The Economics of Ecosystems and Biodiversity
TEEB for Agriculture & Food
Global Symposium, February 2019

Welcoming remarks – the TEEBAgriFood Initiative

25 February 2019, Nairobi

Dr. Salman Hussain, TEEB Coordinator

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

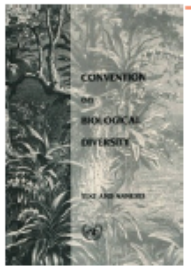
European Commission

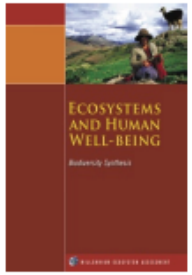
GLOBAL ALLIANCE FOR THE FUTURE OF FOOD

The Economics of Ecosystems & Biodiversity

Image credit: Anup Deodar

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

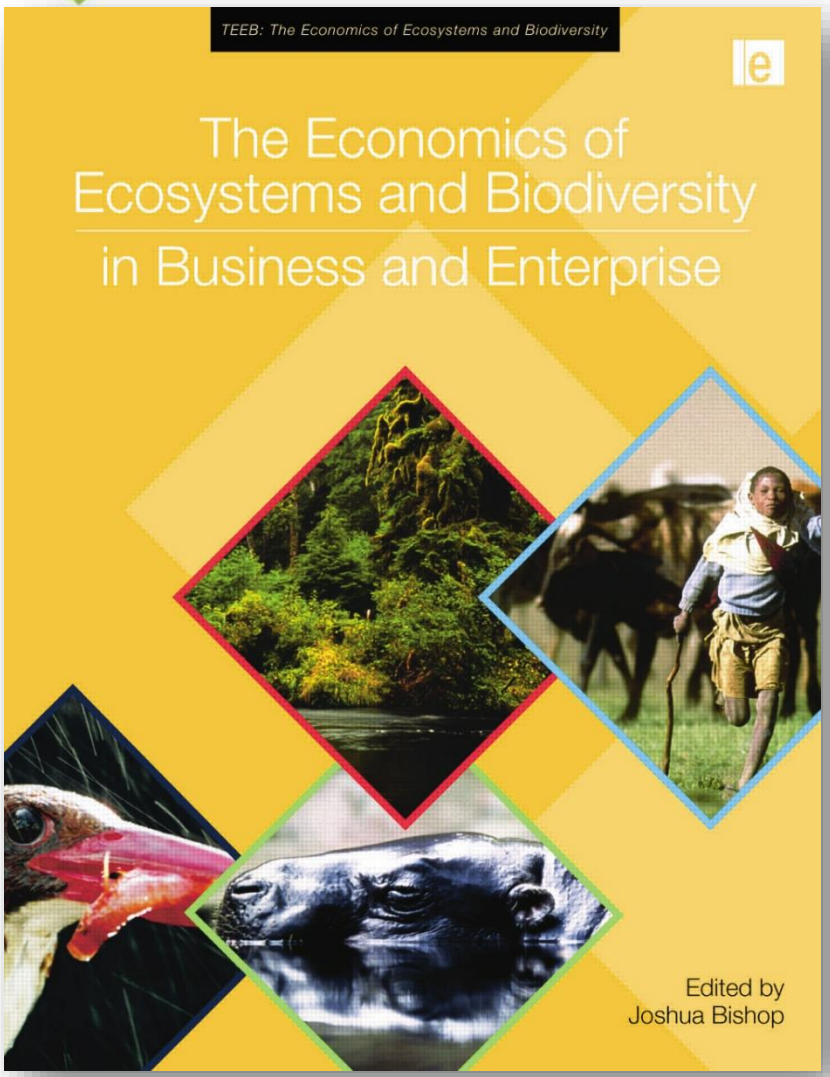
TEEB Synthesis

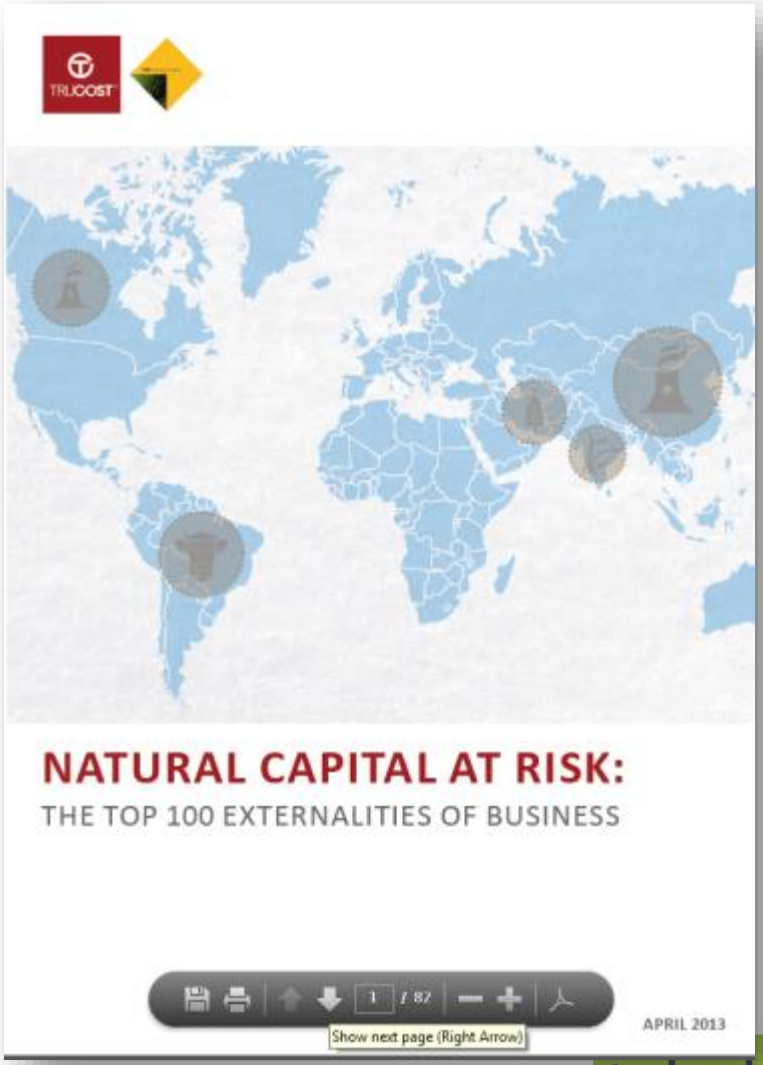
TEEB Books

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 Good’

+ Agriculture employs 1 in 3 of the world’s economically active labour force, or about 1.3 billion people. For the 70 per cent of the world's poor living in rural areas, agriculture is the main source of income and employment.

+ Smallholder farms (i.e. less than 2 hectares) represent over 475 million of the world’s 570 million farms and, in much of the developing world, they produce over 80 per cent of the food consumed.

+ Food production systems produce approximately 2,800 calories per person per day which is enough to feed the world population.

‘The Bad’

- Eighty per cent of new agricultural land has replaced tropical forests since the 1980s, a trend resulting in significant biodiversity loss and ecosystem degradation.

- Crop and livestock farming produce between five and six billion tons of CO_2-equivalent in greenhouse gas (GHG) emissions each year, mostly in developing countries where the agricultural sector has expanded in recent years.

- The agricultural sector utilizes 70 per cent of the water resources we withdraw from rivers, lakes and aquifers, raising serious concerns in terms of sustainability and security.

Summary statement

The **TEEBAgriFood** study is designed to:

1. provide a comprehensive economic evaluation of the ***'eco-agri-food systems' complex***
2. demonstrate that the economic environment in which farmers operate is distorted by ***significant externalities***, both negative and positive, and a lack of *awareness of* ***dependency on natural and social capital***

The visible and invisible flows of agricultural production

COMMENT

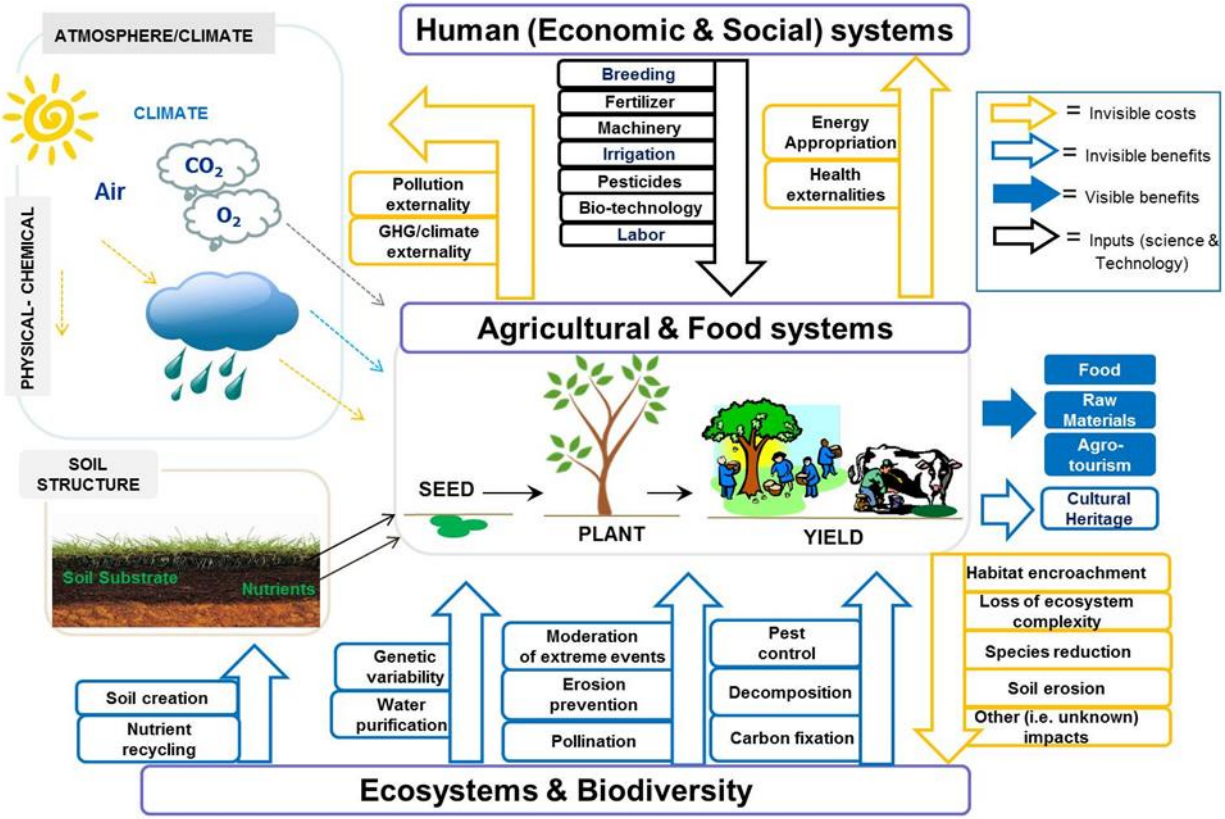
Nature (December 2016)

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

Fix food metrics

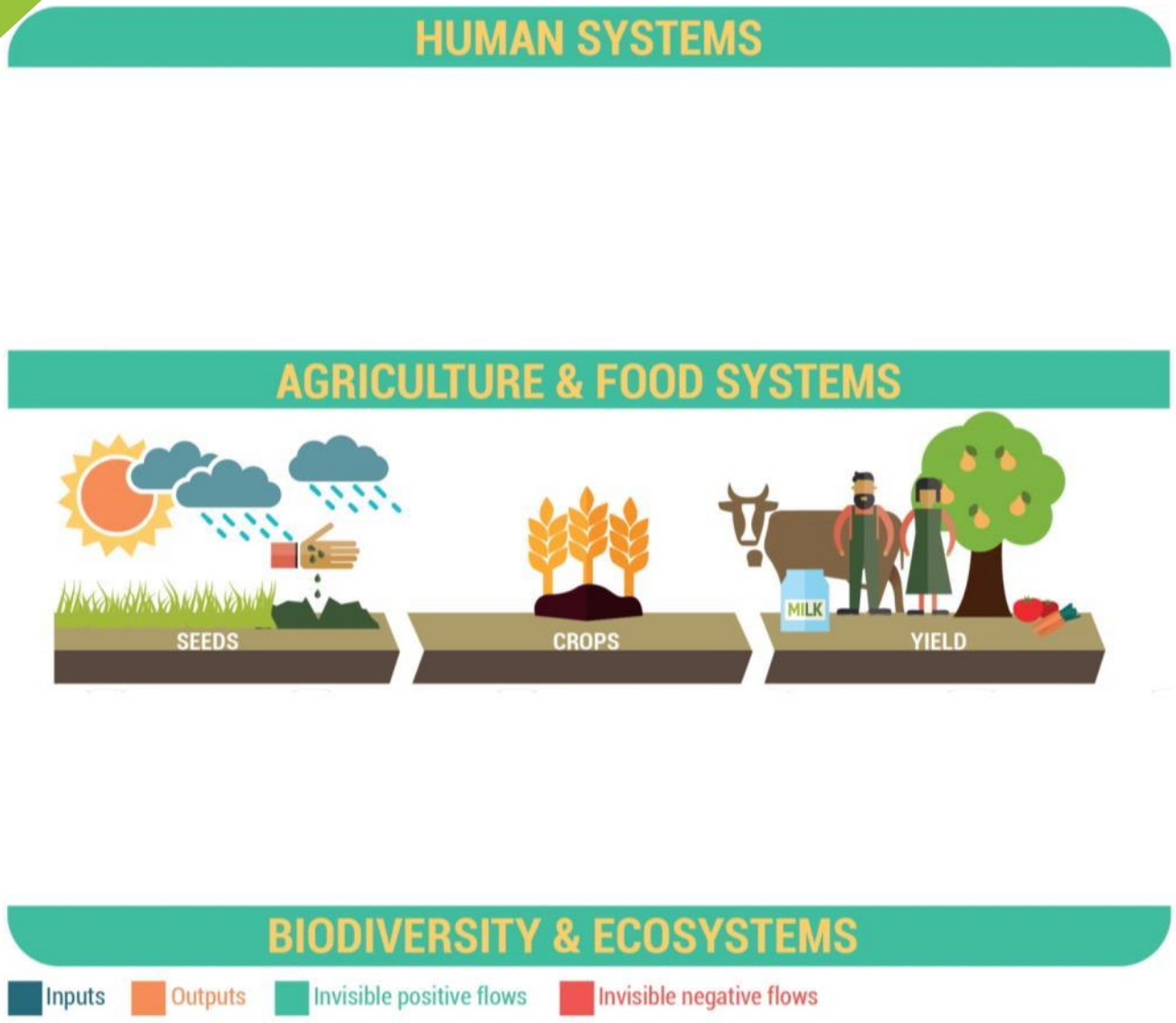
For sustainable, equitable nutrition we must count the true global costs and benefits of food production, urge **Pavan Sukhdev**, **Peter May** and **Alexander Müller**.

The Evolution of The Framework: 2014 Concept note

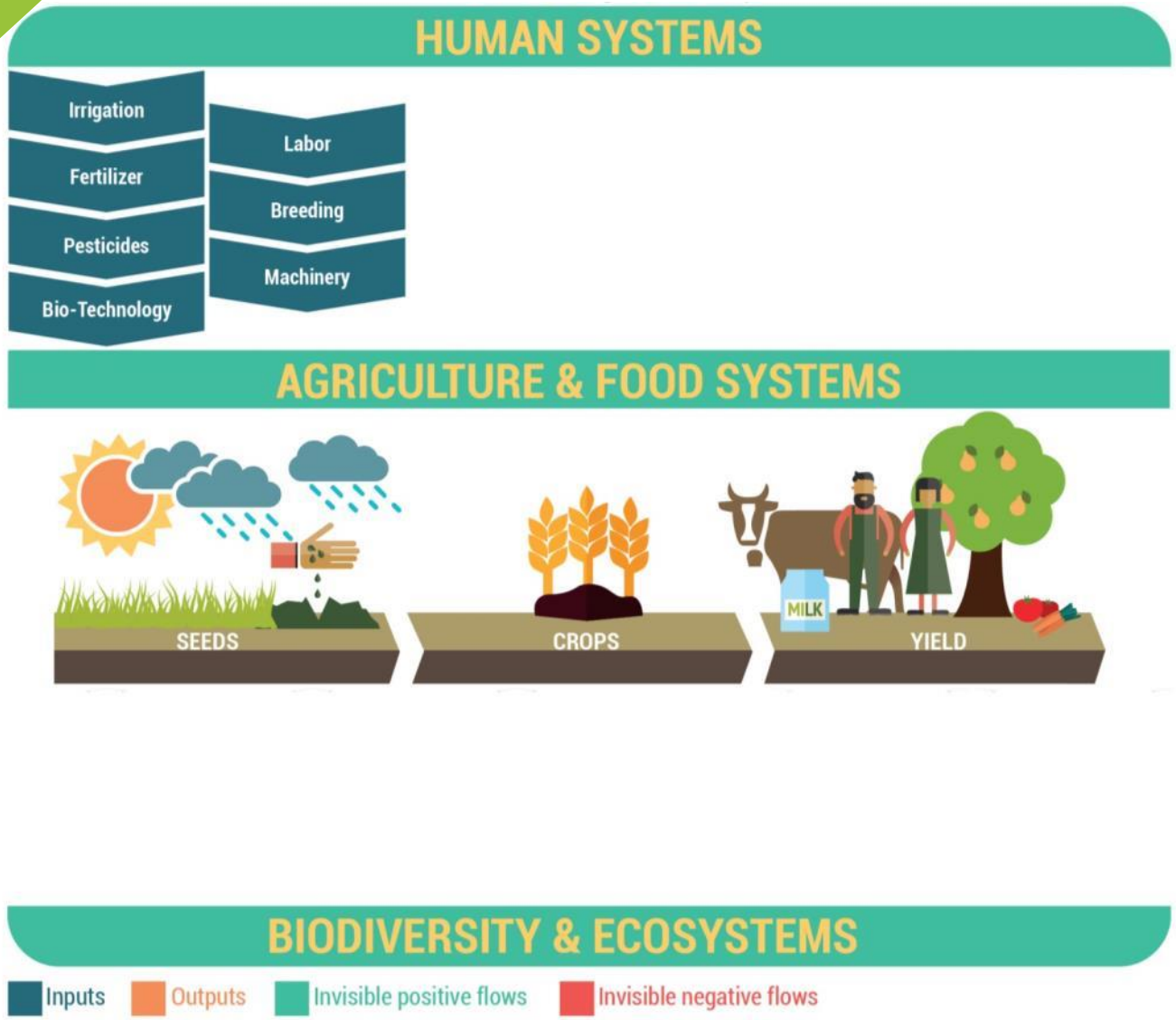


The visible and invisible flows of agricultural production

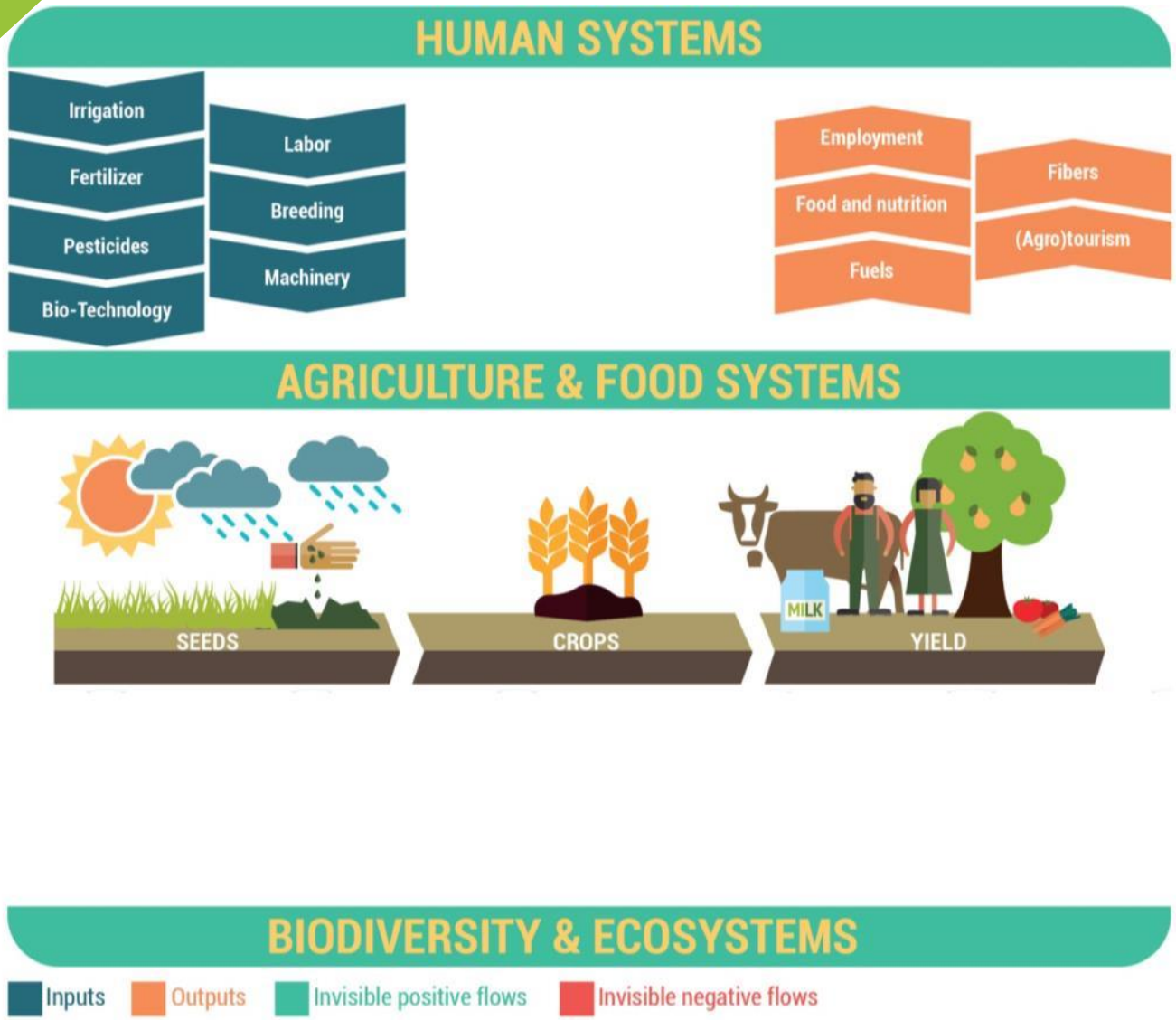
The visible and invisible flows of agricultural production



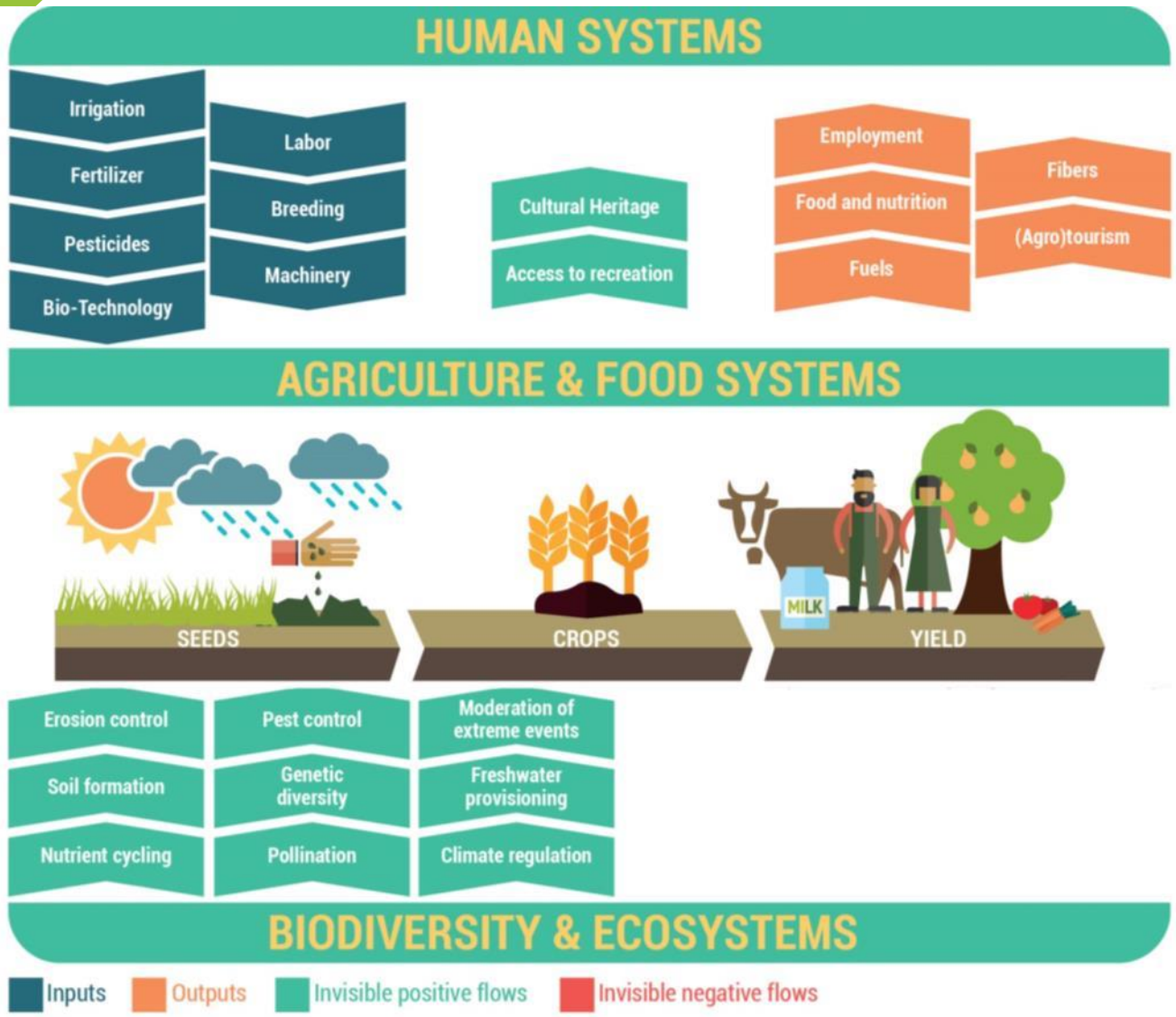
The visible and invisible flows of agricultural production



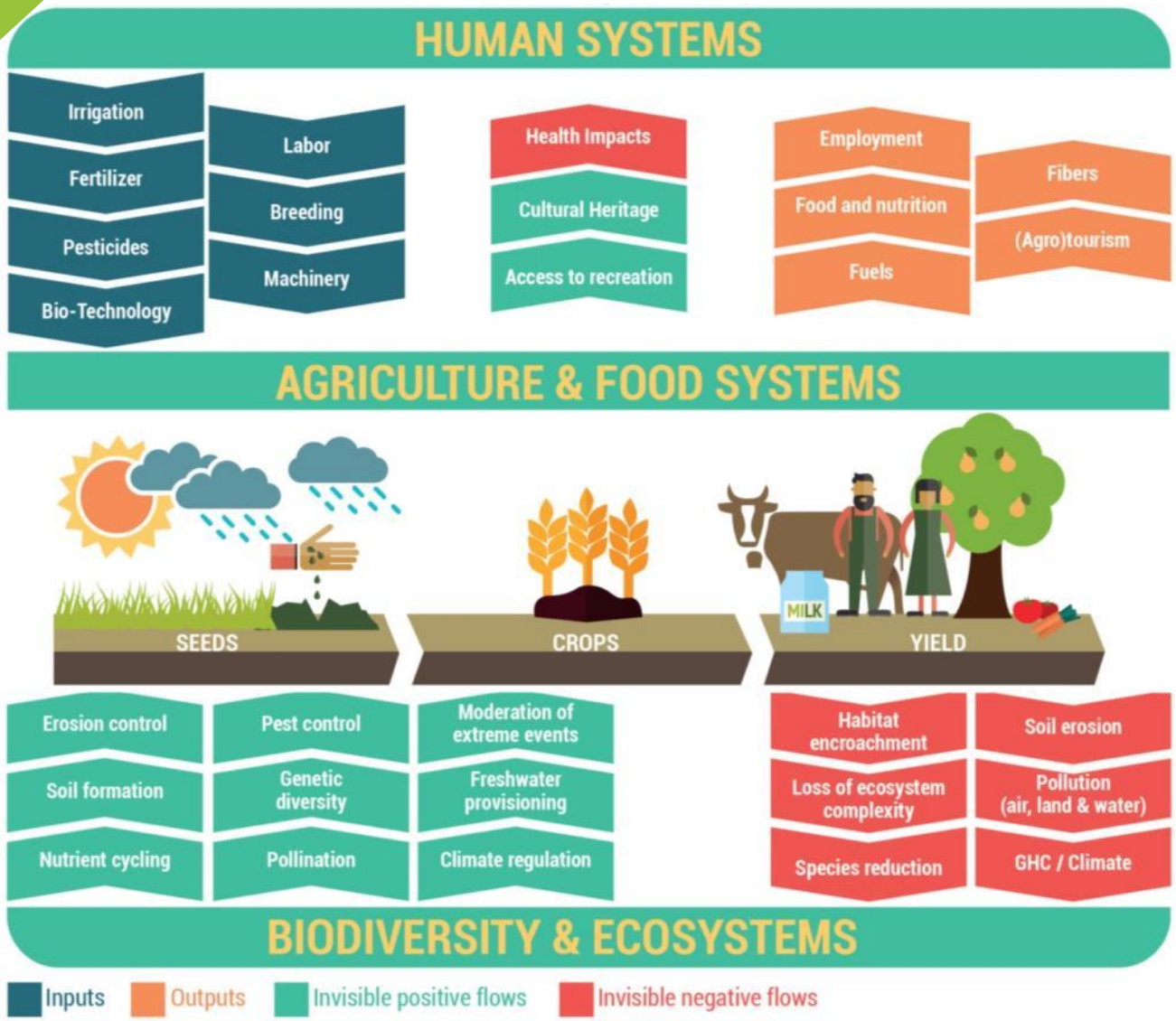
The visible and invisible flows of agricultural production



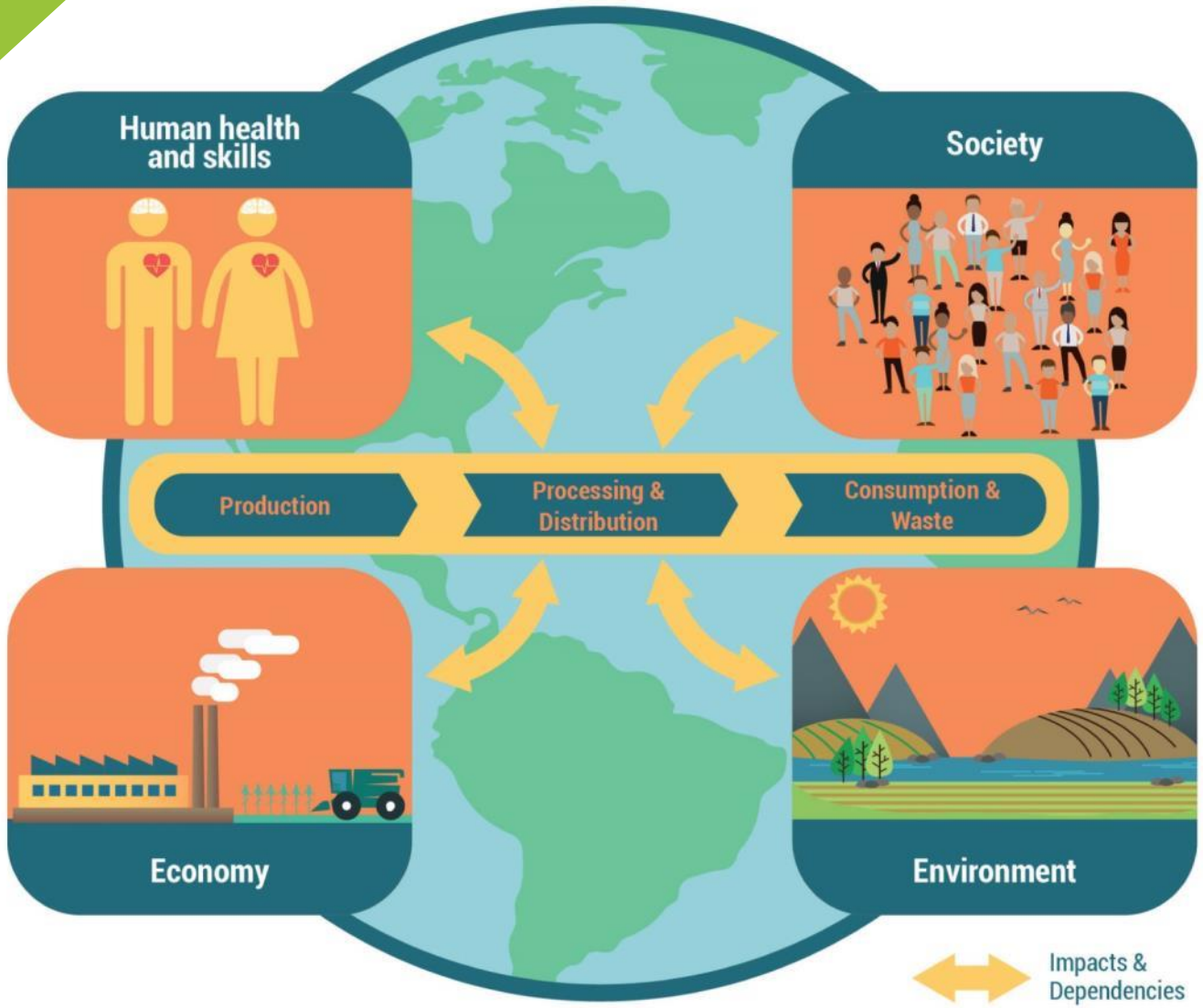
The visible and invisible flows of agricultural production



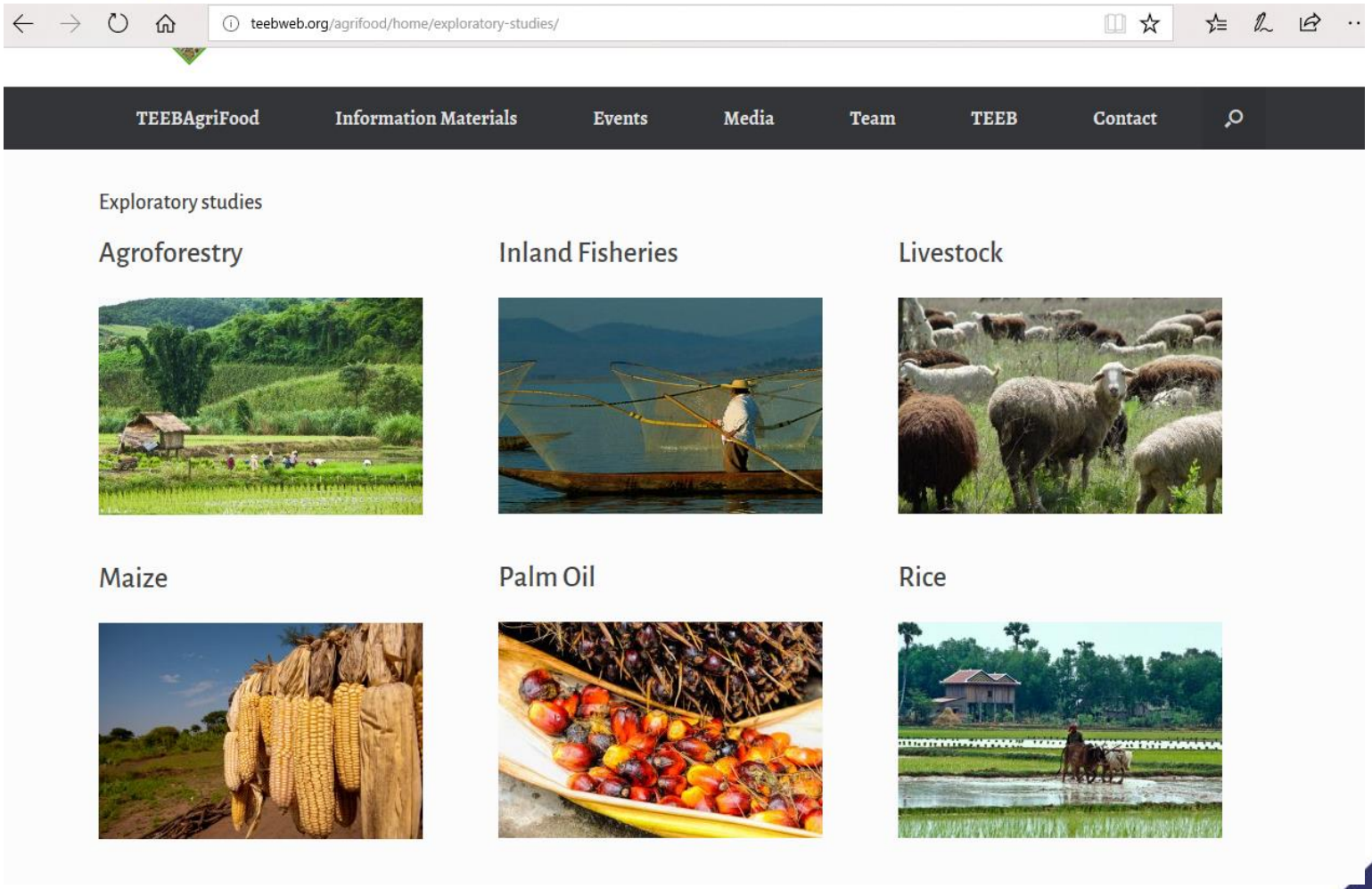
The visible and invisible flows of agricultural production



Eco-agri-food systems complex – impacts and dependencies



2014-2016 ‘Exploratory studies’



Agro-forestry study

- Agroforestry is a practice involving the **deliberate integration of trees or shrubs in farming landscapes** involving crops or livestock in order to obtain benefits from the interactions between trees and/or shrubs the tree and crop or livestock component

Agro-forestry case studies

Selection criteria	Cocoa agroforestry Ghana	Coffee agroforestry Ethiopia	Ngitili system Tanzania
Trend of agroforestry system	Increased by about twice the area in the 1990s to about 1.6 million ha (FAOSTAT 2013)	Increased by 100% since the 1990s to about 520,000 ha (FAOSTAT 2013)	Increased from **600 ha in 1986 to >350000 ha in 2003** (Mlenge 2004)
Number of people benefiting from the system	Between 1.9 million (Coulombe & Wondon 2007) to 6 million people (Anthonio and Aikins, 2009) - 700,000 smallholder farmers (Kolavalli & Vigneri 2011)	**7 million to 15 million people** (Petit 2007); 95% of the coffee produced by smallholder farmers About 4.5 million smallholder farmers (Central Statistical Agency 2013)	No data available, but estimated about 1500 households employed in Shinyanga's formal and informal forestry sector, in which ngitili products play a major role
Contribution to national economy	18.9% of the agricultural GDP; 8.2% of the Ghana's GDP and 30% of total export earnings (GAIN, 2012)	**36% of national export income in 2006/07** (Ejigie 2005) *Approximately* 10% of national GDP (Economic Report on Africa 2013)	No data available but estimated to contribute approximately 0.43% of Shinyanga region's GDP

Developing scenarios

- In Ethiopia, the rate of deforestation is estimated at **1-1.5% per year** (Teferi et al. 2013), mostly driven by smallholder coffee expansion (Davis et al. 2012)
- Coffee profitability is very low in smallholder agroforestry systems in Ethiopia, mostly due to **volatility in global market prices**
- Climatic predictions show that areas bioclimatically suitable for coffee production may **reduce by 65%** (Davis et al. 2012)

Developing scenarios

- In Ethiopia, the rate of deforestation is estimated at **1-1.5% per year** (Teferi et al. 2013), mostly driven by smallholder coffee expansion (Davis et al. 2012)
- Coffee profitability is very low in smallholder agroforestry systems in Ethiopia, mostly due to **volatility in global market prices**
- Climatic predictions show that areas bioclimatically suitable for coffee production may **reduce by 65%** (Davis et al. 2012)

Scenarios plausible?

I: Conversion to maize monocrop - drivers include price volatility, climate change, allocation of land to investors for biofuel

II: Conversion existing agroforestry coffee to heavy shade grown coffee – drivers: ongoing Climate Resilience Green Growth Strategy, the national REDD+ program, certification programs and improvements in land tenure conditions.

III: Conversion and further expansion of heavy shade grown coffee – drivers: contingent on success of scenario II

Agro-forestry: Scenarios and modelling

- The **WaterWorld model** was also used to model ecosystem services change
  - freshwater provision and runoff
  - increased water quality
  - above ground carbon stock
  - reduction of soil erosion

Agro-forestry valuation methods

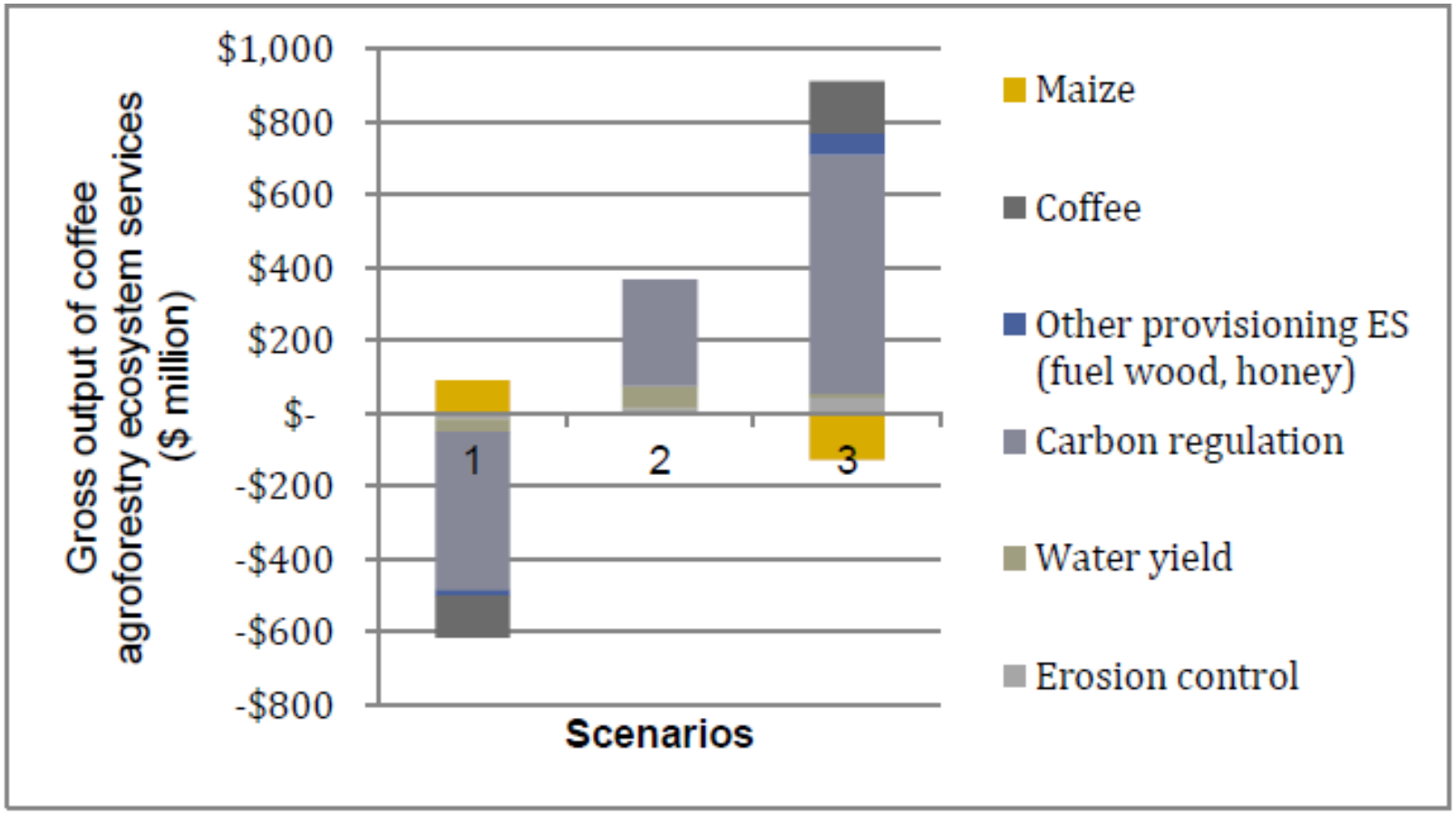
Ecosystem Service	Agroforestry System			Valuation Method
	Cocoa	Coffee	Ngitili	
Provisioning				
Cash Crops	***	***	N/A	Market price[16]
Food Crops	***	***	***	Market price
Tree Crop Products	***	***	N/A	Market price
Medicines	*	*	***	Shadow price[17], replacement cost
Wild Food and all other NTFP	*	***	***	Shadow price
Timber and Poles	***	***	***	Market price
Energy (Wood fuel and Charcoal)	*	***	***	Market price, shadow price, replacement cost
Regulating and Supporting				
Soil and biomass C stocks	***	***	***	Market price, avoided cost
Erosion control	ND	***	ND	Contingent valuation, replacement cost
Soil fertility (Soil N also P and K where available)	**[18]	**	***	Replacement cost
Biological Pest Control	**	**	ND	Insufficient data for benefit transfer
Pollination	**	**	N/A	Insufficient data for benefit transfer
Biodiversity	**	**	**	Insufficient data for monetary valuation
Avian Diversity	**	**	**	Insufficient data for monetary valuation
Vegetative Diversity	**	**	**	Insufficient data for monetary valuation
Other mammalian diversity	**	ND	ND	Insufficient data for monetary valuation

*** Sufficient data for biophysical quantification and monetary valuation;
** Quantitative biophysical data available, but insufficient data for monetary valuation;
* Qualitative information available; ND No relevant data available; N/A No applicable

Agro-forestry Scenario analysis

Ecosystem service	Scenario 1: Converting to Maize monoculture (million $/y)	Scenario 2: Canopy cover ≥ 30% [due to REDD+ or certification incentive] (million $/y)	Scenario 3: Canopy cover ≥ 30% & expansion of agroforestry to all areas bar: (I) urban; (II) priority land use such as forests; and (III) wildlife reserves (million $/y)
Increase in system extent (ha)	-202,342	0	+286,852
Provisioning	**-38.4**	**No change**	**73.4**
Coffee	-115.9	No change	+143.9
Maize	+90.5	No change	-128.3
Other ES (fuel wood, honey)	**-13.0**	**No change**	**+57.9**
Carbon regulation	**-435**	**+292**	**+655**
Other regulating	**-19**	**+74.5**	**+54.3**
Water yield	-34.9	+58.6	+10.7
Soil erosion	+15.9	+15.9	+43.6

Agro-forestry Scenario analysis



teebweb.org/agrifood/home/scientific-and-economic-foundations-report/

TEEB for Agriculture & Food

An initiative of 'The Economics of Ecosystems and Biodiversity' (TEEB)

Scientific and Economic Foundations

Scientific and Economic Foundations Report

Measuring what matters in agriculture and food systems

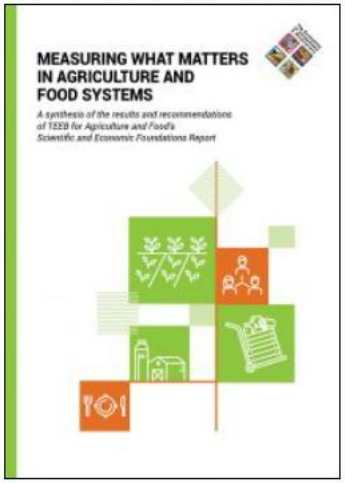
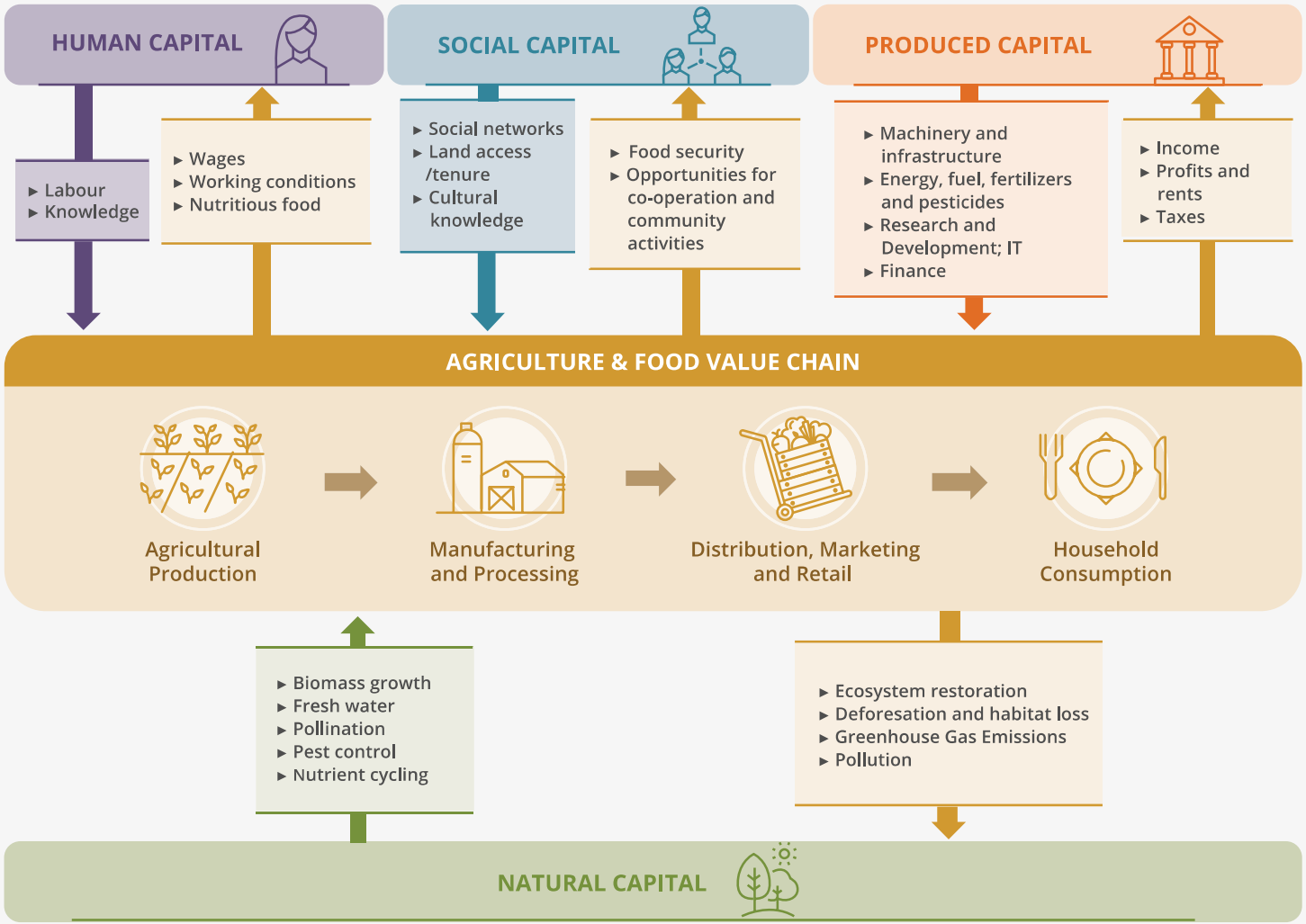
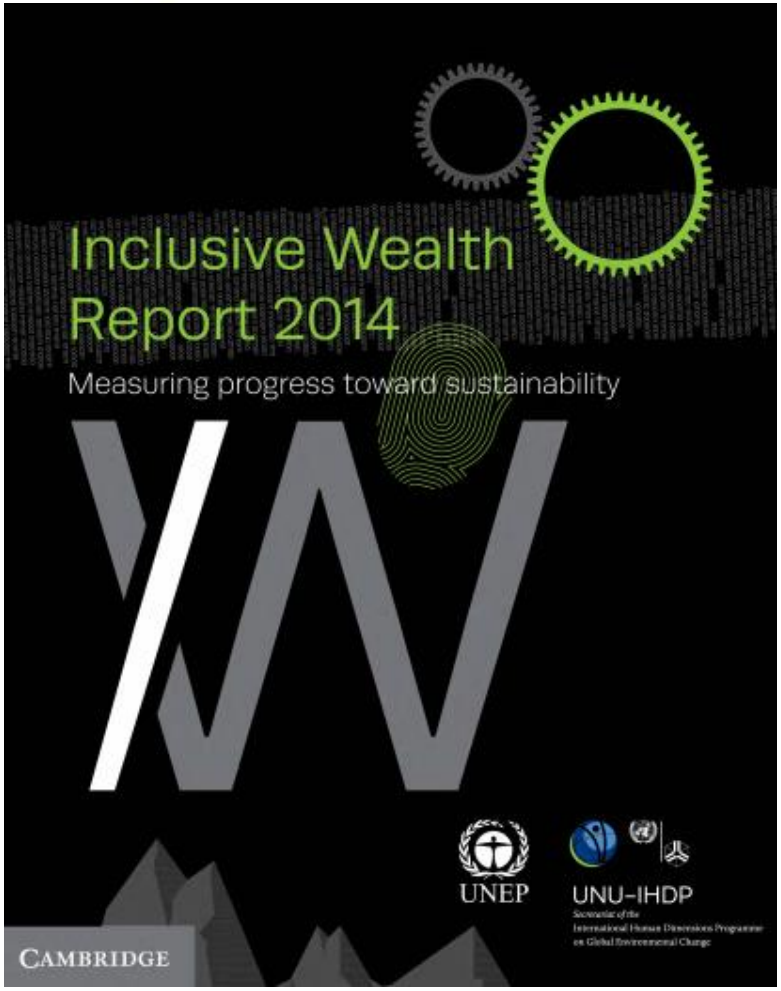


Figure 2.1 Capital stocks and value flows in eco-agri-food systems (Source: Hussain and Vause 2018)





From: ***Foreword, by Prof. Partha Dasgupta***

"Inclusive wealth is the social value of an economy's capital assets*. The assets comprise* ***(i) manufactured capital*** *(roads, buildings, machines, and equipment),* ***(ii) human capital*** *(skills, education, health), and* ***(iii) natural capital*** *(sub-soil resources, ecosystems, the atmosphere).*

Such other durable assets as knowledge, institutions, culture, religion – more broadly, ***social capital*** *– were taken to* ***be enabling assets****; that is, assets that enable the production and allocation of assets in categories (i)-(iii). The effectiveness of enabling assets in a country gets reflected in the shadow prices of assets in categories (i)-(iii)"*

Applying the TEEBAgriFood Framework

I. Evaluate the full value chain:
   - Production
   - Manufacturing / Processing
   - Distribution / Marketing
   - Household consumption

II. Measure stocks of all four capitals:
   - Natural capital
   - Produced capital
   - Human capital
   - Social capital

III. Measure all classes of flows or “impacts”
   - Ag, forest, livestock output
   - Purchased inputs
   - Ecosystem services
   - “Residuals” (Pollution and waste)

Four Capital Stocks

How have these stocks changed as a result of agriculture and food systems?

How do these stocks vary between plausible future scenarios?

	VALUE CHAIN CATEGORY			
	Agricultural Production	Manufacturing & Processing	Distribution & Marketing	Household Consumption
STOCKS / OUTCOMES (Change in capital)				
Natural capital				
Soil (type, structure)				
Vegetation cover				
Habitat (connectivity)				
Water (stock)				
Biodiversity				
Stored carbon				
Produced capital				
Infrastructure				
Research and development				
Technology, equipment				
Financial capital				
Human capital				
Education, skills				
Workforce				
Health				
Social Capital				
Rights and empowerment				
Social cooperation and governance				
Institutions and agencies				
Rule of law (e.g. land tenure)				

Four Classes of Flows

What are the benefits and costs along the value chain, including non-market ecosystem services and ecosystem damages?

	VALUE CHAIN CATEGORY			
	Agricultural Production	Manufacturing & Processing	Distribution & Marketing	Household Consumption
FLOWS / IMPACTS				
Agriculture, forest, or livestock outputs				
Food products				
Timber products				
Income (jobs)				
Profit (businesses)				
Purchased inputs				
Energy (fuel, electricity)				
Fertilizer, pesticides, tools				
Transportation				
Ecosystem services				
Water quality & quantity (seasonal)				
Soil fertility				
Pollination				
Climate regulation (GHG and local)				
Ecotourism				
Residuals				
Pollution				
Solid waste				
GHG Emissions				

Is this possible? Cattle and soy in the Amazon

Data to be obtained through fieldwork

Depreciation/investiment in fixed assests such as roads, equipments and machinery, changes in financial capital. Source: Figure 6.2 – Elements of the TEEB-Agri-food evaluation framework

Component	Indicator/Source		
	State of Mato Grosso	Livestock	Soybean
Buildings	**Forage silos** (quantity and capacity in tonnes). **Silos for storage of other products** (refrigerated and non-refrigerated) Source: Censo Agropecuário. Data collected from Conab-MT, see: https://tsf.agro.uol.com.br/dados-sobre-armazenagem-em-mato-grosso-serao-atualizados-pela-conab/	Data to be obtained through fieldwork	Fieldwork data and sources used by TRUCOST/CI/MONSANTO study of soybean + cerrado.
Machinery and equipment	**Agricultural machinery** and implements in establishments, by type (plows, harrows, rotary hoes, brushcutters). **Tractors** by type of power (less than 100 hp and more than 100 hp) **Means of transport** used in the establishment (trucks, utilities, automobiles, trailers) Source: Censo Agropecuário. **Research on agricultural mechanization in Mato Grosso** (2015). Source: http://www.imea.com.br/imea-site/view/uploads/estudos-customizados/ApresentacaoMecanizacaoAgricola-2015.pdf	Data to be obtained through fieldwork	Fieldwork data and sources used by TRUCOST/CI/MONSANTO study of soybean + cerrado.
Infrastructure	**Electric energy** used by type of sources (combustion, solar, wind, hydro, etc.) **Water resources** existing in the establishment by type (springs with or without forest protection, rivers and streams with or without forest protection, natural lakes, artesian wells, cisterns) **Fuel consumption** (alcohol, sugarcane bagasse, charcoal, gas, gasoline) Source: Censo Agropecuário. **Energy Intensities in Big Agribusiness Scale: Case of the State of Mato Grosso**	***Os Frigoríficos vão ajudar a zerar o desmatamento na Amazônia?*** / Paulo Barreto [et al]; com contribuições de Bruno Marianno, Ana Paula Valdiones e Glaucia Barreto. – Belém, PA: Imazon; Cuiabá: Instituto Centro da Vida, 2017.	Fieldwork data and sources used by TRUCOST/CI/MONSANTO study of soybean + cerrado.
Research and development	**Agricultural practices used** (terracing, crop rotation, use of pasture recovery, fallowing, protection and slope conservation)* Information available to the establishment as a whole, including all farming practices (livestock, agriculture, forestry, etc.). Source: Censo Agropecuário.	Use of **pasture fertilization** by type (nitrogen fertilizer, non-nitrogen fertilizer, manure, urine, green manure, organic compost, earthworm humus, biofertilizers, etc.). ***Costs, Benefits and Challenges of Sustainable Livestock Intensification in a Major Deforestation Frontier in the Brazilian Amazon.*** Edenise Garcia,Fábio Sampaio Vianna Ramos Filho 2, Giovanni Matheus Mallmann and Francisco Fonseca; TNC, 2016.	Fieldwork data and sources used by TRUCOST/CI/MONSANTO study of soybean + cerrado.
Finance	**Financing obtained** (number of establishments and value) by type of financier - banks, credit unions, commodity traders, NGOs, relatives or friends **Financing according to purpose** (investment, costing, commercialization, maintenance of the establishment) **Investments** made (number of establishments and value) by type - land acquired, property, purchase of animals, machinery and implements, etc. Source: Censo Agropecuário. Allocation of **resources from the Low Carbon Agriculture Program in MT** (agricultural credit). Source: http://observatorioabc.com.br/mapa-sistema-abc/ Data **collected from local credit agents** (BB, Banco Santander, etc).	Livestock gains 3 new agricultural credit lines in Mato Grosso. Source: http://www.juaranet.com.br/economia/22414/Pecuaria-ganha-3-novas-linhas-de-credito-em-Mato-Grosso Smeraldi, Roberto & May, Peter H. ***Time to pay the bill: Amazonia, cattle ranching and deforestation*** . São Paulo: Amigos da Terra-Amazônia Brasileira, 2009.	Fieldwork data and sources used by TRUCOST/CI/MONSANTO study of soybean + cerrado.

Produced Capital | Social Capital | Human Capital | Agricultural and food inputs | Purcl ...

Selecting and combining evaluation methods

- **Agronomic or soil models** (e.g. CROPWAT) - *What areas are most suitable for what crops? How do land use practices depend upon or impact soil?*
- **Hydrologic models** (e.g. SWAT) – Models of seasonal water budgets under different land use scenarios

Selecting and combining evaluation methods

- Agronomic or soil models
- Hydrologic models
- **Ecosystem services models** (e.g. InVEST) – Programs to model other services such as carbon sequestration, water pollution (siltation and nutrient loading), or habitat, or biodiversity
- **Ecosystem services valuation –** *Revealed preference, stated preference etc.*

Selecting and combining evaluation methods

- Agronomic or soil models
- Hydrologic models
- Ecosystem services models
- Ecosystem services valuation
- **Economic impact modelling or livelihoods analysis** (input/output, CGE, SLF)
- **Social and Human Capital impacts** (e.g. Network Analysis, health, education) –
  - Agriculture and environment research teams are traditionally biophysical scientists.
  - *Have the researchers conducted human or social capital analysis? How can we pair this with the biophysical analysis?*

Agro-forestry: Phase I 'landing page'

Value chain stages / Visible and invisible flows	Production (and associated waste)			Processing and Distribution (and associated waste)			Consumption (and associated waste)
Flows generated at the level of	**Landscape**	**Infrastructure and Manufacturing**	**Farm**	**Wholesale**	**Food and Beverage**	**Retail**	**Industry/ Household/ Hospitality**
Value Captured by System of National Accounts (SNA)			Income from yield				
Provisioning Services (Materials, Energy, etc.)			Yield				
			Fresh water				
			Timber, fuelwood, honey				
			Medicinal plants				
Regulation and Maintenance Services (Soil, Water, Habitat for biodiversity, etc.)			Freshwater quality				
			Carbon storage and sequestration				
			Soil erosion				
			Soil fertility				
			Biodiversity				
			Pollination				
			Pest control				
Cultural Services (Heritage, Recreation, etc.)							
Health Impacts (Nutrition, Lifestyle diseases, Antibiotic resistance, etc.)							
Pollution Impacts (Nitrates, Pesticides, Heavy metals, etc.)							
GHG Emissions (CO_2, CH_4, etc.)							
Social values (Food security, Gender equality, etc.)			Food security/access				
Risks and uncertainties (Resilience, Health, etc.)							

Monetary estimates
Quantitative estimates
Qualitative discussion

Agro-forestry Phase II: next steps

COVERAGE OF IMPACTS AND DEPENDENCIES BEING ASSESSED IN COCOA VALUE CHAINS IN GHANA AND COFFEE VALUE CHAINS IN ETHIOPIA		Value chain			
		Agricultural production	Manufacturing & processing	Distribution & marketing	Household consumption
Stocks / Outcomes (change in capital					
Natural capital	Water (incl. quality, quantity)	X	X		
	Soil (incl. quality, quantity)	X			
	Air	X	X	X	X
	Vegetation cover and habitat quality	X			
	Biodiversity	X	X		
	Other				
Produced capital	Buildings				
	Machinery and equipment		X	X	
	Infrastructure				
	Research and development				
	Finance	X	X	X	
	Other				
Human capital	Education / skills				
	Health	X	X		X
	Working conditions (decent work)	X	X	X	X
	Other				
Social capital	Land access/tenure (private, public and communal)				
	Food security (access, distribution)				X
	Opportunities for empowerment (gender and minority)				
	Social cooperation (incl networks/unions)	X		X	X
	Institutions				
	Laws and regulations (e.g. child labor)	X			
	Other				
Flows					
Agricultural and food outputs	Agricultural and food products	X			
	Income: value added, operating surplus	X	X	X	X
	Subsidies, taxes and interest				
Purchased inputs	Labour inputs (incl skills)	X	X	X	
	Intermediate consumption (produced inputs such as water, energy, fertilizers, pesticides, animal health and veterinary inputs)	X	X	X	
Ecosystem services	Provisioning (e.g. biomass growth, freshwater)	X			
	Regulating (e.g. pollination, pest control, nutrient cycling)	X	X		
	Cultural (e.g. landscape amenity)				
Residuals	Agricultural and food waste	X	X	X	X
	GHG emissions	X	X	X	
	Other emissions to air, soil and water	X			
	Wastewater		X		
	Solid waste and other residuals				

What is due when?

1. Global Alliance funding (February 2018)
   - Haripriya Gundimeda (Wheat value chain **North India**)
   - Peter May (Cattle and Soy in **Amazon**)
2. TEEBAgriFood DEVCO Africa (April 2019)
   - Livestock (**Tanzania**), cocoa (**Ghana**), coffee (**Ethiopia**), rice (**Senegal**)
3. IKI studies (December 2019)
   - **Colombia:** Putumayo Department - includes Amazon lowlands, highland forests, Colombian plateau and several important water basins
   - **Kenya,** options are two upper Basin areas (Tana Basin and Ewaso Njiro Basin), the Mau catchment area/ Mara River Basin and the drainage basin from Mt Suswa to Lake Magadi
   - **Thailand** – organics production
   - **Tanzania** - Southern Highlands - upstream of the proposed Stiegler hydropower dam
4. EU Partnership Instrument (December 2022)
   - **Brazil, China, India, Indonesia, Malaysia, Mexico, Thailand**

SCIENCE FORUM 2018

CGIAR Independent Science and Partnership Council

STELLENBOSCH, SOUTH AFRICA
10 - 12 OCTOBER, 2018

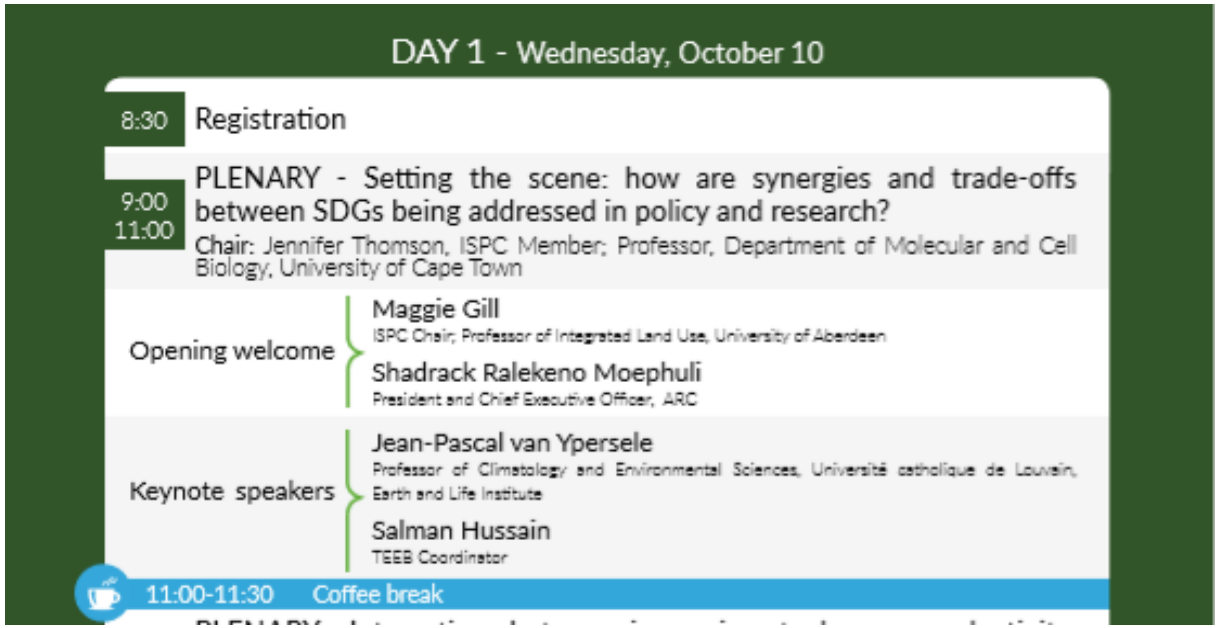
Win more, lose less:

Capturing synergies between SDGs through agricultural research

©FAO/Luis Tato

TEEB for Agriculture and Food

Science Policy Forum 2018



CGIAR network

Dr. Salman Hussain
salman.hussain@unep.org
UNEP TEEB Office