January 7, 2022

Cheryl Laskowski
Transportation Fuels Branch Chief
California Air Resources Board
P.O. Box 2815
Sacramento, CA 95812

RE: Inclusion of field-based practices in Low Carbon Fuel Standard

Dear Dr. Laskowski:

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. Since peaking in 2001, per capita greenhouse gas (GHG) emissions have dropped 25 percent – from 14.0 tonnes per person to 10.5 per person in 2019. At the same time, the state gross domestic product (GDP) grew 2.6 percent while emissions per GDP declined 4.1 percent compared to 2018.[1]

At 39.7 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 CARB Chair Liane Randolph stated in her opening remarks at the 2022 Scoping Plan Update Kick-off Workshop in June. 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 key measures to reduce emissions from the transportation sector is through the State's carbon neutrality goal, set by 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]

Cleaner transportation fuels are a critical component to meeting the State's carbon neutrality goals. An April 2021 report by the University of California Institute of Transportation Studies estimated that nearly 4 billion gasoline gallon equivalents will need to come from a combination of bio-based diesel and bio-

[1] CARB (2021) California Greenhouse Gas Emissions for 2000 to 2019: Trends of Emissions and Other Indicators (https://ww2.arb.ca.gov/sites/default/files/classic/cc/ca_ghg_inventory_trends_2000-2019.pdf)
[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)

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 enters its second decade of operation, Indigo Ag encourages 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.

Indigo Ag uses microbiology and digital technology to improve the quality, yields and environmental sustainability of agriculture. We have recently expanded our expertise to streamline the ability of farms to tap into environmental markets. Using a combination of rigorous testing, 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 across the 3M+ acres that have contracted to be a part of Carbon by Indigo, Indigo Ag is helping these growers to eventually decrease net GHG emissions by more than 1 metric ton per acre of farmland per year.

Agricultural crops can play a significant role in helping California meet its multiple climate change goals. 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 multiple 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]

In July 2020, Argonne National Laboratory, creator of the GREET model used to calculate the carbon intensity (CI) of fuels in California, 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. These practices include optimizing fertilizer application, reducing tillage, using enhanced- efficiency fertilizers, and planting cover crops.[10] Unfortunately, soil carbon from land management practices, such as reducing tillage, planting cover crops, and manure application, are currently not included in the final CI calculation in CA-GREET. Based on the data we have collected from producers participating in our Indigo Carbon program who have implemented new agricultural practices, we have calculated a significant CI reduction in their feedstock. We would like to share our research and work with CARB staff to establish a streamlined process for soil carbon crediting.

[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

Indigo Ag strongly supports including the crediting of field-based practices in the LCFS. Practices such as cover crops, conservation tillage, and crop rotations all show the potential to reduce nitrous oxide (N_2O) emissions and increase soil organic carbon. Unfortunately, these valuable practices are not widely adopted. For example, according to the 2017 U.S. Census of Agriculture, cover crops have only been adopted on about 4 percent (15 million acres) of U.S. cropland acres.[11] Multiple long-term studies have been conducted in North America that have found that the planting of cover crops increased soil organic carbon content with as good as or better crop yields.[12,13] Similar studies have found that conversion from conventional tillage to no-till agriculture stored more than 2 metric tons per acre per year.[14,15,16]

In 2020, the Climate Action Reserve[17] and Verified Carbon Standard[18] adopted carbon offset protocols which use a two-pronged approach to quantify the GHG reductions from field-based practices. This approach uses a biogeochemical model supported by field sampling to quantify the net changes in GHG emissions from implementing 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 approach."[19]

We recognize there is uncertainty in the use of any model or calculation methodology. The protocols not only incorporate direct soil carbon sampling, but they also rigorously address uncertainty through mechanisms to account for sampling, measurement, and modeling uncertainty. The cost of measuring soil carbon has decreased to the point where it can be broadly scaled up, and peer-reviewed data are available for calibrating and validating models for an array of practices. Therefore, the practices farmers implement that reduce a fuel's CI can be supported both by a detailed model and the sampling and analysis of the fields at least every five years. This measurement approach provides a reconciliation between the modeled and directly measured approaches and ensures that the practices farmers implement are improving the fuel's CI. In addition, these samples can be used to further develop and improve the accuracy of these models.

Beyond the scientific basis for quantification, a key concern for any rigorous, modern low carbon fuels program is verifiability. Indigo has already collected annual management data, including historical

[11] USDA National Agricultural Statistics Service (NASS) (2021) 2017 U.S. Census of Agriculture. https://www.nass.usda.gov/Publications/AgCensus/2017/index.php
[12] 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
[13] 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
[14] Marland, G., West, T.O., Schlamadinger, B., Canella, L. (2003) Managing soil organic carbon in agriculture: the net effect on greenhouse gas emissions. *Tellus 55B*, 2 https://doi.org/10.1034/j.1600-0889.2003.00054.x
[15] Nicoloso, R.S., Rice, C.W. (2021) Intensification of No-Till Agricultural Systems: an Opportunity for Carbon Sequestration. https://doi.org/10.1002/saj2.20260
[16] Six, J. and Paustian K. (2014) Aggregate-associated soil organic matter as an ecosystem property and a measurement tool. *Soil Biology & Biochemistry 68*, A4-A9 http://dx.doi.org/10.1016/j.soilbio.2013.06.014
[17] Climate Action Reserve (2020) Soil Enrichment Protocol. Version 1.0 https://www.climateactionreserve.org/how/protocols/soil-enrichment/
[18] Verified Carbon Standard (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
[19] 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

baselines, from growers for every field enrolled in the project. Field-level data and disciplined approaches to data provenance and code documentation are the key to verifying CI scores that incorporate field-specific management practice changes. These components are scalable and in place today for Indigo's carbon offset project, which is currently undergoing independent verification.

We encourage CARB to include the crediting of field-based practices in updates to the LCFS program and we encourage CARB to start a rulemaking no later than the Fall of 2022 with an effective date of January 2024. We believe these practices can generate significant GHG reductions as well as protect watersheds, increase biodiversity, and improve soil health and fertility. We are interested in sharing our research and experience with CARB staff to demonstrate the benefits to the environment of our approach.

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,

Max DuBrisson

Head of Carbon Policy
Indigo