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of the United Nations**



**DEPARTMENT OF ECONOMIC
AND SOCIAL AFFAIRS - STATISTICS DIVISION
UNITED NATIONS**

System of Environmental-Economic Accounting for

Agriculture, Forestry and Fisheries:

SEEA AFF

White Cover version

(pending final UNSD editorial clearance)

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Preface

The scope of the System of Environmental-Economic Accounting for Agriculture, Forestry and Fisheries (SEEA AFF)

1. The SEEA AFF applies the environmental-economic structures and principles described in the System of Environmental-Economic Accounting 2012 Central Framework (SEEA Central Framework) to the activities of Agriculture, Forestry and Fisheries. The SEEA Central Framework, extending the conceptual framework of the 2008 System of National Accounts (EC, et al., 2009), was adopted in 2012 as an international statistical standard by the United Nations Statistical Commission (UNSC). It was jointly published in 2014 by the United Nations, the European Commission, FAO, the International Monetary Fund (IMF), the Organisation for Economic Co-operation and Development (OECD) and the World Bank (United Nations *et al.*, 2014a). The SEEA AFF was endorsed in 2016 by the United Nations Committee on Economic Environmental Accounting (UNCEEA) on behalf of the UNSC, as an *Internationally Approved Methodological Document in support of the SEEA Central Framework*.
2. The focus of the SEEA AFF is therefore on the integration of data needed for describing how biophysical and management information relevant to agriculture, forestry and fisheries production can be integrated into the statistical framework established under the SEEA CF. Its data coverage is therefore rather broad, including data in both monetary and biophysical terms across ten primary data domains.
3. Although agriculture, forestry and fisheries production represent a notable example of ecosystem services, the SEEA AFF does not currently incorporate the accounting approach described in the SEEA Experimental Ecosystem Accounting (SEEA EEA). This is because the data needed to underpin ecosystem accounting, including measurement of ecosystem services and ecosystem condition, are not sufficiently advanced for systematic implementation at country level. The need for closer integration between SEEA AFF and the SEEA EEA is recognized as an important area of future SEEA research, including by the London City Group Research Agenda and the SEEA EEA Technical Committee.
4. An important step towards ecosystem accounting will be the estimation of information at sub-national level. The development of geospatially enabled datasets for agriculture, forestry and fisheries is therefore of critical importance, particularly when considering broader links with sustainable development processes.

Background to the development of SEEA AFF

5. The relevance of extended accounting frameworks for analysis of agriculture, forestry and fisheries activities is well recognized. Important work included:
 - a. *The System of Economic Accounts for Food and Agriculture (FAO, 1996) and the Economic Accounts for Agriculture (EEA) both building on the 1974 Handbook for Economic Accounts for Agriculture*
 - b. *The Integrated Environmental and Economic Accounting for Fisheries (UN & FAO, 2004)*
 - c. *The European Framework for Integrated Environmental and Economic Accounting for Forests (EC & Eurostat, 2002)*. While there are differences in the scope and coverage

of these documents relative to the SEEA AFF they collectively point to the potential to adopt accounting techniques in this area.

6. Following the adoption of the SEEA Central Framework in March 2012, the UN Committee of Experts on Environmental-Economic Accounting (UNCEE) endorsed the FAO-led plan to develop a SEEA for Agriculture, Forestry and Fisheries in June 2012. Work on the SEEA AFF commenced in June 2013 with resourcing from the Global Strategy to Improve Agricultural and Rural Statistics (the Global Strategy) (FAO, UN & World Bank, 2010) led by FAO. A draft version of the SEEA AFF was tested in 2014 via four country pilots in Australia, Canada, Guatemala and Indonesia, followed by two Global Consultations in 2014 and 2015. In 2016, as per request of the UN Statistical Commission (UNSC), the SEEA AFF was finalized as an *Internationally Approved Methodological Document in support of the SEEA Central Framework* by the UN Committee of Experts on Environmental Economic Statistics.
7. The critical role of FAO in support of the development of the SEEA AFF includes its longstanding collection, analysis and dissemination of national statistics covering agricultural, forestry and fisheries activities and related themes, such as land, soil and water resources. FAO furthermore leads critical international work on the development of new data products and indicators within FAOSTAT, FishStat, and other relevant corporate FAO data repositories. The work on the integration and further development of these statistics, as well as their relevance for and integration with national data, is a central motivation underpinning the development of the SEEA AFF.
8. By highlighting and identifying the functional connections among a wide range of data domains, the SEEA AFF seeks to provide a useful framework facilitating analysis of statistics and indicators in support of several ongoing international efforts, including:
 - a. *The 2030 Agenda for Sustainable Development and the SDGs*
 - b. *The UN Climate Change Conference in Paris on December 2015 (COP 21)*
 - c. *Global Strategy to Improve Agricultural and Rural Statistics*

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1. The SEEA Agriculture Forestry and Fisheries (SEEA AFF) is the outcome of a transparent process with wide involvement of member countries and the international statistical community. After initial work started in 2013, the SEEA-AFF final draft underwent two global consultations, respectively in 2013 and 2015, with the involvement National Statistical Offices, Ministries of Agriculture and Ministries of Environment, as well as main international organizations including EUROSTAT, OECD and the World Bank. The final SEEA AFF draft was submitted to the 47th Session of the UN Statistical Commission (UNSC) in March 2016.
2. The 47th UNSC recognized the importance of developing dedicated environmental-economic accounts for Agriculture, Forestry and Fisheries, especially as a tool towards supporting countries implement the 2030 Sustainable Development Agenda, and requested the UN Committee of Experts on Environmental-Economic Accounting (UNCEEA) to support its finalization. The SEEA AFF was endorsed by the UNCEEA at its 11th meeting in June 2016, on behalf of the UNSC, as an *Internationally Agreed Methodological Document in support of the SEEA CF*. This White Cover version includes all final comments and guidance received through the Technical Committee of the UNCEEA, serving through 2017 as Editorial Board of the SEEA AFF.
3. The SEEA Agriculture, Forestry and Fisheries is the result of the work and dedication of many professionals in many international organizations and member countries, under coordination by the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Statistical Division (UNSD). FAO wishes to thank Carl Obst, who served as senior consultant on the project from its inception and functioned as overall SEEA AFF Technical Editor, under the coordination of Robert Mayo and Francesco N. Tubiello, FAO Senior Statisticians, respectively former and current Team Leader of the Environmental Statistics Team of the FAO Statistics Division. Alessandra Alfieri and Ivo Havinga and their staff at the Environmental Economic Accounts Section of UNSD, in particular Sokol Vako, provided significant coordination and support throughout the life of the project, assisting operationally via the implementation of global consultations, as well as technically, through provision of technical feedback and overall direction.
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8. The lead authors of this SEEA AFF publication are: Francesco N. Tubiello, Carl Obst, Robert Mayo, and Silvia Cerilli. They also served as main Editors, under the guidance of the SEEA Technical Committee of the UNCEEA, functioning as Editorial Board during the period 2016-2017, towards the completion of this report.

The United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA) and its Bureau

9. The process of revision of the SEEA AFF involved the United Nations Committee of Experts on Environmental-Economic Accounting; other international, regional and non-governmental organizations; project staff; agencies responsible for compiling official statistics in many countries; city groups; other expert groups; and individual experts in environmental economic accounting and related fields from all regions of the world.
10. The Statistical Commission established the Committee of Experts at its thirty-sixth session in March 2005 with the mandate to mainstream environmental accounts and related statistics and oversee and manage the revision of the SEEA. The Bureau was established in 2007 to assist in carrying out specific activities between meetings. Members of the Bureau are elected from senior officials from National Statistical Offices and International Organizations.
11. The following served as members of the Bureau of the Committee of Experts: Bert Kroese (Chair), Lisa Wardlaw-Kelly and Mark Lound (Australia Bureau of Statistics), Andre Loranger (Statistics Canada), Arturo de la Fuente (Eurostat), Francisco Guillen and Raul Figueroa (INEGI, Mexico), Gerard Eding and Sjoerd Schenau (Statistics Netherlands), Francesco Tubiello (FAO), Peter van der Ven, Myriam Linster and Pierre-Alain Pionnier (OECD), Ivo Havinga and Alessandra Alfieri (United Nations Statistics Division), Glenn-Marie Lange (World Bank); Romeo Recide (Philippines Statistics Authority), Joe de Beer (Statistics South Africa)
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London Group on Environmental Accounting

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Acronyms used in the document

CPC	Central Product Classification
CPUE	Catch per Unit Effort
EC	European Commissions
EEA	Experimental Ecosystem Accounting
EE-IOT	Environmentally-Extended Input-Output Tables
EPEA	Environmental Protection Expenditure Accounts
EU	European Union
Eurostat	Statistical Office of the European Union
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	FAO Statistical database
GAEZ	Global Agro-Ecological Zones
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geospatial Information Systems
IMF	International Monetary Fund
IPCC	Inter-governmental Panel on Climate Change
ISIC	International Standard Industrial Classification
ISSCFC	International Standard Statistical Classification of Fishery Commodities
IUU	Illegal, Unreported and Unregulated (fishing activity)
LKAU	Local Kind of Activity Unit
OECD	Organisation for Economic Co-operation and Development
ReMEA	Resource Management Expenditure Account
SDG	Sustainable Development Goals
SEEA	System of Environmental-Economic Accounting
SIEC	Standard International Energy Product Classification
SNA	System of National Accounts
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

Chapter 1: Introduction to the System of Environmental-Economic Accounting for Agriculture, Forestry and Fisheries (SEEA AFF)

1.1 Overview of the SEEA AFF

- 1.1. The System of Environmental-Economic Accounting for Agriculture, Forestry and Fisheries - SEEA AFF - is a statistical system for organizing data to enable the description and analysis of the relationship between the environment and the economic activities of agriculture, forestry and fisheries. These primary activities depend directly on, as well as have an impact upon, the environment and its resources.
- 1.2. Understanding the complex relationship between these primary activities and the natural environment is critical for the analysis of sustainable food and agriculture, which is dependent on the inter-linkages between food security, natural resource use and the sustainability of food, fibre, material and bio-energy production, rural incomes and employment.
- 1.3. Integrating economic and environmental information about agriculture, forestry and fisheries involves consideration of the connections and trade-offs between the objectives of each activity and the related environmental factors. To this end, the SEEA AFF supports the growing dialogue on the water–climate–food–energy nexus, particularly in the context of the post-2015 Development Agenda (UN, 2012a).
- 1.4. The SEEA AFF is designed to be applicable to and by all countries, regardless of economic or statistical development status, economic structure or environment. Recognizing significant variations from country to country in agriculture, forestry and fisheries activities, the structure of the SEEA AFF accounts easily allows for the inclusion of nationally important activities and products.
- 1.5. The accounting framework described in the SEEA AFF covers both monetary and physical data. In doing so, the SEEA AFF is an application of the accounting principles and structures contained in the System of National Accounts (SNA) and the SEEA Central Framework (SEEA CF), with a focus on the integration of data relevant to agriculture, forestry and fisheries into the national accounting framework. As such, the SEEA AFF is endorsed by the UNCEEA on behalf of the UNSC as an *internationally approved methodological document in support of the SEEA Central Framework*.
- 1.6. The basic organization of the SEEA AFF can be extended in a variety of ways, and it is hoped that extensions and refinements will be undertaken in coming years, based on country needs and experience, to enhance the system described herein. In this sense, the SEEA AFF constitutes a platform for an accounting framework aimed at facilitating the integration and use of data relating to agriculture, forestry and fisheries activities within the domains of economics and the environment.

1.2 Motivation for the development of SEEA AFF

- 1.7. The main purpose of the SEEA AFF is the integration of environmental and economic data with a view to supporting the mainstreaming of environmental information in economic planning, development policy and analysis and monitoring. It applies the SEEA Central Framework to Agriculture, Forestry and Fisheries activities, thus facilitating for these sectors the joint analysis of environment and economy in support of a more complete analytical framework than otherwise possible when performing analysis in each field separately. As a complement and in addition to the

SEEA CF, the SEEA AFF introduces eleven new physical flow and asset accounting tables, including for crops and livestock production, fish and aquatic products, fertilizers, pesticides,, and agriculture-specific economic data, needed to record and analyse relevant agricultural statistics in an integrated, holistic manner. These SEEA AFF specific tables are highlighted in the text in relevant sections of this document.

- 1.8. This issue is important in relation to agriculture, forestry and fisheries because there are fundamental connections between economic units – businesses – and the environments and ecosystems in which they are located and operate. By way of example, farmers rely directly on the quality of soil and the availability of water to grow crops and raise livestock; foresters must balance the extraction of timber against the condition of the forest in terms of factors such as soil stability, biodiversity, the management of pests and disease and fire risks; and fishermen need to understand how their activity affects fish stocks and how the local freshwater or marine environment supports healthy populations.
- 1.9. At the same time, the exclusive focus on environmental and ecological factors ignores the reality that those working in agricultural, forestry and fisheries activities do so to derive an income. They must hence provide for the costs of inputs, delivery, storage, and consider consumer demand and other economic factors that drive economic decisions with respect to use of the environment. Such decision-making is challenging, requiring the balancing of economic and environmental factors.
- 1.10. The SEEA AFF provides information relevant to the analysis of production functions for individual products and activities, but goes beyond standard economic production functions to include environmental inputs, status and impact. Thus, it brings together information to extend and improve the data available for analysis of, for example, the cultivation of rice, the raising of livestock, and the management of forests and fish stocks. A SEEA AFF based dataset can directly assist in the coordination of information to measure these and other production functions, in support of improved evidence-based decision-making.
- 1.11. The larger analytical potential of the SEEA AFF stems from its application of a common framework where concepts, definitions and classifications are consistently applied across different products and activities. The production of wheat, for example, can in this manner be described and more meaningfully compared with the production of forest products or fish. Furthermore, by applying the concepts of the SEEA Central Framework and thus of National Accounts, the SEEA AFF allows for a more consistent and meaningful comparison of agricultural, forestry and fisheries products and activities with the products of the manufacturing, retail and services industries.
- 1.12. In addition to direct structural comparisons between, for example, yield per hectare or energy use per tonne harvested, data that are in a common framework can be used to assess trade-offs between alternative scenarios using various modelling techniques.
- 1.13. Further, because the starting scope of the SEEA AFF is national-level activity, the data in the SEEA AFF framework are not case studies of specific production functions: rather, the observed relationships between inputs and outputs are embedded in aggregate measures of production, supply and demand. Hence the SEEA AFF may help in scaling up to more detailed studies, enabling mainstreaming of detailed technical data into macro-level discussions. The logic of this micro–macro connection is an important aspect of the standard economic accounts. Their adoption can facilitate the integration of survey data on input-output relationships for particular industries (including specifically agriculture, forestry and fisheries), with macro-economic indicators of international trade, consumer demand, government expenditure and business production and investment.

- 1.14. By facilitating integration of relevant information, the SEEA AFF is a very useful framework for assessing the sustainability of agriculture, forestry and fisheries activity. It may nonetheless exhibit a number of possible limitations to this end. First, it can make connections with social data such as employment and household incomes, but it does not incorporate other social aspects such as social capital or education.
- 1.15. Second, its role as a data integration framework may be too general in specific circumstances for capturing critical differences in production practices in particular locations and for particular products.
- 1.16. Third, its focus on integration of data in biophysical terms – tonnes and cubic metres for example – and in monetary terms may hinder analysis of some potential environmental impacts. The relative toxicity of pesticides, for example, will not be recognized if pesticides are accounted for only in terms of tonnes of active ingredients or in terms of their monetary values.
- 1.17. Fourth, the environmental data that are integrated in the SEEA AFF largely concern those stocks and flows that support and provide input to agriculture, forestry and fisheries activities. At this stage, there is no explicit coverage of changes in environmental quality that arise as a result of these activities, although the information relevant to these impacts may be found in accounting for changes in land, soil and water resources. A more complete accounting for environmental quality could be further developed through incorporation of the SEEA Experimental Ecosystem Accounting, as envisaged in the SEEA AFF research agenda.
- 1.18. Notwithstanding these limitations, the integration of environmental and economic data is a major step towards mainstreaming environmental factors in economic policy development and analysis. Information in itself is no guarantee of a particular outcome with respect to policy or decisions, but its availability may encourage a more informed approach to decision-making.

1.3 Potential beneficiaries

- 1.19. A number of possible users and beneficiaries of the SEEA AFF are described below. It should be noted that they may be users of information or compilers of information.
- 1.20. Information agencies, including national statistics offices. These agencies can benefit from the SEEA AFF to place multiple data sources in useful context. The SEEA AFF encourages the use of consistent and non-overlapping concepts, data-item definitions and classifications of activity and products, which can assist in streamlining data collection and facilitating comparison and quality assessment.
- 1.21. Compilers of national accounts. Agricultural, forestry and fisheries activity is a major contributor to economic activity in many countries, particularly in its effects on short-term movements in aggregate GDP. The collection of data on this activity is challenged by the large numbers of widely separated producers, its seasonal nature and the possible prevalence of home and subsistence production. SEEA AFF-based accounts will be directly relevant to the compilation of estimates for the core national accounts, contributing to the compilation of more accurate estimates of GDP.
- 1.22. Government departments. Most countries and many administrative regions have departments with specific responsibilities such as agriculture, forestry, fisheries and the environment and also departments that cover both economic and environmental issues such as macro-economic development and planning institutions. Because these departments' core datasets are many and varied, they may not conducive to the joint consideration of environmental and economic factors. Data compiled following the

SEEA AFF can facilitate departmental understanding of macro-level and micro-level linkages and trade-offs between these factors.

- 1.23. Natural resource managers. The compilation of the SEEA AFF will require input from natural resource managers such as foresters, fisheries experts, soil experts and hydrologists. The SEEA AFF is unlikely to provide additional information to support improved management of individual natural resources, but the common framework will highlight linkages among different natural resources and between natural resources use and economic drivers.
- 1.24. Industry associations and individual economic units, including multi-national corporations. Discussion on the use of the SEEA often focuses on its relevance for government and administrative decision-making. In addition, a broad-based information set on agricultural, forestry and fisheries activities is likely to be of interest to private-sector economic actors, industry associations, agriculture, forestry and fisheries businesses, supporting industries and the finance sector. A SEEA AFF database would be a useful source of business intelligence, would provide a reference for the collection and organisation of data by these agencies, and would support the assessment of risks through the supply chain.
- 1.25. Academic and research institutions. The increasing focus on environmental-economic and other inter-disciplinary linkages suggests that the availability of better integrated datasets would support research and independent monitoring in these areas. The challenges involved in bringing together environmental data expressed in physical terms in an economic accounting framework will require further investigation, and hence opportunities for researchers will emerge.
- 1.26. International agencies. The SEEA AFF framework may provide a number of benefits for international agencies. From a statistical point of view, the SEEA AFF can support work to improve the quality of statistics. From a development policy perspective, increased understanding of environmental linkages is desirable in view of the significance of agricultural, forestry and fisheries activities in terms of employment and development, as is the capacity to make comparisons among countries on the basis of consistent metrics such as agri-environmental indicators.
- 1.27. The numerous global policy initiatives with links to agricultural, forestry and fisheries activities include the following:
 - a. Post-2015 Development Agenda and its Sustainable Development Goals;
 - b. Poverty Environment Initiative of the United Nations Development Programme and the United Nations Environment Programme (PEI);
 - c. United Nations Reducing Emissions from Deforestation and Forest Degradation (UN-REDD);
 - d. United Nations Convention on Biodiversity and Aichi biodiversity targets (UNCBD);
 - e. United Nations Convention on Combating Desertification (UNCCD);
 - f. United Nations Sustainable Energy for All (SEforALL);
 - g. United Nations Framework Convention on Climate Change (UNFCCC).
- 1.28. Each of these initiatives has established or will establish specific targets and benchmarks, but there are benefits in providing an integrated dataset that supports all programmes using the SEEA approach.

1.4 Implementation: expectations and data requirements

- 1.29. The SEEA AFF supports the organization and integration of information from multiple domains based on the accounting principles of the SEEA Central Framework, and hence provides a structure in which compilation exercises may be undertaken.

Importantly, its implementation should be seen as part of a broader national statistical architecture and within the context of each country's national statistical system.

- 1.30. As with all areas of environmental-economic accounting, a combination of agencies and disciplines is required for implementation of the SEEA AFF, with integrated planning and full coordination as fundamental principles. Implementation should not be seen as a purely technical or statistical exercise. To ensure appropriate targeting, producers and owners of information and users of information must be involved from the outset. The interim SEEA Implementation Guide sets out the steps involved in planning and coordination needed to implement the SEEA.
- 1.31. The SEEA AFF has a broad coverage and requires a large amount of data for complete implementation. At the same time, SEEA AFF combines, in a single context, ten domains and underlying datasets that, individually, are either well established or otherwise often available at the national level. Much of the data required by SEEA AFF are those collected through well-established international statistical questionnaires, developed in the various domains. In this sense, the SEEA AFF as accounts are not experimental.
- 1.32. Similarly to the implementation of the SEEA Central Framework, countries are not expected to implement all aspects of the SEEA AFF in a single step. A flexible and modular approach is envisaged, whereby countries would implement components incrementally, taking into consideration national priorities, existing data, available resources and national policy requirements.
- 1.33. To help provide structure for implementation and facilitate implementation by countries at any level of statistical capacity, the SEEA AFF builds on the three-tiered approach used in the IPCC Guidelines for national greenhouse inventories for reporting to the UNFCCC. The ambition is to provide a relatively standard entry point to the SEEA AFF framework for countries, especially those that have relatively less developed statistical systems. Simplified accounts compiled at low tiers can be used as a starting reference point for compilation, quality assessment and quality control, and to facilitate international comparison. Over time, as experience with SEEA AFF grows within a country, countries would progressively move towards more complete and more detailed accounts and hence higher tiers, enabling a broader range of policy discussion and analysis.
- 1.34. In brief, three tiers of implementation are envisaged. The first tier involves the compilation of accounts using as default data those available in International databases; the second tier uses these data and also additional national data that are available or might be sourced following discussion with relevant national agencies; the third tier involves introducing new or expanded data collections to provide accounts that have additional detail, facilitating incorporation of sub-national level data, including the use of geospatial data and models. These three tiers are explained further in Annex 1.
- 1.35. Initial development of the SEEA AFF does not require new questionnaires, though it may require increased harmonization among existing data-collection efforts across different data domains. In this context, the SEEA AFF is a single tool for harmonizing and aligning the data from various agencies within a national statistical system. The data will include information drawn from surveys and censuses, administrative sources and, increasingly, geospatial information systems (GIS).
- 1.36. Other than official statistical collections and processes, data collected in other national and international processes should be utilized: the use of data on greenhouse gas emissions from the United Nations Framework Convention on Climate Change (UNFCCC) processes is an example. There may be differences in measurement scope and definition, but such datasets will provide useful support the development of the integrated accounts envisaged in the SEEA AFF.

- 1.37. Given that the approach of the SEEA AFF is to utilize data from multiple sources, it does not provide guidance on compiling data for specific domains: the focus is on describing a structure and rationale for the integration of data.
- 1.38. The process of integration described in the SEEA AFF does require the collection of additional detail in some areas to support its cross-cutting approach. Such additional detail, particularly at the product level, should be seen as part of the dataset that might be developed using the SEEA AFF. The collection of additional detail should respond to policy and analytical need rather than being viewed as a requirement.
- 1.39. It is understood that although some of the detail described in the SEEA AFF is not the focus of current activity by statisticians at the country level, such detail is commonly used in agricultural, forestry and fisheries modelling and analysis. Hence the SEEA AFF may provide greater transparency in the development of models that integrate and allocate data from a variety of sources.
- 1.40. Consistent use of the SEEA AFF provides the basis for international comparability. Decisions regarding the country-level data that may be collected for international reporting purposes, and the appropriate mechanisms for collection and coordination, will be made through the relevant international statistical processes.

1.5 Summary of uses and applications of the SEEA AFF framework

1.5.1 Primary uses of SEEA AFF data

- 1.41. The SEEA AFF provides a structure for the organization of environmental and economic data that are useful for policy-making and analysis. Accordingly, it must be informed by and responsive to the needs of data users. This chapter outlines ways in which SEEA AFF data might respond to those needs and encourage discussion between data compilers and data users. It also highlights some potential applications, with more examples expected as development and testing proceed.

Statistical data coordination

- 1.42. With its strong connections to the SEEA Central Framework, the SEEA AFF includes many of approaches of National Accounts towards organizing information and statistics, as outlined in the following paragraphs.
- 1.43. Framework for organizing data. By using consistent classifications, for example for “product” and “activity”, and information structures such as supply-and-use tables and asset accounts, the SEEA AFF provides a system for bringing together economic and environmental information coherently within a single setting.
- 1.44. Data gap analysis and gap filling. The SEEA AFF is designed on the basis of the relevance of information rather than its availability. Because it is broad-based, the SEEA AFF framework can be used to identify and assess data gaps or data of poor quality and support the allocation of resources to fill significant data gaps. Further, because the accounting that underpins the SEEA AFF reflects accepted relationships between stocks and flows, the relationships can be used as a basis for filling data gaps through modelling or analogous approaches.
- 1.45. Data collection and reporting. The SEEA AFF can support and encourage the use of consistent data-item definitions in different collections and the use of consistent classifications across collections – for example product classifications. These practices can facilitate the exchange of data among agencies.

- 1.46. Uses in defining indicators. One motivation for the SEEA is the need to facilitate the derivation of indicators that reflect cross-domain comparisons: examples include yield per hectare and water use per tonne of crop produced. For these indicators to be meaningful, the definition of information from the relevant datasets must be consistent. Different datasets usually have their own scope, definitions and classifications, and as a result the quality of the resulting indicators may be compromised.
- 1.47. The SEEA AFF meets this challenge by providing consistent scope and classification for agriculture, forestry and fisheries products and activities for all datasets, thereby constituting a basis for adjusting primary data to derive sound cross-domain indicators and for developing the primary datasets themselves.
- 1.48. The types of indicators that can emerge from the SEEA AFF framework are described in Chapter 6 of the SEEA Central Framework, in Chapter 2 of the SEEA Applications and Extensions and there is a more specific discussion on types of agriculture, forestry and fisheries indicators in section 2.6 of this document. The types of indicators include:
- Descriptive and structural statistics
 - Environmental asset aggregates
 - Environmental ratio indicators
 - Decoupling indicators
 - Polluter-pays indicators
- 1.49. The SEEA AFF provides a framework in which the data used to derive indicators through participatory processes are readily available and coherently organized.
- 1.50. Examples of indicator sets include those being developed for the Sustainable Development Goals, the agri-environmental indicators collected by OECD, Eurostat and FAO,¹ and the indicators in the Sustainable Energy for All Global Tracking Framework. Many of the indicators in these indicator sets can be derived from an SEEA AFF-based dataset and, conversely, it would be relevant when selecting indicators to consider the potential for deriving indicators based on the SEEA AFF.
- 1.51. The SEEA AFF does not define a concept of sustainability, nor does it suggest that direct measures of sustainable development can be derived from a SEEA AFF dataset. However, the SEEA AFF does provide information relevant to assessment of the environmental sustainability of agricultural, forestry and fisheries activity. The distinction between organizing the relevant information and the direct measurement of sustainability must be borne in mind when considering the potential role of the SEEA AFF.

Uses for detailed analysis and modelling

- 1.52. The information in the SEEA AFF can be used to compile environmentally extended input-output tables (EE-IOTs), which are introduced in Chapter 3 of the SEEA Applications and Extensions. The idea of EE-IOTs is that standard input-output tables focused on flows of products in an economy measured in monetary units are extended to incorporate environmental flows measured in physical units, such as greenhouse gas emissions and use of water and energy. The mathematics of input-output analysis has been adapted to suit this extension. The essential point is that the

¹ FAO, OECD and Eurostat share a coherent set of indicators.

organization of information about the additional environmental flows uses the same product and industry classifications as the standard input-output table.

- 1.53. Because standard input-output tables are structurally aligned with the SNA, environmental information organized following the SEEA – including agricultural, forestry and fisheries data – can be readily incorporated into an EE-IOT.
- 1.54. EE-IOTs have been developed for individual countries, and are increasingly being developed to cover several countries; these are called multi-regional input-output tables, which also incorporate connections between countries through international trade in goods and services.
- 1.55. Once EE-IOTs are established, different types of analysis may be supported. The following list of examples are introduced in more detail in the SEEA Applications and Extensions.
 - Multiplier analysis
 - Demand based accounts and indicators, including footprint indicators
 - Structural decomposition analysis
 - Extended productivity analysis
 - Modelling of international trade
 - General and partial equilibrium analysis
 - Life-cycle analysis

1.5.2 Primary policy themes

- 1.56. This section describes various policy areas that might be supported by a well populated SEEA AFF dataset, bearing in mind that the intention of the SEEA AFF and the SEEA generally is to facilitate consideration of connections between environmental and economic factors relevant to economic, planning and development decisions. Statistical information is unlikely to be the sole basis for such decisions, so the approach adopted by the SEEA AFF of integrating data in meaningful ways is just as important as the clarification of definitions and treatments.
- 1.57. The term “policy” is used generically, covering the use of information to:
i) support consideration of alternative options and scenarios in the policy-development process; ii) analyse policy outcomes; and iii) monitor progress in a policy, for example through indicators or benchmarks. In addition to government policy, the term is also applied here to refer to the decision-making frameworks of non-governmental organizations, corporations and small businesses.
- 1.58. The SEEA AFF framework supports discussion in the five themes described below with potential links to particular policies. The themes are a basis for the SEEA AFF combined presentations described in section 2.5.

Theme 1: Activity-specific and product-specific inputs

- 1.59. This theme focuses on analysis of economic and environmental information about a country’s most important products, and the associated trends in the use of environmental inputs and the generation of residual flows. Determination of the “most important” products depends on the criteria applied, which may include products most traded internationally, products that are most significant for nutrition, products that contribute most to production or products that use the most land.

- 1.60. The policy connections relate to understanding the intensity of use of environmental flows: they are hence of direct relevance in assessing the impact of changes in policies and incentives with regard to “green” growth and related objectives.

Theme 2: Food product consumption, losses and waste

- 1.61. Here, the focus is on the production and consumption of food products, particularly tracking sources of supply – domestic production or imports – and destinations of use – final consumption, intermediate consumption, changes in inventories and export. In balancing supply and use, there is always an element of waste and loss of food that must be correctly recorded and attributed.
- 1.62. Two policy connections are: i) the links between food production, and household final consumption – at home and in restaurants; and ii) the potential to improve food security outcomes by reducing food waste in the supply chain; the latter is a focus of work by OECD, the United Nations World Food Programme and FAO. Here, SEEA AFF provides some essential information that can be linked to other physical flow and/or input-output data to map the full supply chain.
- 1.63. A critical theme is the link between food consumption and health, nutrition and undernourishment. Using the common unit of calories or other nutrients, the production and consumption of food products can be considered differently. These relationships are traditionally measured through food balance sheets. In addition, the SEEA AFF enables consideration of the additional links to water use, land use, greenhouse gas emissions and other environmental flows.

Theme 3: Bioenergy

- 1.64. The requirement to consider sources of energy other than fossil fuels has led to rapid increases in the production of energy from agricultural and forestry products. International initiatives such as Sustainable Energy for All, the FAO-led programmes on bioenergy and food security and the Global Bioenergy Partnership reflect the importance of this aspect of agricultural and forestry activity. The information in the SEEA AFF would support an integrated assessment of the factors affecting the production and consumption of bioenergy.

Theme 4: Use of environmental assets – timber, fisheries, water, soil

- 1.65. In this theme the focus is on the extent to which the extraction and use of environmental assets by agricultural, forestry and fisheries activity is depleting available resources below sustainable levels, and hence reducing the capacity to sustain these activities in the long term.
- 1.66. The policy connections involve supporting the management of natural resources, and understanding potential environmental constraints for particular activities.

Theme 5: Cross-industry and activity perspectives.

- 1.67. The focus here is on bringing together information that can be compared across agricultural, forestry and fisheries activities, particularly information on production and value-added, international trade, employment, land use, water and energy use, and greenhouse gas or other air emissions.
- 1.68. The policy connections are numerous. Issues such as land-use planning and the food/water/energy/climate nexus are of particular interest because understanding of the trade-offs between different activities is required. This level of analysis is also likely to be useful for international comparisons and benchmarking.

1.5.3 Other relevant policy connections

- 1.69. The design of SEEA AFF may be extended to encompass more policy themes, as set out in Chapters 3 and 4 in relation to specific data domains.
- 1.70. One additional theme concerns rural incomes as distinct from total incomes from agricultural, forestry and fisheries production activity. A rural-income focus may be supported by integrating information on farm size, income distribution and demographic data, such as age and gender in relation to farm ownership and employment. The challenge in incorporating this view into the SEEA AFF framework is to attribute relevant environmental information, for example about the use of water or fertilizer. It may be possible if, for example, the differences in production techniques between smallholders and large-scale farmers can be documented and measured.
- 1.71. Another policy theme is to consider in more detail the connections between agricultural, forestry and fisheries activity at the domestic level in the context of international trade and food manufacturing, wholesale and retailing activities – the global supply chains. Various international trade models exist – the Global Trade Analysis Project is an example – and the SEEA AFF supports improved data quality for these models. The capacity to track flows relating to specific products and types of corporation would ideally be needed, involving challenges related to a need for restructuring the standard input-output tables.
- 1.72. Other themes that might be considered concern different types of production processes such as organic agriculture and the role of genetically-modified crops. Additional disaggregation of data would need to be undertaken to support these analyses.

1.5.4 Applications at the sub-national level

- 1.73. Although the SEEA AFF is designed to provide national-level information and hence work with national datasets, there will often be interest in the connections between environmental and economic factors at the sub-national level. This is because environmental pressures and scarcities are often location-specific: water scarcity in a particular river basin is an example.

- 1.74. In principle, the SEEA AFF framework may be applied at the sub-national level, provided that appropriate sub-national boundaries can be determined for which a suitable range of data is available. The boundaries may be administrative – which suits the organization of socio-economic data – or environmental, for example by river basin or landscape type. Selecting the sub-national level will require compromises that take into consideration the type of information available, its capacity to be scaled up or down and the question of interest.
- 1.75. Geospatial assessments of the capacity of the environment to sustain agricultural production, as well as the impacts of that production are critical to understating environmental economic interactions; an example is the FAO global agro-ecological zones model. The SEEA AFF framework supports the development of such datasets and models by providing coherent national-level information on relevant environmental and economic factors. This would in turn enable appropriate benchmarking of sub-national models.
- 1.76. The development of sub-national datasets must allow for cross national boundaries analysis: the Mekong delta, the Nile and Lake Victoria are notable examples that highlight this need. SEEA AFF accounts could provide each country with a baseline of comparable national data, ensuring that the relevant sub-national estimates would be more comparable than might otherwise be the case.
- 1.77. An on-going challenge in developing sub-national datasets is determining the scale and related geographical classifications. Socio-economic data, from a census for example, are organized according to one classification, but environmental data are organized according to another – for example by water catchment area. Both classifications may be appropriate for the individual datasets, but in the SEEA context the integration of data requires choices on scale and classification to be made. One option is to downsize all information to the relevant geo-spatial scale and then aggregate the detailed information at higher scales, as required.
- 1.78. Notwithstanding the statistical challenges, sub-national information is particularly relevant, at least for individual datasets, and the technology and techniques are available to generate sub-national data at several scales. Account users must be able to define the questions to be answered and hence identify the data to be integrated. To support this process, it would be useful to map the information from individual datasets, for example on wheat production and water use, and compare the outcomes: particular locations and issues of interest may be highlighted far more effectively in this way than by interpreting information from accounts and tables. It should be noted that the description of approaches for the organisation of data at sub-national scales, including the choice of appropriate spatial units, is a particular feature of the SEEA Experimental Ecosystem Accounting.

1.6 Structure of this document

- 1.79. The SEEA AFF has four chapters. Chapter 1 “Introduction” describes the overall motivation and intent, the potential beneficiaries, the expectations concerning implementation, and summarises the main uses, applications and policy themes.
- 1.80. Chapter 2 “Conceptual framework” gives an overview of the structure and logic of the approach to integrating economic and environmental data pertaining to agricultural, forestry and fisheries activities. In particular, it describes the relevant national accounting principles, gives an overview of the base accounts of the SEEA AFF, highlights some key accounting issues and challenges, and describes combined presentations and indicators that can be derived from the base accounts.

- 1.81. Chapter 3 focuses on physical flows and asset accounts for agricultural, forestry and fisheries production and the associated biological resources (e.g. livestock, forests, fish stocks). In this chapter there is consideration of accounting in both physical and monetary terms.
- 1.82. Chapter 4 focuses on accounts for other relevant environmental assets, including water, land and soil, and physical flows of natural inputs and residuals of high relevance to these three activities, including water, energy, fertilizers and air emissions. The accounting described in this chapter is largely in physical terms.
- 1.83. For each of the base accounts, Chapters 3 and 4 further provide information on the scope and purpose of measurement, the accounting entries and the possible extensions for each of the base accounts in the framework.
- 1.84. Throughout the document considerable referencing to the SEEA Central Framework and the SNA are provided, in order to provide the user with useful information while avoiding duplication of information from these two UN standards.

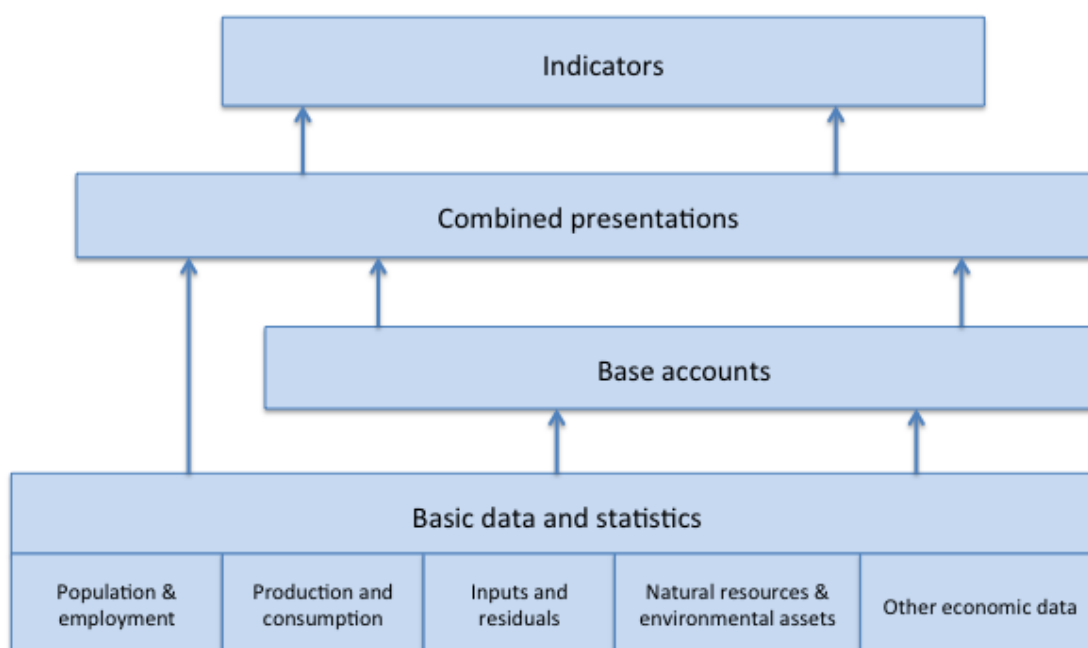
Chapter 2: Conceptual Framework

2.1. Overview of the SEEA AFF Conceptual Framework

2.1. The SEEA AFF is based on the SEEA Central Framework and the SNA, which together provide a foundation for integrating environmental and economic data in monetary and physical terms. This chapter summarizes relevant accounting structures and principles from those standards, and describes the main components of the SEEA AFF framework.

2.2. **Figure 2.1** shows the four main components – basic data and statistics, base accounts, combined presentations and indicators – are linked. It is important to recognize that the nature of the connections between the components should not be subject to strict rules. Hence not all possible basic data will be used to compile base accounts, and the data to be used will depend on the methods used in the base accounts and their level of detail.

Figure 2.1. SEEA AFF Information Flows



2.3. The combined presentations will include select information from the base accounts, relevant to a specific thematic analysis of interest. They may furthermore incorporate additional information, such as population data, which is not in the base accounts. The content of combined presentations may change over time to reflect changing analytical and policy priorities, but the structure of the base accounts will be relatively stable. The derivation of indicators may take information from the combined presentations, in addition from the base accounts.

2.4. The SEEA AFF provides a starting point for the integration of information and support for analysis and discussion. It is not a one-size-fits-all approach: compilers and analysts should adapt the framework to respond to the information needs of users, but adhere to basic national accounting principles.

2.1.1 Main areas of focus and key features

2.5. In accordance with the objective of examining the connection between economic activity and the environment, the SEEA AFF covers agricultural, forestry and fisheries activities, as defined in the International Standard Industrial Classification (ISIC) section A, divisions 01, 02 and 03 (UN, 2008a). The purpose of covering three different types of activity is to facilitate analysis of the trade-offs and dependencies among the activities that should be considered in national-level and local-level planning. The available information sets for each of these activities are often developed independently, which may hinder comparison of the activities and management of the relevant resources, and discourage consideration of alternatives.

Data domains

2.6. The SEEA AFF describes accounts in ten primary data domains. Each domain relates to a general data area that may include data on stocks and flows, and for which data will generally be available from a limited number of sources. The objective of the base accounts is to organize the available information in accordance with the general accounting concepts and principles outlined in this chapter to provide a basis for integrating information across domains.

2.7. The ten primary data domains and their associated base accounts are shown in **Table 2.1 Data Domains and base accounts**. Because the SEEA AFF focuses on activities, rather than a particular type of asset or flow, there is no immediate restriction on the range of analysis or the number of data domains that can be incorporated.

2.8. The ten data domains were selected on the basis of:

- the products supplied by the three ISIC divisions covering agricultural, forestry and fisheries activities;
- the individual environmental assets of direct relevance to agricultural, forestry and fisheries activities based on the classification of environmental assets in the SEEA Central Framework (see Table 5.1);
- the main physical flows associated with agricultural, forestry and fisheries activities that have been the focus of measurement and analysis – water, energy, greenhouse gas emissions, fertilizers, nutrient flows and pesticides; and
- data related to the production and investment activity of agricultural, forestry and fisheries activities within the SNA.

2.9. The domains and the associated accounts have been structured in a manner that supports communication of the SEEA AFF to users and which reflects the common way in which data are organised. In effect it is a thematic structuring. An alternative structuring of the various accounts could be adopted, for example into physical flow accounts on the one hand and asset accounts on the other.

2.10. The selected domains and the associated accounts are the most relevant in terms of understanding (i) the nature of production processes in physical and monetary terms, and (ii) the policy issues relating to agriculture, forestry and fisheries. If additional data domains are identified as relevant during the development and implementation of SEEA AFF at the country level, an extension of the set of SEEA AFF base accounts may be appropriate.

2.11. In each data domain there will be data sources common to many countries. For example, there will be regular agricultural surveys and censuses at the country level. In practice, in the preparation of base accounts, a range of sources and methods will be used to estimate the relevant concepts and variables.

Table 2.1 Data Domains and base accounts

Data domains	Base accounts
Agricultural products and related environmental assets	Physical flow account for crops* Physical flow account for livestock products* Asset account for livestock* Asset account for plantations*
Forestry products and related environmental assets	Physical flow account for forestry products* Asset account for forestry Asset account for timber resources
Fisheries products and related environmental assets	Physical flow account for fish and aquatic products* Asset account for fish and other aquatic resources*
Water resources	Asset account for water resources Physical flow account for water abstraction Physical flow account for water distribution and use
Energy	Physical flow account for energy use
Air Emissions	Physical flow account for air emissions
Fertilizers, nutrient flows and pesticides	Physical flow account for fertilizers* Physical flow account for pesticides*
Land	Asset account for land use Asset account for land cover
Soil resources	Asset account for soil resources
Other economic data	Monetary supply and use table for agricultural, forestry and fisheries products* Extended production and income account for agricultural, forestry and fisheries activities*

* New accounting tables with respect to the SEEA CF

Accounting design

- 2.12. The design logic of the SEEA AFF involves three stages. First, SEEA AFF base accounts are designed: these record data from the ten primary data domains into accounting structures in which the accounts reflect the application of the SEEA Central Framework and SNA accounting approaches. At this first stage the basic accounting identities (see SEEA Central Framework, section 3.2) are applied, with benefits in terms of ensuring data coherence and consistency. The various SEEA AFF base accounts in each data domain are described in Chapters 3 and 4.
- 2.13. Second, data for selected variables within the base accounts are brought together in combined presentations. The presentations may take many forms because they do not need to conform to accounting identities. The combined presentations organize information relevant to the discussion of a particular question or policy theme, but they should aim to integrate as much information as possible across the three economic activities and across all data domains, as described in Section 2.5.
- 2.14. Third, indicators can be derived from the data in the combined presentations to show trends in the relationship between agricultural, forestry and fisheries activities and the environment. A particular focus of these indicators should be the intensity of the use of environmental assets and environmental flows relative to production. It should be possible, for example, to develop indicators that describe the changing intensity of products such as rice, maize and livestock in terms of their use of land, water, energy and fertilizers and their generation of greenhouse gas emissions.

Key products

- 2.15. A particular feature of the SEEA AFF approach is the focus on recording information about the most important products. Hence, in addition to grouping information according to generic activities such as cropping or livestock rearing, a comprehensive set of economic and environmental inputs is articulated for the production of individual products such as wheat, rice, beef, timber and species of fish.
- 2.16. Defining the most important products will require consideration of various factors, and the list of relevant products is likely to vary according to the criteria chosen. At the country level, relevant considerations may be the contribution of product output to agricultural, forestry and fisheries value-added, the contribution of a product to calorie intake or the share of land used to generate a product. At the international level it may be relevant to record information about products that are commonly traded.
- 2.17. There are three motivations for developing a focus on key products in the SEEA AFF. First, full information is likely to be available for the most important products, so developing the accounts to support integration of data at the product level should facilitate the use of as many data as are available. There is, however, a risk in that data in some domains may not be available at the key product level, or only generated through detailed modelling or assumptions: in such cases decisions will be needed as to the priority of generating the information in relation to the quality of the data.
- 2.18. Second, policies for improving environmental sustainability in agriculture, forestry and fisheries will target major products such as rice, palm oil, livestock and tuna. It is hence reasonable to extend the national accounting approach to the key product level to support analysis and policy development. Because national accounts also track total production and other economic activity, the SEEA AFF framework supports on-going assessment of changes in the relative importance of different products, which is an essential part of monitoring.
- 2.19. Third, by using the key-product approach, the SEEA AFF supports analysis by agricultural economists, ecologists and others, which will, at the country level, focus on individual products that are significant in terms of their contribution to agricultural production, exports and food supply or in relation to environmental constraints such as land or water. The structure of production functions for individual products – that is functions describing the relationships between inputs and outputs – are likely to vary considerably by product type, particularly in relation to environmental inputs such as water.
- 2.20. It is also necessary to maintain a connection with broader aggregations, for example at the level of cropping activity, because there are likely to be linkages between product types and general pressures and constraints such as the availability of water and land that need to be assessed.

Other features of the SEEA approach

- 2.21. The structure of the SEEA AFF can in principle be extended to describe specific agricultural products within a given production function: distinguishing organic production of crops is an example. This type of extension is not described in the SEEA AFF base accounts and combined presentations, with the exception of the distinction between capture fisheries and aquaculture.
- 2.22. Although the SEEA AFF works in fine detail, the approach ensures a connection with the organization of information at the industry and national economy levels. The approach is largely to organize macro-level data from the standard national accounts and other national datasets with a view integrating micro-level perspectives.

This approach would be applied, for example, by using aggregate measures of the supply and use of fertilizers, including measures of production, imports and exports, and deriving measures of fertilizer use for major products such as rice or wheat.

- 2.23. The approach should also allow important relationships established at the micro level to be appropriately scaled and their relative importance established. The SEEA AFF aims, in fact, to mainstream detailed economic and scientific research on agricultural, forestry and fisheries production.
- 2.24. The SEEA AFF has been designed to cater for national-level analysis of agricultural, forestry and fisheries activities and products to enable the mainstreaming of environmental information into standard economic assessments of the activities and provide information on a broad scale. It is also possible to develop extensions to the sub-national level across the various data domains, which may be relevant for particular policy issues such as water use in particular catchment areas.
- 2.25. An important logic of the SEEA AFF is that, by starting from a national and broad activity perspective across the data domains, it is possible to partition the information using various data and indicators in such a way that product-level information is seen in a broad context; this approach is known as multi-level analysis. The example of the integration of fertilizer data from the national accounts and for key products is relevant in this context.
- 2.26. By placing product-level information in a wider context, the SEEA AFF moves beyond measurement of the environmental-economic relationship in studies of issues such as wheat production in temperate agricultural zones. Such studies, which may focus on economics or ecology, are likely to be useful – but challenging in terms of scaling up to enable integrated analysis in the context of other economic activities.

2.1.2 *Potential areas of extensions*

- 2.27. The design of the SEEA AFF shows the potential of organizing information that can support analysis of the relationship between the environment and the economy in agricultural activities, and there are various directions in which it might be extended.
- 2.28. First, in line with the discussion in the SEEA Experimental Ecosystem Accounting mentioned above, the production functions for individual agricultural products could be extended: i) to include inputs of ecosystem services; and ii) to consider the supply of ecosystem services from agricultural areas, forests and fisheries ecosystems to other economic units and to society generally. In the context of agricultural, forestry and fisheries production, ecosystem services are the contributions made by the ecosystem to production. Examples of ecosystem services include pollination, soil retention, water provisioning and nutrient flows. The relevant set of ecosystem services will vary for different agricultural, forestry and fisheries products and for different production processes.
- 2.29. Such an extension into ecosystem accounting would consider the range of ecosystem services, the capacity of agricultural and surrounding ecosystems to provide services sustainably and the potential for substitution and trade-offs among ecosystem services and produced goods and services; an example is the use of cultivated bees rather than natural pollinators. Also captured in this extension would be cultural services provided by relevant ecosystems, such as areas of agricultural landscapes.
- 2.30. In assessing the capacity of ecosystems to supply ecosystem services, it is important to consider the measurement of the condition of an ecosystem and how it changes over time. Techniques for measuring the condition of ecosystems at the national level are still being developed, but the general approach is to assess various

characteristics because direct measurement of overall ecosystem condition is not possible. Relevant characteristics will include water resources, soil type, climate and biodiversity. Information on some of these characteristics is already recorded in the accounts of the SEEA AFF.

- 2.31. An important aspect of ecosystem accounting is its use of a spatially explicit approach to measurement and hence its integration of geo-spatial and other remote-sensing data, which are becoming increasingly available.
- 2.32. The development of ecosystem accounting has also been closely linked to the development of national scale carbon accounting wherein the various stocks and flows of carbon, including emissions of carbon dioxide, are tracked over time. Given that the ecosystems and biomass associated with agriculture, forestry and fisheries activities are important stores of carbon, there would be the potential to focus carbon accounting in these areas and the SEEA AFF is able to provide much relevant information.
- 2.33. An extension of the SEEA AFF to incorporate ecosystem accounting is possible in concept, but further research and testing are necessary before a definitive ecosystem accounting approach can be established. Significant advances are expected in the short and medium term and can build directly on the type of information collected in the SEEA AFF as currently described.
- 2.34. Second, the SEEA AFF might be extended to incorporate accounting for economic transactions related to agricultural, forestry and fisheries activities that are considered to be “environmentally related”. Examples include: i) environmental protection and resource management expenditure by economic units involved in agriculture, forestry and fisheries activities; ii) environmental taxes and subsidies payable and receivable by these units; and iii) rents payable by these units, including payments for the use of land, access to forest reserves and payments in relation to fishing quotas. The first type of data may be organised into environmental protection expenditure accounts (EPEA) or resource management expenditure accounts (ReMEA).
- 2.35. Because these are standard economic transactions, their treatment is set out in the 2008 SNA. The SEEA Central Framework provides additional guidance on identifying environmentally related transactions and in the design of EPEA and ReMEA. There is little additional guidance that might be provided in the SEEA AFF, apart from recognizing the potential to identify transactions relevant to agricultural, forestry and fisheries activities. Such information may be drawn into combined presentations as appropriate, but this potential is not set out in the SEEA AFF.
- 2.36. Third, a range of standard, industry-level national accounting data may be included in the tenth data domain – Other economic data. The variables in the relevant base account (see section 3.10) are output, intermediate consumption, gross value-added, compensation of employees, gross operating surplus and mixed income, gross fixed capital formation, consumption of fixed capital (depreciation) and employment. Depending on the focus of interest, information on variables such as expenditure on research and development and on environmental protection and resource management may be included, in accordance with the SEEA Central Framework guidelines. If the data are available, information on innovation activity, interest payments and financial liabilities may also be incorporated.
- 2.37. This extension could also incorporate the description of supply chain, i.e. tracing the movements of agricultural, forestry and fisheries products through the economy. The use of standard national accounts classifications facilitates the connection of data from the SEEA AFF to datasets and models that are used for this analysis.

- 2.38. Fourth, the SEEA AFF could be extended to integrate additional social statistics and indicators. Relevant information is already incorporated in the SEEA AFF, such as employment, food consumption and nutrition. Extensions might be made to include data on rural incomes and poverty, access to water and energy in rural areas and age and gender, which are of interest in terms of policy with regard to sustainable development. This extension would require further discussion and coordination with related projects, particularly in relation to the integration of economic, environmental and social data at the sub-national level, taking advantage of increasingly available data from GIS.
- 2.39. Fifth, with regard to physical flows, additional data might be incorporated on residual flows from agricultural, forestry and fisheries activities where those residual flows represent measures of environmental pressures. Examples include data on flows of solid waste, ozone depleting substances and emissions to water.
- 2.40. Finally, with respect to environmental assets, the domains of the SEEA AFF do not cover directly, changes in the quality or condition of those assets. Rather the focus is on changes in the quantity or volume of the assets, for example of land, water and soil. Thus, while the SEEA AFF accounts provide a strong starting point for framing this work, an extension therefore is to include additional information on changes in the quality of these assets, either as a result of agricultural, forestry and fisheries activity, or due to other factors. Measurement of changes in the quality and condition of assets is a challenging area but is one focus of the work on ecosystem accounting, as described above. It is anticipated that this extension would be covered in applying ecosystem accounting to these areas in addition to capturing the impacts that agriculture, forestry and fisheries activity might have on other environmental assets and characteristics such as biodiversity.

2.2 Basic national accounting principles

2.2.1 Introduction

- 2.41. There are detailed descriptions of national accounting principles in SNA 2008, particularly in Chapters 2 to 5, and a summary of relevant aspects for environmental-economic accounting in the SEEA Central Framework, Chapter 2. This section therefore highlights the relevant principles and directs the reader to the SNA and the SEEA Central Framework.
- 2.42. The measurement of stocks and flows is central to establishing accounting approaches to convey comprehensive and consistent information about stocks of assets, changes in those stocks over time, and flows of production, income, consumption and other transactions associated with the use of the assets. Internal consistency is ensured by the application of accounting identities. The degree of comprehensiveness is determined by the choice of accounting boundaries for the definition of assets, the definition of income and production and the geographical coverage.
- 2.43. With appropriate accounting boundaries and identities in place, consistent classifications can be adopted. The data used for accounting will generally be sourced from a range of agencies and data collections, which will probably have collected and organized it for purposes other than integration and accounting. Core macro-economic statistics are increasingly being collected according to standardized classifications of industries and products, but this standardization does not yet extend to environmental information or the specific activity and product level detail used in the SEEA AFF. In compiling actual accounts, data from various sources will have to be converted to a common classification to enable the application of accounting principles.

- 2.44. The SEEA AFF applies the accounting boundaries and principles described in the SEEA Central Framework. Any differences relate primarily to the structuring of the selected base accounts, because it is here that the SEEA AFF focus on agricultural, forestry and fisheries activities is most apparent.

2.2.2 Types of accounts

- 2.45. The two types SEEA AFF base accounts are: i) physical flow accounts, or physical supply and use tables; and ii) asset accounts. These are described in Section 2.3 of the SEEA Central Framework and a short summary is provided here.

Physical flow accounts

- 2.46. Physical flow accounts or physical supply and use tables (see **Table 2.2** below and SEEA Central Framework Chapter 3) are a central feature of the SEEA Central Framework. Their structure is derived from monetary supply and use tables. Monetary supply and use tables (see **Table 2.3** below, and SNA 2008 Chapter 14) are used to record the flows of products in an economy between different economic units. They are structured to record the total supply of products against the total use of products; the required balance between these, i.e. total supply for each product must always equal total use of each product, is the accounting identity.

Table 2.2 Basic form of a monetary supply and use table

	Industries	Households	Government	Accumulation	Rest of the world	Total
Supply table						
Products	Output				Imports	Total supply
Use table						
Products	Intermediate consumption	Household final consumption expenditure	Government final consumption expenditure	Gross capital formation (incl. changes in inventories)	Exports	Total use
Value added						

* Note that the measure of household final consumption expenditure includes the expenditure of non-profit institutions serving households (see SNA2008, chapter 9).

Dark grey cells are null entries in conceptual terms.

Source: SEEA Central Framework, Table 2.1 (UN, et al. 2014a)

- 2.47. Extensions are required to the structure of the monetary supply and use table to enable the recording of flows to and from the environment. The extensions involve the addition of an “Environment” column and the addition of two rows for “Natural inputs” and “Residuals”. The equality between total supply and total use – applied to each product, natural input and residual flow – remains in physical terms, supported by the law of the conservation of matter.

Table 2.3 Basic form of a physical flow account

	Industries	Households	Accumulation	Rest of the world	Environment	Total
Supply table						
Natural inputs					Flows from the environment	Total supply of natural inputs
Products	Output			Imports		Total supply of products
Residuals	Residuals generated by industry	Residuals generated by final household consumption	Residuals from scrapping and demolition of produced assets			Total supply of residuals
Use table						
Natural inputs	Extraction of natural inputs					Total use of natural inputs
Products	Intermediate consumption	Household final consumption	Gross capital formation	Exports		Total use of products
Residuals	Collection & treatment of waste and other residuals		Accumulation of waste in controlled landfill sites		Residual flows direct to environment	Total use of residuals

Dark grey cells are null entries in conceptual terms.

Source: SEEA Central Framework, Table 2.2 (UN et al, 2014a)

2.48. The extensions make it possible to account fully for flows of materials and energy where the flows are recorded in a common unit of measure. For example, flows of water from the environment, within the economy and back to the environment can be recorded in a physical flow account with a single measurement unit of cubic metres of water. Similarly, energy flows can be recorded in joules irrespective of whether the energy is carried in coal, timber, electricity, heat or food.

2.49. For the purposes of the SEEA AFF, the application of the monetary supply and use tables and physical flow accounts will usually be at the level of individual products – tracing the total supply and use of wheat, for example. This application of supply and use principles is not described in detail in the SNA or the SEEA Central Framework, but it is appropriate and can be completed in line with the general accounting principles and boundaries.

Asset accounts

2.50. Asset accounts (see **Table 2.4**) facilitate the recording of information on stocks of assets at the beginning and end of an accounting period, and changes in them during the accounting period. Monetary and physical asset accounts follow the same structure, the only difference being the inclusion of a row to record revaluations of assets in the monetary asset accounts.

Table 2.4 Asset Account

Opening stock of environmental assets
Additions to stock
Growth in stock
Discoveries of new stock
Upward reappraisals
Reclassifications
<i>Total additions of stock</i>
Reductions of stock
Extractions
Normal loss of stock
Catastrophic losses
Downward reappraisals
Reclassifications
<i>Total reductions in stock</i>
Revaluation of the stock*
Closing stock of environmental assets

Only applicable for asset accounts expressed in monetary terms.

Source: SEEA Central Framework Table 2.3 (UN et al, 2014a)

- 2.51. The internal consistency of asset accounts is determined by the identity that the opening stock plus additions to stock less reductions in stock must equal the closing stock. This identity enables various data on stocks and changes in stock to be reconciled, and data gaps filled.
- 2.52. If the use of an asset involves a physical input to the production process – timber extraction, for example, is an input to the production of wood products – the relevant reduction in stock recorded in the asset account is conceptually equivalent to the flow of natural inputs recorded in the physical flow accounts. There are hence important connections between accounts, which must be taken into consideration in the compilation process. This aspect of accounting may be useful when the aim is to improve the measurement of economic activity for agricultural, forestry and fisheries activities. For example, where data on flows of natural inputs are available, the data quality may be assessed in terms of consistency with changes in the stock of relevant environmental assets.
- 2.53. Although asset accounts may be used to record stocks and changes in stocks of any type of asset, the SEEA Central Framework and the SEEA AFF focus on recording information on environmental assets: “Environmental assets are the naturally occurring living and non-living components of the Earth, together comprising the biophysical environment, which may provide benefits to humanity” (SEEA Central Framework, 2.17).
- 2.54. As explained in Chapter 5 of the SEEA Central Framework, this definition of environmental assets encompasses two perspectives on the measurement of these assets. The first perspective, which is adopted in the SEEA AFF, is to consider individual components of the environment such as resources of timber, soil, water, minerals and energy.
- 2.55. The second perspective is to consider environmental assets in terms of ecosystems, where ecosystems are defined in relation to areas in which individual resources and other environmental features interact through ecological processes. Ecosystem accounting involves measurement of the changing extent and condition of the ecosystem assets in a country, and the ecosystem services that each asset supplies. An approach to accounting for ecosystems in line with standard national accounting has been developed in the SEEA Experimental Ecosystem Accounting, but it is not yet developed with respect to agriculture, forestry and fisheries. In most cases, the measurement of individual environmental assets will be significant in the measurement of the extent and condition of an ecosystem. The

approach described in the SEEA AFF should therefore be seen as a key building block for the development of ecosystem accounting.

2.56. In the SEEA, environmental assets include both natural and cultivated biological resources: thus the asset boundary is not limited to only biological resources subject to human management. Given this boundary, the SEEA AFF asset accounts include measurement of livestock, plantation timber and stocks of farmed fish and aquatic resources, as well as non-cultivated timber resources, non-wood forest products and wild fish for capture. This broad concept of environmental assets is useful in understanding the changing structure of production. Following SNA 2008, cultivated biological resources may be classified as fixed assets or as work in progress, while non-cultivated biological resources are not treated as such, however they are recorded in the SEEA AFF. Treatment as fixed assets occurs for those biological resources that are used for breeding or provide outputs on an ongoing basis over time (e.g. dairy cows for milk, sheep for wool, vineyards for grapes). Treatment as work in progress arises when the biological resources are cultivated for future harvest. This includes plantation timber resources, crops, livestock raised for their meat and aquaculture.

2.2.3 Main accounting rules and principles

2.57. The recording of accounts requires a consistent set of accounting rules and principles. Without them, related transactions and flows may be recorded on different bases, at different times and with different values, thereby making accounting and reconciliation difficult and the information less useful.

2.58. The SEEA AFF follows the same accounting rules and principles as the SEEA Central Framework and the SNA, which are explained at length in those documents. To reduce the risk of alternative or unintended interpretations, they are not described in detail here. This section therefore sets out the main rules and principles of which SEEA AFF compilers should be aware, with supporting references to the SEEA Central Framework and the 2008 SNA as required.

Production boundary

2.59. The definition of production and the production boundary is a fundamental element of the SNA. The production boundary determines which activities should be included in the measurement of value-added, and hence defines the range of products that should be the focus of measurement. The definition of production also affects the scope of consumption and income that is measured in the national accounts framework (see Chapter 6 of the 2008 SNA).

2.60. In general terms, the production boundary is defined as including activities “carried out under the control and responsibility of an institutional unit that uses inputs of labour, capital, and goods and services to produce outputs of goods or services.” (SNA 2008, 6.24). The SNA then goes on to determine some specific treatments related to own-account production and other matters.

2.61. Consistent with the SNA, the production boundary applied in the SEEA AFF includes illegal production and informal, non-observed activity. Approaches to the measurement of this activity, which may be significant in some countries, have been developed for the improvement of national accounts measures (see *Measuring the Non-Observed Economy: A Handbook* (OECD, 2002)). Importantly for agriculture, forestry and fisheries activity, this part of production includes subsistence activity. This activity is commonly assumed to be excluded from the scope of the national accounts and GDP

since it is not the subject of market transactions, but, at least in concept, it is within the measurement scope.

- 2.62. There are issues concerning the application of the production boundary that do not arise in the SNA, but do arise in the context of the SEEA Central Framework and the SEEA AFF when recording physical flows. These largely concern flows internal to a single economic unit – often referred to as “own-account” production and consumption (see SEEA Central Framework Chapter 3 and section 3.4 of the SEEA AFF for discussion of the treatment of these flows for SEEA purposes).

Economic units

- 2.63. Accounting in the SNA and the SEEA Central Framework centres on recording the economic activities – production, consumption and accumulation – of economic or institutional units, which are defined and classified in various ways depending in part on the purpose of the analysis (see 2008 SNA Chapters 4 and 5 and section 2.6 of the SEEA Central Framework for the logic of defining institutional units). Institutional units are generally the focus of statistical collections since they are considered to be the entities with decision-making autonomy and hence have the capacity (and often the requirement) to record information on their activities.
- 2.64. Of particular relevance for the SEEA AFF, is that, in principle it will be appropriate to record information at a fine level of detail to provide specific information about the products and processes used by a given economic unit in a particular location. Thus, the recommendation is that estimates should be compiled based on the level of the local “kind of activity” unit (LKAU). This may be applied through direct collection at that level of detail, including via surveys of sampled units at the farm level or equivalent. Alternatively, it may be necessary to adopt more aggregated, top-down, measurement but the intent should remain to cover only the relevant LKAU.
- 2.65. Where a single institutional unit engages in a single economic activity, the concepts of an institutional unit and an LKAU will align. However, it is common for a single institutional unit to undertake a number of different activities (as classified within ISIC). For example, a farmer may both grow livestock fodder for sale and also raise cattle using some of the fodder.
- 2.66. Ideally, in this type of case, separate LKAU would be formed relating to each activity, with each LKAU classified to a different industry and separate sets of information collected in relation to each. However, in practice, it may not be feasible to make this separation and consequently, units will be recorded as producing multiple outputs – i.e. there will be secondary activities within a single unit.
- 2.67. To support analysis, especially for environmental-economic accounting, it is recommended that the process of defining LKAU be undertaken consistently across all collections whether in the collection of data in monetary terms or in physical terms. Consistent treatment of units, preferably completed in the context of a complete business register, is of great benefit in facilitating the integration of data. Further discussion of secondary production is presented in section 3.4.

Geographic boundary

- 2.68. To determine which economic units are within the scope of a set of national accounts, there are rules and conventions enabling the attribution of each economic unit to a particular country on the basis of the concept of residence (see 2008 SNA, Chapter 4). A country’s geographic boundary delineates its “economic territory”, which may differ from the territory encompassed by its customs boundary.

- 2.69. The scope of the SEEA AFF is consistent with a country's economic territory as applied in its national accounts. The application of this boundary for SEEA AFF purposes is generally straightforward, but challenges can arise in the context of fisheries activities in a country's exclusive economic zone and on the high seas (see SEEA Central Framework, section 5.9).

Asset boundary

- 2.70. The scope of assets is an important measurement boundary in the SNA and the SEEA. Chapter 10 of the 2008 SNA describes the definition and scope of assets, with a focus on the measurement of economic assets in monetary terms. The SEEA Central Framework applies the same asset boundary as the SNA for environmental assets measured in monetary terms, but applies a broader boundary in physical terms (see SEEA Central Framework, chapters 2 and 5). Asset boundaries for environmental assets are described in detail in the SEEA Central Framework, and the same boundaries are applied in the SEEA AFF.

Valuation concepts

- 2.71. Consistent valuation of stocks and flows is a central element of the SNA: without it accounting would not be possible, especially among multiple economic units. In this context the SNA applies a concept of "exchange values". Exchange values reflect the actual or observed price paid by a buyer to a seller, or the price that would have been observed had a transaction taken place (see 2008 SNA, chapter 3 and SEEA Experimental Ecosystem Accounting, chapter 5).
- 2.72. Other elements of valuation in national accounts are the treatment of taxes, subsidies and margins underlying price differentials experienced by buyers and sellers. Concepts such as basic prices, producer prices and purchasers' prices are explained in chapter 6 of the 2008 SNA and section 2.7 of the SEEA Central Framework.

Recording principles

- 2.73. To ensure that data from a variety of sources can be integrated and reconciled, various recording principles must be applied. These include double-entry and quadruple-entry accounting, the length of the accounting period, the time of recording, and accounting identities such as the supply and use identity (see chapter 3 of the 2008 SNA and chapters 2 and 3 of the SEEA Central Framework).

Use of standard classifications

- 2.74. The use of standard classifications in different parts of the accounting system enables the integration of data from various sources, and allows for easier and more valid comparisons. Three classifications are fundamental to the accounting in the SNA and the SEEA: i) classification of institutional sectors (see chapter 4 of the 2008 SNA); ii) classification of economic activities/industries (see ISIC, Rev. 4); and iii) classification of products (see Central Product Classification [CPC], Rev 2.1). Countries and regions will often develop versions of ISIC or CPC with detailed classes reflecting particular features of their economies, but all countries apply the high-level classifications for industries and products described in ISIC and CPC. There are additional classifications relating to exported and imported products, and correspondences between them and the CPC have been developed.
- 2.75. SEEA AFF data domains and base accounts are also consistent with the classifications and classification principles discussed for physical flows in the SEEA Central Framework,

as they cover items that are well identified in those classifications. Besides products, these classifications cover natural resource inputs, natural resource residuals (i.e. natural resource inputs that do not subsequently become incorporated into production processes and, instead, immediately return to the environment), as well as other residual flows (i.e. flows of solid, liquid and gaseous materials, and energy that are discarded, discharged or emitted by establishments and households through processes of production, consumption or accumulation).

- 2.76. These are the main elements of the accounting rules and principles relevant to the compilation of SEEA AFF accounts. It is possible that additional accounting issues will be encountered in the compilation of SEEA AFF base accounts. The resolution of these issues will require further consideration and interpretation among relevant experts.

2.3 SEEA AFF base accounts

2.3.1 SEEA AFF physical flow accounts

- 2.77. The ten physical flow accounts in the set of SEEA AFF base accounts are intended to ensure that data in each relevant domain – crop production, for example – is accounted for consistently across the various elements of supply and use. The base account will in each case require that the total supply of a product – output plus imports – is equal to the total use of that product in terms of intermediate consumption, final consumption, gross fixed capital formation and changes in inventories or exports.

- 2.78. In addition to ensuring data consistency in a domain, the use of physical flow accounts connects the supply and demand sides of agricultural, forestry and fisheries activity. This facilitates the analysis of demand factors such as increasing population or increasing standards of living that may drive changes in production.

- 2.79. There are two kinds of SEEA AFF physical flow accounts. In the first kind, where the focus is on agricultural, forestry or fisheries products or on non-natural inputs to production such as inorganic fertilizers and pesticides, the focus is on recording the supply and use of individual products such as wheat, timber and fertilizer. This kind of account mirrors the structure of monetary supply and use tables because no flows of natural inputs or residuals are recorded, and no column to record flows to and from the environment is required.

- 2.80. The second kind of physical flow account concerns flows related to water, energy and emissions, and in this case the structure of the base accounts resembles the physical flow accounts described in the SEEA Central Framework.

- 2.81. With regard to the product-specific physical flow accounts it is reasonable to conclude – given the link between the structure of these accounts and monetary supply-and-use tables – that data in the physical flow accounts should be aligned with the corresponding data recorded in monetary terms in standard national accounts. For example, the output of wheat recorded in tonnes and the output of wheat recorded in monetary terms should be aligned. The extent of alignment will be reflected in the prices received by wheat producers for their output.

- 2.82. Although some physical data will be used in compiling the monetary estimates of national accounts, there is usually no regular balancing of supply and use in physical terms for particular products. Such balancing, as proposed in the context of the SEEA AFF, will probably lead to improvements in the compilation of national accounts estimates in monetary terms and in the physical flow accounts themselves.

- 2.83. One situation in which physical flows of certain products are balanced is through the compilation of food balance sheets. The accounts are intended to determine overall human consumption of all food items in tonnage and calorie terms to enable assessment of nutrition levels in different countries. The conventions applied by FAO in compiling food balance sheets are different from those used in standard national accounts and the SEEA, but they are similar in the sense that they reconcile the total supply of food with its use. Reconciliation of food balance sheet estimates with related work in monetary terms for national accounts does not usually take place.

2.3.2 *SEEA AFF asset accounts*

- 2.84. There are ten asset accounts in the SEEA AFF. Their main purpose is to organize data on stocks of environmental assets in a specific data domain. The structure of the asset accounts follows the SEEA Central Framework.
- 2.85. The asset accounts in the SEEA AFF may be compiled in both monetary and physical terms. The focus of the discussion in chapters 3 and 4 is on asset accounts in physical terms – e.g. in terms of hectares of land, cubic metres of timber and head of livestock. It is recommended that SEEA AFF compilers focus initially on organizing relevant physical data: i) because these data are usually a prerequisite for valuing environmental assets, many of which have no observed market prices as they are not traded in markets; and ii) because much is to be gained from consideration of physical stocks in assessing the sustainability of production and related productivity-type relationships. At the same time, there can be important benefits in generating valuations of these assets and relevant references to the SNA 2008 and the SEEA Central Framework are noted in the relevant sections.
- 2.86. Like the SEEA Central Framework, the SEEA AFF asset accounts cover natural and cultivated environmental assets. The distinction, which originates in the SNA, involves distinguishing between assets created in a process of production and assets that occur naturally. Examples of cultivated assets in agricultural, forestry and fisheries activity include livestock, orchards, vineyards, oil palm plantations, aquaculture and plantation forests. All of these have a high level of economic activity associated with the establishment, growth, production and eventual use of the assets. Examples of natural assets include land and soil, marine fish stocks, natural forests and wild animals that may be hunted for meat or other products.
- 2.87. Section 5.2 of the SEEA Central Framework provides various considerations to assist in making the often difficult distinction between cultivated and natural assets. However, because the asset accounts comprise both types of environmental asset, the exact distinction is less important than the primary intention of tracking changes in the way environmental assets are managed over time, for example from natural to plantation timber or from capture fisheries to aquaculture.

2.3.4 SEEA AFF other economic data

- 2.88. The term “other economic data” refers here to data that would generally be reported in monetary terms in standard national accounting datasets. For the purposes of the SEEA AFF, two particular aspects of national accounting are considered.
- 2.89. First – economic data describing the supply and use of agricultural, forestry and fisheries products in monetary terms. For a given product, such as wheat, the base account covers data on output, imports and exports, intermediate consumption, final consumption, gross fixed capital formation and changes in inventories. These data may be available in national input-output or supply and use tables, though generally only for major products or groups of products. In conjunction with the physical flow accounts for agricultural, forestry and fisheries products, the data support a fairly full assessment of the links between production and demand because they can be used to examine the effect of prices.
- 2.90. Second – extended production and income accounts for agricultural, forestry and fisheries activities and products are described, initially at a broad activity level. This kind of account brings together information on output, intermediate production costs in terms of inputs such as fuel, seed, fertilizer or water, and compensation of employees and hence reflects a production function. From these items the gross value added can be derived as the difference between total output at basic prices and intermediate consumption at purchasers’ prices. Gross value added can be further broken down into gross operating surplus and gross mixed income – profits – compensation of employees and taxes less subsidies on production and imports.
- 2.91. Other economic data can be incorporated such as estimates of employment and hours worked (recognising that in these activities the contributions of self-employed and non-salaried workers may be significant), gross fixed capital formation and consumption of fixed capital – that is, investment and depreciation – and payments of interest and rent. These data can be used in the derivation of indicators of profitability and productivity.
- 2.92. In theory, production functions can be defined at the levels of: i) activities such as cropping, fisheries and forestry; ii) individual products such as rice, tuna or beef; and iii) production processes for specific products such as paddy rice, extensive grazing or organic farming. In practice, however, the level of detail will be limited by the ability to attribute production costs to individual products and processes, for example employment and management costs. For the SEEA AFF, the proposals in Chapter 4 constitute a basic level of information; decisions as to the level of detail at the national level should be based on data availability, policy and analytical relevance.
- 2.93. In some countries, the role of taxes and subsidies relating to agricultural, forestry and fisheries activity may be important. The national accounts framework provides for the recording of information on these flows.

2.4 Accounting issues

2.4.1 Introduction

- 2.94. Among the accounting challenges in developing the range of base accounts, five are of cross-cutting relevance: i) scoping the products of agriculture, forestry and fisheries; ii) treatment of own-account production and use; iii) treatment of secondary production; iv) treatment of natural and cultivated assets; and v) treatment of changes in inventories, losses and waste. This section discusses these issues in line with the general accounting principles and treatments in section 3.2.

2.4.2 Scoping of products

- 2.95. The outputs from agricultural, forestry and fisheries activities are a common starting point for many supply chains in an economy – food, raw materials and energy for example. It is therefore important for the SEEA AFF to determine the scope of products for inclusion in the accounting framework.
- 2.96. The starting point in defining the scope of SEEA AFF is the set of products that are the primary outputs of economic units classified in ISIC, rev. 4, section A – agriculture, forestry and fisheries – and reflected in Section 0 of the Central Product Classification, rev. 2.1. The following ISIC groups (**Table 2.5**) are within scope of the SEEA AFF. For groups 016 and 024 – support activities to agriculture and forestry – there is generally no production of goods that would be reported in physical supply and use tables but the activity of these groups is included in the monetary accounts described in section 3.10.

Table 2.5 Scope of the SEEA AFF activities by ISIC Division and Group

ISIC Division	ISIC Group
01 Crop and animal production, hunting and related service activities	
	011 Growing of non-perennial crops
	012 Growing of perennial crops
	013 Plant propagation
	014 Animal production
	015 Mixed farming (of crops and animals)
	016 Support activities to agriculture and post-harvest crop activities
	017 Hunting, trapping and related service activities
02 Forestry and logging	
	021 Silviculture and other forestry activities (Forestry)
	022 Logging
	023 Gathering of non-wood forest products
	024 Support services to forestry
03 Fishing and aquaculture	
	031 Fishing
	32 Aquaculture

- 2.97. Based on this scope there are some important implications regarding the structure of the physical flow accounts described in Chapters 3 and 4. In the case of crops, the product scope reflects harvested outputs – wheat, rice, apples or palm oil for example.
- 2.98. With regard to livestock rearing, a distinction is made between the managed raising of animals and the products obtained. The output of raising and breeding animals is part of agricultural production. Generally, products obtained from the killing of animals – meat and hides for example - are considered to be outputs from manufacturing processes rather than the output of agriculture. Other products obtained from livestock including milk, eggs, honey and wool are considered to be the output of agriculture. To support analysis, all of these types of output are included in the SEEA AFF physical flow accounts although it is recognised that the production of meat is a specific exception (for details see Chapter 3).

- 2.99. The capture of animals from the wild through hunting and trapping is a distinct product. It includes for example, animals hunted for bush meat. While conceptually in scope of the SEEA AFF, these products have not been included in the physical flow accounts in Chapter 3 but extensions could be made as appropriate.
- 2.100. A distinction is made between forestry, where the output is the growing of trees, and logging, where the output is felled timber in the form of roundwood. The outputs from both forestry and logging are included in the relevant physical flow accounts. Products made from timber are considered outputs of the manufacturing industry and are excluded from the scope of the SEEA AFF.
- 2.101. The gathering of non-wood forest products including mushrooms, berries, rubber, cork and other products (including for medicinal purposes) is a distinct activity within forestry and logging. While conceptually in scope of the SEEA AFF, these products have not been included in the physical flow accounts in Chapter 3 but extensions could be made as appropriate.
- 2.102. The products from plant propagation (ISIC 013) and from forest nurseries (part ISIC 021) are not included in physical flow accounts.
- 2.103. For fisheries activity, the output in the scope of SEEA AFF is equal to the harvest of fish and aquatic products, whether from capture fishing or from aquaculture.
- 2.104. For analytical purposes it may be of particular interest to understand a more complete supply chain from the outputs of agriculture, forestry and fisheries through the manufacturing, transportation, wholesale and retail industries. The SEEA AFF does not attempt to cover this broad scope, although some initial steps in this direction are included in relation to crops and livestock products to support the recording of information relevant to the assessment of nutrition.

2.4.3 Recording of intra-unit flows

- 2.105. Associated with determining the scope of products is determining which flows of products should be recorded in the accounts. This question arises because not all flows of products occur in the context of transactions between separate economic units since not all units undertake a single activity. For example, one unit may both manage the growth of a forest and also log the timber, or a unit may use milk produced on the farm to raise calves. The treatment of so-called intra-unit flows has been discussed at length in the development of the European Economic Accounts for Agriculture and the SEEA AFF adopts the conventions that have been determined.
- 2.106. In relation to physical flows, the conceptual starting point is that the recording should be “exhaustive”. Thus, ideally all physical flows of all products both between economic units and within economic units should be recorded. It means that if a product is retained for use within the same activity, in the same unit, then the relevant physical flows should be recorded in gross terms. A good example is the retention of seeds (for example from rice or wheat) for use in future crop growing. The application of this treatment means that, in physical terms, the total production is recorded, not only that amount which is used in other activities (e.g. feeding livestock), exchanged with other units or otherwise used.
- 2.107. In relation to monetary flows, the intra-unit, intra-activity flows just described are not recorded since it will generally not be possible to place observed values on flows within an economic unit and since the recording of intra-unit flows representing, simultaneously, an output and an input, adds no information content in the estimation of value-added. The boundary between intra- and inter- activity is defined at the ISIC group level as per **Table 2.5**

- 2.108. In practice, the ability to collect data at these levels of detail will vary depending on the nature of the production processes that exist within a country and the resources available for data collection. A key factor will be the capacity to separately distinguish different types of activity that take place within a given economic unit. Ideally, each different activity (where different activities are determined at the ISIC Group level) would be considered as a separate LKAU (see Section 2.2). Where this is not possible, the treatment relevant in the context of recording secondary production will need to be taken into account (see Section 2.4.6).

2.4.4 Treatment of own-account production and use

- 2.109. Own-account production and use, a feature of most economic activities, occurs when a single economic unit produces a particular good or service that is used within the same unit rather than sold to another unit. In physical terms, in line with the discussion above, all flows of own-account production should be recorded. However, in monetary terms, if a single economic unit is responsible for several stages of production or transformation in the same activity, the usual national accounting treatment is to omit flows within that economic unit because they amount to internal buying and selling with no net addition to value-added.
- 2.110. There are two major exceptions to this in the standard national accounts. First, when the output is used by the same economic unit as part of its final consumption. This is relevant for the SEEA AFF in the case of subsistence agriculture and fisheries activities. If, for example, a farmer or fisherman grows food or fibre and uses that output in the household, the production and associated consumption should be recorded to ensure that estimates of production and consumption are not limited to products bought and sold or otherwise exchanged between economic units. This treatment also includes the products obtained from hunting, trapping and the collection of non-wood forest products. In many countries the estimates of own-account production in agriculture, forestry and fisheries may be substantial and should be appropriately recorded.
- 2.111. Second, when own-account production forms part of investment by the economic unit in produced assets – gross fixed capital formation. This can occur in two distinct ways. Where a farmer breeds dairy cattle or sheep for wool these livestock are treated in the national accounts as produced assets that deliver other outputs (milk, wool, etc.) over time. Breeding stock of farmers and in aquaculture are treated in a similar manner. Such “own-account capital formation” may be important in some situations, but if there are balanced patterns in the number of livestock the recording of the activity will be less important.
- 2.112. Separately, there may be situations where producers in these activities may, for example, build their own storage or processing facilities or invest in the construction of fences and holding facilities. It also applied in cases where land holder engage in land improvements which satisfy the definition of capital formation in the SNA, e.g. the construction of retaining walls and dams. In these various cases, this activity should be recorded as own-account capital formation.
- 2.113. In some cases, this activity will be investment that underpins the primary activity of the producer but in other cases it may be that the investment is used within a separate activity. For example, some logging activities also operate sawmills. Following the principle of recording according to LKAU, the investment related to secondary activity should be recorded separately.

2.4.5 Treatment of joint products

- 2.114. Consideration of the outputs of agricultural, forestry and fisheries activities has to this point focused on the production of individual outputs for individual plant and animal types. The growing of sugar cane, for example, is associated with the production of sugar, and the growing of fruit trees with apples.
- 2.115. But the growing of individual crops and rearing specific types of animals is increasingly leading to the production of more than one type of outputs. Growing sugar cane, for example, leads to the production of sugar, but the crop may be used to generate energy products. Generating multiple outputs from a single production process is known as the production of “joint products”.
- 2.116. It is not the intention here to describe all the variations of mixed and joint production technologies of agriculture, forestry and fisheries activities. New technologies, economic drivers and environmental constraints will continue to shift the production mix over time. From an accounting point of view, however, two key points emerge.
- 2.117. First, all joint products should be recorded as output from the producing unit. Using the sugar cane example above, both the quantity of cane used to produce sugar and the quantity of cane used to produce energy products should be included in the total production volume. Especially, where the mix of uses is changing over time, it is important to track these additional flows to understand the supply chains between these activities and other economic activities. Also, from an environmental asset perspective, any additional removal of biomass may reduce the availability of crop residues that can help to maintain the productivity of the soil.
- 2.118. Second, when processed quantities are converted into a raw material or live-weight equivalent, as is necessary to enable a balanced assessment of supply and use, it is necessary to ensure adjustments are made to the conversion factors to account for joint production. Thus, where there is a change in the mix of outputs and some sugar cane is used to produce energy, the conversion factor for refining must be amended.

2.4.6 Treatment of secondary production

- 2.119. Secondary activity is recorded when a distinct LKAU is not created to recognise that a single institutional unit is undertaking two different activities. In these cases, the institutional unit will be considered to conduct both primary and secondary activity and will be classified to the ISIC group/class of the primary activity.
- 2.120. The type of situation envisaged in section 2.2 in the discussion on economic units, was where a single unit was involved in two activities both within the same ISIC division – e.g. involved in both the growing of fodder and the raising of livestock. In this situation both the primary and secondary activities are within scope of the SEEA AFF. The recording of physical and monetary flows in these instances should follow the treatment described in section 2.4.3.
- 2.121. However, another dimension of secondary production from a national accounting perspective concerns cases where: i) an agricultural, forestry or fisheries unit creates other products, such as those relating to agro-tourism; or ii) an economic unit that is not principally involved in agriculture, forestry or fisheries activity produces output associated with those activities – e.g. a government research farm produces wool. In both cases there is a lack of homogeneity in production within the unit.
- 2.122. For the purposes of the SEEA AFF, the physical flow accounts should focus on the specific products, irrespective of the classification of the unit undertaking the production. Thus, in the physical flow accounts, (i) non-agricultural, forestry and fisheries products should be excluded and (ii) production of agricultural, forestry or fisheries products by units classified to non-AFF activities should be included. The

only exceptions to (i) concern the recording of some manufactured products from crop and livestock products that are included to support analysis of nutritional flows.

2.123. For the accounting in monetary terms, the recording of the supply and use of products should focus only on agricultural, forestry and fisheries products (see Section 3.10). However, for the purposes of compiling the extended production and income accounts (**Table 3.10**) if the secondary activity cannot be separately distinguished, i.e. through the formation of a distinct LKAU, then the estimates of the value of output, intermediate consumption and other variables should be recorded including both primary and secondary activities. This will ensure that this table reflects the total production and income attributable to those units classified to ISIC Divisions 01, 02 and 03 and hence aligns to the recording of other industry divisions in the broader national accounts.

2.124. The concept of secondary production discussed here is a national accounting concept and should be distinguished from the recording of other flows associated with agricultural, forestry and fisheries activity. Such other flows might include:

- the generation of ecosystem services from land managed by agricultural units – carbon sequestration, water regulation or landscape amenity for example;
- income earned from managing or restoring the land and ecosystems for environmental protection and conservation;
- income earned from selling hunting or fishing rights; and
- income earned from providing areas of land for generating renewable energy, for example by wind turbines, or for access to mineral and energy resources such as coal or gas.

2.125. All of these flows are outside the production boundary of the national accounts and their treatment varies according to the flow and nature of the transactions. In general terms for the SEEA AFF: i) the value of ecosystem services may not be fully accounted ii) income earned for restoring land will be treated as a subsidy or a current transfer; and iii) income earned from access rights will be treated as rent. Further details are given in Chapter 4 of the SEEA Central Framework.

2.126. Finally, the concept of secondary production should be distinguished from concepts of externalities and welfare effects that may be associated with agricultural, forestry and fisheries activity in the context of economic analysis. The information in the SEEA AFF should support the measurement of these effects, but it does not report on them directly.

2.4.7 Treatment of natural and cultivated biological resources

2.127. Perhaps the most important measurement boundary in national accounts is the production boundary. The definition of production helps to determine GDP and provides a context for the related concepts of income and consumption. A significant aspect of the definition of production in the SNA is the exclusion of natural processes that take place without human intervention, which is significant in the treatment of many stocks and flows associated with agricultural, forestry and fisheries activities.

2.128. In the SNA natural processes are distinguished from cultivated processes. Cultivated processes are those involving significant human input – labour and produced assets – in the growing of plants or animals. There is no definitive rule as to what constitutes a natural or a cultivated process for national accounting purposes. The important issue is the extent to which human activity influences the growing of the animals or plants.

2.129. The effect on the SEEA AFF base accounts is that distinctions should be made between products resulting from cultivation and management and those sourced from

natural environments. This distinction has different effects in the various activities (see Chapter 4).

2.4.8 *Treatment of changes in inventories, losses and waste*

- 2.130. A feature of agricultural, forestry and fisheries production is the various stages and time lags involved in growing, harvesting, distributing and storing the products produced. A number of economic units will be involved in the supply chain – primary producers, transport companies, manufacturers, wholesalers, retailers and finally households – each of which will hold changing quantities of each commodity. Given the nature of the products, a proportion will be lost through damage, spoiling or other causes, and changes in the quantities held will vary because of changes in production and demand over time.
- 2.131. In the SNA these changes in quantities held are recorded as part of “change in inventories” when the quantities involved are considered recurrent or expected. Significant, or large one-off changes, e.g. due to a catastrophic storm, should be treated as “other changes in volume”. The discussion in this section is focused on the treatment of recurrent losses.
- 2.132. A single entry in monetary terms to cover all possible reasons for change in inventories is satisfactory for the purposes of macro-economic statistics. However, a breakdown into different components is required for accounting in physical terms to provide a more complete set of information for analysis. The focus in the SEEA AFF is the quantities of a product that are lost or otherwise not finally consumed through the supply chain.
- 2.133. The SEEA Central Framework (section 3.2.4) provides a framework for the accounting for losses. It notes four types of losses (i) losses during extraction; (ii) losses during distribution; (iii) losses during storage; and (iv) losses during transformation (which applies only to flows of energy). The principles for the recording of losses described in the SEEA Central Framework apply also in the SEEA Central Framework.
- 2.134. For the SEEA AFF, losses at three stages in the supply chain are identified. First, losses that take place during primary production such as felling residues in forestry², discarded catch in fisheries and pre-harvest losses in agriculture, for example when crops are not harvested because of low prices or adverse weather. These losses are not measured regularly as a rule, and most estimates of output are made on a net production basis – that is, the quantities sold or otherwise supplied by the producing unit to other units. These losses should ideally be recorded, however, because they may indicate levels of efficiency in the use of land, water, forests and fish stocks. At the same time, some level of loss during production is to be expected.
- 2.135. Second, there are losses between the point of the product leaving the producing unit – “the farm gate” – and the point of final consumption or the point of processing into other products. Such “post-harvest losses” of agricultural, forestry and fisheries products are important considerations in countries where transport, distribution and storage infrastructure is less developed. With regard to products that are ultimately sold “fresh” – fruit, vegetables, meat and fish for example – post-harvest losses should include the losses of retailers who do not sell the products or must discard them. Note that the separate identification of post-harvest losses is limited to cases in which there is minimal transformation of the originally harvested product – i.e. it primarily applies

² Note that felling residues are different from natural losses of timber resources that occur through disease, fire, windfall, etc. These changes are accounted for in the asset account for timber resources.

to crops and fish products. Losses that arise during the manufacturing and other transformation processes are not accounted for in this item.

- 2.136. Third, there is “food waste”. In the SEEA AFF this refers to losses within households when products are discarded. Household consumption in national accounting terms is equal to the quantity of commodities purchased or otherwise acquired, not the quantity ultimately consumed. It is therefore relevant to partition estimates of household consumption in physical terms into food waste and quantities consumed.
- 2.137. While losses at three stages are identified, these three types of losses are not considered to represent an exhaustive coverage of losses related to agricultural, forestry and fisheries activities and the associated supply chain. Consistent recording of these losses can provide information for determining policy to reduce losses and increase the effectiveness and productivity of agricultural, forestry and fisheries activity.
- 2.138. In addition to recording losses relating to agricultural, forestry and fisheries products, there may also be interest in accounting for losses of various inputs such as water and energy associated with agricultural, forestry and fisheries activity. Accounting for these losses is not discussed in SEEA AFF but relevant explanations are contained in SEEA Water and SEEA Energy.
- 2.139. There are important links between the treatment and recording of losses and the treatment of joint production as economic units find ways to use materials that might previously have been discarded. More generally, an important area of research is a more complete and consistent articulation of losses, unused biomass, residues, waste, reuse and recycling in relation to biomass.

2.4.9 Issues concerning measurement units and aggregation

- 2.140. The aim of national accounting approaches such as the SEEA AFF is to provide country-level descriptions of relevant trends. Because the descriptions are not usually obtained from direct measurement, information must be aggregated from different sources and breakdowns of data. In national accounting, aggregation is usually a matter of converting stocks and flows into monetary terms and aggregating on the basis of relative prices. Where markets exist, the relevant values of stocks and flows can be observed directly or estimated on the basis of observed transactions.
- 2.141. The use of monetary aggregates is particularly useful as it gives an insight into the relative value that different economic units place on various stocks and flows. Such assessment is possible because the use of a single currency enables comparison across many variables that may not be comparable in physical terms. Thus it allows for assessment of production, incomes, wealth and its distribution, and various other economic concepts in a meaningful manner. In the context of agriculture, forestry and fisheries, an understanding of stocks and flows in monetary terms and the associated prices supports understanding the effect that changes in supply and demand for products has on incomes and production. It also facilitates the analysis of these in a broader, economy-wide context.
- 2.142. At the same time, there are some analytical questions that may be best measured in physical units. For example, for understanding requirements for transportation and storage measurement in physical units such as tonnes or cubic metres is appropriate. Also, in the management of production processes it will be the volume of water or area of land that will represent the key factor in producing a quantity of wheat. For this reason, there is much analytical value in understanding the physical flows involved in production.

- 2.143. However, the aggregation of physical flows needs to be undertaken with caution. Certainly, it is inappropriate to aggregate estimates measured using different measurement units. In this respect accounting identities (for example the balance between supply and use) only hold when a single measurement unit is used. However, even when using the same measurement unit, the meaningfulness of the aggregate should be considered carefully. Thus, understanding the total tonnes of food produced may not have any specific correlation to the available nutrition from that food. Particular care is needed in relation to flows of pesticides. Measuring and aggregating the active ingredients of pesticides in tonnage or monetary terms gives no indication as to the toxicity of the pesticide.
- 2.144. The important point for the SEEA AFF is that the use of an accounting framework supports the use of alternative measurement units and is a platform for discussion of alternative aggregation approaches.
- 2.145. Another common type of macro-level comparison is comparison among countries. For national accounts data in monetary terms, the best approach to comparison is the use of purchasing power parities, which take into account the different mixes of production and consumption in a country, rather than the use of exchange rates or similar methods.
- 2.146. For comparisons among countries in physical terms, per capita measures or per hectare measures will usually be needed to take into account differences in population and area between countries. As with aggregation and comparison among stocks and flows within a country, the appropriate analytical question must be defined, and the appropriate measurement basis selected.

2.5 SEEA AFF combined presentations

2.5.1 Introduction

- 2.147. Chapter 6 of the SEEA Central Framework describes ways in which environmental and economic data may be integrated. An approach described in the SEEA Central Framework section 6.3 is the compilation of combined presentations that integrate monetary and physical information. They are not strictly accounts in that the information they contain does not need to be in the same measurement units, and not all entries in a physical flow or asset account need be translated into a combined presentation.
- 2.148. Combined presentations are valuable mechanisms whereby various data on a particular theme or topic can be presented together, and not scattered through different accounts. Section 6.5 of the SEEA Central Framework provides examples of combined presentations for energy, water, forest products and air emissions, which give an insight into the possibilities.
- 2.149. In the context of the SEEA AFF, the cross-cutting nature of a set of economic activities and the range of environmental and economic information constitute a powerful rationale for developing combined presentations. A number of alternatives structures exist: this section presents five SEEA AFF combined presentations. The first four presentations are linked to individual policy themes as described in Chapter 2. The selection of themes and variables does not reflect a standard presentation but rather should encourage compilers and users to imagine alternative uses and applications of accounting data.
- 2.150. The Reference Combined Presentation is designed to support implementation of SEEA AFF. It is considered a standardised, Tier 1 type, combined presentation. It is intended to provide an indication of the type of detail and coverage relevant when

commencing a program of work on SEEA AFF. This combined presentation is described in section 2.5.3 along with a discussion on the tiered approach to implementation.

2.5.2 SEEA AFF thematic combined presentations

- 2.151. **Table 2.6–2.9** show combined presentations relevant to four policy and analytical themes: i) activity-specific and product-specific inputs; ii) food product consumption and waste; iii) sustainable use of environmental assets; and iv) cross-industry and cross-activity perspectives. They are designed to indicate the potential of combined presentations to bring together data for analysis and support the derivation of indicators. They also show that a range of issues may be considered once a sound underlying database of accounts is compiled. In this sense the SEEA AFF base accounts should not be considered policy-specific. Depending on the issue, different information from the same base account may be relevant.
- 2.152. In the combined presentations, the rows show selected agricultural, forestry and fisheries products or activities. The structure and coverage of these activities and products depend on the issues under consideration. An emphasis in the SEEA AFF is providing information for specific products rather than product groupings: maize, wheat and rice, for example, are shown rather than a “cereals” product group.
- 2.153. The combined presentations that follow are not standard reporting tables. The choice of products is provided as an example. In practice, countries should incorporate the variables and products most relevant to the issue under consideration, using these examples as a starting point.
- 2.154. If required, additional rows within a product group may be added to distinguish different production processes such as capture fisheries and aquaculture, or organic farming and irrigated agriculture. The design of combined presentations is flexible enough to take account of different views, but the implications for the design of the underlying base accounts and the availability of data must be borne in mind.
- 2.155. The combined presentations do not conform to accounting identities. Thus, it will be possible to aggregate different rows and columns in some parts, but not in others. In practice, this is reflected in the fact that the measurement units applied will vary through the table.
- 2.156. The information in the combined presentations can be drawn in large part from the underlying SEEA AFF base accounts (see **Figure 3.1 *Forestry concepts***) The definitions of the data items are hence consistent with the data items defined for the base accounts. For the combined presentations shown in **Table 2.6 - Table 2.9**, data item definitions are provided in Chapters 3 and 4.

Table 2.6 SEEA AFF Combined presentation: Activity and Product specific inputs

SELECTED KEY PRODUCTS ONLY	Economic variables					Environmental variables								
	Ouput		Exports	Imports	Employment	Land use		Use of Irrigated Water	Energy use in agriculture	GHG emission (CO2 eq.)	Use of inorganic fertilizer (tonnes)			Use of pesticide
	(tonnes)	(currency units)	(tonnes)	(tonnes)	(000 people)	Opening stock (ha)	Net Change (ha)	(cubic metres)	(terajoule)	(gigagrams)	N	P	K	(tonnes)
Agricultural products														
Crop products														
Maize														
Rice														
Wheat														
Palm oil														
Sugar														
Potatoes														
Fodder														
Other food crops														
Other non-food crops														
Total														
Livestock products														
Livestock raising														
Eggs														
Raw milk														
Honey														
Other livestock products														
Total														
Other agricultural products														
Total Agriculture														
Forestry products														
Forestry														
Logging														
Other forestry products														
Total Forestry														
Fisheries products														
Aquaculture														
Capture fisheries														
Total Fisheries														

Table 2.7 SEEA AFF Combined presentation: Food production and consumption

FOOD PRODUCTS	Household consumption variables			Supply and use variables					Environmental variables (inputs to production)		
	Food consumption/Nutrition			Ouput	Exports	Imports	Intermediate use	Changes in inventories	Land use		GHG emission (CO2 eq.)
	Household final consumption (tonnes)	of which: Food waste (000 tonnes)	Kcal/per capita/per day	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes) of which: post-harvest losses (tonnes)	Opening stock (ha)	Net Change (ha)	(cubic metres) (gigagrams)
Agricultural products											
Food Crops											
Maize											
Rice											
Wheat											
Palm oil											
Sugar											
Potatoes											
Other food crops											
Total											
Meat products											
Cattle and buffalo meat											
Sheep and goat meat											
Pig meat											
Chicken meat											
Other meat											
<i>Total Meat</i>											
Other Livestock Products											
Honey											
Milk											
Eggs											
Total livestock products											
Fisheries											
Aquaculture (by type of fish)											
Capture fisheries (by type of fish)											
Total Fish and aquatic products											

Table 2.8 SEEA AFF Combined Presentation: Use of environmental assets

ACTIVITY	Ouput (tonnes)	Environmental asset variables						
		Land use	Soil resources	Water resources		Forest and timber resources	Fish and aquatic resources	Livestock numbers
		Opening stock (ha)	of which: used for organic production (ha)	Indicator of soil quality (e.g. measure of soil organic carbon)	Use of irrigated water (cubic metres)	Water abstracted as a share of renewable water resources (%)	(e.g. change in forest area)	(e.g. change in CPUE* indicator)
Agriculture								
Cropping								
Livestock raising								
Other agricultural activity								
Total Agriculture								
Forestry								
Forestry								
Logging								
Other forestry activity								
Total forestry								
Fisheries								
Aquaculture - inland								
Aquaculture - marine								
Capture fisheries - inland								
Capture fisheries - marine								
Total Fisheries								

Table 2.9 SEEA AFF Combined presentation: Cross industry and activity perspectives

ACTIVITY	Economic variables								Environmental variables				
	Output	Intermediate consumption	Subsidies	Value added	Exports	Imports	Gross fixed capital formation	Employment	Land use		Use of Irrigated Water	Energy use in agriculture	GHG emission (CO2 eq.)
	(currency units)	(currency units)	(currency units)	(currency units)	(currency units)	(currency units)	(currency units)	(000 people)	Opening stock (ha)	Net Change (ha)	(cubic metres)	(terajoule)	(gigagrams)
Agriculture													
Cropping													
Livestock raising													
Other agricultural activity													
Total Agriculture													
Forestry													
Forestry													
Logging													
Other forestry activity													
Total forestry													
Fisheries													
Aquaculture - inland													
Aquaculture - marine													
Capture fisheries - inland													
Capture fisheries - marine													
Total Fisheries													
Total Agriculture, Forestry and Fisheries													
Total Economy													

- 2.157. In the columns of the combined presentations, broad groupings of information are suggested – economic variables, consumption variables and environmental variables – each sourced from different base accounts. This is a strength of the SEEA AFF framework in that the use of common classifications and structures facilitates flexible integration of the information, whose coherence and consistency is assured because it is compiled through the base accounts.
- 2.158. The terms “economic” and “environmental” applied to general groupings are used only to give a sense of the type of information that might be included. The economic variables are those commonly measured in the SNA in monetary or physical terms, and the environmental variables are those primarily measured in physical terms relating to environmental assets and related physical flows.
- 2.159. Although they organize information on a large number of variables, the combined presentations shown here provide data for a single time period, and possibly for an average over a number of years. In addition to structural information, time-series data will be required to create a three-dimensional dataset: this is best managed in a database setting. In this sense the combined presentation will be helpful in suggesting the most useful content of an output database and the way in which it might be structured.
- 2.160. Combined presentations should enable the extraction of variables relevant to the derivation of indicators. Indeed, discussion of a combined presentation should assist in the design and selection of indicators of the environmental sustainability of agricultural, forestry and fisheries activity. To derive indicators, additional information – population data, for example – may have to be incorporated that does not pertain to any particular field in the combined presentation but is nonetheless relevant.
- 2.161. The combined presentations are structured to feature a single level of spatial aggregation at the national, sub-national or multi-national level. The facility for looking at several spatial areas – the different regions of a country, for example – may be relevant, particularly in relation to the sustainability of environmental assets. To compare spatial areas, additional layers of information will of course be needed.

2.5.3 SEEA AFF Reference Combined Presentation

- 2.162. In addition to these thematic combined presentations, a SEEA AFF “Reference Combined Presentation” has been designed to provide a focal point for discussion on the description and implementation of SEEA AFF. This combined presentation is based on consideration of those types of information that are considered to be available to form Tier 1 accounts, as described in Annex 1.
- 2.163. The structure of the Reference Combined Presentation is shown in **Table 2.10 SEEA AFF Reference Combined Presentation**. It provides a cross cutting perspective on a set of environmental and economic variables including, land, biological resources, outputs, intermediate and natural inputs, trade flows and residual flows.

Table 2.10 SEEA AFF Reference Combined Presentation

Assets										Inputs								Outputs				Trade flows								Population	Food availability		Environmental Impacts GHG Emission (CO2 eq) from Agriculture (gigagrams)
										Water Withdrawal (m3)	Energy Use (terajoules)	Synthetic Fertilizer			Organic Fertilizer			Pesticides	Actual Production (000 tonnes)	Gross Production Value USD million dollars (current)	Value added USD million dollars (current)	Total GDP USD million dollars (current)	Exports				Imports						
Land Area (000 ha)	Harvested Area (000 ha)	Biomass stock (million tonnes)	Number of Heads (Stock) (000 heads)	Producing Animals (000 heads)		N (000 tonnes)	P ₂ O ₅ (000 tonnes)	K ₂ O (000 tonnes)	N content (000 tonnes)	P ₂ O ₅ (000 tonnes)	K ₂ O (000 tonnes)							(m3)	(000 heads)	(000 tonnes)	USD million dollars (current)	(m3)	(000 heads)	(000 tonnes)	USD million dollars (current)								
TOTAL																														✓ (000)	Food (000 tonnes)	Food supply (Kcal/capit a / day)	
Agriculture																																	
Arable Land																																	
Permanent Crop																																	
Permanent Meadows and Pastures																																	
Crops Primary																																	
Cereals																																	
Roots and tubers																																	
Pulses																																	
Nuts																																	
Oil-bearing crops																																	
Vegetables																																	
Fruits																																	
Fibres																																	
Fodder Crops																																	
Sugar Crops																																	
Stimulants																																	
Spices																																	
Other crops																																	
Cattle and Buffaloes																																	
Beef and buffalos meat																																	
Milk																																	
Sheep and Goats																																	
Sheep and Goats meat																																	
Milk																																	
Pigs																																	
Meat, pigs																																	
Poultry Birds																																	
Eggs primary																																	
Meat, poultry																																	
Other livestock																																	
Meat, other livestock																																	
Forest																																	
Planted forest																																	
Primary forest																																	
Other naturally generated forests																																	
Game meat and edible forest products																																	
Wood Fuel																																	
Industrial Roundwood																																	
Sawlogs and Veneer Logs																																	
Pulpwood, Round and Split																																	
Other Industrial Roundwood																																	
Other forest products																																	
Water																																	
Inland water																																	
Coastal water (EEZ)																																	
Aquaculture products																																	
Fisheries products																																	

2.6 Aggregates and agri-environmental indicators

2.6.1 Types of indicators

- 2.164. Aggregates and indicators are the summary measures that emerge from an accounting framework, providing indications of status, trends and structural changes. These indicators can be compared to externally given reference levels, defined in the same way (as e.g. policy-given targets), as well as to benchmark values derived from within the system itself, such as e.g. averages of larger classes to which the units being evaluated belong. Given their comprehensive and internally consistent nature, accounting tables are designed to provide aggregates such as total water use or total wheat production that conform to the selected accounting boundaries.
- 2.165. Because accounting frameworks have embedded relationships between variables – for example between production and intermediate inputs or between income and assets – it is possible to derive indicators directly from the accounting tables themselves: examples include gross domestic product and net saving.
- 2.166. These aggregates and accounting indicators can be compiled and presented at various levels of classification depending on the data available, for example by industry or institutional sector. Where data are organized in a table reflecting a structured classification – production data classified by product or industry for example – descriptive statistics can be developed that highlight the structure of an economy or set of economic activities. Statistics showing the proportion of total agricultural output attributable to rice production are an example.
- 2.167. All these types of aggregates and indicators can be derived directly from base accounts. Because these accounts pertain to specific data domains, the indicators are limited to those domains, for example the share of water use by agriculture, net greenhouse gas emissions attributable to agriculture, or the agricultural shares of GDP and employment. In this context, the use of base accounts to organize information in a given data domain may seem to provide limited additional value in that the trends and relationships shown by in-domain indicators are unlikely to be significantly affected if the underlying data and statistics are placed in a supply and use table or asset account.
- 2.168. Following the SEEA Central Framework, the SEEA AFF recognises three broad groupings of indicators namely (i) descriptive statistics; (ii) environmental asset aggregates and indicators; and (iii) environmental ratio indicators, of which there are three specific types. These different types of indicator are described in detail in Annex 2.
- 2.169. The additional value of the SEEA approach generally, and the SEEA AFF approach in particular, arises when data are compared across domains. One of the main rationales for the SEEA is to facilitate the comparison of data across domains, particularly in comparing environmental stocks and flows with economic data such as production. Without common measurement boundaries and classifications, otherwise reasonable comparisons may often be misleading or flawed.
- 2.170. These cross-domain indicators are referred to in the SEEA as “environmental ratio indicators”, including productivity and intensity ratios, decoupling ratios and polluter-pays indicators (see Annex 2 for details). Environmental ratio indicators are particularly relevant to the SEEA AFF because in terms of policy development it is often the intensity of use of environmental inputs such as water, energy or pesticides relative to production that is of most interest, rather than the total amounts used.

2.6.2 Role of SEEA AFF in supporting the development and monitoring of indicator frameworks

- 2.171. One aim of the SEEA AFF is to provide the basis for an integrated, multi-domain dataset pertaining to agricultural, forestry and fisheries activities that will ensure that accurate environmental indicators can be derived, data gaps filled and any resulting additional indicators identified in a coherent manner.
- 2.172. Although a set of SEEA AFF indicators is not proposed, it will be clear from the structures of the combined presentations that the derivation of intensity indicators linking water use, fertilizer use, energy use, greenhouse emissions and land use in production, ideally at the product level, is envisaged in the design of a combined presentation. Further, by using the link between supply and demand for each product, these intensity indicators may be linked to consumption and calorie intake. Analysis of these types of ratios may provide insights for the development of policies on food production and distribution.
- 2.173. The discussion above assumes the cross-domain dataset to comprise economic and environmental variables such as production, trade, consumption, land use, water and energy. But, as the SEEA AFF list of data domains makes clear, there is a challenge in comparing stocks and flows across the agriculture, forestry and fisheries domains. Because the compilation of data in these activity domains does not usually follow similar methods and classifications, analysis of the trade-offs between them is difficult. The SEEA AFF applies the same accounting concepts and principles to the three activities to facilitate investigation of cross-cutting issues such as land use, water use and relative contributions to the provision of food, fibre and materials.
- 2.174. One reason for not providing a set of SEEA AFF indicators is to emphasize the principle that the SEEA AFF is a multi-purpose dataset that can be used to support multiple indicator sets and a variety of analysis. The SEEA AFF may be suited to supporting a generic set of agri-environmental indicators, but it should also be relevant in terms of providing information for a set of sustainable development indicators, for example in relation to food security, environmental pressure, production efficiencies, based on coherent compilation of the underlying relevant economic and environmental data.
- 2.175. First, FAOSTAT questionnaires, core statistics and derived agri-environmental indicators, the latter co-developed with EUROSTAT and OECD, are already fully aligned with the SEEA AFF (e.g., see Annex III).
- 2.176. Second, the FAO Global Strategy to Improve Agricultural and Rural Statistics core minimum dataset covering economic, social and environmental domains, could be derived in part using the SEEA AFF data framework.
- 2.177. Finally, considering the many links between the 2030 SDG Agenda with agriculture, forestry and fisheries themes, a number of SDG indicators could in principle be sourced from SEEA AFF-based datasets.

Chapter 3: Accounting for agricultural, forestry and fisheries production and associated biological resources

3.1 Introduction

- 3.1. This chapter describes the SEEA AFF base accounts pertaining to production by agricultural, forestry and fisheries activities and the associated biological resources. For each base accounts the chapter sets out: i) its purpose and scope and its links to other components; ii) the definition of accounting entries, accounting treatments and relevant classifications; and iii) areas of possible extension.
- 3.2. The accounting principles and treatments of the SNA and the SEEA Central Framework apply throughout, and any interpretation of accounting matters should refer to them. The national accounting treatments in the European Economic Accounts for Agriculture and Forestry (Eurostat, 2000) should also help to determine the treatment of individual products and practices in agriculture and forestry.
- 3.3. The SEEA Central Framework offers aflexible and modular design in responding to the resources available in a country and its policy requirements. In the context of the SEEA Central Framework, the interpretation of “modular” concerns the prioritization of accounts and themes – that is, whether priority should be given to for example, energy accounts, environmental protection expenditure accounts or land use accounts. Because the SEEA AFF has a cross-cutting perspective, its implementation cannot be modular in this way and, ideally, all of the relevant base accounts would be compiled in parallel.
- 3.4. Compiling such an extensive range of base accounts – even where the focus is on agricultural, forestry and fisheries activity rather than an entire economy – is a major undertaking. It should involve: i) a planning exercise to match expectations with available resources; and ii) an initial focus on a limited number of data domains that are most relevant to policy and for which data are readily available. This limited initial scope should enable the development of appropriate skills and accounting processes. The main lesson from the development of environmental-economic accounts over the past 20 years is that the optimum approach is to “learn by doing”.
- 3.5. This chapter, and the next, provide a starting point for those seeking to use an accounting approach to organizing information for the analysis of agricultural, forestry and fisheries activities. As experience accumulates with country work, further guidance and supporting material will be developed.
- 3.6. There is no expectation that each country will take the same steps to implementing the SEEA AFF or will structure particular base accounts in exactly the same way. Differences will emerge reflecting economic and environmental circumstance, data availability and policy priorities. Thus the descriptions in this chapter, as reflected in the design of the tables, do not reflect templates or questionnaires for the purposes of international reporting. In due course, reporting mechanisms may emerge and a core set of SEEA AFF
- 3.7.s and data items may be developed. An important aspect in the development of reporting mechanisms will be coordination among the existing reporting on agriculture, forestry, fisheries to international agencies and on related data domains, for example on water, GHG emissions and fertilizers.
- 3.8. This flexibility in table structure was designed with a view to facilitate comparability. Using the SEEA AFF with a focus on key products should ensure that different countries can use comparable approaches to their measurements are. Further, comparability among countries is practicable because aggregate information is sought

at the activity level and through the use of International Standard Classifications of Industries and Products, respectively ISIC and CPC.. Fundamentally, as with national accounting generally, it is the consistent use of the concepts and principles of the SNA and the SEEA Central Framework that provides the basis for international comparability.

- 3.9. The chapter is structured to provide a description of physical flow accounts for the outputs of agriculture, forestry and fisheries activities and asset accounts for the biological resources that underpin these outputs, i.e. plantations, livestock, forest and timber resources and fish and other aquatic resources. The focus of the account descriptions is on accounting in physical terms.
- 3.10. Accounting for these activities in monetary terms is described in Section 3.10. Two tables are described, a monetary supply and use table and an extended production and income account. The descriptions of these two accounts are relatively short since the accounting entries are equivalent to those described in the SNA and there is little advantage in repeating or synthesising the accounting text. These short descriptions are not intended to imply a lack of relevance of monetary information but rather recognise that from an accounting perspective the key challenge will be the integration of physical data to suit national accounting measurement principles.
- 3.11. The description of asset accounts in this chapter also focuses on accounts in physical terms, since it is the physical measure of the various biological resources that determine the scope for monetary valuation. At the same time, the sections describing asset accounts also provide references to relevant sections of the SNA and the SEEA Central Framework in which the accounting for biological resources in monetary terms is described.

3.2 Physical flow account for crops

3.2.1 Measurement purpose and scope

- 3.12. The physical flow account for crops records the supply and use of food and non-food crop products in physical terms, usually tonnes. For each product – rice, for example – the table records: i) total supply of the raw product from the agriculture industry and from the rest of the world; ii) total use of the raw product, for example intermediate consumption to the manufacturing sector or to export; iii) total supply of the processed product; and iv) total use of the processed product, including household consumption.
- 3.13. The recording of supply-and-use flows of crops in both raw and processed forms enables a link with household consumption of food products, and hence the information can support assessment of food security and nutrition. The supply-and-use approach ensures the internal consistency and coherence of data that are often collected from several sources. Confrontation and reconciliation of data from different sources is an important function of accounting frameworks.
- 3.14. The scope of the physical flow account is all crops. In most countries, however, the number of crop products often exceeds 100. Compiling a physical flow account covering more than 100 products in raw and processed forms is a considerable undertaking, especially because many will be insignificant in the assessment of overall production and environmental impact at the national level.
- 3.15. The SEEA AFF therefore suggests that countries develop physical flow accounts for crops that focus on the eight to ten most important crops. Selection is not straightforward, however: products may be important in terms of their share in total food production, their contribution to nutrition, their emerging contribution to bio-

energy production, their share of imports and exports or their use of environmental inputs such as land and water.

- 3.16. The focus on selected products is preferable at the national level because it is the basis for drawing together a range of data and promoting discussion on differences between products. An alternative approach – organizing data by major product groups such as cereals, roots and tubers – may provide data that are more comparable across countries, but they will be less useful for individual countries.
- 3.17. Some crops, particularly maize, are increasingly cultivated for energy rather than food; certain species are in fact grown for specific fuels. Where data allow, it may be relevant to distinguish between crop types used for food and non-food production. If only total production data can be obtained, it is probably more useful to record production for all purposes and show allocations to different uses separately.
- 3.18. Totals for all crops should also be compiled for variables such as output, imports, exports and household consumption. These estimates are relevant to the compilation of combined presentations, and they facilitate the monitoring of changing patterns in the supply and use of crops. If, for example, the difference between the total output of all crops and the output of the selected crops increases over time there may be a need to change the initial list of key products.
- 3.19. Physical flow accounts for crops used primarily for food can be compared with information in food balance sheets, which are used in some countries and by FAO to determine the composition of food consumed. The principles on which they are based are similar to the physical flow accounts described here, but different definitions of supply and use are applied. In the SEEA AFF, supply and use are defined to be consistent with the standard economic accounts and hence to enable straightforward comparisons with economic data, including data in input-output tables. Although total supply and use may be defined differently, in general the components of supply and use from food balance sheets can be used with little adaptation to compile SEEA AFF physical flow accounts.
- 3.20. The physical flow accounts described here are aligned with the accounts known as material flow accounts and physical input-output tables, which record all flows in an economy in physical terms. Information from such accounts may be useful in compiling physical flow accounts for crops.
- 3.21. Physical flow accounts for individual products or groups of products are not provided in the SEEA Central Framework. Section 3.6.2 sets out the possibility of physical flow accounts, but no tables or measurement advice are provided apart from noting the benefit of applying standard boundaries and definitions for natural inputs, products and residuals (see SEEA Central Framework, 3.232).
- 3.22. The recording of flows in monetary terms should be compiled consistently with the requirements of the SNA. Discussion and references are provided in Section 3.10.

3.2.2 Accounting entries

- 3.23. The physical flow account for crops, shown in **Table 3.1**, records the flows in physical terms for selected crop products; it is divided into the supply table and the use table. For each crop and in each row, the total supply must be equal to total use. The selection of products in the supply and use table is indicative, and does not represent a standard set of crop products. As discussed above, selection of the most important products is a matter for consideration at the country level. For instance, the top five or ten most important crops for national production could be chosen.

- 3.24. The SEEA AFF aims at distinguishing between agricultural activity and other economic activity, particularly manufacturing, in such a way that clear connections can be made between the outputs and inputs related to agricultural activity and information in standard economic datasets. This is reflected in the physical flow account for crops, where production of the agricultural industry (ISIC A) and the manufacturing industry (ISIC C) are shown separately and a distinction is made between raw and processed products.
- 3.25. Making this distinction is important, especially in the context of food crops, because the SEEA AFF aims to make the connection between the production of food crops and household consumption. Raw and processed products are recognized in the SEEA AFF because most crops are processed before household consumption, and because there are often alternative uses for crops such as utilizing maize to produce fodder and to generate energy.
- 3.26. In practice, understanding the relationships between raw and processed commodities is a challenge. Commodity “paths” or “trees” may be established to map linkages between different commodities, but this can also be challenging both initially and because these commodity paths will change over time.
-

Table 3.1 Physical flow account for crops (tonnes of raw commodity equivalent)

Physical supply table for crops								
	Output					Imports	Total supply	
	Gross production	Harvest losses	Agricultural industry		Manufacturing industry			
			Total	of which Household production				
Total Output								
Selected products*								
Maize (raw)								
Maize (processed)								
Rice (raw)								
Rice (processed)								
Wheat (raw)								
Wheat (processed)								
Palm oil (raw)								
Palm oil (processed)								
Sugar (raw)								
Sugar (processed)								
Potatoes (raw)								
Potatoes (processed)								
Fodder (raw)								
Fodder (processed)								
Other food crops (raw)								
Other food crops (processed)								
Other non-food crops (raw)								
Other non-food crops (processed)								

Physical use table for crops												
	Intermediate consumption					Household final consumption			Changes in inventories		Flows from the rest of the world	
	Agricul. Ind. (Feed)	Agricul. Ind.(Seed)	Generation of energy products	Food Processing	Non-food processing	Food consumption	of which: Food waste	Other uses	Post-harvest losses	Other changes in inventories	Exports	Total use
Selected products*												
Maize (raw)												
Maize (processed)												
Rice (raw)												
Rice (processed)												
Wheat (raw)												
Wheat (processed)												
Palm oil (raw)												
Palm oil (processed)												
Sugar (raw)												
Sugar (processed)												
Potatoes (raw)												
Potatoes (processed)												
Fodder (raw)												
Fodder (processed)												
Other food crops (raw)												
Other food crops (processed)												
Other non-food crops (raw)												
Other non-food crops (processed)												

* Selection of products is indicative to illustrate the logic of the accounting structure; countries will determine the actual key products for inclusion.

- 3.27. To record the raw and processed versions of each crop, a common basis for recording must be established. The proposed approach is to determine the “raw commodity equivalent” weight for each processed product. In the case of wheat, for example, the relevant weight of the processed product – bread – is not the total weight of the bread but the weight of unprocessed wheat required to produce it. This basis of recording enables a direct connection between production and food consumption.
- 3.28. Determination of raw commodity equivalent weights requires consideration of the actual proportion of raw commodity used as input into the processing stage. In cases where harvested raw commodities are used for different purposes – sugar cane, for example, is used to produce energy as well as sugar – allocations to the different uses must be made in terms of the total weight of raw commodity produced.

Supply table entries

- 3.29. To separate agricultural activities from other activities, the supply table distinguishes between total supplies of raw and processed products: the supply of raw products relates to production by the agricultural industry, whereas the supply of processed products relates to production by the manufacturing industry. The allocation of production to different industries is based on the relationships between products and industry set out in the ISIC. The aim is to show that when alignments with standard measures of economic activity are made there should be a clear separation of products and industries, reflecting a value-added chain from primary producers, to secondary and subsequent activities and finally to consumers.
- 3.30. The SEEA AFF does not aim to articulate the full value-added or supply chain associated with agricultural production; rather, it aims to identify the boundary around the first step in the chain from the agricultural industry to other producers. The second step in the chain will usually be the manufacturing industry, though in practice there will be many other players such as the transport, wholesale and retail industries that might be added to obtain a complete supply and use table for each product.
- 3.31. In the SEEA AFF, these additional steps are not recorded, and consequently the physical flow account for crops shows a stylized link between primary production and final consumption. The account nonetheless provides a basis for integration with economy-wide supply and use tables and input-output tables, which may be relevant in analysis of the agro-food industry, for example, or in tracking the chain of prices through the production-based and margin-based industries.
- 3.32. A particular link in the supply chain relevant to food consumption is the role of restaurant and related food services. In line with the paragraph above, the intermediate consumption of food products by the restaurant industry is not separately identified in the table and the measure of household final consumption includes the consumption of food products in restaurants in addition to those consumed at home.
- 3.33. Total supply is then given in two equations:
- i. Total supply of raw product = agricultural industry output + imports; and
 - ii. Total supply of processed product = manufacturing industry output + imports.
- 3.34. The entry for “output – agriculture industry” relates to total output and includes commercial and non-commercial production and production from kitchen gardens. Output estimates should be reported at the farm level and should include output for sale and barter and output consumed on own-account by the producing unit – subsistence agricultural production, for example.
- 3.35. Output excludes harvesting and threshing losses and the part of the mature crop not harvested for any reason. For analytical purposes such as studies of productivity

and efficiency, however, it may be relevant to include measures of gross output before such losses occur; in this case columns are included in the physical flow account for crops to record gross output and harvest losses. Agricultural industry output is defined as: Net output (farm gate) = gross output – harvest losses.

- 3.36. The entry for “output – manufacturing industry” in the physical flow account for crops is assumed to relate to economic units involved in the manufacture of food, beverages and tobacco products and relevant non-food products such as clothing.
- 3.37. In the physical flow account for crops, estimates of output by the manufacturing industry are based on assumptions regarding the source of products used in final consumption. Three final uses are considered as being supplied by the domestic manufacturing industry, and hence assumed to reflect the quantities of the raw product that are subsequently consumed as: i) household final consumption – food; ii) household final consumption – other uses; and iii) changes in inventories. These are defined below under Use table entries.
- 3.38. The estimate of output for the manufacturing industry is matched by entries reflecting the intermediate use of the raw product by the manufacturing industry (see below: Use table entries). The estimate for intermediate consumption for food and non-food processing also includes amounts used in the manufacture of products that are not attributed to the processed product.
- 3.39. Imports of crops consist of the purchase, barter or receipt of crop products by residents from non-residents. In principle, it includes commercial trade, donated quantities, and illegal or other unrecorded trade. Imports should be recorded in terms of raw commodity equivalent.

Use table entries

- 3.40. The entry for “intermediate consumption – agricultural industry feed” refers to the quantity of product used for feeding livestock and poultry during the reference period, whether it is domestically produced or imported. The quantities are assumed to be raw.
- 3.41. The entry for “intermediate consumption – agriculture industry seed” refers to the quantity of product used for sowing or planting, whether it is domestically produced or imported. The entry also includes quantities used for sowing or planting crops harvested for fodder. The quantities are assumed to be raw.
- 3.42. The entry for “intermediate consumption – generation of energy products” refers to the use of raw products by economic units for the generation by economic units of energy products such as fuel, heat or electricity. A distinction may be required between those crops grown solely for the purpose of the production of biogas and related energy products. In some cases, these may be considered output of the electricity supply industry (ISIC 35) rather than outputs of the agriculture industry.
- 3.43. The “intermediate consumption – food processing” entry refers to the use of raw products by economic units involved in the physical or chemical transformation of raw commodities into food and beverage products.
- 3.44. The entry for “intermediate consumption – non-food processing” refers to the use of raw products in the processing of non-food products.
- 3.45. The “household final consumption – food” entry refers to the total quantity of product consumed as food. It includes the product and any product derived from it by further processing. Food from maize, for example, comprises the quantity of maize, maize meal and any other maize product available for human consumption. All food for human consumption is assumed as consumed directly from the agricultural or

manufacturing industry: the movement of quantities of food products through supporting industries such as wholesale and retail networks or restaurants is therefore not recorded.

- 3.46. The aggregate for “household final consumption – food” includes amounts purchased or otherwise obtained by households. For some policy and analytical purposes, it may be relevant to make a separate measurement of the amount of household food waste.
- 3.47. The “household final consumption – other uses” entry is a catch-all for non-food uses of crop products.
- 3.48. The entry for “changes in inventories – post-harvest losses” refers to quantities of product lost through wastage during the year at all stages between the recording of agricultural output and final consumption, such as losses during storage and transport. Losses occurring before and during harvest should be recorded in “harvest losses”; waste generated from final consumption in households is excluded, but it is recorded in “household consumption”. Quantities lost during the transformation of raw products into processed products are taken into account in the assessment of extraction and conversion rates. Distribution waste can be considerable in countries where the climate is hot and humid or where transport, storage or processing facilities are inadequate, particularly in the case of perishable goods.
- 3.49. The “changes in inventories – other” entry reflects changes in holdings of crop products during the reference period at all stages between output and final sale of processed products. It comprises changes in government stocks and the inventories of manufacturers, importers, exporters, wholesalers, retailers, transport and storage enterprises and farms. It excludes changes in inventories resulting from post-harvest losses.
- 3.50. Exports of crops consist of the sale, barter or transfer of crop products by residents to non-residents. Processed commodity exports should be recorded in terms of raw commodity equivalent.

3.2.3 Measurement issues and possible extensions

- 3.51. Some issues related to the measurement of physical flows of crops require comment. First, the production of food for consumption by a farm household – subsistence agriculture – should be included in the scope of the accounts. Depending on the product or in-country circumstances, it may be relevant to provide an estimate of subsistence production separately from other production.
- 3.52. Second, where production or harvesting of crops is carried out in forest areas the output should be recorded in the physical account for crops or in other relevant tables such as meat production; this will depend on the product. This type of production would not be included in the accounts for forestry, which is limited to the production of timber. For analytical purposes it may be relevant in some countries to make a distinction between food and non-wood forest products.
- 3.53. Third, many crops are produced from plantations, vineyards and orchards. Information on the plantations themselves in terms of area or number of plants may be organized in the form of asset accounts (see section 4.5). Information about the area of plantations may also be included as rows in the land use account (see section 4.15).
- 3.54. Fourth, measuring the production of fodder for livestock may be challenging. In all cases where fodder crops are harvested for sale to other economic units, the production should be included under non-food crops. Where fodder is harvested, but retained on the producing farm to feed livestock, it should be included under production

of non-food crops and intermediate consumption by the agricultural industry. Where pastures are improved or fodder crops grown for grazing, the growth of plant material should not be considered as additional production, but the costs of inputs such as fertilizers, seed and water should be included in other accounts as appropriate.

- 3.55. The physical flow accounts for crops may be extended in various ways depending on data availability and analytical requirements. For example, incorporating information on the type of production process used to grow specific crops such as the use of irrigated and non-irrigated rice production or the use of organic farming practices.

3.3 Asset account for plantations

3.3.1 Measurement scope and purpose

- 3.56. The physical asset account for plantations shows the total area of plantations, by type, and changes over an accounting period. The corresponding SEEA land use classification is 'Land under Permanent Crops.' This information may help to clarify the mix of plantations and their share of land use. Because plantation-based agriculture may involve different production processes and generally operate over a long period of time, the information is relevant in understanding the potential environmental impacts of plantations.
- 3.57. The scope of the asset account is cultivated plantations, or permanent crops, excluding timber: that is, plants managed for a process of crop production by economic units. Forest plantations are instead included in the asset accounts for forests and timber resources. Plantations usually provide most of the associated crop products of economic interest as distinct from the same products harvested from the wild, and will usually be most relevant in assessing environmental impacts.
- 3.58. All plants of each type are included, regardless of age. The asset account should therefore show the area of plantations, increases resulting from planting and decreases caused by removal, natural death and losses from causes such as storm damage or disease.
- 3.59. The monetary asset account for plantations adopts the same scope as for the physical account. Plantations are considered cultivated biological resources in the SNA and the SEEA Central Framework and the accounting entries concerning these resources are discussed specifically in SNA 2008 paragraphs 10.88 – 10.96. Most commonly, plantations are treated in the SEEA AFF as fixed assets, following the SNA 2008, since they will be managed for their production of various crops harvested on a regular basis over time.

3.3.2 Accounting entries

- 3.60. The physical asset account for plantations is shown in **Table 3.2**. It records the opening and closing area of selected types of plantations and additions and reductions in stock over an accounting period. For each plantation type, the opening area plus additions less reductions must equal the closing area.
- 3.61. The information in the plantation physical asset account should be consistent with the information in the land use account.

Table 3.2 Physical asset account for plantations (hectares)

	Opening stock	Additions to stock			Reductions in stock				Net change in Stock	Closing stock
		Increases due to planting	Other additions to stock	Total additions	Reductions due to removal of plants	Catastrophic losses (storm, fire, disease)	Other reductions in stock	Total reductions		
Selected plantation types										
Orchards										
Vineyards										
Oil Palm										
Banana										
Olives										
Almonds										
Coffe										
Tea										
Rubber										
Total										

3.62. The “opening stock” entry records the total area held at the beginning of the accounting period.

3.63. The entries for “additions and reductions in stock” are to show reasons for changes in the total area of plantations over an accounting period. The main changes will result from additional planting, removal of plants because of age or economic circumstances for example, or catastrophic losses. If it is not possible to identify additions and reductions separately, an entry for “net change in stock” may be recorded.

3.64. The “closing stock” entry shows the area of plantations at the end of the accounting period. The closing stock of one accounting period constitutes the opening stock of the following period.

3.65. The monetary asset account for plantations follows the same structure as for the physical account with the exception that an additional column is incorporated to record revaluations of assets – i.e. those changes in the value of the stock of plantations over the accounting period that are due solely to changes in the prices of the assets. The generic asset account in monetary terms including revaluations is presented in SEEA Central Framework Table 5.3.

3.3.3 Measurement issues and possible extensions

3.66. Information about the area of plantations may be usefully supported by data giving the number of trees or plants, and in fact the asset account for a particular plantation type could be compiled using the number of plants rather than the area. With data for the number of plants and the area, indicators of the density of plantations can be derived that may be of use in assessing environmental impacts.

3.4 Physical flow accounts for livestock products

3.4.1 Measurement purpose and scope

3.67. This physical flow account records the supply and use of livestock products in physical terms, generally tonnes. For each product, the account records the total supply

from the agricultural industry and from the rest of the world, and the total use of this supply in the domestic economy and by the rest of the world.

- 3.68. The scope of this physical flow account is the rearing of livestock and the supply of all livestock products. Initial consideration may limit its scope to animals raised for meat or dairy items, but a wider range of products may be incorporated such as eggs, honey, hides, skin, fur and silk. Most of these products are the result of managed rearing of livestock, but they may also be obtained by harvesting wild animals or their outputs.
- 3.69. In theory a physical flow account for livestock products could be extended to cover any or all of these outputs, but it should focus on the managed rearing of livestock and the products derived in line with the approach taken in relation to the physical flow account for crops,
- 3.70. Following the ISIC and the SNA, a distinction is made between the product of raising and breeding livestock and the products derived from them. The product of raising and breeding livestock should always be considered an agricultural activity, whereas the treatment of the products derived from livestock varies according to the product. In general, livestock products that require the killing of an animal – for meat or hides, for example – are considered to be outputs of the manufacturing industry, whereas products obtained from animals on an ongoing basis – such as eggs, milk, wool or honey – are considered outputs of the agricultural industry. To ensure alignment with the SNA, this distinction is maintained in the SEEA AFF, but for guidance on specific products, reference should be made to ISIC Rev. 4 and CPC Rev. 2.0.
- 3.71. The SNA recognizes that the raising and breeding of some livestock is a form of gross fixed capital formation where the animals are used to produce outputs over an extended period of time; examples include dairy cattle for milk and sheep for wool. The SNA recommends that this part of the raising of livestock be capitalized rather than treated as a work-in-progress, which would be the treatment if the animals were raised for slaughter.
- 3.72. As with crop products, the focus should be on recording a country's most important livestock products, with particular emphasis on covering the use of livestock products for nutrition to permit the fullest possible description of the composition of the national diet by type of agricultural product.
- 3.73. As noted with regard to crop products, the SEEA AFF focuses on identifying the boundary around the first step in the value chain from the agricultural industry to other producers. It does not however fully articulate the full value-added or supply chain associated with agricultural production. The second step in the chain will usually be the manufacturing industry, but in practice there will be other players such as the transport, wholesale and retail industries that might also be added to create a full supply and use table for each commodity.
- 3.74. In the SEEA AFF these additional steps are not considered, so the physical flow account for livestock products shows a stylized link between primary production and final consumption and other uses. It does provide nonetheless a basis for integration with economy-wide supply and use tables and input-output tables, which could be relevant in the analysis of the agro-food industry, for example, or in tracking the chain of prices through the production and margin-based industries.
- 3.75. A particular link in the supply chain relevant to food consumption is the place of restaurant and related food services. In line with the paragraph above, the intermediate consumption of food products by the restaurant industry is not separately identified in the table, though this could be done using standard expansions aligned with input-output and supply use tables. The measure of household final consumption

should, however, include the consumption of food products in restaurants in addition to those consumed at home.

- 3.76. The production boundary of the SNA and hence the SEEA includes illegal production, so activity associated with poaching and illegal acquisition of products such as ivory are conceptually within the scope of the SEEA AFF and may form important parts of output in a particular country, depending on their scale and importance for policy formulation.
- 3.77. The recording of flows in monetary terms should be compiled consistently with the requirements of the SNA. Discussion and references are provided in Section 3.10.

3.4.2 Accounting entries

- 3.78. The physical flow account for livestock products is shown in **Table 3.3**. It records the flows in physical terms of major livestock products in the supply table and the use table. For each livestock product, total supply must be equal to total use.

Supply table entries

- 3.79. The entry for “output – agricultural industry” has two main components: i) total additions to livestock numbers over an accounting period; and ii) production of eggs, honey, raw milk and raw wool.
- 3.80. The “output – manufacturing industry” entry includes total meat production from commercial slaughter and farm slaughter. The data are in terms of dressed carcass weight excluding offal and fat. Production of beef and buffalo meat includes veal; pig meat includes bacon and ham in terms of fresh equivalent. Poultry meat includes meat from all domestic birds and refers where possible to ready-to-cook weight. Production of skins and hides is also included when they are a by-product of animals slaughtered for meat.

Table 3.3 Physical flow account for livestock products

Physical supply table for livestock products					Physical use table for livestock products								
	Output			Flows from the rest of the world	Total supply	Household final consumption				Gross fixed capital formation	Changes in inventories	Exports	Total use
	Agricultural industry		Manufacturing industry	Intermediate consumption		Food consumption	of which: Food waste	Other uses					
	Total	of which H/hold prodn							Imports				
Selected products*													
Livestock raising and breeding (head)													
Cattle and buffalo													
Sheep and goats													
Pigs													
Chickens													
Other poultry													
Other animals													
Meat (tonnes)													
Cattle and buffalo meat													
Sheep and goat meat													
Pig meat													
Chicken meat													
Other meat													
Skin and hides (tonnes)													
Eggs (number)													
Honey (tonnes)													
Raw milk (tonnes)													
Processed milk products (tonnes)													
Raw wool (tonnes)													
Processed wool (tonnes)													

- 3.81. The “imports” entry covers the total quantity of meat by type of animal and the total quantity of other livestock products imported from the rest of the world. In principle, it includes commercial trade, donated quantities, and illegal or other unrecorded trade. Quantity is expressed as net weight in tonnes, excluding any container. Imports of livestock are included, and are measured as the number of animals.

Use table entries

- 3.82. The “intermediate consumption” entry covers the use of livestock products by other industries as inputs to other products, including meat.
- 3.83. The entry for “household final consumption – food” includes the quantity of all livestock products consumed by households as food.
- 3.84. The aggregate for household food consumption includes quantities purchased or otherwise obtained. For particular policy and analytical purposes it may be relevant to measure separately the quantities of household food wasted or discarded.
- 3.85. The “household final consumption – other uses” entry includes all non-food uses of livestock products.
- 3.86. The entry for “gross fixed capital formation” records the increase in the number of livestock considered to be an addition to the stock of animals used for breeding or to produce items such as milk or wool.
- 3.87. The “changes in inventories” entry comprises changes in inventories during the reference period at all stages between agricultural production and retail, including post-harvest losses. It covers changes in government stocks and the inventories of manufacturers, importers, exporters, wholesale and retail merchants, transport and storage enterprises, and farms.
- 3.88. The entry for “exports” gives the total quantity of meat by type of animal and other livestock products exported. Quantity is given as net weight in tonnes, excluding any container. Exports of livestock are included, and are measured as the number of animals.

3.3.4 Measurement issues and possible extensions

- 3.89. A challenge in accounting for the output of livestock products is the choice of measurement units. Different units will be used at different stages of the production cycle – numbers of livestock before slaughter, for example, and carcass weight after slaughter – which makes it difficult to balance the supply and use of meat products. There are also variations in weights – boned and boneless, for example, or warm and cold – and the units may vary by type of livestock. In general, the physical flow account for meat products should focus on the carcass weight of the animal at slaughter.
- 3.90. Some livestock products may be obtained from forest areas – bush meat, for example – or from wild animals; this includes illegal activity. Because the physical flow account for livestock products focuses on managed raising of livestock, the harvesting of meat from natural sources is not included, but it could be included where relevant by including additional rows. The activity and its outputs would come under the hunting and trapping elements of the agriculture industry, including cases where animals are hunted professionally for fur or skin, which should be included in the production of livestock products. Where animals are hunted for other reasons, for example on a safari, the activity should be considered a recreational activity in the economic context of supply and use.

- 3.91. In terms of extensions to the livestock product accounts, a distinction could be made between extensive and intensive livestock production in a country if both production types are significant for a particular livestock type.

3.4 Asset account for livestock

3.4.1 Measurement scope and purpose

- 3.92. The asset account for livestock shows the total number of livestock, by type of animal, and changes in the number of livestock over an accounting period. The information may assist understanding the carrying capacity of agricultural areas with respect to livestock, for example the number of cattle per hectare, and estimating the potential output of livestock products and associated environmental impacts.
- 3.93. The scope of the asset account is cultivated livestock – animals bred and managed as a process of production by economic units. Cultivated livestock will usually provide most of the livestock products of economic interest, and will tend to be most relevant in assessing environmental impacts.
- 3.94. All animals of each type are included, regardless of age, sex or use. The asset account should therefore provide a complete report of livestock increases from breeding and imports, and decreases resulting from slaughter, natural deaths and exports.
- 3.95. The monetary asset account for livestock adopts the same scope as for the physical account. Livestock are considered cultivated biological resources in the SNA and the SEEA Central Framework and the accounting entries concerning these resources are discussed specifically in SNA 2008 paragraphs 10.88 – 10.96. These treatments are adopted in the SEEA AFF. Livestock may be treated as either fixed assets or work in progress depending on their use in production. Livestock as fixed assets include those used as breeding stock and those used to produce outputs over a period of time (e.g. milk from dairy cows, wool from sheep). Livestock as work in progress include those raised for slaughter.

3.4.2 Accounting entries

- 3.96. The asset account for livestock is shown in **Table 3..** It records the opening and closing stock of each type of livestock and additions and reductions over an accounting period. In all cases the opening stock plus additions less reductions must equal the closing stock.

Table 3.3 Asset account for livestock (number of livestock)

	Opening stock	Additions to stock				Reductions in stock				Net change in Stock	Closing stock
		Growth in livestock	Imports of stock	Other additions to stock	Total additions	Livestock processed / slaughtered	Exports of stock	Other reductions in stock	Total reductions		
Type of livestock											
Cattle and buffalo											
Sheep											
Goats											
<i>Total Sheep and Goats</i>											
Pigs											
Chickens											
Ducks											
Geese											
Turkeys											
Pigeon and other birds											
<i>Total Poultry and birds</i>											

3.97. The “opening stock” entry records the total number of live animals held at the beginning of the accounting period. Live animals are divided by type; many animal types may be included depending on their significance for a country – horses, camels, bees and silk worms are examples.

3.98. With regard to the “additions to stock” entry, in the SEEA AFF:

- “Growth in livestock numbers” reflects births less normal losses of stock that do not reach maturity (e.g. calves that die shortly after birth). Normal losses of stock that reach maturity (e.g. mature livestock that die due to disease) are assumed to be slaughtered and processed, and are included in reductions in stock (see below). Normal losses are those that might reasonably be expected based on past experience. Normal losses do not include one-off, large-scale losses due to, for example, extended drought or widespread disease. Such large-scale losses should be included under “other reductions in stock”.
- Growth in livestock = closing stock + exports of stock + livestock processed + other reductions in stock – opening stock – imports of stock – other additions to stock.
- Imports of stock includes all live animals imported into national boundaries during the year.
- Other additions to stock records all other additions to stock such as via the domestication of wild animals and upward reappraisals in stock estimates.

3.99. With regard to the “reductions in stock” entry, in the SEEA AFF:

- “Livestock processed / slaughtered” records all animals of indigenous and foreign origin slaughtered in-country; all data are expressed in number of animals.
- “Livestock to the rest of the world” includes all live animals exported from a country during the stock year.
- “Other reductions in stock” records all other reductions such as losses caused by drought or disease and downward reappraisals in stock estimates.

- 3.100. In the “net change in stock” entry, net change is the difference between the closing stock and opening stock.
- 3.101. The “closing stock” entry shows the number of livestock available at the end of the accounting period. The closing stock of one accounting period constitutes the opening stock of the following period.
- 3.102. The monetary asset account for livestock follows the same structure as for the physical account with the exception that an additional column is incorporated to record revaluations of assets – i.e. those changes in the value of the stock of livestock over the accounting period that are due solely to changes in the prices of the assets. The generic asset account in monetary terms including revaluations is presented in SEEA Central Framework Table 5.3.

3.4.3 Measurement issues and possible extensions

- 3.103. Ideally, a distinction would be made between livestock raised for different purposes – cattle for meat or milk, for example, or sheep for meat or wool – to clarify the link between various livestock products and the underlying asset base. This purpose-based approach to measuring livestock numbers is also relevant in distinguishing between the national accounts variables of gross fixed capital formation of livestock and work-in-progress. It may be necessary to adopt conventions for showing the purposes for which particular types of livestock are used.
- 3.104. A related extension is to identify the numbers of livestock used for breeding, which constitute another type of livestock asset. Information on the age distribution of livestock types may also be relevant, especially if it is not stable over time, since this may be an indicator of risks relating to future livestock production.
- 3.105. To align with possible extensions to the set of livestock products, it may be relevant to incorporate information on the stock of animals supporting illegal activity and changes in the stock of wild animals. A distinction between the numbers of livestock in intensive and extensive farming system may also be useful.

3.5 Physical flow account for wood forestry products

3.5.1 Measurement scope and purpose

- 3.106. The physical flow account for wood forestry products³ records the supply and use of forestry products in physical terms, with a view to distinguishing the activities of harvesting timber from the activity of processing raw timber and manufacturing wood products. In line with the general scope of SEEA AFF accounts, the coverage of this account should include all production of forestry products, including non-wood forest products (NWFP),⁴ irrespective of the industry classification of the economic unit undertaking the activity.
- 3.107. Conceptually, the SEEA AFF expands its analysis to forestry products other than wood such as for instance resins and gums, mushrooms, honey, edible insects which are derived from economic activities classified under ISIC A023 “Gathering of non-wood forest products”. However, the current structure of this table is not readily applicable to the recording of non-wood forestry products. In particular, this is because wood and non-food forest products are commonly reported in different measurement units (i.e. volumes vs weights). In this regard, a monetary flow account for forestry

³ FAO, 1982. *Classification and Definitions of forest products* (<http://www.fao.org/3/a-ap410m.pdf>).

⁴ FAO, 2017. Non-wood forest products in international statistical systems (<http://www.fao.org/3/a-i6731e.pdf>).

products would represent a more meaningful development of the accounting framework.

- 3.108. The physical flow account for wood forestry products applies specific focus to ISIC Division 02, Forestry and Logging, *Group 021* (Forestry) and *Group 022* (Logging). In line with the SEEA CF, where timber resources are not managed or cultivated – for example if growth is the result of a natural process outside the production boundary – no output is recorded against ISIC *Group 021* and the only physical flows recorded relate to the logging and removal of roundwood.
- 3.109. Where timber resources are not managed or cultivated – for example if growth is the result of a natural process outside the production boundary – no output is recorded against ISIC *Group 021* and the only physical flows recorded relate to the logging and removal of roundwood.
- 3.110. The physical flow accounts should cover all production of roundwood in a country, including the output by households for their own final consumption. This could include the output sourced all relevant land use, including from small-scale farms, crop plantations such as orchards, and urban tree management. Where possible, this output should be included in the accounts, especially recognising the increasing use of this wood as a source of bioenergy. In practice, the initial accounting could focus on timber and other forestry products sourced from land used for Forestry, i.e., a country's forest land, other wooded land, and included as the primary output of logging activity (ISIC *Group 021* and *022*).
- 3.111. The SEEA AFF physical flow account does not track the flows involved in the manufacture and distribution of wood products such as furniture, paper and pulp, or timber used in construction. Such connections could be made by extending the product and industry scope of the physical flow account. However, because the SEEA AFF is intended to focus on the activities of the agriculture, forestry and fisheries industries and the connection to the environment of these activities, such extensions along the supply chain are not considered.
- 3.112. The recording of flows in monetary terms should be compiled consistently with the requirements of the SNA. Discussion and references are provided in Section 3.10.

3.5.2 Accounting entries

- 3.113. A physical flow account for wood forestry products is shown in **Table 3.4**. It records the flows in physical terms of the products – net annual increment (relating to the output of ISIC 021), and roundwood (including industrial roundwood and wood fuel –corresponding to the outputs of ISIC 022). For each product, total supply equals total use.

Table 3.4 Physical flow account for wood forestry products (cubic metres)

Physical supply table for forestry products

Product	Output				Total output	Imports	Total supply
	Forestry activity (ISIC 021)	Logging activity (ISIC 022)		Other industries			
		Total	of which H/hold prodn				
Net annual increment							
Gross fellings							
Felling residues (not removed)							
Removals (over bark)							
Bark							
Removals (under bark)							
Roundwood (under bark)							
of which Industrial roundwood							
-Sawlogs & veneer logs							
-Pulpwood, round & split							
-Other industrial roundwood							
wood fuel							

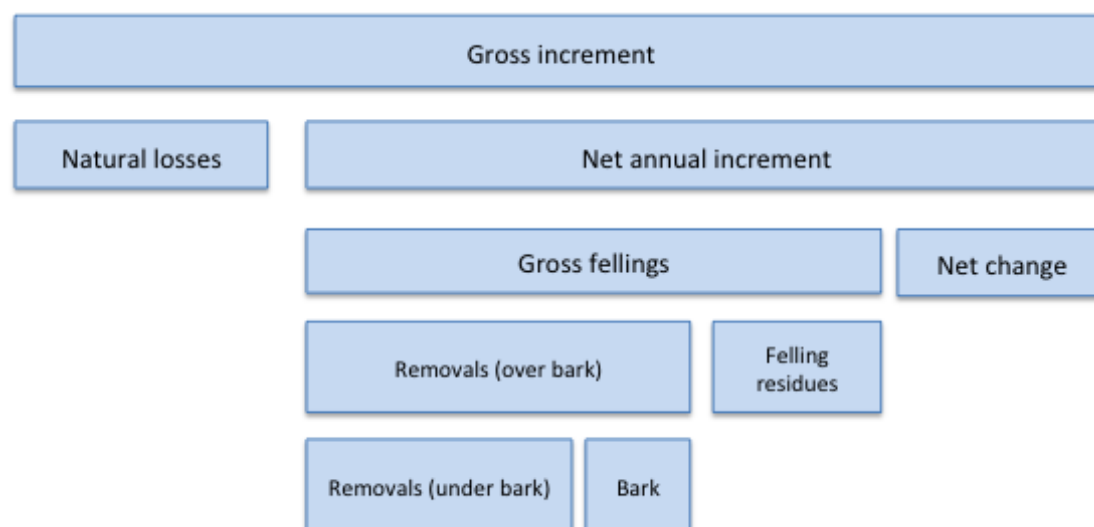
Physical use table for timber products

Product	Intermediate Consumption			Household final consumption		Gross fixed capital formation	Changes in inventories	Exports	Total use
	Logging industry	Manufacturing industry	Generation of energy products (including charcoal)						
				Energy	Other uses				
Net annual increment									
Bark									
Roundwood (under bark)									
of which Industrial roundwood									
-Sawlogs & veneer logs									
-Pulpwood, round & split									
-Other industrial roundwood									
wood fuel									

Supply table entries

- 3.114. The explanation of the scope of the physical flow accounts in the previous sections highlights the intricacies of describing the supply side for forestry activity. Figure 3.1 illustrates the sequence of flows that are the focus of the SEEA AFF. Using the terminology in that figure, the output of forestry activity (ISIC 021), the net annual increment is equal to the gross annual increment less natural losses.
- 3.115. Importantly, the scope of this output measure only applies in cases where the timber resources are actively managed and hence the estimated output will exclude the net increment associated with natural timber resources and the net increment of those timber resources managed by economic units whose primary activity is not ISIC 021. The total net annual increment of a country's timber resources is recorded in the asset account for timber resources (**Table 3.6**).

Figure 3.1 Forestry concepts



Source: Adapted from Päivinen, et al. 1999

- 3.116. In estimating the output of logging activity (i.e. the production of roundwood) there are gross fellings comprising the total volume of all trees, living or dead, that are felled. Felling includes thinning and clearing for commercial or silvicultural purposes.
- 3.117. The output of logging activity (ISIC 022) is measured in terms of removals equal to the volume of timber removed from forest land, other wooded land and other land during the accounting period. The main difference between removals and gross fellings reflects felling residues generally comprising the volume of timber found to be rotten, damaged or undersized at the time of felling. The volume of gross fellings and removals may also be different due to the time of recording. For example, timber is felled in one accounting period but is not removed until a later accounting period.
- 3.118. Standard practice for international reporting⁵ is to record removals excluding, or “under”, bark, and hence the volume of removals is estimated by deducting an estimate of the volume of bark. However, for supply and use recording purposes a complete accounting for the total volume of timber required, thus the table includes rows for removals both over and under bark and a row for the bark itself (since bark that is removed can be used for various purposes (e.g. for fuel, mulch, etc)). It is noted that removals also include removals of felling residues, roots, stumps and burls.
- 3.119. Roundwood measured under bark is a key production statistic and can be separated into two primary products – industrial roundwood and wood fuel (including wood for charcoal). It would be possible to continue to incorporate additional wood products such as logs and pulpwood. This extension to the supply chain is currently not included in the SEEA AFF.
- 3.120. Imports of roundwood include those products imported for domestic consumption or processing, including imports for re-export. The entry excludes in-transit shipments, and is reported in cubic metres of solid volume. Where estimates of imports are recorded in tonnes of dry matter, these volumes should be converted to cubic metres of timber using appropriate conversion factors.

⁵ Following the FAO/Eurostat/OECD/ITTO Joint Forest Sector Questionnaire

Use table entries

- 3.121. The entry for “intermediate consumption – logging industry” relates to the use of the net annual increment from forestry activity as an input to logging activity.
- 3.122. The entry for “intermediate consumption – manufacturing industry” relates to use of the output of roundwood by timber-related manufacturing industries (primarily ISIC 16, Manufacture of wood and of products of wood and cork, except furniture; and 17, Manufacture of paper and paper products) which encompasses the manufacture of wood and wood products, pulp and paper and paper products. The measure of intermediate consumption is equal to the volume of roundwood removed by the logging industry adjusted for imports and exports of roundwood.
- 3.123. Under Intermediate consumption, the “generation of energy products” entry records the use of wood fuel or roundwood as a source of energy, including the production of wood for charcoal. The use of roundwood for the generation of wood pellets and other agglomerates used by households for energy is however excluded from this entry and recorded directly under “households final consumption – energy”. Some production of energy from wood fuel will be ultimately used as an input to the activities of the forestry and forest-related manufacturing industries. Bark may also be a common input to the generation of energy by these industries. Own-account use of timber products to generate energy should be included in the physical flow account.
- 3.124. The “Household final consumption – energy” entry includes roundwood used for cooking, heating or power production. It includes: i) wood harvested from main stems and branches if harvested for fuel; ii) wood for charcoal production – in pit kilns and portable ovens for example; and iii) wood chips for fuel that are made directly – that is, in the forest. These entries are reported in cubic metres of solid volume excluding bark. “Household final consumption –energy” includes raw timber used by households for energy as well as primary wood products, such as wood pellets and other agglomerates, ultimately used by households for energy. Although these primary wood products are not a direct use of roundwood, it is considered to be a sufficiently direct flow to household for it to be recorded as a final use of wood rather than of derived products (which remain excluded from the scope of the account). Quantities of primarily wood products directly consumed by households for energy should be recorded in the “wood fuel” row. Other non-wood energy products ultimately consumed by households that may be generated by other industries that use roundwood or wood fuel as energy sources – such as electricity, biogas and heat - are not included.
- 3.125. The entry for “Household final consumption – other uses” includes all household non-energy uses of roundwood.
- The entry for “Gross fixed capital formation” records uses of roundwood, commonly in the form of logs, as part of land maintenance and restoration activity. It includes direct uses of timber for building, construction and similar purposes.
- 3.126. The entry for “Changes in inventories” reflects the balance between net annual increment in timber resources and fellings due to logging activity. No change in inventory is recorded for roundwood because all timber removed is allocated to intermediate consumption, household consumption, gross fixed capital formation or exports..
- 3.127. The “Exports” entry covers exports of roundwood, including re-exports. It excludes in-transit shipments and is reported in cubic metres of solid volume. Where estimates of exports are recorded in tonnes, these volumes should be converted to cubic metres of timber using appropriate conversion factors.
- 3.128. Note that not all entries in the supply table have a corresponding entry in the use table. In particular, the entries for gross fellings and removals are intended to

support the recording of information on logging activity and place this information in an accounting context. The supply and use related to the output of logging activity is recorded in relation to roundwood and associated products.

3.5.3 Measurement issues and possible extensions

- 3.129. Depending on analytical requirements and the availability of data, the estimate of total output of roundwood can be broken down into production by species of tree – coniferous or broadleaf, for example – or by forest type such as plantation forest. An additional breakdown could separate plantation forests cultivated in short rotations for biofuel. Where the purpose of cultivation is clear, outputs can be allocated to the relevant class of use. Breakdowns in production by forest type may be developed in alignment with asset accounts for forests and timber resources, as described in section 3.7.
- 3.130. A general challenge in measurement is the alignment of information on the source of the timber (e.g. from cultivated or natural forests, or agricultural land) with the total removals and production of roundwood. Not all roundwood may come from forests, although forests will commonly be the most significant source. To obtain a better understanding of the connections between forestry and logging activity and the underlying timber resources, it is therefore recommended that close attention be paid to the scope of the accounts compiled about timber products and the scope of the associated land use accounts for 'Forestry' and those for timber resources (section 3.7). Where significant quantities of timber products are sourced from land use areas other than Forestry, it will be necessary to record the different sources of timber to ensure consistency of measurement between data on the supply and use of timber products and the data on the stock of timber resources.
- 3.131. The focus in accounting for timber products is not intended to ignore the potential contribution of the activity of gathering non-wood forest products, which is part of the forestry industry and is in the scope of the SEEA AFF. Where these products are significant or of policy interest, a separate physical flow account should be established.

3.6 Asset accounts for forestry and asset accounts for timber resources

3.6.1 Measurement scope and purpose

- 3.132. The assessment and analysis of forests and timber resources involves two complementary perspectives: i) the "asset account for forestry" records the area and changes in land used for forestry; and ii) the "timber resources asset account" records the volume of marketable standing timber in terms of stock and changes in stock resulting, for example, from harvesting or natural growth.
- 3.133. As already noted for the physical flow accounts for forestry products (3.109), the scope of the timber resources asset account covers trees in all relevant land uses. Countries should therefore determine the scope of their timber resources accounts based on the relative importance of the types of areas that provide timber resources. In practice, initial accounting efforts could focus on trees in land used for Forestry, i.e., trees in a country's forest land and other wooded land.
- 3.134. The relationship between the perspectives of the two accounts will vary over time and from country to country, depending on national land use definitions, relevance of timber resources outside of land used for forestry, the type of forest, the type of timber, planning and harvesting methods, and economic conditions. In practise,

- 3.135. A second consideration concerning the scope of the timber resources asset account is whether the timber resources are available for wood supply. Some trees may not be available for harvest, for example, due to being in protected areas or due to being in remote or inaccessible locations. It may be useful analytically, to distinguish those resources available for wood supply from other timber resources to better understand the relationship between the stock of timber and current and future timber production. Moreover, while the timber resources not available for wood supply are not included in the economic tables, these timber resources remain in the scope of SEEA AFF in physical terms, as they fulfil the definition of environmental assets and may supply benefits (see also SEEA Central Framework 5.347).
- 3.136. Descriptions of these asset accounts are provided in the SEEA Central Framework: the account for forests and other woodland is described in section 5.6.4, and that for timber resources is described in section 5.8.3. The discussion in the SEEA AFF complements them.
- 3.137. The compilation of asset accounts should indicate the sustainability of the production of timber and non-wood forest products, and hence support analysis of the economic and social implications of changes in forest areas. Information about forest and timber resources can also support discussions of the role of forests in biodiversity and ecosystem management, including the management of carbon sinks in the context of policies to mitigate the effects of climate change. In the context of agricultural policy, information on conversions of forest land and other wooded land will be particularly relevant.
- 3.138. Asset accounts for forests and timber resources can be compiled in monetary terms. A full discussion on the accounting entries and associated measurement options is presented in the SEEA Central Framework Section 5.8. From the perspective of the SNA, forests and timber resources comprise both cultivated and non-cultivated biological resources and relevant text concerning accounting entries is provided in SNA 2008 paragraphs 10.88–96; 10.182–183 and 13.51. Cultivated timber resources are recorded as work in progress following the SNA 2008. More broadly, the treatments of the SEEA Central Framework and the SNA2008 are adopted in the SEEA AFF.

3.6.2 Accounting entries

- 3.139. The asset account for forests is shown in **Table 3.5**. It records the opening stock of forests in a country in hectares, additions and reductions in the area of forests over an accounting period and the closing stock of forest at the end of the accounting period.

Table 3.5 Physical asset account for forestry (hectares)

	Opening stock	Additions to stock	Reductions in stock	Net changes in stock	Closing stock
Forest and other wooded land					
Primary regenerated forest					
Other naturally regenerated forest					
Planted forest					
<i>Forest land (total)</i>					
Other wooded land					

- 3.140. The “opening stock” entry is the total area of land used for forestry, expressed in thousands of hectares, available at the beginning of the accounting period. The area is divided by forest type, as shown in the table; the definition of each type is consistent

with the land use classification of the SEEA Central Framework (see Annex I, section 1.2).

- 3.141. With regard to the “additions and reductions in stock” entry, there are various reasons for changes in the area used for forestry over an accounting period, particularly between different types of land use. The SEEA Central Framework distinguishes between managed and unmanaged expansion/reduction: “managed” refers to increases or decreases in the area as a result of human activity, whereas “unmanaged” refers to increases or decreases resulting from natural processes. An important change may also be changes in area due to reclassification, for example between different types of forest (e.g., relative to land use change from primary forest to planted forest). These should be separately recorded where information is available.
- 3.142. Where possible, the distinctions between additions and reductions in stock and between managed and unmanaged changes should be recorded. However, if the relevant data are not available it may be necessary to record “net change in stock” only. In the absence of information on additions and reductions, “net change in stock” is derived as the difference between closing stock and opening stock.
- 3.143. The “closing stock” entry is the total area used for forestry, expressed in thousands of hectares, available at the end of the accounting period. The closing stock of a given year constitutes the opening stock of the following year.
- 3.144. The physical asset account for timber resources is shown in **Table 3.6**. It records the opening and closing stock of standing timber and changes in the stock caused for example by natural growth, removals, natural losses and catastrophic losses. The timber resources asset account below includes timber resources available for wood supply and those not available for wood supply. Section 5.8.3 of the SEEA Central Framework explains in details the different entries.
- 3.145. The stock of standing timber is defined as the volume of trees, living or dead, which can be used for timber or fuel. Precise measurement conventions exist in estimating these volumes, but various assumptions are usually required when estimating timber volumes, for example the use of factors to convert area of forest land to timber volume.
- 3.146. The monetary asset account for timber resources follows the same structure as for the physical account with the exception that an additional column is incorporated to record revaluations of assets – i.e. those changes in the value of the stock of timber resources over the accounting period that are due solely to changes in the prices of the assets. The generic asset account in monetary terms including revaluations is presented in SEEA Central Framework Table 5.3.

Table 3.6 Physical asset account for timber resources (cubic metres)

Physical asset account for timber resources (cubic metres)										
Opening stock	Additions to stock			Reductions in stock					Net changes in stock	Closing stock
	Natural growth	Reclassifications	Total additions	Removals	Felling residues	Natural losses	Catastrophic losses	Reclassifications	Total reductions	
Type of timber resource										
Cultivated timber resources										
Natural timber resources										
Total										

NB: Depending on data availability it may be preferable to record natural growth net of natural losses thus moving the entry for natural losses from a Reduction in stock to a negative Addition to stock.

3.6.3 Measurement issues and possible extensions

- 3.147. The measurement of the area of land used for forestry can be challenging because various concepts and definitions are used in different situations. In the SEEA AFF the area of land used for forestry is defined in accordance with SEEA Central Framework, Annex I, which is a basis for measurement of the area of land use, not land cover. By applying the concept of land use, estimates of the area used for Forestry can be integrated with estimates of land used for other purposes, particularly Agriculture.
- 3.148. Attention should be given to the possible differences in data collection between forestry, agriculture and other land uses, to ensure consistency of definitions across data sources. The relationship between land-use data and land-cover data for forests is an important area of investigation and reconciliation.
- 3.149. The physical asset account for timber resources distinguishes between cultivated and natural timber resources in the same way as the SNA and the SEEA Central Framework. For national accounting purposes this distinction is important, because it affects the recording of timber resources. Because the growth of natural timber resources is considered to be outside of the production boundary, they are considered non-produced assets on the balance sheet. On the other hand, growth of cultivated timber resources is inside the production boundary, and hence the timber resources are considered as inventories or work-in-progress. Given the different asset types and the difference in the timing of recording of production, maintain the distinction between these types of timber resources is useful.
- 3.150. Distinguishing between cultivated and natural timber resources is not a straightforward exercise, however, requiring the compiler to assess the degree of human management involved in growing the timber resources. The SEEA AFF is aligned with the SEEA Central Framework in not prescribing how to distinguish between these two categories (e.g., see SEEA CF 5.353 to 5.357). In practice, in some cases it may be useful to utilize the distinction between SEEA land use sub-categories of forest land, specifically between primary regenerated forest and planted forest, as a proxy to distinguish timber resources between natural and cultivated.
- 3.151. With regard to the physical flow accounts for forestry products, various alternative presentations may be relevant in the design of asset accounts for forests and timber resources. For forests, it may be useful to distinguish farm forests, industrial forests, public forests and protected areas within forests. In accounting for timber resources, it may be useful to distinguish between natural timber available for wood supply and not available for wood supply, as in the SEEA Central Framework. Further, both asset accounts could be extended with the integration of information by tree species or resources in particular locations.
- 3.152. Another alternative presentation is to consider timber resources as a source of energy. Paragraph 5.372 of the SEEA Central Framework notes that for analytical purposes it would be possible, where the data are available, to construct asset accounts for timber resources with a focus on use for energy, particularly as renewable sources of energy. In this regard, a particular focus may be on identifying short rotation forestry for bioenergy production.
- 3.153. Data on timber resources and forest areas are usually major components in national estimates of carbon stocks, and are important in the measurement of greenhouse gas emissions and emissions resulting from logging and deforestation. Factors reflecting the quantity of carbon per tonne or cubic metre of timber can be used to generate such estimates.
- 3.154. Consistent with the SEEA Central Framework, the physical asset accounts for both forests and timber resources include all forests and timber regardless of whether these resources hold economic value following the principles of the SNA. For many

countries this treatment raises no particular issues. However, for some countries with extensive areas of forest whose timber resources are considered non-economic – due to their being inaccessible or otherwise – there may be a significant difference between the measured scope of the physical asset account and the scope that is relevant for compilation of national balance sheet in monetary terms. Consistent with the recommendation of the SEEA Central Framework (5.347) the physical measures of forests and timber resources that do not have economic value should be clearly distinguished to support alignment and reconciliation in measurement with the SNA.

3.7 Physical flow account for fish and other aquatic products

3.7.1 Measurement scope and purpose

- 3.155. The physical flow account for fish and other aquatic products records the total supply and use of all fish and aquatic products, including production from capture fisheries and aquaculture. Total supply consists of domestic production and imports; total use covers intermediate use of fish products, final consumption by households, changes in inventories and exports.
- 3.156. The information is organized to support the integration of information with standard economic data and the comparison of information with other activities such as agriculture and forestry. The supply-and-use structure facilitates comparisons of data on the production, trade and consumption of fish products.
- 3.157. The analysis of the consumption of fish products in the physical flow table can be extended to calorie and nutritional intake corresponding to household fish consumption. Linking this information, which is also available in food balance sheets, with economic and environmental variables could help to improve assessments of food security and sustainability issues.
- 3.158. The scope of the physical flow account is all fish and other aquatic products, as in the International Standard Statistical Classification of Fishery Commodities (ISSCFC). To support the aggregated perspective of the SEEA AFF, groupings of fish products based on the ISSCFC were created. There are 12 major groups listed below. These groupings of fish products may also be categorized by production process, i.e., aquaculture or capture fisheries.
- freshwater fish
 - diadromous fish
 - demersal fish
 - tuna, bonito, billfish
 - other pelagic fish
 - other marine fish
 - crustaceans
 - cephalopods
 - other molluscs
 - aquatic mammals
 - other aquatic animals
 - aquatic plants, algae
- 3.159. The recording of flows in monetary terms should be compiled consistently with the requirements of the SNA. Discussion and references are provided in Section 3.10.

3.7.2 Accounting entries

- 3.160. The physical flow account for fish and aquatic products is shown in **Table 3.7**. It is divided into the supply table and the use table, with fish products grouped according to the categories above. For each product, total supply must equal total use.
- 3.161. Fish and aquatic products are measured in tonnes. Estimates of nominal catch – the core measure of production – should be in terms of live weight equivalent. For the purposes of balancing supply and use all categories of use, should also be recorded in live weight equivalent. It is important, when deriving relevant conversion factors that the complete range of uses is accounted for. In particular, conversions should recognise the existence of post-harvest and post-catch losses. In some cases, losses and other waste may be converted into other products, such as dry fish meal. These are considered derivative products and are not included in the supply and use table.
- 3.162. For some aquatic products – marine mammals, for example – measurement in tonnes is not appropriate: data relating to them are collected using other measurement units such as the number of individuals. Where the products of such species are significant for a country, an appropriate measurement unit will need to be determined to balance estimates of supply and use.
- 3.163. No aggregates across products are proposed in **Table 3.7**, even though some products could be aggregated to obtain total tonnages for groups of fish products. In view of the diversity of products in the table no meaningful aggregate can be derived in tonnes. In some cases, aggregation involving different products may be possible in terms of nutritional values (e.g. calories, protein content).

Supply table entries

- 3.164. The “gross catch” entry records the total live weight of fish caught. It should in theory include the weight of fish caught in illegal, unreported and unregulated (IUU) fishing activity, but in practice this will be difficult.
- 3.165. The “discarded catch” entry records the difference between the gross catch and the live weight of fish retained and landed by the fisheries unit – the nominal catch. In practice, the measurement of discarded catch is difficult and open to considerable error.
- 3.166. In recording output for “output – fisheries” a distinction is made between capture fisheries (ISIC – 031) and aquaculture (ISIC – 032). Capture fisheries can be defined as an activity leading to the harvesting of fish in a defined area, a broad concept covering all aspects of human fisheries activity including economic, managerial, biological, environmental and technological viewpoints.
- 3.167. In the physical flow account for fishery, the nominal catch – fish landed converted to a live weight equivalent – is equal to the gross catch less discarded catch. The output measure should in principle include the retained catch from IUU activity.

Table 3.7 Physical flow account for fish and aquatic products (tonnes)

Physical supply table for fish and aquatic products													
		Output							Imports			Total supply	
		Capture fisheries			Aquaculture			Other catch (incl h/hold prodn)	Total Output	Food use	Non-food use		Total imports
		Gross catch	Discarded catch	Nominal catch	Harvest	Harvest loss	Nominal harvest						
Fish and other aquatic products													
Fish	Freshwater fish												
	Diadromous fish												
	Demersal fish												
	Tunas, bonitos, billfishes												
	Other pelagic fish												
	Marine fish, other												
Crustaceans													
Molluscs	Cephalopods												
	Other molluscs excl cephalopods												
Aquatic animals, other	Marine mammals												
	Reptiles												
	Other aquatic animals												
	Pearls, sponges and corals												
Aquatic plants, algae	Algae												
	Macro plants												

Physical use table for fish and aquatic products												
		Intermediate consumption		Household final consumption			Changes in inventories		Exports			Total use
		Feed	Other uses	Food consumption	of which: Food waste	Other uses	Post-harvest/catch losses	Other changes	Food use	Non-food use	Total Exports	
Fish and other aquatic products												
Fish	Freshwater fish											
	Diadromous fish											
	Demersal fish											
	Tunas, bonitos, billfishes											
	Other pelagic fish											
	Marine fish, other											
Crustaceans												
Molluscs	Cephalopods											
	Other molluscs excl cephalopods											
Aquatic animals, other	Marine mammals											
	Reptiles											
	Other aquatic animals											
	Pearls, sponges and corals											
Aquatic plants, algae	Algae											
	Macro plants											

3.168. With regard to the “output – aquaculture” entry, in 1988, FAO introduced the following definition: “Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms which are harvested by an individual or corporate body which has owned them throughout their rearing period contribute to aquaculture, while aquatic organisms which are exploitable by the public as a common property resources, with or without appropriate licenses,

are the harvest of fisheries.” (FAO, 2008) This entry records the nominal harvest of fish from aquaculture facilities.

- 3.169. The “output – other catch (incl. household catch)” entry includes other fish production except for capture fisheries and aquaculture, for example household catch or recreational fishing.
- 3.170. The “imports” entry reports total imports of fisheries commodities in live weight equivalent. A distinction is made between: i) imports for food, which includes the categories whole-meat fish, filleted fish and processed fish; and ii) imports for non-food, which includes the categories: fodder, industrial use and other uses.

Use table entries

- 3.171. The “intermediate consumption – feed” entry refers to the use of fish products as input to manufactured feeds, an important element of modern commercial aquaculture: in granule or pellet form, they provide nutrition in a stable and concentrated form to enable the fish to feed efficiently and grow to their full potential. Many of today’s intensively farmed fish are carnivorous: examples include Atlantic salmon, trout, sea bass and turbot; since modern aquaculture started in the 1970s fish meal and fish oil have been major components of feed for these species.
- 3.172. The “intermediate consumption – other purposes” entry refers to all uses other than export, household final consumption and changes in inventories.
- 3.173. The entry “household final consumption – food” refers to the total amount of fish and aquatic products consumed by households as food, whether purchased or otherwise obtained. For particular policy and analytical purposes, it may be relevant to measure household food waste – the amount of food discarded – separately.
- 3.174. The “household final consumption – other uses” entry refers to the total amount of fish and aquatic products consumed by households for purposes other than food.
- 3.175. The entry “changes in inventories – post-harvest losses” relates to losses in terms of the quantity of fish and fish products lost between the point of capture or harvest and the point of use.
- 3.176. The “exports” entry covers the total exports of fisheries commodities in live weight equivalent, with a distinction between: i) exports for food, which includes the categories of whole-meat fish, filleted fish and processed fish; and ii) exports for non-food, which includes the categories of fodder, industrial use and other uses.

3.7.3 Measurement issues and possible extensions

- 3.177. Depending on analytical and policy requirements, information on the production of fish could be considered by individual fishery rather than by species. A focus on individual species could miss the connections between species, which underpin the health of individual fisheries. A related extension would be to distinguish supply and use data between fisheries in inland waters and marine fisheries.
- 3.178. A frequent measurement issue with capture fisheries is the treatment of fish caught in a country’s exclusive economic zone by foreign vessels. Following standard national accounting conventions, such fish products are considered the production of the country in which the fishing vessel is resident (see SEEA Central Framework, 3.132). This is conceptually consistent with the treatment of production in the SNA and hence in measures of GDP and the balance of payments.

- 3.179. However, determining residence for fishing vessels may not be straightforward. A working assumption may be to assign residence to the country of the flag flown by the fishing vessel. This is treatment that underpins the collection of fish catch statistics data by the FAO.⁶ However, the country of the flag flown may not correspond to the country in which the operator of the fishing vessel is considered an economic resident. For accounting purposes, it is important to ensure that there is an alignment in treatment between the physical accounts and the monetary accounts and also between entries related to production and international trade. Where different treatments in determining residence are evident, appropriate adjustments to ensure alignment should be adopted.
- 3.180. Another production boundary issue concerns recreational and sport fishing. Fish caught and consumed by recreational anglers are considered as production, and are within the scope of fisheries activity, akin to the treatment of subsistence fishery activity. A distinction is made, however, if households pay companies for sport fishing: such activities are recorded as recreational activities, and the catch would be excluded from the scope of production used in the SEEA AFF. Nonetheless, in the asset account for fish and other aquatic resources (see section 4.9), the catch of fish by all means and for all purposes should be regarded as a reduction in stock.

3.8 Asset account for fish and other aquatic resources

3.8.1 Measurement purpose and scope

- 3.181. The decline in global fish stocks in recent decades and the corresponding rise in aquaculture facilities is well documented (see, for example, FAO 2016 *The State of World Fisheries and Aquaculture*). Measuring fish stocks and changes in stocks is challenging, but it should be a priority in view of the importance of understanding issues of sustainability.
- 3.182. The SEEA AFF follows the guidance in section 5.9 of the SEEA Central Framework that an asset account for a country's fish and other aquatic resources should cover stocks of aquaculture facilities and all resources in coastal and inland fisheries in its exclusive economic zone throughout their life cycles. Migrating fish and those that straddle the border of a country's exclusive economic zone are considered to belong to that country while inhabiting the zone.
- 3.183. Fish stocks on the high seas and fish stocks subject to international agreements on exploitation should be included in a country's estimate in accordance with the portion of access rights to the resources that belong to it. Estimates of fish and other aquatic resources should be compiled in line with legal frameworks for international fisheries management established under the United Nations Convention on the Law of the Sea.
- 3.184. A physical asset account for fish and other aquatic resources shows the total biomass of all species subject to harvesting or cultivation activity within a national boundary. The scope of harvesting includes commercial sea and freshwater operations and aquaculture, and subsistence and recreational harvesting of aquatic resources.
- 3.185. Asset accounts for fish and other aquatic resources can be compiled in monetary terms. A full discussion on the accounting entries and associated measurement options is presented in the SEEA Central Framework Section 5.9. From the perspective of the SNA, fish and other aquatic resources comprise both cultivated and non-cultivated biological resources and relevant text concerning accounting entries

⁶ Garibaldi L (2012) The FAO global capture production database: a six-decade effort to catch the trend, *Marine Policy*, 36, pp760-768

is provided in SNA 2008 paragraphs 10.88–96; 10.182-183 and 13.51. Those fish and other aquatic resources that are considered cultivated resources may be either fixed assets if they are considered breeding stock or as work in progress if they are being raised for harvest. The treatments of the SEEA Central Framework and the SNA2008 are adopted in the SEEA AFF.

3.8.2 Accounting entries

- 3.186. A basic physical asset account for fish and other aquatic resources is presented in **Table 3.8**. It shows the opening and closing stock of aquatic resources, and additions and reductions in stock resulting from natural growth, catches and other factors.
- 3.187. Section 5.9 of the SEEA Central Framework discusses the measurement of these stocks and flows. For cultivated aquatic resources – stocks as defined in section 3.9 – measurement of the opening and closing stocks and changes in stock should be relatively straightforward given that the stocks are managed and controlled. Challenges may arise when recording re-classifications of cultivated and natural fish stocks, for example when wild fish are introduced as breeding stock or when cultured seeds are released into the wild; escapes from aquaculture facilities in river and marine environments can also occur. Unexpectedly large losses from disease or natural disasters should be recorded as catastrophic losses.
- 3.188. For natural fish and other aquatic resources, direct measurement of opening and closing stocks and elements of change in stocks cannot usually be observed or measured directly; the exception is the measurement of the harvest or gross catch. Biological models and assumptions must therefore be used to make estimates, but such estimates may not be fully robust (see section 5.9 of the SEEA Central Framework).
- 3.189. The monetary asset account for fish and aquatic resources follows the same structure as for the physical account, with the exception that an additional column is incorporated to record revaluations of assets – i.e. those changes in the value of the stock of fish and aquatic resources over the accounting period that are due solely to changes in the prices of the assets. The generic asset account in monetary terms including revaluations is presented in SEEA Central Framework Table 5.3.

Table 3.8 Physical asset account for fish and aquatic resources (000 tonnes)

	Opening stock	Additions to stock			Reductions in stock					Net changes in stock	Closing stock
		Natural growth	Other additions	Total additions	Gross catch/harvest	Natural losses	Catastrophic losses	Other reductions	Total reductions		
Type of fish and aquatic resource											
Cultivated aquatic resources											
	Breeding stock										
	Inventories										
Natural (wild) aquatic resources											

3.8.3 Measurement issues and possible extensions

- 3.190. In view of the measurement challenges, compilation of a complete physical asset account for fish and other aquatic resources is probably not possible at present. It may, however, be possible to provide a more qualitative assessment of fish stocks by considering various biological and bio-economic models and catch statistics to show whether species and fisheries are being under-fished, fully fished or over-fished.
- 3.191. In this vein, a common approach is to consider changes in the gross catch relative to fishing “effort” – labour, days at sea, size of vessel and fishing gear for

example. The catch per unit effort (CPUE) may be a good indicator of the change in stock size, assuming that population density and population size are correlated and that the catch per unit effort increases as population densities increase.

- 3.192. Another approach is to consider indicators of the condition of marine and inland water ecosystems with a view to understanding the state of fish and other aquatic resources. For inland waters, useful information about the surface area of lakes and wetlands may be obtained from land-cover accounts. For marine environments, indicators such as the mean trophic index and the ocean health index may be used.
- 3.193. More research and development is needed to establish practical methods for deriving internationally comparable estimates to populate a physical asset account for fish and other aquatic resources.
- 3.194. Finally, the assessment of the conditions to support fishing activity would be supported by consideration of information on water resources. Ideally, measures of the changing stock and quality of water resources, would provide important information. This may include, for example, indicators of changes in river flow. At this stage, such measures are likely to be available only on an ad hoc basis for specific locations.
- 3.195. A more generally available set of information may be measures of the area of inland waters, including rivers and wetlands. In principle, such measures are included within the scope of the land use and land cover accounts of the SEEA Central Framework, which are also incorporated in the SEEA AFF. Countries are encouraged to develop the inland waters components of these land accounts. Of particular relevance may be assessment of changing seasonal patterns of the area of rivers and wetlands that can provide important habitats for the breeding cycle of certain fish stocks.
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3.9 Base accounts for economic data for SEEA AFF

3.9.1 Measurement purpose and scope

- 3.196. Section 2.3 introduced the types of economic data relevant to the SEEA AFF. Two considerations are relevant: recording the supply and use of agricultural products in monetary terms, and recording extended production and income accounts for agriculture, forestry and fisheries activities and, potentially, products. This section describes these two base accounts and the common data sources and methods.
- 3.197. **Table 3.9** shows a monetary supply and use account for agriculture, forestry and fisheries products. It follows the general structure of the SNA monetary supply and use account, with agriculture, forestry and fisheries products in the rows and standard components of total supply and total use in the columns. For each row, total supply – output plus imports – must equal total use in terms of intermediate consumption, final consumption, gross fixed capital formation, changes in inventories and exports. Note that a column for government final consumption is not included since the purchase of agricultural products by general government units will form part of their intermediate consumption as inputs to the production of government services.
- 3.198. Since the data are in monetary terms, a basis for valuing or pricing the products must be considered. The treatment of taxes and subsidies is relevant here. In line with SNA concepts, total output of the producer is measured in basic prices including the value of subsidies received on a product. Total use and its components are measured at purchasers' prices, in which taxes and margins are added to the basic price and subsidies are deducted. Subsidies on products are included in the output valued at basic prices as received by the producing economic unit, but are not paid by the economic unit purchasing the product; instead, subsidies on products are transfers from the government to the producer. In **Table 3.9** other subsidies on products are recorded as a component of output valued at basic prices; and subsidies on imports are recorded as a component of imports valued at basic prices. As a whole, total supply is valued at basic prices. Additional columns, compared to the physical flow accounts, have been included in **Table 3.9** to record these entries.
- 3.199. Another aspect of subsidies in agriculture, forestry and fisheries is that they are often provided in relation to outputs and inputs of the activities. Subsidies on fuel costs, for example, will reduce the price of the input for the producer and hence affect economic decisions. Subsidy arrangements and similar schemes are discussed in, for example, OECD Agricultural Policy Monitoring and Evaluation (OECD, 2014) and are not considered further here. The organization of information in the SEEA AFF may support analysis of these of issues, and the base accounts could be extended to incorporate additional data.
- 3.200. The scope of products considered in **Table 3.9** includes all output of a given product whether produced by units whose principal activity is agriculture, forestry and fisheries or the output is the secondary production from other units. This scope aims to ensure alignment between the monetary supply and use account and the scope of the physical flow accounts for agriculture, forestry and fisheries products.
- 3.201. An alternative scoping of **Table 3.9** would be to include only products produced by units classified to agriculture, forestry and fisheries, i.e. covering their non-agricultural, forestry and fisheries products. This might include cases of vertical integration where units produce raw products and also manufactured outputs (e.g. raw milk and cheese; grapes and wine); and also unrelated products such as agri-tourism related outputs. In the SEEA AFF, this perspective is presented in **Table 3.10** where the total output and associated income for all agriculture, forestry and fisheries units is included in scope, albeit not at the level of individual products. If a more complete product description is required then analysts should consider using input-output tables and related data sources.

- 3.202. A description of the relevant accounting entries in monetary terms is not provided in the SEEA AFF. Rather, compilers are referred to the relevant sections of the SNA and chapter 2 of the SEEA Central Framework. Of particular relevance are the sections on valuation concepts and prices (SNA2008 6.49-69 and SEEA Central Framework Section 2.7.3); and the discussion of the measurement of output of agriculture, forestry and fisheries in the SNA2008 6.136-138 on recording output; and 10.88-96 on recording capital formation on cultivated biological resources.
- 3.203. **Table 3.9** can supply information to link production to measures of final demand and, in conjunction with physical flow account information for the same products, can give insights into the effects of price changes. In theory, these data should be available from standard national input-output or supply-and-use tables, but the information in these tables may be more aggregated than in Table 3.10, and additional information would then be needed for compilation. The information compiled for an account such as Table 3.10 will also be relevant to input-output tables and supply-and-use tables and cooperation between the compilers is recommended. The compilation of physical flow accounts at the same time as monetary information is also likely to be useful.
- 3.204. **Table 3.10** shows an extended production and income account for agricultural, forestry and fisheries activities. It is based on the standard SNA production account and extended to incorporate other information, to give a complete production function. A number of options exist for the level of presentation in **Table 3.10** including a product perspective, an activity perspective and a process perspective. In theory, a production function exists at the finest level detail of product and process, but there may be challenges in compiling such a view because inputs such as management and financing may only be relevant at the overall business level. Where a single business produces more than one product or uses more than one process, the allocation of inputs may be difficult.
- 3.205. Given these considerations and the aim of the SEEA AFF to support comparison across agriculture, forestry and fisheries, **Table 3.10** uses an activity perspective based on ISIC classes. Depending on the data available and the types of data allocation – for example using micro-level information – a detailed account describing product and process levels could be constructed, at least for some variables. To ensure alignment with the total output and incomes for all units considered as part of these activities, a range of support and service activities classified in ISIC section A must also be included.

Table 3.9 Monetary supply and use table for agricultural, forestry and fisheries products (currency units)

Monetary supply and use table for agricultural, forestry and fisheries products (currency units)											
	Monetary supply table for agricultural, forestry and fisheries products						Monetary supply table for agricultural, forestry and fisheries products				
	Output		Trade and transport margins	Taxes on products	Less subsidies on products	Total supply at purchasers prices	Intermediate consumption	Household final consumption	Gross fixed capital formation	Changes in inventories	Exports
	Agriculture, Forestry and Fisheries units	Non-Agriculture, Forestry and Fisheries units									
Agricultural products											
Crop products											
Maize											
Rice											
Wheat											
Palm Oil											
Sugar											
Potatoes											
Fodder											
Other crops											
Total											
Livestock products											
Livestock raising											
Eggs											
Raw milk											
Honey											
Other livestock products											
Total											
Other agricultural products											
Total agriculture											
Forestry products											
Forestry											
Logging											
Other forestry products											
Total forestry											
Fisheries products											
Aquaculture											
Capture fisheries											

Table 3.10 Extended production and income account for agricultural, forestry and fisheries activities (currency units)

Extended production and income account for agricultural, forestry and fisheries activities (currency units)															
	Intermediate consumption						Gross value added	Compensation of employees	Gross operating surplus & Gross mixed income	Gross fixed capital formation		Changes in inventories		Consumption of fixed capital (depreciation)	Employment (000 people)
	Output	Water	Energy	Fertilizer	Other	Total				Cultivated biological resources	Other produced assets	Cultivated biological resources	Other changes in inventories		
Agriculture	(1)					(2)	(3) = (1) - (2)	(4)	(5) = (3) - (4)	(6)				(7)	(8)
Cropping															
Animal production															
Mixed farming															
Support activities to agriculture															
Hunting and trapping															
Total Agriculture															
Forestry and logging															
Forestry															
Logging															
Gathering non-wood forest products															
Support services to forestry															
Total Forestry and Logging															
Fisheries															
Fishing - marine															
Fishing - freshwater															
Aquaculture - marine															
Aquaculture - freshwater															
Total Fisheries															
Total Agriculture, Forestry and Fisheries															
Total Economy															

- 3.206. The starting point for populating this account will be the standard input-output and supply and use tables, which will provide core information on production and incomes for types of agricultural activity such as cropping, livestock, forestry and fisheries. Data from this source must be reconciled with economy-wide information on industry that relates directly to macro-economic measures of economic activity to put the data in context and indicate relative importance.
- 3.207. If a finer level of detail is required, other relevant information sources will include agricultural, forestry and fisheries surveys, and physical data on inputs to industrial and agricultural production. Among these sources, cost-of-production surveys that collect details of input structures for products and processes will be of particular interest.
- 3.208. Apart from ensuring alignment between the scope of the cost information and the definitions of costs relevant for national accounts purposes, the main challenge in using these data will be establishing a method for scaling cost-of-production data to the national level, rather than reflecting case studies of particular farms. This is where the accounting framework and the “outside – in” approach can be most useful in compiling information for policy analysis at the country level.

3.9.2 Measurement issues and possible extensions

- 3.209. The structures proposed above bring together a basic level of monetary data, which can be linked to the data in other parts of the SEEA AFF framework. There are many possible extensions, depending on the focus for analysis.
- 3.210. One extension would be to focus on capital formation and investment. In the category of gross fixed capital formation, for example, identification of expenditure on machinery, equipment, research and development might be relevant insofar as it pertains to agricultural, forestry and fisheries activity. An extension to consider the stock and changes in stock of supporting infrastructure such as roads, rail and port facilities might also be of interest.
- 3.211. Given the dependence of agriculture, forestry and fisheries activities on resources including land, soil, timber fish and water, data might be gathered on payments for access to these resources, for example in terms of payments for licences, permits, quotas, rights, etc. The relevant information will vary depending on the resource and the management arrangements in place. An introduction to the relevant accounting entries is provided in the SEEA Central Framework Section 4.4.5 and specifically in relation to timber and fish resources in Sections 5.8 and 5.9.
- 3.212. Building further on the dependence on natural resources, information on expenditure concerning landscape restoration, environmental protection and resource management may be relevant for analysis. Such types of investment would be relevant in the consideration of linkages between the environment and the economy, and the relevant accounts could be extended accordingly where data are available, building on the economy wide discussion of the recording of these expenditures described in SEEA Central Framework Chapter 4.
- 3.213. Considerably more detail regarding the cost of production might be compiled to expand the “intermediate consumption” entry. For example, an extension could highlight the relative significance of inputs such as energy, materials, fertilizers, pesticides and labour.
- 3.214. The level of detail might also be expanded by incorporating information on the size and characteristics of economic units involved in agriculture, forestry and fisheries. Information on income by type of activity, for example, could be cross-classified by size of economic unit in terms of employment or production, or by the proportion of output

exported. Incorporating such information would assist in understanding differences between economic units, and hence the effect of policies. In this context, understanding subsidies paid by type of economic unit could be of particular interest.

- 3.215. Given that the information in the tables above is sourced from input-output tables, it would be possible to relate the information to the input-output tables themselves and hence make connections between agriculture, forestry and fisheries activities and the supply chains they support in food, textiles and materials. These upstream activities are not the focus of the SEEA AFF, but clear portrayal of the links between primary industries and the environment they depend on may help secondary and tertiary industries to understand more clearly the risks associated with their supply chains.
- 3.216. A final area of extension noted here is the potential to develop a more complete sequence of accounts going beyond the extended production and income account presented in **Table 3.10**. Additional accounts may include distribution and use of income accounts, capital accounts, financial accounts and balance sheets. The full sequence of accounts is described in both the SNA and in the SEEA Central Framework Chapter 6, which has a particular focus on the recording of depletion. This type of extension has some commonality with the intentions of the Economic Accounts for Agriculture (FAO, 1996). A difficulty with this extension is that the compilation perspective must shift from a production or industry-based perspective to an economic ownership/institutional sector perspective. Such a shift is possible, but relevant assumptions concerning the relationship between these two perspectives would need to be further explained, in order to correctly identify the appropriate sequence of accounts needed.
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Chapter 4: Accounting for environmental assets, primary natural inputs and residual flows

4.1 Introduction

- 4.1. This chapter describes the SEEA AFF base accounts, setting out for each: i) its purpose and scope and its links to other components; ii) the definition of accounting entries, accounting treatments and relevant classifications; and iii) areas of possible extension.
- 4.2. The accounting principles and treatments of the SNA and the SEEA Central Framework apply throughout and any interpretation of accounting matters should refer to them. The national accounting treatments in the European Economic Accounts for Agriculture and Forestry (Eurostat, 2000) should also help to determine the treatment of individual products and practices in agriculture and forestry.

4.2 Physical flow and asset accounts for water resources

4.2.1 Measurement purpose and scope

- 4.3. All agricultural, forestry and fisheries activities depend on water quantity and quality. At a national level, particularly for large countries, differences in the availability of water between regions may not be apparent and hence it will be highly relevant to compile information on water in relation to individual water catchments. In addition, seasonal variations in water availability may be a constraining factor and hence sub-annual data on water availability will be relevant. The fact that activities at the start of a water catchment are likely to affect activities downstream can have regional and international repercussions. There will be possible associated competition for water, for example for economic activities including the production of energy, manufacturing and human consumption. Water will also play an important role in ensuring the delivery of environmental services (e.g. wildlife habitat) and will support different in situ activities such as recreational fishing and transportation.
- 4.4. Maintaining a coherent set of national data on water resources and their links to economic activities and environmental outcomes is critical to address the challenges highlighted above, especially in view of increasing pressures on water availability in many areas. It is recognized that data may not be currently available in all countries, to cover all of relevant dimensions on the supply and use of water resources.
- 4.5. One approach to developing such a set of information is the accounting framework in the SEEA Water, which organizes information on water according to the guidelines in the SEEA Central Framework. The accounts for stocks and flows of water resources in the SEEA AFF include extensions these documents, together with the 2012 International Recommendations for Water Statistics. In addition, the SEEA AFF develops a specific focus on rainfed and irrigated crop production.
- 4.6. The SEEA Water accounts are of two types –physical flow accounts for water and water asset accounts. Physical flow accounts record water flows into the economy from the environment, flows between economic units in the economy, including waste water, and returns to the environment (including both surface water and groundwater). Water asset accounts record the stocks of water resources, primarily surface water and groundwater, and changes in the stocks from flows such as abstraction, precipitation and evaporation. Both of these accounts are adapted for the purposes of the SEEA AFF.

- 4.7. The aim of the SEEA AFF is to assess the use of water in the production of items such as rice and wheat, and the sustainability of use given the available water resources. The use of water should include the effects of different approaches to the production of agricultural, forestry and fisheries products: for example, the information on water in the SEEA AFF relates to irrigation and to attempts to place irrigated agriculture in a broader context.
- 4.8. Focusing solely on water use in agriculture, forestry and fisheries is insufficient, because such use must be considered in reporting the use and availability of water in general. The SEEA AFF tables therefore cover the entirety of water resources and water use in a country, while providing additional detail with regard to agricultural, forestry and fisheries activity.
- 4.9. The SEEA AFF accounts for water resources support the assessment of water yield and the availability of water, aspects of water stress and water efficiency and productivity. As noted above, often it will be necessary to compile information at a river basin level, to more effectively inform policy and analysis. Also, as far as possible, seasonal effects should be considered – possibly through the measurement of some variables on a monthly basis – e.g. precipitation and abstraction.
- 4.10. In line with the SEEA Central Framework and SEEA Water, the SEEA AFF water accounts cover stocks and flows of water without regard to water quality. Work on environmental-economic accounting for water quality, for example in chapter VII of SEEA Water, is not sufficiently advanced to be incorporated into the SEEA AFF at this stage.
- 4.11. The valuation of water resources is considered an on-going item on the research agenda for the SEEA. The flows of water into and from the economy described in the accounts below are recorded in physical terms, generally cubic metres. Transactions in water within the economy, e.g. the purchase of water from water supply companies, are recorded in the standard national accounts. Relevant transactions can be included in the monetary accounts of the SEEA AFF described in section 3.10. For the valuation of stocks of water resources, the relevant measurement issues are described in the SEEA Central Framework Section 5.11.4. As yet, no asset account in monetary terms has been described in the SEEA framework.

4.2.2 Accounting entries – physical flow account

- 4.12. The physical flow account for water (
- 4.13.
- 4.14. **Table 4.1**) mirrors the physical flow account for water presented in the SEEA Central Framework. The differences relate only to the reduction of industry level detail for non-agricultural, forestry and fisheries industries and the inclusion of additional detail on crops and livestock. Although not shown in the table, the columns for crops and livestock could be further disaggregated to highlight key products within these categories. The extent of disaggregation that is undertaken should be based on the relative importance of different activities and products within a country and the needs of users.
- 4.15. Given the strong parallels to the recording of the physical flow accounts in the SEEA Central Framework and the SEEA Water, no additional explanation of the general definitions of the accounting entries are provided here. However, there are some specific issues on the recording of flows of water for agriculture, forestry and fisheries that are highlighted in the following paragraphs.

Table 4.1 Physical flow account for water (cubic metres)

	Agriculture, forestry and fishing	Mining and quarrying, manufacturing and construction	Electricity, gas, steam and air conditioning supply	Water collection, treatment and supply	Sewerage	Other industries	Households	Imports	Flows from the environment	Total supply
(I) Sources of abstracted water										
Inland water resources										
Surface water										
Groundwater										
Soil water										
Total										
Other water sources										
Precipitation										
Sea water										
Total										
Total supply abstracted water										
(II) Abstracted water										
For distribution										
For own use										
(III) Wastewater and reused water										
Wastewater										
Wastewater to treatment										
Own treatment										
Reused water produced										
For distribution										
For own use										
Total										
(IV) Return flows of water										
To inland water resources										
Surface water										
Groundwater										
Soil water										
Total										
To other sources										
To return flows										
of which: losses in distribution										
(V) Evaporation of abstracted water,										
Evaporation of abstracted water										
Transpiration										
Water incorporated into products										
Total supply										

	Abstraction of water; intermediate consumption; return flows						Final consumption	Flows to the rest of the world		
	Agriculture, forestry and fishing	Mining and quarrying, manufacturing and construction	Electricity, gas, steam and air conditioning supply	Water collection, treatment and supply	Sewerage	Other industries	Households	Accumulation	Exports	Flows to the environment
(I) Sources of abstracted water										
Inland water resources										
Surface water										
Groundwater										
Soil water										
Total										
Other water sources										
Precipitation										
Sea water										
Total										
Total use abstracted water										
(II) Abstracted water										
Distributed water										
Own use										
(III) Wastewater and reused water										
Wastewater										
Wastewater received from other units										
Own treatment										
Reused water										
Distributed reuse										
Own use										
Total										

	Abstraction of water; intermediate consumption; return flows						Final consumption	Flows to the rest of the world				
	Agriculture, forestry and fishing	Mining and quarrying, manufacturing and construction	Electricity, gas, steam and air conditioning supply	Water collection, treatment and supply	Sewerage	Other industries		Households	Accumulation	Exports	Flows to the environment	Total use
(IV) Return flows of water												
Return flows of water to the environment												
To inland water												
To other sources												
To return flows of which: losses in distribution												
(V) Evaporation of abstracted water, transpiration and water incorporated into products												
Evaporation of abstracted water												
Transpiration												
Water incorporated into products												
Total use												

4.16. The physical flow account is separated into two tables – a supply table and a use table. Both tables have five main sections of data to enable tracking of the relevant flows of water from the environment to the economy (section I), within the economy (sections II, III & IV) and from the economy to the environment (section V).

4.17. The first section (I) records the total supply and use of water from the environment by type of source. The entries relating to abstraction of water from inland water resources – surface water, groundwater and soil water. The initial focus should be on recording information on abstraction from surface water and groundwater resources, for example for irrigation, for livestock or for aquaculture, as well as on abstraction of soil water by crops.

4.18. Water is also abstracted from the environment through direct collection of water from precipitation into storage tanks, and through desalination of seawater. These, and other sources of water are included to provide a full picture of water entering the economy in

4.19.

4.20. **Table 4.1**, Physical supply and use table for water.

4.21. The second section (II) records whether the water abstracted from the environment is distributed to other economic units or retained for own-use. Abstraction for own-use will be a common situation for agriculture, forestry and fisheries activities.

4.22. The last three sections (III, IV & V) of the table concern flows of water that follow the initial use of abstracted water. There are three possibilities: (i) the water is collected as wastewater before either being reused or returned to the environment, usually following treatment – recorded in section III; (ii) the water is returned directly to the environment – return flows which are recorded in section IV; or (iii) the water evaporates, transpires through plants or is embodied in products, recorded in section

V. A detailed explanation of each of these flows is provided in the SEEA Central Framework and the SEEA Water.

- 4.23. In some countries, the reuse of water, with or without treatment, may be an important part of agricultural processes. The physical flow account provides for the reuse of water to be recorded, both in terms of its generation and its use. It is noted that in cases where water is returned to surface water after use, e.g. to a river, and then further downstream the “same” water is abstracted for use, the flows should be recorded in gross terms to enable appropriate understanding of the total volume of water abstracted for agricultural purposes. The analytical aggregate of final water use (commonly known as water consumption) can be determined after recording all of the relevant accounting entries.
- 4.24. Abstraction of soil water refers to the uptake of water by plants and is equal to the amount of water transpired by plants plus the amount of water that is embodied in the harvested product (SEEA Central Framework 3.198). In the SEEA AFF, soil water is included in principle within scope, as its inclusion supports an assessment of the changing dynamic between rain-fed and irrigated agriculture and allows to draw a more complete picture on the use and availability of water resources.
- 4.25. In practice, the measurement of physical flows and stocks of soil water are difficult, as they can exhibit high variability over time and space within an accounting period and within the accounting boundary. One solution to overcome such problems is to use hydrology models, widely used in agricultural and ecological research, in consultation and engagement with experts in these fields.
- 4.26. As a simplification and alternative to the measurement of soil water, the compiler of SEEA AFF may choose to focus on recording the main inputs and outputs affecting soil moisture over an accounting period (i.e., precipitation and irrigation water as input, and actual evapotranspiration and runoff as output). Such an approach may be relevant particularly in relation to recording water flows and stocks associated with rainfed and irrigated agriculture. While such input output variables may still require some modelling, they are far easier to estimate than soil water variables.
- 4.27. In fact, in terms of assessing consumptive water use by agricultural crops (defined as the balance between actual evapotranspiration and precipitation minus runoff), neither accounting for soil water dynamics nor actual evapotranspiration may be relevant. Specifically, for rainfed agriculture, consumptive water use is by definition zero over one or more accounting periods. For irrigated agriculture, consumptive water use is equal to irrigation water.

4.2.3 Accounting entries – asset accounts

- 4.28. The asset account for water resources records the opening and closing stocks of assets and changes in stocks over an accounting period. This structure may be difficult to apply for water resources, because water is in constant motion and assessment of the functioning of the water cycle is usually of primary interest. Ideally, therefore, stocks of water resources should be measured at the river basin level to provide the most useful information to understand the availability of water and issues such as water stress.
- 4.29. The asset account for water resources is shown in
- 4.30.
- 4.31.

4.32. **Table 4.2.** The relevant accounting entries are described below.

Table 4.2 Asset account for water resources (cubic metres)

Asset account for water resources (cubic metres)

	Surface water				Groundwater	TOTAL
	Lakes	Rivers and streams	Artificial reservoirs	Glaciers, snow and ice		
Opening stock of inland water resources						
Additions to stock from the environment						
Precipitation						
Inflow from other territories						
Inflows from other inland water resources						
Other additions to stock						
Return flows from economy						
Total						
Reductions in stock from the environment						
Evapotranspiration						
Outflows to other territories						
Outflows to the sea						
Outflows to other inland water resources						
Other reductions in stock						
Abstraction by economic units						
Total						
Net change in stock of water resources						
Closing stock of inland water resources						

4.33. With regard to the opening and closing stocks, the scope of the asset account for water resources is limited to inland water resources – artificial reservoirs, lakes, rivers and groundwater.

4.34. The entries for additions and reductions to the stock of inland water resources reflect all flows of water that add to the opening stock of water resources. These entries are detailed in the SEEA Central Framework (section 5.11).

4.35. Where opening and closing stocks cannot be measured reliably, the measurement of the net change in the stock of water over an accounting period may be derived, provided each component series can be measured directly. The net change in stock can be interpreted as a measure of the water yield. Furthermore, following the previous discussions on physical water flows (4.22-4.23), in practice and as a first approximation soil water stocks can be assumed to be unchanged over one or more accounting periods.

4.2.4 Measurement issues and potential extensions

4.36. Various measurement issues should be considered in accounting for water resources. This section reviews some of them; documents such as SEEA Water and the International Recommendations for Water Statistics discuss them in greater depth.

4.37. First, although the accounts described above are applicable at the national level, information should ideally be recorded, and accounts compiled, at the catchment or river basin level. The aim of working at this level of detail is to focus on water resources that are most used in terms of water abstraction relative to the resources available. Compilation at the national level can mask significant variations between water catchments.

- 4.38. Second, water accounts should be compiled on a regular basis, ideally at least annually, particularly in catchments where pressure on water resources is high. Depending on rates of change in abstraction for industry or domestic consumption, water resources may become stressed more quickly than would be understood from long-term averages. In many cases sub-annual measurement of some variables could be considered with a view to accounting for seasonal variations in water availability.
- 4.39. The information in the SEEA AFF does not directly address the question of the overall sustainability of water resources in terms of the extent to which water is available to support economic and human activity. However, the following factors may help to organize information relevant to the issue.
- 4.40. First, assessment of sustainability for a given basin or country requires consideration of abstraction and other water-related activities of all industries and sectors, not only agriculture, forestry and fisheries. Focus on a narrow set of water users may misrepresent the pressures on water use. This is why the water accounts in the SEEA AFF are economy-wide in scope. At the same time, because agriculture is a significant user of water in many areas, consideration of use for agricultural activities is an important point.
- 4.41. Second, understanding how water is used in different activities is likely to be important. In line with the SEEA, water abstraction includes quantities of water used for particular activities and immediately returned to the environment. Examples include: i) hydropower generation, in which the final water use – abstractions less returns, commonly called water consumption – is small, but a large stock of water is required; and ii) aquaculture, in which water requirements will vary depending on the species of fish and the intensity of production.
- 4.42. A number of indicators will be relevant for assessing water resources, depending on the question to be answered. In some cases the focus will be the total quantity of water abstracted; in others it will be final water use.
- 4.43. Third, the water accounts in this section relate to quantities of water only. A complete assessment of water resources requires consideration of water quality and changes in water quality, particularly because quality may change for example within a river catchment and may be closely related to the sustainability of the water resources and their potential use.
- 4.44. Of particular relevance to agricultural, forestry and fisheries activity is the effects they may have on water quality, for example through residual flows of fertilizers and pesticides. These flows can have serious consequences, for example in the creation of “dead zones” in coastal areas near river mouths. The negative consequences of reductions in water quality for other economic activities such as fisheries could also be of interest.
- 4.45. The SEEA AFF does not discuss accounting for and measurement of water quality. Readers are referred to chapter VII of the SEEA Water for more detail, and to section 4.13 of the SEEA AFF for discussion of flows of fertilizers and pesticides to the environment.
- 4.46. The SEEA AFF does not go into detail regarding the treatment and definition of wastewater and reuse of water, but in some situations it may help in establishing the pattern of water use by agricultural, forestry and fisheries activities. Water abstracted by a landholder and returned to a river before re-abstraction by another user is not considered as re-use but as a return of the water to the environment. Many water-harvesting schemes and techniques exist in which multiple uses of water occur before final return to the environment. In such cases, recording and understanding the re-use of water may be relevant. The definition and appropriate recording of wastewater and reused water can be found in the SEEA Central Framework and SEEA Water.

- 4.47. In assessing the overall use of water resources by agricultural activities, the allocation of water use by type of agricultural product may not be required. Where the availability of water is constrained, however, information as to which products – usually crops – are using the largest amounts of water may be relevant in determining responses. In the SEEA AFF framework, it is also possible to link detailed water-use data with related production information, and hence to assess the relative importance of water for particular crops and production approaches.

4.3 Physical flow account for energy use

4.3.1 Measurement purpose and scope

- 4.48. The physical flow account for energy use records the direct use of energy, expressed in joules, by agricultural, forestry and fisheries activities and selected agricultural, forestry and fisheries products. Energy may be used in the form of coal, electricity, petrol and diesel fuels, biofuels, heat, solar power and wind power. Although all of these energy products may be used directly, often they are converted to electricity before their use by economic units. The focus of the physical flow accounts here is recording energy products in the form used directly by the agricultural, forestry or fisheries unit.
- 4.49. In their complete form, physical flow accounts for energy record energy flows in physical units: i) from the environment into the economy – energy from natural inputs; ii) within the economy – energy products; and iii) back to the environment – energy residuals. Details are given in section 3.4 of the SEEA Central Framework.
- 4.50. The physical flow accounts for energy are currently restricted to flows of energy used in agriculture, forestry and fisheries. Ideally, these data would be complemented by figures for the production of energy by the agriculture, forestry and fisheries sector, sources of energy used by those activities and other users,
- 4.51. In line with the SEEA Central Framework, the measure of energy use include the consumption of energy produced on own-account by an agricultural, forestry or fisheries unit. Production of this energy, will directly compete with energy purchased from outside sources, so they must be included to support a complete understanding of energy use and the changing structure of supply.

4.3.2 Accounting entries

- 4.52. The physical flow account for energy use is shown in **Table 4.3 Physical flow account for energy use (joules)**. The first column records the total supply of energy products, by type; these are described below. The “transformation of energy products” row relates to the use of energy products, such as coal, to produce other energy products such as electricity. Because the table focus on the use of energy by agricultural, forestry and fisheries activities, and because the transformation of energy products is not a primary activity of these units, there is no expansion of this aspect of energy use.
- 4.53. Most of the columns relate to the use of energy as an input to agriculture, forestry and fisheries activities, where possible by type of product. Various data sources will be required to compile data at this level of detail. Energy use by other industry groups such as manufacturing and electricity, households, and exports of energy products are recorded in order to establish an economy-wide context for energy use.
- 4.54. The tracking of energy flows into and through the economy must reflect the fact that the original source – coal or hydropower for electricity, for example – may be

transformed before final use in the economy. The use table for energy products must therefore distinguish between energy products used directly by final consumers and energy products used by transforming industries to generate new energy products that are then consumed. Not all energy products are used for energy purposes – oil-based products are used to produce plastic, for example – and it is relevant to distinguish different types of end use for products that are primarily considered to be for energy purposes.

4.55. The energy products in the use table are classified according to the Standard International Energy Product Classification (SIEC), which was developed in the preparation of the International Recommendations for Energy Statistics (UN, 2011) adopted by the United Nations Statistical Commission at its 42nd session in February 2011. The SIEC is expected to guide the collection and compilation of energy statistics at the national and international levels to enhance international comparability and the integration of energy statistics with other statistical domains.

- Coal (SIEC code 0) includes hard coal (SIEC code 01),
 - Peat and peat products (SIEC code 1) include peat (SIEC code 11), peat and peat products (SIEC code 12) and other peat products (SIEC code 129).
 - Gas (SIEC code 3) includes natural gas, liquid natural gas and biogas.
 - Oil (SIEC code 4) includes gasoline, liquefied petroleum gas, gas-diesel and residual fuel oil in fisheries.
 - Biofuel (SIEC code 5) includes modern biofuel, which is generated with modern technology and is highly efficient, and traditional biofuel, which is generated using traditional technology and has low efficiency.
 - Waste energy (SIEC code 6) is energy produced by converting solid waste into an energy product.
-
- Electricity (SIEC code 7) describes the amount of electricity, expressed in terajoules, used in agriculture.
 - Heat (SIEC code 8) is energy diffused among the particles in a substance or system by means of the kinetic energy of the particles.
 - Nuclear fuels and other fuel (SIEC code 9) provide energy through the splitting of the nucleus of an atom – fission – or combining two atoms into a single atom – fusion.

Table 4.3 Physical flow account for energy use (joules)

Physical flow accounts for energy (joules)

	TOTAL SUPPLY	Agriculture, Forestry, Fisheries										Total Agriculture	of which: from own-account production	Total Forestry	of which: from own- account production	Total Fisheries	of which: from own- account production	Other industries	Households	Exports	TOTAL USE
		Agriculture																			
		Maize	Rice	Wheat	Palm oil	Sugar	Potatoes	Other food crops	Non-food crops	Total crops	Livestock										
USE OF ENERGY																					
Transformation of energy products																					
End-use of energy products																					
Coal																					
Hard coal																					
Peat and peat products																					
Gas																					
Natural Gas (including LNG)																					
Biogas																					
Oil																					
Liquefied petroleum gas (LPG)																					
Gas-diesel oil																					
Gasoline																					
Residual fuel oil																					
Biofuel																					
Waste																					
Electricity																					
Heat																					
Nuclear fuels and other fuel nec																					
Total																					

4.56. The initial measurement focus should be the total energy use by product or activity – the bottom row of the table – and the mix of energy products at the level of all agriculture, forestry and fisheries and other industries. For this reason the area of the table showing the use of individual energy products in agricultural products is shaded. It may be possible to develop such estimates using various assumptions and modelling techniques.

4.3.3 Measurement issues and possible extensions

4.57. The main issue concerning the measurement of energy in the SEEA AFF is the lack of articulation of stocks and flows related to the supply of energy. Two potential extensions are considered here.

4.58. First, it is likely to be relevant to organize information on the production of biomass that is subsequently used for the production of biofuels and other energy products such as biogas. For example, certain types of maize can be grown specifically to produce biofuels. In other cases, the generation of energy products represents joint production: the generation of energy from sugar cane is an example. The production of biofuel is not necessarily an input to agricultural, forestry and fisheries activity, but information on the land and water used and emissions generated will be relevant in understanding the food-water-energy-climate nexus.

4.59. One solution to accommodate this demand would be an extension of the physical flow account for energy use described above. The SEEA AFF may in future be extended in this way. At this stage, where there is interest in understanding the physical flows of biomass associated with the production of energy products, it is noted that relevant information is recorded in the physical flow accounts for crops and forestry products. These accounts record the volume of biomass used in the generation of energy products. Using appropriate conversion factors these estimates of volume may be converted to joules to support extended analysis.

4.60. Second, it may be of interest to understand the direct production of energy products by agriculture, forestry and fisheries units and the extent to which these energy products are sold to other units or used on own-account. For example, energy may be captured directly by solar panels or wind turbines located on agricultural properties. This may be an important source of income (for example if electricity is sold to a national grid) but may also be used in for example, the abstraction of groundwater (e.g. using windmills). The production of energy products may also be in the form of fuels (e.g. wood fuel) to run machinery or generate electricity.

4.61. The inclusion of “of which” columns next to the columns for total energy use for each activity to record the quantity of energy sourced from own account production facilities the analysis of the use of energy produced and used on own account. As further step, income earned from the sale of energy products should be included in Tables 3.10 and 3.11 as appropriate.

4.62. At the aggregate economic level, the SEEA Energy and the SEEA Central Framework physical flow accounts for energy map the full range of energy sources with the uses of energy by different activities. Additional information may be required, however, to assess the extent to which the electricity consumed by agriculture, forestry and fisheries could be recorded by original source – coal, nuclear, wind or solar; it should be noted that there would be no need for this extension to connect to energy use also at the product level. If such mapping were undertaken, the sustainability of energy supply in terms of the mix of renewable and non-renewable sources would have to be

considered. It is not, however, the intention of the SEEA AFF to develop extensions of this type because this area of work is covered by SEEA Energy.

- 4.63. Given the links between the measurement of energy use and estimates of greenhouse gas emissions by agriculture, forestry and fisheries, estimates of greenhouse gas emissions will depend on estimates of energy use.

4.4 Physical flow account for air emissions

4.4.1 Measurement purpose and scope

- 4.64. The measurement of anthropogenic greenhouse gas (GHG) emissions has emerged as an important issue for agricultural, forestry and fisheries statistics in recent years. On the one hand, countries already report their emissions from agriculture, forestry and other land use through their national GHG inventories, following the guidelines of the Intergovernmental Panel on Climate Change (IPCC), to the United Nations Convention on Climate Change (UNFCCC). On the other, emissions from agriculture, forestry and fisheries may represent a significant proportion of total national emissions, especially in developing countries, so that planning in these sectors is critical for meeting national mitigation goals as set in Nationally Determined Contributions (NDCs) under the Paris Agreement.

- 4.65. The physical flow account described in the SEEA AFF extends the air emissions account of the SEEA Central Framework by focusing on the GHG emissions from agriculture, forestry and fishing. Emissions are recorded across the three relevant subgroups of ISIC A: *i*) crop and animal production, hunting and related service activities (ISIC A01); *ii*) forestry and logging (ISIC A02); and *iii*) fishing and aquaculture (ISIC A03).

- 4.66. The SEEA AFF account thus facilitates the analysis of mitigation actions in the context of the national economy, for instance through the computation and use of relevant indicators. Specifically, national GHG emissions at the national level are linked to the production and flows of goods and services from ISIC A as well as from other industries. The account allows deriving consistent indicators for policy analysis, such as GHG emissions per unit of value added and per unit of output.

4.4.2 Accounting entries

- 4.67. The SEEA AFF physical flow account for air emissions is shown in **Table 4.4**. The account structures information on the air emissions from agriculture, forestry and fisheries activity from *i*) a perspective on the diverse activities within agriculture; as well as *ii*) from a perspective of selected agricultural, forestry and fishery products. The perspective on agricultural activities enables a correspondence mapping with the measurement and reporting processes of the UNFCCC, following IPCC guidelines, as detailed in the section below. The perspective on products enables a link with production, trade, consumption and other environmental flows in the SEEA AFF framework, with a view to facilitate creation of useful indicators.

- 4.68. The initial focus should be on estimating total GHG emissions from agricultural, forestry and fisheries activities using the activity perspective, while considering a subset of selected products of national interest (i.e. the total across the columns for a single product). There is no requirement to collect data on the mix of products and activities directly, but it may be relevant to consider the link between activities and products when preparing aggregate estimates.

4.4.3 Correspondence to IPCC: System Boundaries and Classifications

- 4.69. The SEEA AFF (Tab 4.4) account provides a mapping of SEEA AFF to IPCC categories, in particular of ISIC A to the *Agriculture, Forestry and Other Land Use* (AFOLU) sector of IPCC. This mapping aims at facilitating the use of SEEA analyses in support of the UNFCCC process. It provides guidance to SEEA AFF compilers towards the estimation of GHG emissions from ISIC A activities by using the internationally established IPCC methodologies.
- 4.70. To this end, SEEA AFF compilers can use IPCC categories⁷ Agriculture, Forestry and Other Land Use, Energy, to estimate ISIC A emissions, as follows:
- 4.71. ISIC A01 emissions can be estimated using IPCC categories Agriculture — including synthetic fertilizers, rice cultivation, drainage of organic soils, crop residues, burning crop residues, enteric fermentation, manure management, manure applied to soils, or manure left on pasture; Land Use—cropland, grassland; Energy—for instance, fuel use for farm machinery.
- 4.72. ISIC A02 emissions can be estimated using IPCC categories Land Use: forest land; Energy—for instance, fuel used for logging machinery; and others. ISIC A03 emissions, that are covered by the SEEA AFF but which do not have a correspondence within IPCC AFOLU categories, can be estimated by linking to relevant IPCC categories in Energy—for instance fuel use in fishing vessels or to operate refrigeration.
- 4.73. When using the mapping to IPCC and related national inventory data, compilers should keep in mind critical differences between the two accounting frameworks, as described below.
- 4.74. The SEEA AFF follows the residence principle, i.e., reports emissions from national economic activities regardless of where these activities occur. The IPCC follows the territorial principle, i.e., records the emissions that are generated within the national territory, regardless of who is causing the emissions. In practice, these differences may result in significant accounting differences in emissions accounting for international shipping and transport activities. This may be relevant in small island nations with significant fishing activities.
- 4.75. While the SEEA AFF account links the GHG emissions to relevant economic activities, the IPCC categories focus on the underlying biophysical processes and on the type of GHG. For instance, emissions from the same ISIC A activity of crop cultivation would be recorded under IPCC into at least two categories, distinguishing between its CO₂ and non-CO₂ emissions.
- 4.76. In its Manual on Air Emission Accounts, Eurostat provides a comprehensive list of specific cases that facilitates understanding the distinctions between the recording of emissions under the IPCC and SEEA. It should be noted however, that several IPCC AFOLU categories are excluded from the scope of EUROSTAT accounts, mostly on the basis of difficulties in estimation, rather than on conceptual grounds.

⁷ IPCC 2006. Guidelines for national GHG inventories, <https://www.ipcc.nggip.iges.or.jp/public/2006gl/>

Table 4.4 Physical flow account for air emissions (gigagrams of CO2 equivalent)

ISIC A AGRICULTURE FORESTRY AND FISHING																				All Other ISIC		TOTAL
ISIC A01 Crop and animal production, hunting and related service activities														ISIC A02 Forestry and logging			ISIC A03 Fishing and aquaculture		Total Supply & Use	Total Supply & Use	Total Supply & Use	
Correspondence Mapping to IPCC/UNFCCC														Correspondence Mapping to IPCC/UNFCCC			Correspondence Mapping to IPCC/UNFCCC					
Syntetic Fertilizers	Rice Cultivation	Drainange of Organic Soils	Crop Residues	Burning Crop Residues	Enteric Fermentation	Manure Management	Manure Applied to Soil	Manure left on Pasture	Crop land	Grass land	Energy	Other	Forest Land	Energy	Other	Energy	Other					
Type of Substance																						
Greenhouse Gases																						
Carbon Dioxide																						
Methane																						
Nitrous oxide																						
Total GHG in CO2eq																						
Other Air Pollutants																						
Dinitrogen oxide																						
Hydrofluorocarbons																						
Perfluorocarbons																						
Sulphur hexafluoride																						
Carbon monoxide																						
Non-methane volatile organic compounds																						
Sulphur dioxide																						
Ammonia																						
Heavy metals																						
Persistent organic pollutants																						
Particulates (including PM10 and dust)																						
GHG: CO2eq by Product																						
Crops Primary																						
Cereals																						
Pulses																						
Fodder Crops																						
Other crops																						
Livestock																						
Cattle and Buffaloes																						
Sheep and Goats																						
Pigs																						
Other livestock																						
Gross Fixed Capital Formation in Land																						
Land Transformation																						
Land Conversion																						

4.4.4 *Measurement issues and possible extensions*

- 4.77. The following clarification is provided with respect to the scope of the GHG emissions in the SEEA AFF account. Both emissions and removals by ISIC A activities should be compiled in **Table 4.4**, in line with the SEEA CF Paragraph 3.243. The SEEA AFF includes the emissions and removals directly linked to an ISIC A activity, for instance emissions from soil cultivation and land clearance, or carbon sequestration in biomass and soils due to specific land management choices.
- 4.78. Following the generic implementation approach of the SEEA AFF discussed earlier in this document, i.e. in terms of adopting Tiers of successive data complexity to aid compilation, it is noted that the SEEA AFF air emissions accounts could be compiled at Tier 1 using the IPCC default, or Tier 1, methodology and coefficients. At this initial level of complexity, most land-based emissions can be reported on a net basis, i.e., the net of emissions minus removals. Reporting using higher tiers may allow further separation of gross fluxes. In an economy wide setting, net flux reporting is however sufficient. Nonetheless, from a national accounts perspective, a gross basis would permit more appropriate attribution of flows to specific activities of interest. As a practical step, SEEA AFF compilers may consider indicating the Tier level used for compiling.
- 4.79. Relevant data for compiling SEEA AFF accounts may be available from UNFCCC inventories and national reports. Reference Tier 1 data consistent with Tab. 4.4 of the SEEA AFF are available from FAOSTAT, for all countries over the time period 1961-present⁸.

4.5 Physical flow accounts for fertilizers, nutrient flows and pesticides

4.5.1 *Measurement purpose and scope: fertilizers and pesticides*

- 4.80. Fertilizers and pesticides are frequently used in agriculture, forestry and fisheries practice. It is important to quantify the flows of fertilizer and pesticide use because of their relative cost in production, because of their potential effects on surrounding ecosystems, and because it is not possible to accurately assess the merits of alternative production practices (such as organic farming systems) without good measures of the intensity of chemical usage.
- 4.81. The use of an accounting approach for recording these flows facilitates comparison of data on the use of fertilizers and pesticides with data on other measures of agriculture, forestry and fisheries activity such as production, consumption and trade.
- 4.82. Data on inorganic fertilizers may be recorded in terms of product weight (in tonnes) or nutrient content (e.g. tonnes of active nutrients - nitrogen (N), phosphate (P) and potassium/potash (K), as defined by FAO. For consistency, data used in the physical flow account should be converted to a common nutrient basis in line with the FAO standard practice “nutrient principles”. This will facilitate comparison between countries and over time, and support coherence in measuring variables such as production, consumption, imports and exports.
- 4.83. It is well known that organic fertilizers are important sources of nutrients and are needed to maintain long-term soil health. Organic fertilizers may also represent an important part of the overall functioning of rural systems being a source of energy for households as well as an input to agriculture. In theory, designing a supply and use

⁸ FAOSTAT Emissions database, at <http://www.fao.org/faostat/en/#data/GT> and <http://www.fao.org/faostat/en/#data/GL>

table for the output of organic fertilizers, including own-account production, and their use in agriculture, forestry and fisheries is straightforward. These elements for various categories of organic fertilizer have been developed in **Table 4.5**. Internationally agreed methods for the estimation of the supply and use of organic fertilizers such as manure, compost and crop residues are well developed with respect to flows of N but are still under discussion with respect to P and K. Estimates of the relevant flows may emerge from the derivation of nutrient budgets (see section 4.13.2) and also as part of the estimation of GHG emissions in section 4.4. Global data with country detail is available on FAOSTAT⁹.

- 4.84. Data on pesticides are available in terms of product weight and active ingredient content. Although there is not a universal standard measurement for measuring the intensity of pesticide use, the SEEA suggests measuring use in terms of active ingredients. One concern with this approach is that it does not account for the differing potencies of active ingredients or their differing environmental impacts.
- 4.85. The SEEA AFF measures the supply and use of fertilizers and pesticides by focusing on the balance of flows within the economy. This ignores the effects on local and neighbouring environments in terms of soil, water and air quality, however. One approach to assessing these effects is to measure nutrient cycles; another is to develop measures of water quality and soil quality and monitor them over time. This area of measurement is still developing from an accounting perspective and is connected to developments in ecosystem accounting.

4.5.2 Measurement purpose and scope: nutrient flows

- 4.86. To obtain a general picture of flows of nutrients and fertilizers, flows of nitrogen and phosphorous may be traced from extraction to movement in and subsequent return to the environment with a view to understanding factors affecting the relationship between agriculture and the environment such as: i) the sustainability of extracting nitrogen and phosphorus from the environment, particularly the latter; ii) nutrient levels in the soil relative to the application of nitrogen and phosphorus; and iii) flows of excess nitrogen and phosphorus to the environment, including to inland and coastal water systems and ammonia emissions to the atmosphere. A more complete assessment would also require understanding of the method and timing of application of nutrients and fertilizers since this can have a substantial bearing on the potential environmental impacts.
- 4.87. An international programme of work on the measurement of nutrient budgets and balances led by the European Commission and OECD issued its most recent measurement guidance, Nutrient Budgets (EC & OECD, 2013), setting out the concepts, sources and methods relevant to the measurement of nutrient flows. For the SEEA AFF, only a brief introduction to this guidance is required. Nutrient budgets cover flows of nitrogen and phosphorous in and across a defined boundary such as a country in a given timeframe, typically a year. They also track stocks and changes in stocks of nitrogen and phosphorous within the boundary. The data cover the relevant media – water, air and soil – and relevant economic sectors.
- 4.88. The basis for measuring nutrient budgets is tracking the nitrogen and phosphorous cycles, including the processes of nitrogen fixation, mineralization and ammonification and the transformation of phosphorous in soils. Through consistent measurement of each part of these cycles an overall indication of change can be obtained, as well as measures of surpluses or deficits of nitrogen and phosphorus.

⁹ see FAOSTAT Fertilizers by Nutrient <http://www.fao.org/faostat/en/#data/RFN> and FAOSTAT Livestock Manure <http://www.fao.org/faostat/en/#data/EMN>

- 4.89. Given the established framework for the measurement of nutrient budgets, no tables or additional advice is provided in the SEEA AFF. In this respect, nutrient budgets are a good example of physical flow accounting as envisaged in the SEEA Central Framework. Countries should implement the methods described in the European Commission and OECD guidance: organizing data in SEEA AFF base accounts will support the measurement process and may improve the coherence of estimates.
- 4.90. Where nutrient budgets are estimated, various measures of interest (e.g. gross nitrogen surplus, phosphorous surplus and ammonia emissions) can be incorporated into SEEA AFF outputs, including into combined presentations.

4.5.3 Accounting entries for fertilizers

- 4.91. The physical flow account for fertilizers is shown in **Table 4.5 Physical flow account for fertilizers (tonnes of nutrient equivalent)**. It records the supply and use of inorganic and organic fertilizers in terms of active nutrients. The account is divided into a supply table and a use table; total supply must equal total use.

Supply table entries

- 4.92. For inorganic fertilizers, the “output” entry refers to the total quantity of synthetic fertilizer produced at the national level, expressed in tonnes of nutrient equivalent.
- 4.93. For organic fertilizers, flows related to N, P and K are recorded. There are two types of supply that are recognised. The first concerns the situation where N, P and K are effectively applied “in situ” as a result of agricultural and land management activity. Three cases are included in the table – urine and dung from grazing animals (N, P and K), crop residues (N only) and the case where there is mineralisation of N when carbon (C) is lost as a result of land use change (e.g. clearing forest land for grazing or cropping).
- 4.94. The second type of supply is where organic fertilizer is collected or manufactured (potentially as a by-product of other processes). The scope here includes manure, compost, sewerage sludge and other organic sources such as guano and rendering and brewery waste. The N, P and K content for collected manure is recorded in the output column. For the other sources just the supply of N is shown in this table but coverage could be extended to P and K as required.
- 4.95. The entry for “imports” refers to the quantity of inorganic and organic fertilizers in tonnes of nutrient equivalent that are imported.

Table 4.5 Physical flow account for fertilizers (tonnes of nutrient equivalent)

Physical flow account for fertilizers (tonnes of nutrient equivalent)

	Output	Imports	TOTAL SUPPLY	Intermediate consumption														Changes in inventories			Exports	TOTAL USE
				Maize	Rice	Wheat	Palm oil	Sugar	Potatoes	Other food crops	Non-food crops	Livestock grazing	Other agriculture	Total agriculture	Forestry	Fisheries	Other industries	Total	Household final consumption	Losses		
Inorganic fertilizers																						
Nitrogen Fertilizers (N total nutrients)																						
Phostate Fertilizers (P ₂ O ₅ total nutrients)																						
Potash Fertilizers (K ₂ O total nutrients)																						
Organic fertilizers (N, P2O5, K2O)																						
In situ sources																						
Urine/dung from grazing animals																						
Nitrogen (N)																						
Potash (P2O5)																						
Phosphate (K2O)																						
Crop residues (N)																						
Mineralisation of N with loss of C during land use change (N)																						
Application of organic fertilizers																						
Collected manure																						
Nitrogen (N)																						
Potash (P2O5)																						
Phosphate (K2O)																						
Compost (N)																						
Sewerage sludge (N)																						
Other (N)																						

Use table entries

- 4.96. The “intermediate consumption” entry refers to “consumption in nutrients” – the total amount of organic and inorganic fertilizers, expressed in tonnes of nutrients, applied to soil to increase crop yield, or the total quantity of fertilizer consumed by a country for agriculture production. Information on the intermediate use of fertilizers should be allocated to key agricultural products, primarily crops and pastures, to show the intensity of fertilizer use by crop type. Consumption by other industries covers use by, for example, municipal parks and golf courses.
- 4.97. The “household final consumption” entry refers to the total quantity of fertilizer products, expressed in nutrient equivalent, consumed by households for non-productive purposes. For inorganic fertilizers this will include activities such as fertilizing gardens and lawns. For organic fertilizers this will include garden use and also, in some countries, the use of manure as an energy source.
- 4.98. The entry for “changes in inventories – losses” refers to the quantity of fertilizer products, expressed in nutrient equivalent, lost during the year in storage and transport between production and final use. It does not include quantities applied to the soil but not taken up by plants or residual flows to the environment.
- 4.99. The “changes in inventories – other changes” entry comprises changes in inventories occurring during the reference period at all stages between production and retail – changes in stocks held by the government, manufacturers, farms, importers, exporters, wholesale and retail merchants and transport and storage enterprises. It excludes losses in inventories.
- 4.100. The “exports” entry refers to the quantity of fertilizers in nutrient equivalent tonnes exported.
-

4.5.4 Accounting entries for pesticides

- 4.101. The physical flow account for pesticides is shown in **Table 4.6**. It records the supply and use of pesticides in terms of active ingredients in eight pesticide groups as defined by FAO (see below). The account is divided into a supply table and a use table; total supply must equal total use.

Table 4.6 Physical flow account for pesticides (tonnes of active ingredients)

	Intermediate consumption																		Changes in inventories		
																		Household final consumption			
	Output	Imports	TOTAL SUPPLY	Maize	Rice	Wheat	Palm oil	Sugar	Potatoes	Other food crops	Non-food crops	Other agriculture	Total agriculture	Forestry	Fisheries	Other uses	Total		Losses	Other changes	Exports
Product																					
Insecticides																					
Mineral Oils																					
Herbicides																					
Fungicides & Bactericides																					
Seed Treatments, Fungicides																					
Seed Treatment, Insecticides																					
Plant Growth Regulators																					
Rododentices																					
Total																					

The eight FAO pesticide groups are outlined below and these are used to structure information for the supply and use table. Other classifications of pesticides may also be appropriate.

- i. Insecticides (FAO code 1309) – chlorinated hydrocarbons, organophosphates, carbamates-insecticides, pyrethroids, botanical and biological products and others (not classified elsewhere).
- ii. Mineral oils (FAO code 1354).
- iii. Herbicides (FAO code 1320) – phenoxy hormone products, triazines, amides, carbamates-herbicides, dinitroanilines, urea derivatives, sulfonyl ureas, bipiridils, uracil and others (not classified elsewhere).
- iv. Fungicides and bactericides (FAO code 1331) – inorganics, dithiocarbamates, benzimidazoles, triazoles, diazoles, diazines, morpholines and others (not classified elsewhere).
- v. Seed treatments, fungicides (FAO code 1331) – dithiocarbamates, benzimidazoles, triazoles, diazoles, botanical and biological products and others (not classified elsewhere).
- vi. Seed treatments, insecticides (FAO code 1353) – organo-phosphates, carbamates-insecticides, pyrethroids and others (not classified elsewhere).
- vii. Plant growth regulators (FAO code 1356).
- viii. Rodenticides (FAO code 1345) – anti-coagulants, cyanide generators, hypercalcaemics, narcotics and others (not classified elsewhere).

Supply table entries

- 4.102. The “output” entry refers to the total quantity of pesticides produced at the national level expressed in tonnes of active ingredients.
- 4.103. The “imports” entry refers to the quantity of pesticides products imported, in tonnes of active ingredients.

Use table entries

- 4.104. The entry for “intermediate consumption – agriculture industry” refers to the quantity of pesticide products, expressed in tonnes of active ingredients, consumed as inputs in agricultural production. Information on the intermediate use of pesticides should be allocated to key agricultural products, primarily crops and pastures, to show the intensity of pesticide use by crop type.
- 4.105. The “intermediate consumption – forestry” entry refers to quantities of pesticide products used in forestry, expressed in tonnes of active ingredients.
- 4.106. The “intermediate consumption – fisheries” entry refers to quantities of pesticide products used in fisheries, expressed in tonnes of active ingredients.
- 4.107. The “intermediate consumption – other uses” entry refers to quantities of pesticide products used in industries other than agriculture, forestry and fisheries, expressed in tonnes of active ingredients.
- 4.108. The entry for “household final consumption” refers to the total quantity of pesticide products, in tonnes of active ingredients, consumed by households during the reference period for non-productive purposes such as treating garden plants.
- 4.109. The “changes in inventories – losses” entry refers to the quantity of pesticide products, in tonnes of active ingredients, lost in storage and transport during the year

from the point of production to final use. It excludes residual flows of pesticides to the environment after application.

4.110. The entry for “changes in inventories – other changes” comprises changes in inventories during the reference period from production to retail – changes in stocks held by the government, manufacturers, farms, importers, exporters, wholesalers, retailers and transport and storage enterprises. It excludes losses in inventories.

4.111. The “exports” entry refers to quantities of pesticides products, in tonnes of active ingredients, exported.

4.5.5 Measurement issues and possible extensions

4.112. Most of the issues related to accounting for fertilizers and pesticides are captured above. A few additional points are made here. First, while some important sources of organic fertilizers have been included in the base account for fertilizers, there are additional sources that may be of interest, for example, lime and biochar. There may also be interest in recording flows of other elements in addition to N, P and K. In theory, all elements contained in organic fertilizers could be accounted for in the supply and use tables, but this has not yet been developed. It is noted that many flows related to organic fertilizers will be captured in the measurement of nitrogen and phosphorus cycles.

4.113. Second, the measurement of pesticides in terms of tonnes of active ingredients is a starting point for assessing the extent of pesticide supply and use. Measurement in tonnes, however, may mask the potential impact of certain pesticides with high levels of toxicity relative to their mass. Adjusting for toxicity and hence risk factors is beyond the accounting framework, but is important from decision-making and policy perspectives.

4.114. Third, there may be interest in distinguishing the use of fertilizers and pesticides between conventional agriculture and organic farming. To the extent that output can also be distinctly recorded for these two farming practices, single factor measures of productivity could be derived.

4.115. Fourth, work on the measurement of fertilizer and pesticide flows will link to other areas of the SEEA AFF framework, particularly the condition of soil resources. Accounting frameworks for soil resources require further development (see section 4.7).

4.116. Fifth, there are links to the measurement of greenhouse gas emissions and the quality of water resources. Measures of water quality, for example taking eutrophication into account, are likely to be important in understanding the sustainability of fisheries activity.

4.6 Asset accounts for land

4.6.1 Measurement purpose and scope

4.117. The SEEA Central Framework section 5.6 describes the various aspects of accounting for land, particularly the distinction between land use and land cover. In line with the definitions in the SEEA Central Framework:

- i. Land use reflects both (a) the activities undertaken and (b) the institutional arrangements put in place in a given area for the purposes of economic production or the maintenance and restoration of environmental functions (SEEA Central Framework, 5.246).

- ii. Land cover refers to the observed physical and biological land cover of the Earth's surface, and includes natural vegetation and abiotic (non-living) surfaces (SEEA Central Framework, 5.257).
- 4.118. For SEEA AFF purposes, both land use and land cover are relevant. Land use information is valuable in studies of agricultural, forestry and fisheries production, food security and cropping intensity. Using the SEEA CF Land Use classification, the SEEA AFF applies a special focus to facilitate analysis of ISIC A activities. Specifically, it proposes a simplified grouping of SEEA CF categories into Agriculture, Forestry and Other Land Use. The latter grouping is aligned with current FAO land use classes¹⁰. Land cover information is relevant for understanding the changing composition and condition of a country's ecosystems, including its agricultural and forest landscape. Land use and cover information can be used together in understanding a country's agricultural sector and in deriving environmental indicators such as those related to land conservation or clearance, for instance afforestation and deforestation.
- 4.119. Apparent mismatches between land use and land cover information are frequent. The area of land used or set aside for forestry, for example, may include recently logged and cleared areas that do not satisfy the criteria for forests (i.e. areas covered with trees) from a land-cover perspective. For this reason, it is relevant from the SEEA perspective to distinguish between land use and land cover and account for each concept separately.
- 4.120. Given the focus on economic activity in the SEEA AFF, areas in a country used for agriculture, forestry or fisheries, including coastal waters, should be identified first. Changes in these areas – for example, in terms of increasing areas of land being used for agriculture compared with forestry, or decreasing areas of agriculture resulting from urban expansion – can be monitored using these data to show the changing mix of land use. Consideration should be given to economy-wide programmes of work on land accounting, because integration of data among large-scale projects is likely to bring significant advantages.
- 4.121. For land use and land cover accounts, the starting point is a country's land territory, including land area and the area of inland water resources such as rivers and lakes. If marine areas are a significant asset, they should be included, particularly for assessments of coastal and marine fisheries activity. The SEEA AFF categories include to this end coastal waters as well as Exclusive Economic Zones.
- 4.122. A major purpose of accounting is to track change over time. The SEEA Central Framework and the SEEA AFF recommend that accounts be compiled annually, to encourage connections with the SNA. For land accounting, however, particularly at large or national scales, the rate of change in land use or land cover may be incremental and accounting at five-to-ten-year intervals may be more appropriate.
- 4.123. Where there are clear, on-going changes in land cover and land use, for example through consistent patterns of deforestation or urbanization, it is recommended that annual accounts be compiled to ensure that regular monitoring is established; this also applies where the mix of cropping types, for example from temporary to permanent crops, is changing on a consistent basis.
- 4.124. The land asset accounts in the SEEA incorporate information on the composition of land in terms of area only; they do not take into consideration changes in the quality of land such as changes in soil or ecosystem condition. These qualitative aspects may be included in accounting for individual environmental assets such as soil and timber resources, or in ecosystem accounting.

¹⁰ FAO Land Use, Irrigation and Agricultural Practices Questionnaire, at: <http://www.fao.org/economic/ess/ess-home/questionnaires/en/>

- 4.125. Asset accounts in monetary terms for land used for agriculture, forestry and fisheries may be of interest. Such accounts are described in the SEEA Central Framework Section 5.6.5. The SEEA Central Framework also notes the possibility to compile asset accounts for land in terms of land ownership. There are some particular measurement challenges involved in valuing land for specific activities that are explained further in section 4.6.3. Consequently, a monetary asset account for land is not yet articulated in the SEEA AFF.

4.6.2 Accounting entries

- 4.126. The physical asset account for land use (**Table 4.7**) facilitates land accounting for crop, livestock, and fisheries production. Based on the SEEA CF account, it introduces specific aggregates, following FAO land use classes, such as ‘Agricultural Land,’ ‘Cropland,’ ‘Arable Land,’ and ‘Other Land.’ Additional entries are provided to account for both capture fisheries and aquaculture activities taking place on inland waters, coastal waters and the EEZ (See Annex III).

Table 4.7 Physical asset account for land use (hectares)

	Opening stock	Additions to stock	Reductions in stock	Net changes in stock	Closing stock
Land					
Agriculture					
Agricultural Land					
<i>Cropland</i>					
Arable Land					
Temporary Crops					
Temporary Meadows and Pastures					
Temporarily Fallow					
Permanent Crops					
Permanent Meadows and Pastures					
Land Under Protective Cover					
Forestry					
Forest Land					
Other Wooded Land					
Other Land					
of which: Land used for Aquaculture					
Inland Waters					
of which: Inland Water used for aquaculture or holding facilities					
of which: Inland Water used for capture fisheries					
Coastal Waters					
of which: Coastal Water used for aquaculture or holding facilities					
of which: Coastal Water used for capture fisheries					
Exclusive Economic Zone (EEZ)					
of which: EEZ used for aquaculture or holding facilities					
of which: EEZ Water used for capture fisheries					

- 4.127. In general, the physical asset accounts for land records the opening and closing stock of land area, in hectares (ha), classified by type of land use and also supports the recording of changes in land use over an accounting period through additions to stock and reductions in stock. At this stage, it is recommended that focus is placed on measurement of the opening and closing stocks and the net change in stock, so that where data on additions and reductions in stock are not available, the asset account can still be compiled.
- 4.128. For SEEA AFF purposes, information on land use should also be allocated by key agricultural product. This will involve the collation of different sources of information and allowances for variations in cropping practices. Ideally, it would be possible for the classes of land use (in particular arable land, permanent crops and permanent meadows and pastures) to be directly attributed to individual crop and product types. However, two factors mean that this is not possible in most circumstances. First, there are cases where within one area of land multiple crops may be grown at the same time – for example in intercropping and alley cropping systems. Second, there will be cases where more than one crop is grown through the course of a year – for example, two (and sometimes three) crops of rice may be harvested from one area.
- 4.129. In both cases, there are often data available on the total area harvested by crop type. However, due to these types of multiple cropping, the sum of the area harvested will be greater than the total area of land. This is a problem from an accounting perspective since there is no initial constraint or boundary on the total area that might be harvested. Conceptually, it is possible to make adjustments such that the sum of the area harvested by crop type would correspond to the total available area of land according to the land use classes in Table 4.8. This would require making adjustments to the area harvested on the basis of cropping intensity factors.
- 4.130. Countries are nonetheless encouraged to maintain data on the area harvested by crop type and changes in this area over time, to support this type of analysis. These variables are routinely collected by FAO via its crop production questionnaires. Further, a general indicator of total area harvested to total arable land and permanent crops may be useful in understanding the changing intensity of agricultural production over time.
- 4.131. The area of forestry is defined in accordance with the area of land supporting the forest asset accounts in section 3.7, so the area of land used for forestry covers forest land and other wooded land.
- 4.132. Beyond the measurement challenges concerning multiple cropping described above, there are also challenges where there are multiple land uses, perhaps on a seasonal basis. For example, grazing in land used for forestry or seasonal use of inland water areas for cropping and grazing during dry seasons. As for the case of multiple cropping, adjustments may be made to ensure aggregation is constrained to the total land area.
- 4.133. The following paragraphs describe the main accounting entries for the asset account for land use.
- 4.134. The “opening stock” entry is the total amount of land area and area of inland waters, in hectares and by land use type, available at the beginning of the reference period – arable land, permanent crops, permanent meadows and pasture, forestry, land used for aquaculture, built up areas, and land used for maintenance and restoration of environmental functions.
- 4.135. Regarding the entry for “additions and reductions in stock”, there are various reasons for changes in the stock of land over an accounting period, particularly between different types of land use. The SEEA Central Framework distinguishes between managed and natural expansion or reduction: the former is an increase or decrease in

the area resulting from human activity, the latter is an increase or decrease in area resulting from a natural process. The SEEA AFF does not give detailed specifications for these entries, but the asset account for land use in the SEEA Central Framework should be used if the data are available.

- 4.136. In the “net change in stock” entry net change is simply the difference between closing stock and opening stock if information on additions and reductions in stock is not available.
- 4.137. The “closing stock” entry is equal to the total area of land or inland waters, in hectares, available at the end of the reference period. The closing stock of a given year constitutes the opening stock of the following year.
- 4.138. The physical asset account for land cover is shown in **Table 4.8**. It records the opening and closing stock of land, in hectares, classified by type of land cover and the changes in land cover over an accounting period through additions to stock and reductions in stock. At this stage the focus of accounting in the SEEA AFF should be the opening and closing stock and the net change in stock, so that where data on additions and reductions in stock are not available, the asset account can still be compiled.

Table 4.8 Physical asset account for land cover (hectares)

	Opening stock	Additions to stock	Reductions in stock	Net changes in stock	Closing stock
Land cover classes					
Artificial surfaces					
Herbaceous crops					
Woody crops					
Multiple or layered crops					
Grassland					
Tree covered areas					
Mangroves					
Shrub covered areas					
Shrubs regularly flooded					
Sparsely vegetated areas					
Terrestrial barren land					
Permanent snow and glaciers					
Inland water bodies					
Coastal water bodies					
TOTAL AREA					

- 4.139. The following paragraphs describe the main accounting entries for the asset account for land cover.
- 4.140. The “opening stock” entry records the total area of land, in hectares, by type of land cover at the beginning of the accounting period.
- 4.141. With regard to the “additions and reductions in stock”, there are various reasons for changes in the stock of land cover during an accounting period, particularly between different types of land cover. The SEEA Central Framework distinguishes

between managed and natural expansion or reduction: the former is an increase or decrease in area resulting from human activity, the latter is an increase or decrease in area resulting from a natural process. The SEEA AFF does not give detailed specifications for these entries, but the asset account for land cover in the SEEA Central Framework should be used where data are available.

- 4.142. The “net change in stock” entry is the difference between closing stock and opening stock, by land cover type.
- 4.143. The “closing stock” entry is the area of land, by land cover type, at the end of the accounting period. The closing stock of one accounting period constitutes the opening stock of the next.
- 4.144. Section 5.6 and Annex 1 of the SEEA Central Framework give a classification of land cover type on the basis of the FAO Land Cover Classification System, version 3 (FAO & Global Land Cover Network, 2009)¹¹:
 - Artificial surfaces – areas with a predominantly artificial surface such as industrial areas, waste dumps and parks.
 - Cropland – herbaceous crops, woody crops and multiple or layered crops.
 - Grassland – areas such as steppe or savannah dominated by natural herbaceous plants.
 - Tree-covered areas – any area dominated by naturally growing trees.
 - Mangroves – any area dominated by woody vegetation permanently or regularly flooded by fresh or brackish water.
 - Shrub-covered areas – any area dominated by natural shrubs.
 - Shrubs and/or herbaceous vegetation, aquatic or regularly flooded – any area dominated by natural herbaceous vegetation permanently or regularly flooded by fresh or brackish water.
 - Sparsely natural vegetated areas – any area where natural vegetation cover is between 2 percent and 10 percent.
 - Terrestrial barren land – any area where natural vegetation is absent or almost absent; may include bare soil.
 - Permanent snow and glaciers – any area covered by snow or glaciers permanently or for more than ten months per year.
 - Water bodies – inland waters and coastal waters.

¹¹ A complete [SEEA Land Cover Domain](http://www.fao.org/faostat/en/#data/LC) (<http://www.fao.org/faostat/en/#data/LC>) has been recently developed in FAO. The FAOSTAT domain **Land Cover** contains land cover information organized by the land cover classes of the SEEA CF. The land cover information is compiled from publicly available Global Land Cover (GLC) maps. In particular it draws information from two following GLC products:

1) SEEA-MODIS which contains land cover area values for the years 2001 to 2012 derived from the International Geosphere-Biosphere Programme (IGBP) product of the MODIS land cover types dataset (MCD12Q1);

2) SEEA-CCI-LC which contains land cover information for the period 1992 to 2015 derived from the annual land cover maps produced by the UCL (Catholic University of Louvain) Geomatics under the European Spatial Agency (ESA) Climate Change Initiative (CCI);

These three different sources have been geo-processed, normalised and mapped to the SEEA Land cover for a 1992–2015 time series.

4.6.3 Measurement issues and possible extensions

- 4.145. There are several challenges in determining areas of land use, especially in terms of use for particular product types. For example, the ways of handling multiple cropping through the year, multiple crops in the same area of land, and various land uses on the same area of land must be considered. Seasonal changes in land use and land cover between wet and dry seasons are also a challenge.
- 4.146. Estimates of land use and land cover at the country level may be made, but the data sources are usually different. It is important to reconcile different estimates of land use and land cover to convey a useful picture of the two concepts. In this regard, consistency with other indicators of land use such as production statistics should be sought. Land cover and land use change matrixes in which changes between the opening and closing stock are categorized by type of change constitute a useful analytical tool.
- 4.147. The links between land accounting and other areas of the SEEA AFF framework include accounting for soil resources and accounting for fisheries activity through the measurement of the surface area of inland waters and marine areas. Also, an understanding of agricultural practice may be enhanced through recording the area of land subject to irrigation. Measures of irrigated land can inform discussion on requirements for abstracted water and the potential for improvements in production if investments in irrigation were undertaken. Similar extensions relating to different farming practices could also be developed, for example to accounting for areas of organic farming and areas subject to specific cultivation practices.
- 4.148. There are also links between land accounting and the emerging field of ecosystem accounting, which considers the areas of land that form ecosystem assets, the quality or condition of these assets, and the ecosystem services generated from the assets. Measures of the condition of land may vary and include measures of biodiversity. In some agri-environmental indicator sets, estimates of the number of farmland bird species are a proxy for biodiversity. Extended accounting to consider these aspects is discussed in SEEA Experimental Ecosystem Accounting.
- 4.149. Land use and land cover information is the starting point for the development and integration of sub-national data. The various characteristics of different land cover and land use are important in the allocation of production and other economic activity from the national level, and can also be used to upscale and downscale information.
- 4.150. In general, it should be recognised that there are a range of measurement initiatives that utilise measures of changes in the composition of land. At an international level examples include the work on measurement of greenhouse gas emissions via the IPCC, work on the measurement of changes in land use in the context of the UN Convention to Combat Desertification (UNCCD), work on the measurement of changes in ecosystems as part of the Convention of Biological Diversity (CBD) and the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) and the long-standing collection of land use data pertaining to agriculture and forestry by FAO.
- 4.151. In each of these cases, the classification of land could benefit from increased international coordination. An important part of the research agenda for the SEEA Central Framework and the SEEA AFF is advancing the discussion on internationally agreed land use and land cover classes. To this end, useful mapping linking IPCC, SEEA land use categories and ISIC A activities is also part of research under the London City Group¹².

¹² https://unstats.un.org/unsd/envaccounting/londongroup/meeting22/D_14.pdf.

- 4.152. With regard to the development of monetary values for land used for agriculture, forestry and fisheries there are a number of measurement issues to consider. In the first instance, the development of these monetary asset accounts requires a clear delineation of the relevant areas of land to be valued. In concept, this will align with the physical asset accounts for land described above. However, information on the monetary value of land may not be available in relation to the same land areas and alignment of areas and values may be challenging. This same challenge does not arise if seeking to obtain an economy wide valuation of land.
- 4.153. More broadly, although it may be possible to identify the value of land based on relevant market transactions or via administrative data sources (for example taxation authorities or land evaluators) these valuations of land will commonly encompass a range of factors which may be difficult to disentangle. Three different factors are relevant here. First, the value of land may incorporate the value of associated soil resources, water resources or timber resources. Following the SEEA Central Framework, ideally the value of these individual resources should be distinguished. In addition, the value of agricultural land may need to be adjusted to exclude the value of relevant buildings and other produced infrastructure that are located on the land. A related consideration is the valuation of land improvements (for example the formation of dams and drainage systems) that require a specific treatment following the SNA.
- 4.154. Second, depending on the location of agricultural, forestry or fisheries land, particular areas may hold an option value to the extent that the land might be used for alternative purposes – for example for housing development in the case of agricultural land or for agriculture in the case of forest land. Distinguishing these option values may be important for analytical purposes and understanding the sustainability of agricultural and forestry activity.
- 4.155. Third, it is likely that areas of land used for agricultural, forestry and fisheries also supply a range of ecosystem services that (i) may be of value to economic units other than the land owner/manager (for example the role of forests in watershed management) or (ii) may be of value to individuals and society more broadly (for example the amenity value of agricultural landscapes or the carbon sequestration value of forests). In these instances the market value of land will likely understate the full value of land. Considering the valuation of these ecosystem services is increasingly being considered in the context of the SEEA Experimental Ecosystem Accounting.
- 4.156. The valuation of land is a multi-faceted exercise that remains a subject of development and research both in an SNA and a SEEA context. In the context of the SEEA AFF, it is relevant to monitor developments on this topic and to also clarify the types of valuation scope most relevant for analysis of agricultural, forestry and fisheries issues.

4.7 Accounting for soil resources

- 4.157. Soil resources are a fundamental environmental asset for agricultural and forestry production. Monitoring the state and change in state of a country's stock of soil resources must therefore be a priority in research and measurement with regard to sustainable agricultural production.
- 4.158. As an indication of what might be possible, the SEEA Central Framework introduces a general approach to accounting for soil resources with a focus on i) the area and changes in area of different types of soil resources in a country; and ii) the volume and changes in volume of soil resources, for example from erosion. Section 5.7 of the SEEA Central Framework provides a context for work on accounting for soil

resources in terms of descriptions of soil resources and ways in which their characteristics might be considered.

- 4.159. **Table 4.9** shows a physical asset account for national soil resources with a focus on recording the composition of soil resources within a country. Types of soil resource may be classified in different ways at country level. The recommended approach for SEEA AFF is use of the classification system of the World reference base for soil resources 2014¹³ Generally, the composition of a country's soil resources, in terms of soil types, will not change significantly over time and hence no detail on additions or reductions in stock is proposed in this asset account. Further, rather than a focus on measuring change, at least initially, it is considered appropriate to focus on mapping different soil types and understanding where certain soil types are located relative to agricultural and forestry activity. Establishing linkages between soil accounts and land accounts may therefore be of interest.

Table 4.9 Asset account for the composition of soil resources (hectares)

Physical asset account for the composition of soil resources (<i>hectares</i>)		
	Type of soil resource	Total area
Opening stock of soil resources		
Additions to stock		
Reductions in stock		
Closing stock of soil resources		

- 4.160. While the composition of soil resources is important information, there is perhaps greater interest in understanding the changing quality of soil over time. This will be relevant in understanding issues such as land degradation and agricultural productivity. Relevant measures include indicators of carbon content, measures of erosion rates, measures of texture, and percentages of positively charged ions.
- 4.161. Work is under way to apply natural capital accounting approaches to soil resources and utilize the developments in the measurement of soil health (see for example, Dominati et al., 2010; Robinson et al., 2014), but further work is needed to apply them to the design and compilation of SEEA-type accounts. Related information on soil conservation practices, such as areas subject to conservation tillage, rotational grazing or cover crop adoption may also be relevant.
- 4.162. In some cases, it may be possible to use accounting approaches to organize the information needed to derive soil health indicators. For example, measures of soil carbon content, for example, could be integrated into a carbon stock account as described in the SEEA Experimental Ecosystem Accounting.
- 4.163. Data sources developed in recent years regarding soil include the Harmonized World Soil Database, v 1.2 (FAO et al., 2012) and the GlobalSoilMap (International Union of Soil Sciences, 2009). Along with the work on natural capital accounting for soils noted above, they should constitute a basis for further progress.

¹³ World reference base for soil resources 2014 - International soil classification system for naming soils and creating legends for soil maps - Update 2015 <http://www.fao.org/3/a-i3794e.pdf>

Annex I Tiered approaches to implementation of SEEA AFF

A critical concept of the SEEA AFF is the phased, tiered approach to implementation. It is recommended that users proceed in successive phases, starting with the use of national-level default data, including from international organizations, which can be used as reference to gauge progress towards inclusion of data at higher tiers, including providing support for data gap-filling and quality assurance / quality control functions.

Tier 1: Global datasets

The compilation of SEEA AFF accounts at a Tier 1 level can be considered an entry level point for both compilers of accounts and users of accounting based information. For compilers, it is envisaged that a country would be able to source a majority of information from existing FAO and similar global data sets and hence compile a basic set of SEEA AFF accounts.

Using these data has a range of benefits including reducing the search and collection costs for data, getting an initial sense of the nature of the accounting approach, and enabling the derivation of some key variables and indicators of relevance for policy and for international reporting – for example, in the context of the sustainable development goals. Since the FAO datasets will also provide a time series of information, the use of these data during the initial efforts can immediately support the description of trends in agriculture, forestry and fisheries which are central to analysis and policy monitoring.

Experience in the compilation of various SEEA accounts suggests that the largest challenge is often simply starting the first set of accounts. Using Tier 1 data is thus one way of lowering barriers to entry and it should provide a sound base for future and on-going work. Box 5.1 provides an example of Tier 1 based SEEA AFF accounts.

Tier 2: National datasets

At Tier 2, a more engaged and broader based compilation of accounts is required. Generally, it will be the case that the provision of data to the FAO and other global datasets will involve the sourcing of data from various government agencies. The task for Tier 2 accounting is to examine the potential for co-ordination of existing data, within the structure of the SEEA AFF accounts, to assess data gaps, including gaps in time series, and to establish mechanisms for integrating existing data at national level across the SEEA AFF domains.

Based on discussion between relevant agencies, it is expected that a broader range of data will be able to be integrated, noting that this may require additional resources to align data to common definition and classifications. In particular, investigation should consider the development of the intended key product focus of the SEEA AFF across the various data domains. To obtain a coherent picture for different products it is likely to be necessary to engage a variety of national experts in agriculture, forestry and fisheries.

An important outcome from discussions on data co-ordination should be an increased understanding of the key national policy issues for agriculture, forestry and fisheries, the associated information gaps and, ultimately, the development of a plan for the development of the relevant information set.

It is to be expected that compilation at Tier 2 will result in a quite complete set of SEEA AFF accounts. Importantly, the expectation at Tier 2 is the co-ordination of existing data rather than the collection of additional data. Given the costs of additional data collection, all avenues for the use of existing data should be explored – provided the right connections can be found it is often surprising how much data are available that can be used to complete sections of accounts. From the perspective of users, the coverage and detail of accounts at

a Tier 2 level should provide quite a comprehensive set of information for policy and analysis.

Tier 3: Additional data collection

At Tier 3, a very complete and full implementation of the SEEA AFF accounts is to be expected. It would not be expected that Tier 3 accounts would be developed in a short term. Rather they would be developed progressively over time, likely with focus on the most relevant domains at national level.

The compilation at Tier 3 will likely require the collection of additional information, for example through the addition of questions to relevant surveys and censuses. In view of the resources that would be required for the collection of information, one approach to Tier 3 accounts is to applying benchmarking approaches (see section 5.4) in which detailed data are collected at 3 or 5 year intervals and, in the intervening years, indicator series are used to interpolate and extrapolate the relevant series. This is a form of modelling that is commonly applied in national accounting.

More generally, Tier 3 accounts may require the use of various models and relationships between different stocks and flows, especially for the development of product level data. Such modelling can be effectively supported in an accounting context since the modelled estimates would be developed in the context of broader estimates of stocks and flows from already developed data sources.

One dimension of Tier 3 accounts is the development of sub-national detail, potentially using GIS techniques. It is likely to be sensible to pursue such fine levels of detail for only a subset of the SEEA AFF accounts, perhaps for specific variables. Nonetheless, it is likely that the availability of sub-national data that can be placed in context with broader, national estimates, will be of high value for policy and analysis.

Annex II: Types of environmental indicators

Descriptive statistics cover measures of aggregates such as total fertilizer use by agriculture and total production of livestock products, where the totals are derived from aggregations within the accounting structure. Descriptive statistics also include structural statistics such as the proportion of irrigated water use attributable to food crops or the share of land used for timber production. In the SEEA AFF, descriptive statistics will tend to be based on information from a single base account or in relation to a single variable such as value-added or employment.

Environmental asset aggregates and indicators cover measures of the stocks and changes in stocks of environmental assets in physical and monetary terms; measures of depletion and estimates of asset or resource life. In physical terms, environmental asset indicators are derived in a single asset account. In monetary terms, the derivation of indicators such as the share of national wealth¹⁴ attributable to individual environmental assets can also be considered.

Environmental ratio indicators are of three types.

Productivity and intensity indicators where the use of a resource or input is related to a measure of economic activity. Examples of these indicators include land used for forestry relative to forestry value added, or water use per unit of crop output. A productivity indicator uses the resource or input measure as the denominator, whereas an intensity indicator uses the resource or input measure as the numerator. The derivation of meaningful productivity and intensity indicators is perhaps the most significant application of the SEEA AFF framework. The intention is to develop these types of indicators across different environmental variables such as land use, water use and energy use and across individual products and activities.

Decoupling indicators. These indicators are similar in form to productivity indicators but focused on residual flows such as emissions or flows considered potentially unsustainable such as energy use at the aggregate level. An example of a decoupling indicator is the ratio of greenhouse gas emissions to GDP, where a decrease in the ratio reflects a decoupling of GDP growth from greenhouse gas emissions. A similar ratio may be developed specifically for agricultural, forestry and fisheries activities.

Polluter-pays indicators. These indicators link estimates of physical flows of residuals such as greenhouse gas emissions or flows of waste with the associated costs to business such as taxes or expenditure to mitigate pollution. To develop these indicators, the set of SEEA AFF accounts would have to be extended to incorporate information on environmentally related taxes and other payments. The use of SEEA AFF in this way could help to quantify the costs of pollution.

¹⁴ The sum of all national economic assets less liabilities to the rest of the world.

Annex III: The SEEA CF Land Use Classes in the SEEA AFF

The SEEA AFF uses the SEEA CF land use classification, with specific aggregations to facilitate analysis of ISIC A activities. From this perspective, Land Area is divided into Agriculture, Forestry and Other Land. The latter is an aggregation of all remaining SEEA CF classes, considered of lesser relevance to SEEA AFF accounting. Within Agriculture, new aggregations are introduced, including Agricultural Area, Cropland, Arable Land and Permanent Crops, using FAO terminology¹⁵. Both capture fisheries and aquaculture are included as activities on Inland Waters, Coastal Waters and the EEZ.

The SEEA AFF also considers Country Area, defined as the area under national sovereignty, and consisting of the sum of: Land Area, Inland Waters, and Coastal Waters. Areas under Exclusive Economic Zones are not part of Country Area, but can be used for accounting within the SEEA AFF.

The Table below provides detailed information on the usage of SEEA CF land use classes for the purpose of SEEA AFF accounting.

¹⁵ FAO Land Use, Irrigation and Agricultural Practices Questionnaire, at: <http://www.fao.org/economic/ess/ess-home/questionnaires/en/>

Land Use Class	Definition	SEEA CF Code
Country Area	Area under national sovereignty. It is the sum of land area, inland waters and coastal waters. It excludes the exclusive economic zone.	
Country Area		
Land area	Country area excluding area under inland waters and coastal waters. It corresponds to the sum of Agriculture, Forestry, and Other Land use	1
Inland Waters	Inland waters are areas corresponding to natural or artificial water courses, serving to drain natural or artificial bodies of water, including lakes, reservoirs, rivers, brooks, streams, ponds, inland canals, dams, and other land-locked waters. The banks constitute limits whether the water is present or not.	2
Coastal Waters	Waters located in between the land territory and the outer limit of the territorial sea. They comprise "Internal waters" (UNCLOS 1982, Art. 8) and "Territorial sea," (UNCLOS 1982, Art. 3) and where applicable, "Archipelagic waters," (UNCLOS 1982, part V)	3
Exclusive Economic Zone	Waters beyond and adjacent to the territorial sea, not extending beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured (UNCLOS 1982, part V).	4
Land Area		
Agriculture	The total of areas under 'Agricultural Land' and "Land under protective cover". Scattered land under farm buildings, yards and their annexes, and permanently uncultivated land, such as uncultivated patches, banks, footpaths, ditches, headlands and shoulders are traditionally included	1.1
Forestry	Land used for forestry. Excludes land that is predominantly under agricultural or urban use.	1.2
Other Land	Land area not classified as "Agriculture and" "Forestry". It includes SEEA categories "Land used for aquaculture," "Built-up and related areas," "Land Use for maintenance and restoration of environmental functions," "Other uses of land not elsewhere classified," and "Land not in use."	1.3-1.7
Agriculture		
Agricultural Land	Land used for cultivation of crops and animal husbandry. The total of areas under "Cropland" and "Permanent meadows and pastures." This category includes tilled and fallow land, naturally grown and cultivated permanent meadows and pastures used for grazing, animal feeding or agricultural purpose.	1.1.1-1.1.6
Land Under Protective Cover	Land used for agriculture occupied by dwellings on farms, etc.: dwellings, operating buildings (hangars, barns, cellars, greenhouses, silos), buildings for animal production (stables, cowsheds, pig sheds, sheep pens, poultry yards), family gardens, farmyards. Excludes buildings for agro-food manufacture and buildings in rural areas for exclusive residential purpose.	1.1.7

Agricultural Land		
Cropland	Land used for cultivation of crops. The total of areas under "Arable land" and "Permanent crops".	1.1.1-1.1.4
Permanent Meadows and Pastures	Land used permanently (five years or more) to grow herbaceous forage crops through cultivation or naturally (wild prairie or grazing land). Permanent meadows and pastures on which trees and shrubs are grown should be recorded under this heading only if the growing of forage crops is the most important use of the area. Measures may be taken to keep or increase productivity of the land (i.e., use of fertilizers, mowing or systematic grazing by domestic animals.) This class includes: <ul style="list-style-type: none"> • Grazing in wooded areas (agroforestry areas, for example) • Grazing in shrubby zones (heath, maquis, garigue) • Grassland in the plain or low mountain areas used for grazing: land crossed during transhumance where the animals spend a part of the year (approximately 100 days) without returning to the holding in the evening: mountain and subalpine meadows and similar; and steppes and dry meadows used for pasture. 	1.1.5 1.1.5.1-1.1.5.2
Cropland		
Arable Land	The total of areas under temporary crops, temporary meadows and pastures, and land with temporary fallow. Arable land does not include land that is potentially cultivable but is not normally cultivated.	1.1.1-1.1.3
Permanent Crops	Land used for crops with a less-than-one-year growing cycle, which must be newly sown or planted for further production after the harvest. Some crops that remain in the field for more than one year may also be considered as temporary crops e.g., asparagus, strawberries, pineapples, bananas and sugar cane. Multiple-cropped areas are counted only once.	1.1.4
Arable Land		
Temporary Crops	Land that is not seeded for one or more growing seasons. The maximum idle period is usually less than five years. This land may be in the form sown for the exclusive production of green manure. Land remaining fallow for too long may acquire characteristics requiring it to be reclassified, as for instance "Permanent meadows and pastures" if used for grazing or haying.	1.1.1
Temporary meadows and pastures	Land temporarily cultivated with herbaceous forage crops for mowing or pasture. A period of less than five years is used to differentiate between temporary and permanent meadows and pastures.	1.1.2
Temporary Fallow	Land that is not seeded for one or more growing seasons. The maximum idle period is usually less than five years. This land may be in the form sown for the exclusive production of green manure. Land remaining fallow for too long may acquire characteristics requiring it to be reclassified, as for instance "Permanent meadows and pastures" if used for grazing or haying.	1.1.3
Forestry		
Forest Land	Land spanning more than 0.5 hectares with trees higher than 5 metres and a canopy cover of more than 10 per cent, or trees able to reach these thresholds in situ. Excludes land that is predominantly under agricultural or urban land use, and land that is predominantly used for maintenance and restoration of environmental function. Explanatory notes:	1.2.1

	<ul style="list-style-type: none"> • Forest land is determined both by the presence of trees and by the absence of other predominant land uses. The trees should be able to reach a minimum height of 5 metres in situ • Includes areas with young trees that have not yet reached but that are expected to reach a canopy cover of 10 per cent and tree height of 5 metres. It also includes areas that are temporarily unstocked owing to clear-cutting as part of a forest management practice or natural disasters, and that are expected to be regenerated within five years. Local conditions may, in exceptional cases, justify the use of a longer time frame • Includes forest roads, firebreaks and other small open areas • May include forest land in national parks, nature reserves and other protected areas, such as those of specific environmental, scientific, historical, cultural or spiritual interest • Includes windbreaks, shelter belts and corridors of trees with an area of more than 0.5 hectares and width of more than 20 metres • Includes abandoned shifting cultivation land with a regeneration of trees that have, or is expected to reach, a canopy cover of 10 per cent and tree height of 5 metres • Includes areas with mangroves in tidal zones, regardless of whether this area is classified as land area or not • Includes areas with bamboo and palms provided that land use, height and canopy cover criteria are met • Some agroforestry systems such as the taungya system, where crops are grown only during the first years of the forest rotation should be classified as forest • Excludes: tree stands in agricultural production systems, such as fruit-tree plantations (→Permanent crops), oil palm plantations, rubber and Christmas trees (→Permanent crops) and agroforestry systems when crops are grown under tree cover 	
Other Wooded Land	<p>Land not classified as “Forest land”, spanning more than 0.5 hectares; with trees higher than 5 metres and a canopy cover of 5-10 per cent, or trees able to reach these thresholds in situ; or with a combined cover of shrubs, bushes and trees above 10 per cent.</p> <p>The definition above encompasses two options:</p> <p>(a) The canopy cover of trees is between 5 and 10 per cent; and trees should be higher than 5 metres or able to reach 5 metres in situ, or</p> <p>(b) The canopy cover of trees is less than 5 per cent but the combined cover of shrubs, bushes and trees is more than 10 per cent. Includes areas of shrubs and bushes where no trees are present.</p> <p>Includes:</p> <ul style="list-style-type: none"> • Areas with trees that will not reach a height of 5 metres in situ and with a canopy cover of 10 per cent or more, e.g., some alpine tree vegetation types, arid zone mangroves. • Areas with bamboo and palms provided that land use, height and canopy-cover criteria are met. 	1.2.2

	• Excludes land that is predominantly under agricultural or urban land use, and land that is predominantly used for maintenance and restoration of environmental function.	
Other Land, of which:		
Land used for Aquaculture	Land used for aquaculture facilities and fish-farming activities. Includes housing facilities for breeding, nursing and rearing seed of fish, invertebrates or aquatic plants to fry, fingerling or juvenile stages.	1.3
Inland Waters, of which:		
Inland waters used for aquaculture or holding facilities	Inland water areas that are used for aquaculture facilities including supporting facilities. Aquaculture facilities include enclosures and pens (water areas confined by net, mesh and other barriers allowing uncontrolled water interchange), cages (open or covered enclosed structure constructed with net, mesh or any porous materials allowing natural water interchange), barrages (semi-permanent or seasonal enclosures formed by impervious man-made barriers and appropriate natural features) and rafts, ropes and stakes (raft, long lines or stakes used to culture shellfish and seaweeds).	2.1
Inland waters used for capture fisheries	Area of inland waters that is used for catching aquatic animals or gathering aquatic plants in the wild.	2.3 (subset of)
Coastal Waters, of which:		
Coastal waters used for aquaculture or holding facilities	Area of Coastal waters used for marine aquaculture facilities including supporting facilities. Aquaculture facilities include enclosures and pens (water areas confined by net, mesh and other barriers allowing uncontrolled water interchange), cages (open or covered enclosed structure constructed with net, mesh or any porous materials allowing natural water interchange), barrages (semi-permanent or seasonal enclosures formed by impervious man-made barriers and appropriate natural features) and rafts, ropes and stakes (raft, long lines or stakes used to culture shellfish and seaweeds). This category includes: Oyster beds and other types of shellfish (mussels, clams, abalones and scallops); Bodies of water used for seaweed production; Bodies of water used for fish rearing.	3.1
Coastal waters used for capture fisheries	Area of Coastal waters that is used for catching aquatic animals or gathering aquatic plants in the wild.	3.3 (subset of)
Exclusive Economic Zone (EEZ), of which:		
EEZ used for aquaculture or holding facilities	Area of EEZ used for marine aquaculture facilities including supporting facilities.	4.1
EEZ used for capture fisheries	Area of EEZ used for catching aquatic animals or gathering aquatic plants in the wild.	4.3 (subset of)

References

- Dominati, E., Patterson, M. & Mackay, A.** 2010. A framework for classifying and quantifying the natural capital and ecosystem services of soils. *Ecological Economics* 69(9): 1,858–1868.
- European Commission, IMF, OECD, United Nations & World Bank.** 2003. *Handbook of National Accounting: Integrated Environmental and Economic Accounting 2003*. Studies in methods, Series F. No 61, rev 1. New York.
- European Commission, IMF, OECD, United Nations & World Bank.** 2009. *System of National Accounts 2008*. Sales No. E.08.XVII.29. Available at: <http://unstats.un.org/unsd/nationalaccount/docs/SNA2008.pdf>
- European Commission & Eurostat.** 2002. *The European Framework for Integrated Environmental and Economic Accounting for Forests*. Luxembourg, Office for Official Publications of the European Communities. Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-BE-02-003/EN/KS-BE-02-003-EN.pdf
- European Commission & Eurostat.** 2009. *Manual for Air Emission Accounts. Eurostat Methodologies and Working Papers*. Luxembourg, Office for Official Publications of the European Communities. Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-09-004/EN/KS-RA-09-004-EN.pdf
- Eurostat.** 2000. *Manual on the Economic Accounts for Agriculture and Forestry*, rev 1.1. Luxembourg, Office for Official Publications of the European Communities. Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-27-00-782/EN/KS-27-00-782-EN.pdf
- Eurostat and OECD.** 2013. *Nutrient budgets: Methodology and handbook*. Luxembourg.
- FAO.** 1995. *Code of Conduct for Responsible Fisheries*. Rome. Available at: <http://www.fao.org/docrep/005/v9878e/v9878e00.htm>
- FAO.** 1996. *System of Economic Accounts for Agriculture*. Rome
- FAO.** 2000. *International Standard Classification of Aquatic Animals and Plants*. Rome. Available at: <ftp://ftp.fao.org/fi/document/cwp/handbook/annex/AnnexS2listISSCAAP2000.pdf>
- FAO.** 2007. *Global Forest Resources Assessment 2010: specification of national reporting table for FRA 2010*. Forest Resources Assessment Programme working paper No. 135, Rome. Available at: <http://www.fao.org/forestry/fra/67094/en/>
- FAO.** 2008. *Glossary of Aquaculture*. Rome. Available at: <http://www.fao.org/fi/glossary/aquaculture/pdf/glossary.pdf>
- FAO.** 2014. *State of the World's Fisheries and Aquaculture*. Rome
- FAO.** 2015. *Global Forest Resources Assessment, 2015: How are the World's Forests Changing?* Rome. Available at: <http://www.fao.org/3/a-i4793e.pdf>
- FAO and Global Land Cover Network.** 2009. *Land Cover Classification System*, v.3. Rome.
- FAO, International Institute for Applied Systems Analysis, International Soil Reference and Information Centre, Institute of Soil Science-Chinese Academy of Sciences and Joint Research Centre of the European Commission.** 2009. *Harmonized World Soil Database*, v. 1.2. Available at: <http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/html/>
- FAO, UN and World Bank.** 2010. *Global strategy to Improve Agricultural and Rural Statistics*. Rome. Available at: http://www.fao.org/fileadmin/templates/ess/documents/meetings_and_workshops/ICAS5/Ag_Statistics_Strategy_Final.pdf
- FAO and International Institute for Applied Systems Analysis.** *Global Agro-Ecological Zones project*. Available at: <http://www.fao.org/nr/gaez/en/>
- IPCC.** 1996. *Revised 1996 Guidelines for National Greenhouse Gas Inventories*
- IPCC.** 2003. *Good Practice Guidance on Land Use, Land Use Change and Forestry*. Penman, J., Gytarsky, M., Krug, T., Kruger, D., Pipatti, R., Buendia, L., Miwa, K., Ngara, T., Tanabe, K. &

- Wagner, F., eds. Hayama, Japan, Institute for Global Environmental Strategies for the IPCC. Available at:
http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_contents.html
- IPCC.** 2006. *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. Available at: <http://www.ipcc-nggip.iges.or.jp/public/gp/english/>
- International Union of Soil Sciences.** 2009. GlobalSoilMap. Available at:
<http://www.globalsoilmap.net/>
- Lequiller, F. and D. Blades.** 2006. *Understanding National Accounts*. OECD, Paris
- OECD.** 2002. *Handbook on measuring the non-observed economy*. Paris
- OECD.** 2007. *Gross nitrogen balances handbook*. Paris. Available at:
<http://www.oecd.org/greengrowth/sustainableagriculture/40820234.pdf>
- OECD.** 2008. *Measuring material flows and resource productivity: OECD guidance manual. Vol. II: A theoretical framework for material flow accounts and their applications at national level. Draft.* Paris. LG/11/6. Available at:
http://unstats.un.org/unsd/envaccounting/londongroup/meeting11/LG11_9a.pdf
- OECD.** 2015. *Agricultural policy monitoring and evaluation*. Paris.
- OECD and Eurostat.** 2007. *Gross phosphorus balances handbook*. Paris. Available at:
<http://www.oecd.org/greengrowth/sustainableagriculture/40820243.pdf>
- OECD and Joint Research Council of the European Commission.** 2008. *Handbook on Constructing Composite Indicators: Methodology and User Guide*. OECD, Paris.
- Paivinen, et al.** 1999. *Global Overview of European Forests*
- PARIS21.** 2011. *Statistics for Transparency, Accountability and Results: A Busan Action Plan for Statistics*. Paris.
- United Nations.** 1993. *Handbook of National Accounting: Integrated Environmental and Economic Accounting, Interim Version*. Studies in methods, Series F. No 61. New York.
- United Nations.** 2008a. *International Standard Industrial Classification of All Economic Activities, rev.4*. Statistical Papers, Series M, No. 4/rev.4. Sales No. E.08.XVII.25. Available at:
<http://unstats.un.org/unsd/cr/registry/isic-4.asp>
- United Nations.** 2008b. *Central Product Classification, v.2*. Available at:
<http://unstats.un.org/unsd/cr/registry/cpc-2.asp>
- United Nations.** 2011. *International recommendations for energy statistics. Draft*. Available at:
<http://unstats.un.org/unsd/energy/ires/default.htm>
- United Nations.** 2012a. *Report of the United Nations Conference on Sustainable Development, Rio de Janeiro, Brazil 20-22 June 2012*. A/CONF.216/16
- United Nations.** 2012b. *International Recommendations for Water Statistics*. Statistical Papers, Series M, No.91. Sales No. 10.XVII.15. Available at:
<http://unstats.un.org/unsd/envaccounting/irws/irwswebversion.pdf>
- United Nations.** 2012c. *SEEA-Water: System of Environmental-Economic Accounting for Water*. Statistical Papers, Series F, No.100. Sales No. E11.XVII.12. Available at:
<http://unstats.un.org/unsd/envaccounting/seeaw/seeawaterwebversion.pdf>
- United Nations.** 2014. *System of Environmental-Economic Accounting 2012 Applications and Extensions*. White cover publication. New York.
- United Nations.** 2015. *Framework for the Development of Environment Statistics*. New York.
- United Nations.** *System of Environmental-Economic Accounting for Energy*. Forthcoming.
- United Nations and FAO.** 2004. *Handbook of national accounting: integrated environmental and economic accounting for fisheries. Final draft*. Available at:
http://unstats.un.org/unsd/envaccounting/Fish_final_whitecover.pdf

United Nations, European Commission, FAO, IMF, Organisation for Economic Co-operation and Development & World Bank. 2014a. *System of Environmental-Economic Accounting 2012 Central Framework*. New York.

United Nations, European Commission, FAO, IMF, Organisation for Economic Co-operation and Development & World Bank. 2014b. *System of Environmental-Economic Accounting 2012 Experimental Ecosystem Accounting*. New York.