

Optimizing agricultural management to mitigate climate change impacts

ARS climate change research builds the science-based foundations for mitigating greenhouse gas emissions, reducing the effects of climate change on production, and helping to create adaptive and resilient production systems. Through transdisciplinary research approaches that integrate information and technology, ARS provides producers with options for increasing the sustainability of their production systems. The following FY 2020 accomplishments highlight ARS advances in developing new management approaches and decision support tools to reduce agriculture's carbon footprint and boost regional farmer incomes.

[Managing Midwest dairy forage production systems to maintain soil carbon.](#) The U.S. dairy industry is committed to environmental stewardship goals, including neutral or reduced carbon emission from dairy farms. Research is needed to determine the opportunities on farms to reduce carbon emissions and sequester carbon, including soil carbon storage. ARS researchers at Saint Paul, MN, monitored carbon balances for 9 years on three fields on a large dairy that uses both solid-liquid separation and anaerobic digestion for manure management. Under the current alfalfa-corn silage production with conventional tillage and inputs of liquid dairy manure, the field soils were losing carbon, with losses more than three times greater under corn silage than alfalfa. To maintain a neutral carbon balance in corn silage, the equivalent of 70 percent of the carbon removed in harvested corn would have to be returned to fields. That value is 30 percent for alfalfa. However, returned carbon should be even greater to have net soil carbon storage. This rate of carbon returns to fields may require changes in tillage, crop rotation, and manure management, all of which may be a challenge given how such changes affect other enterprises on the farm. These results are being used by scientists developing decision-aid tools that can evaluate whole-farm carbon uses and balances, by dairy producers to understand the tradeoffs in their carbon management, and by dairy industry stakeholders supporting carbon sustainability goals.

[New research targets less enteric methane emissions from cattle.](#) Cattle produce the greenhouse gas methane as a natural byproduct of digestion, and researchers are investigating ways to help reduce these enteric methane emissions. ARS scientists from Bushland, TX; Woodward, OK; and El Reno, OK, in collaboration with [Texas A&M AgriLife Research](#), studied how cattle methane emissions were affected by hay nutritional quality and fiber content. Cattle fed a high-quality hay diet (high crude protein) produced less methane per unit of digested organic matter than when fed low-quality hay. ARS researchers at Bushland, TX, and Ames, IA, also showed that adding tannin-rich peanut skin, a common regional byproduct, to cattle diets can suppress rumen microbial methanogenesis. This research shows scientists and producers the multiple benefits of feeding higher quality hay to improve animal performance and reduce emissions and indicates the feed additives that may provide cost-effective mitigation of enteric methane from beef and dairy cattle.

[Reducing our carbon footprint with renewable fuels grown on marginal land.](#) ARS researchers in University Park, PA, showed that ethanol could be produced from barley with a carbon footprint less than half that of gasoline, allowing it to meet the advanced fuel standard of the U.S. Environmental Protection Agency. ARS scientists in Mandan, ND, along with scientists at Michigan Tech and the U.S. Department of Transportation, demonstrated that growing oilseeds in place of fallow in non-irrigated areas of the Great Plains reduces greenhouse gas (GHG) emissions, increases soil carbon, and could boost regional farmer incomes from \$127 million to \$152 million per year through jet fuel production. ARS scientists in Lincoln, NE, and Fort Collins, CO, determined that, compared to GHG-neutral continuous corn under conservation management, long-term (16 years) switchgrass systems mitigate

GHG emissions during feedstock production by capturing more carbon in soil and mitigating nitrous oxide loss. ARS researchers in Temple, TX, identified genetic information in switchgrass that enables it to adapt to different growing conditions across a regional gradient from Texas to South Dakota. This research provides farmers with information about how to diversify income through emerging renewable fuel markets and provides policy makers with data needed to create programs to support renewable fuel production.

See also:

[Evaluating Management Strategies to Increase Agroecosystem Productivity, Resilience, and Viability](#)

[Contributions of Climate, Soils, Species Diversity, and Management to Sustainable Crop, Grassland, and Livestock Production Systems](#)

[Management Practices for Long Term Productivity of Great Plains Agriculture](#)

[Strategic management using new and improved decision tools can improve farm productivity and environmental impacts.](#) Producers and researchers need decision-making tools to estimate how their production decisions influence farm productivity and environmental impacts. ARS researchers in Fort Collins, CO, collaborated with Colorado State University to upgrade the [DayCent model](#), and with [American Farmland Trust](#) (AFT) to develop the [CaRPE tool](#). ARS researchers improved DayCent by accounting for soil freeze-thaw effects on nitrous oxide (N₂O) emissions, representing soil organic matter dynamics to 30-cm depths, addressing how cover crops and their removal affect greenhouse gas (GHG) emissions, and a range of other management factors. These changes increased the accuracy of GHG emissions modelling, which in turn produced more accurate GHG emissions that were 22 percent higher from 1990 to 2017 relative to the previous inventory. The [COMET-Farm tool](#) imbeds algorithms from the DayCent model and is frequently used for field and farm productivity and GHG estimation. It provides much of the modeling power of the CaRPE tool, an interactive management tool that couples crop and grazing land data from the NASS Ag Census with county-level GHG emission reduction coefficients from COMET. CaRPE has been used to explore the regional and national potential for agriculture to reduce GHG emissions and combat climate change, and AFT testified about its impacts before the House Select Committee on the Climate Crisis. These tools will enhance the ability of farmers to manage their systems, provide better estimates of and strategies to control GHG emissions, and provide a better foundation for additional scientific discoveries and agricultural management. The tools are useful to producers, NGOs such as the AFT and The Nature Conservancy, and government organizations, including NRCS, EPA, and NOAA.