



INITIATIVE ON
Foresight



IFPRI's world food supply and demand projections using the IMPACT world food model

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Seminar

Policy Research Institute, Ministry of Agriculture, Forestry and Fisheries

Tokyo, 4 December 2024

Outline



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- **Challenges to the world food system**
- Drivers of change
- IFPRI's IMPACT model
- Projections of demand, supply, and food security
- Conclusions

Food systems are more than production & consumption



Production

Transport,
storage,
processing,
marketing



Consumption



Land, water,
energy, labor,
technology



Policy,
investment,
innovation,
infrastructure



Achievements... challenges... and opportunities

- Increased production
- Increased variety
- Lower prices... until recently
- Reduced hunger... until recently



- Population growth... and decline
- Changes in demand
- Land degradation
- Water scarcity
- Food loss and waste
- Hunger, overweight, micronutrient deficiency
- Climate change
- Pandemics
- Conflict
- Behavior



- Investment
- Innovation
- Technology
- Information
- Economic growth
- Trade
- Better policies
- Behavior



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Demand-side drivers: Population



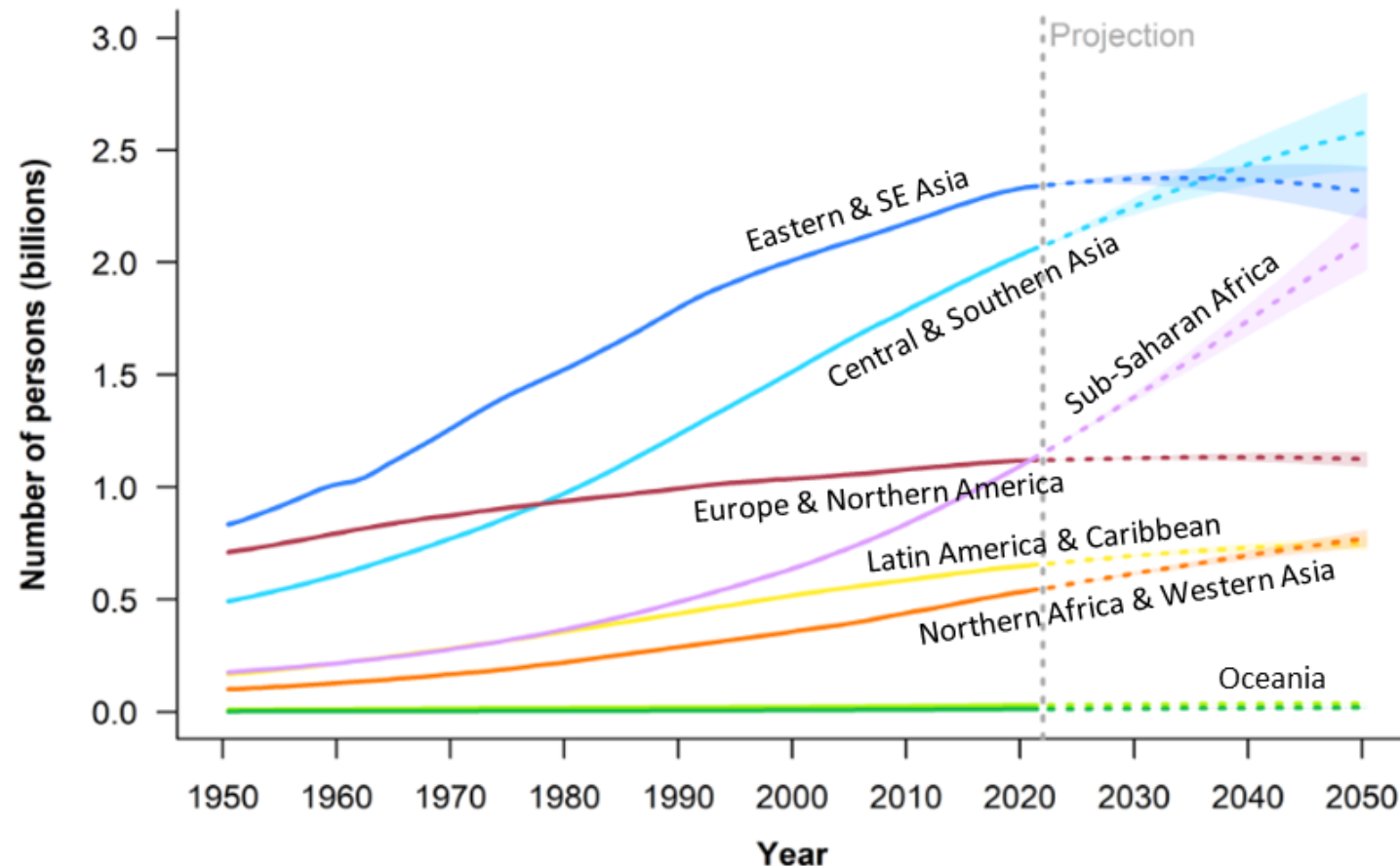
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Population is leveling off in Eastern & Southeast Asia, Europe, and North America, but continues to rise in Africa.

Population estimates, 1950-2022, and projections with 95 per cent prediction intervals, 2022-2050, by region



Demand-side drivers: Income

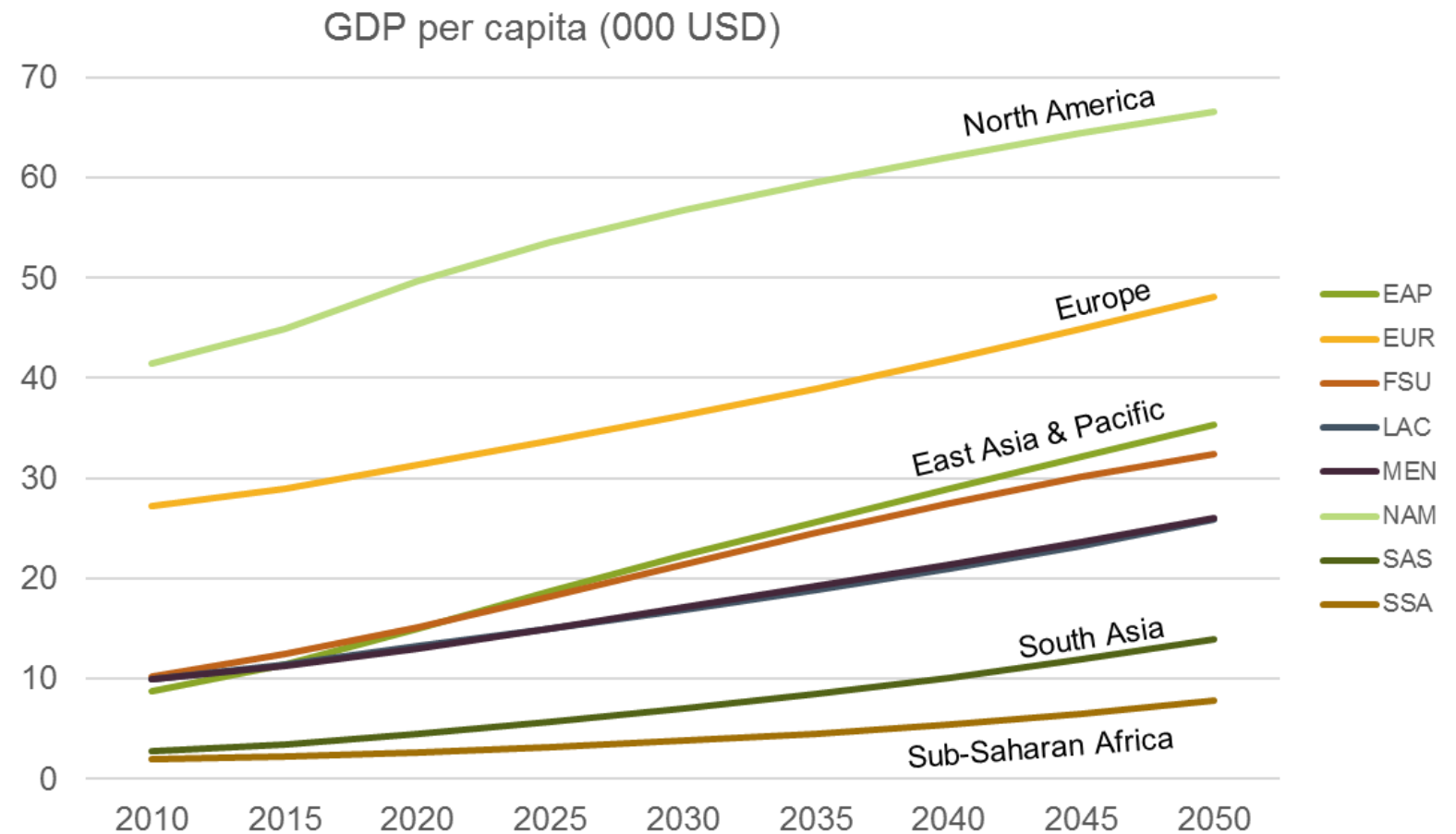


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Incomes are projected to continue rising in all regions, but remain very unequal across and within regions.



Source: IPCC Shared Socioeconomic Pathway 2

Population and GDP to 2050 (SSP2)



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		GDP			Population		
		(Billion 2005 USD)			(Million people)		
		2020	2050	%change	2020	2050	%change
Central and West Asia and North Africa	CWANA	8,000	21,723	172	724	974	35
East and Southern Africa	ESA	1,377	5,664	311 ↑	470	746	59 ↑
Latin America and the Caribbean	LAC	8,507	19,162	125 →	642	742	16 →
South Asia	SA	8,242	32,625	296 ↑	1,820	2,298	26
Southeast and East Asia and the Pacific	SEA	26,865	68,913	157 →	2,084	2,065	-1 →
West and Central Africa	WCA	1,383	7,462	440 ↑	551	943	71 ↑
Rest of the World	ROW	46,896	75,785	62 →	1,327	1,409	6 →
Developed countries	DVD	45,306	73,460	62	1,166	1,302	12
Developing countries	DVG	55,964	157,874	182	6,452	7,875	22
World	WLD	101,270	231,334	128	7,618	9,177	20

Demand-side drivers

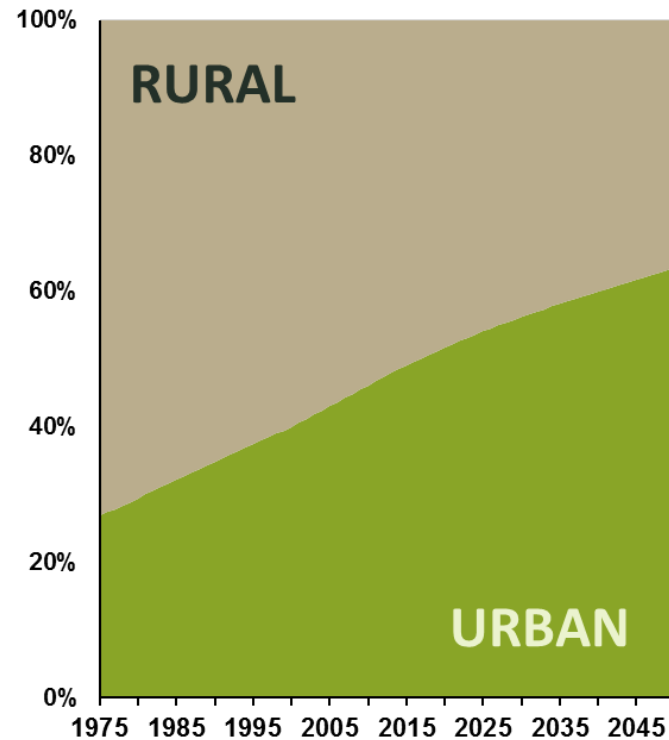


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People are moving



Diets are changing

... towards more fruits and vegetables, more animal-source foods, and more processed foods



Supply-side drivers: Productivity

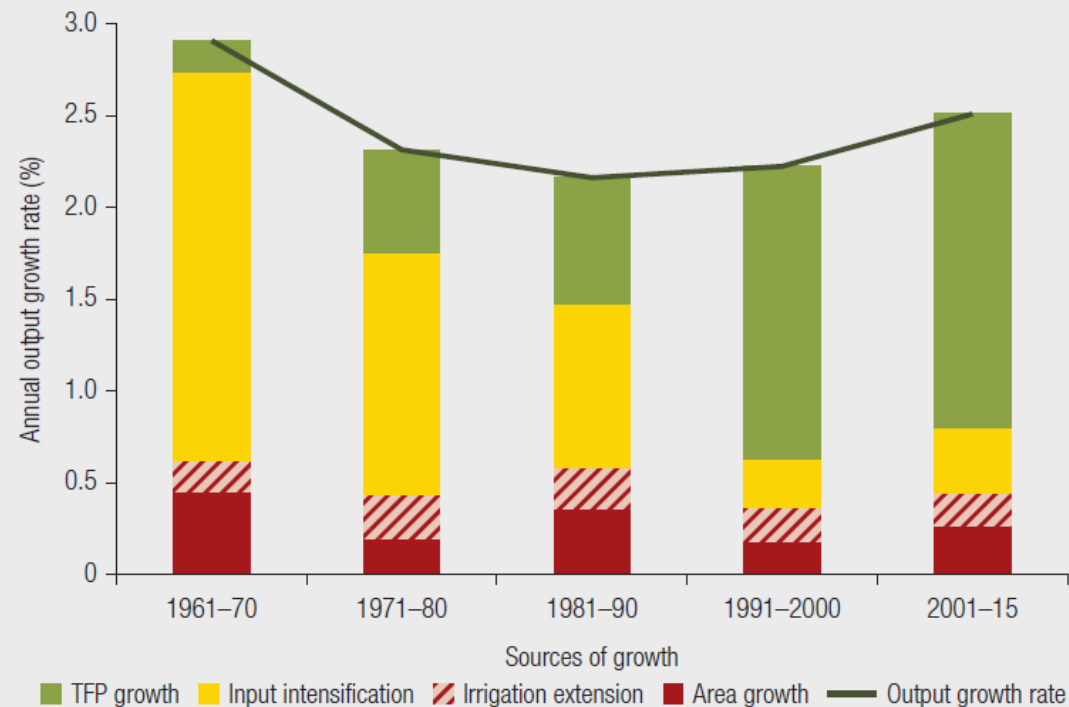


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FIGURE B0.2.2 Increases in Total Factor Productivity Have Become an Increasingly Important Source of Global Agricultural Growth



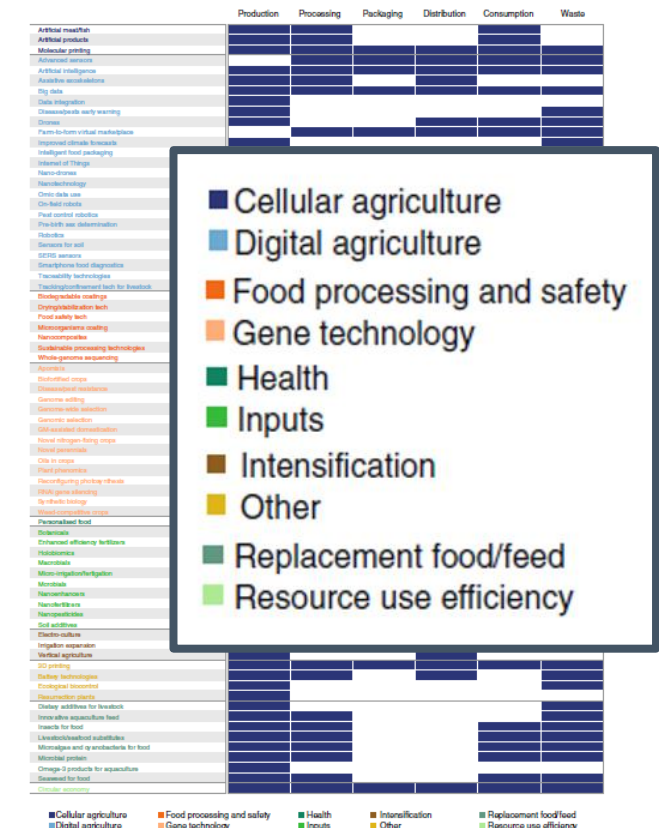
Source: Derived from data from USDA-ERS (2018).

Note: TFP = total factor productivity.

In the past, most agricultural growth came from increasing land area or input use.

Today, most agricultural growth comes from using land and other inputs more efficiently.

Innovation is transforming all parts of the food system

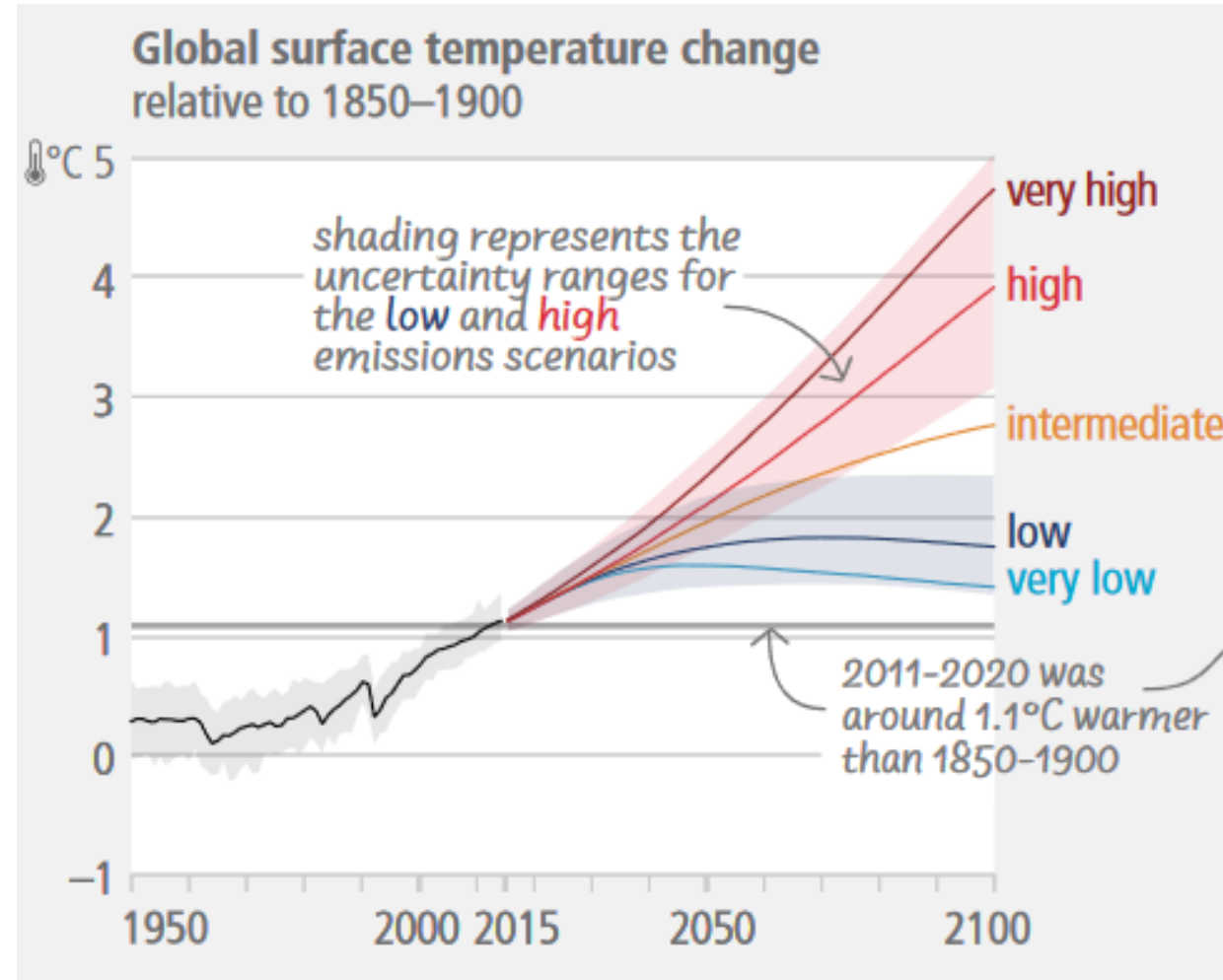


Source: Herrero et al. (*Nature Food*, 2020)

Source: Fuglie et al. (World Bank, 2019)

Supply-side drivers: Climate change

Future climate pathways are uncertain, so modelers use a range of scenarios to explore different possible outcomes.



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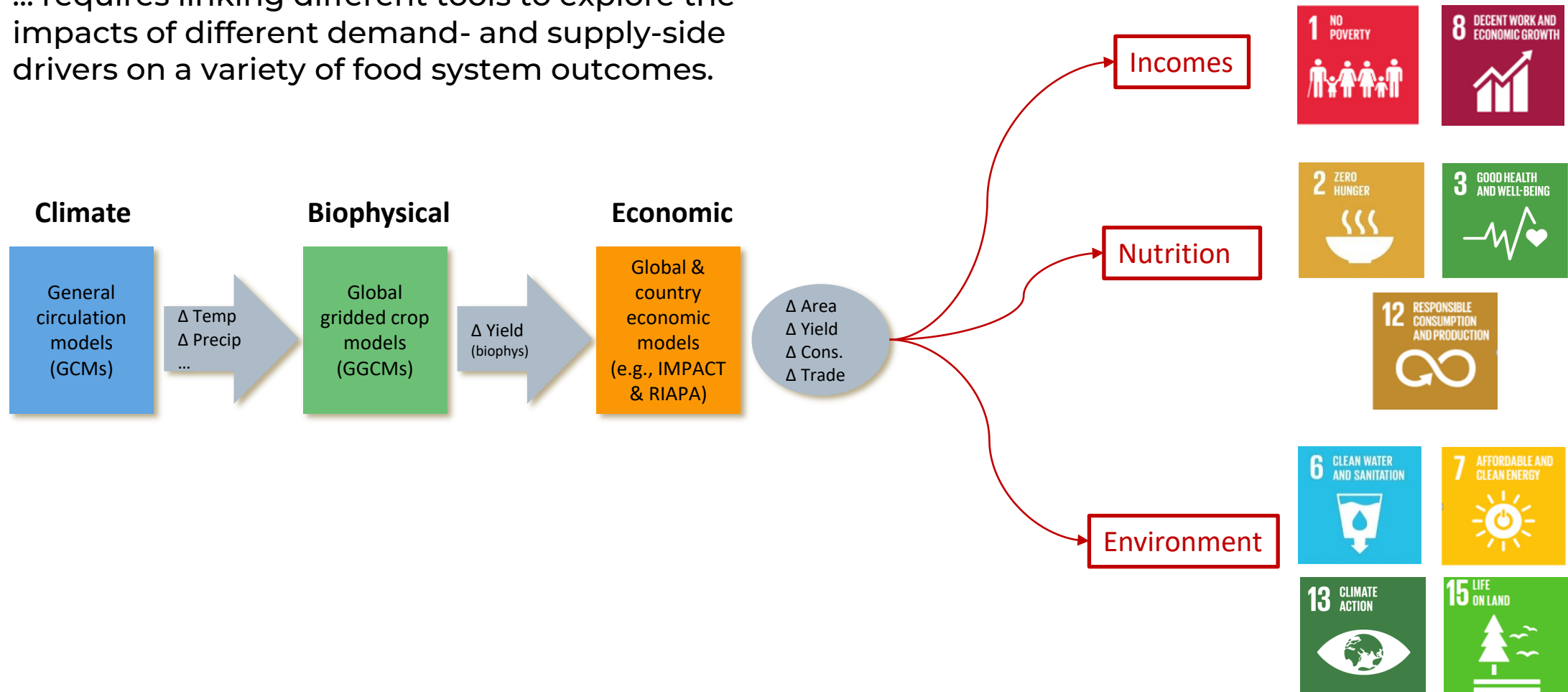


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Modeling alternative futures

... requires linking different tools to explore the impacts of different demand- and supply-side drivers on a variety of food system outcomes.



Adapted from Nelson et al., *Proceedings of the National Academy of Sciences* (2014)



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The IMPACT system of models

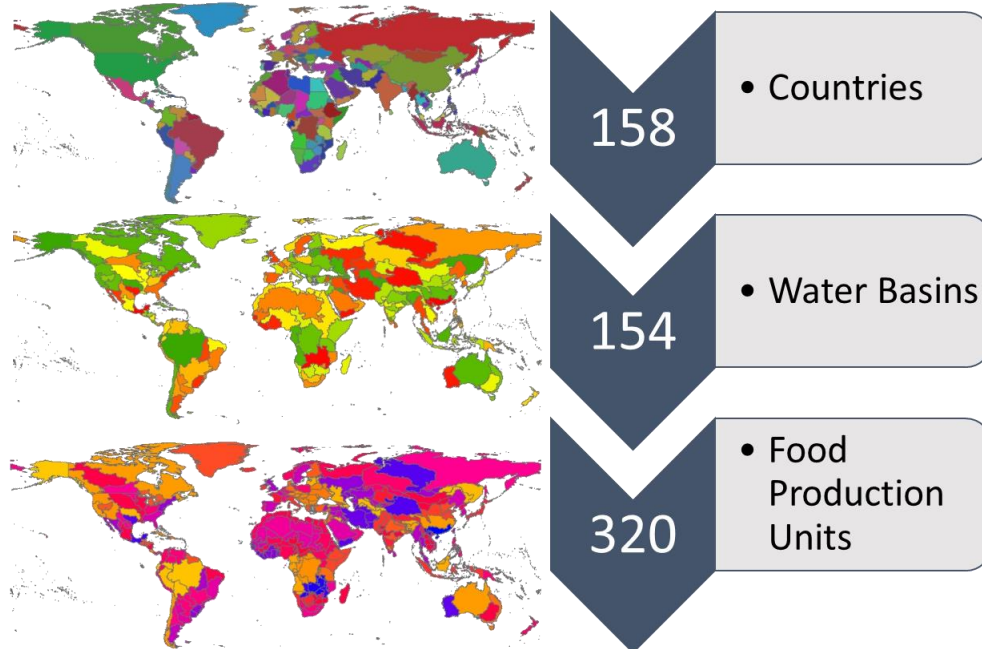


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IMPACT is highly disaggregated geographically and by commodity.



Cattle Dairy Eggs Pigs Poultry Sheep/goat	Barley Maize Millet Rice Sorghum Wheat	Bananas Plantains Sub-tropical fruits Temperate fruits Vegetables
Groundnuts Oil palm Rapeseed Soybeans Sunflower	Cocoa Coffee Cotton Tea	Beans Chickpeas Cowpeas Lentils Pigeonpeas
Cassava Potato Sweet potatoes Yams	Sugarbeet Sugarcane Refined sugar	Others

Projections – not predictions!



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- **Baseline scenario**

- Population and income trends from IPCC medium socioeconomic scenario (SSP2)
- “Business-as-usual” trends in agricultural investment and productivity growth
- Climate change pathway RCP 7.0 (with IPSL climate model)

- Alternative investment scenarios

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Rising demand for non-staple foods

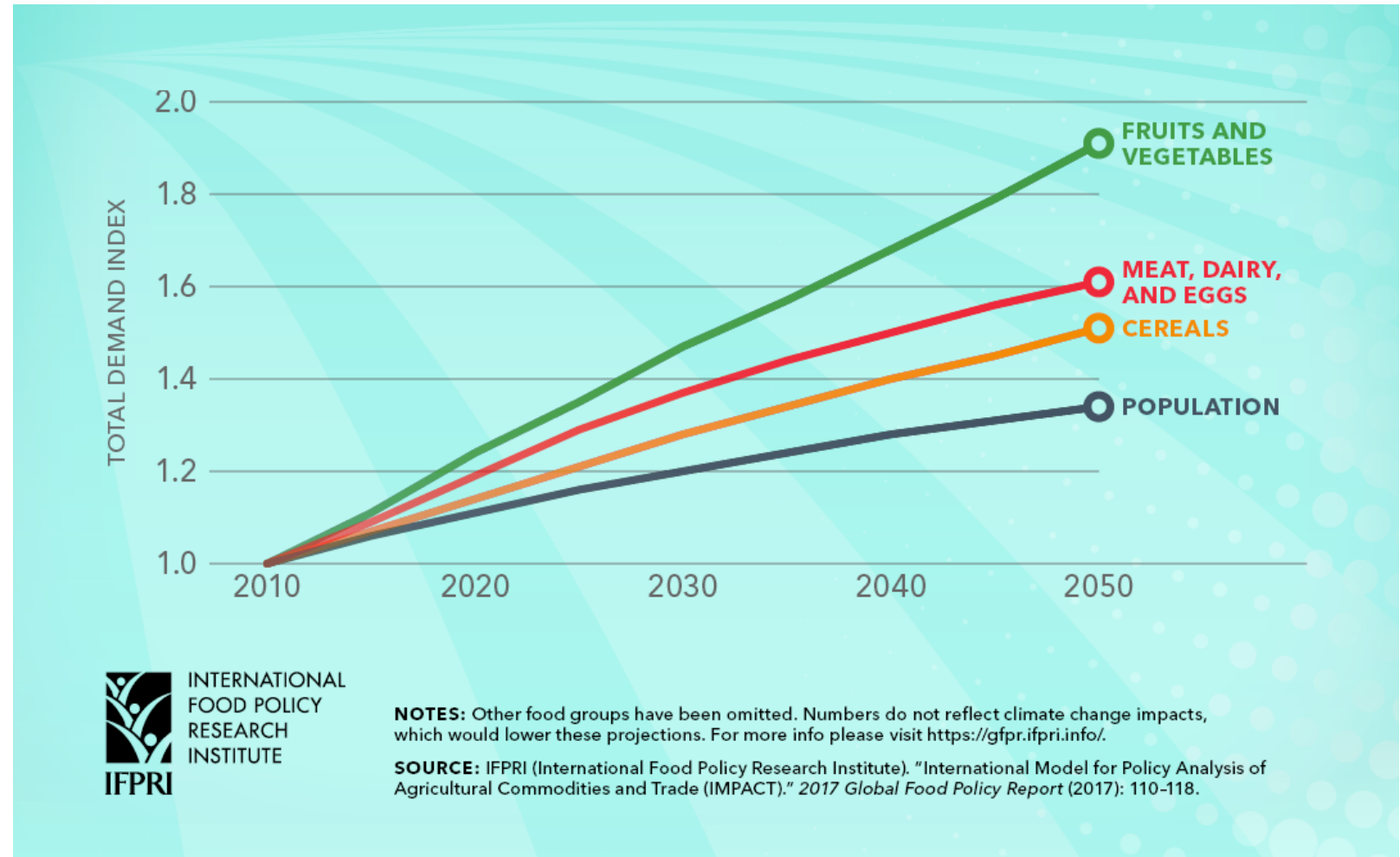


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Demand for staple crops rises slightly faster than global population, increasing about 50% from 2010 to 2050. As incomes rise, however, demand for meat, dairy and eggs is expected to grow more than 60%, and demand for fruits and vegetables will grow even more.



Composition of cereal demand

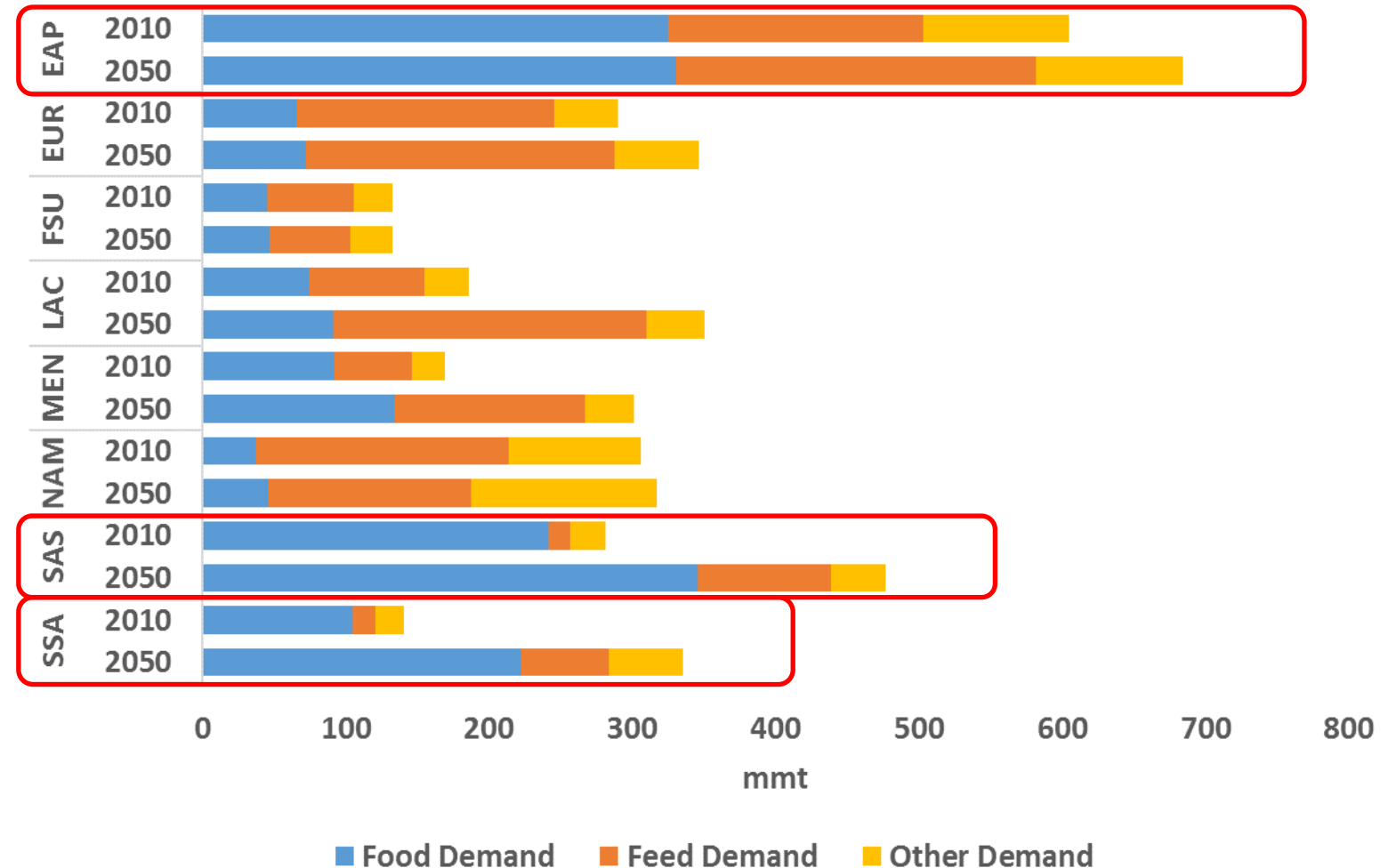


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In South Asia and Sub-Saharan Africa, cereal demand will increase for food, livestock feed and other uses. In East Asia and the Pacific, by contrast, increased cereal demand will be mostly for livestock feed.



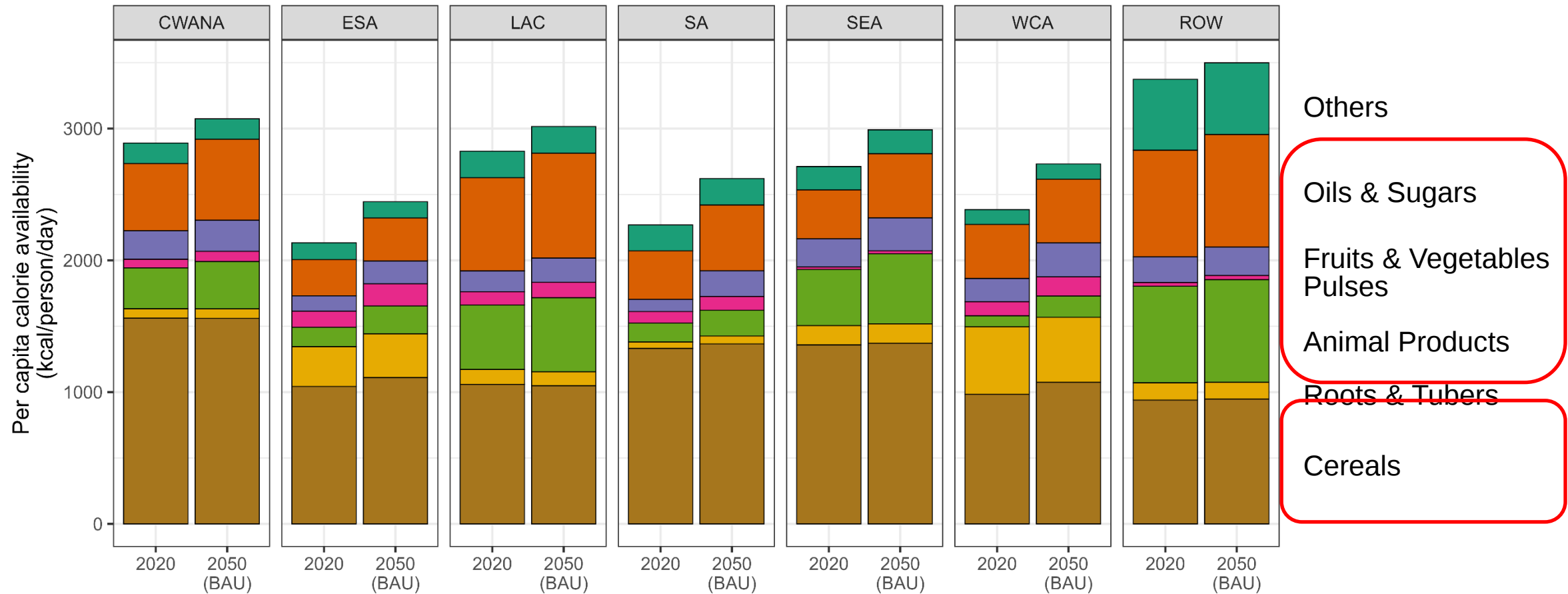
The composition of diets is changing



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CWANA = Central & West Asia & North Africa; ESA = East & Southern Africa; LAC = Latin America & Caribbean; SA = South Asia; SEA = Southeast & East Asia; WCA = West & Central Africa; ROW = Rest of World. Source: IFPRI, IMPACT v3.4, SSP2-RCP7.0-IPSL.

Prices rise with increasing demand

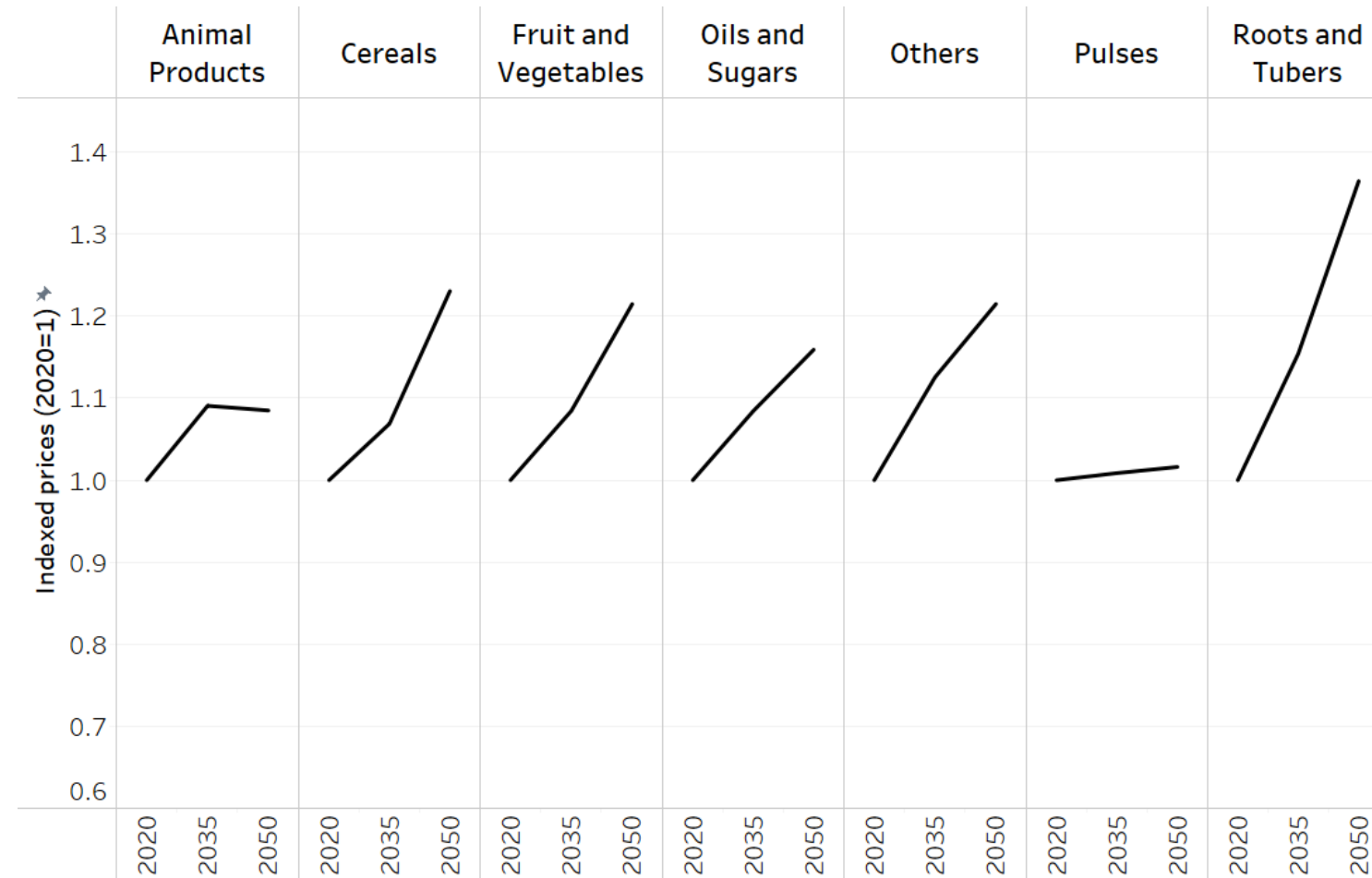


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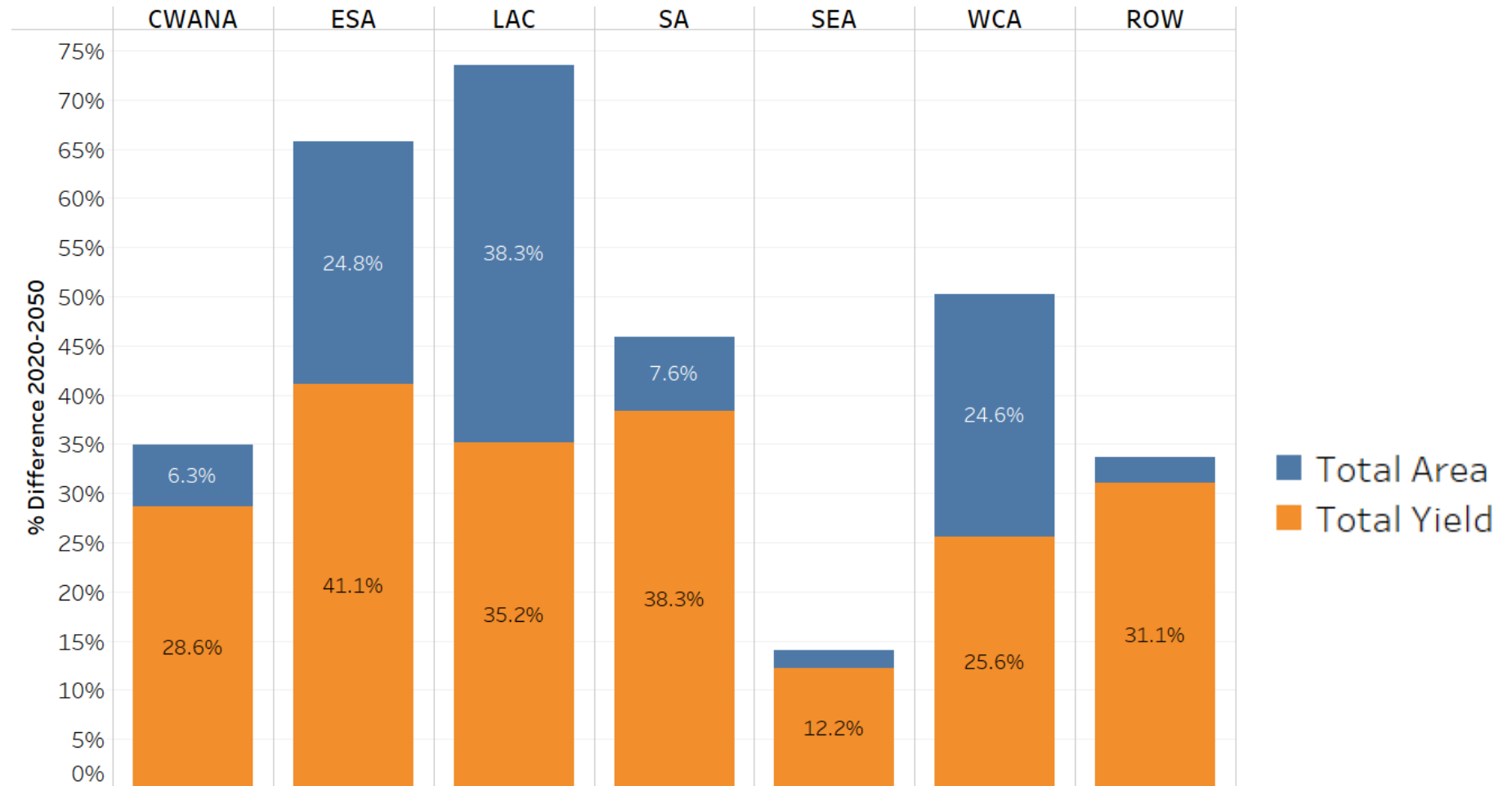
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Prices for all food commodity groups are projected to rise due to increasing demand, but at different rates.



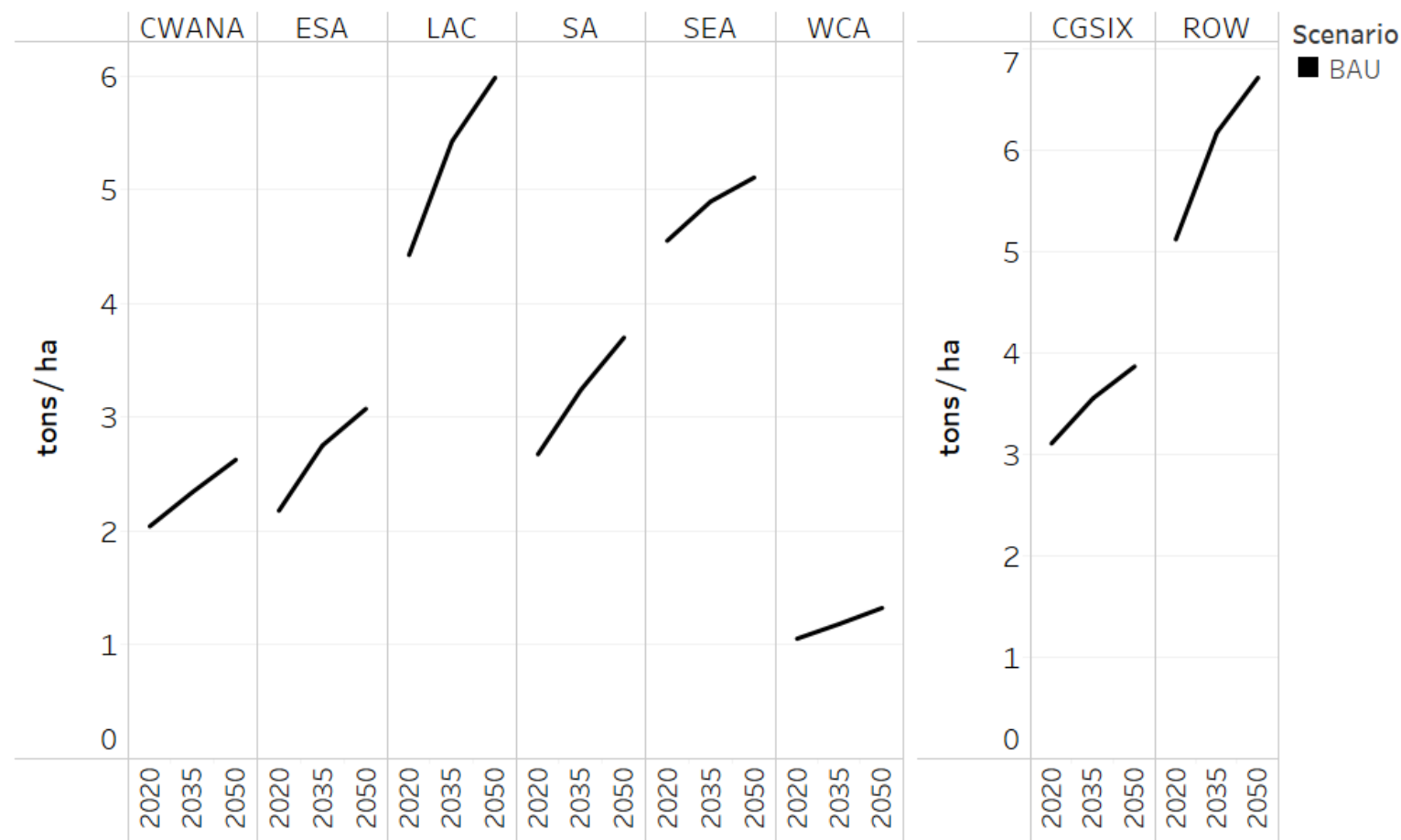
Sources of cereal production growth

Higher prices provide incentives to increase production, both through increases in yields and expansion of cropped area.



Cereal yields continue to rise

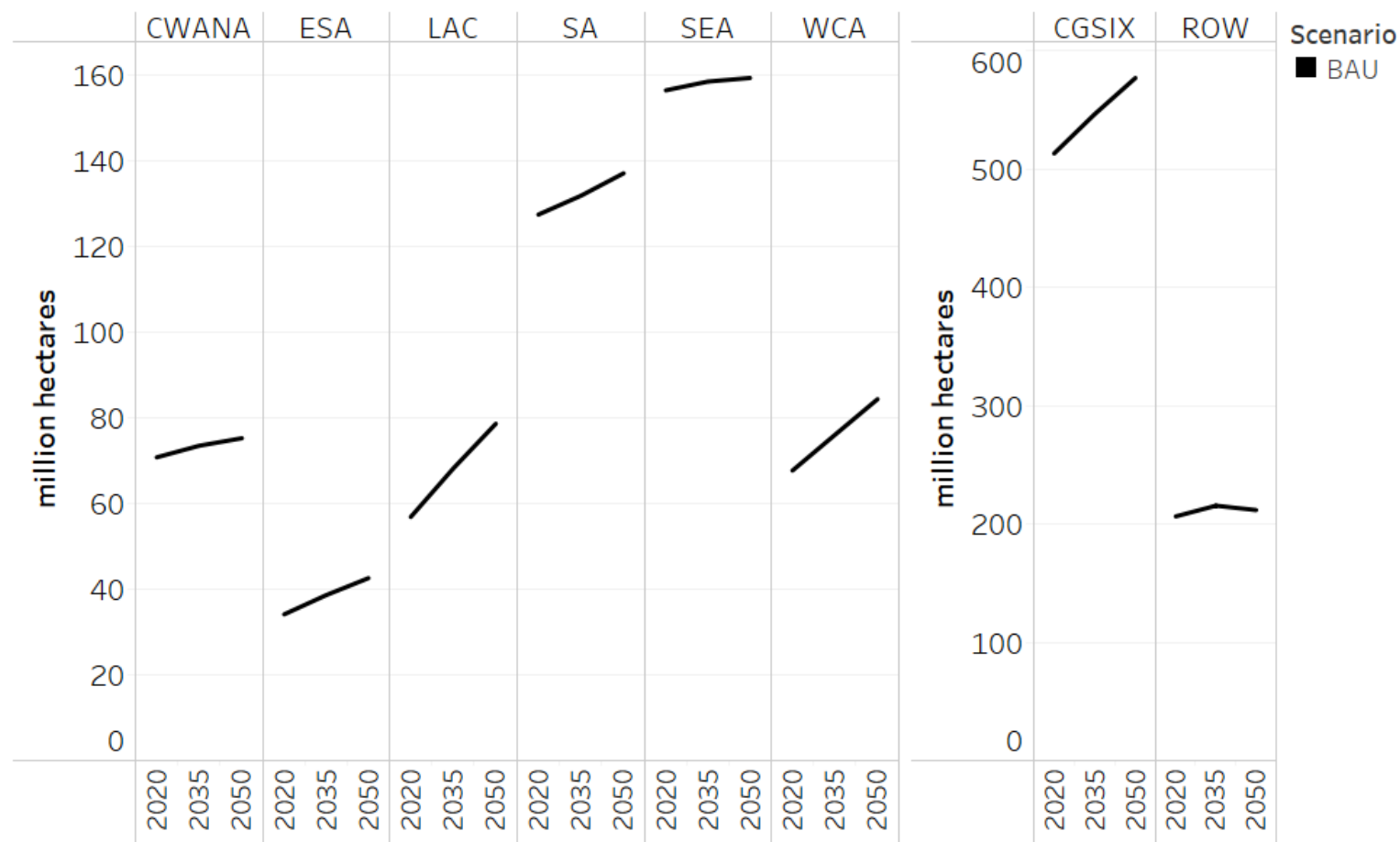
Cereal yields will continue to increase in all regions, but remain low in Africa.



CWANA = Central & West Asia & North Africa; ESA = East & Southern Africa; LAC = Latin America & Caribbean; SA = South Asia; SEA = Southeast & East Asia; WCA = West & Central Africa; CGSIX = Six developing regions; ROW = Rest of World. Source: IFPRI, IMPACT v3.4, SSP2-RCP7.0-IPSL.

Cereal area increases in some regions

Cereal area will increase most rapidly in Latin America and West & Central Africa. It will increase more slowly in Asia and the Rest of World.



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Cereal production and demand

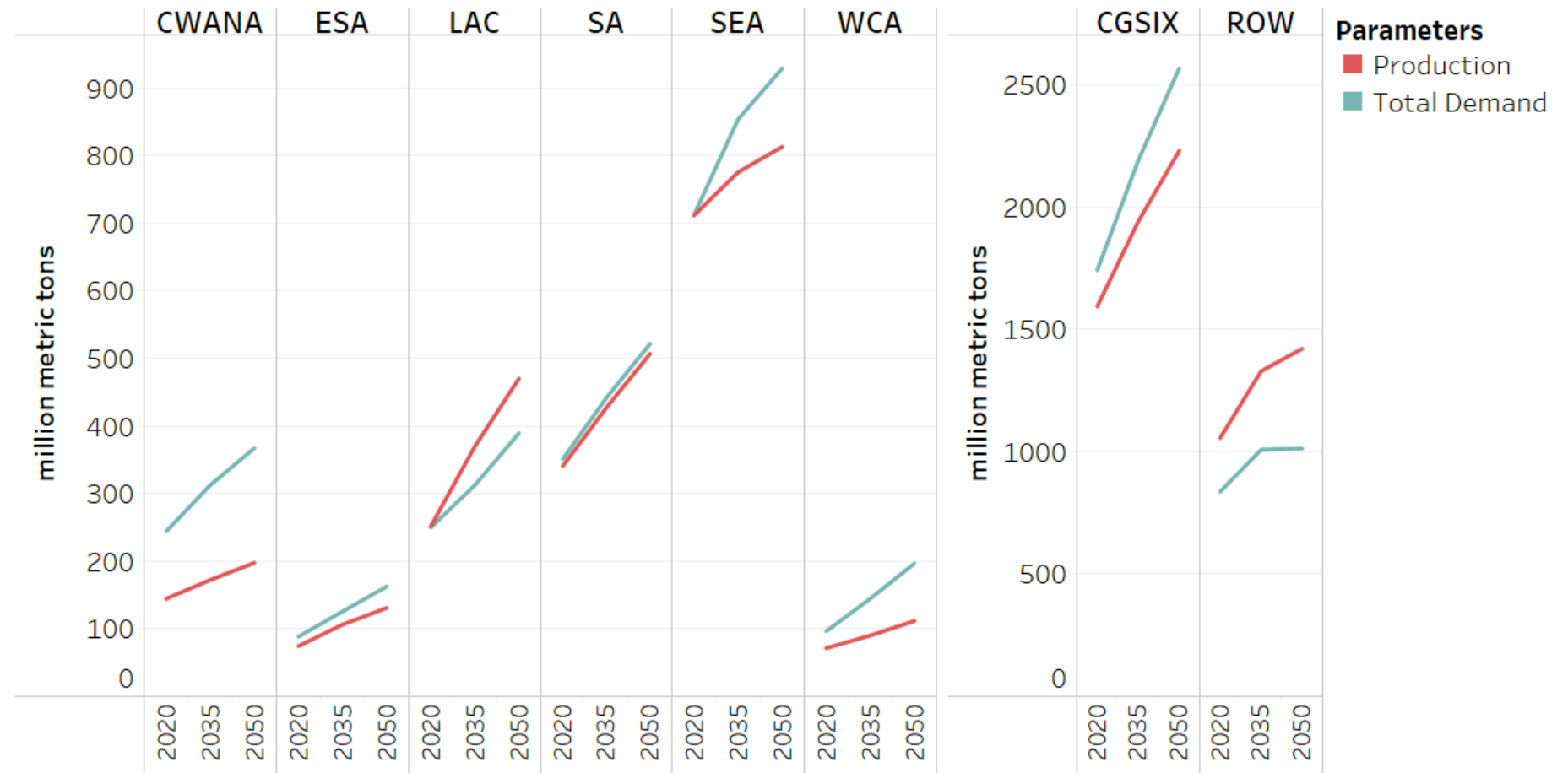


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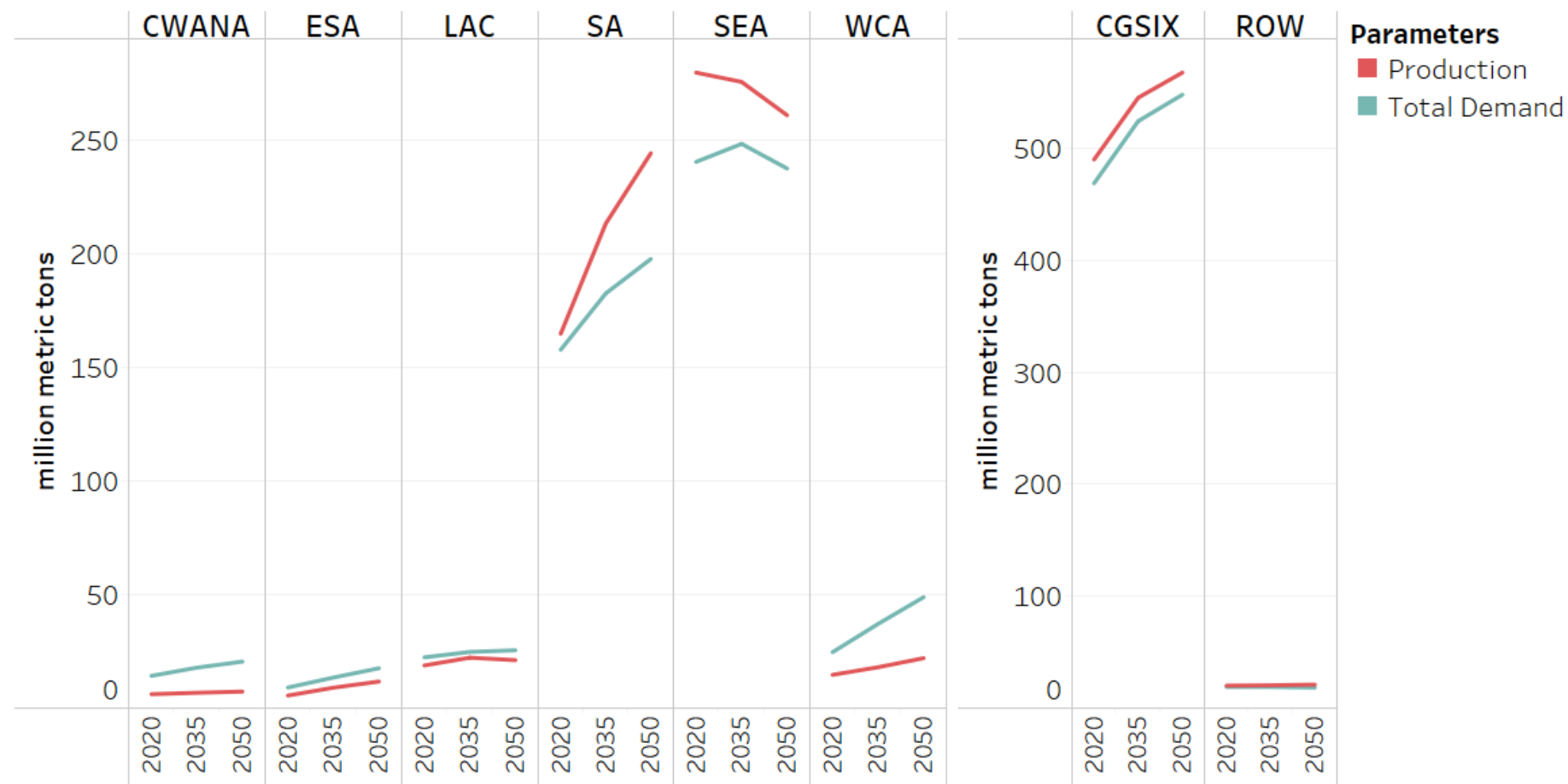
Cereal demand will exceed production in most developing regions (except Latin America), while production will exceed demand in the Rest of World.



CWANA = Central & West Asia & North Africa; ESA = East & Southern Africa; LAC = Latin America & Caribbean; SA = South Asia; SEA = Southeast & East Asia; WCA = West & Central Africa; CGSIX = Six developing regions; ROW = Rest of World. Source: IFPRI, IMPACT v3.4, SSP2-RCP7.0-IPSL.

Rice production and demand

Rice production will continue to exceed demand in Asia, while demand will exceed production in other regions.



CWANA = Central & West Asia & North Africa; ESA = East & Southern Africa; LAC = Latin America & Caribbean; SA = South Asia; SEA = Southeast & East Asia; WCA = West & Central Africa; CGSIX = Six developing regions; ROW = Rest of World. Source: IFPRI, IMPACT v3.4, SSP2-RCP7.0-IPSL.

Cereal trade by region

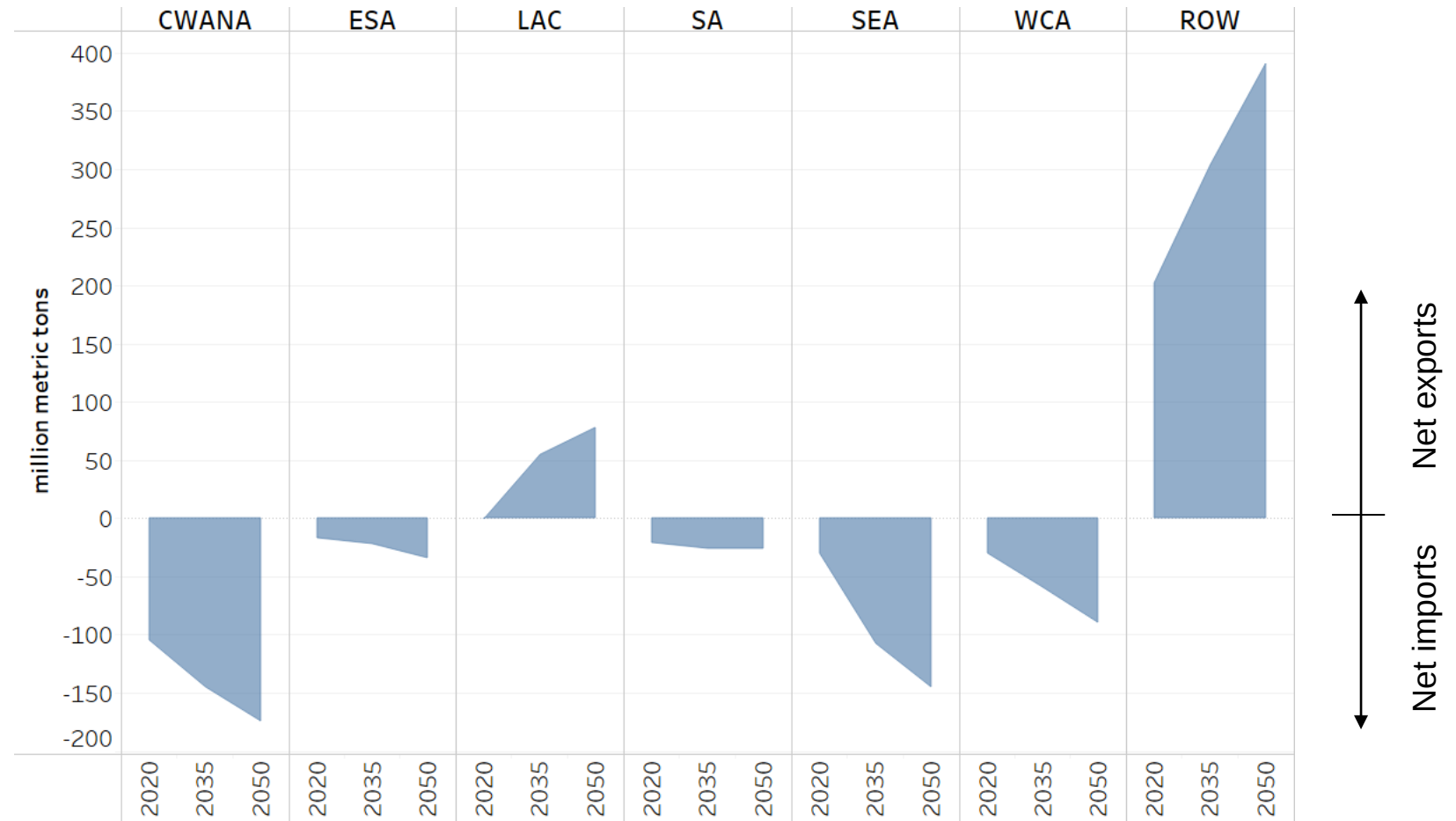


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Net imports of cereals are projected to increase in most developing regions, except Latin America.



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Rice trade by region

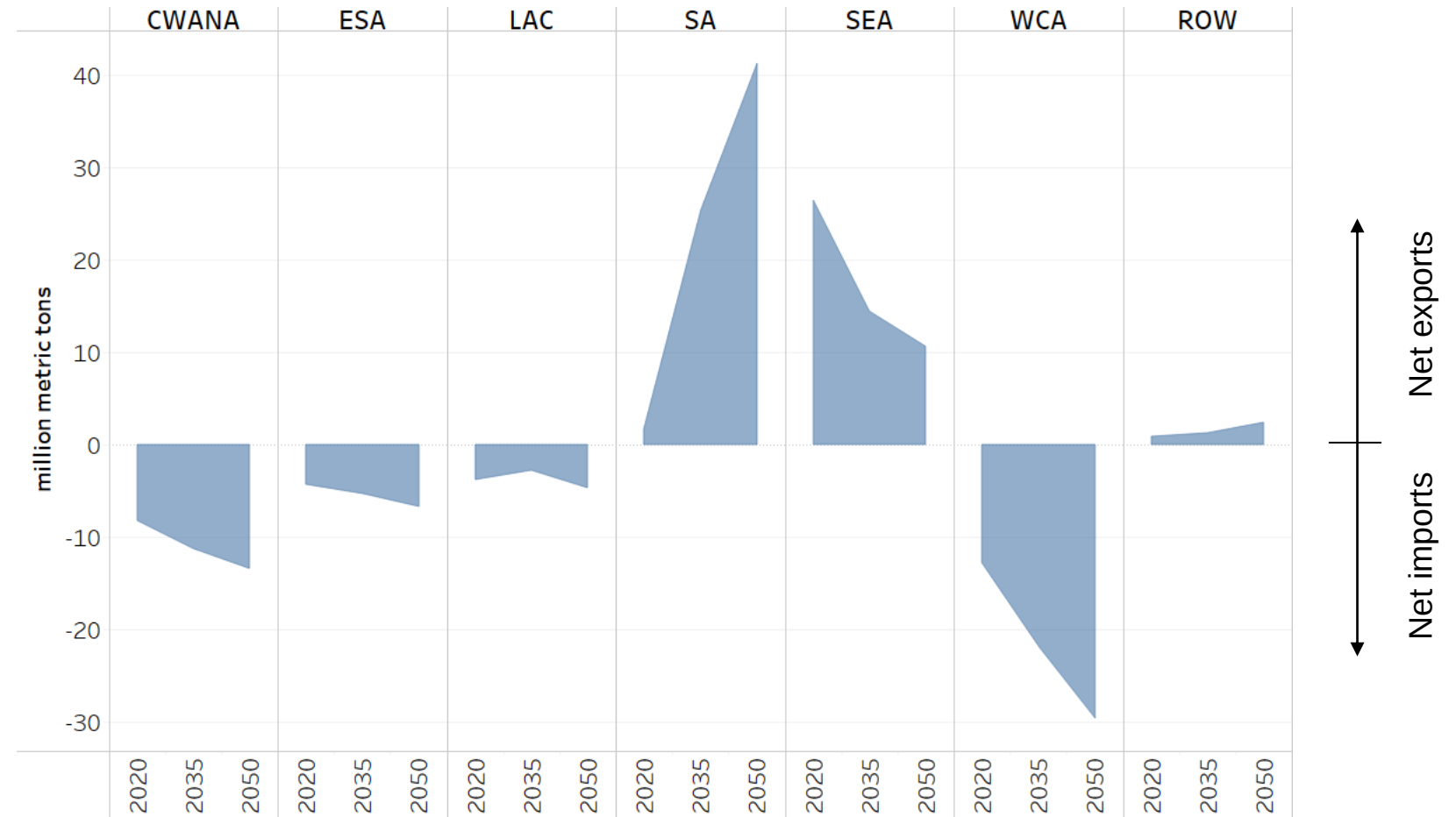


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Net exports of rice are projected to increase in South Asia and decline in Southeast & East Asia. Net imports of rice are projected to increase in Africa.

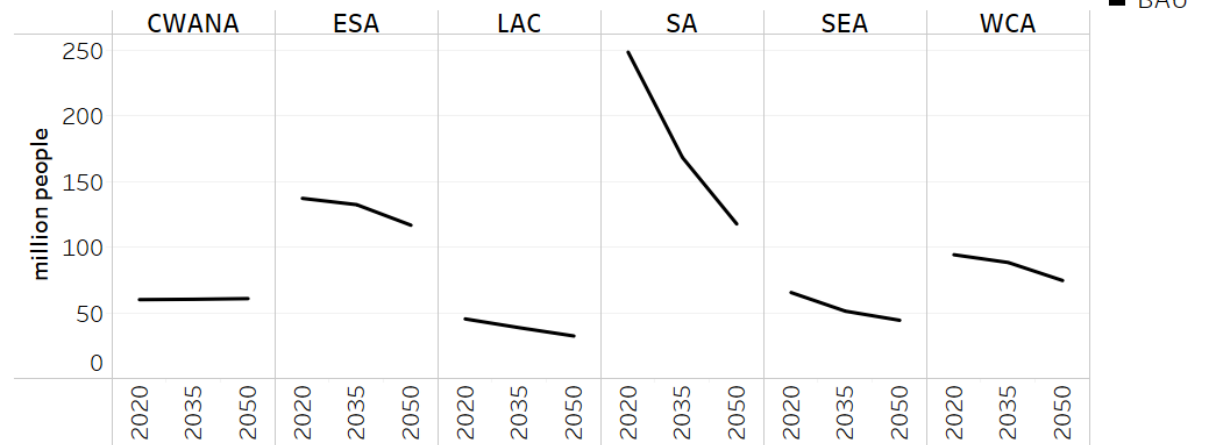


CWANA = Central & West Asia & North Africa; ESA = East & Southern Africa; LAC = Latin America & Caribbean; SA = South Asia; SEA = Southeast & East Asia; WCA = West & Central Africa; ROW = Rest of World. Source: IFPRI, IMPACT v3.4, SSP2-RCP7.0-IPSL.

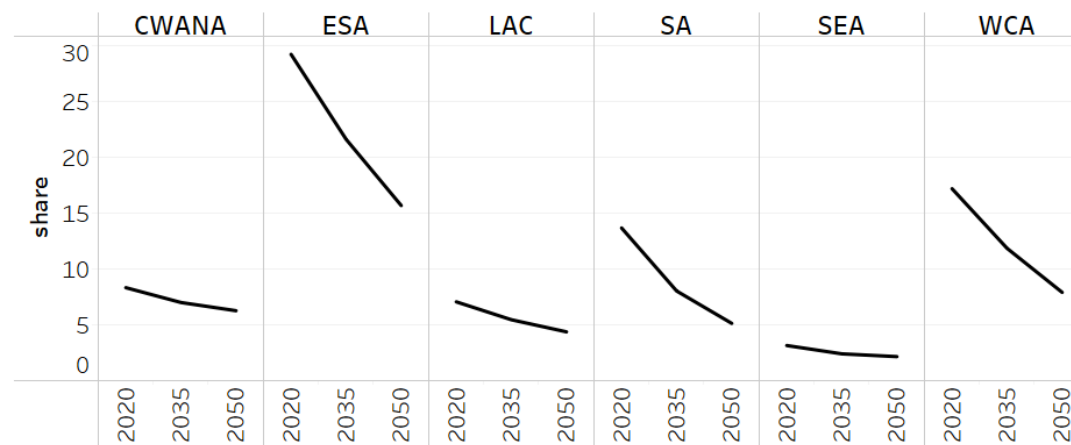
Risk of hunger by region

The risk of hunger is projected to decline in most regions, based on increases in income and production. The numbers and share of population at risk of hunger remain highest in Africa.

Population at risk of hunger



Share at risk of hunger



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Projections – not predictions!



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- Baseline scenario
- **Alternative investment scenarios**
 - Increased investment in agricultural R&D
 - Increased investment in water management
 - Increased investment in infrastructure

Alternative investment scenarios



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Scenario	Description	Abbreviation
Agricultural R&D	Increased research and development (R&D) investment across the CGIAR portfolio plus faster and more efficient adoption of new technologies	HIGH+RE
Water Management	Expansion of irrigated area coupled with increased water use efficiency	IX+WUE
	Improved soil water-holding capacity	SWHC
Infrastructure	Infrastructure improvements to improve market efficiency through the reduction of transportation costs and marketing margins (rail, road, port, and electrification)	RMM
Comprehensive	A combination of the Agricultural R&D, Water Management, and Infrastructure scenarios described above	COMP

Note: *In this study, the combination that defines the REF-NoCC scenario is the Shared Socioeconomic Pathway "2" (SSP2) alone, while the REF-CC scenario is the combination of SSP2 with RCP8.5 via the UK Met Office Hadley Centre Earth System Model (HGEM) GCM.

Source: IFPRI, IMPACT model version 3.3, (Sulser et al. 2021).

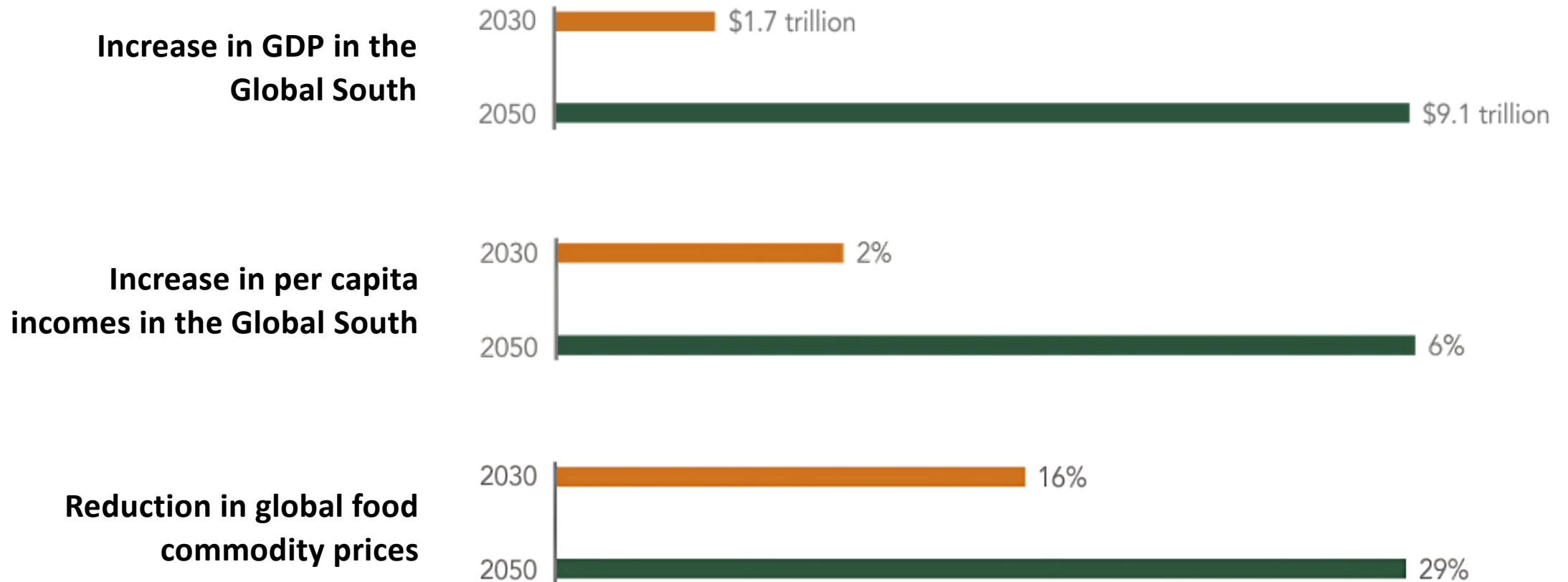
Economic benefits from increased R&D investments



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Combined impacts on hunger

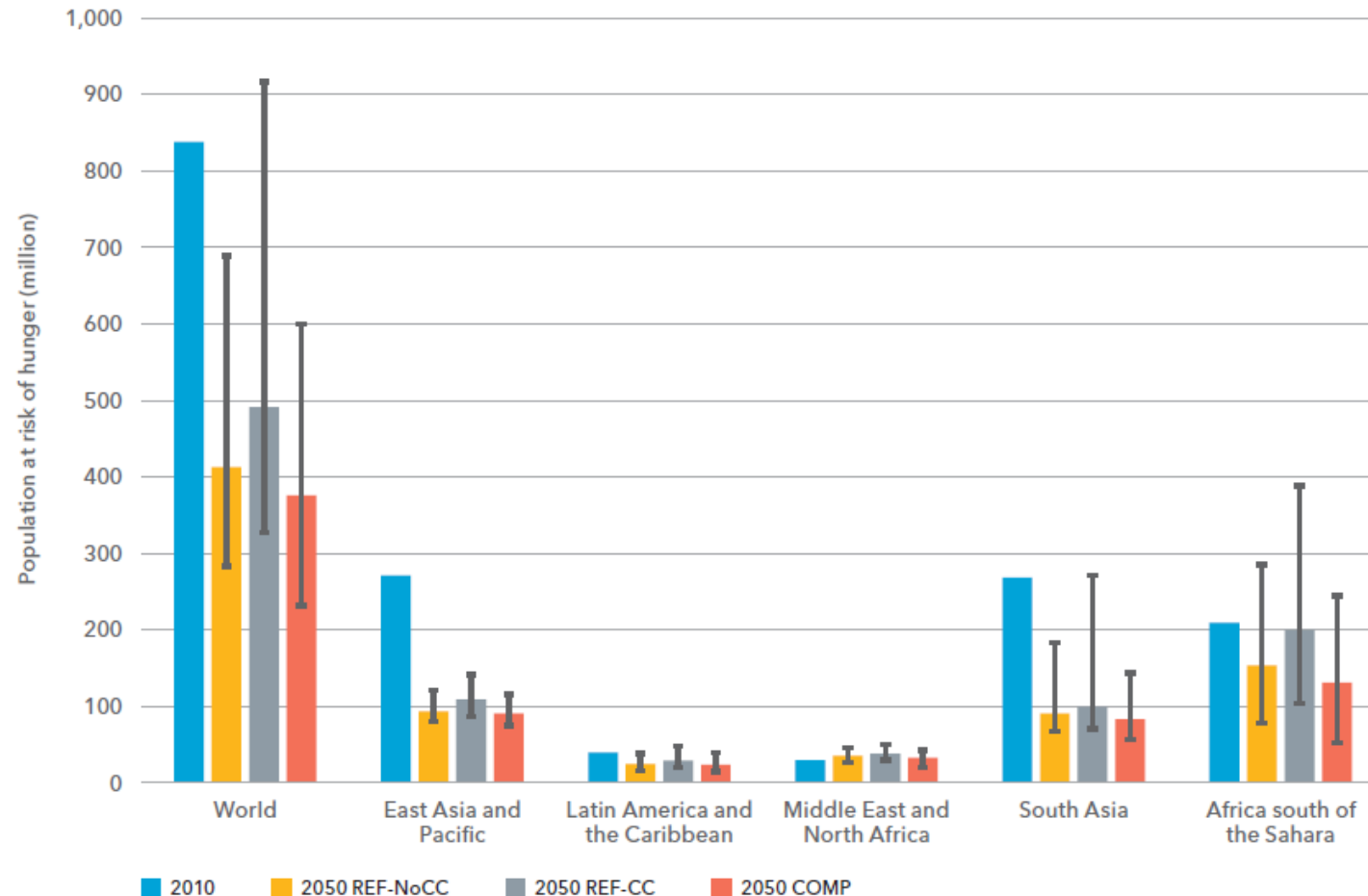


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FIGURE 1 POPULATION AT RISK OF HUNGER IN 2010 AND 2050,
globally and by region in the reference (with and without climate change) and investment scenarios



Climate change reverses progress in reducing hunger, but can be offset by investments in agricultural R&D, resource management, and market infrastructure.

Note: World includes all countries; regions include only developing countries. Data shown are a reference estimate (columns) with the minimum and maximum of a plausible interval (whiskers) using methods described.

Investments and tradeoffs between food system objectives



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Scenario	Average Annual Cost	2050						
		SDG 1	SDG 2			SDG 6/12		
		GDP	Ag Supply	Hunger	Per Capita KCAL Availability	Blue Water Use	Irrigation Water Reliability	Blue Water per KCAL
HIGH+RE	1.97	3.43	7.45	-21.55	5.63	-0.41	0.37	-5.71
IX+WUE	8.11	0.28	0.83	-3.29	0.70	-7.39	12.13	-8.04
SWHC	4.58	0.46	0.91	-3.77	0.71	-2.88	2.02	-3.57
RMM	10.81	0.54	0.14	-0.24	0.08	-0.04	-0.06	-0.12
COMP	25.47	4.62	8.62	-23.66	6.50	-7.95	12.30	-13.57

Heatmap
Legend



Less Advantageous

Neutral

More Advantageous

“High+RE” = increased agricultural research; “IX+WUE” and “SWHC” = improved water management; “”, “RMM” = improved infrastructure; “COMP” = comprehensive investment package. **Source:** IFPRI, IMPACT model version 3.3, (Sulser et al. 2021).

Research priorities depend on the goals to be achieved

International agricultural research plays a key role, but priorities vary depending on the goals that policy makers and other stakeholders may wish to achieve ([Fuglie et al. 2022](#)):

- reducing hunger suggests a focus on investment in cereals
- increasing income suggests a greater focus on investment in fruits and vegetables
- reducing greenhouse gas emissions suggests a greater focus on investments to improve livestock productivity



The Russia-Ukraine conflict has increased prices, poverty, and hunger in Africa

C. Arndt et al.

Global Food Security 36 (2023) 100680

Analysis of the impacts of the Russia-Ukraine conflict and other global crises on food, fuel and fertilizer prices, income, food security, and diet quality in 19 low-income countries ([Diao et al. 2022](#), [Arndt et al. 2023](#)) find that the conflict has resulted in:

- higher food prices
- higher fuel prices
- higher fertilizer prices
- increased poverty
- increased undernourishment
- worsening diets

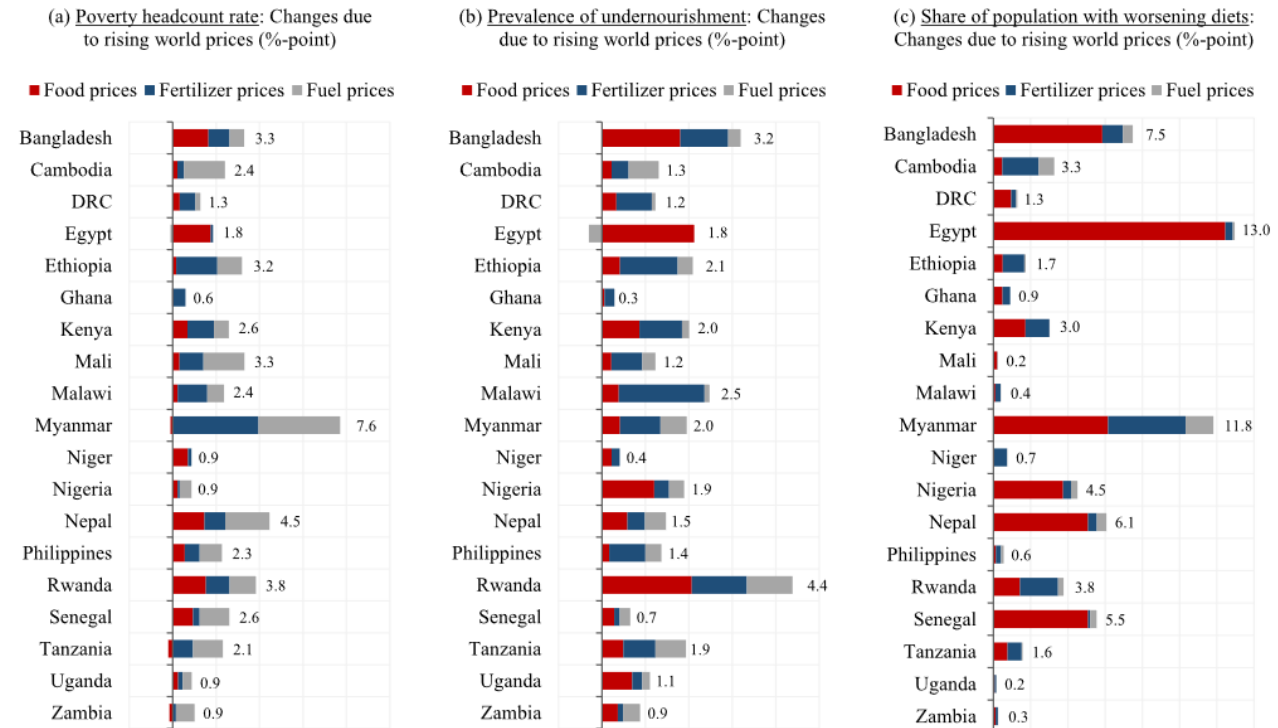


Fig. 3. Estimated impacts on poverty and food security.

Note: Poverty headcount rate is the population share with consumption below the US\$1.90-a-day poverty line. Prevalence of undernourishment is the population share consuming less than the minimum calorie threshold. Diets are defined across six food groups and are deemed to have worsened if individuals become deprived in at least one additional group, where deprivation means consuming less than the minimum described by EAT-Lancet healthy reference diet.

Source: Simulation results from IFPRI's RIAPA models (see www.ifpri.org/project/riapa-model) calibrated to data from IFPRI's Nexus Social Accounting Matrices (available at dataverse.harvard.edu/dataverse/sam).

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Conclusions

- **Changes in population, income, diets, and technology** will continue to be the main drivers of change in agri-food systems through mid-century
- **Shocks** originating both inside and outside the food system exacerbate these longer-term challenges
- **Demand and production** are projected to continue to grow through mid-century, but with large differences across regions
- **Large inequalities** in income and access to economic opportunities remain both across and within regions
- **Climate change will slow progress** in achieving food system goals

Conclusions

- **Overall, the challenge is shifting** from increasing production of staple foods to improving nutrition, health, equitability, sustainability, and resilience of food systems
- **Increased investments in agricultural productivity growth**, irrigation and water use efficiency, and rural infrastructure are highly effective in
 - increasing agricultural production
 - cutting food prices and raising income and consumption
 - reducing hunger rapidly to achieve SDG2 hunger goals
 - reducing greenhouse gas emissions and water use

For more information...



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What do we know about
the future of food systems?**

<https://www.cgiar.org/initiative/foresight/>

CLIMATE CHANGE AND HUNGER

Estimating costs of adaptation in the agrifood system

TIMOTHY B. SULSER, KEITH WIEBE, SHAHNILA DUNSTON, NICOLA CENACCHI, ALEJANDRO NIN-PRATT,
DANIEL MASON-D'CROZ, RICHARD ROBERTSON, DIRK WILLENBOCKEL, AND MARK W. ROSEGRANT

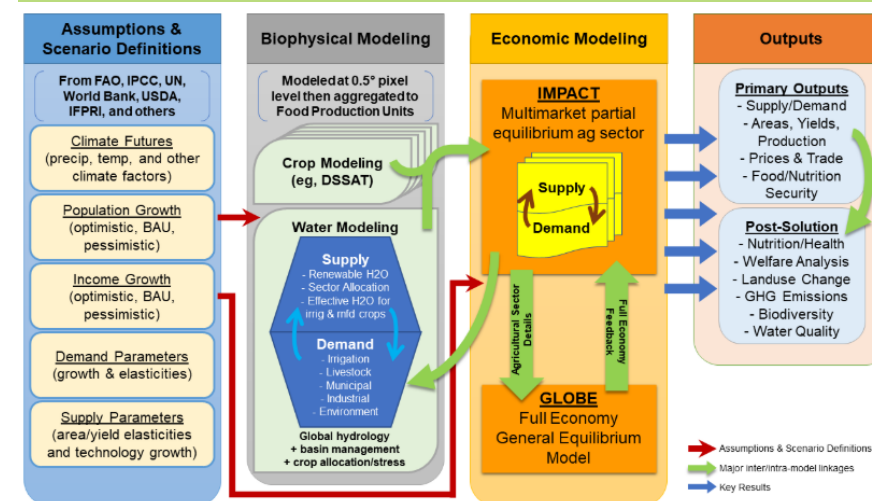
<https://doi.org/10.2499/9780896294165>

Food and nutrition security under changing climate and socioeconomic conditions

Mark W. Rosegrant, Timothy B. Sulser*, Shahnila Dunston, Abhijeet Mishra, Nicola Cenacchi, Yohannes Gebretsadik, Richard Robertson, Timothy Thomas, Keith Wiebe

<https://doi.org/10.1016/j.gfs.2024.100755>

The IMPACT modeling system



<https://www.ifpri.org/project/ifpri-impact-model/>

Thank you for your interest

Keith Wiebe, IFPRI

