CalCAN
California Climate & Agriculture Network

October 30, 2017

Claire Jahns
Assistant Secretary for Climate Issues
California Natural Resources Agency
1416 Ninth Street, Suite 1311
Sacramento, CA 95814

RE: CALAND model workshop comments

Dear Ms. Jahns,

On behalf of the California Climate and Agriculture Network, a coalition of the state's leading sustainable and organic agriculture organizations, I write to provide our comments following the recent CALAND workshop. We appreciated the update on the model development process. We are also supportive of the establishment of a technical advisory committee made up of experts in the field to help inform version 3.0.

Our overarching comment is that CALAND alone is insufficient to inform the Natural and Working Lands Implementation Plan. The limitations on the model's observational data approach will limit the ability of the model to adequately characterize baseline and scenario outcomes for California's diverse agricultural industry.

The state has invested considerable resources into other models that inform climate change mitigation strategies for agriculture. The DNDC model, funded with Air Resources Board and California Department of Food and Agriculture grants, and the COMET tools (both COMET Farm and COMET Planner), funded by CDFA, use biological process modeling to inform how on-farm management changes will impact greenhouse gas emissions and carbon sequestration; and CalEEMod, supported by ARB for the Sustainable Agricultural Lands Conservation Program, and Urban Footprint, funded by the Strategic Growth Council, asses land use changes, including improved farmland conservation, and their impacts on greenhouse gas emissions. Moreover, a current state-funded project with The Nature Conservancy looks to provide regional scale modeling of agricultural and other natural lands climate change mitigation strategies in the Merced area.

To the best of our ability, we should include these existing tools to inform agricultural mitigation strategies in the Implementation Plan to help meet our 2030 Natural and Working Lands reduction and carbon sequestration target of 15-20 MMTCO2e.

California Climate and Agriculture Network
910 K Street Suite 300
Sacramento, CA 95814
jmerrill@calclimateag.org

Please find below additional comments and questions about the CALAND modeling effort.

Thank you for your consideration.

Sincerely,

Jeanne Merrill
Policy Director

1. Observation model approach of CALAND poses too many limitations for agriculture baseline and scenario modeling

We were disheartened to learn of the many limitations of the CALAND observational model approach at the recent workshop. For example, the model currently cannot distinguish between row crop and perennial agriculture, which present very different carbon profiles. While we recognize the significant strides the version 2.0 has made in defining land types (now 940 land types), considerable more work is needed to accurately depict agricultural land management types and their emissions/carbon profiles. We are concerned that the depth and breadth of additional work needed to accurately account for California's diverse agricultural industry will necessarily limit the baseline understanding of the state's farms and ranches carbon and GHG emissions profiles and unnecessarily constrain the scenarios outcomes for the sector. Consequently, we must use additional models to help inform the Implementation Plan for the Natural Working Lands Implementation Plan, as described above. How best to achieve the use of multiple models to inform the Plan should be a question posed to the technical advisory committee.

2. Scenarios modeling should include a greater number of agricultural management practices; and include nitrogen cycle/nitrous oxide emissions issues

The California Climate Smart Agriculture programs have a much greater number of incentivized on-farm management and farmland conservation strategies than what is currently proposed for scenarios modeling under CALAND. We should expand the number of on-farm management strategies and farmland conservation scenarios to better reflect the state's current programmatic focus under Healthy Soils, the State Water Efficiency and Enhancement Program, Dairy Methane (e.g. the Alternative Manure Management Practices program includes pasture and compost strategies that are relevant to carbon and other emissions concerns) and the Sustainable Agricultural Lands Conservation Program. But as we strongly suggest above, CALAND is not likely to able to adequately account for a broader set of scenarios given the data limitations of the model. Thus, the need for other modeling tools, described above, to provide additional scenarios modeling for the Implementation Plan.

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We also strongly support comments made at the workshop that the modeling efforts to inform the Implementation Plan cannot consider the carbon cycle in agriculture without also considering the nitrogen cycle. We provide additional resources on this topic below.

3. Include Agriculture Section in Natural and Working Lands Implementation Plan
As currently framed in the *CALAND Model Development and Next Steps* document provided with the recent workshop, the Natural and Working Lands Implementation Plan is intended to "guide expenditures across multiple programs within CNRA…". However, the inclusion of agriculture in the Implementation Plan should mean that we are looking at a diverse set of strategies that go beyond the CNRA portfolio, including on-farm water management, clean energy production and a diverse set of on-farm management strategies.

How will the diverse set of agricultural mitigation strategies and next steps be accounted for the Implementation Plan?

We appreciate that the cross-cutting nature of agriculture makes it challenging to include the full scope of agricultural mitigation strategies in the Plan. However, we strongly suggest that the Plan include an agriculture sector section that summarizes the full suite of agricultural mitigation strategies. Without doing this, we may lose track and not adequately assess the many ways that agriculture can positively contribute to meeting the state's 2030 GHG emissions reduction target. Even a chart that refers to other Implementation Plans that include agriculture would help to capture the full scope of agricultural mitigation strategies.

4. Additional resources
In 2014, CalCAN conducted a literature review on climate change mitigation strategies for agriculture. It can be found here:
http://calclimateag.org/wp-content/uploads/2015/02/Climate-Benefits-of-Agriculture-2015.pdf

Please find below additional abstracts that may inform CALAND 3.0:

1. Bowles, T.M., A.D. Hollander, K.L. Steenwerth, and L.E. Jackson. 2015. Tightly-coupled plant-soil nitrogen cycling: Comparison of organic farms across an agricultural landscape. *PLoS ONE* 10(6): e0131888. doi:10.1371/journal.pone.0131888
http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0131888

Abstract
How farming systems supply sufficient nitrogen (N) for high yields but with reduced N losses is a central challenge for reducing the tradeoffs often associated with N cycling in agriculture. Variability in soil organic matter and management of organic farms across an agricultural landscape may yield insights for improving N cycling and for evaluating novel indicators of N availability. We assessed yields, plant-soil N cycling, and root expression of N metabolism genes across a representative set of organic fields growing Roma-type tomatoes (*Solanum lycopersicum* L.) in an intensively-managed agricultural landscape in California, USA. The fields spanned a three-fold range of soil carbon (C) and N but had similar soil types, texture, and pH. Organic tomato yields ranged from 22.9 to 120.1 Mg ha^{-1} with a mean similar to the county

average (86.1 Mg ha^{-1}), which included mostly conventionally-grown tomatoes. Substantial variability in soil inorganic N concentrations, tomato N, and root gene expression indicated a range of possible tradeoffs between yields and potential for N losses across the fields. Fields showing evidence of tightly-coupled plant-soil N cycling, a desirable scenario in which high crop yields are supported by adequate N availability but low potential for N loss, had the highest total and labile soil C and N and received organic matter inputs with a range of N availability. In these fields, elevated expression of a key gene involved in root N assimilation, cytosolic glutamine synthetase GS1, confirmed that plant N assimilation was high even when inorganic N pools were low. Thus tightly-coupled N cycling occurred on several working organic farms. Novel combinations of N cycling indicators (i.e. inorganic N along with soil microbial activity and root gene expression for N assimilation) would support adaptive management for improved N cycling on organic as well as conventional farms, especially when plant-soil N cycling is rapid.

2. De Gryze, S., A. Wolf, S.R. Kaffka, J. Mitchell, D.E. Rolston, S.R. Temple, J. Lee, and J. Six. 2010. Simulating greenhouse gas budgets of four California cropping systems under conventional and alternative management. Ecological Applications 20(7), 1805–1819.

Abstract

Despite the importance of agriculture in California's Central Valley, the potential of alternative management practices to reduce soil greenhouse gas (GHG) emissions has been poorly studied in California. This study aims at (1) calibrating and validating DAYCENT, an ecosystem model, for conventional and alternative cropping systems in California's Central Valley, (2) estimating CO2, N2O, and CH4 soil fluxes from these systems, and (3) quantifying the uncertainty around model predictions induced by variability in the input data. The alternative practices considered were cover cropping, organic practices, and conservation tillage. These practices were compared with conventional agricultural management. The crops considered were beans, corn, cotton, safflower, sunflower, tomato, and wheat. Four field sites, for which at least five years of measured data were available, were used to calibrate and validate the DAYCENT model. The model was able to predict 86–94% of the measured variation in crop yields and 69–87% of the measured variation in soil organic carbon (SOC) contents. A Monte Carlo analysis showed that the predicted variability of SOC contents, crop yields, and N2O fluxes was generally smaller than the measured variability of these parameters, in particular for N2O fluxes. Conservation tillage had the smallest potential to reduce GHG emissions among the alternative practices evaluated, with a significant reduction of the net soil GHG fluxes in two of the three sites of 336 +/- 47 and 550 +/- 123 kg CO2-eqha1 yr1 (mean 6 SE). Cover cropping had a larger potential, with net soil GHG flux reductions of 752 +/- 10, 1072 +/- 272, and 2201 +/- 82 kg CO2-eqha1 yr1. Organic practices had the greatest potential for soil GHG flux reduction, with 4577 +/- 272 kg CO2-eqha1 yr1. Annual differences in weather or management conditions contributed more to the variance in annual GHG emissions than soil variability did. We concluded that the DAYCENT model was successful at predicting GHG emissions of different alternative management systems in California, but that a sound error analysis must accompany the predictions to understand the risks and potentials of GHG mitigation through adoption of alternative practices.

3. Williams, J.N., A.D. Hollander, A. Toby O'Geen, L.A. Thrupp, R. Hanifin, K.L. Steenwerth, and L.E. Jackson 2011. Assessment of carbon in woody plants and soil across a vineyard-woodland landscape. *Carbon Balance and Management* 6-11. http://www.cbmjournal.com/content/6/1/11

Abstract
Quantification of ecosystem services, such as carbon (C) storage, can demonstrate the benefits of managing for both production and habitat conservation in agricultural landscapes. In this study, we evaluated C stocks and woody plant diversity across vineyard blocks and adjoining woodland ecosystems (wildlands) for an organic vineyard in northern California. Carbon was measured in soil from 44 one m deep pits, and in aboveground woody biomass from 93 vegetation plots. These data were combined with physical landscape variables to model C stocks using a geographic information system and multivariate linear regression. This research demonstrates that vineyards managed with practices that conserve some fraction of adjoining wildlands yield benefits for increasing overall C stocks and species and habitat diversity in integrated agricultural landscapes. For such complex landscapes, high resolution spatial modeling is challenging and requires accurate characterization of the landscape by vegetation type, physical structure, sufficient sampling, and allometric equations that relate tree species to each landscape. Geographic information systems and remote sensing techniques are useful for integrating the above variables into an analysis platform to estimate C stocks in these working landscapes, thereby helping land managers qualify for greenhouse gas mitigation credits. Carbon policy in California, however, shows a lack of focus on C stocks compared to emissions, and on agriculture compared to other sectors. Correcting these policy shortcomings could create incentives for ecosystem service provision, including C storage, as well as encourage better farm stewardship and habitat conservation.

4. Suddick, E.C., K.M. Scow, W.R. Horwath, L.E. Jackson, D. R. Smart, J.P. Mitchell, and J. Six. 2010. The potential for California agricultural crop soils to reduce greenhouse gas emissions: a holistic evaluation. Donald L. Sparks, editor. *Advances in Agronomy* 107:123-162. http://ucanr.edu/repository/?get=93560

Abstract
Climate change predictions for California indicate that agriculture will need to substantially adapt to reduced water availability, changing crops, and changes in temperatures, in order to sustain the level and diversity of crop production in California. California legislators recently passed the California Global Warming Solutions Act of 2006 (AB 32) that requires all industries to reduce the three major greenhouse gases (GHGs) (CO2, N2O, and CH4) to 1990 levels by 2020. The great diversity of cropping systems and management practices in California agriculture leads, however, to greater uncertainties in estimates of GHG budgets compared to Midwest agriculture. In light of AB 32, we, here, synthesize all the available information on the potentials for California agriculture to sequester C and reduce GHG emissions through various alternative management practices: minimum or no tillage, organic, cover cropping, manuring, and reduced chemical fertilizer management. Our review indicates that C sequestration and GHG emission reductions are possible, but there is no single land management practice or change in inputs that could mitigate the C released from agricultural practices (e.g., fossil fuel usage, land-

use changes, soil erosion, biomass burning, and N fertilizer associated emissions) and meet climate change commitments set out in AB 32. Therefore, it is only the integration of different management strategies that shows considerable potential for C mitigation as well as provides important co-benefits to ensure the future sustainability of California agriculture.

5. Ryan Byrnes, Valerie Eviner, Ermias Kebreab, William R. Horwath, Louise Jackson, Bryan M. Jenkins, Stephen Kaffka, Amber Kerr, Josette Lewis, Frank M. Mitloehner, Jeffrey P. Mitchell, Kate M. Scow, Kerri L. Steenwerth, Stephen Wheeler. September 2017. Review of research to inform California's climate scoping plan: Agriculture and working lands. California Agriculture. Vol. 71. No. 3. http://calag.ucanr.edu/archive/?article=ca.2017a0031

6. Elizabeth Verhoeven, Engil Pereira, Charlotte Decock, Gina Garland, Taryn Kennedy, Emma Suddick, William Horwath, Johan Six. September 2017. N2O emissions from California farmlands: A review. California Agriculture. Vol. 71. No. 3. http://calag.ucanr.edu/archive/?article=ca.2017a0026