Economic Evaluation of Emission Reductions of Nitrous Oxides and Methane in Agriculture in the EU

EXECUTIVE SUMMARY

Methane (CH_4) emissions from agriculture were 194 Mt of CO_2 equivalent in 1990 while nitrous oxide (N_2O) emissions were 206 Mt of CO_2 equivalent in the European Union (EU). These correspond and 41% of CH_4 emissions to 51% of N_2O in 1990. In addition, carbon dioxide (CO_2) emissions were 17 Mt of CO_2. Overall, agricultural greenhouse gas emissions were about 11% of all greenhouse gas emissions of the EU in 1990. As agricultural CO_2 emissions are rather small, the focus of this report is on methane and nitrous oxides.

Between 1990 and 1995 (the latest year for which emissions data was available at the time of writing), agricultural emissions of both gases fell by about 6%, due principally to changes in agricultural practices and production following the reform of the Common Agricultural Policy (CAP).

There are three main sources of emissions of greenhouse gas emissions from agriculture:

- N_2O emissions from soils;
- CH_4 emissions from enteric fermentation;
- CH_4 and N_2O emissions from manure management.

The 1992 CAP reforms have already had an impact on a number of parameters that affect these emissions. On the livestock side there have been changes in types and number of livestock, and an enhancement of the trend towards improved livestock productivity. On the arable side, the shift from production based support mechanisms to direct area based payments, has led to pressure to optimise the use of inputs economically, and a general reduction in fertiliser use. In assessing emission reduction options and projecting emissions from this sector, it is important that the continuation of these trends likely to be brought about by the most recent CAP reforms are taken into account. Several other points are also relevant for the agricultural sector:

- Agricultural practices can vary significantly, not just across the EU, but within individual Member States and within a single region of a Member States. This makes definition of typical savings or applicability of an option difficult.
- An integrated approach to the assessment of reduction options is necessary; both CH_4 and N_2O are emitted and care must be taken that options which reduce emissions of one while possibly increasing emissions of another still lead to a net decrease in GWP weighted emissions.
- A number of other pollutants are of concern, particularly ammonia and nitrates, and again care must be taken that emission reduction options do not increase releases of these pollutants.

N_2O Emissions from soil

In general terms, N_2O emissions from the application of both mineral N fertilisers and organic N in animal manures can be decreased by increasing the overall efficiency with which N is used by crops. Measures include:

- improving maintenance of fertiliser spreaders
- reduction of fertiliser loss at the edge of fields by maintaining a fertiliser free zone
- optimisation of fertiliser distribution geometry
- optimisation of fertiliser application by allowing for manure nitrogen and residual N
- continuation of set asides

These measures are generally cost effective (i.e. the net cost to farmers is negative). However, barriers which prevent their uptake include the risk of a loss of yield if the crop is under fertilised.

Enteric methane emissions

Enteric fermentation is the anaerobic fermentation of polysaccharides and other components of animal feeds in the gut of ruminant animals (the rumen) by micro-organisms. Food enters the rumen where it is fermented to volatile fatty acids (VFA), carbon dioxide and methane. The carbon dioxide and methane are mainly removed by eruction (through the mouth or gut of the animal) with a small proportion of methane is absorbed in the blood and is eliminated through the lungs. Fermentation is also coupled to microbial growth and the microbial cell protein synthesised forms the major source of protein for the animal. Measures to reduce methane production include:

- improved feed conversion efficiency by optimising livestock diets
- improved animal productivity through the use of feed additives or breeding
- improved rumen efficiency through use of feed additives

Greenhouse gas emissions from manure management

Both methane and nitrous oxide can be emitted from manure. Methane emissions depend on the quality of the manure, which in turn depends on the feed intake and digestibility, the methane producing potential which varies by animal type and quality of feed consumed, the way the manure is managed and the climate. Measures to reduce enteric methane emissions are also likely to reduce methane emissions from manure.

Other measures to reduce methane emissions include:

- reducing anaerobic decomposition of manure by better control of the manure management system (this particularly applies to indoor housing of pigs);
- controlled anaerobic digestion (use of the biogas gives additional climate change benefits by offsetting CO_2 emissions from fossil fuel use).

Nitrous oxide emissions are influenced by nitrogen availability, soil moisture content and temperature. It is therefore important to match the nitrogen load to crop demand to help reduce emissions but also to reduce other impacts such as nitrate leaching.

Two other potential options for decreasing methane emissions, daily spreading or composting of manure are not considered desirable as they have adverse environmental impacts including the potential to increase nitrous oxide emissions.

Baseline emissions

The baseline projections are based on forecast changes in livestock numbers. These projections take into account the reform of the Common Agricultural Policy adopted in the framework of Agenda 2000. These trends were extrapolated to 2010 to provide an estimate of the change in the market for products between 1998 and 2010, at the EU level. The projections do not include the effect of any of the reduction options discussed above. The projected baseline trends are for a reduction of 9% in methane by 2010 and of 6% for N_2O.

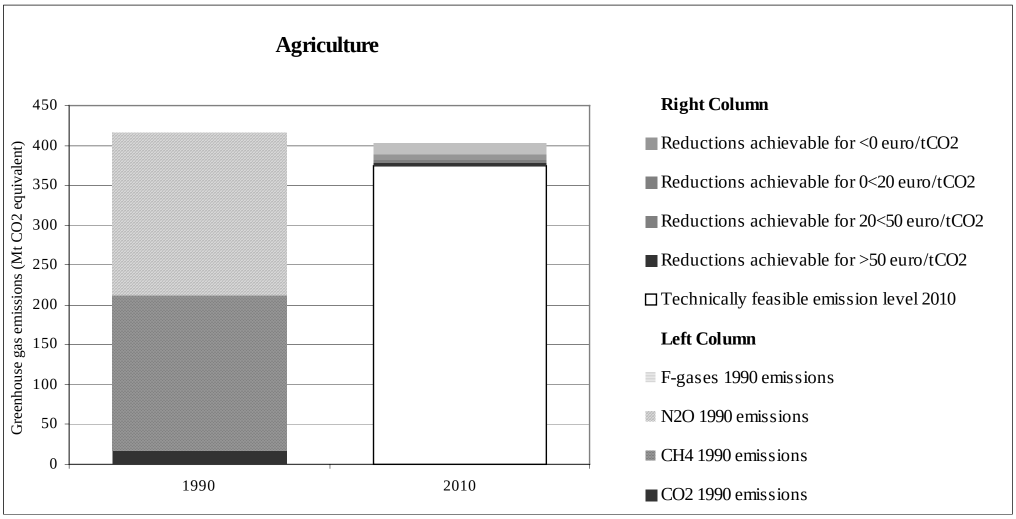
Summary of emissions reductions options

Table 1 below gives an overview of the investment costs, the yearly costs (sum of operation and maintenance costs and savings), average specific avoidance costs and potential for options applicable in the agricultural sector. The specific costs are calculated using a real interest rate of 4% and using the technical lifetime of the option, i.e. installation. The potential assumes no interaction between options. Figure 1 shows the share in emission reduction categorised in four cost brackets.

Table 1. EU15-average costs and total potential (Mt CO_2 equivalent) for emission reduction of methane options in the waste sector (summary table).

Pollutant	Measure Name	Sector	Emission reduction	Investment	Yearly costs	Lifetime	Specific abatement costs
			Mt CO2 eq.	euro/tCO2 eq.	euro/tCO2 eq.	year	euro/tCO2 eq.
CH4 & N2O	Enteric fermentation: replace roughage by concentrates - dairy	Agriculture	0	0	-212	1	-212
	Enteric fermentation: replace roughage by concentrates - non-dairy	Agriculture	0	0	-212	1	-212
	Enteric fermentation: change composition concentrates by extra fat - dairy	Agriculture	0	0	-70	1	-70
	Enteric fermentation: change composition concentrates by extra fat - non-dairy	Agriculture	0	0	-70	1	-70
	Enteric fermentation: improved level feed intake - non-dairy	Agriculture	3	0	-49	1	-49
	Enteric fermentation: improved level feed intake - dairy	Agriculture	2	0	-49	1	-49
	Manure: farm scale anaerobic digestion cooler countries (heat&power)	Agriculture	1	1109	-146	15	-46
	Enteric fermentation: change composition concentrates by Non Structural Carbohydrates - non-dairy	Agriculture	0	0	-16	1	-16
	Enteric fermentation: change composition concentrates by Non Structural Carbohydrates - dairy	Agriculture	0	0	-16	1	-16
	Manure: centralised anaerobic digestion - cooler countries	Agriculture	1	304	-33	15	-6
	Common Agricultural Policy Reforms Set-Aside	Agriculture	6	0	0	1	0
	Manure: slowing down anaerobic decomposition	Agriculture	1	0	0	15	0
	Subtotal : Cost range < 0 Euro / t CO2		**14**				
	Manure: farm scale anaerobic digestion - warmer countries (heat&power)	Agriculture	1	435	-16	15	23
	Enteric fermentation: propionate precursors - dairy	Agriculture	1	0	32	1	32
	Manure: farm scale anaerobic digestion - warmer countries (heat only)	Agriculture	3	275	13	15	38
	Subtotal : Cost range 20 < 50 Euro / t CO2		**4**				
	Enteric fermentation: proprionate precursors - non dairy	Agriculture	0	0	67	1	67
	Manure: farm scale anaerobic digestion - cooler countries (heat only)	Agriculture	2	1036	50	15	143
	Subtotal : Cost range > 50 Euro / t CO2	**Agriculture**	**2**				
	Total emission reduction options		**21**				

Figure 1. Agriculture: 1990 base year direct emissions (left), 2010 frozen technology reference level and reduction potentials per cost bracket (right).



The total technical reduction potential is estimated at 21 Mt of CO_2-eq., about 5% of 2010 baseline emissions. The main reduction potential comes from methane emissions.

Summary of Agricultural Sector

Table 2 below shows that the baseline emissions of methane and nitrous oxide in the agricultural sector are likely to decline by 7% by 2010. If all reduction measures can be implemented to their full extent, and assuming that there are no mutually incompatible measures (i.e. no double-counting) there is a further reduction potential of 21 Mt of CO_2 eq. Thus, if all measures were adopted, agricultural sector would reduce its non-CO_2 emissions in 2010 by 12% from 1990.

Table 2. Summary of emissions (Mt CO_2 equivalent).

	1990	2010 baseline	2010 with measures
Carbon dioxide	**17**	**24**	**24**
Methane	**194**	**177**	**163**
o.w. enteric fermentation	*141*	*127*	*121*
o.w. manure management	*43*	*40*	*33*
o.w. other	*10*	*9*	*9*
Nitrous oxide	**206**	**194**	**188**
Total	**417**	**396**	**375**