NutrientStar response to post hoc analysis of NutrientStar's evaluation of Adapt-N by Shai Sela and Harold van Es

The developers of Adapt-N were concerned that NutrientStar's evaluation of the program by use of 92 field-scale replicated trials in 2016 and 2017 was flawed and did not properly represent the accuracy and potential of Adapt-N. Harold van Es, the lead developer of Adapt-N from Cornell University, requested the opportunity to perform a post hoc analysis of NutrientStar's raw data from the results of the field-scale trials. NutrientStar's Science Review Panel agreed to the post hoc analysis.

The Science Review Panel agreed to an alternative analysis with the hope that the analysis would show how Adapt-N could be used in an adaptive nutrient management context.

The two specific objectives for the alternative analysis based on a re-evaluation of the 2016 and 2017 data that Sela and van Es agreed to were:

1. Evaluating outcomes when yield potentials are more closely aligned with actual achieved yields, and

2. Evaluating outcomes that involved early sidedress applications with significant subsequent rainfall where we would assess whether the tool would have made different recommendations based on higher risk assessments or suggested additional applications with follow-up monitoring. We recognize that in the latter scenario the trial cannot be re-run and fully evaluate an additional application.

The Adapt-N model evaluated in 2016 and 2017 by NutrientStar has been substantially improved based on information from Harold van Es. Current users of Adapt-N should evaluate the model for their environmental and management conditions.

The results of the post hoc analysis by Shai Sela and Harold van Es, which was paid for by Yara ATC the current owner of Adapt-N, are shown below. Immediately before the post hoc analysis are comments from the NutrientStar team about the analysis.

Comments by the NutrientStar team about the post hoc analysis by Sela and van Es of NutrientStar's evaluation of Adapt-N's performance in 2016 and 2017

1 **Use of achieved yields in 44 of the 92 trials instead of expected yields as calculated by consultants who implemented the trials.** Sela and van Es used achieved yields measured in the trials rather than expected yields to estimate N uptake by corn plants in their post hoc analysis. Use of achieved yields in the post hoc analysis greatly improved the performance of Adapt-N. It is not surprising that the performance of Adapt-N greatly improved when measured yields were used to perform a post hoc analysis. We note, however, that the expected yields for these trials were calculated by the consultants running the trials as instructed by Adapt-N scientists. The method used to calculate the expected yield is described on page 26 of the Adapt-N Training Manual with this wording: "We recommend

the fourth highest yield from the last five years" as the expected yield (Moebius-Clune et al. 2014).

Adapt-N uses a mass balance approach to modeling N needs. One of the drawbacks with using a mass balance method is the user of the model has to provide an estimate of the expected yield for the field. In years when the weather cooperates and yields are unusually high, the model will underestimate N needs. This is what we think happened in 2016 and 2017 at the 44 trials where the expected yields were adjusted up to the achieved yields by Sela and van Es.

2 **Use of an estimated yield from extrapolated yields from previous work by Sela et al. (2018) using the linear-plateau and quadratic models instead of the yields NutrientStar calculated using the quadratic model.** The NutrientStar team agrees that the quadratic-plateau model is the preferred model for yield response data in corn. However, strips trials performed in farmers' fields often have an insufficient number of N rates to enable the quadratic plateau model to converge. For this reason, NutrientStar used the quadratic model to calculate yields in this data set. Sela and van Es used the quadratic model to calculate yields at 14 site-years in strip trials reported in Sela et al (2017) when they evaluated recommendations from Adapt-N compared with recommendations from the Corn Nitrogen Calculator used by Cornell extension. We do not understand why it is appropriate for Sela and van Es to use the quadratic model to calculate yields in their papers, but not appropriate for NutrientStar to use the same method.

3 **Concern about time of sidedress N applications not completed at the recommended time between the V6 and V12 stage of growth.** To test the assertion that time of sidedress greatly affects the performance of Adapt-N, we analyzed Adapt-N trial results published by Sela et al. (2016). The paper reports results from 113 trials, which is the largest number of trials evaluating Adapt-N outside of the NutrientStar evaluations. The paper shows that 48.7% of the trials (55 of 113 trials) were sidedressed outside of the recommended V6 to V12 window (Sela, et al., 2016; Supplementary Table S1). Eight of the trials were sidedressed after the V12 growth stage, 47 before the V6 growth stage, and 58 between the V6 and V12 growth stages.

We analyzed the data in Supplemental Tables S1 and S2 from Sela et al. (2016) by dividing return to N (RTN) results from the 113 trials into three groups: 1) trials sidedressed before the V6 growth stage, 2) trials sidedressed from V6 to V12, and 3) trials sidedressed after V12. The results are shown in Table 1. There was no difference in RTN for trials sidedressed before V6 compared with trials sidedressed from V6 to V12. In theory, a model like Adapt-N should increase in accuracy as the season progresses because waiting later into the season should allow the occurrence of more rain events and a better estimate of growing degree

days. However, empirical evidence from these 113 trials suggests that the relationship between the performance of Adapt-N and the time of sidedressing is not clear-cut.

Table 1. Number of trials and mean separation statistics by Tukey's honestly significant difference test for comparisons of return to nitrogen (RTN) for three categories of trials based on the growth stage of corn when nitrogen was sidedressed. (Calculation from data in Supplemental Tables S1 and S2 in Sela et al., 2016).

Category[1]	Number	Mean RTN ($/acre)	Comparison	Tukey HSD p value
A	47	52.67	A vs B	0.890 NS
B	58	53.28	A vs C	0.001
C	8	224.38	B vs C	0.001

[1] Nitrogen sidedressed between: A = V4 and V5 stages of growth; B = V6 to V12 stages of growth; C = V13 to V16 stages of growth.

References

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