Can pastures help mitigate climate change?

Maria Lucia Silveira, Professor
Soil & Water Sciences, Range Cattle Research and Education Center, Ona, Florida

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Agriculture has historically provided much more than just food. It offers a multitude of environmental services and social goods that are critical to society. In addition to the increased pressure to meet global demand for food, today's agriculture also faces the challenge of balancing economic and environmental objectives. Weather uncertainties and extreme flood and drought events caused by climate change pose additional threats to agricultural production. However, these challenges also provide new opportunities for farmers to play an active role on climate change mitigation. In many parts of the world, there has been significant emphasis on encouraging farmers to manage their natural resources in ways that enhance the provision of ecosystem services to the wider society. The ability of agriculture to produce non-commodity outputs and the possibility of farmers to participate in carbon trading and offsets as well as payments for ecosystem services programs may offer new opportunities for agriculture to play an important role on climate change mitigation. However, despite the fact that soil carbon sequestration credit is gaining popularity in many countries like Australia and the U.S., these emerging agriculture-based climate credit programs are still facing many challenges, including lack of tools to accurately measure and monitor the benefits.

Although agriculture is often cited among the largest emitters of greenhouse gasses, it can also be an effective part of the solution. Global estimates suggest that greenhouse gas emissions from agriculture contribute to 10 to 12% of total anthropogenic emissions (Smith et. al, 2007). In 2018, U.S. EPA estimated that agriculture and forestry activities (including carbon dioxide emissions associated with agricultural electricity consumption) account for 9.3% of U.S. greenhouse gas emissions in the U.S. (U.S. EPA 2020). Within the agricultural sector, grazing lands (pastures and rangelands) are responsible for more than half of agricultural emissions. However, large uncertainties exist around these estimates. Decreasing agricultural greenhouse gas emissions is undoubtedly important; however, the lack of accurate estimates presents a major challenge to understand agriculture's role on climate change mitigation potential. For instance, emission factors linked to beef cattle production (i.e., emissions from manure and enteric fermentation) vary significantly regionally and temporarily. Differences in production efficiencies and introduction of new breeds as well as more efficient production methods can result in significant reductions in greenhouse gas emissions. There is also evidence suggesting significant regional differences in agricultural emissions with emissions increasing at a faster rate in developing countries than those in developed countries.

There is a growing body of evidence suggesting that agriculture can capture significant amounts of carbon from the atmosphere, mainly through soil carbon storage. Estimates suggest that cropland and grazing land soils can store up to 8.6 gigatons of carbon dioxide a year (IPCC, 2019). Increases in carbon storage in agricultural soils can offset approximately 12% of total U.S. greenhouse gas emissions (U.S. EPA 2020). Improved grazing land management, increased forage production and soil carbon stocks, and manure management are among the most effective options to increase soil carbon sequestration and mitigation potential of livestock systems. Scientists are currently using integrated approaches to better understand and quantify the potential benefits and tradeoffs associated with implementation of different management practices specifically targeted at a particular region, climate and soil type, and cropping system. Ideally, the goal is to use science-based information as part of decision-support tools that will help farmers choose the most effective practices. Most of these practices also provide co-benefits including improvements in soil health, wildlife habitat, and farm resilience to drought and flooding. However, some of these practices are not being implemented, which suggests that multiple barriers to implementation still exist. A major hurdle is the lack of studies documenting the benefits and tradeoffs associated with different management practices. Lack of data also increases the uncertainty and errors associated with greenhouse emission estimates. Generating reliable metrics that can be used as benchmarks for ecosystem services credit buyers is a critical step in increasing adoption of conservation measures.

During the last 10yr, my research group has developed collaborative research to address the role of grazing lands on soil carbon and greenhouse mitigation. Below a few examples of these past and current research efforts related to these topics are presented.

Results from our early studies demonstrated that both native rangelands and cultivated pastures are strong carbon sinks sequestering as much as 0.9 Mg C ha^{-1} yr^{-1} (Adewopo et. al., 2014). Our data also demonstrated a strong effect of management on soil carbon sequestration potential. For instance, we observed that pasture intensification (i.e., introduction of more productive plant species such as conversion of native vegetation into warm-season grasses) and adoption of proper grazing and fertilization management strategies can be beneficial for enhancing C sequestration (Adewopo et al., 2015a; Xu et al., 2016). Our data also indicated that adoption of improved pasture management can enhance soil carbon stocks (0 to 12 inches soil depth) by 50% or the equivalent of ~ 1 metric ton of carbon per year. This research supports growing evidence that proper pasture management is beneficial for soil and ecosystem carbon sequestration in the long term. Our results also suggested that increases in soil carbon stock in response to improved pasture management may be susceptible to faster turnover and degradation, especially under warming climate scenarios (Xu et al., 2017a). In other words, the benefits associated with increased soil carbon sequestration could be easily reversed by increased temperature or improper management (i.e, overgrazing, inadequate soil fertility program, weed and brush infestation) (Silveira et al., 2014; Adewopo et al., 2015b). In addition, data also suggested that adoption of improved pasture management practices are often beneficial to forage and livestock production, therefore, they may provide an incentive for producers to adopt strategies that enhance soil carbon sequestration while simultaneously increasing forage production. Results from our studies also indicated that long-term land use intensification affected the size, activity, and composition of soil microbial community (Xu et al., 2017b). Conversion of native rangeland into bahiagrass pasture increased soil microbial enzymes which suggested greater microbial activity. Data also suggested changes in microbial composition (e.g., fungal groups are more predominant in native rangelands versus bacterial groups in more intensively managed pasture systems) which are expected to affect ecosystem processes and functioning.

More recently, our involvement with the USDA Long-Term Agroecosystem Research (LTAR) network, a partnership among 18 research sites currently focused on the sustainable intensification of agricultural production, created additional opportunities for data collection and data analysis. For instance, in a recent study using a combination of eddy covariance and chamber measurements to estimate ecosystem carbon exchange and greenhouse gas emissions, we were able to quantify how quickly Florida native rangeland ecosystems recover after fire. Our data (Bracho et al., unpublished) demonstrated that native rangeland vegetation fully recovered its photosynthetic capacity 60 days following prescribed fire. Data demonstrated that native rangelands represent a strong carbon sink sequestering over 1.1 Mg C ha^{-1} per year. Similarly, native rangelands acts as methane sink offsetting between -21 and -51 kg CO_{2eqv} ha^{-1} yr^{-1} as methane.

Our ongoing research efforts continue to be focused on understanding carbon balance and dynamics in native and cultivated pastures, with special emphasis on determining how carbon is decomposed, protected, and stabilized in Florida's sandy coastal plain soils. Some of the basic questions we are trying to address include how pasture management impacts ecosystem carbon balance and global warming potentials? How can we quantify these benefits? To what extent can grazing lands help mitigate climate change?. If you have any questions about these projects, please don't hesitate to contact me (mlas@ufl.edu. Phone number: 863-735-1314 ext. 209)

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Upcoming Events

Visit our calendar online to view all our upcoming events and their registration links:

UF/IFAS Range Cattle REC Field Day & 80th Anniversary Celebration – October 7, 8:00 a.m. – 3:00 p.m. Visit the Center for research updates, graduate student posters, visit with our sponsors, enjoy a steak lunch, and field site visits. General registration: $20, college student ticket is $10 Late registration (Oct. 1 – 5): $40.

Ona Long-Term Agroecosystem Research (LTAR) Highlight with Dr. Sheri Spiegal – October 19, 11:00 a.m. Dr. Spiegal, will present, 'Using Manureshed Management to Connect Distant Links of the Beef Supply Chain.' She is a Range Management Specialist at the USDA-ARS Range Management Research Unit in Las Cruces, New Mexico, where she conducts collaborative research to understand the effects of agricultural management strategies on environmental, economic, and social sustainability outcomes in US agriculture.

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