Agricultural Greenhouse Gas Emissions and the Impact of Soil Management Practices in a Changing Climate: A Meta-Analysis

Sarah Barrows (sarah.barrows@pnnl.gov), Mariefel Olarte (mariefel.olarte@pnnl.gov), and Nikolla P. Qafoku (nik.qafoku@pnnl.gov)
(Pacific Northwest National Laboratory, Richland, WA, USA)

Background/Objectives. As the climate continues to change and the global population continues to grow, it will be increasingly important for agriculture to adapt so it can be resilient and sustainable into the future. Important characteristics and variables of climate change, including frequency of rainfalls, temperature, and variability in normal seasonal patterns, which vary on a locational basis, will affect crop yields and production. Therefore, there is a need to understand not only how climate change will affect crop production for food and energy but also how different soil management practices will affect agriculture's greenhouse gas (GHG) emission fluxes, not just now, but in increasingly severe climate change scenarios. Recent meta-analyses have systematically reviewed soil management effects on various metrics (such as crop yield, and CO_2 and N_2O emissions), but these meta-analyses have not systematically included important developing management practices such as precision agriculture or the application of different soil amendments. Most importantly, these meta-analyses do not explore how climate change impacts might affect emissions under these management practices.
A systematic review of the literature is currently being conducted to compare several key sustainable agriculture practices under various climate change scenarios, summarizing the impact of each practice to soil carbon budget and CO_2, CH_4, and N_2O emissions. This will help us understand which practices have the largest impact now and which ones will be key to sustainable agriculture and decarbonization of the environment as the climate continues to change.

Approach/Activities. In conducting our meta-analysis, we will follow Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. We will perform database searches using relevant search terms to identify records of interest and select records that meet our predetermined eligibility criteria. We will then analyze the accumulated records to summarize the reported ranges of estimates of GHG fluxes from different soil management practices, both in current scenarios, and in future climate change scenarios of increased temperatures, extended drought, and changes in wet/dry cycles. The parameters include fluxes of CO_2, CH_4, and N_2O under the following soil management practices: cover cropping, conservation tillage, precision agriculture, and applications of different minerals and materials amendments (which, in some cases, may help in preserving and/or increasing the organic and inorganic carbon pool in soils).

Results/Lessons Learned. We anticipate having meta-analysis results at the time of the presentation describing the range of GHG increases or decreases associated with several soil management practices in agriculture. We will summarize how these fluxes are anticipated to change in future climate change scenarios. These results will help provide a baseline for expected GHG effects of various sustainable agricultural practices and help increase the understanding of the climate parameters that most affect GHG fluxes generated by those practices. These results can be used to help identify areas of biggest concern for soil management GHG fluxes and suggest potential solutions as we move towards a future of more extreme climate changes.