IMPROVING AGRICULTURAL & RURAL STATISTICS
Global Strategy

# Towards a System of Environmental-Economic Accounting 2015

## Agriculture, Forestry and Fisheries

GUIDELINES

**Cover photo:**
©FAO/ Mario Marzot
©FAO/J. Thompson
©FAO/Roberto Faidutti

# Towards a System of Environmental-Economic Accounting 2015

## Agriculture, Forestry and Fisheries

August 2015

# Contents

FIGURES



TABLES

# Preface

The Guidelines on the System of Environmental-Economic Accounting for Agriculture, Forestry and Fisheries (SEEA Agriculture) were developed as part of the Global Strategy to Improve Agricultural and Rural Statistics (the Global Strategy). These Guidelines are a fundamental contribution to the overall SEEA Agriculture process, which will continue until March 2016, with the submission of a final document for adoption by the UN Statistical Commission (UNSC).

The development of the SEEA Agriculture was initiated under the auspices of the United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA), which was established in 2005 to promote environmental/economic accounting. UNCEEA endorsed the preparation of the SEEA Agriculture in June 2010.

The SEEA Agriculture is led by FAO, in cooperation with the UN Statistical Division (UNSD). As a satellite to the SEEA Central Framework, it provides a novel statistical framework that enables national and international statistical systems to access the data needed to support policy-relevant analysis and decision-making. Indeed, it combines the economic and environmental dimensions of agriculture, forestry, fisheries, land use, water use and other relevant factors with the conventional treatment of agricultural, forestry and fisheries production.

The Global Strategy has contributed significantly to the development of the core SEEA Agriculture, including the overall statistical framework and its component data tables. In the coming months, as the date for submission to the UNSC approaches, this fundamental work will be finalized by FAO in coordination with UNSD and UNCEEA. In particular, these Guidelines will be integrated with specific new features intended to further promote implementation and associated capacity development activities in countries. Such features include the introduction of a phased approach, built on the concept of data Tiers of progressively increasing complexity and a new combined presentation; this will facilitate the analysis of data gaps in data-poor countries, thereby promoting data transparency and international comparability.

Work on the SEEA Agriculture commenced in June 2013 as a topic in the Global Strategy research programme. The various streams of work in progress since then cover:

- design of the framework;
- the potential for populating the accounts with data collated by the Food and Agriculture Organization of the United Nations;
- the feasibility of implementation at the country level; and
- the potential for deriving indicators.

Progress was discussed at meetings of: i) United Nations Committee of Experts on Environmental-Economic Accounting in June 2014; ii) the London Group of Experts in Environmental-Economic Accounting in November 2013 and October 2014; iii) the Expert Group on the SEEA Agriculture in October 2014; and iv) the Scientific Advisory Committee of the Global Strategy in November 2014, at which a draft was considered. A side event at the 2015 United Nations Statistical Commission in March 2015 presented SEEA Agriculture and highlighted its relevance at the national level in the context of the post-2015 development agenda. The participants in these meetings are gratefully acknowledged.

The SEEA Agriculture is an application of the System of Environmental-Economic Accounting Central Framework adopted in 2012 by the United Nations Statistical Commission. It provides a multi-purpose framework for

understanding the interactions between an economy and the environment, and for describing stocks of environmental assets and changes in them. The SEEA uses as its starting point the standard System of National Accounts, which underpins the organization of data on economic activity. A major aim of the System of Environmental-Economic Accounting is to mainstream environmental information into standard economic data structures to promote consideration of environmental factors in economic decision-making.

The concern with interactions between the environment and an economy in the System of Environmental-Economic Accounting is particularly relevant with regard to the economic activities of agriculture, forestry and fisheries, primary industries that use environmental assets such as soil, water, timber and fish. A system that focuses on these three industries is now a reality in the form of SEEA Agriculture.

SEEA Agriculture utilizes the data underlying our current understanding of agriculture, forestry and fisheries to provide an integrated picture of these industries. Such integration of data, which is a standard approach in the measurement economies, is relatively new with regard to environmental and economic data; some practical challenges are therefore likely to emerge. But given the increasing need for an integrated perspective on economic-environmental linkages, these challenges must be met – and the SEEA Agriculture aims to assist in the task.

This draft incorporates feedback from a group of invited experts and an initial round of global consultation in late 2014 and early 2015. The rationale, scope and design of the SEEA Agriculture has been endorsed but some areas require further consultation and technical discussion during 2015, particularly the introduction to data sources and materials in Chapter 5.

This is a living document: it will be revised to include findings from additional country experience and a final version submitted for discussion at the 47th Session of the United Nations Statistical Commission in 2016.

# Acknowledgements

The SEEA Agriculture was prepared by Carl Obst, Honorary Research Fellow at the University of Melbourne Sustainable Society Institute. The work was guided and supervised by Josef Schmidhuber, Deputy Director of the Statistics Division (ESS) of FAO; Robert Mayo, Senior Statistician; and Carola Fabi, Technical Assistance and Training Coordinator of the Global Office of the Global Strategy. Research support was provided by Silvia Cerilli and Bianca Papi of the FAO Statistics Division (ESS).

Gratitude is due to the experts from Australia, Canada, Guatemala and Indonesia who volunteered significant amounts of time to consider early designs of the SEEA Agriculture, evaluating the feasibility of compiling the base accounts and assessing the relevance of the framework to policy priorities at the national level.

The contributions of experts from international agencies such as the Organisation for Economic Co-operation and Development, Eurostat, the United Nations Statistics Division and the World Bank deserve special mention. In the Food and Agriculture Organization of the United Nations, the work was coordinated in the Economic and Social Development Department; the contributions of experts in ESS and several other divisions – particularly forestry, fisheries, water, energy, land and soil resources – are gratefully acknowledged.

The initial consultations involved 34 countries, and two international agencies also provided feedback. Their thoughtful comments and suggestions are warmly acknowledged.

This publication was prepared with the support of the Trust Fund of the Global Strategy, funded by the United Kingdom Department for International Development and the Bill & Melinda Gates Foundation.

# Acronyms

| | |
|---|---|
| AFF | Agriculture, Forestry and Fisheries |
| CPC | Central Product Classification |
| EE-IOT | Environmentally Extended Input-Output Table |
| ESS | FAO Statistics Division |
| FAO | Food and Agriculture Organization of the United Nations |
| GDP | Gross Domestic Product |
| GIS | Geospatial Information System |
| IMF | International Monetary Fund |
| IPCC | Inter-Governmental Panel on Climate Change |
| ISIC | International Standard Industrial Classification |
| NEC | Not Elsewhere Classified |
| OECD | Organisation for Economic Co-operation and Development |
| SEEA | System of Environmental-Economic Accounting for Agriculture |
| SIEC | Standard International Energy Product Classification |
| SNA | System of National Accounts |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNCEEA | United Nations Committee of Experts on Environmental-Economic Accounting |
| UNSC | United Nations Statistical Commission |
| UNSD | United Nations Statistical Division |

# 1

# Introduction

## THE SYSTEM OF ENVIRONMENTAL-ECONOMIC ACCOUNTING FOR AGRICULTURE, FORESTRY AND FISHERIES

### Overview

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 the environment and its resources and also have an impact on their local environments.

1.2 Understanding this relationship supports knowledge about the nature and outcomes of agriculture, forestry and fisheries, and provides information for analysing: i) food security; ii) environmental conditions and the sustainability of food, fibre and material production; iii) bio-energy potential and the associated trade-offs; and iv) issues related to rural incomes and employment.

1.3 Integrating information about agriculture, forestry and fisheries involves consideration of the intersections between the objectives of each activity and the related environmental factors, which are often considered separately. The growing dialogue on the water–climate–food–energy nexus, particularly in the context of the post-2015 agenda, calls for better understanding of relevant linkages and trade-offs – which is what the SEEA Agriculture aims to support.

1.4 The SEEA Agriculture is designed to be applicable to all countries, regardless of economic or statistical development, economic structure or environment. But because agricultural, forestry and fisheries activities vary considerably from country to country, the structure of some SEEA Agriculture accounts will vary to take into account the most important activities and products.

1.5 The SEEA Agriculture is relevant to a wide audience that includes users of information and compilers of statistics and accounts. It is written from the perspective of national accounting, but it aims to highlight 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.

1.6 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 as described here. In this sense the SEEA Agriculture constitutes a platform for an accounting approach to the integration and use of data relating to agriculture, forestry and fisheries activity in the domains of economics and the environment.

## Data requirements

1.7 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).

1.8 As described here, the SEEA Agriculture is very broad and requires a large amount of data for implementation. It may seem ambitious – but the reality is that the SEEA Agriculture combines in a single context ten domains and underlying datasets that, individually, are either well established or regarded as information that should be available at the national level. Much of the data has been the subject of the international statistical questionnaires developed in the various domains over many decades. In this sense, the SEEA Agriculture should not be seen as experimental.

1.9 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 rather than a requirement to support the overall aim of integration and harmonization. The measurement of gross domestic product (GDP), for example, is often supported by detailed input-output tables, but even without such tables it is possible to compile sound measures of GDP by integrating the relevant data in line with the national accounting framework set out in the System of National Accounts (SNA).

1.10 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.

1.11 The SEEA Agriculture is not intended as a reporting framework for the collection of data for purposes of international comparison. The tables and accounts in the SEEA Agriculture are therefore not reporting tables: they are intended to support the logic of integrating economic and environmental information on agriculture, forestry and fisheries. Decisions regarding the country-level data to be collected and the mechanisms for collection and coordination are not part of the SEEA Agriculture itself; they should be made through the appropriate international statistical processes.

## Motivation for the development of SEEA Agriculture, and its limitations

1.12 A large amount of information on agriculture, forestry and fisheries is already available, so the need for an additional framework applying an accounting approach requires explanation. Development of the SEEA Agriculture has two main drivers.

1.13 First, most datasets pertaining to production, consumption, incomes and assets are compiled separately for agriculture, forestry and fisheries. Consequently, definitions, methods, data management and other processes are therefore developed independently. This may be useful for analysis and policy development with regard to each activity, but it significantly limits the potential for understanding the connections and trade-offs among them. Because each activity is competing for "operating space", a framework that integrates a range of data from all of them should prove useful.

1.14 Second, economic data on production, incomes, trade, prices, employment, investment and the like are analysed separately from underlying environmental factors, which are usually recorded in biophysical terms. This separation, particularly at the national level, limits the potential of any dataset in that analysis of future trends or the effects of alternative policies should ideally take into consideration economic and environmental factors together. The SEEA is designed to facilitate such an integration of economic and environmental data, and application of its accounting principles to agriculture, forestry and fisheries is a natural step in view of their close links with the environment.

1.15 The fragmented approach to the measurement of economics and the environment combined with the separation of data on agriculture, forestry and fisheries activities has led to the development of numerous datasets, many of which are in the form of indicator frameworks covering the different dimensions to varying degrees. The SEEA Agriculture is not intended to replace datasets and indicator frameworks developed for specific purposes – but it does offer the potential to identify gaps, overlaps and areas of possible harmonization. It may therefore be useful in setting priorities and finding efficiencies by providing a single context in which to embed the different datasets.

1.16 Although other approaches to integration may be possible, the national accounting approach that underpins the SEEA is useful in various ways. First, it builds on the existing national accounts framework as used in the integration of economic data. Second, the national accounts framework underpins the development of various macro-economic models such as input-output models and general equilibrium models, and analytical indicators such as multi-factor productivity. Extending the national accounts approach to include environmental information means that the same approaches to modelling and analysis can be used. Third, the use of accounting systems requires a holistic approach to the determination of the scope of measurement: the system used is hence independent of the theme under consideration and constitutes a multi-purpose framework for recording information that may be relevant in many settings.

1.17 Using an accounting approach to integrate agriculture, forestry and fisheries data may be appropriate, but the SEEA Agriculture does have some limitations. First, it can make connections with social data such as employment and household incomes – but it does not incorporate elements pertaining to social capital, education or health and so should not be considered a framework for comprehensive assessments of sustainable development. But it may be of direct relevance in assessing the environmental sustainability of agriculture, forestry and fisheries.

1.18 Second, there may be differences in production practices in particular locations and for particular products: because the SEEA Agriculture is designed to provide a broad integration of data, these differences may not be recognized distinctly in a dataset based on the SEEA Agriculture.

1.19 Third, the primary focus of the SEEA Agriculture is the integration of data in biophysical terms – tonnes and cubic metres for example – and in monetary terms. Assessment of data in these terms will not highlight 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 the monetary value of purchases.

## Links with other accounting frameworks

1.20 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), which was adopted as an international statistical standard by the United Nations Statistical Commission in 2012. It was jointly published 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 in 2014 (United Nations *et al*., 2014).

1.21 The SEEA Central Framework provides the system for accounting for: i) physical flows of natural inputs, products and residuals, for example water, energy, emissions and waste; ii) stocks and changes in stocks of individual environmental assets such as timber resources, fish resources, water resources, soil resources and land; and iii) economic transactions that can be considered environmentally related such as environmental taxes, subsidies and similar transfers, environmental protection expenditure, and the production of environmental goods and services. Information on each of these areas is organized according to standard national accounting principles and the classifications and definitions used in the national accounts and economic statistics.

1.22 The framework focuses on environmental-economic accounting at the national economy level as set out above. Specific advice on environmental-economic accounting has been developed for particular themes and asset types including SEEA Water, SEEA Energy, SEEA Fisheries, SEEA Forestry and SEEA Experimental Ecosystem Accounting. The SEEA Agriculture is a member of this "family", in which the SEEA Central Framework functions as an "umbrella" by providing an overarching set of concepts, definitions and accounting structures.

1.23 There are evident overlaps among the other SEEA publications, particularly the SEEA Agriculture: for example the SEEA Agriculture, like the SEEA Water and the SEEA Central Framework, contains accounts relating to the supply and use of water resources. It is expected that countries will recognize these commonalities during implementation and compile data and accounts once for use as appropriate in various applications. In other words, each SEEA provides a different perspective on the integration of underlying data, and so compiling accounts following, for example, the SEEA Water and the SEEA Agriculture should not be interpreted as double counting.

1.24 Indeed, the SEEA Agriculture is intended to complement the accounting structures and principles of the SEEA Central Framework and other SEEA publications. Hence any work on accounting for individual stocks and flows, for example physical supply and use tables for water-use or land-use asset accounts, can be directly utilized in developing a set of SEEA Agriculture accounts. Conversely, work undertaken to implement SEEA Agriculture accounts will support the implementation of the SEEA Central Framework at the national level.

1.25 The SEEA Central Framework and related SEEA publications are based on the SNA. The SEEA frameworks are often considered "satellite accounts" of the SNA in that they extend or provide additional detail regarding the standard SNA accounts. But the SEEA now has sufficient coverage and status to be considered as more than an "add-on" to the SNA.

1.26 In particular, the SEEA is not limited to providing information that can be used to adjust economic measures such as GDP for the costs of natural resource depletion and degradation. This is certainly one aspect of the SEEA framework, but one of its particular features is its application of national accounting principles to the organization of information in physical terms – for instance in describing the formation of accounts for the supply and use of water and physical flows of energy. These accounts are related to the SNA but separate from it.

1.27 The SEEA Agriculture utilizes SNA economic accounting and SEEA Central Framework environmental-economic accounting to develop its set of accounts. Hence its value-added is not in terms of conceptual advances in accounting: its value lies in the integration of information that is considered standard in an SNA

context – data on the monetary value of production, consumption, trade and purchased inputs for example – with biophysical information compiled using approaches from the SEEA Central Framework.

1.28 The SEEA Agriculture does not incorporate the accounting approach described in the SEEA Experimental Ecosystem Accounting, which could be appropriately applied to agricultural, forestry and fisheries activities. At this stage, however, it is not sufficiently advanced in practice to be adapted specifically to these activities.

1.29 It is also appropriate to focus on the integration of existing data relating to the economic-environmental interaction for agricultural, forestry and fisheries activities with a view to enabling countries to start the process of integration using available data and supporting discussion of the linkages between the economy and the environment. Future development of ecosystem accounting for the agriculture, forestry and fisheries industries would be a logical extension.

## SCOPE AND APPROACH

### Summary

1.30 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. 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.

1.31 The SEEA Agriculture covers ten primary data domains, as shown in Table 1.1, which 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 AFF 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 AFF activities within the SNA.

**TABLE 1.1**
**Data domains of the SEEA Agriculture**

| |
|---|
| 1. Agricultural products and related environmental assets |
| 2. Forestry products and related environmental assets |
| 3. Fisheries products and related environmental assets |
| 4. Water resources |
| 5. Energy |
| 6 Greenhouse gas emissions |
| 7. Fertilizers, nutrient flows and pesticides |
| 8. Land |
| 9. Soil resources |
| 10. Other economic data |

1.32 With regard to physical flows, one data area that may have been included is the release of solid waste by agricultural, forestry and fisheries activities; this may be an area for extension. The measurement of food waste is covered in accounting for the supply and use of agricultural and fisheries products.

1.33 With respect to environmental assets, the domains of the SEEA Agriculture do not cover the measurement of ecosystems and the services they supply. This is a deliberate choice in that ecosystem accounting is still developing, and data are not readily available. Consequently, ecological data pertaining to biodiversity and the condition of agricultural ecosystems, forests, bodies of fresh water and coastal and marine environments is not integrated into the SEEA Agriculture.

1.34 But measurement of the stock and changes in stock of individual environmental assets such as resources of timber, fish, water and soil will probably be important indicators of these ecological dimensions. Information on physical flows of water, energy, greenhouse gas emissions, fertilizers, nutrient flows and pesticides will also indicate potential ecological impacts.

1.35 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 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 Chapter 4.

1.36 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 Chapter 3.

1.37 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.

1.38 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.

1.39 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.

1.40 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.

1.41 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 ongoing assessment of changes in the relative importance of different products, which is an essential part of monitoring.

1.42 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.

1.43 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.

1.44 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 between intensive and extensive production of livestock is an example. This extension is not usually described in the SEEA Agriculture base accounts and combined presentations, with the exception of the distinction between capture fisheries and aquaculture.

1.45 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.

1.46 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.

1.47 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.

1.48 An important theme of the SEEA Agriculture is working "from the outside in". The logic is that, by starting from a national and 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 in relation to key products is relevant in this context.

1.49 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.

## Potential extensions

1.50 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.

1.51 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.

1.52 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.

1.53 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.

1.54 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.

1.55 An extension of the SEEA Agriculture to incorporate ecosystem accounting is possible in theory, 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.

1.56 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 expenditure by economic units involved in agriculture, forestry and fisheries activities, known as AFF units; ii) environmental taxes and subsidies payable and receivable by AFF units; and iii) rents payable by AFF units, including payments for the use of land, access to forest reserves and payments in relation to fishing quotas.

1.57 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. There is little additional guidance that might be provided in the SEEA Agriculture, apart from noting 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.

1.58 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 4.16) 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.

1.59 Fourth, the SEEA Agriculture could be extended to integrate more social information. Some – 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.

# BACKGROUND

## Development

1.60 Development of the SEEA Agriculture is part of the work to establish international statistical standards for environmental-economic accounting. The United Nations Statistical Commission agreed at its 38th session in 2007 to revise and upgrade the 1993 SEEA and the SEEA-2003 under the auspices of the new United Nations Committee of Experts on Environmental-Economic Accounting, which has since then managed the development of various environmental-economic accounting documents. The principal document was the SEEA 2012 Central Framework, which was adopted as an international standard in 2012 at the 43rd session of the United Nations Statistical Commission.

1.61 After discussions at its 2012 meeting, the Committee of Experts on Environmental-Economic Accounting endorsed the FAO-led plan to develop an SEEA for agriculture, forestry and fisheries and work on the SEEA Agriculture commenced in June 2013 with resourcing from the Global Strategy to Improve Agricultural and Rural Statistics (the Global Strategy) led by FAO.

1.62 The SEEA Agriculture is part of the SEEA family, and hence has a direct connection with the SEEA Central Framework and the System of National Accounts 2008. It builds on earlier developments in environmental-economic accounting for agriculture, forestry and fisheries, notably: i) work by FAO and Eurostat on the Economic Accounts for Agriculture; ii) work led by FAO on the Integrated Environmental and Economic Accounting for Fisheries (SEEA Fisheries, 2004); and iii) work by Eurostat on the European Framework for Integrated Environmental and Economic Accounting for Forests, 2002.

## Related statistical documents and initiatives

1.63 These activity-specific documents were important in the development of the SEEA Central Framework, particularly with respect to the development of concepts and definitions to account for timber and fish and other aquatic resources. The SEEA Agriculture goes beyond the activity-specific perspective, providing a cross-cutting framework for integrating information and covering more data domains than envisaged in any of the earlier documents.

1.64 The System of Economic Accounts for Agriculture developed by FAO in 1996 built on the 1974 Handbook for Economic Accounts for Agriculture. The motivations for developing the system are the same as for SEEA Agriculture, and there are distinct overlaps in the types of economic and production data described.

1.65 There are three main differences between SEEA Agriculture and the System of Economic Accounts for Agriculture. First, the SEEA Agriculture incorporates more physical data on economic and environmental domains; this reflects the development since 1996 of the physical accounting aspects of the SEEA framework. Second, the SEEA Agriculture incorporates many more environmental and natural resource considerations in support of analysis of the sustainability of agricultural, forestry and fisheries production and consumption. Third, the System of Economic Accounts for Agriculture describes in more detail the connections between agricultural, forestry and fisheries activities and related income allocations across economic sectors such as households. Because both approaches are based on the SNA, it is easy to reconcile the frameworks; the differences should be interpreted in terms of changes in the focus of analysis and policy over the past 20 years.

1.66 The longstanding development and collection of statistics by FAO covering agricultural, forestry and fisheries activities and related themes such as water resources and land cover should be acknowledged: these global datasets, many of which are stored in FAOSTAT, are widely used, and in many respects the FAO leads international work on their maintenance and development. The work on integrating and developing these statistics and the motivation for the SEEA Agriculture are closely connected.

1.67 In covering so many data domains (see Table 1.1), the SEEA Agriculture has potential links to many initiatives. These links need to be explored further, and the SEEA Agriculture could be a catalyst for discussion on integrating the different projects. The remainder of this sub-section highlights some of the statistical initiatives connected to the development of the SEEA Agriculture at the country level.

### *The Global Strategy to Improve Agricultural and Rural Statistics*

1.68 The Global Strategy is a statistical initiative started in 2011 in response to concerns about the quantity and quality of agricultural statistics for many countries. The concerns reflected the understanding that significant connections exist between improved information, improved agricultural performance and improved standards of living for millions of poor rural people.

1.69 Its main focus is the development and implementation of approaches to the collection and use of statistics relevant to agriculture and rural issues, with which the SEEA Agriculture is aligned. The potential for complementarity between improving the coverage and quality of agricultural statistics and implementing the SEEA Agriculture is evident in the similarity of the types of data encompassed by the two frameworks.

1.70 The Global Strategy is intended to provide more and better data, and the SEEA Agriculture should provide a framework for integrating various data sources and assessing data gaps. It is particularly relevant that the Global Strategy aims to develop a "master sampling frame" as the basis for the collection of country-level agricultural statistics. This will support implementation of the SEEA Agriculture.

1.71 Many other statistical initiatives in FAO support implementation of the SEEA Agriculture: this work includes improving statistics for forestry and fisheries, measuring agricultural greenhouse gas emissions for all countries, measuring land cover and maintaining the Global Agro-Ecological Zones database, and developing methods and guidance for compiling food-balance sheets and estimates of the costs of production.

### *Implementation of the SEEA and SNA*

1.72 The adoption of the SEEA Central Framework as an international statistical standard in 2012 implied an expectation that countries would implement it as resources and capacity allow and that the international statistical community would support it worldwide. The implementation strategy endorsed by the United Nations Statistical Commission in 2013 is being carried out.

1.73 Given that the SEEA Agriculture applies SEEA Central Framework structures and accounts to agricultural, forestry and fisheries activities, there should be synergies between any implementation programmes. Indeed, the SEEA Agriculture may be a catalyst for widespread implementation in view of its direct connections to policy issues in many countries.

1.74 Similar implementation strategies exist or are being developed for SEEA components such as SEEA Water and SEEA Energy. Recent legislation in the European Union requiring the development of six SEEA-based accounts has generated guidance and training materials to support implementation at the country level.

1.75 Because the SEEA Agriculture focuses on a specific set of economic activities rather than specific environmental stocks or flows, there are also connections with the 2008 SNA at the national level, particularly in the case of countries where agriculture, forestry and fisheries account for a relatively large share of GDP, for example 15 percent or more. The implementation of SEEA Agriculture should improve estimates of value-added for the industries concerned. Any work on SNA improvement should therefore be considered in the light of the SEEA Agriculture material.

### *Implementation of ecosystem accounting*

1.76 An emerging area of accounting is ecosystem accounting, an approach described in SEEA 2012 Experimental Ecosystem Accounting. The focus of ecosystem accounting is the state and changing state of ecosystems considered as assets, and the associated flows from ecosystems known as ecosystem services. Given the direct link between agricultural, forestry and fisheries activities and ecosystems, the development of ecosystem accounting is of direct relevance here.

1.77 At this stage the SEEA Agriculture does not extend to consideration of ecosystem assets or ecosystem services. But as testing and development advances, the information in the SEEA Agriculture will become directly relevant in estimating components of the ecosystem accounting framework, particularly the measurement of forests, fisheries, soil resources, water resources and production/extraction activity.

### *Connections to other measurement activities*

1.78 Other activities to improve the quality of statistics include the Partnership in Statistics for Development in the 21st Century and the Framework for the Development of Environment Statistics. Depending on the work in any given country, coordination with these other activities is desirable.

1.79 There are several global indicator initiatives to which the SEEA Agriculture is relevant; these are described in Chapter 2. A major initiative is the post-2015 development agenda and the articulation of the Sustainable Development Goals and associated targets and indicators, several of which have links to agricultural, forestry and fisheries activities and therefore the concepts and structures of the SEEA Agriculture are relevant.

## IMPLEMENTATION

1.80 The SEEA Agriculture enables 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.

1.81 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 requirements.

1.82 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 draft SEEA Implementation Guide sets out the steps involved in planning and coordination to implement the SEEA.

1.83 The compilation of the SEEA Agriculture accounts would be started by using existing information or data that are generally compiled at the national level. Initial development of the SEEA Agriculture does not require new questionnaires, though it may promote harmonization among existing data-collection work in different data domains. As with all national-level accounting, in which multiple data sources are integrated, the data to compile the SEEA Agriculture cannot be collected through a single questionnaire or survey.

1.84 Other than official statistical collections and processes, data collected in other national and international processes should be exploited: the 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.

1.85 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. Chapter 5 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

## STRUCTURE OF THIS DOCUMENT

1.86 The SEEA Agriculture has five chapters. Chapter 1 "Introduction" describes its scope and coverage, its links to other parts of the SEEA family of publications and initiatives, and factors relevant to the implementation of the SEEA Agriculture at the country level.

1.87 Chapter 2 "Applications and uses of SEEA Agriculture" provides an overview of the potential beneficiaries of data organized in the SEEA Agriculture framework, and a description of possible areas of policy to which SEEA Agriculture -based data might be applied.

1.88 Chapter 3 "The conceptual framework of the SEEA Agriculture" 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 gives an overview of the base accounts of the SEEA Agriculture and describes combined presentations that can be derived from the base accounts.

1.89 Chapter 4 "Descriptions of SEEA Agriculture base accounts" 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. This chapter constitutes the bulk of this paper.

1.90 Chapter 5 "Overview of implementation and compilation of SEEA Agriculture" gives a short description of national accounting approaches to integration, and provides links to various source materials likely to be relevant in compiling the base accounts.

# 2

# Applications and uses

## INTRODUCTION

### Introduction

2.1 The SEEA Agriculture provides a structure for the organization of data that are useful for policy-making and analysis. It must accordingly 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.

2.2 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. Because environmental and economic data are too often considered independently in support of the analytical frameworks that pertain to each field, a good deal of analysis fails to take sufficient account of a number of factors affecting an overall system.

2.3 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 and the management of pests and disease; and fishermen need to understand how their activity affects fish stocks and how the local freshwater or marine environment supports healthy populations.

2.4 But 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, consumer demand and other economic factors that drive economic decisions with respect to use of the environment. Such decision-making is challenging in that it requires the balancing of economic and environmental factors – which is where the SEEA Agriculture information set will operate.

2.5 The SEEA Agriculture may be seen as relevant only to the analysis of individual, albeit extended, production functions: 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.

An SEEA Agriculture dataset should certainly assist in the coordination of information for these and other production functions, but those directly involved are likely to have the information and experience for decision-making. Hence although the SEEA Agriculture can support such activity-specific analysis, it is not intended to replace this specific experience and expertise.

2.6 The analytical benefits of the SEEA Agriculture stem from its application of the same framework across different products and activities. By utilizing a common framework, comparison between products and activities is facilitated because concepts, definitions and classifications are consistently applied. The production of wheat, for example, can be compared with the production of forest products or fish; and by applying the concepts of the national accounts and the SEEA Central Framework, agricultural, forestry and fisheries products and activities can be compared with the products of the manufacturing, retail and services industries.

2.7 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.

2.8 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 under-appreciated aspect of the standard economic accounts, which facilitate the integration of survey data on input-output relationships for particular industries with macro-economic indicators of international trade, consumer demand, government expenditure and business production and investment.

2.9 The integration of environmental and economic data is a major step towards mainstreaming discussion of 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.

## Potential beneficiaries of SEEA Agriculture

2.10 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.

2.11 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, which can assist in streamlining data collection and facilitating comparison and quality assessment.

2.12 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.

2.13 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.

2.14 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.

2.15 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, and would support the assessment of risks through the supply chain.

2.16 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.

2.17 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.

2.18 The numerous 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; and vii) the UNFCCC. 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.

## Links to SEEA Applications and Extensions

2.19 The SEEA Agriculture is an application of the SEEA Central Framework that focuses on agricultural, forestry and fisheries activity. Hence the various applications, uses and extensions of the SEEA Central Framework are also applicable to the SEEA Agriculture.

2.20 During the drafting of the SEEA Central Framework the SEEA 2012 Applications and Extensions was prepared. This gives an overview of ways in which data organized in line with the SEEA Central Framework can provide indicators, can be used in analysis and can support extensions to related thematic areas. The document should be studied to enhance understanding of potential uses of the SEEA approach.

2.21 A feature of SEEA Applications and Extensions is its description of environmentally extended input-output tables and the ways in which such tables support detailed modelling such as input-output analysis, general and partial equilibrium analysis and other approaches. A summary of possible approaches is provided in Section 2.2.3.

2.22 Because the SEEA Agriculture is based on the SEEA Central Framework, data compiled following the SEEA Agriculture approach will also support this type of analysis. If a country is developing detailed environmental-economic modelling related to agricultural, forestry and fisheries activity, this type of work would be supported by a dataset compiled in line with the SEEA Agriculture; and compilation of the SEEA Agriculture is likely to be informed by collaboration with those involved in such modelling.

## PRIMARY WAYS OF APPLYING THE SEEA AGRICULTURE FRAMEWORK

2.23 This section describes the ways in which the SEEA Agriculture framework may be used: some will be more relevant to some users than others, but the variety of uses highlights the potential of the SEEA Agriculture and the SEEA as an inter-disciplinary and multi-sector platform for engagement.

### Use in statistical and data coordination

2.24 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.

2.25 Framework for a database, and central point 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.

2.26 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.

2.27 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

2.28 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.

2.29 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.

2.30 This section outlines some types of indicators that may be relevant from the perspective of environmental-economic links for agricultural, forestry and fisheries activities. It builds on the introductory information on indicators in Chapter 6 of the SEEA Central Framework and the discussion of indicators in Chapter 2 of the SEEA Applications and Extensions.

2.31 Chapter 6 of the SEEA Central Framework describes three types of indicator: i) descriptive statistics; ii) environmental asset aggregates and indicators; and iii) environmental ratio indicators. All three are relevant to the SEEA Agriculture.

2.32 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.

2.33 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[1] attributable to individual environmental assets can also be considered.

2.34 Environmental ratio indicators are of three types. First, 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.

2.35 Second, 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.

2.36 Third, 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.

2.37 Given this range of potential indicators and the breadth of the SEEA Agriculture framework, it would be possible to develop a set of SEEA Agriculture indicators. But as explained in Section 3.5, the SEEA Agriculture does not propose a set of agri-environmental indicators or sustainability metrics. However, it does provide a framework in which the data used to derive indicators through participatory processes are readily available and coherently organized.

2.38 Examples of indicator sets include those being developed for the Sustainable Development Goals, the agri-environmental indicators collected by OECD, Eurostat and FAO,[2] 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 The sum of all national economic assets less liabilities to the rest of the world.

2 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.

2.39 Once a set of indicators has been established, it may be useful to develop a single indicator that combines the various sub-indicators. The Human Development Index is such a composite indicator in that it combines indicators of life expectancy, knowledge, education and national income. The OECD Handbook on Constructing Composite Indicators[3] provides guidance on the formation of composite indicators.

2.40 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 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

2.41 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.

2.42 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.

2.43 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.

2.44 Once EE-IOTs are established, different types of analysis may be supported. The following examples follow the descriptions in the SEEA Applications and Extensions, to which the reader is referred for more explanations and references.

2.45 Multipliers. Using the structural relationships between inputs and outputs reflected in EE-IOTs, multipliers can be derived that provide a measure of direct and indirect impact per unit of industrial output. Multipliers can, for example, provide a measure of the potential increase in emissions resulting from increases in production in a single industry. The effect can be measured solely for that industry – the direct impact – or for the economy as a whole – the indirect impact. Multipliers may also be considered in terms of backward linkages, which is the chain of inputs and outputs leading to the production of agricultural, forestry and fisheries outputs, and forward linkages, which is the chain of inputs and outputs that commence with those outputs.

2.46 Demand-based indicators. An alternative to the production-based approach of multipliers is to use the structural relationships between inputs and outputs to examine environmental-economic linkages from a demand perspective. The common focus is to attribute responsibility for the environmental flows to producers or to final consumers. The development of footprint indicators is a familiar application of this approach.

3 OECD, Joint Research Council of the European Commission. 2008. *Handbook on Constructing Composite Indicators: Methodology and User Guide*. OECD, Paris.

2.47 By working from a demand perspective it is possible to incorporate environmental inputs and impacts in the country in which the consumption takes place, and also the inputs and impacts in countries whose output is imported into the consuming country. Various assumptions are required to support this kind of analysis, and the availability of SEEA Agriculture data would be of direct relevance in understanding the connections between countries.

2.48 Structural decomposition analysis. This type of analysis, which is also based on the structural relationships in an EE-IOT, enables understanding the drivers of changes in specific variables. Changes in total emissions, for example, may be attributed to changes in the intensity of production, changes in industry structure or changes in final demand. Because the detailed SEEA Agriculture data can be integrated into a dataset for the whole economy, such decomposition analysis can be supported.

2.49 Extended productivity analysis. Traditionally, measures of industry-level and activity-level multi-factor productivity estimated using growth accounting techniques have been limited to considering two factors: labour and produced economic assets. The extended dataset of the SEEA Agriculture would enable consideration of additional factors of production, particularly the role of natural resources, thereby supporting measurement of extended or "green" estimates of multi-factor productivity. A SEEA Agriculture dataset would also support productivity analysis using alternative techniques.

2.50 Modelling international trade. The international trade in agricultural, forestry and fisheries products is an important issue for all countries, and is often a focus of bilateral and multilateral trade discussions. Data based on the SEEA Agriculture framework could be used to model the effects of trade agreements and particularly to encourage consideration of environmental factors when assessing the trade-offs involved. One consideration in this analysis is likely to be the levels of subsidy to agricultural, forestry and fisheries activity provided in different countries.

2.51 General and partial equilibrium analysis. General and partial equilibrium analysis is also based on EE-IOTs, but it incorporates a dynamic approach to assessing structural relationships rather than the static approach used in input-output analysis. In equilibrium analysis additional assumptions regarding the operation of the economy are introduced, thereby enabling resource constraints to be taken into account; examples of constraints include the availability of labour and natural resources. The datasets used for this type of analysis often incorporate social extensions to IOT datasets in the form of social accounting matrixes. The SEEA Agriculture data can also be used to support equilibrium analysis, particularly where there is a focus on agricultural, forestry and fisheries activities and potential constraints related to natural resources such as land and water.

2.52 Life-cycle analysis. This is a common alternative to input-output approaches. In life-cycle analysis, connections between inputs and outputs in the supply chain for a product or group of products are examined, usually from a consumption perspective as for footprint indicators. Although life-cycle analysis does not incorporate the full integrated structure of production and consumption, its bottom-up approach can enable detailed consideration of the relevant environmental and economic factors and drivers.

2.53 Data from SEEA Agriculture-based approaches should support both types of analysis, and there may be synergies in considering approaches based on life-cycle analysis and input-output. But the design must ensure that links through the supply chain can be tracked, for example in the selection of measurement units as livestock move from farm to processor to consumer.

## APPLICATIONS OF THE SEEA AGRICULTURE TO POLICY

2.54 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.

2.55 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. It is also applied to the decision-making frameworks of non-governmental organizations, corporations and small businesses.

### Primary policy themes

2.56 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 3.5.

#### *Theme 1: Activity-specific and product-specific inputs*

2.57 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.

2.58 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*

2.59 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.

2.60 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

2.61 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*

2.62 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*

2.63 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.

2.64 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.*

2.65 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.

2.66 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.

## Other relevant policy connections

2.67 The design of SEEA Agriculture may be extended to encompass more policy themes, as set out in Chapter 4 in relation to particular data domains.

2.68 One approach is to focus on 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.

2.69 Another approach 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.

## Applications at the sub-national level

2.70 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.

2.71 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.

2.72 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.

2.73 The development of sub-national datasets must allow for the existence of areas for analysis that cross national boundaries: the Mekong delta, the Nile and Lake Victoria are examples. 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.

2.74 An ongoing 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 detailed levels such as 1 km grids and then upscale as required.

2.75 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.

# 3

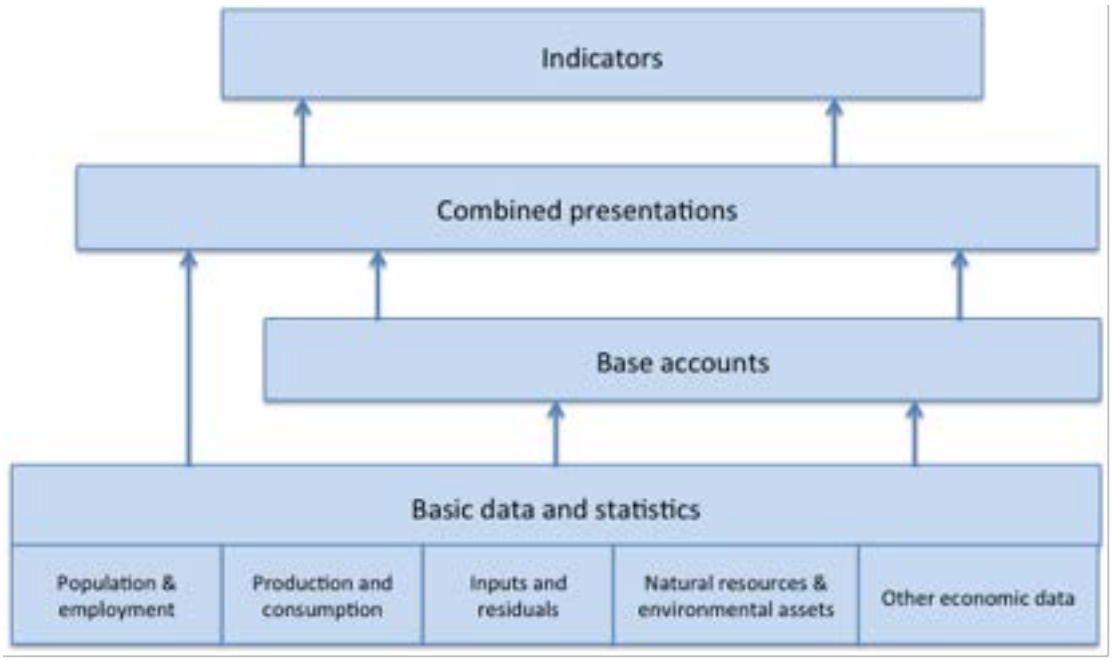
# Conceptual Framework

## INTRODUCTION

3.1 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.

3.2 Figure 3.1 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 3.1**
SEEA Agriculture information pyramid



3.3 The combined presentations will not include all the information from the base accounts. They may, however, 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 will in general take information from the combined presentations, but this should not be considered mandatory.

3.4 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.

# BASIC NATIONAL ACCOUNTING PRINCIPLES

## Introduction

3.5 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.

3.6 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.

3.7 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.

3.8 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.

## Types of accounts

3.9 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. Both types of accounts can be compiled in physical and monetary terms, with slightly different structures.

3.10 Physical flow accounts/physical supply and use tables. Monetary supply and use tables (see Table 3.1, 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 is the accounting identity.

**TABLE 3.1**
**Basic form of a monetary supply and use table (Table 2.1 SEEA Central Framework)**

| | 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).

3.11 Physical flow accounts or physical supply and use tables (see Table 3.2, 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, with extensions 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".

**TABLE 3.2**
**Basic form of a physical flow account (Table 2.2 from SEEA Central Framework)**

| | 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 and treatment of waste and other residuals | | Accumulation of waste in controlled landfill sites | | Residual flows direct to environment | Total use of residuals |

3.12 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.

3.13 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.

3.14 Asset accounts. Asset accounts (see Table 3.3) 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 3.3**
**Asset account (SEEA Central Framework Table 2.3)**

| 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 in monetary terms.

3.15 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.

3.16 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.

3.17 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).

3.18 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.

3.19 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.

3.20 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.

## Main accounting rules and principles

3.21 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.

3.22 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.

3.23 Production boundary. 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).

3.24 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).

3.25 Economic unit. Accounting in the SNA and the SEEA Central Framework centres on recording the economic activities – production, consumption and accumulation – of economic 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 economic units).

3.26 Of particular relevance for the SEEA Agriculture is the fact that it will generally be useful to record information in fine detail to provide specific information about the products and processes used by a given economic unit in a particular location. The recommendation is that data for the SEEA Agriculture should be compiled at the level of the local "kind of activity", which will in many instances involve measurement at the farm level or equivalent.

3.27 Geographic boundary. 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.

3.28 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).

3.29 Asset boundary. 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.

3.30 Valuation concepts. 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).

3.31 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.

3.32 Recording principles. 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).

3.33 Use of classifications. The use of consistent 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). 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.

3.34 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.

## SEEA AGRICULTURE BASE ACCOUNTS

### Data domains

3.35 The SEEA Agriculture base accounts cover ten primary data domains, each of which relates to a general data area that may include data on stocks and flows, and for which data will be available from a limited number of sources. The objective of the base accounts is to organize the available information in accordance with the accounting concepts and principles outlined in the previous section to provide a basis for integrating information across domains.

3.36 The rationale for the selection of the primary data domains was explained in section 1.2. The selection of base accounts in each domain ensures that all relevant data for the domain are captured. In each domain, therefore, a limited number of accounts can support the recording of a range of data items. The focus on designing appropriate accounts ensures that relevant accounting identities can be applied.

3.37 The ten primary data domains and their associated base accounts are shown in Table 3.4. 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.

**TABLE 3.4**
**Data domains and base accounts**

| Data domains | Base accounts |
|---|---|
| Agricultural products and related environmental assets | • Physical flow account for crops<br>• Physical flow account for livestock products<br>• Asset account for livestock<br>• Asset account for plantation crops |
| Forestry products and related environmental assets | • Physical flow account for timber and non-wood forest products<br>• Asset account for forests<br>• Asset account for timber resources |
| Fisheries products and related environmental assets | • Physical flow account for fish and aquatic products<br>• Asset account for fish and other aquatic resources |
| Water resources | • Asset account for water resources<br>• Physical flow account for water abstraction<br>• 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<br>• Nitrogen and phosphorous budgets*<br>• Physical flow account for pesticides |
| Land | • Asset account for land use<br>• 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<br>• 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.

3.38 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.

3.39 In each data domain there will be data sources common to many countries. There will, for example, 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.

3.40 Concerns and inconsistencies are likely to be identified as data collection and analysis improve – and the application of an accounting framework may in itself highlight such issues. The accounts should always be compiled on the basis of the best available evidence and should present as clear a reflection as possible of change over time. Managing disruptions in a time series of source data is a central element of environmental-economic accounting.

3.41 Further discussion of potential data sources for each base account is presented in Chapter 5.

## SEEA Agriculture Physical flow accounts

3.42 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.

3.43 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.

3.44 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.

3.45 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.

3.46 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.

3.47 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.

3.48 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.

## SEEA Agriculture Asset accounts

3.49 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.

3.50 The asset accounts in the SEEA Agriculture use physical data only – hectares of land, cubic metres of timber and head of livestock for example. Asset accounts in monetary terms could also be incorporated using the same structures, in line with the SEEA Central Framework. At this stage, however, it is proposed that SEEA Agriculture compilers should 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.

3.51 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.

3.52 Section 5.2 of the SEEA Central Framework provides various considerations to assist in making the often difficult distinction between cultivated and natural assets. But 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.

### 3.3.4 SEEA Agriculture Other economic data

3.53 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, however, two aspects of national accounting are considered.

3.54 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.

3.55 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 operating surplus and gross mixed income – profits – can be derived. The sum of the gross operating surplus, gross mixed income and compensation of employees provides an estimate of the value-added of the activity.

3.56 Other economic data can be incorporated such as estimates of employment and hours worked, 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.

3.57 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.

3.58 The development of these types of information is an example of the potential of the "outside – in" accounting approach whereby robust macro-level data constitute a base-level information set that can then be refined and extended on the basis of micro-level information.

## ACCOUNTING ISSUES

### Introduction

3.59 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.

### Scoping of products

3.60 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.

3.61 The starting point in the SEEA Agriculture is the set of products principally produced by 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. Using this boundary has some significant implications regarding the structure of the physical flow accounts described in Chapter 4.

i. In the case of cropping activity, the product scope reflects harvest outputs – wheat, rice, apples or palm oil for example. The same product definition applies irrespective of the nature of the production process: strawberries sourced from active farming operations, for example, are included together with wild strawberries harvested in forests. These products fall within the scope of the SEEA Agriculture physical flow accounts.

ii. With regard to livestock rearing, a distinction is usually made between the managed raising of animals in extensive or intensive situations and the products obtained – meat, milk, eggs and hides for example. The SEEA Agriculture makes this distinction to ensure alignment with the ISIC and CPC classes. The products obtained are usually considered to be outputs from manufacturing processes rather than the output of agriculture (see Chapter 4).

iii. A distinction is made between forestry, where the output is the growing of trees, and logging, where the output is felled timber. This distinction is made in the SEEA Agriculture and both outputs 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.

iv. 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.

### Treatment of own-account production and use

3.62 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. If a single economic unit is responsible for several stages of production or transformation, 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.

3.63 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 is a minor consideration for developed countries, but in many

others the estimates of own-account production in agriculture, forestry and fisheries may be substantial and should be appropriately recorded.

3.64 Second, when own-account production forms part of investment by the economic unit in produced assets – gross fixed capital formation. This occurs if a farmer builds his own storage facilities or a farmer breeds dairy cattle or sheep for wool. In these types of activity, the cattle and sheep are treated in the national accounts as produced assets that deliver outputs over time. 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.

3.65 The SEEA Agriculture makes a third exception for the purposes of recording agricultural activity, in line with the treatment in the European Economic Accounts for Agriculture. In some situations, agricultural units may produce an output that is subsequently used in the same unit for a different activity: fodder crops, for example, may be grown to feed livestock that are subsequently sold for slaughter. For the purposes of SEEA Agriculture recording, production that is used within an economic unit but in a different agricultural activity should be recorded in gross terms and recognized as an input to the second activity. The output of the second activity should also be recorded.

## Treatment of secondary production

3.66 Consideration of the outputs of agricultural, forestry and fisheries activities has hitherto 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.

3.67 But growing crops and rearing animals are increasingly leading to the production of multiple 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 for use by other economic units is known in national accounting as "secondary production".

3.68 It is not the intention here to describe all the variations of mixed production technologies for 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 important points emerge.

3.69 First, secondary production should be recorded as output from the producing unit. Thus if a large volume of biomass is removed from a producing farm, forest or fishery, for example, then the total volume should be recorded irrespective of the mix of outputs along with any associated additional income. It is essential to track these additional flows to understand the supply chains between these activities and other economic activities. Also, from an environmental asset perspective the removal of biomass may reduce the availability of crop residues that help to maintain the productivity of the soil.

3.70 Second, processed quantities should not be converted into a raw material or live-weight equivalent if the intention is to account fully for supply and use in terms of a single measurement unit such as tonnes. Converting tonnes of refined sugar back into quantities of sugar cane, for example, will provide a balance between the quantity of sugar cane produced and the quantity used – but only if all sugar cane is refined. If some of the sugar cane is used to produce energy, the proportions allocated for refining and for energy production must be recorded.

3.71 For SEEA Agriculture purposes therefore, the aim in recording the supply and use of individual products in physical terms is to allocate overall production to different uses, which must include post-harvest losses, without conversion to raw commodity or live-weight equivalents.

3.72 The balancing of multiple uses does not affect measurement of supply and use from the nutritional point of view, because uses other than food production have no direct nutritional value for humans and conversion to a raw-commodity equivalent ensures a balance between supply and use.

3.73 Another aspect of secondary production from a national accounting perspective is cases where: i) an agricultural, forestry or fisheries unit creates other products such as agro-tourism; or ii) an economic unit that is not principally involved in agriculture, forestry or fisheries creates products associated with those activities – a government research farm produces wool, for example. In both cases there is a lack of homogeneity in production.

3.74 For the purposes of the SEEA Agriculture, the physical flow accounts and asset accounts should not take either of these cases into account. This will have the effect of understating the total output of agricultural, forestry and fisheries products but provided the secondary production is relatively limited in terms of the quantity or value of production, the impact of this difference in coverage will be small.

3.75 The total income for agricultural, forestry and fisheries units should be included in the monetary accounts of the SEEA Agriculture, but where possible the income from secondary production should be recorded separately.

3.76 The concept of secondary production discussed here is a national accounting concept and should be distinguished from the recording of other flows of output or income 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.

3.77 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.

3.78 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.

## Treatment of natural and cultivated biological resources

3.79 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.

3.80 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.

3.81 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).

## Treatment of changes in inventories, losses and waste

3.82 A feature of agricultural, forestry and fisheries production is the various stages and time lags involved in growing, harvesting, distributing and storing the commodities produced. A number of businesses will be involved in the supply chain – producers, transport companies, manufacturers, wholesalers and retailers – each of which will hold changing quantities of each commodity. Given the nature of the commodities, 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.

3.83 In the SNA these changes in quantities held are referred to as "change in inventories". 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 complete set of information for analysis. The focus in the SEEA Agriculture is the quantities of a commodity that are lost or otherwise not finally consumed through the supply chain (see chapter 3 of the SEEA Central Framework).

3.84 Losses at three stages in the supply chain can be identified. First, losses that take place during production such as felling residues in forestry,[4] 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 production 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 indicate levels of efficiency in the use of land, water, forests and fish stocks.

3.85 Second, there are losses between leaving the producing unit – "the farm gate" – and the point of final consumption or the point of transformation into other products. Such "post-harvest losses" are important considerations in countries where transport, distribution and storage infrastructure is less developed. With regard to commodities 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 or must discard them.

4 Measurement of losses in forestry will be affected by whether gross output is measured under or over bark (see Chapter 4).

3.86 Third, there is "food waste" – losses within households when purchased commodities are thrown away. Household consumption in national accounting terms is equal to the quantity of commodities purchased, not the quantity ultimately consumed: it is therefore relevant to partition estimates of household consumption in physical terms into food waste and quantities consumed.

3.87 By recording each stage of loss, the physical flows of each commodity can be fully accounted for from the point of growth and harvest to the point of consumption. 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.

3.88 There are significant links between the treatment and recording of losses and the treatment of secondary production as economic units find ways to use materials that might previously have been discarded. The accounting approach of tracking actual flows of commodities to the point of transformation into other products should facilitate understanding of this trend.

## Issues in aggregation

3.89 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. For many aspects of the SEEA Agriculture, however, and particularly in the context of accounting in physical terms, such aggregation may be challenging. This section offers some considerations on the topic.

3.90 Monetary valuation of environmental stocks and flows can be difficult because many of them are not traded in a market. Valuation techniques must therefore be used that may be difficult to apply and open to interpretation because of the assumptions made. One reason for highlighting the relevance of accounts in physical terms in the SEEA is that monetary valuation is not a straightforward matter.

3.91 From an accounting perspective, aggregation requires the use of a common measurement unit. The use of a single currency unit is one option; others include measurement in tonnes, cubic metres or calories, as appropriate. Aggregation is not possible if different stocks and flows cannot be meaningfully measured in the same unit.

3.92 One effect of using a common measurement unit for aggregation is that the relative importance of a particular stock or flow is reflected in its share of the total: if the share of wheat in aggregate production of cereals is 80 percent in monetary terms, for example, this reflects its relative importance.

3.93 The use of different measurement units, however, results in different interpretations of relative importance. A different relative importance for wheat in the context of cereals will be obtained if the common measurement unit is tonnes – which would be relevant to questions relating to transport – or calories – which would be relevant for questions relating to nutrition.

3.94 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. The important point for the SEEA Agriculture is that the use of an accounting framework provides the structure for organizing data and supports discussion of alternative aggregation approaches.

3.95 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.

3.96 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.

## SEEA AGRICULTURE COMBINED PRESENTATIONS

### Introduction

3.97 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.

3.98 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.

3.99 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 exist as to their structure: 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.

### SEEA Agriculture combined presentations

3.100 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.

3.101 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.

3.102 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.

3.103 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.

3.104 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.

3.105 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**
**Agriculture Combined presentation: Activity and product specific inputs**

| SELECTED KEY PRODUCTS ONLY | Economic variables | | | | | Environmental variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ouput | | Exports | Imports | Employment | Land use | | Use of Irrigated Water | Energy use in agriculture | GHG emission (CO2 eq.) | Use of inorganic fertilizer (tonnes) | | | Use of pesticides |
| | 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**
**Agriculture Combined presentation: Food product consumption and waste**

| FOOD PRODUCTS | 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 ($CO_2$ eq.) |
| | Agricultural products | 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 density |
| | 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 / ha) |
| **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** | | | | | | | | | |
| Capture fisheries | | | | | | | | | |
| **Total Fisheries** | | | | | | | | | |

**TABLE 3.8**
**SEEA Agriculture Combined presentation: Cross industry and activity perspectives**

| ACTIVITY | Economic variables Environmental 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.) |
| | Agriculture | 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** | | | | | | | | | | | | | |

3.106 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.

3.107 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.

3.108 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.

3.109 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.

3.110 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.

## AGGREGATES AND AGRO-ENVIRONMENTAL INDICATORS

3.111 Aggregates and indicators are the summary measures that emerge from an accounting framework, providing indications of trends and structural changes. 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.

3.112 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.

3.113 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.

3.114 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.

3.115 In terms of indicators, 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.

3.116 These cross-domain indicators are referred to in the SEEA as "environmental ratio indicators" (see section 6.4 of the SEEA Central Framework for details, including productivity and intensity ratios, decoupling ratios and polluter-pays indicators). 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.

3.117 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.

3.118 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.

3.119 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.

3.120 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. The SEEA Agriculture need not harness all potential information relevant to sustainable development, but it might provide the basis for coordinating most of the relevant economic and environmental information.

3.121 Although no specific set of indicators is included, potential links between SEEA Agriculture-based data and three indicator sets are mentioned. 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 indicators for the finalized Sustainable Development Goals could be sourced from SEEA Agriculture-based datasets.

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

3.123 Third, part of the FAO Global Strategy to Improve Agricultural and Rural Statistics is to develop a core minimum dataset covering economic, social and environmental domains. Comparison of this minimum dataset and the SEEA Agriculture framework suggests that much of the minimum set would be covered in a SEEA Agriculture dataset.

# 4

# Base accounts

## 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 should also help to determine the treatment of individual products and practices in agriculture and forestry.

4.3 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.

4.4 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".

4.5 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.

4.6 There is no expectation that each country will take the same steps to implementing the SEEA Agriculture or structure particular base accounts in the same way. Differences will emerge reflecting economic and environmental circumstance, data availability and policy priorities. The starting point described in this

chapter and reflected in the design of the tables should not be considered an international standard data reporting framework. In due course reporting mechanisms will emerge and a core set of tables and data items will be developed.

4.7 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 and that comparability among countries is practicable because aggregate information is sought in all cases at the activity level and through the use of international standard classifications of industry and product. Fundamentally, consistent use of the concepts and principles of the SNA and the SEEA Central Framework will provide the basis for international comparability.

## PHYSICAL FLOW ACCOUNT FOR CROPS

### Measurement purpose and scope

4.8 The physical flow account for crops records the supply and use of 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.

4.9 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.

4.10 The scope of the physical flow account is all crops. In most countries, however, the set 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.

4.11 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.

4.12 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.

4.13 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.

4.14 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.

4.15 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.

4.16 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.

4.17 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).

## Accounting entries

4.18 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.

**TABLE 4.1**
**Physical flow account for crops (tonnes)**

| SUPPLY TABLE | Output | | | | | | |
|---|---|---|---|---|---|---|---|
| Selected products* | Gross production | Harvest losses | Agricultural industry | Manufacturing industry | Total Output | Imports | Total Supply |
| 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 crops (raw) | | | | | | | |
| Other crops (processed) | | | | | | | |

**TABLE 4.1**
**Physical flow account for crops (tonnes)**

| USE TABLE<br>Selected products* | 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 | | |
| 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 crops (raw) | | | | | | | | | | | | |
| Other crops (processed) | | | | | | | | | | | | |

4.19 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 food 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.

4.20 Making this distinction in the context of crops is important, because the SEEA Agriculture aims to make the connection between the production of food crops and the consumption of food by households. Raw and processed products are recognized in the SEEA Agriculture because most food crops are processed before household consumption, and because there are often alternative uses for food crops such as utilizing maize to produce fodder and to generate energy.

4.21 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.

4.22 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.

4.23 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**

4.24 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.

4.25 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.

4.26 In the SEEA Agriculture these additional steps are ignored, so 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.

4.27 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-and-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.

4.28 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.

4.29 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.

4.30 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.

4.31 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.

4.32 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 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.

4.33 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 processing also includes amounts used in the manufacture of food products that are not attributed to the processed product.

4.34 Imports of crops consist of the purchase, barter or receipt of crop products by residents from non-residents. Imports should be recorded in terms of raw commodity equivalent.

**Use table entries**

4.35 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.

4.36 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.

4.37 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.

4.38 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.

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

4.40 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.

4.41 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.

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

4.43 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.

4.44 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.

4.45 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.

## Measurement issues and possible extensions

4.46 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.

4.47 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.

4.48 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).

4.49 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.

4.50 The physical flow accounts for food 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.

## PHYSICAL FLOW ACCOUNTS FOR LIVESTOCK PRODUCTS

### Measurement purpose and scope

4.51 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.

4.52 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, silk, transport and entertainment services. 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.

4.53 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 proposals made in relation to the physical flow account for crops,

4.54 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.

4.55 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.

4.56 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.

4.57 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.

4.58 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.

4.59 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.

4.60 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.

## Accounting entries

4.61 The physical flow account for livestock products is shown in Table 4.2. 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

4.62 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.

4.63 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.

4.64 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. Quantity is expressed as net weight in tonnes, excluding any container. Imports of livestock are included, and are measured as the number of animals.

**TABLE 4.2**
**Physical flow account (measurement unit variable)**

| SUPPLY TABLE | | | | | USE TABLE | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Output | | | | | Household final consumption | | | | | | |
| Selected products* | Agricultural industry | Manufacturing industry | Imports | Total supply | Intermediate consumption | Food consumption | of which: Food waste | Other uses | Gross fixed capital formation | Changes in inventories | Exports | Total use |
| **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)** | | | | | | | | | | | | |

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

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

4.67 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.

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

4.69 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.

4.70 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.

4.71 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.

## Measurement issues and possible extensions

4.72 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.

4.73 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.

4.74 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.

## ASSET ACCOUNT FOR LIVESTOCK

### Measurement scope and purpose

4.75 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.

4.76 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.

4.77 All of each type of animal 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.

### Accounting entries

4.78 The asset account for livestock is shown in Table 4.3. It records the opening and closing stock of each type of livestock and additions and reductions over an accounting period. In all cases the opening stock plus additions less reductions must equal the closing stock.

**TABLE 4.3**
**Asset account for livestock (number of livestock)**

| Type of livestock | Opening stock | Additions to stock | | | Reductions in stock | | | | Net change in Stock | Closing stock |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Net growth in livestock | Livestock from the rest of the world (Imports) | Total additions | Livestock processed / slaughtered | Livestock to the rest of the world (Exports) | 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*** | | | | | | | | | | |

4.79 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.

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

- "Net growth in livestock" reflects births less normal losses of stock that do not reach maturity. Normal losses of mature stock are assumed to be slaughtered and processed, and are included in reductions in stock (see below).
- Net growth in livestock = closing stock + exports + livestock processed + other reductions in stock – opening stock – imports – other additions to stock.
- Livestock from the rest of the world includes all live animals imported into national boundaries during the stock year.

4.81 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.

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

4.83 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.

## Measurement issues and possible extensions

4.84 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.

4.85 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.

4.86 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.

## ASSET ACCOUNT FOR PLANTATIONS

### Measurement scope and purpose

4.87 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.

4.88 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.

4.89 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.

### Accounting entries

4.90 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.

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

**TABLE 4.4**
**Asset account for plantations (000 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 | Catastrophic losses (storm, fire, disease) | Other reductions in stock | Total reductions | | |
| Orchards | | | | | | | | | | |
| Vineyards | | | | | | | | | | |
| Oil Palm | | | | | | | | | | |
| Banana | | | | | | | | | | |
| Olives | | | | | | | | | | |
| Almonds | | | | | | | | | | |
| Coffee | | | | | | | | | | |
| Tea | | | | | | | | | | |
| Rubber | | | | | | | | | | |

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

4.93 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.

4.94 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.

## Measurement issues and possible extensions

4.95 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.

## PHYSICAL FLOW ACCOUNTS FOR TIMBER PRODUCTS

### Measurement scope and purpose

4.96 The physical flow account for timber products records the supply and use of timber products in physical terms, expressed in cubic metres of timber, with a view to focusing on the activities of the forestry industry as distinct from the activity of processing raw timber and manufacturing wood products. One part of the account is to record the use of timber products for energy by industry and by households in the form of fuelwood and charcoal.

4.97 The activities involved must be clearly distinguished. In line with the ISIC, forestry activity must be separated into two types: the growing and management of standing timber, and the logging of standing timber to produce roundwood and wood for fuel. Significantly, where standing timber is not managed or cultivated – for example if growth is the result of a natural process outside the production boundary – the output recorded for these forests is equal to the logging activity, and no output relating to the growth of standing timber should be recorded against the forestry industry.

4.98 Ideally, the physical flow accounts for timber products should cover all production of timber in a country, including the harvest of timber products by households for their own final consumption. This would include the output of timber products sourced from small-scale farms, plantations such as orchards, and urban tree management. The focus should initially be on timber sourced from a country's forests and woodlands, but it should be recognized that other timber sources are increasingly used as sources of bio-energy and accounting for this change may be relevant to policy development.

4.99 No attempt is made to track the flows involved in the production 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, but because the SEEA Agriculture is intended to focus on the activities of the agriculture, forestry and fisheries industries such extensions are not considered.

### Accounting entries

4.100 The physical flow account for timber products is shown in Table 4.5. It records the flows in physical terms of the timber products – forestry, roundwood, fuelwood and charcoal produced by traditional methods. Charcoal produced commercially from roundwood is considered an output of the manufacturing industry. For each timber product, total supply must be equal to total use.

**TABLE 4.5**
**Physical flow account for timber products (000 cubic metres)**

| SUPPLY TABLE Product | Gross felling | Felling residues | Output | | Total output | Imports | Total Supply |
|---|---|---|---|---|---|---|---|
| | | | Forestry | Logging | | | |
| Standing timber | | | | | | | |
| Roundwood | | | | | | | |
| Wood for fuel | | | | | | | |

| USE TABLE Product | Intermediate Consumption | | | | | Household final consumption | Changes in inventories | Exports | Total Use |
|---|---|---|---|---|---|---|---|---|---|
| | Logging industry | Manufacturing industry | Generation of energy products (including charcoal) | Energy | Other uses | | | | |
| Standing timber | | | | | | | | | |
| Roundwood | | | | | | | | | |
| Wood for fuel | | | | | | | | | |

**Supply table entries**

4.101 The measurement of supply will usually focus on production, but because aspects of the logging process may be relevant for analytical purposes the supply table starts with a measure of the gross felling of standing timber and deducts a measure of felling residues before recording measures of output. However, information on gross felling and felling residues is not normally readily available.

4.102 The "gross felling" entry – the cutting down of individual trees as part of logging – reports the volume of all trees, living or dead, that are felled. Felling includes thinning and cleaning for commercial or silviculture purposes. The gross volume of timber felled during the period relative to the volume of timber resources removed, which is reflected in the measure of output, may be of interest.

4.103 The "felling residues" entry records the volume of timber found to be rotten, damaged or undersized at the time of felling. It excludes small branches and unusable parts of a tree, which are also excluded from the scope of timber resources. Estimates of felling residues may provide information about forestry practices in terms of potential for reducing residues relative to total output, or in terms of understanding that felling residues may play an important role in natural forests in supporting the growth of new trees.

4.104 To balance the supply and use of timber products, the treatment of bark may have to be considered. The stock of standing timber is usually measured "over bark" – that is, including the volume of bark – whereas the measurement of roundwood is usually measured "under bark". By default, felling residues capture the volume of bark but it would be appropriate to record an additional product in the supply and use table because bark can be removed and used in its own right.

4.105 In the "standing timber" entry under Output, the total supply of cultivated standing timber resulting from forestry activity is equal to the natural growth of timber resources, measured in cubic metres. This should be measured in terms of the gross annual increment – the volume of increment over the reference period of all cultivated trees, with no minimum diameter. There are no imports of standing timber.

4.106 In the "roundwood, wood for fuel" entry under Output, total output from logging activity is equal to the removal of roundwood and wood for fuel, measured in cubic metres of solid volume.

4.107 Under Imports, "roundwood, wood for fuel" is wood 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.

**Use table entries**

4.108 The "intermediate consumption – logging industry" entry relates to the use of felled timber by the logging industry. The measure of intermediate consumption is equal to the volume of cultivated standing timber removed by the logging industry.

4.109 The "intermediate consumption – manufacturing industry" entry relates to the timber-related manufacturing industries (see ISIC 16 and 17) and covers the manufacture of wood and wood products, and paper and paper products. The measure of intermediate consumption is equal to the volume of roundwood removed by the logging industry.

4.110 Under Intermediate consumption, the "generation of energy products" entry records the production of wood fuel, including wood for charcoal, used as a source of energy as an input to other production processes. Some wood fuel will be used as an input to the activities of the forestry and forest-related manufacturing industries.

4.111 The "household final consumption – energy" entry includes wood fuel 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 – from roundwood. These are reported in cubic metres of solid volume excluding bark. Household final consumption is assumed to be of raw timber: that is, no addition is made for energy products ultimately consumed by households that may be generated by other industries using roundwood or wood fuel as energy sources.

4.112 The entry for "household final consumption – other uses" includes all household non-energy uses of roundwood.

4.113 The entry for "standing timber" under Changes in inventories reflects the balance between growth in standing timber recorded as an output and intermediate consumption of standing timber by the logging industry that occurs when it is felled. No change in inventory is recorded for the logging industry because all timber removed is assumed to be allocated to intermediate or final uses.

4.114 The "exports" entry covers exports of roundwood and wood for fuel, including re-exports. It excludes in-transit shipments and is reported in cubic metres of solid volume.

## Measurement issues and possible extensions

4.115 Depending on analytical requirements and the availability of data, the estimate of total output of roundwood may be broken down into production by type 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 4.7.

4.116 The focus in accounting for timber products is not intended to ignore the potential contribution of other forest products; in particular the activity of gathering non-wood forest products is recognized as part of the forestry industry. Where these products are significant or of policy interest, a separate physical flow account should be established for them. Alternatively, they could be incorporated into physical flow accounts for crops and livestock products, as appropriate.

# ASSET ACCOUNTS FOR FORESTS AND TIMBER RESOURCES

## Measurement scope and purpose

4.117 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.

4.118 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.

4.119 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.

## Accounting entries

4.120 The asset account for forests is shown in Table 4.6. 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 4.6**
**Physical asset account for forests (000 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 | | | | | |

4.121 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.

4.122 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.

4.123 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.

4.124 The physical asset account for timber resources is shown in Table 4.7. 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.

4.125 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 4.7**
**Physical asset account for timber resources (000 cubic metres)**

| Type of timber resource | 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 | | |
| Cultivated timber resources | | | | | | | | | | | | |
| Natural timber resources | | | | | | | | | | | | |
| Total | | | | | | | | | | | | |

## Measurement issues and possible extensions

4.126 The physical asset account for timber resources distinguishes between cultivated and natural timber in the same way as the SNA and the SEEA Central Framework. But 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.

4.127 With regard to the physical flow accounts for timber 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, and 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. The two asset accounts could be extended with the collation of information by tree species or resources in particular locations.

4.128 Another alternative 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.

4.129 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, 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.

4.130 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.

4.131 For national accounting purposes the distinction between natural and cultivated timber resources 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.

4.132 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.

# PHYSICAL FLOW ACCOUNT FOR FISH AND OTHER AQUATIC PRODUCTS

## Measurement scope and purpose

4.133 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.

4.134 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.

4.135 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.

4.136 The scope of the physical flow account is all fish and other aquatic products, as in the International Standard Statistical Classification of Fishery Commodities. 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

## Accounting entries

4.137 The physical flow account for fish and aquatic products is shown in Table 4.8. 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.

4.138 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 attributing estimates to all categories of use, however, accounting entries should be in terms of actual weights rather than live weight equivalent – in other words, the estimates of use should be allocations of the total nominal catch. Measures of use in terms of live weight equivalent remove the requirement to record post-harvest and post-catch losses, which is not desirable in a physical supply and use system.

4.139 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.

4.140 No aggregates across products are proposed in Table 4.8, 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 physical terms.

**TABLE 4.8**
**Physical flow account for fish and aquatic products (000 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 | | | | | | | | | | | |

**Supply table entries**

4.141 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.

4.142 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.

4.143 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.

4.144 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 illegal, unreported and unregulated activity.

4.145 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." This entry records the nominal harvest of fish from aquaculture facilities.

4.146 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.

4.147 The "imports" entry reports total imports of fisheries commodities in live weight equivalent. A distinction is made between: i) imports for food use, which includes the categories whole-meat fish, filleted fish and processed fish; and ii) imports for non-food use, which includes the categories: fodder, industrial use and other uses.

**Use table entries**

4.148 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.

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

4.150 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.

4.151 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.

4.152 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.

4.153 The "exports" entry covers the total exports of fisheries commodities in live weight equivalent, with a distinction between: i) exports for food use, which includes the categories of whole-meat fish, filleted fish and processed fish; and ii) exports for non-food use, which includes the categories of fodder, industrial use and other uses.

## Measurement issues and possible extensions

4.154 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.

4.155 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).

4.156 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.

## ASSET ACCOUNT FOR FISH AND OTHER AQUATIC RESOURCES

### Measurement purpose and scope

4.157 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.

4.158 The proposals for the SEEA Agriculture follow 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.

4.159 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.

4.160 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.

### Accounting entries

4.161 A basic asset account for fish and other aquatic resources is presented in Table 4.9. It shows the opening and closing stock of aquatic resources, and additions and reductions in stock resulting from natural growth, catches and other factors.

4.162 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 4.9 – 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.

4.163 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 4.9**
**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** | | | | | | | | | | |

## Measurement issues and possible extensions

4.164 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 models and catch statistics to show whether species and fisheries are being under-fished, fully fished or over-fished.

4.165 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 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.

4.166 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.

4.167 More research and development is needed to establish practical methods for deriving estimates to populate a physical asset account for fish and other aquatic resources.

## ACCOUNTS FOR STOCKS AND FLOWS OF WATER RESOURCES

### Measurement purpose and scope

4.168 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. The fact that activities at the start of a water catchment are likely to affect activities further 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, a coherent set of data on water resources and links to economic and human activities should be maintained.

4.169 One approach to developing such an information set 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.

4.170 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.

4.171 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.

4.172 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, and provide additional detail with regard to agricultural, forestry and fisheries activity.

4.173 In line with the SEEA Central Framework and SEEA Water, the SEEA Agriculture water accounts cover stocks and flows of water without regard to 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.

### Accounting entries

4.174 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. There are, however, advantages in applying the accounting structure of stocks and flows to the measurement of water because it enables relatively straightforward comparison with information on other resources and with standard economic data.

4.175 The asset account for water resources is shown in Table 4.10. The relevant accounting entries are described below.

**TABLE 4.10**
**Asset account for water resources (000 cubic metres)**

| | Surface water | | Groundwater | TOTAL |
|---|---|---|---|---|
| | Lakes and rivers | Artificial reservoirs | | |
| **Opening stock of inland water resources** | | | | |
| **Additions to stock from the environment** | | | | |
| Precipitation | | | | |
| Inflow from other territories | | | | |
| **Inflows from other inland water resources** | | | | |
| Discoveries and reassessments of water in aquifers | | | | |
| Return flows from economy | | | | |
| **TOTAL ADDITIONS** | | | | |
| **Reductions in stock from the environment** | | | | |
| Evaporation | | | | |
| of which: from Artificial reservoirs | | | | |
| Outflows to other territories | | | | |
| Outflows to the sea | | | | |
| Outflows to other inland water resources | | | | |
| Abstraction by economic units | | | | |
| **TOTAL REDUCTIONS** | | | | |
| **Closing stock of inland water resources** | | | | |

4.176 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 assets may be challenging, particularly for soil water. Totals excluding soil water and focusing on stocks of surface water in lakes and artificial reservoirs and stocks of groundwater may be a practical initial aim.

4.177 The entries for additions to the stock of inland water resources reflect all flows of water that add to the opening stock of water resources. Five sources of additions are recognized in the asset account:

i. Precipitation. This reflects the estimated volume of water falling in the territory before evaporation and transpiration. Amounts retained in the soil are additions to soil water; amounts that run off to rivers and lakes are additions to surface water.
ii. Inflows from other territories. This records volumes flowing into the territory from other countries.
iii. Inflows from other inland water resources. This records flows between different types of water resources in a country such as increases in groundwater from soil water.
iv. Discoveries and reassessments of water in aquifers.

v. Return flows from the economy. After abstraction by economic units, much water is returned to the inland water system, with or without treatment. All return flows are included in this scope, irrespective of quality.

4.178 The entries for reductions in the stock of inland water resources reflect all flows of water that reduce the opening stock of water resources. Five sources of reductions are recognized in the asset account

i. Evaporation. This is the total volume of water that evaporates from the territory. For analytical reasons it may be useful to record separately the evaporation from artificial reservoirs.
ii. Outflows to other territories. This records the volume of water flowing to other countries. It may be useful to record separately any outflows that are "required" pursuant to international obligations.
iii. Outflows to the sea.
iv. Outflows to other inland water resources. This records flows between different types of water resources in a country, for example from soil water to groundwater. The aggregate must completely offset inflows from other inland water resources.
v. Abstraction by economic units. This records all water abstracted from the environment by economic units, including households, for use in production or consumption. It includes water that is abstracted and immediately returned to the inland water system, for example by hydropower facilities. The inclusion of this water as abstracted gives a fuller picture of the water requirements of all economic units.

4.179 There are two physical flow accounts for water in the SEEA Agriculture highlighting different aspects of the connection between agricultural activity and water resources. The first records the quantities of water abstracted by economic units from the environment; the second records the quantities of water used or distributed as inputs into production processes and for consumption. Both accounts are based on the physical supply and use table for water in section 3.5 of the SEEA Central Framework. The second account adds significant detail in terms of water use for agricultural products, particularly food and non-food crops, which supports understanding of the intensity of water use for significant products.

4.180 The physical flow account for water abstraction is shown in Table 4.11. It is divided into two parts: the supply table and the use table. The relevant entries in the account are described below.

**TABLE 4.11**
**Physical flow account for water abstraction (000 cubic metres)**

| | Total abstracted from the environment | Water abstracted by | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Agriculture | Forestry | Fisheries | Total AFF | Water collection, treatment and supply | Mining | Electricity | Other Industries | Households |
| **Water source** | | | | | | | | | | |
| Inland water resources | | | | | | | | | | |
| Surface water | | | | | | | | | | |
| Groundwater | | | | | | | | | | |
| Soil water | | | | | | | | | | |
| **Total from Inland water resources** | | | | | | | | | | |
| **Other sources** | | | | | | | | | | |
| Collected precipitation | | | | | | | | | | |
| Sea water (desalinated water) | | | | | | | | | | |
| **Total** | | | | | | | | | | |

4.181 The first column records the total supply 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 – are equivalent to the entries in the asset account for abstractions from water resources. Soil water is included even though compiling the data is likely to be challenging. The initial focus should be on recording information on abstractions from surface water and groundwater resources.

4.182 Water is also abstracted from the environment through direct collection of water from precipitation into storage tanks, and through desalination of seawater. Both sources must be added to provide a full picture of water entering the economy.

4.183 The remaining columns allocate the total water abstracted from the environment to the economic units abstracting it. A large proportion of the water will be abstracted by collection, treatment and supply facilities before distribution to other economic units. The flows recorded in this table do not imply that an economic unit is the ultimate consumer of the water it abstracts. However, abstractions by industries other than the water collection, treatment and supply industry, will usually be for their own use.

4.184 The physical flow account for water distribution and use is shown in Table 4.12. It provides information that will be very relevant in the context of the SEEA Agriculture in that it records the total quantities of water use in agriculture, forestry and fisheries irrespective of source.

4.185 The second physical flow account for water concerns water distribution and use. Its two parts are the supply table and the use table. The selection of agricultural products should be aligned with the products identified as key products. As discussed earlier in this chapter, selection of the key agricultural products is a matter for consideration at the country level. The relevant entries in the account are described below.

**TABLE 4.12**
**Physical flow account for water distribution and use (000 cubic metres)**

| Water abstracted by: | TOTAL SUPPLY | Water used or reused by/for | | | | | | | | | | | | | Water used or reused by/for | | | | | | | TOTAL USE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Agriculture | | | | | | | | | | Forestry | Fisheries | Total water use by Agriculture, Forestry and Fisheries | Water collection, treatment and supply | Mining | Electricity | Other Industries | Households | Exports | | |
| | | Maize | Rice | Wheat | Palm oil | Sugar | Potatoes | Other food crops | Non-food crops | Total crops | Livestock | Total agriculture | | Aquaculture | | | | | | | | |
| **Agricultural activities** | | | | | | | | | | | | | | | | | | | | | | |
| **Forestry activities** | | | | | | | | | | | | | | | | | | | | | | |
| **Fisheries activities** | | | | | | | | | | | | | | | | | | | | | | |
| **Total water abstracted by Agriculture, Forestry and Fisheries** | | | | | | | | | | | | | | | | | | | | | | |
| Water collection, treatment and supply | | | | | | | | | | | | | | | | | | | | | | |
| Mining | | | | | | | | | | | | | | | | | | | | | | |
| Electricity | | | | | | | | | | | | | | | | | | | | | | |
| Other Industries | | | | | | | | | | | | | | | | | | | | | | |
| Households | | | | | | | | | | | | | | | | | | | | | | |
| Imports | | | | | | | | | | | | | | | | | | | | | | |
| **Total abstraction and distribution** | | | | | | | | | | | | | | | | | | | | | | |
| **Wastewater generated by** | | | | | | | | | | | | | | | | | | | | | | |
| Agriculture | | | | | | | | | | | | | | | | | | | | | | |
| Other industries | | | | | | | | | | | | | | | | | | | | | | |
| Households | | | | | | | | | | | | | | | | | | | | | | |
| **Total wastewater** | | | | | | | | | | | | | | | | | | | | | | |
| **TOTAL** | | | | | | | | | | | | | | | | | | | | | | |

4.186 The entries in the "total supply" column reflect the total amounts abstracted from all sources by different industries. They are equivalent to the corresponding totals in the bottom row of the physical flow account for water abstraction, Table 4.11.

4.187 The entries in the remaining columns, which constitute the use table, record the uses of the abstracted water, with a focus on recording the use of water in the production of key crops and for agricultural activities such as livestock rearing. The dark grey cells indicate combinations of supply and use that are unlikely to apply.

4.188 Economic units commonly re-use water from other economic units, usually when wastewater is generated by an economic unit, collected by a water-treatment facility and distributed treated or untreated to other economic units. In the SEEA, this water is considered as retained in the economy. Where water is used, returned to the environment – a river, for example – and then re-abstracted further downstream, it should be recorded in gross terms – abstracted twice – and hence not considered as re-use.

4.189 The entries in the bottom section of the account record the generation of wastewater by economic units in the first column and the quantities of this wastewater re-used by other economic units. There will generally be a difference between total supply and total use equal to the quantity of wastewater generated, which is returned to the environment rather than re-used. Flows of wastewater that are generated and re-used within a single economic unit are not recorded.

## Measurement issues and potential extensions

4.190 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.

4.191 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.

4.192 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 some cases sub-annual measurement could be considered with a view to allowing for seasonal variations in water availability.

4.193 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.

4.194 First, assessment of sustainability for a given catchment 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.

4.195 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.

4.196 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.

4.197 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.

4.198 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.

4.199 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.

4.200 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.

4.201 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.

## PHYSICAL FLOW ACCOUNTS FOR ENERGY USE

### Measurement purpose and scope

4.202 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.

4.203 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.

4.204 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 AFF sector, sources of energy used by AFF activities and other users and uses of energy by non-AFF activities, including households.

4.205 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.

### Accounting entries

4.206 The physical flow account for energy use is shown in Table 4.13. 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.

4.207 Most of the columns relate to the use of energy as an input to AFF 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 AFF energy use.

4.208 The tracking of energy flows into and through the economy must reflect the fact that the original source

**TABLE 4.13**
**Physical flow account for energy use (joules)**

| USE OF ENERGY | TOTAL SUPPLY | Agriculture, Forestry, Fisheries | | | | | | | | | | | | Manufacturing | Electricity | Other industries | Households | Exports | TOTAL USE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Agriculture | | | | | | | | | Total agriculture | Forestry | Fisheries | | | | | | |
| | | Maize | Rice | Wheat | Palm oil | Sugar | Potatoes | Other food crops | Non-food crops | Total crops | Livestock | | | | | | | | |
| **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** | | | | | | | | | | | | | | | | | | | |

– 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.

4.209 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 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.

4.210 The initial measurement focus should be the total energy use by AFF 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.

## Measurement issues and possible extensions

4.211 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.

4.212 First, it is likely to be relevant to organize information on the production of biofuels and other energy products such as biogas from agricultural and forestry outputs. Certain types of maize can be grown specifically to produce biofuels, but in other cases energy is a secondary product or by-product: 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. The SEEA Agriculture may in future be extended in this way.

4.213 Second, it may be of interest to understand the mix of sources of energy used in agriculture, forestry and fisheries. For example, energy may be captured directly by solar panels or wind turbines, which may be important in the abstraction of groundwater, or it may be in the form of fuels to run machinery or electricity.

4.214 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.

4.215 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.

## PHYSICAL FLOW ACCOUNT FOR GREENHOUSE GAS EMISSIONS

### Measurement purpose and scope

4.216 The measurement of greenhouse gas emissions has emerged as a major 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 greenhouse gas inventories. In many developing countries, the emissions from agriculture, forestry and land use change are a significant proportion of their total greenhouse gas emissions. In this context, it is logical to include greenhouse gas emissions in the SEEA Agriculture framework.

4.217 The physical flow accounts described here record flows of greenhouse gas emissions from AFF activities to the environment, for example through the use of fertilizer or through deforestation. 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.
- Land use, land use change and forestry, 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.
- Energy use in agriculture – electricity, diesel oil, gasoline, liquefied petroleum, natural gas and residual fuel oil used in mechanized activities such as sawing, harvesting, irrigation and drying.

### Accounting entries

4.218 The physical flow account for greenhouse gas emissions is shown in Table 4.14. 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.

4.219 The structure of the physical flow account is a matrix that enables consideration of information on greenhouse gas emissions from AFF 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.

4.220 The shading in the bottom half of Table 4.14 indicates that the initial focus should be estimating total greenhouse gas emissions: i) from agricultural, forestry and fisheries activity, using the activity perspective; and ii) for selected products – 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.

4.221 The physical flow account also includes entries for greenhouse gas emissions from other industries and from households so that AFF emissions can be placed in context.

4.222 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.

- 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) and expressed in carbon dioxide equivalent.
- Manure management (major product grouping: livestock) – methane and nitrous oxide gases from aerobic and anaerobic decomposition, expressed in carbon dioxide equivalent.
- 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 IPCC 2000 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. Data are expressed in carbon dioxide equivalent.
- Synthetic fertilizers (major product grouping: crops) – nitrous oxide gas from synthetic nitrogen additions to managed soil. Data are expressed in carbon dioxide equivalent.
- Manure left on pasture (major product grouping: livestock) – nitrous oxide gas from nitrogen additions to managed soils from livestock: i) direct emissions from microbial nitrification and de-nitrification on site; and ii) indirect emissions from volatilization, re-deposition and leaching. Data are expressed in carbon dioxide equivalent.
- Crop residues (major product grouping: crops) – nitrous oxide gas from decomposition of nitrogen in crop residues on managed soils. Data are expressed in carbon dioxide equivalent.
- Manure applied to soils (major product grouping: crops) – nitrous oxide gas from manure applied to managed soils. Data are expressed in carbon dioxide equivalent.
- Cultivation of organic soil (major product grouping: crops) – nitrous oxide gas from drained organic soils. Data are expressed in carbon dioxide equivalent.
- Burning of crop residues (major product grouping: crops) – methane gas and nitrous oxide gas from burning crop residues on-site. Data are expressed in carbon dioxide equivalent.
- Use of electricity – emissions generated by the use of electricity in agriculture. Data are expressed in carbon dioxide equivalent.
- 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.
- Land use change – country-level estimates of emissions from land use activities, using Tier 1 computations and following the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: i) forest land net emission/removal, FAO code 5065; major product grouping: forest; and ii) crop land net emission/cultivated area, FAO code 5070; major product grouping: crops. Data are expressed in carbon dioxide equivalent.
- Fuel used in fisheries – emissions from energy consumption. Data are expressed in carbon dioxide equivalent.

## Measurement issues and possible extensions

4.223 The measurement of greenhouse gas 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.

4.224 Chapter 5 discusses measurement methods and sources; possible approaches to measurement are described in the FAOSTAT Emissions Agriculture database. There should be close connections between making the estimates for IPCC reporting at the national level and populating the SEEA Agriculture framework with data.

## TABLE 4.14
## Physical flow account for GHG emissions (gigagrams of CO2 equivalent)

| Type of GHG emission | Type of agricultural activity | | | | | | | | | Total | Energy use in agriculture | | | | | | Energy consumed in fisheries | Land use, land use change and forestry (LULUCF) | | | | Mining | Manufacturing | Transport | Other industries | Households | Total economy |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 | | Electricity | Fuel | | | | | | Fuel | Forest land (net forest conversion) | Crop land (Cultivated organic soil) | Other LULUCF activities | | | | | | |
| | | | | | | | | | | | | Gas-diesel oil | Gasoline | Liquefied petroleum (LPG) | Natural Gas (LNG) | Residual fuel oil | | | | | | | | | | | |
| Emissions (C02 equivalent) from nitrous oxide (N20) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Emissions (C02 equivalent) from methane (CH4) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Emissions of carbon dioxide (C02) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Total emissions in carbon dioxide equivalent (CO2 equivalent)** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Agriculture, forestry and fisheries 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 emissions from agricultural, forestry and fisheries products (CO2 equivalent)** | | | | | | | | | | | | | | | | | | | | | | | | | | |

## PHYSICAL FLOW ACCOUNTS FOR FERTILIZERS, NUTRIENT FLOWS AND PESTICIDES

### Measurement purpose and scope: Fertilizers and pesticides

4.225 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.

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

4.227 Data on inorganic fertilizers may be recorded in terms of tonnes of fertilizer products that contain the active nutrients nitrogen, phosphate and potash, 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".

4.228 Information on the supply and use of organic fertilizers such as manure, compost and mulch is incomplete, but these fertilizers are important sources of nutrients and are needed to maintain long-term soil health. 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. One element in the measurement of nutrient flows (see section 4.13.2) requires estimates of flows of manure, including imports and exports.

4.229 The rows in the supply and use table for fertilizers (section 4.13.3) reflect the importance of organic fertilizers, but further work is required to establish appropriate definitions and measurements.

4.230 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.

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

### Measurement purpose and scope: nutrient flows

4.232 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.

**Supply table entries**

4.233 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 – in 2013, setting out the concepts, sources and methods relevant to the measurement of nutrient flows.

4.234 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.

4.235 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.

4.236 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.

4.237 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.

## Accounting entries for fertilizers and pesticides

4.238 The physical flow account for fertilizers is shown in Table 4.15. It records the supply and use of inorganic fertilizers in terms of active nutrients, and organic fertilizers in tonnes. The account is divided into a supply table and a use table; total supply must equal total use.

4.239 The "output" entry refers to the total quantity of fertilizer produced at the national level, expressed in tonnes of nutrient equivalent for inorganic fertilizers and in tonnes of organic fertilizers.

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

**TABLE 4.15**
**Physical flow account for fertilizers (tonnes)**

| Product | Output | Imports | TOTAL SUPPLY | Intermediate consumption | | | | | | | | | | | | | Total | Household final consumption | Changes in inventories | | Exports | TOTAL USE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Maize | Rice | Wheat | Palm oil | Sugar | Potatoes | Other food crops | Non-food crops | Other agriculture | Total agriculture | Forestry | Fisheries | Other uses | | | Losses | Other changes | | |
| ***Inorganic fertilizers*** | | | | | | | | | | | | | | | | | | | | | | |
| Nitrogen fertilizers (N total nutrients) | | | | | | | | | | | | | | | | | | | | | | |
| Phosphate fertilizers (P205 total nutrients) | | | | | | | | | | | | | | | | | | | | | | |
| Potash fertilizers (K20 total nutrients) | | | | | | | | | | | | | | | | | | | | | | |
| ***Organic fertilizers*** | | | | | | | | | | | | | | | | | | | | | | |
| Manure | | | | | | | | | | | | | | | | | | | | | | |
| Other organic fertilizers | | | | | | | | | | | | | | | | | | | | | | |

**Use table entries**

4.241 The "intermediate consumption – agriculture" entry refers to "consumption in nutrients" – the total amount of 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.

4.242 The entries for "intermediate consumption" refer to the quantity of fertilizers used by agriculture, forestry, fisheries and other industries.

4.243 The "household final consumption" entry refers to the total quantity of fertilizer products, expressed in nutrient equivalent, consumed by households for non-productive purposes such as fertilizing gardens and lawns during the reference period.

4.244 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.

4.245 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.

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

4.247 The physical flow account for pesticides is shown in Table 4.16. 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.

The eight FAO pesticide groups are:

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**

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

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

**Use table entries**

4.250 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.

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

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

4.253 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.

4.254 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.

4.255 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.

4.256 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.

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

**TABLE 4.16**
**Physical flow account for pesticides (tonnes of active ingredients)**

| Product | Output | Imports | TOTAL SUPPLY | Intermediate consumption | | | | | | | | | | | | | Total | Household final consumption | Changes in inventories | | Exports | TOTAL USE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Maize | Rice | Wheat | Palm oil | Sugar | Potatoes | Other food crops | Non-food crops | Other agriculture | Total agriculture | Forestry | Fisheries | Other uses | | | Losses | Other changes | | |
| Insecticides | | | | | | | | | | | | | | | | | | | | | | |
| Mineral oils | | | | | | | | | | | | | | | | | | | | | | |
| Herbicides | | | | | | | | | | | | | | | | | | | | | | |
| Fungicides and bactericides | | | | | | | | | | | | | | | | | | | | | | |
| Seed treatments, fungicides | | | | | | | | | | | | | | | | | | | | | | |
| Seed treatment, insecticides | | | | | | | | | | | | | | | | | | | | | | |
| Plant growth regulators | | | | | | | | | | | | | | | | | | | | | | |
| Rodenticides | | | | | | | | | | | | | | | | | | | | | | |
| **Total** | | | | | | | | | | | | | | | | | | | | | | |

## Measurement issues and possible extensions

4.258 Most of the issues related to accounting for fertilizers and pesticides are captured above. A few additional points are made here. First, an important source of fertilizers is organic – manure, compost, lime and biochar for example. In theory such fertilizers should be accounted for in the supply and use tables, but this has not yet been developed. Flows related to these fertilizers will be captured in the measurement of nitrogen and phosphorus cycles.

4.259 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.

4.260 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 4.15).

4.261 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.

## ASSET ACCOUNTS FOR LAND

### Measurement purpose and scope

4.262 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 the activities undertaken and the institutional arrangements in place in a given area for the purposes of economic production and the maintenance and restoration of environmental functions; and ii) land cover refers to observed physical and biological land cover, including natural vegetation and abiotic (non-living) surfaces.

4.263 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 investment in agriculture. 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.

4.264 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.

4.265 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 – as increasing amounts of land being used for agriculture compared with forestry, or decreasing areas of agriculture resulting from urban expansion, for example – can be monitored using these data to show the changing mix of land cover. Consideration should be given to economy-wide programmes of work on land accounting, because integration among large-scale projects is likely to bring significant advantages.

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

4.267 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 terms of land use or land cover may be incremental and accounting at three-year intervals may be more appropriate.

4.268 Where there are clear ongoing 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 be established; this also applies where the mix of cropping types, for example from broad-acre to plantations, is changing on a consistent basis.

4.269 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.

## Accounting entries

4.270 The asset account for land use is shown in Table 4.17. It records the opening and closing stock of land in hectares, classified by type of land use and 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 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 4.17**
**Asset account for land use (hectares)**

| Land use classes | | Opening stock | Additions to stock | Reductions in stock | Net changes in stock | Closing stock |
|---|---|---|---|---|---|---|
| Land | Agriculture | | | | | |
| | Arable land | | | | | |
| | Permanent crop | | | | | |
| | Arable land and permanent crop (tot) | | | | | |
| | Arable land and permanent crop (by crop type) | | | | | |
| | ….. | | | | | |
| | Permanent meadows and pasture (cultivated) | | | | | |
| | Permanent meadows and pasture (naturally growing) | | | | | |
| | Permanent meadows and pastures (tot) | | | | | |
| | Total agriculture | | | | | |
| | 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) | | | | | |

4.271 For SEEA Agriculture purposes the information on land use should be allocated by key agricultural product. This will involve the collation of different sources of information and allowances for variations in cropping practices. The classes of land use correspond to the interim classification in the SEEA Central Framework. The area of forestry is defined in accordance with the area of land supporting the forest asset accounts in section 4.7, so the area of land used for forestry covers forest land and other wooded land.

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

4.273 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. The opening stock of arable land and permanent crops is also allocated by key agricultural product as determined at the country level.

4.274 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.

4.275 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.

4.276 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.

4.277 The asset account for land cover is shown in Table 4.18. 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.

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

**TABLE 4.18**
**Asset account for land cover (hectares)**

| Land cover classes | Opening stock | Additions to stock | Reductions in stock | Net changes in stock | Closing stock |
|---|---|---|---|---|---|
| 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 | | | | | |

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

4.280 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.

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

4.282 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.

4.283 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:

- 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.

## Measurement issues and possible extensions

4.284 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 Chapter 5.

4.285 Estimates of land use and land cover at the country level may be made, but the data sources are usually different. It is important to reconcile different estimates of land use and land cover to convey a useful picture of the two concepts. In this regard, consistency with other indicators of land use such as production statistics should be sought. Land-cover and land-use change matrixes in which changes between the opening and closing stock are categorized by type of change constitute a useful analytical tool.

4.286 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.

4.287 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.

## ACCOUNTING FOR SOIL RESOURCES

4.288 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.

4.289 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.

4.290 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.

4.291 Table 4.19 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.

4.292 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.

**TABLE 4.19**
**Physical asset account for the area of soil resources (000 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** | | |

4.293 Data sources developed in recent years regarding soil include the Harmonized World Soil Database (FAO et al., 2009) and the GlobalSoilMap of the 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.

## BASE ACCOUNTS FOR ECONOMIC DATA FOR SEEA AGRICULTURE

### Measurement purpose and scope

4.294 Section 3.3 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 AFF activities and, potentially, products. This section describes these two base accounts and the common data sources and methods.

4.295 Table 4.20 shows a monetary supply and use account for AFF products. It follows the SNA monetary supply and use account, with AFF 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.

4.296 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 4.20 subsidies are recorded as a component of total supply at basic prices.

4.297 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.

4.298 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 the OECD Agricultural Policy Monitoring and Evaluation 2014, for example, 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.

4.299 Table 4.20 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 4.20, and additional information would then be needed for compilation. The information compiled for an account such as Table 4.20 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.

4.300 Table 4.21 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 4.20, the use of a product-level perspective is an obvious choice, but for Table 4.21 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.

**TABLE 4.20**
**Monetary supply and use table for agricultural products (currency units)**

| | SUPPLY TABLE | | | | USE TABLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Agricultural products | Ouput | | Imports | Total supply at basic prices | Total supply at purchasers prices | Intermediate consumption | Household consumption | Gross fixed capital formation | Changes in inventories | Exports | Total use at purchasers prices |
| | Total at basic prices | of which: subsidies on 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** | | | | | | | | | | | |

4.301 Given these considerations and the aim of the SEEA Agriculture to support comparison across agriculture, forestry and fisheries, Table 4.21 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.

4.302 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.

**TABLE 4.21**
**Extended production and income account for agricultural activities (currency units)**

| | Output | Intermediate consumption | Gross value added | Compensation of employees | Gross operating surplus and Gross mixed income | Gross fixed capital formation | Consumption of fixed capital (depreciation) | Employment (000 people) |
|---|---|---|---|---|---|---|---|---|
| | (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** | | | | | | | | |

4.303 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.

4.304 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.

## Measurement issues and possible extensions

4.305 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.

4.306 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.

4.307 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.

4.308 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.

4.309 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.

4.310 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.

# 5

# Compilation and Implementation

## APPROACHES USED IN NATIONAL ACCOUNTING

5.1 The SEEA Agriculture is an application of the concepts and structures of the SEEA Central Framework, which is derived from the standard national accounts described in the 2008 SNA. Consequently, compilation of the SEEA Agriculture base accounts calls for a national accounting approach to measurement. National accounting is distinct from other approaches to statistical processing and data collection in that statistical outputs cannot be directly related to a single underlying dataset. So although there are similarities in the compilation of national accounts and the compilation of data from surveys, censuses and administrative data sources, there are also important differences.

5.2 This section describes some of the features of the national accounting approach with a view to enabling non-national accountants to appreciate that the SEEA Agriculture is a framework for integrating data from multiple sources, and not a basis for designing a competing, single, integrated questionnaire.

### Features of a national accounting approach

5.3 The role of accounting frameworks is to integrate data to provide a single best picture of a concept or set of concepts such as economic growth or environmental assets. The compiler of accounts must therefore reconcile data from various sources, taking into account differences in scope, frequency, definition and classification.

5.4 For those unfamiliar with the way in which national accountants resolve problems of measurement, two points should be understood. First, national accounting commences with data collected from multiple sources. It is therefore not a matter of framing survey questions, determining sample sizes or collecting and processing data. These tasks are assumed to be completed by experts in specific subject areas or by those in charge of administrative data. There should ideally be a close relationship between compilers of national accounts and those who collect the data, but this can take time to evolve and in any event the national accounting process will always be one step removed from the source data.

5.5 Second, national accountants work “from the outside in”. National accounting is not a bottom-up approach whereby aggregates are formed by summing the available data. Most of the work involves ensuring that the estimates reflect the target concept –economic growth, for example, fixed capital formation or household

consumption. No single data source can fully measure a single concept, and hence national accountants must integrate and otherwise combine data from multiple sources to arrive at estimates for each concept that are as accurate as possible.

5.6 Third, it is not sufficient to obtain a best estimate of each concept in isolation. Measurement of each concept must be considered in the context of the measurement of other concepts, using national accounting identities. For example, total supply and total use of each product must be in alignment. The aim is to produce, at a point in time, the single best picture of the concepts in the scope of the national accounts. This cannot be achieved by relying on a bottom-up approach in which the micro-level builds up neatly to the macro-level. A top-down or "from the outside in" approach must be applied.

5.7 With this in mind, the national accounting compilation principles and approaches described in the following paragraphs should be recognized.

5.8 The maintenance of time series is fundamental. In creating the single best picture, both movements and levels must be considered. It is not sufficient for each data point to stand alone. Time series in national accounts may extend over 30 or 40 years, and few if any data sources are maintained consistently over such periods; in fact the methods and coverage of data collection will generally improve over time. A major role of national accounts is hence to link information from different sources and over time, use various methods to measure the same concept consistently.

5.9 Prices, quantities and values are all relevant. Most of the national accounts framework is presented in terms of relationships in value terms - that is, in terms of the actual monetary amounts transacted. Much work in national accounting involves breaking down – technically, "decomposing" – changes in value into changes in prices and changes in underlying quantities. Most national accounts analyse growth rates, productivity and investment levels in volume terms – that is, after removing price effects. Again, the single best picture requires a balance of approaches to achieve accurate aggregates.

5.10 Accounting is iterative. The process of integrating data is not a one-off process: each time a set of accounts is compiled, integration issues will only be resolved by attempting integration, understanding the reasons for imbalances and implementing possible solutions – and gradually, the single best picture emerges. Ideally, such integration issues are best resolved by involving both accountants and data-supplying areas.

5.11 Revision is an important feature of national accounting approaches. Without a time constraint on the integration of data and the release of results, national accounts would never be completed. There are always new data or new methods that might be adopted to refine the single best picture. National accounting works by releasing the single best picture at regular intervals in the knowledge that it will be revised as additional information comes to hand.

5.12 One consequence of the national accounting approach to estimation is that comparability is based on the accuracy with which different estimates reflect the target concept, rather than primarily on the basis of method. Every national accountant will integrate data from different sources and thus will apply different methods. Hence, a focus on comparability of methods is not likely to be a useful starting point for comparison – though it must be accepted that not all methods will produce estimates of equal quality.

5.13 In putting estimates together, data considered to be sound in a stand-alone context may have to be adjusted to ensure an integrated overall picture. And because the emphasis is on measurement of a defined framework, some data sources may have to be rejected whatever their quality because they are not defined according to the required concepts.

5.14 One benefit of focusing on concepts is that countries will tend to allocate resources to measuring the aspects most relevant to them. For example, in a country where agriculture is a dominant activity, resources would be allocated to measurement of this activity; whereas in a country with a large financial sector, the balance of resources allocated and the accuracy of methods would be different. Because economic structures change over time, methods must be adapted and resources re-allocated. The development of statistics relating to service activities such as entertainment and professional services and related developments in measurement methods over the past 25 years is a good example of this.

5.15 Integrating data in national accounts involves a rigorous process of analysis and decision-making about the relative quality of data – for example between quarterly and annual data – and making choices between different data sources that suggest different trends. With the application of the national accounting approach in the SEEA context, the standard scope – integrating data in monetary terms – is extended to biophysical and scientific data. In other words, the SEEA aims to integrate a wide variety of data about environmental assets and physical flows to present the single best picture.

5.16 In the SEEA, therefore, having data for a particular environmental asset or a particular type of physical flow is necessary – but not sufficient. Every effort must be made to obtain information that enables assessment of the whole: that is, all relevant environmental assets and all relevant physical flows. In the context of the SEEA Agriculture, the base accounts provide the relevant scope for accounting purposes and it would be relevant to allocate most resources to measuring the stocks and flows considered most significant. But this should not detract from the aim of measuring the whole.

## Application of accounting principles

5.17 The following paragraphs discuss the application of some of the accounting principles in Chapter 3. Detailed consideration of the principles is given in the 2008 SNA and the SEEA 2012 Central Framework.

### *Accounting identities*

5.18 The accounting system relies on a number of identities – expressions of relationships between different variables. Two are particularly important in a SEEA Agriculture context. The first is the supply-and-use identity, in which the supply of a product – in this case an ecosystem service – must match the use of that product in physical and in monetary terms. Information on the supply and use of a product will often come from different sources, and so this identity is a means whereby data can be reconciled.

5.19 Second, there is the relationship between balance sheets and changes in assets. This identity is that the opening stock plus additions to stock less reductions in stock must equal the closing stock. Again, it applies in physical and monetary terms. Without this identity there would be no reason to ensure that observed changes in assets match the point-in-time estimates of stocks that underpin the balance sheets.

### *Time of recording*

5.20 To provide a single best picture across multiple data sources a common reference point, referred to in accounting terms as the accounting period, must be established. The recommended accounting period in the SEEA is one year to enable alignment with economic data, which are usually compiled on this basis. Flows are measured in terms of recording all that takes place during the accounting period; stocks are measured at the opening and closing dates.

5.21 Different data sources usually have different reference periods, so adjustments will be required to enable integration. Flows, for example, may cover a date range that is not aligned with the accounting period, and stock information may relate to a point in time other than the opening or closing date. Any adjustments must be made explicit, and if no adjustments are made the reasons why should be given.

5.22 Some common tools and methods applied in national accounts are described in the following paragraphs.

### *Benchmarking, interpolation and extrapolation*

5.23 Among the various data sources, one will usually be particularly sound in terms of coverage and quality. This is often used as a benchmark at a point in time or for a given accounting period. With this information as a base, indicators can be applied: i) to extrapolate it to bring estimates up to date; and ii) to interpolate between benchmarks, for example in cases where reliable data are collected every three years but annual estimates are required for accounting purposes. These techniques are usually applied to generate the first estimates for a particular variable, and may subsequently be adjusted through the balancing and integration process.

5.24 In some respects these types of benchmarking and interpolation/extrapolation are a form of modelling, depending on the sophistication of the technique used. As a rule, regressions and the like are not utilized because maintaining these models across the full extent of a national accounts framework would be very resource-intensive. And because the outputs are eventually integrated into accounting identities, it may be difficult to rationalize the statistical advantage of applying detailed modelling approaches for individual series.

### *Modelling*

5.25 Modelling becomes necessary when there is a shortage of data for particular variables – in other words, when there are no direct estimates or benchmarks to provide a starting point. An example in standard national accounts is the estimation of consumption of fixed capital – depreciation. This is usually estimated through the "perpetual inventory model", which requires estimates of capital formation and assumptions regarding asset lives and depreciation rates.

5.26 In the context of the SEEA Agriculture, there is the potential to incorporate a large amount of detailed information by type of product and activity (and possibly at finer, sub-national spatial levels). Examples include the estimation of energy use and GHG emissions by crop type. If these levels of detail are to be provided, this is likely to increase the need for modelling. These may not be traditional sources of information, but there is no reason why such modelled data cannot be directly incorporated

5.27 A cross-cutting issue in this discussion is data quality. It is not usually possible to give a precise estimate of common measures of data quality, for example in terms of standard errors, for the national accounts. The synthesis of data from multiple sources makes this task difficult. It is also challenging to measure the significance of the application of accounting principles. They clearly lead to coherence in the final data, but it is often unclear how much adjustment was required to achieve coherence.

5.28 Ultimately, the quality of accounts will be judged according to the perceived accuracy of the picture they present. This will involve consideration of: i) how well the accounts reflect and incorporate data considered to be sound; ii) commentary by accountants as to the extent of adjustment required, noting that accounts may in some circumstances be left unbalanced and that the size of a discrepancy may be a measure of quality; iii) the scale of revisions to the estimates: a consistent pattern of large revisions to initial estimates either up or down reflects the relative quality of the sources and methods; and iv) the usefulness of the data to users. Ultimately, if the data from the accounts do not support decision-making or analysis, the quality of the accounts must be questioned.

## Sources of information on national accounting

5.29 To support the compilation of the SEEA Agriculture, and to increase understanding of national accounting compilation approaches, a useful reference is *Understanding National Accounts* by Lequiller and Blades of OECD. It provides a step-by-step explanation of national accounting, with exercises.

5.30 The United Nations Statistics Division national accounts webpage provides links to handbooks, training materials and recent papers; similar documents are available through OECD, IMF, the World Bank and Eurostat, all of which support the implementation of national accounts in all countries.

5.31 From the SEEA Agriculture perspective, the Eurostat manual Economic *Accounts for Agriculture and Forestry* provides comprehensive details of national accounts for agriculture and forestry, and highlights nuances in national accounting treatment that may emerge in dealing with these activities.

## SOURCES FOR THE COMPILATION OF SEEA AGRICULTURE BASE ACCOUNTS

5.32 This section provides a summary of material likely to be relevant in the compilation of SEEA Agriculture base accounts. It is not exhaustive, but as countries gain experience the most useful data sources and methods will emerge and will be collated at a later stage. The aim is that initiatives to improve statistical work such as the Global Strategy to Improve Agricultural and Rural Statistics be considered in the context of the SEEA Agriculture framework, and that opportunities for harmonization or identification of gaps in data may emerge.

### *Agricultural products and related environmental assets*

Relevant materials for this data domain include:

- guidance in the FAOSTAT website;
- FAO handbooks and guidance on the collection of national agricultural production data, including the ten-year agricultural census;
- the Global Strategy to Improve Agricultural and Rural Statistics;
- Eurostat information on the collection of agricultural statistics; and
- guidance on the compilation of the European Economic Accounts for Agriculture and Forestry by Eurostat.

### *Forestry products and related environmental assets*

Relevant materials include:

- guidance for the FAO five-year global Forest Resource Assessment;
- guidance for the Joint Forest Sector Questionnaire;
- the 2002 *European Framework for Integrated Environmental and Economic Accounting for Forests*; and
- sections 5.6 and 5.8 of the SEEA Central Framework.

### *Fisheries products and related environmental assets*

Relevant materials include:

- FAO guidance on collecting fisheries statistics in FishStat – see http://www.fao.org/fishery/statistics/software/fishstatj/en
- the 2004 FAO handbook *Integrated Environmental and Economic Accounting for Fisheries*; and
- section 5.9 of the SEEA Central Framework.

### *Water resources*

Relevant materials for this data domain include:

- SEEA Water, 2012;
- International Recommendations for Water Statistics, 2012;
- FAO guidance on collecting data in AquaStat – see http://www.fao.org/nr/water/aquastat/main/index.stm
- Eurostat guidance developed for its environmental-economic accounting programme of work on water-flow data; and
- sections 3.5 and 5.11 of the SEEA Central Framework.

### *Energy*

Relevant materials include:

- the forthcoming SEEA Energy;
- the 2014 International Recommendations for Energy Statistics;
- International Energy Agency guidance on collecting energy statistics;
- the Sustainable Energy for All Global Tracking Programme;

- Eurostat guidance from its environmental-economic accounting programme for energy flow data; and
- section 3.4 of the SEEA Central Framework.

### *Greenhouse gas emissions*

Relevant materials for this data domain include:

- IPCC guidance on the measurement of emissions in the UNFCCC;
- FAO guidance from its programme of work on measuring greenhouse gas emissions in agriculture;
- Eurostat guidance from its environmental-economic accounting programme of work on emissions flow data; and
- section 3.6 of the SEEA Central Framework.

### *Fertilizers, nutrient flows and pesticides*

Relevant materials include:

- FAO guidance on collecting data on fertilizers and pesticides; and
- the 2013 EU and OECD *Methodology and Handbook on Nutrient Budgets*.

### *Land*

Relevant materials include:

- FAO guidance on collecting data on land use;
- the FAO Land Cover Classification Scheme, version 3;
- the FAO Global Land Cover Network; and
- section 5.6 of the SEEA Central Framework.

### *Soil resources*

Relevant materials for this data domain include:

- the FAO Harmonized World Soil Database; and
- section 5.7 of the SEEA Central Framework.

### *Other economic data*

In addition to data relevant for the compilation of national accounts, other relevant materials include:

- FAO guidance on cost-of-production statistics;
- the United Nations Statistics Division handbook on the compilation of input-output tables; and
- guidance from the International Labour Organization on collecting employment statistics.

5.33 In addition to these materials, a number of economic models have been developed that focus on agriculture and incorporate physical flows and environmental information. They require the integration of data from various data domains as envisaged in the SEEA Agriculture.

- AgroSAM, Müller Marc, 2010: includes social accounting matrices for EU countries using a disaggregated agricultural sector;
- the World Input-Output Database 2012 (Groningen University);
- the 2012 Global Trade Analysis Project database, Purdue University); and
- the Common Agricultural Policy Regionalized Impact Modelling System see: http://www.capri-model.org/dokuwiki/doku.php?id=start

# References

**Dominati, E., Patterson, M. & Mackay, A.** 2010. A framework for classifying and quantifying the natural capital and ecosystem services of soils. *Ecological Economics* 69(9): 1,858–1868.

**European Commission, IMF, OECD, United Nations & World Bank.** 2009. *System of National Accounts 2008*. Sales No. E.08.XVII.29. Available at: http://unstats.un.org/unsd/nationalaccount/docs/SNA2008.pdf

**European Commission & Eurostat.** 2002. *The European Framework for Integrated Environmental and Economic Accounting for Forests*. Luxembourg, Office for Official Publications of the European Communities. Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-BE-02-003/EN/KS-BE-02-003-EN.pdf

**European Commission & Eurostat.** 2009. *Manual for Air Emission Accounts. Eurostat Methodologies and Working Papers*. Luxembourg, Office for Official Publications of the European Communities. Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-09-004/EN/KS-RA-09-004-EN.pdf

**Eurostat.** 2000. *Manual on the Economic Accounts for Agriculture and Forestry*, rev 1.1. Luxembourg, Office for Official Publications of the European Communities. Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-27-00-782/EN/KS-27-00-782-EN.pdf

**FAO.** 1995. *Code of Conduct for Responsible Fisheries*. Rome. Available at: http://www.fao.org/docrep/005/v9878e/v9878e00.htm

**FAO.** 2000. *International Standard Classification of Aquatic Animals and Plants*. Rome. Available at: ftp://ftp.fao.org/fi/document/cwp/handbook/annex/AnnexS2listISSCAAP2000.pdf

**FAO.** 2007. *Global Forest Resources Assessment 2010: specification of national reporting table for FRA 2010*. Forest Resources Assessment Programme working paper No. 135, Rome. Available at: http://www.fao.org/forestry/fra/67094/en/

**FAO.** 2008. *Glossary of Aquaculture*. Rome. Available at: http://www.fao.org/fi/glossary/aquaculture/pdf/glossary.pdf

**FAO.** 2010. *Global Forest Resources Assessment, 2010: Main Report*. FAO Forestry Paper no. 163, Rome. Available at: http://www.fao.org/docrep/013/i1757e/i1757e.pdf

**FAO & Global Land Cover Network.** 2009. *Land Cover Classification System*, v.3. Rome.

**FAO, International Institute for Applied Systems Analysis, International Soil Reference and Information Centre, Institute of Soil Science-Chinese Academy of Sciences & Joint Research Centre of the European Commission.** 2009. *Harmonized World Soil Database*, v. 1.2. Available at: http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/html/

**IPCC.** 2003. *Good Practice, J., Guidance on Land Use, Land Use Change and Forestry*. Penman, J., Gytarsky, M., Krug, T., Kruger, D., Pipatti, R., Buendia, L., Miwa, K., Ngara, T., Tanabe, K. & Wagner, F., eds. Hayama, Japan,

Institute for Global Environmental Strategies for the IPCC. Available at: http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_contents.html

**International Union of Soil Sciences**. 2009. GlobalSoilMap. Available at: http://www.globalsoilmap.net/

**OECD**. 2008. Measuring material flows and resource productivity: OECD guidance manual. Vol. II: A theoretical framework for material flow accounts and their applications at national level. Draft. Paris. LG/11/6. Available at: http://unstats.un.org/unsd/envaccounting/londongroup/meeting11/LG11_9a.pdf

**OECD**. 2007. *Gross nitrogen balances handbook*. Paris. Available at: http://www.oecd.org/greengrowth/sustainableagriculture/40820234.pdf

**OECD and Eurostat**. 2007. *Gross phosphorus balances handbook*. Paris. Available at: http://www.oecd.org/greengrowth/sustainableagriculture/40820243.pdf

**United Nations**. 2008a. *International Standard Industrial Classification of All Economic Activities*, rev.4. Statistical Papers, Series M, No. 4/rev.4. Sales No. E.08.XVII.25. Available at: http://unstats.un.org/unsd/cr/registry/isic-4.asp

**United Nations**. 2008b. *Central Product Classification*, v.2. Available at: http://unstats.un.org/unsd/cr/registry/cpc-2.asp

**United Nations**. 2011. International recommendations for energy statistics. Draft. Available at: http://unstats.un.org/unsd/energy/ires/default.htm

**United Nations**. 2012a. *International Recommendations for Water Statistics*. Statistical Papers, Series M, No.91. Sales No. 10.XVII.15. Available at: http://unstats.un.org/unsd/envaccounting/irws/irwswebversion.pdf

**United Nations**. 2012b. *SEEA-Water: System of Environmental-Economic Accounting for Water*. Statistical Papers, Series F, No.100. Sales No. E11.XVII.12. Available at: http://unstats.un.org/unsd/envaccounting/seeaw/seeawaterwebversion.pdf

**United Nations**. System of Environmental-Economic Accounting for Energy. Forthcoming.

**United Nations and FAO**. 2004. Handbook of national accounting: integrated environmental and economic accounting for fisheries. Final draft. Available at: http://unstats.un.org/unsd/envaccounting/Fish_final_whitecover.pdf

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

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

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