FERTILIZERS AND CLIMATE CHANGE

Enhancing Agricultural Productivity and Reducing Emissions

The primary objective of agriculture is to feed the world. It has been estimated that almost half the people on the Earth (around 48%) are currently fed as a result of manufactured nitrogen fertilizer use (Erisman *et al.* 2008). Yet the share of total global GHG emissions directly related to the production, distribution and use of fertilizers is between 2 and 3%. As the population continues to grow and agricultural production strives to meet food demand worldwide, fertilizer use will increase before eventually reaching a plateau towards the middle of the century. The significant risks and opportunities that climate change presents for agriculture, food supplies and the global fertilizer industry create an imperative for the International Fertilizer Industry Association (IFA) and its member companies to contribute to mitigation and adaptation in the context of achieving a more sustainable path to global food security.

Activity	Share of total global GHG emissions (%)
Agriculture	10-12
Deforestation and land-use change	12
Fertilizer (Total)	2-3
Fertilizer production	0.93
Fertilizer distribution	0.07
Fertilizer use	1.5

Fertilizers are an essential tool to increase food production sustainably

In the context of projected population growth and improving incomes, it is estimated that agricultural demand by 2050 will range from 50 to 80% above today's level of production (Müller 2009, FAO 2006). The expected increase in arable land area is estimated to be much lower, implying a need to further increase land productivity (FAO 2003). Because any reduction in production intensity at one location would need to be compensated by additional production elsewhere, it is imperative to optimize agricultural production per unit of land in order to meet future demand.

Many good agricultural practices that increase productivity also moderate agricultural GHG emissions and have other sustainable development benefits, including greater food security,

Emissions of greenhouse gases from agriculture are mostly related to the following activities

Carbon dioxide (CO_2) emissions: from fertilizers (urea and ammonium bicarbonate), land conversion to cropping, use of agricultural machinery, livestock production.

Nitrous oxide (N_2O) emissions: From nitrogen fertilizers, manures and nitrogen-fixing legumes, as well as microbial conversion of other nitrogen sources in agricultural soils.

Methane (CH_4) emissions: From livestock and irrigated rice production

poverty alleviation, moisture retention in soils and soil conservation. Good agricultural practices also help prevent unwanted environmental impacts related to poorly managed fertilizer use, such as eutrophication of aquatic ecosystems and acidification.

According to the agricultural chapter of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), direct agricultural emissions made up 10-12% of total anthropogenic GHG emissions in 2005 (5.1-6.2 Pg CO_2-eq) (Smith *et al.* 2007). GHG emissions from deforestation, mainly in tropical countries, contributed an additional 5.9 Pg CO_2-eq per year (with an uncertainty range of ±2.9 Pg CO_2-eq), thus equalling or exceeding emissions from all other agricultural sources combined.

Enhanced yields are particularly important in helping to prevent further deforestation, and fertilizers are essential to increase production on existing agricultural land.

The overall level of agricultural greenhouse gas emissions will continue to rise for the foreseeable future as agricultural production expands to keep pace with growing food, feed, fibre and bioenergy demand. Increasing agricultural efficiency is critical to keep overall emissions as low as possible and to reduce the level of emissions per unit of agricultural output. Efficient and responsible production, distribution and use of fertilizers are central to achieving these goals.

Reducing emissions that affect climate is a priority of the fertilizer industry

The fertilizer industry recognizes that it contributes directly and indirectly to emissions of greenhouse gases (GHGs), particularly carbon dioxide (CO_2) and nitrous oxide (N_2O), through the production, distribution and use of fertilizers.

Fertilizer production

IFA estimates that the fertilizer industry's activities in 2007 generated some 465 Tg CO_2-eq (Annex 3). This represents about **0.93% of global GHG emissions**. A significant share (about 20%) of the products manufactured are destined for industrial uses. Implementing Best Practice Technologies (BPTs) in natural gas-based ammonia production and nitric acid production together could reduce these emissions by about 119 Tg CO_2-eq per year in the medium term, or about 26%. The manufacture of all nitrogen fertilizers together accounts for about 94% of the sector's energy use.

Fertilizer distribution

IFA estimates that emissions associated with fertilizer distribution amounted to about 37 Tg CO_2-eq in 2007. This is only **0.07% of total global GHG emissions**.

Fertilizer use

Nitrous oxide (N_2O) emissions from soils related to the use of mineral nitrogen fertilizers in 2006 are estimated at 605 Tg CO_2-eq. This represents less than one-third of N_2O emissions from agricultural soils. CO_2 emissions related to the use of urea and ammonium bicarbonate (ABC) are about 105.6 Tg and 17.9 Tg per year respectively. Altogether, emissions from fertilizer use equal about **1.5% of global GHG emissions**.

IFA encourages its members to minimize their direct emissions, to foster the reduction of emissions related to the use of fertilizers and, where possible, to contribute to the creation or expansion of carbon sinks.

Future natural gas-based ammonia production will use Best Available Techniques (BATs) because of competitiveness and energy efficiency imperatives, thus reducing related greenhouse gas emissions. Clean-coal technologies like Carbon Capture and Storage (CCS) will help address GHG emissions from new coal-based ammonia production capacity. However, it will take decades to bring this new technology online.

In the meantime, wider uptake of Best Practice Technologies (BPTs) can help improve the average performance of existing production sites. For example, new catalytic technology for the nitric acid sector provides significant potential for reducing the fertilizer industry's N_2O emissions in the medium term.

In addition to improvements in production technology, the industry provides stewardship through its marketing, R&D, and application and advisory services. These efforts encourage nutrient management that:

- Minimizes agricultural greenhouse gas emissions;
- Maximizes carbon storage;
- Prevents additional deforestation;
- Optimizes the production of agricultural products, including those that can be substituted for some fossil fuels and products derived from fossil fuels.

To help farmers adapt to climate change, the fertilizer industry is intensifying its efforts to develop and share its knowledge, products and technologies.

The fertilizer industry's role in addressing climate issues throughout the life cycle of its products

FERTILIZER PRODUCTION

- The fertilizer industry has a responsability to minimize emissions of greenhouse gases.
- The industry has an economic incentive to increase energy efficiency and reduce energy use, which has a positive knock-on effect on GHG emissions reductions.

FERTILIZER TRANSPORT & LOGISTICS

- Fertilizer producers and traders can impact the carbon balance of movements of fertilizers by choosing responsible partners, optimizing logistics and manufacturing products that have high nutrient contents.
- Shippers and handlers can opt for modes of transport with lower carbon intensities, alternative fuels, freight consolidation and catalytic emissions abatement.

FERTILIZER USE

- Fertilizer companies that include retail divisions can influence farmers by providing spreading services or application advice at point of sales.
- The fertilizer industry in various countries has created Certified Crop Advisor programmes and established Codes of Practice for fertilizer applications.
- At the global level, IFA has developed a framework for the elaboration and development of Fertilizer Best Management Practices (FBMPs). Fertilizer companies need to work with farmers, policy makers, scientists and other stakeholders to use this framework to establish locally adapted FBMPs and to ensure their adoption. FBMPs can help reduce N_2O emissions and can increase soil carbon sequestration.

Appropriate and timely policy decisions are critical to ensure desired emissions reductions

Fertilizer production and agriculture are both truly global businesses. Policy decisions related to climate change need to take into account local conditions and the possibility of trade substitution (which could lead to "carbon leakage"). Otherwise, competitiveness could be distorted and emissions reduction targets could be undermined.

Policies should recognize early adopters and providers of improved technologies in order to encourage appropriate investments in the near term. Policy makers should provide timely and transparent signals to foster the implementation of better-performing technologies at the earliest possible opportunity.

Financing mechanisms need to address barriers to technology adoption. They also need to take into account the specific needs of agriculture.

Efforts by the fertilizer industry to take responsibility for its greenhouse gas emissions can only be fully effective if policy makers and other partners, such as farmers, also play their parts.

Policy Recommendations		
Fertilizer industry	**Partners**	**Policy**
Optimize the efficiency of fertilizer production by implementing Best Practice Technologies and good management	Provide innovative technologies	Instruments that reward responsible production and early adopters; policies that prevent "carbon leakage" from regulated countries/ regions to others
Implement Best Available Techniques at new production sites	Provide innovative technologies	Incentives for the implementation of better performing technology when cost differentials exist
Install N_2O abatement in relevant production facilities	Provide innovative technologies	Enabling financing mechanisms, such as the UNFCCC's Clean Development Mechanism and Joint Implementation
Conduct Carbon Capture and Storage at appropriate ammonia production sites (especially key for coal-based production)	Provide economical solutions for storage near production sites	Enabling financing mechanisms, such as the UNFCCC's Clean Development Mechanism and Joint Implementation
Opt for transport and logistical solutions that minimize emissions	Provide transport and logistical solutions that minimize emissions	Development of appropriate infrastructure
Develop Fertilizer Best Management Practices	Researchers and others to adapt global FBMP framework to local conditions; farmers to adopt FBMPs within an Integrated Soil Fertility Management framework	Provide knowledge and technology transfer programmes and funding to support partnerships to extend best practices to a wide number of farmers

Note: This brief is an extract from the white paper published by IFA:
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Feeding the Earth represents a series of issue briefs produced by the International Fertilizer Industry Association to provide current information on the role of fertilizers in sustainable agriculture and food production.

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