## **KEY:**

Editor/Reviewer Comments
Author Response
Already in Text
Modified Text
**Comments from Reviewer #3**

**SECOND Review/Response (September 7, 2016)**

**Reviewer: 1**

Comments to the Author

Even though the authors explained the impossibility of using the site specific NUE in the analysis. I still don’t agree with this because the unified NUE using in calculating the optimum rate will mask the real changes. So the conclusion that “optimum N rates were not highly correlated with the high N rate yield or zero N check yield” is not convincing.

Thank you for your added thoughts and comments. Your input has made this a better paper. For the 27 locations where long-term data was reported, 5 included grain N data. Had the authors for each publication reported grain N, an NUE value computed using the difference method would have been accomplished ((N uptake treated – N uptake check)/N rate applied).

Nonetheless, the subset of data that was further analyzed shows that optimum N rates (ONR) when using back calculated estimates of NUE (by site and year, using reported grain N), end up being just as variable, as when using a fixed NUE.

Optimum N rates were not highly correlated with the high N rate yield and/or zero N check yield as was reported, and was a product of the site and year analysis included in this work. We do understand that this information is sensitive, especially for those regions where excess N has been applied.

For the Olson et al (1986) paper that was added, NUE’s that could be computed because grain N was reported, ranged from 0.06 to 0.79 (6 to 79%). The average was 38% (1969 to 1983).

Optimum N rates (using a fixed 33% NUE) ranged from 65 to 345 kg N/ha and averaged 196 kg N/ha, ± 84

Optimum N rates (using by-year observed NUE for the 90 kg N/ha rate) ranged from 94 to 407 kg N/ha and averaged 173 kg N/ha, ± 83.

Our analysis is that the conclusions of this paper are unlikely to change whether or not a “site specific” NUE could be computed (optimum N rates vary considerably from year to year at the same location)

 **Reviewer: 2**

Comments to the Author

Thank you for your revisions. At this point I only have one suggestion that is very minor.

Page 6 line 17 "have taken precision agriculture to a different level" Here you state that sensor technology has taken precision agriculture to a different level. Can you make a more direct statement that does not leave room for interpretation. I assume by "different level" you are meaning it is substantially improving our ability to accurately estimate the optimum N rate each year.

Thank you for the correction and suggestion for needed clarification. Text included below now more succinctly makes this point.

…. In recent years, the use of Normalized Difference Vegetation Index (NDVI) crop sensors like GreenseekerTM (Trimble Navigation Ltd., Sunnyvale, CA), and Crop Circle® (Holland Scientific, Lincoln, NE), have taken precision agriculture to a different level via the ability to both detect N deficiencies and to prescribe environment-specific, mid-season N rates. Sensor based N rate recommendations can vary both spatially and temporally, have been further refined by location and crop ([www.nue.okstate.edu](http://www.nue.okstate.edu)), and are currently available to producers (Franzen et al., 2016).

**Reviewer: 3**

Comments to the Author

See attached file.

**The authors removed the term “central Great Plains” from the title but left it in the abstract (P.**

**1. L. 8). It also needs removed there as well, since few of the articles reviewed are from the**

**central Great Plains.**

Correction made. Thanks.

**Perhaps, the concluding sentence could state this this is a potential solution?** Agreed, correction included below

A potential solution is to employ mid-season sensor based technologies that can accurately predict yield potential and simultaneously encumber N responsiveness known to be independent of yield.

**Mostly done, except for abstract and last paragraph of the introduction.**

Central Great Plains deleted. Thank you for the correction

**I still find it hard to believe that no papers exist from other states, particularly Illinois, Indiana,**

**and Ohio, etc.**

No effort was made to exclude/include data from any region/state, but rather to highlight those where N response in maize was published in a refereed publication. The 26 (now 27) sites included were considered to be representative of maize in the US, and the 83 (now 86) papers cited, a robust and representative collection of maize N rate response data. Your point is excellent in that data exists in these states as well, but that may not have ended up in a refereed journal. It is more of an issue of where you stop.

**Despite your response, this was not done. Page 7, line 11, still states** “exceedingly high N

fertilization rates in maize in the Central Great Plains”. **Please correct this since these states are not in**

**the central Great Plains.**

All references to the Great Plains have been removed.

**Editor:**

Comments to the Author:

One reviewer placed primary importance on use of experimental NUE value, rather than a common value supported by literature. Other readers may well share this concern. The Response Index metric for N response does not depend on assumptions of NUE, and support the authors primary point: maize response to N varies among sites and years. Authors are encouraged to examine this perspective, to strengthen the contribution and address a concern held seriously.

The response index is discussed in the Arnall et al. (2013), Mullen et al. (2003), and Raun et al. (2011) publications that were cited. This is now better referenced in addition to describing the medium-N rate plot mentioned below.

Authors should specify how medium-N rates were identified; what guidelines followed to identify this rate, which likely varied among the numerous studies?

Now included in the text is the following. The medium-N rate was that rate used in each respective experiment that was at or near the middle of the range of N rates applied. This approach was also used by Arnall et al. (2013).

Additional opportunities for clarification are noted below.

Another reviewer indicated results are not restricted to Central Great Plains, rather representing a range of maize growing regions throughout the US. Two references to Central Great Plains (in abstract and final paragraph of introduction) are therefore inappropriate, and should be omitted.

References to the Great Plains, and/or Central Great Plains have been deleted.

P1 L8 Please remove reference to “Central Great Plains” in objective statement; see comments from

Reviewer 3

Deleted

P1 L16-18 This statement is not directly supported by evidence analyzed in the paper; however it is referenced in the introduction; modification to reflect the focus of the experimental objective is appropriate.

The wide range in optimum N rates observed in all maize experiments suggests the need to adjust N rates by year and location.

P1 L11 Please specify “assumed average N use efficiency” or similar; see comments from Reviewer 1

Change included

P6 L17 Please clarify “. . . to a different level.” See comments from Reviewer 2

Change included

P7 L11 Please remove reference to “Central Grain Plains” (Reviewer 3)

Change included

P8 L3 Please clarify %grain N. If the numerical value is used (e.g., 1.2), rather than fractional value (e.g. 0.012) the calculated results will differ by a factor of 100.

Clarification added

P8 L6 Please indicate the direction of bias (e.g., an effective NUE of 0.4 would reduce the optimal N rate relative to the assumed value of 0.33).

Change included

P9 L12-13 Please specify how medium-N rate (R1 Mid-N) was identified, among studies.

Clarified above and Change included

P10 L15-16 Does “. . .slope and intercept. . .” refer to regression of high N rate yield and check plot yield on optimum N rate? If so, please combine statements. Text modified for added clarification.

Slope and intercept components for high N rate yield and check plot yield on optimum N rate were statistically significant (Pr>|t|) at the 0.10 % level.

P10 L16-18 Reviewer 1 placed extreme importance on the assumption that 0.33 represented NUE; the Response Index approach (RI 0-N, RI Mid-N) does not depend on this assumption (or calculation of optimum N rate). Authors can address the concern of Reviewer 1 by elaborating on variability of RI 0-N, as well as stability of RI Mid-N, and interpreting this variability in relation to variation in calculated optimum N rate.

Issues surrounding the use of a fixed NUE value were included in the response to Reviewer 1.

The response index (high N rate or mid N rate plot, divided by the check or 0-N rate plot) is bound to the NUE present at a given site and/or year. In theory, if the RI is lower, NUE should also be lower. Higher RI’s should thus be associated with higher NUE values. Nonetheless, high NUE’s can be misleading (J. Plant Nutr. 32:2107).

Thank you again for your comments and thorough review.

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**FIRST Review/Response (June 21, 2016)**

Reviewer(s)' Comments to Author:

**Reviewer: 1**

Comments to the Author
The authors used fixed NUE to calculate the optimal N rate and analyzed the relationship between yield and optimal N rate and found poor correlation. The NUE data obtained is site specific and no reason to calculate like this. I suggest the authors use the actual data for this analysis.

This is a good point. However, as was delineated on page 9, the rationale for using 33% NUE for all sites was reported. We recognized that this value would be discerned by some, but the other 2 reviewers accepted this approach. Computing NUE by site was a nice recommendation from this reviewer. However it was not possible because the grain N data was not available for all experiments. This has now been clarified.

A fixed NUE value of 33% (0.33) was used to reflect shared findings in cereals and with a derivation coming from a wide range of locations and years (Raun and Johnson, 1999; Olson and Swallow, 1983). Changing this value either higher or lower will result in a predictable bias. Using a fixed NUE for these trials, when combining over locations and years would likely compress the variability in optimum N rates reported. Other estimates of NUE exist and are in the 30 to 40% range (Cassman et al., 2002; Olson, 1980; Olson and Swallow, 1983). Also, computing NUE by individual site was not possible because grain N concentrations were only reported in a few of the papers included in this work.

**Reviewer: 2**

Comments to the Author
This is well written review. It provides valuable and concise information regarding the variability of optimum N rates and the need for in-season management for improving NUE.

Thank you for your comment.

**Reviewer: 3**

Comments to the Author
Review of “Variability in optimum nitrogen rates for maize in the central Great Plains.”

An interesting topic and my specific suggestions/comments are outlined below but, in general, it would have been really useful to include line numbers to help with the review.

1. Title. The title is misleading. With studies cited stretching from Minnesota to Texas and Colorado to Maryland, this region is much larger than the central Great Plains. I suggest removing “in the central Great Plains” from the title.

Thank you for the suggestion. We have removed “Central Great Plains”.

2. Abstract. The concluding sentence seems extremely strong since it refers to a topic that was only minimally covered in the manuscript.

Thank you for your comment as you clearly went through our paper. If a solution exists, and that has citable references, this to us was something that had to come out. It couldn’t just be about the N rates being too high as that was self-evident when evaluating all of these trials together. Authorship required that we offer a potential solution/recommendation for the future.

3. Geographic regions. The use of multiple terms for geographic regions is confusing. Terms used included central Great Plains, north central US, US Grain Belt, Mid-West, Midwest US grain belt, maize belt, North Central US, and Midwest across the Corn Belt. I suggest reducing the number of terms used to describe regions and possibly define what area is included in the region.

This is an excellent point. Most of the studies included are from the mid-west which happen to be the major areas for growing maize in United States i.e. US maize belt. The terms used in the different papers were clearly different, and as such we adhered to what was used to be consistent with the citation.

4. Materials and Methods. Categorizing the studies evaluated in Table 1 as being from the central Great Plains is incorrect. Many of the field experiments are far removed from the central Great Plains, especially the ones from Minnesota, Wisconsin, Kentucky, and Maryland. Based on the definitions that I found for the central Great Plains (Britannica.com and Wikipedia.org), only the studies from Colorado, Kansas, and Nebraska might be considered in the central Great Plains but even they may be too far east.

Good point. Within the text, this has been changed to the maize growing states in the US, or variants of as much so as to work within given sentences.

5. Within the broad region included in the manuscript, I would think there would be other field experiments from states such as Illinois, Indiana, Ohio, etc. Were no published field studies found from these other states? I entered “nitrogen fertilization of corn” for an internet search and immediately came up with a 10-yr summary of corn response to nitrogen fertilizer in Indiana ([www.kingcorn.org/news/timeless/NitrogenMgmt.pdf](http://www.kingcorn.org/news/timeless/NitrogenMgmt.pdf)).

This is another good point. However, the Purdue data you reference was not from a refereed journal publication. We salute their work, and that of others. Nonetheless, our focus was on published papers that had been through a thorough review. We had access to added data from Mead, NE (14 years, Professor Robert A. Olson) that similarly was not used, because it had not been formally published. But, it too shows that optimum N rates are highly variable from year to year.

6.Results. The first three sentences of the results seem to fit better under Materials and Methods.

This is an excellent point. The text has been moved back into the Materials and Methods section.

7. The concluding paragraph states the effect of nutrient loading on the growth of the hypoxic zone in the Gulf of Mexico from “exceedingly high N fertilization rates in maize in the Central Great Plains” while on page 3 it is stated that the region of “south western Minnesota, Indiana, Iowa, Illinois, and Ohio are the greatest contributor of nitrate to the Mississippi river”. The region described on page 3 is not part of the central Great Plains.

These are good points. Combined with the changes requested on the use of the “Great Plains”, this paper has been significantly improved. Not all of the references can be reconciled with the removal of Great Plains.

Page 3 included a reference from Dale et al. (2010) that specifically delineated Illinois, Iowa, and Indiana, and we reported as such. The David et al. (2010) reference also specifically noted “Minnesota, Indian, Iowa, Illinois, and Ohio”… For both we cited those states that they specifically reported.

Overall, I believe the authors need to better define the geographic region they are addressing. This might mean restricting the area to fewer states, e.g. perhaps concentrating on Iowa, Minnesota, and Nebraska. On the other hand, if the focus is to address the hypoxic zone in the Gulf of Mexico, they would need to include publications (if available) on more of the states that have drainage going into the Mississippi River. I recommend that the manuscript be reviewed again after the authors address the concerns mentioned above.

Addressed above

**Associate Editor: 1**
Comments to the Author:
This manuscript analyzes yield responses of maize to supplemental N. An acceptable means of calculating optimal N rates was applied to 198 site-years of published results. A response index was constructed, relating yield at maximum N rate to either zero supplementation or a moderate level of N supplementation. Analysis of these results demonstrates substantial variability across sites and among years within a site. The potential contribution of this work is the analysis of consistent measures of corn yield response to N, e.g. a method quantifying optimum N rates and the N response index. This potential contribution is recognized by one reviewer.

One reviewer identified use of a single N use efficiency term as a critical flaw in the method.

Addressed above

One reviewer found reference to "Central Great Plains" as confusing, given the broad geographical region represented in source data, and not relevant to the objective, nor to essential conclusions.

The recommendation is to eliminate reference to "Central Great Plains", to include information from the corn belt (either in data analysis, or in literature review). Specific comments of each review should be explicitly addressed.

These changes have been made

Some sentences in Discussion and Conclusion require substantiation or clarification. Examples:
"Expected differences in by-site. . . (Table 1)" Table 1 does not report any information about rainfall and temperature. No evidence is provided to support this discussion point.

One of many articles addressing year to year variability in yields due to environmental/climate differences has been included.

Mamo, M., G. L. Malzer, D. J. Mulla, D. R. Huggins, and J. Strock. 2003. Spatial and Temporal Variation in Economically Optimum Nitrogen Rate for Corn Contrib. from the Dep. of Soil, Water, and Climate, Univ. of Minnesota, and the Minnesota Agric. Exp. Stn. . Agron. J. 95:958-964. doi:10.2134/agronj2003.9580

"Other reasons for differing estimates of N responses includes (sic) yield level that impacts response/demand. . ." Not clear what authors are referring to.

This comes from the Gehl et al. (2005) publication. Their work simply highlighted that N demand was influenced by the yield level. This has been clarified.

"As such, maize producers should consider the unpredictable weather patterns. . ." In what way should producers consider an unpredictable production factor?

Knowledge that weather from one year to the next is highly variable is a reminder that the N rates from year to year are also expected to change. Producers that ignore as much and apply the same N rate, year after year are unlikely to benefit from a mid-season N decision.

The final sentence in conclusion "This in turn asks the question as to why by-site fertilizer N rates being applied to not reflect that same variability in the Central Grain Plains." is neither clear, nor a conclusion. I recommend omitting this.

This has been changed as per your suggestion. The final sentence now reads as follows.

Published results coming from an array of sources, and from multiple sites, and years, revealed extensive variability in optimum N rates for maize and that should be reflected in current day N recommendations.

A revised manuscript must include line numbers, to facilitate review and comments.

Line numbers included. Thank you for your excellent review

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