



Climate resilient agriculture solutions with natural farming

Ravi Prabhu

National Workshop on “Innovative Agriculture”,
(Azadi Ka Amrit Mahostav)
25th April, 2022, Vigyan Bhawan, New Delhi





Modern agriculture emerged as an optimization challenge of **using external resources** (*“infinite inputs”*) to **deliver outputs** – products and waste.
Former to markets, latter into an *“infinite waste sink”*.

Unfortunately, we live in a finite world

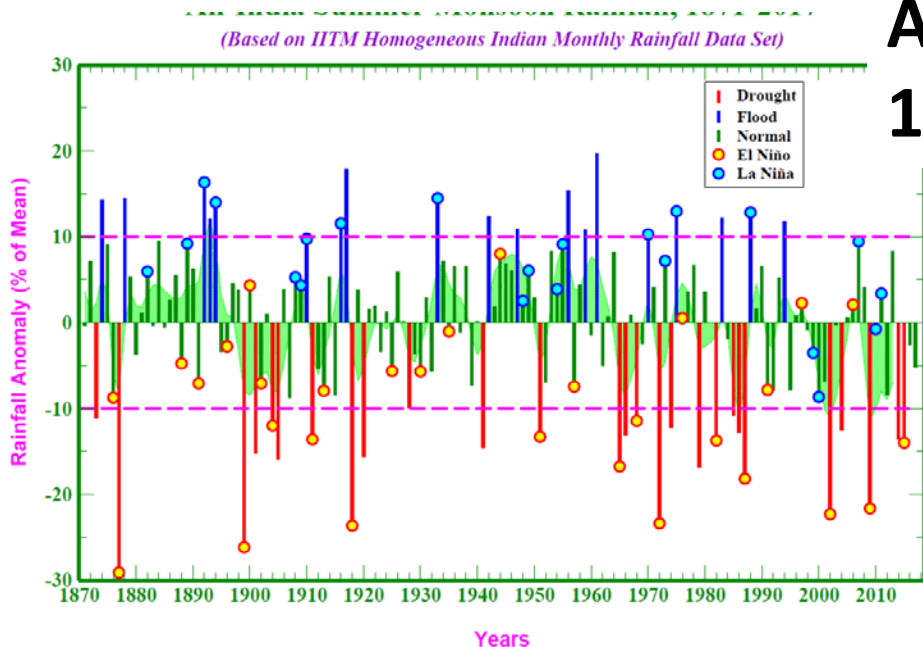
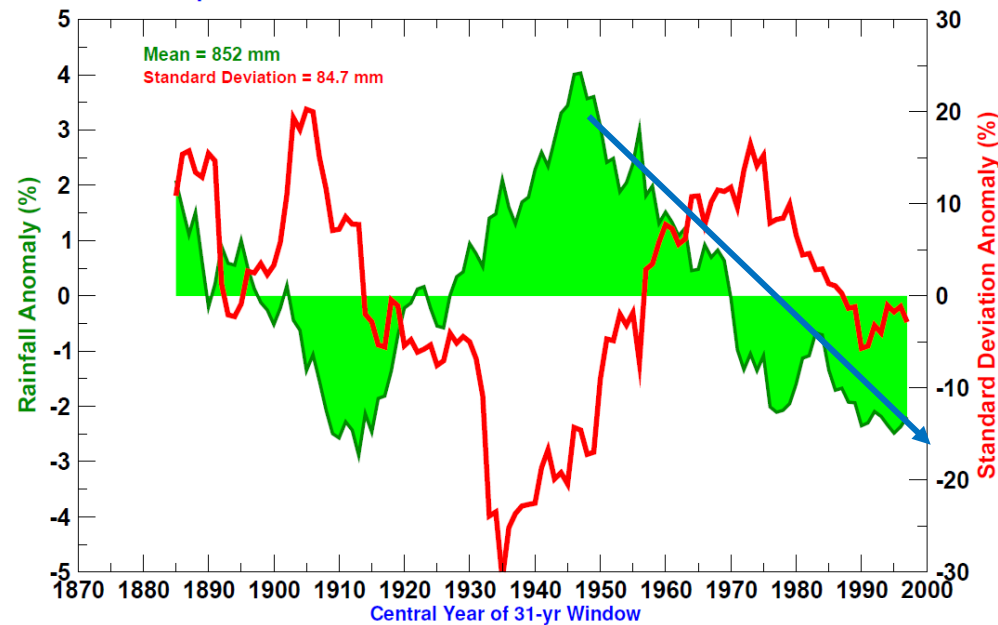


Unfortunately, we live in a finite world...

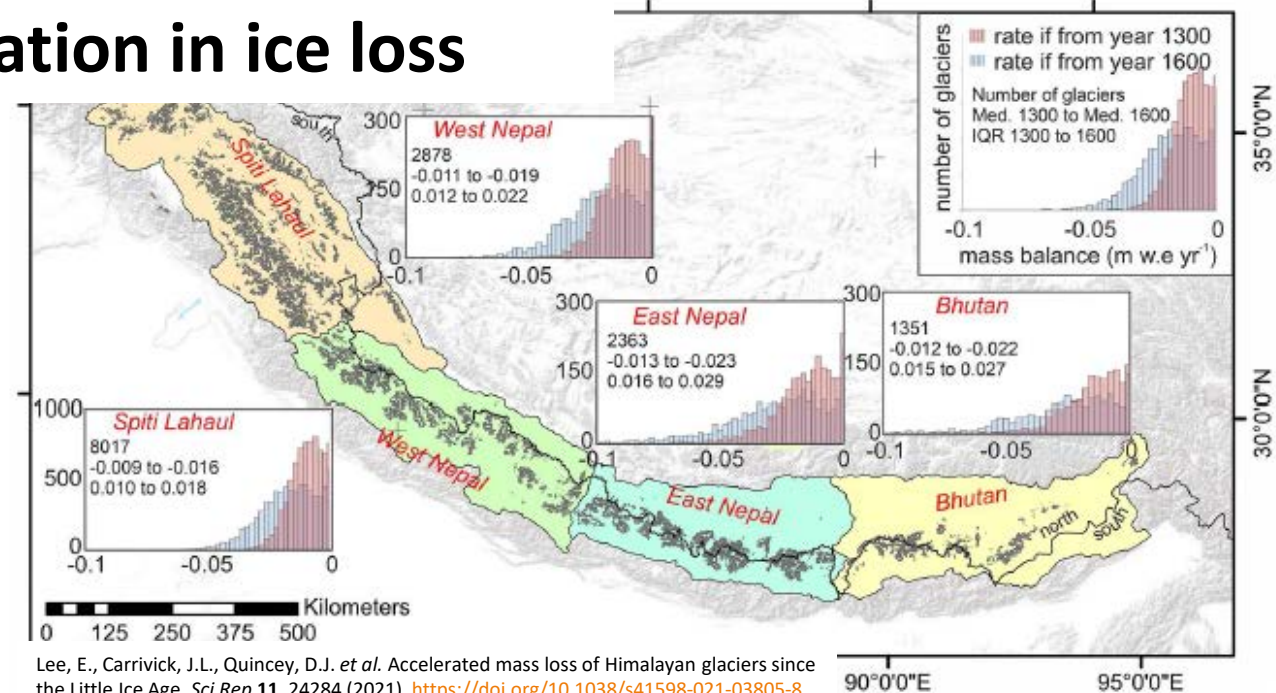
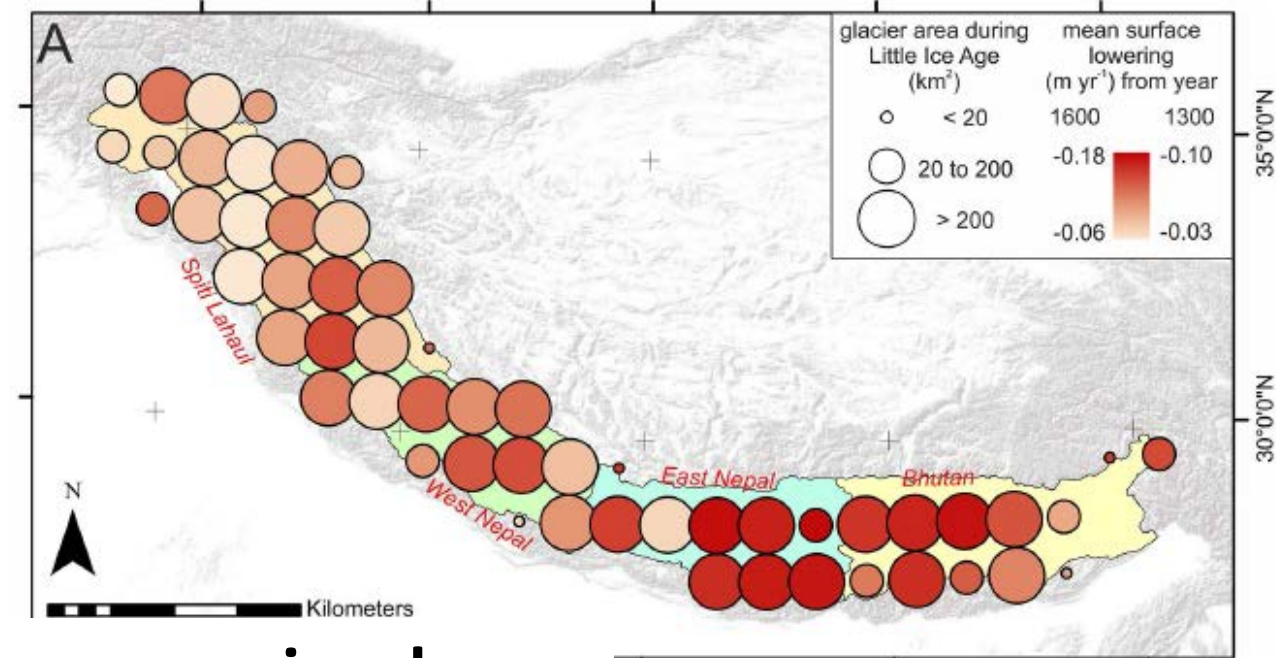
Where sources (*e.g. water, fertilizer*) and sinks (*e.g. rivers, atmosphere*) are depleting



Epochal Patterns of All-India Summer Monsoon Rainfall



**Average monsoon rains down;
10x acceleration in ice loss**



The All-India area-weighted mean summer monsoon rainfall, based on a homogeneous rainfall data set or 306 rain gauges in India, developed by the Indian Institute of Tropical Meteorology, is widely considered as a reliable index of summer monsoon activity over the Indian region. Long time series of this index since 1871 have revealed several interesting aspects of the interannual and decadal-scale variations in the monsoon as well as its regional and global teleconnections.

Lee, E., Carrivick, J.L., Quincey, D.J. *et al.* Accelerated mass loss of Himalayan glaciers since the Little Ice Age. *Sci Rep* 11, 24284 (2021). <https://doi.org/10.1038/s41598-021-03805-8>

Majority of the Rivers in India are highly polluted (CWC Study)

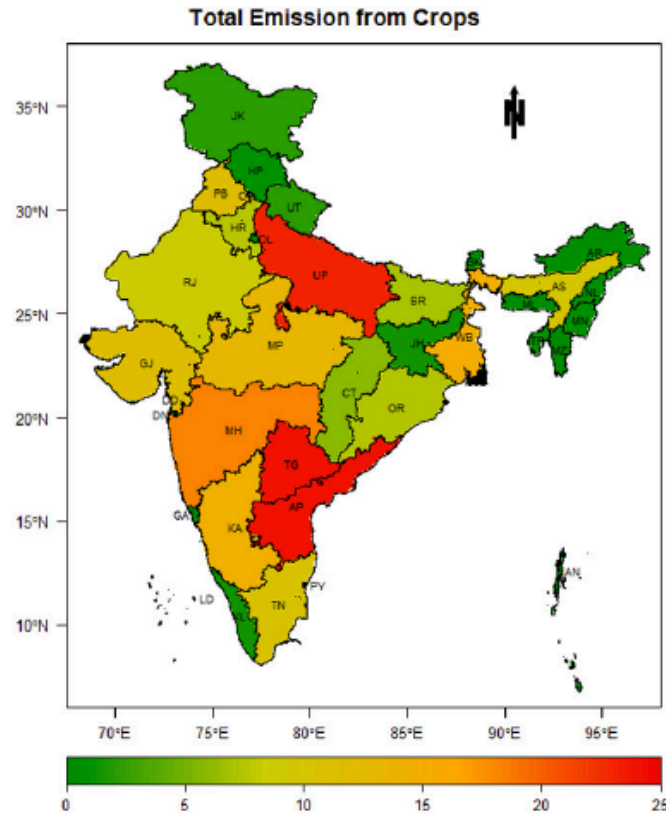
Number of rivers polluted with unacceptable levels of heavy metals

Contaminant	Permissible limit	No of rivers
Lead	10 µg/L	69
Nickel	20 µg/L	25
Iron	300 µg/L	137
Copper	50 µg/L	10
Chromium	50 µg/L	21
Cadmium	3 µg/L	25

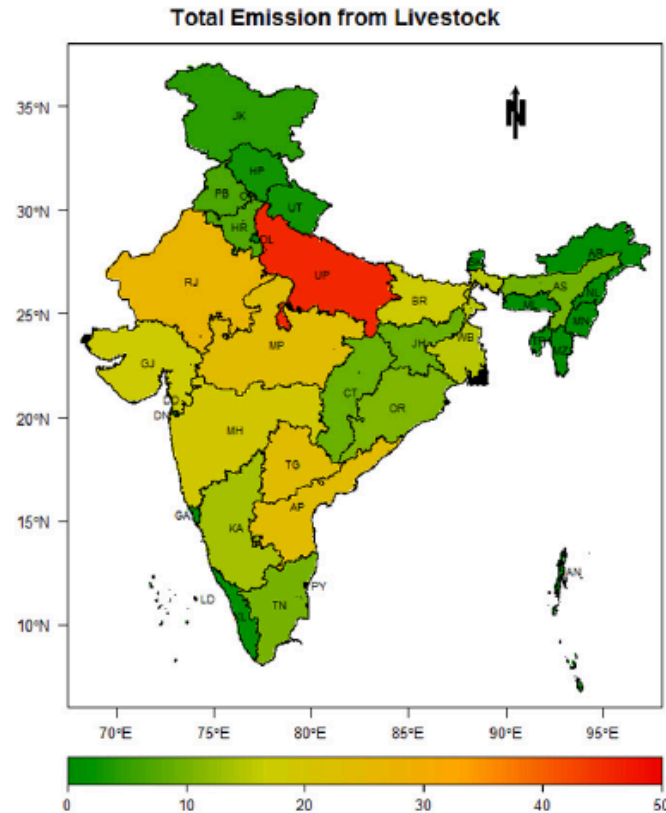
- The Central Water Commission (CWC) collected a total of 442 surface water samples from 62 rivers in India of which 287 were polluted by heavy metals.
- The most common heavy metal found was iron, and above safe limits in 156 samples. Lead, nickel, chromium, cadmium and copper were the other metals.
- The Paddy and other vegetables grown in the catchment areas are highly polluted (Kiran Pandel et al. (2018)
- Ganga, the national river, was found to be polluted with five heavy metals—chromium, copper, nickel, lead and iron—six rivers—Arkavathi, Orsang, Rapti, Sabarmati, Saryu and Vaitarna—had unacceptably high concentration of four pollutants.

Source of agricultural emissions in India

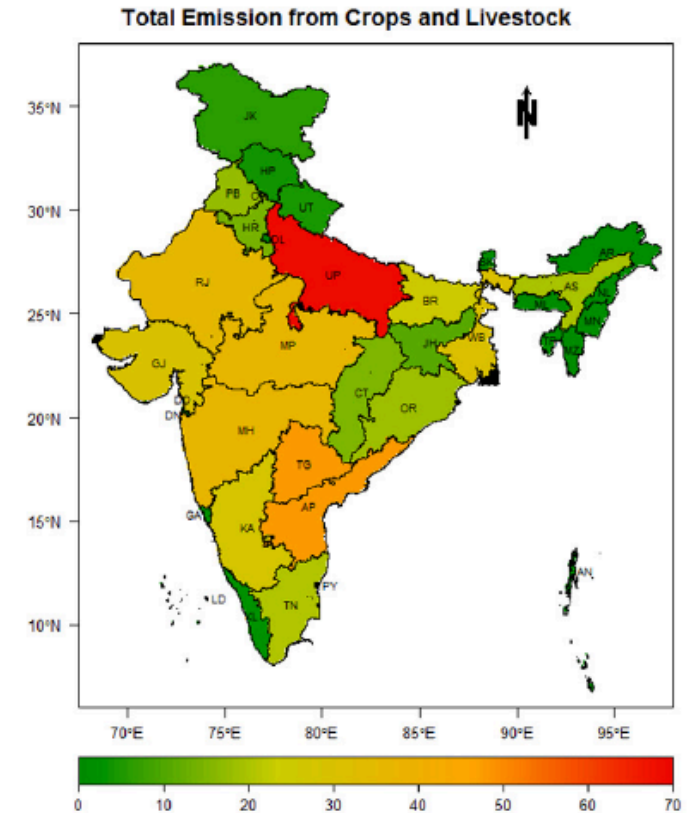
CROPS



LIVESTOCK



CROPS + LIVESTOCK

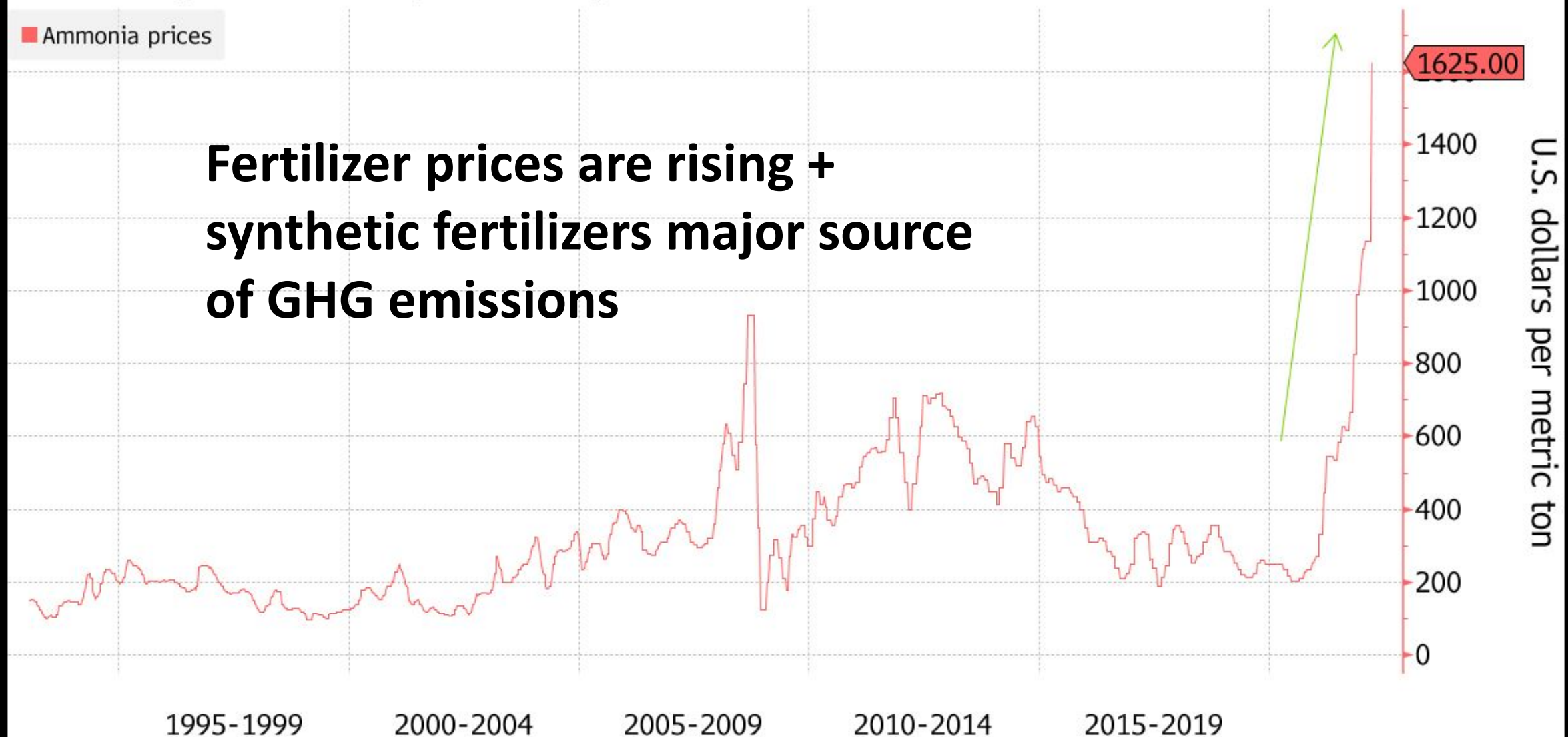


Fertilizer Frenzy

U.S. Tampa ammonia prices surge to record

Ammonia prices

**Fertilizer prices are rising +
synthetic fertilizers major source
of GHG emissions**



Source: Green Markets, Bloomberg

Bloomberg

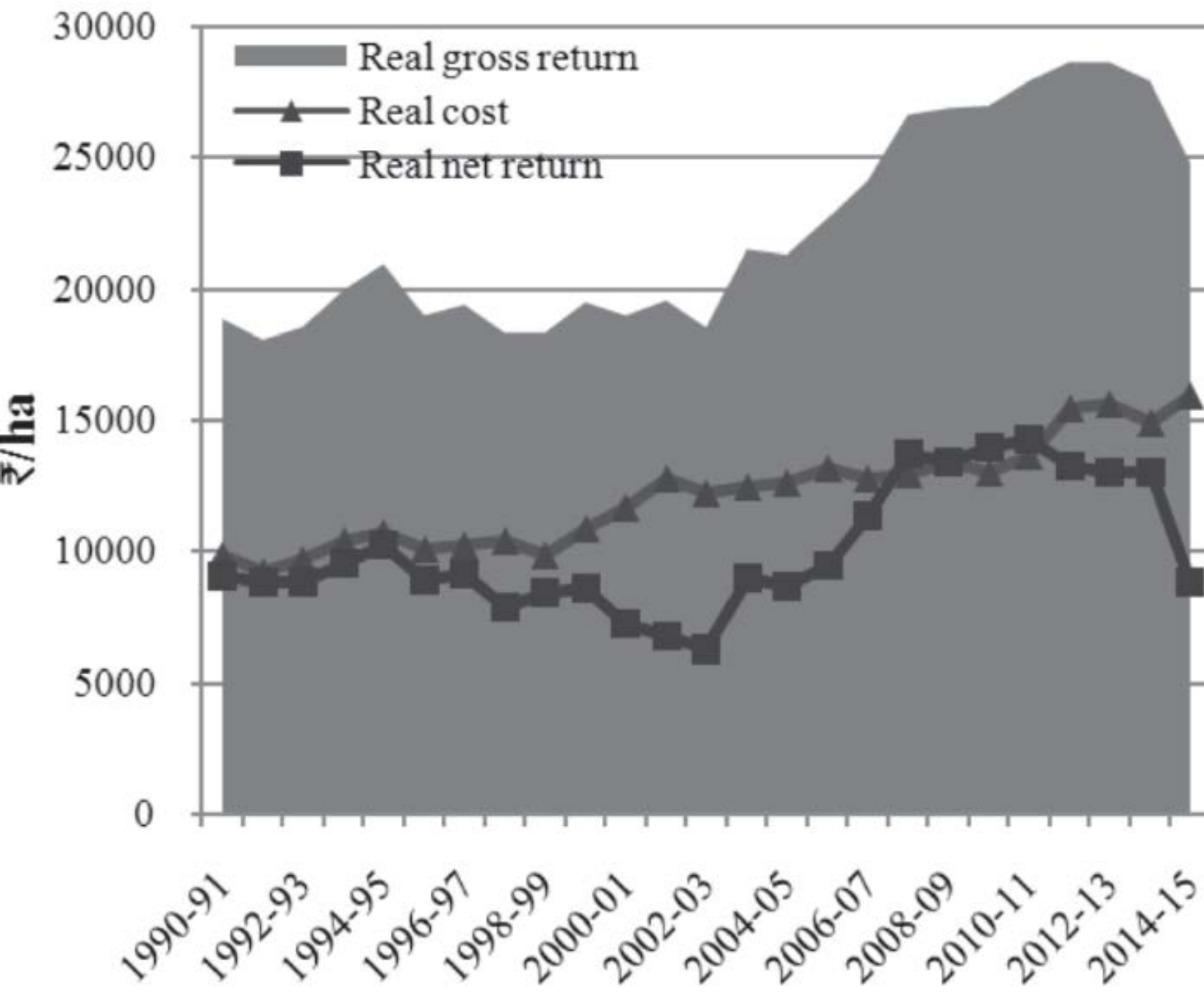
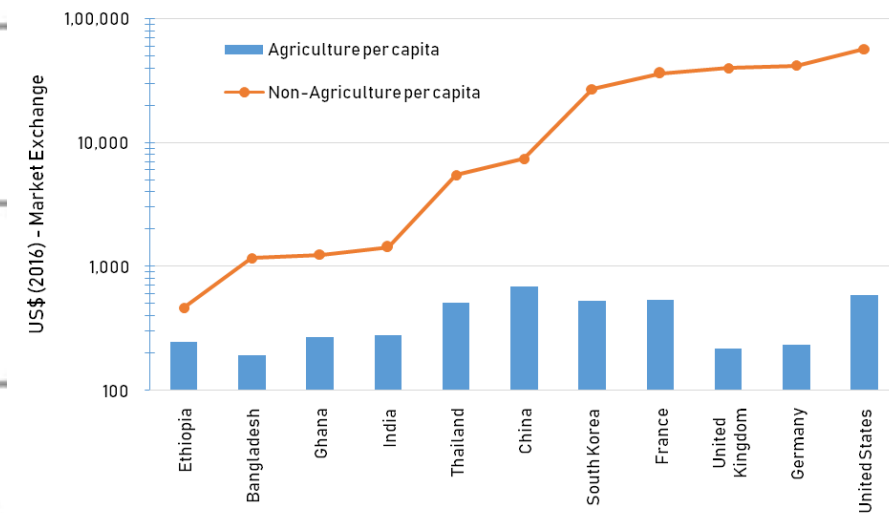


Figure 1: GDP per capita



Source: World Bank

Gap between cost and return in conventional agriculture

FOOD SYSTEMS SUMMIT DIALOGUE:

TRUE COST ACCOUNTING FOR
FOOD SYSTEMS: REDEFINING
VALUE TO TRANSFORM
DECISION-MAKING

The UN Food Systems Summit
NEEDS YOUR VOICE!

Join us on the:
8 June 13:00

**We have the tools to get the full
picture ...**

**Finding climate resilient
solutions... *like Natural
Farming...* are within grasp**

Routledge Studies in Food, Society
and the Environment

earthscan
from Routledge

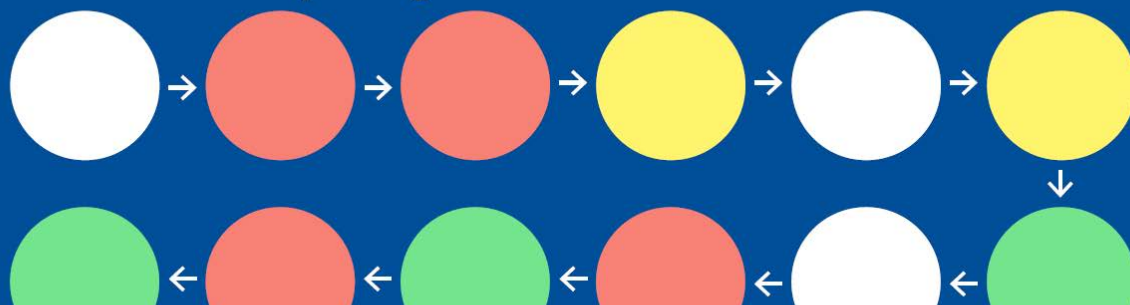
True Cost Accounting for Food

Balancing the Scale

Edited by Barbara Gemmill-Herren,
Lauren E. Baker and Paula A. Daniels

TRUE COST ACCOUNTING AGRIFOOD HANDBOOK

Practical guidelines for the food and
farming sector on impact measurement,
valuation and reporting



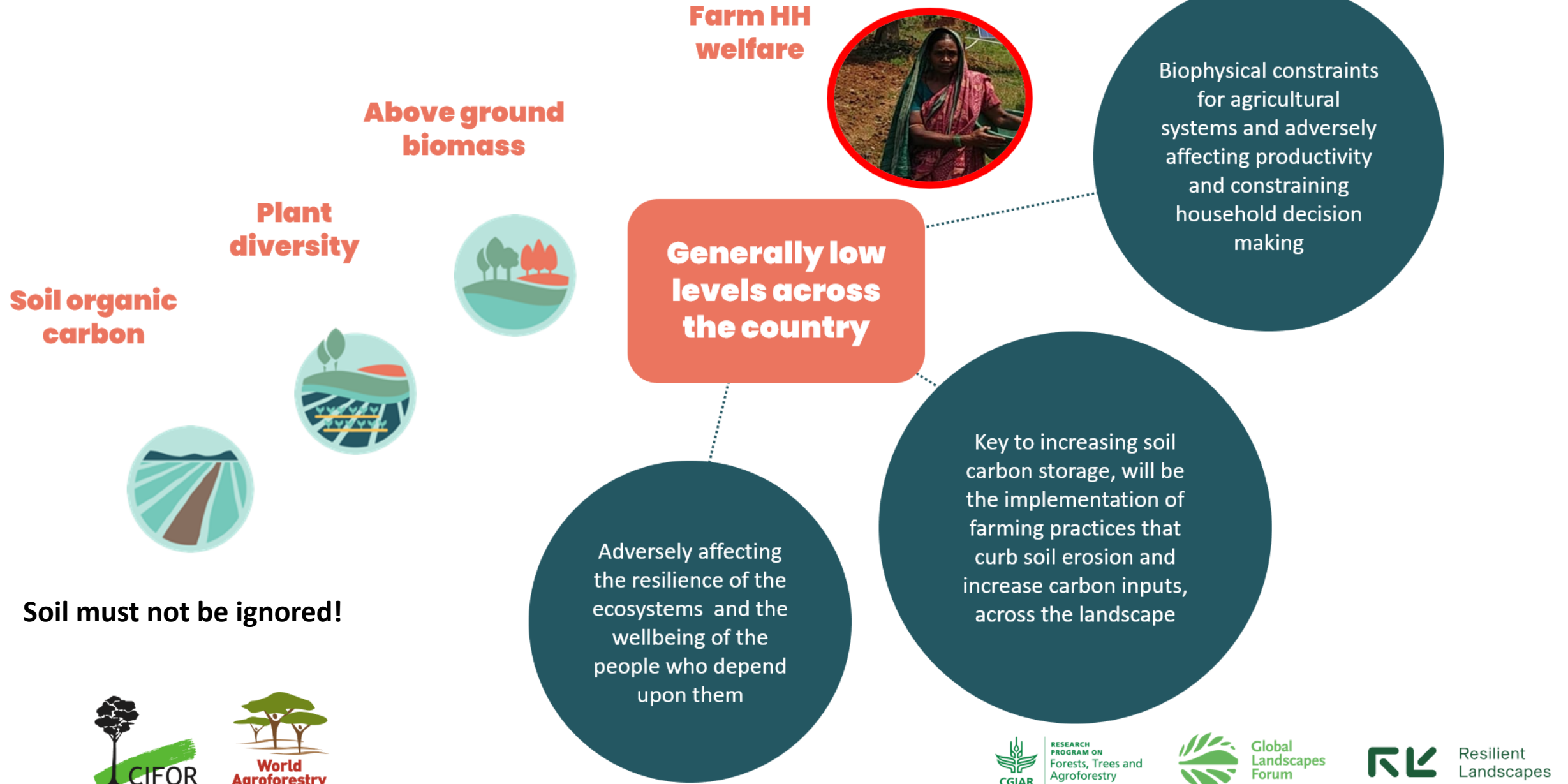
paper, March 2022

Natural farming is inspired by nature and seeks to optimize circular use of materials and energy, *minimizing external inputs and waste* – building on agroecological principles – to produce food, improve farmer welfare and stewardship of nature, at multiple, *nested scales*.

Because we live in a finite world



Why we need to build resilience in India



The Global Relevance of Soil

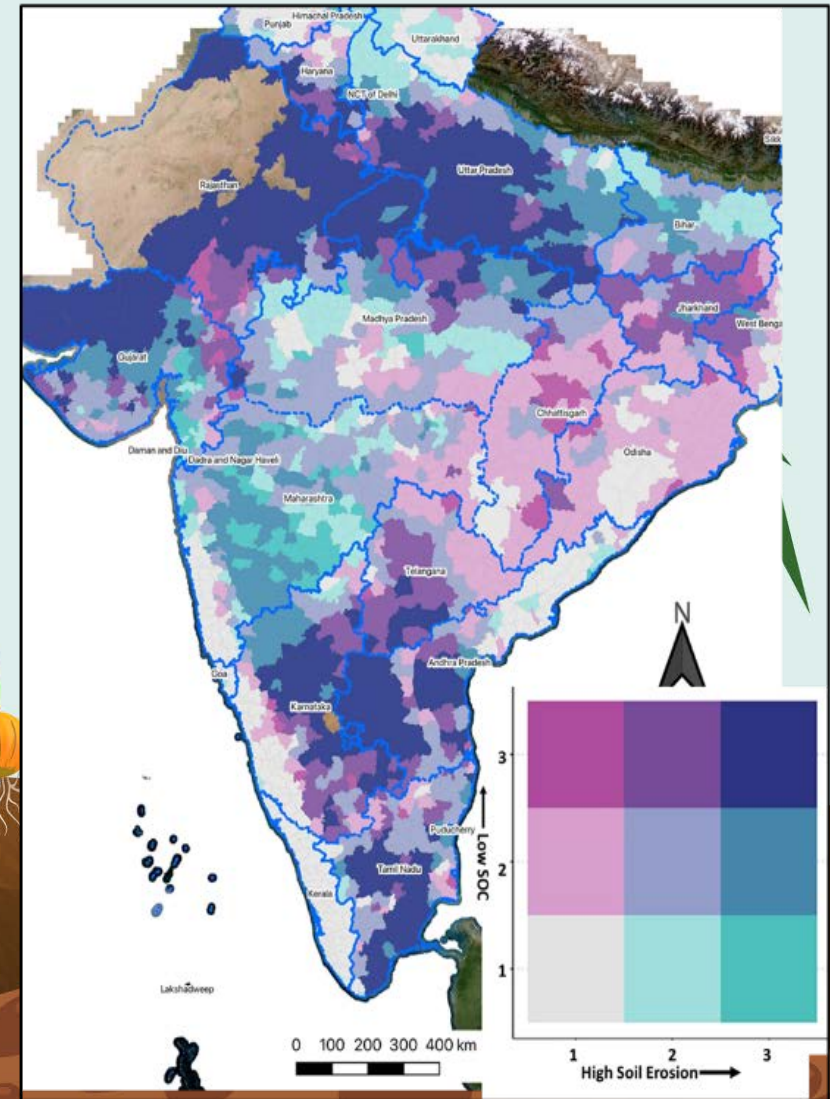
95%

of our food is directly or indirectly produced on our soils

Sustainable soil management could produce up to 58% more food



It is estimated that 40% of the Earth's soil is degraded



Soil erosion (Blue = high), and Soil Organic Carbon (Red= Low) in various Indian states

Analysis: ICRAF/Tor Vagen

Some key principles and practices to achieve a transition to climate resilient agriculture

High-external input

Low-external input

Water, fertilizers, pesticides, etc., lower **but not knowledge & technology**

Linear economy

Circular economy

Carbon emission

Carbon sequestration

Especially in soil and living biomass

Monocropping

Multicropping

**Land equivalent ratios are ~1 or higher
Total factor productivity is high**

Pollution

Planetary healthy production

Requires consideration of multiple, nested scales (burden cannot be put on farmers alone)

Low tree/woody cover

Improved tree cover

Modulates bioclimate, resilient portfolios of products & services

Farmers in debt

Stewardship economy

Rewards for exercising 'care', supports welfare outcomes

Natural farming & other agroecological approaches

Farm Landscape Region

Low-external input

better knowledge & technology

Circular economy

Carbon sequestration

Especially in soil and living biomass

Multicropping

Planetary healthy production

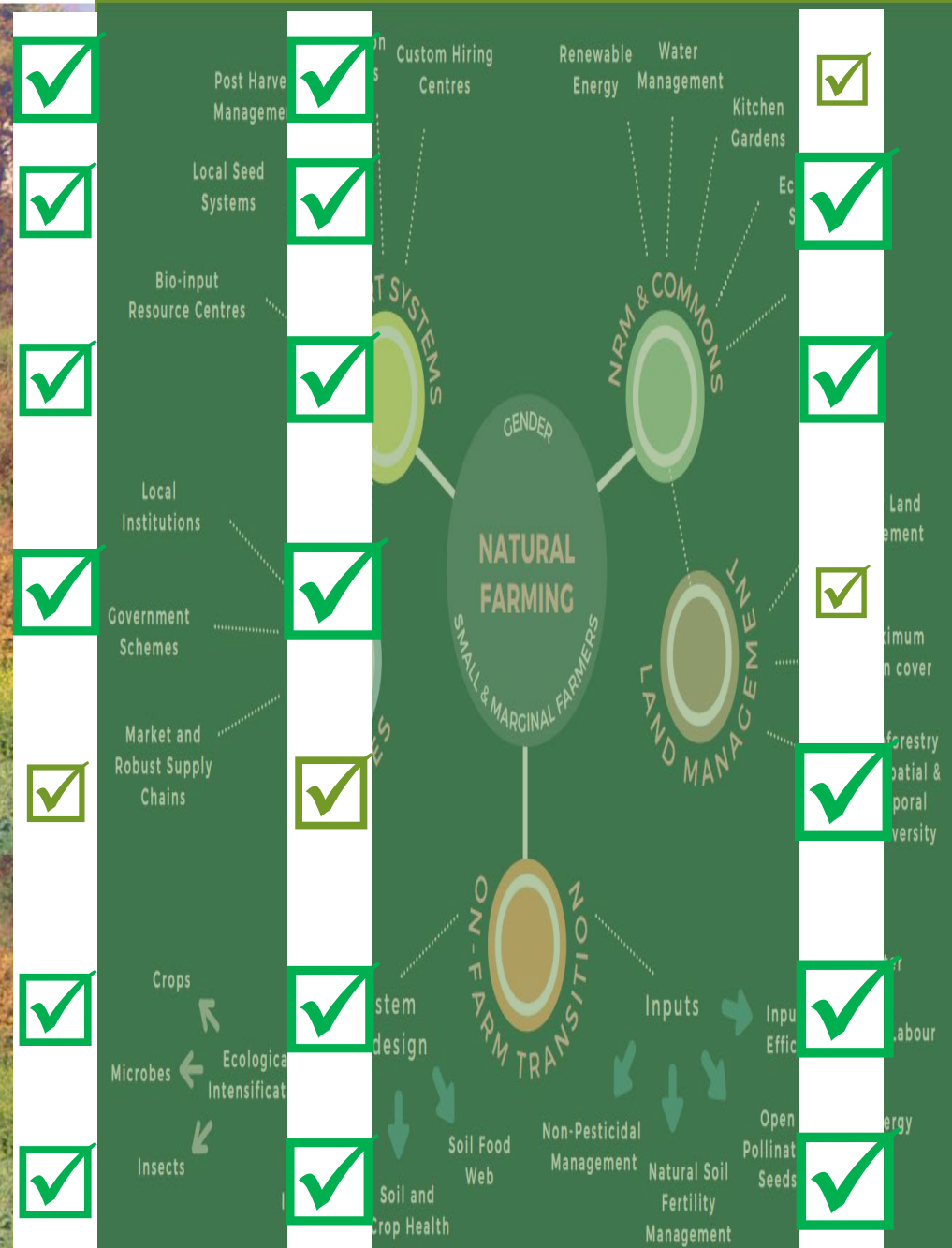
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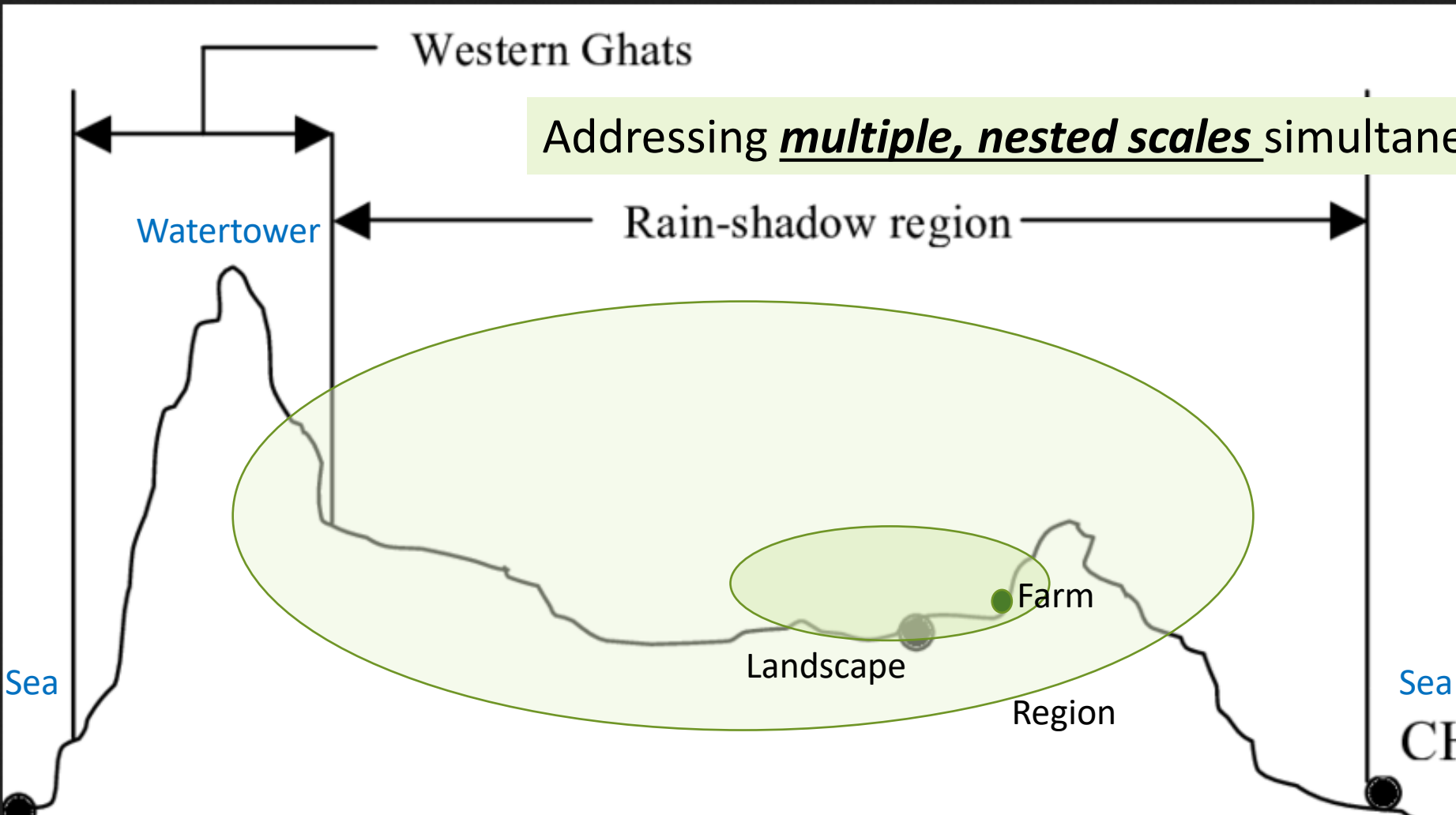
Improved tree cover

Modulates bioclimate, resilient portfolios of products & services

Stewardship economy

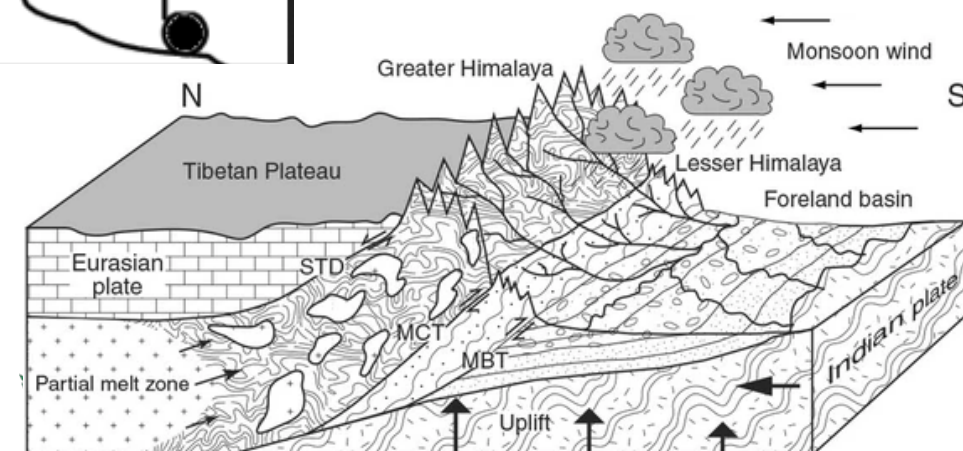
Rewards for exercising 'care', supports welfare outcomes





Indian farming landscapes could be managed as the land between “*water towers*” and the *sea* (or ocean, river, ...)

Line drawing from: Gopakumar, Govind (2009) Investigating Degenerated Peripheralization in Urban India: The Case of Water Supply Infrastructure and Urban Governance in Chennai. Public Works Management & Policy. DOI - 10.1177/1087724X09350629





Natural Farming

(agroforestry, organic agriculture, permaculture and other agroecological approaches) offers a transformation opportunity at nested scales.

It follows agroecological principles, aims to deliver without synthetic inputs.

Potentially a systemic change and the promise of a climate resilient transition, with benefits for farmers and land.

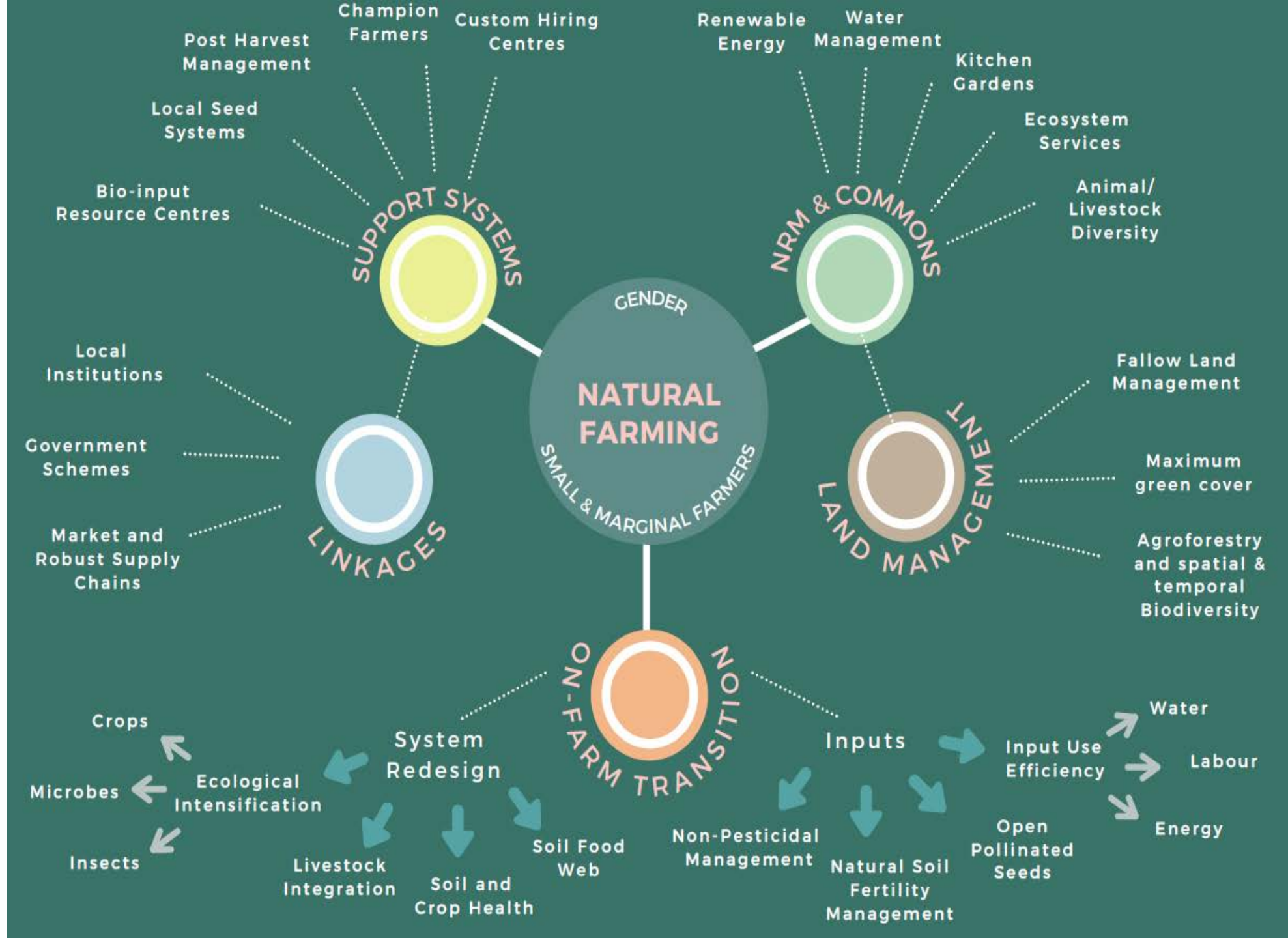


Table 2. Constraints faced by Respondents in adopting Climate Resilient Technologies

Major constraints are data, information, knowledge and capacity to innovate! n=45

S. No.	Constraints	Garret Mean Score	Rank
1	Limited knowledge on climate resilient adaptation measures	52.98	I
2	Inadequate number of extension functionaries at grass root level	47.68	II
3	Inadequate weather based farm advisories	44.68	III
4	Lack of knowledge about climate change	42.21	IV
5	Inadequate training regarding climate resilient practices	41.08	V
6	Lack of feedback/reporting system (between extension, research and clients/end-users)	38.54	VI
7	Lack of access to timely information on climate vagaries	31.25	VII
8	Inadequate number of automatic weather stations	30.72	VIII
9	Lack of access to climate resilient crop varieties & other inputs (Drought / Heat resistance etc.)	28.80	IX
10	Less expertise of field staff on climate change and its management practices	24.88	X

APCNF – an approach based on agroecological principles

Minimise the use of synthetic fertilizers and pesticides



Building on biological nitrogen fixation coupled with nutrient and biomass recycling from livestock and biodiverse plant associations in and around farmers' fields, with lower input costs as a whole

Improve or maintain

Farmer welfare



Water holding capacity



Soil organic carbon



Functional microbial diversity

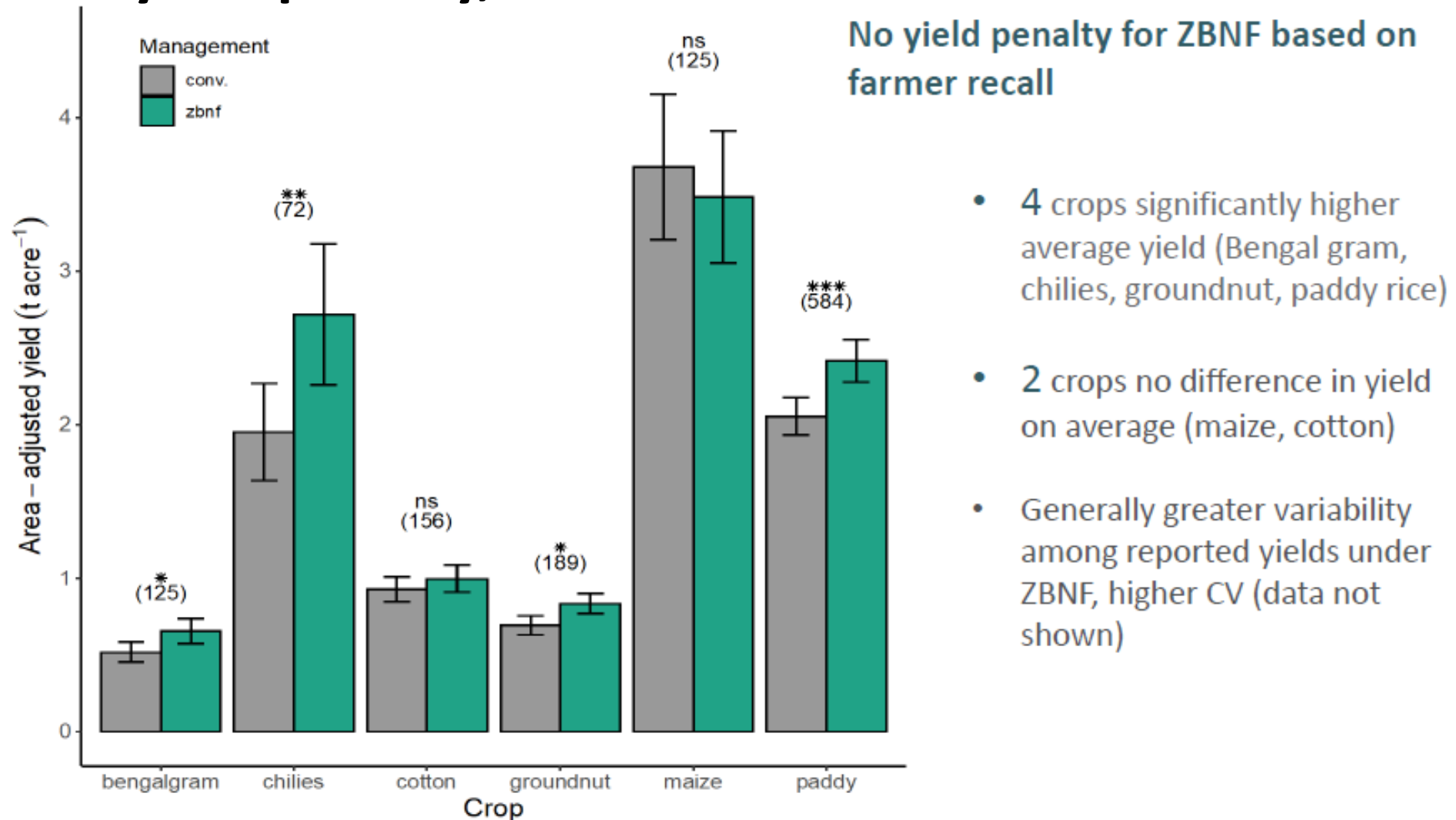


Balanced pest-predator populations



YIELD HYPOTHESIS:
APCNF > | = CONVENTIONAL

No yield penalty, lower GHG emissions!



APCNF:

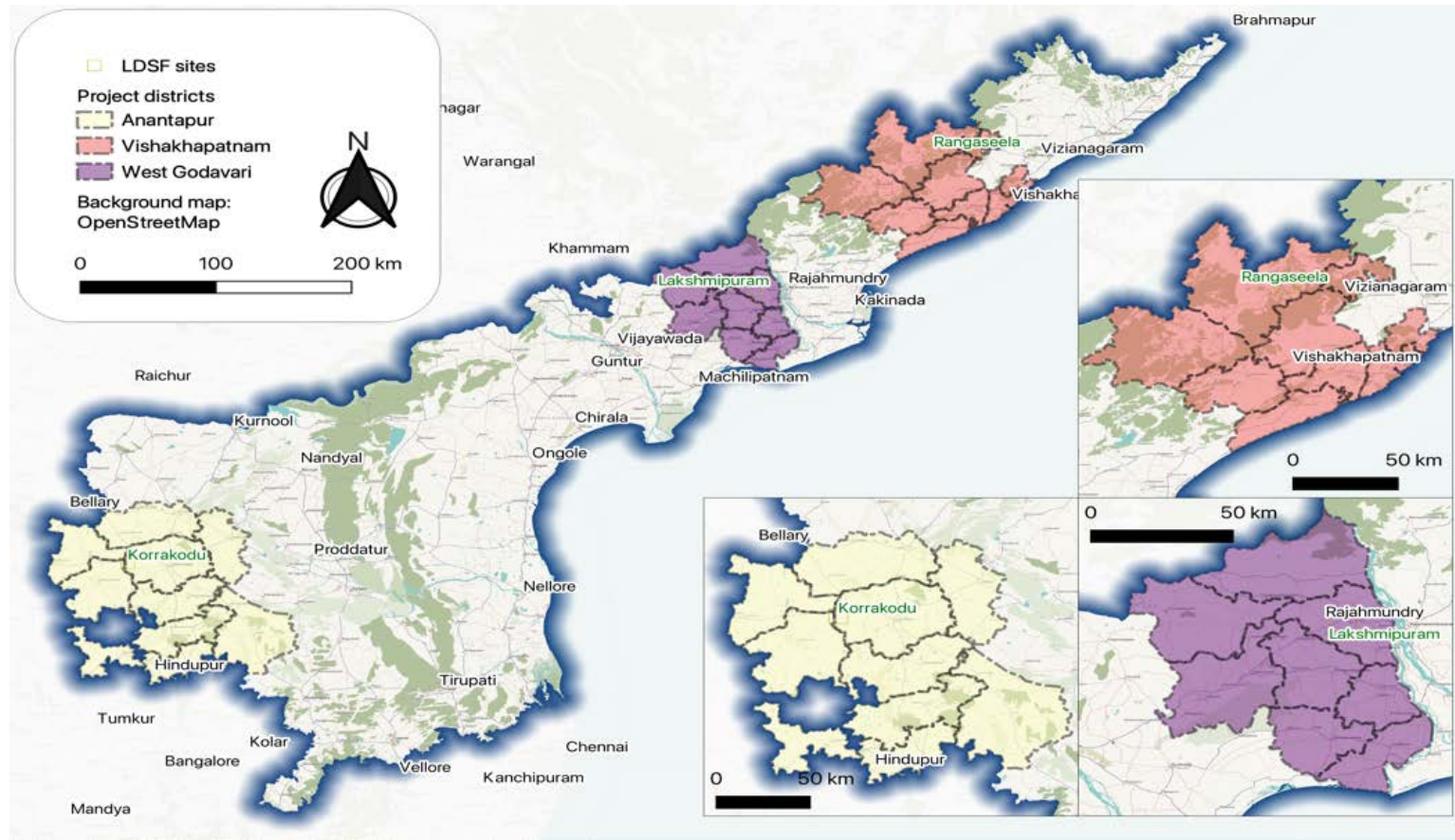
Net income appears to improve

Table 5 | Comparison of costs from existing literature (INRs).

Crop	Bharucha et al. 2020			CEEW et al. 2020			Gupta et al. 2020		
	Conv	ZBNF	% Δ	Conv	ZBNF	% Δ	Conv	ZBNF	% Δ
Bengal gram				10,851	6693	-38.3			
Chilies									
Cotton	23,532	15,849	-32.7						
Groundnut	15386	11,406	-25.8	15,564	15,023	-3.5	12,759	16,637	30.4
Maize	10,565	9,124	-13.6	20,581	14,835	-27.9	23,534	16,672	-24.9
Paddy	17,529	12,486	-28.8	19,597	13,962	-28.8	18060	1,4267	-21

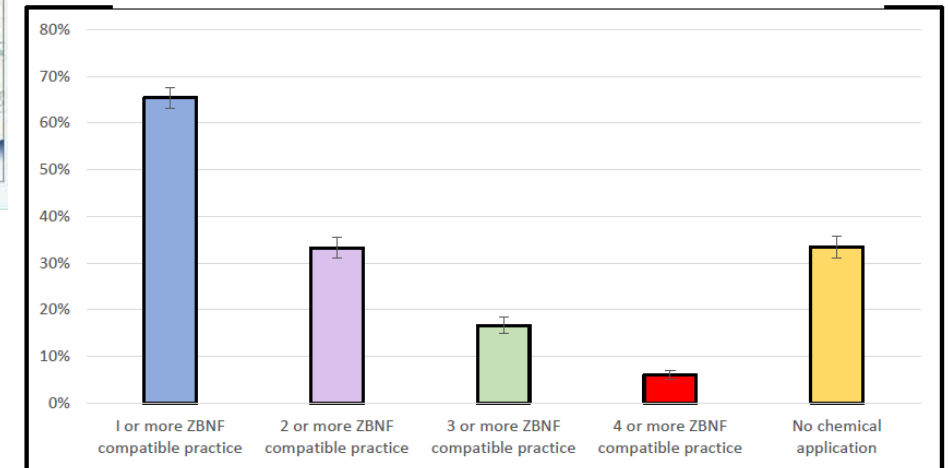
* Rainfed.

We will study this further in 3 exemplar landscapes in AP



Farmers are willing to take up natural farming in AP

APCNF Practice Indicators



% farming families practicing various levels of APCNF/ZBNF compatible practices (n=3,634)

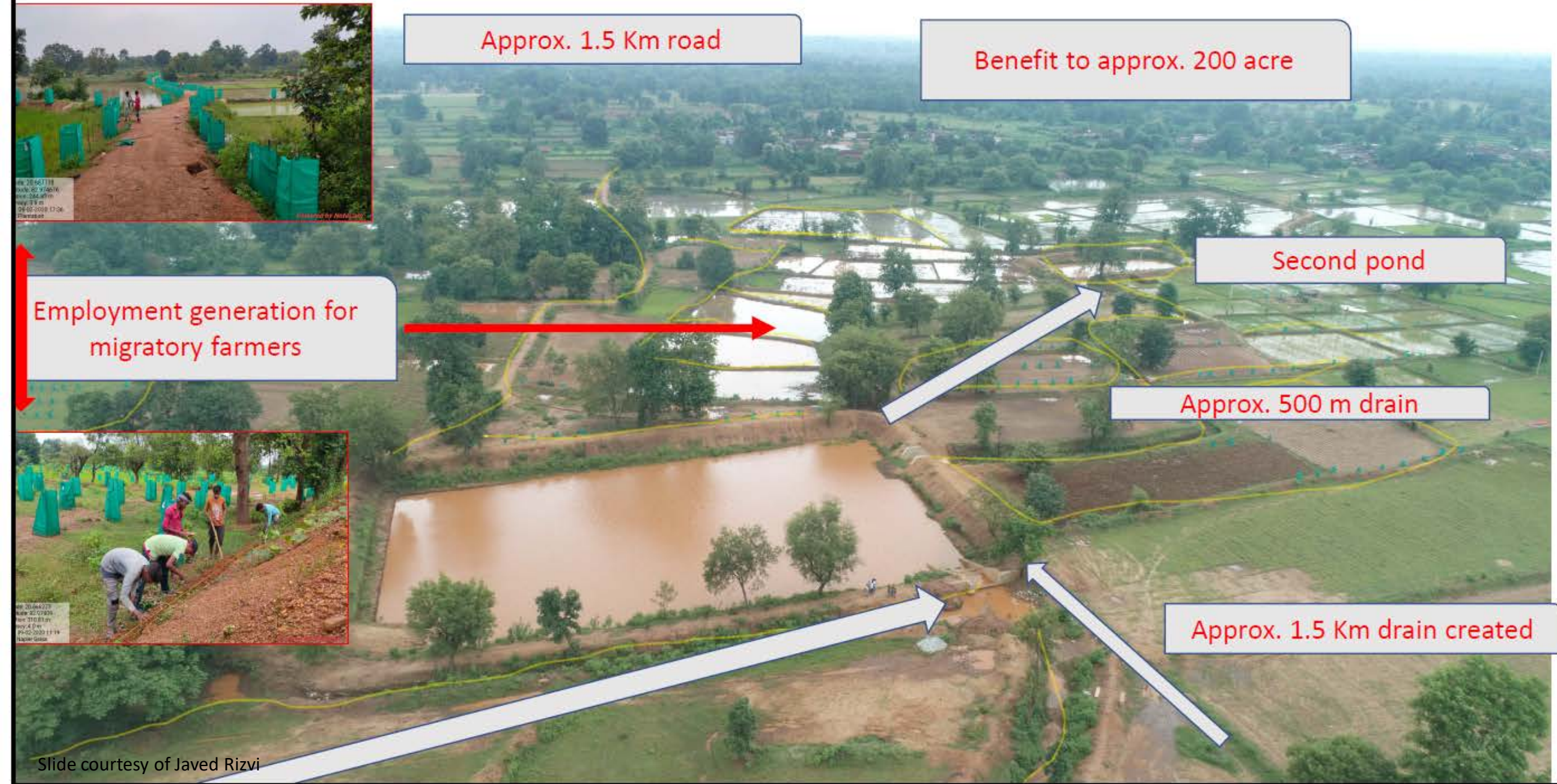
*sample weights used to adjust for differences in GP cluster population size and sample size variation

*standard errors clustered at village/habitation level, given cluster sampling design

* denotes error bars, indicating 95% confidence that the true population figure falls within this range



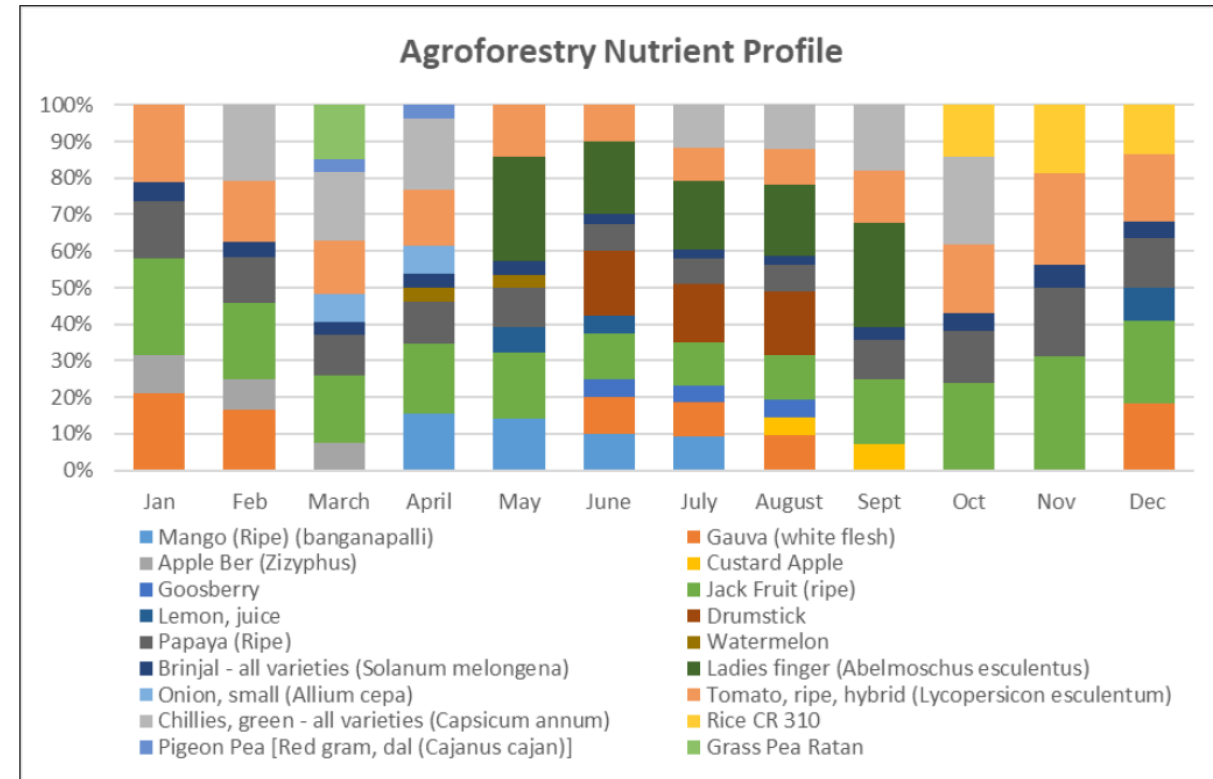
Agroforestry, water, landscape approach to nutrition & income in Odisha





A ‘*portfolio*’ of trees, shrubs and annuals can change the ‘*nutrition profile*’ of the landscape, adding key vitamins and micronutrients to diets.

This is based on knowledge of fruiting and flowering of key tree, woody and annual species and working with farmers to find the best choices.



Odisha: Initial impacts of landscape agroforestry approach...



Income has improved significantly

Fruits (per plant estimated income): Rs1450 from third year (Total plants : 186, 000)
From backyard horticulture: Rs. 11,820 per HH (Total Households: 7691)



Nutritional Profile has improved

Biofortified rice: increased per hectare availability of protein (500 kg), zinc (150 g), iron (150 g)
Diversified cropping systems with high-Fe, high-Zn rice & pulses are expected to lower malnutrition by at least 8-10%



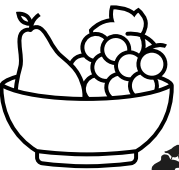
Extra Crop in Fallow

Introduced Grasspea, covering 1200 ha, providing 600-700 kg per ha yield , income of Rs 17,500 per ha in rabi season



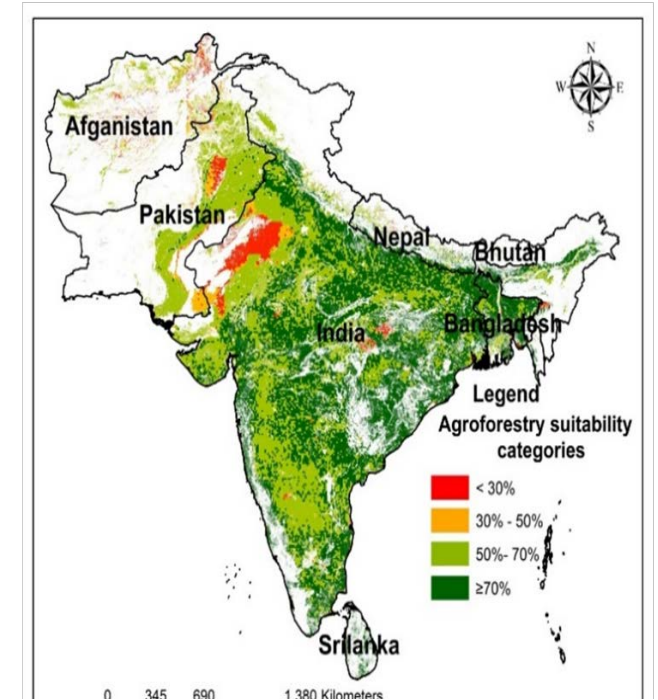
Water use is more efficient

85 ha bunding; Rainwater harvesting = 85,000 cum
Water harvesting from ponds : 70,500 cubic meters; 21,000 cum water used for rabi irrigation
1.25 Lakh Cum water infiltrated into ground
8.4 ton/ha soil was saved from erosion; total soil saved: 714 ton



Establishing sustainable seed chain

5 FPOs involving 53 farmers registered for production of certified seeds of Paddy.
Resulted in production of 64.3 tons certified paddy seeds of var. CR Dhan 310, which were procured by OSSC (Odisha State Seeds Corporation)



Agroforestry potential areas within croplands, South Asia

A phased shift to more climate resilient forms of agriculture like natural farming, agroforestry, regenerative agriculture, organic agriculture etc. will lead to a productive and sustainable transformation of agriculture

Focus on agroecological principles, let practices evolve & emerge

Build knowledge and capacity to innovate, harness technology at multiple scales (don't put all the burden on farmers!). Social capital!

Think of this transformation as a journey rather than a destination:

An innovative journey to adaptive and productive resilience of agriculture!



If rivers can fly, we can definitely transform Indian agriculture!

Thank you!

Cited in: Mimicking nature to reduce agricultural
impact on water cycles: A set of mimetics
Meine van Noordwijk, et al, 2021... Sage

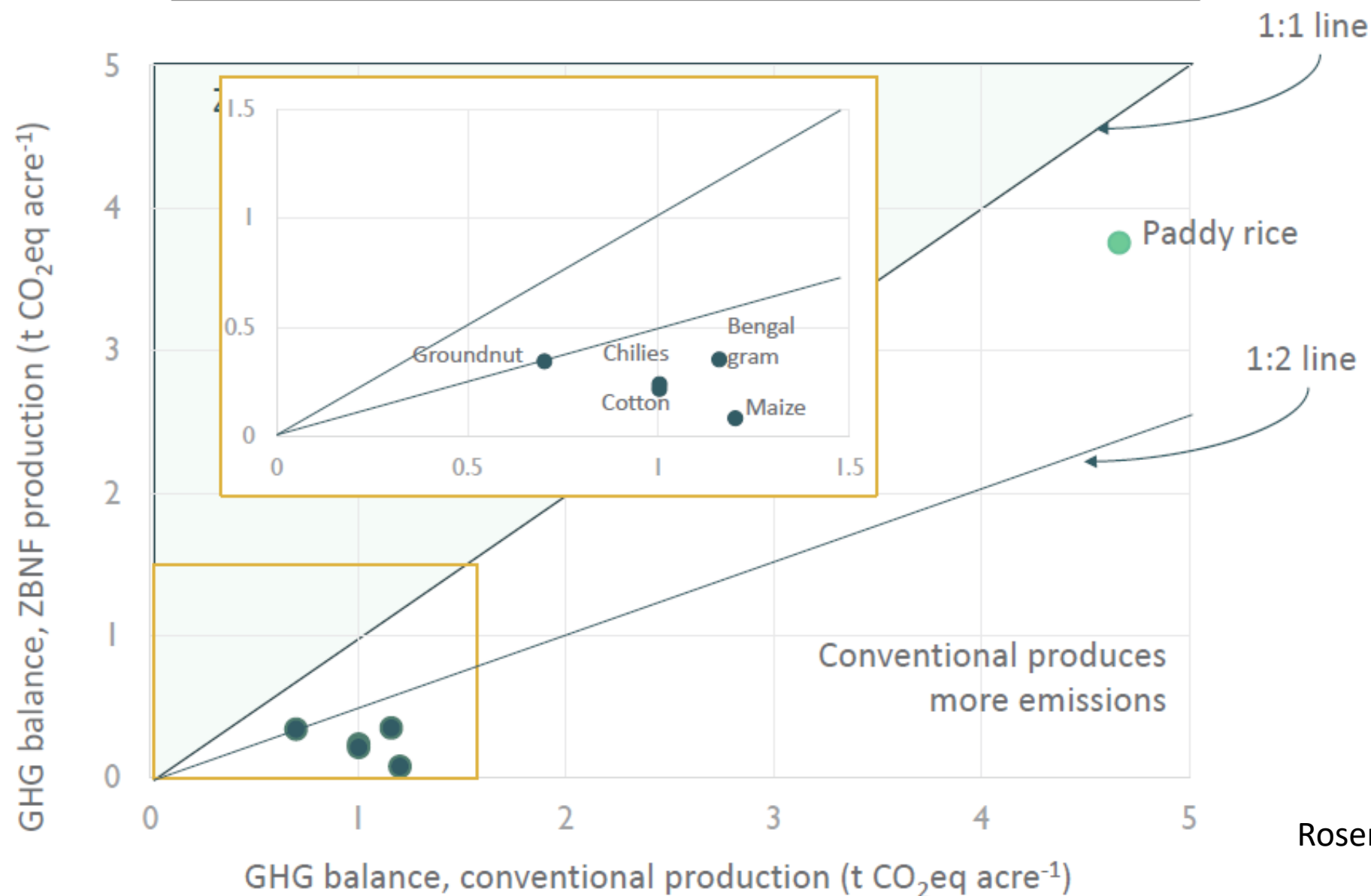
Flying rivers


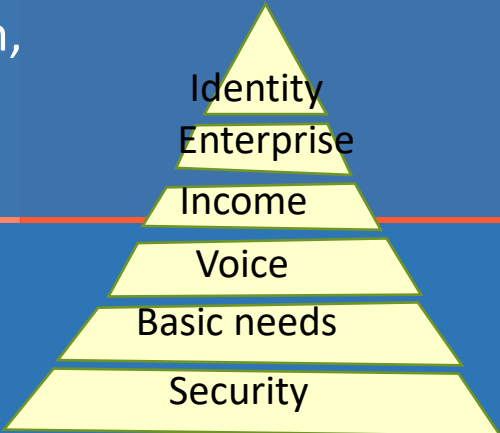
SCIENCE DIVISION

July 2021




GHG EMISSIONS HYPOTHESIS: APCNF < CONVENTIONAL



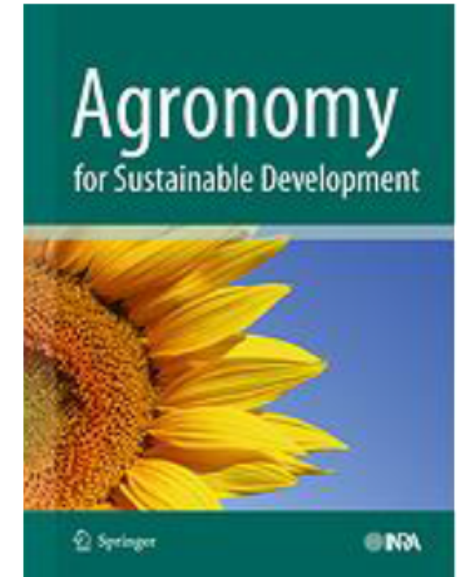
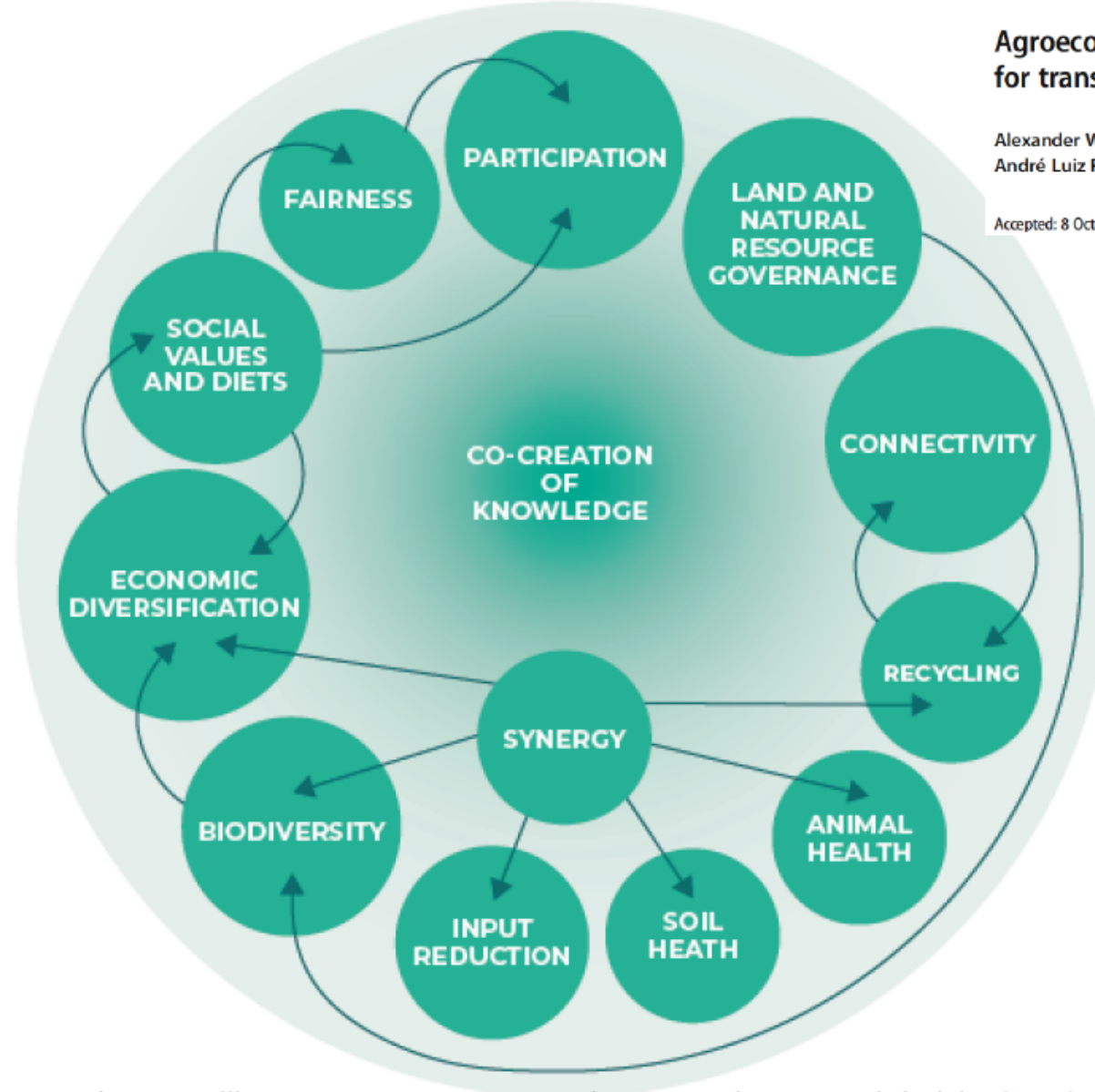
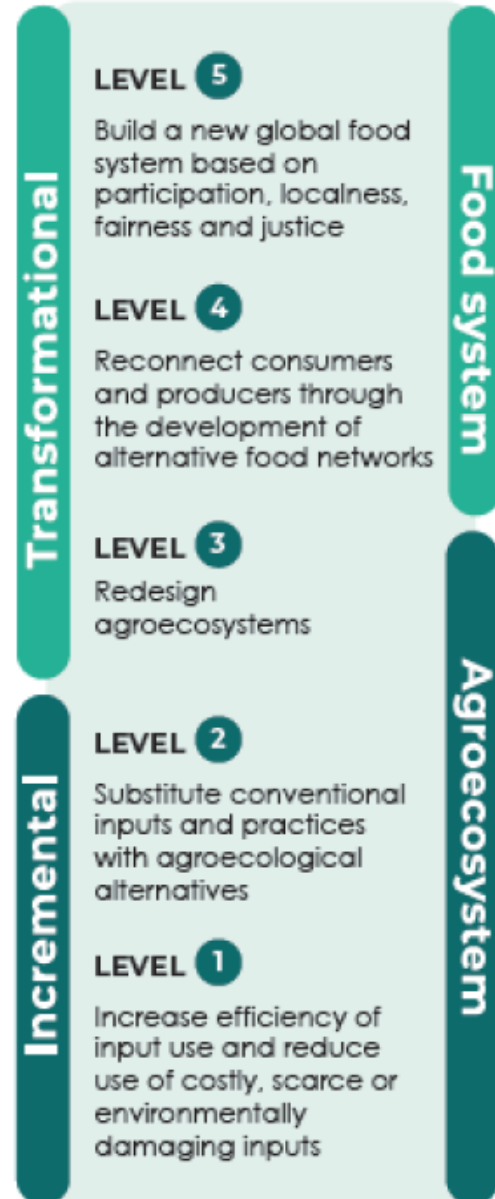
After: van Noordwijk et al. 2022. Carbon footprints, informed consumer decisions and shifts towards responsible agriculture, forestry, and other land uses?		Data	Functional feedbacks	Rules&roles	Goals
Global	SDG targets & indi-cators, IPCC, IPBES, FAO, ...	Tipping points, Tele-connections, Scenario modeling	WTO, UNFCCC, CBD, REDD+, zero-defores-tation trade, C-tax...	SDGs	
National	National GHG com-munications, NDC reporting, Equity	Adjusted GDP, National Adaptation Plans, Disaster resp.	Parliaments, Laws, Ministries, NITI Aayog, Tax/subsidies, Invest	Constitution, Identity, Sovereignty, NDC, National development	
Sub-national/ Region (water tower to sea)	Emission intensity CO _{2e} /GDP, OpCost, C-credits, Votes	Value addition, em-ployment, equity, conflict, investment	States, Departments, Land use plans & rights, permits, tax, rates, RySS	Green growth, Social-economic development, Land Use synergy	
Community/ Landscape	Emission factors of land uses, Mimetrics, Risk estimates, LER _{MULT}	Instrumental & rela-tional value, Disaster vulnerability, Water	Panchayat, Block Dev, Coops, SHG, Collective action, Commons	Resilient livelihoods, Respect, Eudaimonia, Spirituality	
<div>Sustainable Landscape Management</div>					
Individual/ Farm & field	Footprints, Health, Awareness, Lifestyle choices, Wellbeing	Responsible con-sumption, certified products, coinvest	Human rights, education, resource use, tenure, jobs, health care, tax		

Principles and transition levels

Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review

Alexander Wezel¹  • Barbara Gemmill Herren² • Rachel Bezner Kerr³ • Edmundo Barrios⁴ • André Luiz Rodrigues Gonçalves⁵ • Fergus Sinclair^{6,7}

Accepted: 8 October 2020



FAO Elements – entry points

HLPE Principles – characterisation and analysis