	1			2			3			4		

FIGURE 2. An example of a farmer's field layout testing three treatments, including a control strip with zero N applied.

Greenhouse gas emissions

When a farmer reduces the amount of chemical N fertilizer applied to a field, two sources of greenhouse gas (GHG) emissions associated with crop production are avoided: the GHGs (expressed as carbon dioxide equivalents, CO_2e) released during fertilizer manufacturing processes, and the nitrous oxide (N_2O) released from the soil due to biological processes driven by N application. To convert N_2O to CO_2e, a 100-year time horizon was assumed based on intergovernmental Panel on Climate Change (IPCC) recommendations [5]. Over the period of 100-years, one pound of N_2O will have a forcing potential equal to 298 pounds of CO_2e [5].

The CO_2 released during fertilizer manufacturing was estimated using two values: (1) energy used to manufacture nitrogen fertilizers as reported from the 2022 GREET® (Greenhouse gases, Regulated Emissions, and Energy use in Technologies) model, developed by the Department of Energy's Argonne National Laboratory (58 MJ/kg N) [6], and (2) the amount of CO2e released per MJ of energy used as reported by the Environmental Protection Agency [7]. The avoided N_2O as a result of decreased N application was estimated using the IPCC methodologies for both direct and indirect agricultural N_2O emissions [8]. All above calculations can be simplified to a constant conversion factor: the pounds of N reduced per acre from the typical rate can be multiplied by 7.82 to get pounds of CO_2e avoided per acre.

The acres needed to reduce a given amount of N application to equate to the emissions generated by a single United States (US) vehicle were calculated using the EPA's estimates for vehicle emissions [9]. The EPA uses statistics to represent an average US gasoline vehicle (22 miles per gallon, driven 11,500 miles per year), and estimates the emissions from one vehicle using those values (estimated to be 10,141 lb CO_2e/year) [9].

TABLE 1. Summary of price scenarios constructed from N fertilizer costs and corn prices reported by farmers in 2025.

	DESCRIPTION	N COST	CORN PRICE RECEIVED
Best-case savings	Expensive N, low corn revenue	$1.16/lb N	$3.50/bu
Midpoint savings	Midpoint N, midpoint corn revenue	$0.80/ lb N	$4.37/bu
Worse-case savings	Cheap N, high corn revenue	$0.43/lb N	$5.25/bu

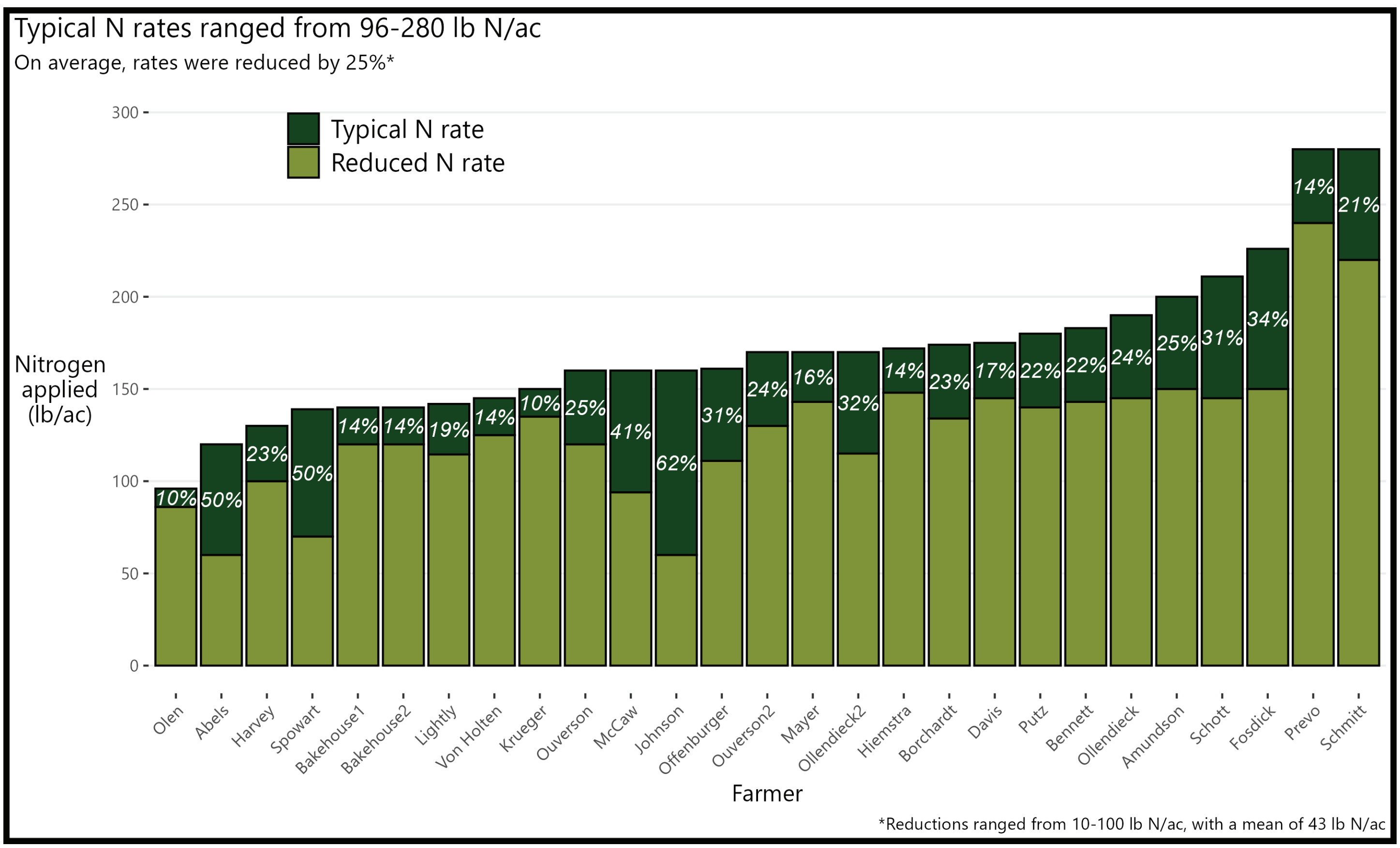


FIGURE 3. Twenty-seven trials tested two nitrogen (N) application treatments in the 2025 growing season. A cooperator's typical N rate (**dark green bar**), chosen reduced N rate (**light green bar**), and the reduction relative to the typical rate (white text). Ten of these 27 trials also included treatment strips in which no N was applied (0N, not pictured).

RESULTS AND DISCUSSION

Treatments

Twenty-four farmers conducted a total of 27 independent N trials. The chosen treatments reflected the diversity in farming systems, with typical N rates ranging from 96-280 lb N/ac and reduced N rates ranging from 60-240 lb N/ac (**Figure 3**). When averaged over all trials, typical and reduced N rate treatments were 171 lb N/ac and 128 lb of N/ac, respectively, for an average reduction of 43 lb N/ac.

Farmers used a variety of N application timings in their production systems, with most using sidedressing. For the reduced N treatment, 21 of the 27 trials chose to reduce N rates during sidedressing, while keeping other applications constant (**Table 2**).

Weather

All sites experienced above-average temperatures in early spring (March-April) and again in early Fall (September-November). Most sites shifted to wetter-than-average conditions beginning in mid- to late July, with cumulative precipitation remaining above the 30-year average through August and into early fall.

TABLE 2. Majority of farmers adjusted sidedress nitrogen applications for their reduced N rates in 2025.

TIMING	DESCRIPTION	USED	ADJUSTED
Fall	After crop harvest – Dec. 14	7	0
Winter	Dec. 15 – March 14	1	0
Pre-plant	March 15 – three days before planting	9	2
At plant	Two days before planting – one week after corn planting	15	2
Sidedress	Eight days after corn planting – corn canopy closure	23	21
Top dress	After corn canopy closure	3	2

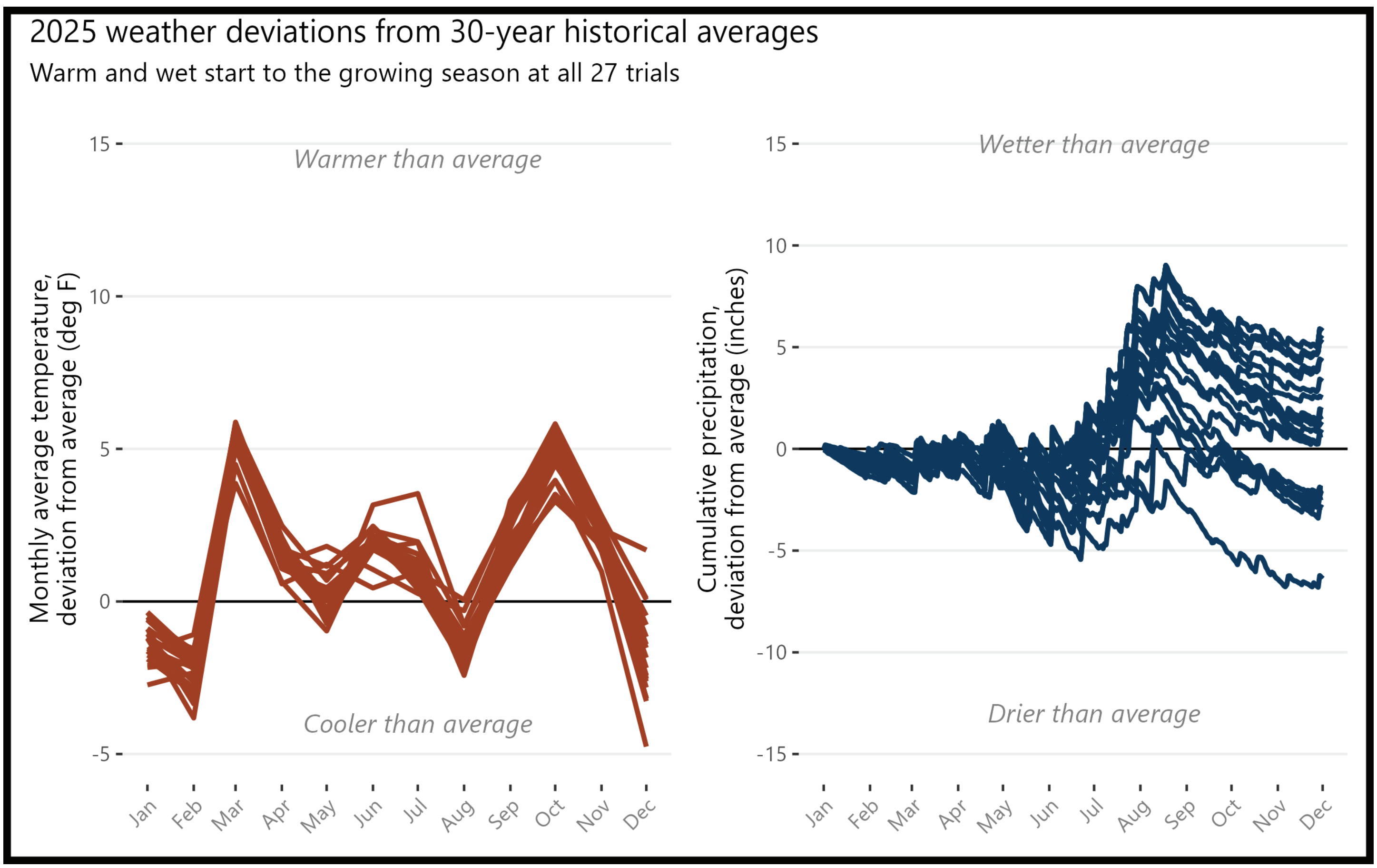


FIGURE 4. Individual cooperator site weather compared to 30-year historical averages for that site. (Left) Average **monthly air temperature** deviations and (right) **cumulative precipitation** deviations. Overall, although all sites experienced a warm start and wet growing season, the diversity in N application amounts, sources, methods, and timing as well as cropping systems history contributed to varied outcomes for each cooperator.

Yields

Sixteen of the 27 replicated strip trials (56%) saw statistically significant reductions in corn yields at the reduced N rate. However, it is important to note that statistical significance in yield declines is not related to financial outcomes (**Figure 5, left panel**). Statistical significance is a function of both the magnitude of the difference in treatments, as well as how variable the yields in the field were. It helps readers and farmers decide how much to 'trust' the yield changes, and therefore how to calculate financial outcomes. For example, Matt Ollendieck's reduced N treatment yielded 12 bu/ac less than his typical N treatment, and this reduction was statistically significant, so he can be confident that reduction was real. In contrast, Ben Offenburger's trial showed only a 2 bu/ac reduction at the reduced N rate, and this difference was not statistically significant. This indicates that yield variability among strips was greater at Ollendieck's site than at Offenburger's. While they may have different conclusions about the impact of the reduced N treatment on corn yields, they both saw potential financial savings at the reduced N rate (**Figure 5, right panel**).

The addition of a zero-nitrogen (0N) treatment this year, used by ten farmers participating in this research, provided further insights into nitrogen's role in corn production. Nine of the ten farmers experienced statistically significant reductions in yield when comparing their 0N with the typical N treatment. Yield declines at 0N treatment ranged from -34 to -116 bu/ac when compared to the typical N rate (**Table 3**). Financially, the 0N resulted in substantial revenue losses across nine trials, with midpoint ROI reductions ranging from -$22 to -$392/ac compared to the typical N rate. Despite the yield declines and revenue losses, the 0N provided valuable insights into the baseline productivity of these fields in the absence of synthetic nitrogen inputs.

Finances

The financial outcomes of reducing applied N varied by trial and price scenario (**Figure 5, right panel**). Eleven trials saved money in the reduced N treatment compared to the typical N treatment regardless of the price scenario (**Table 1**). An additional eight trials showed potential for savings under at least one price scenario. For example, Michael Fosdick saved $61/ac in the best-case scenario, $27/ac in the mid-point scenario, but lost $8 in the worst-case scenario. Eight trials lost money in every price scenario. In this set of trials, the worst potential financial loss observed was $159/ac (Lightly's worst-case scenario), and the best potential financial savings was $116/ac (Johnson's best-case scenario).

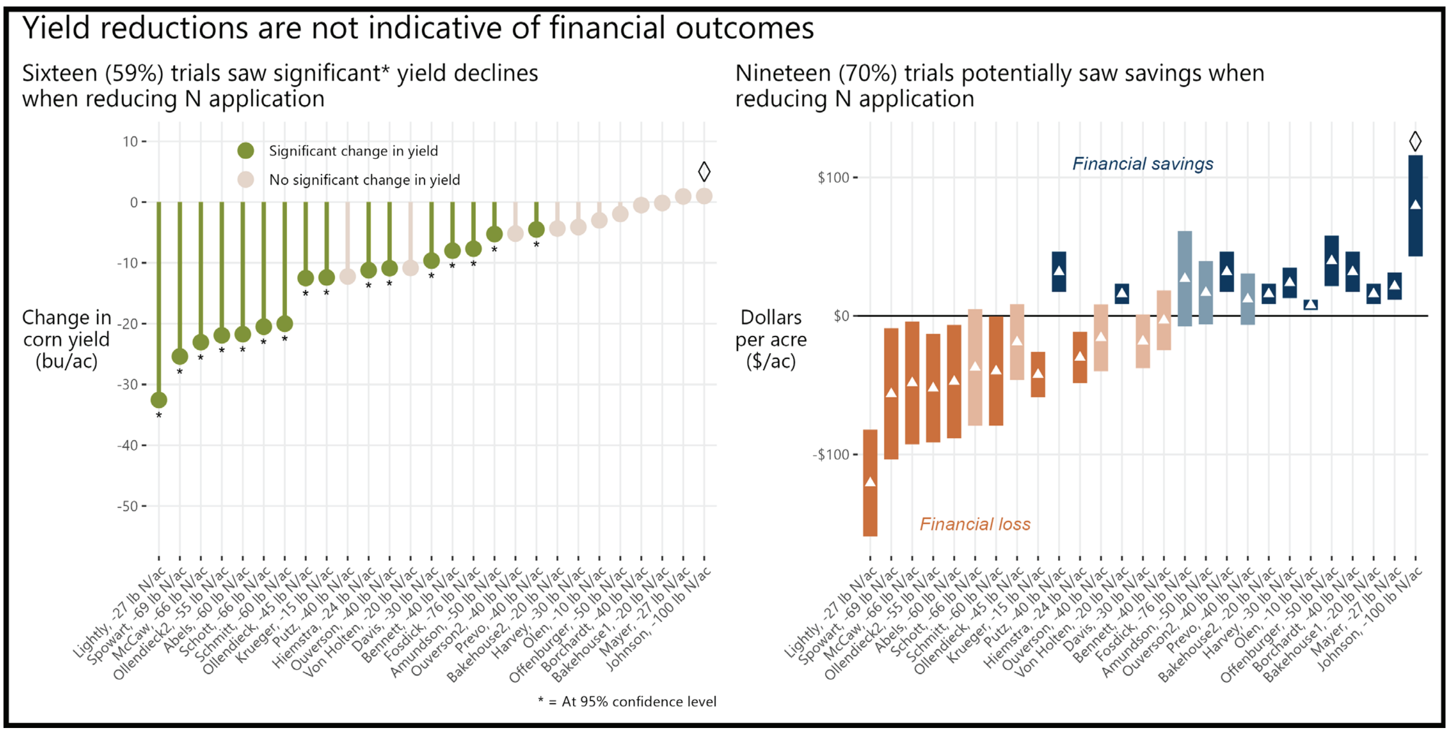


FIGURE 5. Impact of reducing N rates on corn yields and finances. The x-axis labels present each farmer and the amount they reduced their typical N rate to achieve the reduced N treatment (see **Figure 3**), ordered by their change in corn yield when reducing N rates. (*Left*) The y-axis presents the change in corn yields in the reduced N treatment relative to yields in the typical N treatment, with the color indicating whether the change was statistically significant (**green** with *) or not significant (**tan**). (*Right*) The x-axis presents the farmers, still ordered by their yield change, and the y-axis presents the financial outcome in the reduced N treatment relative to the typical N treatment assuming best-case (top of vertical bar), worst-case (bottom of bar) and midpoint 2024 price scenarios (**white triangles**). **Blue bars** indicate a financial savings in the midpoint price scenario, **orange bars** indicate a financial loss in the midpoint price scenario, and lighter colored bars indicate the financial outcome was sensitive to the price scenario considered.

◊Johnson's site received foliar applications of various nutrients and microbial products that could have influenced his results. See **appendix J** for more details.

TABLE 3. Impact of nitrogen treatments on corn yield and midpoint return on investment (ROI) across ten on-farm trials in 2025. Yield reductions in the 0N treatment were statistically significant (*) in nine of ten trials in 2025. The financial ROI followed a similar trend, with the 0N treatment resulting in substantial losses relative to both the typical and reduced N treatments.

	YIELD (bu/ac)			MIDPOINT ROI ($/ac)	
Farmer	Typical	Reduced	Zero	Reduced	Zero
Abels	177	-22*	-72*	-47	-218
Harvey	158	-4	-94*	+6	-308
Johnson	200	+1	+1	+80	+127
Lightly	231	-33*	-115*	-121	-392
Mayer	224	+1	-84*	+26	-244
McCaw	230	-23*	-34*	-48	-22
Ollendieck_2	177	-22*	-64*	-52	-145
Ouverson_2	222	-5	-116*	+9	-373
Spowart	219	-25*	-89*	-56	-277
Von Holten	256	-11	-69*	-32	-186

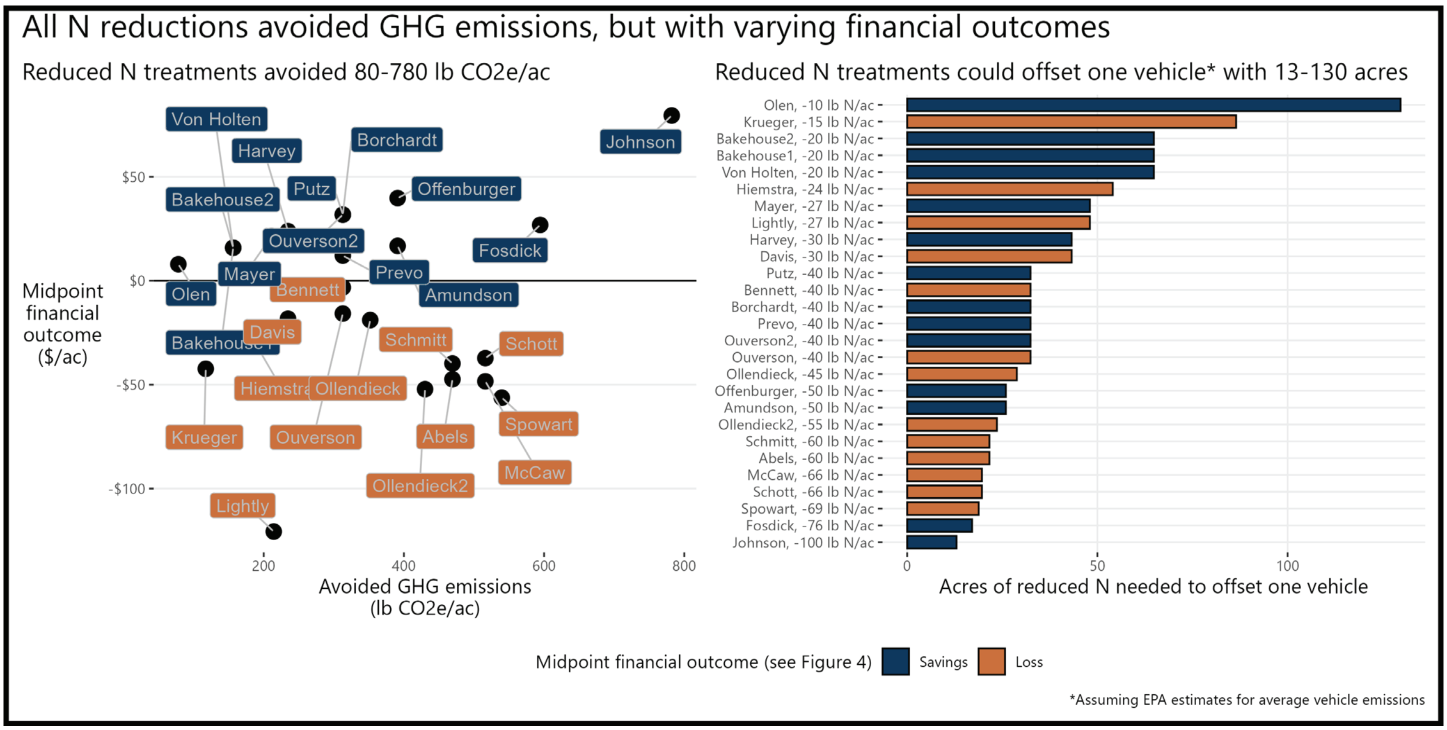


FIGURE 6. Thirteen farmers lost money while reducing GHG emissions, while fourteen farmers potentially saved money in 2025. *(Left)* All trials avoided GHG emissions and 14 of the 27 trials also saved money assuming mid-point price scenarios (**dark blue**), while 13 trials lost money in the mid-point price scenario (**orange**). *(Right)* Based on the Environmental Protection Agency [9] estimated GHG emissions for one average gasoline vehicle (22.2 miles per gallon, driven 11,500 miles per year), reducing N applications by 10-100 lb/ac would offset one vehicle's emissions if utilized on 13-130 acres.

Greenhouse gas emissions

Reducing N applications will always reduce GHG emissions associated with corn production. In 2025, avoided GHGs ranged from 80-780 lb CO_2e/ac. However, using midpoint price scenarios (**Table 1**), in fourteen trials those avoided emissions co-occurred with a financial savings, while in 13 trials the reduced GHG emissions came at a financial loss (**Figure 6, left panel**).

To put these avoided GHG emissions into perspective, one vehicle emits around 10,000 lb CO_2e/year [9]. Using each trial's selected N reduction, we back-calculated how many acres the farmer would need to apply their reduced N treatment to offset one vehicle. For example, Alec Amundson chose to reduce his typical N application by 50 lb/ac. Amundson could offset one vehicle's emissions by using his reduced N rate on 26 acres (**Figure 6, right panel**). Using his midpoint price scenario savings of $17/ac (**Figure 5, right panel**) he would potentially save around $440. However, if, for example, Emery Davis applied his reduced N treatment (30 lb/ac reduction) to 43 acres, he could offset one vehicle's emissions but also lose $18/ac, or around $770.

CONCLUSIONS AND NEXT STEPS

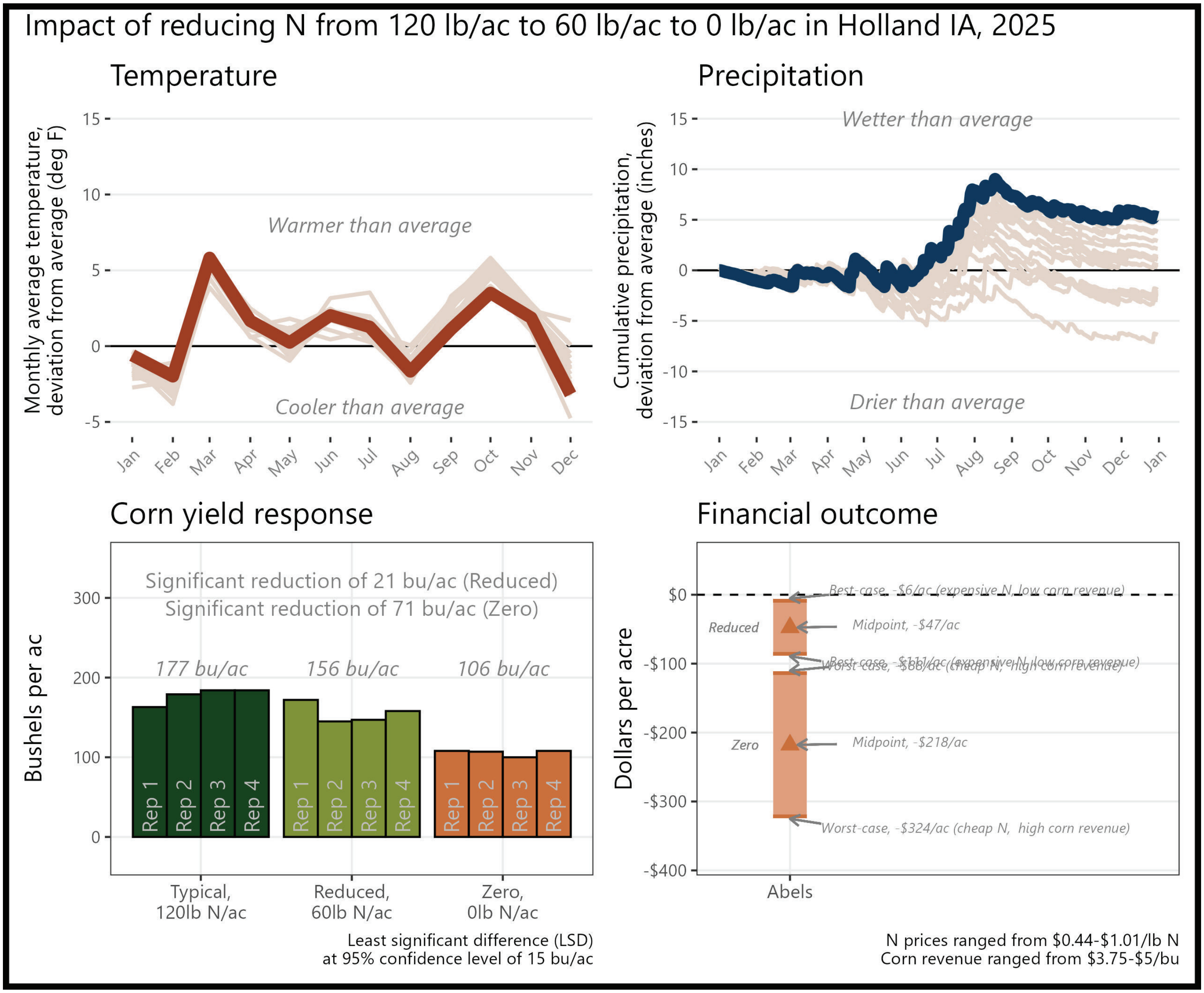
Of the 27 replicated strip-trials, nineteen potentially saved money in the reduced N treatment (any part of the bars above the zero line in the right panel of **Figure 5**). More specifically, eleven trials saved money under all three price scenarios, three trials saved money under best- and mid-point price scenarios, and five trials saved money only under the best-case price scenario. Eight trials likely lost money in the reduced N treatment under all price scenarios.

All trials avoided GHG emissions by reducing N fertilizer and 14 of the 27 trials could do so while also saving money under the mid-point scenario (**left pane of Figure 6**). To offset the emissions of a single vehicle, those farmers would have to apply their reduced N rate to 13-130 acres on their farms. That is a climate-smart win-win for farming and the environment.

The fourth year of the N rate trials builds upon prior findings, further evaluating the economic and environmental implications of reduced nitrogen (N) applications in corn production. Although weather variability and other uncontrollable factors continue to influence outcomes, ongoing data collection will strengthen our understanding of how soil health–building practices contribute to more resilient and sustainable corn systems across the Midwest. As participant Chris Von Holten noted, “By increasing the soil biologically I can lower my N rates and still maintain good yields.” Continued multi-year evaluation will allow us to better account for interannual variability and refine management recommendations, ensuring that conclusions are supported by a robust dataset rather than isolated seasonal conditions.

> "[From conducting this trial] you can see how good your land is, and practices that you do."

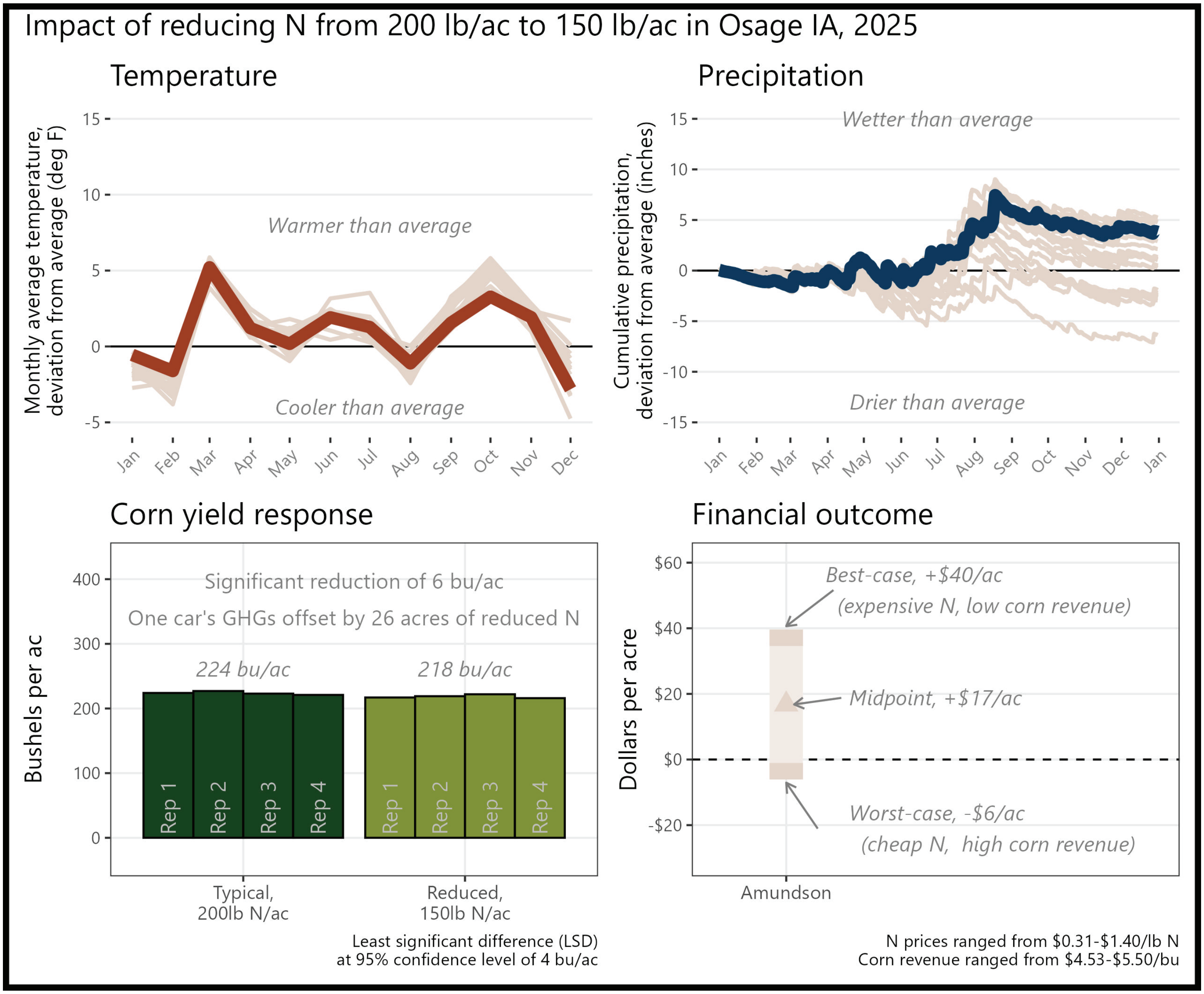
The financial outcome at both the reduced N rate and zero N rate resulted in a **financial loss** compared to the typical N rate. A reduction of 60 lb N/ac was likely too large this year, but there may be potential financial savings with a smaller N reduction. While considerable yield losses are expected when no nitrogen is applied, the 0N treatment is important for understanding the full impact of nitrogen on yield and profitability.



Historical cropping system (5 year):	No-till soybeans and corn; cereal rye cover crop
Previous crop:	Soybeans
Strip size:	0.81 ac
Corn planting/harvest date:	May 12/October 31
Corn row spacing/planting density:	30 in; 34,000 seeds/ac
Nitrogen sources and timing:	Chemical; Pre-plant, sidedress

"Nitrogen is a moving target, we need to continue to test and learn so we can manage it better."

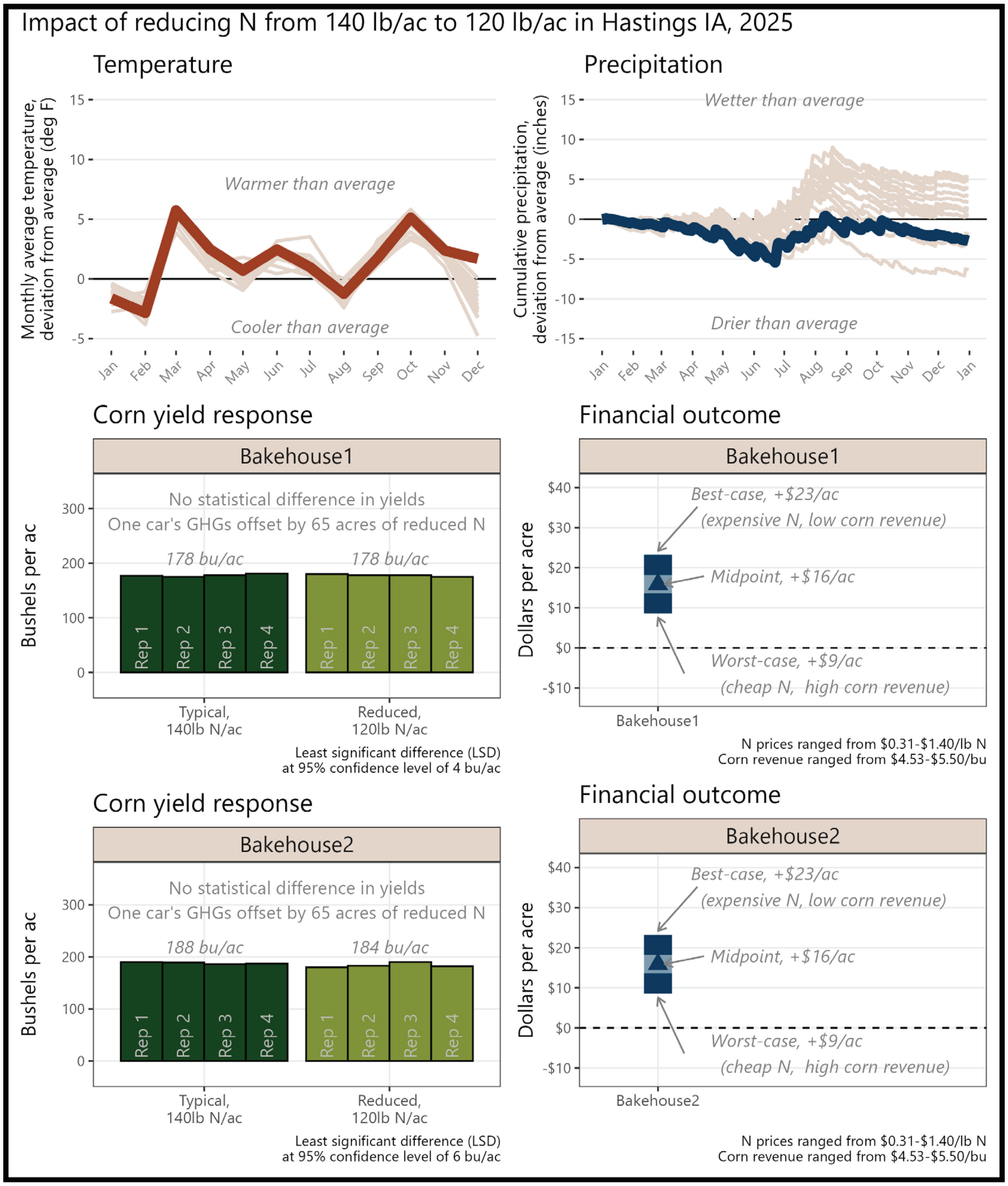
The financial outcome at the reduced N rate was likely a **financial savings** compared to the typical N rate. A 50 lb N/ac reduction saved money this year, and, when applied to at least 26 acres, could offset the average annual GHGs of one vehicle.



Historical cropping system (5 year):	No-till corn and soybeans; diverse mix and cereal rye cover crops
Previous crop:	Soybeans
Strip size:	2 ac
Corn planting/harvest date:	May 4/October 8
Corn row spacing/planting density:	30 in; 34,500 seeds/ac
Nitrogen sources and timing:	Chemical; Fall, At plant, sidedress, top dress

> "As we hone in on the best rates, the trials have given me confidence to trim them beyond what I may have been comfortable with."

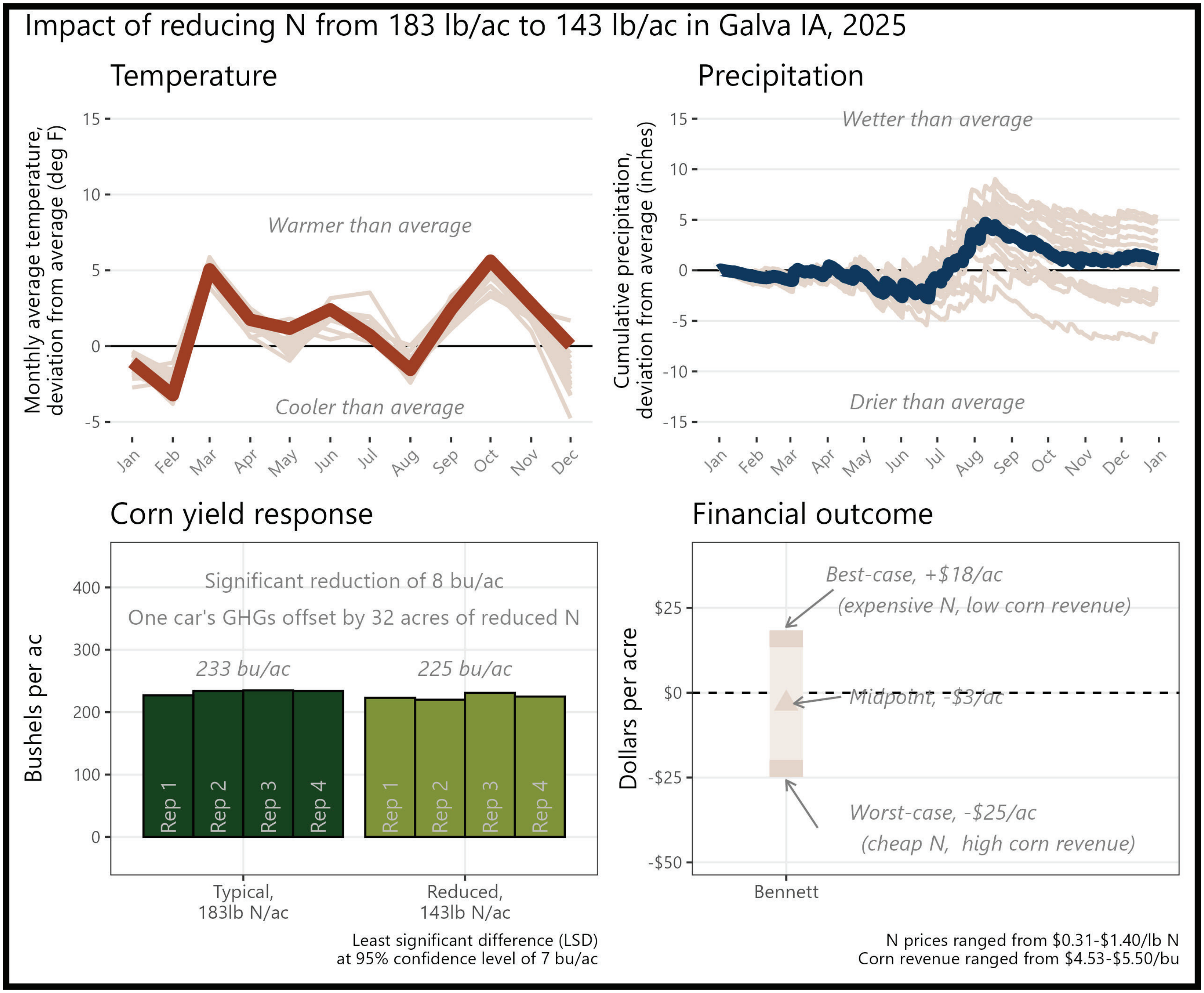
The financial outcome at the reduced N rate was likely a **financial savings** compared to the typical N rate in both trials. A 20 lb N/ac reduction saved money this year, and, when applied to at least 65 acres, could offset the average annual GHGs of one vehicle.



Historical cropping system (5 year):	No-till corn and soybeans; cereal rye cover crop
Previous crop:	Soybeans
Strip size:	1.45 ac (field 1) and 0.77 ac (field 2)
Corn planting/harvest date:	April 29/October 1
Corn row spacing/planting density:	30 in; 33,400 seeds/ac
Nitrogen sources and timing:	Chemical; Pre-plant, sidedress

"Adding a year of data to my own set of trials, as well as comparing the data of other repeat cooperators, helps me to gauge the weather year's effect on optimum N rate."

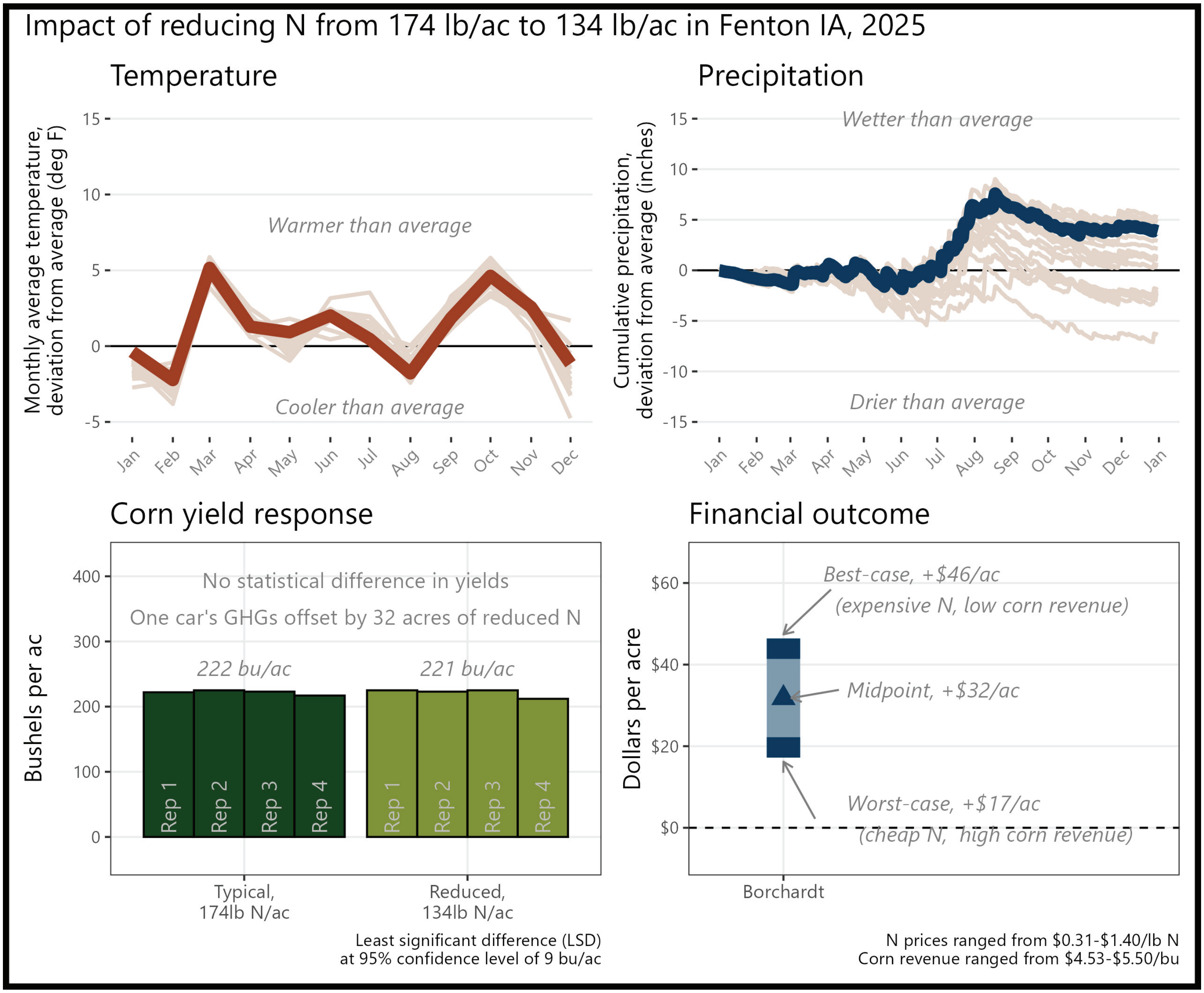
The financial outcome at the reduced N rate was likely a **financial loss**. A 40 lb N/ac reduction was likely too large this year, but a smaller N reduction could bring financial savings.



Historical cropping system (new field):	No-till corn and soybeans; cereal rye cover crop; chicken/turkey litter application
Previous crop:	Soybeans
Strip size	1 ac
Corn planting:	May 14/October 16
Corn row spacing/planting density:	30 in; 36,000 seeds/ac
Nitrogen sources and timing:	Organic – Fall; Chemical – At plant; sidedress

> "[The most valuable aspect of conducting this trial was] being aware of N rates on yields."

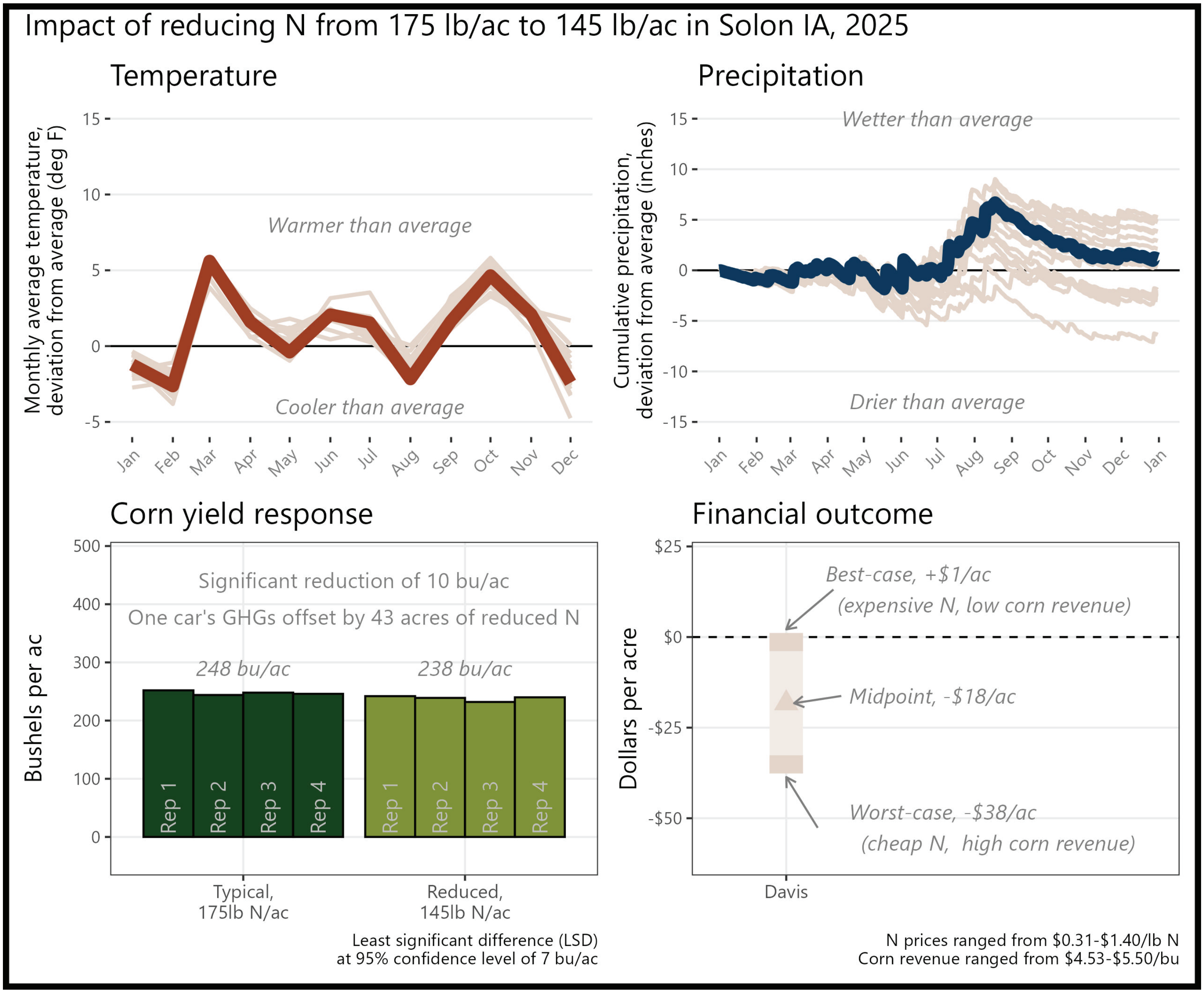
The financial outcome at the reduced N rate was likely a **financial savings** compared to the typical N rate. A 40 lb N/ac reduction saved money this year, and, when applied to at least 32 acres, could offset the average annual GHGs of one vehicle.



Historical cropping system (5 year):	Strip-till corn and soybeans
Previous crop:	Soybeans
Strip size:	0.76 ac
Corn planting/harvest date:	May 5/October 14
Corn row spacing/planting density:	30 in; 34,500 seeds/ac
Nitrogen sources and timing:	Chemical; Pre-plant, sidedress

"This trial showed that I'm probably in the sweet spot for nitrogen use so I probably shouldn't reduce the rate further."

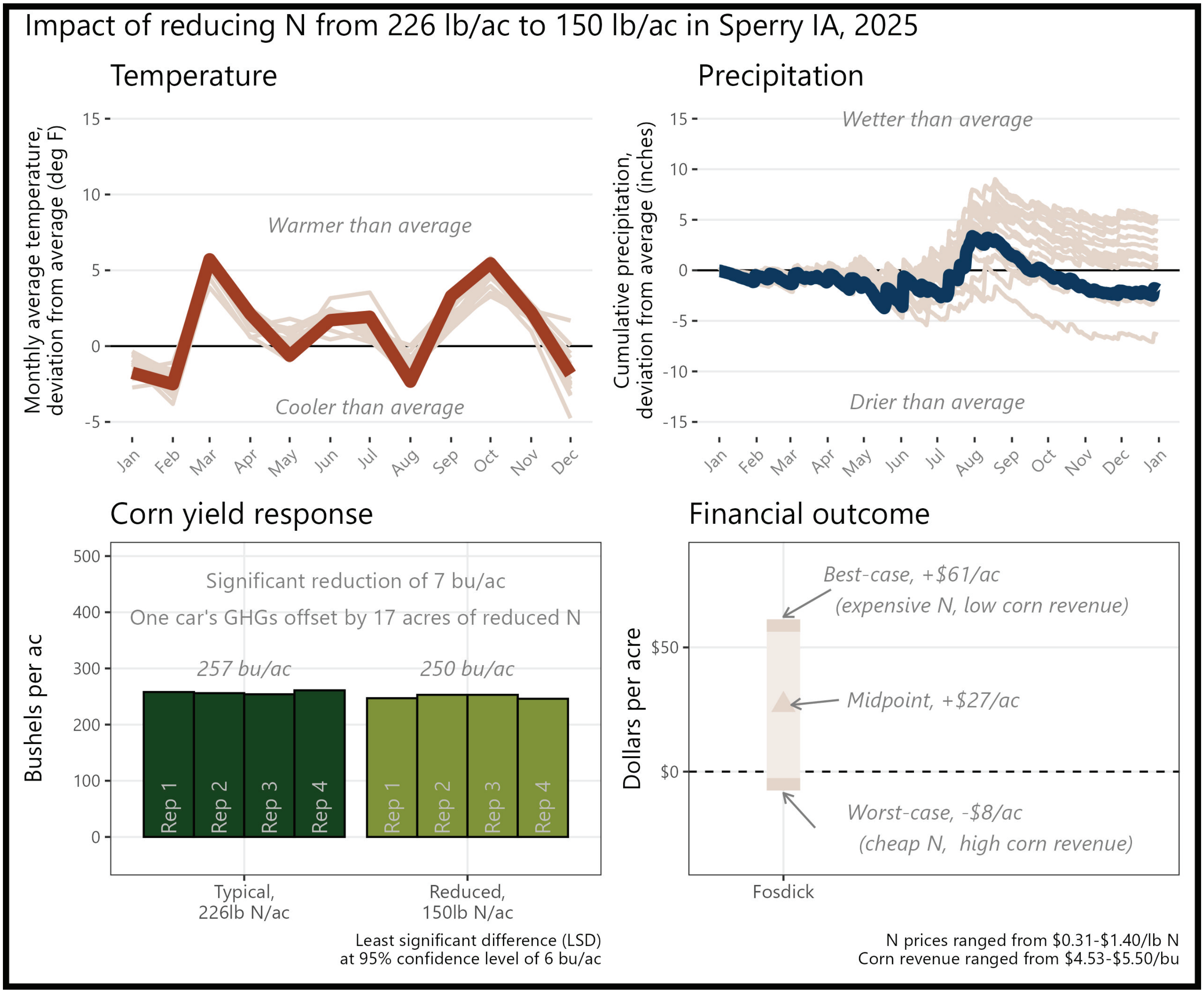
The financial outcome at the reduced N rate was likely a **financial loss.** A 30 lb N/ac reduction was likely too large this year, but a smaller N reduction could bring financial savings.



Historical cropping system (5 year):	No-till corn, soybeans and wheat; cereal rye and red clover cover crops
Previous crop:	Wheat
Strip size:	1 ac
Corn planting/harvest date:	April 28/NA
Corn row spacing/planting density:	30 in; 34,000 seeds/ac
Nitrogen sources and timing:	Chemical; At-plant, sidedress, top dress

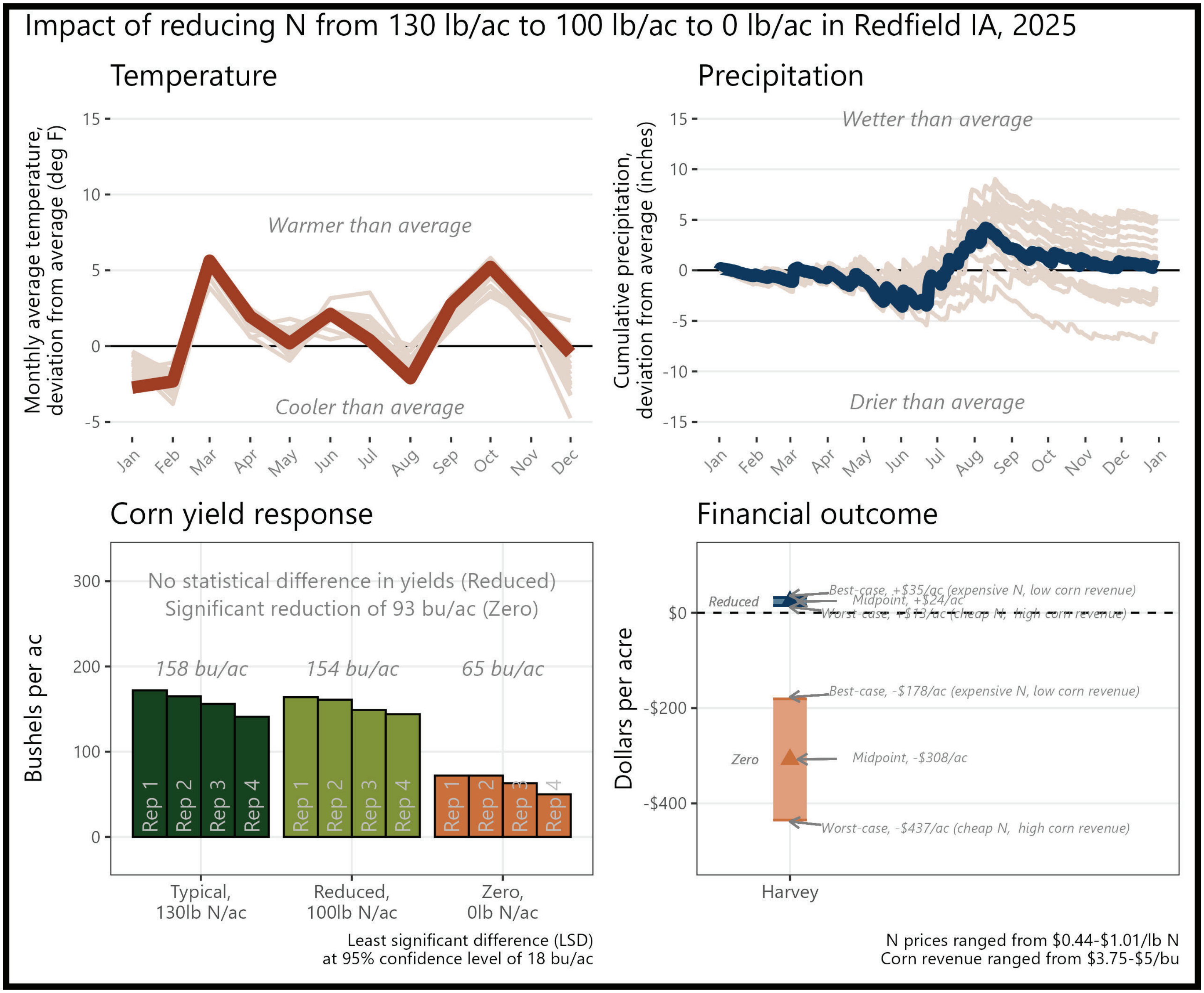
"Reduce up front N and keep split application" are the likely changes Fosdick will apply to his farm after conducting his trial.

The financial outcome at the reduced N rate was likely a **financial savings** compared to the typical N rate in both trials. A 76 lb N/ac reduction saved money this year, and, when applied to at least 17 acres, could offset the average annual GHGs of one vehicle.



Historical cropping system (5 year):	No-till/Strip-till corn and soybeans; cereal rye
Previous crop:	Soybeans
Strip size:	1.2 ac
Corn planting/harvest date:	April 16/September 27
Corn row spacing/planting density:	30 in; 33,800 seeds/ac
Nitrogen sources and timing:	Chemical; Fall, at plant, sidedress

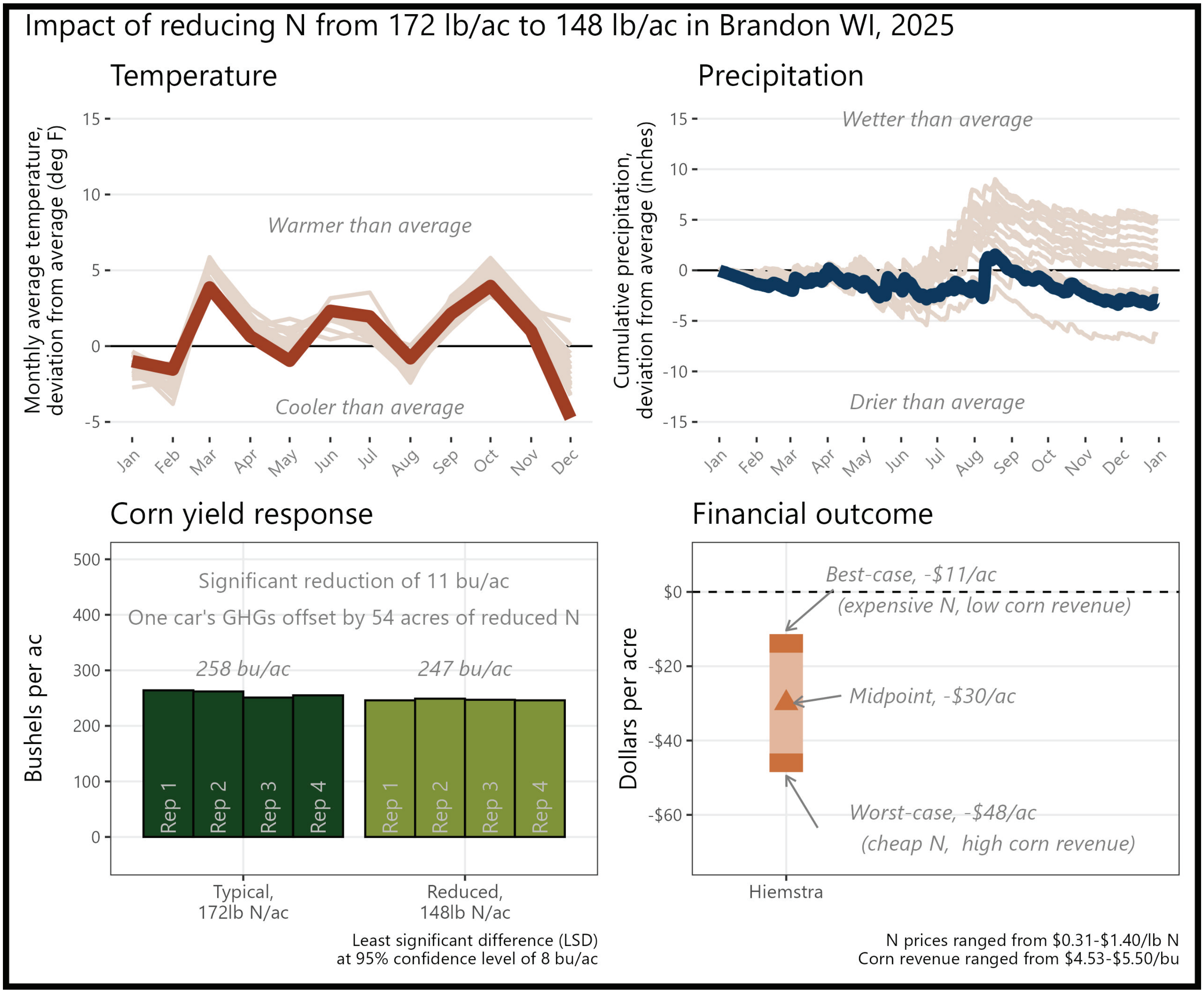
The financial outcome at the reduced N rate was likely a **financial savings** compared to the typical N rate. A 30 lb N/ac reduction saved money this year, and, when applied to at least 43 acres, could offset the average annual GHGs of one vehicle. The financial outcome at the zero N rate resulted in a **financial loss** compared to the typical N rate. While considerable yield losses are expected when no nitrogen is applied, the 0N treatment is important for understanding the full impact of nitrogen on yield and profitability.



Historical cropping system (5 year):	Corn-soybeans; cereal rye cover crop
Previous crop:	Soybeans
Strip size:	0.80 ac
Corn planting/harvest date:	April 28/October 9
Corn row spacing/planting density:	30 in; 30,000 seeds/ac
Nitrogen sources and timing:	Chemical; Winter, sidedress

> "Learning how to be more profitable while being environmentally responsible" was the most valuable aspect of this trial for Josh.

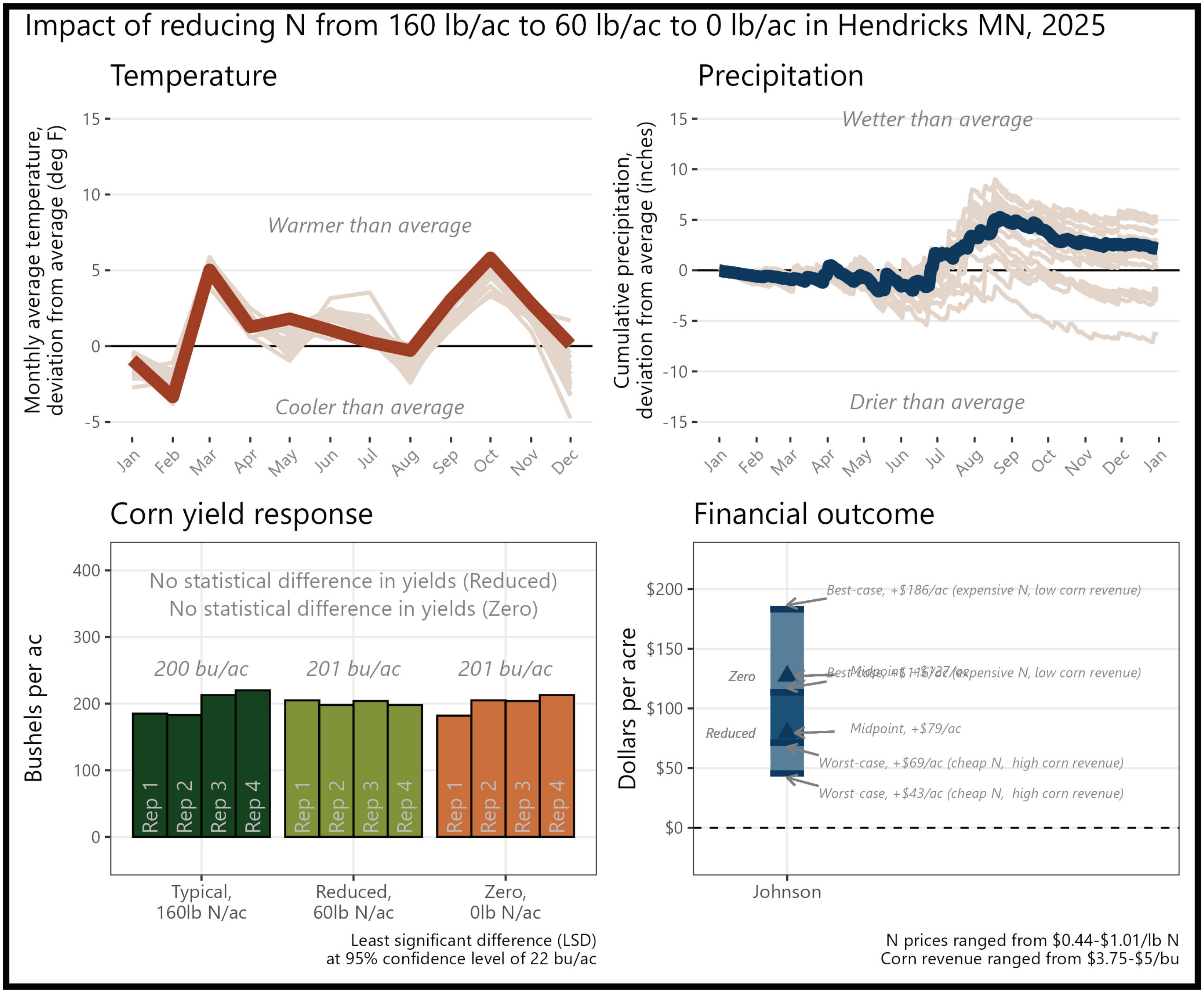
The financial outcome at the reduced N rate was likely a **financial loss**. A 24 lb N/ac reduction was likely too large this year, but a smaller N reduction could bring financial savings.



Historical cropping system (5 year):	Corn (silage)-Winter Wheat-Soybeans; cereal rye and cover crop mixes
Previous crop:	Corn (silage)
Strip size:	0.31 ac
Corn planting/harvest date:	May 7/October 1
Corn row spacing/planting density:	30 in; 32,800 seeds/ac
Nitrogen sources and timing:	Organic – Fall; Chemical – Preplant, at plant, sidedress

> "I'm getting a better idea of what my operation fertility needs. I'm finding that it isn't just soil type but the organic matter as well."

The financial outcome at both the reduced N rate and zero N rate resulted in a **financial savings** compared to the typical N rate. A 100 lb N/ac reduction saved money this year, and, when applied to at least 13 acres, could offset the average annual GHGs of one vehicle.



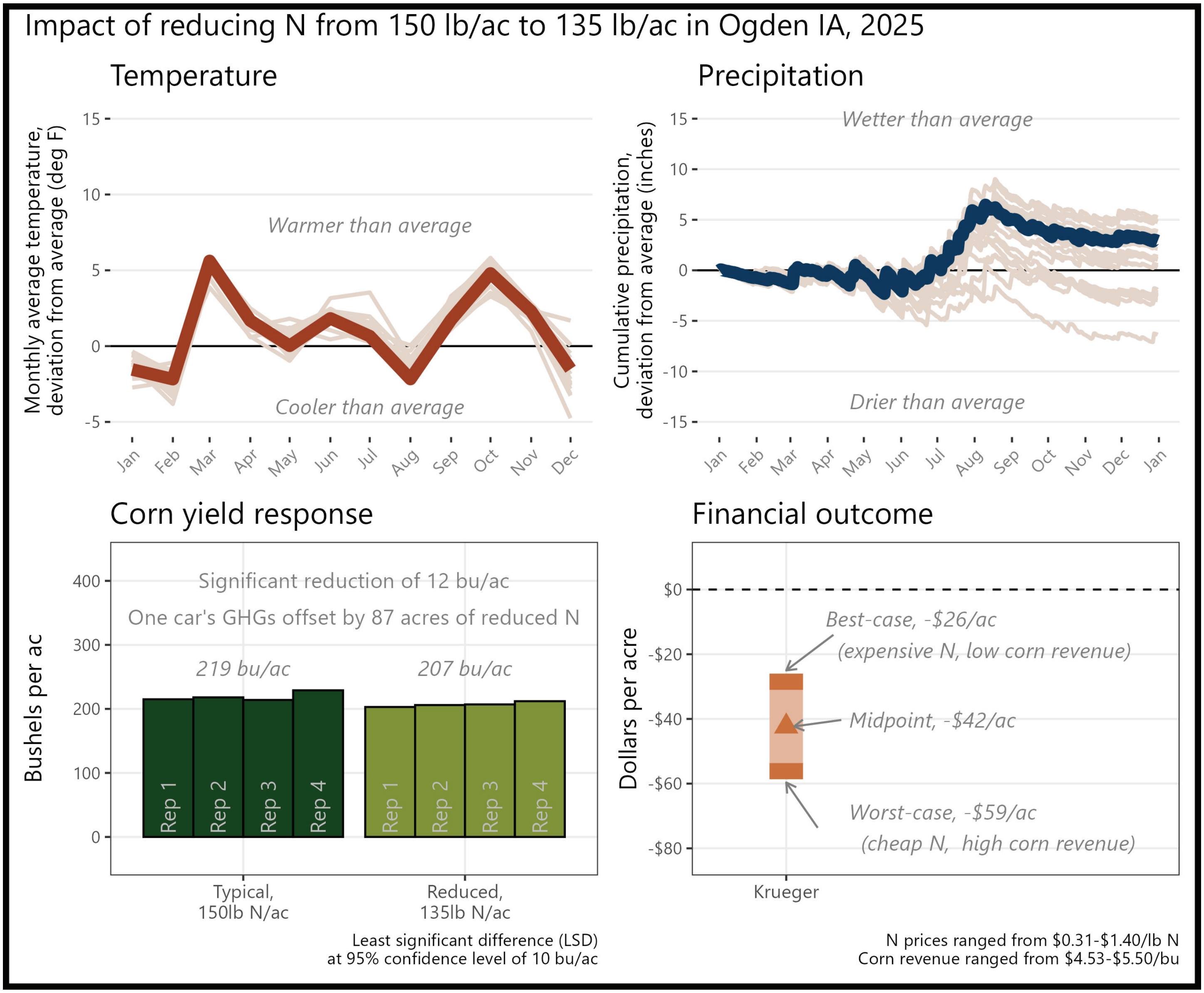
Historical cropping system (5 year):	Oats-Corn-Soybeans-Winter Barley; cover crop mix; compost application
Previous crop:	Winter barley/double crop soybeans
Strip size:	0.83 ac
Corn planting/harvest date:	May 8/October 10
Corn row spacing/planting density:	30 in; 30,700 seeds/ac
Nitrogen sources and timing:	Chemical + foliar nutrients; sidedress

Foliar products used by Johnson and Olsen in their trial. Because product costs were not provided, financial results reflect only the cost of chemical nitrogen fertilizer.

TYPICAL	REDUCED	ZERO
1 pt pro primer (fulvic acid) 1 gal ProK (Potassium) 1 gal Micro1000 (MicroPak with 10 micronutrients)	1 gal MacroPak 1 gal MicroPak I qt HoloK 1 qt Copper	16 oz Bioquest 1 gak Seashield

> "This trial continues to show the same results year after year. It is helping me get more confident in what the correct rate is on my farm."

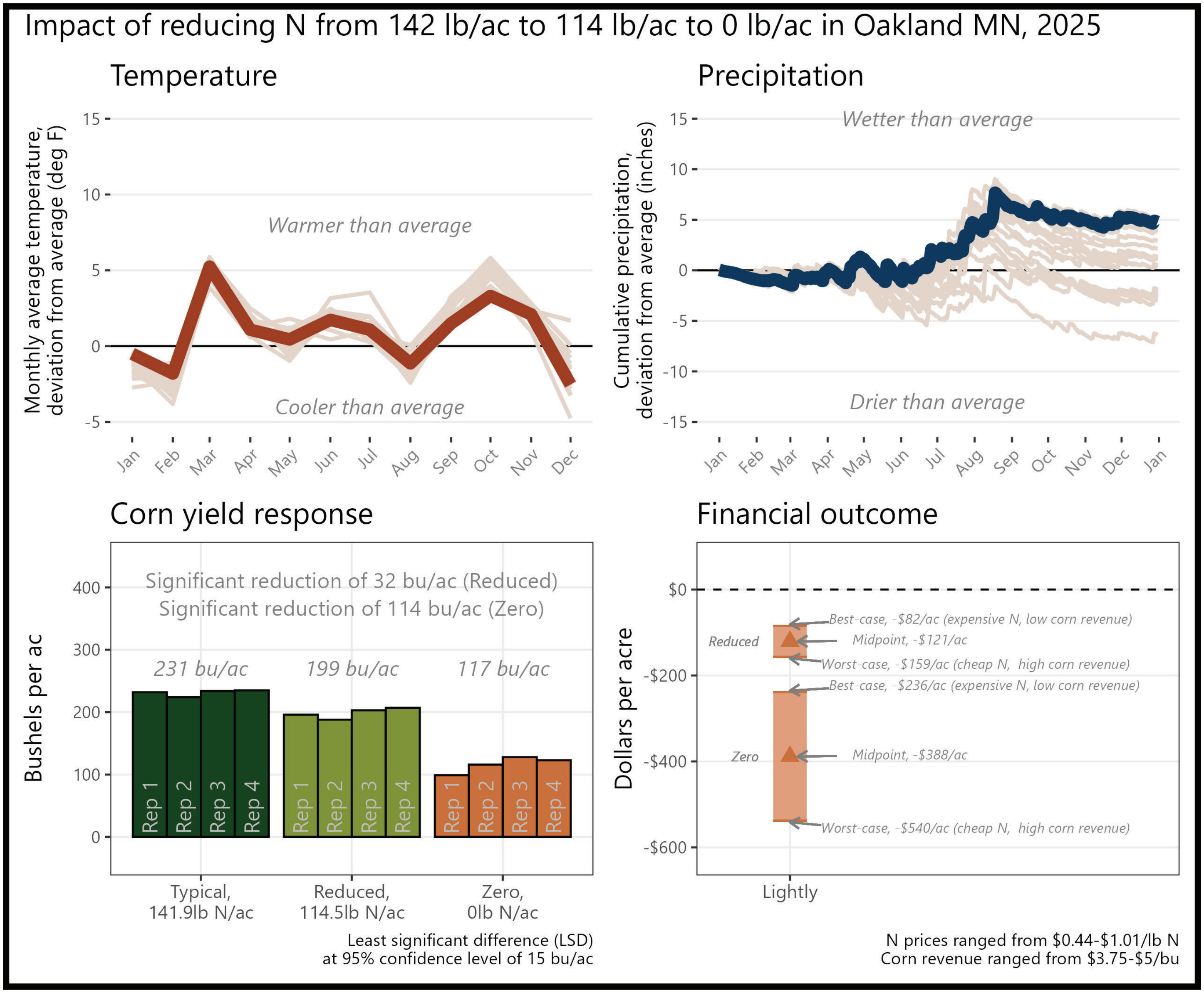
The financial outcome at the reduced N rate was likely a **financial loss.** A 15 lb N/ac reduction was likely too large this year, but a smaller N reduction could bring financial savings.



Historical cropping system (5 year):	No-till/Strip-till corn and soybeans; oats, triticale, camelina and cereal rye cover crops; cattle grazing
Previous crop:	Soybeans
Strip size:	0.48 ac
Corn planting/harvest date:	May 3/October 13
Corn row spacing/planting density:	30 in; 32,500 seeds/ac
Nitrogen sources and timing:	Chemical; Pre-plant, sidedress

APPENDIX L. SCOTT LIGHTLY; OAKLAND, MN

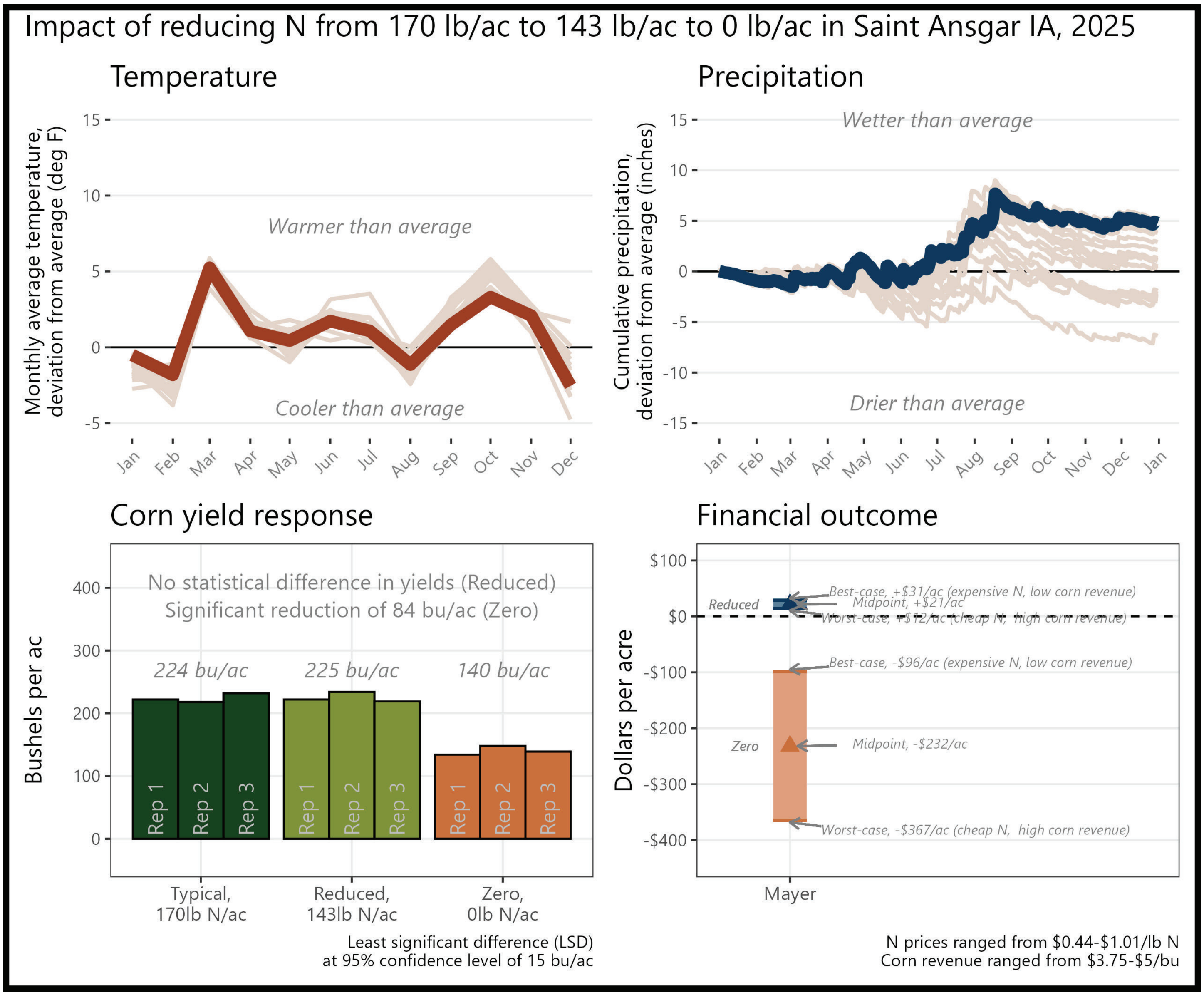
The financial outcome at both the reduced N rate and zero N rate resulted in a **financial loss** compared to the typical N rate. A reduction of 27 lb N/ac was likely too large this year, but there may be potential financial savings with a smaller N reduction. While considerable yield losses are expected when no nitrogen is applied, the 0N treatment is important for understanding the full impact of nitrogen on yield and profitability.



Historical cropping system (5 year):	No-till soybeans and corn; cereal rye and cover crop mixes
Previous crop:	Soybeans
Strip size:	0.27 ac
Corn planting/harvest date:	May 9/October 10
Corn row spacing/planting density:	30 in; 36,000 seeds/ac
Nitrogen sources and timing:	Chemical; At plant, sidedress, top dress

"I will continue gradually decreasing rates and trialing to find economic tipping point for my operation."

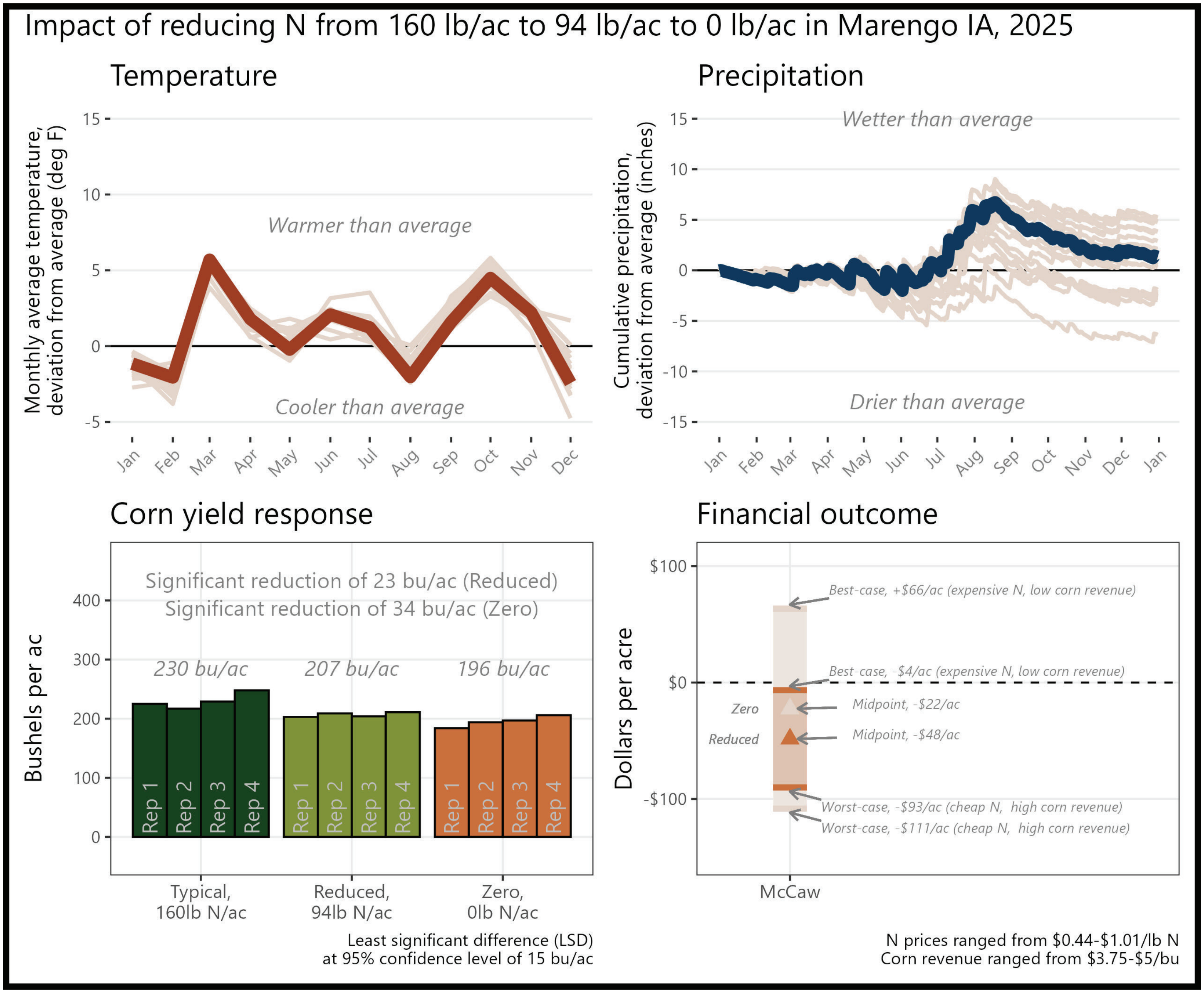
The financial outcome at the reduced N rate was likely a **financial savings** compared to the typical N rate. A 27 lb N/ac reduction saved money this year, and, when applied to at least 48 acres, could offset the average annual GHGs of one vehicle. The financial outcome at the zero N rate resulted in a **financial loss** compared to the typical N rate. While considerable yield losses are expected when no nitrogen is applied, the 0N treatment is important for understanding the full impact of nitrogen on yield and profitability.



Historical cropping system (5 year):	No-till/strip-till corn and soybeans; cereal rye
Previous crop:	Soybeans
Strip size:	1.65 ac
Corn planting/harvest date:	May 11/October 12
Corn row spacing/planting density:	30 in; 35,000 seeds/ac
Nitrogen sources and timing:	Chemical; Fall, at-plant, sidedress

> "Comparing low to no nitrogen treatments was an eye opener. It's good to know that the biology on this farm is working."

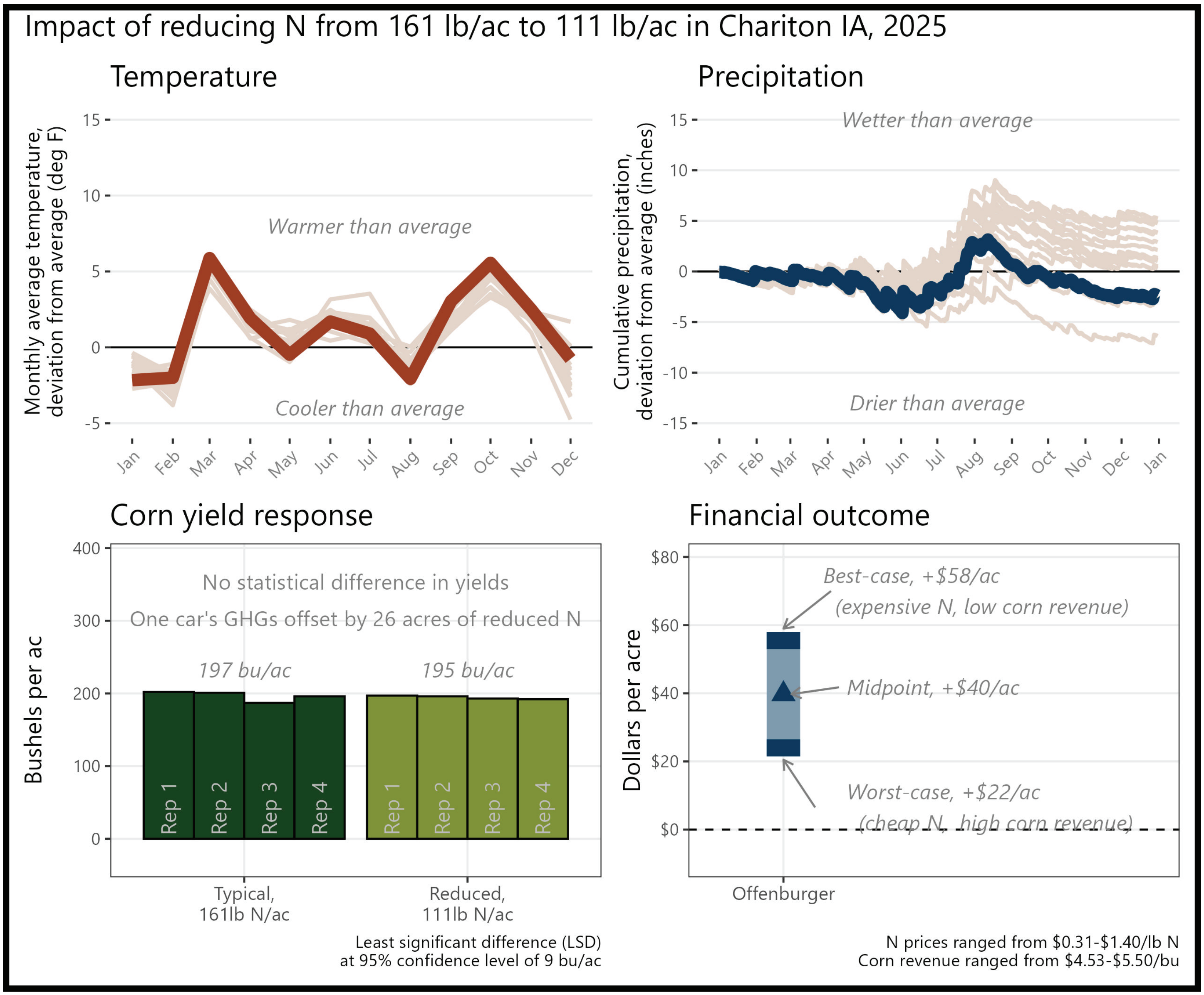
The financial outcome at both the reduced N rate and zero N rate resulted in a **financial loss** compared to the typical N rate. A reduction of 66 lb N/ac was likely too large this year, but there may be potential financial savings with a smaller N reduction. While considerable yield losses are expected when no nitrogen is applied, the 0N treatment is important for understanding the full impact of nitrogen on yield and profitability.



Historical cropping system (5 year):	No-till corn and soybeans; cereal rye cover crop
Previous crop:	Soybeans
Strip size:	0.73-0.86 ac
Corn planting/harvest date:	May 12/October 22
Corn row spacing/planting density:	30 in; 34,000 seeds/ac
Nitrogen sources and timing:	Chemical; Pre-plant, sidedress

"With tight margins this year I plan to reduce N rate applied pre plant. I have seen that there was statistically no difference in my reduced rate. This will save me money, and I have peace of mind that it will not hurt yield too badly. I can still add more nitrogen later on depending on how the year goes with weather and finances."

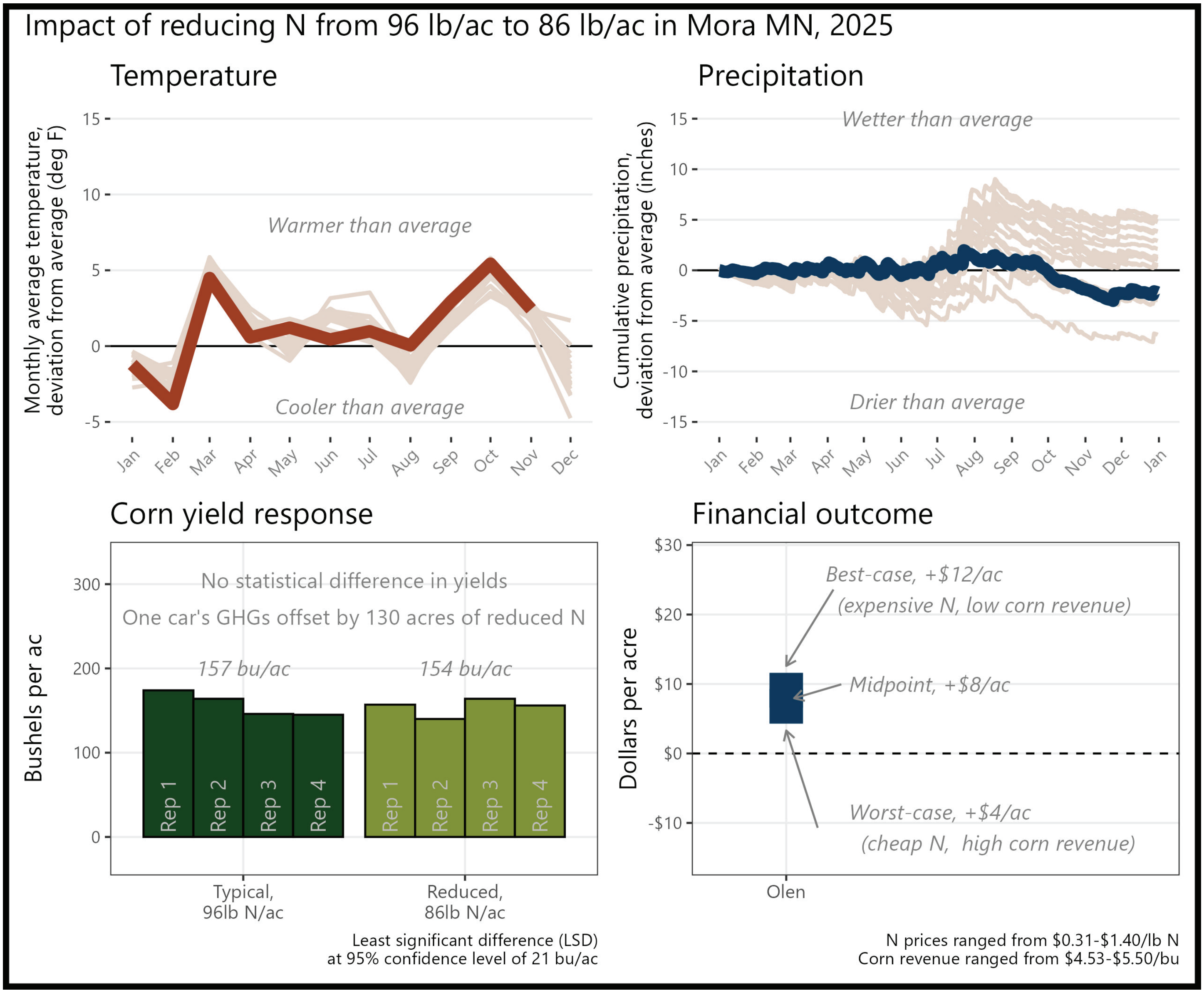
The financial outcome at the reduced N rate was likely a **financial savings** compared to the typical N rate. A 50 lb N/ac reduction saved money this year, and, when applied to at least 25 acres, could offset the average annual GHGs of one vehicle.



Historical cropping system (5 year):	No-till corn and soybeans; cereal rye cover crop; grazing
Previous crop:	Soybeans
Strip size:	Not reported
Corn planting/harvest date:	May 6/October 13
Corn row spacing/planting density:	30 in; 32,000 seeds/ac
Nitrogen sources and timing:	Chemical; Pre-plant

APPENDIX P. LUCAS OLEN; MORA, MN

The financial outcome at the reduced N rate was likely a **financial savings** compared to the typical N rate. A 10 lb N/ac reduction saved money this year, and, when applied to at least 130 acres, could offset the average annual GHGs of one vehicle.

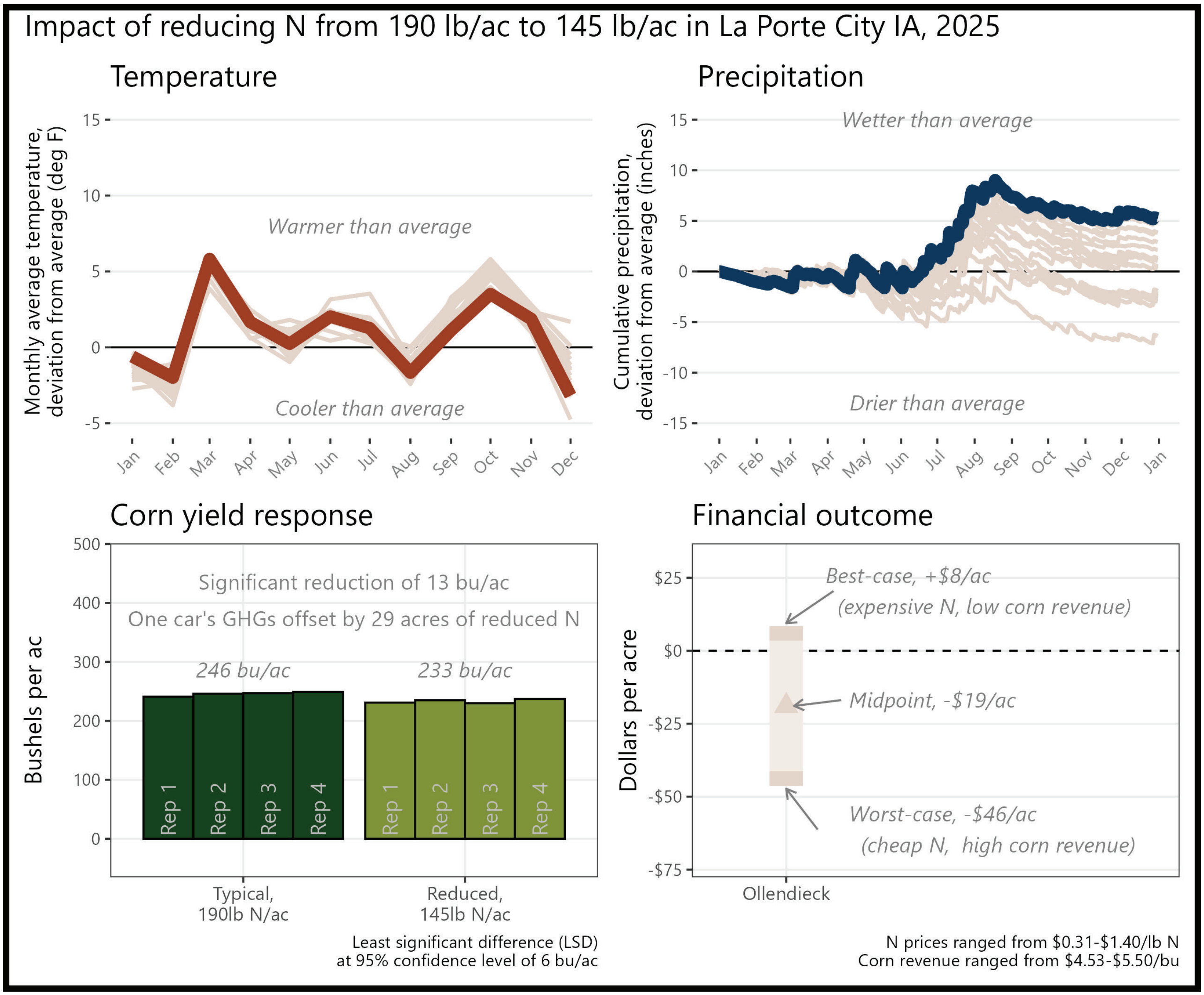


Historical cropping system (5 year):	No-till corn and soybeans; cereal rye, radish, and turnip field peas cover crops
Previous crop:	Soybeans (2023); prevent plant (2024)
Strip size:	1.8-3.8 ac
Corn planting/harvest date:	May 1/November 15
Corn row spacing/planting density:	Not reported
Nitrogen sources and timing:	Chemical; at-plant, sidedress

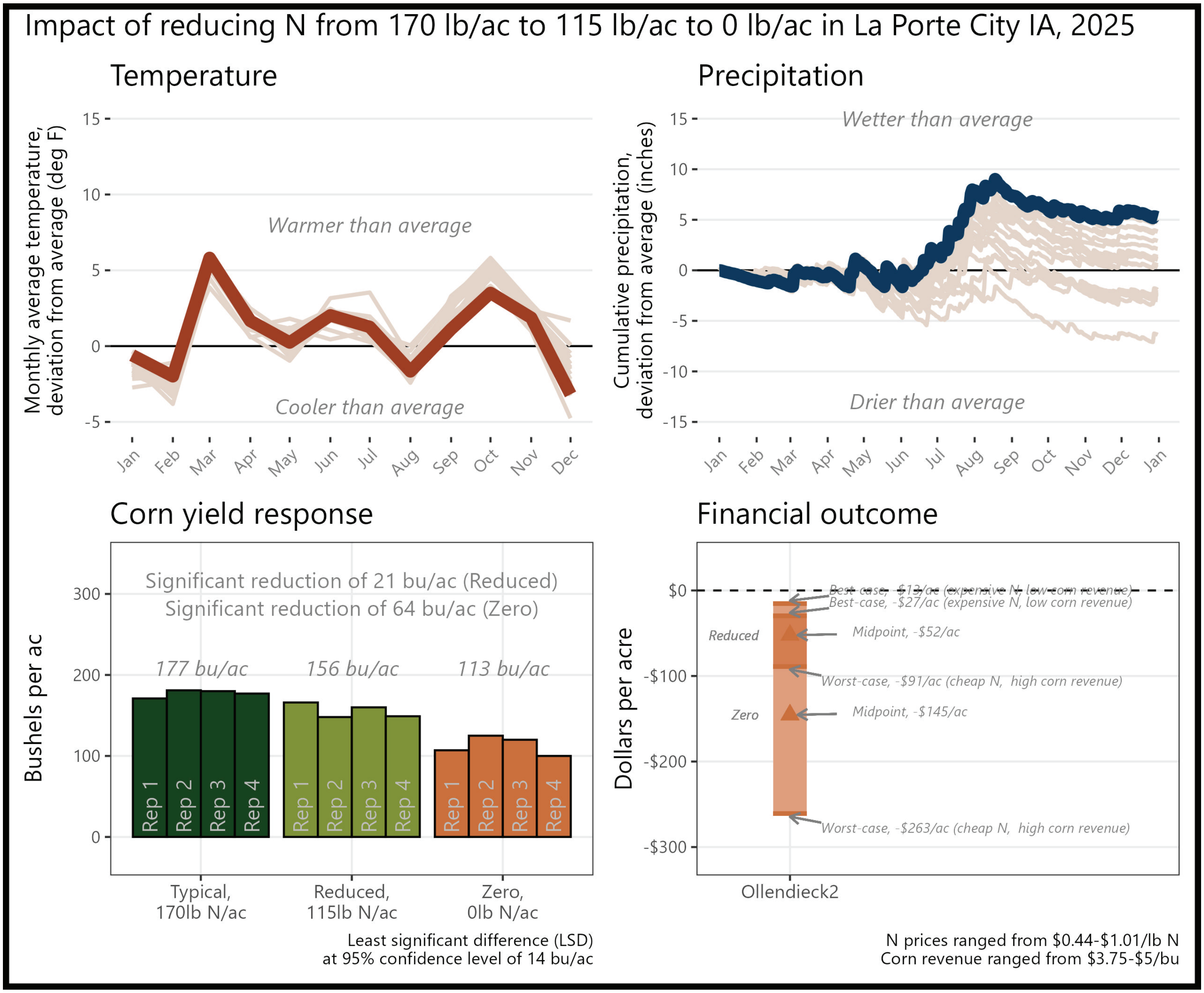
> "I feel like we have nitrogen rates dialed into a decent range, but this [trial] helped quantify that."

The financial outcome at the reduced N rate was likely a **financial loss**. A 45 lb N/ac reduction was likely too large this year, but a smaller N reduction could bring financial savings.

For the second trial (0N), the financial outcome at both the reduced N rate and zero N rate resulted in a **financial loss** compared to the typical N rate. A reduction of 55 lb N/ac was likely too large this year, but there may be potential financial savings with a smaller N reduction.



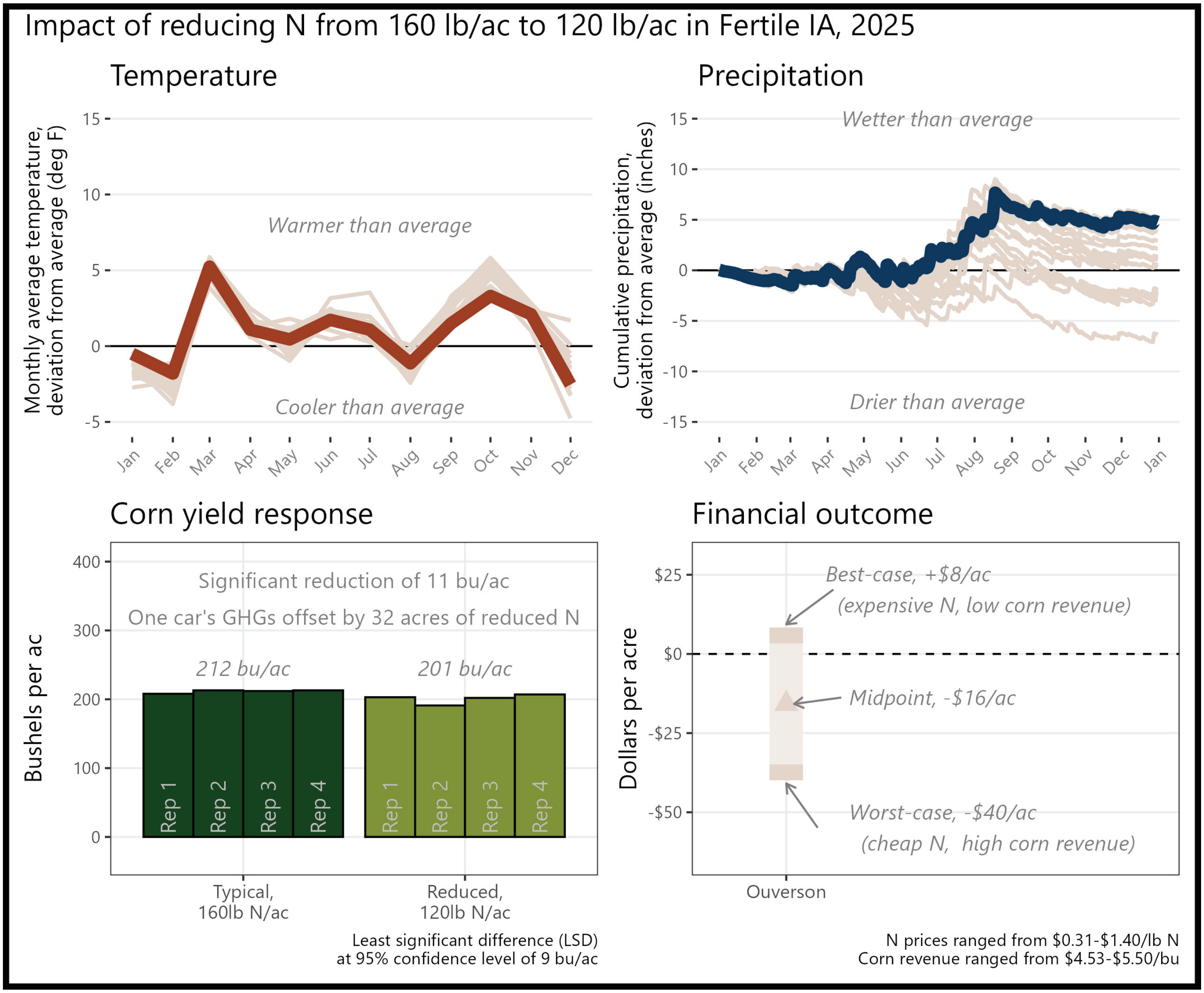
Historical cropping system (5 year):	No-till corn and soybeans; cereal rye and oat/radish cover crops
Previous crop:	Soybeans
Strip size:	1.25 ac
Corn planting/harvest date:	May 5/October 21
Corn row spacing/planting density:	30 in; 34,000 seeds/ac
Nitrogen sources and timing:	Chemical; At-plant, sidedress

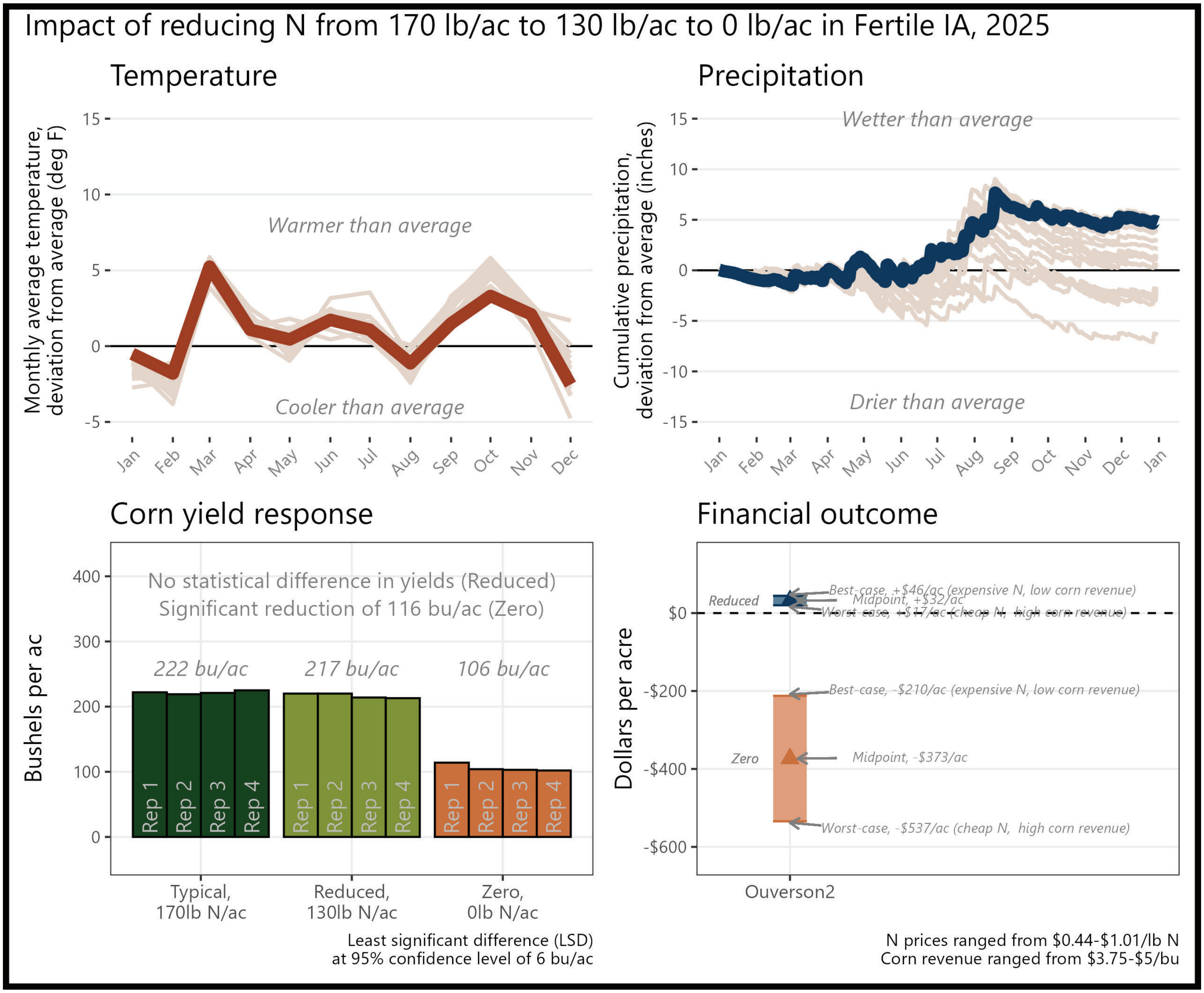


Historical cropping system (5 year):	No-till corn and soybeans; cereal rye and oat/radish cover crops
Previous crop:	Soybeans
Strip size:	1.25 ac
Corn planting/harvest date:	May 15/November 13
Corn row spacing/planting density:	30 in; 32,000 seeds/ac
Nitrogen sources and timing:	Chemical; At-plant, sidedress

The financial outcome at the reduced N rate was likely a **financial loss.** A 40 lb N/ac reduction was likely too large this year, but a smaller N reduction could bring financial savings.

For the second trial (0N), the financial outcome at the reduced N rate was likely a **financial savings** compared to the typical N rate. A 40 lb N/ac reduction saved money, and, when applied to at least 32 acres, could offset the average annual GHGs of one vehicle. The financial outcome at the zero N rate resulted in a **financial loss** compared to the typical N rate.

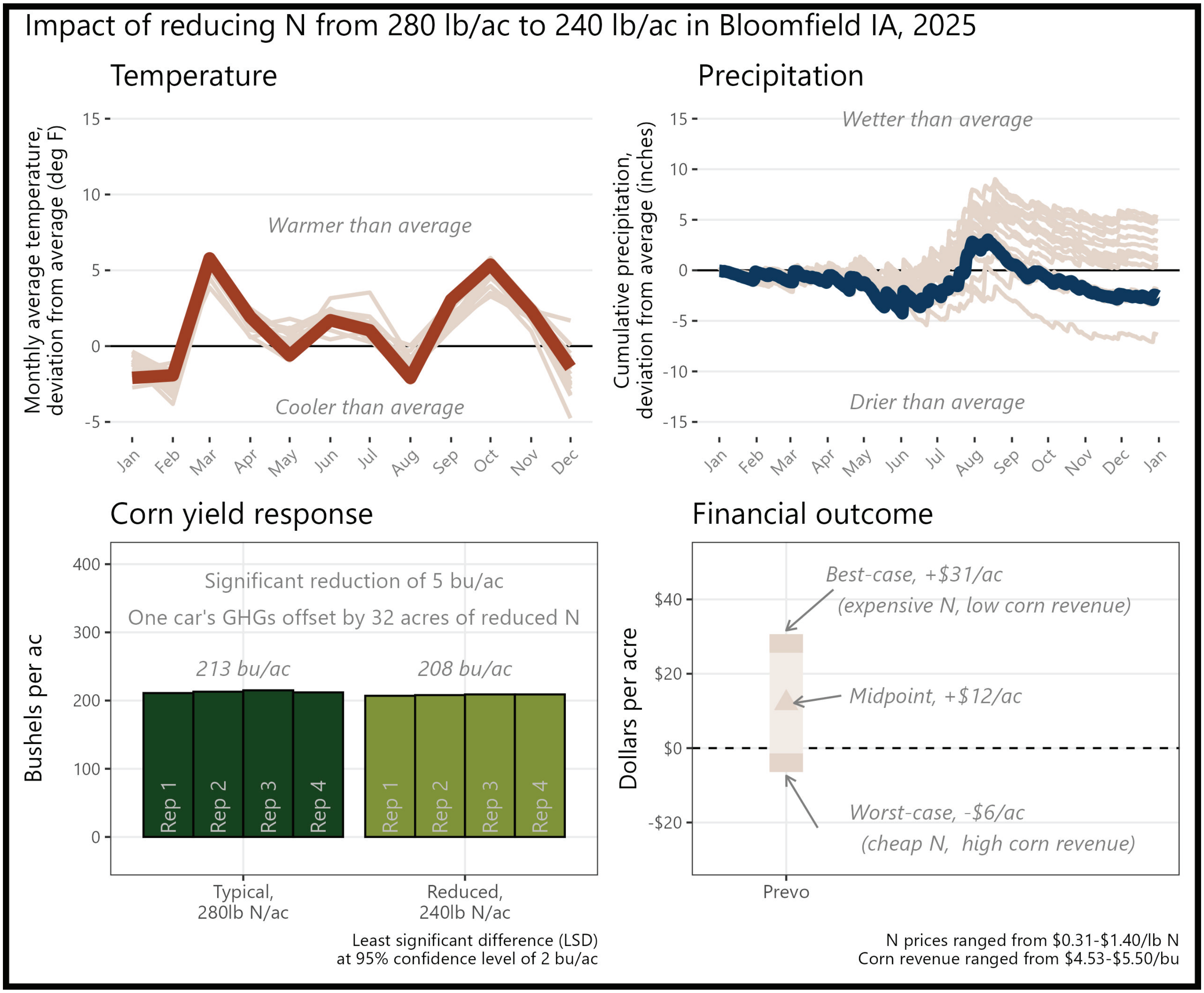




Historical cropping system (5 year):	No-till/Strip-till corn and soybeans; cereal rye, rapeseed, and oats cover crops
Previous crop:	Soybeans
Strip size:	0.77 ac
Corn planting/harvest date:	May 12/NA
Corn row spacing/planting density:	30 in; 34,000 seeds/ac
Nitrogen sources and timing:	Chemical; At-plant, sidedress

"[The most valuable aspect of conducting this trial was] validation of my practices."

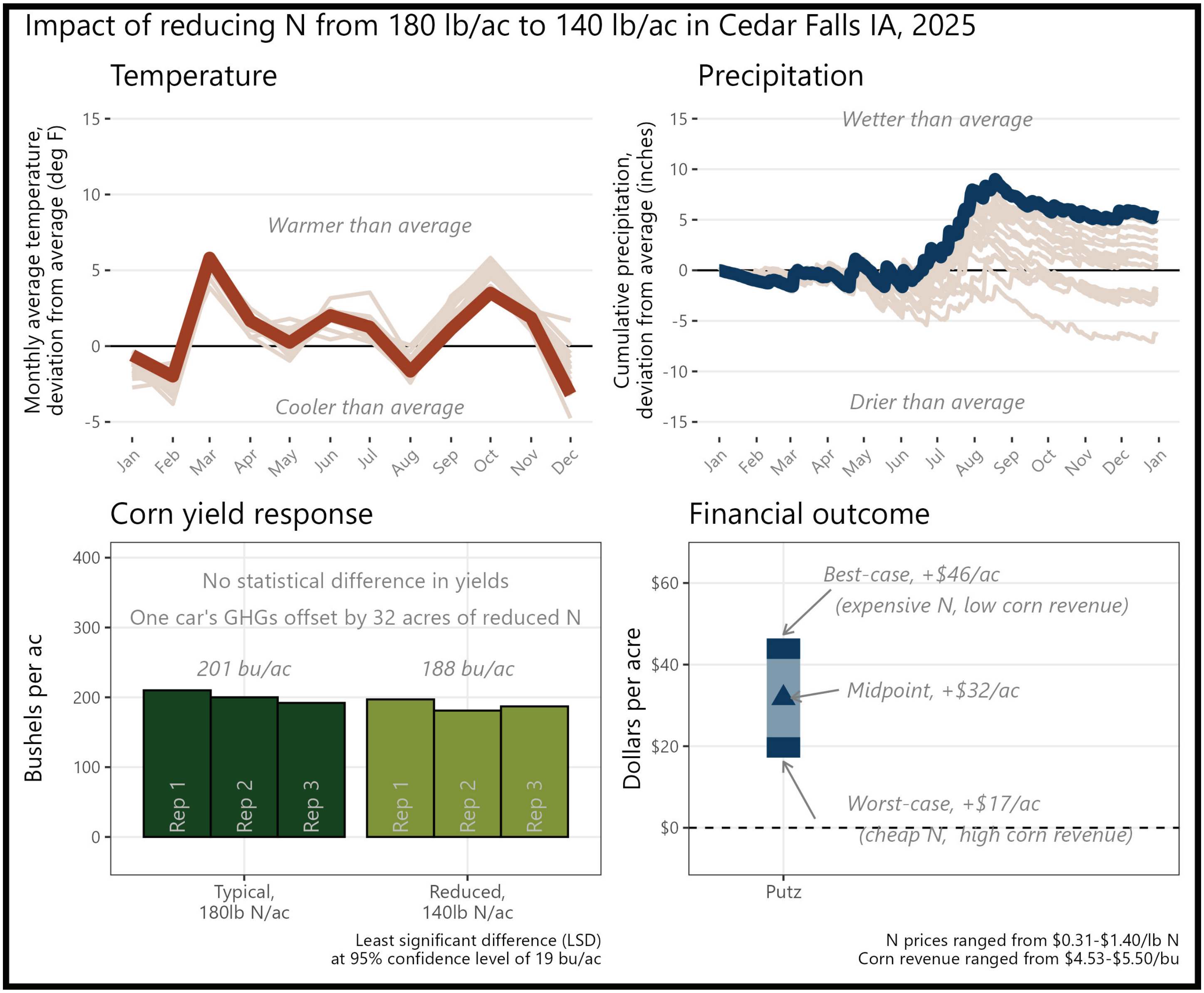
The financial outcome at the reduced N rate was likely a **financial savings** compared to the typical N rate. A 40 lb N/ac reduction saved money this year, and, when applied to at least 32 acres, could offset the average annual GHGs of one vehicle.



Historical cropping system (5 year):	No-till corn and soybeans; cereal rye and diverse mix cover crops; hog manure application; grazing
Previous crop:	Soybeans
Strip size:	0.31 ac
Corn planting/harvest date:	April 9/September 30
Corn row spacing/planting density:	30 in; 32,000 seeds/ac
Nitrogen sources and timing:	Organic - Fall; Chemical - sidedress

> *"This has been the second year of this trial, and we're wanting at least 5 years in order to come to a full consensus."*

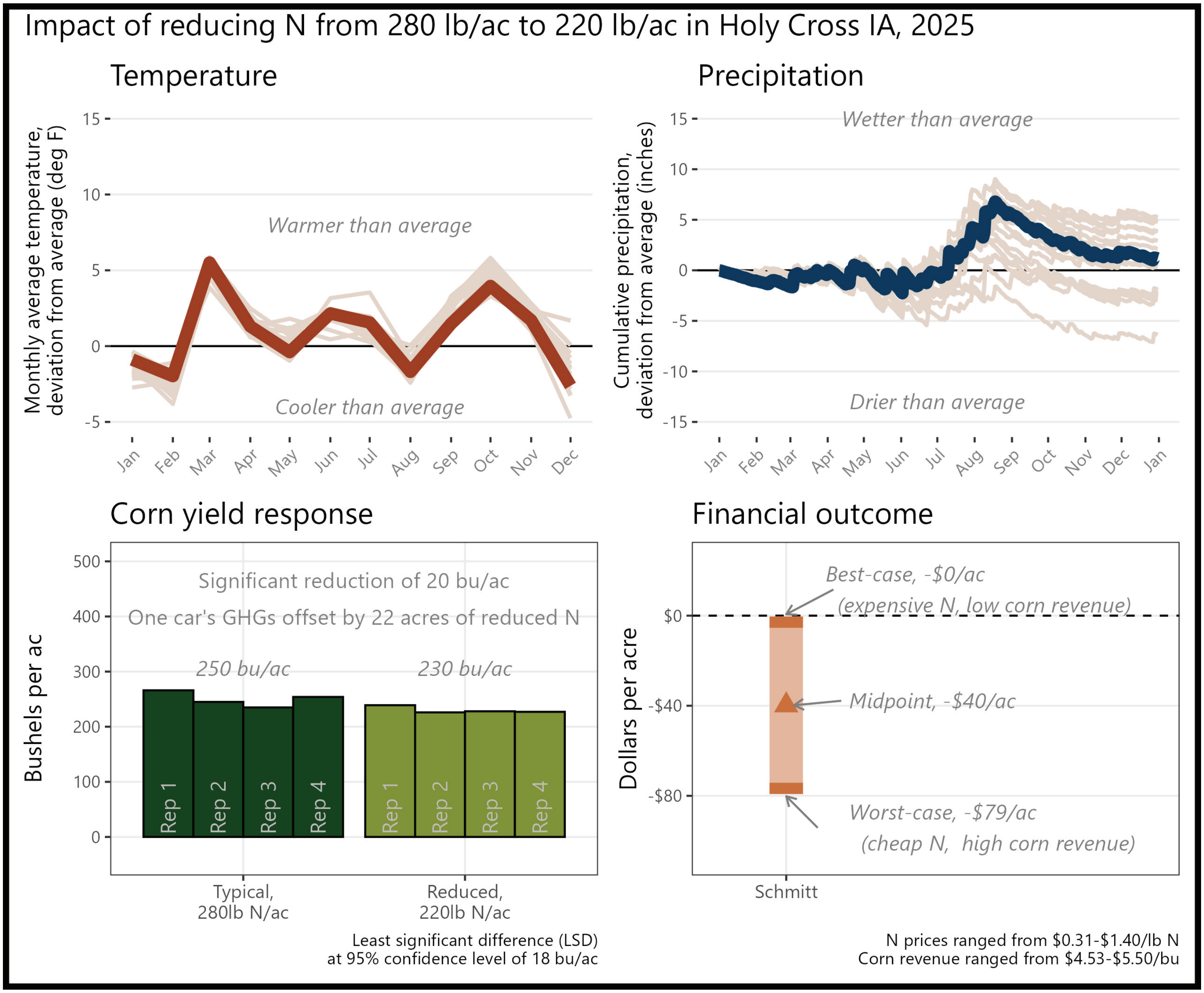
The financial outcome at the reduced N rate was likely a **financial savings** compared to the typical N rate. A 40 lb N/ac reduction saved money this year, and, when applied to at least 32 acres, could offset the average annual GHGs of one vehicle.



Historical cropping system (5 year):	No-till corn and soybeans; rye and camelina cover crops
Previous crop:	Soybeans
Strip size:	0.92 ac
Corn planting/harvest date:	April 29/October 17
Corn row spacing/planting density:	30 in; 33,500 seeds/ac
Nitrogen sources and timing:	Chemical; Pre-plant, sidedress

> "I didn't think we would have a positive yield response, but N rates are affected by so many factors that it is nearly impossible to have a blanket recommendation."

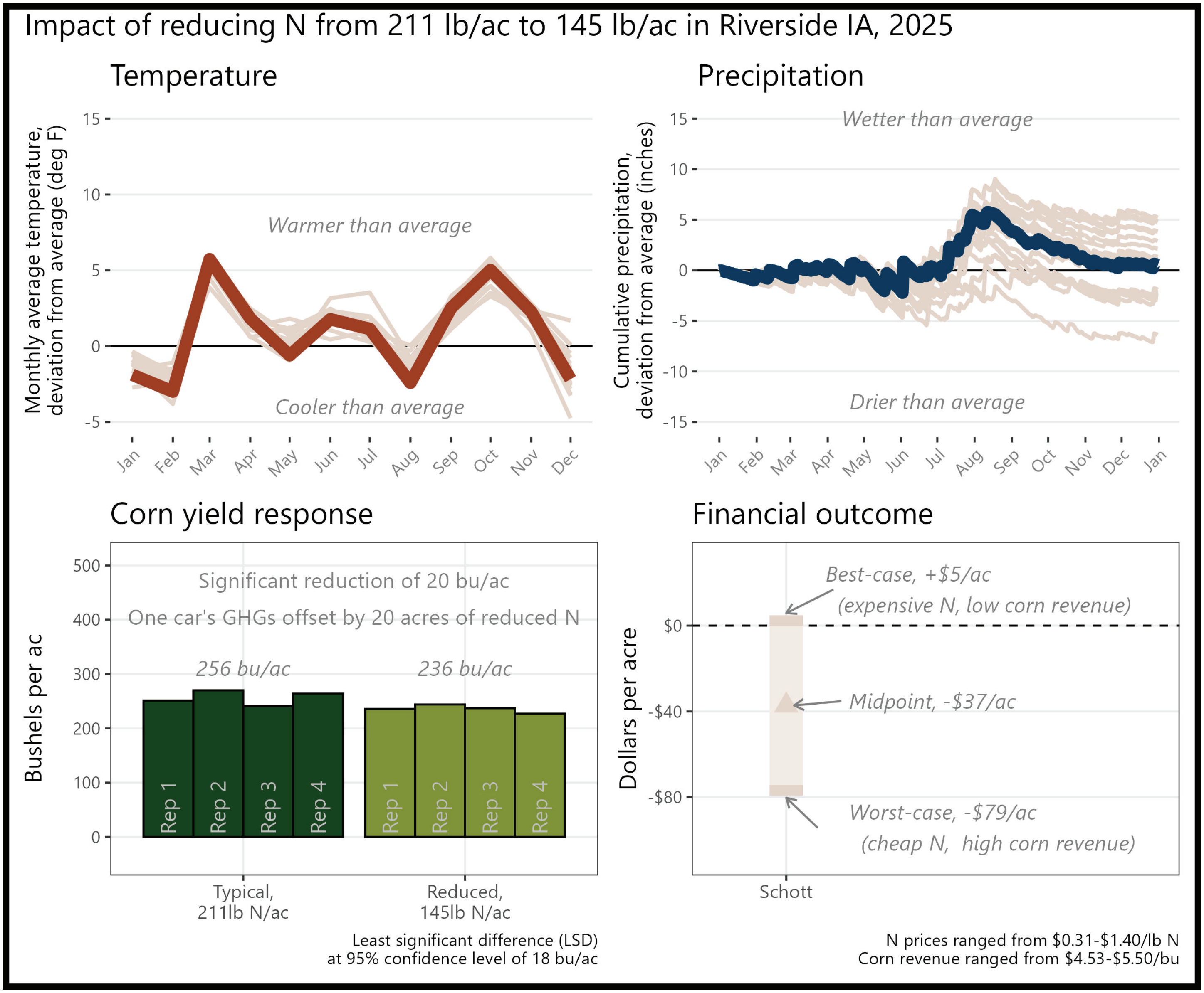
The financial outcome at the reduced N rate was likely a **financial loss**. A 60 lb N/ac reduction was likely too large this year, but a smaller N reduction could bring financial savings.



Historical cropping system (5 year):	No-till corn and soybeans; cereal rye cover crops; hog manure
Previous crop:	Soybeans
Strip size:	0.57 ac
Corn planting/harvest date:	May 7/November 5
Corn row spacing/planting density:	30 in; 34,500 seeds/ac
Nitrogen sources and timing:	Chemical; At plant

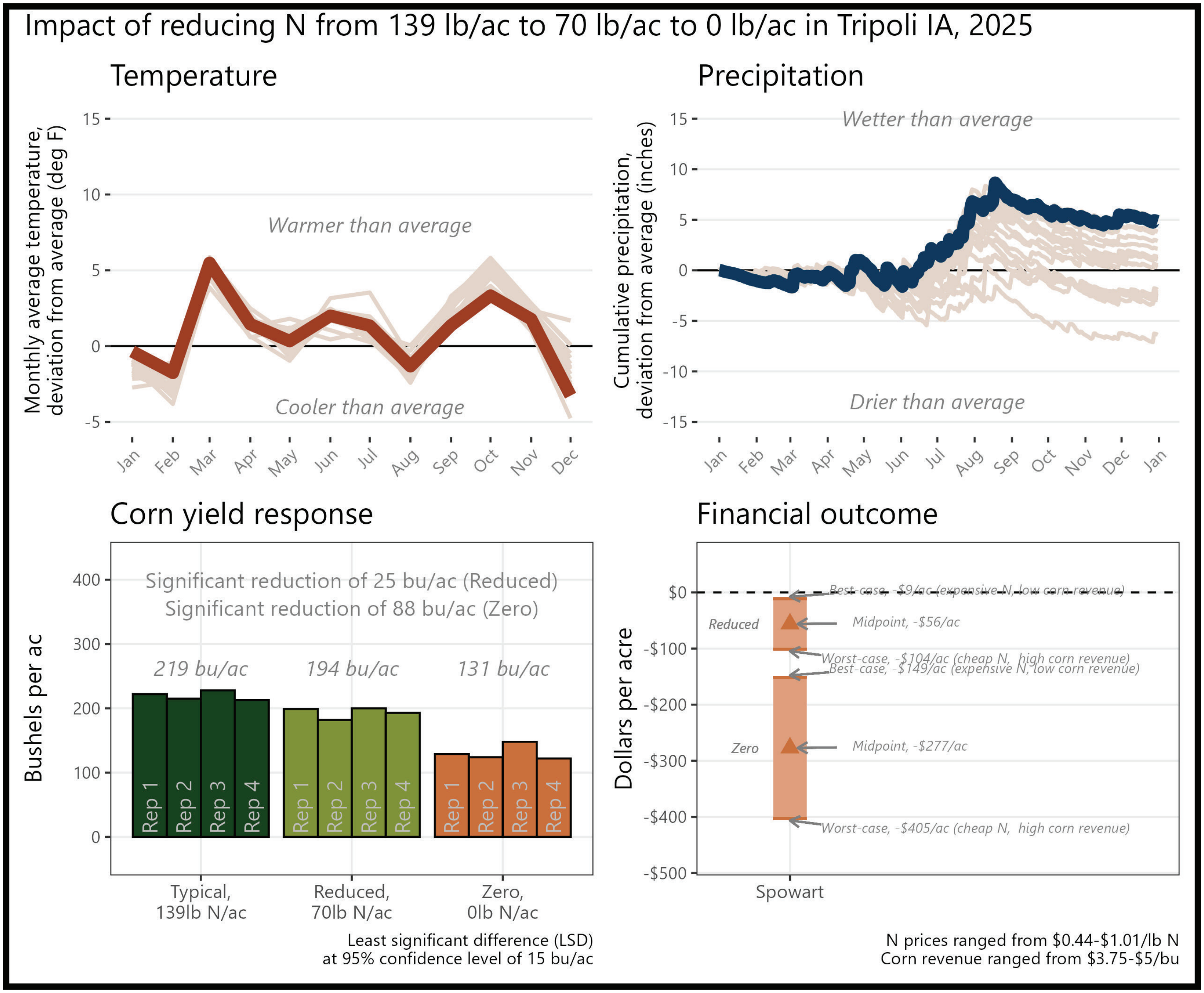
"I think it is always important to evaluate if we are using too much nitrogen. This helped answer that question for us this year."

The financial outcome at the reduced N rate was likely a **financial loss.** A 66 lb N/ac reduction was likely too large this year, but a smaller N reduction could bring financial savings.



Historical cropping system (5 year):	No-till/soil finish corn and soybeans
Previous crop:	Corn
Strip size:	0.28 ac
Corn planting/harvest date:	April 14/September 11
Corn row spacing/planting density:	30 in; 33,100 seeds/ac
Nitrogen sources and timing:	Chemical; Pre-plant, at plant, sidedress

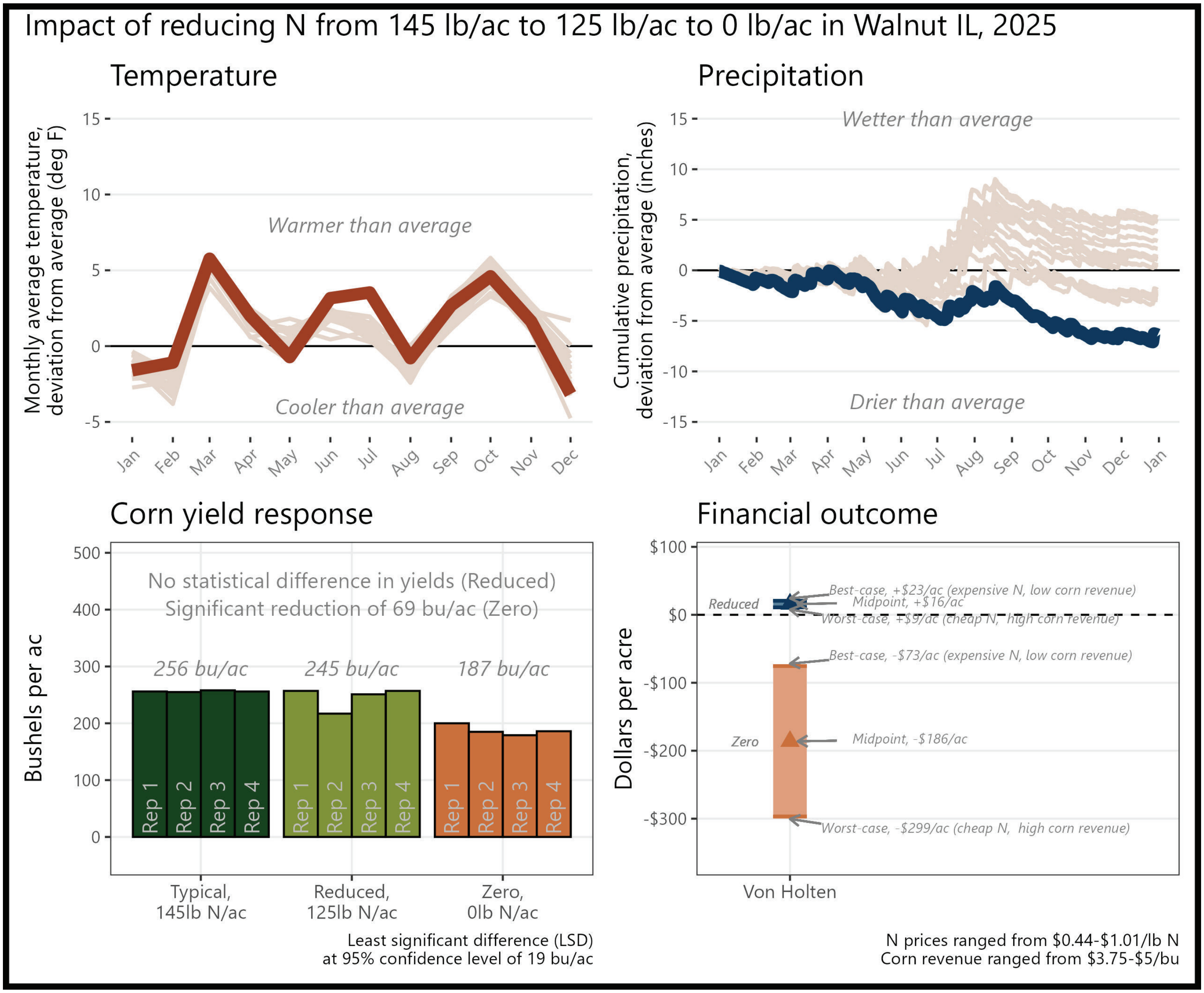
The financial outcome at both the reduced N rate and zero N rate resulted in a **financial loss** compared to the typical N rate. A reduction of 69 lb N/ac was likely too large this year, but there may be potential financial savings with a smaller N reduction.



Historical cropping system (5 year):	No-till/strip-till corn and soybeans; cereal rye cover crops
Previous crop:	Corn
Strip size:	0.53 ac
Corn planting/harvest date:	May 8/October 9
Corn row spacing/planting density:	30 in; 34,000 seeds/ac
Nitrogen sources and timing:	Chemical + foliar applications; Top dress

"Trial results showed me that I can potentially lower my N rates by 20 lbs/ac. By doing this I won't give up much yield and have positive ROI from the reduced N rate."

The financial outcome at the reduced N rate was likely a **financial savings** compared to the typical N rate. A 20 lb N/ac reduction saved money, and, when applied to at least 65 acres, could offset the average annual GHGs of one vehicle. The financial outcome at the zero N rate resulted in a **financial loss** compared to the typical N rate.



Historical cropping system (5 year):	No-till corn and soybeans; cereal rye cover crop
Previous crop:	Soybeans
Strip size:	0.92 ac
Corn planting/harvest date:	April 17/October 13
Corn row spacing/planting density:	30 in; 32,000 seeds/ac
Nitrogen sources and timing:	Chemical; At plant, sidedress

APPENDIX Y. DETAILED METHODS

Weather data

Each cooperator chose a US Census-recognized town with which to associate their trial. The latitude and longitude of the chosen town were used to retrieve weather data from the National Aeronautics and Space Administration (NASA) Prediction of Worldwide Energy Resources (POWER) project using the nasapower package [10] for R software [11]. Data was downloaded for the period spanning January 1, 1995 through December 31, 2025. Two weather variables were used: (1) cumulative daily precipitation values and (2) the average daily air temperature at two meters above ground level. The weather data was separated into two data sets: one comprising the entire 30 years of data (historical weather data), and one containing only data from January 1 – December 31, 2025 (trial year data).

To provide context for each trial's temperatures, the historical mean temperature for month at a given site was calculated using the historical weather dataset. The historical value was subtracted from the trial year average temperature for that month to provide an estimate of the deviation from average conditions.

GHG Emissions

Both direct and indirect (volatilization, leaching) N_2O emissions were considered in these calculations. Additionally, although N_2O emissions do vary by the form of N fertilizer used, in this trial farmers only adjusted chemical forms of N fertilizer, and the variation between chemical fertilizer types was small compared to the absolute estimates (~1%), so an average of the fertilizer types was used.

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