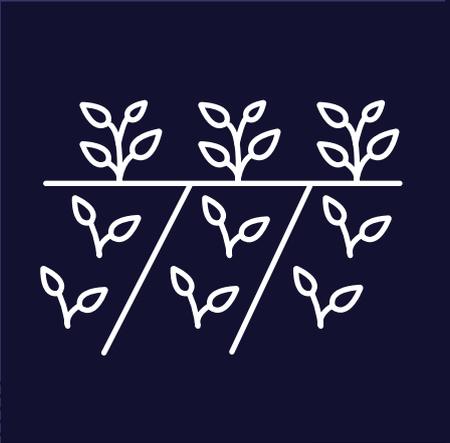


# TEEB FOR AGRICULTURE & FOOD

## SCIENTIFIC AND ECONOMIC FOUNDATIONS REPORT



'The Economics of Ecosystems and Biodiversity' (TEEB) is an initiative hosted by United Nations Environment Programme (UN Environment), and coordinated by the TEEB Office in Geneva, Switzerland. 'TEEB for Agriculture & Food' (TEEBAgriFood) encompasses various research and capacity-building projects under TEEB focusing on the holistic evaluation of agriculture and food systems along their value chains and including their most significant externalities. This 'Scientific and Economic Foundations' report addresses the core theoretical issues and controversies underpinning the evaluation of the nexus between the agri-food sector, biodiversity and ecosystem services and externalities including human health impacts from agriculture on a global scale. It is supported by the Global Alliance for the Future of Food.



**Project Steering Committee:** 'TEEB for Agriculture & Food' is governed by a high-level Steering Committee, chaired by Alexander Müller (*TMG – Thinktank for Sustainability*), and comprising senior experts across agriculture, food, health and ecosystem economics, including: Patrick Holden (*Sustainable Food Trust*), Peter May (*Federal Rural University of Rio de Janeiro*), Kathleen Merrigan (*George Washington University*), Danielle Nierenberg (*Food Tank*), Walter Pengue (*National University of General Sarmiento/University of Buenos Aires*), Jules Pretty (*University of Essex*), Maryam Rahmanian (independent), Ruth Richardson (*Global Alliance for the Future of Food*), Pavan Sukhdev (*GIST Advisory / UN Environment*) and Abdou Tenkouano (*West and Central Africa Council for Agricultural Research and Development*).

**Project Management Team:** 'TEEB for Agriculture & Food' is managed and coordinated by a core team of individuals, including:

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- **Special Adviser:** Pavan Sukhdev (*GIST Advisory / UN Environment*)
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# **TEEB FOR AGRICULTURE & FOOD**

## **SCIENTIFIC AND ECONOMIC**

### **FOUNDATIONS REPORT**



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# FOREWORD

2,500 years ago Socrates established *“the importance of seeking evidence, closely examining reasoning and assumptions, analyzing basic concepts, and tracing out implications not only of what is said but of what is done as well.”*<sup>1</sup>

There are two important elements here. The first is establishing *“the importance of seeking evidence, closely examining reasoning and assumptions, analyzing basic concepts.”* As we wrestle with how to boldly meet the scale and complexity of the challenges we face as a global community – climate change, skyrocketing rates of diabetes and obesity, biodiversity loss, migration, deepening poverty and hunger – we can’t underestimate the need to find transformative solutions; the need for tools that help us seek evidence, examine long-held assumptions, and analyze basic concepts such as transparency, fairness, and accountability.

There is perhaps no other field for which this kind of urgent solution-seeking is needed, as much as food systems. Food systems are one of the most defining issues of our time, at the centre of many of the critical issues we face today, with their impacts experienced unequally across the globe and the burden placed on vulnerable and marginalized populations. Thus, getting the future of food right, quickly, is fundamental to fulfilling our daunting commitments to the Sustainable Development Goals, Paris Agreement, and other indispensable international treaties and conventions.

This is why what follows in this report is so timely, imperative, and potentially transformative. The TEEBAgriFood Framework is arguably one of the most important tools we now have in our food systems toolbox to understand, analyze, and shift food systems through its ability to highlight what’s wrong with the current system and point to changes needed to bring about a more desirable future, while leaving no one behind.

Which brings us to the second element of Socrates’ efforts: establishing *“the importance of tracing out implications not only of what is said but of what is done as well.”* Evidence and analysis for evidence-and-analysis-sake is, of course, not enough in this time of urgency and global consequence. Socrates’ emphasis was on the *“implications for what is done.”* In other words, to imply action.

The ultimate goal of TEEBAgriFood is action. It is food

systems’ transformation towards – in the words of the TEEBAgriFood leadership – *“sustainable agrifood systems that nourish, provide energy, damage neither health nor environment, and support equitable access to resources.”* It is getting the future of food right, one that will lead us along a path to real sustainability, along which we can draw ever closer to ending poverty, protecting the planet, and ensuring prosperity for all.

We at the Global Alliance for the Future of Food are behind this agenda. We are committed to food system reform and believe that transformational change at the scale and speed needed requires us to see the whole system in necessary and powerful new ways. And to make choices about the future of our shared food systems; choices that avoid siloed approaches, unintended consequences, and limited, narrow, short-term solutions.

But it’s an agenda for all of us. We are all part of the food system. For current and future generations, this is a shared responsibility upon which we, as a global community, simply must act to better understand the impacts of food systems, address the most harmful practices, and find new positive pathways forward, together. TEEBAgriFood now gives us a potent means by which to do that.

It is our hope, through collective effort and broad-based support, that TEEBAgriFood will realize its potential as a formidable tool for change in our urgent pursuit of food systems that are truly sustainable, secure, and equitable.

Sincerely,



A handwritten signature in black ink that reads "Ruth Richardson".

**Ruth Richardson**  
Executive Director  
Global Alliance for the Future of Food

<sup>1</sup> Foundation for Critical Thinking, 2016, p.1

# FOREWORD

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The world's food systems face two immense challenges today. One, to produce enough food to nourish a global population of seven billion people without harming the environment. Two, to make sure food systems deliver nutrition to everyone, particularly the world's poorest, many of whom suffer from chronic under-nutrition. This Report produced by The Economics of Ecosystems and Biodiversity for Agriculture and Food Scientific Foundation, aims to support the design of sustainable and equitable food systems for the future.

The way we are currently producing food is negatively impacting climate, water, top soil, biodiversity and marine environments. If we do not change course, we will seriously undermine our ability to deliver adequate food for future populations. In addition to the negative environmental impacts, we are struggling to deliver nutritious and healthy diets in an equitable way. Diet-related chronic diseases are on the rise even as we fail to deliver nutritious food to millions of poor people around the world.

As I write, a remarkable change is underway in the West Godavari district of Andhra Pradesh in India. Thousands of farmers are now turning to zero budget natural farming, replacing chemical fertilizers and pesticides with natural inputs. Its rejuvenating soil, delivering higher yields and improving biodiversity. UN Environment is proud to be partnering now with the Government of Andhra Pradesh and private sector partners to provide private capital to scale-up this initiative to six million farmers in the state.

The global development agenda aims to "leave no one behind". Re-designing food systems that do no harm to the environment, improve nutrition for all, and ensure decent work, is at the heart of this agenda. This Report authored by experts from around the world, provides a clear set of recommendations on designing and evaluating food systems for their impact on nature and human health. I hope that it provides useful insights to national planners, farmers and agriculturists, and citizens, thereby strengthening the links between health, prosperity and our planet.



A handwritten signature in black ink that reads "Erik Solheim".

**Erik Solheim**  
Executive Director  
UN Environment

# LEXICON

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- agri-food (as in system):** a subset of *eco-agri-food* in which ecological considerations (e.g. impacts and dependencies upon *natural capital*) are often left out
- capital:** the economic framing of the various stocks in which each type of capital embodies future streams of benefits that contribute to human well-being (see also '*stock*' as well as '*human capital*', '*natural capital*', '*produced capital*' and '*social capital*')
- consumption:** the final of four stages in the value chain, including purchases of food for consumption within the household, purchases of food supplied by restaurants and the hospitality industry more generally, and consumption of food grown at home
- distribution, marketing and retail:** the third of four stages in the value chain, including the activities associated with the transport and sale of goods, for example to retailers or consumers
- driver:** a *flow* which arises from the activities of agents (i.e. governments, corporations, individuals) in *eco-agri-food* value chains, resulting in significant *outcomes* and leading to material *impacts*
- eco-agri-food (as in system):** a descriptive term for the vast and interacting complex of ecosystems, agricultural lands, pastures, inland fisheries, labor, infrastructure, technology, policies, culture, traditions, and institutions (including markets) that are variously involved in growing, processing, distributing and consuming food
- ecosystem service:** the contributions that ecosystems make to human well-being (e.g. classified by CICES into provisioning, regulation & maintenance and cultural)
- externality:** a positive or negative consequence of an economic activity or transaction that affects other parties without this being reflected in the cost price of the goods or services transacted
- feedback (loop):** a process whereby an initial cause ripples through a chain of causation, ultimately to re-affect itself
- flow:** a cost or benefit derived from the use of various capital stocks (categorized into agricultural and food outputs, purchased inputs, ecosystem services and residuals)
- Framework, TEEBAgriFood Evaluation:** an approach for describing and classifying the range of outcomes/impacts for a given scope and value chain boundary, and caused by specified drivers, that answers the question "what should be evaluated?"
- human capital:** the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being
- impact:** a positive or negative contribution to one or more dimensions (environmental, economic, health or social) of human well-being
- manufacturing and processing:** the second of four stages in the value chain, including the operations involved in converting raw materials into finished products
- marketing:** (see '*distribution, marketing and retail*')
- natural capital:** the limited stocks of physical and biological resources found on earth, and of the limited capacity of ecosystems to provide ecosystem services.
- outcome:** a change in the extent or condition of the stocks of capital (natural, produced, social and human) due to value-chain activities
- processing:** (see '*manufacturing and processing*')
- produced capital:** all manufactured capital, such as buildings, factories, machinery, physical infrastructure (roads, water systems), as well as all financial capital and intellectual capital (technology, software, patents, brands, etc.)
- production:** the first of four stages in the value chain, including activities and processes occurring within farm gate boundaries (including the supply of ecosystem services, the supply of goods and services, and connections between producers)
- retail:** (see '*distribution, marketing and retail*')
- social capital:** encompasses networks, including institutions, together with shared norms, values and understandings that facilitate cooperation within or among groups

**stock:** the physical or observable quantities and qualities that underpin various flows within the system, classified as being produced, natural, human or social (see also '*capital*')

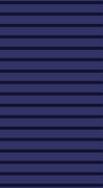
**system:** a set of elements or components that work together and interact as a whole

**systems thinking:** an approach that focuses on the identification of interrelationships between components of a system

**theory of change:** a basis for planning intervention in a given policy or project arena that helps to identify processes and preconditions whereby actions can best attain their intended consequences

**value:** the worth of a good or service as determined by people's preferences and the tradeoffs they choose to make given their scarce resources, or the value the market places on an item

**value chain:** the full range of processes and activities that characterize the lifecycle of a product from *production*, to *manufacturing and processing*, to *distribution, marketing and retail*, and finally to *consumption* (including waste and disposal across all stages)



# CHAPTER 1

## TEEB FOR AGRICULTURE & FOOD: BACKGROUND AND OBJECTIVES

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**Suggested reference:** Hussain, S. and Vause, J. (2018). TEEB for Agriculture & Food: background and objectives. In TEEB for Agriculture & Food: Scientific and Economic Foundations. Geneva: UN Environment.

# CHAPTER 1

## KEY MESSAGES

- Chapter 1 sets the scene for the *Foundations* report, i.e. why we need a project on The Economics of Ecosystems and Biodiversity for Agriculture and Food ('TEEBAgriFood'), and specifically why we need a report on *Scientific and Economic Foundations*, and how this report interfaces with the wider TEEB Initiative.
- A short answer is that we need to fix food metrics, and we need to start this by interrogating evidence from the science and economics literatures.
- The longer answer – and the mission statement of TEEBAgriFood – is as follows: The TEEBAgriFood study is designed to (1) provide a comprehensive economic evaluation of the eco-agri-food systems complex, and (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, social, human and produced capitals.
- The 'eco-agri-food systems complex' is a collective term encompassing the vast and interacting complex of ecosystems, agricultural lands, pastures, inland fisheries, labour, infrastructure, technology, policies, culture, traditions, and institutions (including markets) that are variously involved in growing, processing, distributing and consuming food.
- TEEBAgriFood adopts a systems approach: It is neither possible nor sensible to isolate impacts and dependencies of primary agricultural production (within the farm gate) from the rest of the eco-agri-food system if we are to find truly sustainable and equitable solutions to the agri-food challenges we face.
- Chapter 1 sets out the structure of the report, with four chapter clusters: (i) outlining the systems approach; (ii) evidence that a change in metrics is required (from agriculture, human health, and ethics perspectives); (iii) defining and setting out examples of how we change metrics via the TEEBAgriFood Evaluation Framework; and (iv) how change might be brought about – the Theory of Change.
- The TEEB initiative is ideally situated to operationalize the Theory of Change as it has, for a decade, focused on the economic invisibility of the costs of biodiversity loss and the degradation of ecosystems, and no industrial sector is more reliant on well-functioning ecosystems than the agriculture sector.
- TEEB has championed valuation in its widest form, and thus has eschewed and criticized the commoditization of nature. It has also successfully led to values being recognized, demonstrated and captured in a range of decision-making contexts – for national and sub-national government, for businesses and for consumers and citizens.

## CHAPTER 1

# TEEB FOR AGRICULTURE & FOOD: BACKGROUND AND OBJECTIVES

## 1.1 TEEB: GENESIS, SCOPE, ACHIEVEMENTS & EVOLUTION

Across the world, we are building a better understanding of the ramifications of environmental change on human livelihoods. Much of this awareness has been gained after tipping points have been reached or as a result of catastrophic events such as flooding, drought, fire and famine. ‘The Economics of Ecosystems and Biodiversity’ (TEEB) was originally created to help answer the call to make the values of nature more visible so that decision-making and policy outcomes can be informed by a better understanding of our impacts and dependence on the natural world.

As the world’s population grows, so does the need for more resilient food and agricultural systems that address human need while minimizing environmental damage and further biodiversity loss. TEEB is focused on how we can make the values of nature visible to support a transition to agriculture systems that are truly sustainable and benefit both human and environmental health.

### 1.1.1 Brief History of TEEB

Inspired by the Stern Review on the Economics of Climate Change (Stern 2007), which revealed the economic inconsistency of inaction with regard to climate change, Environment Ministers from the governments of the G8+5 countries<sup>1</sup> agreed at a meeting in Potsdam, Germany in 2007 to “initiate the process of analysing the global economic benefit of biological diversity, the costs of the loss of biodiversity and the failure to take protective measures versus the costs of effective conservation”. Aiming to address the economic invisibility of nature, TEEB emerged from that decision.

Although the underlying problem of the economic invisibility of environmental damage in decisions is similar to the problem of economic invisibility where loss of biodiversity is concerned, the solutions are very different. To avoid catastrophic climate change, the world needed, and still needs, to reduce greenhouse gas emissions; the task is massive but progress can be charted through the single, universal metric of carbon dioxide equivalence. Where in the world carbon savings are made is important in terms of equity, but in the end it is global emissions measured in carbon dioxide equivalents that matter.

Biodiversity is very different from this perspective in that it is the living fabric of our planet including all its ecosystems, species and genes, in all their quantity and diversity. It is therefore neither intellectually nor ethically appropriate to attempt to reduce this complexity to any single indicator or numeraire. Ethics, social context, ecology and geography matter to both the costs and benefits of action – in other words, people and places are intrinsically important in the context of TEEB. The costs and benefits are also more diverse, from the protection and preservation of water flows through to the pollination of crops as well as links to cultural identity. There is no single target or metric, but multiple benefits which all need to be considered. Combined, these factors implied that, as well as the need to have a global analysis as per the Stern Review, TEEB would only be relevant if it also targeted decisions and decision-makers more directly at the scales and in the contexts in which they were operating.

Furthermore, TEEB also differs from the Stern Review (and the wider climate change discourse) in that the effects of climate change on nature and on human livelihoods are real and potentially catastrophic but do not emerge from within. TEEB is concerned with the why and the how of valuing nature in and of itself, and understanding the incentives for action (and inaction) in many different contexts by a whole range of decision-makers: policy makers at national and local levels, communities, businesses, and society at large. As such, it is also about valuing something that we all cherish, and on which all of our lives depend. This has also meant that TEEB has, since its inception, distanced

<sup>1</sup> The G8+5 includes the heads of government from the G8 nations (Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States), plus the heads of government of five emerging economies (Brazil, China, India, Mexico and South Africa).

itself from any calls to commoditize nature: *our living planet is most definitely not for sale*. TEEB is concerned with valuing nature's contribution to people, in all its disparate forms.

With this focus in mind, TEEB aims to provide a bridge of valuation knowledge and expertise between the multi-disciplinary science of biodiversity and ecosystem management and the interconnected arenas of policymaking in the international, national and local government domains as well as in business management. In this context, the original phase of the project (2007-2011) developed outputs specifically for these audiences as well as web-based material aimed more directly at citizens and consumers.

The TEEB Synthesis Report (TEEB 2010) collected this work from the original phase where it was presented at the Convention on Biological Diversity's Conference of the Parties in Nagoya, Japan in 2010. The influence of the TEEB studies (and the process of bringing authors and stakeholders together to produce them) was visible both in the decisions made in Nagoya and the work which followed. TEEB was officially welcomed by the Parties in the context of the new Strategic Plan for Biodiversity 2011-2020, as well as featuring explicitly in decision text around incentive measures and business engagement. It is notable that of the 20 international biodiversity targets for 2020 agreed at the meeting (the Aichi Biodiversity targets), target 2 aimed to address the underlying drivers of biodiversity loss requiring that *"by 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems."*

The TEEB initiative was originally scheduled to conclude with the Synthesis Report in 2010, however, the decisions of the 193 countries represented in Nagoya reflected both the need and desire for countries both to deepen their understanding of the connections between nature and the wellbeing of their people, and to ensure these connections are captured. Several countries announced their intention to carry out TEEB country studies and their interest in implementing TEEB recommendations. TEEB revealed that the drivers of biodiversity loss were widespread throughout our economies and societies, and the benefits of addressing these drivers went far beyond biodiversity alone, to include human health and livelihoods, water use and climate stability. TEEB stimulated demand to re-orientate our economic compass, and therefore officially entered an implementation phase of work aimed to put theory and into practice across a range of different areas. This included encouraging the world

of business<sup>2</sup> to co-create and publish formal and universal guidance on measuring, valuing and reporting corporate impacts and dependencies on nature (TEEB 2012; Natural Capital Coalition 2016).

TEEB's initial phase catalysed activities to make the impacts and dependencies of societies and public/private interests more visible in order to contribute to better policy and decision-making outcomes, at a number of levels:

- **National** - countries started conducting baseline ecosystem assessments to include Natural Capital in their national accounts; *Local and regional* – ICLEI, an international organisation focusing on local government, actively promoted TEEB tools and decision-making plans for the management of regional and municipal biodiversity and ecosystems;
- **Business** - some businesses (such as Puma) started to examine the impacts and dependencies on ecosystems and biodiversity along their supply chain.

TEEB's priorities have also evolved in the context of the wider international discourse in this space, a key element of which has been the emergence of the 2030 Agenda for Sustainable Development and the associated Sustainable Development Goals (SDGs) – see **Box 1.1**.

Critically, a common feature of both the work to date in the implementation phase of TEEB and the emerging approach to development and doing business in a world committed to meeting the Sustainable Development Goals are the interconnections and interdependencies between social, economic and environmental problems and achievements. It is therefore also clear that the pursuit of solely private profit or value as measured by markets, which neglect both positive and negative social and environmental externalities and impacts, cannot be relied upon to deliver effective or efficient solutions. Further, there is an economic incentive for those agents from both the public and the private sector that benefit from the status quo to lobby for it to be maintained.

2 "TEEB for Business" led (TEEB 2011) to the creation of a "TEEB for Business Coalition" comprising business, institutional & government stakeholders, which was re-named the "Natural Capital Coalition" in 2013 and in 2016 published the "Natural Capital Protocol".

### Box 1.1 TEEBAgriFood and the Sustainable Development Goals (SDGs)

The SDGs are a series of 17 internationally agreed, universally applicable goals that are recognized as indivisible and cover issues across the spectrum of development from poverty, food security and water security, through equity, health, access to decent work, peace and a stable natural environment. In an article, *The Guardian* (2017) linking the SDGs to food and agriculture, TEEB Study Leader Pavan Sukhdev outlines some of the challenges of implementation.

Indivisibility is key to the success of the SDGs as progress on one goal might be contingent on another, and this requires systems thinking. SDG 2 on zero hunger is perhaps most closely linked to TEEBAgriFood, but the fact that fish provide the main source of animal protein (and essential micronutrients) to more than one billion people globally implies that achieving SDG 2 also requires addressing SDG 14, on conserving and sustainably using the oceans. As Rockström and Sukhdev (EAT 2016) note, we are already using around 40 per cent of available land for growing food, a figure that is projected to rise to 70 per cent under a 'business and usual' scenario. How can achieving SDG 2 under this pathway then be compatible with achieving SDG 15 concerning life on land? The authors also note that the agri-food system also contributes over one-fourth of greenhouse gas emissions, so again achieving SDG 13 on climate change depends on how we tackle our goal of ending hunger, improving food security and improved nutrition. Our food choices also make a critical contribution to the global burden of disease, linking SDG 2 to SDG 3, the latter aiming to ensure good health and well-being. More broadly, global trends in shifts in the 'food plate' also do not auger well for achieving SDG 12 on responsible consumption and production. The analysis above points to the need for a 'joined up' approach and the application of systems thinking, i.e. not focusing on the delivery of kilocalories as the unifying performance metric of the agri-food sector, and this a core tenet of TEEBAgriFood.

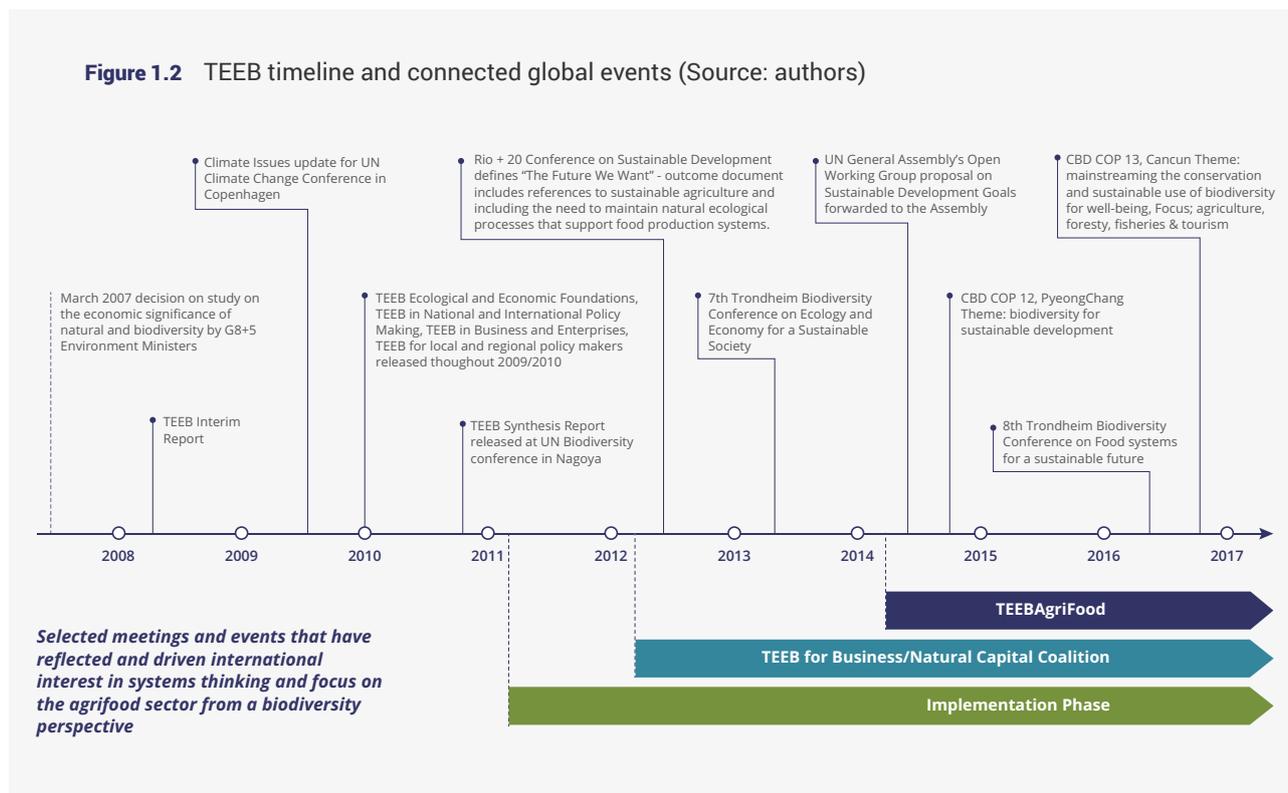
Figure 1.1 The SDG 'wedding cake' (EAT 2016)



Rockstrom and Sukhdev further note that the delivery on the full range of SDGs is based first on achieving 'biospheric' or ecological goals (6, 13, 14, 15), i.e. it is a necessary but not sufficient condition of achieving social goals (such as SDG 1 on poverty and SDG 10 on reduced inequalities) and economic goals (such as SDG 8 on good jobs and economic growth) that we have resilient and stable ecosystems. This is reflected in their 'wedding cake' structure (see Figure 1.1). TEEB rests on a central tenet that ecosystems and biodiversity are primary and we must search for incentive mechanisms and achieve the enabling conditions to make them our core concern.

The focus of the current implementation phase of TEEB (2013 onwards) has included both demand-driven efforts to help build capacity for TEEB-style analysis of policy issues (at national, regional and local scale, as well as for businesses) alongside strategic interventions internationally to catalyse further efforts - reflecting the awareness of those involved in TEEB that it is not the only initiative in this space. TEEB developed (and continues to develop) a community of practice. The TEEB for Business Coalition (now the Natural Capital Coalition) was one of the first initiatives to develop from

an initiative undertaken by the TEEB Study Leader and other key stakeholders in the TEEB for Business Report (TEEB 2012a) as set out in **Figure 1.2**. The Natural Capital Coalition was established to engage key stakeholders from business, government and civil society in open source collaboration in order to raise awareness and provide a leading-edge forum to shape the future of business thinking and action on 'natural capital', i.e. the critical role of properly functioning ecosystems in delivering economic prosperity.

**Figure 1.2** TEEB timeline and connected global events (Source: authors)

Key work areas in the current implementation phase of TEEB have included business, water and wetlands, natural capital accounting, oceans, and of course TEEB for Agriculture and Food (henceforth 'TEEBAgriFood') – the subject of the current volume.

### 1.1.2 The emergence of demand for TEEB for Agriculture and Food

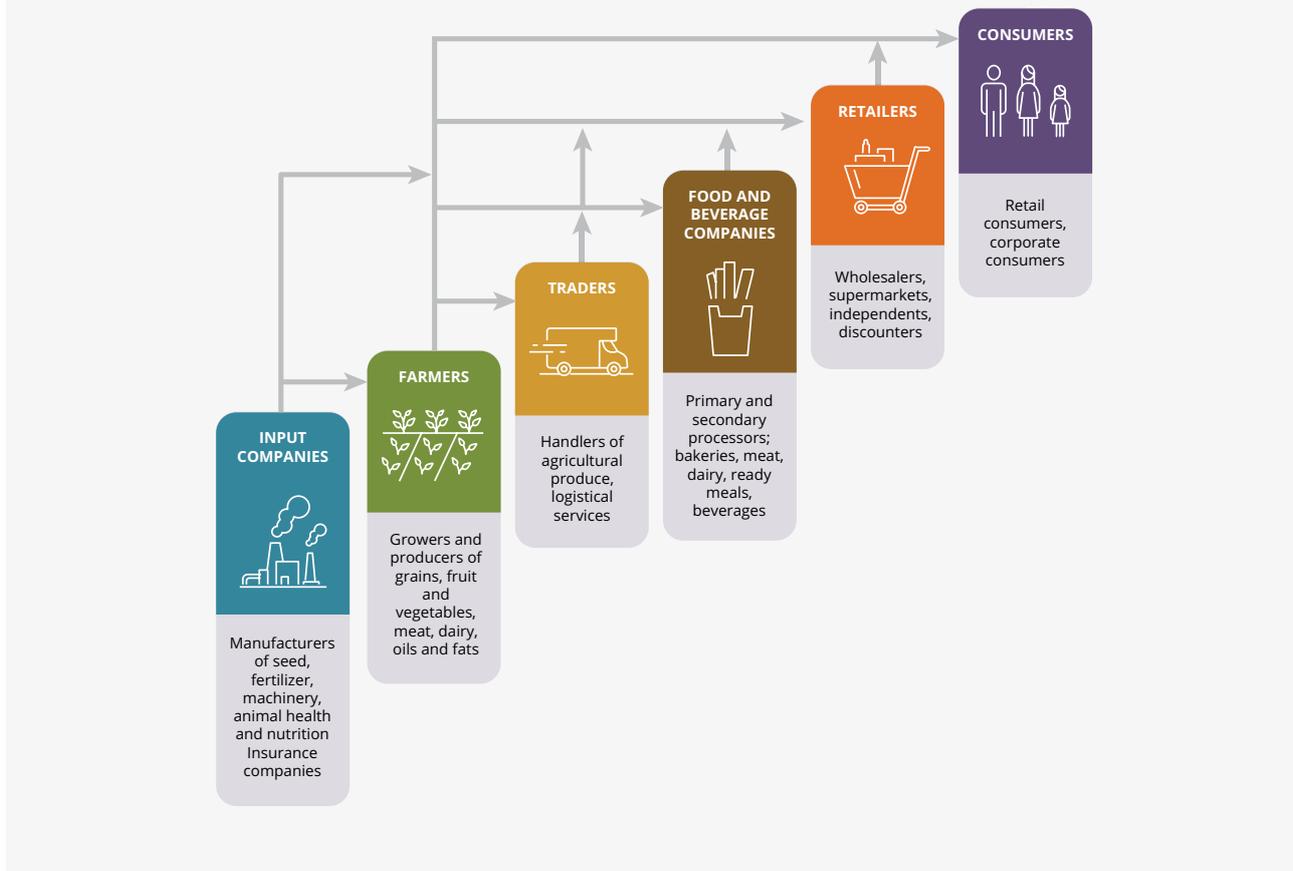
The agri-food sector featured in the earlier phase of TEEB. The range of outputs in this earlier phase were all built on the same foundations – the academic underpinnings from both the scientific and economic perspective, brought together in *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations* (TEEB 2010b). This publication explored the values of biodiversity to agriculture, the trade-offs between different ecosystem services in agricultural systems, the cultural values of agricultural landscapes, as well as ideas of resilience and the potential value and the livelihood and environmental benefits of genetic variation in crops and crop wild relatives. The way that we produce and consume food and manage agricultural landscapes also featured in the TEEB publications developed for businesses (TEEB 2012a), for public policy makers at national level (TEEB 2011) and at local and regional level (TEEB 2012b), and in three of the 10 key recommendations in the TEEB Synthesis Report (TEEB 2010a). In short, the original TEEB studies (2007-2012) sought to highlight the depth of existing knowledge with respect to the interconnections between nature and food production.

Although the agri-food sector did feature in the earlier phase of TEEB, the remit of TEEB was to 'correct the economic compass' by presenting appropriate ways of recognizing, demonstrating and then capturing the value of nature. Thus the earlier phase of TEEB considered the entire economy with its many industrial sectors. For an assessment of the eco-agri-food systems complex (as opposed to just the agri-food sector), a comprehensive understanding of all impacts and dependencies across the system, including externalities is required. This is the aim to which TEEBAgriFood seeks to contribute.

## 1.2 RATIONALE AND OBJECTIVES OF TEEBAGRIFOOD

### 1.2.1 TEEBAgriFood mission statement

The TEEBAgriFood study is designed to (1) provide a comprehensive economic evaluation of the eco-agri-food systems' complex, and (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, social, human and produced capitals.

**Figure 1.3** The food and beverage value chain (Trucost 2016)

## 1.2.2 What is the eco-agri-food systems complex?

Agriculture is an *economic sector*. It typically encompasses areas of economic activity beyond farm operations to include farm-related activities, such as processing, manufacturing and transport, so we may refer to it as the agri-food sector. There is a *value chain* in the sector, as set out in Figure 1.3, and there are systemic economic interlinkages and economic cross-dependencies in this value chain.

This economic system is underpinned by complex *ecological and climatic systems* at local, regional and global levels. Biodiversity and ecosystems – the study of which is at the heart of TEEB – underpin the delivery of economic output from this sector. Overlaying these natural systems are *social systems* influencing inter alia: (i) the composition of our food plates (i.e. what we eat), (ii) how we go about sourcing, purchasing, storing, cooking, and consuming food, and then discarding the food waste, (iii) our attitudes and behaviours towards farmers and the land that is used for agricultural production, and (iv) the way that cultural norms and values are transmitted between and across generations.

These three systems (economic, ecological and climatic, and social) interface and interact with each other, and that is why we refer to the ‘eco-agri-food systems complex’.

In terms of a definition, as set out in the TEEBAgriFood Interim Report (TEEB 2015), the eco-agri-food systems complex is a collective term encompassing the vast and interacting complex of ecosystems, agricultural lands, pastures, inland fisheries<sup>3</sup>, labour, infrastructure, technology, policies, culture, traditions, and institutions (including markets) that are variously involved in growing, processing, distributing and consuming food.

## 1.2.3 Why is there is a need to examine the externalities of eco-agri-food systems complex?

This question was tackled in depth in the TEEBAgriFood Interim Report and later summarized in an article for the journal *Nature* (Sukhdev *et al.* 2016). This article sets out the shortcomings of current patterns of crop and livestock production and of processing, transport and consumption with respect to what is required by society as a whole - the delivery of sufficient, healthy, nutritious food that does not damage nature.

<sup>3</sup> Marine fisheries are out of scope of TEEBAgriFood.

The current eco-agri-food systems complex impacts both on human health and on the natural environment in detrimental ways; it is now the source of 60 per cent of terrestrial biodiversity loss, 24 per cent of greenhouse gas emissions, 33 per cent of soil degradation and 61 per cent of the depletion of commercial fish stocks (UNEP 2016). For example, failures in access and distribution contribute to the fact that 800 million people in developing countries consume less than the 2,100 kilocalories of food recommended by the World Food Programme whilst at the same time 1.9 billion people in the developed world consume more than 3,000 calories a day (FAO 2015). This imbalance also has wider ramifications. The impact of undernutrition across Africa and Asia is estimated at 11 per cent of Gross Domestic Product (GDP) annually (IFPRI 2016). Similarly, one in four adults are now overweight or obese, with obesity behind many of the chronic diseases that are sweeping the globe, from type 2 diabetes to heart disease. The World Health Organization has estimated the direct costs of diabetes alone at more than US\$827 billion per year globally (WHO 2016).

The TEEBAgriFood Interim Report reflects on the role that agriculture plays in providing employment for around 1.3 billion people in a world that is already short of around 200 million jobs (ILO 2015). One billion of these jobs are in small-holder agriculture (less than 2 hectares) so it is important to address how society could provide alternative livelihoods for as many as 500 million more people if the concentration and mechanization of agribusinesses continues.

These are impacts on a global scale, yet in spite of the fact they are all connected to the same process (producing and consuming food), they have not yet been evaluated as an entire system, using a systems approach.

From a human health perspective, the Global Panel on Agriculture and Food Systems for Nutrition (2016) includes a call to scientists, governments and donors to work out how to craft and sustain food systems to provide nutritious diets for all. The report authors highlight that SDG 2 (zero hunger) and SDG 3 (good health and wellbeing) cannot be achieved with piecemeal action: “the trends are so large and so interconnected that the entire system needs overhauling” (Haddad *et al.* 2016, p.31). The emergence of initiatives such as The Food and Land-Use Coalition (FOLU), the International Panel of Experts on Sustainable Food Systems (IPES-Food) and the High Level Panel of Experts on Food Security and Nutrition (HLPE), each of which aims to bring together change agents in this space, shows that decision-makers understand the need for change and are ready to act.

Similarly, the emergence of the planetary health agenda, which is building a better understanding of the ramifications of environmental change on human livelihoods, pushes the need for more resilient food and agricultural systems that address both undernutrition and overnutrition, reduction of waste, diversification diets, and minimization of environmental damage. The impacts arising from feedbacks

in the system from our current behaviour are likely to be profound. The Lancet Commission on Planetary Health’s report (Whitmee *et al.* 2015) estimated climate change will result in 250,000 additional deaths between 2030 and 2050, that soil degradation leads to the loss of 1–2 million hectares of agricultural land every year, and that by 2050 40 per cent of the world’s population could be living in areas under severe water stress. The connections to food systems are clear, especially in terms of some of the identified solutions for a healthier planet - reducing food waste, halting deforestation, using water more efficiently and supporting healthier, lower environmental impact diets.

The need to bring together the environment, human health and human development agendas is increasingly evident. This is illustrated neatly by the impact of Kate Raworth’s recent book *Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist* (Raworth 2017) which aims to define both an environmentally-safe and socially-just space for humanity and assess how economies need to change to achieve this. This builds on the notion of planetary boundaries and the safe operating space within which human systems can operate, with its accompanying environmental limits. Juxtaposing this with factors which can cause human deprivation can be useful in assessing options to allow people to thrive within the limits of the planet. This thinking is very much embedded within the holistic approach advocated in this current TEEBAgriFood report.

Irrespective of the particular socio-economic, cultural and ecological context in which a particular eco-agri-food system is situated, there are always positive and negative externalities and impacts across the entire value chain, i.e. from production, through processing and transport, to final consumption. The question is thus not whether such externalities and impacts exist but rather their extent, which agents in society are affected, and whether we can promote a decision-making environment in which the positive impacts flourish and the negatives are mitigated.

#### **1.2.4 Why should TEEB be examining the externalities of eco-agri-food systems?**

The demand for a TEEB study on eco-agri-food systems was based on at least three key understandings: (1) the extent of the positive and negative externalities (i.e. non-compensated impacts on third parties) of the agri-food sector are likely larger than that of any other sector; (2) the approaches applied to date have been inadequate owing in part to the lack of a coherent, universal evaluation framework that includes these disparate externalities along with useful metrics; and (3) the TEEB community can develop, communicate and operationalize such an evaluation framework, and thereby contribute significantly to the integrity and functioning of ecosystems and to improving human livelihoods.

With respect to the first of these - the extent of externalities in the agri-food sector - an important report entitled “Natural Capital at Risk: The Top 100 Externalities of Business” (Trucost 2013) intended to help reveal the business case for further private sector engagement with the issue of natural capital and to help prioritize actions. It examined a wide range of impacts of business on the natural environment – the effects of which tend not to be reflected in the market prices of associated financial transactions (hence termed ‘externalities’).

The report looked at different types of non-market impacts on natural capital across different sectors and in varying regions of the world. The top 100 – ranked by the estimated monetary value of the impacts – were presented in the report. Whilst the research was open about the limitations in its the valuation approach, the magnitude of the figures highlighted the need for attention. The top 100 externalities had an estimated cost of around US\$4.7 trillion per year in terms of the environmental and social costs of lost ecosystem services and pollution. Crucially, in the context of TEEBAgriFood, 11 out of the top 20 externalities were related to agri-food sectors, ranging from the land impacts of cattle ranching in South America, to the water use impacts of wheat production in East Asia and corn production in North Africa.

In 2014, the Natural Capital Coalition (formerly the TEEB for Business Coalition) launched the Natural Capital Protocol, which provides a framework to help businesses begin to explore their relationship with nature. Reflecting the frequency with which agri-food sectors appeared in the top 100, a food and beverage sector supplement was released in 2016. The Protocol highlights from a business perspective the interconnections across agriculture and food systems and the varying degrees of resulting horizontal and vertical integration, underscoring the need to look system-wide to understand how to drive change. The supplement itself provides practical details and applied examples to help businesses in the food and beverage sector think about and take account of their impact and dependencies on natural capital in their decision making and planning.

What the “Natural Capital at Risk: The Top 100 Externalities of Business” and the food and beverage supplement tell us is that there is a need to tackle the externalities in the sector, and that TEEBAgriFood is not alone in recognizing this need. TEEBAgriFood offers a unique value-addition in this space in that the TEEBAgriFood Evaluation Framework (hereafter ‘Evaluation Framework’ or ‘Framework’) presented in Chapter 6 of this report is both *comprehensive* and *universally applicable*, and applies a *systems perspective* (described in Chapter 2).

There are myriad externalities and impacts – both positive and negative – created in the production and consumption of food. The Evaluation Framework is

designed to be comprehensive. For instance, there is a focus not just on the impacts and dependencies between the agri-food sector/ecosystems and biodiversity but also on the agri-food sector’s contribution to human health outcomes. This has also meant that the TEEB community of practice has been extended for TEEBAgriFood to include academics, policy-makers, civil society groups etc. operating in the human health and nutrition fields.

A challenge, which is perhaps unique to the agri-food sector, is the extent of the heterogeneity within and across food systems. The Natural Capital Protocol’s food and beverage sector guide is targeted at business. In many ways, all agribusinesses are firms of one kind or another but small-scale producers are unlikely to have the same objectives and constraints as large firms. One size does *not* fit all in this sector. TEEB from its inception has championed the ‘GDP of the Poor’ therein flagging the particular dependence of the poorer segments of society on well-functioning ecosystems, and thus developing and applying a universal Evaluation Framework that is applicable to scenario analysis for small-scale producers. But equally the Framework must be (and indeed is) applicable to large-scale agribusiness.

Systems thinking is central to TEEBAgriFood. It is not possible or sensible to isolate impacts and dependencies of primary agricultural production (within the farm gate) from the rest of the eco-agri-food system if we are to find truly sustainable and equitable solutions. Issues cut across current commodity production systems and across spatial and temporal scales. Analyses will need to be context-specific. TEEBAgriFood sets out and illustrates a comprehensive system-wide analytical lens that can be used to examine different issues given this need.

It is recognized that TEEB engages substantially with the issues around agriculture and food. The TEEBAgriFood Interim Report (TEEB 2015) was noted by the 13<sup>th</sup> Conference of the Parties of the Convention on Biological Diversity in Cancún in December 2016 in the context of a decision focused on “actions to enhance the implementation of the Strategic Plan for Biodiversity [agreed in 2010]”, which specifically highlights efforts with respect to mainstreaming the integration of biodiversity within and across sectors. Recognition is growing that problems of biodiversity loss cannot (and should not) be tackled by conservationists alone, but rather by society at large including the business community.

This report builds substantially on the TEEBAgriFood Interim Report (TEEB 2015), focusing on developing the Framework and analysis on which transformations can be based. It is therefore both timely and urgent – it is essential that such a change in how we look at our food systems is adopted and used quickly.

## 1.3 STRUCTURE OF THE REPORT

The aspiration of the TEEBAgriFood *project* is to change the way that we produce and consume food, so as to reflect the hitherto invisible positive and negative externalities and impacts in the eco-agri-food systems complex. This *report* – the ‘Scientific and Economic Foundations’ report – focuses on the need to ‘make the case’ for this new paradigm. As such, this report contributes to the aspiration of the TEEBAgriFood project but needs to (and will) be complemented by: (1) other reports targeted at specific change agents, (2) projects where change is tested and implemented at corporate, regional, national and supra-national levels, and (3) communications and outreach.

Following this Introductory chapter, the report is divided into four segments, as per sections 1.3.1-1.3.4 below. Figure 1.4 provides a schematic representation of the entire eco-agri-food systems complex – the visible and invisible flows of agricultural production. This figure is used below to illustrate the rationale for the chapter ordering and the narrative thread of the report.

### 1.3.1 The lens through which we analyse the eco-agri-food systems complex – the systems approach

Chapter 2 lays out the foundation for using systems thinking as a guiding perspective in TEEBAgriFood. This is required so as to understand the relationships across multiple sectors, disciplines and perspectives, thereby embracing holism and avoiding reductionist, ‘silo’ thinking. Systems theory emphasizes circular flows with both negative and positive dynamic feedbacks between the economy, the environment and human social systems. Applying a systems approach requires looking at feedbacks across the entire value chain from ‘agricultural production’ through to ‘household consumption’ via ‘manufacturing & processing’ and ‘distribution, marketing and retail’, while analysing multifarious impacts and dependencies (*c.f.* Figure 1.4).

### 1.3.2 Evidence that we need to change the eco-agri-food systems complex

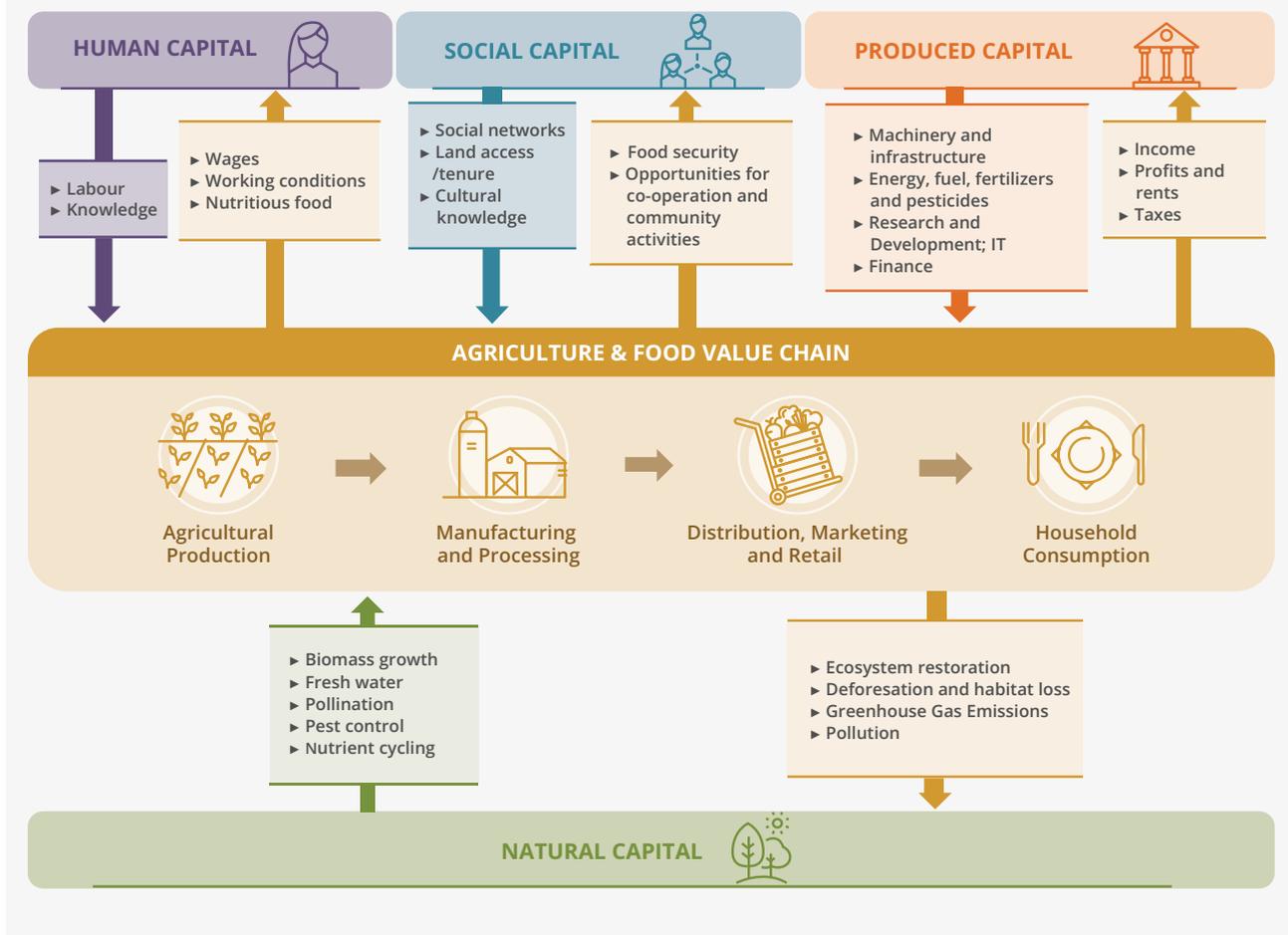
Since the metric commonly used to assess on-farm economic performance has (and continues to be) yield/hectare, agricultural systems research has focused on irrigation, breeding, machinery etc. – the visible inputs to the agricultural system in the schematic. These include – with reference to Figure 1.4 – ‘labour’ (from human capital), and ‘manufacturing and infrastructure’ and ‘energy,

fuel, fertilisers and pesticides’ (from produced capital). TEEBAgriFood aims to *change food metrics*. Chapter 3 sets out the available scientific data and evidence not just on the visible flows in Figure 1.4 but also those that tend to be invisible, with a particular focus on the flows coming from natural capital. Some flows can be visible or invisible depending on circumstances. For instance, agri-tech consultancies market their ‘knowledge’ (from human capital) to large-scale commercial producers in ‘manufacturing & processing’, but local indigenous knowledge of crop varieties – although critical to maintaining resilient social communities – might remain invisible.

The TEEBAgriFood assessment acknowledges and explores the heterogeneity across agricultural systems and finds that positive and negative externalities and impacts are pervasive across all eco-agri-food systems, and further across the value chains in which these systems are situated.

‘The way we produce, process, distribute, and consume food (as well as how we deal with its disposal) impacts human health and nutritional security, which in turn (with reference to Figure 1.4) impacts on the availability of ‘labour’ and on the types of ‘social networks’. Chapter 4 focuses on this subject, looking across the entire value chain. Six of the top 11 risk factors driving the global burden of disease are diet related. The quality of life for billions of people is impacted by malnutrition. Across the food system, people can additionally be impacted via work-related injuries (or death) or toxin/pathogen exposure. Coupled with these direct food system impacts are indirect impacts that are felt now and will be felt in future generations. The food system can be either an enabler of food and nutrition security, livelihood procurement, and environmental sustainability, or it can be a disabler. We can develop food systems that allow a large number of individuals to secure a livelihood through the food system or one in which large numbers of food system workers are systematically exploited. This chapter explores a number of endpoints in various food system strategies and suggests a strategy for exploration, mitigation, change, and ultimately transformation of our global food system to one in which health – human, ecosystem, and community – is the norm for 9-10 billion people.

Figure 1.4 Capital stocks and value flows in eco-agri-food systems (Source: authors)



All of the choices that we make vis-à-vis food - as individual consumers or citizens, as farmers, as fiduciary agents of agribusiness corporations, as part of sub-national, national or global policy-making - have an ethical dimension. In an equitable food system, all people have meaningful access to sufficient healthy and culturally appropriate food, and the benefits and burdens of the food system are equitably distributed. This is the focus of [Chapter 5](#). The overall objective of this chapter is to identify key aspects of social equity of the world's food systems in order to provide pathways and indicators that can be used to assess the impacts of food systems in equity outcomes.

Chapters 3-5 collectively provide evidence that: (i) the wrong metrics are being used to assess the eco-agri-food systems complex; (ii) applying today's metrics leads to outcomes that degrade the ecosystems and biodiversity that agricultural systems depend on, and negatively impact on human health; and (iii) these burdens fall disproportionately on the poorer segments of society. Chapters 3-5 express the *need for a change in the metrics*. Chapters 6-8 set out TEEBAgriFood's *proposal for such a change* in the form of the Evaluation Framework.

### 1.3.3 The TEEBAgriFood Evaluation Framework: a tool to assess the eco-agri-food systems complex

[Chapter 6](#) sets out the Framework. The Framework highlights all relevant dimensions of the eco-agri-food value chain and pushes policymakers, researchers, and businesses to include these in decision-making. These dimensions include social, economic, and environmental elements as well inputs/outputs across the value chain. The Framework therefore establishes all of “*what should be evaluated*”.

Guiding principles are that the Framework is comprehensive (covering all elements), universal (be applicable to all decision-making contexts), and supports multi-criteria assessments (e.g. production, consumption, greenhouse gas emissions, fertilizer use, health impacts and decent work).

Whereas [Chapter 6](#) is concerned with what to value, [Chapter 7](#) turns to “*how to carry out the evaluation*.” The chapter makes the distinction between (and presents

examples of) methods for the *economic valuation* of ecosystem services and disservices in both monetary and non-monetary terms, *evaluation* methods, and *modelling* tools and techniques. Policy-makers are unlikely to rely solely on the outcomes of an economic valuation study, but such information can be an important component in decision-making. Valuation results might be used as *an input* to an evaluation approach such as Cost Benefit Analysis or Multi-Criteria Analysis, which may be informed by (for example) Systems Dynamics modelling. Chapter 6 provides an illustrative example of integrated modelling in Kilombero, Tanzania to help explain the distinction between valuation, evaluation and modelling.

One of the guiding principles for the Framework as mentioned above is universality. The objective of [Chapter 8](#) is to provide case study examples of five clusters of possible applications: (i) agricultural management systems; (ii) business analysis; (iii) dietary comparison; (iv) policy evaluation; and (v) national accounts for the agriculture and food sector.

The examples in Chapter 8 illustrate not only how a published study fits into the Framework but also *equally how it does not*. We argue that the broad methodological approaches required to apply Framework testing do already exist (and are presented in Chapter 7) but, as with any paradigm shift, the data and results from studies that pre-date the Framework are not adequate for a full Framework application. Thus gaps are to be expected.

The aim of the final two chapters in this report is to explore what has to change in order for us to realize this paradigm shift – for the Framework to become the new orthodoxy.

### 1.3.4 How do we change the eco-agri-food systems complex?

[Chapter 9](#) on the theory of change seeks to explore how attempts to redirect the eco-agri-food systems complex might be perceived from the perspectives of key actor groups, suggesting avenues to escape ‘path dependencies’ that lock in unsustainable practices. What form might such path dependency take? It may be the case that individual farmers or agribusinesses see the benefit of a transformative shift in the way that food is produced and, were they all to *collectively and simultaneously* agree to shift behaviours, they could then operationalize this transformative change. But concerted and coordinated actions are required in such instances, and there are strong corporate (and sometimes cultural) forces that dissuade these farmers and agri-businesses from shifting from the dominant orthodoxy. They are ‘locked into’ an unsustainable path dependency.

Chapter 9 explores pathways towards sustainability. Information alone often fails to motivate change. Manipulation of data has led consumers to doubt

scientific results, serving special interests at the expense of public benefit. The chapter sets out a range of actor-relevant theories of change. These include consumer advocacy (e.g. the threat of boycotts and reputational risk), product certification, promoting institutional and societal learning, developing strategic alliances etc.

Part of the impetus for the transformative shift discussed above will likely come from TEEBAGriFood aligning itself with on-going initiatives and processes, be they global agreements or business-led initiatives, and demonstrating the value-added of the Framework. This is the subject of [Chapter 10](#). Such global initiatives include the Right to Food, the Aichi Targets, and (as discussed earlier in Box 1.1) the 2030 Agenda and its Sustainable Development Goals. Linking TEEBAGriFood to business platforms is important in that they support learning and, if linked to citizen representation, can enhance accountability.

## 1.4 THE TEEB APPROACH: REPLICATING THE SUCCESS OF EARLY TEEB WORK FOR TEEBAGRIFOOD

It is the belief of those who have been involved with TEEB throughout its development that the initiative’s success and longevity are not solely due to the compelling narrative behind the work, but also its delivery approach. TEEB work is not only deliberately open and transparent, but also reliant on the communities of practice that it aims to foster and develop. Through open and widely publicized calls for evidence, both the original TEEB work and TEEBAGriFood reached out to this community to gather evidence and to encourage further development and uptake of best practice.

Change cannot be realised without developing a community that connects researchers and decision makers across different sectors. This is a critical element of the way TEEB works. It is our hope that the reader of this report will be inspired to become part of this community, which is not just focused on knowledge generation, but the connection of this knowledge to those who can influence change.

TEEB’s governance structure is also supportive of this. The TEEB initiative is coordinated through the TEEB office situated in UN Environment and geographically based in Geneva, Switzerland. The overall TEEB initiative is guided by a high-level independent Advisory Board with members spanning government, business, academia and civil society, and TEEB study leader and UN Goodwill Ambassador Pavan Sukhdev. It is also supported by a

Coordination Group, including those working directly on the TEEB work programme and policy makers from supporting countries. This helps to ensure links to ongoing international policy processes and to see that TEEB responds to and is relevant in the context of international demands.

As it is a major new undertaking, the TEEBAgriFood study also has its own Project Steering Committee (chaired by Alexander Mueller, the TEEBAgriFood Study Leader), whose members are more substantively engaged in the TEEBAgriFood work, providing support in various forms including expert contacts, direct input and guidance and peer review. Summaries of the governance structure and work to date on this project are readily available via the agriculture and food section of the TEEB website <http://www.teebweb.org/agriculture-and-food/>.

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# CHAPTER 2

## SYSTEMS THINKING: AN APPROACH FOR UNDERSTANDING 'ECO-AGRI-FOOD SYSTEMS'

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**Suggested reference:** Zhang, W., Gowdy, J., Bassi, A.M., Santamaria, M., DeClerck, F., Adegboyega, A., Andersson, G.K.S., Augustyn, A.M., Bawden, R., Bell, A., Darnhofer, I., Dearing, J., Dyke, J., Failler, P., Galetto, L., Hernández, C.C., Johnson, P., Jones, S.K., Kleppel, G., Komarek, A.M., Latawiec, A., Mateus, R., McVittie, A., Ortega, E., Phelps, D., Ringler, C., Sangha, K.K., Schaafsma, M., Scherr, S., Hossain, M.S., Thorn, J.P.R., Tyack, N., Vaessen, T., Viglizzo, E., Walker, D., Willemen, L. and Wood, S.L.R. (2018). Systems thinking: an approach for understanding 'eco-agri-food systems'. In TEEB for Agriculture & Food: Scientific and Economic Foundations. Geneva: UN Environment.

# CHAPTER 2

## KEY MESSAGES

- The Economics of Ecosystems and Biodiversity for Agriculture and Food (TEEBAgriFood) aims to provide guidance and illustrations for comprehensive evaluations of the eco-agri-food systems. The TEEBAgriFood has brought together scientists, economists, policymakers, business leaders, farmers, and civil society from all over the world in order to agree on how to frame, undertake, and use holistic evaluations of agricultural and food practices, products, policy scenarios, and so on against a comprehensive range of impacts and dependencies across the eco-agri-food system value chains.
- 'Eco-agri-food systems' is our collective term for the vast and interacting complex of ecosystems, agricultural lands, pastures, inland fisheries, labour, infrastructure, technology, policies, culture, traditions, and institutions (including markets) that are variously involved in growing, processing, distributing and consuming food.
- Diverse agricultural production systems grow our crops and livestock and employ more people than any other economic sector. They are underpinned by complex biological and climatic feedback loops at local, regional and global levels. These natural systems are overlaid by social and economic systems, which transform agricultural production into food and finally deliver it to people based on market infrastructure, economic forces, government policies, and corporate strategies interacting with consumer and societal preferences. Furthermore, technologies, information and culture are continually re-shaping production, distribution and consumption, as well as the interactions among them.
- The global food system is one of the most important drivers of planetary transformation and it is experiencing multiple failures. Many dimensions of the eco-agri-food system create complex analytical and policy challenges. In the end, the state of human wellbeing, including the health of people and the planet, are determined by these diverse interlinked "eco-agri-food systems" and consumer choices made within these systems.
- This chapter makes the case for using systems thinking as a guiding perspective for TEEBAgriFood's development of a comprehensive Evaluation Framework for the eco-agri-food system.
- Eco-agri-food systems are more than production systems. Using one-dimensional metrics such as "per hectare productivity" ignores the negative consequences and the trade-offs across multiple domains of human and planetary wellbeing and fails to account for the various dimensions of sustainability.
- Silo approaches are limiting our ability to achieve a comprehensive understanding of the interconnected nature of the eco-agri-food system challenges. We need a holistic framework that allows the integration of well-understood individual pieces into a new, complete picture.
- Systems thinking allows better understanding and forecasting the outcomes of policy decisions by illuminating how the components of a system are interconnected with one another. Systems thinking identifies the drivers of change as determined and impacted by feedback loops, delays and non-linear relationships. Synergies and coherence can be gained when evidence is generated and used based on concepts and methods aligned with systems thinking.
- In the context of TEEBAgriFood, an important role of systems thinking is to identify the main components, drivers, dynamics and relationships that impact the entire value chain of the eco-agri-food system. This helps make side effects and tradeoffs visible, allows for identification of winners and losers, and uncovers synergies that can be realized through the implementation of public policies or other behaviour interventions.
- To establish the building blocks of a theory of change, systems thinking empowers us to move beyond technical analysis and decision-tool toward more integrated approaches that can aid in the forming of a common ground for cultural changes.

# CHAPTER 3

## 'ECO-AGRI-FOOD SYSTEMS': TODAY'S REALITIES AND TOMORROW'S CHALLENGES

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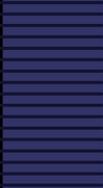
**Reviewers:** Brajesh Jha (*Institute of Economic Growth*), Asad Naqvi (*UN Environment*), Unai Pascual (*Basque Centre for Climate Change*), Ben Phalan (*Oregon State University*), Jules Pretty (*University of Essex*) and Kamaljit K. Sangha (*Charles Darwin University*)

**Suggested reference:** Pengue, W., Gemmill-Herren, B., Balázs, B., Ortega, E., Viglizzo, E., Acevedo, F., Diaz, D.N., Díaz de Astarloa, D., Fernandez, R., Garibaldi, L.A., Giampietro, M., Goldberg, A., Khosla, A. and Westhoek, H. (2018). 'Eco-agri-food systems': today's realities and tomorrow's challenges. In *TEEB for Agriculture & Food: Scientific and Economic Foundations*. Geneva: UN Environment.

# CHAPTER 3

## KEY MESSAGES

- Chapter 3 provides an overview of the complexities, roles and functions of eco-agri-food systems. The diversity of global agriculture and food production systems is profiled; the challenges ahead for the world's agriculture and food systems are presented; and pathways to sustainability for agriculture and food systems, building on ecosystem services and biodiversity, are explored.
- Globally, there many diverse types of agriculture and food systems, each with different contributions to global food security, impacts on natural resources and varying ways of working through food system supply chains. Using a typology recently adopted by international initiatives, the world's food systems can be characterized as traditional, mixed and modern. Each of these systems can strengthen their linkages to natural capital and ecosystem service provisioning.
- The contribution of small and medium sized farms of traditional and mixed systems – providing food to an estimated two thirds of the world's population in highly diverse landscapes – is highlighted, reinforcing the contribution of ecosystem services and biodiversity in food and agriculture.
- Prevailing economic logic reinforces forms of food production that fail to account for the contributions of nature, while negatively impacting both the environment and human welfare. This situation has created externalities such as wide-spread degradation of land, water and ecosystems; high greenhouse gas emissions; biodiversity losses; chronic over- and undernutrition and diet-related diseases; and livelihood stresses for farmers around the world. The nature of international trade resulting from such forces and pressures has many ramifications for equity and sustainability.
- An emerging feature of global food systems is the existence of multiple, insidious forms of visible and invisible flows of natural resources. Socio-economic crises and the often-unpredictable impacts of climate change present additional and compounding challenges for farmers and local communities.
- Pathways to sustainability, going forward, must recognize and strengthen those forms of agricultural production that explicitly enhance biodiversity and ecosystem services and build the natural capital that underpins food systems, creating regenerative forms of agriculture and food systems that generate positive externalities.
- Pathways to sustainable food systems must look at the dependencies and interactions within the entire food chain and at multiple scales, from farm to landscape to city to regional food systems.



# CHAPTER 4

## HUMAN HEALTH, DIETS AND NUTRITION: MISSING LINKS IN ECO-AGRI-FOOD SYSTEMS

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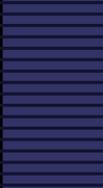
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**Suggested reference:** Hamm, M.W., Frison, E. and Tirado von der Pahlen, M.C. (2018). Human health, diets and nutrition: missing links in eco-agri-food systems. In *TEEB for Agriculture & Food: Scientific and Economic Foundations*. Geneva: UN Environment.

# CHAPTER 4

## KEY MESSAGES

- The purpose of this chapter is to explore ways in which current agri-food approaches impact food security, nutrition and human health and to develop options for transforming these systems into eco-agri-food systems that promote human and ecological health.
- Human health is directly linked to and influenced by food and nutrition security, all of which are hugely important (and largely ignored) considerations when evaluating the impacts and externalities of eco-agri-food systems.
- There are five key channels through which food systems negatively impact health: occupational hazards; environmental contamination; contaminated, unsafe, and altered foods; unhealthy dietary patterns and food insecurity.
- Eco-agri-food systems can be either enablers or disablers (i.e. have either positive or negative impacts and externalities) in terms of health and food/nutrition security, depending on a variety of factors that influence what, how and how much food is produced, processed and consumed.
- The challenge to accomplishing sustainable, universal food and nutrition security is multi-faceted and will depend on four interrelated developments: dietary pattern change, social justice, food waste and appropriate technological development.
- Six of the top ten risk factors driving the global burden of disease are diet-related with the quality of life for billions of people impacted by malnutrition.
- Lives and livelihoods can additionally be impacted via food system work-related injuries or deaths or exposure to toxins/pathogens. There are also indirect impacts now and for future generations.
- Population increase, urbanisation and modernisation continue to negatively impact human health and food/nutrition security, for example with 1.9 billion people currently overweight or obese, whereas more localised, traditional systems can offer important lessons for having positive impacts.
- Harvest and post-harvest management of crops and animal products is critical to ensuring food can be consumed without contamination (chemical or biological) and with minimal losses and decline in nutritional quality.
- Projected dietary pattern shifts – the nutrition transition - will place an unacceptable burden on ecosystems and natural resources as well as chronic disease incidence.
- Several Sustainable Development Goals are directly linked to human health and food/nutrition security, with all of them indirectly linked, and this analysis can be used as part of their 'toolkit for resolution'.



# CHAPTER 5

## SOCIAL EQUITY, ETHICS AND JUSTICE: MISSING LINKS IN ECO-AGRI-FOOD SYSTEMS

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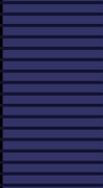
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**Suggested reference:** Tirado von der Pahlen, M.C., Arias, D., Comim, F. Sassi, F., Briseño, A., Kinderlerer, J., Lee, S., Platais, G. and Rapallo, R. (2018). Social equity, ethics and justice: missing links in eco-agri-food systems. In *TEEB for Agriculture & Food: Scientific and Economic Foundations*. Geneva: UN Environment.

# CHAPTER 5

## KEY MESSAGES

- Social equity is a fundamental aspect of our food system and it is one of the principal values underlying sustainable development with all people and their quality of life being recognized as central. In order to be sustainable the global food system should meet the needs of present and future generations for its products, services and outcomes, such as health, while ensuring profitability, environmental health and social and economic equity.
- Consideration of the different aspects of social equity of the world's food systems from production to consumption, including food waste management, and measuring food systems' equity outcomes is critical to ensure sustainability. Equity in food production systems is vital in assuring that the acceleration of global production to meet increasing demand, brings benefits for and does not exclude the world's poor and does not leave anybody behind.
- In an equitable food system, all people have meaningful access to sufficient healthy and culturally appropriate food, and the benefits and burdens of the food system are equitably distributed.
- There is a need for an adequate policy environment and incentives to build Equitable Food System. Creating an equitable food system requires improving poor people's access to land, water and other natural resources, ensuring labor rights, access to new technologies; creating access to local and international markets; and investing in improving gender equality, women's education and status, among others.
- Social Equity is a critical component of most SDGs and the TEEB/AgriFood framework can provide tool to collect organize information and data on social equity related to food systems to assess progress towards the SDGs. The TEEB/AgriFood framework offers a tool to assess the costs and benefits of social equity of different food systems considering all the components, institutions and policies of the food system, from production, processing, trade and distribution, to access and consumption and including food waste management.



# CHAPTER 6

## THE TEEBAGRIFOOD FRAMEWORK: TOWARDS COMPREHENSIVE EVALUATION OF ECO-AGRI-FOOD SYSTEMS

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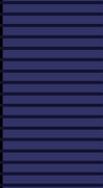
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**Suggested reference:** Obst, C. and Sharma, K. (2018). The TEEBAgriFood Framework: towards comprehensive evaluation of eco-agri-food systems. In *TEEB for Agriculture & Food: Scientific and Economic Foundations*. Geneva: UN Environment.

# CHAPTER 6

## KEY MESSAGES

- This chapter presents a framework that supports the evaluation of different eco-agri-food systems, covering their human, social, economic, and environmental dimensions, from production through to consumption.
- Common assessment metrics, such as yield per hectare, ignore a wide and significant range of social, human, and environmental costs and benefits of eco-agri-food systems.
- The primary goal of the TEEB-Agri-Food Evaluation Framework is to support decision-makers in establishing “what should be evaluated” in a given assessment, and consequently, to bring transparency and context to all assessments, by highlighting elements which may have been overlooked.
- The Framework systematically categorizes all elements – including human, social, economic, and environmental stocks, flows, outcomes and impacts - which could potentially be described and analyzed in an assessment of eco-agri-food systems.
- The Framework has been developed with three guiding principles:
  1. universality: providing a common language in all decision-making contexts;
  2. comprehensiveness: including all relevant social, environmental, human, and economic elements along the entire value chain;
  3. inclusiveness: supporting multiple approaches to evaluation and assessment including in both qualitative and quantitative terms.
- The Framework is designed to support (a) the description of the structure and trends in eco-agri-food systems and hence underpin the derivation of indicators and metrics to better understand issues such as capacity, sustainability, productivity and efficiency; and (b) the analysis of eco-agri-food systems using various tools such as cost-benefit analyses, integrated profit and loss statements, ecosystem services valuation, and measures of inclusive wealth.
- The Framework adopts a multiple capitals approach recognizing that eco-agri-food systems, from the production to the consumption stages, are sustained by – and impact upon – all four types of capital: human, produced, social, and natural. A holistic assessment should include all pathways by which eco-agri-food systems interact with these capital bases.
- Eco-agri-food systems are dynamic, with their elements changing and influencing each other over varying spatial and temporal scales; any assessment needs to account for these dynamics.
- The extent of exposure to risk and the degree of resilience of an eco-agri-food system are important considerations for any assessment.
- The range of qualitative and quantitative information needed in order to provide a complete description of an eco-agri-food system cannot be simply aggregated; and, in analysis, care must be taken in selecting relevant variables for each decision-making context.
- The Framework is intended for use in an interdisciplinary manner, where the questions to be analysed, the options to be compared, and the scale, scope, and relevant variables included are determined in an open and participatory way, before the appropriate assessment and valuation methods are implemented.



# CHAPTER 7

## TEEBAGRIFOOD METHODOLOGY: AN OVERVIEW OF EVALUATION AND VALUATION METHODS AND TOOLS

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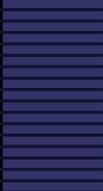
**Reviewers:** Joseph Glauber (*International Food Policy Research Institute*), Shunsuke Managi (*Kyushu University*), Jules Pretty (*University of Essex*), David Simpson (*RDS Analytics, LLC*) and Mesfin Tilahun (*Mekelle University / Norwegian University of Life Sciences*)

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# CHAPTER 7

## KEY MESSAGES

- This chapter presents an overview of available evaluation and valuation methods and tools relevant for the analysis of dependence and impacts of various agricultural and food (eco-agri-food) systems on human wellbeing.
- The eco-agri-food system has undergone deep economic and technological transformation. As a result there have been a number of intended and unintended impacts on human well-being. These necessitate a careful evaluation of the associated external effects and the social, economic and environmental impacts.
- Several market and non-market valuation tools and methods can take into account the externalities along the value chain from the farm gate to the food plate of the eco-agri-food system. However, no single tool or model addresses all the needs of the stakeholders and effectively takes account of the complexity of the system analysed.
- Valuation methods can provide credible numbers but to do so they require a lot of data as well as information on the context, purpose and the assumptions behind the values.
- The challenges of valuation of agricultural and food systems arise from their spatial dependence, scale of occurrence of ecosystem services, temporal dimensions, management practices and attribution of values across multiple services.
- The transferability of values from one context to another is possible but requires extensive socio-economic and environmental information about the site where they were estimated and the site where they will be applied.
- Decision making does not depend only on economic values but also included wider dimensions. There are tools that can integrate the economic values into wider dimensions of policy making.
- The external impact of the eco-agri-food value chain is dynamically linked to economic and social impacts through positive and negative feedback loops. Thus the system has to be analysed and integrated as a whole, taking account of these dynamic factors.
- Use of a systems approach can support the integration of knowledge across fields and complement existing work by generating an assessment of the social, economic and environmental impacts of production and consumption, and by estimating strategy/policy impacts for a specific project/policy and for society.
- The scenarios of the systems approach can help simplify and understand the complexity of the eco-agri-food system, and evaluate the short vs. longer-term advantages and disadvantages of the analysed interventions.



# CHAPTER 8

## APPLICATION OF THE TEEBAGRIFOOD FRAMEWORK: CASE STUDIES FOR DECISION-MAKERS

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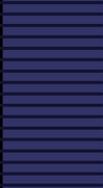
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# CHAPTER 8

## KEY MESSAGES

- The framework enables a comprehensive overview of the positive and negative externalities associated with various examples that are explored.
- It also provides opportunity to modify the framework to capture all stocks and flows of natural, human and social capital through the entire value chain so that they can be better reflected in national accounts.
- There is need to extend the scope of the framework to examine trade-offs at each stage of value chain as found in various examples especially while comparing management systems and evaluating policy scenarios.
- There is no single example where the entire value chain was explored, therefore, there is a compelling case to develop and apply TEEBAgriFood framework to understand all positive and negative externalities in an eco-agri-food system complex.
- There are challenges within the TEEBAgriFood framework to reflect the “visible and invisible flows” between the two contrasting examples.
- A comprehensive and full scale application of the TEEBAgriFood framework can help address policy questions, if the challenges are included in the scope of the study.
- The framework can be used by consumers to understand sustainable diets, health implications of the current food consumption patterns, and food footprints.
- There is need to redefine priorities and plan further testing of the framework that can consider entire value chain to evaluate capital (natural, social, human) and stocks (flow of ecosystem services) in agriculture sector. Complete application will require a considerable amount of time and resources to populate the framework. Given the limited number of case studies that are explored here, there are uncertainties around the data availability.
- The evolutionary nature of the framework will allow it to be modified to manage risks associated with degradation of natural, social and human capitals.



# CHAPTER 9

## THE TEEBAGRIFOOD THEORY OF CHANGE: FROM INFORMATION TO ACTION

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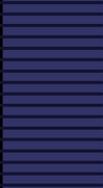
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# CHAPTER 9

## KEY MESSAGES

- Information alone often fails to motivate change. Manipulation of data has led consumers to doubt scientific results, serving special interests at the expense of public benefit. Information overload implies the need for synthesis to enable better access and impact.
- Rationalizations against the need for change include: fatalism, arguing that business is already changing of its own accord, that cheap food is more important than good food, and that the marketplace will adjust for externalities.
- These views do not address the long-term systemic consequences of the global corporate model of food systems in a society that derives calories from corn syrup and protein from hamburger resulting in obesity and disease.
- Free market, neoliberal policies are incapable of resolving externalities that affect public goods such as ecosystem services. Faith in the infallibility of the market is a shortcoming of economics.
- Path dependency is a key barrier to change in food systems, causing inertia, but may also lock-in positive systemic change. A science of intentional systemic change is arising, grounded in better understanding of human economic behavior as the basis for collective action.
- We espouse not one theory but rather a range of actor-relevant theories of change.
- Consumer advocacy can bring businesses to assume greater responsibility for the effects of their actions. This theory of change has found expression in the threat of boycotts and reputational risk.
- Certification has led to improvement in production practice within market niches but its true success begins when it pressures change in policy and practice throughout supply chains.
- Governance of intentional transformation in food systems requires knowledge of political pressure points, and systematic efforts to shape narratives of principal actors, to redirect financial resources and to promote institutional and societal learning and adaptation.
- We address the potential of multilateral organizations and agreements, national governments, the financial industry, agribusiness, producers and consumer groups to respond to the need for change. The roles of different actors are interlocking: there is no single point of entry for a theory of change.
- The roles of principal actors are drawn along a continuum of change, suggesting specific roles and types of actions to be addressed in evaluation and intervention. Given societal concern, agents for change may persevere within government, agribusiness or civil society organizations; their ability to bring change is dynamic and opportunistic, and driven by strategic alliances. As levers of agrifood system transformation, it is crucial to engage influential governmental actors as change agents.
- Actors' respective ability to adopt the results of TEEBAgriFood studies as a tool to direct change will depend on how well those results are communicated and adopted as narratives by influential actors and as entry points for education and consumer consciousness.



# CHAPTER 10

## TEEBAGRIFOOD AND THE SUSTAINABILITY LANDSCAPE: LINKING TO THE SDGS AND OTHER ENGAGEMENT STRATEGIES

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# CHAPTER 10

## KEY MESSAGES

- **TEEBAgriFood is part of and adds value to several initiatives ranging from international science-policy interfaces to firm level accounting systems. It also supports the implementation of global agreements relevant to the eco-agri-food system.** The Right to Food, the Aichi Target, and the SDGs provide political reference points for actors seeking transformations in the eco-agri-food system.
- **This chapter aims to illustrate how the diverse actors identified in TEEBAgriFood's theory of change may adopt the findings of TEEBAgriFood to promote the transition towards greater sustainability.** To this end, the chapter places TEEBAgriFood in today's global sustainability governance context and suggests concrete engagement strategies for groups of actors.
- **Governments, businesses, and civil society should apply TEEBAgriFood as a tool for the implementation of the Sustainable Development Goals.** It corresponds to key principles of the 2030 Agenda, it supports the follow up and review processes envisaged by it, and it can become a much-needed tool in overcoming fragmented approaches to sustainability transformations in the eco-agri-food system.
- **Governments and businesses must become agents of the transition from financing agricultural production to food system finance.** Food system finance encompasses the range of financial incentives and disincentives to support transformations in the eco-agri-food system; the Addis Ababa Action Agenda provides the political reference point for this purpose.
- **There is also a need to create further ownership and accountability among businesses for transformations in the eco-agri-food system.** By including governments and civil society to enhance accountability, TEEBAgriFood Business Platforms represent an important step in this regard.
- **Empowered citizens are key to transforming the eco-agri-food system. To make informed decisions, citizens must be able to access relevant information.** Tailored TEEBAgriFood communication tools are pivotal in this regard and represent an important strategy to engage the general public.
- **The strategies developed in this chapter demonstrate how TEEBAgriFood could be used in achieving eco-agri-food system transformations:** (i) supporting a more encompassing understanding of the eco-agri-food system, (ii) reaching out to a broad range of constituencies to support alliance building to increase the leverage of those interested in changes in the eco-agri-food system, and (iii) offering a holistic analysis which supports identifying strategic interventions and setting priorities.
- Relevant as the proposed strategies may be, they do not aim to be comprehensive. Knowledge-based change depends on learning and iteration. Hence, **the proposed engagement strategies aim to offer a first starting point for joint efforts to further apply TEEBAgriFood's Evaluation Framework and its findings.**



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