Climate
Impact Platform

Climate change impacts on food and water systems in Asia and Africa and pathways to resilience

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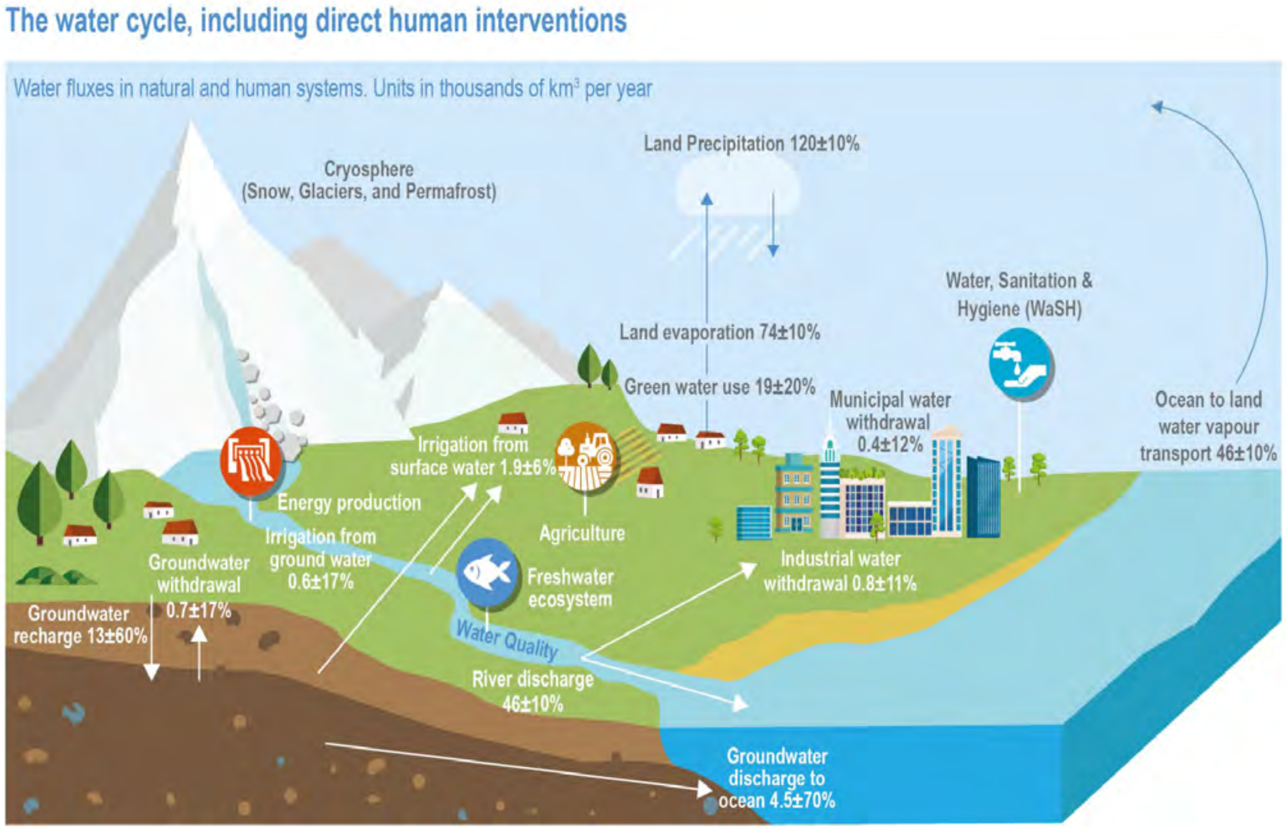
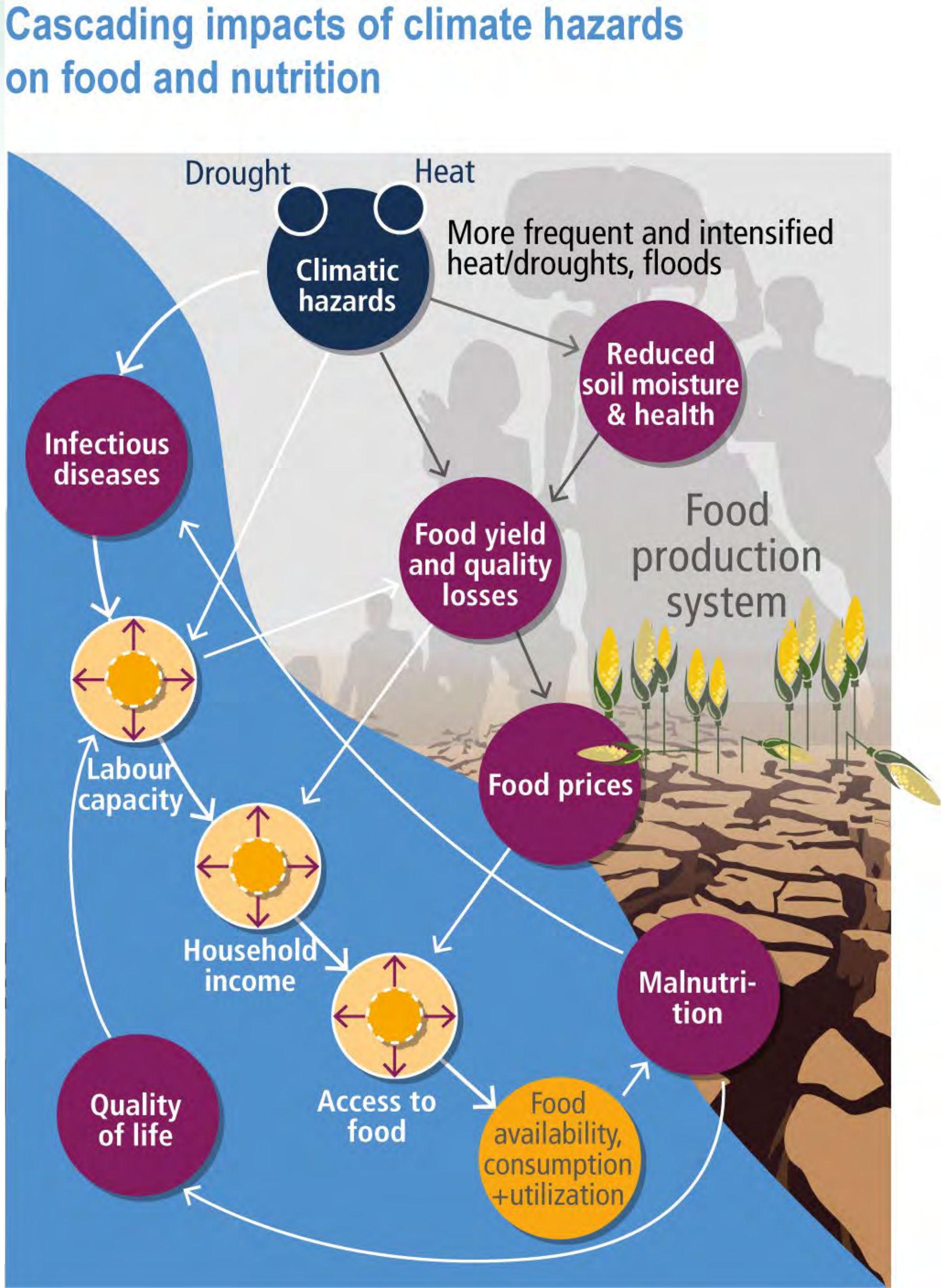
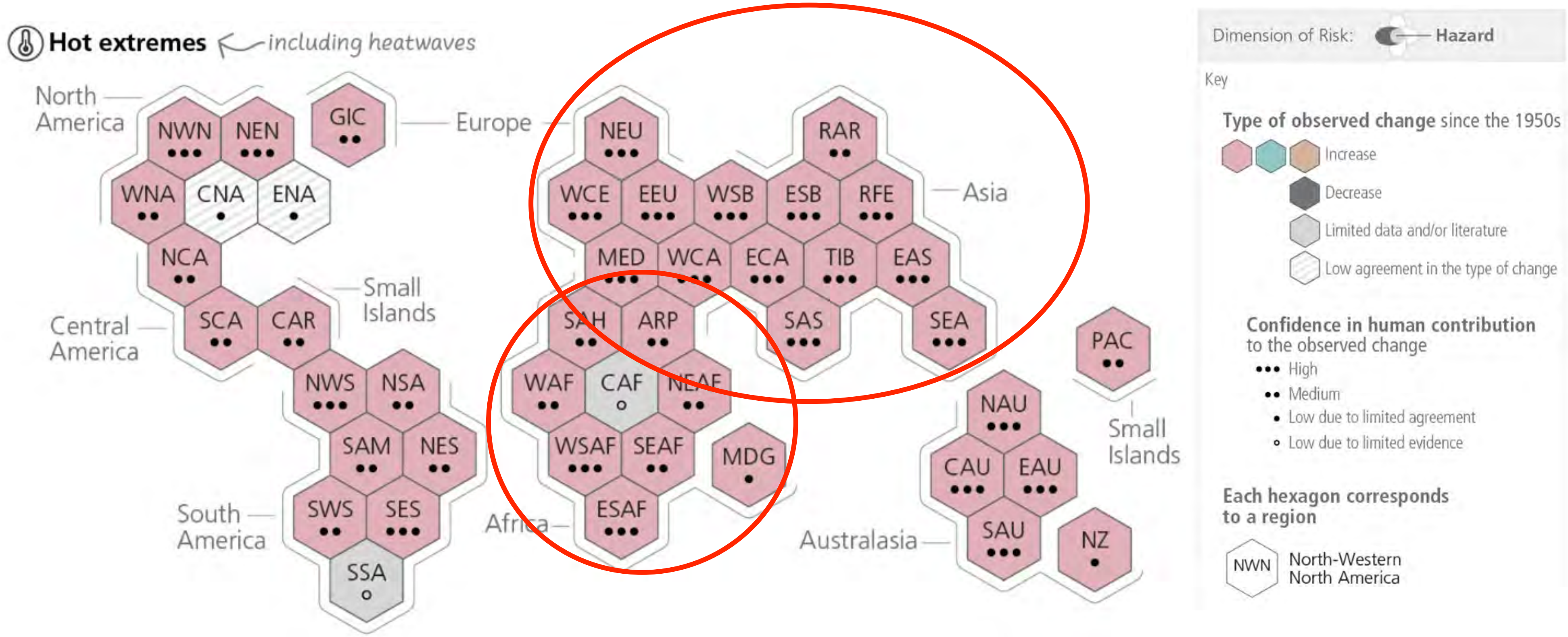
Changes in all components of water cycle coupled with temperature rise, has had cascading impacts on food and nutrition security





Source: IPCC AR6, WGII, Chapter 4 Water; Chapter 5 Food

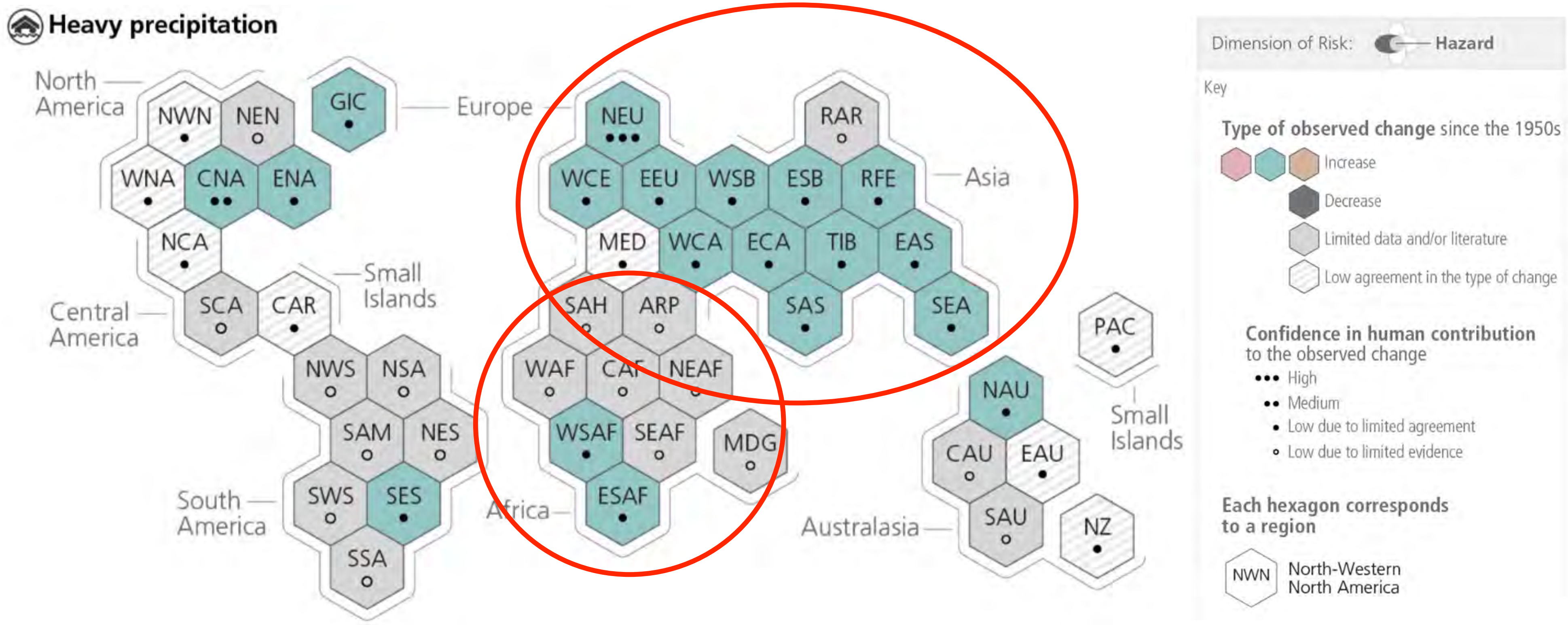
Hot extremes including heat waves have increased on most places on earth since 1950s



IPCC AR6 WGI reference regions: **North America: NWN** (North-Western North America, **NEN** (North-Eastern North America), **WNA** (Western North America), **CNA** (Central North America), **ENA** (Eastern North America), **Central America: NCA** (Northern Central America), **SCA** (Southern Central America), **CAR** (Caribbean), **South America: NWS** (North-Western South America), **NSA** (Northern South America), **NES** (North-Eastern South America), **SAM** (South American Monsoon), **SWS** (South-Western South America), **SES** (South-Eastern South America), **SSA** (Southern South America), **Europe: GIC** (Greenland/Iceland), **NEU** (Northern Europe), **WCE** (Western and Central Europe), **EEU** (Eastern Europe), **MED** (Mediterranean), **Africa: MED** (Mediterranean), **SAH** (Sahara), **WAF** (Western Africa), **CAF** (Central Africa), **NEAF** (North Eastern Africa), **SEAF** (South Eastern Africa), **WSAF** (West Southern Africa), **ESAF** (East Southern Africa), **MDG** (Madagascar), **Asia: RAR** (Russian Arctic), **WSB** (West Siberia), **ESB** (East Siberia), **RFE** (Russian Far East), **WCA** (West Central Asia), **ECA** (East Central Asia), **TIB** (Tibetan Plateau), **EAS** (East Asia), **ARP** (Arabian Peninsula), **SAS** (South Asia), **SEA** (South East Asia), **Australasia: NAU** (Northern Australia), **CAU** (Central Australia), **EAU** (Eastern Australia), **SAU** (Southern Australia), **NZ** (New Zealand), **Small Islands: CAR** (Caribbean), **PAC** (Pacific Small Islands)

IPCC AR6 SYR Figure 2.3a

Heavy precipitation has increased in many places since 1950s.



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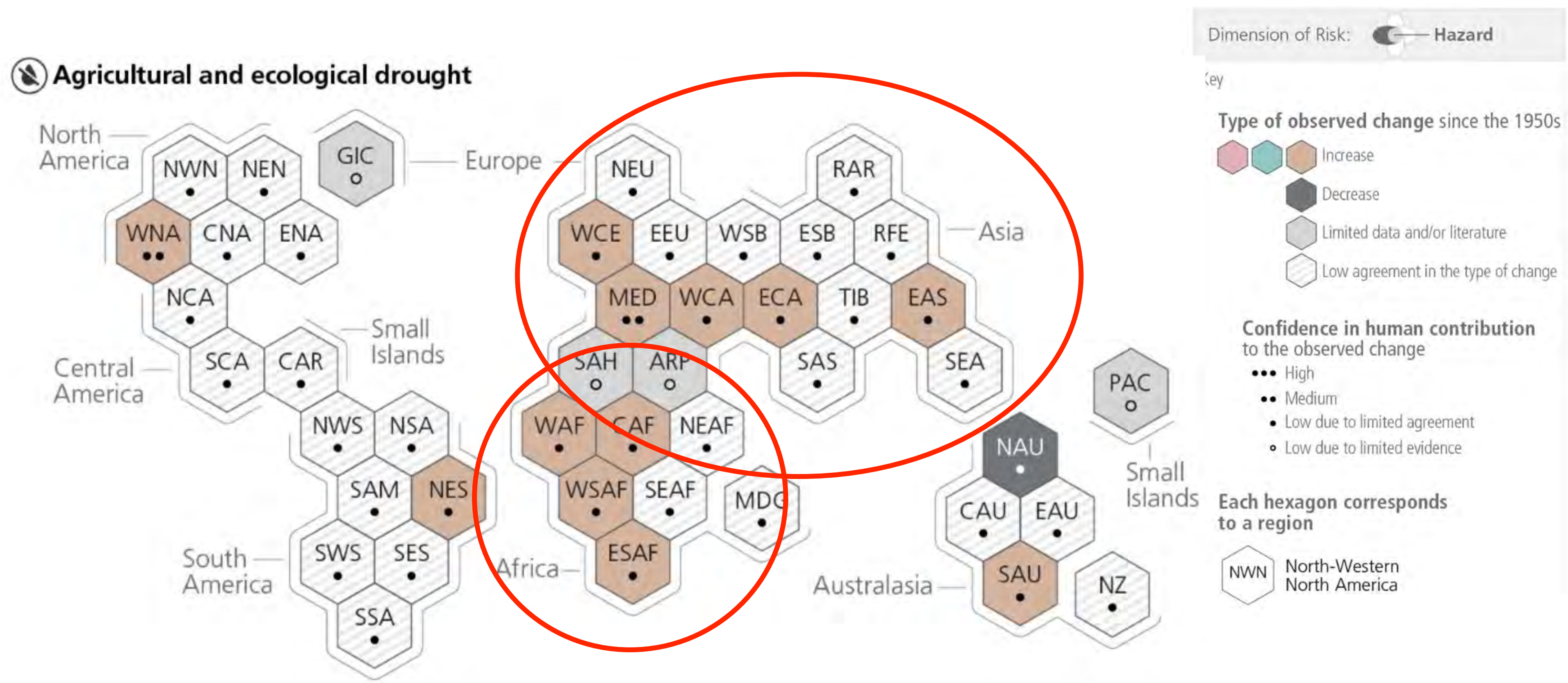
IPCC AR6 SYR Figure 2.3a

Agricultural and ecological drought has increased in many places s



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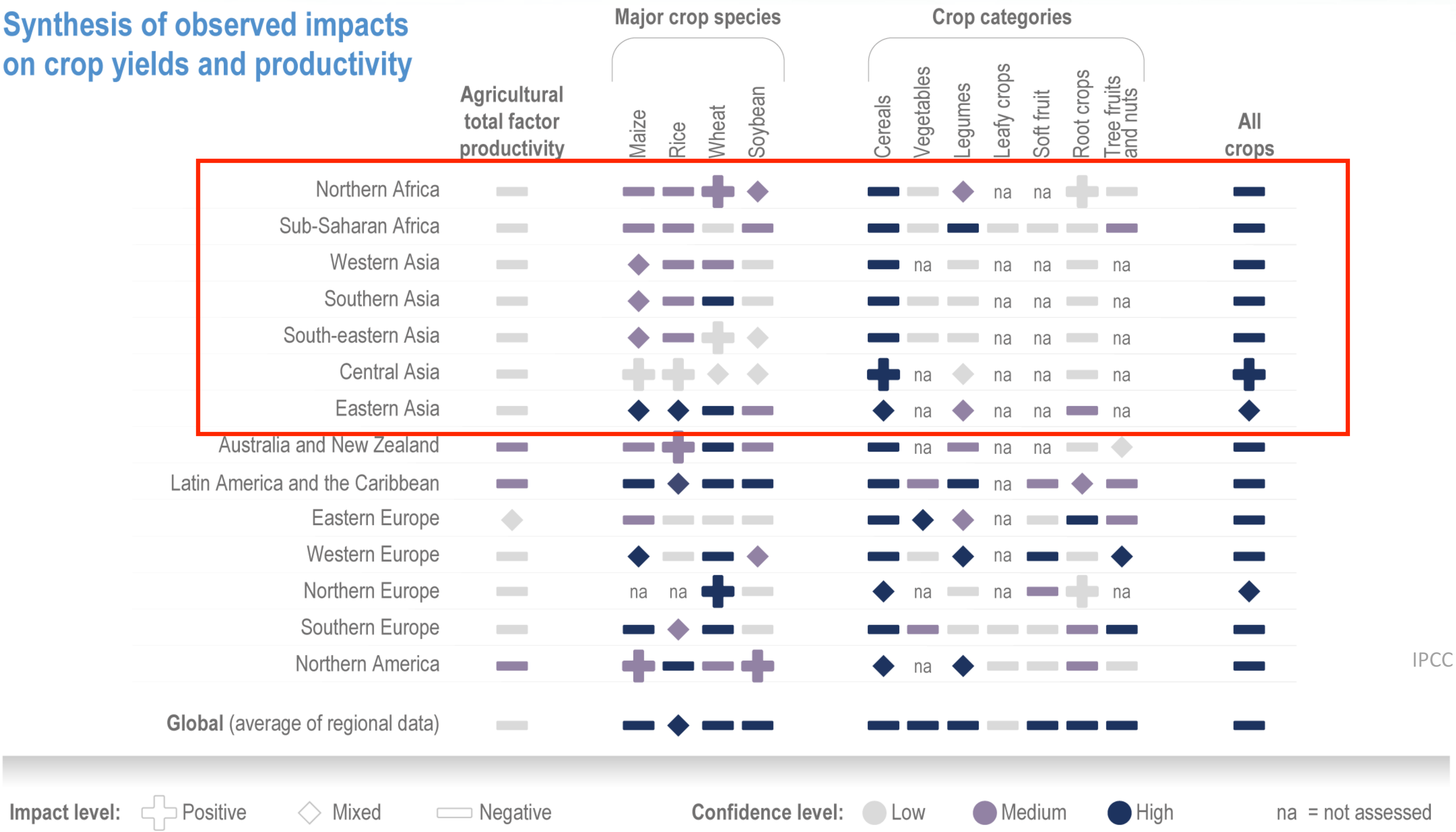
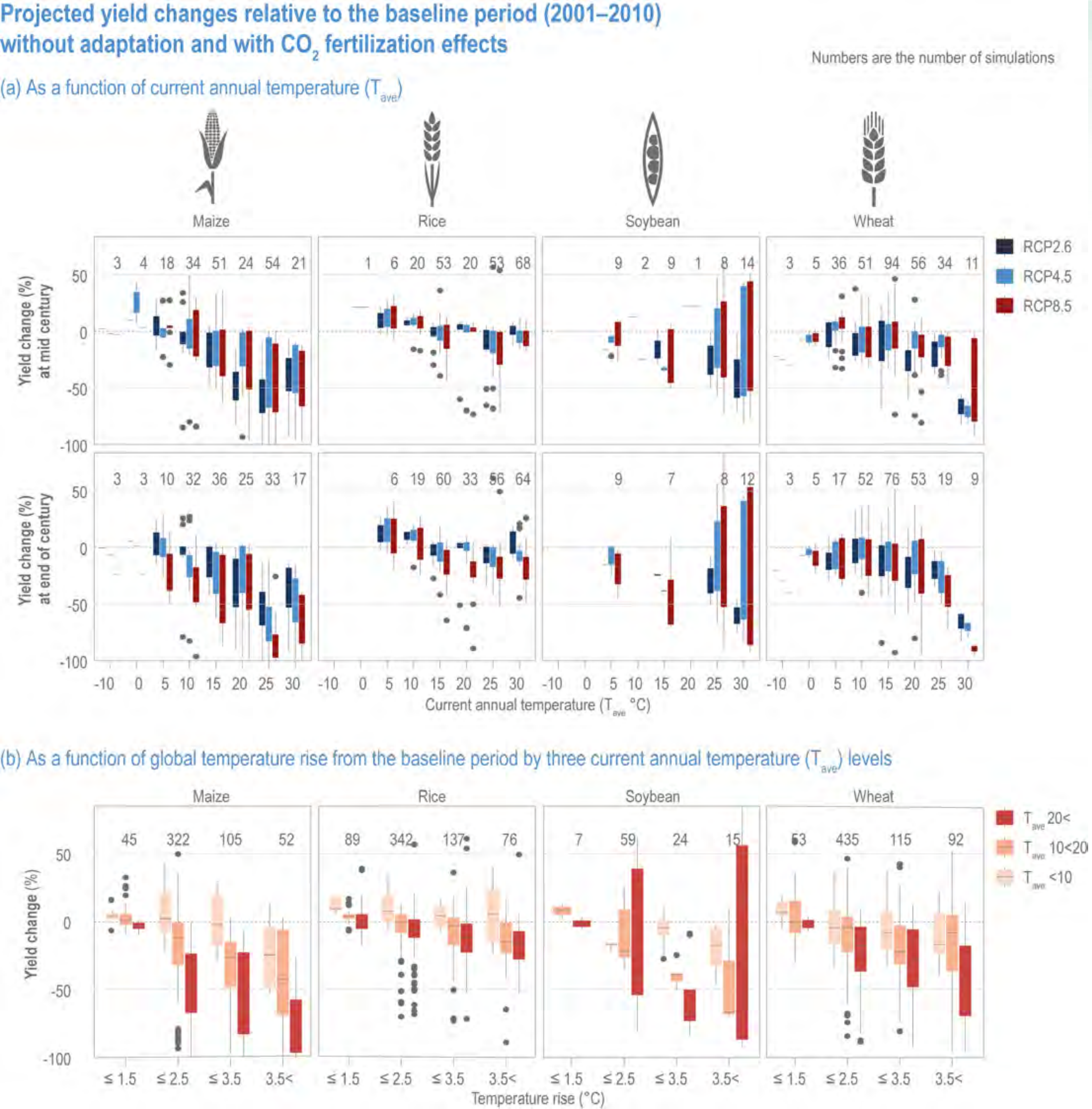
IPCC AR6 SYR Figure 2.3a

Most crops, in most regions, have seen reduction in yields over the past 50 years due to climate change

Synthesis of observed impacts on crop yields and productivity



IPCC AR6 WGII Chapter 5



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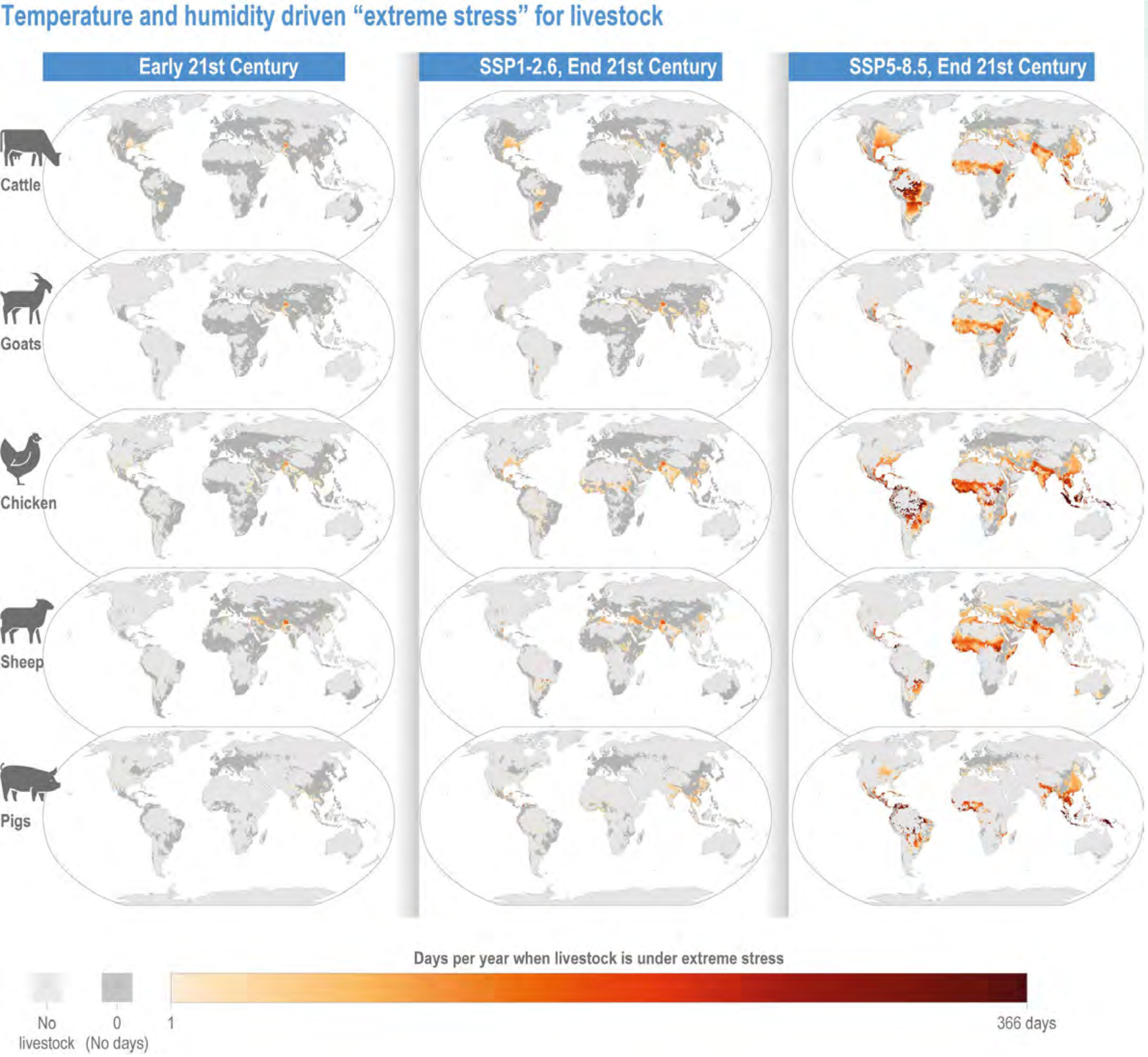
Yields of all major crops are also projected to decline in a future warmer world– more so at higher warming levels, with major non-linear impacts

IPCC AR6 WGII Chapter 5



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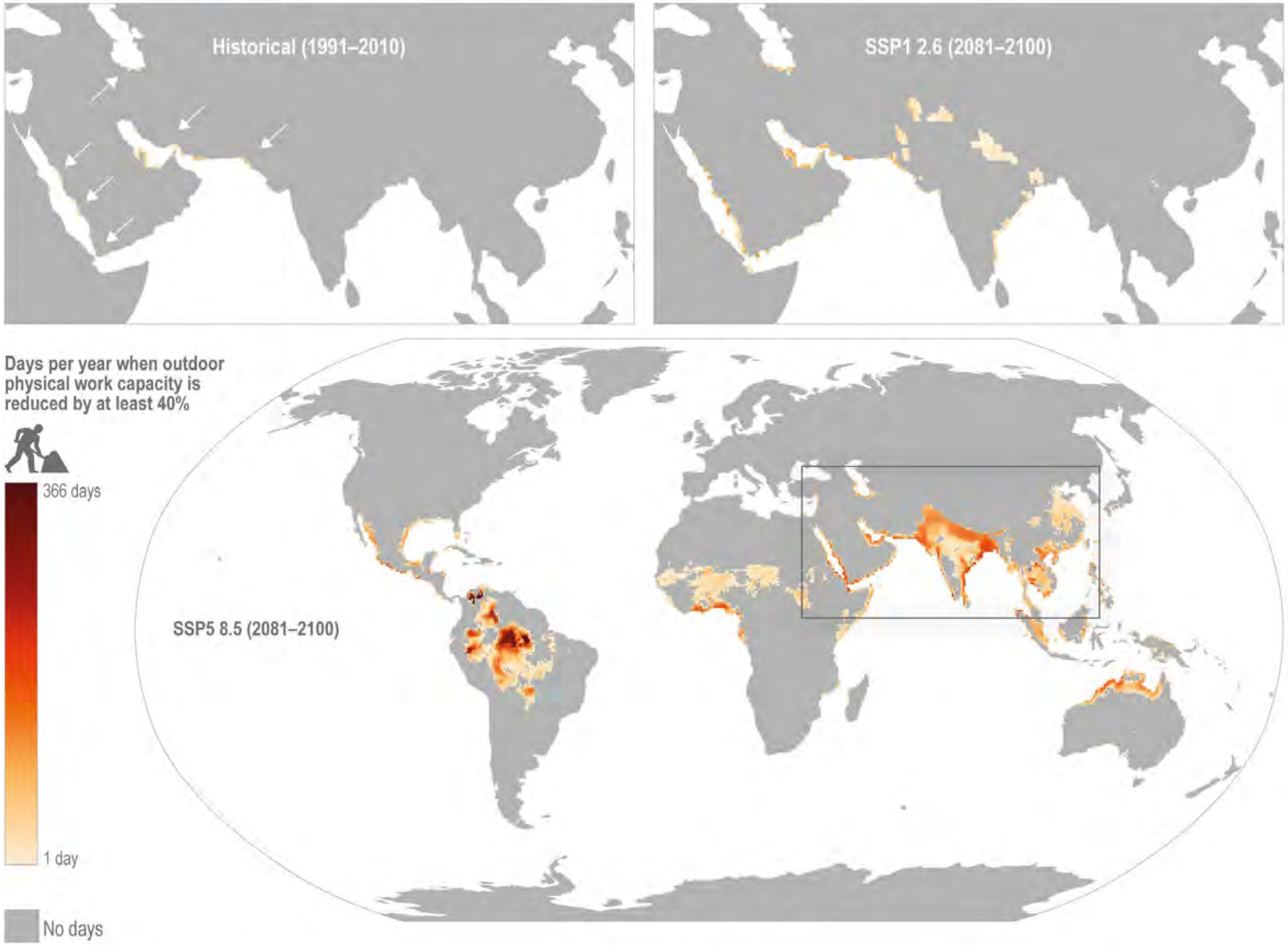
Most livestock is projected to be under "extreme stress" in mid to high global warming scenarios, and with more pronouced impacts in Africa and Asia

IPCC AR6 WGII Chapter 5

Temperature and humidity-driven reduction in first-hour physical capacity for outdoor work

Upper insets and arrows point to the only locations across the globe where the first hour **loss of physical work capacity*** is 40% for the early century and end century SSP1-2.6 scenario. Other locations will have large capacity losses over the course of a work day. End century impacts will be much greater and more widespread under SSP5-8.5.



* The research for the representation of lost physical work capacity was undertaken in a controlled environment. The worker was on a treadmill operating at a constant speed for one hour in a room with controlled temperature and humidity. These conditions approximate work in a field with no wind (which would reduce heat effects) and no direct exposure to solar radiation (which would worsen heat effects). In addition, work capacity declines as hours in the field extend beyond one hour. Research is underway to take these additional factors into account.

Physical capacity for outdoor work is projected to be reduced significantly under medium to high global warming levels, affecting farmers and agricultural labourers, with large impacts in South and South East Asia

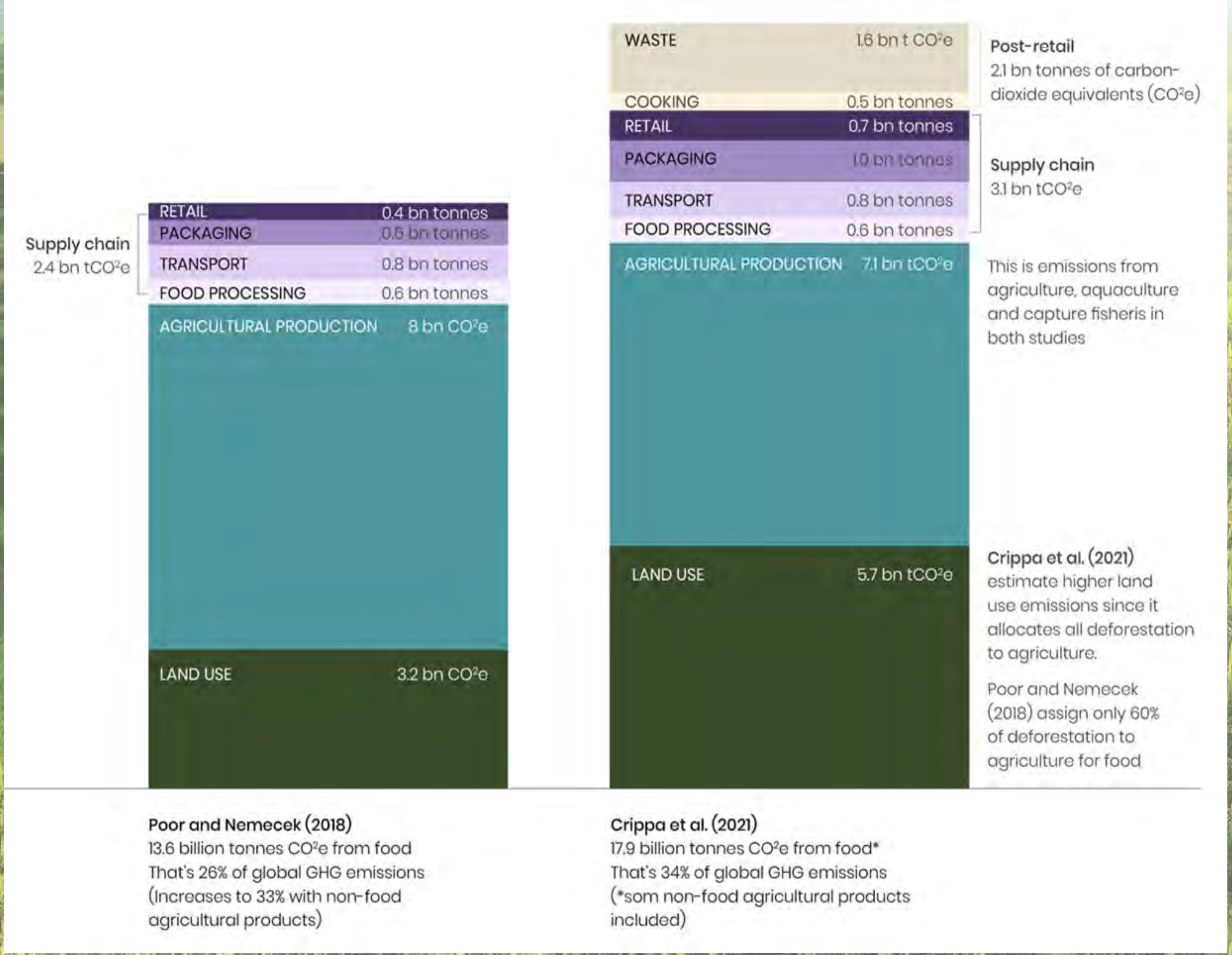
IPCC AR6 WGII Chapter 5

Agriculture and Food Systems are Key Drivers of Climate Change

Agriculture and food systems contribute **30% of global greenhouse gas** (GHG) emissions, second only to the energy sector.

Emissions from agrifood systems have increased over past decades

Deforestation and land-use changes driven by agriculture **diminish carbon sinks**



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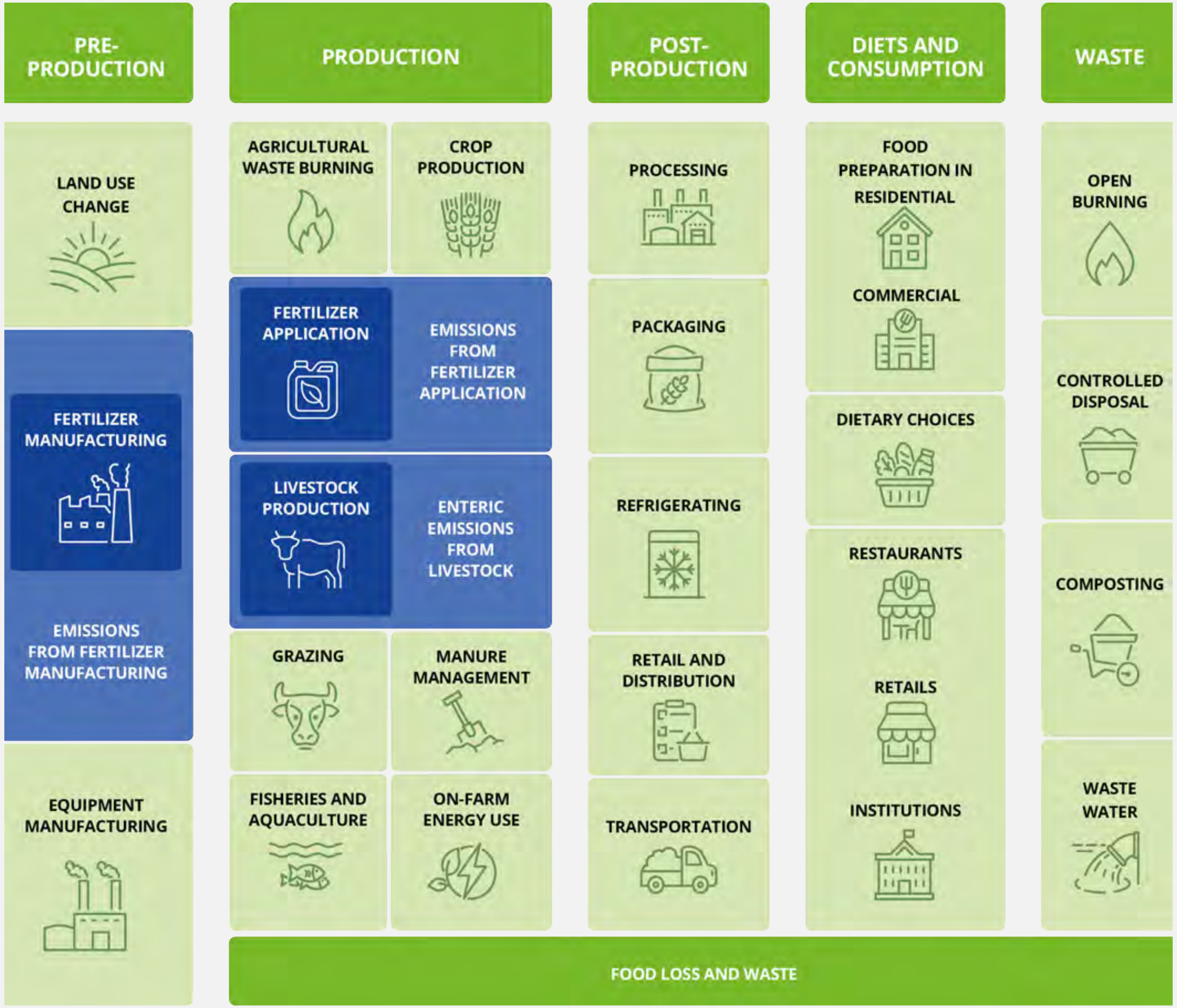
Emissions in agri-food systems happens throughout the value chain– from production to consumption

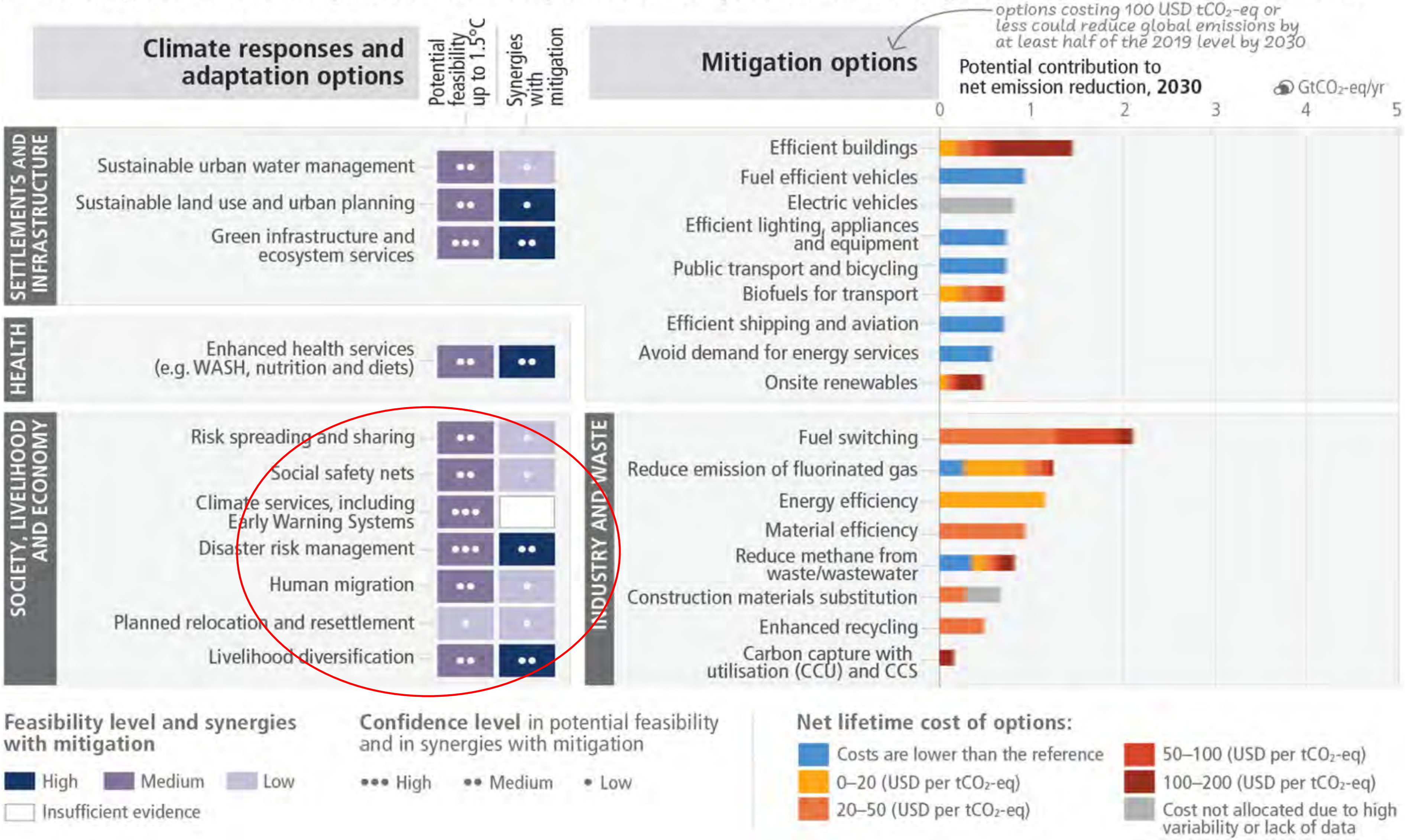


Agrifood systems account for approximately one-third of all greenhouse gas (GHG) emissions globally, when food production, transport, processing, and retailing are considered ([Crippa et al. 2021](); [IPCC-2022]()).

Sources of GHG emissions from various components across the entire value chain of the agrifood system. Adapted from Balasubramanian et al. 2021 and Rosenzweig et al. 2021.The sectors where we do a deep dive are marked in blue.

There are multiple opportunities for scaling up climate action

Feasibility of climate responses and adaptation, and potential of mitigation options in the near-term



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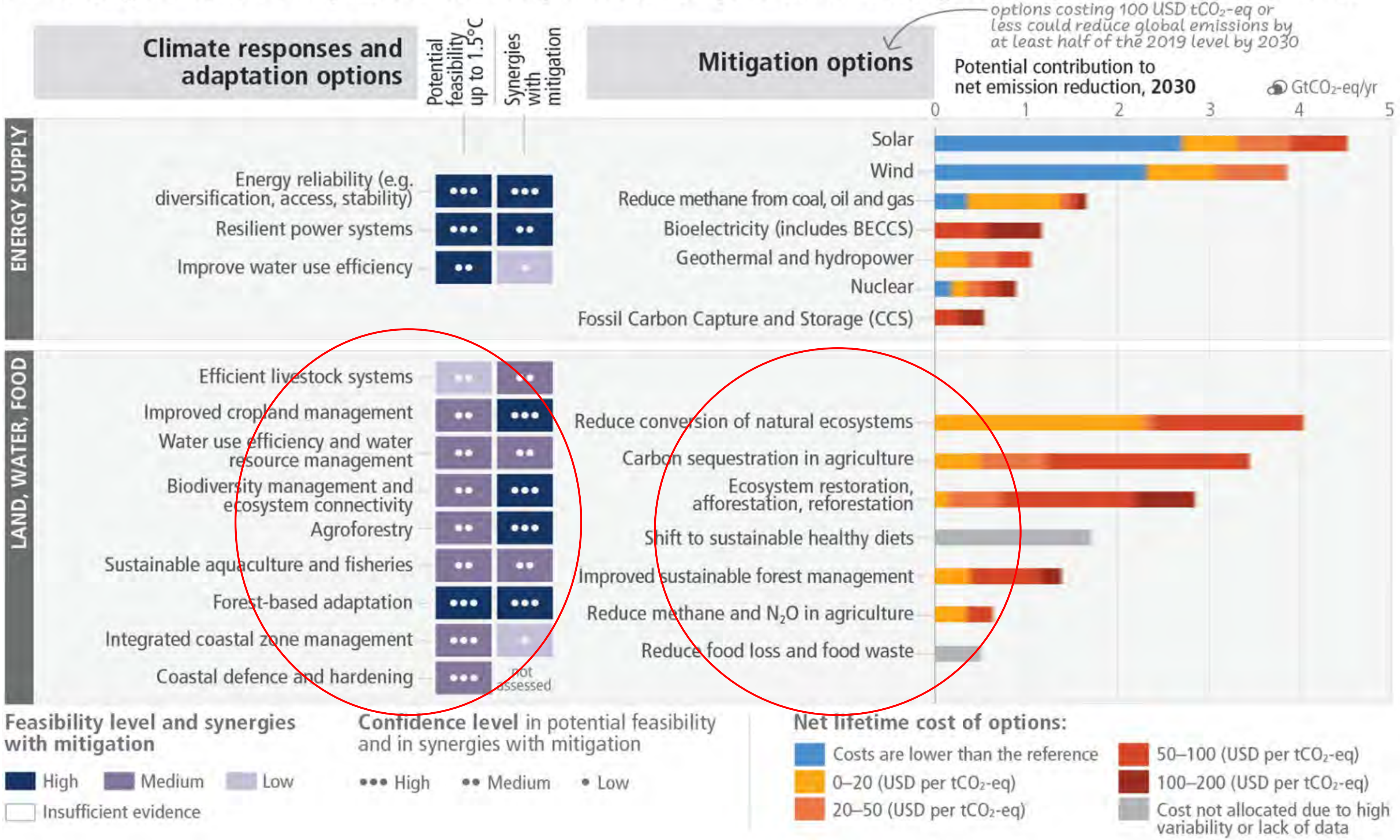

IPCC AR6 SYR Figure SPM.2c

Mitigation action in livestock and fertilizer with adaptation co-benefits

- Reducing enteric emissions via low-methane forages
- Reducing emissions from fertilizer application via site-specific nutrient management (SSNM)

Reducing enteric emissions via low-methane forages

- Improved forages, including legumes and grasses enriched with anti-methanogenic compounds, offer a potentially cost-effective solution for reducing methane emissions (Bratta 2015).
- These compounds inhibit methanogenic microbes in the rumen and alter the microbial community to favour alternative fermentation pathways without affecting animal productivity (Molina-Botero et al. 2024; Arndt et al. 2022; Jayanegara et al. 2019).
- **Low-methane forages could also improve carbon sequestration in soil and enhance soil health, with the potential for developing land-based GHG removal projects (Costa Jr et al. 2022; Paul et al. 2020).**

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Reducing emissions from fertilizer application via site-specific nutrient management (SSNM)

- SSNM aims to increase nitrogen use efficiency (NUE) through the precise application of balanced fertilizer inputs, leading to higher crop productivity and other environmental benefits (Dobermann and White 1998; Dobermann et al. 2002).
- SSNM is an important axis of integrated soil fertility management (ISFM), a set of soil fertility management practices adapted to local conditions that aim to maximize the agronomic use efficiency of the applied nutrients and improve crop productivity (Vanlauwe et al. 2010).
- Supported by advances in **big data science**, **crop modeling**, and **geospatial analytics**, and with the increasing availability of remote sensing products, SSNM is supported by decision tools that guide the right source of nutrients, at the right rate, the right time, and in the right place, i.e., the 4Rs (Johnston and Bruulsema 2014).
- Efficiently used fertilizer means that available nitrogen in the soil is minimal, reducing the potential for nitrous oxide emissions (Tian et al. 2020).

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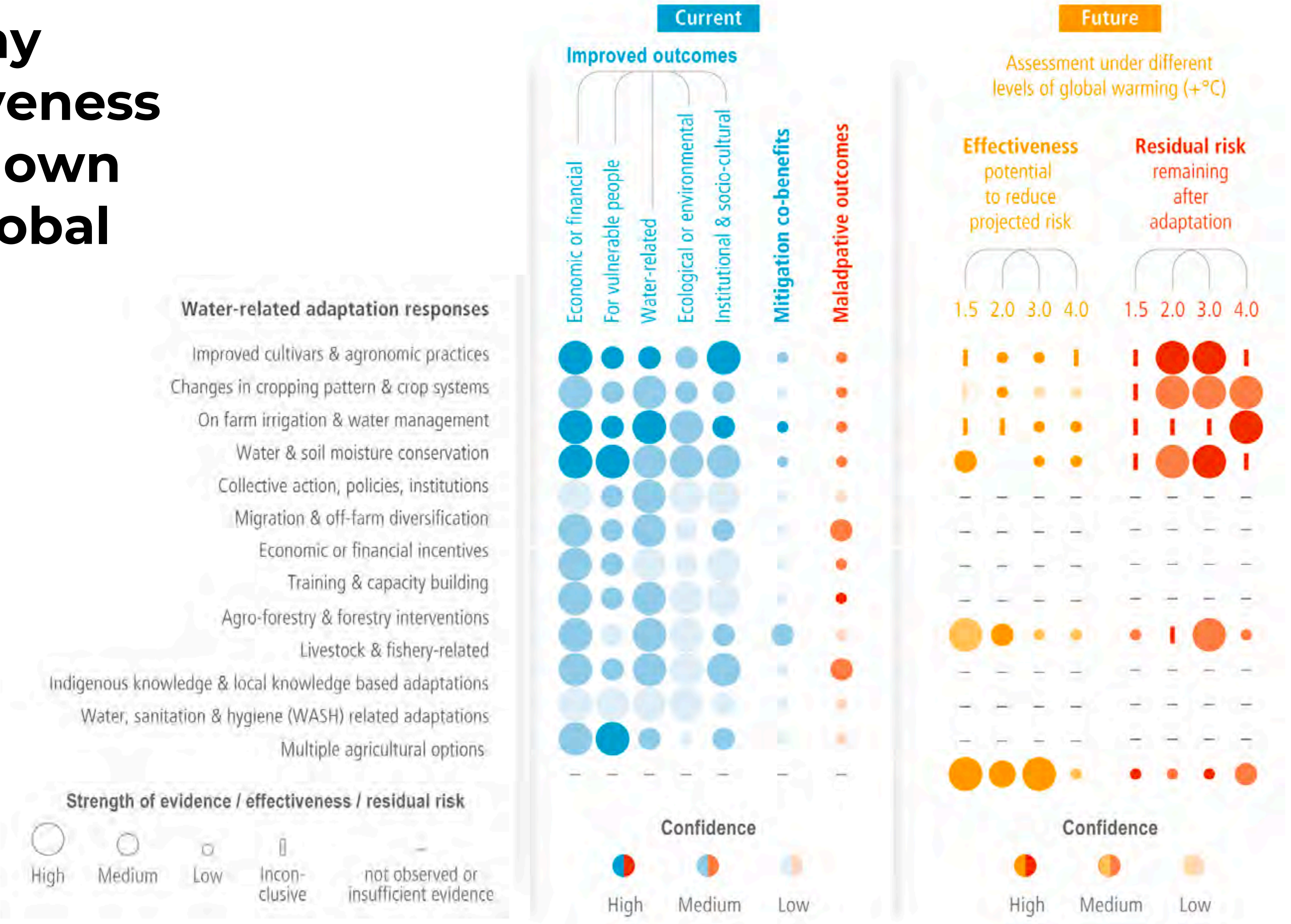
While adaptation is happening with many benefits, but effectiveness of adaptation goes down at higher levels of global warming

- Water and agricultural adaptation is most effective up to 1.5°C and effectiveness decreases with increasing warming
- Residual impacts remain, especially at higher levels of warming



IPCC AR6 WGII Chapter 4 (Water)

Five pathways towards resilience in the agri-food sector

Pathway 1

Reduce unsustainable consumption where such consumption has harmful effects on health, climate, and the environment

- Reduce **fertilizer** use by improving NUE in high-use areas
- Reduce unsustainable intake of ASF in HIC contexts by partial replacement with **alternative proteins**
- Reduce **food waste**
- Use **digital services** to aid all above
- Promote sustainable healthy diets with low carbon footprint

Pathway 2

Increase production of sustainable, healthy and nutritious food, particularly in LMICs, without expanding agriculture into new lands

- Increase production through optimal application of low emissions **fertilizers** in areas of underuse
- Increase production through **crop breeding** in areas of low productivity
- Increase production through climate-smart **livestock** practices & **agroecological** & other sustainable approaches
- Use **digital services** to aid all above

Pathway 3

Reduce damage to natural resources such as soil, water, and biodiversity

- Improve NUE of **fertilizers** allowing less pollutants to leach into water bodies
- Adopt low external input **agroecological** & other sustainable approaches
- Reduce **food waste & loss**
- Use **digital services** to aid all above
- Improve agricultural water management

Pathway 4

Reduce emissions, either absolute emissions or emissions intensity with the ultimate aim of reducing absolute emissions

- Improve NUE & adoption of low emissions **fertilizers**
- Reduce methane emissions from **livestock** sector; & promote adoption of **alternative proteins**
- Reduce **food waste & loss**
- Use **digital services** to aid all above
- Reduce methane emissions from rice paddy

Pathway 5

Prioritise the needs and interests of smallholder producers

- **Digital services**, e.g. climate advisory & indexed based insurance for smallholder producers
- Increase productivity & incomes through **crop & livestock breeding** for smallholder farmers
- Improve resilience of smallholder production systems by adoption of **agroecological** & other sustainable approaches
- Invest in social safety nets for smallholder producers

https://www.cgiar.org/2024-breakthrough-agenda-report-agriculture/

Research priorities for the future

- How can we assessing **losses and damages in the agri-food sector** and attributing it to climate change? Potential to use the recent International Court of Justice Advisory Opinion to hold polluters responsible

- What does **transformational adaptation** mean in context of agri-food systems context? Transformational adaptation is on the table for discussions at COP30 as a part of Global Goals on Adaptation Indicators

- What role with **Carbon-dioxide removals (CDRs) and land as sink** play in future mitigation?– All future mitigation pathways assume CDRs, and land to act as carbon sinks. But future warming also reduces the ability of land (and oceans) to act as carbon sinks.

- **What happens to land, water, biodiversity (and oceans) and food security, when we overshoot 1.5 degrees**, remain there for a few decades, and come back again to 1.5?

- How do we achieve **just transitions in agri-food systems?** – how to manage our journey to low emissions/net zero future while protecting their lives and livelihoods?

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Thank you