

Supplementary Materials for

Food matters: Dietary shifts increase the feasibility of 1.5°C pathways in line with the Paris Agreement

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This PDF file includes:

Figs. S1 to S16
Table S1
References

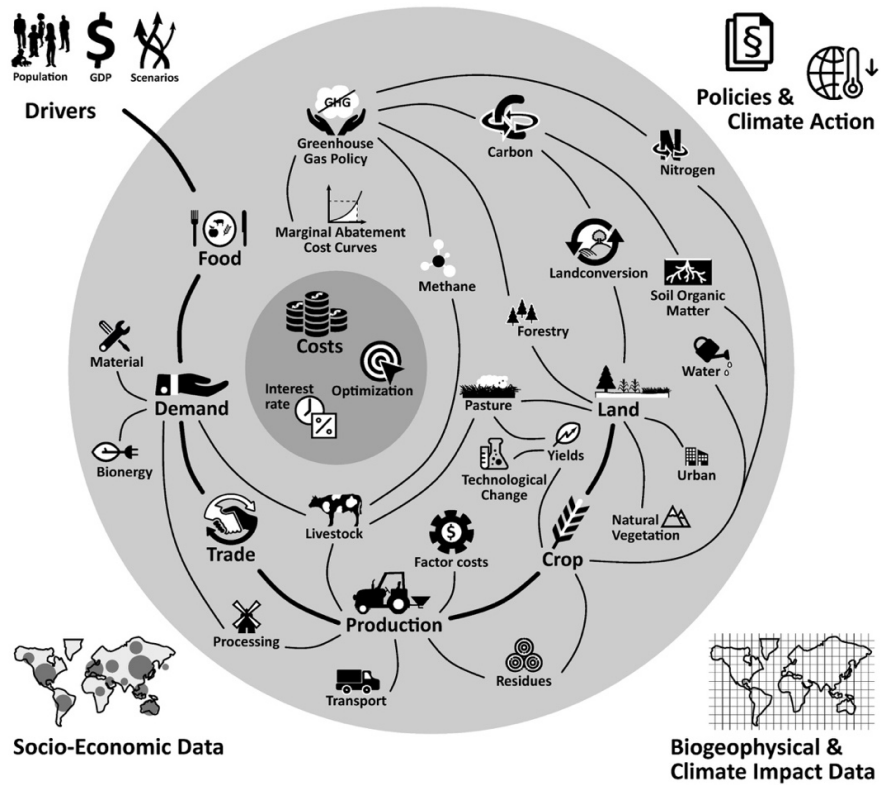


Fig. S1: **MAGPIE 4 framework**. Simplified modular structure and module interactions. Reproduced from (42) under CC-BY-4.0 license.

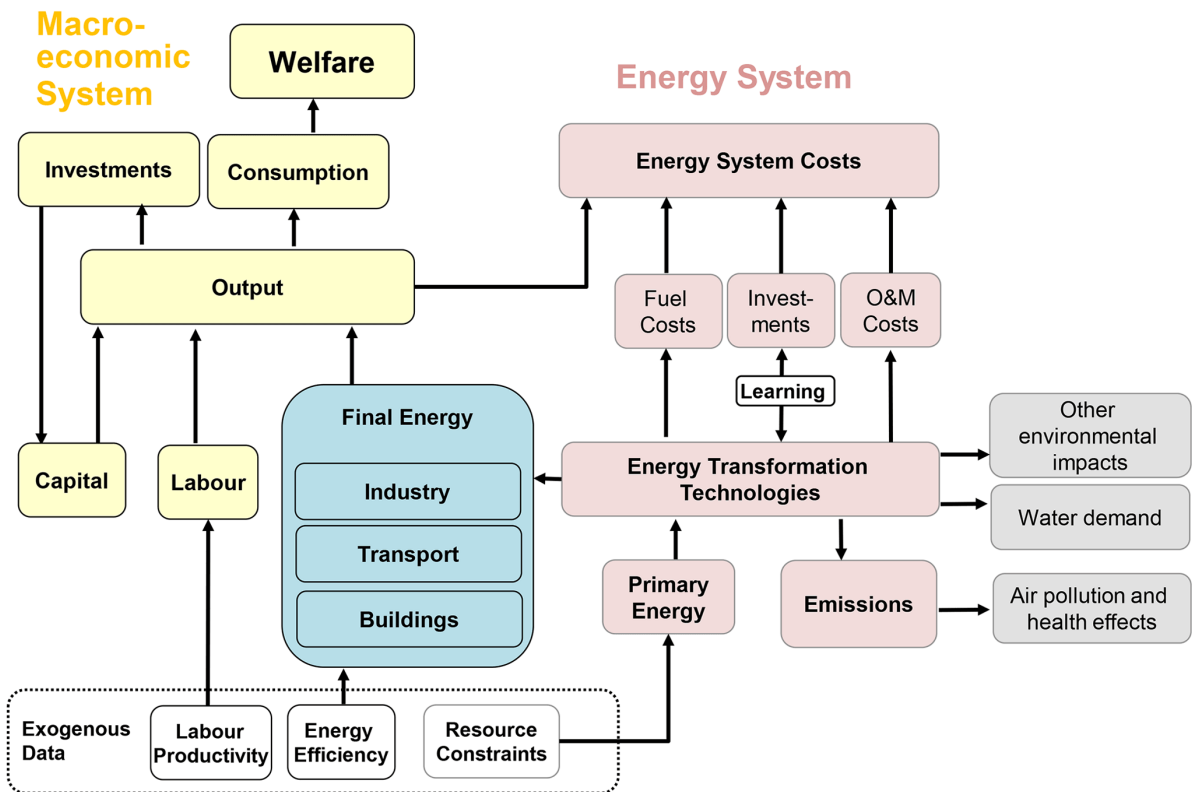


Fig. S2: **Structure of REMIND**. Reproduced from (55) under CC-BY-4.0 license.

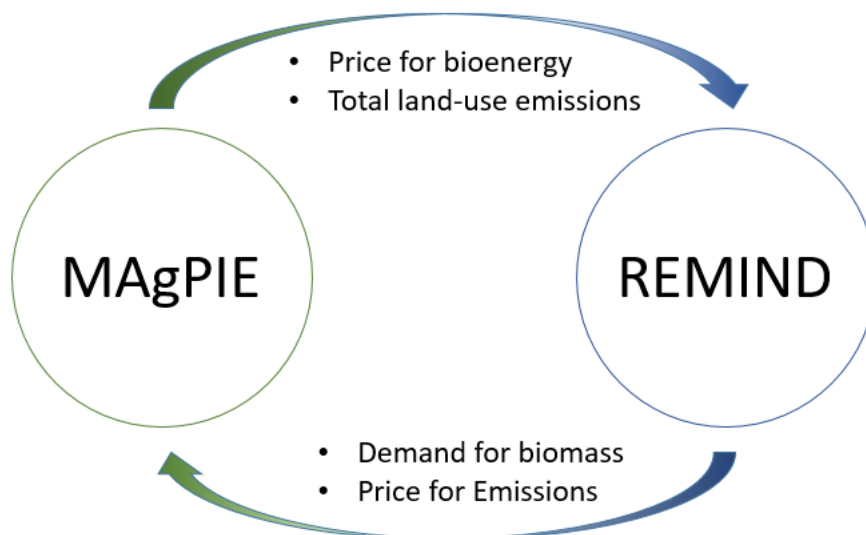


Fig. S3: **Coupling of REMIND and MAgPIE.** Reproduced from the tutorial for running REMIND and MAgPIE in (41) under GNU AGPL-3.0 license.

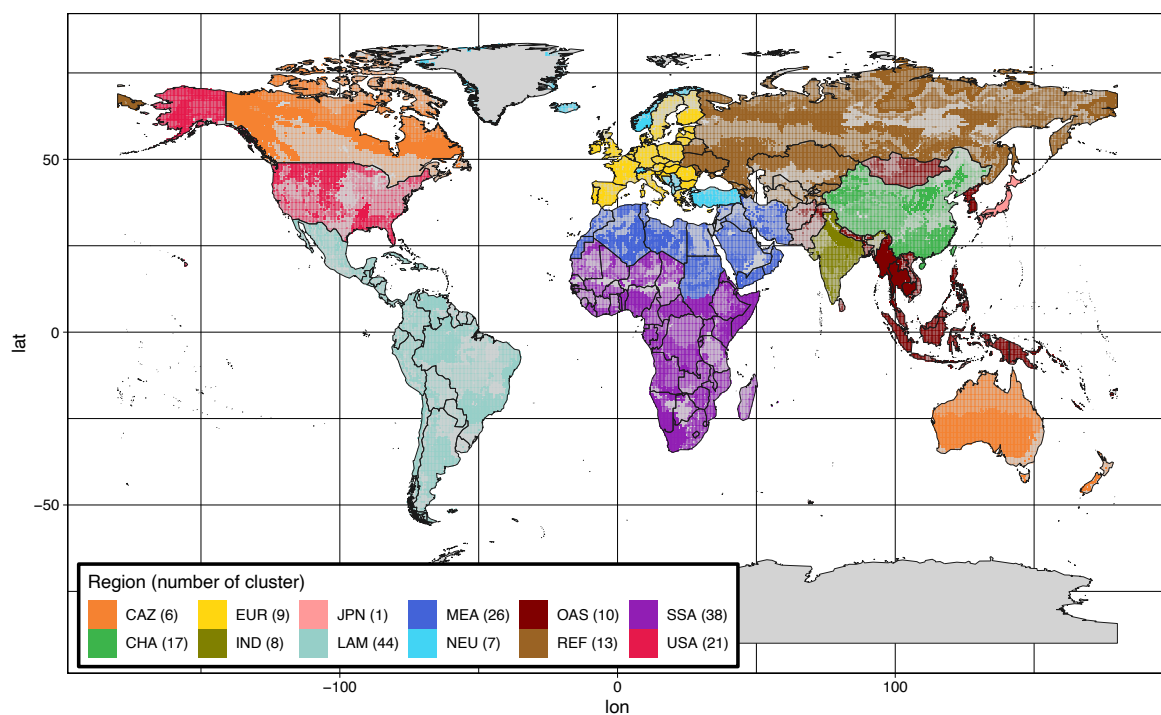


Fig. S4: **Map of REMIND-MAgPIE regions and associated spatial simulation units.** Regional definitions: CAZ (Canada, Australia, and New Zealand); CHA (China); EUR (European Union); IND (India); JPN (Japan); LAM (Latin America); MEA (Middle East and north Africa); NEU (non-EU member states); OAS (other Asia); REF (reforming countries); SSA (Sub-Saharan Africa); USA (United States). The country map is based on the object "wrld_simpl" in the R package "mapproj".

Name of region	Income group	REMIND-MAGPIE regions
HIR	high-income	Canada, Australia, New Zealand (CAZ), European Union (EUR), United States (USA), Japan (JPN)
MIR	middle-income	Latin America (LAM), China (CHA), other Asia (OAS), non-EU member states (NEU), Middle East and North Africa (MEA), reforming countries (REF)
LIR	low-income	India (IND), Sub-Saharan Africa (SSA)

Table S1: Regional mapping. Definition of aggregated regions used in this study, income group and the corresponding MAGPIE regions (see Fig. S4 for a map of REMIND-MAGPIE regions).

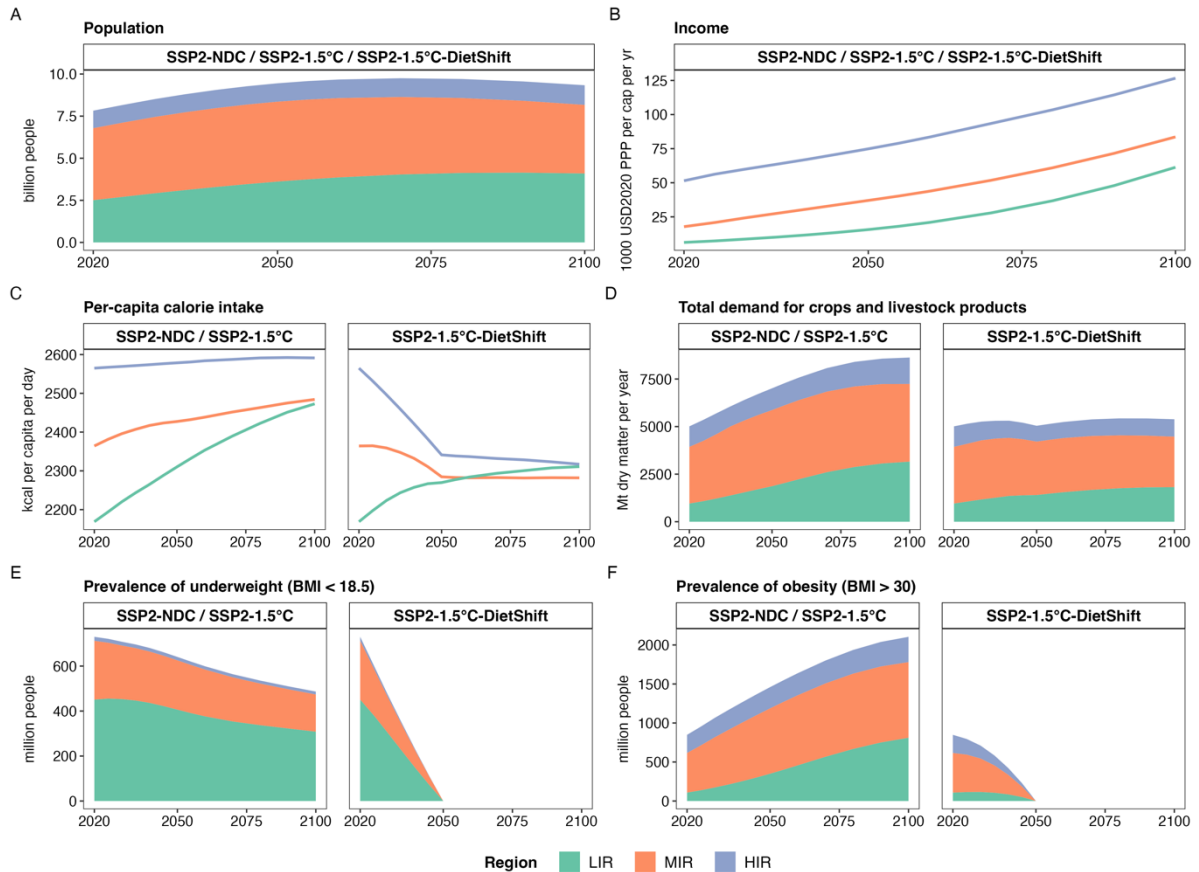


Fig. S5: Key socio-economic drivers and assumptions for future food demand in REMIND-MAGPIE. Data is shown for three pathways (SSP2-NDC, SSP2-1.5°C and SSP2-1.5°C-DietShift) and has been aggregated to low-, middle and high-income regions (LIR, MIR and HIR; see Table S1 for mapping of regions). Population (A) and per-capita income (B) used for food demand calculations follow SSP2 middle-of-the-road trajectories. Per-capita calorie intake (C) follows SSP2 assumptions in SSP2-NDC / SSP2-1.5°C and shifts towards intake levels that correspond with a healthy body mass index (BMI) in SSP2-1.5°C-DietShift. Total global demand for crops and livestock products (for food, feed and other purposes) (D) increases in SSP2-NDC / SSP2-1.5°C and remains rather constant in SSP2-1.5°C-DietShift. Prevalence of underweight (E) slightly declines in SSP2-NDC / SSP2-1.5°C and is eliminated by 2050 in SSP2-1.5°C-DietShift. Prevalence of obesity (F) more than doubles in SSP2-NDC / SSP2-1.5°C and vanishes by 2050 in SSP2-1.5°C-DietShift.

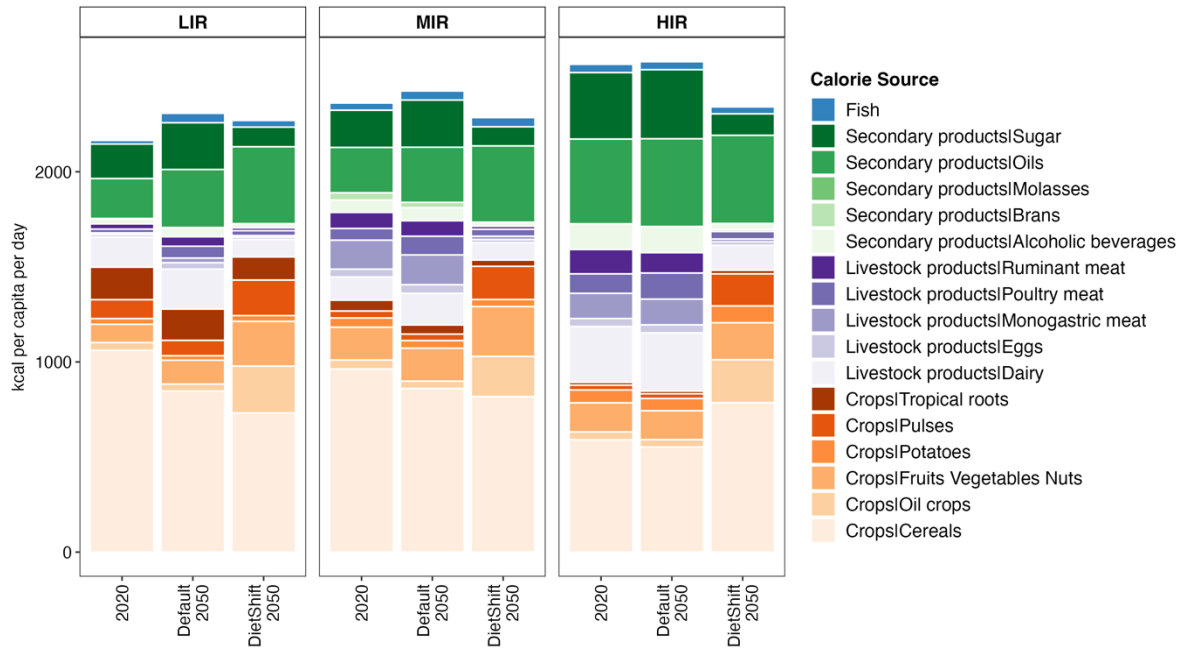


Fig. S6: *Per-capita calorie intake and dietary composition*. Data is shown for 2020, Default 2050 (SSP2-NDC / SSP2-1.5°C) and DietShift 2050 (SSP2-1.5°C-DietShift). Data has been aggregated to low-, middle and high-income regions (LIR, MIR and HIR; see Table S1 for mapping of regions). In the SSP2-1.5°C-DietShift pathway, all regions shift towards EAT-Lancet recommendations (planetary health diet) by 2050.

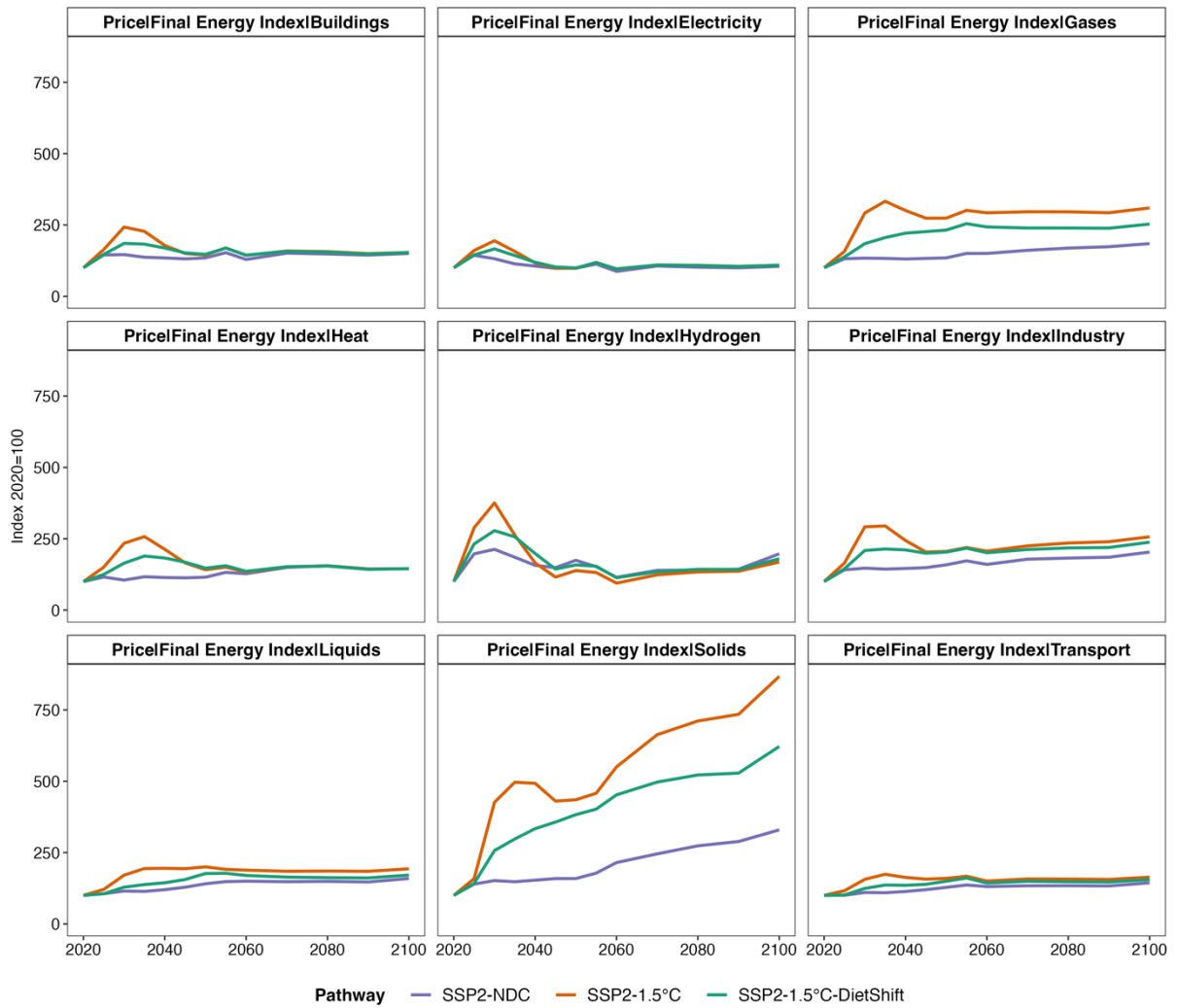
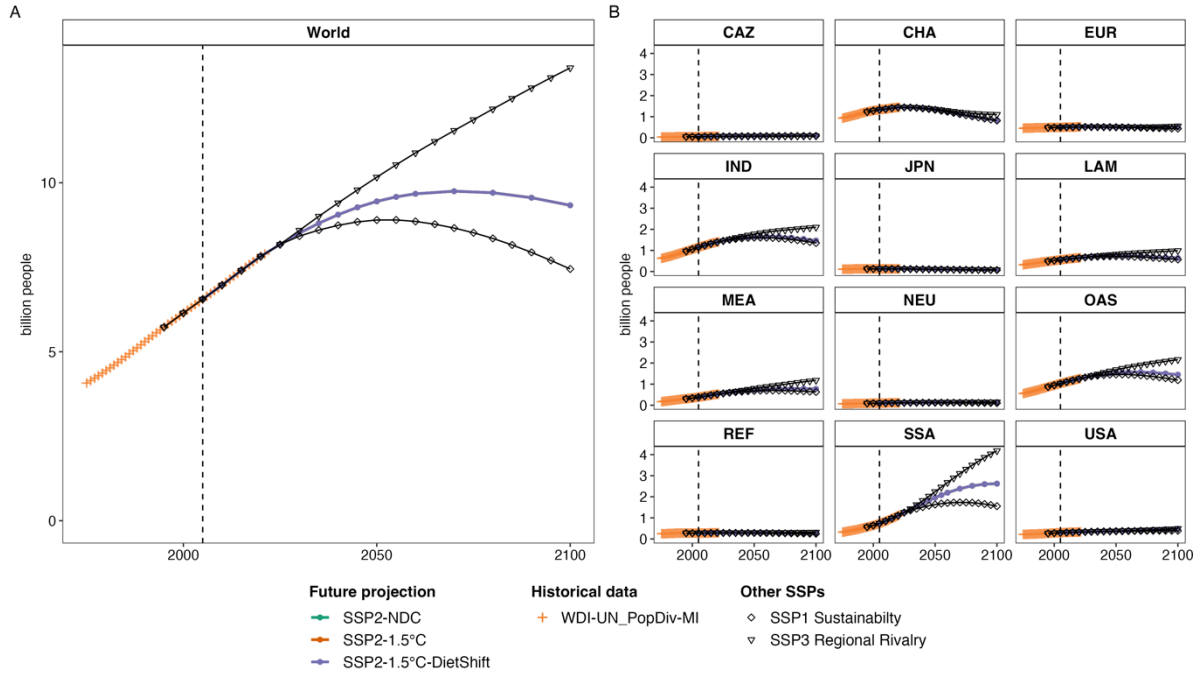
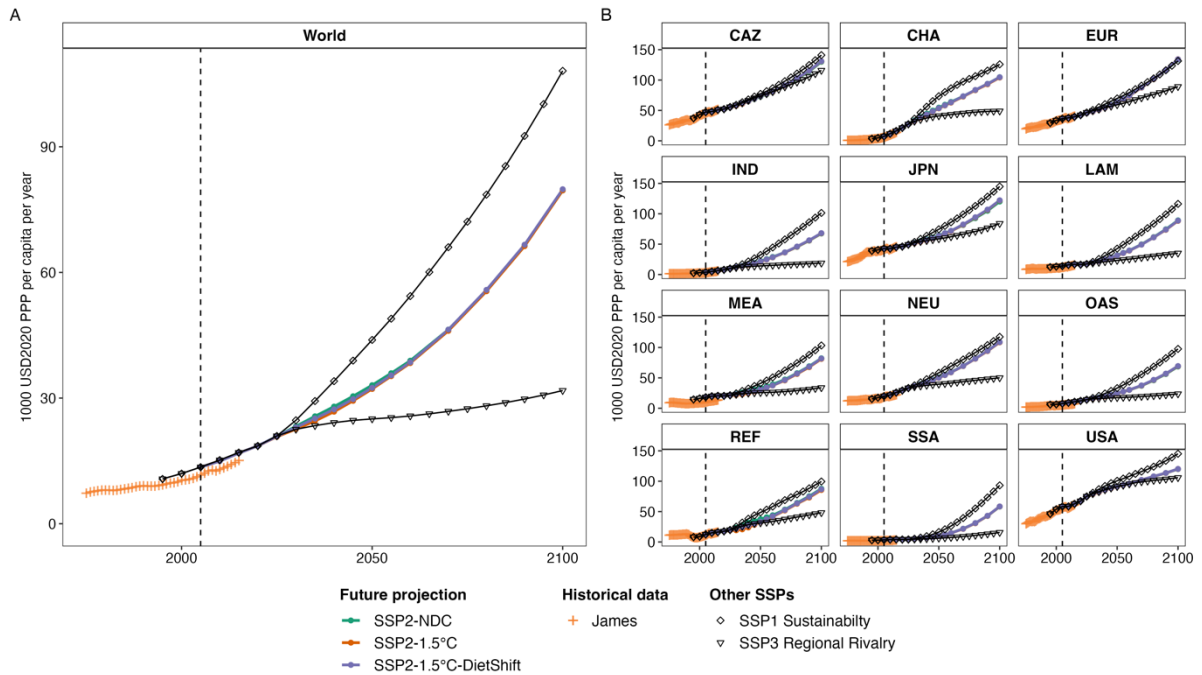


Fig. S7: Final energy price indices at global level in the 21st century.



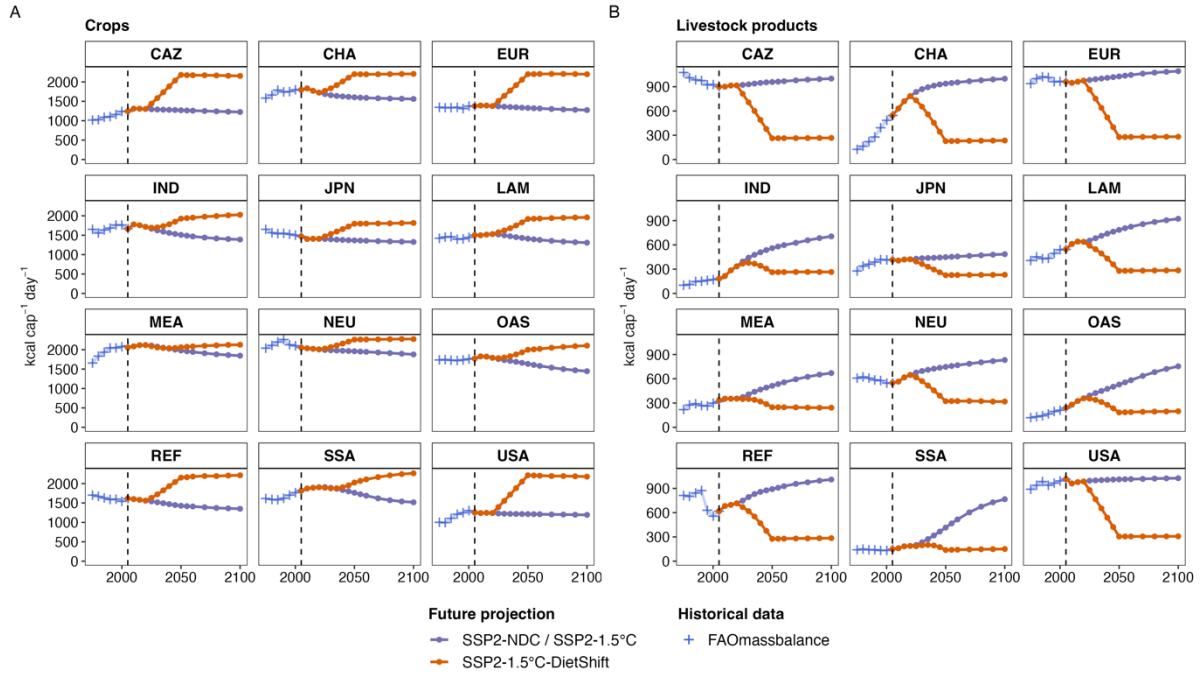
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Fig. S8: **Population**. A) shows global data. B) shows regional data. Population in this study follows SSP2 assumptions (same for all pathways). SSP1 and SSP3 are shown for context only. Population projections are based on KC and Lutz (57). Historical data for comparison from World Bank World Development Indicators (WDI) (58). The historical data has been processed using the *pik-piam/mrvalidation* R package (59).



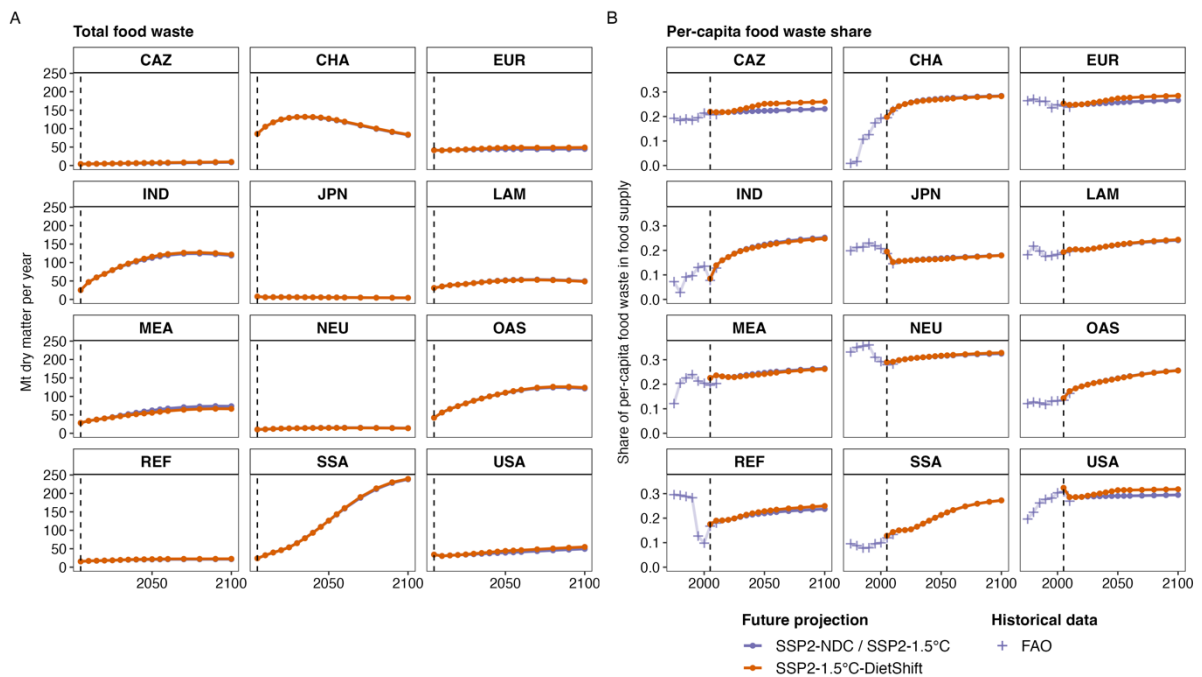
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Fig. S9: **Income**. A) shows global data. B) shows regional data. Income in this study is calibrated to SSP2 assumptions in all pathways. Income is very similar but not identical in all pathways because of model-endogenous second-order effects of climate policy on income. SSP1 and SSP3 are shown for context only. Income projections are based on Dellink et al (60). Historical data for comparison from James et al (61). The historical data has been processed using the *pik-piam/mrvalidation* R package (59).



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Fig. S10: **Per-capita calorie supply**. Calorie supply is the sum of calorie intake and food waste. Data is shown at regional level. A) shows crops. B) shows livestock products. Historical data from FAO (62). The historical data has been processed using the *pik-piam/mrvalidation* R package .



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Fig. S11: **Food waste**. A) shows total food waste in million ton dry matter per year. B) shows per-capita food waste as share of per-capita calorie supply. Data is shown at regional level. Historical data from FAO (62). The historical data has been processed using the *pik-piam/mrvalidation* R package (59).

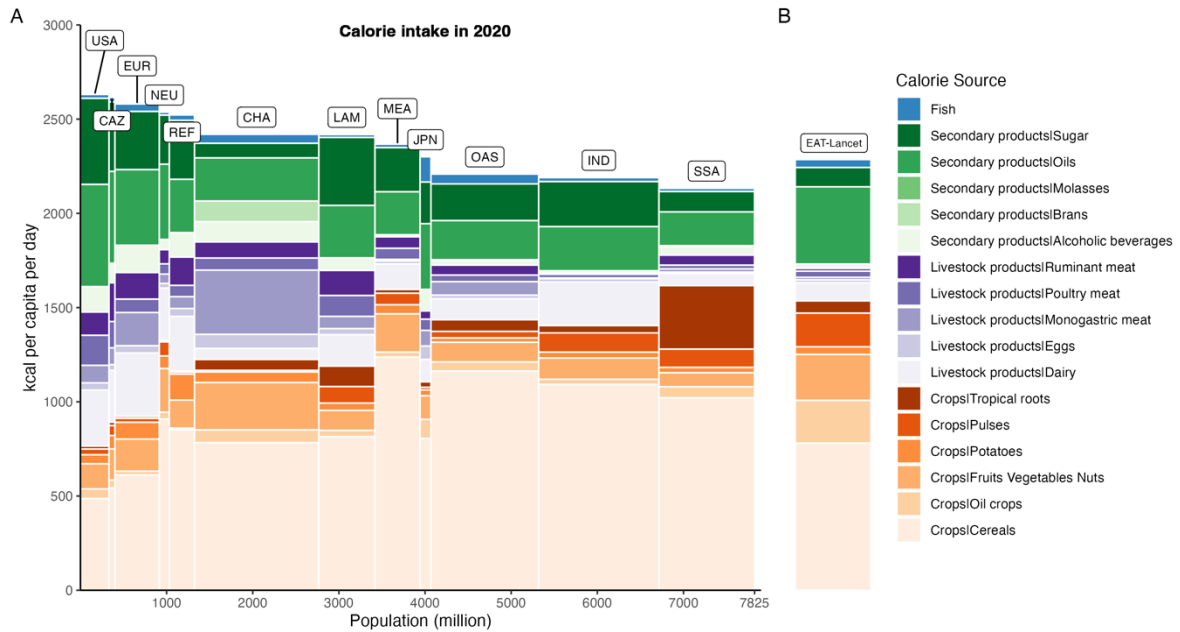


Fig. S12: **Per-capita calorie intake, dietary composition and population.** A) shows regional data for 2020. The height of each rectangle shows per-capita kcal intake, the width shows the population of the region, so that the area of the rectangles refers to the total calorie intake for each region. B) shows EAT-Lancet recommendations (planetary health diet), aggregated to global level. In the SSP2-1.5°C-DietShift pathway, all regions shift towards EAT-Lancet recommendations by 2050.

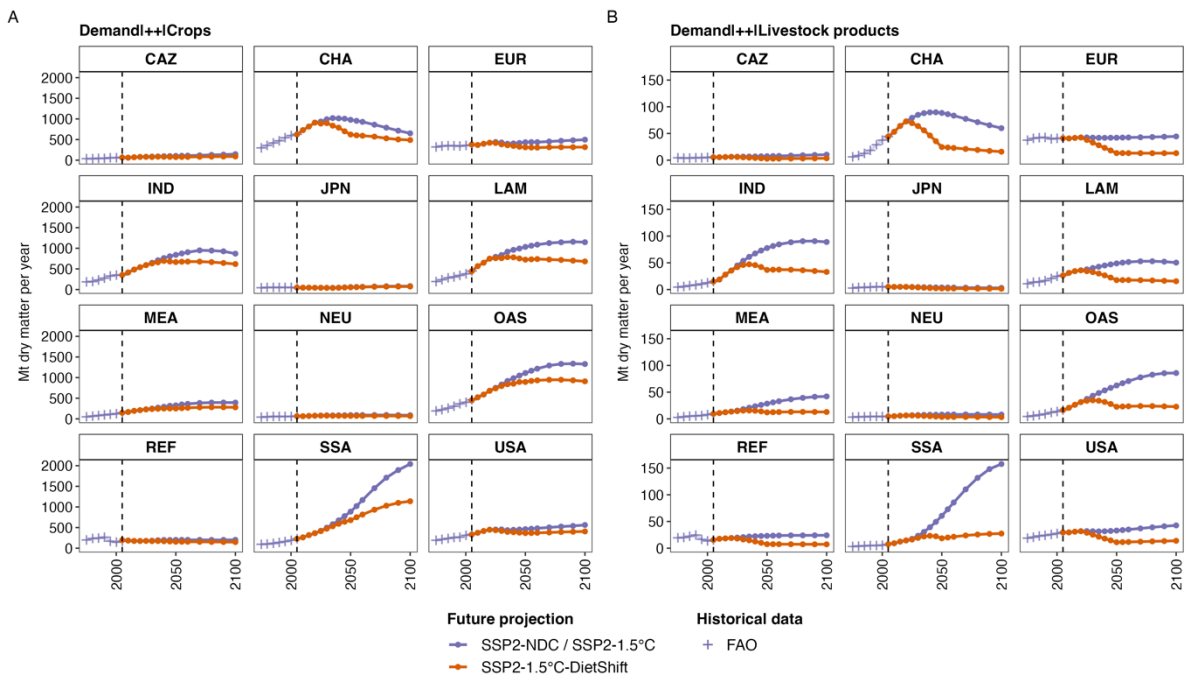
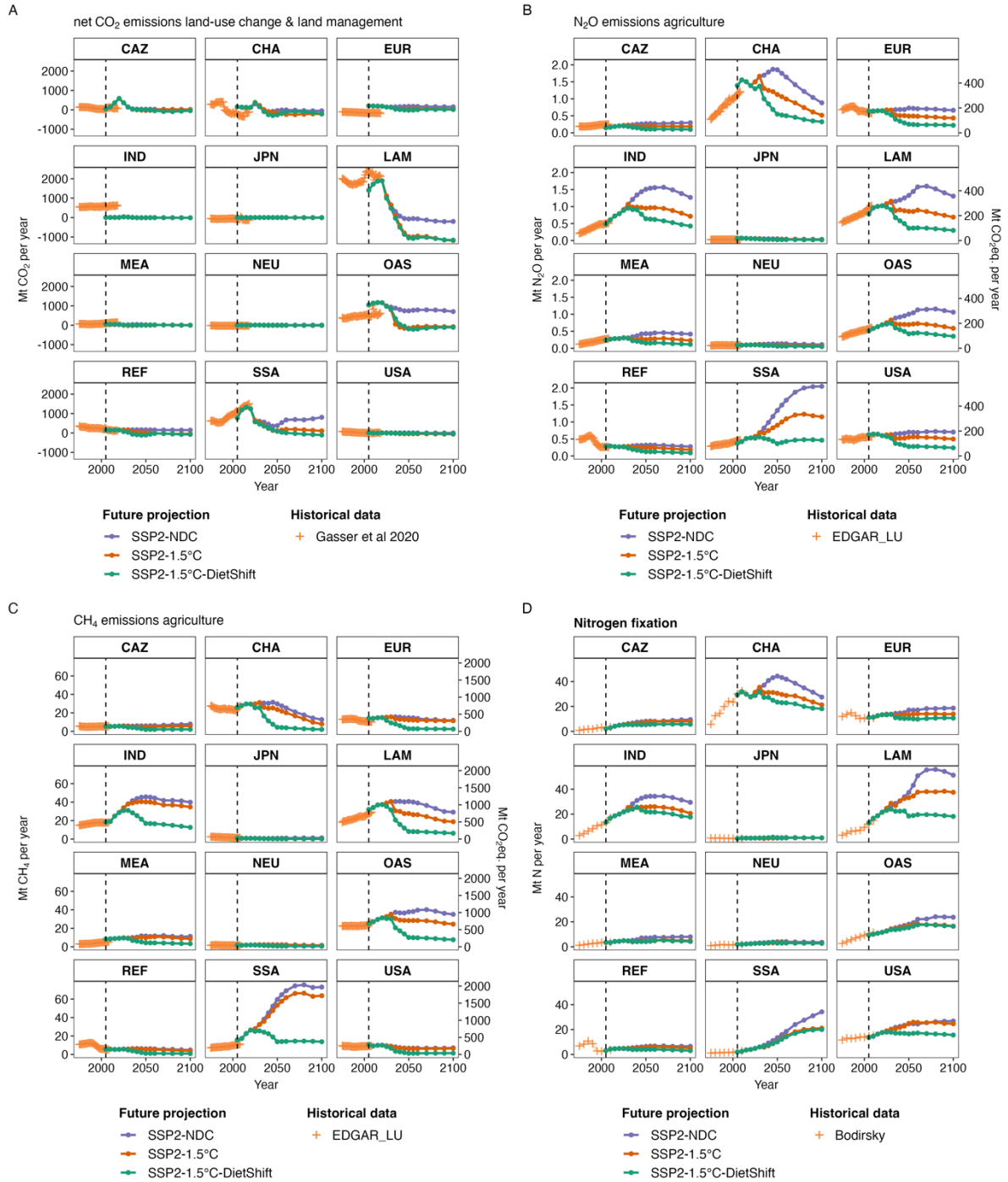
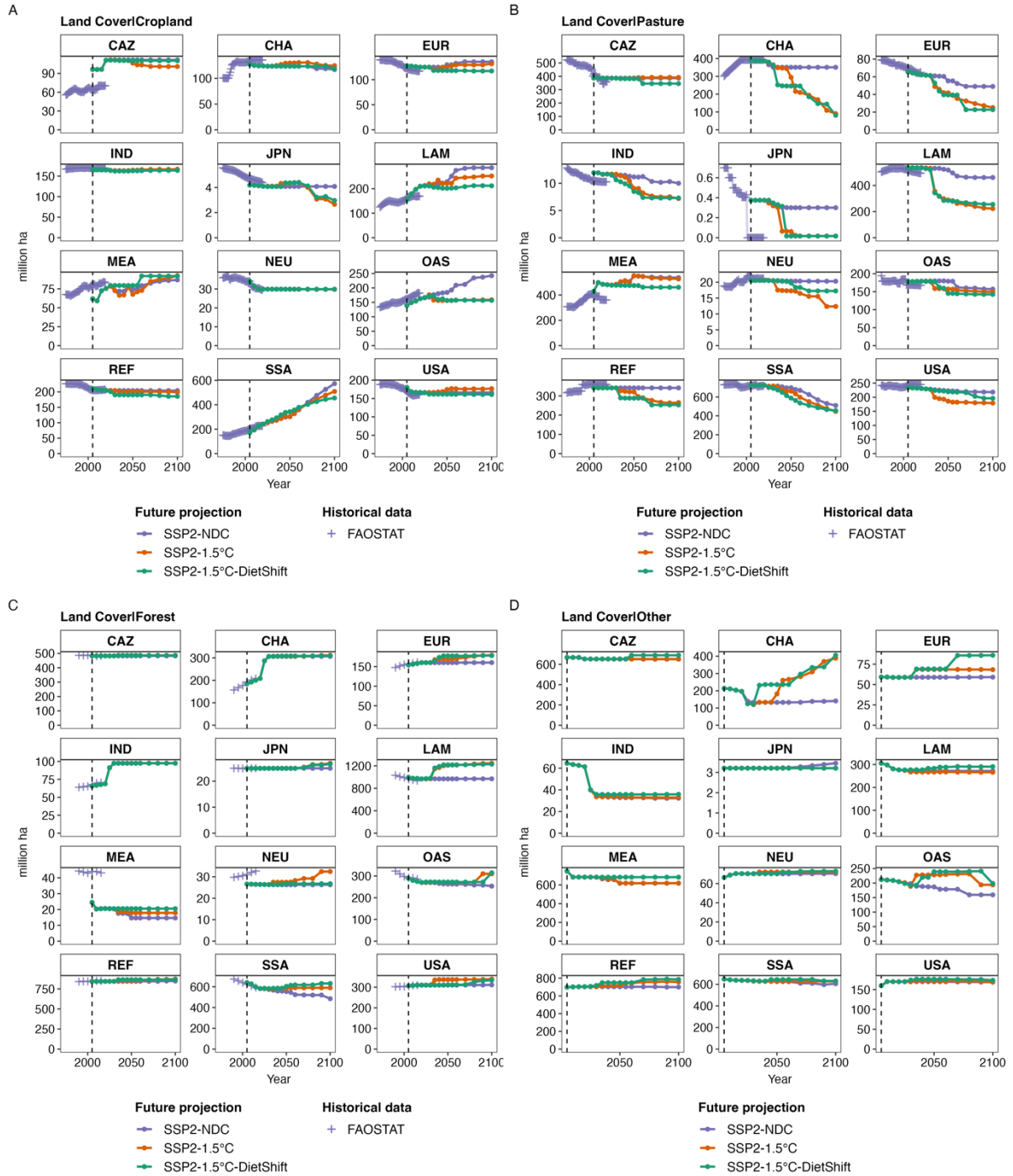


Fig. S13: **Total agricultural demand for food, feed and other purposes.** Data is shown at regional level. A) shows crops. B) shows livestock products. Historical data for comparison from FAO (62). The historical data has been processed using the pik-piam/mrvalidation R package (59).



2023-10-23

Fig. S14: **Validation of environmental indicators: GHG emissions and nitrogen fixation.** Data is shown at regional level. A) shows net CO₂ emissions from land-use change and management. B) shows N₂O emissions from agriculture. C) shows CH₄ emissions from agriculture. D) shows nitrogen fixation. For the conversion of N₂O and CH₄ emissions into CO₂ equivalents (right axis) we used IPCC AR6 GWP100 factors of 273 and 27, respectively. Historical data for comparison from Gasser et al (63), the EDGAR emissions database version 4.2 (64) and Bodirsky et al (50). The historical data has been processed using the *pik-piam/mrvalidation* R package (59).



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Fig. S15: **Validation of main land classes.** Data is shown at regional level. A) shows cropland. B) shows pasture. C) shows forest. D) shows other natural land. Historical data for comparison from FAO (62). The historical data has been processed using the *pik-piam/mrvalidation* R package (59).

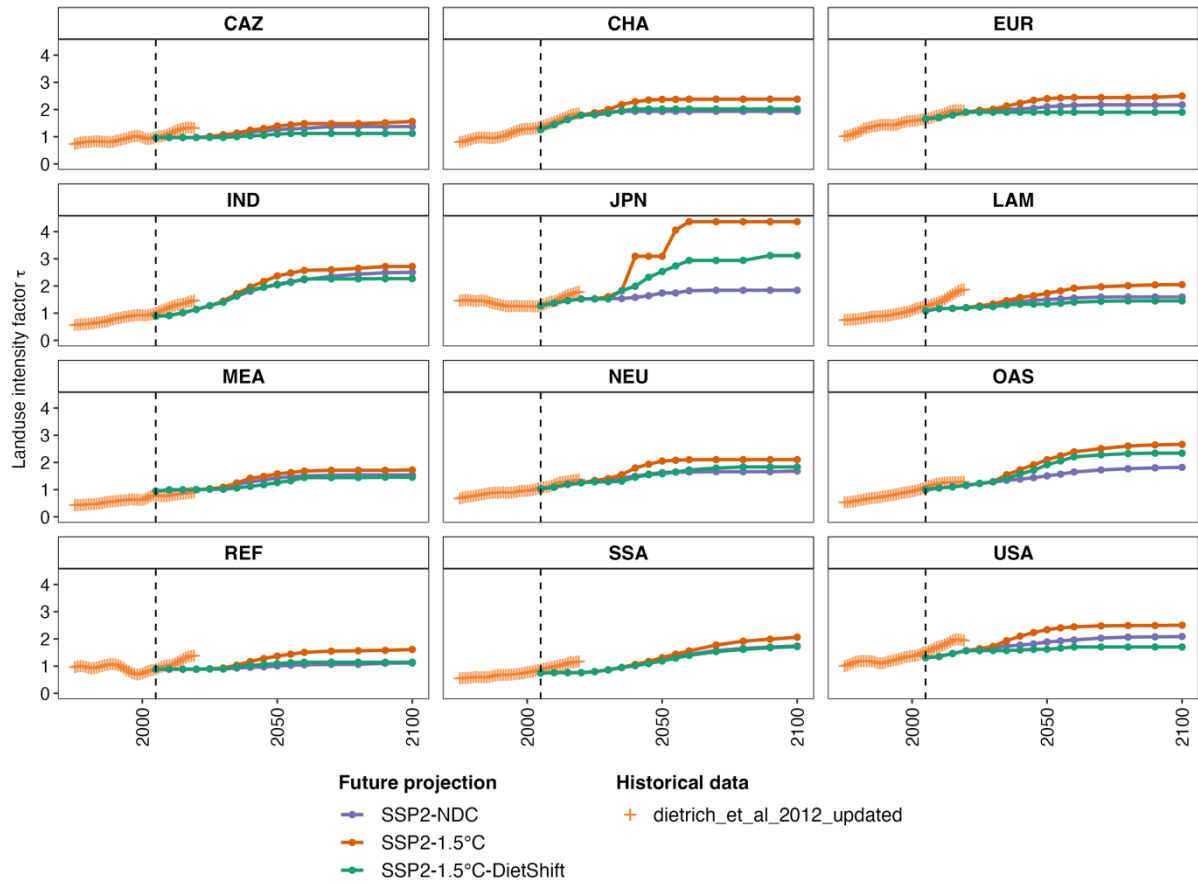


Fig. S16: **Land-use intensity factor τ** . The τ factor reflects the degree of crop yield amplification caused by human activities. A duplication of τ implies a doubling of crop yields under fixed environmental conditions. Data is shown at regional level. Historical data for comparison from Dietrich et al (65). The historical data has been processed using the *pik-piam/mrvalidation* R package (59).

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