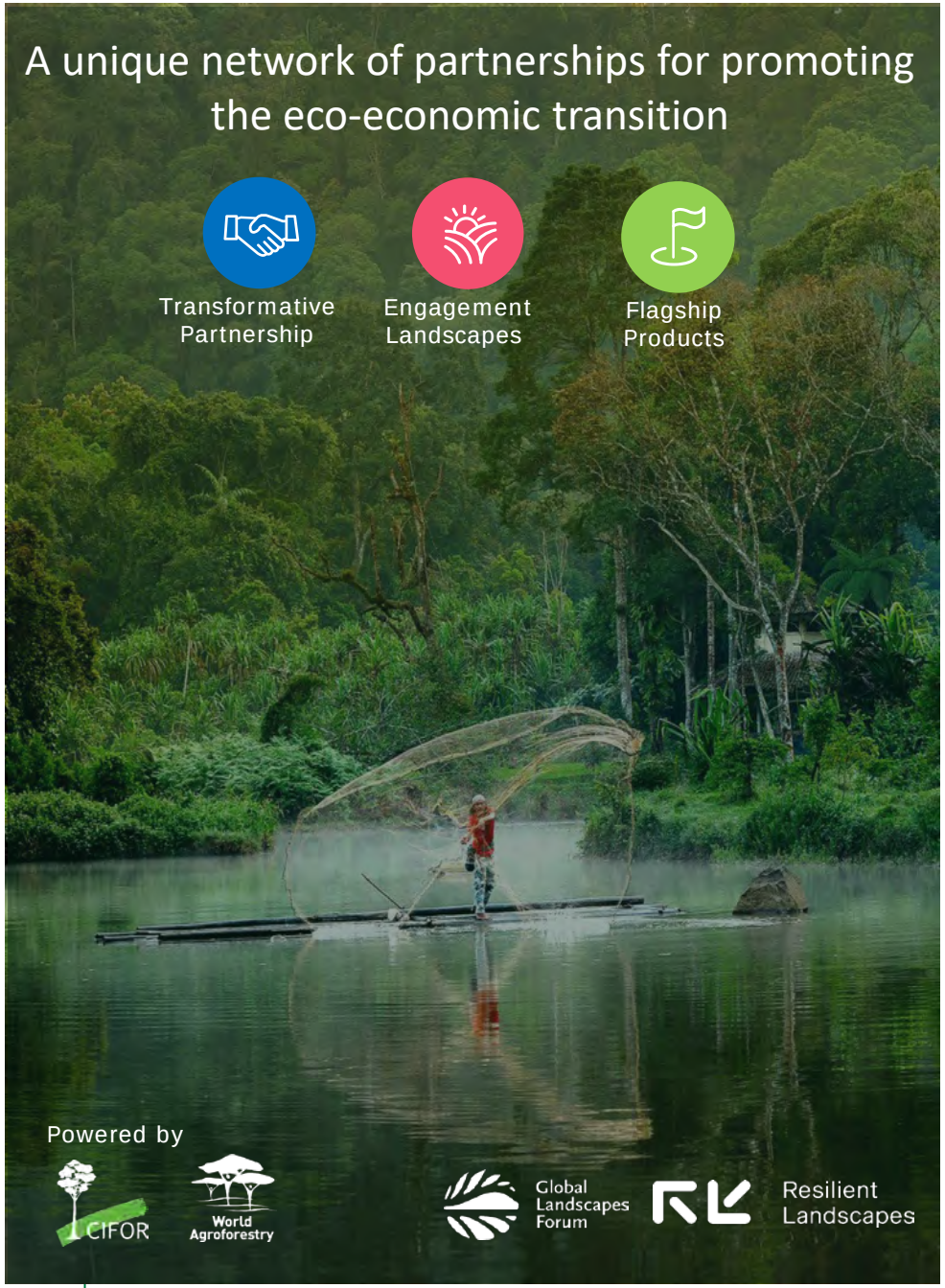
AGROFORESTRY FOR NOURISHING LIVELIHOODS AND LANDSCAPES

Chandrashekhar Biradar, PhD
Country Director-India & Chief of Party-TOFI
CIFOR-ICRAF Asia Continental Program

AARDO-CIFOR-ICRAF International E-Lecture Series
Role of Agroforestry in Poverty Alleviation for All*

CIFOR
World Agroforestry
CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry
Global Landscapes Forum
Resilient Landscapes



CIFOR-ICRAF

Forestry Research - World Agroforestry

A world-class research institution focused on agroforestry, forestry and landscape management that brings more than 65 years of combined experience.

- Research excellence to design **evidence-based, actionable solutions** to address the world's most pressing challenges
- **Holistic approach** to achieve transformation of health of land, people and the planet
- Restoring **biodiversity and sustainable green value chains**
- Driving the **global dialogue** on agri-food system landscapes and forests to improve **lives & livelihoods** while preserving the environment

700
staff in 33 countries

+2,200
projects completed in 92 countries

+190
Active partnerships

25,000
publications and knowledge products

CGIAR Research Program on Forests, Trees and Agroforestry
Global Landscapes Forum
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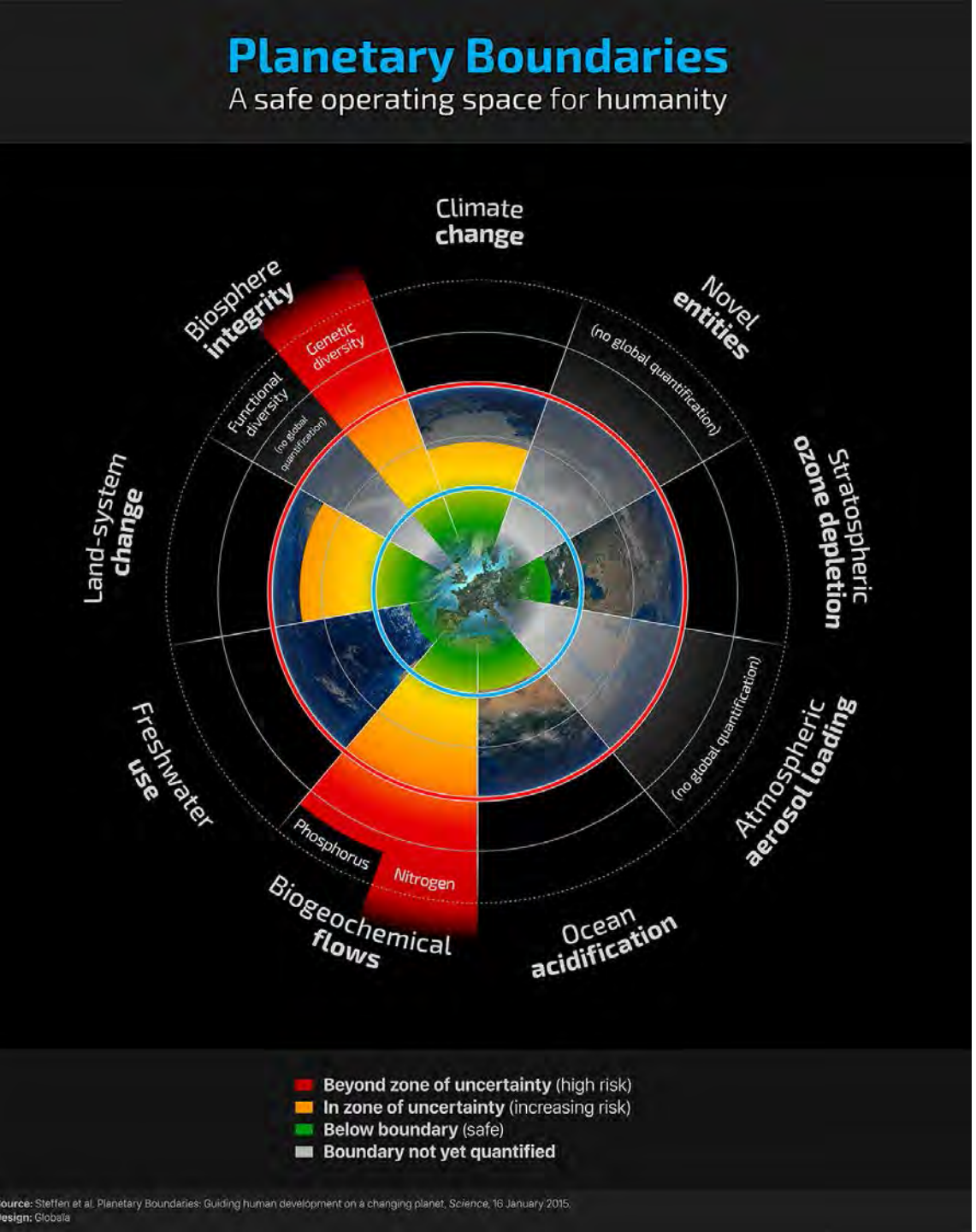
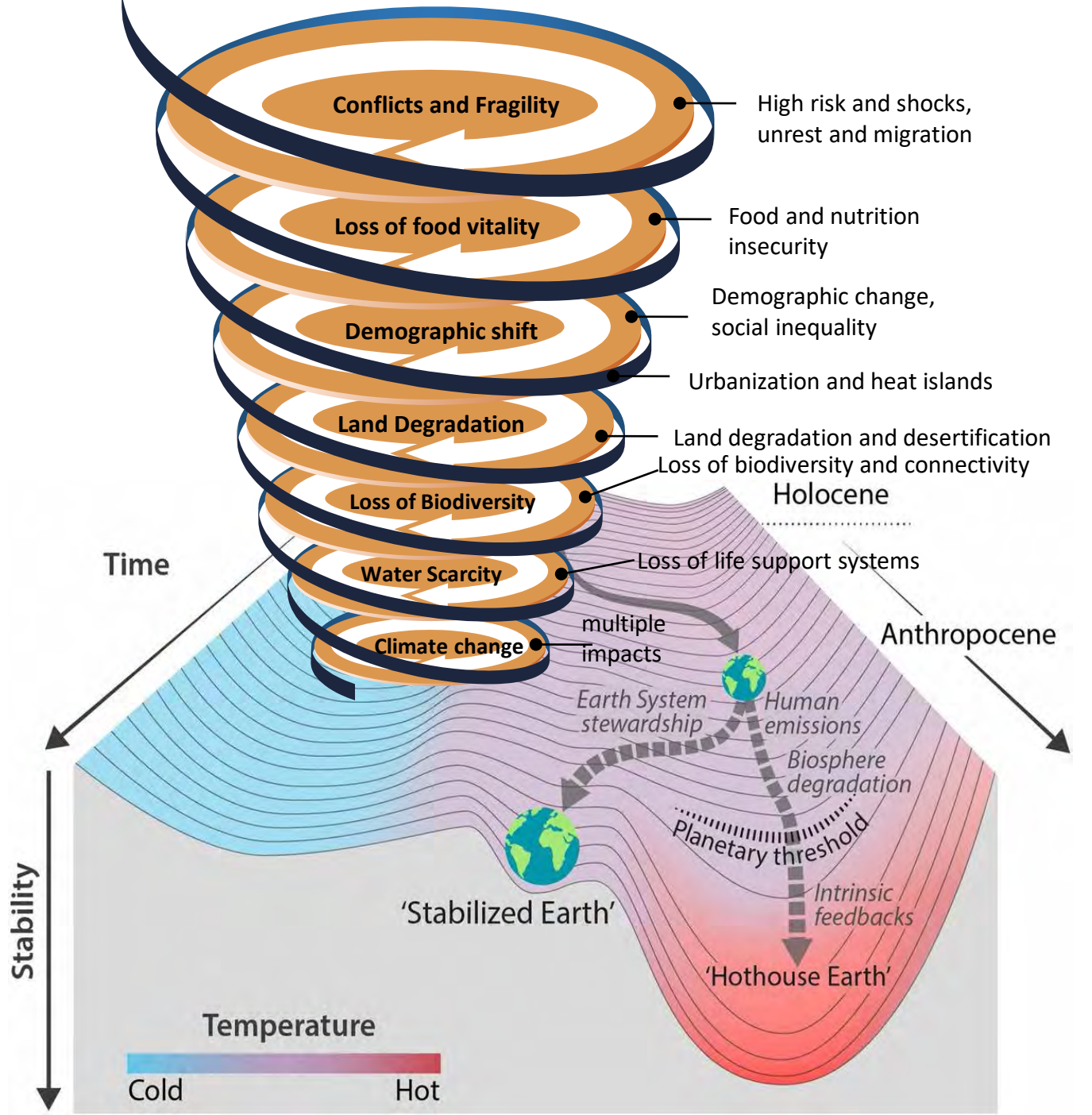




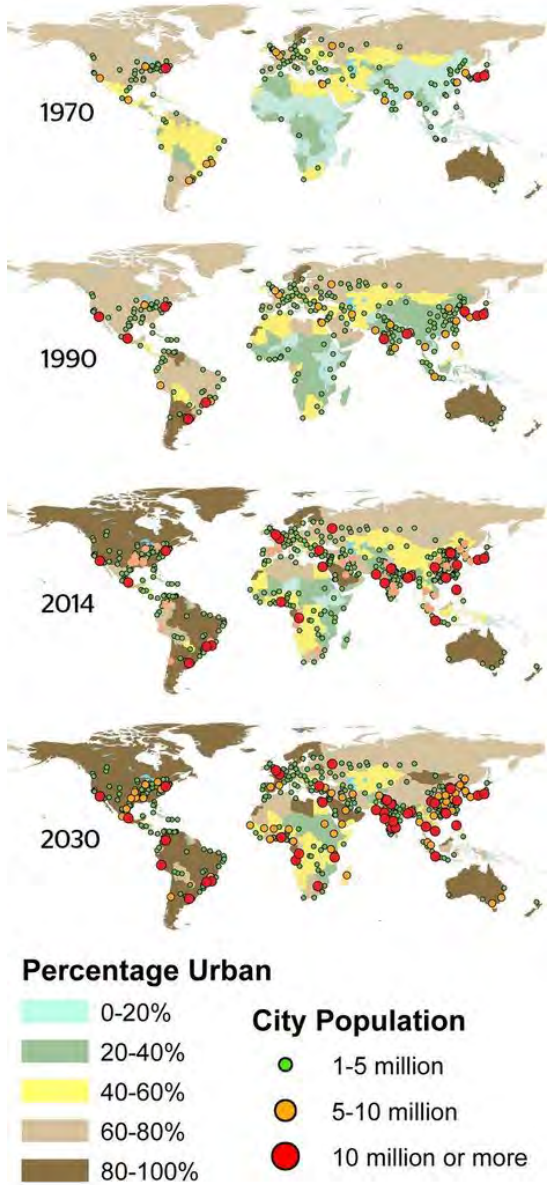
Source: Trajectories of the Earth System in the Anthropocene

Changing diets and demographics

World Population & Urbanization

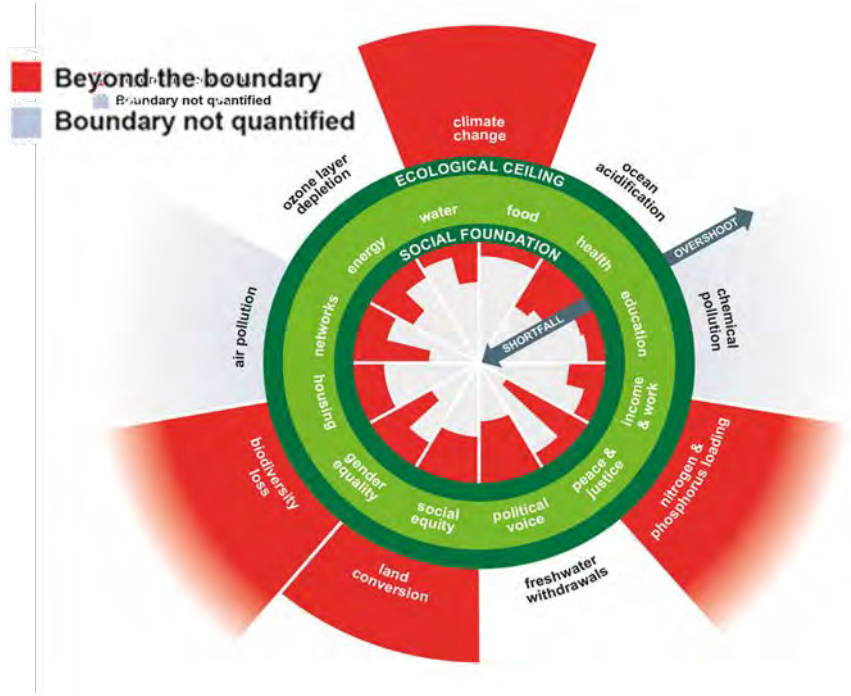
1990	5.3 billion	20%
2015	7.3 billion	50%
2030	8.5 billion	60%
2050	9.7 billion	70%
2100	11.2 billion	80%

Source: United Nations

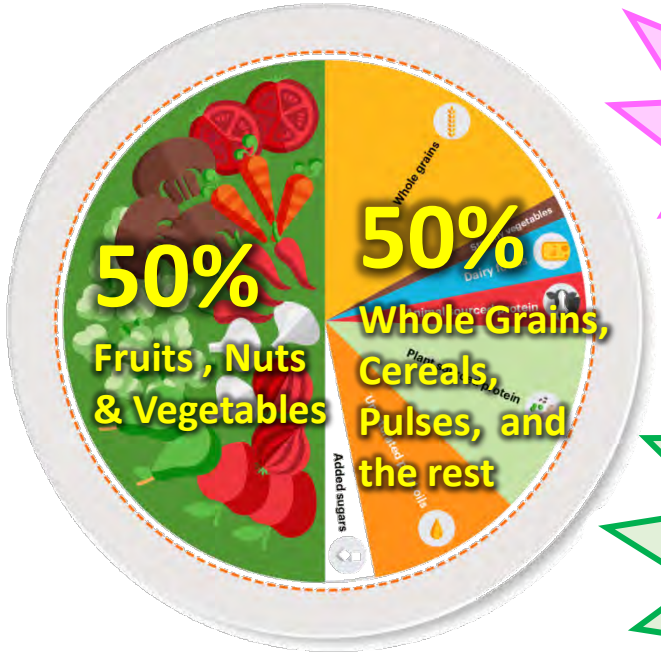


Crossroads of System Transformation

We cannot continue our current trajectory of **production systems in the way we grow, consume and dispose off** at the **unsustainable cost** to natural resources, the environment, human and planetary health.



Ecosystem Restoration



EAT Lancet Recommendation

Nature +ve Food System Transformation

Restoring functional productivity for health and climate resilience

[Balanced Agroecosystems for Balanced Diets and Better Health]

Transforming lives and landscapes with trees

What you eat you become and serve

GROW

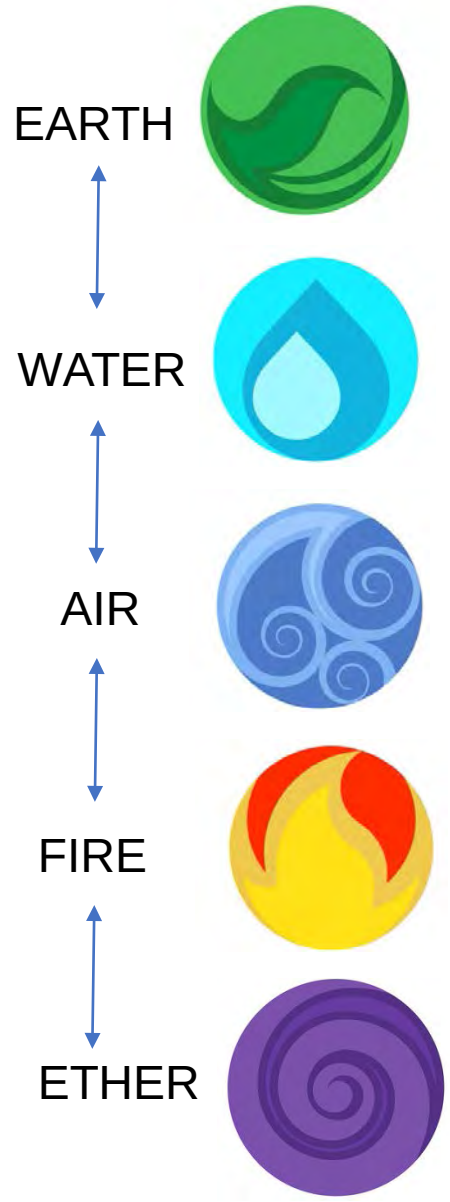
right

Health is a state of complete **wellness** in physically, mentally, socially, and **ecologically**

#Azadi Ka Amrit Mahostava 75years of Independence

Mahatma Gandhi's *Key to Healthy Diet and Diet Reforms:*

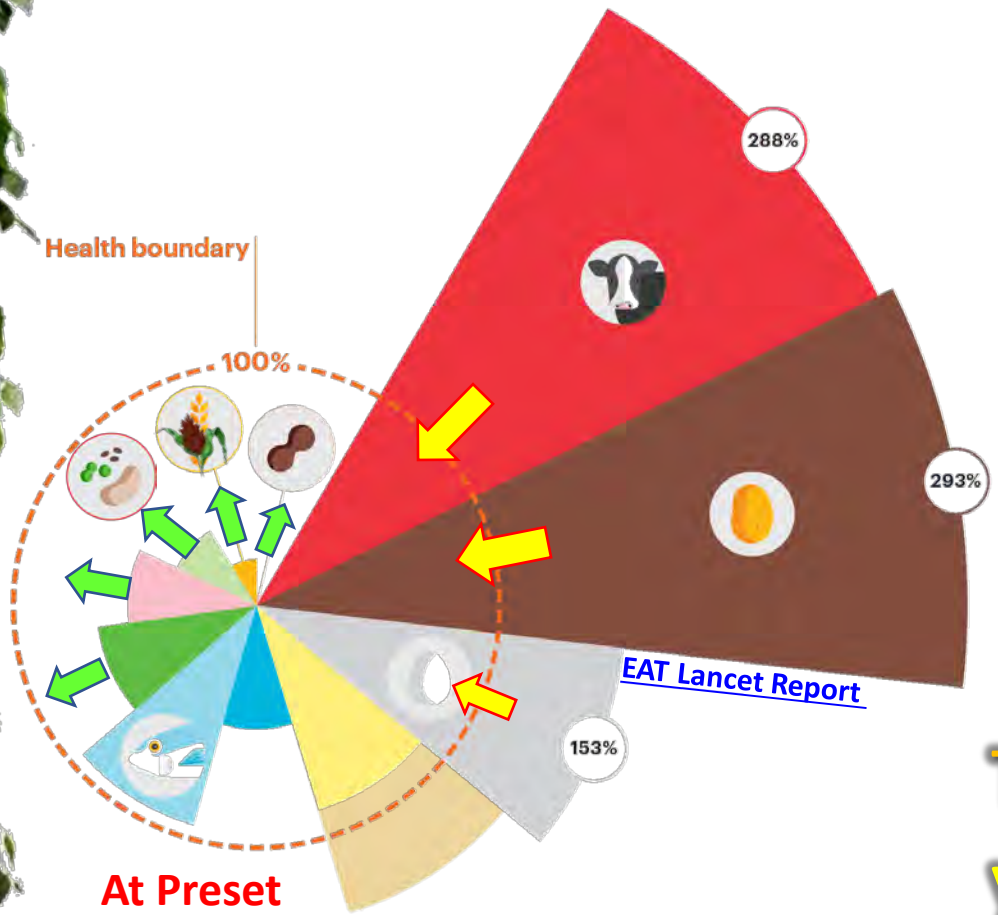
Gandhiji limited his diet largely to **raw fruits, nuts, vegetables,** with curd, coarse grains, millets, unpolished rice, leafy vegetables, pulses, neem seeds, jaggery, guava seeds, tamarind, groundnut cake and often steam or boiled vegetables with a hint of salt



Transforming lives and landscapes with trees

Changing way we grow food, consume >> lifestyle

>> for sustainable living and landscapes



Unsustainable Diets and Greed
Are the source of climate crisis

Impact of various diets and water use

	Pulses	Chicken	Mutton	Beef
Water used >>	1,250 liters	4,325	5,520	13,000

There is a need for a paradigm shift from
yield centric to nutrition focus (health)
while using natural resources consciously

"Every 1 gram of carbon absorbs 8 grams of water"

1 tree absorb 21 kg CS

"Every 4 % tree cover absorb 1 degree of heat"

1 tree absorb 12 degree C

Trees are source of resilient Food, Nitration and Livelihoods

Trees based systems are efficient to restore the food system planetary boundary

Tree based intervention play vital role in every SDGs

SUSTAINABLE DEVELOPMENT GOALS

One Earth < > One Health < > One System

the way we produce, consume & dispose

Functional System is connecting every SGDs & CCAs

"The health of soil, plant, animal and man is one and indivisible" - Albert Howard, Agricultural Testament, 1940,

Vitality from soil to stomach by Anderson J, 2019
Eat Lancet Commission, Walter et al., 2020
Ultra processed planet by Soil Association, 2021

*Health of the people, plants, soils, animals, planet

Transforming lives and landscapes with trees

Why Tree Based >>>

trees are the sources of healthy life and planetary health

RAIN MAKER

Source of cloud nuclei for condensation, regulate hydrology, save soil and continuum

SAVE SOIL

Humus for Soil life, Reduce surface albedo, feedback loops, carbon sequestration

ONE-HEALTH

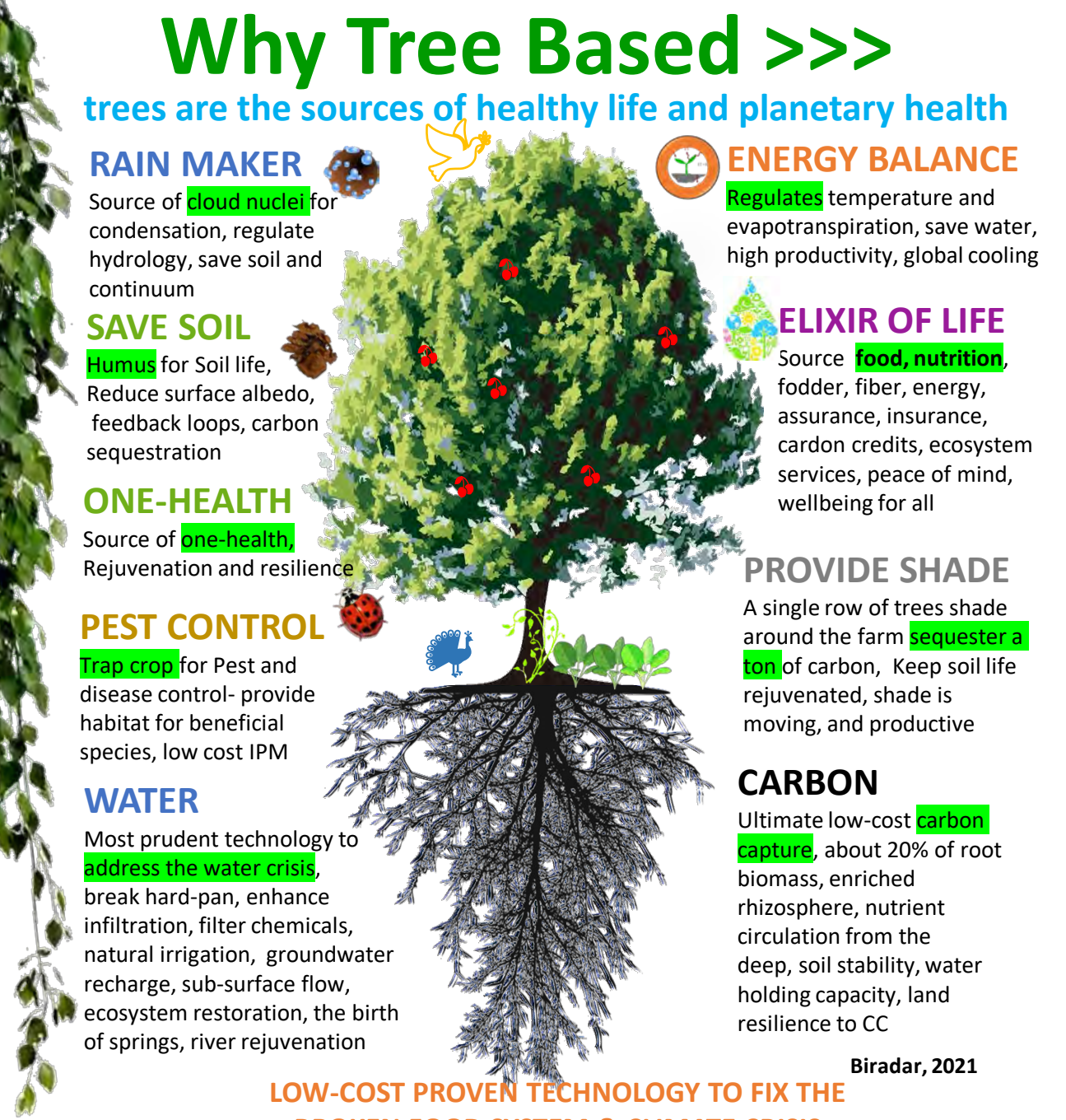
Source of one-health, Rejuvenation and resilience

PEST CONTROL

Trap crop for Pest and disease control- provide habitat for beneficial species, low cost IPM

WATER

Most prudent technology to address the water crisis, break hard-pan, enhance infiltration, filter chemicals, natural irrigation, groundwater recharge, sub-surface flow, ecosystem restoration, the birth of springs, river rejuvenation



ENERGY BALANCE

Regulates temperature and evapotranspiration, save water, high productivity, global cooling

ELIXIR OF LIFE

Source **food, nutrition**, fodder, fiber, energy, assurance, insurance, cardon credits, ecosystem services, peace of mind, wellbeing for all

PROVIDE SHADE

A single row of trees shade around the farm sequester a ton of carbon, Keep soil life rejuvenated, shade is moving, and productive

CARBON

Ultimate low-cost carbon capture, about 20% of root biomass, enriched rhizosphere, nutrient circulation from the deep, soil stability, water holding capacity, land resilience to CC

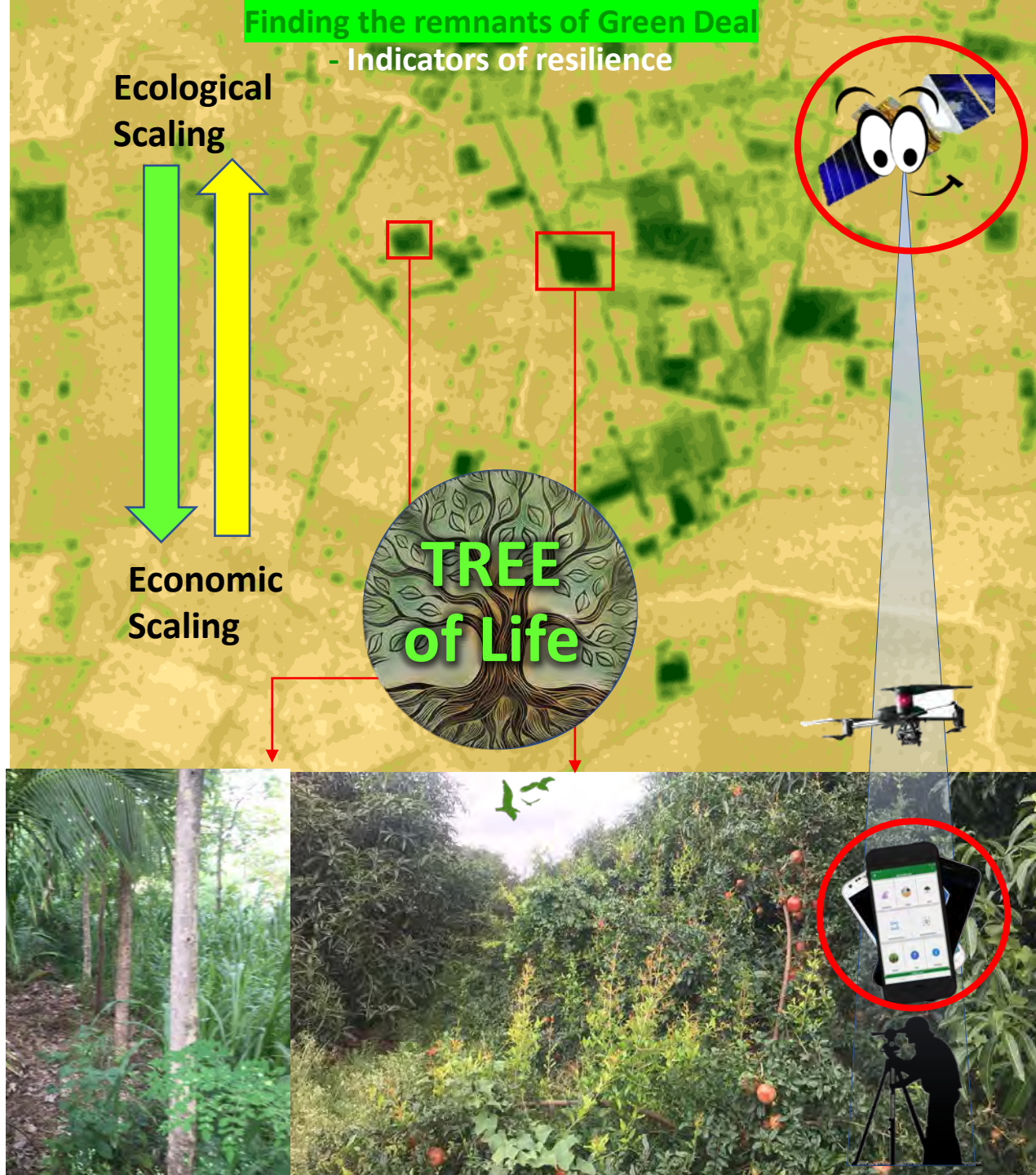
Biradar, 2021

LOW-COST PROVEN TECHNOLOGY TO FIX THE BROKEN FOOD SYSTEM & CLIMATE CRISIS

Transforming lives and landscapes with trees

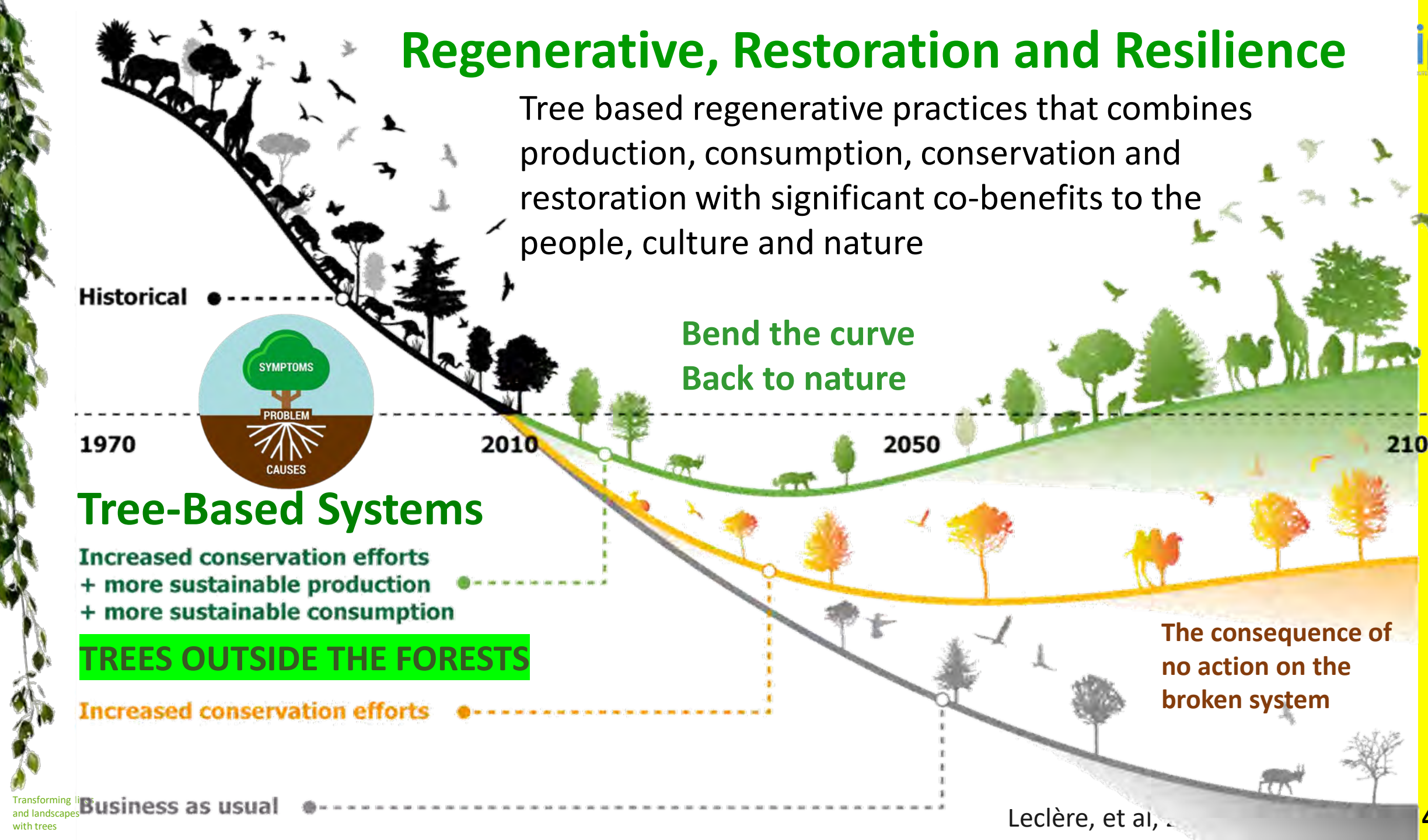
Finding the remnants of Green Deal

- Indicators of resilience



Regenerative, Restoration and Resilience

Tree based regenerative practices that combines production, consumption, conservation and restoration with significant co-benefits to the people, culture and nature



Transforming li
and landscapes
with trees

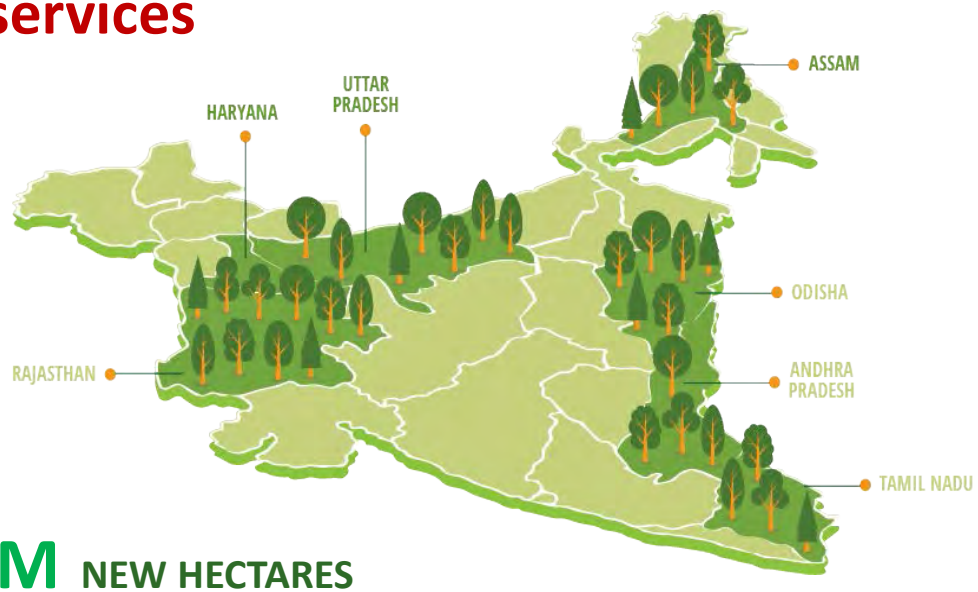
Degenerative to Regenerative Agroecosystems– Kiss the Ground

Transform
and lands
with tree

Trees Outside Forests in India (TOFI) Program

Significantly expand the area under trees outside the forests while enhancing landscapes, livelihoods and ecosystem services

- Enabling environment strengthened for expansion of trees outside forests.
- Expansion of area of trees outside forests economically incentivized and risks reduced.
- Improved access to quality and actionable information about trees outside forests.



2.8M NEW HECTARES of land under Trees Outside Forests

420M TONS of carbon dioxide (CO_2) equivalent sequestered

13.1M PEOPLE to benefit from improved livelihoods & environmental services

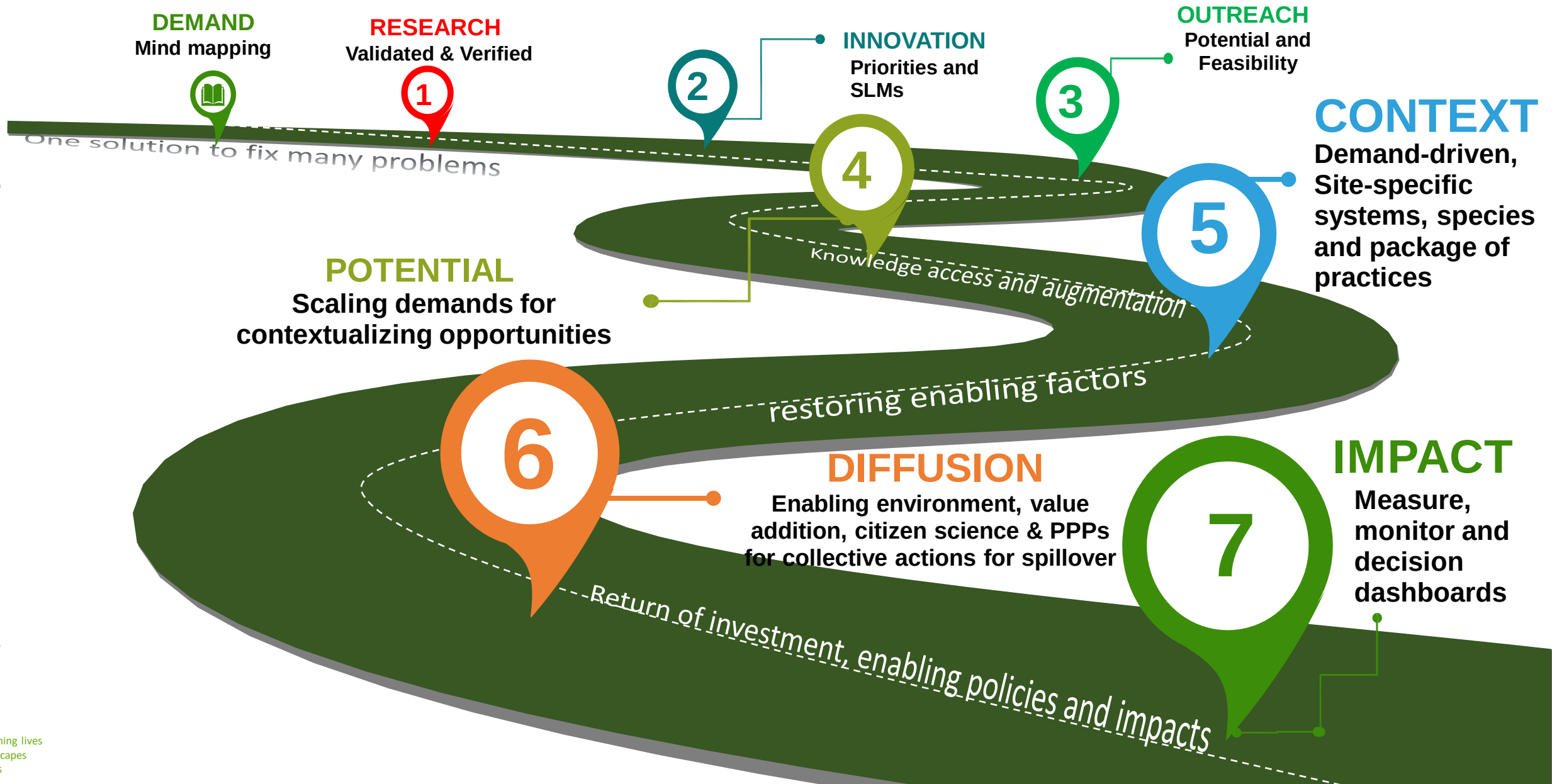
cifor-icraf.org/tofi

Transforming lives and landscapes with trees

Together for global challenges

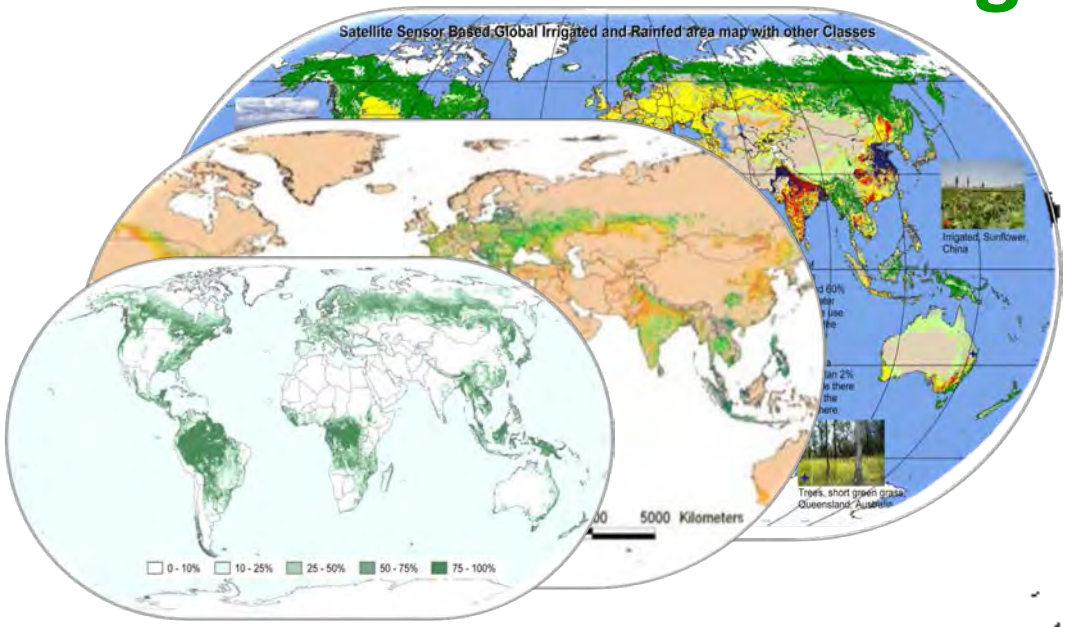
Roadmap for system-level transformation

Location and context-specific opportunities and advisories



Transforming lives and landscapes with trees

Global to Regional Perspective



(Biradar et al, 2009; Zomer et al., 2009; Hansen et al., 2010; Thenkabail et al, 2019; FAO, 2009, 2020)

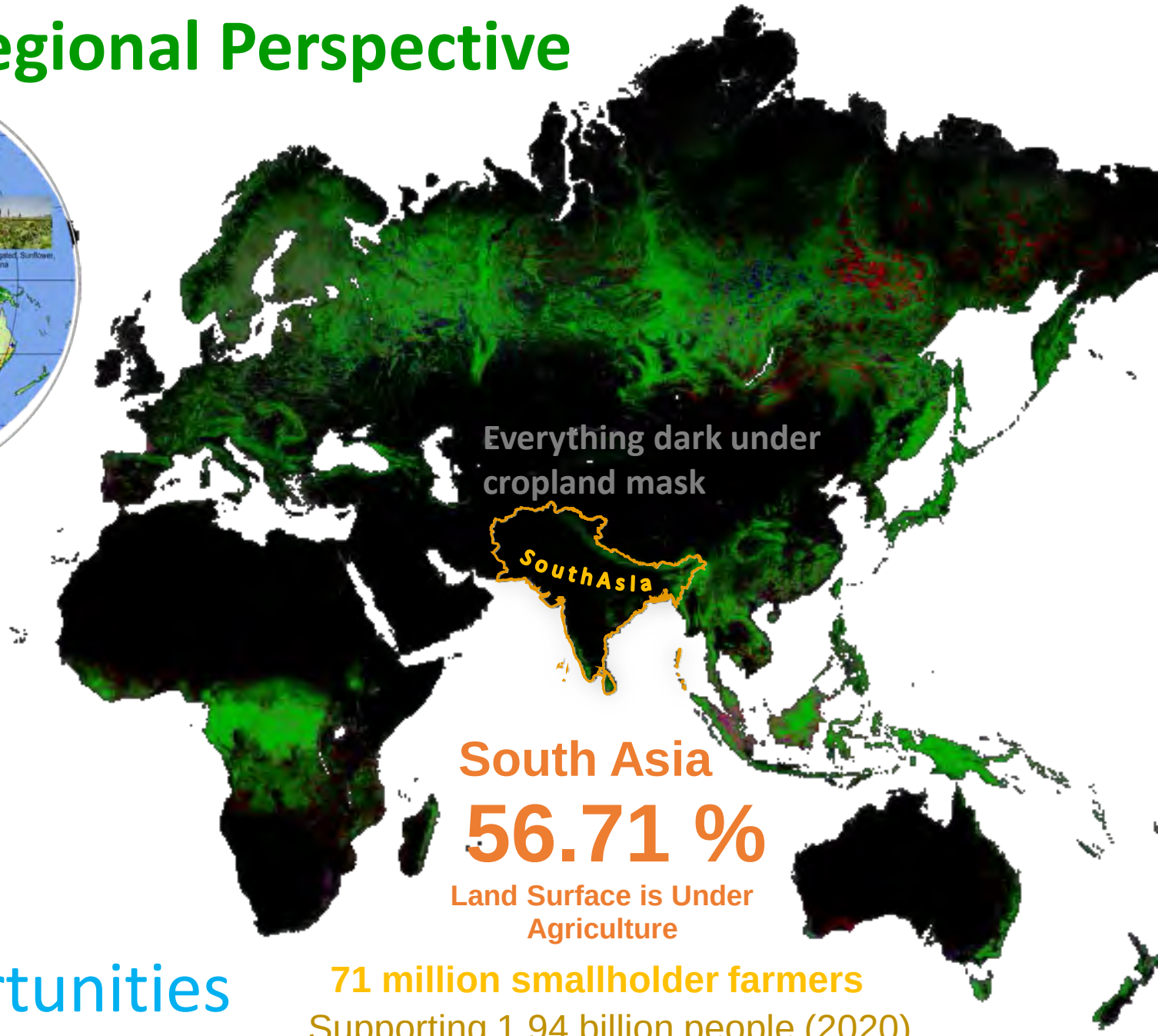
5.1 billion ha agricultural Area

80% is tilled agriculture

1.0 billon ha under agroforestry

~10% tree cover

4.0 billon ha of opportunities



South Asia

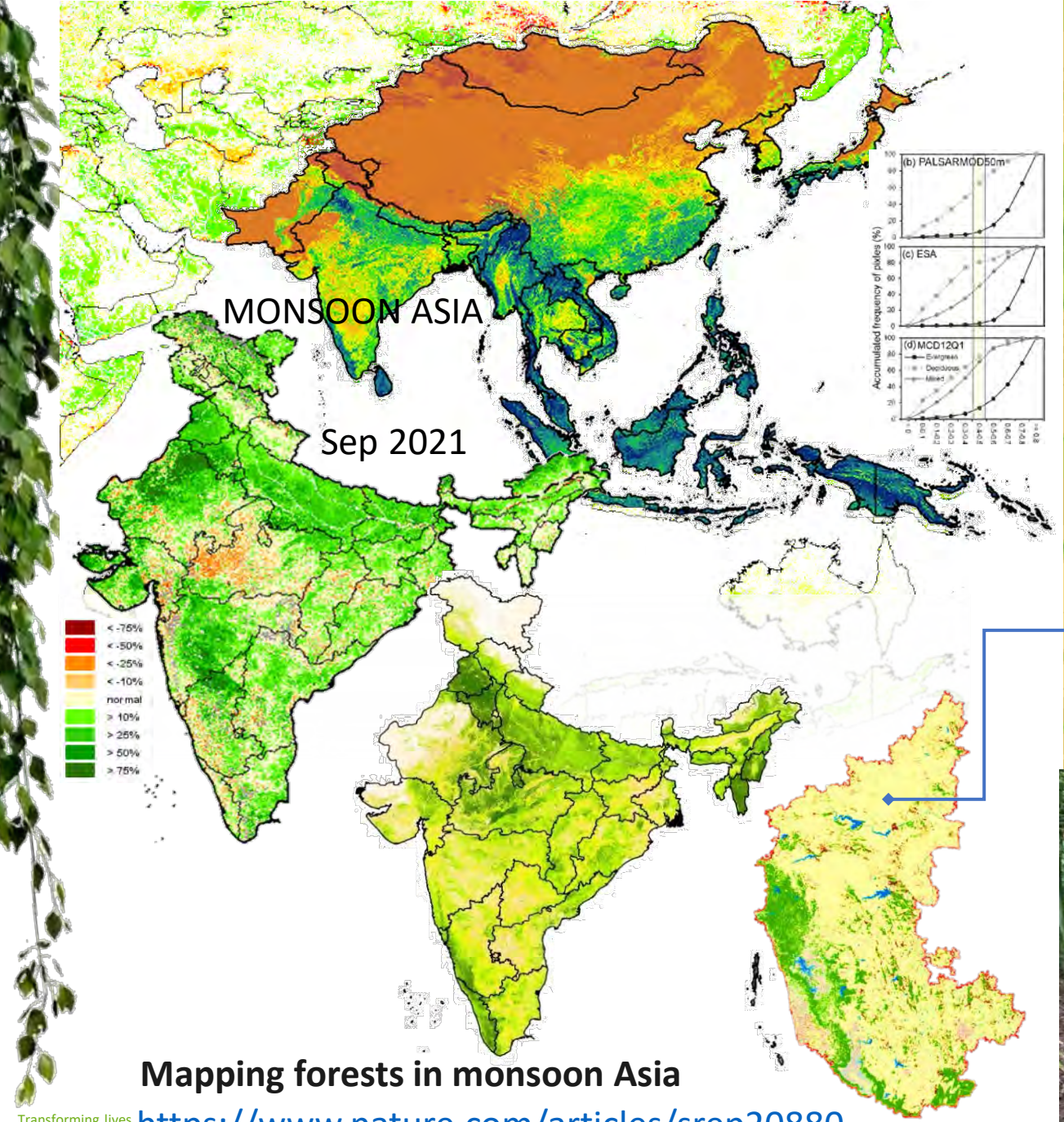
56.71 %

Land Surface is Under Agriculture

71 million smallholder farmers

Supporting 1.94 billion people (2020)

Transforming lives and landscapes with trees



Mapping forests in monsoon Asia

https://www.nature.com/articles/srep20880

Transforming lives and landscapes with trees

Finding the remnants
- Indicators of resilience

Ecological Scaling

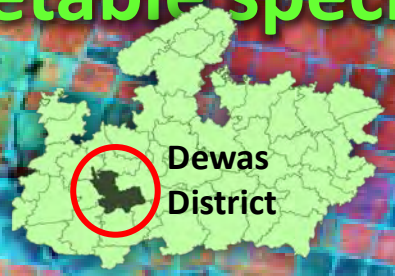
Economic Scaling

Potential of Agroforestry & Tree Fruits and Vegetables

Fingerprinting of the production systems to make informed decisions

Mapping length of the farm boundaries for bund planting of fruits and vegetable species

Dewas District, Madya Pradesh



- Geographical Area = 702,000 ha
- Cultivable Area = 624,500 ha
- Length of Farm Boundaries = 295,679 km
- Trees on bunds with 4m canopy cover= 18.93% TOF

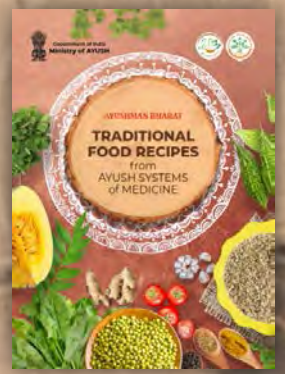
Potential of TOF planting across the India

- Road and rail networks= 5.89 million km
- Length of major rivers and canals= 2,28,681 km
- Degraded lands = 130 million hectares

Transform
and lands
with trees

Food, Fodder, Fuel, Fiber, Manure, Medicines, Resilience, ‘Peace of Mind’

- Harvest BIS of over 3000 economically value species
- Traditional crops and recipes
- Indigenous Knowledge



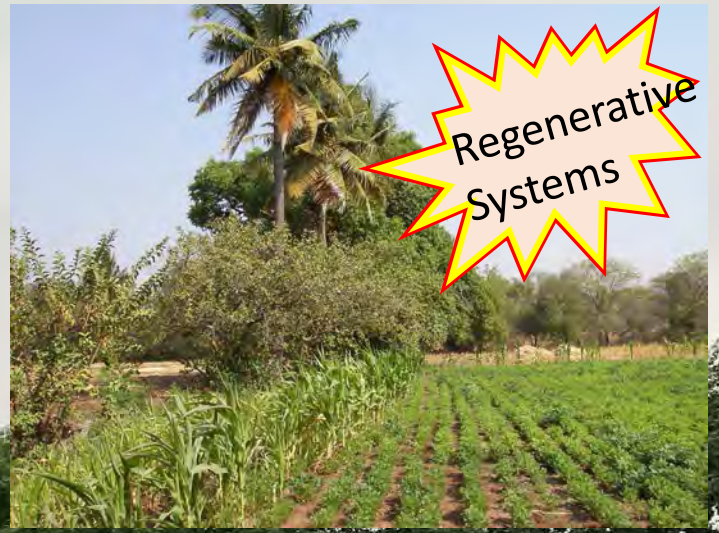
Return of recipes

Growing Wellness Industry

Transforming and landscape with trees

Trees Based food system transformation

Transform
and landsc
with trees



Mainstreaming Tree Based Regenerative Practice: source of prosperity and resilience

Bridging the gaps with evidence-based scaling

“Urban <-> Periphery <-> Rural”

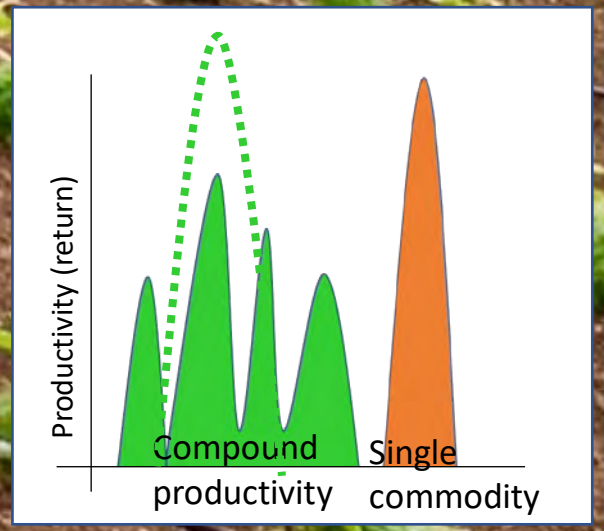
Multi-functional agroforestry systems

Reducing loss of nutrition, food miles, water, carbon footprints and human induced climate change impacts

Mainstreaming Agroforestry: source of food, nutrition, income

Planting multiple crops for monthly income while main crop continue to grow with trees as insurance

Example1: Growing monthly harvestable crops like salad greens (arugula), red radish, leafy amaranth, coriander, dill, spinach in main Cotton crop: high resource use efficiency, less chemical use and high return per unit area with monthly income throughout the season



Accounting of evidence-based scaling

2/06/2020

2/07/2020

17/07/2020

1/08/2020

20/08/2020

31/08/2020

23/09/2020

23/09/2020

15/11/2020

18/12/2020

Accounting of evidence-based scaling

Multilayer Multicropping Model Revenue Calculation

Crop Area (In Acre)	1					
Crop Name	**Seed/Plant**	**Unit**	**Production Per Unit Quantity**	**Total Estimated Production (kg)**	****Per Unit Rate (INR)**	**Gross Income (INR)**
Creeper Veg(Bittergourd)	1600	Nos.	4	6400	8	51200
Papaya	400	Nos.	75	30000	10	300000
Turmeric	200	kg	7	1400	40	56000
Tomato	2300	Nos.	3	6900	8	55200

Seed Expanse		
Seed Rate (INR/Unit)	Crop Repeatation in 2 years	Seed Expanse (INR)
2	4	12800
15	1	6000
35	2	14000
2	1	4600

**** All the rates are whole sale rate. (**

Note	1.Time duration of ths model is 2 years as papaya lasts for 2 years 2. In this 2 years 4 crops of creeper vegetable can be taken 3. 2 times turmeric can be taken 4. One crop of tomato can be taken

Total Revenue generation in 2 years

Crop	Crop Repeatation in 2 years	Revenue Generated in one season (INR)	Total Revenue Generation in 2 years (INR)
Creeper Veg	4	51200	204800
Papaya	1	300000	300000
Turmeric	2	56000	112000
Tomato	1	55200	55200
			616800

Net Income Calculation

Cost of Construction	**50000**	**INR**
Labour Expanse	**120000**	**INR**
Other Expanses	**30000**	**INR**
Net Income in 2 years	**416800**	**INR**
Net Income Per Year	**208400**	**INR**

***** If you manage to retail , the per acre net revenue per year will be nearly 600000 INR**

Multi-Layer Natural Farming: 2 lakh ($2750) per acer

Youths & New Consumerism in Food Systems Transformation

Win-Win Situation for Farmers, Consumers and Nature

Transforming lives and landscapes with trees

Why Invest in AFS for Restoring Agroecosystems

Investments in restoring regenerative production systems are **growing with recognition** of nourishment, carbon-neutral, net-zero, wellbeing, climate-resilience, ecologically sustainable, and economically profitable.

Agroforestry can return **8-13 times** more profit than conventional agriculture with **peace of mind** and **contentment** of actions

Establish Restoration Alliance: **Incentive driven** Xprize for carbon removal and reverse climate change.

-ve 1-1x conventional

+10x

Every $1 invested in CGIAR yields up to $10 in benefits

+30x

Every $1 invested in landscape restoration yields up to $30 in benefits

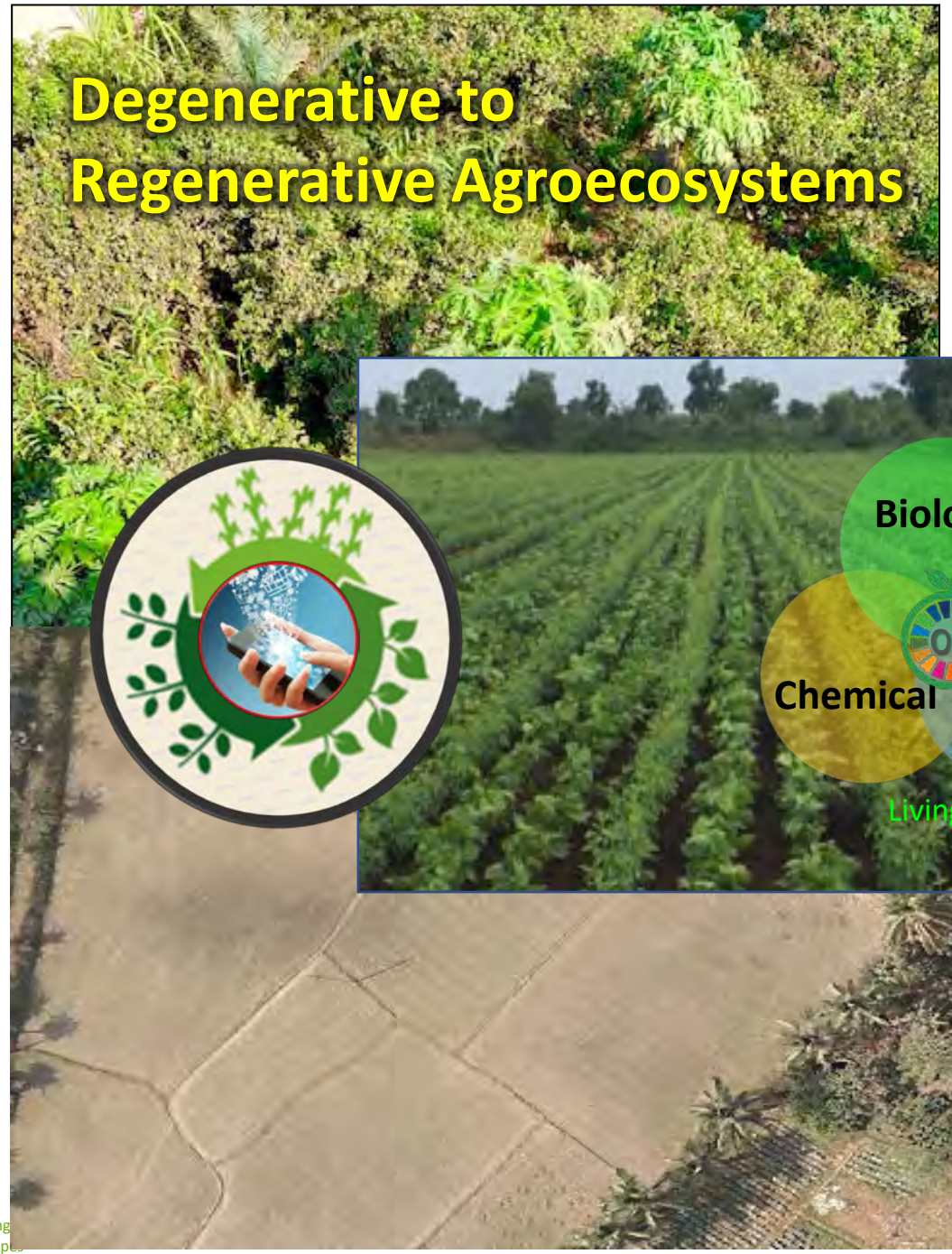
+50x*

Every $1 invested in agroecology yields up to $50 in benefits

Investors say agroforestry isn't just productive and climate friendly — it's also profitable (Hanes, 2020)

Transforming lives and landscapes with trees

Degenerative to Regenerative Agroecosystems



Nutritious Food to Feed the family

Premium quality produce to sell

Transforming and landscapes with trees

Empty Calories to Nutri Thali

Yield
+
Calories

Poverty
Zero Hunger

Cp Yield
+
Calories
+
Nutrition

Wellness
Carbon Neutral

Transforming lives
and landscapes
with trees

System Approach for Transition to Green Deal

Total Factor Productivity
Nutrition, Net Return and Carbon Neutral
Ecosystem Restoration & Green Economic Transition

Basics of regenerative practices

- **Diversity of crops, trees and animals is the source regenerative system and the basis of restoring natural resources**
- Growing in harmony with nature
- **Synch ecology with economy**
- Benefits for all: producers, consumers, culture and nature.

<<<more **health** per acre>>>

Read: HEALTH PER ACRE: Wealth Per Acre by V Shiva and V Singh, 2014;
° **Health of Plants, Soil, Animals, People & Planet**

Transforming lives and landscapes with trees

Planet filled with Rich Agrobiodiversity, but lacks creativity in cultivation and use

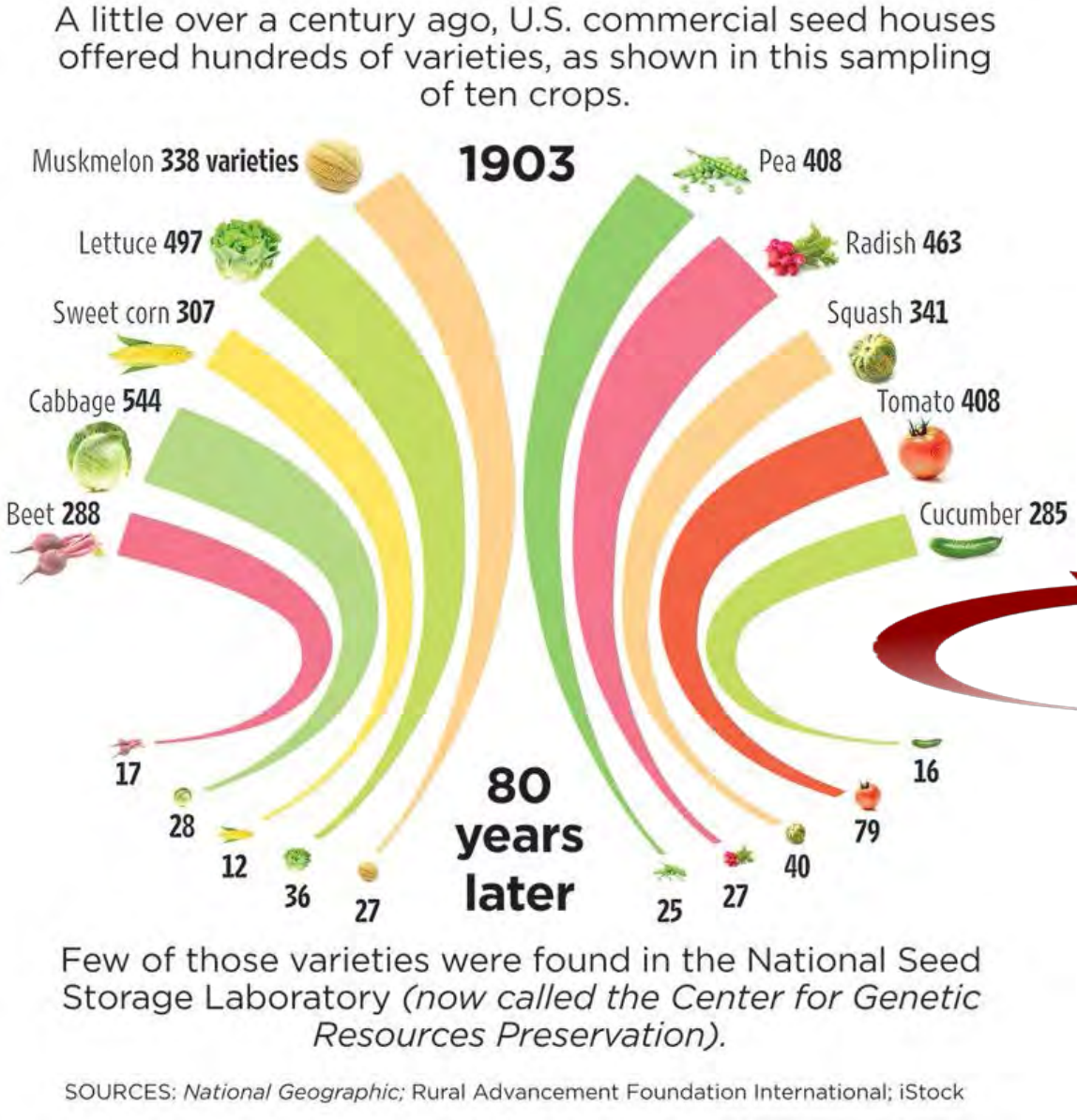
Out of 400,000 plants species at least half (200,000) are edible / useful for human consumption.

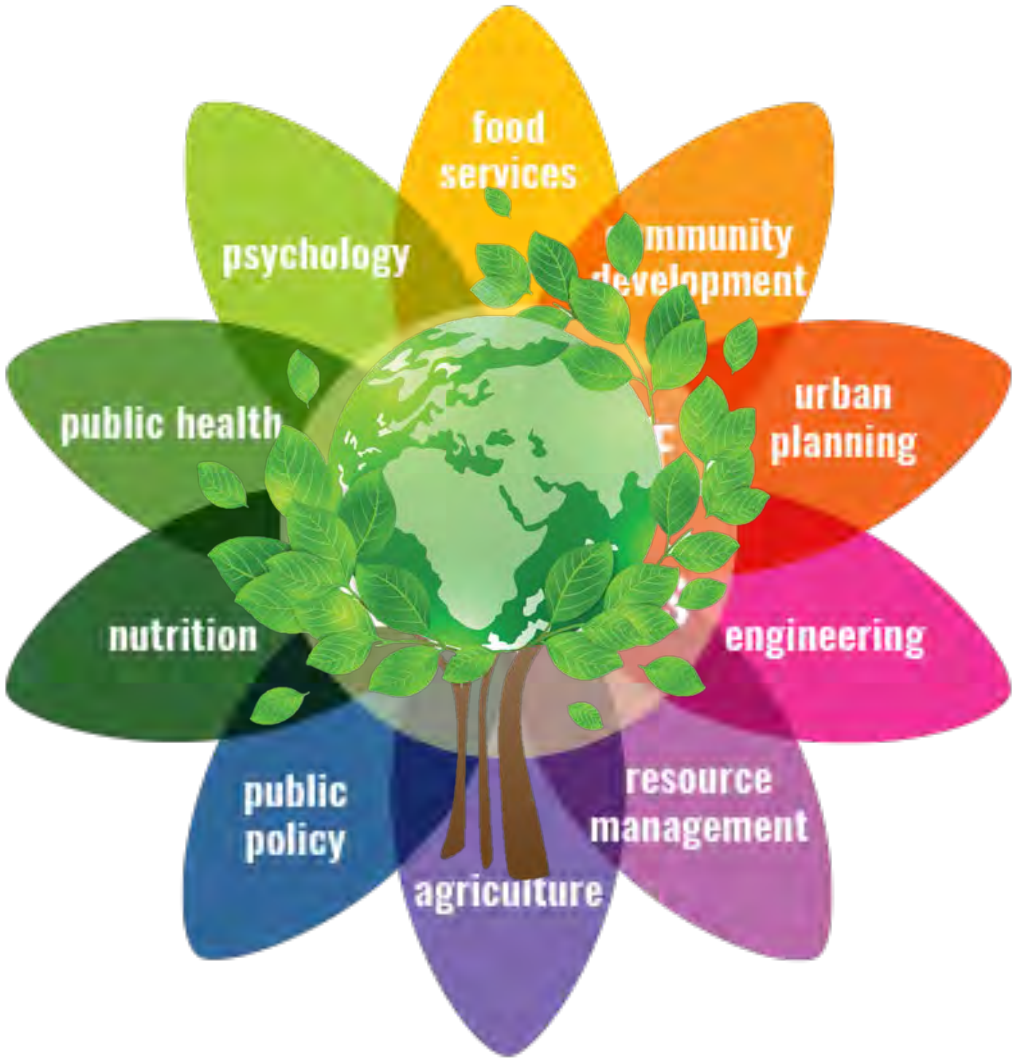
6000 are used as food.

150 Crops are cultivated on a significant scale.

Only 4 crops dominate food systems - **Wheat, Rice, Maize, Soybean** which supply **70%** of the calories

Dwindling Diet Diversity and Sustainable Future





graham.umich.edu/news/sustainable-diet-menu

Transforming lives and landscapes with trees

Untapped potential for new system and consumerism

Indigenous Knowledge and Inclusive Development

Convectional food systems

Inputs guzzling depleted foods

vs

Rare & Resilient Nutritious Indigenous Fruits, Vegetables, Spices and Condiments

Tree based Agroecosystems

Resource guzzling foods to resource-use efficient production systems

Less chemicals, less water, less energy, less labor, less carbon footprint

Increasing demand for traditional fruits and vegetables- tremendous market potential

Underutilized Diet Diversity for Better Health

Super Smart Food

Just an example of one
cereal and one legume

Sorghum & Horse Gram

Return of the springs

Transfor
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Evidence based scaling

Transform
and landsc
with trees

Tree based systems for one-health and planetary health

Nurture Our Soil, Water, Food

Nature Care, People Care, Faire share

Transforming
and landscap
with trees


Agroecological approach
Conventional approach

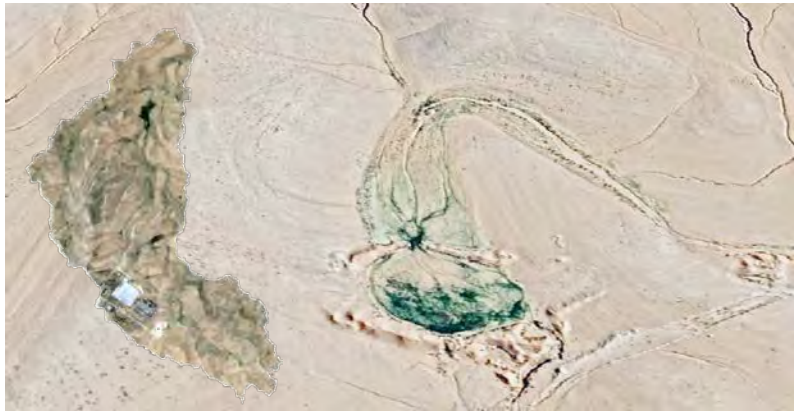

Green Gold Food Forest
Urban Agroforestry in 40*60 feet site

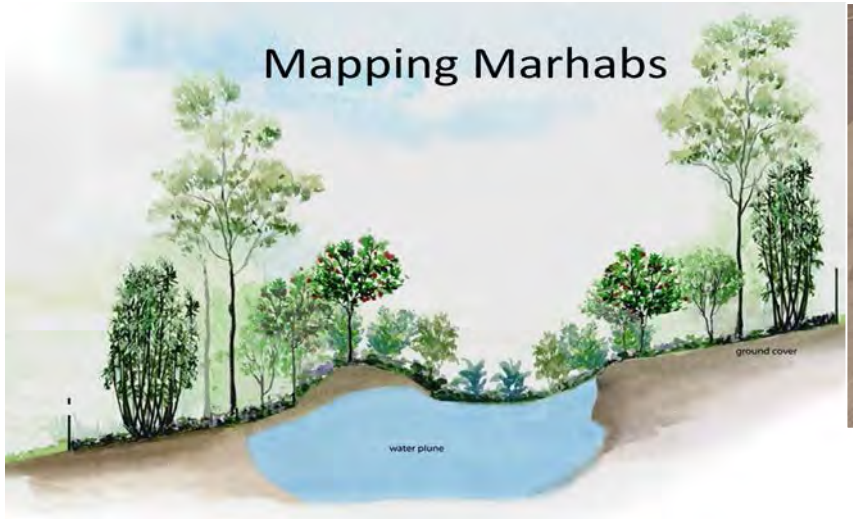
Urban Food Forest and Edible Landscapes

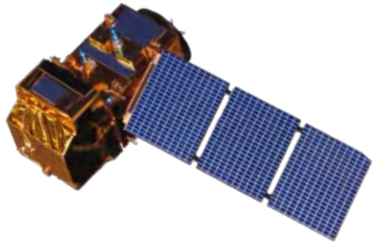
Transforming li
and landscapes
with trees

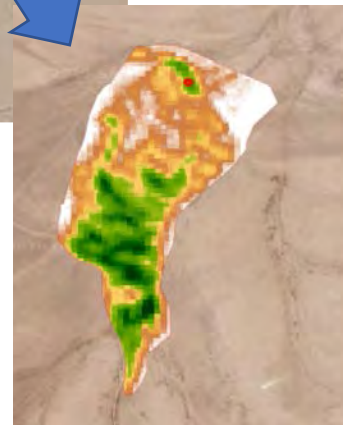
Solar-Food-Carbon Farming

Space technology to target RWH interventions and impacts









Spatial framework for mapping marhabs

Quantification of multiple Gaps @ multiple scales

e.g. Targeting SLMs for closing yield and nutrition gaps

Google Earth Engine

Scripts Docs Assets

- CLIMATE trends
- COVID-19 Rapid response
- Crop type mapping
- Harmonic Regression MENA
- India Aridity Index
- India Hormonics
- Kuwait site
- Landsat8 NDVI
- Landsat8 classification
- MENA EVI
- MENA EVI Forecast

VegChange MENA — Get Link | Save | Run | Reset

```
17  */
18
19  // Load the vector/shapefile data, "geometry" is the column name of KML data
20  var fusionID = "ft:148w0BHmEj2P2225vacSaxPmF8bCV5SByWSPBhuox";
21  var MENA = ee.FeatureCollection(fusionID,
22
23  // Add ROI shapefile as a
24  Map.addLayer(MENA, {},
25
26  Map.centerObject(
27
28  var GRAYMAP =
```

Inspector Console Tasks

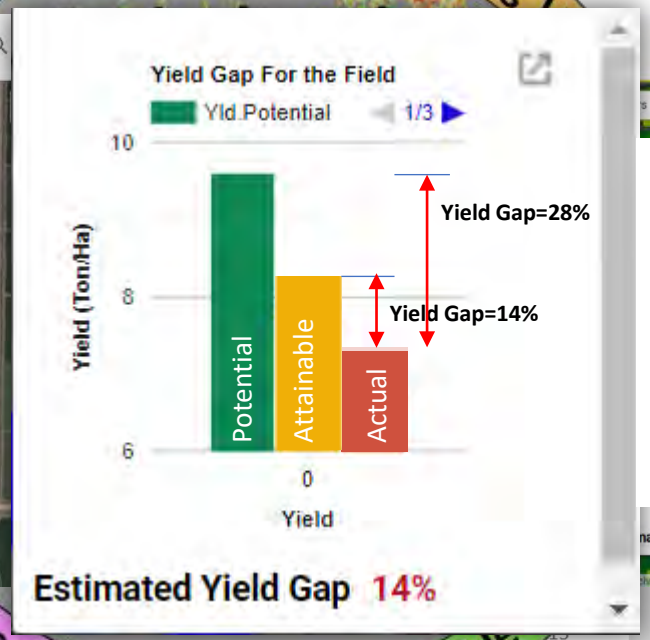
Use print(...)

Earth Engine Apps Experimental

Execution Steps:

1. Zoom-in to a Farm.
2. Select a drawing mode.
   - Rectangle
   - Polygon
3. Draw the Boundary of Farm.
4. Wait for chart to render.
4. Repeat 1-3 or edit/move geometry for a new chart.

Note: Remember not drawing out side Kafr El Sheikh or Non-Wheat growing fields.



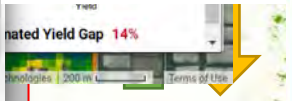
Reducing

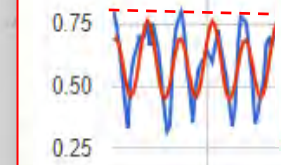
innovation

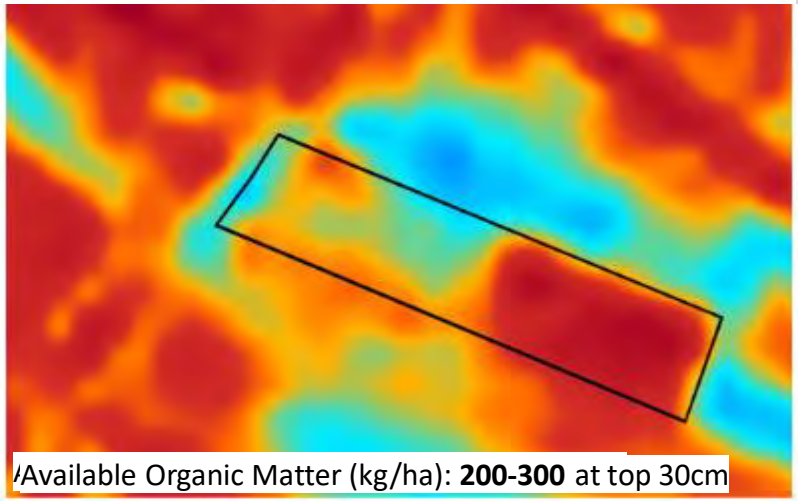
Impacts

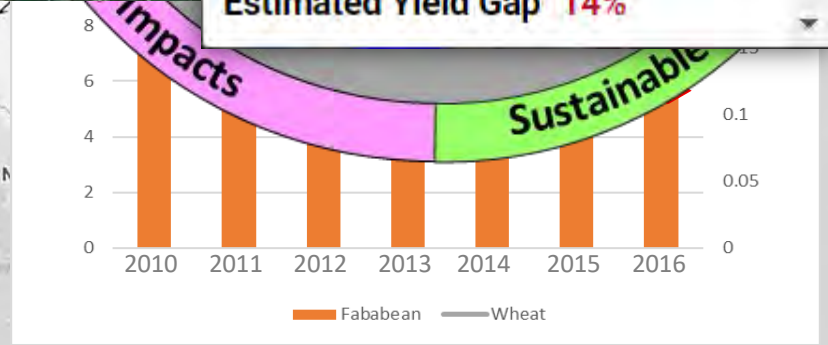
Sustainable

C-Seq gaps
WUE gaps
Yield gaps
Income gap?
Health gap?
Ecology gap?







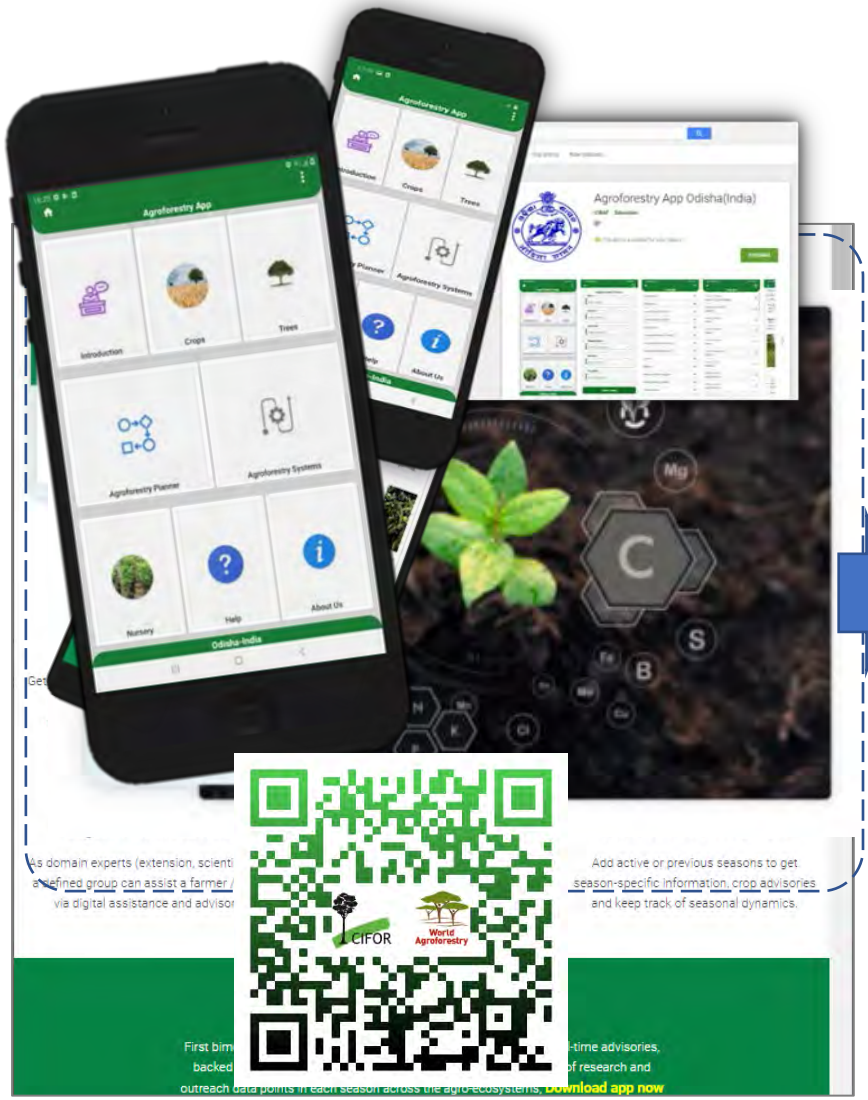


Veg. Changes
+0.2
+0.1
0.0
-0.1
-0.2

Mali
Senegal
The Gambia
Guinea-Bissau
Guinea
Burkina Faso
Benin
Sierra Leone
Côte d'Ivoire
Togo
Ghana
Liberia
DRC
Rwanda
Burundi
Singapore

Alliance for System Level Augmentation

Leveraging digital technologies and ICTs



Niche Mapping

Inseason Practices

Post Harvesting

Right Tree for Right Place for Right Reason

Pre-planning advisories

Site-specifics, Multi-criterial analysis, choice of crops/trees- Demand driven inputs markets- Quality Planting Materials

Citizen Science
Empowered Extension

In-season advisories

Optimal inputs, choice of species, Package of Practices, Yield Compounding, Risk Reduction, Peer-network

Block Chains
PPPs, FPOs, SVCs

Post harvest advisories

Policies, GI Tagging, Demand-Driven Harvests, Aggregation, Value Chains, MSMEs, C-Credits, ES-Payment, Health Scoring

Real-time DASHBOARD for result based management, M&E, Scaling, C-credits, trade, IPGs,

Responsible consumerism, new dietary guidelines,

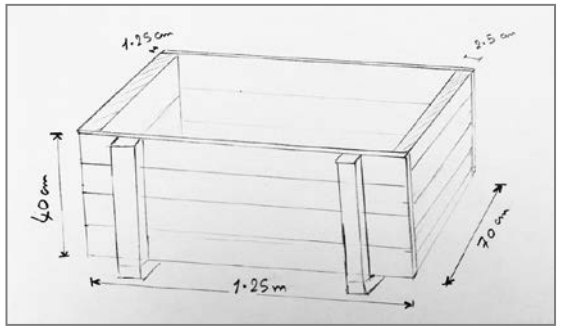
New horizon Research and OUTREACH for investment and expansion

Ecologically sustainable and economically viable options

Restore, Regenerate, Resilience and Rural Welfare

Transforming lives and landscapes with trees

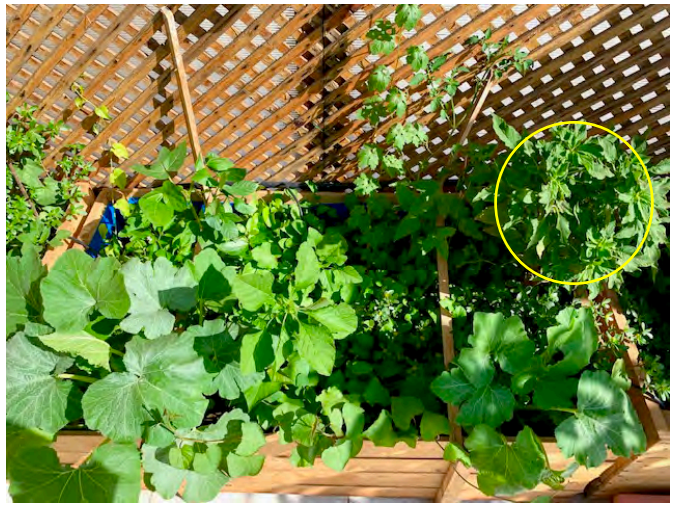
Multi-layer Smart Food Garden in a 8 Square Feet Box



Started on May 20 (first seed sowing)

June 5

June 10



June 20 (ready for harvest)

June 20 (harvest twice already)

More than 15 types of vegetables in 8 squire feet: (1) Amaranth (2 types), (2) Arugula, (3) Purslane, (4) Spinach, (5) Basil, (6) Chilies, (7) Tomatoes, (8) Sweet potatoes, (9) Cluster beans, (10) Long Beans, (11) Zucchini, (12) Okra, (13) Bitter gourd, (14) Giloi, (15) Marigold, (16) Tulsi,(17) Drumstick

Multilayer Nutri Garden: Joy of growing, eating, sharing and caring

Rainbow carrots

Tra
and
with trees

Vision 30:30:30
50:50:50 long way to go

Paradigm shift in farming systems, diet diversity and lifestyle

By **2030** at least **30%** of population eating at least **30%** of fruits and vegetables as their daily diets derived from tree-based agroecosystems

By **2050** at least **30%** of population eating at least **30%** of fruits and vegetables as their daily dietary needs derived from tree-based agroecosystems

Biradar, C, 2020

Diverse choices of food with great flavor, taste and nutrition


CIFOR
World Agroforestry
CGIAR
RESEARCH PROGRAM ON
Forests, Trees and Agroforestry
Global Landscapes Forum
Resilient Landscapes


CIFOR
World Agroforestry
CGIAR
RESEARCH PROGRAM ON
Forests, Trees and Agroforestry
Global Landscapes Forum
Resilient Landscapes

Collective actions for One Earth and One Family

- Healthy and ecologically sound food production **becoming a norm in the future of farming**
- Integrating **trees into mainstream ag**riculture with **indigenous knowledge** for increased dietary and diversity through **context-specific agroforestry**
- Leverage innovation of **digitally-enabled citizen science** for demand-driven needs and better access
- **Technologies are matured** enough to implement but lack collective actions for scaling at large
- System level **transformation must combine <u>resilience, conservation and restoration</u>** with co-benefits to producers, consumers and nature
- Restore the **sustainable livelihoods and landscapes**

Production follows functions

Let’s leverage technology, diversity and local intelligence, indigenous wisdom to rebuild broken food systems for healthy living and planetary health

Tree based system for nourishing livelihoods and landscapes

Thank You

c.biradar@cgiar.org