EUROPEAN COMMISSION
EUROSTAT

Directorate E: Sectoral and regional statistics

Luxembourg, 12 December 2011
ESTAT/E1//AMK

CPSA/AEI/100

WORKING GROUP
"AGRICULTURE AND ENVIRONMENT"
OF THE STANDING COMMITTEE FOR
AGRICULTURAL STATISTICS

TO BE HELD IN LUXEMBOURG,
BECH BUILDING-ROOM QUETELET
ON 9 AND 10 FEBRUARY 2012, 9:30 A.M.

CHAIRED BY: M. ERNENS

POINT 2.1.1

METHODOLOGY
GROSS NUTRIENT BALANCES

Foreword

In the Task Force on Gross Nutrient Balances (GNB) held at 14/15 November in Luxembourg the methodology of the GNB was discussed. Please note that the discussion mostly focused on the Gross Nitrogen Balance (GNB-N), as this indicator is most advanced. In this document the issues and the outcome of the Task Force on the general framework of the GNB at national level are discussed and the questions to the Working Group meeting at 9 and 10 February 2012 are defined. A strategy to derive regional GNB is discussed in a separate document (CPSA/AEI/101). A list of definitions can be found in Annex 1. The definition of the reference area of the GNB is discussed in document CPSA/AEI/102. The reference period is discussed in Chapter 5.

There are 3 types of balances: the farm balance, the land balance and the soil balance, see Chapter 1. To define the methodology of the Gross Nutrient Balances, a choice needs to be made on the approach taken. In the Task Force the participants favoured to continue with the land balance approach.

As there is much interest by the policy DG's not only in identifying the total risk of Nitrogen to the environment but also the aquatic risk, it is proposed to estimate next to the Total Gross Nitrogen Surplus (GNS), the Atmospheric Gross Nitrogen Surplus (aGNS), which represents the part of the GNS emitted to the air and the Hydrospheric Gross Nitrogen Surplus (hGNS), which represents the part of the GNS at risk of leaching and run-off from soils, see Chapter 2.

The ideal GNB-N following the land balance approach and the proposed practical implementation are discussed in Chapter 3, and the Gross Phosphorous Balances (GNB-P) in Chapter 4.

A list of questions posed to the members of the Working Group on AEI can be found in Chapter 6.

A list of definitions used in this document can be found in Annex 1.

Contents

1 Types of balances

1.1 Introduction

DireDate has described several types of nutrient balances (nutrient balances), see [Task 3 Report DireDate](). A clear description of the different balance types for Nitrogen (farm, land and soil balances) can be found in the upcoming article ["Farm, land, and soil nitrogen balances for agriculture in Europe calculated with CAPRI"](), by Leip, A. et al. Table 1 is derived from this article, it shows the differences between the three identified types of N balances.

Table 1. N inputs, outputs and surpluses in farm, land and soil balances

	Input			Output			Surplus		
	Farm	Land	Soil	Farm	Land	Soil	Farm	Land	Soil
Animal products (meat, milk, etc.)				x					
Sold crop products				x	x	x			
Fodder[a]					x	x			
Mineral fertilizer	x	x	x						
Feed (concentrates)	x								
External organic nitrogen sources[b]	x	x	x						
Net manure import/export, and withdrawals[c]	x	x							
Manure excretion		x							
Manure application[d]			x						
Crop residues					x	x			
Crop residues returned to/left on the soil		x	x						
Biological N fixation	x	x	x						
Atmospheric deposition	x	x	x						
Soil N-stock changes[e]						x	x	x	
N-gas emissions before manure application[f]							x	x	
Leaching and run-off before manure appl.							x	x	
N-gas emissions from soil[f]							x	x	x
Leaching and run-off from soils							x	x	x

[a] Fodder crops, cereals and other crops grown for feeding, grazed and cut grass.

[b] Sewage sludge, compost, etc.

[c] In the soil budget manure import/export and withdrawals must be implicitly considered in the application rate. Note that for the farm and land N-budget manure export and withdrawals are considered as negative N input with manure.

[d] Net of losses from housing and manure management systems.

[e] Soil N-stock changes are accounted as positive contribution of NS for farm and land budgets if the soil is depleting in nitrogen. It is accounted as positive contribution to the output of the soil N-budget if nitrogen is accumulating in the soil.

[f] NH_3, NO_x, N_2O, N_2.

Source: Leip, A., et al., Farm, land, and soil nitrogen budgets for agriculture in Europe calculated with CAPRI, Environmental Pollution (2011), doi:10.1016/j.envpol.2011.01.040

The **farm N balance** is constructed in the boundaries of the farm and records the N in all kinds of products that enter and leave the farm-gate. This balance can however be calculated at a country level as well, in this case the whole farming sector in a country is considered as a single farm. The **land** and **soil N balances** take a certain land or soil area as boundary. The difference between the land and the soil N balance is that in the land N balance manure excretion is included whereas in the soil N balance manure application (which is net of losses in animal housing and manure management systems) is included. The Nitrogen Surplus estimated with the land N balance therefore includes N-gas emissions to the air during animal housing and manure management, whereas these are excluded from the Nitrogen Surplus estimated with the soil N balance.

From Table 1 it can be seen that though the Nitrogen Surplus estimated with the farm or land N balance includes N-gas emissions, a Nitrogen Surplus excluding these N-gas emissions can be derived from these approaches as well by excluding the N-gas emissions from the estimated Nitrogen Surplus. Vice versa, a total Nitrogen Surplus can be estimated from the soil balance by including the N-gas emissions. The major difference between the three balances is which items are included in the in- and output side of the balance.

The farm N balance:
Advantages
- Most integrative, most meaningful indicator overall N pressure agricultural activities[1].
- Most accurate estimation according to DireDate and other scientists: throughputs such as excretion and home produced fodder do not need to be specified.
- That's why some countries use this approach for national use.
- Easiest for the farmer to understand: inputs to and outputs from the farm.
- Inputs bought and outputs sold should be available from farmers bookkeeping.
- Data at national scale available from sales, trade and production statistics.

Disadvantages
- Some data needed, e.g. animal feed, not everywhere available and difficult to survey.
- Not always easy to assign nutrient contents to individual feeding stuff such as to vegetable cakes and meals which can vary by some degree.
- Data are not available at regional level.

The soil N balance:
Advantages:
- More meaningful indicator for identifying aquatic risk.

Disadvantages:
- Data on manure applied required, which are often not available and difficult to collect. Therefore often estimated based on excretion corrected for volatilisation of N before application.

The land N balance:
Advantages:
- Long experience: the Eurostat/OECD GNB corresponds to the land N balance.

Disadvantages:
- Data on manure and fodder production are required. Measured data generally not available and are therefore generally estimated with model calculations.

Whatever approach is taken, excretion coefficients will still need to be estimated to fulfil the requirements for GHG and NH3 emissions inventories, data on grassland consumption is still needed when excretion coefficients are estimated using a mass balance approach. Farmers

[1] Bach, M., Frede, H.-G., 2005. Assessment of Agricultural Nitrogen Balances for Municipalities e Example Baden-Wuerttemberg (Germany). European Water Association (EWA). Nevens, F., Verbruggen, I., Reheul, D., Hofman, G., 2006. Farm gate nitrogen surpluses and nitrogen use efficiency of specialized dairy farms in Flanders: evolution and future goals. Agricultural Systems 88, 142e155. Oenema, O., Kros, H., de Vries, W., 2003. Approaches and uncertainties in nutrient balances: implications for nutrient management and environmental policies. European Journal of Agronomy 20, 3e16. Schröder, J.J., Scholefield, D., Cabral, F., Hofman, G., 2004. The effects of nutrient losses from agriculture on ground and surface water quality: the position of science in developing indicators for regulation. Environmental Science & Policy 7, 15e23.

can influence emissions by feeding practices, data on animal feed is necessary to capture these abatement measures and to estimate excretion.

1.2 Outcome of the Task Force meeting on GNB

In the meeting the different types of balances have been discussed. Some participants expressed a favour to estimate the national balance following the farm balance approach, as this approach provides more robust estimations. However other participants stated that they do not have the required data in their countries to estimate the balance following the farm balance approach. Most participants agreed that the farm balance approach is not suited to estimate the GNB at sub-national level, due to lacking data. As most countries have a long experience with estimating GNB following the land balance approach and as this approach is most suited at sub-national level the participants agreed that the land balance approach should be taken for the GNB at national and sub-national level.

2 Partitioning the Gross Nitrogen Surplus

As there is much interest by the policy DG's not only in identifying the total risk of N to the environment but also the aquatic risk, it is proposed to estimate next to the Total Gross Nitrogen Surplus (GNS), the Atmospheric Gross Nitrogen Surplus (aGNS), which represents the part of the GNS emitted to the air and the Hydrospheric Gross Nitrogen Surplus (hGNS), which represents the part of the GNS at risk of leaching and run-off from soils, see Equation 1.

Equation 1.	**GNS = aGNS + hGNS**

The following N-gas emissions are proposed to be included in the definition of aGNS. Please note that data on these emissions are required[2] for the UNFCCC GHG Inventories, the UNECE CLTRP, and the National Emissions Ceiling Directive:

- NH3 emissions from manure animal housing, storage and with the application to the land.
- NH3 emissions from soils due to the application of mineral fertilisers and sewage sludge.
- NH3 emissions from Field burning of agricultural wastes.
- NO(x) emissions from manure during storage.
- N2 emissions from manure during storage.
- NO(x) emissions from Field burning of agricultural wastes.
- Direct N2O (Nitrous oxide) emissions from manure during animal housing and storage.
- NO(x) emissions from soils due to application of mineral fertilisers and sewage sludge.
- Direct N2O emissions from soils.

In this definition of aGNS both immediate N gas emissions (of manure and fertilisers before application to the soil and immediately after application from the soil surface) as N-gas emissions after N has entered the soil (nitrification and denitrification processes in the soil) have been taken into account.

To estimate the aGNS and hGNS it is proposed to include a new worksheet in the current woksheets used for the GNB estimations, see Table 6 in the Annex 2.

2.1 Outcome of the Task Force meeting on GNB

The participants agreed to include the N emissions in the balance sheets, to be able to distinguish between the total N surplus, the emissions and the N surplus which is potential at risk for leaching. Some participants expressed that we should be careful in the presentation of the indicator and the results, to avoid misinterpretation by policy makers.

[2] See p77 of the Working Document provided for the TF on GNB for more information.

3 The Gross Nitrogen Balance

Table 2 shows the differences between the current GNB-N and the ideal GNB-N. The ideal GNB-N includes all flows from and to agricultural soils and estimates the total GNS, the aGNS and the hGNS following the land N balance approach for the reference area[3]. In the current GNB-N crop residues removed from the soil and returned to the soil were not taken into account. These items need to be taken into account to estimate Nitrogen Use Efficiencies.

The data collection of GNB-N in 2010 showed that there is a need to improve the data availability for some items. Resources in the countries are however limited. This means that we not only need to prioritise new data collection but also existing data collection (to make room for new data, not only for data needed for GNB but for policy needs in general). In the end we want to establish a clear Handbook; defining the methodology, terms and data sources. In this Handbook the ideal GNB-N will be described, but we propose to also include a practical implementation, which is a compromise between the ideal GNB-N and what we can achieve in reality with limited resources. This practical implementation of the ideal GNB-N is represented in the third column of Table 2.

Table 2. Current, ideal and proposed improved Gross Nitrogen Balances

Current GNB-N **Inputs**	Ideal GNB-N	Practical GNB-N
1) Mineral fertilisers 2) Manure production 3) Net manure import/export, withdrawals, stocks 4) Other organic fertilisers 5) Biological N fixation 6) Atmospheric N deposition 7) Seed and planting materials	1) Mineral fertilisers 2) Manure production 3) Net manure import/export, withdrawals, stocks 4) Other organic fertilisers 5) Biological N fixation 6) Atmospheric N deposition 7) Seed and planting materials 8) Crop residues (returned/left on the field)	1) Mineral fertilisers 2) Manure production 3) Net manure import/export, withdrawals 4) Other organic fertilisers 5) Biological N fixation 6) Atmospheric N deposition 8) Crop residues (returned/left on the field)
*9) **Total inputs** =sum(1,2,3,4,5,6,7)* **Outputs**	*10) **Total inputs** =sum(1,2,3,4,5,6,7,8)*	*11) **Total inputs** =sum(1,2,3,4,5,6,8)*
12) Crop production 13) Fodder production 14) Crop by-products (removed from the field)	12) Crop production 13) Fodder production 14) Crop by-products (removed from the field)	12) Crop production 13) Fodder production 14) Crop by-products (removed from the field)
*15) **Total outputs** = sum(12, 13, 14)* **Surpluses**	*15) **Total outputs** = sum(12, 13, 14)*	*15) **Total outputs** = sum(12, 13, 14)*
*16) **GNS** = 9 – 15*	*17) **GNS** = 10 - 15* *19) **aGNS** = Total N gas emissions* *20) **hGNS** = 17 - 19*	*18) **GNS** = 11 - 14* *19) **aGNS** = Total N gas emissions* *21) **hGNS** = 18 - 19*

[3] The reference area is discussed in a separate document: CPSA/AEI/102

Below the items included in the ideal GNB-N and the proposed practical implementation of the GNB-N are described.

1) Mineral fertilisers

Ideal: All mineral fertilisers used in the reference area.

Practical: Data source to be used are official national statistics of mineral fertiliser use at NUTS0 and NUTS2.

Please see for a discussion on this item document CPSA/AEI105. This item will be discussed in more detail under point 2.2.1 on the agenda.

2) Manure production

Ideal: All manure produced in the reference area.

Practical: Data source to be used is excretion as reported to UNFCCC.

Please see for a discussion on this item document CPSA/AEI/104. This item will be discussed in more detail under point 2.1.5 on the agenda.

3) Net manure import/export, withdrawals

Ideal: Manure export, manure import, stock changes, non-agriculture use and processing.

Practical:

- Manure export and import required at NUTS0 and NUTS2 level only when significant.
- Manure export and import checked with other data sources (GHG Inventory).
- At regional level checked with modelling.
- Data on stocks are no longer required (assumed zero).
- Decision whether and how to improve data on manure processing taken at a later stage.
- Reporting of non-agricultural use only accepted with sufficient proof by statistical data or scientific research.

Manure imports and exports

Manure imports and exports are insignificant in most countries and regions; a European data collection is therefore not justified. As trade is however significant in certain countries and regions, and not including estimates on trade would lead to a significant bias in the estimated balances of these countries and regions, Eurostat proposes that it is the responsibility of the countries to provide estimations on trade to Eurostat for the national level and to check and improve the estimations at sub-national level with CAPRI. Eurostat will check these estimations at national level with data reported to the UNFCCC GHG Inventories. To identify regions with possible significant trade of manure, Eurostat proposes to model the probability of transports of manure based on the availability of manure, crop requirements and legislative limits on nutrient use in a region. The results of such modelling could be discussed with the MS in bilateral discussions to verify and improve estimations by the MS.

Stocks

Almost no countries have data available on changes in manure stocks. Under normal circumstances it can however be assumed that the change in manure stocks is on average zero. As the stocks will have none or limited impact on the balance estimations at national and regional level, it is not worthwhile to invest in collecting data on manure stocks. Eurostat proposes that stocks will be assumed zero.

Manure processing

Data on manure processing are currently limited available. Data in the GNB of the NL and Flanders show that the withdrawal of nutrients due to manure processing represents less than 2.5 % of the total nutrients content of manure production in these countries. The Inventory of manure Processing Activities in Europe (DG ENV, 2011) shows that manure processing has reached a level of 6.9% of livestock manure production in the EU, with big variations between countries ranging from 0% in BG to 29% in DK. Manure treatment and processing is likely to become of growing importance in the EU-27, for instance for biogas production. DG ENV has carried out a study on manure processing and treatment activities in Europe. We propose to wait for the results of this study. Perhaps this study could provide a starting point to estimate the nutrients lost to agriculture with manure treatment and processing.

Non-agricultural use

Non-agricultural use may be significant in a few countries. However data need to be verifiable. Therefore Eurostat proposes data only to be accepted with proof by statistical data or scientific research.

4) Other organic fertilisers

Ideal: All other organic fertilisers used in the reference area.

Practical:

- Only sewage sludge required.
- MS are encouraged to report other organic fertilisers as well.

Data on other organic fertilisers are scarce. As resources are limited and a prioritization needs to be made, Eurostat proposes to simplify this item and require only data on sewage sludge. Data on sewage sludge used in agriculture is required by Directive 86/278/EEC. However not all countries fulfil the data requirements of this Directive at the moment. DG ENV will look into the possibilities to ensure that countries meet the data requirements specified in the Directive.

Countries are however encouraged to invest in estimating and reporting other organic fertilisers as well. We have asked data from the European Composting network on compost use in countries. Due to limited sources available in this institution, data could not be made available. Some data are however available in the report of a study carried out by ECN; "Compost production and use in the EU", 2008, Barth, J. et al, ORBIT e.v./ECN. This report is available at Circa. The report also includes a list of consulted experts in Annex 6.

5) Biological N fixation

Ideal: Biological N fixation by leguminous crops and free living organisms.

Practical:

- Data on free living organisms no longer required.
- TF to improve biological N fixation by leguminous crops.

Free living organisms

Scientific data is limited available in MS on the N fixed by free living soil bacteria. Almost all countries have used a 'default' value of 4 kg N per ha. The N fixed by free living soil bacteria is generally small, i.e. < 5 kg N per ha per year[4]. DireDate recommends this item can be neglected. As resources are limited and a prioritization needs to be made Eurostat proposes to simplify this item and require only data on N fixation by leguminous crops.

[4] Paul, E.E., and F.E. Clark. 1996. Soil microbiology and biochemistry. 2nd ed. Academic Press, San Diego, CA.

Leguminous crops

Data on Biological N fixation is required by the revised IPCC 1996 Guidelines for UNFCCC GHG Inventories. Countries may use default values or country-specific data. The UNFCCC is considering implementing the 2006 Guidelines in 2015. The 2006 guidelines no longer require data on Biological N fixation.

Leguminous crops, especially those planted specifically for N fixation, are often grown as secondary crops. Data on secondary crops is usually less available from regular statistics. Grassland can be mixed with legumes. Grass-legume mixtures contribute significantly to biological fixation. Data on areas covered with grass-legume mixtures are however not available as European statistics on land use do not distinguish between areas of grass-legume mixtures and pure grass areas. The proportion of legumes in grass needs to be identified as well to estimate the amount of nitrogen fixated in grass-legume mixed areas. The level of fixation in grass-legume mixed areas is also depending on grassland management and fertilisation.

There is a wide variation in coefficients used, as can also be seen in the reporting of GNB. Methodologies to estimate the fixation by leguminous crops vary between MS. There is a need to review the methodologies and data used by MS. DK has described in its pilot project on AEI a model to estimate biological fixation in grasslands, which is also used by SE. DK recommends reviewing the coefficients used by MS comparing them with coefficients calculated with an empirical model.

Eurostat proposes to organise a TF on estimating biological fixation with agronomists and statisticians: how to identify the proportion of legumes in grassland, how to identify the area of legume/grass mixture, how to take into account levels of fertilisation in determining the coefficient for leguminous crops and legume/grassland mixtures? How are the areas covered by leguminous crops estimated and the coefficients for leguminous crops? What should be the frequency of updating the coefficients? How to derive data at NUTS2 level? We are currently looking at possibilities to organise such a workshop with the European project Legumes Futures, possibly in 2013/2014.

6) Atmospheric N deposition

Ideal: Atmospheric N deposition deposited on the reference area.

Practical: Data source to be used is EMEP country estimates of N deposition divided by the total land area (L0008, landuse statistics crop production statistics) and multiplied by the reference area.

Atmospheric deposition varies by location. Precise data on atmospheric deposition on the reference area is not available. An approximation of the N deposited on the reference area could be derived by multiplying the national average deposition rate per ha with the reference area. EMEP models the total N deposition at NUTS0 level and at grid level in a harmonised way mandated by the Convention on Long-range Transboundary Air Pollution of which the EU is a signatory. EMEP makes use of national expertise and research.

7) Seeds

Ideal: All seeds input are included.

Practical: Data on seeds are no longer required.

Data on seeding rates are not available in many countries or are only available for a limited amount of crops or are based on standard or assumed seeding rates. The minor importance of this item of the balance, and the presence of other higher priority data needs in the situation of limited resources, does not justify efforts to improve data availability on this item. In the discussion in the Task Force meeting the participants were in favour to drop this item from the balance.

8) Crop residues returned to the soil

Ideal: All crop residues returned to the soil are included.

Practical: Total N in crop residues left on the field as reported to the UNFCCC.

Data N in crop residuals returned to the soil should be available from the national inventories for GHG reporting (table 4D.s1 in CRF reports). The default values in the revised 1996 IPCC guidelines should be used (see Table 3) unless better national information is available. The calculation of N in crop residues is described in Volume 2, p. 4.36-4.37:

Data needed to calculate nitrogen input from crop residues (FCR) are:

- Dry biomass production of pulses and soybean in country, CropBF (kg/yr)
- Dry biomass production of other crops in country, Crop0 (kg/yr)

Crop residue returned to soils (FCR, in kg N/yr) is calculated as:

FCR = 2 x [Crop0 x FracNCR0 + CropBF x FracNCRBF] x (1-FracR) x (1-FracBURN)

Where:

CropBF = production of pulses + soybeans in country (kg dry biomass/yr);

Crop0 = production of non-N-fixing crops in country (kg dry biomass/yr);

FracNCRBF = fraction of nitrogen in N-fixing crops (kg N/kg of dry biomass);

FracNCR0 = fraction of nitrogen in non-N-fixing crops (kg N/kg of dry biomass);

FracR = fraction of crop residue that is removed from the field as crop (kg N/kg crop-N); FracBURN = fraction of crop residue that is burned rather than left on field

The factor 2 converts edible crop production to total crop biomass production.

Table 3. Default values Table 4-17 IPCC 1996 Guidelines

TABLE 4-17
SUMMARY OF DEFAULT VALUES FOR PARAMETERS

$Frac_{BURN}$	=	0.25 in developing countries 0.10 or less in developed countries (kg N/kg crop-N)
$Frac_{FUEL}$	=	0.0 kg N/kg nitrogen excreted [a]
$Frac_{GASF}$	=	0.1 kg NH_3–N + NO_x–N/kg of synthetic fertiliser nitrogen applied
$Frac_{GASM}$	=	0.2 kg NH_3–N + NO_x–N/kg of nitrogen excreted by livestock
$Frac_{GRAZ}$	=	See Table A-1, Appendix A (Column Pasture Range and Paddock).[a]
$Frac_{LEACH}$	=	0.3 kg N/kg nitrogen of fertiliser or manure
$Frac_{NCRBF}$	=	0.03 kg N/kg of dry biomass
$Frac_{NCR0}$	=	0.015 kg N/kg of dry biomass
$Frac_{R}$	=	0.45 kg N/kg crop-N

[a] Countries are recommended to obtain country specific data.

The default values result in out of the total crop-N being produced during the season, a default of 45% in the harvested part, <=10% loss by agricultural waste burning, leaving 50-55% of the N originally present in plat tissue.

Crop residues only apply to dead biomass, rest of biomass of annual crops which is left to decay with the nitrogen mineralizing into ammonia and nitrate susceptible to take-up by next year's crop. The situation is different with living biomass in perennial crops or grassland, that biomass will remain biomass and is not considered residue (also as the N in plant material will not be released).

Different practice in individual countries may affect the real factor quite a bit. If straw is not used in a specific country and left on fields, and if it is burnt in another country; or if grazing is the dominant form of land use - all of that does make a difference.

Eurostat proposes to include these data at the input side of the balances. Countries are encouraged to improve this estimation reported to the UNFCCC by investing in country-specific data.

12) Crop production

Ideal: All crop products harvested are included.

Practical:

- Data source to be used are the crop production as reported to Eurostat with Crop production statistics.
- Grants in several MS to improve crop coefficients.
- Contract to verify crop coefficients and identify best practices and guidelines and default values for minor crops.

Data on the harvested production of main crops are available at NUTS0 and for some main crops at NUTS2 level (NUTS1 in DE/UK) from a harmonised European data source (the crop production statistics). Additional regional crop production data may however be available in the MS.

In many MS crop coefficients to transform data of production in nutrient contents are lacking or based on outdated research. Eurostat has set up grants for countries to improve the crop coefficients. Eurostat intends to have a contact on crop coefficients (covering the main crop, fodder, by-product removed from the soil and crop residues returned to the soil) to review the crop N and P coefficients used in countries, identify best practices and recommend guidelines, establish benchmark values based on fertiliser inputs and yields and default values, recommend appropriate frequency for updating coefficients. The contract could also involve comparisons with data used in other studies (e.g. MITERRA-EUROPE), and should take into account the data reported to the UNFCCC.

13) Fodder production

Ideal: All fodder harvested and grazed are included.

Practical:

- Data source to be used are the fodder production as reported to Eurostat with Crop production statistics.
- Grants in several MS to improve crop coefficients, see also point 12.
- Contract to verify crop coefficients and identify best practices and guidelines and default values for minor crops, see also pint 12.
- Scientific workshop on the estimation of grassland production in cooperation with EGF (3 june 2012).
- Eurostat TF establishing guidelines on the estimation of grassland production and which data need to be collected (2013).
- Grant program to aid implementation in MS (2013/2014).
- Data collection grassland production (2014).

Please see for a discussion on this item document CPSA/AEI103. This item will be discussed in more detail under point 2.1.4 on the agenda.

14) Crop by-products removed from the soil.

Ideal: All Crop by-products removed from the soil are included.

Practical: Removal of crop by-products of crops mentioned in Table 4 will be estimated based on country-specific data or if not available rates mentioned in Table 4 and default values for above ground crop residues N content (Nag) in Table 11.2 IPCC 2006 Guidelines.

By-products like straw and leaves are not counted in regular statistics. Estimation of harvested by-products is therefore necessary to determine the amount of nutrients in by-products which are removed from the field. Some of the by-products removed from the field can be reapplied (e.g. in compost, litter). Care must be given that these nutrients are not double-counted. For instance nutrients in straw which are used for bedding could also be included in the excretion coefficients. By-products returned to the soil can be estimated by including an extra item in sheet 1.4/2.4/3.4 to account for the by-products returned to soil or it can be taken into account in by-products removed from the field by correcting the amount or the coefficient. JRC proposes to include all ‘potential by-products’ in the output (harvest), and the part left on the field in the input. The coefficients for manure that includes a certain amount of straw should be adapted for this nitrogen content. Data on by-products removed from the field have been limited submitted in the current balances. Data on used by-products are requested from MS for the compilation of Economy Wide Material Flow Accounts, see text box below.

Economy Wide Material Flow Accounts. Compilation Guidelines for the EW-MFA 2011 Questionnaire

Step 1: Identification of crops which provide residues for further socio-economic use. In most cases this will include all types of cereals, sugar crops, and oil bearing crops. Only in exceptional cases other crops need to be considered.

Step 2: Estimation of available crop residues via harvest factors. The procedure to estimate the amount of crop residues available is based on assumptions on the relation between primary harvest and residues of specific crops. In agronomics, different measures for this relation are used: the most prominent is the harvest index, which denotes the share of primary crop harvest of total aboveground plant biomass, and the grain to straw ratio. This relation is typical for each cultivar, however, subject to breeding efforts and therefore variable over time. Based on this, one can calculate a harvest factor, which allows for the extrapolation of total residue biomass from primary crop harvest.

Available crop residues [t (as is weight)] = primary crop harvest [t (as is weight)] * harvest factor

Typical harvest factors, which can be used in absence of national information, are provided in Table 4.

Step 3: Estimation of fraction of used residues. In most cases, only a certain fraction of the totally available crop-residue will be harvested and further used. The actual used fraction of residues (recovery rate) can be estimated based on expert knowledge or specific studies, but it should be noted that it may vary considerably between regions, countries, and over time. In cases in which no information on the country specific share of used residues is available, recovery rates provided in Table 4 can be applied for European countries.

Used crop-residues [t (as is weight)] = available crop-residues [t (as is weight)] * recovery rate

Table 4. Standard values for harvest factors and recovery rates for the most common crop residues used in Europe

	Harvest factor	Recovery rate
Wheat	1	0.7
Barley	1.2	0.7
Oats	1.2	0.7
Rye	1.2	0.7
Maize	1.2	0.9
Rice	1.2	0.7
All other cereals	1.2	0.7
Rape seed	1.9	0.7
Soy bean	1.2	0.7
Sugar beet	0.7	0.9
Sugar cane	0.5	0.9

Source: Wirsenius 2000[5]

The proposed contact on crop coefficients should also apply to coefficients for crop by-products. The grants on crops countries can also be used to improve data on by-products and nutrient contents.

4 The Gross Phosphorus Balance

As agreed in the WG meeting on AEI in October 2010, the Gross Phosphorus Balance (GNB-P) needs to be expressed in P, to convert data expressed in P2O5 the factor 62/142 must be used. The compilation of the Gross Phosphorus Balance (GNB-P) is less complex than the GNB-N. Table 5 shows the differences between the current GNB-P and the ideal GNB-P. The ideal GNB-P includes all flows from and to agricultural soils and estimates the total GPS, following the land balance approach for the reference area[6].

The data collection of GNB-P in 2010 showed that there is a need to improve the data availability for some items. Resources in the countries are however limited. This means that we not only need to prioritise new data collection but also existing data collection (to make room for new data, not only for data needed for GNB but for policy needs in general). In the end we want to establish a clear Handbook; defining the methodology, terms and data sources. In this Handbook the ideal GNB-P will be described, but we propose to also include a practical implementation, which is a compromise between the ideal GNB-P and what we can achieve in reality with limited resources. This practical implementation of the ideal GNB-P is represented in the third column of Table 5.

[5] Wirsenius, S. (2000): Human Use of Land and Organic Materials. Modeling the Turnover of Biomass in the Global Food System. Doktorsavhandlingar vid Chalmers Tekniska Högskola 1574, 1-255.
[6] The reference area is discussed in a separate document: CPSA/AEI/102

Table 5. Current and proposed improved Gross Phosphorus Balance

Current GNB-P **Inputs**	Ideal GNB-P	Practical GNB-P
1) Mineral fertilisers 2) Manure production 3) Net manure import/export, withdrawals 4) Other organic fertilisers 6) Atmospheric P deposition 7) Seed and planting materials	1) Mineral fertilisers 2) Manure production 3) Net manure import/export, withdrawals 4) Other organic fertilisers 6) Atmospheric P deposition 7) Seed and planting materials 8) Crop residues (returned/left on the field)	1) Mineral fertilisers 2) Manure production 3) Net manure import/export, withdrawals 4) Other organic fertilisers 8) Crop residues (returned/left on the field)
*9) **Total inputs** =sum(1,2,3,4,6,7)* **Outputs**	*10) **Total inputs** =sum(1,2,3,4,6,7,8)*	*11) **Total inputs** =sum(1,2,3,4,8)*
12) Crop production 13) Fodder production 14) Crop by-products (removed from the field)	12) Crop production 13) Fodder production 14) Crop by-products (removed from the field)	12) Crop production 13) Fodder production 14) Crop by-products (removed from the field)
*15) **Total outputs** = sum(11, 12, 13)* **Surpluses**	*15) **Total outputs** = sum(11, 12, 13)*	*15) **Total outputs** = sum(11, 12, 13)*
*15) **GPS** = 9 - 15*	*16) **GPS**= 10 - 15*	*16) **GPS**= 11 - 15*

Below the items included in the ideal GNB-P and the proposed practical implementation of the GNB-P are described, where diverging from the discussions in Chapter 3.

2) Manure production

Ideal: All manure produced in the reference area.

Practical: Contract establishing guidelines for the estimation of P coefficients.

Please see for a discussion on this item document CPSA/AEI/104. This item will be discussed in more detail under point 2.1.5 on the agenda

6) Atmospheric P deposition

Ideal: Atmospheric P deposition deposited on the reference area.

Practical: No data are required.

Most countries do not have data available on P deposition. Available data (DE, FI, SE, UK, CZ, CH, NO) show that it is significant only in CZ (> 4.5% of total inputs). DireDate: the atmospheric P deposition is small and can be neglected in the P balance calculations.

8) Crop residues returned to the soil

Ideal: All crop residues returned to the soil are included.

Practical: Total crop residues left on the field as reported to UNFCCC multiplied with P coefficient.

Data on crop residuals returned to the soil should be available from the national inventories for GHG reporting, see also Chapter 3. The contract on crop coefficients should also look at NP coefficients for crop residuals returned to the field, taking into account IPCC Guidelines.

5 Reference period

The GNB are currently compiled for calendar years. The reference period is not specified, should the GNB reflect the year that the leaching may take place or the agricultural production that causes the leaching? The data used in the GNB are often calculated for different periods, e.g.:

- Fertiliser statistics are in some countries estimated per calendar year and in other countries for crop years[7].
- Crop statistics provide, for a given product, the area, the yield and the production harvested during the crop year at national level. The reference period is the harvest year: 2004 indicates that the data refer to production harvested during the 2004 calendar year.
- Livestock numbers are estimated at a certain date or represent the average amount of animals during the calendar year.
- Emissions are estimated for calendar years.

Some of these inconsistencies may have only a slight or non-significant impact on the balance outcome. It is an open question what the reference period of the GNB should be and how this impact the definition of the data requirements in terms of to which reference period they should refer.

6 Questions

[1] Do you agree to further develop and improve the methodology and data sources for the Eurostat/OECD GNB methodology, following the land balance approach? See Table 2 and 0.

[2] Do you agree to estimate the GNS, aGNS and hGNS as defined in Chapter 2?

[3] Do you agree with the proposed worksheet on emissions to be included in the current worksheets used to estimate the GNB, see Table 6?

[4] Do you agree with the description of the ideal GNB-N (see Chapter 3)? If not, on which items do you disagree and what is your counterproposal?

[5] Do you agree with the proposed practical implementation of the ideal GNB-N, as described in Chapter 3? If not, on which items do you disagree and what is your counterproposal?

[6] Do you agree with the description of the ideal GNB-P (see Chapter 4)? If not, on which items do you disagree and what is your counterproposal?

[7] Do you agree with the proposed practical implementation of the ideal GNB-P, as described in Chapter 4? If not, on which items do you disagree and what is your counterproposal?

[8] What should be the reference period of the balances? How to deal with the fact that data on different items may refer to different reference periods?

[7] A **crop year** is the duration from one years harvest to the next. Crop years will vary with each different commodity and harvest cycle.

Annex 1

The **Gross Nutrient Balances (GNB)** includes the Gross Nitrogen Balance and the Gross Phosphorus Balance.

The term **Gross Nitrogen Balance (GNB-N)** is commonly used by Eurostat and OECD indicating the whole system of accounting nitrogen flows and surpluses within and across well defined system boundaries; It can be presented by, for instance, a table, showing all the relevant N fluxes (N inputs, N outputs and N surpluses) within and across well defined system boundaries. If the proposals in this document are accepted the GNB-N follows the land balance approach. The items of the GNB-N are discussed in Chapter 3.

The **Gross Nitrogen Surplus (GNS)** estimated by the GNB-N is the difference between total N inputs and total N outputs from agricultural soils. It represents the total Nitrogen Surplus which is potentially susceptible to be emitted in the air (adding to air pollution, acidification and climate change), to the soil and to run-off/leaching into ground- and surface water (adding to water pollution and eutrophication); it therefore presents a holistic indication of the risk of N pollution by agriculture to the environment. It can be presented as a total or per hectare.

The **Atmospheric Gross Nitrogen Surplus (aGNS)** represents the part of the GNS which is lost to the air in the form of NH3, NOx, N2O and N2. These include N-gas emissions occurring immediately from animal housing, manure management and the application of manure and inorganic fertilisers to the soil and after N has entered the soil, from denitrification and nitrification processes. A list of the N-gas emissions included can be found in Chapter 2.

The **Hydrospheric Gross Nitrogen Surplus (hGNS)** is the part of the Gross Nitrogen Surplus at risk of leaching and run-off from soils; it is estimated as the residual from the GNS minus the aGNS.

The term **Gross Phosphorus Balance (GNB-P)** is commonly used by Eurostat and OECD indicating the whole system of accounting phosphorus flows and surpluses within and across well defined system boundaries; It can be presented by, for instance, a table, showing all the relevant P fluxes (P inputs, P outputs and P surpluses) within and across well defined system boundaries. Such a representation is for instance shown in 0.

The **Gross Phosphorus Surplus[8] (GPS)** estimated by the Gross Phosphorus Balance is the difference between total P inputs and total P outputs from agricultural soils. It represents the total Phosphorus Surplus which can be stored into the soil and which can be susceptible to run-off/leaching into ground- and surface water (adding to water pollution and eutrophication). It can be presented as a total or per hectare.

Manure export can be defined as all the nutrients of manure products (including treated/processed manure) which are exported to another country/region. The nutrient content of exported manure needs to be estimated taking into account the different nutrient contents of manure products and treated manure.

Manure import can be defined as all the nutrients of manure products (including treated/processed manure) which are imported to the country/region. The nutrient content of

[8] Please note that the in this document proposed adjustments to the current methodology have been taken into account in the definition of the Gross Phosphorus Surplus.

imported manure needs to be estimated taking into account the different nutrient contents of manure products and treated manure.

Manure processing/treatment can be defined as all the nutrients which are lost from agriculture during the processing/treatment of manure. Not all of the nutrients in manure which is being treated/processed are lost to agriculture, for instance the digester effluent, which contains all of the nitrogen, phosphorus, potassium, and micronutrients in the original manure can be further processed or land applied. The nutrients which are reapplied to agricultural soils either in the same country/region or which have been exported to another country/region after treatment/processing (is counted under export) should not be reported under this item. The coefficient for nutrient withdrawals due to manure processing or treatment should be corrected for the reapplication of processed and treated manure to agricultural land. It should only count the nutrients which have become lost to agriculture. It is not clear whether this is taken into account in the present figures MS have reported in the GNB collected in 2010. Not taking into account the reapplication of processed and treated manure to agricultural land can lead to biased results.

Other organic fertilisers are organic fertilisers not originating from livestock excretion, e.g. compost, sewage sludge, industrial waste.

Harvested crop-production is defined in Eurostat statistics as the following: ‘harvested production’ means production including on-holding losses and wastage, quantities consumed directly on the farm and marketed quantities, indicated in units of basic product weight. Only the main output of the cultivation is included under this definition. By-products and crop residuals are excluded under this definition. To illustrate the differences: of cereals, the cereals production (which is the main objective of the agricultural cultivation of cereals) is accounted under harvested crop production, whereas the harvested straw falls under the definition of by-products removed from the soil.

The **by-products removed from the soil** is the part of the crop which is not the main purpose of cultivating the plant, but which is removed with the harvest from the soil. By-products include: products used for animal feed (e.g. straw), as bedding material in animal housings, use for electricity or heat production, as raw material for the production of (second generation) biofuels or other industrial products.

The **crop residual** is the part of the plant which is not harvested and is left in or on the field.

Grassland production is defined by the production of grass as hay, silage, fresh grass fed in stable and grass grazed from permanent and temporary grasslands.

Annex 2

Table 6. Proposed worksheet for including N atmospheric emissions in GNB-N

Nitrogenous Emissions		**Tonnes of Nitrogen**		
EU Code	**Description**	**1985**	**…**	**2011**
TNEM	**Total N Emissions**			
TNEM_M	**Total N Emissions during Manure management**			
NH3_4B1a	NH3 Cattle dairy			
NH3_4B1b	NH3 Cattle non-dairy			
NH3_4B2	NH3 Buffalo			
NH3_4B3	NH3 Sheep			
NH3_4B4	NH3 Goats			
NH3_4B6	NH3 Horses			
NH3_4B7	NH3 Mules and asses			
NH3_4B8	NH3 Swine			
NH3_4B9a	NH3 Laying hens			
NH3_4B9b	NH3 Broilers			
NH3_4B9c	NH3 Turkeys			
NH3_4B9d	NH3 Other poultry			
NH3_4B13	NH3 Other			
NO2_4B1a	NO2 Cattle dairy			
NO2_4B1b	NO2 Cattle non-dairy			
NO2_4B2	NO2 Buffalo			
NO2_4B3	NO2 Sheep			
NO2_4B4	NO2 Goats			
NO2_4B6	NO2 Horses			
NO2_4B7	NO2 Mules and asses			
NO2_4B8	NO2 Swine			
NO2_4B9a	NO2 Laying hens			
NO2_4B9b	NO2 Broilers			
NO2_4B9c	NO2 Turkeys			
NO2_4B9d	NO2 Other poultry			
NO2_4B13	NO2 Other			
N2O_4s2B11	Direct N2O Manure management: Anaerobic Lagoons			
N2O_4s2B12	Direct N2O Manure management: Liquid systems			
N2O_4s2B13	Direct N2O Manure management: Solid storage and Dry Lot			
N2O_4s2B14	Direct N2O Manure management: Other AWMS			
TNEM_S	**Total N Emissions from Soils**			
NH3_4D1a	NH3 Synthetic N-fertilizers			
NH3_4D2a	NH3 Farm-level agricultural operations including storage, handling and transport of agricultural products			
NH3_4D2b	NH3 Off-farm storage, handling and transport of bulk agricultural products			
NH3_4D2c	NH3 N-excretion on pasture range and paddock unspecified			

NH3_4F	NH3 Field burning of agricultural wastes			
NH3_4G	NH3 Agriculture other			
NO2_4D1a	NO2 Synthetic N-fertilizers			
NO2_4D2a	NO2 Farm-level agricultural operations including storage, handling and transport of agricultural products			
NO2_4D2b	NO2 Off-farm storage, handling and transport of bulk agricultural products			
NO2_4D2c	NO2 N-excretion on pasture range and paddock unspecified			
NO2_4F	NO2 Field burning of agricultural wastes			
NO2_4G	NO2 Agriculture other			
N2O_4D1_1	Direct Soil Emissions Synthetic Fertilizers			
N2O_4D1_2	Direct Soil Emissions Animal Manure Applied to Soils			
N2O_4D1_3	Direct Soil Emissions N-fixing Crops			
N2O_4D1_4	Direct Soil Emissions Crop Residue			
N2O_4D1_5	Direct Soil Emissions Cultivation of Histosols			
N2O_4D1_6	Direct Soil Emissions Other direct emissions			

* Data on NO2 and NO emissions can be downloaded from national inventories to CLTRAP (http://www.ceip.at/submissions-under-clrtap/2011-submissions)

* Data on N2O can be downloaded from national inventories to UNFCCC (http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5888.php)