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February 21, 2020

To: House Environment and Transportation Committee

From: Dr. Sara Via, Professor and Climate Extension Specialist, University of Maryland College Park

Sara Via

Re: Testimony in support of HB 1176

HB 1176 will launch the next phase of MDA's Healthy Soils Program by providing initial funds to incentivize carbon sequestration in Maryland's agricultural soils. The landmark legislation that created the Healthy Soils Program in 2017 (HB1063) made Maryland one of the very first states in the nation to formalize a strategy to improve soil health that also prioritizes carbon sequestration. Maryland is a national leader in the use of healthy soils practices, and other states are already emulating Maryland's policies to accelerate the recovery of soil health and increase the agricultural sequestration of carbon.

Unfortunately, the legislation establishing the Healthy Soils Program did not include the funding required to accomplish its goals. Despite this lack of funding, MDA has made good use of the past two years to lay the groundwork for a strong evidence-based program that will increase the use of farming practices that boost soil health and sequester carbon. Both of these goals are highly beneficial to Marylanders:

Increasing soil health allows farmers to produce healthy crops using fewer inputs, reduces soil erosion and sedimentation in our waterways, **r**educes runoff and the flow of nutrients and agricultural chemicals to Chesapeake Bay, and increases the profitability of Maryland agriculture.

Sequestering carbon in the soil is a key "natural climate solution" that complements and extends Maryland's efforts to reduce GHG emissions. Scientists now realize that reducing emissions will not be enough to hold global warming to 2°C. It is also necessary to draw CO_2 from the atmosphere. Although there are various technological methods for removing atmospheric CO_2,[1] none are ready to be used on a large scale in any cost-effective way. In contrast, effective strategies for sequestering carbon in soils and woody plants are available now and extremely cost-effective, with many of the key practices coming in at less than $100/Mt CO_2e.[2] Some preliminary cost-effectiveness data for sequestering carbon in Maryland's soils are addressed below.

I have spent much of the past two years working with the Maryland Department of Agriculture (MDA) to evaluate the scientific basis of practices that sequester carbon in agricultural soils. As one of the few scientists in MDA's Healthy Soils Consortium, I took on the task of performing a detailed review of the scientific literature on this topic to evaluate the efficacy of a wide range of carbon-sequestering agricultural practices. As a result of this work, I developed a menu of recommended agricultural practices that will effectively sequester carbon in Maryland's agricultural soils (attached as Appendix 1). This list of recommended practices includes expected GHG reductions per acre per year for each

[1] 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

[2] Griscom, Bronson W., Justin Adams, Peter W. Ellis, Richard A. Houghton, Guy Lomax, Daniela A. Miteva, William H. Schlesinger, et al. 2017. "Natural Climate Solutions." *Proceedings of the National Academy of Sciences* 114 (44): 11645–50. https://doi.org/10.1073/pnas.1710465114.

practice, calculated using the current method of choice, COMET-Planner (developed by Colorado State University, USDA and NRCS).[3]

Currently under review at MDA, this list of recommended practices provides the scientific basis for new incentive programs being developed at MDA to improve soil health and sequester carbon. As part of MDA's planned contributions to greenhouse gas reductions in Maryland, the list of recommended carbon-sequestering practices was entered by MDA as Appendix K in the Draft 2019 Greenhouse Gas Reduction Plan.

I cannot stress strongly enough how important it is to require that policy be grounded in solid scientific evidence. This is true in general, but it is particularly important in the area of carbon sequestration. Many poorly supported claims have been made about "carbon farming" in the popular press and low-level non-peer reviewed scientific outlets. Some practices such as rotational grazing in pasturelands or the use of biochar have been vigorously promoted even though their efficacy is unclear because few high-quality scientific studies are available at present. Eventually the data may become available to support these practices as valid routes to carbon sequestration, but there is not enough evidence at present to support incentivizing them.

In other cases, vague strategies for sequestering carbon are promoted, such as "increase fungal biomass". It would be hard to know how to incentivize such a vague recommendation, since it is an outcome rather than a specific activity or practice. In fact, recommending an increase in fungal biomass is unnecessary, because most of the practices on MDA's Menu of Recommended Practices (Appendix 1, attached) produce this outcome by feeding and/or protecting the overall soil microbial community. In contrast to some vague prescription of a desired outcome, each of the recommended practices is a recognized and specific activity with well-established standards for implementation already defined by the USDA-NRCS (National Resource Conservation Service). Moreover, the outcomes of each practice for soil health and carbon sequestration have already been determined.

I am one of Maryland's representatives to the US Climate Alliance's Natural and Working Lands Workgroup. We are currently developing estimates of the cost effectiveness of practices on the recommended list. This work is in very early stages and we are still gathering data for implementation costs for many of the practices. Simply for purposes of illustration, I attach a **draft table of preliminary estimates** of \$/Mt CO_2e reductions from nine of the 21 recommended NRCS practices (Appendix 2). Averaging \$52.93/ Mt CO_2e per acre per year, the costs range from <\$5/Mt CO_2e per acre per year for grass buffers and tree planting to \$74-115/Mt CO_2e per acre per year for no-till and reduced tillage to a high of \$943/Mt CO_2e per acre per year for rotational grazing. Further work on the cost effectiveness of the recommended carbon-sequestering practices will provide useful information for directing incentives to the most cost-effective practices.

In sum, I recommend a positive report for HB 1176. This is a useful first step toward and increasing carbon sequestration in Maryland's agricultural soils. Fulling funding MDA's Healthy Soils Program is a crucial part of Maryland's GHG reduction efforts and it will have significant environmental and economic co-benefits.

[3] Swan, A., SA Williams, K. Brown, A. Chambers, J Creque, J. Wick, and K. Paustian. 2015. COMET-Planner. Carbon and Greenhouse Gas Evaluation for NRCS Conservation Practice Planning. Available at: http://comet-planner.com/

Appendix 1, Via testimony HB 1176, Feb. 21, 2020

RECOMMENDED PRACTICES FOR CARBON SEQUESTRATION IN AGRICULTURE

Greenhouse Gas Reductions From Agriculture: Menu of Recommended Practices				
GHG estimates from comet-planner.nrel.colostate.edu/COMET-Planner_Report_Final.pdf		GHG Reduction		
NRCS Conservation Practices		Mt CO2e/ac/yr		
Cropland Management	**Description of practice**	**CO_2**	**N_2O**	**Sum**
Conventional Tillage to No Till (CPS 329)	No-till or similar practice leaving >30% crop residue	0.42	-0.11	0.31
Conventional Tillage to Reduced Tillage (CPS 345)	Use of tillage practice leaving 15-30% of crop residue	0.13	0.07	0.20
N Fertilizer Management (CPS 590)	Improve N fertilizer management to reduce by 15% through 4R or nitrification inhibitors	0.00	0.11	0.11
Replace N Fertilizer w/ Soil Amendments (CPS 590)	Soil amendments include compost, manure	1.75	NE	1.75
Conservation Crop Rotation (CPS 328)	Decrease fallow or add perennial crop to rotation	0.21	0.01	0.22
Cover Crops (CPS 340)	Add seasonal cover crop to cropland	0.32	0.05	0.37
Insert forage planting into rotation (CPS 512)	Add annual or perennial forage to rotation	0.21	0.01	0.22
Mulching (CPS 585)	Add high carbon mulch to cropland	0.32	NE	0.32
Land use changes- add herbaceous plants				
Conservation Cover (CPS 327)	Convert to permanent unfertilized grass, legume, pollinator or other mix, ungrazed	0.98	0.28	1.26
Forage and biomass planting (CPS 512)	Convert to grass, forage or biomass plant, harvested	0.21	0.01	0.22
Riparian herbaceous cover (CPS 390)	Convert area near water to permanent unfertilized gra	0.98	0.28	1.26
Contour buffer strips (CPS 332),	Covert strips to permanent unfertilized grass, legume, pollinator or other mix	0.98	0.28	1.26
Field border (CPS 386)	Convert strips to permanent unfertilized grass/legume to reduce runoff	0.98	0.28	1.26
Filter Strip (CPS 393)	Convert strips to permanent unfertilized grass/legume	0.98	0.28	1.26
Grassed Waterway (CPS 412)	Convert strips to permanent unfertilized grass/legume to filter water	0.98	0.28	1.26
Vegetative barrier (CPS 601/342)	Plant stiff vegetative cover on hillsides or by streams to reduce erosion; can be used in critical areas	0.98	0.28	1.26
Land use changes- add woody plants				
Convert unproductive cropland or grassland to farm woodlot (CPS 612)	Plant trees and shrubs in marginal cropland to restore diversity, improve water quality	1.98	0.28	2.26
Tree & shrub establishment (CPS 612)	Plant trees and shrubs	1.98	0.28	2.26
Riparian Forest Buffer Establishment (CPS 391)	plants	2.19	0.28	2.47
Alley Cropping (CPS 311)	Replace 20% of annual cropland with woody plants	1.71	0.03	1.74
Multistory Cropping (CPS 379)	Replace 20% of cropland with trees & shrubs of different heights, could be permaculture	1.71	0.03	1.74
Hedgerows (CPS 422)	could combine with Conservation Cover for pollinators	1.42	0.28	1.70
Grazing				
Silvopasture (CPS 381)	Add trees & shrubs to grazed pastures (> 20 plants/ac	1.34	NE	1.34
Prescribed grazing/rotational grazing (CPS 528)	Any form of Management Intensive Grazing (MIG)	0.26	NE	0.26

Note: Some implementation guidelines not listed in the NRCS Conservation Practice Standards (CPS) may be required to ensure adequate carbon sequestration and alignment with the GHG reduction estimates from COMET-Planner.

NE = Not estimated

Estimated Cost Efficiencies of Agricultural BMPs for Nutrient Management and Carbon Sequestration

CAST BMP Full Name	annual GHG red. (MT CO2e)	Count	Practice Lifespa	Implementation Cost			Units	Annual O&M Costs	Annualized Cost				Cost Efficiency			
				Minimum	Maximum	Average			Simple	Simple + Land	CAST Method (incl O&M only)	CAST Method (incl O&M + land)	$/lb of N reduction	$/lb of P reduction	$/ MtCO2e reduction	Annual $/ Mt CO2e
Forest Buffers	2.47	126	10	$ 375.00	$ 2,973.63	$ 2,001.55	acres	$ 10.00	$ 210.16	$ 219.40	$ 269.21	$ 273.83	$ 32.58	$ 1,227.95	$ 108.99	$ 10.90
Grass Buffers	1.26	66	10	$ 38.13	$ 500.00	$ 301.02	acres	$ 10.00	$ 40.10	$ 49.35	$ 48.98	$ 53.61	$ 6.24	$ 391.50	$ 38.88	$ 3.89
Grass Buffer - Narrow with Exclusion Fencing	1.26	169	10	$ 0.85	$ 8.32	$ 3.26	linear feet	$ 5.00	$ 5.33	NA	$ 5.42	NA	$ 0.07	$ 0.28	$ 4.30	$ 0.43
Grass Buffer - Streamside with Exclusion Fencing	1.26	NA	10	NA	NA	$ 304.28	linear feet	$ 5.00	$ 35.43	$ 44.68	$ 44.41	$ 49.03	$ 1.96	$ 7.33	$ 35.24	$ 3.52
Land Retirement to Open Space		47	10	$ 93.73	$ 3,042.86	$ 547.75	acres	$ 25.00	$ 79.77	$ 89.02	$ 95.94	$ 100.56	$ 29.38	$ 3,782.26	$ -	$ -
Loafing Lot Management		61	10	$ 10,701.67	$ 3,237,092.67	$ 294,933.27	acres	$ 25.00	$ 29,518.33	NA	$ 38,220.21	NA	$ 2,026.19	$ 30,363.23	$ -	$ -
Off Stream Watering Without Fencing - Troughs		100	10	$ 940.44	$ 27,295.62	$ 5,680.68	acres	$ 25.00	$ 593.07	NA	$ 760.67	NA	$ 13,916.76	$ 98,162.84	$ -	$ -
Wetland Restoration - Headwater		23	30	$ 266.41	$ 17,730.70	$ 5,032.11	acres	$ 25.00	$ 192.74	$ 195.82	$ 352.35	$ 356.97	$ 132.85	$ 4,033.92	$ -	$ -
Water Control Structures		16	10	$ 69.92	$ 583.84	$ 253.16	acres	$ 50.00	$ 75.32	NA	$ 82.79	NA	$ 42.32	-	$ -	$ -
Animal Waste Management System - Livestock		87	15	$ 12.81	$ 2,553.47	$ 1,045.03	animal uni	$ -	$ 69.67	NA	$ 100.68	NA	$ 1,364.25	$ 20,705.97	$ -	$ -
Manure Transport		3050	1	$ -	$ 141.60	$ 15.41	dry tons	$ -	$ 15.41	NA	$ 16.18	NA	$ 4.53	$ 27.70	$ -	$ -
Conservation Plan		NA	1	NA	NA	$ 46.94	acres	$ -	$ 46.94	NA	$ 49.29	NA	$ 34.67	$ 551.96	$ -	$ -
Conservation Tillage - reduced till	0.2	NA	1	NA	NA	$ 21.85	acres	$ -	$ 21.85	NA	$ 22.94	NA	$ 15.33	$ 114.72	$ 114.71	$ 114.71
High Residue Tillage (no-till?)	0.31	NA	1	NA	NA	$ 21.85	acres	$ -	$ 21.85	NA	$ 22.94	NA	$ 15.33	$ 114.72	$ 74.01	$ 74.01
Cropland Irrigation Management		NA	1	NA	NA	$ 12.15	acres	$ -	$ 12.15	NA	$ 12.76	NA	$ 14.24	-	$ -	$ -
Horse Pasture Management		NA	5	NA	NA	$ 352.88	acres	$ 15.00	$ 85.58	NA	$ 96.51	NA	-	$ 2,416.47	$ -	$ -
Manure Incorporation Low Late		NA	1	NA	NA	$ 53.97	acres	$ -	$ 53.97	NA	$ 56.67	NA	$ 31.65	$ 466.01	$ -	$ -
Land Retirement to Pasture	1.26	NA	5	NA	NA	$ 163.75	acres	$ 25.00	$ 57.75	$ 76.25	$ 62.82	$ 67.45	$ 9.96	$ 827.44	$ 49.86	$ 9.97
Nutrient Management	0.11	NA	1	NA	NA	$ 47.73	acres	$ -	$ 47.73	NA	$ 50.11	NA	$ 80.31	$ 1,400.04	$ -	$ -
Non Urban Stream Restoration		NA	30	NA	NA	$ 133.36	linear feet	$ 1.00	$ 5.45	NA	$ 9.68	NA	$ 2,254.23	$ 2,893.48	$ -	$ -
Precision Intensive Rotational/Prescribed Grazing	0.26	NA	1	NA	NA	$ 219.33	acres	$ 15.00	$ 234.33	NA	$ 245.29	NA	$ 265.88	$ 1,252.16	$ 943.44	$ 943.44
Tree Planting	2.26	NA	30	NA	NA	$ 3,527.70	acres	$ 10.00	$ 127.59	$ 130.67	$ 239.48	$ 244.11	$ 174.47	$ 5,103.22	$ 105.97	$ 3.53
cover crops																
conservation cover																
forage and biomass planting																
filter strip																
grassed waterway (could we use the figures for grassed buffer?																

KEY
- (yellow) need definitions for these practices to see if we might have GHG reduction numbers for them
- (blue) need cost estimates for these practices to estimate $/Mt CO2e