European Network of Agricultural and Rural Policy Research Institutes

POTENTIAL WTO TRADE REFORM

MULTIFUNCTIONALITY IMPACTS FOR IRELAND?

TREVOR DONNELLAN

AND

KEVIN HANRAHAN

POTENTIAL WTO TRADE REFORM
MULTIFUNCTIONALITY IMPACTS FOR IRELAND?
ENARPRI WORKING PAPER NO. 16/MAY 2006

TREVOR DONNELLAN AND KEVIN HANRAHAN[*]

Abstract

The economic impact of trade policy reforms on various sectors of the economy receives more attention than the effects on the environment. This may be partly owing to the secondary importance attributed to environmental or multifunctionality issues when economic consequences take centre stage. An additional consideration, however, may be the practical difficulties of bringing together models that examine the economic impact of trade policy reforms and models that can measure environmental or multifunctionality indicators.

This paper examines one aspect of the relationship between trade policy and the environment, namely that between agricultural trade policy reform and emissions from the agricultural sector. The paper analyses the impact of agricultural production levels and practices on the level of greenhouse gas (GHG) and ammonia emissions from this sector in Ireland.

The study combines an economic, partial equilibrium, agricultural commodity and inputs model (the FAPRI-Ireland model) with a model for the estimation of GHG and ammonia emissions from agriculture. The paper considers a potential reform of agricultural trade policy under a possible World Trade Organisation agreement, to reveal the extent to which there are environmental effects associated with such a reform that need to be considered in addition to the conventional economic ones.

Keywords: partial equilibrium models, multifunctionality, greenhouse gas emissions

---

[*] Trevor Donnellan and Kevin Hanrahan are with the Rural Economy Research Centre, Teagasc – The Irish Agricultural and Food Development Authority, Athenry, Galway, Ireland (e-mail address: tdonnellan@rerc.teagasc.ie).

Contents

Potential WTO Trade Reform

Multifunctionality Impacts for Ireland?

ENARPRI Working Paper No. 16/May 2006

Trevor Donnellan and Kevin Hanrahan

---

1.   Introduction

Since the industrial revolution the use of fossil fuels (oil, coal and natural gas), has provided power for industry and facilitated the lifestyle of Western societies. Owing to the use of fossil fuels, levels of atmospheric carbon dioxide have increased and this may augment the greenhouse effect to the point where a change in climate may result. Higher levels of other trace gases such as nitrous oxide (N_{20}), methane (CH_4) and chlorofluorocarbons (CFCs) may also contribute to a change in climatic conditions.

Collectively these gases are referred to as greenhouse gases (GHG). In Ireland agricultural production is a leading contributor of GHG emissions to the atmosphere in the form of methane and nitrous oxide.

While some remain sceptical about the evidence of global warming, a growing number believe that a significant alteration of our climate is possible within this century. Continuing global warming may affect, among other things, crop yields and water supply. Furthermore, it may generate the potential for altering the range or number of pests that affect plants as well as diseases that threaten the health of both humans and animals. An increase in global temperatures may cause the melting of polar icecaps, which would raise sea levels and inundate low-lying land areas around the world.

Reflecting growing international concern about global warming, the Kyoto Protocol[1] was signed in Japan in 1997. It resulted in specific limitations for GHG emission levels to be achieved by 2010 in countries that are signatories. These targets were set with reference to GHG levels in 1990. Most developed countries must reduce their GHG emissions below the 1990 level to comply with the Protocol. Within the EU, Ireland received a concession that allows an increase in its GHG emissions by no more than 13% above the 1990 levels by 2010.

In 2000 the National Climate Change Strategy for Ireland (NCCS) was published. It projected that without policies to contain the level of emissions, Ireland would in fact exceed its target of 60.74 million tonnes (Mt) of carbon dioxide equivalent by up to 22% by 2010.[2] In the NCCS, the Irish Department of the Environment set out specific measures to control GHG emissions.

Relative to other EU member states and most other developed countries, Ireland is unusual in terms of the percentage contribution made by agriculture to national GHG emissions. Of the 68,000 tonnes of GHG CO_2 equivalent produced in Ireland in 2004, it is estimated that 28% was contributed by Irish agriculture (Environmental Protection Agency, 2005). This reflects both the high degree of agricultural activity and relatively lower levels of other GHG sources (such as heavy industry) in Ireland. The emission of GHGs from agriculture principally comes from animals but is also the result of agricultural practices such as the use of fertiliser and manure

---

[1] See the US Department of State, Bureau of Oceans and International Environmental and Scientific Affairs (1998) for more details.

[2] See the NCCS, Department of the Environment (2000), p. 12.

management. It is likely that policy-makers will seek to reduce GHG emissions below the levels projected in the NCCS report. In this regard they may consider the cost of reducing emissions from each sector in order to minimise the effect on the overall economy. There is thus a need to estimate GHG emissions from the various sectors of the economy, including agriculture.

This paper projects the future level of GHG emissions under existing agricultural policies prevailing in the EU and then contrasts that outcome with projections made under an assumed World Trade Organisation (WTO) agreement, thereby capturing the potential impact of such a trade reform for GHG emissions from agriculture.

In addition to concerns relating to GHG emissions, since the 1970s there has been growing international concern about air pollution. In the EU an objective of policy-makers is to formulate and implement strategies to improve air and water quality. To meet this objective, the control of emissions from a variety of industrial, commercial and agricultural sources is a key aim. With this in mind the European Council issued a Directive (Directive 2001/81/EC) in 2001 that sets limits for each EU member state in terms of total emissions of specific gases. These limits are to be met by 2010.

Four categories of pollutants – sulphur (SO_2), nitrous oxides (NO_x), volatile organic compounds (VOCs) and ammonia (NH_3) – have been identified as responsible for acidification, eutrophication and ground-level ozone pollution. The Directive allows member states to provide their own mechanisms to ensure that reduction targets are achieved. As part of the Directive member states will be required to report each year on their actual and projected future levels of emissions of these substances. National programmes will be required to specify how national ceilings will be met. The Directive contains provisions for reviews in 2004 and 2008 to identity the progress being made and whether further actions are required.

Some of the pollutants mentioned above can be transported considerable distances through the air or in water and this means that pollution arising in one country may have an impact in another. Thus a coordinated international approach, which extends beyond the EU, is required to address the issue. Accordingly, EU member states together with Central and Eastern European countries, the US and Canada have negotiated the UNECE Gothenburg Protocol to the 1979 Convention on Long Range Transboundary Air Pollution to Abate Acidification, Eutrophication and Ground Level Ozone (UNECE, 1999). It was agreed in November 1999. The Gothenburg Protocol contains emission ceilings that are not as stringent as those decided by the European Council. Under the Gothenburg Protocol, Ireland has agreed to reduce its NH_3 emission levels by 9% on those estimated for 1990. With regard to agriculture's contribution to these forms of pollution, a number of consequences can be identified as below.

Eutrophication refers to the gradual increase in the concentration of phosphorus, nitrogen, ammonia and other plant nutrients in water ecosystems such as lakes. As the amount of organic material that can be broken down into nutrients increases, the productivity or fertility of such an ecosystem increases. Runoff from land may enter water systems containing, among other things, fertiliser and decomposing plant matter. This can cause algal blooms – highly concentrated amounts of micro-organisms – to develop on the water surface, which then prevents the light penetration and oxygen absorption necessary for aquatic life.

This process can be intensified when excessive amounts of fertilisers (as well as sewage and detergents) are prevalent. Ammonia is a major constituent of fertiliser, which contributes to the process of eutrophication.

Acidification can result from emissions of sulphur dioxide, nitrogen oxides and ammonia. Although sulphur is the biggest contributor to acidification, nitrogen compounds are also a significant source. When soil becomes acidified it can cause nutrients to leach, which then reduces soil fertility. Metals can also be released from the process, which can affect the micro-

organisms that facilitate decomposition in the soil and in turn, birds, animals and humans can be affected. Tree damage such as leaf and needle losses has been linked with acidification and high concentrations of ground ozone.

We examine the level of ammonia produced by the various sub-sectors of Irish agriculture. We use economic projections for future levels of agricultural activity in conjunction with per unit estimates of ammonia emissions to calculate future levels of ammonia emissions from the whole sector.

In this paper we do not consider the issue of whether GHG or ammonia emissions from agriculture should or should not be considered as a multifunctional output of the agricultural sector. The Organisation for Economic Cooperation and Development (OECD) has produced an analytical framework wherein the nature and definition of multifunctionality is discussed at length (OECD, 2001).

The rest of this paper is divided into four further sections. Section 2 examines the methodology for the estimation of the impact of trade policy on the level of agricultural activity and in turn the impact of GHG and ammonia production. Section 3 outlines two states of the world for examination. The first, referred to as a baseline, examines agricultural activity and emissions generation under a continuation of existing WTO trade policies and the existing common agricultural policy (CAP). The second state of the world, a WTO reform scenario, alters trade policies (as a result of a hypothetical WTO reform) to assess the impact on agricultural activity and emissions generation. The policy change considered under the WTO reform is also detailed in this section. The difference between emission levels under the two scenarios is an estimate of the environmental impact of the WTO reform. Section 4 presents results for agricultural production, GHG and ammonia emissions under both the baseline and the WTO reform scenario. Section 5 of the paper provides some conclusions and areas for further work.

2.   Method of analysis

The approach used here involves the use of two distinct modelling frameworks, which interact with each other to produce projections of the impact of policy reform on GHG and ammonia emissions. The first component is an econometric, partial equilibrium commodity model and the second component is the satellite GHG and ammonia emissions projection models.

2.1   Partial equilibrium commodity model

The FAPRI-Ireland[3] model is a set of econometric, dynamic, multi-product, partial equilibrium commodity models. In its current version, the model has an agricultural commodity coverage that extends to markets for grains (wheat, barley and oats), other field crops (potatoes, sugar beet and vegetables), livestock (cattle and beef, pigs, poultry and sheep) and milk and dairy products (cheese, butter, whole milk powder and skim milk powder). Many of the equations in the model are estimated using annual data from the period 1973-2002 or over shorter periods when data are not available or where for policy reasons longer estimation periods would not be meaningful.

The FAPRI-Ireland model is structured as a component of the FAPRI EU GOLD model, which is a commodity model of EU agriculture. The GOLD model in turn can form a component of

---

[3] The FAPRI-Ireland Partnership is a research affiliation between Teagasc – The Irish Agriculture and Food Development Authority and the Food and Agricultural Policy Research Institute (FAPRI) based at the University of Missouri (see http://www.tnet.teagasc.ie/fapri).

the FAPRI world modelling system for world agriculture. In this way the model for Ireland can incorporate the impact of changes in international trade policy as they relate to agriculture.

The primary purpose of the FAPRI-Ireland model is to analyse the effect of policy changes on economic indicators such as the supply and use of agricultural products, agricultural input expenditure and sector income. In so doing the model produces future projections of animal numbers, input usage volumes and other indicators. These indicators can be incorporated into the satellite GHG models to enable the provision of base data and projections relating to multifunctionality indicators, such as GHG emissions, fertiliser usage and ammonia emissions. In this paper, however, we focus solely on the GHG emissions. Key components of the structure of the partial equilibrium model are set out below.

The equation for the total agricultural area farmed is modelled as:

$$taf_t = f\left(agout_{t-1} \big/ gdp_{t-1} \right) \tag{1}$$

where taf_t is the total agricultural area in year t and $agout_{t-1}$ is the value of agricultural output in year $t-1$ and gdp_{t-1} is a measure of national income in year $t-1$. The equations used to determine the share of the total agricultural area farmed within each agricultural culture group can be expressed as:

$$ash_{i,t} = f\left(ret_{i,t-1}, agout_{t-1}, ash_{i,t-1}, V_t, Z_t \right) \qquad i = 1,\ldots,5 \tag{2}$$

where $ash_{i,t}$ is the share of the total agricultural area to be allocated to i-th culture group in year t, $ret_{i,t-1}$ is the value of the output from the i-th culture group and $agout_{t-1}$ is the value of total agricultural output in year $t-1$, while V and Z are vectors of exogenous and endogenous variables that could have an impact on the area allocated to agriculture culture group i. The land use associated with one of the five agriculture culture groups modelled (pasture, hay and silage, potatoes, sugar beet and cereals) is derived as the residual land use so as to ensure land-use balance.

The total area allocated to the i-th agricultural culture group is then derived as the product of the i-th area share times the total agricultural area:

$$af_{i,t} \equiv ash_{i,t} * taf_t \tag{3}$$

Within each of the i agricultural culture groups, land may be further allocated among competing cultures, for example within the land area allocated to the cereals culture group soft wheat 'competes' with barley and oats for land. Within the culture group allocation of land this is modelled using area allocation equations of a similar form to (2):

$$asf_{i,t}^j = f\left(ret_{i,t-1}^j, \sum_{\substack{k=1 \\ k \neq j}}^{m} ret_{i,t-1}^k, asf_{i,t-1}^j, S_t, W_t \right) \qquad j,k = 1,\ldots,m \tag{4}$$

where $asf_{i,t}^j$ is the share of the j-th culture within the culture group i, $ret_{i,t-1}^j$ is the return to the j-th culture in year $t-1$, and S_t and W_t are other endogenous and exogenous variables that may affect the allocation of land among the j competing cultures within any given culture group i. The land (in hectares) allocated to the j-th culture is then derived as the product of the total land allocated to the i-th culture group ($af_{i,t}$) times the area share ($asf_{i,j,t}$):

$$aha_{i,t}^{j} \equiv asf_{i,t}^{j} * af_{i,t} \qquad (5)$$

The yield equations of culture k in culture group i can be written as:

$$r_{i,t}^{k} = f\left(p_{i,t-1}^{j}, r_{i,t-1}^{k}, V\right) \qquad j,k = 1,...,n \qquad (6)$$

where $r_{i,t}^{k}$ is the yield per hectare of culture k belonging to the culture group i, and V is a vector of variables, which could have an impact on the yield per hectare of the culture being modelled.

On the demand side, crush and feed demand and non-feed use per capita are modelled using the following general functional forms:

$$Fu_{i,t}^{k} = f\left(p_{i,t}^{j}, Z\right) \qquad j,k = 1,...,n \qquad (7)$$

where $Fu_{i,t}^{k}$ is the feed demand for culture k belonging to the culture group i and Z is a vector of endogenous variables, which could have an impact on the demand considered (on meat production for example);

$$NFu_{i,t}^{k} = f\left(p_{i,t}^{j}, NFu_{i,t-1}^{k}\right) \qquad j,k = 1,...,n \qquad (8)$$

where $NFu_{i,t}^{k}$ is the non-feed demand for culture k belonging to the culture group i;

$$CR_{i,t}^{k} = f\left(p_{i,t-1}^{h}, p_{i,t-1}^{h}, p_{i,t-1}^{l}, CR_{i,t-1}^{h}\right) \qquad h, l = 1,...,n \qquad (9)$$

where $CR_{i,t}^{k}$ is the crush demand for oilseed culture k and $p_{i,t-1}^{h}$ the real price of considered seed oil and $p_{i,t-1}^{l}$ the real price of the seed meal produced as a product of the crushing process.

While the structure of individual livestock sub-models varies, their general structure is similar and is presented below. Ending numbers of breeding animals can be written as:

$$cct_{i,t} = f\left(cct_{i,t-1}p_{i,t}, V\right) \qquad i = 1,...,n \qquad (10)$$

where $cct_{i,t}$ is the ending number in year t for the breeding animal type i, $p_{i,t-1}$ is the real price in year $t-1$ of the animal i considered, and V is a vector of exogenous variables that could have an impact on the ending inventory concerned (such variables are the direct payment linked to the animals concerned or specific national policy instruments).

Numbers of animals produced by the breeding herd inventory can be written as:

$$spr_{i,t} = f\left(cct_{i,t-1}, ypa_{i,t}\right) \qquad i = 1,...,n \qquad (11)$$

where $spr_{i,t}$ is the number of animals produced from breeding herd $cct_{i,t}$ in year t and $ypa_{i,t}$ is the exogenous yield per breeding animal concerned.

Within each animal culture i there may be m categories of slaughter j. The number of animals in animal culture i that are slaughtered in slaughter category j can be written as:

$$ktt_{i,t}^{j} = f\left(cct_{i,t}^{j}, p_{i,t}, z_{i,t}^{j}, V\right) \qquad i = 1,...,n \qquad j = 1,...,m \qquad (12)$$

where $ktt_{i,t}^{j}$ is the number of animals slaughtered in category j of animal culture i in year t, $z_{i,t}^{j}$ is an endogenous variable that represents the share of different categories of animals slaughtered in the total number of animals slaughtered for the animal culture concerned, and V is a vector of exogenous variables.

Ending stocks of animals (breeding and non-breeding) are derived using identities involving beginning inventories of animals, animal production (births), slaughter, and live exports and imports.

2.2 GHG emissions model

The projections of commodity outputs and input usage from the FAPRI-Ireland model can be converted into projections of emissions of GHGs using the default conversion coefficients outlined by Houghton et al. (1996) in their contribution to the Intergovernmental Panel on Climate Change (IPCC), modified, where possible, with specific coefficients for Ireland.

The methodology for the establishment of the GHG inventories was proposed by Houghton et al. (1996). It was subsequently adopted and adjusted to allow for conditions specific to Ireland by the Department of the Environment (1997). The approach essentially involves applying conversion coefficients to agricultural data and calculating the associated emissions of GHGs from enteric fermentation, manure management practices and agricultural soil management as defined by Houghton et al. (1996).

Data on livestock numbers, enterprise areas and input applications is obtained from the FAPRI-Ireland model. Livestock emission factors are expressed in terms of the annual amount of methane produced by the animal. These emission factors vary by animal type, not only because of their differing size and feed consumption, but also because of the manner in which food is digested and the animal manure is subsequently treated.

Concerning manure management, the nature of production systems tends to favour the management of cattle and pig manure in liquid systems, which facilitate anaerobic respiration and the emission of methane. By contrast, sheep are rarely housed and consequently methane emissions from their manure are negligible.

The emission of GHGs from agricultural soils varies in accordance with the manner in which the land is managed, which in turn depends on the type of crop production system in place. For the purposes of emissions calculations, the IPCC categorises farmland under three uses. Crop land and more intensively farmed grassland have quantities of fertiliser applied to them, whereas less intensively farmed grassland may have no fertiliser applied to it. Consequently, the levels of methane and nitrous oxide emissions from cropland and more intensively farmed grassland are considerably higher than grassland maintained without fertiliser.

GHGs in the form of methane and nitrous oxide emissions from each sub-sector i are thus a function of the number of animals, crop areas harvested and nitrogen application. Since the global warming potential of CH_4 and N_2O differ, these are brought to a common base of CO_2 equivalents using standard weighting systems:

$$CH_{4,i,t} = f\left(q_{i,t}, \alpha_i\right)$$

(12)

where $CH_{4,i,t}$ is the total amount of CH_4 produced by sector i, in year t, q is the quantity of animal or crop category i in year t, and α is the methane conversion coefficient associated with the animal or crop category i.

Similarly,

$$N_2O_{j,t} = f\left(q_{j,t}, \beta_j\right)$$
(13)

where $N_2O_{j,t}$ is the total amount of N_2O produced by sector j in year t, q is the quantity of animal or crop category j in year t and β is the nitrous oxide conversion coefficient associated with the animal or crop category j.

Finally, total GHG emissions in the common base of CO_2 equivalents can be expressed as:

$$GHG_t = \delta \sum_{i=1}^{n} CH_{4,i,t} + \gamma \sum_{j=1}^{m} N_2O_{j,t}$$
(14)

where $\delta = 21$ and $\gamma = 310$ are the global warming potentials of methane and nitrous oxide respectively.

The next section provides a brief review of the results for the agricultural variables used in the generation of GHG emissions. The consequent baseline and alternative scenario projections of GHG emissions from Irish agriculture are then presented.

2.3 Ammonia emissions model

The projections of commodity outputs and input usage from the FAPRI-Ireland model can be converted into projections of emissions of ammonia using conversion coefficients. Estimates are based on the quantities of synthetic fertiliser applied (urea, CAN and other) per hectare. From 2000 onwards projections are calculated to allow for lower nitrogen (N) application rates on the land areas that participate in the Rural Environment Protection Scheme (REPS).

3. Baseline and WTO-reform scenario descriptions

The method of reporting the effect of trade policy on GHG and ammonia emissions relies upon a comparison of two states of the world, one including and the other excluding the trade policy change under examination.

Baseline scenario: This scenario calculates the level of activity that would arise in the future under a base case set of agricultural policies. Projections of activity levels under the base case of agricultural policy are referred to as the baseline policy outcome.

The baseline projections of agricultural activity used in this section are based on the baseline (CAP Mid-Term Review and the GATT[4] Uruguay Round Agreement on Agriculture or URAA) as outlined in Binfield et al. (2006). Projections of GHG emissions based on these agricultural projections are presented below.

Alternative scenario: This scenario calculates the level of activity that would arise in the future under alternative agricultural policies. Projections of activity levels under alternative policies are referred to as the alternate policy outcomes.

---

[4] GATT refers to the General Agreement on Tariffs and Trade – the precursor to the World Trade Organisation.

At the time of writing (December 2005), the outcome of the WTO Doha Round negotiations is unknown. The WTO reform scenario formulated and analysed here is close to the current position of the EU within the Doha Round negotiations (EU Trade Commissioner Peter Mandelson's offer of the 28th of October 2005). Under the WTO scenario, as defined in Table 1, the aggregate measure of support (AMS) is cut by 70% from the bound URAA levels. Under the export competition heading the EU phases out its export subsidies over the course of 10 years. Also, in this WTO scenario, 50% of the cut in export subsidies is front-loaded on the first year (2007) with the remaining 50% phased out in equal instalments over the remaining nine years. Under the market access headings a cut in average tariffs of 60% is implemented with lower cuts in tariffs applying to sensitive products set at 25%. Beef and butter are designated as 'sensitive' products for the EU and are subject to these lower tariff reductions. No other market access provisions (e.g. tariff rate quotas or TRQs) are altered.

Under the WTO reform scenario analysed, the Green and Blue Box classification of current government support to agriculture are retained and unaffected by the changes proposed.

Table 1. WTO reform scenario

	Domestic support	**Export subsidies**	**Market access**
WTO scenario	70% reduction in the total AMS based on Uruguay Round final bound levels with retention of Green and Blue Boxes	Phasing out of export subsidies over 10 years, with a 50% down payment in year 1 and 9 years of equal instalments thereafter	60% average cut in tariff lines, with a 25% minimum cut (to apply to products designated as 'sensitive')

The effect of the change in policy can be measured by the difference between the projections for the baseline and the WTO reform scenario.

4. Results

Here the results for GHG emissions are presented under both the baseline policy and the WTO reform scenario. The results include a summary of the impact on agricultural production levels as well as details on GHG emissions.

4.1 Irish agricultural production: Baseline policy

Under baseline policies the number of livestock in Ireland is projected to decline over time. The number of dairy cows declines because with total milk production limited by a milk quota and genetic improvement leading to dairy cows becoming more productive over time, the number of cows required to fill the quota declines. Dairy cows are by far the largest source of agricultural GHG emissions, on a per head basis, so this reduction will have a sizable effect on total agricultural GHG emissions.

Under the baseline projection, the decoupling of agricultural policy recently introduced in the EU will lead to a decrease in beef cattle and sheep numbers over the period to 2015, since the policy will make it unprofitable for some producers to raise these animals. The baseline number of pigs and other animal categories is projected to remain relatively static over the projection period.

The total land area in agricultural use in Ireland will have declined slightly by about 1% under baseline policies by 2015 relative to the level in 2004. It is projected that there will be some changes in land use over the period, with the area planted with cereals and root crops declining

and largely shifting into use as pasture. Although animal numbers are expected to decline, the move towards a more extensive livestock production will mean that the proportion of land devoted to pasture, hay and silage will not change markedly. Conditions attached to the receipt of the decoupled payments limits the extent to which land will move between these use categories.

4.2   GHG emissions from Irish agriculture: Baseline policy

The baseline projections for total emissions from agriculture are presented in Figure 1. Overall, the baseline projections suggest that, with the introduction of decoupling as an agricultural policy, there will be a reduction in overall agricultural activity and consequently GHG emissions are also set to decline. The reduction comes mainly through a decrease in the projected future numbers of cattle (dairy and beef) and sheep. Total GHG emissions from Irish agriculture are projected to decline by approximately 14% by 2015 relative to 2004. Measured against a 1990 base, the decline by 2015 is projected to be over 16%.

Figure 1. Projections of GHG emissions from Irish agriculture: Baseline policy
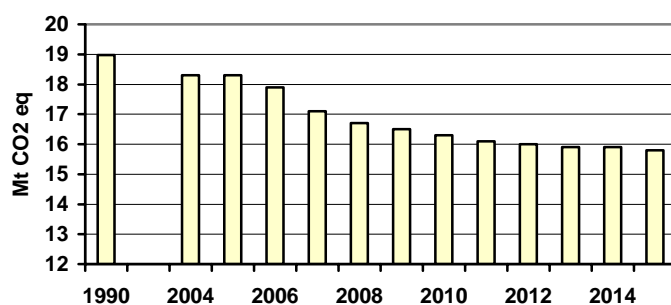
Note: Totals represent CH_4 and N_2O (in CO_2 equivalents) from enteric fermentation, manure management and agricultural soils.
Source: FAPRI-Ireland Partnership Model (2006).

While emissions must be reduced by 8% for the EU-15 as a whole, under the EU Burden-Sharing Agreement Ireland is committed to minimising its rate of increase in GHG emissions to 13% above the 1990 level agreed under the terms of the Kyoto Protocol. Strong economic growth has given rise to a significant increase in emissions in the non-agricultural sectors of the Irish economy since 1990, so the projected decrease in agricultural emissions is an important contribution towards the attainment of Ireland's target. Projected emissions under the baseline scenario are summarised in Table 2.

Table 2. GHG emissions by Irish agriculture from 1990 to 2015: Baseline policy

Source category	†	1990	Baseline 2015	% Change
Methane (CH_4)	Gg	551.6	469.8	-14.83
Nitrous oxide (N_2O)	Gg	23.9	21.3	-10.88
Total (CO_2 equivalent)	Mt	18.97	15.8	-16.71

† Gg = thousand tonnes; Mt = million tonnes

Note: The CO_2 equivalent measure represents the change in the global warming potential of methane and nitrous oxide.
Source: FAPRI-Ireland Partnership Model (2006).

The next section outlines the results of the WTO-reform scenario analysis conducted with the FAPRI-Ireland model. The consequent effects on GHG emissions under these alternate policy scenarios are presented.

4.3 Projections of agricultural activity: WTO reform scenario

It is projected that under the WTO reform scenario, milk quotas will continue to be filled in Ireland. Cow numbers will decline at a slightly lower rate than indicated in the baseline. This is because the WTO reform scenario will lead to a reduction in milk prices that is greater than in the baseline. This slightly impedes the growth in milk yields and, as a corollary, it also slows the fall in cow numbers. Cross-sectoral effects of the reforms in the beef sector are likely to only marginally affect the rate of decrease in dairy cow numbers.

Under the WTO scenario, there is a further contraction in Irish beef cow numbers as lower exports (due to the elimination of export refunds) and increased imports (due to reduced import tariffs) lead to lower beef prices across EU member states including Ireland. In the case of sheep, Irish prices and production also decline as imports from outside the EU increase (due to lower import tariffs). The number of pigs and other animal categories is projected to remain relatively static over the projection period under the WTO reform scenario.

Relative to the baseline, the WTO reform scenario leads to only minor changes in the allocation of Irish farmland to pasture, hay and silage, cereals and root crops. As indicated under the baseline projections, the conditions attached to the receipt of the decoupled payments will limit the extent to which land will move between use categories.

4.4 Projections for GHG emissions: WTO reform scenario

Since cattle and sheep numbers fall appreciably relative to the baseline levels under the WTO reform scenario, methane emissions from both enteric fermentation and manure management are expected to decrease by a greater extent than under the baseline.

Emissions levels under the WTO reform scenario for methane, nitrous oxide and GHG equivalent emissions of CO_2 are illustrated in Table 3. Under the WTO reform scenario, by 2015 the total GHG emissions from agriculture are expected to decrease by 3.5 Mt of CO_2 equivalent (a decrease of almost 20%) relative to the position in 1990.

Table 3. GHG emissions by Irish agriculture from 1990 to 2015: Luxembourg Agreement/EU WTO scenario

Source category	†	1990 Actual	2015 WTO reform scenario	% Change
Methane (CH_4)	Gg	551.6	456.9	-17.17
Nitrous oxide (N_2O)	Gg	23.9	20.9	-12.55
Total (CO_2 equivalent)*	Mt	18.97	15.3	-19.35

† Gg = thousand tonnes; Mt = million tonnes

Note: The CO_2 equivalent measure represents the change in the global warming potential of Methane and Nitrous Oxide.
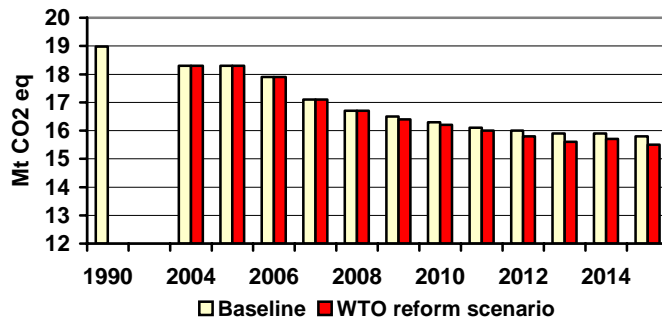
Source: FAPRI-Ireland Partnership Model (2006).

By contrast, the baseline analysis, presented earlier, projected a reduction of 3.2 Mt of CO_2 equivalent relative to the 1990 level (a decrease of over 16%). Under the WTO reform scenario the 2015 outcome represents a reduction in emissions relative to 1990 levels that is almost 3%

below the reduction projected to occur in the baseline. This result suggests that the WTO reform examined would deliver additional environmental benefits to those already projected to occur under the agricultural reforms taking place in the EU.

Figure 2 presents the GHG emissions projection from Irish agriculture under the baseline and the WTO reform scenario in CO_2 equivalent terms.

Figure 2. Projections of GHG emissions from Irish agriculture: Baseline & WTO scenarios

Note: Totals represent CH_4 and N_2O (in CO_2 equivalent) from enteric fermentation, manure management and agricultural soils.

Source: FAPRI-Ireland Partnership Model (2006).

4.5   Projections of ammonia emissions: Baseline and WTO reform scenarios

Apart from any environmental restrictions that might come into place, the type of agricultural policy pursued in the future will affect the level of agricultural activity and in turn the total level of ammonia emissions. The level of ammonia emissions can be projected under both the baseline and WTO scenario. The approach builds on earlier work (Behan & Hyde, 2003).

It is found that under both the baseline and the WTO scenarios emissions of ammonia are likely to decline relative to current levels. By 2015 it is projected that ammonia emissions from agriculture will have declined by 13% relative to the 2004 level. Despite the decrease this would still mean that the level of ammonia emissions from agriculture would be very close to the 1990 base year for the Gothenburg Protocol. Ireland's commitment under this Protocol is for a 9% reduction on the 1990 level of emissions of ammonia in aggregate economy-wide terms. Projections of ammonia emissions are shown in Figure 3.

The reduction in emissions in the baseline is due to the decoupling of payments leading to fewer beef and sheep numbers. With milk production fixed by a quota, the continuing increase in milk yields per cow means that dairy cow numbers are also reduced in the baseline.

Under the WTO reform scenario it is projected that there will be further reductions in beef and sheep numbers relative to the levels projected in the baseline but the decline in dairy cow numbers is in line with that of the baseline. Relative to 2004 the reduction achieved by 2015 represents a decline of 14%. The extent of the decline is only slightly (1%) greater under the WTO scenario relative to the baseline.

The analysis here suggests that the effects on non-dairy sectors of EU and Irish agriculture of the WTO elements of the scenario analysed would be somewhat modest. The changes that arise under the scenario relative to the baseline in these sectors arise largely as a result of policy

changes within the Luxembourg Agreement. Nevertheless, more extensive trade reforms might have a more widespread impact on agriculture in the EU and Ireland. Results will also be sensitive to the future exchange rate between the euro and the US dollar.

Figure 3. Projected ammonia emissions from agriculture: Baseline & WTO scenarios
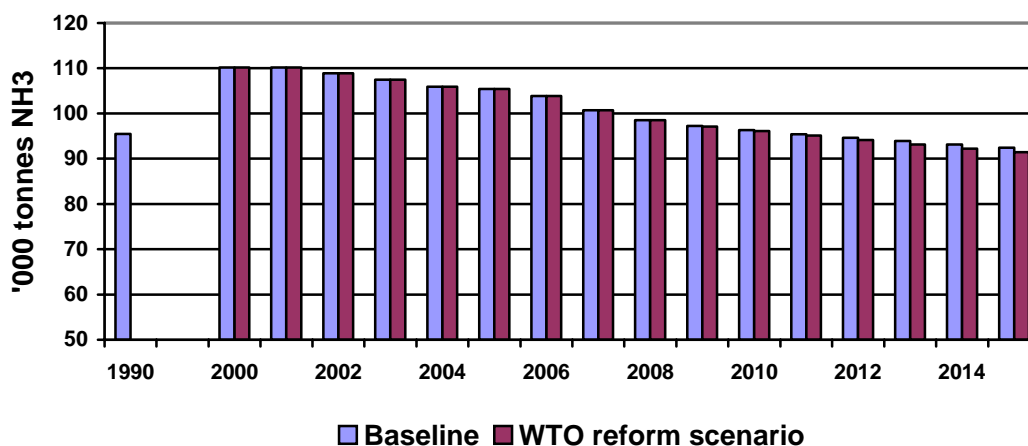
Source: FAPRI-Ireland Partnership Model (2006).

4.6   Comments of the overall results

The overall results in the case of both GHG and ammonia emissions suggest that the reductions in emissions projected to be achieved over time will largely be owing to CAP reforms rather than to international trade policy (WTO) reforms. Although this is the most obvious conclusion to make, it may also be slightly misleading. The motivations for reform of the CAP relate, to some degree, to pressures external to the EU – principally the need to make the CAP more compatible with a future WTO agreement. It is unlikely that the 2003 CAP reform would have taken the shape it has, had it not been for these WTO-related pressures. Therefore one could argue that the reductions in emissions projected under the baseline are also motivated by trade policy reform and not merely by domestic policy reform.

5.   Conclusions

This paper provides projections of some of the environmental/multifunctionality impacts in Ireland of the recent reforms to EU agricultural policy (baseline). The paper also provides projections of the potential environmental/multifunctionality effects of a WTO agreement in Ireland.

Under baseline policies (the Luxembourg CAP Reform Agreement), it is found that over the next 10 years, GHG emissions from Irish agriculture are projected to decline relative to existing levels. Potential WTO trade reforms that might become part of a future WTO agreement would lead to only modest additional reductions in GHG emissions by 2015.

In Ireland, increasing milk yields in the presence of a milk quota and the introduction of decoupled payments will reduce the number of dairy cows, other cattle and sheep. These livestock are the three leading contributors to GHG emissions from Irish agriculture. As a result

of EU CAP reform (the decoupling of direct payments) and ongoing productivity improvements in agriculture, substantial reductions in methane and nitrous oxide emissions are possible, even in the absence of trade reform.

The dairy sector will remain the main source of agricultural GHG emissions in Ireland. This sector is projected to continue to produce at the maximum level allowed under the milk quota system. It is likely that it would require a greater degree of WTO reform than examined in this WTO scenario to further reduce emissions from the dairy sector.

Estimates for 2004 indicated that agriculture contributed over one-quarter of all Irish GHG emissions. Consequently, the reduction in emissions from Irish agriculture arising out of both the CAP reform and any future WTO trade reform should represent a significant contribution from the agricultural sector in meeting the Irish national Kyoto target of a maximum 13% increase in GHG emissions over the 1990 emissions levels.

Emissions of ammonia from Irish agriculture are projected to decline under both the baseline and the WTO reform scenario. Yet much of the decline projected under the WTO scenario is estimated to occur in any event under the baseline scenario. The impact of the WTO scenario on ammonia emissions only represents an additional 1% reduction in ammonia emissions from agriculture by 2015, relative to the 2015 baseline position.

It should be noted that projections in this paper are produced at a national level. In the case of ammonia emissions there may be regional or local considerations that fall outside the scope of this model. For example, while it is anticipated that trade reform will lead to an overall lowering of agricultural output in Ireland, it could lead to local-level intensification or extensification of production, which the national model is unable to capture.

The projections in this paper have been produced under the IPCC Tier I basis, since this is the current level of detail allowed by the FAPRI-Ireland commodity model as presently structured. Future work will aim at redesigning aspects of the FAPRI-Ireland commodity model to allow a greater disaggregation of agricultural activity and enable emissions projections to be made on an IPCC Tier II basis.

References and Further Reading

Behan, J. and B. Hyde (2003), *Baseline Projections of Ammonia Emissions from Irish Agriculture*, Rural Economy Research Centre, Teagasc, Ireland.

Binfield, J., T. Donnellan, K. Hanrahan and P. Westhoff (2006), "The World Trade Reform: Possible Impact of the Doha Round on EU and Irish Agriculture", mimeo, Teagasc, Ireland.

Department of the Environment, Heritage and Local Government (1997), *Ireland Second National Communication under the United Nations Framework Convention on Climate Change*, Dublin.

————— (1998), *Limitation and Reduction of CO_2 and Other Greenhouse Gas Emissions in Ireland*, Dublin.

————— (2000), *National Climate Change Strategy Ireland*, Stationery Office, Dublin.

European Commission (2002), Communication from the Commission to the Council and the European Parliament: Mid-Term Review of the Common Agricultural Policy, COM(2002) 394 final, Brussels, 20.7.2002.

European Council (2001), Directive 2001/81/EC of 23 October on national emission ceilings for certain atmospheric pollutants OJ L 309/22, 27.11.2001.

Environmental Protection Agency (EPA) (2005), *Ireland's Environment 2004 – The State of the Environment*, EPA, County Wexford, Ireland (http://www.epa.ie/NewsCentre/ ReportsPublications/IrelandsEnvironment2004).

Houghton, J.J., L.G. Meiro Filho, B.A. Callander, N. Harris, A. Kattenberg and K. Maskell (eds) (1996), *Climate Change 1995: The Science of Climate Change, Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge and New York: Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC) (1997), *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual*, IPCC, Geneva (http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm).

————— (2001), *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, IPCC, Geneva (http://www.ipcc-nggip.iges.or.jp/public/gp/ gpgaum.htm).

OECD (2001), *Multifunctionality: Towards an Analytical Framework,* OECD, Paris, ISBN 9264186255.

United Nations (1992), United Nations Framework Convention for Climate Change, United Nations, New York (http://unfccc.int/resource/ccsites/senegal/conven.htm).

United Nations Economic Commission for Europe (UNECE) (1999), Gothenburg Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution (CLRTAP) on the Abatement of Acidification, Eutrophication and Ground-level Ozone, UN, New York.

US Department of State, Bureau of Oceans and International Environmental and Scientific Affairs (1998), *The Kyoto Protocol on Climate Change,* Washington, D.C. (http://www.state.gov/www/global/oes/fs_kyoto_climate_980115.html).

US Environmental Protection Agency (EPA), Global warming website, EPA, Washington, D.C. (http://www.epa.gov/global warming).

Titles in the ENARPRI Working Paper Series

(€12 in print or available for free downloading from www.enarpri.org or http://shop.ceps.be)

No. 14 *Modelling the Effects of Trade Policy Scenarios on Multifunctionality in Greek Agriculture: A Social Accounting Matrix Approach*, D. Psaltopoulos and E. Balamou, September 2005

No. 13 *Evaluating the Impact of Alternative Agricultural Policy Scenarios on Multifunctionality: A Case Study of Finland*, Heikki Lehtonen, Jussi Lankoski and Jyrki Niemi, July 2005

No. 12 *WTO Agricultural Negotiations: A Comparison of the Harbinson Proposal and the Swiss Formula,* Martina Brockmeier, Marianne Kurzweil, Janine Pelikan and Petra Salamon, February 2005

No. 11 *Multilateral Market Access Reforms of the Doha Round and Implications for EU Agriculture: A Preliminary Assessment*, Wusheng Yu and Hans G. Jensen, January 2005

No. 10 *Scenarios for Modelling Trade Impacts upon Multifunctionality in European Agriculture*, Janet Dwyer, David Baldock, Hervé Guyomard, Jerzy Wilkin and Dorota Klepacka, February 2005

No. 9 *Different Road to Liberalisation: Scenarios for a Moroccan Case Study of Euro-Mediterranean Agreements*, Marijke Kuiper, Crescenzo dell'Aquila and Alessandro Antimiani, October 2004

No. 8 *Scenarios for Examining General Trade Agreements*, Chantal Pohl Nielsen with Hans Grinsted Jensen and Martina Brockmeier, July 2004

No. 7 *Review of Methodological Challenges: Multifunctionality and Trade*, Hervé Guyomard, forthcoming

No. 6 *Fifty Ways to Leave Your Protection: Comparing Applied Models of the Euro-Med Association Agreements*, Marijke Kuiper, May 2004

No. 5 *EU Preferential Agreements and Agricultural Trade: A Review of Methodology*, Crescenzo dell' Aquila and Petra Salamo, forthcoming

No. 4 *Multifunctionality Interaction and Issues,* Hervé Guyomard and Katell Le Bris, December 2003

No. 3 *An Overview of Different Trade Agreements,* Petra Salamon, November 2003

No. 2 *Which Road to Liberalisation? A First Assessment of the EuroMed Association Agreements*, Crescenzo dell'Aquila and Marijke Kuiper, October 2003

No. 1 *The Impact of Preferential, Regional, and Multilateral Trade Agreements: A Case Study of the EU Sugar Regime,* Ellen Huan-Niemi and Jyrki Niemi, September 2003