Statistical Commission
Forty-seventh session
8 – 11 March 2016
Item 3(e) of the provisional agenda
Environmental-economic accounting

Background document
Available in English only

SEEA Agriculture, Forestry and Fisheries

Prepared by the Food and Agriculture Oganization of the United Nations and the United Nations Statistics Division under the auspices of the UN Committee of Experts on Environmental-Economic Accounting

DEPARTMENT OF ECONOMIC
AND SOCIAL AFFAIRS - STATISTICS DIVISION
UNITED NATIONS

System of Environmental-Economic Accounting

for Agriculture, Forestry and Fisheries

Background Document

United Nations Statistical Commission

March, 2016

The following draft is submitted as a background document for the consideration of the United Nations Statistical Commission. The companion background document entitled: "*SEEA Agriculture, Forestry and Fisheries: Summary of revisions implemented after the Second Global Consultation*," drafted with guidance from the SEEA CF Technical Committee serving as Editorial Board of the SEEA Agriculture, describes the revision process in detail and should be read in conjunction with this draft.

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Preface

(To be finalised ahead of publication)

The scope of SEEA Agriculture

The SEEA Agriculture applies the environmental-economic structures and principles described in the System of Environmental-Economic Accounting 2012 Central Framework (the SEEA Central Framework) to the activities of agriculture, forestry and fisheries. The SEEA Central Framework was adopted in 2012 as an international statistical standard by the United Nations Statistical Commission. 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 Agriculture also applies the conceptual framework of the System of National Accounts (SNA), the most recent edition being the 2008 SNA (EC, et al., 2009). The value-added of SEEA Agriculture lies not in terms of conceptual advances in accounting, but rather in the integration of information that is considered standard from either an SNA or SEEA perspective.

The data coverage of the SEEA Agriculture is broad including data in both monetary and biophysical terms and data from ten primary data domains (see Table 2.1). The focus is on the integration of information rather than a complete description of data from each of the different areas. In particular, since the common underpinning framework is the SNA, more focus is placed on describing how biophysical information may be integrated into the monetary frameworks rather than on describing the monetary framework with respect to agriculture, forestry and fisheries.

The SEEA Agriculture does not incorporate the accounting approach described in the SEEA Experimental Ecosystem Accounting, because the data needed to underpin ecosystem accounting, including measurement of ecosystem services and ecosystem condition, is not sufficiently advanced for systematic implementation at a country level. However, recognising the increasing relevance of an ecosystem approach in the context of agriculture, forestry and fisheries, the application of ecosystem accounting is considered an important extension and area of future research.

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 Agriculture

The relevance of extended accounting frameworks for analysis of agriculture, forestry and fisheries has been recognised for some time. Important advances included:

- The System of Economic Accounts for Agriculture (FAO, 1996) and similar work by Eurostat both building on the 1974 Handbook for Economic Accounts for Agriculture.
- work led by FAO on the Integrated Environmental and Economic Accounting for Fisheries (UN & FAO, 2004) and
- work by Eurostat on 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 Agriculture they collectively point to the potential to adopt accounting techniques in this area.

Following the adoption of the SEEA Central Framework in March 2012, the UN Committee of Experts on Environmental-Economic Accounting (UNCEEA) endorsed the FAO-led plan to develop a SEEA for agriculture, forestry and fisheries in June 2012. Work on the SEEA Agriculture 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.

The critical role of FAO in support of the development of the SEEA Agriculture includes its longstanding collection, analysis and dissemination of national statistics covering agricultural, forestry and fisheries activities and related themes, such as land 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 Agriculture.

By highlighting and identifying the functional connections among a wide range of data domains, the SEEA Agriculture may furthermore provide a useful framework in support of several ongoing international efforts:

- Global Strategy to Improve Agricultural and Rural Statistics
- PARIS21 framework
- Integration of the SEEA CF and the SNAs
- Experimental ecosystem accounting for agriculture, forestry and fisheries
- Development and monitoring of indicators for the SDGs

Acknowledgements

(To be drafted ahead of publication)

Acronyms used in the document

C	carbon
CPC	central product classification
CPUE	catch per unit effort
EC	European Commissions
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-government Panel on Climate Change
ISIC	international standard industrial classification
ISSCFC	international standard statistical classification of fishery commodities
IUU	illegal, unreported and unregulated (fishing activity)
K	potassium / potash
LKAU	local kind of activity unit
N	nitrogen
nec	not elsewhere classified
OECD	Organisation for Economic Co-operation and Development
P	phosphorous
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

1.1 SEEA Agriculture: The System of Environmental-Economic Accounting for Agriculture, Forestry and Fisheries

1.1.1 Overview of SEEA Agriculture

1.1. The System of Environmental-Economic Accounting for Agriculture, Forestry and Fisheries - SEEA Agriculture - 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 is critical for the analysis of sustainable food and agriculture, which is dependent on the interlinkages between food security, natural resource use and the sustainability of food, fibre, material and bio-energy production, rural incomes and employment.

1.3. Integrating 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 Agriculture 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 Agriculture is designed to be applicable to and by all countries, regardless of economic or statistical development, economic structure or environment. Recognizing significant variations from country to country in agriculture, forestry and fisheries activities, the structure of the SEEA Agriculture accounts easily allows for the inclusion of nationally important activities and products.

1.5. The accounting framework described in the SEEA Agriculture covers accounting of both monetary and physical data. In doing so, the SEEA Agriculture is an application of the accounting principles and structures contained in the System of National Accounts (SNA) and the SEEA Central Framework. Since accounting for the monetary aspects of these activities is well established and described, in general, the focus of the descriptions in the SEEA Agriculture is on the integration of physical data into the national accounting framework. The SEEA Agriculture is thus a complement to other guidelines rather than a document that has complete coverage of all possible national accounting matters related to agriculture, forestry and fisheries.

1.6. The SEEA Agriculture is relevant to a wide audience, including users of information and compilers of statistics and accounts. It is written from the perspective of national accounting, while highlighting the connections between the compilation of underlying statistics, the organization of those statistics in an accounting framework and the use of the information for analysis and policy-making. It is intended to complement guidance on the collection of statistics and the development of analytical and decision-making tools.

1.7. The basic organization of the SEEA Agriculture may be extended in a variety of ways, and it is hoped that extensions and refinements will be undertaken to enhance the system described herein. In this sense the SEEA Agriculture constitutes a platform for an accounting approach for the integration and use of data relating to agriculture, forestry and fisheries activity within the domains of economics and the environment.

1.1.2 Motivation for the development of SEEA Agriculture

1.8. The main purpose of the SEEA Agriculture 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. This approach facilitates the joint analysis of environmental and economic in support of a more complete analytical framework than otherwise possible when performing analysis in each field separately.

1.9. 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. 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.

1.10. 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.

1.11. The SEEA Agriculture 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. Thus a SEEA Agriculture based dataset ais at assisting in the coordination of information for these and other production functions, in support of improved evidence-based decision-making.

1.12. The larger analytical potential of the SEEA Agriculture stems from its application of the same framework across different products and activities. By utilizing a common framework where concepts, definitions and classifications are consistently applied. 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 national accounts and the SEEA Central Framework, the SEEA Agriculture 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.

1.13. 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.

1.14. Further, because the starting scope of the SEEA Agriculture is national-level activity, the data in the SEEA Agriculture framework are not case studies of exemplar production functions: rather, the observed relationships between inputs and outputs are embedded in aggregate measures of production, supply and demand. Hence the SEEA Agriculture 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.

1.15. While facilitating integrated analysis, SEEA Agriculture may exhibit a number of possible limitations. 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. Thus, while it is not a framework to inform all areas of sustainable development, it is a very useful framework that is of direct relevance in assessing the sustainability of agriculture, forestry and fisheries.

1.16. 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.

1.17. 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.

1.18. Notwithstanding these limitations, the integration of environmental and economic data is a major step forward 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.

1.1.3 Potential beneficiaries of SEEA Agriculture

1.19. A number of possible users and beneficiaries of the SEEA Agriculture 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 Agriculture to place multiple data sources in context. The SEEA Agriculture 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 prevalence of home and subsistence production. Because the SEEA Agriculture has a basis in the SNA – the measurement standard for GDP – the compilation of SEEA Agriculture-based accounts will be directly relevant to the compilation of estimates for the core national accounts, and so can contribute 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 are not conducive to the joint consideration of environmental and economic factors. Data compiled

following the SEEA Agriculture should improve 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 Agriculture will require input from natural resource managers such as foresters, fisheries experts, soil experts and hydrologists. The SEEA Agriculture 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 and economic drivers for their use.

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. Nonetheless, 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. An SEEA Agriculture database would be a useful source of business intelligence, would provide a focal point 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 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 Agriculture framework may provide a number of benefits for international agencies. From a statistical point of view, the SEEA Agriculture can support work to improve the quality of statistics, particularly through the Global Strategy. 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, 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:

i. the post-2015 development agenda and its Sustainable Development Goals
ii. the Poverty Environment Initiative of the United Nations Development Programme and the United Nations Environment Programme
iii. the United Nations Environment Programme's Reducing Emissions from Deforestation and Forest Degradation
iv. the Aichi biodiversity targets of the Convention on Biological Diversity
v. the United Nations Convention on Deforestation and Desertification
vi. Sustainable Energy for All
vii. the 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 Agriculture, even though its coverage with respect to each programme may not be complete.

1.1.4 Implementation: Expectations and data requirements

1.29. The SEEA Agriculture supports the organization and integration of information from multiple domains based on the accounting principles of the SEEA Central Framework and the SNA 2008, and hence provides a structure in which compilation exercises may be undertaken. Its connections to the SNA and the SEEA, and its connections to various activity specific data collections, also support its implementation 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 Agriculture, 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 to implement the SEEA.

1.31. The SEEA Agriculture has a broad coverage and requires a large amount of data for complete implementation. At the same time, SEEA Agriculture combines, in a single context, ten domains and underlying datasets that, individually, are either well established or otherwise regarded as information that should be available at the national level. Much of the data has been the subject of international statistical questionnaires developed in the various domains over many decades. In this sense, the SEEA Agriculture should not be seen as experimental.

1.32. Nonetheless, like the implementation of the SEEA Central Framework, countries are not expected to be able to implement all aspects of the SEEA Agriculture in a single step. A flexible and modular approach is envisaged whereby countries would implement the components incrementally, taking into consideration available resources and national policy requirements.

1.33. To help provide some structure for implementation, the FAO is developing a "tiered" approach to the implementation of SEEA Agriculture, building on the tiered approach used in the measurement of greenhouse gas emissions for national reporting to the UNFCCC. The ambition is to provide a relatively standard entry point to the SEEA Agriculture framework for countries, especially those that have relatively less developed statistical systems. Over time, as experience with SEEA Agriculture grows within a country, under such a phased tier approach, countries would progressively move towards more complete and more detailed accounts and hence higher tiers, with the aim to support 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 data that are globally available; the second tier uses these data and also additional national data that 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 or, perhaps, incorporate sub-national level data. These three tiers are explained further in Annex 1 and will also be described in the SEEA Agriculture Implementation Guide.

1.35. Initial development of the SEEA Agriculture does not require new questionnaires, though it may require increased harmonization among existing data-collection work in different data domains. In this context, the SEEA Agriculture 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 be a basis for developing the integrated accounts envisaged in the SEEA Agriculture.

1.37. Given that the approach of the SEEA Agriculture 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. The SEEA Agriculture Implementation Guide sets out the most common data sources relevant to populating the base accounts described in the SEEA Agriculture and provides links to topic-specific methodological advice to indicate areas in which those coordinating and planning SEEA Agriculture might concentrate their work.

1.38. Ultimately, the process of integration described in the SEEA Agriculture does, however, 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 Agriculture. 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 Agriculture 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 Agriculture 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 Agriculture 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.

1.2 Summary of uses and applications of the SEEA Agriculture framework

1.41. The SEEA Agriculture provides a structure for the organization of 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 Agriculture 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.

1.2.1 Primary uses of SEEA Agriculture data

Statistical data coordination

1.42. With its strong connections to the SEEA Central Framework and the SNA, the SEEA Agriculture includes many of their approaches to 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 Agriculture provides a system for bringing together economic and environmental information in a single setting.

1.44. Data gap analysis and gap filling. The SEEA Agriculture is designed on the basis of the relevance of information rather than its availability. Because it is broad-

based, the SEEA Agriculture 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 Agriculture 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 Agriculture 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.

Uses in defining indicators

1.46. 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 Agriculture 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 Agriculture 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 Agriculture 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 Agriculture-based dataset and, conversely, it would be relevant when selecting indicators to consider the potential for deriving indicators based on the SEEA Agriculture.

1.51. The SEEA Agriculture does not define a concept of sustainability, nor does it suggest that direct measures of sustainable development can be derived from a SEEA Agriculture dataset. However, the SEEA Agriculture does provide information

[1] Each agency has its own database of agri-environmental indicators; OECD and Eurostat have the same set of indicators. The FAO set of agri-environmental indicators is based on the OECD/Eurostat set, with variations to enable global coverage.

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 Agriculture.

Uses for detailed analysis and modelling

1.52. The information in the SEEA Agriculture 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 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 described in 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

1.2.2 Primary policy themes

1.56. This section describes various policy areas that might be supported by a well populated SEEA Agriculture dataset, bearing in mind that the intention of the SEEA Agriculture 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 Agriculture 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 Agriculture framework supports discussion in the five themes described below with potential links to particular policies. The themes are a basis for the SEEA Agriculture 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 Agriculture 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. Another link is that between food consumption and health, nutrition and obesity. 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, but the SEEA Agriculture 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 Agriculture 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 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.

1.2.3 Other relevant policy connections

1.69. The design of SEEA Agriculture may be extended to encompass more policy themes, as set out in Chapters 3 and 4 in relation to particular 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 Agriculture 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 measured, but the approach is not yet developed in the SEEA Agriculture framework.

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 Agriculture supports improved data quality for these models. The capacity to track flows relating to specific products and types of corporation would ideally be needed, but it would involve a restructuring of the standard input-output table and statistical challenges would have to be addressed. These considerations are not yet developed in the SEEA Agriculture framework.

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. In various accounts the development of additional disaggregations of data might be undertaken to support analysis of these types of themes.

1.2.4 Applications at the sub-national level

1.73. Although the SEEA Agriculture is designed to integrate national-level 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 Agriculture framework may be applied at the sub-national level, but the challenges are to find a suitable range of data at that level and to determine appropriate sub-national boundaries. 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 optimum 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. The discussion of appropriate spatial units for accounting is a specific topic in SEEA Experimental Ecosystem Accounting.

1.75. More and more datasets are being developed to bring together detailed spatial data derived from GIS to enable assessment of the capacity of the environment to sustain agricultural production; an example is the FAO global agro-ecological zones. The SEEA Agriculture framework would support the development of such datasets by providing coherent national-level information about 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. The benefit of the SEEA Agriculture in this context is that each country would be compiling national data on a comparable basis, and hence the resulting 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. The description of approaches for the organisation of data at sub-national scales is a particular feature of the SEEA Experimental Ecosystem Accounting.

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.

1.3 Structure of SEEA Agriculture

1.79. The SEEA Agriculture 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 Agriculture, highlights some key accounting issues and challenges, and describes combined presentations and indicators that can be derived from the base accounts.

1.81. Chapters 3 and 4 provide a detailed description of the SEEA Agriculture base accounts with each section focusing on a different account. In chapter 3 the focus is 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. In chapter 4 the focus is 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, greenhouse gas emissions and fertilizer. The accounting described in this chapter is largely in physical terms.

1.83. For each of the base accounts in chapters 3 and 4, the material provides 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, the intent is not to duplicate the content and details contained elsewhere, and hence there is considerable referencing to other guiding documents, in particular the SEEA Central Framework and the SNA.

Chapter 2: Conceptual Framework

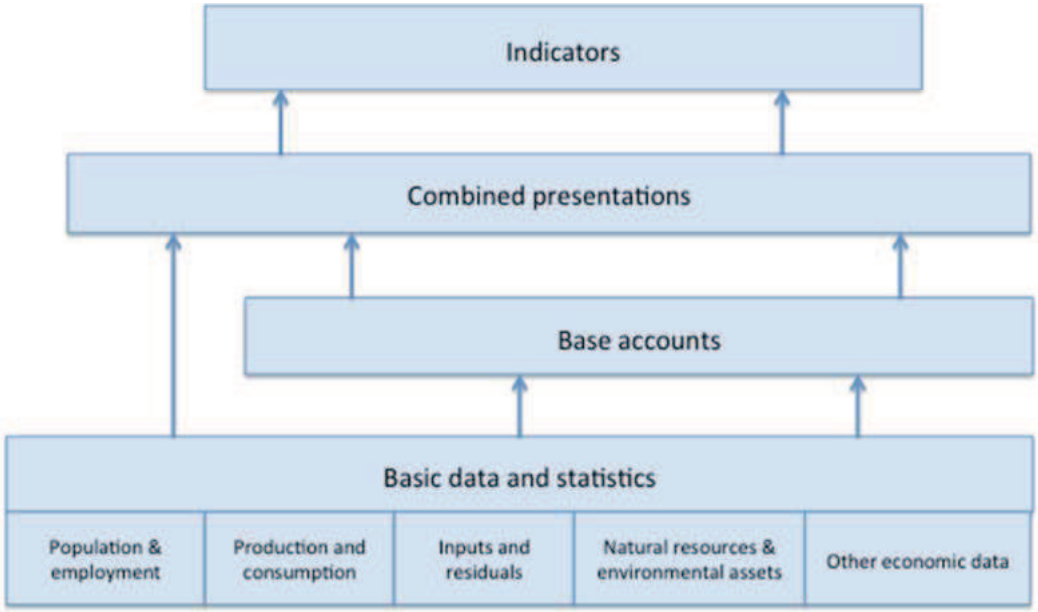
2.1 Introduction

2.1.1 Introduction

2.1. The SEEA Agriculture 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 Agriculture framework.

2.2. Figure 2.1 shows how 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 Agriculture information pyramid



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, that 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 Agriculture 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.

2.1.2 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 Agriculture 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 Agriculture 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. Because the SEEA Agriculture 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 Agriculture 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 Agriculture at the country level, an extension of the set of SEEA Agriculture 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. But 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 timber products Asset account for forests 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
Greenhouse gas emissions	Physical flow account for greenhouse gas emissions
Fertilizers, nutrient flows and pesticides	Physical flow account for fertilizers Physical flow accounts for nitrogen and phosphorous (Nitrogen and phosphorous budgets*) 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

* These have been developed outside the SEEA framework, but they are a form of asset accounting for these elements.

Accounting design

2.12. The design logic of the SEEA Agriculture involves three stages. First, SEEA Agriculture 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 Agriculture 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 Agriculture 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 Agriculture. 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 Agriculture 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 Agriculture 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. In agriculture, it would in theory be possible to extend the structure of the SEEA Agriculture to create functions for different approaches to the production of particular products: distinguishing organic production of crops is an example. This type of extension is not described in the SEEA Agriculture base accounts and combined presentations, with the exception of the distinction between capture fisheries and aquaculture.

2.22. Although the SEEA Agriculture 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 Agriculture aims, in fact, to mainstream detailed economic and scientific research on agricultural, forestry and fisheries production.

2.24. The SEEA Agriculture 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 Agriculture 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 Agriculture 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.

2.1.3 Potential areas of extensions

2.27. The design of the SEEA Agriculture 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 2012 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.

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.

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 Agriculture would be able to provide much relevant information.

2.33. An extension of the SEEA Agriculture 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.

2.34. Second, the SEEA Agriculture 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 Agriculture, 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 Agriculture.

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 Agriculture to datasets and models that are used for this analysis.

2.38. Fourth, the SEEA Agriculture could be extended to integrate more social information. Some such information – employment, food consumption and nutrition, for example – is already incorporated, but 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 Agriculture 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. An extension therefore is to include additional information on changes in the quality of water, air and soil 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 Agriculture. 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 Agriculture 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 Agriculture focus on agricultural, forestry and fisheries activities is most apparent.

2.2.2 Types of accounts

2.45. The two types SEEA Agriculture 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 2.3 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 2.2 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 Agriculture, 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
Total additions of stock
Reductions of stock
Extractions
Normal loss of stock
Catastrophic losses
Downward reappraisals
Reclassifications
Total reductions in stock
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 Agriculture 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 Agriculture, 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 Agriculture should therefore be seen as complementary to the development of ecosystem accounting.

2.56. In the SEEA, environmental assets include natural and cultivated assets: thus the asset boundary is not limited to only biophysical resources considered to be outside human management. Given this boundary, the SEEA Agriculture asset accounts include measurement of livestock, plantation timber and stocks of farmed fish. This a broad concept of environmental assets is useful in understanding the changing structure of production.

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 Agriculture 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 Agriculture 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 Agriculture 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 Agriculture 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 Agriculture 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 Agriculture, is that it will generally be useful 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 data for the SEEA Agriculture should be compiled at the level of the local "kind of activity" (LKAU), which will in many instances involve measurement at the farm level or equivalent.

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 Agriculture is consistent with a country's economic territory as applied in its national accounts. The application of this boundary for SEEA Agriculture 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 Agriculture.

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 Agriculture 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 Agriculture accounts. It is possible that additional accounting issues will be encountered in the compilation of SEEA Agriculture base accounts. The resolution of these issues will require further consideration and interpretation among relevant experts.

2.3 SEEA Agriculture base accounts

2.3.1 SEEA Agriculture physical flow accounts

2.77. The ten physical flow accounts in the set of SEEA Agriculture 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 Agriculture 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 Agriculture, 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 Agriculture asset accounts

2.84. There are ten asset accounts in the SEEA Agriculture. Their main purpose is to organize data on stocks of environmental assets in a specific data domain. Except for the recording of nitrogen and phosphorous budgets, the structure of the asset accounts follows the SEEA Central Framework.

2.85. The asset accounts in the SEEA Agriculture 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 Agriculture 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 Agriculture 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.

2.3.3 SEEA Agriculture 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 Agriculture, 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 Agriculture, 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 Agriculture to determine the scope of products for inclusion in the accounting framework.

2.96. The starting point in defining the scope of SEEA Agriculture 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 Agriculture. 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 SEEA Agriculture 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
	032 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.

i. In the case of crops, the product scope reflects harvested outputs – wheat, rice, apples or palm oil for example.

ii. 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 Agriculture physical flow accounts although it is recognised that the production of meat is a specific exception (for details see Chapter 3).

iii. 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 Agriculture, these products

have not been included in the physical flow accounts in Chapter 3 but extensions could be made as appropriate.

iv. 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 Agriculture.

v. The gathering of non-wood forest products including mushrooms, berries, rubber, cork and other products is a distinct activity within forestry and logging. While conceptually in scope of the SEEA Agriculture, these products have not been included in the physical flow accounts in Chapter 3 but extensions could be made as appropriate.

vi. The products from plant propagation (ISIC 013) and from forest nurseries (part ISIC 021) are not included in physical flow accounts.

vii. For fisheries activity, the output in the scope of SEEA Agriculture is equal to the harvest of fish and aquatic products, whether from capture fishing or from aquaculture.

2.98. 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 Agriculture 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

2.99. 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 Agriculture adopts the conventions that have been determined.

2.100. 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.

2.101. 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.

2.102. 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

2.103. 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.

2.104. 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 Agriculture 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.

2.105. 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.

2.106. 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.

2.107. 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

2.108. 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.

2.109. 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".

2.110. 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.

2.111. 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.

2.112. 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

2.113. 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.

2.114. 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 Agriculture. The recording of physical and monetary flows in these instances should follow the treatment described in section 2.4.3.

2.115. 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.

2.116. For the purposes of the SEEA Agriculture, 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.

2.117. 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 3.11) 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.

2.118. 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.

2.119. 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: i) the value of ecosystem services will be excluded from the accounts completely; 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.

2.120. 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 Agriculture 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

2.121. 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.

2.122. 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.

2.123. The effect on the SEEA Agriculture 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

2.124. 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.

2.125. 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.

2.126. 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 Agriculture is the quantities of a product that are lost or otherwise not finally consumed through the supply chain.

2.127. 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.

2.128. For the SEEA Agriculture, losses at three stages in the supply chain are identified. First, losses that take place during primary production such as felling residues in forestry[2], 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] 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.

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

2.130. Third, there is "food waste". In the SEEA Agriculture 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.

2.131. 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.

2.132. 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 Agriculture but relevant explanations are contained in SEEA Water and SEEA Energy.

2.133. 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

2.134. The aim of national accounting approaches such as the SEEA Agriculture 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.

2.135. 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 facilitate the analysis of these in a broader, economy-wide context.

2.136. 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.

2.137. 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.

2.138. The important point for the SEEA Agriculture 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.

2.139. 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.

2.140. 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 Agriculture combined presentations

2.5.1 Introduction

2.141. 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.

2.142. 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.

2.143. In the context of the SEEA Agriculture, 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 four SEEA Agriculture combined presentations with a view to linking them to individual policy themes as described in Chapter 2, and also to encouraging compilers and users to think of alternative presentations using the base accounts as a starting point for discussion and further analysis.

2.144. To support implementation of SEEA Agriculture, a standard, Tier 1, combined presentation has also been designed. It is intended to provide an indication of the type of detail and coverage relevant when commencing a program of work on SEEA Agriculture.

2.5.2 SEEA Agriculture combined presentations

2.145. Tables 3.5–3.8 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 the derivation of indicators. They also show that a range of issues may be considered once a sound underlying database is constructed. In this sense the SEEA Agriculture base accounts should not be considered policy-specific. Depending on the issue, different information from the same base account may be relevant.

2.146. In the combined presentations, the rows show selected agricultural, forestry and fisheries products or activities. The structure and coverage depends on the themes considered; alternative groupings are possible, and will depend on the areas of interest. An emphasis in the SEEA Agriculture is providing information for specific products rather than product groupings: maize, wheat and rice, for example, are shown rather than a "cereals" product group.

2.147. If required, additional rows in 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.

2.148. The combined presentations are not intended to be accounts that conform to accounting identities. 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.

2.149. The information in the combined presentations will largely be drawn from the underlying SEEA Agriculture base accounts (see Figure 3.1). The definitions of the data items are hence consistent with the data items defined for the base accounts. For the combined presentations shown in Tables 3.5 – 3.8, data item definitions are provided in Chapter 4.

2.150. The combined presentations that follow are not intended as standard reporting tables. The choice of products is intended to show what different combined presentations could look like. In practice, countries should incorporate the variables and products most relevant to the issue under consideration, using these examples as a starting point.

Table 3.5 SEEA Agriculture Combined presentation: Activity and product specific inputs

	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 pesticides
SELECTED KEY PRODUCTS ONLY	Production Quantity (000 Tonnes)	Gross Production Value (Million SLC)	Quantity (000 tonnes)	Quantity (000 tonnes)	(000 people)	(000 ha)	Net Change (000 ha)	(000 cubic metres)	(Terajoule)	(Gigagrams)	N	P	K	(tonnes)
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														
Total Fisheries														

Table 3.6 SEEA Agriculture Combined presentation: Food product consumption and waste

	Household consumption variables			Supply and use variables						Environmental variables			
	Food consumption/Nutrition			Ouput	Exports	Imports	Intermediate use	Changes in inventories		Land use		Use of Irrigated Water	GHG emission (CO2 eq.)
FOOD PRODUCTS	Total food purchased/obtained by households (000 tonnes)	of which: Food waste (000 tonnes)	Kcal/per capita/per day	Production Quantity (000 Tonnes)	Quantity (000 tonnes)	Quantity (000 tonnes)	Quantity (000 tonnes)	Total (000 tonnes)	of which: post-harvest losses (000 tonnes)	(000 ha)	Net Change (000 ha)	(000 cubic metres)	(Gigagrams)
Agricultural products													
Food Crops													
Maize													
Rice													
Wheat													
Palm oil													
Sugar													
Potatoes													
Other food crops													
Total													
Meat products													
Catlle and buffalo meat													
Sheep and goat meat													
Chicken meat													
Other poultry													
Pigmeat													
Other meat													
Total Meat													
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 3.7 SEEA Agriculture Combined presentation: Use of environmental assets

ACTIVITY	Ouput/Domestic production	Environmental asset variables							
		Land use		Soil resources	Water resources		Forest and timber resources	Fish and aquatic resources	Livestock numbers
	Production Quantity (000 Tonnes)	(000 ha)	of which: used for organic production	Indicator of soil quality (e.g. measure of soil carbon)	Use of irrigated water (000 cubic metres)	Water abstracted as a share of renewable water resources (%)	(e.g. change in forest area)	(e.g. change in CPUE)	(head)
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 3.8 SEEA Agriculture Combined presentation: Cross industry and activity perspectives

	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.)
ACTIVITY	Gross Production Value (Million SLC)	Value (Million SLC)	Value (Million SLC)	Currency (Million SLC)	Value (Million SLC)	Value (Million SLC)	Value (Million SLC)	(000 people)	(000 ha)	Net Change (000 ha)	(000 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													

2.151. 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 Agriculture 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.

2.152. 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.

2.153. 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.

2.154. 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.

2.155. 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.

2.156. In addition to these thematic combined presentations, a SEEA Agriculture "Reference Combined Presentation" has been designed to provide a focal point for discussion on the description and implementation of SEEA Agriculture. 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.

2.157. The structure of the reference combined presentation is shown in Table 3.9. 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. Further details on the compilation of the reference combined presentation is a feature of the SEEA Agriculture Implementation Guide.

SEEA-AGRICULTURE COMBINED PRESENTATION

	Assets				Inputs							Outputs					Trade flows				Population	Food availability		Environmental Impacts
					Abstracted water	Energy Use	Inorganic Fertilizer			Organic Fertilizer	Pesticides	Output		Gross Production Value	Value added	Total GDP	Exports		Imports					GHG Emission (CO2 eq) from Agriculture
	Land Area (000 ha)	Harvested Area (000 ha)	Biomass stock (million tonnes)	Number of Heads (Stock) (000 heads)	(m3)	(terajoules)	N (000 tonnes)	P_2O_5 (000 tonnes)	K_2O (000 tonnes)	N (000 tonnes)	(000 tonnes)	(000 tonnes)	(m3)	USD million dollars (current)	USD million dollars (current)	USD million dollars (current)	Quantity	USD million dollars (current)	Quantity	USD million dollars (current)	(mill)	Food (000 tonnes)	Food supply (Kcal/capita / day)	(gigagrams)
TOTAL				*See note 1								*See note 1												
Agriculture				*See note 1								*See note 1												
Arable Land																								
Permanent Crop																								
Permanent Meadows and Pastures																								
Crops Primary																								
Cereals																								
Roots and tubers																								
Pulses																								
Nuts																								
Oil-bearing crops																								
Vegetables																								
Fruits																								
Fibres																								
Fodder Crops																								
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 Solit																								
Other Industrial Roundwood																								
Other forest products																								
Water																								
Inland water																								
Coastal water (EEZ)																								
Aquaculture products																								
Fisheries products																								

Legend

Not applicable

Higher tier

*Note 1: Information is provided below by sub-category, but not added up in this cell

2.6 Aggregates and agri-environmental indicators

2.6.1 Types of indicators

2.158. 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.

2.159. Because accounting frameworks have embedded relationships between variables – for example between production and intermediate inputs or between income and assets – it is possible derive indicators directly from the accounting tables themselves: examples include gross domestic product and net saving.

2.160. These aggregates and accounting indicators can be compiled and presented at various levels of classification, for example by industry or institutional sector, depending on the data available. 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.

2.161. 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.

2.162. Following the SEEA Central Framework, the SEEA Agriculture 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.

2.163. The additional value of the SEEA approach generally, and the SEEA Agriculture 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.

2.164. 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 Agriculture because in terms of policy development 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 Agriculture in supporting the development and monitoring of indicator frameworks

2.165. One aim of the SEEA Agriculture 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.

2.166. Although a set of SEEA Agriculture 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.

2.167. 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 Agriculture 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 Agriculture 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.

2.168. One reason for not providing a set of SEEA Agriculture indicators is to emphasize the principle that the SEEA Agriculture is a multi-purpose dataset that can be used to support multiple indicator sets and a variety of analysis. The SEEA Agriculture 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.

2.169. Although no specific set of indicators is included, links between SEEA Agriculture-based data and existing relevant indicator frameworks can be identified. First, the post-2015 development agenda involves the articulation of a set of Sustainable Development Goals, with their targets and indicators. In view of their links with agriculture, forestry and fisheries in terms of environmental, social and economic goals, a number of SDG indicators could be sourced from SEEA Agriculture-based datasets.

2.170. Second, FAO, OECD and Eurostat have established a set of agri-environmental indicators, most of which can be sourced from a SEEA Agriculture-based dataset. Review of the indicator set may be supported by consideration of the SEEA Agriculture-framework.

2.171. Third, 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 Agriculture data framework.

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

3.1 Introduction

3.1. This chapter describes the SEEA Agriculture 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 is designed to be flexible and modular 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 – for example whether priority should be given to energy accounts, environmental protection expenditure accounts or land use accounts. Because the SEEA Agriculture has a cross-cutting perspective, its implementation cannot be modular in this way and ideally all 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, which 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 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 is accumulated, 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 Agriculture or will structure particular base accounts in 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, should not be considered to present templates or questionnaires for the purposes of international reporting. In due course, reporting mechanisms may emerge and a core set of SEEA Agriculture tables and data items may be developed. An important aspect in the development of reporting mechanisms will be coordination of the existing reporting to international agencies on agriculture, forestry, fisheries and related data domains, for example on water, GHG emissions and fertilizers.

3.7. This flexibility should not be interpreted as reflecting a system that limits comparability. Using the SEEA Agriculture with a focus on key products should ensure that comparable approaches to their measurement will be used by different

countries. 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. 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.

3.2 Physical flow account for crops

3.2.1 Measurement purpose and scope

3.8. 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.

3.9. 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 is often collected from several sources. Confrontation and reconciliation of data from different sources is an important function of accounting frameworks.

3.10. 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.

3.11. The SEEA Agriculture 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.

3.12. 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.

3.13. 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.

3.14. 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.

3.15. 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 Agriculture, 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 Agriculture physical flow accounts.

3.16. 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.

3.17. 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).

3.2.2 Accounting entries

3.18. The physical flow account for crops, shown in Table 4.1, 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.

3.19. One aim of the SEEA Agriculture is to distinguish 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.

3.20. Making this distinction is important, especially in the context of food crops, because the SEEA Agriculture aims to make the connection between the production of food crops and household consumption. Raw and processed products are recognized in the SEEA Agriculture 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.

3.21. 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 equivalents)

SUPPLY TABLE	Output					Imports	Total Supply
	Gross production	Harvest losses	Agricultural industry	Manufacturing industry	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)							

USE TABLE	Intermediate consumption					Household final consumption			Changes in inventories		Exports	Total Use
	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		
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)												

not applicable

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

3.22. 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.

3.23. 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

3.24. 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.

3.25. The SEEA Agriculture 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.

3.26. In the SEEA Agriculture, 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.

3.27. 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.

3.28. 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.

3.29. 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.

3.30. 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.

3.31. 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.

3.32. 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.

3.33. 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.

3.34. 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

3.35. 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.

3.36. 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.

3.37. 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.

3.38. 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.

3.39. The entry for "intermediate consumption – non-food processing" refers to the use of raw products in the processing of non-food products.

3.40. 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 to be 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.

3.41. 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.

3.42. The "household final consumption – other uses" entry is a catch-all for non-food uses of crop products.

3.43. 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.

3.44. 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.

3.45. Exports of crops consist of the sale, barter or transfer of crop products by residents to non-residents. Exports should be recorded in terms of raw commodity equivalent.

3.2.3 Measurement issues and possible extensions

3.46. 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.

3.47. 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.

3.48. 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).

3.49. 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.

3.50. The physical flow accounts for crops may be extended in various ways depending on data availability and analytical requirements. An example is incorporating information on the type of production of specific crops – irrigated and non-irrigated rice production, for example.

3.3 Asset account for plantations

3.3.1 Measurement scope and purpose

3.51. The asset account for plantations shows the total area of plantations, by type, and changes over an accounting period. This information may help to clarify the mix of plantations and their share of land use. Because plantation-based agriculture will involve different production processes and will generally operate over a long period of time, the information is relevant in understanding the potential environmental impacts of plantations.

3.52. The scope of the asset account is cultivated plantations, excluding timber: that is, plants managed as a process of production by economic units. Timber plantations are excluded here but 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.

3.53. 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.

4.3.2 Accounting entries

3.54. The asset account for plantations is shown in Table 4.4. 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.

3.55. The information in the plantation asset account should be consistent with the information in the land use account.

Table 3.2 Asset account for plantations (hectares)

Selected plantation types	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	Catastropic losses (storm, fire, disease)	Other reductions in stock	Total reductions		
Orchards										
Vineyards										
Oil Palm										
Banana										
Olives										
Almonds										
Coffe										
Tea										
Rubber										

3.56. The "opening stock" entry records the total area held at the beginning of the accounting period.

3.57. 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.

3.58. 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.

3.3.3 Measurement issues and possible extensions

3.59. 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

3.60. 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.

3.61. 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.

3.62. 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,

3.63. 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 Agriculture, but for guidance on specific products, reference should be made to ISIC Rev. 4 and CPC Rev. 2.0.

3.64. 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.

3.65. 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.

3.66. As noted with regard to crop products, the SEEA Agriculture does not aim to articulate the full value-added or supply chain associated with agricultural production. 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, 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.

3.67. In the SEEA Agriculture these additional steps are ignored, so the physical flow account for livestock products shows a stylized link between primary production and final consumption and other uses. But it does provide 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.

3.68. 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**.**

3.69. 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 Agriculture and may

form important parts of output in a particular country, depending on their scale and importance for policy formulation.

3.4.2 Accounting entries

3.70. The physical flow account for livestock products is shown in Table 4.3. 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

3.71. 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.

3.72. 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

	SUPPLY TABLE				USE TABLE							
	Output		Imports	Total Supply	Intermediate consumption	Household final consumption			Gross fixed capital formation	Changes in inventories	Exports	Total Use
	Agricultural industry	Manufacturing industry				Food consumption	of which: Food waste	Other uses				
Selected products*												
Livestock raising and breeding (000 head)												
Cattle and buffalo												
Sheep and goats												
Pigs												
Chickens												
Other poultry												
Other animals												
Meat (000 tonne)												
Cattle and buffalo meat												
Sheep and goat meat												
Pig meat												
Chicken meat												
Other meat												
Skin and hides (000 tonne)												
Eggs (000 number)												
Honey (000 litre)												
Raw milk (000 litre)												
Processed milk products (000 tonne)												
Raw wool (000 tonne)												
Processed wool (000 tonne)												

3.73. 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

3.74. The "intermediate consumption" entry covers the use of livestock products by other industries as inputs to other products, including meat.

3.75. The entry for "household final consumption – food" includes the quantity of all livestock products consumed by households as food.

3.76. 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.

3.77. The "household final consumption – other uses" entry includes all non-food uses of livestock products.

3.78. 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.

3.79. 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**.**

3.80. 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.

4.3.3 Measurement issues and possible extensions

3.81. 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.

3.82. 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.

3.83. 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.

3.5 Asset account for livestock

3.5.1 Measurement scope and purpose

3.84. 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.

3.85. 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.

3.86. 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.

3.5.2 Accounting entries

3.87. The asset account for livestock is shown in Table 3.4. 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 3.4 Asset account for livestock (number of livestock)

Type 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		
Cattle and buffalo											
Sheep											
Goats											
Total Sheep and Goats											
Pigs											
Chickens											
Ducks											
Geese											
Turkeys											
Pigeon and other birds											
Total Poultry and birds											

3.88. 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.

3.89. With regard to the "additions to stock" entry, in the SEEA Agriculture:

- "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.

3.90. With regard to the "reductions in stock" entry, in the SEEA Agriculture:

- "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.

3.91. In the "net change in stock" entry, net change is the difference between the closing stock and opening stock.

3.92. 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.

3.5.3 Measurement issues and possible extensions

3.93. 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. Since all livestock are ultimately killed for meat, it may be necessary to adopt conventions for showing the purposes for which particular types of livestock are used.

3.94. 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.

3.95. 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.

3.6 Physical flow account for forestry products

3.6.1 Measurement scope and purpose

3.96. The physical flow account for forestry products records the supply and use of forestry products in physical terms with a view to focusing on the activities of harvesting timber as distinct from the activity of processing raw timber and manufacturing wood products. In line with the general scope of SEEA Agriculture accounts, the coverage of this account should ideally include all production of forestry products irrespective of the industry classification of the economic unit undertaking the activity.

3.97. The scope of the activities and products involved must be clearly delineated. In line with the ISIC, there are four types of activity within the forestry industry:

- the growing and management of timber resources (ISIC group 021)
- the production of roundwood (including industrial roundwood and wood fuel) through the logging of timber resources (ISIC group 022)
- the gathering of non-wood forest products (ISIC group 023)
- support services to forestry (ISIC group 024).

3.98. For the purposes of the physical flow account in the SEEA Agriculture, the scope excludes support services to forestry since these are not generally measured in physical terms. Further, while products from all other forestry activities are in scope, generally, it is expected that the account would focus on wood products – i.e., the growing and management of timber resources and the production of roundwood. Non-wood forest products should be included when they are of policy or analytical significance.

3.99. 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.

3.100. In concept, the physical flow accounts should cover all production of roundwood in a country, including the output by households for their own final consumption. This would include the output sourced from small-scale farms, 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. However, the initial accounting focus should be on timber sourced from a country's forests, woodlands or other significant sources and included as the primary output of logging activity (ISIC 022).

3.101. The SEEA Agriculture physical flow account is not designed to 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 Agriculture 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.

3.6.2 Accounting entries

3.102. A physical flow account for timber products[3] is shown in Table 3.5. 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 3.5: Physical flow account for timber products (cubic metres)

SUPPLY TABLE	Output			Total output	Imports	Total Supply
	Forestry activity (ISIC 021)	Logging activity (ISIC 022)	Other industries			
Product						
Net annual increment						
Gross fellings						
Felling residues (not removed)						
Removals (over bark)						
Bark						
Removals (under bark)						
Roundwood (under bark)						
of which Industrial roundwood						
Wood fuel						

USE TABLE	Intermediate Consumption			Household final consumption		Gross fixed capital formation	Changes in inventories	Exports	Total Use
	Logging industry	Manufacturing industry	Generation of energy products	Energy	Other uses				
Product									
Net annual increment									
Bark									
Roundwood (under bark)									
of which Industrial roundwood									
Wood fuel									

Supply table entries

3.103. 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 4.1 is intended to assist in understanding the sequence of flows that are the focus of the SEEA Agriculture. 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.

3.104. 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 3.7).

[3] The scope of this account could be extended to include non-wood forest products.

Figure 4.1 Forestry concepts (figure to be updated)

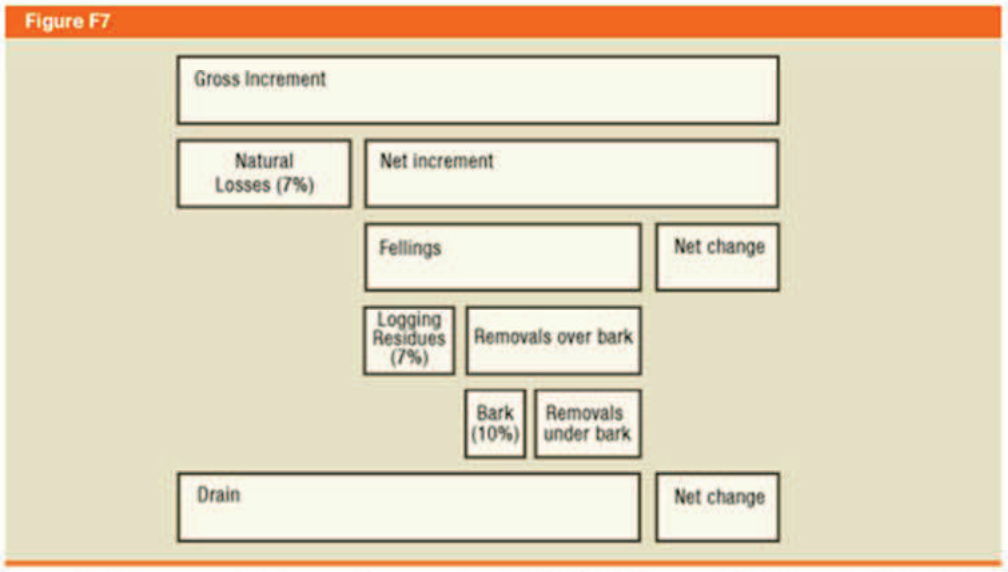


Figure F7: Components of gross increment and drain in Europe (Päivinen et al. 1999)

Source: Päivinen, et al. 1999

3.105. 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.

3.106. 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, where timber is felled in one accounting period but not removed until a later accounting period.

3.107. Standard practice[4] 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 the table includes rows for removals both over and under bark and a row for bark 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.

3.108. Roundwood measured under bark is a key production statistic and can be separated into two primary products – industrial roundwood (wood in the rough) and wood fuel (including wood for charcoal). It would be possible to continue to incorporate additional wood products such as logs and pulpwood but this extension to the supply chain is not presented in the SEEA Agriculture.

[4] Following the FAO/Eurostat/OECD/ITTO Joint Forest Sector Questionnaire

3.109. 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, these volumes should be converted to cubic metres of timber using appropriate conversion factors.

Use table entries

3.110. 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.

3.111. The entry for "intermediate consumption – manufacturing industry" relates to use of the output of roundwood by timber-related manufacturing industries (primarily ISIC 16 and 17) 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.

3.112. Under Intermediate consumption, the "generation of energy products" entry records the production of various wood products from wood fuel or roundwood, including the production of wood for charcoal, used as a source of energy. Some production of energy from wood fuel will be 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.

3.113. 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 is assumed to be of raw timber (possibly in the form of wood pellets and other agglomerates): that is, energy products ultimately consumed by households that may be generated by other industries that use roundwood or wood fuel as energy sources are not included. For example, the use of heat by households from the burning of wood products is not included in household final consumption in this physical flow account.

3.114. 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.

3.115. 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 assumed to be allocated to intermediate or final uses.

3.116. 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.

3.117. 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.

3.6.3 Measurement issues and possible extensions

3.118. 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.

3.119. 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. It is simply not the case that all roundwood comes from forests, although this 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 on forestry products and the scope of the associated accounts for forest land and timber resources (section 3.7). It will be possible to make the appropriate alignment but this may require more detailed data.

3.120. 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. Where these products are significant or of policy interest, a separate physical flow account should be established for them.

3.7 Asset accounts for forests and timber resources

3.7.1 Measurement scope and purpose

3.121. The assessment and analysis of forests and timber resources involves two complementary perspectives: i) the "asset account for forests" records the area and changes in land identified as forest and other woodland; 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. The relationship between these perspectives will vary over time and from country to country depending on the type of forest, the type of timber, planning and harvesting methods, and economic conditions.

3.122. 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 Agriculture complements them.

3.123. 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 will be particularly relevant.

3.7.2 Accounting entries

3.124. The asset account for forests is shown in Table 3.6. 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 3.6: Physical asset account for forests (hectares)

	Opening stock	Additions to stock	Reductions in stock	Net changes in stock	Closing stock
Forest and other wooded land					
Forest land					
Primary forest					
Other natural regenerated forest					
Total naturally regenerated forest					
Planted forest					
Total forest land					
Other wooded land					

3.125. The "opening stock" entry is the total area of forest and other woodland, 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 given in section 5.6.4 of the SEEA Central Framework.

3.126. With regard to the "additions and reductions in stock" entry, there are various reasons for changes in the area of forest and other woodland 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. Where possible, the distinctions between additions and reductions in stock and between managed and unmanaged changes should be recorded, but 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.

3.127. The "closing stock" entry is the total area of forest and other woodland, 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.

3.128. The physical asset account for timber resources is shown in Table 3.7. 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. Section 5.8.3 of the SEEA Central Framework explains the different entries.

3.129. The stock of standing timber is defined as the volume of trees, living or dead, that 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 such as the use of factors to convert the area of forest land to timber volume.

Table 3.7: Physical asset account for timber resources (cubic metres)

	Opening stock	Additions to stock			Reductions in stock						Net changes in stock	Closing stock
		Natural growth	Reclassi-fications	Total additions	Removals	Felling residues	Natural losses	Catastrophic losses	Reclassi-fications	Total reductions		
Type of timber resource												
Cultivated timber resources												
Natural timber resources												
Total												

3.7.3 Measurement issues and possible extensions

3.130. The measurement of the area of forested land can be challenging because various concepts and definitions used in different situations. In the SEEA Agriculture the area of forested land is measured in accordance with the FAO Forest Resources Assessment (FAO, 2015), which is based on the measurement of the area of land used for forestry, not land cover. By applying the concept of land use, estimates of the area of forests can be integrated with estimates of land used for other purposes, particularly agriculture.

3.131. Given the differences in data collection between forestry, agriculture and other land uses, the data should always be checked to ensure that they are sound and consistent. The relationship between land-use data and land-cover data for forests is an important area of investigation and reconciliation.

3.132. 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 treatment of change in timber resources. Because the growth of natural timber resources is considered to be outside of the production boundary, whereas the growth of cultivated timber resources is inside the production boundary, production from cultivated timber resources should be recorded as the trees grow rather than at the time of felling and removal.

3.133. However, in practice, determining which timber resources are cultivated and which are natural is not straightforward, as explained paragraphs 5.353 to 5.357 in the SEEA Central Framework. It may often seem relevant to utilize the distinctions between types of forest land such as between primary and planted forest as described in the asset account for forest land. However, but these may not align with the intended distinction between cultivated and natural forest in the SEEA, which is predicated on the degree of human management involved in growing the timber. For this reason, no assumptions are made regarding the connections between forest types and cultivated or natural timber resources, as in the SEEA Central Framework.

3.134. 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.

3.135. 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.

3.136. 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.

3.8 Physical flow account for fish and other aquatic products

3.8.1 Measurement scope and purpose

3.137. 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.

3.138. 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.

3.139. 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.

3.140. 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 Agriculture, groupings of fish products based on the ISSCFC have been created. There are 12 major groups listed below. These groupings of fish products may also be categorized by production process, that is 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

3.8.2 Accounting entries

3.141. The physical flow account for fish and aquatic products is shown in Table 3.8. 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.

3.142. Fish and aquatic products will usually be 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 in accounted for. In particular, conversions should recognise the existence of post-harvest and post-catch losses.

3.143. 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.

3.144. No aggregates across products are proposed in Table 3.8, 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 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

3.145. 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.

3.146. 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.

3.147. 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.

3.148. 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 3.8: Physical flow account for fish and aquatic products (tonnes)

SUPPLY TABLE		Output								Imports			Total supply
		Capture fisheries			Aquaculture			Other catch	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												

USE TABLE		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											

3.149. 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.

3.150. 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.

3.151. 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

3.152. 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.

3.153. The "intermediate consumption – other purposes" entry refers to all uses other than export, household final consumption and changes in inventories.

3.154. 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.

3.155. 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.

3.156. 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.

3.157. 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.

3.8.3 Measurement issues and possible extensions

3.158. 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.

3.159. A frequent measurement issue with capture fisheries is the treatment of fish caught in a country's exclusive economic zone by foreign-registered vessels. Following standard conventions, such fish products are considered the production of the country in which the fishing vessel is registered (see SEEA Central Framework, 3.132).

3.160. 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 Agriculture. 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.

3.9 Asset account for fish and other aquatic resources

3.9.1 Measurement purpose and scope

3.161. The decline in global fish stocks in recent decades and the corresponding rise in aquaculture facilities is well documented (see, for example, FAO 2014 *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.

3.162. The SEEA Agriculture 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.

3.163. 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.

3.164. 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.

3.9.2 Accounting entries

3.165. A basic asset account for fish and other aquatic resources is presented in Table 3.9. It shows the opening and closing stock of aquatic resources, and additions and reductions in stock resulting from natural growth, catches and other factors.

3.166. 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.

3.167. 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).

Table 3.9: 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											

3.9.3 Measurement issues and possible extensions

3.168. 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.

3.169. 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.

3.170. 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.

3.171. 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.

3.172. 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.

3.173. 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 Agriculture. 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.

3.10 Base accounts for economic data for SEEA Agriculture

3.10.1 Measurement purpose and scope

3.174. Section 2.3 introduced the types of economic data relevant to the SEEA Agriculture. 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.

3.175. Table 3.10 shows a monetary supply and use account for agriculture, forestry and fisheries products. It follows 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.

3.176. 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 are included in the income earned by the producer but are not paid by the purchaser of the product: instead, they are transferred from the government to the producer. In table 3.10 subsidies are recorded as a component of total supply at basic prices.

3.177. The SNA and chapter 2 of the SEEA Central Framework provide details on the relevant valuation concepts. The SEEA Agriculture does not provide additional material on valuation because the data will be drawn from available national account datasets.

3.178. 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 Agriculture may support analysis of these of issues, and the base accounts could be extended to incorporate additional data.

Table 3.10 Monetary supply and use table for agricultural, forestry and fisheries products (currency units)

	SUPPLY TABLE							USE TABLE					
	Ouput		Imports	Trade and transport margins	Taxes on products	less Subsidies on products	Total supply at purchasers prices	Intermediate consumption	Household consumption	Gross fixed capital formation	Changes in inventories	Exports	Total Use at purchasers prices
	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													
Total Fisheries													

3.179. Table 3.10 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: cooperation between the compilers is recommended. The integration of physical flow accounts at the same time as monetary information is also likely to be useful.

3.180. Table 3.11 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. For Table 3.10, the use of a product-level perspective is an obvious choice, but for Table 3.11 the choice of perspective is less clear with regard to a detailed production function; options include a product perspective, an activity perspective or 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 inputs 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.

3.181. Given these considerations and the aim of the SEEA Agriculture to support comparison across agriculture, forestry and fisheries, Table 3.11 uses an activity perspective based on the 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 3.11 Extended production and income account for agricultural, forestry and fisheries activities (currency units)

	Output	Intermediate consumption					Gross value added	Compensation of employees	Gross operating surplus & Gross mixed income	Taxes less subsidies on production and imports	Gross fixed capital formation		Changes in inventories		Consumption of fixed capital (Depreciation)	Employment (000 people)
		Water	Energy	Fertiliser	Other	Total					Cultivated biological resources	Other produced assets	Cultivated biological resources	Other changes in inventories		
	(1)					(2)	(3) = (1)-(2)	(4)	(5) = (3) - (4)		(6)				(7)	(8)
Agriculture																
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																

3.182. 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.

3.183. 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.

3.184. 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.

3.10.2 Measurement issues and possible extensions

3.185. The compilation of national accounting tables for input and output and for supply and use calls for specialist knowledge. Chapter 5 provides some details and links to relevant guidance.

3.186. The structures proposed above are intended to bring together a basic level of monetary data that can be linked to the data in other parts of the SEEA Agriculture framework. There are many possible extensions, depending on the focus for analysis.

3.187. 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.

3.188. Considerably more detail as to the cost of production might be compiled to expand the "intermediate consumption" entry, which would highlight the relative significance of inputs such as energy, materials, fertilizers, pesticides and labour. 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.

3.189. 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 Agriculture, 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.

3.190. Finally, there may be particular interest in organizing detailed data on gross fixed capital formation by agriculture, forestry and fisheries. As well as information on the purchase of machinery and equipment, data could be gathered on expenditures for research and development, innovation, landscape restoration and environmental protection. 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.

Chapter 4: Accounting for environmental assets, primary natural inputs and residual flows

4.1 Introduction

4.1. This chapter describes the SEEA Agriculture 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 Accounts for stocks and flows of water resources

4.2.1 Measurement purpose and scope

4.3. All agricultural, forestry and fisheries activity depends on the quantity and quality of the water. At the national level, differences in the availability of water between regions may not be apparent, and seasonal variations in water availability may be a constraining factor. Further, 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 also be competition for water use, for example for energy, manufacturing and human consumption. With these points in mind, and in view of increasing pressures on water availability in many areas, a coherent set of data on water resources and links to economic and human activities should be maintained.

4.4. 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 Agriculture include extensions of those in the SEEA Central Framework and SEEA Water. These documents and the 2012 International Recommendations for Water Statistics underpin the discussion here.

4.5. The SEEA Water accounts are of two types – water asset accounts and physical flow accounts for water. 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. Physical flow accounts for water record flows into the economy from the environment, flows between economic units in the economy, including waste water, and returns to the environment. Both of these accounts are adapted for the purposes of the SEEA Agriculture.

4.6. The aim of the SEEA Agriculture 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 Agriculture relates to irrigation and to attempts to place irrigated agriculture in a broader context.

4.7. 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 Agriculture 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.

4.8. The SEEA Agriculture 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.

4.9. In line with the SEEA Central Framework and SEEA Water, the SEEA Agriculture 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 Agriculture at this stage.

4.2.2 Accounting entries – physical flow account

4.10. The physical flow account for water (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.

4.11. 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).

4.12. Given the strong parallels to the recording of the physical flow accounts in the SEEA Central Framework and the SEEA Water, no 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)

Physical supply table for water

	Abstraction of water; Production of water; Generation of return flows										Flows from the rest of the world	Flows from the environment	Total supply
	Agriculture			Forestry	Fisheries	Total agriculture, forestry and fisheries	Water collection, treatment and supply	Sewerage	Other industries	Households	Imports		
	Crops*	Livestock	Total agriculture		Aquaculture								
(I) Sources of abstracted water													
Inland water resources													
Surface water													
Groundwater													
Soil water													
Other water sources													
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)													
(IV) Return flows of water													
To inland water resources													
To other sources													
Total Return flows													
(V) Evaporation of abstracted water, transpiration and water incorporated into products													
Evaporation of abstracted water													
Transpiration													
Water incorporated into products													
Total supply													

Note: Crops* - this column can be disaggregated into key product groups as required.

Physical use table for water

	Abstraction of water; Intermediate consumption; Return flows								Final consumption	Accumulation	Flows to the rest of the world	Flows to the environment	Total use
	Agriculture			Forestry	Fisheries	Total agriculture, forestry and fisheries	Water collection, treatment and supply	Sewerage	Other industries	Households		Exports		
	Crops*	Livestock	Total agriculture		Aquaculture									
(I) Sources of abstracted water													
Inland water resources													
Surface water													
Groundwater													
Soil water													
Other water sources													
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)													
(IV) Return flows of water													
Returns of water to the environment													
(V) Evaporation of abstracted water, transpiration and water incorporated into products													
Total													
Total use													

Note: Crops* - this column can be disaggregated into key product groups as required.

4.13. 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. The recording of soil water is discussed further below.

4.14. 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 must be included to provide a full picture of water entering the economy.

4.15. 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.

4.16. 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.

4.17. 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.

4.18. 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). Soil water is included within scope since, conceptually, its inclusion supports an assessment of the changing dynamic between rain-fed and irrigated agriculture and presenting a more complete picture on the use and availability of water resources.

4.19. However, there are two measurement issues to consider, the first is an accounting one and the second a practical issue of estimation. On the accounting issue, a distinction in treatment is required depending on whether there is irrigation taking place. In concept, where there is no irrigation, the total abstraction of soil water will be equivalent to the total transpiration and water incorporated into products. However, in cases where irrigation takes place, in gross terms there will be abstraction from surface water, groundwater or other sources to supply the water for irrigation on the one hand, as well as abstraction of soil water as the plant transpires and incorporates some of the water. Entries will be required in the physical flow account in order to ensure that there is a reconciliation between the total water abstracted and the actual volume of water transpired and incorporated into products.

Further details on the accounting treatment will be explained in the SEEA Agriculture Implementation Guide.

4.20. The practical measurement issue is that the measurement of flows of soil water can only be accomplished via modelling of evapotranspiration and crop production. Further, the stocks of soil water (soil moisture) can be variable over time and space which complicates the modelling of the flows. While these models are not commonly applied in the development of official statistics, they have been widely applied in agricultural and ecological research. If such models are applied, then consultation and engagement with experts in these fields will be necessary.

4.21. Given that such models have not been regularly used in official statistics and accounting, it is recommended that the measurement of soil water flows be considered only in countries where there are on-going policy concerns, for example in situations of long term drought or water stress. Separately, as an interim step towards accounting for soil water, it may be relevant to record changes in soil moisture using qualitative indicators (e.g. of areas with dry soil). While such indicators would still require some modelling, they may support providing a more complete picture of water resources for policy and analysis.

4.2.3 Accounting entries – asset accounts

4.22. The asset account for water resources is designed to record 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.

4.23. The asset account for water resources is shown in Table 4.2. The relevant accounting entries are described below.

Table 4.2: Asset account for water resources (cubic metres)

	Surface water				Groundwater	Soil water*	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 addtions to stock							
Return flows from economy							
Total							
Reductions in stock from the environment							
Evaporation							
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							

4.24. 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, groundwater and soil water (see the SEEA Central Framework and SEEA Water). Measurement of these stocks may be challenging, particularly for soil water (see discussion above). Totals excluding soil water and focusing on stocks of surface water and groundwater is likely to be a practical initial aim.

4.25. 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.

4.26. 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).

4.2.4 Measurement issues and potential extensions

4.27. 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.

4.28. 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.

4.29. 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.

4.30. The information in the SEEA Agriculture 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.

4.31. 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 Agriculture 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.

4.32. 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.

4.33. The conclusion here is that 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.

4.34. 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.

4.35. 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.

4.36. The SEEA Agriculture 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 Agriculture for discussion of flows of fertilizers and pesticides to the environment.

4.37. The SEEA Agriculture 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.

4.38. 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 Agriculture 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

4.39. The physical flow account for energy use records the use of energy, expressed in joules, by agricultural activities and selected agricultural, forestry and fisheries products. Energy may be used in the form of electricity, petrol and diesel fuels, biofuels, solar power and wind power.

4.40. 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.

4.41. 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, and uses of energy by other activities, including households.

4.42. In line with the SEEA Central Framework, the measure of energy use should include the consumption of energy produced on own-account by an agricultural, forestry or fisheries unit. Production of this energy, for example by solar panels or wind turbines, will directly compete with energy purchased from outside sources, so they must be included to support understanding of energy use and the changing structure of supply.

4.3.2 Accounting entries

4.43. The physical flow account for energy use is shown in Table 4.3. 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.

4.44. 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.

4.45. 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.

4.46. 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), brown coal (SIEC code 02, and coal products (SIEC code 03).
- 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)

	TOTAL SUPPLY	Agriculture, Forestry, Fisheries																Other industries	Households	Exports	TOTAL USE
		Agriculture										Total Agriculture	of which: from own-account production	Total Forestry	of which: from own-account production	Total Fisheries	of which: from own-account production				
		Maize	Rice	Wheat	Palm oil	Sugar	Potatoes	Other food crops	Non-food crops	Total crops	Livestock										
USE OF ENERGY																					
Tranformation 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																					

4.47. 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

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

4.49. 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.

4.50. One extension to accommodate this demand would be the development of an energy supply table to complement the energy use table described above. The SEEA Agriculture 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. In these accounts the volume of biomass used in the generation of energy products is recorded. Using appropriate conversion factors these estimates of volume may be converted to joules to support extended analysis.

4.51. 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.

4.52. To support analysis of the use of energy produced and used on own-account, an extension (presented in Table 4.3) is 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. Income earned from the sale of energy products should be included in Tables 3.10 and 3.11 as appropriate.

4.53. 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 Agriculture to develop extensions of this type because this area of work is covered by SEEA Energy.

4.54. 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 greenhouse gas emissions

4.4.1 Measurement purpose and scope

4.55. The measurement of greenhouse gas (GHG) emissions has emerged as an important issue for agricultural, forestry and fisheries statistics in recent years. The national parties to the UNFCCC are committed to reporting such emissions from agriculture, forestry and land use change through compilation of national GHG inventories. In many developing countries, the emissions from agriculture, forestry and land use change are a significant proportion of their total GHG emissions, and their reduction will be a large part of their future mitigation commitments under the new Paris Agreement. In this context, it is logical to include GHG emissions in the SEEA Agriculture framework.

4.56. The physical flow accounts described here record flows of GHG emissions from agriculture, forestry and fisheries activities to the environment, for example through the use of fertilizer or through land clearance. Emissions are categorized as related to:

- Process – emissions reported under "agriculture" in accordance with UNFCCC decisions for Annex I and non-Annex I Parties (see UNFCCC Common Reporting Format Tables under item 3 Agriculture, and their associated Inter-Governmental Panel on Climate Change [IPCC] guidelines). Emission categories include enteric fermentation, manure management, rice cultivation, synthetic fertilizers, manure left on pasture, crop residues, manure applied to soils, drained organic soils and burning of crop residues.
- Energy use in agriculture – including use of diesel oil, gasoline, liquefied petroleum, natural gas and residual fuel oil used in mechanized activities such as sawing, harvesting, irrigation and drying.
- Land use, land use change and forestry (LULUCF), corresponding to UNFCCC Common Reporting Format Table 4. It includes activities such as management of forests, cropland and grazing land, clearing of forest land and drainage of organic soils.

4.4.2 Accounting entries

4.57. The physical flow account for GHG emissions is shown in Table 4.5. In theory, it follows the logic of a supply and use table, but because the only "use" of emissions is when they are "received" by the environment, there is no need to record it. In concept then, the supply of GHG emissions is recorded on a gross basis, i.e. the volume of emissions released by an economic unit as a direct result of economic activity.

4.58. The structure of the physical flow account is a matrix that enables consideration of information on GHG emissions from agriculture, forestry and fisheries activity: i) from the perspective of different activities within agriculture; and ii) from the perspective of selected agricultural, forestry and fisheries products. The activity perspective enables a link to be made with the measurement processes of the

UNFCCC reporting process, following IPCC guidelines. The product perspective enables a link with production, trade, consumption and other environmental flows in the SEEA Agriculture framework.

4.59. The shading in the bottom half of Table 4.5 indicates that the initial focus should be estimating total GHG emissions for both: (i) agricultural, forestry and fisheries activities (i.e. using the activity perspective); and (ii) selected products (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.

4.60. The physical flow account also includes entries for GHG emissions from other industries and from households so that agriculture, forestry and fisheries emissions can be placed in context.

4.61. The following bullet points describe the activities within the scope of agriculture from the perspective of recording greenhouse gas emissions. An indication of the associated product grouping is provided for each activity, but more detail will be required to attribute emissions to particular crops and agricultural products at the country level. All entries should be expressed in carbon dioxide equivalent using appropriate conversion factors.

- Enteric fermentation (major product grouping: livestock) – methane gas produced by ruminants and, to a lesser extent, non-ruminants. It is computed at Tier 1 following the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006).
- Manure management (major product grouping: livestock) – methane and nitrous oxide gases from aerobic and anaerobic decomposition.
- Rice cultivation (major product grouping: crops) – methane gas from anaerobic decomposition of organic matter. Data are computed at Tier 1 following the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, vol. 3, Chapter 4 and the 2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.
- Synthetic fertilizers (major product grouping: crops) – nitrous oxide gas from synthetic nitrogen additions to managed soil.
- Manure left on pasture (major product grouping: livestock) – nitrous oxide gas from nitrogen additions to managed soils from livestock comprising: (i) emissions from microbial nitrification and de-nitrification on site; and (ii) emissions from volatilization, re-deposition and leaching.
- Crop residues (major product grouping: crops) – nitrous oxide gas from decomposition of nitrogen in crop residues on managed soils.
- Manure applied to soils (major product grouping: crops) – nitrous oxide gas from manure applied to managed soils.

Table 4.5: Physical flow account for GHG emissions (gigagrams of CO2 equivalent)

	Type of agricultural activity										Energy use in agriculture					Energy use in Forestry	Energy use in Fisheries	Land use, Land use change & Forestry				Total Agriculture	Total Forestry	Total Fisheries	Other industries	Households	Total Economy
											Fuel type															
	Enteric Fermentation	Manure Management	Rice cultivation	Synthetic Fertilizers	Manure left on pasture	Crop residues	Manure applied to soils	Cultivation of organic soils	Burning - Crop residues	Total	Gas-diesel oil	Gasoline	Liquefied petroleum (LPG)	Natural Gas (LNG)	Residual fuel oil			Forest Land (Net forest conversion)	Cropland (Cultivated organic soil)	Grassland	Other LULUCF activities						
Type of GHG emission																											
Emissions (CO2eq) from Nitrous Oxide (N20)																											
Emissions (CO2eq) from Methane (CH4)																											
Emissions of Carbon Dioxide (C02)																											
Total Emissions in Carbon Dioxide eq.(CO2 eq)																											
CO2 eq Emissions by Product																											
Food crops																											
Maize																											
Rice																											
Wheat																											
Palm Oil																											
Sugar																											
Potatoes																											
Other food crops																											
Total																											
Non-food crops																											
Livestock products																											
Timber products																											
Fish and other aquatic products																											
Total agricultural products																											

Note: LULUCF entries and associated aggregates recorded on a net basis

- Cultivation of organic soil (major product grouping: crops) – nitrous oxide gas from drained organic soils.
- Burning of crop residues (major product grouping: crops) – methane gas and nitrous oxide gas from burning crop residues on-site.
- Use of fuel – emissions estimated by type of fuel used in agriculture: i) diesel, FAO code 6801; ii) gasoline, FAO code: 6800; iii) liquefied petroleum gas, FAO code 6805; iv) natural gas, FAO code 6802; v) residual fuel oil, FAO code 6804, attributed to capture fisheries activity. Data are expressed in carbon dioxide equivalent.
- Fuel used in fisheries – emissions from energy consumption.
- Land use, land use change and forestry (LULUCF) – country-level estimates of emissions from land use activities, following the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: i) forest land net emission/removal; major product grouping: forest; ii) crop land net emission/cultivated area; major product grouping: crops; and iii) grassland net emission/cultivated area; major product grouping: livestock.

4.62. Table 4.5 includes total emissions attributed to agriculture, forestry and fisheries. For agriculture, the total is equal to the sum of GHG emissions by type of agricultural activity, energy use in agriculture and LULUCF categories cropland and grassland, including net forest conversion to these categories. For forestry, the total is equal to the sum of GHG emissions for energy use in forestry and LULUCF category forest land. For fisheries, the total is equal to GHG emissions from energy use in fisheries.

4.63. Note that for IPCC reporting the emissions from the use of electricity in agriculture are also included. Following the SEEA reporting principles these emissions are attributed to the Electricity industry, included as part of Other industries in Table 4.5.

4.4.3 Measurement issues and possible extensions

4.64. The following clarification is provided with respect to the scope of the LULUCF based emissions. First, the reporting of emissions against agricultural activities following the IPCC categories covers non-carbon dioxide emissions from agriculture. Accounting for carbon dioxide emissions and removals from agriculture are reported under LULUCF categories cropland and grassland, and include deforestation activities appropriately attributed to agriculture.

4.65. Second, the recording of LULUCF emissions is aligned with the intended scope of air emissions reporting in the SEEA Central Framework. Paragraph 3.243 recognises the inclusion of emissions that are the direct result of economic production processes. In SEEA Agriculture, this includes emissions due, for instance, to soil cultivation and land clearance, but also removals (carbon sequestration in biomass and soils) due to forest and other land management activities.

4.66. Third, further articulation of the boundary between LULUCF emissions recorded following IPCC reporting guidelines and the principles of recording in the SEEA is required to consider individual cases and give appropriate guidance. An initial step in this direction is provided in the Eurostat Manual on Air Emission Accounts where a comprehensive listing of cases is considered. In that manual, it is noted that many categories that fall within the LULUCF IPCC boundary are excluded

from the scope of the accounts on the basis of difficulties in estimation rather than on conceptual grounds. Further guidance on this boundary issue will be provided in the SEEA Agriculture Implementation Guide.

4.67. Finally, following IPCC reporting guidelines, Tier 1 default estimates of LULUCF emissions are reported on a net basis, i.e. taking into account both the release and the sequestration of carbon. Reporting using higher tiers can allow separation of gross fluxes. In an economy wide setting, net flux reporting is appropriate, but from a national accounts perspective ideally a gross basis of reporting would be followed, such that appropriate attribution of flows to industries can occur. As a practical step, for SEEA Agriculture it is suggested that, whenever recording follows the net flux treatment, this difference be noted when data are presented.

4.68. The measurement of GHG emissions at the national level is directly linked to the measurement of activities in the agricultural, forestry and fisheries industries. Because these activities include those in the SEEA Agriculture, there should be a clear connection between the estimates in this account and those in other SEEA Agriculture accounts. By using these connections, it will be possible to derive relevant indicators such as GHG emissions per unit of value added and per unit of output.

4.69. Relevant information is available on the FAOSTAT Emissions database As highlighted through this section, GHG estimates compiled for IPCC reporting at the national level and for SEEA Agriculture are closely connected. Adjustments will be required in some instances to utilise IPCC data in SEEA based accounts. For example, for emissions from fisheries, an adjustment will be required to ensure reporting on the basis of residence of the fishing operator (following recording principles of the SNA and the SEEA Central Framework). The SEEA Agriculture Implementation Guidelines will discuss measurement methods and sources in greater detail.

4.5 Physical flow accounts for fertilizers, nutrient flows and pesticides

4.5.1 Measurement purpose and scope: fertilizers and pesticides

4.70. Fertilizers and pesticides are fundamental inputs to agricultural, forestry and fisheries practice. It is relevant to understand the intensity of fertilizer and pesticide use because of their cost and their potential effects on ecosystems, particularly when assessing the merits of production practices such as organic farming that do not involve manufactured fertilizers and pesticides.

4.71. The use of an accounting approach for recording these flows facilitates comparison of data on the use of fertilizers and pesticides with agriculture, forestry and fisheries production and consumption data, and enables the comparison of data on their production, trade and consumption with a view to developing coherent underlying data.

4.72. Data on inorganic fertilizers may be recorded in terms of tonnes of fertilizer products that contain the active nutrients nitrogen (N), phosphate (P) and potassium/potash (K), or in terms of tonnes of nutrients themselves. For consistency between countries and over time and for coherence measuring variables such as production, consumption, imports and exports, data used in the physical flow account should be converted to a common nutrient basis in line with the FAO standard practice “nutrient principles”.

4.73. Methods for the estimation of the supply and use of organic fertilizers such as manure, compost and crop residues is still developing, but these fertilizers are

important sources of nutrients and are needed to maintain long-term soil health. They 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 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 4.6. 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.

4.74. With regard to pesticides, data are available in terms of active ingredients and weight of product. The SEEA Agriculture focus should be measurement in terms of active ingredients, even though standard measurement across different products is yet to be developed for purposes of aggregate statistics; a particular concern is that the weights of different active ingredients may not be a sound indication of effectiveness or potential environmental impact.

4.75. The focus in the measurement of fertilizers and pesticides is on their supply and use in agriculture, forestry and fisheries activity in the context of the overall 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

4.76. To obtain a complete 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.

4.77. 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.

4.78. For the SEEA Agriculture, 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.

4.79. 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.

4.80. Given the established framework for the measurement of nutrient budgets, no tables or additional advice is provided in the SEEA Agriculture. 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 Agriculture base accounts will support the measurement process and may improve the coherence of estimates.

4.81. Where nutrient budgets are estimated, various measures that may be of interest can be incorporated into SEEA Agriculture outputs such as combined presentations. These include measures of gross nitrogen surplus, phosphorous surplus and ammonia emissions.

4.5.3 Accounting entries for fertilizers

4.82. The physical flow account for fertilizers is shown in Table 4.6. 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

4.83. 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.

4.84. For organic fertilizers the focus presented here is on the supply of N but extension could be made to encompass supplies of P and K. For N there are two types of supply that are recognised. The first concerns the situation where N is 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, crop residues 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).

4.85. 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 content of all of these sources of supply should be recorded in the output column.

4.86. The entry for "imports" refers to the quantity of inorganic and organic fertilizers in tonnes of nutrient equivalent that are imported.

Table 4.6: Physical flow account for fertilizers (tonnes of nutrient equivalent)

	Output	Imports	TOTAL SUPPLY	Intermediate consumption															Household final 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		Losses	Other changes		
Inorganic fertilizers																							
Nitrogen Fertilizers (N total nutrients)																							
Phostate Fertilizers (P_2O_5 total nutrients)																							
Potash Fertilizers (K_2O total nutrients)																							
Organic fertilizers																							
In situ sources of N																							
Urine/dung from grazing animals																							
Crop residues																							
Mineralisation of N with loss of C during land use change																							
Application of organic fertilizers (N total nutrients)																							
Collected manure																							
Compost																							
Sewerage sludge																							
Other																							

Use table entries

4.87. 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.

4.88. 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.

4.89. 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.

4.90. 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.

4.91. The "exports" entry refers to the quantity of fertilizers in nutrient equivalent tonnes exported.

4.5.4 Accounting entries for pesticides

4.92. The physical flow account for pesticides is shown in Table 4.7. 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 4.7: Physical flow account for pesticides (tonnes of active ingredients)

				Intermediate consumption														Household final consumption	Changes in inventories		Exports	TOTAL USE
	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		
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

4.93. The "output" entry refers to the total quantity of pesticides produced at the national level expressed in tonnes of active ingredients.

4.94. The "imports" entry refers to the quantity of pesticides products imported, in tonnes of active ingredients.

Use table entries

4.95. 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.

4.96. The "intermediate consumption – forestry" entry refers to quantities of pesticide products used in forestry, expressed in tonnes of active ingredients.

4.97. The "intermediate consumption – fisheries" entry refers to quantities of pesticide products used in fisheries, expressed in tonnes of active ingredients.

4.98. 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.

4.99. 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.

4.100. 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.

4.101. 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.

4.102. The "exports" entry refers to quantities of pesticides products, in tonnes of active ingredients, exported.

4.5.5 Measurement issues and possible extensions

4.103. 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, and also interest in recording organic fertilizer in relation to elements in addition to N. In theory, all such 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 these fertilizers will be captured in the measurement of nitrogen and phosphorus cycles.

4.104. 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.

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

4.106. Fourth, 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

4.107. 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)

4.108. For SEEA Agriculture purposes, land use and land cover are both relevant. Land use information is valuable in studies of agricultural production, food security and cropping intensity; it can be used in understanding a country's agricultural sector and in deriving environmental indicators such as those related to land clearance. Land cover information is relevant as a basis for understanding the changing composition

and condition of a country's ecosystems, including its agricultural and forestry landscape.

4.109. 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 areas that do not satisfy the criteria for forests 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.

4.110. Given the focus on economic activity in the SEEA Agriculture, areas in a country used for agriculture, forestry or fisheries 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.

4.111. For land use and land cover accounts, the starting point is a country's land area, including areas 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.

4.112. A major purpose of accounting is to track change over time. The SEEA Central Framework and the SEEA Agriculture 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.

4.113. 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 broad-acre to plantations, is changing on a consistent basis.

4.114. 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 condition or tree density. These qualitative aspects may be included in accounting for individual environmental assets such as soil and timber resources, or in ecosystem accounting.

4.6.2 Accounting entries

4.115. The asset account for land use is shown in Table 4.8. It records the opening and closing stock of land in hectares, classified by type of land use and also records changes in land use over an accounting period through additions to stock and reductions in stock. At this stage, the accounting in the SEEA Agriculture should focus on measurement of 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: Asset account for land use (hectares)

		Opening stock	Additions to stock	Reductions in stock	Net changes in stock	Closing stock
Land use classes						
Land	Land used for agriculture					
	Arable Land					
	Permanent Crop					
	Arable land and permanent crop (tot)					
	Permanent meadows and pasture (cultivated)					
	Permanent meadows and pasture (naturally growing)					
	Permanent meadows and pastures (tot)					
	Total					
	Land used for forestry					
	Land used for aquaculture					
	Use of built up areas					
	Land used for maintenance and restoration of environmental functions					
	Other uses of land nec					
	Land not in use					
	Land area (total)					
Inland waters	Inland waters used for aquaculture or holding facilities					
	Inland waters used for maintenance and restoration of environmental functions					
	Other uses of inland waters nec					
	Inland waters not in use					
	Inland water (Total)					

4.116. For SEEA Agriculture 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 the growing of crops within agro-forestry 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.

4.117. 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.

4.118. Conceptually, it would be possible to make adjustments to the area harvested data 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. While the calculation of these factors is of analytical interest, this is considered a step beyond the compilation of base accounts for the SEEA Agriculture. Countries are however, encouraged to maintain data on the area harvested by crop type and changes in this area over time, to support this type of analysis. 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.

4.119. 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, including if the latter is on cropland or pasture.

4.120. The following paragraphs describe the main accounting entries for the asset account for land use.

4.121. The "opening stock" entry is the total amount of land and 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.

4.122. Regarding the entry for "additions and reductions in stock", there 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 Agriculture 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.

4.123. 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.

4.124. 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.

4.125. The asset account for land cover is shown in Table 4.9. 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 Agriculture should be the opening and closing stock and the net change in stock, so that even if data on additions and reductions in stock are not available the asset account can still be compiled.

Table 4.9: 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					
Herbaceaous 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					

4.126. The following paragraphs describe the main accounting entries for the asset account for land cover.

4.127. The "opening stock" entry records the total area of land, in hectares, by type of land cover at the beginning of the accounting period.

4.128. 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 use. 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 Agriculture 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.

4.129. The "net change in stock" entry is the difference between closing stock and opening stock, by land cover type.

4.130. 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.

4.131. 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):

- 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.

4.6.3 Measurement issues and possible extensions

4.132. 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 and multiple crops in the same area of land must be considered; the latter may be problematic if crops are grown in forest areas. Seasonal changes in land use and land cover between wet and dry seasons are also a challenge. Techniques for these measurements are discussed in the SEEA Agriculture Implementation Guide.

4.133. 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.

The links between land accounting and other areas of the SEEA Agriculture framework include accounting for soil resources and accounting for fisheries activity through the measurement of the surface area of inland waters and marine areas. There are also links between land accounting and the emerging field of ecosystem accounting, which considers the area of land – ecosystem assets – and its quality, and 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.

4.134. Land cover and land use 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.

4.135. 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 GHG 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.

4.136. In each of these cases, the classification of land has not been developed in a co-ordinated manner. The land use and land cover classes determined in the context of the SEEA Central Framework are additions to the selection. An important part of the research agenda for the SEEA Central Framework and the SEEA Agriculture is advancing the discussion on internationally agreed land use and land cover classes. Also, to the extent possible, the SEEA Agriculture Implementation Guide will provide bridging information between some existing land classifications.

4.7 Accounting for soil resources

4.137. 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.

4.138. Work is under way to apply natural capital accounting approaches to soil resources (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.

4.139. 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.

4.140. Table 4.10 shows the physical asset account for national soil resources. Important issues are the development of methods for estimating variables and determination of a classification of types of soil resources for SEEA purposes. Material on soil classifications is plentiful, but its application to aggregating changes in soil quality and quantity needs further consideration.

Table 4.10 Physical asset account for the area of soil resources (hectares)

	Type of soil resource	Total area
Opening stock of soil resources		
Additions to stock		
Due to changes in land cover		
Due to changes in soil quality		
Due to changes in soil environment		
Total additions to stock		
Reductions in stock		
Due to changes in land use		
Due to changes in soil quality		
Due to changes in soil environment		
Total reductions in stock		
Closing stock of soil resources		

4.141. An interim step towards full accounting for soil resources may be the development of standard indicators for changing quantities and quality of soil. These

could include indicators of carbon content, measures of erosion, measures of texture, and percentages of positively charged ions. It may also be possible to use accounting approaches to organize the information needed to derive the indicators. Measures of soil carbon content, for example, could be integrated into a carbon stock account as described in the SEEA Experimental Ecosystem Accounting.

4.142. Data sources developed in recent years regarding soil include the Harmonized World Soil Database (FAO et al., 2009) 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 progress in measuring soil resources.

ANNEX 1 Tiered approaches to implementation of SEEA Agriculture

A critical concept of the SEEA Agriculture 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 Agriculture 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 Agriculture 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 Agriculture 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 Agriculture accounts, to assess data gaps, including gaps in time series, and to establish mechanisms for integrating existing data at national level across the SEEA Agriculture 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 Agriculture 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 Agriculture 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 Agriculture 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 Agriculture 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 2: 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 Agriculture, 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 wealth[5] 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 Agriculture 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 Agriculture accounts would have to be extended to incorporate information on environmentally related taxes and other payments. The use of SEEA Agriculture in this way could help to quantify the costs of pollution.

[5] The sum of all national economic assets less liabilities to the rest of the world.

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