Supply and demand based greenhouse gas mitigation

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GHG emissions from the AFOLU sector
GHG emissions growth has accelerated despite policies. Most growth is CO₂ from fossil fuels
Agricultural emissions are increasing, but net forestry CO₂ emissions have fallen recently

- AFOLU accounts for 24% of total anthropogenic GHG emissions
- AFOLU is the only sector where net emissions fell in the most recent decade
- Whilst agricultural non-CO₂ GHG emissions increased, net CO₂ emissions fell, mainly due to decreasing deforestation, and increased afforestation rates

Smith et al. (2014) – IPCC WGIII AR5
Emissions intensity of AFOLU products is falling as agriculture and forestry become more efficient

- Note that ruminant meat has a GHG intensity much higher than other agricultural products
- But also note that these are direct emissions only. If we include the emissions from the human-edible feed for mono-gastric animal products, they move closer to ruminant meat

Smith et al. (2014) – IPCC WGIII AR5
Agricultural GHG mitigation – supply-side measures
What is the potential of the mitigation options for reducing GHG emissions in the AFOLU Sector?

- Global economic mitigation potentials in agriculture in 2050 are estimated to be 0.5–10.6 GtCO₂eq/yr.
- Reducing food losses & waste: GHG emission savings of 0.6–6.0 GtCO₂eq/yr.
- Changes in diet: GHG emission savings of 0.7–7.3 GtCO₂eq/yr.
- Forestry mitigation options are estimated to contribute 0.2–13.8 GtCO₂/yr.

Smith et al. (2014) – IPCC WGIII AR5
Demand- and supply-side measures need to be considered

- Supply-side measures in the AFOLU sector are large & cost-competitive
- Demand-side measures such as dietary change and waste reduction also have large, but uncertain, mitigation
- Demand-side measures may be difficult to implement, but are worthy of further research
- Other options in the AFOLU sector include bioenergy

Smith et al. (2014) – IPCC WGIII AR5
Agricultural GHG mitigation – demand-side measures
Big differences in the GHG intensity of different foods

Ripple et al. (2014)
### Changed consumption patterns

<table>
<thead>
<tr>
<th>Variant</th>
<th>Description</th>
<th>GtC eq.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>Agricultural production for 2000–2030 (Bruinsma 2003) and 2030–2050 (FAO 2006). The 2000–2030 projections are country-scale and aggregated to the 24 world regions of the IMAGE model. The projections for 2030–2050 have a continental scale</td>
<td>3.0</td>
</tr>
<tr>
<td>No Ruminant Meat (NoRM)</td>
<td>As reference, but with complete substitution of proteins from ruminant meat (cattle, buffaloes, sheep and goats) by plant-proteins, starting in 2010 and completed by 2030. By-products such as wool and leather are also assumed to be substituted by other materials</td>
<td>3.3</td>
</tr>
<tr>
<td>No Meat (NoM)</td>
<td>As NoRM, with additional substitution of white meat (pork, poultry) by plant proteins, starting in 2010 and completed by 2030</td>
<td>1.7</td>
</tr>
<tr>
<td>No Animal Products (NoAP)</td>
<td>As NoM, with additional substitution of milk and eggs by plant proteins, starting in 2010 and completed by 2030</td>
<td>1.5</td>
</tr>
<tr>
<td>Healthy Diet (H Diet)</td>
<td>“Healthy Eating” recommendations from the Harvard Medical School (Willett 2001) implemented globally for meat and eggs, starting in 2010 and completed by 2030. See also Table 4</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.1</td>
</tr>
</tbody>
</table>

Land based GHG emissions:

- Fewer animal products in global diet allows everyone to be fed, and land is available for energy and nature conservation

Stehfest *et al.* (2009)
Reducing GHG emissions – dietary change vs. technical mitigation

Without technical mitigation

With technical mitigation

Popp et al. (2011)
Food demand must be managed because sustainable intensification alone will not suffice.

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Yields</th>
<th>Demand side reduction measures:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current trends in yields</td>
<td>Yield gap closures (sustainable intensification)</td>
</tr>
<tr>
<td>CT1</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>CT2</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>CT3</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>YG1</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>YG2</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>YG3</td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

Bajželj *et al.* (2014) Nature CC
Food demand must be managed because sustainable intensification alone will not suffice.
Food demand must be managed because sustainable intensification alone will not suffice

<table>
<thead>
<tr>
<th></th>
<th>Current yield trend</th>
<th>Yield gap closure only</th>
<th>Yield gap closure + demand options</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>units</td>
<td>2009*</td>
<td>CT1 (+44%)</td>
</tr>
<tr>
<td>Cropland</td>
<td>MkM²</td>
<td>15.6</td>
<td>22.5</td>
</tr>
<tr>
<td>Pasture</td>
<td>MkM²</td>
<td>32.8</td>
<td>35.2 (+7%)</td>
</tr>
<tr>
<td>Net Forest cover</td>
<td>MkM²</td>
<td>26.1</td>
<td>23.1 (-12%)</td>
</tr>
<tr>
<td>Tropical Pristine Forests</td>
<td>MkM²</td>
<td>7.9</td>
<td>7.2 (-9%)</td>
</tr>
<tr>
<td>Total GHG emissions</td>
<td>GtCO₂/y</td>
<td>13.5</td>
<td>22.2 (+64%)</td>
</tr>
<tr>
<td>Carbon sink potential</td>
<td>GtCO₂/y</td>
<td>14.7</td>
<td>14.5 (-1%)</td>
</tr>
<tr>
<td>Fertiliser use</td>
<td>Mt/yr</td>
<td>103</td>
<td>166 (+61%)</td>
</tr>
<tr>
<td>Irrigation water use</td>
<td>km³/yr</td>
<td>2889</td>
<td>6496 (+125%)</td>
</tr>
</tbody>
</table>

Bajželj *et al.* (2014) *Nature CC*
How will food demand be met in future?

Smith (2014b)
Other papers arriving at similar conclusions......

ARTICLE

Global diets link environmental sustainability and human health

David Tilman¹,² & Michael Clark¹

Diets link environmental and human health. Rising incomes and urbanization are driving a global dietary transition in which traditional diets are replaced by diets higher in refined sugars, refined fats, oils and meats. By 2050 these dietary trends, if unchecked, would be a major contributor to an estimated 80 per cent increase in global agricultural greenhouse gas emissions from food production and to global land clearing. Moreover, these dietary shifts are greatly increasing the incidence of type II diabetes, coronary heart disease and other chronic non-communicable diseases that lower global life expectancies. Alternative diets that offer substantial health benefits could, if widely adopted, reduce global agricultural greenhouse gas emissions, reduce land clearing and resultant species extinctions, and help prevent such diet-related chronic non-communicable diseases. The implementation of dietary solutions to the tightly linked diet–environment–health trilemma is a global challenge, and opportunity, of great environmental and public health importance.
Taxes on food by GHG emissions?

Fig. 9  Taxes per kg (fresh weight) food product for GHG weighted consumption taxes on animal food equivalent to €60 per ton CO₂-eq. Percentages on top of bars show the corresponding relative increase in consumer price. Wirsenius et al. (2011)
Conclusions

• We can feed 9-10 billion people
• Food supply needs to be increased whilst reducing environmental impact of agriculture
• Need to find options and policies that co-deliver improved food security and improved environmental outcomes
• Some promising supply-side measures (e.g. efficiency improvements) improve food security and reduce environmental impact
• Demand-side measures (e.g. changing diets, waste reduction) are under-researched, for food security and for potential to reduce environmental impact
• We need to change consumption patterns (demand-side measures) – techno-fixes are not enough to make the necessary changes

Smith (2014a)
Implications for policy

• Supply-side measures should be implemented immediately with focus on sustainable intensification

• Demand-side measures – it will take time for behaviour change to occur - policy should be introduced quickly, and should aim to co-deliver to other policy agendas

• Joined-up policy to address multiple objectives is required now more than ever.

Smith (2014)
Thank you for your attention