Hobson's Choice:

Finding the right mix of agricultural and environmental policy for Irish agriculture

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Abstract

As part of its international obligations, Ireland faces emission reduction targets with respect to greenhouse gases (GHG). These reduction targets are to be achieved both in the short term and over the coming decades. Agriculture is a substantial source (33%) of Ireland's GHG emissions.

Whereas the economic welfare of farmers has been the dominant force in shaping agriculture policy for several decades, there has been a notable increase in environmental concerns and a gradual emergence of environmental policies which are relevant to agriculture, particularly in the last 10 years.

The future evolution of the agri-food sector in Ireland must therefore be seen in the context of both the economic growth objectives of national agricultural policy, as well as national environmental policy objectives arising from international obligations. In light of the recent proposals with respect to the EU Common Agricultural Policy (CAP) post-2020 (EC, 2018), environmental objectives will become an increasingly important subset of the CAP objectives and the implementation of the CAP in Ireland.

The EU Effort Sharing Decision (ESD) requires that Ireland reduce its non-ETS GHG emission by 20% by 2020 relative to the 2005 level. The reduction target for the non-ETS sector for 2030 is 30%, but incorporates so called flexibility mechanisms designed to make the achievement of this target less onerous.

A partial equilibrium model of Irish agriculture is used to explore differing future outcomes in terms of the sector's size and associated GHG emissions to 2030. The scenario analysis employed demonstrates the implications of different future pathways for bovine (dairy and beef) agriculture, the dominant sector in Irish agriculture and the principal source of its GHG emissions. Mitigation actions are then factored in to provide measures of future levels of emissions inclusive of this mitigation capacity.

While technical mitigation actions are largely grounded in interventions that are based on science, the scenario analysis makes clear that the scale of the ultimate challenge in mitigating agricultural GHG emissions will be determined by the overall size of the agriculture sector and the intensity of production per hectare.

The dairy and beef sectors in Ireland are noteworthy for their contrasting levels of profitability; dependence on support payments; and farm income. Now that the EU milk quota has been eliminated, from the perspective of economic development, an increase in the size of the dairy sector and entry into the dairy sector are desirable economic policy objectives.

However, the paper demonstrates the strong contrast between dairy and beef farms, not just in terms of income but also in terms of intensity of production per hectare and the associated level of emissions produced. It follows that a transition from beef production to dairy production, while desirable from the point of view of farm income, could have adverse consequences for emissions.

Introduction

Irish agriculture is predominantly ruminant livestock based. Two thirds of agricultural output comes from beef and dairy production (Eurostat, 2019). These two emissions intensive agricultural sectors, along with sheep production, represent the core of Irish grassland agriculture which absorbs over 90 percent of Ireland agricultural area.

A number of Irish Government (and industry) strategy documents have advocated increased agricultural activity in Ireland over the short to medium term (DAFF 2010, DAFM, 2015). Aware that an increase in economic activity could also have implications for environmental concerns, policy makers have also emphasized that sectoral growth must be sustainable. The capacity to reduce the emissions intensity of agri-food production is seen as a pathway that can allow further economic growth in the agri-food sector.

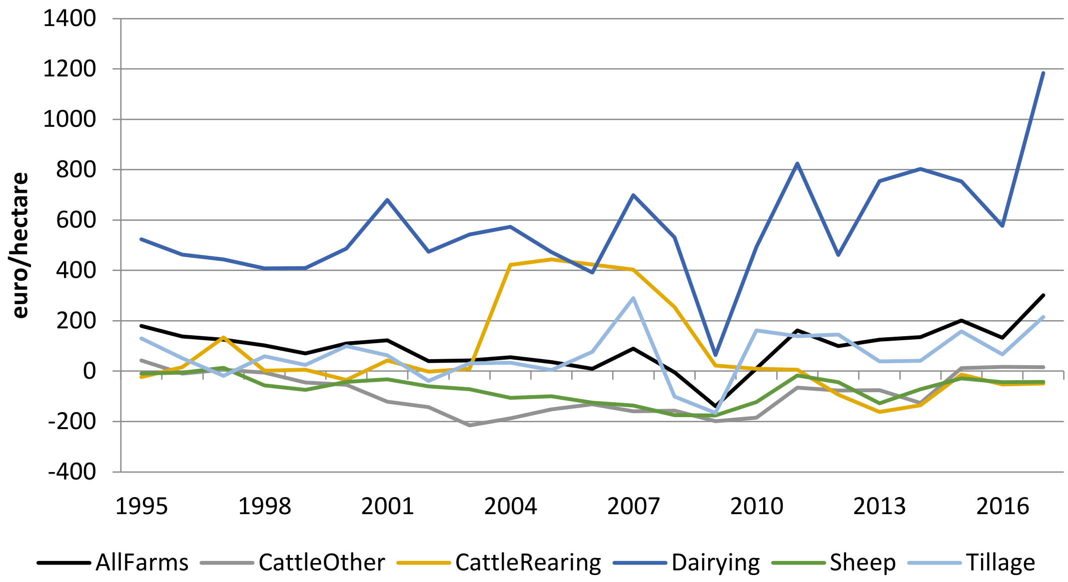
Since its inception, the maintenance of incomes for farmers has been a core objective of the Common Agricultural Policy (CAP). Yet there has been a growing trend towards embedding environmental considerations within the CAP. It follows that any development in the agriculture sector in Ireland needs to address both farm income and environmental objectives.

In light of the recent proposals with respect to the CAP post-2020 (EC, 2018), environmental objectives will become an increasingly important subset of the CAP in Ireland (Donnellan, Hanrahan and Lanigan, 2018).

The contrasting economic performance of the various agricultural sectors in Ireland is shown in Figure 1. When direct payments are deducted from Family Farm Income (FFI), the profitability of all sub-sectors of Irish agriculture, except in the case of dairy farms, is quite low. This means that a considerable portion of Irish agriculture is CAP support dependent as an income source.

While beef and dairy production are by some distance the two largest land uses in Irish agriculture, from an economic perspective these two bovine grassland activities have little in common. On average, Irish dairy farms are typically larger in physical size than beef farms, while the average Irish dairy farms operates at a much higher stocking rate than the average beef farm. Irish dairy farms make use of considerably more purchased inputs (such as feed, fertilizer and energy) than the average Irish beef farms. Overall, dairy farms in Ireland generate a much higher margin per hectare than beef farms and because of their larger size, dairy farms typically receive a higher level of support payments from the CAP. The end result is a very large gap in the average income level of an Irish dairy farm relative to a beef farm. However, even controlling for farm size, the average dairy farm receives considerably more income that any other of the principal land using activities in agriculture.

Figure 1: Average Family Farm Income per hectare (exclusive of direct payments) on different Irish farm types



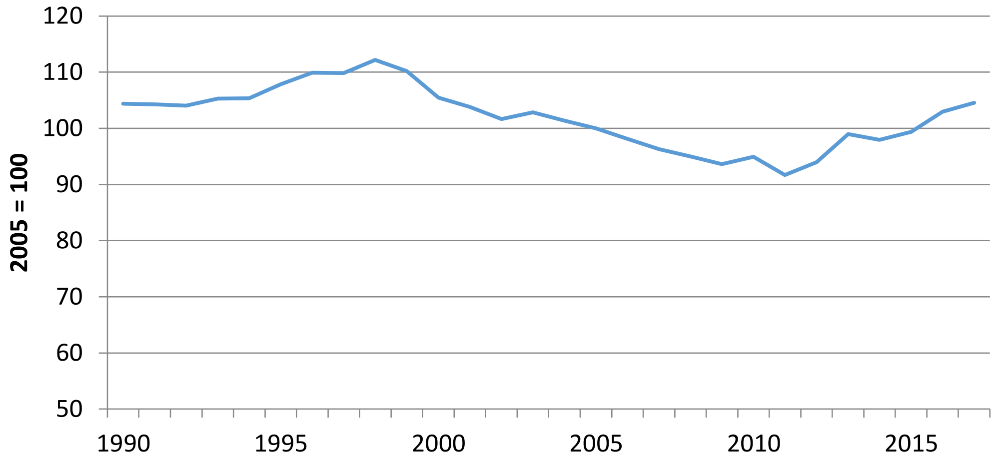
Source: Teagasc NFS data.

The operation of the EU milk quota system from 1984 to 2015, in many ways shaped the evolution of bovine agriculture in Ireland. There was a gradual exit from dairy farming, with the number of dairy farms falling from 45,000 or so in 1984 to less than 18,000 by 2015. Over this period the average dairy herd size increased to absorb the milk quota released through the fall in dairy farm numbers. At the same time, with the increase in milk yield per cow, the area required to satisfy Ireland's milk quota declined and the area available for beef production increased. As the number of dairy cows declined, there was broadly an offsetting increase in the number of beef cows. The overall cattle population peaked in the late 1990s and moved inro a very slow decline thereafter.

Simultaneously, increased efficiencies in the use of nitrogen based fertilizers, led to a sharp fall in their use particularly in the 1900s and 2000s. Collectively, the decline in animal numbers and more efficient use of fertilizer meant that GHG emissions from Irish agriculture declined throughout the first decade of the 2000s.

However, when it became clear that the milk quota would come to end, activity in the dairy sector in Ireland began to increase and GHG emissions from Irish agriculture began to rise as the number of dairy cows and their progeny and the usage of nitrogen fertilizers again began to move on an upward trend. Having been at one stage almost 10 percent below the 2005 level, GHG emissions have risen above the 2005 level in recent years.

Figure 1: Index of GHG emissions from Irish Agriculture (2005=100)



Source: FAPRI Ireland Model

Given the recent increase in Irish agricultural activity and the associated emissions, pressures to improve the sustainability of the agricultural sector will intensify.

The Policy Dilemma

In order to allow the agriculture sector to grow, decoupling the path of agricultural GHG emissions from the upward path in agricultural activity is crucial. The search for actions that would mitigate emissions has intensified, as has the work necessary to identify the potential scale of any mitigation and its associated cost. However, many of these measures are in their infancy and the extent of the uptake at the farm level over the next decade is uncertain (Schulte and Donnellan, 2012). Environmental objectives and international commitments such as those embodied in the ESD could be satisfied through restructuring agricultural activity, but doing so might compromise the growth objectives set out in national agri-food industry development strategy documents. This is the agri-food development and environmental policy dilemma facing Irish policy makers and the wider Irish agri-food industry identified by Donnellan, Hanrahan and Breen (2014).

While the decoupling of CAP direct payments broke the link between production and direct income support in 2005, it replaced it with a link between land ownership and that support. That link between land and support payments was renewed in the implementation of the 2013 CAP reform in Ireland. In Ireland Pillar I support levels remain at about €250 per hectare on average, with additional payments made to Irish farmers under Pillar II. For farms that have low levels of profitability from their production activities these Pillar I and II supports represent an important income stream, and where farms produce no profit at all from production acitivites these payments represent the only income stream.

However, the income safety net that these support payments provide also represents an impediment to a market based movement of agricultural land towards more profitable activities. While it was in place, the milk quota system acted as a constraint on the reallocation of land to more profitable agricultural activities. However, milk quota elimination and CAP reform have the potential to change the Irish agricultural landscape. There is now a realisable opportunity to pursue economic growth in dairy production, but there is also an emerging emphasis on agriculture to deliver improved environmental outcomes. To some extent these two goals may be in conflict.

It is therefore necessary to explore the impact of future economic developments in Irish agriculture, but also to explore the implication that these developments could have for the level of GHG emission produced, taking account of the likely capacity of existing GHG mitigation technologies.

This paper therefore examines how agricultural GHG emissions in Ireland could evolve and where that might leave the sector with respect to potential emissions reduction targets arising out of Ireland's GHG emissions reduction commitments. Of particular concern is the continuing growth potential of the dairy sector in Ireland, which has already expanded considerably over the last 5 years.

Methodology and Scenarios

The paper uses the FAPRI-Ireland partial equilibrium model of the Irish agricultural economy to examine this research question. This model is a partial equilibrium, dynamic, multi-commodity model capable of producing supply and use-balance estimates including output, trade, domestic use stock and prices and which can also provide projections of the Economic Accounts for Ireland, including agricultural income. An extended version of the model incorporates projections of GHG emissions. This model has been in use in Ireland in the provision of evidence based policy analysis for over 20 years (see Donnellan and Hanrahan (2006) for an early use of the FAPRI-Ireland model in an environmental policy context).

Projecting the future of Irish agriculture is blighted by some very significant "known unknowns" with respect to agricultural policy and broader trade policy. Uncertainties include Brexit (Donnellan and Hanrahan, 2016; Davis et al. 2017, Matthews, 2017) and what it will deliver in terms of the UK's future trading relationship with the EU, as well as yet to be determined trade agreements between the EU and other countries. The shape of next CAP reform and its implementation in Ireland (and other Member States) represents a further source of uncertainty.

To take account of these uncertainties regarding the likely future level of agricultural activity in Ireland, the analysis includes projections under a

Baseline scenario (S1) and five other alternate scenarios (S2 – S6). Given that bovine agriculture is the principal source of Irish agricultural GHG emissions, the alternative scenarios considered are grounded in differing assumptions about how the Irish cattle population (and its sub-components) might evolve in the period from now to 2030 and how associated volumes of synthetic fertilizer used would also evolve. These scenarios are summarized in appendix Table A1.

The various scenarios are based on differing combinations of assumptions about the positive growth rates in the Irish dairy cow herd and differing rates of contraction in the size of the Irish beef cow herd. We exclude from consideration scenarios in which the Irish dairy herd remains static (or contracts) and scenarios in which the Irish beef cow herd expands, as these are not considered to be probable given our understanding of the current and likely future profitability of these two agricultural activities.

These projections of GHG emissions do not consider the effect of potential mitigation actions. Specifically in an Irish context, Lanigan et al. (2018) have undertaken an extensive examination of these mitigation options in term of their applicability, likely adoption rate, their magnitude in terms of mitigation capacity and associated costs per tonne of GHG emissions mitigated and these are considered later in the paper.

Scenario Projections and Results obtained

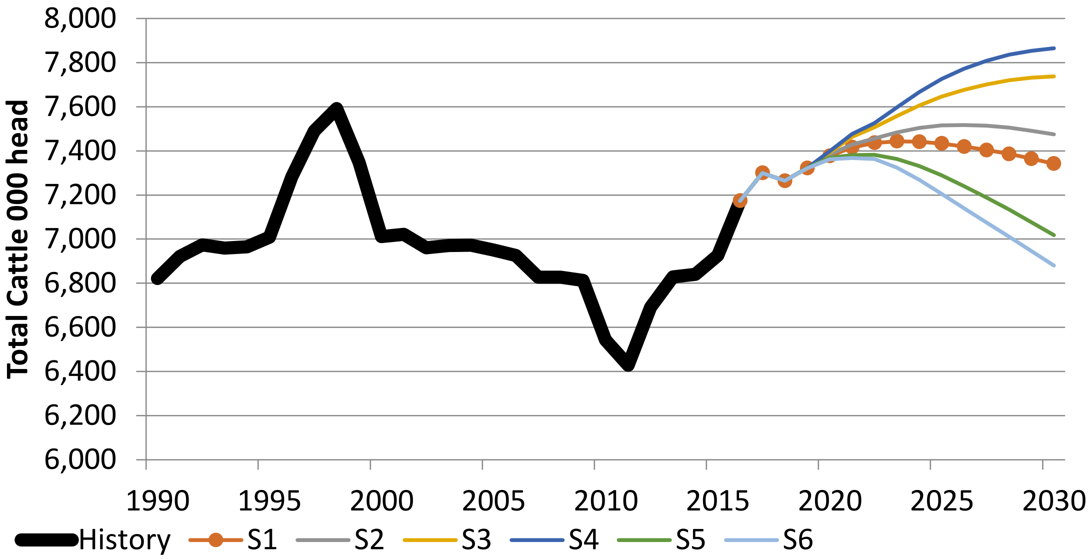
Before mitigation is considered, GHG emissions are projected to increase under all of the scenarios modelled. The largest increase in emissions is associated with the scenario with the highest level of agricultural activity (S4) and the lowest level of emissions is associated with the scenario with the lowest level of agricultural activity (S6).

Relative to a situation where mitigation actions are completely absent, the widespread adoption of mitigation actions would reduce the future path of agricultural GHG emissions, below the crucial 2005 reference level. However, reducing emissions substantially below the 2005 level would need to rely on the flexibilities provided to Ireland.

Figure 2 summarizes projected developments over the period to 2030 of Ireland’s bovine herd under the six different scenarios. Among the six scenarios examined, the highest cattle population is observed under the S4 scenario, which is the scenario with the largest increase in dairy cow population and the smallest (negative) change in the Irish beef cow population. Scenario S6 has the lowest cattle population, given that it has a lower rate of growth in the dairy cow population and a large reduction in the Irish beef cow population. Comparing the S4 scenario with the S6 scenario, the difference in the size of the total Irish cattle population in 2030 is almost 1.0 million head. The bovine population in 2030 and the change relative to

2005 for a 6 scenarios is shown in Appendix Table A2. Appendix Figures A1 to A3 show the projected pathway for the dairy cow and beef cow populations under Scenario 1, Scenario 4 and Scenario 6.

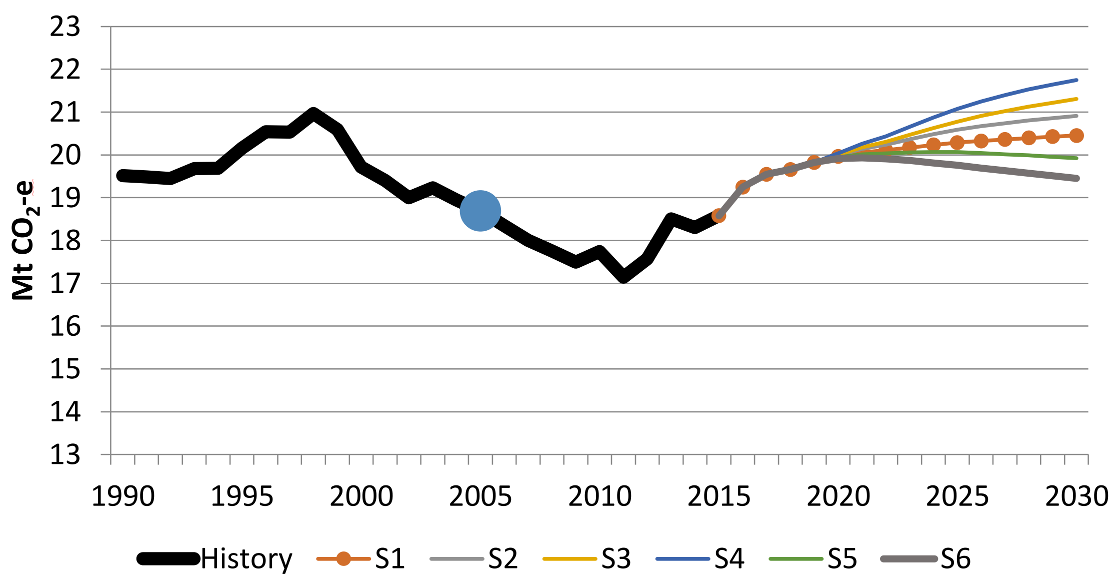
Figure 2: Total Cattle Population: Summary of Scenarios S1 to S6



Source: FAPRI-Ireland Model

Figure 3 shows the spread in projected GHG emissions across the 6 scenarios over the period to 2030, exclusive of mitigation actions.

Figure 3: Agricultural GHG emission projections under the six scenarios – (excludes mitigation actions)



Source: FAPRI-Ireland Model

The associated emissions in 2030 and the percentage change relative to 2005 are show in appendix Table A3.

Consistent with developments in the cattle population, the S4 scenario has the highest level of projected GHG emissions and the S6 scenario has the lowest level of projected GHG emissions. The gap between the level of GHG emissions under the S4 and S6 scenarios in 2030 is 2.3 Mt CO_2-e.

GHG Mitigation Actions

In total 26 GHG mitigation measures have been identified in a GHG marginal abatement cost curve (MACC) for the period to 2030 (Lanigan et al., 2018). Based on the agricultural activity projections under scenario 1 (Base scenario), the analysis identified a little over 3.07 million tonnes of CO_2 equivalent (Mt CO_2eq) of agricultural emissions mitigation by 2030, with a mean annual agricultural mitigation over the period 2021-2030 of 1.85 Mt CO_2eq.

Due to differences in the level of various agricultural activities in each scenario, there were some differences in the amount of agricultural mitigation identified in each scenario. There is a proportionate increase in the abatement potential of several measures (dairy EBI, nitrogen-use efficiency, fertiliser formulation, slurry management measures, etc.) as the level of agricultural activity increases across 5 of the 6 scenarios modelled.

Table 1: Mean greenhouse gas (GHG) mitigation potential for a) agricultural emissions, b) land-use and c) (bio)energy between 2021-2030 and maximum mitigation potential in the year 2030.

	2005	2016	2030	Mean Mitigation 2021-2030			Maximum Mitigation 2030		
Scenario				Agricultural Mitigation	Land-Use Mitigation	Energy Mitigation	Agricultural Mitigation	Land-Use Mitigation	Energy Mitigation
					Mt CO_2-e				
Historical	18.69	19.24							
S1			20.45	1.85	2.97	1.37	3.07	3.89	2.03
S4			21.75	1.97	2.97	1.37	3.25	3.89	2.03
S6			19.45	1.74	2.97	1.53	2.90	3.89	2.31

Source: Donnellan, Hanrahan and Lanigan (2018)

Note: mean mitigation is calculated assuming a linear uptake of the mitigation actions over the 10 year period

In addition to the 3.07 Mt CO2eq of agricultural mitigation identified for 2030 in Scenario 1, sequestration related to Land Use, Land Use Change and Forestry (LULUCF) of 3.89 Mt CO2eq was also identified. This form of mitigation is consistent across the six scenarios.

Across the six scenarios, further mitigation of 2.01 to 2.3 Mt CO_2eq could be achieved through farm level energy efficiencies and the displacement of fossil fuel emissions through the production of a range of bioenergy crops.

By the year 2030, agricultural mitigation would result in emissions in scenario S4 decreasing from a level 16% above 2005 in 2030 to being on a par with 2005 emissions in 2030. By contrast, emissions would be projected to be 7% and 12% below the 2005 level, under S1 and S6 scenarios respectively in 2030.

Emissions intensity

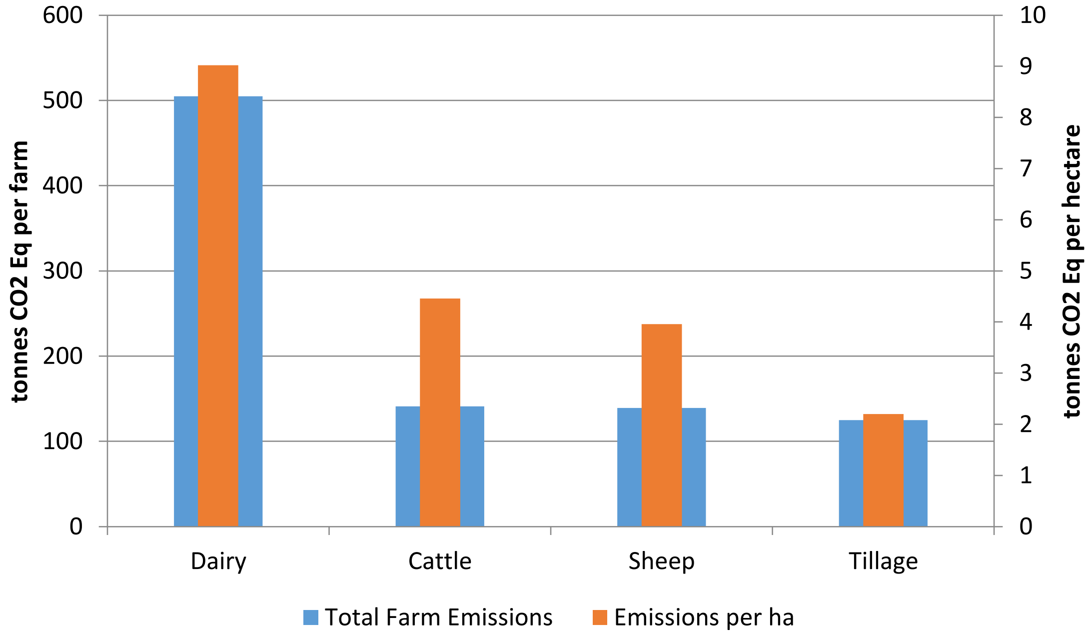
The scenarios explored in this paper involve an expansion in the size of the dairy cow herd and a reduction in the size of the beef cow herd in Ireland in the period to 2030. While there are economic incentives to increase dairy production in Ireland, in spite of the identified mitigation, the overall agricultural sector may still face pressure to further reduce its emissions in the coming years. The negligible profitability of beef production in Ireland suggests that the sector will decrease in size (Buckley et al., 2019). Such a decrease could accelerate if the level of support for the sector were to decline as an outcome of future policy reform.

As a result of the economic returns available, the dairy sector is likely to seek additional land area, while the economically disadvantaged beef sector may well lose some of its agricultural land area base. However, the transfer of land from beef production to dairy production could have significant consequences for GHG emissions.

Dairy farming in Ireland typically operates at a higher intensity than beef farming. An Irish dairy farm will typically have a far higher stocking rate per hectare than a beef farm and the dairy farm will also use more nitrogen based fertilizer per hectare than the beef farm. The variation in the intensity of production in these bovine systems has important implications for GHG emissions per hectare.

Figure 4 shows the average level of emissions per hectare for various farm types in Ireland in 2017. Emissions of GHGs from a dairy farm are on average about twice the level of those on a beef farm. Therefore, while it would be economically desirable to see land used more intensively in a system that is more profitable, the downside is that the emissions per hectare increase considerably.

Figure 4: Average total emissions per farm and average emissions per hectare by farm type



Source: Buckley et al. (2019)

Discussion

The mitigation actions identified generally represent technical solutions that could be adopted at farm level, which would reduce the emissions associated with the production of specific outputs, due to higher animal productivity, more efficient input usage, changes to the types of inputs used, changes in the type of machinery used to spread farm slurry, changes to animal diets and increased levels of farm afforestation.

Switching farm systems is also a mitigation action that could be considered. In fact it is advocated anyway as a means for farmers to both increase and diversify their farm incomes. Across the scenarios examined there are considerable differences in the relative share of dairy cows and beef cows in Ireland. Principally, it is differences in the future returns from dairy production and beef production that are projected to drive such changes.

Changes in policy supports could also be used to affect the share of bovines in the dairy and beef systems. However, as a means to address GHG emissions, using policy to drive a switch between agricultural production systems, may lead to some unintended outcomes.

Moving from low intensity bovine (beef) production to forestry, may lead to an increase in farm income as well as an immediate reduction in animal emissions and will eventually result in considerable carbon sequestration. However, moving from low intensity beef production to high intensity dairy production will actually lead to an increase in stocking rates, increased input utilization and higher GHG emissions per hectare.

Policy makers may have to think therefore about how changes in the level of beef production will have implications for the land base that is used in beef production. There will be a trade-off between retaining land in beef production, perhaps farming it a lower intensity than even is currently the case, and allowing the land to move into dairy production, which would likely see the emissions per hectare increase.

It follows that policies, whose aim it is to encourage farmers to look at alternatives to beef production, need careful design. If implemented aggressively, there is a risk that measures aimed at switching production systems may actually cause producers to instead exit production. While this might lead to land abandonment in the case of some beef farms, it could also mean that land changes ownership. This potentially allows the land to be used more intensively for other purposes (in Ireland most likely dairy), leading to an increase in GHG emissions rather than the reduction intended as an outcome of the policy.

This suggests that where the objective is to reduce aggregate emissions on bovine farms with low profitability, strategies that reduce rather than eliminate emissions may actually be more effective.

Conclusion

In this paper we have presented a range of alternative scenarios concerning the future development of agricultural activity levels in Ireland and assessed the likely level of GHG emissions that would arise taking account of GHG mitigation measures.

The Baseline scenario (S1) represents our best assessment of how Irish agricultural activity is likely to develop over the medium term, given current projections of international agricultural commodity and input prices and existing agricultural and agricultural trade policy settings. Scenario S4 and Scenario S6 present outer ranges for the path of likely emissions, reflecting differing assumptions about how the bovine sector might evolve. This set of alternative development paths for the Irish agricultural sector was developed in order to reflect the uncertainty that exists regarding how the sector could evolve in response to international agri-food market and agricultural policy signals

Widespread and immediate adoption of mitigation action is required or the agricultural sector may find itself constrained in its ability to grow over the medium to longer term.

The level of mitigation that can be achieved is decomposed into 3 parts, with assessment of the average level of mitigation over the period 2021-2030 and mitigation in the year 2030 being provided. In total by 2030 there is the potential for about 9 Mt CO2eq, but it is notable that 2 to 2.3 Mt CO2eq of this is fossil fuel GHG mitigation arising from biofuel production.

The dairy and beef components of the bovine population differ enormously in terms of their profitability in Ireland, and this is likely to have implications for how the respective dairy and beef cows herds develop in the period to 2030. From an economic perspective, growth in the dairy sector would be desirable as would a transfer of land from beef to dairy production.

However, if there were to be significant movement of land from beef to dairy production, it could lead to even further acceleration of growth in the dairy sector, which could have adverse consequences for the level of GHG emissions generated.

Simple solutions to reduce Ireland's agricultural emissions below 2005 levels are not obvious. Policy choices may need to be made about the mix of approaches that should be used.

Policy makers may need to consider the tradeoffs between the additional farm income that would be derived from transition from beef to dairy production and the increase in GHG emissions that would likely come about from such a transition.

The analysis highlights the continuing dilemma between policy driven and industry motivated ambitions to increase agricultural activity levels and commitments to reduce emissions. The resolution of this dilemma is perhaps the most important challenge currently facing the Irish agri-food sector.

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Table A1: Summary Description of the Six Scenarios

		No of Dairy Cows		
		Stable	Strong Increase	Stronger Increase
Number of Beef Cows	Strong Decrease	NA	S6	S5
	Moderate Decrease	NA	S1 (Baseline)	S2
	Stable/Modest Decrease	NA	S3	S4
	Increase	NA	NA	NA

Source: Authors' own elaboration

Table A2: Six Scenarios for the size of the projected Total Cattle Population in 2030

	2005	2016	2030	2030 vs 2005	2030 vs 2016
	Million Head			% change	% change
Historical	6.951	7.173			
S1			7.342	6%	2%
S2			7.475	8%	4%
S3			7.738	11%	8%
S4			7.865	13%	10%
S5			7.018	1%	-2%
S6			6.880	-1%	-4%

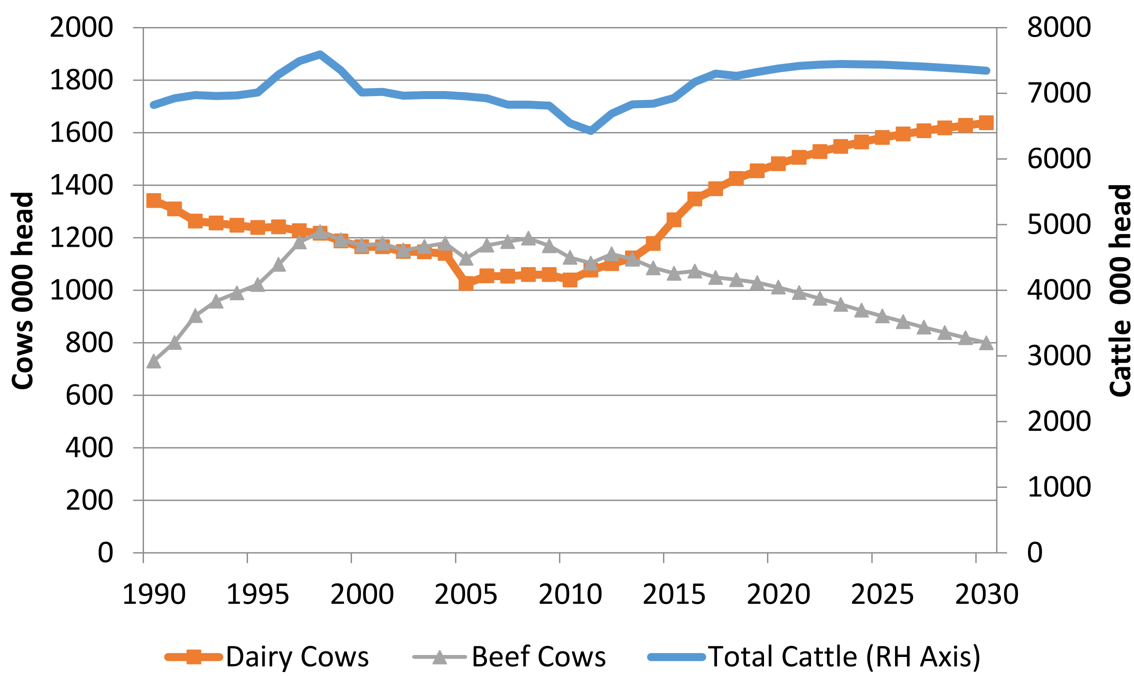
Source: FAPRI-Ireland Model

Table A3: Six Scenarios Implications for GHG emissions in 2030 (excludes mitigation)

	2005	2016	2030	2030 vs 2005	2030 vs 2016
		Mt CO_2-e		% change	% change
Historical	18.69	19.24			
S1			20.45	9%	6%
S2			20.91	12%	9%
S3			21.31	14%	11%
S4			21.75	16%	13%
S5			19.92	7%	4%
S6			19.45	4%	1%

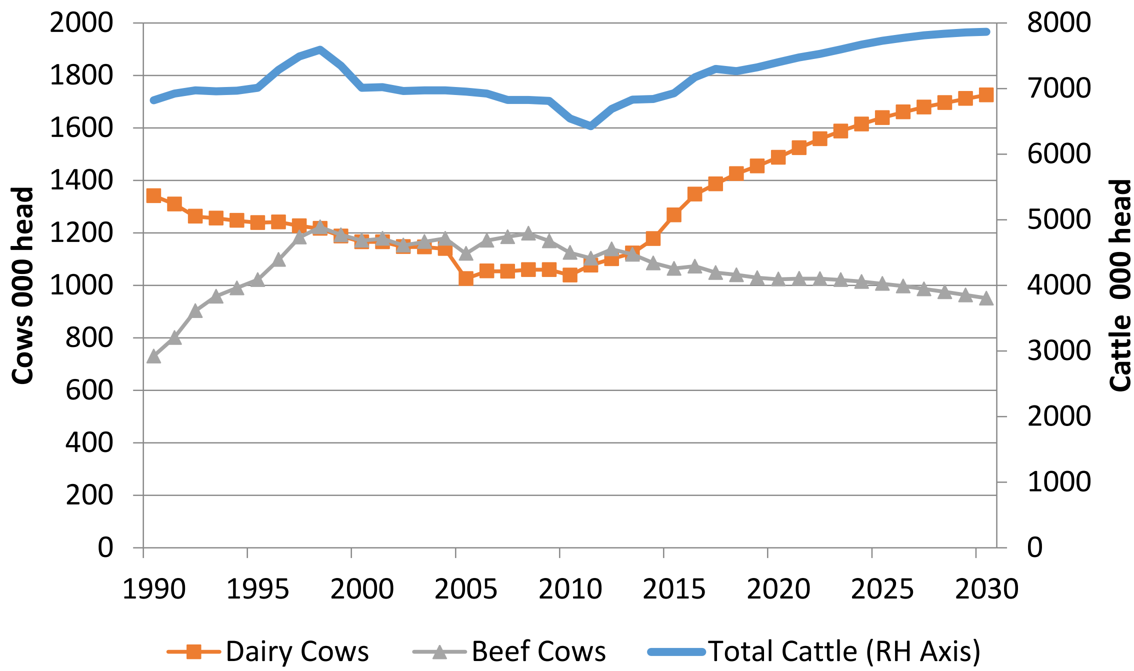
Source: FAPRI-Ireland Model

Figure A1: S1 Moderate rate of decrease in suckler cows and strong rate of increase in dairy cows (Baseline)



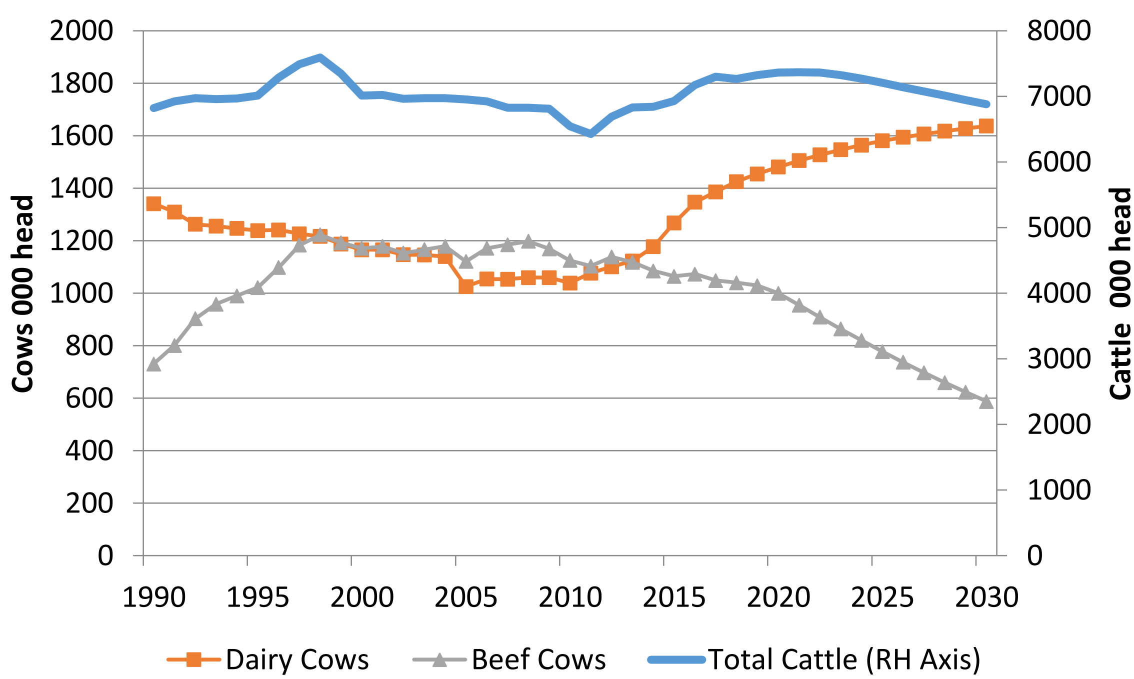
Source: FAPRI-Ireland Model

Figure A2: S4. Modest rate of decrease in suckler cows and stronger rate of increase in dairy cows



Source: FAPRI-Ireland Model

Figure A3: S6 Strong rate of decrease in suckler cows and stronger rate of increase in dairy cows



Source: FAPRI-Ireland Model