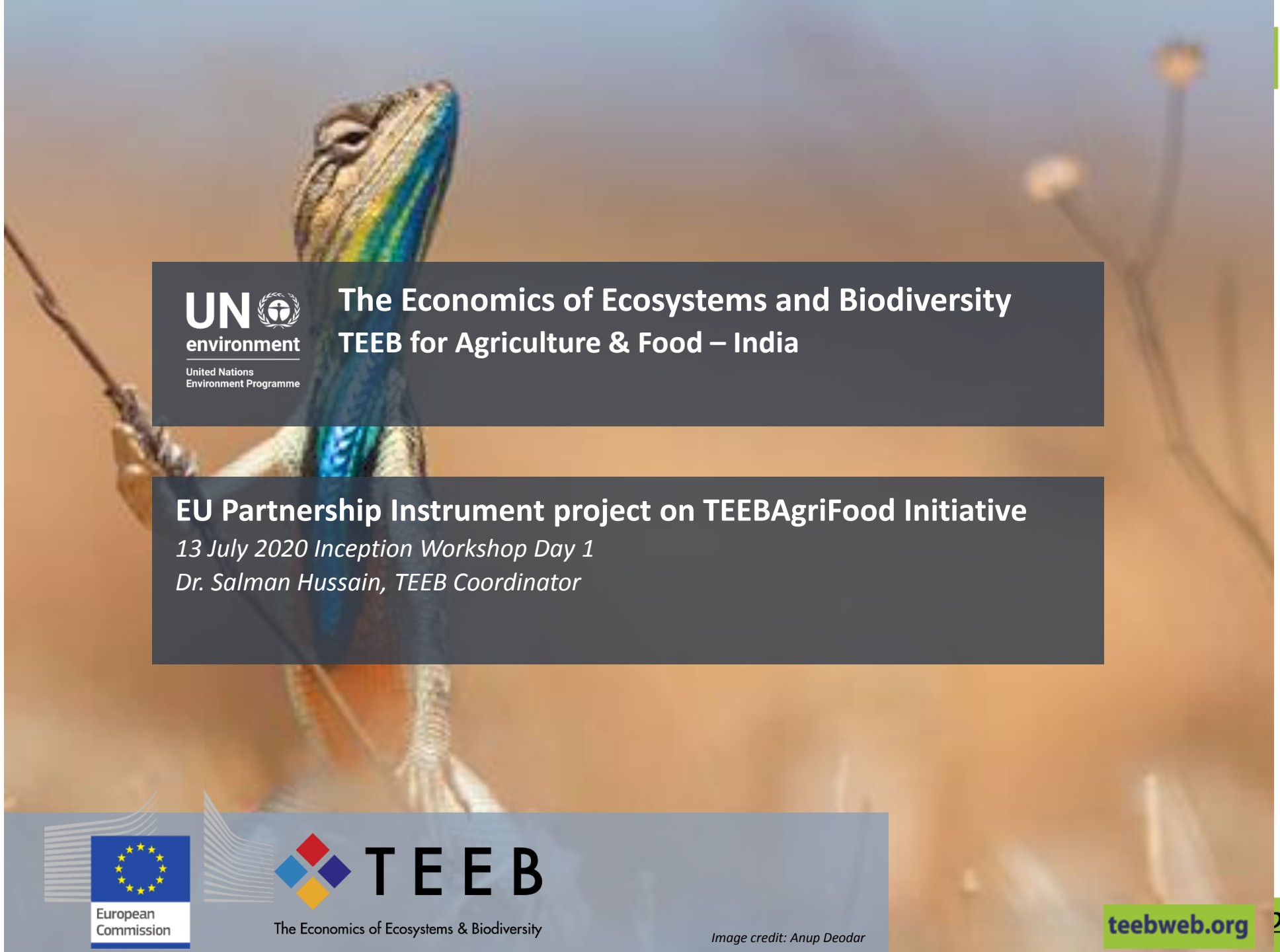
TEEB Agrifood
Virtual Inception Workshop

3 pm IST



The Economics of Ecosystems and Biodiversity
TEEB for Agriculture & Food – India

EU Partnership Instrument project on TEEBAgriFood Initiative

13 July 2020 Inception Workshop Day 1

Dr. Salman Hussain, TEEB Coordinator

UN environment
United Nations Environment Programme

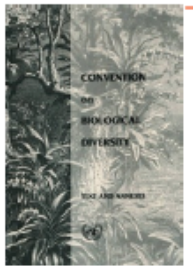
European Commission

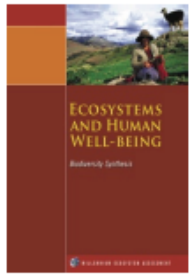
TEEB
The Economics of Ecosystems & Biodiversity

Image credit: Anup Deodar

I. What is TEEBAgriFood?

TEEB initiative (2008-2012)





Ecol./Env. Economics literature

G8+5 Potsdam 2007

"Potsdam Initiative – Biological Diversity 2010"

The economic significance of the global loss of biological diversity….

Importance of recognising, demonstrating & responding to values of nature…

Interim Report

CBD COP 9 Bonn 2008

Climate Issues Update

Input to UNFCCC 2009

TEEB End User Reports Brussels 2009, London 2010

India, Brazil, Belgium, Japan & South Africa Sept. 2010

TEEB Synthesis

TEEB Books

BD COP 10 Nagoya, Oct 2010

CBD COP11 India

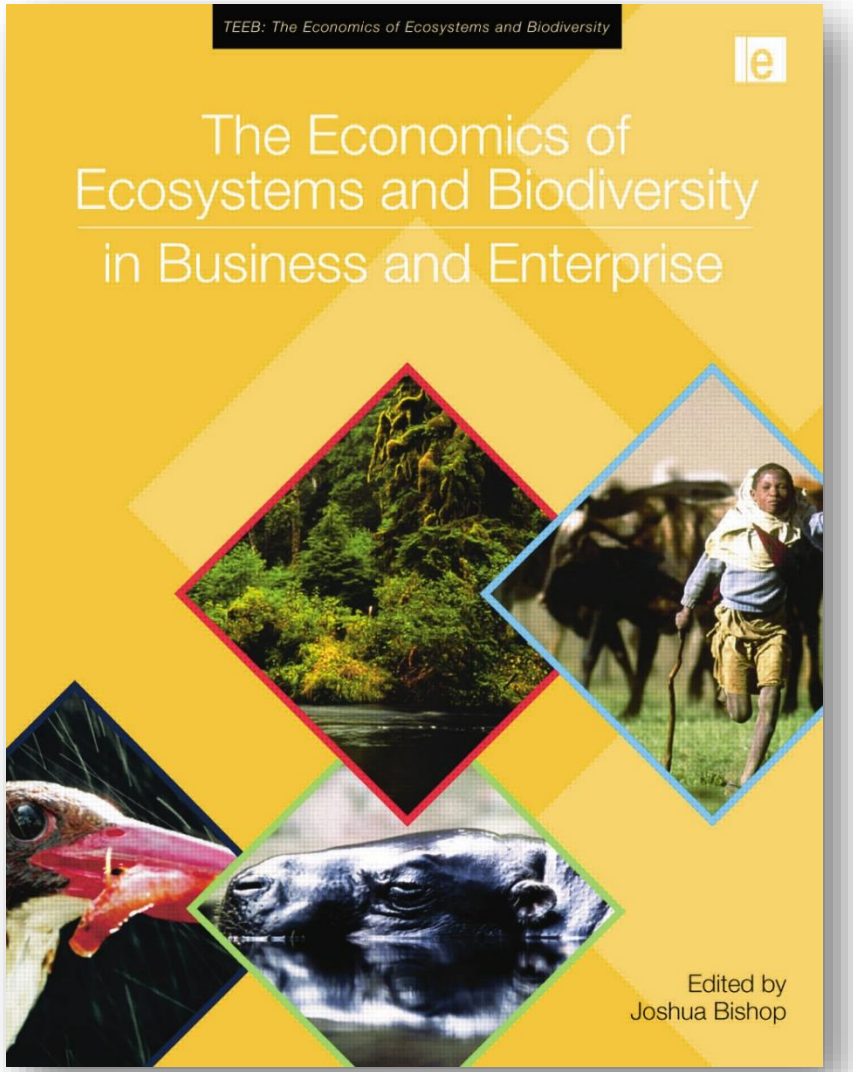
National TEEB Work

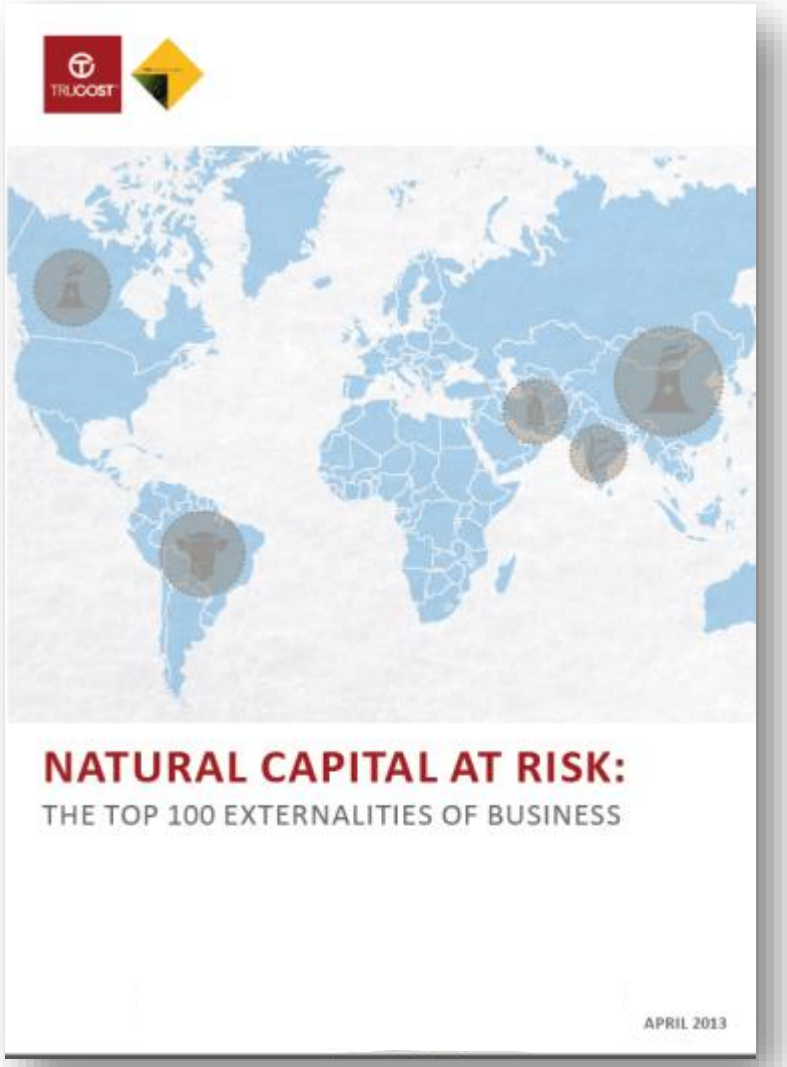
Sectoral TEEB Work

Business Externalities Work

Rio+20 Brazil

TEEB for business





Why select the agriculture sector?

7.1.2 THE GLOBAL 20 REGION-SECTORS

Ranking of the 20 region-sectors with the greatest total impact across the 6 EKPIs when measured in monetary terms.

RANK	SECTOR	REGION	NATURAL CAPITAL COST, US$ BN	REVENUE, US$ BN	IMPACT RATIO
1	COAL POWER GENERATION	EASTERN ASIA	452.8	443.1	1.0
2	CATTLE RANCHING AND FARMING	SOUTH AMERICA	353.8	16.6	18.8
3	COAL POWER GENERATION	NORTHERN AMERICA	316.8	246.7	1.3
4	WHEAT FARMING	SOUTHERN ASIA	266.6	31.8	8.4
5	RICE FARMING	SOUTHERN ASIA	235.6	65.8	3.6
6	IRON AND STEEL MILLS	EASTERN ASIA	225.6	604.7	0.4
7	CATTLE RANCHING AND FARMING	SOUTHERN ASIA	163.0	174.0	0.8
8	CEMENT MANUFACTURING	EASTERN ASIA	147.0	5.8	23.0
9	WATER SUPPLY	SOUTHERN ASIA	111.7	14.1	7.9
10	WHEAT FARMING	NORTHERN AFRICA	100.1	7.4	13.6
11	RICE FARMING	EASTERN ASIA	99.3	91.2	1.1
12	WATER SUPPLY	WESTERN ASIA	86.7	18.4	4.7
13	FISHING	GLOBAL	86.1	136.0	0.6
14	RICE FARMING	NORTHERN AFRICA	84.2	1.2	69.6
15	CORN FARMING	NORTHERN AFRICA	80.4	1.7	47.8
16	RICE FARMING	SOUTH-EASTERN ASIA	79.7	41.0	1.9
17	WATER SUPPLY	NORTHERN AFRICA	76.4	3.4	22.2
18	SUGARCANE	SOUTHERN ASIA	75.6	6.0	12.5
19	PETROLEUM AND NATURAL GAS EXTRACTION *(excludes water and land use)*	EASTERN EUROPE	72.6	371.6	0.2
20	NATURAL GAS POWER GENERATION	NORTHERN AMERICA	69.4	122.7	1 .0

The visible and invisible flows of agricultural production

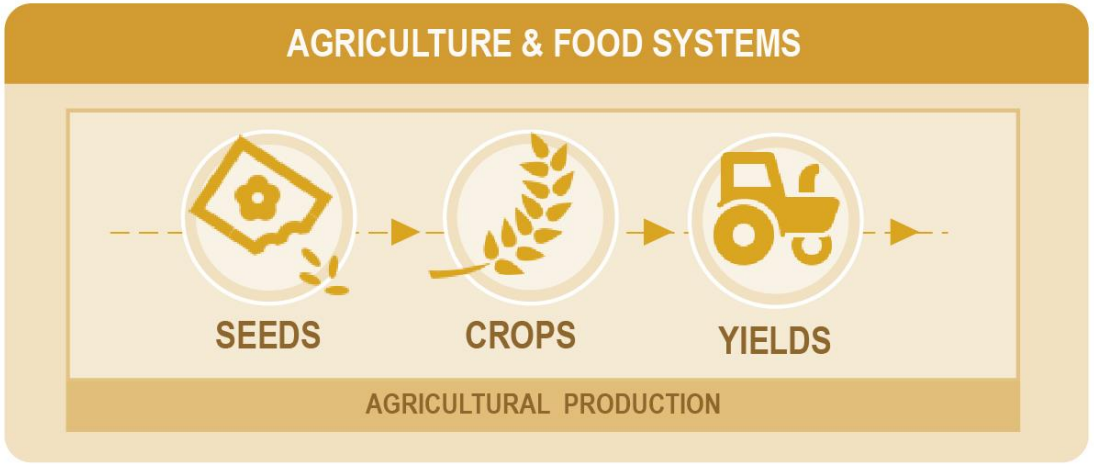
ZAKIR HOSSAIN CHOWDHURY/ANADOLU AGENCY/GETTY

Drying red chillis under the sun provides one of the few sources of employment for women in an area of Bangladesh.

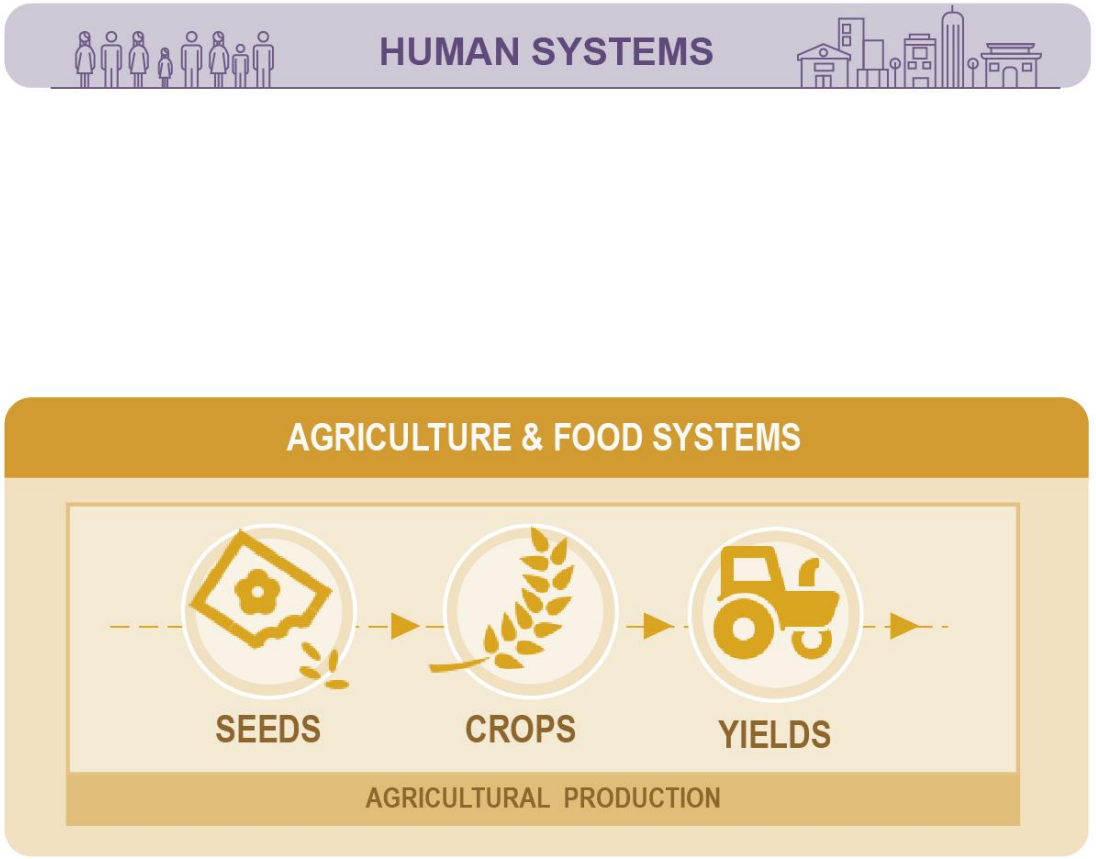
Fix food metrics

For sustainable, equitable nutrition we must count the true global costs and benefits of food production, urge **Pavan Sukhdev**, **Peter May** and **Alexander Müller**.

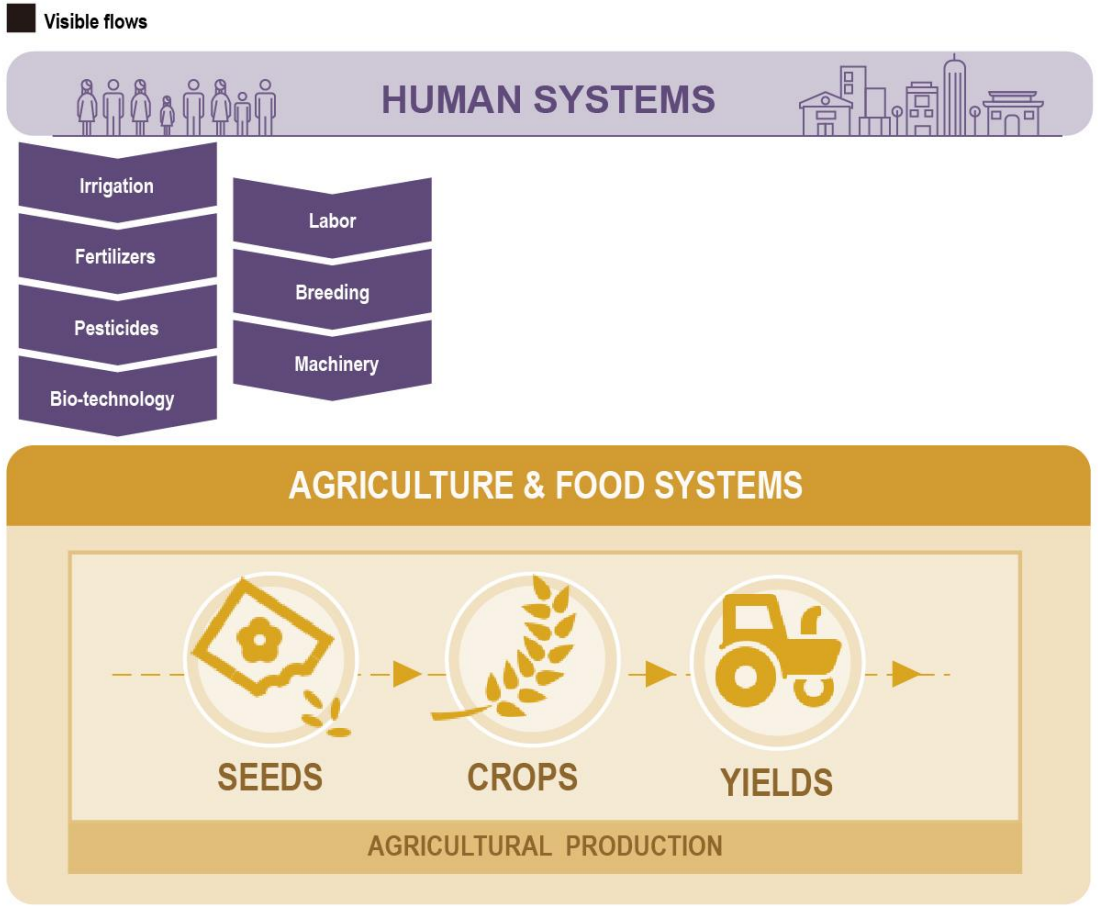
The visible and invisible flows of agricultural production



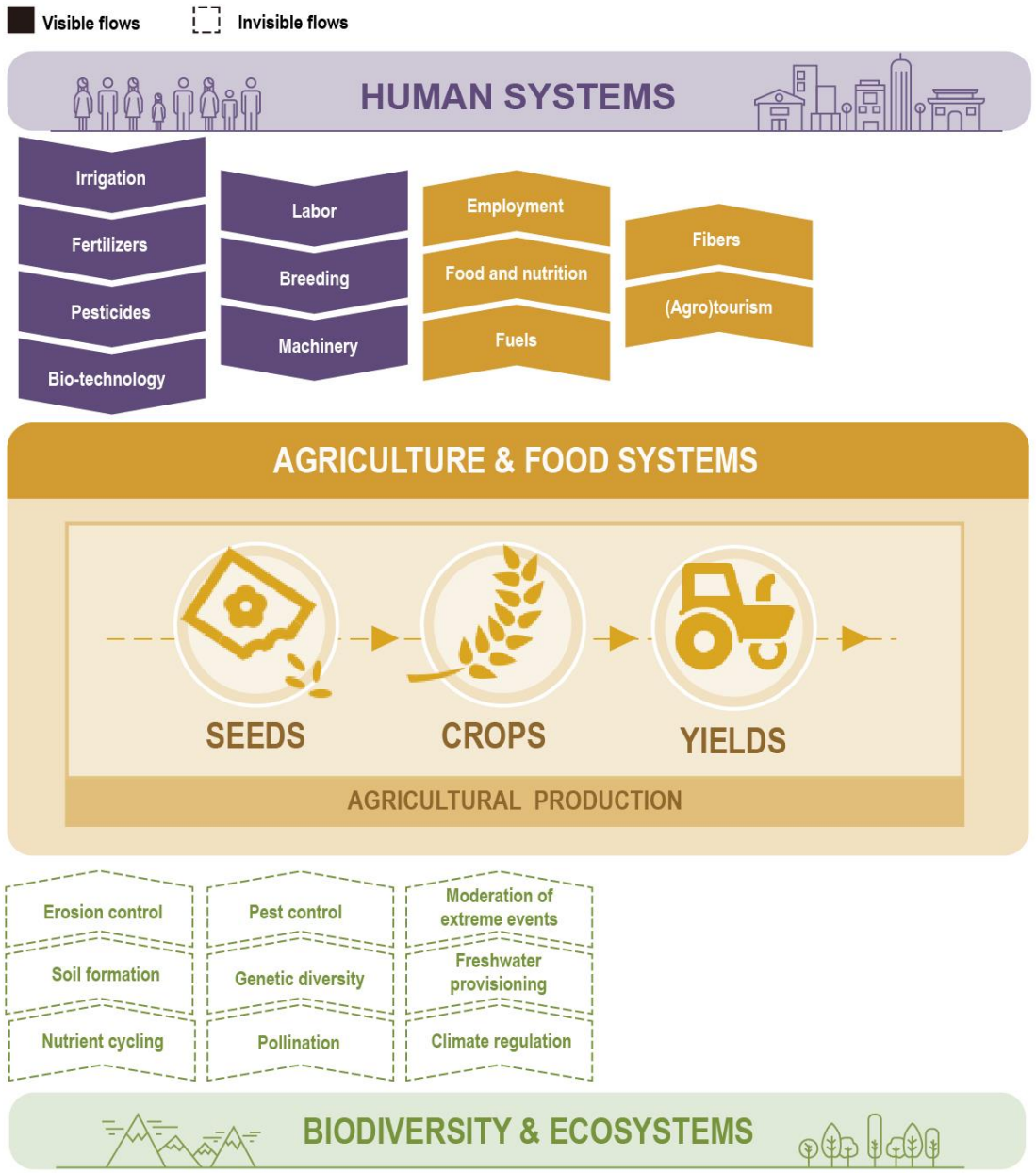
The visible and invisible flows of agricultural production



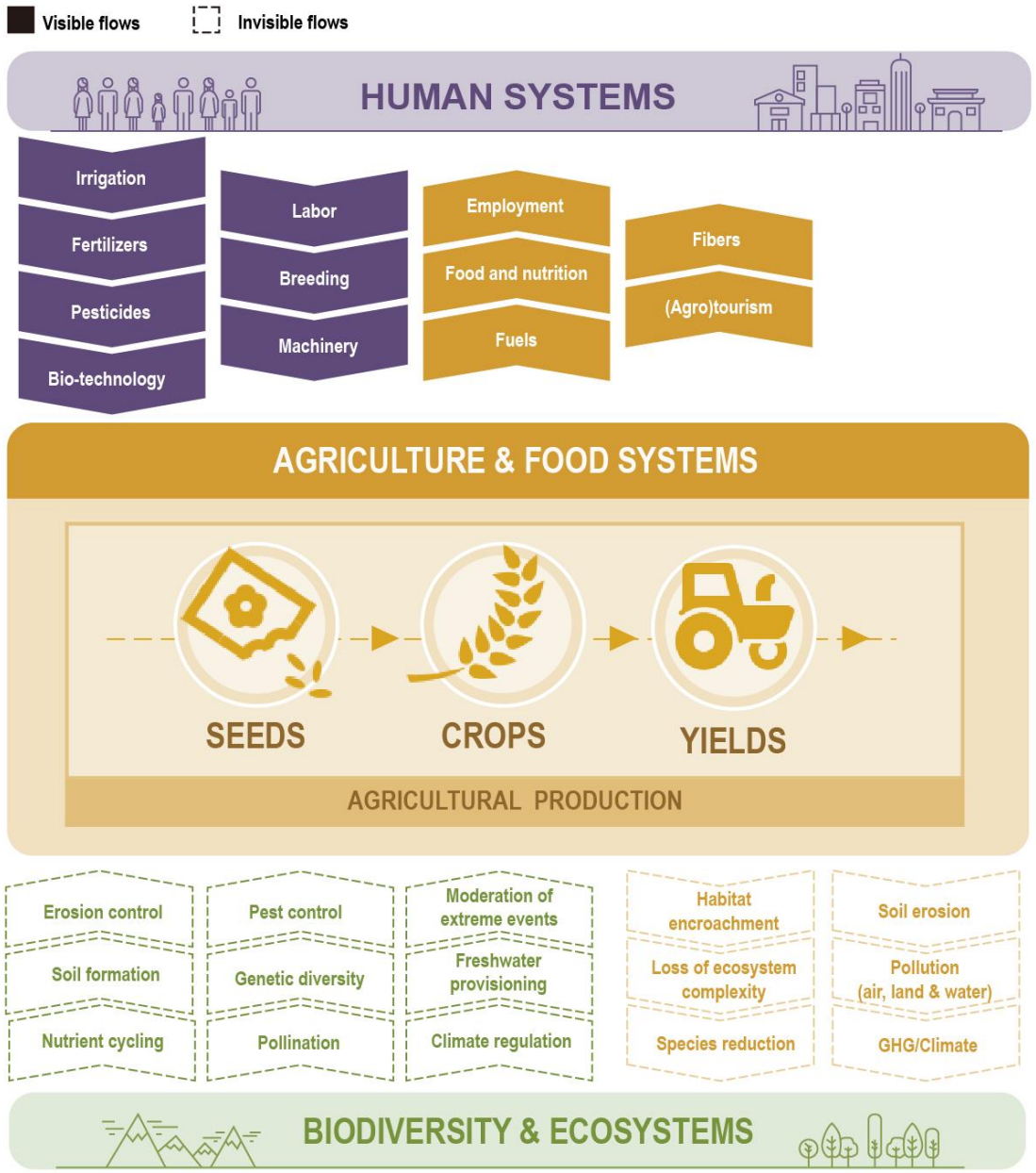
The visible and invisible flows of agricultural production



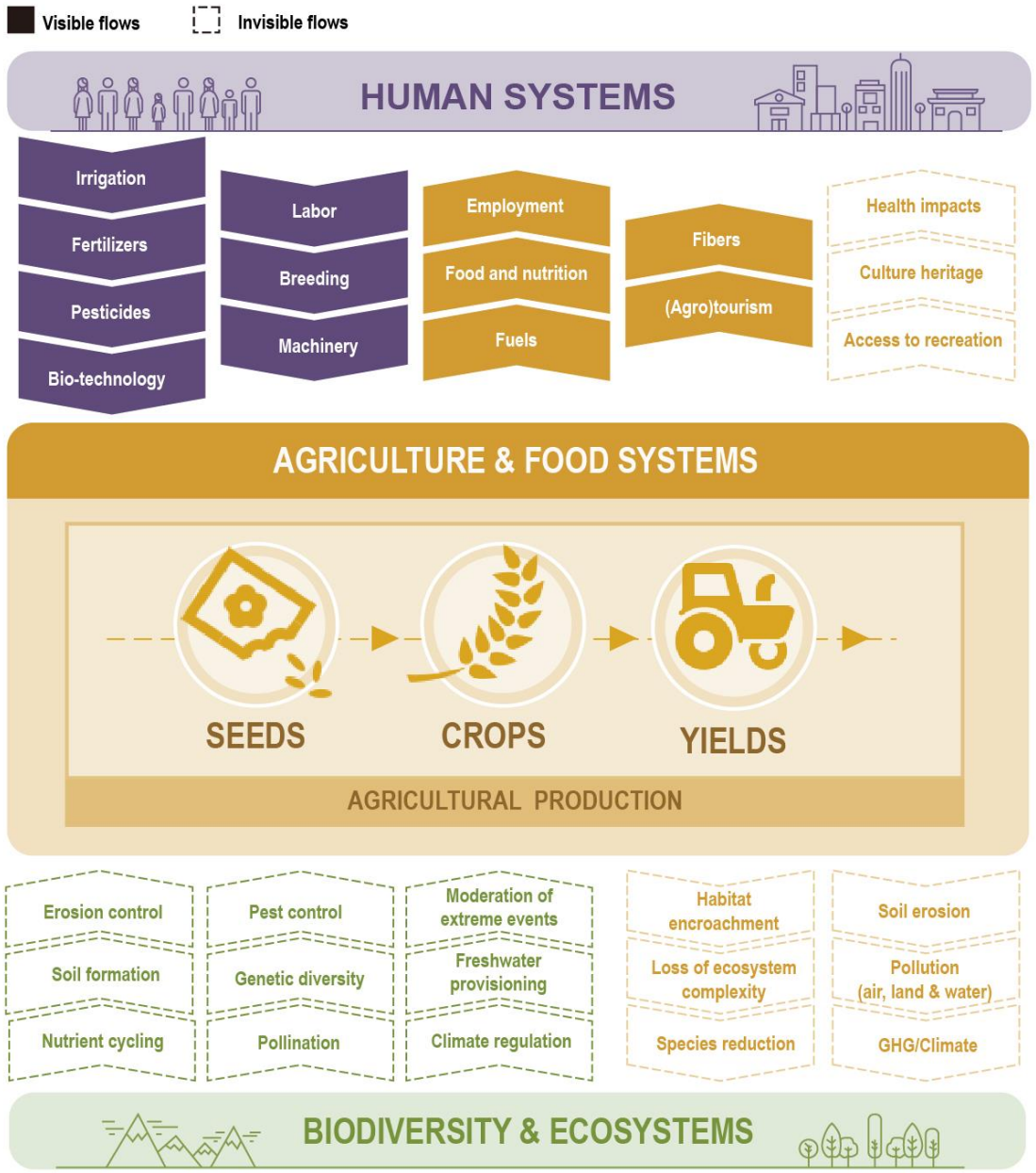
The visible and invisible flows of agricultural production



The visible and invisible flows of agricultural production



The visible and invisible flows of agricultural production



The visible and invisible flows of agricultural production

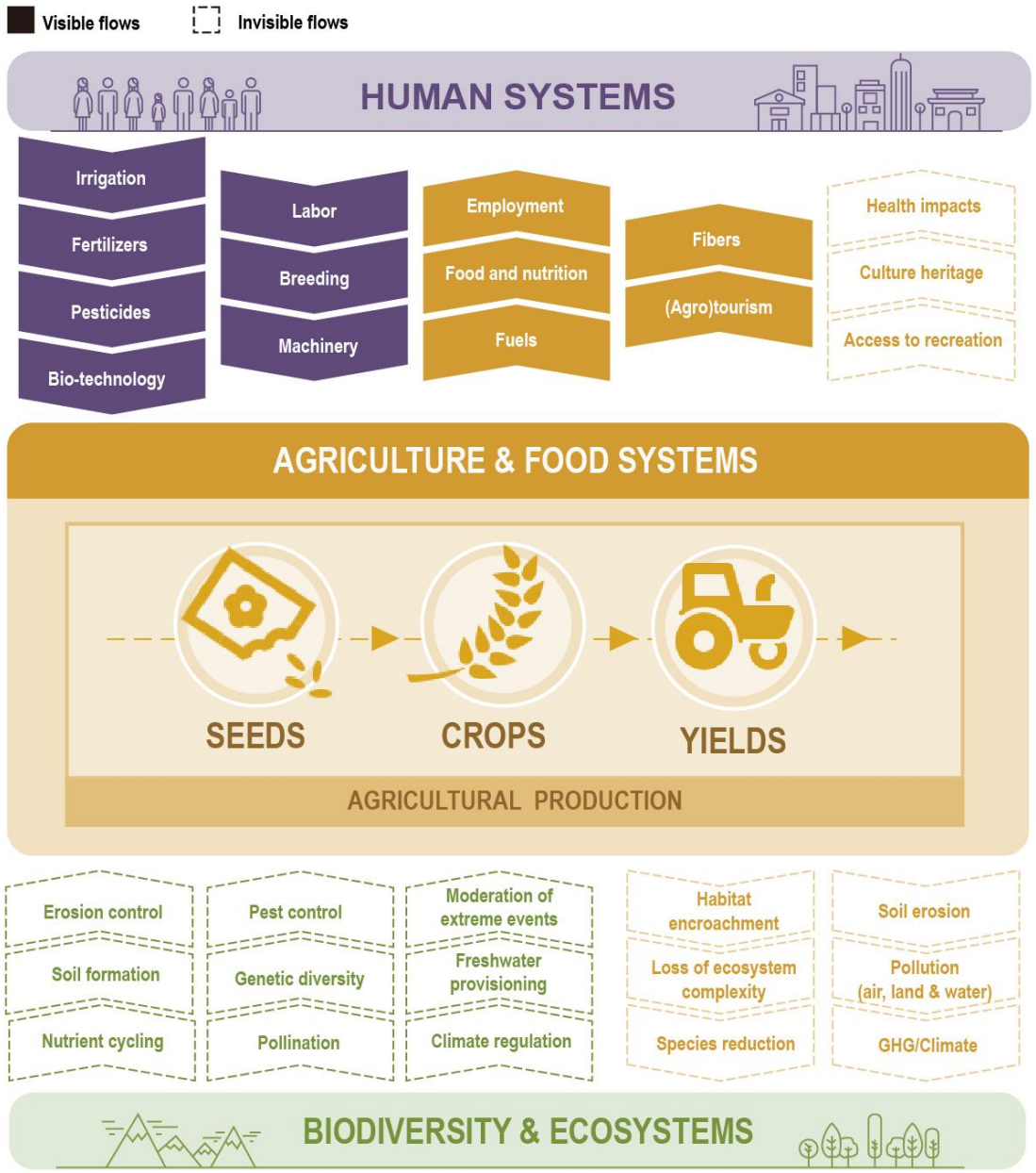
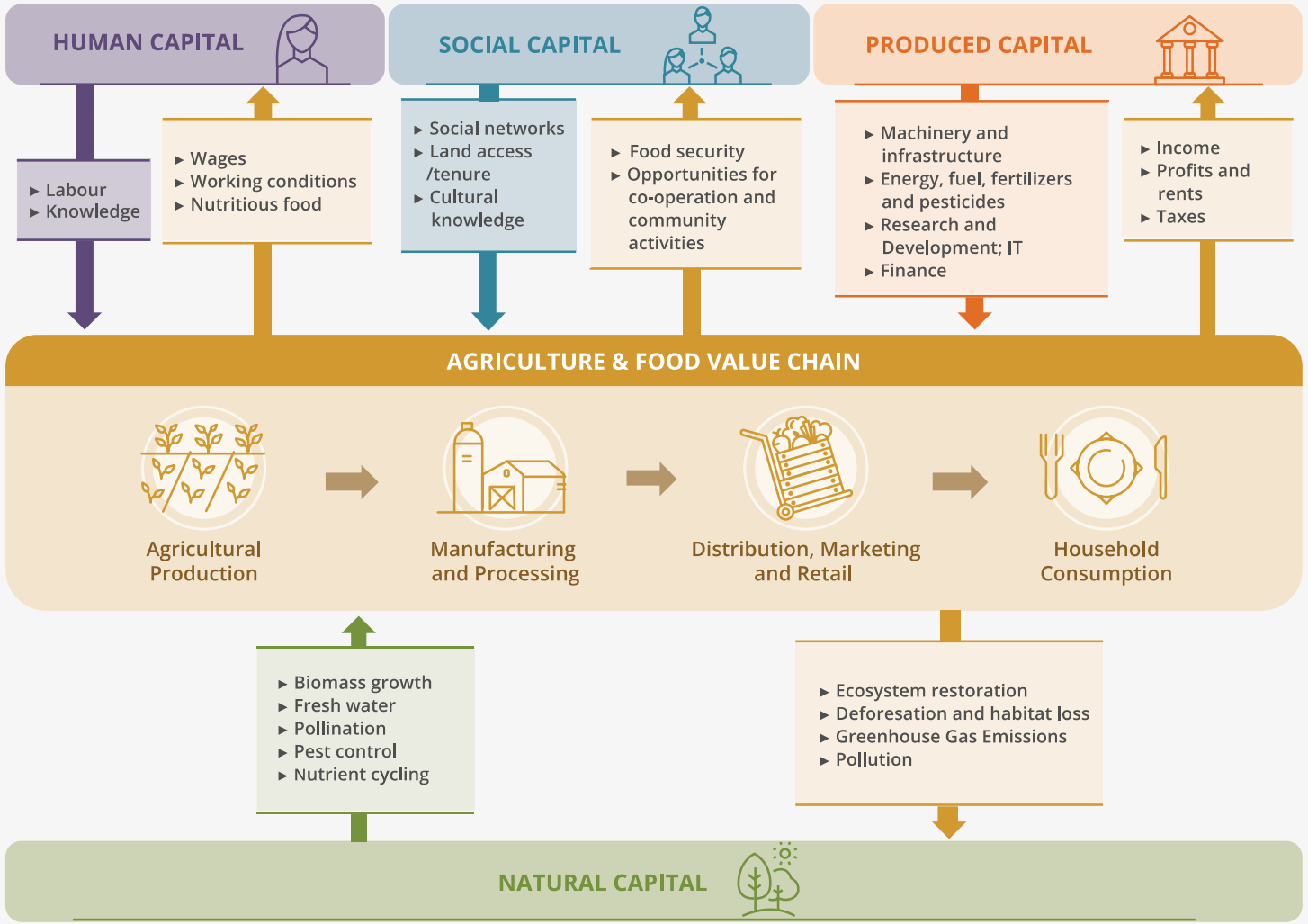
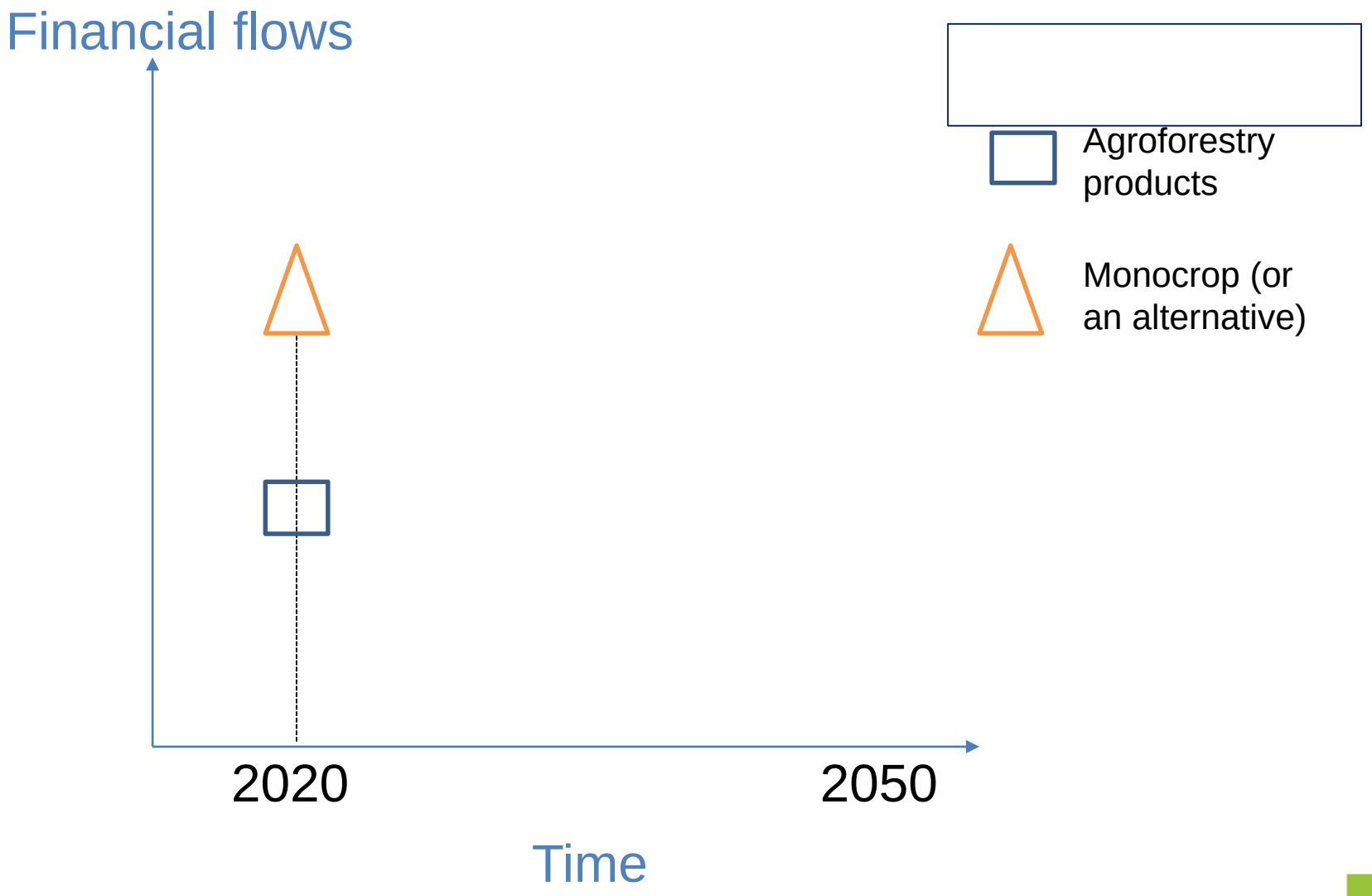


Figure 2.1 Capital stocks and value flows in eco-agri-food systems (Source: Hussain and Vause 2018)

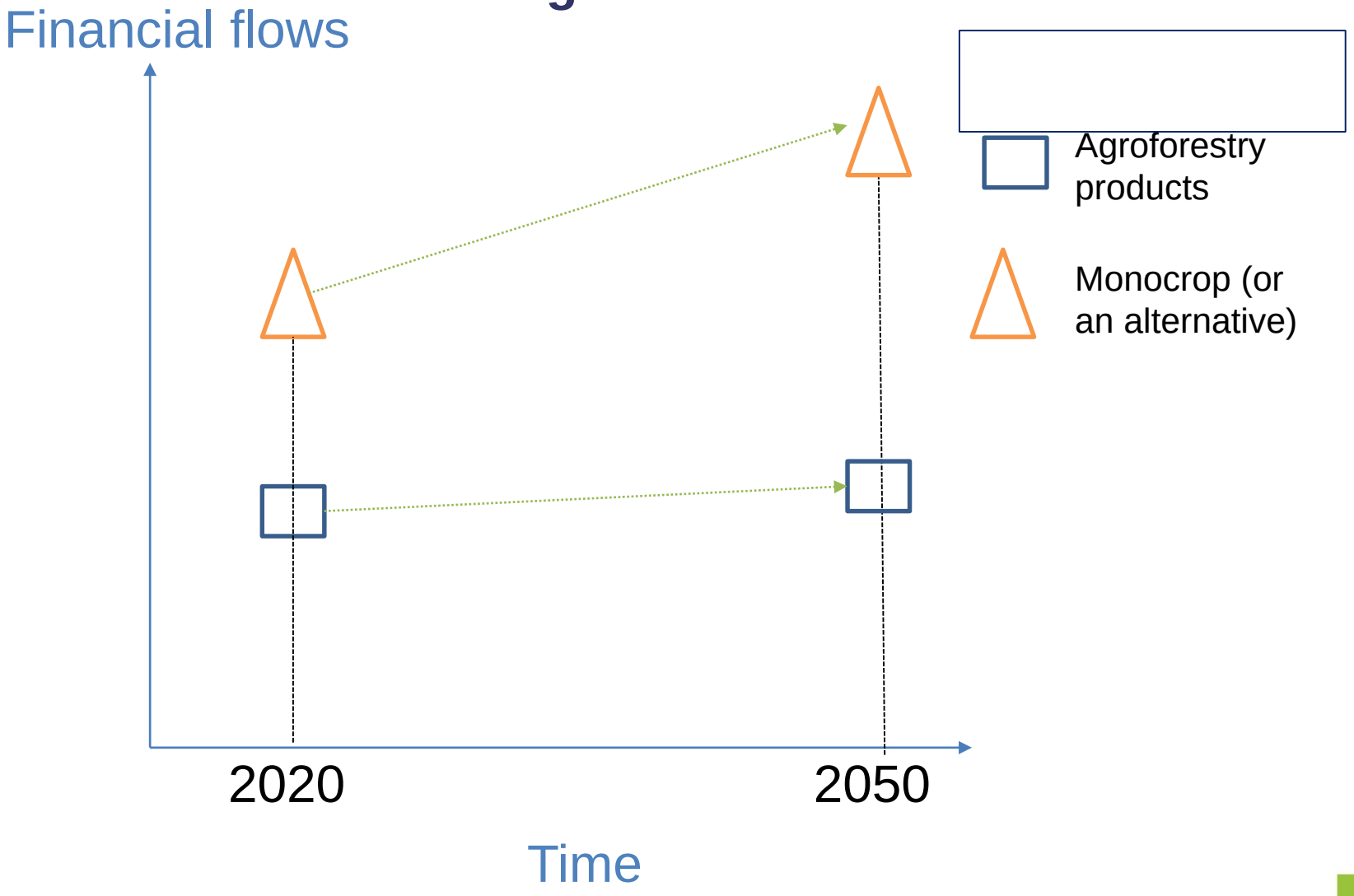


II. Why should the Indian government and private sector be engaged with the project?

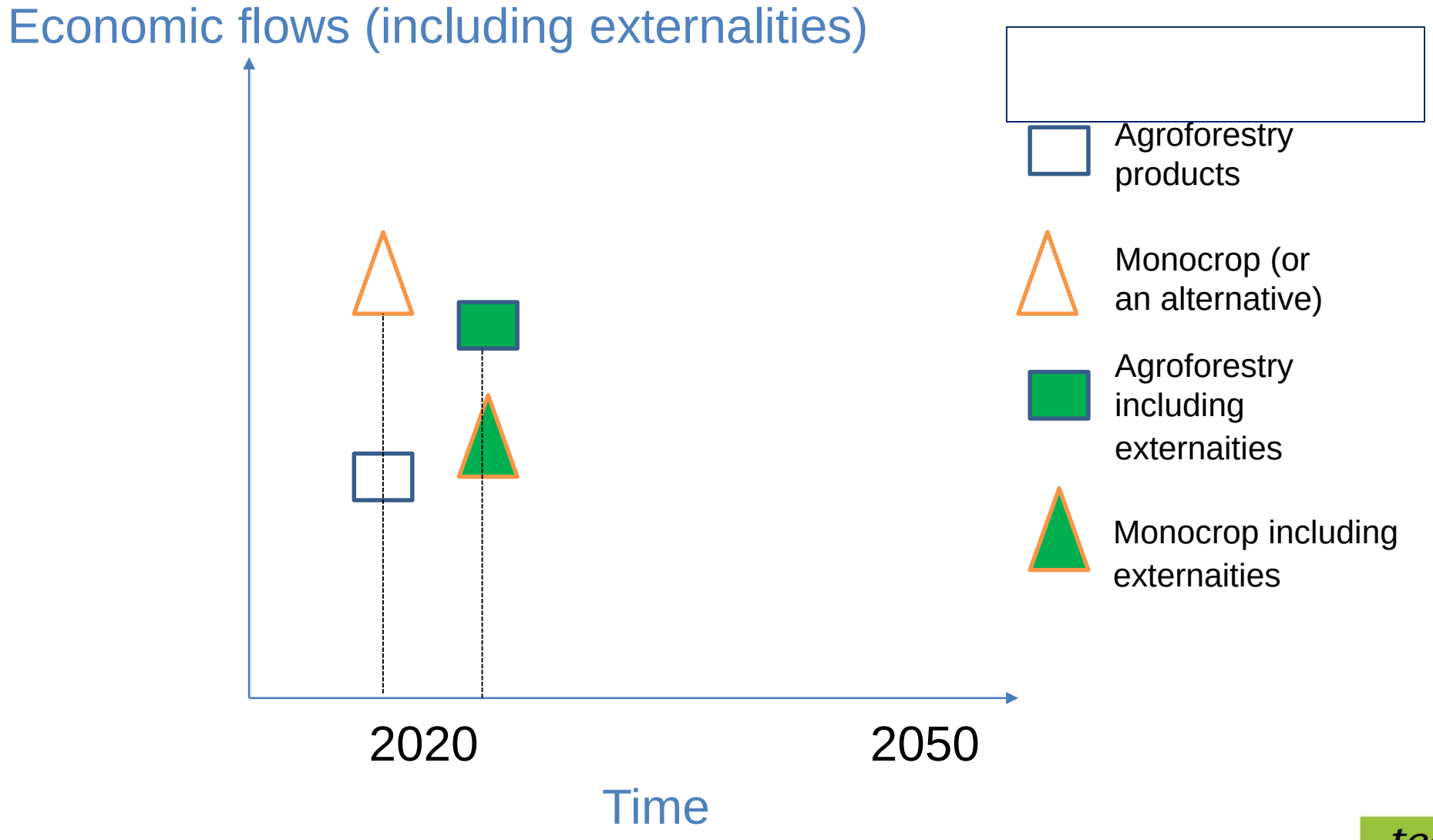
Agro-forestry [or ZBNF, or organic production, or agro-ecology, or a multi-use landscape...] versus monoculture: *current assumption*



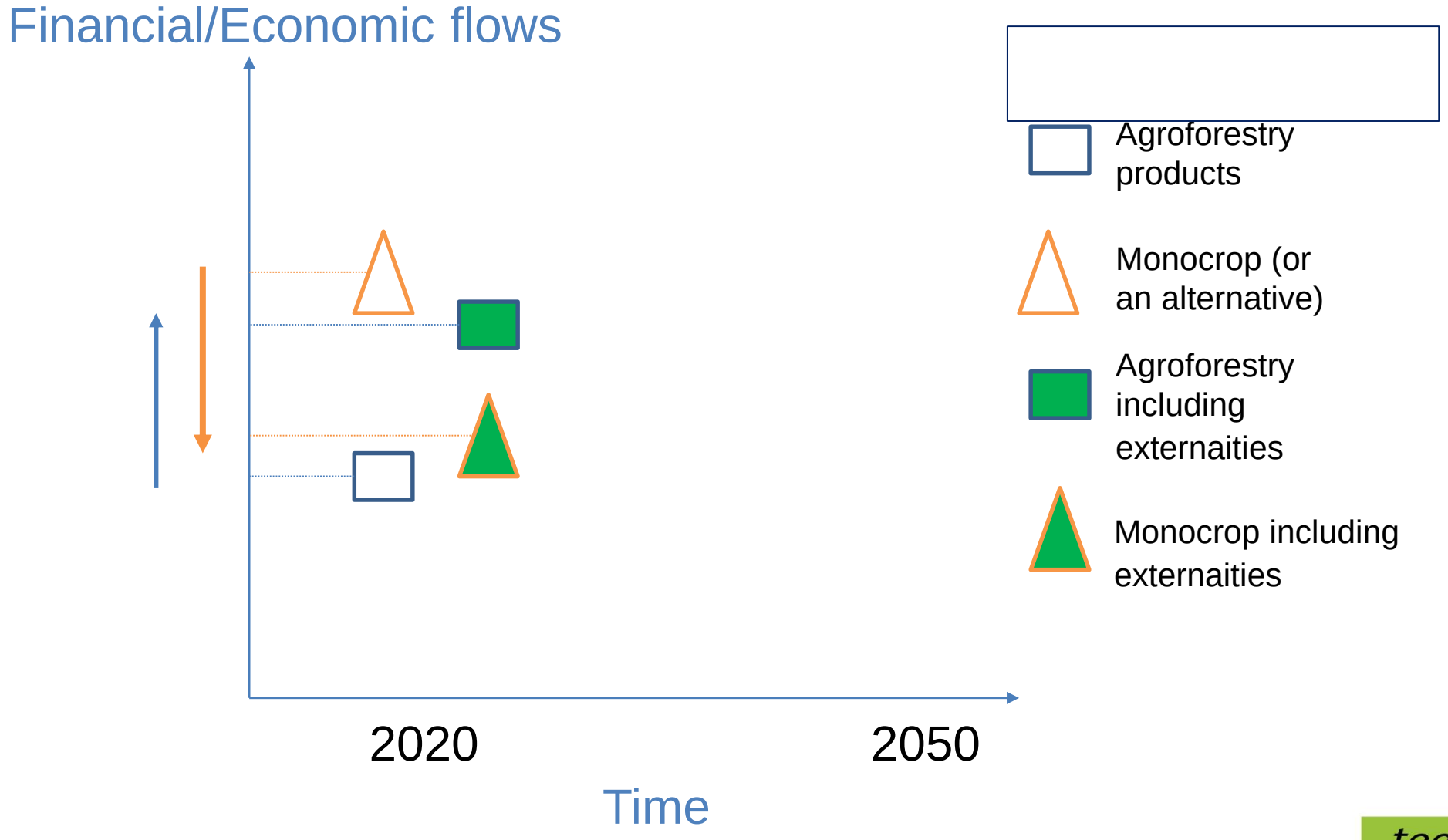
Agro-forestry versus monocrop: Assumption about changes over time



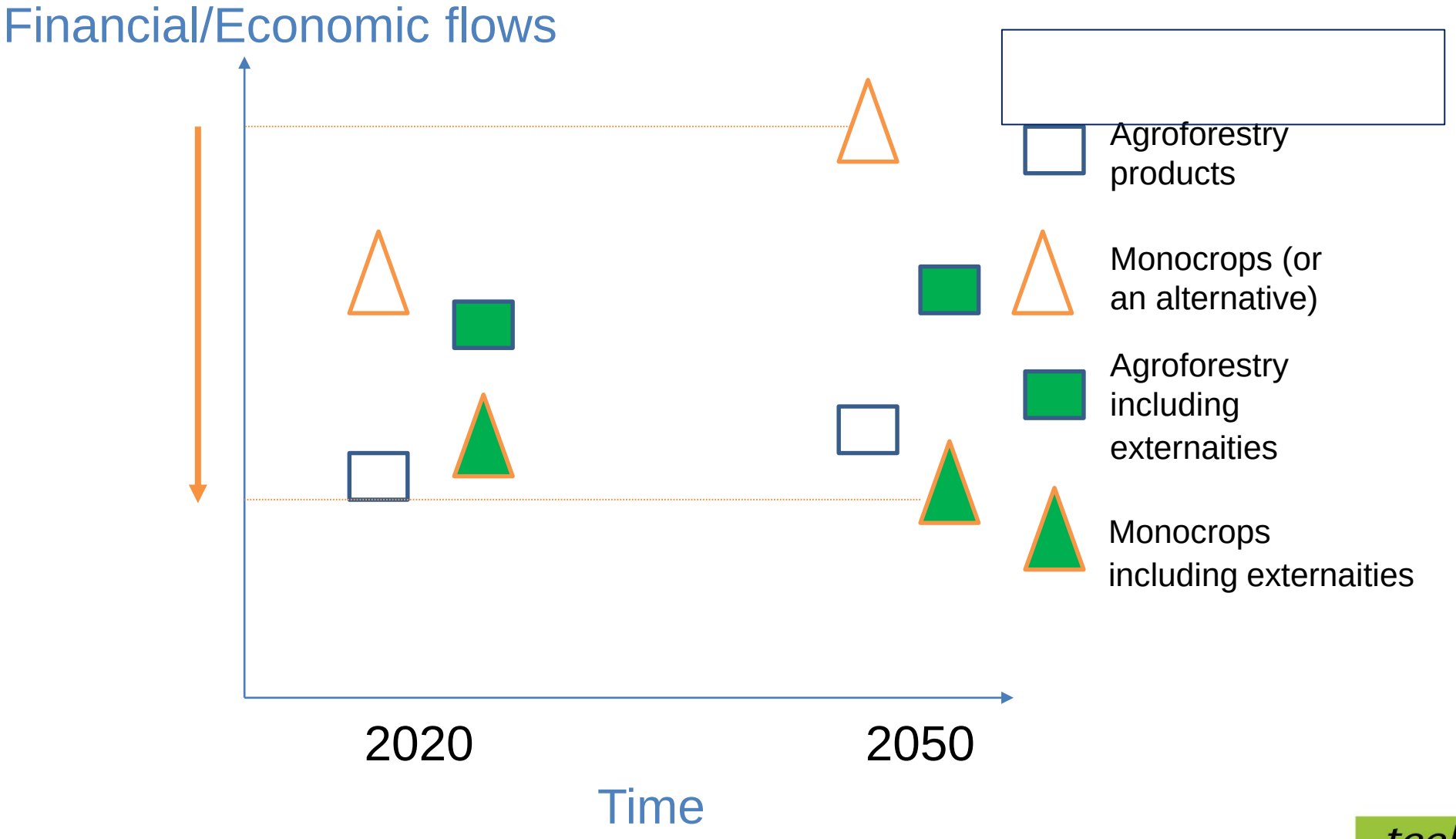
Agro-forestry versus monocrop:
2020 including externalities



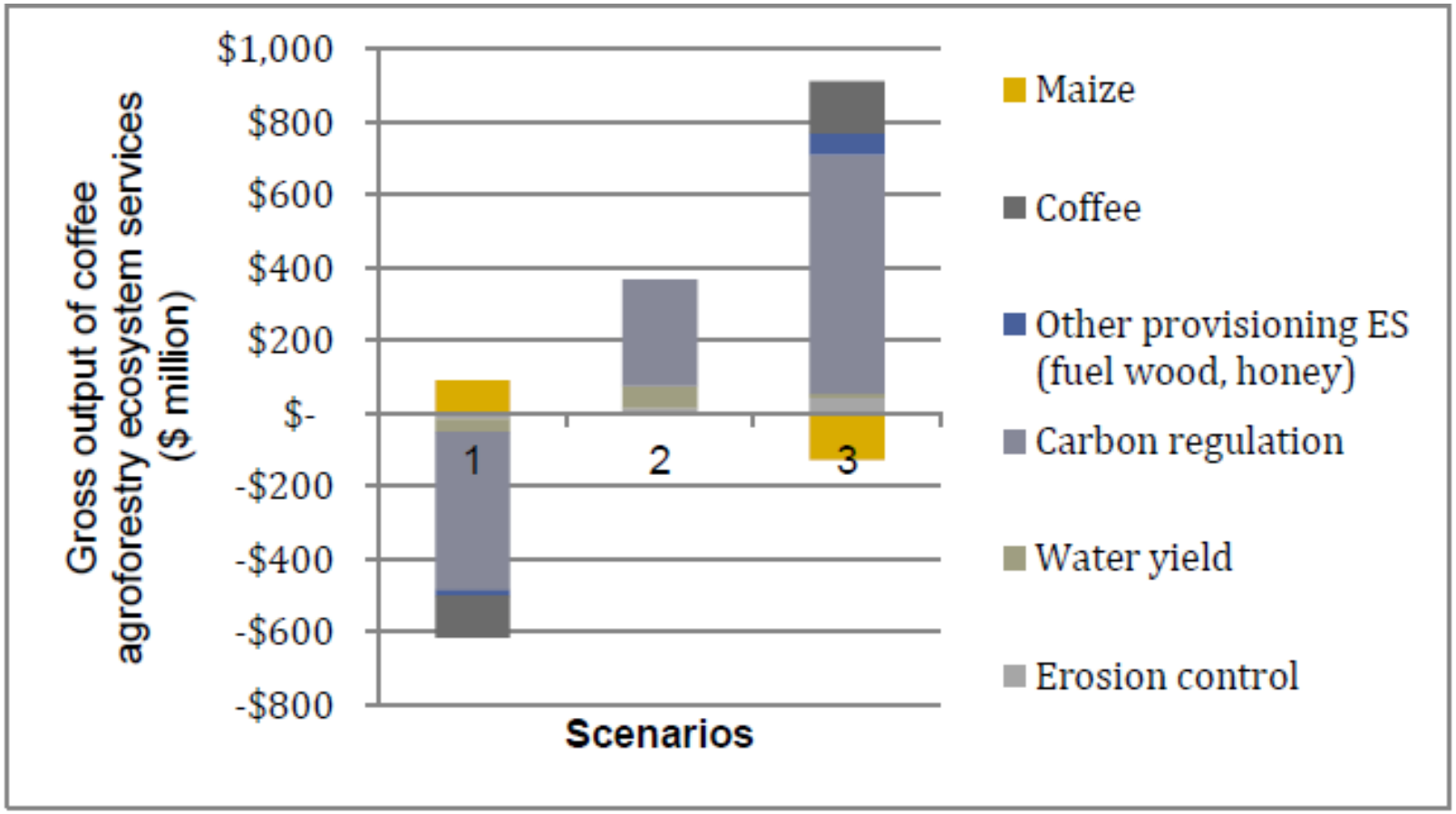
Agro-forestry versus monocrop:
2020 including externalities



Agro-forestry versus monocrops:
2050 for the monocrop



Agro-forestry
Scenario analysis



III. The EU Partnership Instrument
Project specifics

Project Objectives

- The core project goal is to **stimulate biodiversity conservation and ecosystem service provisioning** for agricultural landscapes for the seven countries in scope (Brazil, China, India, Indonesia, Malaysia, Mexico, Thailand)

Potential solutions – work package 4

	Change agents				
Opportunities	National Government	Local Government	Farmers	Agri-Business	Civil Society
1. agricultural extension					
2. peer-to-peer learning					
3. macro accounting					
4. sustainability standards and certification					
5. Payment for Ecosystem Services					
6. UN-REDD					
7. banking sector					
8. reforms to taxes and subsidies					
9. land tenure					
10. Intra-government jurisdictions of line ministries					

Project log frame (overview)

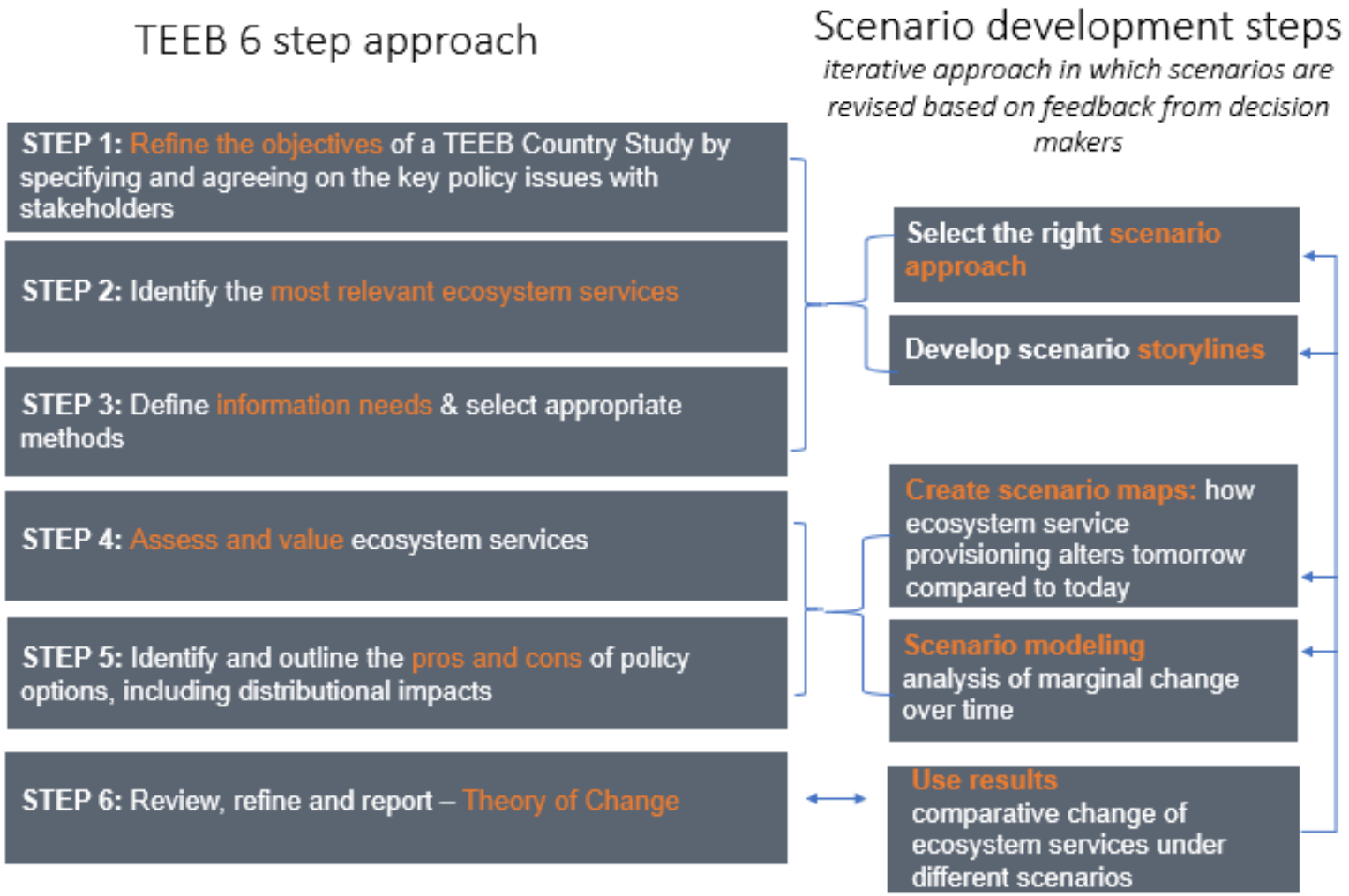
Year		Year 1				Year 2				Year 3				Year 4			
	Work Packages and activities	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WP 1	Country specific analysis – lessons learned from previous interventions																
WP 2	Policy mapping																
WP 3	Determine and refine the case studies																
WP 4	Engaging agri-business with NCP																
WP 5	Scenario Analysis																
WP 6	Develop a roadmap of concrete steps to implement a change																
WP 7	Deliver the change and ensure project sustainability																
WP 8	Communicating biodiversity benefits and mainstreaming																

IV. Developing scenarios

Developing scenarios

- Selection of **which policy interventions to test/apply** using the TEEBAgriFood Framework will be determined by government and stakeholder priorities
- In carrying out the **scenario analysis**, Business-as-Usual and the policy-on scenarios includes known changes
  - Urbanization
  - Population demographics
  - Changing dietary patterns
  - Climate change scenarios
  - Covid19 responses

TEEB Six-Step Approach



TEEB

The Economics of Ecosystems & Biodiversity

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UNEP TEEB Office

European Commission

TEEB: Challenges and Policy Options for Agriculture and Food Systems in India

Dr Harpinder Sandhu

Virtual Inception Workshop for UNEP Project

TEEB Implementation: Promoting a Sustainable Agriculture and Food Sector

13-14 July 2020

Transformations of global agriculture and food systems

- Global agriculture and food systems are at crossroads — struggling to produce nutritious food in adequate quantity for a growing population and reduce risks to ecosystems and society
- 0.8 billion people still go to bed hungry
- 2 billion people suffer from malnutrition
- 1.9 billion adults are overweight, and of these, 0.65 billion are obese (FAO, 2018)

Feature

Transformation of Agriculture and Food Systems: Application of TEEBAgriFood Framework

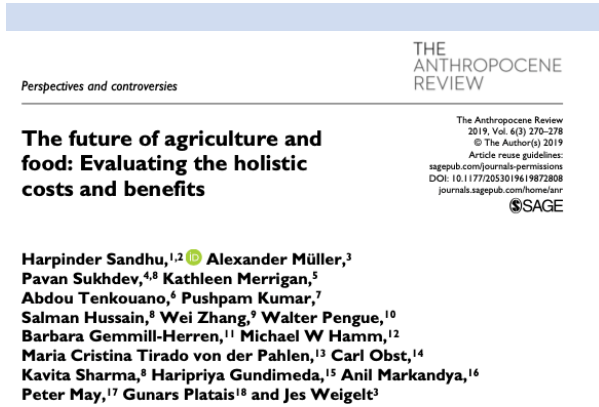
by Harpinder Sandhu, Alexander Müller, and Pavan Sukhdev

H. Sandhu

Canola field in South Australia

In Brief

The focus of global agriculture since the Green Revolution of 1960s is only on increasing productivity by practicing intensive agriculture. This intensive agriculture is often supported by large quantities of subsidies for inputs such as fertilizers, pesticides, and improved seed etc. Worldwide research shows, however, that these intensive practices have resulted in negative consequences for biodiversity, the environment and human health. And at the same time more than 800 million people are still hungry. Therefore, such a focus on productivity supported by subsidised agriculture that leads to perverse and pervasive outcomes is obsolete for future agriculture and food systems. Globally, agricultural and food systems need to transform and modify their approach and bring the desired change with new ways to integrate natural capital into social and economic systems. They also need to recognise and reward human capital. We recommend adoption of the TEEBAgriFood framework to measure and quantify all inter-dependencies between agriculture and the environment and to highlight the role of human and social capital. This transformed approach has the potential to secure food and ecological security to all, and to improve planetary health and well-being in society.



Perspectives and controversies

THE ANTHROPOCENE REVIEW

The future of agriculture and food: Evaluating the holistic costs and benefits

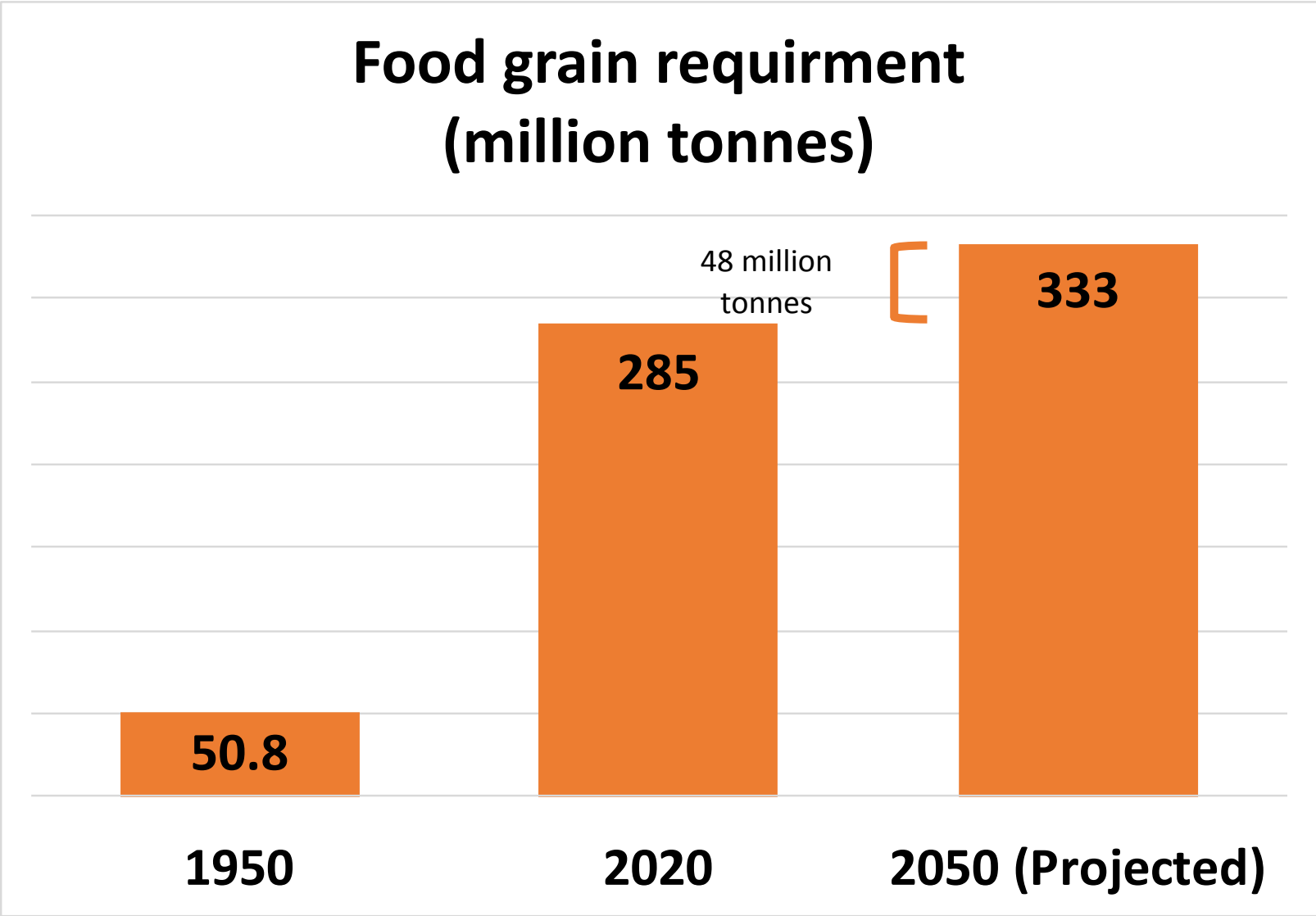
The Anthropocene Review
2019, Vol. 6(3) 270–278

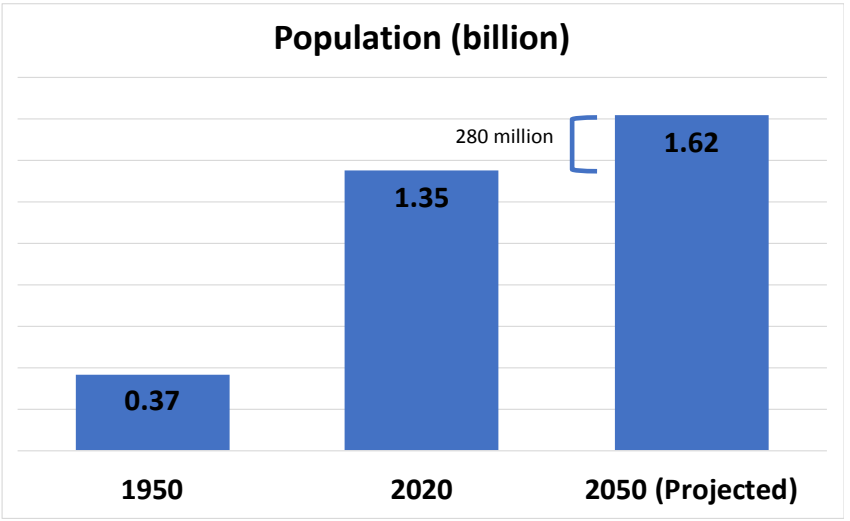
DOI: 10.1177/2053019619872808
journals.sagepub.com/home/anr
SAGE

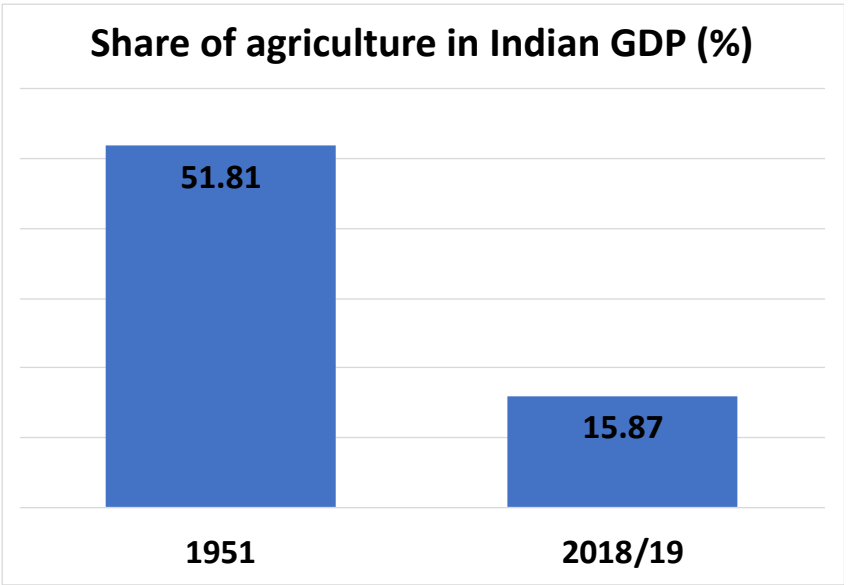
Harpinder Sandhu,[1,2] Alexander Müller,[3] Pavan Sukhdev,[4,8] Kathleen Merrigan,[5] Abdou Tenkouano,[6] Pushpam Kumar,[7] Salman Hussain,[8] Wei Zhang,[9] Walter Pengue,[10] Barbara Gemmill-Herren,[11] Michael W Hamm,[12] Maria Cristina Tirado von der Pahlen,[13] Carl Obst,[14] Kavita Sharma,[8] Haripriya Gundimeda,[15] Anil Markandya,[16] Peter May,[17] Gunars Platais[18] and Jes Weigelt[3]

Abstract

Inadequacies of the current agriculture and food systems are recognised globally in the form of damages to environment and human health. In addition, the prevailing economic and policy systems do not reflect these damages in its accounting systems and standards. These shortcomings lead to perverse and pervasive outcomes for society at large. Our proposal is to consider all social and environmental externalities – both negative and positive, in global agriculture and food systems and reflect them in an economic system by evaluating comprehensive costs and benefits. This can be done by adopting an innovative, universal, and inclusive framework (the 'TEEBAgriFood' framework) in order to stimulate appropriate policy responses.







Status of agriculture and food in India

Challenges in agrifood systems in India

- Produced capital
- Social capital
- Human capital
- Natural capital

Produced capital

GROSS VALUE ADDED
$271 BILLION

GVA SHARE 14%

LABOUR EMPLOYED
42%

Social capital

- Small and marginal land holdings
- 90 million agricultural households
- **Social inequity:** For example, smallholders or ‘resource poor’ farms in rainfed dryland landscapes, without access to private tube-well irrigation, have remained largely exempt from the benefits of agrarian policies such as free electricity for pumping groundwater experienced by more prosperous farmers in Punjab.
- **Low income:** average income of farmers, which is Rs 36,938 from cultivation of crops and Rs 9,176 from livestock per year per household, much below the average income from non-farm sector.

Food and nutritional security and health

CHILDREN UNDER 5 YEARS – 38% STUNTED

21 % ARE WASTED

WOMEN 15 -49 YEARS – 55.3% ANEMIA

ADOLESCENT GIRLS 15-18 YEARS - 44.7% WITH LOW BMI <18.5

23% OF WOMEN AND 20%OF MEN AGE 15-49 ARE THIN.

21% OF WOMEN AND 19% OF MEN ARE OBESE

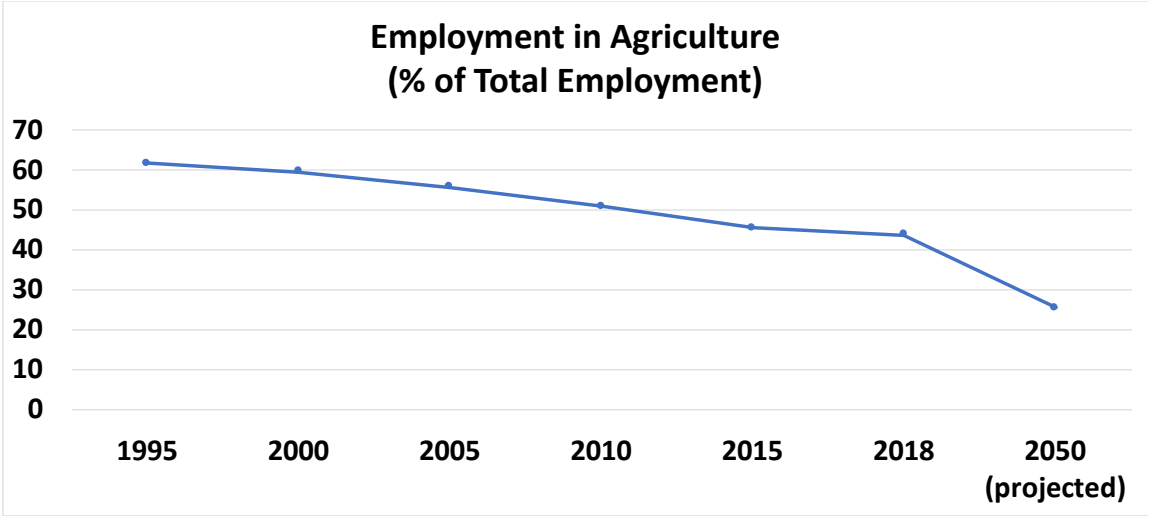
India ranks 76th amongst 113 countries with a score of 50.1 (world average is 58.4) in GFSI

Rising burden of non-communicable diseases in Indian States

- the largest disease burden from 1990 to 2016 was observed for diabetes, at 80%, and ischaemic heart disease, at 34%.
- 1081 disability-adjusted life-years (DALYs) per 100,000 population were lost in India in 2013 due to deficiencies of Fe, Zn and vitamin A,
- 2489 disability-adjusted life-years per 100,000 population were lost due to high serum total cholesterol or BMI.
- An estimated 20% of men and 21 % of women aged ≥20 years were obese in 2013 using South Asian-specific obesity cut-offs.

(Joy, E. et al. 2017)

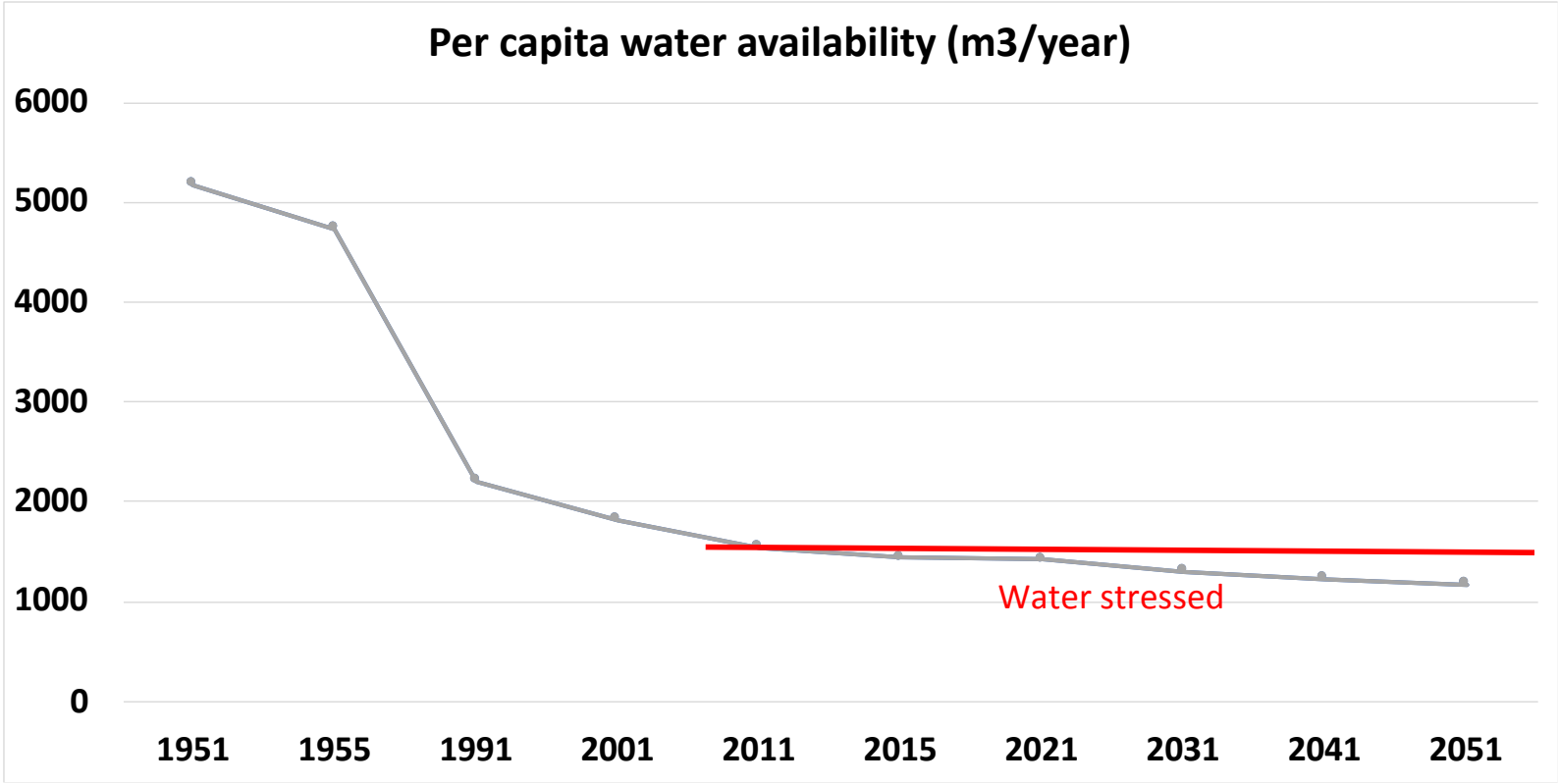
Human capital



Natural capital

Water

- Current water supply is 740 billion m^3.
- By 2030, demand in India will grow to almost 1.5 trillion m^3,
- Driven by domestic demand for rice, wheat, and sugar for a growing population.



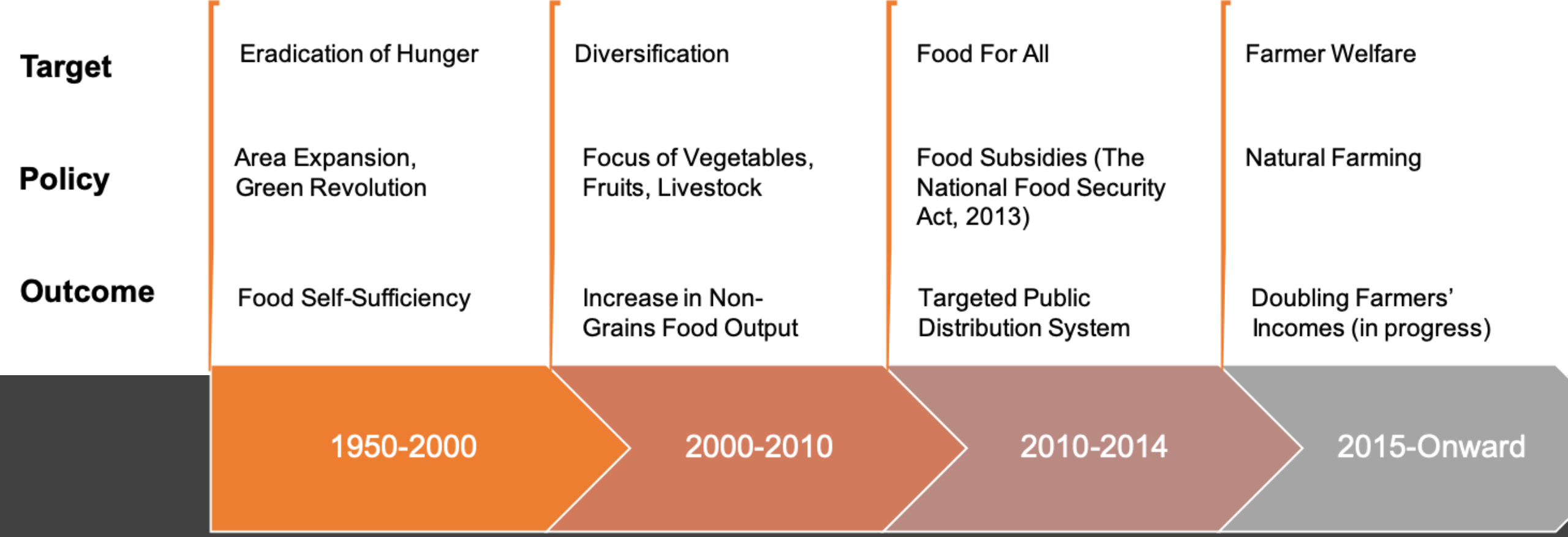
Climate change

3-4 degree Celsius rise by 2100
agricultural incomes will fall by 12% on average, and by as much as 18% in unirrigated areas by the end of the century.
impacts farmers' incomes and GDP.

Soil health

- 120.7 Million hectare (Mha) or 36.7% of the total arable and non-arable land surface of the country suffers from various forms of degradation.
- 15.35 tonnes per hectare of soil is lost resulting in loss of 5.37 to 8.4 Million tonnes (Mt) of nutrients, reduction in crop productivity, occurrence of floods/droughts, reduction in reservoirs capacity (1 to 2% annually), and loss of biodiversity

Policy options



Timeline of major agricultural policies and outcomes

Current policy response

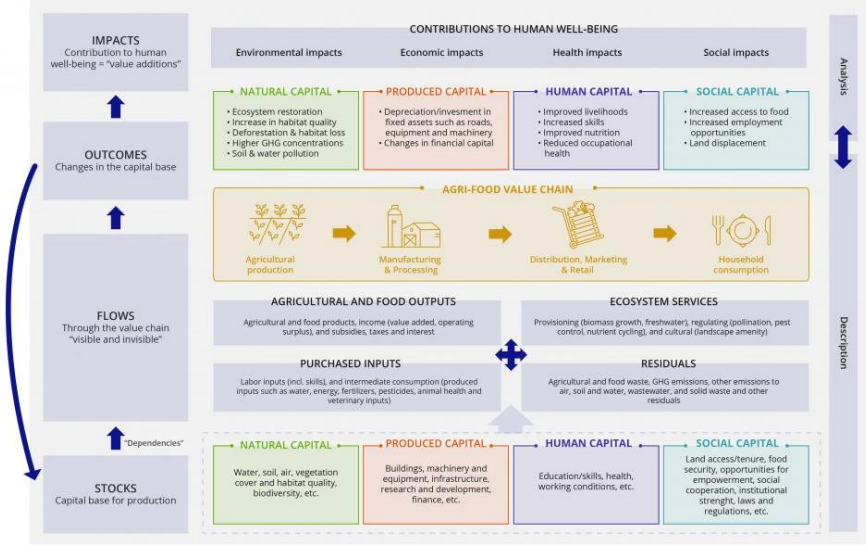
	Theme	Challenges	Policy response
1	Social capital	Food security	TPDS
		Nutritional security	Mission for Integrated Development of Horticulture (MIDH), National Horticulture Mission (NHM), National Horticulture Board, Horticulture Mission for Northeast and Himalayan States (HMNEH), Coconut Development Board (CDB), Central Institute of Horticulture
2	Human capital	Health	Nation Commission on Macroeconomics and Health
3	Natural capital	Sustainable agriculture	National Mission for Sustainable Agriculture (NMSA), Rainfed Area Development (RAD), Pradhan Mantri Krishi Sinchai Yojana-Per Drop More Crop (PMKSY-PMDC), Sub-mission on agroforestry (SMAF), Integrated Nutrient Management (INM), Soil Health Management (SHM), Paramparagat Krishi Vikas Yojana (PKVY), Soil and Land Use Survey of India (SLUSI), National Rainfed Area Authority (NRAA), Mission Organic Value Chain Development in North-Eastern Region (MOVCDNER), National Centre for Organic Farming (NCOF), Central Fertilizer Quality Control and Training Institute (CFQC&TI)

TEEB in India

TEEB has been applied in three sectors –

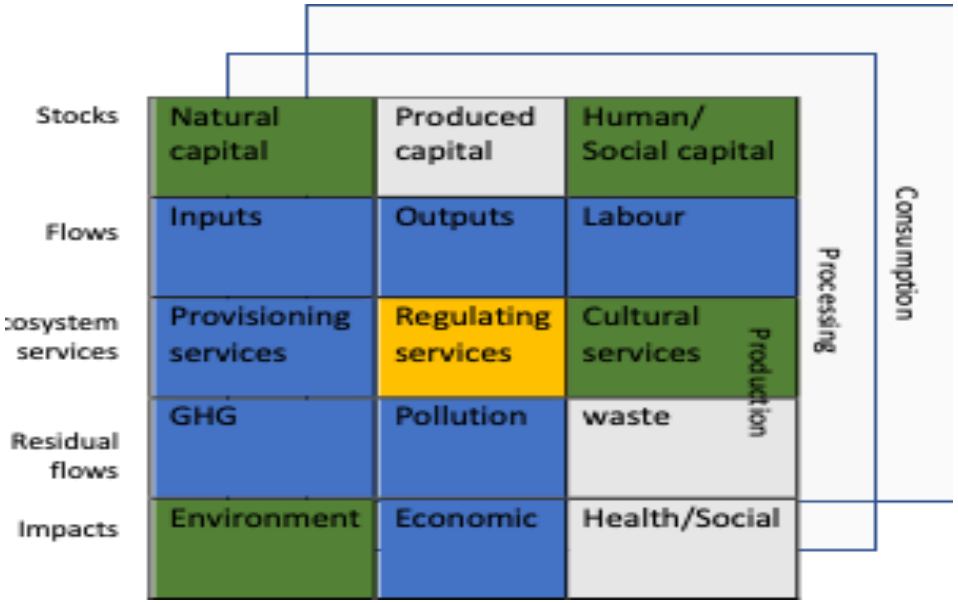
- Forests, Inland wetlands, Coastal and marine ecosystems
- to identify the importance, issues, and the challenges of economic valuation of ecosystems and biodiversity
- In addition to this, there are several Natural Resource Accounting (NRA) Projects being undertaken in India

TEEBAgriFood in India



TEEBAgriFood can help in identifying

- best practices or management systems that can be promoted by relevant policies.
- transitions to sustainable agriculture must follow three distinct non-linear phases: efficiency, substitution and redesign.



FOUR Options

1. EVALUATING ZERO BUDGET NATURAL FARMING
2. PROMOTING SUSTAINABLE LAND MANAGEMENT FOR AGRICULTURE IN DROUGHT PRONE AREAS
3. STRENGTHENING AGROFORESTRY INITIATIVES IN INDIA
4. MOVING TOWARDS A SUSTAINABLE RICE AGRONOMY

OPTION 1. Evaluating Zero Budget Natural Farming

What is ZBNF?

It is a farming practice involving natural growth of crops without adding any fertilizers and pesticides

Why is TEEB useful for this option ?

Multi-location studies are needed to scientifically validate the long-term impact and viability of the model before it can be scaled up

What should the study include?

- Go beyond productivity per hectare analysis
- Assess impact on soil health and yields **for different crops** overtime
- Identify potential region with opportunity for impact

Select Scientific Journal	
Centre for Economic and Social studies (2019) (commissioned by RySS)	↓COST OF INPUTS for paddy (with variation) ranged from 27 % to 90 % - depending on the district
Kumar et al (2019)	↑ yield for rice in AP ↓ Yield for sugar cane in both Karnataka and Andhra Pradesh
Smith et al. (2020)	↑ Yield in low input systems ↓ Yield in high input systems

Context of India

- Increasing fertilizer use- Between 1977 and 2019, **per hectare usage** increased from 24 kg to 138 kg (ICRIER, 2019).

- Growing body literature on the impact of ZBNF (placed in increasing order of credibility)
  1. Blogs - farmers success stories
  2. Newspaper articles - Moongbay and down to earth
  3. Scientific journals- Andhra Government / independent

  Positive-impacts on yields, increase in income

More needs to be done to test the robustness of ZBNF

Option 1 Opportunity for Impact

Impact - ORGANIC FARMING Umbrella

- **Paramparagat Krishi Vikas Yojana (PMKSY)** launched to promote organic farming among small and marginal farmers.
- **The National Project on Organic Farming** of MoAFW saw a significant jump in allocation between 2018-19 and 2020-21 (from 20 million INR to 125 million INR).
- **High level Panel at NITI Aayog** reiterated the importance of natural farming and the need to look beyond yields at diversity and nutrition. (May 2020)

Impact- ZBNF

- **Finance minister's announcement** "there will be "strengthening organic farming in the country,…, and also ZBNF (February, 2020)

Option 2: Sustainable Land Management for Agriculture in Drought Prone Areas

What is SLM?

- It is defined as "**use of land resources …** to meet changing human needs, while simultaneously ensuring the **long-term productive potential of these resources** and the maintenance of their environmental functions".(IPCC Report- Climate Change and Land, 2019)
- Long term-> zoom in long terms scenarios of Climate Change deeply

Why is TEEB needed for this option ?

- To investigate, land-water- climate change and agriculture with a systems approach in drought prone areas

What should the study do?

- Include Scenario Analysis for agriculture (modelled with climate)
- Include Human and Social dimensions - impact of climate variability on land-water- crops- biodiversity and livelihoods
- Identify potential region with opportunity for impact

Context:

- 96.4 million ha of the country is affected by land degradation (29.32% of the Geographic Area of India) (SAC, 2016)
- Water erosion (10.98%), vegetation degradation (8.91%) are top two causes of land degradation. (SAC, 2016)
- During 1996-2015, nearly 17.5 million people annually were affected by droughts in India. (United Nations World Water Development Report, 2019)
- An economic loss of 2.5 percent of GDP due to land degradation in India (TERI, 2018)
- Increasing trends in the frequency of dry days in most parts of the country. (India's 2nd BUR to UNFCCC - Indian Meteorological Department (IMD Data)
- Climate change exacerbates land degradation (IPCC Report- Climate Change and Land Report, 2019)

Challenges

- Over extraction of groundwater, monoculture, growing high water use crops in drought areas
- Silo approach – land- water- energy- agriculture- climate

Option 2 Opportunity for Impact

- **National Mission for Sustainable Agriculture** under the Sustainable Agriculture Mission, one of the eight Missions outlined under National Action Plan on Climate Change (NAPCC).

- **Pradhan Mantri Krishi Sinchayee Yojana** (PMKSY)- inter-ministerial scheme of MoJS, MORD and MoAFW- to extend the coverage of irrigation and improve water use efficiency with end-to-end solutions for source creation, distribution, management, field application and extension.

Option 3: Strengthening agroforestry initiatives in India

What is Agroforestry?

- It is defined as land-use systems whereby a combinatory approach is utilized for the cultivation of woody perennials such as trees, shrubs, palm, bamboo etc. along with crops and/or animals within the same land management unit

Why is TEEB needed for this option ?

- More research is needed to identify different agroforestry models suitable for diverse ecological landscapes of India

What should the study do?

- ➢ Quantify value of environmental benefits
- ➢ Identify potential region with opportunity for impact

Context:

- 23.25 million hectares is under agroforestry in India, i.e. 8.69% of the total geographical area- Central Agroforestry Research Institute (ICAR-CAFRI, 2019)
- 1st country to have National Agroforestry policy- 2014- The policy seeks to address the bottlenecks impeding large scale implementation
- Potential for agroforestry untapped- Studies show increase in farm profitability with an annual income of INR 3.64 lakhs per hectare as compared to a rice-wheat cropping system of INR 1.66 lakhs per hectare (Singh, M. et al., 2018).

Challenges:

- Lack of marketing infrastructure and agricultural extension services.
- Lack of research studies on agroforestry systems at an ecosystem or landscape level as most research focuses on small plots of land.

Option 3 Opportunity for Impact

- National Agroforestry Policy (2014)
- India's NDC Commitments- 1) to increase forest cover to 33 per cent of its geographical area 2) increase carbon sinks- to create an additional **carbon sink** of 2.5 to 3 billion tons of carbon dioxide equivalent through additional forest
- Nation Mission for a Green India (2014) under India's National Action Plan on Climate Change (NAPCC)- To enhance India's diminishing forest cover by increasing green cover across India by five million hectares (mha) and increasing the existing quality of tree cover in another 5 mha.
- Sub-mission on Agroforestry (SMAF) under the National Mission for Sustainable Agriculture
- Mission for Integrated Development of Horticulture (MIDH). Agroforestry initiatives is integral for the success of the mission.

OPTION 4: Moving towards a sustainable rice agronomy

What is ‘Sustainable Rice Agronomy’ ?

- Agronomy - maximise yields for profit.
- Combines sustainable rice production with Agronomy

Why is TEEB needed for this option ?

- A systems approach for medium and long-term studies is required to assess costs and benefits associated with different rice management practices .

What should the study do?

- A range of approaches to sustainable rice production, depending on the context for instance, conservation agriculture practices such as zero-tillage, dry direct seeding of rice.

Context

- 1/3rd of the total rice cultivation in the world happens in India. (World: 157 million hectares India: 44.1 million hectares)FAOSTAT
- Largest exporter of rice in the world, I/4th of the global exports of rice (MoAFW, 2019)
- Concerns over soil fertility, productivity and declining yields.

Challenges

- High intensity rice production resulting in salinization, water-logging, loss of soil biodiversity etc.(Shukla, A. K., and Behera, S. K. (2011).
- Number of small and farmers in the country- over 78% of farmers with limited resources for increasing efficiency and productivity .
- To meet a projected Indian population of 1.8 billion by 2050, India would need to double its current cereal production (Swaminathan, M.S., Bhavani, R.V., 2013)

Option 4 Opportunity for Impact

- **National Food Security Mission** (NFSM) was launched in 2007-08 to increase the production of rice, wheat and pulses through area expansion and productivity enhancement; restoring soil fertility and productivity; creating employment opportunities; and enhancing farm level economy.
- **National Policy for Farmers 2007** aims aims to improve economic viability of farming and increase net income of farmers.
- **National Mission for Sustainable Agriculture** (NMSA) under National Action Plan on Climate Change.
- **Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)** is an inter-ministerial scheme of MoJS, MoRD and MoAFW.

Thank you

Session 1: SETTING THE CONTEXT

UN environment programme

TEEB

TEEB Implementation:

Promoting a Sustainable Agriculture and Food Sector

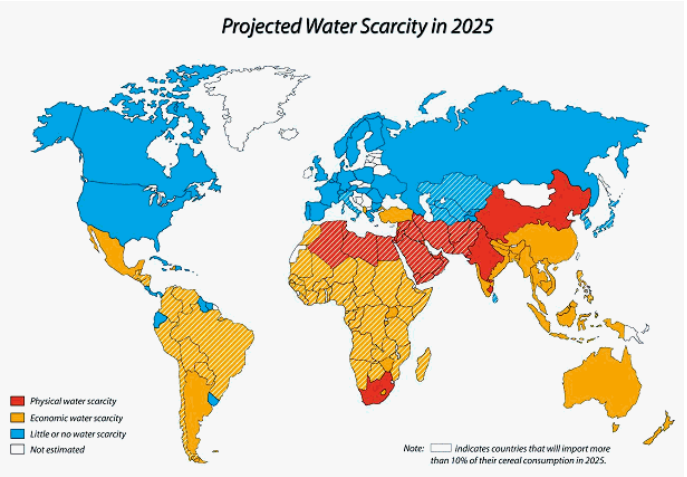
RESEARCH PRIORITIES

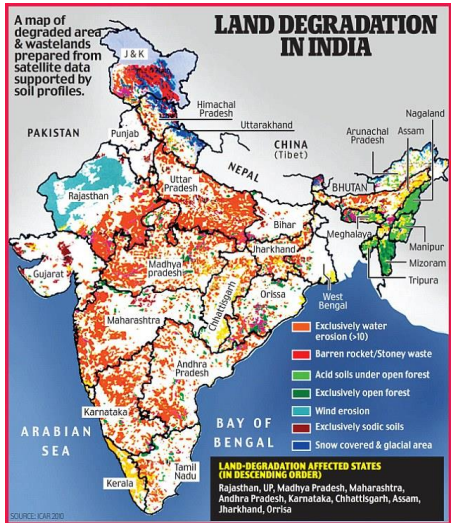
Prof. Ravindranath. N.H

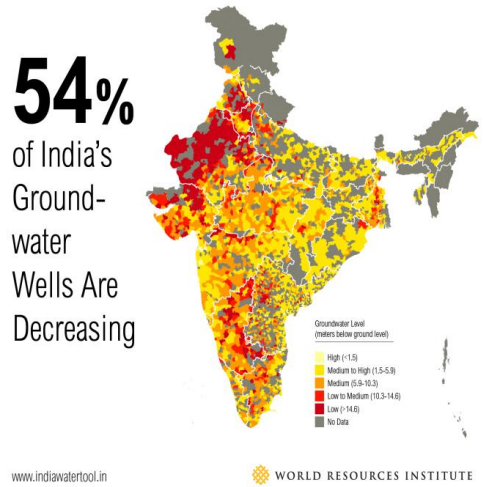
Indian Institute of Science

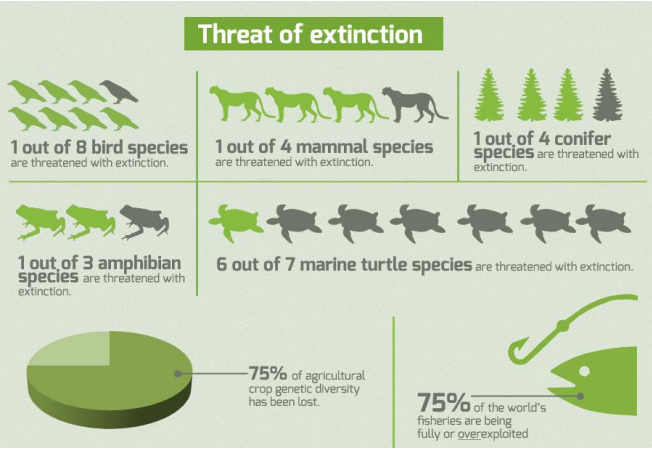
Bangalore

ENVIRONMENTAL CHALLENGES FACING AGRICULTURE









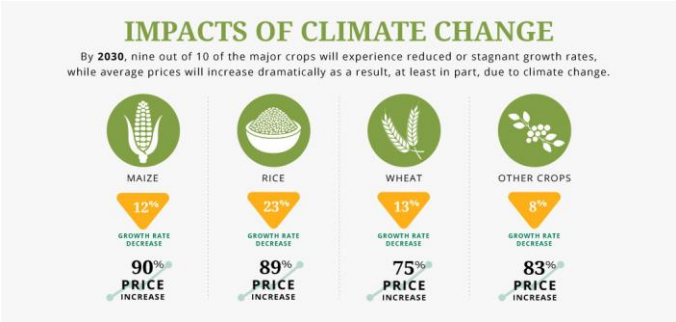
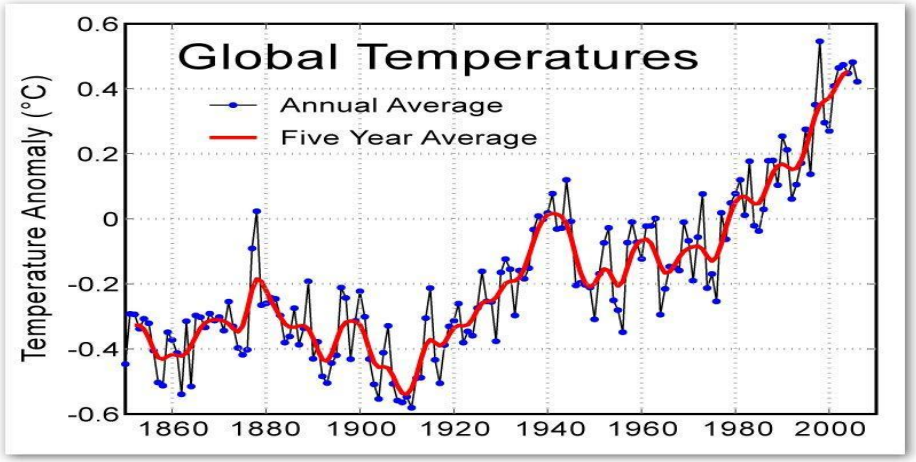
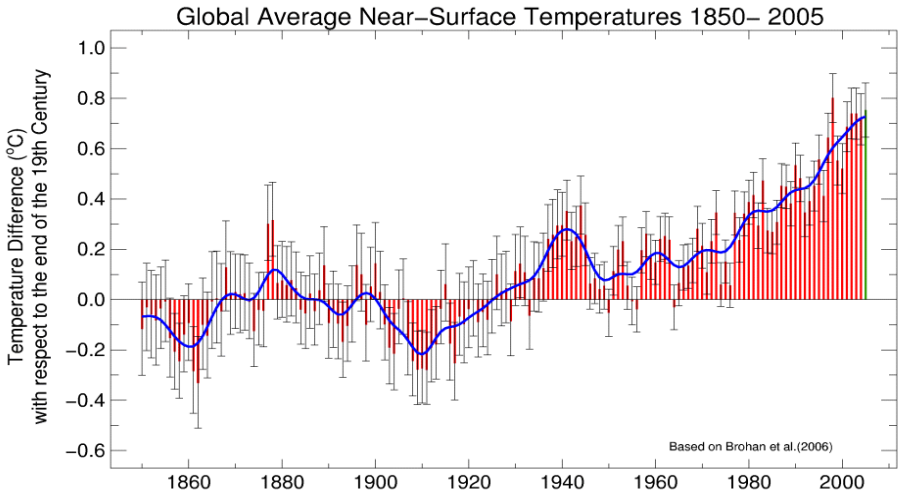


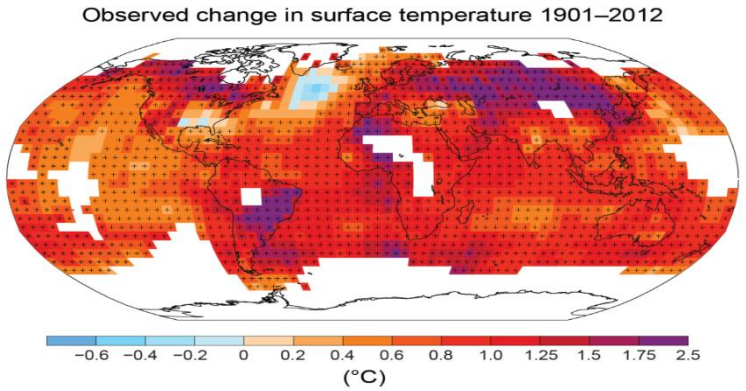
Fig. 1: Global state and trends figures for key elements of biodiversity important to food and agriculture.

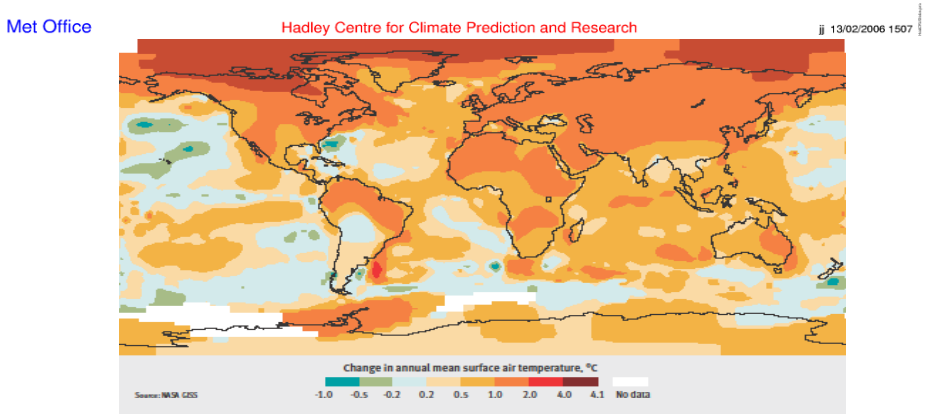
From: Declining biodiversity for food and agriculture needs urgent global action

Is Global Warming occurring?



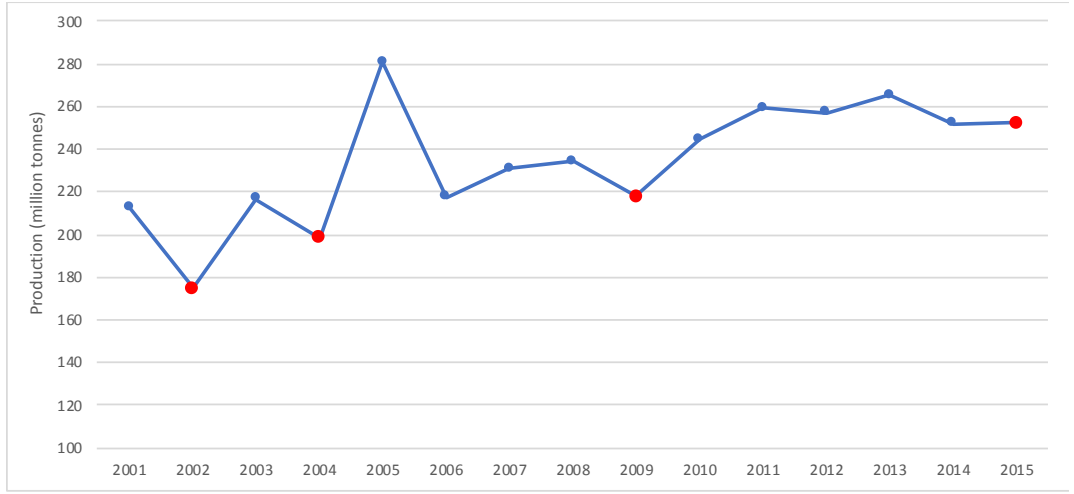




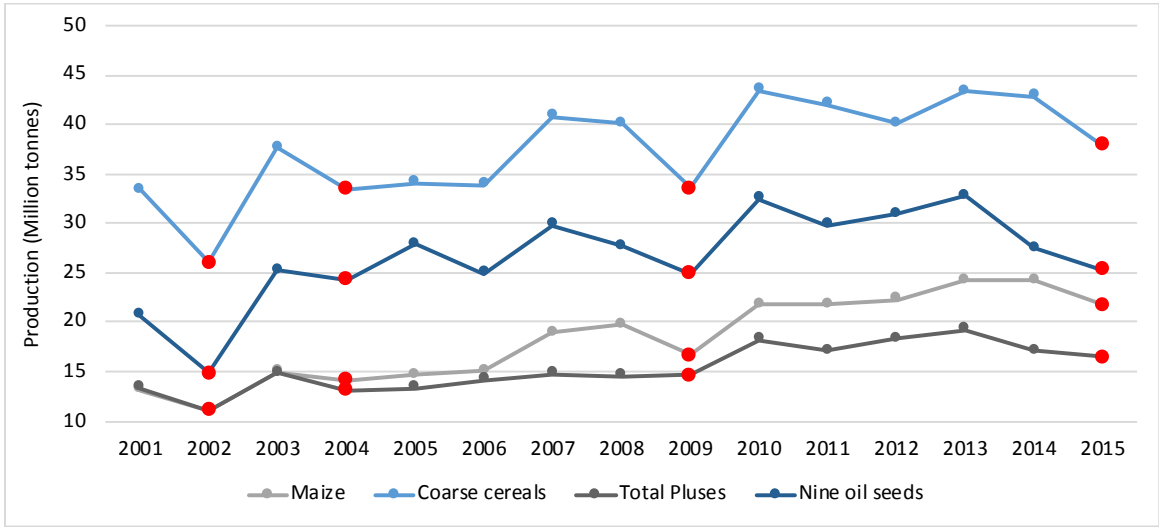


Trends in Food production and Crop Productivity

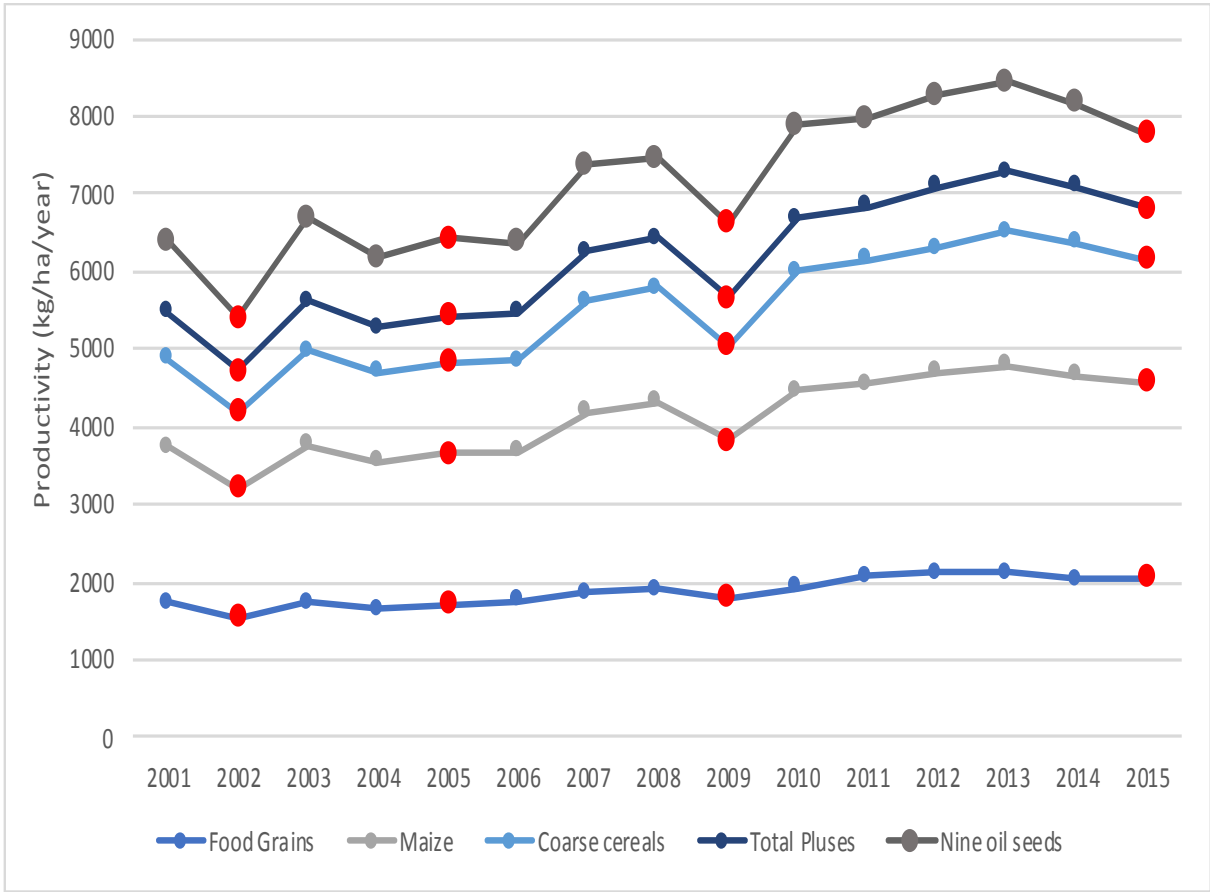
2001 to 2015



Trends in total food production (million tonnes)



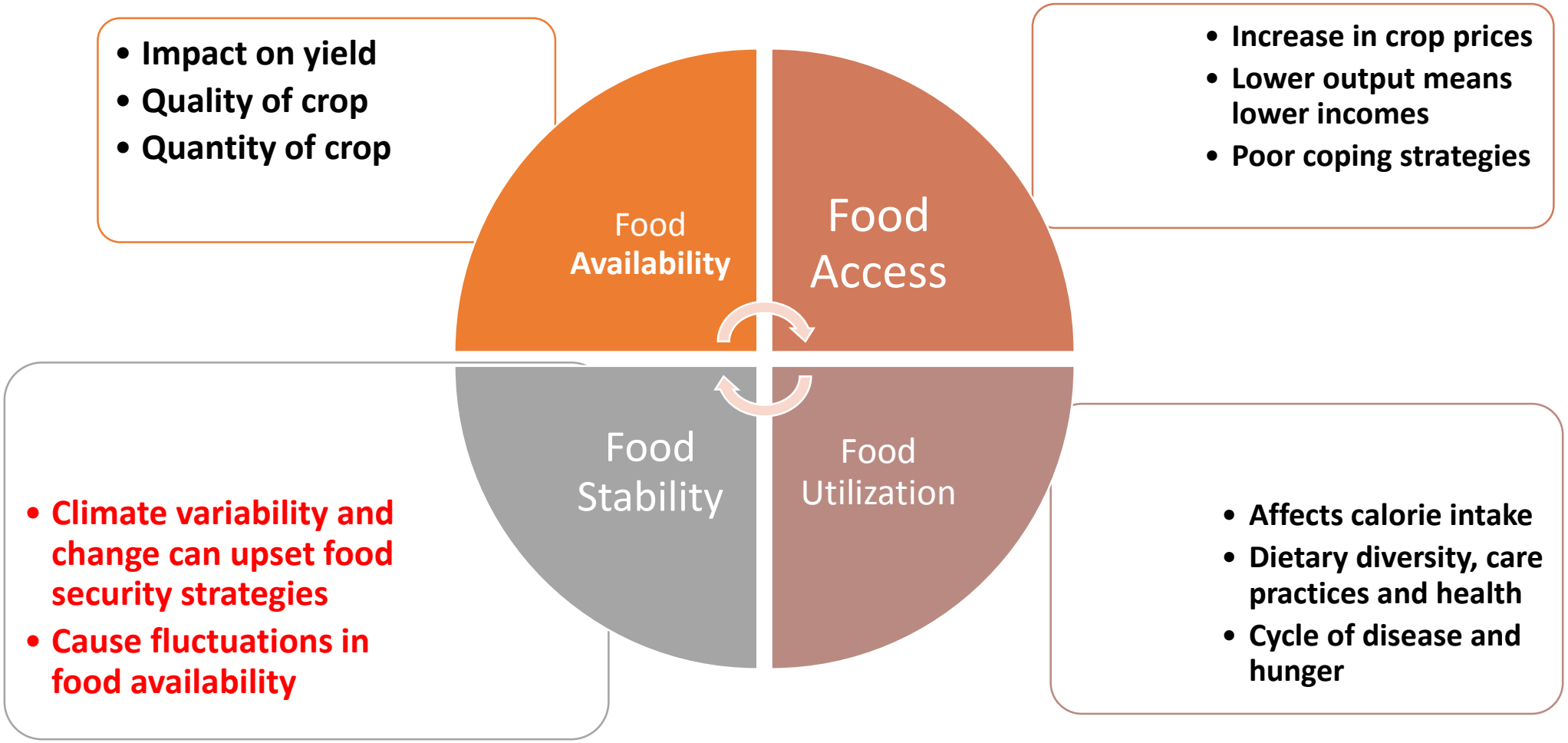
Trends in production (million tonnes) of major rainfed crops



Trends in crop productivity (kg/ha/year) of rainfed crops

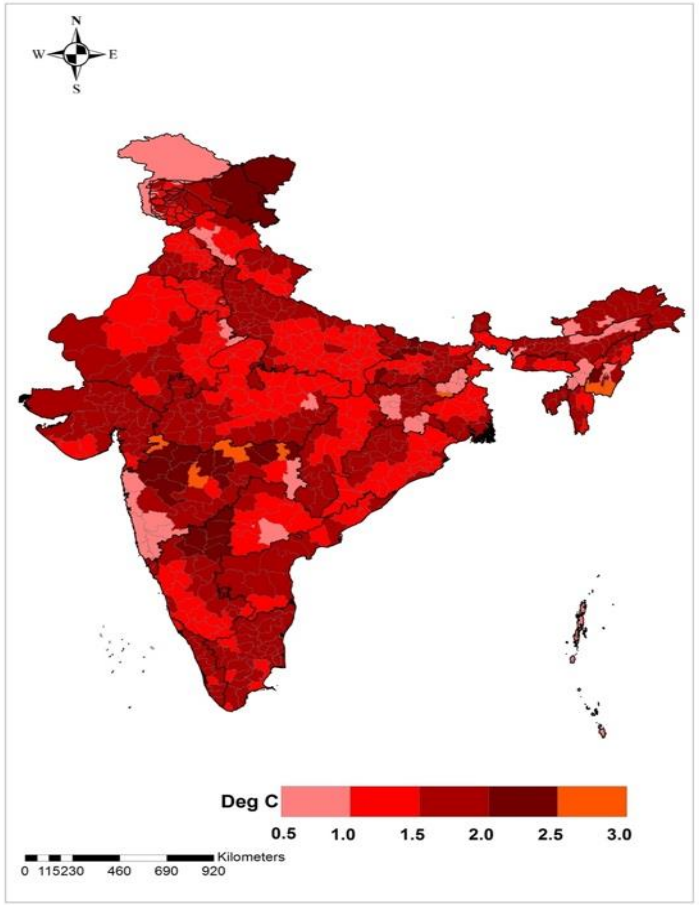
Climate Variability and Change Implications for Food Security?

Source: World Food Programme, 2016

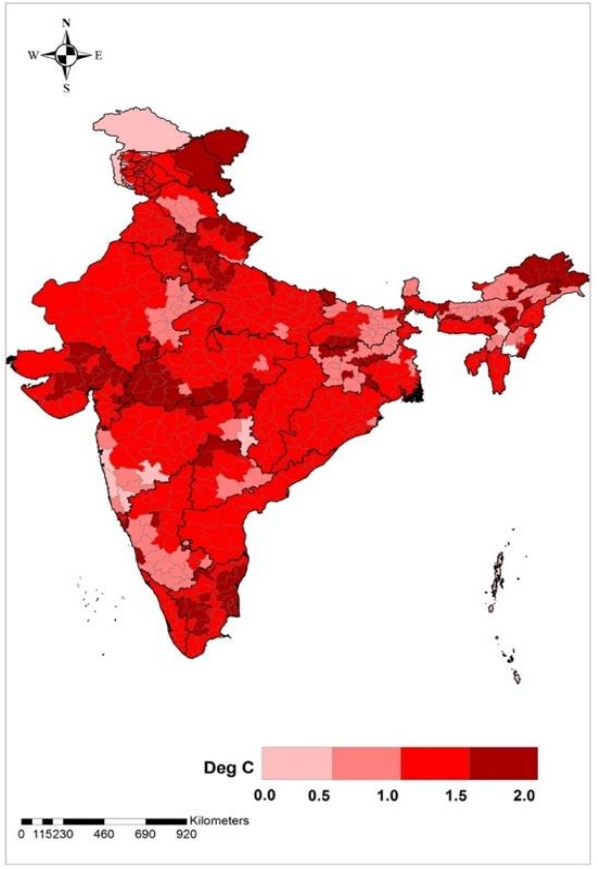


Warming projections for 2035

RCP 4.5

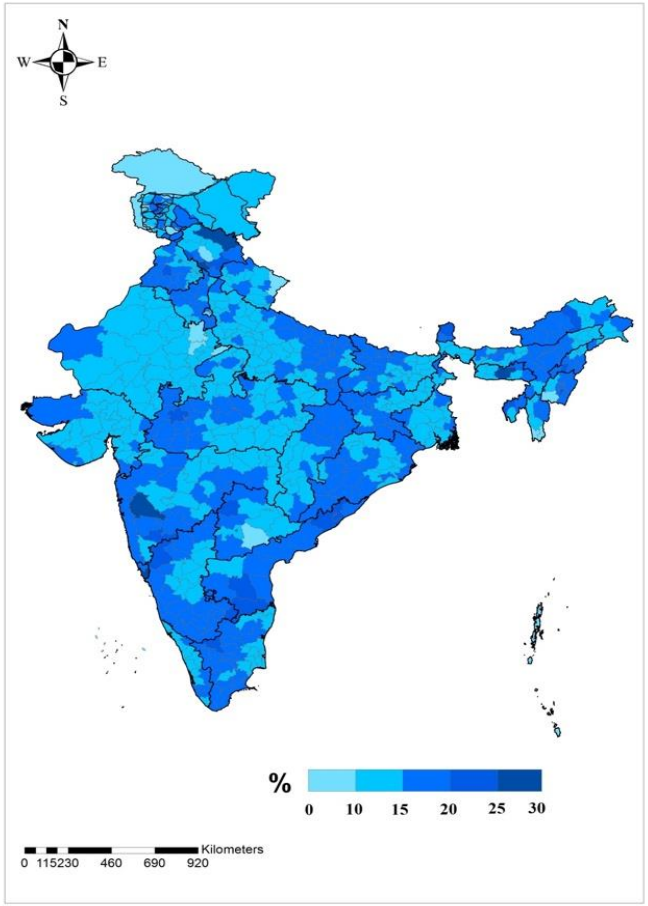


RCP 8.5

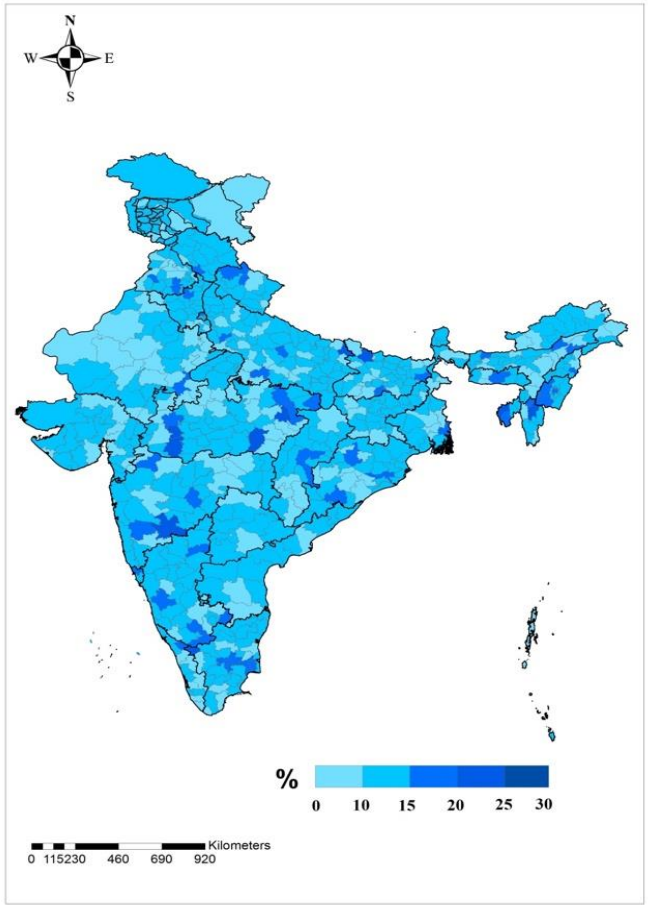


Projected changes in Rainfall - JJAS

RCP 4.5



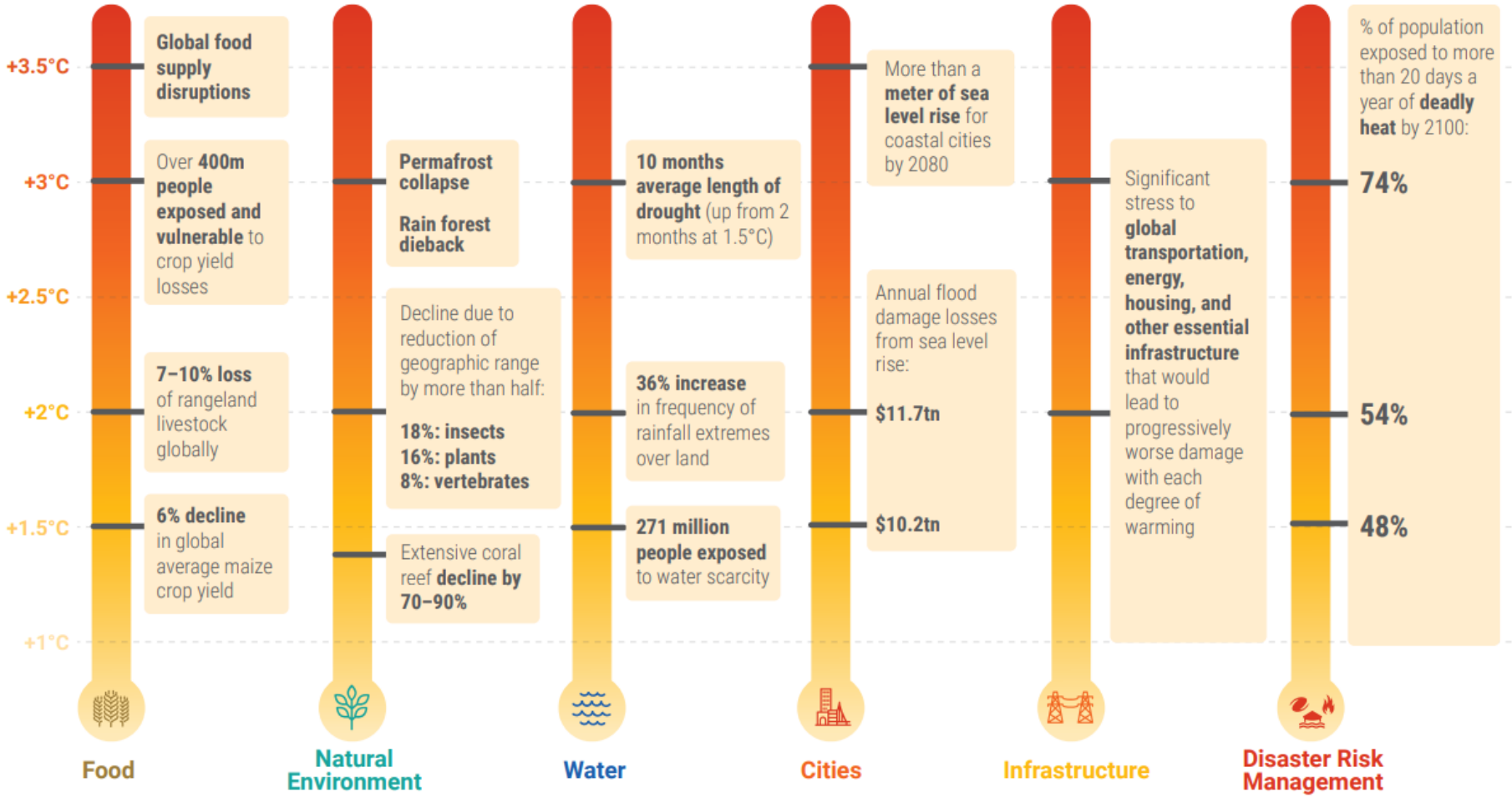
RCP 8.5



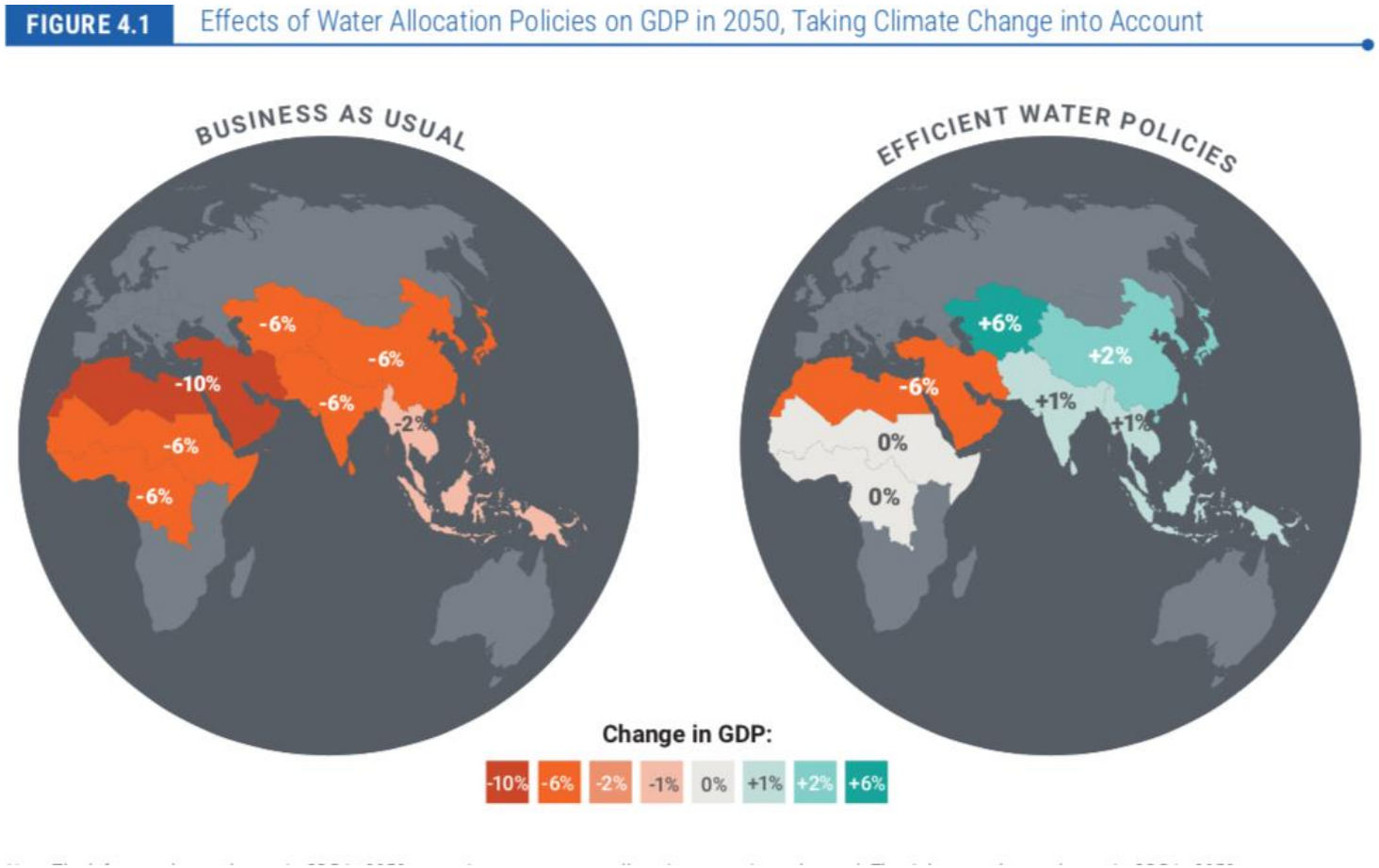
Climate Change: Risk and Impacts

1. **Without adaptation, climate change may depress growth in global agriculture yields up to 30 percent by 2050.**
   - **The 500 million small farms around the world will be most affected.**
2. **The number of people who may lack sufficient water, at least one month per year, will soar from 3.6 billion today to more than 5 billion by 2050.**
3. **Increased flooding, rising seas and greater storm surges and cyclones**
   - **Could force hundreds of millions of people from coastal areas**
   - **Impact Fish biodiversity and catch**
   - **Impact Coastal agriculture**

The Risk of Catastrophic Events Increases with Temperature



Implication of Water allocation in the context of Climate Change



Challenges facing agriculture and its Sustainability

1. **Limited scope for land expansion for agriculture in India**
2. **Land degradation – Soil erosion, salinity, desertification, loss of soil fertility**
3. **Decline in ground water – In most districts**
4. **Decline in water storage capacity of water bodies; Dams, tanks, ponds**
5. **Projected warming and changes in Rainfall intensity and distribution**
6. **Extreme events – El Nino, Droughts and floods – leading to crop loss**
7. **High variability of crop yields – linked to rainfall variability / unseasonable rainfall events**
8. **Lack of access to weather forecasts and climate information services**
9. **Lack of access to agro-met or crop advisories**
10. **Lack of access to quality seeds and storage facilities**
11. **Poor coverage of crop insurance**

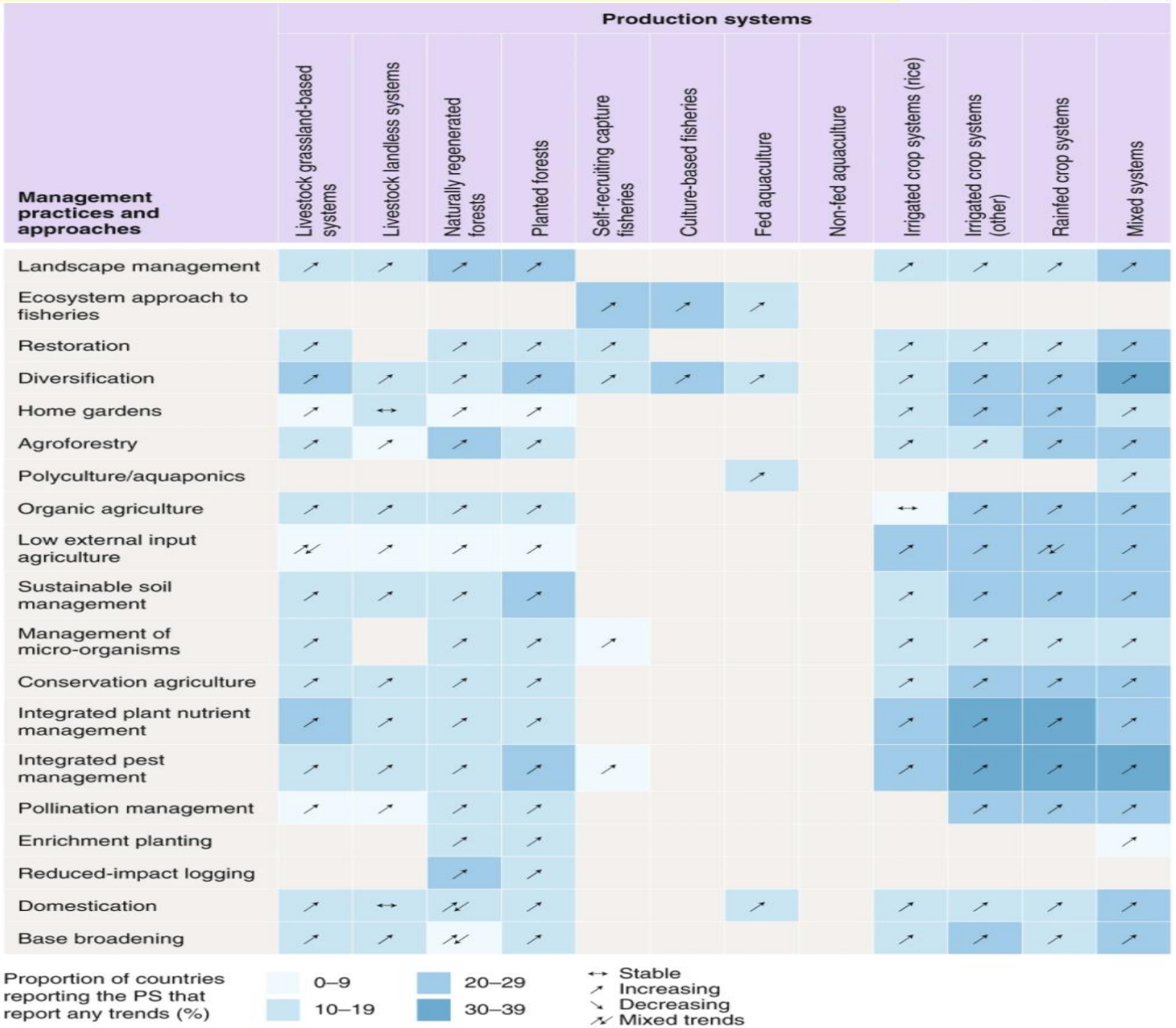
Sustainable Agriculture; Research Challenges

1. **Assess the Status, Trends and Drivers and Economic Implication of Loss Biodiversity**
   - On agricultural production sustainability at local and regional scales.
2. **Economic loss and Damage assessment due to degradation of Natural capital to crop production, farmers' livelihoods and incomes; soil, water, BD, pollinators, etc.**
   - Habitat destruction, pollution, inappropriate use of agricultural inputs, overharvesting, pests, diseases and invasive species, loss of pollinators,
   - Policies as Drivers; Land, water, fertilizer, irrigation, electricity, crop pricing, etc.
3. **Strategies and interventions to conserve and restore natural capital to enable sustainable and profitable agriculture; at local and regional scales.**
4. **Sustainable agricultural practices – region or location specific**
   - Which are also profitable to farmers even in the short term
5. **Impacts of projected climate change at district to Panchayat scale for different crops and**
   - Leading to Development of adaptation strategies and practices for different cropping systems
6. **Generating and creating access to information on weather, climate and adaptation, status of natural resources at local levels**
   - Weather advisories, climate change advisories and Agro-Met advisories at block and panchayat level

Research Challenges: Climate Change and Agriculture

1. **Reliable-short term Climate Change projections at local level**
   - Watershed/Block/Cropping System/Forest type
   - Projection of Extreme events; droughts / Floods/ Hurricanes
2. **Multi-model based impact assessments & Experimental simulations**
   - Local or micro-level
   - Crops/forest types/watersheds
3. **Assessment of economic loss and damage due to climate change**
   - At regional and local level and for different cropping systems
4. **Vulnerability assessment using IPCC-2014 framework**
   - Current climate variability & Climate Change scenarios
5. **Adaptation / Resilience planning**
   - Breeding new crop varieties; drought, temperature, salt and pest tolerant varieties
   - Development of climate resilient Agronomic, soil and water management practices,
   - Monitoring and measurement of impact of adaptation actions
   - Practical tools for mainstreaming adaptation
6. **Long-term monitoring of CC impacts on Agriculture, soils, biodiversity, river systems, mountains, biodiversity, etc.**

Thank you



Analysis based on 91 country reports. See ref. [12] for details of the methodology. PS, production systems. Figure reproduced with permission from ref. [12], FAO.

Managing soil resources towards sustainable agriculture in India

A K Patra

ICAR- Indian Institute of Soil Science

Bhopal 462038

FOOD GRAIN PRODUCTION IN INDIA (1947 to 2020)

Year	Population (10^6)	Food grain (mt)
1947	330	50
2019-20	1380	296
Factor	4.18	5.96
Projection 2050	1700	400
Factor	5.15	8.0

- Hunger and malnutrition dilemma in India
- SDGs

Challenges

- **Shrinking and deteriorating natural resources (land, water & biodiversity) for sustainable intensification of food production**
- ***Increasing cost of energy and inputs.***
- ***Risk of climate (abiotic and biotic stresses)***
- ***Decreasing factor productivity and farmers' income***
- **Adverse environmental impacts of unsustainable agricultural intensification**

Major Focus

Increasing Productivity and Farmers' Income, Food and Nutritional Security, Ecological Safety

- **Soil Health Improvement**
  - *Organic recycling, INM, fossil fuel substitution*
  - *Enhancing NUE*
  - *New fertilizer products (Nano, specialty)*
  - *Restoration, Remediation and Reclamation of problematic soils*

- **Water Resources Management**
  - *Reduce, Recycle, Reuse, Recharge (4R)*

- **Climate Smart Agriculture**
  - *Conservation agriculture*
  - *Integrated Farming Systems, Agroforestry*
  - *C Management (e.g., 4PT)*
  - *Smart advisories/contingency planning*

- **Precision/Digital Agriculture**

- **Ecosystem Services**
  - *Valuation*
  - *Policy and incentives*

- **Extension and mass awareness**

Thank you

Session 2: MODERATED DISCUSSION

UN environment programme

TEEB

Mr. JIGMET TAKPA
Joint Secretary, Ministry of Environment, Forest and Climate Change

- Officer of the Indian Forest Service (IFS), presently serving as Joint Secretary and heading the Desertification Cell in the Ministry of Environment, Forest and Climate Change, Government of India.
- National Focal Point of UNCCD for India
- Mr. Takpa has carried out pioneering work in biodiversity conservation, rural development in Ladakh. These have resulted in a rapid growth in the populations of key species in the Ladakh Himalayas such as the snow leopard, bar-headed goose, black-necked crane, wild yaks, the asiatic ibex and the Tibetan antelope.

Mr. UMAKANT
Joint Secretary, Department of Land Resources, Ministry of Rural Development

- Officer of the Indian Administrative Service (IAS), presently serving as the Joint Secretary, Department of Land Resources, Ministry of Rural Development.
- Holds the portfolio for the Integrated Watershed Management Programme (IWMP) and international cooperation in respect of watershed management.

- Held several important portfolios in north east India which is rich in Biodiversity in Arunachal Pradesh and Mizoram.
- Worked in the Ministry of Environment, Forest and Climate Change, Delhi: managing the work on Forest fire, Climate Change, Compensatory Afforestation Fund of India, among others.

Session 3:
OPEN
DISCUSSION

All participants

UN environment programme

TEEB

Summary
Way Forward