Future Scenarios for Irish Agriculture: Implications for Greenhouse Gas and Ammonia Emissions

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EXECUTIVE SUMMARY

- As part of its international obligations, Ireland faces emission reduction targets with respect to greenhouse gases (GHGs) and ammonia. These reduction targets are to be achieved both in the short term and over the coming decades.
- This report presents projections of future levels of GHG and ammonia emissions from Irish agriculture and the mitigation of those emissions that could be delivered.
- The purpose of this research is to examine where future agricultural GHG and ammonia emissions might end up relative to current national reduction targets.
- The analysis relies on projections under a Baseline scenario (S1) and five further alternate scenarios (S2 – S6) in order to take account of the uncertainty regarding the likely future level of agricultural activity in Ireland.
- Given that bovine agriculture is the principal source of Irish agricultural GHG and ammonia emissions, the alternative scenarios considered are grounded in differing assumptions about how the Irish cattle population might evolve in the period from now to 2030.
- Before mitigation is considered, 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).
- Emissions of ammonia from agriculture in all scenarios increase at a faster rate than emissions of GHGs.
- Relative to a situation where mitigation actions are completely absent, the widespread adoption of mitigation actions would reduce the future path of emissions. Bringing emissions below the level of the crucial 2005 reference period in the years to 2030, however, would appear to be very challenging for both emissions of GHGs and ammonia.
- 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.

- 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.

- Aside from the national level penalties that Ireland would incur for failure to meet GHG and ammonia emissions reduction targets, the clean green image of the sector highlighted in the Food Harvest 2020 and Food Wise 2025 agri-food sector development strategies could be vulnerable if customers internationally and at home form the impression that Ireland's agri-food sector is not contributing to national emission reduction obligations.

- Detailed information on the agricultural activity level projections underlining the projections of GHG and ammonia emissions presented are provided in the appendices to this report.

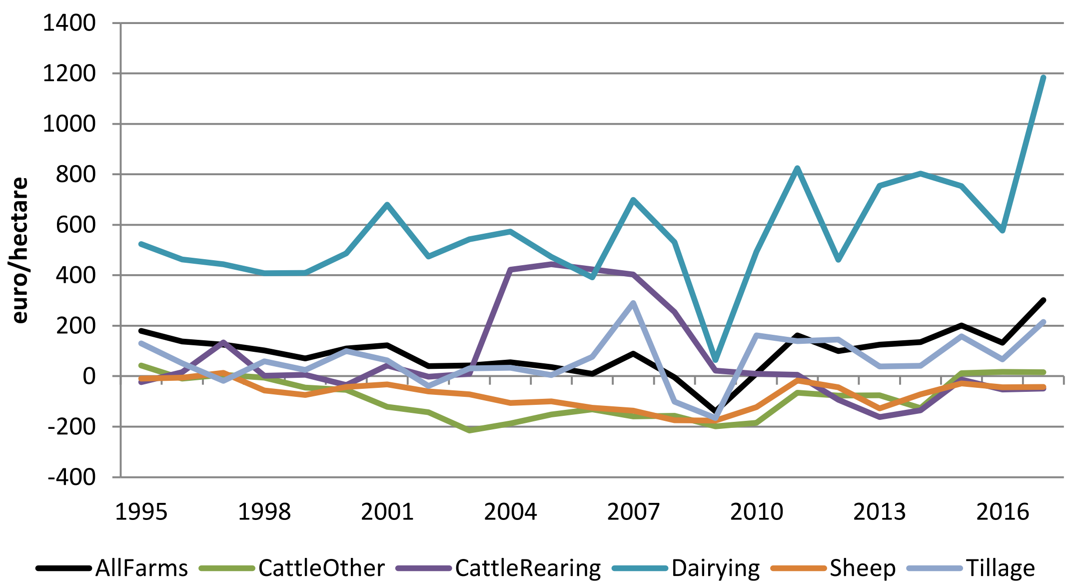
1. OVERVIEW

The Food Wise 2025 report sets out a course of development for the Irish agri-food sector in which the economic size of the Irish agri-food sector (measured in terms value of exports and gross value added) increases over the next decade (DAFM, 2015). In this report we consider the implications that such growth could have, particularly in the context of environmental sustainability and existing national commitments to reduce GHG and ammonia emissions.

Whereas the economic welfare of farmers has been the dominant force in shaping agriculture policy over the last 30 years, there has been a notable increase in environmental concerns and a gradual emergence of environmental policies which are relevant to agriculture. 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. 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 EU Common Agricultural Policy (CAP) objectives and the CAP implementation in Ireland.

To begin, it is useful to examine the development of profitability at the farm level across the principal sectors of Irish agriculture. Figure 1 show that when direct payments are deducted from Family Farm Income (FFI), the profitability of all sub-sectors of Irish agriculture, except for the dairy sector, is quite low. The low profitability of Irish dry-stock production systems goes some way towards explaining the observed lack of growth in output volume in the dry-stock sectors.

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



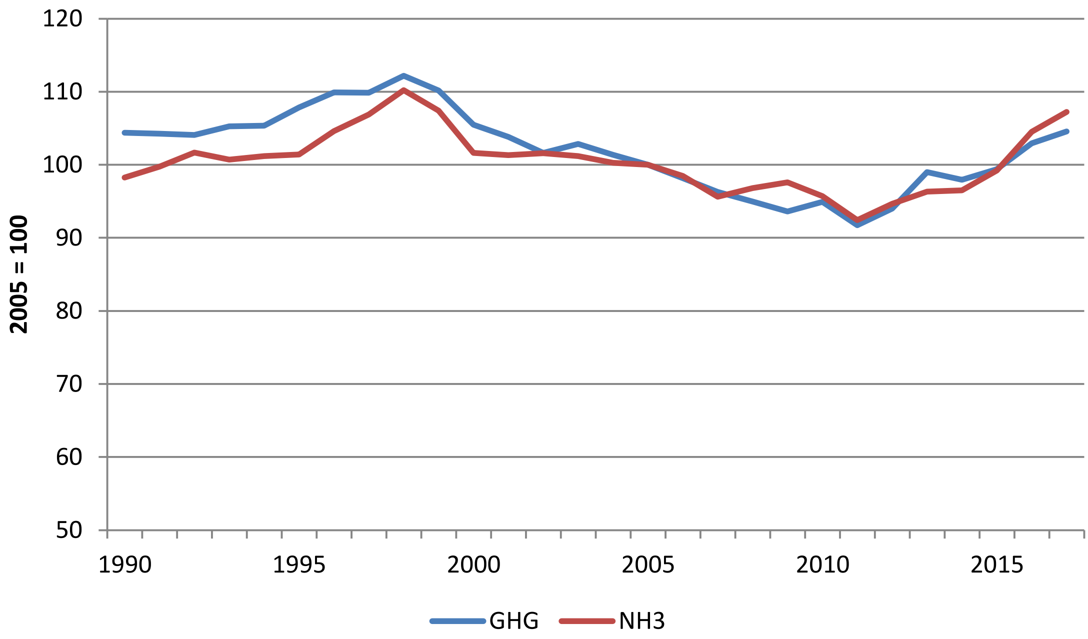
Source: Teagasc NFS data.

The 1990s and 2000s saw land exit agriculture for other purposes, but the overall reduction in the agricultural land base was not substantial in a national context, albeit that there were more pronounced localised effects in agricultural regions bordering urban areas. In the context of a relatively fixed agricultural output volume and a slowly declining agricultural land base, the extent of the intensification of Irish agriculture was relatively modest over much of the last 20 years, particularly given the constraining presence of the milk quota system over most of this period.

It can be said that Irish agriculture engaged in a form of sustainable intensification over this period, but the extent of this intensification was modest. At the farm level, up to the point when the milk quota was removed, Irish agriculture produced more or less the same amount in volume terms as in the late 1990s, but used fewer inputs.

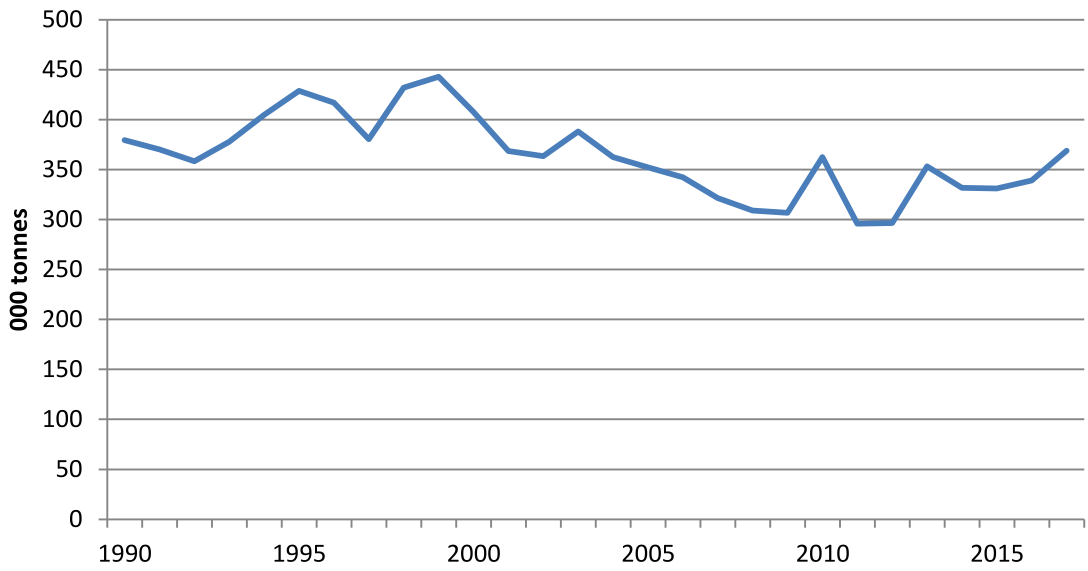
From a peak in the late 1990s, greenhouse gas (GHG) emissions from Irish agriculture have generally been on the decline. The decline over the period 1997 to 2011 was principally due to higher milk yields, declining dairy cow and sheep numbers and a strong reduction in synthetic nitrogen usage. The ending of the milk quota system in 2015 led to growth in dairy cow numbers and milk production and has led to an increase in GHG emissions. Agricultural ammonia emissions have evolved in a broadly similar fashion and for the same reasons as GHG emissions (see Figure 2).

Figure 2: Index of GHG and NH3 emissions from Irish Agriculture (2005=100)



Source: FAPRI Ireland Model

Figure 3: Total Synthetic Nitrogen Use in Irish Agriculture



Source: DAFM.

Taking emissions of GHGs and ammonia as examples, and acknowledging that there are other environmental concerns such as those outlined in Wall et al. (2016), the environmental impact of primary agriculture has generally been on a downward trajectory. Aggregate agricultural emissions have however begun to increase in the last couple of years. Moreover, the economic growth ambitions for the agricultural sector (e.g. FW2025), and the potentially ambitious emissions reduction targets associated with existing national environmental policy commitments, will mean that pressures to improve the sustainability of the agricultural sector will intensify.

Concern over the environmental impact of the agricultural sector implies that fewer aggregate emissions from the sector would be preferable to more emissions, without prescribing how this would be achieved. While the successful deployment of emissions abatement measures might *partially* decouple the relationship between changes in agricultural output volume and agricultural emissions, these measures are in their infancy and the extent of the uptake at the farm level over the next decade is an unknown (Schulte et al., 2012). Environmental objectives could be satisfied through restrictions on agricultural activity levels, but such choices would conflict with other national policy objectives, such as those set out in the Food Harvest 2020 and Food Wise 2025 strategies that seek to grow the contribution of the Irish agri-food sector to the Irish economy. This is the agri-food development and environmental policy dilemma facing Irish policy makers and the wider Irish agri-food industry (Donnellan, Hanrahan and Breen, 2014).

2. EU COMMON AGRICULTURAL POLICY DIMENSION

At the EU level, agricultural policy has evolved over the last 25 years, with a shift from price support to coupled support from the early 1990s, with direct payments decoupled from production from 2005 onwards. The decoupling of direct income support payments from production has, however, meant that land ownership and control, rather than the volume of current production, became the key to accessing support payments which were based on historical levels of agricultural production. This link between land ownership and support payments was reinforced in the CAP reform of 2013, with the introduction of the basic payment system and the other CAP payments, which are still largely allocated on the same land area based approach in Ireland (historical model) as under the previous CAP framework. Empirical research on the capitalisation of support payments into agricultural land rents suggests that the income support payments are capitalised into Irish agricultural rents (O'Neill and Hanrahan, 2016), with theoretical models (Ciaian, Kancs and Swinnen, 2014) and the most recently published empirical research (Ciaian, Kancs and Espinoza, 2018) indicating that the 2013 reform of the CAP increased the capitalisation of income support subsides into agricultural land rents in the EU.

The European Commission CAP reform proposals (EC, 2011a; 2011b; 2011c; 2011d) placed an emphasis on a move towards the equalisation of the value of income support payment per hectare, both between EU Member States (so called external convergence) and within EU Member States (internal convergence). These Commission proposals met with strong opposition from many Member States, since it created both winning and losing Member States and winners and losers across the farm population within Member States. In the final political agreement reached in June 2013 (EU, 2013a; 2013b; 2013c; 2013d) Ireland successfully retained most of its pre-existing national Pillar I CAP budgetary allocation and also retained the freedom to implement the internal convergence reform in a manner that ensured that it would have the minimal impact on the existing distribution of direct income support amongst Irish farmers. The so-called *Irish Model* left a small number of farmers worse off and a small number better off and most farmers largely unaffected in financial terms by the 2013 reform (Donnellan et al., 2014).

Under the 2013 CAP reform agreement, the average hectare of land in Ireland continues to attract upwards of €250 euro per hectare in total Pillar I payments, with subsidy payments from Pillar II for farms participating in agri-environmental schemes and/or located in areas of natural constraint. These payments help to maintain income levels per hectare on unprofitable farms, and by providing an income stream which bears little relation to the income derived from farming agricultural land, the CAP helps loss making farms to stay in business. Though this outcome may be considered a desirable social objective, the corollary is that it hinders the process of land reallocation that might be expected to occur if agricultural income supports were allocated in a manner that was not linked to the control of agricultural land. Under the CAP, agricultural land is less likely to move from less productive to more productive uses and as a consequence the CAP makes it more difficult for profitable farms to grow in size.

Whether or not the current agricultural policy setting is considered desirable is a political question. With current CAP policy supporting the continuation of existing agricultural structures, growth in the volume of Irish agricultural output over the medium term is unlikely to arise from structural change; growth in output volume will not primarily be based on increases in the area of land farmed (growth on the extensive margin) but will be more based on increases in the intensity of agricultural activity on existing land area (growth on the intensive margin). The likely absence of significant opportunities for agricultural output growth on the extensive margin, will both limit the absolute level of volume growth likely to be achieved (because policy makes changes in agricultural structures more expensive) and make the growth that is likely to occur to be more spatially concentrated.

The most recent European Commission CAP reform proposals (EC, 2018) place greater emphasis on the delivery by agriculture of improved environmental outcomes. The proposals potentially provide increased financial resources to farmers for efforts to improve the environmental performance of agriculture and propose to strengthen the environmental conditionality of on-going direct income support for farmers. While the outcome of the CAP reform process is unclear at this early stage, the direction of travel established in the 2013 CAP reform, of an increase in the importance of environmental outcomes as objectives of European and Irish agricultural policy, is clear.

3. EU ENVIRONMENTAL POLICY DIMENSION

EU environmental policy has an impact on agriculture in a number of ways, but two environmental issues (and possible policy responses) are of particular importance to Irish agriculture and could affect the potential of the sector to grow over the medium to longer term. These issues are the national level limitations on i) GHG emissions and ii) ammonia emissions to which Ireland is committed. In 2016 Irish agriculture generated 32% of all of Ireland's GHG emissions, while Agriculture and Transport collectively represent over 73 % of Ireland's GHG emissions that fall outside the scope of the Emissions Trading Scheme (ETS), so called non ETS emissions (EPA, 2018a). In the case of ammonia, the share of Ireland's emissions originating from agriculture is higher still, at 98% (EPA, 2018b).

Reduction targets for GHGs and ammonia within the EU have been apportioned at a national level for the period to 2020, with proposals in place in relation to further reduction targets to be achieved by 2030, but member state ratification is still outstanding in some cases. No target for GHG reductions in agriculture in Ireland exists at present, as the allocation of emissions reductions in the non-ETS sector is in large measure a national level prerogative. By contrast, the fact that emissions of ammonia in Ireland come almost exclusively from agriculture means that the national ammonia reduction target for Ireland, *de facto*, represents a reduction target to be achieved by the agriculture sector.

Ireland is perhaps unique among the EU Member States in having detailed and specific Government supported growth objectives for its agriculture and wider agri-food sector. Earlier analysis (Donnellan and Hanrahan, 2011) has demonstrated that if the Food Harvest 2020 growth targets were achieved in the period to 2020 it would put Irish agricultural GHG emissions on an upwards, rather than a downwards trajectory. Even with the deployment of abatement measures the likely level of emissions of GHGs was seen as problematic (Schulte et al., 2012). With no sector to share the emissions reduction effort in the case of ammonia, agriculture faces a considerable challenge in meeting possible reduction targets (Lanigan et al., 2015).

4. THE POLICY DILEMMA

So how can Irish agriculture expect to grow output and income within the potential confines of environmental constraints (GHG and ammonia) as we look towards 2030? The sectoral and sub-sectoral growth targets set out in the Food Harvest 2020 strategy, as noted above, may conflict with environmental policy commitments under international and EU agreements. Equally, the growth ambition of the Food Wise 2025 strategy may also conflict with the environmental policy objectives of reducing ammonia and GHG emissions 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*, which mean that the actual collective reduction target for 2030 for the sectors within the non-ETS would be 20% relative to the 2005 level. In 2016 agricultural GHG emissions in Ireland represented 45% of Ireland's non-ETS GHG emissions, with the reminder dominated by the transport sector. To date no sectoral emissions reduction targets have been set for agriculture or other sectors. However, as a major contributor to emissions from the non-ETS sector, the smaller the reduction delivered by agriculture, the larger the effort that would be required from other non-agricultural non-ETS sectors (and vice versa).

As a party to the Convention on Long-Range Transboundary Air Pollution (CLRTAP, also known as "Gothenburg Protocol"), Ireland has to, amongst other things, reduce its ammonia emissions. The agriculture sector currently accounts for 98% of all Irish ammonia emissions (EPA, 2018b). As an EU member Ireland is subject to the National Emission Ceilings Directive (NECD) (EU, 2001), which implements the Gothenburg targets for EU Member States. Target emissions for Ireland under the EU National Emissions Ceilings Directive were reviewed in 2012 with a new target of 0.5% reductions on 2005 levels by 2020.

In addition to targets set for 2020, negotiations have concluded at EU level that will result in more onerous targets to be achieved by Ireland in respect of both GHG and ammonia emissions by 2030 and beyond.

As noted in the earlier discussions of the evolution of Irish agriculture over the last 25 years, the volume of Irish agricultural output has been largely static in aggregate terms. Only latterly has it begun to grow following the removal of the milk quota system in 2015. Unless significant emissions efficiencies can be realised, increases in the physical volume of agricultural output over the medium term, as advocated in the FH2020 and FW2025 strategies, are likely to conflict with the objectives of environmental policy. This is because of

1) the intrinsic relationship between agricultural activity levels and levels of environmental emissions, and,
2) the limited scope to abate these emissions through the deployment of new technologies.

If high level objectives of agri-food industry development strategies such as the FH2020 and FW2025 are to be achieved, there may need to be an assessment of how the Irish agri-food sector can derive the most value added or income/profit per unit of emissions. In so far as environmental policy introduces constraints to the growth in the volume of Irish agricultural output, it will be in the interest of the Irish agri-food industry (and wider Irish society) that the output and output growth achieved in the future generates the maximum possible level of value added. There is no reason to believe *a priori* that the current configuration or composition of Irish agricultural activities and associated outputs is one which either currently or in the future maximizes the value added contribution of the agri-food sector.

The SEA report for the FW2025 report (Farrelly and Co., 2015) as well as the FW2025 Committee's report (DAFM, 2015) acknowledge that the achievement of the growth ambitions set out in the FW2025 vision, while simultaneously meeting GHG and ammonia reduction targets, will be challenging.

> Making the right choice now will make sure Ireland is well positioned to deliver sustainable growth far into the future
>
> Food Wise 2025 Strategy p.4

> Ireland does however face significant challenges in meeting some national and international environmental targets for air quality, biodiversity and water quality. Agriculture has a key role to play in contributing to meeting these targets. Meeting Greenhouse Gas (GHG) and

ammonia emission reduction targets will be particularly challenging, but arresting biodiversity losses and continuing the improvement of water quality while increasing production will be equally demanding.

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As the industry embraces new levels of growth it will also be required to show an absolute commitment to the principles of sustainability recognising that gains in productivity must not be at the expense of the environment.

The appropriate nurturing and strengthening of the sustainability credentials of Ireland's production systems in parallel with increases in production levels will ensure that the comparative advantages of the sector are maximised for the Irish economy and environment into the future.

Food Wise 2025 Strategy p.24

A guiding principle to meet these sustainability goals will be that environmental protection and economic competiveness will be considered as equal and complementary, one will not be achieved at the expense of the other. The three pillars of sustainability - social, economic and environmental - are equally important and carry commensurate weight ensuring that as the sector continues to develop and grow this development will be undertaken in the context of addressing environmental challenges.

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Growth in agricultural output value is often associated with growth in income (or value added) but these terms are not synonymous. Over the medium term, the outlook for agricultural and other commodity markets is one in which the strong contribution of output price inflation to growth in Irish agricultural output value observed in recent years is unlikely to be repeated (OECD-FAO, 2017; EC, 2017). In the absence of significant output price inflation, growth in output value will have to be largely based on growth in output volume or movement upward in the value chain that increases the value added of the products produced.

While growth in output volume can arise as a result of increases in productivity, output volume growth is also generally associated with increased use of inputs. This reflects the "no free lunch" axiom of economics. While, over the medium term, agricultural input prices (e.g. feed, fertiliser, energy) are not projected to grow significantly, increases in the volumes of inputs used to produce more output will be associated with growth in expenditure on inputs to the agricultural production process. This growth in the expenditure on production (intermediate consumption) will mean that growth in the income arising from agricultural production will be less than growth in output value.

5. SCENARIO PROJECTIONS

It is impossible to know the future level of activity in Irish agriculture with certainty. It will depend on several factors, including:

- international supply/demand as reflected in commodity and farm prices
- policy (Mercosur, Brexit, CAP, environment)
- potential new national CAP choices may also be a factor in future.

The FAPRI-Ireland model (Donnellan and Hanrahan, 2006) has been used extensively in the analysis of agricultural and trade policy changes in Ireland for close to 20 years. Using the FAPRI-Ireland model, Donnellan and Hanrahan (2011) had in conjunction with the EPA previously assessed the impact of Food Harvest 2020 on animal numbers and fertiliser use in order to estimate future agricultural GHG emissions. The FAPRI-Ireland model is also used to regularly provide the EPA with projections of future levels of agricultural activity which drive projections of future GHG and ammonia emissions from the agriculture sector (see EPA, 2018c).

In this analysis, the FAPRI-Ireland model is used to provide a baseline projection of the future level of activity in Irish agriculture. The projections under S1 are those provided by Teagasc to the EPA and used in the EPA (2018c) GHG projections report. Reflecting the fact that the future is uncertain, for many reasons - including those outlined earlier, the FAPRI-Ireland model was also used to derive a set of five further scenarios, reflecting differing levels of overall agricultural activity. Given that the bovine sector is the principal source of Irish agricultural GHG emissions, the scenarios mainly differ in terms of the size of the total cattle population, the composition of that cattle population, and the associated volume of synthetic fertiliser that is required.

For the baseline (hereafter denoted as scenario S1) and the five other scenarios (S2 through to S6) the FAPRI-Ireland model was used to project the total level of agricultural GHG and ammonia emissions. Importantly, In section 6 these projections of GHG and ammonia emissions from the FAPRI-Ireland model do not consider the effect of mitigation actions and in that sense, for each of the scenarios analysed, the projected level of emissions can be considered as worse case outcomes. Mitigation options, their magnitude and associated costs are summarised in section 7 and are also considered in detail in the Teagasc Agricultural GHG Emissions Marginal Abatement Cost Curve (Lanigan et al., 2018a) and Agricultural Ammonia Emissions Marginal Abatement Cost Curve (Lanigan et al., 2018b) reports.

Over the projection period, conventional agricultural land area in Ireland is projected to decrease over time as land leaks away into other uses. These non-agricultural and other uses are

1. Non-agricultural uses (related to economic growth)
    - Roads, housing and other buildings.
2. Forestry and Bioenergy crops land use
    - Afforestation: assumed increase 7,500 ha per year
    - Bioenergy crops: assumed increase 2,000 ha per year.

Therefore it can be said that even if the existing level of agricultural production were held constant into the future, the intensity of production (i.e. volume of production per hectare) would increase, simply because there would be less land available for agricultural purposes.

The 6 scenarios analysed assume different (positive) growth rates for the dairy cow herd and either stabilisation or reductions in the size of the suckler herd (negative growth rates). We exclude from consideration scenarios in which the Irish dairy herd remains static (or contracts) and scenarios in which the Irish suckler cow herd expands. In designing the scenarios, these choices are based on the high level of profitability in the dairy sector relative to other agricultural land uses and the low level of profitability in the Irish suckler beef sector (see Figure 1 for historical data on family farm income per hectare across different Irish farming systems). These paths for the dairy and beef cow herds leave six scenarios for exploration, as set out in Table 1 below.

Table 1: 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

6. Scenarios Results

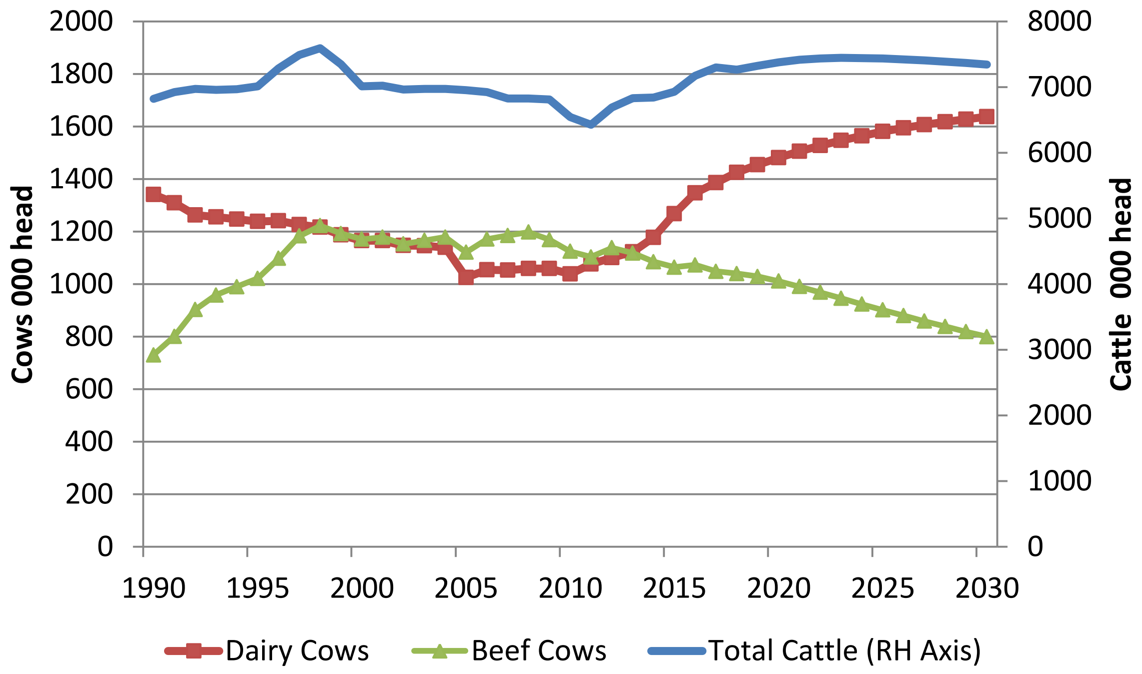
It is important to note that, while scenarios are based around assumptions concerning the growth rates in the bovine breeding herds, each set of scenario projections has information about the extent of activities in other sectors, reflecting the agronomic and economic inter-relationships between the various sectors. For example, if under a given scenario, there is intensification in bovine production, this has implications for land areas, fertiliser usage, feed usage etc. as well as implications for the level of activity in other sectors. Table 2 summarises the level of the total Irish cattle population in 2030 under the six different scenarios analysed, while Figures 4 through 9 provide information on the projected path of dairy and suckler cow herds and the associated total cattle herd under each of the six scenarios examined. Figure 10 summarises projected developments over the period to 2030 of Ireland's bovine herd under the six different scenarios. Figure 11 then presents the associated projections for synthetic nitrogen use across the six analysed scenarios. Full details of the activity levels associated with each of the six scenarios (S1-S6) are provided in Appendix B of this document.

Table 2: 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%

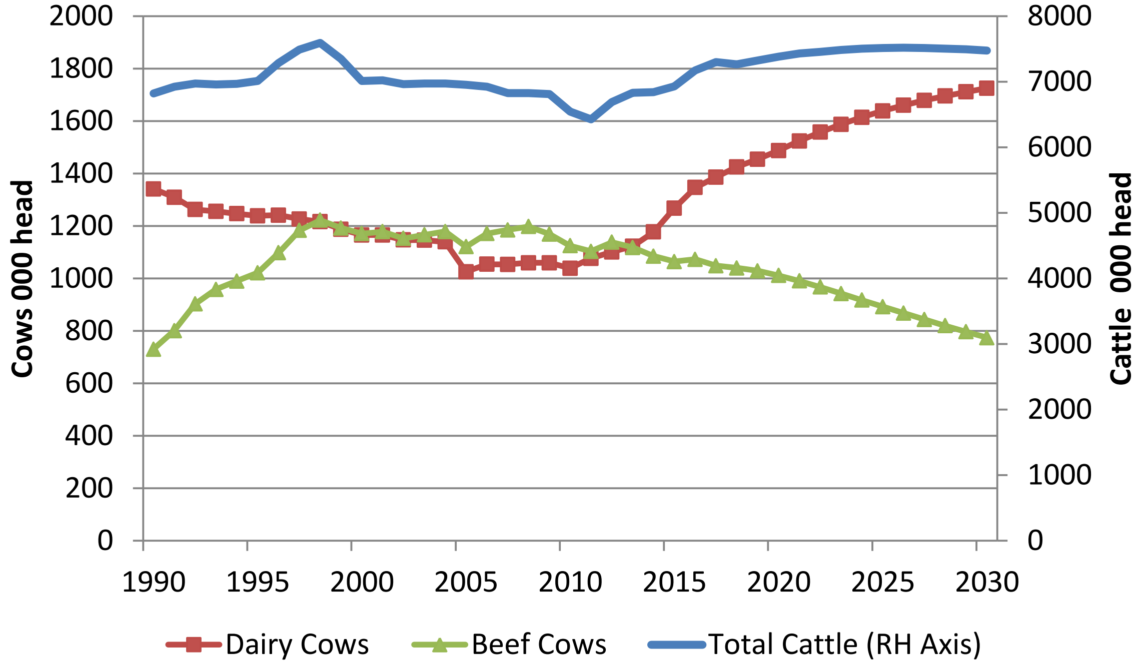
Source: FAPRI-Ireland Model

Figure 4: S1 Moderate rate of decrease in suckler cows and strong rate of increase in dairy cows (Baseline)



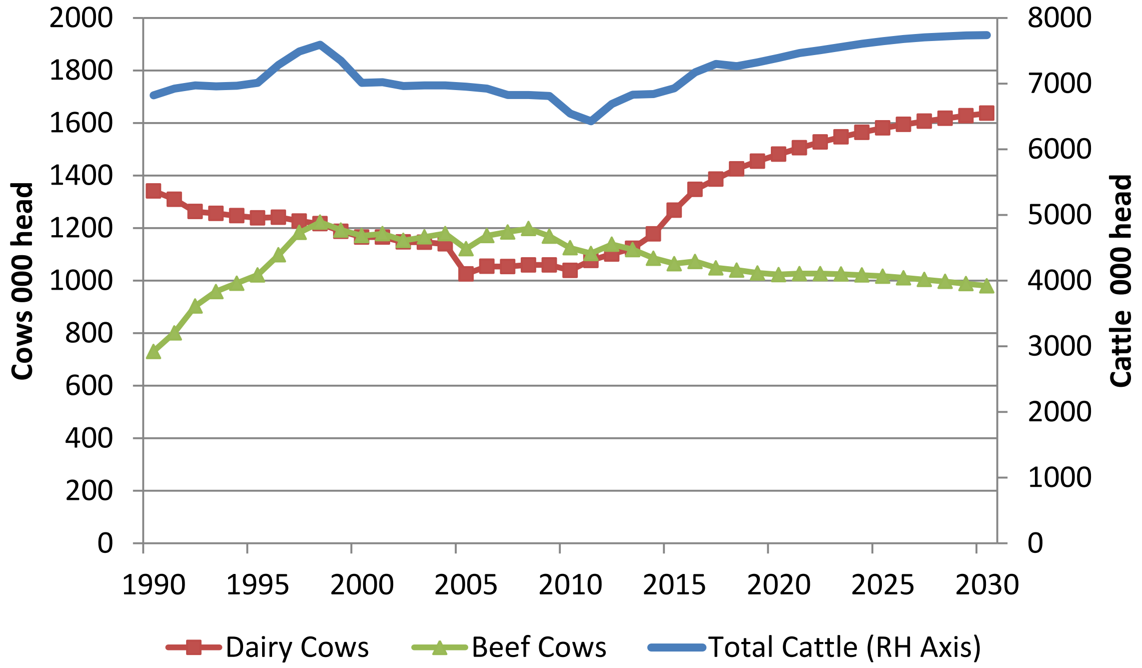
Source: FAPRI-Ireland Model

Figure 5: S2 Moderate rate of decrease in suckler cows and stronger rate of increase in dairy cows



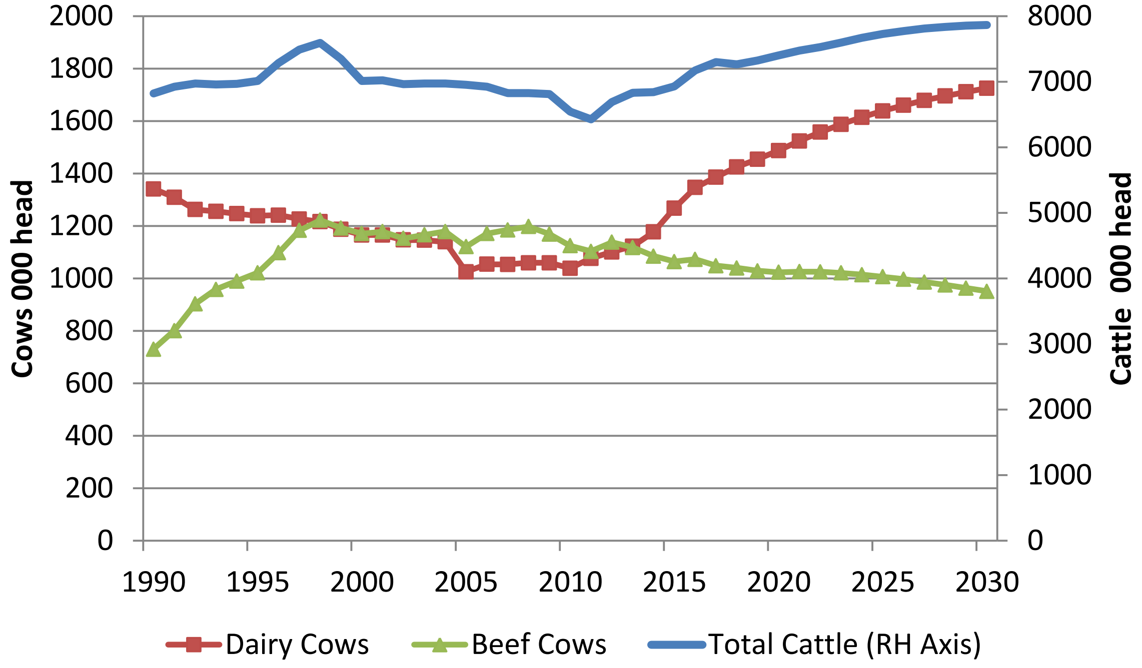
Source: FAPRI-Ireland Model

Figure 6: S3 Modest rate of decrease in suckler cows and strong increase in dairy cows



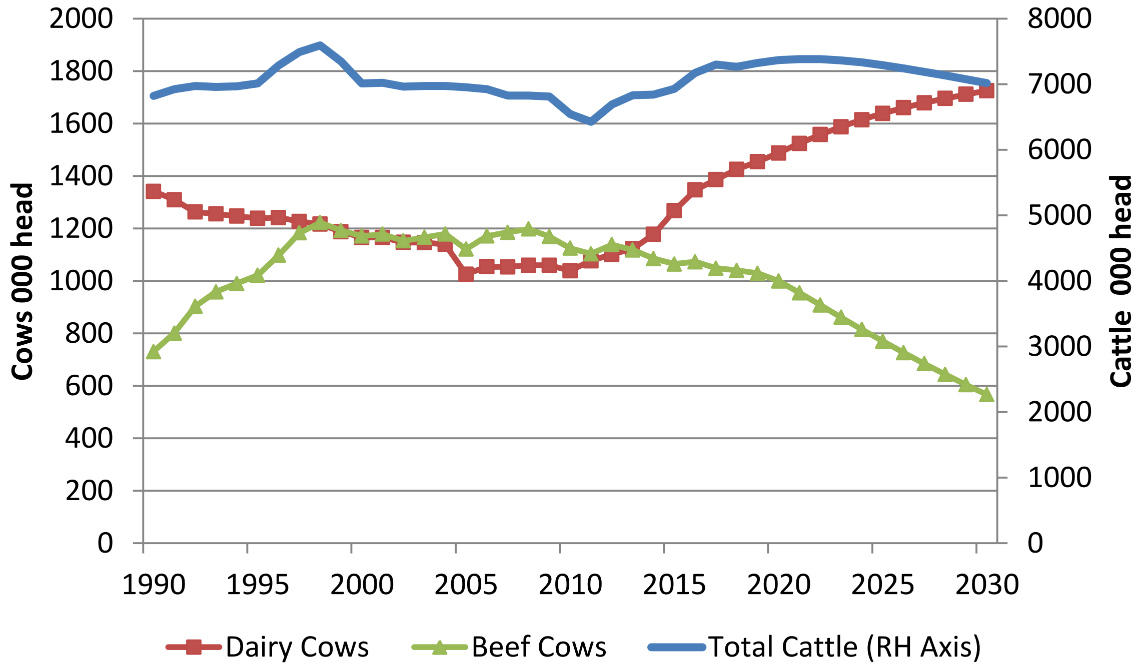
Source: FAPRI-Ireland Model

Figure 7: S4. Modest rate of decrease in suckler cows and stronger rate of increase in dairy cows



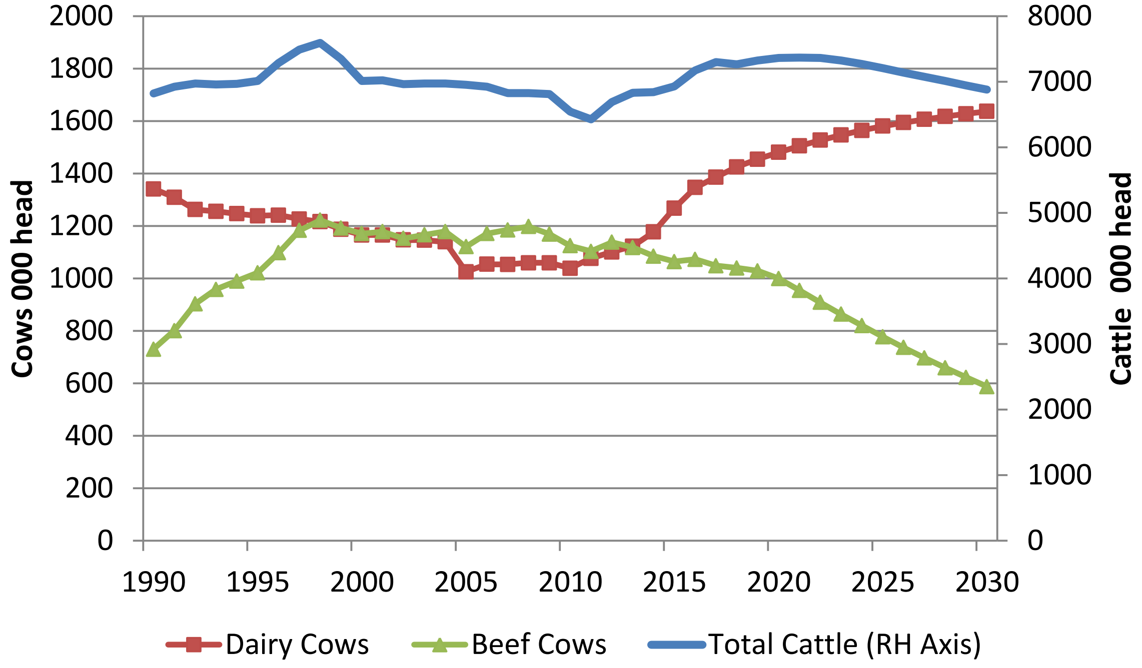
Source: FAPRI-Ireland Model

Figure 8: S5 Strong rate of decrease in suckler cows and strong rate of increase in dairy cows



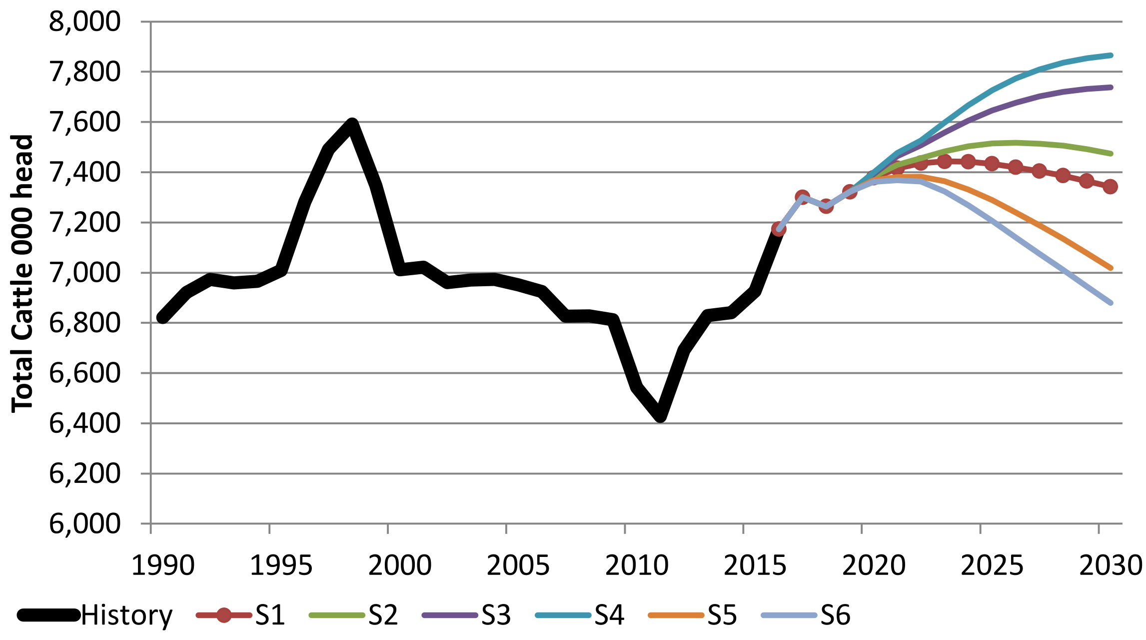
Source: FAPRI-Ireland Model

Figure 9: S6 Strong rate of decrease in suckler cows and stronger rate of increase in dairy cows



Source: FAPRI-Ireland Model

Figure 10: Total Cattle Population: Summary of Scenarios S1 to S6

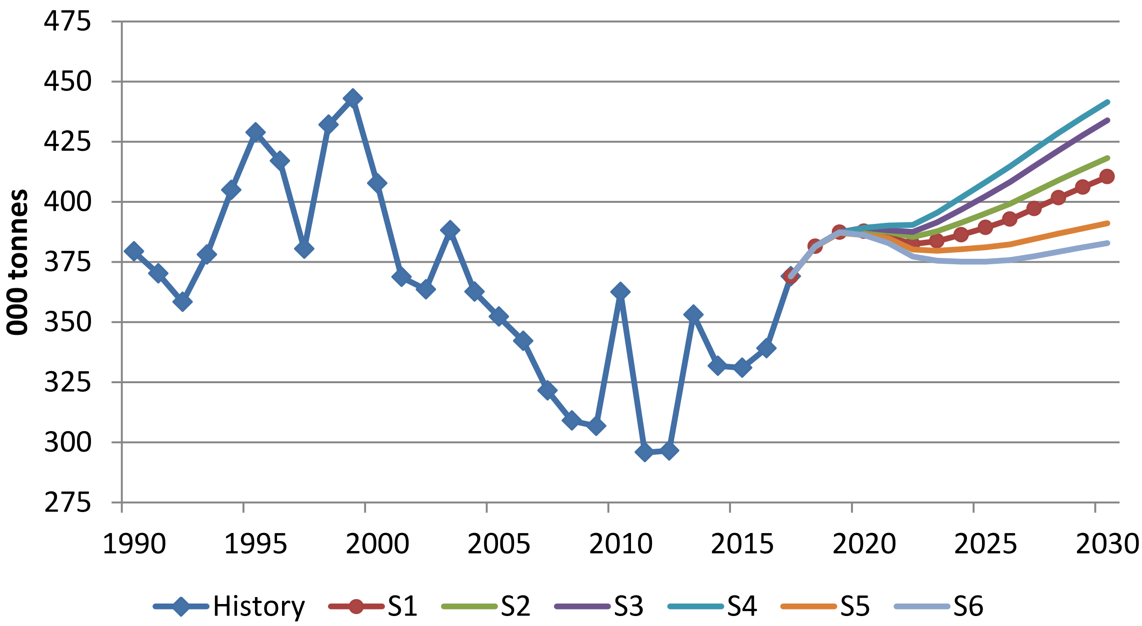


Source: FAPRI-Ireland Model

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 suckler 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 suckler 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 FAPRI-Ireland model allows for the projection of the impact on synthetic nitrogen use arising from the differing cattle populations and declining agricultural land base under the six alternative scenarios examined (Figure 11).

Figure 11: Projected implication of the six scenarios for the level of synthetic nitrogen use

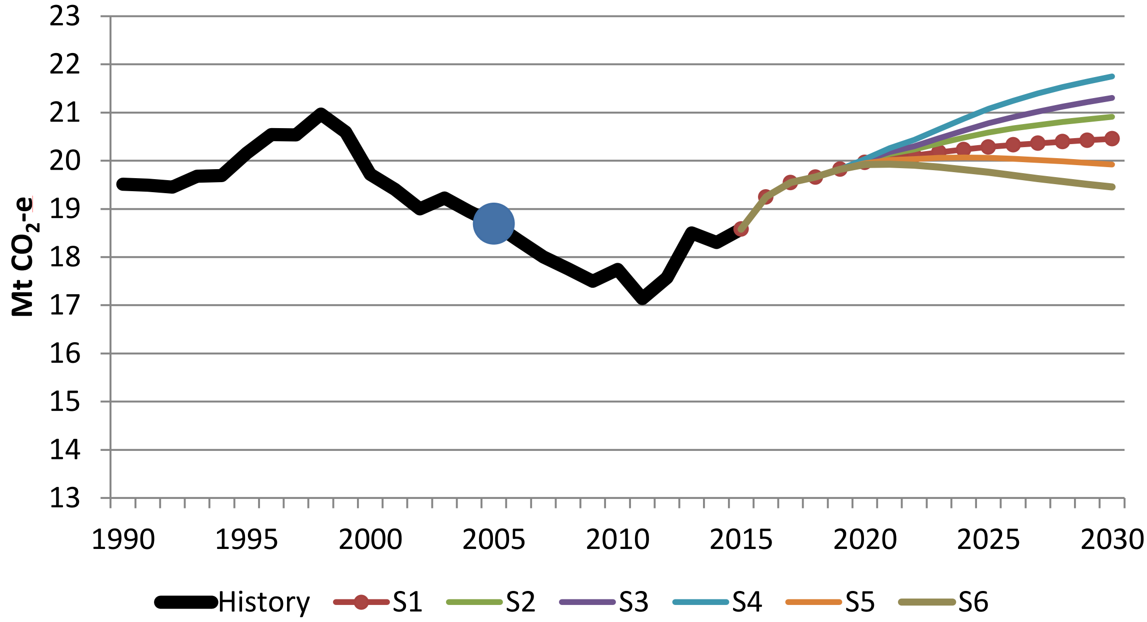


Source: FAPRI-Ireland Model

Activity data (animal inventories, crop areas and synthetic fertilizer use) from the 6 scenarios are next converted to GHG and ammonia emissions using internationally established IPCC methods. Figure 12 shows the spread in projected GHG emissions across the 6 scenarios over the period to 2030.

The projected levels of GHG emissions in 2030 across the six different alternative scenarios are presented in Table 3. 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.

Figure 12: Agricultural GHG emission projections under the six scenarios - excludes mitigation actions



Source: FAPRI-Ireland Model

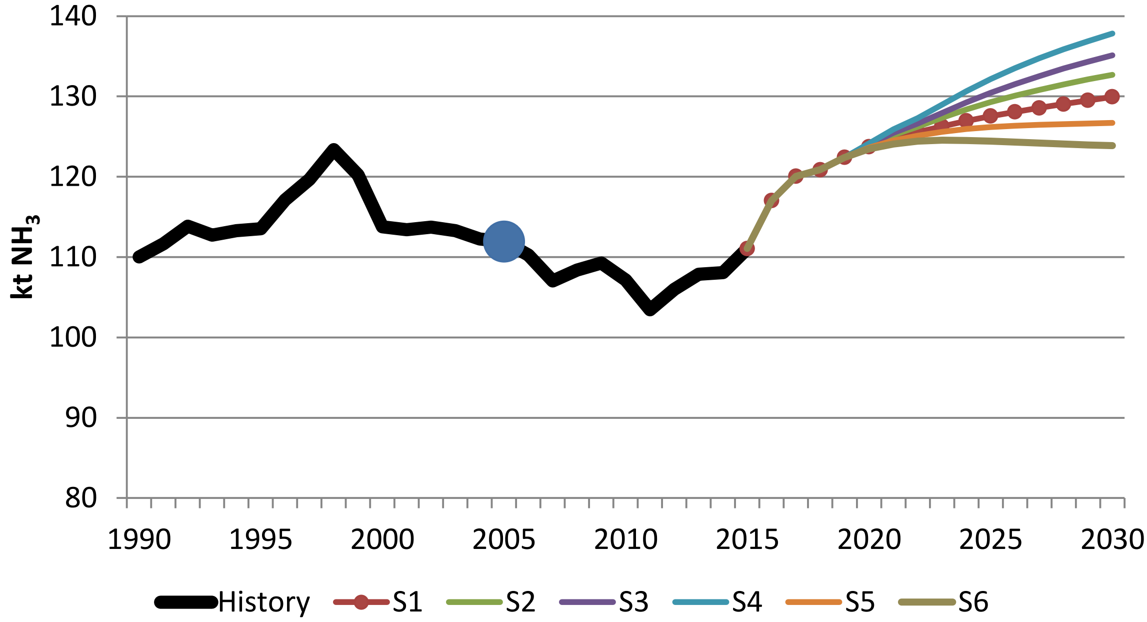
Table 3: Six Scenarios Implications for GHG emissions in 2030 (excludes mitigation)

	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 13 shows projections of agricultural ammonia emission for the six scenarios. There is an almost 14 kt range in the emission levels in 2030, with all scenarios significantly above the 2005 reference level for emission reductions. Note that these projections do not factor in mitigation actions and hence represent a worse case outcome for the scenarios examined.

Figure 13: Agricultural ammonia emission projections under the six scenarios - excludes mitigation actions



Source: FAPRI-Ireland Model

Table 4 shows the projected deviation in agricultural ammonia emissions in 2030 from the 2005 reference level. These 2030 emissions do not include mitigation actions and therefore can be considered a worse case outcome for each scenario.

Table 4: Six Scenarios Implications for Ammonia emissions in 2030 (excludes mitigation)

	2005	2016	2030	2030 vs 2005	2030 vs 2016
		kt NH_3		% change	% change
Historical	111.95	117.03			
S1			129.95	16%	11%
S2			132.70	19%	13%
S3			137.14	23%	17%
S4			137.82	23%	18%
S5			126.70	13%	8%
S6			123.87	11%	6%

Source: FAPRI-Ireland Model

Finally, Figure 14, Figure 15 and Figure 16 summarise the level of agricultural commodity production in each sector, (e.g. milk and meat volumes) relative to their level in 2005 for the Baseline S1 scenario, the S4 (highest emissions) scenario and the S6 (lowest emissions) scenarios.

Figure 14: Index (Base 2005) of historical and projected production volumes S1 Scenario

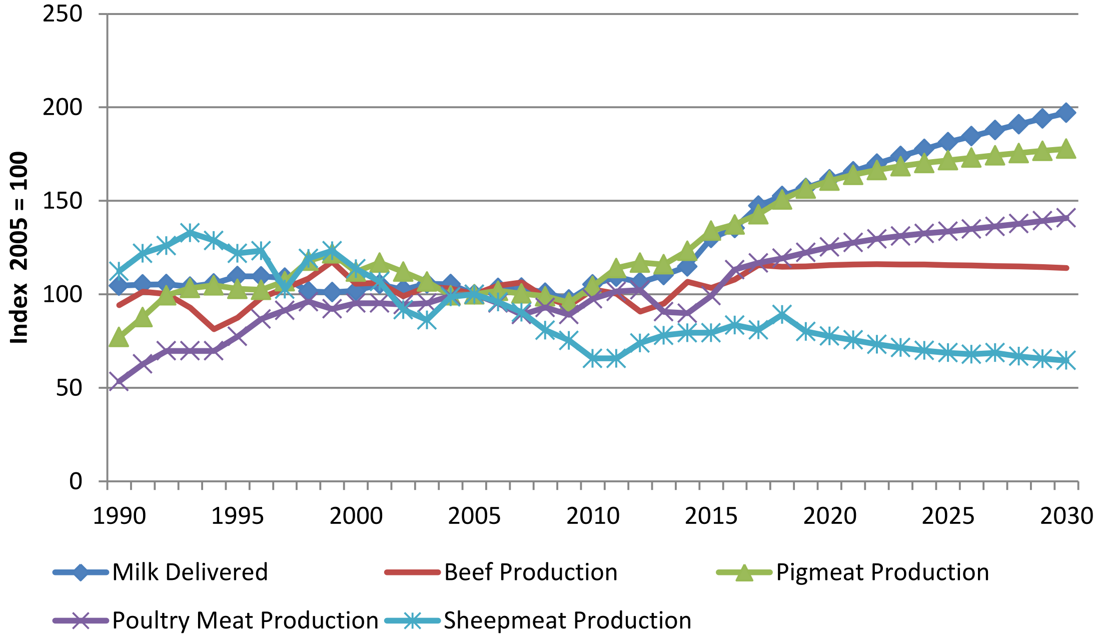


Figure 15: Index (Base 2005) of historical and projected production volumes S4 Scenario

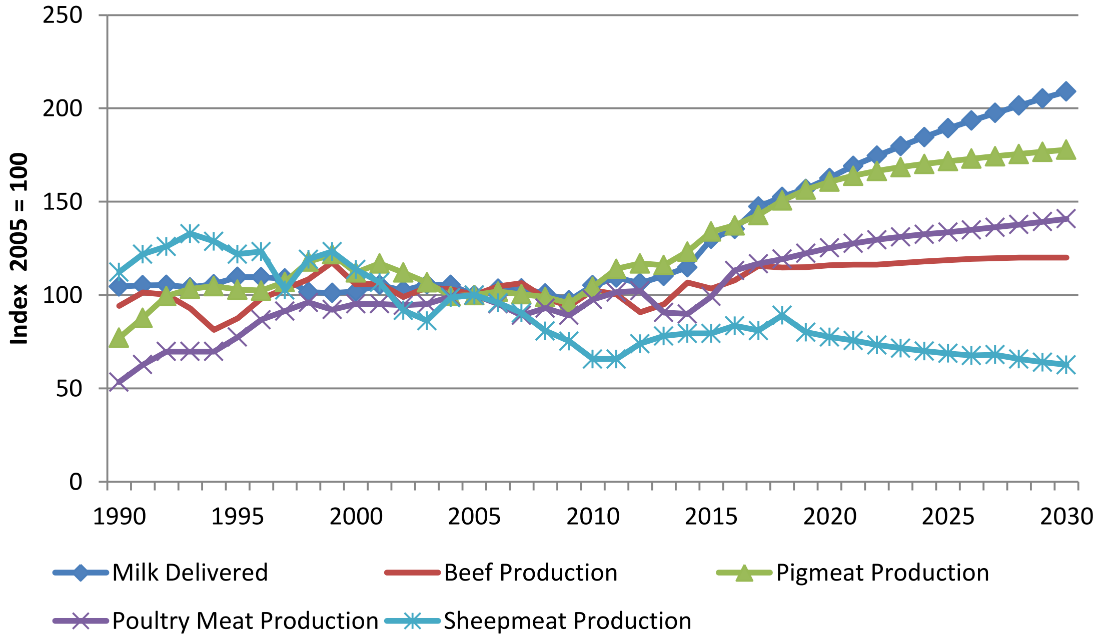
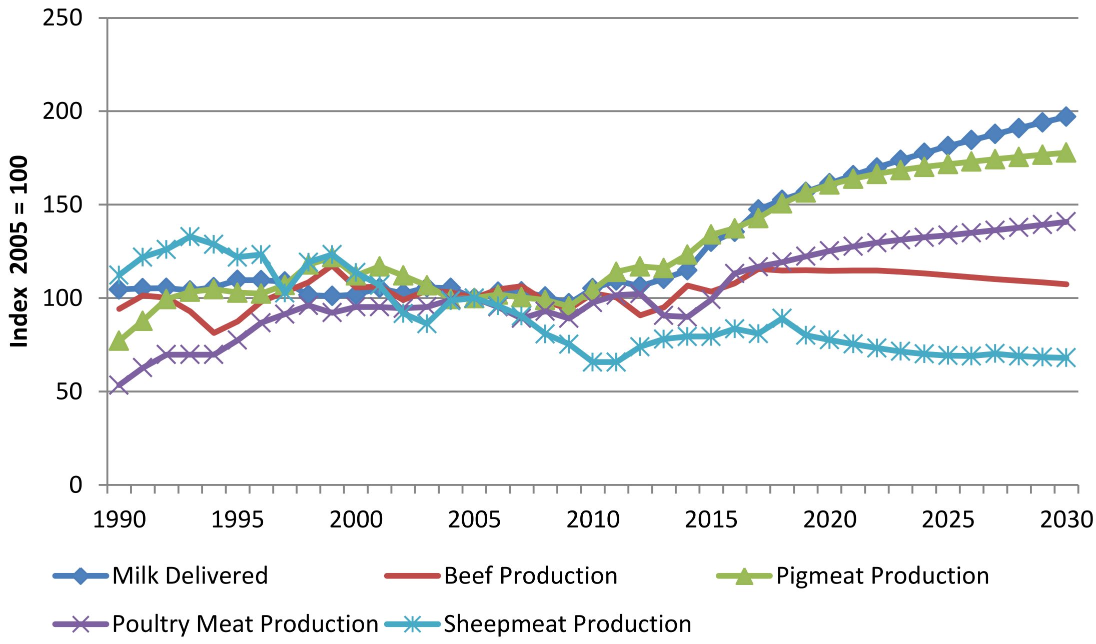


Figure 16: Index (Base 2005) of historical and projected production volumes S6 Scenario



7. GHG and Ammonia Mitigation Capacity under the Scenarios

GHG and ammonia mitigation for the baseline (S1) scenario and the scenarios with the highest (S4) and lowest (S6) emissions have been quantified using the methodology of Lanigan et al. (2018a; 2018b). The impact of 26 measures was assessed using ammonia and GHG inventory models, so that the impacts and synergies/antagonisms of individual measures could be assessed.

The mean mitigation for the S1 scenario is detailed in the GHG Marginal Abatement Cost Curve analysis (Lanigan et al., 2018a). It equates to a mean total abatement value of 6.19 megatonnes CO2-e per annum (Mt CO2-e yr-1) assuming linear uptake of measures. This total comprises 1.85 Mt CO2-e yr-1 from agricultural emissions, 2.97 Mt CO2-e yr-1 from land-use measures and 1.37 Mt CO2-e yr-1 from energy measures (Table 5).

By 2030, when the full uptake of measures is achieved, the maximum abatement potential will be 8.99 Mt CO2-e (3.07 Mt from agriculture, 3.89 Mt from land-use and 2.03 Mt from energy). The impact of the range of scenarios on mitigation potential is detailed in Tables 5. Total agricultural mitigation increases as the level of activity (i.e. dairy cow numbers and fertiliser use) increases.

As a result, 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. Under the S6 scenario, there is a small decrease in absolute mitigation, as activity levels are lower than under the Baseline (S1) and other alternative scenarios. There is also no change in land-use mitigation. However, there is a forecast small (0.28 Mt CO2-e) increase in energy mitigation, as the decrease in total cattle numbers in S6 results in increased land availability for willow and miscanthus production.

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.

Table 5: Mean greenhouse gas (GHG) mitigation potential for a) agricultural emissions, b) land-use and c) (bio)energy between 2021-2030 (assuming linear uptake) 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

Mean ammonia abatement is quantified at 12.43 kt NH_3 yr_{-1} for the S1 scenario, reaching a maximum of 22.6 kt NH_3 by 2030. Under this scenario, assuming linear uptake of measures, compliance with ammonia emission targets will not be achieved until 2027. The range of ammonia mitigation varies across scenarios, since it related to the level of activity data (fertiliser use, animal numbers, etc.) with a variation in mean ammonia abatement (2020-2030) of 1.79 kt NH_3 yr^{-1} and a range in 2030 abatement of 3.20 kt NH_3 yr_{-1} between the S4 and S6 scenarios. This difference is mainly driven by changes in total amounts of slurry N and fertiliser usage across the scenarios.

Under the S4 scenario, agriculture would miss compliance with 2020-2030 ammonia ceiling targets completely (by 2030 emissions would be 3% above 2005 levels). Emissions under this scenario would achieve parity with 2005 levels in 2032 and would only comply with post-2030 ammonia targets (5% reduction on 2005 levels) by 2035 at the earliest. Under the S6 scenario, the 2020-2030 target of a 1% reduction in ammonia emissions would (with linear uptake of measures) be achieved by 2027. Under Scenario S1, again assuming linear uptake of measures, the 1% reduction target would be achieved in 2028. The Post-2030 target of a 5% reduction in ammonia emissions, with a linear uptake of measures would only be achieved in 2031 under S1. Under scenario S6, due to the lower agricultural activity levels as compared with both S1 and S4, the 5% reduction target for the post 2030 period would be achieved by 2029.

Table 6: Mean ammonia (NH3) mitigation potential for between 2020 and 2030 (assuming linear uptake) and maximum mitigation potential in the year 2030

	2005	2016	2030	Mean mitigation 2021-2030	Maximum Mitigation 2030
				kt NH3	
Historical	111.95	117.03			
S1			129.95	12.43	22.60
S4			141.75	13.25	24.11
S6			123.54	11.46	20.91

Full details of the measures evaluated and the associated mitigation potential of GHG and ammonia is provided in Lanigan (2018a; 2018b).

8. CONCLUSIONS

In this report we have presented a range of alternative scenarios concerning the future development of agricultural activity levels in Ireland. 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 and has been used in Lanigan et al. (2018a; 2018b) in developing revised marginal abatement costs curves for agricultural GHG and agricultural ammonia emissions.

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. The Baseline projections (S1) presented here are the same as those provided by Teagasc to the EPA and used in the EPA report on Ireland's GHG emissions for the period 2017-2035 (EPA, 2018c).

Because of the inherent uncertainty regarding future developments in international agricultural and other commodity markets we have also analysed a range of five alternative possible development paths that the Irish agricultural sector could follow. The alternative scenarios (S2 to S6) are based on differing assumptions about the rate of change over the period to 2030 in the Irish dairy and beef breeding inventories.

The associated agricultural activity levels, under each of the six scenarios, are converted into GHG and ammonia emissions in a so called business as usual context, which precludes actions to mitigate those emissions. The analysis suggests that there is a wide range of uncertainty about the both future level of agricultural activity and associated future level of GHG and ammonia emissions from Irish agriculture.

Without considerable mitigation actions, Irish agricultural emissions of both GHGs and ammonia are set to increase relative to their respective levels in 2005. Widespread adoption of mitigation actions, as set out in Lanigan et al. (2018a, 2018b) will lower the future level of GHG and ammonia emissions (below the level emissions would reach if no mitigation actions are adopted), but reaching emissions reduction targets below the 2005 level over the next decade and beyond is likely to be very challenging.

Under the six scenarios examined, GHG and ammonia emissions, inclusive of mitigation actions would not be substantially below their 2005 levels by 2030. The bottom line is that scenarios which involve increased levels of agricultural activity in the future will require either one or all of the following:

- a wide-scale deployment of available mitigation actions
- moderation of the level of ambition for emissions reduction within the sector
- a re-examination of the growth ambitions for the sector.

More extreme development paths than those considered in this report can be imagined and these could be associated with either much higher or, much lower levels of agricultural emissions than projected under Scenarios S1 to S6. The six scenarios examined are not assumed or designed to be exhaustive, but rather their purpose is to illustrate the consequences of different development paths for agricultural emissions and to highlight the impact of mitigation options associated with these different agricultural activity levels.

The analysis in this report highlights the vitally important role that the mitigation technologies and their adoption, as outlined in detail by Lanigan et al. (2018a; 2018b), will play in reducing Irish agricultural emissions of both GHG and ammonia across different possible future agricultural sector development paths. The analysis also 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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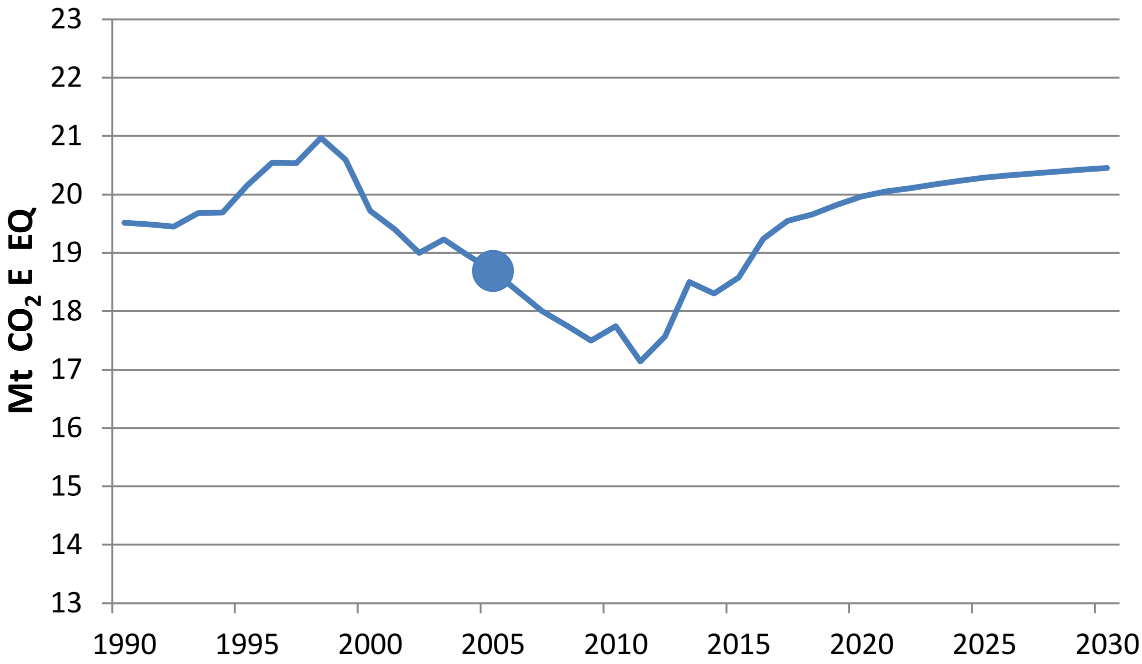
APPENDICES

APPENDIX A

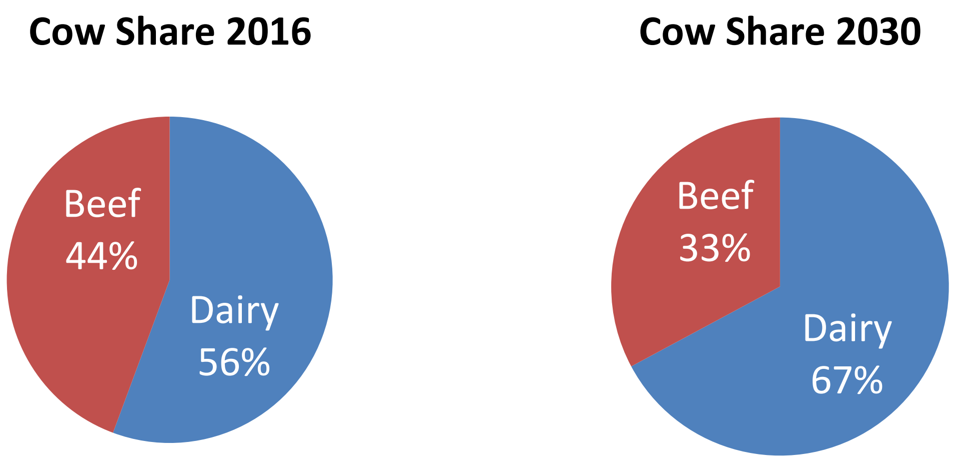
Figure A1 to Figure A12 below show the impact with the various scenarios have for GHG emissions and the underlying composition of the bovine breeding herd.

Figure A 1: Projected GHG emissions under the S1 Scenario (Moderate rate of decrease in suckler cows and strong rate of increase in dairy cows -Baseline)



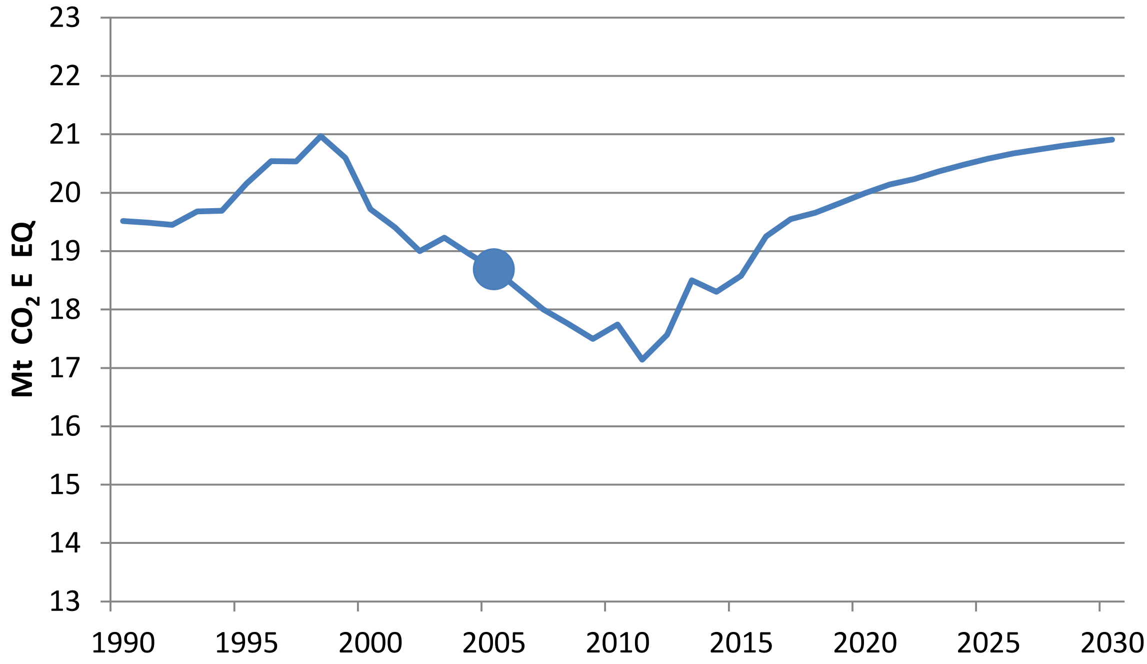
Source: FAPRI-Ireland Model

Figure A 2: Implications of the S1 Scenario for the relative share of dairy cows and beef cows in the total cow population



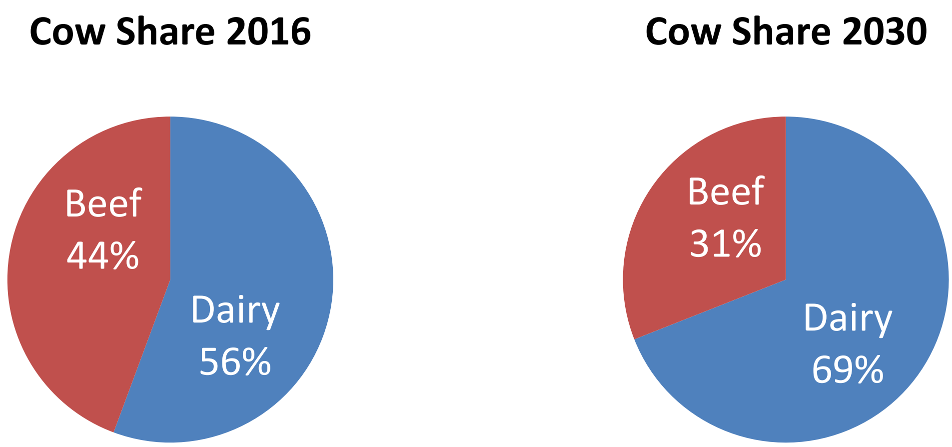
Source: FAPRI-Ireland Model

Figure A 3: Projected GHG emissions under the S2 scenario (Moderate rate of decrease in suckler cows and stronger rate of increase in dairy cows)



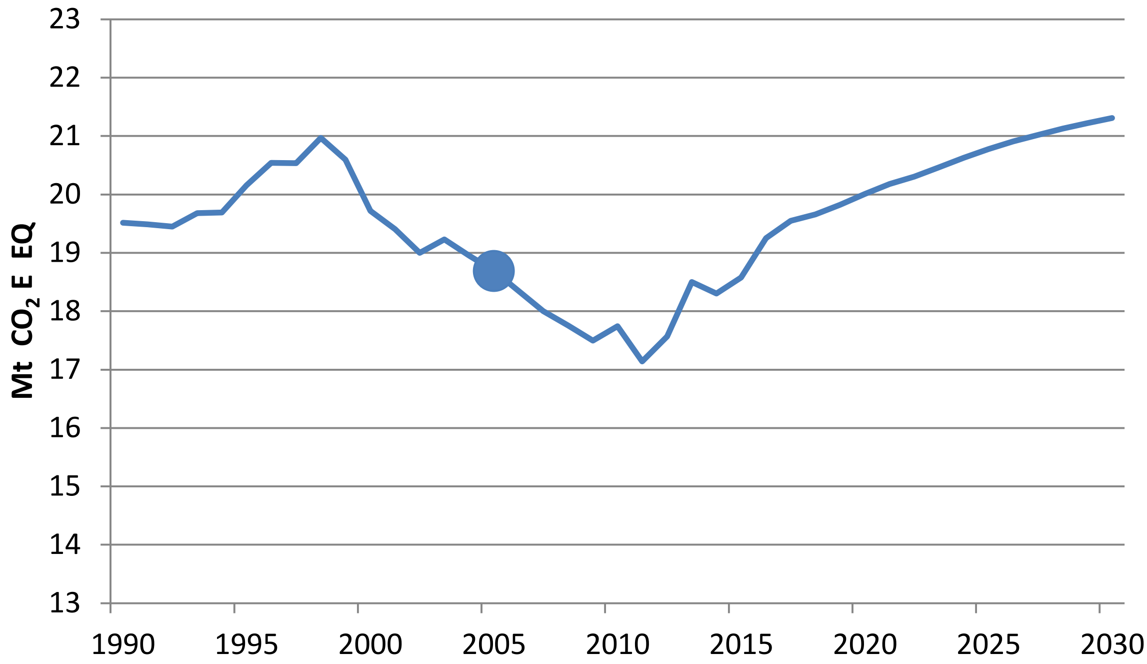
Source: FAPRI-Ireland Model

Figure A 4: Implications of the S2 Scenario for the relative share of dairy cows and beef cows in the total cow population



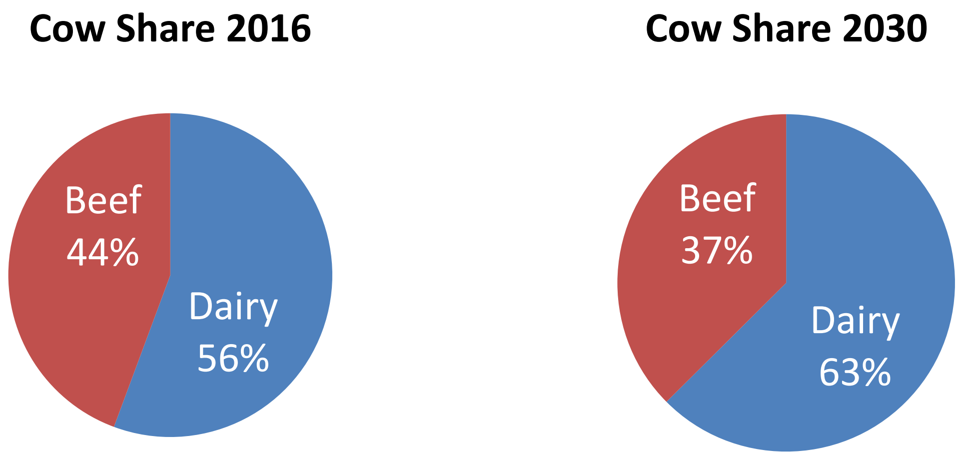
Source: FAPRI-Ireland Model

Figure A 5: Projected GHG emissions under the S3 scenario (Modest rate of decrease in suckler cows and strong increase in dairy cows)



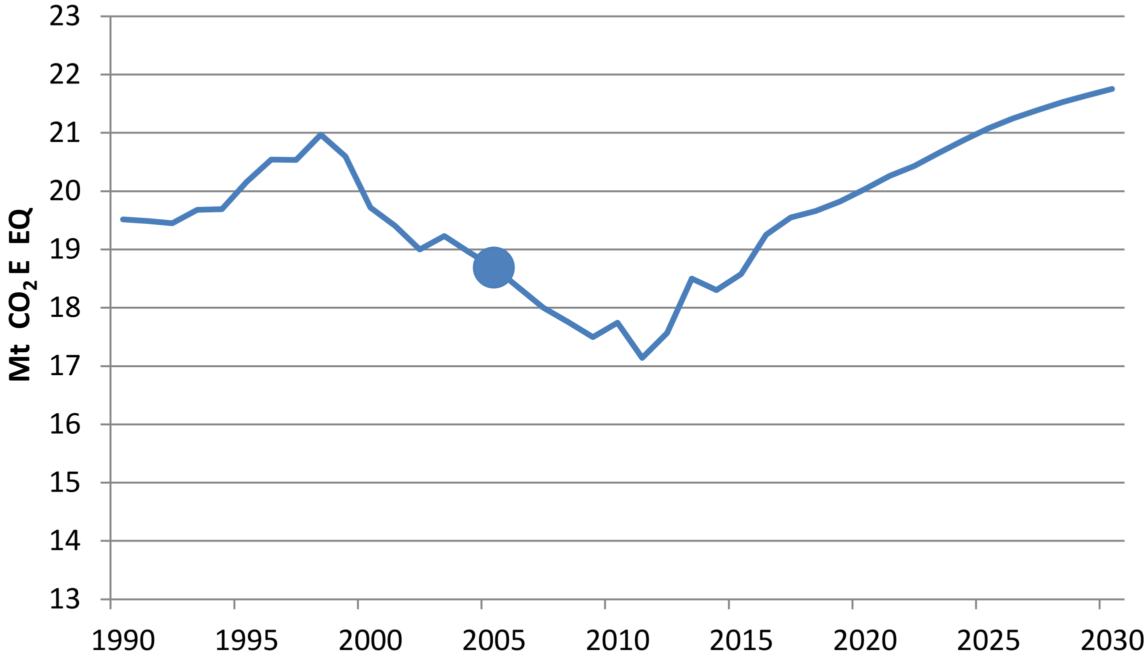
Source: FAPRI-Ireland Model

Figure A 6: Implications of the S3 Scenario for the relative share of dairy cows and beef cows in the total cow population



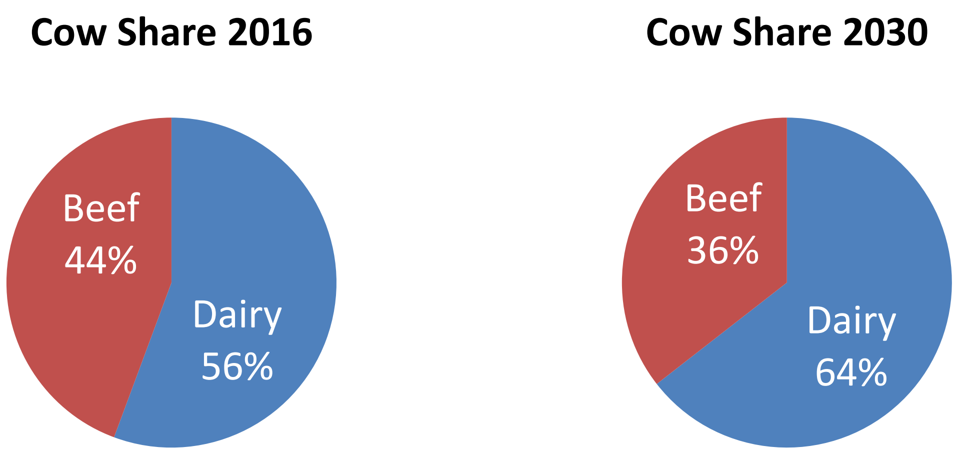
Source: FAPRI-Ireland Model

Figure A 7: Projected GHG emissions under the S4 scenario (Modest rate of decrease in suckler cows and stronger rate of increase in dairy cows)



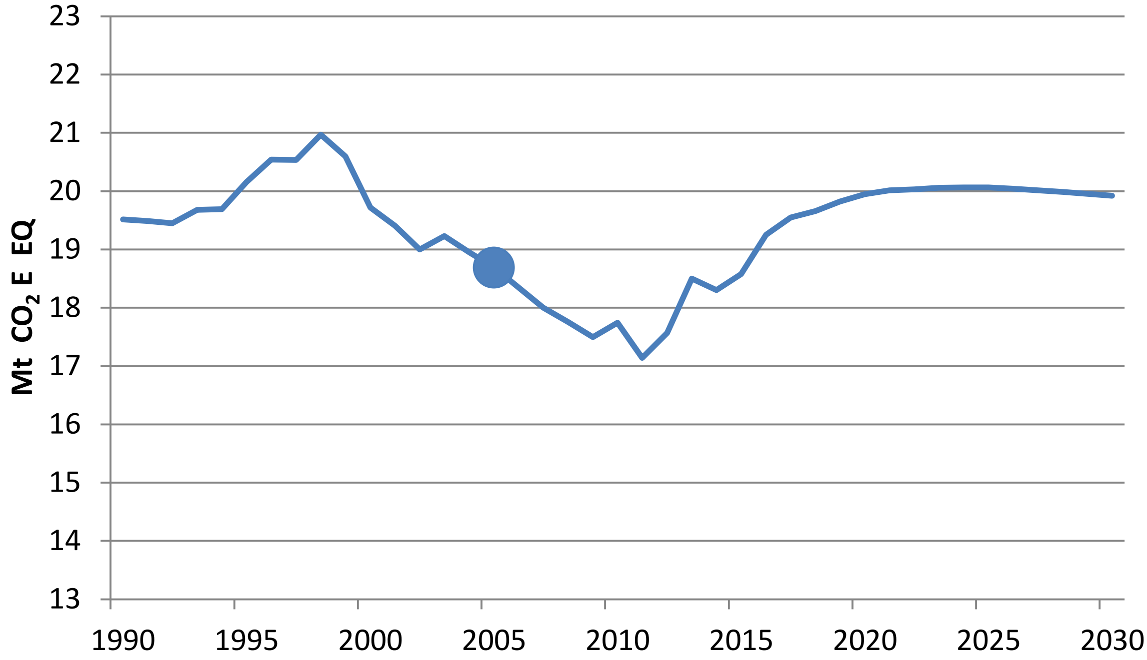
Source: FAPRI-Ireland Model

Figure A 8: Implications of the S4 Scenario for the relative share of dairy cows and beef cows in the total cow population



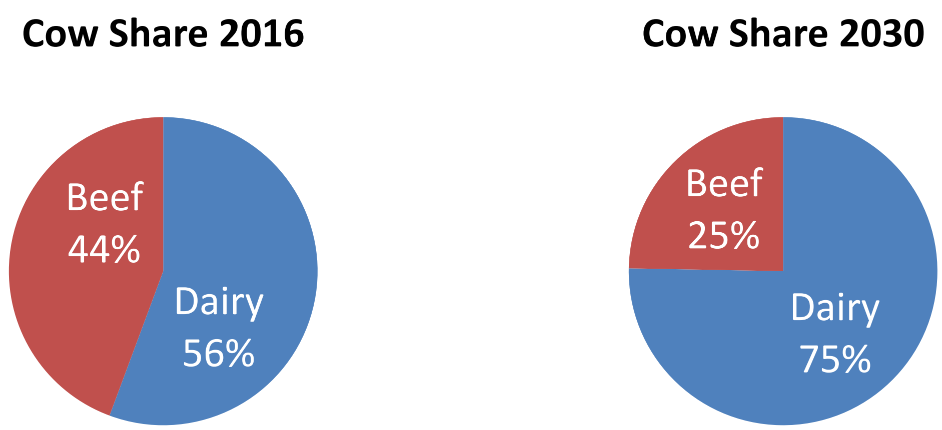
Source: FAPRI-Ireland Model

Figure A 9: Projected GHG emissions under the S5 scenario (Strong rate of decrease in suckler cows and strong rate of increase in dairy cows)



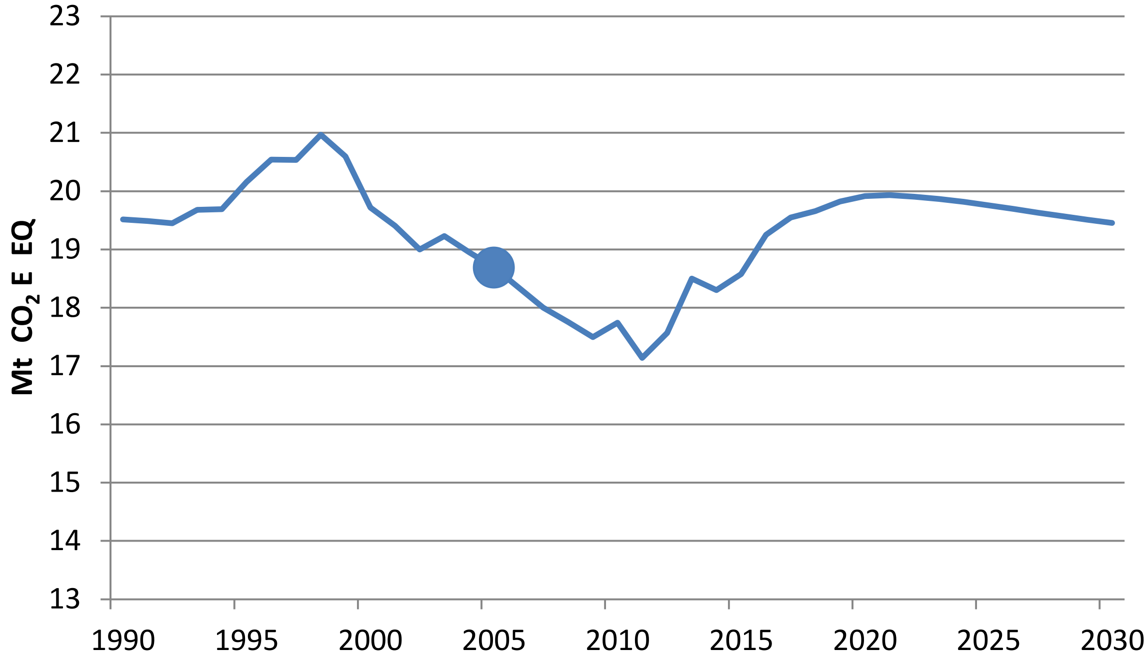
Source: FAPRI-Ireland Model

Figure A 10: Implications of the S5 Scenario for the relative share of dairy cows and beef cows in the total cow population



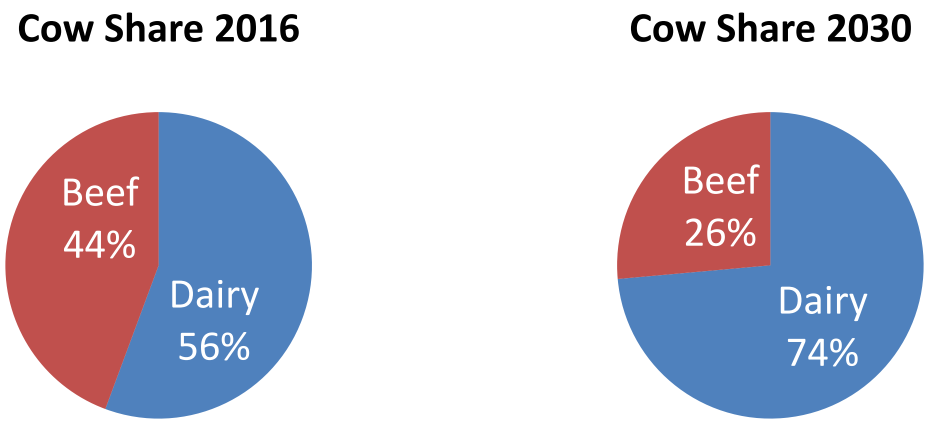
Source: FAPRI-Ireland Model

Figure A 11: Projected GHG emissions under the S6 scenario (Strong rate of decrease in suckler cows and stronger rate of increase in dairy cows)



Source: FAPRI-Ireland Model

Figure A 12: Implications of the S6 Scenario for the relative share of dairy cows and beef cows in the total cow population



Source: FAPRI-Ireland Model

APPENDIX B

Tables B1 to B6 provide the key activity level data (as defined by the EPA) that are used to develop the agricultural emission projections for each of the six alternative scenarios.

Table B 1: Actual and Projected Activity Levels under Scenario S1

	1990	2000	2005	2010	2015	2020	2025	2030
	000 head							
Total Cattle	6822	7012	6951	6543	6926	7377	7433	7342
Dairy Cows	1341	1165	1025	1039	1268	1481	1580	1637
All Other Cattle	5481	5847	5926	5505	5658	5896	5853	5705
Other Cows	730	1171	1121	1125	1065	1011	902	800
Dairy Heifers	172	205	214	234	331	364	383	393
Other Heifers	80	133	191	170	188	158	144	132
Cattle < 1 yrs	1716	1752	1962	1761	2042	2231	2263	2240
Cattle 1 - 2 yrs	1663	1517	1642	1407	1373	1510	1531	1515
Cattle > 2 yrs	1093	1016	734	760	628	609	617	611
Bulls	27	53	61	47	33	14	14	14
Total Sheep	8021	7957	6431	4328	4870	4190	3908	3561
Ewes Lowland	2397	2814	2627	1920	1960	1770	1598	1485
Ewes Upland	1961	1206	657	480	490	440	398	373
Rams lowland	64	77	77	59	60	53	48	45
Rams upland	53	33	19	15	15	13	12	11
Other Sheep>1 - lowland	164	143	124	96	110	91	88	78
Other Sheep>1 - upland	134	61	31	24	27	23	22	20
Lambs - lowland	1787	2535	2317	1387	1766	1440	1394	1240
Lambs - upland	1462	1086	579	347	442	360	348	310
Pigs	1222	1727	1679	1508	1506	1729	1903	1972
Gilts in Pig	21	21	20	19	20	20	20	20
Gilts not yet Served	12	18	20	15	15	17	17	17
Sows in Pig	83	110	100	92	82	87	88	88
Other Sows for Breeding	31	32	34	29	27	35	35	35
Boars	6	4	2	2	1	1	1	1
Pigs 20 Kg +	749	1038	1010	953	934	1072	1194	1242
Pigs Under 20 Kg	319	504	494	400	427	496	548	568
Poultry	11413	15321	16042	14923	16721	18718	19977	21050
Layer	1868	1572	1950	2145	3268	3673	3920	4131
Broiler	8035	12426	12818	11904	12223	13636	14553	15335
Turkey	1509	1322	1274	874	1231	1409	1504	1584
Ducks	347	347	520	279	265	265	265	265
Geese	12	12	11	10	7	7	7	7
Horses	62	70	80	106	93	111	111	111
Mules	8	5	6	8	9	10	10	10
Goats	17	8	7	11	11	10	10	10
Farmed Deer	12	12	10	5	1	1	1	1
Mink	185	146	149	183	198	198	198	198
Fox	26	4	2	0	0	0	0	0
Fertiliser (tonnes N)	379311	407598	352165	362395	330959	387681	389272	410426

Source: FAPRI-Ireland Model

Table B 2: Actual and Projected Activity Levels under Scenario S2

	1990	2000	2005	2010	2015	2020	2025	2030
				000 head				
Total Cattle	6822	7012	6951	6543	6926	7384	7515	7475
Dairy Cows	1341	1165	1025	1039	1268	1487	1639	1725
All Other Cattle	5481	5847	5926	5505	5658	5897	5876	5749
Other Cows	730	1171	1121	1125	1065	1011	893	774
Dairy Heifers	172	205	214	234	331	368	397	413
Other Heifers	80	133	191	170	188	158	144	130
Cattle < 1 yrs	1716	1752	1962	1761	2042	2229	2272	2266
Cattle 1 - 2 yrs	1663	1517	1642	1407	1373	1508	1538	1534
Cattle > 2 yrs	1093	1016	734	760	628	608	620	619
Bulls	27	53	61	47	33	14	14	13
Total Sheep	8021	7957	6431	4328	4870	4194	3955	3653
Ewes Lowland	2397	2814	2627	1920	1960	1771	1620	1525
Ewes Upland	1961	1206	657	480	490	440	402	380
Rams lowland	64	77	77	59	60	53	49	46
Rams upland	53	33	19	15	15	13	12	11
Other Sheep>1 - lowland	164	143	124	96	110	91	89	80
Other Sheep>1 - upland	134	61	31	24	27	23	22	20
Lambs - lowland	1787	2535	2317	1387	1766	1443	1409	1272
Lambs - upland	1462	1086	579	347	442	361	352	318
Pigs	1222	1727	1679	1508	1506	1729	1903	1973
Gilts in Pig	21	21	20	19	20	20	20	20
Gilts not yet Served	12	18	20	15	15	17	17	17
Sows in Pig	83	110	100	92	82	87	88	88
Other Sows for Breeding	31	32	34	29	27	35	35	35
Boars	6	4	2	2	1	1	1	1
Pigs 20 Kg +	749	1038	1010	953	934	1072	1194	1243
Pigs Under 20 Kg	319	504	494	400	427	496	548	568
Poultry	11413	15321	16042	14923	16721	18718	19977	21050
Layer	1868	1572	1950	2145	3268	3673	3920	4131
Broiler	8035	12426	12818	11904	12223	13636	14553	15335
Turkey	1509	1322	1274	874	1231	1409	1504	1584
Ducks	347	347	520	279	265	265	265	265
Geese	12	12	11	10	7	7	7	7
Horses	62	70	80	106	93	111	111	111
Mules	8	5	6	8	9	10	10	10
Goats	17	8	7	11	11	10	10	10
Farmed Deer	12	12	10	5	1	1	1	1
Mink	185	146	149	183	198	198	198	198
Fox	26	4	2	0	0	0	0	0
Fertiliser (tonnes N)	379311	407598	352165	362395	330959	387735	395167	418263

Source: FAPRI-Ireland Model

Table B 3: Actual and Projected Activity Levels under Scenario S3

	1990	2000	2005	2010	2015	2020	2025	2030
				000 head				
Total Cattle	6822	7012	6951	6543	6926	7392	7646	7738
Dairy Cows	1341	1165	1025	1039	1268	1481	1580	1637
All Other Cattle	5481	5847	5926	5505	5658	5911	6066	6101
Other Cows	730	1171	1121	1125	1065	1023	1017	980
Dairy Heifers	172	205	214	234	331	364	383	393
Other Heifers	80	133	191	170	188	161	164	161
Cattle < 1 yrs	1716	1752	1962	1761	2042	2231	2301	2333
Cattle 1 - 2 yrs	1663	1517	1642	1407	1373	1510	1557	1578
Cattle > 2 yrs	1093	1016	734	760	628	609	628	636
Bulls	27	53	61	47	33	14	16	20
Total Sheep	8021	7957	6431	4328	4870	4184	3800	3291
Ewes Lowland	2397	2814	2627	1920	1960	1770	1553	1362
Ewes Upland	1961	1206	657	480	490	440	391	350
Rams lowland	64	77	77	59	60	53	47	41
Rams upland	53	33	19	15	15	13	12	11
Other Sheep>1 - lowland	164	143	124	96	110	90	85	72
Other Sheep>1 - upland	134	61	31	24	27	23	21	18
Lambs - lowland	1787	2535	2317	1387	1766	1436	1353	1150
Lambs - upland	1462	1086	579	347	442	359	338	287
Pigs	1222	1727	1679	1508	1506	1729	1903	1973
Gilts in Pig	21	21	20	19	20	20	20	20
Gilts not yet Served	12	18	20	15	15	17	17	17
Sows in Pig	83	110	100	92	82	87	88	88
Other Sows for Breeding	31	32	34	29	27	35	35	35
Boars	6	4	2	2	1	1	1	1
Pigs 20 Kg +	749	1038	1010	953	934	1072	1194	1243
Pigs Under 20 Kg	319	504	494	400	427	496	548	568
Poultry	11413	15321	16042	14923	16721	18718	19977	21049
Layer	1868	1572	1950	2145	3268	3673	3920	4130
Broiler	8035	12426	12818	11904	12223	13636	14553	15334
Turkey	1509	1322	1274	874	1231	1409	1504	1584
Ducks	347	347	520	279	265	265	265	265
Geese	12	12	11	10	7	7	7	7
Horses	62	70	80	106	93	111	111	111
Mules	8	5	6	8	9	10	10	10
Goats	17	8	7	11	11	10	10	10
Farmed Deer	12	12	10	5	1	1	1	1
Mink	185	146	149	183	198	198	198	198
Fox	26	4	2	0	0	0	0	0
Fertiliser (tonnes N)	379311	407598	352165	362395	330959	389188	402420	433863

Source: FAPRI-Ireland Model

Table B 4: Actual and Projected Activity Levels under Scenario S4

	1990	2000	2005	2010	2015	2020	2025	2030
				000 head				
Total Cattle	6822	7012	6951	6543	6926	7399	7727	7865
Dairy Cows	1341	1165	1025	1039	1268	1487	1639	1725
All Other Cattle	5481	5847	5926	5505	5658	5912	6088	6140
Other Cows	730	1171	1121	1125	1065	1023	1007	951
Dairy Heifers	172	205	214	234	331	368	397	413
Other Heifers	80	133	191	170	188	161	164	158
Cattle < 1 yrs	1716	1752	1962	1761	2042	2229	2311	2358
Cattle 1 - 2 yrs	1663	1517	1642	1407	1373	1508	1564	1596
Cattle > 2 yrs	1093	1016	734	760	628	608	631	644
Bulls	27	53	61	47	33	14	16	19
Total Sheep	8021	7957	6431	4328	4870	4188	3849	3390
Ewes Lowland	2397	2814	2627	1920	1960	1771	1575	1406
Ewes Upland	1961	1206	657	480	490	440	395	359
Rams lowland	64	77	77	59	60	53	47	42
Rams upland	53	33	19	15	15	13	12	11
Other Sheep>1 - lowland	164	143	124	96	110	91	86	75
Other Sheep>1 - upland	134	61	31	24	27	23	22	19
Lambs - lowland	1787	2535	2317	1387	1766	1438	1370	1184
Lambs - upland	1462	1086	579	347	442	359	342	296
Pigs	1222	1727	1679	1508	1506	1729	1903	1973
Gilts in Pig	21	21	20	19	20	20	20	20
Gilts not yet Served	12	18	20	15	15	17	17	17
Sows in Pig	83	110	100	92	82	87	88	88
Other Sows for Breeding	31	32	34	29	27	35	35	35
Boars	6	4	2	2	1	1	1	1
Pigs 20 Kg +	749	1038	1010	953	934	1072	1194	1243
Pigs Under 20 Kg	319	504	494	400	427	496	548	568
Poultry	11413	15321	16042	14923	16721	18718	19977	21049
Layer	1868	1572	1950	2145	3268	3673	3920	4130
Broiler	8035	12426	12818	11904	12223	13636	14553	15334
Turkey	1509	1322	1274	874	1231	1409	1504	1584
Ducks	347	347	520	279	265	265	265	265
Geese	12	12	11	10	7	7	7	7
Horses	62	70	80	106	93	111	111	111
Mules	8	5	6	8	9	10	10	10
Goats	17	8	7	11	11	10	10	10
Farmed Deer	12	12	10	5	1	1	1	1
Mink	185	146	149	183	198	198	198	198
Fox	26	4	2	0	0	0	0	0
Fertiliser (tonnes N)	379311	407598	352165	362395	330959	389242	408286	441449

Source: FAPRI-Ireland Model

Table B 5: Actual and Projected Activity Levels under Scenario 5

	1990	2000	2005	2010	2015	2020	2025	2030
				000 head				
Total Cattle	6822	7012	6951	6543	6926	7369	7289	7018
Dairy Cows	1341	1165	1025	1039	1268	1487	1639	1725
All Other Cattle	5481	5847	5926	5505	5658	5882	5650	5293
Other Cows	730	1171	1121	1125	1065	1000	770	566
Dairy Heifers	172	205	214	234	331	368	397	413
Other Heifers	80	133	191	170	188	154	121	94
Cattle < 1 yrs	1716	1752	1962	1761	2042	2229	2232	2161
Cattle 1 - 2 yrs	1663	1517	1642	1407	1373	1508	1510	1462
Cattle > 2 yrs	1093	1016	734	760	628	608	609	590
Bulls	27	53	61	47	33	14	12	7
Total Sheep	8021	7957	6431	4328	4870	4201	4068	3954
Ewes Lowland	2397	2814	2627	1920	1960	1771	1666	1663
Ewes Upland	1961	1206	657	480	490	440	410	404
Rams lowland	64	77	77	59	60	53	50	50
Rams upland	53	33	19	15	15	13	12	12
Other Sheep>1 - lowland	164	143	124	96	110	91	91	87
Other Sheep>1 - upland	134	61	31	24	27	23	23	22
Lambs - lowland	1787	2535	2317	1387	1766	1448	1452	1374
Lambs - upland	1462	1086	579	347	442	362	363	343
Pigs	1222	1727	1679	1508	1506	1729	1903	1973
Gilts in Pig	21	21	20	19	20	20	20	20
Gilts not yet Served	12	18	20	15	15	17	17	17
Sows in Pig	83	110	100	92	82	87	88	88
Other Sows for Breeding	31	32	34	29	27	35	35	35
Boars	6	4	2	2	1	1	1	1
Pigs 20 Kg +	749	1038	1010	953	934	1072	1194	1243
Pigs Under 20 Kg	319	504	494	400	427	496	548	568
Poultry	11413	15321	16042	14923	16721	18718	19978	21051
Layer	1868	1572	1950	2145	3268	3673	3920	4131
Broiler	8035	12426	12818	11904	12223	13636	14554	15336
Turkey	1509	1322	1274	874	1231	1409	1504	1585
Ducks	347	347	520	279	265	265	265	265
Geese	12	12	11	10	7	7	7	7
Horses	62	70	80	106	93	111	111	111
Mules	8	5	6	8	9	10	10	10
Goats	17	8	7	11	11	10	10	10
Farmed Deer	12	12	10	5	1	1	1	1
Mink	185	146	149	183	198	198	198	198
Fox	26	4	2	0	0	0	0	0
Fertiliser (tonnes N)	379311	407598	352165	362395	330959	386228	381105	391020

Source: FAPRI-Ireland Model

Table B 6: Actual and Projected Activity Levels under Scenario 6

	1990	2000	2005	2010	2015	2020	2025	2030
				000 head				
Total Cattle	6822	7012	6951	6543	6926	7362	7206	6880
Dairy Cows	1341	1165	1025	1039	1268	1481	1580	1637
All Other Cattle	5481	5847	5926	5505	5658	5881	5625	5243
Other Cows	730	1171	1121	1125	1065	1000	778	588
Dairy Heifers	172	205	214	234	331	364	383	393
Other Heifers	80	133	191	170	188	154	122	96
Cattle < 1 yrs	1716	1752	1962	1761	2042	2231	2223	2134
Cattle 1 - 2 yrs	1663	1517	1642	1407	1373	1510	1503	1444
Cattle > 2 yrs	1093	1016	734	760	628	609	606	582
Bulls	27	53	61	47	33	14	12	7
Total Sheep	8021	7957	6431	4328	4870	4197	4023	3870
Ewes Lowland	2397	2814	2627	1920	1960	1770	1645	1625
Ewes Upland	1961	1206	657	480	490	440	406	397
Rams lowland	64	77	77	59	60	53	49	49
Rams upland	53	33	19	15	15	13	12	12
Other Sheep>1 - lowland	164	143	124	96	110	91	90	85
Other Sheep>1 - upland	134	61	31	24	27	23	23	21
Lambs - lowland	1787	2535	2317	1387	1766	1445	1438	1345
Lambs - upland	1462	1086	579	347	442	361	359	336
Pigs	1222	1727	1679	1508	1506	1729	1903	1973
Gilts in Pig	21	21	20	19	20	20	20	20
Gilts not yet Served	12	18	20	15	15	17	17	17
Sows in Pig	83	110	100	92	82	87	88	88
Other Sows for Breeding	31	32	34	29	27	35	35	35
Boars	6	4	2	2	1	1	1	1
Pigs 20 Kg +	749	1038	1010	953	934	1072	1194	1243
Pigs Under 20 Kg	319	504	494	400	427	496	548	568
Poultry	11413	15321	16042	14923	16721	18718	19978	21051
Layer	1868	1572	1950	2145	3268	3673	3920	4131
Broiler	8035	12426	12818	11904	12223	13636	14554	15336
Turkey	1509	1322	1274	874	1231	1409	1504	1585
Ducks	347	347	520	279	265	265	265	265
Geese	12	12	11	10	7	7	7	7
Horses	62	70	80	106	93	111	111	111
Mules	8	5	6	8	9	10	10	10
Goats	17	8	7	11	11	10	10	10
Farmed Deer	12	12	10	5	1	1	1	1
Mink	185	146	149	183	198	198	198	198
Fox	26	4	2	0	0	0	0	0
Fertiliser (tonnes N)	379311	407598	352165	362395	330959	386174	375175	382892

Source: FAPRI-Ireland Model