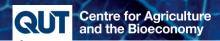


Testing the greenhouse gas abatement of bio-based production from agricultural residues

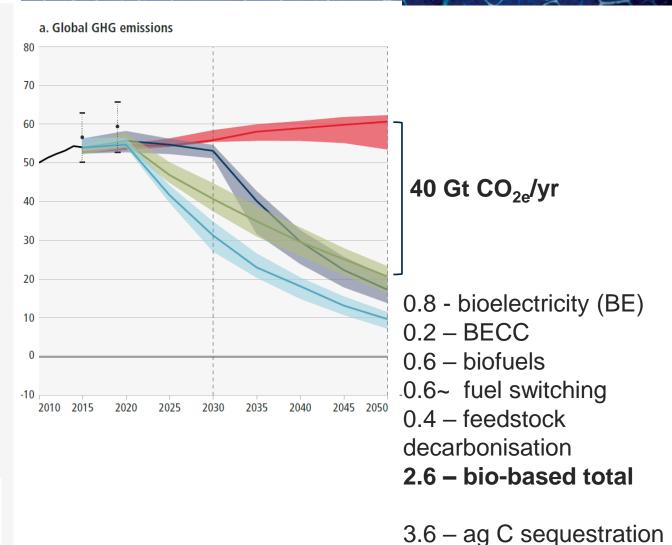
Marguerite Renouf Peter Grace Hakan Bakir Naoya Takeda Johannes Friedl

Centre for Agriculture and the Bioeconomy, Queensland University of Queensland, Brisbane



Potential contribution to net emission reduction, 2030 (GtCO₂-eq yr⁻¹) Mitigation options Wind energy Solar energy Bioelectricity Hydropower Geothermal energy Nuclear energy Carbon capture and storage (CCS) Bioelectricity with CCS _ Reduce CH4 emission from coal mining Reduce CH4 emission from oil and gas Carbon sequestration in agriculture Reduce CH₄ and N₂O emission in agriculture Reduced conversion of forests and other ecosystems Ecosystem restoration, afforestation, reforestation Improved sustainable forest management Reduce food loss and food waste Shift to balanced, sustainable healthy diets Avoid demand for energy services Efficient lighting, appliances and equipment New buildings with high energy performance Onsite renewable production and use Improvement of existing building stock Enhanced use of wood products Fuel-efficient light-duty vehicles Electric light-duty vehicles Shift to public transportation Shift to bikes and e-bikes Fuel-efficient heavy-duty vehicles Electric heavy-duty vehicles, incl. buses Shipping - efficiency and optimisation Aviation - energy efficiency Net lifetime cost of options: Biofuels Costs are lower than the reference Energy efficiency 0-20 (USD tCO₂-eq-1) Material efficiency 20-50 (USD tCO2-eq-1) Enhanced recycling 50-100 (USD tCO2-eq-1) Fuel switching (electr. nat. gas. bio-energy. H.) 100-200 (USD tCO2-eq-1) Feedstock decarbonisation, process change Cost not allocated due to high Carbon capture with utilisation (CCU) and CCS variability or lack of data Cementitious material substitution → Uncertainty range applies to Reduction of non-CO2 emissions

Role of bio-based production in GHG mitigation



Source: IPCC 2022. Climate change 2022. Mitigation of Climate Change. Summary for Policymakers. Sixth Assessment Report (6AR). Fig SPM.7

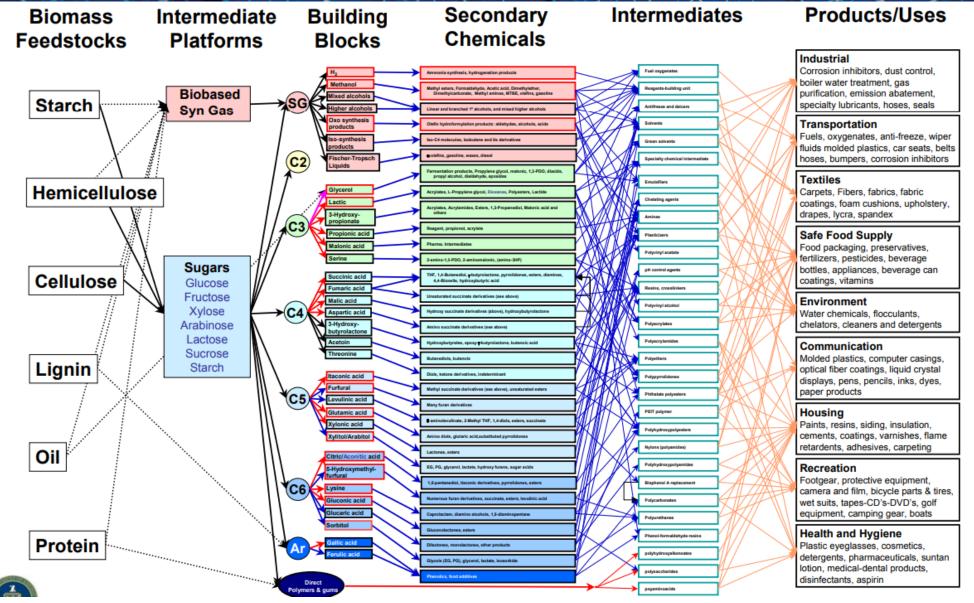


Bioproduction pathways





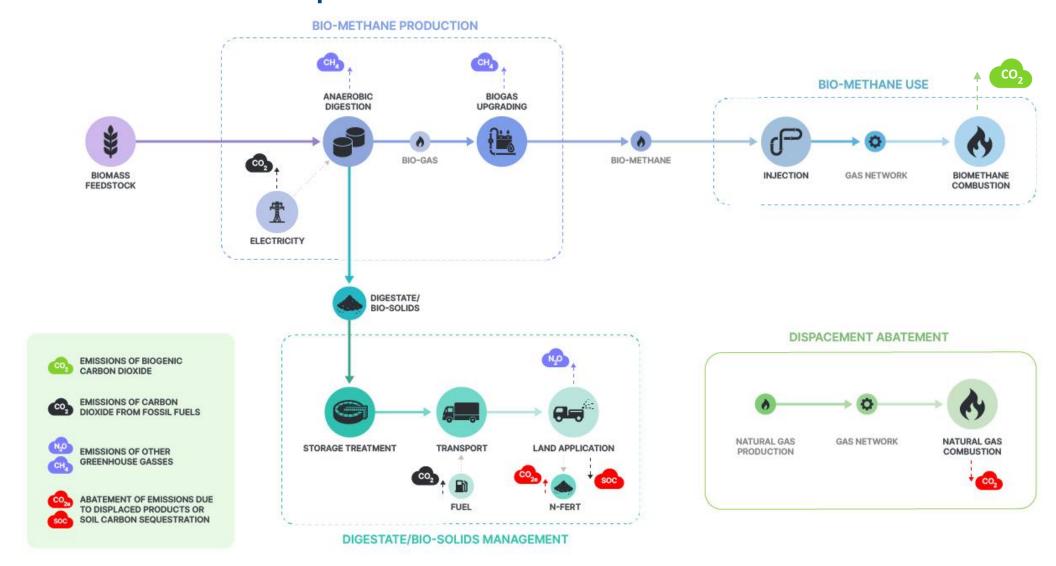
Bioproduction pathways





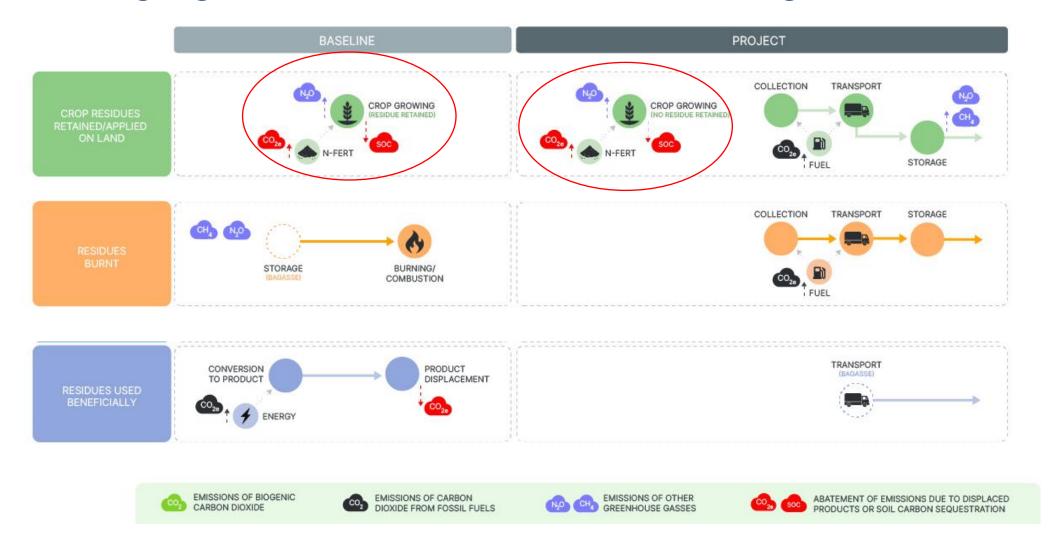
GHG emissions and abatement

Biomethane example



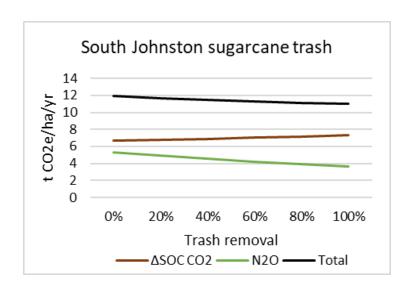
GHG emissions and abatement

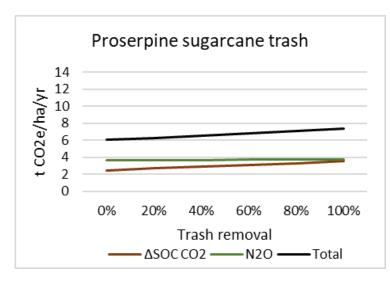
Diverting agricultural residues from existing uses

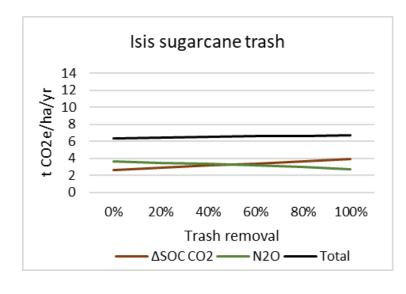


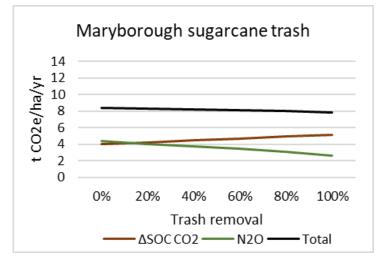
APSIM modelling of residue removal

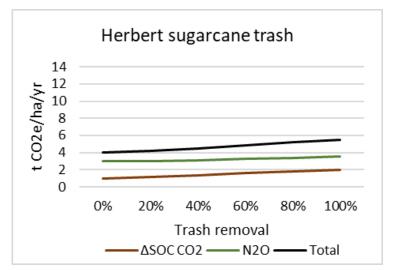
How residue removal influence on-farm GHG flux

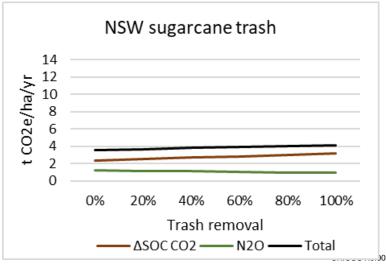






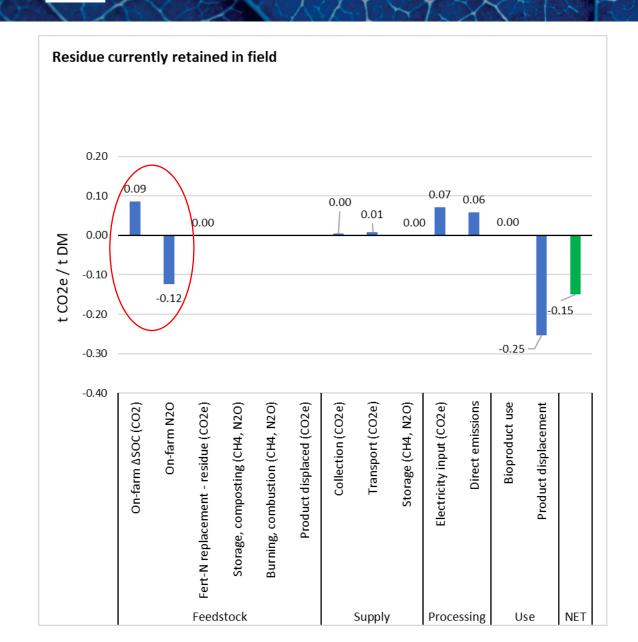


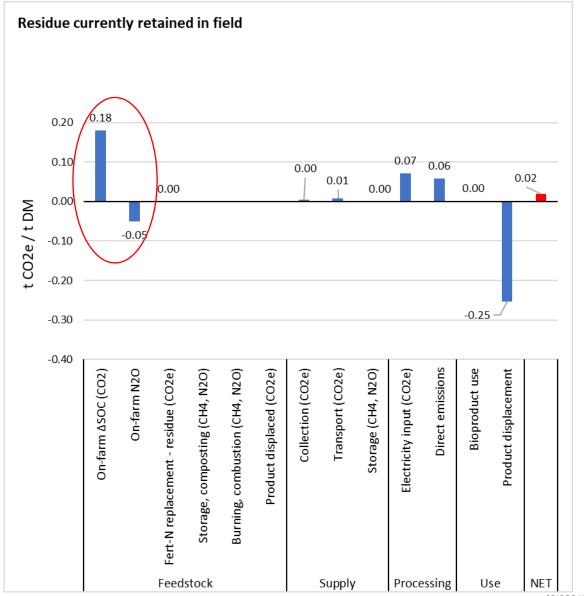






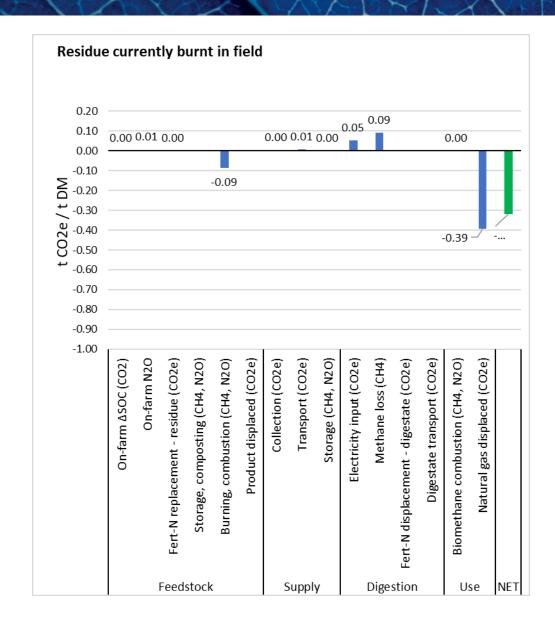
How GHG mitigation is achieved from bio-production

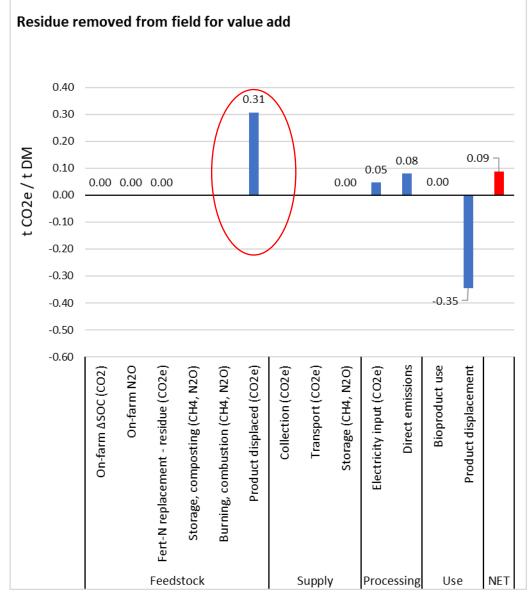






How GHG mitigation is achieved from bio-production





Areas of potential leakages

- For residues removed from land in some regions, increased CO2 emissions from SOC loss can be greater than reduced N2O emissions, resulting in an overall increase in on-farm GHG emissions.
- For residues that are already value-added into products, the lost displacement abatement when they are diverted away from these uses can also be a leakage.
- For residues with valuable nitrogen (N) content, urea-N replacement when they are removed also increases on-farm emissions.

This challenges the assumption that agricultural residues, often considered to be 'wastes', come free of embodied or consequential impacts when used as inputs to production processes.