ENVIRONMENTAL SCIENCE & POLICY XXX (2013) XXX–XXX

Available online at www.sciencedirect.com
ScienceDirect
journal homepage: www.elsevier.com/locate/envsci

An evaluation of the effect of greenhouse gas accounting methods on a marginal abatement cost curve for Irish agricultural greenhouse gas emissions

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ARTICLE INFO

Article history:
Received 16 April 2013
Received in revised form 27 August 2013
Accepted 1 September 2013
Available online xxx

Keywords:
Marginal abatement cost curve
Greenhouse gas
Life cycle assessment
Intergovernmental Panel on Climate Change

ABSTRACT

Marginal abatement cost curve (MACC) analysis allows the evaluation of strategies to reduce agricultural greenhouse gas (GHG) emissions relative to some reference scenario and encompasses their costs or benefits. A popular approach to quantify the potential to abate national agricultural emissions is the Intergovernmental Panel on Climate Change guidelines for national GHG inventories (IPCC-NI method). This methodology is the standard for assessing compliance with binding national GHG reduction targets and uses a sector based framework to attribute emissions. There is however an alternative to the IPCC-NI method, known as life cycle assessment (LCA), which is the preferred method to assess the GHG intensity of food production (kg of GHG/unit of food). The purpose of this study was to compare the effect of using the IPCC-NI and LCA methodologies when completing a MACC analysis of national agricultural GHG emissions. The MACC was applied to the Irish agricultural sector and mitigation measures were only constrained by the biophysical environment. The reference scenario chosen assumed that the 2020 growth targets set by the Irish agricultural industry would be achieved. The comparison of methodologies showed that only 1.1 Mt of the annual GHG abatement potential that can be achieved at zero or negative cost could be attributed to agricultural sector using the IPCC-NI method, which was only 44% of the zero or negative cost abatement potential attributed to the sector using the LCA method. The difference between methodologies was because the IPCC-NI method attributes the abatement from agricultural mitigation measures, partially or fully, to other sectors within a nation or to activity taking place in other countries. This suggests that it may be politically difficult to justify to farmers that mitigation measures should be adopted

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1462-9011/$ – see front matter
http://dx.doi.org/10.1016/j.envsci.2013.09.001

in agriculture, if the accounting process does not credit this mitigation to them. The disagreement between methodologies also indicates that unilateral national or regional policies to reduce agricultural GHG emissions based on the IPCC-NI method could lead to mitigation options that increase global emissions (carbon leakage). The limitations of the IPCC-NI method for assessing national agricultural GHG emissions could be overcome by reforming or expanding the accounting methodology to include domestic offsetting and to assess emissions associated with national consumption via LCA. This would overcome the problem of carbon leakage and credit (in part) agricultural practices that reduce emissions in other sectors or nations without emission caps.

1. Introduction

In order to prevent adverse climatic changes caused by increasing greenhouse gas (GHG) emissions, some developed countries (Annex I nations) ratified the Kyoto Protocol (UNFCCC, 1998) to reduce emissions, but beyond this agreement only EU member states have legally agreed to continue reducing GHG emissions (European Council, 2009). As part of this EU commitment some member states, such as Denmark and Ireland, are obliged to reduce emissions from the non-emission trading sector (non-ETS), which includes agriculture, by 20% relative to 2005 levels by 2020 (European Council, 2009). The agricultural sector emitted 10% of EU GHG emissions in 2011, but on a national basis this varied from 2% in Malta to over 30% in Ireland (EEA, 2013). The very high contribution of agriculture to the latter nation's emissions can largely be explained by the absence of a significant heavy industry sector and the high population ratio of cattle to humans (CSO, 2012).

Besides reducing GHG emissions, agriculture is also faced with the challenge of increasing production to feed a growing world population (FAO, 2006) and providing feedstock for expanding biofuel production (OECD-FAO, 2012). For instance, in the next 40 years the OECD-FAO (2012) project that agricultural production will need to increase by 60%, which translates into an additional billion tonnes of cereal and 200 mega tonnes of meat compared with 2005/07 levels. To satisfy this demand agricultural output will need to increase in developing and developed countries. However, without the deployment of abatement technologies, agricultural GHG emissions are anticipated to increase. Consequently, the sector is coming under increasing scrutiny to identify strategies to reduce the GHG intensity (kg of GHG/unit of food) of agricultural produce.

Several studies have investigated the potential of mitigation strategies to reduce GHG emissions per unit of agricultural output. Examples of strategies that have been reported to reduce the GHG intensity of agricultural produce include supplementation of livestock diets with oil or fat (Jordan et al., 2006; Martin et al., 2010); improving grassland and nitrogen fertilizer management (Velthof et al., 1998; Wims et al., 2010); increasing ruminant productivity (O'Brien et al., 2010; Foley et al., 2011); the application of nitrification inhibitors (Di and Cameron, 2002; Dennis et al., 2012) and reducing the levels of total mixed ration (TMR) in dairy cow diets (O'Brien et al., 2012). Assuming the full implementation of these strategies allows an estimate of the technical mitigation potential. However, it is important to distinguish technical mitigation potential from the economic potential, where in the case of the latter the suitability of mitigation measures also depends on the cost per unit of emissions abated. In other words, the technical mitigation potential includes all possible abatement measures, but the economic mitigation potential only considers measures that cost less than the value of carbon credits.

In general, marginal abatement cost curve (MACC) analysis is used to assess the economic potential for agricultural GHG emissions reduction (MacLeod et al., 2010; Moran et al., 2011). A MACC analysis provides a menu of GHG mitigation measures, where the measures are additional to the mitigation activity that would be expected in a given future reference scenario, typically the 'business as usual' scenario (Moran et al., 2011). The MACC allows the quantification of the volume of GHG emissions mitigated by various measures and ranks mitigation measures according to their associated marginal cost. Mitigation is considered desirable until the marginal cost of mitigation is less than the cost of purchasing carbon credits.

It is important to note that a MACC analysis is not definitive and will change over time as new technologies become more widely available at lower cost or as agronomic and socio-economic conditions evolve. In addition, some of the abatement measures in a MACC curve may be cost saving (negative cost) or cost beneficial (MacLeod et al., 2010). The reasons why some farmers have not already adopted cost saving mitigation measures are diverse and may include farmers' risk aversion behaviour in response to new technology, or because farmers may not behave to maximise profit. An alternative explanation may be that the MACC does not capture the full cost of the measure and therefore farmers' decision making in relation to technology choices may be logical.

Previous studies that have completed a MACC analysis of national agricultural emissions, as far as we are aware, have only considered mitigation measures that could be included in national GHG inventories. The standard approach for reporting GHG emissions and evaluating compliance with national GHG targets is the Intergovernmental Panel on Climate Change (IPCC) guidelines for national GHG inventories (IPCC, 1997, 2000, 2006), hereafter referred to as the IPCC-NI method. This methodology estimates emissions from the production and consumption of goods within defined national boundaries and emissions from the production of goods exported from a nation, but does not consider emissions from the production of inputs that are imported into a nation (Peters, 2008). Furthermore, the IPCC-NI method adopts a sector-based approach to quantify national GHG emissions (Schils et al.,