GTAP CONFERENCE 2026

Multi-Model Assessment Reveals Context-Specific Regional Priorities in Food System Transformation

Presented by Marina Sundiang
June 18, 2026

FOOD SYSTEMS & GLOBAL CHANGE

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College of Agriculture and Life Sciences
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Part of Cornell's work on leading the modelling assessment for EAT-Lancet Commission 2.0

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NOTE: RESULTS PRESENTED TODAY ARE PRELIMINARY AND ARE NOT FOR CITATION

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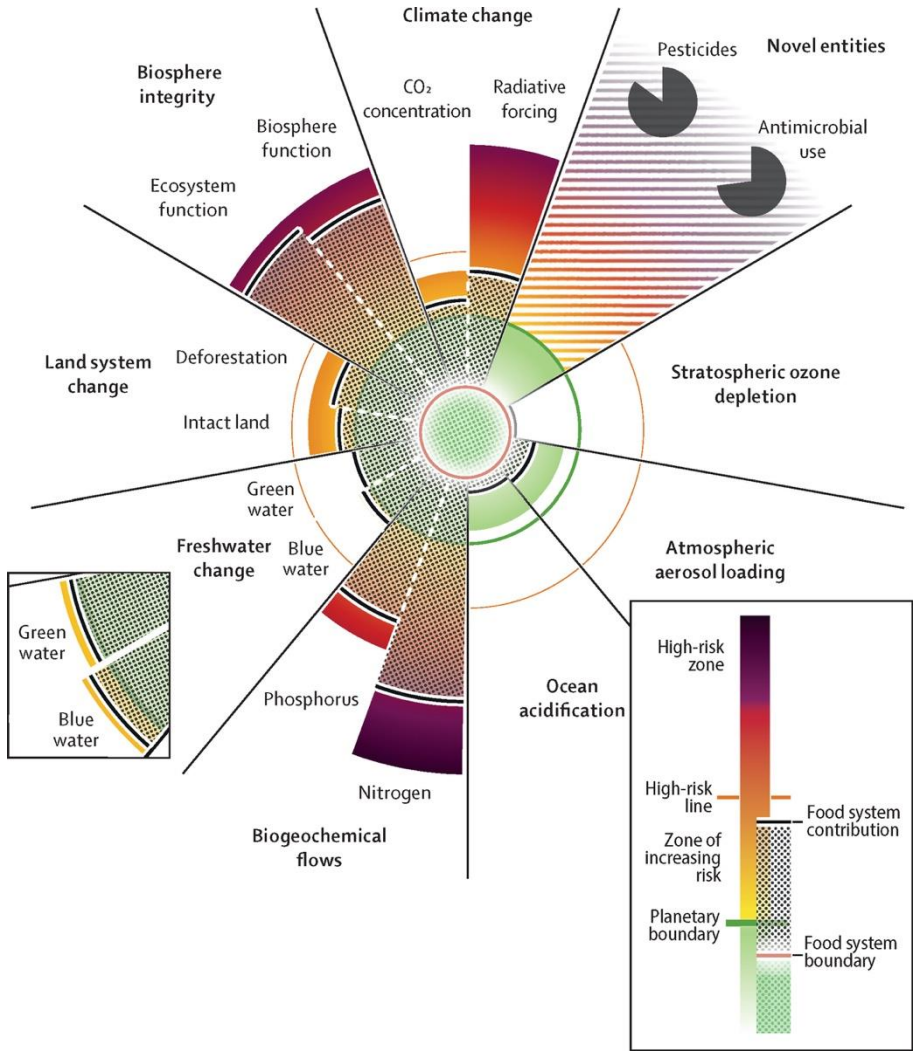
- The current food system significantly contributes to the transgression of several safe and just planetary boundaries (Rockström et al, 2025)
- Double burden of malnutrition: co-existence of undernutrition and overweight
- Urgent need to transform how we produce and consume food



Rockström et al, 2025

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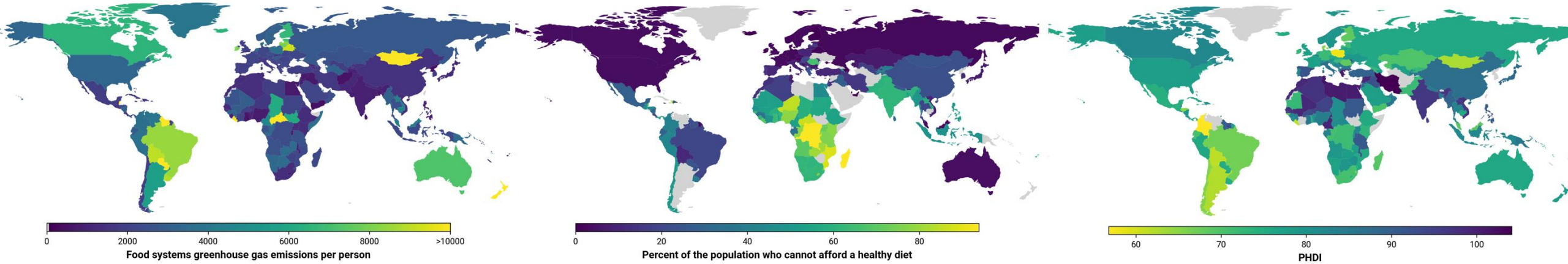
Current state (2020): data from FAOSTAT (via Food Systems Dashboard), and Gu et al 2024



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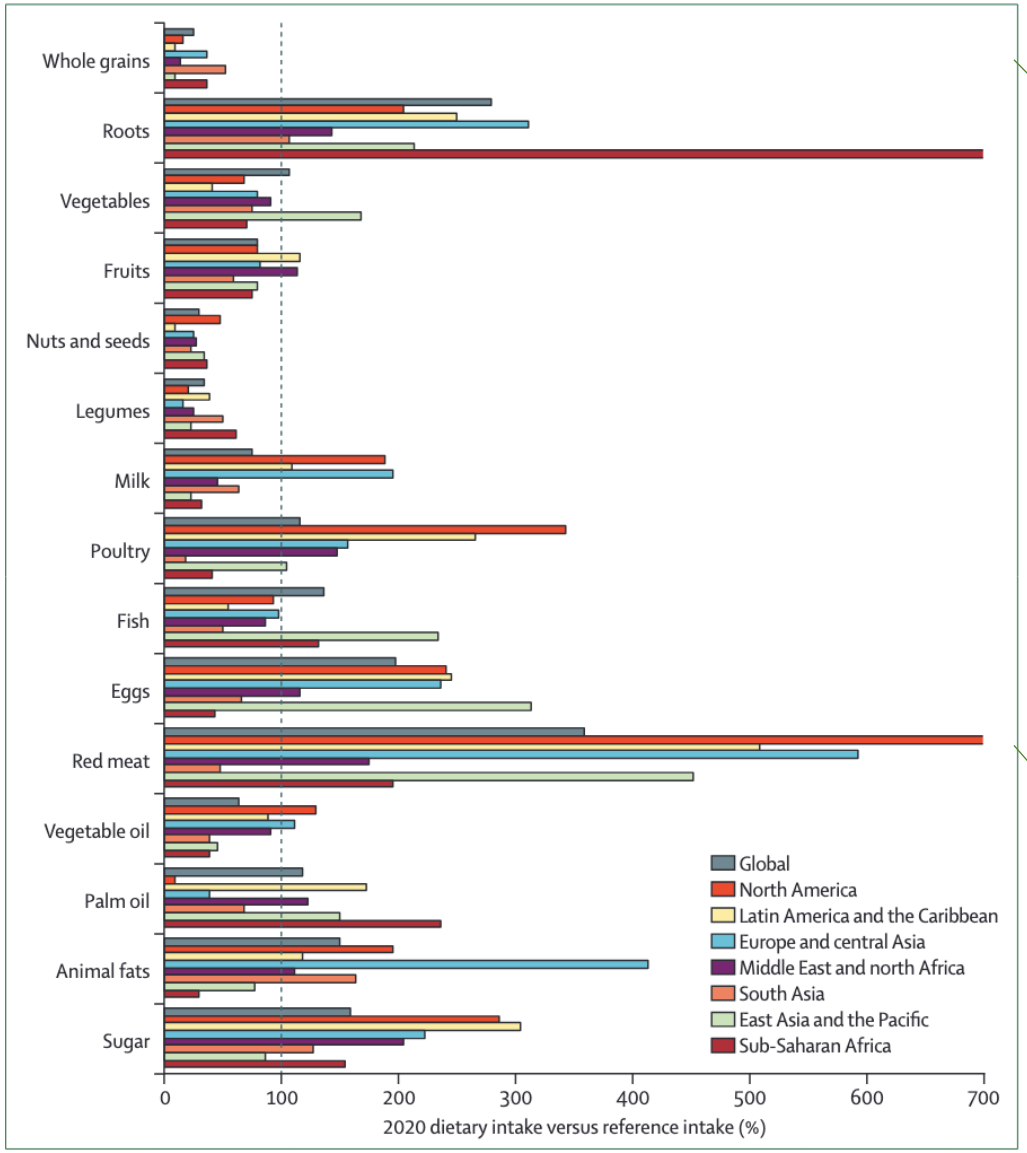

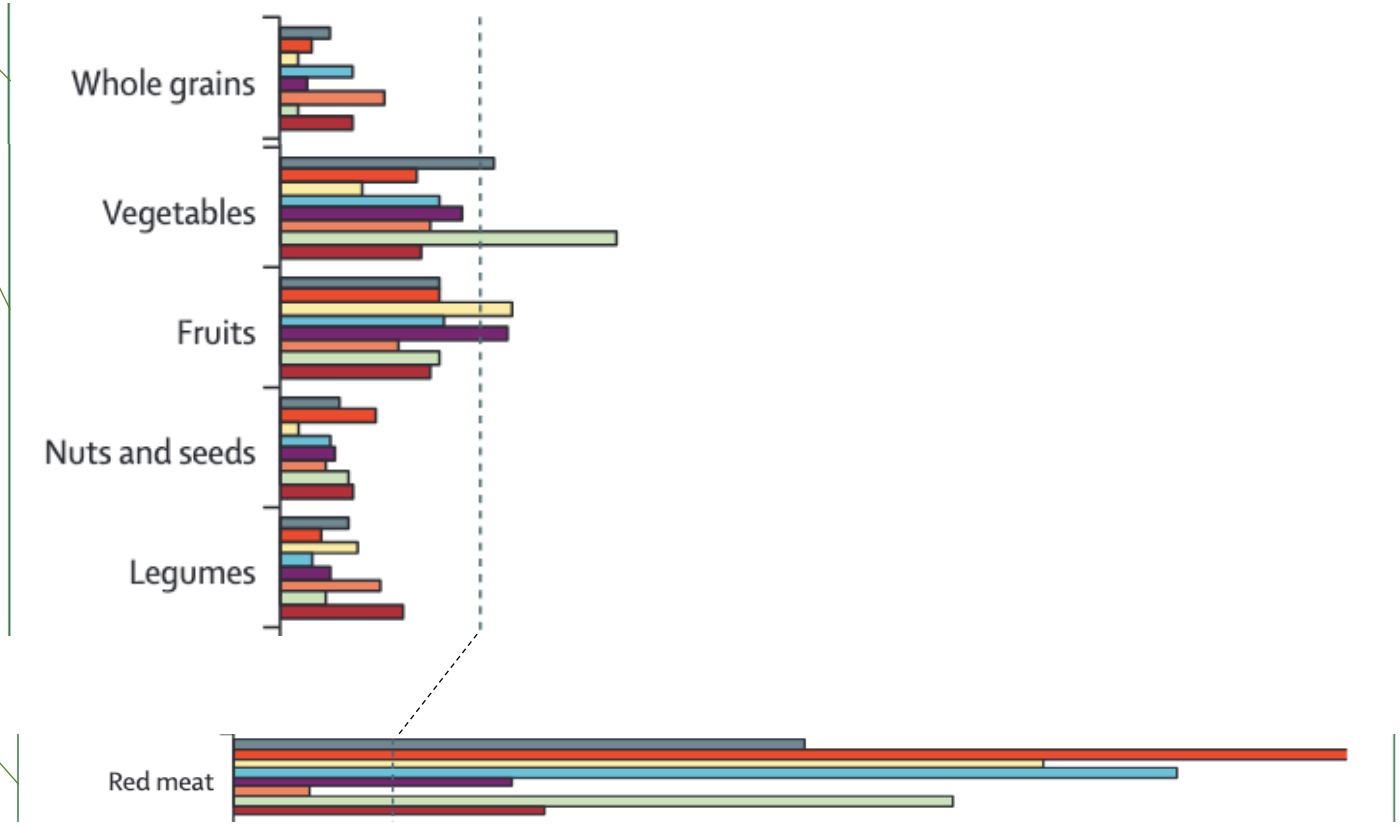

Figure 2: **Differences between adult diets in 2020 and the planetary health diet globally and by region**
The dashed line represents the reference values of the flexitarian version of the PHD from table 1 (see appendix 1 pp 24–25 for source).[195]

Rockström et al, 2025

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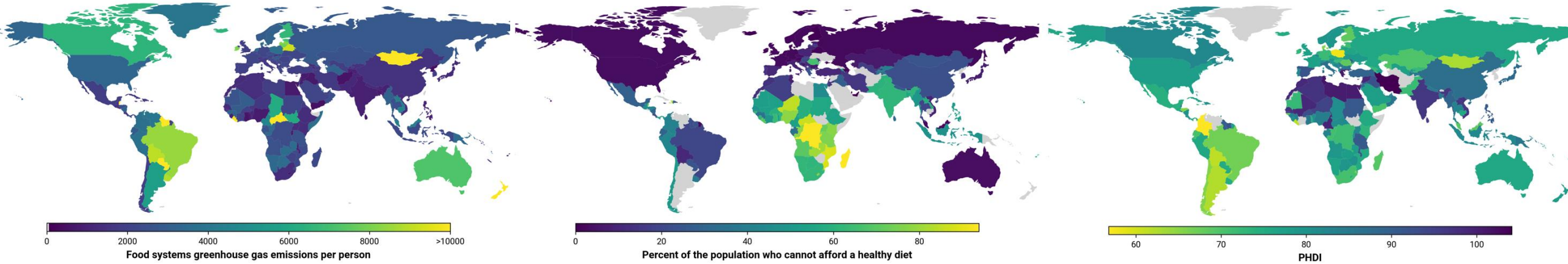

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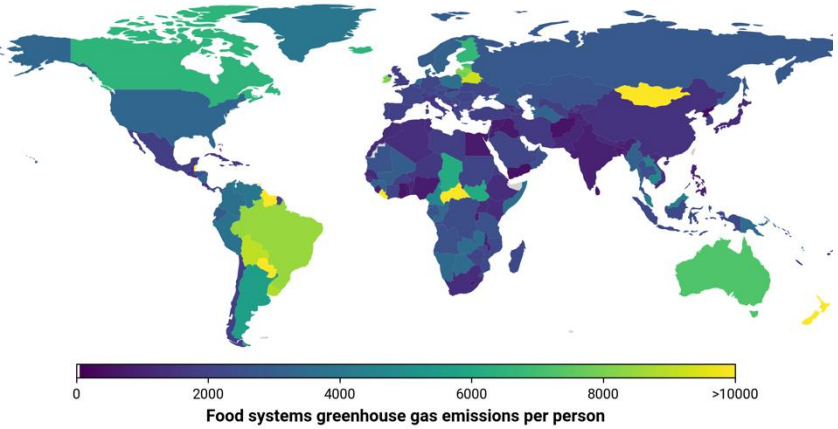
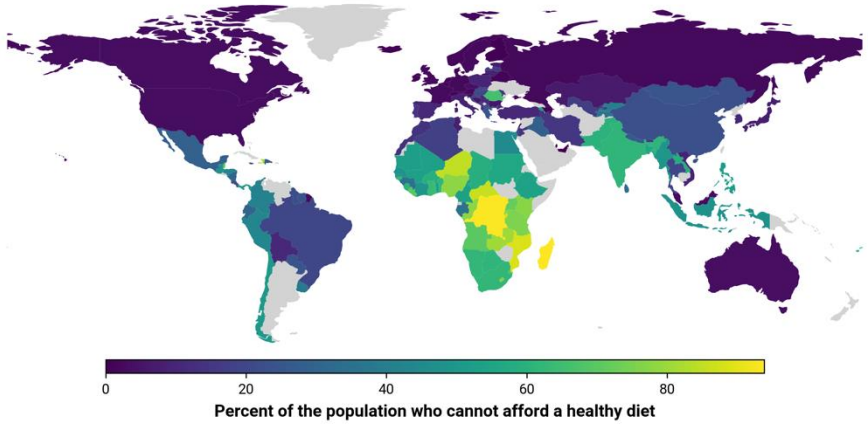
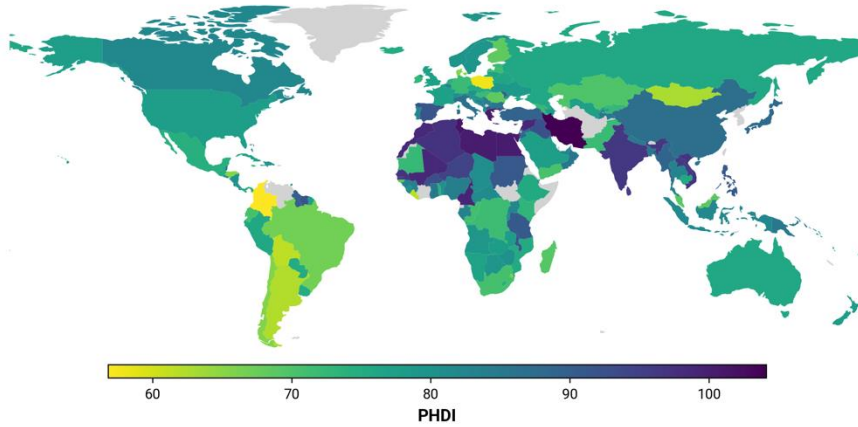
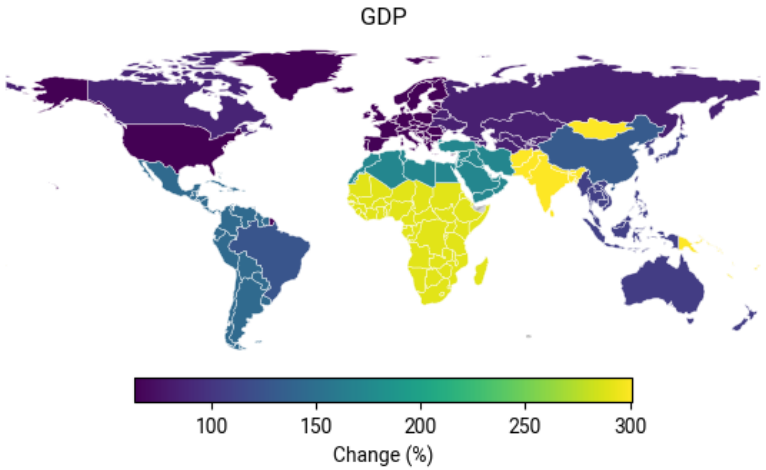


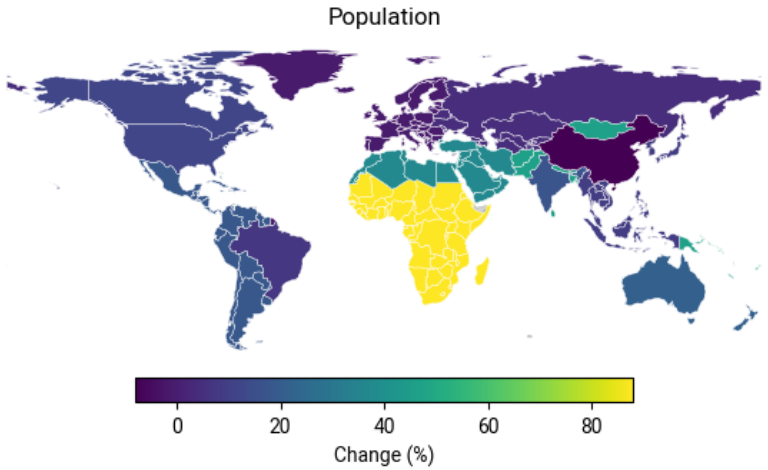


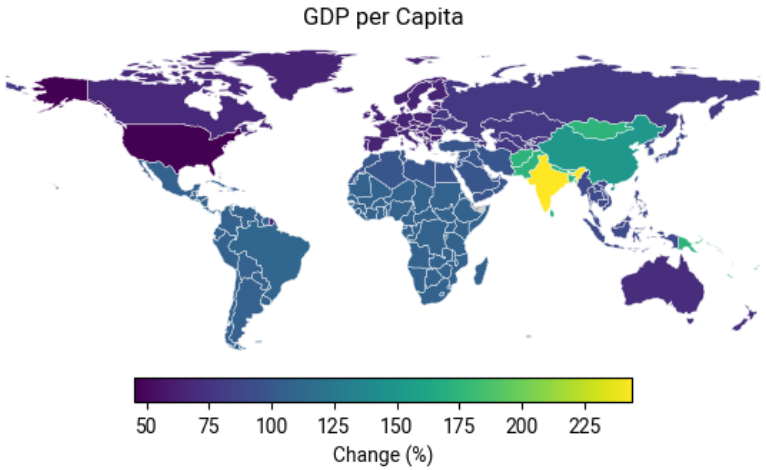


data from FAOSTAT (via Food Systems Dashboard), and Gu et al 2024

Middle-of-the-road Shared Socioeconomic Pathways Projections: percentage change from 2020 to 2050 (%) *aggregated to 13 AgMIP regions







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MODEL	FULL NAME	INSTITUTIONS	TYPE
AIM	Asia-Pacific Integrated Model	National Institute for Environmental Studies & Kyoto University	CGE
CAPRI	Common Agricultural Policy Regionalised Impact Model	European Commission Joint Research Centre	PE
ENVISAGE	Environmental Impact and Sustainability Applied General Equilibrium Model	Purdue University	CGE
FARM	Future Agricultural Resources Model	U.S. Department of Agriculture	CGE
GCAM	Global Change Analysis Model	Pacific Northwest National Laboratory, Joint Global Change Research Institute (PNNL, JGCRI)	PE
GLOBIOM	Global Biosphere Management Model	International Institute for Applied Systems Analysis (IIASA)	PE
IMAGE	Integrated Model to Assess the Global Environment	Netherlands Environmental Assessment Agency (PBL)	PE/IAM
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade	International Food Policy Research Institute (IFPRI)	PE
MAGNET	Modular Applied General Equilibrium Tool	Wageningen University	CGE
MAgPIE	Model of Agricultural Production and its Impact on the Environment	Potsdam Institute for Climate Impact Research (PIK)	PE

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EAT-Lancet Levers

Scenario Component	Description	Food Systems Transformation Dimensions			Climate Mitigation and Land-use Policies
		Diet	Productivity Assumptions	Waste	
BAU	Business as usual scenario based on SSP2 with a higher climate impact reflected by RCP 7.0	Model BAU assumptions on diets to 2050	Model BAU assumptions on crop and livestock productivity.	Model BAU assumptions on FLW	Model BAU assumptions on climate mitigation and LUC policies
DIETARY PREFERENCE SHIFT	Adds EAT-Lancet Diet to BAU	Globally achieves EAT-Lancet diet by 2050			
IMPROVED PRODUCTIVITY	Adds high productivity to BAU		High productivity growth rate similar to productivity trends associated with SSP1		
REDUCING FLW	Adds a reduction of food loss and waste to BAU			Reduction of FLW	
MITIGATION POLICIES	Adds mitigation and land-use policies consistent with 1.5C by 2050 to BAU				Mitigation and LUC policies consistent with 1.5C
EL with Mitigation (ELM)		Globally achieves EAT-Lancet diet by 2050	High productivity growth rate similar to productivity trends associated with SSP1	Reduction of FLW	Mitigation and LUC policies consistent with 1.5C

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Decomposition Analysis

- **Individual effect of driver:** the effect of the driver *in isolation*
  - One-at-a-time scenarios
  - (BAU + only the driver) - (BAU)

- **Total effect of the driver:** the effect of the driver *when bundled* with other drivers
  - Leave-one-out scenarios
    - E.g. (PROD+WAST+MITI+DIET) - (PROD+WAST+MITI) = total effect of DIET
  - Includes individual effect and its interactions with the other drivers when bundled

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REDUCING FLW	REMOVES a reduction of food loss and waste to BAU			Model BAU assumptions on FLW	
MITIGATION POLICIES	REMOVES mitigation and land-use policies consistent with 1.5C by 2050 to BAU				Model BAU assumptions on climate mitigation and LUC policies

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- Are there broad patterns of restructuring of agriculture across regions under ELM?

- How are the four scenario drivers contributing to ELM outcomes across these broad patterns?

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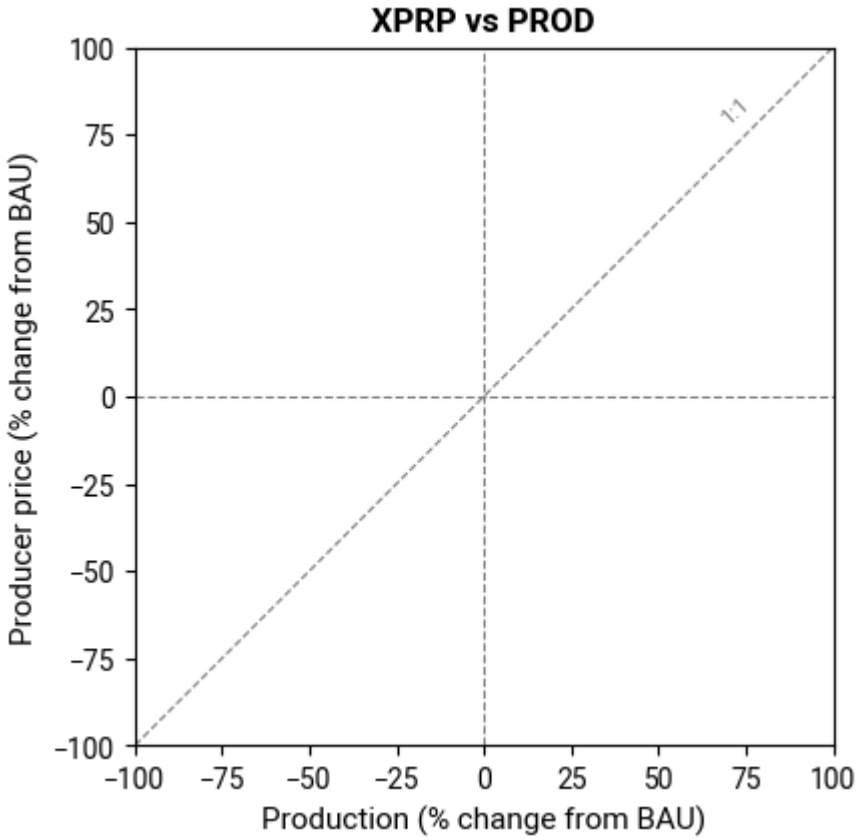

- Relationship between relative change in producer prices (XPRP) and agricultural production (PROD)

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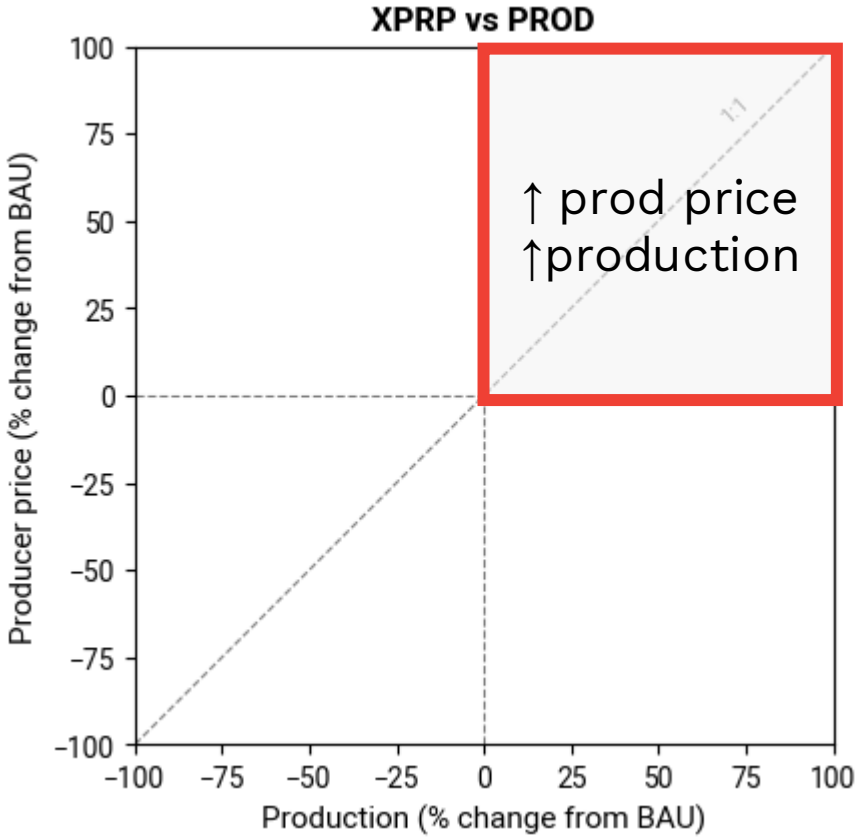

- **increase in both** in producer prices and agricultural production
- Can indicate that <u>demand growth is outpacing supply</u>
  - Rapidly growing regions can experience this

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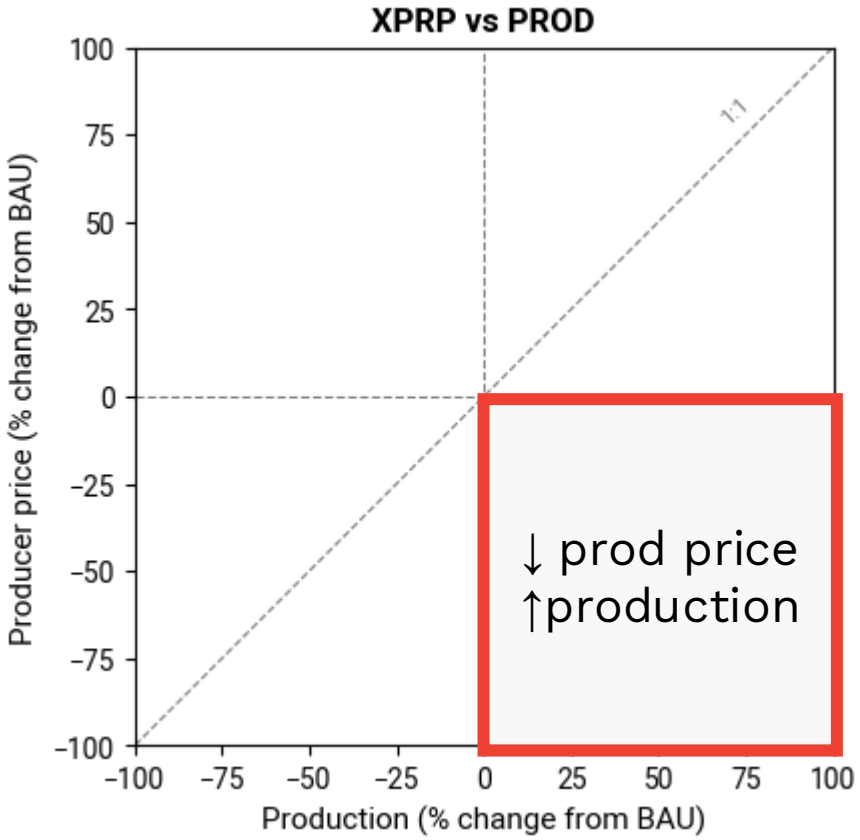

- **decrease** in producer prices and **increase** agricultural production
- Captures efficiency improvements where productivity gains expand production at lower cost

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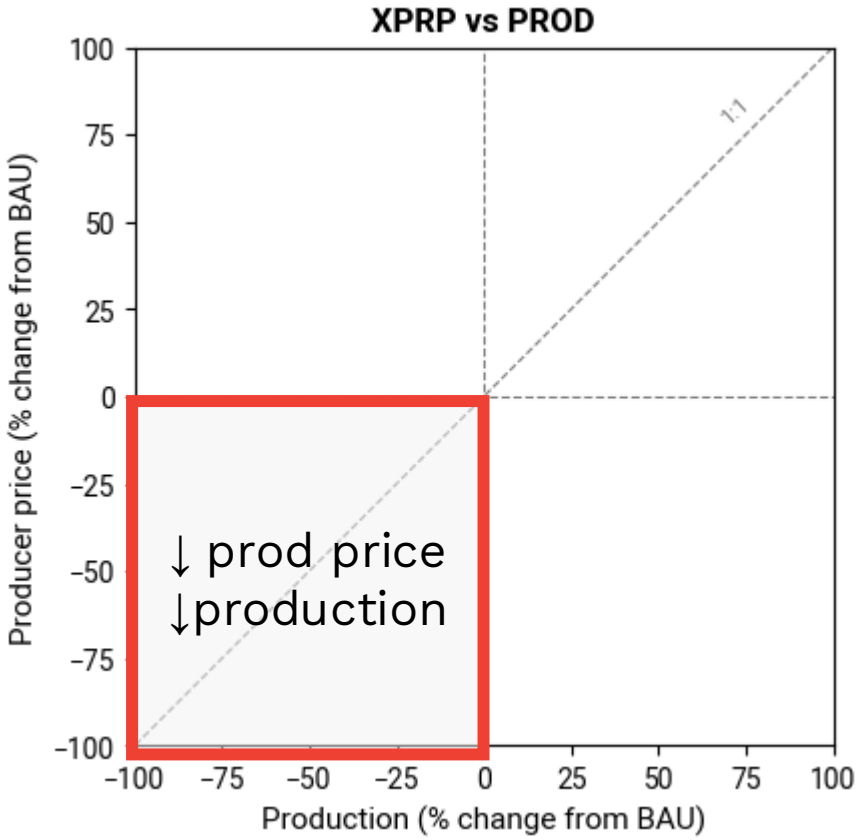

- **decrease in both** in producer prices and agricultural production
- Demand-led contraction

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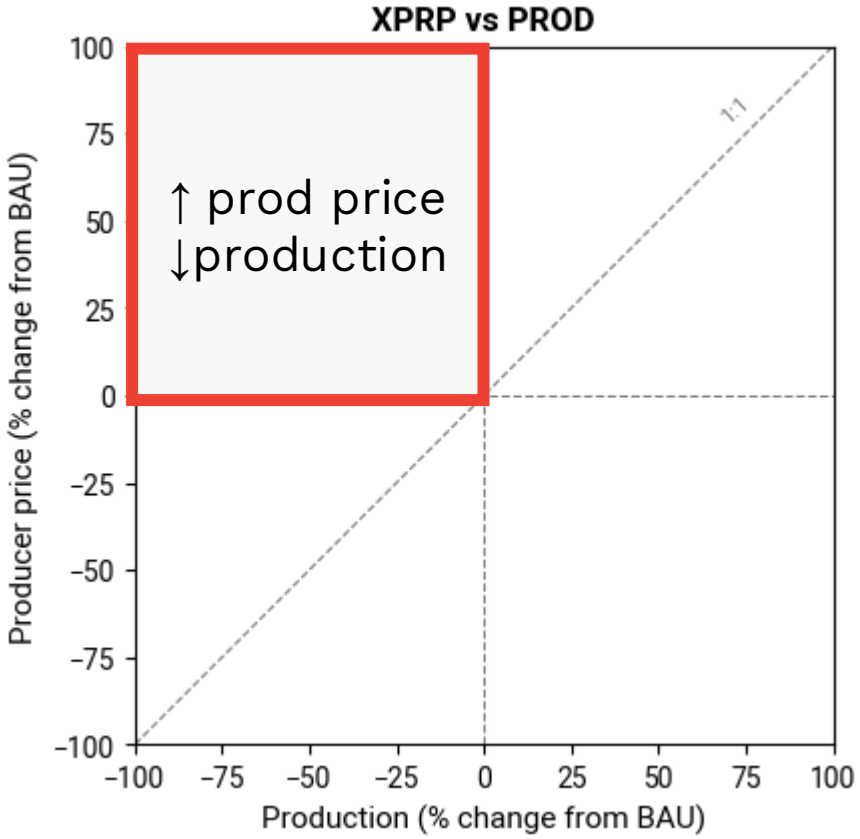
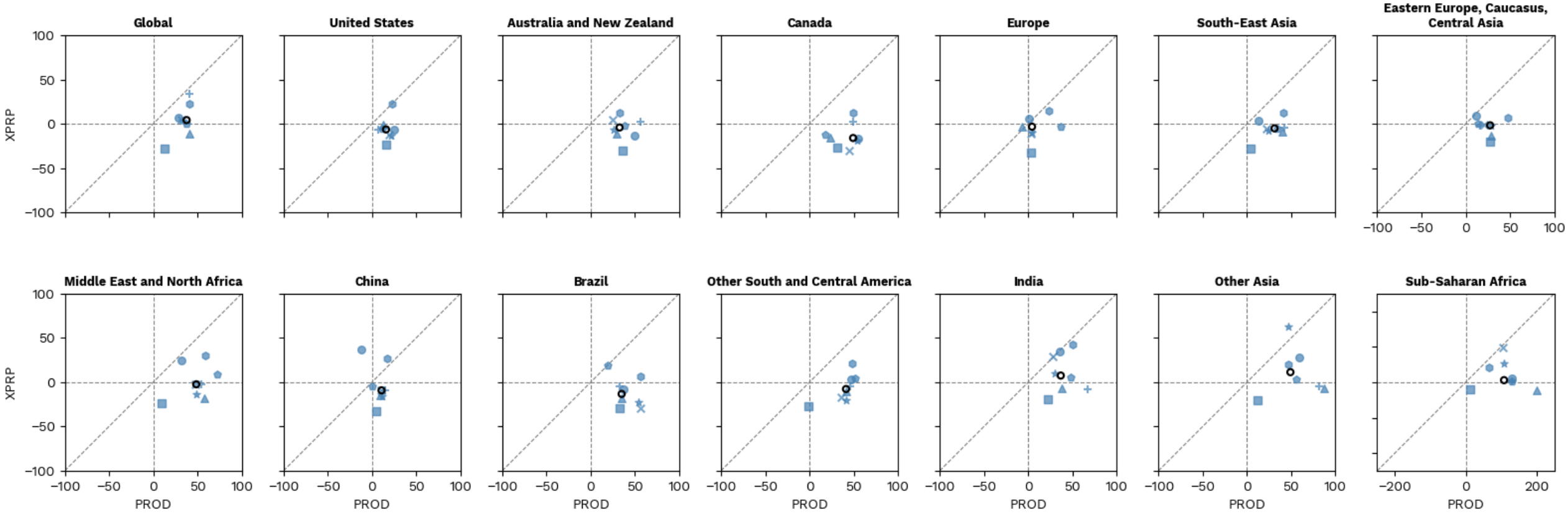


- **increase** in producer prices and **decrease** agricultural production
- contraction where supply constraints outpace demand reductions

Real producer price vs agricultural production (% change from 2020): BAU



- Agricultural production projected to increase more than producer price in BAU 2050

AIM CAPRI ENVISAGE FARM GCAM GLOBIOM IMAGE IMPACT MAgPIE MAGNET Ensemble Median

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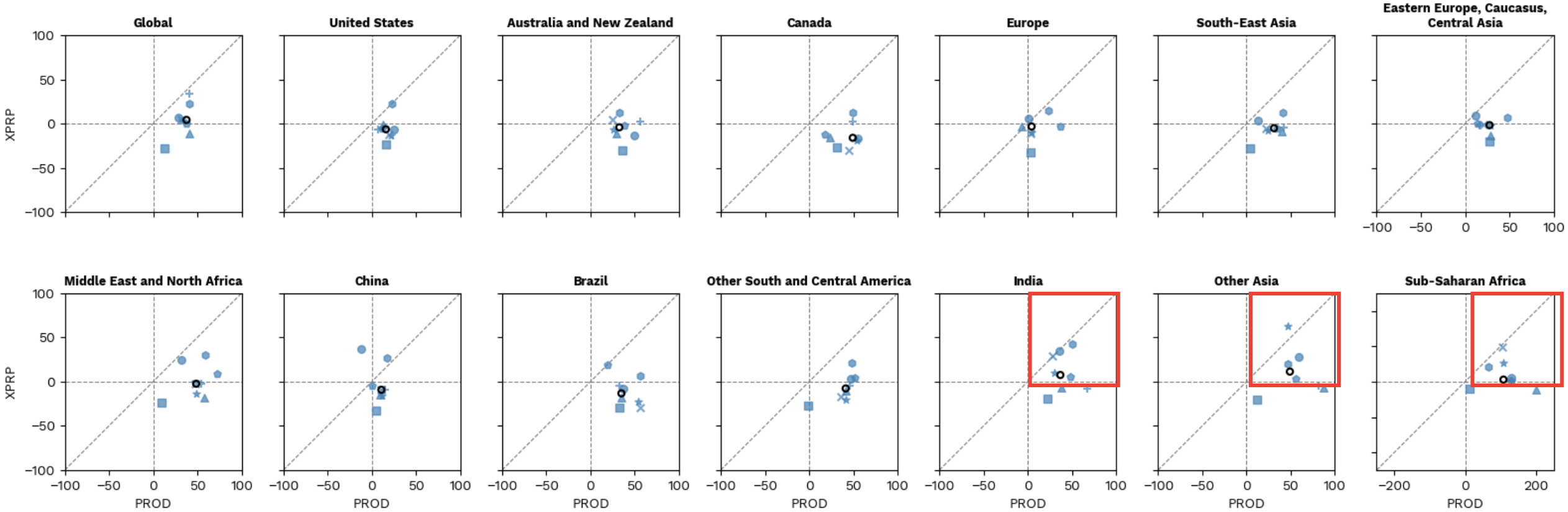
Real producer price vs agricultural production (% change from 2020): BAU



* different scale for SSA

- Agricultural production projected to increase more than producer price in BAU 2050
- Median increase in producer price for IND, OAS, and SSA – regions growing rapidly

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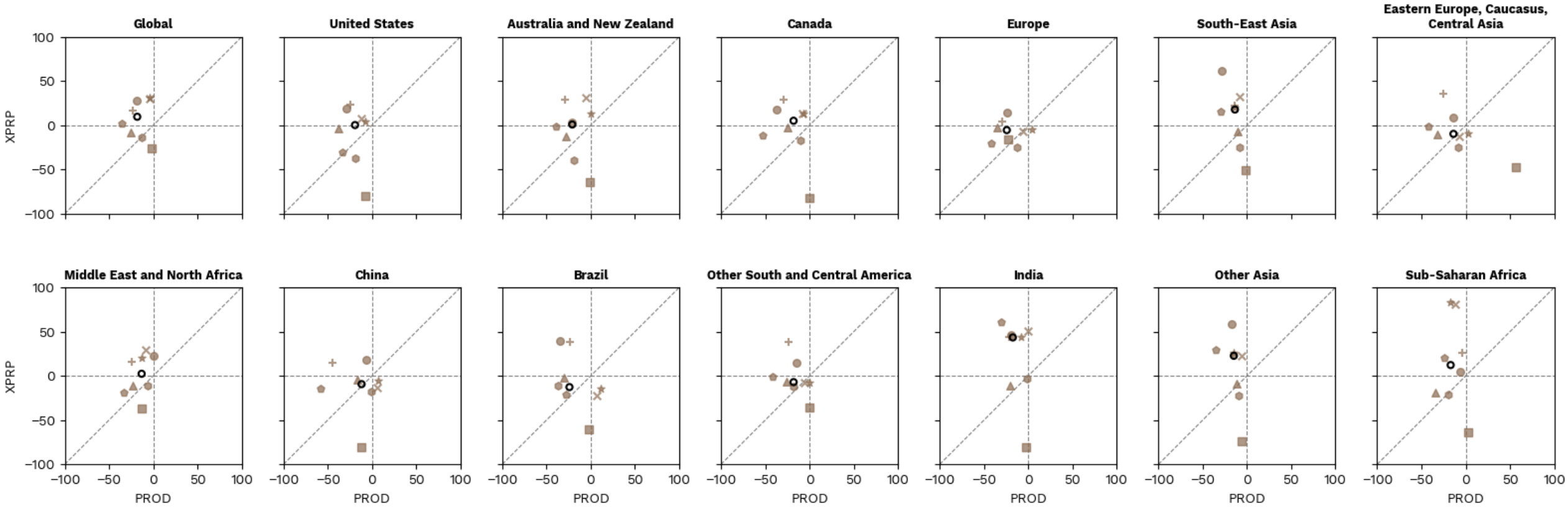
Real producer price vs agricultural production (% change from BAU 2050): ELM



- Agricultural production decreases globally and regionally in ELM compared to BAU 2050
- There is uncertainty in the direction of change for producer prices across models

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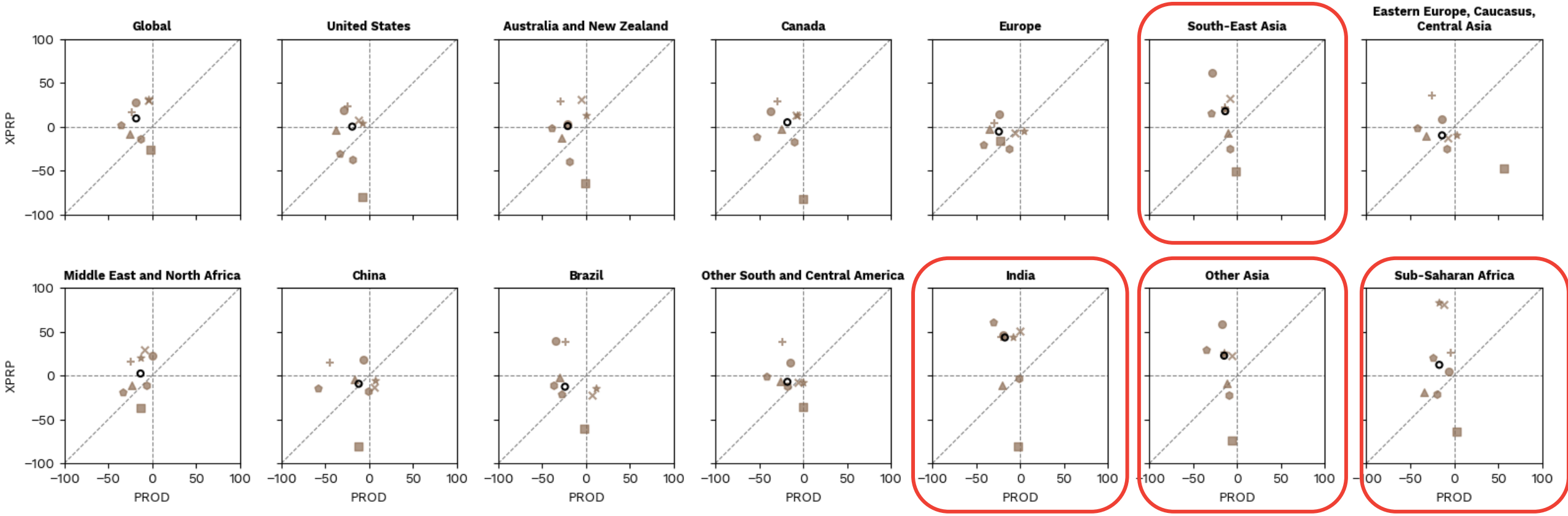

- Supply-constrained contraction of agriculture in SEA, IND, OAS, SSA

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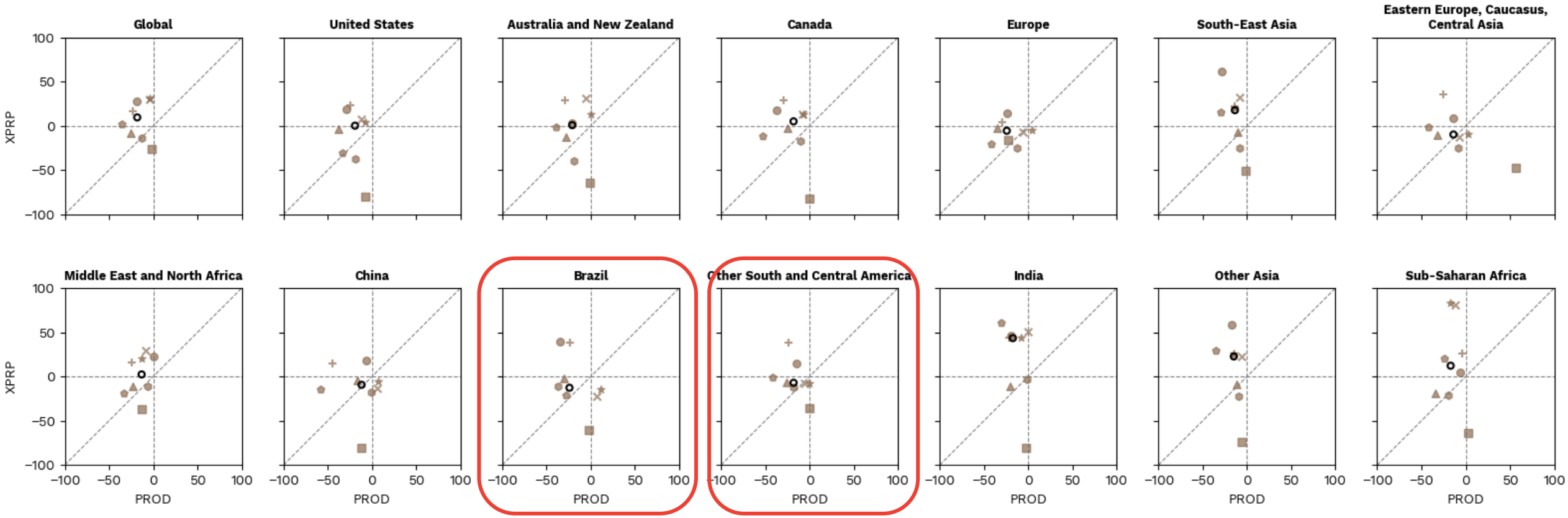
Real producer price vs agricultural production (% change from BAU 2050): ELM



- Supple-constrained contraction of agriculture in SEA, IND, OAS, SSA
- Demand-led contraction of agriculture in BRA, OSA

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- Are there broad patterns of restructuring of agriculture across regions under ELM?
  - Agricultural sectors contract everywhere in ELM relative to BAU, but through two fundamentally different mechanisms: **supply-constrained contraction (eg. IND, OAS, SEA, SSA) vs. demand-led contraction (eg. BRA, OSA).**
- How are the four scenario drivers contributing to ELM outcomes across these broad patterns?

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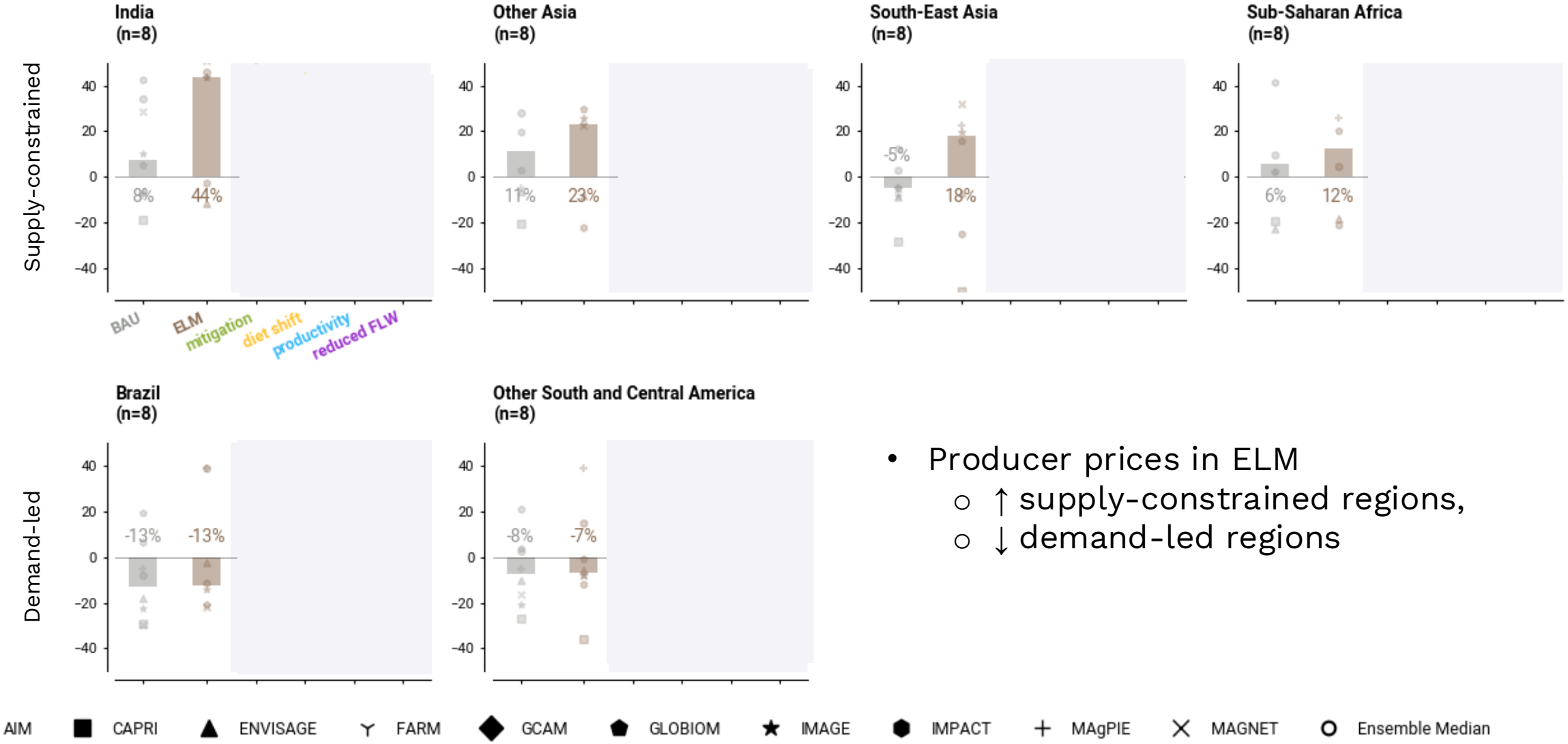
Agricultural Producer price (n=8)



- Producer prices in ELM
  - ↑ supply-constrained regions,
  - ↓ demand-led regions

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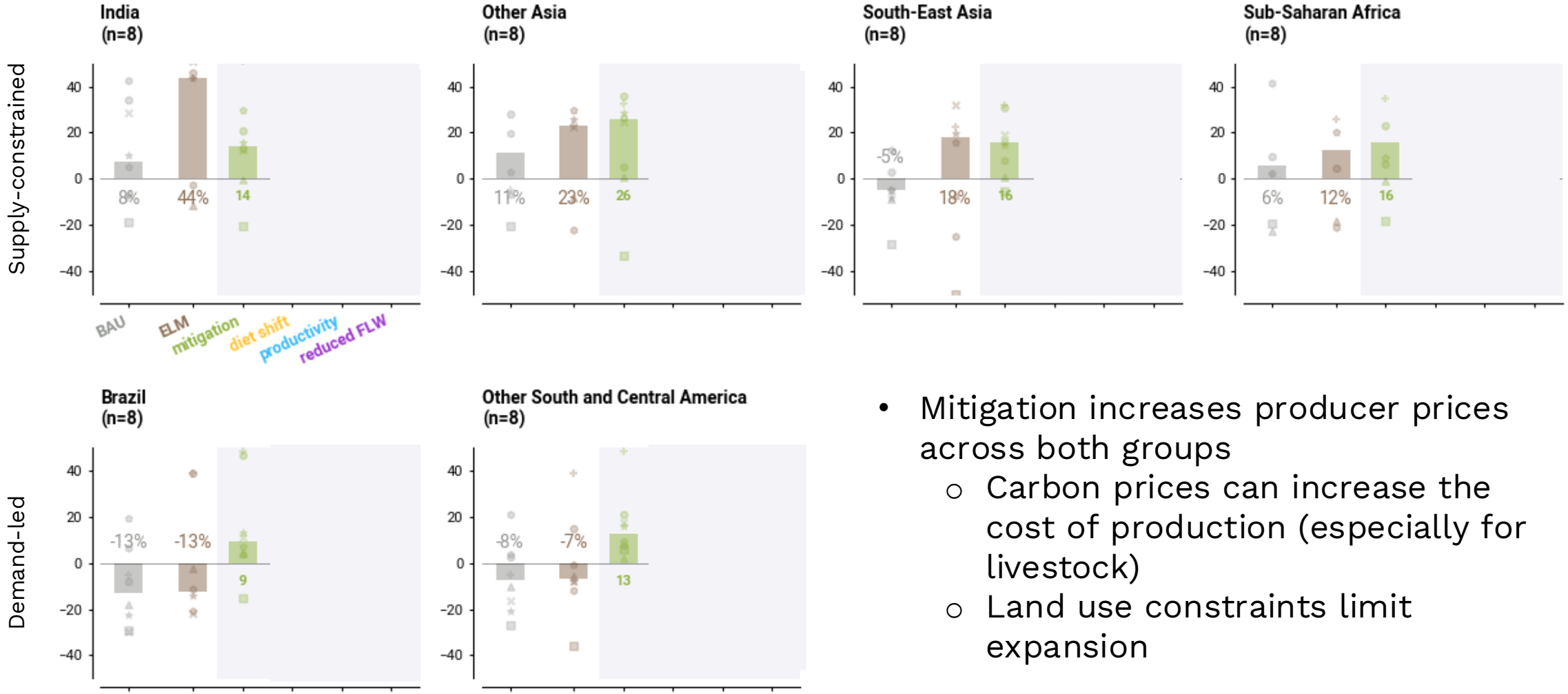

- Mitigation increases producer prices across both groups
  - Carbon prices can increase the cost of production (especially for livestock)
  - Land use constraints limit expansion

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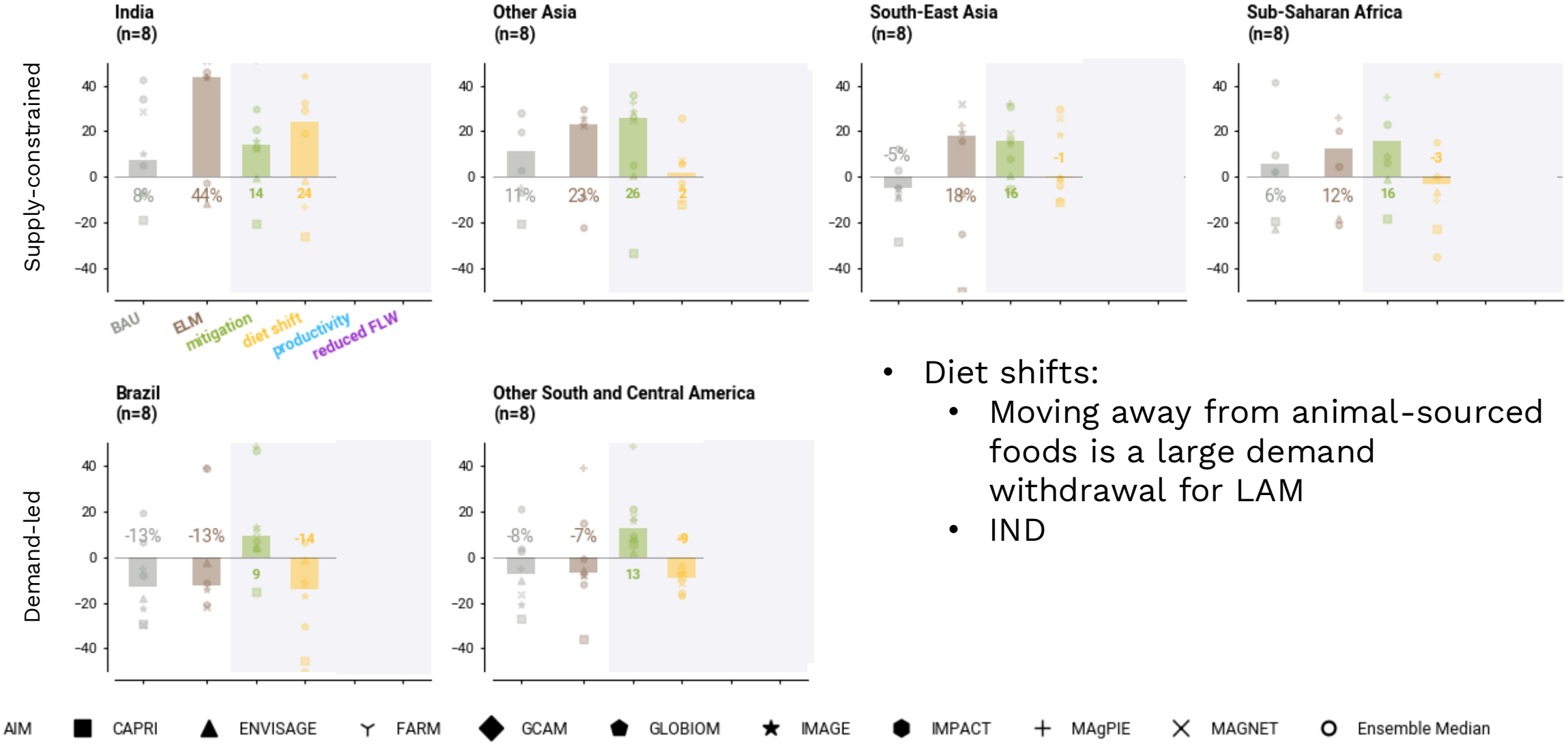

- Diet shifts:
  - Moving away from animal-sourced foods is a large demand withdrawal for LAM
  - IND

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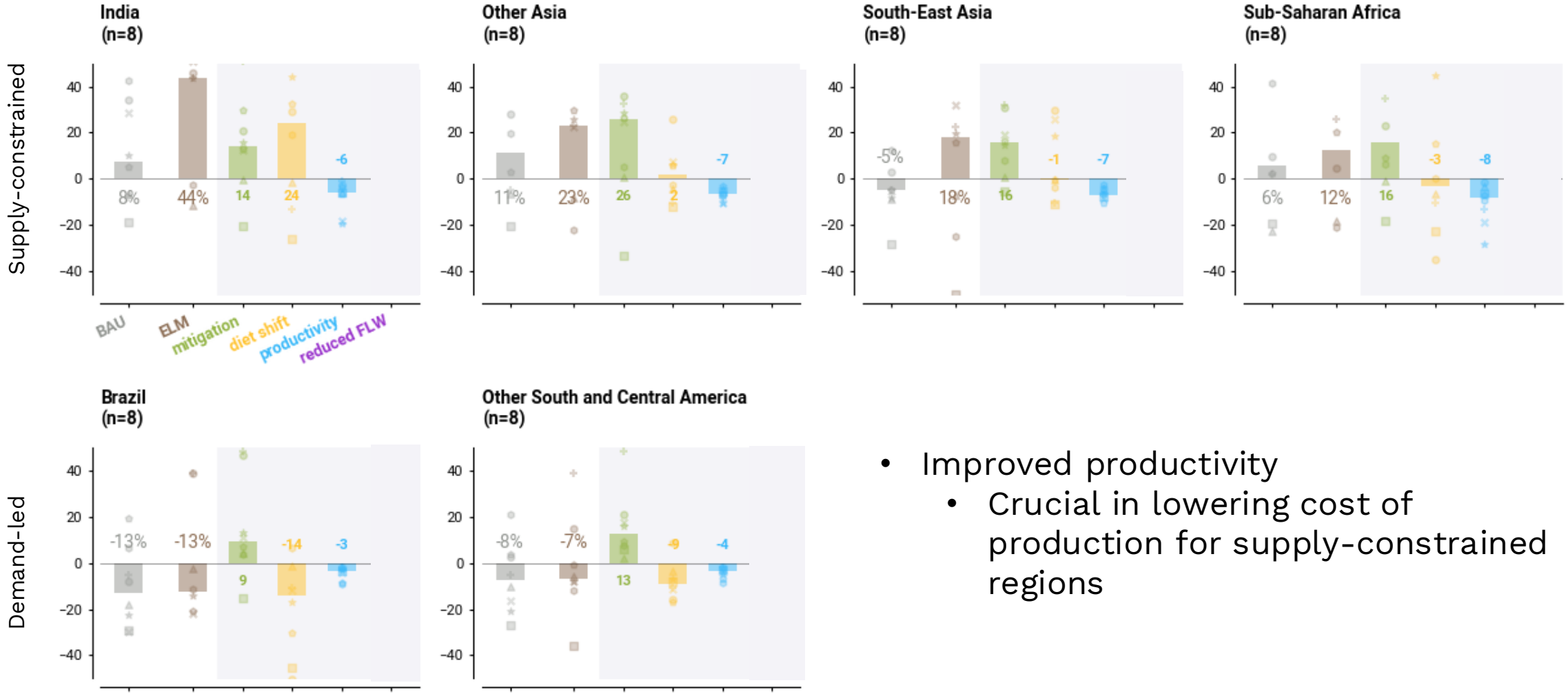

- Improved productivity
  - Crucial in lowering cost of production for supply-constrained regions

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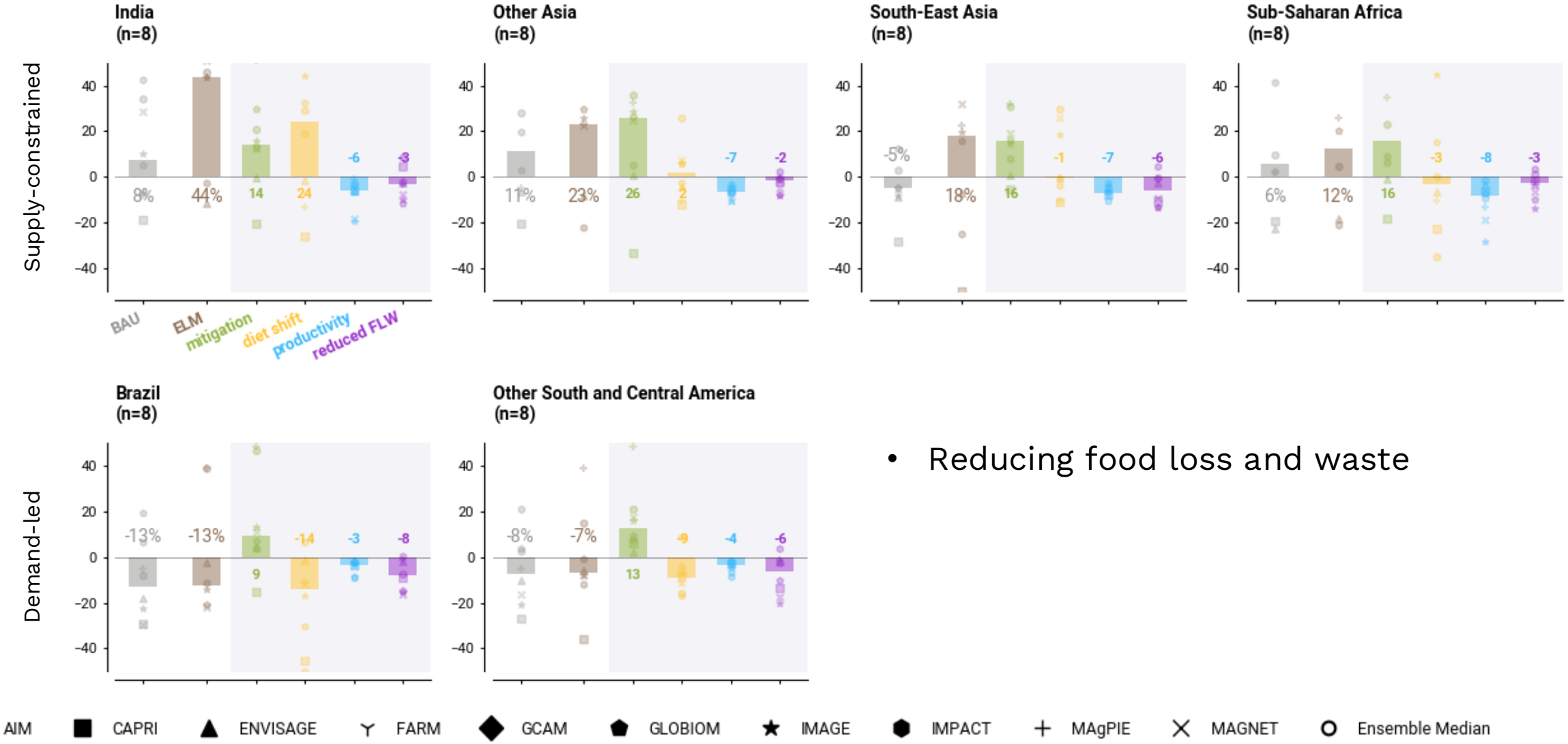

- Reducing food loss and waste

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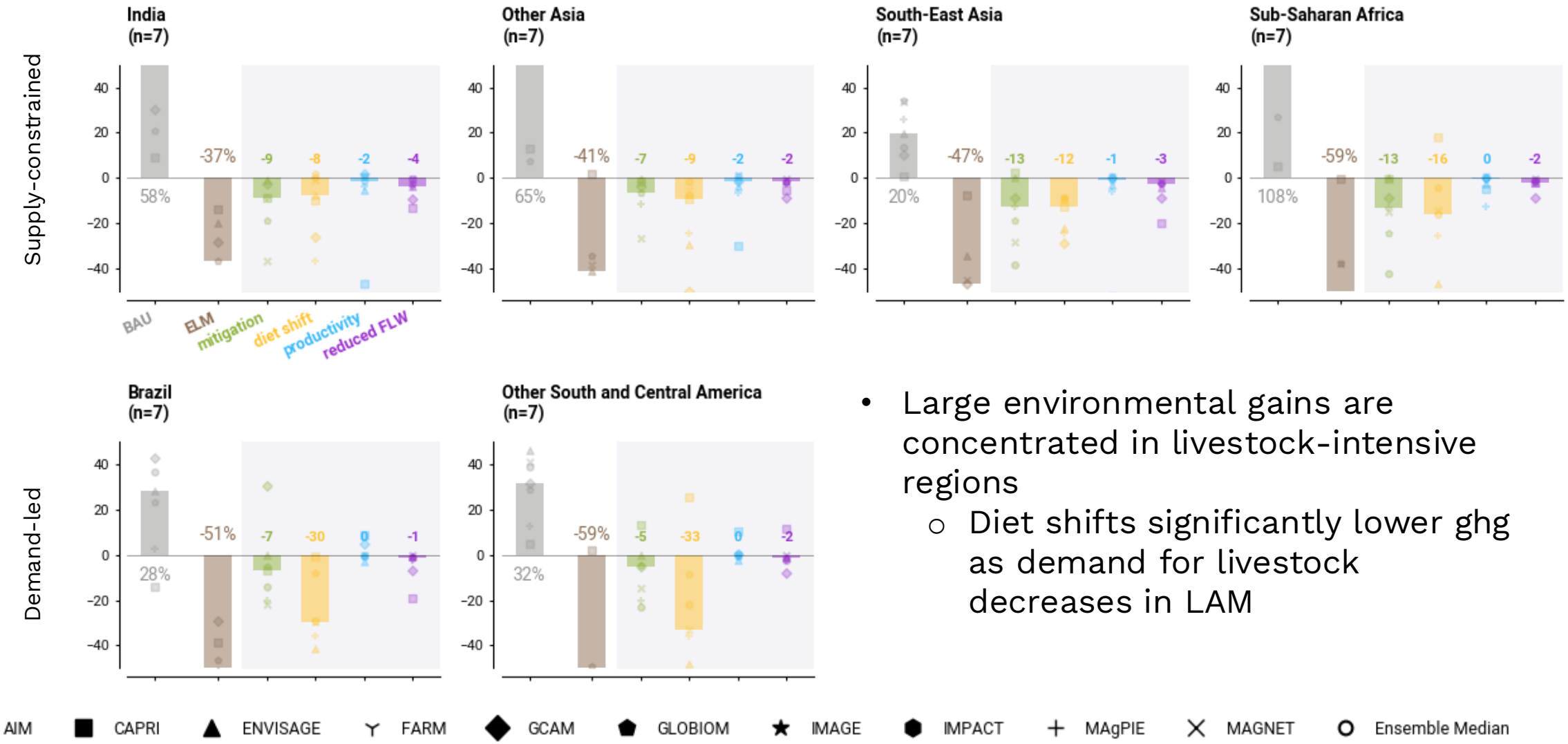
Non-CO2 Emissions from Agriculture



- Large environmental gains are concentrated in livestock-intensive regions
  - Diet shifts significantly lower ghg as demand for livestock decreases in LAM

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- How are the four scenario drivers contributing to ELM outcomes across these broad patterns?
  - For supply-constrained regions (IND, OAS, SEA, SSA): PROD is necessary to buffer cost increases that MITI and DIET could impose
  - For demand-led regions (BRA, OSA): the way DIET is implemented will shape how and how smoothly the sector reorients

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FUTURE DIRECTIONS

- Investigating more output dimensions (eg. Labor, trade) and whether these additional dimensions can uncover more patterns of transformation
- Investigation on sources of model disagreement and uncertainty – a feature not a bug of multi-model ensembles
    - Regions: Improved regional representation and regional models.
    - Sectors: investigate driver importance by sector and region especially LSP and VFN
    - Drivers: improved narratives of change especially for diet shifts

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Thank you

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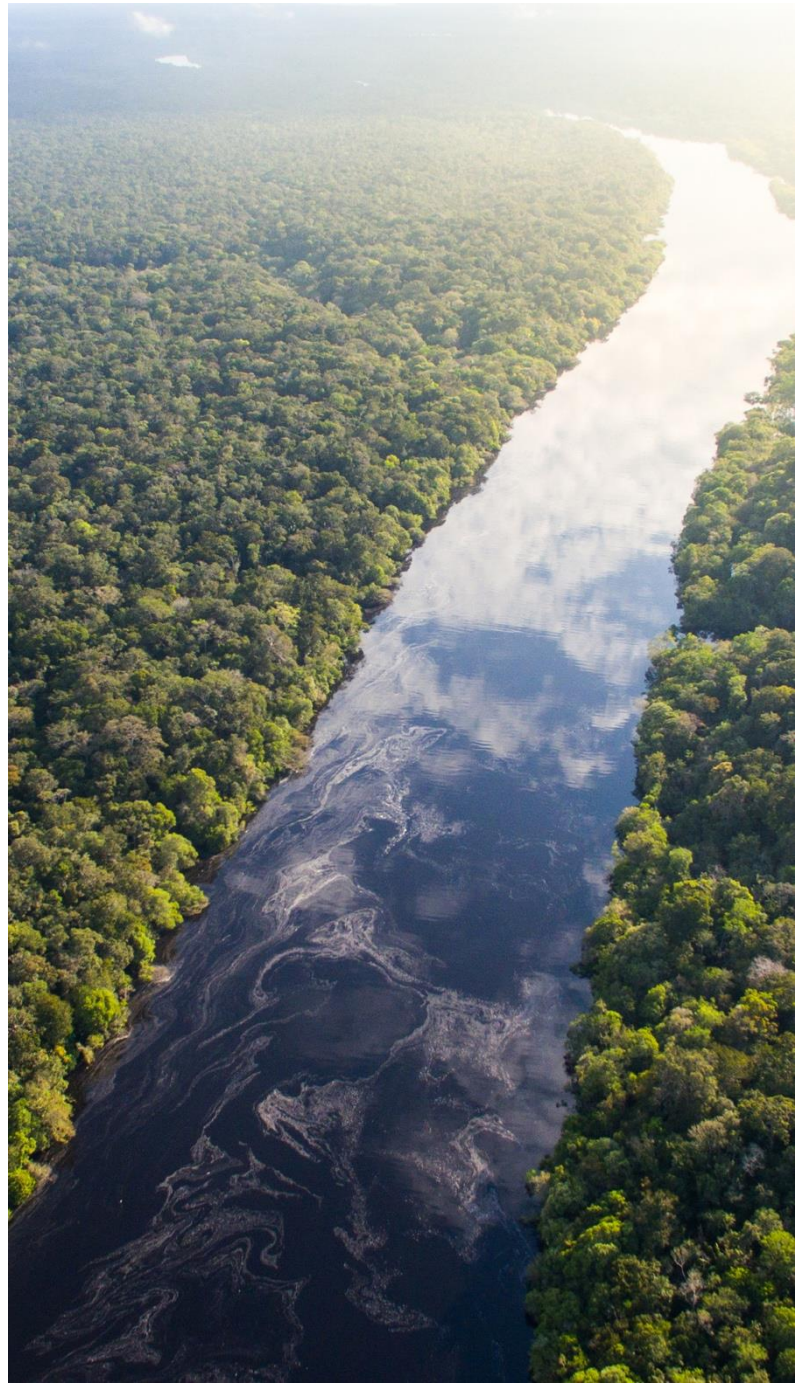
Cornell CALS

College of Agriculture and Life Sciences

Global Development



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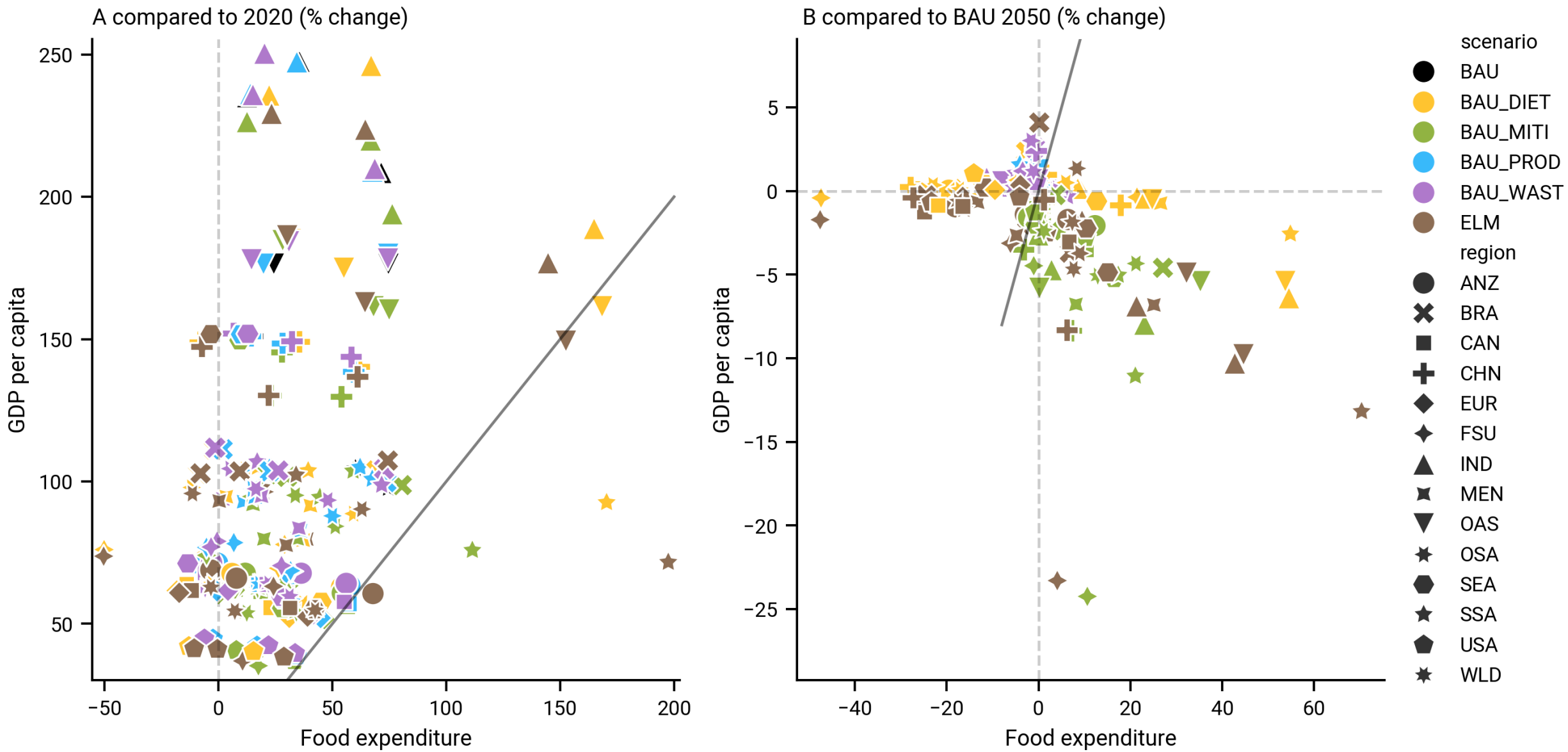
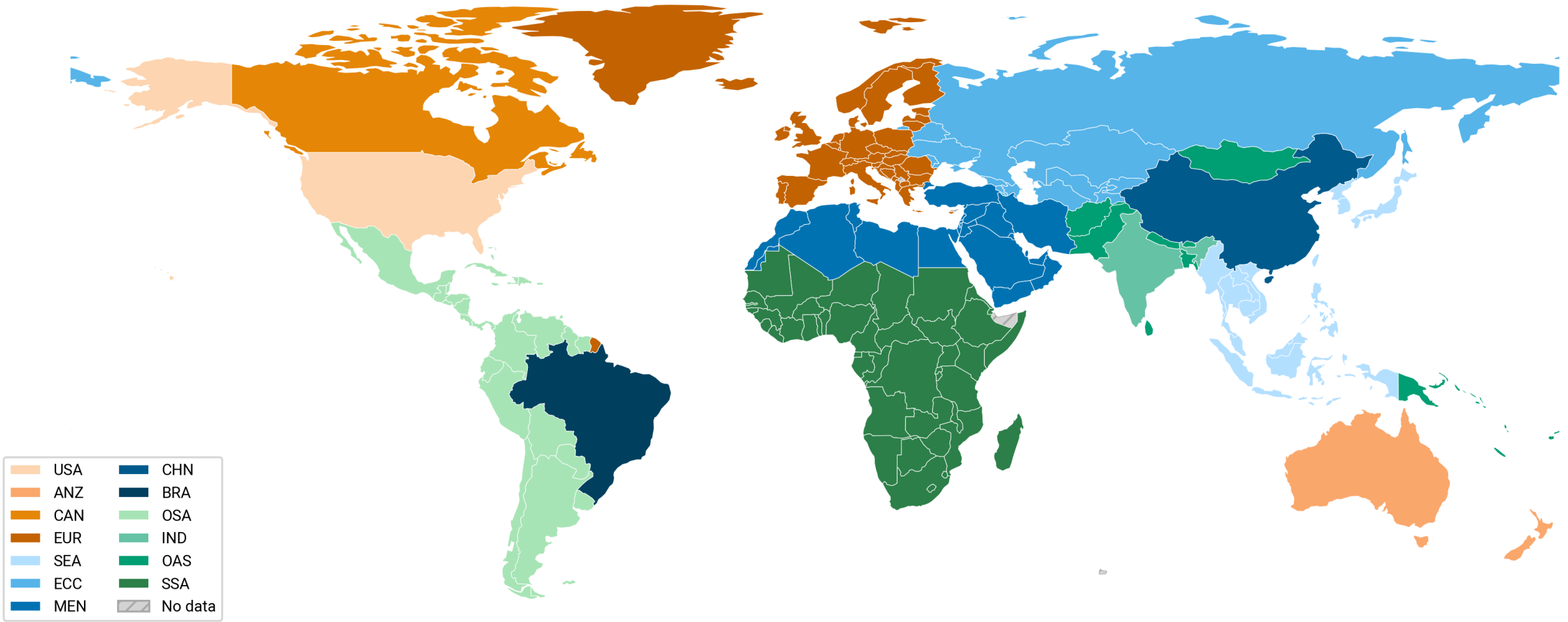
	Description
Business as usual (BAU)	BAU scenario based on the middle-of-the-road shared socioeconomic pathway, following recent economic, technological, and dietary trends. There are no additional climate mitigation and land-use policies other than national policies that are already implemented.
Increased productivity (PROD)	Agricultural productivity increases consistent with the shared socioeconomic pathway of taking the greener road (SSP1), which represents a more sustainable and optimistic world with greater investments in agricultural research and technology compared with the BAU scenario. Models applied **exogenous improvements to crop yields and livestock feed conversion efficiency following SSP1 assumptions**. Several models also incorporated endogenous mechanisms where productivity improvements respond to economic incentives such as **reduced interest rates, particularly in low- and middle-income regions**
Reduced food loss and waste (WAST)	Reducing food loss and waste consistent with Sustainable Development Goal 12.3 on halving per-capita food waste and reducing losses along the supply chain. Models applied exogenous reductions to loss and waste shares across different stages of the food supply chain (production, processing, retail, and consumption) and food groups, targeting a 50% reduction in these shares by 2050
Diet shift (DIET)	Shifting diets towards healthier consumption patterns consistent with the EAT-Lancet healthy reference diet. Models implemented dietary shifts towards the EAT–Lancet healthy reference diet, primarily through exogenous shocks to **shift demand curves or adjusting elasticity parameters that modify consumption patterns to align with recommended intake levels by food group and region by 2050**. The models allowed for endogenous price and market responses to these demand shifts, with some incorporating region-specific adjustments to account for local food preferences and economic constraints.
Mitigation policies (MITI)	Climate mitigation and land-use policies aligned with achieving a 1·5°C target by 2100. Models achieved this through **carbon pricing mechanisms that put a cost on greenhouse gas emissions, with carbon prices increasing over time.** This incentivised shifts towards less emission-intensive production methods, adoption of mitigation technologies, limited land expansion, incentivised land-based carbon sequestration such as reforestation and afforestation, and increased demand for bioenergy crops. Several models also incorporated **land-use policies such as forest protection**
Combined scenario (EAT–Lancet food system transformation with mitigation; ELM)	A scenario that combines PROD, WAST, DIET, and MITI

Per Capita GDP and Food Expenditure




USA
ANZ
CAN
EUR
SEA
ECC
MEN
CHN
BRA
OSA
IND
OAS
SSA
No data

Decomposition analysis: background

A Methodology for Determining Interactions in Probabilistic Safety Assessment Models by Varying One Parameter at a Time

Emanuele Borgonovo*

$$\Delta y = g(z^1) - g(z^0) = \sum_{i=1} \Delta_i g + \sum_{i<j} \Delta_{i,j} g + \cdots + \Delta_{1,2,\ldots,n} g$$

Change in y

Difference between g in scenario z1 and scenario z2

Change in g if only drivers i and j were changed (second order)

Change in g if only i driver was changed, Sum over all I (first order)

- Demonstrated that one can derive the total effect (sum of first order and higher order [interaction] effects) of a driver using this simplification:

$$\phi_i^T = g(z^1) - g([z_1^1, z_2^1, \ldots, z_{i-1}^1, z_i^0, z_{i+1}^1, \ldots, z_n^1])$$

- Allows total, individual and interaction effects to be estimated in 2n+1 experiments vs 2^n-1

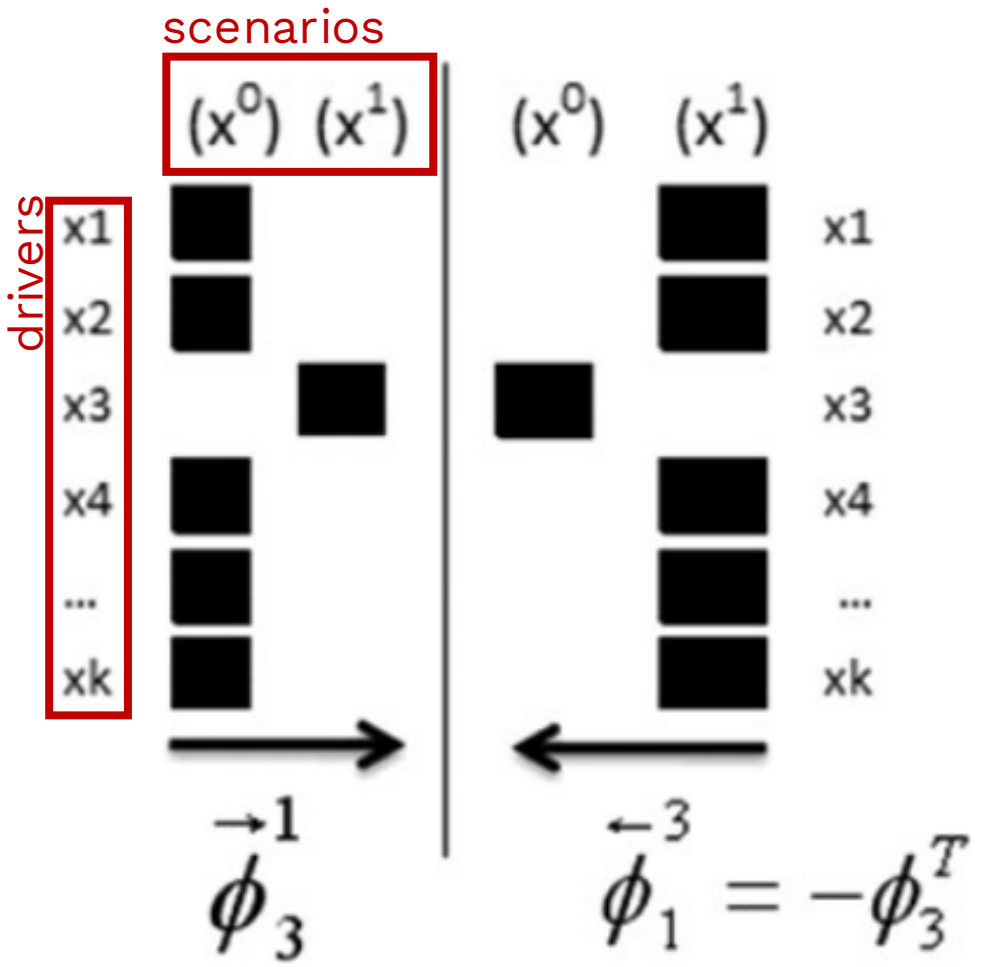


Fig. 2. A visual representation of the symmetry effect that allows to estimate ϕ^T by one-parameter-at-a-time variations.

Decomposition analysis: background

individual effect of *

g(nothing but the input) − g(nothing) = effect of * by itself

- nothing but the input
- nothing

→ BAU = nothing

BAU_* = nothing but * → BAU_* − BAU

total effect of *

g(all) − g(all but *) = effect of * when other drivers are present

- all
- all but * → ELM − ELM_*

ELM = all

→ ELM_* = all but *

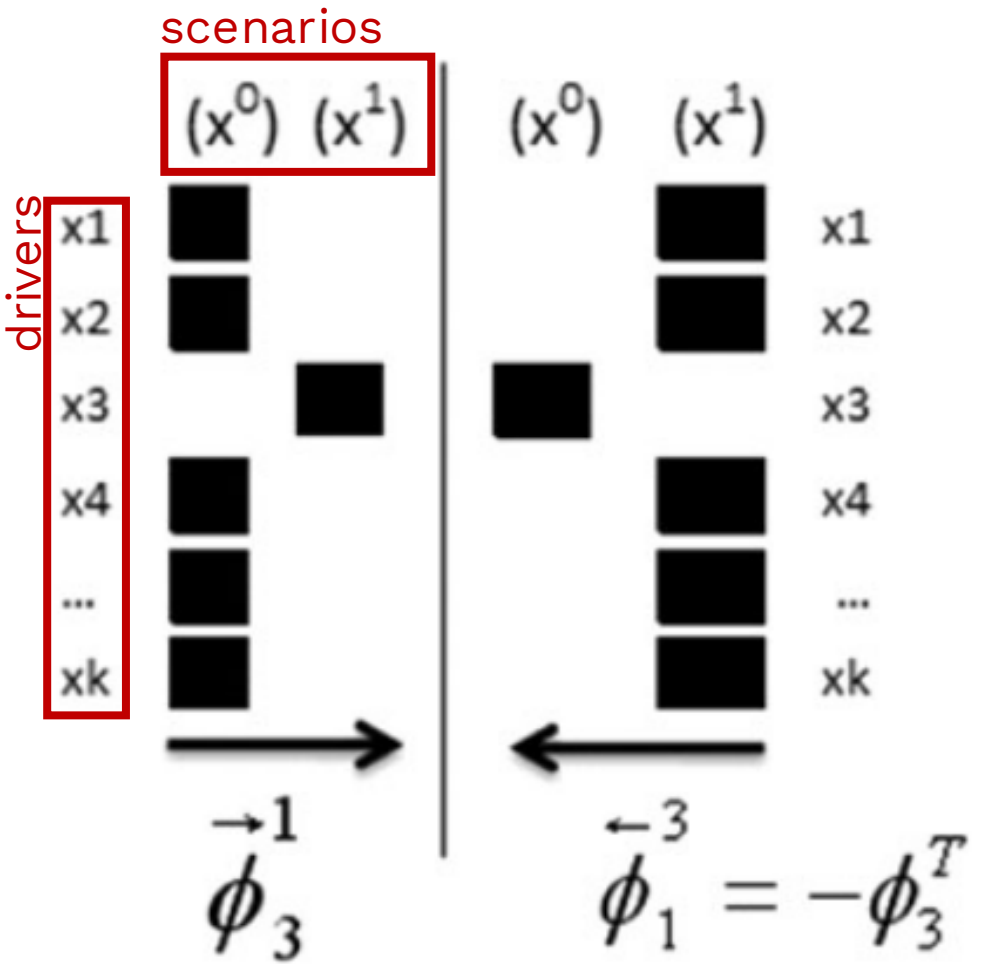
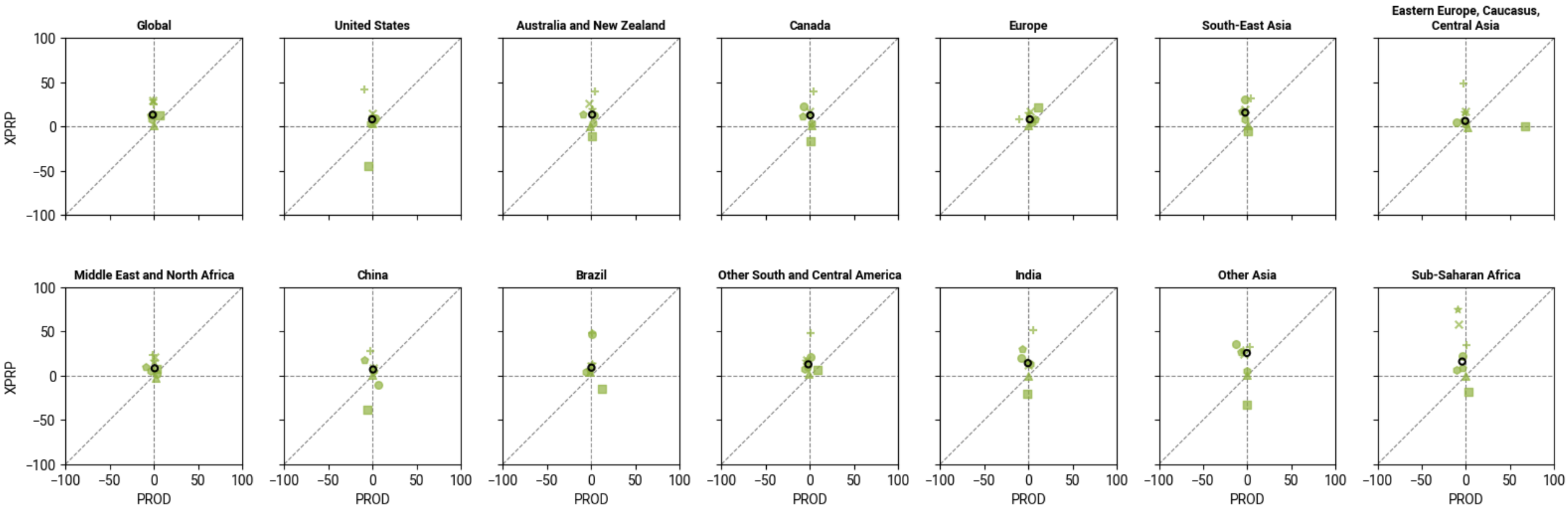
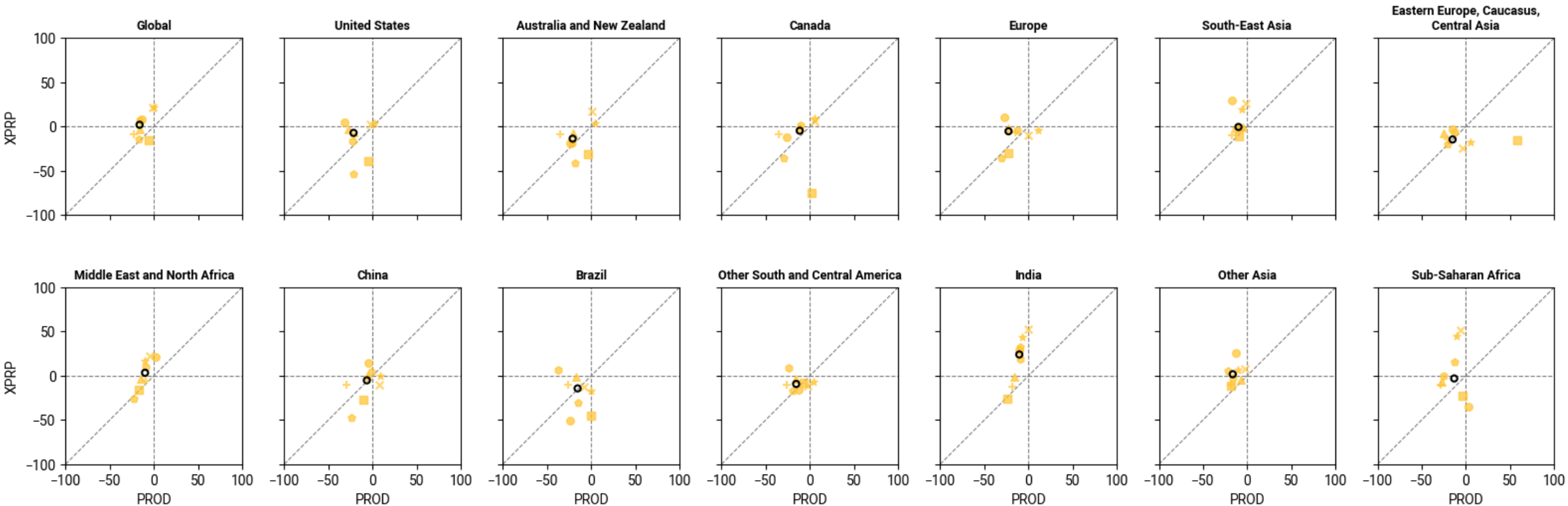


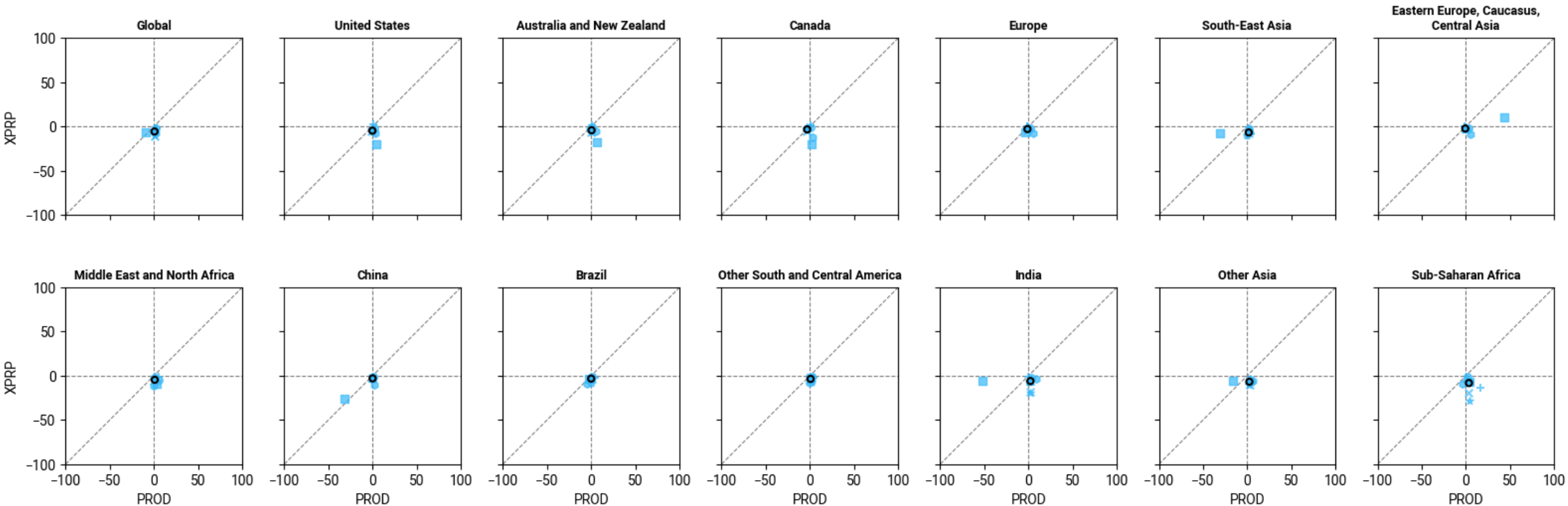
Fig. 2. A visual representation of the symmetry effect that allows to estimate ϕ^T by one-parameter-at-a-time variations.

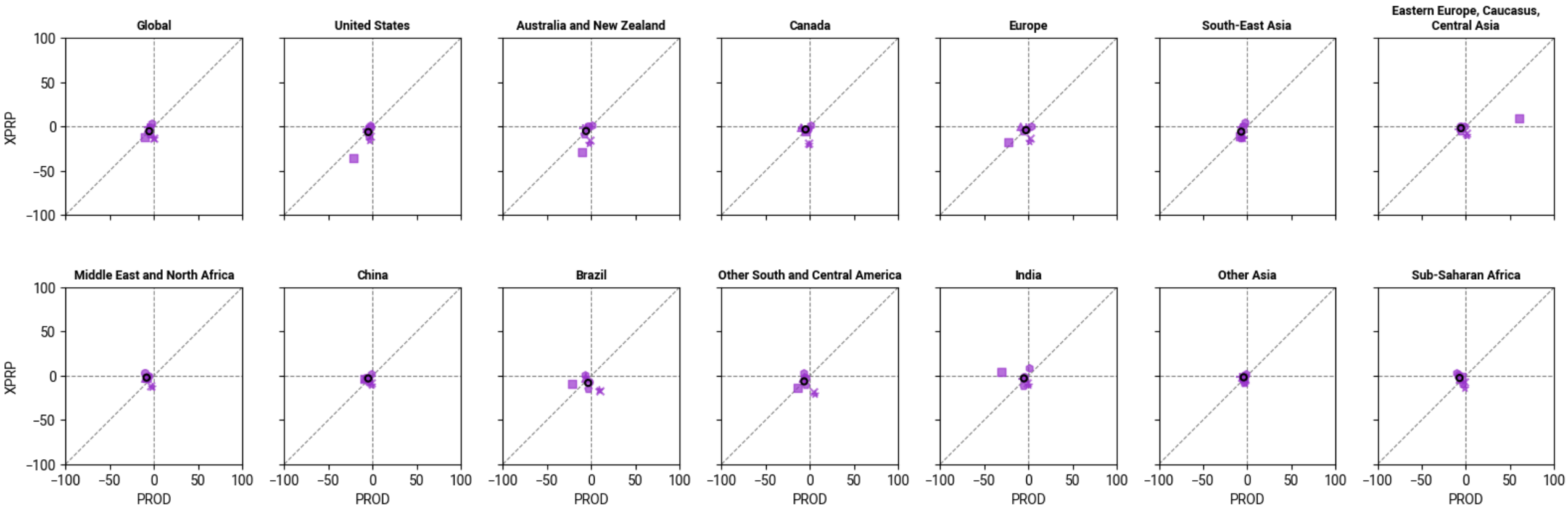
Food system impacts across scenarios and drivers (% change from BAU)

Environmental impacts across scenarios and drivers (% change from BAU)

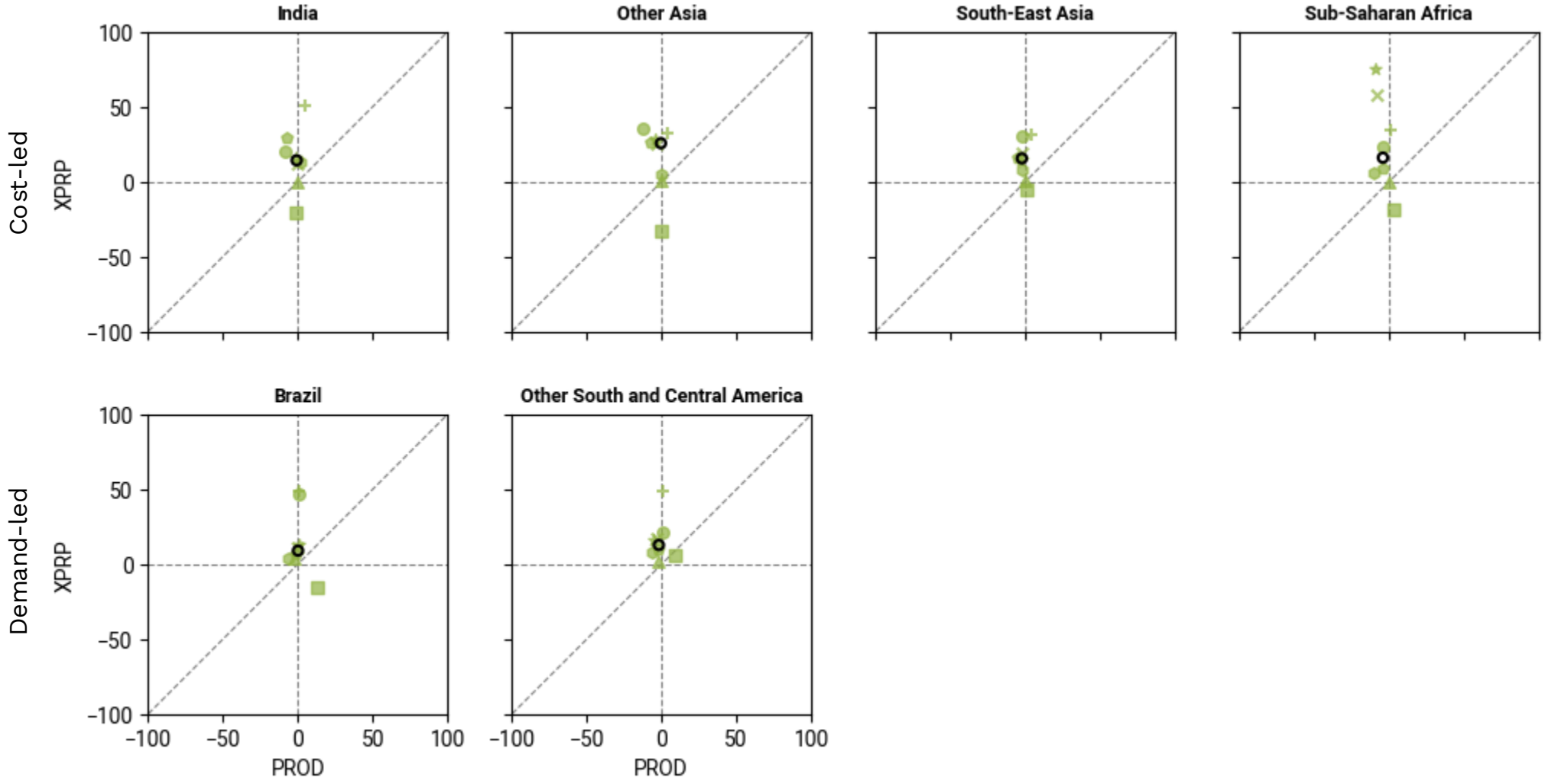

AGR: XPRP vs PROD — MITI driver (% change from BAU 2050)
Global
United States
Australia and New Zealand
Canada
Europe
South-East Asia
Eastern Europe, Caucasus, Central Asia
Middle East and North Africa
China
Brazil
Other South and Central America
India
Other Asia
Sub-Saharan Africa
XPRP
PROD
100
50
0
−50
−100


AGR: XPRP vs PROD — DIET driver (% change from BAU 2050)
Global
United States
Australia and New Zealand
Canada
Europe
South-East Asia
Eastern Europe, Caucasus, Central Asia
Middle East and North Africa
China
Brazil
Other South and Central America
India
Other Asia
Sub-Saharan Africa
XPRP
PROD
100
50
0
−50
−100


AGR: XPRP vs PROD — PROD driver (% change from BAU 2050)
Global
United States
Australia and New Zealand
Canada
Europe
South-East Asia
Eastern Europe, Caucasus, Central Asia
Middle East and North Africa
China
Brazil
Other South and Central America
India
Other Asia
Sub-Saharan Africa
XPRP
PROD
100
50
0
−50
−100

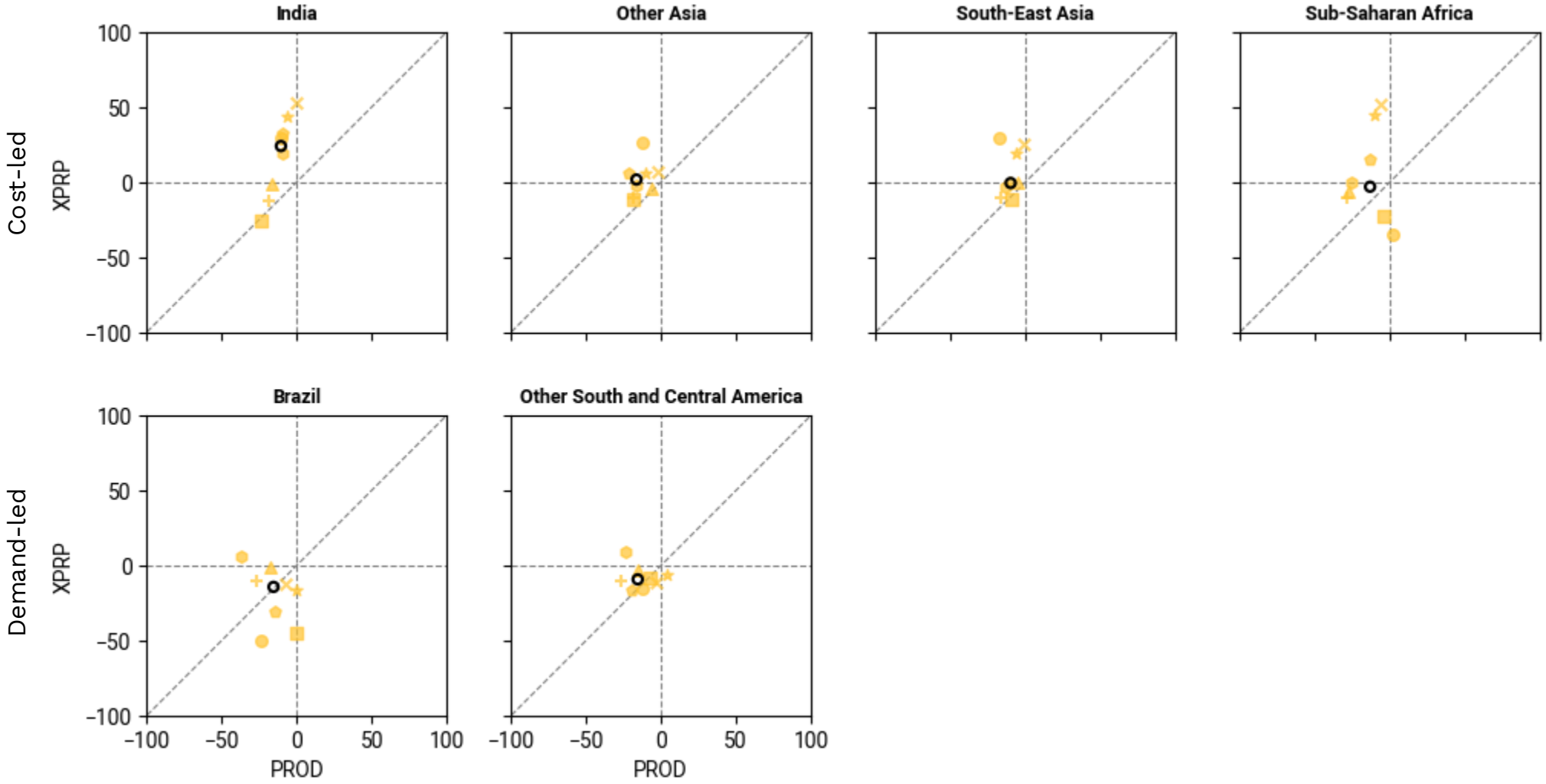

AGR: XPRP vs PROD — WAST driver (% change from BAU 2050)
Global
United States
Australia and New Zealand
Canada
Europe
South-East Asia
Eastern Europe, Caucasus, Central Asia
Middle East and North Africa
China
Brazil
Other South and Central America
India
Other Asia
Sub-Saharan Africa
XPRP
PROD
100
50
0
−50
−100

Real producer price vs agricultural production: total effect of mitigation policies



NOTE: RESULTS PRESENTED ARE PRELIMINARY AND ARE NOT FOR CITATION

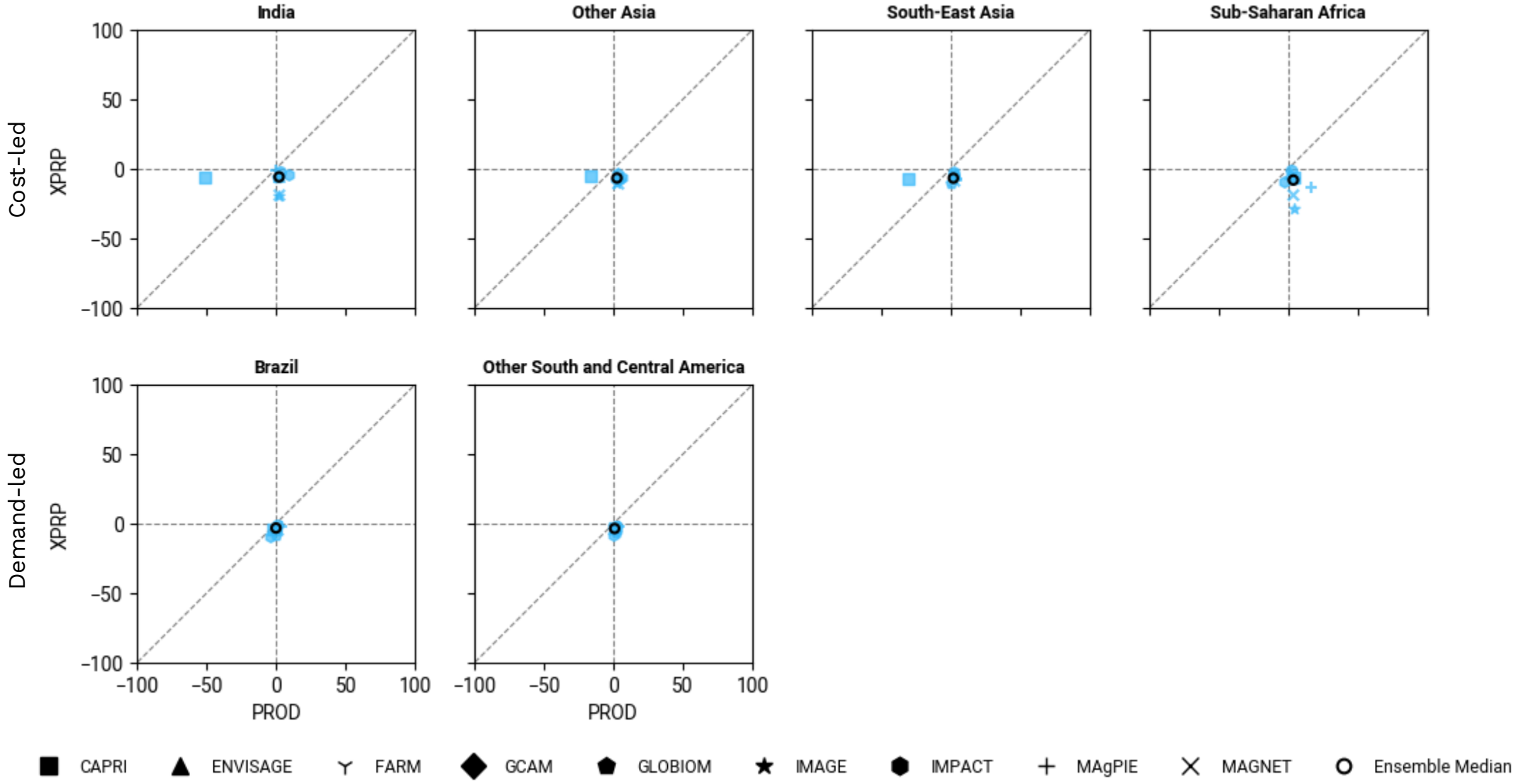
Real producer price vs agricultural production: total effect of diet shifts



FOOD SYSTEMS & GLOBAL CHANGE

NOTE: RESULTS PRESENTED ARE PRELIMINARY AND ARE NOT FOR CITATION

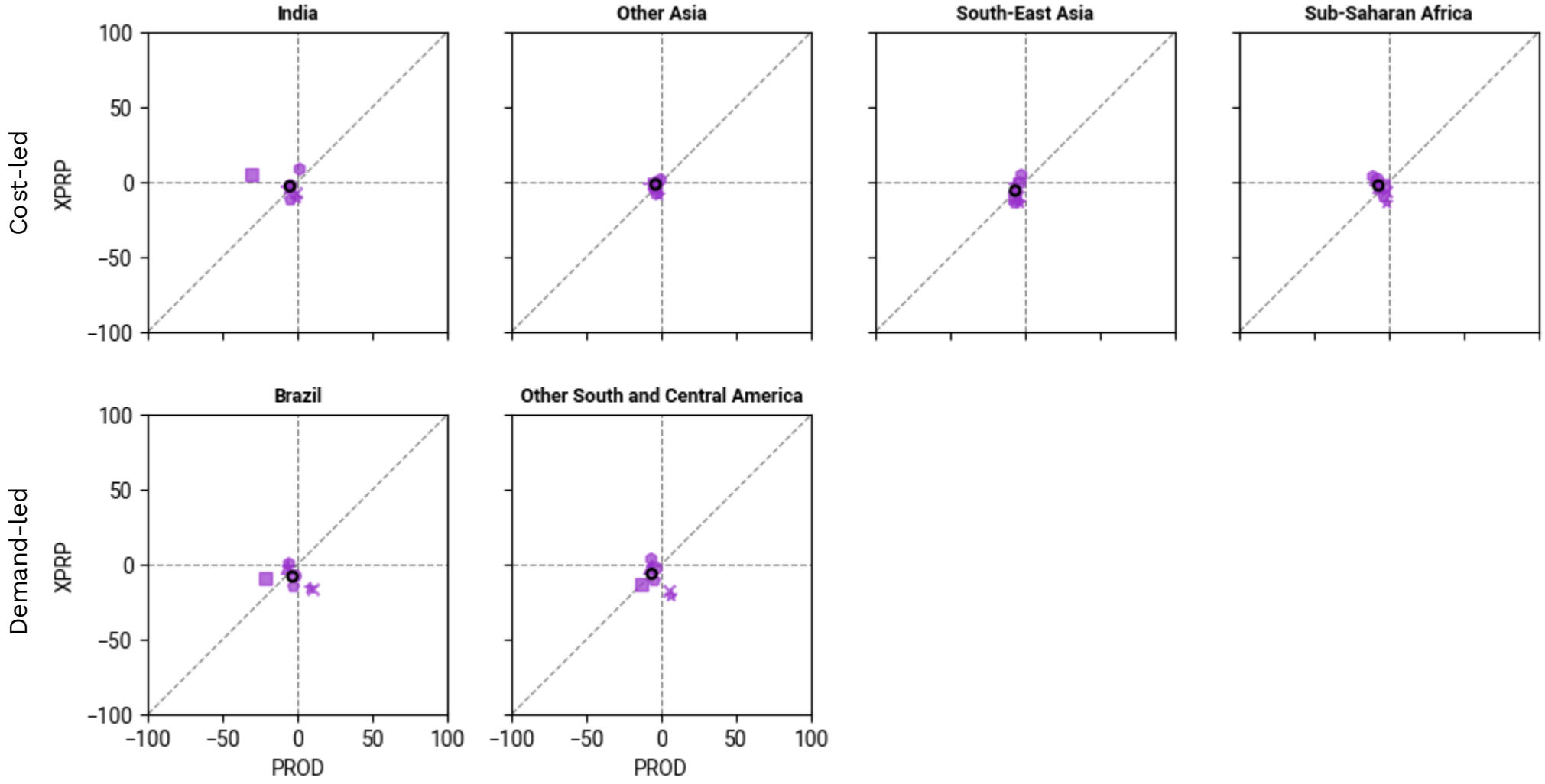
Real producer price vs agricultural production: total effect of increased productivity



FOOD SYSTEMS & GLOBAL CHANGE

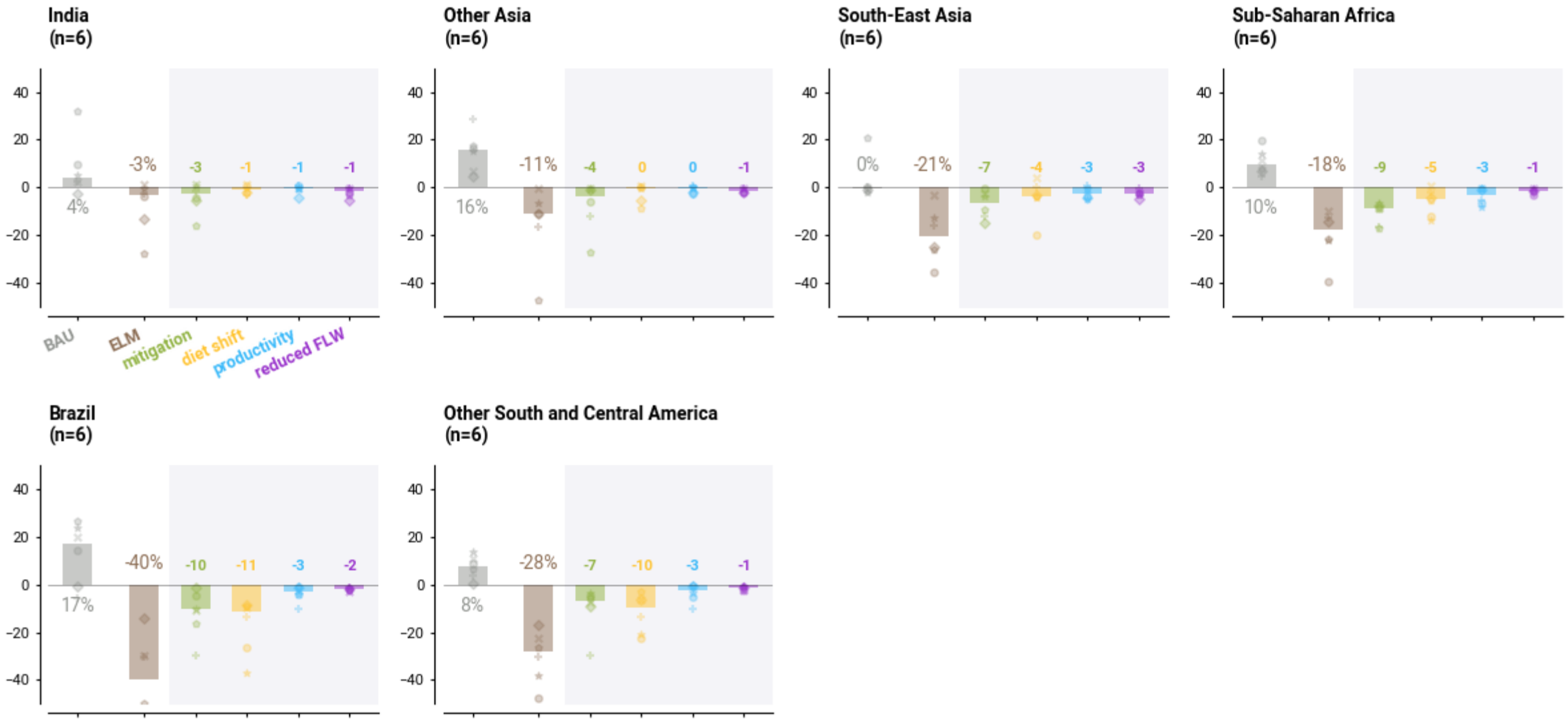
NOTE: RESULTS PRESENTED ARE PRELIMINARY AND ARE NOT FOR CITATION

Real producer price vs agricultural production: total effect of reducing FLW



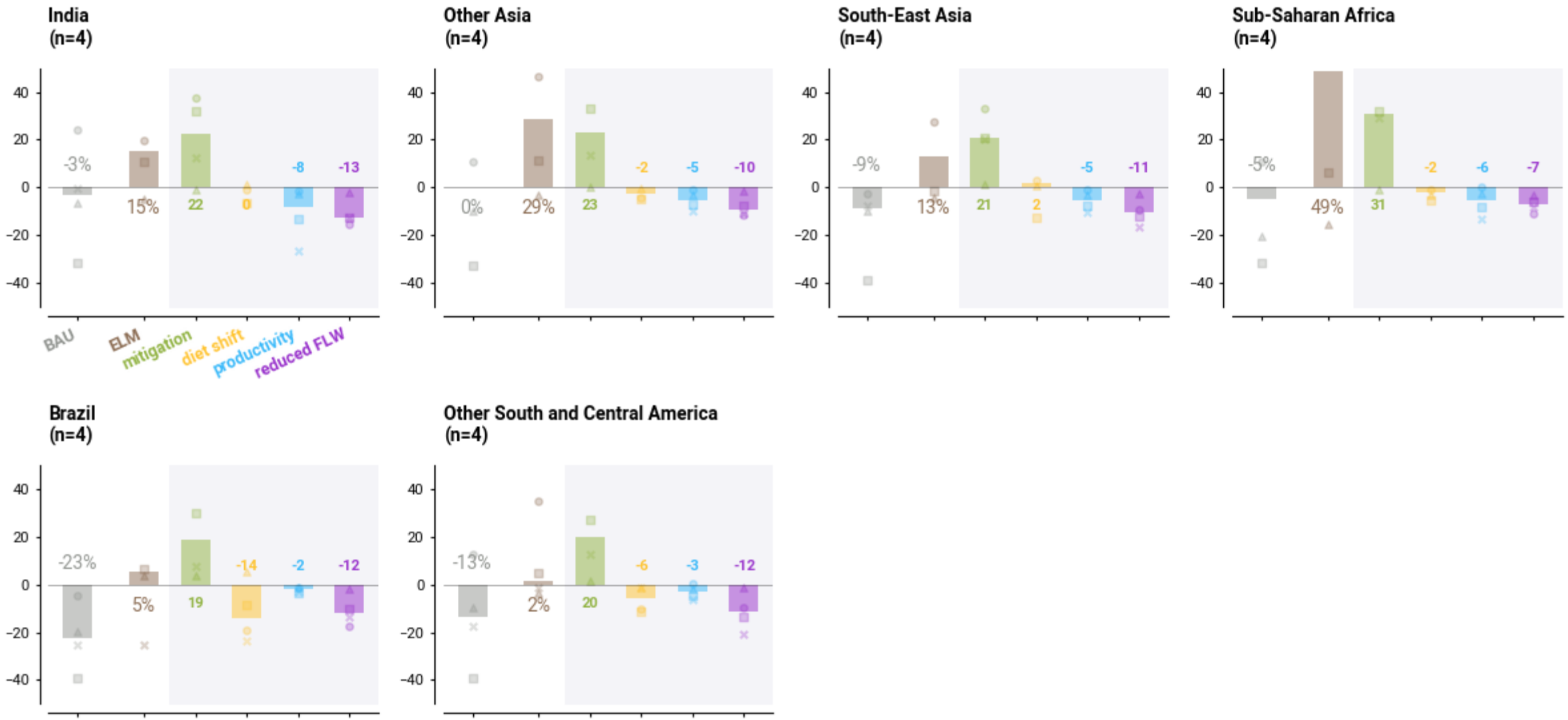
NOTE: RESULTS PRESENTED ARE PRELIMINARY AND ARE NOT FOR CITATION

AGR_added: Decomposition of LAND_added change from BAU by driver (total effect only)



FOOD SYSTEMS & GLOBAL CHANGE

AGR: Decomposition of XPRC change from BAU by driver (total effect only)



FOOD SYSTEMS & GLOBAL CHANGE