Changing dietary habits and potential regionalization: Implications for agro-diversity and future GHG emissions

To feed the growing population and to reduce related environmental consequences, we need sustainable implementation of combinations of agricultural intensification, expansion, and trade as well as diet shifts toward a lower share of animal products.

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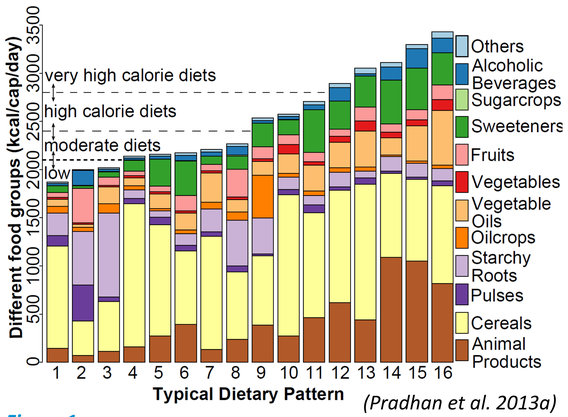
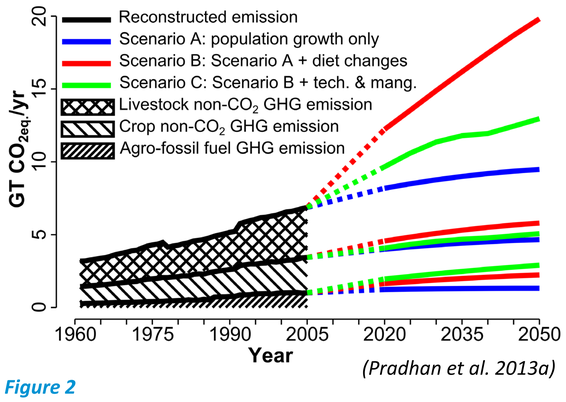
PIK RD II Climate Impacts & Vulnerabilities
Research Area: Climate Change & Development (CCD)

Dietary patterns and embodied emissions: Sixteen dietary patterns were identified globally. Dietary patterns are changing toward affluent diets with a large share of animal products. Embodied emissions are relative large in high calorie diets.



(Pradhan et al. 2013a)

Figure 1
The sixteen dietary patterns observed world-wide for the analyzed period 1961-2007.

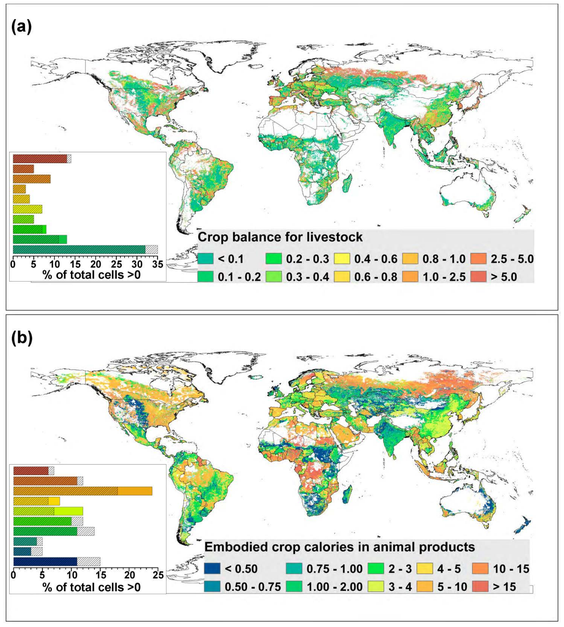


(Pradhan et al. 2013a)

Figure 2
Reconstructed and projected global agricultural emissions for three scenarios.

- emissions > 2 times (20 Gt $CO_{2eq.}$/yr) by 2050 (Scenario B)
- emissions can be reduced up to in 7 Gt $CO2_{eq.}$/yr (comparing Scenario C with B)

Interrelation between crop and livestock production: About 40% of the global crop calories are currently used as livestock feed. Some regions consume more feed than crops they produce locally. The current feed calorie use is four times the produced animal calories. This embodied crop calories varies between < 1 and > 10 locally.

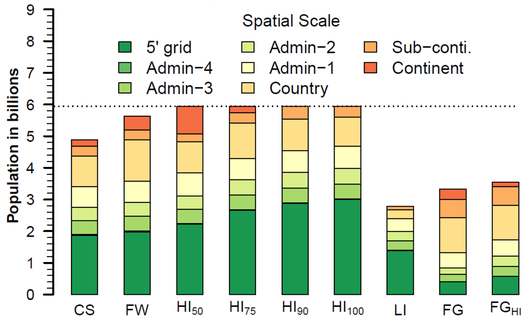


(Pradhan et al. 2013b)

Figure 3
Ratios among crop calorie produced, animal calorie produced, and feed consumed for the year 2000: (a) crop balance for livestock, and (b) embodied crop calories in animal products.

- feed demand to be > 2 times by 2050 due to population growth and diet shifts
- need more crops to raise livestock than to nourish human being
- larger increase for Africa, South-East Asia, and South Asia (> 3 times)
- enhancing feed conversion efficiency and lowering animal product consumption will reduce the feed demand

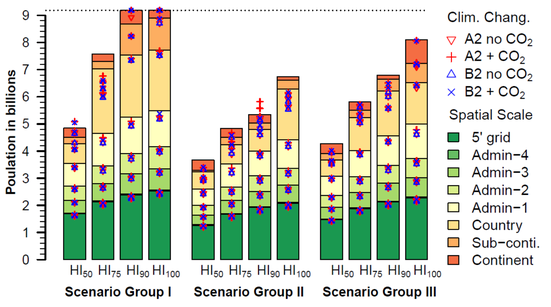
Local and regional food self-sufficiency: This analysis considers the produced crop and animal calories on supply side, and the consumed food by humand and feed by livestock on demand side.



(Pradhan et al. 2014a)

Figure 4
Food self-sufficient population estimated for 2000 based on: current situation (CS), reducing food waste (FW), closing yield gaps to 50%-100% of high-input potential (HI_{50}-HI_{100}), low-input production (LI), and consumption of food groups (FG).

- closing yield gaps by 100% increases self-sufficient people in 5' grid from 2 to 3 billions
- reduces the net international agricultural trade from 1000 to 400 trillion kcal/yr

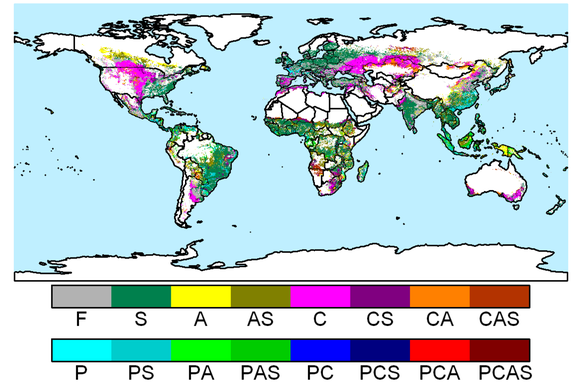


(Pradhan et al. 2014a)

Figure 5
Food self-sufficient population estimated for 2050.

- closing yield gaps only will not be enough due to diet shifts, agricultural expansion needed
- 1.5 to 6 billion people will depend on trade
- climate change will further increase agriculture trade by 4% to 16%

Measures to close yield gaps: Multiple measures are needed to address local production constraints and biophysical limitations for closing yield gaps. Careful implementation of these measures is required to avoid related environmental impacts.



(Pradhan et al. 2014b)

Figure 6
Inputs and management required in addition to fertilizer (F) for closing yield gaps: soil quality (S), market accessibility (A), climatic yield variability (C), and pests, diseases and weeds (P).

- additionally, closing yield gaps requires global N-fertilizer application to increase by 45% to 73%, P_2O_5 by 22 to 46%, and K_2O by 2 to 3 times compared to the year 2010

Conclusion: Overall, we answer the following research question: "*How can food security be ensured on local, regional, and global scales, and environmental impacts of agriculture be reduced considering the major drivers for growing food and feed demand, and socio-ecological constraints that limit local food production?*"

References

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