Report on DIFM Field Trial Fifth Gen Farm_Field 18 Seed Rate Trial_2024

Table 0.1: Field Management Information

Field Name	Field 18 Seed Rate Trial
Field Size	33 acre
Plot Length	239 - 250 ft
Plot Width	86.66 ft
Planter Width	86.66 ft
Sections	1
Harvester Width	35 ft
Experimental Design	Latin-Square Trial
Targeted Rates	1.28, 1.58, 1.87, 2.17 (lb/acre)
Producer's Status Quo Strategy	1.87 (lb/acre)
Price of Canola	$8.25/bu
Price of Seed	$16.00/lb

1 Summary

Table 0.1 presents the basic information about the trial. Trial implementation had some machine alignment problems, which resulted in the removal of impacted parts of the field data. The estimated management implications coming from the data are that, in a growing season with weather the same as in 2024, planting at the optimal whole-field uniform application rate of 1.48 lb/acre would have raised profits by $12.6/acre above the average profit in areas where the grower's status quo rate of 1.87 lb/acre was applied. Furthermore, a site-specific strategy existed that would have raised profits by approximately an additional $0.17/acre, for a total gain of approximately $12.77/acre above status quo profits. Tables 1.1 and 1.2 present the basic trial results.[1] Of course, these results are weather-dependent and might change greatly under different growing conditions. Additional experimentation in future years would provide more information about how different strategies affected the probabilities of various economic outcomes. Since the economically optimal seed rates were consistently at or near the bottom of the trial's range of rates, we recommend that if similar trials are run in the future, a lower range of rates be employed to examine whether rates even lower than the lowest rate of the trial might be economically optimal in some part of the field.

Table 1.1: Mean Observed Yield and Profit by Average As-Applied Rate

Targeted Rates (lb/acre)	Average As-applied Rate (lb/acre)	Mean Yield (acre)	Mean Profit ($/acre)
1.28	1.48	50.60	393.78
1.58	1.78	50.08	384.66
1.87	2.09	50.06	379.52
2.17	2.50	51.71	386.61

Table 1.2: Model-Predicted Optimized Strategies and Profits

Optimal uniform rate	1.48
Profit gain from switching from the status quo strategy to the optimal uniform application strategy	$13.00
Profit gain from switching from the status quo strategy to the optimal site-specific application strategy	$13.00

2 Trial Design and Implementation

Figure 2.1 displays the seed rate trial design and the trial's raw as-planted data. The farmer's "status quo" seeding strategy (that is, the one that the farmer would have used had there been no field trial conducted) was to target the seeding rate uniformly across the field at 1.87 lb/acre. The status quo target rate was assigned to a buffer zone around the perimeter of the trial, but observations from the buffer zone were not included as part of the trial in later analysis. The trial design's targeted seed rates were 1.28, 1.58, 1.87, 2.17 lb/acre.

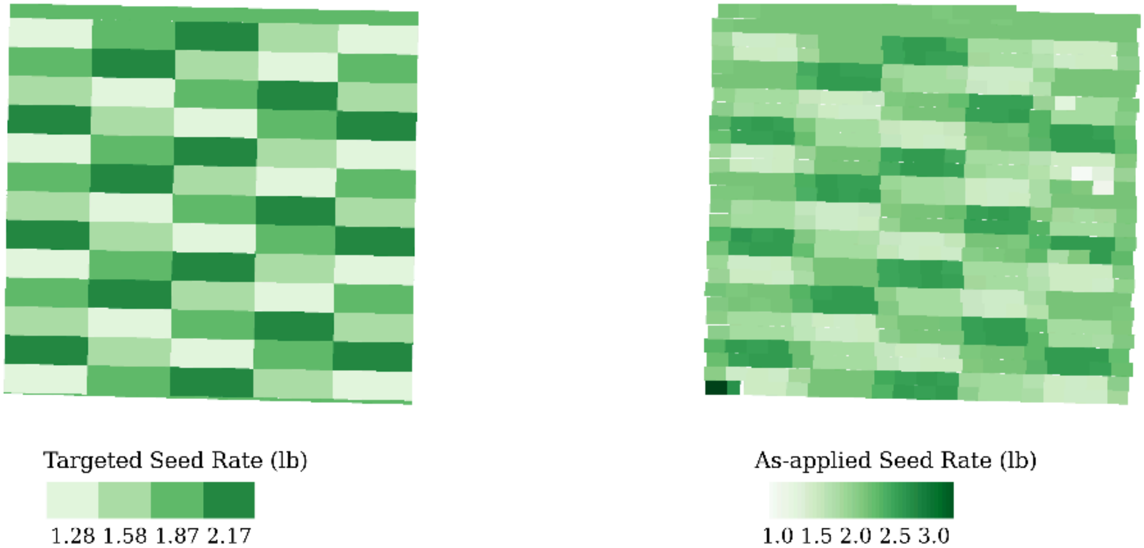

Figure 2.1: Trial Design and as-planted seed

DIFM data processing algorithms identified locations at which the combine harvested from multiple treatment plots simultaneously and removed data from those locations from the analyses. Overall, this field had some machinery alignment problems, with 86 percent of this field having proper alignment between the seeding and harvest. Figures 2.2 and 2.3 illustrate the data removal methods, showing where DIFM data processing algorithms identified three areas of the field with the average, best, and worst alignments; the areas had14,4, and25percent of their data removed because of misalignment.

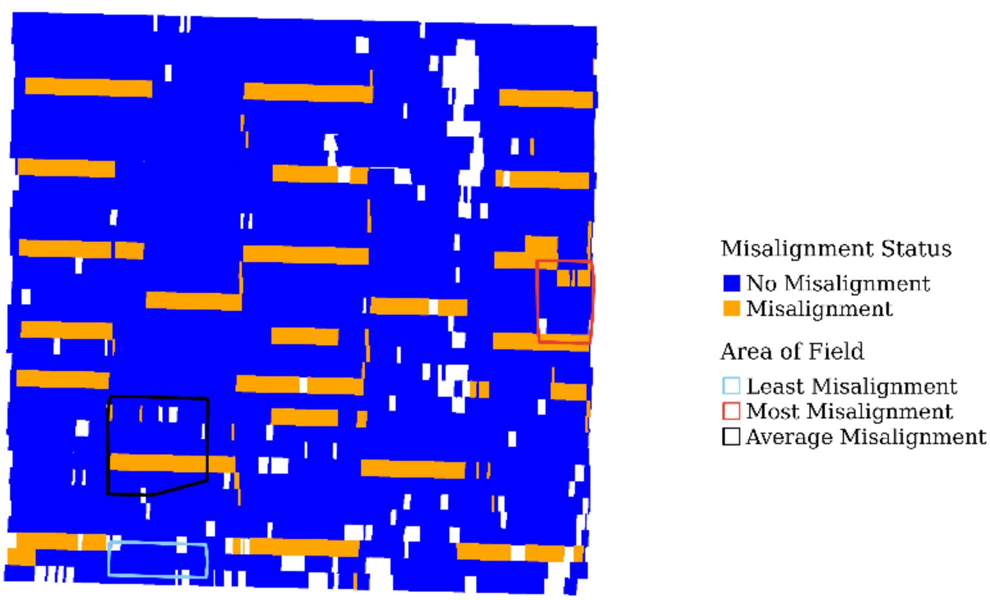

Figure 2.2: Map of Misalignment Status across the Field and the Areas used for Implementation Figures

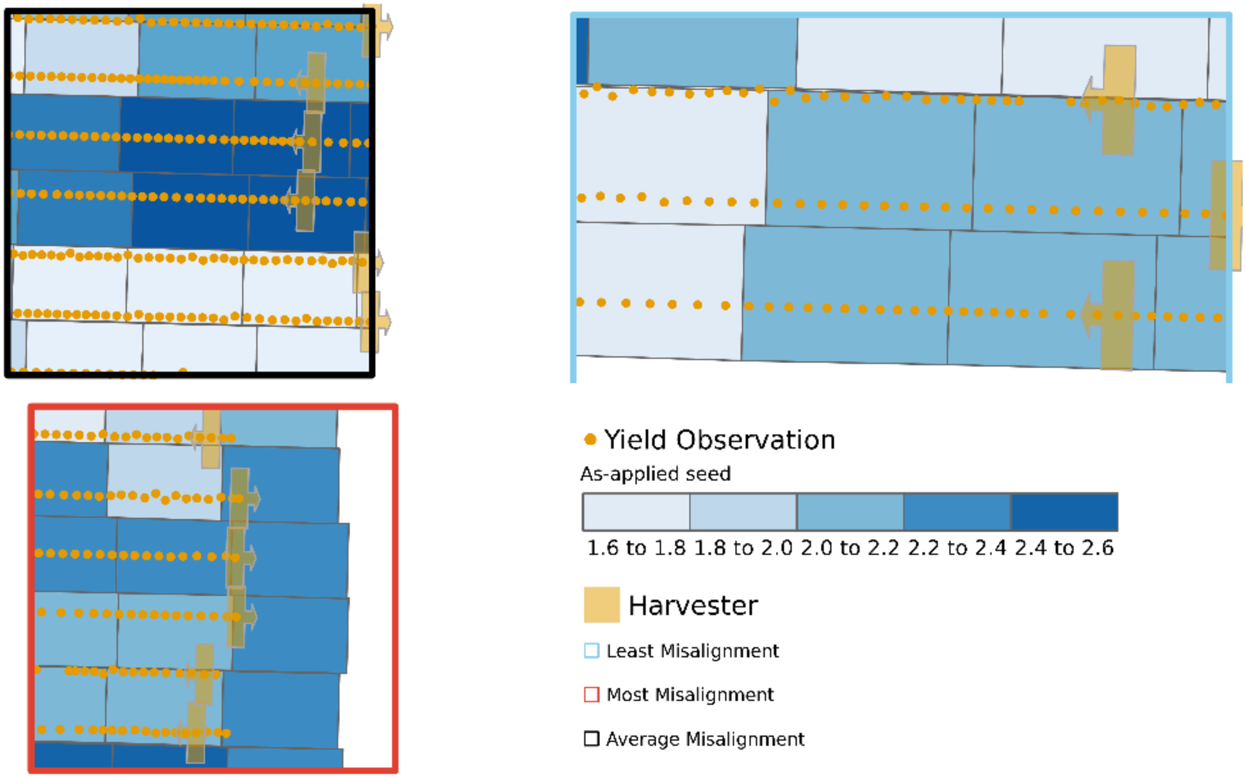

Figure 2.3: Figures showing the observations and how the machinery was driven in each of the field areas representing average, best, and worst machinery alignment

3 Yield Response to Seed Rate: Broad Picture

The top panels in figure 3.1 show how yield and profit[2] responded to increased seed rates in individual subplots. The bottom panel depicts *average* yield and profit for our averaged as-applied seed rates (these are the numbers found in table 1.1). The blue bars are the yield for each as-applied grouping and the overlaid orange line represents the corresponding average profit.[3]

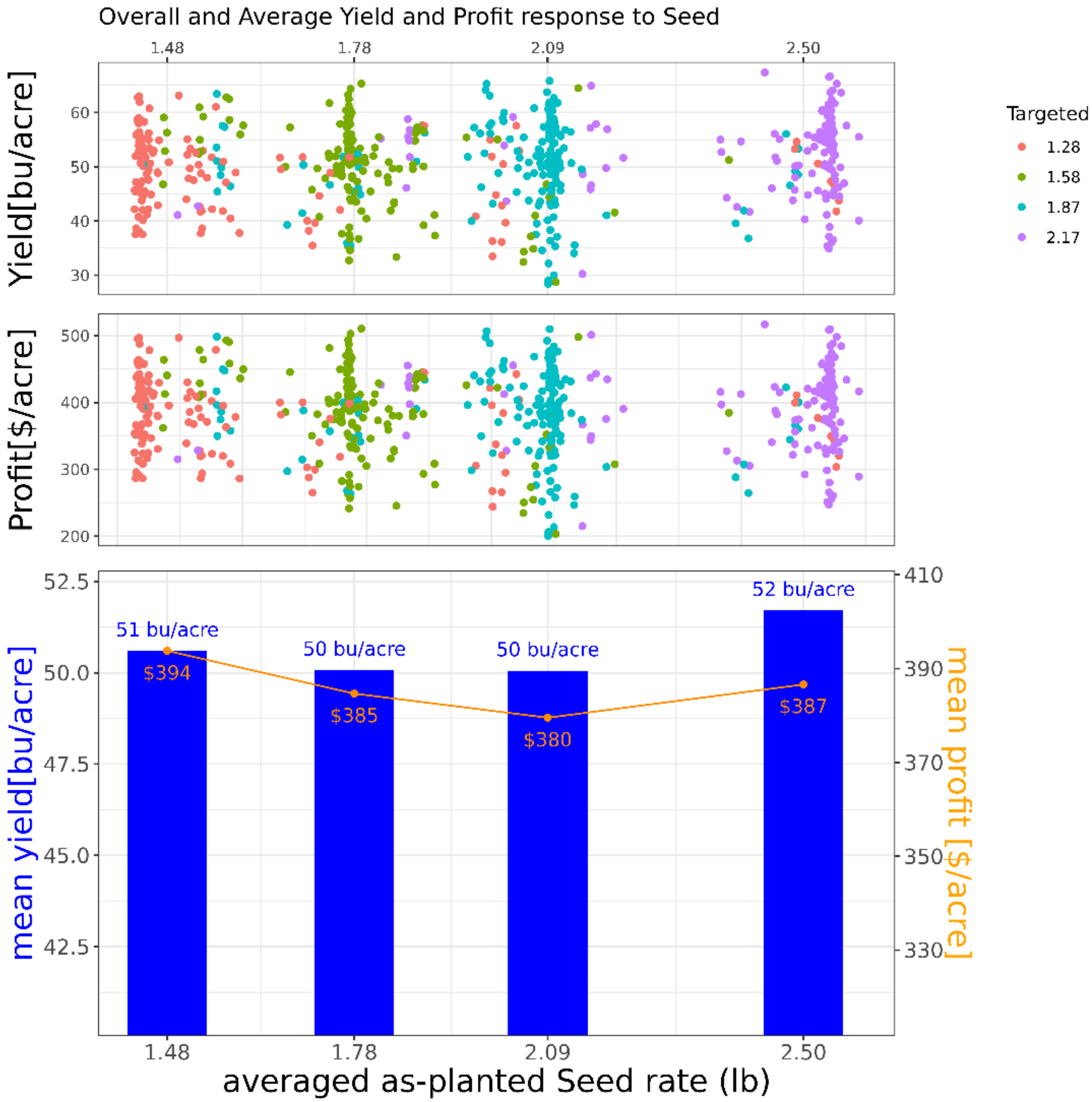

Figure 3.1: Overall yield and profit response scatterplots and mean responses to seed rate

4 Impacts of Field Characteristics on Yield Response to Seed Rate

DIFM's applied machine learning algorithms flagged (elev) and slope (slope) as potentially important covariates that interacted with the seeding rate in impacting yield. Figures 4.1-4.2 show the yield and profit responses under different levels of elev and slope. The estimated optimal seed rates decreased in areas with high elev and increased in areas with high slope.

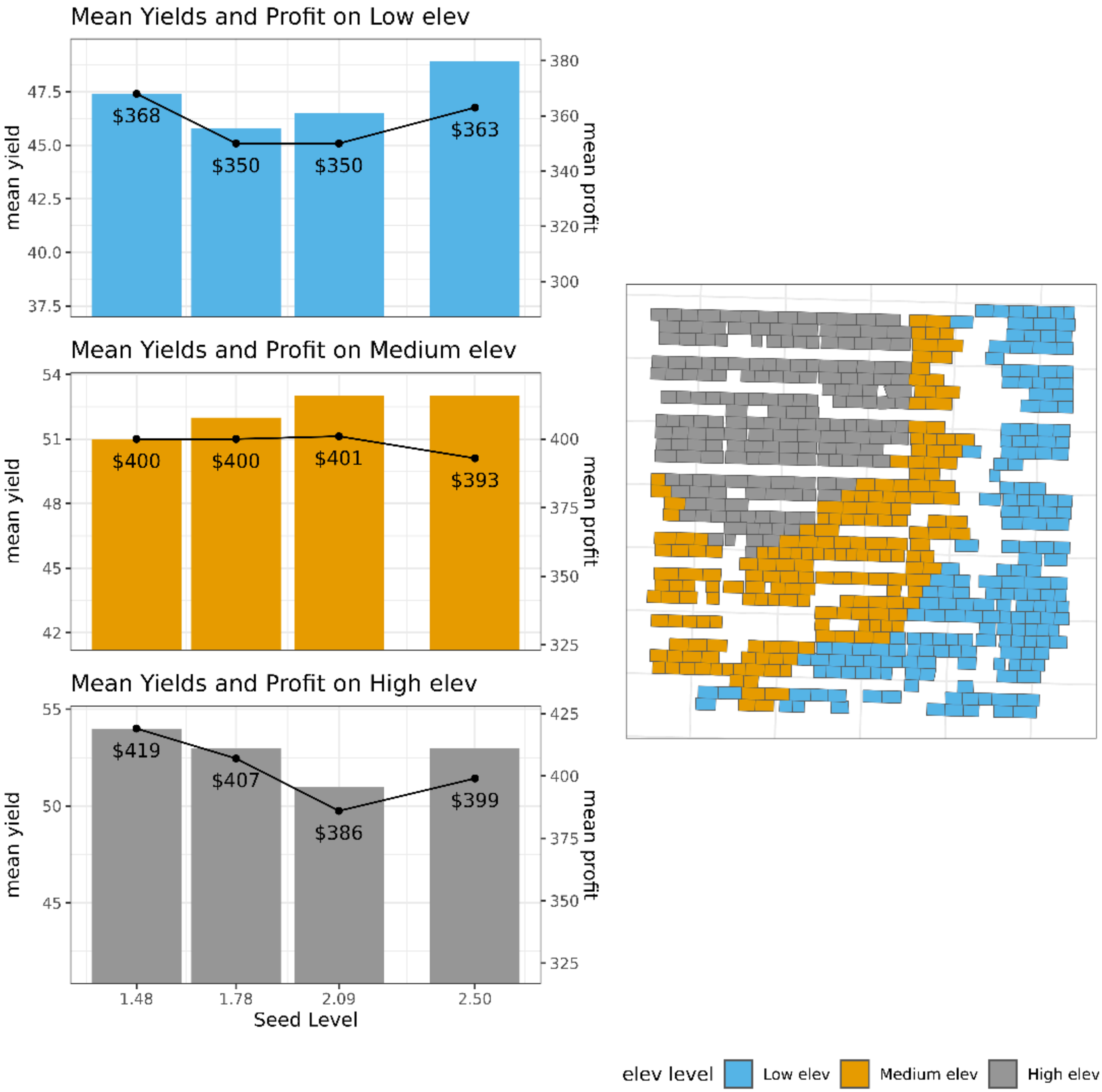

Figure 4.1: Yield and profit response to seeding strategy by elev level

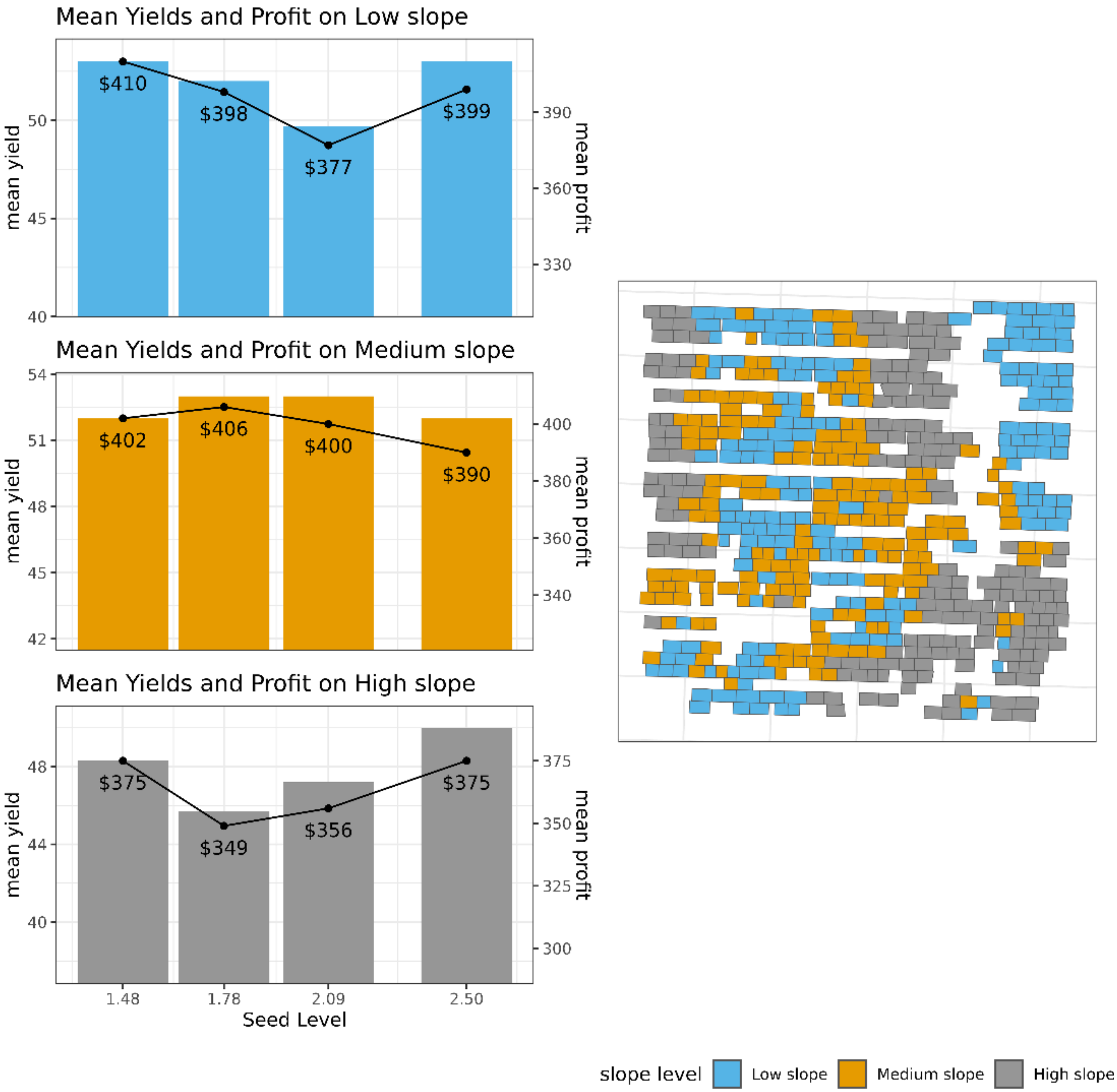

Figure 4.2: Profit and yield response to seeding strategy by slope level

5 Economic Results and Implications

It is estimated that implementing this strategy under the same growing season weather as in 2024 would have raised profits over $12.77/acre relative to status quo profit. Approximately $13.00/acre of those increased profit would come from changing to the optimal uniform rate of 1.48 lb/acre from the status quo rate of 1.87lb/acre. An additional $0.00 in profit gain would come from using the optimal site-specific strategy in place of the optimal uniform strategy. See table 5.1.

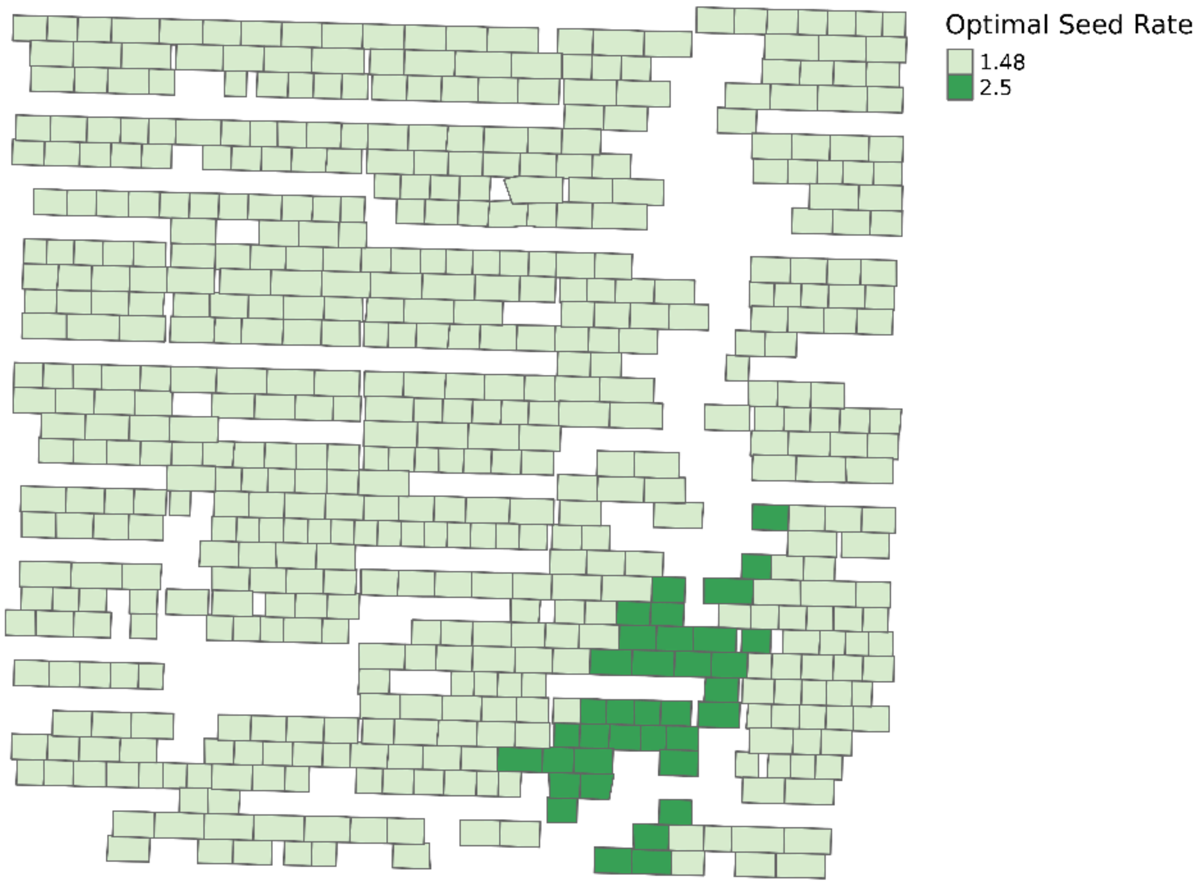

Figure 5.1: Map of economically optimal seeding application strategy

Table 5.1: Economic Results

Change in Management Strategy	Estimated Gain in Profits (per acre)
Substitution of the economically optimal uniform rate strategy for the grower's chosen strategy	$13.00
Substitution of the economically optimalsite-specific strategy for the economically optimal uniform rate strategy	$0.00

6 Appendix: Overview of Data Processing

The variable-rate planter and yield monitor provided raw as-planted and harvest data. An initial cleaning removed observations with extreme yield or as-planted rates (“outliers”) from the raw data. Points were also removed from the headlands, where the data is less reliable due to differences in sun exposure, changes in driving speed, potential application overlaps, etc. The yield points were grouped into polygons using the distance between points, swath width, and the headings recorded in the raw yield data. Subplots were created by grouping contiguous yield polygons with similar seed rates into sets of four. (Subplots were treated as the unit of observation in later analysis.)

A yield polygon was judged as having a “dominant treatment” when the standard deviation of the yield values at points within the polygon was below a threshold level. Adjacent as-planted polygons were judged as not being in the same group when the difference in application rates surpassed a threshold level. Polygons without a dominant treatment were not included in the data set used for analysis. This technique also helped eliminate "transition zones, which are areas in which the data show where the harvester and planter did not immediately adjust to new target rates or yield levels when passing from one plot into another. Each subplot’s mean as-planted rate and yield were recorded as data. The as-applied rates are averaged together in as many groups as there are target rates.

Finally, for each subplot the means of the electrical-conductivity data, and USGS digital elevation data were recorded. In addition, the values topographical aspect, slope, curvature, topographical position index and topographical wetness index were calculated from the raw data, and each subplot’s means of these values were included in the data used for analysis. Figure 6.1 shows maps of the processed yield and as-planted data.

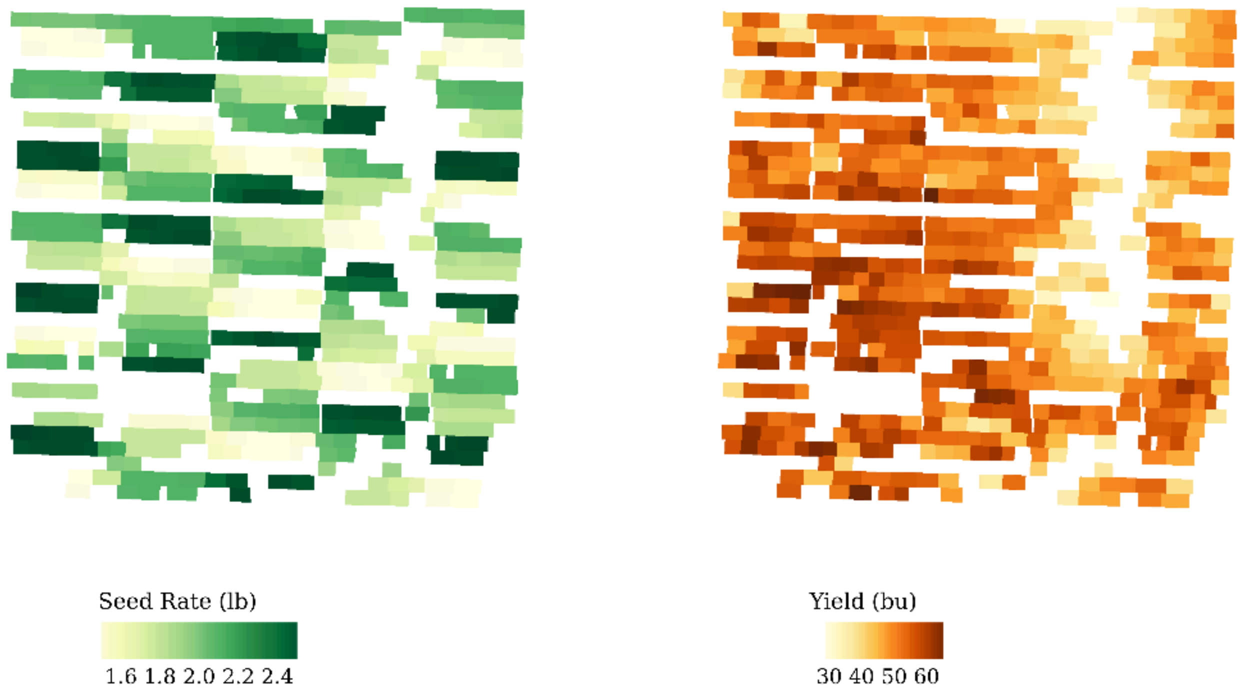

Figure 6.1: Yield and as-planted seed rates after data processing

7 Compensation Calculation

DIFM calculation of compensation is based on an estimation of the average difference in net revenues from areas in which the “status quo” rate, 1.87 lb seed per acre (that is, the rate the farmer would have used if not participating in the research) and all other rates applied. Per-acre net revenues are defined as Canola price times yield per acre minus seed costs per acre. Compensation equals this difference in per-acre net revenues times the acreage in the trial.

Of the 33 acre in the field, 25 acre had trial rates. Observations with an applied rate within 1.66 to 1.91 lb/acre of seed were considered as receiving the status quo application. Figure 7.1 is a map of the field with status quo areas in blue and the other trial rates (non-status_quo) in red.

The average net revenue on trial plots assigned status quo rates was $-4.00 less than the average net revenue on non-trial plots. As the status quo rate had a lower mean net revenues than did the other rates, the total compensation payment for this field is $0. There is also a “Thank You” stipend of $1,000 for all of the farm this year.

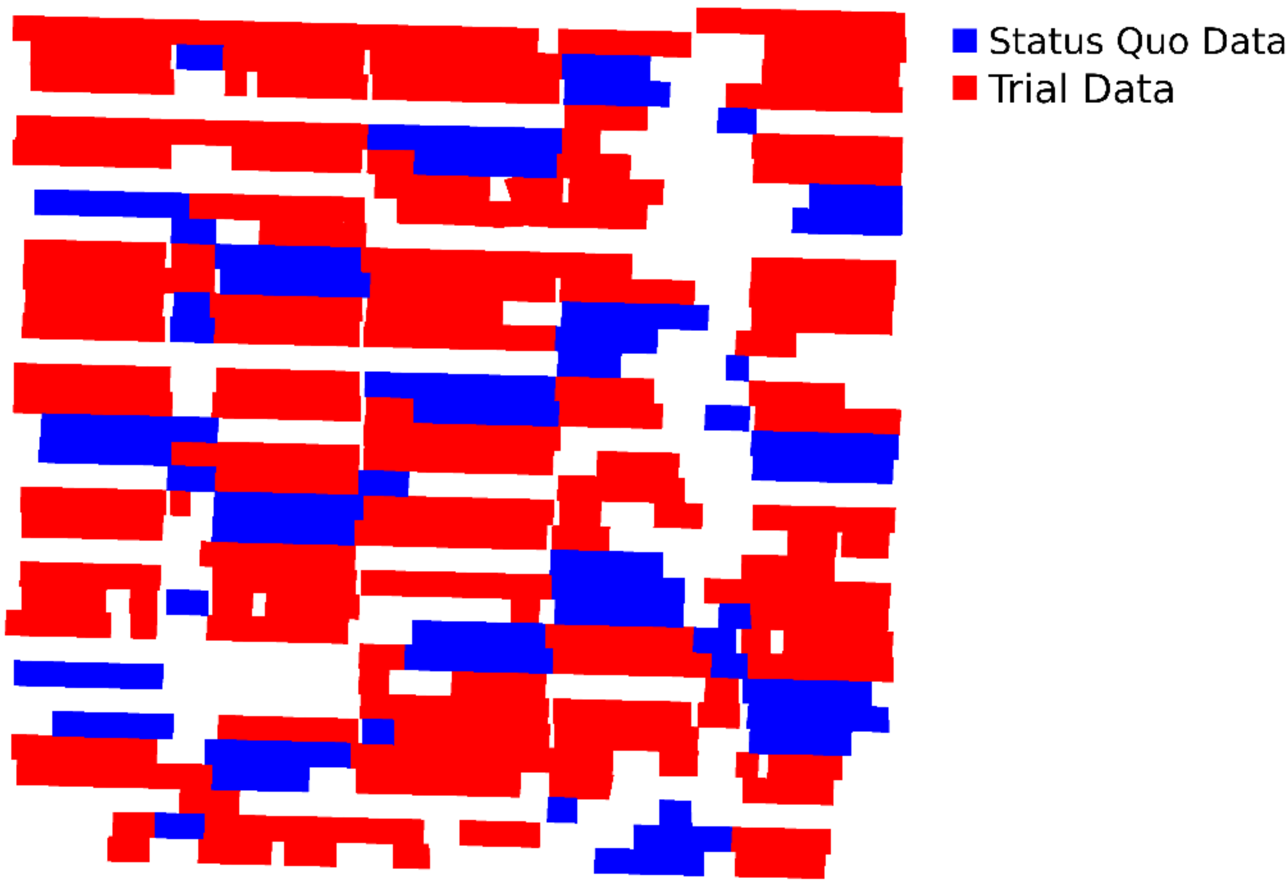

Figure 7.1: Map of areas with status quo and other trials rates

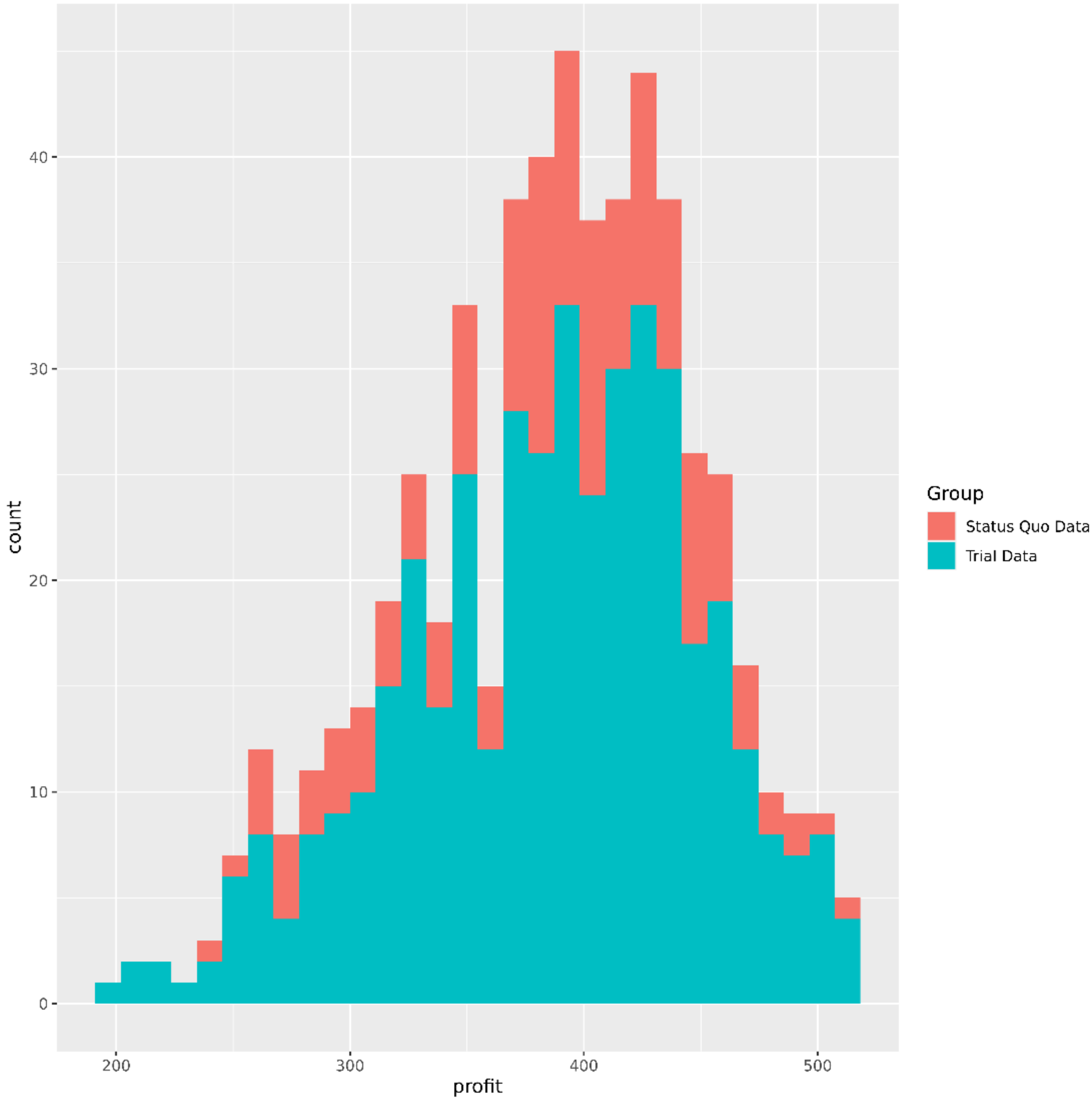

Figure 7.2: Histogram of profits on the status quo and trial area of the field

Table 7.1: Compensation Results

Status Quo Range	Number of Status Quo Observations	Profit Difference (SQ - Trial)	Area in Trial Rates	Total Compensation
[1.66 - 1.91]	145	$-4.00	25	$0

Tables 1.1 and 1.2 and Figures 3.1-4.2 show averages of the processed data, whereas recommendations, such as are reported in Table 1.2 and Figure 5.1, come from the statistical model that was fit to the data. In some cases, the “averages” of the data can differ from the model predictions. The discrepancy can come about because the number of plots targeted at a certain rate may be under- or over-represented is relatively small areas of the field. For example, if a disproportionate number of the plot assigned a particular target rate also happen to be often assigned to low-producing parts of the field, then their average yield in the actual data may be low. But the estimated model can account for this, and so predict higher profits from applying that target rate than appear in the actual data.↩

Profit here is defined as revenues per acre from Canola minus seed costs. No other production costs are considered here but should be subtracted to give an estimate of actual potential profit.↩

The stacking of these plots and the coloring of the dots in the scatterplot is intended to demonstrate the transition from the trial’s target rates to the averaged as-planted rates (the rates that make up the first two columns of table 1.1).↩