July 9, 2021

Liane M. Randolph
Chair
California Air Resources Board
P.O. Box 2815
Sacramento, CA 95812

RE: Public Workshop Series to Commence Development of the 2022 Scoping Plan Update (sp22-kickoff-ws)

Dear Ms. Randolph:

Indigo Ag applauds the leadership of the California Air Resources Board (CARB) to reduce greenhouse gas (GHG) emissions across the State since the passage of the Global Warming Solutions Act (AB32) in 2006. California's progressive environmental policies have reduced GHG emissions by 24 percent while growing the State's economy by 59 percent. Even more impressive is the nearly 40 percent decrease in emissions from the electric sector between 2000 and 2018.

Unfortunately, the transportation sector has only seen a 5 percent decrease during the same timeframe.[1] At 41 percent, transportation is the largest single category of GHG emissions in the State. The emissions total increases to 50 percent when the GHG emissions associated with the refining sector are included. Achieving the State's goal "to achieve carbon neutrality by 2045"[2] will require a rapid transition to zero carbon fuels as you stated in your opening remarks at the 2022 Scoping Plan Update Kick-off Workshop on June 8, 2021. At the same workshop, CARB Executive Officer, Richard Corey stated that the State needs to eliminate fossil fuel combustion wherever we can. He went on to comment that where it is not yet possible to eliminate combustion technology, we need to use cleaner fuels.

One of the ways to reduce emissions from the transportation sector to achieve the State's carbon neutrality goal was set by Governor Newsome on September 23, 2020 when he signed Executive Order N-79-20. This Executive Order set goals for "100 percent of in-state sales of new passenger cars and trucks [to] be zero-emission by 2035" and for "100 percent of medium- and heavy-duty vehicles in the State [to] be zero-emission by 2045."[3] However, even if the state achieves these ambitious goals for vehicles by 2045, 30 percent of cars and 23 percent of heavy-duty fleet vehicles will still be powered by fossil fuels.[4]

[1] CARB (2020) Current California GHG Emission Inventory Data: 2000-2018 GHG Inventory (2020 Edition). 2000-210 Trends Figure Data (https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2018/2000_2018_ghg_inventory_trends_figures.xlsx)
[2] Brown (2018) Executive Order B-55-18 to Achieve Carbon Neutrality. (https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf)
[3] Newsom (2020) Executive Order N-79-20. (https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf)
[4] Pournazeri, S. (2021) Vision for Zero Emission Transportation: Public Workshop Series to Commence Development of the 2022 Scoping Plan Update. (https://ww2.arb.ca.gov/sites/default/files/2021-06/carb_sp_kickoff-transportation_june2021.pdf)

Cleaner transportation fuels are a critical component to meeting the State's carbon neutrality goals. In an April 2021 report by the University of California Institute of Transportation Studies, the Institute estimated that nearly 4 billion gasoline gallon equivalents will need to come from a combination of bio-based diesel and bio-based gasoline.[5] Therefore, it is critically important that the State continues to innovate and support market-based programs such as the Low Carbon Fuel Standard (LCFS) to reduce the carbon intensity of fuels sold and used in California. Since the LCFS program started in 2011, it has reduced GHG emissions from transportation fuels by more than 77 million metric tons.[6] As the LCFS program starts its second decade of operation, we encourage CARB to consider the opportunities that field-based agricultural practices can play in generating additional GHG reductions for the LCFS program and support the State's transition to a carbon neutral economy.

Agricultural crops can play a significant role in meeting the State's ambitious carbon neutrality goal. Historically the cultivation of crops to supply biofuels to the California market has left soils severely depleted – croplands soils around the world have lost on average 26 percent of the carbon in the top 30 cm of soil.[7] Fortunately, the agricultural community recognizes the importance of soil carbon and is working to restore it. According to the National Academy of Sciences, there are many conservation practices that can "increase carbon stocks in soils and are successfully practiced by progressive farmers and ranchers."[8] Furthermore, these practices are not limited to their GHG benefits; they provide "additional ecosystem service benefits, including watershed protection, increased biodiversity, and improved soil health and fertility."[9]

The State's ambitious carbon neutrality goal will require the adoption of new technologies and practices. Recent developments in the monitoring and measurement of the GHG benefits of agricultural practices position agriculture as a significant and scalable opportunity to provide low carbon fuels. In July 2020, Argonne National Laboratory, creator of the GREET model used to calculate the carbon intensity (CI) of fuels in California for the LCFS, published a paper estimating that field-based practices can reduce the CI of gasoline or diesel by as much as 44.4 g CO_2/MJ.[10] Including these field-based practices as a part of California's transportation fuel programs provide a critical source of the low carbon fuels necessary for the state to meet its goal and reduce the most significant impacts of climate change.

Indigo Ag is well positioned to help the state in those efforts. Indigo Ag uses microbiology and digital technology to improve the quality, yields, and environmental sustainability of agriculture. We are now

[5] Brown, A.L., et. al. (2021) Driving California's Transportation Emissions to Zero. Institute of Transportation Studies, University of California. Figure EX-2. (https://doi.org/10.7922/G2MC8X9X)
[6] Renewable Fuels Association (May 2021) The California and Ethanol: A Decade of Reducing Greenhouse Gas Emissions. https://ethanolrfa.org/wp-content/uploads/2021/05/RFA-LCFS-Report_PDF.pdf
[7] Sanderman, J., Hengl, T., Fiske, G.J. (2017) Soil carbon debt of 12,000 years of human land use. *Proceedings of the National Academy of Sciences of the United States of America* 114 (36) 9575-9580. https://doi.org/10.1073/pnas.1706103114
[8] National Academies of Sciences, Engineering, and Medicine (2019) *Negative Emissions Technologies and Reliable Sequestration: A Research Agenda*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25259
[9] ibid.
[10] Liu, X. et. al. (2020) Shifting agricultural practices to produce sustainable, low carbon intensity feedstocks for biofuel production. *Environ. Res. Lett.* https://doi.org/10.1088/1748-9326/ab794e

expanding our expertise to streamline the ability of farms to tap into environmental markets. Using a combination of direct sampling, farm-level data collection, biogeochemical models, and remote sensing (including satellite analytics), Indigo Ag can accurately determine the current carbon footprint of a farm and implement changes to decrease that footprint. Working with the millions of acres that have contracted to be a part of Carbon by Indigo (and millions more who have expressed interest), Indigo Ag is helping growers on a journey to decrease net GHG emissions by more than 1 metric ton per acre of farmland annually.

Indigo Ag strongly supports the inclusion of field-based practices in market-based California fuels programs, including the LCFS. Practices such as cover crops, reduced tillage, and crop rotations all show the potential to reduce nitrous oxide (N_2O) emissions and increase soil organic carbon sequestration. Unfortunately, these valuable practices are not widely adopted. For example, conservation tillage practices have been implemented on less than 2 percent of cropland acres in California's Central Valley.[11] Long-term studies in the San Joaquin Valley have demonstrated that no-till and cover cropping can increase soil carbon by more than 11 metric tons per acre.[12] Comparable long-term studies have been conducted in other regions of North America with similar results.[13, 14]

As you develop the 2022 Scoping Plan, we encourage CARB to add field-based practices to the LCFS program. These practices can be added through a similar process as renewable natural gas was included in the LCFS program. Dairies throughout the United States can use CARB's Compliance Offset Protocol for Livestock Projects to quantify, monitor and verify the generation of renewable natural gas by dairy digesters. This approach has generated a significant and valuable source of low carbon transportation fuels used by California's Compressed Natural Gas (CNG) fleet. This same approach could be used to include field-based farming practices in the LCFS program.

In 2020 the Climate Action Reserve[15] and Verified Carbon Standard[16] both adopted carbon offset protocols which use a two-pronged approach to quantify the GHG reductions from field-based practices. These protocols use a biogeochemical model supported by direct soil sampling to quantify the net changes in GHG emissions and soil organic carbon fluxes from implementing conservation practices on croplands. Biogeochemical models are increasingly being used to calculate the methane, N_2O, and carbon sequestration from agronomic practices. A recent paper demonstrated that these models are capable of calculating seasonal and annual N_2O emissions from a diverse array of crops and these calculations are more accurate "than the Intergovernmental Panel on Climate Change emission factor

[11] Mitchell, J.P., Klonsky, K., Shrestha, A., Fry, R., DuSault, A., Beyer, J., Harben, R. (2007) Adoption of conservation tillage in California: current status and future perspectives. *Aust. J. Exp. Agric.* 47 (12), 1383–1388.
[12] Mitchell, J.P., et. al. (2017) Cover cropping and no-tillage improve soil health in an arid irrigated cropping system in California's San Joaquin Valley, USA. *Soil & Tillage Research*. 165. 325–335. http://dx.doi.org/10.1016/j.still.2016.09.001
[13] Chahal, I., Vyn, R. J., Mayers, D., Van Eerd, L. L. (2020) Cumulative impact of cover crops on soil carbon sequestration and profitability in a temperate humid climate. *Scientific Reports*. 10 (13381). https://doi.org/10.1038/s41598-020-70224-6
[14] Olson, K., Ebelhar, S. A., Lang, J. M. (2014) Long-Term Effects of Cover Crops on Crop Yields, Soil Organic Carbon Stocks and Sequestration. Open Journal of Soil Science. 4, 284-292. http://dx.doi.org/10.4236/ojss.2014.48030
[15] Climate Action Reserve (September 30, 2020) Soil Enrichment Protocol. Version 1.0 https://www.climateactionreserve.org/how/protocols/soil-enrichment/
[16] Verified Carbon Standard (October 19, 2020) Methodology for Improved Agricultural Land Management. Version 1.0. https://verra.org/wp-content/uploads/2020/10/VM0042_Methodology-for-Improved-Agricultural-Land-Management_v1.0.pdf

approach."[17] The State already uses biogeochemical models to calculate N_2O emissions from agricultural soil management in croplands.[18] These same models will be used in future versions of the State's Natural and Working Land Inventory for the calculation of soil carbon fluxes.[19] These protocols use biogeochemical models on an annual basis to quantify the GHG flows using data including temperature; precipitation; fertilizer application rate, method, and form; soil type; and agricultural practices. The State already uses biogeochemical models to calculate N_2O emissions from agricultural soil management in croplands.[20] These same models will be used in future versions of the State's Natural and Working Land Inventory for the calculation of soil carbon fluxes.[21] Furthermore, a recent paper demonstrated that these models are capable of calculating seasonal and annual N_2O emissions from a diverse array of crops and these calculations are more accurate "than the Intergovernmental Panel on Climate Change emission factor approach."[22]

In addition to using biogeochemical models, farms participating in projects under these protocols measure their soil carbon at a minimum of every five years. While the technology to measure soil carbon is mature, significant research is rapidly improving the accuracy and reducing the costs. For example, the U.S. Department of Energy's Advanced Research Projects Agency-Energy (ARPA-e) Systems for Monitoring and Analytics for Renewable Transportation Fuels from Agricultural Resources and Management (SMARTFARM) program has funded a University of Utah project to "develop and deploy a distributed carbon sensor system that is buried into the soil, capable of locally stimulating a surrounding volume of soils at multiple depths, and sensing carbon and carbon flux at ultra-low operational cost. The sensor will enable high-accuracy and real-time decision data for cost-effective carbon removal, storage, and management."[23] By applying these approaches with a statistical, sample-based approach to aggregation and stratification, the protocols become far more scalable, and the transaction costs far more manageable than past agricultural protocols.

Indigo Ag is currently implementing the Climate Action Reserve's (CAR) Soil Enrichment Protocol (SEP) with several hundred growers on millions of acres (Project ID CAR1459) across the US. The project is preparing for its initial verification and we expect to receive registry approval and generate credits in early 2022. This is the largest agriculture carbon project in the history of environmental markets in terms of the scale of aggregation and practice change. This project will demonstrate that it is possible

[17] Deng, J., Li, C., Burger, M., Horwath, W. R., Smart, D., Six, J., et al. (2018). Assessing short-term impacts of management practices on N_2O emissions from diverse Mediterranean agricultural ecosystems using a biogeochemical model. *Journal of Geophysical Research: Biogeosciences*, 123, 1557–1571. https://doi.org/10.1029/2017JG004260
[18] CARB (2018) CARB GHG Inventory Updates Documentation. p.8. https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2016/ghg_inventory_00-16_method_update_document.pdf
[19] CARB (December 2018) Technical Support Document for the Natural & Working Lands Inventory. p.87. https://ww3.arb.ca.gov/cc/inventory/pubs/nwl_inventory_technical.pdf
[20] CARB (2018). CARB GHG Inventory Updates Documentation. p.8. (https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2016/ghg_inventory_00-16_method_update_document.pdf)
[21] CARB (2018). Technical Support Document for the Natural & Working Lands Inventory. p.87. (https://ww3.arb.ca.gov/cc/inventory/pubs/nwl_inventory_technical.pdf)
[22] Deng, J., Li, C., Burger, M., Horwath, W. R., Smart, D., Six, J., et al. (2018). Assessing short-term impacts of management practices on N_2O emissions from diverse Mediterranean agricultural ecosystems using a biogeochemical model. *Journal of Geophysical Research: Biogeosciences*, 123, 1557–1571. (https://doi.org/10.1029/2017JG004260)
[23] US DOE ARPA-e (2021). ARPA-E Announces $16.5 Million for Technologies Supporting the Biofuels Supply Chain. (https://arpa-e.energy.gov/news-and-media/press-releases/arpa-e-announces-165-million-technologies-supporting-biofuels-supply-chain)

and economic to incentivize the implementation of new GHG benefits that meet AB 32's requirements and the SEP should be considered as a future opportunity to generate low carbon fuels for the State.

CARB has done a tremendous job developing programs to reduce GHG emissions across the California economy, and the inclusion of agricultural land practices will continue the State's leadership. As a part of its strategy to meet the State's 2045 carbon neutral goals, Indigo Ag strongly recommends that CARB include field-based practices using the CAR SEP as an opportunity to reduce the CI of bio-based diesel and bio-based gasoline. We thank CARB for the opportunity to offer these comments and look forward to continued collaboration to implement policies and strategies that further reduce emissions from the transportation sector.

Sincerely,

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