

GHG mitigation measures in the agriculture and forestry sectors of Aragon

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1. Introduction

Climate change is a negative externality from economic activities that is already damaging the natural environment and its ecosystems, and could endanger seriously the human well being in the coming decades. The large growth in wealth and population since the industrial revolution, based in accelerated technological developments, have largely increased atmospheric GHG concentrations. These emissions are changing the energy balance of the earth and the climate system, and threatening with a future of higher temperatures, lower precipitations in arid and semiarid regions, rises of the sea level, and more severe and frequent extreme events (IPCC 2007).

The agriculture and forestry sectors are responsible for about one third of global anthropogenic GHG emissions. Forestry generates 17 percent of emissions, mainly from deforestation and forest degradation, forest fires and unsustainable management. Agriculture accounts for around 14 percent of emissions and it is the main source of non-CO₂ emissions such as methane (CH₄) and nitrous oxide (N₂O), coming from nitrogen fertilization in cultivated soils, large animal production facilities, and nitrogen pollution loads in rivers and water streams (IPCC 2007). However, these sectors provide numerous ecosystem services and positive externalities such as biodiversity and habitat maintenance, soil conservation, water regulation, recreational services, and climate change mitigation. The agriculture and forestry sectors could contribute to climate change mitigation by reducing their GHG emissions, and by maintaining and sequestering carbon in soils and vegetation (Schneider et al. 2007).

2. Land use and GHG emissions in Aragon

Agriculture in Aragon releases almost 3.5 million t CO₂eq per year of GHG, representing 20 percent of the total emissions of the region, which is well above the percentage of agricultural emissions for the whole Spain (11%). The reason is the large extension of the region, which supports important agricultural activities.

Emissions from livestock are 2.5 million t CO₂eq, including methane (CH₄) from enteric fermentation, and nitrous oxide (N₂O) and methane (CH₄) from manure handling and storage. Emissions of swine manure amount to 1.8 million t CO₂eq, from the large swine herd close to 5 million heads. Emissions of cattle production activities are 0.7 million t CO₂eq mainly from enteric fermentation.

Emissions from crop and soil management are close to 1 million t CO₂eq of nitrous oxide (N₂O), generated by the excessive use of mineral and organic fertilization in more than 1 million hectare of irrigated and rainfed lands. Fertilization contains 110,000 t of nitrogen, and produces direct N₂O emission close to 0.7 million t CO₂eq. Indirect N₂O emission resulting from nitrogen runoff are 0.3 million t CO₂eq.

One problem derived from agricultural activities in Aragon is the overuse and mismanagement of nitrogen fertilizers. Recent estimations indicate that nitrogen fertilization from mineral and organic sources exceeds crop requirements by 24 percent. The consequence is a nitrogen surplus of 42,000 t of nitrogen (MARM 2011). In addition, estimations of nitrogen content from manure reveal that its nitrogen availability could cover up to 80 percent of the nitrogen requirements of crops. This would reduce the use of mineral fertilizers, saving costs, solving manure disposal problems, and abating pollution. In Aragon, farmers do not take advantage of the large amount of manure available, because of the high costs of transportation and spreading, the difficulties of management, and the uncertainty of the impact on crop yields (Orús et al. 2011).

Furthermore, the control of nitrogen fertilization sought by the European Nitrates Directive is limited to cultivation areas located over aquifers or streams declared officially vulnerable to nitrate pollution, and administrative enforcement is based on inspections of farms drawn by chance, where noncompliant farms are penalized in their CAP payments. The usefulness of this fertilization control mechanism remains to be seen, because it ignores cultivation over the whole region, rainfed lands, and very polluting crops that are not receiving subsidies such as vegetables or fruit trees.

Forests in Aragon play an important role in mitigating GHG emissions, and are an important reserve of carbon. Forests remove 3.4 million t CO₂eq per year from the atmosphere, with an area exceeding one million and a half hectares. Environmental benefits from carbon sequestration are estimated at 75 million € per year, surpassing the market value of forest productive activities.

3. Instruments for GHG mitigation

GHG emissions from economic activities are negative externalities that cause harmful environmental and socioeconomic impacts. The Stern review estimates that without the implementation of GHG mitigation policies in all sectors, the impacts of climate change could result in damages equivalent to 5 percent of global GDP per year, while the costs of mitigation policies could be limited to around 1 percent (Stern 2007).

Agriculture and forestry are nonpoint source sectors, and therefore the control of emissions presents an important problem of information and knowledge. The reasons are the impossibility of identifying the agents generating the emissions or sinks, the precise spatial location of sources, and the amount of emission loads or sinks at the source. Several issues arise in the design and implementation of policies to control diffuse emissions. These issues are linked to uncertainties about sources and controlling factors, the complexity and randomness of biophysical processes, and the strategic behavior of stakeholders facing mitigation measures. These factors make very costly and complicated the measurement of emissions and sinks, and the design and enforcement of policies to control GHG emissions from agriculture and carbon sequestration in forests.

Several GHG mitigation measures in the agriculture and forestry sectors of Aragon have been analyzed in this study. Results indicate that there is not a unique preferred measure, and that a single instrument could not address the mitigation of GHG emissions. A combination of suitable measures is needed to contribute towards climate stabilization while achieving cost efficiency. The choice of measures depends on the objectives of decision-makers, but also on the availability of biophysical and economic information, and the willingness to cooperate of stakeholders. Local characteristics, economic and environmental effects, and social acceptability have to be considered in the design of measures.

Economic instruments that follow the “polluter pays” principle such as taxes on emissions, nitrogen fertilizer or irrigation water are quite inefficient in abating agricultural nonpoint pollution. Economic instruments display very high abatement costs for farmers, between 273 and 1,143 €/t CO₂eq. These instruments achieve a very small abatement of pollution, less than 5 percent.

The alternative is using institutional and command and control instruments such as standards limiting nitrogen fertilization, limits on pollutants, livestock herd reduction in areas with high livestock densities, and managing forests for carbon sequestration. These instruments promote stakeholders’ cooperation for a better land use planning and protection of environmental assets. However, these measures face a number of obstacles, such as high transaction costs, difficulties to enforce quantitative limits, and problems with the current environmental legislation and enforcement. These shortcomings can be overcome by promoting the involvement of private and public stakeholders, and this will be the key driver to change the farmers’ behavior in addressing climate change mitigation. Cooperation is needed for a reasonable allocation of resources and for achieving significant nonpoint pollution abatement efforts.

4. Conclusions

The agriculture and forestry sectors could contribute significantly to GHG mitigation, and provide also opportunities to reduce GHG mitigation efforts in other sectors where abatement costs are higher. The conditions are the promotion of stakeholders' cooperation, the use of good farming and forestry practices, and the support of collective action by public institutions.

The empirical findings of this study indicate that pure economic instruments can only be ancillary in the design of mitigation policies. The main thrust of policy efforts should be focused on nurturing stakeholders' collective action and on supporting the necessary institutional setting. This study analyses some measures for the agricultural sector of Aragon that could induce farmers' cooperation in abating emissions. These measures display reasonable abatement costs between -54 y 42 €/t CO₂eq and abatement potential close to 10 percent, such as adjusting nitrogen inputs to crop requirements and the better use of organic fertilizers, swine herd reduction, and limits on nitrogen leaching in irrigation returns. The management of forests oriented towards climate change mitigation could increase carbon sequestration in Aragon by up to 70 percent, without significant losses of the market revenues from forest productive activities.

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