CalCAN
CALIFORNIA CLIMATE & AGRICULTURE NETWORK

Office of Environmental Farming and Innovation
California Department of Food and Agriculture
1220 N Street
Sacramento, CA 95814

December 15, 2017

Re: Nutrient Management Practice Proposal for Healthy Soils Program

Dear OEFI Staff,

Only about half the nitrogen applied in California agriculture ends up where it is intended to.[1] The remainder is lost, negatively affecting our health, environment, and climate.[2] Excess reactive nitrogen in agricultural soils contributes to the formation of both air and water pollutants, which disproportionately harm people in agricultural areas and have detrimental impacts on native species and biodiversity. [3] Excess nitrogen in soils also contributes to emissions of nitrous oxide (N_2O), a potent greenhouse gas which constitutes roughly a quarter of California agriculture's greenhouse gas emissions. [4] As such, improving nitrogen use efficiency and reducing excess nitrogen in soils through better nutrient management is clearly in the State's interest.

At the October 26th EFA SAP meeting, three nutrient management practices (under the framework of USDA NRCS CPS 590) were proposed for addition to the Healthy Soils Program: 1) 15% reduction in nitrogen application rate, 2) nitrification inhibitors, and 3) slow-release fertilizers.

We support the proposal to add a nutrient management practice (under the comprehensive framework of USDA NRCS CPS 590) that results in at least a 15% reduction in a grower's nitrogen application (compared to their three-year historical average) to the Healthy Soils Program based on widespread agreement in the literature that such a practice will reduce N_2O emissions across a wide spectrum of California's agricultural regions, soil types, cropping systems, and irrigation methods. Using CPS 590 will allow growers to achieve that nitrogen reduction through any number of approaches that can be tailored to their operation, taking into account their irrigation methods, nitrogen sources, application timing (e.g. splitting up applications to match plant growth rates), application placement, application rate, and data from soil and tissue sampling.

However, to be eligible for the Healthy Soils Program, a management practice should, according to statute: "contribute to healthy soils *and* result in net long-term on-farm greenhouse gas benefits."[5] Healthy Soils are defined in statute as "soils that enhance their continuing capacity to function as a biological system, increase soil organic matter, improve soil structure and water- and nutrient-holding capacity, and result in net long-term greenhouse gas benefits."

While a 15% reduction in nitrogen application will clearly result in a GHG benefit, it will not adequately contribute to healthy soils as a standalone practice. Therefore, to fulfill the soil health objective of the program, and to prevent the Healthy Soils program from becoming redundant with other state policy efforts aimed solely at nitrogen reduction[6], **we propose a requirement that a 15% reduction in N rate be paired with at least one other Healthy Soils practice.** In other words, limited program funding should not be used to incentivize farmers seeking only to adopt a single practice that does not have an adequate soil health benefit and will likely be required through enforceable regulation of fertilizer use in the near future anyway.

According to the IPCC (2007), the most effective way to reduce GHG emissions in intensive agricultural systems is through minimization of N surpluses.[7] The 2016 California Nitrogen Assessment from the University of

California Agricultural Sustainability Institute labeled “Reducing Nitrogen Rate” as having a positive mitigative effect on N_2O emissions to the atmosphere, and considered the practice generally accepted, meaning it has a high amount of evidence and medium amount of agreement. [8] Widespread over-fertilization has been documented in many California crops. [9] The Assessment states that “under these conditions, nitrogen applications could be reduced without jeopardizing productivity or economic solvency.”[10] According to its analysis, “Average producers of 5 of 12 vegetable crops and 4 of 12 perennial crops… apply more nitrogen than the maximum rate suggested in the UC guidelines, suggesting there may be opportunities for reducing fertilizer nitrogen rate on many crops… But even for crops that are generally not [fertilized excessively], potential rate reductions are plausible simply because of the wide ranges in nitrogen application rates among fields and farms.” [11] The Assessment estimates suggest that plausible reductions in N rates in California could result in nearly 40,000 tons less fertilizer nitrogen use per year. [12]

In their 2012 “Assessment of Baseline Nitrous Oxide Emissions in California Cropping Systems,” Burger and Horwath from the University of California Davis conclude “the strategies with the highest potential to lower N_2O emissions in California cropping systems are to increase nitrogen use efficiency and to control soil moisture through alternative irrigation techniques.”[13] Reductions in nitrogen application rates reliably lead to increases in nitrogen use efficiency (i.e. the proportion of nitrogen applied that is taken up by the crop).[14] In their 2017 review of N_2O emissions from California farmland, Verhoeven et al. conclude “judicious and synchronized application of water and nitrogen, timed with crop demand, is predicted to reduce emissions across climate zones and crops.”[15] Furthermore, absolute reductions of synthetic nitrogen inputs will also reduce upstream emissions associated with the Haber-Bosch process, which consumes 3-5% of the world’s natural gas and 1-2% of the world’s annual energy supply, and transport of fertilizer.[16][17]

The other two practices proposed at the EFA SAP meeting – nitrification inhibitors and slow-release fertilizers, also known as Enhanced Efficiency Fertilizers (EEFs) – do not yet have sufficient California based evidence or agreement within the literature to merit an incentive. Nor do they contribute to healthy soils as standalone practices.

While certain meta-analyses (e.g. Akiyama, 2010[18]) point to the potential for EEFs[19] to reduce N_2O emissions on a global scale, limited research has been done on EEFs in California’s unique and diverse agricultural context. Given the key role edaphic factors have on EEF efficacy[20], it is important to have research specific to California’s Mediterranean climate and soils. Additionally, the conclusions of many studies on EEFs and GHG emissions have been called into question. The California Nitrogen Assessment states, “…the results of the research on EEFs and N_2O may be confounded by experimental design. Some evidence suggests that although EEFs present lower initial fluxes, N_2O production may extend for longer periods and therefore may show higher total losses (Delgado and Mosier, 1996) or similar total annual losses (Parkin and Hatfield, 2010) when compared to fertilizer application without nitrification inhibitors.”[21]

Moreover, Lam et al. (2016) suggests that nitrification inhibitors may be much less effective than previously thought when both direct and indirect emissions are taken into account. [22] After reviewing the limited studies available that took into account both direct and indirect N_2O emissions (from increased ammonia volatilization, subsequent deposition and N_2O emissions), they write: “Our results suggest that the beneficial effect of nitrification inhibitors in decreasing direct N_2O emissions can be undermined or even outweighed by an increase in NH_3 volatilization.”[23] Furthermore, simply switching from conventional fertilizers to EEFs will not reduce the energy use associated with the Haber-Bosch process and transport of fertilizers.[24]

The limited research on EEFs in California has shown mixed results based on specific combinations of fertilizers, inhibitors, crops, and irrigation methods. For example, in tests of the dicyandiamide (DCD) nitrification inhibitor, the inhibitor reduced N_2O emissions by more than 60% in two out of three years of a furrow irrigated corn trial, but the inhibitor had no effect in one out of the three years.[25] In subsurface drip-irrigated tomato systems, the effect of the DCD inhibitor on N_2O emissions was small overall and differed significantly between the two years of the trial. [26] The efficacy of inhibitors has also been found to vary significantly by fertilizer source in California experiments.[27] In microirrigation systems, the results of EEFs are less impressive, likely due to the increased efficiency of fertilization by fertigation.[28] Subsurface drip irrigation by itself has been shown to reduce N_2O emissions more consistently than any other EEF treatment.[29] Consequently, it is important to note that California cropland irrigation methods significantly trended away from surface irrigation (-37%) and towards drip/micro irrigation (+38%) between 1972-2010 in California, such that 43% of irrigated cropland is now irrigated by surface irrigation and 41% by micro/drip, with the remainder (15%) irrigated by sprinkler.[30]

In a study that monitored the efficiency of controlled-release fertilizer (CRF) across three strawberry fields (with randomized block experimental design and four replicates per CRF rate) in Salinas, Watsonville, and Castroville, Hartz and Farrara (2013) found that the rate of N release was much faster than the rate of strawberry N uptake and that CRF had minimal effect on crop N uptake.[31] They also found that reducing CRF or eliminating it altogether did not affect marketable fruit yield for two out of the three sites. [32] These results led them to conclude that current CRF use patterns are not efficient, and that reducing overall CRF rates could be done with minimal risk to crop productivity. [33] They write “Rather than routinely using high preplant CRF rates to protect against such unusually high winter rainfall or inefficient irrigation, a program of more accurate irrigation scheduling, soil NO3-N testing in the spring, and earlier fertigation (where appropriate) would be a more nitrogen efficient practice.” [34] Given the uncertain yield improvements and N_2O benefits of EEFs, many farmers would choose not to make the financial investment to use them.

Recognizing these uncertainties and California agriculture’s unique climate, diversity of crops, and advances in irrigation systems, the California Nitrogen Assessment states: “Under current farming conditions, however, it is not clear if EEFs will produce comparable benefits in California as in other regions where they are being promoted. Benefits of EEFs are maximized when periodic and uncontrolled soil moisture decrease control of N, conditions only found during winter in some parts of California agricultural valleys. The more common production conditions–hot, dry, and fertigated–can provide equivalent or greater control of nutrients if managed astutely.”[35]

If at some point enough California-based evidence emerges to define EEF practice parameters that will have a high certainty of reducing N_2O emissions, EEFs would still not contribute to Healthy Soils as defined and mandated in statute. Consequently, the practice would also need to be paired with other Healthy Soils practices to be eligible for incentives payments.

In sum, we agree with the conclusions of multiple reviews of potential N_2O mitigation strategies in California that reducing nitrogen application rates by at least 15% will reduce N_2O emissions; thus, we support the addition of that practice to the program as long as it is required to be coupled with other practices that contribute to the production of healthy soils. For reasons cited above, we cannot support the addition of EEFs to the program at this time.

Sincerely,

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[1] Tomich T, Brodt S, Dahlgren R, Scow K eds. 2016. Executive Summary. In: The California Nitrogen Assessment. University of California Davis Agricultural Sustainability Institute. Available from: http://asi.ucdavis.edu/programs/sarep/research-initiatives/are/nutrient-mgmt/california-nitrogen-assessment/ExecutiveSummaryLayout_FINAL_reduced.pdf?pdf=CNA-Sum

[2] Ibid.

[3] Ibid.

[4] Burger M, Horwath W, Six J. 2016. Evaluating Mitigation Options of Nitrous Oxide Emissions in CA Cropping Systems. Report for the California Air Resources Board. Available from: www.arb.ca.gov/research/single-project.php?row_id=65096

[5] California Food and Agriculture Code, Section 569. Emphasis added.

[6] The Irrigated Lands Regulatory Program is expected to produce enforceable regulations limiting nitrogen use in agriculture. The Fertilizer Research and Education Program represents a complimentary effort to equip farmers with the knowledge they need to reduce fertilizer use.

[7] Parry M, Canziani O, Palutikof J, van der Linden P, Hanson C eds. 2007. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Available from: https://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg2_report_impacts_adaptation_and_vulnerability.htm

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[9] Rosenstock T, Brodt S, Burger M, Leverenz H, Meyer D. 2016. Appendix 7.1: Technical options to control the nitrogen cascade in California agriculture. In: The California Nitrogen Assessment. Available from: http://asi.ucdavis.edu/programs/sarep/research-initiatives/are/nutrient-mgmt/california-nitrogen-assessment/appendices-and-supplemental-information-1/ch7-appendix-7-1-final.pdf

[10] Ibid.

[11] Ibid.

[12] Tomich T, Brodt S, Dahlgren R, Scow K eds. 2016. Executive Summary. In: The California Nitrogen Assessment. University of California Davis Agricultural Sustainability Institute. Available from: http://asi.ucdavis.edu/programs/sarep/research-initiatives/are/nutrient-mgmt/california-nitrogen-assessment/ExecutiveSummaryLayout_FINAL_reduced.pdf?pdf=CNA-Sum

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[16] Sutton M, Oenema O, Erisman J, Leip A, van Grinsven H, Winiwarter W. Too much of a good thing. Nature. 2011;472: 159–161. Available from: https://www.nature.com/articles/472159a

[17] University of Cambridge. Improving ammonia synthesis could have major implications for agriculture and energy. Science Daily; 22 November 2010. Available from: https://www.sciencedaily.com/releases/2010/11/101117094031.htm

[18] Akiyama H, Yan X, Yagi K. Evaluation of effectiveness of enhanced-efficiency fertilizers as mitigation options for N_2O and NO emissions from agricultural soils: meta-analysis. Global Change Biology. 2010;16: 1837-1846. Available from: http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2486.2009.02031.x/abstract;jsessionid=EDCC390BECAFEA8C14C3495A0E6399E6.f04t01

[19] It is important to note that a wide range of EEFs are available in the marketplace and their mode of action in the soil is different.

[20] Steenwerth K, Hodson A, Bloom A, Carter M, Cattaneo A, Chartres C, Hatfield J, Henry K, Hopmans J, Horwath W, Jenkins B, Kebreab E, Leemans R, Lipper L, Lubell M, Msangi S, Prabhu R, Reynolds M, Solis S, Sischo W, Springborn M, Tittonell P, Wheeler S, Vermeulen S, Wollenberg E, Jarvis L, Jackson L. Climate-smart agriculture global research agenda: scientific basis for action. Agriculture & Food Security. 2014;3(11). Available from: https://agricultureandfoodsecurity.biomedcentral.com/articles/10.1186/2048-7010-3-11

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[33] Ibid.

[34] Ibid.

[35] Rosenstock T, Brodt S, Burger M, Leverenz H, Meyer D. 2016. Appendix 7.1: Technical options to control the nitrogen cascade in California agriculture. In: The California Nitrogen Assessment. Available from: http://asi.ucdavis.edu/programs/sarep/research-initiatives/are/nutrient-mgmt/california-nitrogen-assessment/appendices-and-supplemental-information-1/ch7-appendix-7-1-final.pdf