POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH

Smart food systems to mitigate climate change and to attain Sustainable Development Goals

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Background

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- Currently, agriculture causes severe environmental impacts and consumes huge amounts of anthropogenic inputs.
- Food production in return is also affected by the environmental impacts.
- The future global food demand is projected to increase by 60–110% between 2005 and 2050 due to population growth and dietary shifts.

Sustainable Development Goals

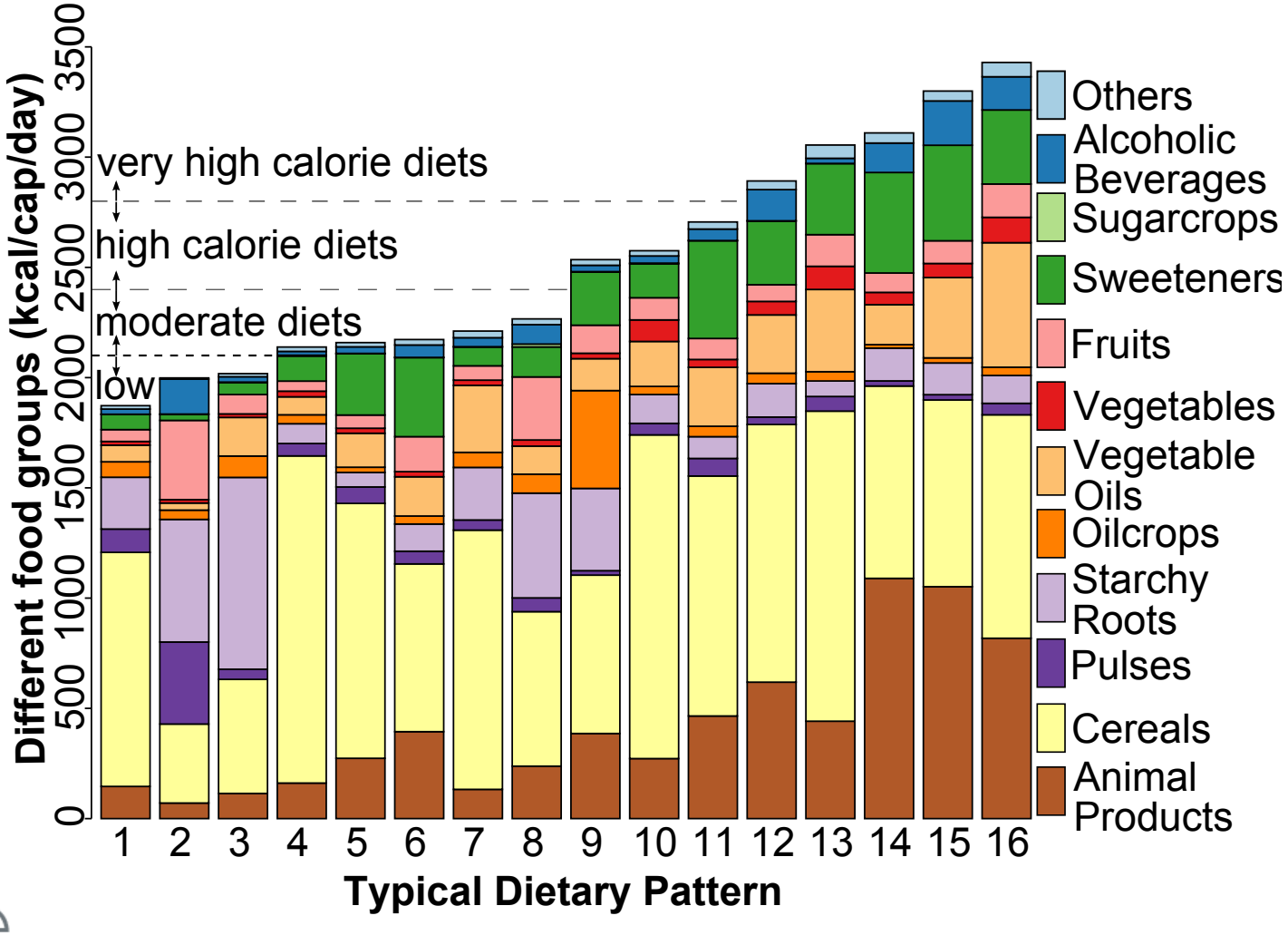
Research approach

- We analyzed several freely available dataset and model results.
  - FAOSTAT (FAO Statistics)
  - GLW (Gridded Livestock of the World)
  - GAEZ (Global Agro-ecological Zone)

- We applied empirical and model based analysis with global, regional, national, and local focus.
  - artificial neural network
  - scenario analysis
  - data aggregation and downscaling
  - cross-scale analysis

Dietary habits

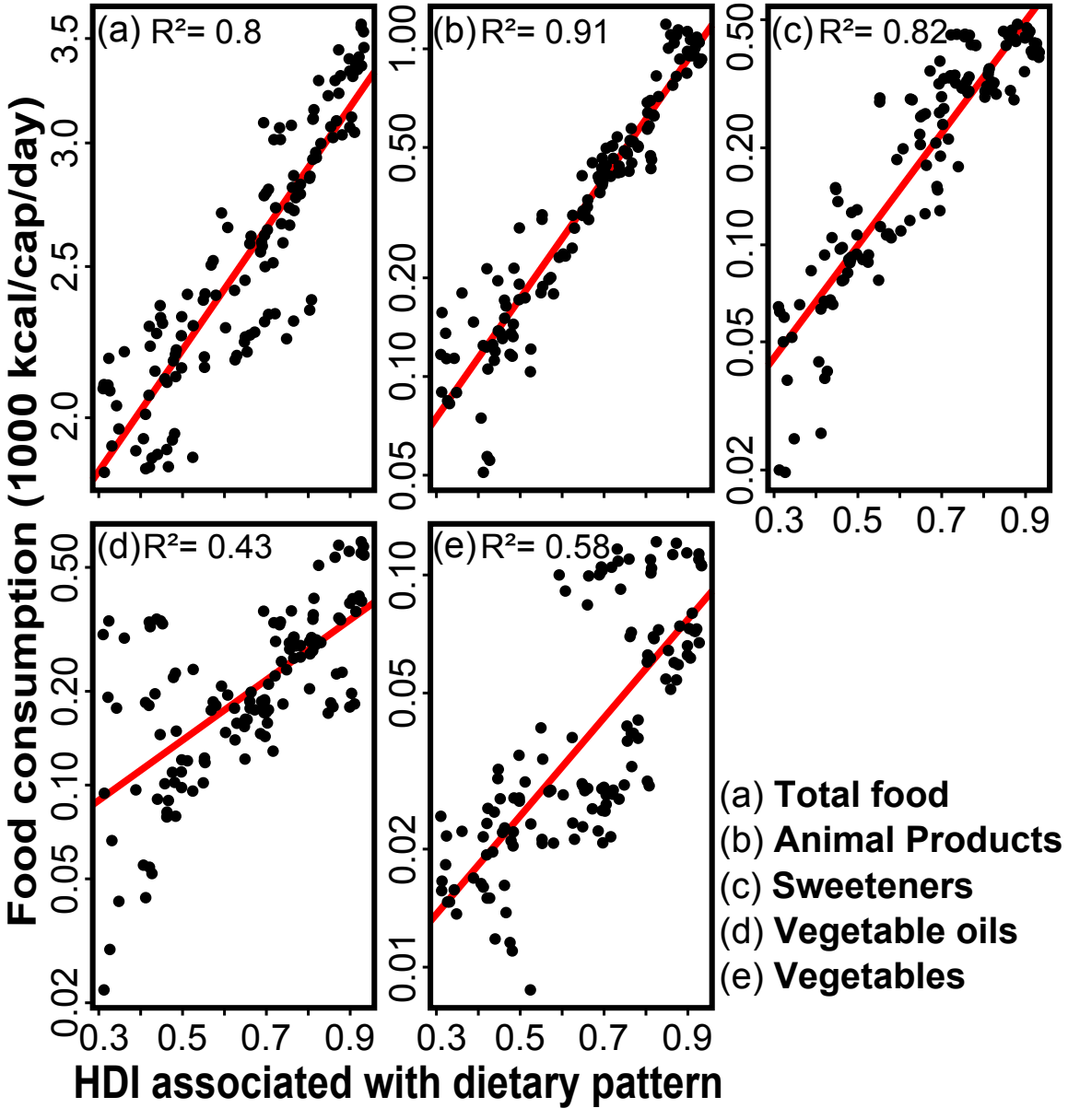
Dietary habits, composition of food consumption, vary across time and regions.



(Pradhan et al. 2013, PLoS ONE)

Diets and human development

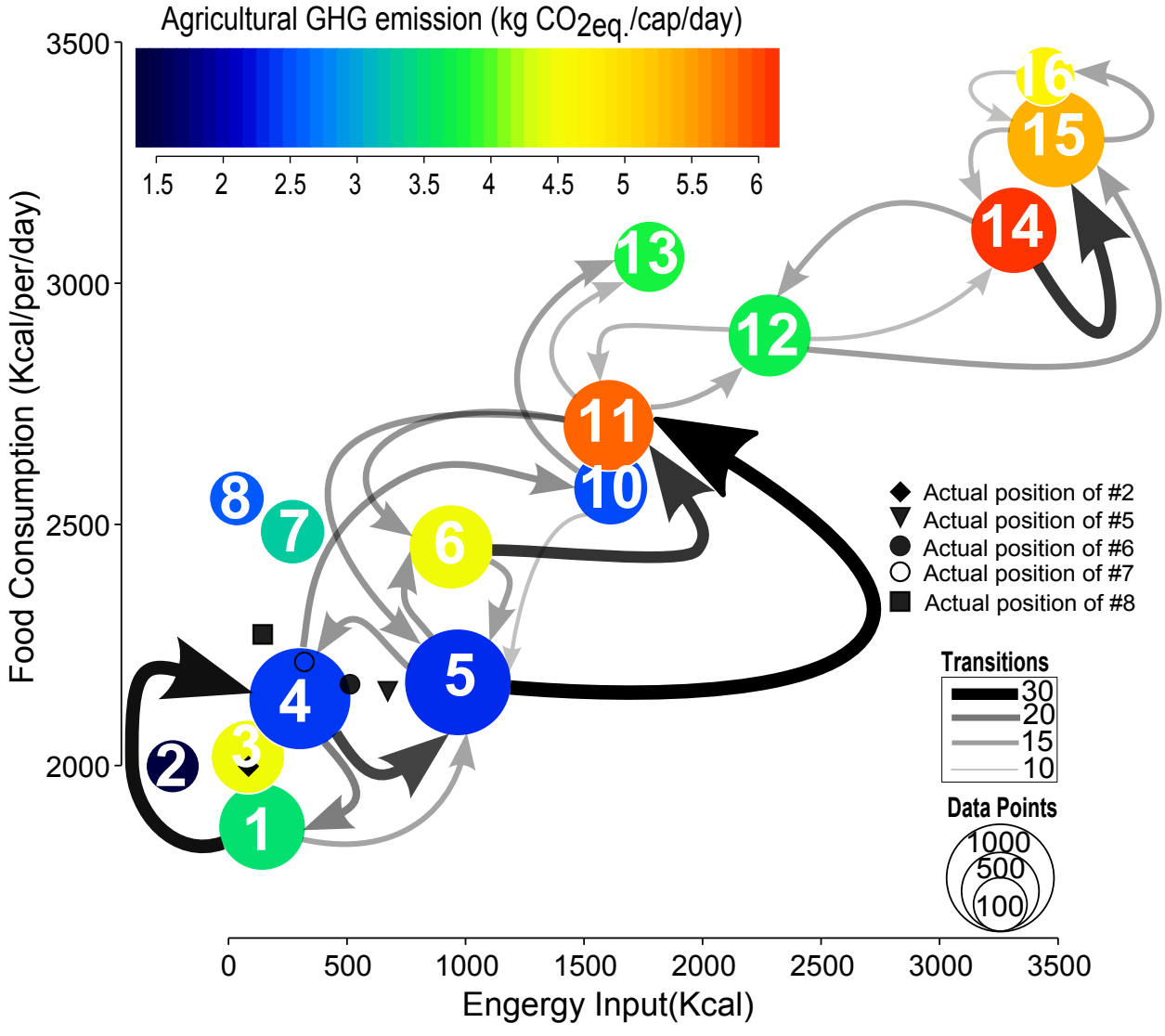
With development, food consumption habits converse towards affluent diets, composed of a larger share animal products, sugar, oils, and vegetables.



(Pradhan et al. 2013, PLoS ONE)

Diet matters

Environmental footprint is determined by quantity and composition of consumed food.



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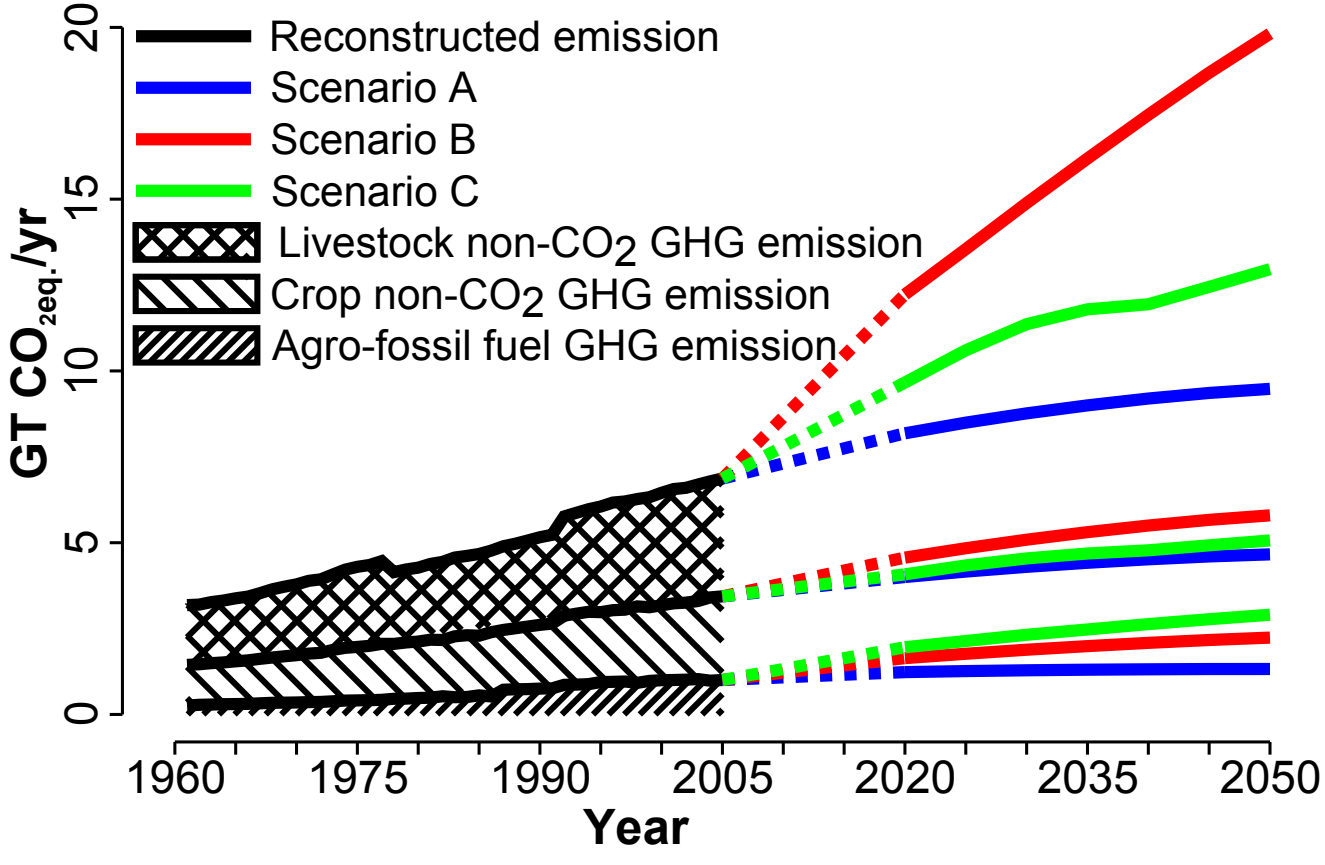
Agricultural emissions

Smart food systems need to address agricultural greenhouse emissions that might more than double by 2050.

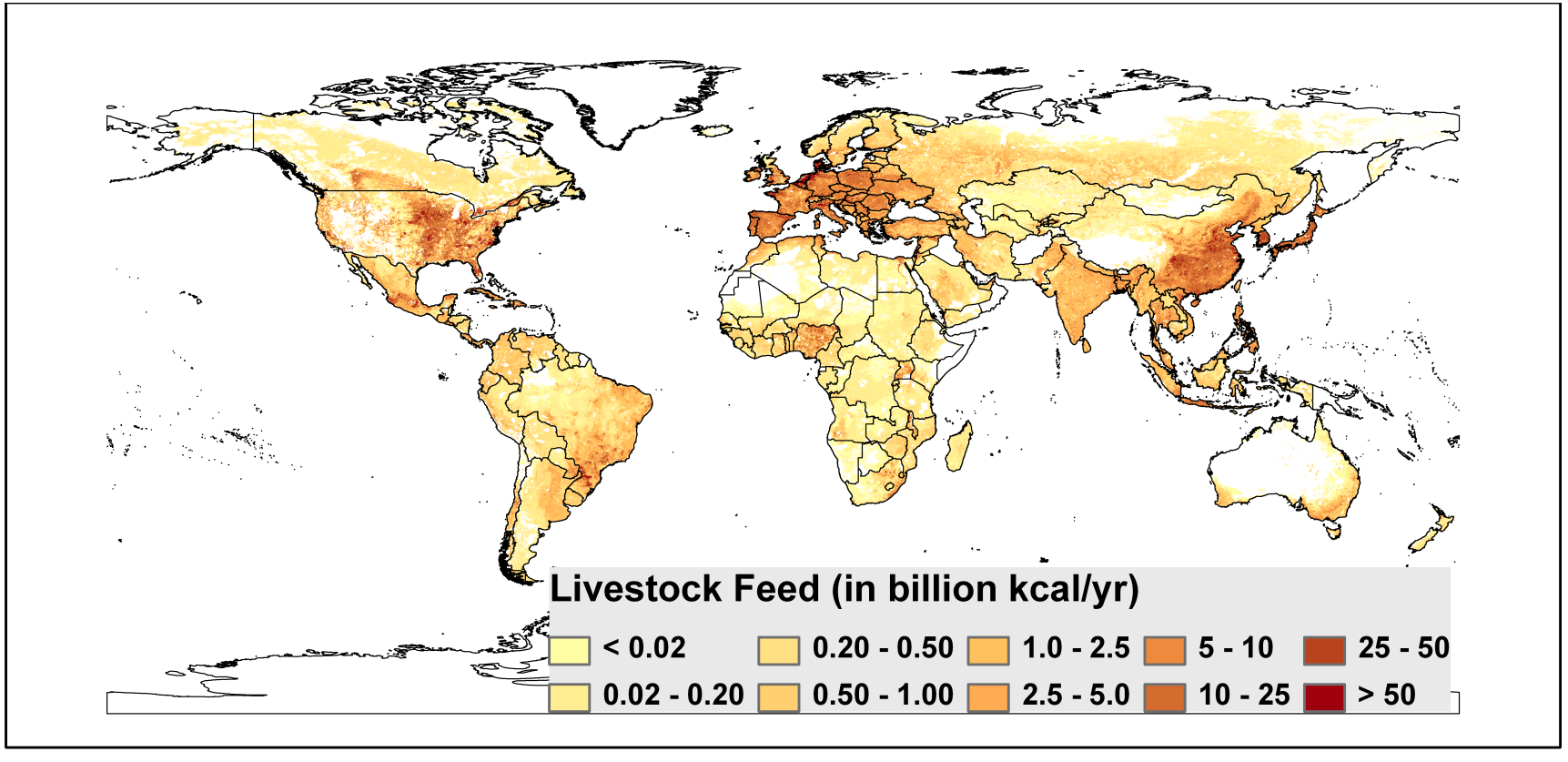


Scenario A: population growth; Scenario B: Scenario A + dietary shifts; Scenario C: Scenario B + technological progress

(Pradhan et al. 2013, PLoS ONE)

Livetsock feed

Amount of crop fed to livestock in N. America, Europe, and E. Asia is enough to nourish 800 million people currently suffering from undernourishment and hunger.



Spatial patterns of crop calories fed to livestock

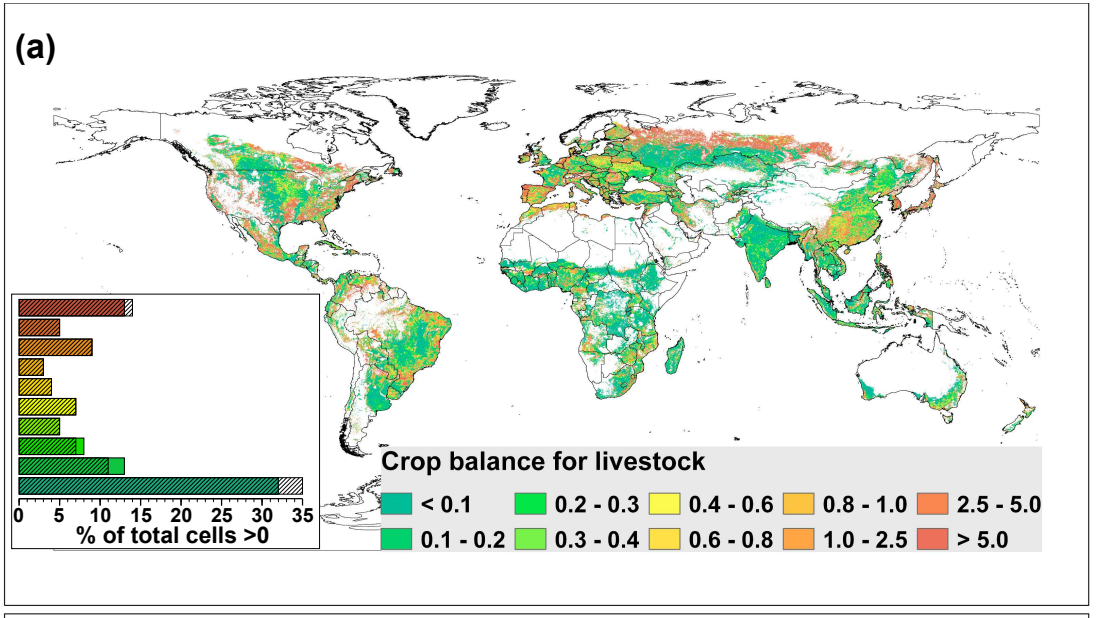
(Pradhan et al. 2013, ERL)

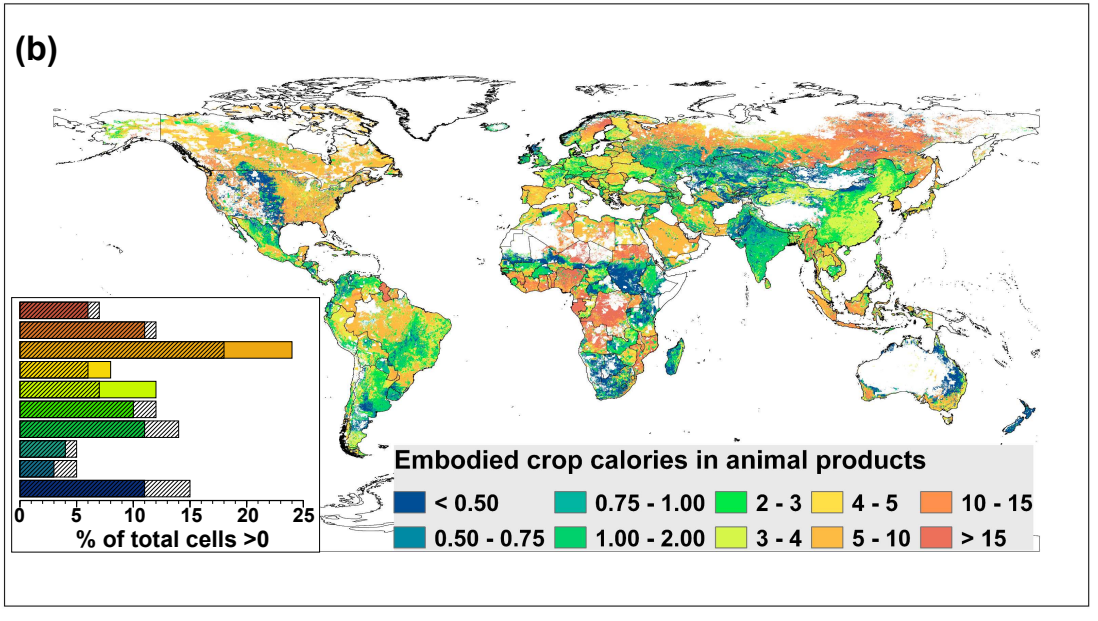
Crop and livestock production

Only 60% of the crop production is directly used to nourish humans, the rest is mostly fed to livestock.

To produce one calorie of animal product, on an average four crop calories are fed to livestock.

More crops may need to be grown to feed livestock than to nourish humans in the future.

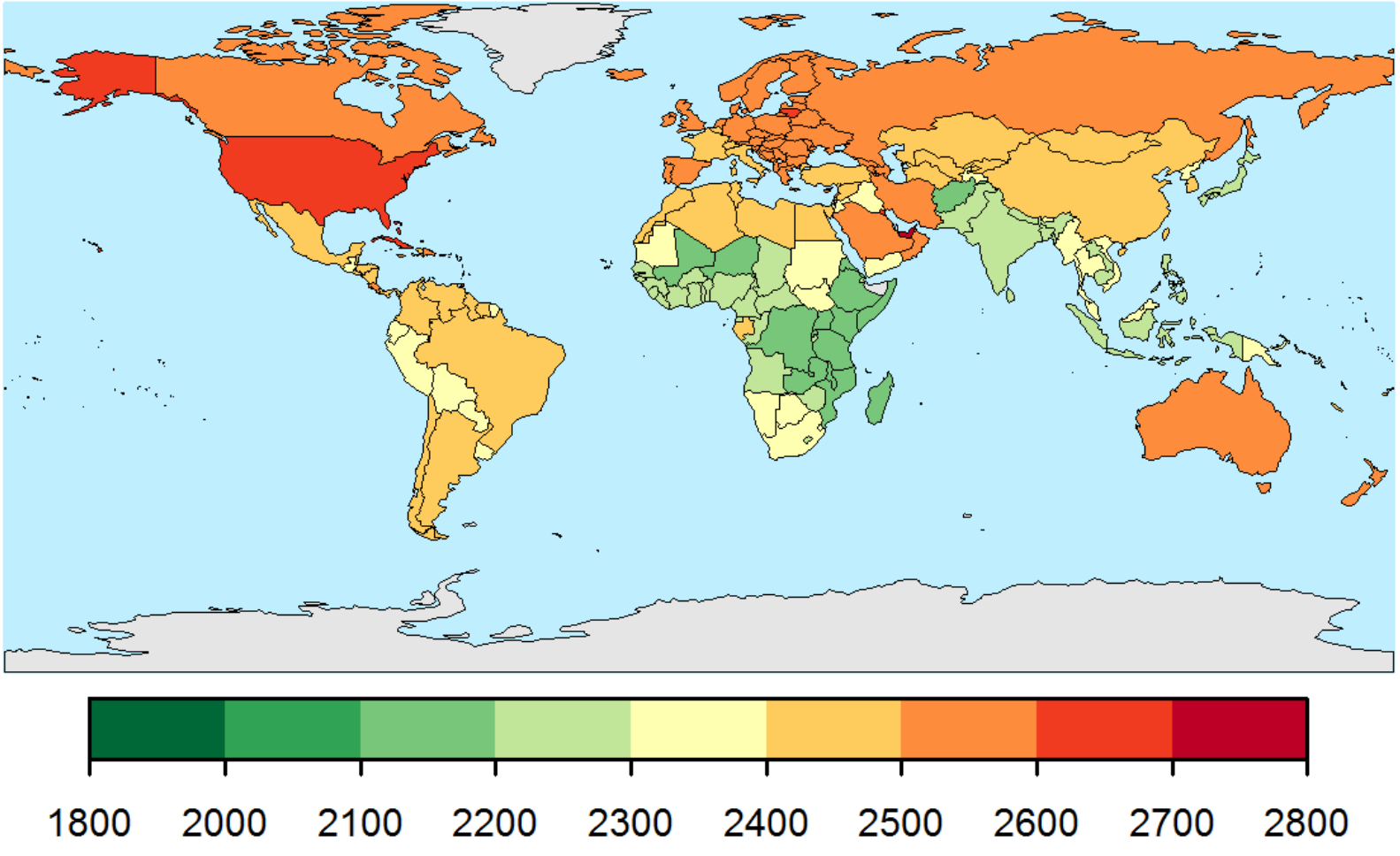




(Pradhan et al. 2013, ERL)

Food waste and food requirement

Average food requirement per capita varies across the world based on body size and demographic pyramid.

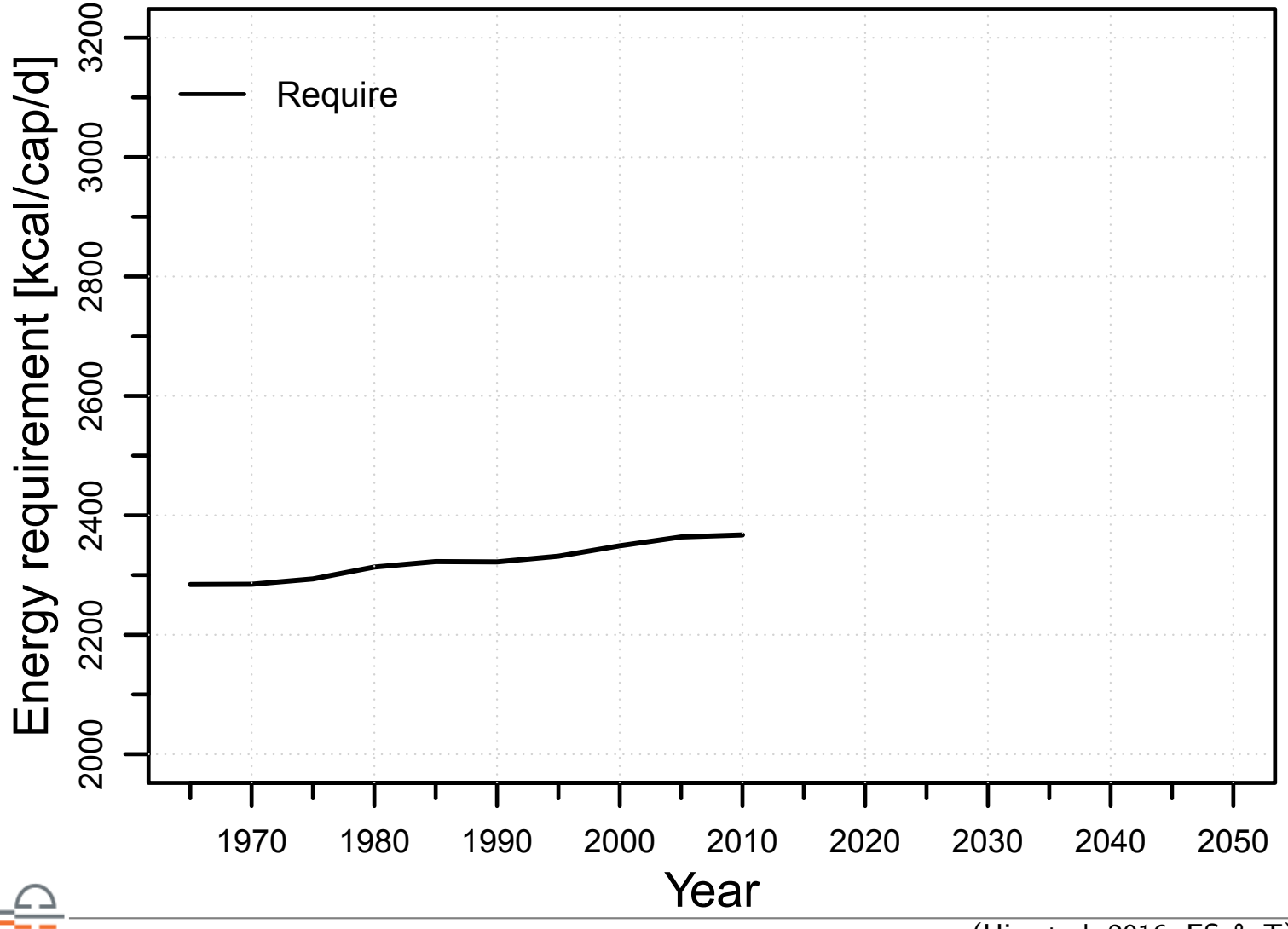


Country scale food energy requirements for 2010 considering moderate PAL in kcal/cap/d

(Hiç et al. 2016, ES & T)

Trend and projections

The global food requirement per capita remains almost constant



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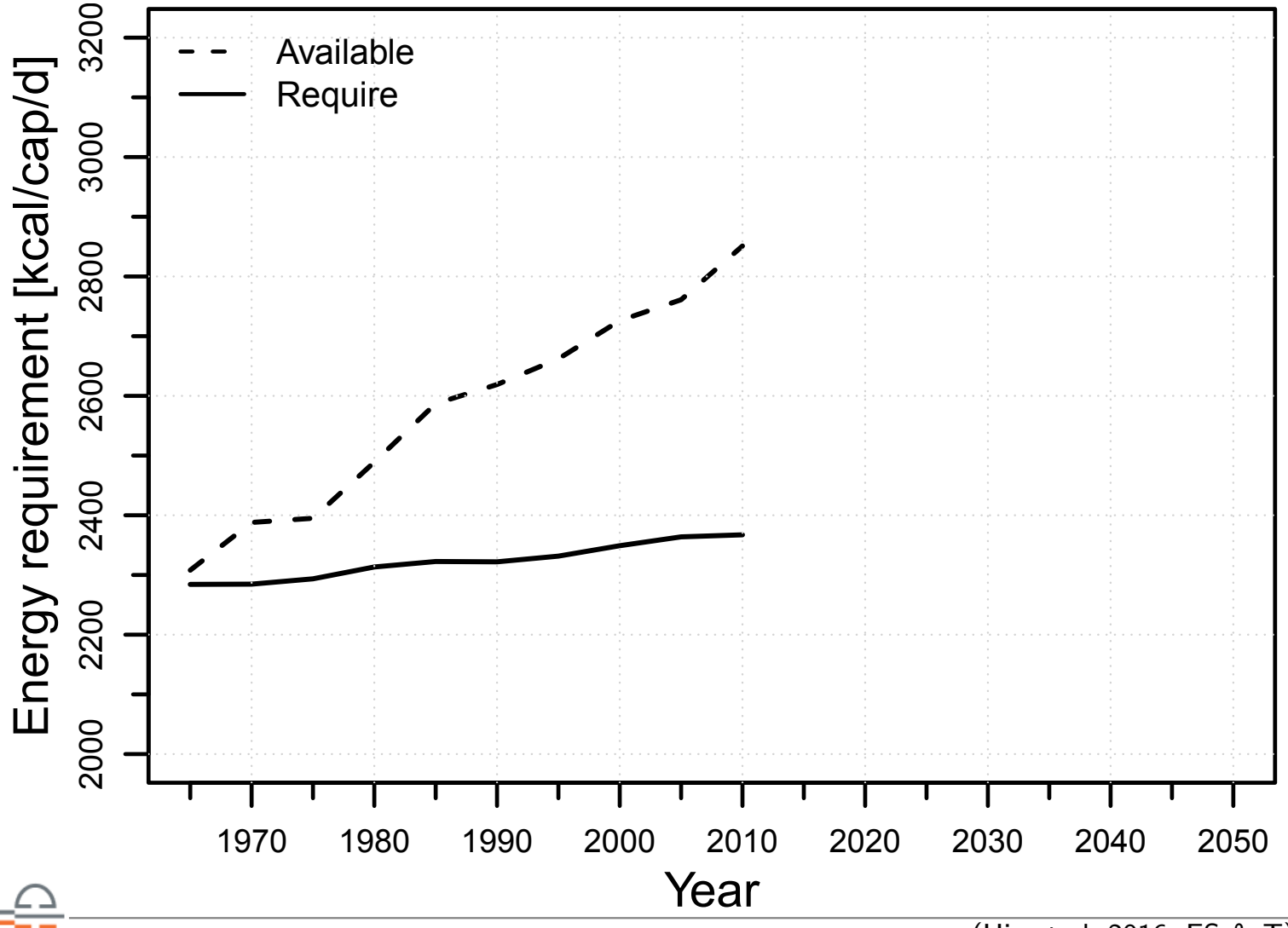
Trend and projections

The global food requirement per capita remains almost constant but available food has tremendously increased.



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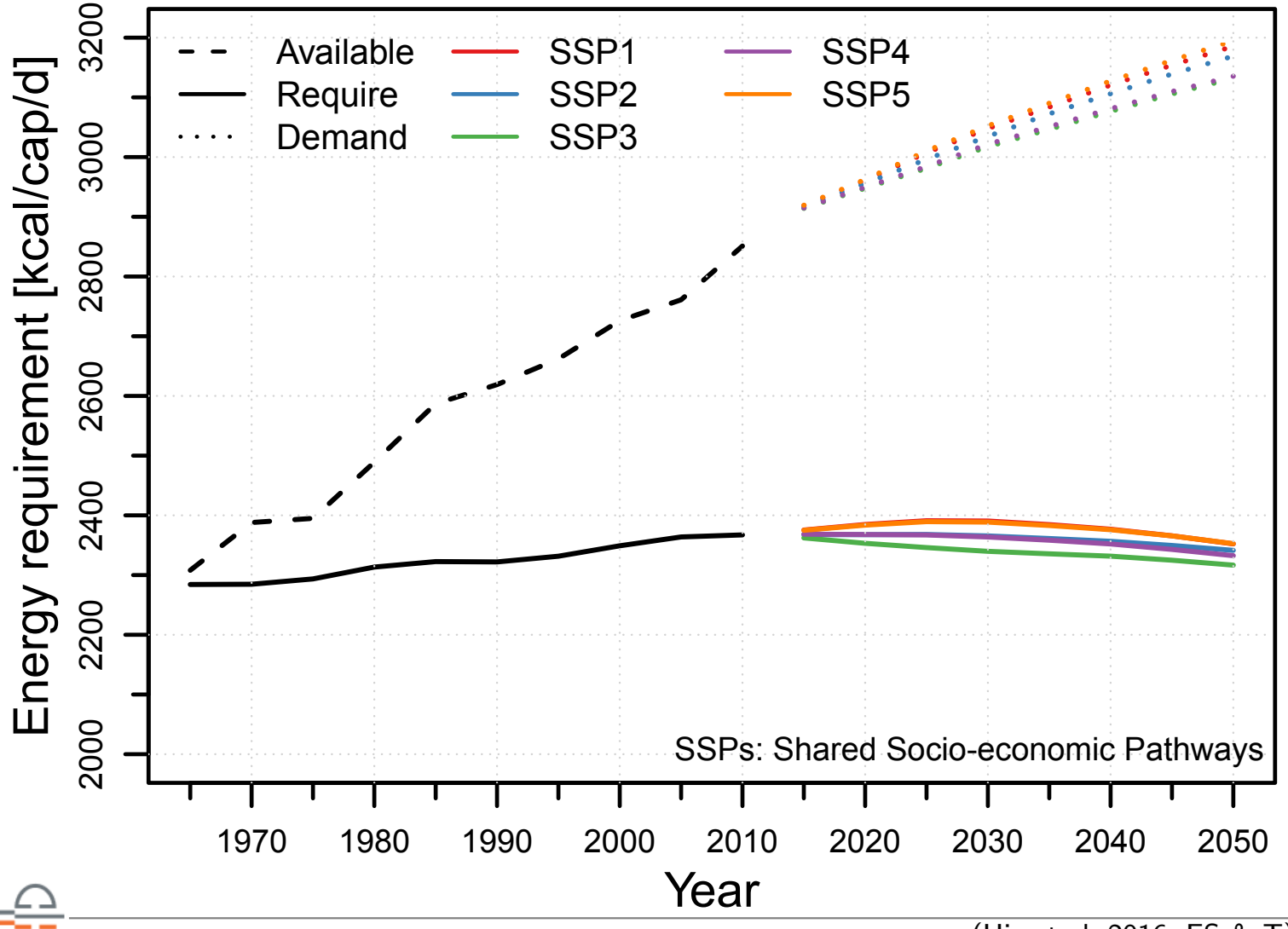
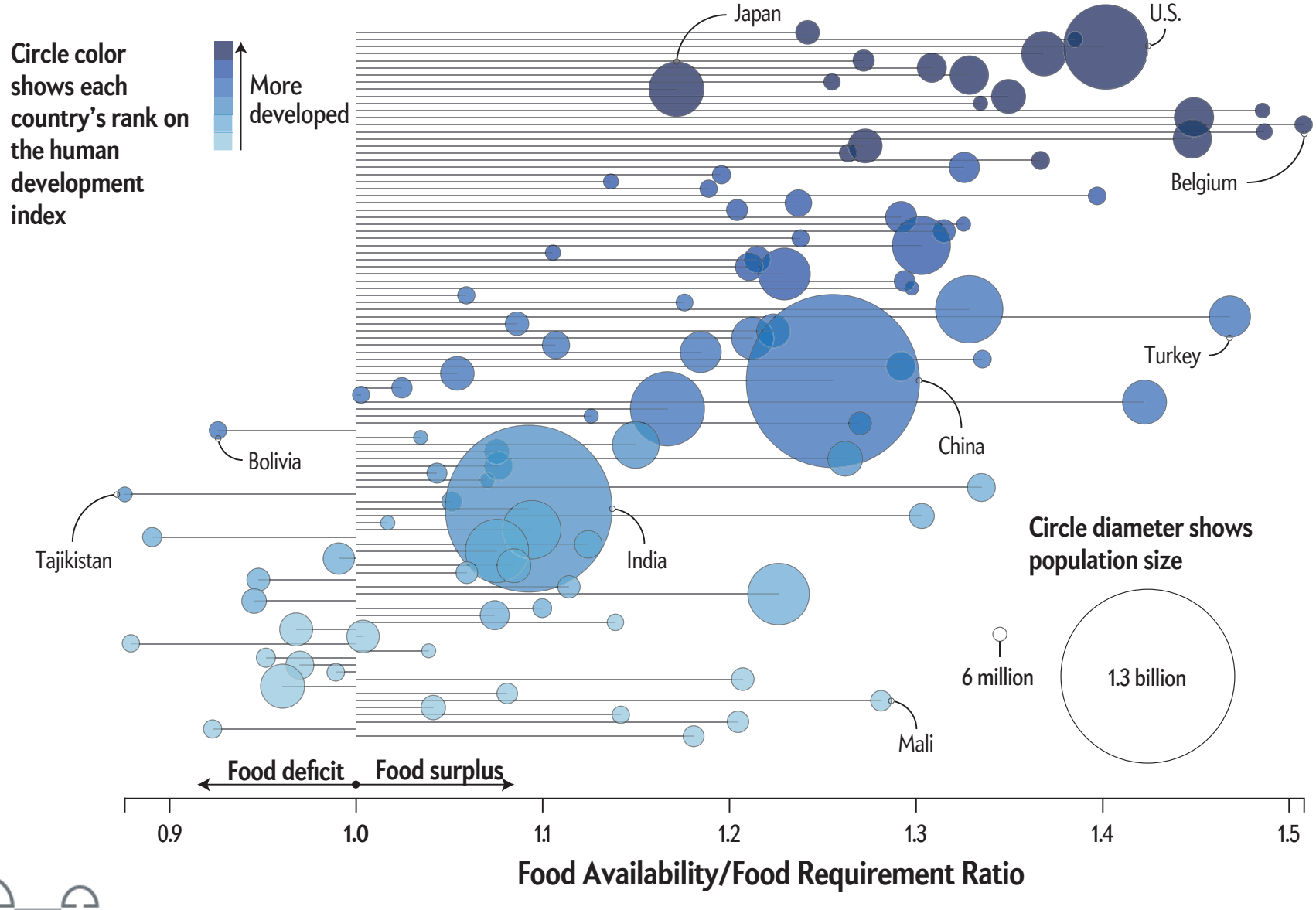


(Hiç et al. 2016, ES & T)

Food waste and human development

More developed a country is more food is wasted there.

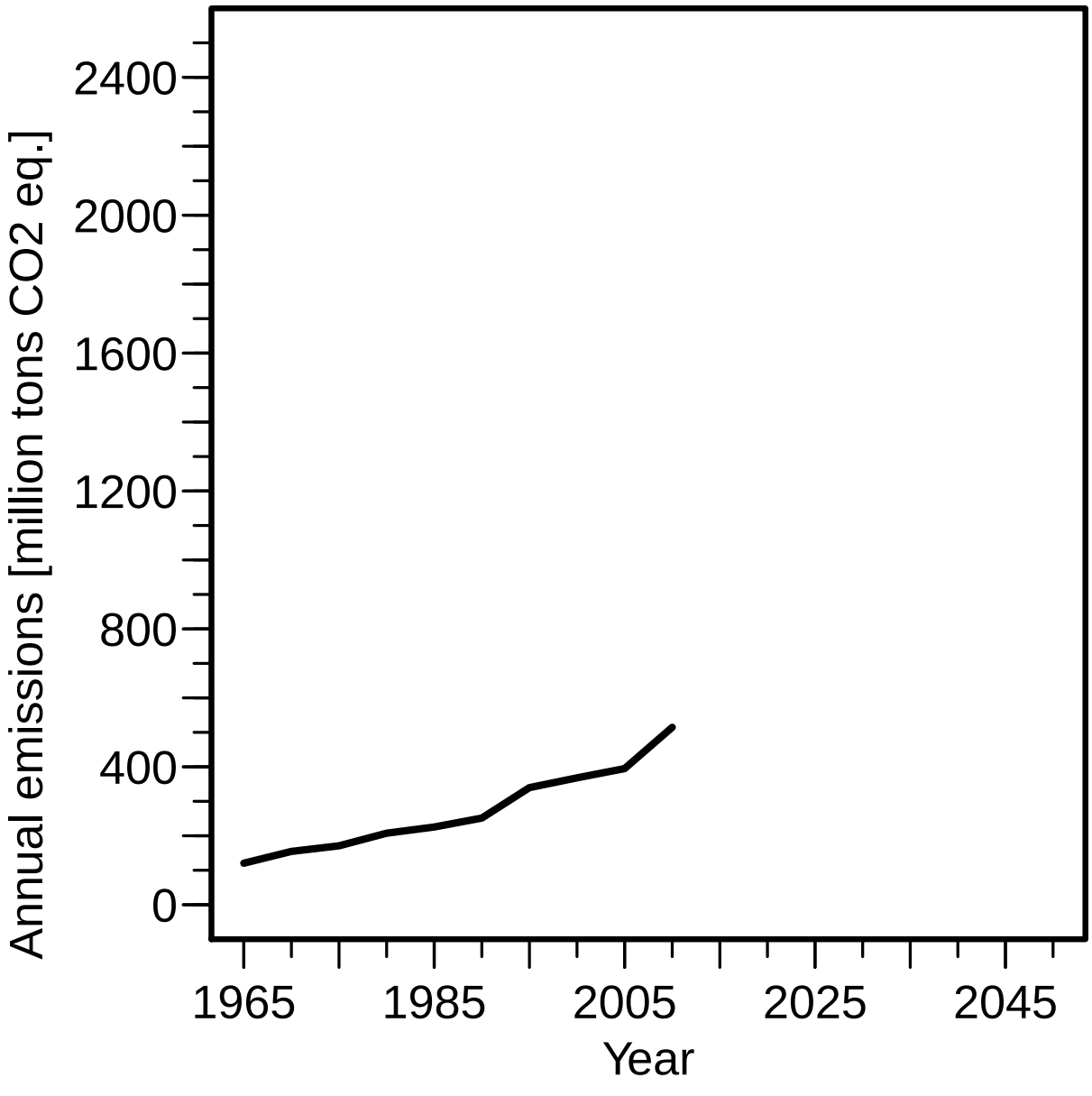


(Montañez 2016, Scientific American based on Hiç et al. 2016, ES&T)

Avoidable GHG emissions

Reducing food waste could help mitigate climate change.

- Food waste emissions grew from 130 to 530 Mt CO_{2eq}/yr between 1965 and 2010.
- By 2050, the emissions may increase up to 2400 Mt CO_{2eq}/yr.



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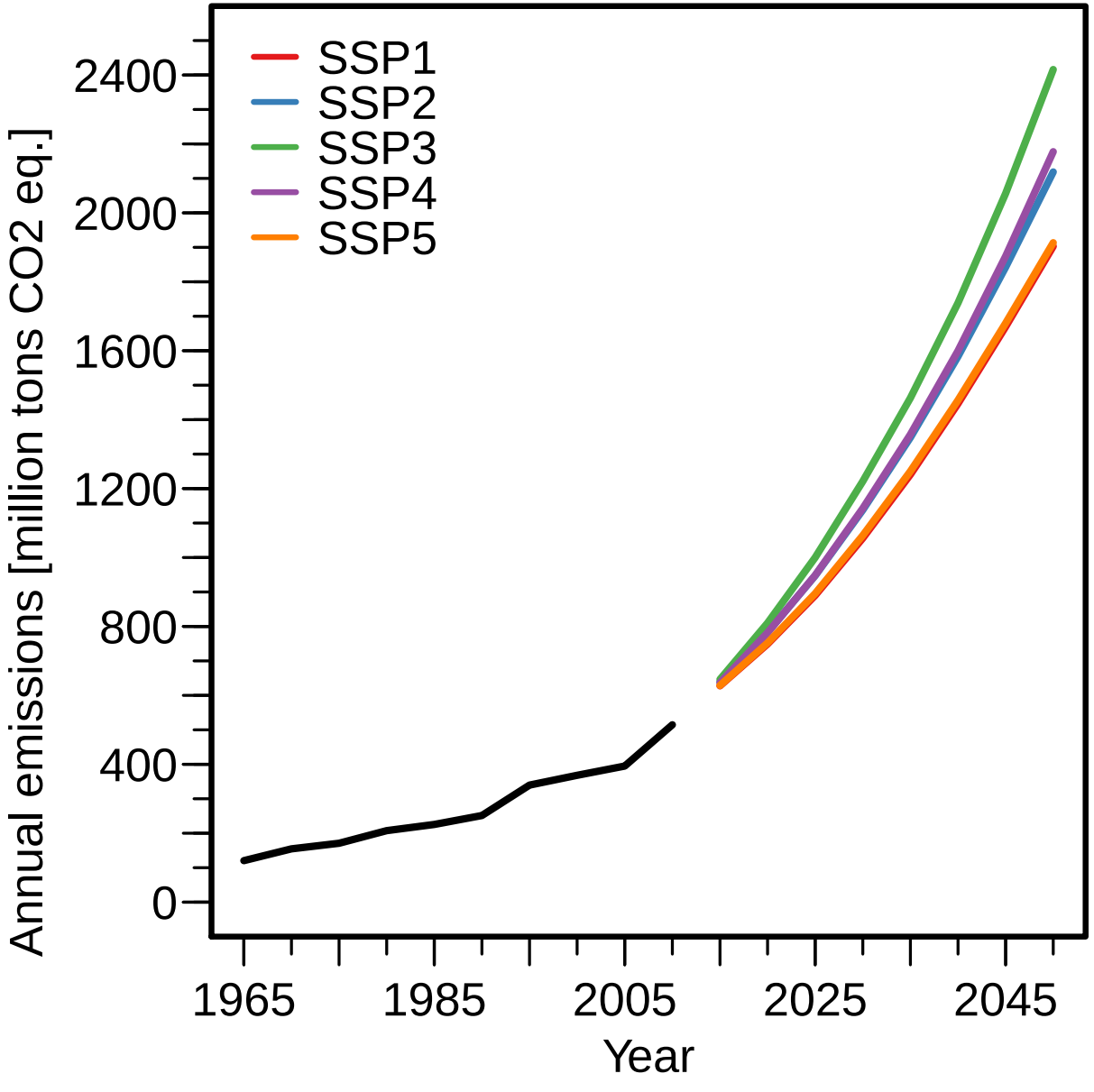

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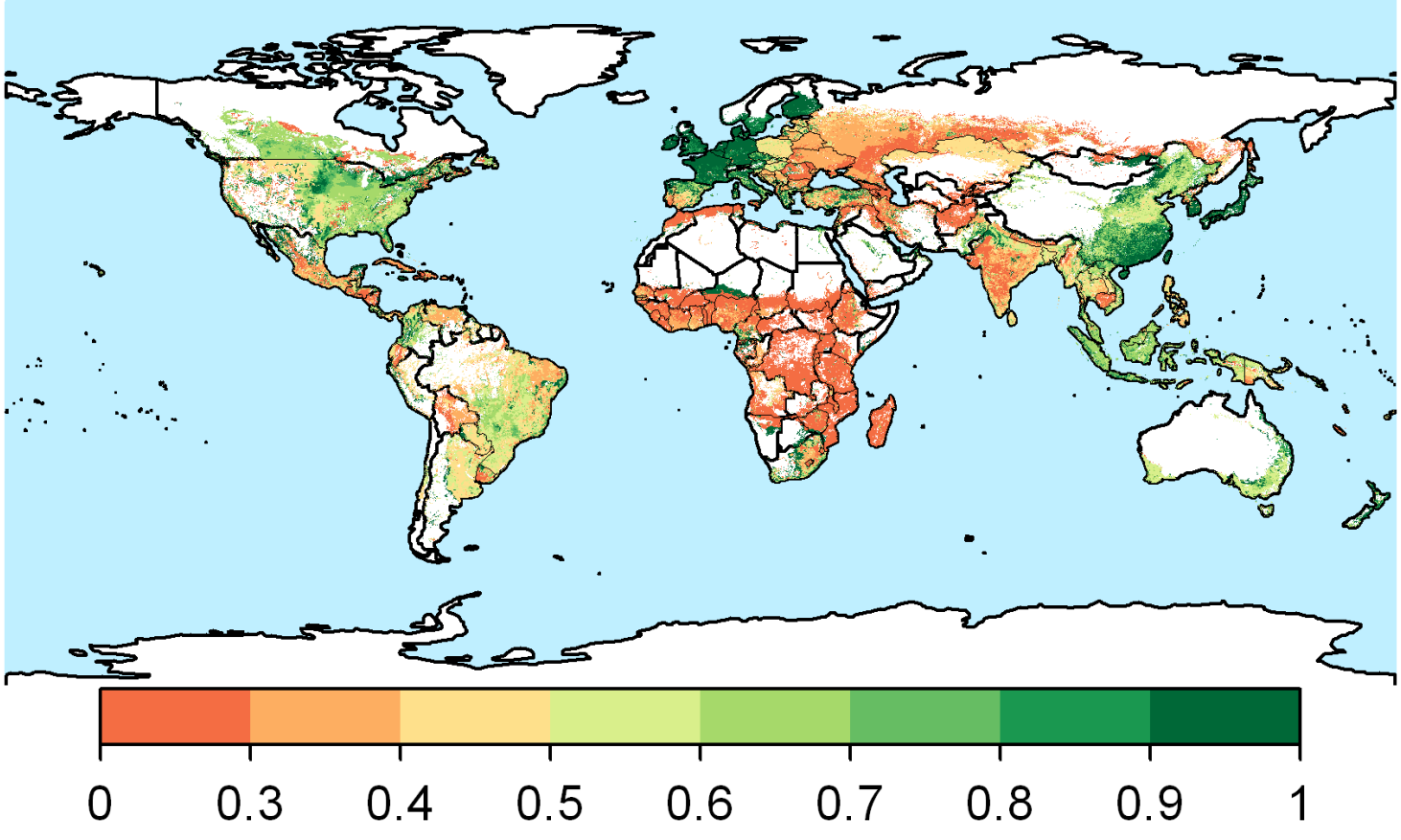
Crop production gaps

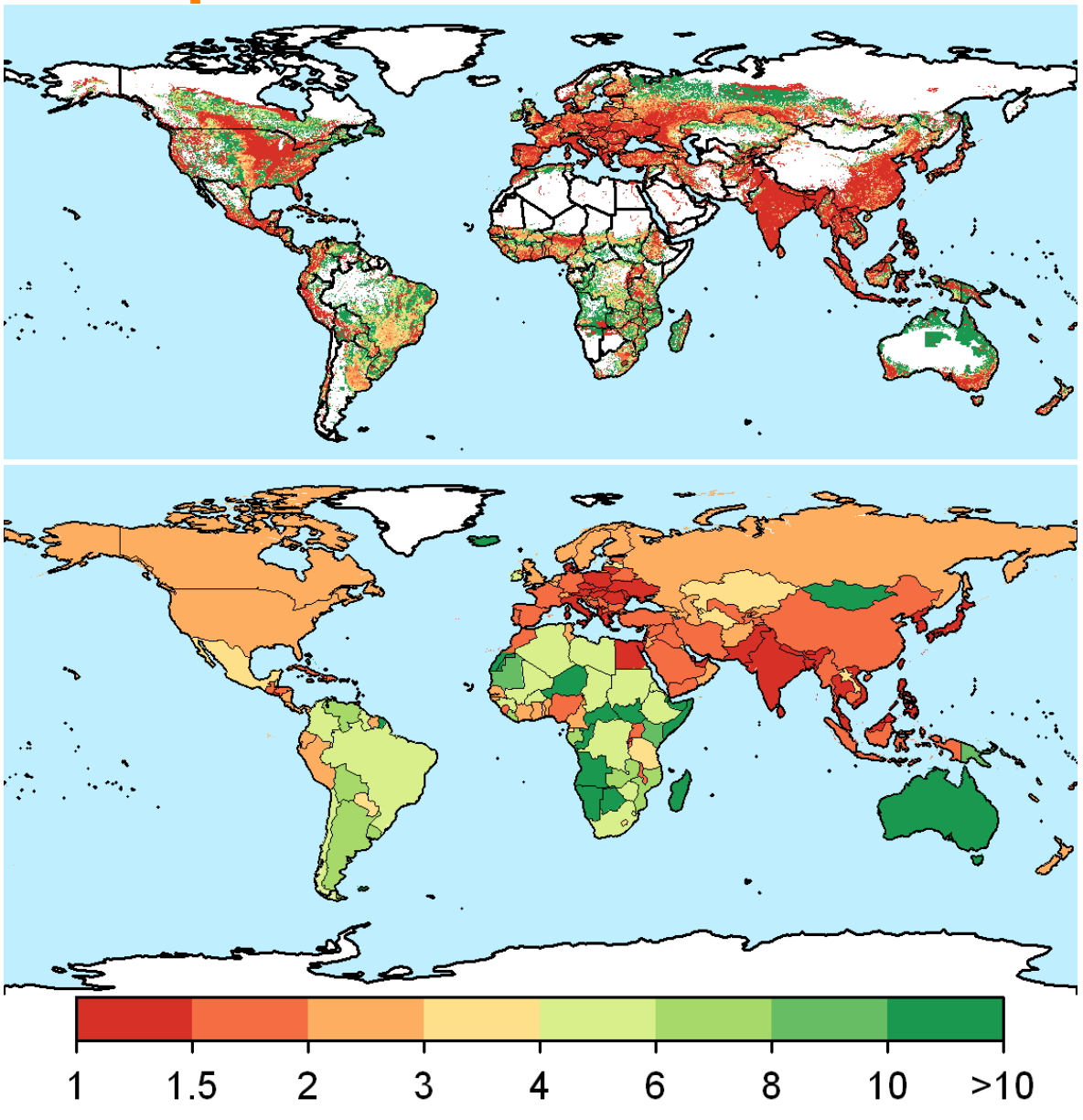
Most regions in Africa, South Asia, and Eastern Europe are lag behind in attaining their potential crop calorie production.



(Pradhan et al. 2015, PLoS ONE)

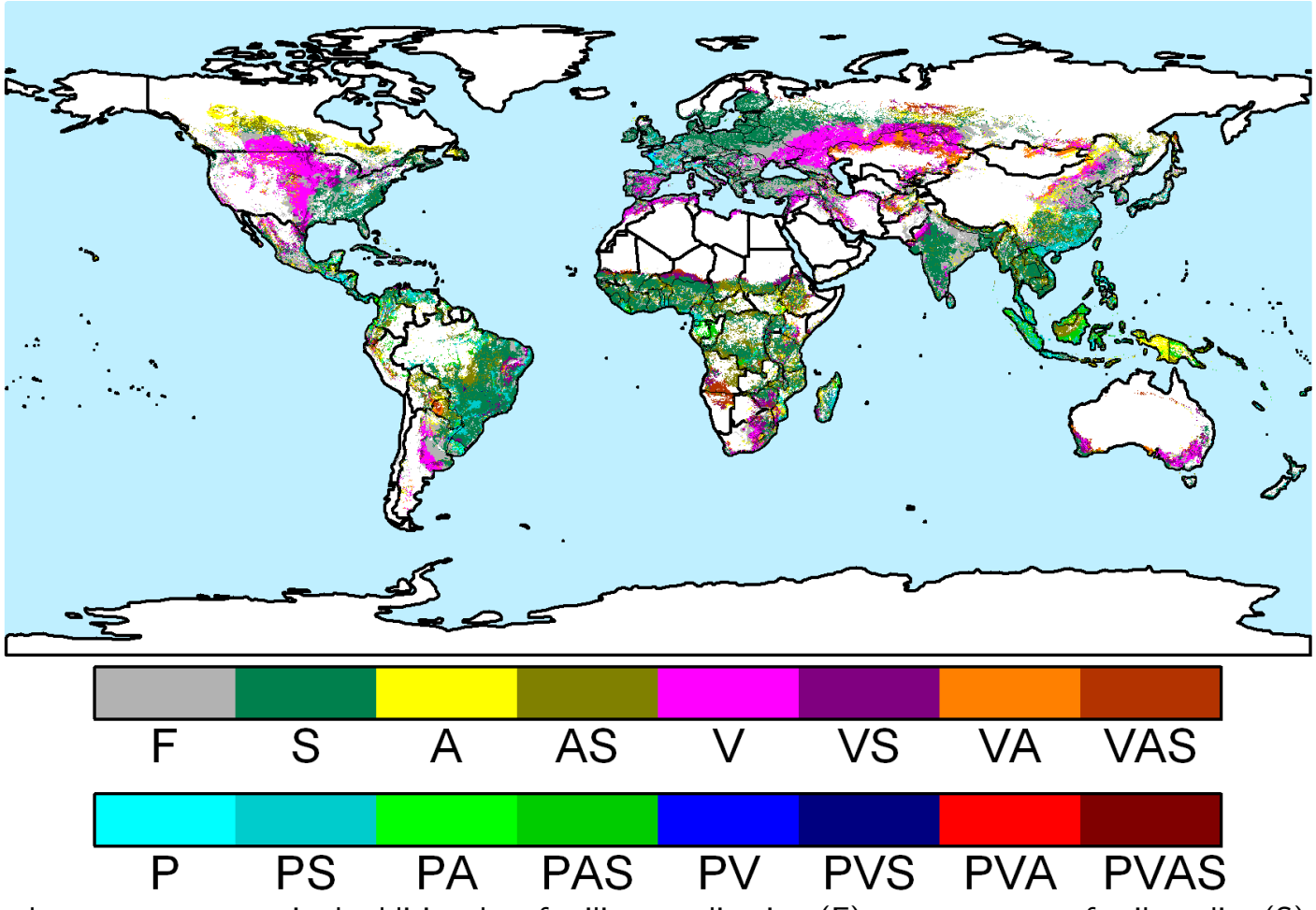
Agricultural expansion potential

Limited suitable land is available for agricultural expansion, which is unevenly distributed among the countries.



Required strategies to close yield gaps

Location specific inputs and management strategies is required to close yield gaps in beyond fertilizer and irrigation water.

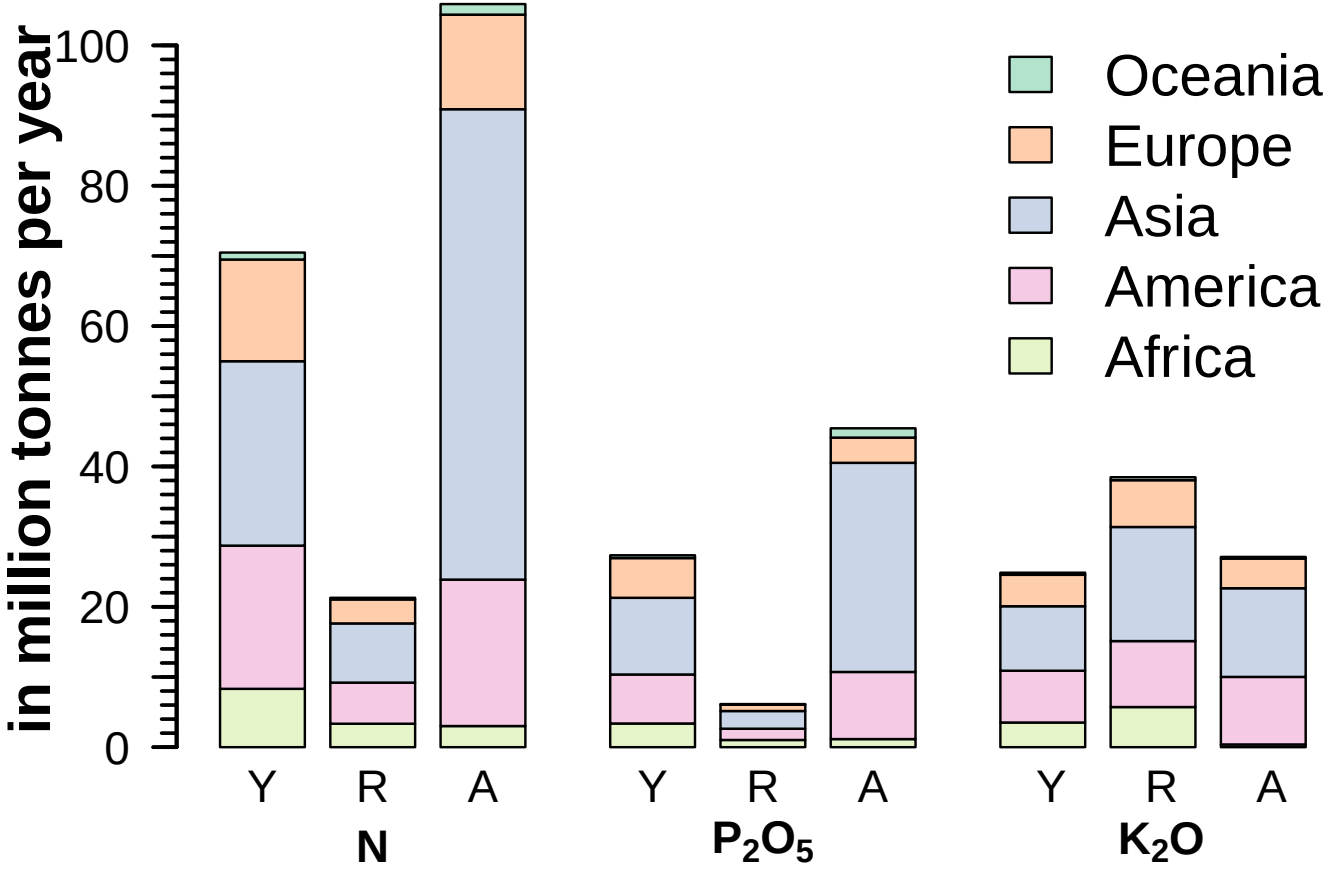


inputs and management required additional to fertilizer application (F): management of soil quality (S), market accessibility (A), climatic yield variability (V), and pests, diseases, and weeds (P)

(Pradhan et al. 2015, PLoS ONE)

Required nutrients

Fertilizer application efficiency needs to be improved in many world regions for limiting the required fertilizer to close crop yield gaps.

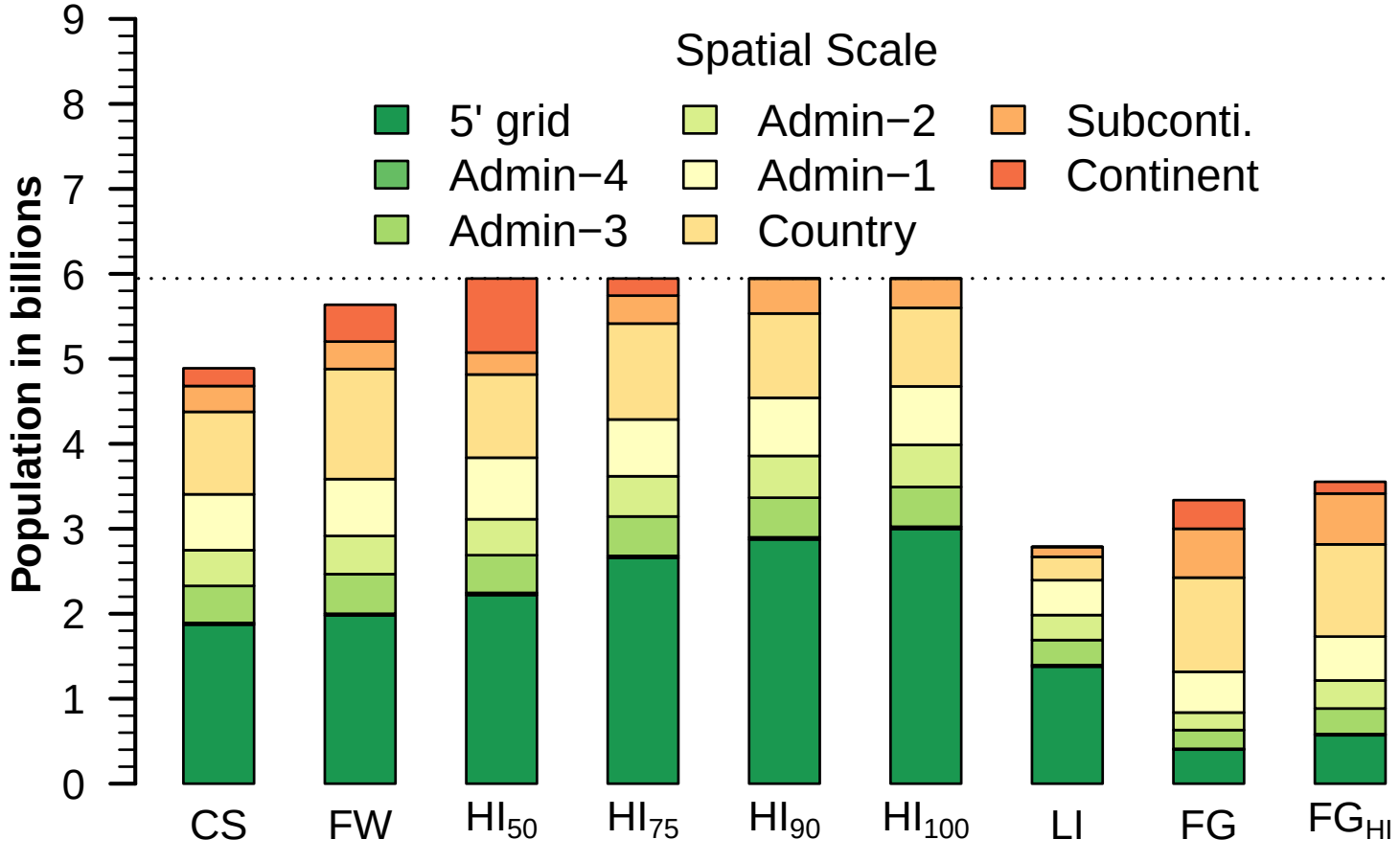


additional nutrients uptake in yield (Y) and crop residues (R) while obtaining high-input potential yields, applied nutrients (A) in 2010

(Pradhan et al. 2015, PLoS ONE)

Food self-sufficiency 2000

Food self-sufficiency can be enhanced by reducing food waste, closing crop yield gaps, and diversifying food production.

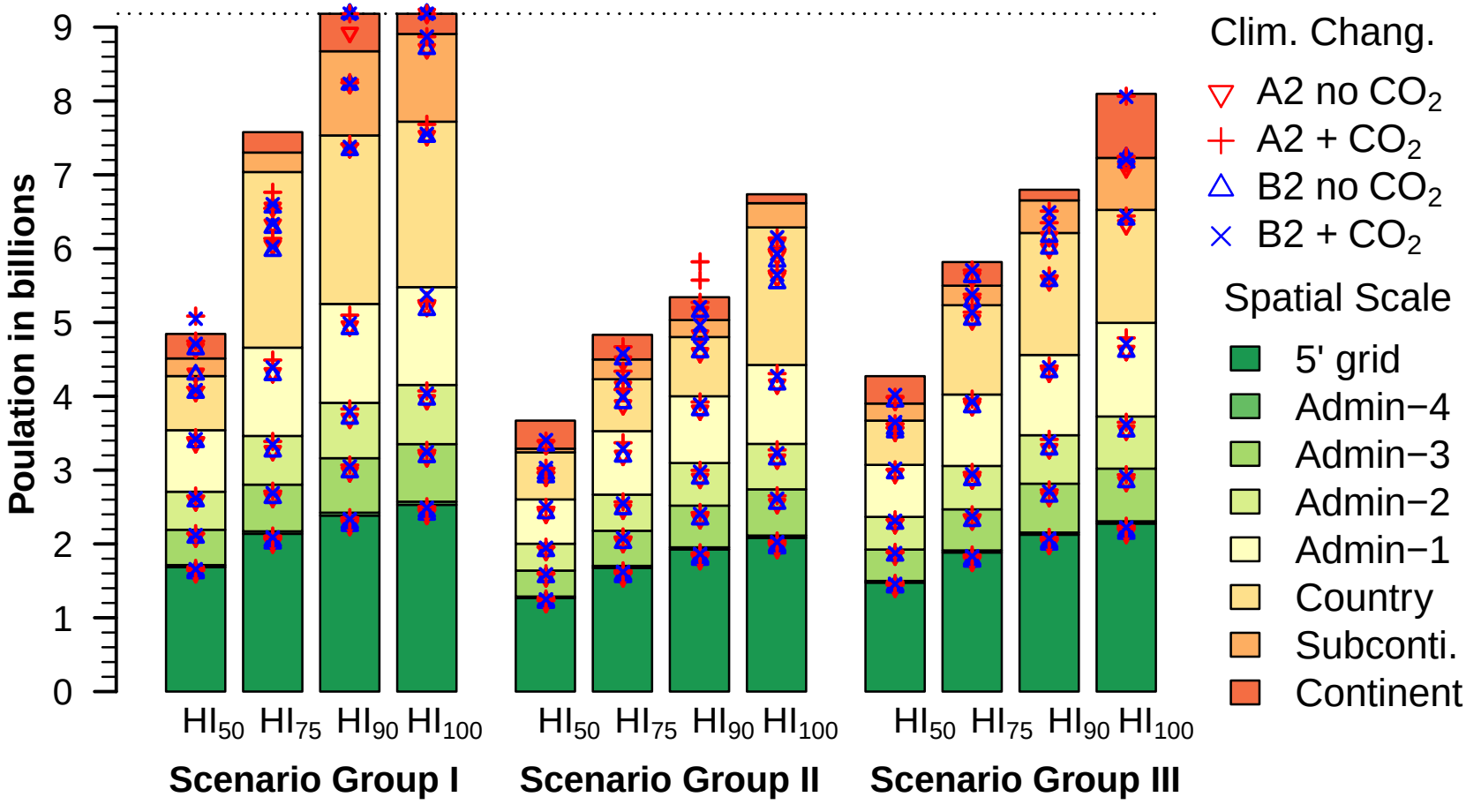


current situation (CS), reducing food waste (FW), closing yield gaps to 50–100% of high-input potential (HI_{50}–HI_{100}), low-input production (LI), and food groups (FG)

(Pradhan et al. 2014, ES & T)

Food self-sufficiency (FSS) 2050

The future FSS largely depends on population growth, dietary shifts, and level of yield gaps closing.



Scenario Group (SG) I: population growth; SG II: SG I + dietary shifts; SG III: SG II + improved feed conversion efficiency; closing yield gaps to 50–100% of high-input potential (HI_{50}–HI_{100})

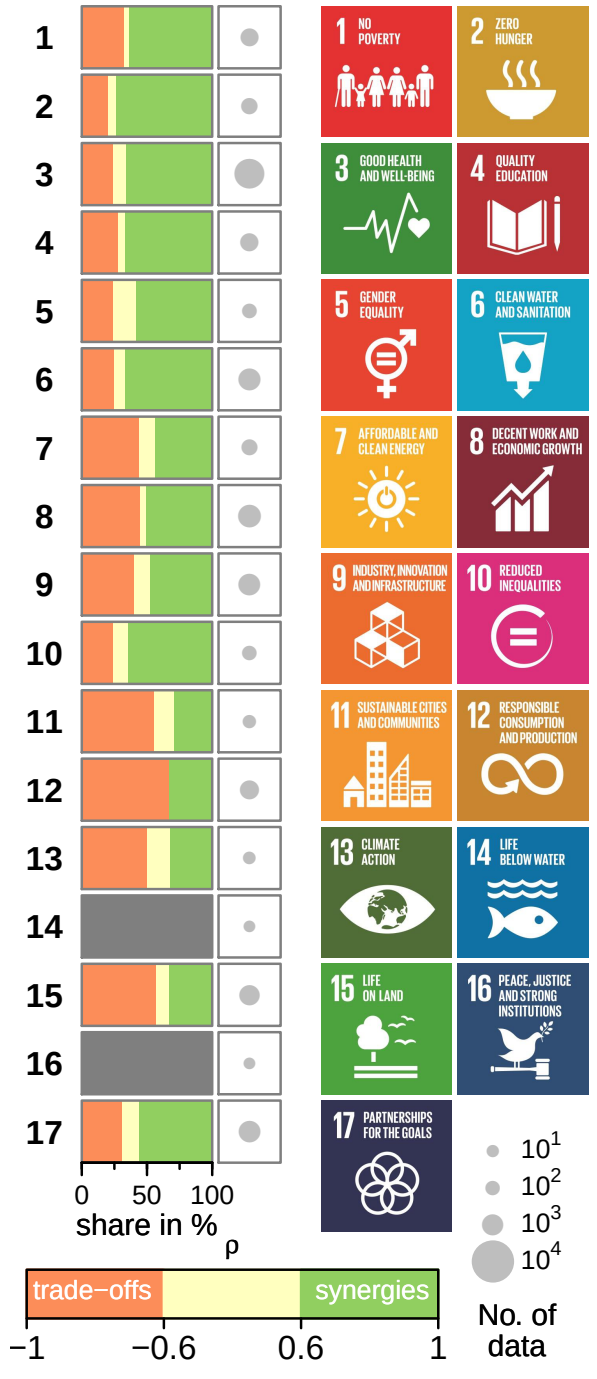
(Pradhan et al. 2014, ES & T)

Food system and SDGs

Several SDGs are directly and indirectly related to food systems, both on production and consumption sides.

SDG2 interactions

Synergies among the goals can be leveraged and trade-offs need to be negotiated and made structurally non-obstructive to achieve the SDG agenda.



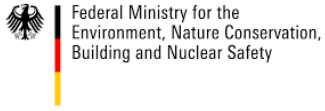
(Pradhan et al. under review, Earth's Future)

Conclusion

To nourish a growing population combinations and sustainable implementations of following measures are required:

- food waste reduction
- dietary shits towards a lower share of animal products,
- consumption of local and regional food,
- promotion of agrodiversity
- agricultural intensification,
- agricultural expansion, and
- international food trade.

Acknowledgements



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Thank You...

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