Climate Change and Agricultural Policy Coherence: Agricultural Growth and GHG Emissions in Ireland

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Paper prepared for presentation at the 87th Agricultural Economics Society Annual Conference, University of Warwick April 8-10, 2013

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Abstract
In this paper the tensions between environmental policy, which commits to limiting and reducing greenhouse gas (GHG) emissions, and agricultural policy which seeks to increase agricultural production and agriculture's contribution to Ireland economic recovery are explored. Results from a partial equilibrium model of the Irish agricultural sector which is capable of simulating the impact of policy change on agricultural activity levels and associated GHG emissions are used to investigate this dilemma.

Ireland, as part of the EU Effort Sharing Agreement, has committed to reducing its GHG emissions by 20 percent by 2020 and in the event of a successor to the Kyoto Protocol by 30 percent below the 2005 level of emissions. In Ireland emissions from agriculture account, in a European context, for a very large share of total GHG emissions. Any reduction in Irish national emissions will likely require a reduction in the emissions from agriculture. In this policy context the Irish Government has adopted an ambitious growth strategy for the Irish agricultural sector, known as *Food Harvest 2020*. The Food Harvest strategy does not explicitly address how such dynamic growth in agricultural production can be achieved while simultaneously reducing GHG emissions from agriculture.

This tension between Irish environmental and agricultural policies is likely to be replicated at the European and global levels given the significant contribution of agricultural production to anthropogenic climate change and the role of agriculture in addressing emergent food security concerns.

Introduction

This paper explores the tensions between Irish environmental and agricultural policy using a partial equilibrium model of the Irish agricultural sector known as the FAPRI-Ireland model (Binfield et al., 2008). This model which has been widely used in the analysis of agricultural policy change (Binfield et al., 2003, 2005, 2008) has a sub-module which provides projections of GHG and other emissions to air that are associated with agricultural activity (Donnellan and Hanrahan, 2006). In this paper we present projections of agricultural activity, sectoral income and GHG emissions associated with the achievement of the Irish Government's Food Harvest 2020 growth strategy and explore how the growth in agricultural production envisaged can be achieved in the context of Ireland's commitment, under the EU Effort Sharing Agreement (OJ L 140, 5.6.2009), to reducing its GHG emissions by 20 percent by 2020.

During what has become known as the "Celtic Tiger" era the contribution of agriculture to Ireland's GDP declined and the share of agriculture in the Irish economy converged with that in other EU15 counties. This convergence was largely due to the dynamic growth of the non-agricultural economy rather than a contraction in the agricultural economy. The dramatic growth in the Irish economy, particularly since the introduction of the euro, is now seen to have been based on an unsustainable expansion in the non-traded sectors of the Irish economy, particularly the construction industry. This was facilitated by an excessive expansion of credit due to the integration of European financial markets and insufficient regulation of the financial industry (Honohan, 2009; Whelan, 2010).

With the onset of the international financial crisis in 2008 and the recession that followed, the macroeconomic contraction in Ireland has been very severe. Ireland's GDP in 2011 was 15.8 percent lower than in 2007 (CSO, 2012). Government policy in Ireland has, as in other peripheral euro-zone economies, been to dramatically reduce government expenditure and increase taxes while seeking to generate economic growth from the export orientated sectors of the economy. Within this context there has been an increased realisation by Irish policy makers of the important role that the Irish agri-food sector might play in the recovery of the Irish marcoeconomy. The export orientation of Irish agriculture is one of its defining characteristics, with over 80 percent of all Irish dairy and beef production exported. Given the outlook for continued growth in world population and the expectation, that with increasing affluence, global diets will increasingly include more meat and dairy products, the outlook for Irish agricultural commodity markets is relatively buoyant (OECD, 2012; FAPRI, 2012). The relatively optimistic market outlook, when combined with agreed changes in EU agricultural policy (the ending of the milk quota system in 2015) will see perceived impediments to growth in dairy output removed. This has led to increased optimism concerning the potential contribution of Irish agriculture to Irish economic recovery.

In 2009 the Irish Government appointed a Committee of Irish agri-food industry experts to develop a "… draft strategy for the medium-term development of the agri-food (including drinks) fisheries and forestry sector for the period to 2020. The strategy will outline the key actions needed to ensure that the sector contributes to the maximum possible extent to our export-led economic recovery..." (DAFF, 2010). The Committee's report, which has become known as the Food Harvest 2020 (FH) report, was published in July 2010 and subsequently adopted as Irish Government policy. The FH report sets ambitious targets for output growth from the different sub-sectors of Irish agriculture. By 2020 total output from agriculture, forestry and fisheries is to increase by €1.5 billion. Within agriculture, specific targets were set for growth in milk output and for growth in the value of output from the beef, sheep and pig sub-sectors. The report envisages that by 2020 the volume of milk produced in Ireland will have grown by 50 percent when compared with a base period of 2007-2009. The target growth in the value of output from the beef and sheep sub-sectors is 20 percent by 2020 and the target for growth in pig sector output value by 2020 is 50 percent.

With agriculture contributing 29 percent of Ireland's total GHG emissions, the Irish agricultural sector is relatively unique in the EU. Across the EU 27 agriculture is, on average, responsible for 9 percent of total GHG emissions (Breen et al., 2010). Unlike some other sectors of the economy, agriculture is not part of the EU Emissions Trading Scheme (ETS) and thus there are no policy measures in place at present that would lead to a reduction in agricultural GHG emissions. Apart from agriculture, the other non-ETS GHG emission sources include transport, households, services, smaller industrial installations and waste. Agriculture represented 41 percent of emissions in the non-ETS sector in 2010 (EPA, 2012). With this large share of non-ETS emissions, insulating agriculture from any GHG emissions reduction requirement would be controversial, as it would require other non-ETS sectors to make greater emission reductions.

The Government policy objective of facilitating and encouraging strong growth in agricultural production (Food Harvest 2020) contrasts with policy relating to climate change. Ireland's public policy in relation to climate change is framed within the EU climate change policy framework. Ireland, as an EU member state, is committed to reducing GHG emissions under the EU Effort Sharing Agreement. Under the EU Effort Sharing Agreement, Ireland's GHG emissions are to be reduced by 20 percent relative to the level in 2005 by 2020. In the event that an international agreement on climate change is reached Ireland's reduction commitment under the EU agreement increases to 30 percent. Recent reports prepared for the Irish Government by the secretariat of the National Economic and Social Council (NESC 2012a, 2012b) set out strategies for decarbonising Irish society by 2050. Within these documents the "vision" for the agriculture sector (and its decarbonisation) is framed within the context of the IPCC conventions relating to agriculture, land use and land use change and forestry (LULUCF). While current and proposed national policy (DECLG, 2013) does not yet specify any sectoral allocation a reduction in emissions of 20 percent by 2020 will have to be achieved by non-ETS, since emission reductions by industries covered by the ETS are governed by the operation of the EU ETS. Any special or differential treatment for agriculture within the context of the national emissions reduction target would necessarily imply significantly higher reductions in the transport and residential sectors that account for the vast majority of the non-agricultural elements of non-ETS GHG emissions in Ireland

The conflict between GHG emissions reduction commitments and associated environmental policies and agricultural policies that seek to encourage agricultural production are particularly acute for large agricultural exporters. In an EU context Ireland is somewhat unique in both its export orientation and the ruminant animal basis of its agri-food industry. Milk and meat output from ruminant animals accounts for the majority of Irish agricultural output (61 percent) and the majority of that output is exported. Increasing the production of food while reducing GHG emissions is a dilemma faced by Ireland and by the wider global community. Agriculture accounts for a very large share of GHG emissions globally and increasing agricultural production while simultaneously reducing the contribution of agriculture to climate change is listed as one of the major challenges facing the international food system in the recent Beddington Report (GO-Science, 2011).

Given the agreements on climate change policy entered into by Ireland, Irish policy makers face the task of implementing policies that will allow Ireland to meet its GHG reduction commitments. As McCarthy and Scott (2008) note, for any emissions target, such as the 20 percent and potential 30 percent reductions in the EU Effort

Sharing Agreement, there are competing menus of policy actions which could deliver the desired reduction. Of interest to policy makers is that some GHG abatement policy measures have much higher economic costs per tonne of emission reduction than others measures. Given that a reduction in a tonne of CO2 equivalent emissions from source x has the same beneficial affect on climate change as a tonne reduction from source y, society and public policy on climate change should seek to identify the least-cost abatement strategy. Where the costs associated with reductions from various sectors differ, it follows that the share of the reduction sought from each sector should not be uniform.

In the context of reducing agriculture's GHG emissions, those agricultural activities that contribute to GHG emissions and that are currently marginally economic or uneconomic (in the sense of their profitability) should be the first focus of policy makers in their search for the least cost abatement policy. If an activity, such as steel production or cattle production is unprofitable, then from a societal perspective, the costs of reducing the GHG emissions associated with such activities are likely to be negative (i.e. it will actually be economically beneficial). This means that such activities will be close to the top of most policy makers' climate change policy menus. This climate change policy "arithmetic" explains the focus in the remainder of this paper on the contribution of the dairy and beef sub-sectors to Irish agriculture's GHG emissions and to the achievement of the Food Harvest 2020 Report targets and what changes are likely to be necessary to resolve the tension between Government policy relating to climate change and agricultural production.

The remainder of this paper is structured as follows. In the next section we discuss the strategies that could be adopted to abate emissions in agriculture given that mitigation strategies are likely to be insufficient to meet the reduction commitments entered into. In the next section following a short description of the FAPRI-Ireland model and its GHG emissions sub-module, we outline the definitions of the reference (Food Harvest) and greenhouse gas reduction scenarios analysed using the FAPRI-Ireland partial equilibrium model. The projections of agricultural activity, sectoral income and GHG emissions under the reference and alternative greenhouse gas reduction scenarios are then presented. The paper closes with a discussion of the impact of the imposition of greenhouse gas reduction targets on the Irish agricultural sector and the general conflict between environmental policies that seek to reduce emissions of GHG and agricultural policies that seek to increase agricultural production.

Strategies to Abate Emissions in Agriculture

While science and technology holds out the promise of a more carbon efficient agricultural sector, it should be understood that there are limits to what can be achieved within the short timeframe to 2020 (Schulte et al., 2012). The contribution to GHG abatement of the technologies that flow from agricultural production research programmes will first have to be accepted by the IPCC. Farmers will then have to adopt the technologies proposed. Experience suggests that neither of these processes is either rapid or guaranteed.

The process whereby farmers adopt new technology will only begin, and subsequently accelerate, if farmers see an economic reason to change their behaviour (i.e. adopt more carbon efficient production practices). Creating these economic incentives involves the internalisation of the external costs of GHG emissions, through the imposition of measures such as a carbon tax, GHG quota or an emission permits trading scheme (Clark, 2008).

Given the very short time frame within which the reductions in Ireland's GHG emissions have to be made, the contribution of technological solutions alone is almost certainly going to be insufficient if the GHG reduction targets set for agriculture are sizable. The extent to which the different GHG abatement technologies under development can be considered additive in terms of their contribution to GHG abatement is also unclear. Thus, if agriculture were to make a proportionate contribution to the achievement of the GHG reduction targets set in EU and national climate change policies, a range of other agricultural and environmental policy options will have to be considered.

By increasing the costs of production, the application of a carbon tax in Ireland would reduce the international competitiveness of the traded goods sector, including agriculture. Reduced incomes in the agricultural sector following from the carbon tax would reduce the production of agricultural output in Ireland and thereby reduce emissions of GHG. However, since global emissions of GHG are driven by global demand for agricultural and food products, lower agricultural output in Ireland would almost certainly be offset completely by increased agricultural production elsewhere with next to no change in global emissions of GHG (so-called carbon leakage).

Taxing the consumption of beef and dairy products in Ireland would face the similar difficulties to those associated with the imposition of a carbon tax on agricultural production. Consumption taxes could change consumer choices by raising the price of these foods, however, the Irish Government can only levy such taxes in Ireland. Consumers in the rest of the EU would not be subject to such taxes and would continue to demand Irish beef and dairy commodities. The incentives, i.e. prices, faced by Irish farmers, would not change very much and consequently the reduction in GHG emissions from Irish agriculture through an Irish consumption tax is likely to be minimal.

A command and control approach to addressing the problem of achieving GHG reduction targets in agriculture could involve the allocation of a non-tradable GHG quota to each farmer based on their agricultural activity in a base period. Over the period to 2020 the level of this quota would then be reduced so that a national GHG reduction target for agriculture would be achieved.

There are a number of problems with the command and control approach. Some involve the calculation of the initial GHG emissions quota at the farm level. Actual emissions vary from farm to farm, due to scale, the intensity of production (e.g. yield of milk per cow) and according to production practices (e.g. application of artificial fertilizers). Establishing what these were for each farm in some reference period would be a daunting exercise. Assessing, on an ongoing basis, farmers' compliance with their GHG emissions quota would likely present an even more formidable challenge in terms of designing and implementing enforcement mechanisms.

The introduction of a quota would also ensure that a least cost abatement solution to the achievement of Irish agriculture's GHG emissions targets would not be achieved, since all farmers would have to achieve the same percentage reduction (Baumol and Oates, 1988). From an economic perspective, those farms with lower abatement costs should reduce their GHG emissions more than those with higher abatement costs, since otherwise the total cost of achieving the reduced GHG emissions level will be higher than necessary.

If GHG quotas were tradable amongst farmers then the overall costs of achieving a given reduction would be reduced compared with a fixed GHG quota regime. In the GHG context such a policy regime is known as a "cap and trade" system. Agriculture in New Zealand is to be an integral part of that county's emissions trading scheme (NZ ETS) from 2015. Agriculture in NZ will be integrated within the New Zealand ETS indirectly via the involvement of dairy and meat processing companies, live animal exporters, fertilizer manufacturers and importers and egg producers (MAF-NZ, 2010). The costs of carbon permits traded by agricultural processors and input suppliers will be reflected in the output and input prices faced by farmers.

From the perspective of the wider economy and with the objective of minimising the total economy costs of GHG abatement, it could make more sense for emissions permits to be tradable outside of agriculture. However, for agriculture this could lead to a flow of GHG permits out of agriculture to the non-agricultural economy with negative consequences for the level of agricultural and food production in the EU. A compromise might involve confining the tradability of "agricultural" GHG quota to the agricultural sector. This would prevent the flow of GHG quota out of agriculture and most likely reduce the price at which such quota would trade between farmers or other economic agents involved in an agricultural ETS.

In the analysis in the next section the consequence of the imposition of a binding GHG constraint on Irish agricultural production is investigated. In this analysis the least profitable sub-sector of Irish agriculture (beef) adjusts and thereby facilitates the expansion in production of the most profitable sub-sector (dairy). The change in production that occurs is likely to be akin to that which would arise if an agricultural sector cap and trade scheme were used to achieve a given reduction in GHG emissions. In the presence of a cap and trade scheme those farms expanding their level of agricultural activity would purchase GHG quota from those reducing their level of agricultural activity. This trade would not affect total agricultural sector income since it would involve transfers from one part of the sector to another. However, it would alter the costs of expanding production and the benefits of curtailing or ceasing loss making production activities. These expansion and contraction costs and benefits and the operation of a carbon permit market have not been incorporated in this analysis. Breen (2008) found, using a linear programming model, that the economic costs of reductions in agricultural greenhouse gas emissions in Ireland are smaller using a tradable emissions permit approach rather than a command and control approach. Future research will seek to incorporate an emissions permit market within the FAPRI-Ireland aggregate sector model.

Methodology

Future GHG emission levels from agriculture will be the product of emission factors and the future level of agricultural activity. Considerable work has been done to provide GHG emission factors which are specific to Ireland, notably the work by O'Mara et al. (2006). The other element of the future GHG emissions equation, are the projected future levels of agricultural activity. We use the FAPRI-Ireland partial equilibrium model of the Irish agriculture sector to generate projections under the assumption that the Food Harvest 2020 output growth targets are achieved. The FAPRI-Ireland model (Binfield et al., 2003, 2007, 2008) is a dynamic partial equilibrium model that is integrated within the FAPRI EU Gold model (Hanrahan, 2001). The FAPRI approach to the development of agriculture sector models and the conduct of policy analysis is described in Meyers et al. (2010) and Westhoff and Meyers (2010). The FAPRI-Ireland model has a sub-module which generates projections of GHG and other emission to air that are associated with agricultural production. Details of the GHG sub-module and earlier policy scenario analysis can be found in Donnellan and Hanrahan (2006).

The assessment of the economic impact of a future constraint on agricultural activity needs first to establish the future level of agricultural activity under specific policy assumptions. Accordingly, a *Reference Scenario*, based on a specific set of future policy assumptions is set out. This reference scenario reflects the achievement of the targets that are set out in the Food Harvest Report. The reference scenario also includes the agreed series of annual 1 percent expansions of the milk quota and its eventual elimination in 2015. Trade and CAP policy remain unchanged, as no World Trade Organization (WTO) agreement or CAP reform agreement is assumed to occur.

Using the FAPRI-Ireland model the projected level of agricultural activity related to these policy assumptions is estimated. These projections provide an estimate of the distance agriculture would be from achieving a 20 percent GHG reduction target if no policies to address GHG emissions from agriculture were pursued. This Reference Scenario also provides projections of the future value of agricultural output, input expenditure and agricultural income.

Next a *GHG Emission Reduction* scenario is specified. In the GHG Emission Reduction scenario the reduction in Irish agricultural output required to reduce GHG emissions from the sector by 20 percent was estimated. Estimates of the economic impact of meeting the target in terms of its impact on the value added in agriculture are produced. This economic impact assessment is carried out for primary agriculture only and does not extent to include the impact on beef processing and wider economic activity.

Results and Discussion

The model is used to produce the reference scenario projections of agricultural activity and associated GHG emissions. As illustrated in Figure 1a, GHG emission decline initially relative to current levels but then increase in later years of the projection period as milk quotas are removed. The cattle population increases, mainly due to a rise in the number of dairy cows (and their progeny) as illustrated in Figure 1b, and the targets set out in the Food Harvest strategy are achieved. It can therefore be said that if agriculture is required to reduced its GHG emissions in future years, that achievement of the Food Harvest output targets would make the achievement of any reduction in emissions of GHG from Irish agriculture more difficult.

The model is then run with a GHG constraint where emissions must be 20 percent below the 2005 level by 2020. For the purposes of this scenario we assume that the approach taken is limit GHG emissions from the suckler herd (and associated progeny) while other areas of agricultural activity continue in an unconstrained fashion. The model is used to find a cattle population and production intensity that is consistent with the imposed GHG constraint.

As illustrated in Figure 1c the extent of the decrease in the cattle population required to achieve the GHG reduction target of 20% below 2005 levels is dramatic. Given that the GHG reduction is targeted at the specialist bovine sector, the decrease that is required in the suckler cow herd is even more pronounced than the overall reduction in the cattle population. Projections for the Reference scenario are presented in Figures 1a and1b, while projections under the GHG reduction scenario are presented in Figures 1c and 1d.

Figure 1a: GHG Emissions and Cattle Population under the Reference Scenario

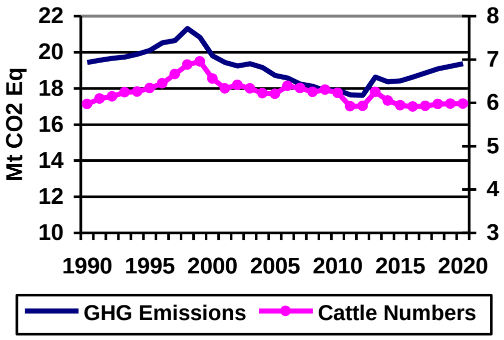


Figure 1b: Dairy Cow and Sucker population under the Reference Scenario

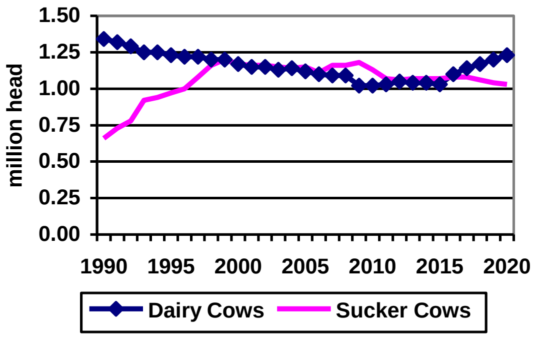
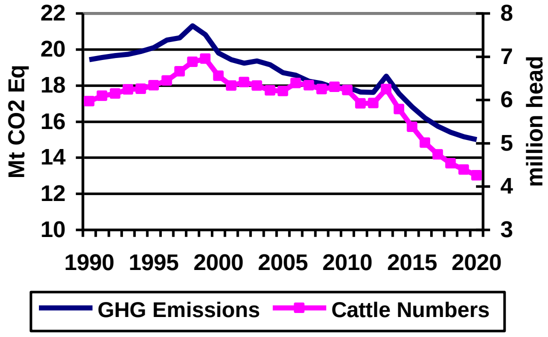
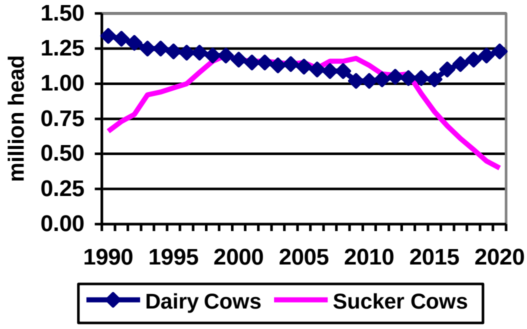


Figure 1c: GHG Emissions and Cattle Population under the GHG Reduction scenario

Figure 1d: Dairy Cow and Sucker population under the GHG Reduction Scenario





Source: FAPRI-Ireland GHG model (2012).

To reach the specified 20 percent GHG reduction target by 2020 requires that cattle numbers are reduced to 4.26 million head by 2020. Total cattle numbers were 6.21 million head in 2005 and are projected to be 5.86 million in 2020 under the Reference Scenario. Suckler cows numbers are reduced to just under 0.396 million head by 2020 to achieve the 20 percent target. Sucker cows numbers were 1.15 million head in 2005 and are projected to be 1.06 million in 2020 under the Reference Scenario. The dramatic decline in suckler cow numbers under the GHG Emissions Reduction Scenario is reflected in reduced production of beef in Ireland. By 2020 Irish beef production would decreases to 0.369 mt to achieve the 20 percent reduction target. Beef production was 0.55 mt in 2005 and is projected to be 0.56 mt in 2020 under the Reference Scenario. The magnitude of the change in beef production is smaller than that in suckler cow numbers reflecting the increased importance of dairy calves to Irish beef production.

Given that there is projected to be little change in Irish beef consumption over the period to 2020, the impact which meeting the 20 percent GHG reduction target has on the value of beef production would be mirrored by a broadly similar percentage reduction in the value of Irish beef exports. Table 1 summarises the impact on the bovine population, beef production and the value of cattle output.

Table 1: Animal Numbers, Beef Production and Cattle Sector Value under Food Harvest 2020 and Under a 20 % GHG reduction target

		FH	GHG Minus 20%	FH v 2005	GHG Minus 30% v 2005	FH v GHG Minus 30%
	2005	2020	2020			
	000 head			percent change		
Total Cattle	6,210	5,980	4,260	-4	-31	-29
Dairy Cows	1,120	1,260	1,260	13	13	0
Suckler Cows	1,150	1,020	400	-11	-65	-61
	Million Tonnes			percent change		
Beef Production	0.55	0.56	0.369	2	-33	-34

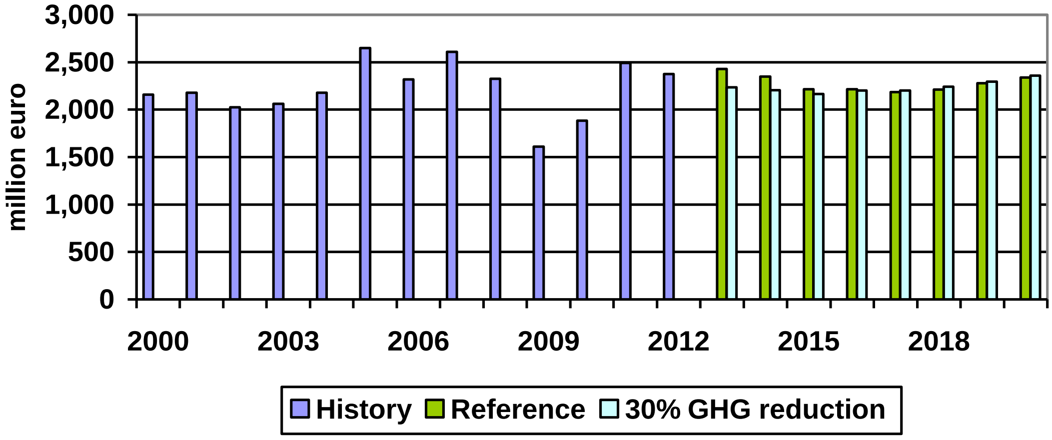
	Euro Millions		percent change			
Cattle Output Value	1,413	1,921	1,225	36	-13	-36

Source: FAPRI-Ireland GHG Model (2012)

While the reductions in the value of beef output resulting from the 20 percent GHG reduction targets are substantial, these reductions have only a limited impact on the level of operating surplus by 2020, since much of this beef production is loss making (the cost of production exceeds output value). The impact of the 20 percent GHG reduction target on the operating surplus in agriculture is illustrated in Figure 2.

These results demonstrate that that a cut in primary beef production would not have a significant impact on the operating surplus (income) in primary agriculture. This is because profitability in the beef sector is particularly low and the reduction in output is offset by a reduction in input usage of similar magnitude, leaving operating surplus almost unaffected by the GHG constraint.

Figure 2: Operating Surplus from Irish Agriculture 2000 to 2020 with projections for the reference scenario and the 20% GHG reduction



Source: FAPRI-Ireland GHG Model (2012)

However, it is also necessary to consider the economic impact of the GHG constraint beyond the farm gate. While primary beef production is relatively unprofitable, the same cannot be said for beef processing which does have a significant positive value added. It is beyond the scope of this paper to examine in detail the associated economic impact of a reduction in beef processing. As indicated in Table 1, the contraction in cattle output to meet a 20% GHG reduction constraint would lead to a reduction of 34 percent in the volume of beef processed. Accordingly, a pro rata reduction in the value added in beef processing would amount to a loss in value added of close to €170 million euro in the beef processing sector annually by 2020.

Abatement Strategies

Incorporation of abatement technologies in this type of analysis would be complex for several reasons. Even though proven abatement technologies exist, it is very difficult to project the level of adoption of abatement technologies that will take place at farm level in the short to medium term. Some abatement technologies may be prohibitively expensive and hence uneconomic. Other abatement technologies may be cost neutral and there are even some abatement technologies which are said to be cost negative, i.e. these technologies when adopted actually improve farm productivity. The difficulty with such abatement technologies is that even through they may reduce emission on a per unit of output basis, they also improve farm profitability. Other things being equal, measures which improve farm profitability would also lead to increased production and GHG emissions, which may then counteract the beneficial impact of the abatement technology.

Conclusion

Using Ireland as an example, this paper has shown that where the agriculture sector is a significant component of a country's total GHG emissions, and where agriculture is faced with large short to medium term GHG reduction targets, the least cost solution may be to reduce the level of agricultural production.

The Food Harvest targets for growth in Irish agricultural output volume and value were explicitly framed within the context of an economy that was in deep recession and an understanding that the agi-food sector (as an overwhelmingly export orientated sector) could contribute positively to economic recovery. On the basis of the analysis presented here it is difficult to see how reductions in emissions from the sector that approach the levels envisioned for the non-ETS parts of the Irish economy under the EU effort sharing agreement can be achieved while the agri-food sector simultaneously grows the volume and value of output in line with the Food Harvest strategy targets.

The incoherence in Irish Government policy between agricultural and climate change policies generalises to the international dimension. The results presented in this paper illustrate the potential difficulty that agricultural net exporters will face in the context of future GHG reduction commitments which impact on agriculture. Increasingly policy makers and the general public in Ireland and internationally will need to consider the implications which international agreements designed to tackle climate change have on global food production. An argument can be made that the current system of agreement for the monitoring and reduction of GHG emissions is inappropriate and in conflict with the desire to produce cheap food for the global population.

Under existing global agreements the GHG emissions created in the production of food are associated with the food exporter rather than the food importer. There is already precedent for an alternative treatment of particular sectors. For example fossil fuel emissions are associated with the fuel consuming country rather than the fuel producing country.

Do alternative mechanisms to constrain GHG emissions from agriculture, such as an approach focused on the intensity of GHG emissions per unit of food output deserve consideration? Given the scale of the increase in global food production required over the coming decades, and the desire to produce food at affordable price levels, GHG emissions abatement in agriculture may require an approach that is not in conflict with countries' desire to exploit their comparative advantage in the production of particular food commodities. This argument has even greater merit in the case of food net exporting countries, such as Ireland and New Zealand, where agricultural production has a low GHG emission intensity (Leip et al., 2010).

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