CABBI
CENTER FOR ADVANCED BIOENERGY AND BIOPRODUCTS INNOVATION

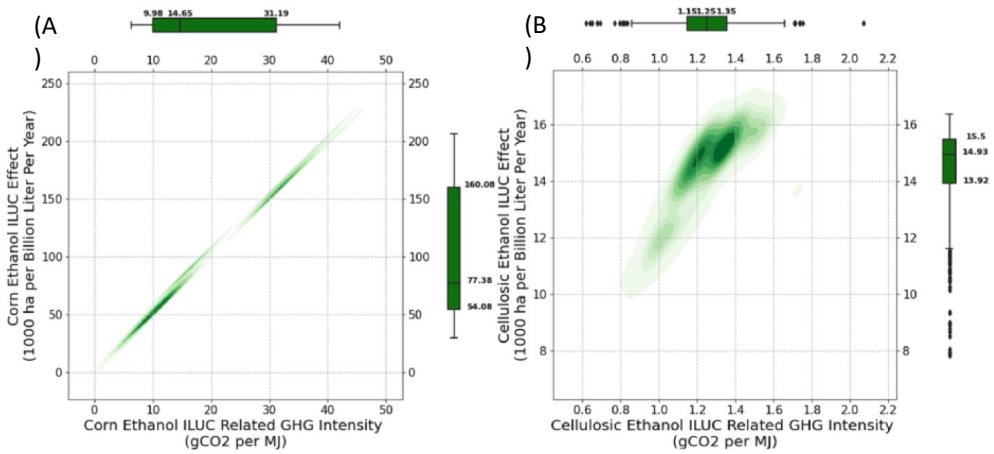
Quantifying Uncertainties in Greenhouse Gas Savings and Abatement Costs with Cellulosic Biofuels

Background/Objective

Cellulosic biofuels offer a promising alternative to fossil fuels, but uncertainty remains regarding their induced land use change (ILUC) effects, net greenhouse gas (GHG) savings potential, and economic costs. To address this knowledge gap, researchers analyzed the implications of multiple uncertainties along the biofuel supply chain on these outcomes.

Approach

- Coupled the BEPAM economic model, DayCent biogeochemical model, and BioSTEAM techno-economic and life cycle assessment model.
- After generating 1,000 combinations of uncertain input variables (including crop yield, available marginal land, refinery cost, and carbon intensity), 1,000 simulations for each of three policy scenarios (baseline, corn ethanol mandate, and corn + cellulosic ethanol mandate) were run over the period 2016-2030.
- Simulation outcomes were used to examine the range of uncertainty in economic outcomes and abatement costs of GHG emissions.



Range of Uncertain Outcomes in ILUC Effects: (A) Corn ethanol ILUC effect and Corn ethanol ILUC related GHG intensity (2016-2030); (B) Cellulosic ethanol ILUC effect and Cellulosic ethanol ILUC related GHG intensity (2016-2030).

Results

Median ILUC effect of cellulosic ethanol (14.9 ha/million L) and related GHG intensity (1.25 gCO_2-eq/MJ) were both substantially lower than the same values for corn ethanol (77.4 ha/million L and 14.7 gCO_2-eq/MJ, respectively). A 60.6 billion-L mandate for cellulosic biofuels in 2030 had the potential to reduce GHG emissions by 7.3% (7.1%–7.4%) more than that would be achieved by maintaining corn ethanol production at 57 billion L in 2030. The overall welfare cost per unit GHG abatement over the 2016–2030 period with the addition of cellulosic biofuels was significantly smaller and less uncertain ($149 [$137.3–$160.0] per Mg CO_2) than with corn ethanol alone $232.8 [$218.9–$241.4] per Mg CO_2.

Significance/Impacts

This work suggests that cellulosic biofuels from bioenergy crops have the potential to make robust and substantial contributions to climate change mitigation and that this potential is twice as high as that with maintaining the status quo level of corn ethanol production.

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