Food and Agriculture Organization of the United Nations

Estimating Greenhouse Gas Emissions in Agriculture

A Manual to Address Data Requirements for Developing Countries

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ESTIMATING GREENHOUSE GAS EMISSIONS IN AGRICULTURE

A MANUAL TO ADDRESS DATA REQUIREMENTS FOR DEVELOPING COUNTRIES

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Acronyms

AFOLU	Agriculture, Forestry and Other Land Use
AD	Activity Data
BUR	Biennial Update Report
CfRN	Coalition for Rainforest Nations
COP	Conference of the Parties
CRF	Common Report Format
CS	Country Specific
DOM	Dead Organic Matter
ES	Economic and Social Development Department of FAO
EF	Emission Factors
EIT	Economies in Transition
ESS	Economic and Social Statistics Division of FAO
FAO	Food and Agriculture Organization of the United Nations
FRA	Global Forest Resource Assessment database of FAO
FO	Forestry Department of FAO
FOLU	Forestry and Other Land Use
GAEZ	Global Agro-Ecological Zones
GFED4	Global Fire Emission Database 4
GHGI	Greenhouse Gas Inventory
GHG	Greenhouse Gas
GPG	Good Practice Guidance
GS	Global Strategy
GWP	Global Warming Potential
HWSD	Harmonized World Soil Database
IEA	International Energy Agency
IEF	Implied Emission Factor
IPCC	Intergovernmental Panel on Climate Change
LDCs	Least Developed Countries
LECB	Low Emissions Capacity Building
LULUCF	Land Use, Land-Use Change and Forestry
MAGHG	Monitoring and Assessment of GHG Emissions and Mitigation Potential in Agriculture
MDG	Millennium Development Goals
MMS	Manure Management Systems
MOP	Meeting of the Parties
MRV	Monitoring Reporting and Verification
NAMAs	Nationally Appropriate Mitigation Actions
NCs	National Communications
NGHGI	National Greenhouse Gas Inventory
NGOs	Non-governmental organizations
NIR	National Inventory Report
NRC	Climate, Energy and Tenure Division of FAO
OECD	Organization for Economic Co-operation and Development
REDD+	Reduced Emissions from Deforestation and Forest Degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
SIDS	Small Island Developing States

SBI	Subsidiary Body Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SC	Steering Committee
SOM	Soil Organic Matter
TFI	Task Force on National Greenhouse Gas Inventories
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UNREDD	United Nations Program on Reduction of Emissions from Deforestation and Forest Degradation
WG	Working Group

1

Introduction

Countries report their greenhouse gas (GHG) emissions and removals from all sectors via national GHG Inventories, submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in accordance with international climate policy agreements and technical guidelines developed by the Intergovernmental Panel on Climate Change (IPCC).

The agriculture sector represents a unique challenge for national inventory compilers, especially in developing countries, due to significant difficulties in compiling and regularly updating national statistics for agriculture, forestry and land use —the first necessary step in preparing national GHG estimates.

The limited capacity to identify and collect reliable activity data and to quantify emissions by sources and removals by sinks, including in countries where agriculture and land use activities are a key component of the national economy and a driver of employment, could furthermore lead to limited access to international climate finance of importance to rural development, such as for instance REDD+ activities and Nationally Appropriate Mitigation Actions (NAMAs).

FAO supports its Member Countries with data, guidelines and technical expertise towards an enhanced global knowledge base on GHG emissions and mitigation potentials. The Monitoring and Assessment of GHG Emissions and Mitigation Potentials in Agriculture – MAGHG Project of the Climate, Energy and Land Tenure Division's Mitigation Programme (MICCA), in close collaboration with the FAO Statistics Division and the FAO Forestry Division UN REDD Programme, has developed and made available relevant activity data, GHG emission estimates databases and analysis tools through the FAOSTAT database. These products are used in regional and country-level capacity development activities that support practitioners in assessing and reporting GHG emissions from agriculture and land use categories, with a view to strengthening their national processes, with a focus on preparation and submission of GHG Inventories, Biennial Update Reports (BURs) and NAMAs.

This Manual provides Member Countries with a tool and methodology to help identify, build and access he minimum set of activity data needed for GHG estimation. Required data is largely drawn from country's official national agricultural and forestry statistics, as disseminated in FAO's corporate database FAOSTAT, and integrated by geo-spatial data obtained from recognized international sources. Users are provided with step-by-step guidance on how to use this minimum set to build a default, yet complete national GHG emission dataset for agriculture and land use, which follows the default, Tier 1 approach of the Intergovernmental Panel on Climate Change (IPCC) Guidelines on National GHG Inventories.

This Manual therefore contributes to FAO and the Global Strategy support to national processes towards improved agricultural and rural statistics. It can be used as a guide by staff of national statistical offices, environmental ministries and other relevant national agencies, to understand the international context of international climate policy (Ch. 2) and international guidelines (Ch. 3), identify needs for improved agricultural and rural data as well as emission estimates towards improving GHG Inventories (Ch. 4), while supplying practical information and examples based on accessing and using the FAOSTAT Emissions database for agriculture and land use (Ch. 5).

Improving statistical processes for GHG estimation has wider implications beyond climate change mitigation. Improved statistics on agricultural and land use activities enable Member Countries better identify climate responses that are consistent with their rural development and food security objectives, including preserving natural resources, increasing resilience of production systems and creating new employment opportunities.

2

The Institutional Framework

2.1 THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE

The Member States of the UN, meeting at the United Nations Conference on Environment and Development (UNCED, Rio de Janeiro, 1992), signed a Declaration on sustainable development as an instrument to ensure a healthy and productive life for human beings, in harmony with nature, for current and future generations. Sustainable Development commitments include the need to ensure that activities within Member States' jurisdiction or control do not damage the environment, both within their territories and in other States or areas beyond the limits of their respective national jurisdictions.

In this context, the UN Member States gathered at the UNCED also agreed to sign the United Nations Framework Convention on Climate Change (UNFCCC), with the specific commitment to *stabilize greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner* (UNFCCC, Article 2). To achieve these global sustainable development goals in the AFOLU sector, the Parties to the UNFCCC *shall promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs, including biomass, forests, as well as other terrestrial and coastal ecosystems*.

In 1997, to strengthen the global response to climate change, the countries that were party to this Convention also adopted the Kyoto Protocol to the UNFCCC. The Kyoto Protocol legally binds developed countries to meet emission reduction targets. The Protocol's first commitment period began in 2008 and ended in 2012. The second commitment period began on 1 January 2013, and will end in 2020.

Today, there are 195 Parties to the Convention and 192 Parties to the Kyoto Protocol. The UNFCCC Secretariat supports all bodies involved in international climate change negotiations, especially the Conference of the Parties (COP), the Conference of the Parties serving as the Meeting of the Parties (CMP), the Subsidiary Bodies (SBSTA and SBI) which advise the COP and CMP, and the Bureau of the COP and CMP (which deals mainly with procedural and organizational issues arising from the COP and CMP, and also enjoys certain technical functions).

A brief description of how these UNFCCC bodies are interrelated is available at http://unfccc.int/bodies/items/6241.php.

At the same time, the fundamental goals of sustainable rural development and food security that underpin the goals of UNFCCC and UNCED represent the core mission, principles and technical expertise of the Food and Agriculture Organization of the United Nations (FAO). FAO therefore focuses on developing knowledge and providing assistance to its Member Countries, towards identifying and implementing, for the agriculture, fisheries and forestry sectors, appropriate adaptation and mitigation responses that respect natural resources, increase food production and achieve food security under climate change.

2.2 EXISTING REPORTING REQUIREMENTS FOR MITIGATION IN THE AGRICULTURE, FORESTRY AND OTHER LAND USE SECTOR UNDER THE UNFCCC

Parties to the UNFCCC have committed to the implementation of specific actions and programs to mitigate climate change. In particular, Article 4 of the UNFCCC states that:

"All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall:
(a) Develop, periodically update, publish and make available to the Conference of the Parties […] national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties;
(b) Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol[…]
(c) Communicate to the Conference of the Parties information related to implementation […]."

From Article 4 of the Convention, different reporting requirements have emerged for developed and developing countries (respectively, UNFCCC Annex I and non-Annex I Parties).

Within the AFOLU sector, mitigation consists of actions taken to reduce GHG emissions and enhance carbon sinks and reservoirs, compared to a benchmark value as the business-as-usual reference level. Parties must report these actions periodically to the UNFCCC, as specified in a set of decisions agreed upon at the annual Conference of Parties (COP). The reporting requirements for the respective sets of parties are the following:

Annex I Parties

- National Communications (NC) containing information, from the last submitted GHG Inventory, on national GHG emissions and removals, climate-related policies and measures, GHG projections, vulnerability and adaptation to climate change, financial assistance and technology transfer to non-Annex I Parties, and actions to raise public awareness on climate change;
- National GHG Inventories (NGHGI) containing information on GHG emissions and removals, such as activity data, emission factors, and the methodologies used to estimate emissions. An NGHGI is composed of two separate documents: the Common Reporting Format (CRF) tables, which contain a time-series of GHG emission estimates (from 1990 until the year x-2, where x is the year when the NGHGI is submitted); and the National Inventory Report (NIR), which includes all information on the background data and the methods used, as well as the data analysis and institutional arrangements underlying the preparation of the NGHGI.
- Biennial Reports (BRs), which outline the progress made in achieving net emissions reduction and in providing financial, technological, and capacity-building support to non-Annex I Parties for dealing with climate change.

Annex I Parties must submit national communications every 4 years (Decisions 8/CP.1 and 11/CP.4). The communications are prepared and reported periodically by Annex I Parties, on the basis of agreed reporting guidelines (Decision 4/CP.5), and, with regard to the GHG estimates, of the methodology developed by the IPCC and adopted by the COP for the NGHGI. Submissions by Annex I Parties can be found here: http://unfccc.int/national_reports/annex_i_natcom/submitted_natcom/items/4903.php

National GHG inventories are submitted (Decision 3/CP.5) by Annex I Parties annually. They are prepared on the basis of reporting guidelines agreed by the COP (Decision 14/CP.11) and of methodologies developed by the IPCC. National inventory arrangements should be in place to ensure that a NGHGI is fully compliant with reporting requirements and is submitted on time. Submissions by Annex I Parties can be found here: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/7383.php

Biennial Reports are to be submitted (Decision 2/CP.17) by developed country Parties every 2 years; the first biennial report (BR1) was due on 1 January 2014. These Reports are prepared on the basis of agreed reporting guidelines (Decision 2/CP.17 Annex I) and on methodologies developed by the IPCC, as per the NGHGI. Submissions by Parties can be found here: http://unfccc.int/national_reports/biennial_reports_and_iar/submitted_biennial_reports/items/7550.php

Each Report is subject to a review process supported by the UNFCCC Secretariat, and implemented by experts taken from the UNFCCC Roster of Experts (RoE).

Non-Annex I Parties Reports

- National Communications (NC) containing information on national circumstances, national GHG emissions and removals, the steps taken or envisaged to implement the Convention, and any other information considered relevant to the achievement of the Conventions' objective, including, if feasible, material relevant to calculating global emissions and emission trends;
- Biennial Update Reports (BURs), containing updated information on national circumstances and institutional arrangements for reporting on a continuous basis, national GHG emissions and removals information – including a national inventory report – and information on mitigation actions, effects, needs, and the support received.

National communications are expected to be submitted by non-Annex I Parties every 4 years (Decision 10/CP.2), following decisions for each submission taken by the Conference of the Parties (COP). The communications are prepared and reported periodically by non-Annex I Parties in accordance with agreed reporting guidelines (Decision 17/CP.8), which are in turn based on methodologies developed by the IPCC and adopted by the COP. Submissions by non-Annex I are available here: http://unfccc.int/national_reports/non-annex_i_natcom/ items/2979.php

Biennial Update Reports are to be submitted by non-Annex I Parties every 2 years (Decision 2/CP.17), and are prepared in accordance with agreed reporting guidelines (Decision 2/CP.17) that are in turn based on methodologies developed by the IPCC and adopted by the COP. Least developed country Parties and small island developing States may submit biennial update reports at their discretion.

The first biennial report (BUR1) is due by December 2014 and is expected to contain information on the current levels and trends of GHG emissions and removals within each country's territory. As part of the International Consultation and Analysis process, the Biennial Update Reports will be subject to a technical assessment; the process aims to increase the transparency of mitigation actions and their effects, also by means of a facilitated sharing of views.

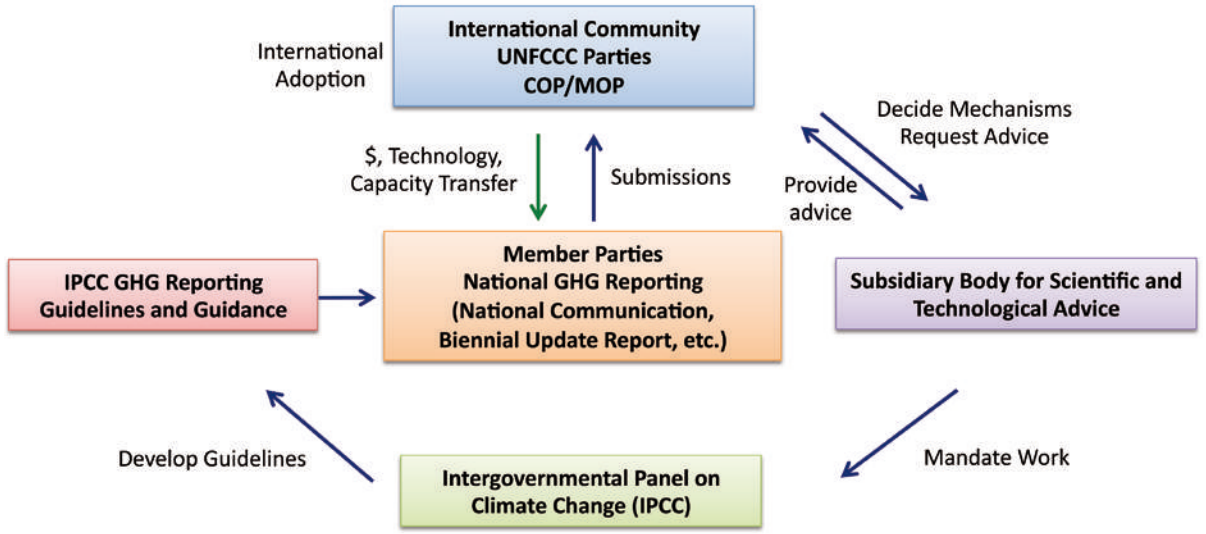
For activities listed in Decision 1/CP.16, Paragraph 70 (commonly referred to as REDD+):

- Information on Forest Reference Emissions Levels and Forest Reference Levels is prepared on the basis of agreed reporting guidelines (Decision 12/CP.17) and methodologies developed by the IPCC. The information is subject to assessment.
- Information on safeguards is to be provided in National Communications (and may also be included in the BUR).

For receiving payments for results-based actions, information on forest-related emissions by sources and removals by sinks resulting from the implementation of the activities must be prepared on the basis of agreed reporting guidelines (Decision 14CP.19) and methodologies developed by the IPCC; the information must be reported in an annex to the BUR. Although the IPCC guidance does not identify REDD+ activities specifically, the Methods and Guidance Document produced by the Global Forest Observations Initiative describes how this may be done. The information is also assessed, as part of the ICA process. Detailed information on all references made above is available in Annex 4.

Figure 1 below illustrates the connections between the processes linked to national GHG reporting.

FIGURE 1
Robust national GHGI systems are key to accessing funding and support



2.3 NATIONAL GHG INVENTORY SYSTEMS AND THEIR ROLE IN INTERNATIONAL PROCESSES

The core elements of information communicated by both Annex I and non-Annex I countries party to the Convention, pursuant to the UNFCCC, are those on GHG emissions and removals of greenhouse gases (GHG inventories), and the activities that Parties have undertaken to implement their contributions to the Convention's ultimate goals, i.e. their Policies and Measures for Mitigation and for Adaptation.

To collect, analyze and report this information, each country must have a national data system in place. This system can be defined as a set of institutional arrangements among all bodies involved in ensuring the collection of adequate data within established time-schedules, their analysis (including quality assurance), the compilation of data into estimates of GHG emissions and removals (including quality checks) and the quality assurance of those estimates.

All institutional arrangements should identify the relevant responsible body for the task at hand (e.g. the forestry service), and contain information on the task (e.g. collecting data on forests' carbon stocks) including data quality requirements and timing, on the resources available, and finally on the entity or entities to which the body must report (e.g. the GHG inventory unit entrusted with compiling GHG estimates for forest land).

Further information is available from the Handbook on National Greenhouse Gas Inventory Management Systems, authored by the Consultative Group of Experts on National Communications from Parties not included in Annex I to the Convention.

The Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It was established in 1988 by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO), to provide the world with a clear scientific view on the current state of knowledge on climate change, and its potential environmental and socio-economic impacts. In the same year, the UN General Assembly endorsed the WMO's and UNEP's joint establishment of the IPCC.

One of the IPCC's main activities is the preparation of comprehensive Assessment Reports on the state of scientific, technical and socio-economic knowledge on climate change, its causes, potential impacts and response strategies.

Since 1992, the IPCC has prepared methodologies and guidelines (IPCC National Greenhouse Gas Inventories Programme) to assist the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol in preparing national inventories of GHG emissions by source and removals by sinks. The latest major publication is the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
The IPCC's Task Force on National Greenhouse Gas Inventories (TFI), based in Japan, is the executive body for the implementation of the IPCC National Greenhouse Gas Inventories Programme.

3

The IPCC Guidelines for National GHG Inventories

3.1 THE STRUCTURE OF IPCC GUIDELINES

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines) were prepared upon the invitation of the UNFCCC, to provide good practice methodologies for countries to use in preparing GHG inventories when reporting to the UNFCCC. As shown in the picture below, the GHG inventory sectors are: Energy, Industrial Processes & Product Uses (IPPU), Agriculture, Forestry & Other Land Use (AFOLU) and Waste.

he 2006 IPCC Guidelines are an evolutionary development with respect to the 1996 IPCC Guidelines, the GPG 2000 and the GPG-LULUCF 2003. The 2006 approach ensures continuity and enables experiences with the existing guidelines, new scientific information, and the results of the UNFCCC review process to be incorporated.

One of the most significant changes between the 1996 and 2006 versions of the Guidelines is the assembly of Land Use, Land Use Change and Forestry (LULUCF) and the Agriculture sectors into a single Agriculture, Forestry and Other Land Use (AFOLU) sector.

The categories from both sectors (LULUCF and Agriculture) were integrated into this new framework, to resolve inconsistencies and avoid double counting. In addition, this enabled:

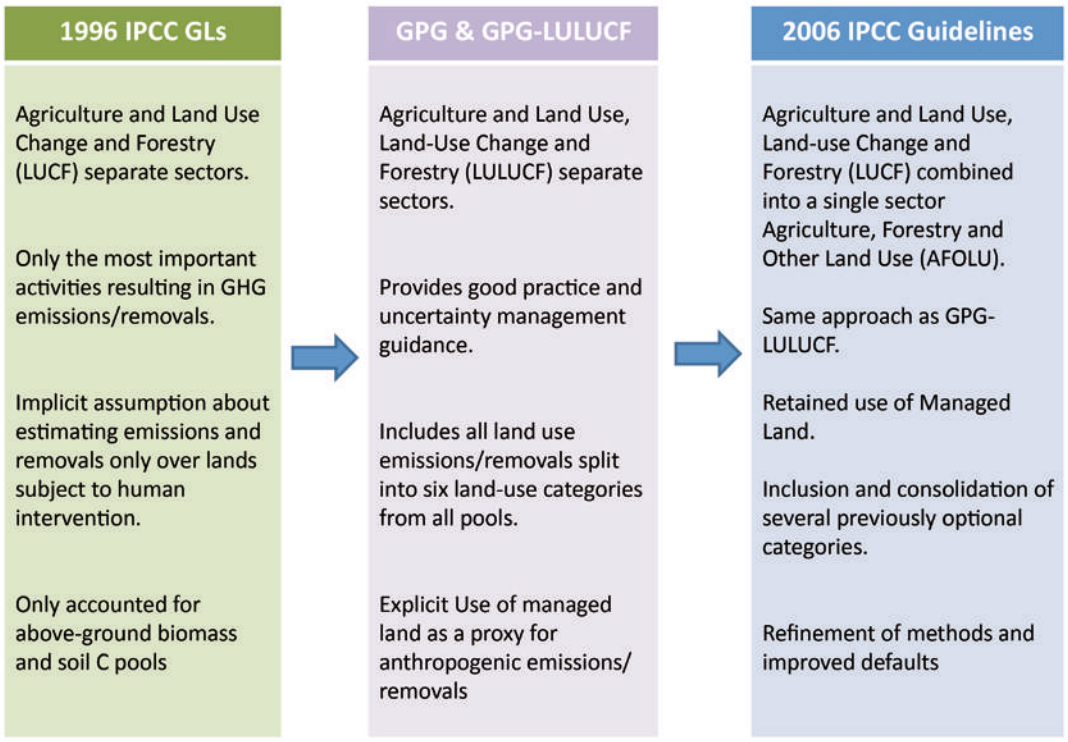
- Removal of the somewhat arbitrary distinction between these categories in the previous versions of the guidance, and promotion of consistent use of data between them, especially for more detailed methods;
- Consistency in the treatment of gases in the Agriculture and LULUCF Sectors, thus enabling a more consistent treatment of land conversions.

FIGURE 2
Main source and sink categories of 1996 and 2006 IPCC Guidelines

This integration recognizes that the processes underlying GHG emissions and removals, as well as the different forms of terrestrial carbon stocks, can occur across all types of land, and
is intended to improve consistency and completeness in estimating and reporting GHG emissions and removals.

Figure 3 below (IPCC 2006) shows the evolution from the 1996 to the 2006 versions of the IPCC guidelines, having regard to the Agriculture/LUCF, Agriculture/LULUCF and AFOLU sectors.

FIGURE 3
Evolution of IPCC Guidelines for National GHG Emission Inventories



3.2 THE QUALITY OF THE EMISSION INVENTORY

The IPCC Guidelines reflect the international data quality requirements defined by the UNI ISO 14064 (http://www.iso.org/iso/catalogue_detail?csnumber=38381), in order to build inventories that are consistent, comparable, complete, accurate and transparent; this, in turn, enables inventory quality to be improved over time (IPCC-2006, Chapter 1.4).

The 2006 Guidelines encourage the continuous improvement of emission inventory compilation, by adopting the principles required by international standards during all steps of the process and by recommending regular communication and consultation with data providers throughout all the inventory activities (from data collection to final reporting).

The inventory brings benefits in terms of both efficiency and quality, through the relationship between data suppliers and inventory compilers. This ongoing communication and consultation will also enable the inventory compilers to be promptly informed of any new datasets being developed, and also provide opportunities to influence the planning and specifications of data providers' data collection activities.

In each phase of the GHGI (shown below, Figure 4), the inventory compiler should verify the quality of the data (absence of bias and magnitude of uncertainties) the appropriateness of the data for the methodology applied (consistency of definitions and timeliness), the suitability of the methodology selected for the data available, the improvement in estimate accuracy and data collection quality (accuracy in sampling design and measurements, increase of time frequency).

As mentioned, Figure 4 below summarises the GHGI's main steps:

FIGURE 4
Main steps in compiling a GHG Inventory

- **Data collection.** This activity covers the evaluation of existing sources of data, and the planning of new emission measurements and surveys; extensive reference is made to the information provided by other organisations. The IPCC guidelines provide information on initiating and maintaining a data collection program, on the data collection process and on other general issues.
- **Uncertainty analysis**. The IPCC guidelines provide information on estimating and combining uncertainties, along with a discussion of the conceptual underpinnings of inventory uncertainty, and the uncertainty issues related to specific categories of emissions and removals. The uncertainty analysis characterises the range and likelihood of possible values for the national inventory, as a whole and for its individual components. An awareness of the uncertainty of parameters and results provides inventory compilers with insight when evaluating suitable data for the inventory, during the data collection and compilation phases.
- **Methodological choice and Key category analysis.** IPCC guidelines provide good practice guidance on how to identify key categories of emissions and removals. This phase includes the concept of the key category together with decision trees, to guide users in choosing the methodology for each category.
- **Time-series consistency.** This activity provides methods for ensuring time-series consistency, in cases where it is not possible to use the same method and/or data over the entire period. The IPCC guidelines provide good practice guidance on when to recalculate estimates for previous years, and methods for accounting for changes in emissions and removals over time.

- **Quality Assurance (QA) and Quality Control (QC) and Verification.** The IPCC Guidelines describe the general QA/QC aspects to be considered when compiling an inventory of emissions and removals, including good practice guidance on sector-specific quality control checks. Techniques for verifying inventories using external data are also outlined.
- **Reporting.** The IPCC Guidelines contain Reporting Guidance and Tables, and specifically address issues related to reporting, including the following: reporting coverage, in terms of sectors, categories, national territory, gases, pools; its time-frame; the use of notation keys, units and digits. This aims to ensure completeness, promote transparency and establish comparability.

3.3 THE AFOLU SECTOR AND ITS STRUCTURE

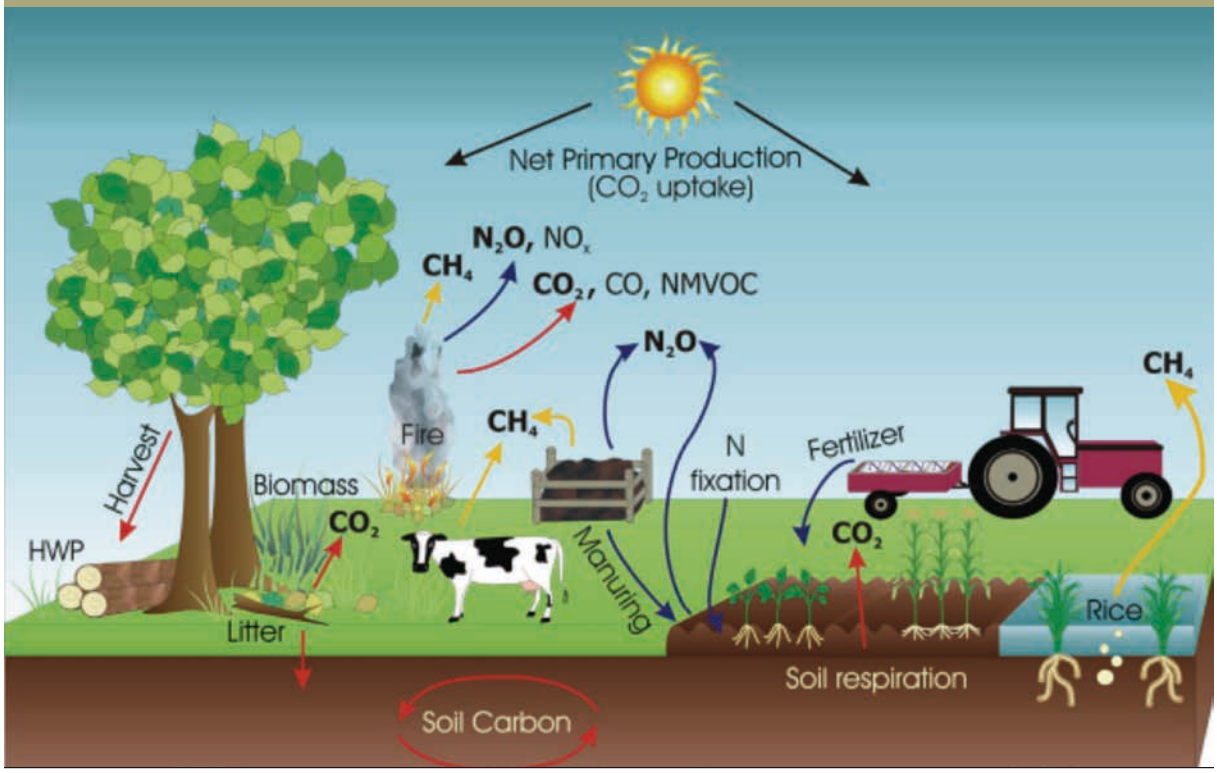
The Agriculture, Forestry and Other Land Use (AFOLU) sector deals with anthropogenic GHG emissions and removals, defined as all emissions and removals occurring on 'managed land' and that are associated with the use of land, including agriculture and husbandry. Managed land is land where human interventions and practices have been applied to perform production, ecological or social functions (IPCC, 2006).

Figure 5 below provides a synthetic image on how land use and management can influence a variety of ecosystem processes, which in turn can affect greenhouse gas fluxes such as photosynthesis, respiration, decomposition, nitrification/denitrification, enteric fermentation, and combustion.

These processes involve transformations of carbon and nitrogen, driven by biological (activity of microorganisms, plants, and animals) and physical processes (combustion, leaching, and run-off).

The estimates of GHG emissions and removals deriving from AFOLU include:

FIGURE 5
GHG emission sources/removals and processes in managed ecosystems



Source: (IPCC, 2006).

- CO_2 emissions and removals resulting from C stock changes in biomass, dead organic matter (DOM), soil organic matter (SOM) of organic and mineral soils, and harvested woody products (HWP) for all managed lands;
- CO_2 from cultivated organic soils;
- non-CO_2 emissions from fire on all managed land;
- CH_4 emissions from rice cultivation;
- N_2O emissions from all managed soils;
- CO_2 emissions associated with liming and urea application to managed soils;
- CH_4 emissions from livestock enteric fermentation;
- CH_4 and N_2O emissions from manure management systems.

Greenhouse gas fluxes can be estimated in two ways:
- as net changes in C stocks over time (used for most CO_2 fluxes) and
- directly, as gas flux rates to and from the atmosphere (used for estimating non-CO_2 emissions and some CO_2 emissions).

The use of C stock changes to estimate CO_2 emissions and removals is based on the fact that changes in ecosystem C stocks occur predominantly (but not exclusively) through CO_2 exchange between the land surface and the atmosphere (i.e. other C transfer process such as leaching are assumed to be negligible). Hence, increases in total C stocks over time are equated with a net removal of CO_2 from the atmosphere, and decreases in total C stocks (less transfers to other pools such as harvested wood products) are equated with a net emission of CO_2. Non-CO_2 emissions are largely a product of microbiological processes (i.e. within soils, animal digestive tracts and manure) and of the combustion of organic materials.

The emission and removal processes are organized by the ecosystem components:
- **Biomass**: plant biomass, including above-ground and below-ground parts, is the main conduit for CO_2 removal from the atmosphere.
- **Dead organic matter:** the bulk of biomass production contained in living plant material, which is eventually transferred to dead organic matter (DOM) pools (i.e. dead wood and litter.
- **Soils:** as dead organic matter is fragmented and decomposed, it is transformed into soil organic matter. Further soils are fertilized and amended.
- **Livestock**: animal production systems, particularly those featuring ruminant animals, can be significant sources of greenhouse gas emissions.

AFOLU emission sources/sinks are categorized by:
1. **Land use.** Each land use is subdivided into land remaining in the same category (e.g. Forest Land Remaining Forest Land) and land converted from one category to another (e.g. Forest Land converted to Cropland). Countries may choose to further stratify land in each category by climatic or other ecological regions, depending on the choice of the method and its requirements. Greenhouse gas emissions and CO_2 removals determined for each specific land use include CO_2 (as carbon stock changes) from biomass, dead organic matter, soils and HWP, if any, as well as non-CO_2 emissions from burning.

Land use comprises the following categories:
- **Forest Land**. This category includes all land with woody vegetation consistent with the thresholds used to define Forest Land in the national greenhouse gas inventory. It also includes systems with a vegetation structure that currently fall below, but that *in situ* could potentially reach, the threshold values used by a country to define the Forest Land category.
- **Cropland**. This category includes cropped land, including rice fields, and agro-forestry systems where the vegetation structure falls below the thresholds used for the Forest Land category.

- **Grassland**. This category includes rangelands and pasture land that are not considered Cropland. It also includes systems with woody vegetation and other non-grass vegetation, such as herbs and brushes that fall below the threshold values used in the Forest Land category. The category also includes all grassland, from wild lands to recreational areas as well as agricultural and silvo-pastoral systems, consistent with national definitions.
- **Wetlands**. This category includes areas of peat extraction and land that is covered or saturated by water for all or part of the year (e.g. peatlands), and that do not fall within the Forest Land, Cropland, Grassland or Settlements categories. It includes reservoirs as a managed sub-division, and natural rivers and lakes as unmanaged sub-divisions.
- **Settlements**. This category includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories. The elements falling within this category should be consistent with national definitions.
- **Other Land.** This category includes bare soil, rock, ice, and all land areas that do not fall into any of the other five categories. It enables the total of identified land areas to match the national area, where data are available. If data are available, countries are encouraged to classify unmanaged lands by the above land-use categories (e.g. Unmanaged Forest Land, Unmanaged Grassland, and Unmanaged Wetlands).

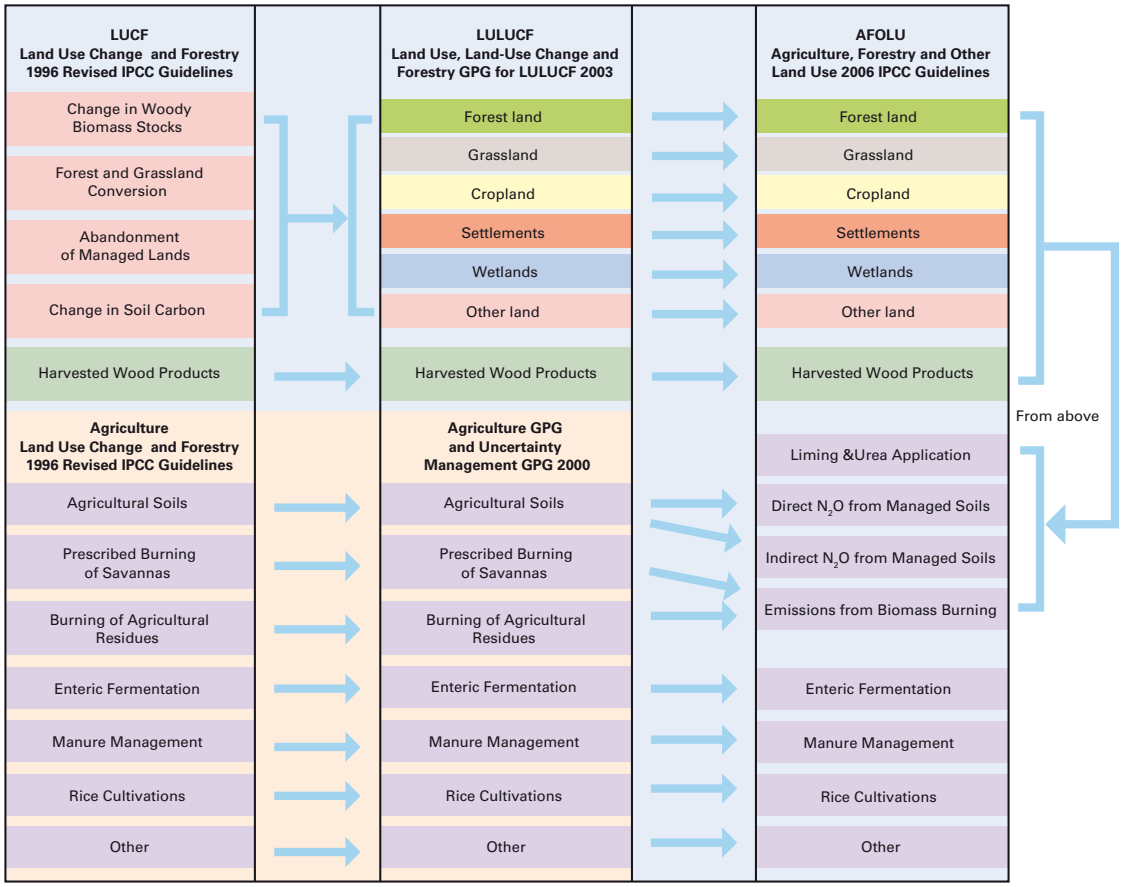
2. **Agricultural practices** include the following categories:

- **Enteric Fermentation.** This is the fermentation process that produces methane as a by-product of the normal livestock digestive process, in which microbes resident in the animal's digestive system ferment the feed consumed by the animal.
- **Manure Management.** Livestock manure is primarily composed of organic material and water. Under anaerobic conditions, the organic material is decomposed by anaerobic bacteria. The end products of anaerobic decomposition are methane, carbon dioxide, and stabilized organic material. The methane production potential of manure depends on the manure's specific composition, which in turn depends on the composition and digestibility of the animal diet.
- **Biomass Burning.** It includes only living biomass. Although, the fuel components other than live biomass are often very significant, especially in peatlands (i.e. DOM).
- **Managed soils.** This category includes all agricultural soils.
- This category includes direct and indirect nitrous oxide emissions that are usually estimated from data on nitrogen supplied to soils, including nitrogen fertiliser usage or sales, crops residue management, organic amendments, cultivation of organic soils (i.e. drainage of peatlands in agricultural land) and land-use conversions that enhance mineralisation of nitrogen in soil organic matter.
- **Liming** is used to reduce soil acidity and improve plant growth in managed systems, particularly agricultural lands and managed forests. Adding carbonates to soils in the form of lime (e.g., calcic limestone ($CaCO_3$), or dolomite ($CaMg(CO_3)_2$) leads to CO_2 emissions as the carbonate limes dissolve and release bicarbonate ($2HCO_3$), which evolves into CO_2 and water (H_2O). These are methods for soil fertilization. Adding urea to soils during fertilisation leads to a loss of the CO2 that was fixed in the industrial production process. **Urea** ($CO(NH_2)_2$) is converted into ammonium (NH_4^+), a hydroxyl ion (OH^-), and bicarbonate (HCO_3^-), in the presence of water and urease enzymes. Similar to the soil reaction following addition of lime, the bicarbonate that is formed evolves into CO_2 and water. This source category is included because the CO_2 removal from the atmosphere during urea manufacturing is estimated in the Industrial Processes and Product Use Sector.
- **Rice cultivation.** This category refers to the anaerobic decomposition of organic material in flooded rice fields that produces methane, which escapes to the atmosphere primarily through air-bubbles and by being transported through the rice plants. The amount emitted is a function of the rice species, the number and duration of harvests, the soil type and temperature, the irrigation method, and fertilizer use.

This structure has undergone some changes over time to meet user needs, as reflected in the IPCC Guidelines of 1996 – 2006.

Figure 6 below shows the mapping of the emission category structures of AFOLU (from IPCC-2006), LULUCF from the GPG for LULUCF 2003 and 1996, and LUCF from the Revised Guidelines 1996.

FIGURE 6
GHG emission sources/removals and processes in managed ecosystems



Different Sectoral Mapping

- "Enteric Fermentation: Poultry" is now reported under "other"
- "Manure Management" is now reported by animal type only
- "Agricultural Soils" and "CO_2 Emissions and Removals from Soils" have been moved from Managed Soils to 3G Liming, 3H Urea Application, 3D Direct N_2O Emissions

Fires, previously under "Forest and Grassland Conversion", "Field Burning of Agricultural Residues" and "Prescribed Burning of Savannas", are re-classified under Biomass Burning.

New categories

The following new categories have been introduced:

- 3D Indirect N_2O Emissions from the Atmospheric Deposition of Nitrogen in NO_x and NH_3
- 3H Urea Application
- 3D Harvested Wood Products

Figure 7 shows the differences in Categorization of Sources and Sinks of UNFCCC reporting tables related to the Revised 1996 IPCC Guidelines, the Good Practice Guidance and the 2006 IPCC Guidelines.

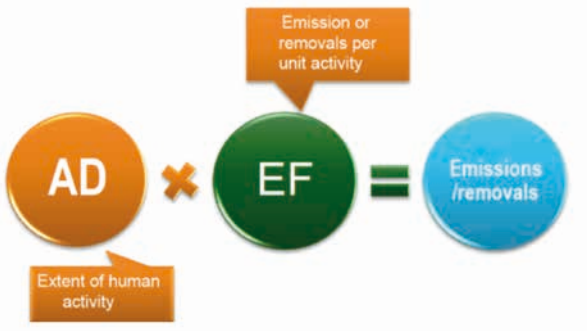
FIGURE 7
Categorization of Sources and Sinks of IPCC Guidelines reporting tables, 1996 - 2006

Revised 1996 IPCC Guidelines		IPCC GPG 2000		2006 IPCC Guidelines (AFOLU)	
4	**AGRICULTURE**	**4**	**AGRICULTURE**	**3**	**AGRICULTURE**
4.A	Enteric Fermentation	4.A	Enteric Fermentation	3.A	Enteric Fermentation
4.B	Manure Management	4.B	Manure Management	3.B	Manure Management
4.C	Rice Cultivations	4.C	Rice Cultivations	3.C	Rice Cultivations
4.D	Agricultural Soils	4.D	Agricultural Soils	3.D	Agricultural Soils
4.E	Prescribed Burning of Savannas	4.E	Prescribed Burning of Savannas	3.E	Prescribed Burning of Savannas
4.F	Field Burning of Agricultural Residues	4.F	Field Burning of Agricultural Residues	3.F	Field Burning of Agricultural Residues
				3.G	Liming
				3.H	Urea application
				3.I	Other carbon-containing fertilizers
4.G	Other	4.G	Other	3.J	Other
			IPCC GPG 2003		
5	**LAND-USE CHANGE & FORESTRY**	**5**	**LULUCF**	**4**	**LULUCF**
5.A	Change in Forest and other Woody Biomass Stocks	5.A	Forest Land	4.A	Forest land
5.B	Manure Management	5.B	Cropland	4.B	Cropland
5.C	Rice Cultivations	5.C	Grassland	4.C	Grassland
5.D	Agricultural Soils	5.D	Wetlands	4.D	Wetlands
		5.E	Settlements	4.E	Settlements
		5.F	Other Land	4.F	Other land
5.G	Other (Harvested wood products	5.G	Other (Harvested wood products)	4.G	Other (Harvested wood products)

3.4 REPORTING METHODS

The fundamental formula for estimating the quantity of GHG emissions can always be expressed as the multiplication of the activity data (AD) by the emission factor (EF), as follows:

FIGURE 8
Equation to calculate GHG emissions/removals



Where:

- **EF = Emission factor**

  Emission factors are coefficients that quantify the emissions or removals of a gas per unit activity data. Emission factors are based on samples of measurements, averaged at various levels of detail depending upon the Tier methodology used, to develop a representative rate of emission for a given activity level under a given set of operating conditions.

- **AD = Activity data**
  Activity data describe the magnitude of a human activity resulting in emissions or removals of greenhouse gases, taking place during a given period of time and over a specified area.

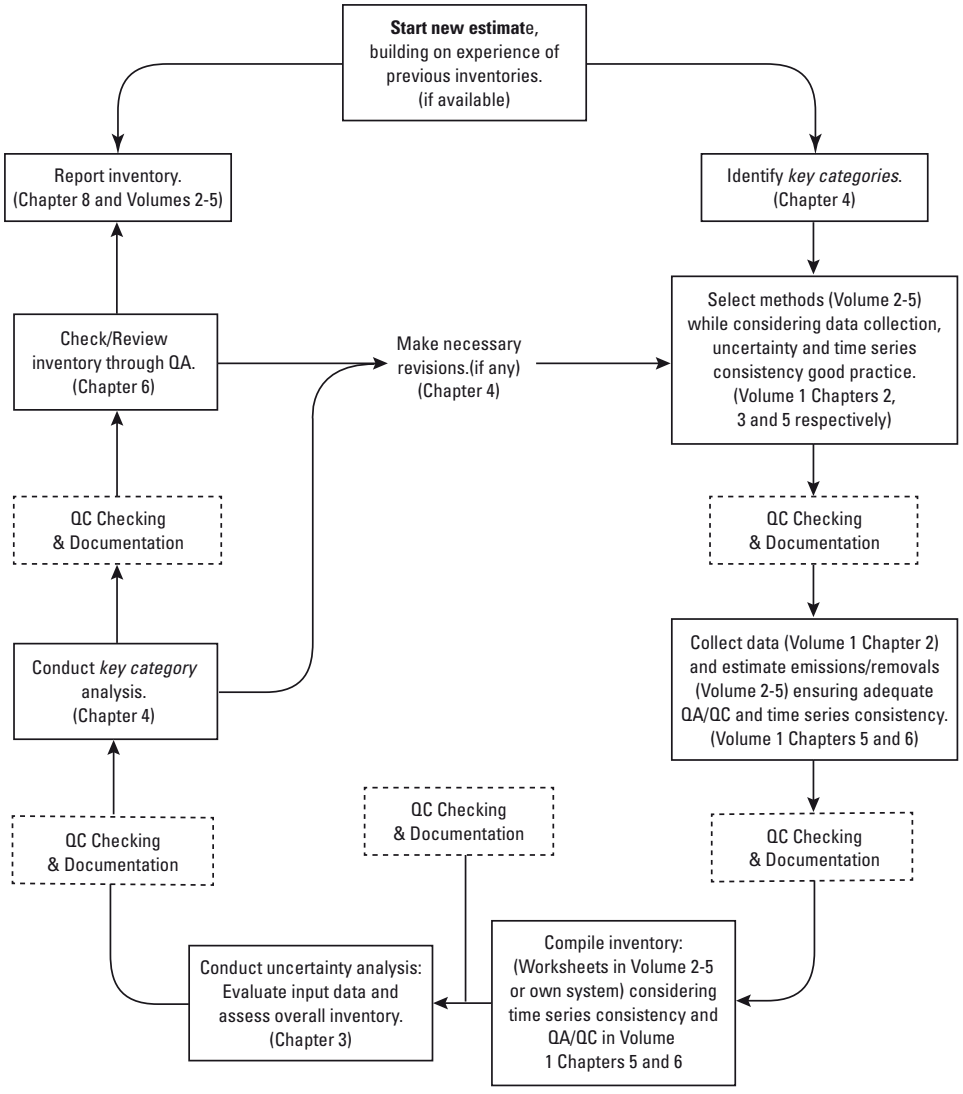
  Data on livestock type and numbers, the area extent of managed agriculture, pastures, forests and associated changes or the amount of synthetic or organic fertilizer applied, are all examples of AD relevant to the computation of emissions for the AFOLU sector.
  In addition to the AD and the EF, this basic equation can also incorporate other estimation parameters to reflect actual emissions or removals.

The quantification of GHG emissions in an inventory is a multi-step process for each category (for Non-Annex I, a detailed step-by-step training is available at http://unfccc.int/resource/ cd_roms/na1/ghg_inventories/index.htm).

3.5 ESTIMATION PROCESS

The IPCC 2006 Guidelines provide comprehensive documentation on how to proceed for estimating the emission and removals, as shown in the Inventory development cycle below (IPCC, 2006):

FIGURE 9
Inventory development cycle



Below the initial steps of the process are described; these steps are also analysed and reported in the guidelines for each gas category.

3.5.1 The identification of Key Categories

A key category is one that is prioritised within the national inventory system, because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level, the trend, or the uncertainty in emissions and removals.

Whenever the term "key category" is used, it includes both source and sinks categories. Key categories should be the priority for countries when allocating inventory resources for data collection, compilation, quality assurance/ quality control and reporting. The main purposes are:

- To focus available resources for improving data and methods upon categories identified as key;
- To analyse what level of methodological complexity can be applied (e.g. Tier 2 and 3 methods);
- To give further attention to key categories, in terms of quality assurance and quality control.

Any inventory compiler who has experience in preparing a national GHG inventory will be able to identify key categories, in terms of their contribution to the absolute level of national emissions and removals. For those inventory compilers who have prepared a time series, the quantitative determination of key categories should include an evaluation of both the absolute level and the trend of emissions and removals. Some key categories may be identified only when their influence on the trend of the national inventory is taken into account.

Two approaches for performing the key category analysis have been developed. Both approaches identify key categories in terms of their contribution to the absolute level of national emissions and removals and to the trend of emissions and removals.

- In Approach 1, key categories are identified using a pre-determined cumulative emissions threshold. Key categories are those that, when summed together in descending order of magnitude, add up to 95 percent of the total level.
- Approach 2 can be used by inventory compilers, if category uncertainties or parameter uncertainties exist. Under Approach 2, categories are sorted according to their contribution to this uncertainty.

The results of Approach 2 are additional to those that may be obtained from Approach 1.

For each key category, where relevant, the inventory compiler should determine whether certain subcategories are particularly significant. Usually, for this purpose, the subcategories should be ranked according to their contribution to the aggregate key category. Those subcategories that, considered together, contribute over 60 percent to the key category should be treated as being particularly significant. It may be appropriate to focus efforts towards making methodological improvements with regard to these most significant subcategories.

Having regard to the Key categories for AFOLU, it is necessary to identify the following elements:

- Which CO_2 net emissions or removals, from which land-use categories and management activities, are significant;
- Which CH_4 or N_2O emissions, from which land-use and management activities, are significant;
- Within categories, which (sub)category and/or which C pool is significant;
- In accordance with the key category analysis, the IPCC determines which tier level methodology should be applied when preparing the estimate.

3.5.2 The selection of methods and measurement

The IPCC-2006 Guidelines report three tiered approaches related to methods used in the AFOLU Sector:

- Tier 1 is the basic method;
- Tier 2 is the intermediate method; and
- Tier 3 is the most demanding, in terms of complexity and data requirements.

Generally, moving to higher tiers improves the inventory's accuracy and reduces uncertainty, but the complexity and resources required for conducting inventories also increase. Tiers 2 and 3 are sometimes referred to as higher-tier methods, and are generally considered to be more accurate.
If necessary, a combination of tiers can be used, e.g. Tier 2 can be used for biomass and Tier 1 for soil carbon. The methods and data presented focus on Tier 1 inventories. The methods will be generally applicable to Tier 2 inventories, but the default data presented for Tier 1 will be partly or wholly replaced with national data as part of the Tier 2 estimation. Tier 3 methods are not described in detail, but good practices in their application are outlined.

The framework of the Tier structure for AFOLU methods is as follows:

- **Tier 1** methods are designed to be the simplest to use; equations and default parameter values (e.g., emission and stock change factors) for these methods are provided by IPCC guidelines.

  Country-specific activity data are necessary, but for Tier 1 sources of activity data estimates are often globally available (e.g. deforestation rates, agricultural production statistics, global land cover maps, fertilizer use, livestock population data, etc.), although these data are usually spatially coarse. It is good practice to use data from official international sources when national data are lacking.

- **Tier 2** can use the same methodological approach as Tier 1, but applies emission and stock change factors that are based on country- or region-specific data, for the most important land-use or livestock categories.

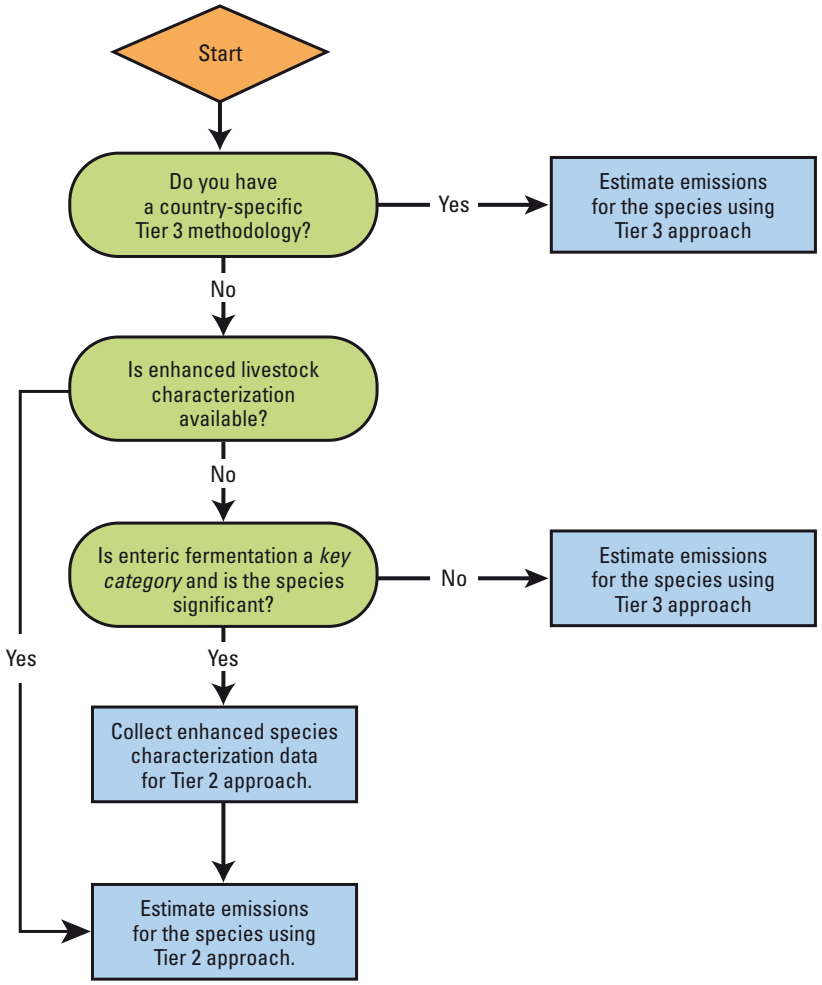
  Country-defined emission factors are more appropriate for the climatic regions, land-use systems and livestock categories in that country. Higher temporal and spatial resolution and more disaggregated activity data are typically used in Tier 2 to correspond with country-defined coefficients for specific regions and specialized land-use or livestock categories.

- In **Tier 3**, higher order methods are used, including models and inventory measurement systems tailored to national circumstances, repeated over time, and driven by high-resolution activity data and disaggregated at the sub-national level.

  These higher order methods provide estimates of greater certainty than lower tiers. Higher order systems may include comprehensive field sampling repeated at regular time intervals and/or GIS-based systems of age, class/production data, soils data, and land-use and management activity data, integrating several types of monitoring. Pieces of land where a land-use change occurs can usually be tracked over time, at least statistically. In most cases, these systems present a climate dependency, and thus provide source estimates with inter-annual variability. Detailed dis-aggregation of livestock population according to animal type, age, body weight etc., can be used. Models should undergo quality checks, audits, and validations, and be thoroughly documented.

To facilitate analysis of the methods, the Guidelines propose using a "decision tree" model, which assists the inventory compiler to navigate the guidance and select the appropriate tiered methodology for their circumstances, based on their assessment of the key categories.

FIGURE 10
Decision tree for the Livestock category



The Figure 10 shows an example of methodological tiers decision tree, for "livestock categories" (Source IPCC, 2006).

This should be repeated for each livestock species and gas. It is important to note, however, that many countries often do not have access to Tier 2 data even for key categories. This manual guides them, even in these cases, on how to build a Tier 1 inventory, which can then be used as a solid, sustainable base for further refinement once human and financial resources become available.

3.5.3 The selection and collection of activity data

Data collection is an integral part of developing and updating a GHG inventory. Formalised data collection activities should be established, adapted to countries' national circumstances, and reviewed periodically as a part of implementing good practices.

Data sources:

- **National and International Literature**
  The IPCC Guidelines recommend collecting data from bodies such as National Statistical Agencies, and national

regulatory authorities responsible for permitting of industrial and other processes subject to pollution emission legislation.

There will be occasions, however, when other sources of specialised literature provide activity data, e.g. UN statistics (including the FAOSTAT database: http://faostat3.fao.org/faostat-gateway/go/to/home/E), the US Geological Survey (USGS) reports on commodities, and technical reports, guidelines, standards, sectoral surveys issued by industrial trade associations.

- **Surveys & Census information**
  Survey and census information provide the best agricultural, production and energy statistics that can be used for greenhouse gas inventories. Generally, these data are compiled by national statistical agencies (NSAs) or relevant ministries, for national policy purposes or to comply with international demand for data, or other activities that are beyond the direct control of the inventory compiler. However, the needs of the inventory may sometimes trigger or influence surveys or censuses.

More detailed information is available at the section on Data Collection of the IPCC guidelines (IPCC 2006, Vol.1 – CH. 2.2.5).

3.5.4 The selection of emission factors or carbon stock change factors

The IPCC Guidelines define the emission factor as the average emission rate of a given GHG for a given source, relative to units of activity.

The 2006 IPCC Guidelines, adopting the Tier 1 methods for all categories, enable the use of readily available national or international statistics, in combination with provided default emission factors and additional parameters provided, thus making it feasible to prepare estimates for all countries.

A practical example could be the calculation of methane emissions from enteric fermentation.
Methane is produced by the fermentation of feed within an animal's digestive system. Generally, a higher feed intake produces higher methane emission. Although the extent of methane production is affected by the composition of the animal's diet, feed intake is positively related to animal size, growth rate and production (e.g. milk production, wool growth, or pregnancy). All these variables assume a range of values in accordance with the husbandry characteristics, which in turn change according to the region.

Selecting the Tier 1 method, the 2006 IPCC provides the default emission factors that are more appropriate for the country's livestock characteristics. These have been drawn from previous studies, and are organized by region for ease of use.

Figure 11 shows the Emission Factors of Enteric Fermentation by the Cattle sub-category, and by regional area.

FIGURE 11
Tier 1 CH_4 Emission Factors from Enteric Fermentation for Cattle

Regional characteristics	Cattle category	Emission factor (kg CH_4 ead^{-1} y^{r-1})	Comments
North America: Highly productive commercialized dairy sector feeding high quality forage and grain. Separate beef cow herd, primarily grazing with feed supplements seasonally. Fast-growing beef steers/ heifers finished in feedlots on grain. Dairy cows are a small part of the population.	Dairy	128	Average milk production of 8,400 kg $head^{-1}$ yr^{-1}.
	Other Cattle	53	Includes beef cows, bulls, calves, growing steers/ heifers, and feedlot cattle.
Western Europe: Highly productive commercialised dairy sector feeding high quality forage and grain. Dairy cows also used for beef calf production. Very small dedicated beef cow herd. Minor amount of feedlot feeding with grains.	Dairy	117	Average milk production of 6,000 kg $head^{-1}$ yr^{-1}.
	Other Cattle	57	Includes bulls, calves, and growing steers/heifers.
Eastern Europe: Commercialised dairy sector feeding mostly forages. Separate beef cow herd, primarily grazing. Minor amount of feedlot feeding with grains.	Dairy	99	Average milk production of 2,550 kg $head^{-1}$ yr^{-1}.
	Other Cattle	58	Includes beef cows, bulls, and young.
Oceania: Commercialised dairy sector based on grazing. Separate beef cow herd, primarily grazing rangelands of widely varying quality. Growing amount of feedlot feeding with grains. Dairy cows are a small part of the population.	Dairy	90	Average milk production of 2,200 kg $head^{-1}$ yr^{-1}.
	Other Cattle	60	Includes beef cows, bulls, and young.
Latin America: Commercialised dairy sector based on grazing. Separate beef cow herd grazing pastures and rangelands. Minor amount of feedlot feeding with grains. Growing non-dairy cattle comprise a large portion of the population.	Dairy	72	Average milk production of 800 kg $head^{-1}$ yr^{-1}.
	Other Cattle	56	Includes beef cows, bulls, and young.
Asia: Small commercialised dairy sector. Most cattle are multi-purpose, providing draft power and some milk within farming regions. Small grazing population. Cattle of all types are smaller than those found in most other regions.	Dairy	68	Average milk production of 1,650 kg $head^{-1}$ yr^{-1}.
	Other Cattle	47	Includes multi-purpose cows, bulls, and young
Africa and Middle East: Commercialised dairy sector based on grazing with low production per cow. Most cattle are multi-purpose, providing draft power and some milk within farming regions. Some cattle graze over very large areas. Cattle are smaller than those found in most other regions.	Dairy	46	Average milk production of 475 kg $head^{-1}$ yr^{-1}.
	Other Cattle	31	Includes multi-purpose cows, bulls, and young
Indian Subcontinent: Commercialised dairy sector based on crop by-product feeding with low production per cow. Most bullocks provide draft power and cows provide some milk in farming regions. Small grazing population. Cattle in this region are the smallest compared to cattle found in all other regions.	Dairy	58	Average milk production of 900 kg $head^{-1}$ yr^{-1}.
	Other Cattle	27	Includes cows, bulls, and young. Young comprise a large portion of the population

4

Addressing Data and Methodological Requirements

The key gaps and needs for improving statistical data and apply methodologies for estimation of national GHG inventories, which are routinely communicated by practitioners in member countries, are institutional gaps and a lack of basic data. Institutional gaps refer to the need to improve coordination across and within relevant national agencies involved in statistical data compilation and analysis on the one hand, and GHG data estimation on the other, with the objective of ensuring efficient production, inclusion in national statistical systems, and long-term sustainability of databases. Lack of basic data is a well-recognized gap especially for agriculture, forestry and land use data, being the focus of several ongoing international capacity development programs, including the *Global Strategy to Improve Agricultural and Rural Statistics*, funded by international and national agencies alike.

While the two gaps mentioned above are typical of many statistical domains, those linked to GHG reporting processes present a unique feature, one that opens opportunities for progress through practical steps and useful cross-linkages. The unique feature lies in the 'legal' nature of GHG inventories for developed countries, so-called Annex I parties, who submit annually their GHG inventories for reporting as per international climate policy agreements under the UNFCCC. For those Annex I parties that are also signatories to the Kyoto Protocol, national GHG inventories are the *de facto* Monitoring, Verification and Reporting (MRV) international instrument used to assess national performance against country-specific GHG reduction targets.

Even for developing countries with no GHG emission reduction targets, a robust and complete GHG Inventory system—allowing for analysis of time-series and extrapolation of trends, as well as identification of hotspots and of mitigation options— allows all member countries to communicate transparently their intended national mitigation actions to the international community, thus representing a mean for accessing international funding mechanisms such as REDD+ and NAMAs.

As discussed in previous chapters, each member country builds its own GHG inventory following the relevant IPCC guidelines, in line with its national capacity, including the possibility to utilize sub-national activity data and refined emission factors where possible. It is nonetheless useful to also build, at the outset, a simplified, reference GHG Inventory based on official national data and IPCC Tier 1 methodologies, to be used by national practitioners as: i) a starting point whenever national capacity for higher Tiers is lacking; ii) to determine national data gaps and perform QA/QC analyses; and iii) to evaluate specific opportunities and costs for inventory refinement at higher Tiers. A simplified reference inventory is furthermore useful to compare data from different countries within a coherent data framework.

And yet, many countries to date lack a reference, Tier 1 GHG inventory, while lack of more advanced national data and methods continues to hinder completion of GHG inventories at higher Tiers, especially for agriculture, forestry and land use.

This Manual shows which data, emission factors and computation procedures are necessary and sufficient to build a simplified yet robust GHG national Inventory at Tier 1. In order to provide practical steps to the reader, reference is regularly made to the FAOSTAT Emissions database, which provides a complete set of activity data and emission estimates using the IPCC 2006 Guidelines, covering all member countries over the period 1961-present, and for all relevant agriculture, forestry and land use sectors.

4.1 ACTIVITY DATA SOURCES

Official national activity data (AD) needed to build a Tier 1 inventory include those typically communicated by member countries to FAO and collected in the FAOSTAT (agriculture activities and land resources) and FRA (forest activities) databases. The FAO process for food and agricultural data received annually by countries includes collection, harmonization, gap filling in case of no communication, and statistical data validation by member countries and FAO according to international standards of the United Nations system. For more information on relevant FAO statistical processes, please see http://www.fao.org/statistics/en/ and http://www.fao.org/forestry/fra/en/.

FIGURE 12
FAOSTAT Emissions database Sources of Activity Data

CATEGORY		Activity Data Source
Enteric Fermentation		FAOSTAT
Manure Management		
Rice Cultivation		
Agricultural soils	Synthetic Fertilizers	
	Manure applied to soils	
	Manure left on pasture	
	Crop residues	
	Cultivated organic soils	• Harmonized World Soil • Global Land Cover 2000
Burning - Savanna		• Global Fire Emission Database 4 • Climatic map (JRC) • Global Ecological Zones
Burning – Crop residues		FAOSTAT
LULUCF	Forest land	Global Forest Resources Assessment
	Cropland	• Harmonized World Soil • Global Land Cover 2000
	Grassland	
	Burning Biomass	• Global Fire Emission Database 4 • Climatic map (JRC) • Global Ecological Zones
	Wetlands	
	Settlements	
	Other land	

These activity data sources are discussed in further detail below:

1) **FAOSTAT database.** As described in the previous chapter, the data derive from national questionnaires and pertain to various agricultural sectors (samples of these questionnaires may be viewed at http://www.fao.org/economic/ess/ess-home/questionnaires/en/). In particular, the questionnaires on production, fertilizers, land use and irrigation collect basic data for the calculation of the GHG emissions. These are compiled by National Statistics Offices (NSOs) or Ministers of Agriculture, and sent to FAO Statistics Division on an annual basis. The questionnaire data are checked with countries and validated, so that coherent and consistent time series may be obtained (more information is available in Annex 2 to this publication). In case of gaps or missing official data, time series are completed with other international data sources and calculated through estimation methods. The data are disseminated online after a thorough evaluation process.

Detailed information on FAO concepts and the definitions and classifications adopted by FAOSTAT is available at the "Methods & Standards" section of the FAOSTAT website: http://faostat3.fao.org/faostat-gateway/go/to/mes/glossary/*/E. Annex 3 to this Manual includes a Glossary that explains the concepts and definitions of selected indicators, and of items representing the GHG emissions' data activity. The correspondence between the IPCC classification and the FAOSTAT Commodity list of livestock items is reported in Table 61.

2) **Global Forestry Resources Assessments.** These are the most comprehensive assessments of forests and forestry performed to date. For its design and implementation, FAO worked closely with countries and specialists, through regular contact and expert consultations, and organizing ten regional and sub-regional workshops and other training sessions for national correspondents.

   Data is disseminated through periodic Forestry Resources Assessment (FRA) reports. Detailed information is available at http://www.fao.org/forestry/fra/fra2010/en/.

   To date, FRA includes information collated from 233 countries and territories for four points in time: 1990, 2000, 2005 and 2010. It covers the extent, condition, uses and values of forests and other wooded land, with the aim of assessing all benefits deriving from forest resources.

3) **Geospatial data.** Data of emissions from burning activities and from cultivated organic soils need to be calculated using Geographic Information System (GIS) analysis and satellite data processing. Further details are provided in the metadata and calculation procedure sections.

   Source data include, for instance:
   - Harmonized World Soil (HWSD): http://www.fao.org/nr/lman/abst/lman_080701_en.htm
   - Global Land Cover 2000 (GLC 2000), prepared by the European Commission Joint Research Centre (JRC): http://bioval.jrc.ec.europa.eu/products/glc2000/glc2000.php
   - Global Fire Emission Database 4 (GFED4): http://www.globalfiredata.org/
   - Climatic map (JRC) based on IPCC methodology: http://eusoils.jrc.ec.europa.eu/projects/RenewableEnergy/
   - Global Ecological Zones (GEZ): http://www.fao.org/docrep/017/ap861e/ap861e00.pdf

Figures 13-15 represent, as a notable example, three fundamental steps that could be used in calculating GHG emissions from biomass burning.

Figure 13 shows an example of the total burned area for savannas in Africa in 2013. This is the first input dataset for retrieving final emissions.

FIGURE 13
Map of savanna burned areas in 2012

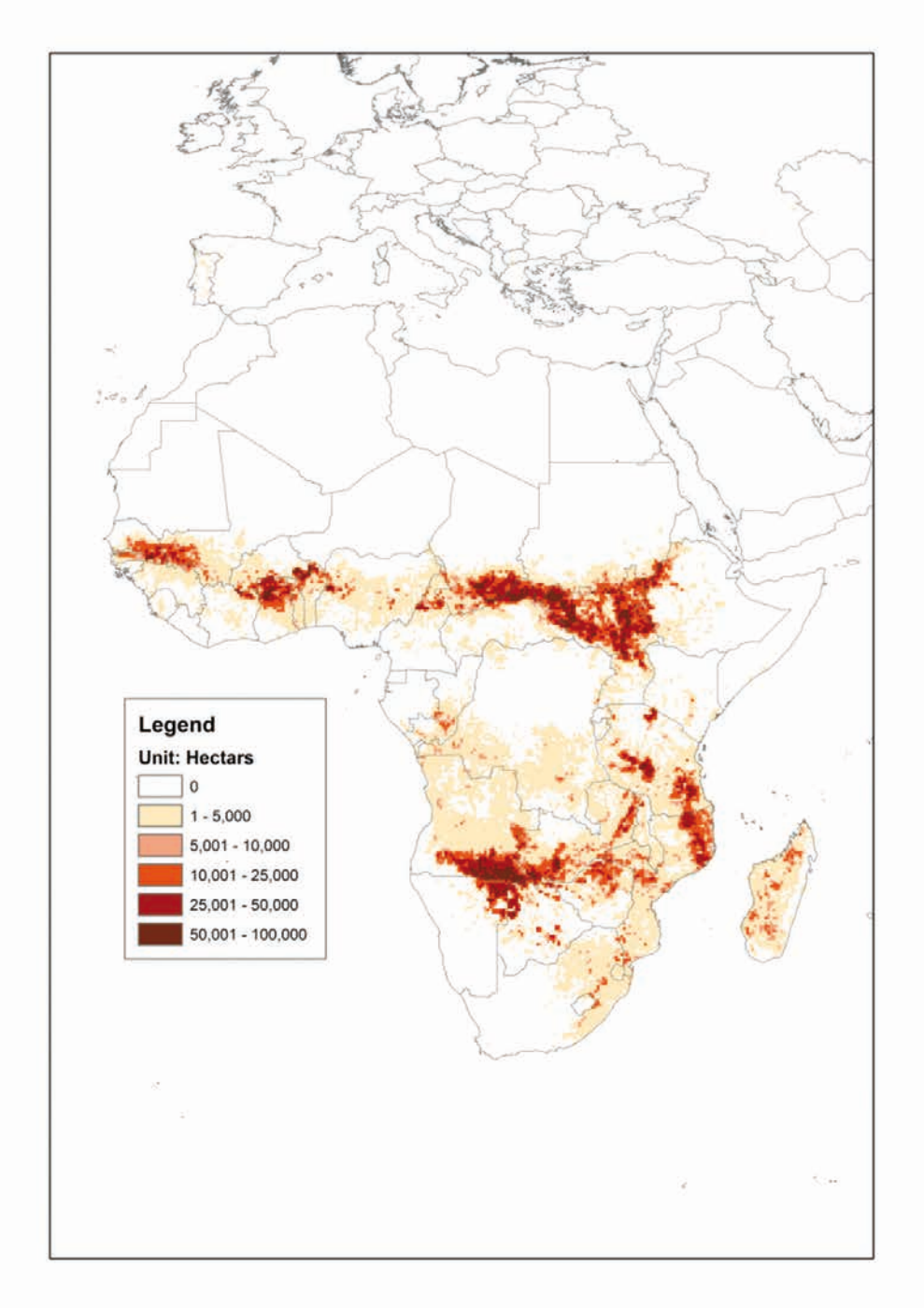


Figure 14 displays the biomass burned for savannas in 2012, calculated with parameters from the 2006 IPCC Guidelines.

FIGURE 14
Savanna dry biomass burned in 2012

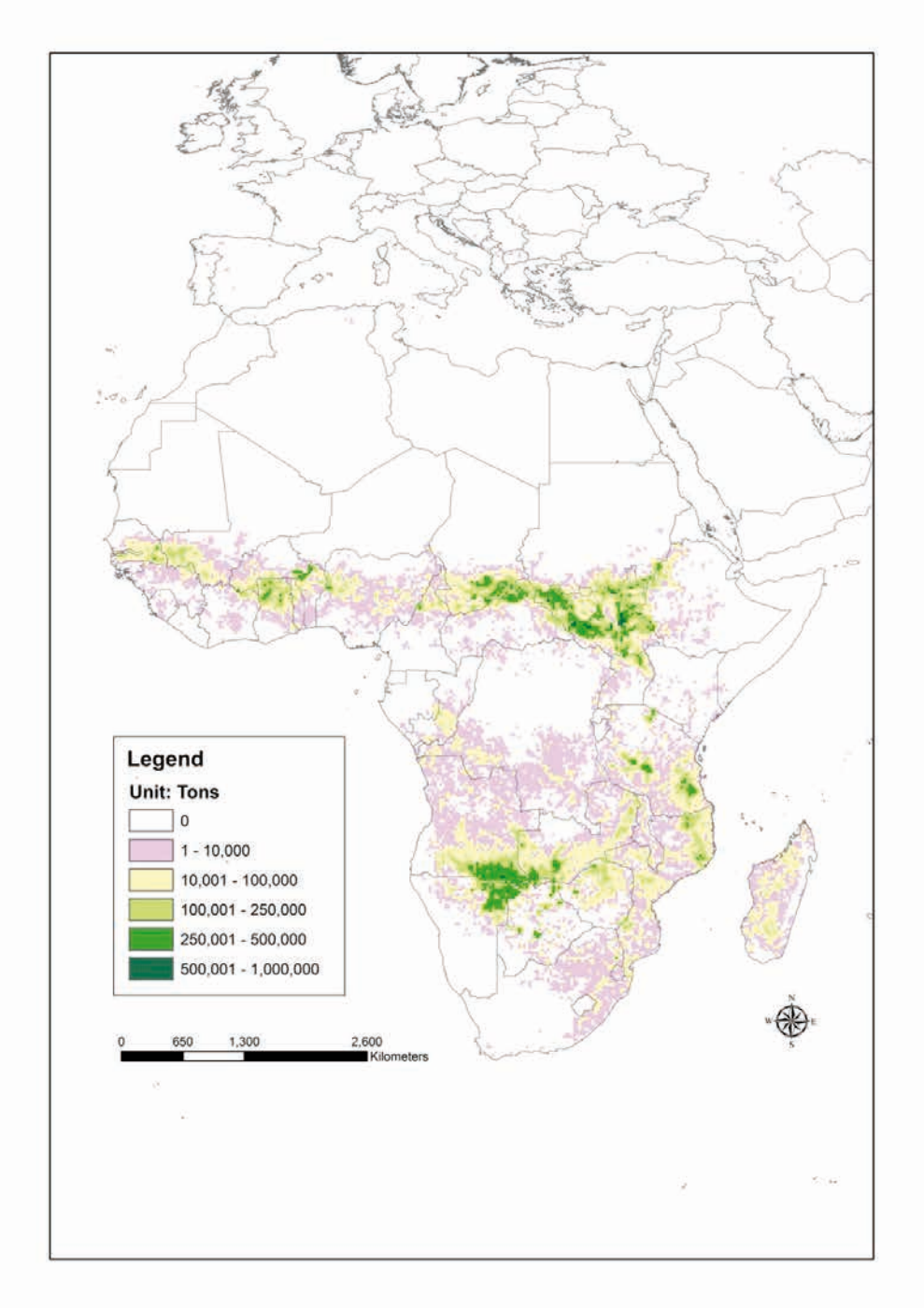
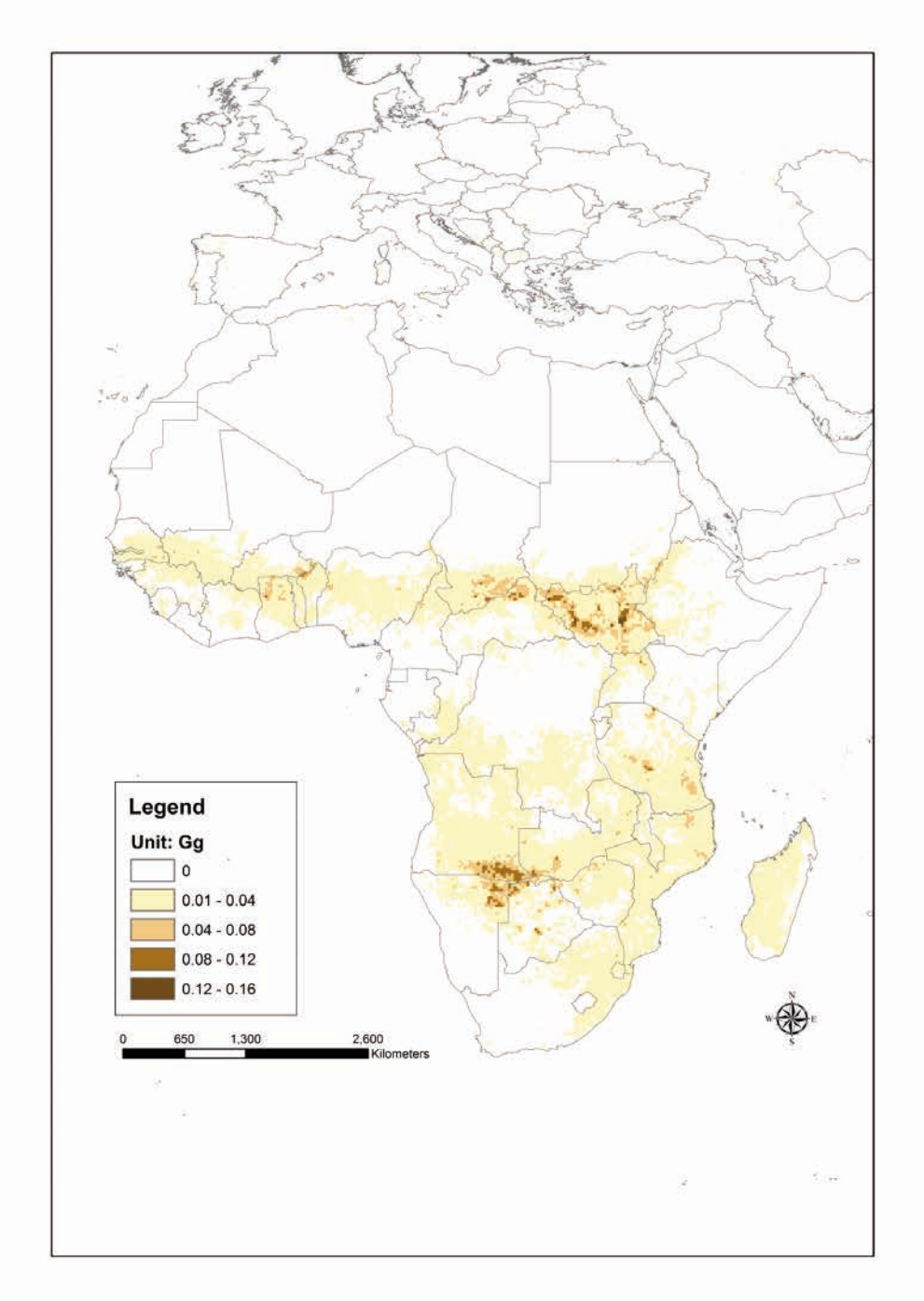


Figure 15 is the final result of data processing, with N_2O gas emissions from savannas burned in Africa in 2012.

FIGURE 15
Map of N_2O Emissions from Savanna Burned in 2012



4.2 EMISSION FACTORS

The IPCC Guidelines provide a complete set of deafult emission factors (EFs) for agriculture, forestry and land use activities, often specified at regional and/or subcategory/subdivision level, as derived from a thorough literature review. As discussed in the Introduction, Ch. 5 provides a complete guide on how to assign specific EFs to each relevant category or sub-category of interest, with the provision of explanations and detailed tables by country. Each member country chooses the IPCC guidelines most appropriate to national circumstances, taking into consideration COP/MOP decisions taken under the UNFCCC processes and discussed in Ch. 2 above. For simplicity, this Manual only addresses the process of determining emission factors and emission estimations related to the application of the IPCC 2006 Guidelines. This is a useful exercise regarldelss of specific national choices of guidelines, considering that the IPCC 2006 guidelines, as discussed in Ch.3, are consistent with and in fact incorporate most of the Revised 1996 IPCC Guidelines, including GPG 2000 and GPG 2003. Below we provide a general view of the kind of variables that need to be covered to build a GHG inventory for agriculture, forestry and the land use sectors.

4.3 METADATA AND EMISSIONS CATEGORIES FOR AGRICULTURE

Agriculture contains all the emissions produced in the different agricultural sub-domains. We further provide guidance on estimating emissions from energy use in agriculture, consistently with information currently provided and compiled by FAO.

GHG emissions from the AFOLU sector consist of non-CO_2 gases, namely methane (CH_4) and nitrous oxide (N_2O), generated through crop and livestock production and management activities. Emissions from energy used in agriculture consist mainly of CO_2 and, to a lesser extent, of CH_4 and N_2O. All emissions may be expressed, for convenience and easy comparison across domains, in Giga grams of gas emitted or in Giga grams of CO_2 equivalents (CO_{2eq}).

All relevant activity data from official national sources can be found in FAOSTAT, as specified in detail in Ch. 5. Following simple prescriptions, national GHG emissions can thus be computed at Tier 1 with official national data for all member countries, relative to the period 1961-present, and applying default IPCC guidelines. Exceptions are the Energy sub-domain, which given data availability through the International Energy Agency (IEA) can ‘only’ start from 1970, and the Cultivation of Organic Soils and Burning Savanna sub-domains, which are not based on official national statistics and only cover the period 1990-present due to the nature of the underlying remote-sensing methodologies used to derive the underlying activity data. Emission projections to 2030 and 2050 can also calculated for all agriculture domains, offering an opportunity to member countries to produce reference scenarios to be used in setting future emission targets.

Uncertainties in estimates of GHG emissions are due to uncertainties in emission factors and activity data. They may be related to, *inter alia*, natural variability, partitioning fractions, lack of spatial or temporal coverage, or spatial aggregation.

The tables in Figures 16-18 below illustrates how the relevant national GHG data can be organized in a "Emissions – Agriculture" database domain. Each sub-domain identifies an emission source category. Each category includes elements, which provide the quantity of activity data (input) and the estimated emissions for each item (output). Each element is expressed with the corresponding unit of measurement.

FIGURE 16
Data structure in the FAOSTAT "Emissions – Agriculture" domain (1)

Subdomain	Item	Element	Unit
Enteric Fermentation	Asses Buffalo Camels Dairy cattle Non-dairy cattle Goat Horses Llamas Mules Sheep Swine breeding Swine market *Aggregated items:* All GHG Animals + (Total) Camels and Llamas + (Total) Cattle + (Total) Mules and Asses + (Total) Sheep and Goats + (Total) Swine + (Total)	Stocks Implied emission factor for CH_4 Emissions (CH_4) Emissions (CO_2eq)	Head kg CH_4/head Gigagrams Gigagrams
Manure Management	Asses Buffalo Camels Dairy cattle Non-dairy cattle Chickers broilers Chickens layers Ducks Goat Horses Llamas Mules Sheep Swine breeding Swine market Turkeys *Aggregated items:* All GHG Animals + (Total) Camels and Llamas + (Total) Cattle + (Total) Chickens + (Total) Mules and Asses + (Total) Poultry Birds + (Total) Sheep and Goats + (Total) Swine + (Total)	Stocks Implied emission factor for CH_4 Emissions (CH_4) Emissions (CO_2eq) from CH_4 Manure (N content) Implied emission factor for N_2O Direct Emissions (N_2O) Indirect Emissions (N_2O) Direct emissions (CO_2eq) Indirect emissions (CO_2eq) Emissions (N_2O) Emissions (CO_2eq) from N_2O Emissions (CO_2eq)	Head kg CH_4/head Gigagrams Gigagrams kg kg N_2O-N/kg N Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams
Rice Cultivation	Rice, paddy	Area harvested Implied emission factor for CH_4 Emissions (CH_4) Emissions (CO_2eq)	Ha g CH_4/m^2 Gigagrams Gigagrams
Synthetic Fertilizers GY	Nitrogen Fertilizers (N total nutrients)	Consumption Implied emission factor for N_2O Direct Emissions (N_2O) Direct emissions (CO_2eq) Indirect Emissions (N_2O) Indirect emissions (CO_2eq) Emissions (N_2O) Emissions (CO_2eq)	Kg of nutrients kg N_2O-N/kg N Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams

FIGURE 17
Data structure in the FAOSTAT "Emissions – Agriculture" domain (2)

Subdomain	Item	Element	Unit
Manure Applied to Soil	Asses Buffalo Camels Dairy cattle Non-dairy cattle Chickers broilers Chickens layers Ducks Goat Horses Llamas Mules Sheep Swine breeding Swine market Turkeys *Aggregated items:* All GHG Animals + (Total) Camels and Llamas + (Total) Cattle + (Total) Chickens + (Total) Mules and Asses + (Total) Poultry Birds + (Total) Sheep and Goats + (Total) Swine + (Total)	Manure (N content) Implied emission factor for N_2O Direct Emissions (N_2O) Direct emissions (CO_2eq) Indirect Emissions (N_2O) Indirect emissions (CO_2eq) Emissions (N_2O) Emissions (CO_2eq)	Kg kg N_2O-N/kg N Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams
Manure left on pasture	Asses Buffalo Camels Dairy cattle Non-dairy cattle Chickers broilers Chickens layers Ducks Goat Horses Llamas Mules Sheep Swine breeding Swine market Turkeys *Aggregated items:* All GHG Animals + (Total) Camels and Llamas + (Total) Cattle + (Total) Chickens + (Total) Mules and Asses + (Total) Poultry Birds + (Total) Sheep and Goats + (Total) Swine + (Total)	Manure (N content) Implied emission factor for N_2O Direct Emissions (N_2O) Direct emissions (CO_2eq) Indirect Emissions (N_2O) Indirect emissions (CO_2eq) Emissions (N_2O) Emissions (CO_2eq)	Kg kg N_2O-N/kg N Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams
Crop residues	Barley Beans, dry Maize Millet Oats Potatoes Rice, paddy Rye Sorghum Soybeans Wheat *Aggregated items:* All GHG Crops + (Total)	Residues (N content) Implied emission factor for N_2O Direct Emissions (N_2O) Direct emissions (CO_2eq) Indirect Emissions (N_2O) Indirect emissions (CO_2eq) Emissions (N_2O) Emissions (CO_2eq)	Tonnes kg N_2O kg^{-1} N in residues Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams
Cultivation of Organic soils	Cropland organic soils Grassland organic soils *Aggregated items:* Cropland and Grassland organic soils + (Total)	Area Implied emission factor for N_2O Emissions (N_2O) Emissions (CO_2eq)	Ha kg N_2O-N/ha Gigagrams Gigagrams

FIGURE 18
Data structure in the FAOSTAT "Emissions – Agriculture" domain (3)

Subdomain	Item	Element	Unit
Burning - Crop residues	Maize Rice, paddy Sugar cane Wheat *Aggregated items:* All GHG crops + (Total)	Biomass burned (dry matter) Implied emission factor for N_2O Implied emission factor for CH_4 Emissions (N_2O) Emissions (CH_4) Emissions (CO_2eq) from N_2O Emissions (CO_2eq) from CH_4 Emissions (CO_2eq)	Tonnes g N_2O/kg dry matter g CH_4/kg dry matter Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams
Burning - Savanna	Savanna Woody Savanna Closed Shrublands Open Shrublands Grasslands *Aggregated items:* Burning - all categories + (Total) Savanna and Woody Savanna + (Total) Closed and open Shrubland (+Total)	Burned Area Biomass burned (dry matter) Implied emission factor for N_2O Implied emission factor for CH_4 Emissions (N_2O) Emissions (CH_4) Emissions (CO_2eq) from N_2O Emissions (CO_2eq) from CH_4 Emissions (CO_2eq)	Ha Tonnes g N_2O/kg dry matter g CH_4/kg dry matter Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams
Energy Use	Gas - diesel oils Gasoline Natural gas (including LNG) Liquefied petroleum gas (LPG) Residual fuel oil Hard coal Electricity Gas - diesel oils in fisheries Residual fuel oil in fisheries Energy for power irrigation *Aggregated items:* Total Energy + (Total) Transport fuel consumed in agriculture (excl. fishery) + (Total) Energy consumed in fishery + (Total)	Consumption in Agriculture Consumption in Agriculture Implied emission factor for CH_4 Emissions (CH_4) Emissions (CO_2eq) from CH_4 Implied emission factor for N_2O Emissions (N_2O) Emissions (CO_2eq) from N_2O Implied emission factor for CO_2 Emissions (CO_2) Emissions (CO_2eq)	Terajoule million kWh Kg/TJ Gigagrams Gigagrams Kg/TJ Gigagrams Gigagrams g/kWh Gigagrams Gigagrams

In the remainder of this document, a metadata sheet and a detailed methodology are presented for each of the sub-domains above.

4.4 METADATA AND EMISSIONS CATEGORIES FOR FORESTRY AND LAND USE

Land Use contains all the emissions produced in the different forestry and land use sub-domains. We further provide guidance on estimating emissions from biomass burning in all ecosystem categories other than in agriculture, based on remote-sensing information, consistently with updated FAO activity data aggregated at national level and IPCC guidelines.

GHG emissions from the Land Use sector consist largely of CO_2 gas, generated mainly through cropland, grassland and forest management activities, including carbon gain and losses linked to anthopogenic land use changes. Emissions from biomass fires include in addition significant CH_4 and N_2O components. All emissions may be expressed, for convenience and easy comparison across domains, in Giga grams of gas emitted or in Giga grams of CO_2 equivalents (CO_{2eq}).

Relevant activity data from official national sources can be found in FRA, as well as in a set of ancillary geo-spatial data aggregated at national level, recently made available by FAO via FAOSTAT, as specified in detail in Ch. 5. Following simple prescriptions, national GHG emissions can thus be computed at Tier 1, land approach 1, using official national data for all member countries, relative to the period 1990-present. Exceptions are the Cultivation of Organic Soils and Burning Biomass sub-domains, which are not based on official national statistics and only cover the period 1990-present due to the nature of the underlying remote-sensing methodologies and reporting characteristics of the statistics used to derive the underlying activity data.

Uncertainties in estimates of GHG emissions are due to uncertainties in emission factors, carbon stocks and activity data. They may be related to, inter alia, natural variability, partitioning fractions, lack of spatial or temporal coverage, and spatial aggregation.

The table in Figure 19 below illustrates how the relevant national GHG data can be organized in a “Emissions – Land use” database. Each sub-domain groups one or more emission source category (the grey-coloured text indicates emissions data that are not covered by the Manual). For each category, a number of elements provide the quantity of activity data (input) and the estimated emissions (output). Each element is expressed according to the correspondent unit measure, visible in the “Unit” column.

FIGURE 19
Data Structure of the "Emissions – Land Use" Domain

Subdomain	Item	Element	Unit
Land Use Total	Forest land Cropland Grassland Burning biomass *Aggregated items:* Land Use Total + (Total)	Net emissions/removals (CO_2) Net emissions/removals (CO_2eq) Emissions (CO_2eq) from N_2O Emissions (CO_2eq) from CH_4	Gigagrams Gigagrams Gigagrams Gigagrams
Forest Land GF	Forest Land Net forest conversion	Area Implied emission factor for CO_2 Net emissions/removals (CO_2) Net emissions/removals (CO_2eq)	Ha Tonnes CO_2/Ha Gigagrams Gigagrams
Cropland GC	Cropland organic soils	Area Implied emission factor for CO_2 Net emissions/removals (CO_2) Net emissions/removals (CO_2eq)	Ha Tonnes CO_2/Ha Gigagrams Gigagrams
Grassland GC	Grassland organic soils	Area Implied emission factor for C Net emissions/removals (CO_2) Net emissions/removals (CO_2eq)	Ha Tonnes C/Ha Gigagrams Gigagrams
Burning - Biomass GI	Humid tropical forest Other forest **Organic soils**	Burned Area Biomass burned (dry matter) Implied emission factor for N_2O Implied emission factor for CH_4 Implied emission factor for CO_2 Emissions (N_2O) Emissions (CH_4) Emissions (CO_2eq) from N_2O Emissions (CO_2eq) from CH_4 Emissions (CO_2) Emissions (CO_2eq)	Ha Tonnes g N_2O/kg dry matter g CH_4/kg dry matter g CO_2/kg dry matter Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams Gigagrams
Wet land	Wet land remaining wet land Land converted to other land Net other land conversion	Area Net emissions/removals (C) Net emissions/removals (CO_2) Net emissions/removals (CO_2eq)	1000 Ha Gigagrams of carbon Gigagrams CO_2eq Gigagrams
Settlements	Settlements remaining settlements Land converted to settlements Net settlements conversion	Area Net emissions/removals (C) Net emissions/removals (CO_2) Net emissions/removals (CO_2eq)	1000 Ha Gigagrams of carbon Gigagrams CO_2eq Gigagrams
Other land	Other land remaining other land Land converted to other land Net other land conversion	Area Net emissions/removals (C) Net emissions/removals (CO_2) Net emissions/removals (CO_2eq)	1000 Ha Gigagrams of carbon Gigagrams CO_2eq Gigagrams

5

Minimum Data Availability for Developing Countries: Structure and data organization using FAOSTAT as guide

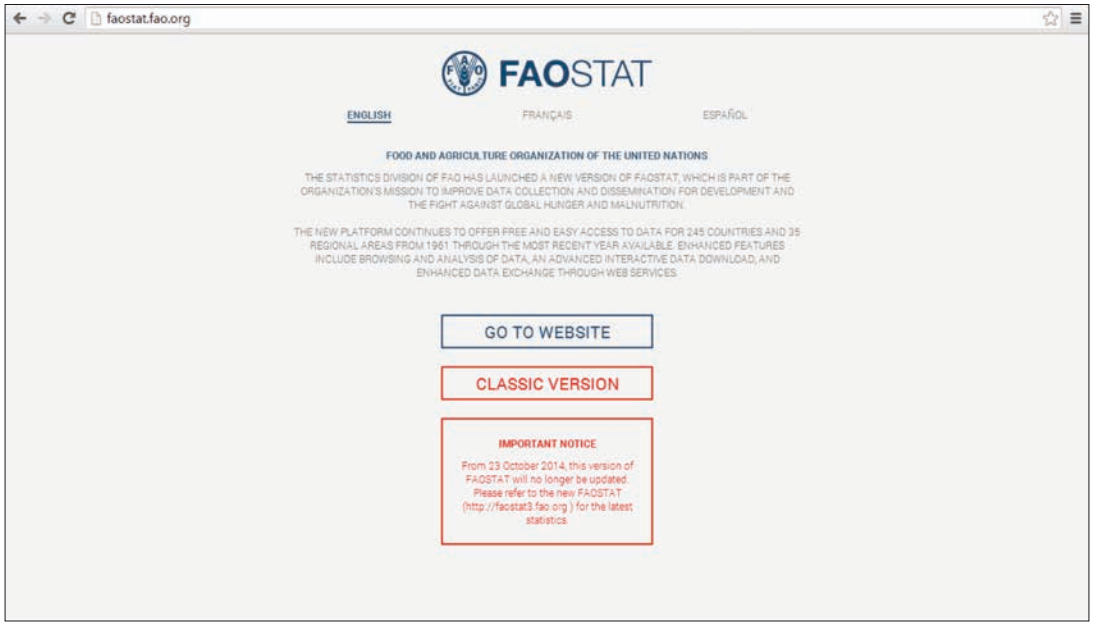
The FAOSTAT Emissions database, constructed on the basis of a robust methodology that conforms to the IPCC-2006 Guidelines, seeks to provide user-friendly support for policy decision makers and other users in Member Countries in preparing their GHG inventory of AFOLU sector. The database serves as a foundation for GHG reporting obligations, such as NCs and BURs under the UNFCCC.

In particular, the database was created to support Member Countries in their performance of the following activities:

- providing regular updates on global and regional trends in GHG emissions and removals from AFOLU;
- bridging gaps in Member Countries' capacity to assess and report GHG emissions and removals for AFOLU, in observance of the new requirements established by the Durban accords (BURs);
- setting up QA/QC procedures and performing data analyses, as the database provides an internationally-accepted and neutral data platform to support national reporting;
- developing indicators for further analysis, and deriving complex indexes useful for analysis and policy support.

The FAOSTAT Emissions database may be accessed from the following link http://faostat.fao.org/. As shown in Figure 20 below, the database home page enables access to the "FAOSTAT classic" and the "New FAOSTAT" platforms. The information is available in three languages: English, French and Spanish.

FIGURE 20
FAOSTAT database Homepage



FAO collects, analyses, interprets, and disseminates information related to nutrition, food and agriculture[1], and furnishes such technical assistance at governments' requests. Member Countries, for their part, regularly communicate statistical and technical data, and other information published by governments (respectively, Articles I and XI of the FAO Constitution).

The Statistics Division of FAO collates and disseminates food and agricultural statistics globally[2], while FAOSTAT is the corporate statistical database maintained by the Division. The Statistics Division compiles, processes and stores statistical information by country starting from 1961. The database contains data from over 245 countries and 35 regional areas, and covers domains on agriculture (production, consumption, trade, prices and resources), nutrition, fisheries, forestry, food aid, land use, population and agro-environment.

FAOSTAT is the world's largest and most comprehensive statistical database on food and agriculture. FAOSTAT was created pursuant to the need to provide a single point of statistical time series for data collection and entry, validation and generation, and analysis, and is fully compliant with the principles of good practice governing international statistics.

The FAOSTAT database is based on a data collection system for agricultural and forest statistics that is implemented every year, through questionnaires delivered to Member Countries' National Statistics Offices (NSO's), and when applicable, to other relevant institutions such as Ministry of Agriculture or other specific departments. At year end, the FAO Statistics Division again sends questionnaires to Member Countries, notifying the relevant FAO country representatives and FAO Regional Offices, and collects data for the previous year. Over the subsequent year, the questionnaires are collected, analysed and interpreted.

[1] The term "agriculture" and its derivatives include fisheries, marine products, forestry and primary forestry products.
[2] http://www.fao.org/economic/ess/en/.

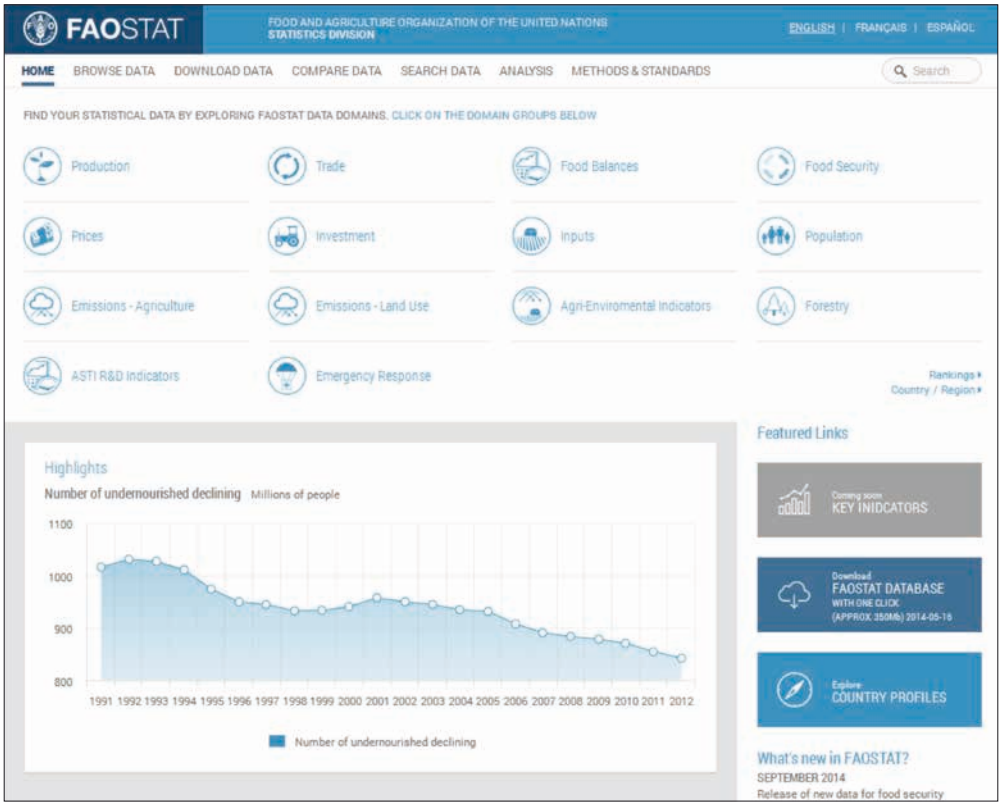
If the FAO Statistics Division is to fulfil its mandate and collect and disseminate information adequately, Member Countries must cooperate in providing information, and relevant indicators on food security and agricultural development must be available to Member Countries. A calendar of disseminating activities is available every year, for each FAOSTAT domain[3]. The global data refer to statistics on crops, livestock, irrigation, land use, fertilizers, pesticide consumption, agricultural machinery, and forestry, including statistics on imports and exports of woods and paper[4].

The New FAOSTAT platform[5] contains information organised by subject domain: Production (which includes crops, livestock), Trade, Food supply, Commodity balances, Food balance sheets, Prices, Resources, Population, Investments, Emissions-Agriculture, Emissions-Land Use (including emissions/removals from Forest land), and Forestry. FAOSTAT is the main source of the time-series activity data required to compile the AFOLU GHG inventory.

FAOSTAT classic and New FAOSTAT are also available in French and Spanish, and both platforms contain the same datasets. However, the New FAOSTAT offers easy access to data and introduces enhanced features tailored to the needs of a wider range of users. New domains in FAOSTAT, such as Emissions-Agriculture and Emissions-Land Use, address emerging data requirements related principally to global warming and environmental monitoring.

Clicking on the "New FAOSTAT" button leads to the platform's homepage (depicted in Figure 21 below), where three options for accessing the GHG database are provided.

FIGURE 21
The New FAOSTAT Homepage



[3] http://faostat3.fao.org/home/faostatReleaseCalendar.html (or Latest news: http://faostat.fao.org/site/291/default.aspx).
[4] http://www.fao.org/corp/statistics/en/.
[5] http://faostat.fao.org/.

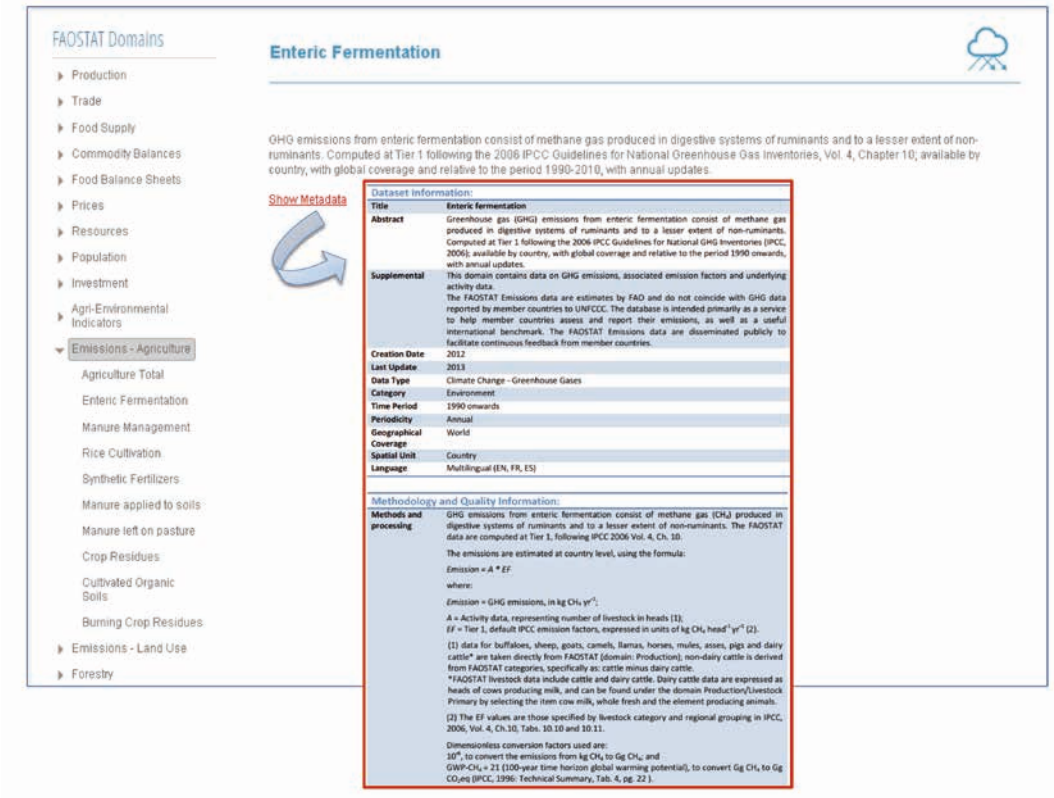
Clicking on the “Emissions Agriculture” icon leads to the Standard download webpage (Figure 22 below), which displays three different options:

- The menu on the far left of the page lists all domains and sub-categories.
- The menu in the “Index” box links to each category’s metadata.
- The map on the right of the page enables to visualize data with charts and graphics.

FIGURE 22
The FAOSTAT Emissions database

Figure 23 below shows an example of metadata, for the "Enteric Fermentation" category.

FIGURE 23
Metadata in the FAOSTAT Emissions database



The database has a hierarchical structure that comprises two main domains: "Emissions – Agriculture" and "Emissions – Land Use". Each domain includes a series of sub-domains, which identify emission categories. For each sub-domain, data are organized by four dimensions:

- Geographical Area: Countries, Regions, Global and Special Groups (i.e. aggregated by economic, political or other categories). The Regional and Global areas aggregate data by total and annual average;
- Elements: this section includes activity variables and estimated GHG emissions;
- Items: the set of Activity Data;
- Years: the time period of the data available, for instance, 1961-present.

Data can be selected in two different ways: "Browse data" and "Download data".

a) Positioning the pointer on the "BROWSE DATA" icon at the top of the menu, the list of main categories appears. Click on the selected category to retrieve the maps and graphics required.
The "**Browse Data**" option enables the user to retrieve aggregate data (annual average or sum) for immediate analysis.
The data are expressed in pie-charts, graphs and comparisons among countries and regions.

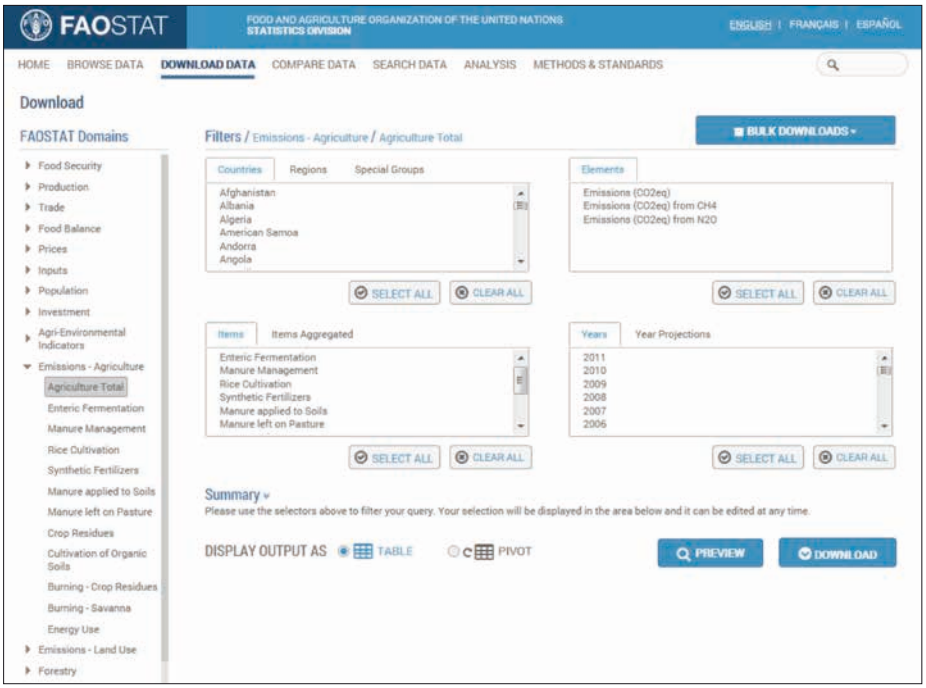
The figure 24 shows an example from the "EMISSION-AGRICULTURE" category. By selecting the item, area, year and aggregation variables on the query boxes, maps, data and graphics may be viewed.

FIGURE 24
The "Browse Data" option

b) "DOWNLOAD DATA" enables actual retrieval of the data from the database.

With the "**Download Data**" option, the estimated gas emissions become available for direct download. The picture below shows all available variables in the four sub-domains.

FIGURE 25
"Download data" option



Example:

How can GHG emissions statistics be accessed? What is the yearly average of CO_2-equivalent emissions produced by rice cultivation in South-Eastern Asia from 2004 to 2010?

a) "Browse Data" option:

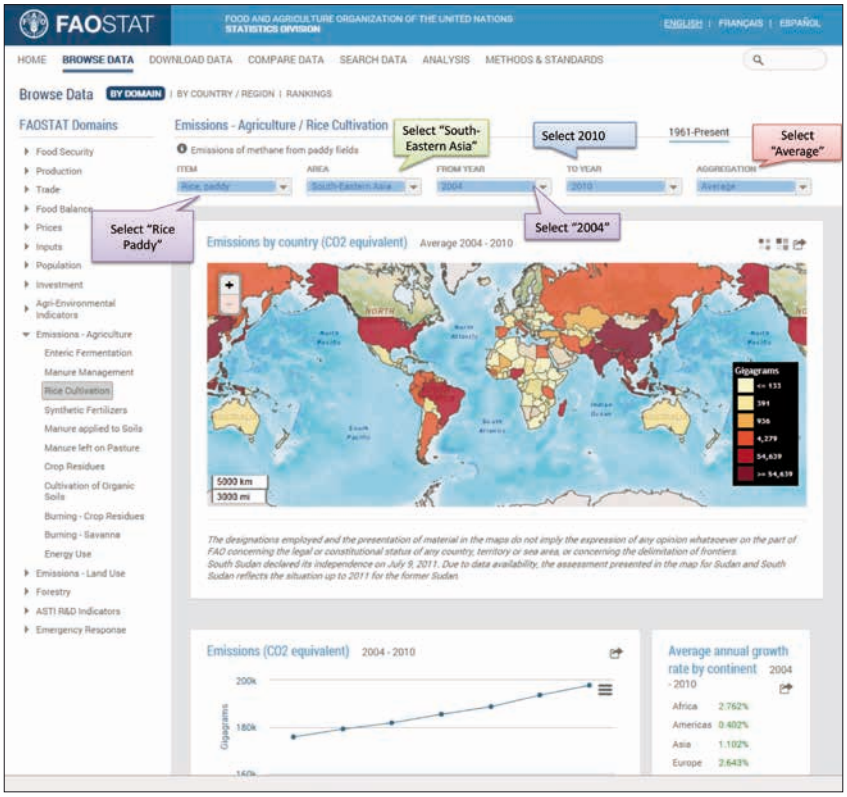
FIGURE 26
The FAOSTAT "Browse data" section

Step 1.

Step 2.


FAOSTAT
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
STATISTICS DIVISION
ENGLISH | FRANÇAIS | ESPAÑOL
HOME
BROWSE DATA
DOWNLOAD DATA
COMPARE DATA
SEARCH DATA
Menu on top of the page allow users to modify the default graphics by choosing a single country, different years of analysis and other options specific to the sub domain.
Browse Data
BY DOMAIN
BY COUNTRY / REGION
RANKINGS
FAOSTAT Domains
Food Security
Production
Trade
Food Balance
Prices
Inputs
Population
Investment
Agri-Environmental Indicators
Emissions - Agriculture
Enteric Fermentation
Manure Management
Rice Cultivation
Synthetic Fertilizers
Manure applied to Soils
Manure left on Pasture
Crop Residues
Cultivation of Organic Soils
Burning - Crop Residues
Burning - Savanna
Energy Use
Emissions - Land Use
Forestry
ASTI R&D Indicators
Emergency Response
Emissions - Agriculture / Rice Cultivation
1961-Present
Projections
Emissions of methane from paddy fields
ITEM
AREA
FROM YEAR
TO YEAR
AGGREGATION
Rice, paddy
World
1990
2011
Average
Emissions by country (CO2 equivalent)
Average 1990 - 2011
Gigagrams
5000 km
3000 mi
The designations employed and the presentation of material in the maps do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal or constitutional status of any country, territory or sea area, or concerning the delimitation of frontiers.
South Sudan declared its independence on July 9, 2011. Due to data availability, the assessment presented in the map for Sudan and South Sudan reflects the situation up to 2011 for the former Sudan.
Emissions (CO2 equivalent)
1990 - 2011
Gigagrams
Average annual growth rate by continent
1990 - 2011
Africa
Americas
Asia
Europe

Step 3.

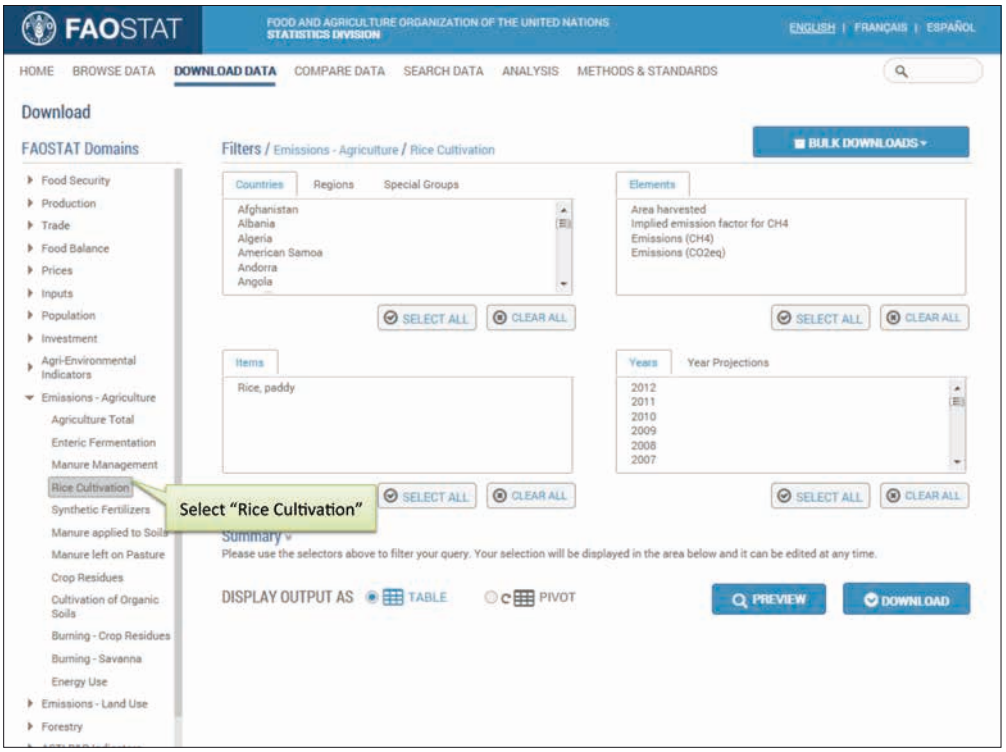

FAOSTAT
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
STATISTICS DIVISION
ENGLISH | FRANÇAIS | ESPAÑOL
HOME
BROWSE DATA
DOWNLOAD DATA
COMPARE DATA
SEARCH DATA
ANALYSIS
METHODS & STANDARDS
Browse Data
BY DOMAIN
BY COUNTRY / REGION
RANKINGS
FAOSTAT Domains
Emissions - Agriculture / Rice Cultivation
Select "South-Eastern Asia"
Select 2010
1961-Present
Select "Average"
Select "Rice Paddy"
Select "2004"
Emissions of methane from paddy fields
ITEM
AREA
FROM YEAR
TO YEAR
AGGREGATION
Rice, paddy
South-Eastern Asia
2004
2010
Average
Emissions by country (CO2 equivalent)
Average 2004 - 2010
Gigagrams
5000 km
3000 mi
The designations employed and the presentation of material in the maps do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal or constitutional status of any country, territory or sea area, or concerning the delimitation of frontiers.
South Sudan declared its independence on July 9, 2011. Due to data availability, the assessment presented in the map for Sudan and South Sudan reflects the situation up to 2011 for the former Sudan.
Emissions (CO2 equivalent)
2004 - 2010
Gigagrams
Average annual growth rate by continent
2004 - 2010
Africa
Americas
Asia
Europe

b) "Download Data" option:

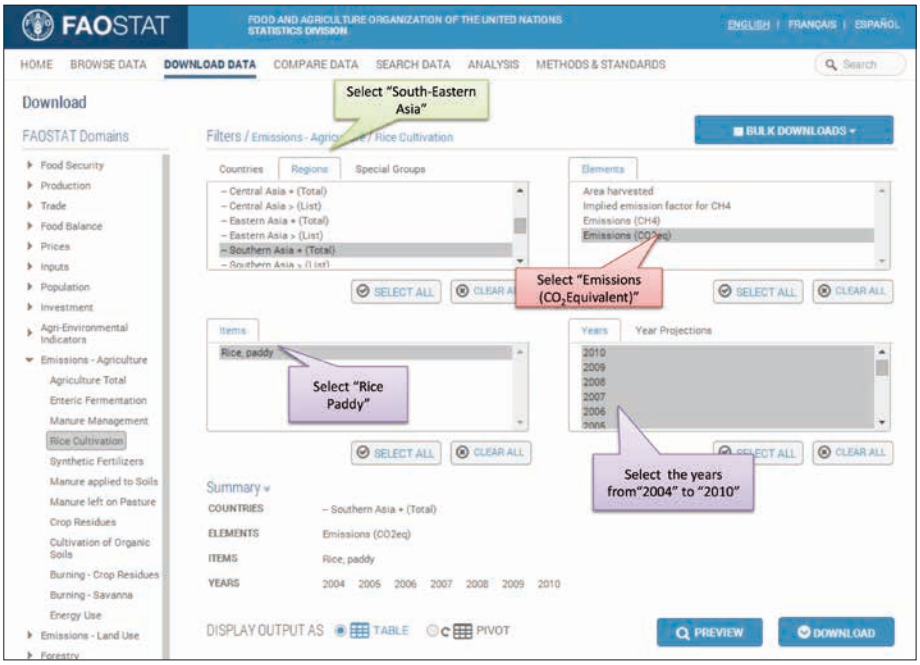
FIGURE 27
The FAOSTAT "Download Data" webpage

Step 1.

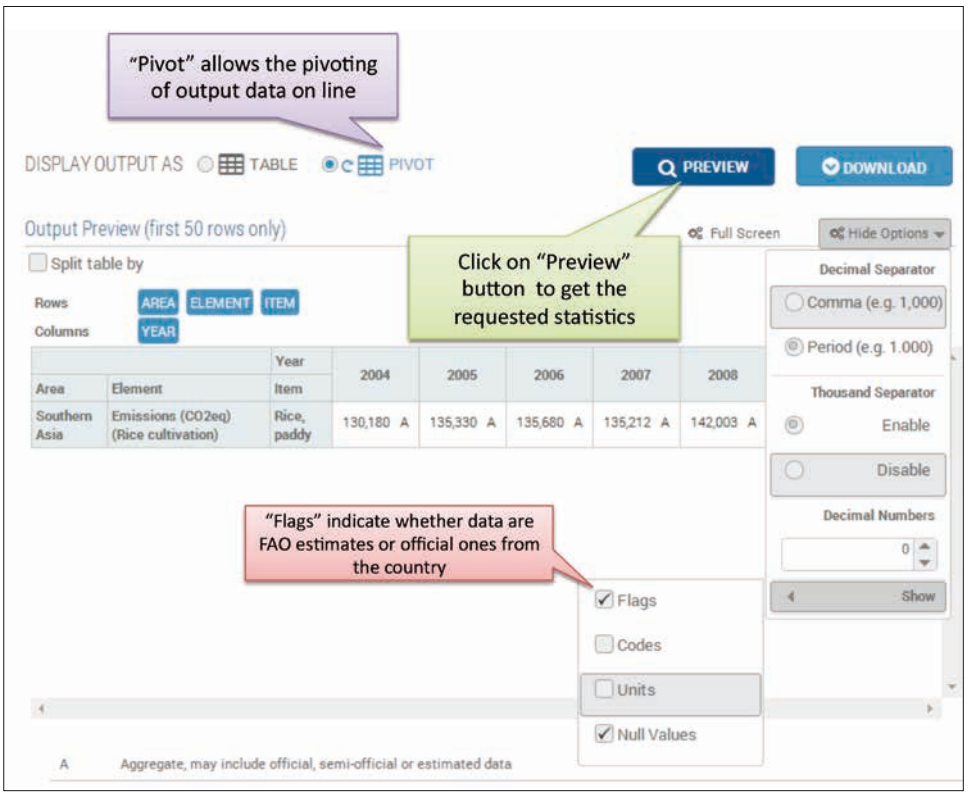
Step 2.



Step 3.



In the "Output Options" section, further down the same page, additional information is provided on the statistics selected.



5.1 AGRICULTURE

5.1.1 Enteric Fermentation

Dataset Information	
Title	**Enteric fermentation**
Definition	Greenhouse gas (GHG) emissions from enteric fermentation consist of methane gas produced in the digestive systems of ruminants and, to a lesser extent, of non-ruminants.
Methodology and Quality Information	
Methods and processing	GHG emissions from enteric fermentation consist of methane gas (CH4) produced in the digestive systems of ruminants and, to a lesser extent, of non-ruminants. The FAOSTAT data are computed at Tier 1, following IPCC 2006 Vol. 4, Ch. 10. The emissions are estimated at country level, using the formula $Emission = A * EF$ where • *Emission* = GHG emissions, in kg CH_4 yr^{-1}; • *A* = Activity data, representing the number of livestock in heads (1); • *EF* = Tier 1, default IPCC emission factors, expressed in units of kg CH_4 $head^{-1}$ yr^{-1} (2). (1) Activity data cover the following animal categories: buffaloes, sheep, goats, camels, llamas, horses, mules, asses, pigs, and dairy and non-dairy cattle*. For the period between 1961-present, the activity data are taken directly from FAOSTAT (domain: Production/Live animals). Projections of activity data for 2030 and 2050 for the categories of dairy and non-dairy cattle, buffaloes, sheep, goats, pigs and poultry, are computed with respect to a baseline, defined as the 2005-2007 average of the corresponding FAOSTAT activity data, and by applying percentage growth rates from FAO perspective studies (Alexandratos and Bruinsma, 2012). Activity data for animal categories for which no FAO projection was available were set to the most recent available FAOSTAT value. The FAO projections used cover about 140 countries. Projections of activity data for countries that were not included assume the same growth rate of neighbouring countries. *FAOSTAT livestock data include cattle and dairy cattle. Dairy cattle data are expressed as heads of cows producing milk, and can be found under the Production/Livestock Primary domain by selecting the item "Cow milk, whole fresh" item and the "Producing animals/Slaughtered" element. Non-dairy cattle are derived from FAOSTAT categories, specifically as "cattle minus dairy cattle". (2) The EF values are specified by livestock category and regional grouping in the IPCC Guidelines, 2006, Vol. 4, Ch. 10, Tables 10.10 and 10.11. The dimensionless conversion factors used are • 10^{-6}, to convert the emissions from kg CH_4 to Gg CH_4; and • GWP-CH_4 = 21 (100-year time horizon global warming potential), to convert Gg CH_4 to Gg CO_2eq (IPCC, 1996: Technical Summary, Tab 4, p. 22). The enteric fermentation domain contains the following data available for download: country-level GHG emissions in both Gg CH_4 and Gg CO_2eq, by livestock species and by species aggregates, as well as their total; implied emission factors; and activity data. Uncertainties in estimates of GHG emissions are due to uncertainties in emission factors and activity data. In the case of enteric fermentation, further information is available in the IPCC Guidelines (Vol. 4, Ch. 10, Section 10.3.4).

Calculation Procedure

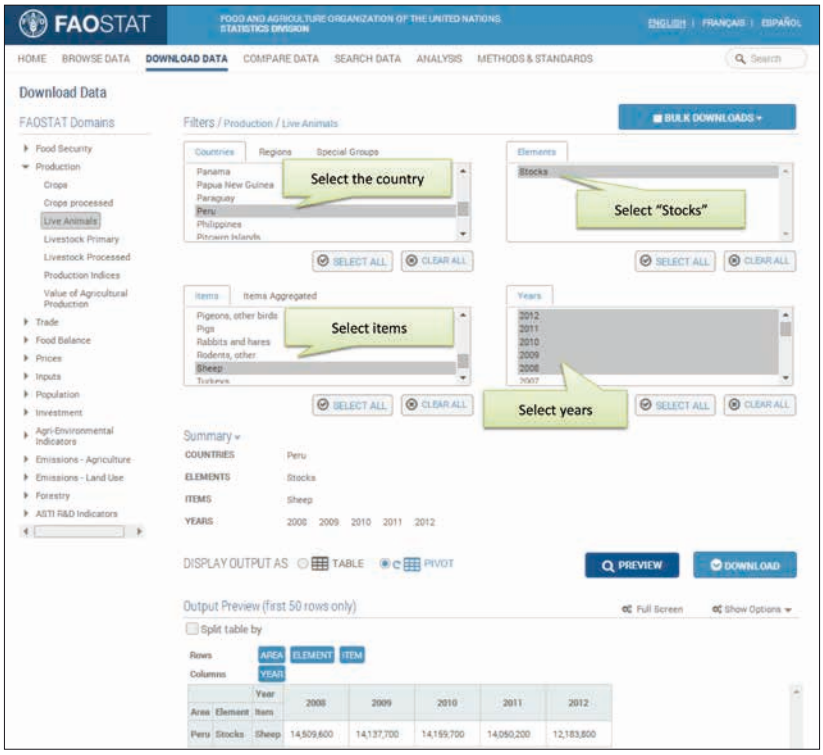
Step 1. Activity data

In this sub-domain, activity data refers to the number of heads (Stock) of the following items: dairy and non-dairy cattle, buffaloes, sheep, goats, camels, horses, mules, asses, swine ("Pigs" in FAOSTAT nomenclature) and llamas ("Camelids, other" in FAOSTAT nomenclature).

The definitions used by FAOSTAT for the "Number of Live Animals/Stock" and for the individual items are available in the Glossary (see Annex 1), at "Definition of items-livestock" or on the FAOSTAT website, at http://faostat3.fao.org/faostat-gateway/go/to/mes/glossary/*/E. The unit measure is expressed in terms of the number of heads.

Data (from 1961 to present) are to be found under the FAOSTAT – Production, Live Animals sub-domain:

FIGURE 28
"Number of Heads of Sheep" from the FAOSTAT database

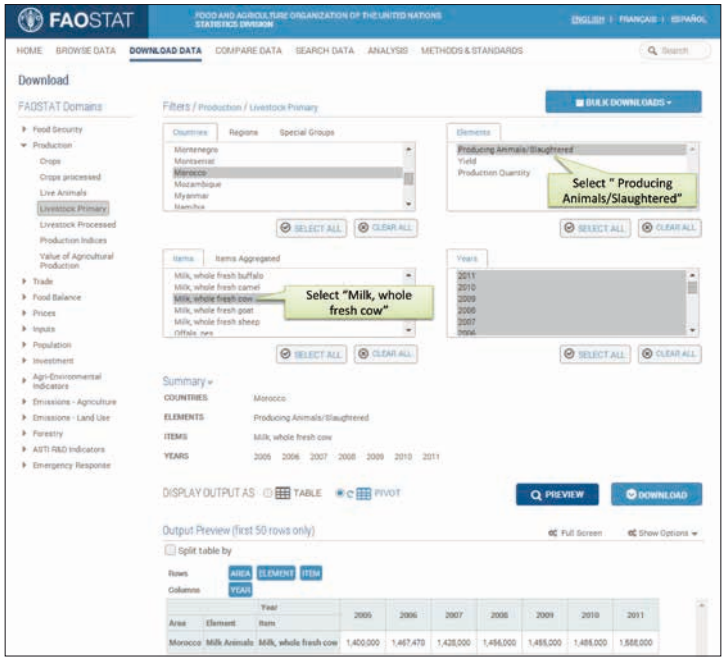


For cattle and swine, in accordance with the 2006 IPCC prescriptions, the FAOSTAT Emissions provides emission data disaggregated by dairy and non-dairy cattle, breeding and market swine.

However, no corresponding stock data (heads) may be found in the FAOSTAT Production Live Animals sub-domain, because FAOSTAT does not collect this disaggregated data. However, this information can be retrieved from FAOSTAT with the following steps.

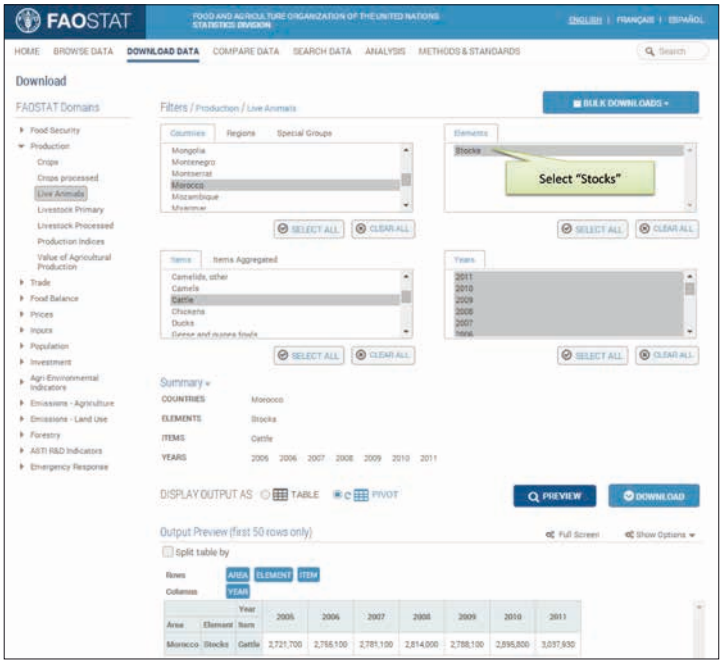
1. The data sets of "dairy" cattle and "non-dairy" cattle are obtained as follows:
   - the number of dairy cattle heads is in the Production Livestock Primary sub-domain, under the element "Producing Animals/Slaughtered" and the item "Milk, whole fresh":

FIGURE 29
"Number of Heads of dairy cattle" from FAOSTAT database



- the number of non-dairy cattle heads may be derived by subtracting the number of heads of dairy cattle from the Total Cattle (Stocks), which can be found in the Production, Live Animals sub-domain, under the element "Stocks" and the item "Cattle".
- The global stock of non-dairy cattle in 2010 was 1,410,800 = 2,895,000 (total stock) -1,485,000 (dairy cattle).

FIGURE 30
"Number of Heads of Cattle" from the FAOSTAT database

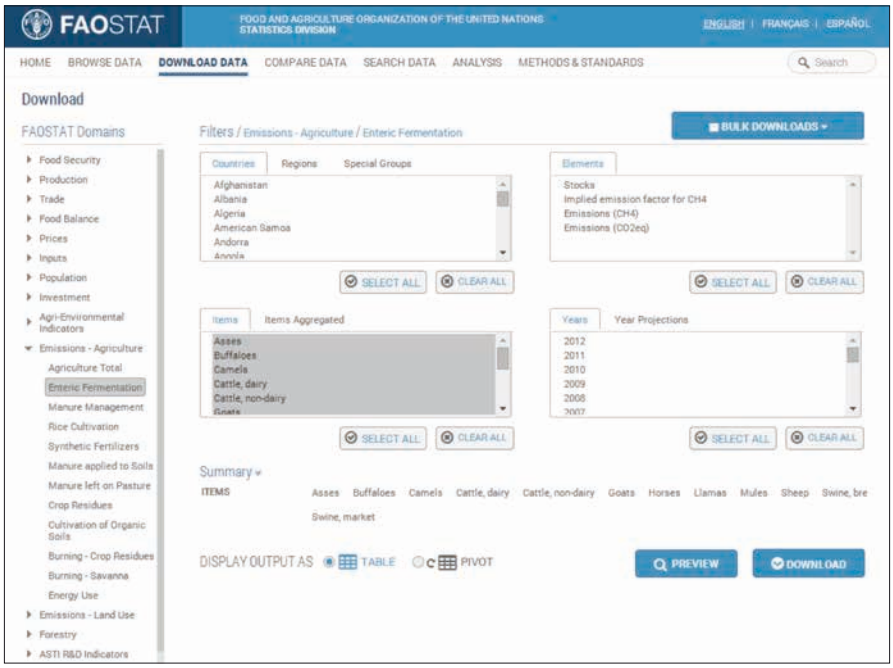


2. The market swine data set may be obtained by multiplying the total heads of pigs from FAOSTAT Production – Live Animals domain by 0.9, following the default 2006 IPCC Guidelines (Table 60).

3. The breeding swine data set may be obtained by multiplying the total heads of pigs from FAOSTAT Production – Live Animals domain by 0.1, following default 2006 IPCC Guidelines (Table 60).

The FAOSTAT Emissions Enteric Fermentation sub-domain provides the data, disaggregated by sub-categories: dairy, non-dairy, breeding and market swine.

FIGURE 31
Livestock Sub-Categories of the FAOSTAT Emissions database



1.2 Projections of Stocks

Projections of activity data for 2030 and 2050 for the dairy and non-dairy cattle, buffaloes, sheep, goats, pigs, categories were computed with respect to a baseline provided by FAO perspective studies[6]:

$$N_{(T)y} = \alpha_{(T)_y} \times N_{(T)_{2005-2007}}$$

Where

- $N_{(T)y}$ = number of heads for animal category T in the projected year y
- $\alpha_{(T)y}$ = projection ratio for animal category T, in projected year y with respect to the baseline
- $N_{(T)\ 2005\text{-}2007}$ = baseline heads computed as the 2005, 2006, 2007 average heads of the animal category T
- T = animal category
- y = projected years 2030 and 2050.

[6] Alexandratos, N. & Bruinsma, J. 2012. *World agriculture towards 2030/2050: the 2012 revision*. ESA Working Paper No. 12-03. Rome: FAO.

Step 2. Emissions (CH_4)

IPCC 2006, Equation 10.19

$$Emissions(CH_4)_{(T)} = EF_{(T)} \times \frac{N_{(T)}}{10^6}$$

Where

- *Emissions* $(CH_4)_{(T)}$ = Methane emissions for animal category *T* ,Gg CH_4 yr^{-1}
- $EF_{(T)}$ = emission factor for animal type *T* , kg CH_4 $head^{-1}$ (Table 1)
- $N_{(T)}$ = number of heads for animal category *T*
- *T* = animal category

Step 3. Emissions (CO_2eq)

$$Emissions(CO_2eq)_{(T)} = Emissions(CH_4)_{(T)} \times GWP$$

Where

- *Emissions* $(CO_2eq)_{(T)}$ = methane emissions in CO_2 equivalent for animal category *T* , Gg CO_2eq yr^{-1}
- *Emissions* $(CH_4)_{(T)}$ = methane emissions for animal category *T* ,Gg CH_4 yr^{-1}
- *GWP* = 21 (100-year time horizon global warming potential), to convert Gg CH_4 to Gg CO_2eq
- *T* = animal category

Step 4. Implied emissions factor for CH_4

$$IEF_{(T)} = \frac{Emissions(CH_4)_{(T)}}{N_{(T)}} \times 10^6$$

Where

- $IEF_{(T)}$ = implied emission factor for animal category *T*, kg CH_4 $head^{-1}$ yr^{-1}
- *Emissions* $(CH_4)_{(T)}$ = methane emissions for animal category *T*, Gg CH_4 $head^{-1}$
- $N_{(T)}$ = number of heads for animal category *T*
- *T* = animal category

Example: *What are the emissions from livestock enteric fermentation (cattle) in Morocco in the year 2010?*

The emissions from Enteric Fermentation are estimated with the equation set out in Step 2 above.

We must therefore retrieve both the number of heads (the activity data) for the requested country by year, and the emission factor, as follows:

1. The number of heads of live animals is available in the FAOSTAT database Production domain, at http://faostat3.fao.org/faostat-gateway/go/to/download/G1/GE/E.
   - Collect the data set of the “dairy” cattle stock for Morocco.
   - Collect data of “non-dairy” cattle stock (which corresponds to “Other cattle” in IPCC-2006) for Morocco. In FAOSTAT, this is derived by subtracting, from the stock of cattle in Production/Live Animals, the number of heads for dairy cattle.

     The stock of “Non-dairy” cattle in 2010 is 1,410,800 = 2,895,000 (total stock) -1,485,000 (dairy cattle). The values described in the following table result.

Livestock category	Annual Average Population (FAOSTAT) (Heads of cattle)
Dairy cows	1,485,000
Other cattle	1,410,800

2. The EF values are those specified for the livestock category and regional grouping in IPCC 2006, Vol. 4, Ch. 10, Tables 10.10 and 10.11.

TABLE 10.11
TIER 1 ENTERIC FERMENTATION FACTORS FOR CATTLE

Latin America: Commercialised dairy sector based on grazing. Separate beef cow herd grazing pastures and rangelands. Minor amount of feedlot feeding with grains. Growing non-dairy cattle comprise a large portion of the population.	Dairy	72	Average milk production of 800 kg head-1 yr^{-1}
	Other Cattle	56	Includes beef cows, bulls, and young.
Asia: Small commercialised dairy sector. Most cattle are multi-purpose, providing draft power and some milk within farming regions. Small grazing population. Cattle of all types are smaller than those found in most other regions.	Dairy	68	Average milk production of 1,650 kg head-1 yr^{-1}
	Other Cattle	47	Includes multi-purpose cows, bulls, and young
Africa and Middle East: Commercialised dairy sector based on grazing with low production per cow. Most cattle are multi-purpose, providing draft power and some milk within farming regions. Some cattle graze over very large areas. Cattle are smaller than those found in most other regions.	Dairy	46	Average milk production of 475 kg $head^{-1}$ yr^{-1}
	Other Cattle	31	Includes multi-purpose cows, bulls, and young

The solution is as follows:

Livestock category	Annual Average Population (FAOSTAT) (Heads of cattle)	Emission Factor for enteric fermentation (kg CH_4 $head^{-1}$ yr^{-1} (Table 10.11 Chapter 10, Vol. 4, 2006 IPPC Guidelines)	CH4 emission from livestock enteric fermentation (cattle) (Gg CH_4 yr^{-1})
	(AD)	(EF)	(E=AD*EF)
Dairy cows	1,485,000	46	68.31
Other cattle	1,410,800	31	43.73
Total			**112.04**

5.1.2 Manure management

Dataset Information	
Title	**Manure management**
Definition	Greenhouse gas (GHG) emissions from manure management consist of methane and nitrous oxide gases from aerobic and anaerobic manure decomposition processes.
Methodology and Quality Information	
Methods and processing	GHG emissions from manure management consist of methane and nitrous oxide gases from aerobic and anaerobic decomposition processes. The FAOSTAT emission data are computed at Tier 1, following the IPCC 2006, Vol. 4, Ch. 10 and 11. The term "manure" includes both urine and dung (i.e. both liquid and solid material) produced by livestock. More specifically, CH_4 gas is produced by the anaerobic decomposition of stored or treated manure, while N_2O is produced directly by nitrification and de-nitrification processes in the manure, and indirectly by nitrogen (N) volatilization and re-deposition processes, as well as from leaching of manure N. $$Emission = A * EF$$ where • *Emission* = GHG emissions, in kg CH_4 yr^{-1}; • *A* = Activity data, representing the number of livestock in heads (1); • *EF* = Tier 1, default IPCC emission factors, expressed in units of kg CH_4 $head^{-1}$ yr^{-1} (2) (1) Activity data cover the following animal categories: buffaloes, sheep, goats, camels, llamas, horses, mules, asses, ducks, turkeys, dairy and non-dairy cattle*, chickens layers and broilers** and market and breeding swine***. For the period between 1961-present, activity data are taken directly from FAOSTAT (Production/Live animals domain). Projections of activity data for 2030 and 2050 for the categories of dairy and non-dairy cattle, buffaloes, sheep, goats, pigs and poultry, are computed with respect to a baseline, defined as the 2005-2007 average of the corresponding FAOSTAT activity data, and by applying percentage growth rates from FAO perspective studies (Alexandratos and Bruinsma, 2012). Activity data for animal categories for which no FAO projections were were set to the most recent available FAOSTAT value. The FAO projections used cover about 140 countries. Projections of activity data for countries that were not included assume the same growth rate of neighbouring countries. *FAOSTAT livestock data include the "cattle" and "dairy cattle" items. Dairy cattle data are expressed as heads of cows producing milk, and can be found under the Production/Livestock Primary domain by selecting the "Cow milk, whole fresh" item and the "Producing animals" element. Non-dairy cattle is derived from FAOSTAT categories, specifically as "cattle minus dairy cattle"; **FAOSTAT livestock data include the "chicken" and "chickens, layers" items. Chicken layers are expressed in 1000 heads of hens which have laid eggs in the reference period, and can be found under the Production/Livestock Primary domain by selecting the "Hen eggs, in shell" item and the "Producing animals". element "Chickens, broilers" is derived from FAOSTAT categories, specifically as "chickens minus chickens, layers"; ***FAOSTAT livestock data include the "pigs" item. Market and breeding swine are calculated as 90% and 10% of the pigs item respectively (IPCC 2006, Vol. 4, Ch. 10, Table 10.19). (2) EF values are assigned to each country (IPCC, 2006: Table 10.14 for cattle, buffaloes and pigs and Table 10.15 for all other animals), as a function of country-level average annual temperature (^0C). Average annual temperatures by country are taken from the FAO Global Agro-Ecological Zones (GAEZ) dataset (IIASA/FAO, 2012), relative to the baseline period 1961-1990.

Methodology and Quality Information	
Methods and processing	**Direct N_2O emissions** are estimated at the country level, using the formula *Emission = A * EF* where *Emission* = GHG emissions in kg N_2O-N yr^{-1}; *A* = Activity data, representing the total amount of N in manure treated in manure management systems (MMS) in kg N yr^{-1} (3); *EF* = Tier 1, default IPCC emission factors, expressed in kg N_2O-N/kg N yr^{-1} (4). (3) This is the total amount of N excreted (i) for each livestock category (ii) treated in MMS (iii). (i) Following IPCC, 2006, Vol. 4, Ch. 10 Equation 10.30, the total amount of N excreted by each livestock category is calculated by multiplying the number of livestock heads by two coefficients: a) the Typical Animal Mass (TAM) and b) the N excretion coefficient (Nex). Both parameters vary according to the geographic region. TAM values are obtained from IPCC, 2006, Vol.4, Ch. 10, Annex 10A.2, Tables 10A-4 to 10A-9; Nex values are derived from IPCC, 2006, Vol. 4, Ch. 10, Table 10.19. (ii) See (1) for the livestock categories. (iii) Default IPCC percentages of total N treated in different MMS, by region and livestock category, are taken from IPCC, 2006, Vol. 4, Ch. 10, Annex 10A.2 Tables 10A-4 to 10A-9 (for poultry: IPCC, 1997, Ch. 4 Table 4.21). (4) The EF values depend on the specific MMS, as per IPCC 2006, Vol. 4, Ch. 10, Table 10.21. **Indirect N_2O emissions** are estimated at the country level, using the formula *Emission = A * EF* where • *Emission* = GHG emissions in kg N_2O-N yr^{-1}; • *A* = Activity data, representing the fraction of the total amount of nitrogen (N) in manure treated in MMS that volatilises as NH_3 and NOx, and is lost through runoff and leaching, in kg N yr^{-1} (5); • *EF* = Tier 1, default IPCC emission factors, expressed in kg N_2O-N kg -1N yr^{-1} (6). (5) The fractions for volatilisation by animals and MMS are taken from IPCC, 2006, Vol. 4, Ch. 10, Table 10.22. A mean fraction value of 10% for all countries is used for leaching (IPCC, 2006, Vol. 4, Ch. 10, note to Equation 10.28). (6) All countries are assigned global default EF values for volatilization and leaching (IPCC, 2006, Vol. 4, Ch. 11, Table 11.3). The dimensionless conversion factors used are: • 44/28, to convert the emissions from kg N_2O-N to kg N_2O gas; • 10^{-6}, to convert kg to Gg; • GWP-CH_4 = 21 and GWP-N_2O = 310 (100-year time horizon global warming potential), to convert Gg CH_4 or Gg N_2O to Gg CO_2eq (IPCC, 1996, Technical Summary, Table 4 p. 22). The manure management domain contains the following data categories, available for download: country-level GHG emissions, provided as total, direct and indirect amounts in Gg CH_4, Gg N_2O and Gg CO_2eq, by livestock species and by species aggregates, as well as their total; implied emission factors; and activity data. Uncertainties in estimates of GHG emissions are due to uncertainties in emission factors and activity data. In the case of manure management, more detailed information is available in the IPCC Guidelines (IPCC, 2006, Vol. 4, Ch. 10, Section 10.5.5).

Calculation Procedure

Step 1. Activity data

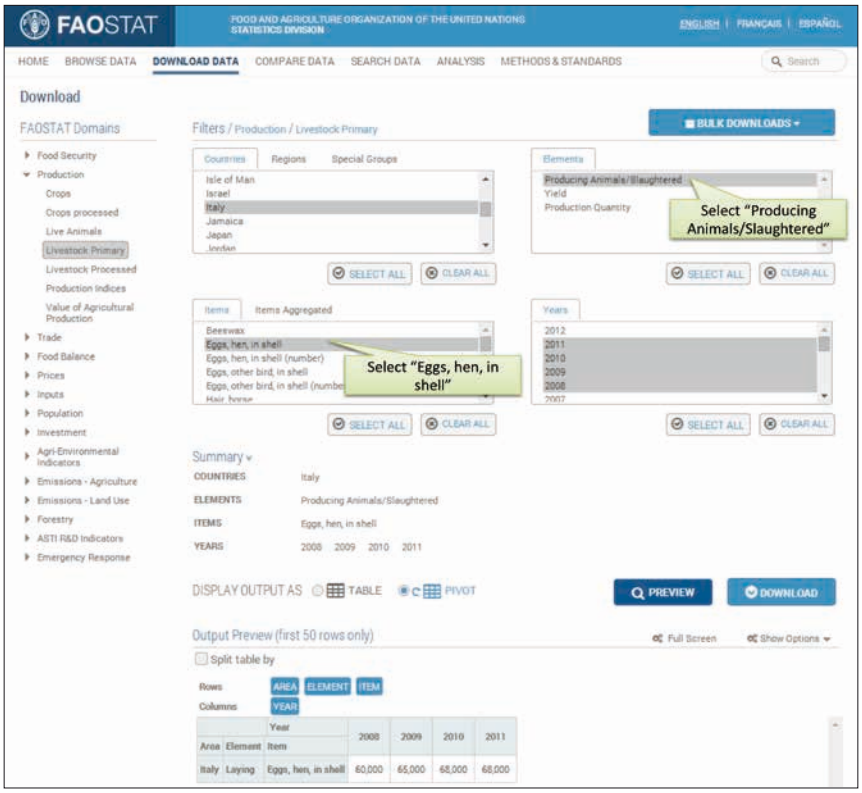
In this domain, activity data refers to the number of heads (Stock) of the following items: dairy and non-dairy cattle, buffaloes, sheep, goats, chickens layers, chickens broilers, turkeys, ducks, market and breeding swine ("Pigs" in FAOSTAT nomenclature), camels and llamas ("Camelids, other" in FAOSTAT nomenclature). Camels and llamas data are used to calculate CH_4 emission only.

The definitions used by FAOSTAT for the "Number of Live Animals/Stock" and for the individual items are available in the Glossary (see Annex 1) at "Definition of items-livestock" or on the FAOSTAT website: http://faostat3.fao.org/faostat-gateway/go/to/mes/glossary/*/E. The unit measure is expressed in number of heads.

Data (from 1961 to present) are to be found under the FAOSTAT – Production, Live Animals sub-domain and must be retrieved as described in the "Enteric Fermentation Activity Data" section.
With regard to chickens layers and chickens broilers, data can be downloaded as follows:

1. the number of heads of chicken layers may be retrieved from the Production, Livestock Primary sub-domain, choosing the element "Producing Animals/Slaughtered", and the item "Eggs, hen eggs, in shell":

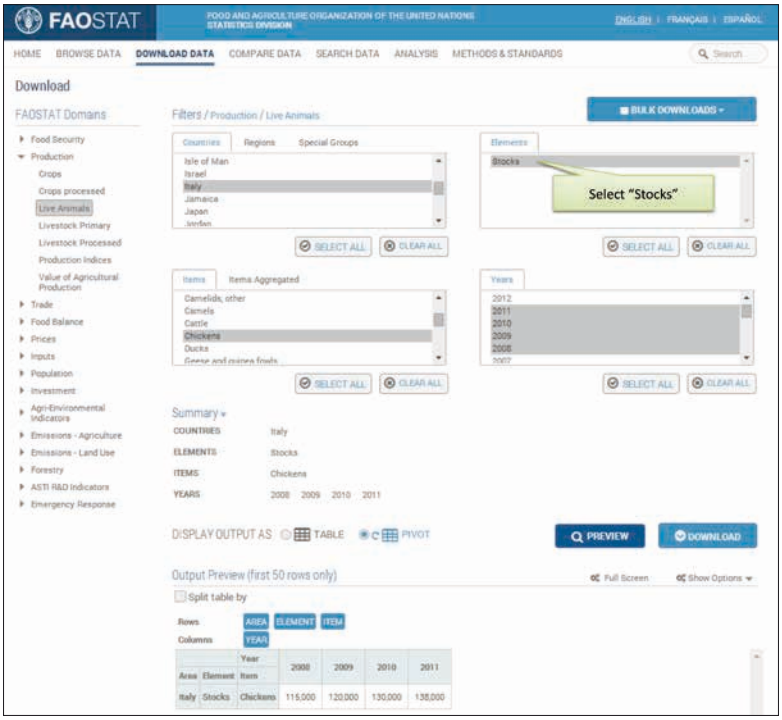
FIGURE 32
"Stock of Laying Animals" from the FAOSTAT database



2. the number of heads of broilers is obtained by subtracting the number of heads of layers from the stock of chickens.

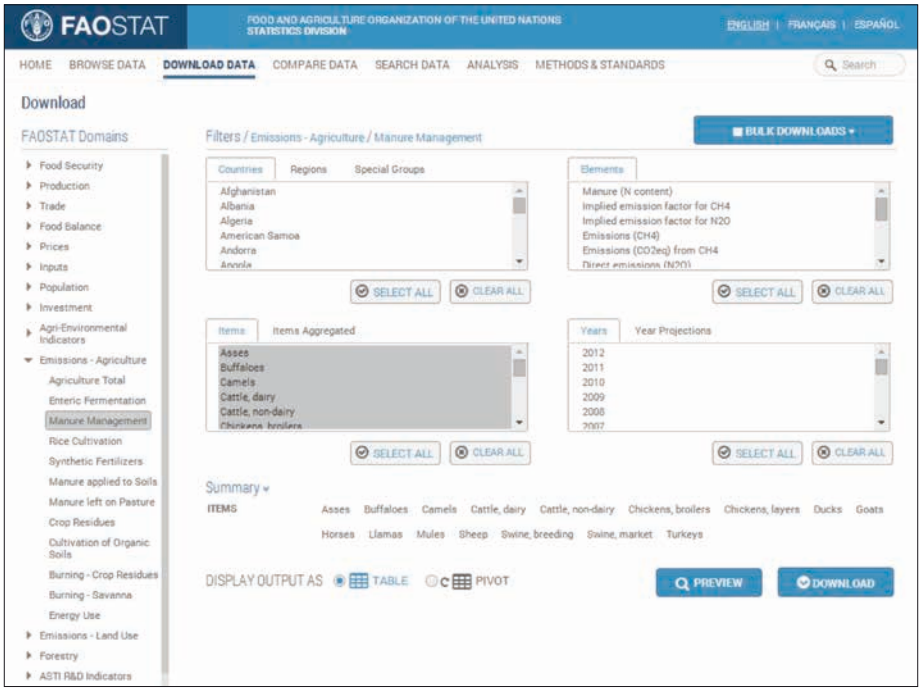
3. The stock of chickens may be found in Production, Live Animals as follows:

FIGURE 33
"Stock of Chickens, etc." from the FAOSTAT database



The FAOSTAT Emissions Manure Management sub-domain provides data disaggregated by sub-categories: dairy and non-dairy cattle, breeding and market swine, chicken layers and broilers.

FIGURE 34
Manure Management Items from the FAOSTAT Emissions database



1.2 Projections of Stocks

Projections of activity data for 2030 and 2050 for the dairy and non-dairy cattle, buffaloes, sheep, goats, pigs, poultry, etc. categories are computed with respect to a baseline provided by FAO perspective studies (Alexandratos, and Bruinsma, 2012). This is as follows:

$$N_{(T)y} = \alpha_{(T)_y} \times N_{(T)_{2005-2007}}$$

Where

- $N_{(T)y}$ = number of heads for animal category *T* in the projected year *y*
- $\alpha_{(T)y}$ = projection ratio for animal category *T*, in projected year *y* with respect to the baseline
- $N_{(T)\ 2005\text{-}2007}$ = baseline heads computed as the 2005, 2006, 2007 average heads of the animal category *T*
- *T* = animal category
- *y* = projected years 2030 and 2050.

Step 2. Emissions (CH_4)

IPCC 2006, Equation 10.22

$$Emissions(CH_4)_{(T)} = EF_{(T)} \times \frac{N_{(T)}}{10^6}$$

Where

- *Emissions* $(CH_4)_{(T)}$ = Methane emissions for animal category *T*, Gg CH_4 yr^{-1}
- $EF_{(T)}$ = emission factor for *T*, CH_4 $head^{-1}$ yr^{-1} (Table 2)
- $N_{(T)}$ = number of heads for animal category *T*, heads yr^{-1}
- *T* = animal category

Step 3. Emissions (CO_2eq) rom CH_4

$$Emissions(CO_2eq)_{(T)} = Emissions(CH_4)_{(T)} \times GWP$$

Where

- *Emissions* $(CO_2eq)_{(T)}$ = methane emissions in CO_2 equivalent for animal category *T* , Gg CO_2eq yr^{-1}
- *Emissions* $(CH_4)_{(T)}$ = Methane emissions for animal category *T* ,Gg CH_4 yr^{-1}
- *GWP* = 21 (100-year time horizon global warming potential), to convert Gg CH_4 to Gg CO_2eq
- *T* = animal category

Step 4. Implied emissions factor for CH_4

$$IEF_{(T)} = \frac{Emissions(CH_4)_{(T)}}{N_{(T)}} \times 10^6$$

Where

- *IEF(T)* = implied emission factor for *T*, kg CH_4 $head^{-1}$
- *Emissions* $(CH_4)_{(T)}$ = Methane emissions for animal category *T*, Gg CH_4 yr^{-1}
- $N_{(T)}$ = number of heads for animal category *T* heads yr^{-1}
- *T* = animal category

Step 5. Excretion rate per animal

IPCC 2006, Equation 10.30

$$Nex_{(T)} = N_{rate(T)} \times \frac{TAM_{(T)}}{1000} \times 365$$

Where

- $Nex_{(T)}$ = N excreted in manure for animal category *T*, kg N animal^{-1} yr^{-1}
- $N_{rate(T)}$ = default N excretion rate per mass, kg N (tonnes animal mass)$^{-1}$ day^{-1} (Table 3)
- $TAM_{(T)}$ = typical animal mass for animal category *T*, kg animal^{-1} (Table 4)
- *T* = animal category

Step 6. Manure N content to Manure Management Systems

$$NE_{MS(T)} = (N_{(T)} \times Nex_{(T)} \times MS_{(S,T)})$$

Where

- $NE_{MS(T)}$ = total nitrogen excreted from manure management systems for animal category *T*, kg N yr^{-1}
- $N_{(T)}$ = number of head of animal category *T*, heads yr^{-1}
- $Nex_{(T)}$ = Annual N excretion for animal category *T* , kg N animal^{-1} yr^{-1}
- $MS_{(S,\,T)}$ = share of manure treated in each systems *S* for animal category *T* (Tables 5 to 13)
- *T* = animal category
- *S* = manure management system (Lagoon, Slurry, Solid Storage, Drylot, Daily Spread, Digester, Pit<1Month, Pit>1Month, Other)

Step 7. Direct Emissions (N_2O)

IPCC 2006, Equation 10.25

$$Direct\ Emissions(N_2O)_{(T)} = \sum_S [NE_{MS} \times EF_{3(S)}] \times \frac{44}{28} \times 10^{-6}$$

Where

- $Direct\ Emissions(N_2O)_{(T)}$ = Direct N_2O emissions from manure management systems for animal category *T*, Gg N_2O yr^{-1}
- NE_{MS} = total nitrogen excreted from manure management systems for animal category *T*, kg N yr^{-1}
- $EF_{3(S)}$ = emission factor for direct N_2O emissions from each manure management system *S*, kg N_2O–N/kg N (Table 22)
- *T* = animal category
- *S* = manure management system

Step 8. Direct Emissions (CO_2eq)

$$Direct\ Emissions(CO_{2eq})_{(T)} = Direct\ Emissions(N_2O)_{(T)} \times GWP$$

Where

- $Direct\ Emissions\ (CO_{2eq})_{(T)}$ = Direct N_2O emissions from manure management systems in CO_2 equivalent for animal category *T*, Gg CO_2eq yr^{-1}
- $Direct\ Emissions\ (N_2O)_{(T)}$ = Direct N_2O emissions from manure management systems for animal category *T*, Gg N_2O yr^{-1}
- *GWP* = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq
- *T* = animal category

Step 9. Indirect emissions (N_2O)

$$Indirect\ Emissions(N_2O)_{(T)} = NE_{MS(T)} \times \left[(Frac_{GasMS_{(S)}} \times EF_4) + (Frac_{LeachMS} \times EF_5)\right] \times \frac{44}{28} \times 10^{-6}$$

Where

- *Indirect Emissions* $(N_2O)_{(T)}$ = Indirect N_2O emissions produced from the atmospheric deposition of N volatilised from manure management systems for animal category *T* , Gg N_2O yr^{-1}
- $NE_{MS(T)}$ = total nitrogen excreted from manure management systems for animal category *T* , kg N yr^{-1}
- $Frac_{GasMS(S)}$ = fraction of applied organic N fertiliser materials that volatilises as NH_3 and NO_X, kg N volatilised from each system *S* (Tables 14 to 21)
- EF_4 = emission factor for indirect N_2O emissions from atmospheric deposition of N on soils and water surfaces, kg N–N_2O/kg NH_3-N + NO_x-N volatilised (Table 24)
- $Frac_{Leach}$* = fraction of applied organic N fertiliser materials that leaches as NH_3 and NO_X, kg N leached/kg of N applied (Table 23)
- EF_5 = emission factor for indirect N_2O emissions from N leaching and runoff, kg N_2O N/kg N (Table 25)
- *T* = animal category
- *S* = manure management system

* *According to the note on p. 10.56 of the 2006 IPCC Guidelines: the percent of managed manure nitrogen losses for livestock category* T *due to runoff and leaching during solid and liquid storage of manure has a typical range of 1-20%; Tier 2 method.*

Step 10. Indirect Emissions (CO_2eq)

$$Indirect\ Emissions(CO_{2eq})_{(T)} = Indirect\ Emissions(N_2O)_{(T)} \times GWP$$

Where

- *Indirect Emissions* $(CO_2eq)_{(T)}$ = Indirect N_2O emissions from manure management systems in CO_2 equivalent, for animal category *T*, Gg CO_2eq yr^{-1}
- *Indirect Emissions* $(N_2O)_{(T)}$ = Indirect N_2O emissions from manure management systems for animal category *T*, Gg N_2O yr^{-1}
- *GWP* = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq
- *T* = animal category

Step 11. Emissions (N_2O)

$$Emissions(N_2O)_{(T)} = Direct\ Emissions(N_2O)_{(T)} + Indirect\ Emissions(N_2O)_{(T)}$$

Where

- *Emissions* $(N_2O)_{(T)}$ = total N_2O emissions from manure management systems for animal category *T*, Gg N_2O yr^{-1}
- *Direct Emissions*$(N_2O)_{(T)}$ = Direct N_2O emissions from manure management systems for animal category *T*, Gg N_2O yr^{-1}
- *Indirect Emissions* $(N_2O)_{(T)}$ = indirect N_2O emissions from manure applied on soils for animal category *T*, Gg N_2O yr^{-1}
- *T* = animal category

Step 12. Implied emissions factor for N_2O

$$IEF_{(T)} = \frac{Emissions(N_2O)_{(T)}}{NE_{MMS(T)}} \times 10^6 \times \frac{28}{44}$$

Where

- *IEF(T)* = implied emission factor for animal category *T*, kg N_2O/ kg N applied
- *Emissions* $(N_2O)_{(T)}$ = total N_2O emissions from manure management systems for animal category T, Gg N_2O yr^{-1}
- $NE_{MMS(T)}$ = total nitrogen excreted from manure management systems for animal category *T*, heads yr^{-1}
- *T* = animal category

5.1.3 Rice cultivation

Dataset Information	
Title	**Rice cultivation**
Definition	Greenhouse gas (GHG) emissions from rice cultivation consist of methane gas from the anaerobic decomposition of organic matter in paddy fields.
Methodology and Quality Information	
Methods and processing	GHG emissions from rice cultivation consist of methane gas (CH_4) emitted by anaerobic decomposition of organic matter in paddy fields. The FAOSTAT data are computed at Tier 1 following the criteria established in IPCC, 1997, Vol. 3, Ch. 4 and IPCC, 2000, Ch. 4. The emissions are estimated at the country level, using the formula $Emission = A * EF$ where • *Emission* = GHG emissions, in g CH_4 m^{-2} yr^{-1}; • *A* = Activity data, representing the annual rice paddy harvested area in m^{-2} (1); • *EF* = Tier 1, default IPCC emission factors, in g CH_4 m^{-2} yr^{-1} (2). (1) Activity data cover the following animal categories: buffaloes, sheep, goats, camels, llamas, horses, mules, asses, ducks, turkeys, dairy and non-dairy cattle*, chickens layers and broilers** and market and breeding swine***. For the period between 1961-present, activity data are taken directly from FAOSTAT (Production/Live animals domain). Projections of activity data for 2030 and 2050 for the categories of dairy and non-dairy cattle, buffaloes, sheep, goats, pigs and poultry, are computed with respect to a baseline, defined as the 2005-2007 average of the corresponding FAOSTAT activity data, and by applying percentage growth rates from FAO perspective studies (Alexandratos and Bruinsma, 2012). Activity data for animal categories for which no FAO projections were were set to the most recent available FAOSTAT value. The FAO projections used cover about 140 countries. Projections of activity data for countries that were not included assume the same growth rate of neighbouring countries. (2) Seasonally integrated EF values are specified for key rice producing countries in the IPCC Guidelines (IPCC, 1997, Vol. 3, Ch. 4, Table 4.13). For countries with no default EF value, the following strategy is applied: for Asia, countries are assigned an area-weighted average EF (15.7 g CH_4 m^{-2} yr^{-1}); in all other regions, countries are either assigned the IPCC EF value reported for a neighbouring country, where one exists, or the IPCC global default EF value (20 g CH_4 $m^{-2}yr^{-1}$). Also, seasonally integrated EF values are further modified by the application of a dimensionless scaling factor for water regimes (i) and a dimensionless correction factor for organic amendments (ii). (i) The scaling factors for rice paddy water regimes (IPCC, 1997, Vol. 3, Ch. 4, Table 4.12) are in the range of 0-1. Specifically, for all countries, a scaling factor of 0.7 is used for rain-fed rice, and 0 for upland rice or dry conditions (IPCC, 2000, Table 3, p. 403).

Methodology and Quality Information	
Methods and processing	(ii) The correction factor for organic amendments is the default value of 2 for all countries, corresponding to the assumption that 40% of farmers use organic amendments (IPCC, 2000, Table 3, p. 403). The dimensionless conversion factors used are • 10^{-4}, to convert the activity data from m^{-2} to ha; • 10^{-9}, to convert the emissions from g CH_4 to Gg CH_4; and • GWP-CH_4 = 21 (100-year time horizon global warming potential), to convert Gg CH_4 to Gg CO_2eq (IPCC, 1996, Technical Summary, Table 4, p. 22). The rice cultivation sub-domain contains the following data categories available for download: country-level GHG emissions both in Gg CH_4 and Gg CO_2eq; implied emission factors; and activity data. Uncertainties in estimates of GHG emissions are due to uncertainties in emission factors and activity data. In the case of rice cultivation, more detailed information is available in the IPCC Guidelines (IPCC, 2000, Ch. 4, Section 4.9.1.6).

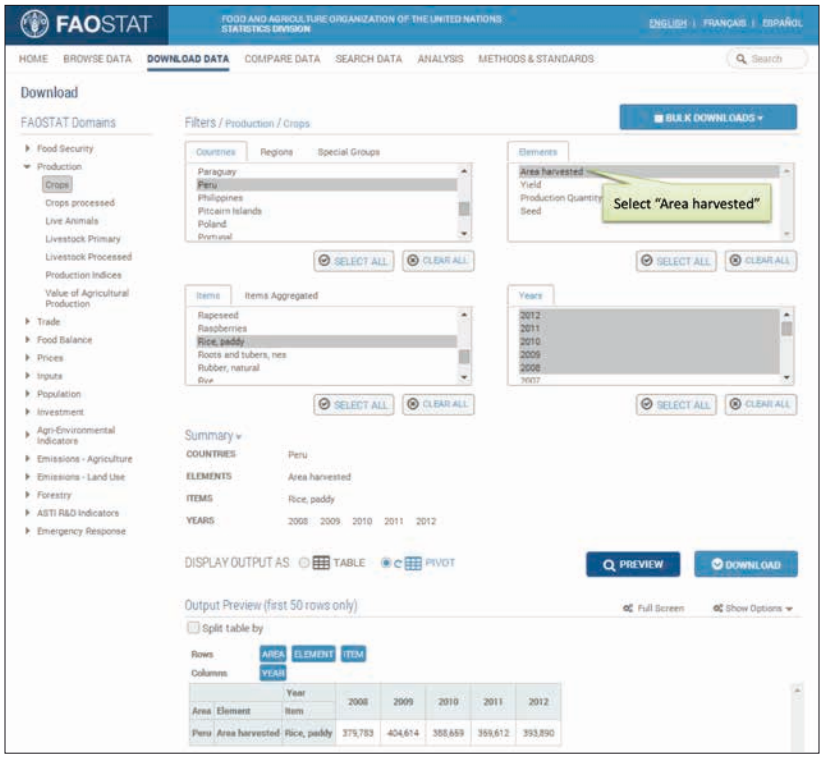
Calculation Procedure

Step 1. Activity data

In this sub-domain, activity data refers to the paddy rice harvested area. The definition used by FAOSTAT for "Area Harvested" is available in the Glossary–Area harvested; the definition for the "Rice paddy" item may also be found at the Glossary- Rice paddy or on the FAOSTAT website, at http://faostat3.fao.org/faostat-gateway/go/to/mes/glossary/*/E. The unit measure is expressed in hectares.

The data, from 1961-present, are disseminated in the FAOSTAT – Production, Crops sub-domain:

FIGURE 35
Paddy rice area harvested, from the FAOSTAT database



The data on the area harvested can be also downloaded from the FAOSTAT Emissions database, in particular from the Emissions – Agriculture Rice Cultivation sub-domain, at the following link http://faostat3.fao.org/faostat-gateway/go/to/download/G1/GR/E.

The area must be disaggregated into two water regimes, namely irrigated (*i*) and rainfed (*j*) regimes, using default IPCC shares (Table 29).

Please note that the upland regime does not emit methane. Therefore so there is no need to calculate.

$$A_i = \alpha_i \times A$$

$$A_j = \alpha_j \times A$$

Where

- A_i = area harvested of rice paddy for *i* water regimes, ha yr^{-1}
- A_j = area harvested of rice paddy for *j* water regimes, ha yr^{-1}
- $A_{i,j}$ = fraction representing the two water regimes, constant in time
- A = rice paddy area harvested , ha yr^{-1}
- *i* and *j* = respectively, irrigated and rainfed water regimes.

1.2 Projections of Area

The projections of activity data for 2030 and 2050 are computed with respect to a baseline provided by FAO perspective studies (Alexandratos and Bruinsma, 2012), as follows:

$$A_y = \alpha_y \times A_{(2005-2007)}$$

Where:

- A_y = Area for rice in the projected year *y*
- α_y = projection ratio for crop area A, at projected year *y* with respect to the baseline
- $A_{2005\text{-}2007}$ = baseline area for rice computed as the average of the 2005, 2006 and 2007 area values
- *y* = the projected years 2030 and 2050

Note: for the area projection too, the area should be split into different water regimes after Step 1.

Step 2. Emissions (CH_4)

The following equation was extrapolated from Table 3 of the IPCC 2002 background paper.

$$Emissions\ (CH_4) = \frac{EF \times\ SF_o \times \left(A_i + \left[A_j \times SF_j\right]\right)}{10^5}$$

Where

- *Emissions* (CH_4) = methane emissions per rice paddy, Gg CH_4 yr^{-1}
- *EF* = seasonal methane emission factor, g m^{-2} yr^{-1} (Table 30)
- $A_{i,j}$ = rice paddy area harvested in the two water regimes, irrigated and rainfed, ha yr^{-1}
- SF_o = 1.4 correction factor for organic amendments, for all countries
- SF_j = 0.7 scaling factor for A_j

Step 3. Emissions (CO_2eq)

$$Emissions(CO_2eq)_{(T)} = Emissions(CH_4)_{(T)} \times GWP$$

Where

- *Emissions (CO_2eq)* = methane emissions in CO_2 equivalent per rice paddy , Gg CO_2eq yr^{-1}
- *Emissions (CH_4)* = methane emissions per rice paddy, Gg CH_4yr^{-1}
- *GWP* = 21 (100-year time horizon global warming potential), to convert Gg CH_4 to Gg CO_2eq

Step 4. Implied emissions factor for CH_4

$$EF = \frac{Emissions(CH_4)}{A} \times 10^5$$

Where

- *IEF* = implied emission factor per rice paddy, g m^{-2} yr^{-1}
- *Emissions (CH_4)* = methane emissions per rice paddy, Gg CH_4 yr^{-1}
- *A* = rice paddy harvested area, ha yr^{-1}

5.1.4 Synthetic fertilizers

Dataset Information	
Title	**Synthetic Fertilisers**
Definition	Greenhouse gas (GHG) emissions from synthetic fertilisers consist of nitrous oxide gas from synthetic nitrogen additions to managed soils.
Methodology and Quality Information	
Methods and processing	GHG emissions from synthetic fertilisers consist of direct and indirect nitrous oxide (N_2O) emissions from nitrogen (N) added to agricultural soils by farmers. Specifically, N_2O is produced by microbial processes of nitrification and de-nitrification, taking place on the addition site (direct emissions), and after volatilisation/re-deposition and leaching processes (indirect emissions). The FAOSTAT data are estimated at Tier 1, following IPCC, 2006, Vol. 4, Ch. 11. **Direct emissions** are estimated at country level, using the formula *Emission = A * EF* where • *Emission* = GHG emissions, in kg N_2O-N yr^{-1}; • *A* = Activity data, representing the amount of annual synthetic N applications in kg N yr^{-1} (1); • *EF* = Tier 1, default IPCC emission factors, expressed in kg N_2O-N / kg N (2). (1) N consumption data are taken from the FAOSTAT Fertilisers Archive Dataset (1990-2001) (Inputs/ Fertilisers Archive sub domain) and the Fertilisers Dataset (2002 to present) (Inputs/Fertilizers sub domain). These are derived as an annual balance of N production and net trade. Projections of activity data for 2030 and 2050 are computed with respect to a baseline, defined as the 2005-2007 average of the corresponding FAOSTAT activity data, and by applying percentage growth rates from FAO perspective studies (Alexandratos and Bruinsma, 2012). The FAO projections used cover about 140 countries. Projections of activity data for countries that are not included assume the same growth rate of neighbouring countries. The following assumption is made: N application data = FAOSTAT N consumption data.

Methodology and Quality Information	
Methods and processing	(2) Global default EF values are taken from IPCC, 2006, Vol. 4, Ch.11, Table 11.1. **Indirect emissions** are estimated at country level, using the formula $Emission = A * EF$ where • *Emission* = GHG emissions, in kg N_2O-N yr^{-1}; • *A* = Activity data, representing the amount of annual synthetic N applications that volatilises as NH_3 and NO_x and is lost through runoff and leaching in kg N yr^{-1} (3); • *EF* = Tier 1, default IPCC emission factors, expressed in kg N_2O-N / kg N yr^{-1} (4). (3) Obtained through the volatilisation and leaching factors in IPCC, 2006, Vol. 4, Ch. 11, Table 11.3. (4) Global default EF values from IPCC, 2006, Vol. 4, Ch. 11, Table 11.3. The dimensionless conversion factors used are • 44/28, to convert the emissions from kg N_2O-N to kg N_2O gas; • 10^{-6}, to convert the emissions from kg N_2O to Gg N_2O; and • GWP-N_2O = 310 (100-year time horizon), to convert Gg N_2O to Gg CO_2eq (IPCC, 1996, Technical Summary, Table 4, p. 22). The synthetic fertiliser sub-domain contains the following data categories available for download: country-level GHG emissions, provided as total, direct and indirect amounts in both Gg N_2O and Gg CO_2eq; implied emission factors; and activity data. Uncertainties in estimates of GHG emissions are due to uncertainties in emission factors and activity data. In the case of synthetic fertilisers, more detailed information is available in the IPCC Guidelines (IPCC, 2006, Vol.4, Ch. 11, Section 11.2.1.4 for direct emissions, and Section 11.2.2.4 for indirect emissions).

Calculation Procedure

Step 1. Activity data

Activity data in this domain refers to the Consumption of Fertilisers. The definitions used by FAOSTAT of "Consumption of Fertilisers" is available in the Glossary– Consumption of Fertilizers (see Annex 1) or on the FAOSTAT website, specifically at http://faostat3.fao.org/faostat-gateway/go/to/mes/glossary/*/E.

Data in the FAOSTAT Inputs sub domain is divided into two sub-domains that reflect the different methodologies adopted over time: the first series ("Fertilizers archive", see Figure 34 below) includes data from 1961 to 2002 and the second[7] ("Fertilizers", Figure 35 below) lists data from 2002 to present. In the latter dataset, the element "Nitrogen Fertilizers (N total nutrients)" corresponds to the old "Nitrogenous Fertilizers"; "Consumption in nutrients (tonnes of nutrients)" corresponds to the old "Consumption".

[7] Data collected with a revised methodology and presented in a new format. See http://faostat3.fao.org/faostat-gateway/go/to/download/E/*/E.

FIGURE 36
Fertilizers Archive, from the FAOSTAT database

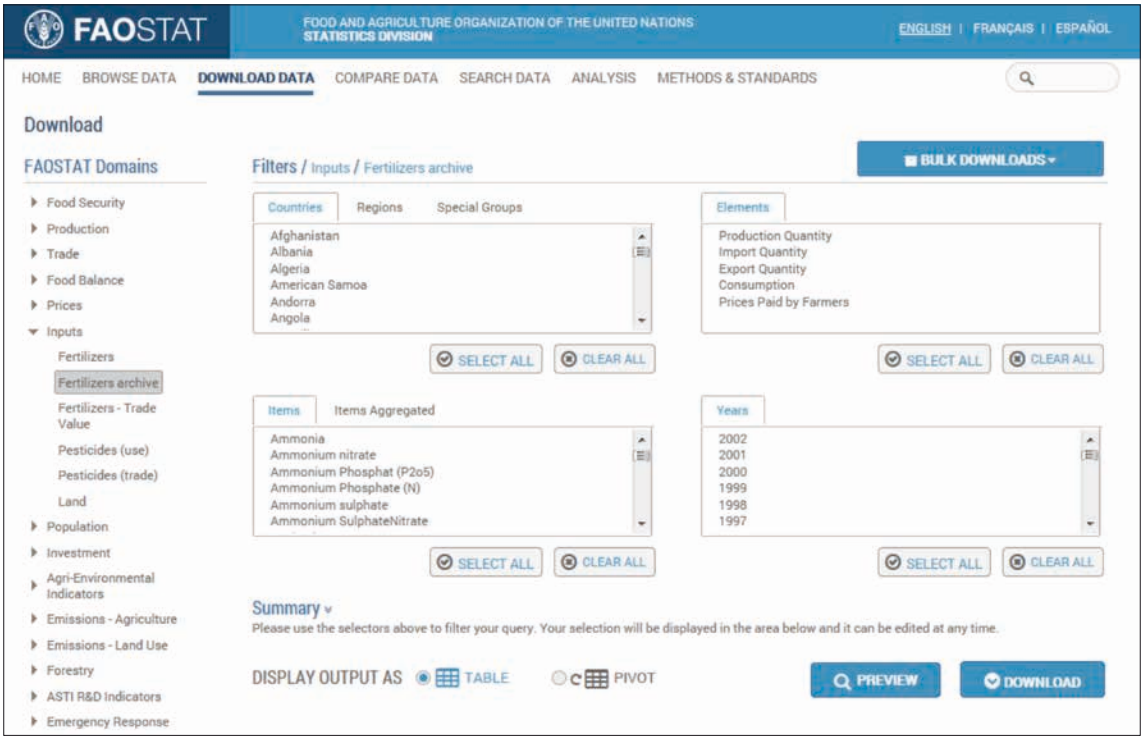
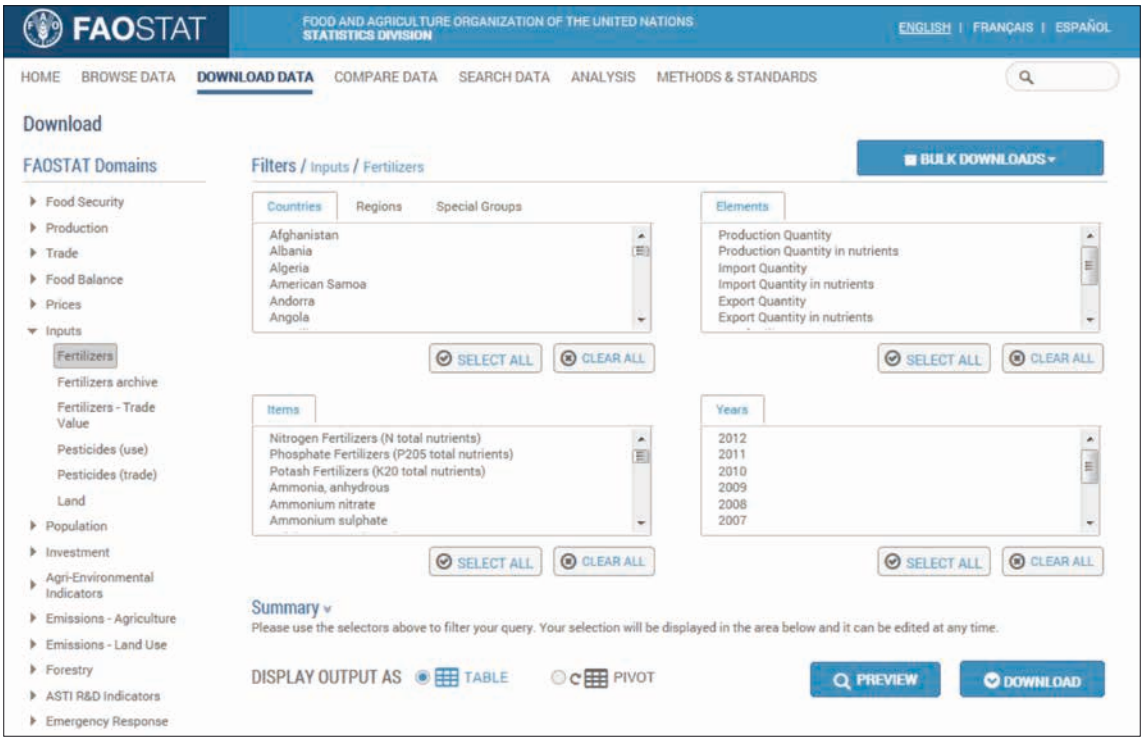


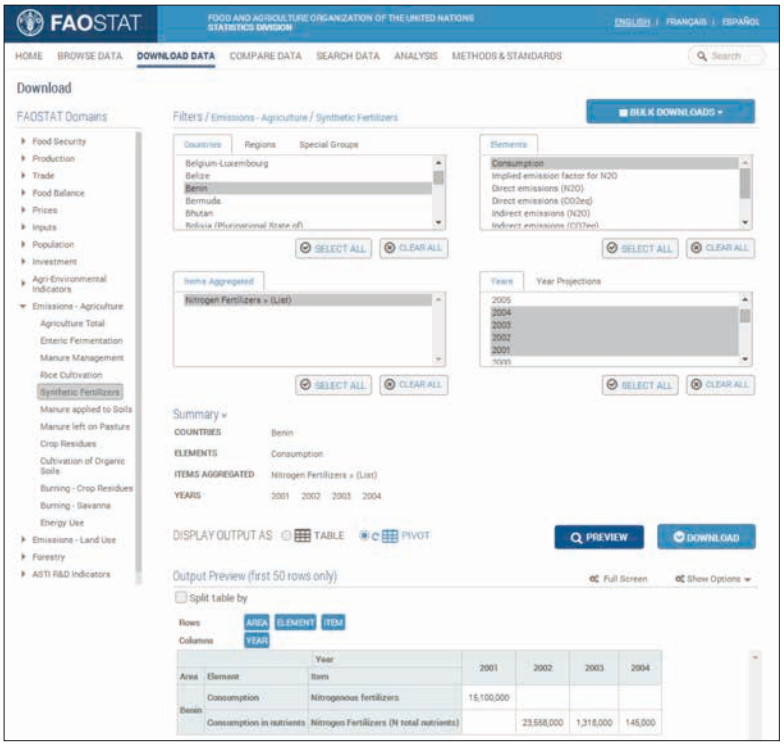
FIGURE 37
Fertilizers data set from the FAOSTAT database



In the FAOSTAT Emissions database, data from 1961 onwards is available in the Synthetic Fertilizers sub-domain with a unique "Nitrogen Fertilizers" item, but this query provides separate time series: the "Fertilizer Archive" data, from 1961 to 2002 (Nitrogenous fertilizers) and "Fertilizer" data from 2002 to present (Nitrogen fertilizers).

Data under "Nitrogen Fertilizers" has been converted into the nitrogen nutrients, and expressed in kg.

FIGURE 38
Synthetic Fertilizers Items from the FAOSTAT Emissions database



1.2 Projections of Consumption in Nutrients

The projections of activity data for 2030 and 2050 are computed with respect to a baseline provided by FAO perspective studies (Alexandratos and Bruinsma, 2012). The baseline is the following:

$$N_y = \alpha_y \times N_{2005-2007}$$

Where:

- N_y = consumption in nutrients of nitrogen fertilizers in the projected year y
- α_y = projection ratio for synthetic fertilizer, at projected year y with respect to the baseline
- $N_{2005\text{-}2007}$ = baseline of the consumption in nutrients of nitrogen fertilizers computed, as the average of years 2005, 2006 and 2007, tonnes
- y = the projected years 2030 and 2050

Step 2. Direct Emissions (N_2O)

$$Direct\ Emissions\ (N_2O) = N \times \frac{44}{28} \times EF_1 \times 10^{-6}$$

Where

- *Direct Emissions (N_2O)* = Direct N_2O emissions from synthetic nitrogen additions to the managed soils, Gg N_2O yr^{-1}
- *N* = Consumption in nutrients of nitrogen fertilizers, kg N input yr^{-1}
- EF_1= emission factor for N_2O emissions from N inputs, kg N_2O–N/kg N input (Table 26)

N.B. The following assumption is made: *N* application data = FAOSTAT Nitrogen Consumption data.

Step 3. Direct Emissions (CO_2eq)

$$Direct\ Emissions(CO_{2eq})_{(T)} = Direct\ Emissions(N_2O)_{(T)} \times GWP$$

Where

- *Direct Emissions (CO_2eq)* = Direct N_2O emissions from synthetic nitrogen additions to the managed soils, in CO_2 equivalent, Gg CO_2eq yr^{-1}
- *Direct Emissions (N_2O)* = Direct N_2O emissions from synthetic nitrogen additions to the managed soils, Gg N_2O yr^{-1}
- *GWP* = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq

Step 4. Indirect emissions (N_2O)

$$Indirect\ Emissions\ (N_2O) = N \times [(Frac_{GASF} \times EF_4) + (Frac_{Leach} \times EF_5)] \times \frac{44}{28} \times 10^{-6}$$

Where

- *Indirect Emissions (N_2O)* = Indirect N_2O emissions produced from atmospheric deposition of N, volatilised from managed soils, Gg N_2O–N yr^{-1}
- *N* = Consumption in nutrients of nitrogen fertilizers, kg N input
- $Frac_{GASF}$ = Fraction of applied synthetic N fertilizer materials that volatilises as NH_3 and NO_X, kg N volatilised/kg of N applied (Table 28)
- EF_4 = Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, kg N–N_2O/kg NH_3-N + NO_x-N volatilised (Table 24)
- $Frac_{Leach}$ = Fraction of applied synthetic N fertilizer materials that leaches as NH_3 and NO_X, kg N leached/kg of N additions (Table 27)
- EF_5 = Emission factor for N_2O emissions from N leaching and runoff, kg N_2O–N/kg N (Table 25)

Step 5. Indirect Emissions (CO_2eq)

$$Indirect\ Emissions(CO_{2eq})_{(T)} = Indirect\ Emissions(N_2O)_{(T)} \times GWP$$

Where

- *Indirect Emissions (CO_2eq)* = Indirect N_2O emissions from synthetic nitrogen additions to managed soils, in CO_2 equivalent, Gg CO_2eq yr^{-1}
- *Indirect Emissions (N_2O)* = Indirect N_2O emissions from synthetic nitrogen additions to managed soils, Gg N_2O yr^{-1}
- *GWP* = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq

Step 6. Emissions (N_2O)

$$Emissions\ (N_2O) = Direct\ Emissions(N_2O) + Indirect\ Emissions(N_2O)$$

Where

- *Emissions (N_2O)* = Total N_2O emissions from synthetic nitrogen additions to managed soils, Gg N_2O yr^{-1}
- *Direct Emissions (N_2O)* = Direct N_2O emissions from synthetic nitrogen additions to managed soils, Gg N_2O yr^{-1}
- *Indirect Emissions (N_2O)* = Indirect N_2O emissions from synthetic nitrogen additions to managed soils, Gg N_2O yr^{-1}

Step 7. Emissions (CO_2eq)

$$Emissions\ (CO_{2eq}) = Emissions(N_2O) \times GWP$$

Where

- *Emissions (CO_2eq)* = Total N_2O emissions from synthetic nitrogen additions to managed soils, in CO_2 equivalent, Gg CO_2eq yr^{-1}
- *Emissions (N_2O)* = Total N_2O emissions from synthetic nitrogen additions to managed soils, Gg N_2O yr^{-1}
- *GWP = 310 ($1_0$0*-year time $h_o$rizon global warming potential), to convert Gg N_2O to Gg CO_2eq

Step 8. Implied emissions factor for N_2O

$$IEF = \frac{Emissions(N_2O)}{N} \times 10^6 \times \frac{28}{44}$$

Where

- *EF* = Implied emission factor for synthetic nitrogen additions to managed soils T, kg N_2O/kg of N applied yr^{-1}
- *Emissions (N_2O)* = Total N_2O emissions from synthetic nitrogen additions to managed soils, Gg N_2O yr^{-1}
- *N* = Consumption in nutrients of nitrogen fertilizers (kg)

5.1.5 Manure applied to soils

Dataset Information	
Title	**Manure applied to soils**
Definition	Greenhouse gas (GHG) emissions from manure applied to soils consist of nitrous oxide gas, from nitrogen additions in the treated manure that is applied to managed soils.
Methodology and Quality Information	
Methods and processing	GHG emissions from manure applied to soils consist of direct and indirect nitrous oxide (N_2O) emissions from manure nitrogen (N) added to agricultural soils by farmers. Specifically, N_2O is produced by microbial processes of nitrification and de-nitrification taking place on the application site (direct emissions), and after volatilisation/re-deposition and leaching processes (indirect emissions). The FAOSTAT data are estimated at Tier 1, following the IPCC Guidelines, 2006, Vol. 4, Ch.s 10 and 11. **Direct emissions** are estimated at country level, using the formula $$Emission = A * EF$$ where • *Emission* = GHG emissions, in kg N_2O-N yr^{-1}; • *A* = Activity data, representing the total amount of N in manure applied to soils in kg N yr^{-1} (1); • *EF* = Tier 1, default IPCC emission factors in kg N_2O-N/kg N yr^{-1} (2). (1) This is the amount of N excreted (see below, note *i*) by livestock (*ii*), treated in manure management systems (MMS) (*iii*) and net of losses through volatilisation, runoff and leaching from MMS, and other human use (*iv*), plus the N contribution from bedding materials where present (*v*). (*i*) Following IPCC, 2006, Vol. 4, Ch. 10, Equation 10.30, the total amount of N excreted by each livestock category is calculated by multiplying the number of livestock heads by two coefficients: a) the Typical Animal Mass (TAM) and b) the N excretion coefficient (N_{ex}). Both parameters vary according to geographic region. TAM values are obtained from IPCC, 2006, Vol. 4, Ch. 10, Annex 10A.2, Tables 10A-4 to 10A-9; N_{ex} values are derived from IPCC, 2006, Vol. 4, Ch. 10, Table 10.19. (*ii*) Livestock data cover the following animal categories: buffaloes, sheep, goats, camels, llamas, horses, mules, asses, ducks and turkeys, dairy and non-dairy cattle*, chickens layers and broilers** and market and breeding swine***. For the period 1961-present, activity data are taken directly from FAOSTAT (domain: Production/Live animals). Projections of activity data for 2030 and 2050 for the categories of dairy and non-dairy cattle, buffaloes, sheep, goats, pigs and poultry, are computed with respect to a baseline, defined as the 2005-2007 average of the corresponding FAOSTAT activity data, and by applying percentage growth rates from FAO perspective studies (Alexandratos and Bruinsma, 2012). Activity data for animal categories for which no FAO projections were available were set to the most recent FAOSTAT value available. The FAO projections used cover about 140 countries. Projections of activity data for countries that were not included assume the same growth rate of neighbouring countries. *FAOSTAT livestock data include the cattle and dairy cattle items. Dairy cattle data are expressed as heads of cows producing milk, and can be found under the Production/Livestock Primary domain by selecting the "Cow milk, whole fresh" item and the "Producing animals" element. Non-dairy cattle is derived from FAOSTAT categories, specifically as cattle minus dairy cattle. **FAOSTAT livestock data include the items chickens and chicken layers. Chicken layers are expressed in 1000 heads of hens which have laid eggs in the reference period, and can be found under the Production/Livestock Primary domain by selecting the "Hen eggs, in shell" item. The "Producing animals. Chickens broilers" element is derived from FAOSTAT categories, specifically as chickens minus chickens layers; ***FAOSTAT livestock data include the "Pigs" item. Market and breeding swine are calculated, respectively, as 90% and 10% of item pigs (IPCC, 2006, Vol. 4, Ch. 10, Table 10.19).

Methodology and Quality Information	
Methods and processing	(*iii*) Default IPCC percentages of total N treated in different MMS, by region and livestock category, are taken from IPCC, 2006, Vol. 4, Ch. 10, Annex 10A.2, Tables 10A-4 to 10A-9 (for poultry: IPCC, 1997, Vol. 3, Ch. 4, Table 4.21). (*iv*) Default IPCC values for total N losses from different MMS depend on the livestock category, as per IPCC, 2006, Vol. 4, Ch. 10, Tab. 23. Losses of treated manure due to use for construction, feed or fuels are set to zero, as per IPCC, 2006, Vol. 4, Ch. 11, p. 11.13. It is assumed that all treated manure, net of the above losses, is applied to soils following IPCC, 2006, Vol. 4, Ch. 11, p. 11.13. (*v*) Default amounts of N used in bedding (for solid storage and deep bedding) as per IPCC, 2006, Vol. 4, Ch. 10, p. 10.66. (2) Global IPCC default EF values are taken from IPCC, 2006: Vol. 4, Ch. 11, Table 11.1. **Indirect emissions** are estimated at country level, using the formula $Emission = A * EF$ where • *Emission* = GHG emissions in kg yr^{-1}; • *A* = Activity data, representing the fraction of manure N applications that volatilises as NH_3 and NO_x, and is lost through runoff and leaching in kg N yr^{-1} (3); • *EF* = Tier 1, default IPCC emission factors in kg N_2O-N/kg N yr^{-1} (4). (3) Obtained through the volatilisation and leaching factors in IPCC, 2006, Vol. 4, Ch. 11, Table 11.3. (4) Global IPCC default EF values, from IPCC, 2006, Vol. 4, Ch. 11, Table 11.3. The dimensionless conversion factors used are • 44/28, to convert the emissions from kg N_2O-N to kg N_2O gas; • 10^{-6}, to convert the emissions from kg N_2O to Gg N_2O; • GWP-N_2O = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq (IPCC, 1996, Technical Summary, Table 4, p. 22). The "manure applied to soils" domain contains the following data categories available for download: country-level GHG emissions, provided as total, direct and indirect amounts in both Gg N_2O and Gg CO_2eq; implied emission factors; and activity data. Uncertainties in estimates of GHG emissions are due to uncertainties in emission factors and activity data. In the case of manure applied to soil, more detailed information is available in the IPCC Guidelines (IPCC, 2006, Vol. 4, Ch. 11, Section 11.2.1.4 for direct emissions, and Section 11.2.2.4 for indirect emissions).

Calculation Procedure

Step 1. Activity data

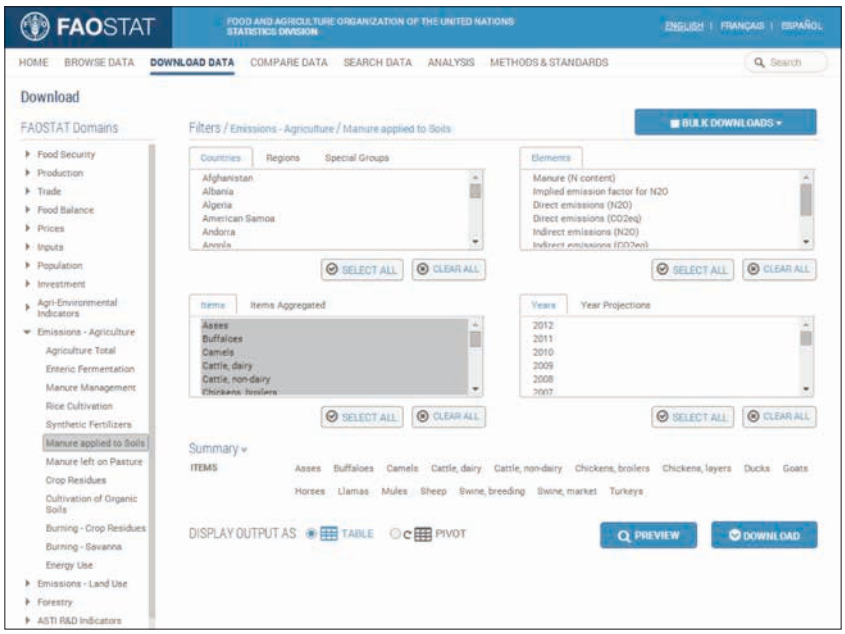
Activity data in this subdomain refers to the number of heads (Stock) of the following items: dairy and non-dairy cattle, buffaloes, sheep, goats, chickens, turkeys, ducks, market swine and breeding swine ("Pigs" in FAOSTAT nomenclature).

The definitions used by FAOSTAT for the "Number of Live Animals/Stock" and for the individual items are available in the Glossary (see Annex 1) at "Definition of items-livestock", or on the FAOSTAT website, at http://faostat3.fao.org/faostat-gateway/go/to/mes/glossary/*/E. The unit measure is expressed in terms of number of heads, except for poultry (chickens, ducks, and turkeys), which are expressed in terms of 1000 heads.

Data (from 1961 to present) are to be found under the FAOSTAT – Production, Live Animals sub-domain. Data of all live animals categories must be retrieved as described above in the "Enteric Fermentation Activity Data" section. With regard to "Chickens, layers" and "Chickens, broilers", data can be retrieved as described in the "Manure Management Activity Data" section.

The FAOSTAT Emissions database provides the data, disaggregated by the sub-categories of dairy and dairy cattle, swine, layers, and broilers.

FIGURE 39
Manure Applied to Soils Items from the FAOSTAT Emissions database



1.2 Projections of Stocks

Projections of activity data for 2030 and 2050 for the categories of dairy and non-dairy cattle, buffaloes, sheep, goats, pigs and poultry, are computed with respect to a baseline provided by FAO perspective studies (Alexandratos and Bruinsma, 2012). The baseline is as follows:

$$N_{(T)y} = \alpha_{(T)_y} \times N_{(T)_{2005-2007}}$$

Where:

- $N_{(T)}$ = number of heads for animal category *T*, in the projected year *y*
- $\alpha_{(T)y}$ = projection ratio for animal category *T*, in projected year *y* with respect to the baseline
- $N_{(T)\ 2005\text{-}2007}$ = baseline heads computed as the average of the heads of animal category *T* for years 2005, 2006, 2007
- *T* = animal category
- *y* = the projected years 2030 and 2050

Step 2. Excretion rate per animal

IPCC 2006, Equation 10.30

$$Nex_{(T)} = N_{rate(T)} \times \frac{TAM_{(T)}}{1000} \times 365$$

Where

- $Nex_{(T)}$ = Annual N excretion for animal category *T*, kg N animal^{-1} yr^{-1}
- $N_{rate(T)}$ = default N excretion rate, kg N (tonnes animal mass)$^{-1}$ day^{-1} (Table 3)
- $TAM_{(T)}$ = typical animal mass for livestock category T, kg animal^{-1}(Table 4)
- *T* = animal category

Step 3. Nitrogen in manure available for application to managed soils and for other uses (fuel/feed/constructions)

IPCC 2006, Equation 10.30

$$N_{MS\_Avb(T)} = \sum_{S}\left[N_{(T)} \times Nex_{(T)} \times MS_{(S,T)} \times \left(1 - Frac_{Loss(S,T)}\right)\right] + \left[N_{(T)} \times MS_{SolidStorage(T)} \times \frac{N_{bedding\_SolidStorage(T)}}{1000}\right]$$

Where:

- $N_{MS\_Avb(T)}$ = amount of managed manure nitrogen available for application to managed soils and for other uses, for animal category *T*, kg N yr^{-1}
- $N_{(T)}$ = Number of heads of animal category *T*, heads yr^{-1}
- $Nex_{(T)}$ = Annual N excretion for animal category *T*, kg N $animal^{-1}$ yr^{-1}
- $MS_{(S,\,T)}$ = Share of manure treated in each MS, for animal category *T*, (Tables 5 to 13)
- $Frac_{Loss(S,\,T)}$ = fraction of managed manure nitrogen for livestock category T that is lost in each system S (Tables 32 to 37)
- $MS_{SolidStorage(T)}$ = Share of manure treated in Solid Storage for animal category *T* (Table 7)
- $N_{bedding\_SolidStorage\ (T)}$ = Amount of nitrogen from bedding for solid storage MS for animal category *T*, kg N $animal^{-1}$ yr^{-1} (Table 31)
- *T* = Animal category
- *S* = Manure management system (Lagoon, Slurry, Solid Storage, Drylot, Daily Spread, Digester, Pit<1Month, Pit>1Month, Other)

Step 4. Nitrogen in manure applied to soils

IPCC 2006, Equation 11.4

$$F_{AM(T)} = N_{MS\_Avb(T)} \times \left[1 - \left(Frac_{FEED(T)} + Frac_{FUEL(T)} + Frac_{CNST(T)}\right)\right]$$

Where

- $F_{AM(T)}$ = Amount of managed manure nitrogen applied to managed soils, for animal category *T*, kg N yr^{-1}
- $N_{MS\_Avb(T)}$ = Amount of managed manure nitrogen available for application to managed soils or for feed fuel, or construction purposes, for animal category *T*, kg N yr^{-1}
- $Frac_{FEED(T)}$ = Fraction of managed manure used for feed for animal category *T* (Table 39)
- $Frac_{FUEL(T)}$ = Fraction of managed manure used for fuel for animal category *T* (Table 40)
- $Frac_{CNST(T)}$ = Fraction of managed manure used for construction for animal category *T* (Table 41)

Step 5. Direct Emissions (N_2O)

$$Direct\ Emissions(N_2O)_{(T)} = F_{AM(T)} \times EF_1 \times \frac{44}{28} \times 10^{-6}$$

Where

- *Direct Emissions* $(N_2O)_{(T)}$ = Direct N_2O emissions from manure applied on managed soils for animal category *T*, Gg N_2O yr^{-1}
- $F_{AM(T)}$ = Amount of animal manure N applied to managed soils, kg N yr^{-1}
- EF_1 = Emission factor for N_2O emissions from N inputs, kg N_2O–N/kg N input (Table 26)
- *T* = animal category

Step 6. Direct Emissions (CO_2eq)

$$Direct\ Emissions(CO_{2eq})_{(T)} = Direct\ Emissions(N_2O)_{(T)} \times GWP$$

Where

- *Direct Emissions* $(CO_2eq)_{(T)}$ = Direct N_2O emissions from manure applied on managed soils in CO_2 equivalent, for animal category T, Gg $CO_2eq\ yr^{-1}$
- *Direct Emissions* $(N_2O)_{(T)}$ = Direct N_2O emissions from manure applied on managed soils for animal category *T*, Gg $N_2O\ yr^{-1}$
- *GWP* = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq
- *T* = animal category

Step 7. Indirect emissions (N_2O)

$$Indirect\ Emissions(N_2O)_{(T)} = F_{AM\,(T)} \times [(Frac_{GASM} \times EF_4) + (Frac_{Leach} \times EF_5)] \times \frac{44}{28} \times 10^{-6}$$

Where

- *Indirect Emissions* $(N_2O)_{(T)}$ = Indirect N_2O emissions produced from atmospheric deposition of N, volatilised from managed soils, for animal category *T*, Gg $N_2O\ yr^{-1}$
- $F_{AM\,(T)}$ = Amount of animal manure N applied to managed soils for animal category *T*, kg N yr^{-1}
- $Frac_{GASM}$ = Fraction of applied organic N fertilizer materials that volatilises as NH_3 and NO_X, kg N volatilised/kg of N applied)(Table 38)
- EF_4 = emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, kg N_2O –N/kg NH_3-N + NO_x-N volatilised (Table 24)
- $Frac_{Leach}$ = fraction of applied organic N fertilizer materials that leaches as NH_3 and NO_X, kg N leached/kg of N additions (Table 27)
- EF_5 = emission factor for N_2O emissions from N leaching and runoff , kg N_2O–N/kg N volatilized (Table 25)
- *T* = animal category

Step 8. Indirect Emissions (CO_2eq)

$$Indirect\ Emissions(CO_{2eq})_{(T)} = Indirect\ Emissions(N_2O)_{(T)} \text{ x } GWP$$

Where

- *Indirect Emissions* $(CO_2eq)_{(T)}$ = Indirect N_2O emissions from manure applied on managed soils in CO_2 equivalent for animal category T, Gg $CO_2eq\ yr^{-1}$
- *Indirect Emissions* $(N_2O)_{(T)}$ = Indirect N_2O emissions from manure applied on managed soils for animal category T, Gg $N_2O\ yr^{-1}$
- *GWP* = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq
- *T* = Animal category

Step 9. Emissions (N_2O)

$$Emissions(N_2O)_{(T)} = Direct\ Emissions(N_2O)_{(T)} + Indirect\ Emissions(N_2O)_{(T)}$$

Where

- *Emissions* $(N_2O)_{(T)}$ = Total N_2O emissions from manure applied on managed soils for animal category *T*, Gg N_2O yr^{-1}
- *Direct Emissions* $(N_2O)_{(T)}$ = Direct N_2O emissions from manure applied on soils for animal category *T*, Gg N_2O yr^{-1}
- *Indirect Emissions* $(N_2O)_{(T)}$ = Indirect N_2O emissions from manure applied on soils for animal category *T*, Gg N_2O yr^{-1}
- *T* = Animal category

Step 10. Emissions (CO_2eq)

$$Emissions(CO_{2eq})_{(T)} = Emissions(N_2O)_{(T)} \times GWP$$

Where

- *Emissions* $(CO_2eq)_{(T)}$ = Total N_2O emissions from manure applied on managed soils, in CO_2 equivalent, for animal category *T*, Gg CO_2eq yr^{-1}
- *Emissions* $(N_2O)_{(T)}$ = Total N_2O emissions from manure applied on managed soils for animal category *T*, Gg N_2O yr^{-1}
- *GWP* = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq
- *T* = Animal category

Step 11. Implied emissions factor for N_2O

$$IEF_{(T)} = \frac{Emissions(N_2O)_{(T)}}{F_{PRP(T)}} \times 10^6 \times \frac{28}{44}$$

Where

- *IEF(T)* = Implied emission factor for animal category *T*, kg N_2O/kg of N applied
- *Emissions* $(N_2O)_{(T)}$ = Total N_2O emissions from manure applied on soils for animal category *T* , Gg N_2O yr^{-1}
- $F_{AM(T)}$ = Amount of managed manure nitrogen applied to managed soils for animal category *T*, kg N yr^{-1}
- *T* = Animal category

5.1.6 Manure left on pasture

Dataset Information	
Title	**Manure left on pastures**
Definition	Greenhouse Gases (GHG) emissions data from manure left on pasture consist of nitrous oxide gas from nitrogen additions, made by grazing livestock, to managed soils.
Methodology and Quality Information	
Methods and processing	GHG emissions from manure left on pastures consist of direct and indirect nitrous oxide (N_2O) emissions from manure nitrogen (N) left on pastures by grazing livestock. Specifically, N_2O is produced by microbial processes of nitrification and de-nitrification taking place on the deposition site (direct emissions), and after volatilisation/ re-deposition and leaching processes (indirect emissions). The FAOSTAT data are estimated at Tier 1 following the IPCC Guidelines, 2006, Vol. 4, Ch. 10 and 11. **Direct emissions** are estimated at country level, using the formula $$Emission = A * EF$$ where • *Emission* = GHG emissions in kg yr^{-1}; • *A* = Activity data, representing the total amount of manure N left on pasture in kg N yr^{-1} (1); • *EF* = Tier 1, default IPCC emission factors, expressed in kg N_2O-N/kg N yr^{-1} (2). (1) Computed as per IPCC, 2006, Vol. 4, Ch. 11, Equation 11.5, as the amount of total N excreted (see below, note i) by livestock (ii) and left on pastures as urine and dung (iii). (i) Following IPCC, 2006, Vol. 4, Ch. 10, Equation 10.30, the total *amount of nitrogen excreted in manure* is calculated, for each livestock category, by multiplying the number of livestock heads by two coefficients: a) the Typical Animal Mass (TAM) and b) the N excretion coefficient (N_{ex}). Both parameters vary according to geographic region. TAM values are obtained from IPCC, 2006, Vol. 4, Ch. 10, Annex 10A.2, Tables 10A-4 to 10A-9; N_{ex} values are derived from IPCC, 2006, Vol. 4, Ch. 10, Tables 10.19. (ii) Livestock data cover the following animal categories: buffalo, sheep, goats, camels, llamas, horses, mules, asses, ducks, turkeys, dairy and non-dairy cattle*, chickens layers and broilers** and market and breeding swine***. For the period between 1961-present, activity data are taken directly from FAOSTAT (domain: Production/Live animals). Projections of activity data for 2030 and 2050 for the categories of dairy and non-dairy cattle, buffaloes, sheep, goats, pigs and poultry, are computed with respect to a baseline, defined as the 2005-2007 average of the corresponding FAOSTAT activity data, and by applying percentage growth rates from FAO perspective studies (Alexandratos and Bruinsma, 2012). Activity data for animal categories for which no FAO projections were available were set to the most recent available FAOSTAT value. The FAO projections used cover about 140 countries. Projections of activity data for countries that were not included assume the same growth rate experienced in neighbouring countries. *FAOSTAT livestock data include the "Cattle" and "Dairy cattle" items. Dairy cattle data are expressed as heads of cows producing milk, and can be found under the Production/ Livestock Primary domain by selecting the item "Cow milk, whole fresh" and the "Producing animals" element. Non-dairy cattle is derived from FAOSTAT categories, specifically as "Cattle" minus "Dairy cattle"; **FAOSTAT livestock data include the "Chickens" and "Chickens, layers" items. Chicken layers are expressed in 1000 heads of hens which have laid eggs in the reference period, and can be found under the Production/Livestock Primary domain by selecting the "Hen eggs, in shell" item and the "Producing animals" element. "Chickens, broilers" is derived from FAOSTAT categories by subtracting the values for "Chickens, layers" from chickens; ***FAOSTAT livestock data include the "Pigs" item. Market and breeding swine are calculated as, respectively, 90% and 10% of this item (IPCC, 2006, Vol. 4, Ch.10, Table 10.19).

Methodology and Quality Information	
Methods and processing	(iii) Default IPCC percentages of total excreted N in different Manure Management Systems (MMS) by region and livestock category, as per IPCC, 2006, Vol. 4, Ch. 10, Annex 10A.2, Tables 10A-4 to 10A-9 (for poultry: IPCC, 1997, Vol. 3, Ch. 4, Table 4.21). With reference to these tables specifically, the amount of manure left on pasture contributing to GHG emissions is the sum of 100% of the total excreted N left on pasture, as per IPCC percentage value "Pasture/Range/Paddock", and 50% of the total excreted N as per IPCC percentage value "Burned for Fuel" (IPCC, 2006, Vol. 4, Ch. 10, p. 10.58). (2) Global default EF values taken from IPCC, 2006, Vol. 4, Ch. 11, Table 11.1. **Indirect emissions** are estimated at country level, using the formula $Emission = A * EF$ where • *Emission* = GHG emissions in kg yr^{-1}; • *A* = Activity data, representing the fraction of manure N left on pastures that volatilises as NH_3 and NO_x and is lost through runoff and leaching in kg N yr^{-1} (3); • *EF* = Tier 1, default IPCC emission factors, expressed in kg N_2O-N/kg N yr^{-1} (4). (3) Obtained through the volatilisation and leaching factors in IPCC, 2006, Vol. 4, Ch. 11, Table 11.3. (4) Global IPCC default EF values from IPCC, 2006, Vol. 4, Ch. 11, Tab. 11.1. The dimensionless conversion factors used are • 44/28, to convert the emissions from kg N_2O-N to kg N_2O gas; • 10^{-6}, to convert the emissions from kg N_2O to Gg N_2O; • GWP-N_2O = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq (IPCC, 1996, Technical Summary, Table 4, p. 22). The "manure left on pastures" domain contains the following data categories available for download: country-level GHG emissions, provided as total, direct and indirect amounts in both Gg N_2O and Gg CO_2eq; implied emission factors; and activity data. Uncertainties in the estimates of GHG emissions are due to uncertainties in emission factors and activity data. In the case of manure left on pastures, more detailed information is available in the IPCC Guidelines (IPCC, 2006, Vol. 4, Ch. 11, Section 11.2.1.4 for direct emissions, and Section 11.2.2.4 for indirect emissions).

Calculation Procedure

Step 1. Activity data

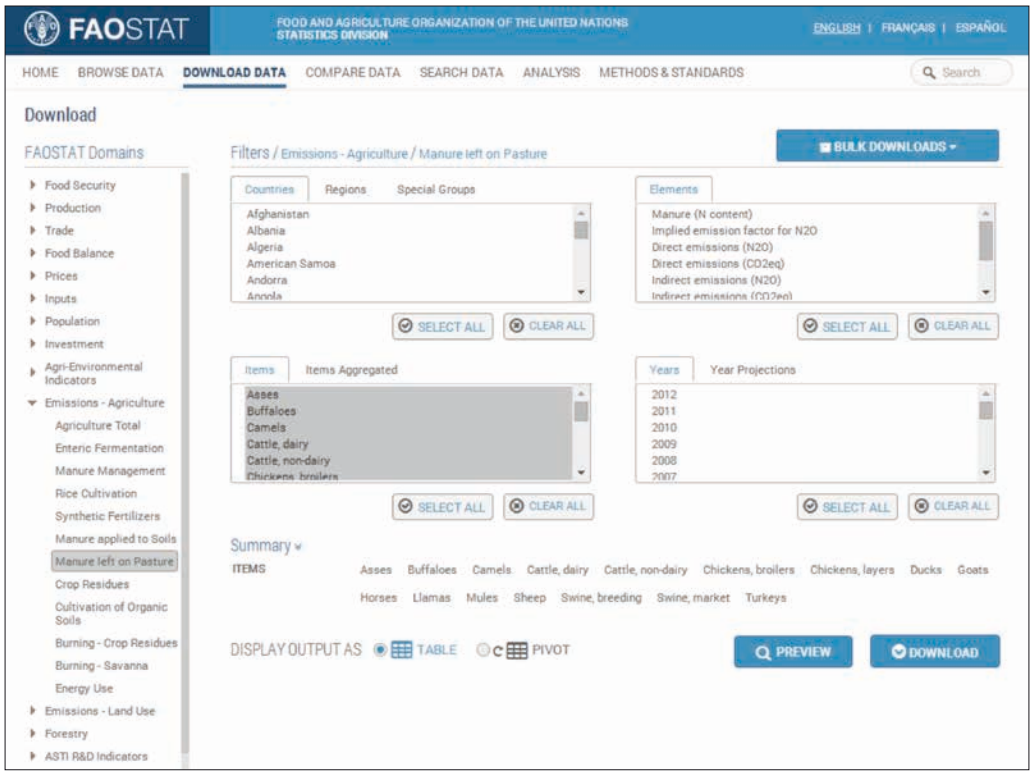
In this sub-domain, activity data refers to the number of heads (Stock) of the following items: dairy and non-dairy cattle, buffaloes, sheep, goats, chickens, turkeys, ducks, market swine and breeding swine ("Pigs" in FAOSTAT nomenclature).

The definitions used by FAOSTAT for the "Number of Live Animals/Stock" and for individual items are available in the Glossary (see Annex 1) at "Definition of items-livestock" or on the FAOSTAT website, at http://faostat3.fao.org/faostat-gateway/go/to/mes/glossary/*/E. The unit measure is expressed in terms of numbers of heads, except for poultry (chickens, ducks, and turkeys), which are expressed in terms of 1000 heads.

Data (from 1961 to present) are to be found under the FAOSTAT – Production, Live Animals sub-domain. Data of all categories must be retrieved as described in the "Enteric Fermentation Activity Data" section. With regard to the "Chickens, layers" and "Chickens, broilers", data can be retrieved as described in the "Manure Management Activity Data" section above.

The FAOSTAT Emissions database provides the data required, disaggregated by the sub-categories of dairy and dairy cattle, swine, layers, and broilers.

FIGURE 40
Manure Left on Pasture Items from the FAOSTAT database



1.2 Projections of Stocks

Projections of activity data for 2030 and 2050 for the categories of dairy and non-dairy cattle, buffaloes, sheep, goats, pigs and poultry, are computed with respect to a baseline provided by FAO perspective studies (Alexandratos and Bruinsma, 2012). The baseline is as follows:

$$N_{(T)y} = \alpha_{(T)_y} \times N_{(T)_{2005-2007}}$$

Where:

- $N_{(T)}$ = Number of heads for animal category T in the projected year y
- $\alpha_{(T)y}$ = Projection ratio for animal category T, in projected year y with respect to the baseline
- $N_{(T)\ 2005\text{-}2007}$ = Baseline heads computed as the average of the heads of animal category T for years 2005, 2006, 2007
- T = Animal category
- y = The projected years 2030 and 2050

Step 2. Excretion rate per animal

IPCC 2006, Equation 10.30

$$Nex_{(T)} = N_{rate(T)} \times \frac{TAM_{(T)}}{1000} \times 365$$

Where

- $Nex_{(T)}$ = Annual N excretion for animal category T, kg N animal^{-1} yr^{-1}
- $N_{rate(T)}$ = Default N excretion rate, kg N/tonnes animal mass day^{-1} (Table 3)
- $TAM_{(T)}$ = Typical animal mass for livestock category T, kg animal^{-1} (Table 4)
- T = Animal category

Step 3. Nitrogen in urine and dung deposited by grazing animals on pastures, ranges and paddocks

$$F_{PRP(T)} = \left[\left(N_{(T)} \times Nex_{(T)}\right) \times MS_{PRP(T)}\right] + \frac{\left[N_{(T)} \times Nex_{(T)} \times MS_{BurnedForFuel(T)}\right]}{2}$$

Where:

- $F_{PRP(T)}$ = Amount of animal manure N left on pastures for animal category *T*, kg N yr^{-1}
- $N_{(T)}$ = Number of heads of animal category *T*, heads yr^{-1}
- $Nex_{(T)}$ = Annual N excretion for animal category *T* , kg N $animal^{-1}$ yr^{-1}
- $MS_{PRP(T)}$ = Share of total annual N excretion for each animal category T that is deposited on pastures, ranges and paddocks (Table 42)
- $MS_{BurnedForFuel(T)}$ = Share of total annual N excretion for each animal category *T* that is deposited on pastures, ranges and paddocks in the form of urine (Table 43)
- *T* = Animal category

NB: the N in the urine (50%) remains in the field; the N in the dung (50%) is removed and burned (IPCC, 2006, Vol. 4 Ch. 10 p. 10.58).

Step 4. Direct Emissions (N_2O)

$$Direct\ Emissions(N_2O)_{(T)} = F_{AM(T)} \times EF_1 \times \frac{44}{28} \times 10^{-6}$$

Where

- $Direct\ Emissions(N_2O)_{(T)}$ = Direct N_2O emissions from manure left on pastures for animal category *T*, Gg N_2O yr^{-1}
- $F_{PRP\ (T)}$ = Annual amount of animal manure N applied to managed soils for animal category *T*, kg N yr^{-1}
- $EF_{3PRP\ (T)}$ = Emission factor for N_2O emissions from N inputs on pastures for animal category *T*, kg N_2O–N/ kg N input (Table 44)
- *T* = Animal category

Step 5. Direct Emissions (CO_2eq)

$$Direct\ Emissions(CO_{2eq})_{(T)} = Direct\ Emissions(N_2O)_{(T)} \times GWP$$

Where

- $Direct\ Emissions\ (CO_2eq)_{(T)}$ = Direct N_2O emissions from manure left on pastures in CO_2 equivalent, for animal category *T*, Gg CO_2eq yr^{-1}
- $Direct\ Emissions,\ N_2O)_{(T)}$ = Direct N_2O emissions from manure left on pastures for animal category *T*, Gg N_2O yr^{-1}
- *GWP = 310 (100-year time horizon global warming potential)*, to convert Gg N_2O to Gg CO_2eq
- *T* = Animal category

Step 6. Indirect emissions (N_2O)

$$Indirect\ Emissions(N_2O)_{(T)} = F_{AM\,(T)} \times [(Frac_{GASM} \times EF_4) + (Frac_{Leach} \times EF_5)] \times \frac{44}{28} \times 10^{-6}$$

Where

- *Indirect Emissions* $(N_2O)_{(T)}$ = Indirect N_2O–N emissions produced from atmospheric deposition of N volatilised from managed soils, for animal category *T*, Gg N_2O–N yr^{-1}
- $F_{PRP(T)}$ = Amount of animal manure N left on pastures for animal category, kg N yr^{-1}
- $Frac_{GASM}$ = Fraction of applied organic N fertilizer materials that volatilises as NH_3 and NO_X, kg N volatilised/kg of N applied (Table 38)
- EF_4 = Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, kg N_2O –N/kg NH_3–N + NO_x-N volatilised (Table 24)
- $Frac_{Leach}$ = Fraction of applied organic N fertilizer materials that leaches as NH_3 and NO_X,, Kg N leached/kg of N applied (Table 27)
- EF_5 = Emission factor for N_2O emissions from N leaching and runoff , kg N_2O –N/kg N volatilised (Table 25)
- *T* = Animal category

Step 7. Indirect Emissions (CO_2eq)

$$Indirect\ Emissions(CO_{2eq})_{(T)} = Indirect\ Emissions(N_2O)_{(T)} \times GWP$$

Where

- *Indirect Emissions* $(CO_2eq)_{(T)}$ = Indirect N_2O emissions from manure left on pastures in CO_2 equivalent, for animal category *T*, Gg CO_2eq yr^{-1}
- *Indirect Emissions* $(N_2O)_{(T)}$ = Indirect N_2O emissions from manure left on pastures for animal category *T*, Gg N_2O yr^{-1}
- *GWP* = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq
- *T* = Animal category

Step 8. Emissions (N_2O)

$$Emissions(N_2O)_{(T)} = Direct\ Emissions(N_2O)_{(T)} + Indirect\ Emissions(N_2O)_{(T)}$$

Where

- *Emissions* $(N_2O)_{(T)}$ = Total N_2O emissions from manure left on pastures for animal category *T*, Gg N_2O yr^{-1}
- *Direct Emissions*$(N_2O)_{(T)}$ = Direct N_2O emissions from manure left on pastures for animal category *T*, Gg N_2O yr^{-1}
- *Indirect Emissions* $(N_2O)_{(T)}$ = Indirect N_2O emissions from manure left on pastures for animal category *T*, Gg N_2O yr^{-1}
- *T* = Animal category

Step 9. Emissions (CO_2eq)

$$Emissions(CO_{2eq})_{(T)} = Emissions(N_2O)_{(T)} \times GWP$$

Where

- *Emissions* $(CO_2eq)_{(T)}$ = Total N_2O emissions from manure left on pastures in CO_2 equivalent, for animal category *T* , Gg CO_2eq yr^{-1}
- *Emissions* $(N_2O)_{(T)}$ = Total N_2O emissions from manure left on pastures for animal category *T*, Gg N_2O yr^{-1}
- *GWP* = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq
- *T* = Animal category

Step 10. Implied emissions for N_2O

$$IEF_{(T)} = \frac{Emissions(N_2O)_{(T)}}{F_{PRP(T)}} \times 10^6 \times \frac{28}{44}$$

Where

- $IEF_{(T)}$ = Implied emission factor for animal category *T* (kg N_2O/kg of N applied)
- *Emissions* $(N_2O)_{(T)}$ = Total N_2O emissions from manure applied on soils for animal category *T*, Gg N_2O yr^{-1}
- $FPRP_{(T)}$ = Amount of animal manure N left on pastures for animal category *T*, kg N yr^{-1}
- *T* = Animal category

5.1.7 Crop residues

Dataset Information	
Title	**Crop residues**
Definition	Greenhouse Gas (GHG) emissions from crop residues consist of nitrous oxide gas deriving from the decomposition of nitrogen in crop residues, left on managed soils.
Methodology and Quality Information	
Methods and processing	Greenhouse gas (GHG) emissions from crop residues consist of direct and indirect nitrous oxide (N_2O) emissions from nitrogen (N) in crop residues, and forage/pasture renewal left on agricultural fields by farmers. Specifically, N_2O is produced by microbial processes of nitrification and de-nitrification taking place on the deposition site (direct emissions), and after volatilisation/re-deposition and leaching processes (indirect emissions). The FAOSTAT data are estimated at Tier 1, following IPCC, 2006, Vol. 4, Ch.s 2 and 11. **Direct emissions** are estimated at the country level, using the formula *Emission = A * EF* where • *Emission* = GHG emissions in units of Kg N_2O yr^{-1}; • *A* = Activity data, representing the total amount of N in crop residues in Kg N yr^{-1}, (1); • *EF* = Tier 1, default IPCC emission factors, expressed in Kg N_2O-N/Kg N yr^{-1} (2).

Methodology and Quality Information	
Methods and processing	(1) Activity data are calculated from crop yield and harvested area, and cover for the following crop categories: Barley, Beans-dry, Maize, Millet, Oats, Potatoes, Rice-paddy, Rye, Sorghum, Soybeans, and Wheat. Crop yield and harvested area data are used to estimate the amount of biomass N in above and below-ground residues, by crop and by country, using Equation 11.6 in IPCC, 2006, Vol. 4, Ch. 11, and the default crop values available in Table 11.2. In some cases where default parameters were not provided (N content of below-ground residues for Rice and Millet, and Ratio of below-ground residues to above-ground biomass for Millet, Sorghum, Rye, and Beans-dry) the corresponding default values for crops with similar biophysical characteristics were used. This biomass N amount is then reduced by the fraction of crop residue burnt on site, assumed to be 10% by area, following IPCC, 2000, Ch. 4, Section 4A.2.1.1 with specified combustion coefficients by crop, as per IPCC, 2006, Vol. 4, Ch. 2, Table 2.6. Finally, all N in crop residues, net of amount burnt, is assumed to remain on the field, as per IPCC, 2006, Vol. 4, Ch. 11, Equation 11.6. For the period 1961-present, data relating to crop yield and harvested area are taken from FAOSTAT (domain: Production/Crops). Projections of crop yield and harvested area for 2030 and 2050 are computed with respect to a baseline, defined as the 2005-2007 average of the corresponding FAOSTAT activity data, and by applying percentage growth rates from FAO perspective studies (Alexandratos and Bruinsma, 2012). The FAO projections used cover about 140 countries. Projections of activity data for countries not included assume the same growth rate experienced in neighbouring countries. (2) Global default EF values taken from IPCC, 2006, Vol. 4, Ch. 11, Table 11.1. **Indirect emissions** are estimated at country level, using the formula $Emission = A * EF$ where • *Emission* = GHG emissions, in units of Gg N_2O yr^{-1}; • *A* = Activity data, representing the fraction of N in crop residues forage/pasture renewal that is lost through runoff and leaching in kg N yr^{-1} (3); • *EF* = Tier 1, default IPCC emission factors, expressed in kg N_2O-N / kg N yr^{-1} (4). (3) Obtained through the leaching factor in IPCC, 2006, Vol. 4, Ch. 11, Table 11.3. (4) Global IPCC default EF values from IPCC, 2006, Vol. 4, Ch. 11, Table 11.1. The dimensionless conversion factors used are • 10^{-3}, to convert the activity data from kg to tonnes; • 44/28, to convert the emissions from kg N_2O-N to kg N_2O gas; • 10^{-6}, to convert the emissions from kg N_2O to Gg N_2O; and • GWP-N_2O = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq (IPCC, 1996, Technical Summary, Table 4, p. 22). The Crop residues domain contains the following data categories, which are available for download: country-level GHG emissions, provided as total, direct and indirect amounts in both Gg N_2O and Gg CO_2eq; implied emission factors; and activity data. Uncertainties in the estimates of GHG emissions are due to uncertainties in emission factors and activity data. In the case of crop residues, more detailed information is available in the IPCC Guidelines (IPCC, 2006, Vol.4, Ch. 11, Section 11.2.1.4 for direct emissions, and Section 11.2.2.4 for indirect emissions).

Calculation Procedure

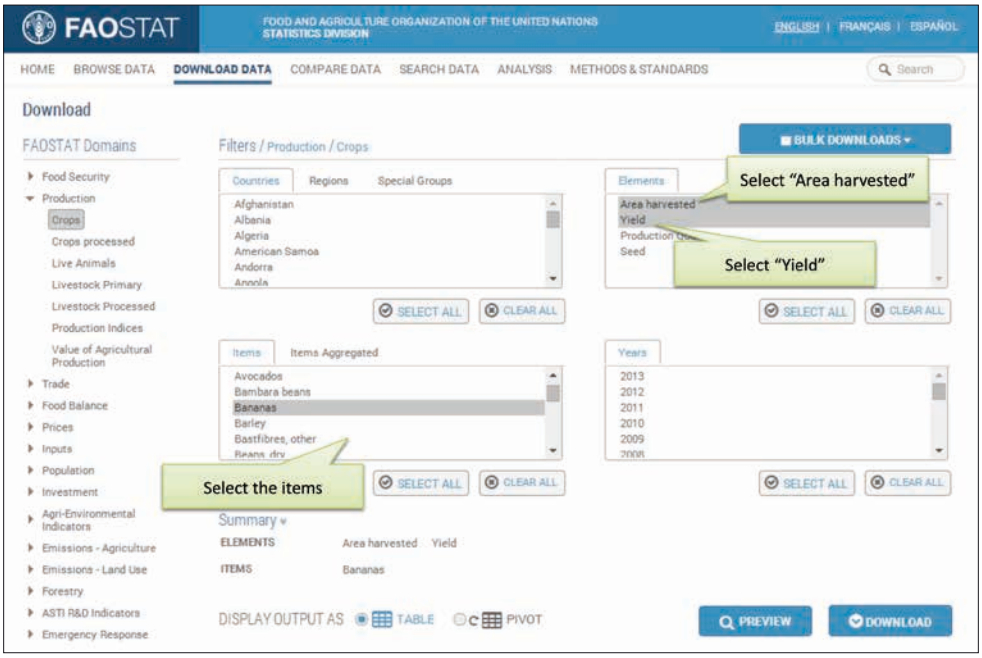
Step 1. Activity data

In this sub-domain, activity data refers to the Area harvested and the Yield of the following crop items: Barley, Dry beans, Maize, Millet, Oats, Potatoes, Paddy rice, Rye, Sorghum, Soybeans, and Wheat.

Definitions used by FAOSTAT for Area harvested", "Yield" and for the individual items are available on Glossary, or on the FAOSTAT website at http://faostat3.fao.org/faostat-gateway/go/to/mes/glossary/*/E. The unit measure is expressed in "ha" for the Area harvested and in "hg/ha" for the Yield.

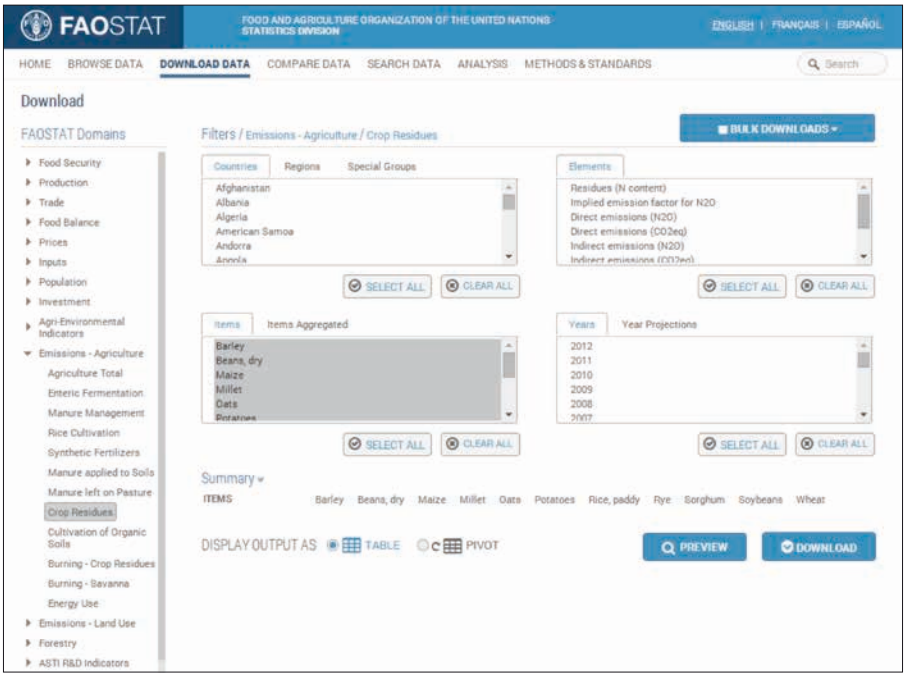
Data from 1961 to present are disseminated from the FAOSTAT – Production, Crops sub-domain, as follows:

FIGURE 41
Area harvested and Yield data



For the Crop Residues sub-domain, the FAOSTAT Emissions database only includes the selected items. The unit measure is expressed in tonnes of nutrients of nitrogen.

FIGURE 42
Crops Residues items



1.2 Projections of Area

The projections of activity data for 2030 and 2050 are computed with respect to a baseline provided by FAO perspective studies (Alexandratos and Bruinsma, 2012), as follows:

$$A_{(T)y} = \alpha_{(T)_y} \times A_{(T)_{2005-2007}}$$

Where:

- $A_{(T)y}$ = Area for crop type *T* in the projected year *y*
- $\alpha_{(T)y}$ = Projection ratio for crop area *A*, in projected year *y* with respect to the baseline
- $A_{(T)\ 2005\text{-}2007}$ = Baseline area for crop type *T*, computed as the average of the 2005, 2006, 2007 area values
- *T* = Crop type
- *y* = The projected years, 2030 and 2050

Step 2. Harvested annual Dry Matter Yield

$$Crop_{(T)} = \frac{Crop_{fresh(T)} \times DRY_{(T)}}{10}$$

Where

- $Crop_{(T)}$ = Harvested dry matter yield for crop *T*, kg dry matter ha^{-1} yr^{-1}
- $Crop_{fresh(T)}$ = Harvested fresh yield for crop *T*, hg ha^{-1} yr^{-1}
- $DRY_{(T)}$ = Dry matter fraction of harvested product for crop *T* (Table 45)
- *T* = Crop item

Step 3. Area Burned

$$AreaBurnt_{(T)} = Area_{(T)} \times Frac_{Burnt}$$

Where:

- $AreaBurnt_{(T)}$ = Area of crop *T* burnt, ha yr^{-1}
- $Area_{(T)}$ = Total annual area harvested of crop *T*, ha yr^{-1}
- $Frac_{Burnt}$ = 0.1 fraction of burnt area
- *T* = Crop items

Step 4. Above-ground residues dry matter

$$AG_{DM(T)} = \frac{Crop_{(T)}}{1000} \times slope_{(T)} + intercept_{(T)}$$

Where

- $AG_{DM(T)}$ = Above-ground residues dry matter for crop *T*, kg dry matter ha^{-1}
- $Crop_{(T)}$ = Harvested dry matter yield for crop *T*, kg dry matter ha^{-1}
- $Slope_{(T)}$ = Slope element (Table 46)
- $Intercept_{(T)}$ = Intercept element (Table 47)
- *T* = Crop items

Step 5. Ratio of above-ground residues dry matter (AGDM$_{(T)}$) to harvested yield

$$R_{AG(T)} = \frac{(AG_{DM(T)} * 1000)}{Crop_{(T)}}$$

Where

- $R_{AG(T)}$ = Ratio of above-ground residues dry matter ($AG_{DM(T)}$) to harvested yield for crop *T*
- $AG_{DM(T)}$ = Above-ground residues dry matter for crop *T*, kg dry matter ha^{-1}
- $Crop_{(T)}$ = Harvested annual dry matter yield for crop *T* , kg dry matter ha^{-1}
- *T* = Crop items

Step 6. Ratio of below-ground residues dry matter to harvested yield for crop T

$$R_{BG(T)} = R_{BG-BIO(T)} \times \left[\frac{\left((AG_{DM(T)} * 1000) + Crop_{(T)}\right)}{Crop_{(T)}}\right]$$

Where

- $R_{BG(T)}$ = Ratio of below-ground residues to harvested yield for crop *T* , kg dry matter/kg dry matter
- $R_{BG\text{-}BIO(T)}$ = Ratio of below-ground residues to above-ground biomass for crop *T*, kg dry matter/kg dry matter (Table 48)
- $AG_{DM(T)}$ = Above-ground residues dry matter for crop *T*, kg dry matter ha^{-1}
- $Crop_{(T)}$ = Harvested annual dry matter yield for crop *T*, kg dry matter ha^{-1}
- *T* = Crop items

Step 7. Residues (N content)

IPCC 2006, Equation 11.6

$$F_{CR(T)} = Crop_{(T)} \times \left(Area_{(T)} - AreaBurnt_{(T)} \times C_f\right) \times Frac_{Renew} \times \left[R_{AG(T)} \times N_{AG(T)} \times (1 - Frac_{Remove}) + R_{BG(T)} \times N_{BG(T)}\right]$$

Where:

- $F_{CR(T)}$ = Amount of N in crop residues (above and below ground), including N-fixing crops, and from forage/pasture renewal, returned to soils annually for crop *T*, kg N yr^{-1}
- $Crop_{(T)}$ = Harvested annual dry matter yield for crop *T*, kg dry matter ha^{-1}
- $Area_{(T)}$ = Total annual area harvested of crop *T* , ha yr^{-1}
- $AreaBurnt_{(T)}$ = annual area of crop *T* that is burnt, ha yr^{-1}
- C_f = Combustion factor (dimensionless) (Table 49)
- $Frac_{Renew(T)}$ = Fraction of total area under annual crop that is renewed annually
- $R_{AG(T)}$ = Ratio of above-ground residues dry matter ($AG_{DM(T)}$) to harvested yield, for crop *T* ($Crop_{(T)}$) kg dry matter/kg dry matter
- $N_{AG(T)}$ = N content of above-ground residues for crop *T*, kg N/kg dry matter (Table 50)
- $Frac_{Remove(T)}$ = Fraction of above-ground residues of crop *T* removed annually for purposes such as feed, bedding and construction, kg N/kg dry matter
- $R_{BG(T)}$ = Ratio of below-ground residues to harvested yield for crop *T*, kg dry matter/kg dry matter
- $N_{BG(T)}$ = N content of below-ground residues for crop *T*, kg N/kg dry matter (Table 51)
- *T* = Crop items

Step 8. Direct Emissions (N_2O)

$$Direct\ Emissions(N_2O)_{(T)} = F_{CR(T)} * EF_1 \times \frac{44}{28} \times 10^{-6}$$

Where

- *Direct Emissions* $(N_2O)_{(T)}$ = Direct N_2O emissions from crop residues and Forage/Pasture renewal for crop *T*, Gg N_2O yr^{-1}
- $F_{CR(T)}$ = Annual amount of N in crop residues (above and below ground), including N-fixing crops, and from forage/pasture renewal, returned to soils annually for crop *T*, kg N yr^{-1}
- EF_1 = Emission factor for N_2O emissions from N inputs, kg N_2O–N/kg N input (Table 26)
- *T* = Crop item

Step 9. Direct Emissions (CO_2eq)

$$Direct\ Emissions\ (CO_2eq) = Direct\ Emissions\ (N_2O) \times GWP$$

Where

- *Direct Emissions* $(CO_2eq)_{(T)}$ = Direct N_2O emissions from crop residues and Forage/Pasture renewal in CO_2 equivalent, for crop *T*, Gg CO_2eq yr^{-1}
- *Direct Emissions* $(N_2O)_{(T)}$ = Direct N_2O emissions from crop residues and Forage/Pasture renewal for crop T, Gg N_2O yr^{-1}
- *GWP* = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq
- *T* = Crop items

Step 10. Indirect emissions (N_2O)

$$Indirect\ Emissions(N_2O)_{(T)} = F_{CR\,(T)} \times Frac_{Leach} \times EF_5 \times \frac{44}{28} \times 10^{-6}$$

Where

- *Indirect Emissions* $(N_2O)_{(T)}$ = Indirect N_2O emissions produced from atmospheric deposition of N, volatilised from crop residues and Forage/Pasture renewal, for crop *T* ,Gg N_2O yr^{-1}
- $F_{CR(T)}$ = Annual amount of N in crop residues (above and below ground), including N-fixing crops, and from forage/pasture renewal, returned to soils annually for crop *T* , kg N yr^{-1}
- $Frac_{Leach}$ = Fraction of N from crop residues that leaches as NH_3 and NO_Xm, kg N leached/kg of N additions (Table 27)
- EF_5 = Emission factor for N_2O emissions from N leaching and runoff, kg N_2O–N/kg N leached (Table 25)
- *T* = Crop items

Step 11. Indirect Emissions (CO_2eq)

$$Indirect\ Emissions(CO_{2eq})_{(T)} = Indirect\ Emissions(N_2O)_{(T)}\ \mathrm{x}\ GWP$$

Where

- *Indirect Emissions* $(CO_2eq)_{(T)}$ = Indirect N_2O emissions from crop residues and Forage/Pasture renewal in CO_2 equivalent for crop *T*, Gg CO_2eq yr^{-1}
- *Indirect Emissions* $(N_2O)_{(T)}$ = Indirect N_2O emissions from crop residues and Forage/Pasture renewal for crop *T*, Gg N_2O yr^{-1}
- *GWP* = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq
- *T* = Crop items

Step 12. Emissions (N_2O)

$$Emissions(N_2O)_{(T)} = Direct\ Emissions(N_2O)_{(T)} + Indirect\ Emissions(N_2O)_{(T)}$$

Where

- *Emissions* $(N_2O)_{(T)}$ = Total N_2O emissions from crop residues and Forage/Pasture renewal, for crop *T*, Gg N_2O yr^{-1}
- *Direct Emissions* $(N_2O)_{(T)}$ = Direct N_2O emissions from crop residues and Forage/Pasture renewal for crop *T*, Gg N_2O yr^{-1}
- *Indirect Emissions* $(N_2O)_{(T)}$ = Indirect N_2O emissions from crop residues and Forage/Pasture renewal for crop *T*, Gg N_2O yr^{-1}
- *T* = Crop items

Step 13. Emissions (CO_2eq)

$$Emissions(CO_{2eq})_{(T)} = Emissions(N_2O)_{(T)} \times GWP$$

Where

- *Emissions* $(CO_2eq)_{(T)}$ = Total N_2O emissions from crop residues and Forage/Pasture renewal in CO_2 equivalent for crop *T* , Gg CO_2eq yr^{-1}
- *Emissions* $(N_2O)_{(T)}$ = Total N_2O emissions from crop residues and Forage/Pasture renewal for crop *T*, Gg N_2O yr^{-1}
- *GWP* = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq
- *T* = Crop items

Step 14. Implied emissions factor for N_2O

$$IEF_{(T)} = \frac{Emissions(N_2O)_{(T)}}{F_{CR(T)}} \times 10^6 \times \frac{28}{44}$$

Where

- *IEF(T)* = Implied emission factor for crop *T*, kg N_2O /kg of N applied
- *Emissions* $(N_2O)_{(T)}$ = Total N_2O emissions from crop residues and Forage/Pasture renewal for crop *T*, Gg N_2O yr^{-1}
- $F_{CR(T)}$ = Annual amount of N in crop residues (above and below ground), including N-fixing crops, and from forage/pasture renewal, returned to soils annually for crop *T*, kg N yr^{-1}
- *T* = Crop items

5.1.8 Cultivation of Organic soils

Dataset Information	
Title	**Cultivation of Organic Soils**
Definition	Greenhouse gas (GHG) emissions data from cultivation of organic soils are those associated with nitrous oxide gas emissions, from drained histosols under cropland and grassland.
Methodology and Quality Information	
Methods and processing	GHG emissions data from cultivation of organic soils are those associated with nitrous oxide gas from cultivated organic soils under cropland (item: Cropland organic soils) and grassland (item: Grassland organic soils). The FAOSTAT data are computed at Tier 1, following IPCC, 2006, Vol. 4, Ch. 11. The emissions are estimated at pixel level, using the formula: $Emission = A * EF$ where • *Emission* = Annual emissions, in units of kg N_2O–N yr^{-1}; • *A* = Activity data, representing the annual area of cultivated organic soils, in hectares (1). • *EF* = Tier 1, default IPCC emission factors, expressed in units of kg N_2O–N ha^{-1} (2). (1) Data are obtained through the stratification of three different global datasets: i. The Harmonized World Soil Database (FAO *et al.*, 2012), used to estimate the area covered by Histosols classes. ii. The Global Land Cover dataset, GLC2000 (EU-JRC, 2003), used to estimate the amount of cropland and grassland area in each pixel. For cropland, three "cropland" classes from GLC2000 are used, in accordance with You *et al.* (2008): **CLASS** / **NAME** / **CROPLAND SHARE PER PIXEL** 16 / Cultivated and managed areas / 100% 17 / Mosaic: cropland/tree cover/Other natural vegetation / 50% 18 / Mosaic: cropland/Shrub and/or grass cover / 10% For grassland, two "herbaceous" and two mosaics GLC2000 classes are used, in line with the FAO Land Cover Classification Scheme (LCCS): **CLASS** / **NAME** / **GRASSLAND SHARE PER PIXEL** 13 / Herbaceous Cover, closed-open / 100% 14 / Sparse herbaceous or sparse shrub cover / 50% 17 / Mosaic: Cropland/Tree Cover/Other natural vegetation / 25% 18 / Mosaic: Cropland/Shrub and/or grass cover / 45% iii. The Gridded Livestock of the World for cattle and sheep (Wint and Robinson, 2007), used as an additional mask over grassland as a proxy to estimate drained area. With this mask, only those pixels with non-zero drained grassland histosols area and a livestock density > 1 head/ha are included. For the period between 1990-present, the activity data reported in this sub-domain are a constant value, representing the year 2000, i.e. the reference year of the GLC2000 database. (2) The EF values are those specified in IPCC, 2006, Vol. 4, Ch. 11, Table 11.1. The EF were assigned at the pixel level, to distinguish the relevant climate zone, as defined in IPCC, 2006, Vol. 4, Ch. 3, Annex 3A.5, using the climatic zones map from the Joint Research Centre of the European Commission (EC-JRC, 2010). The analysis was carried out in GIS, combining the above datasets. The GHG estimates made at the pixel level were subsequently aggregated at country level, using the FAO Global Administrative Unit Layers (GAUL) data set.

Methodology and Quality Information	
Methods and processing	The dimensionless conversion factors used are • 44/28, to convert the emissions from kg N_2O-N to kg N_2O gas; • 10^{-6}, to convert the emissions from kg N_2O to Gg N_2O; and • GWP-N_2O = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq (IPCC, 1996, Technical Summary, Table 4, p. 22). The "Cultivation of organic soils" sub-domain contains the following data categories, available for download: country-level GHG emissions in both Gg N_2O and Gg CO_2eq; implied emission factors; and activity data. Uncertainties in the estimates of GHG emissions are due to uncertainties in the emission factors and activity data. In the case of cultivation of organic soils, more detailed information is available in the IPCC Guidelines (IPCC, 2006, Vol. 4, Ch. 11, Section 11.2.1.4).

Calculation Procedure

Step 1. Activity data

Activity data are represented by the annual area of organic soils covered by cropland or grassland organic soils, in hectares. The $Area_{(T)}$ is calculated in a GIS for T = cropland and T = grassland.

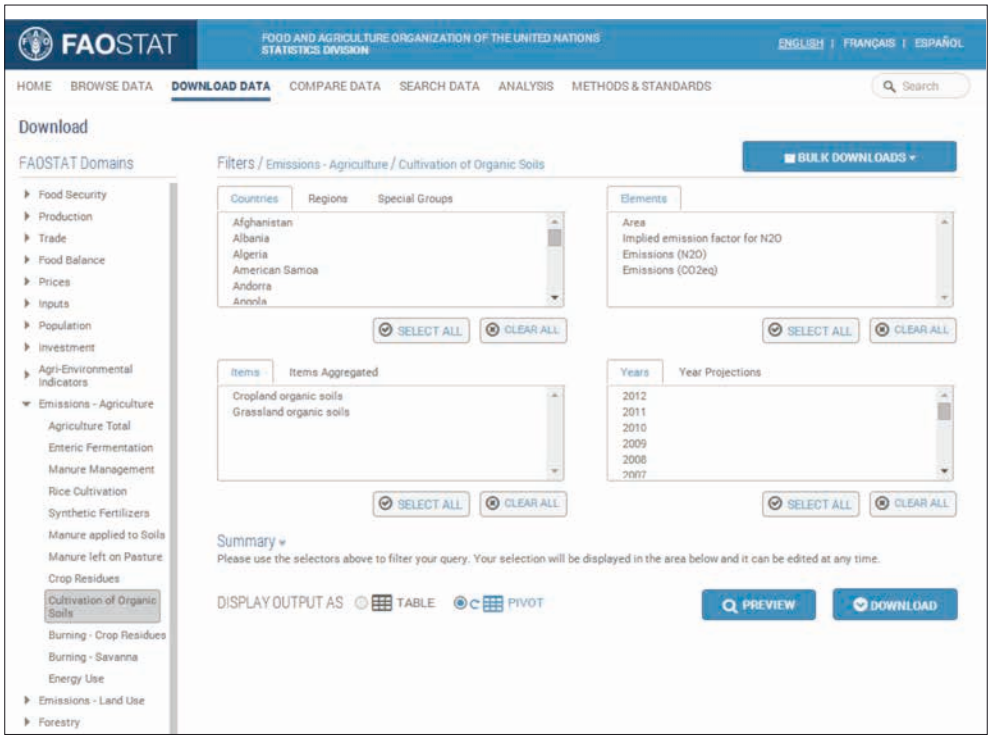
The cropland area has been identified from the global land cover dataset, GLC2000 (EU-JRC, 2003) available at http://bioval.jrc.ec.europa.eu/products/glc2000/glc2000.php, and which uses the three "cropland" classes. The mosaic classes have been reduced, proportionally to the general share of the cropland per pixel for each class, according to the values reported in the metadata above.

The grassland area has been identified from the global land cover dataset, GLC2000 (EU-JRC, 2003), using four classes. The mosaic classes have been reduced, proportionally to the general share of the grassland per pixel for each class, according to the values reported in the metadata above.

The area of organic soils has been identified from the Harmonized World Soil Database, available at http://www.fao.org/nr/lman/abst/lman_080701_en.htm. All the pixels in which histosols are present are selected, with the relative pixel share indicated as a percentage.

The $Area_{(T)}$ was been calculated by overlaying the organic soils with the land cover layers. Only for T = *Grassland*, the Gridded Livestock of the World was used as a proxy to identify the areas of managed grasslands. The values are fixed, calculated for each country and accessible in the FAOSTAT Emissions database from the Emissions-Land Use/Grassland domain. The data concerns the years between 1990 and 2050 and may be retrieved as follows:

FIGURE 43
Organic Soils Data from the FAOSTAT database



1.2 Projections of Area

The area values for 2030 and 2050 are produced simply by replicating the country values for 2011.

Step 2. Emissions (N_2O-N)

The emissions are calculated in a GIS at the pixel level, using the formula

$$Emissions\ (N_2O - N)_{(T)} = Area_{(T)} \times EF_{(T)}$$

Where

- *Emission* $(N_2O\text{-}N)_{(T)}$ = Annual emissions of N_2O-N for item T, kg N_2O-N yr^{-1}
- $Area_{(T)}$ = Activity data, representing the area of organic soils under item T, ha
- $EF_{(T)}$ = Tier 1, default IPCC emission factors for item T, kg N_2O–N ha^{-1} yr^{-1}(Table 57)

The EF values are specified in IPCC, 2006, Vol. 4, Ch. 11, Table 11.1. The EF were assigned at pixel level to the relevant climate zone, as defined in IPCC, 2006, Vol. 4, Ch. 3, Annex 3A.5. The climatic zones map used was developed by the Joint Research Centre of the European Commission (EC-JRC, 2010), following the IPCC's prescriptions.

The emissions are relate to the year 2000, which is the reference year of the land cover map used in the estimations. These values are also used for subsequent years, to cover the period between 1990 and 2011. Additional country-level disaggregations that have occurred over the period 1990-2011 are also provided.
As long as no new country split arises, the emission values for new years after 2011 can be easily produced, by simply replicating the country values of 2011.

Step 3. Emissions (N_2O)

$$Emissions\ (N_2O)_{(T)} = Emissions\ (N_2O - N)_{(T)} \times \frac{44}{28} \times 10^{-6}$$

Where:

- *Emission* $(N_2O)_{(T)}$ = Annual emissions of N_2O for item *T*, Gg N_2O yr^{-1}
- *Emission* $(N_2O\text{-}N)_{(T)}$ = Annual emissions of N_2O-N for item *T*, kg N_2O-N yr^{-1}

Step 4. Emissions (CO_2eq)

$$Emissions(CO_{2eq})_{(T)} = Emissions(N_2O)_{(T)} \times GWP$$

Where

- *Emissions* $(CO_2eq)_{(T)}$ = N_2O emissions from item *T*, in CO_2 equivalent, Gg CO_2eq yr^{-1}
- *Emissions* $(N_2O)_{(T)}$ = N_2O emissions from item *T*, Gg N_2O yr^{-1}
- *GWP* = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq

Step 5. Implied emissions factor for N_2O-N

$$IEF_{(T)} = \frac{Emissions(N_2O - N)_{(T)}}{Area_{(T)}}$$

Where

- $IEF_{(T)}$ = Implied emission factor for item *T* , kg N_2O-N ha^{-1}
- *Emissions* $(N_2O\text{-}N)_{(T)}$ = Total N_2O-N emissions from item *T*, kg N_2O-N yr^{-1}
- $Area_{(T)}$ = Area of Cultivated Organic Soils under item *T*

5.1.9 Burning crop residues

Dataset Information	
Title	**Burning crop residues**
Definition	Greenhouse Gas (GHG) emissions from burning crop residues consist of methane and nitrous oxide gases, produced by the combustion of a percentage of the crop residues burnt on-site.
Methodology and Quality Information	
Methods and processing	Greenhouse Gas (GHG) emissions from burning crop residues consist of methane (CH_4) and nitrous oxide (N_2O) gases produced by the combustion of a percentage of crop residues burnt on-site.The mass of fuel available for burning should be estimated, taking into account the fractions removed before burning due to animal consumption, decay in the field, and use in other sectors (e.g. biofuel, domestic livestock feed, building materials, *etc.*).The FAOSTAT data are estimated atTier 1 in accordance with IPCC, 2006, Vol. 4, Chapters 2 and 5. The CH_4 and N_2O emissions are estimated at country level, using the formula *Emission = A * EF* where • *Emission* = GHG emissions in units of g CH_4 and g N_2O; • *A* = Activity data, representing the total amount of biomass burned, kg of dry matter (1); • *EF* =Tier 1, default IPCC emission factors, expressed in g CH_4/kg of dry matter and g N_2O/kg of dry matter (2).

Methodology and Quality Information	
Methods and processing	(1) Activity data are calculated from harvested area statistics and cover the following crops: wheat, maize, rice, and sugarcane. For the period between 1961-present, the harvested area data is taken from FAOSTAT (domain: Production/crops). Projections of harvested area for 2030 and 2050 are computed with respect to a baseline, defined as the 2005-2007 average of the corresponding FAOSTAT activity data, and by applying percentage growth rates from FAO perspective studies (Alexandratos and Bruinsma, 2012). The FAO projections used cover about 140 countries. Projections of activity data for countries that were not included assume the same growth rate experienced in neighbouring countries. The harvested area is used to estimate the amount of biomass burned, using mean default crop values of the mass of fuel available for combustion (MB) and the combustion factor (Cf) available in IPCC, 2006, Vol. 4, Ch. 2, Table 2.4. The mass is then reduced by the fraction of crop residue burnt on-site, assumed to be 10%, following IPCC, 2000, Ch.4, Section 4A.2.1.1. (2) Global default EF values taken from IPCC, 2006, Vol. 4, Ch. 2, Table 2.5. The dimensionless conversion factors used are • 10^{-9}, to convert the emissions from g CH_4 to Gg CH_4 and g N_2O to Gg N_2O; • GWP- CH_4 = 21 (100-year time horizon global warming potential), to convert Gg CH_4 to Gg CO_2eq and • GWP-N_2O = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq (IPCC, 1996, Technical Summary, Table 4 p. 22). The burning crop residues domain contains the following data categories, available for download: country-level GHG emissions, provided as total, in Gg CH_4, Gg N_2O and Gg CO_2eq; implied emission factors; and activity data. Uncertainties in the estimates of GHG emissions are due to uncertainties in the emission factors and activity data. In the case of burning crop residues, more detailed information is available in the IPCC Guidelines (IPCC, 2006, Vol. 4, Ch. 5, Section 5.2.4.4).

Calculation Procedure

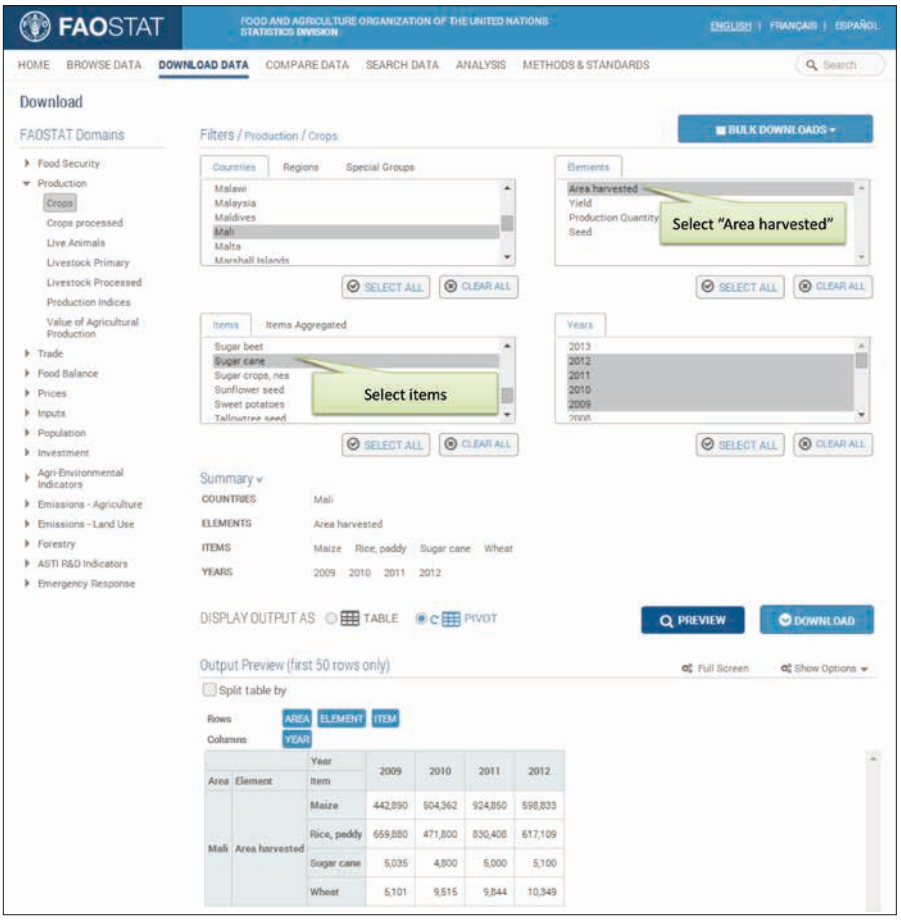
Step 1. Activity data

In this sub-domain, activity data refers to the Area harvested of the following crop items: Maize, Paddy Rice, Sugar Cane and Wheat.

The definitions used by FAOSTAT for the term “Area harvested”, and for individual items, are available at the Glossary, or on the FAOSTAT website at http://faostat3.fao.org/faostat-gateway/go/to/mes/glossary/*/E. The unit of measurement is expressed in hectares (“Ha”).

The data from 1961-present are disseminated from the FAOSTAT – Production, Crops sub-domain, as follows:

FIGURE 44
Area harvested data from the FAOSTAT database



1.2 Projections of Area

The projections of activity data for 2030 and 2050 are computed with respect to a baseline provided by FAO perspective studies (Alexandratos and Bruinsma, 2012). This baseline may be computed as follows:

$$A_{(T)y} = \alpha_{(T)_y} \times A_{(T)_{2005-2007}}$$

Where

- $A_{(T)y}$ = Area for crop type T in the projected year y
- $\alpha_{(T)y}$ = Projection ratio for crop area A, in projected year y with respect to the baseline
- $A_{(T)\ 2005\text{-}2007}$ = Baseline area for crop type T computed as the average of the 2005, 2006 and 2007 area values
- T = Crop type
- y = The projected years, 2030 and 2050

Step 2. Area Burned

$$AreaBurnt_{(T)} = Area_{(T)} \times Frac_{Burnt}$$

Where

- $AreaBurned_{(T)}$ = Annual area of crop T burned , ha yr^{-1}
- $Area_{(T)}$ = Total annual area harvested of crop T, ha yr^{-1}
- $Frac_{Burned}$ = Fraction of burned area
- T = Crop category

Step 3. Biomass burned (dry matter)

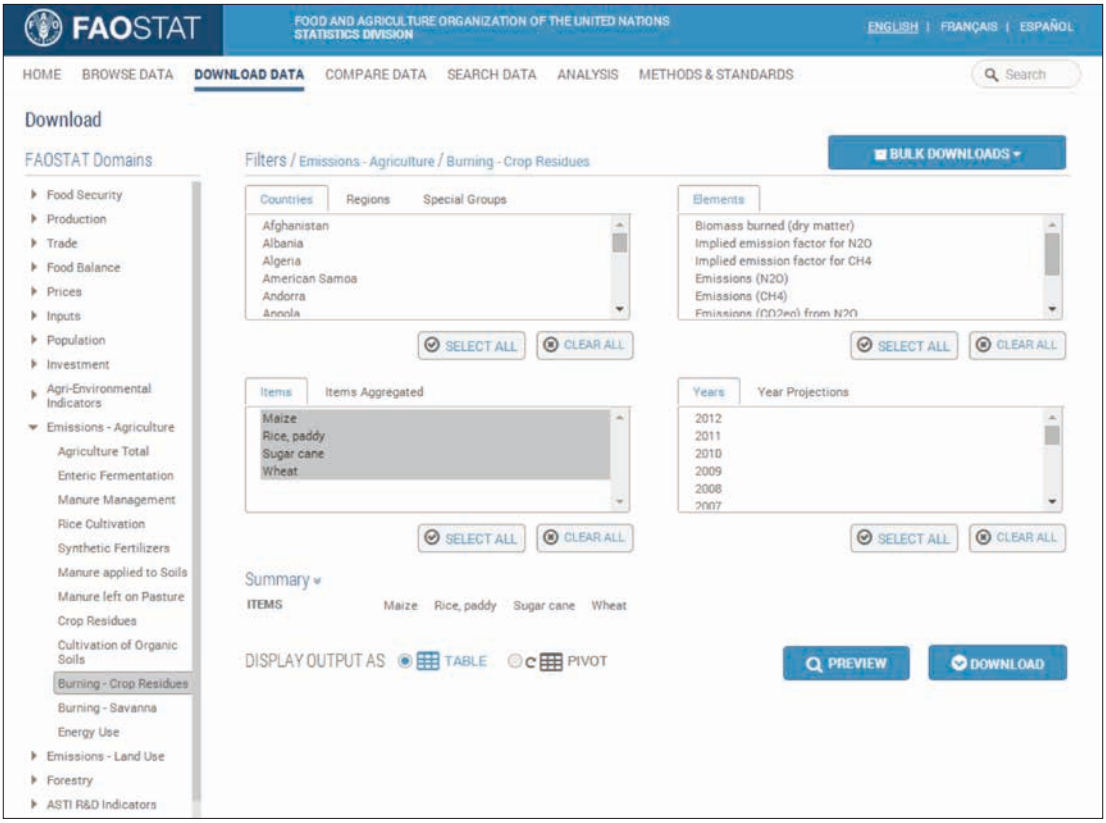
$$BB_{(T)} = AreaBurned_{(T)} \times Fuel_{(T)}$$

Where

- $BB_{(T)}$ = Biomass burned for crop *T*, tonnes dry matter yr^{-1}
- $AreaBurned_{(T)}$ = Annual area of crop *T* burned, ha yr^{-1}
- $Fuel_{(T)}$ = Mb x Cf , mass of fuel available x combustion factor (tonnes dry matter ha^{-1}) (Table 52)
- *T* = crop category.

The FAOSTAT Emissions database provides data relating to the biomass burned for the selected items:

FIGURE 45
Burning Crops items



Step 4. Emissions (CH_4) and (N_2O)

IPCC 2006, Equation 2.27

$$Emissions(gas)_{(T)} = BB_{(T)} \times G_{ef(gas)} \times 10^{-6}$$

Where

- $Emissions(gas)_{(T)}$ = Amount of emissions of *Gas* from crop residues burning for crop *T* , Gg CO_2eq yr^{-1}
- $BB_{(T)}$ = Biomass burned for crop *T*, tonnes yr^{-1}
- $G_{ef(gas)}$ = Emission factor g/kg dry matter burnt (Table 53)
- *Gas* = (CH_4, N_2O)
- *T* = Crop category

Step 5. Emissions (CO_2eq) from CH_4 and N_2O

$$Emissions(CO_2eq)_{(T)}\ from\ (gas) = Emissions(gas)_{(T)} \times GWP_{(gas)}$$

Where

- *Emissions*$(CO_2eq)_{(T)}$ *from (gas)* = Amount of *Gas* emissions in CO_2eq from crop residues burning for crop *T*, Gg $CO_2eq\ yr^{-1}$
- *Emissions (gas)*$_{(T)}$ = Amount of Gas emissions from crop residues burning for crop *T*, Gg yr^{-1}
- $GWP_{(N2O)}$ = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq
- $GWP_{(CH4)}$ = 21 (100-year time horizon global warming potential), to convert Gg CH_4 to Gg CO_2eq
- *T* = Crop category
- *Gas* = Gas (CH_4, N_2O)

Step 6. Emissions (CO_2eq)

$$Emissions(CO_2eq)_{(T)} = Emissions(CO_2eq)_{(T)} from\ N_2O + Emissions(CO_2eq)_{(T)} from\ CH_4$$

Where

- *Emissions*$(CO_2eq)_{(T)}$ = Amount of emissions in CO_2eq from crop residues burning for crop *T*, Gg $CO_2eq\ yr^{-1}$
- *Emissions*$(CO_2eq)_{(T)}$ *from* N_2O = Amount of N_2O emissions in CO_2eq from crop residues burning for crop *T*, Gg $CO_2eq\ yr^{-1}$
- *Emissions*$(CO_2eq)_{(T)}$ *from* CH_4 = Amount of CH_4 emissions in CO_2eq from crop residues burning for crop *T*, Gg $CO_2eq\ yr^{-1}$
- *T* = Crop category.

Step 7. Implied emissions factors for N_2O and CH_4

$$IEF_{(T,gas)} = \frac{Emissions(gas)_{(T)}}{BB_{(T)}} \times 10^6$$

Where

- $IEF_{(T,\ gas)}$ = Implied emission factor for Gas for crop *T*, g/kg applied
- *Emissions(gas)*$_{(T)}$ = Amount of Gas emissions from crop residues burning for crop *T*, Gg yr^{-1}
- $BB_{(T)}$ = Biomass burned for crop *T*, tonnes yr^{-1}
- *T* = Crop category
- *Gas* = Gas (CH_4, N_2O)

5.1.10 Burning – Savanna

Dataset Information	
Title	**Burning – Savanna**
Definition	Greenhouse Gas (GHG) emissions from burning of savanna consist of methane and nitrous oxide gases from biomass combustion.
Methodology and Quality Information	
Methods and processing	Greenhouse Gas (GHG) emissions from burning of savanna consist of methane (CH_4) and nitrous oxide (N_2O) gases produced from the burning of vegetation biomass in the following five land cover types: Savanna, Woody Savanna, Open Shrublands, Closed Shrublands, and Grasslands. The FAOSTAT data are estimated at Tier 1, in accordance with IPCC, 2006, Vol. 4, Ch. 2, Equation 2.27. CH_4 and N_2O emissions are estimated on a spatial grid, at a 0.25 degree resolution (approximately 25 km at the Equator), using the formula $$Emission = A * EF$$ where • *Emission* = GHG emissions in g CH_4 and g N_2O; • *A* = Activity data, representing the total mass of fuel burned in each pixel, kg of dry matter (1); • *EF* = Tier 1 IPCC emission factor, expressed in g CH_4 or g N_2O per kg of burned dry matter (2). (1) Total mass of fuel burned is computed by multiplying the burned area (i) by the fuel biomass consumption values (ii). (i) Yearly composite burned area values are produced from monthly statistics of the Global Fire Emission Database v.4, based on MODIS remote-sensing data (see GFED4, Giglio *et al.*, 2013). The data set provides data on burned area by land cover classes, as identified by the MODIS Land Cover product (MCD12Q1, Hansen et al., 2000). (ii) Fuel biomass consumption values were assigned at pixel level to the relevant climate zone, as defined in IPCC, 2006, Vol. 4, Ch. 2, Table 2.4. The climatic zones map used was developed by the Joint Research Centre of the European Commission (EC-JRC, 2010), and follow IPCC prescriptions. The data period available on FAOSTAT is 1990-present, with annual updates, and projections to 2030 and 2050. Since GFED4 data are not available before 1996 and for future periods, yearly values for the period between 1990 and 1995, as well as for 2030 and 2050, are set as a constant, and estimated as the average of the period between 1996 and 2012. (2) Default EF values are taken from IPCC, 2006, Vol. 4, Ch. 2, Table 2.5. GHG estimates made at pixel level were subsequently aggregated at the country level, using the FAO Global Administrative Unit Layers (GAUL) data set. The dimensionless conversion factors used are • 10^{-9}, to convert the emissions from g CH_4 to Gg CH_4 and g N_2O to Gg N_2O; • GWP- CH_4 = 21 (100-year time horizon global warming potential), to convert Gg CH_4 to Gg CO_2eq • GWP-N_2O = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq (IPCC, 1996, Technical Summary, Table 4 p. 22). The Burning – Savanna sub-domain contains the following data categories available for download, for each land cover class: country-level GHG emissions, provided as totals, in Gg CH_4, Gg N_2O and Gg CO_2eq; implied emission factor; burned area; and total mass of fuel available. Data is available for all countries and territories with an area large enough to be monitored at the resolution of GFED4 data, as well as for standard FAOSTAT regional aggregations, plus Annex I and non-Annex I groups. Uncertainties in the estimates of GHG emissions are due to uncertainties in emission factors and activity data. In the case of biomass burning, more detailed information is available in the IPCC guidelines (IPCC, 2006, Vol. 4, Ch. 5, Section 5.2.4.4).

Calculation Procedure

Step 1. Activity data

The Burning – Savanna domain considers emissions from fires in the following land cover classes: "Savanna", "Woody Savanna", "Closed Shrublands", "Open Shrublands" and "Grasslands". The GHG considered in this domain are CH_4 and N_2O.

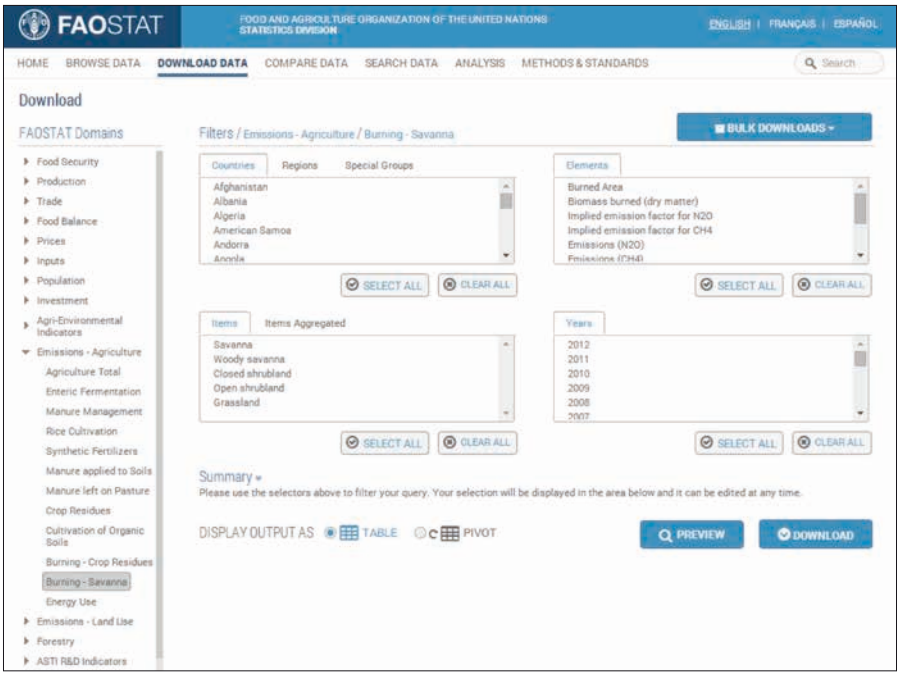
The annual burned area for each land cover is derived from the Global Fire Emission Database burned area data set, version 4 (GFED4). This is available at http://www.globalfiredata.org/

GFED4 provides global monthly burned area maps at 0.25° spatial resolution, from mid-1995 to present (the most recent year currently available is 2012; see Giglio *et al*. 2013). The GFED4 dataset combines a 500m Moderate Resolution Imaging Spectro-radiometer (MODIS) burned area data set with active fire data sets from the Tropical Rainfall Measuring Mission (TRMM) Visible and Infrared Scanner (VIRS), and the Along-Track Scanning Radiometer (ATSR) family of sensors. The annual burned area for each land cover class is calculated by adding up the GFED4 monthly data by country.

The Biomass Burned (BB) activity data for each land cover class, as well as the resulting emissions of N_2O and CH_4, are estimated using the IPCC 2006 default methodology. This is based on Equation 2.27, with default parameters for biomass consumption per hectare in different climates and vegetation types provided by Table 2.4, and emission factors for each vegetation type taken from Table 2.5. The biomass burned and emission computations are performed at pixel level in a GIS environment, using additional data sets to associate the correct IPCC parameters to the pixel's specific climate and vegetation characterization.

The methodology set out below enables the calculation of annual GHG emissions for the period between 1990-1995, based on averages for the period between 1996-present; the conversion of non-CO_2 emissions into CO_2 equivalents; and the calculation of implied emission factors for N_2O and CH_4.
The calculated data are available in the FAOSTAT Emissions database, under the Emission-Agriculture/Burning Savanna domain, as shown below:

FIGURE 46
Area Burned" data



1.2 Projections of Area

Since GFED4 data are not available for years before 1996 and, obviously, for future periods, yearly values for the period 1990-1995, as well as for 2030 and 2050, are set as a constant, and estimated as the average of the period between 1996 and 2012.

Step 2. Production of 1990-1995 data

For each country, yearly values for the period 1990-1995, X_i, are to be estimated, as the average value over the period between 1996-present:

$$X_i = \overline{X_{1996-present}}$$

Where

- X = Variable (Burned Area, Biomass Burned, Emissions)
- $X_{(1996\text{-}present)}$ = Average value for the years 1996-present
- i = Year (period between 1990-1995)

Step 3. Emissions (CO_2eq) from CH_4 and N_2O

$$Emissions(CO_2eq)_{(T)}\ from\ (gas) = Emissions(gas)_{(T)} \times GWP_{(gas)}$$

Where

- *Emissions* $(CO_2eq)_{(T)}$ *from (gas)* = Amount of *GHG* emissions in CO_2eq from biomass burning for land cover *T*, Gg CO_2eq yr^{-1}
- *Emissions(gas)*$_{(T)}$ = Amount of *Gas* emissions from biomass burning for crop *T*, Gg yr^{-1}
- $GWP_{(N2O)}$ = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq
- $GWP_{(CH4)}$ = 21 (100-year time horizon global warming potential), to convert Gg CH_4 to Gg CO_2eq
- *T* = Land cover class
- *Gas*= CH_4, N_2O

Step 4. Emissions (CO_2eq)

$$Emissions(CO_2eq)_{(T)} = Emissions(CO_2eq)_{(T)} from\ N_2O + Emissions(CO_2eq)_{(T)} from\ CH_4$$

Where

- *Emissions*$(CO_2eq)_{(T)}$ = Amount of emissions in CO_2eq from biomass burning, for land cover *T*, Gg CO_2eq yr^{-1}
- *Emissions*$(CO_2eq)_{(T)}$ *from* N_2O = Amount of N_2O emissions in CO_2eq from biomass burning for crop *T*, Gg CO_2eq yr^{-1}
- *Emissions*$(CO_2eq)_{(T)}$ *from* CH_4 = Amount of CH_4 emissions in CO_2eq from biomass burning for crop *T*, Gg CO_2eq yr^{-1}
- *T* = land cover class

Step 5. Implied emission factor for N_2O and CH_4

$$IEF_{(T,gas)} = \frac{Emissions(gas)_{(T)}}{BB_{(T)}} \times 10^6$$

Where

- $IEF_{(T,\ gas)}$ = Implied emission factor for Gas for land cover *T*, g/kg yr^{-1}burnt
- *Emissions(gas)*$_{(T)}$ = Amount of Gas emissions from biomass burning for land cover *T*, Gg yr^{-1}
- $BB_{(T)}$ = Biomass burned for land cover *T*, tonnes yr^{-1}
- *T* = Land cover class
- *Gas* = Gas (CH_4, N_2O)

5.1.11 Energy Use

Dataset Information	
Title	**Energy Use**
Definition	Greenhouse gas (GHG) emissions from direct energy use consist of carbon dioxide, methane and nitrous oxide gases associated with fuel burning and the generation of electricity used in agriculture (including fisheries).
Methodology and Quality Information	
Methods and processing	GHG emissions from direct energy use consist of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) gases associated with fuel burning and generation of electricity used in agriculture (including fisheries). The FAOSTAT data are computed at Tier 1, following the criteria established in IPCC 2006, Vol. 2, Ch. 2 and 3, with the exception of the country electricity-only emission factors (see below). Data are estimated for each main energy carrier (fuels and electricity) used in agriculture, for the following carriers: Motor gasoline, Gas-Diesel oil, Natural gas, Residual fuel oil, Liquefied petroleum gas, Coal and Electricity, and for selected agricultural sub-domains (i.e. irrigation and fisheries). Renewable energy for electricity indirectly contributes to the GHG emission calculation, via country emission factors, which depend on a country's chosen energy mix for electricity generation. The emissions are estimated at country level, using the formula $$Emission = A * EF$$ where • *A* = Activity data, representing the amount of fuel consumed in Kt (1000 metric tons) yr^{-1}, TJ (terajoules) yr^{-1} or ktoe (k tonnes of oil equivalent) yr^{-1} for fuels, and GWh yr^{-1} for electricity (1); • *EF* = Tier 1, default IPCC emission factors, expressed as kg of gas emitted per terajoule (for fuels) or gram per kilowatt hour (for electricity) of energy used per year (2). (1) The activity data relating to fuels are taken from the United Nations Statistics Division (UNSD) Energy Statistics database; the data relating to fuels used in fisheries, specifically "Gas-Diesel oil used in fisheries" and "Residual fuel oil used in fisheries" are taken from the International Energy Agency (IEA) database of "World energy balances"; for energy used for power irrigation, the irrigated area is taken from FAO AQUASTAT (*). The activity data (**) cover the following: a. Gas-Diesel oil (including fisheries); b. Motor gasoline; c. Natural gas (including Liquefied Natural Gas); d. Liquefied petroleum gas; e. Residual fuel oil (including fisheries); f. Coal (other bituminous coal or, if not available, Hard coal); g. Electricity; h. Gas-diesel oil used in fisheries; i. Residual fuel oil used in fisheries; j. Energy for power irrigation. (*) The irrigated area considered is the sum of the "Total area equipped for full control irrigation: sprinkler" and the "Total area equipped for full control irrigation: localized", values taken from the FAO AQUASTAT database. Annual values in FAOSTAT are estimated by repeating the last-available value reported in AQUASTAT within the relevant time interval. Regional factors indicating the energy required to irrigate one hectare of land (Stout, 1990) have been applied to estimate the energy consumed for irrigation. Specifically, for Europe, Northern America and Oceania, this is 1,929 kWh/ha; for Africa and Asia, 2,411 kWh/ha; for Central America, South America and the Caribbean, 2,170 kWh/ha. (**) For items a, b, d, e and f, the amount of energy from the mass of fuels was derived using the Net Calorific Values reported in IPCC 2006, Vol. 2, Ch. 1, Table 1.2; (2) The EF values are those reported by energy carrier in IPCC 2006, Vol. 2, Ch. 2, Table 2.5, and Ch. 3, Table 3.31. A summary table is shown below:

Methodology and Quality Information

Methods and processing

Energy carrier	Use	CO_2	CH_4 kg/TJ	N_2O
Gas/Diesel oil	Mobile	74,100	4.15	28.6
Motor gasoline	Mobile	69,300	80	2
Natural gas liquids	Stationary	64,200	10	0.6
Residual fuel oil	Stationary	77,400	10	0.6
Liquefied petroleum gases	Stationary	63,100	5	0.1
Coal (Other Bituminous Coal)	Stationary	94,600	300	1.5

For electricity, country emission factors for CO2, namely electricity-only factors, are those reported by the IEA (OECD/IEA, 2012). These are based on 1996 IPCC Guidelines for National Greenhouse Gas Inventories; the 1990 country emission factors are applied to previous years. Non-CO2 emission factors for electricity used for all countries are estimated on the basis of the IEA global electricity emission factor for CO2, considering these emissions as a fraction of the CO2 emitted (CH4: 300/98,300 for coal, 5/56,100 for natural gas, 10/73,300 for crude oil; N2O: 1.5/98,300 for coal, 0.1/56,100 for natural gas, and 0.6/73,300 for crude oil). The relevant energy mix for electricity is: 48% coal, 22% natural gas, and 6% crude oil.

The dimensionless conversion factors used are

- 10^{-6}, to convert kg to Gg; and
- GWP-CH_4= 21; GWP-N_2O= 310 (100-year time horizon global warming potential), to convert Gg CH_4 or Gg N_2O to Gg CO_2eq (IPCC, 1996, Technical Summary, Table 4, p. 22);
- 1 GWh = 3.6 TJ

The energy use domain contains the following data categories, available for download: country-level GHG emissions, provided as a total, in Gg CH_4, Gg N_2O and Gg CO_2eq; implied emission factors; and activity data.

Calculation Procedure

Step 1. Activity data

The following items are included as activity data: Gas-diesel oils, Motor gasoline, Natural gas (including LNG), Liquefied petroleum gas (LPG), Residual fuel oil, Coal, Electricity, Gas - diesel oils in fisheries, Residual fuel oil in fisheries, and Energy for power irrigation. Their definitions are available in the Glossary.

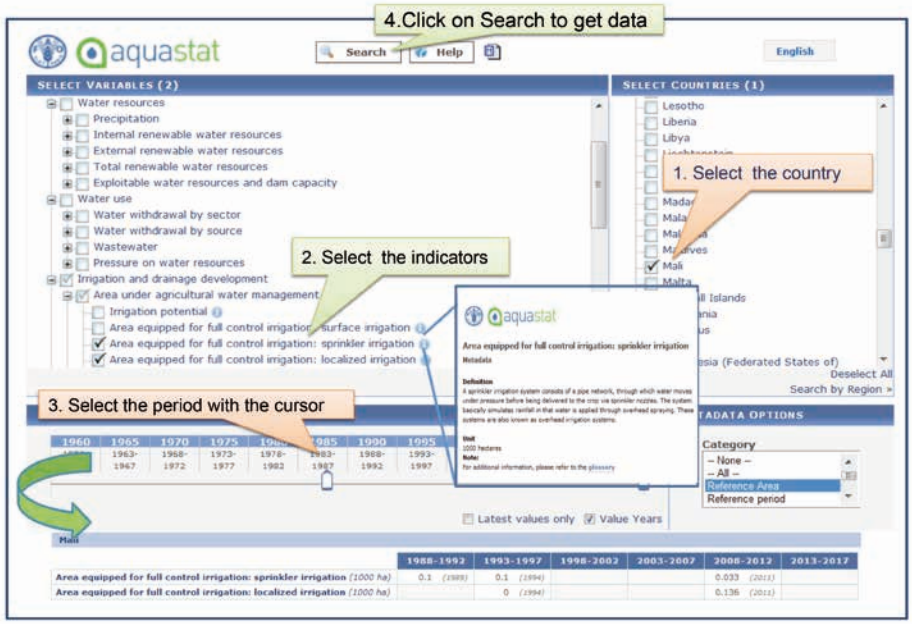
The activity data for Gas-diesel oils, Motor Gasoline, Natural gas (including LNG), Liquefied petroleum gas (LPG), Residual fuel oil, Coal (Hard Coal or Other bituminous coal), and Electricity, are taken from the UNSD Energy Database, which is publicly available (for data after 1990) at the UN DATA portal (http://data.un.org/Explorer.aspx?d=EDATA).

Data relating to *energy consumed in fisheries*, specifically "Gas-diesel oils used in fisheries" and "Residual fuel oil used in fisheries", are taken from the IEA Statistics 2013 (http://www.iea.org/statistics/).

For *Energy for power irrigation*, the source of the activity data is the sum of the values for the "Area equipped for full control irrigation: sprinkler" and for the "Area equipped for full control irrigation: localized" that can be found in the Glossary and on the FAO AQUASTAT database website, at http://www.fao.org/nr/water/aquastat/data/query/index.html.

Figure 45 below shows how to access to the data of the "Area equipped for full control irrigation", both sprinkler and localized.

FIGURE 47
Data on the Area Equipped for Power Irrigation, from the AQUASTAT database



Step 2. Calculate Consumption in Agriculture

a) For the Gas-Diesel oil, Gasoline, Liquefied petroleum gas (LPG), Residual fuel oil, and Coal (Hard coal or Other bituminous coal) items, consumptions are converted to TJ by applying the parameters reported in (Table 54) in Annex 3, and the formula

$$CA_{(F)}\ (Tj) = MF\ (Kt) x\ NCV_{(F)}$$

Where

- $CA_{(F)}$ = Consumption of fuel F in agriculture (TJ)
- MF = Mass of fuel consumed (1000 metric tons)
- $NCV_{(F)}$ = Default net calorific value of fuel F (Table 54) and consistent with IPCC 2006 Guidelines)
- F = Fuel

Natural gas (including LNG) is provided in TJ from the original source. Residual fuel oil and Gas-Diesel oil used in fisheries are provided in Ktoe from the original source and converted to TJ (1 Ktoe = 41.868 TJ). Electricity consumption is provided in GWh from the original source and converted to TJ (1 GWh = 3.6 TJ).

2.2 For the "Energy for power irrigation" item, the following formula was applied:

$$CA_{(el)}\ (KWh) = Api\ (ha) x\ TC$$

Where

- $CA_{(el)}$ = Consumption of power irrigation in agriculture (KWh)
- Api = Total area equipped for full control irrigation: sprinkler and localized (ha)
- TC = Technical coefficient indicating the energy needed to irrigate one hectare of land (adapted from Stout, 1990) as follows: Europe, Northern America, Oceania – 1,929 kWh/ha; Africa, Asia – 2,411 kWh/ha; Central America, South America, Caribbean – 2,170 kWh/ha

FAO's regional groups were applied.

Step 3. Calculating Emissions of CH_4, N_2O and CO_2

a) For the Gas-Diesel oils, Gasoline, Natural Gas (including LNG), Liquefied petroleum gas (LPG), Coal, Residual fuel oil, Gas-Diesel oils in fisheries, and Residual fuel oil in fisheries items, the formula is

$$Emissions(gas)_{(F)} = CA_{(F)} \times G_{ef(F,gas)} \times 10^{-6}$$

Where

- $Emissions(gas)_{(F)}$ = Amount of emissions of Gas from energy use in agriculture of energy carrier *F* (Gg yr^{-1})
- $CA_{(F)}$ = Energy consumption in agriculture (TJ yr^{-1})
- $G_{ef(gas)}$ = Implied emission factor (kg TJ^{-1})
- *Gas* = (CO_2, CH_4, N_2O)
- *F* = Energy carrier

The emission factors used are specified by energy carrier, in IPCC 2006, Vol. 2, Ch. 2, Table 2.5, and Ch. 3, Table 3.31; they are reported in Table 54 in Annex 3 to this publication. For Coal, the default NCV and emission factor of "Other bituminous coal" is applied.

b) For the Electricity and Energy for power irrigation items, the formula used was

$$Emissions(gas)_{(el)} = CA_{(el)} \times G_{ef(el)} \times 10^{-3}$$

Where

- $Emissions(gas)_{(el)}$ = Amount of emissions of Gas from electricity use in agriculture, Gg yr^{-1})
- $CA_{(el)}$ = Electricity consumption in agriculture, GWh yr^{-1}
- $G_{ef(el)}$ = Country emission factor (electricity-only) of country C, g KWh^{-1}
- *Gas*= (CO_2, CH_4, N_2O)

For electricity, country emission factors for CO_2 – namely, electricity-only factors – are those reported by the IEA (OECD/IEA, 2012). These are based on the 1996 IPCC Guidelines for National Greenhouse Gas Inventories; the 1990 country emission factors are applied to previous years. Non-CO_2 emission factors for electricity used for all countries are estimated on the basis of the IEA global electricity emission factor for CO_2, considering these emissions as a fraction of the CO_2 emitted[8], and considering the following energy mix for electricity: 48% coal, 22% natural gas, and 6% crude oil.

Step 4. Calculate Emissions (CO_2eq) from CH_4 and N_2O

The relevant formula was

$$Emissions(CO_2eq)_{(T)}\ from\ (gas) = Emissions(gas)_{(T)} \times GWP_{(gas)}$$

Where

- $Emissions(CO_2eq)\ from\ (gas)$ = Amount of GHG emissions, in CO_2eq, from energy use in agriculture, Gg CO_2eq yr^{-1}
- $Emissions(gas)_{(F)}$ = Amount of *Gas* emissions from energy use in agriculture for energy carrier *F*, Gg yr^{-1}
- $GWP_{(CO2)}$ = 1
- $GWP_{(CH4)}$ = 21 (100-year time horizon global warming potential), to convert Gg CH_4 to Gg CO_2eq

[8] CH_4: 300/98,300 for coal, 5/56,100 for natural gas, 10/73,300 for crude oil; N_2O: 1.5/98,300 for coal, 0.1/56,100 for natural gas, 0.6/73,300 for crude oil.

- $GWP_{(N2O)}$ = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq
- *F* = Energy carrier
- *Gas* = CH_4, N_2O

Step 5. Calculate Overall CO_2eq Emissions

The relevant formula is

$$Emissions(CO_2eq)_{(F)} = Emissions\ (CO2)(F) + Emissions(CO_2eq)_{(F)} from\ CH_4 + \ Emissions(CO_2eq)_{(F)} from\ N_2O$$

Where

- *Emissions* $(CO_2eq)_{(F)}$ = Amount of emissions in CO_2eq from energy use for energy carrier *F*, Gg $CO_2eq\ yr^{-1}$
- *Emissions* $(CO_2)_{(F)}$ = Amount of CO_2 emissions from energy use for energy carrier *F*, Gg $CO_2eq\ yr^{-1}$
- *Emissions* $(CO_2eq)_{(F)}$ *from* N_2O = Amount of N_2O emissions in CO_2eq from energy use for energy carrier *F*, Gg $CO_2eq\ yr^{-1}$
- *Emissions* $(CO_2eq)_{(F)}$ *from* CH_4 = Amount of CH_4 emissions in CO_2eq from energy use for energy carrier *F*, Gg $CO_2eq\ yr^{-1}$
- *F* = Energy carrier

The items are also provided as the following groups:

Total energy = Gas-diesel oils + Motor gasoline + Natural gas (including LNG) + Liquefied petroleum gas (LPG) + Residual fuel oil + Coal + Electricity.

Transport fuel consumed in agriculture (excluding fisheries) = Gas-Diesel oil + Motor gasoline - Gas-Diesel oil in fisheries.

Energy consumed in fisheries = Gas-Diesel oil in fisheries + Residual fuel oil in fisheries.

5.2 FORESTRY AND LAND USE

5.2.1 Forest Land

Dataset Information	
Title	**Forest Land**
Definition	The annual net CO_2 emissions/removals from Forest Land consist of the net carbon stock gain/loss in the living biomass pool (aboveground and belowground biomass) associated with *Forest* and *Net Forest Conversion*.
Methodology and Quality Information	
Methods and processing	The net CO_2 emissions/removals from Forest Land consist of the net carbon stock change in the living biomass pool (aboveground and belowground) associated with: i) Forest, referring to C stock changes occurring on Forest Land in the reported year; and ii) Net Forest conversion from Forest Land to other land uses. The FAOSTAT data are computed at Tier 1, with the stock difference method, following the criteria established in IPCC 2006, Vol. 4, Ch.s 2 and 4. The net CO_2 emissions/removals (E/R) are estimated at country level, using the formula $E/R = A * CSCF * -44/12 / 1,000$ where • *E/R* = Net CO_2 emission/removal, in Gg CO_2 yr^{-1} (3); • *A* = Activity data, representing the forest area under forest management or the forest area net change, in ha (1); • *CSCF* = per-hectare carbon stock change in the living biomass pool (aboveground + belowground) of forest land, expressed in units of t C/ha (2); (1) The area of forest, A, is calculated from the annual areas of forest land taken directly from the Global Forest Resource Assessment (FRA) conducted by FAO (available at http://www.fao.org/forestry/fra/fra2010/en/). Data for the years 1990, 2000, 2005 and 2010, as provided by FRA, for the categories of *Primary forest, Other naturally regenerated forest* and *Planted forest* were linearly interpolated to compile, for each country, complete time series of areas for each category, for the period between 1990-2010. The FRA categories of *Primary forest* and *Other naturally regenerated forest* were aggregated, while *Planted forest* was considered separately, to compute the following forest area components at year *t*: a. Area of forest that was still forest in the previous year (area type SFA), computed as *Min [A(t), A(t-1)]*; b. For Forest Land (Forest Management): the new net area converted to forest in the same year (area type NAD), computed as: *Max[A(t)-A(t-1),0]*, thus including only positive net forest area change; or c. For Net Forest Conversion: the net area loss converted from forest to other land uses (area type NAD), computed as: *Min[A(t)-A(t-1),0]]*, thus including only positive net forest area change. (2) CSCF is computed from the per-hectare carbon stock in the living biomass (aboveground + belowground) pool in the country in year *t*, *b(t)*. The latter is obtained from data on per-hectare carbon stocks taken directly from the FRA database for the years 1990, 2000, 2005 and 2010. These were linearly interpolated to compile, for each country, a complete time series of per-hectare average carbon stock in the living biomass pool, *b(t)*, for the period between 1990-2010. For countries for which FRA carbon stock data were not available, the relevant FRA regional carbon stock (FRA 2010, Table T2.21) was applied. For each year *t*, and each forest area type above, the CSCF is calculated as follows: For *Forest*: i. $CSCF(t, SFA) = \Delta b\ (t) = b(t) - b(t-1)$, for SFA-type forest areas; ii. $CSCF^*(t, NAD) = b\ (t)$, for NAD-type forest areas. The overall net carbon stock change factor at year *t*, *CSCF(t)*, is computed as: $CSCF(t) = [CSCF(t,SFA)^*SFA + CSCF(t,NAD)^*NAD]/A$ For *Net Forest Conversion*: i. $CSCF^*(t, NAD) = b\ (t-1)$, for NAD-type forest areas

Methodology and Quality Information	
Methods and processing	The overall net carbon stock change factor at year *t, CSCF(t)*, is computed as: *CSCF(t) = CSCF(t, NAD)*NAD/A* The dimensionless conversion factors used were • -44/12, to convert from carbon mass to CO_2 emissions; • 10^{-3}, to convert tonnes into Gg. The Forest Land sub-domain contains the following data, available for download: country-level Net CO_2 emissions/removals in Gg CO_2, and Carbon stock change in Gg C; implied emission factors (i.e. the CSCFs); and underlying activity data. Data are available for all individual countries and territories, as well as for standard FAOSTAT regional aggregations, and Annex I and non-Annex I groups. The data period covers 1990-present, with periodic updates in line with FRA releases. For estimating uncertainty, it should be noted that information on growing stock and basic wood densities is typically used to compute living biomass carbon stocks. FRA 2005 estimates uncertainties in growing stock at ±8% for industrialized countries and ±30% for non-industrialized countries, and uncertainties for basic wood density around 10 to 40%. FAOSTAT estimates area uncertainties at ±10%.

Calculation Procedure

Step 1. Activity data

In this sub-domain, the activity data are taken from the "Global Forest Resources Assessments" website, available at http://www.fao.org/forestry/fra/en/. The website includes datasets for 1990, 2000, 2005 and 2010 (FRA 2010), by item and country.

The FRA is the most comprehensive assessment of forests and forestry to date, in terms of the number of countries and individuals involved. It examines the current status and recent trends for about 90 variables, covering the extent, condition, uses and values of forests and other wooded land, with the aim of assessing all benefits that may be derived from forest resources. All methodological documentation referenced in this section is available at the Global Forest Resources Assessments website (http://www.fao.org/forestry/fra/67094/en/).

The FRA 2010 database may be accessed at http://www.fao.org/forestry/fra/fra2010/en/.

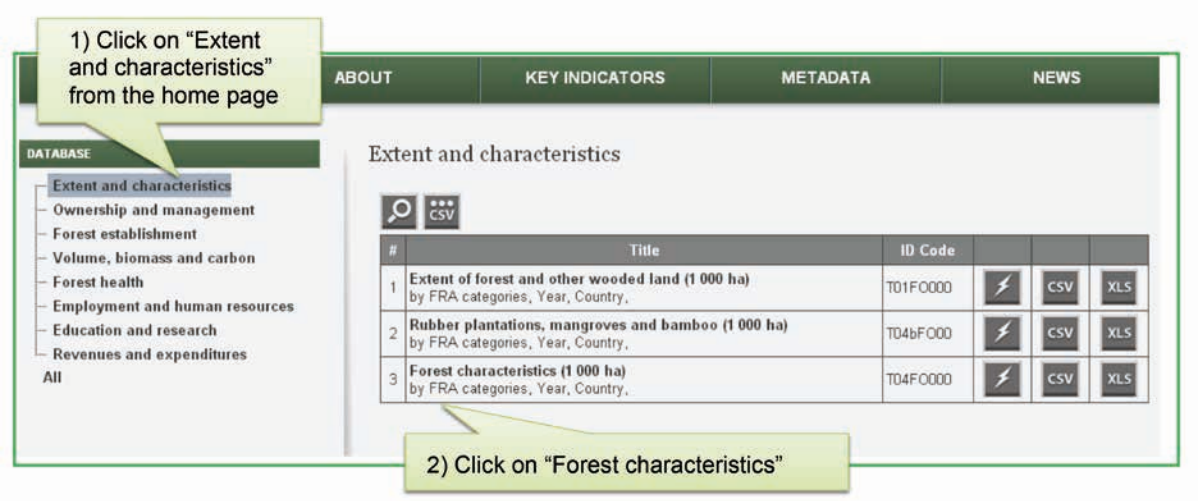
FIGURE 48
The "Global Forest Resources Assessment 2010" Homepage

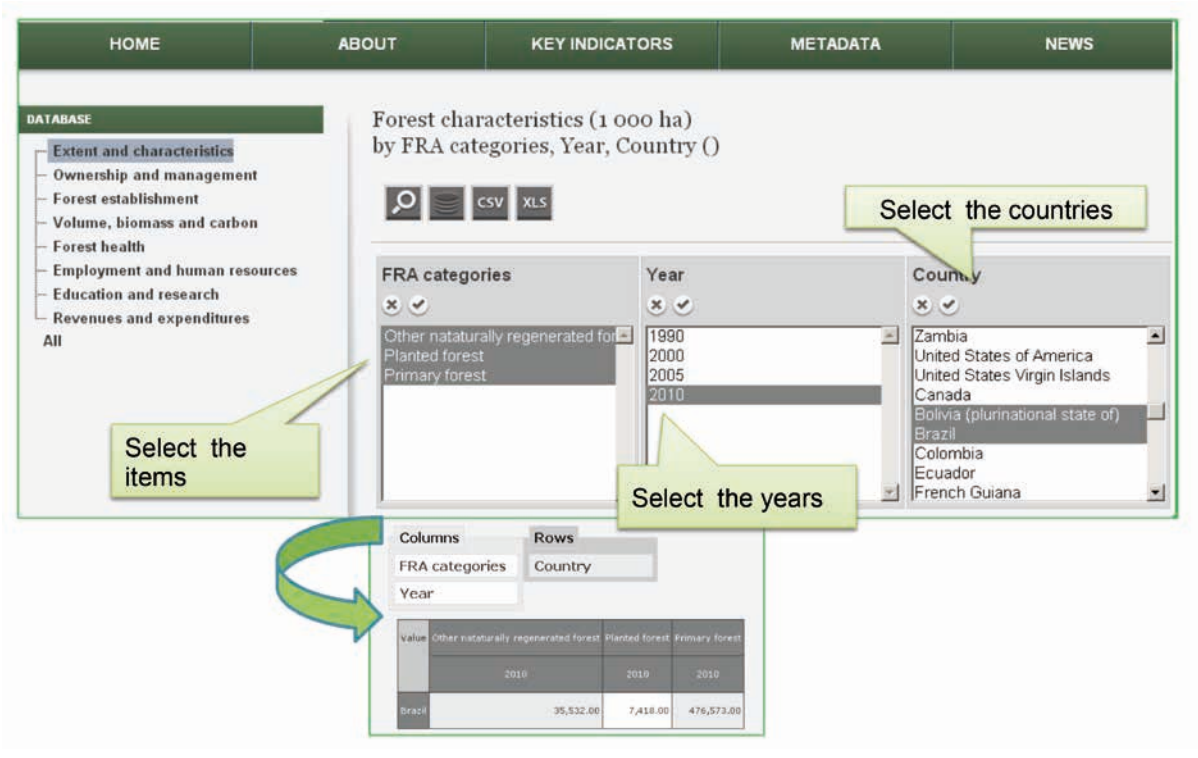
FRA data are distributed according to the following categories:

- Primary Forest (ha) (PA)
- Secondary Forest (ha) (SA)
- Planted Forest (ha) (PLA)
- Carbon density of living biomass (tC/ha) (CD)

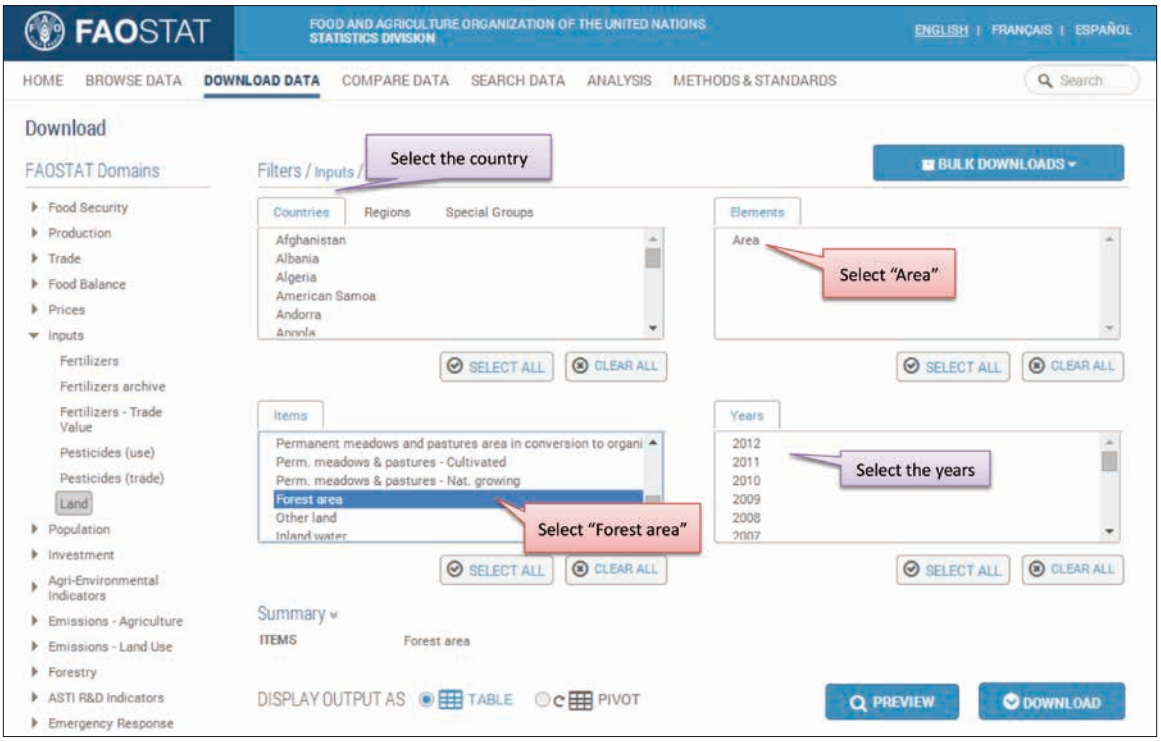
1.1 Data for the **Primary forest**, **Secondary forest (Other naturally regenerated forest)**, and **Planted forest** categories are accessible as follows:

FIGURE 49
Forestry Area from the FRA database



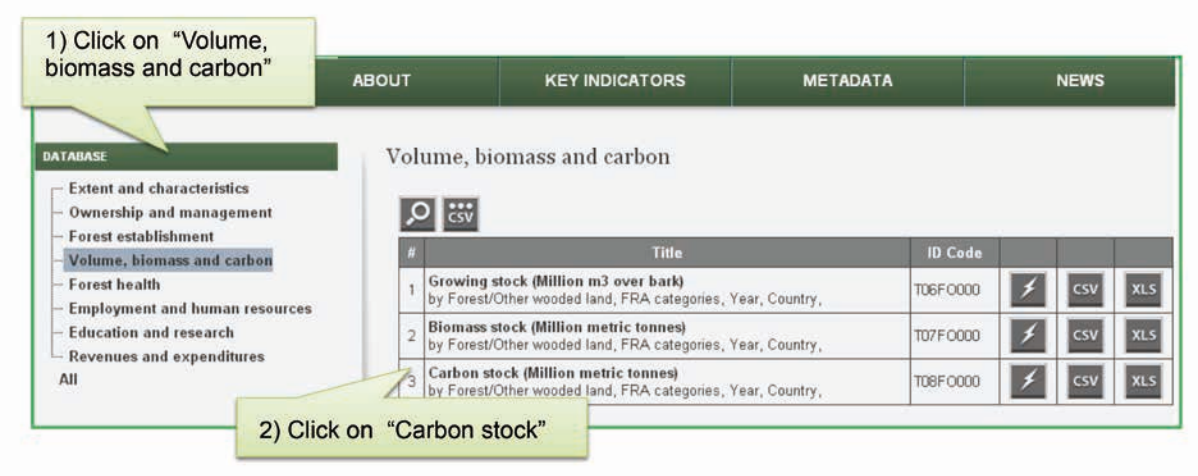


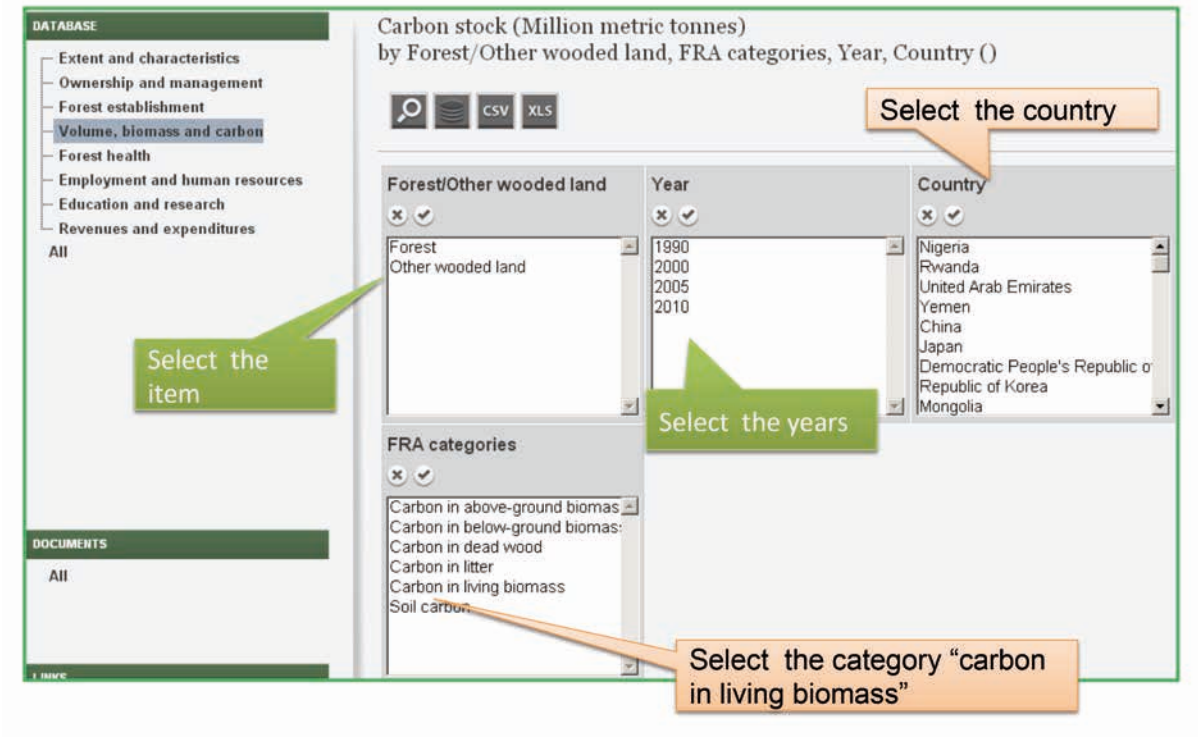
However, the FAOSTAT Emissions database uses the complete time series (1990-2011) of total forest area which is available in FAOSTAT database (Inputs Land sub domain http://faostat3.fao.org/faostat-gateway/go/to/download/R/RL/E) and derived from FRA data.



1.2 The data relating to the **Carbon density of living biomass** are accessible as follows:

FIGURE 50
Carbon Stock Data Set from the FRA database





FRA data are based on the country reports compiled by officially appointed country correspondents, in collaboration with FAO staff. Prior to finalization, these reports are subject to validation by the forestry authorities of the relevant countries.

The official national reports are available at the following link http://www.fao.org/forestry/fra/67090/en/.

The FRA data were used to compute the following items and components:

Items	• **Net Forest Conversion**	
Components	• Net Area Difference (ha)	NAD
	• Carbon Stock Change (Gg C)	CSC
	• CO_2 Emissions (Gg CO_2)	CEM
Items	• **Forest**	
Components	• Steady Forest Area (ha)	SFA
	• Net Area Difference (ha)	NAD
	•Total Forest Area (ha)	TFA
	• Carbon Stock Change (Gg C)	CSC
	• Net CO_2 Emissions/Removals (Gg CO_2)	NER

The methodology is illustrated below.

Step 2. Net Forest Conversion

for each country and year

2.1 Calculation of Net Area Difference (NAD)

- An area difference based on primary and secondary forest areas must be computed:

$$NAD^{PS}_{(i,j)} = \text{Min}\,[\,PA_{(i,j)} + SA_{(i,j)} - PA_{(i-1,j)} - SA_{(i-1,j)},\,0]$$
for i =1991,…,2010; j =country j
with $NAD^{PS}(1990, j) = NAD^{PS}(1991, j)$

- An area difference based on planted areas only must then be computed:

$$NADPLA_{(i,j)} = \text{Min}\,[\,PLA_{(i,j)} - PLA_{(i-1,j)},\,0]$$
for i =1991, …, 2010; j = country j
with NADPLA (1990, j) = NADPLA (1991, j)

- Finally, compute the sum of these two values:

$$NAD_{(i,j)} = NADPS_{(i,j)} + NADPLA_{(i,j)} \text{ for i =1990,…,2010; j =country j}$$

Note: NAD, NAD^{PS} and NAD^{PLA} are always <= 0

2.2 Calculation of Carbon Stock Change (CSC)

- This is simply computed as

$$CSC_{(i,j)} = NAD_{(i,j)} \times CD_{(i-1,j)}$$
for i =1991, …, 2010; j = country j

Where

- $CD_{(i-1,j)}$ = Carbon Density in Living Biomass in the previous year, from the parameter file.

Note: in this case, CSC is always negative or zero.

2.3 Calculation of CO_2 Emissions, CEM [CO_2, xx] [CO_2eq, xx]

- This is computed simply, as:

$$CEM_{(i,j)} = - CSC_{(i,j)} \times 44/12$$
for i =1990, …, 2010; j = country j

Note: The CEM amount in CO_2eq is equal to the NER in CO_2.

Step 3. Forest Land

3.1 Calculation of Net Area Difference (NAD)

- An area difference based on primary and secondary forest areas must be computed:

$$NAD^{PS}_{(i,j)} = Max [PA_{(i,j)} + SA_{(i,j)} – PA_{(i-1,j)} –SA_{(i-1,j)}, 0]$$
for i =1991, …, 2010; j = country j
with NAD^{PS} (1990, j) = NAD^{PS} (1991, j)

- An area difference based on planted areas only must be computed:

$$NAD^{PLA}_{(i,j)} = Max [PLA_{(i,j)} – PLA_{(i-1,j)}, 0]$$
for i =1991, …, 2010; j = country j
with NAD^{PLA} (1990, j) = NAD^{PLA} (1991, j)

- The total must then be calculated:

$$NAD_{(i,j)} = NAD^{PS}_{(i,j)} + NAD^{PLA}_{(i,j)}$$
for i =1990, …, 2010; j = country j

Note: NAD, NAD^{PS} and NAD^{PLA} are always >= 0

Step 4. Calculation of Steady Forest Area (SFA)

- First, compute the steady forest area of primary and secondary forests:

$$SFA^{PS}_{(i,j)} = Min [PA_{(i,j)} + SA_{(i,j)}, PA_{(i-1,j)} + SA_{(i-1,j)}]$$
for i =1991, …, 2010; j = country j
With SFA^{PS} (1990, j) = SFA^{PS} (1991, j)

- Then, compute an area difference based on planted areas only:

$$SFA^{PLA}_{(i,j)} = Max [PLA_{(i,j)}, PLA_{(i-1,j)}]$$
for i =1991, …, 2010; j = country j
With SFA^{PLA} (1990, j) = SFA^{PLA} (1991, j)

- Finally, compute the total:

$$SFA_{(i,j)} = SFA^{PS}_{(i,j)} + SFA^{PLA}_{(i,j)}$$
for i =1990, …, 2010; j = country j

Step 5. Calculation of Total Forest Area (TFA)

- This may be simply computed, as:

$TFA_{(i,j)} = NAD_{(i,j)} + SFA_{(i,j)}$ for i =1990,…,2010; j = country j

Step 6. Calculation of Carbon Stock Change (NCSC)

- The following formula must be applied for $NAD_{(i,j)}$:

$CSC^{NAD}_{(i,j)} = NAD_{(i,j)} \times CD_{(i,j)}$
for i =1990, …, 2010; j = country j

Where

$CD_{(i,j)}$ = Carbon Density in Living Biomass, from the parameter files of the Average Carbon Stock in Forest Living Biomass (t ha^{-1}), available in the FRA 2010, by geographical group area and year (Table 55), and of the Total Carbon Stock in Forest Living Biomass (M t), available in the FRA 2010 by Country (Table 56).

Note: CSC^{NAD} is always positive or zero in this case.

- The following must be computed for $SFA_{(i,j)}$:

$CSC^{SFA}_{(i,j)} = [CD_{(i,j)} - CD_{(i-1,j)}] * SFA_{(i,j)}$

Where

CSC(1990,j) = CSC(1991,j);

$CD_{(i,j)}$ = Carbon Density in Living Biomass, from the parameter of the Average Carbon Stock in Forest Living Biomass (t ha-1), available in the FRA 2010 by geographical group area and year (Table 55), and the Total Carbon Stock in Forest Living Biomass (M t), available in the FRA 2010 by Country (Table 56).

- Finally, compute the total:

$CSC_{(i,j)} = CSC^{NAD}_{(i,j)} + CSC^{SFA}_{(i,j)}$
for i =1990, …, 2010; j = country j

Step 7. Net CO_2 Emissions/Removals, NER [CO_2, xx] [CO_2eq, xx])

- This may be simply computed as:

$NER_{(i,j)} = - CSC_{(i,j)} \times 44/12$
for i =1990, …, 2010; j = country j

Note: The NER amount in CO_2eq is equal to the NER in CO_2.

5.2.2 Cropland

Dataset Information	
Title	**Cropland**
Definition	Greenhouse gas (GHG) emissions data from cropland are currently limited to emissions from cropland organic soils. They are associated with carbon losses from drained histosols under cropland.
Methodology and Quality Information	
Methods and processing	GHG emissions data from cropland are currently limited to emissions from cultivated organic soils. They are associated with carbon losses from drained organic soils. The FAOSTAT data are computed at Tier 1, following the criteria established in IPCC, 2006, Vol. 4, Ch. 5. The emissions are estimated at the pixel level, using the formula $Emission = A * EF$ where • *Emission* = Annual emissions, in units of tonnes C yr^{-1}; • *A* = Activity data, representing the annual area of cultivated organic soils, in hectares (1). • *EF* = Tier 1, default IPCC emission factors, expressed in units of tonnes C ha^{-1} (2). (1) The data are obtained through the stratification of two different global datasets: i. The Harmonized World Soil Database (FAO *et al.*, 2012), used to estimate the area covered by Histosols classes. ii. The Global Land Cover dataset, GLC2000 (EU-JRC, 2003), used to estimate the amount of cropland and grassland area in each pixel. For cropland, three "cropland" classes from GLC2000 are used, following You *et al.* (2008):

CLASS	NAME	CROPLAND SHARE PER PIXEL
16	Cultivated and managed areas	100%
17	Mosaic: cropland/tree cover/Other natural vegetation	50%
18	Mosaic: cropland/Shrub and/or grass cover	10%

For the period 1990-present and for 2030 and 2050, the activity data reported in this sub-domain are a constant value, representing the year 2000, i.e. the reference year of the GLC2000 database.

(2) The EF values are specified in IPCC, 2006, Vol. 4, Ch. 5, Table 5.6. The EF were assigned at the pixel level to the relevant climate zone, as defined in IPCC, 2006, Vol. 4, Ch. 3, Annex 3A.5. The climatic zones map used was developed by the Joint Research Centre of the European Commission (EC-JRC, 2010), in accordance with IPCC prescriptions.

The analysis was carried out in a GIS environment, combining the above data sets. The global emissions dataset was summarized by country.
The dimensionless conversion factors used were

- 44/12, to convert the emissions from tonnes C to tonnes CO_2 gas;
- 10^{-3}, to convert the emissions from tonnes C to Gg C

The cropland sub-domain contains the following data categories, available for download: country-level GHG emissions in both Gg C, Gg CO_2 and Gg CO_2eq; implied emission factors; and activity data.

Uncertainties in the estimates of GHG emissions are due to uncertainties in emission factors and activity data. In the case of cultivated organic soils, more detailed information is available in the IPCC Guidelines (IPCC, 2006, Vol. 4, Ch. 5, and Section 5.2.3.5).

Calculation Procedure

Step 1. Activity data

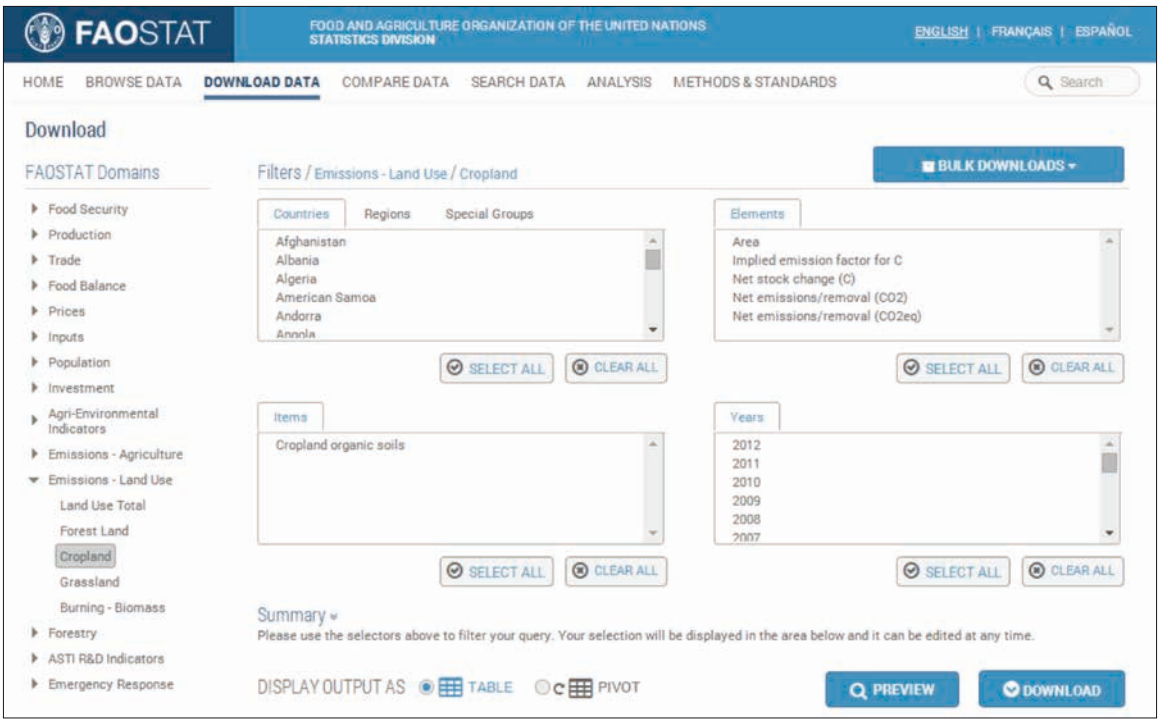
Activity data are the annual area of organic soils covered by cropland, expressed in hectares. The $Area_{(T)}$ is calculated in a GIS environment.

The cropland area was identified from the Global Land Cover data set GLC2000 (EU-JRC, 2003), available at http://bioval.jrc.ec.europa.eu/products/glc2000/glc2000.php. The three "cropland" classes were used. The mosaic classes were reduced proportionally to the general share of the cropland per pixel for each class, according to the values reported in the metadata above.

The area of organic soils was identified from the Harmonized World Soil Database, available at http://www.fao.org/nr/lman/abst/lman_080701_en.htm, selecting all the pixels where histosols are present, with the relative pixel share expressed as percentages.

The $Area_{(T)}$ has been calculated by overlaying the soil and the land cover layers. The values are fixed, calculated per each country and accessible in FAOSTAT Emissions database on Emissions-Land Use/Cropland domain from 1990 to 122012 as follows:

FIGURE 51
Cropland items from the FAOSTAT Emissions database



Step 2. Emissions (C)

The emissions are calculated in a GIS environment at the pixel level, using the formula

$$Emissions\ (C)_{(T)} = Area_{(T)} \times EF_{(T)}$$

Where

- *Emission* $(C)_{(T)}$ = Annual emissions of C for item *T*, tonnes C yr^{-1}
- $Area_{(T)}$ = Activity data, representing the area of cropland organic soils under item *T*, ha
- $EF_{(T)}$ = Tier 1, default IPCC emission factors for item *T*, tonnes C ha^{-1} yr^{-1} (Table 58)
- *T* = the item of this category source is Cropland organic soils.

The EF values are specified in IPCC, 2006, Vol. 4, Ch. 5, Table 5.6. The EF were assigned at the pixel level to the relevant climate zone, as defined in IPCC, 2006, Vol. 4, Ch. 3, Annex 3A.5. The climatic zones map used was developed by the Joint Research Centre of the European Commission (EC-JRC, 2010), in accordance with IPCC prescriptions.

The emissions are related to the year 2000, which is the reference year of the land cover map used in the estimations. These values are also used for subsequent years, to cover the period 1990-2011. Additional country-level disaggregations that have occurred over the period 1990-2011 are also provided.
As long as a country's boundary do not change, the area values for new years after 2011 can be produced by simply replicating the country values of 2011.

Step 3. Emissions (CO_2)

$$Emissions\ (CO_2)_{(T)} = Emissions\ (C)_{(T)} \times \frac{44}{12} \times 10^{-3}$$

Where

- *Emission* $(CO_2)_{(T)}$ = Annual emissions of CO_2 for item *T*, Gg $CO_2 yr^{-1}$
- *Emission* $(C)_{(T)}$ = Annual emissions of C for item *T* , tonnes C yr^{-1}

Step 4. Emissions (CO_2eq)

$$Emissions\ (CO_2eq)_{(T)} = Emissions\ (CO_2)_{(T)}$$

Where

- *Emissions* $(CO_2eq)_{(T)}$ = CO_2 emissions from item *T* in CO_2 equivalent, Gg CO_2eq yr^{-1}
- *Emissions* $(CO_2)_{(T)}$ = CO_2 emissions from item *T*, Gg CO_2 yr^{-1}

Step 5. Implied emissions factor for C

$$IEF_{(T)} = \frac{Emissions(C)_{(T)}}{Area_{(T)}}$$

Where

- $IEF_{(T)}$ = Implied emission factor for item *T*, tonnes C ha^{-1}
- *Emissions* $(C)_{(T)}$ = C emissions from item *T*, Gg C yr^{-1}
- *A* = Area of Cropland Organic Soils under item *T ha*

Step 6. Replication

Emissions are assumed to be constant in any given year, unless changes in the boundaries of the countries occur. In that case, a new GIS analysis would be required.

5.2.3 Grassland

Dataset Information	
Title	**Grassland**
Definition	Greenhouse gas (GHG) emissions data from grassland are currently limited to emissions from grassland organic soils. They are associated with carbon losses from drained histosols under grassland.
Methodology and Quality Information	
Methods and processing	GHG emissions data from grassland are currently limited to emissions from grassland organic soils. They are associated with carbon losses from drained organic soils. The FAOSTAT data are computed at Tier 1, following the criteria established in IPCC, 2006, Vol. 4, Ch. 6. The emissions are estimated at pixel level, using the formula $Emission = A * EF$ where • *Emission* = Annual emissions, in units of tonnes C yr^{-1}; • *A* = Activity data, representing the annual area of grassland organic soils, in hectares (1). • *EF* = Tier 1, default IPCC emission factors, expressed in units of tonnes C ha^{-1} (2). (1) The data are obtained through the stratification of two different global data sets: i. the Harmonized World Soil Database (FAO *et al.*, 2012), used to estimate the area covered by histosols classes, and ii. the Global Land Cover dataset, GLC2000 (EU-JRC, 2003), used to estimate the amount of cropland and grassland area in each pixel. For grassland, two "herbaceous" and two mosaics GLC2000 classes are used, in line with the FAO Land Cover Classification Scheme (LCCS):

CLASS	NAME	GRASSLAND SHARE PER PIXEL
13	Herbaceous Cover, closed-open	100%
14	Sparse herbaceous or sparse shrub cover	50%
17	Mosaic: Cropland/Tree Cover/Other natural vegetation	25%
18	Mosaic: Cropland/Shrub and/or grass cover	45%

iii. the Gridded Livestock of the World for cattle and sheep (Wint and Robinson, 2007), used as an additional mask over grassland histosols as a proxy to estimate drained area. With this mask, only pixels with non-zero drained grassland histosols area and livestock density >1 head/ha are included.

For the period 1990-present as well for 2030 and 2050, the activity data reported in this sub-domain are a constant value, representing the year 2000, i.e., the reference year of the GLC2000 database.

(2) The EF values are those specified in IPCC, 2006, Vol. 4, Ch. 6, Table 6.3. The EF were assigned at pixel level to the relevant climate zone, as defined in IPCC, 2006, Vol. 4, Ch. 3, Annex 3A.5. The climatic zones map used was developed by the Joint Research Centre of the European Commission (EC-JRC, 2010), following IPCC prescriptions.

The analysis was carried out in a GIS environment, combining the above datasets; the global emissions dataset was summarized by country.

The dimensionless conversion factors used were:

• 44/12, to convert the emissions from tonnes C to tonnes CO_2 gas;
• 10^{-3}, to convert the emissions from tonnes C to Gg C

The cultivated organic soils domain contains the following data categories, available for download: country-level GHG emissions in both Gg C, Gg CO_2 and Gg CO_2eq; implied emission factors; and activity data.

Uncertainties in the estimates of GHG emissions are due to uncertainties in emission factors and activity data. In the case of cultivated organic soils, more detailed information is available in the IPCC Guidelines (IPCC, 2006, Vol. 4, Ch. 6, Section 6.2.3.5).

Calculation Procedure

Step 1. Activity data

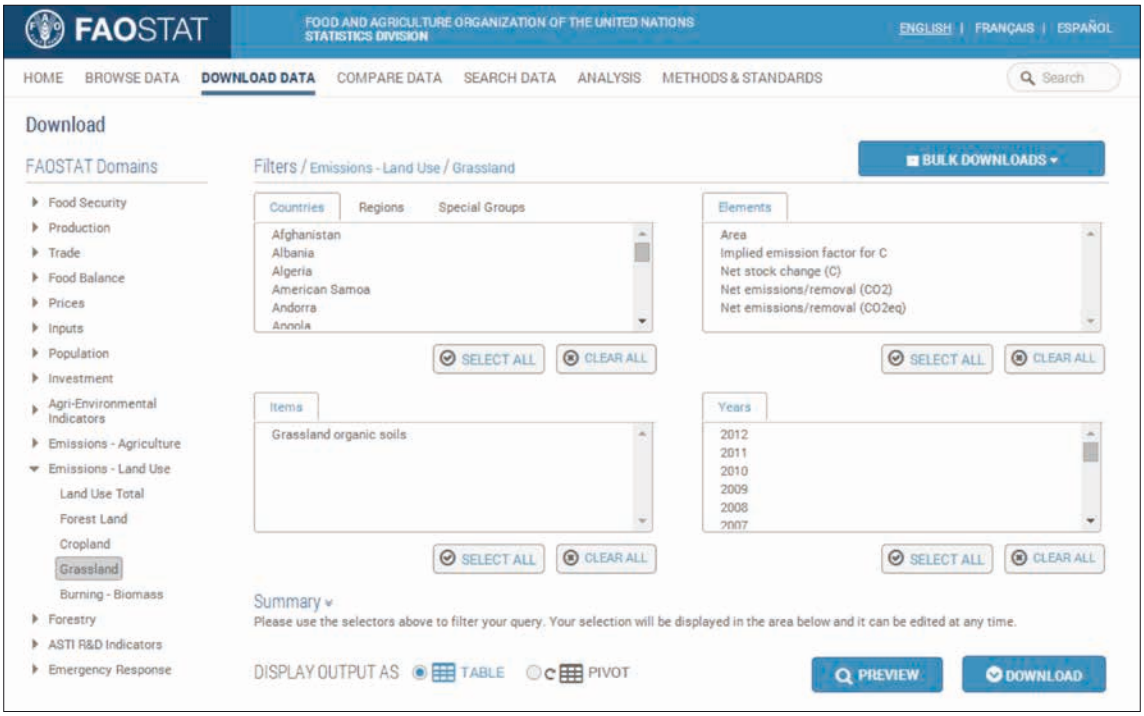
The activity data are the annual area of organic soils covered by grassland, in hectares. The $Area_{(T)}$ is calculated in a GIS environment.

The grassland area was identified from the Global Land Cover dataset, GLC2000 (EU-JRC, 2003), available at http://bioval.jrc.ec.europa.eu/products/glc2000/glc2000.php, using four classes. The mosaics classes were reduced proportionally to the general share of the grassland per pixel for each class, according to the values reported in the metadata above.

The area of organic soils was identified from the Harmonized World Soil Database, available at http://www.fao.org/nr/lman/abst/lman_080701_en.htm, selecting all the pixels where histosols were present, with the related pixel share expressed as a percentage.

The $Area_{(T)}$ was calculated by overlaying the soil and the land cover layers, and using the Gridded Livestock of the World as a proxy to identify the areas of managed grasslands. The values are fixed and calculated for each country. The results are accessible in the FAOSTAT Emissions database, in the Emissions-Land Use/Grassland domain from 1990 to 2012:

FIGURE 52
Grassland items from the FAOSTAT Emissions database



Step 2. Emissions (C)

The emissions are calculated in a GIS environment at the pixel level, using the formula

$$Emissions\ (C)_{(T)} = Area_{(T)} \times EF_{(T)}$$

Where

- *Emission* $(C)_{(T)}$ = Annual emissions of C for item *T*, tonnes C yr^{-1}
- $Area_{(T)}$ = Activity data, representing the area of grassland organic soils under item *T*, ha
- $EF_{(T)}$ = Tier 1, default IPCC emission factors for item *T*, tonnes C ha^{-1} yr^{-1} (Table 59)
- *T* = the item of this category source is Grassland organic soils.

The EF values are those specified in IPCC, 2006,Vol. 4, Ch. 5, Table 5.6. The EF values were assigned at the pixel level to the relevant climate zone, as defined in IPCC, 2006, Vol. 4, Ch. 3, Annex 3A.5. The climatic zones map used was developed by the Joint Research Centre of the European Commission (EC-JRC, 2010), following IPCC prescriptions.

The emissions concern the year 2000, which is the reference year of the land cover map used in the estimations. These values are also used for subsequent years, to cover the period 1990-2011. Additional country-level disaggregation occurring over the period 1990-2011 are also provided.
As long as no new country split occurs, the area values for new years after 2011 can be produced by simply replicating the country values of 2011.

Step 3. Emissions (CO_2)

$$Emissions\ (CO_2)_{(T)} = Emissions\ (C)_{(T)} \times \frac{44}{12} \times 10^{-3}$$

Where

- *Emission* $(CO_2)_{(T)}$ = Annual emissions of CO_2 for item *T*, Gg CO_2yr^{-1}
- *Emission* $(C)_{(T)}$ = Annual emissions of C for item *T* , tonnes C yr^{-1}

Step 4. Emissions (CO_2eq)

$$Emissions\ (CO_2eq)_{(T)} = Emissions\ (CO_2)_{(T)}$$

Where

- *Emissions* $(CO_2eq)_{(T)}$ = CO_2 emissions from item *T* in CO_2 equivalent, Gg CO_2eq yr^{-1}
- *Emissions* $(CO_2)_{(T)}$ = CO_2 emissions from item *T*, Gg CO_2 yr^{-1}

Step 5. Implied emissions factor for C

$$IEF_{(T)} = \frac{Emissions(C)_{(T)}}{Area_{(T)}}$$

Where

- $IEF_{(T)}$ = implied emission factor for item *T*, tonnes C ha^{-1}
- *Emissions* $(C)_{(T)}$ = C emissions from item *T*, tonnes C yr^{-1}
- *A* = Area of Grassland organic soils under item *T*

Step 6. Replication

Emissions are assumed to be constant in any given year, unless changes in the boundaries of the countries occur. In that case, a new GIS analysis would be required.

5.2.4 Burning – Biomass

Dataset Information	
Title	**Burning – Biomass**
Definition	Greenhouse Gas (GHG) emissions from burning of biomass consist of methane and nitrous oxide gases, from biomass combustion of forest land, covering the classes "Humid and Tropical Forest" and "Other Forests". The gases consist of methane, nitrous oxide, and carbon dioxide gases, from combustion of organic soils.
Methodology and Quality Information	
Methods and processing	Greenhouse Gas (GHG) emissions from burning of biomass consist of gases produced from the burning of biomass for the following items: "Humid Tropical Forest", "Other Forests" and "Organic Soils". They consist of methane (CH_4), nitrous oxide (N_2O), and, only in the case of Organic Soils, also carbon dioxide (CO_2). The "Humid Tropical Forest" item is defined by aggregating the following FAO-FRA Global Ecological Zones (FAO 2012): "Tropical Rainforest" and "Tropical moist deciduous forest". The "Other Forests" area contains the rest of the FAO-FRA Global Ecological Zones for Forests. The "Organic Soils" item is defined as the histosols class in the Harmonized World Soil Database (FAO *et al.*, 2012), consistently with the FAOSTAT Emissions database "Cultivation Organic Soils" definition. The emissions are estimated following the IPCC, 2006, Vol. 4, Ch. 2, Equation 2.27, by aggregation at the national level of spatially distributed information, produced on a spatial grid at 0.25 degree resolution (approximately 25 km at the Equator). For each item, and for each pixel, the following formula is used $$Emission = A * EF$$ where • *Emission* = GHG emissions in g CH_4, g N_2O and g CO_2. • *A* = Activity data, representing the total mass of fuel burned, in kg of dry matter (1); • *EF* = Tier 1 IPCC emission factor, expressed in g CH_4, g N_2O or g CO_2, per kg of burned dry matter (2). (1) The total mass of fuel burned is computed by multiplying the burned area (*i*) by the fuel biomass consumption values (ii). (i) Yearly composite values of burned area are obtained as the sum of the monthly burned area data, from the Global Fire Emission Database v.4 (GFED4; Giglio *et al.* 2013). For forests, the GFED4 burned forest area is an aggregate of the burned areas in the following MODIS land cover classes (MCD12Q1, Hansen *et al.*, 2000): Evergreen Needle-leaf, Evergreen Broadleaf, Deciduous Needle-leaf, Deciduous Broadleaf, and Mixed Forest. For "Humid Tropical Forest", the burned area is obtained by overlapping the GFED4 Burned Forest area data with the relevant FAO-FRA Global Ecological Zones. For "Other Forest", the burned area is obtained as the GFED4 burned Forest area minus the Humid Tropical Forest burned area. For "Organic Soils", the burned area is obtained by overlapping the GFED4 Burned area data with the Histosols class information of the Harmonized World Soil Database (FAO *et al.*, 2012), assuming the even distribution of organic soils within the grid cell. The projections of activity data for 2030 and 2050 are the average of the entire duration of the burned area satellite data time series (1996-present). (ii) Fuel biomass consumption values are taken from IPCC, 2006, Vol. 4, Ch. 2, Table 2.4. The different values are climate-dependent, and were geographically allocated using the JRC Climate Zones map (EC-JRC, 2010). (2) EF values are taken from IPCC, 2006, Vol. 4, Ch. 2, Table 2.5. The different values were assigned at the pixel level to the relevant climate zone. The climatic zones map used was developed by the Joint Research Centre of the European Commission (EC-JRC, 2010), following IPCC prescriptions.

Methodology and Quality Information	
Methods and processing	For each item, the emissions at the pixel level were subsequently aggregated at the country level, using the FAO Global Administrative Unit Layers (GAUL) data set. The dimensionless conversion factors used were • 10^{-9}, to convert the emissions from g CH_4 to Gg CH_4 and g N_2O to Gg N_2O; • GWP- CH_4 = 21 (100-year time horizon global warming potential), to convert Gg CH_4 to Gg CO_2eq; • GWP-N_2O = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq (IPCC, 1996, Technical Summary, Table 4, p. 22). The Burning-Biomass sub-domain contains the following data categories, available for download for each land cover class: country-level GHG emissions, provided as totals, in Gg CH_4, Gg N_2O and Gg CO_2eq; the implied emission factor; the burned area; and total mass of fuel available. Since GFED4 data are not available before 1996 and for future periods, a single yearly value for the period 1990-1995, as well as for projections for 2030 and 2050, were estimated for each country, as the average of the period 1996-2012. Uncertainties in the estimates of GHG emissions are due to uncertainties in the emission factors and activity data. These may be related to, *inter alia*, natural variability, partitioning fractions, lack of spatial or temporal coverage, spatial aggregation, or errors in satellite data. In the case of biomass burning, more detailed information is available in the IPCC Guidelines (IPCC, 2006, Vol. 4, Ch. 5, Section 5.2.4.4).

Calculation Procedure

Step 1. Activity data

The items under the Burning-Biomass domain include the following land cover classes: *Humid tropical forest*, *Other forest*, and *Organic soils*.
Greenhouse gases considered in this domain are CH_4, N_2O, and (only for organic soils) CO_2.
The annual burned area for each land cover is derived from the Global Fire Emission Database burned area data set, Version 4 (GFED4).

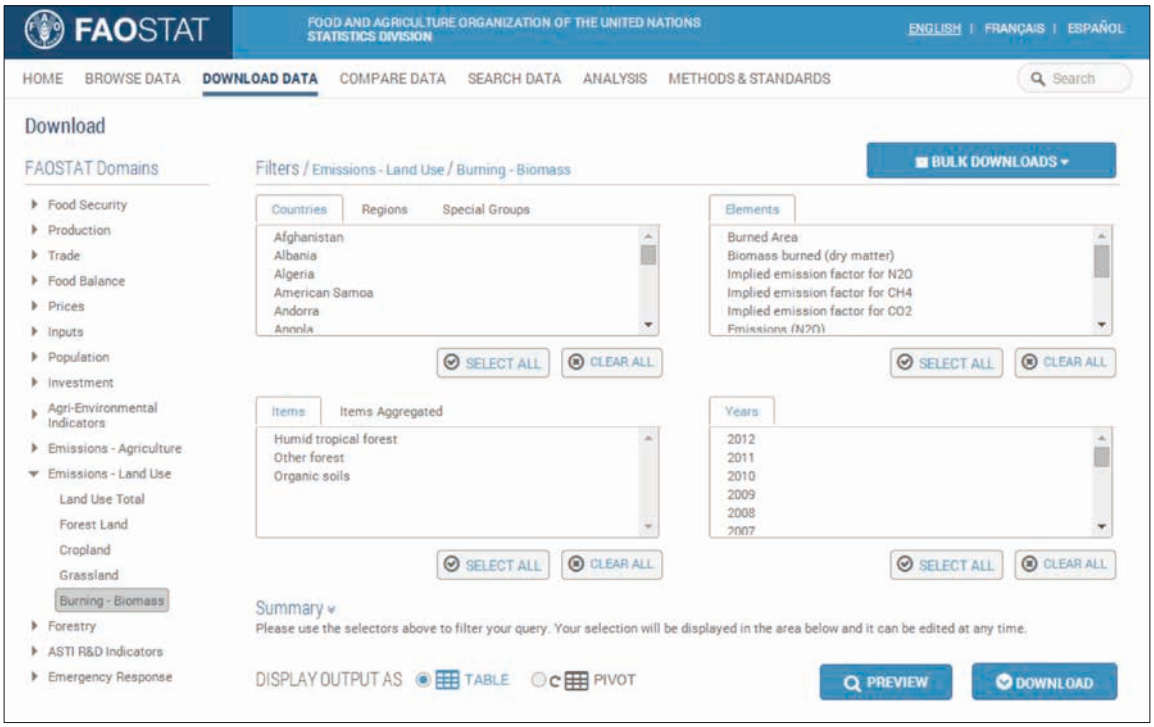
GFED4 provides global monthly burned area maps at 0.25° spatial resolution, from mid-1995 to present (currently 2012, see Giglio *et al*. 2013). The GFED4 dataset combines a 500m Moderate Resolution Imaging Spectro-radiometer (MODIS) burned area dataset with active fire datasets from the Tropical Rainfall Measuring Mission (TRMM) Visible and Infrared Scanner (VIRS) and the Along-Track Scanning Radiometer (ATSR) family of sensors. The annual burned area for each land cover class is calculated by adding up the GFED4 monthly data, by country.

The biomass burned (BB) activity of the Biomass burned (dry matter) for each land cover class, as well as the resulting emissions of N_2O, CH_4, and (only for organic soils) CO_2, are estimated using IPCC (2006) default methodology, based on Equation 2.27 therein; reference is made to default parameters for biomass consumption per hectare in different climates and vegetation types provided by Table 2.4, and to emission factors for each vegetation type taken from Table 2.5. The Biomass burned and emission computations are performed at the pixel level in a GIS environment, using additional data sets to associate the correct parameters to the specific climate and vegetation characterization of the pixel.

The methodology set out below enables the calculation of annual GHG emissions for the period 1990-1995, based on averages of the period 1996-present; of the conversion of non-CO_2 emissions into CO_2 equivalents; and of implied emission factors for N_2O, CH_4, and (only for organic soils) CO_2.

The data is available in the FAOSTAT Emissions database, in the Emissions-Land Use/Burning-Biomass domain from 1990 to 2050:

FIGURE 53
Burning - Biomass items from the FAOSTAT Emissions database



Step 2. Production of 1990-1995 data

For each country, yearly values for the period 1990-1995, X_i, may be estimated simply as the average value over the period 1996-present:

$$X_i = \overline{X_{1996-present}}$$

Where

- X = Variable (Burned area, Biomass burned, Emissions)
- $X_{(1996\text{-}present)}$ = Average value for the years 1999-present
- i = Year (period 1990-1995)

Step 3. Emissions (CO_2eq) from CH_4 and N_2O

$$Emissions(CO_2eq)_{(T)}\ from\ (gas) = Emissions(gas)_{(T)} \times GWP_{(gas)}$$

Where

- *Emissions* $(CO_2eq)_{(T)}$ *from (gas)* = Amount of GHG emissions in CO_2eq from biomass burning for land cover T, Gg CO_2eq yr^{-1}
- *Emissions* $(gas)_{(T)}$ = Amount of *Gas* emissions from biomass burning for crop T, Gg yr^{-1}
- $GWP_{(N2O)}$ = 310 (100-year time horizon global warming potential), to convert Gg N_2O to Gg CO_2eq
- $GWP_{(CH4)}$ = 21 (100-year time horizon global warming potential), to convert Gg CH_4 to Gg CO_2eq
- T = land cover class
- *Gas*= CH_4, N_2O

Step 4. Emissions (CO_2eq)

$$Emissions(CO_2eq)_{(T)} = Emissions(CO_2eq)_{(T)} from\ N_2O + Emissions(CO_2eq)_{(T)} from\ CH_4 + Emissions(CO_2)_{(only\ for\ T=Organic\ Soils)}$$

Where

- *Emissions* $(CO_2eq)_{(T)}$ = Amount of emissions in CO_2eq from biomass burning for land cover *T*, Gg $CO_2eq\ yr^{-1}$
- *Emissions* $(CO_2eq)_{(T)}$ *from* N_2O = Amount of N_2O emissions in CO_2eq from biomass burning for land cover *T* , Gg $CO_2eq\ yr^{-1}$
- Emissions $(CO_2eq)_{(T)}$ *from* CH_4 = Amount of CH_4 emissions in CO_2eq from biomass burning for land cover *T* , Gg $CO_2eq\ yr^{-1}$
- *Emissions* $(CO_2)_{(T=Organic\ Soils)}$ = Amount of CO_2 emissions from biomass burning for organic soils, Gg $CO_2eq\ yr^{-1}$
- *T* = land cover class

Step 5. Implied emission factor for N_2O, CH_4 and CO_2

$$IEF_{(T,gas)} = \frac{Emissions(gas)_{(T)}}{BB_{(T)}} \times 10^6$$

Where

- $IEF_{(T,\ gas)}$ = Implied emission factor for *Gas* for land cover *T*, g/kg burned
- *Emissions* $(gas)_{(T)}$ = Amount of Gas emissions from biomass burning for land cover *T*, Gg yr^{-1}
- $BB_{(T)}$ = Biomass burned for land cover *T*, tonnes yr^{-1}
- *T* = Land cover class
- *Gas* = Gas (CH_4, N_2O, CO_2)

Annex 1

GLOSSARY: CONCEPTS, DEFINITIONS AND SYMBOLS

Title	Definition	Source
Production	The domain of production includes the figures relating to total domestic production, within or outside the agricultural sector, i.e. including non-commercial production and production from kitchen gardens. Unless otherwise indicated, production is reported at the farm level for crop and livestock products (i.e. in the case of crops, excluding harvesting losses) and in terms of live weight for fish items (i.e. the actual ex-water weight, at the time of the catch). With regard to livestock, all data relates to total meat production, from both commercial and farm slaughter. Data are expressed in terms of dressed carcass weight, excluding offal and slaughter fats. Production of beef and buffalo meat includes veal; mutton and goat meat include meat from lambs and kids; and pig meat includes bacon and ham in fresh equivalent. Poultry meat includes meat from all domestic birds and refers, wherever possible, to ready-to-cook weight.	FAOSTAT Glossary Concepts common to FAOSTAT & CountrySTAT
Production Quantity of Primary Crops	Data refer to the actual harvested production from fields, orchards or gardens, excluding harvesting and threshing losses and those parts of crops that were not harvested for any reason. Production therefore includes the quantities of the commodity sold in markets (marketed production) and the quantities consumed or used by producers (auto-consumption). When the production data available refers to a production period falling in two successive calendar years, and it is not possible to allocate the amounts produced to the respective years, the production data is usually referred to the year in which the bulk of production took place. Crop production data are recorded in tonnes (t). In many countries, crop production data are obtained as a function of the estimated yield and the total area. If countries enforce such a compilation method of production statistics, they must ensure that the total area does not refer to sown or planted area, which would thus give the "biological production", but to the area that was actually harvested during the year. It is recommended that primarily production in terms of harvested production be reported; when this is not possible, the concept adopted in reporting production (and yield) figures should be clearly indicated.	
Area Harvested	The data refer to the area from which a crop is gathered. Therefore, the area harvested excludes the area from which, although sown or planted, there was no harvest due to damage, failure, etc. It is usually net for temporary crops and sometimes gross for permanent crops. The net area differs from the gross area insofar as the latter includes uncultivated patches, footpaths, ditches, headlands, shoulders, shelterbelts, etc. If the crop under consideration is harvested more than once during the year, as a consequence of successive cropping (i.e. the same crop is sown or planted more than once in the same field during the year), the area is counted as many times as it is harvested. On the contrary, the area harvested will be recorded only once if the crop is successively gathered during the year from the same standing crops. With regard to mixed and associated crops, the area sown relating to each crop should be reported separately. When the mixture refers to particular crops, generally grains, it is recommended to treat the mixture as if it were a single crop; therefore, the area sown would be recorded only for the crop reported. The area harvested is reported in hectares (ha).	
Area Sown	This refers to the area on which sowing or planting has been carried out, for the crop under consideration, on the soil prepared for that purpose. The area is usually reported net of uncultivated patches, footpaths, ditches, headlands, shoulders, shelterbelts, etc. For tree crops, the gross concept may be applied. With regard to mixed and associated crops, countries are requested to report the area sown for each crop separately. When the mixture refers to particular crops, generally grains, it is recommended to treat the mixture as if it were a single crop. Data are recorded in hectares (ha). The information on area sown allows for a particular application of the SUA system, in which the quantity allotted for the next year's sowing, that enters the accounts for the current year, is calculated as a seeding rate times the area sown of the next year.	

Title	Definition	Source
Crop yield	The harvested production per unit of harvested area, for crop products. In most cases, yield data are not recorded, but are obtained by dividing the production data by the data on area harvested. The data on the yields of permanent crops are not as reliable as those for temporary crops, either because most of the area information may correspond to planted area, as for grapes, or because the area figures reported by the countries are scarce or unreliable, as for example for cocoa and coffee. Data are expressed as Production (Hg)/Area harvested (ha).	
Number of Live Animals (Stocks)	This variable indicates the number of animals of the species present in the country at the time of enumeration. It includes animals raised either for draft purposes, for meat, eggs and dairy production, or kept for breeding. Live animals in captivity for fur or skin such as foxes, minks etc. are not included in the system, although fur skin trade is reported. The enumeration to be chosen when more than one survey is taken, is that closest to the beginning of the calendar year. Livestock data are reported in terms of the number of heads (units), except for poultry, rabbits and other rodents, which are reported in thousand units. For FAO, figures for the year *N* relate to animals enumerated by the country any day between October of year *N-1* and September of year *N*. The statistics are related to the total stock and the number of female animals.	
Milk Animals	Milk animals are those which, in the course of the reference period, have been milked. This concept is related to that applied for the production of milk, excluding the milk sucked by young animals. If, for example, the whole milk of a cow is sucked by the calf, the cow is not considered to be a "milk animal". Data are reported in terms of the number of heads (units).	
Laying Animals	Covers the number (in thousands) of all domestic birds which have contributed to egg production during the year, wherever they lay, and the corresponding total production, including eggs intended to be used for hatching. However, the figure excludes waste on farms. Some countries have no statistics on egg production, and estimates must be derived from related data such as chicken or total poultry numbers, and reported or assumed rates of egg laying.	
Primary Crops	Primary crops are those which come directly from the land, and which have not undergone any real processing apart from cleaning. These crops maintain all the biological qualities possessed when they were still on the plants. Certain primary crops can be aggregated, with their actual weight, into totals offering meaningful figures on area, yield, production and utilization; for example, cereals, roots and tubers, nuts, vegetables and fruits. Other primary crops can be aggregated only in terms of one or the other component common to all of them. For example, primary crops of the oil-bearing group can be aggregated in terms of oil or oil cake equivalent. Primary crops are divided into temporary and permanent crops. Temporary crops are those which are both sown and harvested during the same agricultural year, sometimes more than once; permanent crops are sown or planted once and not are replanted after each annual harvest.	FAOSTAT commodity list
Cereals:	These are generally of the gramineous family. For FAO purposes, the term refers to crops harvested for dry grain only.	
Wheat	"*Triticum spp.*: common (*T. aestivum*), durum (*T. durum*) spelt (*T. spelta*)". Common and durum wheat are the main types. The main varieties of common wheat are spring and winter, hard and soft, and red and white. At the national level, different varieties should be reported separately, reflecting their different uses. Used mainly for human food.	
Rice Paddy	"*Oryza spp.*" mainly *oryza sativa*. Rice grain after threshing and winnowing. Also known as rice in the husk and rough rice. Used mainly for human food.	
Barley	"*Hordeum spp.*: two-row barley (*H. disticum*), six-row barley (H. hexasticum), four-row barley (H. vulgare)". Tolerates poorer soils and lower temperatures better than does wheat. Varieties include with husk and without (naked). Used as a livestock feed, for malt and for preparing foods. The roasted grains are a coffee substitute.	
Maize	"*Zea mays* Corn, Indian corn, mealies". A grain with high germ content. At the national level, hybrid and ordinary maize should be reported separately, owing to their widely different yields and uses. Used largely for animal feed and commercial starch production.	
Rye	"*Secale cereal*". A grain that is tolerant of poor soils, high latitudes and altitudes. Mainly used in making bread, whisky and beer. When fed to livestock, it is generally mixed with other grains.	

Title	Definition	Source
Oats	"*Avena spp.*, mainly Avena sativa". A plant with open, spreading panicle-bearing large spikelets. Used primarily in breakfast foods. Makes excellent fodder for horses.	FAOSTAT commodity list
Millets	These include, *inter alia*: "barnyard or Japanese millet (*Echinocloa frumentacea*); ragi, finger or African millet (*Eleusine coracana*); teff (*Eragrostis abyssinica*); common, golden or proso millet (*Panicum miliaceum*); koda or ditch millet (*Paspalum scrobiculatu*m); pearl or cattail millet (*Pennisetum glaucum*); foxtail millet (*Setaria italic*)". Small-grained cereals that include a large number of different botanical species. Originated by the domestication of wild African grasses in the Nile valley and the Sahel zone, millets were subsequently taken to China and India. These cereals tolerate arid conditions and possess a small, highly nutritious grain that stores well. Used locally, both as a food and as a livestock feed. In all areas where they are cultivated, millets are used in traditional beer brewing. Also used as a feed for birds.	
Sorghum	"*Sorghum spp.*: guinea corn (*S. guineense*); common, milo, feterita, kaffir corn (S. vulgare); durra, jowar, kaoliang (S. dura)". A cereal that has both food and feed uses. Sorghum is a major food grain in most of Africa, where it is also used in traditional beer brewing. It is desirable hybrid and other varieties to be reported separately.	
Roots and Tubers	Plants yielding starchy roots, tubers, rhizomes, corms and stems. Used mainly for human food (as such or in processed form), for animal feed and for manufacturing starch, alcohol and fermented beverages including beer. The denomination "roots and tubers" excludes crops cultivated mainly for feed (mangolds, swedes) or for processing into sugar (sugar beets), and those classified as "roots, bulb and tuberous vegetables" (onions, garlic and beets). The term does include starch and the starchy pith and flour obtained from the trunk of the sago palm and the stem of the Abyssinian banana (Musa ensete). Certain root crops, notably bitter cassava, contain toxic substances, particularly in the skins. As a result, certain processes must be undertaken to make the product safe for human consumption. Apart from their high water content (70-80 percent), these crops contain mainly carbohydrates (largely starches that account for 16-24 percent of their total weight), with very little protein and fat (0-2 percent each). Methods of propagating root crops vary. A live potato tuber or seed must be planted, but only part of the live yam tuber and a piece of the stalk (not the root) in the case of cassava. Production data of root crops should be reported in terms of clean weight, i.e. free of earth and mud. FAO distinguishes between seven primary root and tuber crops.	
Potatoes	"*Solanum tuberosum*, Irish potato". A seasonal crop grown in temperate zones all over the world, but primarily in the northern hemisphere.	
Oil Crops:	Include both annual (usually called oilseeds) and perennial plants whose seeds, fruits or mesocarp and nuts are valued, mainly for the edible or industrial oils that are extracted from them. Dessert and table nuts, although rich in oil, are listed under Nuts. Annual oilseed plants that are either harvested green or are used for grazing and for green manure are included with Fodder Crops. Some of the crops included in this chapter are also fiber crops, in that both the seeds and the fibers are harvested from the same plant. Such crops include: coconuts, yielding coir from the mesocarp; kapok fruit; seed cotton; linseed; and hempseed.	
Soybeans	"*Glycine soja*". The most important oil crop. Also widely consumed as a bean and in the form of various derived products because of its high protein content, e.g. soya milk, meat substitutes, etc.	
Livestock – Live Animals	The term "livestock" is used in a broad sense to cover all grown animals, regardless of age, location or purpose of breeding. Non-domesticated animals are excluded under this definition unless they are kept or raised in captivity. Domestic animals included are large and small quadrupeds, poultry, insects (bees) and larvae of insects (silkworms). Figures on livestock numbers should refer to live animals enumerated on a given day or on several consecutive days. The FAO practice is that figures for an indicated year relate to animals reported by countries for any day between October of the previous year and September of the year indicated. Statistics on live animals by age, sex and utilization are generally not included in the resulting list, even though such breakdowns are extremely desirable in terms of national statistics. For each animal species, FAO proposes that information be maintained on changes in national herds during the year, according to the following equation: initial herd + animals born + imports of live animals - exports of live animals - natural losses - slaughter = closing herd.	

Title	Definition	Source
Cattle	"Cattle Common ox (*Bos taurus*); zebu, humped ox (*Bos indicus*); Asiatic ox (subgenus Bibos); Tibetan yak (*Poephagus grunniens*)". Animals of the genus listed, regardless of age, sex, or purpose raised. Data are expressed in number of heads.	FAOSTAT commodity list
Buffaloes	"Buffalo Indian, Asiatic, pygmy, water buffalo (*Bubalus bubalus*; *B. arnee*; *B. depressicornis*); African buffalo (*genus Syncerus*); American bison (*Bison bison*); European bison (*Bison bonasus*); beeffalo (a cross between a bison and a domesticated beef animal)". Animals of the genus listed, regardless of age, sex, or purpose raised. Wild bisons and buffaloes are excluded. Data are expressed in terms of the number of heads.	
Sheep	"*Ovis spp.*:"Animals of the genus listed, regardless of age, sex, or purpose raised. It includes Uriel, Argali, Bighorn, Karakul and Astrakhan. Data are expressed in terms of number of heads.	
Goats	"Goat, *Capra spp"*. Animals of the genus listed, regardless of age, sex, or purpose. Hircus, Ibex, Nubiana, Pyrenaica, Tibetana, Kashmir and Angora are included. Data are expressed in terms of number of heads.	
Pigs	"Pigs: domestic pig (*Sus domestica*); wild boar (*Sus scrofa*)". Animals of the genus listed, regardless of age, sex, or purpose raised. Non-domesticated wild boars are excluded. Data are expressed in terms of number of heads.	
Chickens	"Chicken fowl (*Gallus domesticus*); Guinea fowl (*Numida meleagris*" Data are expressed in terms of 1000 heads.	
Ducks	"Ducks, *Anas spp*." Data are expressed in terms of 1000 heads.	
Turkeys	"Geese, *Anser spp*." Data are expressed in terms of 1000 heads.	
Horses	"Horses, *Equus caballus spp*.". Animals of the genus listed, regardless of age, sex, or purpose raised. Data are expressed in terms of number of heads.	
Asses	"Asses, *Equus asinus spp*.". Animals of the genus listed, regardless of age, sex, or purpose raised. Data are expressed in terms of number of heads.	
Mules	Includes hinnies. Mules are the offspring of a male ass and a female horse (mare); a hinny is the offspring of a female ass and a male horse (stallion). Both are sterile. Animals of the genus listed, regardless of age, sex, or purpose raised. Data are expressed in terms of number of heads.	
Other Camelids	Various species of Lama: e.g. *glama pacos* (alpaca); *peruana* (llama); *huanacos* (guanaco); *vicugna* (vicuna)". Animals of the genus listed, regardless of age, sex, or purpose raised. Data are expressed in terms of number of heads.	
Camels	"Bactrian camel (*Camelus bactrianus*); Arabian camel (*C. dromedarius*)". Animals of the genus listed, regardless of age, sex, or purpose raised. Data are expressed in terms of number of heads.	
Dairy cows and Buffalo	Dairy cows are defined in this method as mature cows that are producing milk in commercial quantities for human consumption. This definition corresponds to the dairy cow population reported in the FAO Production Yearbook. In some countries, the dairy cow population consists of two well-defined segments: (i) high-producing (also called improved) breeds in commercial operations; and (ii) low-producing cows, managed with traditional methods. These two segments can be combined, or can be evaluated separately by defining two dairy cow categories. However, the dairy cow category does not include cows kept principally to produce calves for meat or to provide draft power. Low productivity multi-purpose cows should be considered as "Other cattle".	IPCC 2006- Vol.4- CH10 page 10.10
Broiler chickens	Typically grown approximately 60 days before slaughter. Data are obtained by multiplying data from FAOSTAT (available in the Production – Live Animals domain of the FAOSTAT database) by 1000.	IPCC 2006- Vol.4- Ch. 10 page 10.8
Market swine	Considered as a "dynamic" animal, and may vary from nursery pigs weighing less than 30 kilograms to finished pigs weighing over 90 kilograms. Data are obtained multiplying the total heads of pigs (available in the Production – Live Animals domain of the FAOSTAT database) by 0.9.	IPCC 2006- Vol.4- Ch. 10, Table 10.19
Breeding swine	Considered as a "static" animal. Data are obtained by multiplying the total heads of pigs (available in the Production – Live Animals domain of the FAOSTAT database) by 0.1.	IPCC 2006- Vol.4- Ch. 10, Table 10.19

Title	Definition	Source
Annual average population	Annual average populations are estimated in various ways, depending on the data available and on the nature of the animal population. In the case of static animal populations (e.g. dairy cows, breeding swine, layers), estimating the annual average population may be as simple as obtaining data related to one-time animal inventory data. However, estimating annual average populations for a growing population (e.g. meat animals, such as broilers, turkeys, beef cattle, and market swine) requires further evaluation. Most animals in these growing populations are alive for only part of a complete year. Animals should be included in the populations regardless of whether they were slaughtered for human consumption or they die of natural causes.	IPCC 2006- Vol.4- Ch. 10 page 10.8
Fertilizers	The domain includes data on Fertilizers. They are compiled in terms of fertilizer products and then converted into nutrients and classified according to the HS coding systems. Finally, total N (Nitrogen), P_2O_5 (Phosphate) and K_2O (Potash) are calculated for: Production, Imports, Exports, Non-fertilizer use and Consumption. Fertilizers may be organic, inorganic or mineral. Organic fertilizers play an important role in crop production and are derived from animals, plants and compost. Mineral fertilizers are available to farmers in solid or liquid form, and are delivered to the farm either in bulk, in bags or in pressurized containers. All fertilizers contain at least one of the major plant nutrients: nitrogen (N), phosphorus (P) or potassium (K).	FAOSTAT Glossary Concepts common to FAOSTAT & CountrySTAT
Consumption of Fertilizers	Refers the total quantity of fertilizers applied to the soil to increase crop yields (for crop production use). This refers to the "Actual Consumption, defined as actual deliveries to agriculture by the manufacturers or actual quantity consumed by a country for agriculture production".	
Synthetic Fertilizers	Inorganic compounds usually derived from by-products of the petroleum industry. Examples are ammonium nitrate, ammonium phosphate, superphosphate, and potassium sulphate.	
Ammonia, anhydrous (NH_3)	A material mostly produced by a synthetic process; at standard temperature and pressure, it is a gas. Fertilizer-grade anhydrous ammonia contains about 82% of nitrogen (HS code 2814).	
Ammonium nitrate (NH_4NO_3)	Produced by neutralizing nitric acid (HNO_3) with ammonia (NH_3). Ammonium nitrate may be in white or off-white granular or prilled form, and coated with a suitable material to prevent absorption of moisture and caking during storage. Pure ammonium nitrate may have a total nitrogen content of about 35%, of which one-half is present as ammoniac nitrogen and the other half as nitrate nitrogen (HS code 310230).	
Ammonium sulphate $(NH_4)_2SO_4$	Produced by reacting ammonia with sulphuric acid (H_2SO_4). It is produced in the form of fine white granules or crystals, and contains no less than 20.6% nitrogen in ammoniac form (HS code 310221).	
Calcium ammonium nitrate (NH_4NO_3+$CaCO_3$)	Produced from ammonium nitrate and finely pulverized calcium carbonate ($CACO_3$). It contains no less than 20.5% and up to 28% of nitrogen, half of which is in the form of ammoniac nitrogen and the other half in the form of nitrate nitrogen. It is produced in the form of white, off-white or grey granules or prills (HS code 310240).	
Urea – $CO(NH_2)_2$	Produced from synthetic ammonia and carbon dioxide (CO_2) and contains 46% nitrogen in ammoniac form. Urea may be in granular, prilled or crystalline form (HS code 310210).	
Urea and ammonium nitrate solutions	Produced from concentrated solutions of urea and ammonium nitrate, by chemical or blending processes (HS code 310280).	
Diammonium phosphate (DAP) – $(NH_4)_2HPO_4$	Produced by evaporating a solution of phosphoric acid with an excess of ammonia (HS code 310530).	
Monoammonium phosphate (MAP) – $NH_4H_2PO_4$	Formed when a solution of phosphoric acid is added to ammonia until the solution is distinctly acid (HS code 310540).	
Other NP compounds	Can be produced as the result of a chemical reaction of nitric acid on phosphate rock, with or without added ammonia and/or phosphoric and/or sulphuric acid; a reaction between sulphuric acid and ammonia; or by simple mechanical mixing or blending. Other NP compounds may also include some AN grades with small amounts of phosphates (HS code 310500).	

Title	Definition	Source
Other nitrogen & phosphates compounds	Can be produced as the result of a chemical reaction of nitric acid on phosphate rock, with or without added ammonia and/or phosphoric and/or sulphuric acid; a reaction between sulphuric acid and ammonia; or by simple mechanical mixing or blending. Other NP compounds may also include some AN grades with small amounts of phosphates (HS code 310551).	FAOSTAT Glossary Concepts common to FAOSTAT & CountrySTAT
Other nitrogen & phosphorus compounds	Can be produced as the result of a chemical reaction of nitric acid on phosphate rock, with or without added ammonia and/or phosphoric and/or sulphuric acid; a reaction between sulphuric acid and ammonia; or by simple mechanical mixing or blending. Other NP compounds may also include some AN grades with small amounts of phosphates (HS code 310559).	
NPK complex	Can be produced as the result of a chemical reaction of nitric acid on phosphate rock – the nitro phosphate route, with or without added ammonia and/or phosphoric and/or sulphuric acid – or between sulphuric acid and ammonia, i.e. the ammoniation route (HS code 310610).	
NPK complex <=10kg	Can be produced as the result of a chemical reaction of nitric acid on phosphate rock – the nitro phosphate route, with or without added ammonia and/or phosphoric and/or sulphuric acid – or between sulphuric acid and ammonia, i.e. the ammoniation route (HS code 310510).	
NPK complex >10kg	Can be produced as the result of a chemical reaction of nitric acid on phosphate rock – the nitro phosphate route, with or without added ammonia and/or phosphoric and/or sulphuric acid – or between sulphuric acid and ammonia, i.e. the ammoniation route (HS code 310520).	
NPK blends	Consist of two or more intermediate granular fertilizer materials of matching physical characteristics, blended together (HS code 310620).	
Potassium nitrate ($KNONH_3H_2PO_4$)	Can be produced from naturally occurring sodium nitrate and potassium chloride, and typically contains 13%N and 45% K_2O (HS code 283421).	
Organic Fertilizers	Animal or vegetable fertilizers, whether or not mixed together or chemically treated; or fertilizers produced by the mixing or chemical treatment of animal or vegetable product. These play an important role in crop production and are derived from animals, plants and compost. Mineral fertilizers are available to farmers in solid or liquid form, and are delivered to farms either in bulk, in bags or in pressurized containers. They include Cattle manure, Horse manure, Pig manure, Sheep manure, Poultry manure, Guano, Composts and Sewage waste.	
Forest	Land spanning more than 0.5 hectares with trees higher than 5 metres and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use.	FRA 2010 Terms and Definitions
Primary Forest	Naturally regenerated forest of native species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed.	
Other Naturally Regenerated Forest	Naturally regenerated forest with clearly visible indications of human activities and where the trees are predominantly of introduced species.	
Planted Forest	Forest predominantly composed of trees established through planting and/or deliberate seeding, and where the planted/seeded trees are predominantly of introduced species (Rubber plantations, mangroves and bamboo).	
Carbon density of living biomass	Carbon in all living biomass above the soil, including stem, stump, branches, bark, seeds, and foliage.	
Forest land	Includes all land with woody vegetation consistent with the thresholds used to define forest land in the national GHG inventory, sub-divided at the national level into managed and unmanaged land and also by ecosystem type, as specified in the IPCC Guidelines. This category also includes systems with vegetation that currently falls below, but is expected to exceed, the threshold of the forest land category.	IPCC 2006-Glossary
Net Forest Conversion	Change from forest land use to another use. For example, deforestation, reforestation and afforestation activities.	
Dry Matter	Dry matter refers to biomass that has been dried to an oven-dry state, often at 70°C.	

Title	Definition	Source
Area equipped for power irrigation	Area equipped for irrigation where pumps are used for water supply, from the source to the scheme. The term also includes areas where water is drained out with human- or animal-driven water lifting devices. The term does NOT refer to pumping required for the technology used within the field (such as sprinkler irrigation or localized irrigation, which require pressure and thus pumping).	AQUASTAT database of FAO
Area equipped for full control irrigation: sprinkler irrigation	A sprinkler irrigation system consists of a pipe network through which water moves under pressure, before being delivered to the crop via sprinkler nozzles. The system basically simulates rainfall in that water is applied through overhead spraying. These systems are also known as overhead irrigation systems. Unit measure: 1000 hectares.	
Area equipped for full control irrigation: localized irrigation	Localized irrigation is a system where the water is distributed under low pressure through a piped network, in a pre-determined pattern, and applies water as a light discharge to each plant or adjacent to it. There are three main categories of localized irrigation: drip irrigation (where drip emitters are used to apply water slowly to the soil surface), spray or micro-sprinkler irrigation (where water is sprayed to the soil near individual plants or trees) and bubbler irrigation (where a light stream is applied to flood small basins or the soil adjacent to individual trees). The following terms are also sometimes used to refer to localized irrigation: micro-irrigation, trickle irrigation, daily flow irrigation, drop-irrigation, sip irrigation, and diurnal irrigation. Unit measure: 1000 hectares.	
Motor gasoline	Gasoline (or motor gasoline) is a light hydrocarbon oil for use in internal combustion engines such as motor vehicles, excluding aircraft. It distills between 35°C and 200°C, and is treated to reach a sufficiently high octane number, generally between 80 and 100 RON. The substance may be treated by reforming, blending with an aromatic fraction, or by adding to it benzole or other additives (such as tetraethyl lead).	UNSD Glossary (Energy balances and electricity profiles)
Residual fuel oil	A heavy oil that makes up the distillation residue. It comprises all fuels (including those obtained by blending) with a kinematic viscosity above 27.5 cSt at 38oC. Its flash point is always above 50oC and its specific gravity is higher than 0.90. It is commonly used by ships and industrial large-scale heating installations as a fuel in furnaces or boilers.	
Coal	Coal corresponds to 'Other bituminous coal' or, when not available for the specific country, to 'Hard coal' (which includes the latter). Hard coal is a coal that has a high degree of coalification, with a gross calorific value above 23,865 KJ/kg (5,700 kcal/kg) on an ash-free but moist basis, and a mean random reflectance of vitrinite of at least 0.6. Slurries, middling and other low-grade coal products, which cannot be classified according to the type of coal from which they are obtained, are included under hard coal. There are two sub-categories of hard coal: (i) coking coal and (ii) other bituminous coal and anthracite (also known as steam coal). Coking coal is a hard coal with a quality that allows the production of coke suitable to support a blast furnace charge. Steam coal is coal used for steam raising and space heating purposes and includes all anthracite coals and bituminous coals not classified as coking coal. 'Other bituminous coal' has a higher volatile matter and a lower carbon content than anthracite.	
Anthracite	Coal that has a high degree of coalification with a gross calorific value above 23,865 KJ/kg (5,700 kcal/kg) on an ash-free but moist basis, and a mean random reflectance of vitrinite of at least 0.6. Slurries, middling and other low-grade coal products, which cannot be classified according to the type of coal from which they are obtained, are included under hard coal. There are two sub-categories of hard coal: (i) coking coal and (ii) other bituminous coal and anthracite (also known as steam coal). Coking coal is a hard coal with a quality that allows the production of coke suitable to support a blast furnace charge. Steam coal is coal used for steam raising and space heating purposes, and includes all anthracite coals and bituminous coals not classified as coking coal.	
Electricity	Final electricity consumption by the agriculture sector.	

Title	Definition	Source
Gas-diesel oils used in fisheries	Gas-diesel oils include heavy gas oils used in fishery. Gas oils are obtained from the lowest fraction from atmospheric distillation of crude oil, while heavy gas oils are obtained by vacuum re-distillation of the residue from the atmospheric distillation. Gas-diesel oil distils between 180°C and 380°C. Several grades are available depending on the uses: diesel oil for diesel compression ignition (cars, trucks, marine, etc.), light heating oil for industrial and commercial uses, and other gas oil including heavy gas oils which distil between 380°C and 540°C and which are used as petrochemical feed stocks.	Adapted from IEA Oil products definitions
Residual fuel oil used in fisheries	Oils that make up the distillation residue. This comprises all residual fuel oils, including those obtained by blending, used in fisheries. Its kinematic viscosity is above 10 cSt at 80°C. The flash point is always above 50°C and the density is always higher than 0.90 kg/l.	
Gas-diesel oils	Heavy oils distilling between 200oC and 380oC, but distilling less than 65% in volume at 250oC, including losses, and 85% or more at 350oC. Its flash point is always above 50oC and its specific gravity is higher than 0.82. Heavy oils obtained by blending are grouped together with gas oils on the condition that their kinematic viscosity does not exceed 27.5 cSt at 38oC. Also included are middle distillates intended for the petrochemical industry. Gas-diesel oils are used as a fuel for internal combustion in diesel engines, as a burner fuel in heating installations, such as furnaces, and for enriching water gas to increase its luminosity. Other names for this product are diesel fuel, diesel oil, gas oil and solar oil.	UNSD Glossary (Energy balances and electricity profiles)
Natural gas (including LNG)	Gases consisting mainly of methane occurring naturally in underground deposits. It includes both non-associated gas (originating from fields producing only hydrocarbons in gaseous form) and associated gas (originating from fields producing both liquid and gaseous hydrocarbons), as well as methane recovered from coal mines and sewage gas. Production of natural gas refers to dry marketable production, measured after purification and extraction of natural gas liquids and sulphur. Extraction losses and the amounts that have been re-injected, flared, and vented are excluded from the data on production.	Natural gas (including LNG)
Liquefied petroleum gas (LPG)	Hydrocarbons which are gaseous under conditions of normal temperature and pressure but are liquefied by compression or cooling to facilitate storage, handling and transportation. They are (i) extracted by stripping of natural gas at crude petroleum and natural gas sources; (ii) extracted by stripping of imported natural gas in installations of the importing country; and (iii) produced both in and outside of refineries, in the course of processing crude petroleum or its derivatives. It comprises propane (C_3H_8), butane (C_4H_{10}), or a combination of the two. Also included is ethane (C_2H_6) from petroleum refineries or natural gas producers' separation and stabilization plants.	UNSD Glossary (Energy balances and electricity profiles)
Country emission factor (electricity-only)	The CO_2 emissions in the numerator of this indicator include emissions from fossil fuels, industrial waste and non-renewable municipal waste that are consumed for electricity generation; electricity output in the denominator includes electricity generated from fossil fuels, nuclear, hydropower (excluding pumped storage), geothermal, solar, biofuels, etc. As a result, the emissions per kWh may vary from year to year, depending on the generation mix. A fixed-heat-efficiency approach is used, which fixes the efficiency of the heat part of the generation, and calculates the electricity part of the input accordingly. More information is available in Chapter 4 of the IEA's *CO_2 Emissions from Fuel Combustion Highlights*, available at https://www.iea.org/co2highlights/co2highlights.pdf.	IEA, 2012, CO_2 Emissions from Fuel Combustion – Highlights

Symbols

C	Carbon
CO_2	Carbon dioxide
N_2O	Nitrous oxide
CH_4	Methane
$CaCO_3$	Calcic limestone
$CaMg(CO_3)_2$	Dolomite
$CO(NH_2)_2$	Urea
NH_4+	Ammonium
OH-	Hydroxyl ion
HCO_3-	Bicarbonate
CO_2eq	Carbon dioxide equivalent
NOX	Nitrogen oxides
N_2O-N	Units of measurement expressed in molecular nitrogen (N_2). - Molar mass N_2O = 14+14+16 = 44 g/mol - Molar mass N_2 = 14*2 = 28 g/mol 1 kg of N_2O-N corresponds to 1 kg * 44/28 = 1.57 kg N_2O
Gg	A unit of mass equal to 1,000,000,000 grams
Tonnes	A unit of mass equal to 1,000 kilograms
PJ	A petajoule is equal to 1 joule x 10^{15}
TJ	A terajoule is equal to 1 joule x10^{12}
KWh	kilowatt hour
GWP (N_2O)	Global Warming Potential for N_2O, kg-CO_2-e (kg-N_2O)-1 (IPCC default = 310)

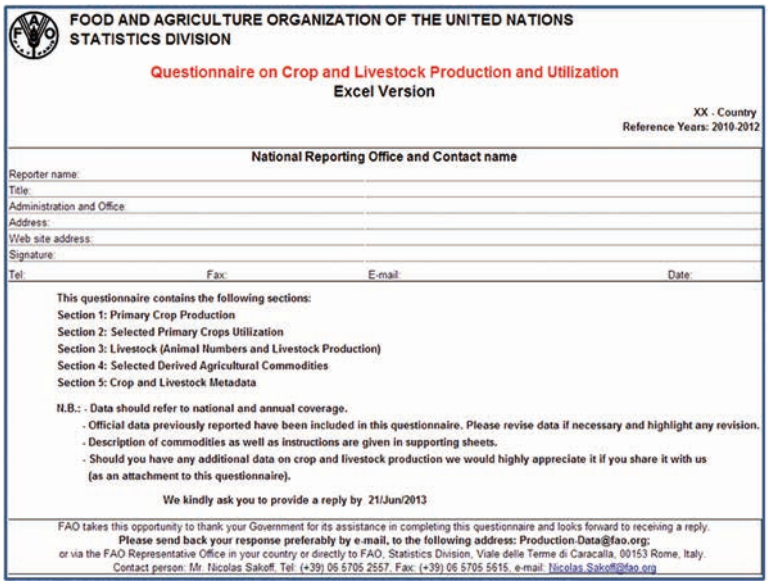
Annex 2

DATA ACTIVITIES: EXAMPLE OF NATIONAL QUESTIONNAIRE ON DATA COLLECTION

Countries are requested to provide agricultural data coming from primary sources, i.e. agricultural censuses, surveys and administrative records, including related metadata (the methodology, the contact name responsible of the office, *etc.*).

The data are organized in order to respond to a standard methodology of concepts, definitions and classification of commodities adopted by FAO (FAOSTAT) in line with the international requirements of data quality, so that the data is comparable and reliable. Figure 53 below shows a sample Excel file of the production domain, which includes statistics on the area harvested by crop and on livestock production.

FIGURE 54
Example of a FAOSTAT Questionnaire



FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
STATISTICS DIVISION

Questionnaire on Crop and Livestock Production and Utilization
Excel Version

XX - Country
Reference Years: 2010-2012

National Reporting Office and Contact name

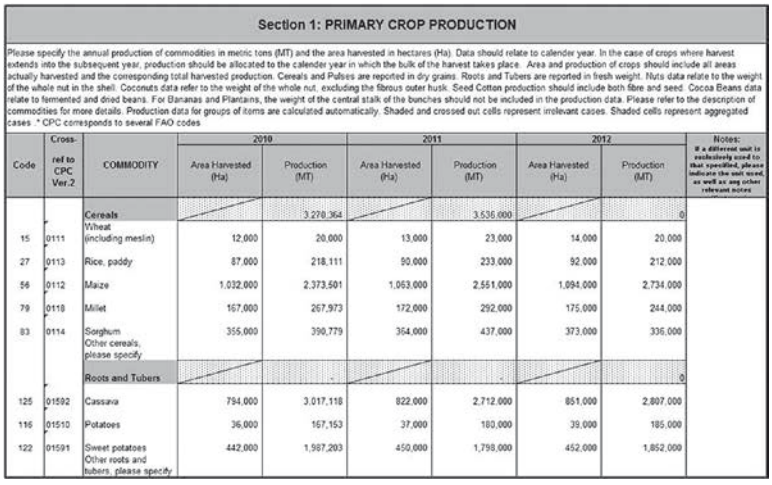
Reporter name:
Title:
Administration and Office:
Address:
Web site address:
Signature:
Tel: Fax: E-mail: Date:

This questionnaire contains the following sections:
Section 1: Primary Crop Production
Section 2: Selected Primary Crops Utilization
Section 3: Livestock (Animal Numbers and Livestock Production)
Section 4: Selected Derived Agricultural Commodities
Section 5: Crop and Livestock Metadata

N.B.: - Data should refer to national and annual coverage.
- Official data previously reported have been included in this questionnaire. Please revise data if necessary and highlight any revision.
- Description of commodities as well as instructions are given in supporting sheets.
- Should you have any additional data on crop and livestock production we would highly appreciate it if you share it with us (as an attachment to this questionnaire).

We kindly ask you to provide a reply by 21/Jun/2013

FAO takes this opportunity to thank your Government for its assistance in completing this questionnaire and looks forward to receiving a reply.
Please send back your response preferably by e-mail, to the following address: Production-Data@fao.org;
or via the FAO Representative Office in your country or directly to FAO, Statistics Division, Viale delle Terme di Caracalla, 00153 Rome, Italy.
Contact person: Mr. Nicolas Sakoff, Tel: (+39) 06 5705 2557, Fax: (+39) 06 5705 5615, e-mail: Nicolas.Sakoff@fao.org



Section 1: PRIMARY CROP PRODUCTION

Please specify the annual production of commodities in metric tons (MT) and the area harvested in hectares (Ha). Data should relate to calender year. In the case of crops where harvest extends into the subsequent year, production should be allocated to the calender year in which the bulk of the harvest takes place. Area and production of crops should include all areas actually harvested and the corresponding total harvested production. Cereals and Pulses are reported in dry grains. Roots and Tubers are reported in fresh weight. Nuts data relate to the weight of the whole nut in the shell. Coconuts data refer to the weight of the whole nut, excluding the fibrous outer husk. Seed Cotton production should include both fibre and seed. Cocoa Beans data relate to fermented and dried beans. For Bananas and Plantains, the weight of the central stalk of the bunches should not be included in the production data. Please refer to the description of commodities for more details. Production data for groups of items are calculated automatically. Shaded and crossed out cells represent irrelevant cases. Shaded cells represent aggregated cases. * CPC corresponds to several FAO codes

Code	Cross-ref to CPC Ver.2	COMMODITY	2010		2011		2012		Notes: If a different unit is exclusively used to that specified, please indicate the unit used, as well as any other relevant notes
			Area Harvested (Ha)	Production (MT)	Area Harvested (Ha)	Production (MT)	Area Harvested (Ha)	Production (MT)	
		Cereals		3,270,364		3,536,000		0	
15	0111	Wheat (including meslin)	12,000	20,000	13,000	23,000	14,000	20,000	
27	0113	Rice, paddy	87,000	218,111	90,000	233,000	92,000	212,000	
56	0112	Maize	1,032,000	2,373,601	1,063,000	2,551,000	1,094,000	2,734,000	
79	0118	Millet	167,000	267,973	172,000	292,000	175,000	244,000	
83	0114	Sorghum	355,000	390,779	364,000	437,000	373,000	336,000	
		Other cereals, please specify							
		Roots and Tubers						0	
125	01592	Cassava	794,000	3,017,118	822,000	2,712,000	851,000	2,807,000	
116	01510	Potatoes	36,000	167,153	37,000	180,000	39,000	185,000	
122	01591	Sweet potatoes	442,000	1,987,203	450,000	1,798,000	452,000	1,852,000	
		Other roots and tubers, please specify							

The FAOSTAT questionnaires are also sent to compile Fertilizers, Pesticides, Land Irrigation, Producer Prices and other agricultural domains; for trade, countries provide data coming from the national customs.

This information is provided by National Statistical Offices or Ministries. Detailed information on questionnaires is available in the "Questionnaires" section of the FAO Statistics Division's website (http://www.fao.org/economic/ess/ess-home/questionnaires/en/).

The FAOSTAT commodity list of Production is based on the Standard International Trade Classification of the UN (SITC), to provide a framework for the harmonization of production and trade data and the compilation of SUA/FBS, and to calculate various indexes (Agricultural Production Index Number – food and non-food). Details on the relevant concepts and definitions are available in the Glossary section.

Although FAOSTAT, as an international source, has adopted a process of data harmonization and validation required by international standards, during the data collection process (i.e. questionnaire compilation), experience with countries has shown that national statistical structures have had to face the following issues, at different levels:

- Data scattering coming from multiple structures responsible for producing statistics;
- Production of the same kind of statistics by different structures;
- Incompleteness of statistics;
- Absence or incompleteness of national classifications;
- Discrepancies between national and international classifications of products;
- Lack of correspondence between national and international nomenclatures;
- Absence of an organized national level for the validation and harmonization of data;
- Weakness of data organization;
- Lack of management tools and digital archiving of statistical data;
- Weakness of the technical documentation that must accompany the production data (metadata);

With the objective to produce good quality food and agriculture statistics, the FAO Statistics Division implements projects to promote data quality, which in turn enables effective decision and policy making. In this context, national technical working groups have been organized, composed of the main national institutions. In collaboration with the Statistics Division, it is envisaged that these groups will address and eventually solve the following issues encountered in practice:

1. Incoherent data among national sources;
2. Missing data;
3. Anomalies in historical trends;
4. Incoherence between related indicators;
5. Incoherence between CORE and Sub-national data;
6. Inconsistencies between local and international concepts and definitions;
7. Lack of correspondence between national and international classifications.

In collaboration with Member Countries, the FAO Statistics Division has provided suggestions to address each of the abovementioned issues. These may be viewed as part of the E-Learning course, available at http://www.fao.org/economic/ess/ess-capacity/countrystathome/foundations/en/#.Uuul0T1dWHc

Annex 3

TECHNICAL PARAMETERS

TABLE 1
Emission factor for methane for animal category, kg CH_4 $head^{-1}$ by IPCC area

IPCC Area	Dairy	Non-dairy	Buffalo	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	58.00	27.00	55.00	18.00	10.00	10.00	46.00	46.00
Eastern Europe	99.00	58.00	55.00	18.00	10.00	10.00	46.00	46.00
Africa	46.00	31.00	55.00	18.00	10.00	10.00	46.00	46.00
Oceania	90.00	60.00	55.00	18.00	10.00	10.00	46.00	46.00
Western Europe	117.00	57.00	55.00	18.00	10.00	10.00	46.00	46.00
Latin America	72.00	56.00	55.00	18.00	10.00	10.00	46.00	46.00
Middle east	46.00	31.00	55.00	18.00	10.00	10.00	46.00	46.00
Northern America	128.00	53.00	55.00	18.00	10.00	10.00	46.00	46.00
Asia	68.00	47.00	55.00	18.00	10.00	10.00	46.00	46.00

Developed/developing	Pigs	Sheep	Goats
Developed	1.50	8.00	8.00
Developing	1.00	5.00	5.00

TABLE 2
Emission factor for methane for animal category, kg CH_4 $head^{-1}$ by country

FAO Country Name	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Horses	Asses	Mules	Camels	Llamas	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys
Afghanistan	5.00	2.00	4.00	3.00	3.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Albania	13.00	7.00	5.00	3.00	5.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Algeria	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
American Samoa	30.00	2.00	2.00	13.00	24.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Andorra	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Angola	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Anguilla	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Antigua and Barbuda	2.00	1.00	2.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Argentina	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Armenia	9.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Aruba	2.00	1.00	2.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Australia	29.00	2.00	2.00	13.00	24.00	0.28	0.20	2.34	1.10	1.10	2.37	2.37	0.02	0.03	0.03	0.02
Austria	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Azerbaijan	9.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Bahamas	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Bahrain	3.00	1.00	5.00	5.00	5.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Bangladesh	5.00	2.00	5.00	6.00	6.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Barbados	2.00	1.00	2.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Belarus	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Belgium	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Belgium-Luxembourg	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Belize	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Benin	1.00	1.00	5.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Bermuda	93.00	2.00		19.00	37.00	0.28	0.20	2.34	1.10	1.10	2.37	2.37	0.02	0.03	0.03	0.02
Bhutan	5.00	2.00	4.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Bolivia (Plurinational State of)	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Bosnia and Herzegovina	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Botswana	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Brazil	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
British Virgin Islands	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Brunei Darussalam	31.00	1.00	2.00	7.00	7.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Bulgaria	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Burkina Faso	1.00	1.00	5.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Burundi	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Cambodia	31.00	1.00	2.00	7.00	7.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02

FAO Country Name	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Horses	Asses	Mules	Camels	Llamas	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys
Cameroon	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Canada	48.00	1.00		10.00	19.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Cape Verde	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Cayman Islands	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Central African Republic	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Chad	1.00	1.00	5.00	1.00	1.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Channel Islands	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Chile	1.00	1.00	1.00	1.00	1.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
China, Hong Kong SAR	9.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
China, Macao SAR	9.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
China, mainland	9.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
China, Taiwan Province of	9.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Colombia	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Comoros	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Congo	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Cook Islands	30.00	2.00	2.00	13.00	24.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Costa Rica	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Côte d'Ivoire	1.00	1.00	5.00	1.00	1.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Croatia	12.00	6.00	5.00	3.00	5.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Cuba	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Cyprus	16.00	1.00	2.00	3.00	3.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Czech Republic	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Czechoslovakia	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Democratic People's Republic of Korea	9.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Democratic Republic of the Congo	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Denmark	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Djibouti	1.00	1.00	5.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Dominica	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Dominican Republic	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Ecuador	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Egypt	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
El Salvador	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Equatorial Guinea	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Eritrea	1.00	1.00	5.00	1.00	1.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Dominica	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Dominican Republic	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Ecuador	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02

FAO Country Name	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Horses	Asses	Mules	Camels	Llamas	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys
Egypt	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
El Salvador	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Equatorial Guinea	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Eritrea	1.00	1.00	5.00	1.00	1.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Estonia	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Ethiopia	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Ethiopia PDR	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Falkland Islands (Malvinas)	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Faroe Islands	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Fiji	30.00	2.00	2.00	13.00	24.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Finland	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
France	23.00	7.00	4.00	6.00	10.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
French Guiana	2.00	1.00	2.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
French Polynesia	30.00	2.00	2.00	13.00	24.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Gabon	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Gambia	1.00	1.00	5.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Georgia	9.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Germany	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Ghana	1.00	1.00	5.00	1.00	1.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Gibraltar	27.00	8.00	5.00	7.00	11.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Greece	29.00	8.00	5.00	8.00	12.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Greenland	48.00	1.00		10.00	19.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Grenada	2.00	1.00	2.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Guadeloupe	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Guam	31.00	2.00	2.00	13.00	24.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Guatemala	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Guinea	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Guinea-Bissau	1.00	1.00	5.00	1.00	1.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Guyana	2.00	1.00	2.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Haiti	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Holy See	34.00	10.00	6.00	9.00	13.00	0.28	0.20	2.34	1.10	1.10	2.37	2.37	0.02	0.03	0.03	0.02
Honduras	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Hungary	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Iceland	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
India	5.00	2.00	5.00	5.00	5.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Indonesia	28.00	1.00	2.00	6.00	6.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Iran (Islamic Republic of)	15.00	1.00	2.00	3.00	3.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02

FAO Country Name	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Horses	Asses	Mules	Camels	Llamas	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys
Iraq	2.00	1.00	5.00	4.00	4.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Ireland	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Isle of Man	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Israel	2.00	1.00	5.00	3.00	3.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Italy	25.00	7.00	5.00	7.00	10.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Jamaica	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Japan	10.00	1.00	1.00	2.00	2.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Jordan	2.00	1.00	5.00	3.00	3.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Kazakhstan	9.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Kenya	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Kiribati	31.00	2.00	2.00	13.00	24.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Kuwait	2.00	1.00	5.00	5.00	5.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Kyrgyzstan	9.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Lao People's Democratic Republic	24.00	1.00	2.00	5.00	5.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Latvia	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Lebanon	2.00	1.00	4.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Lesotho	1.00	0.00	4.00	0.00	0.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Liberia	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Libya	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Liechtenstein	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Lithuania	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Luxembourg	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Madagascar	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Malawi	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Malaysia	28.00	1.00	2.00	6.00	6.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Maldives	17.00	1.00	2.00	4.00	4.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Mali	1.00	1.00	5.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Malta	43.00	13.00	8.00	11.00	16.00	0.28	0.20	2.34	1.10	1.10	2.37	2.37	0.02	0.03	0.03	0.02
Marshall Islands	28.00	2.00	2.00	13.00	23.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Martinique	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Mauritania	1.00	1.00	5.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Mauritius	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Mayotte	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Mexico	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Micronesia (Federated States of)	31.00	2.00	2.00	13.00	24.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Monaco	27.00	8.00	5.00	7.00	11.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Mongolia	9.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01

FAO Country Name	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Horses	Asses	Mules	Camels	Llamas	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys
Montenegro	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Montserrat	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Morocco	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Mozambique	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Myanmar	23.00	1.00	2.00	5.00	5.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Namibia	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Nauru	31.00	2.00	2.00	13.00	24.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Nepal	5.00	2.00	4.00	3.00	3.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Netherlands	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Netherlands Antilles	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
New Caledonia	31.00	2.00	2.00	13.00	24.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
New Zealand	23.00	1.00	1.00	11.00	20.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Nicaragua	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Niger	1.00	1.00	5.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Nigeria	1.00	1.00	5.00	1.00	1.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Niue	30.00	2.00	2.00	13.00	24.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Norfolk Island	31.00	2.00	2.00	13.00	24.00	0.37	0.26	3.13	1.52	1.52	3.17	3.17	0.02	0.03	0.03	0.02
Northern Mariana Islands	31.00	2.00	2.00	13.00	24.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Norway	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Occupied Palestinian Territory	2.00	1.00	5.00	3.00	3.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Oman	3.00	1.00	5.00	5.00	5.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Pacific Islands Trust Territory	31.00	2.00	2.00	13.00	24.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Pakistan	5.00	2.00	5.00	4.00	4.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Palau	31.00	2.00	2.00	13.00	24.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Panama	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Papua New Guinea	30.00	2.00	2.00	13.00	24.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Paraguay	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Peru	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Philippines	28.00	1.00	2.00	6.00	6.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Pitcairn Islands	30.00	2.00	2.00	13.00	24.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Poland	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Portugal	34.00	10.00	6.00	9.00	13.00	0.28	0.20	2.34	1.10	1.10	2.37	2.37	0.02	0.03	0.03	0.02
Puerto Rico	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Qatar	3.00	1.00	5.00	5.00	5.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Republic of Korea	10.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Republic of Moldova	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Réunion	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Romania	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02

FAO Country Name	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Horses	Asses	Mules	Camels	Llamas	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys
Russian Federation	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Rwanda	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Saint Helena	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Saint Kitts and Nevis	2.00	1.00	2.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Saint Lucia	2.00	1.00	2.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Saint Pierre and Miquelon	48.00	1.00		10.00	19.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Saint Vincent and the Grenadines	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Samoa	31.00	2.00	2.00	13.00	24.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
San Marino	27.00	8.00	5.00	7.00	11.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Sao Tome and Principe	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Saudi Arabia	2.00	1.00	5.00	5.00	5.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Senegal	1.00	1.00	5.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Serbia	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Serbia and Montenegro	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Seychelles	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Sierra Leone	1.00	1.00	5.00	1.00	1.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Singapore	31.00	1.00	2.00	7.00	7.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Slovakia	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Slovenia	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Solomon Islands	31.00	2.00	2.00	13.00	24.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Somalia	1.00	1.00	5.00	1.00	1.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
South Africa	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
South Sudan	6.00	2.00	5.00	6.00	6.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Spain	27.00	8.00	5.00	7.00	11.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Sri Lanka	6.00	2.00	5.00	6.00	6.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Sudan	6.00	2.00	5.00	6.00	6.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Sudan (former)	1.00	1.00	5.00	1.00	1.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Suriname	2.00	1.00	2.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Svalbard and Jan Mayen Islands	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Swaziland	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Sweden	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Switzerland	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Syrian Arab Republic	2.00	1.00	5.00	3.00	3.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Tajikistan	9.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Thailand	28.00	1.00	2.00	6.00	6.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
The former Yugoslav Republic of Macedonia	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02

FAO Country Name	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Horses	Asses	Mules	Camels	Llamas	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys
Timor-Leste	26.00	1.00	2.00	6.00	6.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Togo	1.00	1.00	5.00	1.00	1.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Tokelau	31.00	2.00	2.00	13.00	24.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Tonga	30.00	2.00	2.00	13.00	24.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Trinidad and Tobago	2.00	1.00	2.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Tunisia	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Turkey	10.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Turkmenistan	12.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Turks and Caicos Islands	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Tuvalu	30.00	2.00	2.00	13.00	24.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Uganda	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Ukraine	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
United Arab Emirates	3.00	1.00	5.00	5.00	5.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
United Kingdom	21.00	6.00	4.00	6.00	9.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
United Republic of Tanzania	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
United States of America	48.00	1.00		10.00	19.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
United States Virgin Islands	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Uruguay	1.00	1.00	1.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
USSR	11.00	6.00	5.00	3.00	4.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Uzbekistan	11.00	1.00	1.00	2.00	2.00	0.10	0.11	1.09	0.60	0.60	1.28	1.28	0.01	0.01	0.01	0.01
Vanuatu	30.00	2.00	2.00	13.00	24.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Venezuela (Bolivarian Republic of)	2.00	1.00	2.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Viet Nam	24.00	1.00	2.00	5.00	5.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Wallis and Futuna Islands	31.00	2.00	2.00	13.00	24.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Western Sahara	1.00	1.00	5.00	2.00	2.00	0.20	0.22	2.19	1.20	1.20	2.56	2.56	0.02	0.02	0.02	0.02
Yemen	2.00	1.00	5.00	5.00	5.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Yugoslav SFR	11.00	6.00	5.00	3.00	4.00	0.19	0.13	1.56	0.76	0.76	1.58	1.58	0.02	0.03	0.02	0.02
Zambia	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02
Zimbabwe	1.00	1.00	5.00	1.00	1.00	0.15	0.17	1.64	0.90	0.90	1.92	1.92	0.02	0.02	0.02	0.02

TABLE 3
Nitrogen excreted in manure for animal category, kg N head^{-1} by IPCC area

IPCC Area	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.47	0.34	0.32	0.42	0.24	1.17	1.37	1.10	0.82	0.83	0.74	0.46	0.46	0.46	0.46	0.46
Eastern Europe	0.35	0.35	0.32	0.55	0.46	0.9	1.28	1.10	0.82	0.83	0.74	0.30	0.30	0.30	0.38	0.38
Africa	0.6	0.63	0.32	1.57	0.55	1.17	1.37	1.10	0.82	0.83	0.74	0.46	0.46	0.46	0.46	0.46
Oceania	0.44	0.5	0.32	0.53	0.46	1.13	1.42	1.10	0.82	0.83	0.74	0.30	0.30	0.30	0.38	0.38
Western Europe	0.48	0.33	0.32	0.51	0.42	0.85	1.28	1.10	0.96	0.83	0.74	0.26	0.26	0.26	0.38	0.38
Latin America	0.48	0.36	0.32	1.57	0.55	1.17	1.37	1.10	0.82	0.83	0.74	0.46	0.46	0.46	0.46	0.46
Asia	0.47	0.34	0.32	0.42	0.24	1.17	1.37	1.10	0.82	0.83	0.74	0.46	0.46	0.46	0.46	0.46
Middle east	0.7	0.79	0.32	1.57	0.55	1.17	1.37	1.10	0.82	0.83	0.74	0.46	0.46	0.46	0.46	0.46
Northern America	0.44	0.31	0.32	0.42	0.24	0.42	0.45	1.10	0.83	0.83	0.74	0.30	0.30	0.30	0.38	0.38

TABLE 4
Typical Animal Mass, kg by IPCC area and animal category

IPCC Area	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys
Indian Subcontinent	275	110	295	28	28	0.9	1.8	2.7	6.8
Eastern Europe	550	391	380	50	180	0.9	1.8	2.7	6.8
Africa	275	173	380	28	28	0.9	1.8	2.7	6.8
Oceania	500	330	380	45	180	0.9	1.8	2.7	6.8
Western Europe	600	420	380	50	198	0.9	1.8	2.7	6.8
Latin America	400	305	380	28	28	0.9	1.8	2.7	6.8
Asia	350	391	380	50	180	0.9	1.8	2.7	6.8
Middle east	275	173	380	28	28	0.9	1.8	2.7	6.8
Northern America	604	389	380	46	198	0.9	1.8	2.7	6.8

IPCC Area	Sheep	Goats	Horses	Asses	Mules	Camels	Llamas
Developed	48.50	38.50	377.00	130	130	217	217
Developing	28.00	30.00	238.00	130	130	217	217

TABLE 5
Share of manure treated in MS lagoon for each animal category, by IPCC area

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0,000	0,000	0,000	0,090	0,090	0,000	0,000	0,010	0,010	0,010	0,010	0,000	0,000	0,000	0,000	0,000
Eastern Europe	0,000	0,000	0,000	0,030	0,030	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Africa	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Oceania	0,160	0,000	0,000	0,540	0,540	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Western Europe	0,000	0,000	0,000	0,087	0,087	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Latin America	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Asia	0,040	0,000	0,000	0,000	0,000	0,000	0,000	0,010	0,010	0,010	0,010	0,000	0,000	0,000	0,000	0,000
Middle east	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Northern America	0,150	0,000	0,000	0,328	0,328	0,000	0,000	0,050	0,050	0,050	0,050	0,000	0,000	0,000	0,000	0,000

TABLE 6
Share of manure treated in MS slurry for animal category by IPCC area

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.010	0.010	0.000	0.220	0.220	0.000	0.000	0.020	0.020	0.020	0.020	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.175	0.225	0.240	0.000	0.000	0.000	0.000	0.280	0.280	0.280	0.280	0.000	0.000	0.000	0.000	0.000
Africa	0.000	0.000	0.000	0.060	0.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.357	0.252	0.200	0.000	0.000	0.000	0.000	0.130	0.130	0.130	0.130	0.000	0.000	0.000	0.000	0.000
Latin America	0.010	0.000	0.000	0.080	0.080	0.000	0.000	0.090	0.090	0.090	0.090	0.000	0.000	0.000	0.000	0.000
Asia	0.380	0.000	0.000	0.400	0.400	0.000	0.000	0.020	0.020	0.020	0.020	0.000	0.000	0.000	0.000	0.000
Middle east	0.010	0.000	0.000	0.140	0.140	0.000	0.000	0.010	0.010	0.010	0.010	0.000	0.000	0.000	0.000	0.000
Northern America	0.270	0.002	0.000	0.185	0.185	0.000	0.000	0.040	0.040	0.040	0.040	0.000	0.000	0.000	0.000	0.000

TABLE 7
Share of manure treated in MS solid storage for animal category by IPCC area

IPCC Area	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.000	0.000	0.000	0.160	0.160	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.600	0.440	0.000	0.420	0.420	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.010	0.000	0.000	0.060	0.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.000	0.000	0.000	0.030	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.368	0.390	0.000	0.137	0.137	0.020	0.000	0.010	0.010	0.010	0.010	0.000	0.000	0.000	0.000	0.000
Latin America	0.010	0.000	0.000	0.100	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.263	0.000	0.000	0.042	0.042	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 8:
Share of manure treated in MS dry lot for animal category by IPCC area

IPCC Area	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.000	0.040	0.040	0.300	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.000	0.010	0.000	0.870	0.870	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.000	0.090	0.000	0.150	0.150	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.000	0.000	0.790	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.000	0.000	0.000	0.410	0.410	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.000	0.460	0.410	0.540	0.540	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.000	0.010	0.000	0.690	0.690	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.000	0.184	0.000	0.040	0.040	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 9
Share of manure treated in MS daily spread for animal category by IPCC area

IPCC Area	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.190	0.200	0.210	0.090	0.090	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.050	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.070	0.018	0.000	0.020	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.620	0.000	0.000	0.020	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.290	0.020	0.040	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.020	0.020	0.190	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.184	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 10
Share of manure treated in MS digester for animal category by IPCC area

IPCC Area	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.010	0.010	0.010	0.080	0.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.020	0.000	0.000	0.070	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 11
Share of manure treated in MS pit below one month for animal category by IPCC area

IPCC Area	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.000	0.000	0.000	0.030	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.000	0.000	0.000	0.247	0.247	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.000	0.000	0.000	0.010	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.000	0.000	0.000	0.028	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 12
Share of manure treated in MS pit above one month for each animal category, by IPCC area

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.010	0.010	0.000	0.220	0.220	0.000	0.000	0.020	0.020	0.020	0.020	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.175	0.225	0.240	0.000	0.000	0.000	0.000	0.280	0.280	0.280	0.280	0.000	0.000	0.000	0.000	0.000
Africa	0.000	0.000	0.000	0.060	0.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.357	0.252	0.200	0.000	0.000	0.000	0.000	0.130	0.130	0.130	0.130	0.000	0.000	0.000	0.000	0.000
Latin America	0.010	0.000	0.000	0.080	0.080	0.000	0.000	0.090	0.090	0.090	0.090	0.000	0.000	0.000	0.000	0.000
Asia	0.380	0.000	0.000	0.400	0.400	0.000	0.000	0.020	0.020	0.020	0.020	0.000	0.000	0.000	0.000	0.000
Middle east	0.010	0.000	0.000	0.140	0.140	0.000	0.000	0.010	0.010	0.010	0.010	0.000	0.000	0.000	0.000	0.000
Northern America	0.270	0.002	0.000	0.185	0.185	0.000	0.000	0.040	0.040	0.040	0.040	0.000	0.000	0.000	0.000	0.000

TABLE 13
Share of manure treated in other MS for each animal category, by IPCC area

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.000	0.000	0.000	0.000	0.000	0.170	0.050	0.520	0.520	0.520	0.520	0.050	0.050	0.050	0.050	0.050
Eastern Europe	0.020	0.135	0.470	0.000	0.000	0.270	0.080	0.710	0.710	0.710	0.710	0.080	0.080	0.080	0.080	0.080
Africa	0.040	0.000	0.000	0.000	0.000	0.010	0.010	0.190	0.190	0.190	0.190	0.010	0.010	0.010	0.010	0.010
Oceania	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.970	0.970	0.970	0.970	0.000	0.000	0.000	0.000	0.000
Western Europe	0.005	0.020	0.000	0.000	0.000	0.110	0.040	0.840	0.840	0.840	0.840	0.040	0.040	0.040	0.040	0.040
Latin America	0.000	0.010	0.010	0.000	0.000	0.000	0.010	0.490	0.490	0.490	0.490	0.010	0.010	0.010	0.010	0.010
Asia	0.000	0.000	0.000	0.000	0.000	0.170	0.050	0.520	0.520	0.520	0.520	0.050	0.050	0.050	0.050	0.050
Middle east	0.000	0.020	0.190	0.000	0.000	0.000	0.000	0.280	0.280	0.280	0.280	0.000	0.000	0.000	0.000	0.000
Northern America	0.026	0.000	0.000	0.000	0.000	0.100	0.080	0.900	0.900	0.900	0.900	0.080	0.080	0.080	0.080	0.080

TABLE 14
Fraction of applied organic N fertilizer in MS slurry for each animal category, by IPCC area

IPCC Area	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 15
Fraction of applied organic N fertilizer in MS lagoon for each animal category, by IPCC area

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.350	0.000	0.000	0.400	0.400	0.000	0.000	0.550	0.550	0.550	0.550	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.350	0.000	0.000	0.400	0.400	0.000	0.000	0.550	0.550	0.550	0.550	0.000	0.000	0.000	0.000	0.000
Africa	0.350	0.000	0.000	0.400	0.400	0.000	0.000	0.550	0.550	0.550	0.550	0.000	0.000	0.000	0.000	0.000
Oceania	0.350	0.000	0.000	0.400	0.400	0.000	0.000	0.550	0.550	0.550	0.550	0.000	0.000	0.000	0.000	0.000
Western Europe	0.350	0.000	0.000	0.400	0.400	0.000	0.000	0.550	0.550	0.550	0.550	0.000	0.000	0.000	0.000	0.000
Latin America	0.350	0.000	0.000	0.400	0.400	0.000	0.000	0.550	0.550	0.550	0.550	0.000	0.000	0.000	0.000	0.000
Asia	0.350	0.000	0.000	0.400	0.400	0.000	0.000	0.550	0.550	0.550	0.550	0.000	0.000	0.000	0.000	0.000
Middle east	0.350	0.000	0.000	0.400	0.400	0.000	0.000	0.550	0.550	0.550	0.550	0.000	0.000	0.000	0.000	0.000
Northern America	0.350	0.000	0.000	0.400	0.400	0.000	0.000	0.550	0.550	0.550	0.550	0.000	0.000	0.000	0.000	0.000

TABLE 16
Fraction of applied organic N fertilizer in MS solid storage for each animal category, by IPCC area

IPCC Area	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.300	0.450	0.450	0.450	0.450	0.120	0.120	0.400	0.400	0.400	0.400	0.120	0.120	0.120	0.120	0.120
Eastern Europe	0.300	0.450	0.450	0.450	0.450	0.120	0.120	0.400	0.400	0.400	0.400	0.120	0.120	0.120	0.120	0.120
Africa	0.300	0.450	0.450	0.450	0.450	0.120	0.120	0.400	0.400	0.400	0.400	0.120	0.120	0.120	0.120	0.120
Oceania	0.300	0.450	0.450	0.450	0.450	0.120	0.120	0.400	0.400	0.400	0.400	0.120	0.120	0.120	0.120	0.120
Western Europe	0.300	0.450	0.450	0.450	0.450	0.120	0.120	0.400	0.400	0.400	0.400	0.120	0.120	0.120	0.120	0.120
Latin America	0.300	0.450	0.450	0.450	0.450	0.120	0.120	0.400	0.400	0.400	0.400	0.120	0.120	0.120	0.120	0.120
Asia	0.300	0.450	0.450	0.450	0.450	0.120	0.120	0.400	0.400	0.400	0.400	0.120	0.120	0.120	0.120	0.120
Middle east	0.300	0.450	0.450	0.450	0.450	0.120	0.120	0.400	0.400	0.400	0.400	0.120	0.120	0.120	0.120	0.120
Northern America	0.300	0.450	0.450	0.450	0.450	0.120	0.120	0.400	0.400	0.400	0.400	0.120	0.120	0.120	0.120	0.120

TABLE 17
Fraction of applied organic N fertilizer in MS dry lot for each animal category, by IPCC area

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.200	0.300	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.200	0.300	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.200	0.300	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.200	0.300	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.200	0.300	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.200	0.300	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.200	0.300	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.200	0.300	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.200	0.300	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 18
Fraction of applied organic N fertilizer in MS daily spread for each animal category, by IPCC area

IPCC Area	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 19
Fraction of applied organic N fertilizer in MS digester for each animal category, by IPCC area

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 20
Fraction of applied organic N fertilizer in MS pit below and above one month for each animal category, by IPCC area

IPCC Area	Cattle, dairy	Cattle, non-dairy	Buffalo	Swine, market	Swine, breeding	Sheep	Goats	Chickens, Broilers	Chickens, Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 21
Fraction of applied organic N fertilizer in other MS for each animal category, by IPCC area

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.280	0.300	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.280	0.300	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.280	0.300	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.280	0.300	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.280	0.300	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.280	0.300	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.280	0.300	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.280	0.300	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.280	0.300	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 22
Emission factor for direct N_2O emissions for manure management system, kg N_2O-N (kg N)$^{-1}$, by IPCC area

IPCC Area	Lagoon	Liquid/Slurry	Solid Storage	Drylot	Daily Spread	Digester	Pit<1	Pit>1	Other
Indian Subcontinent	0	0.005	0.005	0.02	0	0	0.002	0.002	0.005
Eastern Europe	0	0.005	0.005	0.02	0	0	0.002	0.002	0.005
Africa	0	0.005	0.005	0.02	0	0	0.002	0.002	0.005
Oceania	0	0.005	0.005	0.02	0	0	0.002	0.002	0.005
Western Europe	0	0.005	0.005	0.02	0	0	0.002	0.002	0.005
Latin America	0	0.005	0.005	0.02	0	0	0.002	0.002	0.005
Asia	0	0.005	0.005	0.02	0	0	0.002	0.002	0.005
Middle east	0	0.005	0.005	0.02	0	0	0.002	0.002	0.005
Northern America	0	0.005	0.005	0.02	0	0	0.002	0.002	0.005

TABLE 23
Percent of N losses due to runoff and leaching during solid and liquid storage of managed manure, by IPCC area

IPCC Area	FracLeachMS
Indian Subcontinent	0.10
Eastern Europe	0.10
Africa	0.10
Oceania	0.10
Western Europe	0.10
Latin America	0.10
Asia	0.10
Middle east	0.10
Northern America	0.10

TABLE 24
Emission factor for indirect N_2O emissions from atmospheric deposition of N on soils and water surfaces, kg N_2O-N (kg NH_3-N + NO_x-N)$^{-1}$, volatilised by IPCC area

IPCC Area	EF4
Indian Subcontinent	0.01
Eastern Europe	0.01
Africa	0.01
Oceania	0.01
Western Europe	0.01
Latin America	0.01
Asia	0.01
Middle east	0.01
Northern America	0.01

TABLE 25
Emission factor for indirect N_2O emissions from N leaching and runoff, kg N_2O–N (kg N)$^{-1}$, leached and runoff by IPCC area

IPCC Area	EF5
Indian Subcontinent	0.0075
Eastern Europe	0.0075
Africa	0.0075
Oceania	0.0075
Western Europe	0.0075
Latin America	0.0075
Asia	0.0075
Middle east	0.0075
Northern America	0.0075

TABLE 26
Emission factor for N_2O emissions from N inputs, kg N_2O–N (kg N input)$^{-1}$, by IPCC area

IPCC Area	EF1
Indian Subcontinent	0.01
Eastern Europe	0.01
Africa	0.01
Oceania	0.01
Western Europe	0.01
Latin America	0.01
Asia	0.01
Middle east	0.01
Northern America	0.01

TABLE 27
Percent of N added to/mineralized in managed soils, in regions where leaching/runoff occurs, that is lost through leaching and runoff, kg N (kg of N additions)$^{-1}$, by IPCC area

IPCC Area	Frac leach
Indian Subcontinent	0.30
Eastern Europe	0.30
Africa	0.30
Oceania	0.30
Western Europe	0.30
Latin America	0.30
Asia	0.30
Middle east	0.30
Northern America	0.30

TABLE 28
Fraction of applied synthetic N fertilizer materials that volatilises as NH_3 and NO_X, kg N volatilised (kg of N applied)$^{-1}$, by IPCC area

IPCC Area	Frac_GASF
Indian Subcontinent	0.10
Eastern Europe	0.10
Africa	0.10
Oceania	0.10
Western Europe	0.10
Latin America	0.10
Asia	0.10
Middle east	0.10
Northern America	0.10

TABLE 29
Water regimes by country and type of regime (ha y^{-1})

Country Name	irrigated share	rainfed share	upland share
Afghanistan	1	0	0
Albania	1	0	0
Algeria	1	0	0
Angola	1	0	0
Argentina	1	0	0
Australia	1	0	0
Azerbaijan	1	0	0
Bangladesh	0.22	0.7	0.08
Belize	0.1	0	0.9
Benin	0.1	0	0.9
Bhutan	0.5	0.46	0.04
Bolivia (Plurinational State of)	0.25	0	0.75
Brazil	0.19	0.06	0.75
Brunei Darussalam	0.79	0	0.21
Bulgaria	1	0	0
Burkina Faso	0.89	0	0.11
Burundi	0.25	0	0.75
Cambodia	0.08	0.9	0.02
Cameroon	0.25	0	0.75
Central African Republic	0.25	0	0.75
Chad	0.25	0	0.75
Chile	0.79	0	0.21
China, Hong Kong SAR	1	0	0
China, mainland	0.93	0.05	0.02
China, Taiwan Province of	1	0	0
Colombia	0.67	0.1	0.23
Comoros	1	0	0
Congo	0.25	0	0.75
Costa Rica	0.1	0	0.9
Côte d'Ivoire	0.06	0.07	0.87
Cuba	1	0	0
Democratic People's Republic of Korea	0.67	0.2	0.13
Democratic Republic of the Congo	0.05	0.05	0.9
Dominican Republic	0.98	0	0.02
Ecuador	0.4	0.5	0.1
Egypt	1	0	0
El Salvador	0.1	0	0.9
Ethiopia	0.5	0	0.5
Fiji	0.5	0	0.5
France	1	0	0
French Guiana	0.95	0	0.05
Gabon	0.25	0	0.75

Country Name	irrigated share	rainfed share	upland share
Gambia	0.9	0	0.1
Ghana	0.24	0	0.76
Greece	1	0	0
Guatemala	0.1	0	0.9
Guinea	0.08	0.45	0.47
Guinea-Bissau	0.25	0	0.75
Guyana	0.95	0	0.05
Haiti	0.4	0	0.6
Honduras	0.1	0	0.9
Hungary	1	0	0
India	0.53	0.32	0.15
Indonesia	0.72	0.17	0.11
Islamic Republic of Iran	1	0	0
Iraq	1	0	0
Italy	1	0	0
Jamaica	0.4	0	0.6
Japan	0.99	0	0.01
Kazakhstan	1	0	0
Kenya	0.25	0	0.75
Kyrgyzstan	1	0	0
Lao People's Democratic Republic	0.02	0.61	0.37
Liberia	0	0.06	0.94
Madagascar	0.1	0.76	0.14
Malawi	0.25	0	0.75
Malaysia	0.66	0.22	0.12
Mali	0.25	0	0.75
Mauritania	1	0	0
Mauritius	0.1	0.76	0.14
Mexico	0.41	0	0.59
Micronesia	0.72	0.17	0.11
Morocco	1	0	0
Mozambique	0.25	0	0.75
Myanmar	0.18	0.76	0.06
Nepal	0.23	0.74	0.03
Nicaragua	0.1	0	0.9
Niger	0.35	0	0.65
Nigeria	0.16	0.33	0.51
Pacific Islands Trust Territory	0.72	0.17	0.11
Pakistan	1	0	0
Panama	0.05	0	0.95
Papua New Guinea	0.72	0.17	0.11
Paraguay	0.5	0	0.5
Peru	0.84	0	0.16

Country Name	irrigated share	rainfed share	upland share
Philippines	0.61	0.37	0.02
Portugal	1	0	0
Puerto Rico	0.75	0	0.25
Republic of Korea	1	0	0
Réunion	0.1	0.76	0.14
Romania	1	0	0
Russian Federation	1	0	0
Rwanda	0.25	0	0.75
Saudi Arabia	1	0	0
Senegal	0.25	0	0.75
Sierra Leone	0.01	0.32	0.67
Solomon Islands	0.72	0.17	0.11
Somalia	0.5	0	0.5
South Africa	1	0	0
Spain	1	0	0
Sri Lanka	0.37	0.56	0.07
South Sudan	0.5	0	0.5
Sudan	0.5	0	0.5
Sudan (former)	0.5	0	0.5
Suriname	1	0	0
Swaziland	0.25	0	0.75
Syrian Arab Republic	1	0	0

Country Name	irrigated share	rainfed share	upland share
Tajikistan	1	0	0
Thailand	0.07	0.92	0.01
The former Yugoslav Republic of Macedonia	1	0	0
Timor-Leste	0.72	0.17	0.11
Togo	0.04	0	0.96
Trinidad and Tobago	0.45	0	0.55
Turkey	1	0	0
Turkmenistan	1	0	0
Uganda	0.25	0	0.75
Ukraine	1	0	0
United Republic of Tanzania	0.03	0.75	0.22
United States of America	1	0	0
Uruguay	1	0	0
USSR	1	0	0
Uzbekistan	1	0	0
Venezuela	0.9	0	0.1
Viet Nam	0.53	0.39	0.08
Yugoslav SFR	1	0	0
Zambia	0.25	0	0.75
Zimbabwe	0.25	0	0.75

TABLE 30
Seasonal emission factor of methane, g m^{-2} yr^{-1}, by country

Country Name	EF
Afghanistan	10
Albania	20
Algeria	20
Angola	20
Argentina	20
Australia	22.5
Azerbaijan	20
Bangladesh	10
Belize	20
Benin	20
Bhutan	10
Bolivia (Plurinational State of)	20
Brazil	20
Brunei Darussalam	15.7
Bulgaria	20
Burkina Faso	20
Burundi	20
Cambodia	15.7
Cameroon	20
Central African Republic	20

Country Name	EF
Chile	20
China, Hong Kong SAR	13
China, mainland	13
China, Taiwan Province of	13
Colombia	20
Comoros	20
Congo	20
Costa Rica	20
Côte d'Ivoire	20
Cuba	20
Democratic People's Republic of Korea	15.7
Democratic Republic of the Congo	20
Dominican Republic	20
Ecuador	20
Egypt	20
El Salvador	20
Ethiopia	20
Fiji	20
France	36

Country Name	EF
French Guiana	20
Gabon	20
Gambia	20
Ghana	20
Greece	36
Guatemala	20
Guinea	20
Guinea-Bissau	20
Guyana	20
Haiti	20
Honduras	20
Hungary	20
India	10
Indonesia	18
Iran (Islamic Republic of)	15.7
Iraq	20
Italy	36
Jamaica	20
Japan	15
Kazakhstan	15.7
Kenya	20
Kyrgyzstan	15.7
Lao People's Democratic Republic	15.7
Liberia	20
Madagascar	20
Malawi	20
Malaysia	15.7
Mali	20
Mauritania	20
Mauritius	20
Mexico	20
Micronesia	20
Morocco	20
Mozambique	20
Myanmar	15.7
Nepal	10
Nicaragua	20
Niger	20
Nigeria	20
Pacific Islands Trust Territory	20
Pakistan	10
Panama	20
Papua New Guinea	20
Paraguay	20

Country Name	EF
Peru	20
Philippines	27.5
Portugal	36
Puerto Rico	20
Republic of Korea	15
Réunion	20
Romania	20
Russian Federation	20
Rwanda	20
Saudi Arabia	20
Senegal	20
Sierra Leone	20
Solomon Islands	20
Somalia	20
South Africa	20
Spain	36
Sri Lanka	10
South Sudan	20
Sudan	20
Sudan (former)	20
Suriname	20
Swaziland	20
Syrian Arab Republic	20
Tajikistan	15.7
Thailand	16
The former Yugoslav Republic of Macedonia	20
Timor-Leste	15.7
Togo	20
Trinidad and Tobago	20
Turkey	20
Turkmenistan	15.7
Uganda	20
Ukraine	20
United Republic of Tanzania	20
United States of America	25
Uruguay	20
USSR	20
Uzbekistan	15.7
Venezuela (Bolivarian Republic of)	20
Viet Nam	15.7
Yugoslav SFR	20
Zambia	20
Zimbabwe	20

TABLE 31
Amount of nitrogen from bedding to be applied for solid storage and deep bedding in MS (if known organic bedding usage), kg N animal^{-1} yr^{-1}, by IPCC area and animal category

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	7.000	4.000	0.000	0.800	5.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	7.000	4.000	0.000	0.800	5.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	7.000	4.000	0.000	0.800	5.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	7.000	4.000	0.000	0.800	5.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	7.000	4.000	0.000	0.800	5.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	7.000	4.000	0.000	0.800	5.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	7.000	4.000	0.000	0.800	5.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	7.000	4.000	0.000	0.800	5.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	7.000	4.000	0.000	0.800	5.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 32
Fraction of applied organic N fertilizer in MS lagoon, by IPCC area and animal category

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.770	0.000	0.000	0.780	0.780	0.000	0.000	0.770	0.770	0.770	0.770	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.770	0.000	0.000	0.780	0.780	0.000	0.000	0.770	0.770	0.770	0.770	0.000	0.000	0.000	0.000	0.000
Africa	0.770	0.000	0.000	0.780	0.780	0.000	0.000	0.770	0.770	0.770	0.770	0.000	0.000	0.000	0.000	0.000
Oceania	0.770	0.000	0.000	0.780	0.780	0.000	0.000	0.770	0.770	0.770	0.770	0.000	0.000	0.000	0.000	0.000
Western Europe	0.770	0.000	0.000	0.780	0.780	0.000	0.000	0.770	0.770	0.770	0.770	0.000	0.000	0.000	0.000	0.000
Latin America	0.770	0.000	0.000	0.780	0.780	0.000	0.000	0.770	0.770	0.770	0.770	0.000	0.000	0.000	0.000	0.000
Asia	0.770	0.000	0.000	0.780	0.780	0.000	0.000	0.770	0.770	0.770	0.770	0.000	0.000	0.000	0.000	0.000
Middle east	0.770	0.000	0.000	0.780	0.780	0.000	0.000	0.770	0.770	0.770	0.770	0.000	0.000	0.000	0.000	0.000
Northern America	0.770	0.000	0.000	0.780	0.780	0.000	0.000	0.770	0.770	0.770	0.770	0.000	0.000	0.000	0.000	0.000

TABLE 33
Fraction of applied organic N fertilizer in MS slurry, by IPCC area and animal category

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.400	0.000	0.000	0.480	0.480	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 34
Fraction of applied organic N fertilizer in MS solid, by IPCC area and animal category

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.400	0.500	0.500	0.500	0.500	0.150	0.150	0.500	0.500	0.500	0.500	0.150	0.150	0.150	0.150	0.150
Eastern Europe	0.400	0.500	0.500	0.500	0.500	0.150	0.150	0.500	0.500	0.500	0.500	0.150	0.150	0.150	0.150	0.150
Africa	0.400	0.500	0.500	0.500	0.500	0.150	0.150	0.500	0.500	0.500	0.500	0.150	0.150	0.150	0.150	0.150
Oceania	0.400	0.500	0.500	0.500	0.500	0.150	0.150	0.500	0.500	0.500	0.500	0.150	0.150	0.150	0.150	0.150
Western Europe	0.400	0.500	0.500	0.500	0.500	0.150	0.150	0.500	0.500	0.500	0.500	0.150	0.150	0.150	0.150	0.150
Latin America	0.400	0.500	0.500	0.500	0.500	0.150	0.150	0.500	0.500	0.500	0.500	0.150	0.150	0.150	0.150	0.150
Asia	0.400	0.500	0.500	0.500	0.500	0.150	0.150	0.500	0.500	0.500	0.500	0.150	0.150	0.150	0.150	0.150
Middle east	0.400	0.500	0.500	0.500	0.500	0.150	0.150	0.500	0.500	0.500	0.500	0.150	0.150	0.150	0.150	0.150
Northern America	0.400	0.500	0.500	0.500	0.500	0.150	0.150	0.500	0.500	0.500	0.500	0.150	0.150	0.150	0.150	0.150

TABLE 35
Fraction of applied organic N fertilizer in MS dry lot, by IPCC area and animal category

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.300	0.400	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 36
Fraction of applied organic N fertilizer in MS daily, by IPCC area and animal category

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.220	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 37
Fraction of applied organic N fertilizer in MS Pit below 1 and Pit above 1, by IPCC area and animal category

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.000	0.000	0.000	0.250	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 38
Fraction of applied organic N fertilizer materials (FON) and of urine and dung N deposited by grazing animals (FPRP) that volatilises as NH_3 and NOx, kg N volatilised (kg of N applied or deposited)$^{-1}$, by IPCC area and by animal category

IPCC Area	Frac GASM
Indian Subcontinent	0.20
Eastern Europe	0.20
Africa	0.20
Oceania	0.20
Western Europe	0.20
Latin America	0.20
Asia	0.20
Middle east	0.20
Northern America	0.20

TABLE 39
Fraction of managed manure used for feed, by IPCC area and animal category

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 40
Fraction of managed manure used for fuel, by IPCC area and animal category

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 41
Fraction of managed manure used for construction, by IPCC area and animal category

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 42
Fraction of total annual N excretion for each livestock species/category *T* deposited on pastures, ranges and paddocks, by IPCC area and animal category

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.270	0.220	0.190	0.030	0.030	0.830	0.950	0.440	0.440	0.440	0.440	0.950	0.950	0.950	0.950	0.950
Eastern Europe	0.180	0.200	0.290	0.057	0.057	0.730	0.920	0.010	0.010	0.010	0.010	0.920	0.920	0.920	0.920	0.920
Africa	0.830	0.950	0.000	0.000	0.000	0.990	0.990	0.810	0.810	0.810	0.810	0.990	0.990	0.990	0.990	0.990
Oceania	0.760	0.910	0.000	0.280	0.280	1.000	1.000	0.030	0.030	0.030	0.030	1.000	1.000	1.000	1.000	1.000
Western Europe	0.200	0.320	0.000	0.030	0.030	0.870	0.960	0.020	0.020	0.020	0.020	0.960	0.960	0.960	0.960	0.960
Latin America	0.360	0.990	0.990	0.400	0.400	1.000	0.990	0.420	0.420	0.420	0.420	0.990	0.990	0.990	0.990	0.990
Asia	0.200	0.500	0.500	0.000	0.000	0.830	0.950	0.450	0.450	0.450	0.450	0.950	0.950	0.950	0.950	0.950
Middle east	0.800	0.790	0.200	0.000	0.000	1.000	1.000	0.710	0.710	0.710	0.710	1.000	1.000	1.000	1.000	1.000
Northern America	0.108	0.815	0.000	0.000	0.000	0.880	0.920	0.010	0.010	0.010	0.010	0.920	0.920	0.920	0.920	0.920

TABLE 43
Share of manure of dung and urine excreted on fields and burned for fuel as sun dried dung cakes, by IPCC area and animal category

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.510	0.530	0.550	0.000	0.000	0.000	0.000	0.010	0.010	0.010	0.010	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Africa	0.060	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oceania	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Western Europe	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Latin America	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Asia	0.070	0.020	0.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middle east	0.170	0.170	0.420	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern America	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 44
Emission factor for N_2O emissions from urine and dung N, deposited on pastures, ranges and paddocks by grazing animals, kg N_2O–N (kg N input)$^{-1}$, by IPCC area and animal category

IPCC Area	Cattle. dairy	Cattle. non-dairy	Buffalo	Swine. market	Swine. breeding	Sheep	Goats	Chickens. Broilers	Chickens. Layers	Ducks	Turkeys	Horses	Asses	Mules	Camels	Llamas
Indian Subcontinent	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.000	0.000	0.000	0.000	0.000
Eastern Europe	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.000	0.000	0.000	0.000	0.000
Africa	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.000	0.000	0.000	0.000	0.000
Oceania	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.000	0.000	0.000	0.000	0.000
Western Europe	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.000	0.000	0.000	0.000	0.000
Latin America	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.000	0.000	0.000	0.000	0.000
Asia	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.000	0.000	0.000	0.000	0.000
Middle east	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.000	0.000	0.000	0.000	0.000
Northern America	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.000	0.000	0.000	0.000	0.000

TABLE 45
Dry matter fraction of harvested product for crop, by IPCC area

IPCC Area	Barley	Beans, dry	Maize	Millet	Oats	Potatoes	Rice, paddy	Rye	Sorghum	Soybeans	Wheat
Indian Subcontinent	0.89	0.9	0.87	0.9	0.89	0.22	0.89	0.88	0.89	0.91	0.89
Eastern Europe	0.89	0.9	0.87	0.9	0.89	0.22	0.89	0.88	0.89	0.91	0.89
Africa	0.89	0.9	0.87	0.9	0.89	0.22	0.89	0.88	0.89	0.91	0.89
Oceania	0.89	0.9	0.87	0.9	0.89	0.22	0.89	0.88	0.89	0.91	0.89
Western Europe	0.89	0.9	0.87	0.9	0.89	0.22	0.89	0.88	0.89	0.91	0.89
Latin America	0.89	0.9	0.87	0.9	0.89	0.22	0.89	0.88	0.89	0.91	0.89
Asia	0.89	0.9	0.87	0.9	0.89	0.22	0.89	0.88	0.89	0.91	0.89
Middle east	0.89	0.9	0.87	0.9	0.89	0.22	0.89	0.88	0.89	0.91	0.89
Northern America	0.89	0.9	0.87	0.9	0.89	0.22	0.89	0.88	0.89	0.91	0.89

TABLE 46
Slope element for crops, by IPCC area

IPCC Area	Barley	Beans, dry	Maize	Millet	Oats	Potatoes	Rice, paddy	Rye	Sorghum	Soybeans
Indian Subcontinent	0.98	0.36	1.03	1.43	0.91	0.1	0.95	1.09	0.88	0.93
Eastern Europe	0.98	0.36	1.03	1.43	0.91	0.1	0.95	1.09	0.88	0.93
Africa	0.98	0.36	1.03	1.43	0.91	0.1	0.95	1.09	0.88	0.93
Oceania	0.98	0.36	1.03	1.43	0.91	0.1	0.95	1.09	0.88	0.93
Western Europe	0.98	0.36	1.03	1.43	0.91	0.1	0.95	1.09	0.88	0.93
Latin America	0.98	0.36	1.03	1.43	0.91	0.1	0.95	1.09	0.88	0.93
Asia	0.98	0.36	1.03	1.43	0.91	0.1	0.95	1.09	0.88	0.93
Middle east	0.98	0.36	1.03	1.43	0.91	0.1	0.95	1.09	0.88	0.93
Northern America	0.98	0.36	1.03	1.43	0.91	0.1	0.95	1.09	0.88	0.93

TABLE 47
Intercept element for crops, by IPCC area

IPCC Area	Barley	Beans, dry	Maize	Millet	Oats	Potatoes	Rice, paddy	Rye	Sorghum	Soybeans	Wheat
Indian Subcontinent	0.59	0.68	0.61	0.14	0.89	1.06	2.46	0.88	1.33	1.35	0.52
Eastern Europe	0.59	0.68	0.61	0.14	0.89	1.06	2.46	0.88	1.33	1.35	0.52
Africa	0.59	0.68	0.61	0.14	0.89	1.06	2.46	0.88	1.33	1.35	0.52
Oceania	0.59	0.68	0.61	0.14	0.89	1.06	2.46	0.88	1.33	1.35	0.52
Western Europe	0.59	0.68	0.61	0.14	0.89	1.06	2.46	0.88	1.33	1.35	0.52
Latin America	0.59	0.68	0.61	0.14	0.89	1.06	2.46	0.88	1.33	1.35	0.52
Asia	0.59	0.68	0.61	0.14	0.89	1.06	2.46	0.88	1.33	1.35	0.52
Middle east	0.59	0.68	0.61	0.14	0.89	1.06	2.46	0.88	1.33	1.35	0.52
Northern America	0.59	0.68	0.61	0.14	0.89	1.06	2.46	0.88	1.33	1.35	0.52

TABLE 48
Ratio of below-ground residues to above-ground biomass for crops, by IPCC area

IPCC Area	Barley	Beans, dry	Maize	Millet	Oats	Potatoes	Rice, paddy	Rye	Sorghum	Soybeans	Wheat
Indian Subcontinent	0.22	0	0.22	0	0.25	0.2	0.16	0	0	0.19	0.24
Eastern Europe	0.22	0	0.22	0	0.25	0.2	0.16	0	0	0.19	0.24
Africa	0.22	0	0.22	0	0.25	0.2	0.16	0	0	0.19	0.24
Oceania	0.22	0	0.22	0	0.25	0.2	0.16	0	0	0.19	0.24
Western Europe	0.22	0	0.22	0	0.25	0.2	0.16	0	0	0.19	0.24
Latin America	0.22	0	0.22	0	0.25	0.2	0.16	0	0	0.19	0.24
Asia	0.22	0	0.22	0	0.25	0.2	0.16	0	0	0.19	0.24
Middle east	0.22	0	0.22	0	0.25	0.2	0.16	0	0	0.19	0.24
Northern America	0.22	0	0.22	0	0.25	0.2	0.16	0	0	0.19	0.24

TABLE 49
Combustion factor for crops, by IPCC area

IPCC Area	Barley	Beans, dry	Maize	Millet	Oats	Potatoes	Rice, paddy	Rye	Sorghum	Soybeans	Wheat
Indian Subcontinent	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9
Eastern Europe	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9
Africa	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9
Oceania	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9
Western Europe	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9
Latin America	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9
Asia	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9
Middle east	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9
Northern America	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9

TABLE 50
N content of above-ground residues for crops, by IPCC area

IPCC Area	Barley	Beans, dry	Maize	Millet	Oats	Potatoes	Rice, paddy	Rye	Sorghum	Soybeans	Wheat
Indian Subcontinent	0.007	0.01	0.006	0.007	0.007	0.019	0.007	0.005	0.007	0.008	0.006
Eastern Europe	0.007	0.01	0.006	0.007	0.007	0.019	0.007	0.005	0.007	0.008	0.006
Africa	0.007	0.01	0.006	0.007	0.007	0.019	0.007	0.005	0.007	0.008	0.006
Oceania	0.007	0.01	0.006	0.007	0.007	0.019	0.007	0.005	0.007	0.008	0.006
Western Europe	0.007	0.01	0.006	0.007	0.007	0.019	0.007	0.005	0.007	0.008	0.006
Latin America	0.007	0.01	0.006	0.007	0.007	0.019	0.007	0.005	0.007	0.008	0.006
Asia	0.007	0.01	0.006	0.007	0.007	0.019	0.007	0.005	0.007	0.008	0.006
Middle east	0.007	0.01	0.006	0.007	0.007	0.019	0.007	0.005	0.007	0.008	0.006
Northern America	0.007	0.01	0.006	0.007	0.007	0.019	0.007	0.005	0.007	0.008	0.006

TABLE 51
Ratio of below-ground residues to harvested yield for crops, by IPCC area

IPCC Area	Barley	Beans, dry	Maize	Millet	Oats	Potatoes	Rice, paddy	Rye	Sorghum	Soybeans	Wheat
Indian Subcontinent	0.014	0.01	0.007	0	0.008	0.014	0	0.011	0.006	0.008	0.009
Eastern Europe	0.014	0.01	0.007	0	0.008	0.014	0	0.011	0.006	0.008	0.009
Africa	0.014	0.01	0.007	0	0.008	0.014	0	0.011	0.006	0.008	0.009
Oceania	0.014	0.01	0.007	0	0.008	0.014	0	0.011	0.006	0.008	0.009
Western Europe	0.014	0.01	0.007	0	0.008	0.014	0	0.011	0.006	0.008	0.009
Latin America	0.014	0.01	0.007	0	0.008	0.014	0	0.011	0.006	0.008	0.009
Asia	0.014	0.01	0.007	0	0.008	0.014	0	0.011	0.006	0.008	0.009
Middle east	0.014	0.01	0.007	0	0.008	0.014	0	0.011	0.006	0.008	0.009
Northern America	0.014	0.01	0.007	0	0.008	0.014	0	0.011	0.006	0.008	0.009

TABLE 52
Fuel (Mb *x Cf , mass of fuel available x combustion factor, Tonnes d.m. ha^{-1}) by crop item

Item	Value
Surgarcane	6.5
Maize	10
Rice paddy	5.5
Wheat	4

TABLE 53
Emission factor, g kg^{-1} dry matter burnt (G_{ef})

Parameter Code	Value	Parameter Description
Gef(N_2O)	0.07	Emission factor (g kg^{-1} d.m. burned)
Gef(CH_4)	2.7	Emission factor (g kg^{-1} d.m. burned)

TABLE 54
Parameters for Energy use

Element	Gas-Diesel oil (including gas-diesel oil in fisheries)	Motor gasoline	Natural Gas	LPG	"Residual Fuel Oil (including residual fuel oil in fisheries)"	Coal (Other bituminous coal)	Electricity
Net calorific value [GJ/t]	43.0	44.3		47.3	40.4	26.7	
Emission factor CO_2 [kg/TJ]	74100	69300	64200	63100	77400	94600	Depending on the national energy mix for electricity generation
Emission factor CH_4 [kg/TJ]	4.15	80	10	5	10	300	1.2
Emission factor N_2O [kg/TJ]	28.6	2.0	0.6	0.1	0.6	1.5	0.01

TABLE 55
Average Carbon Stock in Forest Living Biomass (t ha^{-1}) from FRA-2010, by geographical group area and year

Years	1990	2000	2005	2010
Regions-Subregions				
Eastern Africa	57.6	58.2	58.5	58.9
Southern Africa	57.6	58.2	58.5	58.9
Northern Africa	21.7	22.1	22.2	22.2
Western Africa	115.4	116.2	116.6	116.9
Central Africa	115.4	116.2	116.6	116.9
Eastern Asia	31.5	33.9	34.5	34.4
Southern Asia	89.5	91.4	88.7	85.6
South-Eastern Asia	89.5	91.4	88.7	85.6
Western Asia	36.4	37.9	38.7	39.8
Central Asia	36.4	37.9	38.7	39.8
Caribbean	65.5	72.4	74.4	74.4
Central America	88.6	89.6	89.9	90.4
Northern America	51.9	53.3	54.1	55
South America	116.5	117.5	117.8	118.2
Australia and New Zealand	54.7	54.5	54.4	54.8
Melanesia	54.7	54.5	54.4	54.8
Micronesia	54.7	54.5	54.4	54.8
Polynesia	54.7	54.5	54.4	54.8
Northern Europe	53.7	58.5	61.2	63.9
Southern Europe	53.7	58.5	61.2	63.9
Eastern Europe	42.7	43.3	43.9	44.8
Western Europe	53.7	58.5	61.2	63.9

TABLE 56
Total Carbon Stock in Forest Living Biomass (M t), from FRA-2010 by country

Years	1990	2000	2005	2010
Regions-Subregions				
Afghanistan	38.3	38.3	38.3	38.3
Albania	49.2	49.3	48.3	48.8
Algeria	78	74	72	70
American Samoa	2.02	1.98	1.96	1.94
Andorra				
Angola	4.573.00	4.479.00	4.432.00	4.385.00
Anguilla				
Antigua and Barbuda				
Argentina	3.414.00	3.236.00	3.143.00	3.062.00
Armenia	16.52	14.54	13.54	12.55
Aruba				
Australia	6.724.00	6.702.00	6.641.00	6.606.00
Austria	339	375	399	393
Azerbaijan	54.44	54.44	54.44	54.44
Bahamas				
Bahrain				
Bangladesh	83	82	81	81
Barbados				
Belarus	385.6	481.6	540.4	610.7
Belgium	50.35	60.8	63.08	64.37
Belize	195	183	177	171
Benin	331.59	291.29	276.93	262.56
Bermuda				
Bhutan	296	313	324	336
Bolivia (plurinational state of)	4.877.00	4.666.00	4.561.00	4.442.00
Bosnia and Herzegovina	95.85	117.88	117.88	117.88
Botswana	680	663	655	646
Brazil	68.119.00	65.304.00	63.679.00	62.607.00
British Virgin Islands				
Brunei Darussalam	80.82	76.21	73.9	71.59
Bulgaria	126.6	161.2	181.9	202.1
Burkina Faso	355	323	308	292
Burundi	25.2	19.2	17.6	16.5
Cambodia	609	537	495	464
Cameroon	3.292.00	2.993.00	2.844.00	2.696.00
Canada	14.283.00	14.317.00	14.021.00	13.909.00
Cape Verde	3.3	4.7	4.8	4.9
Cayman Islands				
Central African Republic	2.936.00	2.898.00	2.880.00	2.861.00
Chad	722	677	655	635
Chile	1.293.60	1.328.40	1.338.30	1.348.50
China	4.414.40	5.295.00	5.801.90	6.202.90
Colombia	7.032.00	6.919.00	6.862.00	6.805.00
Comoros	1.65	1.16	0.72	0.35
Cook Islands	38.3	38.3	38.3	38.3
Costa Rica	49.2	49.3	48.3	48.8
Croatia	78	74	72	70
Cuba	2.02	1.98	1.96	1.94
Cyprus				
Czech Republic	4.573.00	4.479.00	4.432.00	4.385.00

Years	1990	2000	2005	2010
Regions-Subregions				
Côte d'Ivoire	1.811.00	1.832.00	1.847.00	1.842.00
Democratic People's Republic of Korea	239	207	190	171
Democratic Republic of the Congo	20.433.00	20.036.00	19.838.00	19.639.00
Denmark	22.1	25.5	36.2	36.9
Djibouti	0.23	0.23	0.23	0.23
Dominica				
Dominican Republic	113.5	113.5	113.5	113.5
Ecuador				
Egypt	4.38	5.87	6.67	6.96
El Salvador				
Equatorial Guinea	231.9	217.3	210	202.8
Eritrea				
Estonia	168.5283333	168.33	167.28	165.04
Ethiopia	289	254	236	219
Faroe Islands				
Falkland Islands (Malvinas)	-	-	-	-
Fiji				
Finland	720.8	802.4	832.4	832.4
France	965	1.049.00	1.165.00	1.208.00
French Guiana	1.672.00	1.657.00	1.654.00	1.651.00
French Polynesia	20.51	20.51	20.51	20.51
Gabon	2.710.00	2.710.00	2.710.00	2.710.00
Gambia	29.09	30.32	30.94	31.56
Georgia	191.64	202.64	207.45	212.25
Germany	981	1.193.00	1.283.00	1.405.00
Ghana	564	465.3	423.1	380.9
Gibraltar	-	-	-	-
Greece	67	73	76	80
Greenland				
Grenada	1.32	1.32	0.84	1.08
Guadeloupe	13.3	12.8	12.6	12.4
Guam	1.8	1.8	1.8	1.8
Guatemala	365.2	323.6	302.9	281.3
Guinea	687	653	636	619
Guinea-Bissau	105	101	99	96
Guyana	1.629.00	1.629.00	1.629.00	1.629.00
Haiti	6.29	5.9	5.69	5.47
Holy See	-	-	-	-
Honduras	517	407	368	330
Hungary	117	130	136	142
Iceland	0.11	0.17	0.22	0.27
India	2.223.00	2.377.00	2.615.00	2.800.00
Indonesia	16.335.00	15.182.00	14.299.00	13.017.00
Iran (Islamic Republic of)	248.6	249.1	253.8	258
Iraq				
Ireland	15.8	18.2	19.9	22.6
Isle of Man				
Israel	4.8	4.5	4.6	4.7
Italy	375.3	466.6	512.3	557.9
Jamaica	48.41	48.06	47.83	47.65
Japan	1.159.00	1.381.00	1.526.00	1.722.33

Years	1990	2000	2005	2010
Regions-Subregions				
Jordan	2.36	2.36	2.36	2.36
Kazakhstan	137.42	136.61	136.79	136.79
Kenya	525.3	502.7	488.7	476.2
Kiribati				
Kuwait				
Kyrgyzstan	26.9	33.7	37	56
Lao People's Democratic Republic	1.186.00	1.133.00	1.106.00	1.074.00
Latvia	193.48	234.23	244.11	271.56
Lebanon	1.65	1.66	1.66	1.73
Lesotho	2.11	2.21	2.27	2.32
Liberia	666.02	625.48	605.21	584.94
Libya	6.05	6.05	6.05	6.05
Liechtenstein	0.48	0.51	0.51	0.51
Lithuania	134.1	145.6	150.8	152.5
Luxembourg	7.35	9.36	9.36	9.36
Madagascar	1.778.00	1.691.00	1.663.00	1.626.00
Malawi	173	159	151	144
Malaysia	2.822.00	3.558.00	3.361.00	3.212.00
Maldives				
Mali	317.42	299.58	290.66	281.74
Malta	0.06	0.06	0.06	0.06
Marshall Islands	2.31	2.31	2.31	2.31
Martinique	8.4	8.4	8.4	8.4
Mauritania	12.5	9.5	8	7.3
Mauritius	2.53	2.52	2.27	2.27
Mayotte				
Mexico	2.186.00	2.111.00	2.076.00	2.043.00
Micronesia (Federated States of)	20.2	20.29	20.33	20.38
Monaco	-	-	-	-
Mongolia	671	626	605	583
Montenegro	33.3	33.3	33.3	33.3
Montserrat				
Morocco	189.88	211.97	224.19	222.78
Mozambique	1.878.00	1.782.00	1.733.00	1.692.00
Myanmar	2.040.00	1.814.00	1.734.00	1.653.00
Namibia	252.77	231.71	220.99	210.23
Nauru	-	-	-	-
Nepal	602	520	484	484
Netherlands	20.5	24	25.6	27.7
Netherlands Antilles				
New Caledonia	60.49	60.49	60.49	60.49
New Zealand	1.176.00	1.234.00	1.263.00	1.292.00
Nicaragua	506.3	427.8	388.5	349.3
Niger	60	41	38	37
Nigeria	2.016.00	1.550.00	1.317.00	1.085.00
Niue				
Norfolk Island				
Northern Mariana Islands	3.37	3.21	3.12	3.04
Norway	280	323	360	395
Occupied Palestinian Territory				
Oman				

Years	1990	2000	2005	2010
Regions-Subregions				
Pakistan	330	271	243	213
Palau	10.09	10.47	10.66	10.66
Panama	428.6	380.7	374	367.4
Papua New Guinea	2.536.80	2.422.50	2.365.40	2.306.20
Paraguay				
Peru	8.832.00	8.713.00	8.654.00	8.559.00
Philippines	641.39	655.35	660.12	663.42
Poland	691	807	887	968
Portugal	102.00	102.00	102	102
Puerto Rico	14.24	23.47	25.76	28.05
Qatar	-	-	-	-
Republic of Korea	109	181	224	268
Republic of Moldova	22.27	26.09	27.5	28.9
Romania	599.72	599.25	601.13	618.05
Russian Federation	32.504.00	32.157.00	32.210.00	32.500.00
Rwanda	35.2	17.58	34.55	39.48
Réunion	6	6	5.9	6
Saint Kitts and Nevis				
Saint Lucia				
Saint Pierre and Miquelon				
Saint Vincent and the Grenadines				
Samoa				
San Marino	-	-	-	-
Sao Tome and Principe	3.81	3.81	3.81	3.81
Saudi Arabia	5.93	5.93	5.93	5.93
Senegal	377	357	348	340
Seychelles	3.57	3.57	3.57	3.57
Sierra Leone	247.13	231.6	223.83	216.07
Singapore				
Slovakia	162.7	189.8	202.4	211.2
Slovenia	116	140.7	159.2	178.3
Solomon Islands	191	186.4	184.2	181.9
Somalia	483	438	415	394
South Africa	806.9	806.9	806.9	806.9
Spain	289.15	396.13	399.56	421.84
Sri Lanka	89.63	74.12	65.94	60.85
Sudan (former)	1.520.00	1.403.00	1.398.00	1.392.00
Suriname	3.168.30	3.168.30	3.168.30	3.164.50
Svalbard and Jan Mayen Islands	-	-	-	-
Swaziland	22.6	22.3	22.1	22
Sweden	1.178.10	1.182.70	1.219.00	1.255.30
Switzerland	126	135	139	143
Syrian Arab Republic				
Tajikistan	3.05	2.8	2.8	2.8
Thailand	908	882	877	881
The former Yugoslav Republic of Macedonia	60.1	62.1	60.4	60.4
Timor-Leste				
Togo				
Tokelau	-	-	-	-
Tonga	1.03	1.03	1.03	1.03
Trinidad and Tobago	20.54	19.75	19.62	19.17
Tunisia	5.8	7.5	8.2	9.3

Years	1990	2000	2005	2010
Regions-Subregions				
Turkey	686.14	742.62	782.23	821.85
Turkmenistan	11.3	11.3	11.7	11.7
Turks and Caicos Islands				
Tuvalu				
Uganda	171.3	139.7	123.9	108.8
Ukraine	499	662	711.5	761
United Arab Emirates	12.24	15.49	15.56	15.85
United Kingdom	120	119	128	136
United Republic of Tanzania	2.505.00	2.262.00	2.139.00	2.019.00
United States Virgin Islands	0.6	0.57	0.56	0.54
United States of America	16.950.00	17.998.00	18.632.00	19.308.00
Uruguay				
Uzbekistan	7.8	14	17.5	19.3
Vanuatu				
Venezuela (Bolivarian Republic of)				
Viet Nam	777	927	960	992
Wallis and Futuna Islands				
Western Sahara	32.65	32.65	32.65	32.65
Yemen	5.16	5.16	5.16	5.16
Zambia	2.578.68	2.497.32	2.456.64	2.415.96
Zimbabwe	697.23	594.27	542.8	491.51

TABLE 57
Emission Factors for N_2O-N Emissions from Cropland and Grassland Organic Soils

Climatic Class	Climatic Class Name	EF: N_2O-N (Kg ha^{-1} yr^{-1})
1	Warm Temperate Moist	8
2	Warm Temperate Dry	8
3	Cool Temperate Moist	8
4	Cool Temperate Dry	8
5	Polar Moist	8
6	Polar Dry	8
7	Boreal Moist	8
8	Boreal Dry	8
9	Tropical Montane	16
10	Tropical Wet	16
11	Tropical Moist	16
12	Tropical Dry	16

TABLE 58
Emission Factors for C Emissions from Cropland Organic Soils

Climatic Class	Climatic Class Name	EF: C (tonnes ha^{-1} yr^{-1})
1	Warm Temperate Moist	10
2	Warm Temperate Dry	10
3	Cool Temperate Moist	5
4	Cool Temperate Dry	5
5	Polar Moist	5
6	Polar Dry	5
7	Boreal Moist	5
8	Boreal Dry	5
9	Tropical Montane	20
10	Tropical Wet	20
11	Tropical Moist	20
12	Tropical Dry	20

TABLE 59
Emission Factors for C Emissions from Grassland Organic Soils

Climatic Class	Climatic Class Name	EF: C (tonnes ha^{-1} yr^{-1})
1	Warm Temperate Moist	2.5
2	Warm Temperate Dry	2.5
3	Cool Temperate Moist	0.25
4	Cool Temperate Dry	0.25
5	Polar Moist	0.25
6	Polar Dry	0.25
7	Boreal Moist	0.25
8	Boreal Dry	0.25
9	Tropical Montane	5
10	Tropical Wet	5
11	Tropical Moist	5
12	Tropical Dry	5

TABLE 60
Default Values for Nitrogen Excretion Rate (kg N (1000 kg Animal Mass)$^{-1}$ Day $^{-1}$)

TABLE 10.19 DEFAULT VALUES NITROGEN EXCRETION RATE* (KG N (1000 KG ANIMAL MASS)$^{-1}$ DAY $^{-1}$								
Category of animal	Region							
	North America	Western Europe	Eastern Europe	Oceania	Latin America	Africa	Middle Est	Asia
Dairy Cattle	0,44	0,48	0,35	0,44	0,48	0,6	0,7	0,47
Other Cattle	0,31	0,33	0,35	0,5	0,36	0,63	0,79	0,34
Swineb	0,5	0,68	0,74	0,73	1,64	1,64	1,64	0,5
Market	0,42	0,51	0,55	0,53	1,57	1,57	1,57	0,42
Breeding	0,24	0,42	0,46	0,46	0,55	0,55	0,55	0,24
Poultry	0,83	0,83	0,82	0,82	0,82	0,82	0,82	0,82
Hens >/= 1 yr	0,83	0,96	0,82	0,82	0,82	0,82	0,82	0,82
Pullets	0,62	0,55	0,6	0,6	0,6	0,6	0,6	0,6
Other Chickens	0,83	0,83	0,82	0,82	0,82	0,82	0,82	0,82
Broilers	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1
Turkeys	0,74	0,74	0,74	0,74	0,74	0,74	0,74	0,74
Ducks	0,83	0,83	0,83	0,83	0,83	0,83	0,83	0,83
Sheep	0,42	0,85	0,9	1,13	1,17	1,17	1,17	1,17
Goats	0,45	1,28	1,28	1,42	1,37	1,37	1,37	1,37
Horses (and mules, asses)	0,3	0,26	0,3	0,3	0,46	0,46	0,46	0,46
Camelsc	0,38	0,38	0,38	0,38	0,46	0,46	0,46	0,46
Buffaloc	0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,32
Mink and Polecat (kg N head^{-1} yr^{-1})d	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59
Rabbits (kg N head^{-1} yr^{-1})	8,1	8,1	8,1	8,1	8,1	8,1	8,1	8,1
Fox and Racoon (kg N head^{-1} yr^{-1})d	12,09	12,09	12,09	12,09	12,09	12,09	12,09	12,09

"The uncertainty in these estimates is +50%.

a. Summarized from 1996 IPCC Guidelines, 1997; European Environmental Agency, 2002; USA EPA National NH3 Inventory Draft Report, 2004; and data of GHG inventories of Annex I Parties submitted to the Secretariat UNFCCC in 2004.

b. Nitrogen excretion for swine are based on an estimated country population of 90% market swine and 10% breeding swine.

c. Modified from European Environmental Agency, 2002.

d. Data of Hutchings et al., 2001."

TABLE 61
Correspondence between IPCC and FAOSTAT Nomenclatures of Animals categories

IPCC			FAOSTAT Emissions database	FAOSTAT database - Production domain
Livestock population	**Main categories**	**Animal / Subcategories**	**Animal category**	**Livestock category**
Cattle	Mature Dairy Cow	High-producing cows that have calved at least once and are used principally for milk production	Dairy cattle	Cattle*
		Low-producing cows that have calved at least once and are used principally for milk production		
	Other Mature Cattle	Cows used to produce offspring for meat		
		Cows used for more than one production purpose: milk, meat, draft		
		Bulls used principally for breeding purposes		
		Bullocks used principally for draft power		
	Growing Cattle	Calves pre-weaning	Non Dairy Cattle	
		Replacement dairy heifers		
		Growing / fattening cattle post-weaning		
		Feedlot-fed cattle on diets containing > 90 % concentrates		
Buffalo	Mature Dairy Buffalo	High-producing buffalos that have calved at least once and are used principally for milk production	Dairy Buffalo	Buffalo*
		Low-producing buffalos that have calved at least once and are used principally for milk production		
		Buffalos used to produce offspring for meat		
	Other Mature Buffalo	Buffalos used for more than one production purpose: milk, meat, draft	Non Dairy Buffalo	
		Bulls used principally for breeding purposes		
		Bullocks used principally for draft power		
		Calves pre-weaning		
	Growing Buffalo	Replacement dairy heifers		
		Growing / fattening buffalo post-weaning		
		Feedlot-fed buffalos on diets containing > 90 % concentrates		
		Breeding ewes for production of offspring and wool production		
Sheep	Mature Ewes	Milking ewes where commercial milk production is the primary purpose	Sheep	Sheep*
		–		
	Other Mature Sheep (>1 year)	Intact males		
	Growing Lambs	Castrates		
		Females		
		Sows in gestation		
Goats	Mature Goat	Milking goat where commercial milk production is the primary purpose	Goats	Goats*
		–		
	Other Mature Goat (>1 year)	Intact males		
	Growing Goat	Castrates		
		Females		
		Goats in gestation		

IPCC			FAOSTAT Emissions database	FAOSTAT database - Production domain
Livestock population	**Main categories**	**Animal / Subcategories**	**Animal category**	**Livestock category**
Swine	Mature Swine (Breeding)	Sows which have farrowed and are nursing young	Breeding Swine	Pig
		Boars that are used for breeding purposes		
	Breeding Growing Swine	Growing boars that will be used for breeding purposes		
		Nursery		
	Market Growing Swine	Finishing	Market Swine	
		–		
Chickens	Broiler chickens grown for producing meat	–	Dairy Buffalo	Buffalo*
	Layer chickens for producing eggs, where manure is managed in dry systems (e.g., high-rise houses)	–	Non Dairy Buffalo	
	Layer chickens for producing eggs, where manure is managed in wet systems (e.g., lagoons)	–		
	Chickens under free-range conditions for egg or meat production	–		
Turkeys	Breeding turkeys in confinement systems	–	Turkeys	Turkeys
	Turkeys grown for producing meat in confinement systems	–		
	Turkeys under free-range conditions for meat productions	–		
Ducks	Breeding ducks	–	Ducks	Ducks
	Ducks grown for producing meat	–		
Camels	Camels	–	Camels	Camels
Mules and Asses	Mules and Asses	–	Mules	Mules
			Asses	Asses
Horses	Horses	–	Horses	Horses
Llamas, Alpacas	Llamas, Alpacas	–	Llamas	Other Camelids
			Alpacas	
Rabbits	Rabbits	–	Rabbits	Rabbits
Geese	Geese	–	Geese	Geese
Fur bearing animals	Fur bearing animals	–	–	Live Animals, non-food NES (not else specified)
Ostrich	Ostrich	–	Ostrich	Live Animals NES (not else specified)
Deer	Deer		Deer	

* FAOSTAT database includes data subset of cattle, buffalos, sheep, goat and camels related to the milk animals, a subset of chickens related to laying animals for Supply Utilization Account/Food Balance Sheet purpose, although they are not considered as categories of the FAOSTAT commodity list.

Annex 4

The United Nations Member States, meeting at the United Nations Conference on Environment and Development (UNCED, Rio de Janeiro, 1992), agreed to sign a Declaration on Sustainable Development[9] as an instrument to ensure a healthy and productive life for human beings, in harmony with nature, for current and future generations. The Sustainable Development commitments of UN Member States include the need to ensure that activities within their jurisdiction or control do not cause damage to the environment, both within their territories as well as in those of other States, or areas beyond the limits of their national jurisdiction.

The United Nations Framework Convention on Climate Change (UNFCCC)[10] was signed by countries committing to *stabilize greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner* (UNFCCC, Article 2). To achieve these global sustainable development goals in the AFOLU sector, Parties to the UNFCCC *shall promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs, including biomass, forests, as well as other terrestrial and coastal ecosystems*.

At the same time, sustainable rural development and eradication of hunger, as specified in both UNCED and UNFCCC core principles, are at the basis of FAO's mission[11]. In particular, FAO generates knowledge and provides assistance to its Member Countries towards adopting appropriate adaptation and mitigation responses in the agriculture, fisheries and forestry sectors,[12] to ensure sustainability of production systems and to maintain food security under climate change.

Parties to the UNFCCC have committed to implement specific actions and programs to mitigate climate change. In particular, Article 4 of the UNFCCC states that

"All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall:
(a) Develop, periodically update, publish and make available to the Conference of the Parties […] *national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties;*
(b) Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol […]
(c) Communicate to the Conference of the Parties information related to implementation […]"

From Article 4 of the Convention, different reporting requirements have emerged for developed and developing countries (UNFCCC Annex I and non-Annex I Parties, respectively)[13].

[9] http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm
[10] http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf
[11] http://www.fao.org/docrep/x3551e/x3551e02.htm
[12] Climate Change and Food Security: A Framework document – FAO 2008; available at: http://www.fao.org/forestry/15538-079b31d45081fe9c3dbc6ff34de4807e4.pdf
[13] Annex I Parties include the industrialized countries that were members of the OECD in 1992, plus countries with economies in transition (EIT); Non-Annex I Parties are mostly developing countries.

This note provides information on UNFCCC reporting requirements relating to the mitigation of climate change in the AFOLU sector, for developed and developing countries. Within the AFOLU sector, mitigation consists of actions taken to reduce GHG emissions and enhance carbon sinks and reservoirs, compared to a business-as-usual scenario/reference level. Parties must report these actions to the UNFCCC periodically, as specified in a series of decisions agreed at the annual Conference of Parties (COP). In particular, these reports should take the following forms:

Annex I Parties Report:

- National Communications (NC), containing information, from the last GHG Inventory submitted, on national GHG emissions/removals, climate-related policies and measures, GHG projections, vulnerability and adaptation to climate change, financial assistance and technology transfer to non-Annex I Parties, and actions to raise public awareness on climate change;
- National GHG Inventories (NGHGI), containing information on GHG emissions and removals, such as activity data, emission factors, and methodologies used to estimate these emissions. An NGHGI is composed of two distinct documents: the Common Reporting Format (CRF) tables, which contain a time-series of GHG emission estimates (from 1990 till the year x-2; where x is the submission year of the NGHGI); and the National Inventory Report (NIR), which includes all information on background data and methods used, and the data analysis and institutional arrangements underlying the preparation of the NGHGI.
- Biennial Reports (BRs), which outline progress in achieving net emissions reductions and provision of financial, technological, and capacity-building support to non-Annex I Parties for dealing with climate change.

National communications are to be submitted by Annex I Parties every 4 years[14] (Decisions 8/CP.1, 11/CP.4). They are prepared and reported periodically by Annex I Parties based on agreed reporting guidelines (Decision 4/CP.5)[15] and, for GHG estimates, on the methodology developed by the Intergovernmental Panel on Climate Change (IPCC), as adopted for the NGHGI by the COP. Submissions by Annex I Parties can be found http://unfccc.int/national_reports/annex_i_natcom/submitted_natcom/items/4903.php

National GHG inventories are submitted (3/CP.5) by Annex I Parties annually. They are prepared on the basis of reporting guidelines[16] agreed by the COP (14/CP.11) and on methodologies developed by the IPCC[17]. National inventory arrangements should be in place to ensure that an NGHGI is fully compliant with reporting requirements and is submitted on time. Submissions by Annex I Parties can be found at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/7383.php

[14] The exact timing depends on specific decisions taken by the Conference of the Parties (COP), which establishes the due date for each subsequent submission; this could vary between 3-5 years

[15] Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications (pages 80-100), Annex to Decision 4/CP.5 at http://unfccc.int/resource/docs/cop5/07.pdf

[16] Currently, Annex I Parties are using the Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11. Note by the Secretariat (available at http://unfccc.int/resource/docs/2006/sbsta/eng/09.pdf).
From 2014, Annex I Parties will use the Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories (Annex I to Decision 24/CP.19), available at http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf.

[17] Currently, Annex I Parties are using the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (at http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html), the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (at http://www.ipcc-nggip.iges.or.jp/public/gp/english/index.html), and the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (at http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html)
From 2014, Annex I Parties will use the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (at http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html), the 2013 Supplement to the 2006 Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement) (at http://www.ipcc-nggip.iges.or.jp/home/docs/wetlands/Wetlands_Supplement_precopyedit.pdf) and for KP reporting, the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (KP Supplement) (at http://www.ipcc-nggip.iges.or.jp/home/docs/kpsg/KP_Supplement_precopyedit.pdf).

Biennial Reports are to be submitted (2/CP.17) by Developed Country Parties every 2 years; the first biennial report (BR1) was due on 1 January 2014. These Reports are prepared on the basis of agreed reporting guidelines (2/CP.17 Annex I)[18] and on methodologies developed by the IPCC, as per the NGHGI. Submissions by Parties can be found at http://unfccc.int/national_reports/biennial_reports_and_iar/submitted_biennial_reports/items/7550.php

Each report is subject to a review[19] process[20], assisted by the UNFCCC Secretariat and implemented by experts selected from the UNFCCC Roster of Experts (RoE).

Non-Annex I Parties Report:

- National Communications (NC), containing information on national circumstances, national GHG emissions/removals[21], steps taken or envisaged to implement the Convention, and any other information considered relevant to the achievement of the objective of the Convention including, if feasible, material relevant to calculations of global emissions and emission trends;
- Biennial Update Reports (BURs), containing updated information on national circumstances and institutional arrangements for reporting on a continuous basis[22], national GHG emissions/removals information[23], including a national inventory report, and information on mitigation actions[24], effects, needs, and support received.

National communications are expected be submitted (decision 10/CP.2) by non-Annex I Parties every 45 years, following decisions for each submission taken by the Conference of the Parties (COP). They are prepared and reported periodically by non-Annex I Parties based on agreed reporting guidelines (Decision 17/CP.8)[25], which are based on methodologies developed by the IPCC[26] and adopted by the COP. The Methods and Guidance Document (MGD) of the Global Forest Observations Initiative describes how IPCC guidance can be used to estimate emissions and removals associated with REDD+ activities described in decisions of the COP. The MGD was produced in consultation with expertise from UNFCCC, IPCC and FAO, and can be accessed at http://gfoi.org/methods-guidance-documentation.

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[18] UNFCCC Biennial Reporting Guidelines for Developed Country Parties (Decision 2/CP.17) (at http://unfccc.int/resource/docs/2011/cop17/eng/09a01.pdf)

[19] The review process is governed by the Annex to Decision 23/CP.19 (*Guidelines for the technical review of information reported under the Convention related to greenhouse gas inventories, biennial reports and national communications by Parties included in Annex I to the Convention*) at http://unfccc.int/resource/docs/2013/cop19/eng/10a02.pdf.

[20] The objectives of the review of information reported under the Convention related to GHG inventories, BRs and NCs and pursuant to relevant decisions of the COP are the following:

a. To provide, in a facilitative, non-confrontational, open and transparent manner, a thorough, objective and comprehensive technical review of all aspects of the implementation of the Convention by individual Annex I Parties and Annex I Parties as a whole;
b. To promote the provision of consistent, transparent, comparable, accurate and complete information by Annex I Parties;
c. To assist Annex I Parties in improving their reporting of information contained in GHG inventories, BRs and NCs and pursuant to other relevant decisions of the COP and the implementation of their commitments under the Convention;
d. To ensure that the COP has accurate, consistent and relevant information in order to review the implementation of the Convention.

[21] For the years 1994 (1st NC), and 2000 (2nd NC).

[22] This includes, for REDD+ activities, the national forest monitoring system, including for providing information on how the safeguards are being addressed and respected (Decision 1/CP.16).

[23] The decision text has not fixed the starting year, nor the time-series of GHG estimates to be reported in the BUR. In any case, from 2014 onwards, the pace of the time series will be biennial.

[24] I.e. Nationally Appropriate Mitigation Actions (NAMAs) and REDD+ activities.

[25] Guidelines for the preparation of national communications from Parties not included in Annex I to the Convention (Decision 17/CP.8) at http://unfccc.int/resource/docs/cop8/07a02.pdf.

[26] Currently, for non-Annex I Parties, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (at http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html) have been adopted and the use of the 2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (at http://www.ipcc-nggip.iges.or.jp/public/gp/english/index.html) and 2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (at http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html) has been encouraged (see Decision 17/CP.8). Note that for the LULUCF (Land Use, Land-Use Change & Forestry), sector methodologies provided in the 2003 GPG for LULUCF replace those provided in the Revised 1996 IPCC Guidelines.
However, non-Annex I Parties may use the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (at http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html) and any further IPCC supplement to these Guidelines as adopted under the UNFCCC.

Submissions by non-Annex I Parties can be found here: http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

Biennial Update Reports are to be submitted (2/CP.17) by non-Annex I Parties every 2 years, and are prepared on the basis of agreed reporting guidelines (Decision 2/CP.17)[27] which are, in turn, based on methodologies developed by the IPCC[28] and adopted by the COP. Least Developed Country Parties and Small Island Developing States may submit biennial update reports at their discretion.

The first biennial report (BUR1) is due by December 2014 and is expected to contain information on current levels and trends of GHG emissions and removals within countries' territories. The Biennial Update Reports will be subject[29] to a technical assessment[30] as part of the International Consultation and Analysis process, which aims to increase the transparency of mitigation actions and their effects.

For activities listed in Decision 1/CP.16, paragraph 70 (activities commonly referred to as REDD+) [31]:

[27] UNFCCC biennial update reporting guidelines for Parties not included in Annex I to the Convention (Decision 2/CP.17) can be found at http://unfccc.int/resource/docs/2011/cop17/eng/09a01.pdf.

[28] The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (at http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html), 2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (at http://www.ipcc-nggip.iges.or.jp/public/gp/english/index.html) and 2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (at http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html) must be used for reporting (see Annex III to Decision 2/CP.17). Note that for the LULUCF (Land Use, Land-Use Change & Forestry), the sector methodologies provided in the 2003 GPG for LULUCF replace those set out in the Revised 1996 IPCC Guidelines.
However, non-Annex I Parties may use the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (at http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html) and any further IPCC supplement to these Guidelines as adopted under the UNFCCC.

[29] Decision 2/CP.17 (Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention) at http://unfccc.int/resource/docs/2011/cop17/eng/09a01.pdf#page=4.

[30] Decision 20/CP.19 (*Composition, modalities and procedures of the team of technical experts under international consultation and analysis*) at http://unfccc.int/resource/docs/2013/cop19/eng/10a02.pdff.

[31] Developing Country Parties are encouraged to contribute to mitigation actions in the forest sector by undertaking the following activities, as deemed appropriate by each Party and in accordance with their respective capabilities and national circumstances:
a. Reducing emissions from deforestation;
b. Reducing emissions from forest degradation;
c. Conservation of forest carbon stocks;
d. Sustainable management of forests;
e. Enhancement of forest carbon stocks.

- Information on Forest Reference Emissions Levels and/or Forest Reference Levels is prepared on the basis of agreed reporting guidelines (Decision 12/CP.17)[32] and methodologies developed by the IPCC[33]. The information is subject to assessment[34].
- Information on safeguards must be reported[35].

For receiving payments for results-based actions, information on forest-related emissions by sources and removals by sinks resulting from the implementation of the activities is prepared on the basis of agreed reporting guidelines (Decision 14/CP.19)[36].

[32] Guidelines for submissions of information on reference levels; these are available at http://unfccc.int/resource/docs/2011/cop17/eng/09a02.pdf#page=16.

[33] Methodologies of the most recent IPCC Guidelines, which have been either adopted or encouraged to be used by non-Annex I Parties, should be applied, as appropriate. Currently:

- for compiling the NC of non-Annex I Parties, the use of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories have been adopted and the 2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and the 2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry has been encouraged (see Decision 17/CP.8). Note that for the LULUCF (Land Use, Land-Use Change & Forestry), the sector methodologies provided in the 2003 GPG for LULUCF replace those provided in the Revised 1996 IPCC Guidelines;
- for compiling the BUR of non-Annex I Parties, the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, the 2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and the 2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry have been adopted (see Annex III to Decision 2/CP.17). Note that for the LULUCF (Land Use, Land-Use Change & Forestry), the sector methodologies provided in the 2003 GPG for LULUCF replace those provided in the Revised 1996 IPCC Guidelines.

However, non-Annex I Parties may use the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and any further IPCC supplement to these Guidelines as adopted under the UNFCCC.

[34] Annex to Decision 13/CP.19 (*Guidelines and procedures for the technical assessment of submissions from Parties on proposed forest reference emission levels and/or forest reference levels*) at http://unfccc.int/resource/docs/2013/cop19/eng/10a01.pdf.

[35] Annex to Decision 12/CP.17 (*Guidance on systems for providing information on how safeguards are addressed and respected*) at http://unfccc.int/resource/docs/2011/cop17/eng/09a02.pdf#page=16.

[36] Guidelines for elements to be included in the technical annex referred to in paragraph 7 of decision 14/CP.19 as contained in the Annex to Decision 14/CP.19 (*Modalities for measuring, reporting and verifying*) at http://unfccc.int/resource/docs/2013/cop19/eng/10a01.pdf.

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This Manual seeks to guide the staff of national statistical offices and environmental ministries and agencies in compiling statistics related to GHG emissions and removals. In particular, the Manual provides information on accessing and using the FAOSTAT Emissions database. In addition, the manual sets out a step-by-step approach on estimating GHG emissions with the 2006 IPCC Guidelines for National GHG Emission Inventories.

The FAOSTAT Emissions database provides Member Countries with the opportunity to identify the official agricultural and forestry statistics (data gap filling) required for GHG emission estimations, and to perform GHG data analysis linked to data gap filling and Quality Assurance/Quality Control processes.

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To Improve Agricultural & Rural Statistics

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