College of Agricultural, Consumer and Environmental Sciences

National Center on Carbon Management and Soil Health in Arid and Semi-Arid Environments

Carbon Management and Soil Health Newsletter

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Farming the Future: Carbon Center Projects Dig Deeper into Biochar for Regenerative Sustainability

The NMSU Carbon Management and Soil Health Center has been leading projects on regenerative approaches to improve soil health and enhance carbon storage in arid and semi-arid environments. Through grant funding supported by the National Science Foundation and the National Institute of Food and Agriculture, the center researchers are conducting multiple field, greenhouse, and laboratory studies. These studies quantify biochar's potential to enhance carbon storage, improve soil health, and reduce greenhouse gas (GHG) emissions in arid farming systems. The center collaborates with researchers from Auburn University, the University of Delaware, and a few international partners. Within NMSU, the Center director Dr. Ghimire and affiliated faculty members Drs. John Idowu, Catie Brewer, Jinfa Zhang, and Xiufen (Sophia) Li have been characterizing biochar and testing their impacts on soil health, microbial community responses, and crop production.

Cutting-edge technology, such as solar-powered LI-COR soil flux system with automated chambers at the Clovis Science Center, enabled the researchers to continuously measure carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) emissions in biochar and compost amended fields. Complementary laboratory and greenhouse trials further explore how different types of modified biochar applications affect the cycling of carbon, nitrogen, and phosphorus cycling in soil, and their role in regulating N_2O emissions. Meanwhile, studies at the Leyendecker Plant Science Center aim to optimize biochar rates for cotton cultivars under irrigated and drought conditions. Together, these interdisciplinary projects are charting a new path for agricultural and environmental sustainability in dryland regions, positioning biochar as a promising tool to enhance agricultural sustainability and resilience in hot, dry regions.

Carbon Projects on Display at ACES Open House

On April 5th, NMSU ACES Open House brought NMSU researchers and key agricultural stakeholders together. In this event, the students and researchers working at the Carbon Management Center showcased their research through poster presentations and discussed ongoing research, outreach, and educational activities with stakeholders. The event provided an opportunity to highlight the center's achievements and foster dialogue with both the community and university leadership on key issues of agricultural and environmental sustainability in dry regions.

Publication Highlights

Using artificial intelligence to study greenhouse gas emissions

Accurately quantifying greenhouse gas emissions on farms is often costly, labor-intensive, and difficult to scale. Empirical and process-based models are often used to estimate the emissions, but they are also complex and require extensive data. To improve accuracy and efficiency in estimation and identify the key factors driving emissions, researchers are turning to artificial intelligence, particularly machine learning and deep learning models. A recent paper led by Dr. Prakriti Bista, applied five machine learning models to field GHG emission data. Their study show irrigation was the major driver of CO_2 emissions and air temperature was the primary driver of N_2O emissions in the cropping systems they studied. The study found that machine learning can provide accurate estimation of greenhouse gas emissions using simple environmental variables, helping to develop climate-smart farming practices and policies to reduce emissions. For details, please refer to Bista et al. (2025). Evaluating machine learning models for greenhouse gas emissions prediction in diversified semi-arid cropping systems. Soil Science Society of America Journal.

Biochar for increasing soil carbon storage and sustainability

Biochar has been increasingly promoted in sustainable agriculture. Biochar prepared from farmland waste, such as orchard pruning or animal manure, could improve soil health, increase soil carbon storage, reduce GHG emissions, and resolve waste disposal issues, leading to agricultural sustainability and development of circular farm economy. A study by Sapkota et al. (2025) showed a significant contribution of biochar on carbon storage and sustainable crop production. Specifically, pecan wood biochar increased soil organic carbon by 72% and improved stability of carbon, while manure biochar considerably improved soil phosphorus, magnesium, and other nutrients to support crop production. The findings show that plant residue biochar is more effective for carbon storage and stability, while manure biochar enhances soil fertility and crop yield. For more details, please visit: Sapkota et al., 2025. Contrasting effects of plant and animal residue biochars on soil health, carbon stability, and crop yield. Journal of Soils and Sediments.

Researchers Visited Trinity College Dubin and Northern Ireland Agri-Food and Biosciences Institute

The Carbon center researchers are part of international collaboration project on carbon and nutrient cycling. Drs. Rajan Ghimire and Juan P. Frene visited Trinity College Dublin, Ireland and Northern Ireland Agri-Food and Biosciences Institute in the second week of June 2025 to observe on-going research projects at these institutions. The visit was also planned to foster an exchange of research ideas and strengthen collaboration among experts from diverse disciplines. The visit was very productive and informative. It also set the stage for advancing innovative and sustainable agriculture strategies through international collaborations.

Celebrating Success: Dr. Atinderpal Singh Secured a Faculty Position

Dr. Atinderpal Singh, a postdoctoral scholar at the Carbon Center with an expertise in soil health and water dynamics, will be joining Montana State University as an Assistant Professor in the Department of Research Centers, starting Fall 2025. Based in Northern Agricultural Research Center at Havre, Montana. Dr. Singh will continue advancing research in sustainable cropping systems. We congratulate Dr. Singh for his new position, thanks for his great contributions at NMSU, and wishes him a grand success in his new role!

Prepared by: Sundar Sapkota and Rajan Ghimire

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