<u>To</u>: Climate Action Reserve

<u>From</u>: Noel Gurwick, representing The Union of Concerned Scientists
Meredith Niles, UC Davis
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<u>Subject</u>: Comments pertaining to the *Nitrogen Management Project Protocol Version 1.0 for Public Comment (April 24, 2012).*

<u>Date</u>: May 23, 2012

We have several concerns with the limited scope of the draft protocol – under which farmers can earn GHG credits for only one management practice, reducing the amount of nitrogen fertilizer applied annually to corn in the Midwest (Table 2.2, p. 6) -- and the approaches used to quantify changes in $N_2O$ emissions from reductions in N fertilizer application to corn, under a variety of circumstances (farms that use manure, fields that do/do not use cover crops). We detail these concerns below.

1) **Extrapolation from measurements on five fields to 12 states** (Use of MSU-EPRI empirical relationship, Table 3.1 p. 11)**.**

The reduction in $N_2O$ emissions is estimated using a nonlinear regression developed at Michigan State University, based on several years of measurements on five fields in Michigan, all planted in corn (Section 5.4 p. 31-32) (Hoben et al. 2011). The draft protocol applies this regression across 12 states, called collectively the "North-Central Region (NCR)," and known commonly as the Corn Belt. Soil texture is a key driver of $N_2O$ emissions, as is soil moisture (which responds to tile drainage). Yet variation in soil texture, soil drainage, and temperature are all much greater across the NRC than across the five fields where this regression equation was developed. Similarly, climate patterns determine moisture availability; there is a large gradient in precipitation across the region considered, with Nebraska, North Dakota, and South Dakota significantly drier than the MI sites from which the equations were developed. In sum, the 12 state region represented in the draft protocol varies significantly from the five Michigan field sites. As a result, we do not believe the regression equation used to quantify $N_2O$ emission reductions should be extrapolated that far from the conditions under which it was developed. Doing so misrepresents the potential $N_2O$ emission reductions that can actually be achieved.

Within the range of soil texture common in agricultural lands, 5-10% clay content is a good proxy for categorizing the soil into fine, medium, or coarse (alternatively heavy, medium, light) texture classes (http://soils.usda.gov/technical/aids/investigations/texture/). Categorizing the Bouwman et al. (2002) database into $N_2O$ emissions by crop and soil texture shows significant differences in mean, median, minimum, and maximum $N_2O$ flux among these texture classes (Tonitto et al 2009). And in DNDC model runs soil % clay is one of the most significant controls on $N_2O$ loss.

For precipitation, relationships developed with data from the five Michigan fields can reasonably be extrapolated to areas where the 10-year average growing season precipitation is within 1 standard deviation of the 10-year average of field sites.

Recommendation: Until further field observations are available to refine these relationships, the relationship currently used in the CAR draft protocol should be limited to soils within 5-10% of clay content of field sites, to sites that have a 10-year average annual growing season precipitation within 1 standard deviation of the 10-year precipitation average at the study sites, to sites that do not have tile-drainage or irrigation, and to sites where the USDA plant-hardiness index falls within 1 unit of the study sites. In doing so, we aim to ensure that $N_2O$ emission calculations based on this MSU EPRI study are conservative and that they do not overestimate $N_2O$ emission reductions.

## 2) Incomplete system analysis

*Background*

Decisions about how to award credit (or not) for different changes in management practice depend upon decisions about where to draw boundaries for calculating greenhouse gas emissions in the system, how to treat gas fluxes that occur inside or outside of the boundary, and how much rigor to demand for different parts of the nitrogen and carbon budgets. The draft protocol contains a number of inconsistencies in the approach used to draw these boundaries and define appropriate levels of rigor for deriving estimates.

In some cases, these inconsistencies relate to the Reserve's preference of assigning fewer credits to a change in practice when estimates suggest that emissions increase as a result of a project but not assigning more credits when a project is estimated to decrease emissions. This approach supports the Reserve's efforts to ensure a conservative approach, i.e. to increase confidence that estimated reductions in GHG emissions are real. And it comes into play especially when considering "secondary" emissions: those that occur as an unintended result of the project (e.g., change in fertilizer use leads to change in yield leads to change in fertilizer use on a different site). While this approach makes sense in the abstract, we do not believe it is always wise to apply it in this draft protocol.

*2a) Leaching of nitrogen (Table 4.1, p. 22, top line; and equation 5.13, p.33)*

Emissions of $N_2O$ occur on the farm field, but also occur "downstream," as a result of nitrogen that leaches into groundwater (L) or runs off into streams (R), or volatilizes and redeposits (VO). (In the draft protocol, CAR refers to these as LRVO emissions.)

The literature documenting how different farming practices can reduce N leaching – and hence downstream $N_2O$ emissions is very clear. A rigorous meta-analysis showed that for any given N application rate, using cover crops in grain cropping systems results in an average reduction in nitrate leaching of 40% for legume cover crops and 70% for non-legume cover crops (Figure 1, Tonitto et al. 2006). Additional evidence from 15N analysis also shows that fields using a legume N source retain 40% more N than other fields (Gardner and Drinkwater 2009). From an ecosystem budget point of view, these N losses are as important as $N_2O$ emissions that occur directly on the farm field, and estimates of how different agriculture practices influence leaching are much stronger than estimates of how $N_2O$ emissions, per se, respond to different management practices.

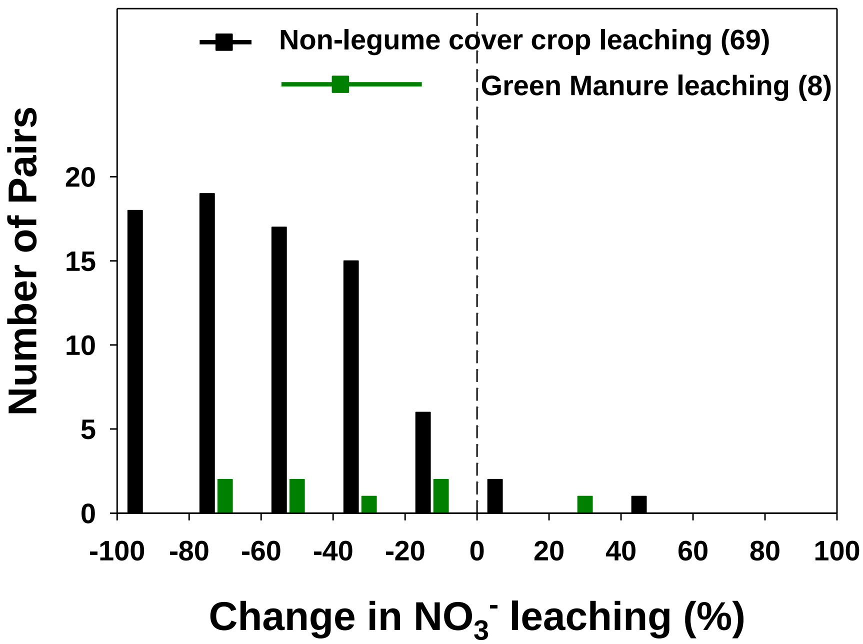


Figure 1. Change in nitrate leaching under winter cover crop management relative to the control treatment of a winter bare fallow. The histogram shows the distribution of individual paired comparisons of nitrate leaching from fields managed with a winter cover crop compared to a winter bare fallow. The meta-analysis compares nitrate leaching from non-legume cover crop systems (fertilized) and nitrate leaching from legume cover crop systems (unfertilized) to fertilized systems with a winter bare fallow. Mean values and 95% confidence intervals of the back-transformed response ratios are shown in the legend (number of comparisons in parentheses). (Data from Tonitto et al. 2006, Figure 7)

In section 1, we recommended limiting application of the MSU-EPRI equations to non-tile-drained fields, which reflects the abiotic state of the sites where observations were acquired. Once $N_2O$ flux data for tile-drained grain regions is available, and appropriate functional relationships are established to include tile-drained lands into the draft protocol, extensive field work in Iowa by Kaspar et al. (2012, 2007), provides nitrate leaching data relevant to tile-drained fields common in the most productive regions of the Corn Belt. Kaspar et al. (2012, 2007) demonstrated that the inclusion of a rye cover crop consistently reduced nitrate leaching, with the annual reduction in nitrate leaching ranging from 35-75% and averaging a 53% reduction over a decade of study. Over the course of this study, nitrate loss as a percentage of N applied in corn years ranged from 15-30% and averaged 20% of N applied. However, if CAR accepts our recommendation to exclude tile-drained lands from the protocol, then given that data underlying the MSU-EPRI protocol were collected on non-drained fields, the data from the Tonitto et al. (2006) meta-analysis, which included many studies on non-drained fields, are most applicable.

Operationally, the way to take these practices into account is to make a slight modification to equation 5.13, presented on page 33 of the draft protocol. It is understandable that this equation would have been used because it appears in the IPCC 2006 guidelines for estimating $N_2O$ emissions (Klein et al. 2006). This equation assumes leaching of nitrogen added to a farm field

(FRACleach) is 30% regardless of the N type or timing, and regardless of the farming system to which the N fertilizer is added. However, the knowledge base for estimating how farming practices influence N leaching has taken some big leaps forward since the publication of the 2006 guidance, and it is time to begin taking advantage of this knowledge.

In our view, the draft protocol is science-based and should take advantage of this strong understanding. Therefore, growers should be given credit for these downstream reductions.

**For non-tile-drained field:**

For legume cover crops, IPCC default of 30% of applied N leached * 60% (40% reduction) = 18% (based on Tonitto et al. 2006)

For non-legume cover crops, IPCC default of 30% of applied N leached * 30% (70% reduction) = 9%. (based on Tonitto et al. 2006)

**For tile-drained fields (our recommendation for a future protocol version)**

For legume cover crops, a default of 20% of applied N leached * 60% (40% reduction) = 12% (based on Kaspar et al. 2012, 2007; Tonitto et al. 2006)

For non-legume cover crops, a default of 20% of applied N leached * 50% (50% reduction) = 10%. (based on Kaspar et al. 2012, 2007)

<u>Recommendation</u>**:** Modify FRACleach in equation 5.13 so that: For default conditions, FRACleach=30% of N applied. For fields with legume cover crops, FRACleach=18%. For fields with non-legume cover crops, FRACleach=9%.

*2b) Management-induced changes to fossil fuel $CO_2$ emissions from synthetic fertilizer production (Table 4.1, pp. 23-24 Section 8 of the table)*

The level of detail requested for tracking fossil fuel emissions is inconsistent across the crop management systems that this draft protocol is designed to influence. CAR has been reluctant to give farmers credit for the reductions in $CO_2$ emissions that occur as a result of reduced synthetic fertilizer use on the farm field. However, estimates of these reductions are likely more robust than estimates of any other change in GHG emissions associated with reduced fertilizer use.

We do not find the arguments for excluding these changes in emissions convincing. The justification for excluding them is that: (1) as the farmer is not directly responsible for changes in production at the fertilizer factory, it is unclear to whom the credits would belong; (2) the fertilizer industry may be regulated at some point which would make it ineligible to generate offsets. To the first point, fertilizer factories produce fertilizer largely because of farmer demand. Less demand would mean less production. To the second point, we recognize that in California's cap and trade policy, set to begin in 2012, fertilizer production facilities are a capped industry. However, the scope of the draft protocol only encompasses Midwestern states that do not have legal requirements to reduce greenhouse gas emissions in fertilizer factories.

Recommendation: The protocol should grant GHG credits for the reduced $CO_2$ emissions associated with a reduction in synthetic fertilizer production.

*2c) Limited range of management practices considered*

Initially, CAR considered a much broader suite of management activities (Table 2.1, p. 5) but did not include any of them in this draft protocol. We encourage continued efforts to compile data sufficient to create appropriate $N_2O$ flux functional relationships across varied cropping systems.

**3) Manure management**

The draft protocol considers nitrogen amendment reductions on fields that are managed with both synthetic and organic N amendment (Sections 5.1- 5.2 pp. 26- 29).

*3a) Management-induced changes to fossil fuel $CO_2$ emissions – manure life cycle analysis.*

As currently written, the N management protocol is an incomplete life cycle analysis (LCA) with respect to $CO_2$ emissions A farmer does not receive additional credits for the reduction in $CO_2$ emissions that result from avoided production of synthetic N fertilizer (Table 4.1 point 8 pp. 23-24, discussed above). However, the draft protocol does consider $CO_2$ emissions associated with manure transport; if a farmer increases manure use as a consequence of switching from synthetic N to manure N, the farmer would incur a reduction in offset credits (Table 4.1 point 6 p. 23; 5.5.3 p. 39). Both of these $CO_2$ sources occur outside the farm gate. It is inconsistent to consider only some sources of $CO_2$ emissions resulting from farm management; an incomplete LCA results in a bias against particular agricultural practices, some of which deliver important societal and environmental benefits. If $CO_2$ emissions from farm management are to be considered, all of them need to be represented.

Recommendations:

*Preferred*: Do a complete LCA or none at all, to avoid biases towards or against particular practices.

*Alternative*: At a minimum, if emissions from manure transport are to be considered, then emissions from synthetic fertilizer transport should be similarly counted.

*3b) Manure management changes: $N_2O$ from CAFO manure storage* (Table 4.1, point 5, p. 23; 5.5.2, p. 38)

By reducing the need to generate synthetic fertilizer and by reducing standing anaerobic manure waste mounds, manure amendments to farm fields as a source of N to promote crop growth generally reduces GHG emissions from the entire system. This provides a strong rationale for allowing growers to switch from synthetic to organic N sources.

However, as currently written, the draft protocol takes these observations and turns them on their heads. The draft protocol assumes that reductions in manure-N amendments will result in greater amounts of manure storage on the CAFO and therefore higher GHG emissions relative to maintaining baseline N amendment rate. The consequence is that the responsibility for the manure's existence is placed on the crop farmer. A farmer using manure as an N source who decreases manure-N use to comply with draft protocol mandates will, according to the draft protocol rules for estimating emissions, create increased manure storage at a CAFO. By making the crop farmer responsible for the change in manure storage at the CAFO, the draft protocol makes it very difficult for farmers who use manure as the primary N source to participate. These farmers will always be forced to consider outside-the-farm-gate emission sources over which they have no control, as they reduce their manure inputs.

In reality, it is unreasonable for the protocol to assert that all manure not used on a field will be stored on a CAFO and continue to produce emissions. In fact, since the CAR draft protocol allows for a farmer to switch from synthetic N to manure N, it is possible that manure reductions on one farm will be utilized by another, also participating in the protocol.

Recommendation: Do not attempt to address CAFO waste issues in this protocol. Reducing the scale of excess nutrients at the CAFO requires a landscape-scale redesign of agriculture. Because the protocol is field-scale, the CAFO waste issue is beyond the scope of this work.

*3c) Accounting for increased $N_2O$ emissions off-site as a result of decreased yield (leakage)* (Section 5.5.4 pp. 40-41)

The draft protocol is concerned with the possibility that management changes will reduce yield and therefore cause increased planting elsewhere. The draft protocol only penalizes the case where management reduces yield, but does not credit the case where management improves yield relative to conventional practice (Equation 5.22 p. 40). There are different ways to achieve reduction in N amendment to a field. For example, a farmer may choose to use cover crops, increasing N retention and resulting in mineralization of this N throughout the growing season. The net effect of using cover crops is expected to be no decline in yield (Tonitto et al. 2006), with increased yields in some years and decreased yields in others. Based on the current protocol, adding cover crops to a system would result in a penalty during years with lower yield than conventional systems, but no credits in years with improved yields.

Recommendation: If there has been no net yield decline over the course of the crediting period, no yield penalties should be applied to greenhouse gas credits awarded to the grower.

Literature cited

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