Challenges and Opportunities for Nutrition Security in the 21\textsuperscript{st} Century

Climate Change and Economic Growth

Gerald Nelson
Professor Emeritus
University of Illinois, Urbana-Champaign
Faculty Disclosure

No conflicts to disclose.
Income growth and climate change effects on global nutrition security to mid-century

Gerald Nelson1*, Jessica Bogard2, Keith Lividini3, Joanne Arsenault4, Malcolm Riley5, Timothy B. Sulser3, Daniel Mason-D’Croz2, Brendan Power2, David Gustafson6, Mario Herrero2, Keith Wiebe3, Karen Cooper7, Roseline Remans8,9 and Mark Rosegrant3
Nutrition Security Today: Calories versus Nutrients

• 820 million people in the world suffer from undernourishment
• One in three women of reproductive age globally suffer from anemia
• Adult obesity is over 13 percent, or almost 700 million people
• Childhood overweight affects over 38 million children

Bennett’s Law as a guide to nutritional security

- As income increases, a consumer spends a
  - smaller share on starchy staples with high energy content
  - larger share on tastier and more expensive food items (e.g., meat, fats and oils, fruits, and vegetables)
- Income growth makes nutritious food more affordable
- Changes in relative prices encourage shifts to relatively cheaper foods
Agricultural research greatly lowered prices of *staples* in 20\textsuperscript{th} century

How does climate change affect nutritional status

- Reduces yields
- Alters mix of crops/animals grown
- Alters nutrient content (*not included in the analysis*)
  - Known
    - Higher temps -> staples have less protein, more starch
  - Unknown – effects on
    - Fruits and veggies
    - Nutrients other than protein, starch [a bit of research on this now]
- Effects worsen over time -> Need for scenario analysis
Scenario inputs to determine nutrient outcomes

- SSPs provide range of GDP and population futures
- IMPACT model generates
  - Average food availability for 61 food items
  - Country specific results
- Nutrient content from USDA Food Composition Tables
- Recommended Daily Allowances

**Adequacy ratio**
Ratio of average nutrient availability to the RDA for a representative consumer
In 2050, food budget share is much smaller in poorer countries, in all scenarios.

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>SSP2_NoCC</th>
<th>SSP2_HGEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSP1_NoCC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSP3_NoCC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Food budget share of income (%)
Nutrition Status Today
Deficiencies of some *micronutrients* are a problem everywhere today.

<table>
<thead>
<tr>
<th>Carbohydrate</th>
<th>Protein</th>
<th>Calcium</th>
<th>Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Map" /></td>
<td><img src="image2.png" alt="Map" /></td>
<td><img src="image3.png" alt="Map" /></td>
<td><img src="image4.png" alt="Map" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zinc</th>
<th>Folate</th>
<th>Vitamin A</th>
<th>Vitamin D</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5.png" alt="Map" /></td>
<td><img src="image6.png" alt="Map" /></td>
<td><img src="image7.png" alt="Map" /></td>
<td><img src="image8.png" alt="Map" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vitamin E</th>
<th>Vitamin B12</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image9.png" alt="Map" /></td>
<td><img src="image10.png" alt="Map" /></td>
</tr>
</tbody>
</table>

**Adequacy ratio, 2010**

- Red is low
- Green to blue is high

**Adequacy:** Ratio of average nutrient availability to (RDA-based) requirement for representative consumer

But macronutrients, especially carbohydrates, are plentiful.
Building scenarios to 2050: Choose drivers to capture range from worst to best plausible future

• Climate change – None (NoCC) to highest in IPCC (HGEM - RCP 8.5)
• Income growth – low to high (SSP3, SSP2, SSP1)
• Population growth – high to low (SSP1, SSP2, SSP3)
Compare effects of climate change and income growth on adequacy in 2050
Climate change has only small effect on adequacy in 2050.

Percent change in 2050 adequacy with and without climate change.
Income growth improves adequacy for some micronutrients

Percent change in adequacy between 2010 and 2050 with no climate change
But micronutrient deficiencies remain
<table>
<thead>
<tr>
<th>Carbohydrate</th>
<th>Protein</th>
<th>Calcium</th>
<th>Iron</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Map" /></td>
<td><img src="image2" alt="Map" /></td>
<td><img src="image3" alt="Map" /></td>
<td><img src="image4" alt="Map" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zinc</th>
<th>Folate</th>
<th>Vitamin A</th>
<th>Vitamin D</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5" alt="Map" /></td>
<td><img src="image6" alt="Map" /></td>
<td><img src="image7" alt="Map" /></td>
<td><img src="image8" alt="Map" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vitamin E</th>
<th>Vitamin B12</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image9" alt="Map" /></td>
<td><img src="image10" alt="Map" /></td>
</tr>
</tbody>
</table>

Adequacy ratio, 2050, with climate change:

- 1
- 2
- 3

2050
Some results with global perspective

• Average *macronutrient* availability is more than adequate now and to 2050

• Low availability of some micronutrients is widespread and likely to remain so

• Benefits of even slow economic growth are much stronger than negative effects of climate change, to 2050

• Some nutrients with *negative* health effects are likely to become more available
Implications for agricultural research policies

• Assess climate change effects beyond temperature and precipitation on many crops (and animals)
• Prepare for worsening climate change effects on all foods
• Reorient public sector agricultural research expenditures and policy
  • More productivity funding for micronutrient dense foods (e.g. fruits and veggies)
  • Biofortification
  • Food additives
Country level analysis is essential

• https://impactnutrients.ifpri.org/nutrientModeling/
Address the known unknowns

The models don’t include effects of

- Increasing ozone
- Increasing extreme events and more weather variability
- Increasing pest and disease pressure
- Effects on nutritional content

These effects could be much larger than those already modeled, even over the next 35 years to 2050.

... and it’s likely to get much worse after 2050
Thanks!