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Farm data needed for Agri-environmental reporting

Technical document summarizing the findings of the DireDate project for the Final Seminar in Luxembourg on 28 March 2011

Study financed by Eurostat, European Commission
and undertaken by a consortium led by ALTERRA (The Netherlands)

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http://circa.europa.eu/Public/irc/dsis/diredate/library?l=/diredate_documents&vm=detailed&sb=Title

Summary

The purpose of this document is to summarize the results of Tasks 1 to 7 of DireDate for the Final Seminar in Luxembourg on 28 March 2011. The general objective of DireDate is "*to create a framework for setting up a sustainable system for collecting a set of data from farmers and other sources that will serve primarily European and national statisticians for creating the agreed 28 agri-environmental indicators (AEIs) and thus serve policy makers, but as well agricultural and environmental researchers, observers of climate change and other environmental issues linked to agriculture*".

The analysis of EU policy reporting requirements for agri-environmental data indicates that a large amount of farm data and information are needed. The majority of the data and parameters required for agri-environmental policy are also required for calculation of AEIs. A number of key AEIs have data requirements in common with key policy reporting requirements. This points towards an opportunity to harmonise data collection and reporting for agri-environmental policies.

The analysis of the data requirements for calculating the AEIs has identified a total of 97 different types of data, of which 25 are related to area. Twenty types of data can be obtained from the Farm Structure Survey (FSS) and 12 from the Survey on Agricultural Production Methods (SAPM). The relatively high number of data available from SAPM indicates that the AEI data collection system could be improved considerably if SAPM were carried out at regular intervals rather than as a one-off survey. In addition to FSS and SAPM, 43 other different data sources have been identified. The results of the review are presented in uniform factsheets for each of the 28 AEIs.

The analysis of methodologies for the calculation of greenhouse gas and ammonia emissions and gross nitrogen and phosphorus balances has identified the farm data that need to be collected for emission accounting and emission abatement. These data can only be collected by sampling at the farm scale, and relate especially to animal feeding, animal housing, manure storage and manure application. Some of these data are being collected through the SAPM. The methodologies for calculating greenhouse gas and ammonia emissions are enshrined in international law and so not for discussion, unlike those for calculating gross nitrogen and phosphorus balances, which have not been standardised.

The characterization of the data collection – processing – reporting systems for agri-environmental data and information in EU Member States reveals the diversity and complexity of these systems. They are diverse because of differences between Member States in historical and cultural backgrounds. They are complex because agri-environmental interactions are complex, and characterizing these interactions adequately requires a large amount of good-quality data and information. Many institutions are involved in collection – processing – reporting. There is a need for increased coordination, harmonization and streamlining throughout the whole chain.

There are clear prospects for a common and harmonized data collection – processing – reporting chain. Detailed schemes and procedures for this chain have been developed for key farm data. Five groups of data have been distinguished for this purpose. The first and largest group relates to manure and fertiliser use and includes gross N (and P) balances (AEI

15), ammonia emission (AEI 18), emissions of the greenhouse gases N_2O and CH_4 (AEI 19), fertilizer N and P consumption (AEI 5), manure storage (11.3), soil cover (11.1), risk of pollution by phosphorus (AEI 16), irrigation AEI 7), tillage practice (AEI 11.2), soil quality (AEI 26), soil erosion (AEI 21), cropping pattern (AEI 10.1), livestock pattern (AEI 10.2), and nitrate pollution (AEI 27.1). Adopting these procedures would greatly harmonize and economize the data collection – processing – reporting chains.

Three proposals/scenarios for a common and harmonized data collection system have been developed. The proposals differ in 'distance' from the ideal data collection – processing – reporting system, and hence in burden (see also Chapters 6 and 7):

1. Proceed as indicated in Regulation 1166/2008 with FSS in 2010, 2013 and 2016, and SAPM in 2010/2011. Include data from existing and additional survey(s) related to fertilizers, pesticides, energy, animal feeding and manure management in intermediate years, preferably at farm level. From 2016, proceed with proposal 2.

2. Re-combine the FSS and SAPM supplemented with key questions in such a way that two new questionnaires result. One of these should address the operational and tactical farm management aspects and should be carried out once every ~3 years. The other should address the farm structural management aspects (e.g., buildings, machines, labour) and should be carried out once every ~5 years.

3. Combine FSS and SAPM with questions on animal feeding into a condensed new questionnaire to be carried out once every 3 years. In addition, derive key data related to farm inputs and management from the annual surveys of the annual Farm Accountancy Data Network (FADN) and sales data of market organization. Evidently, this proposal has the lowest farm data collection burden, but may face some loss of accuracy.

Finally, the 28 AEIs capture the main agri-environmental interactions. They are of extreme importance for the EU agri-environmental policy reporting, but the AEIs are not yet institutionalized in agri-environmental policy. This study indicates that there is much to gain from:

- harmonization and streamlining of the data requirements for policy reporting;
- the further prioritization of key AEIs;
- using key AEIs as source for EU agri-environmental policy reporting;
- setting up an institutional and organizational structure for embedding the estimation of AEIs in formal protocols and guidance documents; and
- adopting the proposal for common and harmonized data collection - processing – reporting chains.

The recommendations in this report address (i) the policy arena (European Commissions and the Departments of agriculture and the environment in Member States), (ii) DG Eurostat and the National Statistical Offices, and (iii) Research Institutes and Agencies in Member States.

1 Introduction

1.1 Objectives of this Document

The purpose of this document is to summarize the results of Tasks 1 to 7 of DireDate for the Final Seminar in Luxembourg on 28 March 2011.

The general objective of DireDate is "*to create a framework for setting up a sustainable system for collecting a set of data from farmers and other sources that will serve primarily European and national statisticians for creating the agreed 28 agri-environmental indicators and thus serve policy makers, but as well agricultural and environmental researchers, observers of climate change and other environmental issues linked to agriculture*".

The specific tasks of DireDate are to:
1. Analyse and describe the data requirements of the 28 AEIs;
2. Analyse and describe the EU policy reporting needs related to AEIs;
3. Analyse and describe the methodologies for calculating greenhouse gas and ammonia emissions and nutrient balances;
4. Provide recommendations for priority data collection;
5. Analyse the feasibility for a combined data collection and processing;
6. Characterise the data collection – processing - reporting systems in Member States;
7. Organise expert meetings on specific issues of interest to the project;
8. Summarise the main results, conclusions and recommendations in a report; and
9. Discuss the main findings at a workshop with Member States and other stakeholders (DG EUROSTAT, DG AGRI, DG ENV, EEA, etc).

1.2 Agriculture – Environment Interactions

Agriculture exerts various effects on the wider environment. For the production of food, feed and fibre, agriculture requires resources and emits substances, which both affect the wider environment.

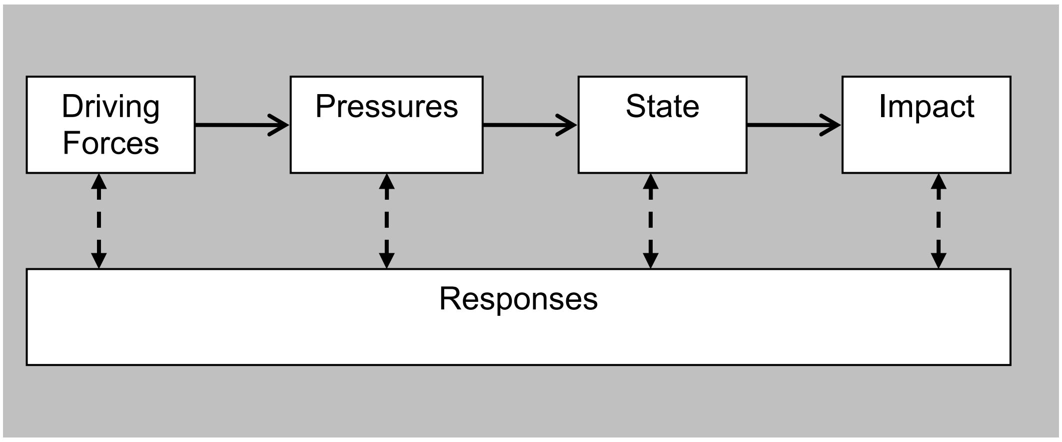
Traditional resources used by agriculture are land, labour and capital. In modern agriculture the range of resources is much wider and includes land, water, energy, genetic materials, machines, building, fertilizers, pesticides and medicines, labour and management. Through resource use, agriculture changes rural landscapes and contributes to resource depletion and degradation.

Agriculture emits various substances into the wider environment. These emissions may contribute to a series of ecological impacts, including human health effects, biodiversity loss, and climate change.

The impacts on the environment of resource use and emissions by agriculture are diverse and complex. The Driving Forces – Pressures – State – Impact – Responses (DPSIR)

Framework is instrumental in analyzing and understanding the agriculture-environment interactions (Figure 1.1). 'Driving forces' include changes in demography, technology, markets and governmental policy that contribute to changes in agriculture. 'Pressures' represent the (changes in) resource use by agriculture and its emissions to the environment. 'State' represents the changes in the concentrations and physical appearance of agriculture and the wider environment, while 'Impact' represents human health effects and ecological impacts'. 'Responses' include the responses by the society, including governmental policy, public pressure groups, consumers, etc.

Figure 1.1: Schematic representation of the 'Driving Forces – Pressures – State – Impact – Responses' Framework (after OECD, EEA).



1.3 The Environmental Policy Response

The success of the CAP has greatly contributed to modernization of agriculture in EU-27. The CAP has also contributed to the increasing effects of EU agriculture on the wider environment. In response, a series of reforms of the CAP have taken place in the 1990s, 2000, 2003, 2008 and 2013. These reforms have led to a 'greening' of the CAP.

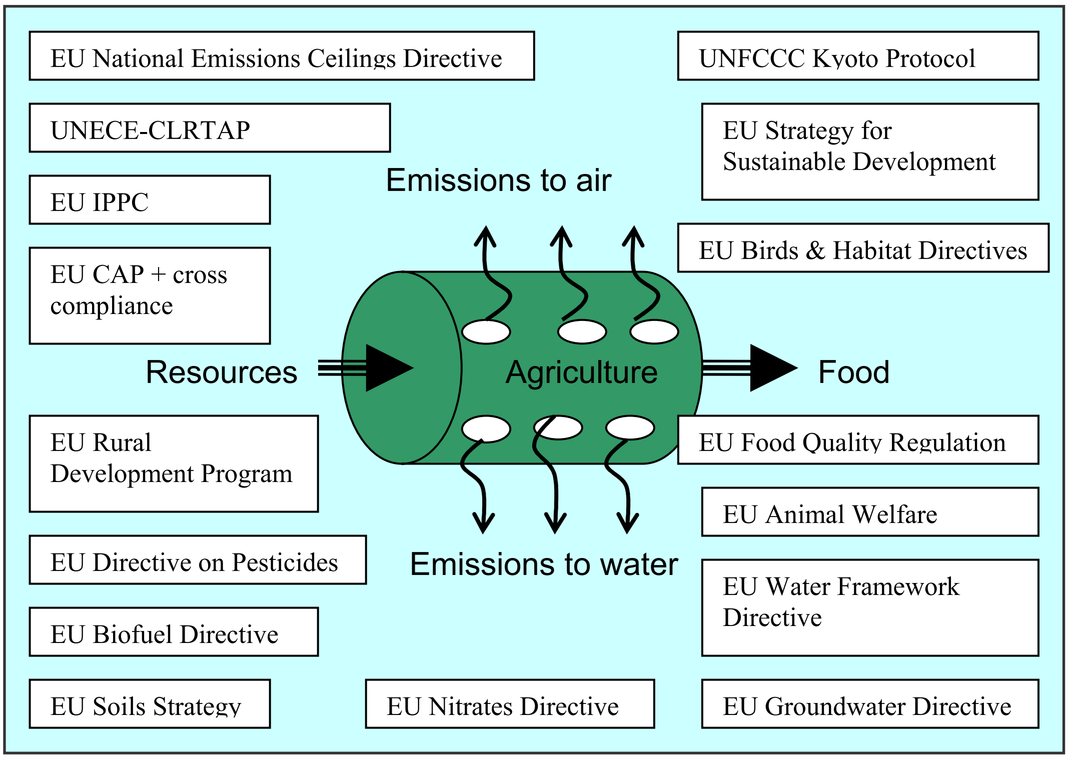
Moreover, a series of environmental policies have been adopted. These environmental policies have implemented (i) resource use constraints and limits, (ii) emissions and concentration limits, and (iii) best available techniques, methods and practices. Further, nature conservation policies have been implemented. These nature conservation policies also set constraints to nearby agriculture.

Currently, agriculture is influenced by a range of EU policy measures, which can be summarized in seven categories (Figure 1.2):

i. The Common Agricultural Policy (CAP), including Cross Compliance, Agri-Environmental and Rural Development regulations;
ii. Water Framework Directive, including the Nitrates Directive and Groundwater Directive;
iii. Air related Directives (National Emission Ceiling, Air Quality, and Integrated Pollution and Prevention Control),
iv. Climate change policies (related to the UNFCCC Kyoto Protocol);
v. Nature conservation legislation, the Birds and Habitats Directives;
vi. Soil related policies, including the Soil Thematic Strategy, Sewage Sludge Directive;
vii. Food safety, plant protection, animal health and animal welfare regulations

Member States have to report on the progress of the implementation of the agri-environmental policies on a regular basis (once in 1 to 6 years). For these reports detailed information is needed about the (changes) in resource use, emissions and production methods in agriculture (Pressure, State and Impacts in Figure 1.1).

Figure 1.2: Agriculture symbolized as 'a hole-in-the-pipe-model', with resources as inputs and food and emissions as traditional outputs.



The boxes in the figure represent the EU environmental policy measures that set constraints on agricultural production, its resource use and emissions.

1.4 Agri-environmental indicators

Agri-environmental indicators are important in the assessment of trends over time of (i) the effects of agriculture on the environment, and (ii) the effectiveness and efficiency of agricultural and environmental policy measures. An indicator can be defined as "*a parameter or a value derived from parameters, which points to, provides information about, describes the state of a phenomenon/environment/area, with a significance extending beyond that directly associated with a parameter value*" (OECD, 1994).

Eurostat coordinates the work within the European Commission and with the EEA on the 28 Agri-environmental indicators (AEIs) that were identified in the Commission Communication COM(2006) 508 and subsequently approved by the Agricultural Council. The 28 AEIs are listed in Table 1.1. The AEIs are increasingly seen as means to report on the agri-environmental interaction and on the implementation of agri-environmental policies. When well defined and approved, the reporting on agri-environmental interaction and the implementation of agri-environmental policies through AEIs can be done in a uniform way, which facilitates comparison between regions and over time. Evidently, AEIs need good quality data and information at the appropriate spatial and temporal scales and at the appropriate level of detail, to be able to convey meaningful information to policy makers, public and the research community. This work is closely correlated with the developments in the same domain in the OECD.

Table 1.1: The 28 Agri-environmental indicators (AEIs) identified in the Commission Communication COM(2006) 508[1]

No	Indicator title (AEI)	No	Indicator title (AEI)
1	Agri-environmental commitments	14	Risk of land abandonment
2	Agricultural areas under Natura 2000	15	Gross nitrogen balance
3	Farmers' training levels	16	Risk of pollution by phosphorus
4	Area under organic farming	17	Pesticide risk
5	Mineral fertiliser consumption	18	Ammonia emissions
6	Consumption of pesticides	19	Greenhouse gas emissions
7	Irrigation	20	Water abstraction
8	Energy use	21	Soil erosion
9	Land use change	22	Genetic diversity
10.1	Cropping patterns	23	High nature value farmland
10.2	Livestock patterns	24	Production of renewable energy
11.1	Soil cover	25	Population trends of farmland birds
11.2	Tillage practices	26	Soil quality
11.3	Manure storage	27.1	Water quality - Nitrate pollution
12	Intensification/ extensification	27.2	Water quality - Pesticide pollution
13	Specialisation	28	Landscape - State and diversity

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0508:FIN:EN:PDF

2 Policy reporting needs related to agri-environmental data

2.1 Introduction

From the end of the 1980s, an increasing number of agri-environmental policy measures have been implemented in the EU (Chapter 1.3; Figure 1.2). These agri-environmental Strategies, Directives and Regulations often address specific agri-environmental aspects, i.e. specific components of the biosphere (air, surface waters, groundwater, natural environments), specific substances (greenhouse gas emissions, ammonia, nitrate, pesticides) and specific themes (biodiversity, rural development, renewable energy, etc.). The agri-environmental policies often have their own implementation, evaluation and reporting procedures. Member States are obliged to comply with all Strategies, Directives and Regulations, and have to report on the progress made with the implementation of these policy measures on a regular basis.

The purpose of this Chapter is to briefly summarize the reporting needs of a selection of EU policies with respect to agri-environmental data and information, especially data that are also required for the Agri-Environment Indicators (AEIs). Hence, this overview may provide information that will help to harmonise these data collection – processing – reporting strategies, identify overlaps, useful synergies and any potential conflicts in AEI and related data collection. The full analysis of the data and reporting needs of these policies can be found in the Task 2 Report of DireDate (Wilson et al., 2011).

2.2 Greenhouse gas emissions accounting (UNFCCC)

The United Nations Framework Convention on Climate Change (UNFCCC) is an international treaty to which most of the countries of the world signed up in 1992. An addition to the treaty, the Kyoto Protocol, entered into force in 2005 and commits member Parties to stabilise their greenhouse gas concentrations by setting targets for decreases in emissions from 1990 levels by 2012. Parties are required to submit an annual inventory detailing all their national GHG emissions by gas and source sector. For agriculture, this relates to methane (CH4) and nitrous oxide (N2O) from various sources (fertilizers, manure management, ruminants, paddy rice production, crop residues, etc.). The data needs for calculating GHG emissions from the agriculture sector of UNFCCC are presented below.

2.2.1 Activity data

- Annual data on livestock populations per region are necessary for the calculation of emissions from enteric fermentation, manure management and agricultural soils. If a tier 1 approach is taken, subdivision should be by broad livestock category. For tier 2, subdivision by representative types for key livestock categories is required.
- Milk production per head per year for dairy cattle is required for calculation of CH4 emissions from enteric fermentation.

- Manure management data (% of each type) are required annually for the calculation of emissions from manure management.
- Calculation of emissions from rice cultivation requires annual activity data on the total area of irrigated land for rice production.
- Calculation of emissions from soils requires annual activity data on the total nitrogen input to soils by synthetic fertilisers (Kg N/yr). Tier 2 methods require these data by climate zone and soil type. Also requires annual activity data on dry pulses and soybeans produced and dry production of other crops (Kg/yr). Areas of organic soils (peat soils or Histosols, ha) are also required for calculation of emissions from soils.
- Calculation of emissions from soils, crop residue burning and rice cultivation require activity data on crop production, including crop areas; ratios of residue to crop production; and fraction of residue burned.
- For detailed emission accounting (Tiers 2 and 3) further information is required about animal feeding, animal grazing activity, manure storage and application techniques (see also Chapter 3).

2.2.2 Coefficients

- Emission factors for CH4 from enteric fermentation are required by livestock category. The source and level of detail depends upon the tier level used.
- Nitrogen excretion per head by livestock category is required for estimating N2O emissions from manure management. Emission factors for CH4 and N2O from manure management by livestock category and manure management system are also required.
- Emission factors for CH4 emissions from rice fields for the various categories of water regimes are required to estimate emissions from rice production.
- Emission factors required for the calculation of direct emissions from soils are; (i) N2O emitted from various N applications to soils; (ii) N2O emitted from area of histosols; (iii) N2O emitted from N deposited by grazing animals. For indirect emissions, factors associated with volatilised and re-deposited N and N loss through leaching/run-off are also necessary.
- For crop residue burning emission calculations, the dry matter C and N content of the residue are needed.

2.3 Carbon dioxide emissions from LULUCF

The Land-use, Land-use Change and Forestry (LULUCF) sector of the UNFCCC reports on activities that result in GHG emissions and removals from land (i.e., CO2). LULUCF activities can be used to offset emissions by removing GHGs from the atmosphere through afforestation, revegetation and reforestation. LULUCF should not be considered as separate from the UNFCCC as it is part of the same policy, however it is reviewed separately due to methodological differences and the significance of the sector. The data needs for estimating GHG emissions and removals from the LULUCF sector are presented below.

2.3.1 Required data

The area of each of the broad land use categories (including cropland and grassland) and the area of land use change from one category to another are required annually for the calculation of CO2 emissions/ removals from land. These activity data should be subdivided into climate regions and soil types at a minimum.

Coefficients are required to estimate the rates of carbon accumulation and loss for each land use category. Carbon stock changes following land use change are estimated using coefficients. Emission factors are also required for liming.

2.4 Rural Development Programme

The Rural Development Programme (RPD) 2007-2013 provides a menu of measures from which Member States can choose, and for which they receive Community financial support. These measures focus on three core policy objectives corresponding to axes: (Axis 1) improving the competitiveness of agriculture and forestry, (Axis 2) supporting land management and improving the environment, and (Axis 3) improving the quality of life and encouraging diversification of economic activities. Different types of indicators, as defined in the Common Monitoring and Evaluation Framework (CMEF), are used to monitor progress against targets at regular intervals and to assess the impact of the programme overall. The data needs related to agri-environment are presented below.

2.4.1 Required indicators and data

Baseline indicators are required nationally at the start of the programming period, and should also be monitored and updated throughout the course of the programme. Baseline indicators in the RDP 2007-13 relating to farmer experience and agri-environment are:

- Age structure of farmers
- The share of farmers with practical experience only, basic or full agricultural training
- Land cover (agriculture, forest, natural, artificial)
- UAA in LFA areas
- Areas of extensive agriculture
- Natura 2000 area (total and UAA/ forest under N2K)
- Populations of farmland birds
- High Nature Value farmland areas
- Tree species composition of forested areas
- Protected forest area
- Development of forest area (average annual increase)
- Forest ecosystem health (defoliation classes)
- NVZ areas
- Gross nutrient balances
- Pollution by nitrates and pesticides (annual trends in concentrations)
- Water use (percentage of UAA irrigated)
- Protective forests concerning primarily soil and water
- Areas at risk of soil erosion
- UAA under organic farming
- Production of renewable energy from agriculture & forestry
- UAA devoted to biomass crops
- GHG emissions from agriculture

Output indicators are used to measure activities directly realised within programmes, and are calculated quarterly from scheme monitoring data by measure (see Wilson et al., 2011 for a list of required data for output indicators for each of the Axis 2 measures).

Result indicators are used to measure the direct and immediate effects of the intervention and are required to be reported annually to the EC. The common result indicators identified by CMEF for Axis 2 are the area under successful land management contributing to:

- Bio diversity and high nature value farming/forestry
- Water quality
- Mitigating climate change
- Soil quality
- Avoidance of marginalisation and land abandonment

Impact indicators are used to measure the benefits of the programme beyond the immediate effects on its direct beneficiaries, both at the level of the intervention and more generally in the programme area. They are normally expressed in "net" terms, which means subtracting effects that cannot be attributed to the intervention (e.g. double counting, deadweight), and taking into account indirect effects (displacement and multipliers). Impact indicators are required to be calculated at mid-term and ex-post evaluation. Those relating to Axis 2 are;

- Change in trend of biodiversity decline as measured by farmland bird species population
- Changes in high nature value areas
- Changes in gross nutrient balance
- Increase in production of renewable energy

2.5 Water Framework Directive

The EU Water Framework Directive was adopted in 2000. The main aims of the Directive are to (i) increase the scope of the previously fragmented water policy to cover all surface waters and groundwater in the EU; (ii) achieve 'good status' for all waters by a set deadline; (iii) base water management on river basins and (iv) use a 'combined approach' of emission limit values and quality standards. A 'river basin management plan' is required to be established and updated every six years, setting out the measurable objectives and how these are to be achieved. The data needs of the WFD are presented below.

2.5.1 Data requirements

Characterisation requires surface water bodies to be categorised by type, ecoregion, altitude, catchment area and geology, and maps of the geographical locations of the water body types submitted to the EC. Locations and boundaries of groundwaters should be defined and characterised by type of strata and pressures.

Pressures and impacts assessment require data for each water body: significant point source pollution; significant diffuse source pollution; significant water abstractions; significant water flow regulation; significant morphological alterations; and land use patterns. Further data required for water bodies that are considered at risk include locations of abstraction and discharge points; rates of abstraction and discharge; chemical composition of discharges; land-use in the catchment.

Special protection is required for designated water bodies. These include (i) those used for abstraction of drinking water; (ii) those designated for the protection of economically significant aquatic species; (iii) those designated as recreational waters; (iv) nutrient sensitive areas; (v) areas designated for the protection of habitats or species sensitive to water quality.

Monitoring networks (surveillance and operational) should be set up following pressures and impacts assessment with the purpose of classifying the ecological status of each water body. For surface waters, this should cover biological quality elements (e.g. phytoplankton); hydromorphological quality elements (e.g. hydrological regime); chemical quality elements (e.g. nutrient conditions) and physico-chemical quality elements (e.g. transparency). Pollution levels should also be monitored. Under surveillance monitoring, all quality elements and pollutants should be monitored for at least one year during the six-year River Basin Management Plan. Monitoring frequency for operational monitoring is chosen by the Member State. For groundwaters, monitoring should cover the chemical and quantitative status. This is measured by concentrations of pollutants, conductivity measurements and groundwater level. Surveillance monitoring should be carried out once every six years as a minimum; and operational monitoring at least once a year.

2.6 Nitrates Directive

The Nitrates Directive was adopted in 1991 to protect waters against agriculturally derived nitrogen pollution. Member States are required to (i) establish monitoring networks in order to identify polluted or threatened waters; (ii) establish a voluntary code of good agricultural practice; (iii) allocate all land that drains into polluted waters as nitrate vulnerable zones (NVZ); (iv) establish mandatory action programmes within NVZ and (v) review the action programmes and NVZ boundaries every four years. The data needs are presented below.

2.6.1 Data requirements

Maps must be provided for identified polluted waters and the locations of the designated vulnerable zones, taking into account guidelines for the presentation of the spatial data.

Monitoring programmes must be created and implemented at least every four years to measure nitrate concentrations at ground and surface water sites. Information on the trophic status of surface waters should also be gathered.

Records of fertiliser and manure applications are required to keep within the restrictions. Member States are also required to explain the physical and environmental characteristics of the waters and land, their understanding of the behaviour of nitrogen compounds in both water and soils, and of the impact of actions taken. The Directive does not set out specific details of data requirements but information on livestock numbers, soil crop cover in winter, land use and land management, soil characteristics and fertiliser consumption are all relevant.

Impact assessment of the action programme measures requires Member States to provide information on the following elements;

- Total number of farmers, and farmers with livestock
- Total land (km2)

- Agricultural land (km2)
- Agricultural land available for application of manure (km2)
- Permanent pasture
- Permanent crops
- Annual contribution of mineral and organic forms of N (Kg N/ha)
- Annual use of mineral and organic N (kilotonnes)
- Nitrogen discharge into the environment from agriculture, urban wastewater and industry.

2.7 National Emissions Ceiling Directive

The aim of the National Emissions Ceiling Directive (NECD) is to limit emissions of acidifying and eutrophying pollutants and ozone precursors. Under the original Directive (2001/81/EC), national emission ceilings for ammonia (NH3), sulphur dioxide (SO2), oxides of nitrogen (NOX) and volatile organic compounds (VOCs), were established for each member state, to be met by 2010. Proposals for the revision of the NECD, anticipated in 2009, as part of the Thematic Strategy on Air Pollution, are still in preparation. The data needs for calculating emissions of these gases from the agriculture sector for the National Emissions Ceiling Directive (NECD) are presented below.

2.7.1 Activity data

- Estimation of emissions arising from fertilizers and animal manures applied to agricultural land require annual activity data on the consumption of major N-fertilizer types for arable and grassland; the amounts of crop residue returned to the soil by crop type; grazing livestock numbers by type and the area of organic soils (histosols) under cultivation.
- For non-fertilized agricultural land, activity data include the area of legumes cultivated by crop type; the area of unfertilized grassland grazed by livestock; and atmospheric deposition to soils.
- For estimation of emissions from field burning of agricultural vegetation wastes, activity data on the amount (dry weight) of waste or crop residue combusted are required.
- For estimation of emissions from manure management regarding organic and nitrogen compounds, required activity data include animal numbers in relevant sub-categories; animal performance and feed; and the frequency distribution of the respective manure management systems.

2.7.2 Coefficients

- N concentrations of crop residues returned to the soil by crop type.
- N deposited in excreta by animals whilst grazing by livestock type.
- Dry weight of burned residue by crop type.
- Excretion rate of volatile solids as a function of animal performance and feed.

2.8 Framework Directive on the Sustainable Use of Pesticides

The Framework Directive on the Sustainable Use of Pesticides (FDSUP) (2009/128/EC) was published in November 2009 and contains requirements on training provision of pesticide advisors and spray operators, and the testing of spray equipment. The Commission proposed a regulation concerning statistics on plant protection products and this was adopted as new Regulation (EC) No 1185/2009 of the European Parliament and of the Council concerning statistics on pesticides which was published on 10 December 2009 and contains details of the requirements for pesticide statistic provision by all Member States. The data needs for reporting about the progress of the implementation of the Framework Directive on the Sustainable Use of Pesticides (FDSUP) is presented below.

2.8.1 Data requirements

Sales data: The statistics regulation requires that the nationally sold annual weight (kg) of all active substances identified in Annex III of the regulation be collected under certain major groups and categories of products including fungicides and bactericides; herbicides, haulm destructors and moss killers; insecticides and acaricides; molluscicides; plant growth regulators; other plant protection products.

Usage data requirements are for representative crops (selected by Member State) within a one-year reference period within a 5-year reporting. Key pieces of data required are the quantity (kg) of each substance used on each crop, and the area (ha) treated with each substance.
Member States are required to adopt harmonized risk indicators for pesticides, although these are still under development. Usage data required includes pesticide consumption; pesticide characteristics; soil characteristics; application rates; application timings; mitigation measures.

2.9 Birds and Habitats Directives

The **Birds Directive** (BD) was adopted by all EU Member States in 1979, with the aim of providing international cooperation for the protection of birds in Europe. The Directive sets a number of objectives, with the legislation and implementation determined by each individual territory. Endangered and migratory wild birds are listed on Annex I of the Directive and are protected by a network of Special Protection Areas (SPAs). The **Habitats Directive** (HD) was adopted in 1992 to protect natural habitats and wild species. The 216 habitats listed in Annex I and 1,182 species listed in Annexes II, IV and V of the Directive are protected by a number of Special Areas of Conservation (SACs).

The areas designated as SPAs and SACs are collectively known as Natura 2000 sites. The objective of Natura 2000 is to create and maintain networks of protected areas in all the Member States of the EU. Data required for **designating Natura 2000 sites** include the following;

- Site identification data
- Location data including coordinates, area, altitude, and biogeographical region
- Habitat and species present on the site including details of cover/ population.

- An assessment for each habitat and species
- Description of site characteristics
- Protection status and relationship with Corine biotype sites
- Impacts and management measures present at site

2.9.1 Data required by Birds Directive

Data required to be entered in a questionnaire once every three years include;
- List of species from each Annexe of the Directive present in the MS territory, with numbers if possible
- Measures taken to protect the habitats and bird species within SPAs

2.9.2 Data required by Habitats Directive

Data required to be submitted in reports at national and biogeographical region level every six years include the following;
- Number of SACs and their total surface area
- Maps outlining the distribution of each habitat and species in the Annexes that are present in the MS territory at 10 x 10 km resolution ideally.
- Surface area of the range within each biogeographical region for habitats
- Quality of data concerning range
- Range trend and reasons for trend
- Population estimate within each biogeographical region for species
- Quality of data concerning population estimate
- Population trend and reasons for trend
- Main pressures and threats impacting on the habitat/ species
- Assessment of conservation status for each habitat/ species

2.10 Strategy for Sustainable Development

The Renewed EU Strategy for Sustainable Development (EU SDS) was adopted in 2006, with the aim of developing sustainable communities for the efficient use of resources in future generations. One of the core objectives of the EU SDS is to measure the progress made by EU Member States towards sustainable development. This is done by Eurostat, who monitor and report on progress every two years based on a set of Sustainable Development Indicators (SDIs). The data collection requirements for a selection of SDIs that are related to agri-environment are presented below.

- Final energy consumption by sector – calculated as the sum of energy supplied to final users from all sources, including agriculture.
- Area under agri-environmental commitment – calculated from the percentage of the UAA that is enrolled in agri-environmental measures.
- Area under organic faming – calculated as the share of the UAA that has adopted organic farming practices.
- Livestock density index – calculated as the number of livestock units per hectare of UAA.
- Greenhouse gas emissions by sector, including the agricultural sector.

- Share of renewables in gross inland energy consumption, which is the ratio between the energy produced from renewable energy (split by source, including biomass and waste) and the gross inland energy consumption for a given calendar year.
- Common bird index, which provides information on the abundance and diversity of a selection of 135 common European bird species, including a subset of 36 farmland birds.
- Sufficiency of sites designated under the EU Habitats Directive, which measures the extent to which Sites of Community Importance (SCIs) proposed by Member States for designation, cover the terrestrial species and habitats listed in Annexes.
- Surface and groundwater abstraction as a share of available resources. Annual total water abstraction is calculated as a percentage of the total resources available for abstraction over a long-term period.
- Biochemical oxygen demand – defined as the mean annual amount of oxygen required to decompose organic matter over a five day period and in the dark.
- Built-up areas – measured by the change in land cover from natural and semi-natural to built-up land.
- Percentage of total land area at risk of soil erosion – currently under development.

2.11 Conclusions

A large amount of data are required to be collected for the reviewed policies, and through comparison with data requirements of the AEIs, it can be ascertained that the majority of parameters required for calculation of AEIs are also required, at least in part, for agri-environmental policy. There are a number of AEIs for which data requirements have the most in common with policy data requirements and that have parameters represented across multiple policies.

The data requirements of policy that have similarities to data requirements of the AEIs can be summarised by category of AEI data (see Velthof et al., 2011) as follows (see also Annex 2; Wilson et al., 2011):

The inputs category includes consumption of fertilisers and pesticides; water abstraction; and energy use. Most of the input parameters that are needed for policy are represented under the policies that require the calculation of pollution levels from agriculture – namely UNFCCC; WFD; Nitrates Directive; National Emissions Ceiling Directive; and Framework Directive on the Sustainable Use of Pesticides. This group of parameters is also represented under RDP and EU-SDS, however these data are usually collected from other existing sources.

Parameters on land use, nature and climate are well represented under RDP; LULUCF; Birds & Habitat Directives; and EU-SDS. Crop area by crop type and climate feature across a number of policies.

The crop production parameters that are needed for policy are represented under the policies that require calculation of pollution or emissions from crop production: UNFCCC and National Emissions Ceiling Directive. The renewable energy production parameter also features under RDP and EU-SDS.

Similarly, livestock parameters are required under policies that calculate pollutants from livestock: UNFCCC; Nitrates Directive and NECD.

The type of manure storage is data commonly collected for policy purposes, specifically UNFCCC; Nitrates Directive and NECD. A soil tillage parameter is also required for the latter two.

Soil data is fairly sparsely collected for policy, the most significant being under the Nitrates Directive. Soil parameters are well represented under EU-SDS, but do not necessarily exactly match the AEI parameters. Water quality is the ultimate reporting requirement of WFD and Nitrates Directive. These data are collected from other sources for RDP and SDI as indicators.

It is clear that there are a large number of parameters that are required by more than one policy, outweighing those that are required by one policy only or not at all. This balance encouragingly points towards an opportunity to harmonise data collection and identifies synergies between policies across the EU (Wilson et al., 2011).

3 Data requirements of the 28 Agri-Environmental Indicators

3.1 Introduction

Agri-environmental indicators are meant to capture the most important agri-environmental interactions (e.g. Chapter 1.4). The European Commission has identified 28 Agri-environmental indicators (AEIs) in 2006 (COM (2006) 508).
Following suggestions of Eurostat, a distinction was made between two sets of AEIs (Table 3.1), based on the fact that the data needed for the establishment of the first set of AEIs certainly need to be derived primarily from the farm, but a stable source has not yet been identified. In contrast, in the second set AEIs are either not yet mature, or the data required are likely to be derived from sources other than at farm level, or stable data sources have already been identified.

Table 3.1: List of the 28 AEIs, divided in a first and second set

First set of AEIs	DPSIR	Second set of AEIs	DPSIR
AEI 5 Mineral fertiliser consumption	D	AEI 1 Agri-env commitment	R
AEI 6 Consumption of pesticides	D	AEI 2 Agricultural areas under Natura 2000	R
AEI 7 Irrigation	D	AEI 3 Farmers' training level …..	R
AEI 8 Energy use	D	AEI 4 Area under organic farming	R
AEI 11.1 Soil cover	D	AEI 9 Land use change	D
AEI 11.2 Tillage practices	D	AEI 10.1 Cropping patterns	D
AEI 11.3 Manure storage	D	AEI 10.2 Livestock patterns	D
AEI 12 Intensification/extensification	D	AEI 13 Specialisation	D
AEI 15 Gross nitrogen balance	P	AEI 14 Risk of land abandonment	D
AEI 16 Risk of pollution by phosphorus	P	AEI 17 Pesticide risk	P
AEI 18 Ammonia emissions	P	AEI 20 Water abstraction	P
AEI 19 Greenhouse gas emissions	P	AEI 21 Soil erosion	P
AEI 26 Soil quality	S	AEI 22 Genetic diversity	P
		AEI 23 High Nature Value farmland	P
		AEI 24 Renewable energy	P
		AEI 25 Farmland birds	S
		AEI 27.1 Water quality – Nitrate	S
		AEI 27.2 Water quality – Pesticide	S
		AEI 28 Landscape - State and diversity	S

Capital letters in the last columns indicate the relationships with the DPSIR framework (Figure 1.1).

The general objectives of task 1 of the DireDate project are (i) to further define and describe the AEIs and their data requirements; (ii) to identify the relationships between AEIs and (iii) to identify the relationships between the data requirements of AEIs and the data requirements for agri-environmental policies.

The purpose of this Chapter is to briefly summarize the results of Task 1. The complete descriptions (factsheets) of the AEIs, summary tables of the data requirements and their links to agri-environmental policies can be found in the Task 1 Report of DireDate (Vinther et al., 2011).

3.2 Results and statements relating to data requirements

Annex 1 provides a summary of the ideal data requirements of each of the AEIs. This means that it is not a final list of future data to be made available, merely a long-term vision. In total 97 different types of data have been identified, of which 25 are related to area, 27 to amounts, content or numbers, and 45 are miscellaneous. Twenty of the pieces of data can be obtained from the Farm Structure Survey (FSS) and 12 from the Survey on Agricultural Production Methods (SAPM). The relatively high number of data available from SAPM indicates that the AEI data collection system could be improved considerably if SAPM were carried out at regular intervals rather than as a one-off survey. Generally, the type of data required for most AEIs are related to area, i.e. utilised agricultural area (UAA), and to fertiliser application and number of animals.

3.3 Results and statements relating to Policy needs

In total, 18 different policies or programmes were identified that require similar data for reporting or have direct influence on the AEIs. For these policies or programmes the AEIs could potentially be used to monitor the effectiveness of the agri-environmental policies, and/ or provide a harmonised approach to data collection for policy requirements. The analysis showed that the highest numbers of AEIs are needed for the Rural Development Programme, followed by the Nitrates Directive, the Water Framework Directive, and the United Nations Framework Convention on Climate Change. Further, these four policies are in one way or another linked to an additional number of AEIs.

3.4 Results and statements relating to links between AEIs

The analyses show that the first set of AEIs have many linkages with other AEIs; generally more than the second set of AEIs. In total 19 AEIs require similar data about areas, 7 AEIs require similar data about fertilized areas, 7 about number of animals, 5 about amounts of fertilizer N applied per crop, and 4 about manure storages and about nitrogen and phosphorus contents in manure. In general, the data requirements of 'state' AEIs are linked to the highest number of other AEIs, which is intuitive since several of these other indicators serve as input to the 'state' AEIs.

3.5 Results and statements relating to data sources

In total, 45 different data sources were identified, with FSS and SAPM identified as the key existing data sources. The Farm Accountancy Data Network (FADN) also seems to be a potentially important data source. However, the data source needs to be consistent and sustainable, and the applicability of a dataset must be considered carefully. For example, FADN should preferably be avoided as a data source because it is entirely based on economics (FADN includes only commercial farms, i.e. around 40-50 % of FSS farms) and is therefore less representative of the farming population.

It is also important to consider future developments. The farm structure survey (FSS), which is run every 3 years, provides a high proportion of the required data. The survey requires rethinking however, as at present the system doesn't provide the required flexibility and is already too big to add new data requests.
The survey on agricultural production methods (SAPM), running in 2010-2011, provides a high proportion of the required data, however SAPM is a one-off survey and there are no current plans for it to continue. The DireDate project has identified SAPM as a potentially useful source of information for a number of AEIs, and it is recommended that SAPM be continued (in a concise form) and carried out at regular intervals – every 2-3 years.

Actions of farmers are often linked to subsidies. For both SAPM and FSS it will be a huge step forward to include information/questions related to subsidised activities on the farm in order to evaluate the reasons for possible trends in the AEI. The activity data is also the most politically sensitive information.

3.6 Conclusions and recommendations

- The set of AEIs require many different types of data, including activity data, coefficients and other information, but there is much potential for harmonization in the collection of these data to avoid duplication of effort.
- Existing sources of data are able to provide suitable information for a number of the AEIs, however coordinated and well designed farm-level surveys are required on a regular basis (annually for many indicators) to provide the necessary data.
- The ideal data requirements are included as being a common goal for data collection. They are not intended to discourage Member States by showing the burden in acquiring these data; such an ideal data collection remains practical and achievable in the medium to long-term.
- An important consideration when designing farm-level data collection systems is that samples are representative of the farming population at the level for reporting, and that data that are collected together (i.e. on the same farm) should be kept together to help understand interactions. It is for this reason that many of the ideal recommendations include disaggregation by farm type to help characterize farms and their resultant environmental impacts.
- Ideal spatial scales for reporting have been proposed that are specific to individual AEIs, but are kept realistic, often at NUTS 2 level. A territorial approach rather than a national approach is essential to capture the diversity in farming systems and the environment. The frequency of data collection is recommended based on the rate of change of the indicator, but also to enable the detection of trend and to satisfy policy requirements without overwhelming the data provider.
- The set of AEIs have much in common with policy requirements, and even those that are not required directly for policy are useful for monitoring the outcomes of policy implementation. It is therefore expected that use of the AEIs will provide much needed

coordination for data collection at an EU level to meet the needs of the key agri-environmental policies.

- Due to the fact that most farms in the EU are now specialized, and specialization alone does not indicate the level of environmental pressure, it is recommended that the 'Specialization' indicator is removed from the list or redefined.
- AEIs are not only in place to serve policy needs, as policies are continually evolving. They should also be used to guide policy implementation, for example, 'Soil cover' and 'Tillage practices' do not currently have any policy reporting obligations, however they may be useful to inform future policy developments.
- Additional indicators are also proposed. These include an indicator for desertification, which is a particular issue in southern European countries. There is also a need for more 'efficiency indicators' – that is relating to the efficiency of production of food. For example, supplementary indicators on the area of land; volume of water; amount of energy; amount of fertilizer required to produce 1 kg or L of wheat; potatoes; milk; beef; poultry etc.
- As a final point, whilst many of the AEIs provide detailed information about primary production, nothing is captured about the effectiveness and efficiency of the transfer of products from the primary producers to final consumers (from crop and animal to plate). In addition, no information is provided about the losses in the food chain and the return of residues back to the primary producers. Suppliers, processors and retailers are important drivers of production and thus induce environmental impacts.

4 Estimating NH_3, CH_4, N_2O emissions & nutrient balances

4.1 Introduction

Agriculture has relatively large shares in the total emissions of ammonia (NH3) and the greenhouse gases methane (CH4) and nitrous oxide (N2O) into the atmosphere. These gases have also relatively large ecological impacts, including (e.g. Sutton et al., 2011):

- A decline in human health, due to NH_3 induced formation of particle matter ($PM_{2.5}$) and smog;
- Plant damage through high NH_3 concentrations in air;
- A decrease in species diversity of natural areas due to N enrichment through atmospheric deposition of NH_3;
- Acidification of soils because of deposition of NH_3;
- Global warming because of emission of CH_4 and N_2O; and
- Stratospheric ozone destruction due to N_2O

Nitrogen (N) and phosphorus (P) are the main crop growth limiting nutrients in agriculture. Losses of N and P into the wider environment have major ecological impact, including the abovementioned impacts, and

- Pollution of ground water and drinking water due to nitrate leaching;
- Eutrophication of surface waters due to N P enrichment, leading to excess and possibly toxic algal blooms and a decrease in faunal and floristic species diversity.

Moreover, the production of N fertilizers is energy-intensive and accompanied by large CO2 emissions. Phosphorus fertilizers are produced from scarce rock phosphate resources, which will be depleted within decades unless appropriate measures are taken. Hence, N and P balances are key agri-environmental indicators.

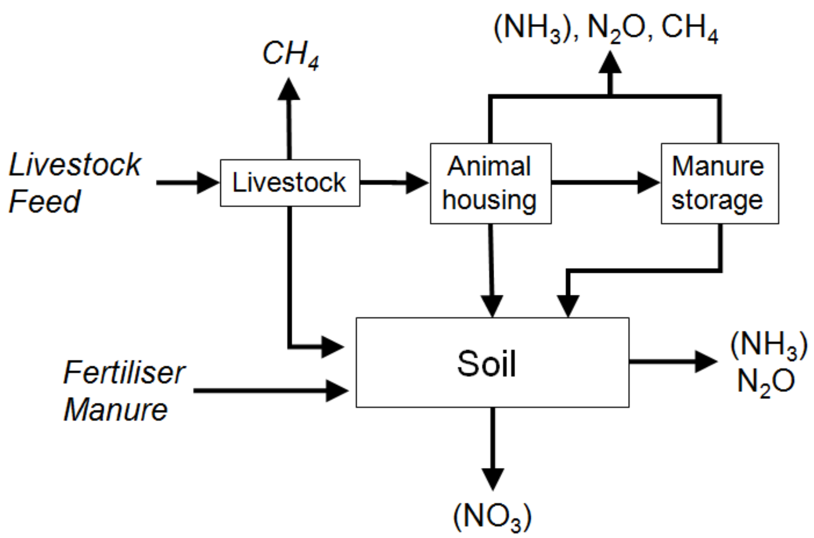
There are various diffuse sources of NH3, CH4 and N2O in agriculture. Estimating these sources accurately is not without difficulty. Also, N and P balances of agricultural systems are not easy to assess. Because of the importance and complexities involved in the accounting of ammonia and greenhouse gas emissions, and of N and P balances of agricultural systems, a special task (Task 3) of DireDate related to analysing the methodologies for calculating NH3, CH4, N2O emissions and N and P balances. Particular emphasis was given to the coefficients used in the calculations and the underlying data needs, and to identify best practices for these calculations, based on available scientific research.

The purpose of this Chapter is to briefly summarize the results of Task 3. The full analysis of the methodologies for calculating NH3, CH4, N2O emissions and N and P balances can be found in the Task 3 Report of DireDate (Amon et al., 2011).

4.2 Greenhouse gas and ammonia emissions

Greenhouse gas emissions from agriculture occur from a number of sources. Dominant sources of methane (CH4) are enteric fermentation, manure management and wetlands, including paddy rice fields (Figure 4.1). Direct sources of nitrous oxide (N2O) are manure management and agricultural soils. Indirect sources of N2O are the emission of ammonia (NH3) and the leaching of nitrate (NO3) from agriculture (Figure 4.1).

Figure 4.1: Schematic representations of the main sources of NH_3, CH_4, and N_2O emissions in agricultural systems



Emissions of greenhouse gases are within the scope of the UN Framework Convention on Climate Change (UNFCCC) whereas those of ammonia are within the scope of the UN Convention on Long-Range Transboundary Air Pollution (CLTRP). Guidance on the methodologies for calculating greenhouse gas and ammonia emissions is provided in the IPCC Guidelines ('the Guidelines') and the EMEP/EEA Air Pollution Emission Inventory Guidebook ('the Guidebook') respectively. The trend seen within both UNFCCC and CLRTP is for emission limits to be progressively reduced over time. For both greenhouse gas and ammonia emissions, agriculture represents a major source. When faced with the need to reduce emissions, countries are usually faced with a choice between a number of different abatement measures. The implementation of abatement measures will often result in an increased cost to agriculture and to the environmental authority that must monitor compliance. Identifying the most cost-effective abatement measures for agriculture requires a range of activity data to be collected.

Emissions are estimated by multiplying activity data with emission factors. Compiling the national inventory therefore comprises two main steps: (i) obtaining national activity data and (ii) choosing emission factors (either default or country specific emission factors).

Agricultural emissions strongly depend on the animal housing, and on the manure management system (MMS) distribution. These data are a mandatory pre-requisite for accurate emission estimates, with a low range of uncertainty. The impact of mitigation measures on the national emissions reported under UNFCCC and CLRTP must be documented and this is only possible if representative data on the MMS distribution are available. A lack of these data leads to two major disadvantages:

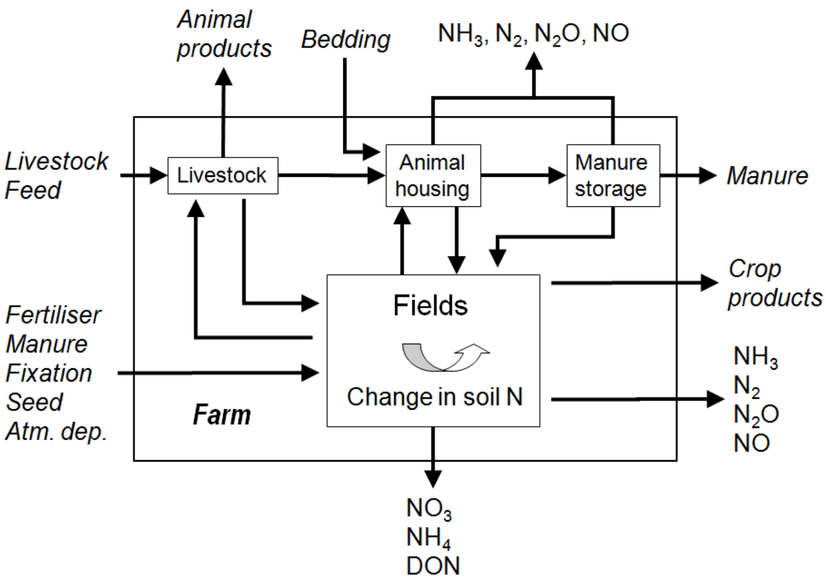
1. Country-specific values can only to a small extent be integrated in the national emission inventory. Major parts of the inventory must be set up with default values that misrepresent the processes typically found in the respective country.
2. Due to the lack of activity data, the effect of mitigation measures cannot be included in the national emission inventory.

4.3 Nitrogen and phosphorus balances

The gross nitrogen and phosphorus balances provide holistic indicators of the related environmental pressure exerted by agriculture. For N, significant losses occur to the atmosphere in the form of ammonia, nitrous oxide, nitric oxide (NO) and dinitrogen (N2). Ammonia, nitrous oxide and nitric oxide are pollutants, whereas the emission of dinitrogen reduces the effectiveness of manure and fertilisers and the fertility of soils. Nitrogen is lost to aquatic environments in the form of nitrate, ammonium and dissolved organic N, all of which can lead to pollution and all of which reduce the fertility of the soil. The nitrogen flows and losses in agricultural systems are schematically shown in Figure 4.2. For calculating the gross N balance, the farm N balance, the soil N balance and the gross P balance, slightly different methodologies are applied (see Annex 2).

Unlike greenhouse gas and ammonia emissions, countries are not required to report N and P balances for agriculture as part of any international conventions. As a consequence, there is no organisation equivalent to the IPCC or UNECE who has responsibility for standardising and improving the methodology to calculate such balances. However, Eurostat and OECD have jointly established a de facto standard for gross N balances, and the soil N balance calculated by the CAPRI model has gained acceptance in European policymaking. Furthermore, the Task Force on Reactive Nitrogen (TFRN), established under CLRTP, is currently establishing national N balances that include agriculture. As an organisation established within an international convention and dedicated specifically to N, we consider that that in the long term, the TFRN is the appropriate organisation to standardize and improve the methodology related to N balances. We note, however, that while the scientific community is strongly represented in the TFRN, the number of statisticians is low. We would therefore encourage representatives of national statistical bureau to become more involved in the work of this organisation.

Figure 4.2: Schematic representations of the main nitrogen flows and losses in agricultural systems



4.4 Data needs and data collection

The data needs for calculating NH3, CH4, N2O emissions and N and P balances are relatively large, especially for large emissions sources, because of the required accuracy for estimates of large sources. Currently, these data are not always available in Member States.

Based on experiences in various countries, it is suggested that farm structure surveys should be carried out every five years for collecting information about housing systems, manure storage systems and manure application techniques. Table 4.1 presents the list of data that should be collected. Table 4.1 distinguishes the following main NH3, CH4 and N2O emissions sources: (i) housing (cattle, pigs, and poultry), (ii) water management, (iii) slurry storage and farmyard manure (FYM) storage systems, (iv) slurry and farmyard manure application techniques, and (v) the diets of the animals.

Table 4.1 qualifies data requirements into "optimum" and "minimum" data collection requirements. Activity data listed under "minimum requirement" must be collected, because without these data, a proper inventory reporting is not possible. The effect of mitigation measures cannot be shown in the inventory and the cost effectiveness of mitigation measures cannot be assessed. Activity data listed under "optimum requirement" should be collected for more accurately estimating inventories. They offer more possibilities for country-specific and cost-effective mitigation measures and enable the assessment of environmental impacts of farm management practices. For most of these data, the additional effort for collecting them is small and the additional effect is large.

Annex 4 provides a detailed overview of data and coefficients required for calculating gross N and P balances and ammonia and greenhouse gas emissions.

Table 4.1: Data to be collected through surveys at farm level for calculating NH_3, CH_4, N_2O emissions and N and P balances

Activity data collection	**Reasoning**
Housing cattle - minimum requirement	
Liquid / solid system	EF* differ between both systems, system has great influence on subsequent losses
Tied / loose housing	
Grazing	Necessary for estimation a consistent N flow, necessary for NH_3 and N_2O emission estimates, IPCC requires data on grazing
Housing cattle – optimum requirement	
Subcategory of housing systems prevalent in the country	Considerable differences in emissions; easy to answer for the farmer; necessary for the assessment of mitigation measures
Floor system	
Yard	
Housing pigs - minimum requirement	
Liquid / solid system	EF differ between both systems, system has great influence on subsequent losses
Housing pigs – optimum requirement	
Subcategory of housing systems prevalent in the country	Considerable differences in emissions; easy to answer for the farmer; necessary for the assessment of mitigation measures
Floor system	
Yard	
Air scrubber	
Housing poultry - minimum requirement	
Housing system	Considerable differences in EF; easy to answer for the farmer
Manure treatment	
Housing poultry - optimum requirement	
Drinkers	Considerable differences in emissions; easy to answer for the farmer; necessary for the assessment of mitigation measures
Frequency of manure removal from the house	
Water management – optimum requirement	
Cleaning of the house, water addition to slurry	Diluted slurry emits less NH_3
Slurry storage - minimum requirement	
Slurry store cover	Great influence on NH3 emissions; cost effective mitigation measure; likely to become mandatory in the future
Slurry storage - optimum requirement	
Store size	Considerable differences in emissions; Easy to answer for the farmer; necessary for the assessment of mitigation measures
Slurry treatment	
Slurry storage during warm and cold season	
FYM storage - optimum requirement	
Size of the store and duration of storage	Considerable differences in emissions; easy to answer for the farmer; necessary for the assessment of mitigation measures
FYM treatment	
Direct FYM application	
Duration of FYM storage	
Cover of FYM stores	

Slurry application - minimum requirement	
Application technology	NH_3 emissions after slurry application are large contributors to total NH_3 emissions. Emissions can be effectively abated by low emission application techniques. Some countries give subsidies for low emission techniques. Environmental effects of these subsidies do not show up if activity data are unavailable.
Application to grassland or arable land	Differences in EF
Slurry application – optimum requirement	
Timing and amount of application	Considerable differences in emissions; easy to answer for the farmer; necessary for the assessment of mitigation measures; esp. timing and amount of application are low cost or even no cost mitigation measures. They will only show up in the inventory if activity data are available.
Incorporation after application	
FYM application - minimum requirement	
Application to grassland or arable land	Differences in EF
Incorporation after application	Drastically reduces NH3 emissions; only measure available to reduce NH3 emissions after FYM application.
Animal diet – optimum requirement	
Components of cattle diet	Important influence on N excretion and CH4 emissions from enteric fermentation; information will greatly help to improve national defaults on CH4 emissions from enteric fermentation, N and VS excretion; all mitigation measures set at the beginning of the chain will have the largest potential to reduce emissions
Components of pig diet	Important influence on N and VS excretion; information will greatly help to improve national defaults N and VS excretion; all mitigation measures set at the beginning of the chain will have the largest potential to reduce emissions
Phase feeding for pigs	One of the most effective measures to reduce N emissions from pig manure; measure can be implemented a low or no costs; farmers might even gain by reducing N content in the pig diets.
Farm-scale data - minimum requirements	
Number of livestock present, with major livestock categories identified separately	Required for calculating NH3 and N2O emissions and for calculating or checking N and P balances
Import of N fertiliser	Required for calculating NH3 emission and N balances
Import of protein supplements	Required for calculating or checking N and P balances
Import of energy supplements	
Export of protein-rich cereals	
Export of other cereals	
Farm-scale data -optimum requirements	
Import of animal manure	These data enable a more accurate calculation of N and P balances and are necessary if N and P balances are to be disaggregated below the national scale.
Import of other organic manure	
Import of bedding material	
Export of animal manure	
Export of straw	

* Emission Factors

4.5 Conclusions and Recommendations

4.5.1 Methodologies

The methodologies for calculation of greenhouse gas and ammonia emissions are enshrined in international law, so are not for discussion. In nearly all European states, agriculture is defined as a key source with regards to greenhouse gas and ammonia emissions. As such, Member States are obliged to use a Tier 2 methodology for inventory reporting. Tier 2 methodologies require data that are both detailed and respect the relationships between emission sources. These data can only be collected by sampling at the farm scale.

The methodologies for calculating N balances are not enshrined in international law. The OECD/EUROSTAT gross N balance represents the difference between the inputs and outputs of N to agriculture, divided by the land area occupied. As such, it is equivalent to a farm N balance and represents a holistic indicator of the potential environmental impact. The current methodology requires the estimation of the input of N by livestock excretion and the output of N in crop products used by livestock on the same farm, both of which are difficult to obtain. Since there are no significant gaseous N emissions from the animals themselves, these inputs and outputs could be replaced by the N in imported animal feed and the N exported in animal products, where these can be estimated with greater accuracy. Currently, there are varying opinions on whether the farm balance is easier to obtain than a soil surface balance.

The impact of agricultural N on the aquatic environment is likely to be more closely related to a soil N balance than to a farm N balance. When calculating a soil N balance, it is recommended to use the country-specific N excretion values reported under UNFCCC and the Tier 2 methodology of the EMEP/EEA Air Pollutant Emission Inventory Guidebook for calculating the gaseous emissions of N in animal housing and manure storage, and after field application of manure or fertiliser.

4.5.2 Importance of coefficients

Obtaining accurate values for the coefficients used in calculating emissions or nutrient balances is essential. The default values provided in the IPCC Guidelines and the EMEP/EEA Guidebook are intended to be reasonable estimates for the specified geographic area. These default values often disguise a wide geographic variation in actual values, either due to variations in climate or to regional variations in agricultural practices. In addition, the default values presented in the various guidance documents generally relate to situations where no abatement measures have been implemented. Member States are encouraged to use nationally or regionally appropriate values of the coefficients. It is good practice to support the use of these coefficients with empirical measurements. The consequences of relatively small errors in coefficients can be significant. It is important that the source of the coefficients used is documented. Where default values are used, the source should be indicated.

The value of some coefficients varies with agricultural practice. For example, the emission of ammonia following field application of animal manure depends on the manure application method used. The coefficients may need to be updated periodically to take account of significant changes in agricultural practices.

4.5.3 Detailed procedures needed for emission abatement strategies

The trend seen within both UNFCCC and CLRTP is for emission limits to be progressively reduced over time. For both greenhouse gas and ammonia emissions, agriculture represents a major source. As noted above, for implementing abatement measures the use of Tier 3 methodologies is generally recommended. The implementation of abatement measures will often result in an increased cost to agriculture and environmental authority that must monitor compliance.

Identifying the most cost-effective abatement measures for agriculture usually requires data that exceeds that which is necessary to support a Tier 2 approach for calculating emissions. This is because the complex and very varied nature of agriculture results in large differences in the abatement measures that are available and their associated costs.

4.5.4 Data collection

Agricultural emissions strongly depend on the animal housing, and on the manure management system distribution. These data are a mandatory pre-requisite for accurate emission estimates that with a low range of uncertainty. The impact of mitigation measures on the national emissions reported under UNFCCC and CLRTP must be documented and this is only possible if representative data on the manure management system are available. It is recommended to collect activity data via surveys at farm level every five years.

Development of cost-effective mitigation measures relating to greenhouse gas and ammonia emissions or nitrate leaching require relational statistics that can only be obtained by a farmer surveys. Since farm management of nutrients tend to vary systematically with farm type (cattle, pig etc) and size, such surveys can be usefully stratified according to farm type and size.

Some European countries have already collected activity data at farm level. The data surveys were carried out with great success and the national inventories could be improved. Country specific mitigation options and potentials were identified. It was found that the only way forward towards a more sustainable and environmentally friendly, yet at the same time economically viable, agriculture was to gain better knowledge of farm management practices. Only then can practically feasible, efficient and economic mitigation measures be proposed and implemented.

5 Data collection – processing - reporting in Member States

5.1 Introduction

Member States have to collect agri-environmental data and information to be able to report on the impact of agriculture on the environment, the progress of the implementation of the EU agri-environmental policies, as well as to estimate the agreed 28 AEIs.

There is as yet little insight in the actual data collection – processing – reporting chains in the Member States. There is no information about 'who is doing what'. The methods and procedures are also not well known.

The general objective of Task 6 of DireDate was to characterize the data collection – processing – reporting systems for Agri-Environmental Indicators (AEIs) in Member States of the EU-27.

The purpose of this Chapter is to briefly summarize the results of Task 6. The full analysis and characterization of the data collection – processing – reporting systems in Member States can be found in the Task 6 Report of DireDate (Beek et al., 2011).

5.2 Results obtained from questionnaires

The response rates of the four questionnaires to Statistical Offices, Governmental Departments and Research Institutes ranged from low to high. Quite a few returned questionnaires were incomplete. The following observations were made:

- Many organizations are involved in data collection – processing – reporting chains of agri-environmental data and information in Member States, especially in Member States with decentralized, federal governments.
- Nobody in Member States has a complete overview of the agri-environmental data collection – processing – reporting chains.
- The Rural Development Programme (RDP) requires the collection of a lot of agri-environmental data, which Member States often do not have.
- Insufficient data are available for the accurate estimation of many of the AEIs.
- Most Member States use random quality checks, but there is no easy accessible information about the quality of the reported data and information
- The strategy of 'report once, use many times' is highly welcomed by Member States, but they note that prior to streamlining of the data flows, there should be a phase of harmonization of data reporting requirements.
- Member States noted that there are several barely reconcilable differences in reporting requirements between EU Directives (timeframe of reporting, different formats, different units, differences in the level of details, etc.)

- Member States use various methods for data aggregation, depending in part on the institute that is doing the data processing. Within guidance documents there is often scope for variable interpretation, which ends up in different results if done by different people.
- In general, Member States are not willing to providing the raw data to the European Commission to be aggregated centrally, because of loss of background information.

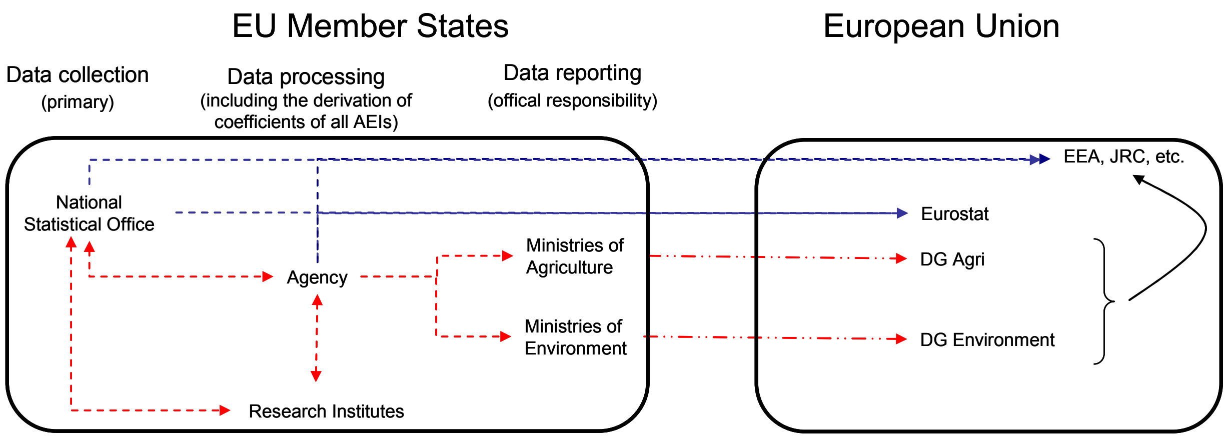
5.3 Results obtained from case-studies and interviews

The results of case studies in Poland and The Netherlands indicate that the data collection – processing – reporting chains for ammonia and greenhouse gas emissions and N balances are highly complex. The complexity is scale-dependent. The procedures and practices of collecting, processing and reporting data and information are at different stages of development in the EU-27.

The interviews revealed that there are different perceptions of best practices for data collection and processing. Many experts emphasized the need for simplification of reporting requirements, and suggested a leading role for DG Eurostat. The need for detailed agri-environmental data was not always understood, and some questioned the effectiveness and relevance of some AEIs.

Member States foresee a key role for National Statistical Offices in further coordinating and streamlining the data collection – processing – reporting chain, in liaison with DG Eurostat and European Environmental Agency. Research Institutes have a role in establishing calculation procedures and guidelines for estimating coefficients, and in data collection. Independent agencies should have key roles in reporting (see Figure 5.1).

Figure 5.1: Suggested framework for the data collection – processing – reporting chain in Member States, and the flow of information from Member States towards the European Commission



5.4 Conclusions and recommendations

The data collection – processing – reporting chains for agri-environmental data and information in EU Member States are diverse and complex. They are diverse because of differences between Member States in historical and cultural backgrounds. They are complex because agri-environmental interactions are complex and characterizing these interactions adequately requires a large amount of good-quality data and information. It should also be noted that the current collection – processing – reporting chains for AEIs in EU Member States have not been designed specially for reporting agri-environmental data and information, including the 28 AEIs, to the European Commission. Rather, the current data collecting and reporting systems in EU Member States reflect the status quo in which the emphasis was on agro-economic and much less on agri-environmental characterizations.

Evidently, the data collection – processing – reporting chains in EU Member States are in development. We observed that there is sometimes a lack of appropriate data and then 'guesstimates' are being made. On the other hand, we also observed that duplicates are being made. Guesstimates are defined as 'data that has a verifiable origin somewhere, but that has become vague and untraceable through multiple manipulations'. Duplicates may occur when policy reports demand similar data and these data are then collected, processed and reported by different departments without much tuning or harmonisation. We were not able to quantify the extent and occurrences of duplicates and guesstimates.

We recommend that Member States appoint a coordinating institution and develop an integral overview of the data collection – processing – reporting chains. National Statistical Offices seem the most obvious organizations for coordination. Currently, they rely on the support (and goodwill) of many other institutions. We recommend that the European Commission and the Member States strengthen (by political decisions) the responsibility and domains of the National Statistical Offices for the coordination of the data collection – processing – reporting chains for all agri-environmental data and information.

We recommend the European Commission to further streamline the reporting requirements for agri-environmental policies, especially as regards the requirements for agri-environmental data. We also recommend that the data collection – processing – reporting chains for agri-environmental policies and AEIs are fully harmonized and/or standardized, i.e., the AEIs should form the basis for reporting about the progress of the agri-environmental policies.

We recommend the set-up of Task Forces for the development and approval of protocols and guidelines for uniform data collecting – processing - reporting of agri-environmental data and information. Experts from all Member States should be involved in these Task Forces, while DG Eurostat should have a coordinating and stimulating role. The protocols and guidelines should be updated on a regular basis (once in ~five years) to be able to incorporate new insights from science, policy and practice. The institutional structure with quality control and assurance, and uniform protocols and formats for reporting of GHG and ammonia emissions may serve as a model for the creation of uniform and harmonious data collecting and reporting systems for all AEIs across EU-27.

There is a certain 'questionnaire fatigue' among Statistical Offices, Governmental Departments and Research Institutes. This can be concluded from the low response rates to some of the questionnaires and from the responses. This 'fatigue' is also a signal to the policy arena and political arena; it is time for action and more support for the agri-environmental data collection – processing - reporting chains.

6 Towards common data collection-processing-reporting chains

6.1 Introduction

The previous chapters conclude that EU policy reporting (Chapter 2) and Agri-Environmental Indicator reporting (Chapters 3 and 4) require various agri-environmental data and information, which Member States feel as a heavy burden (Chapter 5). This feeling of a burden also emanates from the facts that the agri-environmental data collection – processing – reporting chains are not 'optimized' (Chapters 2, 3, 5).

Tasks 4 and 5 of the DireDate project address the 'optimization' of the agri-environmental data collection – processing – reporting chains. The aims of Task 4 "Recommendations for priority data collection" are:

- To summarise the AEI data needs identified in Tasks 1-3;
- To determine the simplest common data collection approaches applicable across multiple AEI requirements;
- To identify potential harmonisation synergies, and
- To provide recommendations for priority data collection.

The aim of Task 5 "Analysis of feasibility for data combination" is

- To analyse needs for and feasibility of AEI data complementarity and combination for the calculation of AEIs at parcel, farm, regional or national level and the subsequent demands on the collection and processing systems.

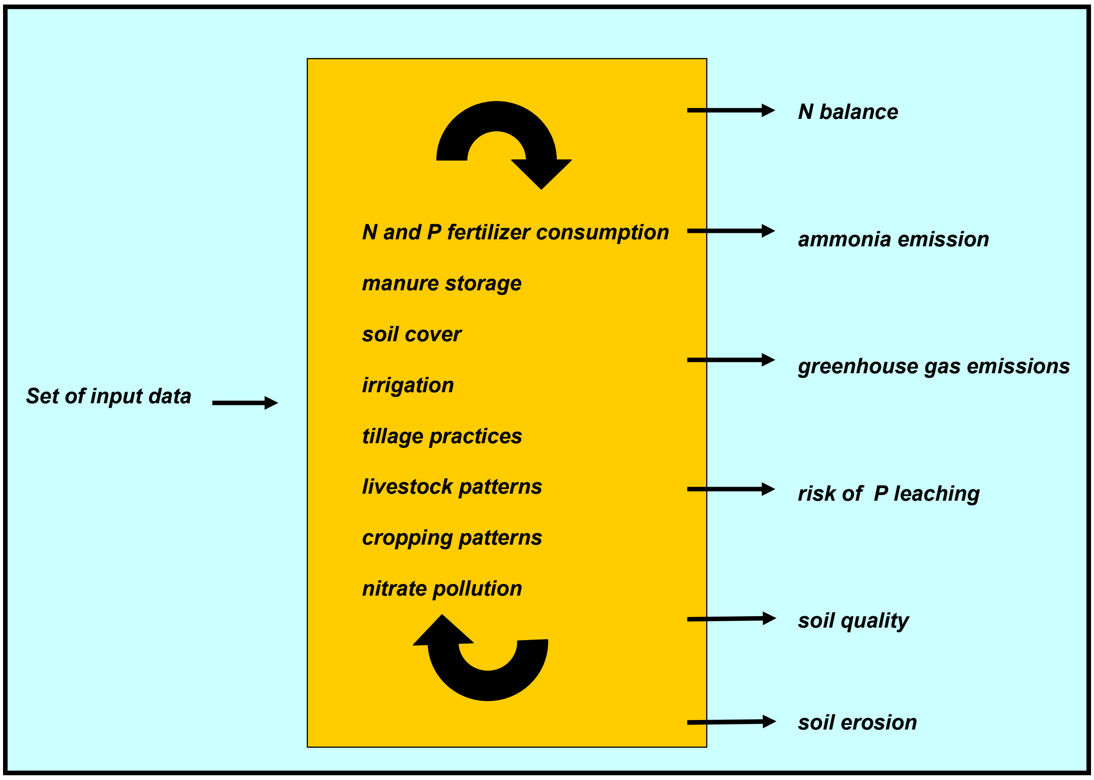
The purpose of this Chapter is to briefly summarize the results of Tasks 4&5. The full analysis of the 'optimization' of the agri-environmental data collection – processing – reporting chains can be found in the Task 4&5 Report of DireDate (Velthof et al., 2011).

6.2 Potential for a common and harmonised data collection

There are large differences in data needs between AEIs (see Chapter 3, Annex 1). Some AEIs are directly based on one or a limited number of activity data and coefficients (e.g. the use of nitrogen (N) and phosphorus (P) fertilizer). However, other AEIs have to be calculated from (large) sets of activity data and coefficients (e.g. N balance, ammonia emission and greenhouse gas emissions). It is also shown that there are similarities in the need for data of some AEIs, and especially AEIs related to fertilizer and manure use (N balance, ammonia emission, and greenhouse gas emissions). Moreover, all these AEIs also include data needed by other AEIs. This points towards a clear potential for common and harmonized data collection for at least part of the AEIs.

Schemes for a common and harmonized data collection have been developed for AEIs gross N *(and P) balances*, *ammonia emission*, *emissions of the greenhouse gases nitrous oxide (N_2O) and methane (CH_4)*, *N and P fertilizer consumption, manure storage, soil cover, risk of pollution by phosphorus,* *irrigation, tillage practice, soil quality, soil erosion, livestock pattern, cropping pattern, and nitrate pollution* (Figure 6.1). The AEIs in the yellow box in Figure 6.1 are AEIs that can be derived directly from current surveys and statistics. The AEIs on the right side of the Figure have to be derived on the basis of additional data and coefficients.

Figure 6.1: Schematic scheme for common data collection for AEIs Gross N (and P) balances, ammonia emission, greenhouse gas emissions (N_2O and CH_4), N and P fertilizer consumption, manure storage, soil cover, risk of pollution by phosphorus, irrigation, tillage practice, soil quality, soil erosion, livestock pattern, cropping pattern, and nitrate pollution



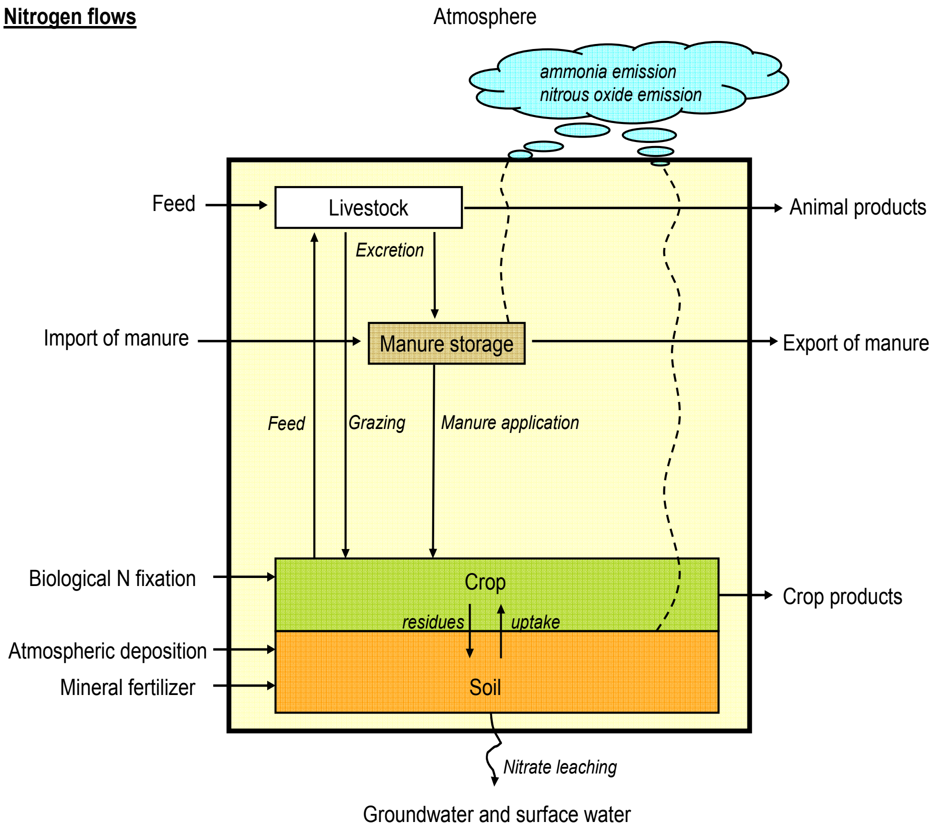
The AEIs in the yellow box can be derived directly from surveys and statistics. The AEIs on the right side of the Figure have to be derived on the basis of (various) data and coefficients (including other AEIs).

6.3 Data collection for AEIs related to manure and fertilizer use

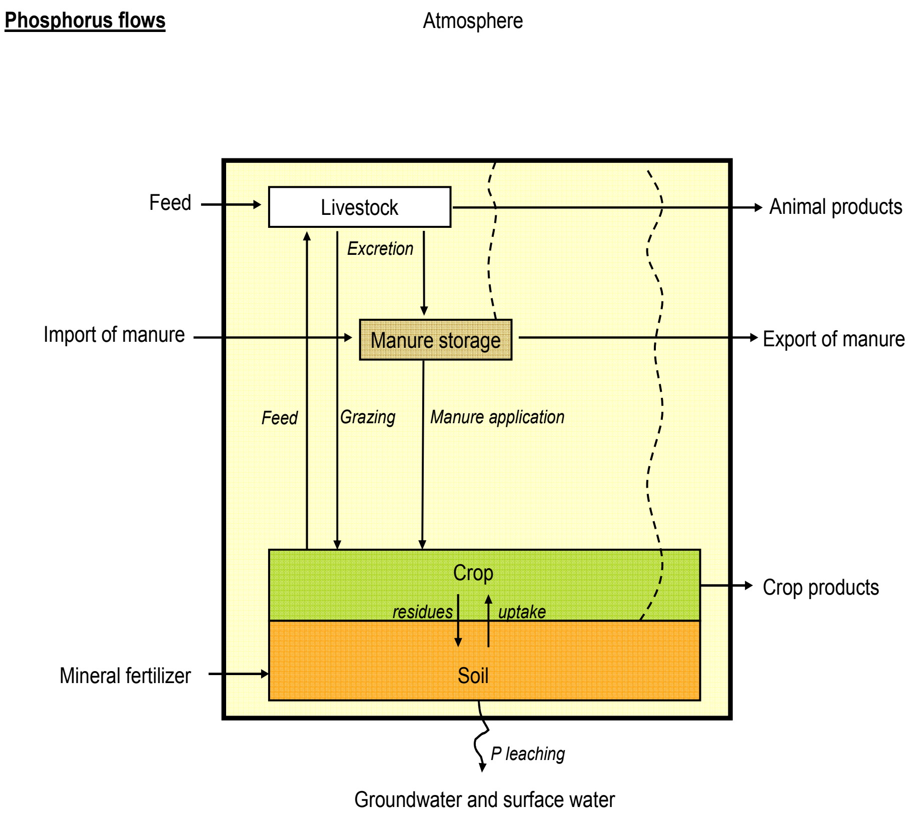
The N and P flows in farming systems are schematically presented in Figure 6.2 (see also Chapter 4). The outer box can be considered as a farm, but also as a region or country. Within the farm or region, various components are distinguished (soil, crop, livestock, manure storages). Arrows indicate the input into and output of N (upper figure) and P (lower figure) out of the farming system (delineated by the outer box). In addition, there are various internal flows.

In Figure 6.3 the AEIs related to and depending on N and P flows and emissions of ammonia and greenhouse gases are positioned in the scheme with N and P flows. The AEIs are divided in AEIs that can be derived estimated directly on the basis of data collected in surveys and from statistics and AEI that have to be calculated on the basis of data and coefficients.

Figure 6.2: Schematic overview of N and P flows in farming systems.



The box in each figure can be considered as farm, region or country. Notice that the total N2 losses by denitrification are not indicated in the Figure, as these losses are not included in the AEIs.



AEIs derived directly from data collected in surveys and from statistics are:

- AEI 5 *Mineral fertilizer consumption*. This indicator is also needed to calculate N and P balances, ammonia emission, and greenhouse gas emissions.
- AEI 11.3 *Manure storage*. Also needed to calculate NH_3 and GHG emissions.
- AEI 11.1 *Soil cover*. This indicator is also needed to calculate the N and P removal by harvested crops in the N and P balance and can be used for assessment of risk of pollution by P and erosion.
- AEI 10.1 *Cropping pattern*. This indicator is also needed to calculate the N and P removal by harvested crops in the N and P balance and can be used for assessment of risk of pollution by phosphorus and erosion.
- AEI 7 *Irrigation*. This indicator can also be used for estimate of the crop yield and for assessment of risk of pollution by P and erosion.
- AEI 11.2 *Tillage practice*. This indicator can also be used for assessment of risk of pollution by phosphorus and erosion, and for the soil quality indicator.
- AEI 10.2 *Livestock pattern*. This indicator is also needed to calculate the N and P excretion by livestock.
- AEI 27.1 *Nitrate pollution* (measured water quality).

AEIs that have to be calculated using additional data and coefficients are:

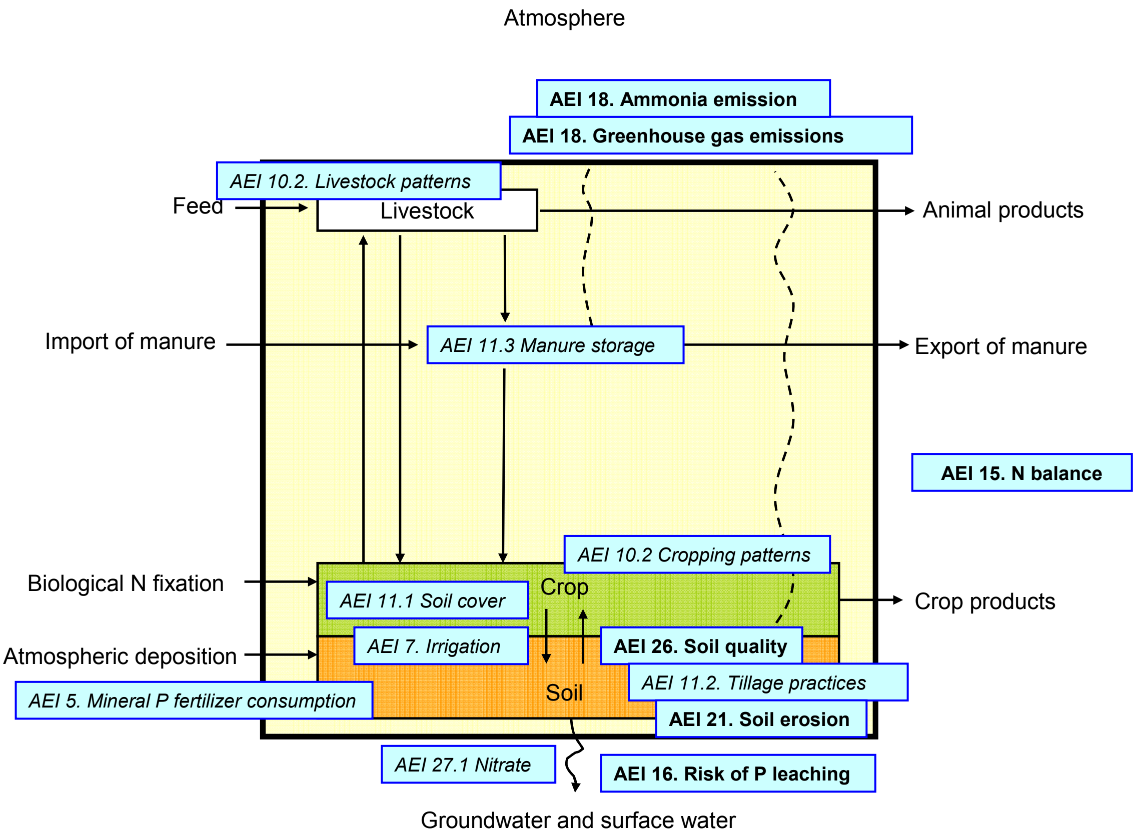
- AEI 15 *Gross N balance*;
- AEI 18 *Ammonia emission*;
- AEI 19 *Greenhouse gas emissions (N_2O and CH_4)*;
- AEI 16 *Risk of pollution by phosphorus*;
- AEI 26 *Soil quality*;
- AEI 21 *Soil erosion*.

Based on Figures 6.2 and 6.3 a calculation scheme has been set up with 12 steps for data collection and processing so as to derive all the AEIs discussed in this paragraph. The aim of this calculation scheme is to set up a systematic approach to collect data and coefficients, and to harmonize data collection and processing (data and coefficients) for different AEIs.

A calculation scheme with 12 steps has been set up and is presented in Annex 3. This scheme allows the calculation of 14 AEIs in a systematic and uniform way.

Annex 4 provides a detailed overview of data and coefficients required for calculating gross N and P balances and ammonia and greenhouse gas emissions.

Figure 6.3: AEIs positioned in the scheme with N and P flows and emissions of greenhouse gases.



The AEIs are indicated as the blue boxes. AEIs which can be directly collected from surveys and statistics are indicated with an italic letter type and the AEIs that have to be calculated are indicated with a normal letter type.

6.4 Data collection for the other Agri-Environmental Indicators

Paragraphs 6.2 and 6.3 present a coherent and uniform calculation scheme for 14 AEIs. The other AEIs can be conveniently split in four groups, as regards their estimation.

6.4.1 First group of other AEIs, related to resource use

The first group includes three AEIs relating to resource use, and which are linked with some of the AEIs in Figure 6.3, i.e.

- AEI 13. *Specialisation,* relates to many AEIs, including fertilizer consumption, cropping patterns, livestock patterns, soil cover, tillage practice, N balance, and risk of P pollution.
- AEI 12. *Intensification/extensification,* related to fertilizer use, livestock and cropping patterns, and irrigation.
- AEI 20. *Water abstraction,* related to irrigation

The following data have to be collected for AEI 12 Intensification:

- Input of mineral fertilizers, energy and pesticides (and water if possible);
- Livestock density and amounts of purchased feed;
- Ratio between input and output in monetary terms.

The data for mineral fertilizers, energy, livestock density and pesticides also need to be collected for other AEIs. The required data for calculation of the indicator AEI 12 in monetary terms is collected through the FADN. FADN data can be used as a basis for the intensity typology, and are routinely collected. In the short term, it is recommended to use the current FADN data collection. In the long term, it would be advisable to extend the FADN sample so that also all environmentally relevant farms are included (including also the smaller and part-time farms, and farms that are below the current economic size threshold).

As regards required data on agricultural water use (AEI 20 Water abstraction), the current systems (FSS, SAPM, OECD/Eurostat Joint Questionnaire on Inland Waters, LUCAS, AQUASTAT, JRC database, WFD reporting) can be used. However, harmonization and tuning is needed here, given the number of sources.

6.4.2 Second group of other AEIs, related to pesticide use and risks

There are three AEIs related to use of pesticides:

- AEI 6 *Pesticide consumption*
- AEI 17 *Pesticide risk*
- AEI 27.2 *Pesticide in water*

These AEIs are related in part to the AEIs shown in Figure 6.3, for example via cropping patterns, as the type and area of crops have a large influence on pesticide use. The AEI Pesticide risk has linkages to AEI 11.1 Soil cover and AEI 11.2 Tillage practice. Data required for Pesticide consumption are being collected under Regulation 1185/2009 concerning statistics on pesticides. Data on pesticide consumption should be supplied for selected crops in one year of each five-year reporting period. Data collection can be based on surveys, administrative sources or a combination of different means including statistical estimation procedures.

It is recommended to quantify AEI 17 Pesticide risk, using the modelling framework HAIR (Harmonised environmental indicators for pesticide risk) which is developed by Alterra in a separate project. The HAIR databases and software includes data on pesticide use (linked to AEI 6 Pesticide consumption), agricultural practice, land use, GIS information and ecotoxicology, at the catchment scale. In the long-term, it is recommended to develop HAIR at a finer resolution, but this requires detailed information on tillage and cropping practice, pesticide application, drainage, topography, and soil type.

For AEI 27.2 Pesticide in water, the data produced from the monitoring of surface water quality can be used, as published by EEA in the WISE data base. There are three datasets publicly available via WISE. 'Waterbase – Lakes', 'Waterbase – Rivers' and 'Waterbase – Groundwater', all of which contain data on concentrations of priority and other chemical substances along with monitoring site attribute data (including point location).

6.4.3 Third group of other AEIs, related to energy

There are two AEIs related to energy,

- AEI 24 *Production of renewable energy*
- AEI 8 *Energy use*

These AEIs are also related to some of the AEIs shown in Figure 6.3. For example, the AEI Production of renewable energy is related to AEI 10.1 Cropping patterns and the AEI Energy use to AEI 5 Mineral fertilizer consumption, and AEI 7 Irrigation. The Sustainable Development Indicators also demand data on energy use. Information is required on final energy consumption by sector by energy source at a country level. The main indicator refers to total use of fossil energy at farm level. There is discussion about the need to include indirect energy use in the definitions.

Data on energy are collected by Eurostat (Eurostat Energy Statistics). This system has a full EU coverage, but the main focus is on industry and households. The FADN collects data from a sample of the agricultural holdings in the EU. Energy consumption could be estimated from expenditure data in FADN in combination with energy prices collected by Eurostat. The necessary data to calculate energy unit costs and estimate energy consumption are available with annual updates. This has been tried before and for various reasons proved to be difficult, suggesting that additional efforts may be needed here.

It is recommended to install a working group that reviews the gaps in data on energy use in agriculture (based on Eurostat Energy Statistics and FADN), and that give recommendation for improving the collection of data on energy use by agriculture. In the short term, the current data collection systems can be used, as they provide the required estimates of energy use by agriculture for Sustainable Development Indicators.

The indicator AEI 24 Production of renewable energy has relevance for several policies, including Sixth Environmental Action Programme, United Nations Framework Convention on Climate Change, and 6th Environmental Action Programme. The Sustainable Development Indicators requires data on the share of renewables in gross inland energy consumption at a national scale every 2 years. Ideally, the following data should be collected at farm level each year: i) type and area of targeted biomass cropping and ii) amount of harvested primary and secondary biomass feedstocks converted into bioenergy at farm and outside the farm (this includes oil, starch, sugar feedstocks for biofuel, ligno-cellulosic/woody material from primary (crops) and secondary (e.g. straw, cuttings) sources, manure). There are several collection systems in place, including ePure, EBB and the Eurobserv'ER (data on fuel, bioethanol, biodiesel and biogas production, and AEBIOM of the European Biomass Association (compilation of all data available from EU and national sources). However, the required data are not consistently collected throughout the EU (rare and scattered national and regional sources). As a result, there is a considerable margin of error, as a) biodiesel is partly produced from imported vegetable oils and oilseeds, and b) "biogas from other sources" contains not only biogas from agricultural sources but also biogas plants based on bio-waste. Also, grasses and short rotation crops are not included but may become of significance in future. Further, DG AGRI data on agricultural area supported at MS level under the 2 regimes (set-aside for non-food crops and energy crop premium), that are currently used for the supporting indicator "area of energy crops", will not be available anymore from 2009 onwards, since the two regimes have been abolished by the Health Check reform in 2008.

Summarizing, it is recommended to improve the data collection systems in order to get better coverage of data across the EU and to improve the quality of the estimates of the different renewable energy sources, on the basis of farm data and aforementioned data sources. Note also that there is a clear linkage between AEI 24 Production of renewable energy and the AEI 10.2 Cropping patterns; perhaps data about 'area of energy crops' could be collected through a further specification of the data collected for AEI 10.2.

6.4.4 Fourth group of other AEIs, related to land & ecological impacts

Finally, there is a group of AEIs related to land use and the ecological impacts of farming systems; some of these having linkages with each other.

- AEI 1 *Agri commitments*
- AEI 2 *Agricultural areas under Natura 2000*
- AEI 3 *Farmers training*
- AEI 4 *Area under organic farming*
- AEI 9 *Land use changes*
- AEI 14 *Risk of Farmland abandonment*
- AEI 22 *Genetic diversity*
- AEI 23 *High nature farmland*
- AEI 25 *Farmland birds*
- AEI 28 *Landscape*

All these AEIs are part of the second set of AEIs (see Table 3.1). AEI 1 Agri commitments is a response indicator, together with AEI 2 Agricultural areas under Natura 2000, AEI 3 Farmers training, and AEI 4 Area under organic farming. Existing data sources are administrative data collected to monitor the implementation of rural development programmes. The quality of the data is considered as quite low. Data for Farmers training are collected in the Common Monitoring and Evaluation Framework (CMEF), which is compulsory to report under the Rural Development programming period 2007-2013. Also FSS provides information on farm management practices. The Area under organic farming is collected by Eurostat in a specific questionnaire and in FSS.

Agricultural areas under Natura 2000 serves as input to AEI 23 *High Nature Value farmland*, AEI 12 *Intensification/extensification*, and AEI 14 *Risk of farmland abandonment*. There are also linkages to other AEIs, as the type of farm management in Natura 2000 areas is needed, which demands information on stocking density, fertilized area, amount of fertilizer applied, and pesticide application. To estimate the types of land use in Natura 2000 areas, GIS datasets of land cover and Natura 2000 sites are required. The former is available from the 2006 Corine Land Cover (CLC) raster dataset. However, CLC does not provide the required level of detail to spatially define small areas. Data obtained at farm level of the area located in a Natura 2000 site would be ideal.

The AEI Land use change does not serve as an input to other AEIs, but it has indirect links to all AEI indicators, with land use area as denominator. It has links to AEI 2 Agricultural areas under Natura 2000, AEI 11.1 Soil cover, AEI 10.1 Cropping patterns, AEI 14 Risk of farmland abandonment, AEI 23 High nature value farmland, and AEI 28 Landscape. The Corine Land Cover is the most useful data sources for this indicator. Other land use data are collected in LUCAS, Agricultural surveys, and reporting for LULUCF. Improvements in data related to Land use change should be made for the distinction between types of grassland, the distinction between agricultural land and recently abandoned land. Moreover, different Member States may use slightly different definitions, classification and interpretations for extensively used grassland, high-nature value farmland, nature conservation land and abandoned land. This demands harmonization of definitions.

The indicator Risk of Farmland abandonment is not yet developed, but this AEI has links to AEI 11.1 Soil cover, AEI 9 Land use change, AEI 21 Soil erosion, AEI 23 HNV farmland, and AEI 25 Population trends of farmland birds. The AEI Population trends of farmland birds is mature and the methodology has continuously been improved. The AEI Landscape has links to many other AEIs, but due to the complexity of European landscapes this AEI is difficult to capture by a single or even a group of parameters/indicators.

6.5 Recommendations for data collection approaches and procedures

It is recommended to use the following categories of AEIs for harmonized data collection:

1. Related to manure and fertilizer use (see Figure 6.3)
2. Related to the 1st category and resource use
3. Related to pesticides
4. Related to energy
5. Related to land use and ecological impacts of farming

The AEIs related to manure and fertilizer use have the most in common with policy data requirements and they have coefficients represented across multiple policies. Therefore, highest priority should be given to the collection of these data. The following types of data can be distinguished:

- Data related to inputs of N and P to agricultural systems, as they affect both N and P balances and ammonia and greenhouse gas emissions.
- Data and coefficients related to the emissions of ammonia and greenhouse gases, i.e. factors that determine the emissions that occur from manure and N fertilizers, such as the type of housing, manure storage, and application technique.
- Data and coefficients related to the output of N and P in the gross N and P balance, i.e. the N and P in harvested crop products.

6.5.1 Data and coefficients related to the input of N and P

- An international Task Force should establish and approve a common methodology for the derivation of N and P excretion rates for all livestock categories (see also Chapter 4).
- Member States should establish a working group of experts that would apply this methodology, taking into account national specific issues. The working groups should use this methodology for estimating the N and P excretion rates each year, for all livestock categories. The common methodology should be used for all policy reports

(e.g. Nitrates Directive, National Emission Ceilings Directive, UNFCCC, UNECE-CLRTAP, Rural Development Program, Sustainability Indicator, N and P balances for OECD, FAO, etc.).

- It is recommended that Eurostat takes the lead in exploring the possibility (and reliability) of using livestock registers for the number of cattle, pigs, sheep, goat, and horses. This should be carried in close corporation with Member States.
- Eurostat has to explore if SAPM can be used for estimating the number of grazing days. If not, recommendations should be made how to collect information on grazing days, for example by the aforementioned working groups.
- The collection and processing of fertilizer use demand several actions:
  - Improve the statistics of national fertilizer consumption. This should be a joined action of Eurostat, Fertilizers Europe (EFMA) and (national) fertilizer trading associations, in collaboration with FAO.
  - An international Task Force should establish and approve a common methodology for disaggregating national fertilizer consumption data to crop-specific data at regional scale (NUTS-2) (see also Chapter 4).
  - Member States should establish a working group of experts that would apply this methodology, taking into account national specific issues.
  - Eurostat in collaboration with Member States should set up targeted surveys to validate and improve the methodology of deriving crop-specific and regional-specific N and P fertilizer use data on the basis of the disaggregation of national fertilizer consumption statistics.
  - The application of the methodology for deriving crop-specific and regional-specific N and P fertilizer use data should be done by the national statistical offices.
  - The methodology, as well as the annual crop-specific and regional-specific N and P fertilizer use data, should be made available to others and should be used for all policy reports (e.g. Nitrates Directive, National Emission Ceilings Directive, UNFCCC, UNECE-CLRTAP, Rural Development Program, Sustainability Indicator, N and P balances for OECD, FAO, etc.).
- An international Task Force should establish and approve a common methodology for the derivation of N fixation by clover in grasslands (see also Chapter 4).
- Member States should establish a working group of experts that would apply this methodology, taking into account national specific issues.
- Data of dry and wet N deposition are available at EMEP-website at different spatial and temporal scales. It is recommended that Eurostat consults EMEP about use of N deposition data in the calculation of the N balances.

6.5.2 Data and coefficients related to ammonia and GHG emissions

For types of housing and manure storage systems, it is recommended to collect data on a farm level (farm survey) every 5 years. In the short term (< 2 years) information of the type of manure should be collected, i.e. systems based on solid and liquid manure, as type of manure has a large impact on ammonia, nitrous oxide, and methane emissions. In the intermediate term (2-5 years) it is recommended to collect data according to the IPCC guidelines. In the long-term (> 5 years) it is recommended to collect data to be used in Tier 2 or 3 approaches to calculate emissions. It is recommended to include (and expand) the collection of types of housing and manure storage in the Survey on Agricultural Production Methods (SAPM) of FSS.

For collecting data on manure application techniques, it is recommended to collect in the short-term (< 2 years) data on application techniques not aiming at reducing ammonia emissions (i.e. broadcast or no incorporation) and reduced ammonia application techniques (i.e. the other techniques). In the short term, estimates derived for the GAINS model can be used (i.e. partly based on consultation of member states) and start a survey to collect data on farms. In the long-term (> 5 years) it is recommended to collect data for more types of application techniques. It is recommended to include (and expand) the collection of manure application techniques in SAPM.

There are already good guidebooks, working groups and/or task forces in place to derive methods and coefficients to estimate ammonia and greenhouse gas emissions, i.e. the IPPC (IPPC guidelines), different task forces under the UNECE, and the EMEP/EEA Guidebook. There is no further action needed to improve the methodologies and coefficients and EU member states are recommended to use Tier 2 or 3 approaches to estimate ammonia and greenhouse gases.

6.5.3 Data and coefficients related to the output of N and P

For calculation of the outputs, data on the yields and N and P contents of the crop products are needed. For the yields, the current data collection system of Eurostat and member states can be used. However, it is recommended to evaluate the procedures followed by the different countries (estimates by local experts or measured) and to verify if the estimated yields are the average yields. The yields of major crops in a member state should be collected at the regional level, especially in large countries with regional differences in climatic conditions (and other factors affecting yields, such as soil type).

A methodology should be developed to estimate the grassland yields in different countries/regions in EU-27, taking the different management types into consideration (rough grazing, extensively managed, and intensively managed). This estimate may be based on empirical data (field experiments), results of crops models, expert estimates, and feed balances of dairy cattle (i.e. the feed N take can be estimated from the milk yield). It is recommended to install a working group (or start a project) with scientists, agronomists, and statisticians of different member states in order to develop such a method.

Verification of the yield estimates obtained from the surveys is recommended using forecasts made by the Monitoring Agricultural ResourceS (MARS) Unit of JRC, which can be used as a source of yields or validation of yields.

It is recommended to carry out a desk study to obtain the N and P contents in the crop products in different regions in the EU and/or dependent on the N and P inputs.

7 Towards a sustainable framework for farm data collection

7.1 Introduction

Our analyses indicate that in total 97 different types of data are needed to satisfy the minimal reporting needs for EU Agri-environmental policies and the 28 AEIs. A total of 58 types of data are farm data, i.e. should be collected at the farm. For *accurate* GHG and NH_3 emissions accounting, additional farm data are needed, especially related to animal feeding, housing and manure management. Some of the needed data are used for many different policy reports and AEIs, while some are used only once. Often-used data include cropping and livestock patterns, fertiliser consumption, manure storage and application, nitrogen balances, GHG and NH_3 emissions, and water quality (pollution by nitrates and pesticides) (Vinther et al., 2011; Wilson et al., 2011; Velthof et al., 2011; Amon et al., 2011).

Our analyses indicate that the majority of the data required for calculation of AEIs are also required for reports on the reviewed Agri-environmental policies. A few AEIs do not have a clear linkage with these policies, i.e. are not required (yet), or are not fully compatible with data requirements for policy (Wilson et al., 2011).

Our analyses also indicate that in total 45 different data sources are being used for the 97 different types of data. Twenty of the pieces of data can be obtained from the Farm Structure Survey (FSS), 12 from the Survey on Agricultural Production Methods (SAPM), and 9 from the Farm Accountancy Data Network (FADN). A total of 23 different sources provide one type of data, while 11 sources provide two types of data (Vinther et al., 2011). The additional data needed for *accurate* GHG and NH_3 emissions accounting are not yet addressed fully by any data source.

Our analyses also indicate that many institutions are involved in the data collection – processing – reporting chain or system. For example, 15 different institutions (Departments, Institutes, Agencies, Working Groups) are involved in the data collection – processing – reporting chain for Gross Nitrogen and Phosphorus Balances in The Netherlands (Beek et al., 2011).

Finally, we observed (i) wishes for additional data and information due to new societal concerns and policy needs, (ii) needs for lowering/limiting the statistical response burden on farmers and survey costs for national statistical offices, and (iii) needs for harmonizing/lowering the reporting needs for EU Agri-environmental policies. Evidently, prioritization, an optimal solution and compromise are needed.

The purpose of this Chapter is to provide recommendations for an efficient, harmonized and common farm data collection system, on the basis of the analyses and reviews made in Tasks 1 to 7 of DireDate (Vinter et al., 2011; Wilson et al., 2011; Amon et al., 2011; Velthof et al., 2011; Beek et al., 2011; Perez-Soba et al., 2011).

7.2 Review of current data collection systems

Regulation No 1166/2008 outlines the Farm Structure Survey (FSS) for 2010, 2013 and 2016, and also the Survey on Agricultural Production Methods (SAPM) for 2010. The FSS distinguishes 7 categories (i) General characteristics of the farms, (ii) Land use, (iii) Livestock number, (iv) Machines and equipment, (v) Labour Force, (vi) Other gainful activities of the farm, and (vii) Support for rural development. The SAPM complements the FSS and includes 8 categories: (i) Soil tillage methods, (ii) Landscape features, (iii) Animal grazing, (iv) Animal housing, (v) Manure application, (vi) Manure storage and treatment, and (viii) Irrigation. Both FSS and SAPM are statistically representative at the level of NUTS 2.

The FSS is the backbone of EU agricultural statistics. The survey provides comparable statistical data on the structures of farms and horticultural enterprises in all member states. It is fully harmonised between the Member States and, since the individual data are sent to Eurostat for processing, it is flexible in terms of the possibilities for data extraction. It is conducted every three years and therefore enables the analysis of structural trend. The FSS is relatively strong in providing data on organic farming characteristics, land use characteristics, labour characteristics, and other gainful activities. The FSS is weak in characterizing external farm inputs (fertilizers, pesticides, energy, water) and management, and hence, in characterizing the agri-environmental interactions. Further, whilst more than 70% of the utilized agricultural area (UUA) in EU-27 is used for animal production, and more than 70% of the GHG and NH_3 emissions to the atmosphere and nitrate leaching to groundwater and surface waters originates from animal production, most questions in FSS seem not to be related to animal production systems. Though a backbone for agricultural statistics, FSS does not cover all data needed for agri-environmental policy reporting needs and AEIs.

The SAPM is a one-off supplement to FSS, focusing on production methods and management. It provides a high proportion of the required data for many of the policy reporting needs and AEIs and is fully representative of the farming community. However, it also does not address external farm inputs (apart from irrigation water). Also, it is a one-off survey and therefore does not enable the analysis of structural trends in production methods and management. Together, FSS and SAPM cover a large fraction of the data requirements (though not always at the required level of detail).

The Farm Accountancy Data Network (FADN) is another important source of data. However, FADN is entirely based on economics and includes only commercial farms, i.e. only around 40-50 % of FSS farms and is therefore less representative of the farming population.

Some 42 additional data sources are used to cover the data requirements for reporting policy needs and AEIs, although most of these additional data sources provide data other than farm data. Altogether, these different data sources provide a complex web. The large numbers of data sources likely originate from the recent changes in agri-environmental awareness and priority, the compartmentalization and specialization in science, policy and practice, and the lack of harmonization and integration.

7.3 Ideal data collection

Ideally, much of the required 58 types of farm data should be collected via farm surveys. The temporal and spatial resolution required for the data collection depends on the reporting requirements, but also on the dynamics, the volatility of the data. Conveniently, 5 spatial and 4 temporal scales may be distinguished for the policy reporting needs and AEIs (Table 7.1).

Table 7.1: Ideal spatial and temporal scales for data collection

	Spatial scales				
Temporal Scale ▼	**Farm**	**Catchment**	**NUTS 3**	**NUTS 2**	**NUTS 1**
Monthly		Water quality data			
Annual	Crop areas & yield, Livestock numbers, Farm inputs, Management (soil, crop, livestock)		Wild life counts		
3-5 years	Machines, Housings/buildings, Conversion factors Organic farming	Erosion	Land cover, Natural habitats,		
5-10 years	Farm structure, Training	Soil data, Climate data, Landscape		Non-agricultural areas	

Note that the scales of data collection are not necessary the scales of reporting.

For any data collection, the data source needs to be consistent and sustainable, and the applicability of a dataset must be considered carefully. Because of the huge diversity in farming systems and the large number of processing steps for some of the policy reporting needs and AEIs (see chapters 4 and 6), aggregations and averaging must be done as a final step (i.e. first combining the appropriate data as outlined in chapter 6 and then averaging). Annex 4 provides a detailed overview of data and coefficients required for calculating gross N and P balances and ammonia and greenhouse gas emissions.

Depending on overall objectives, there seems considerable potential for collection of much of the data required and at the same time to reduce survey effort and burden. This will also have the added benefit of enabling the effects of combined farm characteristics or management practices on the AEIs to be investigated if the data are kept together. When characterization of agri-environmental interactions is a key objective of a common and harmonized farm data collection, then resource use (including water, fertilizers, energy, and pesticides) and management characteristics (e.g., animal feeding and grazing, manure storage and application, and soil cultivation practices), must be included in the surveys, along with cropping and livestock patterns, and buildings and machines characteristics. When priorities have to be made, it is clear that the last three categories of the FSS (see Chapter 7.2) contribute much less to characterization of the agri-environmental interaction than farm

inputs and farm management. Evidently, the SAPM greatly complements the FSS, but would do even better if more questions related to farm inputs had been included.
Farm management responds to changes in weather conditions, markets, technological developments, governmental policy and civil society pressure. These responses relate to changes in (i) operational management, (ii) tactical management, and (iii) structural management. The operational management responses are at short notice (days to months), the tactical management at medium term (seasons to year), and the structural management at the long term (5 to 20 years). Farm inputs are greatly defined by the operational and tactical management and therefore should be surveyed in short intervals (1-3 yrs). In contrast, buildings, machines, labour force, and other gainful activities change more slowly and may be surveyed once in 5 to 8 years. Note also that trends in farm input use derived from observations at low temporal resolutions may be obscured by incidental inputs resulting from weather extremes.

The policy relevance of some of the AEIs justifies that investments are being made in accurate farm data collection. Chapter 4 provides a synthesis of the farm data needed for establishing the key AEIs 15 (Gross N balance), 18 (Ammonia emissions) and 19 (GHG emissions) accurately. Currently, there is lack of information about (i) animal feeding practices (rations), (ii) animal grazing practices, (iii) animal housing systems, (iv) manure type and storage systems, and (v) fertilizers and manure application rates and techniques, as function of crop types. The Survey on Agricultural Production Methods (SAPM) carried out in 2010/2011 addresses this lack to some extent. However, the aforementioned AEIs can not be estimated accurately without the data and information identified in Table 4.1. Surveys in Switzerland and Austria indicate that the required information can be obtained at reasonable costs.

Based on the aforementioned considerations as well as the conclusions and recommendations in the previous Chapters, we present here three proposals for a common and harmonized data collection (and processing) system. In all proposals, the primary objective of the data collection is the characterization of the agri-environmental interactions and related policy reporting needs and AEIs. The proposals differ in 'distance' from the ideal data collection – processing – reporting. In all cases, the processing of the collected data and information should proceed according to the schemes presented in Chapter 6.

1. Proceed as indicated in Regulation 1166/2008 with FSS in 2010, 2013 and 2016, and SAPM in 2010/2011. Include data from existing and additional survey(s) related to the consumption of fertilizers, pesticides, and energy, and on animal feeding and manure management in intermediate years (Table 4.1). The surveys should be carried out in such a way that the data from the different surveys may be combined with minimal bias. Evidently, this proposal allows for the continuation of current surveys and structures, but increases the data collection burden, also because of the additional survey(s). For beyond the timeframe of Regulation 1166/2008, the second recommendation should be considered.
2. Re-combine the FSS and SAPM supplemented with questions derived from Table 4.1 in such a way that two new questionnaires result. One of these should address the operational and tactical farm management aspects and should be carried out once in ~3 years. The other should address the farm structural management aspects and should be carried out once in ~5 years. This proposal has the potential of a common and

harmonized collection of key farm data for accurate characterization of the agri-environmental interactions, but may not necessary lower the data collection burden.

3. Combine key aspects of FSS and SAPM with key questions on animal feeding into a highly condensed new questionnaire to be carried out once in 2-3 years. In addition, derive key data related to farm inputs and management from the annual surveys of the FADN and sales data of market organization. Evidently, this proposal has the lowest farm data collection burden, but will require coordinated efforts by research institutes across EU for establishing harmonized relationships between data of the FSS-SAPM and data derived from FADN, to be able to derive accurate data for agri-environmental policy reporting and AEIs. Moreover, there is a risk of loss of accuracy.

7.4 Conclusions and recommendations

The current fragmented, complex and non-transparent farm data collection – processing – reporting chains in Member States are the results of diverse cultural and historical developments and insufficient support, embedding, and institutional structure, at both the level of the European Commission and Member States. A framework for a sustainable system for farm data collection – processing – reporting chain requires a proper embedding in policy and proper institutional and organizational structures, with appropriate support.

The EU policy reporting requirements demand a huge amount of data and information about agri-environmental interactions, which have to be reported more than once, for different policies, often in slightly different formats, units, and spatial and temporal scales. Moreover, the agri-environmental data and information requirements for policy reporting are similar to those required for reporting the 28 agreed AEIs. These observations lead to three recommendations to policy:

- Scrutinize (prioritize), and harmonize the agri-environmental data and information requirements of the EU agri-environmental policies;
- Use the AEIs and underlying data and information in a uniform way as 'building blocks' for policy reporting; and
- Streamline the flows of agri-environmental data and information between Member States and European Commission further.

Some AEIs are much more important than others. The AEIs for which data requirements have the most in common with policy data requirements and that have parameters represented across at least three policies include some 10 AEIs (Chapters 2, 3, 4, 5). Conversely, AEI 3 (Farmers training), AEI 11.1 (Soil cover), AEI 11.2 (Tillage practice), AEI 12 (Intensification/extensification), AEI 13 (Specialization) all seem to have a relatively low reporting need. Hence, there is room for prioritization. On the other hand, developments in societal awareness and perceptions may warrant new AEIs to be included or current AEIs to be redefined and/or extended. For example, there are concerns about desertification in some regions of EU-27 and there is a need for adaptation to climate change. Also, whilst the main purpose of agriculture is to produce food, there are no AEIs that provide information about the efficiency of food production; how many resources (inputs) are being used to produce one kilogram of wheat, barley, potato, vegetable, milk, beef, pork, poultry. These observations lead to the following recommendations:

- Scrutinize (prioritize) the list of 28 AEIs, delete less essential AEIs and categorize the remaining AEIs in a first set and second set of indicators. The differentiation that has been done in the current project (see Table 3.1) could be used as basis for further prioritisation and categorization;
- Address upcoming societal concerns in a timely and appropriate manner, and (re)define AEIs that address desertification and efficiency of food production.

The rate of change of agri-environmental data ideally warrants a categorization into three groups (i) annual observations (e.g. registers), (ii) three-yearly observations and (iii) 5-10 yearly observations. Annual observations are needed for data related to resource use (land, water, energy, fertilizers, pesticides), cropping types, animal numbers, and nutrient concentrations in water bodies. These data change relatively quickly in response to markets, policy, technology and weather conditions. Three-yearly observations are needed for farm management practices like animal feeding, animal grazing practices, fertilizer and manure application techniques, tillage practices, etc. Finally, five-to-ten-yearly observations are needed for farm structural aspects, like animal housing systems, manure storage systems, irrigation systems, land use change, organic farming, farmers training, genetic diversity, etc. The proposals for a common and harmonized farm data collection discussed in Chapter 7.3 address this categorization. Proposal 3 seems cheapest, although an initial investment will be needed to making the results of the FADN and sales statistics more agri-environmental relevant and analytical sound. In all cases, the data provided by the SAPM are highly relevant.

Finally, Chapter 6 convincingly shows the prospects of a harmonized data collection – processing – reporting chain. A detailed procedure for a common and harmonized data collection – processing – reporting has been developed for the AEIs 15 (Gross N (and P) balances), 18 (Ammonia emission), 19 (Emissions of the greenhouse gases N_2O and CH_4), 5 (N and P fertilizer consumption), 11.3 (Manure storage), 11.1 (Soil cover), 16 (Risk of pollution by phosphorus), 7 (Irrigation), 11.2 (Tillage practice), 26 (Soil quality), 21 (Soil erosion), 10.1 (Cropping pattern), 10.2 (Livestock pattern), and 27.1 (Nitrate pollution). In addition, four additional categories of AEIs have been distinguished, which would need common and harmonized data collection – processing – reporting chains. These notions lead to the following recommendations:

- Adopt the recommended procedures for a more harmonized data collection – processing – reporting chains for the five categories of AEIs distinguished.
- Develop protocols and formats (for example in Excel) for automated calculation of the AEIs according to the proposed harmonized data collection – processing – reporting chains.
- Establish Task Forces and working groups for deriving the needed coefficients.

ANNEXES

Annex 1. Summary of the ideal data needs of the 28 AEIs

The first set of AEIs (see Table 3.1 of the main document) are shaded in grey

AEI	Title	Data requirements
1	Agri-environmental commitments	Ideally, the following data should be collected at NUTS 2 level each year: • Physical area under AE commitment (Axis 2) by measure (Ha) • Total Utilised Agricultural Area (Ha) • Area under AE commitment also within Natura 2000 areas (Ha) • Number of unique agricultural holdings under AE commitment by measure • Total number of unique agricultural holdings • AE commitment expenditure (€) • Total RDP expenditure (€)
2	Agricultural areas under Natura 2000	The following data should be collected at regional level every 6-7 years to correspond with policy reporting: • Type of land uses (crops, grassland) in Natura 2000 area • Natura 2000 payments (€) • Total RDP expenditure (€) Ideally, the following data should be collected at farm level for farms within Natura 2000 areas by habitat type: • The % of UAA in Natura 2000 area • Type of management of Natura 2000 area i) stocking density (GLU/ha) ii) fertilised area (ha) iii) amount of fertiliser applied (Kg/ha) iv) pesticide application (Kg/ha)
3	Farmers' training level and use of environmental farm advisory services	Ideally, the following data should be collected at NUTS 2 level each year: • Number of farm managers having made use of farm advisory services • Number of farm managers having practical experience • Number of farm managers having basic training • Number of farm managers having full agricultural training • Area of agricultural area managed by the farmer (ha)
4	Area under organic farming	The following data are required, ideally every 2-3 years at NUTS 2 level: • Area under organic farming (ha) • Total Utilised Agricultural Area (ha)
5	Mineral fertiliser consumption	Ideally, the following primary activity data should be collected at farm level each year and reported at NUTS 2: • Fertilised area per farm (ha) • Crop types and area per crop type (ha) • Application rate of nitrogen via mineral fertilizers, animal manures, composts and sludge per crop type (Kg N/ ha/ yr) • Application rate of phosphorous via mineral fertilizers, animal manures, composts and sludge per crop type (Kg P/ ha/ yr) • Total amount of nitrogen applied via mineral fertilizers, animal manures, composts and sludge (kg N/ farm/ year).

		• Amount of phosphorus applied via mineral fertilizers, animal manures, composts and sludge (kg P/ farm/ year). Secondary activity data to be collected at farm level each year: • Number and categories of livestock on the farm • Manure storage conditions and manure application techniques • Weight and composition of imported animal manures, composts and sludge Coefficients: • N and P content of animal manure under different storage and application conditions
6	Consumption of pesticides	Ideally, the following information should be collected at farm level each year and reported at NUTS 2 or Climate Zone for estimating the *main indicator*: • Crop types and area per crop type (ha) • Dose of each application of each active ingredient per crop (g/ha) • Number of applications of each active ingredient per crop • Percentage of crop area treated per application for each active ingredient (%) Ideally, the following information should be collected at NUTS 2 level each year for estimating the *supporting indicator*: • Quantity used of each active ingredient (= active substance) (Kg)
7	Irrigation	Ideally, the following data and information should be collected at farm level once every five years and reported at NUTS 2 or Climate Zone: • Total area of the farm (ha) • Crop types and areas (ha per type) • Areas equipped with irrigation facilities (ha) • Areas actually irrigated (ha) • Area covered by different types of irrigation installation (including sprinklers, drip irrigation, flood irrigation, etc.) (ha) If the actual water use has to be reported, the following additional data and information should be collected annually: • Amount of water used in total (mm per ha) per crop per year and per month
8	Energy use	For the main indicator and supporting indicator, the following data should be collected at farm level once every 5 years and reported nationally by farm type: • Direct energy use, specified according to fuel type (oil products, natural gas, coal, electricity, derived heat), and total energy use (GJ per farm per year) • Type of farming system (glasshouse, arable farming, horticulture, dairy farming, beef farming, pig, poultry, etc.) • Farm area (ha) • Number of animals • Main crops When the purpose is also to estimate indirect energy use, the following additional data should be collected at farm level: • Indirect energy use in GJ per farm per year related to the purchase of farm inputs: fertilizers, pesticides, machines, buildings, purchased feed, etc.

<table>
<tr><td>9</td><td>Land use change</td><td>The data requirements of this indicator should be 5-yearly quantitative estimates of the areas of agricultural land (ideally subdivided into arable; improved grassland; unimproved grassland etc.) that have changed their function into:
urban, industrial and infrastructural surfaces
waste dump areas
amenity areas (golf course, sport areas)
abandoned land areas
nature conservation areas, including forests
All expressed in hectare of land per year and in percentage of the total agricultural area per year.</td></tr>
<tr><td>10.1</td><td>Cropping patterns</td><td>The ideal data that should be collected annually at farm level and reported at NUTS 2 by farm type, size and soil type for estimating cropping patterns are:
Total agricultural area of the farm (ha)
Area with individual crops (ha).
Yield of individual crops (kg dry matter per ha)
The latter is included since areas combined with yields provide information about agricultural productivity.</td></tr>
<tr><td>10.2</td><td>Livestock patterns</td><td>Ideally, the following data should be collected at farm level each year for reporting at NUTS 2 by farm type and size:
Number of animals in the different subgroups of the major animal types.
Conversion factor for calculation of LSU for each animal type and subgroup
Total feed uptake and purchased feed.
Area of grazing land and forage crops</td></tr>
<tr><td>11.1</td><td>Soil cover</td><td>Ideally, the following data should be collected at the farm level every 2-3 years and reported at NUTS 2 by farm type:
Total arable area (ha)
Area with winter crops (ha)
Area with grass (ha)
Area with maize (ha)
Area with catch crops (ha)
Straw removed or incorporated in soil (ha)
Can be improved by including:
Information about topography
The indicator may be slightly improved by including the following data at farm level:
Dates of sowing and harvesting
Number of days from sowing until crop is established.</td></tr>
<tr><td>11.2</td><td>Tillage practices</td><td>In order to estimate share of the different tillage practices, the following data should ideally be collected at farm level every 2-3 years and reported at NUTS 2 by farm type and major soil type:
Area managed by reduced tillage, i.e., without ploughing
Area managed by zero tillage (direct seeding)
Area managed by conventional tillage, i.e., with ploughing</td></tr>
</table>

11.3	Manure storage	To assess ammonia losses from storage, the following data should ideally be collected at farm level every 2-3 years and reported at NUTS 2 by farm type: • Type of manure (animal type, solid/liquid or slurry) • Type of storage (solid storage combined with liquid system, slurry tank, lagoon, covered, sealed on the ground, etc) • Storage capacity (months) To assess ammonia losses from animal housing, the following data are ideally needed per farm: • Animal type (e.g. pigs, cows, hens) • Housing or floor type (as listed in SAPM questionnaire '5. Animal housing') To assess ammonia loss during manure/slurry spreading the following data are ideally needed per farm and manure type: • Spreading technique (broad spreading/hose trail spreading/direct injection) • Time of spreading (autumn, spring, all year around) • Rate of application to arable/ grassland (Kg/ ha)
12	Intensification/ extensification	Ideally intensity classifications should be based on a range of data collected at farm level and reported at sector level. These data should provide a detailed picture on a range of practices determining the environmental pressures a farm exerts on the environment, but also the potentially positive contribution farms may have on biodiversity and habitats. Overall it is clear that input levels linked to output levels are the best indicators for expressing intensity. Ideally they should be provided at the farm and even field level, enabling not only the classification of farms in intensity classes, but also the farm land categories. This leads to at least the following requirements: • Input of mineral fertilisers, energy and pesticides in amounts per hectare and per land use type • Livestock density and amounts of purchased feed; • Ratio between input and output in monetary terms For data requirements see descriptions of AEI 5 (Mineral fertilizer Description), AEI 6 (Consumption of pesticides) AEI 7 (Irrigation) and AEI 8 (Energy use). For the development of a typology it is important to base it on a combination of input indicator information at farm level.
13	Specialisation	Ideally, the following data are required annually at NUTS 2 level: • The agricultural area managed by specialised farm types (ha) • The total agricultural area (ha)
14	Risk of land abandonment	Not yet known
15	Gross nitrogen balance	The gross nitrogen balance is calculated as the average for the agricultural land within a particular geographic area. Activity data are required to be collected at farm level each year and the N balance reported at NUTS 2 by farm type and size; • The amounts of nitrogen fertiliser, animal feed, organic fertiliser (livestock manure, domestic compost, sewage sludge), seed and livestock sold or donated to agriculture from non-agricultural sources or from outside the geographic area. • The export of crop products (e.g. grain, straw) and animal products (livestock, milk, wool etc) from agriculture for non-agricultural purposes (e.g. human consumption) or to outside the geographic area.

		• The area planted with nitrogen-fixing crops (e.g. clover, peas) within the geographic area. In addition, modelled data on atmospheric nitrogen deposition to the geographic area are required. (See Task 3 for details)
16	Risk of pollution by phosphorus	**Main indicator:** "P surplus of agricultural land" For the *farm P balance* the P inputs data required at farm level are; • Mass of the animal feeds, fertilizer, manures, seeds and bedding material imported into the farm (Kg) • The P mass fraction in these products (%) The P outputs data required at farm level are: • Mass of the harvested crop products and animal products (including animal manure) exported from the farm (Kg) • The P mass fraction in these products (%) For the *field P balance* the P inputs data required at field level are; • Mass of the seeds, manure and fertilizer applied to the field (Kg) • The P mass fraction in these products (%) The P outputs data required at field level are; • Mass of the harvested biomass (crop products) (Kg) • The P mass fraction in these products (%) The required data are further specified in the Task 3 Report. **Supporting indicator** "Vulnerability of agricultural land to phosphorus leaching and run-off" Estimation of the vulnerability of agricultural land to P leaching and run-off requires spatially and temporally explicit data: • *Soil P status*: the release of P into a mobile water phase (surface and subsurface) depends largely on the degree of P saturation in soils, which typically is related to soil test P. Similarly, the release of colloidal P is also related to soil test P. • *Soil type*: soil texture and mineralogy affect the risk of erosion and macropore transport as well as colloid mobilization; the P retention capacity depends on the contents of active P sorbents and pH. • *Tillage and cropping practice*: the vulnerability to erosion and surface runoff is affected by plant and residue cover, surface roughness, tramlines and traffic-induced soil compaction. • *Fertilisation practice*: there is a risk of direct P loss from fertilisers and manures when they are not incorporated into soils during periods with high precipitation. Also, historic P applications affect soil P enrichment and hence the soil P status and degree of P saturation. • *Climate*: total rainfall and its distribution over the year affect the hydrological pathways and the vulnerability to leaching and runoff. • *Drainage*: land drainage creates shortcuts between P-enriched soils and water courses. • *Topography*: surface and subsurface runoff depend to a large degree on terrain attributes like slope gradient and upslope contributing area as well as the distance of effective discharge and eroding areas to water courses. • *Landscape structure*: the connectivity between P sources and receiving waters depends on field size and shape as well as landscape elements like hedges, roads, ditches and buffer zones.

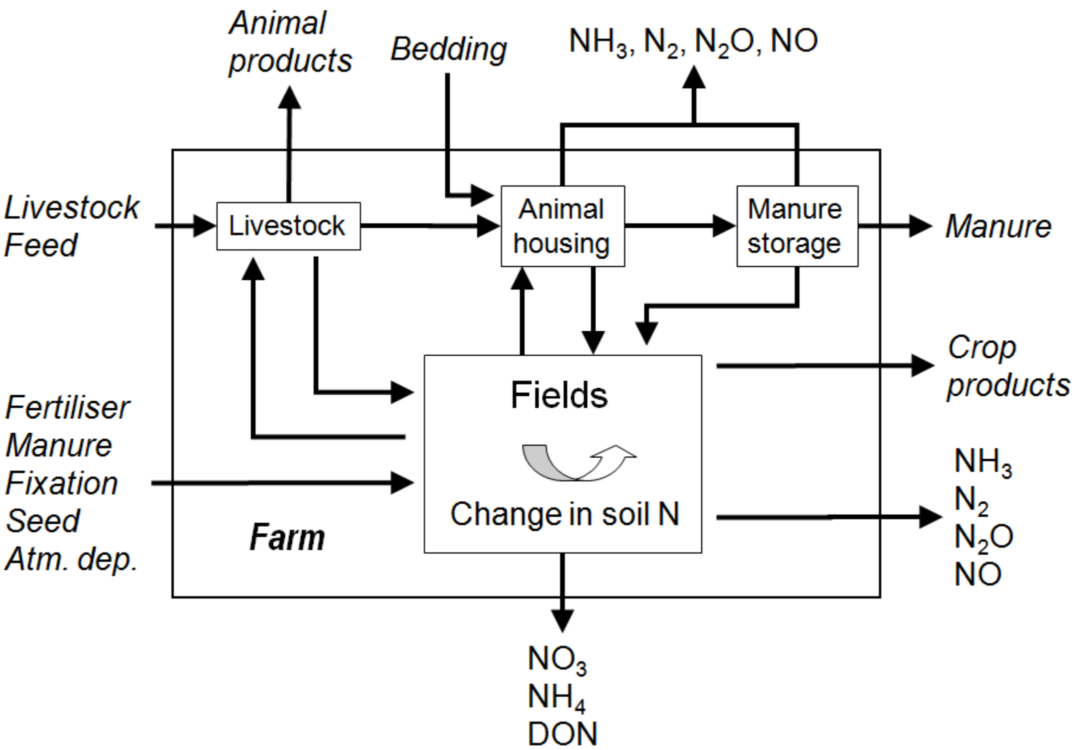
17	Pesticide risk	In order to assess the risk of pesticide run-off the following usage data should be collected, preferably at field or finer scales: • Crop management; cropped and pesticide treated area (ha) • Amount of each pesticide applied per crop (kg a.i. per ha per year). • Application dates of each pesticide to each crop And the following spatial data may be collated from maps with European coverage at the finest spatial scale available, or from farm surveys: • Surface water area (including streams, lakes, etc) *Potential data source – Waterbase rivers and lakes (WISE)* • Terrain attributes from high-resolution digital elevation models. *Potential data source – NEXTMap Europe (Intermap)* • Soil maps including texture. *Potential data source – European Soil Database (JRC)* • Landscape elements and field maps including buffer zones along water courses. *Potential data source – farm scale mapping (field survey)* • Drainage maps. *Potential data source – farm scale mapping (field survey)* • Detailed climate records. *Potential data source - E-OBS (a daily gridded observational dataset for precipitation and temperature)(European Climate Assessment & Dataset)*
18	Ammonia emissions	Data requirements are almost the same as for AEI 11.3 (Manure storage) concerning the activity data on animal types, housing and manure storage facilities. These state variables must be multiplied by an emission factor, i.e., kg N emitted per animal or per kg N in manure. Details about emission factors are described in Task 3.
19	Greenhouse gas emissions	The data requirements necessary for the IPCC 2006 methodology are described in detail in Tasks 2 and 3. Despite the differences in methodologies for estimating national excretion by livestock, the key data requirements are the same or similar for all methodologies. In brief, for UNFCCC they include activity data on livestock numbers by type, manure management practices, cropping areas, fertiliser use, crop yield; and emission factors of GHGs for each. For LULUCF, they include activity data on broad land use areas, land-use change, and emission factors of GHGs for each.
20	Water abstraction	Ideally, the following data should be collected annually at farm level and reported at the catchment scale: • Irrigated area (ha) (yearly) • Amount of water used (mm per ha) and per crop per year and per month • Source; ground or surface water • Type of irrigation installation/infrastructure
21	Soil erosion	Work carried out at JRC suggest that the following types of data are needed: • Soil data (texture, organic carbon content, structure, permeability) • Climate data (precipitation, temperature) • Land cover, as provided by CORINE, leaf areal index • Topography, as provided by e.g. the topographic model Shuttle Radar Topography Mission (SRTM) • Management – human and agricultural practices

22	Genetic diversity	Ideally, the following data should be collected at farm level each year, to be reported at NUTS 2: • Main breeds per livestock type • Most dominant varieties of seeds used for the production of the main crops
23	High Nature Value farmland	The ideal data needed relate to: • Intensity of land use (e.g. size of fields, density of crop, presence of weeds, conditions of the fields (e.g. irrigation facilities, steepness, rockiness, wetness, etc.)) • Presence of semi-natural features (size, length, density of linear, point and area features) • Presence of land use mosaics (diversity in land use)
24	Renewable energy production	Ideally, the following data should be collected at farm level every 2-3 years and reported at NUTS 2: • Type and area of targeted biomass cropping • Amount of harvested primary and secondary biomass feedstocks converted into bioenergy at farm and outside the farm (this includes oil, starch, sugar feedstocks for biofuel, ligno-cellulosic/woody material from primary (crops) and secondary (e.g. straw, cuttings) sources, manure)
25	Population trends of farmland birds	Ideally *bird counts* should be made on every farm on a regular (every 2 to 5 years) basis. To gain maximum benefit from this indicator, these observations should be made in conjunction with detailed land use and land management information.
26	Soil quality	• Soil: texture, soil taxonomic class, available soil water (both for topsoil and subsoil), pH, CEC, N, P, and K • Climate: Climate Areas of Europe • Land use: cropland and grassland/pasture land use types • Topography: SRTM-based DEM • Management: fertiliser input (N, P, and K), tillage (conventional / reduced / zero tillage), manure applied
27.1	Water quality – Nitrate pollution	The required data are *time series measurements of nitrate concentration* in water bodies at monitoring sites selected by individual member states as critical areas with respect to nitrate pollution.
27.2	Water quality – Pesticide pollution	The required data are *time series measurements of pesticide concentration* in water bodies at monitoring sites selected by individual member states as critical areas with respect to pesticide pollution.
28	Landscape – State and diversity	The complexity of European landscapes is difficult to capture by a single or even a group of parameters/indicators. Some landscape indices and or parameters are also hard to understand for the general public. This indicator aims to give easy to understand messages. Therefore, the indicator is structured in three components: • *Degree of naturalness*: it measures the distance of the actual system from the natural one. It is calculated on the basis of land use and intensity of management • *Rural-agrarian landscape structure*: it measures the internal structure and configuration of the rural-agrarian landscape (nr of crop types), and the structure of such landscape in reference to the overall landscape matrix (largest patch index) • *Societal appreciation*: it is a proxy of the interest/perception that society has for the rural-agrarian landscape. This involves the assumption that such interest can be demonstrated with the regulations on landscape protection and with the use and enjoyment that society makes of this type of landscape (labelled products and agritourism)

Annex 2. Nitrogen and phosphorus balances

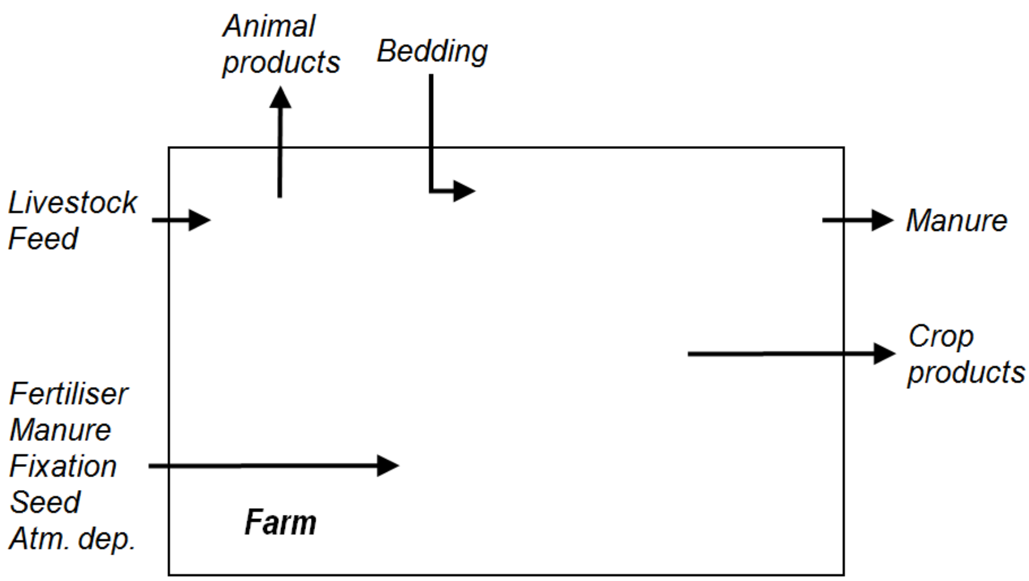
This Annex provides supplementary information to Chapter 4 about nitrogen and phosphorus balances. The gross nitrogen and phosphorus balances provide holistic indicators of the related environmental pressure exerted by agriculture. For N, significant losses occur to the atmospheric in the form of ammonia, nitrous oxide, nitric oxide (NO) and dinitrogen (N_2). Ammonia, nitrous oxide and nitric oxide are pollutants whereas the emission of dinitrogen reduces the effectiveness of manure and fertilisers and the fertility of soils. Nitrogen is lost to aquatic environments in the form of nitrate, ammonium and dissolved organic N, all of which can lead to pollution and all of which reduce the fertility of the soil. The nitrogen flows and losses in agricultural systems are schematically shown in Figure A.2.1.

Figure A.2.1: Schematic representations of the main nitrogen flows and losses in agricultural systems



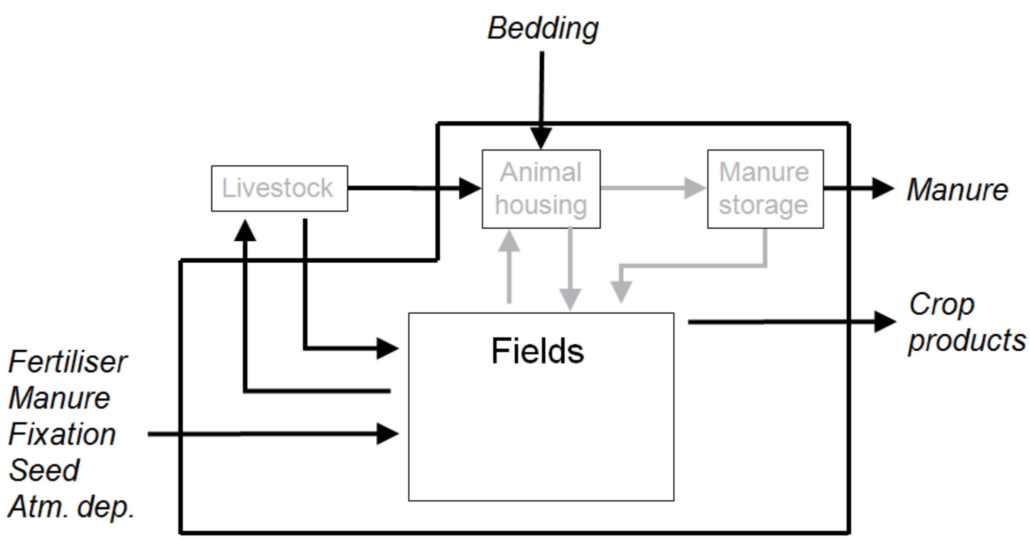
In a farm N balance, all internal flows of N are ignored (Fig A.2.2). The balance therefore includes all losses of N to the atmospheric and aquatic environments, plus any changes in the storage of N in the soil. When applied at the national scale, it would be more correct to call this a sector N balance, since the transfer of N between individual farms is then treated as an internal flow.

Figure A.2.2: Schematic representation of a farm N balance



The gross N balance captures the identical information as the farm N balance but it is calculated differently (Figure A.2.3). Here, the imports of N in animal feed and the export in animal products are not required, whereas estimates are required for the excretion of N by livestock and the amount of N consumed by livestock in feed that is produced within the area of interest (farm, region, sector).

Figure A.2.3: Schematic representation of a gross N balance. Flows shown in grey are not included in the calculation



In a soil nitrogen balance, the gaseous emissions from animal housing and manure storage are subtracted (Figure A.2.4), so this balance is of greater value if the aquatic environment is the main focus of interest. An even closer relationship to the pressure on the aquatic environment would be obtained if the ammonia emission from field-applied manure was subtracted from the soil nitrogen balance. However, the farm management data necessary to calculate the soil nitrogen balance are currently scarce and uncertain.

Phosphorus is a potential pollutant of aquatic environments, since it leads to eutrophication. There is no major loss of P to the atmosphere; losses occur by surface run-off, erosion and leaching. The calculation of P balances is less problematic than for N because there are fewer sources of inputs of P to agriculture and there are no major gaseous losses. The P flows and losses in agricultural systems are schematically shown in Figure A.2.5. Further, since there are no major gaseous losses of P, the soil P balance is little more informative than the farm balance.

Figure A.2.4: Schematic representation of the main nitrogen flows of a soil nitrogen balance of agricultural systems

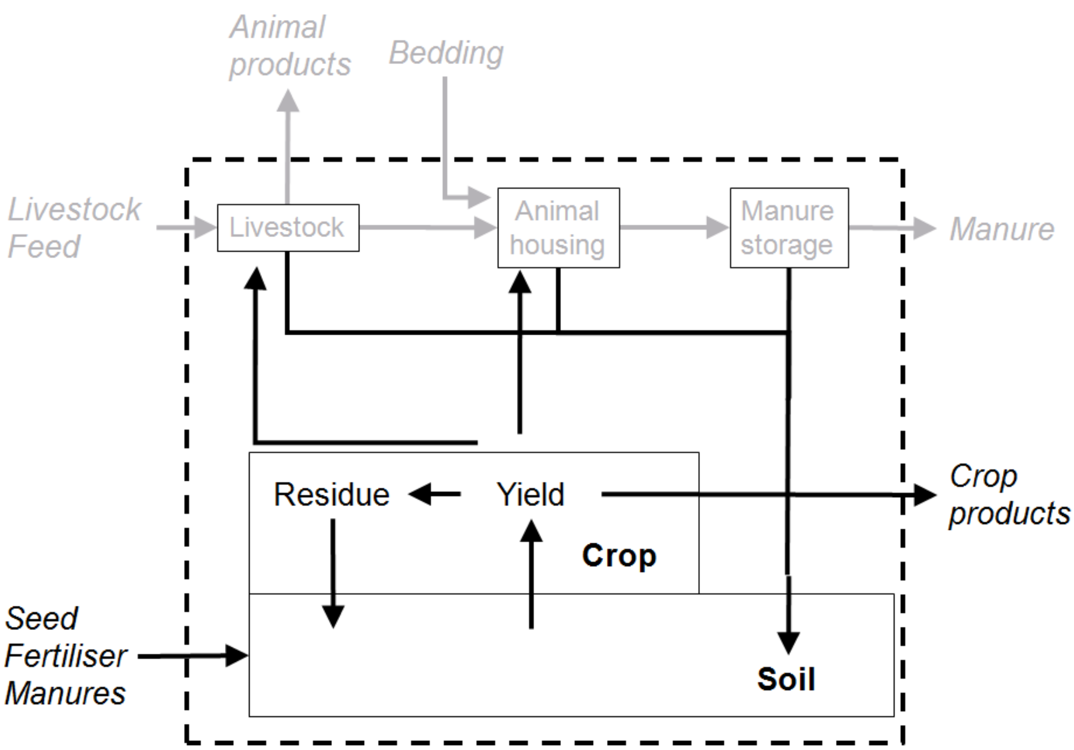
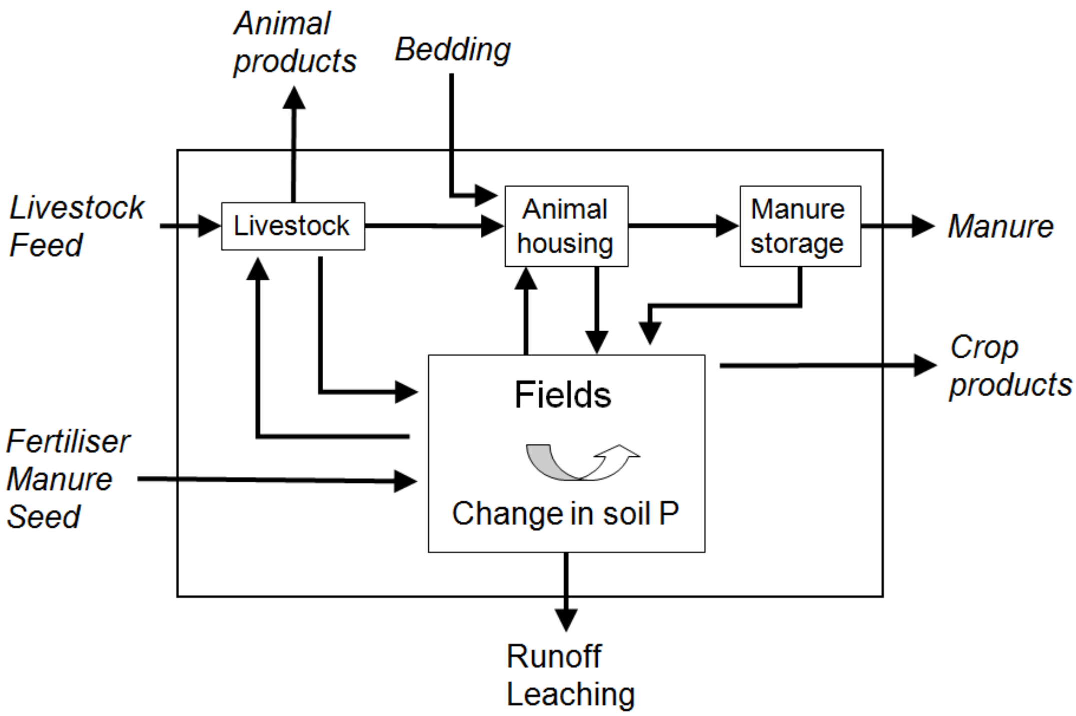


Figure A.2.5: Schematic representation of the main phosphorus flows and losses in agricultural systems



The following aspects deserve particular attention:

- Changes in the amount of N stored in the soil can have a large effect on the N balances when there are significant changes in land management, especially when wetlands are drained. A methodology should be developed to account for this change.

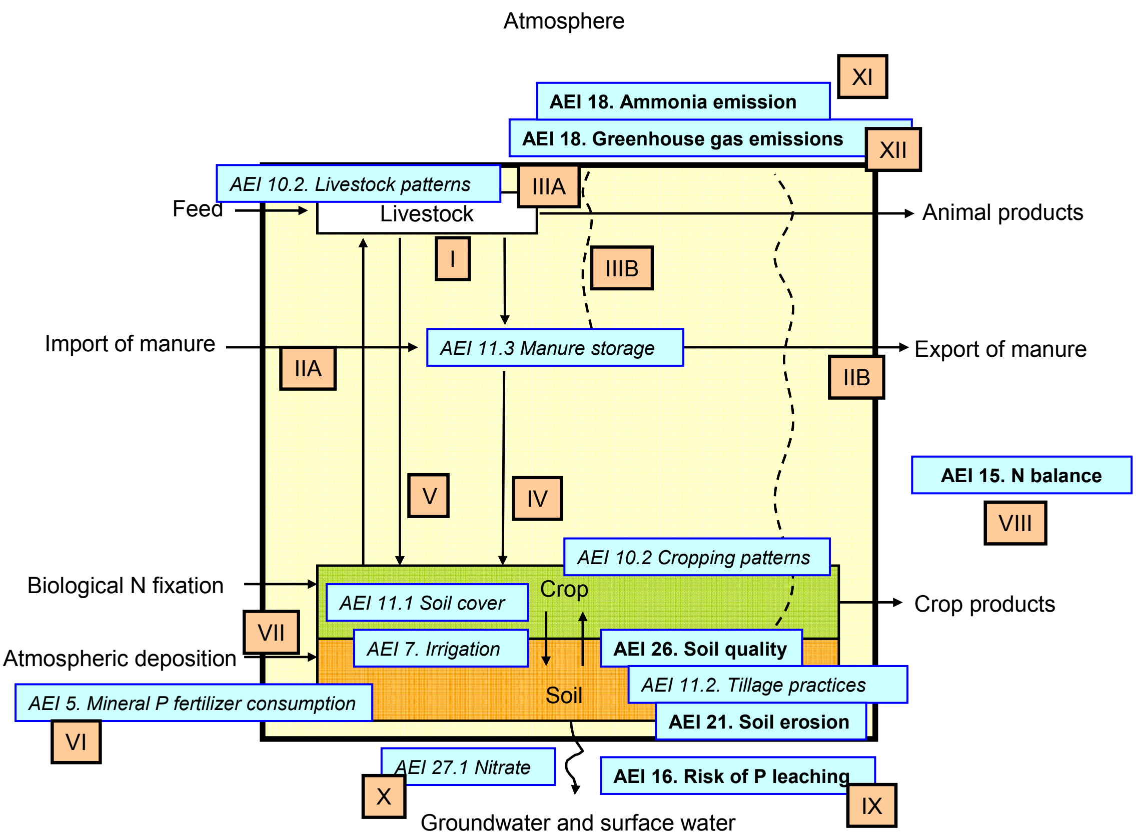
- The credibility of expert estimates of the excretion of N by livestock should be assessed periodically, using statistics relating to animal production and the efficiency of N use for the production of animal products.

- Efforts should be made to improve the statistics concerning the import of animal feed, with a view of their use in calculating gross N balances, farm P balances and providing an additional method of assessing the credibility of N excretion estimates.
- Disaggregation of national N and P balances to finer spatial scales is often valuable for policymaking but faces significant methodological challenges. Initial investigations concerning the use of farm typologies in the spatial disaggregation are promising and deserve further investigation.

Annex 3. Towards a common and harmonized data collection for AEIs related to manure and fertilizer use

This annex presents data requirements and recommendations for each step in the common and harmonized data collection – processing – reporting chain for AEIs related to manure and fertilizers, as discussed in Chapter 6. The various steps are indicated in Figure A.3.1.

Figure A.3.1: Scheme with calculations steps for data collection and processing to estimate the AEIs related to emissions of N and P balances and emissions of ammonia and greenhouse gases



The steps (Roman numbers in boxes) are explained in the text.

Step I. *Calculate the total annual N and P excretion by livestock during grazing and in housing. The excretion of carbon may be included if it is needed for calculating methane emissions from manure storage.*

Required data:

- The number of livestock per category.
- The N, P and C excretion per animal category per year.
- The portion of the manure excreted in housing and during grazing (calculated from housing/grazing days).

Recommendations:

- The number of livestock should be collected at farm level and give an estimate of the average number of animal heads of live animals per year per livestock category.
- The unit is live animal per animal category per year.
- Detailed collection of the number of livestock categories for AEIs is only useful if the N and P excretion of specific categories can be estimated. If not, it is more efficient to aggregate livestock categories.
- An accurate estimate of the major animal categories (i.e. with highest manure production) has the highest priority, which are generally dairy cattle, beef cattle, sows, fattening pigs, broilers and laying hens. However, in certain member states also other livestock categories significantly contribute to the manure production in a country, such as sheep and goat.
- The current data collection surveys estimate cattle, pig, sheep and goat livestock numbers. However, there is no legal obligation to produce livestock statistics for poultry, horses, donkeys, mules or other animals. The number of poultry can be estimated from the statistics on eggs and chicks. The contribution of horses, donkeys, mules or other animals in the total manure production is generally small. Collection of number of these numbers of livestock does not have a high priority.
- It is recommended to collect data about grazing system of cattle (i.e. the major category) at farm level. The data about grazing systems or time need to be translated in N and P excretion in housing and during grazing. Methodology and coefficients are needed for this.
- Use region specific N and P excretion rates for dairy cattle in countries, where large regional differences in milk production occur. For countries with small regional differences in milk production and for all other livestock categories, N and P excretion have to be estimated on a country level.
- Develop a uniform approach to calculate N and P excretion in the EU-27 countries. The methodologies to calculate N and P excretion, using input-output balances and several data sources, are available.
- Some countries have systems in place to calculate N and P excretion by livestock, based on country specific feed composition and livestock production (e.g. used in Action Programmes for the Nitrates Directive). It is recommended that these countries use the calculated N and P excretion rates for the AEIs.
- The N and P excretion must be expressed in kg N or kg P (or P_2O_5) per live animal per year.

- The focus on improvement of N and P excretion figures must focus on the major categories such as dairy cattle, beef cattle, sows, fattening pigs, broilers and laying hens, as these categories have the largest effect on manure production and related emissions.
- For countries that use a method based on TAN-based (TAN = Total ammoniacal nitrogen) method to calculate ammonia emissions, the TAN excretion has to be estimated. This can be done using standard values for TAN or by calculation using the composition of feed.
- For calculation of the C excretion, the IPCC methodology can be used.

Step II. *Calculate the amounts of N and P imported (IIA) and/or exported (IIB) as manure.*

Required data:
- Export and import of manure per year and the contents of N and P of this manure.

Recommendations:
- The export/import of manure has to be considered on a region scale (i.e. transport between regions within a country) and national scale (i.e. transport between countries).
- The transport of manure is mostly based on volumes. The amount of N and P transported have to be estimated using average N and P contents of the manure. In most member states, composition of manures is indicated in action programmes of the Nitrates Directive and/or fertilizer recommendations. These mean N and P contents should have a firm and scientifically sound underpinning.

Step III. *Calculate the gaseous emissions from livestock (IIIA), housing and manure storage (IIIB) per year: N_2O, NH_3, and CH_4. In order to calculate the amount of N that is transported from manure storage to the field, also the N_2 emission has to be calculated.*

Required data:
- The minimum data requirements for calculating CH_4 emission from enteric fermentation are the type of livestock and emission factors for CH_4.
- Amount of stored manure, expressed in mass of N and C (derived from the calculations in Steps I and II) per year,
- Emission factors for NH_3, N_2O, N_2, and CH_4 dependent of type of housing,

Recommendations:
- The CH_4 emission from enteric fermentation is calculated from the number of livestock per category and a CH_4 emission factor.
- The important livestock categories are ruminants, and especially dairy cattle and beef cattle. Other livestock categories that may significantly contribute to national CH_4 emissions in certain countries are sheep.

- For CH_4 emission factors, it is recommended to follow IPCC guidelines (minimum requirement), i.e. a Tier 2 method for dairy cattle and other cattle, and Tier 1 for the other categories. The CH_4 emission factor should be derived on a national level.
- The Tier 1 CH_4 emission factors are presented in the IPCC Guidelines 2006.
- The Tier 2 CH_4 emission factors for dairy and other cattle have to be calculated using the methodology described by IPCC. This methodology demands for detailed data, including
    - weight (kg);
    - average weight gain per day (kg);
    - feeding situation: confined, grazing, pasture conditions;
    - milk production per day (kg/day) and fat content (%);
    - average amount of work performed per day (hours day^{-1});
    - mean winter temperature (ºC):
    - percentage of females that give birth in a year;
    - wool growth;
    - number of offspring; and
    - feed digestibility (%).
- For member states that apply a Tier 2 or Tier 3 methodology for the estimation of CH_4, N_2O and NH_3 emissions, detailed information about housing and manure systems is needed. The required data are dependent on the used methodology and coefficient. In the ideal situation, the data includes information about type of floor (capture/no capture of leachate), amount of straw added as bedding, direct spreading of manure, housing (fully-slatted floor, partially slatted floor, tied, loose, mechanical ventilation, scrubbers or biofilters), manure separation, manure to anaerobic digester (AD), supplements added to AD (food waste, crop residues, whole crops), slurry storage (open tanks, covered tanks, lagoons, underfloor pits), manure stored in manure heaps, manure composted, and manure incinerated.
- For member states that do not have sufficient data to use Tier 2 or Tier 3, it is recommended to use a Tier 1 approach using the manure management systems indicated by IPPC 2006 Guidelines or the GAINS model.
    - The IPCC guidelines provide estimates for emissions factors of greenhouse gas emissions for several manure management systems: (i) anaerobic lagoon, (ii) liquid system, (iii) daily spread, (iv) solid storage and dry lot, (v) pasture range and paddock, (vi) used fuel, and (vii) other systems.
    - The GAINS model uses a Tier 1 approach, in which for pigs and cattle liquid and solid manure management systems are considered and for the other livestock categories one (average) systems.
- The primary data on housing systems and manure storage systems should be collected at the farm level.
- The coefficients to calculate the amount of manure stored and the emissions of NH_3, N_2O, N_2, and CH_4 have to be determined (minimum level) at international level (e.g. IPCC or EEA/EMEP Guidelines). Member states can use country-specific or region-specific coefficients if these coefficients can be scientifically underpinned.
- For the calculation of the manure N applied to soils, also the N_2 and NOx losses in housing systems have to be considered. It is recommended to use the default

emission factors for NOx and N_2 presented in the EEA/EMEP guidebook for slurry and solid manure or country-specific values.

- For countries that use a TAN-based methodology to calculate ammonia emissions, the mineralization and immobilization of N during the storage of manure have to be calculated. It is recommended to follow EEA/EMEP Guidebook.

Step IV. *Calculate the amounts of manure N applied to the soil, and the associated emissions of NH_3 and N_2O.*

Required data:

- Amount of N applied as manure per year, divided over crop and grassland areas. The amount of N applied is calculated as: the amount of excreted N in housing - the export of manure N and P + the import of manure N – gaseous N emissions from housing and storage (NH_3 + N_2O + N_2).
- Emission factors for NH_3 for different application techniques, and if available for soils and crops.

Recommendations

- Use the default emission factor of ammonia and nitrous oxide (in % of the N applied) presented in EEA/EMEP Guidebook and IPCC Guidelines.
- If data are available, derive country specific emission factors for ammonia and nitrous, e.g. dependent on factors as mineral N fertilizer type, manure N application technique, crop and soil type.

Step V. *Calculate the amounts of N and P excreted during grazing, and the associated emissions of NH_3 and N_2O.*

Required data:

- N and P excretion (result of calculation in Step II) during grazing per year,
- Grassland area, and
- Emission factors for NH_3 and N_2O.

Recommendations

- Use the default emission factor of ammonia and nitrous oxide for N excreted during grazing (in % of the N applied) presented in EEA/EMEP Guidebook and IPCC Guidelines.
- If data are available, derive country specific emission factors for ammonia and nitrous, e.g. the dependent of the N content of the feed.

Step VI. *Calculate the amounts of N and P applied as N and P fertilizer, and the emissions of NH_3 and N_2O associated with N fertilizer use.*

The application of nitrogen and phosphorus via mineral fertilizers are needed. The emissions are dependent of the type of N fertilizer. Data of soil cover (area grassland, fodder crops and arable crops) are needed to calculate the application rates per ha.

Required data:

- Amounts of N and P fertilizer use per year,
- Crop and grassland areas (soil cover), and
- Emission factors for NH_3 and N_2O for different types of N fertilizers.

Recommendations

- The total N and P fertilizer consumption is needed on regional scale, as the calculations for the N and P balances and ammonia and nitrous oxide emissions are based on regional and national scale. For the Nitrates Directive the amount of N fertilizer used in nitrate vulnerable zones is needed.
- For ammonia emission, the national use ammonium nitrate, calcium ammonium nitrate, anhydrous ammonia, ammonium phosphate, urea, urea-ammonium nitrate solution (UAN), and other N fertilizers is needed.
- For nitrous oxide emission, the total mineral N fertilizer use.
- The determination of risk of P leaching on a farm scale is considered as long-term development, and not feasible for the short-term (because of the need of very detailed data environmental conditions information). Therefore, it is recommended to derive P mineral fertilizer use on the regional level.
- Data from fertilizer producers and retailers (e.g. via EFMA or FAO) may be used, but may need a correction to translate fertilizer production in fertilizer consumption. EFMA provides statistics such as total N and P fertilizer use (Kt) per country, and fertilizer consumption per crop (%) in the EU-27.
- Ideally, it the N and P balance should be derived on a regional level and an agricultural sector basis, since policies designed to reduce the surpluses on the N and P balances would be more cost-effective if the sources of inefficiency can be identified. There is no need for calculation of N and P balances on the farm level.
- It is recommended to derive a method of downscaling (disaggregation) of national mineral N and P fertilizer use to crop and regional level. The results should be checked with data from targeted surveys of fertilizer use on selected farms. The data collected in such a survey can be used to improve the methodology if needed. Ideally, the down scaling of national data on mineral N and P fertilizer use is carried out with the same methodology.
- Use the default emission factor of ammonia and nitrous oxide (in % of the N applied) presented in EEA/EMEP Guidebook (see Table 13) and IPCC Guidelines.
- If data are available, derive country specific emission factors for ammonia and nitrous, e.g. dependent on factors as mineral N fertilizer type, manure N application technique, crop and soil type.

Step VII. *Calculate the N inputs via biological N fixation and atmospheric N deposition and related N_2O emissions*

Required data:

- Biological N fixation
- Atmospheric N deposition

Recommendations

- The best estimate of N fixed by clover can be made from local experts with knowledge of the grasslands and management of grassland.
- The N fixed by other leguminous, such pulses and soya, can be estimated as the N uptake of the total crop.
- The N fixed by free living soil bacteria is generally very small, i.e. < 5 kg N per ha per year, and can be neglected in the balance calculation.
- It is recommended to collect data on atmospheric N deposition on the regional scale (and especially for countries with large spatial differences in atmospheric deposition). Local and European sources of N deposition are available.
- The atmospheric P deposition is small and can be neglected in the P balance calculations.
- It is recommended to derived estimates of the total use of organic products in countries or regions from companies that produce/sell these products, such compost producers, and water purification plants. The European Compost Network (ECN) may be a source of information.
- The use of compost and other organic products are probably expressed in tonnes product. Estimates of the N and P (and organic C and heavy metals) should be derived by a literature/desk study to derived average (default) values if these contents are not available.
- Use the default emission factor of ammonia and nitrous oxide (in % of the N applied) presented in EEA/EMEP Guidebook (see Table 13) and IPCC Guidelines.
- If data are available, derive country specific emission factors for ammonia and nitrous, e.g. dependent on factors as mineral N fertilizer type, manure N application technique, crop and soil type.

Step VIII*. Calculate the Gross N balance*

Required data:

- N inputs
    - Manure N applied (**Step IV**). For the soil N balance, the gaseous N losses during housing and from manure stored has to be extracted from the N excretion, so as to estimate the actual amount of N applied.
    - N excreted during grazing (**Step V).**
    - Mineral N fertilizer application (**Step VI**).
    - Biological N fixation (**Step VII).**
    - Atmospheric N deposition (**Step VII).**

- N outputs:
    - N removed by harvested crop products (yields), calculated from the yields and N contents of the harvested products per year, cropping patterns (including catch crops and winter crops; soil cover) and grassland area. The AEI 7 *Irrigation* can be used to estimate the yield.

Recommendations

- The harvested yields (i.e. removed from the field) have to be used on regional or national scale (depends on the size of the country). The current yields estimates of Eurostat can be used for the balance calculations.
- Accurate yields of grasslands are lacking, but are needed to obtain data for the N and P balances. A methodology should be developed to estimate the grassland yields in different countries/regions in EU-27, taking the different management types into consideration (rough grazing, extensively managed, and intensively managed).
- It also recommended to verify if the estimates and forecasts made by the Monitoring Agricultural Resources (MARS) Unit of JRC can be used as a source of yields or validation of yields.
- For irrigation, it is recommended to use on the short term the current FSS data set on (1) total irrigable area (area covered with irrigation infrastructure), total cultivated area irrigated at least once a year (actual irrigated area), and (3) cultivated area of 10 main crops irrigated at least once a year.
- It is recommended to collect irrigation data in targeted farm surveys every five years. The collected data should include data on:
    - The areas equipped with irrigation facilities;
    - The areas and types of crops actually irrigated;
    - The area covered by different types of irrigation installation, i.e. sprinklers, drip irrigation, flood irrigation, and other types of irrigation
- It recommended carrying out a desk study to obtain the N and P contents in the crop products in different regions in EU or in dependency of the N and P inputs.

***Step IX**. Calculate the risk of pollution by phosphorus.*

The risk of pollution by phosphorus is calculated as the P surplus on the P balance, i.e. the difference from the P inputs via i) mineral fertilizer, ii) manure, and iii) grazing and the P output via crop removal, including the P removed by cut or grazed grass. This is the main indicator. The vulnerability to phosphorus leaching and run-off is a supporting indicator. A method to quantify the vulnerability to phosphorus leaching and run-off needs further development, and may include, in addition to the P balance, AEIs 11.1 *Soil cover*, AEI 26 *Soil quality* (including soil P status), AEI 7 *Irrigation*, AEI 11.2 *Tillage practice*, AEI 21 *Soil erosion*, and climate, topography, hydrology.

Required data:

- P inputs
    - Manure P applied (**Step IV**).
    - P excreted during grazing (**Step V).**
    - Mineral P fertilizer application (**Step VI**).

- P outputs:
    - P removed by harvested crop products (yields), calculated from the yields and P contents of the harvested products per year, cropping patterns (including catch crops and winter crops; soil cover) and grassland area. The AEI 7 *Irrigation* can be used to estimate the yield.

Recommendations:
Estimation of the vulnerability of agricultural land to P leaching and run-off to the aquatic environment requires a large amount of spatially and temporally explicit data. The following (combination of data) are helpful to improve the estimate of the risk of P leaching in combination with the P surplus:

- Phosphorus status of soils, soil test P values, P saturation index and P sorption capacity. *Potential data source – LUCAS 2009, soil samples (JRC)*
- Crop management; cropped and fertilised area (ha).
- Amounts of fertilizer and manure P applied
- Amounts of fertilizer and manure P applied in the past
- Soil texture (Potential data source – European Soil Database (JRC)
- Tillage and cropping practice.
- Climate: total rainfall and its distribution over the year and irrigation affect the hydrological pathways and the vulnerability to leaching and runoff.
- Topography: surface and subsurface runoff depend to a large degree on terrain attributes like slope gradient and upslope contributing area as well as the distance of effective discharge and eroding areas to water courses.

In order to estimate share of the different tillage practices, the following data are needed per farm:

- Area managed by reduced tillage, i.e., without ploughing.
- Area managed by zero tillage (direct seeding).
- Area managed by conventional tillage, i.e., with ploughing.

Step X*. Nitrate pollution*

Data of measured nitrate concentrations in groundwater and surface waters have to be collected at well-defined and described sampling stations, through monitoring programs. For groundwater, one or two samples per years is usually sufficient, for surface waters monthly or quarterly samples have to be taken and analyzed.

Recommendations:

- Use monitoring for Water Framework Directive and Nitrates Directive EEA, as published by EEA in the WISE data base (Water Information System for Europe). There are three datasets publicly available via WISE. 'Waterbase – Lakes', 'Waterbase – Rivers' and 'Waterbase – Groundwater'.

Step XI*. Ammonia emissions*

The AEI 18 *Ammonia emissions* is calculated as the sum of the emissions from housing and manure storage (**Step III**), manure application (**Step IV**), grazing (**Step V**), and mineral N fertilizer (**Step VI**).

Step XII*. Greenhouse gas emissions*

The AEI 19 *Greenhouse gas emissions* is the sum of nitrous oxide, methane and carbon dioxide emissions, all expressed in carbon dioxide equivalents per ha per year. In this report, the non-CO_2 greenhouse gas (N_2O and CH_4) emissions are considered only, as agriculture is the main source of these greenhouse gases.

The total direct nitrous oxide emission is calculated as the sum of the emissions from housing and manure storage (**Step III**), manure application (**Step IV**), grazing (**Step V**), and mineral N fertilizer application (**Step VI**).

The total methane emission is calculated as the sum of the methane emission from livestock (enteric fermentation; **Step II**) and storage of manure (**Step III**). Notice that wetland rice is also a source of methane, but in EU the area of wetland rice is limited (some regions in Italy, Spain and Bulgaria). Wetland rice is not included in this report, but countries with wetland rice have to include the emission in the calculation of total methane emission.

The total indirect nitrous oxide emission (i.e. the emission related to ammonia emissions and nitrate leaching) have to calculated as:

- Total ammonia emission (**Step XI**) and the emission factor for the indirect nitrous oxide emission from ammonia.
- Total N input to the soil (see **Step VIII**), the leaching fraction (for example, the $FRAC_{leach}$ factor of IPCC), and the emission factor for the indirect nitrous oxide emission from nitrate leached.

Required data:

- The emission factor for the indirect nitrous oxide emission from ammonia,
- The emission factor for the indirect nitrous oxide emission from nitrate,
- The nitrate leaching fraction.

Recommendations:

- Use the default emission factors for indirect N_2O emission nitrous oxide presented in the IPCC Guidelines.
- Use the default leaching fraction of the IPCC Guidelines.
- If data are available, derive country specific indirect N_2O emission factors related to ammonia emission and nitrate leaching.
- If data or methods are available, a country specific N leaching or FracLEACH can be derived.

Annex 4. Specific recommendations for collection of farm data related to gross nitrogen and phosphorus balances and ammonia and greenhouse gas emissions.

This annex presents 6 tables with specific recommendations for collecting the farm data required to calculate gross nitrogen (N) and phosphorus (P) balances and ammonia (NH_3) and greenhouse gas (GHG) emissions, as discussed in Chapters 4, 6 and 7. The 6 tables (Tables A4.1 to A4.6) include specifications for:

1. data related to inputs of N and P.
2. coefficients related to inputs of N and P.
3. data related to factors affecting emissions of ammonia and greenhouse gases.
4. coefficients related to factors affecting emissions of ammonia and greenhouse gases.
5. data related to N and P in harvested crop products.
6. coefficients related to N and P in harvested crop products

Table A4.1: Recommendations for collection of data related to inputs of N and P

Two scenarios are included. The minimum scenario is the scenario with collection of data which are at least needed for reporting for policies and AEI (e.g. Tier 1) and the optimum scenario is the scenario for collection of data in detailed approaches (e.g. Tier 2 and 3 methods).

Type of data	**Scenario**	**Data specification**	**Unit**	**Policy need**	**AEI need**	**Scale of collection**		**Source/method**
		Number/amount				**Spatial**	**Temporal**	
Number of livestock	Minimum	dairy cattle	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Minimum	beef cattle	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Minimum	other cattle	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Minimum	sows, incl. piglets	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Minimum	fattening pigs	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Minimum	broilers	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Minimum	laying hens	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Minimum	other poultry	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS

Type of data	Scenario	Data specification	Unit	Policy need	AEI need	Scale of collection		Source/method
		Number/amount				Spatial	Temporal	
Number of livestock	Minimum	other	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	dairy cattle	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	beef cattle	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	young cattle	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	calves	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	sows, incl. piglets	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	fattening pigs	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	boars	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	other pigs	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	broilers	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS

Type of data	Scenario	Data specification	Unit	Policy need	AEI need	Scale of collection		Source/method
		Number/amount				Spatial	Temporal	
Number of livestock	Optimum	laying hens	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	turkey	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	ducks	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	other poultry	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	sheep	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	goat	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Number of livestock	Optimum	horses	average number of live animals per farm	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Farm	Annual	Livestock registers, FSS
Grazing system	Minimum	dairy cattle	% of time spent outside	UNFCCC, WFD, ND, NECD	11.3, 10.2, 12, 13, 15, 16, 18, 19	Farm	1x 3 yrs	SAPM
Grazing system	Minimum	other cattle	% of time spent outside	UNFCCC, WFD, ND, NECD	11.3, 10.2, 12, 13, 15, 16, 18, 19	Farm	1x 3 yrs	SAPM
Grazing system	Minimum	other grazing livestock	% of time spent outside	UNFCCC, WFD, ND, NECD	11.3, 10.2, 12, 13, 15, 16, 18, 19	Farm	1x 3 yrs	SAPM

Type of data	Scenario	Data specification Number/amount	Unit	Policy need	AEI need	Scale of collection		Source/method
						Spatial	Temporal	
Grazing system	Optimum	dairy cattle	% of time spent outside	UNFCCC, WFD, ND, NECD	11.3, 10.2, 12, 13, 15, 16, 18, 19	Farm	1x 3 yrs	SAPM
Grazing system	Optimum	beef cattle	% of time spent outside	UNFCCC, WFD, ND, NECD	11.3, 10.2, 12, 13, 15, 16, 18, 19	Farm	1x 3 yrs	SAPM
Grazing system	Optimum	young cattle	% of time spent outside	UNFCCC, WFD, ND, NECD	11.3, 10.2, 12, 13, 15, 16, 18, 19	Farm	1x 3 yrs	SAPM
Grazing system	Optimum	calves	% of time spent outside	UNFCCC, WFD, ND, NECD	11.3, 10.2, 12, 13, 15, 16, 18, 19	Farm	1x 3 yrs	SAPM
Grazing system	Optimum	sheep	% of time spent outside	UNFCCC, WFD, ND, NECD	11.3, 10.2, 12, 13, 15, 16, 18, 19	Farm	1x 3 yrs	SAPM
Grazing system	Optimum	goat	% of time spent outside	UNFCCC, WFD, ND, NECD	11.3, 10.2, 12, 13, 15, 16, 18, 19	Farm	1x 3 yrs	SAPM
Grazing system	Optimum	horses	% of time spent outside	UNFCCC, WFD, ND, NECD	11.3, 10.2, 12, 13, 15, 16, 18, 19	Farm	1x 3 yrs	SAPM
Grazing system	Optimum	other grazing livestock	% of time spent outside	UNFCCC, WFD, ND, NECD	11.3, 10.2, 12, 13, 15, 16, 18, 19	Farm	1x 3 yrs	SAPM
N fertilizer consumption	Minimum	ammonium nitrate	kg N per country per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	National	Annual	Calculated on the basis of approved Protocols
N fertilizer consumption	Minimum	calcium ammonium nitrate	kg N per country per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	National	Annual	Calculated on the basis of approved Protocols

Type of data	Scenario	Data specification Number/amount	Unit	Policy need	AEI need	Scale of collection		Source/method
						Spatial	Temporal	
N fertilizer consumption	Minimum	anhydrous ammonia	kg N per country per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	National	Annual	Calculated on the basis of approved Protocols
N fertilizer consumption	Minimum	ammonium phosphate	kg N per country per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	National	Annual	Calculated on the basis of approved Protocols
N fertilizer consumption	Minimum	urea	kg N per country per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	National	Annual	Calculated on the basis of approved Protocols
N fertilizer consumption	Minimum	urea-ammonium nitrate solution (UAN)	kg N per country per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	National	Annual	Calculated on the basis of approved Protocols
N fertilizer consumption	Minimum	other N fertilizers	kg N per country per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	National	Annual	Calculated on the basis of approved Protocols
P fertilizer consumption	Minimum	P fertilizers (all types)	kg P per country per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	National	Annual	Calculated on the basis of approved Protocols
N fertilizer consumption	Optimum	calcium ammonium nitrate	kg N per ha per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	Farm	Annual	Farm survey
N fertilizer consumption	Optimum	anhydrous ammonia	kg N per ha per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	Farm	Annual	Farm survey
N fertilizer consumption	Optimum	ammonium phosphate	kg N per ha per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	Farm	Annual	Farm survey
N fertilizer consumption	Optimum	urea	kg N per ha per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	Farm	Annual	Farm survey

Type of data	Scenario	Data specification	Unit	Policy need	AEI need	Scale of collection		Source/method
		Number/amount				Spatial	Temporal	
N fertilizer consumption	Optimum	urea-ammonium nitrate solution (UAN)	kg N per ha per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	Farm	Annual	Farm survey
N fertilizer consumption	Optimum	other N fertilizers	kg N per ha per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	Farm	Annual	Farm survey
P fertilizer consumption	Optimum	P fertilizers (all types)	kg P per ha per year	UNFCCC, WFD, ND, NECD	12, 13, 15, 16, 18, 19	Farm	Annual	Farm survey
Biological N fixation	Minimum/ optimum	clover	ha	UNFCCC, WFD, ND	4, 12, 13, 15, 16, 18, 19	Regional	Annual	FSS / Farm survey
Biological N fixation	Minimum/ optimum	peas	ha	UNFCCC, WFD, ND	4, 12, 13, 15, 16, 18, 19	Regional	Annual	FSS / Farm survey
Biological N fixation	Minimum/ optimum	beans	ha	UNFCCC, WFD, ND	4, 12, 13, 15, 16, 18, 19	Regional	Annual	FSS / Farm survey
Biological N fixation	Minimum/ optimum	soya bean	ha	UNFCCC, WFD, ND	4, 12, 13, 15, 16, 18, 19	Regional	Annual	FSS / Farm survey
Biological N fixation	Minimum/ optimum	lucerne	ha	UNFCCC, WFD, ND	4, 12, 13, 15, 16, 18, 19	Regional	Annual	FSS / Farm survey
Biological N fixation	Minimum/ optimum	lupins	ha	UNFCCC, WFD, ND	4, 12, 13, 15, 16, 18, 19	Regional	Annual	FSS / Farm survey
Atmospheric N depostion	Minimum/ optimum	dry deposition	kg N per ha per year	UNFCCC, WFD, ND, NECD	15, 18, 19	Regional	Annual	EMEP data base
Atmospheric N depostion	Minimum/ optimum	wet deposition	kg N per ha per year	UNFCCC, WFD, ND, NECD	15, 18, 19	Regional	Annual	EMEP data base

Table A4.2: Recommendations for collection of coefficients related to inputs of N and P

Two scenarios are included. The minimum scenario is the scenario with collection of data which are at least needed for reporting for policies and AEI (e.g. Tier 1) and the optimum scenario is the scenario for collection of data in detailed approaches (e.g. Tier 2 and 3 methods).

Type of coefficient	Scenario	Data specification	Unit / dimension	Policy need	AEI need	Scale of estimate		Source/method
						Spatial	Temporal	
N excretion	Minimum	dairy cattle	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Regional	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Minimum	beef cattle	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Minimum	other cattle	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Minimum	sows, incl. piglets	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Minimum	fattening pigs	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Minimum	broilers	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Minimum	laying hens	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Minimum	other poultry	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Minimum	other	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	dairy cattle	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Regional	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	beef cattle	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	young cattle	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	calves	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols

Type of coefficient	Scenario	Data specification	Unit / dimension	Policy need	AEI need	Scale of estimate		Source/method
						Spatial	Temporal	
N excretion	Optimum	sows, incl. piglets	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	fattening pigs	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	boars	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	other pigs	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	broilers	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	laying hens	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	turkey	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	ducks	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	other poultry	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	sheep	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	goat	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
N excretion	Optimum	horses	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Minimum	dairy cattle	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Regional	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Minimum	beef cattle	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Minimum	other cattle	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols

Type of coefficient	Scenario	Data specification	Unit / dimension	Policy need	AEI need	Scale of estimate		Source/method
						Spatial	Temporal	
P excretion	Minimum	sows, incl. piglets	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Minimum	fattening pigs	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Minimum	broilers	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Minimum	laying hens	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Minimum	other poultry	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Minimum	other	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	dairy cattle	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	Regional	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	beef cattle	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	young cattle	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	calves	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	sows, incl. piglets	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	fattening pigs	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	boars	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	other pigs	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	broilers	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols

Type of coefficient	Scenario	Data specification	Unit / dimension	Policy need	AEI need	Scale of estimate		Source/method
						Spatial	Temporal	
P excretion	Optimum	laying hens	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	turkey	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	ducks	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	other poultry	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	sheep	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	goat	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
P excretion	Optimum	horses	kg/animal/yr	UNFCCC, WFD, ND, NECD	10.2, 12, 13, 15, 16, 18, 19	National	1 x 3 yr	Calculated on the basis of approved Protocols
Biological N fixation	Minimum/ optimum	clover	kg N per ha of leguminous per year	UNFCCC, WFD, ND	4, 12, 13, 15, 16, 18, 19	Regional	1 x 3 yr	Calculated on the basis of approved Protocols
Biological N fixation	Minimum/ optimum	peas	kg N per ha of leguminous per year	UNFCCC, WFD, ND	4, 12, 13, 15, 16, 18, 19	Regional	1 x 3 yr	Calculated on the basis of approved Protocols
Biological N fixation	Minimum/ optimum	beans	kg N per ha of leguminous per year	UNFCCC, WFD, ND	4, 12, 13, 15, 16, 18, 19	Regional	1 x 3 yr	Calculated on the basis of approved Protocols
Biological N fixation	Minimum/ optimum	soya bean	kg N per ha of leguminous per year	UNFCCC, WFD, ND	4, 12, 13, 15, 16, 18, 19	Regional	1 x 3 yr	Calculated on the basis of approved Protocols
Biological N fixation	Minimum/ optimum	lucerne	kg N per ha of leguminous per year	UNFCCC, WFD, ND	4, 12, 13, 15, 16, 18, 19	Regional	1 x 3 yr	Calculated on the basis of approved Protocols
Biological N fixation	Minimum/ optimum	lupins	kg N per ha of leguminous per year	UNFCCC, WFD, ND	4, 12, 13, 15, 16, 18, 19	Regional	1 x 3 yr	Calculated on the basis of approved Protocols

Table A4.3: Recommendations for collection of data related to factors affecting emissions of ammonia and greenhouse gases

Two scenarios are included. The minimum scenario is the scenario with collection of data which are at least needed for reporting for policies and AEI (e.g. Tier 1) and the optimum scenario is the scenario for collection of data in detailed approaches (e.g. Tier 2 and 3 methods).

Type of data	**Scenario**	**Data specification**	**Required data**	**Unit / dimension**	**Policy need**	**AEI need**	**Scale of estimate**		**Source / method**
							Spatial	**Temporal**	
Housing system	minimum	dairy, beef, and other cattle	Manure type; Solid/liquid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	minimum	dairy, beef, and other cattle	Manure type; Solid/liquid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	optimum	dairy, beef, and other cattle	tied housing with fully-slatted floor	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	optimum	dairy, beef, and other cattle	tied housing partially slatted floor	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	optimum	dairy, beef, and other cattle	loose housing with fully-slatted floor	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	optimum	dairy, beef, and other cattle	loose housing partially slatted floor	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	optimum	dairy, beef, and other cattle	tied housing with fully-slatted floor with scrubbers/biofilters	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	optimum	dairy, beef, and other cattle	tied housing partially slatted floor with scrubbers/biofilters	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	optimum	dairy, beef, and other cattle	loose housing with fully-slatted floor with scrubbers/biofilters	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM

Type of data	Scenario	Data specification	Required data	Unit / dimension	Policy need	AEI need	Scale of estimate		Source / method
							Spatial	Temporal	
Housing system	optimum	dairy, beef, and other cattle	loose housing partially slatted floor with scrubbers/biofilters	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	optimum	dairy, beef, and other cattle	solid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	optimum	dairy, beef, and other cattle	liquid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	optimum	dairy, beef, and other cattle	manure separation	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	optimum	dairy, beef, and other cattle	liquid with anaerobic digestion without supplements	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 24, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	optimum	dairy, beef, and other cattle	liquid with anaerobic digestion with supplements	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 24, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	minimum	pigs	Solid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	minimum	pigs	Liquid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	minimum	pigs	Solid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	minimum	pigs	Liquid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	optimum	pigs	Solid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	optimum	pigs	Liquid with scrubbers/biofilters	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	optimum	pigs	solid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM

Type of data	Scenario	Data specification	Required data	Unit / dimension	Policy need	AEI need	Scale of estimate		Source / method
							Spatial	Temporal	
Manure storage system	optimum	pigs	liquid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	optimum	pigs	manure separation	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	optimum	pigs	liquid with anaerobic digestion without supplements	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 24, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	optimum	pigs	liquid with anaerobic digestion with supplements	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 24, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	minimum	poultry	Solid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	minimum	poultry	Liquid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	minimum	poultry	Solid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	minimum	poultry	Liquid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	optimum	poultry	Battery cages	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Housing system	optimum	poultry	Battery cages with drying	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	optimum	poultry	Free range	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	optimum	poultry	Aviary house	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	optimum	poultry	Other	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	optimum	poultry	Solid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	optimum	poultry	Liquid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM

Type of data	Scenario	Data specification	Required data	Unit / dimension	Policy need	AEI need	Scale of estimate		Source / method
							Spatial	Temporal	
Housing system	minimum	other	Solid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure storage system	minimum	other	Solid	Dimension less	UNFCCC, ND, NECD	11.3, 12, 16, 18, 19, 28	Farm	1 x 5 yr	FSS; SAPM
Manure application technique	minimum	grassland and arable land	surface spreading	Dimension less	UNFCCC, ND, NECD	11.2, 12, 15, 16, 18, 19	Farm	1 x 3 yr	FSS; SAPM
Manure application technique	minimum	grassland and arable land	reduced ammonia application	Dimension less	UNFCCC, ND, NECD	11.2, 12, 15, 16, 18, 19	Farm	1 x 3 yr	FSS; SAPM
Manure application technique	optimum	grassland and arable land	Broadcast - no incorporation	Dimension less	UNFCCC, ND, NECD	11.2, 12, 15, 16, 18, 19	Farm	1 x 3 yr	FSS; SAPM
Manure application technique	optimum	arable land	Broadcast - incorporation <2hrs	Dimension less	UNFCCC, ND, NECD	11.2, 12, 15, 16, 18, 19	Farm	1 x 3 yr	FSS; SAPM
Manure application technique	optimum	arable land	Broadcast - incorporation <1 day	Dimension less	UNFCCC, ND, NECD	11.2, 12, 15, 16, 18, 19	Farm	1 x 3 yr	FSS; SAPM
Manure application technique	optimum	grassland and arable land	Band spread	Dimension less	UNFCCC, ND, NECD	11.2, 12, 15, 16, 18, 19	Farm	1 x 3 yr	FSS; SAPM
Manure application technique	optimum	grassland and arable land	Deep injection	Dimension less	UNFCCC, ND, NECD	11.2, 12, 15, 16, 18, 19	Farm	1 x 3 yr	FSS; SAPM
Manure application technique	optimum	grassland and arable land	Shallow injection	Dimension less	UNFCCC, ND, NECD	11.2, 12, 15, 16, 18, 19	Farm	1 x 3 yr	FSS; SAPM

Table A4.4: Recommendations for collection of coefficients related to factors affecting emissions of ammonia and greenhouse gases

Two scenarios are included. The minimum scenario is the scenario with collection of data which are at least needed for reporting for policies and AEI (e.g. Tier 1) and the optimum scenario is the scenario for collection of data in detailed approaches (e.g. Tier 2 and 3 methods).

Type of data	**Scenario**	**First data specification**	**Second data specification**	**Unit / dimension**	**Required coefficient**	**Policy need**	**AEI need**	**Scale of estimate**		**Source/ method**
								Spatial	**Temporal**	
Housing system	minimum	dairy, beef, and other cattle	Solid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Housing system	minimum	dairy, beef, and other cattle	Liquid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	minimum	dairy, beef, and other cattle	Solid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	minimum	dairy, beef, and other cattle	Liquid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Housing system	optimum	dairy, beef, and other cattle	tied housing with fully-slatted floor	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Housing system	optimum	dairy, beef, and other cattle	tied housing partially slatted floor	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Housing system	optimum	dairy, beef, and other cattle	loose housing with fully-slatted floor	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Housing system	optimum	dairy, beef, and other cattle	loose housing partially slatted floor	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Housing system	optimum	dairy, beef, and other cattle	tied housing with fully-slatted floor with scrubbers/biofilters	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Housing system	optimum	dairy, beef, and other cattle	tied housing partially slatted floor with scrubbers/biofilters	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Housing system	optimum	dairy, beef, and other cattle	loose housing with fully-slatted floor with scrubbers/biofilters	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Housing system	optimum	dairy, beef, and other cattle	loose housing partially slatted floor with scrubbers/biofilters	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	optimum	dairy, beef, and other cattle	solid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	optimum	dairy, beef, and other cattle	liquid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	optimum	dairy, beef, and other cattle	manure separation	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	optimum	dairy, beef, and other cattle	liquid with anaerobic digestion without supplements	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Manure storage system	optimum	dairy, beef, and other cattle	liquid with anaerobic digestion with supplements	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Housing system	minimum	pigs	Solid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Housing system	minimum	pigs	Liquid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	minimum	pigs	Solid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	minimum	pigs	Liquid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Housing system	optimum	pigs	Solid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Housing system	optimum	pigs	Liquid with scrubbers/biofilters	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	optimum	pigs	solid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	optimum	pigs	liquid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	optimum	pigs	manure separation	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Manure storage system	optimum	pigs	liquid with anaerobic digestion without supplements	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	optimum	pigs	liquid with anaerobic digestion with supplements	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	National	1 x 5 yr	EEA/EMEP Guidebook
Housing system	minimum	poultry	Solid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Housing system	minimum	poultry	Liquid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	minimum	poultry	Solid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	minimum	poultry	Liquid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Housing system	optimum	poultry	Battery cages	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	National	1 x 5 yr	EEA/EMEP Guidebook
Housing system	optimum	poultry	Battery cages with drying	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	optimum	poultry	Free range	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	National	1 x 5 yr	EEA/EMEP Guidebook

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Manure storage system	optimum	poultry	Aviary house	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	optimum	poultry	Other	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	optimum	poultry	Solid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	optimum	poultry	Liquid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook
Housing system	minimum	other	Solid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Manure storage system	minimum	other	Solid	% of N excreted	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Manure application technique	minimum	grassland and arable land	surface spreading	% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Manure application technique	minimum	grassland and arable land	reduced ammonia application	% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Manure application technique	optimum	grassland and arable land	Broadcast - no incorporation	% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	EEA/EMEP Guidebook

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Manure application technique	optimum	arable land	Broadcast - incorporation <2hrs	% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure application technique	optimum	arable land	Broadcast - incorporation <1 day	% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure application technique	optimum	grassland and arable land	Band spread	% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure application technique	optimum	grassland and arable land	Deep injection	% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	National	1 x 5 yr	EEA/EMEP Guidebook
Manure application technique	optimum	grassland and arable land	Shallow injection	% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	National	1 x 5 yr	EEA/EMEP Guidebook
N fertilizer	Minimum/ optimum	ammonium nitrate		% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
N fertilizer consumption	Minimum/ optimum	calcium ammonium nitrate		% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
N fertilizer consumption	Minimum/ optimum	anhydrous ammonia		% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
N fertilizer consumption	Minimum/ optimum	ammonium phosphate		% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18, 19	No; default	1 x 5 yr	EEA/EMEP Guidebook

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
N fertilizer consumption	Minimum/ optimum	urea		% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
N fertilizer consumption	Minimum/ optimum	urea-ammonium nitrate solution (UAN)		% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
N fertilizer consumption	Minimum/ optimum	other N fertilizers		% of N applied	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Grazing	Minimum/ optimum	grazing livestock		% of N excreted during grazing	ammonia emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	EEA/EMEP Guidebook
Housing system	minimum	dairy, beef, and other cattle	Solid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
Housing system	minimum	dairy, beef, and other cattle	Liquid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
Manure storage system	minimum	dairy, beef, and other cattle	Solid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
Manure storage system	minimum	dairy, beef, and other cattle	Liquid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Housing system	optimum	dairy, beef, and other cattle	tied housing with fully-slatted floor	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Housing system	optimum	dairy, beef, and other cattle	tied housing partially slatted floor	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Housing system	optimum	dairy, beef, and other cattle	loose housing with fully-slatted floor	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Housing system	optimum	dairy, beef, and other cattle	loose housing partially slatted floor	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Housing system	optimum	dairy, beef, and other cattle	tied housing with fully-slatted floor with scrubbers/biofilters	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Housing system	optimum	dairy, beef, and other cattle	tied housing partially slatted floor with scrubbers/biofilters	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Housing system	optimum	dairy, beef, and other cattle	loose housing with fully-slatted floor with scrubbers/biofilters	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Housing system	optimum	dairy, beef, and other cattle	loose housing partially slatted floor with scrubbers/biofilters	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Manure storage system	optimum	dairy, beef, and other cattle	solid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure storage system	optimum	dairy, beef, and other cattle	liquid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure storage system	optimum	dairy, beef, and other cattle	manure separation	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure storage system	optimum	dairy, beef, and other cattle	liquid with anaerobic digestion without supplements	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure storage system	optimum	dairy, beef, and other cattle	liquid with anaerobic digestion with supplements	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Housing system	minimum	pigs	Solid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
Housing system	minimum	pigs	Liquid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
Manure storage system	minimum	pigs	Solid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
Manure storage system	minimum	pigs	Liquid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Housing system	optimum	pigs	Solid	% of N excreted	nitrous oxide emission factor	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Housing system	optimum	pigs	Liquid with scrubbers/biofilters	% of N excreted	nitrous oxide emission factor	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure storage system	optimum	pigs	solid	% of N excreted	nitrous oxide emission factor	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure storage system	optimum	pigs	liquid	% of N excreted	nitrous oxide emission factor	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure storage system	optimum	pigs	manure separation	% of N excreted	nitrous oxide emission factor	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure storage system	optimum	pigs	liquid with anaerobic digestion without supplements	% of N excreted	nitrous oxide emission factor	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure storage system	optimum	pigs	liquid with anaerobic digestion with supplements	% of N excreted	nitrous oxide emission factor	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Housing system	minimum	poultry	Solid	% of N excreted	nitrous oxide emission factor	UNFCCC , ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
Housing system	minimum	poultry	Liquid	% of N excreted	nitrous oxide emission factor	UNFCCC , ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Manure storage system	minimum	poultry	Solid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
Manure storage system	minimum	poultry	Liquid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
Housing system	optimum	poultry	Battery cages	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Housing system	optimum	poultry	Battery cages with drying	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure storage system	optimum	poultry	Free range	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure storage system	optimum	poultry	Aviary house	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure storage system	optimum	poultry	Other	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure storage system	optimum	poultry	Solid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure storage system	optimum	poultry	Liquid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Housing system	minimum	other	Solid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Manure storage system	minimum	other	Solid	% of N excreted	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
Manure application technique	minimum	grassland and arable land	surface spreading	% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
Manure application technique	minimum	grassland and arable land	reduced ammonia application	% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
Manure application technique	optimum	grassland and arable land	Broadcast - no incorporation	% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure application technique	optimum	arable land	Broadcast - incorporation <2hrs	% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure application technique	optimum	arable land	Broadcast - incorporation <1 day	% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure application technique	optimum	grassland and arable land	Band spread	% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure application technique	optimum	grassland and arable land	Deep injection	% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
Manure application technique	optimum	grassland and arable land	Shallow injection	% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology
N fertilizer	Minimum/ optimum	ammonium nitrate		% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
N fertilizer consumption	Minimum/ optimum	calcium ammonium nitrate		% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
N fertilizer consumption	Minimum/ optimum	anhydrous ammonia		% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
N fertilizer consumption	Minimum/ optimum	ammonium phosphate		% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
N fertilizer consumption	Minimum/ optimum	urea		% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
N fertilizer consumption	Minimum/ optimum	urea-ammonium nitrate solution (UAN)		% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
N fertilizer consumption	Minimum/ optimum	other N fertilizers		% of N applied	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
Grazing		grazing livestock		% of N excreted during grazing	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology
Crop residues				% in crop residue	nitrous oxide emission factor	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Housing system	minimum	dairy, beef, and other cattle	Solid	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	minimum	dairy, beef, and other cattle	Liquid	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	minimum	dairy, beef, and other cattle	Solid	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	minimum	dairy, beef, and other cattle	Liquid	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	optimum	dairy, beef, and other cattle	tied housing with fully-slatted floor	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	optimum	dairy, beef, and other cattle	tied housing partially slatted floor	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Housing system	optimum	dairy, beef, and other cattle	loose housing with fully-slatted floor	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	optimum	dairy, beef, and other cattle	loose housing partially slatted floor	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	optimum	dairy, beef, and other cattle	tied housing with fully-slatted floor with scrubbers/biofilters	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	optimum	dairy, beef, and other cattle	tied housing partially slatted floor with scrubbers/biofilters	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	optimum	dairy, beef, and other cattle	loose housing with fully-slatted floor with scrubbers/biofilters	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	optimum	dairy, beef, and other cattle	loose housing partially slatted floor with scrubbers/biofilters	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Manure storage system	optimum	dairy, beef, and other cattle	solid	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	optimum	dairy, beef, and other cattle	liquid	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	optimum	dairy, beef, and other cattle	manure separation	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	optimum	dairy, beef, and other cattle	liquid with anaerobic digestion without supplements	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	optimum	dairy, beef, and other cattle	liquid with anaerobic digestion with supplements	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	minimum	pigs	Solid	% of N excreted	total denitrification loss	UNFCCC , ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Housing system	minimum	pigs	Liquid	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	minimum	pigs	Solid	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	minimum	pigs	Liquid	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	optimum	pigs	Solid	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	optimum	pigs	Liquid with scrubbers/biofilters	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	optimum	pigs	solid	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Manure storage system	optimum	pigs	liquid	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	optimum	pigs	manure separation	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	optimum	pigs	liquid with anaerobic digestion without supplements	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	optimum	pigs	liquid with anaerobic digestion with supplements	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	minimum	poultry	Solid	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	minimum	poultry	Liquid	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Manure storage system	minimum	poultry	Solid	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	minimum	poultry	Liquid	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	optimum	poultry	Battery cages	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	optimum	poultry	Battery cages with drying	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	optimum	poultry	Free range	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	optimum	poultry	Aviary house	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Manure storage system	optimum	poultry	Other	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	optimum	poultry	Solid	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	optimum	poultry	Liquid	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	National	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	minimum	other	Solid	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Manure storage system	minimum	other	Solid	% of N excreted	total denitrification loss	UNFCCC, ND, NECD	15, 16, 18 19	No; default	1 x 5 yr	IPPC methodology / EEA/EMEP Guidebook
Housing system	minimum	dairy, beef, and other cattle	Enteric fermentation	kg CH4/ animal/yr	methane emission factor	UNFCCC	19	No; default	1 x 5 yr	IPCC methodology
Manure storage system	minimum	dairy, beef, and other cattle	Solid	kg CH4/ animal/yr	methane emission factor	UNFCCC	19	No; default	1 x 5 yr	IPCC methodology

Type of data	Scenario	First data specification	Second data specification	Unit / dimension	Required coefficient	Policy need	AEI need	Scale of estimate		Source/ method
								Spatial	Temporal	
Manure storage system	minimum	dairy, beef, and other cattle	Liquid	kg CH4/ animal/yr	methane emission factor	UNFCCC	19	No; default	1 x 5 yr	IPCC methodology
Housing system	minimum	pigs	Enteric fermentation	kg CH4/ animal/yr	methane emission factor	UNFCCC	19	No; default	1 x 5 yr	IPCC methodology
Manure storage system	minimum	pigs	Solid	kg CH4/ animal/yr	methane emission factor	UNFCCC	19	No; default	1 x 5 yr	IPCC methodology
Manure storage system	minimum	pigs	Liquid	kg CH4/ animal/yr	methane emission factor	UNFCCC	19	No; default	1 x 5 yr	IPCC methodology
Manure storage system	minimum	poultry	Solid	kg CH4/ animal/yr	methane emission factor	UNFCCC	19	No; default	1 x 5 yr	IPCC methodology
Manure storage system	minimum	poultry	Liquid	kg CH4/ animal/yr	methane emission factor	UNFCCC	19	No; default	1 x 5 yr	IPCC methodology
Housing system	minimum	other	Enteric fermentation	kg CH4/ animal/yr	methane emission factor	UNFCCC	19	No; default	1 x 5 yr	IPCC methodology
Manure storage system	minimum	other	Solid	kg CH4/ animal/yr	methane emission factor	UNFCCC	19	No; default	1 x 5 yr	IPCC methodology
Manure storage system	minimum	other	Liquid	kg CH4/ animal/yr	methane emission factor	UNFCCC	19	No; default	1 x 5 yr	IPCC methodology

Table A4.5: Recommendations for collection of data related to N and P in harvested crop products

Two scenarios are included. The minimum scenario is the scenario with collection of data which are at least needed for reporting for policies and AEI (e.g. Tier 1) and the optimum scenario is the scenario for collection of data in detailed approaches (e.g. Tier 2 and 3 methods).

Type of data Crop type	Scenario	Data specification	Unit / dimension	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Wheat	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Rye	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Barley	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Spring barley	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Oats	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Grain maize	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Sorghum	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Triticale	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS

Type of data Crop type	Scenario	Data specification	Unit / dimension	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Rice	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Other cereals	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Peas	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Beans	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Potatoes	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Sugar beet	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Fodder beet	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Other root crops	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Rape	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Sunflower seed	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP,	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS

Type of data Crop type	Scenario	Data specification	Unit / dimension	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
				RDP				
Soya bean	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Other oil seeds	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Industrial crops (flax, hemp, cotton, tobacco, hops)	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Officinal herbs, aromatic plants	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Silage maize	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Clover and mixtures	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Lucerne	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS

Type of data Crop type	Scenario	Data specification	Unit / dimension	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Temporary grassland	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Permanent grassland	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Common pasture, heathland, rough grazing	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Fruit trees	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Olives	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Vineyards	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Other permanent crops	Optimum	area	ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	FSS
Wheat	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys

Type of data Crop type	Scenario	Data specification	Unit / dimension	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Rye	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Barley	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Spring barley	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Oats	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Grain maize	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Sorghum	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Triticale	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Rice	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys

Type of data Crop type	Scenario	Data specification	Unit / dimension	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Other cereals	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Peas	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Beans	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Potatoes	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Sugar beet	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Fodder beet	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Other root crops	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Rape	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys

Type of data Crop type	Scenario	Data specification	Unit / dimension	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Sunflower seed	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Soya bean	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Other oil seeds	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Industrial crops (flax, hemp, cotton, tobacco, hops)	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Officinal herbs, aromatic plants	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Silage maize	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Clover and mixtures	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys

Type of data Crop type	Scenario	Data specification	Unit / dimension	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Lucerne	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Temporary grassland	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	Estimated on the basis of approved Protocol
Permanent grassland	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	Estimated on the basis of approved Protocol
Common pasture, heathland, rough grazing	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	Estimated on the basis of approved Protocol
Fruit trees	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Olives	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Vineyards	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys
Other permanent crops	Optimum	harvested yield	kg product per ha	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Farm	Annual	MARS, FADN, crop yield surveys

Table A4.6: Recommendations for collection of coefficients related to N and P in harvested crop products

Two scenarios are included. The minimum scenario is the scenario with collection of data which are at least needed for reporting for policies and AEI (e.g. Tier 1) and the optimum scenario is the scenario for collection of data in detailed approaches (e.g. Tier 2 and 3 methods).

Type of Data Crop type	Scenario	Data specification	Unit	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Wheat	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Rye	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Barley	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Spring barley	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Oats	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study

Type of Data Crop type	Scenario	Data specification	Unit	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Grain maize	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Sorghum	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Triticale	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Rice	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Other cereals	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Peas	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Beans	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Potatoes	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study

Type of Data Crop type	Scenario	Data specification	Unit	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Sugar beet	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Fodder beet	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Other root crops	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Rape	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Sunflower seed	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Soya bean	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Other oil seeds	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Industrial crops (flax, hemp, cotton, tobacco, hops)	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study

Type of Data Crop type	Scenario	Data specification	Unit	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Officinal herbs, aromatic plants	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Silage maize	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Clover and mixtures	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Lucerne	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Temporary grassland	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Regional	1x 5 yr	Results desk study
Permanent grassland	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Regional	1x 5 yr	Results desk study
Common pasture, heathland, rough grazing	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Regional	1x 5 yr	Results desk study
Fruit trees	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study

Type of Data Crop type	Scenario	Data specification	Unit	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Olives	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Vineyards	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Other permanent crops	Optimum	N content	kg N per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Wheat	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Rye	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Barley	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Spring barley	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Oats	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study

Type of Data Crop type	Scenario	Data specification	Unit	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Grain maize	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Sorghum	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Triticale	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Rice	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Other cereals	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Peas	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Beans	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Potatoes	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study

Type of Data Crop type	Scenario	Data specification	Unit	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Sugar beet	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Fodder beet	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Other root crops	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Rape	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Sunflower seed	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Soya bean	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Other oil seeds	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study

Type of Data Crop type	Scenario	Data specification	Unit	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Industrial crops (flax, hemp, cotton, tobacco, hops)	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Officinal herbs, aromatic plants	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Silage maize	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Clover and mixtures	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Lucerne	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Temporary grassland	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Regional	1x 5 yr	Results desk study
Permanent grassland	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Regional	1x 5 yr	Results desk study

Type of Data Crop type	Scenario	Data specification	Unit	Policy need	AEI need	Scale of collection		Source/ method
						Spatial	Temporal	
Common pasture, heathland, rough grazing	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	Regional	1x 5 yr	Results desk study
Fruit trees	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Olives	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Vineyards	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study
Other permanent crops	Optimum	P content	kg P per kg harvested product	UNFCCC, LULUCF, ND, NECD, FDSUP, RDP	5, 6, 7, 8, 9, 10.1, 10.2, 11.1, 15, 16, 26	EU	1 x 5 yr	Results desk study

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