July 2020

BIPARTISAN POLICY CENTER

DEPARTMENT OF AGRICULTURE
[Docket No. USDA–2020–0003] - Solicitation of Input from Stakeholders on Agricultural Innovations

Bipartisan Policy Center Response

Responses:

1. **What agricultural commodity, group of commodities, or customer base does your response pertain to or would benefit?**

   Through our Farm and Forest Carbon Solutions Initiative, the Bipartisan Policy Center is engaging in the development of policies that support farmers, ranchers, and forest landowners in implementing practices that sequester carbon while also providing economic and environmental co-benefits. Programs that incentivize practices that produce new sources of revenue for rural landowners, that allow them to act as providers of natural climate solutions, and that invest more broadly in agriculture and forestry could help build an important coalition of rural stakeholders and demonstrate that bipartisan climate policy solutions are achievable. BPC recently released a report to identify federal policy opportunities to facilitate enhanced carbon sequestration in soils and forests. [1]

   The Department of Agriculture Innovation Agenda has set a goal to increase U.S. agricultural production by 40% while reducing the environmental footprint of the agricultural sector 50% by 2050.[2] Innovation in row crop agriculture has the potential to meet and even surpass these goals to achieve net-zero or net-negative carbon emissions. Emissions from crop production could be reduced by more than 100 million metric tons of carbon dioxide equivalent (MMT CO_2e) per year by 2050 (equivalent to cutting current U.S. cropland emissions by 40%) if public agricultural research and development was doubled in the next ten years.[3] While we focus here on cropland opportunities, livestock production can also significantly reduce greenhouse gas emissions through methane digesters, methane capture, new feed combinations to reduce enteric emissions, improved grazing systems, and other advances.

   Investment in agricultural innovation would also increase American competitiveness in the global market while bolstering an industry recovering from the economic impacts of the COVID-19 pandemic. BPC has published a set near-term stimulus and recovery policy recommendations that leverage U.S. agriculture and forests to create new economic opportunities in rural communities while providing environmental and climate-change related contributions.[4] In a recent report, The Breakthrough Institute found that thousands of jobs could be created

[1] https://bipartisanpolicy.org/report/natural-carbon-solutions-in-u-s-farms-and-forests-building-a-policy-agenda-for-congressional-action/
[2] https://www.usda.gov/sites/default/files/documents/agriculture-innovation-agenda-vision-statement.pdf
[3] https://s3.us-east-2.amazonaws.com/uploads.thebreakthrough.org/RD_Maintenance_Memo_final.pdf
[4] https://bipartisanpolicy.org/wp-content/uploads/2020/07/BPC-Agriculture-and-Forestry-Near-Term-Stimulus-and-Recovery-Policies.pdf

through stimulus and recovery investments in agricultural research and development.[5] Additionally, increasing the extent of both carbon removal and GHG emissions reduction practices that can be achieved on farms would allow farmers to sell carbon credits in voluntary and compliance markets, creating a new source of income.

2. **What are the biggest challenges and opportunities to increase productivity and/or decrease environmental footprint that should be addressed in the next 10- to 30-year timeframe?**

The greatest opportunity for agricultural innovation is the development of the technologies and practices necessary to decarbonize and create carbon removal market opportunities from major row crops. The following technologies have significant potential to lower net emissions from row crops and provide a variety of ecosystem services while increasing the economic competitiveness of American farmers:

- **Carbon sequestering cultivars** – There is opportunity for innovation via the genetic modification of row crops to increase their carbon dioxide removal potential. Most soil carbon comes from plant roots and breeding for deeper, larger roots can add more carbon to the soil.[6] There is a strong foundation of research in this area, including work funded by the Department of Energy's Advanced Research Projects Agency-Energy Rhizosphere Observations Optimizing Terrestrial Sequestration (ROOTS) program and private sector efforts. However, further investment is needed to overcome the technological barriers to proof of concept and demonstration of new carbon sequestering cultivars.

- **Perennialization** – Current U.S. crop agriculture consists of annual plants with shallow roots. Converting these crops to continuously grown, deep-rooted perennials through genome design can increase retention of soil carbon and reduce environmental impacts. Two of the most advanced perennial grain crops, Kernza® perennial grain and perennial rice, will soon be ready for commercial application.[7] Continued investments into genomic research combined with investments in field trials of these two advanced perennial crops will inform the further development of other perennial grain crops.

- **Sensors and instrumentation to measure soil carbon and expansion of the COMET carbon sequestration database** – Innovation in digital and automated remote and in situ sensors could assist in farm data management, help farmers optimize inputs and minimize waste. These technologies are especially critical to support carbon accounting, monitoring, verification, and validation processes necessary for farmers to participate in carbon markets. Soil and forest carbon monitoring can be expensive, reducing profits for farmers and forest owners, and driving up carbon credit prices for consumers, and hence reducing market demand. USDA should continue to populate the COMET model

[5] https://thebreakthrough.org/articles/econ-recovery-ag-innovation
[6] https://www.dropbox.com/s/2y36ngfrcbpv37f/EFI%20Clearing%20the%20Air%20Full%20Report.pdf?dl=0
[7] https://bipartisanpolicy.org/wp-content/uploads/2019/12/BPC-Farm-and-Forest-Natural-Carbon-Solutions-Initiative-Working-Papers.pdf

with more data from sites across the country to establish credible carbon sequestration rates for all types and locations of forests and soils. Develop protocols to certify carbon credits for sale using COMET to determine sequestration rates, and thus reduce or eliminate the need for expensive monitoring.

- **Improved yield through C4 and CAM Photosynthesis –** The vast majority of crops for human consumption and energy supply use C3 photosynthesis which is relatively inefficient in terms of water, nitrogen and solar energy utilization as compared to the C4 photosynthetic pathway. C4 photosynthesis is common among forage grasses at lower latitudes but is present in only a few food crops. Peak yields of C4 plants in warm environments can exceed those of C3 plants by 50% or more. CAM is a third photosynthetic pathway and CAM plants have the highest water-use efficiencies.[8] Given that the C4 pathway is up to 50% more efficient than the C3 pathway, introducing C4 traits into a C3 crop would have a dramatic impact on crop yield.

There exist various challenges to reach net-zero or net-negative emissions from row crops while increasing yields. The following challenges will need to be addressed:

- **Underinvestment from the private sector** – Private sector investors tend to focus on low risk research which has high near-term benefits, and it can be challenging for companies to profit from investment in early-stage research.

- **Soil carbon accounting/monitoring, reporting, and verification** – Soil carbon is difficult to measure and there is a need for increased investment in reliable and effective measurement/monitoring, reporting and verification technologies, as well as enhancing the COMET model with additional data so that farmers and forest owners do not need to independently undertake expensive monitoring to certify credits.

- **Prohibitive costs** – Further research and development is needed to develop, test, and drive down costs to allow wide-scale adoption of technologies and practices to decarbonize row crops.

- **Lack of knowledge or expertise** – Farmers will require technical assistance and education to adopt new technologies and practices.

[8] https://academic.oup.com/jxb/article/65/13/3323/2877563

3. **For each opportunity identified, answer the following supplemental questions:**
   a. **What might be the outcome for the innovation solution (e.g., the physical or tangible product(s) or novel approach) from each of the four innovation clusters?**

   b. **What are the specific research gaps, regulatory barriers, or other hurdles that need to be addressed to enable eventual application, or further application, of the innovation solution proposed from each of the four innovation clusters?**

Carbon sequestering cultivars

a. Genome design - Innovation in carbon sequestering cultivars will enable new markets and strengthen U.S. agricultural competitiveness on a global scale. Approximately 500 to 800 MMT CO_2 per year could be sequestered in the U.S. through wide-spread adoption of high carbon input crops.[9] Increased soil carbon can improve fertilizer use efficiency, water use efficiency, total yield, resilience, and reduce soil erosion.[10]

b. On-farm innovation trials will be necessary to support the deployment of carbon sequestering cultivars and to attract private sector investment. Further technology development and regulatory programs will be required to validate and verify amounts of sequestered carbon. Currently, there is no centralized office at USDA that focuses on and coordinates cross-cutting innovation activities, from university labs to field trials. One interesting concept that has been discussed and proposed in the ARPA-Terra Act of 2019 (S. 2732/H.R. 4902) is the establishment of an Advanced Research Projects Agency within USDA to address this gap.

Perennialization

a. Genome design - Converting major row crops to continuously grown, deep-rooted perennials could increase carbon sequestration, reduce soil degradation, reduce water quality impacts from runoff, and help farms become more resilient to extreme weather events. The DOE's ARPA-E ROOTS program is currently exploring advanced technologies to develop crop cultivars that increase soil carbon by 50%, reduce nitrous oxide emissions by 50%, and increase water productivity by 25%.[11] In the near-term, on-farm innovation trials will be necessary to support the deployment of the two existing perennials grains. Attracting private sector investment will require investor confidence in the success of implementing perennial grains at scale.

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[9] https://www.dropbox.com/s/2y36ngfrcbpv37f/EFI%20Clearing%20the%20Air%20Full%20Report.pdf?dl=0

[10] https://arpa-e.energy.gov/?q=arpa-e-programs/roots#:~:text=To%20this%20end%2C%20projects%20in,increasing%20water%20productivity%20by%2025

[11] https://arpa-e.energy.gov/?q=arpa-e-programs/roots

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Sensors and instrumentation to measure soil and root carbon and expansion of the COMET carbon sequestration database

a. Digital/Automation – Innovation in sensors and instrumentation to measure soil and root carbon could help drive down the computational energy cost through the development of passive sensors and improve data management for capital utilization. Reliable soil carbon measurements would also allow farmers to participate in carbon markets and generate additional income. Collecting additional data on carbon sequestration rates from soils and forests across a wide range of U.S. climates and geographies could enhance the value and reproducibility of sequestration estimates in COMET and hopefully allow farmers and forest owners to avoid expensive monitoring in the future to support carbon credit generation and certification.

b. A lack of knowledge or training on applying these technologies could impede widespread owner adoption. Also, digital sensors require broadband access which may not be available in rural communities and IT hardware and software that can be costly to purchase and install. Technical assistance and education programs will be needed to shorten the learning curve for new technologies.

Improved yield through C4 and CAM Photosynthesis

a. Genome design – A long-term innovation program is required to drive applied research and development in photosynthetic pathways and expressing C4 and CAM processes in C3 plants. Increasing efficiency of plants to convert available energy from sun allows for increased yield per acre with decreased resource requirements. Developing C4/CAM versions of major agricultural crops would push the cutting edge of genomic design for plants and improve our fundamental knowledge of photosynthetic metabolism.

b. A strategic long-term cross-cutting innovation program would be required to enable this type of innovation, which would require the USDA to create an office of agricultural innovation based on the best technology management practices from across the federal government, based on organizations such as DARPA, ARPA-E and NASA COTS.

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