Global Perspective on Transformations in Agriculture & Food Systems for Nutrition and Resilience?

Prof Andy Dougill, University of York, UK
@AndyDougill

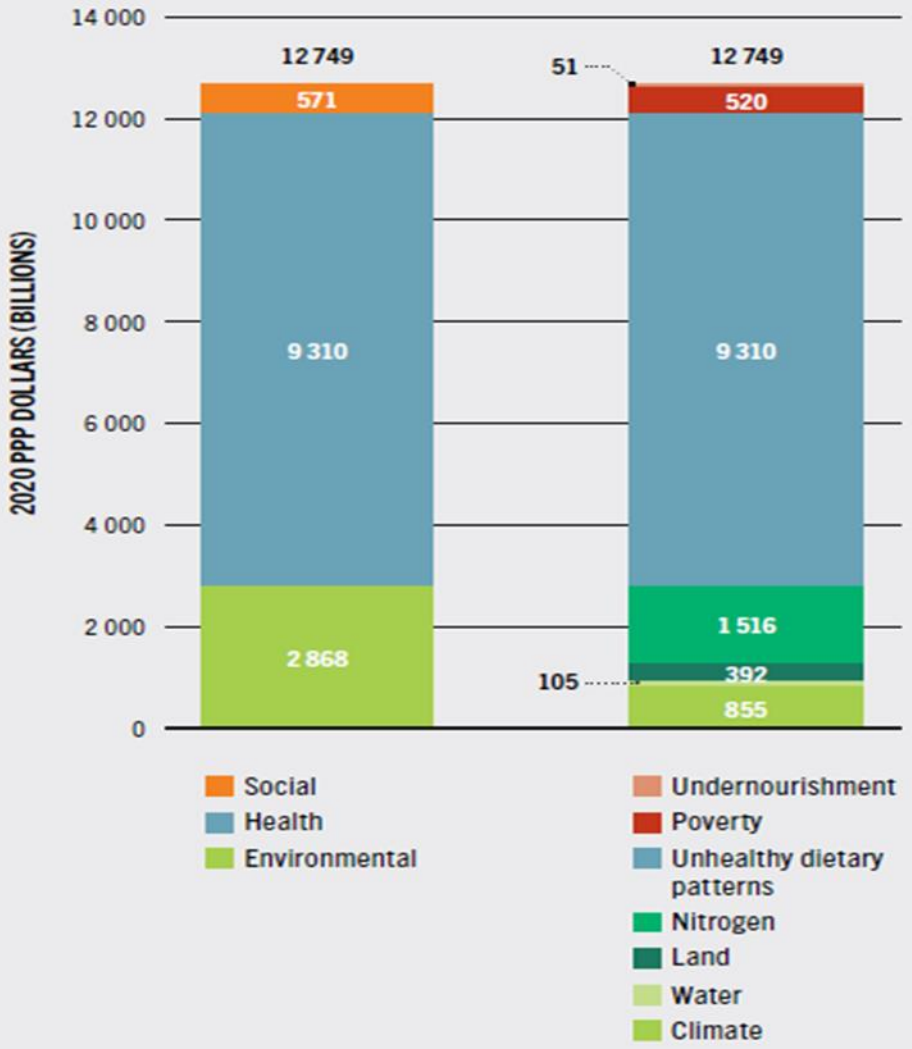
- Food System Transformation as a Worldview & Exemplars of Research – Policy Interface Developments
- Three Horizons Framing & Scenario Planning Tool

- Malawian Food System Transformations in a Changing Climate

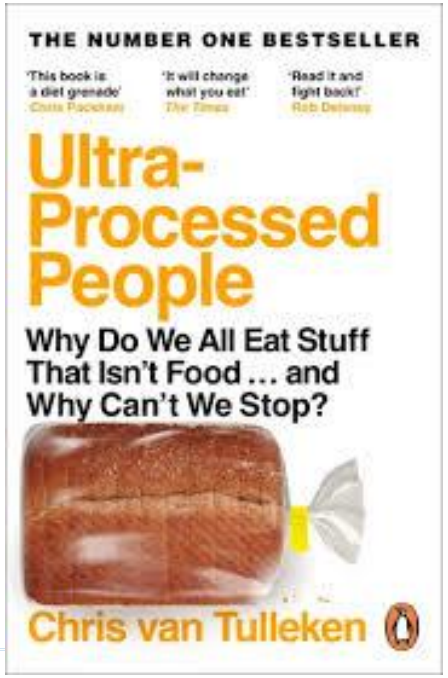
- Climate-Smart Agriculture & Food System Resilience Building

Food system transformation is moving from fringe thinking to centrality due to the huge fiscal costs externalised: need to transform *and* build resilience

FIGURE 6 QUANTIFIED HIDDEN COSTS OF AGRIFOOD SYSTEMS BY COST CATEGORY (LEFT) AND SUBCATEGORY (RIGHT), 2020



NOTE: All values are expected values.
SOURCE: Lord, S. 2023. *Hidden costs of agrifood systems and recent trends from 2016 to 2023 – Background paper for The State of Food and Agriculture 2023*. FAO Agricultural Development Economics Technical Study, No. 31. Rome, FAO.



Definitional aspects of resilience

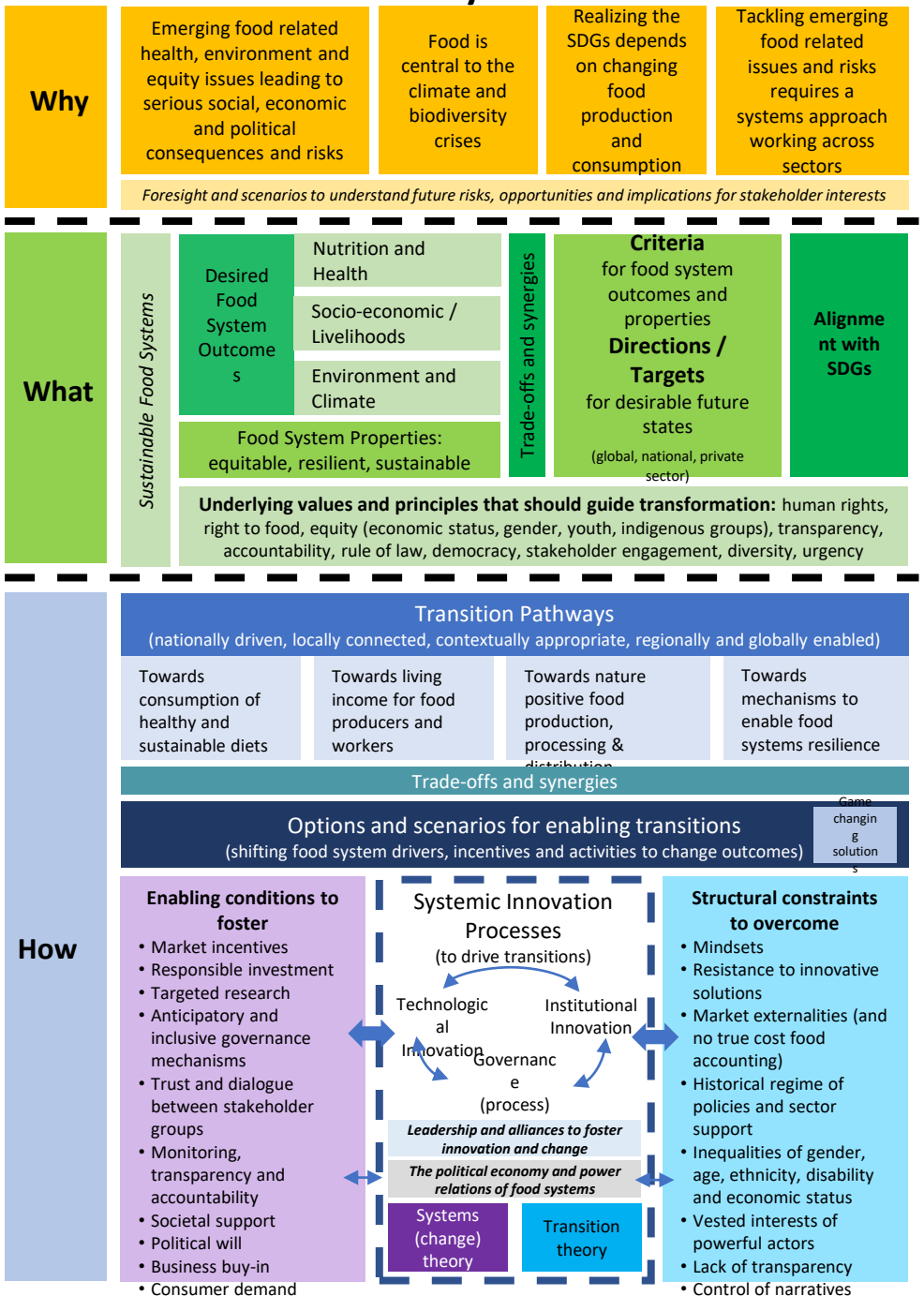
- **In the presence of a “shock”:**
  - **Is functionality maintained (robustness)?**
  - **How far is functionality degraded and how quick to recover (resilience)?**
- **Key question: resilience of *what*, to *what*, for *whom?***

Of what? food security, food system, supply chain, business?

To what? Different sorts of shocks – border closure, vs production shock?

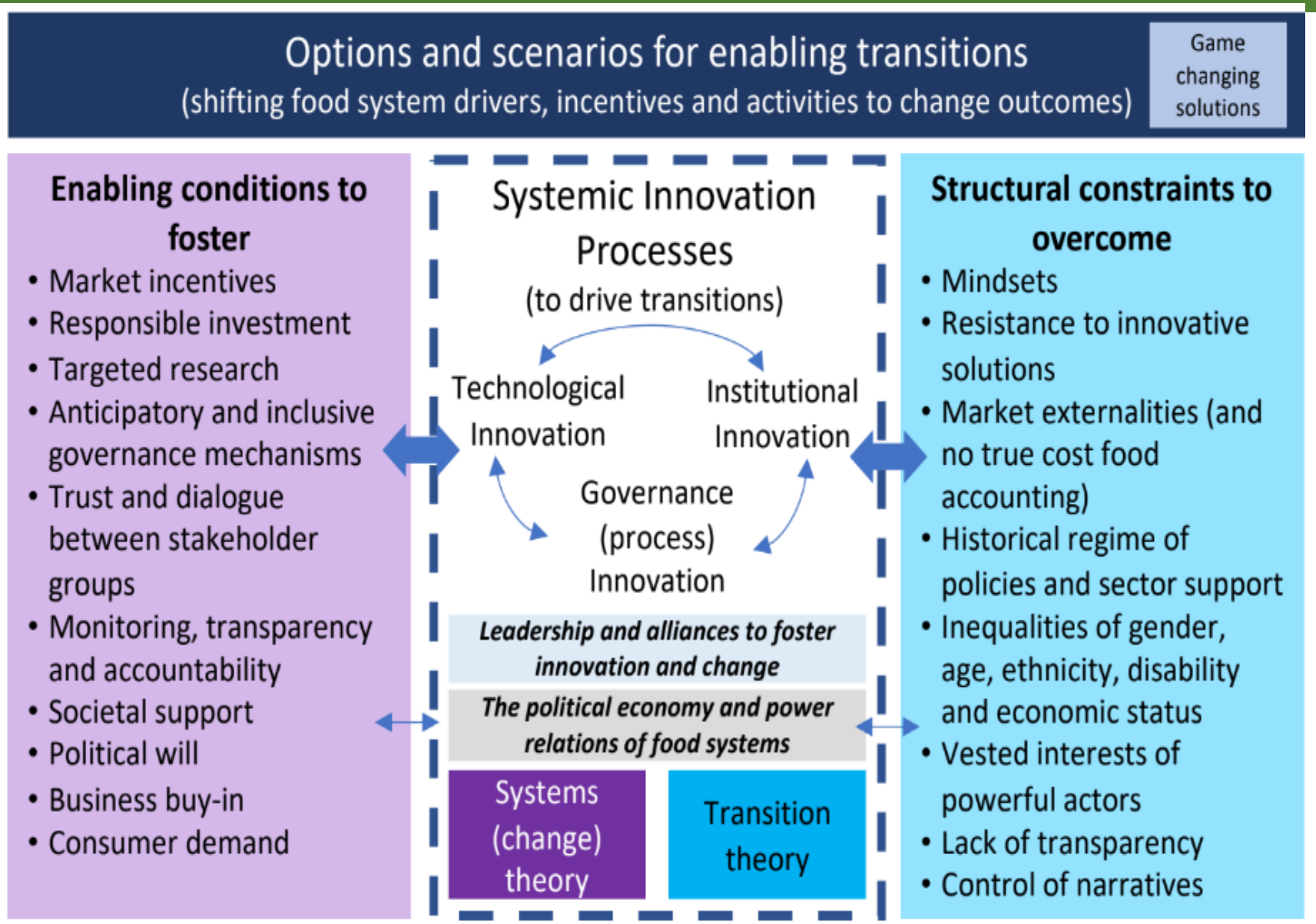
For whom? Country, business, average citizen, marginalised citizens?

A Framework for Food Systems Transformation

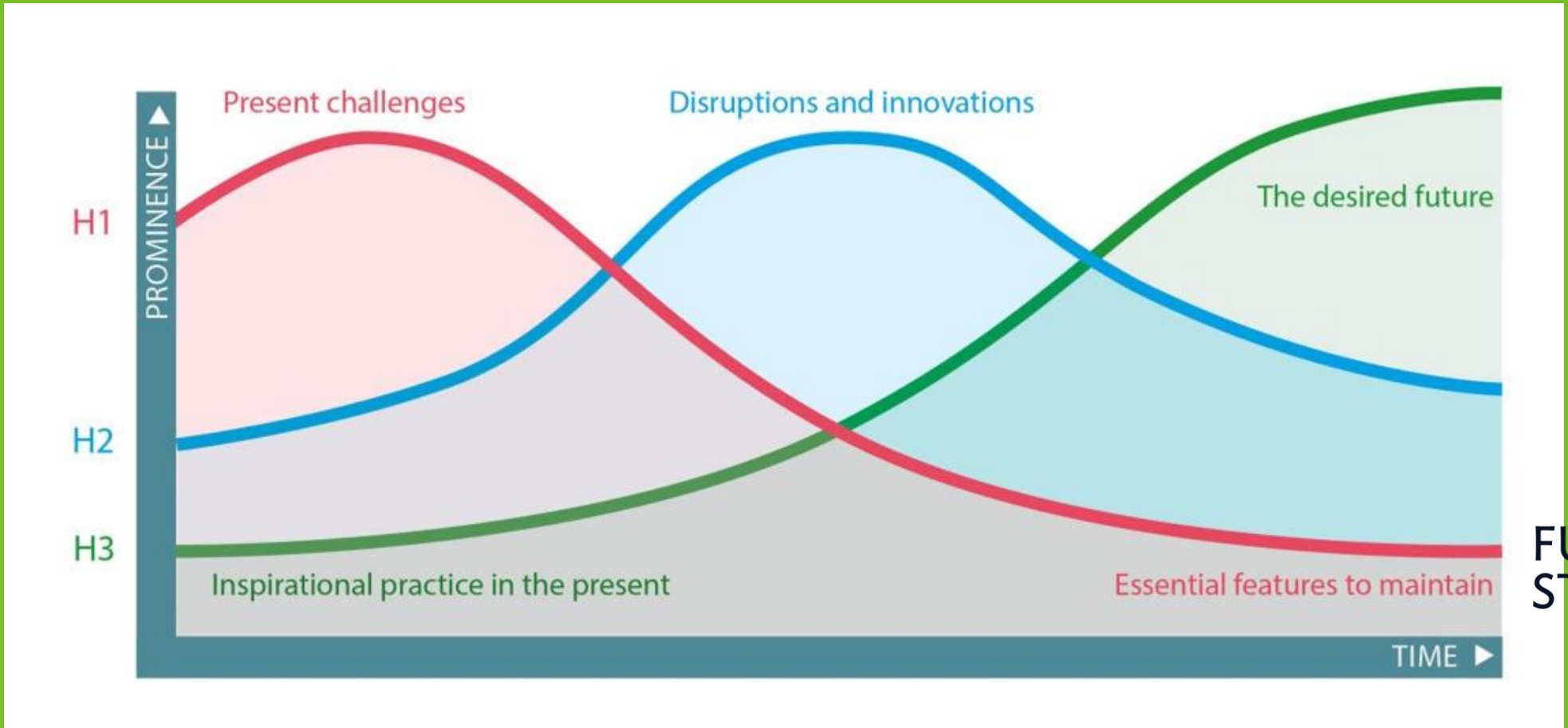


Source: Woodhill, 2022 – draft – comments welcome

Charting a Path through Complexity



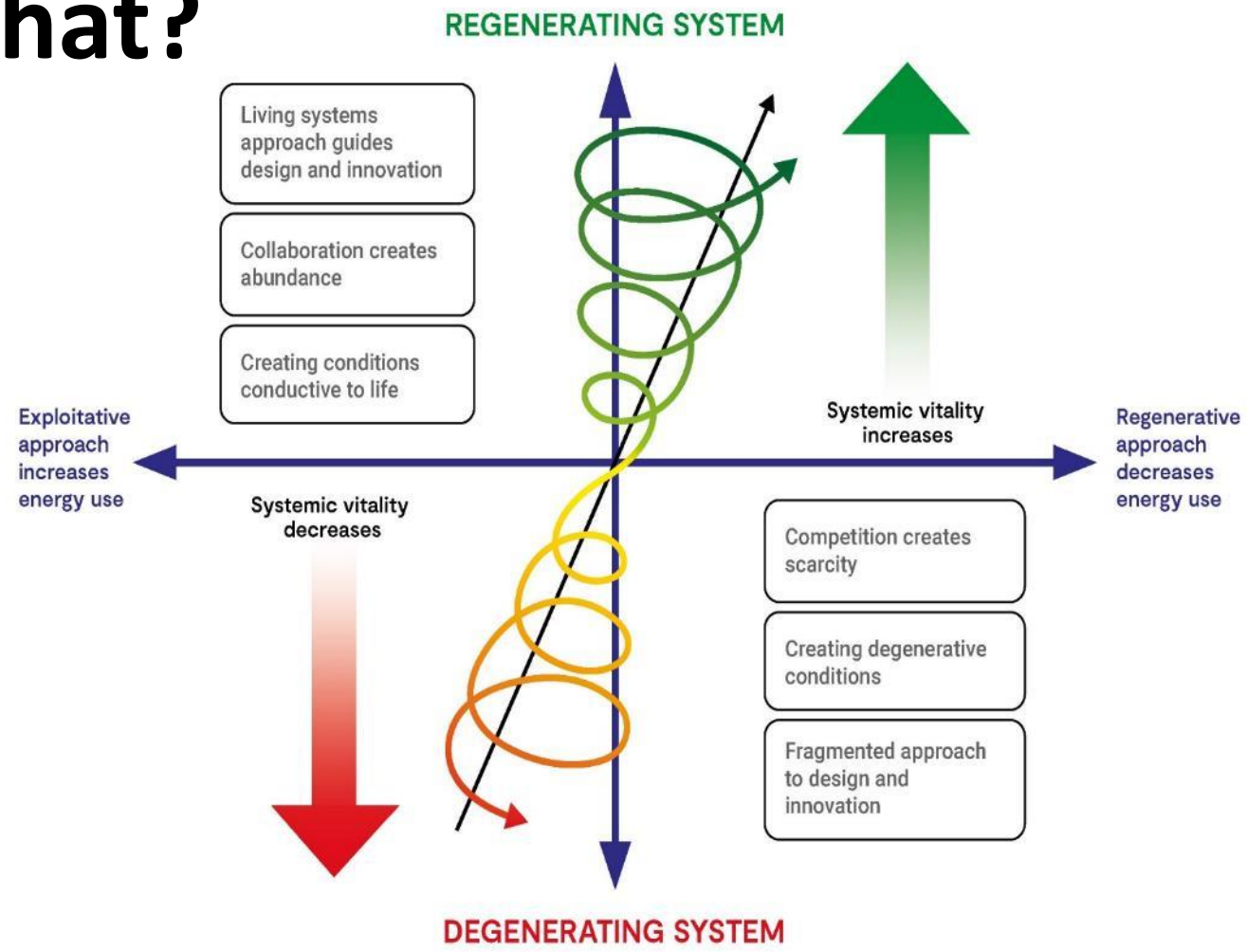
Food System Transformations for 2030s & Beyond



From "*Negative Mindsets to Positive Perspectives*" by thinking across 3 Horizons / Stages of Change

Transformation to what?

- Being clear about what a transformed system will be like retains focus on fundamental change
- An example: regenerative systems
- Regenerative food systems: not just regenerative farming



Modified from Wahl, D. C. 2016. Designing regenerative cultures. Triarchy Press, Axminster, UK.

FSNet AFRICA

Food Systems Research Network for Africa

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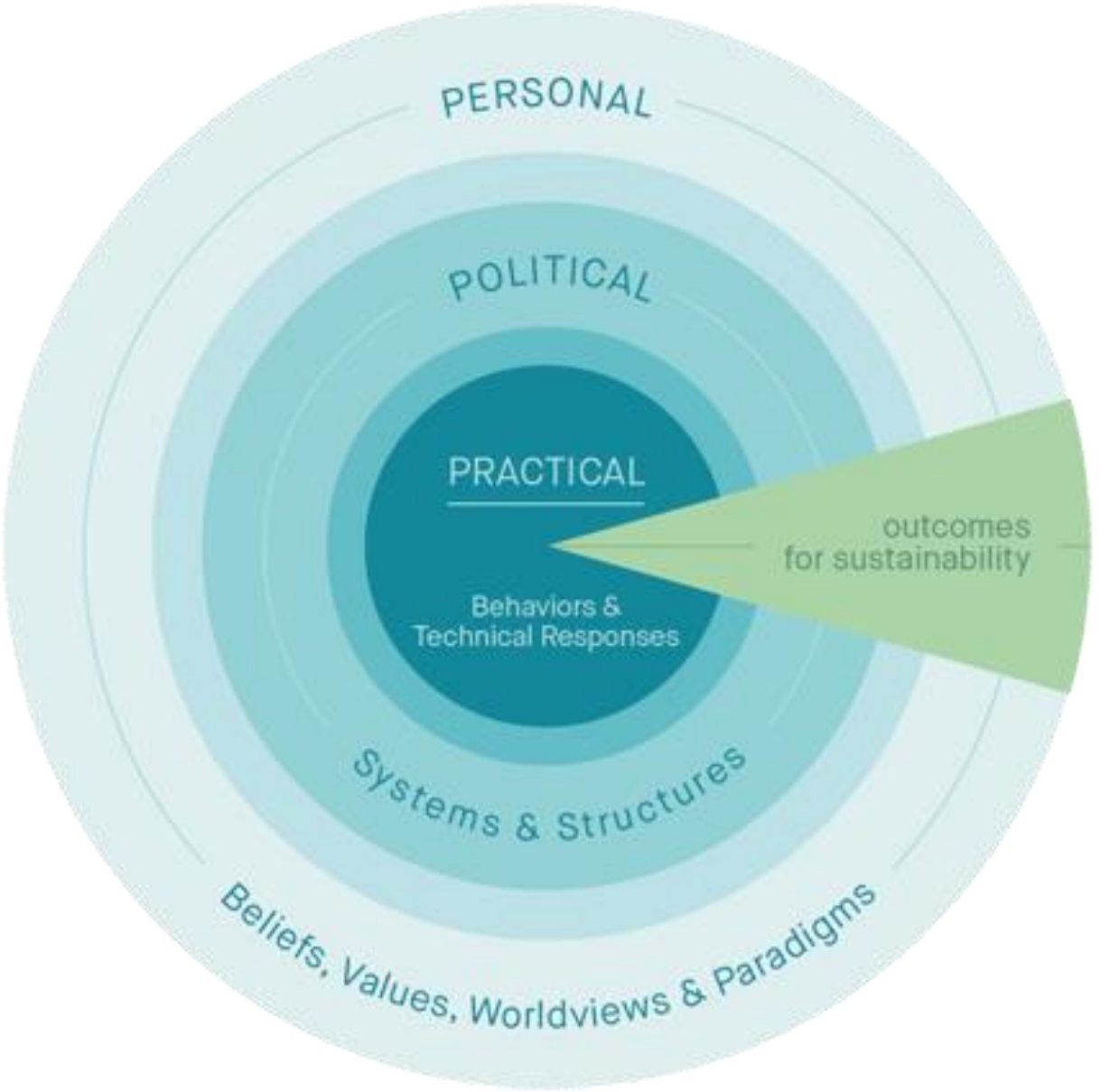
Transformation through what?

- 3 spheres
- Outer & inner transformations
- Requires working with multiple actors & changing power dynamics between them



O'Brien, K. 2018. Is the 1.5°C target possible? Exploring the three spheres of transformation. *Current Opinion in Environmental Sustainability* 31:153-160.

Whose transformation?

- Transformation involves multiple actors & is always embedded in political processes
- Shifting patterns of power relations, agency, inclusion & distributional impact are core elements of ‘system change’ aligned with this perspective
- Design for transformational contribution can look quite different from a ’top-down’, ‘bottom-up’, or from a coalition perspective

Parsons, K. H., C.; Wells, R. 2019. What is the food system? A food policy perspective. Centre for Food Policy, London.

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Building coalitions for transformation

UK climate movement: Coalitions can bridge differences of power and combine different roles & positions

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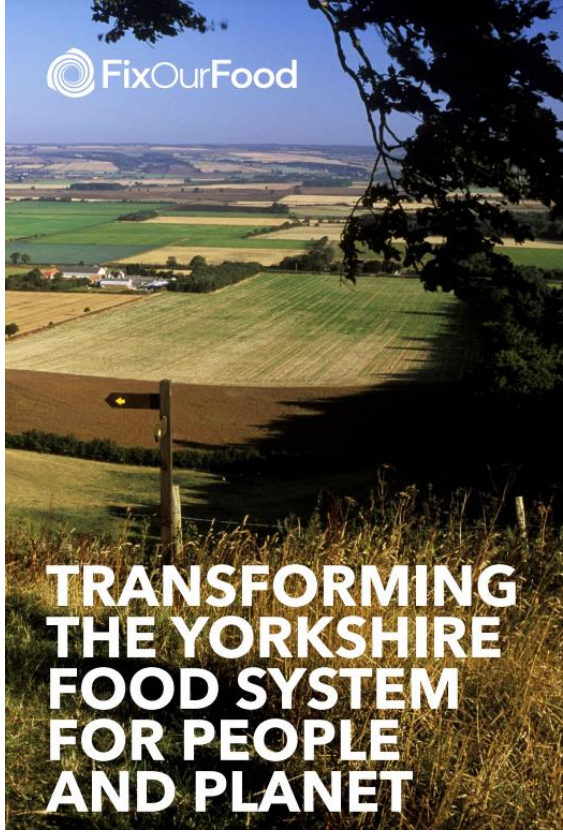
FixOurFood - Transforming the Yorkshire Food System



- £6 million over 5 years from UKRI Transforming UK Food Systems Strategic Priority Fund
- Interdisciplinary and multi-university
- Integration between all teams – sharing research findings and planned work at least every six weeks
- Significant stakeholder collaboration & co-creation
- Transformational thinking underpins the approach – areas of action identified through a rigorous Three Horizons process
- Created the *FixOurFood Commission* to bring regional organisations together to push through food system change – this will be a legacy for the programme

www.fixourfood.org

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Regenerative agriculture
Field plot trials designed with farmers to test interventions and measure yield, crop quality and greenhouse gas emissions. Computer modelling of regenerative agriculture.

School food
Increasing access to free school meals. Ensuring that school food is tasty and nutritious - healthy for the students and the planet. Encouraging whole school approaches to food.

Metrics
Creating a dashboard that can be used to help decision making - modelling outcomes based on different scenarios and interventions in the food system.

Transformation
Using the Three Horizons process to identify areas of action to drive transformation of the Yorkshire food system. Looking at the governance structures required to support that transformation.

Policy and governance
Identifying which policies and governance structures are needed to support transformative change, with a particular focus on new innovative tools.

Hybrid food economies
Creating a toolkit for businesses that want to adopt purpose driven business models. Overcoming supply chain barriers and improving procurement.

Vertical urban farming
Action research - running a community vertical farm in a shipping container in the centre of York growing microgreens and herbs. Exploring sustainable business models for this type of enterprise.

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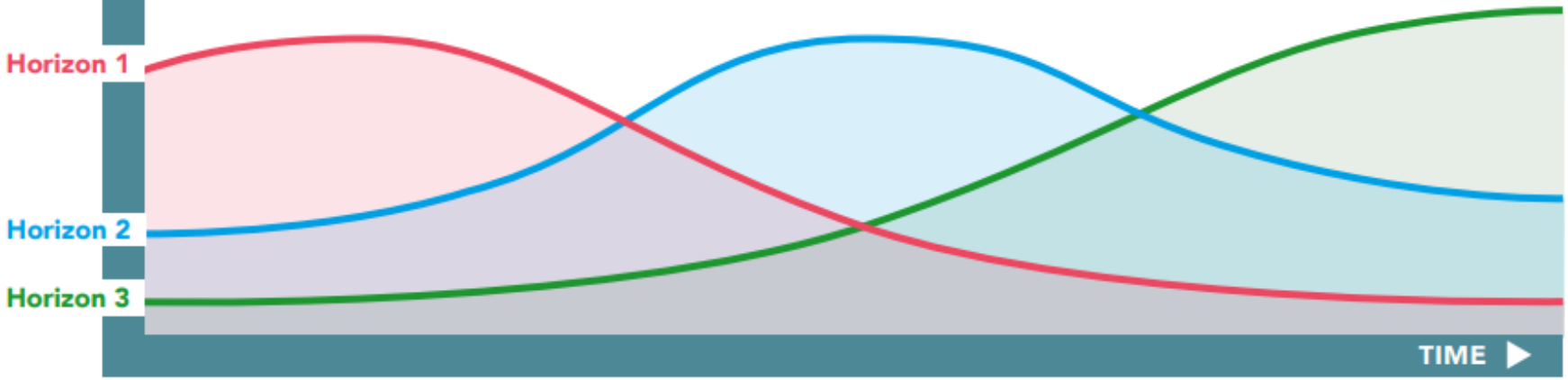
Transforming the Yorkshire Food System

PROMINENCE ▲

Current challenges	Transformative action	The desired future
Declining diversity	Enhance supply chain connectivity and innovation	Local diversity and empowerment increasing self-sufficiency
Poor, unequal nutrition	Scale environmentally beneficial farming	Thriving regenerative farming
Dominant mindsets encouraging unsustainable behaviour	Empower consumer demand	People (re)connected to their food
Lack of public awareness, interest and skills	Provide trusted knowledge and support for standards and incentives	Regional self-awareness and connectivity
Lack of leadership, agency and resources for transformation	Support schools and young people as drivers of long-term change	Holistic and ambitious policy
Siloed and untransparent policy		Nutritious food for all, boosting wellbeing
Crises discourage sustainable thinking and practice		Systemic adaptation and resilience to wider conditions



- 1400 insights from 113 experts based in 55 organisations across England's largest county
- Maintaining ambition, celebrating successes & strategically focusing on transformational change will be important for a new kind of regenerative food future

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The main take home message:

Transformation is a particular kind of change. So, to support transformation, you need to carefully attend to **what** you think transformation is, **how** you expect transformational change occurs, and how you intend to strategically bring it about (& with **who**).

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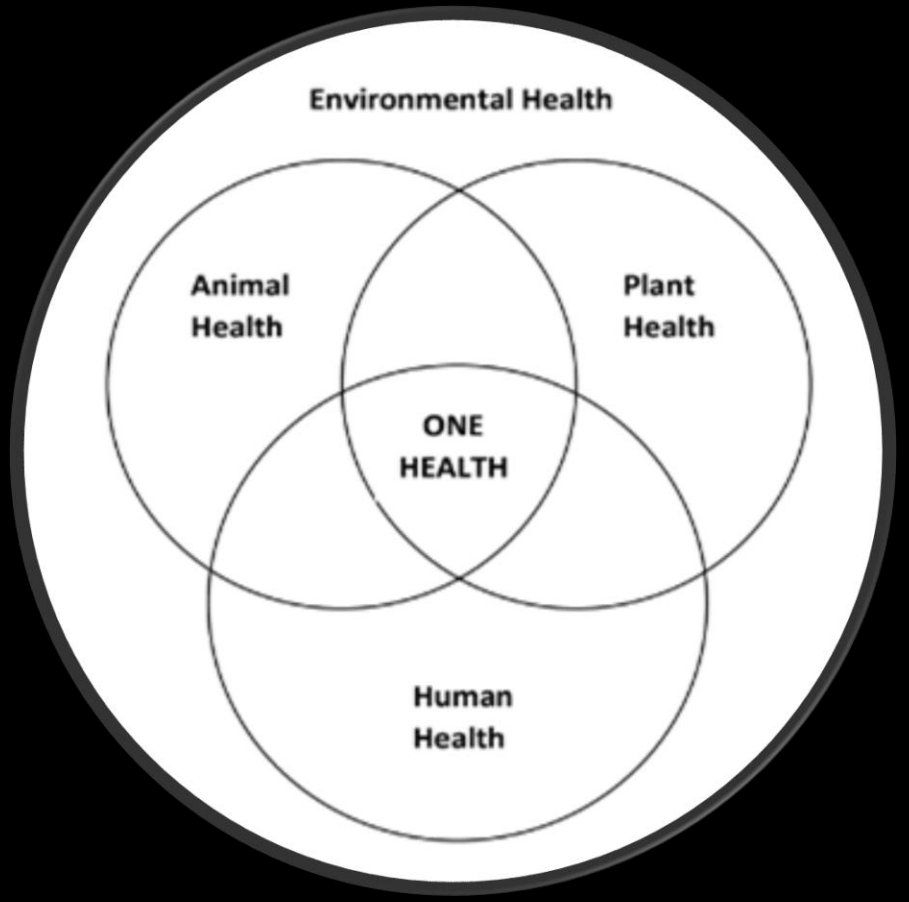
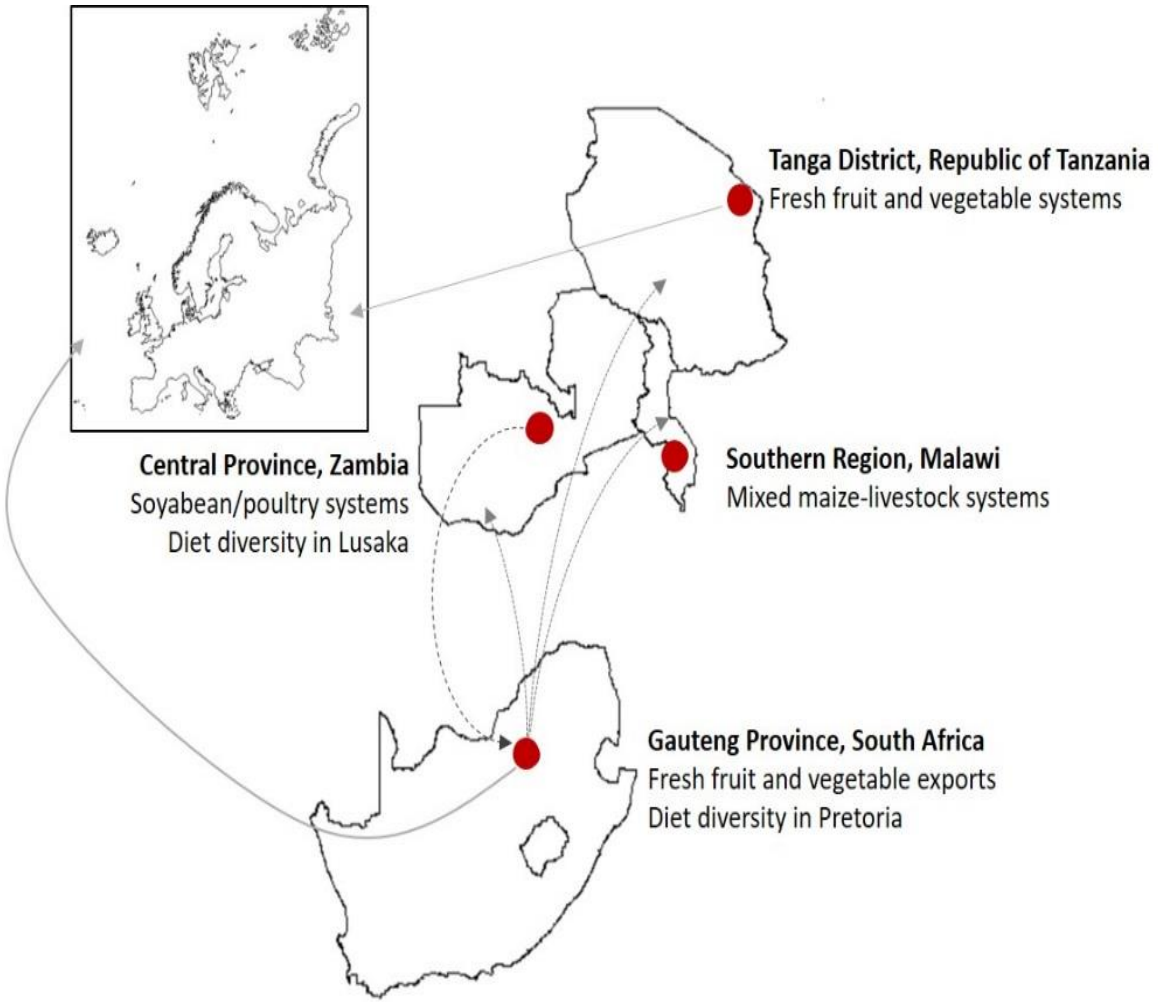
Food Systems Transformation in Southern Africa for One Health

FOSTA HEALTH

www.fosta-health.eu



Four Food Systems Transformations

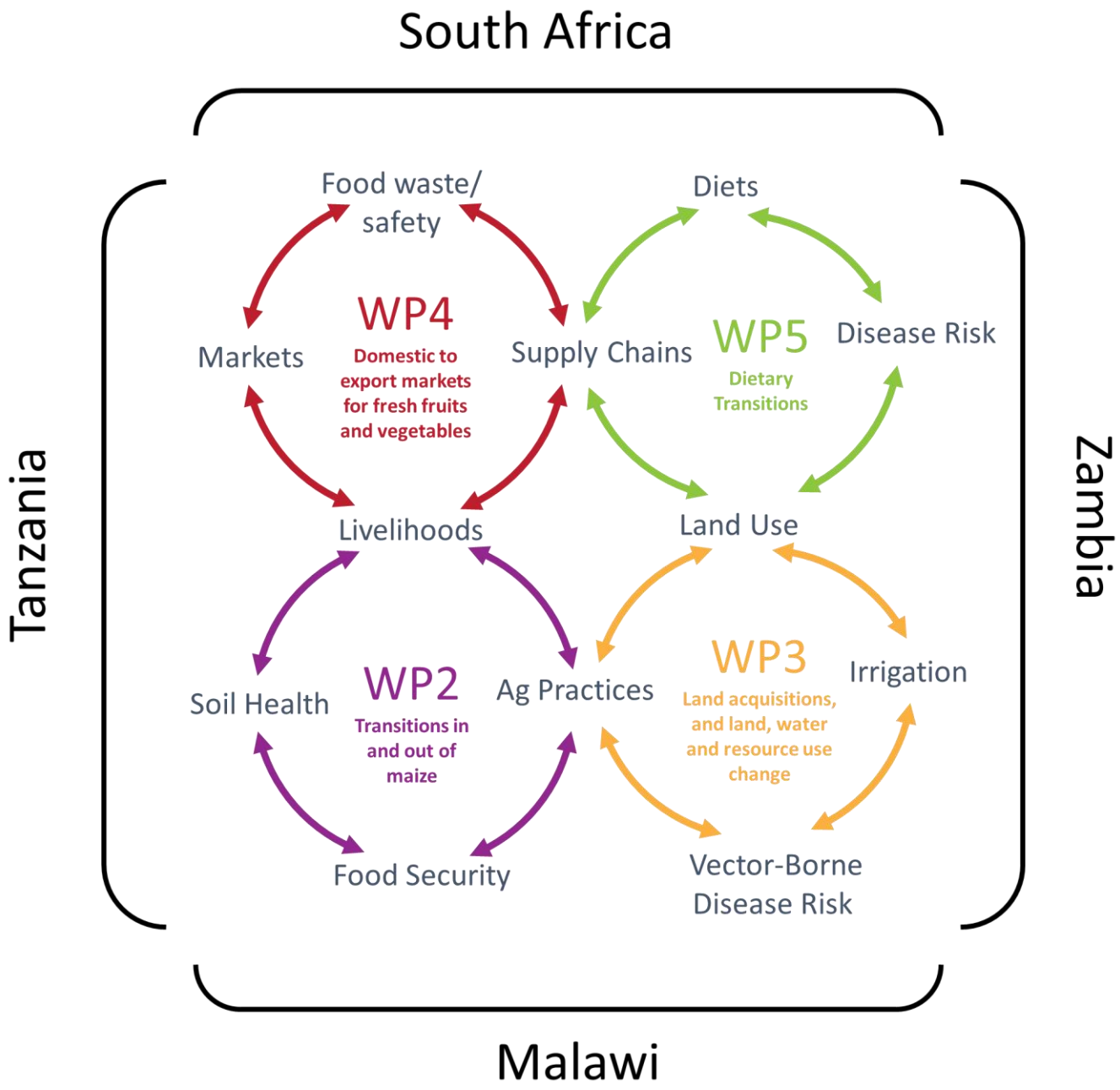


1. **Transformations within and out of maize production**
   - (the region's dominant staple) with a focus on production systems in the sites of the CARE Titukulane Programme in Southern Malawi and the Tanga District of Tanzania (WP2)

2. **Transformations of land and water use**
   - including intensification, land use expansion and irrigation, with a focus on Southern Malawi and Central Zambia (WP3).

3. **Transformations from domestic to export markets**
   - for high value commodity crops, such as fresh fruits and vegetables, with a comparative focus on the Tanga District of Tanzania and Gauteng Province, South Africa (WP4).

4. **Diet diversification and transformations**
   - towards higher protein, fats and refined oils in diets, with a focus on the interconnected supply chains of soyabean, poultry and beef across Zambia and South Africa (WP5).



Stakeholder Engagement

Representative

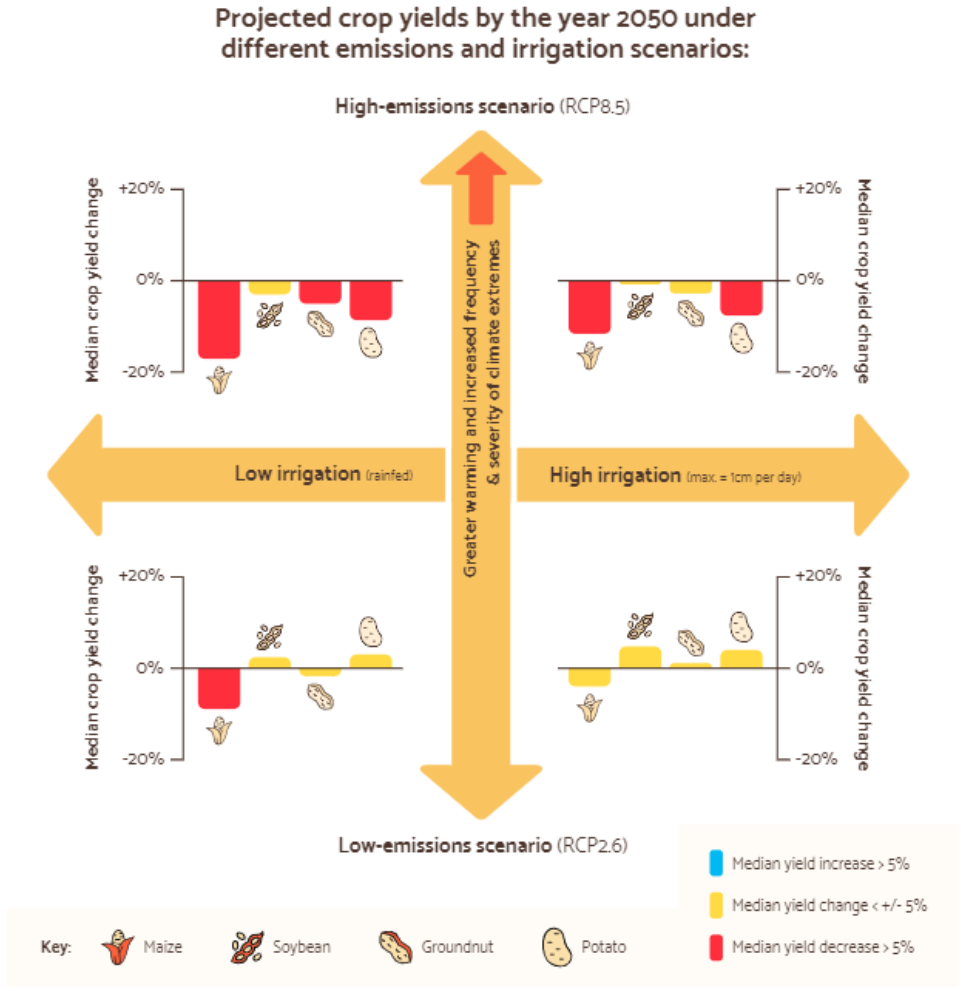
Transformative

Pathways

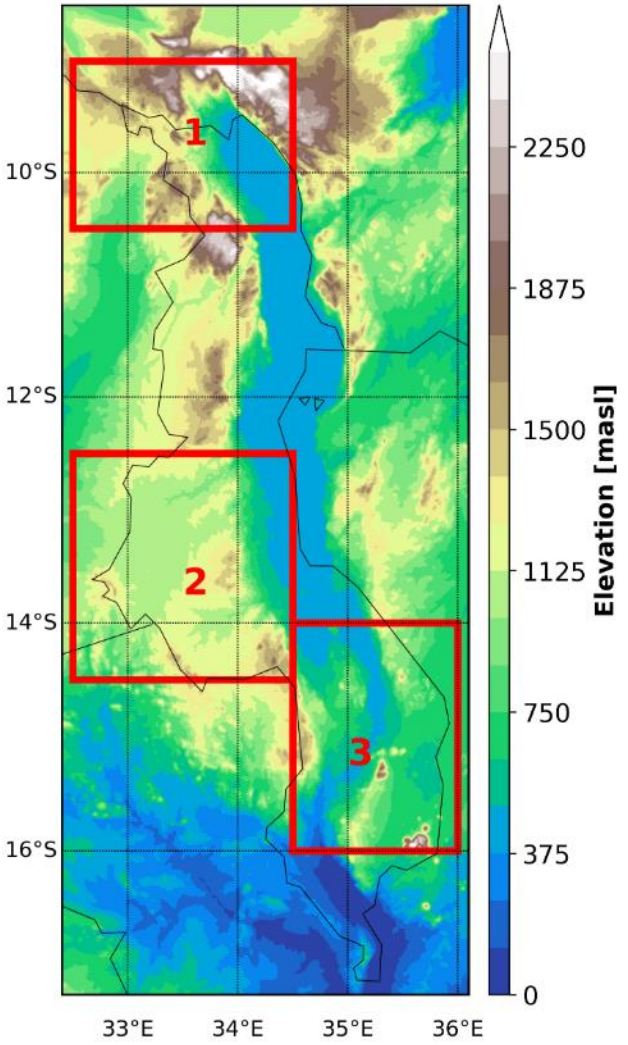
16 RTPs

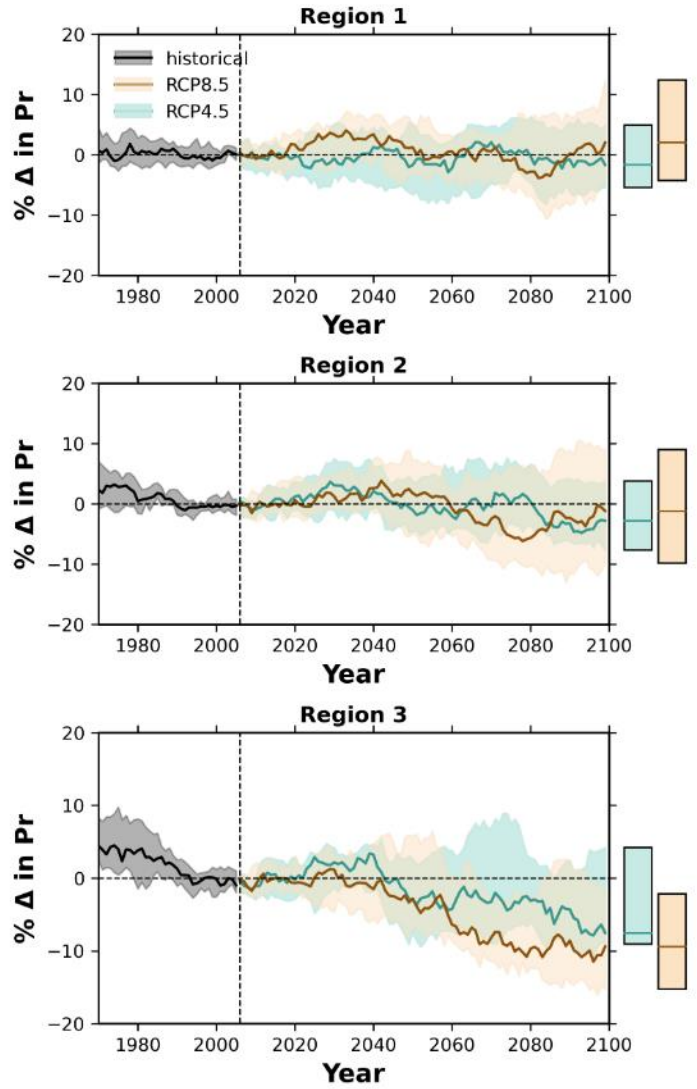
Integrated modelling to 2050 against context of climate change

Climate Change, Irrigation & Malawi's Cropping Systems



RCP = Representative Concentration Pathway - is a greenhouse gas concentration trajectory adopted by the Intergovernmental Panel on Climate Change (IPCC). A higher RCP represents a higher emissions scenario associated with greater warming and more frequent/severe extremes





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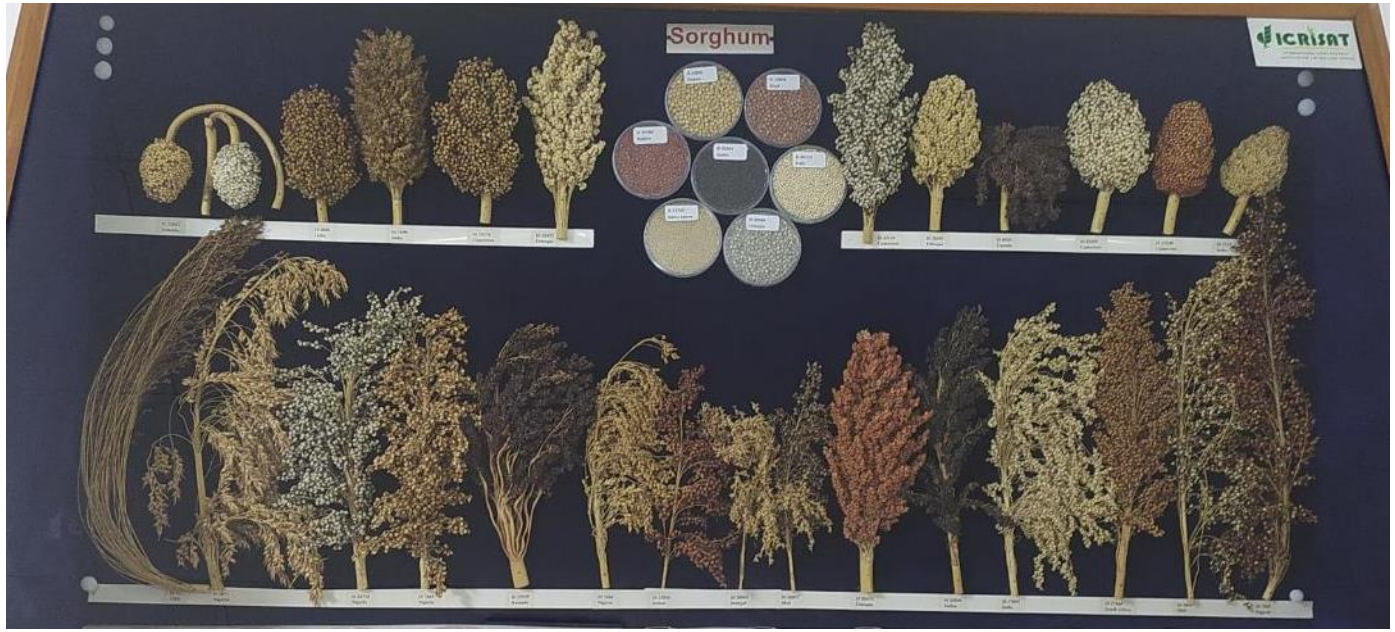
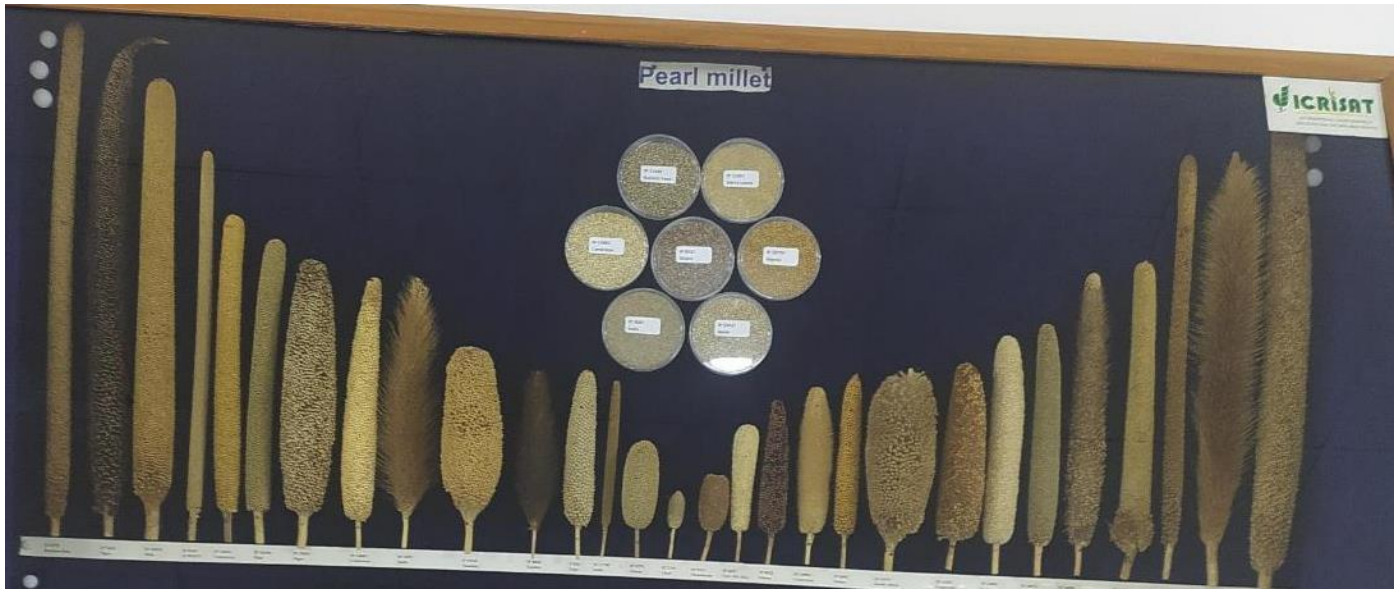
Diversity in sorghum and millet, is an opportunity for diverse products if added value enabled through post-harvest & processing advances (Zimba *et al*., 2023)

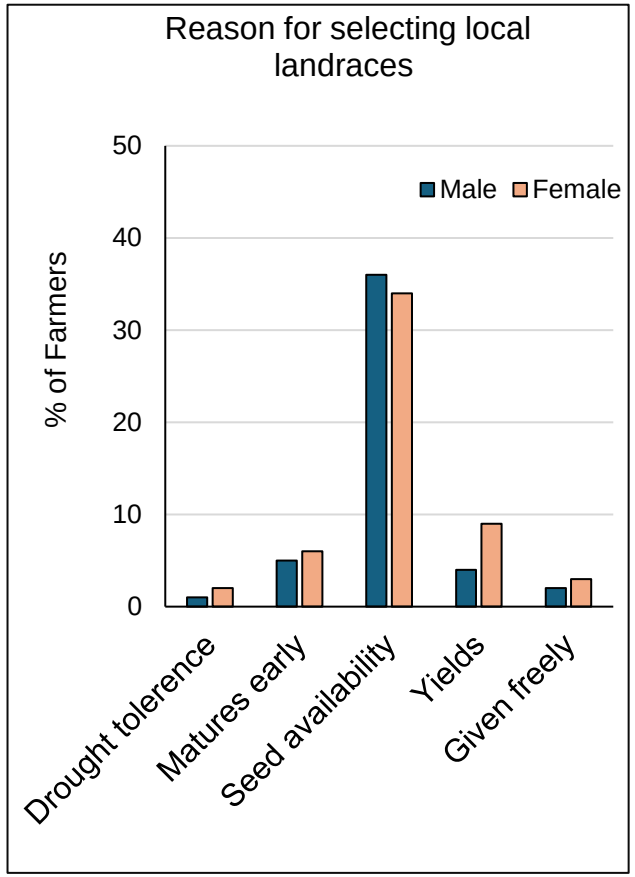


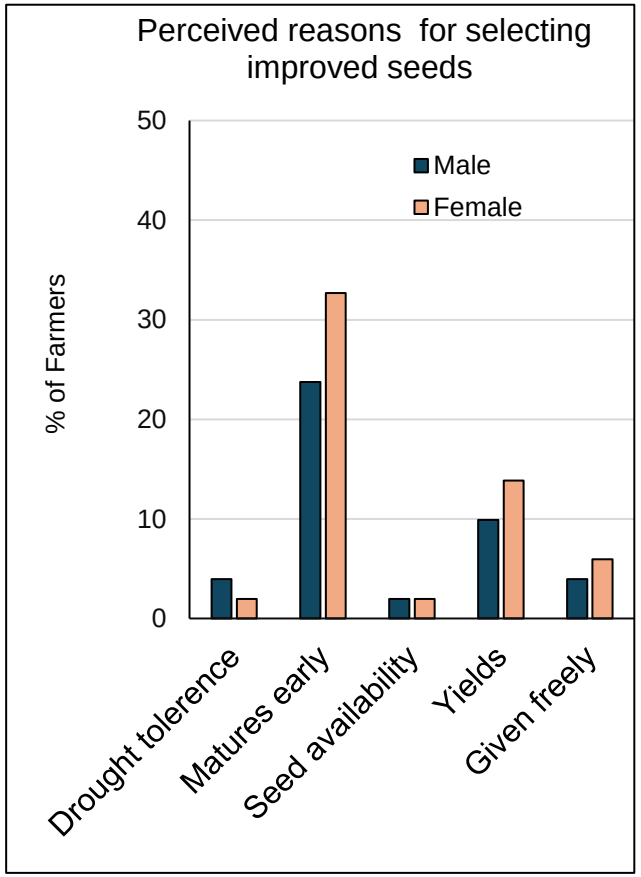
Cookies from Hyderabad, India



Pearl millet

Access to improved seed is significant for climate-resilience





Plants People Planet

RESEARCH ARTICLE | Open Access

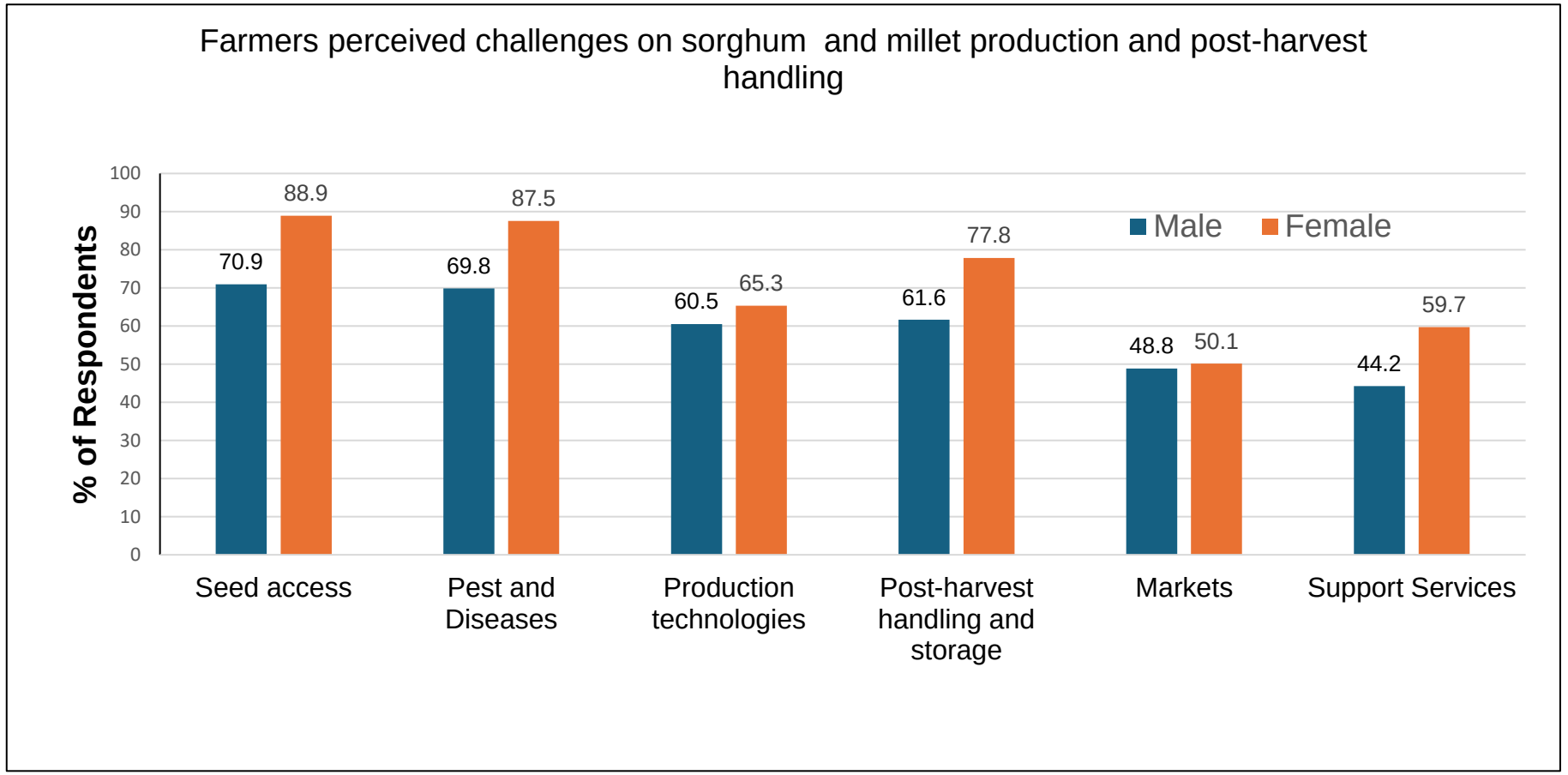
Gender differential in choices of crop variety traits and climate-smart cropping systems: Insights from sorghum and millet farmers in drought-prone areas of Malawi

Sibongile Zimba, Andrew Dougill, Charity Chanza, Christine Boesch, Stefan Kepinski

First published: 06 December 2023 | https://doi.org/10.1002/ppp3.10467

Farmers perceived challenges on sorghum & millet production and post-harvest handling

Low production/quantity to sustain the supply of raw materials for consistent agro-processing:
a case of sorghum and millet production challenges.



Poor postharvest handling practices reduces the quality of potential raw materials for processing.

Pearl millet image taken during our survey in CK and NE.

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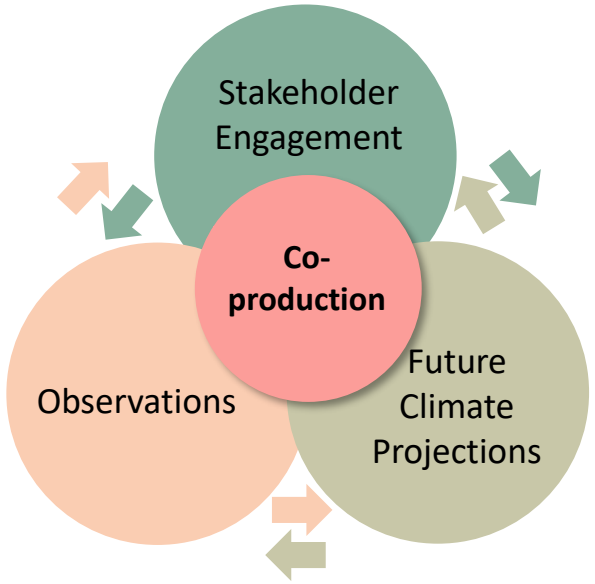
Climate Information for Resilient Tea Production

HyCRISTAL and UMFULA joint project



Contents lists available at ScienceDirect

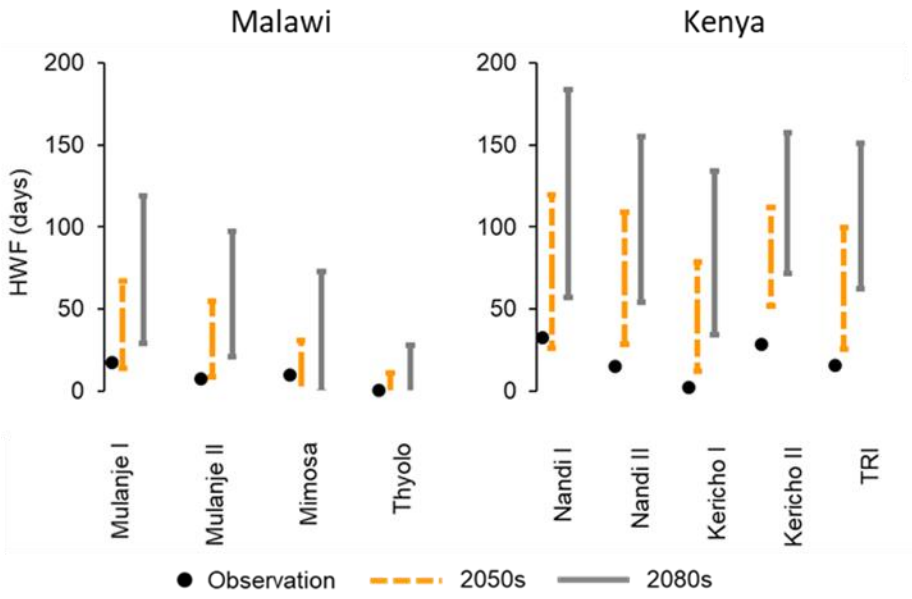
Climate Risk Management

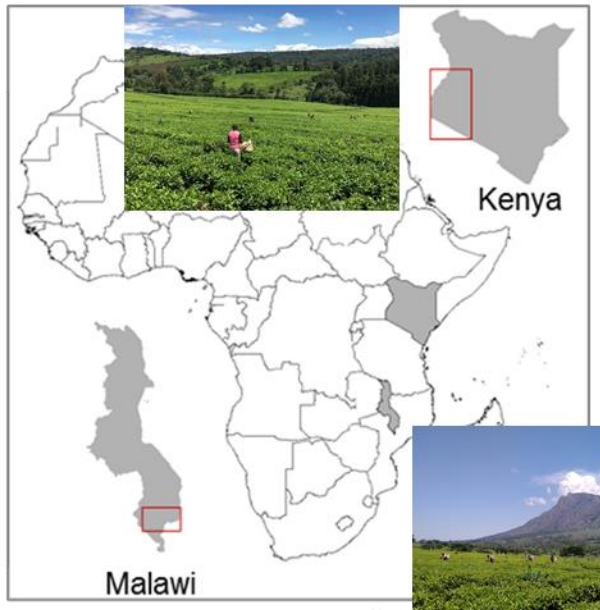
journal homepage: www.elsevier.com/locate/crm

Tailored climate projections to assess site-specific vulnerability of tea production

Neha Mittal [a,*], David P. Rowell [b], Andrew J. Dougill [a], Bernd Becker [b], John H. Marsham [a,c], John Bore [d], Anne Tallontire [a], Katharine Vincent [e], David Mkwambisi [f], Joseph Sang [g]

[a] School of Earth and Environment, University of Leeds, Leeds, United Kingdom
[b] Met Office Hadley Centre, Exeter, United Kingdom
[c] National Centre for Atmospheric Science, University of Leeds, Leeds, United Kingdom
[d] Tea Research Institute, Kericho, Kenya
[e] Kulima Integrated Development Solutions, Pietermaritzburg, South Africa
[f] Malawi University of Science and Technology, Limbe, Malawi
[g] Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya





UTZ Better farming Better future

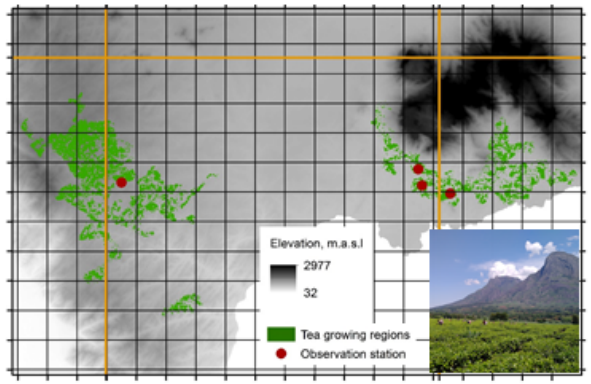
Finlays Since 1750

Ethical Tea Partnership

KULIMA

KALRO Kenya Agricultural & Livestock Research Organization

Co-production process is as important as the product



Observations + CP4-Africa + 29 CMIP5 models

Stakeholders

Site Specific Projected Range

Value addition helps build trust

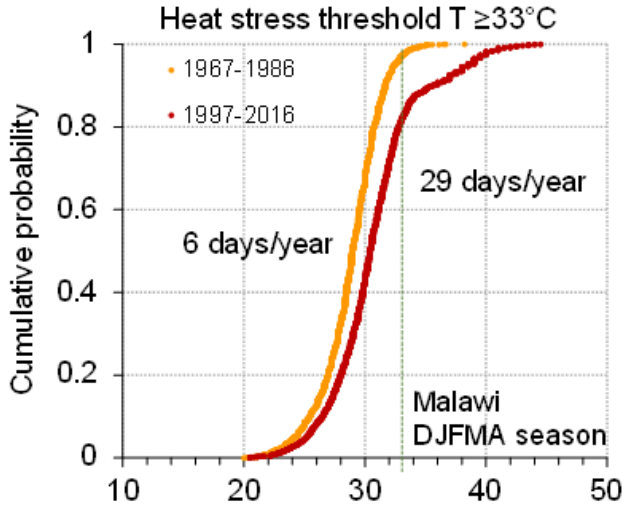
Projections

Information needs

Decision needs drive climate analysis approach

Rainfall and temperature metrics

Rainfall and temperature observations



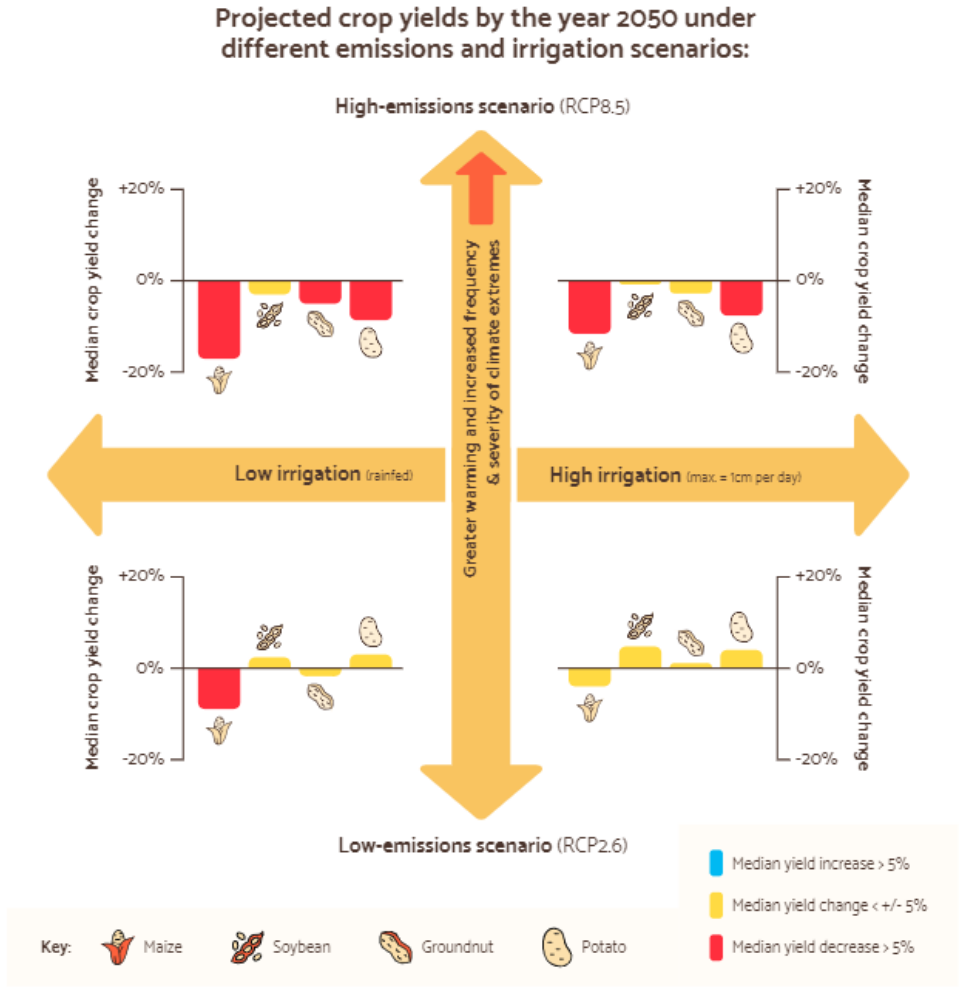
Provided by stakeholders

Process direction

Feedback through iterations

Input to the process

Climate Change, Irrigation & Malawi's Cropping Systems



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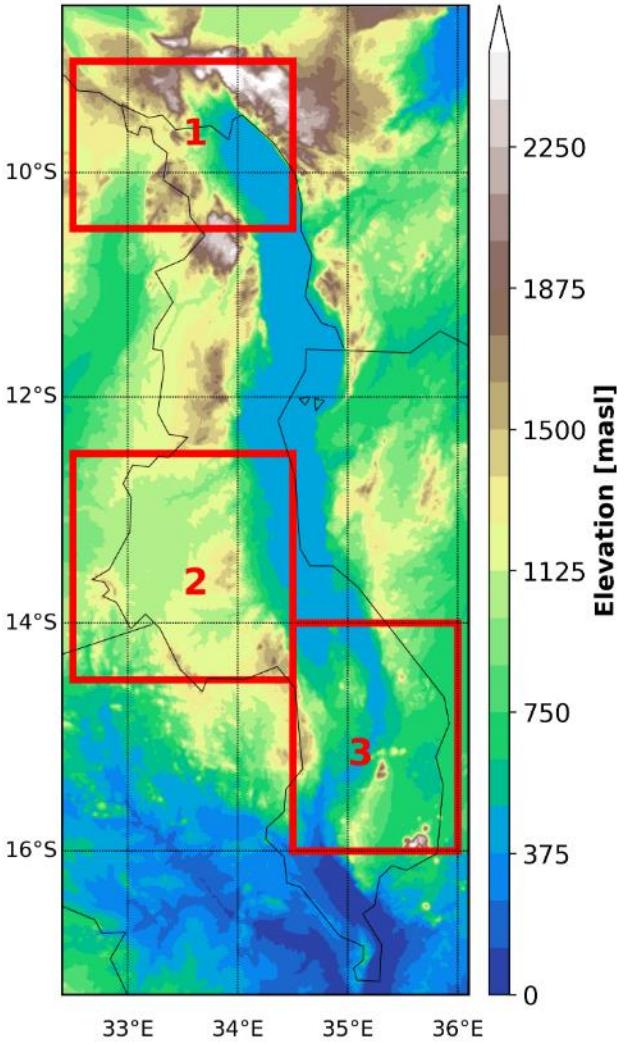

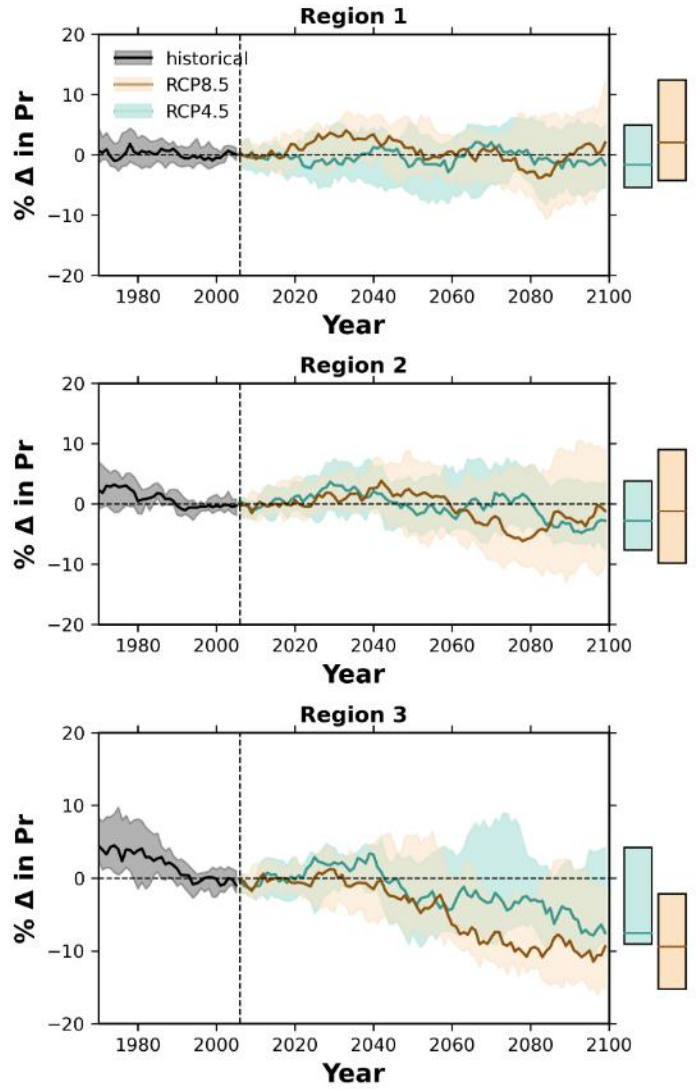

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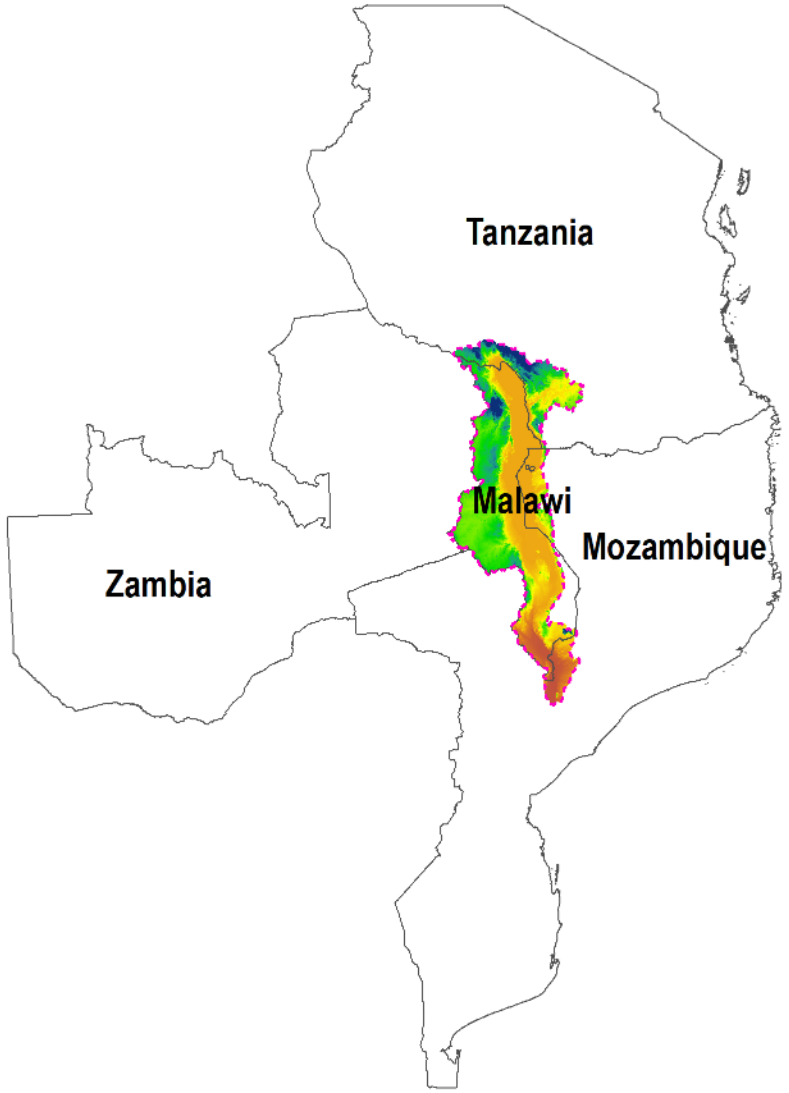
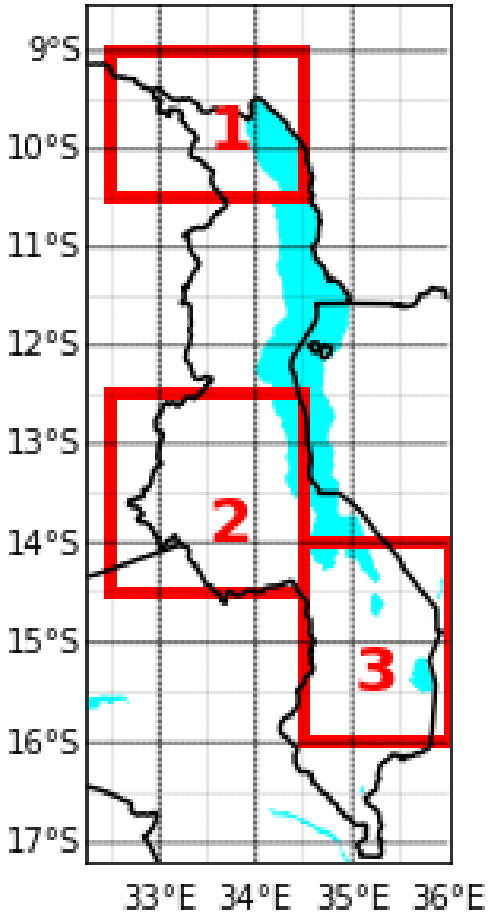
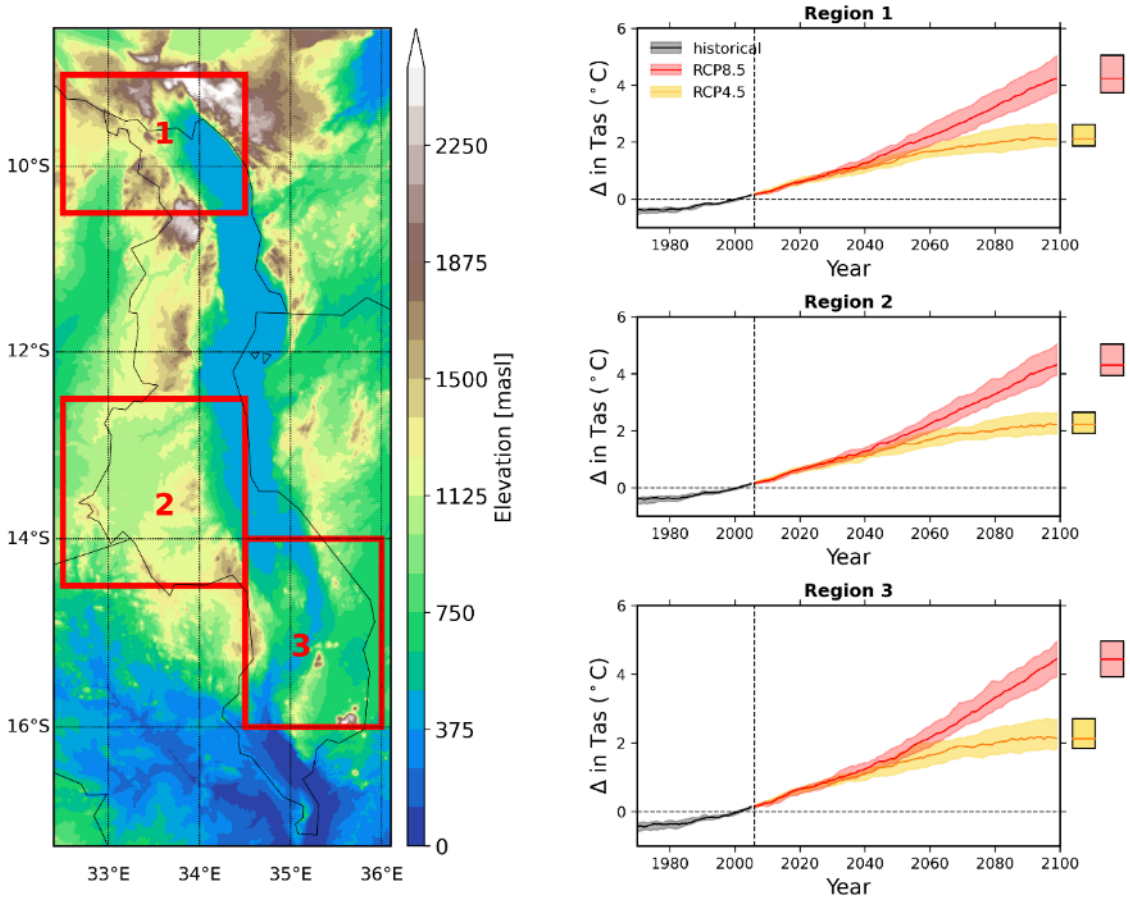
Basin-scale Modelling Approach (FoSTA-Health)





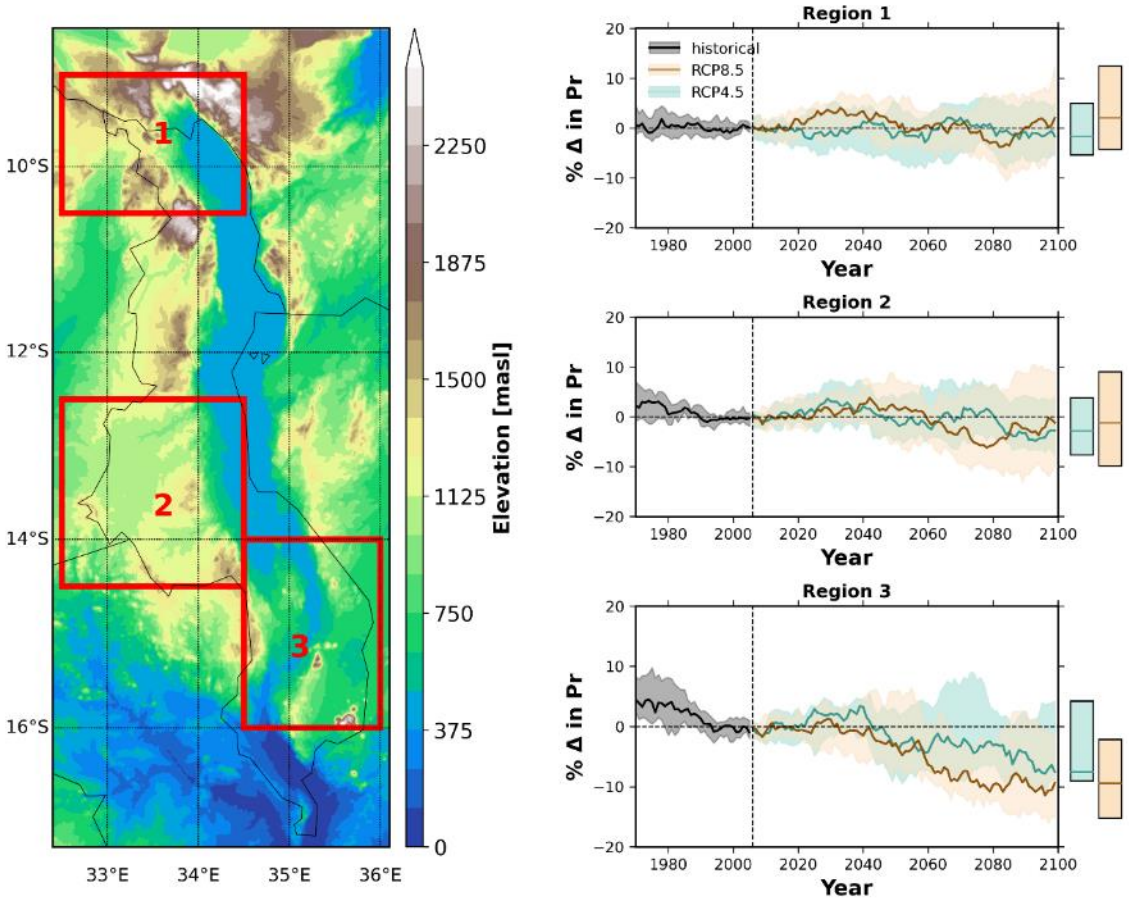
- Mix of methods to develop a comprehensive picture of drought risk in Malawi
  - Used the Standardized Precipitation and Evapotranspiration Index with the run theory to identify and characterize droughts in Malawi from observations [CRU] and present-day climate simulations [CMIP-5]. Examined atmospheric patterns associated with droughts and their simulations in CMIP5 vs ERA5.
  - Identified and characterized droughts in twenty-first century climate projections [AMMA-2050 Bias-corrected for Africa].
  - Performed hydrological simulations in SWAT to examine implications for irrigation across four river basins in the Lake Malawi Shire River Basin – forced with AMMA-2050 precipitation and temperature.

21st Century Outlook
Projected changes in temperature over Malawi



- Projected increase in temperature
  - evapotranspiration, crop water requirements and irrigation water demand across Malawi

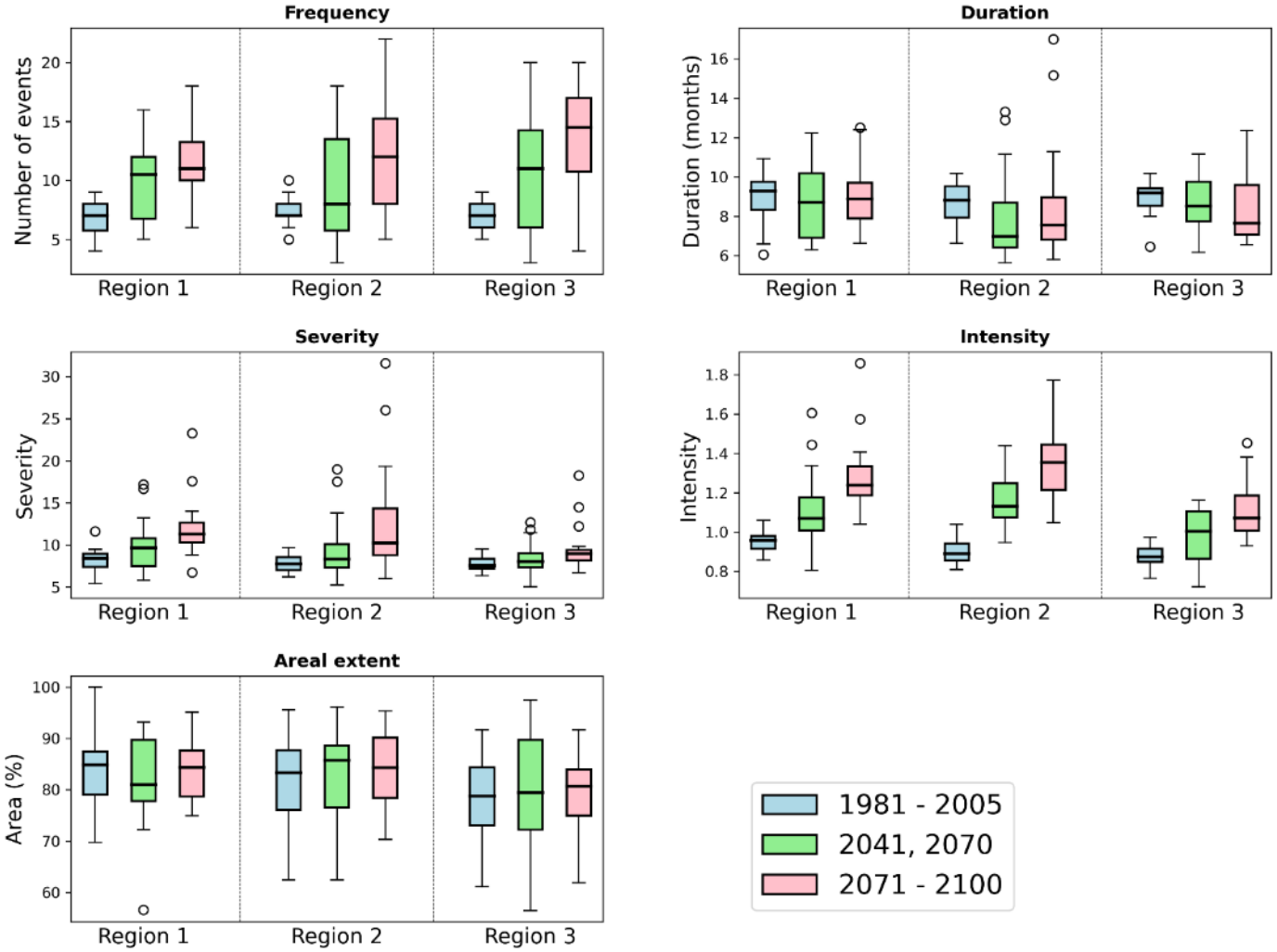
Projected changes in precipitation across Malawi



Rainfall projections are characterized with considerable uncertainties in the direction and magnitude of change – esp. over the northern and central areas.

Dry signal in the south potential affecting effective precipitation (i.e., that which is available for plant utilization)

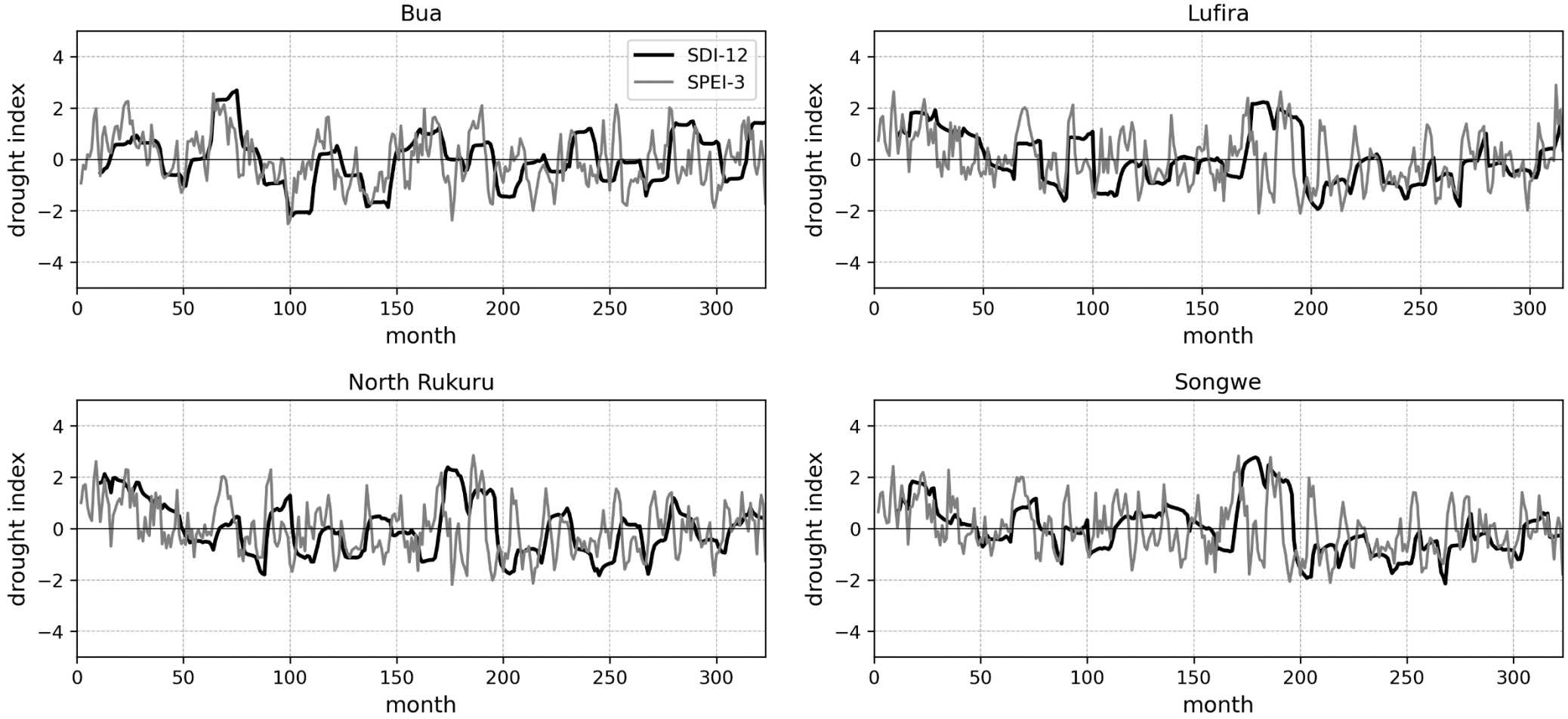
More droughts, severe droughts over the course of the 21st century?



Droughts consistently projected to become more frequent and more severe

The extent of dryness at any point during a drought is projected to become much higher relative to the historical reference period

Drought signal propagation



Low inertia across all basins [due to low groundwater storage] determines rapid propagation of drought signal from meteorological to hydrological drought

Key Recommendations

- Need for sustainable, climate-smart irrigation investments - as it is imperative to start looking at irrigation itself as being susceptible to climate change impacts
- Better management of existing irrigation schemes
- Prioritise climate-smart cropping & farm management practices within schemes is essential & links to agri-processing support
- Trade-offs emerge between lake level management & downstream WEF sector requirements, which makes analysing the decision context crucial including role of model uncertainty
- Residual risks suggest the need for exploring more options, adaptive management, & evaluation of national & District-level development plans

Climate-Smart Agriculture (CSA) as a Route to Building Climate Resilience in Food Systems

- CSA refers to land management practices with objectives to increase productivity, build climate resilience & reduce GHG emissions / enhance C storage, including:
  - Conservation Agriculture (no-till, surface cover & intercropping)
  - Soil & Water Conservation
  - Agroforestry
  - Improved Drought Tolerant Seeds
- Africa still lacks a strong evidence base on the impacts of CSA practices on soil health, making empirical studies essential plus meta-analyses from field / farm trials

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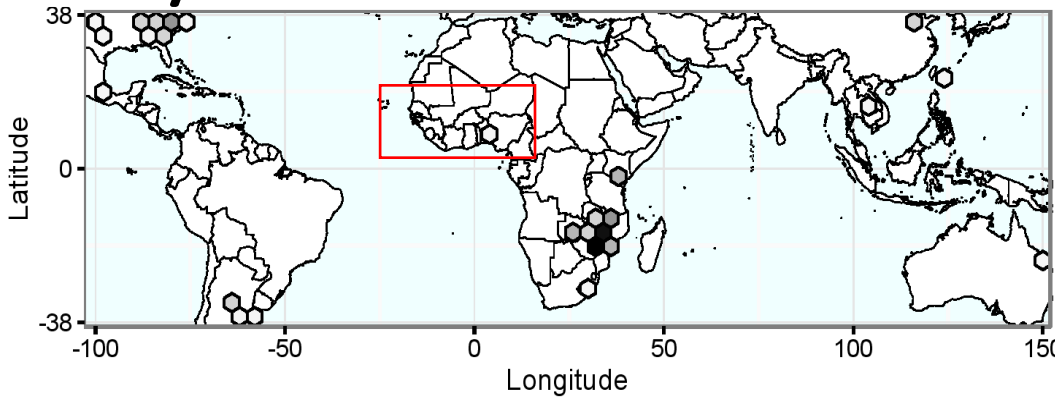
THE ROYAL SOCIETY

Conservation Agriculture as Route to Enhance Climate-Resilience in Maize-based Systems

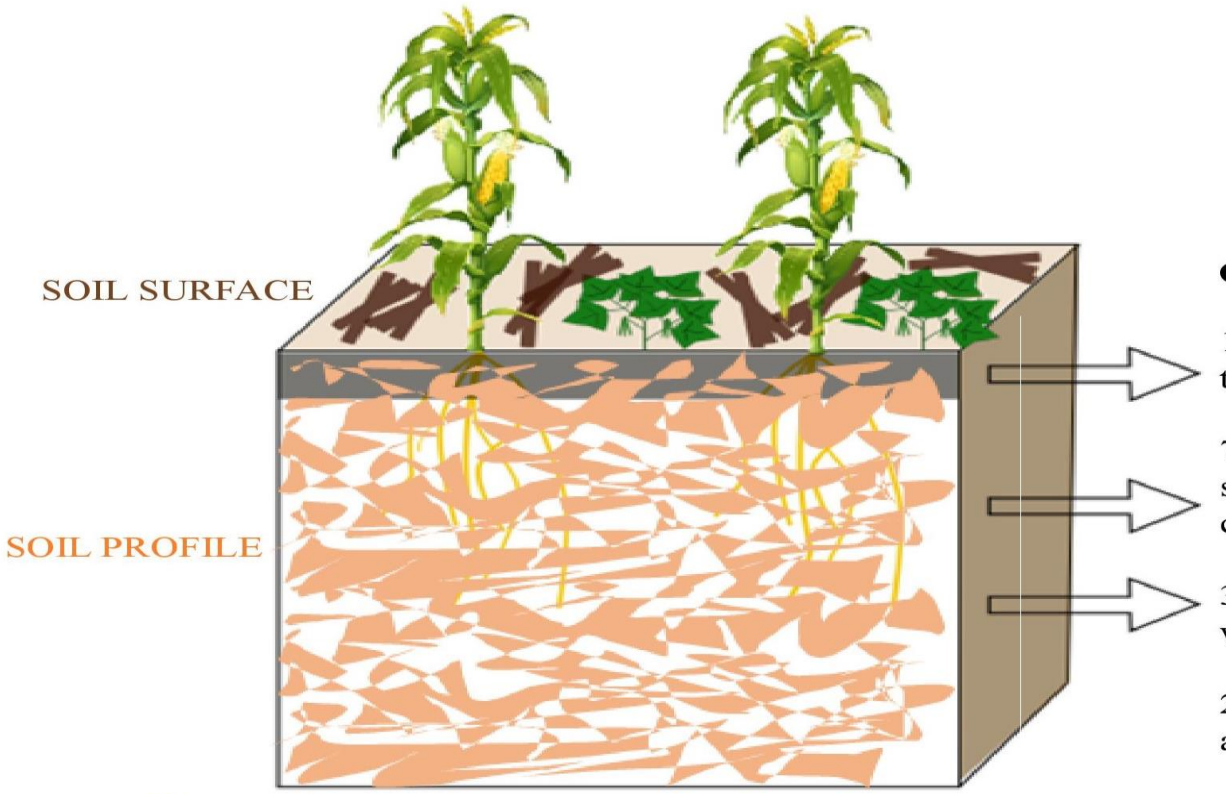
- Global network of CA field trials in a range of soil & climatic settings supported through CGIAR, FAO etc.
- Meta-analysis shows that maize yields under CA outperforms conventional agriculture when negative moisture balance, medium – low clay soils & low rates of N fertilisation / good residue management (Steward *et al*., 2018a)
- CA yield benefits seen after *c*. 5 years & significantly increases with growing season heat stress & number of dry days as compared to conventional practices (Steward *et al*., 2018b)
- Bundling agronomic practices with improved crop varieties increases yields compared to using improved varieties alone => improved land management can double yields of improved crop varieties



CA Impacts on Soil Structure, Hydraulic Properties & Root Architecture

Conservation Agriculture

Zero tillage
Crop residues retained
Maize-legume intercrop/rotations



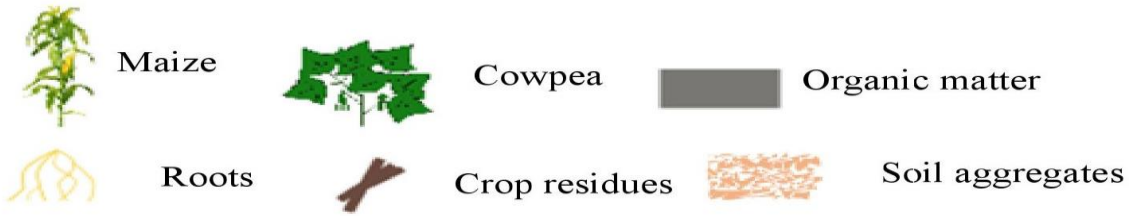
Observed impacts

14-49% increase in total porosity

78-314% increase in saturated hydraulic conductivity

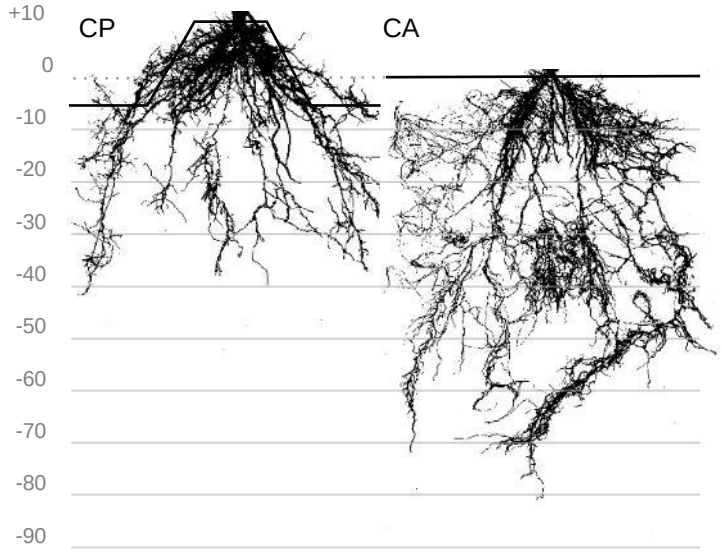
33-171% increase in fine water storage pores

27-84% increase in plant available water capacity

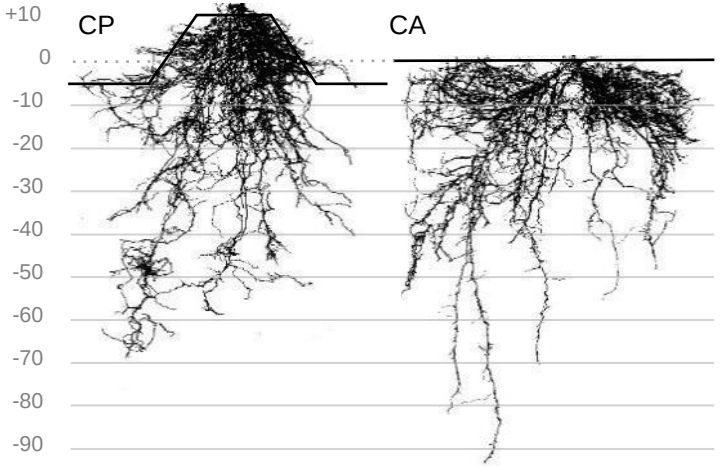


Eze *et al.*, 2020

Variety: DKC80-53; Location: Mwansambo



Variety: PAN53; Location: Mwansambo



Conclusions from CSA Studies (Dougill *et al*., 2021)

- CSA practices improve soil health only ***when*** contextualised for local soil, climate & knowledges
- Monitoring soil health & the application of context specific CSA practices are possible & ***can*** enhance crop yields without degrading the environment
- A hybrid approach that combines conventional techniques & farmer's observations provides a more comprehensive assessment of CSA impacts & ***should*** be promoted widely
- Increasing awareness of soil health & climate information services needs to be mainstreamed in ***agricultural extension*** efforts to promote & upscale sustainable land management practices to enhance food system resilience

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