Treatment of cultivated biological resources in SEEA-MFA

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1. !ntroduction

1.1 Objective

At the Rome meeting of the London Group a paper on the harmonization of the SEEA and the OECD Guidance Manual on Material Flow Accounts[1] was discussed and a number of recommendations where formulated.

As far as the issue of cultivated crops and trees was concerned, the paper presented the "modified harvest approach" to address the boundary issue of how to deal with the inputs from the environment to the economy and the outputs from the economy to the environment in the case of cultivated assets.

It was concluded:

"The London Group supported in principle the proposal that ecosystems inputs be replaced by the inputs from harvested crops and trees and the changes in inventories of nonharvested crops and trees to ensure a proper balance between supply and use of mass. The London Group however recommended that additional work be done in particular to understand the implications for the standard tables and the balancing items. There is a boundary issue on how to present growth of cultivated crops and trees. In fact, growth is considered in the SNA as output of the economy and not as an input from the environment as in the MFA. The London Group agreed that a proposal for an alternative presentation of the mass balances should be developed. This alternative should take into consideration that the harvest of cultivated assets are considered as inputs from the environment into the economy, contrary to standard national accounts concepts."

It is the aim of this paper

(a) to introduce a solution of the issue of "cultivated crops and trees" for the SEEA-MFA by following the principal line of the London Group conclusions;

(b) to provide an improved presentation of the alternatives for dealing with cultivated crops and trees in MFA accounting;

(c) and to present the implications of the proposed approach for other MFA modules.

1.2 EW-MFA as a sub-module of SEEA-MFA

In the new SEEA-MFA manual EW-MFA will be designed as a fully integrated sub-module. Being fully integrated the EW-MFA can play a central role as it covers all materials with the exception of water. It shows the interaction of the economy with the outside world in a detailed breakdown by type of material, but the flows within the economy are – except of some general waste flows - treated as a black box. The other sub-modules concentrate on the flows of material within the economy. The different resource accounts focus on the transformation and the use of natural resources within the economy. For that purpose the flow of selected raw materials or groups of raw materials and related products (upstream or downstream the production chain) are reported. The different "emission accounts" record the generation (supply) of different types of emissions (e.g. air, solid waste) by economic activities and, as far as applicable, the use of that materials within the economy (recycling, treatment and permanent storage).

[1] LG 12/2 Harmonization of all SEEA Physical Flow Accounts into an Organic and SNA-coherent System in the Light of the OECD Guidance Manual on Material Flow Accounts (K. Schoer, O. Gravgård and A. Femia in cooperation with OECD and Eurostat)

2. Approaches for recording the flow of biological resources

In order to take account of different analytical purposes and different national conditions it is proposed for the SEEA-MFA to use a number of alternative approaches for dealing with the input of biological resources into the economy. The difference between the concepts refers to whether specific types of biological resources are regarded as being created within the environment by a natural process or whether they are considered as beeing generated by a production process within the economy. In this paper it is suggested to use the so called "harvest approach" as the standard concept for the SEEA-MFA, including the EW-MFA module.

2.1 Classification of biological resources

Biological resources (biomass) are natural materials that comprise organic non-fossil material of biological origin. Annex 1 shows the classification of biological resources that is suggested for SEEA-MFA[2]. The classification of Biological resources comprises „Resources from agriculture, horticulture and market gardening", "Live animals and animal resources (excluding meat)", "Forestry resources" and "Fish and other fishing resources". The biological resources of the natural input classification (A0) correspond to section 0 of the Central Product classification (CPC). However for the purpose of MFA a basic destinction has to be made between cultivated biological resources and non-cultivated biological resources (wild biota).

Wild biota especially comprises wild crops, plants and trees, including grazed biomass from wild meadows, the catch of wild fish and other aquatic resources and hunting of wild animals. For the purpose of MFA all "resources from agriculture, horticulture and market gardening" (A.0.1) and "live animal resources (excluding meat)" (A.0.2) are regarded as cultivated. As far as the "forestry recources" (A.0.3) and the "fish and other fishing resources" (A.0.4) are concerned it has to be differentiated between cultivated and non-cultivated resources. It is assumed for practical purposes that the non-wood forest resources (A.3.2) are exclusively non-cultivated and that the item comprises all non cultivated plants and animals (excluding non-cultivated grazed biomass). The items "wood" (A.0.1.1, A.0.1.2) and "fish and fishing resources" (A.0.4.1, A.0.4.2, A.0.4.3) have to be further splitd into cultivated and non-cultivated.

Specific versions of the classification of biological resources have to be established for the different approaches of accounting for the generation of those resources, ranging from including all biological resourcres to only regarding non-cultivated resources.

2.2 Non-cultivated biological resources

The extraction of **non-cultivated biological resources** is generally treated like the extraction of any other non-biological natural resource from the environment. A non-cultivated biological resource is created within the environment by a natural process. Only the act of extraction of that resource from the environment is regarded as an economic production process.

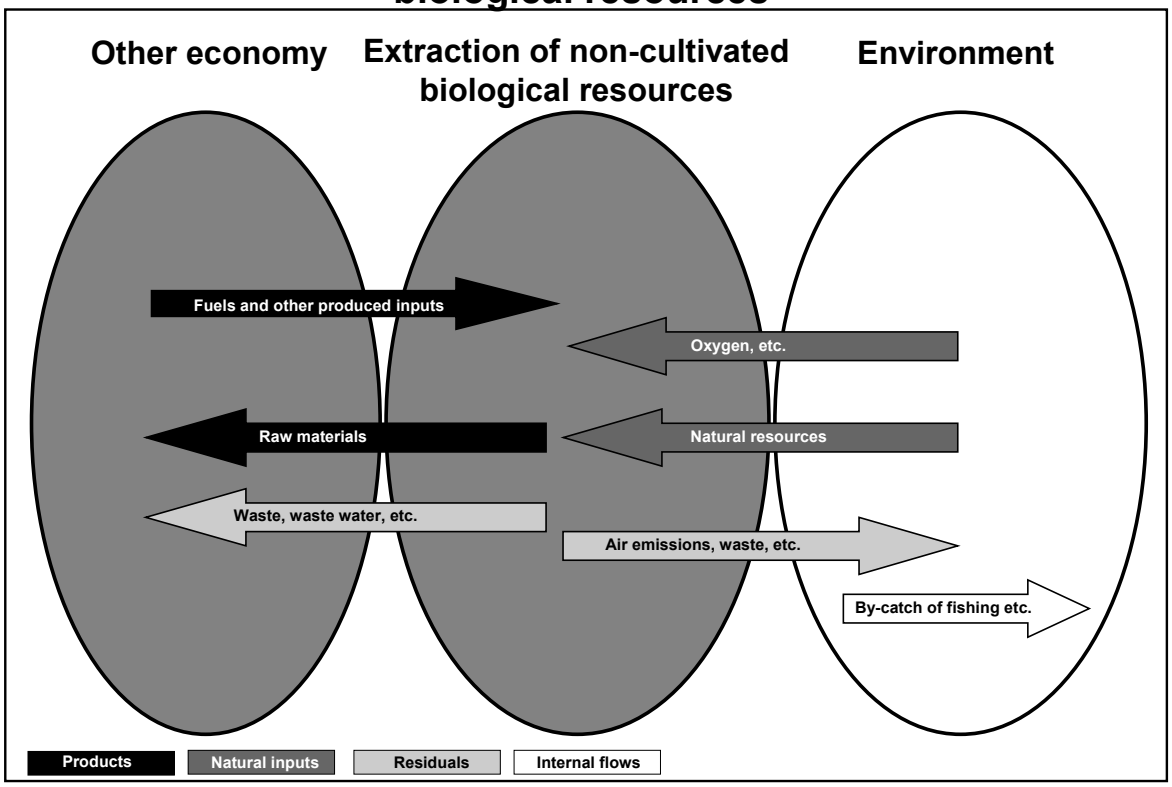
Figure 1 shows the relevant flows between that production process and the rest of the economy as well as with the environment. The production process uses intermediate inputs of products from the economy, like fuels, and inputs from the environment, which is the extracted non-cultivated biological resource itself as well as other natural inputs, like oxygen for fuel combustion. The outputs are the raw material (product) and waste or other residuals which are absorbed by the economy for further treatement and residuals which are directly disposed to the environment, like air emissions from fuel combustion. The extraction process may also cause a flow of so called unused materials, like by-catch of fishing, which do not

[2] See also paper on "Classifications of Material Flows for SEEA-MFA", presented to this London Group meeting.

enter the economy (flow within the environment) and which are therefore regarded as taking place outside the system boundary of MFA.

Figure 1

Material flows of extraction of non-cultivated biological resources



2.3 Cultivated biological resources

As far as the treatment of cultivated biological resources is concerned three different approaches are suggested for the purpose of SEEA-MFA, the “ecosystem approach”, the “harvest approach” and the “extended harvest approach”.

In the “ecosystem approach”, which strictly follows the SNA convention for monetary accounting, cultivated biological resources are considered to be created completely within the economy by a production process in the SNA sense. Against that in the “harvest approach” cultivated crops, plants and trees are viewed as natural inputs which are predominatly generated within the environment. The “extended harvest approach” additionally includes also cultivated animal resources and cultivated aquatic resources as natural inputs. As already mentioned, the harvest approach is used for the sub-module of EW-MFA and it is also recommended as the standard approach for SEEA-MFA for pragmatic reasons.

The “harvest approach” takes account of the fact that cultivation is a specific production process under an environmental perspective. Further pragmatic reasons for recommending the harvest approach as the standard approach for EW-MFA are listed below.

Usually production can be described as a pure technical metabolism, i.e. the products are generated by technical processes which are almost completely under human control. However, cultivation is quite frequently dominated by a biological metabolism which is only supported by a technical metabolism. The biological metabolism refers to the growth of

biological resources; the technical metabolism comprises all other production activities related to that process, like ploughing and harvesting. The biological metabolism interacts directly with the environment by taking up natural inputs and solar energy (in case of plants) from and by disposing residuals to the environment. In sofar cultivation has a double role, comprising elements of a natural as well as of a technical process. The double role of cultivation as being both a natural as well as an economic process was already acknowledged in the SEEA 2003 classification of environmental assets by including also cultivated assets. It depends on the concrete characteristics of the individual cultivation process whether the technical or the biological metabolism dominates.

The view the SNA takes on cultivation processes is fully appropriate with respect to monetary accounting, where only the monetary flows of produced inputs and the output of products are regarded, whereas non-monetary flows of natural inputs and residuals do not matter. Against that the subject of MFA is flows of materials. A main objective of MFA is to depict the non-product flows between the environment and the economy and not only the flows of materials within the economy which have a monetary equivalent (products). Insofar, for MFA it can make a substantial difference wether cultivation is considered to take place completely within the economy or whether it is assumed that cultivation is a semi-natural process where the process is split into an economic (technical metabolism) and a natural process (biological metabolism).

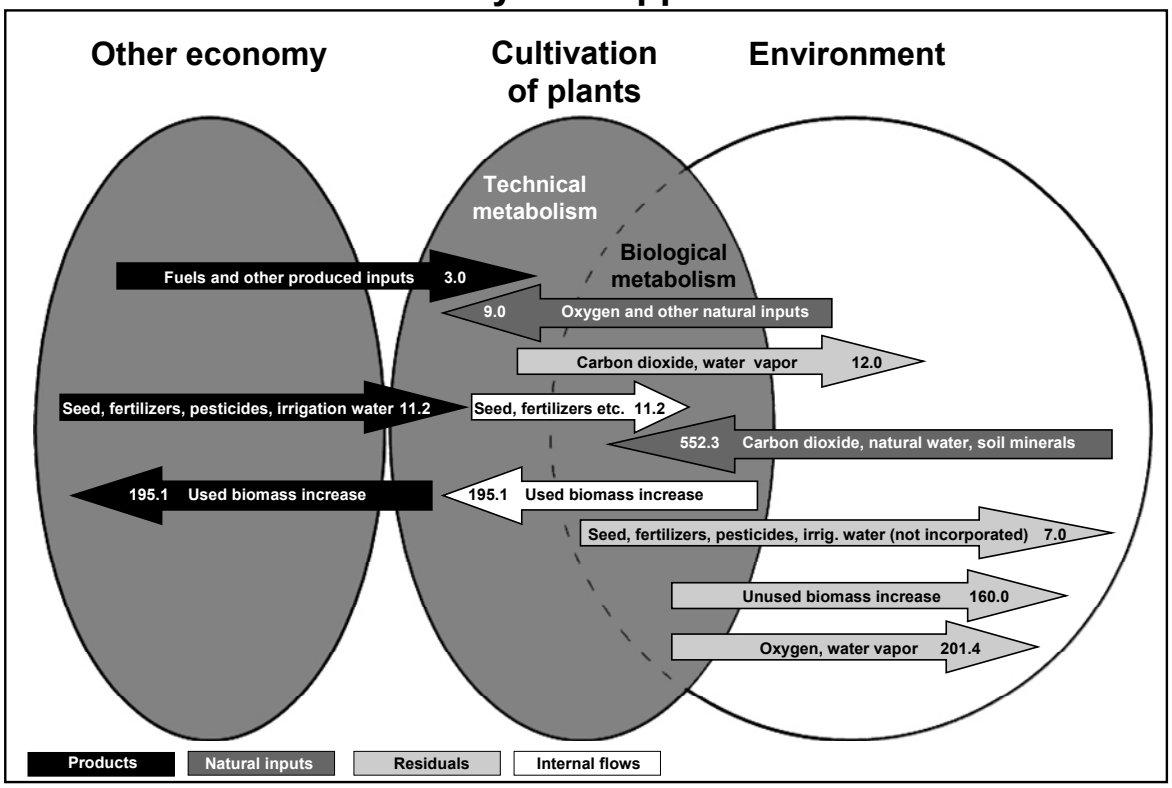
The consequences of the two different accounting approaches for the material flows are illustrated below.

2.3.1 Ecosystem approach

Figure 2 shows the material flows for plant cultivation under the assumption that cultivation as a purely economic process ("ecosystem approach")

Figure 2

Material flows of plant cultivation: "ecosystem approach"



Following the “ecosystem approach” the cultivated plants are created by a combination of a technical and a biological metabolism, which are both situated within the economy (dark shaded circle). Two principal types of inputs are used for the cultivation process, firstly products, like seed, fertilizers, pesticides, irrigation water, fuels and other produced materials and secondly natural inputs, like carbon dioxide, natural water, soil minerals and oxygen for fuel combustion.

The material ouput is comprised of products which are used by the economy and residuals as output to the environment. The generated products are labelled as used biomass increase, which denotes that only that part of the plants which is used as a product is included. Outputs to the environment[3] are comprised of those parts of the produced inputs which where not incorporated into the growing plants (not incorporated seeds, ferlilisers etc.), unused biomass, i.e. that part of the plants which is not used as a product and which is usually left behing in the field, oxygen and water vapour from the biological metabolism as well as residuals from the technical metabolism, like carbon dioxide and water vapour from fuel combustion. Produced inputs and product outputs are transferred by a technical process to and from the biological metabolism. Those flows between the biological and the technical metabolism are regarded in the “ecosystem approach” as internal flows within the cultivation process which takes place completely within the economy.

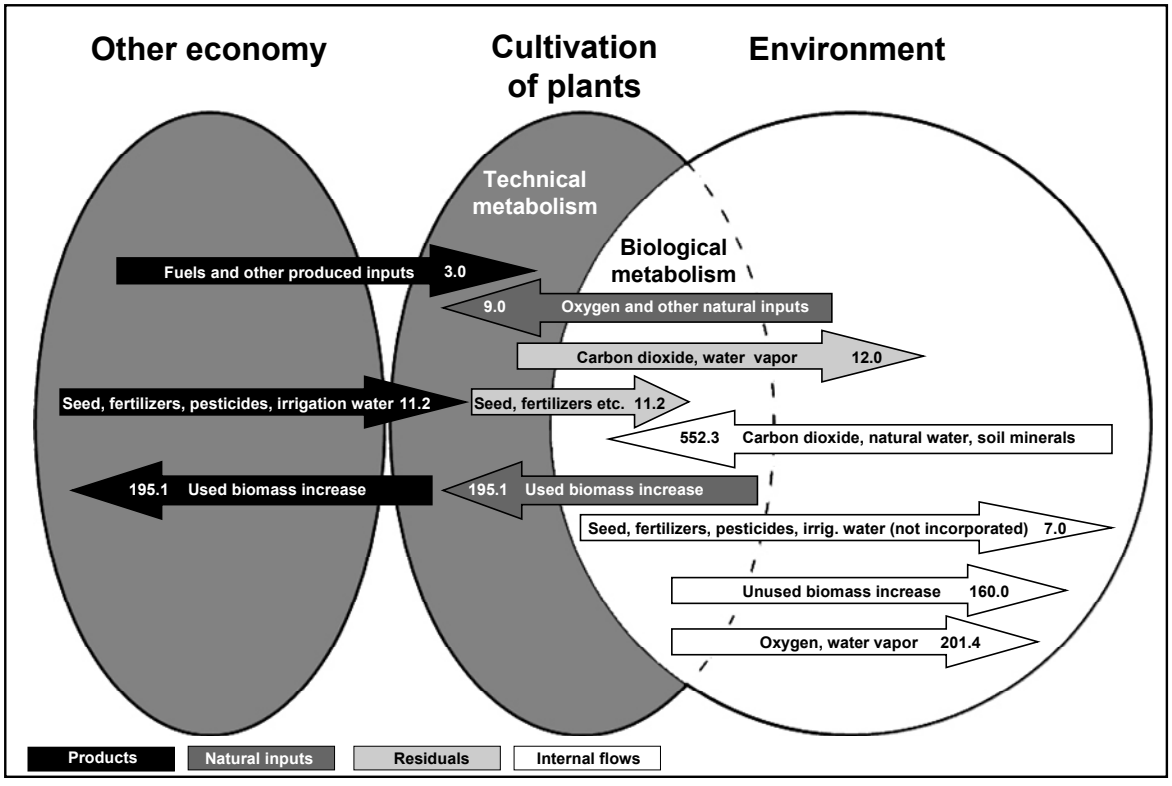
2.3.2 Harvest apporach

2.3.2.1 The flows of material

In the “harvest approach”, cultivation is viewed as a semi-natural process. Figure 3 depicts the material flows of a semi-natural process at the example of the cultivation of plants.

Figure 3

Material flows of plant cultivation: “harvest approach”



[3] Residuals to the economy can also occur, but are neglected in the graph

According to the “harvest approach” the cultivation process is also split into a technical and a biological metabolism. Wheras the technical metabolism is considered to be an economic process (dark shaded part of the circle) it is assumed that the biological metabolism takes place in the environment (light part of the circle). Following that approach has two consequences:

a) all flows between the biological metabolism and the environment are viewed as flows within the environment (internal flows) and

b) all flows between the technical and the biological metabolism are regarded as flows between the economy and the environment.

Therefore, the main effect of applying the “harvest approach” is that the plants generated by a biological metabolism are regarded as an input from the environment to the economy and the total input of products into the biological megtabolism (seeds, ffertilizers etc.) is treated as an output to the environment (dissipative use of products).

It has to be noted that the biomass increase covers also the change in inventories of standing crops (work in progress). Including also the work in progress follows the SNA concept of (product) output. For cultivation of plants the item change in inventories of standing crops might be usually rather negligible in practice. However that item can be highly relevant in case of cultivation of trees due to the long production cycles.

2.3.2.2 Relationship to the SNA production concept

Figure 4 highlights the relationship between the “harvest approach” and the SNA production concept.

Figure 4

Approaches for recording material flows of plant cultication

mn tons

"Ecosystem approach"

Inputs		Outputs	
Product flows			
Products	**14.2**	**Products**	**195.1**
Seed, fertilizers, pesticides etc.	11.2	Biomass increase (used)	195.1
Other products	3.0		
Non-product flows			
Natural inputs	**561.3**	**Output to the environment**	**380.4**
Carbon dioxide, natural water, oil minerals etc.to biological metabolism	552.3	Oxygen, water vapor from bilological metabolism	201.4
		Seed, fertilizers etc. from biological metabolism (not incorporated)	7.0
		Unused biomass increase from biological metabolism	160.0
Oxygen etc. to technical metabolism	9.0	Carbon dioxide, water vapor from technical metabolism	12.0
Total	**575.5**	**Total**	**575.5**

"Harvest approach"

Inputs		Outputs	
Product flows			
Products	**14.2**	**Products**	**195.1**
Seed, fertilizers, pesticides etc.	11.2	Biomass increase	195.1
Other products	3.0		
Non-product flows			
Natural inputs	**195.1**	**Output to the environment**	**23.2**
Biomass increase (used) from biological metabolism	195.1	Seed, fertilizers etc.(incorporated and not incorporated)	11.2
Oxygen etc. to technical metabolism	9.0	Carbon dioxide, water vapor from technical metabolism	12.0
Total	**218.3**	**Total**	**218.3**

The figure compares the material flows of the “harvest approach”and the “ecosystem approach”in an account form as a numerical example which was taken from the German Physical Input-Output Table for the year 1990. Main source is the table on the biological metabolism. However some rough estimates had to be added, as not all flows were included there (crop residues) and some were not calculated or published in the required degree of disaggregation.

It is obvious from the figure that the “harvest approach” implicates - compared to the “ecosystem approach” - only a modified recording of non-product flows which are related to the biological metabolism (dark shaded cells). All product flows as well as all environmental flows which are related to the technical metabolism remain completely unchanged under the alternative convention. That is, applying the "harvest approach" does not implicate any change of the production or other conventions of the SNA and therefore the coherence between product flows in monetary and physical terms is not affected by the alternative convention.

2.3.2.3 Cultivation of trees

It is suggested to account for the cultivation of trees in anology to cultivation of crops and plants. So, the “harvest approach” for cultivated trees regards the generation of timber and other used parts of the trees (used biomass increase) as natural resource input to the economy and the complete produced inputs to the biological metabolism as dissipative output to the environment. The change in inventories of standing timber has to be regarded as part of the used biomass increase[4].

2.3.2.4 Harvest approach as the standard

As described above, the “harvest approach” was introduced to take account of the fact that creating cultivated resources is a specific type of production process which is comprised by two elements, a biological and a technical metabolism. Further pragmatic reasons have to be mentioned for applying that approach instead of the “ecosystem approach” as the standard for SEEA-MFA:

a) Dominance of the biological metabolism
b) Harmonisation with EW-MFA
c) Analytical usefulness
d) Data availability

Dominance of biological metabolism: With the exception of greenhouse farming, the cultivation of crops, plants and trees takes place in the open nature. Therefor a clear domince of the biological metabolism against the technical metabolism can be stated for that type of cultivation.

Harmonization: harmonization of the system of MFA is an important reason for changing the convention. Already the SEEA 2003 proposed for the reasons put forward in this section a deviating accounting of cultivation of crops and trees for the purpose of EW-MFA as an optional approach. The EW-MFA is a well developed module of material flow at the European level. Data are collected for almost all EU member states at an annual basis. From the very beginning the EW-MFA was using an approach that is quite close to what is proposed now. Using the „harvest approach“ as a general approach for MFA will lead to a harmonization of both systems with the advantage that the data of the EW-MFA provide a

[4] However, it might be useful not to include the change in inventories of standing timber into some general indicators. See below.

coherent frame for the partial data produced by other MFA modules which concentrate on specific materials or issues.

Analytical usefulness: regarding the comprehensibility and the usefulness of the data for analytical purposes the "harvest approach" appears to be much more appropriate. Using the „ecosystem approach" for EW-MFA would not provide useful indicators. It is a well established practice to use the data of EW-MFA in a detailed breakdown by type of material for indicating environmental pressures and for assessing impacts on the environment[5]. Against that following the „ecosystem approach" the input of plants and trees into the economy would only be reported in terms of the mass of the balancing items, which are "ecosystem inputs in the terminology of the SEEA 2003. However. The environmental pressures and impacts of plant cultivation can be rather substantial and the differentiation by type of crop can be used as a rough but easily accessible indicator. Compared to that, "ecosystem inputs", which rather are recorded as balancing items for keeping the principle of mass balancing, are hardly a meaningful indicator of pressures to the environment by cultivation of crops, plants and trees.

Data availability: it appears rather difficult if not impossible to estimate many of the data required for the "ecosystem approach" with a meaningful degree of accuracy[6]. As a rule, except for the output and input of products, only rough estimates for the elements of biological metabolism are possible. For these estimates, physiologic information has to be combined with data on the production of cultivated plants by categories. It is also rather difficult to arrive at an estimate of what part of the fertilizers, farm manure and pesticides is incorporated into cultivated plants and what part is dissipated directly into the environment, for example, as nitrate pollution of groundwater. Compared to that most of the data that are required for the „harvest approach" can be obtained rather easily from official statistics.

2.3.3 Extended harvest approach

In the "extended harvest approach" not only cultivated crops, plants and trees, but also cultivated animal and / or aquatic resources are regarded as natural inputs. It is recommended to use the extended harvest approach for countries where the biological metabolism dominates the cultivation of animal and / or aquatic resources.

Similar to crops, plants and trees, the biological metabolism play also a role in the generation of animal and aquatic resources. But usually the biological metabolism is much less central for the latter type of cultivation. However there is only a gradual and not a principal difference compared to plant production. As already mentioned, there are also types of crop cultivation, like green house farming, where the direct interaction of the plants with the environment is rather limited. Also the characteristics of livestock and fish breeding may vary substantially, ranging from predominantly natural to almost industrialised technical processes.

In much of Europe intensive animal husbandry clearly dominates with produced inputs of fodder and water that are not applied in the open nature but predominantly in the cattle shed. At least for that type of process, the "harvest approach", which requires that the produced inputs are recorded as dissipation of residuals to the environment and the output of excreta had to be regarded as a flow within the environment, would not be meaningful adequation.

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[5] The recent efforts of Eurostat to develop an Europe wide environmental impact indicator that is based on EW-MFA data on the input from the environment to the economy by type of material is an example for that type of application (see task Force on environmental impacts).

[6] An exception in terms of data availability and usefulness may be carbon-binding by growth of trees, as that information has to be included into the inventories of the international green house gas reporting process. That requirement has lead or will lead to an improvement of the statistical basis for calculating those figures. However, it is suggested to cover that issue in the specific sub-module on wood and wood products.

However, in many developing countries the cultivation processes frequently may take place in the open nature, like cattle ranching with low densities of animals per hectare where virtually all the fodder and water is provided from natural ecosystems with comparatively few other inputs. In those case it appers useful to apply the extended harvest approach.

3. Consequences of using the "harvest approach" for the current EW-MFA reporting system and for SEEA-MFA modules

3.1 EW-MFA

Using the "ecosystem" or the "harvest approach" will foremost affect, as described above, the EW-MFA on the input as well as on the output side. For EW-MFA, using the "harvest approach" will improve the usefulness of the data for indicator building and other analytical puposes considerably. This indeed was one of the main reasons foro recommending that approach as the standard.

The proposal of using the "harvest approach" is in line with the current practice on EW-MFA data compilation by Eurostat, with a slight difference. The Eurostat approach excludes changes in inventories of standing crops and timber from the biomass growth. The Eurostat task force on MFA agreed in its meeting in November 2007 to adopt the "harvest approach" as it is designed for SEEA-MFA also for Eurostat reporting. But it was recommended to exclude the change in inventories of standing timber from the general environmental pressure indicators of EW-MFA, like "domestic extraction". The task force argued that from an ecological perspective the harvesting of trees represents the main environmental pressure related to the cultivation of trees and a decrease of the specific environmental asset. Against that the growth in the stock of trees can be regarded as an increase of the specific environmental asset. Therefore it seems not to be appropriate to add up those two flows of felling and change in inventories for building a meaningful environmental pressure indicator.

3.2 Other SEEA-MFA modules

It was already explained that only the non-products flows that are related to the biological metabolism of cultivation of crops, plants and trees are affected by using the "harvest approach" instead of the "ecosystem approach". All product flows and all non-product flows that are related to technical metabolisms remain unchanged.

Figure 5 presents the sub-modules going to be recommended for the SEEA-MFA[7]. Besides EW-MFA it will be suggested to establish sub-modules for all important types of raw material and related products ("resource accounts") and for residuals ("emission accounts").

Only those modules are affected by using the "harvest approach" which deal with biological metabolisms, that are the modules on agriculture, forestry, water and waste.

As far as the modules on agriculture and forestry are concerned, the change in the accounting convention by using the "harvest approach" might play only a rather marginal role. It is the major aim of those modules to provide data on the environmental pressures caused by the production and consumption of certain products. For that purpose it is sufficient to compile specific data on product and residual flows without showing a complete mass balance with all types of inputs and outputs.

Applying the harvest approach to the water module would imply that the direct take up of natural water by plants – and in case of the extended harvest approach, also by cultivated

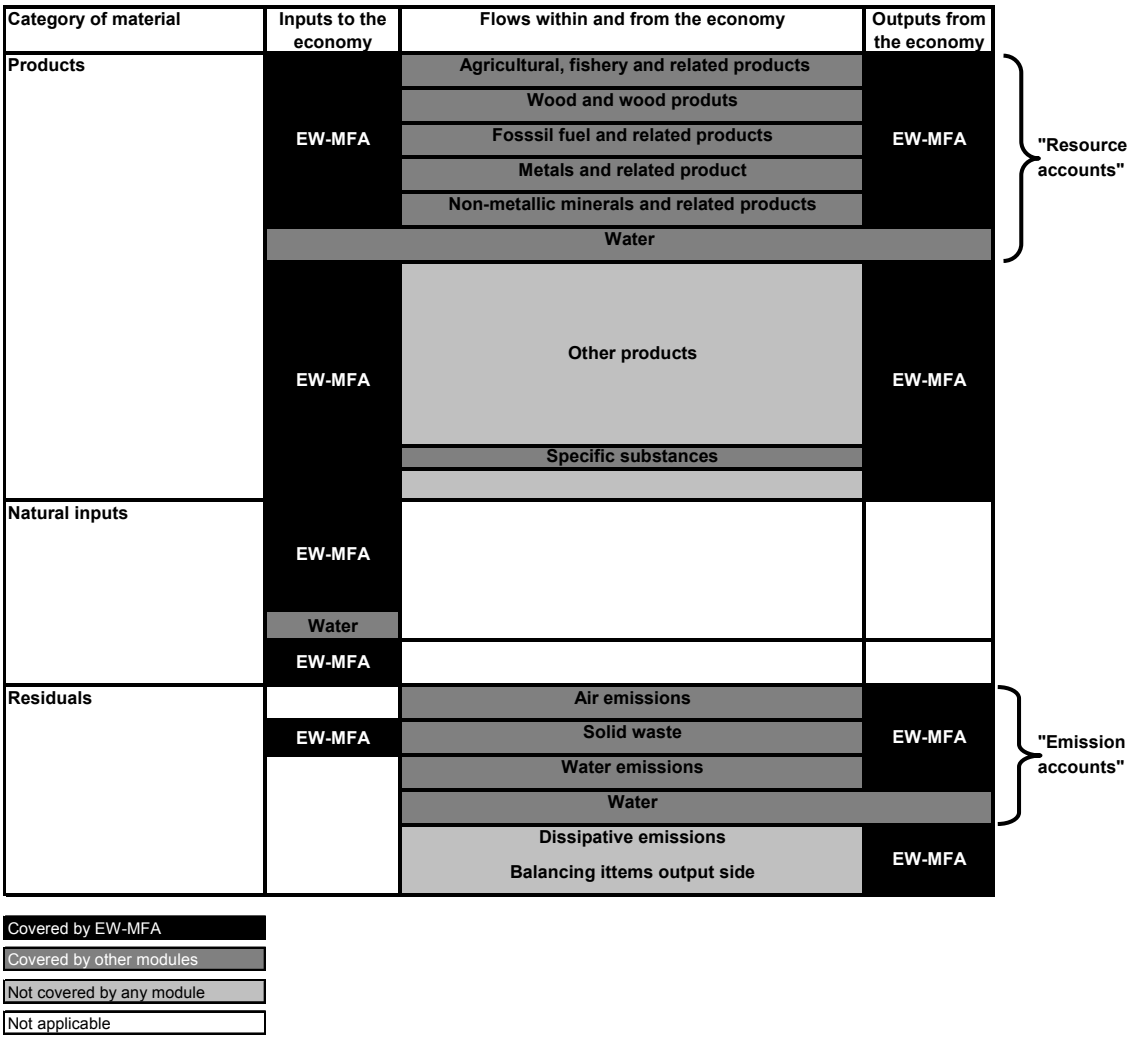
[7] See paper presented to the last London group meeting: "The Structure of the SEEA-MFA Manual Accounts" (K. Schoer, O. Gravgård and A. Femia in cooperation with OECD and Eurostat)

animals – is excluded. However all irrigation water, which is regarded to be a product, will also covered by the harvest approach.

Using the harvest approach for waste accounts would mean that unused crop residues are not regarded as waste.

Figure 5

Coverage of material flows by specific sub-modules of MFA



However, If required for analytical purposes those missing informations could easily be added to the modules as memorandum items for certain flows within the environment, like consumption of natural water by crops (rainfeed agriculture), carbon sequestration by trees, or unused crop residues without establishing a complete new mass balance for the sectors, with might carry a number of other analytically rather useless information.

Annex: Classification of biological resources

MFA code	CPC Vers. 2 (draft) code	Description	Ecosystem approach	Harvest approach	Extended harvest approach
A.0	0	**Biological resources from agriculture, forestry and fishery**			
A.0.1	01	**Resources from agriculture, horticulture and market gardening**			
A.0.1.1	011	Cereals			
A.0.1.2	012	Vegetables			
A.01.3	013	Fruits and nuts			
A.0.1.4	014	Oilseeds and oleaginous fruits			
A.0.1.5	015	Edible roots and tubers with high starch or inilin content			
A.0.1.6	016	Stimulant, spice and aromatic crops			
A.0.1.7	017	Pulses (dried leguminous vegetables)			
A.0.1.8	018	Sugar crops			
A.0.1.9	019	Forage resources, fibres, living plants, cut flowers and flower buds, unmanufactured tobacco, natural rubber, (including crop residues used for animal feed)			
A.0.1.10	n.a.	Grazed biomass			
A.0.2	02	**Live animals and animal resources (excluding meat)**			
A.0.2.1	021	Live animals			
A.0.2.2	022-025	Raw milk,eggs and other animal resources (excluding meat)			
A.0.3	03	**Forestry resources**			
A.0.3.1	031	Wood in the rough			
A.0.3.11	0311, 0312	Logs of coniferous wood; Logs of non-coniferous wood			
A.0.3.11.a		Logs of coniferous wood; Logs of non-coniferous wood, cultivated			
A.0.3.11.b		Logs of coniferous wood; Logs of non-coniferous wood, non-cultivated			
A.0.3.13	0313	Fuel wood, in logs, in billets, in twigs, in faggots or in similar forms			
A.0.3.13.a		Fuel wood, in logs, in billets, in twigs, in faggots or in similar forms, cultivated			
A.0.3.13.b		Fuel wood, in logs, in billets, in twigs, in faggots or in similar forms, non-cultivated			
A.0.3.2	032	Non-wood forest resources			
A.0.4	04	**Fish and other fishing resources**			
A.0.4.1	041	Fishes, live, fresh or chilled			
A.0.4.1.a		Fishes, live, fresh or chilled, cultivated			
A.0.4.1.b		Fishes, live, fresh or chilled, non-cultivated			
A.0.4.2	042	Crustaceans, not frozen; oysters; other molluscs and aquatic invertebrates, live, fresh or chilled			
A.0.4.2.a		Crustaceans, not frozen; oysters; other molluscs and aquatic invertebrates, live, fresh or chilled, cultivated			
A.0.4.2.b		Crustaceans, not frozen; oysters; other molluscs and aquatic invertebrates, live, fresh or chilled, non-cultivated			
A.0.4.9	049	Othe aquatic plants and animals			
A.0.4.9.a		Othe aquatic plants and animals, cultivated			
A.0.4.9.b		Othe aquatic plants and animals, non-cultivated			

Item included as natural input

Item not included as natural input