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The Role of Agricultural Systems Conservation and Regeneration to Adapt to and Mitigate Climate Change

Hasegawa Toshihiro (Toshi)

Institute for Agro-Environmental Sciences, NARO
Coordinating Lead Author of Chapter 5 of the IPCC
WG2 AR6

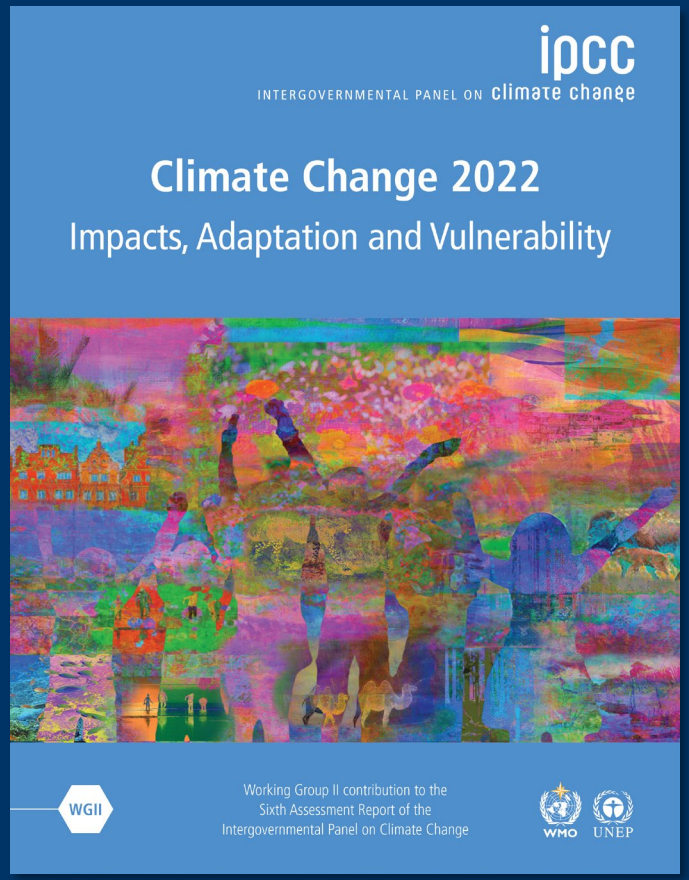
National Agriculture and Food Research Organization

NARO

Topics

- Messages from IPCC AR6 WG2 report related to sustainable food production
  - Impacts of climate changes and associated risks
  - Assessment of adaptations
- Post-AR6 literature related to climate action using sustainable food production
  - Climate change adaptation
  - Climate change mitigation
- Challenges

Note: This presentation will cover several similar approaches to sustainable food transformation without distinction.



A brief summary of the IPCC WG2 AR6:

The scientific evidence is unequivocal: climate change is a threat to human well-being and the health of the planet.

Any further delay in concerted global action will miss the brief, rapidly closing window to secure a liveable future.

This report proposes solutions to the world.

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

5

Food, fibre, and other ecosystem products

Chapter 5 provides a global assessment of climate change impacts and risks to agriculture, forestry, fisheries and aquaculture, as well as adaptation solutions and limits.

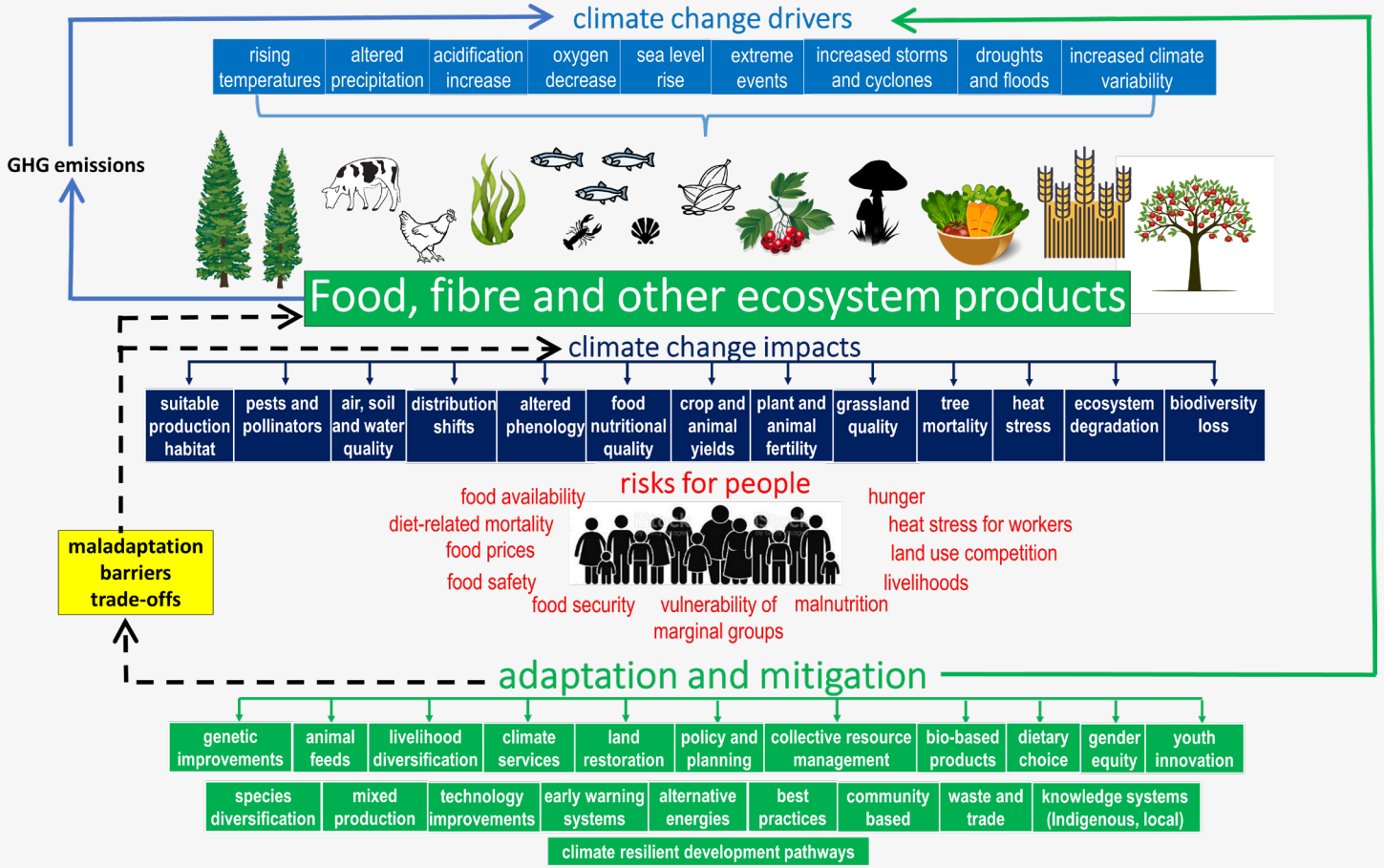
Coordinating Lead Authors: Rachel Bezner Kerr (USA/Canada), Toshihiro Hasegawa (Japan), Rodel Lasco (Philippines)

Lead Authors: Indra Bhatt (India), Delphine Deryng (Germany/France), Aidan Farrell (Trinidad and Tobago/Ireland), Helen Gurney-Smith (Canada/UK), Hui Ju (China), Salvador Lluch-Cota (Mexico), Francisco Meza (Chile), Gerald Nelson (USA), Henry Neufeldt (Denmark/Germany), Philip Thornton (Kenya/UK)

Review Editors: Pauline Dube (Botswana), James Morison (UK)

Chapter Scientists: Emily Baker (USA), Hitomi Wakatsuki (Japan), Elizabeth Sprout (UK/USA)

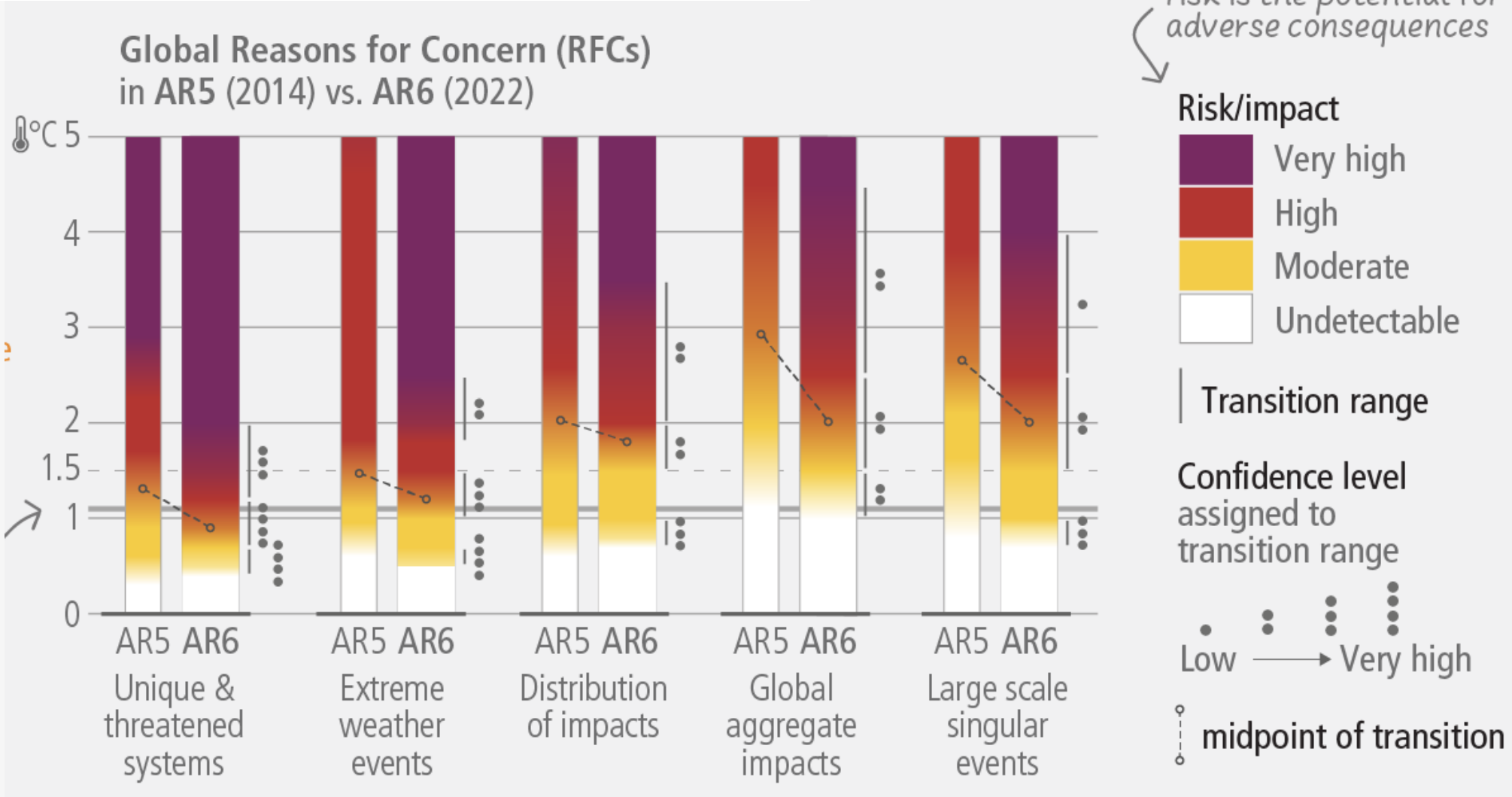
+ 72 **contributing authors**



Risk transitions are projected to occur at lower GWLs than in AR5.

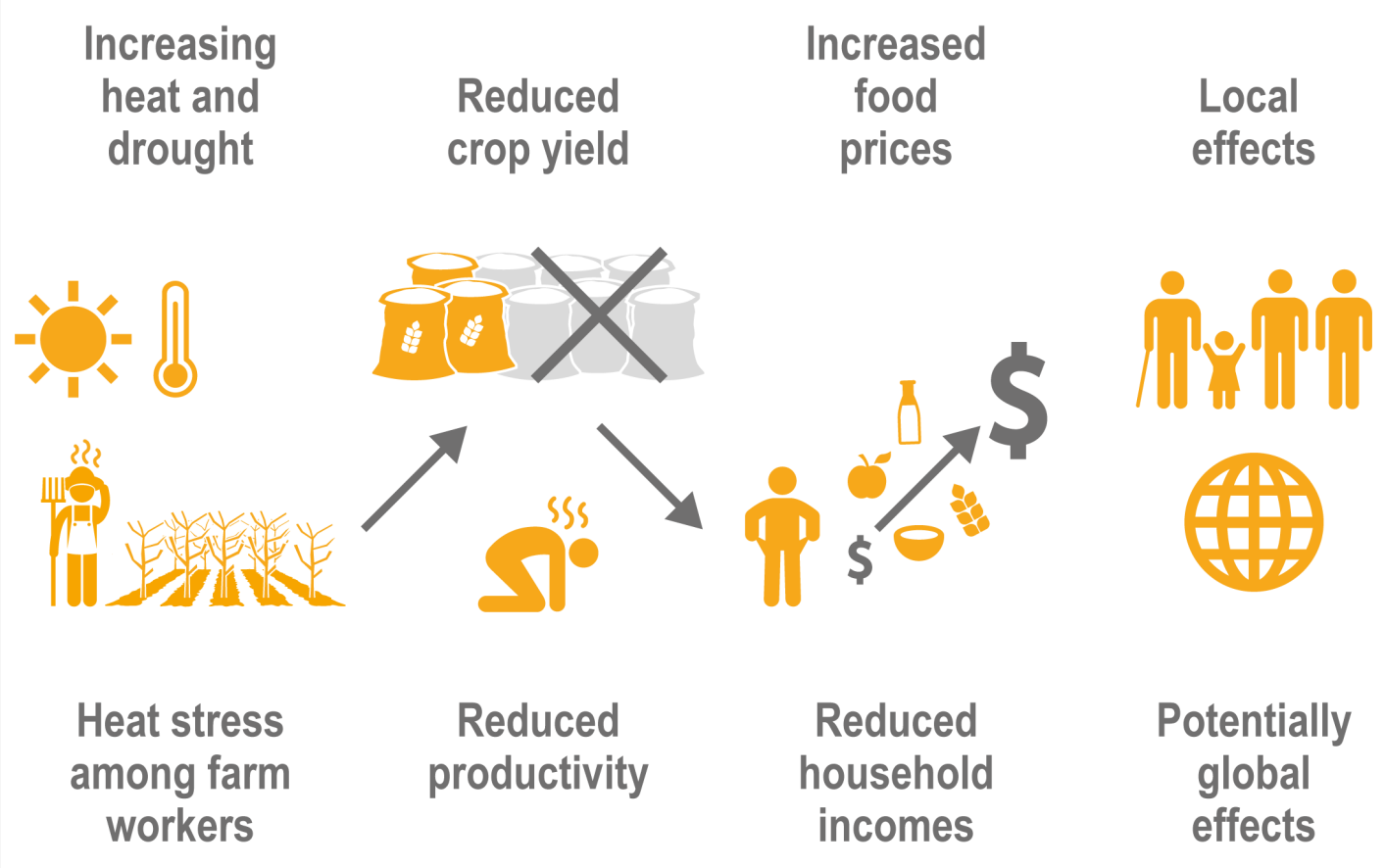
Warming level in 2011-2020

Global warming level (GWL) from 1850-1900 (°C)



IPCC AR6 Synthesis report SPM figure

Many risks are compounding and cascading:



IPCC AR6 WG2

See also this for a review on **breadbasket failures.**

Hasegawa, T., Wakatsuki, H., Nelson, G.C., 2022. Evidence for and projection of multi-breadbasket failure caused by climate change. Curr. Opin. Environ. Sustain. 58, 101217. https://doi.org/10.1016/j.cosust.2022.101217

Action on adaptation has increased

Effective options:

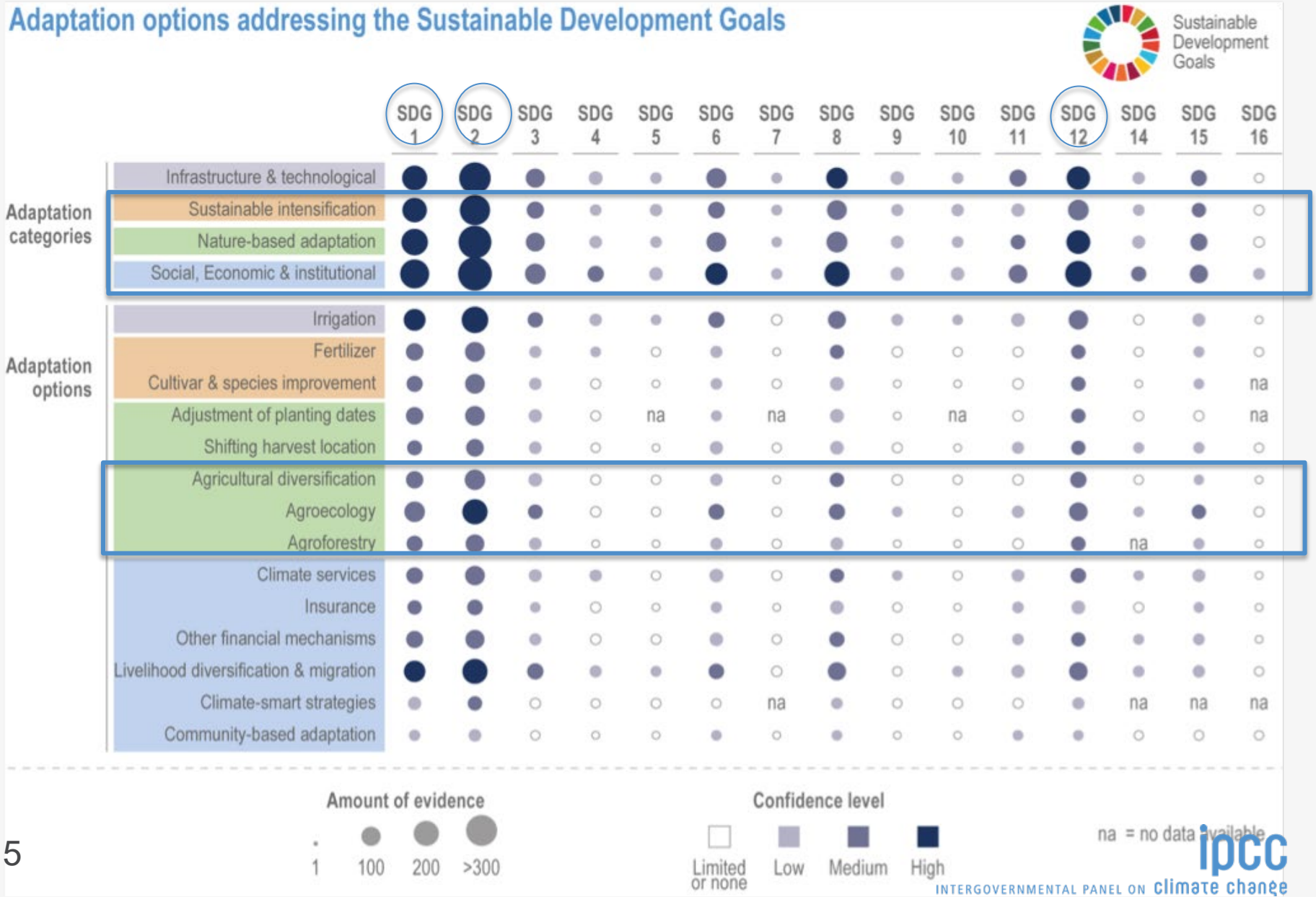
- Cultivar improvements
- Agroforestry
- Farm and landscape diversification
- Community-based adaptation
- Strengthening biodiversity

Wider benefits:

- Food security and nutrition
- Health and well-being
- Livelihoods

[Jacquelyn Turner / CCAFS CC BY-NC-SA 2.0; FAO / Riccardo De Luca]

Systematic review provides evidence of synergies of adaptation with SDGs.



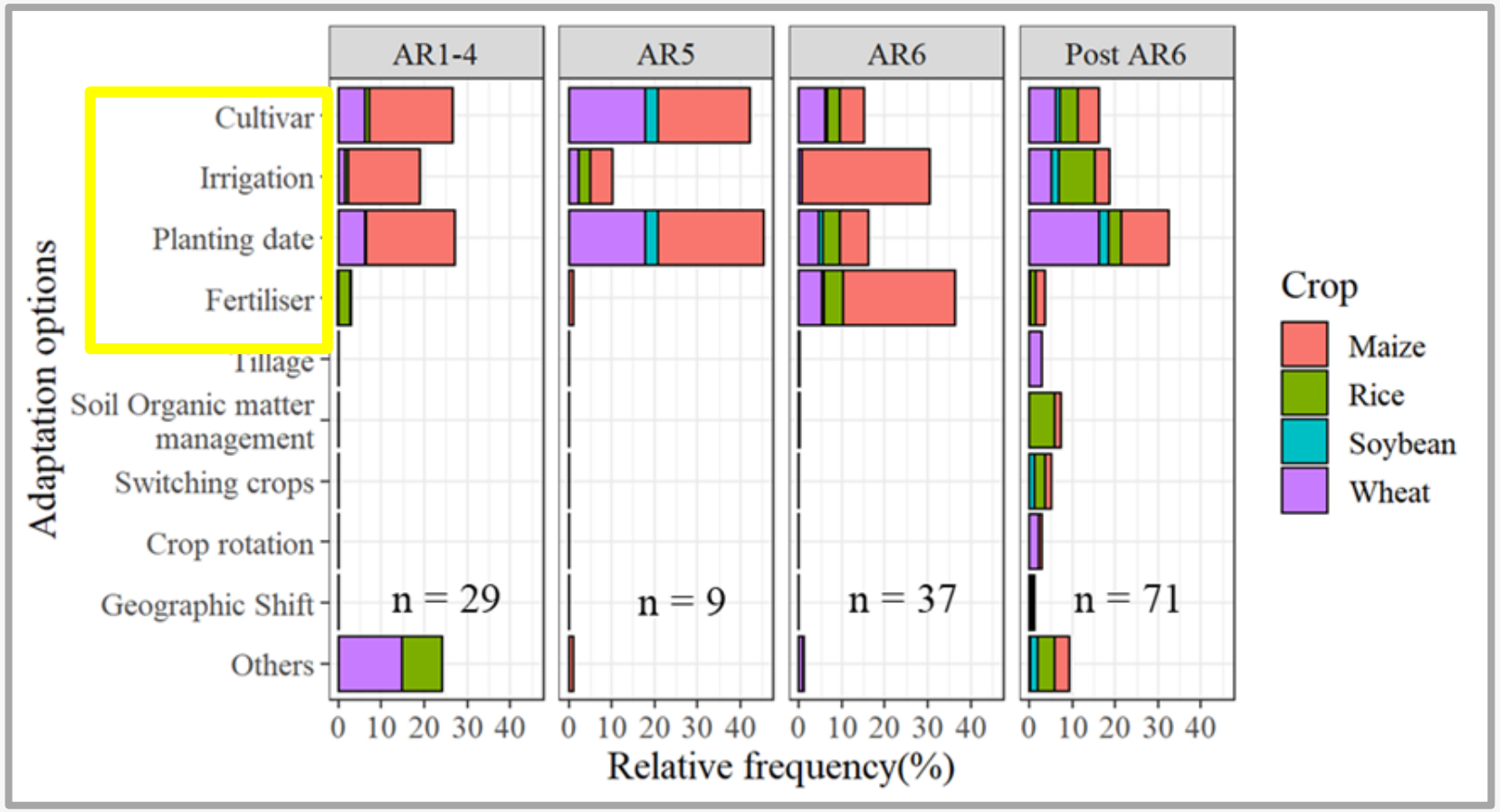
IPCC WG2 AR6 Chp. 5

- **Autonomous adaptation measures** are being deployed
- Common strategies include switching crop cultivars, soil organic management, or the timing of crop planting or animal stocking.
- Sustainable approaches are reported particularly in African countries

IPCC WG2 AR6 Chp. 5

Figure 5.20 | Observed adaptation across regions in food, fibre and other ecosystem products based on the GAMI database (Berrang-Ford et al., 2021a). The bars indicate the number of evidence for the options *x* region.

Some adaptations effects are quantified



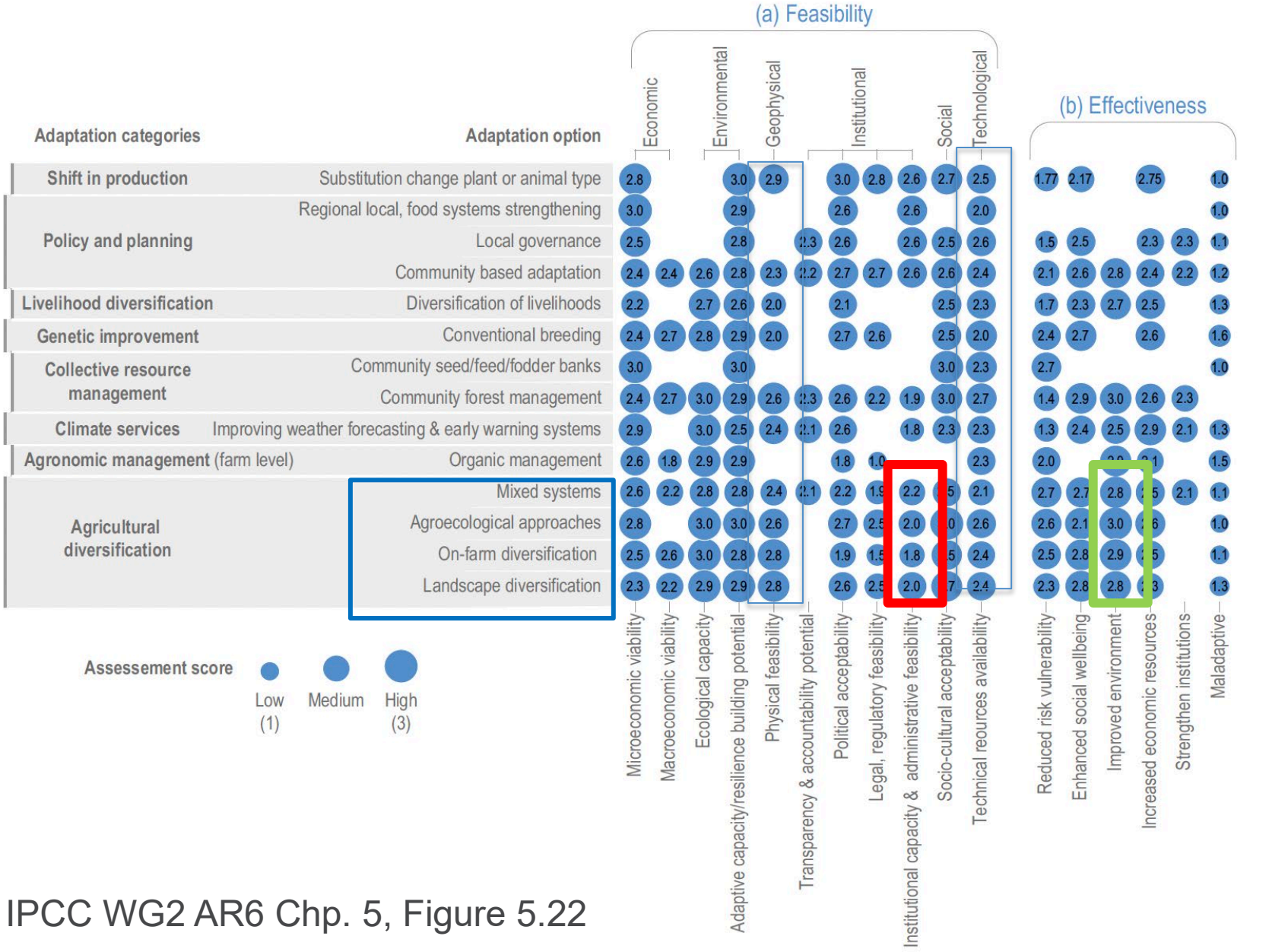
A systematic review for the crop simulation studies (Wakatsuki et al., 2023)

These measures are **not enough to offset negative impacts and risks.**

Few sustainable management practises have been quantitatively assessed using simulation models, but new studies such as ‘agroforestry’, ‘organic farming’, ‘climate-smart agriculture', and ‘cropping system diversification’ are emerging.

Wakatsuki et al., 2023. Curr. Opin. Environ. Sustain. 60, 101249. https://doi.org/10.1016/j.cosust.2022.101249

Adaptation feasibility and effectiveness assessment in AR6



IPCC WG2 AR6 Chp. 5, Figure 5.22

Most options are technically feasible, with generally high political and social acceptability.

Sustainable approaches generally have high effectiveness in improved environment, but most adaptation options have limited evidence for institutional feasibility.

Approaches to sustainable transformation in agriculture

Literature related to Agroecology, regenerative agriculture, and nature-based solutions

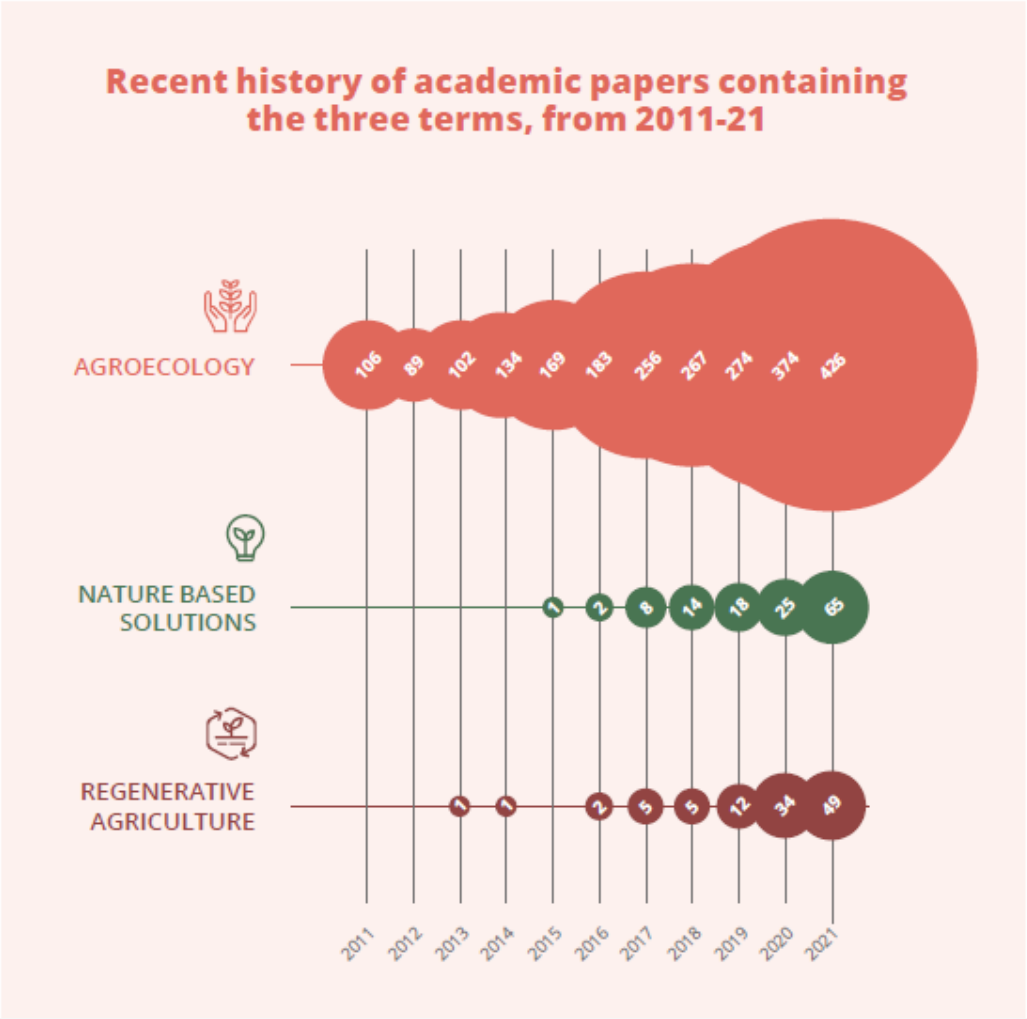


Figure 3 provides an illustration of trends over the last decade, illustrating the predominance of agroecology but the recent rapid expansion of the other terms, particularly nature-based solutions related to agriculture and farming. Section 5 of this report will provide further evidence of this trend by referencing global policy spaces that have adopted this concept.

FIGURE 3

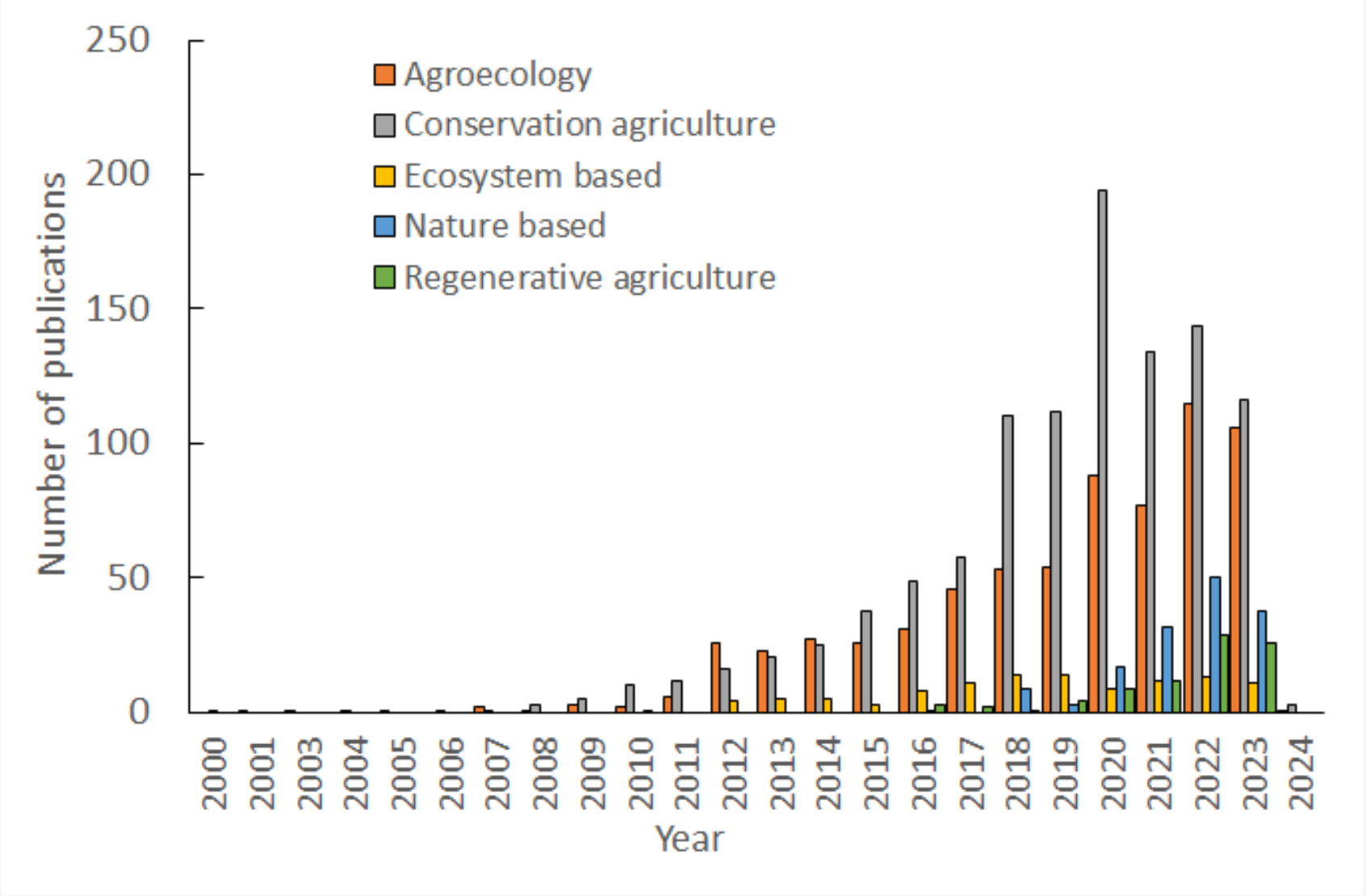
Agroecology has been by far widely used for an extended period.

Source: IDS & IPES-Food, 2022. Agroecology, regenerative agriculture, and nature-based solutions: Competing framings of food system sustainability in global policy and funding spaces., Drawdown. https://www.ipes-food.org/_img/upload/files/SmokeAndMirrors_BackgroundStudy.pdf

Literature related to climate change (climate resilience)

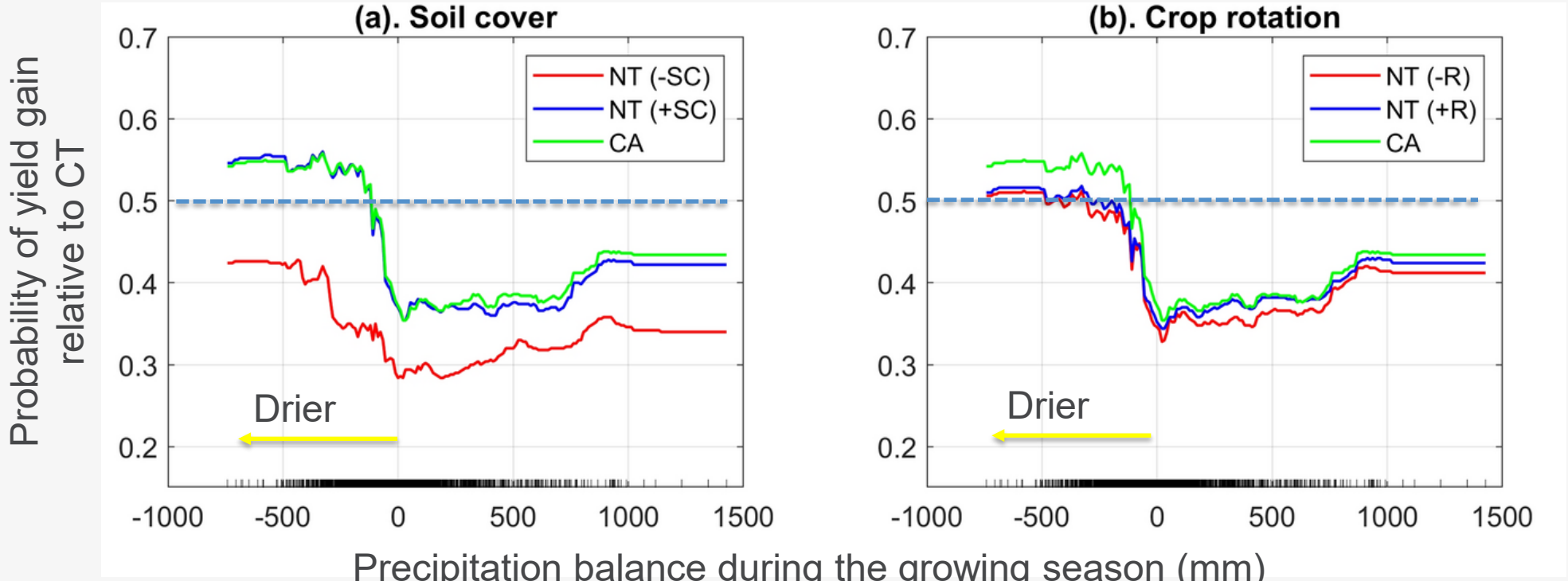
Web of Science literature search using five terms AND (climate change or climate resilience) as of November, 2023

In the context of climate change or climate resilience, **conservation ag and agroecology** have been reported more frequently than others.
Literature on **regenerative agriculture** in the context of CC is emerging.



A global meta-analysis in the context of **climate change adaptation**

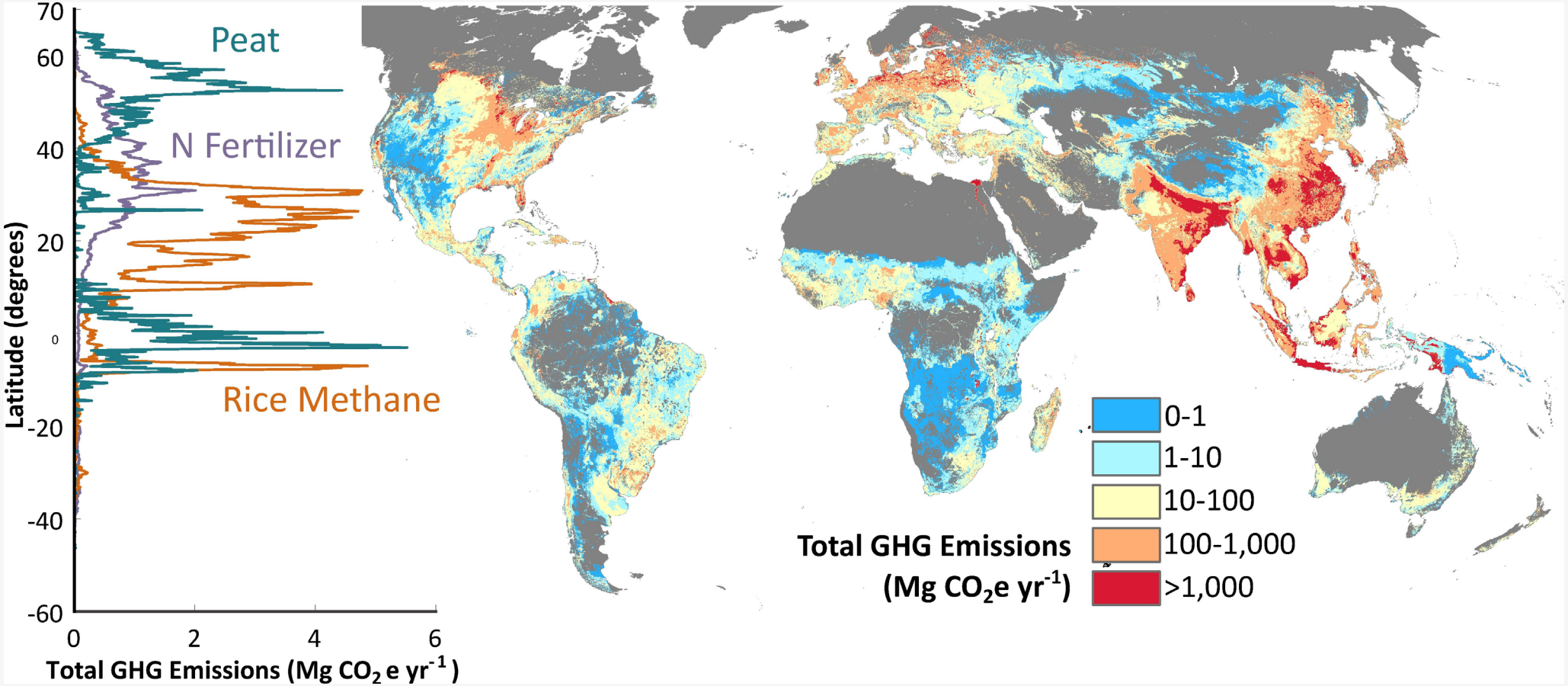
Testing three principles of conservation agriculture (**CA**): permanent soil cover (**SC**), minimising soil disturbance (no till, **NT**), and diversifying crops (Rotation, **R**) relative to conventional tillage (**CT**) (Su et al., 2021).



Impact of crop management practices on CA performance, shown in 1-dimension partial dependence plot of the probability of yield gain as a function of precipitation balance (mm). ± SC indicates NT with/without soil cover. ± R indicates NT with/without rotation. ± F indicates NT or CA and CT with/without fertilization. ± WD indicates NT or CA and CT with/without weed and pest control. Plot a compares the productive performance of CA, NT+SC, and NT-SC. Plot b compares the productive performance of CA, NT+R, and NT-R.

Su, Y., Gabrielle, B., Beillouin, D., Makowski, D., 2021. High probability of yield gain through conservation agriculture in dry regions for major staple crops. Sci. Rep. 11, 1–8. https://doi.org/10.1038/s41598-021-82375-1

GHG emissions from cropland

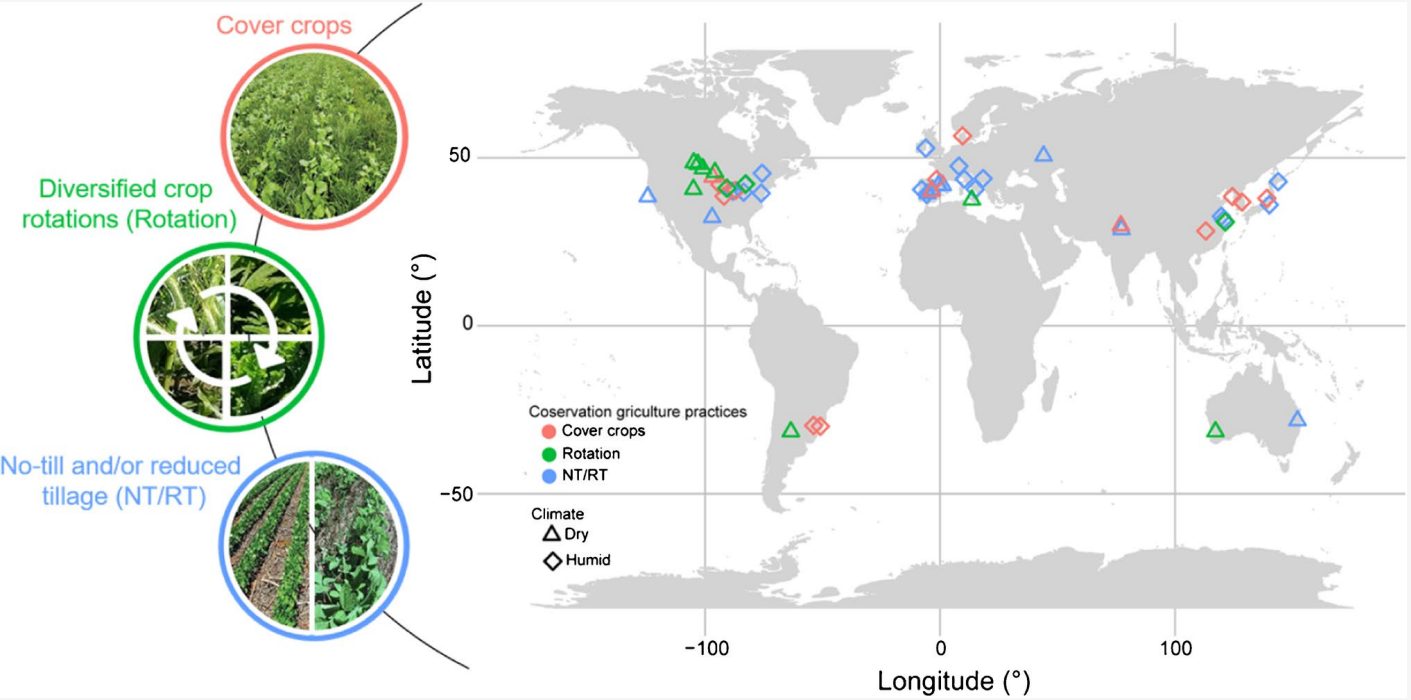


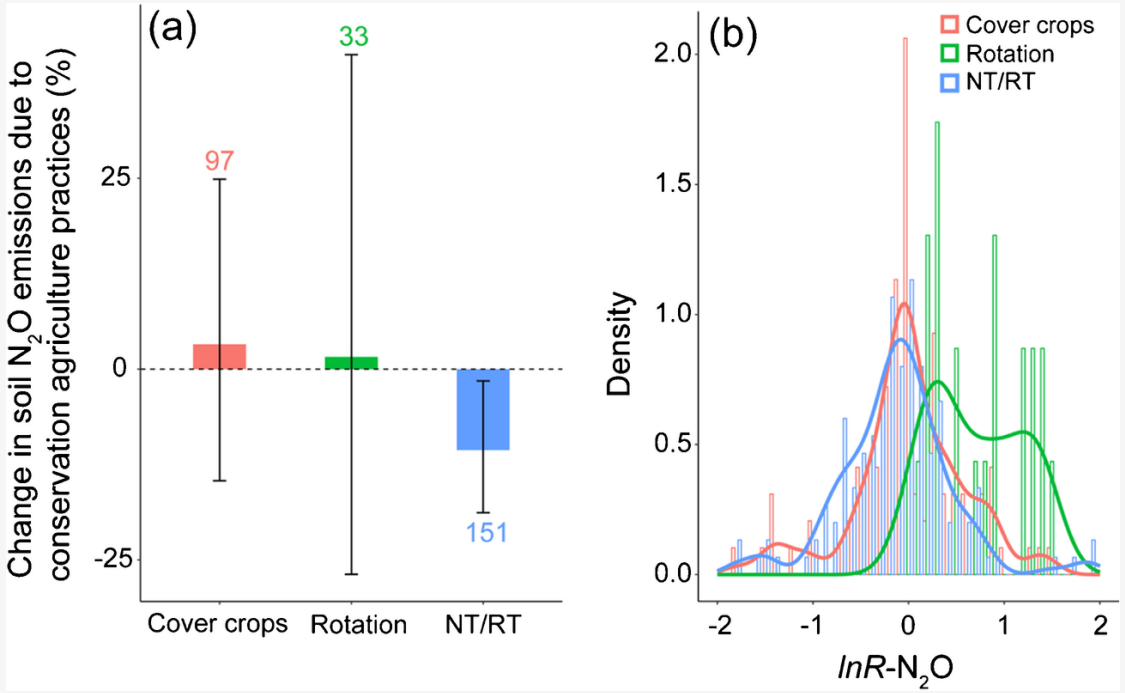
Cropland GHGs consist of CH_4 from rice cultivation, CO_2, N_2O, and CH_4 from peatland draining, and N_2O from N fertiliser application. Total emissions from each grid cell are concentrated in Asia, and are distinct from patterns of production intensity (Carlson et al. 2017). Emissions related to deforestation or changes in soil carbon are not included.

Mbow, C., Rosenzweig, C., Tubiello, F., Benton, T., Herrero, M., Pradhan, P., Barioni, L., Krishnapillai, M., Liwenga, E., Rivera-Ferre, M., Sapkota, T., & Xu, Y. (2019). IPCC Special Report on Land and Climate Change. Chapter 5: Food Security (pp. 437–550).

A global meta-analysis in the context of climate change mitigation

The effects of **cover crop**, **no till**, and **crop rotation** on **nitrous oxide emissions** relative to conventional tillage (Li et al., 2023).



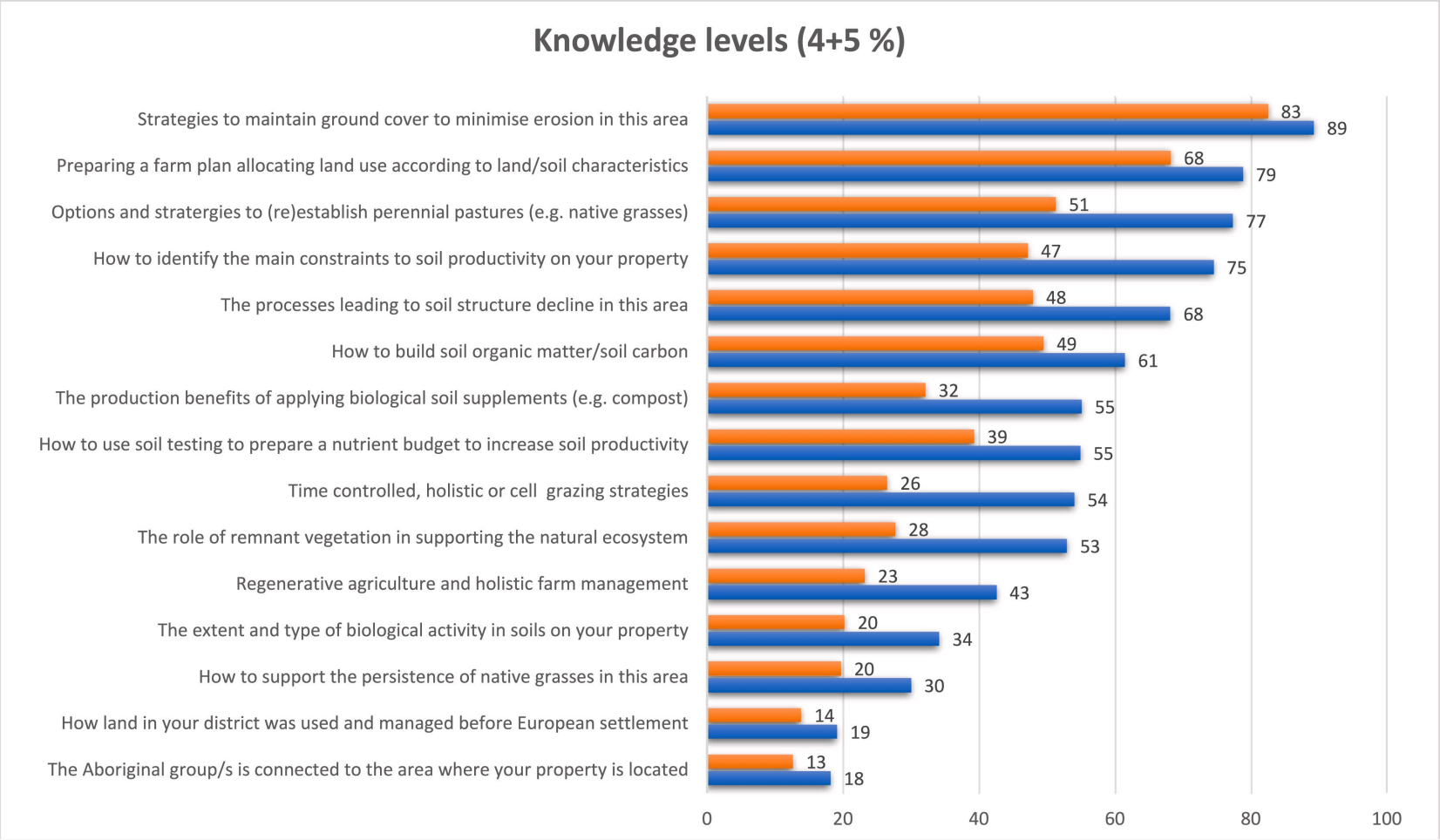


Effects of cover crops, diversified crop rotations (rotation), and no- till and/or reduced tillage (NT/RT) on soil N_2O emissions. (**b**) Distribution of log- transformed response ratios of soil N_2O emissions (*lnR*- N_2O) to cover crops, diversified crop rotations and NT/RT practices. Error bars refer to bootstrap 95% confidence intervals (CIs). The numbers are sample sizes. The fitted curves are from the estimated Gaussian distribution in frequency.

Li, Y., Chen, J., Drury, C.F., Liebig, M., Johnson, J.M.F., Wang, Z., Feng, H., Abalos, D., 2023. The role of conservation agriculture practices in mitigating N2O emissions: A meta-analysis. Agron. Sustain. Dev. 43, 1–13. https://doi.org/10.1007/s13593-023-00911-x

A survey study in Australia: a major driver of adopting RAP

"Self-reported knowledge levels of a range of best practices, divided up by the new groups, with those implementing practices related to regenerative agriculture reporting significantly higher knowledge-levels across all practices."



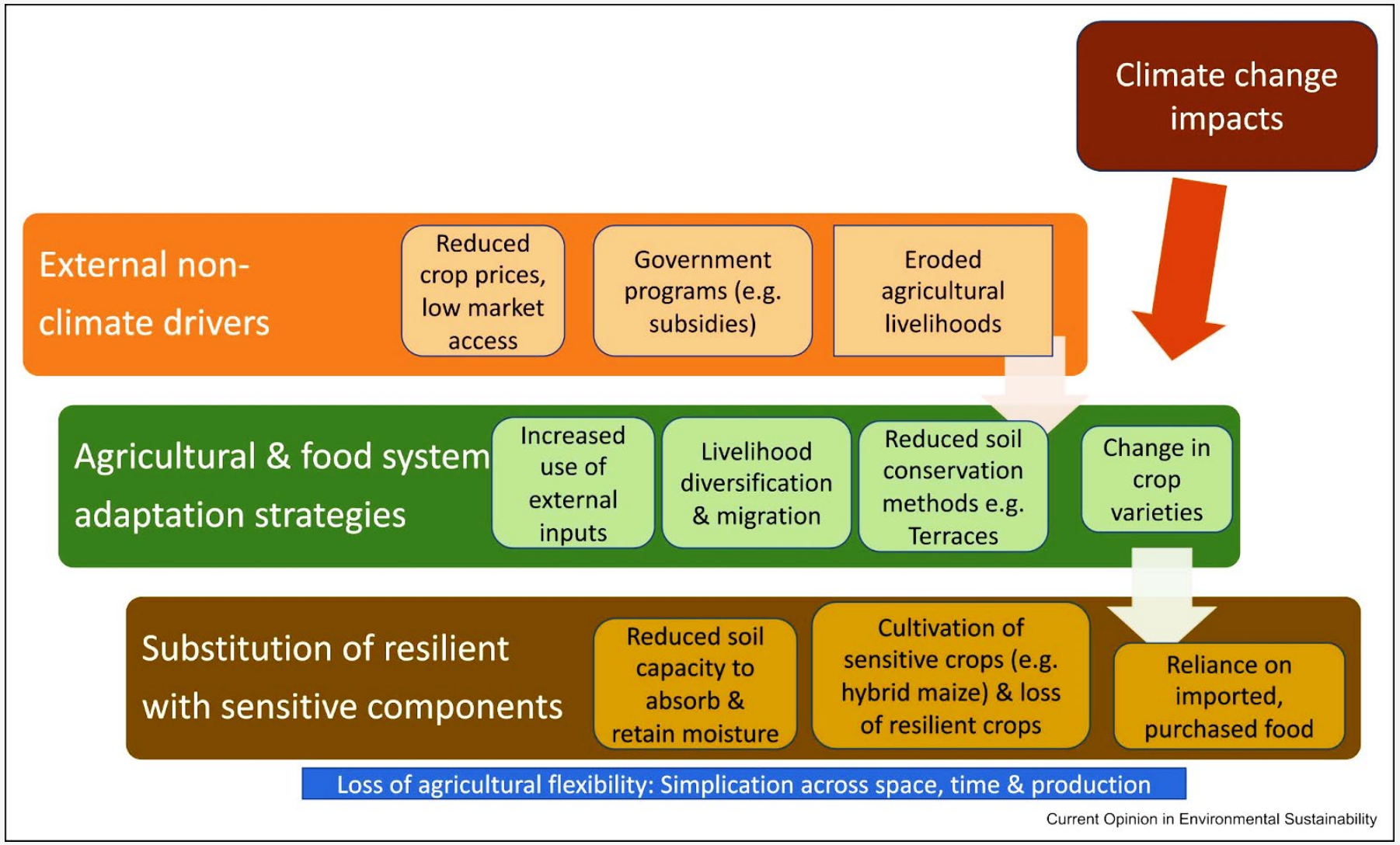
Comparison of two groups: Farmers practising Regenerative Agriculture (RAP) and not practicing it.(Non-RAP)

Note: The distinction between RAP and non-RAP was made by the authors.

Knowledge is a key driver:

Alexanderson, M.S., Luke, H., Lloyd, D.J., 2023. Regenerative farming as climate action. J. Environ. Manage. 347, 119063. https://doi.org/10.1016/j.jenvman.2023.119063

Potential pathways leading to mal-adaptations in food systems



More evidence is reported for maladaptation and/or malmitigation, but it could be avoided using knowledge related to the approaches to sustainable transformation.

Bezner Kerr, R., 2023. Maladaptation in food systems and ways to avoid it. Curr. Opin. Environ. Sustain. 61, 101269. https://doi.org/10.1016/j.cosust.2023.101269

Conclusions

- Approaches to sustainable food transformation are the key climate action to enhancing the climate resilience of food systems.
- The effectiveness of the approaches is context-dependent, but data science can help clarify the contexts.
- Feasibility needs institutional, financial, and political support.
- Scientific evidence is increasing but needs to be more comprehensive to assess the multiple dimensions of the approaches.
- Knowledge is the key driver and can help avoid maladaptation and malmitigation.