Analysis of the impact on farm income of market and non-market based strategies to reduce greenhouse gas emissions on Irish farms

DAFF Project Ref No: RSF 07 555
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End date: 31/05/2011

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Other Principle Collaborating Researchers: James Breen, Thia Hennessy, Michael Wallace, Tom Johnson

Please tick below the appropriate area on the research continuum where you feel this project fits

<table>
<thead>
<tr>
<th>BASIC/FUNDMENTAL</th>
<th>APPLIED/PRE COMMERCIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Key words: (max 4)

Farm income, Economics, GHG emissions, GHG abatement
1. **Rationale for Undertaking the Research**

   Increasing concern over climate change has led to a number of international agreements to control greenhouse gas (GHG) emissions, including the Kyoto Protocol and the EU 20-20-20 target. As a result targeted reductions in GHG may be set for the Irish agricultural sector and farmers now face the prospect of a whole new set of challenges. To date research into GHG emissions from Irish agriculture has focused on two main themes (i) projecting future emission levels and (ii) devising abatement strategies at the farm level. This project will link these two areas of research and increase our level of understanding on the most cost efficient means of reducing GHG emissions.

2. **Research Approach**

   In this project data from the 2006 Teagasc National Farm Survey (NFS) was used to construct a farm-level linear programming model for Irish agriculture. Linear programming (LP) is an optimisation model in which you maximise or minimise a given objective function. The LP model consisted of all 1,170 farms in the 2006 NFS and used price projections from the FAPRI-Ireland aggregate model to inflate each of the agricultural output and input prices out to 2020. This allowed us to simulate farmer behaviour over a 10 year time-horizon, thus adding a dynamic element to the model. The farm weighting from the NFS was applied to each of the 1,170 farms allowing them to be weighted up to represent a farming population of more than 100,000 farms. The objective function of this model was to maximise the overall sectoral gross margin. Thus the optimal solution provided agricultural activity levels for each of the farmers within the model and GHG emissions coefficients were then applied to calculate each farmers GHG emissions level under alternative scenarios.

   These farm level projections have facilitated the estimation of the cost-benefit of adopting various abatement strategies. These projections can then be aggregated up to estimate the capacity of an abatement strategy to allow us to meet a particular national GHG abatement target. One of the more innovative aspects of the project includes an analysis of the impact of market based mechanisms, tradable emissions permits and emission charges, in reducing emissions from agriculture. This project constitutes the first such analysis with Irish farm level data.

   A second model was also used within this project; a Social Accounting Matrix (SAM) which had previously been developed for the Border, Midlands and Western (BMW) region of Ireland by Matt Fannin and Tom Johnson of the University of Missouri was used. A SAM allows us to examine the impact of changes in one sector on that sector and other sectors through the use of multipliers. The BMW SAM initially consisted of one agricultural sector, through the use of CSO and NFS data the agricultural sector within the BMW SAM was disaggregated into seven agricultural sectors (dairy, cattle, sheep, forage crops, cereal crops, other agriculture and agricultural contracting), this new version of the BMW SAM was then used to examine the impact of differing GHG emissions policies on the wider BMW region.

3. **Research Achievements**

   A peer review paper 'Estimating the marginal cost of greenhouse gas abatement for Irish Agriculture' was submitted to the Australian Journal of Agriculture and Resource Economics. Marginal abatement cost curves were estimated for 11 representative farms and for the Irish Agricultural sector, under two sets of scenarios. Aggregate marginal abatement cost curves
were estimated both with and without abatement technologies, in both cases the curves illustrated that almost half of the total emission from agriculture could be abated at a cost of less than €100 per tonne of CO2 equivalent, the bulk of these emissions being associated with the drystock sector. As emissions from the dairy and tillage sectors are abated the marginal cost of abatement increases sharply.

A peer review paper ‘Simulating a Market for Tradable Greenhouse Gas Emissions Permits in Irish Agriculture’ was submitted to the Journal of Ecological Economics. A linear model to examining three scenarios [1) emission standards of 20% applied across all farms, 2) as per 1 but with the flexibility to trade emission permits with other farmers and 3) assumption of market for tradable emission permits, with a transaction cost of €5 per permit incurred by farmers purchasing the permits] compared with a baseline of no emissions reduction for agriculture was developed. Scenarios examined assuming no uptake of abatement technologies and then assuming abatement technologies were adopted where suitable and profitable to do so.

It was estimated that an emission tax of €51 per tonne of CO2 equivalents would be needed in order to reduce GHG emission from agriculture by 20%. In the case of a fuel carbon tax on agriculture, specialist tillage and specialist dairy farms were on average expected to experience the largest increase in costs as a result of the fuel tax.

A further paper prepared for peer review submission examines the emissions tax required to achieve a 20 percent GHG emissions reduction target.

In a further task within the project the BMW SAM was disaggregated to include seven agricultural sectors rather than one, and this disaggregated model was used to examine 1) the impact of a 20% GHG emission standard by 2020 and 2) as per one, but achieved through the introduction of tradable emission permits. In both scenarios the largest loss in the value of agricultural output was in the cattle sector and the loss in gross output was lower in scenario 2. A description of the work and the main findings from this task are outlined in a working paper.

4. Impact of the Research

Output from this research project and work by other authors in this research area from across Europe was presented at an international Workshop which took place in Dublin on April 2nd 2009. The Workshop was held as part of the annual conference of the Agricultural Economics Society (AES) on Tuesday 31st of March and Wednesday the 1st of April. The workshop was chaired by Wilfrid Legg (Head of Policies and Environment Division, OECD) and there were eight presentations in total. Presentations were made by leading international experts in the field of modeling GHG emissions from agriculture, including Bernard Hyde of the Environmental Protection Agency, Adrian Leip of the Joint Research Centre of the European Commission, Ispra, Italy (Institute for Environment and Sustainability, Climate Change Unit), Caroline Saunders of Lincoln University New Zealand, Trevor Donnellan of Teagasc, Stephane De Cara of INRA, Dominic Moran of the Scottish Agricultural College, Werner Hediger of the Swiss College of Agriculture and James Breen Teagasc. James Breen presented results from this project.

In total there were over 40 participants in the workshop including public servants, policymakers and staff from state agencies in Ireland as well as international agricultural economists who
were attending the conference. The discussion after the workshop focused on the need for greater international collaboration in the modelling of greenhouse gas emissions from agriculture. The presentations from the workshop were made available to download on the Agricultural Economics Society of Ireland website at http://www.aesi.ie/aes2009/thursday.htm

5. **Exploitation of the Research**
The model development in this project is considered to be public good research and as such no commercial use of the model is envisaged. The output of the research project will be of use to policy makers with responsibility for GHG emissions abatement, as well as the wider community of stakeholders in the agricultural sector. The research allows for the comparison of various policy and technical abatement measures designed to reduce the level of GHG emissions associated with agriculture. The research demonstrates the cost of achieving abatement, the sectoral implications of abatement policies and the wider economy consequences of reducing emissions in the agricultural sector. To this end research output from this project has been presented at a number of events attended by both stakeholders and members of academia.

6. **Summary of Research Outputs**

(a) **Intellectual Property applications/licences/patents**
1. Not applicable to this type of project
2. 

(b) **Innovations adopted by industry**
1. Not applicable to this type of project
2. 

(c) **Number of companies in receipt of information**
Not applicable to this type of project

(d) **Outcomes with economic potential**
1. The output of the project includes a model that can be used to find least cost solutions to emissions abatement.
2. The project has also developed the capacity to examine the wider economy impact of agricultural GHG emissions abatement.

(e) **Outcomes with national/ policy/social/environmental potential**
1. Development of a model for tradable emissions permits which can inform policy makers
2. Development of capacity to examine wider economy impact of abatement

(f) **Peer-reviewed publications, International Journal/Book chapters.**


(h) National Report

(i) Popular non-scientific publications

2. 

(j) Workshops/seminars/open days at which results were presented (excluding those in (g))
1. GHG Workshop, Irish Management Institute, Dublin April 2\textsuperscript{nd} 2009 material from the Workshop is available at [http://www.aesi.ie/aes2009/thursday.htm](http://www.aesi.ie/aes2009/thursday.htm) [accessed March 6\textsuperscript{th} 2012]

7. Permanent Researchers

<table>
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<tr>
<th>Institution Name</th>
<th>Number of Permanent staff contributing to project</th>
<th>Total Time contribution (months)</th>
<th>Average time contribution per permanent staff member</th>
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<td>UCD</td>
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<td>2.04</td>
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8. Researchers Funded by RSF

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<th>Average time</th>
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<tr>
<td>PhD postgraduates</td>
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<tr>
<td>Masters postgraduates</td>
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<tr>
<td>Temporary researcher</td>
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<tr>
<td>Other</td>
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9. Postgraduate Research

Total Number of PhD theses: 0

Total Number of Masters theses: 0

10. Project Expenditure

Total expenditure of the project: \( \text{€} \ 180,749.04 \)

Total Award by RSF: \( \text{€} \ 187,952.82 \)

Other sources of funding (specify): \( \text{€} \ 0 \)
Breakdown of Total Expenditure

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<th>UCD Institution 2</th>
<th>Name Institution 3</th>
<th>Name Institution 4</th>
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<tr>
<td>Post doctorates</td>
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<tr>
<td>Post graduates</td>
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<td>Durable equipment</td>
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<td>180,749.04</td>
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11. Future Strategies
This research represents a significant development in the existing modelling capacity within Ireland. The work builds on the existing farm-level modelling capacity through the inclusion of GHG emissions and the development of a model which can be used to examine the potential impact of GHG emissions policy on farm profitability. There are plans to further develop the model to include a wider range of abatement technologies. The inclusion of forestry and biomass crops as alternative activities within the linear programming model is also being considered. A project linking the model developed as part of this work and the FAPRI-Ireland GHG Emissions model to the Irish TIMES model which has been developed in UCC is also under way.

12. Industry Collaboration
The main area of interaction with stakeholders associated with this project relates to policy makers rather than industry. The work undertaken under this project also involved considerable consultation with other researchers in Ireland who are engaged in research examining agriculture's contribution to GHG emissions.