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
I. What is TEEBAgriFood?
TEEB initiative (2008-2012)

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

Input to UNFCCC 2009

Climate Issues Update

TEEB End User Reports Brussels 2009, London 2010

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

TEEB Synthesis

TEEB Books

CBD COP11 India

National TEEB Work

Sectoral TEEB Work

Business Externalities Work

Rio+20 Brazil
TEEB for business

The Economics of Ecosystems and Biodiversity in Business and Enterprise

Edited by Joshua Bishop

NATURAL CAPITAL AT RISK:
THE TOP 100 EXTERNALITIES OF 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.

<table>
<thead>
<tr>
<th>RANK</th>
<th>SECTOR</th>
<th>REGION</th>
<th>NATURAL CAPITAL COST, US$ BN</th>
<th>REVENUE, US$ BN</th>
<th>IMPACT RATIO</th>
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<tbody>
<tr>
<td>1</td>
<td>COAL POWER GENERATION</td>
<td>EASTERN ASIA</td>
<td>452.8</td>
<td>4431</td>
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<td>2</td>
<td>CATTLE RANCHING AND FARMING</td>
<td>SOUTH AMERICA</td>
<td>353.8</td>
<td>166</td>
<td>18.8</td>
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<td>COAL POWER GENERATION</td>
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<td>WHEAT FARMING</td>
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<td>8.4</td>
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<td>RICE FARMING</td>
<td>SOUTHERN ASIA</td>
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<td>658</td>
<td>3.6</td>
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<td>6</td>
<td>IRON AND STEEL MILLS</td>
<td>EASTERN ASIA</td>
<td>225.6</td>
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<td>CATTLE RANCHING AND FARMING</td>
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<td>EASTERN ASIA</td>
<td>99.3</td>
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<td>CORN FARMING</td>
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<td>SUGAR CANE</td>
<td>SOUTHERN ASIA</td>
<td>75.6</td>
<td>60</td>
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<td>19</td>
<td>PETROLEUM AND NATURAL GAS EXTRACTION (includes water and land use)</td>
<td>EASTERN EUROPE</td>
<td>72.6</td>
<td>3716</td>
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<td>NORTHERN AMERICA</td>
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<td>1227</td>
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</table>
The visible and invisible flows of agricultural production

Nature (December 2016)

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

Visible flows:
- Irrigation
- Fertilizers
- Pesticides
- Bio-technology
- Labor
- Breeding
- Machinery

Human Systems

Agriculture & Food Systems:
- Seeds
- Crops
- Yields

Agricultural Production

Biodiversity & Ecosystems
The visible and invisible flows of agricultural production

**HUMAN SYSTEMS**
- Irrigation
- Fertilizers
- Pesticides
- Machinery
- Labor

**AGRICULTURE & FOOD SYSTEMS**
- Seeds
- Crops
- Yields

**TEEB for Agriculture**

**Biodiversity & Ecosystems**
- Erosion control
- Soil formation
- Nutrient cycling
- Pest control
- Genetic diversity
- Pollination
- Elevation of extreme events
- Freshwater provisioning
- Climate regulation

[teebweb.org](http://teebweb.org)
The visible and invisible flows of agricultural production

HUMAN SYSTEMS
- Irrigation
- Fertilizers
- Pesticides
- Bio-technology
- Labor
- Breeding
- Machinery
- Employment
- Food and nutrition
- Fuels
- Fibers
- (Agro)tourism

AGRICULTURE & FOOD SYSTEMS
- Seeds
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AGRICULTURAL PRODUCTION
- Erosion control
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- Genetic diversity
- Pollination
- Moderation of extreme events
- Freshwater provisioning
- Climate regulation
- Habitat encroachment
- Loss of ecosystem complexity
- Species reduction
- Soil erosion
- Pollution (air, land & water)
- GHG/Climate

Biodiversity & Ecosystems

teebook.org
The visible and invisible flows of agricultural production

HUMAN SYSTEMS

- Irrigation
- Fertilizers
- Pesticides
- Breeding
- Machinery
- Labor
- Employment
- Food and nutrition
- Fibers
- (Agro)tourism
- Health impacts
- Culture heritage
- Access to recreation

AGRICULTURE & FOOD SYSTEMS

- SEEDS
- CROPS
- YIELDS

AGRICULTURAL PRODUCTION

- Erosion control
- Soil formation
- Genetic diversity
- Pest control
- Climate regulation
- Pollination
- Provisioning
- Freshwater
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The visible and invisible flows of agricultural production

TEEB for Agriculture &

HUMAN SYSTEMS
- Irrigation
- Fertilizers
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- Fibers
- (Agro)tourism
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AGRICULTURE & FOOD SYSTEMS
- SEEDS
- CROPS
- YIELDS

AGRICULTURAL PRODUCTION
- Erosion control
- Pest control
- Genetic diversity
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- Habitat encroachment
- Pollution (air, land, water)

BIODIVERSITY & ECOSYSTEMS
- Soil formation
- Genetic diversity
- Pollination
- Climate regulation
- Loss of ecosystem complexity
- Species reduction
- GHG/Climate

teebweb.org
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

Financial flows

Time

2020

2050

Agroforestry products

Monocrop (or an alternative)
Agro-forestry versus monocrop: 2020 including externalities

Economic flows (including externalities)

- Agroforestry products
- Monocrop (or an alternative)
- Agroforestry including externalities
- Monocrop including externalities

Time: 2020 to 2050
Agro-forestry versus monocrop: 2020 including externalities

Financial/Economic flows

- Agroforestry products
- Monocrop (or an alternative)
- Agroforestry including externalities
- Monocrop including externalities

Time

2020

2050
Agro-forestry versus monocrops: 2050 for the monocrop

Financial/Economic flows

- Agroforestry products
- Monocrops (or an alternative)
- Agroforestry including externalities
- Monocrops including externalities

Time

2020

2050
Agro-forestry Scenario analysis

Gross output of coffee agroforestry ecosystem services ($ million)

Scenarios

1
2
3

Maize
Coffee
Other provisioning ES (fuel wood, honey)
Carbon regulation
Water yield
Erosion control

www.teeweb.org/ agriculture-and-food/agroforestry
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

### Opportunities

<table>
<thead>
<tr>
<th>Opportunities</th>
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<tbody>
<tr>
<td>1. agricultural extension</td>
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<tr>
<td>2. peer-to-peer learning</td>
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<td>3. macro accounting</td>
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<td>4. sustainability standards and certification</td>
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<td>5. Payment for Ecosystem Services</td>
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<td>6. UN-REDD</td>
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<td>7. banking sector</td>
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<td>8. reforms to taxes and subsidies</td>
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<td>9. land tenure</td>
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<td>10. Intra-government jurisdictions of line ministries</td>
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### Change agents

<table>
<thead>
<tr>
<th>National Government</th>
<th>Local Government</th>
<th>Farmers</th>
<th>Agri-Business</th>
<th>Civil Society</th>
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[teebweb.org](http://teebweb.org)
Project log frame (overview)

<table>
<thead>
<tr>
<th>Work Packages and activities</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
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<tbody>
<tr>
<td>WP 1 Country specific analysis – lessons learned from previous interventions</td>
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<td>WP 2 Policy mapping</td>
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<td>WP 3 Determine and refine the case studies</td>
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<td>WP 4 Engaging agri-business with NCP</td>
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<tr>
<td>WP 5 Scenario Analysis</td>
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<tr>
<td>WP 6 Develop a roadmap of concrete steps to implement a change</td>
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<tr>
<td>WP 7 Deliver the change and ensure project sustainability</td>
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<tr>
<td>WP 8 Communicating biodiversity benefits and mainstreaming</td>
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</tbody>
</table>
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 6 step approach**

**STEP 1:** Refine the objectives of a TEEB Country Study by specifying and agreeing on the key policy issues with stakeholders

**STEP 2:** Identify the most relevant ecosystem services

**STEP 3:** Define information needs & select appropriate methods

**STEP 4:** Assess and value ecosystem services

**STEP 5:** Identify and outline the pros and cons of policy options, including distributional impacts

**STEP 6:** Review, refine and report – Theory of Change

**Scenario development steps**

Iterative approach in which scenarios are revised based on feedback from decision makers

- Select the right scenario approach
- Develop scenario storylines
- Create scenario maps: how ecosystem service provisioning alters tomorrow compared to today
- Scenario modeling: analysis of marginal change over time
- Use results: comparative change of ecosystem services under different scenarios

teebweb.org
Dr. Salman Hussain

salman.hussain@unep.org

UNEP TEEB Office
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)
Status of agriculture and food in India

Food grain requirement (million tonnes)
- 1950: 50.8 million tonnes
- 2020: 285 million tonnes
- 2050 (Projected): 333 million tonnes

Population (billion)
- 1950: 0.37 billion
- 2020: 1.35 billion
- 2050 (Projected): 1.62 billion

Share of agriculture in Indian GDP (%)
- 1951: 51.81%
- 2018/19: 15.87%
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

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

Employment in Agriculture (% of Total Employment)

- 1995: 70%
- 2000: 60%
- 2005: 50%
- 2010: 40%
- 2015: 30%
- 2018: 20%
- 2050 (projected): 10%

(Images of a rural scene with cows and a person walking)
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
<table>
<thead>
<tr>
<th>Theme</th>
<th>Challenges</th>
<th>Policy response</th>
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<tbody>
<tr>
<td>Social capital</td>
<td>Food security</td>
<td>TPDS</td>
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<tr>
<td>Human capital</td>
<td>Health</td>
<td>Nation Commission on Macroeconomics and Health</td>
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<tr>
<td>Natural capital</td>
<td>Sustainable agriculture</td>
<td>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&amp;TI)</td>
</tr>
</tbody>
</table>
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 over time
- Identify potential region with opportunity for impact
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
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”\footnote{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
• 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 combinatorial 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.
• 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

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**

- 1/3\textsuperscript{rd} 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, 1/4th 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 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
TEEB Implementation:

Promoting a Sustainable Agriculture and Food Sector

RESEARCH PRIORITIES

Prof. Ravindranath. N.H
Indian Institute of Science
Bangalore
ENVIRONMENTAL CHALLENGES FACING AGRICULTURE

Projected Water Scarcity in 2025

Land Degradation in India

54% of India’s Groundwater Wells Are Decreasing

Threat of extinction

IMPARTS OF CLIMATE CHANGE

By 2050, one out of 10 of the major crops will experience reduced or stagnant growth rates, while average yields will increase dramatically as a result, at least in part, due to climate change.

WATER FOR FOOD

7 BILLION PEOPLE TO FEED TODAY

9 BILLION IN 2050

= 60% more food needed
+19% increase of agricultural water consumption (including both rainfed and irrigated) by 2050
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 crop productivity (kg/ha/year) of rainfed crops

Trends in production (million tonnes) of major rainfed crops
Climate Variability and Change Implications for Food Security?

Source: World Food Programme, 2016

- Impact on yield
- Quality of crop
- Quantity of crop

- Increase in crop prices
- Lower output means lower incomes
- Poor coping strategies

- Climate variability and change can upset food security strategies
- Cause fluctuations in food availability

- Affects calorie intake
- Dietary diversity, care practices and health
- Cycle of disease and hunger
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

- **+1°C**
  - 6% decline in global average maize crop yield

- **+1.5°C**
  - Extensive coral reef decline by 70–90%
  - 7–10% loss of rangeland livestock globally

- **+2°C**
  - Permafrost collapse
  - Rain forest dieback
  - Decline due to reduction of geographic range by more than half:
    - 18%: insects
    - 16%: plants
    - 8%: vertebrates

- **+2.5°C**
  - Over 400 million people exposed and vulnerable to crop yield losses

- **+3°C**
  - Global food supply disruptions

- **+3.5°C**
  - More than a meter of sea level rise for coastal cities by 2080

- **% of population exposed to more than 20 days a year of deadly heat by 2100:**
  - Food: 48%
  - Natural Environment: 54%
  - Water: 74%
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
### Production systems

<table>
<thead>
<tr>
<th>Management practices and approaches</th>
<th>Livestock grassland-based systems</th>
<th>Livestock landless systems</th>
<th>Naturally regenerated forests</th>
<th>Planted forests</th>
<th>Self-recruiting capture fisheries</th>
<th>Culture-based fisheries</th>
<th>Fed aquaculture</th>
<th>Non-fed aquaculture</th>
<th>Irrigated crop systems (rice)</th>
<th>Irrigated crop systems (other)</th>
<th>Rainfed crop systems</th>
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Analysis based on 91 country reports. See ref. 12 for details of the methodology. PS, production systems. Figure reproduced with permission from ref. 15, 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)

<table>
<thead>
<tr>
<th>Year</th>
<th>Population ($10^6$)</th>
<th>Food grain (mt)</th>
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<tbody>
<tr>
<td>1947</td>
<td>330</td>
<td>50</td>
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<td>2019-20</td>
<td>1380</td>
<td>296</td>
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<td>Factor</td>
<td>4.18</td>
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<td>Projection</td>
<td>1700</td>
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<td>2050</td>
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<tr>
<td>Factor</td>
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</table>

- 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
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
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
Summary
Way Forward