



THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY (TEEB)
FOR AGRICULTURE & FOOD

CONCEPT NOTE
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THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY (TEEB) FOR AGRICULTURE & FOOD - CONCEPT NOTE¹

1. OBJECTIVE

The objective of this note is to present the case for a TEEB for Agriculture² & Food (henceforth TEEBAF) study and set out a work plan for moving ahead with subsequent phases and envisaged deliverables, in line with the original mandate provided by the TEEB Advisory Board³ in March 2012. We describe the rationale for the study, potential research questions to be addressed, report structure and delivery process.

This concept note builds upon and supersedes the concept note dated 4 October 2013. Revisions are based in part on a two-day scoping workshop that was hosted by the European Commission (DG DEVCO), 22-23 January 2014, in addition to post-workshop discussions with members of TEEB governance bodies. The list of those who registered for the workshop and respective affiliations is provided in Annex 1.

The TEEBAF study is designed to provide a comprehensive economic evaluation of the 'eco-agri-food systems' complex, and 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 capital. A "double-whammy" of economic invisibility of impacts from both ecosystems and agricultural & food systems is a root cause of increased fragility and lower resilience to shocks in both ecological and human systems.

2. THE ECO-AGRI-FOOD SYSTEM COMPLEX

Ecosystems and agricultural & food systems are typically evaluated in isolation from one another, despite their many and significant links. The economic invisibility of many of these links is a major reason for this 'silo' thinking. However, ecosystems are the ecological home in which crop and livestock systems thrive and produce food for humans, and in turn agricultural practices, food production, distribution and consumption impose several unquantified externalities⁴ on ecosystem health.

There is a growing body of evidence demonstrating the large environmental footprint of agricultural activities, particularly in efforts to increase output through expansion and

¹ Prepared by Dr Salman Hussain (TEEB Coordinator; Salman.Hussain@UNEP.org) and Dustin Miller (TEEB Secretariat) with input from Pavan Sukhdev & other members of the TEEB Advisory Board, and the TEEB Coordination Group. UNEP-WCMC provided input to an earlier draft (4 October 2013); some text and analysis remains in the current version.

² We limit our discussion of agriculture herein principally to crop and livestock systems, and to a more limited extent agro-forestry; we do not consider fisheries and aquaculture as these sectors fall within the scope of *TEEB for Oceans and Coasts*.

³ Demand and support for a TEEB for Agriculture & Food was first expressed at the TEEB Advisory Board meeting in Leipzig, Germany on 19 March 2012.

⁴ An externality is said to arise when (i) the actions of one economic agent in society impose costs or benefits on other agent(s) in society, and (ii) these costs or benefits are not fully compensated for and thus do not factor into that agent's decision-making. Without intervention in the free market to internalize externalities, positive externality benefits are chronically under-supplied and negative externality costs are over-supplied.

intensification. For example, Foley et al (2011)⁵ estimate that about 80 per cent of new croplands are replacing tropical forests, a pattern which is resulting in the loss of biodiversity, depletion of critical ecosystem services and increased levels of greenhouse gases. Yet this expansion has done relatively little to add to global food production; most production gains have instead been achieved through various forms of intensification. Nonetheless, both processes often involve long-term costs to ecosystem services, such as habitat loss; soil erosion; nutrient run off), and to human health (e.g. from pesticides and fertilizers), ultimately undermining the natural base upon which agricultural livelihoods depend. The human appropriation of energy (net primary product, or NPP) stems from developments in science and technology and can have a direct impact on not only human well-being but also on ‘ecosystems and biodiversity’ as less energy is available for non-human species and biodiversity is ‘crowded out’.

Without natural ecosystems, agricultural systems will suffer. This applies universally – whether industrial and input-intensive commodity cropping or traditional and small-scale organic farming, as well as everything in between. Regardless of scale or type of production system, or whether in a developed or developing country context, nature provides innumerable benefits to the agricultural sector. It should, however, still be emphasized that the effects of the interaction between natural systems and agricultural systems is much more profound in those regions where smallholder production systems exist. With much of the rural poor concentrated in fragile environments and remote areas, such smallholders are faced with high transportation and transaction costs and limited access to inputs such as pesticides, fertilizer and irrigation systems, as well as a lack of access to extension services. These factors not only prohibit their participation in national and global markets but increase their dependency upon the local provisioning of ecosystems. In fact, natural capital is estimated to account for around 40 to 90 per cent of what is referred to as “GDP of the poor”⁶. Therefore, the impacts of ecosystem degradation and agricultural biodiversity loss are most significant for this particular group of stakeholders as a whole (although this is not universally the case). But taking stock globally of the need for more sustainable agricultural systems requires an assessment and valuation of the ecosystem services that *all* agricultural systems rely on, including large-scale conventional production. Thus our analysis is not limited to smallholders in this study.

In general, the use and management of agro-ecosystems by humans will depend on existing policy and incentive frameworks at local, national and international levels. For instance, the post-2015 global development agenda will contain a number of sustainable development goals (SDGs) likely to target the themes of, *inter alia*, sustainable agriculture and/or food security. As part of an overall transition to a greener economy⁷, greening the agricultural sector will also be instrumental to this process, whether by increasing efficiency, reducing poverty, improving nutrition and health, creating rural employment, and/or reducing pressure on the environment, such as deforestation and greenhouse gas emissions. Toward these ends, a growing range of novel and innovative approaches are already being employed worldwide, including ‘payments for ecosystem services’ (PES) and ‘reducing emissions from deforestation and forest degradation’

⁵ Foley, J.A., Ramankutty, N., Brauman, K.A., Cassidy, E.S., Gerber, J.S., Johnston, M., Mueller, N.D., O’Connell, C., Ray, D.K., West, P.C., Balzer, C., Bennett, E.M., Carpenter, S.R., Hill, J., Monfreda, C., Polasky, S., Rockstrom, J., Sheehan, J., Siebert, S., Tilman, D. and Zaks, D.P.M. (2011) “Solutions for a cultivated landscape”, *Nature*, 478: 337-342.

⁶ ten Brink, P., Gantioler, S., Gundimeda, H., Sukhdev, P., Tucker, G., Weber, J-L. (2011) “Strengthening Indicators and Accounting Systems for Natural Capital” in P. ten Brink (ed.), *TEEB in National and International Policy Making* (pp. 113-118), London and Washington: Earthscan.

⁷ A ‘green economy’ is defined by UNEP as one that ‘results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive’.

(REDD+⁸) schemes, and offer opportunities to mainstream the value of nature within the agricultural sector.

With an improved understanding of the benefits to agricultural production that are provided by biodiversity and ecosystem services and the negative impact (costs) of agriculture on biodiversity and ecosystem services, the expected outcome would be the ability to recognise, demonstrate and capture the values of ecosystem services and mainstream them in decision-making in the agricultural sector. This understanding will make it possible to assess the economic trade-offs between short-term productivity gains on the one hand and longer-term ecosystem impacts as well as long-term impacts on agri-productivity on the other, and to design incentive mechanisms to facilitate greener and more sustainable outcomes. In order to achieve this, a TEEBAF study will seek to gather the evidence necessary to identify policy options to facilitate a transition towards more sustainable agricultural practices, with particular emphasis on the role of smallholder farmers.

3. WHY TEEB SHOULD FOCUS ON AGRICULTURE & FOOD

The underpinning rationale for the UNEP-TEEB project in general is to make the natural capital inputs as well as the externalities of economic production systems *visible*. Ultimately, decision-makers need to be enabled to *capture* these respective values in order to improve decision making from a comprehensive economic standpoint. Earlier phases of the TEEB project were concerned more with establishing appropriate analytical frameworks and describing the application of methods to value benefits in both monetary and non-monetary terms as well as policy options to better include ecosystem services in decision making; the current phase (Phase III) of the TEEB project is more focused on *implementation*. As such the success of the TEEBAF study depends on the extent to which it stimulates the implementation of a suite of policy changes arising from capturing the value of natural capital and positive and negative externalities at different scales and by a wide constituency of decision-makers, from individual small-scale farmers to global geo-political fora. The current proposed structure of the study is guided by this ambition to implement change.

We discuss externalities and the natural capital degradation herein as two different elements of 'invisibility'. Externalizing the costs of production *to third parties* (including more generally society at large) is associated with rational, self-interested behaviour. The state of externality implies market failure and the need for intervention in the market. But individual private farmers or agri-businesses may degrade their *own privately-owned* natural capital (on their farm enterprise). This self-inflicted harm may be irrational but is prevalent. It might arise owing to a lack of information on the dependency on ecosystem services, or the lack (or incapacity) to take a long-term perspective (potentially owing to discount rates), the lack of necessary inputs or technologies, attitudes to risk and uncertainty, or property rights regimes (e.g. a lack of incentive to maintain natural capital if tenure is not assured). The TEEBAF is concerned with positive and negative externalities (and thus third-party impacts) but also with stimulating a shift away from (predominantly unintentional) behaviour wherein the agri-business harms its own long-term viability.

⁸ REDD+ encompasses activities in developing countries aimed at: a) reducing emissions from deforestation; b) reducing emissions from forest degradation; c) conservation of forest carbon stocks; d) sustainable management of forests; and e) enhancement of forest carbon stocks.

Earlier TEEB activities did not focus on any single production sector or biome. Although a number of earlier TEEB case studies⁹ contextually evaluated a subset of the benefits of ecosystems to agriculture, for specific ecosystem services such as pollination, or a wider range of services in some geo-political regions, TEEB has not to date conducted a systematic, structured and wide-ranging analysis of the eco-agri-food complex. Further, we argue that there is a strong social & economic rationale for such a TEEBAF study: (i) agriculture accounts for roughly 40 per cent of the world's economically active labour force or about 1.3 billion people¹⁰; (ii) the impact of the externalities (positive and negative) associated with agriculture and food production systems are extremely significant and the current policy discourse does not adequately capture these externalities; and (iii) these impacts fall disproportionately on the poor and on women in particular, and this links in with the TEEB foci on the gender and equity implications of the 'GDP of the Poor'¹¹.

The focus of the proposed study is also *timely*. The Final Communiqué of the Agriculture Ministers attending the Global Forum for Food and Agriculture 2014 meeting¹² (Berlin, 18.1.2014) states that “The progressive scarcity of natural resources, the negative impacts of climate change, extreme natural disasters, and the loss of genetic diversity and soil fertility prevent agricultural potential from being fully realized.” This sets the broader context for the TEEBAF study, which will seek to support a wide platform of research into agro-ecosystems. But the Communiqué also states (p2) the need to “recognize the range of values provided by ecosystems as a basis for the sustainable use of resources”. This *recognition* is not proprietary to TEEB but has been one of its main *raison d'être*, and TEEB has contributed to an explicit consideration of ecosystem services including the use of ecosystem valuation by decision-makers that were hitherto reluctant to do so, such as evidenced by TEEB for Business¹³.

Indeed, farmers at each and every scale are in essence business-people. The GDP of the Poor as well as a focus on livelihoods is also given support (p2) in the Final Communiqué in that “Particular attention needs to be given to family-owned farms and smallholders, because of their important role in feeding the global population”. Smallholder farmers represent over 80 per cent of the world's 500 million farms and in parts of the developing world they are responsible for producing over 80 per cent of the food consumed¹⁴. The analysis of smallholder farmers and rural livelihoods is a core element of the current study, and is timely given that 2014 is the International Year of Family Farming¹⁵.

We note above that the TEEBAF is concerned not only with the negative externalities of agricultural and food production (at all scales and across types of production system) but also with *positive* externalities, or more generally positive impacts on wider society provided by the sector. These positive externalities include rural viability such as support for the cultural diversity of farming communities around the world, the cultural and aesthetic amenities of traditionally farmed landscapes, and the provision of habitats for plant and animal species that have coevolved

⁹ <http://www.teebweb.org/resources/case-studies/>

¹⁰ FAOSTAT 2013

¹¹ <http://www.teebweb.org/wp-content/uploads/Study%20and%20Reports/Reports/Synthesis%20report/TEEB%20Synthesis%20Report%202010.pdf>

¹² http://www.gffa-berlin.de/images/stories/GFFA2014/PDFs/Final_Abschlusskommunique_GFFA_18-01-2014.pdf

¹³ <http://www.teebweb.org/areas-of-work/teeb-for-business/>

¹⁴ <http://www.ifad.org/media/press/2013/27.htm>

¹⁵ <http://www.un.org/apps/news/story.asp?NewsID=46566&Cr=food+security&Cr1>

with agricultural land-use. The key here is balance. The agriculture-society-ecology nexus is characterized by polarized viewpoints. TEEB Phase III will continue the best practice operationalized in the earlier phases of the project, *viz.* extensive peer-review. For TEEBAF this means that both advocates of a viewpoint and its opponents need to be included. This process particularly lends itself to an investigation of agriculture as a sector, as few contemporary issues create as strong a partisan view as biotechnology, food availability and food access versus distribution, and the impacts of agro-chemicals on human health to mention a few. The TEEBAF will present an evidence-based evaluation of these issues (by applying meta-analysis on the assembled evidence so as to avoid cherry-picking) and embed them in an analysis of externalities, natural capital and impacts on livelihoods.

Finally, the outcomes of the TEEBAF will only lead to absorption by policy-makers and implementation of policy change if there is strategic communication and outreach to disseminate its findings. The TEEB project has an excellent track record in this regard¹⁶. One of the reasons for this previous success has been the designation of a structure for reporting that focused on the needs of a specific category of end-user¹⁷ or decision-maker. Although all agri-businesses are firms of one kind or another, heterogeneity within agricultural and livestock production is huge. Further, small-scale producers are unlikely to have the same objectives as large firms. Therefore the structure of the TEEBAF reports is such that there is the analysis of impacts and dependencies on ecosystems at different scales (in terms of firm size), in different markets and across a range of socio-cultural contexts and norms. The elements of the reports that are most relevant to particular stakeholder groups will be clearly signposted.

In summary, the need for this TEEBAF report stems from the current political discourse and an appreciation of the invisible dependencies as well as impacts through externalities and the degradation of natural capital on ecosystems; there is a need to assess fragile systems and equally fragile and dependent social/community systems, but also conventional systems that equally are a part of the global food security discourse.

The TEEB process in terms of report-construction and review reflects the focus of the study and is also ideally suited to tackle the controversies around agriculture, ecosystem services and biodiversity and communicate findings, both in terms of the theoretical exposition of the issues but also new analyses of policy implementations related to agriculture. It will complement and build on other initiatives such as IPBES and the Economics of Land Degradation¹⁸.

4. OVERARCHING REPORT STRUCTURE

We propose following the earlier and successful structuring of reports for TEEB Phase II, with some necessary modifications. There are to be two core reports: TEEBAF Scientific & Economic Foundations (“Foundations” for short) and TEEBAF Policies, Production & Consumption (“Policies” for short). There are also two ancillary reports: TEEBAF Interim Report (“Interim”) and TEEBAF Synthesis Report (“Synthesis”).

¹⁶<http://www.teebweb.org/>

¹⁷<http://www.teebweb.org/our-publications/teeb-study-reports/>

¹⁸<http://www.ipbes.net/about-ipbes.html>; <http://www.eld-initiative.org/>

In order to produce impetus for the TEEBAF project overall, an Interim Report¹⁹ will precede the two core reports (Foundations and Policies). This Interim Report is structured so as to provide new and compelling (but balanced and science-based) evidence from both primary research and meta-analyses. The Interim Report will be a stand-alone product unto itself which will be disseminated by TEEB but also a springboard for the main reports.

TEEBAF Foundations sets out the core theoretical issues and controversies underpinning the evaluation of the nexus between the agri-food sector, biodiversity and ecosystem services and externalities from agriculture on a global scale. In essence it seeks to set the theoretical context for the evaluation of policy implementation. Included in this context is a typology to determine how to characterize (and learn lessons from) the policy evaluation in the TEEBAF Policies report. For instance, can we compare an example of the externalities of large scale livestock ranching in Brazil with small-scale pastoralism in Tanzania? There is a commonality in terms of the broad type of agricultural output created in both systems, but there are clearly also huge differences.

What is the appropriate lens through which to view different types of production systems and agricultural practices? Efficiency? Equity and distributional issues as they affect rural livelihoods? Food security? Is it conceivable that, given OECD-FAO projections²⁰ on population projections and changes in diet (to a more animal protein-rich diet) that up-scaling small-scale production could meet demand projections? Is this even the right question, *viz.* should we be voicing concerns about food waste and also the appropriateness or otherwise of a meat-rich diet? If so what are the range and types of policy lever and can they be assessed in isolation? These are the kinds of questions that require a theoretical Foundations report so as to *underpin* TEEBAF Policies. We do not suggest that TEEBAF will provide definitive *answers* to these questions, but will add an additional perspective. The on-going controversies will likely persist, but advocates on different sides of such controversies might then use analysis from TEEBAF to inform the debate.

The TEEBAF Policies report will by definition focus on the evaluation of different agro-ecological production systems in different socio-economic contexts. Part of the evaluation will include the analyses of various production systems (with respect to externalities, dependencies on ecosystems and livelihood impacts) such as for instance cattle ranching in Latin America versus Eastern Africa. This is likely to inform debates on policy, as differing patterns of advantages and disadvantages are likely to emerge. In other cases, there will be more direct assessment of policy, e.g. the effect of reducing agricultural subsidies for fertilizers, or the extension of protected areas (or wildlife corridors) and the spillover impacts on biodiversity and the state of the ecosystem both in the protected area and in adjacent agro-ecosystems. Other analyses might consider the impacts of changing land cover in different parts of the world, say from forestry to intensive agriculture, or assessments of how genetic diversity contributes to climate change adaptation – there is an array of potential cases.

Since the TEEBAF concerns not only agriculture but entire food systems as well, the TEEBAF Policies will also consider food policies, including those targeting food waste and food safety along the entire food chain, from production to final disposal, as well as food quality in nutritional terms. Both TEEBAF Foundations and Policies will therefore have a section dedicated to the behavior of consumers, and on civil society.

¹⁹ If sufficient funding is available, it would be appropriate to start the analysis for Foundations report concurrently with the development of case studies for the Interim Report so as to facilitate the structuring of TEEBAF Policies, determining the key comparisons that ought to be made.

²⁰ OECD/FAO (2013), *OECD-FAO Agricultural Outlook 2013*, OECD Publishing.

Finally, following the success of a similar model applied in TEEB Phase II, the outcomes and key findings of Interim, Foundations and Policies reports will form the content and messaging of the final TEEBAF Synthesis report.

5. TEEBAF INTERIM REPORT

A global spread of sector-specific studies (6-8) will be commissioned to provide the basis for the TEEBAF Interim Report. These studies are to be conducted in a relatively short time horizon (around six months, by independent commissioned teams) and as such some will rely on meta-analysis of existing studies. It is however intended that some of these studies will require some level of primary data collection and analysis in order to contribute to the novelty of the report.

The final designation of the study mix depends in part on the availability of research consortia to conduct the analyses, but the selection will include studies which allow comparisons to be made, e.g. rice production at different scales across regions. The full Interim Report launch is scheduled for spring 2015, and possible events for dissemination are set out in Box 1.

Box 1 - Interim Report Event Horizon

A number of international environmental processes and fora are occurring throughout 2014-2015 that present strategic opportunities for communicating the key findings and messages of the Interim Report, either in its preliminary or final stages. These include:

- FAO's International Year of Family Farming (2014; global)
- CBD COP-12 (Pyeongchang, Republic of Korea, 6-17 October 2014)
- 18th IFOAM Congress (Istanbul, Turkey, 13-15 October 2014)
- IUCN World Parks Congress (Sydney, Australia, 12-19 November 2014)
- UNFCCC COP-20 (Lima, Peru, 1-12 December 2014)
- World Soil Day (5 December 2014; global)
- FAO's International Year of Soils (2015; global)
- Post-2015 Sustainable Development Goal (SDG) agenda
- European Development Days 2015
- FAO Commission on Genetic Resources for Food and Agriculture 19-23 January 2015 (Special Event on Food Security and Genetic Diversity on 16 January)
- IPBES-3, January 2015

6. TEEBAF SCIENTIFIC AND ECONOMIC FOUNDATIONS

A possible way of characterizing the eco-agri-food system complex is presented in Figure 1. The draft wireframe for the Foundations report is based on the need to characterize the linkages

between the three main components of this nexus, i.e. (i) ‘human (economic and social) systems’ (ii) ‘agriculture and food systems’, and (iii) ‘ecosystems and biodiversity’.

Science and technology provide a number of inputs to ‘agriculture and food systems’. Some of these categories of inputs have been developed and applied over many centuries (such as ‘machinery’ and ‘breeding’) whereas others are more recent developments (e.g. ‘bio-technology’). ‘Labor’ is a factor of production but might also include more broadly ‘human capital’, i.e. human knowledge of agro-ecological processes (e.g. composting, crop livestock integration). The cumulative effect of these inputs in recent decades has been the rapid expansion in food availability. Research and Development to stimulate innovations (and pathways to their adoption by the farming sector) are governed by economic and social systems that provide stimuli. The strong focus on productivity increases may have led to *perverse incentives* promoting innovations that reduce the resilience of ‘ecosystems and biodiversity’, in term potentially reducing the reliable provisioning of ecosystem services.

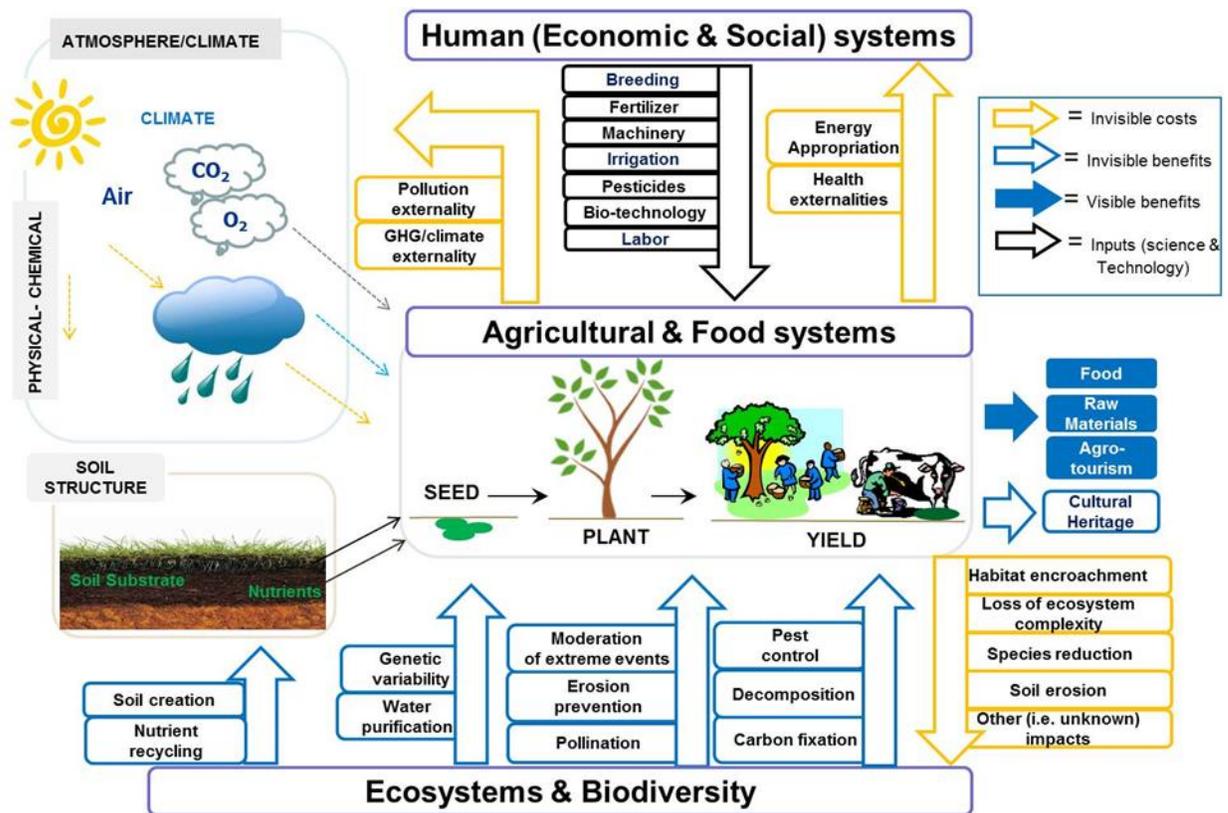


Figure 1 TEEBAF schematic to characterize the eco-agri-food system complex

There are positive outputs from ‘agriculture and food systems’. Some of these are visible and generally marketed (such as ‘food’ and ‘raw materials’.) In other cases there are positive impacts that are invisible (or less visible). There are a range of benefits linked to cultural heritage (cultural ecosystem services). These might include aesthetic appreciation of a managed agricultural landscape, leisure and recreation within such landscapes in the form of agro-tourism, or cultural identity arising from the cultivation of and consumption of local farming produce. Perhaps a less

obvious benefit broadly associated with cultural heritage is the maintenance of agro-biodiversity. This service is termed ‘maintenance of genetic diversity’ and there is likely to be a significant insurance value²¹ for this service, particularly with climate change.

There are also negative externalities from ‘agriculture and food systems’. Some affect human welfare directly, such as health impacts arising from agro-chemicals. Others affect humans indirectly such as the range of pollution externalities. For instance, nutrient run-off from farmland might affect the quality of bathing water, which in turn impacts on the leisure and recreation opportunities. But it also might affect the farmer’s *own* land, in which it is not an externality but is a cost to production (that may be invisible).

The human appropriation of energy (net primary product, or NPP) stems from developments in science and technology as well as low-technology conversion of primary ecosystems. It can have a direct impact on not only human well-being, but also on ‘ecosystems and biodiversity’ as less energy is available for non-human species and biodiversity is ‘crowded out’.

‘Agriculture and food systems’ contribute significantly to climate change, a global public good issue and pervasive negative externality. Emissions of greenhouse gases arise from agricultural production and there are research initiatives to ‘farm for a better climate’²². There is also the potential to mitigate emissions across the entire food system, most obviously in terms of developing infrastructure and information to reduce food waste, but also across the entire life cycle of production such as energy use in the production of fertilizers, emissions from manure etc.

The final element of the schematic is the inputs provided by ‘ecosystems and biodiversity’ to ‘agriculture and food systems’. The agricultural sector is and always has been more intertwined with ecosystems (and dependent on their provisioning of services) than most other industrial sectors. We have labelled all ecosystem service elements as ‘invisible’ but recognize this to be a broad-brush characterization. The reason for this characterization is that the value of these services often remains invisible *until it is no longer provided* by ‘ecosystems and biodiversity’. Clear examples are human labor being expended for pollination when natural pollinators are no longer available in sufficient quantities, or the need for agro-chemicals to substitute for natural forms of pest control. But there are less obvious (but potentially equally valuable) services. For instance, mangroves may buffer storm surges, their removal implying the degradation of farm land close to the coastline.

While the schematic in Figure 1 forms the basis for the structure of the TEEBAF study overall, it is more specifically intended for TEEBAF Foundations and its structure/wireframe. Before turning to inter-linkages and dependencies *between* the three main components identified above, a preliminary (but far from trivial) task is to characterize the *state* of each component in turn. Pollution from farming and livestock systems apply pressures (on both ‘human systems’ and on ‘ecosystems and biodiversity’) and the impact of such pressures changes state conditions, both on-farm (with self-inflicted damage that is privately-borne but invisible) or on third parties/society (negative externalities). The impact depends on: (i) the *current state* of ‘human society’ and ‘nature and biodiversity’; (ii) the *other impacts* that are affecting the state of each component (i.e. a focus on cumulative rather than single, isolated impacts); and (iii) the *resilience* of these components (i.e. if they can ‘bounce back’).

²¹ Pascual, U. and Muradian, R. (2012) “The Economics of Valuing Ecosystem Services and Biodiversity” in Kumar, P (Ed.), *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations* (pp. 192-194), Abingdon and New York: Routledge.

²² See for instance: http://www.sruc.ac.uk/info/120175/farming_for_a_better_climate

Framing the assessment of system state forms the content for Section I of the Foundations report. Given that this study is part of the TEEB portfolio (The Economics of Ecosystems *and Biodiversity*), it is critical to appraise the role that biodiversity plays as a supporting input to production. This includes for instance reduced vulnerability to pests and diseases (and pesticide use, with its associated negative impacts) from managing diversity at different scales. The report then turns to Frameworks for Assessments (Section III), Impacts and Dependencies (Section IV) and finally Approaches for Policy Appraisal (Section V). Section V does not entail policy analysis *per se* as this is the domain of the TEEBAF Policies report. It does however characterize the range of policy instruments available (market-based, regulatory and informational) and how criteria for determining an appropriate policy mix are selected.

We present below in Box 2 a sketch of a proposed wireframe for Foundations, with Section headings and Chapter headings. A more detailed commentary on the internal structure and content of the chapters is provided in Annex 2.

Box 2: Proposed summary wireframe for TEEB Scientific and Economic Foundations

SECTION I: THE CURRENT STATE OF KNOWLEDGE ON AGRICULTURE, ECOSYSTEMS

1. Food production and food distribution: Is there a current or impending crisis?
2. Why is there a need to re-assess the eco-agri-food systems complex?
3. Bio-fuel and cash crop production in low income countries and associated impacts on the eco-agri-food systems complex
4. The potential roles of bio-technology in sustainable agriculture
5. Food safety and food waste

SECTION II: AGRO-BIODIVERSITY

6. The role of biodiversity in supporting agricultural systems
7. Agro-biodiversity across different agricultural systems: Status and Trends

SECTION III: FRAMEWORKS FOR ASSESSMENT

8. Frameworks for assessing the benefits and costs of agricultural and food systems on human society
9. Frameworks for assessing the state of agriculture and food systems

SECTION IV: IMPACTS AND DEPENDENCIES

10. Making the ecosystem service benefits provided by ecosystems and biodiversity to agriculture and food systems visible
11. Making the hidden benefits of agriculture and food systems to human welfare visible
12. Negative Health Externalities
13. Negative Pollution Externalities
14. Greenhouse Gas emissions from the agriculture and food sector

SECTION V: APPROACHES FOR POLICY APPRAISAL

15. A typology and review of policy interventions for agriculture

7. TEEBAF POLICIES, PRODUCTION & CONSUMPTION

The content of the TEEBAF Policies report will be guided in part by a consultative process and a *Call for Evidence*. In TEEB Phase II, a similar call resulted in a range of TEEB Cases²³ with a fairly wide geographical spread and covering a range of ecosystem services and approaches to their inclusion in decision making. For TEEBAF, the Call for Evidence will go out to the wider agri-food community, a few months ahead of the proposed TEEBAF Policies launch.

The inputs arising from this Call may be used as a platform for further research, to ‘leverage’ outcomes that are a good fit for the TEEBAF study. TEEBAF may commission follow-up work which builds on extant studies in a particular region/agriculture and food system by applying the TEEBAF approach, i. e focusing on the valuation of positive and negative externalities and GDP of the Poor and on the identification of incentive structures and other causes of these externalities.

Analysis of the outcomes of the TEEBAF Interim Report will also guide the choice of which elements in the agri-eco-food complex to focus on and which policies to evaluate. The analysis will highlight areas of enquiry where the outcomes have been strongest, and where the highest value-added might lie for the TEEBAF Policies studies in terms of the core remit of the study, i.e. to bring about the implementation of policy change.

As mentioned above in Section 5, comparisons may be made between two similar farm systems in different socio-ecological contexts, or two different scales of farming operation producing the same (or similar) outputs, or some similar variant. Comparisons might be made using different outcome indicators such as productivity per unit labor, per unit energy input, or per unit land area. The study will not be limited to comparison *per se*; analysis of policy will include potential modifications to improve the sustainability of production practices more generally.

The main objective of TEEBAF Policies is to show the economic and social benefits of managing agricultural and food systems in order to both reduce negative externalities and enhance positive externalities, linked to the provisioning of ecosystem services and safeguarding biodiversity. The main focus will lie on how to achieve this through improved policies targeted at consumers and producers. Any case study might be characterized in terms of the type of policy intervention (e.g. market-based, regulatory, behavioral or informational), the type of farming system, the type of agro-ecosystem, and the socio-cultural and economic context (e.g. developed versus developing world). The split may also be on the basis of the scale at which the policy is implemented, e.g. international, national or local. Alternatively, the studies may be grouped in terms of the agents that are most affected by the policy.

As stated above, TEEBAF Policies also includes consumers and the demand side. Policy interventions regulating or reducing consumer choice are among the least popular options in political terms and therefore less likely to be implemented. Consumer decision-making may well be more influenced by informational interventions that estimate and then disseminate the externalities (positive and negative) of competing products or categories of products. Such information provision is in essence capturing estimates of the “true costs” of products. This can resonate strongly with consumers, particularly if there are alternative consumptive choices available. It is important here to identify the agent(s) responsible for the externality, e.g. governments applying perverse subsidies, or firms providing false and/or misleading information on the ecosystem impacts of their production processes (‘greenwashing’), or consumers signaling a preference in the market for food sorted and packaged in a particular way.

²³ <http://www.teebweb.org/resources/case-studies/>

The goal here is to provide evidence-based recommendations on how the costs of negative externalities can be lowered and shared more equitably in order to achieve access to healthy food for all. The impacts on different agents of such changes should be specified. Of course any policy analysis would need to carefully characterize the additionality of impact as there are a multitude of initiatives aimed at achieving (for example) reductions in food waste along the supply chain²⁴. Further, without due attention being paid to the consumer/demand side, policy recommendations will lack the impetus necessary to influence policy makers.

The chapter structure for the TEEB Policies study can be constructed in various ways. Box 3 provides one way to categorize the case studies that would constitute the main body of the study, but alternatives may be applied.

Box 3: Proposed draft summary wireframe for TEEB Policies, Production and Consumption

SECTION I: OPTIONS FOR THE IMPROVED MANAGEMENT OF AGRICULTURE AND FOOD PRODUCTION

1. Case studies illustrating how to better manage the habitat and species biodiversity that underpins ecosystem services on which agriculture relies, e.g. maintaining soil fertility, water availability and retention capacity, pollination, genetic diversity, pest control.

SECTION II: OPTIONS TO CAPTURE THE EXTERNALITIES OF FOOD PRODUCTION AND CONSUMPTION

2. Options on the demand side (consumers): Individual household behavior
3. Options on the demand side (consumers): Cumulative consumption
4. Options on the supply side (producers): Farm-scale agri-food production
5. Options on the supply side: Regional and global scale

SECTION III: GOVERNANCE AND INSTITUTIONAL CAPACITY

6. Long-term versus short-term political time horizons: comparative analyses
7. Case studies on impact of good/poor governance and institutional capacity
8. Aligning incentives: Case studies in reduced monitoring and enforcement costs

One important task for the TEEBAF coordinators is to determine the extent to which results from a single study or groups of studies (each with a particular socio-cultural and ecological context) might be generalized (or extrapolated). Great caution is required whenever attempts are made to extrapolate, but at the same time the TEEBAF is intended to have reach which goes beyond the specifics of one study area. In the current proposal this is set out in Section 3.

²⁴ See for instance: <http://www.fao.org/save-food/en/>

8. TEEBAF SYNTHESIS REPORT

The aim of the Synthesis Report is to have clearly articulated Key Messages and Recommendations arising from the findings of the individual studies, written with a broad readership in mind. Key messages can arise from individual studies that included primary research, or meta-analyses, or from the integration of the outcomes of individual reports. The Synthesis Report is likely to be around 30 pages and be disseminated widely in various high-level policy fora.

9. TIMELINES

1. February-March 2014: Identify a Study Leader and extension of TEEB Advisory Board membership. High-level governance for the TEEBAF study is to be the mandate of the TEEB Advisory Board. The membership of the Board may if required be extended to include internationally-recognised individuals from agri-business for the duration of the TEEBAF study.

2. February 2014–December 2014: Project Implementation – TEEBAF Interim Report. The TEEB Coordination Group, with input from the TEEB Secretariat and oversight from the TEEB Advisory Board, will commission a series of individual case studies that will be used as inputs to the Interim Report. A Coordinating Lead Author for the Interim Report is also to be appointed.

3. March 2014-September 2014: Call for Evidence launched for TEEB Policies. This call is to be channelled through the existing TEEB networks but also augmented by agri-business networks.

4. March 2014-October 2014: Background work for TEEB Foundations. Wireframe finalised, Chapter leads appointed and contractual arrangements put in place.

5. October 2014 – December 2015: Background work for TEEB Policies. Review of inputs from Call for Evidence and preliminary findings from Interim Report assessed. SWAT analysis leading to designation of studies to be commissioned. Contractual arrangements put in place.

6. November 2014 – December 2015: Project Implementation – TEEBAF Foundations. To include monthly meetings between Section Coordinators and Report Lead.

7. January 2015 – December 2015: Project Implementation – TEEBAF Policies. To include monthly meetings between Section Coordinators and Report Lead.

8. January 2015-March 2015: Dissemination and outreach activities – TEEB Interim report

9. January 2016-March 2016: Project Implementation – TEEBAF Synthesis Report.

10. January 2016-June 2016: Communications. To include launch events, dissemination, activities, outreach.

10. GOVERNANCE

The oversight and strategic visioning of the TEEBAF lies with the TEEB Advisory Board. Once appointed, the Study Lead will adopt the role of overall project coordinator. S/he would also act as overall Report Lead for the Interim Report and would be supported in day-to-day management and final peer review by the TEEB Secretariat.

The Foundations study and the Policies study would each have an appointed Report Lead. The Study Lead may choose to also be Report Lead for one or other of these reports. The Study Lead and Report leads would form a sub-committee that would report periodically to the TEEB Coordination Group that will also contribute to planning and management, particularly of important communication events. The TEEB Advisory Board will include additional expertise for TEEBAF and focus on strategic advice.

The governance framework beyond this is to be determined. One possible model is to appoint institutions as Section coordinators for Foundations and Policies, and these institutions would themselves conduct the day-to-day management and coordination activities including final peer review for their respective sections. They would not be supported substantively by the TEEB Secretariat. The Section leads and Report leads would meet as a sub-committee.

ANNEX 1 REGISTERED PARTICIPANTS - TEEBAF SCOPING WORKSHOP, EC (DG DEVCO), 22-23 JANUARY 2014

	Last name	First name	Institution
	Baldock	David	Institute for European Environmental Policy (IEEP)
	Barkmann	Jan	Georg-August-Universität Göttingen
	Bas	Luc	IUCN European Union Office
	Bherwani	Hemant	GIST Advisory
	Blaney	Ralph	UNEP - World Conservation Monitoring Centre (WCMC)
	Bucella	Pia	European Commission, DG-ENV
	Bunker	Abigail	Royal Society for the Protection of Birds (RSPB)
	Castilleja	Guillermo	Gordon & Betty Moore Foundation
	Christov	Strahil	European Commission, DG-ENV
	Coates	David	Convention on Biological Diversity (CBD)
	Collette	Linda	Food and Agriculture Organization (FAO)
	Dagerskog	Linus	Stockholm Environment Institute (SEI)
	DeClerck	Fabrice	Bioversity International
	Diana	Olivier	European Commission, DG-AGRI
	Dickson	Barney	UNEP - World Conservation Monitoring Centre (WCMC)
	Drucker	Adam	Bioversity International
	Fielding	Matthew	Stockholm Environment Institute (SEI) / Swedish International Agricultural Network Initiative (SIANI)
	Foli	Samson	Center for International Forestry Research (CIFOR)
	Gruère	Guillaume	Organisation for Economic Co-operation and Development (OECD)
	Gwabu	Clifton	Papua New Guinea National Agricultural Research Institute (NARI)
	Henderson	Iain	UNEP - Finance Initiative
	Herren	Hans Rudolf	Millennium Institute
	Herweg	Christiane	League for Pastoral Peoples and Endogenous Livestock Development (LPP)
	Holden	Patrick	Sustainable Food Trust
	Hussain	Salman	UNEP-TEEB Office
	Jacques-de-Dixmude	Arnold	European Commission, DG-DEVCO
	Katushabe	Elizabeth	Pastoral and Environmental Network in the Horn of Africa (PENHA)
	Krishnamurthy	Pushpanath	Centre for Social Markets (CSM)
	Ledoux	Laure	European Commission, DG-ENV
	Lipper	Leslie	Food and Agriculture Organization (FAO)
	Lomax	James	UNEP – Division of Technology, Industry and Economics (DTIE)
	McVittie	Alistair	Scotland's Rural College (SRUC)
	Mendoza	Luis Alberto Paz	Bolivian Association of Small Farmers

Miko	Ladislav	European Commission, DG-SANCO
Miller	Dustin	UNEP-TEEB Office
Mizzi	Leonard	European Commission, DG-AGRI
Morgado	Maria	UNEP - Brussels Liaison Office to the EU
Myers	John	Environmental Health Sciences
Naqvi	Asad	UNEP - Green Economy Initiative
Nkonya	Ephraim	International Food Policy Research Institute (IFPRI)
Olsen	Nathalie	International Union for the Conservation of Nature (IUCN)
Oros	Rolando	PROINPA Foundation
Parr	Mathew	International Union for the Conservation of Nature (IUCN) – Netherlands
Rao	Bhavana	Watershed Organization Trust (WOTR)
Ridolfi	Roberto	European Commission, DG-DEVCO
Rokitzki	Martin	Oxfam
Salathé	Tobias	Ramsar Convention Secretariat
Sassen	Marieke	UNEP - World Conservation Monitoring Centre (WCMC)
Schauer	Mark	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
Sukhdev	Pavan	GIST Advisory
ten Brink	Patrick	Institute for European Environmental Policy (IEEP)
Todorović	Sonja Karoglan	ECOLOGICA
Wegerdt	Patrick	European Commission, DG-ENV
Wittmer	Heidi	Helmholtz Centre for Environmental Research (UFZ)
Zhang	Wei	International Food Policy Research Institute (IFPRI)
Znaor	Darko	Independent consultant

ANNEX 2 DRAFT WIREFRAME FOR TEEBAF SCIENTIFIC AND ECONOMIC FOUNDATIONS

We refer in this annex to Figure 1 and have copied it below for ease of exposition.

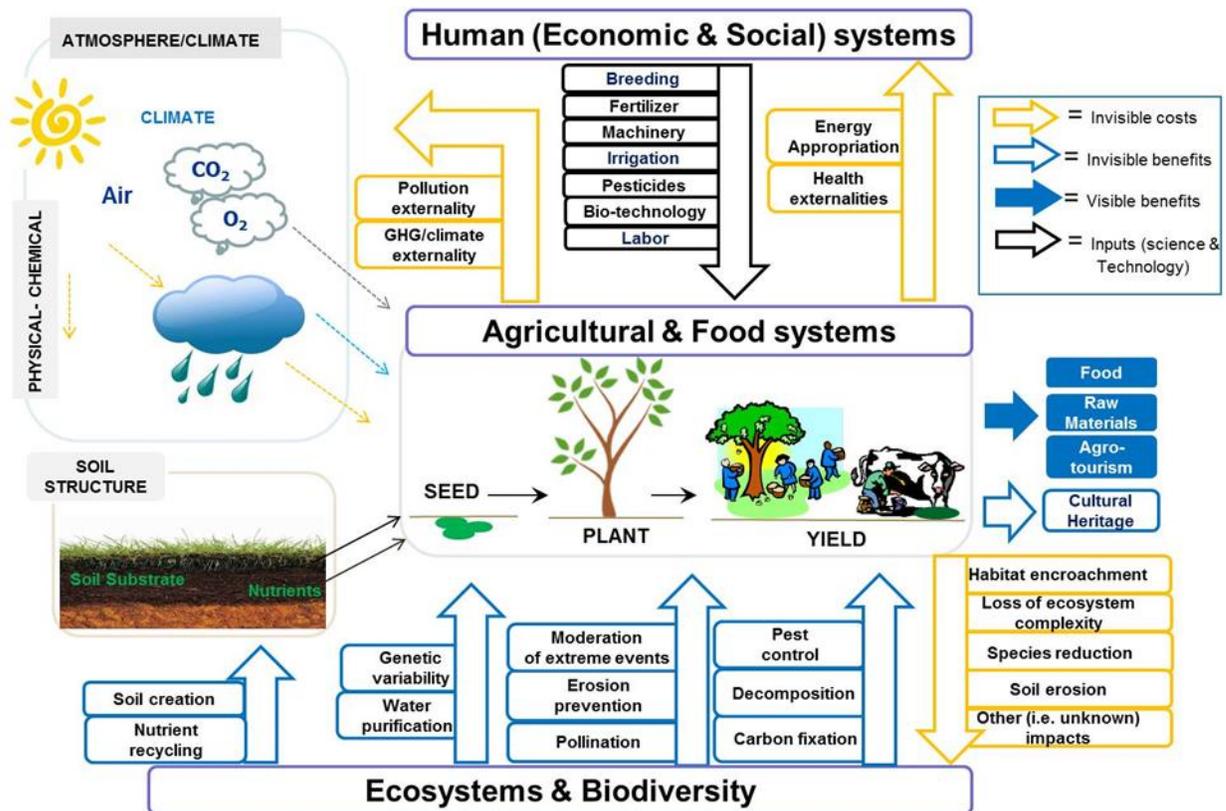


Figure 1 TEEBAF schematic to characterize the eco-agri-food system complex

The wireframe sketch outlined below is subject to change and modification and we welcome comments and suggestions. It is currently split into four broad sections.

SECTION I: THE CURRENT STATE OF KNOWLEDGE ON AGRICULTURE AND ECOSYSTEMS

1. Food production and food distribution: Is there a current or impending crisis?

This introductory chapter will set out trends and projections in food production and distribution and revisits the long-standing Malthusian discourse on growth in agricultural productivity versus population growth. This discourse is also linked with the 'energy appropriation' category in Figure 1 in that the human appropriation of Net Primary Product (NPP) by agriculture reduces the NPP available to all other (non-human) species.

2. Why is there a need to re-assess the eco-agri-food systems complex?

This chapter will set out and develop the complex, adapted from Figure 1. It will also draw on global assessments on ecological limits to growth inter alia research of Planetary Boundaries and the Global Footprint of agricultural systems. It will also include opposing world-views and

evidence in support of these alternative perspectives. This chapter links with the segment of the schematic that categorizes impacts of ‘agro-ecosystems’ on ‘nature and biodiversity’, e.g. habitat encroachment and species reduction.

3. Bio-fuel and cash crop production in low income countries and associated impacts on the eco-agri-food systems complex

The shift in land use towards bio-fuel production and cash crops and away from agricultural production for human consumption is part of the changing eco-agri-food complex. Bio-fuel production is treated separately here as ‘raw materials’ and ‘food’ are the two provisioning ecosystem services that are most visible in the market. This chapter will chart trends and projections in bio-fuel production and cash cropping and provide evidence on impacts.

4. The potential role of bio-technology in sustainable agriculture

The conflicting perspectives on the potential contribution of bio-technology to ecological sustainability and livelihoods is set out in this chapter.

5. Food safety and food waste

There is an emerging debate on mechanisms to reduce food waste across the entire production-consumption chain. This can be linked in part to consumer (mis)perceptions with regards food safety. This chapter will assess trends and critically review policy proposals to tackle these issues.

SECTION II: AGRO-BIODIVERSITY

6. The role of biodiversity in supporting agricultural systems

The link between biodiversity (of both habitats and species) and agriculture is not well documented, beyond the over-arching statement that biodiversity is critical (overall). This chapter explores the role that agro-biodiversity plays in terms of the productivity as well as resilience to acute shocks and to chronic pressures (such as pests).

7. Agro-biodiversity across different agricultural systems: Status and Trends

Whereas Chapter 6 sets out the benefits in maintaining types of agro-biodiversity, this chapter sets out status and trends in terms across different systems, therein setting up the costs of policy inaction (in terms of not conserving agro-biodiversity) and the benefits of intervention to support agro-biodiversity.

SECTION III: FRAMEWORKS FOR ASSESSMENT

8. Frameworks for assessing the benefits and costs of agriculture and food systems on human society

This chapter will focus not on the types of externalities, but on how to measure the impacts on human well-being; analysis of appraisal frameworks inter alia those based on sustainable livelihoods, Sen’s Entitlement Approach, and Resilience Theory but contrasted and compared with more neo-classical alternatives. It will also investigate the definition of and measurement of food security, as this clearly impinges on human livelihoods.

9. Frameworks for assessing the state of agriculture and food systems

The first part of this chapter will outline various typologies that might be used to delineate agriculture and food systems and how they inter-relate. Such frameworks have for instance been developed by FAO but there are alternatives such as IDRISI (amongst others). The TEEB

analysis would require agro-ecological mapping to be combined with socio-economic data layers, including income distribution. This chapter would not only review and assess extant geo-spatial mapping options.

SECTION IV: IMPACTS AND DEPENDENCIES

10. Making the positive ecosystem service benefits provided by ecosystems and biodiversity to agriculture and food systems visible

As per Figure 1, 'ecosystems and biodiversity' provides a host of ecosystem service benefits to 'agriculture and food systems', e.g. pest control and pollination. This chapter will characterize and quantify each in turn, setting out evidence on the variability in provisioning across different agro-ecosystems and farming systems. Where possible, the provisioning of these ecosystem services will be valued.

11. Making the positive hidden benefits of agriculture and food systems to human welfare visible

As well as the visible benefits of food production and raw materials (discussed in Section I of Foundations), agriculture and food systems also provide positive externalities. Agro-tourism can be either marketed or non-marketed, whereas broader cultural ecosystem services are likely to be invisible. This chapter will set out evidence on preferences for and valuation of difference cultural services provided by agricultural systems.

12. Negative Health Externalities

Impacts on human health are routinely valued in the health economics literature. This chapter will review the scientific evidence on the potential increases in mortality and/or morbidity arising from the use of agro-chemicals and estimate value changes in monetary terms.

13. Negative Pollution Externalities

This chapter focuses on pollution externalities (other than greenhouse gas emissions which are treated separately in Chapter 12. These externalities would include for instance nutrient loading arising from the application of fertilizers.

14. Greenhouse gas emissions from the agriculture and food sector

This chapter will review and synthesis analyses of greenhouse gas mitigation potential across different farming systems, and across different production techniques applied within a given farming system. Greenhouse gases will include not only carbon dioxide but also methane, nitrous oxide etc.

SECTION V: APPROACHES FOR POLICY APPRAISAL

15. A typology and review of policy interventions for agriculture

It is difficult to think of any policy that would not in some direct or indirect way impinge on the food and agriculture sector. There is thus a need to categorize the range of policies and, in applying the Theory of Change discourse, determine the potential of policies to make externalities visible and allow policy-makers to capture these values.