Assessing the potential for greenhouse gas mitigation and carbon management with advanced biofuels

Background

- Biofuels can contribute to climate stabilization via displacement of conventional fuel use and direct sequestration of carbon.
- The climate benefits of biofuels have been challenged based on carbon debt, carbon opportunity costs, and indirect land use change (ILUC).

Approach

- We paired ecosystem and biorefinery models to track carbon cycling in feedstock-producing agro-ecosystems, through conventional and future carbon-negative biorefineries.
- We assessed using abandoned agricultural land for switchgrass cultivation and advanced biofuel production, compared to reforestation or grassland restoration.

Outcome

- Current-day switchgrass ethanol production has similar per-area climate benefits as reforestation and much greater than grassland restoration.
- Future biofuel systems with integrated carbon capture and storage may achieve four times the per-area climate benefit of reforestation.
- These direct climate benefits dwarf previous estimates of ILUC risks.

Significance

- Current and future cellulosic biofuel production have distinctive climate benefits over many alternative natural climate solutions.
- Ongoing R&D is required to realize the high-performing future scenarios.

Field, JL et al. 2020. Robust paths to net greenhouse gas mitigation and negative emissions *via* advanced biofuels. *PNAS*
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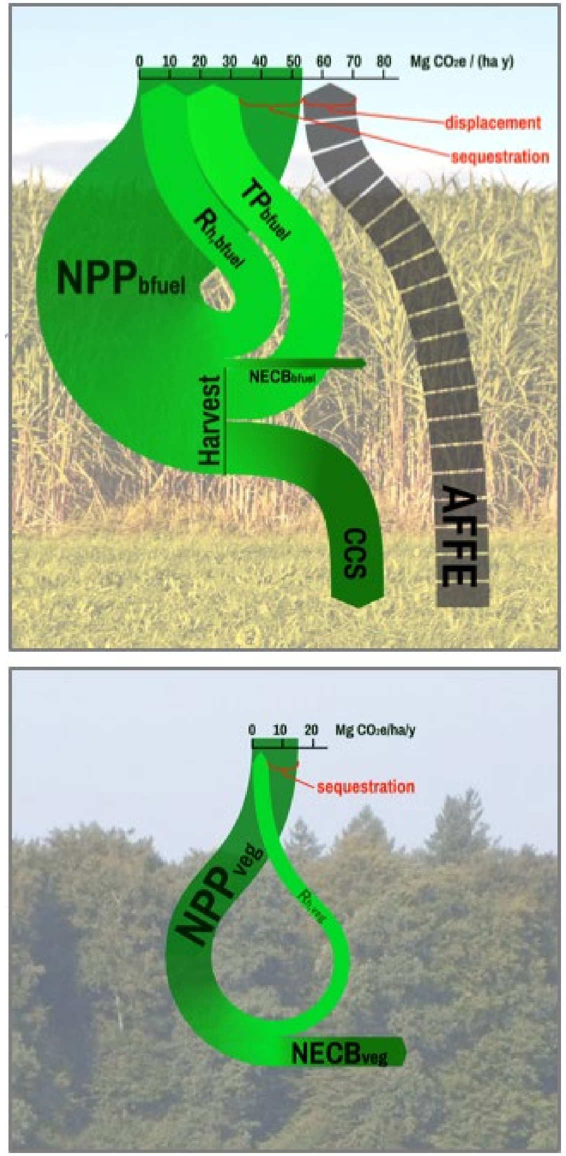

Carbon cycling in a future carbon capture and storage (CCS)-enabled switchgrass biofuel system (top panel) compared to reforestation (bottom panel). Fluxes include net primary production (NPP), heterotrophic respiration (R_h), net ecosystem carbon balance (NECB), tailpipe emissions (TP), and avoided fossil fuel emissions (AFFE).

Comparison of literature estimates of ILUC risk to the climate benefits from various bioenergy system design factors.