NutrientStar response to Dr. Harold Van Es blog: http://blogs.cornell.edu/newadaptn/research/edfs-nutrientstar-reports-do-not-reflect-adapt-n-capabilities/

The NutrientStar program recently posted 2016 and 2017 data for in-season nitrogen management model Adapt-N. In response, Dr. Harold Van Es, who is a leader of the research team that developed the Adapt-N model, posted a blog (see above link) criticizing the NutrientStar program's methodology and results.

Dr. Van Es' main criticisms are: 1) the NutrientStar field trials use methodologies based on old paradigms; 2) the ability of the consultants in the NutrientStar field trial network vary; 3) the NutrientStar findings contradict other research findings; 4) the TED framework suggests a level of precision that masks underlying weaknesses in the trial data; and 5) NutrientStar reports do not reflect the true use potential of Adapt-N.

The NutrientStar Science Review Panel stands by both the field trial methods used to test Adapt-N and the results from those trials.

Our summary points in brief:

- Dr. Van Es suggested the NutrientStar team should change the input values for the model to bring expected yields (which are a required input to the model at the time of sidedress) more in line with achieved yields (known after harvest) to report results. NutrientStar does not perform *posthoc* analyses to assess tool performance as this does not represent the true performance of the model as a farmer or consultant would use it in real time.
- Consultants in the NutrientStar testing network are trained professionals, many of them CCAs, - some have performed field trials for 10 years, and many have used the Adapt N model for at least three years. Based on their feedback the NutrientStar team posted Helpful Hints for using Adapt N on its website. We hope that these Helpful Hints might also be useful for the Adapt N research team as they further calibrate the model.
- Dr. Van Es argues for use of Adapt-N as a decision support tool for N sidedress applications at relatively late vegetative growth stages but such applications are often not feasible because most farmers do not have the required high clearance application equipment, so their sidedress applications must go on earlier.
- The other research studies Dr. Van Es references are all studies for which Dr. Van Es is a lead author. These studies provided results that differ from our NutrientStar report . NutrientStar is a third party review program, as such we maintain a high level of objectivity, and have no motivation to favor or disfavor model performance.

Summary of Dr. Van Es' criticisms and NutrientStar rebuttal points

The NutrientStar team discussed Dr. Van Es' criticisms with the NutrientStar Science Review Panel and the Panel members unanimously support all of the rebuttals detailed below.

Dr. Van Es:

> *NutrientStar evaluated Adapt-N in the old paradigm through fixed N response trials and post-season assessment of the optimum rates. This ignores that growers can use technologies that allow them to adjust N inputs and risk levels during the season to respond to in-season weather. Therefore, trial results are not based on the actual use potential of Adapt-N. This was most apparent in wetter seasons when many early sidedress applications – often at stages V3-V4 (too early for effective use of the tool) – were followed by significant rainfall and N losses.*

NutrientStar Science Review Panel reply:

- If effective use of the tool is only achieved after the V3-V4 stages, farmers who do not have late-season application equipment are not able to practically apply the model rate recommendations. The Adapt-N Training Manual (Moebius-Clune et al., 2014) recommends that "sidedressing is implemented between V6 and V12 for best results." The reality is most farmers lack the equipment needed to apply N to tall corn, and they are concerned about a risk of yield loss if they cannot enter wet fields to apply N.
- NutrientStar conducted its own analysis of the impact of sidedress timing on performance of Adapt-N, using results from 113 field trials published by Dr. Van Es and his team. The analysis indicates that the time of sidedressing N in relation to the stage of growth of corn may not be as important as indicated by the Adapt-N guidelines or by Dr. Van Es. The detailed analysis is appended.

Dr. Van Es:

> *The NutrientStar program mostly relies on crop consultants to implement the on-farm trials…their abilities to effectively use the Adapt-N tool varied greatly. This was reflected in the very diverse outcomes from the on-farm trials with each regional consultant (average profit ranges from -$131 to +$40). Upon review of the data, we found inconsistencies with data entry and implementation practices with some of the consultants, notably incorrect assumptions about yield potential and rooting depths. In many cases this approach strongly influenced results, which therefore do not represent the best use of the tool. This "naive" approach with some consultants (we were not given an opportunity to provide training) also negates the notion that the use of more sophisticated management tools like Adapt-N improves with practice and local adaptation. It is also out of line with results from many rigorous on-farm evaluations of the tool that showed win-win outcomes (see:1, 2, 3, 4, 5).*

NutrientStar Science Review Panel reply:

- Diverse outcomes from field trials are typical of on-farm evaluations of this type because results are impacted by many variables that operate in commercial-scale crop production. It would be extremely rare to see uniform results across trials.
- Consultants in the NutrientStar evaluation network received training and technical support from Agronomic Technology Corporation staff Greg Levow and Matt Sweeney when needed and when requested. The team had access to at least as much training as any consultant who would choose to use the Adapt N model.

- Consultants used their local knowledge of the fields rather than the generic rooting depth supplied by the SSURGO data base to adjust rooting depth values. The Adapt-N model allows for such adjustments to be made.
- For expected yields, all the consultants used the recommended method in the Adapt-N manual, which is to use the "fourth highest yield from the last five years" (Moebius-Clune et al., 2014).
- Dr. Van Es indicated NutrientStar should adjust yields when reporting results. This is evidenced in an exchange of emails between Dr. Van Es and NutrientStar administrators about NutrientStar's results from 2016. In the email, Dr. Van Es states "*I did a cursory evaluation of discrepancies between expected yields and achieved yields for the Nutrient Star trials. There are definitely a number of trials where they were out of line. In many cases this involved trials where Adapt-N appeared to be off-target, and appropriate adjustments would improve closeness to the EONR and reduce profit losses.*"
- No consultant or farmer could know at side-dress time what the season's yields will be. As stated earlier, NutrientStar does not make *post-hoc* adjustments to model inputs that would favor the model performance. This type of adjustment would not represent a real-time use of the model by an advisor in the field and would bias the results in favor of Adapt-N.
- Dr. Van Es is a lead author on all the papers listed as references for the "rigorous on-farm evaluations of the tool." NutrientStar values third-party evaluations over company evaluations in all cases.

Dr. Van Es:

> *The NutrientStar reports compare our technology with farmer rates. However, it was not a direct side-by-side comparison but an indirect assessment after curve fitting procedures. The trials actually involved multiple pre-selected nitrogen rates which were fitted with a yield response curve. The Adapt-N and farmer rates were evaluated on how they fit on the response curve. NutrientStar uses quadratic functions, which are known to calculate optimum N rates that are too high. Moreover, NutrientStar emphasizes the relative profits (returns to nitrogen) and not the N reductions and environmental gains from the tested technologies. Many trials involved minor profit tradeoffs with significant environmental gains, as indicated by the fact that virtually all trials showed increases in nutrient use efficiency.*

NutrientStar Science Review Panel reply:

- Dr. Van Es' research team also used curve-fitting procedures as well as quadratic functions to evaluate Adapt-N in multi-rate trials as reported in Sela et al. 2017.
- The NutrientStar team used modelled yields for both the N rates applied by farmers and for the N rates recommended by Adapt-N, which would make any upward bias in the yields similar for both N rates. The team used the quadratic model because the yields were unusually high in 2016 and 2017 and the quadratic plateau model would not fit the data.
- NutrientStar reports NUE achieved and profitability achieved in the same table. NutrientStar's audience and users are agronomic advisors and farmers, who care about NUE, environmental outcomes and profitability.

Dr. Van Es:

> *The farmer rates did not reflect a representative range of real farmer practices, but were generally based on consultant recommendations for farmers that use a fixed N management approach with in-season application technology. The NutrientStar results therefore underestimate the potential benefits from technologies like Adapt-N to help farmers optimize 4R-Plus management through its advanced reporting features.*

NutrientStar Review Panel reply:

- It is true that most of the farmers who performed the NutrientStar Evaluation Network field trials routinely sidedress N, making them perhaps more progressive than the majority of farmers. However, Dr. Van Es and colleagues' evaluations of Adapt-N also included many farmers who routinely sidedress N.
- We agree that finding farmers who typically apply much of their N in the fall or all of their N as preplant to evaluate models like Adapt-N would provide more variety of practices in the sample. At the same time, there is still room to improve inefficient sidedress application practices that can also lead to yield and N losses.

Dr. Van Es:

> *The TED framework used with NutrientStar allows a user to look at the apparent regional adaptability of a technology. However, the results in different types of growing regions are highly confounded with the practices of the regional consultants who conducted the trials. Therefore, the notion that a technology works better or worse in a particular TED region is an inaccurate representation of its actual regional performance potential. We found Adapt-N performance to be similarly good for many regions of the country.*

NutrientStar Science Review Panel reply:

- The NutrientStar main page for Adapt N data displays results by state. Users are able to see trial results presented for both states and TEDs.
- The differences in the results reported by Dr. Van Es and colleagues and the NutrientStar Network is unlikely to be due to the practices of the regional consultants who conducted the trials for the NutrientStar network, but rather is likely the result of differences in the genetics X environments X managements between the two sets of trials.

In summary, the NutrientStar team is highly motivated by objectivity and the desire to present data and information to farmers and their advisors that is subjected to rigorous third-party review. The NutrientStar team is not motivated to favor or disfavor Adapt-N. If anything, the team would prefer that such models could be shown to consistently perform well.

References:

Moebius-Clune, B.N., M. Carlson, H. M. van Es, J. J. Melkonian, A. T. DeGaetano, and L. Joseph. 2014. Adapt-N Training Manual - A tool for precision N management in corn. Edition 1.0, Extension Series No. E14-1, Department of Crop and Soil Sciences, Cornell University, Ithaca, New York 14853. Available at: file:///C:/Users/Admin/Downloads/adapt-n-manual%20(2).pdf.

Sela, S., H. M. van Es, B. N. Moebius-Clune, R. Marjerison, J. Melkonian, D. Moebius-Clune, R. Schindelbeck, and S. Gomes. 2016. Adapt-N Outperforms Grower-Selected Nitrogen Rates in Northeast and Midwestern United States Strip Trials. Agron. J. 108:1726–1734.

Detailed analysis: sidedress timing impacts on performance of Adapt-N

To test the assertion that time of sidedress greatly impacts performance of Adapt-N, we analyzed Adapt-N trial results published by Sela et al. (2016). The analysis showed that 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. The average time between growth stages of corn is only 3 days, which means only a 6-day difference between a trial sidedressed at the V4 growth stage and a trial sidedressed at the V6 growth stage. Sidedress N rate recommendations from a computer model like Adapt-N would change little in 6 days unless there was a substantial rainfall event that caused large leaching or denitrification of nitrate in those 6 days. This analysis suggests that there were too few large rainfall events that altered N recommendations and changed the RTN when corn was sidedressed between the V4-V5 growth stages compared with the V6-V12 growth stages.

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.