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The FAOSTAT Emissions Database

Contributed by: *FAO Climate, Land Tenure and Energy Division; FAO Statistics Division*

1. Introduction

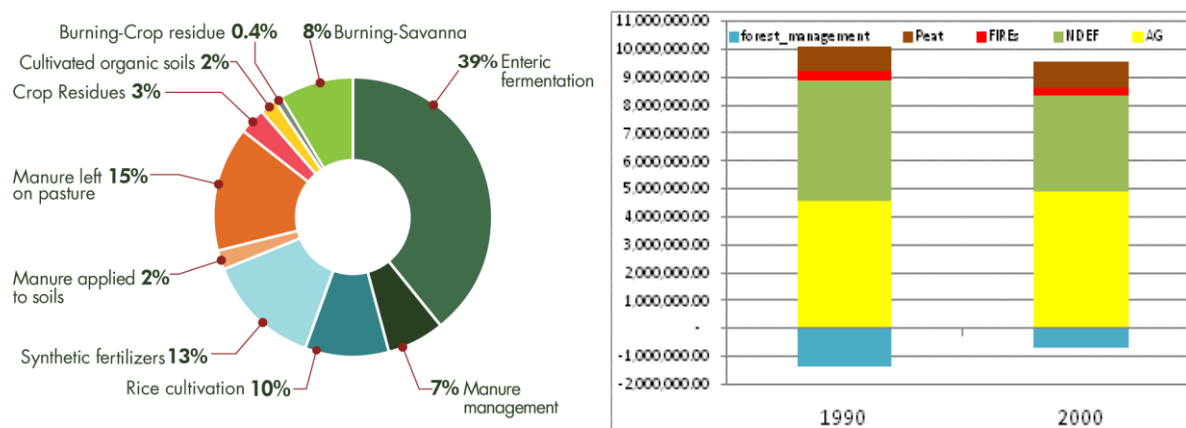
The agricultural sectors face increased environmental challenges linked to new production methods and intensified production systems required to meet global population growth and energy demands. Energy, chemical products, and labor inputs necessary to increase agro-ecosystem production inevitably alter natural biogeochemical cycles, leading to serious environmental damage including soil degradation, water pollution, biodiversity loss, increased greenhouse gas (GHG) emissions, and disruption of carbon sinks.

In particular, climate change presents unique challenges to agriculture. Global anthropogenic greenhouse gas (GHG) emissions, currently estimated at over fifty billion metric tonnes of carbon-dioxide (CO₂) annually, are altering atmospheric concentrations well beyond natural levels. Atmospheric CO₂ concentrations have surpassed 400 ppm in 2013, about 35% above their pre-industrial equilibrium levels. Perhaps even more importantly, the rates of GHG increase in the atmosphere are much faster today than those of the underlying natural cycles.

Agriculture is both a major culprit, as well as a potential victim, to the ensuing climate changes. On the one hand, it emits 20-25% of total anthropogenic emissions globally, through

land management activities for crop cultivation and livestock production, as well as through the associated deforestation and degradation of organic soils. On the other hand, agriculture stands to suffer the combination of warming temperatures and increased frequency and intensity of extreme weather events that are associated with the climate change regimes predicted for coming decades.

Figure 1. Agricultural Emissions by Sector and total AFOLU contributions (FAOSTAT, 2013)



Agriculture and related land use changes emit approximately one-fifth of global anthropogenic emissions of carbon dioxide (CO₂), over half of methane (CH₄), and two-thirds of nitrous oxide (N₂O) (FAOSTAT, 2013). Emissions of CO₂ are dominated by deforestation and peatland degradation, with a small component from energy and machinery use; emissions of methane are dominated by livestock production and rice cultivation; while emissions of N₂O result mainly from the use of industrially produced inorganic fertilizer and animal manure applications to soils and pastures. Overall, livestock and feed production—including their role as a major driver of deforestation—contribute three-quarters of total agricultural emissions.

A focus on environmentally-sustainable production methods can lead to many synergies with current rural development needs. In particular, many climate change mitigation strategies in agriculture tend to address food security needs, by leading to better climate-adapted production systems with enhanced resilience, and by creating employment opportunities. The Intergovernmental Panel on Climate Change (IPCC) reports periodically on both the state of climate science, while also developing guidelines for the assessment, measurement, and reporting of GHG emissions including those from agriculture and related land use changes.

IPCC Guidelines provide methodological guidance to countries for reporting their annual inventories of greenhouse gas emissions and removals to the United Nations Framework Convention on Climate Change (UNFCCC). The IPCC emission category *Agriculture, Forestry and Other Land Use (AFOLU)* presents a unique challenge to inventory compilers, especially

from developing countries, due to the scarcity of national data and the difficulty in regularly monitoring and updating land use and land use change statistics.

2. Data and Knowledge Gaps

The FAO Statistics Division is preparing a multidisciplinary agri-environmental dataset from the thematic databases already available at FAO and from other institutions. Agri-environmental indicators (AEIs) describe and assess trends in order to advise scientists and policymakers. To be useful, AEIs must be robust and relevant to different stakeholders. In general, the main constraint in the operational use of AEIs is the lack of reliable data, which limits the number of indicators that can be regularly produced.

The OECD¹ and EUROSTAT² led the statistical methodological development of the AEI framework. The FAOSTAT Agri-environmental domain was developed in coordination with these OECD and EUROSTAT frameworks in order to build upon their theoretical base with the aim of extending geographical coverage of AEIs to the remaining FAO Member countries as available. However, while OECD and EUROSTAT designed their frameworks primarily over a limited number of developed countries, FAO must address all Member countries, and this can be challenging in countries where data is lacking.

A major component of these efforts has been devoted to quantifying GHG emissions and mitigation potentials, with the goal of obtaining synthetic and comprehensive assessments for Member countries, consistent with IPCC methodologies and UNFCCC requirements. Specific attention has been and will continue to be focused on addressing the needs of least developed countries (LDCs).

Until recently, developing countries were allowed to report their emissions to UNFCCC at intervals that depended on their national circumstances and capacity. However, starting in 2014, they will be asked to report biannually their GHG emissions to the UNFCCC in Biennial Update Reports (BURs).

¹ OECD. 2001. Environmental Indicators for Agriculture. Vol. 3: Methods and Results. Paris: OECD. <http://www.oecd.org/dataoecd/24/35/40680869.pdf>

³ European Commission. 2006. Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy. Communication from the Commission to the Council and the Parliament. COM (2006) 508 final.

Eurostat, DG Agriculture, DG Environment, JRC, EEA. 2001. Towards agri-environmental indicators - Integrating statistical and administrative data with land cover information. Topic Report No. 6. Copenhagen: EEA. http://www.eea.europa.eu/publications/topic_report_2001_06

This FAO GHG activity described herein is being carried out by the project “*Monitoring and Assessment of GHG Emissions and Mitigation Potentials in Agriculture - MAGHG*”.³ Funded by the Norwegian and German Governments, the key project goals are as follows:

- Generate knowledge that can help developing countries identify mitigation options in agriculture, forestry, and fisheries, consistent with rural development and food security goals;
- Develop an FAO-AFOLU Emissions database, within FAOSTAT, to support countries in reporting data to the UNFCCC, and provide guidance in the identification of national mitigation goals and strategies, including Nationally Appropriate Mitigation Actions (NAMAs); *and*
- Collaborate with IPCC, United Nations Development Program/Low Emission Capacity Building Programme (UNDP/LECB), United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD), and UNFCCC on capacity development activities at regional level linked to the Regional FAO Commission on Agricultural Statistics (CAS).

A preliminary activity of FAO MAGHG was to link directly with IPCC at the outset of its activities, in order to jointly analyze needs and gaps toward improving emission data collection and reporting activities, and to provide key recommendations. With regard to improved measurement and reporting of agricultural statistics, IPCC needs include the following:

- Increase in the submission frequency of National Communications submitted by non-Annex I countries;
- Commitment to develop country-specific emission factors, i.e., higher tiers for calculating emissions; *and*
- Establishment of a coherent data platform that can be used to benchmark National Communications and the strengthening of these exchanges to the international community and the UNFCCC.

The most recent IPCC Fourth Assessment Report (2007) offered many options for GHG mitigation in agriculture, such as more efficient chemical fertilizers use to reduce N₂O emissions, improvements to animal waste management systems, and soil management techniques and land conservation. The challenges ahead lie in identifying specific subsets of such activities that are appropriate within the specific regional and socio-economic contexts of countries, and subsequently, quantifying the associated GHG emission reductions. With a focus on developing countries and LDCs, there is a critical need to assess monitoring and reporting gaps, and to

⁴ <http://www.fao.org/climatechange/micca/ghg/en/>

investigate the potential for regional scaling up. Today, FAO MAGHG is a direct contributor of AFOLU GHG data to the IPCC Fifth Assessment Report, to be published in 2014.

Preliminary consultations with IPCC identified a number of key international data sources for GHG extant at FAO. The key data sources relevant to AFOLU GHG data include:

- FAO, *Forest Resource Assessment* (FRA www.fao.org/forestry/fra);
- FAO, *National Forest and Monitoring Assessment - NFMA*
<http://www.fao.org/forestry/nfma/en/>;
- FAO, *Harmonized World Soil Database*
<http://www.fao.org/nr/water/news/soil-db.html>;
- FAO, *Global Climate Maps*
http://www.fao.org/nr/climpag/climate/index_en.asp;
- FAO, *Global Planted Forests Thematic Study*
<http://www.fao.org/forestry/plantedforests/10368/en/>; and
- FAO, *FAOSTAT*
<http://faostat.fao.org/default.aspx>

Despite these key data sources, major data gaps and inconsistencies still exist regarding country reporting requirements of annual inventories of greenhouse gas emissions and removals to the UNFCCC, as international and national agricultural statistics traditionally focused on issues relating to agricultural production, agricultural trade, and food security, including FAO's statistical datasets. At the national level, many statistical systems are not yet designed for collecting data on parameters relevant to GHGs. Assessments such as life-cycle analysis, which requires information at each stage and for each input of production systems, is even more difficult to gather. Many countries require additional capacity and guidance on collecting this type of data. Emission and carbon stock factors are often available, but these require further development and validation.

A number of general issues on the subject of data gaps were identified:

- Data gaps are particularly large in developing countries. Approximately 110 countries regularly report agricultural production data to FAO. Non-reporting countries are unlikely to start reporting in the short-term. Considerable investment in staff and resources is needed to improve this situation.
- Data quality generally has not been systematically assessed. It is therefore difficult to evaluate the quality of data within some national datasets.

- A great deal of the required data is in private hands. There is an increasingly significant problem obtaining confidential (commercial) data, particularly on various agri-environmental inputs such as fertilizers and pesticides.
- Guidance is necessary to address data gaps. Clear and consistent data collection protocols must be established and implemented in the various agri-environmental data domains.
- Baseline emissions factors from different farming systems must be established; detailed descriptions of agricultural land management practices and their emissions impacts are necessary.

The AFOLU FAOSTAT Emissions Database

The rationale for the AFOLU FAOSTAT Emissions Database stems from the fact that FAO can act as an impartial institution and data broker, and support member countries in building robust inventories by compiling and presenting agricultural and land use emissions data. Anthropogenic emissions of GHG gases can in principle be estimated in isolation or *via* combinations of complementary approaches:

- i) inventory-based, bottom-up accounting based on statistical compilation of activity data and regional emission factors;
- ii) atmospheric-based, top-down accounting using global mixing ratios and inversion modeling; *and/or*
- iii) process-based approaches, based on dynamic modeling of underlying processes, with specific rules for scaling-up in space and time (*Montzka et al., 2011*).

In order to compile a global AFOLU Emissions database with regional detail, all three methods can and have been used (e.g., *IPCC 2006; Crutzen et al., 2007; Montzka et al. 2011*). However, in order to address sectoral and regional contributions, including national level details, methods under ii) are unsuitable. For national-level reporting of GHG emissions to the UNFCCC, IPCC guidelines (*IPCC, 1996, 2000, 2003, 2006*) endorse a range of methodological approaches specified under i) and iii) above, from simple bottom-up methods (i.e., Tier 1) to more complex procedures, often involving process modeling and rules for scaling-up in time and space (Tier 2 and Tier 3).

FAO developed a global GHG emission database with country level detail, using activity data from the FAOSTAT database (*FAO, 2013; see Fig. 2*). The data themselves were collected by member countries, typically *via* National Agriculture Statistical Offices, and reported to FAO - a process that results in an internationally approved, coherent data platform covering key information. The database was tested in peer-review mode for a period of two months during the

summer and fall 2012, and officially launched to the public in December, 2012. The database includes emissions from the following AFOLU categories:

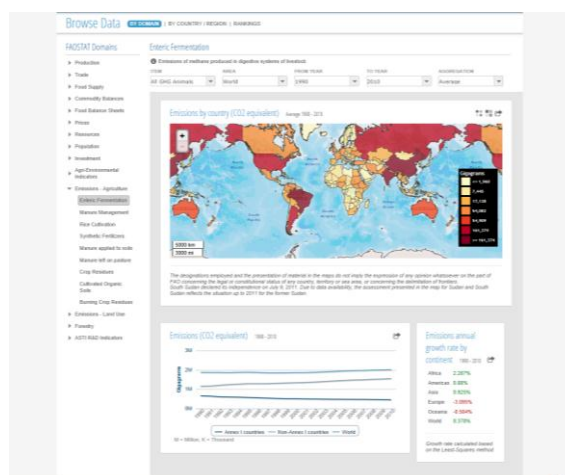
Agriculture:

- Enteric fermentation
- Manure management
- Synthetic fertilizers
- Manure applied to soils
- Manure left on pasture
- Crop residues
- Rice Cultivation
- Cultivated organic soils
- Burning crop residues
- Savanna Burning

Land Use Land Use Change and Forestry:

- Land Use - Emissions or removals from forest management, forest conversion to other land uses, peat and other biomass fires, and drained cultivated organic soils

Figure 2. Computer screenshot of the new AFOLU FAOSTAT GHG database http://faostat3.fao.org/faostat-gateway/go/to/browse/G1/*E



The AFOLU FAOSTAT Emission database is increasingly being used worldwide as a source of statistical information. Examples include use and dissemination of FAOSTAT data by the Intergovernmental Panel on Climate Change Fifth Assessment Report, the World Resource's Institute, the Economic and Social Commission for Asia-Pacific and the FAO Year Book. The AFOLU FAOSTAT Emissions database can be used by practitioners in Member countries alongside four main dimensions, to improve national data collection and institutional coordination in support of national, regional and international climate change agreements and related implementation mechanisms:

- i) Global and Regional assessments: for regular updates by FAO on the status of global and regional GHG emissions, to be used for both science and policy processes;
- ii) Filling gaps and capacity development: a tool for member countries to facilitate data collection, analysis, and reporting, and identify data gaps and improving national data systems;
- iii) Benchmarking and QA/QC analysis: to provide an internationally accepted and neutral data platform for evaluation of national reporting; *and*
- iv) Development of indicators for further analysis: coherence of GHG and activity data may be used as a starting point for national level discourse on necessary steps to improve reporting.

3. FAO Capacity Development Activities to improve GHG Statistics

FAO has implemented since 2012, via its Monitoring and Assessment of GHG Emissions Project, a series of Capacity Development workshops in support of its developing member countries in the assessment and reporting of GHG emissions, from GHG inventory management, to new emerging needs under the climate convention such as compilation of Biennial Update Reports (BURs) and data support for Nationally Appropriate Mitigation Actions (NAMAs). These regional workshops are held in the context of the FAO Regional Commission on Agricultural Statistics (CAS). MAGHG organised the Inception Workshop in conjunction with the Asia-Pacific Commission on Agricultural Statistics (APCAS) in Vietnam in October 2012. The Second Regional Workshop, for Latin America and the Caribbean, took place in Trinidad and Tobago in June 2013 in conjunction with Instituto Interamericano de Cooperación para la Agricultura (IICA). The Third GHG Workshop focused on Africa (Casablanca, Dec 2-3 2013) and was organized in conjunction with AFCAS 23. The goal of the GHG workshops is to facilitate dialogue among practitioners in member countries, exchange experiences at the regional level, and support capacity development of national agencies by bringing together high-level staff of Ministries of Agriculture, National Statistical Agencies, and Bureaus responsible for national GHG reporting under international climate policy processes.

The GHG workshops combine brief theoretical presentations and practical implementation activities. Working groups and role play activities provide an opportunity for countries to reflect upon and share circumstances particular to their own countries and work together in a group setting. At the workshops, participants analyze and discuss options to improve inter-institutional coordination and information sharing via diverse methods of data collection.

4. Recommendations for consideration by APCAS Members

- Endorse the work undertaken by FAO in developing a Greenhouse Gas Emissions database for Agriculture, Forestry and other Land Uses (AFOLU) in FAOSTAT and its use as a platform for analysis of mitigation data.
- Endorse the use of the FAOSTAT AFOLU Emissions database by member countries as a useful support in developing robust GHG inventories, elaborate Biennial Update Reports

(BURs), provide basic data for development of Nationally Appropriate Mitigation Actions (NAMAs), and develop indicators for policy analysis.

- Recommend that FAO continues to work with member countries, individually and at regional level, to support their analysis and estimation of GHG emissions data and indicators to use in developing inventories, and to plan mitigation strategies in agriculture that are aligned with rural development goals.

Questions, inputs and contributions can be sent by e-mail to
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5. Bibliography

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