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

- Source Water Protection
- Biodiversity Protection
- Food Security, Health, and Nutrition
- Renewable Energy Expansion
- Climate Change Mitigation
- Rural Economic Development

- 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 decarbonization
  - Agriculture and forestry expected to play an important role in U.S. climate action
    - Carbon sequestration, renewable energy supply, non-CO₂ emissions reduction

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.

• Potential environmental co-benefits

Disease Burden due to Dietary Risks

About 20% of deaths are attributable to dietary risks, or 170,761 deaths per year (per 100,000 people) in 2017 (Afshin et al., 2019) supplementary info Table 7.

Dietary risks also lead to 3.982 disability-adjusted life years (DALYS), or years of healthy life lost due to an inadequate diet (Afshin et al., 2019) supplementary info Table 7.

10.5% of the population suffers from diabetes (CDCP 2020a) and 48% of adults suffer from cardiovascular diseases, which can be due to/ caused by dietary risks (Benjamin Emeka J, et al., 2019).

Source: Wu et al. (2020)

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 changes
  – 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
Meat and feed grain production decline substantially under healthier diet scenarios.
Crop production impacts are mixed – e.g., increased production of some grains and alternative proteins under healthy diets.
• 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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