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Can Healthier Diets and Agricultural Productivity Growth Contribute to Sustainability and Climate Policy Targets in the United States?

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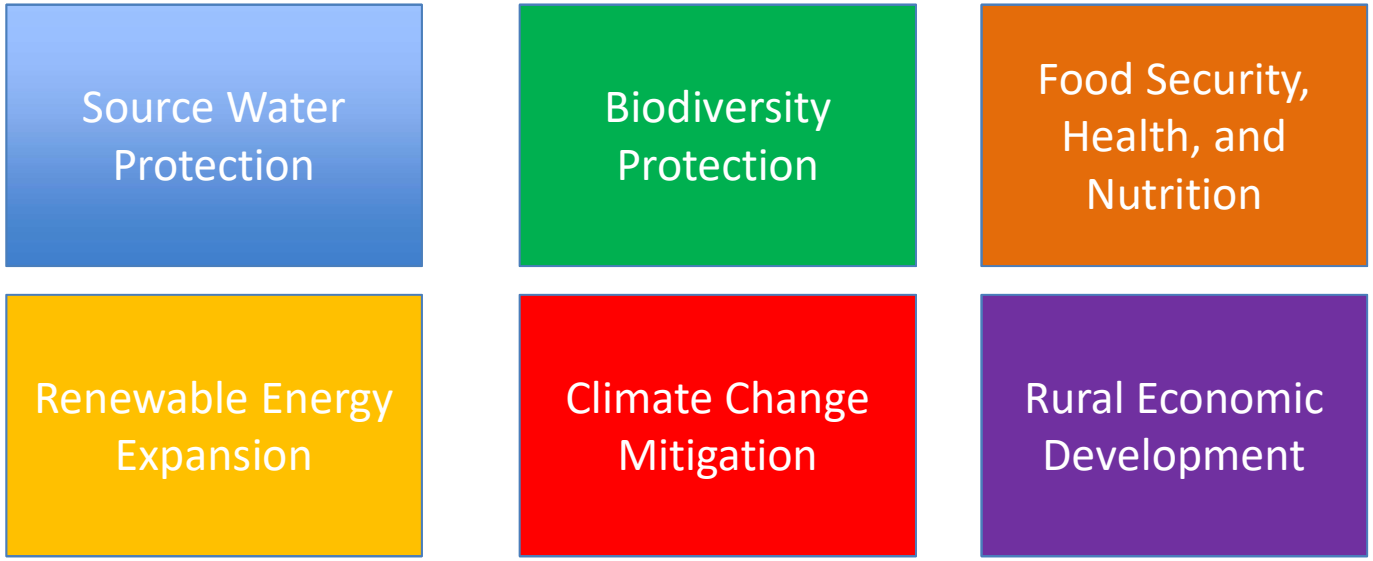
Motivation for Sustainable Land Use Pathways Assessment

- Land use/management tied to several sustainable development goals (SDGs)
- Land is critical input in most climate stabilization projections
- ***Challenges***
  - Growing demands for food, fiber, energy, and development space
  - Global concerns regarding rapid biodiversity loss
  - Environmental change

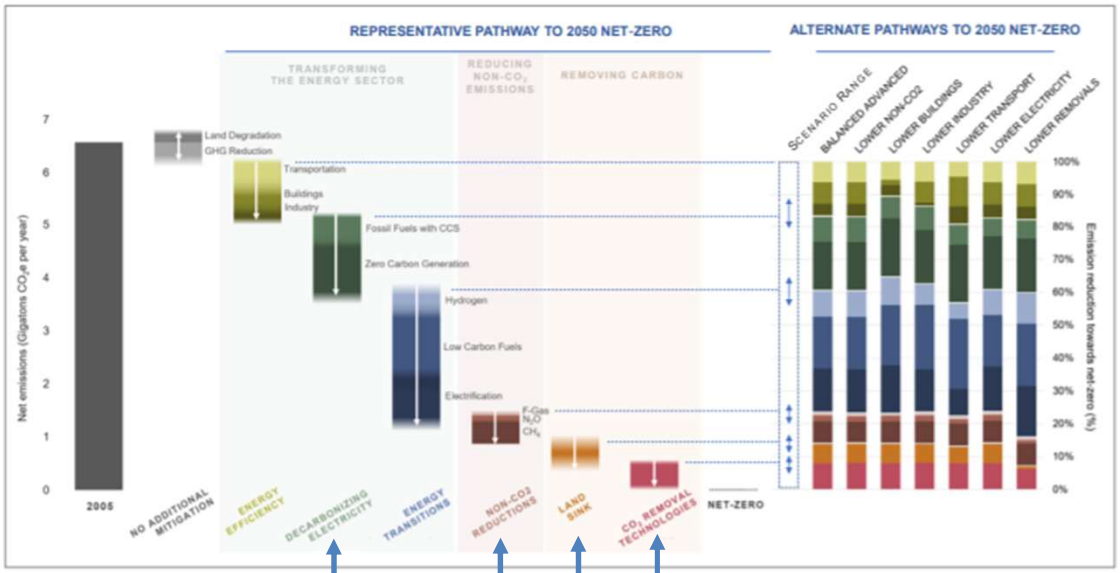
A Confluence of Policy Priorities Affecting the Land Use Sectors



- Separate policies shift resource demands independently
- Interactions between separate policy goals not clear, but in some contexts can be complementary

U.S. Policy Landscape

- White House Long-term strategy for de-carbonization
  - Agriculture and forestry expected to play an important role in U.S. climate action
    - Carbon sequestration, renewable energy supply, non-CO_2 emissions reduction



Land-dependent mitigation components

Source: https://www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf

US Policy Landscape

- Continuation of federal conservation programs
  - CRP, EQIP, etc.
- USDA Innovation Initiative
  - 30% reduction in nutrient loss
  - 50% reduction in food waste
  - *Increase agricultural productivity*
  - Expanded soil C sequestration

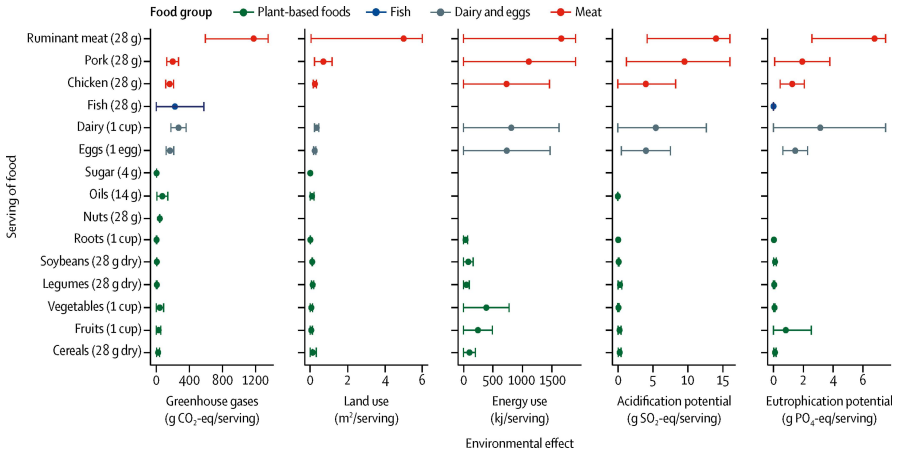
- *US Healthy Diet Guidelines*
  - *Shift to alternative sources of protein (fish, planted-based)*
  - *Higher proportion of calories from produce and grains*
- Biofuels/bioenergy
  - RFS2, state-led RPS/CES standards
  - and grains

Why Healthier Diets?

- Reduce disease burden in the U.S.

Source: Wu et al. (2020)

- Potential environmental co-benefits



Source: Willet et al. (2019)

Analysis Overview

- ***Objectives:***
  - Evaluate whether healthier diets and productivity growth in the U.S. can complement sustainability and climate goals
  - Explore interactions between demand and supply-side policies, as well national vs. globally defined diet transitions
- ***Approach:***
  - Multi-model (global) simulation analysis of alternative diet and productivity growth scenarios

Contributions

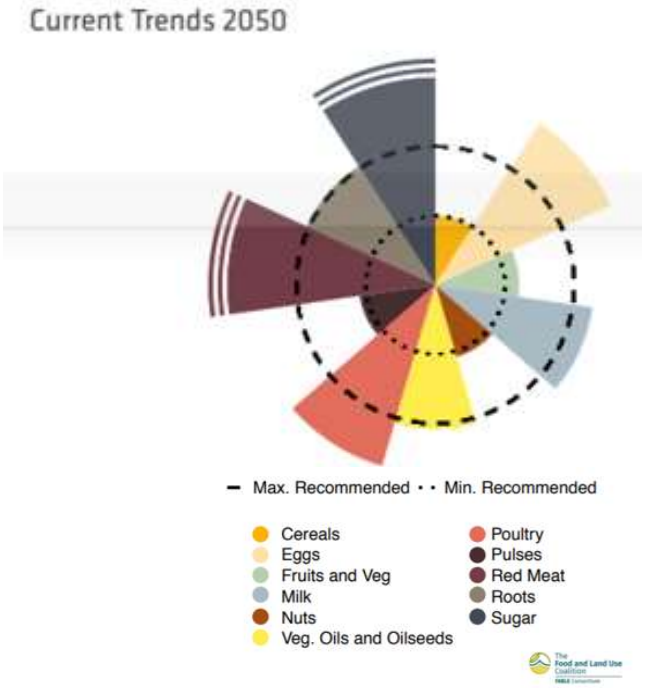
- Empirical techniques not always well-suited to evaluate new policies or multi-decadal time horizons (Baker et al., 2019)
- Recent U.S. land sector modeling has focused extensively on:
  - broad scenario narratives (Gurgel et al., 2021; Binsted et al., 2021; Jones et al., 2019)
  - climate change impacts (Baker et al., 2018)
  - direct climate policy incentives such as carbon pricing (Wade et al., 2021) or bioenergy (Kim et al., 2018)
- Dietary transitions largely ignored in the U.S. economic modeling literature
  - with recent global assessments lacking national perspective (Perez-Dominguez et al., 2021)

Modeling Approach

- Global Biosphere Management Model (GLOBIOM)
  - Global partial equilibrium, spatial allocation model of land use
  - Recursive dynamic, solves for economic surplus under future socioeconomic, policy and environmental changess
  - Captures national and global market feedback through trade
    - E.g., Baker et al. (2018), Janssens et al. (2020)
    - https://iiasa.github.io/GLOBIOM/
- FABLE Calculator
  - Spreadsheet-based equilibrium displacement model
  - Captures connections between production systems, land use, and environmental outputs
  - Facilitates multi-country iterative analysis and rapid assessment of sustainable land use scenarios
    - https://www.foodandlandusecoalition.org/fable/

Modeling Approach – GLOBIOM

- BAU Scenario
  - SSP2 income growth
  - U.S. and global diets consistent with current consumption patterns
  - Productivity growth calibrated to USDA projections



Source: Wu et al. (2020)

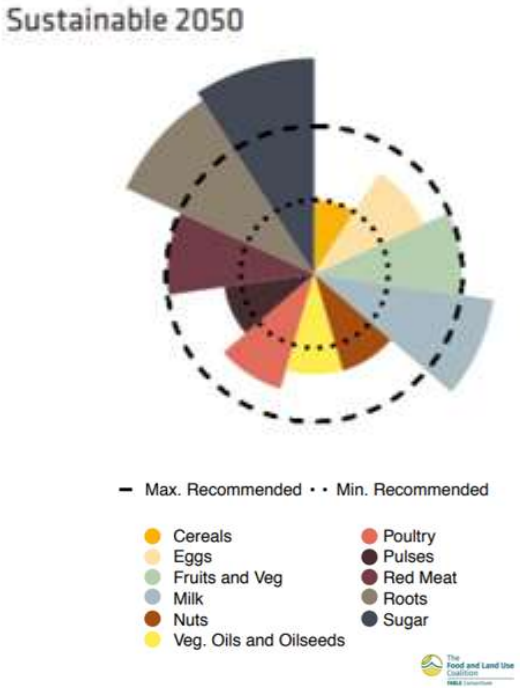
Modeling Approach – GLOBIOM

- Sensitivity Analysis
  - Healthy Diets US* Only
  - Healthy Diets US + High Yields^
  - Healthy Diets ROW+ Only
  - Healthy Diets US and ROW
  - Sustainability

    * = USDA Healthy Diet Guidelines

    + = SSP1 projected dietary preferences (Riahi et al., 2017)

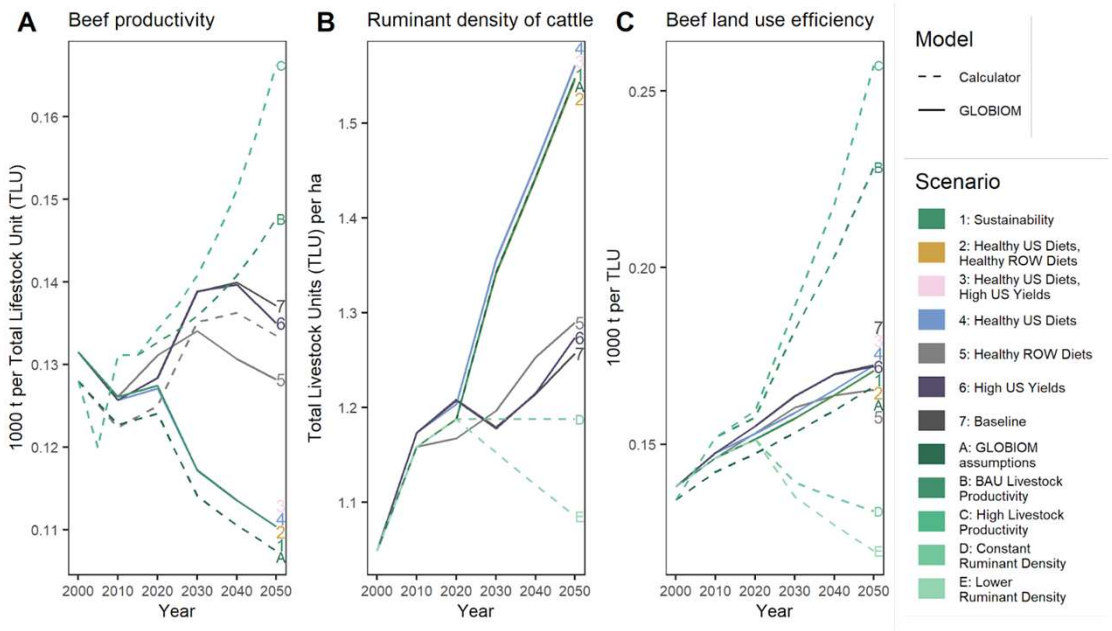
    ^ = increased exogenous productivity change for individual crops



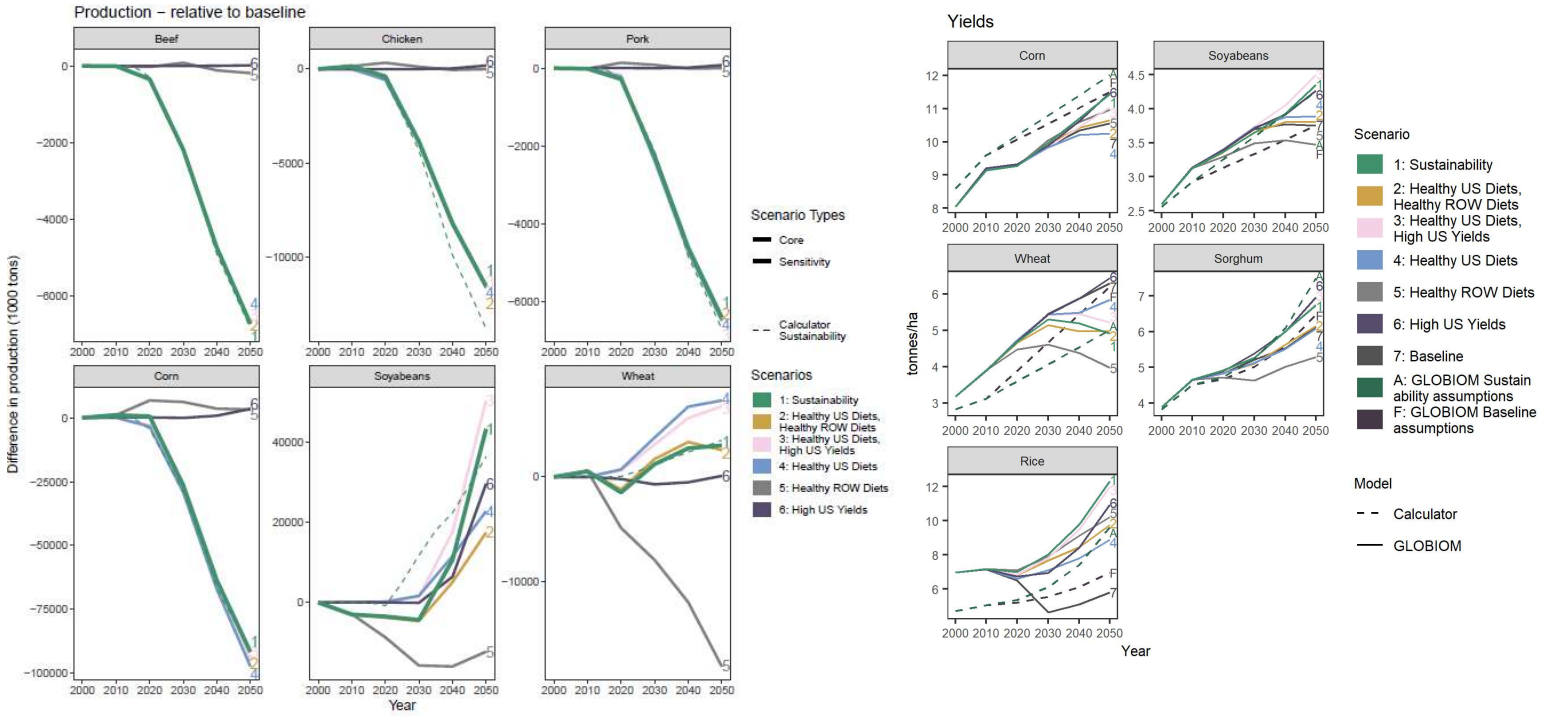
Source: Wu et al. (2020)

Modeling Approach – FABLE Calculator

- GLOBIOM projects market conditions and trade-flows
- FABLE Calculator builds on these projections to explore further sensitivities
  - Livestock parameters that are endogenous in GLOBIOM

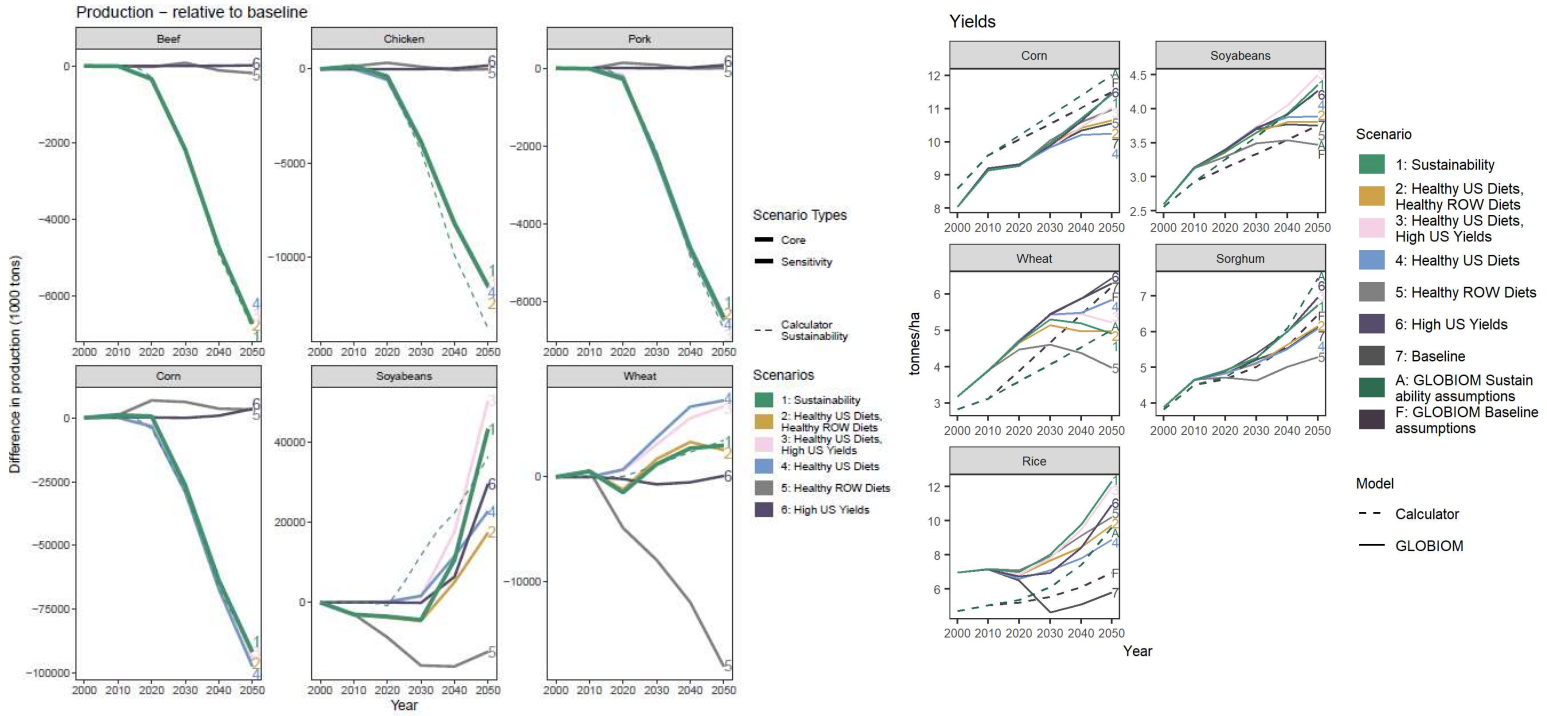


Change in Production from BAU



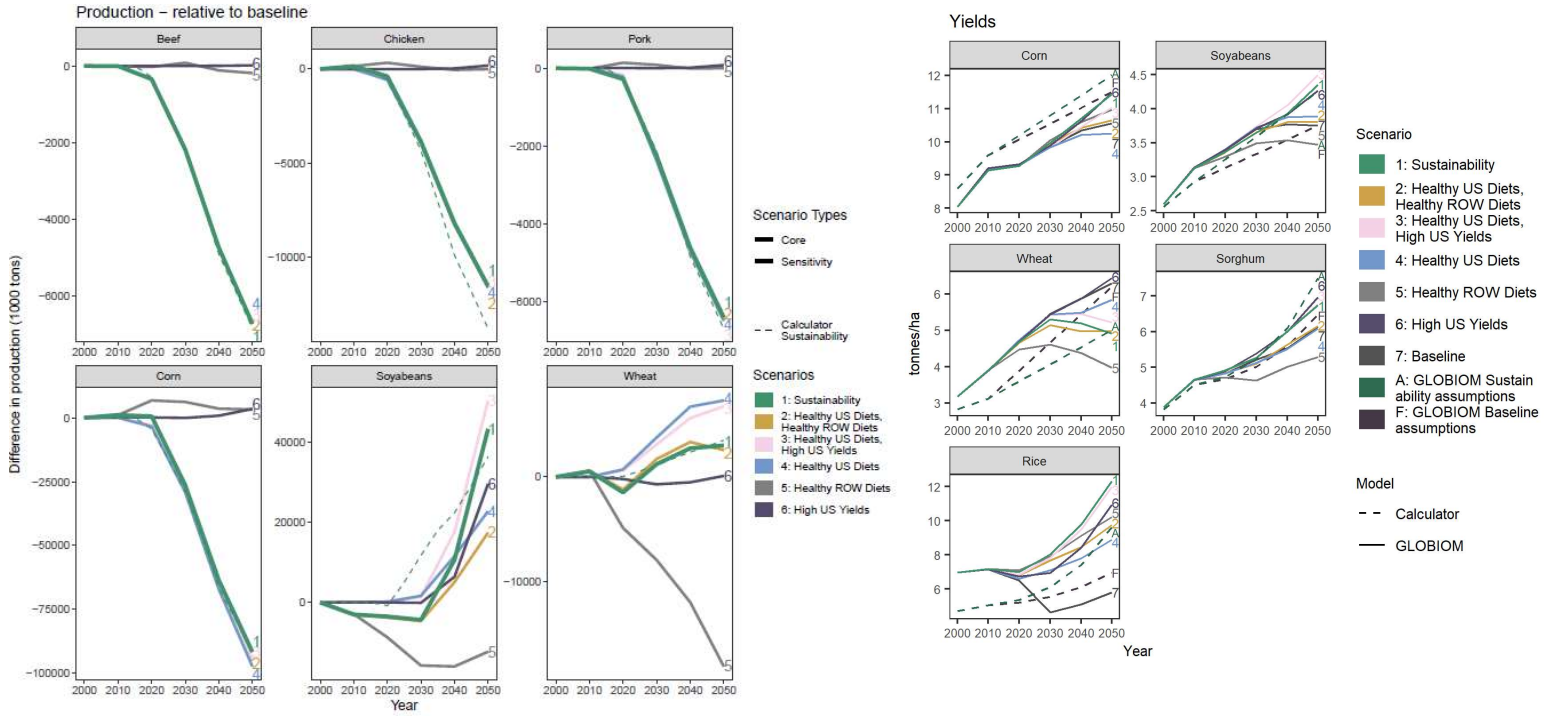
- Meat and feed grain production decline substantially under healthier diet scenarios

Change in Production from BAU



- Crop production impacts are mixed – e.g., increased production of some grains and alternative proteins under healthy diets

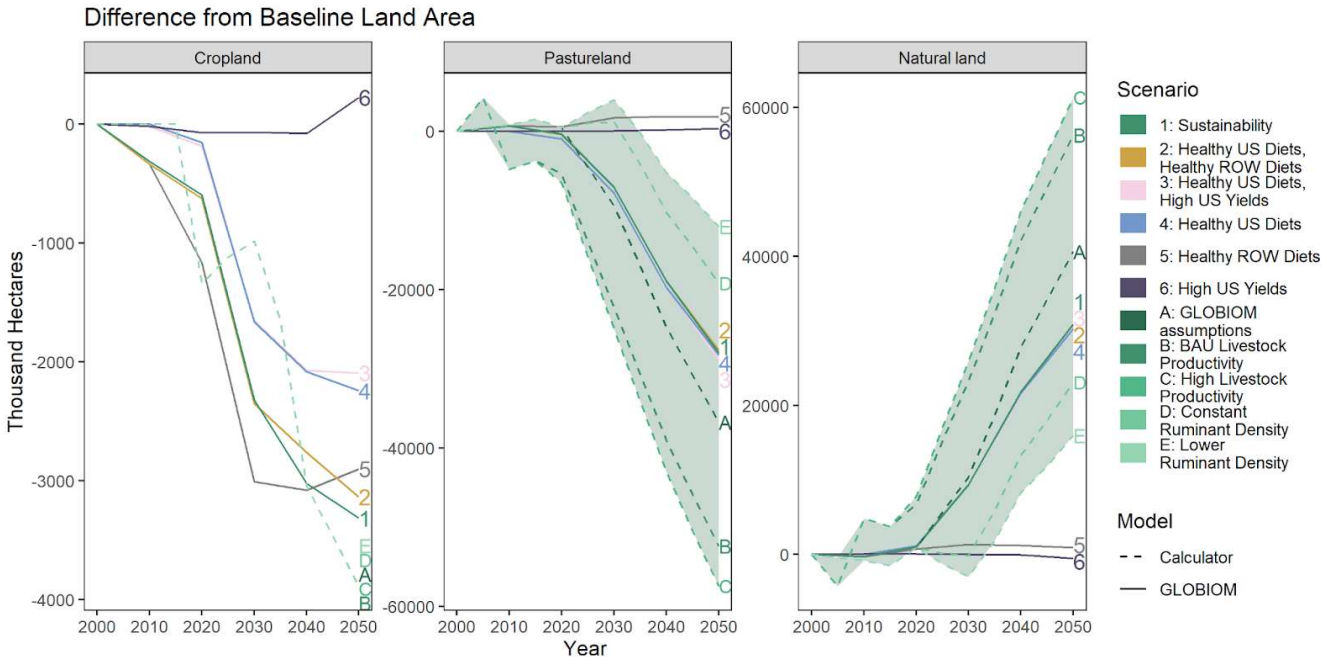
Change in Production from BAU



- Healthier diets reduce yields for some crops due to lower prices, lower endogenous yield response

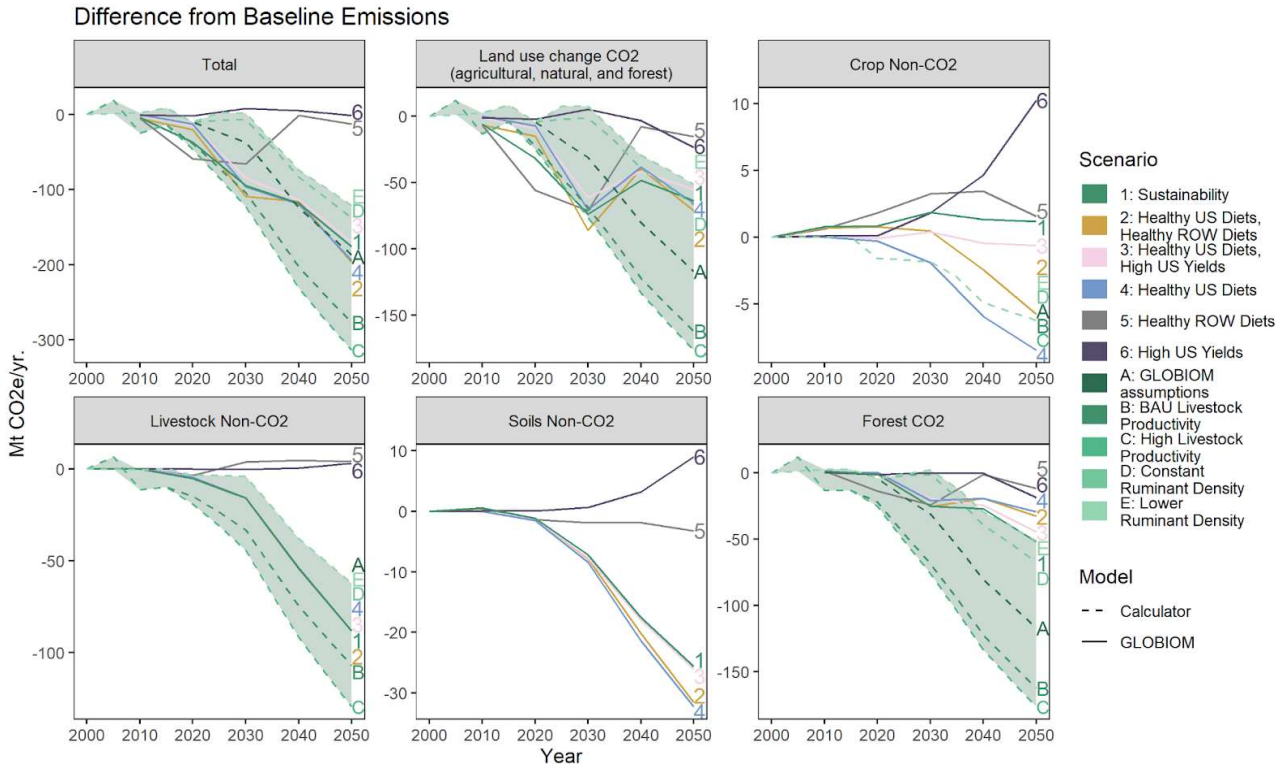
Change in Projected Land Use from BAU

- **2-4** million ha ↓ in cropland
- **~25** million ha ↓ in pasture use
- **~30** million ha ↑in natural areas



Change in Emissions from Baseline

- Healthier US diets ↓ livestock emissions ~75 MtCO2e
- ↑ in natural area provides ↑ forest C sequestration
- Emissions results highly sensitive to livestock productivity parameters



Key Takeaways

- Healthier diets in the U.S. complement climate and sustainability goals
  - Direct mitigation from ↓ non-CO2 emissions from livestock systems
  - Indirect mitigation from land use change
- Livestock system intensification can provide additional mitigation benefits
- Crop productivity growth may not be land-sparing locally
  - improves US comparative advantage and crop rents, hence increasing production emissions
- Global interactions matter
  - domestic production and emissions vary with ROW diets

Conclusion

- This study contributes to a growing literature on sustainable land use pathways
- We assess the implications of healthier diet transitions and agricultural productivity growth on U.S. land use systems
  - Results show that healthier diets and livestock system productivity growth can complement climate policy goals; results are inconclusive for crop productivity
- New analysis is needed to explore interactions between U.S. healthy diets and other direct environmental policy incentives
  - E.g., payments for ecosystem services, conservation set-asides

Thank You!

- Questions?
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