

## **Response to “Biofuels from crop residue can reduce soil carbon and increase CO<sub>2</sub> emissions”**

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In their recent paper<sup>1</sup> Liska et al. examine the potential for corn stover removal from corn fields as a biofuel feedstock to reduce soil carbon stocks, thereby releasing CO<sub>2</sub> into the atmosphere. The authors conclude that, when SOC changes from residue removal are considered, life-cycle greenhouse gas (GHG) emissions from corn stover ethanol are much higher than previously reported and in fact may exceed those of conventional gasoline.

Reviewing the paper raised an important question that deserves close attention. What is the trend in baseline Corn Belt SOC stocks in a scenario without stover harvest? It is important to consider whether current SOC stocks in the Corn Belt are increasing, stable, or decreasing and how removal of corn stover at different levels would influence this trend. To address this question, we turned to the literature to better understand Corn Belt SOC levels under conventional corn agriculture.<sup>2-4</sup> Although most studies that we surveyed concluded Corn Belt SOC stocks had increased with time in recent history, estimates of SOC stocks in the Corn Belt vary and are dependent on production of other crops including soy. It is possible that corn stover harvest could alter the generally increasing trend in Corn Belt SOC stocks. It could reduce the magnitude of the SOC increase, cause SOC stocks to stay constant, or decrease Corn Belt SOC stocks into the future. It is also possible that management practices including reduced tillage, cover crops, and application of manure could mitigate SOC declines from residue removal and even increase SOC.<sup>5</sup> In future analyses of SOC impacts of corn stover harvest, it will be important to have a well-defined baseline for Corn Belt SOC that can serve as a point of comparison for alternative scenarios with stover harvest. Our limited review of the literature to this point revealed several calls for improved Corn Belt SOC data through long-term studies at spatial scales that capture regional variability. Improved data are critical for understanding Corn Belt SOC stocks to better calibrate and validate SOC models for predicting SOC changes so that valuable SOC stocks can be managed in the future as agriculture evolves.

Despite the importance of the baseline, Liska et al. do not provide SOC values for the Corn Belt baseline scenario. They report they built the baseline using U.S. Department of Agriculture yield and SOC data but their model uses time and temperature as the variables driving SOC changes and does not take into account key factors such as soil texture, tillage practices, prior land use history, and precipitation that impact SOC changes in soils.<sup>4</sup> In Figure S2, Liska et al. provide baseline modeling results for the Mead, NE site that reveal a decline in SOC with time, despite residue carbon return to the soil. It is unclear whether residue return is reducing the magnitude of SOC loss, but the baseline scenario does not exhibit SOC maintenance. The authors state that the results for the Nebraska site agreed well with “average trends in SOC across the larger region” so we may expect that the baseline Liska et al. generated for the Corn Belt also shows an SOC decline, which is in contrast with our literature review.

This leads us to question whether Liska et al.'s baseline scenario reflects the general trend in the literature of increasing Corn Belt SOC with time and opens the possibility that the model in the Liska et al. study overpredicts SOC losses under corn agriculture. If so, the model may also overpredict SOC loss under scenarios with stover removal. In our opinion, it will be important to develop a baseline for Corn Belt SOC that is consistent with the literature to engender confidence in predictions of SOC changes under corn agriculture with stover removal.

A key take-away from Liska et al.'s work echoes a literature theme:<sup>6–8</sup> carbon stocks are an invaluable resource and the production of bioenergy crops must be done in a manner that avoids potential SOC depletion. With the value of SOC well-recognized, existing LCAs of biofuels from corn stover have mostly assumed that this resource will be well-managed and SOC declines from stover collection will be minimal under sustainable stover removal rates. For this reason among others, including a co-product credit for electricity generation at cellulosic ethanol plants, LCA results to-date have predicted high GHG reductions compared to conventional gasoline. Liska et al. have reminded us that it is important to ensure sustainable stover removal rates and adopt good management practices to maintain soil health and achieve GHG reductions of stover-based biofuels, but their results should not be taken to mean that GHG emissions reductions from corn stover-derived biofuels are not achievable.

## References

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