A food system transformation can enhance global health, environmental conditions and social inclusion

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Miodrag Stevanovic, Alexandre Koberle, Xiaoxi Wang, Vartika Singh,
Claudia Hunecke, Quitterie Collignon, Pepijn Schreinemachers, Simon Dietz,
Ravi Kanbur, Jan Dietrich, Hermann Lotze-Campen, Alexander Popp

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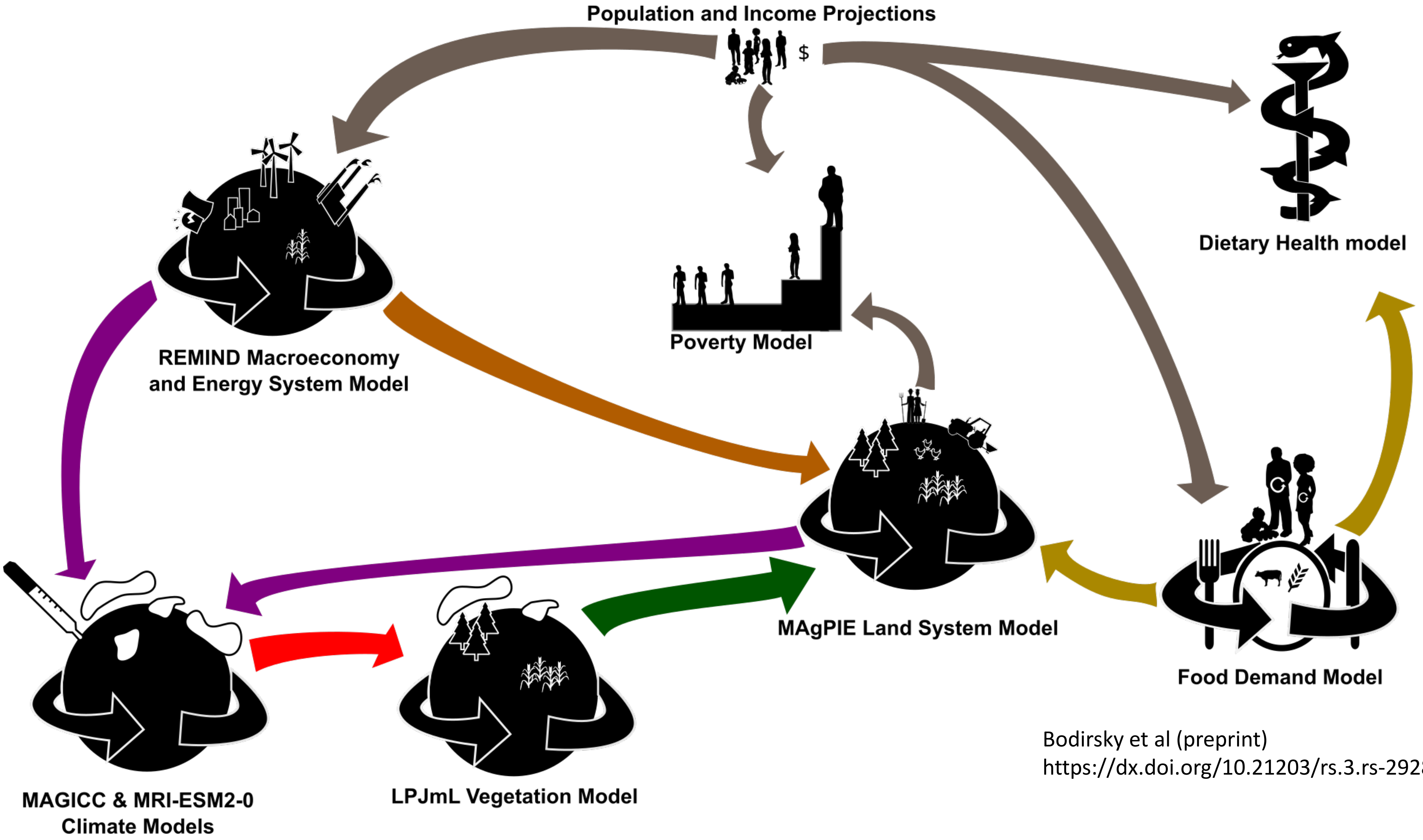
PIK
Potsdam-Institut für Klimafolgenforschung

Food System Economics Commission

Is our food system on track?

Global health
Environmental conditions
Social inclusion



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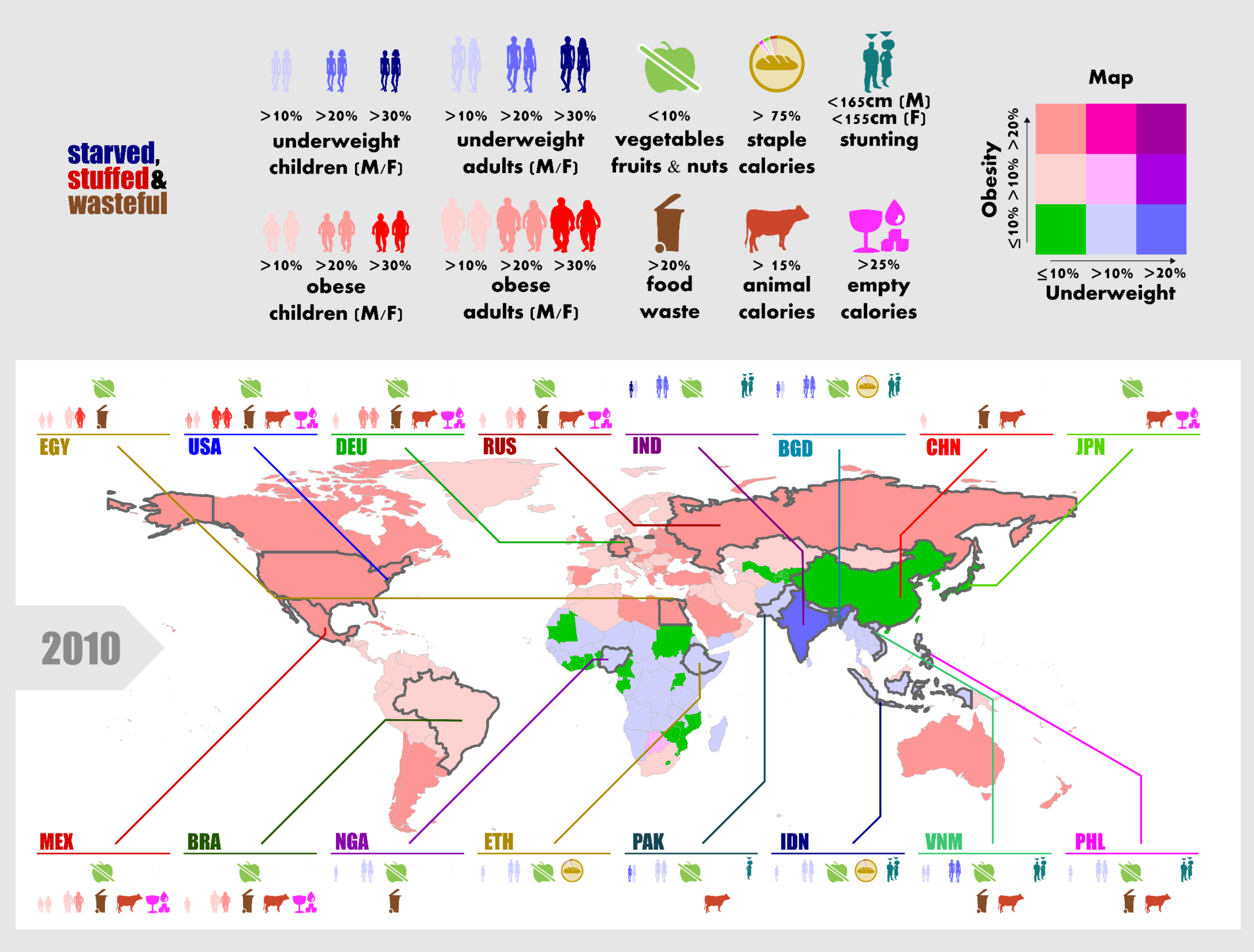
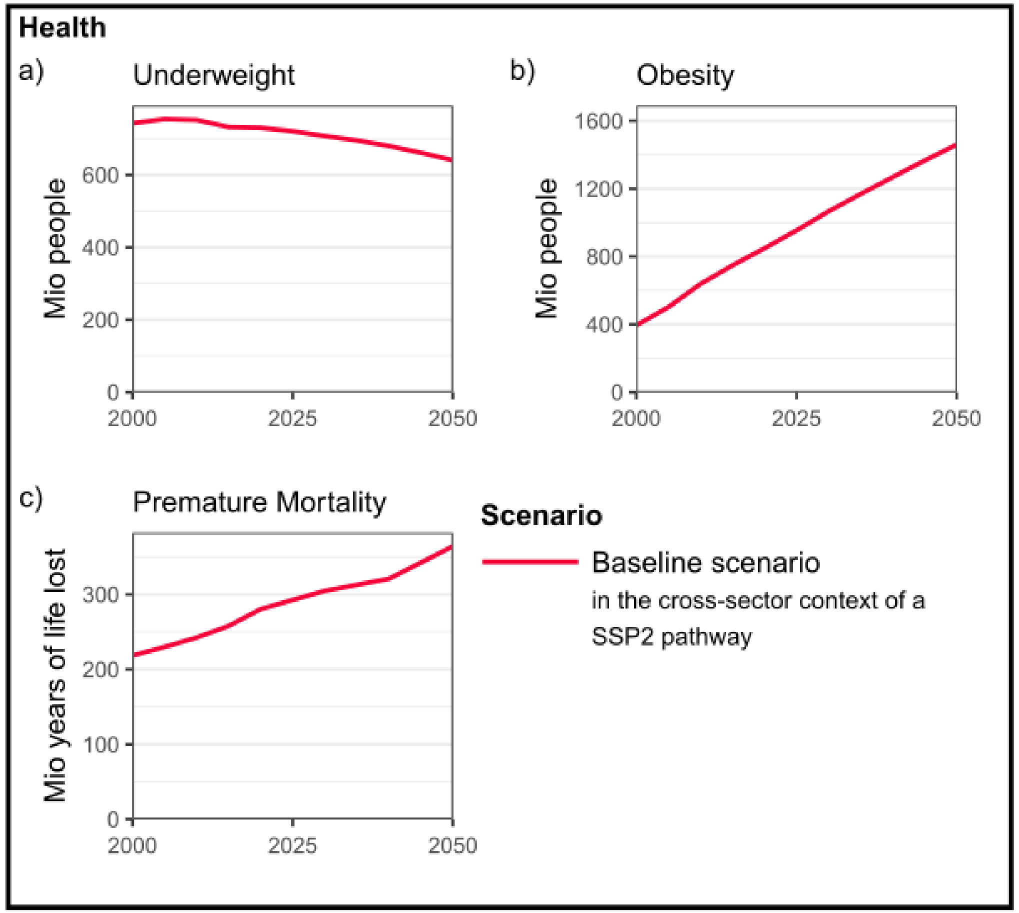


Bodirsky et al.
2020
Scientific Reports

Baseline trends: Food security improves but dietary health deteriorates



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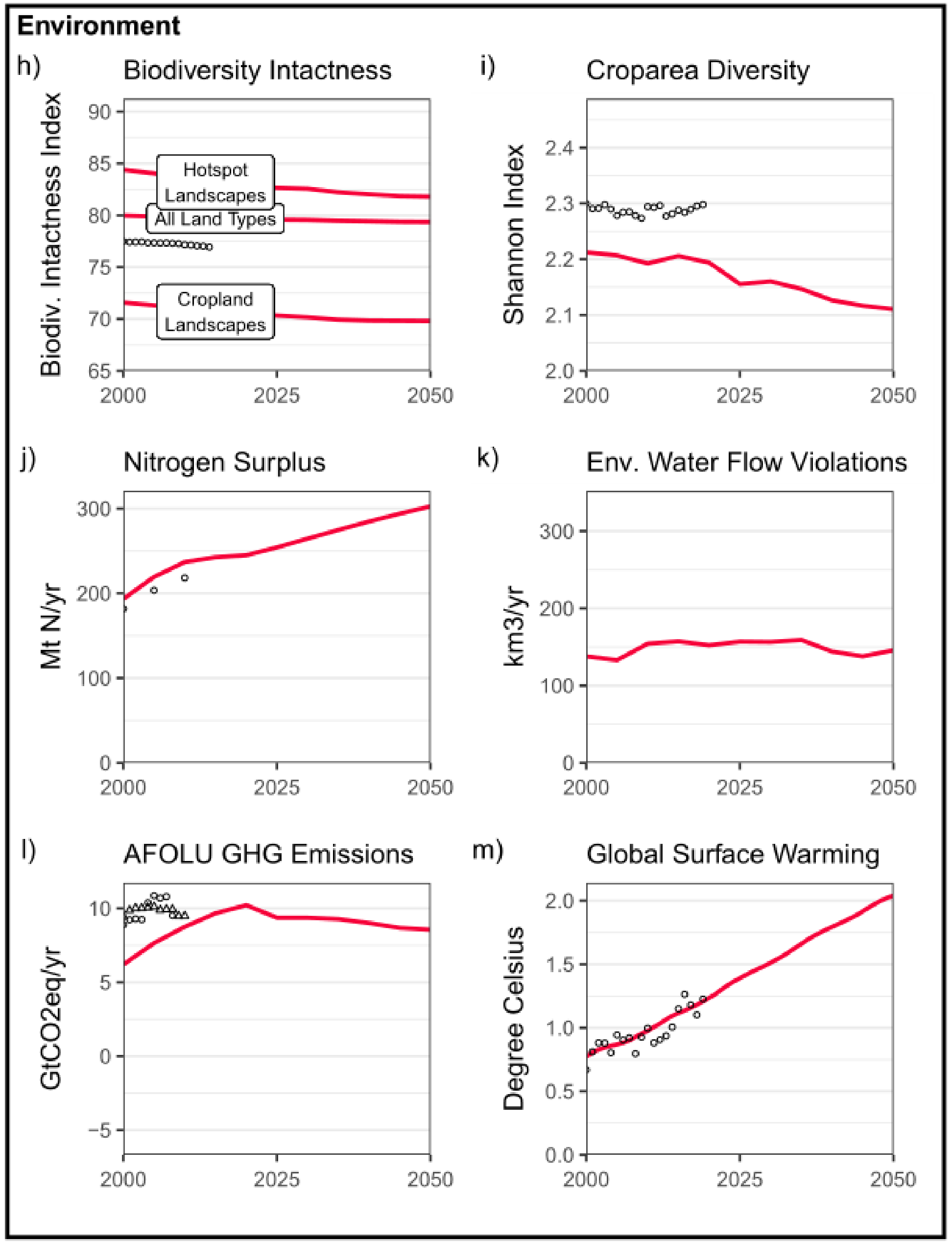
Baseline trends: Most global environmental indicators deteriorate



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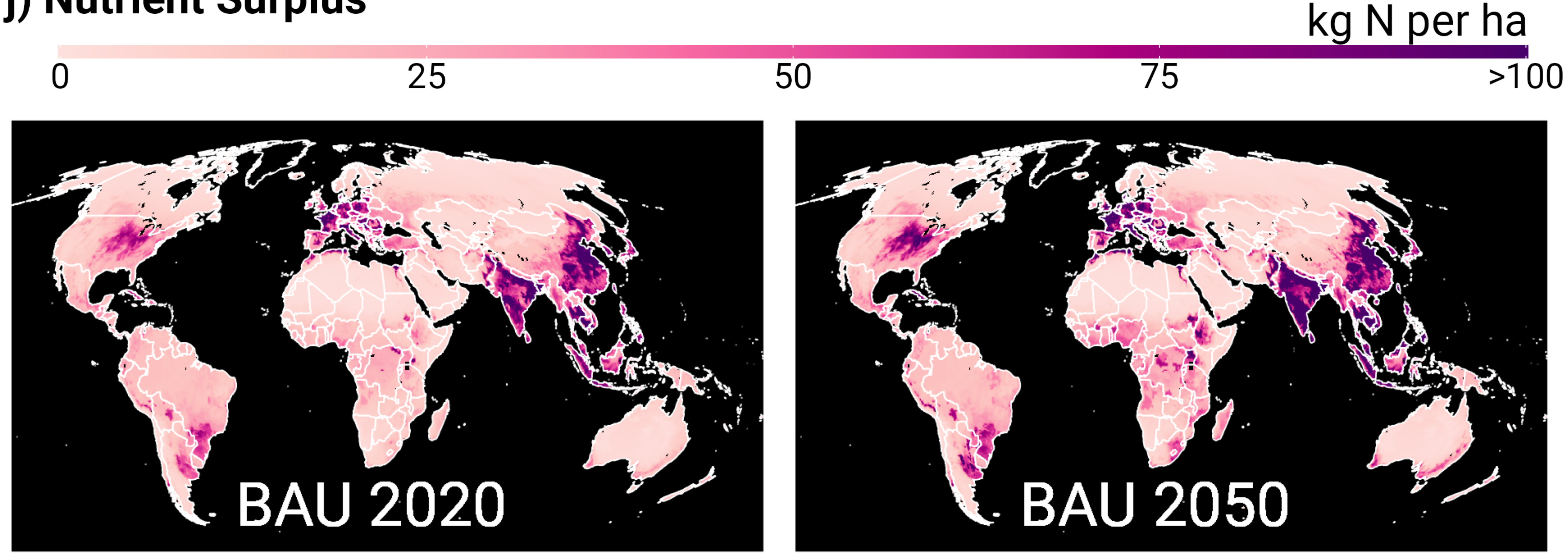
j) Nutrient Surplus



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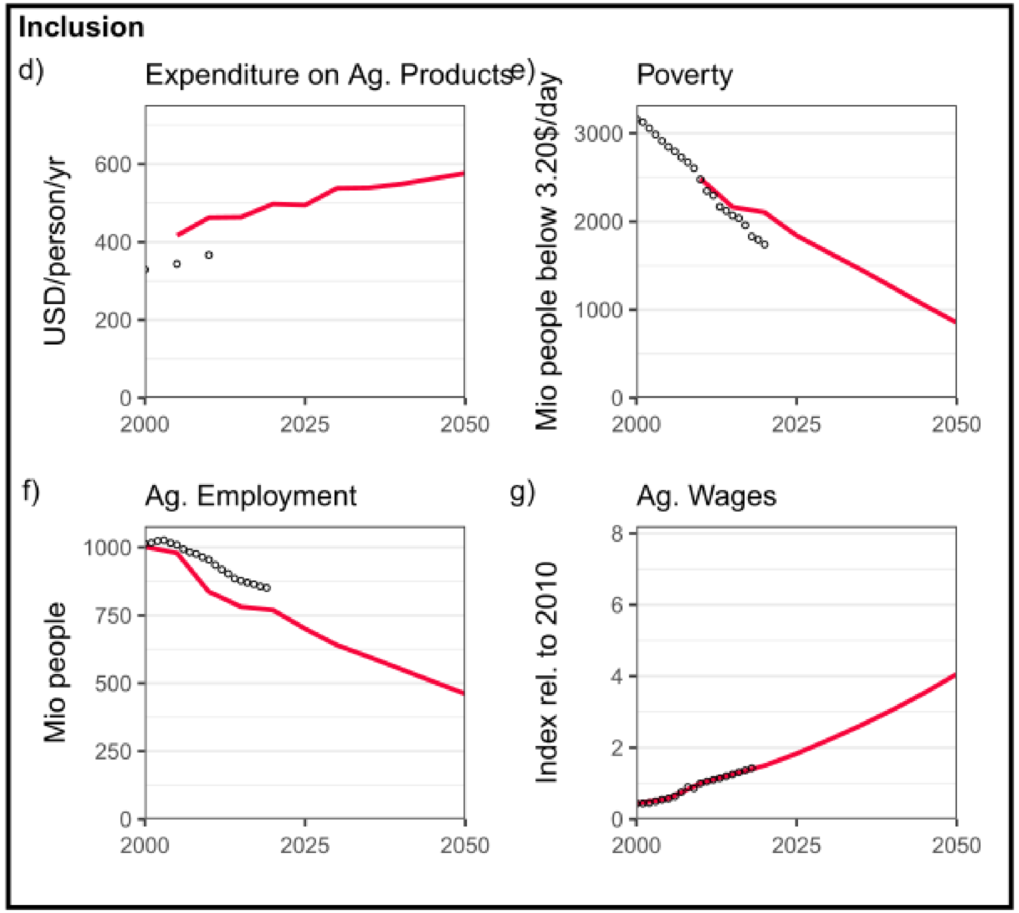
Baseline trends: Poverty is reduced, employment in agriculture falls, and the share of agriculture in the economy declines



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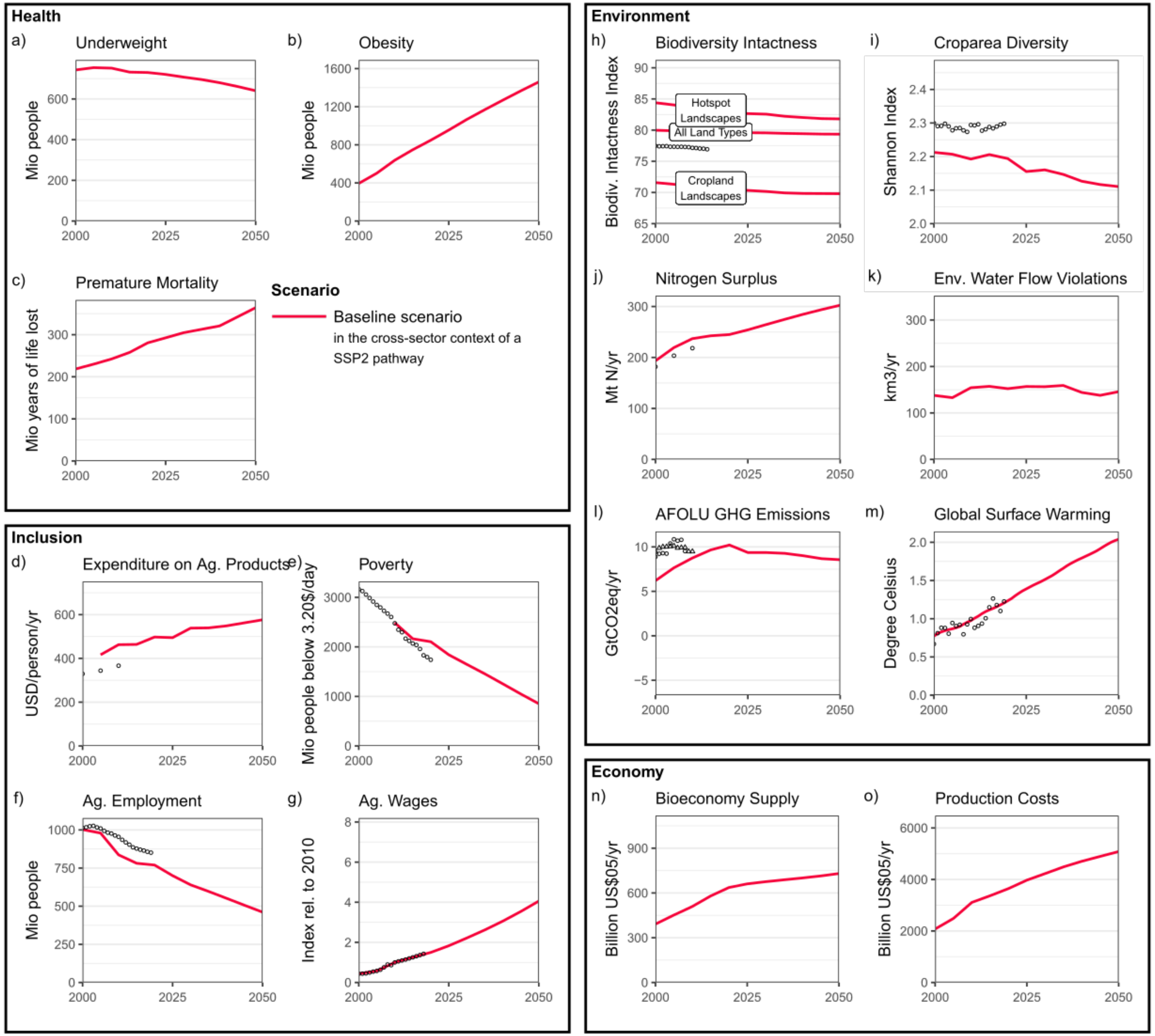


Our food system is not on track.

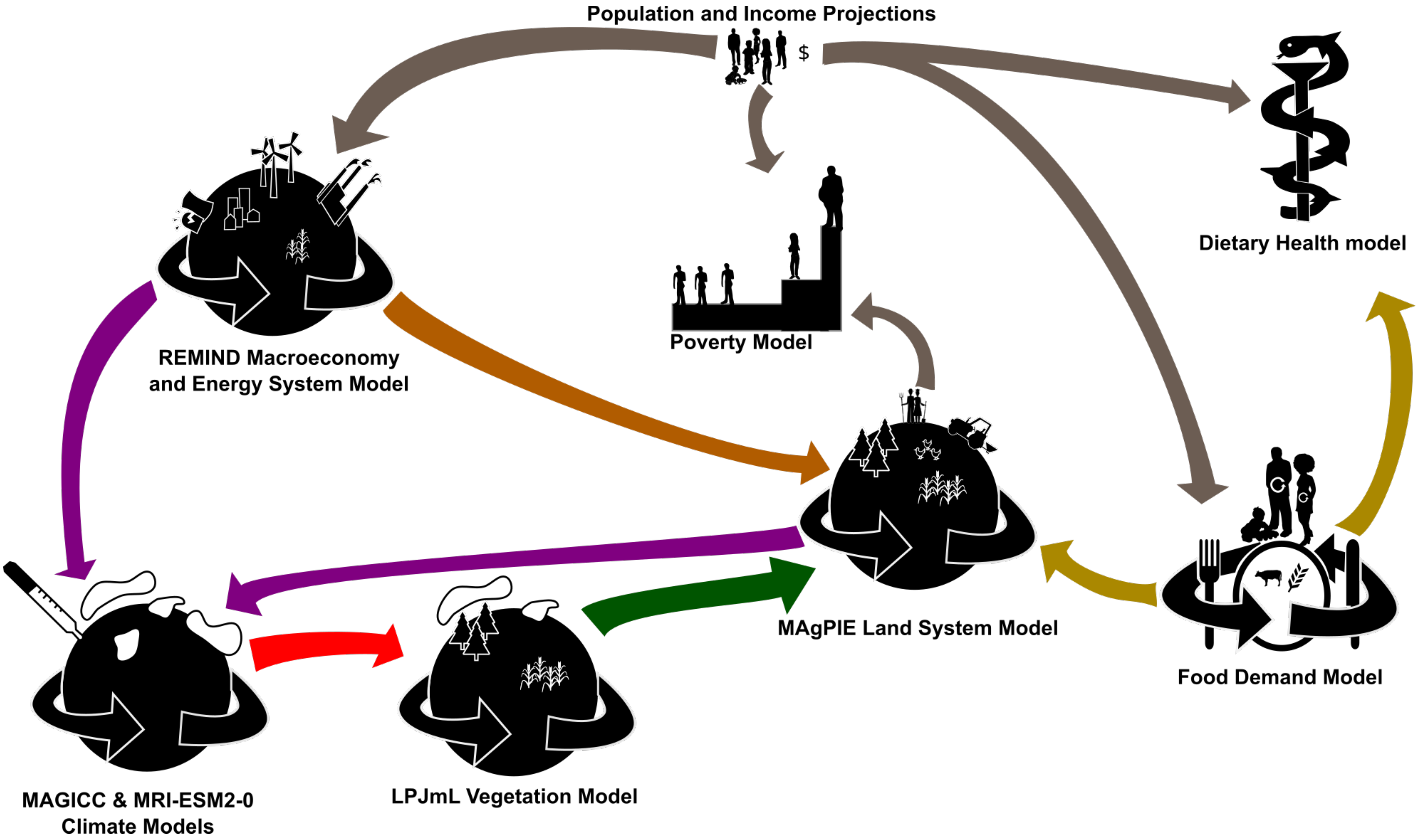
Sometimes it requires an acceleration of development, sometimes it requires a trend reversal.

Bodirsky et al (preprint)
https://dx.doi.org/10.21203/rs.3.rs-2928708/v1

We need a food system transformation.

How does such a transformation look like?
How does a sustainable food system look like?

Bodirsky et al (in prep)
Illustration: Jan von Holleben


Population and Income Projections
$
Dietary Health model
Poverty Model
REMIND Macroeconomy
and Energy System Model
MAgPIE Land System Model
Food Demand Model
MAGICC & MRI-ESM2-0
Climate Models
LPJmL Vegetation Model

nature food

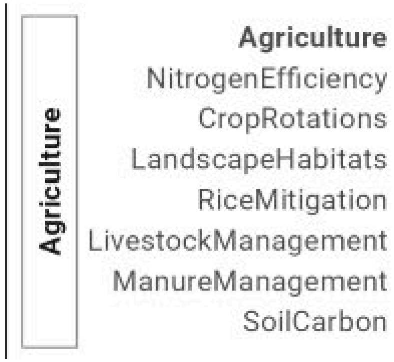
ARTICLES

https://doi.org/10.1038/s43016-022-00500-3

Integrating degrowth and efficiency perspectives enables an emission-neutral food system by 2100

Benjamin Leon Bodirsky[1,2,5], David Meng-Chuen Chen[1,3,5] ✉, Isabelle Weindl[1], Bjoern Soergel[1], Felicitas Beier[1,3], Edna J. Molina Bacca[1,3], Franziska Gaupp[1,4], Alexander Popp[1] and Hermann Lotze-Campen[1]

Degrowth proponents advocate reducing ecologically destructive forms of production and resource throughput in wealthy economies to achieve environmental goals, while transforming production to focus on human well-being. Here we present a quantitative model to test degrowth principles in the food and land system. Our results confirm that reducing and redistributing income alone, within current development paradigms, leads to limited greenhouse gas (GHG) emission mitigation from agriculture and land-use change, as the nutrition transition towards unsustainable diets already occurs at relatively low income levels. Instead, we show that a structural, qualitative food system transformation can achieve a steady-state food system economy that is net GHG-neutral by 2100 while improving nutritional outcomes. This sustainable transformation reduces material throughput via a convergence towards a needs-based food system, is enabled by a more equitable income distribution and includes efficient resource allocation through the pricing of GHG emissions as a complementary strategy. It thereby integrates degrowth and efficiency perspectives.



Bodirsky et al (preprint)
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	Health			Environment							Inclusion				Economy	
	Underweight Mio people	Obesity Mio people	Premature Mortality Mio years of life lost	Cropland Landscapes Biodiv. Intactness Index	Hotspot Landscapes Biodiv. Intactness Index	Croparea Diversity Shannon Index	Nitrogen Surplus Mt N/yr	Env. Water Flow Violations km3/yr	AFOLU GHG Emissions GtCO2eq/yr	Global Surface Warming Degree Celsius	Expenditure on Ag. Products USD/person/yr	Poverty Mio people below 3.20$/day	Ag. Employment Mio people	Ag. Wages Index rel. to 2010	Bioeconomy Supply Billion US$05/yr	Production Costs Billion US$05/yr
BASE_SSP2	640	1461	364	69.8	81.8	2.11	303	146	8.6	2.04	576	852	461	4.06	730	5084
Agriculture																
NitrogenEfficiency																
CropRotations																
LandscapeHabitats																
RiceMitigation																
LivestockManagement																
ManureManagement																
SoilCarbon																

Agriculture

Bodirsky et al (preprint)
https://dx.doi.org/10.21203/rs.3.rs-2928708/v1

Relative change: best / better / none / worse / worst

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	BASE_SSP2	640	1461	364	69.8	81.8	2.11	303	146	8.6	2.04	576	852	461	4.06	730	5084
Agriculture	NitrogenEfficiency				69.77	81.66	2.1	217	144	7.6	2.03	604	859	515	4.06	731	5329
	CropRotations				69.24	81.21	2.28	302	214	9.5	2.05	578	853	463	4.06	732	5159
	LandscapeHabitats				70.47	81.79	2.09	303	143	8.4	2.04	580	851	461	4.06	730	5091
	RiceMitigation				69.84	82.13	2.09	303	146	8.2	2.03	577	851	470	4.06	730	5119
	LivestockManagement				69.68	81.74	2	306	169	6	2	648	877	581	4.06	730	5710
	ManureManagement				69.83	81.77	2.09	297	145	7.9	2.03	591	855	484	4.06	732	5206
	SoilCarbon				69.67	82.91	2.06	304	169	5.5	2.02	584	856	461	4.06	730	5129

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Relative change: best, better, none, worse, worst

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BASE_SSP2	640	1461	364	69.8	81.8	2.11	303	146	8.6	2.04	576	852	461	4.06	730	5084
Biosphere																
REDD+				70.17	82.96	2.06	305	157	5.1	2.01	610	874	460	4.06	730	5153
LandConservation				69.75	82.88	2.08	303	165	8.3	2.04	588	854	461	4.06	730	5099
PeatlandRewetting				69.61	81.82	2.08	304	158	7.1	2.03	584	853	460	4.06	730	5114
WaterConservation				69.72	81.86	2.09	302	0	8.8	2.04	575	851	461	4.06	730	5100
BiodivOffset				70.43	82.86	2.09	305	150	7.6	2.03	589	861	461	4.06	730	5098

Bodirsky et al (preprint)
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Relative change: best / better / none / worse / worst

	Health			Environment							Inclusion				Economy	
	Underweight Mio people	Obesity Mio people	Premature Mortality Mio years of life lost	Cropland Landscapes Biodiv. Intactness Index	Hotspot Landscapes Biodiv. Intactness Index	Croparea Diversity Shannon Index	Nitrogen Surplus Mt N/yr	Env. Water Flow Violations km3/yr	AFOLU GHG Emissions GtCO2eq/yr	Global Surface Warming Degree Celsius	Expenditure on Ag. Products USD/person/yr	Poverty Mio people below 3.20$/day	Ag. Employment Mio people	Ag. Wages Index rel. to 2010	Bioeconomy Supply Billion US$05/yr	Production Costs Billion US$05/yr
BASE_SSP2	640	1461	364	69.8	81.8	2.11	303	146	8.6	2.04	576	852	461	4.06	730	5084
Diets																
Diets	0	730	163	70.46	82.67	2.35	222	104	1.4	1.94	350	796	376	4.06	718	3557
LowProcessed			318	69.86	81.85	2.09	303	139	8.5	2.04	540	844	462	4.06	731	4749
HighLegumes			340	69.7	81.73	2.14	301	154	8.7	2.04	592	857	462	4.06	724	5164
LowMonogastrics			356	70.01	82.33	2.17	277	125	7.5	2.03	478	829	392	4.06	740	4413
LowRuminants			355	70.37	82.4	2.15	263	146	2.5	1.96	470	811	395	4.06	739	4505
HighVegFruitsNuts			331	69.66	81.73	2.14	306	158	8.6	2.04	625	869	546	4.06	736	5471
HalfOverweight	640	730	327	69.96	82.04	2.1	296	138	8	2.04	557	847	450	4.06	724	4939
NoUnderweight	0	1461	224	69.76	81.84	2.08	305	153	8.6	2.04	588	855	471	4.06	733	5164
LowFoodWaste			364	70.03	82.2	2.13	286	134	7.3	2.03	520	838	425	4.06	708	4673

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		Health			Environment							Inclusion				Economy	
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	BASE_SSP2	640	1461	364	69.8	81.8	2.11	303	146	8.6	2.04	576	852	461	4.06	730	5084
Livelihoods	**Livelihoods**				70.06	82.32	2.12	299	140	7.6	2.03	702	856	397	7.08	730	5019
	LibTrade				69.95	82.2	2.13	298	146	7.6	2.03	556	834	435	4.06	729	4978
	MinWage				69.95	82.03	2.1	303	148	8.2	2.04	712	862	426	7.08	730	5067
	CapitalSubst				69.87	81.86	2.07	303	144	8.5	2.04	587	852	485	4.06	731	5206

Relative change: best, better, none, worse, worst

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Relative change: best / better / none / worse / worst

		Health			Environment							Inclusion				Economy	
		Underweight Mio people	Obesity Mio people	Premature Mortality Mio years of life lost	Cropland Landscapes Biodiv. Intactness Index	Hotspot Landscapes Biodiv. Intactness Index	Croparea Diversity Shannon Index	Nitrogen Surplus Mt N/yr	Env. Water Flow Violations km3/yr	AFOLU GHG Emissions GtCO2eq/yr	Global Surface Warming Degree Celsius	Expenditure on Ag. Products USD/person/yr	Poverty Mio people below 3.20$/day	Ag. Employment Mio people	Ag. Wages Index rel. to 2010	Bioeconomy Supply Billion US$05/yr	Production Costs Billion US$05/yr
	BASE_SSP2	640	1461	364	69.8	81.8	2.11	303	146	8.6	2.04	576	852	461	4.06	730	5084
Diets	**Diets**	0	730	163	70.46	82.67	2.35	222	104	1.4	1.94	350	796	376	4.06	718	3557
	LowProcessed			318	69.86	81.85	2.09	303	139	8.5	2.04	540	844	462	4.06	731	4749
	HighLegumes			340	69.7	81.73	2.14	301	154	8.7	2.04	592	857	462	4.06	724	5164
	LowMonogastrics			356	70.01	82.33	2.17	277	125	7.5	2.03	478	829	392	4.06	740	4413
	LowRuminants			355	70.37	82.4	2.15	263	146	2.5	1.96	470	811	395	4.06	739	4505
	HighVegFruitsNuts			331	69.66	81.73	2.14	306	158	8.6	2.04	625	869	546	4.06	736	5471
	HalfOverweight	640	730	327	69.96	82.04	2.1	296	138	8	2.04	557	847	450	4.06	724	4939
	NoUnderweight	0	1461	224	69.76	81.84	2.08	305	153	8.6	2.04	588	855	471	4.06	733	5164
	LowFoodWaste			364	70.03	82.2	2.13	286	134	7.3	2.03	520	838	425	4.06	708	4673
Livelihoods	**Livelihoods**				70.06	82.32	2.12	299	140	7.6	2.03	702	856	397	7.08	730	5019
	LibTrade				69.95	82.2	2.13	298	146	7.6	2.03	556	834	435	4.06	729	4978
	MinWage				69.95	82.03	2.1	303	148	8.2	2.04	712	862	426	7.08	730	5067
	CapitalSubst				69.87	81.86	2.07	303	144	8.5	2.04	587	852	485	4.06	731	5206
Biosphere	**Biosphere**				70.44	84.02	2.07	306	0	5	2.01	621	879	460	4.06	730	5251
	REDD+				70.17	82.96	2.06	305	157	5.1	2.01	610	874	460	4.06	730	5153
	LandConservation				69.75	82.88	2.08	303	165	8.3	2.04	588	854	461	4.06	730	5099
	PeatlandRewetting				69.61	81.82	2.08	304	158	7.1	2.03	584	853	460	4.06	730	5114
	WaterConservation				69.72	81.86	2.09	302	0	8.8	2.04	575	851	461	4.06	730	5100
	BiodivOffset				70.43	82.86	2.09	305	150	7.6	2.03	589	861	461	4.06	730	5098
Agriculture	**Agriculture**				70.54	82.53	2.14	217	336	1.7	1.96	716	905	669	4.06	731	6170
	NitrogenEfficiency				69.77	81.66	2.1	217	144	7.6	2.03	604	859	515	4.06	731	5329
	CropRotations				69.24	81.21	2.28	302	214	9.5	2.05	578	853	463	4.06	732	5159
	LandscapeHabitats				70.47	81.79	2.09	303	143	8.4	2.04	580	851	461	4.06	730	5091
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	ManureManagement				69.83	81.77	2.09	297	145	7.9	2.03	591	855	484	4.06	732	5206
	SoilCarbon				69.67	82.91	2.06	304	169	5.5	2.02	584	856	461	4.06	730	5129
	FST_SSP2	0	730	144	70.9	84.9	2.46	171	0	-5.6	1.86	539	835	385	7.08	718	4011

Bodirsky et al (preprint)
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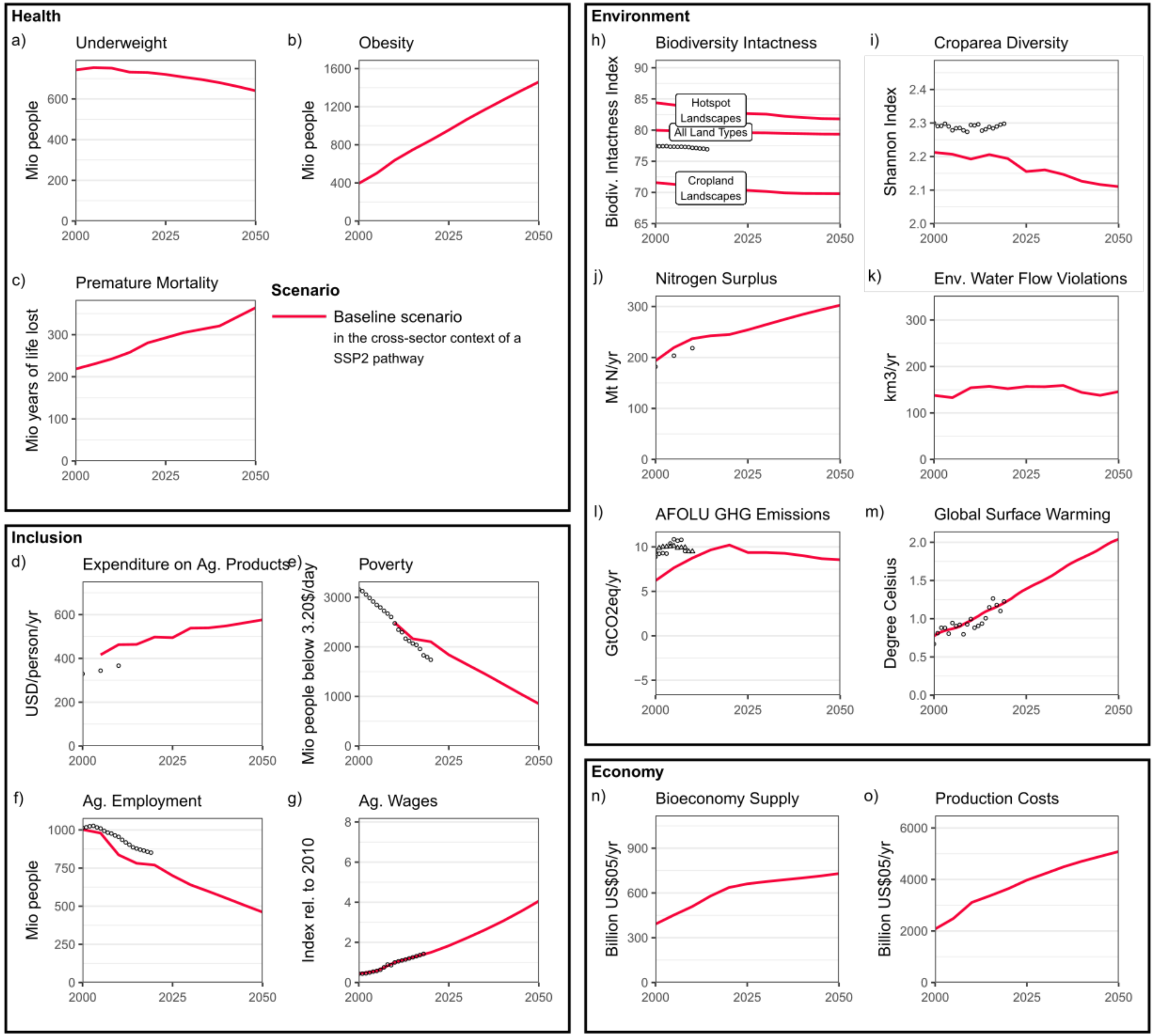

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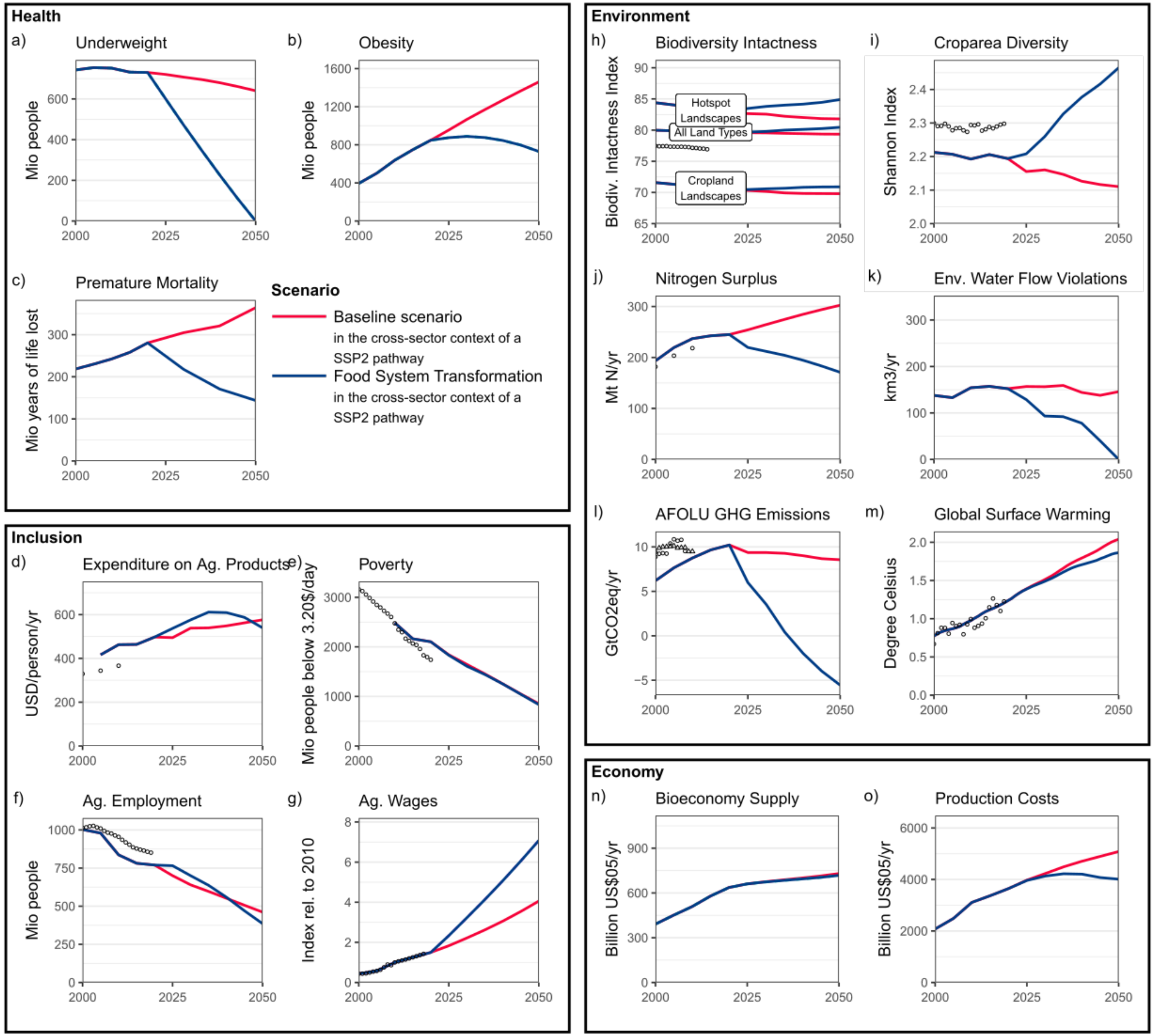

Food System Transformation achieves

- *Large improvement of dietary health*
- *Reduction of environmental impacts*
- *Similar employment but higher wages*
- *Similar poverty*

But:

- *Cannot stop climate change alone*
- *Cannot reduce poverty*

Bodirsky et al (preprint)
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Relative change: best / better / none / worse / worst

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		Underweight Mio people	Obesity Mio people	Premature Mortality Mio years of life lost	Cropland Landscapes Biodiv. Intactness Index	Hotspot Landscapes Biodiv. Intactness Index	Croparea Diversity Shannon Index	Nitrogen Surplus Mt N/yr	Env. Water Flow Violations km3/yr	AFOLU GHG Emissions GtCO2eq/yr	Global Surface Warming Degree Celsius	Expenditure on Ag. Products USD/person/yr	Poverty Mio people below 3.20$/day	Ag. Employment Mio people	Ag. Wages Index rel. to 2010	Bioeconomy Supply Billion US$05/yr	Production Costs Billion US$05/yr
	BASE_SSP2	640	1461	364	69.8	81.8	2.11	303	146	8.6	2.04	576	852	461	4.06	730	5084
CrossSector	**CrossSector**	530	1610	238	69.7	81.52	2.07	274	172	7.1	1.74	549	242	346	5.71	1065	5555
	Population	606	1446	407	69.87	82.15	2.12	294	142	7.3		582	854	431	4.06	719	4883
	HumanDevelop	556	1633	215	69.62	81.74	2.16	270	142	9		544	241	318	5.71	716	4975
	EnergyTrans				69.85	81.65	2.01	326	166	9	1.73	574	849	528	4.06	988	5786
	Bioplastics				69.79	81.82	2.08	307	153	8.6		576	850	472	4.06	782	5195
	TimberCities				69.8	81.86	2.09	303	148	7.7		582	853	461	4.06	794	5213

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Relative change: best, better, none, worse, worst

	Health: Underweight (Mio people)	Health: Obesity (Mio people)	Health: Premature Mortality (Mio years of life lost)	Environment: Cropland Landscapes Biodiv. Intactness Index	Environment: Hotspot Landscapes Biodiv. Intactness Index	Environment: Croparea Diversity Shannon Index	Environment: Nitrogen Surplus Mt N/yr	Environment: Env. Water Flow Violations km3/yr	Environment: AFOLU GHG Emissions GtCO2eq/yr	Environment: Global Surface Warming Degree Celsius	Inclusion: Expenditure on Ag. Products USD/person/yr	Inclusion: Poverty Mio people below 3.20$/day	Inclusion: Ag. Employment Mio people	Inclusion: Ag. Wages Index rel. to 2010	Economy: Bioeconomy Supply Billion US$05/yr	Economy: Production Costs Billion US$05/yr
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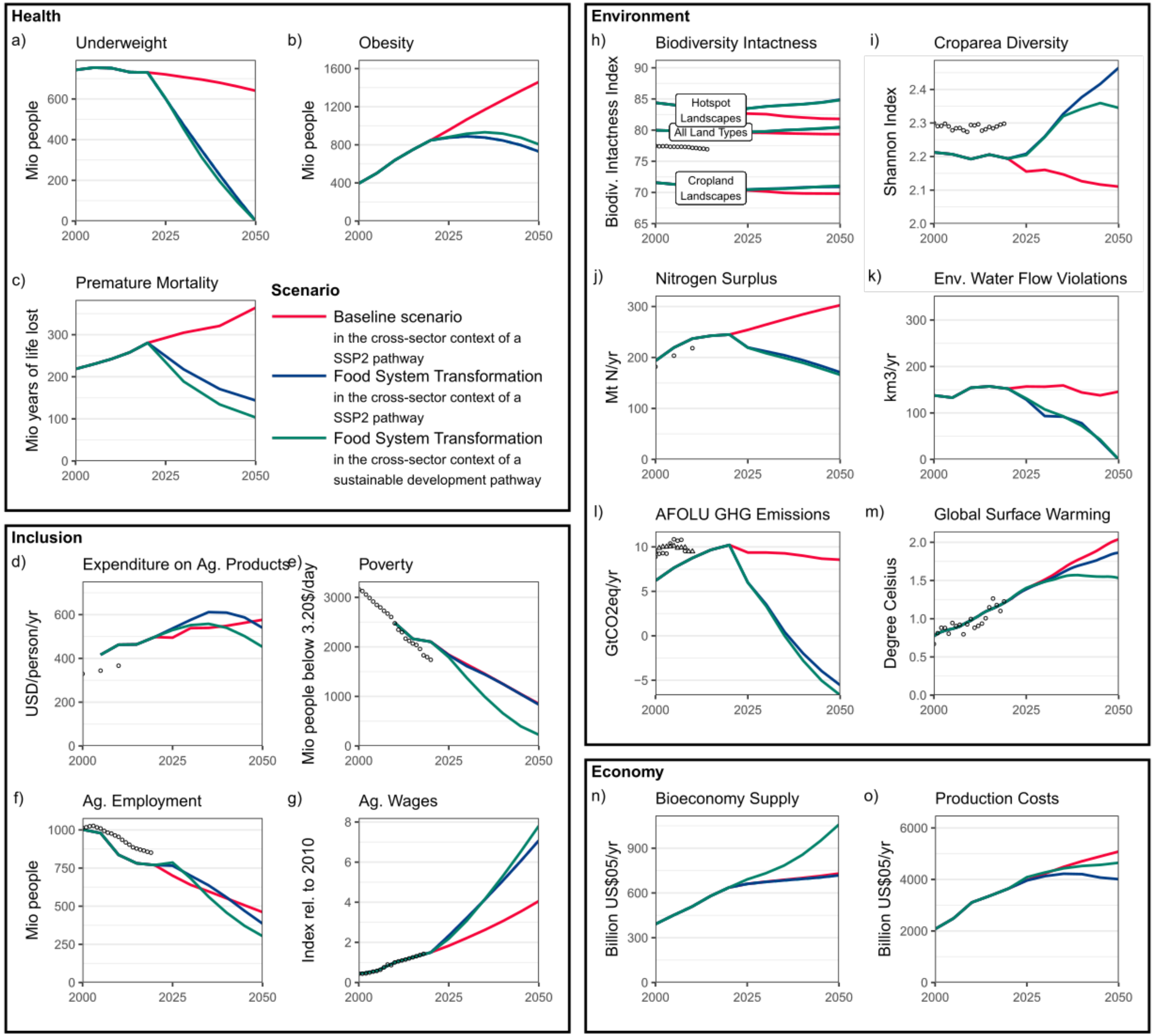
LowFoodWaste			364	70.03	82.2	2.13	286	134	7.3	2.03	520	838	425	4.06	708	4673
Livelihoods																
Livelihoods				70.06	82.32	2.12	299	140	7.6	2.03	702	856	397	7.08	730	5019
LibTrade				69.95	82.2	2.13	298	146	7.6	2.03	556	834	435	4.06	729	4978
MinWage				69.95	82.03	2.1	303	148	8.2	2.04	712	862	426	7.08	730	5067
CapitalSubst				69.87	81.86	2.07	303	144	8.5	2.04	587	852	485	4.06	731	5206
Biosphere																
Biosphere				70.44	84.02	2.07	306	0	5	2.01	621	879	460	4.06	730	5251
REDD+				70.17	82.96	2.06	305	157	5.1	2.01	610	874	460	4.06	730	5153
LandConservation				69.75	82.88	2.08	303	165	8.3	2.04	588	854	461	4.06	730	5099
PeatlandRewetting				69.61	81.82	2.08	304	158	7.1	2.03	584	853	460	4.06	730	5114
WaterConservation				69.72	81.86	2.09	302	0	8.8	2.04	575	851	461	4.06	730	5100
BiodivOffset				70.43	82.86	2.09	305	150	7.6	2.03	589	861	461	4.06	730	5098
Agriculture																
Agriculture				70.54	82.53	2.14	217	336	1.7	1.96	716	905	669	4.06	731	6170
NitrogenEfficiency				69.77	81.66	2.1	217	144	7.6	2.03	604	859	515	4.06	731	5329
CropRotations				69.24	81.21	2.28	302	214	9.5	2.05	578	853	463	4.06	732	5159
LandscapeHabitats				70.47	81.79	2.09	303	143	8.4	2.04	580	851	461	4.06	730	5091
RiceMitigation				69.84	82.13	2.09	303	146	8.2	2.03	577	851	470	4.06	730	5119
LivestockManagement				69.68	81.74	2	306	169	6	2	648	877	581	4.06	730	5710
ManureManagement				69.83	81.77	2.09	297	145	7.9	2.03	591	855	484	4.06	732	5206
SoilCarbon				69.67	82.91	2.06	304	169	5.5	2.02	584	856	461	4.06	730	5129
FST_SSP2	0	730	144	70.9	84.9	2.46	171	0	-5.6	1.86	539	835	385	7.08	718	4011
CrossSector																
CrossSector	530	1610	238	69.7	81.52	2.07	274	172	7.1	1.74	549	242	346	5.71	1065	5555
Population	606	1446	407	69.87	82.15	2.12	294	142	7.3		582	854	431	4.06	719	4883
HumanDevelop	556	1633	215	69.62	81.74	2.16	270	142	9		544	241	318	5.71	716	4975
EnergyTrans				69.85	81.65	2.01	326	166	9	1.73	574	849	528	4.06	988	5786
Bioplastics				69.79	81.82	2.08	307	153	8.6		576	850	472	4.06	782	5195
TimberCities				69.8	81.86	2.09	303	148	7.7		582	853	461	4.06	794	5213
FST_SDP	0	805	103	71.06	84.81	2.35	166	0	-6.7	1.53	452	225	304	7.81	1059	4649

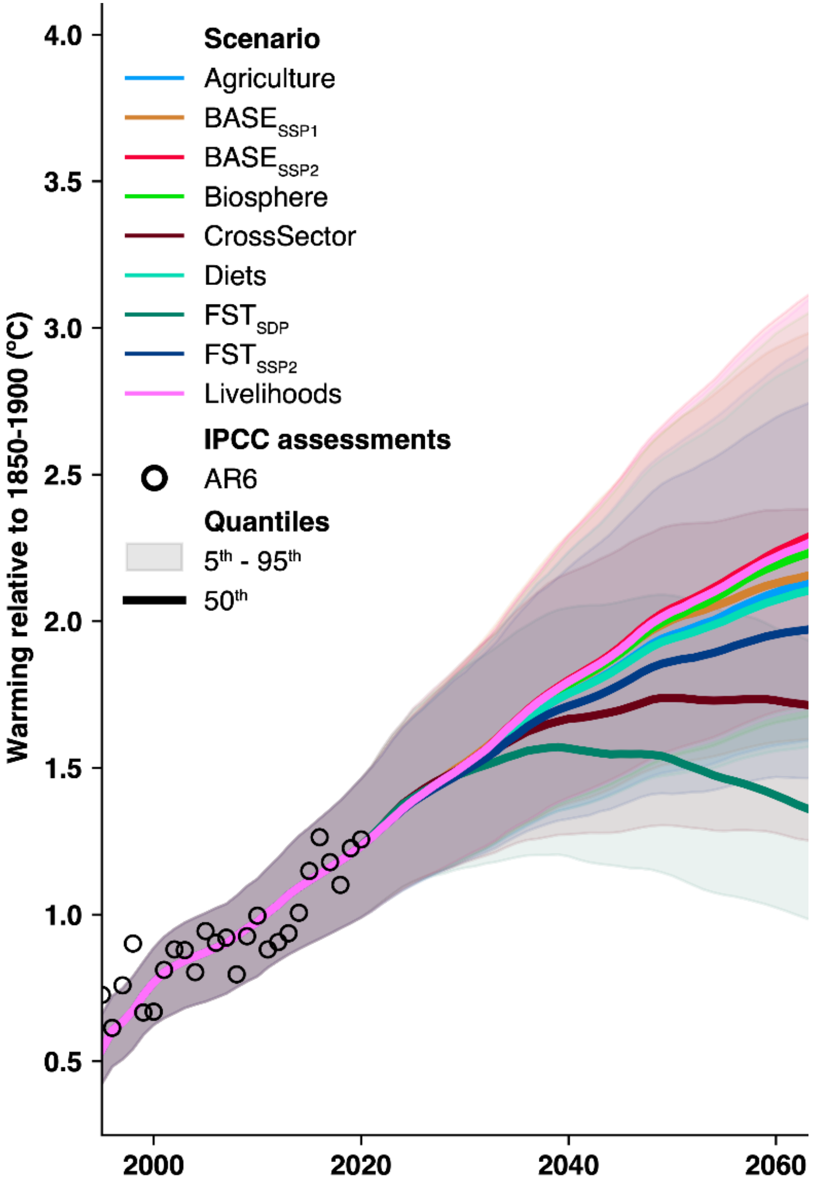
Bodirsky et al (preprint)
https://dx.doi.org/10.21203/rs.3.rs-2928708/v1



In combination with cross-sectoral impacts from a general sustainable development pathway

- *Climate change can be limited to 1.5°*
- *Poverty can be drastically reduced*
- *Employment in agriculture falls even faster*

Bodirsky et al (preprint)
https://dx.doi.org/10.21203/rs.3.rs-2928708/v1



Global warming relative to 1850-1900 from MAGICC7.5.3 for key scenarios until 2100. Lines represent median value across 600 runs of the MAGICC reduced-complexity climate model. Ribbons represent 5th-95th percentiles.

Baseline

Only FST

Cross-sector sustainable development without FST

FST within cross-sector sustainable development

Limitations

- 28 measures * 15 indicators = 420 interactions
- Feedback from nature via ecosystem services not included
- Distributional impacts of farmer income and employment changes not included
- Health impacts mostly focus on dietary non-communicable diseases

- We do not specify the policy instruments
- We don’t say something about the political economy required
  - But we show that bundling can create win-wins

Bodirsky et al (in prep)
Illustration: Jan von Holleben

Conclusions

1) We need visions of sustainable food systems.
   - Stimulates an informed debate
   - Provides orientation
   - Motivates actors
   - Forms expectations
2) All measures have co-benefits and trade-offs
   - Explains inertness of the system
3) Combinations of measures can create win-win solutions.
   This can also facilitate change.
4) In our sustainable visions, dietary change played a central role
   - It reduced environmental impacts
   - It reduces pressure in the food system
5) A sustainable food system is possible
   - But it requires a system-wide transformation

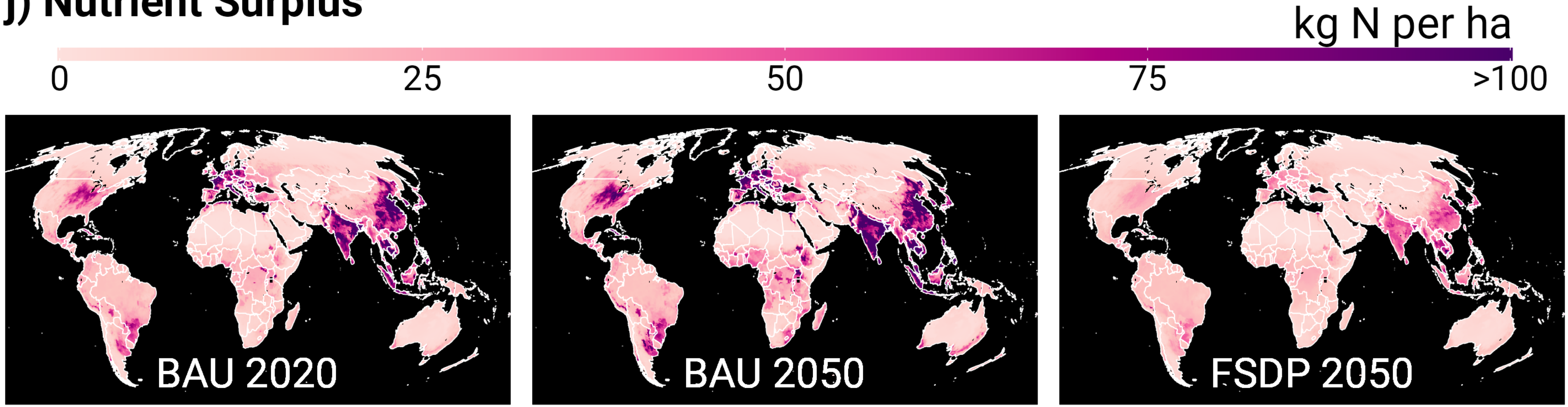
Bodirsky et al (in prep)
Illustration: Jan von Holleben

Vielen Dank!

bodirsky@pik-potsdam.de

Backup slides

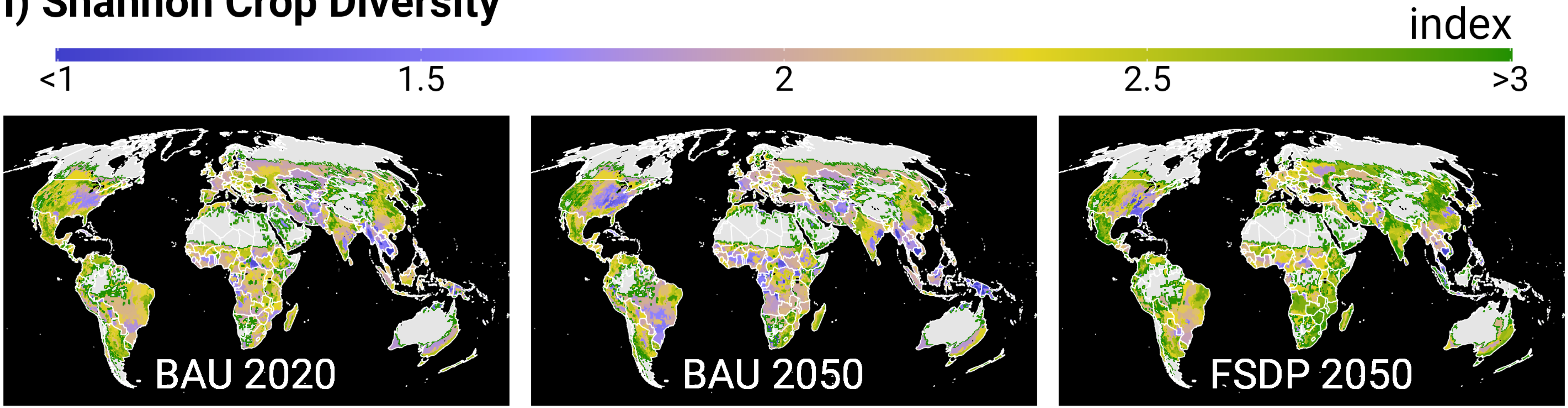
j) Nutrient Surplus



Data range: 0 to 547

Projection: Mollweide

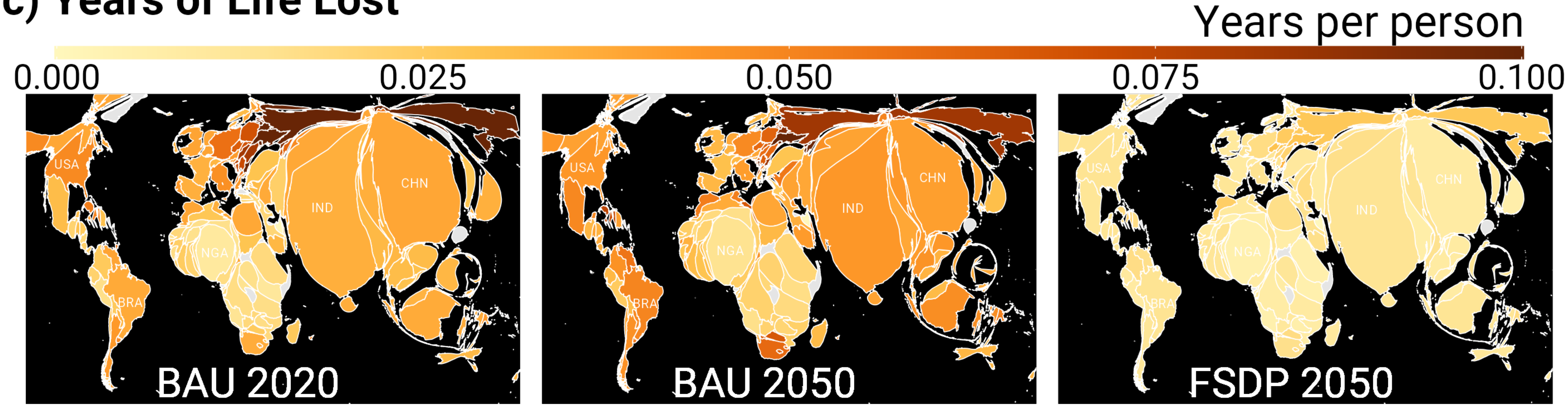
i) Shannon Crop Diversity



Data range: 0.01 to 3.27

Projection: Mollweide

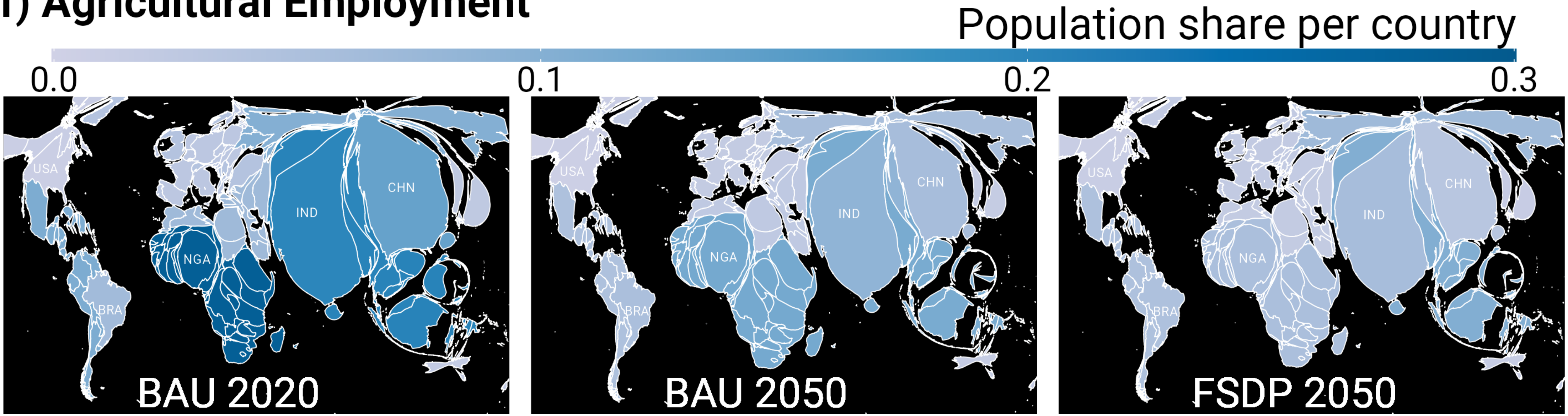
c) Years of Life Lost



Data range: 0 to 0.16

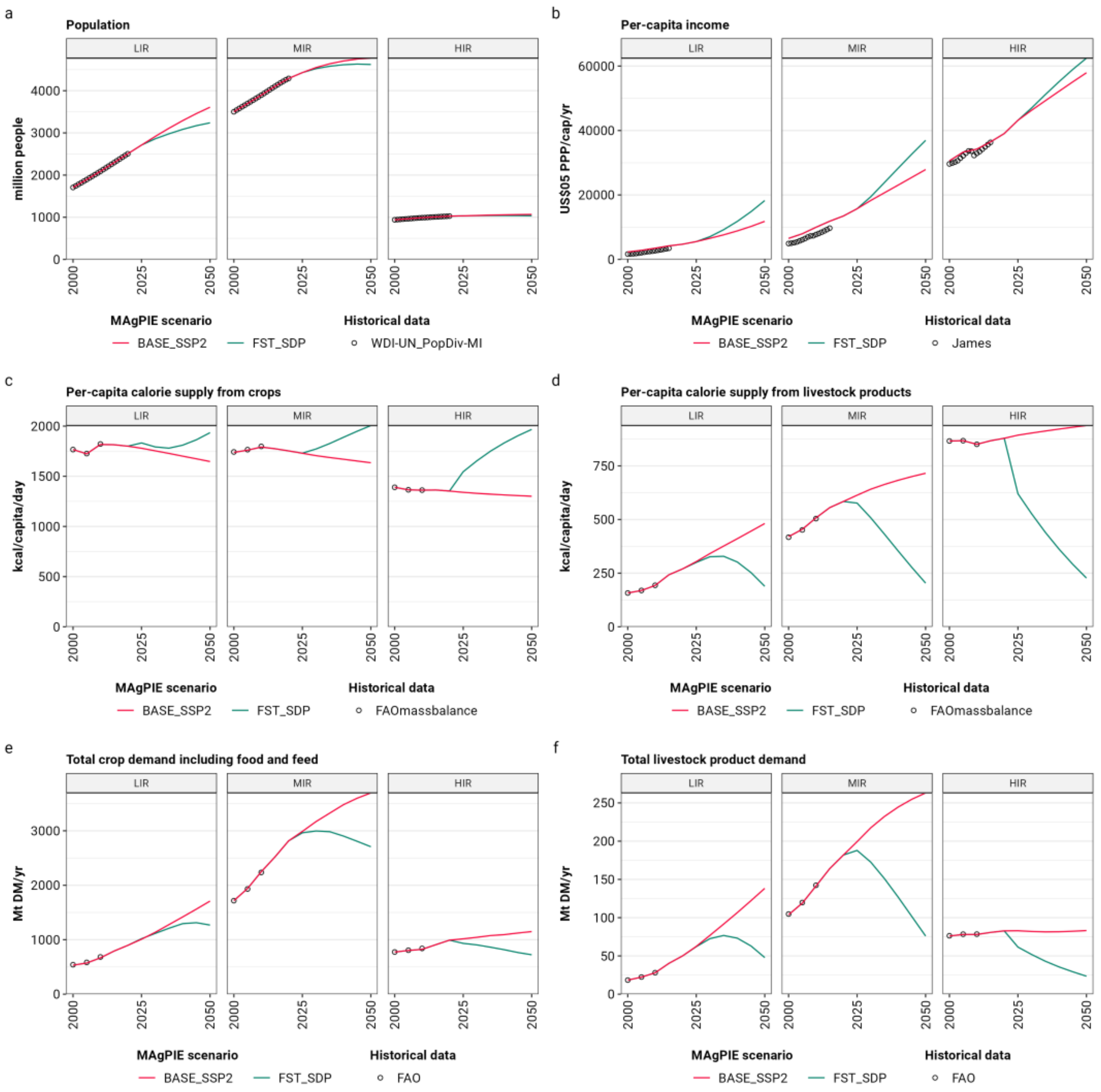
Cartogram projections with areas proportional to population

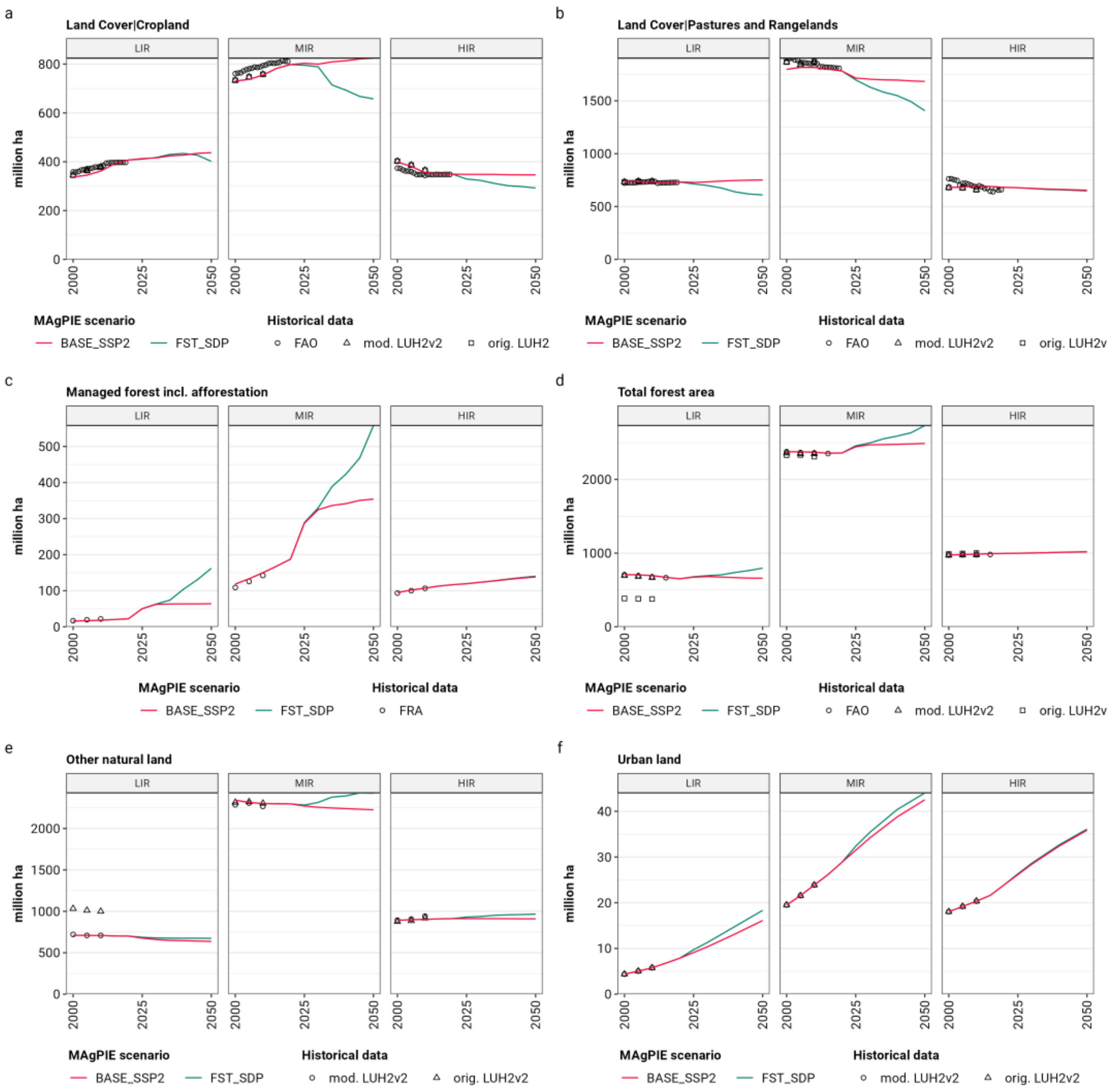
f) Agricultural Employment

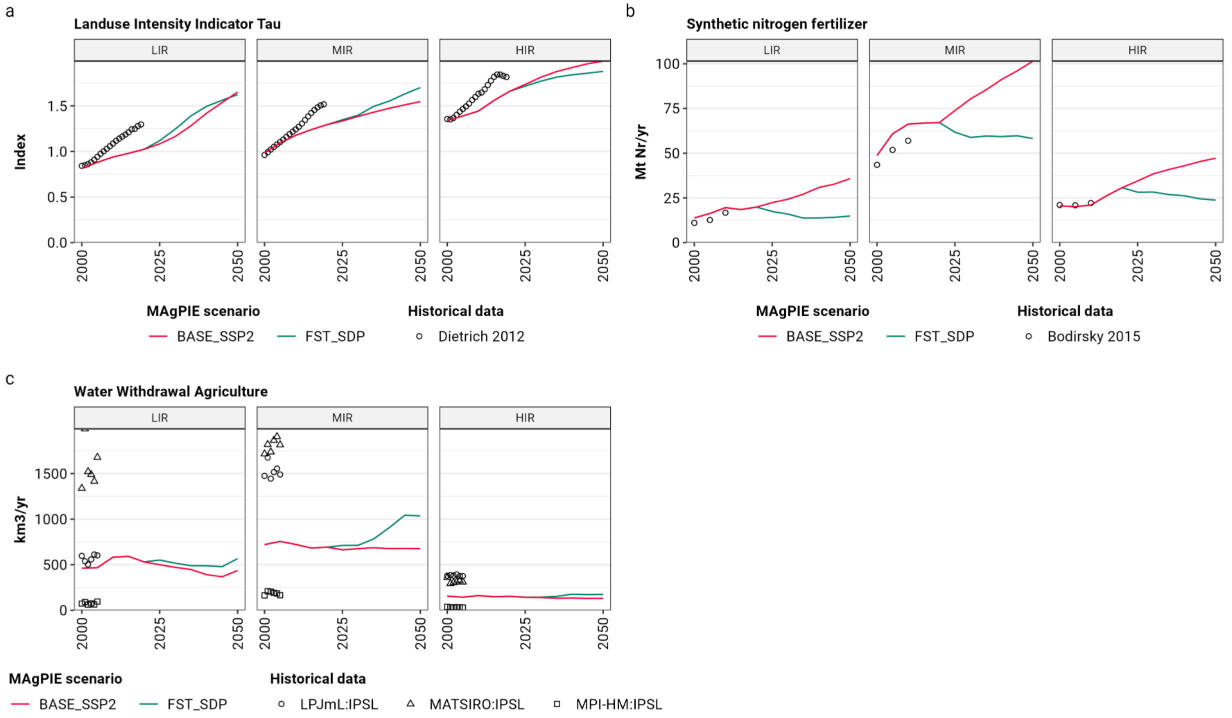


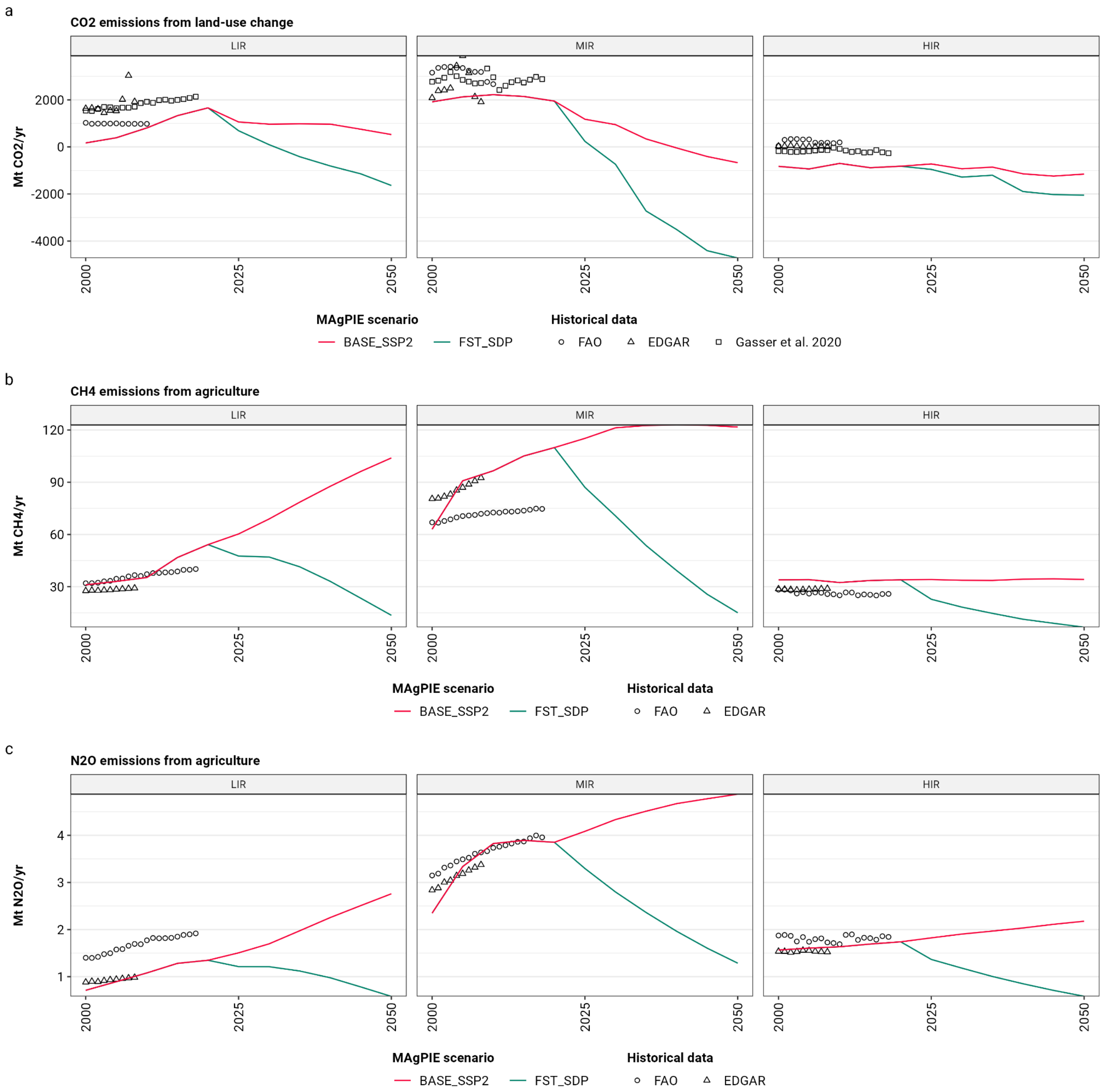
Data range: 0.01 to 0.28

Cartogram projections with areas proportional to population

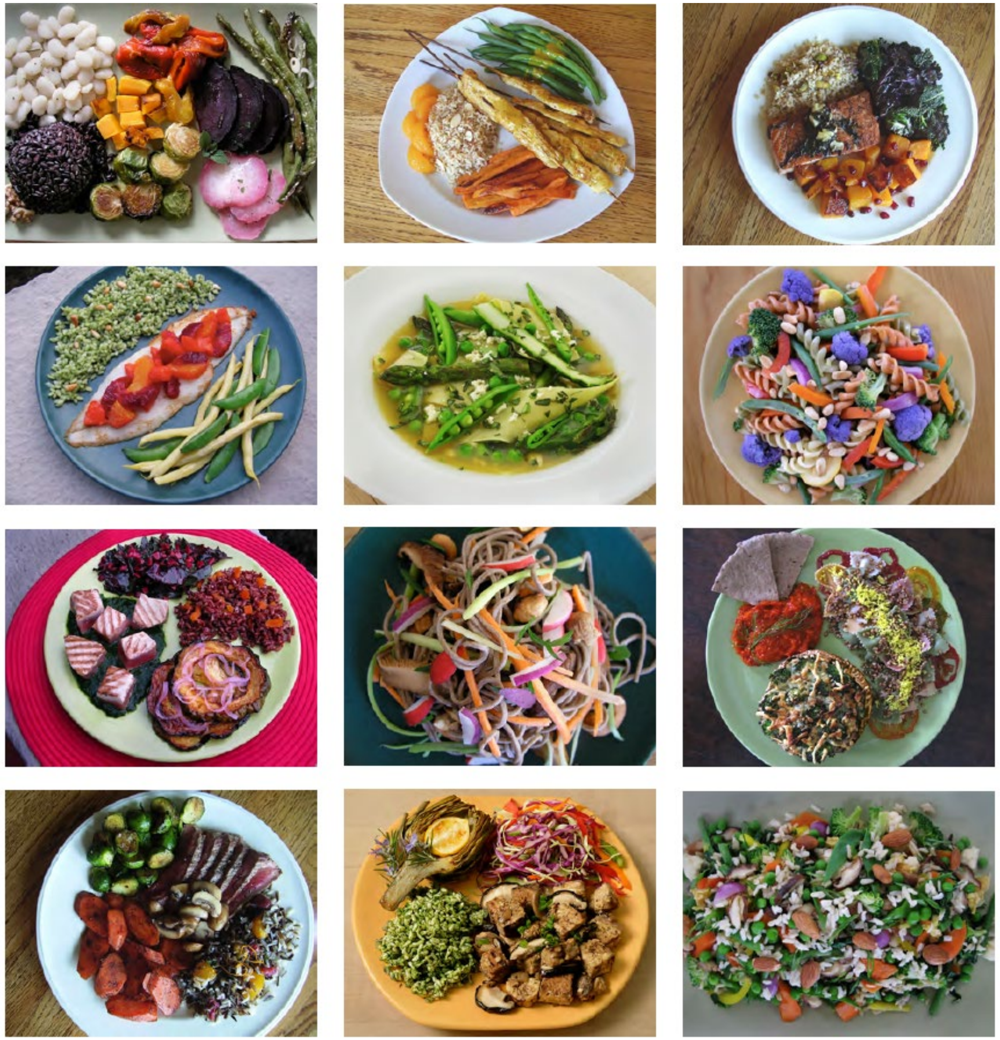

a
Population
LIR
MIR
HIR
million people
MAgPIE scenario
BASE_SSP2
FST_SDP
Historical data
WDI-UN_PopDiv-MI
b
Per-capita income
US$05 PPP/cap/yr
James
c
Per-capita calorie supply from crops
kcal/capita/day
FAOmassbalance
d
Per-capita calorie supply from livestock products
e
Total crop demand including food and feed
Mt DM/yr
FAO
f
Total livestock product demand


a
Land Cover|Cropland
LIR
MIR
HIR
million ha
0
200
400
600
800
2000
2025
2050
MAgPIE scenario
BASE_SSP2
FST_SDP
Historical data
FAO
mod. LUH2v2
orig. LUH2
b
Land Cover|Pastures and Rangelands
0
500
1000
1500
MAgPIE scenario
BASE_SSP2
FST_SDP
Historical data
FAO
mod. LUH2v2
orig. LUH2v
c
Managed forest incl. afforestation
0
100
200
300
400
500
MAgPIE scenario
BASE_SSP2
FST_SDP
Historical data
FRA
d
Total forest area
0
1000
2000
MAgPIE scenario
BASE_SSP2
FST_SDP
Historical data
FAO
mod. LUH2v2
orig. LUH2v
e
Other natural land
0
500
1000
1500
2000
MAgPIE scenario
BASE_SSP2
FST_SDP
Historical data
mod. LUH2v2
orig. LUH2v2
f
Urban land
0
10
20
30
40
MAgPIE scenario
BASE_SSP2
FST_SDP
Historical data
mod. LUH2v2
orig. LUH2v2

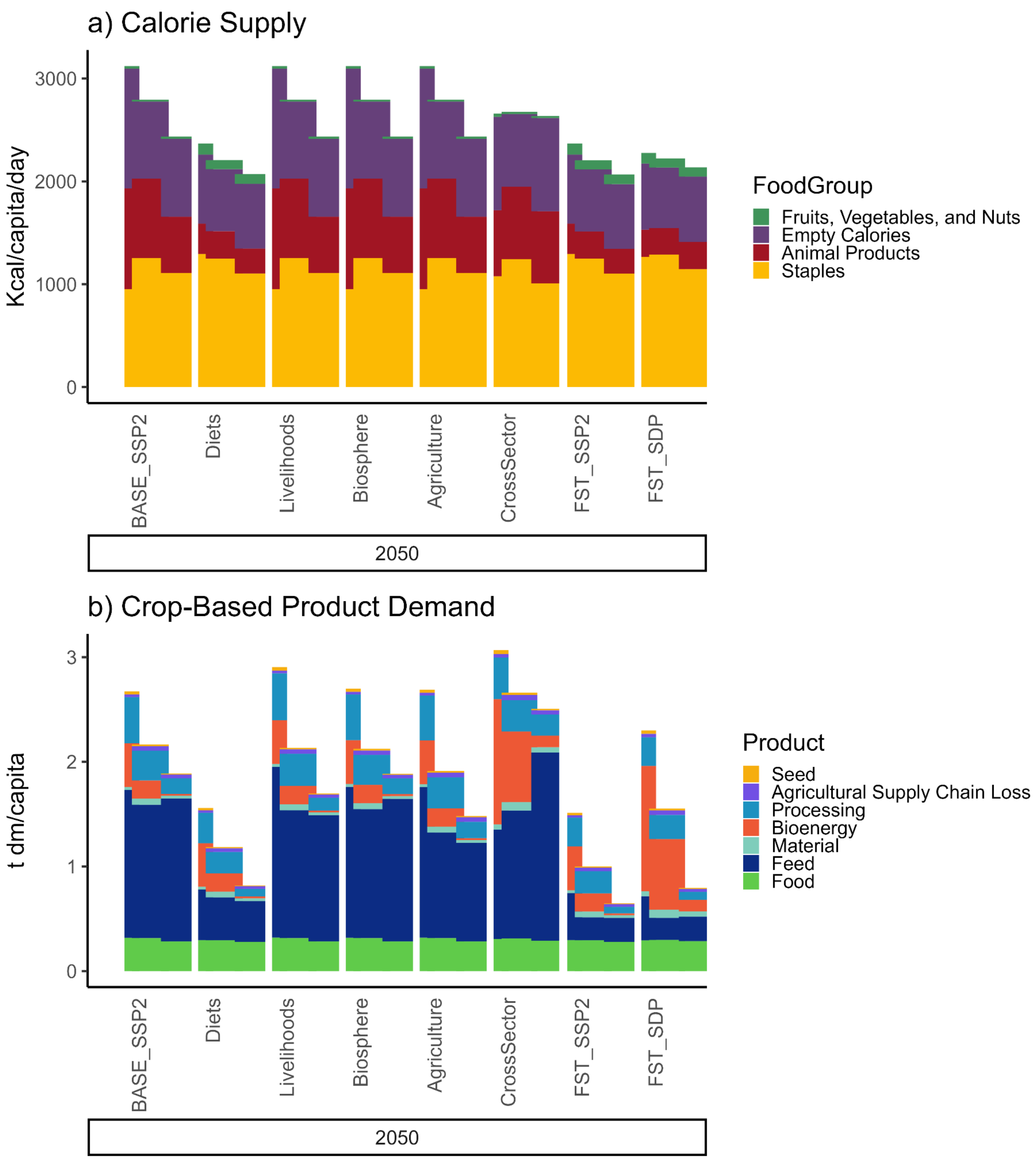

a
Landuse Intensity Indicator Tau
LIR
MIR
HIR
Index
0.0
0.5
1.0
1.5
2000
2025
2050
MAgPIE scenario
BASE_SSP2
FST_SDP
Historical data
Dietrich 2012
b
Synthetic nitrogen fertilizer
Mt Nr/yr
0
25
50
75
100
Bodirsky 2015
c
Water Withdrawal Agriculture
km3/yr
0
500
1000
1500
LPJmL:IPSL
MATSIRO:IPSL
MPI-HM:IPSL


a
CO2 emissions from land-use change
LIR
MIR
HIR
Mt CO2/yr
2000
0
-2000
-4000
2000
2025
2050
MAgPIE scenario
BASE_SSP2
FST_SDP
Historical data
FAO
EDGAR
Gasser et al. 2020
b
CH4 emissions from agriculture
LIR
MIR
HIR
Mt CH4/yr
120
90
60
30
2000
2025
2050
MAgPIE scenario
BASE_SSP2
FST_SDP
Historical data
FAO
EDGAR
c
N2O emissions from agriculture
LIR
MIR
HIR
Mt N2O/yr
4
3
2
1
2000
2025
2050
MAgPIE scenario
BASE_SSP2
FST_SDP
Historical data
FAO
EDGAR

EAT-Lancet: Eine gesunde UND nachhaltige Ernährung



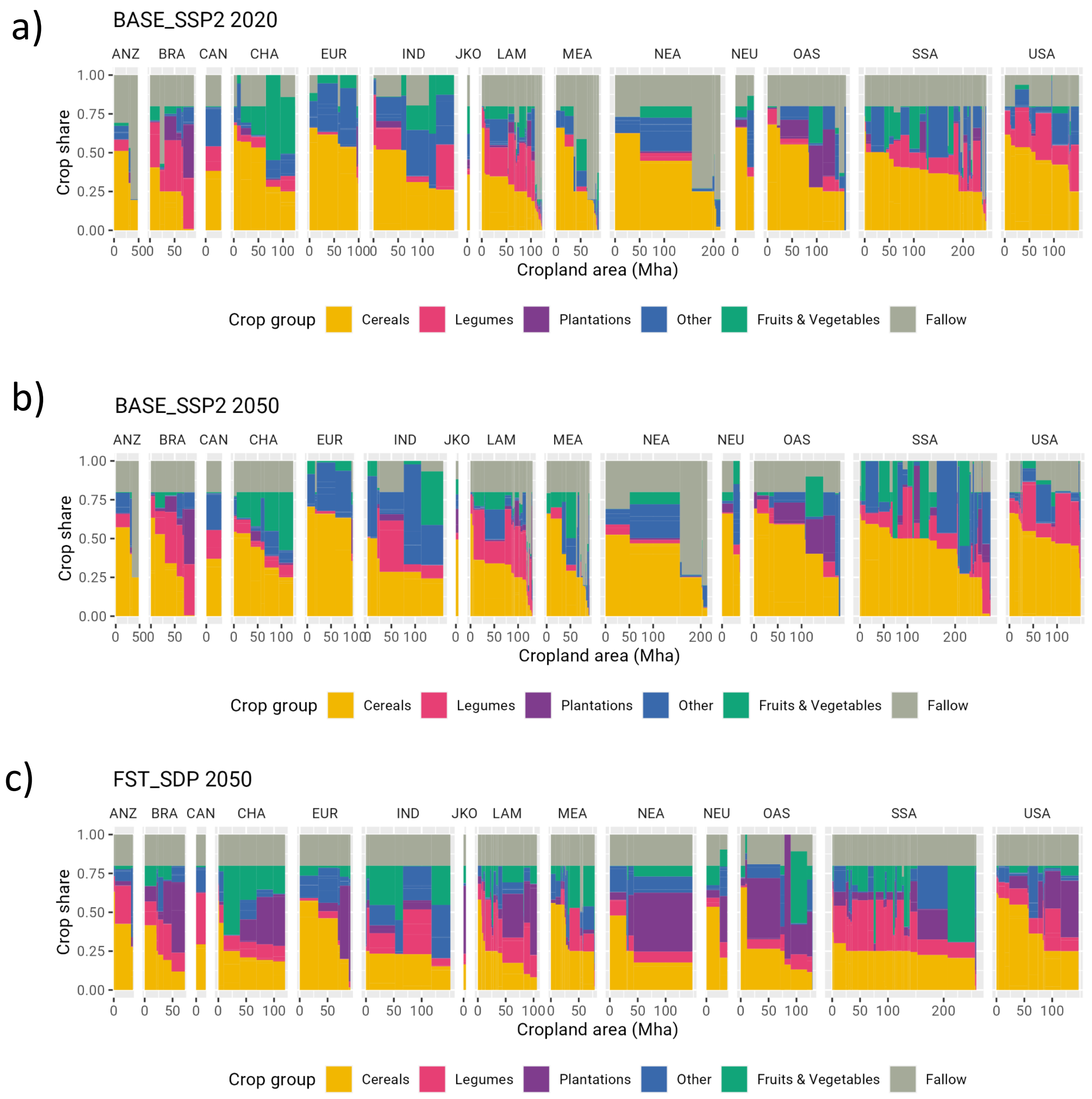
EAT-Lancet Commission 2019



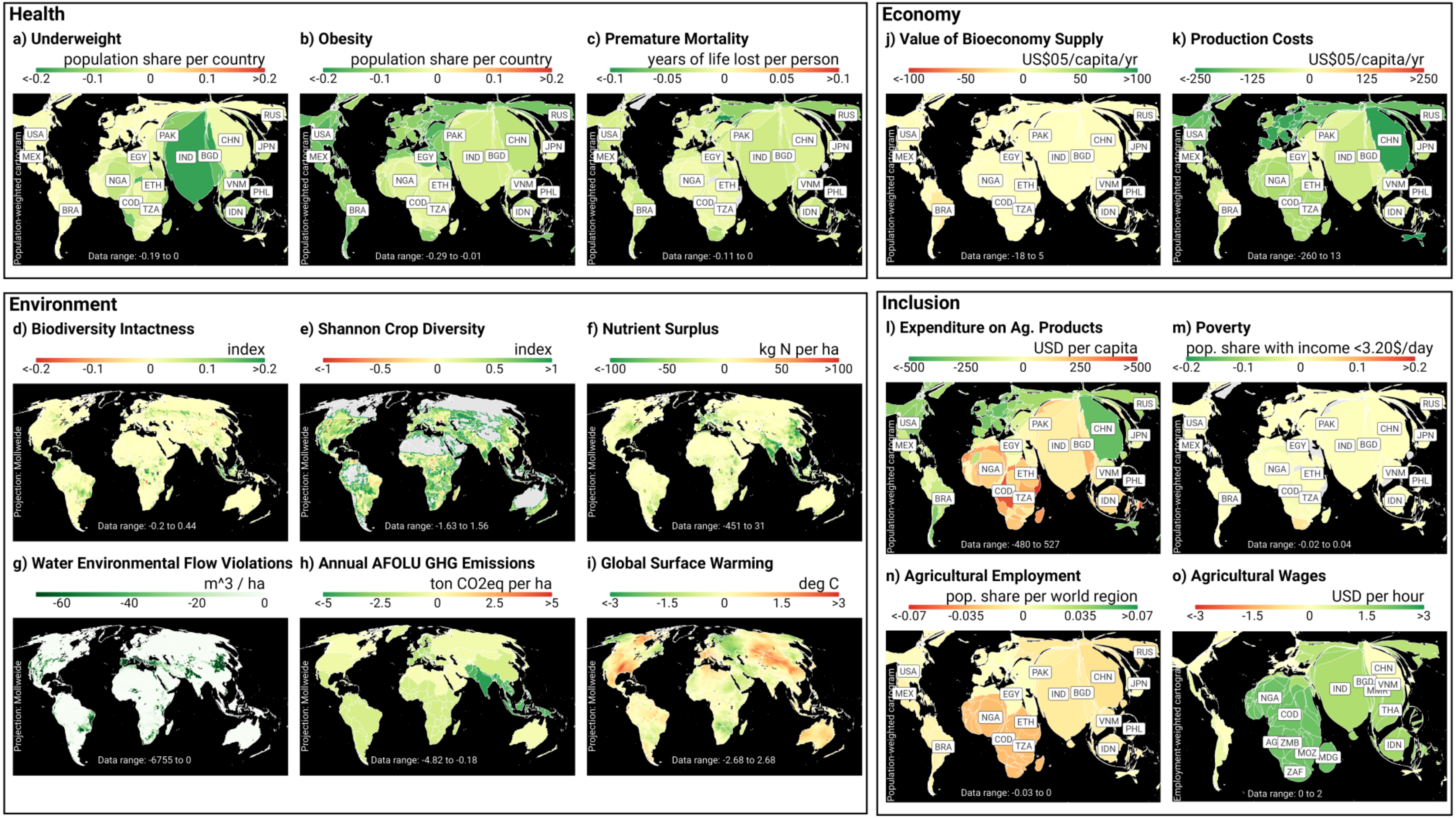
a) Per-capita food demand by product in kcal per capita per day and

b) crop-based product demand by utilization category in t DM per capita per year.

Grouped bars include, from left to right, the average values for current low-income, middle-income, and high-income world regions (see S1.1.1). Bar width indicates the population size of these groups. Grouped bars are arranged by scenario and year.



Croparea composition for (a) the scenario $BASE_{SSP2}$ in the year 2020, (b) in the year 2050, and (c) for the scenario FST_{SDP} in the year 2050. Y-axis shows the shares of major crop groups within the crop area of a cluster cell, and x-Axis shows the size of a cluster cell within major world regions (see section S1.1.1). Plantations include grassy and woody cellulosic bioenergy plants, oilpalms and sugar cane. Other crops include for example roots and forage crops.


Health
a) Underweight
population share per country
<-0.2 -0.1 0 0.1 >0.2
Population-weighted cartogram
USA MEX BRA PAK EGY IND BGD CHN RUS JPN NGA ETH COD TZA VNM PHL IDN
Data range: -0.19 to 0
b) Obesity
population share per country
<-0.2 -0.1 0 0.1 >0.2
Data range: -0.29 to -0.01
c) Premature Mortality
years of life lost per person
<-0.1 -0.05 0 0.05 >0.1
Data range: -0.11 to 0
Economy
j) Value of Bioeconomy Supply
US$05/capita/yr
<-100 -50 0 50 >100
Data range: -18 to 5
k) Production Costs
US$05/capita/yr
<-250 -125 0 125 >250
Data range: -260 to 13
Environment
d) Biodiversity Intactness
index
<-0.2 -0.1 0 0.1 >0.2
Projection: Mollweide
Data range: -0.2 to 0.44
e) Shannon Crop Diversity
index
<-1 -0.5 0 0.5 >1
Data range: -1.63 to 1.56
f) Nutrient Surplus
kg N per ha
<-100 -50 0 50 >100
Data range: -451 to 31
g) Water Environmental Flow Violations
m^3 / ha
-60 -40 -20 0
Data range: -6755 to 0
h) Annual AFOLU GHG Emissions
ton CO2eq per ha
<-5 -2.5 0 2.5 >5
Data range: -4.82 to -0.18
i) Global Surface Warming
deg C
<-3 -1.5 0 1.5 >3
Data range: -2.68 to 2.68
Inclusion
l) Expenditure on Ag. Products
USD per capita
<-500 -250 0 250 >500
Data range: -480 to 527
m) Poverty
pop. share with income <3.20$/day
<-0.2 -0.1 0 0.1 >0.2
Data range: -0.02 to 0.04
n) Agricultural Employment
pop. share per world region
<-0.07 -0.035 0 0.035 >0.07
Data range: -0.03 to 0
o) Agricultural Wages
USD per hour
<-3 -1.5 0 1.5 >3
Employment-weighted cartogram
NGA COD AGO ZMB MOZ MDG ZAF IND BGD MMR VNM CHN THA IDN
Data range: 0 to 2