Iowa Climate Science Statement 2016: The Multiple Benefits of Climate-Smart Agriculture

In April 2015, U.S. Secretary of Agriculture Tom Vilsack announced the new U.S.D.A. initiative, Building Blocks for Climate-Smart Agriculture [1]. Through this program, Iowa's former governor proposed expanding voluntary, incentive-based programs and initiatives to enable farmers, ranchers, and forest owners to confront human-caused global warming.

Farmers and land managers who have implemented proven conservation practices have positioned Iowa to lead implementation of Climate-Smart Agriculture. Iowa's leadership through wider adoption of conservation practices will benefit our state, while these practices lessen human contribution to net greenhouse gas emissions. Iowa – once replete with soil carbon built by deep-rooted perennial vegetation [2], [3] – can reduce net greenhouse gas emissions with crop-perennial systems that pull heat-trapping carbon dioxide from the atmosphere and rebuild soil carbon [4]. Thus Iowa – already a world leader in agricultural production and products – could now also take pride in "carbon-storage farms" that also improve soil health, wildlife and pollinator habitat, and water quality.

Carbon can be rebuilt in soils through boosting two widely accepted conservation practices prioritized by the Climate-Smart Agriculture program. First, transforming marginal croplands to perennial vegetation in land set-aside programs [5] permanently stores carbon in soils, preventing its exposure to air and transformation to carbon dioxide, while also incorporating nitrogen that otherwise would enter waterways [6]. Second, reducing cropland tillage [7] prevents soil erosion, thereby reducing silt and phosphorus runoff [8] and returning carbon and nutrients to the soil just below the surface.

Climate-Smart Agriculture aims by 2025 to reduce nation-wide net emissions and enhance carbon storage in the soil by over 120 million metric tons of CO_2 equivalent annually – the same effect as taking 25 million passenger vehicles off the road. By comparison, Iowa has 4.3 million registered vehicles. This achievement would match the greenhouse gas reduction of U.S. wind farms built from 2000 to 2015 [9].

Iowa's and our nation's Climate-Smart Agriculture efforts will be one part of a worldwide initiative, strengthened by the U.N.-sponsored climate talks held in December 2015 in France. The resulting Paris Climate Agreement [10] produced new commitment toward implementation of national plans for limiting human-caused global warming.

We, as Iowa educators, believe Iowa should play a leadership role in this vital effort, just as our state has already done for wind energy. We urge our representatives to help Iowa's innovative farmers [11] and land managers establish a multi-faceted vision for land stewardship by vigorously implementing federal, state, and other conservation programs [12]. Doing so could generate a more diverse landscape with acres dedicated to deep-rooted, native perennial vegetation within working lands (buffer strips, strip prairies [13], grazing land [14], and integrated crop-livestock systems [15] among other possibilities). Such a landscape would benefit all Iowans by transforming Iowa's vast croplands into resources that simultaneously generate food, feed, fuel, a healthier climate, better soils, wildlife habitat, and cleaner waters.

October 2016

[1] Climate Smart Agriculture Announcement:

http://www.usda.gov/wps/portal/usda/usdamediafb?contentid=2016/05/0112.xml&printable=true&contentidonly=true

Climate Smart Agriculture Implementation Plan:

http://www.usda.gov/documents/building-blocks-implementation-plan-progress-report.pdf

http://www.usda.gov/wps/portal/usda/usdahome?contentidonly=true&contentid=climate-smart.html

Climate Smart Agriculture for row crops includes goals for Soil Health, Nitrogen Stewardship, and Conservation of Sensitive Lands. The document at the URL above describes actions taken to date and detailed plans through FY 2018 with goals set through 2025.

Soil Health building blocks prevent the loss of soil carbon through transformation to carbon dioxide and build soil carbon by converting carbon dioxide into organic material in the soil. This building block is cross-cutting; changes in soil health impact and are impacted by a number of the other building blocks. As such, the benefit of improved soil health for climate change mitigation and many other desirable environmental, social, and economic outcomes are diverse, are an opportunity in all land management systems, and can be challenging to quantify completely.

Soil Health Goal: By 2025, greenhouse gas reduction of 4 – 18 $MMTCO_2e$ per year through improved soil health, decreased erosion of top soil, and increased soil organic matter.

Nitrogen Stewardship building blocks addresses the Nitrous Oxide (N_2O) emissions, a greenhouse gas that is over 250 times more potent than the same amount of carbon dioxide. Agricultural soils contribute about 50% of the global N_2O emissions (Houghton et al., 2001). This building block aims to reduction greenhouse gas emissions through improved nitrogen management practices and increased nitrogen use efficiency on crop and pasturelands.

Nitrogen Stewardship Goal: By 2025, greenhouse gas reduction of 7 $MMTCO_2e$ per year through nutrient management on 64 million acres of cropland and pastureland.

Houghton, J., et al. "IPCC 2001: Climate Change 2001." The Climate change Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change 159 (2001).

[2] Liu, S., Tan, Z., Li, Z., Zhao, S. and Yuan, W., 2011. Are soils of Iowa USA currently a carbon sink or source? Simulated changes in SOC stock from 1972 to 2007. Agriculture, Ecosystems and Environment, 140(1), pp.106-112.

Liu et al. (2011) estimates that Iowa lost 10% of soil carbon during 1972 – 2007. The reduction rate prior to the mid-1980s was greater than after the mid-1980s.

[3] Paustian, K., E.T. Elliott, and K. Killian. 1998. Modeling soil carbon in relation to management and climate change in some agroecosystems in central North America. p. 459–471. In R. Lal et al. (ed.) Soil processes and the carbon cycle. CRC Press, Boca Raton, FL.

Paustian et al. (1998) estimate decline of soil organic carbon of 30 – 50% from pre-cultivation stocks at Manhattan, Kansas and Arlington, Wisconsin.

[4] Russell, A.E., Laird, D.A., Parkin, T.B. and Mallarino, A.P., 2005. Impact of nitrogen fertilization and cropping system on carbon sequestration in Midwestern Mollisols. Soil Science Society of America Journal, 69(2), pp.413-422.

Russell et al. (2005) measured carbon storage and mineralization in experimental sites first established in 1954 (Kanawha, Iowa) and 1979 (Nashua, Iowa). The systems sampled were Corn-Corn for grain (CC), Corn-Soybean (CS), Corn-Corn-Oats-Alfalfa (CCOA), and Corn-Oats-Alfalfa-Alfalfa (COAA). They conclude the following:

> Our data indicate that the dominant cropping system of the upper Midwest, CS rotation with conventional tillage (chisel plowing for corn phase and disking for soybean phase) is not suitable for increasing soil organic carbon (SOC) stocks. On the other hand, cropping systems that include alfalfa in 1 to 2 yr of a 4-yr rotation are a viable management option for increasing SOC stocks. This study was not designed, however, to test whether the increased SOC quantity and quality in the CCOA system were the result of crop traits per se, or reduction in tillage intensity.

[5] Land set-aside is land that is removed from row crop production and placed into conservation reserve or used for moderate livestock grazing.

Brenner et al. (2001) provides model-based estimates of soil carbon increase for land removed from production in Iowa during 1989 to 1998. The state-wide rate of increase is 0.58 tons per acre per year. For land under Corn-Soybean production with intensive tillage to no tillage, average rates of increase of C stocks during the first 10 years varied from less than 0.22 tons per acre per year to greater than 0.29 tons per acre per year. The greatest response is predicted to occur on sandy soils in the eastern half of the state.

The U.S.D.A. Climate Smart Agriculture has targeted growth in two land set-aside programs in support of its goals for soil health: Conservation Reserve Program and Agricultural Conservation Easement Program.

Conservation Reserve Program is a land conservation program administered by the Farm Service Agency (FSA). In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality. Contracts for land enrolled in CRP are 10-15 years in length. The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat. The land must be suitable for any of the following practices: Buffers for Wildlife Habitat, Wetlands Buffer, Riparian Buffer, Wetland Restoration, Filter Strips, Grass Waterways, Shelter Belts, Living Snow Fences, Contour Grass Strips, Salt Tolerant Vegetation, and Shallow Water Areas.

U.S.D.A. Climate Smart Agriculture has a goal to enroll by 2025 an additional 400,000 acres with high greenhouse-gas benefits and gain additional benefits by transferring expiring CRP acres to permanent easements.

Agricultural Conservation Easement Program is a new conservation easement program created by the 2014 Farm Bill. It combines three separate previous easement programs — the Wetlands Reserve Program, Grassland Reserve Program, and Farm and Ranch Lands Protection Program.

U.S.D.A Climate Smart Agriculture has a goal to protect 40,000 acres through easements In addition to the transfer of expiring CRP acres to permanent easements.

[6] The Iowa Nutrient Reduction Strategy provides science-based estimates of reductions in non-point pollution for a broad suite of practices (http://www.nutrientstrategy.iastate.edu). Nitrogen reduction estimates from land set-asides are 75% +/- 9%, from riparian buffers 50% +/-13%, and from strips of retired land seeded to prairie vegetation up to 84%.

[7] Two classifications are used commonly to describe reduced tillage in conservation practices.

Reduced tillage (sometimes called conservation tillage), where 30% or more of the soil surface is covered with crop residue after planting.

No-tillage, where 70% or more of the soil surface is covered with crop residue after planting.

Model-based estimates of soil carbon increase on land that has been switched into either conservation tillage or no-tillage are provided in Brenner et al. (2001). In Iowa, the fraction of farmers using no-till and reduced tillage increased from, respectively, <3% and 20% of annual cropland in 1989 to 11% and 28% in 1998. The estimated conversion of atmospheric carbon dioxide to permanent storage as soil carbon ranged between 0.22 and 0.31 tons per acre per year.

Brenner, J., K. Paustian, G. Bluhm, J. Cipra, M. Easter, E.T. Elliott, T. Kautza, K. Killian, J. Schuler and S. Williams. 2001. Quantifying the change in greenhouse gas emissions due to natural resource conservation practice application in Iowa. Final report to the Iowa Conservation Partnership. Colorado State University Natural Resource Ecology Laboratory and USDA Natural Resources Conservation Service, Fort Collins, CO, USA.

The primary loss of soil carbon under reduced tillage and no-tillage systems is soil erosion. Causarano et al. (2008) find increased soil carbon at 0.5 m below surface in simulations for Iowa farming under no tillage and reduced tillage practice. However, soil loss from erosion offset the sub-surface soil gain so that when accounting for soil carbon loss by erosion the total soil profile had a loss of soil organic carbon. This points to the need to incorporate approaches to reduce erosion, such as cover crops, even within reduced tillage and no-tillage systems.

Causarano, H.J., Doraiswamy, P.C., McCarty, G.W., Hatfield, J.L., Milak, S. and Stern, A., 2008. EPIC modeling of soil organic carbon sequestration in croplands of Iowa. Journal of environmental quality, 37(4), pp.1345-1353.

Cropping systems will reach an equilibrium level of soil organic carbon. This means soil carbon sequestration is not a long-term, continuous solution for removing excess carbon dioxide emitted by fossil fuels. Although emissions reductions must be employed to maintain the carbon stock, sequestration should be employed as a transition to lower carbon dioxide levels (Feng et al. 2000).

Feng, H., Zhao, J. and Kling, C.L., 2000. Carbon sequestration in agriculture: value and implementation.

A drawback of no-tillage production is the need to increase pesticide and herbicide application. Iowa State University farm enterprise budgets estimate no till corn following soybeans compared to conventional till corn following beans used 19 percent more herbicides by cost, suggesting an increase in

volume of herbicide application. While no-tillage is effective at reducing phosphorous and silt runoff, further research is needed to reduce the dependence on other potential water contaminants.

U.S.D.A. Climate Smart Agriculture has a goal to increase by 2025 the national acres of no-till cropland from the current 67 million acres to over 100 million acres.

[8] The Iowa Nutrient Reduction Strategy estimates phosphorous reduction from adoption of chisel plowing (reduced tillage) to replace traditional moldboard plowing is 33% +/-49% and of no-tillage to replace chisel plowing is 90% +/- 17%.

[9] http://www.awea.org/MediaCenter/pressrelease.aspx?ItemNumber=8634

"U.S. wind farms reduced electric power sector carbon dioxide emissions by an estimated 132 million metric tons in 2015, according to the American Wind Energy Association's (AWEA) forthcoming annual U.S. wind industry market report. Those avoided emissions are equal to that from 28 million cars, or more than six percent of all carbon dioxide (CO2) emissions from U.S. electricity generation last year."

[10] https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf

The Paris Climate Agreement has set an international goal of holding the increase in the global average temperature to well below 2 °C above pre- industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre- industrial levels. On Earth Day 2016, 175 nations signed the Paris Climate Agreement. This is a record for the number of countries signing an international agreement on the first available day. The previous record goes back to the Law of the Sea in Montego Bay, which was signed by 119 countries in 1982.

[11] Iowa's farmers have voluntarily increased no-till from 800,000 acres in 1987 to over 7 million in 2012.

http://www.iowaagriculture.gov/press/2016Press/press04162016.asp

Increased use of no-tillage and reduced tillage has reduced soil erosion by an estimated 26 percent from 1982 to 2012, now estimated at slightly more than 6 tons per acre (for sheet and rill erosion). https://www.iowafarmbureau.com/Article/Iowa-conservation-progress-and-future-challenges

Iowa's leadership on no-tillage production could significantly help attain the nationwide U.S.D.A Climate Smart Agriculture program goal to multiply no-till cropland from the current 67 million acres to over 100 million acres by 2025. If Iowa were to double the pace of no-till implementation set during 1987 to 2012, Iowa would contribute 15% of the acres to the national goal and would lead the nation in total acres under no-till production.

Iowa's farmers are participants in an innovative nitrogen reduction program called SUSTAIN. The SUSTAIN™ platform is a nitrogen reduction program delivered through a partnership between United Suppliers and Environmental Defense Fund. Its goal is to enroll 10 million acres of cropland in Iowa by 2020, reducing greenhouse gas emissions by 5 $MMTCO_2$-e.

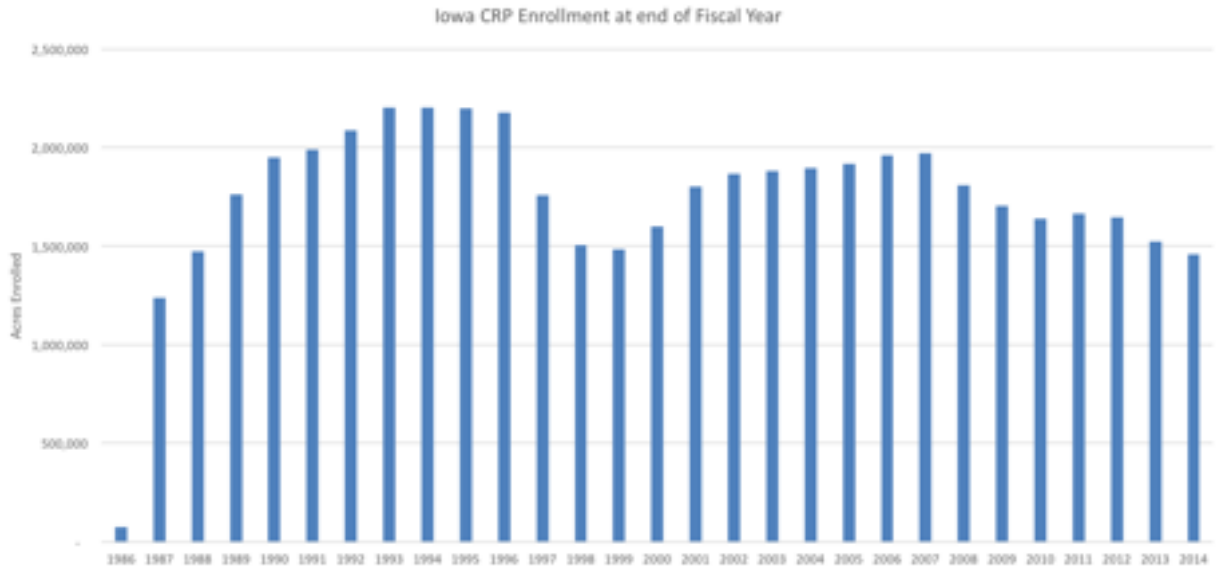
http://blogs.edf.org/growingreturns/2016/02/17/how-an-ag-retail-program-is-scaling-up-sustainable-practices/

https://www.google.com/#q=SUSTAIN+EDF+United+Suppliers+acres+10+Million

[12] http://www.desmoinesregister.com/story/money/agriculture/2016/05/05/crp-attracting-record-number-farmers/83935048/

"When Congress begins working on the 2018 farm bill, they will be working under a different set of assumptions as it relates to the (Conservation Reserve Program)," Vilsack said. "It does behoove Congress as they prepare for 2018, I think they really do need to look at more than saving money in establishing the number of acres."

Iowa leads the nation in new Conservation Reserve Program enrollment by enrolling 128,212 of the 800,000 new acres in 2016 — the most of any state. In 1993 – 1994, Iowa had 2.2 million Conservation Reserve Program acres, a number that dropped with funding cuts. With funding returned to the program, Iowa could return to its previous peak and, in so doing, could provide a significant fraction of the national U.S.D.A. goal of enrolling 400,000 acres with high greenhouse gas benefits.



Every Iowan can urge state and federal representatives to expand agricultural conservation programs through signing petitions in support of conservation program expansion in the 2018 Farm Bill. Petitions and other means to voice support for conservation programs will be distributed by the Environmental Working Group and Center for Rural Affairs (CFA). Contact the Iowa CFA member Stephanie Enloe (http://www.cfra.org/user/stephanie-enloe) for more details: stephaniee@cfra.org

[13] http://www.nrem.iastate.edu/research/STRIPs/

STRIPS stands for Science-based Trials of Rowcrops Integrated with Prairie Strips. The project is composed of a team of scientists, educators, and extension specialists who have chosen to work together on the use of prairie strips as a farmland conservation practice. We strive to more fully understand the assembly, management, function, and value of prairie strips; to communicate our results to diverse audiences; and to assist others with the implementation of prairie strips on farm fields. Our initial research site is located at Neal Smith National Wildlife Refuge near Prairie City, Iowa. We are now

implementing and maintaining research and demonstration sites across the Midwest, including on private commercial farms.

[14] Miller, J.R. L.W. Morton, D.M. Engle, D.M. Debinski and R.N. Harr. 2012. Nature Reserves as Catalysts for Landscape Change. Frontiers in Ecology and the Environment 10(3):144-152 [doi:10.1890/100227]

http://whiterockconservancy.org/?avada_portfolio=grazing-research-projects

https://www.leopold.iastate.edu/files/pubs-and-papers/2014-08-grazing-native-plants-iowa-processes-and-experiences.pdf

[15] Teague, W.R., Apfelbaum, S., Lal, R., Kreuter, U.P., Rowntree, J., Davies, C.A., Conser, R., Rasmussen, M., Hatfield, J., Wang, T. and Wang, F., 2016. The role of ruminants in reducing agriculture's carbon footprint in North America. Journal of Soil and Water Conservation, 71(2), pp.156-164.