zef
Center for
Development Research
University of Bonn

UNIVERSITÄT BONN

Feeding the World and Environmental Sustainability

Joachim von Braun

Professor for Economic and Technological Change, Bonn University, Germany

National Academies of Sciences, Engineering, and Medicine

Standing Committee on Evidence Synthesis and Communications in Diet and Chronic Disease Relationships

Advancing a Food Systems Approach to Prioritize Healthy People and a Healthy Planet

Washington DC virtual March 9, 2023

Feeding the world and environmental sustainablity

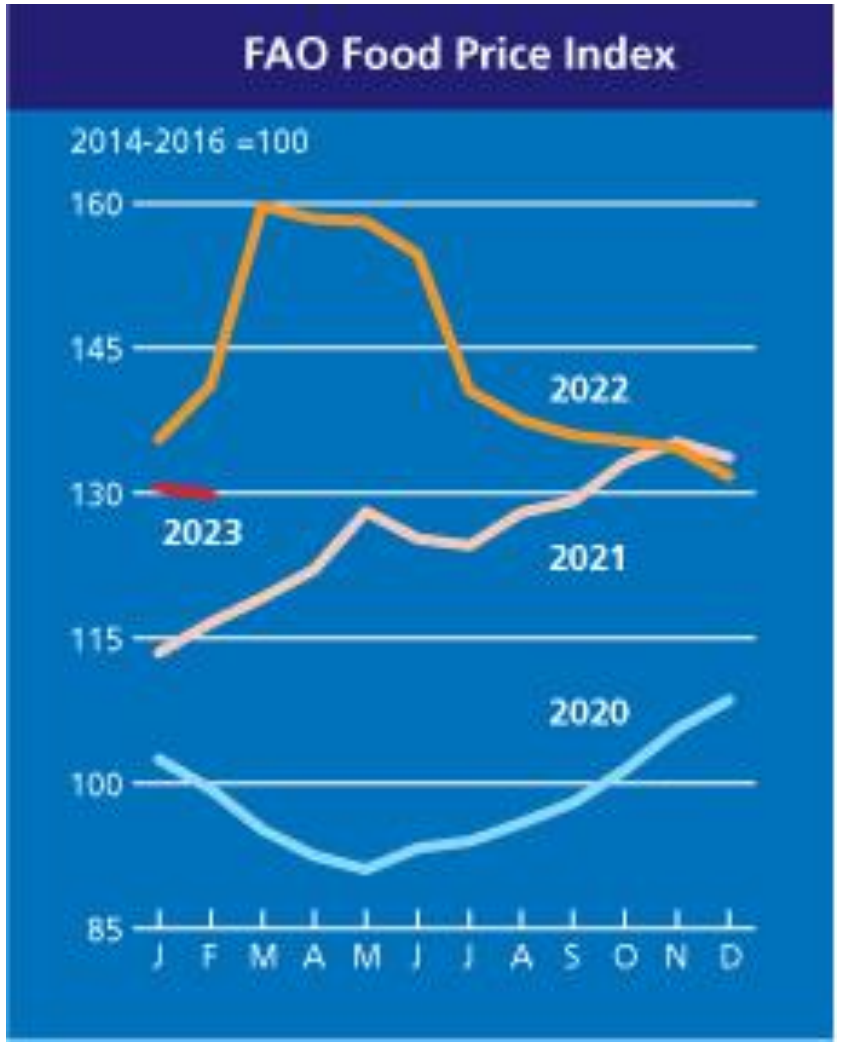
Overview

1. **Food systems in economic and environmental crisis**
2. **Action areas for food security and ecology**
3. **Comprehensive strategies**

The multi-dimensional food crisis on supply and demand sides and at systems levels

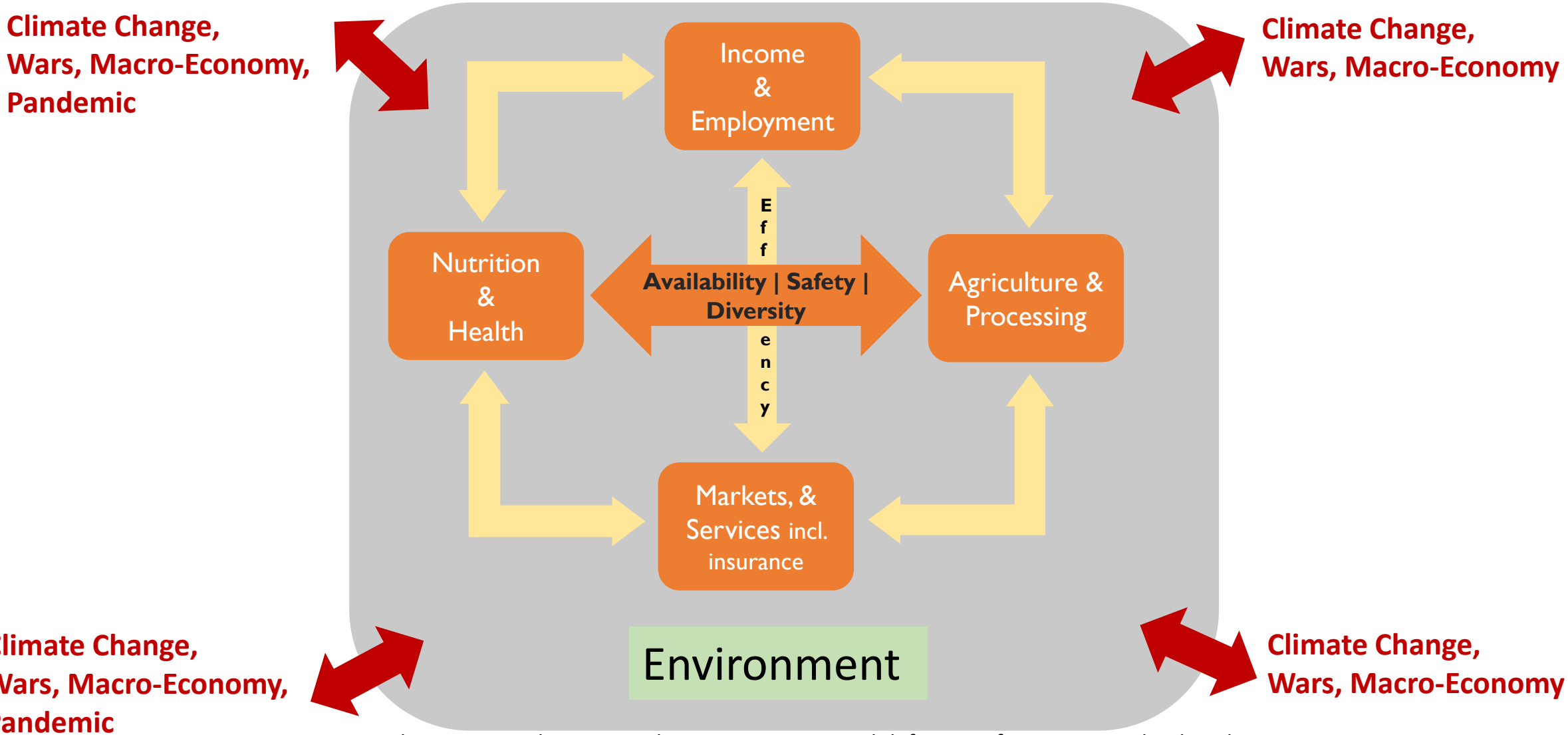
1. **Covid19** disrupted food value chains,
2. **Wars** add to uncertainty and hinder trade,
3. **Food prices** make healthy diets unaffordable,
4. **Accumulated debts** cut nutrition programs,
5. **High energy and raw material (fertilizer) prices** constrain agriculture and food industries
6. **Climate change** destroys food systems resilience
7. **Erosion of biodiversity** undermines food security

At different time paths



https://www.fao.org/worldfoodsituation/foodpricesindex/en/

“Feeding the World” needs a Food Systems Approach



Source: von Braun et.al. Nature Food 2021. Food system concepts and definitions for science and political action https://www.nature.com/articles/s43016-021-00361-2

Framing: “Feeding the World“ and “Environmental Sustainability“

Feeding the World

1. Production and Processing
2. Trade and Distribution
3. Demand and Consumption
4. Nutrition and health

Environmental Sustainability

1. Climate (and energy)
2. Biodiversity (incl. Agr-biodiversity)
3. Soils, Landuse
4. Water systems

Action areas

R&D for Innovation

Nutr. Interventions

Market & trade policies

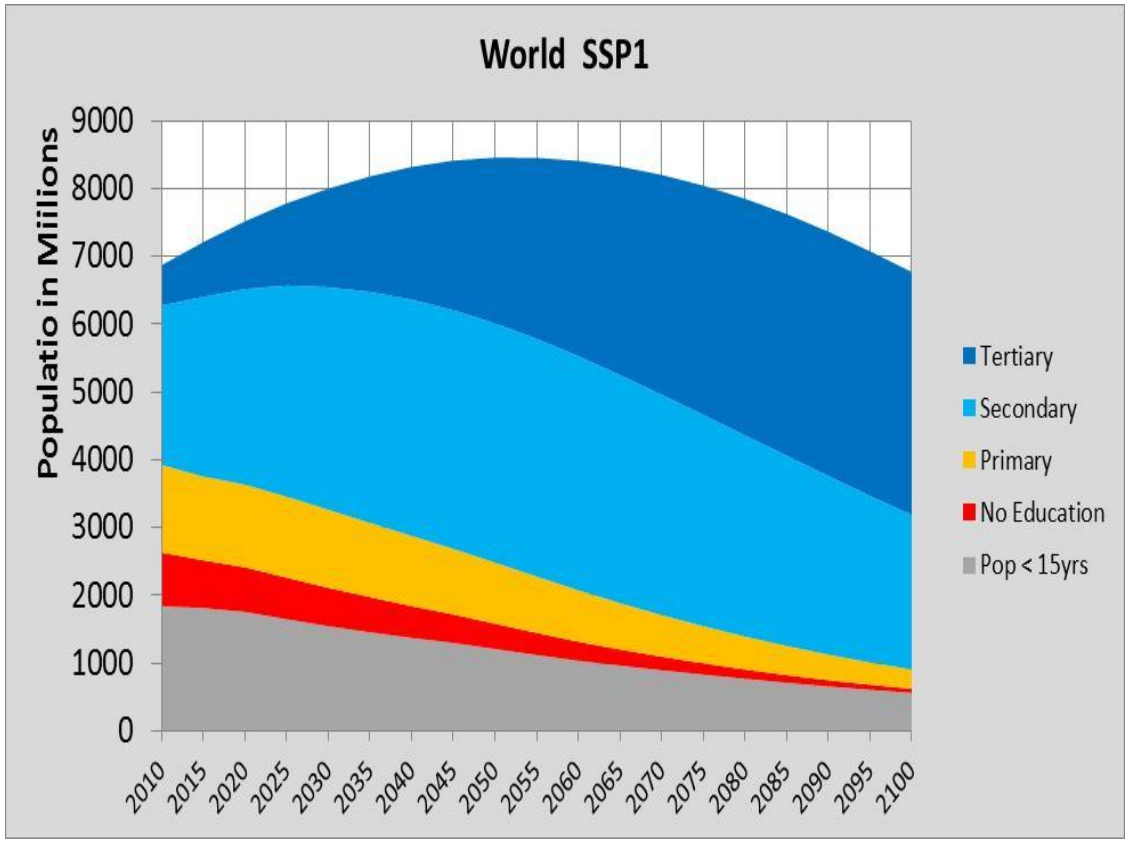
Regulations and diplomacy

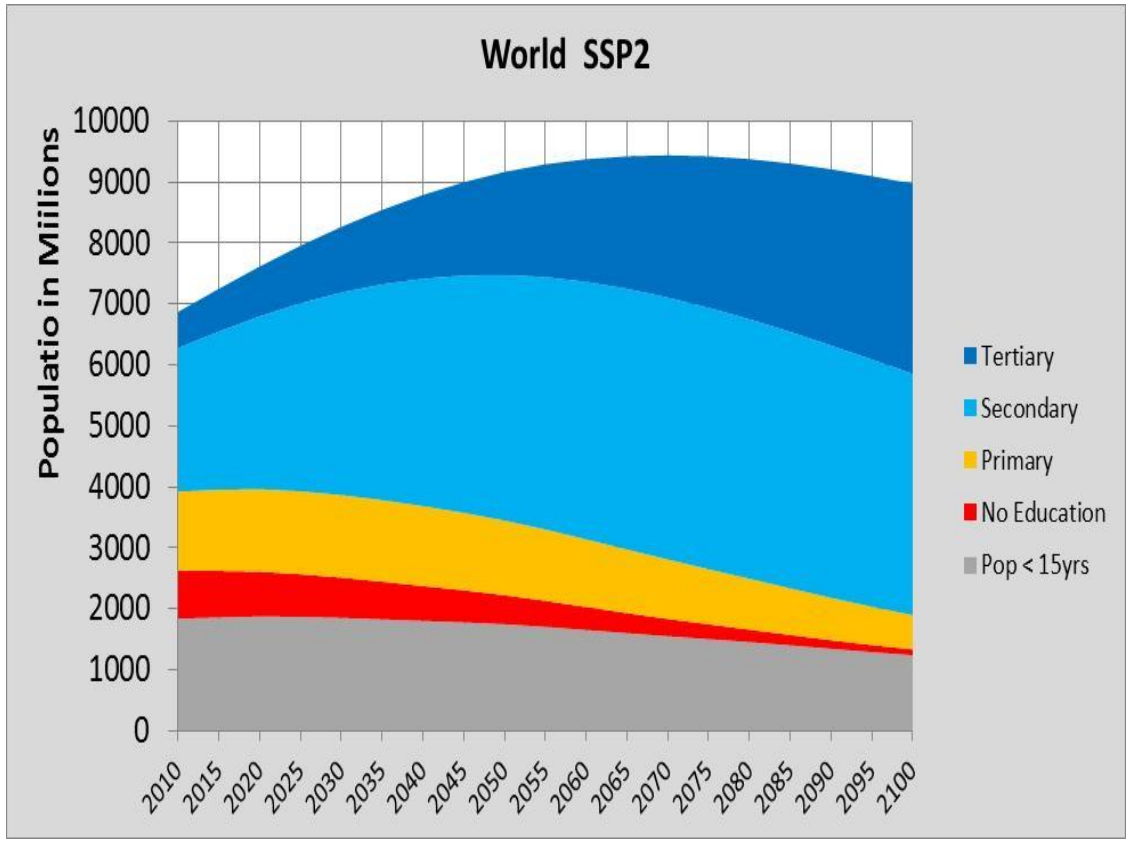
Feeding the world and environmental sustainablity

Overview

1. **Food systems in economic and environmental crisis**
2. **Action areas for food security and ecology**
3. **Comprehensive strategies**

Population: education matters for bending the curve - implications for food / climate / biodiversity -

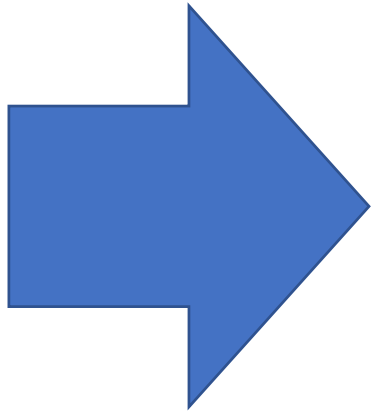




Source: **"World Population Trends and the Rise of homo sapiens literata" Wolfgang Lutz (2020). In:** TRANSFORMATIVE ROLES OF SCIENCE IN SOCIETY: FROM EMERGING BASIC SCIENCE TOWARD SOLUTIONS FOR PEOPLE'S WELLBEING Joachim von Braun Marcelo Sánchez Sorondo (ed.) Pontificiae Academiae Scientiarvm Acta 25 http://www.pas.va/content/accademia/en/publications/acta/acta25.html

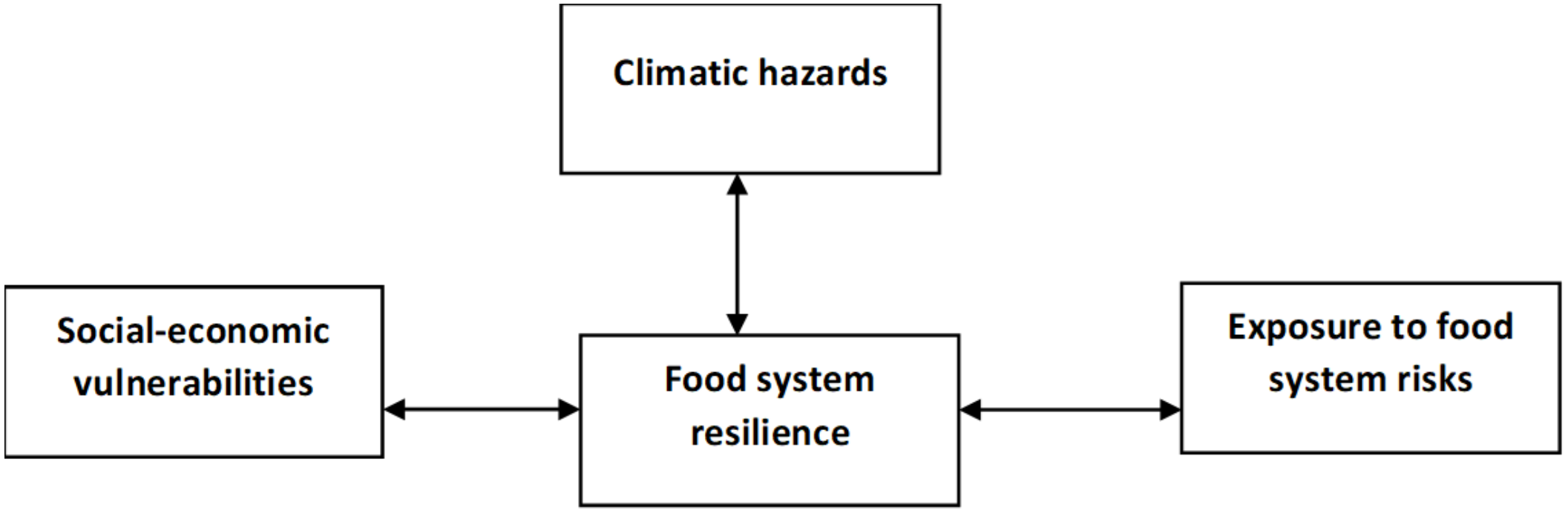
Climate Change: Meterological, Biophysical, Socio-Economic Consequences

- Increasing extreme events (Heat waves, Droughts, Floods)
- Rising sea levels
- Ocean acidification
- Melting glaciers
- water systems change
- Degradation of ecosystems
- Risk of fires
- Insect pest upsurges



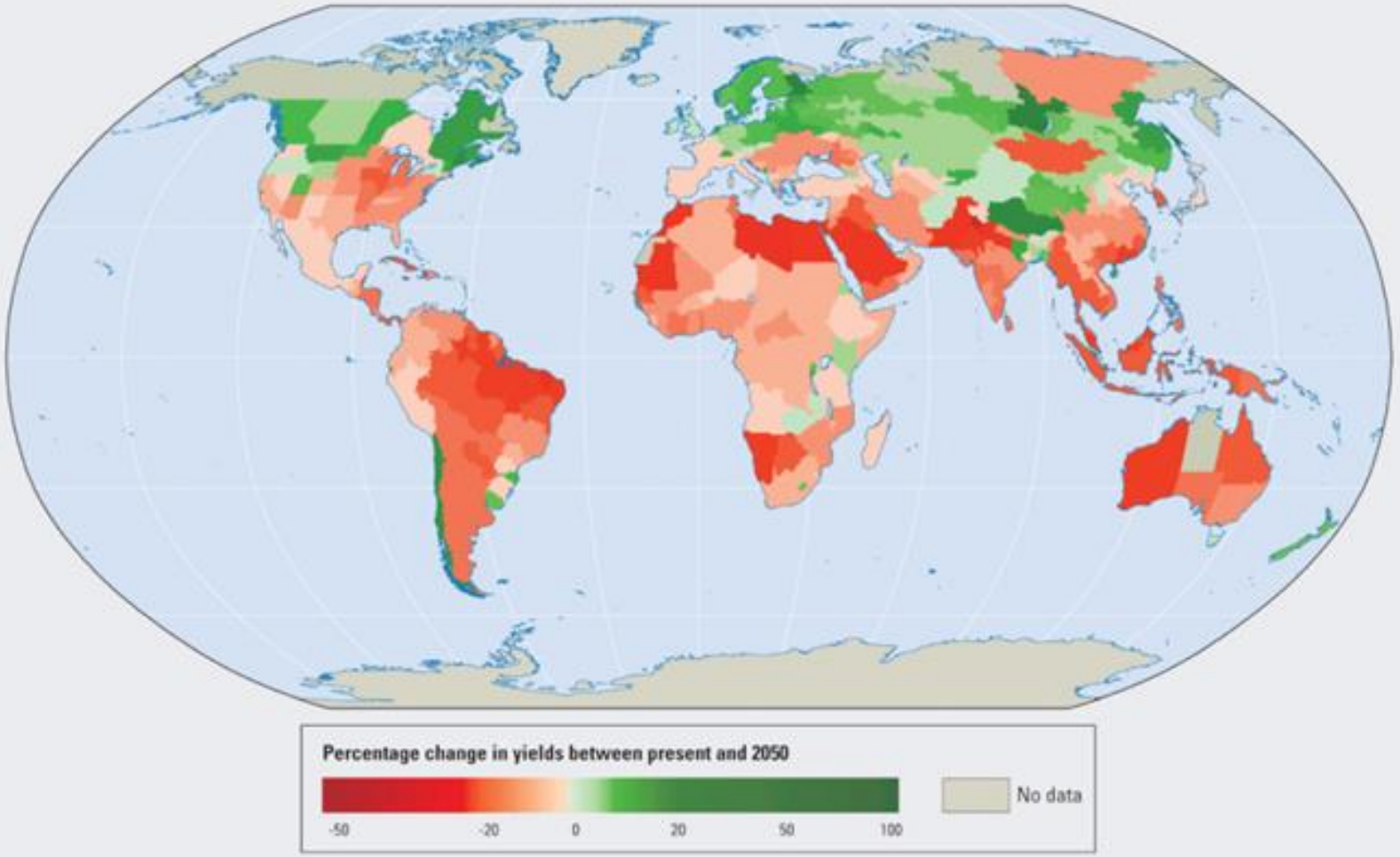
- **Food and nutrition problems**
- **Health problems**
- **Decline of income and assets**
- **Labor productivity decline**
- **Growing inequality**

Food Systems Resilience Framework



Source: von Braun, Mirzabaev (2022). Resilient Food Systems. “Resilience of People and Ecosystems under Climate Stress” 13-14 July, 2022. The Pontifical Academy of Science, Vatican. Modified from the IPCC risk framework in Abram et al. (2019).

Climate change and crop yields



Source: World Bank Publishers, World Bank Development Report 2010, http://wdronline.worldbank.org/

Key roles of science and technology for food systems' sustainability:

- Breeding and genomics
- Crop Cultivation
- Livestock
- Irrigation
- Food processing science and technologies

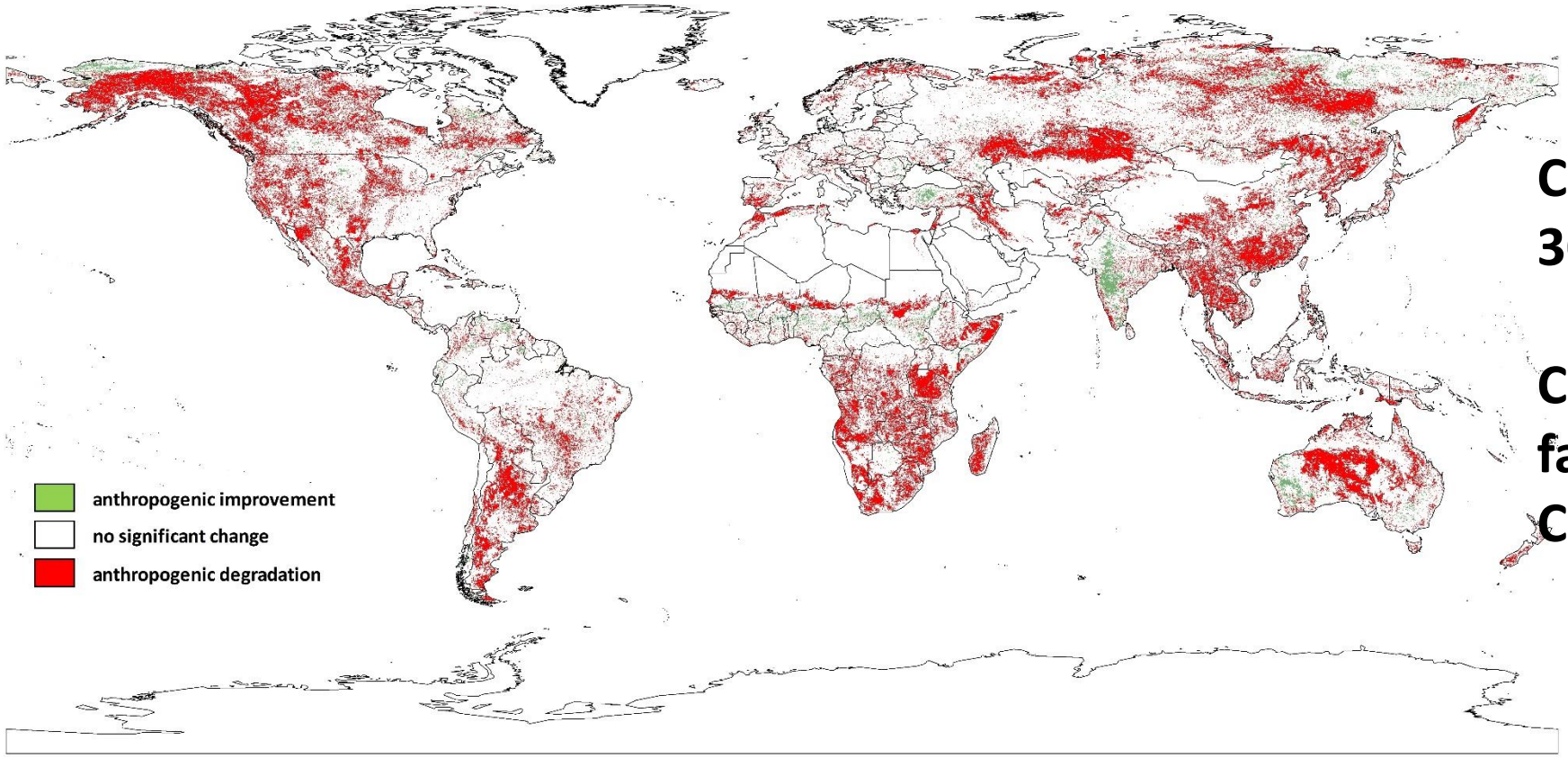
Climate Change requires crop variety adaptation

The Svalbard Seed Vault, Norway

- **Faster phenological development of crops due to climate warming a main driver for potential future yield reductions.**
- **About 39% of global cropland could require new crop varieties to avoid yield loss from climate change**
- **Region-specific breeding efforts** are required to allow for a successful adaptation.

Source: Zabel F, Müller C, Elliott J, et al. Large potential for crop production adaptation depends on available future varieties. Glob Change Biol. 2021;00:1–13. https://doi.org/10.1111/gcb.15649

Global land degradation



Cost ca.
300 Bill US$ per annum

Cost of action
far below
Cost of in-action

Source: Le et al (2016) in: Source: Nkonya, E., A. Mirzabaev, J. von Braun (ed.) 2016. Economics of land degradation and sustainable land management. Springer. http://link.springer.com/book/10.1007/978-3-319-19168-3

Science Challenges in Biodiversity / Food System linkages

Two way relations

- Food systems depend on biodiversity while contributing to its erosion
- Food systems generate agro-biodiversity, while reducing it

Time, risk, distance – trade offs

- Short term trade offs *versus* long term synergies (food versus/cum biodiversity)
- Well-known risks of hunger *versus* uncertain risks of biodiversity loss
- Biodiversity erosion is "far away", and *not internalized* by food consumers

Ethical issues – "Food" *versus* "Nature"

15th Conference of Parties to the UN Convention on Biological Diversity adopted the "Kunming-Montreal Global Biodiversity Framework" (GBF)

Targets for 2030 with link to food system:

- Effective conservation and management of at least **30% of the world's lands**…
- Have **restoration … on at least 30%** of degraded terrestrial ecosystems
- Cut global **food waste in half** and significantly **reduce over consumption …**
- **Reduce by half** both excess nutrients and the overall risk posed by **pesticides** and highly hazardous chemicals
- Progressively **phase out or reform by 2030 subsidies** that harm biodiversity by at least $500 billion per year

Goals:

A: The **genetic diversity** within populations of wild and domesticated species, is maintained, safeguarding their adaptive potential.

B: **Biodiversity is sustainably used** and managed and nature's contributions to people, including ecosystem functions and services, are valued…

C: The **monetary and non-monetary benefits** from the utilization of genetic resources, and digital sequence information … and of traditional knowledge … are **shared fairly and equitably**… including…with indigenous peoples,

D: Adequate means of i**mplementation**, including financial resources …

>> Not yet a food systems perspective<<

Feeding the world and environmental sustainablity

Overview

1. **Food systems in economic and environmental crisis**
2. **Action areas for food security and ecology**
3. **Comprehensive strategies**

1: Identifying trade offs & synergies of policy actions

No single investment intervention can end malnourishment.

Actions generate trade-offs in …

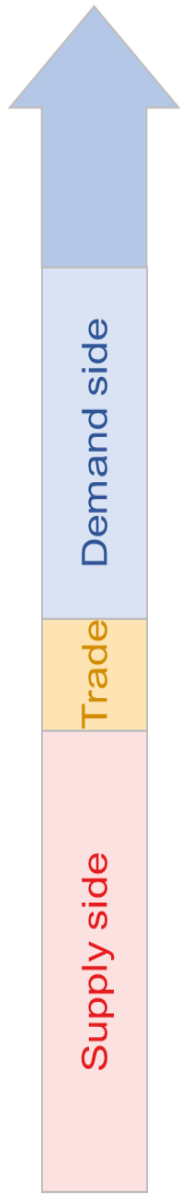
- greenhouse gas emissions (from agricultural production, energy, land use),
- chemical inputs (increased use per hectare),
- biodiversity (reduction of forest habitat and agricultural land)

But: The levels of trade-offs across all interventions are *relatively small.*

Helpful: Environmental improvement from reducing food loss and waste.

Need: stimulate carbon farming, related payment for ecosystems services

See: D. Laborde and Maximo Torero (2023) Modeling Actions for Transforming Agrifood Systems. https://link.springer.com/chapter/10.1007/978-3-031-15703-5_7
In: von Braun, Afsana, Fresco and Hassan (2023) Science and Innovations for Food Systems Transformation Springer. https://link.springer.com/book/10.1007/978-3-031-15703-5



TRANSFORMATIONS	OUTCOMES				Quantitative studies
	Target 2.1 Target 2.2		Target 2.3	Target 2.4 and envt. SDGs	
	Food availability (quantities)	Food access (prices)	Smallholder income	Environmental outcomes	
Reducing waste and overconsumption					1, 4, 5, 6, 7
Adopting healthy diets					4, 5
Adopting sustainable diets					1, 2, 3, 6, 7
Improving trade integration					1, 5, 6
Increasing agricultural productivity					1, 2, 3, 4, 5, 6, 7
Reducing food losses					1, 4, 5, 6, 7
Improving agricultural practices and resource management					1, 3, 4, 7
Protecting and reallocating resource to other SDGs					1, 3, 5, 6, 7

Key transformations implemented in global analyses and their typical impact for relevant indicators: green = positive impact, red = negative impact, orange = ambiguous impact.

Source: Hugo Valin, et.al (FSS Brief, May 2021) https://sc-fss2021.org/wpcontent/uploads/2021/06/SDG2_Synergies_and_tradeoffs.pdf

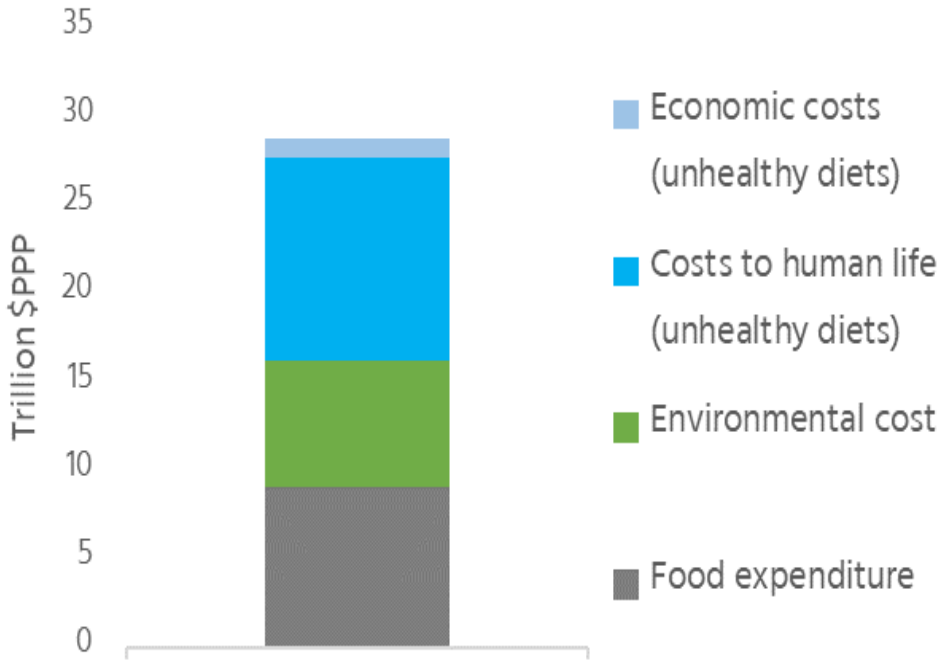
2: Addressing externalities of food systems

Type of externality	Examples of externalities	Impacts
Environmental (effects on natural capital)	Air, water and soil pollution, GHG-emissions, Land use, Overuse of renewable resources, Soil depletion, Use of scarce materials, Water use	Contribution to climate change, health effects, ecosystem services, and biodiversity related.
Social (effects on social rights and human & social capital)	Animal welfare, Child and forced labour, Discrimination and harassment, High and variable prices, Training, Underpayment and underearning	Poverty, well-being, food security and human skills.
Health (effects on human health)	Antimicrobial resistance, Undernutrition Unhealthy diet composition, Zoonoses	Human life (mortality and the quality of life), Economic (medical costs, informal care, lost working days)
Economic (effects on financial, manufactured and intellectual capital)	Food waste, Tax evasion	Increased food demand, and a decrease in public funds

Source: S. Hendriks et.al. 2023. The True Cost of Food: A Preliminary Assessment https://link.springer.com/chapter/10.1007/978-3-031-15703-5_32
In: von Braun, Afsana, Fresco and Hassan (2023) Science and Innovations for Food Systems Transformation. Springer. https://link.springer.com/book/10.1007/978-3-031-15703-5

TRUE TRUE COST OF FOOD

- **Market** prices do not take into account…
  - benefits of affordable or healthy food
  - costs of unhealthy or unsustainable food
- **Business' profits** do not reflect value created/reduced for society
- **GDP** of food system does not reflect contribution to welfare



9 trillion = food in markets
+ 7 trillion = environm. costs
+12 trillion = health costs

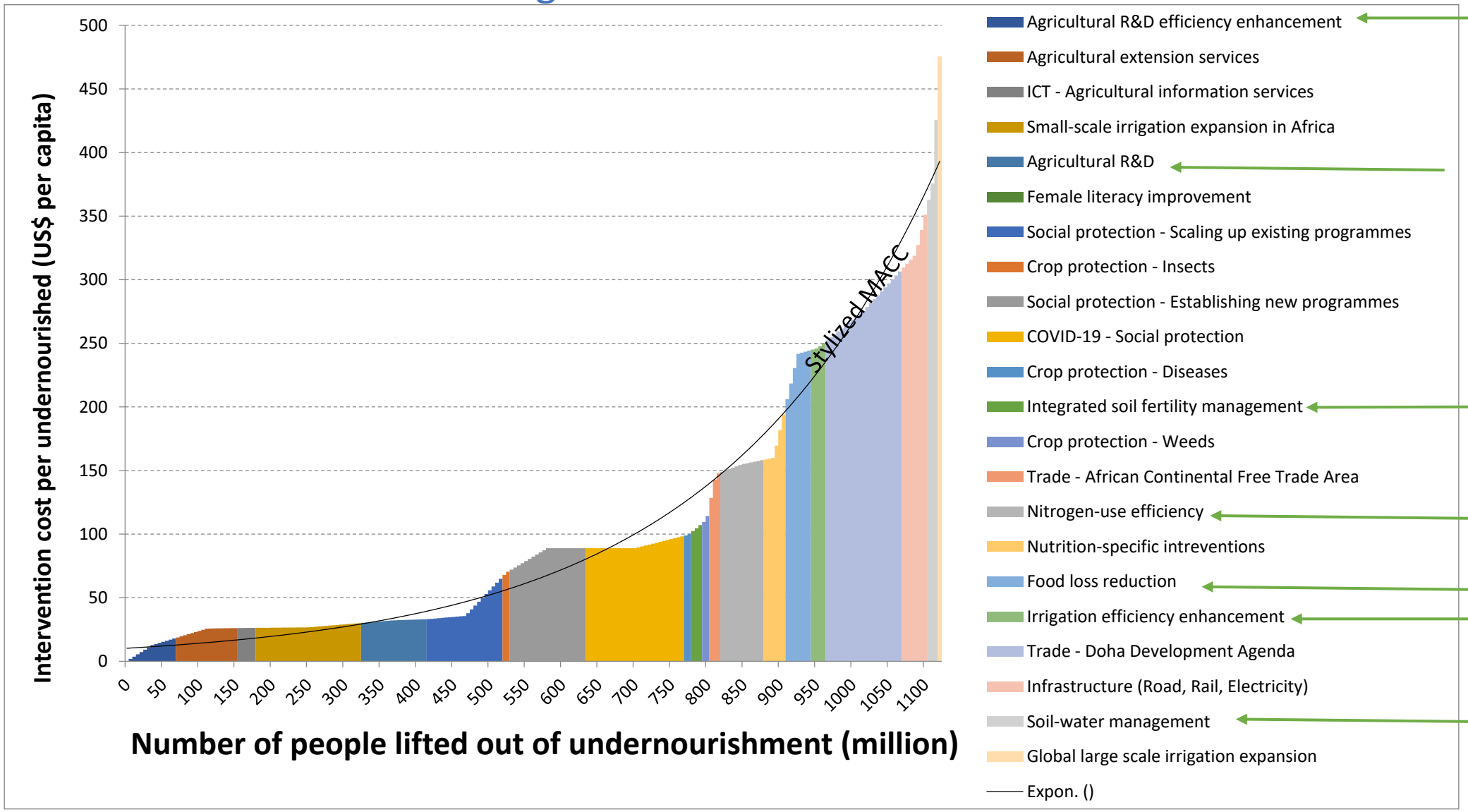
ca. = 28 trillion US$

Toward internalization of external costs by price and non-price measures

Source: S. Hendriks et.al. 2023. The True Cost of Food: A Preliminary Assessment https://link.springer.com/chapter/10.1007/978-3-031-15703-5_32
In: von Braun, Afsana, Fresco and Hassan (2023) Science and Innovations for Food Systems Transformation. Springer. https://link.springer.com/book/10.1007/978-3-031-15703-5

3: Remain focused on ending global hunger by 2030

Marginal Abatement Cost Curve



Source: Chichaibelu, Bekchanov, von Braun and Torero 2021. The global cost of reaching a world without hunger: Investment costs and policy action opportunities. In Food Policy. https://doi.org/10.1016/j.foodpol.2021.102151

4: Support Countries to follow up to UN FSS with science for food systems

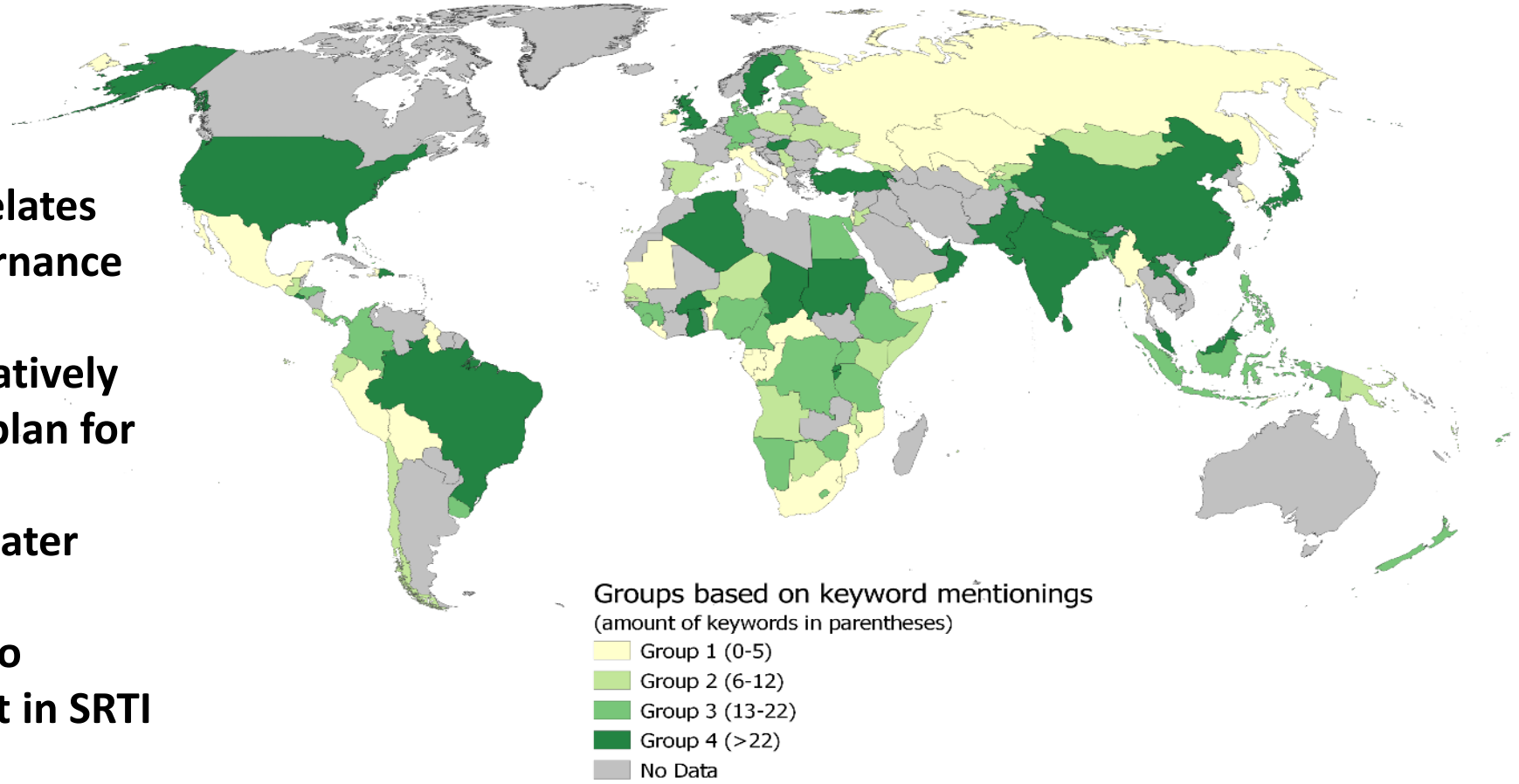
UN-Food Systems Summit 2021 National Pathways reports of 118 Countries' attention to science, research, innovation and technology (SRTI)

Findings:

1. SRTI strongly correlates with countries' governance effectiveness,

2. Countries with relatively larger food systems plan for more SRTI.

3. Countries with greater problem of under-nourishment show no stronger engagement in SRTI



Source: von Braun. 2023. UN Food Systems Summit 2021 – What Role Science and Innovation in the Summit and in Countries' Plans and Why?. (ZEF Discussion Paper 325)
https://www.zef.de/fileadmin/webfiles/downloads/zef_dp/ZEF_DP_325.pdf

Ways forward for “Feeding the World Sustainably”

Short term actions :

1. **Prevent supply shocks: Keep markets open, avoid restrictive trade policies; engage in war contexts to overcome grain trade barriers**
2. **Strengthen nutrition: direct nutrition actions in emergency contexts, and addressing debt issue of countries where hunger is high**

Long-term food system strengthening:

3. **Invest in food systems infrastructures, land resources, and adaptation for climate resilience**
4. **Invest in Science & Tech.: in food systems with crop and food processing innovations**

Kornher and von Braun. The global food crisis will not be over when international prices are back to normal. ZEF POLICY BRIEF NO 43 January 2023. https://www.zef.de/fileadmin/user_upload/ZEF_Policy_Brief_42_.pdf