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NOTE

From:	Presidency
To:	Delegations
Subject:	Towards climate-smart agriculture – *Exchange of views*

In view of the "Agriculture and Fisheries" Council on 22 October 2015, delegations will find in the ANNEX the above mentioned document, prepared by the Luxembourg Presidency.

ANNEX

Towards climate-smart agriculture

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Agricultural impact on climate change

Agricultural activity is a source of greenhouse gases (GHG) as well as a sink, notably through the storage of carbon in the soil organic matter and in biomass.

The main **sources** of greenhouse gas emissions in agriculture are:

- Emissions of **carbon dioxide (CO_2)** due to the use of fossil energy in agriculture (fuel, electricity, gas), the change of carbon stock in agricultural soils and the use of fossil energy during the production process of agricultural inputs (mineral fertilizers, animal feed, pesticides,….)

- Emissions of **methane (CH_4)** during anaerobic fermentations: Enteric fermentation of ruminants, anaerobic fermentation during the handling and storage of animal manure, anaerobic fermentation in flooded rice fields

- Emissions of nitrous **oxide (N_2O)** linked to the use of mineral and organic nitrogen fertilizers and to manure management.

To a lesser extent, agriculture also produces fine particles in the form of salts that reflect the sun in the atmosphere, such as ammonium nitrate (NH_4NO_3) and sulfates.

Regarding the **sink** side of emissions, agriculture and forestry, unlike other economic sectors, have the capacity to fix atmospheric carbon by photosynthesis and to sequestrate it in the soil and in biomass. Grassland, humid zones and forests in particular can fix carbon in large quantities. However, these carbon stocks can also be lost, for instance through land use change (i.e. deforestation, ploughing of grassland, drainage of humid zones, etc.) or by exceptional climatic events (i.e. storms, fire, etc.) leading to a rapid release of the stocked carbon to the atmosphere as CO_2.

Biomass produced in agriculture and forestry and used as energy (renewable energy) or as raw material (biomaterials, plant based chemistry) is another way to increase the bio-sequestration of carbon.

Emissions from the agricultural sector can be calculated at different levels: The inventory of the agricultural sector as a whole, the accounting at individual farm level and the life cycle assessment, which calculates emissions based on agricultural products.

For the agricultural sector as a whole, an **inventory** can be established, for instance inventory submitted annually by Annex I Member States to UNFCCC and to the European Environment Agency (EEA, the EEA being in charge of the submission of the inventory of the whole EU to UNFCCC).

However, the GHG inventory defined by the UNFCCC does not properly take into account the role of agriculture, forestry and bio-industry in GHG emissions, nor their contribution to carbon sequestration and reduction of emissions in other sectors. The CO_2 accounts of agriculture and forestry are indeed spread over different sectors of the inventory.

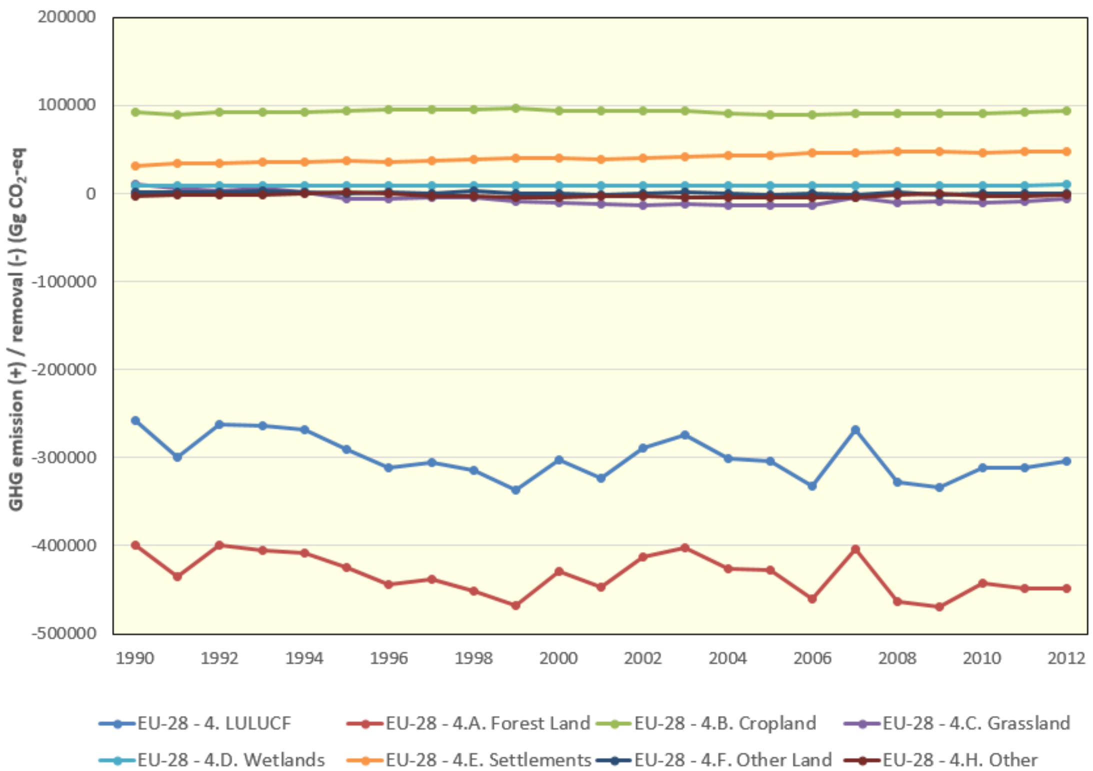

Figure 1 : Greenhouse gas emissions and removals from LULUCF (EU28) between 1990 and 2012

Emissions of CO_2 caused by the use of fossil energy are not accounted for in the agricultural sector but in the energy sector. Emissions in relation with the production of mineral fertilizers or animal feed are reported under "industrial processes". Emissions and removals due to land use, land use change and forestry are reported under a separate sector (LULUCF sector) while the absorption, storage and substitution effects downstream of agricultural production are not taken into consideration at all.

Based on the UNFCCC inventory method, GHG emissions of the European Union (EU28) for the year 2012 amounted to 4,544 million tons of CO_2 equivalents without the emissions/withdrawals of CO_2 from land use, land use change and forestry (LULUCF). The share of emissions from the agricultural sector represented 469 million tons of CO_2 equivalents, corresponding to 10.3% of total GHG emissions (without LULUCF). The agricultural part of LULUCF consisted of 89.0 million tons of CO_2 emissions from arable land and 7.9 million tons of CO_2 removals in form of carbon sequestration.

In 2012, forests fixed 451.5 million tons of CO_2 from the atmosphere, of which 397.5 million tons were fixed by forests and remaining forests and 54.0 million tons by land converted into forest. The LULUCF sector was a sink of 304 million tons of CO_2. The net emissions of the EU in 2012 thus represented 4,544 – 304 = 4,241 million tons of CO_2 equivalents.

In the EU emissions from agriculture have dropped from 617 million tons of CO_2 equivalents in 1990 to 469 million tons of CO_2 equivalents in 2012, i.e. a decrease of 23% (see Figure 2), while the total GHG emissions of the EU have also decreased significantly. The share of agricultural emissions in the total emissions slightly decreased during that period from 11% in 1990 to 10% in 2012.

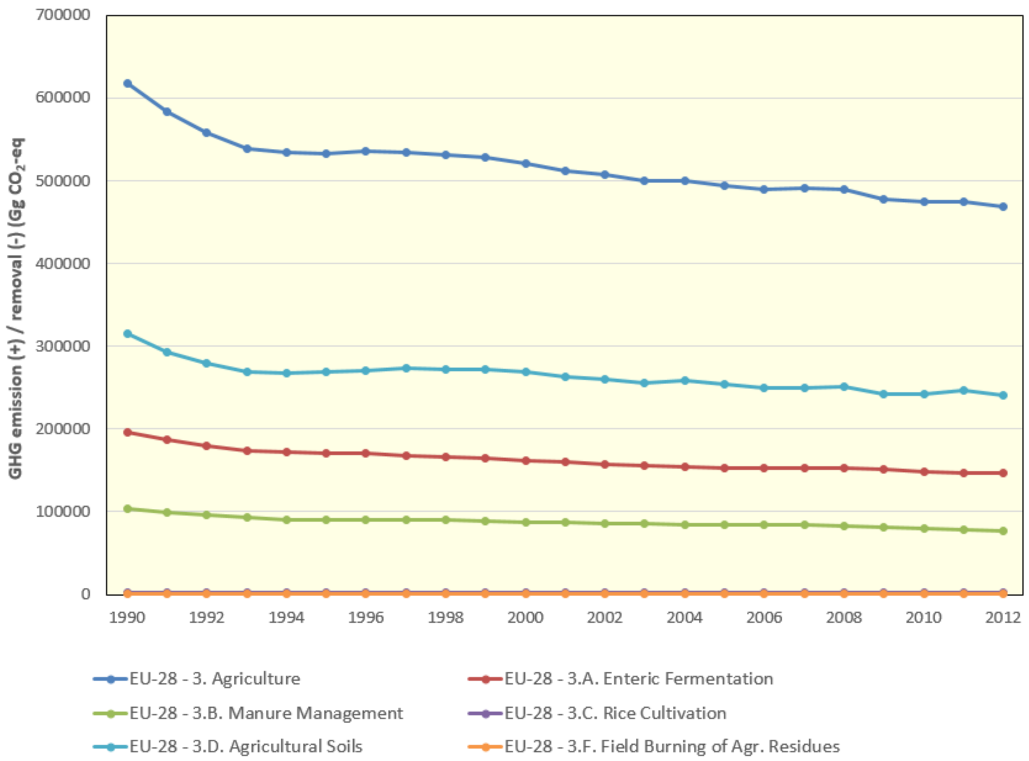

Figure 2 : Greenhouse gas emissions from agriculture (EU28) between 1990 and 2012

The impact of agriculture on GHG emissions can also be estimated at the level of individual agricultural holdings, with a balance sheet system taking into account the emissions of GHG gases (carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)) on one hand and the removals of CO_2 (carbon credits) due to the sequestration of carbon in soils and the production of renewable energy and biomaterials on the other. There are three main sources of emissions: rearing of animals, plant production and the production of agricultural inputs. The “emissions – removals” balance reflects the efficiency of holdings regarding their GHG emissions.

A balance sheet of GHG emissions/removals - called **life cycle assessment** (LCA) - can also be established for agricultural products (milk, beef, arable crops, biogas etc.). For holdings with several production branches, these balance sheets consider each branch individually. Thus different production branches can be compared in regard to their climatic efficiency.

Climate change impact on agriculture

The impact of climate change on agriculture can be estimated by modelling. Climate change is affecting production not only in one direction: it can have divergent effects (increase/decrease of production) that depend greatly on regional conditions. The effects can be a rise in temperatures, drier summers, milder and rainy winters, an increase of extreme weather events with an important impact on soil erosion (i.e. floods, drought, etc.) and, indirectly, an increase in CO_2 content in the atmosphere that favors photosynthesis. The agricultural sector has to adapt to climate change in many areas. These include in particular the choice of species and varieties, the adaptation of the field works to the calendar (more flexibility), the adaptation of plant production practices (i.e. fertilization, plant protection, irrigation, etc.) or the adoption of plant production practices that increase the soil organic matter content or the soil coverage by plants. The latter measures aim at slowing down soil erosion.

Environment, climate and food security

Agricultural production can have numerous effects on the climate, the environment and biodiversity. For example, a high efficiency in the use of nitrogen in animal nutrition, manure storage and manure spreading goes hand in hand with low ammonia emissions and a low level of leaching of nitrogen to the groundwater and the superficial water bodies (water protection). Lower GHG emissions can also be achieved through a reduction of indirect N_2O-emissions and in the use of mineral nitrogen fertilizer.

The conservation of grassland and humid zones has a positive effect on GHG emissions and biodiversity. Agricultural commodities aiming at the production of renewable energy and biomaterials, if managed in a sustainable way, also contribute to preserving the environment since they reduce the dependence on fossil energy.

GHG reduction measures that have the highest synergetic effects with other environmental protection objectives and biodiversity should be given priority.

High productivity levels in agricultural production have already been achieved in many EU regions. Agricultural land is not only an agricultural production factor, it also plays a key role in water protection, soil protection and the maintenance of landscape and biodiversity. To maintain extensive production systems with a low input level, such as organic agriculture and extensive livestock, rearing has to be encouraged. Such systems contribute to the rural economy, the protection of the environment and the landscape as well as to the quality of life in general.

At constant demand levels for agricultural products, a decrease in production in the EU would actually lead to a geographic transfer to non-EU countries of production as well as of GHG emissions, which in turn would lead to a global rise in emissions from agricultural production. Animal protein production in the EU relies to a large extent on the import of soybeans from South America. This has controversial impacts in terms of LULUCF in soybean producing countries, especially where equatorial rain forest is converted to arable land.

How can agriculture contribute to climate change mitigation (climate-smart agriculture)?

Contribution of research

Better knowledge as starting point. Gaseous exchanges between agricultural systems and the atmosphere are subject of intense research activity. Indeed, in order to develop mitigation measures it is important to get better knowledge of the processes which are at the origin of emissions or removals of GHG in agricultural systems. Most research activities in this domain are organized in networks. One of these networks at European level is the Integrated Carbon Observation System Research Infrastructure (ICOS-RI). Networks are necessary to make efficient use of research infrastructures and to obtain harmonized data on GHG emissions and removals at a large scale (Europe, World).

Agriculture – a key player. Agriculture has the potential to become a key player for reducing GHG emissions and mitigating climate change - not only through reducing emissions in agriculture but also by influencing emissions in other sectors. On a global scale, the waste sector is responsible for about 3% of GHG emissions and agriculture can contribute to mitigate these emissions, especially through the bio-methanisation (anaerobic digestion syn. Biogas) of organic waste, waste water, and crop residues to produce useful methane. The effect will be amplified by the use of N-fixating crops and the recovery of essential nutrients such as N, P and K thus reducing the emissions linked to the synthesis and transport of mineral fertilizers (12% of the agricultural emissions, FAO, 2014) currently accounted for in the sector "industrial process" under the UNFCCC inventory. Europe is highly dependent on imports of phosphorous and potassium fertilizers (finite resources) and of natural gas used for the synthesis of nitrogen fertilizers.

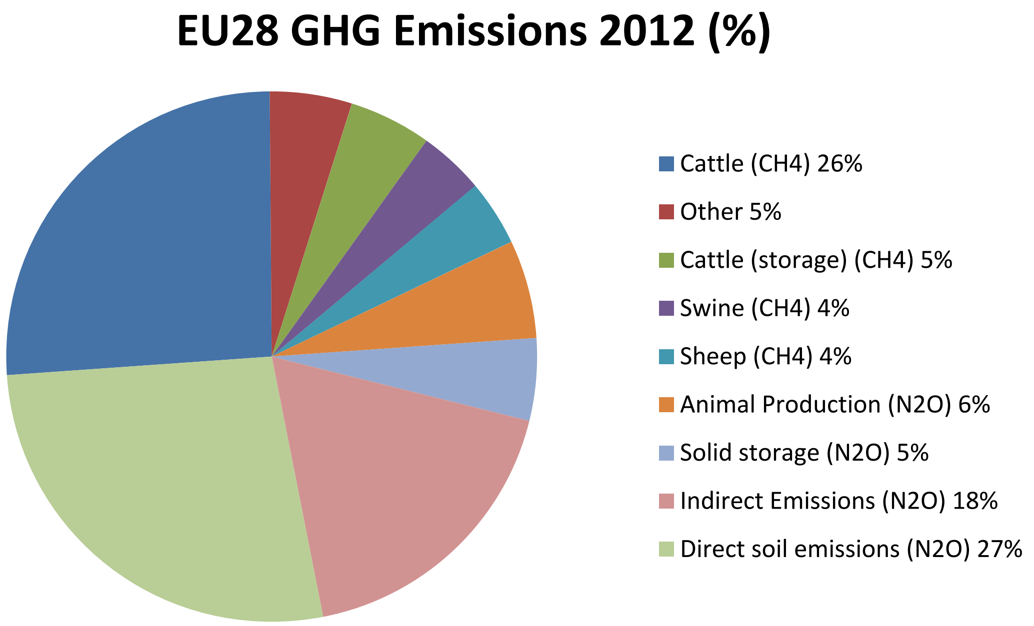

Figure 3 : Sources of agricultural greenhouse gas emissions (EU28) in 2012

Cleaner agriculture. Agriculture in Europe can tackle the main sources of its own GHG emissions, which are principally linked to animal production and, more specifically, to emissions related to ruminants (about 2/3 of agricultural emissions). Whereas it is difficult to reduce GHG emitted during enteric fermentation (methane producing microbes live within small unicellular animals in the rumen and researchers attempt to eradicate/reduce these organisms from the cattle stomach), proposing and developing new ways to better collect and manage animal manure and crop residues has the potential to reduce 26% and 4% of the agricultural emissions, respectively.

The best advanced technology to achieve this is the conversion of manure and crop residues into biogas, since it is the only process that allows producing a flexible energy vector (CH_4) while regaining essential nutrients under highly bioavailable forms for crop production. Nevertheless, adequate technologies have to be further developed, optimized, and transferred into practice to guarantee a real benefit in terms of climate change mitigation.

Agriculture and non-food production. Through the production of dedicated biomass for energy and biomaterials, agriculture has also an important role to play in shifting the current fossil based economy towards a green circular economy. To achieve this objective, agricultural research has to explore the best adapted and most sustainable production systems, including new plant species, new rotation systems and environmentally friendly bio-pesticides that will allow the greening of the “energy” and “material” sectors.

Such new production methods have to be assessed carefully because of the rebound effects they can have on the biogeochemical cycles. There is much evidence that arable land-use change towards renewables could intensify in the years to come, thus increasing the proportion of perennial second generation energy crops (SGEC). There is broad agreement among scientists and conservationists that land-use change is a major threat to biodiversity. However, this usually refers to the conversion of natural landscapes such as forests and wetlands into arable land. Much less attention has been paid to the impact of conversion among different forms of arable land on biodiversity and population viability. However, it would seem appropriate to also consider new potentials arising from a likely increase in cultivation of perennial crops in the near future concerning e.g. biodiversity, carbon storage and water cycling, and the consequences for the processes that are governed and the ecosystem goods and services that these potentials underpin.

Transfer of knowledge from research to agricultural practice (innovation)

The largest impact that can realistically be achieved to reduce agricultural GHG emissions in the EU is to tackle manure management and manure valorization (26% of the agricultural emissions). **Farmer awareness** is the first key action to be conducted across the EU to rebuild the farmers' confidence in manure as an efficient and sustainable source of energy and nutrients in their production systems. **Support to policy makers** and **incentives** have to be developed to promote rapid coverage of manure storages and, ideally, to promote small scale co-digestion biogas plants (manure alone is converted with difficulty, co-digestion with crop residues and energy crops should be promoted). Mitigation in terms of GHG emissions during manure storage, and through the large potential displacement of fossil energy by the production of biogas, can contribute to cover the cost of such incentives. Researchers are currently developing new monitoring and control tools to help farmers optimize the biogas process.

The EU **nitrogen management strategies** have to be reconsidered in light of (1) the **promotion of organic fertilization** at the expense of chemical fertilizers (that are extremely energy demanding for their synthesis and contribute to 12% of the emissions), (2) the scientifically proven fact that most crops prefer the N-ammonium form present in manure and biogas digestate instead of the N-nitrate form which is highly prone to be leached to the water table.

Therefore, new and **adequate farm implements** have to be developed and promoted to ensure optimal use-efficiency of nitrogen from organic origin, thus reducing N_2O emissions (N_2O = 298 CO_2eq) and ammonia emissions which indirectly contribute to green-house effect.

Contribution of agricultural practice (best practice)

The mitigation of greenhouse gas emissions at the level of agricultural practice is closely linked to an awareness of the contribution of each single production process in emitting CO_2-equivalents or in storing/saving carbon (carbon credits). Thus, it is fundamental that farmers have the best possible knowledge of the sources and the amounts of emissions as well as the potential of storing carbon in the soil or saving carbon through production of renewable energies Mitigation options can only be assessed properly - and effective measures to reduce greenhouse gas emissions or to increase carbon credits can only be taken – if the sources of emissions and carbon credits of the farm are well-known.

A second important issue is the fact that a combined evaluation of both surface-related and product-related emissions is necessary in order to correctly assess the performance of the farm (or production branch) in emitting CO_2-equivalents or accumulating carbon credits. The surface-related emissions represent the environmental protection performance of the farm/branch, while the product-related emissions refer to its production efficiency.

Farmers should be actively involved in actions aiming at the mitigation of GHG emissions, such as optimized animal nutrition or sustainable use of commodities produced on the farm. This could significantly reduce emissions caused by transport and the EU dependency on imported soybeans. Permanent grassland presents an important carbon and nitrogen sink due to the soil microflora or the cultivation of perennial crops which allow for the establishment of a durable soil carbon stock (ex. miscanthus, silphium, sida …) are feasible options. Perennial pasture land generates rough forages for cattle and sheep with very little complement required to reach productivity while at the same time it presents the best conditions to valorize animal effluents with minimal GHG emissions.

Anaerobic digestion should be promoted and manure should be collected as quickly as possible to limit GHG emission and to reach high energy potential from manure. Practices used to spread manure or biogas digestate in the field or in meadow land have extreme influence on GHG emissions. Ideally organic fertilizers should be spread in a liquid form to penetrate rapidly in the soil, or if solid, should be rapidly incorporated. Farmers can share expensive implements that target an optimized use of manure and digestate reducing thus N_2O and NH_3 emissions. Crop rotation with N-fixating legumes can contribute to more sustainable production systems and reduce the EU-28 dependency on nitrogen fertilizers. Such local legume crops can replace advantageously the imported soybeans in the animal diet. Reduced tillage and cover crops grown in winter for biomass production are also practices of high interest to reach a climate smart agriculture.

Questions:

1. Today agriculture does already implement a number of instruments to mitigate the effects of climate change. In your opinion, which existing actions should be prioritized in order to address climate mitigation in an effective way? Are there new actions that should be implemented as a priority?

2. How could we improve the link between science and agricultural practice at EU level, including the different stages of knowledge-transfer, in order to tackle climate change challenges in the agricultural sector?