Briefing Note

Greenhouse Gas Emissions by Irish Agriculture:

Consequences arising from the Food Harvest Targets

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Executive Summary

- Over the next ten years an expansion in the value of Irish agriculture is projected to take place. However, the magnitude of the projected expansion is likely to be insufficient to ensure that the targets set in the Food Harvest report are achieved without the implementation of the actions recommended by the Food Harvest Committee in its Food Harvest 2020 Report.

- The return of global economic growth over the next ten years is projected to lead to increases in most agricultural commodity prices. Under a continuation of current agricultural policies (and without the implementation of the Food Harvest 2020 Report's recommendations) an increase in the volume of milk production is still expected. The improved market environment is expected to lead to increases in the output value of the beef, sheep and pig sectors. However, the increases would not be sufficient to meet the Food Harvest targets.

- In this paper two scenarios have been examined. Scenario 1 is a no policy change scenario and Scenario 2 reflects the achievement of the Food Harvest 2020 targets.

- Under the no policy change scenario (Scenario 1) Irish agricultural sector income is projected by 2020 to be 21 percent higher than during base period 2007-2009. This growth in sector income is due largely to increased Irish dairy sector output following the abolition of milk quota in 2015.

- Given the assumption of no new policy change under Scenario 1 the level of subsidies received by the Irish agricultural sector the decline over the period 2007-2009 to 2020 is due to announced changes in the support of agri-environmental schemes, the expiry of the suckler cow welfare scheme and the implementation of increased rates of modulation agreed in the 2008 CAP Health Check.

- The FAPRI-Ireland Model indicates that under Scenario 1, projected agricultural output would give rise to greenhouse gas emissions (GHG) from Irish agriculture (exclusive of fuel combustion) in 2020 of approximately 16.8 mt C02 eq. (10 percent lower in 2020 than the 2005 level).

- Under Scenario 2 the output targets set out in the Food Harvest Committee's report are achieved by 2020. By 2020 the level of agricultural sector income under Scenario 2 is projected to be 23 percent higher than under Scenario 1.

- The large increase in agricultural sector income under Scenario 2 is due to the increases in the value of output arising in the beef, sheep and pig sector and the 50 percent increase in the volume of Irish milk output. The value of agricultural goods output at producer prices in 2020 under Scenario 2 is projected to be 14 percent higher than under Scenario 1. The value of Irish agricultural output in 2020 under Scenario 2, when measured against the base period of 2007-2009, is projected to be €861 m (28 percent) higher.

- Using the FAPRI-Ireland model, the economic and environmental consequences of the achievement of the output targets set by the Food Harvest 2020 Committee (Scenario 2) can be projected.

- The achievement of the Food Harvest 2020 targets is projected to lead, inter alia, to an increase in the share of dairy cows in the bovine population and an increase in the intensity of fertiliser usage. Both of these changes result in increased GHG emissions from agriculture.

- GHG emissions (exclusive of fuel combustion) associated with the levels of agricultural activity envisaged under the Food Harvest initiative are projected to be 18.1 mt CO_2 eq. in 2020 (3 percent lower in 2020 than the 2005 level).

- Under the two scenarios analysed, no additional or novel abatement technologies are assumed to be deployed. Therefore, other things being equal, the use of abatement technologies would lead to lower levels of emissions than projected here.

1. Introduction

In July 2010 the Food Harvest 2020 Committee report (DAFF, 2010), which sets ambitious targets for growth in the value and volume of production from the Irish agri-food sector over the period to 2020, was launched by the Minister for Agriculture, Fisheries and Food.

The primary agricultural sector accounts for a significant share (29 percent) of total Irish Greenhouse Gas (GHG) emissions (EPA, 2010). Given that the main sources of agricultural GHG emissions in Ireland relate to bovine agricultural production systems, achievement of the output targets in the Food Harvest report would be expected , other things being equal, to lead to an increase in the emissions of GHGs from Irish agriculture.

This paper uses an economic model of Irish agriculture (the FAPRI-Ireland model) together with an integrated model of GHG emissions (FAPRI-Ireland GHG Model), to project the change in Irish agricultural GHG emissions that would result from the achievement of the targets set out in the Food Harvest report. An important assumption associated with these projections is that GHG abatement technologies that are currently under development by research scientists (such as livestock dietary management, grassland management and grassland/cropland nutrient management) are not adopted over the period to 2020. The projected GHG emissions associated with the achievement of the Food Harvest targets (referred to as Scenario 2) are contrasted with the current level of GHG emissions from the agriculture sector and the projected level of agricultural production and associated GHG emissions that might prevail in 2020 in the absence of the Food Harvest implementation plan (referred to as Scenario 1).

2. Food Harvest 2020

The Food Harvest 2020 Committee's Report was published in July 2020. The Report (hereafter the Food Harvest 2020 Report) includes a range of specific volume and value growth targets for the different elements of the Irish agricultural, forestry, bioenergy, fishing and food sectors. A key target within the report is to increase the value of primary output from the agriculture, fisheries and forestry sectors by €1.5 billion.

The Food Harvest milk output target is an increase of 50 percent in milk production by 2020, relative to the average volume of milk production over the period 2007-2009. No volume target is set for beef or sheep production, rather a target of increasing the output value of each of sectors by 20 percent by 2020 is set relative to the average of the period 2007-2009. In the case of the pig sector the target is to increase output value by 50 percent by 2020. Food Harvest targets for forestry and bioenergy crops are not specified, but for the purposes of this analysis an annual growth target of 7,500 ha per year is used and forestry and for bioenergy crops a target of 4,000 ha per year is specified.

Food Harvest and GHG

Irish agriculture is primarily grassland based and is largely focused on milk, beef and sheep production. The total Irish cattle population in 2009 was almost 6 million, comprising approximately 1.1 million dairy cows, 1.1 million beef (suckler) cows and their associated progeny. While live exports of cattle take place, volumes are variable and remain relatively small. Between 5 percent and 15 percent of cattle disposals are accounted for by live exports, depending on the year in question. The bulk of calves born in Ireland are raised either as replacements for the breeding herd (dairy and beef) or will be fattened for slaughter, which usually occurs between 24 and 30 months of age.

Ireland has a population of just over 4 million people. Hence the scale of its agriculture sector means that it has a substantial export surplus in its main agricultural outputs. The dairy and beef sectors are heavily export focused with exports of beef and dairy products accounting for 90 percent and 80 percent of respective levels of production.

Of the many different agricultural production systems that exist, ruminant agriculture is noted for the GHG emissions it produces in the form of methane. As large ruminants, cattle are significant emitters on a per head basis. In addition to methane emissions from enteric fermentation and manure management, grass based production systems require nitrogen based fertilisers as a key production input. The use of nitrogen fertiliser creates GHG

emissions in the form of nitrous oxide. Given that Irish agriculture is largely based on dairy and beef production, these two sectors together generate the bulk of GHG emissions from Irish agriculture.

Achievement of the Food Harvest targets for dairy and beef is likely to result in some change in the intensity of production as well as in the composition and size of the Irish cattle herd. However, accurately assessing how the changing intensity of production or changes in the composition of the herd will affect GHG emissions is not a simple task, since many factors have to be taken into consideration. For example, bovine emission factors differ depending on whether the animal is a dairy cow or beef cow and also depend on the age of the animal and its gender. To add further complexity, GHG emissions per dairy cow increase as cows become more productive (higher milk yields), but GHG emissions decrease on a per unit of output basis. Emissions also vary as a function of fertiliser usage intensity. Fertiliser use in turn depends on, among other things, the level of fertiliser prices relative to feed prices, animal stocking densities and animal productivity. To capture the collective impact of these relationships and their complex interaction, a model for the agriculture sector and its GHG emissions is required.

For the Irish agriculture sector an economic model (the FAPRI-Ireland model) projects how the sector and its sub-sectors are likely to evolve over a projection period to 2020. Based on projected international supply and demand conditions (FAPRI, 2010) and assumptions concerning agricultural policy and the general macroeconomic environment, it is possible to project the level of input usage and associated costs (fertiliser, feed), agricultural output prices paid to farmers and the projected volume of agricultural production (animal numbers, milk yields, slaughter weights, crop areas, crop yields) in Ireland. Based on the projected level of agricultural production and input usage, projections of GHG emissions from Irish agriculture can be provided using a model for GHG emissions projections that is integrated with the FAPRI-Ireland economic model.

The FAPRI-Ireland model has been used extensively in the analysis of agricultural and trade policy changes over the last 10 years (Binfield et al., 2000, 2001, 2002, 2003a, 2003b, 2003c, 2006, 2007, 2008). In general model based projections simulated under a changed policy environment are compared with those simulated under a no policy change assumption. This means that for a given future year, the impact of the considered policy change can be inferred from the difference between model simulations that are made with and without the policy change.

In examining the impact of the Food Harvest Report we examine the consequences of achieving the output targets as set out in the Report. If the level of production under Scenario 1 in 2020 is less than the Food Harvest targets, then using the model it is possible to examine possible changes that would be required in order for the Food Harvest targets to be achieved. The level of GHG emissions produced, under the assumption that the Food Harvest targets are achieved (Scenario 2), can be determined and can be contrasted with the level of GHG emissions projected under the no policy change scenario (Scenario 1). In this manner it is possible to determine the likely change in GHG emissions from Irish agriculture that would arise with the achievement of the Food Harvest agricultural output targets.

Given the scale of agricultural GHG emissions as a proportion of the total GHG emissions produced in Ireland, GHG emissions from agriculture have greater implications for Ireland, than would be the case elsewhere in the EU (Breen et al 2010). Ireland faces a 20 percent GHG reduction target by 2020 under the EU Effort Sharing Agreement (OJ L 140, 5.6.2009, p136-148). As well as assessing the economic impact of the achievement of Food Harvest it is useful to explore the implications for the associated level of GHG emissions.

In summary, the modelling exercise reported in this paper can provide us with a number of important pieces of information:

Agricultural Production

- No policy change scenario (Scenario 1) projections of the volume and value of agricultural production in 2020;
- The volume and value of agricultural production, assuming that the Food Harvest 2020 targets are achieved (Scenario 2);

Agricultural GHG emissions

- Projections of the GHG emissions from the Irish agriculture in 2020 under a no policy change scenario (Scenario 1);
- Projections of the level of GHG emissions assuming that the Food Harvest 2020 targets are achieved (Scenario 2);

Agricultural Incomes

- Projections of the change in Irish agricultural sector income, relative to the no policy change (Scenario 1) level, that are likely to be associated with achievement of the Food Harvest 2020 targets;
- The change in the 2020 level of GHG emissions, relative to the no policy change (Scenario 1) level, that are associated with achievement of the Food Harvest 2020 targets (Scenario 2);

3. Scenario 1: No Policy Change Scenario

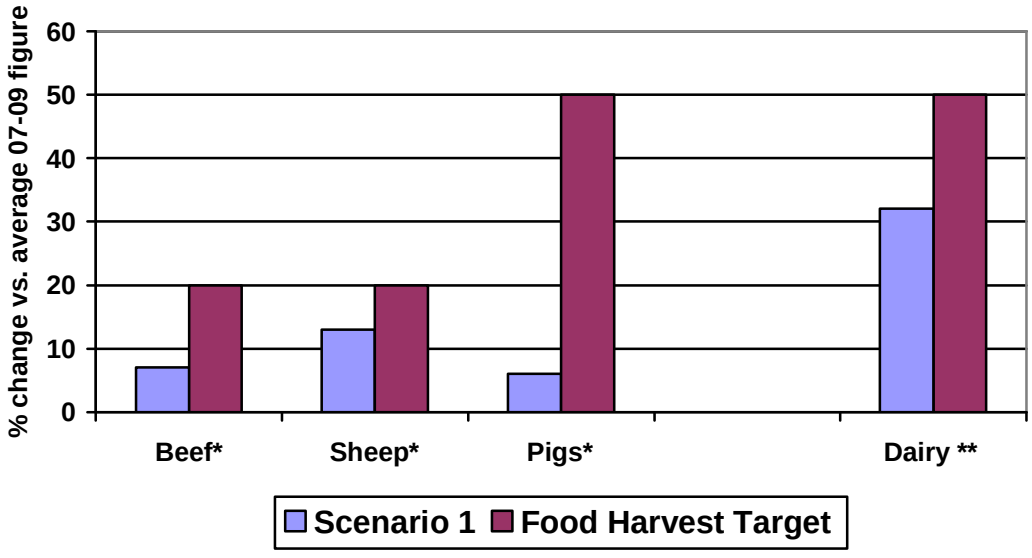
In developing a no policy change scenario (Scenario 1), a set of agricultural and trade policy assumptions needs to be considered. Generally this usually involves "locking in" currently agreed policies and assuming that they continue to prevail to the end of a 10 year projection period.

The no change agricultural policy assumptions that are used include:

- No CAP +2013 reform
- No conclusion of the WTO Doha Round
- No Mercosur-EU bilateral trade agreement
- Milk quotas are removed in 2015
- Annual planting rates of 7,500 ha for forestry and 2,000 ha for bioenergy crops
- The suckler cow welfare scheme & grassland sheep scheme are not renewed beyond their current agreed expiry dates (2012)
- No measures to assure achievement of the Food Harvest targets as might be developed by the Food Harvest implementation body are introduced.

The projected changes in the Scenario 1 levels of output in the beef, sheep, pig and dairy sectors between the 2007-2009 reference period and 2020 are shown in Figure 1. These are contrasted with the targets that are presented in the Food Harvest 2020 Committee's report.

Figure 1: **Scenario 1 increase in activity by 2020 & Food Harvest 2020 Targets**



Source: FAPRI-Ireland (2010)
*Note: * The output targets for beef, sheep and pigs are value targets. ** The output target for dairy is a volume target.*

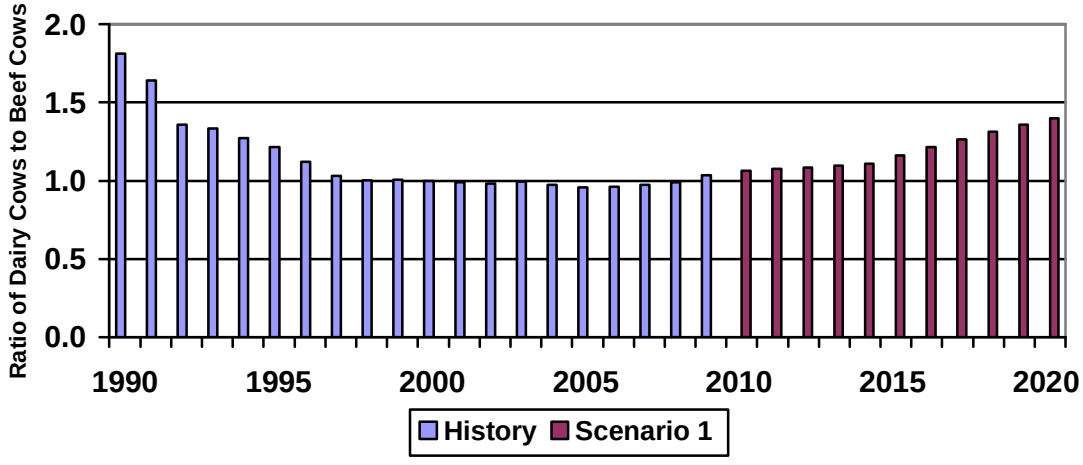
Under Scenario 1, the Food Harvest 2020 targets would not achieved by 2020. The value of output from the beef, sheep and pig sectors is projected to increase, but the magnitude of improvement in the value of output projected is significantly lower than the target set for

2020 in the Food Harvest report. Most of the improvement in beef, sheep and pig output value is based on projected increases in the prices of agricultural commodities that are expected over the next 10 years.

In the beef and sheep sectors, despite improved output prices, continuing low levels of profitability mean that levels of activity and associated beef and lamb production contract over the period to 2020. The projected decline in the Irish suckler cow herd means it would supply fewer calves, while the expected growth in the dairy cow herd mean that it would supply more calves. The impact of the contraction in the suckler herd on beef production is partially offset by the impact of the projected expansion in the dairy herd, so that the decrease in overall beef production is relatively small. Overall, an increase in the value of beef output of 7 percent is projected by 2020 relative to the reference period. By 2020 the value of Irish sheep output is projected to increase by 11 percent. In the case of pigs an expansion in the value of output of 17 percent is achieved by 2020 relative to the reference period. This increase is largely driven by improving prices for pigs. Under Scenario 1 Irish milk production is projected to expand by approximately 26 percent in volume terms by 2020.

Figure 2 shows how the ratio of dairy cow to beef cows is expected to evolve under Scenario 1. The projected changes in milk and beef production have implications for the composition of the Irish cattle herd. The proportion of the overall cattle herd that is the progeny of dairy cows increases, while the share from the beef herd declines over the projection period. By 2020 under Scenario 1, the projected increase in the number of dairy cows and the fall in the number of suckler cows, returns the ratio of dairy cows to beef cows to a level last observed in the mid 1990's.

Figure 2: Ratio of Dairy Cows to Beef Cows in the Irish Cattle Herd: Historical and Scenario 1 Projections



Source: FAPRI-Ireland (2010)

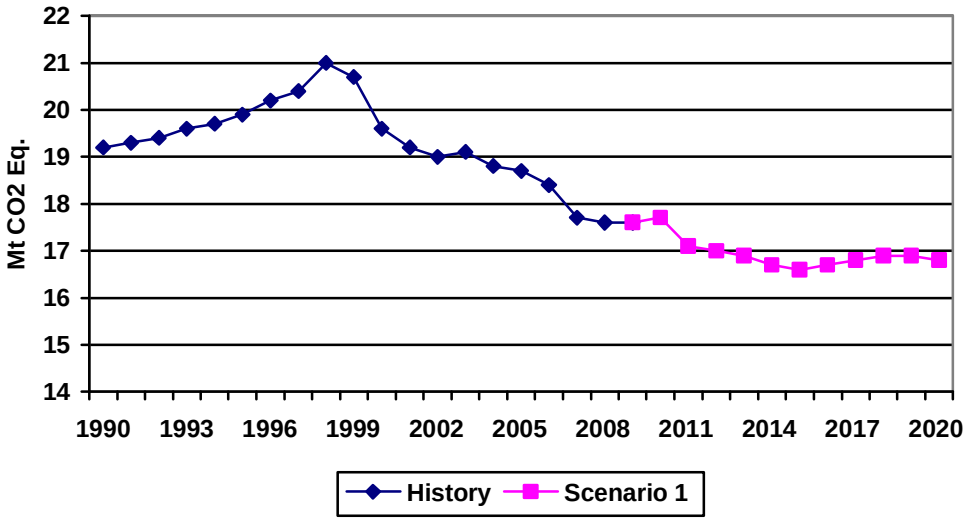
Under Scenario 1 total Irish cereal area contracts by 15 percent between 2007-2009 and 2020. The base period 2007-2009, which was characterised by large cereal areas harvested, explains some of the projected decline though the flat grain prices over the projection period when combined with improving milk prices lead to a decline in area sown with cereals. Yields per hectare are projected to improve over the period 2007-2009 to 2020. However, the expected growth in yields is insufficient to offset the decline in area harvested and Irish production of cereals under Scenario 1 is projected to decline. The decline in production of barley exceeds the decline in the production of wheat as the area share of barley contracts and wheat area share expands under Scenario 1.

Scenario 1 GHG emissions from Irish Agriculture

The activity projections for various sectors of Irish agriculture, including dairy, beef, sheep and pigs under Scenario 1 are used to calculate the level of GHG emissions for each year out to 2020. These projected GHG emissions, along with historical emissions since 1990, are shown in Figure 3.[1] The decline in GHG emissions that has taken place over the period since 1998 is notable. Over the projection period, aggregate agriculture GHG emissions exhibit a decline relative to the 2005 level of 10 percent by 2020. However, the relatively flat projections path for the aggregate level of emissions from 2010 onwards masks notable changes in terms of the contribution of individual agricultural sub-sectors to total GHG emissions from the Irish agricultural sector.

[1] It is possible to express GHG emissions from agriculture either inclusive or exclusive to emission from fuel combustion. Unless otherwise stated GHG figures in the main text and graphics are exclusive of fuel combustion. The tables in this appendix present detailed projections for GHG emissions both inclusive and exclusive of emissions from fuel combustion.

Figure 3: Historical and projected Scenario 1 GHG emissions from Irish Agriculture



Source: FAPRI-Ireland (2010)
Note: Excludes agricultural emissions from fuel combustion

Over the Scenario 1 projection period, the expansion in milk output of 26 percent, that is projected to arise following the elimination of the milk quota in 2015, generates an increase in GHG emissions. These increased emissions are associated with projected increases in dairy cow numbers and dairy cow productivity. However, the projected increase in dairy emissions is offset by a contraction in the size of the suckler cow herd, which reduces the GHG emissions associated with beef production. Emissions from sheep are also projected to decline as inventories of sheep decline under Scenario 1. The net effect of projected developments under the no policy change scenario (Scenario 1) is to leave agricultural GHG emissions in 2020, at just under 16.8 mt CO_2 eq.

Agricultural Sector Output, Costs and Income under Scenario 1

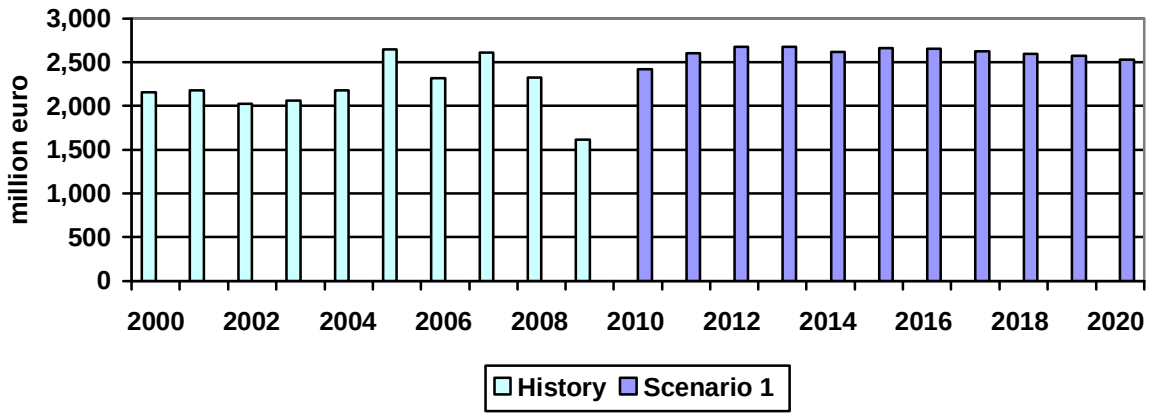
Under Scenario 1, Irish agricultural sector output value is projected to increase by 11 percent relative to the average level in the 2007-2009 reference period by 2020. This increase in output value is based on an increase in the value of milk output in particular, and a more modest increase in the value of output from the other main sub-sectors of Irish agriculture.

In aggregate, by 2020 the expenditure on production costs decreases by almost 1 percent by 2020 relative to the average level of 2007 to 2009. While the lack of increase in these costs in the period to 2020 might seem optimistic, it should be noted that the reference period 2007-09 was characterised by historically high feed and fertilizer prices, so the base figure is quite high. In addition some of the inflation in the price of particular input items, is offset through productivity gains which reduce input utilisation per unit output (notably in the case of feed and fertiliser)

Over the short term, agricultural income recovers from the very low level observed in 2009 due to higher output prices and in particular due to increases in the volume of milk production. Over the medium term increases in the cost of production, the ending of the suckler cow and grassland sheep schemes and reduced agri-environmental payments mean that not all of the benefits of higher output prices are captured in terms of increased agricultural sector income.

Figure 4 shows historical agricultural sector income in Ireland and Scenario 1 projections to 2020. Agricultural income is projected to be just over €2,530 million in 2020. This represents a 16 percent increase in agricultural sector income over the average of 2007 to 2009.

Figure 4: Irish Agricultural Sector Income: Historical Values and Scenario 1 Projections



Source: FAPRI-Ireland (2010)

4. Scenario 2: Food Harvest Scenario

Section 3 showed that under Scenario 1, the Food Harvest growth targets for beef, sheep, pig and dairy would not be achieved by 2020 and that by 2020 GHG emissions from Irish agriculture would decline by 10 percent relative to the 2005 level. We now consider how the Food Harvest targets could be met for these sectors and the resultant consequences for GHG emissions from agriculture. A number of possible initiatives are listed below and these could contribute both individually and collectively to the achievement of the Food Harvest targets. Other policies and initiatives may arise as a result of the work of the Food Harvest implementation group.

A) Increase in Irish farm gate prices relative to those of our competitors

One possibility is that through the Food Harvest implementation strategy, initiatives would be put in place that would lead to a *relative* improvement in Irish farm gate milk, beef, lamb and pig prices. This would lead to the improvement in enterprise profitability necessary for an increase of Irish milk, beef, sheep and pig production over and above the level that is projected under Scenario 1, and would also lead to an increase in the value of output of the overall sector.

It is important to emphasise that any price increase would need to be relative to the prices received by Irish agriculture's competitor countries. A uniform increase in prices in Ireland and competitor countries would improve profitability in Ireland but would also improve profitability in other countries. Such a price increase would lead to an increase in beef and milk production internationally which would in time be likely to put downward pressure on Irish and European beef and milk prices, and in such circumstances any increase in output in Ireland is more likely to be transitory.

By contrast, a relative (or real) price improvement, whereby Irish prices increase relative to prices in competitor countries, would allow for an increase in Irish production without inducing an increase in production in competitor countries. The production increase in Ireland under such circumstances is more likely to be enduring. Increased Irish production would not adversely affect international prices, since Ireland is a relatively small player on global agricultural markets.

It should be emphasised that generating a relative price improvement of this kind would not be trivial and is likely to be difficult to achieve. It could arise through, for example, an

improvement in the position of Irish food exports on the EU market which could deliver a higher wholesale prices which in turn could lead to an increase in Irish farm gate prices.

B) Cost savings ex farm gate

Food industry consolidation could deliver savings in processing costs, marketing, R&D, distribution etc., which could lead to higher prices at farm level. However, market power at various points in the supply chain could be a limiting factor in terms of the additional benefit delivered to farmers from such cost savings.

C) Increased real Irish farm gate prices (cost savings within the farm gate)

Another possibility that would aid the achievement of the Food Harvest targets is an increase in Irish farm gate prices relative to the costs of production (a real price increase). Such a reduction in productions costs could be brought about through better farm management skills and by increased adoption of technologies at farm level in Ireland which reduce costs of production. Other being things equal, a reduction in the costs of production in Ireland, increases real prices at farm level, and in economic terms is equivalent to a price increase relative to competitor countries.

In reality some combination of the above approaches would be required to deliver the economic impetus to achieve the growth targets that have been set out in the Food Harvest Report. Relying exclusively on one of the above approaches as a strategy for delivering growth is probably unrealistic and inappropriate.

Scenario 2 GHG emissions from Irish Agriculture

Assumptions for Scenario 2 include:

- The achievement of the Food Harvest targets for dairy, beef, sheep and pig sectors;
- Annual planting rate of 7,500 ha for forestry and 4,000 ha for bioenergy crops;
- As per the Scenario 1 assumptions, no major external policy changes occur
    - i.e. No CAP +2013, No WTO and No Mercosur bilateral trade agreements.

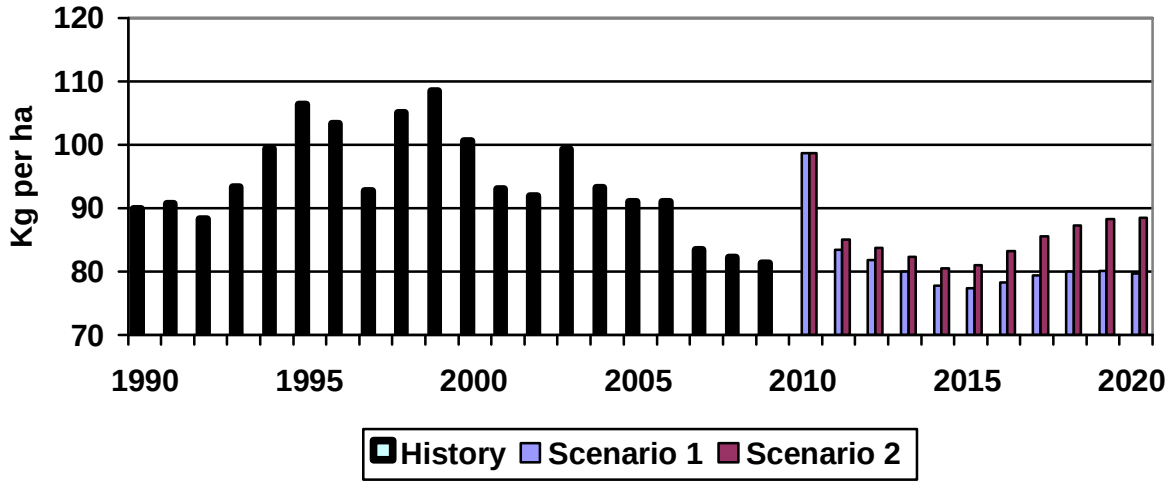
Just as in Scenario 1, for this set of GHG projections we do not consider the potential of abatement technologies to reduce emissions.

Using the FAPRI-Ireland model, through an iterative process Irish farm gate milk, beef, sheep and pigs prices are adjusted until the increase in the value and volume of output for

these sectors is in line with the targets set for 2020 in the Food Harvest report. For a given output volume, higher output price increase the value of that output, but since this is an economic model higher output prices also lead to increased volumes of production which also contribute to the increase in the value of output.

In Figure 5 the intensity of nitrogen fertiliser usage per hectare of grassland is shown under Scenario 1 and the Scenario 2. The increased intensity of dairy production under the FH scenario causes some increase in the usage of nitrogen but this is partially offset by the reduction in the suckler herd. The net result is an 11 percent increase in fertiliser usage per ha of grassland under Scenario 2 (Food Harvest) relative to the Scenario 1 by 2020. Other things being equal, this increase in nitrogen usage has adverse consequences for GHG emissions.

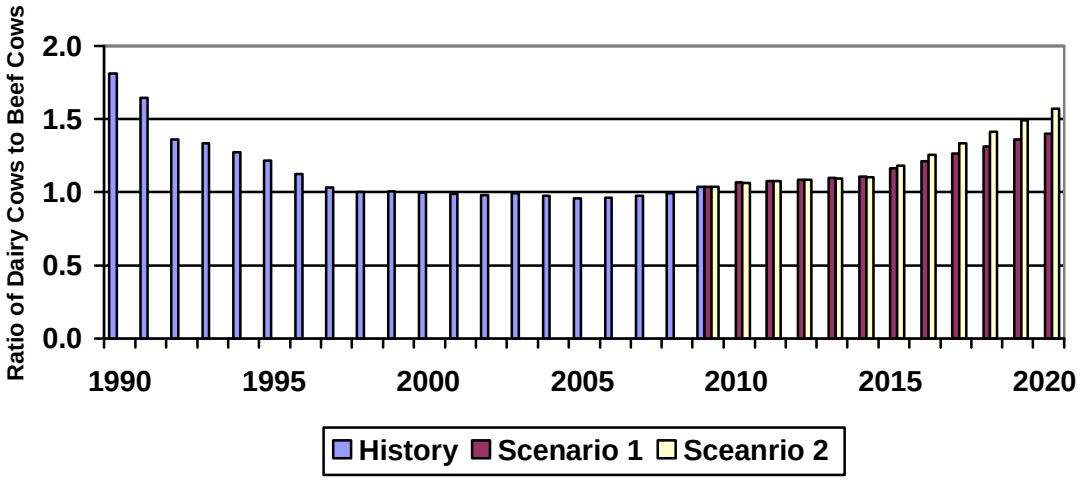
Figure 5: Intensity of Nitrogen Usage on grassland in Ireland: Historical data and Projections under Scenario 1 and Scenario 2



Source: FAPRI-Ireland (2010)

Figure 6 shows the ratio of dairy cow to beef cows and how that ratio would evolve under Scenario 2 (Food Harvest). The increase in the number of dairy cows and the fall in the number of suckler cows under Scenario 2 are projected to return the ratio to levels last seen in the early 1990's. This has important consequences for carcass weights since animals of dairy origin typically have lower slaughter weights. Herd composition also has consequences for the level of GHG emissions, given that dairy cows produce more emissions per head than beef cows

Figure 6: Ratio of Dairy Cows to Beef Cows in the Irish Cattle Herd: Historical data and Projections under Scenario 1 and Scenario 2



Source: FAPRI-Ireland (2010)

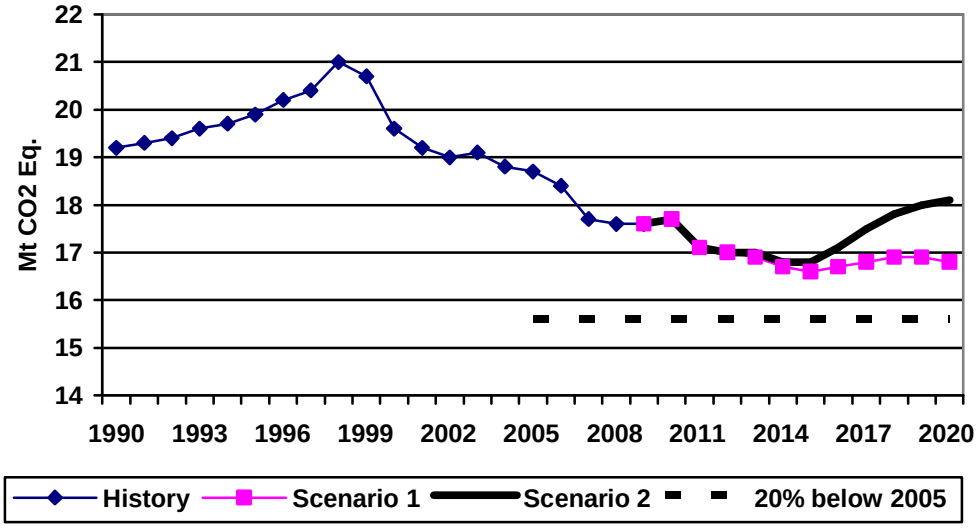
Under Scenario 2 the cereal area harvested in 2020 is 4 percent lower than under Scenario 1. The increased levels of output (value and volume) from the principal grassland sectors (dairy, beef and sheep) required to achieve the Food Harvest output targets are driven by increased real output prices for these commodities. The improvement in real milk, beef and lamb prices under Scenario 2 causes land to switch from grain to grassland (pasture, hay and silage). Given the relative scale of grassland and tillage land use in Ireland marginal increases in grassland land use can translate into much larger changes in cereal area.

The activity levels specified in Scenario 2 can be used to estimate the level of GHG emissions from Irish agriculture and these can then be compared with both the historical level of GHG emissions and the GHG emissions projected under Scenario 1. In Figure 7 historical GHG emissions are presented along with the projected level of GHG emission under Scenario 1 and Scenario 2 (Food Harvest).

Under Scenario 2 (Food Harvest) GHG emissions increase relative to Scenario 1, principally due to the increase in dairy cow numbers and associated dairy emissions which more than offset the contraction in emissions arising as a result of the fall in the size of the suckler herd over the projection period.

By 2020 the level of GHG emissions in Scenario 2 is almost 18.1 million tonnes CO2 Eq. This level of emissions represents an increase over the Scenario 1 level in 2020 of about 1.2 million tonnes CO2 Eq.

Figure 7: Historical, projected Scenario 1 and projected Scenario 2 GHG emissions from Irish Agriculture



Source: FAPRI-Ireland (2010)

It is important to note that the projected level of emissions under both Scenario 1 and the Scenario 2 do not consider potential emission reductions that might arise through the adoption of abatement technologies.

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

Agricultural GHG emission projections for Scenario 1 and Scenario 2 are summarised in Table 1.

Table 1: Historical, projected Scenario 1 and projected Scenario 2 GHG Emissions from Irish Agriculture

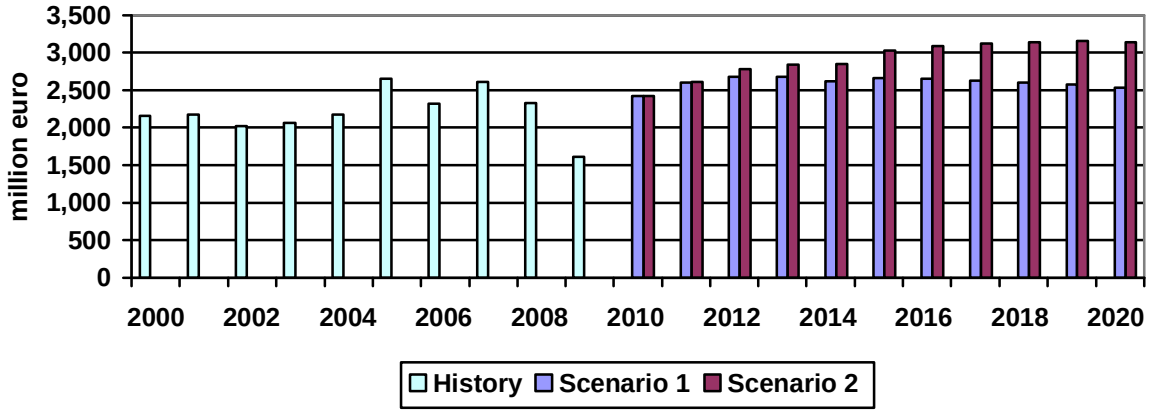
	2005	2020	change	% change
	Mt CO2 Eq.			%
Scenario 1	18.7	16.8	-1.9	-10
Scenario 2		18.1	-0.6	-3
change		1.3		

Source: FAPRI-Ireland (2010)

Agricultural Sector Output, Input and Income under Scenario 2

Under Scenario 2 agricultural sector output increases by 14 percent (€ 861 million) relative to the Scenario 1 level by 2020. In aggregate, input expenditure under Scenario 2 increases by 6 percent by 2020 relative to the Scenario 1. Under Scenario 2, there is an increase in agricultural sector income of 24 percent (€ 609million) relative to Scenario 1 by 2020. This increase mainly reflects the increase in the value of milk output and the stronger milk price assumption required to provide the 50 percent volume increase in milk production target in the Food Harvest report. In addition, the increase in agricultural income in Scenario 2 relative to Scenario 1 reflects the fact that beef production with a low level of profitability is being replaced by milk production with a higher level of profitability.

Figure 8: Irish Agricultural Sector Income: Historical, Scenario 1 Projections and Scenario 2 Projections



Source: FAPRI-Ireland (2010)

Alternatively, the Scenario 2 income figure would represent an increase of just over € 958 million or 44 percent relative to the average for the period 2007-2009. Income levels for Scenario 1 and Scenario 2 are summarised in Table 2.

Table 2: Historical, projected Scenario 1 and projected Scenario 2 sectoral Income in Irish Agriculture

	2007-2009 average	2020	change	% change
	Million Euro			%
Scenario 1	**2,182**	**2,531**	**349**	**16**
Scenario 2		**3,140**	**958**	**44**
change	**-**	**609**	**-**	**-**

Source: FAPRI-Ireland (2010)

5. Conclusions

The overall level of uncertainty regarding future levels of GHG emissions from agriculture remains high, even when we abstract from the uncertainty related to agricultural and trade policy and the general macroeconomic environment that currently prevails.

What is clear, however, is that in the absence of the widespread adoption of practical GHG abatement technologies over the next 10 years, increases in agricultural output as set out in the Food Harvest targets would lead to increased GHG emissions from the Irish agriculture sector.

6. Caveats: Issues of uncertainty surrounding the projections

Some of the factors that should be taken into consideration when interpreting these results are detailed below.

Developments in the Suckler Herd

Under Scenario 1 and Scenario 2, Irish beef cow numbers decline relative to 2009 levels. If, on the other hand, suckler cow numbers remain close to current levels, Irish agricultural GHG emissions in 2020 would be higher than projected under both Scenario 1 and Scenario 2. Under each of the scenarios, the Suckler Cow Welfare Scheme is not maintained beyond its expiry date. A change to this policy would support Irish suckler cow numbers.

Extent of the Live Cattle Trade

If the share of live exports in total cattle disposals were to increase and if the age profile of these exports was maintained or became younger (for example if exports of male dairy calves for veal production increased) then this would, other things equal, lead to lower GHG emissions under both Scenario 1 and Scenario 2. In effect the emissions from these animals would be exported. However, such an increase in live exports would negatively affect the capacity of the agricultural sector to achieve the growth target for beef sector output value set n the Food Harvest Committee report.

Intensity of Fertiliser Use

Fertiliser use is highly dependent on animal stocking rates. In the analysis produced here there is no marked increase in nitrogen usage per ha of grassland because the decline in beef cow numbers makes a greater land area available for dairy production. An alternative outcome could involve some land abandonment and an intensification of bovine production on a smaller land base which would be likely to require more intensive nitrogen usage, resulting in higher emissions of GHGs than projected here.

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APPENDIX TABLES

Table A1: Scenario 1 Output, Input and Income in Agriculture

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2007-2009 vs. 2020
Livestock	**2,254**	**2,316**	**2,378**	**2,451**	**2,471**	**2,469**	**2,479**	**2,473**	**2,472**	**2,474**	**2,487**	**2,493**	**4%**
of which: *cattle*	1,468	1,504	1,545	1,601	1,611	1,618	1,634	1,635	1,636	1,639	1,650	1,655	7%
pigs	307	324	334	335	330	328	329	328	328	330	331	331	6%
sheep and lambs	**2,254**	**2,316**	**2,378**	**2,451**	**2,471**	**2,469**	**2,479**	**2,473**	**2,472**	**2,474**	**2,487**	**2,493**	13%
Livestock Products	**1,142**	**1,618**	**1,669**	**1,639**	**1,651**	**1,667**	**1,783**	**1,860**	**1,922**	**1,969**	**2,005**	**2,025**	**34%**
of which: *milk*	1,100	1,576	1,628	1,597	1,610	1,626	1,741	1,819	1,880	1,927	1,963	1,984	35%
Crops	**1,372**	**1,512**	**1,461**	**1,467**	**1,489**	**1,518**	**1,536**	**1,545**	**1,551**	**1,556**	**1,561**	**1,566**	**1%**
Total Cereals	107	194	178	179	177	177	175	175	174	174	173	171	-6%
Root Crops	82	99	100	99	98	97	94	92	89	87	84	81	-8%
Forage Plants-Output	852	908	856	860	882	910	928	936	941	946	950	955	3%
Goods output producer prices	**4,768**	**5,446**	**5,508**	**5,557**	**5,612**	**5,655**	**5,798**	**5,878**	**5,944**	**5,999**	**6,053**	**6,084**	**12%**
Contract Work	269	262	258	262	269	278	286	295	302	309	316	322	15%
Subsidies less taxes on products	15	-10	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	0.0%
Ag. Output basic prices	**5,051**	**5,698**	**5,751**	**5,804**	**5,866**	**5,917**	**6,069**	**6,158**	**6,231**	**6,293**	**6,354**	**6,391**	**12%**
Intermediate consumption	**4,068**	**3,973**	**3,794**	**3,768**	**3,809**	**3,886**	**3,960**	**4,027**	**4,090**	**4,147**	**4,198**	**4,245**	**1%**
Feeding stuffs	1,079	1,013	971	920	898	897	904	917	932	945	957	967	-13%
Fertilisers	416	421	342	340	345	350	359	365	371	374	376	376	-12%
Energy & Lubricants	303	335	342	354	362	368	371	373	376	378	381	384	19%
Forage Plants-Input	844	892	840	844	866	895	913	921	926	931	935	940	3%
Contract Work-Input	269	262	258	262	269	278	286	295	302	309	316	322	15%
Gross value added basic prices	**952**	**1,725**	**1,957**	**2,037**	**2,057**	**2,031**	**2,109**	**2,131**	**2,141**	**2,147**	**2,156**	**2,147**	**44%**
Fixed capital consumption	756	724	707	701	710	727	749	773	797	821	846	872	17%
Net value added basic prices	**196**	**1,097**	**1,349**	**1,434**	**1,446**	**1,403**	**1,459**	**1,458**	**1,443**	**1,425**	**1,409**	**1,374**	**70%**
Subsidies less taxes on production	1,846	1,830	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	-6%
Factor income	**2,042**	**2,831**	**3,000**	**3,085**	**3,097**	**3,054**	**3,110**	**3,109**	**3,094**	**3,075**	**3,060**	**3,025**	**15%**
Compensation of employees	427	409	400	407	420	433	445	457	467	476	485	494	13%
Operating surplus	**1,615**	**2,422**	**2,600**	**2,679**	**2,677**	**2,621**	**2,664**	**2,652**	**2,627**	**2,599**	**2,575**	**2,531**	**16%**

Source: FAPRI-Ireland GOLD Model (2010).
Historical data, CSO *Output, Input and Income in Agriculture.*

Table A2: Historical and Projected Scenario 1 GHG emissions from Irish Agriculture

	1990	1995	2000	2005	2010	2015	2020
	Gg	*Gg*	*Gg*	*Gg*	*Gg*	*Gg*	*Gg*
Total CH4 from Fermentation(CH4 Gg/Yr)	452.07	458.71	452.52	437.48	411.85	396.66	405.79
Total CH4 from Manure (CH4 Gg/Yr)	110.69	111.84	109.90	107.07	102.43	98.86	102.07
Total CH4 from Livestock	562.76	570.55	562.42	544.55	514.28	495.52	507.86
CO2 equivalent of CH4	11,818.00	11,981.45	11,810.80	11,435.60	10,799.90	10,405.94	10,665.03
Total N2O emitted from Slurry System(Gg N2O/yr)	0.18	0.19	0.19	0.18	0.17	0.16	0.17
Total N2O from Solid System(Gg N2O/yr)	1.10	1.18	1.20	1.11	1.02	0.97	0.97
Total N2O from Pasture System(Gg N2O/yr)	9.04	9.32	9.33	9.10	8.30	7.95	7.90
Direct N2O emissions from fertiliser (N2O Gg/yr)	7.34	8.30	7.84	6.81	7.01	5.54	5.61
Direct N2O from soils - FAW (Gg N2O/yr)	1.49	1.56	1.61	1.53	1.46	1.39	1.42
Direct N2O from N-Fixing Crops N2O (Gg N2O/yr))	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Direct N2O-Crop Residue (Gg N2O/yr)	0.39	0.38	0.43	0.35	0.20	0.19	0.18
Indirect Emissions of N2O due to volatilisation of NH3 from manure and fertiliser inputs (N2O Gg/Yr)	1.42	1.48	1.55	1.39	1.31	1.23	1.24
Nitrous Oxide Emissions from Leaching (Gg of N2O/yr)	2.92	3.16	3.09	2.83	2.77	2.40	2.43
Total Nitrous Oxide	23.89	25.59	25.22	23.31	22.24	19.85	19.94
CO2 equivalent of N2O	7,404.66	7,931.89	7,819.38	7,227.54	6,894.77	6,153.23	6,182.07
Total Agriculture CO2 equivalent emissions	19,222.66	19,913.34	19,630.18	18,663.14	17,694.67	16,559.17	16,847.10
Fuel Combustion	689.16	950.92	858.14	899.52	850.00	850.00	850.00
Total CO2e Gg	19,911.82	20,864.26	20,488.32	19,562.66	18,544.67	17,409.17	17,697.10

Source: FAPRI-Ireland (2010).

Table A3: Scenario 1 Activity Levels for Irish Agriculture - Housing Period

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total Cattle	000 head	5,848.1	5,661.2	5,577.9	5,506.0	5,449.4	5,404.1	5,403.1	5,435.0	5,452.9	5,442.4	5,404.7
Dairy Cows	000 head	1,107.0	1,117.2	1,107.9	1,106.8	1,109.7	1,111.8	1,166.8	1,204.5	1,230.6	1,247.3	1,256.6
All Other Cattle (excl. Dairy Cows)	000 head	4,741.1	4,544.0	4,470.1	4,399.3	4,339.7	4,292.3	4,236.3	4,230.6	4,222.3	4,195.1	4,148.1
Other Cows	000 head	1,069.5	1,049.4	1,029.6	1,021.9	1,012.0	1,003.9	1,004.3	992.9	974.1	950.8	925.3
Dairy Heifers	000 head	222.5	215.9	227.2	227.7	233.6	243.1	249.6	254.0	256.7	257.9	260.8
Other Heifers	000 head	118.5	106.9	102.1	99.5	96.1	93.6	91.6	90.4	88.8	86.7	84.1
Cattle < 1 yrs	000 head	1,565.1	1,507.3	1,477.9	1,448.5	1,423.4	1,401.1	1,371.7	1,373.1	1,377.9	1,376.7	1,366.4
Cattle < 1 yrs - male	000 head	772.9	788.3	773.0	757.6	744.4	732.8	717.4	718.1	720.6	720.0	714.6
Cattle < 1 yrs - female	000 head	792.2	719.0	705.0	690.9	678.9	668.3	654.3	655.0	657.2	656.7	651.8
Cattle 1 - 2 yrs	000 head	1,174.0	1,123.1	1,101.2	1,079.3	1,060.6	1,044.0	1,022.1	1,023.1	1,026.7	1,025.8	1,018.1
Cattle 1 - 2 yrs - male	000 head	654.8	678.3	665.1	651.8	640.5	630.5	617.3	617.9	620.0	619.5	614.9
Cattle 1 - 2 yrs - female	000 head	519.2	444.8	436.1	427.5	420.0	413.5	404.8	405.2	406.6	406.3	403.2
Cattle > 2 yrs	000 head	533.7	483.8	474.4	464.9	456.9	449.7	440.3	440.7	442.3	441.9	438.6
Cattle > 2 yrs - male	000 head	300.4	277.6	272.2	266.8	262.2	258.1	252.7	252.9	253.8	253.6	251.7
Cattle > 2 yrs - female	000 head	233.3	206.2	202.1	198.1	194.7	191.6	187.6	187.8	188.5	188.3	186.9
Bulls	000 head	57.8	57.6	57.6	57.4	57.3	57.0	56.7	56.4	56.0	55.4	54.9
Total Sheep	000 head	4,694.6	4,986.0	5,362.1	5,644.8	5,383.1	5,186.3	5,086.8	5,024.8	4,981.1	4,954.3	4,941.2
Ewes Lowland	000 head	1,782.9	2,029.2	2,233.9	2,402.2	2,262.1	2,144.3	2,068.1	2,013.6	1,973.3	1,946.2	1,930.2
Ewes Upland	000 head	445.7	458.1	478.9	496.1	494.8	475.4	461.5	450.7	442.2	435.9	431.4
Rams	000 head	66.9	74.6	81.4	86.9	82.7	78.6	75.9	73.9	72.5	71.5	70.8
Other Sheep>1	000 head	98.3	121.0	135.5	148.5	140.3	130.3	122.5	116.4	111.7	108.4	106.3
Lambs	000 head	2,300.8	2,303.1	2,432.5	2,511.1	2,403.2	2,357.7	2,359.0	2,370.2	2,381.4	2,392.3	2,402.4

Source: FAPRI-Ireland (2010)

Table A4: Scenario 1 Activity Levels for Irish Agriculture - Pasture Period

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total Cattle	000 head	6,531.9	6,323.1	6,230.2	6,149.9	6,086.6	6,036.0	6,034.9	6,070.6	6,090.5	6,078.8	6,036.6
Dairy Cows	000 head	1,117.9	1,128.7	1,118.8	1,117.7	1,120.8	1,123.0	1,181.5	1,221.5	1,249.2	1,267.1	1,276.9
All Other Cattle (excl. Dairy Cows)	000 head	5,414.0	5,194.4	5,111.3	5,032.2	4,965.8	4,913.0	4,853.4	4,849.0	4,841.2	4,811.8	4,759.7
Other Cows	000 head	1,130.3	1,109.1	1,088.2	1,080.1	1,069.6	1,061.0	1,061.4	1,049.4	1,029.5	1,004.8	977.9
Dairy Heifers	000 head	215.3	208.9	219.9	220.4	226.0	235.2	241.6	245.8	248.4	249.6	252.4
Other Heifers	000 head	127.2	114.8	109.6	106.8	103.1	100.5	98.3	97.0	95.3	93.0	90.2
Cattle < 1 yrs	000 head	1,527.2	1,456.4	1,429.7	1,402.6	1,380.0	1,360.0	1,334.9	1,336.9	1,341.6	1,340.4	1,330.8
Cattle < 1 yrs - male	000 head	750.6	715.8	702.6	689.4	678.2	668.4	656.1	657.1	659.4	658.8	654.1
Cattle < 1 yrs - female	000 head	776.6	740.6	727.0	713.3	701.7	691.6	678.8	679.9	682.2	681.6	676.8
Cattle 1 - 2 yrs	000 head	1,454.7	1,387.3	1,361.8	1,336.1	1,314.5	1,295.5	1,271.6	1,273.5	1,278.0	1,276.8	1,267.7
Cattle 1 - 2 yrs - male	000 head	857.3	817.6	802.6	787.4	774.7	763.5	749.4	750.5	753.1	752.5	747.1
Cattle 1 - 2 yrs - female	000 head	597.4	569.7	559.3	548.7	539.8	532.0	522.2	523.0	524.8	524.4	520.6
Cattle > 2 yrs	000 head	890.5	849.2	833.7	817.9	804.7	793.1	778.4	779.6	782.3	781.6	776.1
Cattle > 2 yrs - male	000 head	598.9	571.1	560.7	550.1	541.2	533.4	523.5	524.3	526.1	525.7	521.9
Cattle > 2 yrs - female	000 head	291.6	278.1	273.0	267.9	263.5	259.7	254.9	255.3	256.2	256.0	254.1
Bulls	000 head	68.7	68.7	68.5	68.4	68.0	67.7	67.2	66.8	66.1	65.5	64.6
Total Sheep	000 head	4,694.6	4,986.0	5,362.1	5,644.8	5,383.1	5,186.3	5,086.8	5,024.8	4,981.1	4,954.3	4,941.2
Lowland Ewes	000 head	1,782.9	2,029.2	2,233.9	2,402.2	2,262.1	2,144.3	2,068.1	2,013.6	1,973.3	1,946.2	1,930.2
Upland Ewes	000 head	445.7	458.1	478.9	496.1	494.8	475.4	461.5	450.7	442.2	435.9	431.4
Rams	000 head	66.9	74.6	81.4	86.9	82.7	78.6	75.9	73.9	72.5	71.5	70.8
Other Sheep>1	000 head	98.3	121.0	135.5	148.5	140.3	130.3	122.5	116.4	111.7	108.4	106.3
Lambs	000 head	2,300.8	2,303.1	2,432.5	2,511.1	2,403.2	2,357.7	2,359.0	2,370.2	2,381.4	2,392.3	2,402.4

Source: FAPRI-Ireland (2010)

Table A5: Scenario 1 Activity Levels for Irish Agriculture (PART I)

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Pigs	000 head	1,504.84	1,526.46	1,545.21	1,557.73	1,563.06	1,562.84	1,559.04	1,553.47	1,547.16	1,541.00	1,535.13
Gilts in Pig	000 head	21.86	22.20	22.40	22.50	22.55	22.57	22.57	22.56	22.55	22.54	22.52
Gilts not yet Served	000 head	18.83	19.12	19.30	19.39	19.42	19.44	19.44	19.43	19.43	19.42	19.40
Sows in Pig	000 head	97.32	98.84	99.76	100.20	100.40	100.48	100.49	100.46	100.41	100.35	100.29
Other Sows for Breeding	000 head	30.79	31.27	31.56	31.70	31.77	31.79	31.79	31.78	31.77	31.75	31.73
Boars	000 head	1.97	2.00	2.02	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03
Pigs 20 Kg +	000 head	1,010.58	936.19	950.53	963.58	972.46	976.24	976.07	973.33	969.30	964.74	960.33
Pigs Under 20 Kg	000 head	420.75	395.21	400.89	405.81	409.10	410.50	410.44	409.44	407.98	406.32	404.71
Poultry	000 head	13,814.66	13,701.29	13,809.27	14,048.69	14,410.08	14,869.29	15,367.74	15,896.05	16,455.77	17,055.46	17,668.15
Layer	000 head	1,761.89	1,747.43	1,761.20	1,791.74	1,837.83	1,896.39	1,959.96	2,027.34	2,098.73	2,175.21	2,253.35
Broiler	000 head	11,381.48	11,288.08	11,377.04	11,574.29	11,872.03	12,250.36	12,661.01	13,096.27	13,557.41	14,051.47	14,556.25
Turkey	000 head	671.29	665.79	671.03	682.67	700.23	722.54	746.76	772.44	799.63	828.77	858.55
Horses	000 head	98.10	98.10	98.10	98.10	98.10	98.10	98.10	98.10	98.10	98.10	98.10
Mules	000 head	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80	8.80
Goats	000 head	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10	10.10
Fertiliser	kg of N	363,046	310,858	304,524	297,239	288,700	286,482	288,564	291,408	292,720	292,365	290,323

Source: FAPRI-Ireland (2010)

Table A6: Scenario 1 Activity Levels for Irish Agriculture (PART II)

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Pulses Production	tonnes	18,600	18,600	18,600	18,600	18,600	18,600	18,600	18,600	18,600	18,600	18,600
Potatoes Production	tonnes	400,572	404,052	400,671	393,956	383,519	370,981	356,881	341,964	326,804	311,755	296,946
Sugar Beet Production	tonnes	0	0	0	0	0	0	0	0	0	0	0
Barley Production	tonnes	1,180,069	1,096,719	1,099,206	1,088,793	1,078,110	1,069,924	1,061,043	1,054,265	1,047,429	1,040,933	1,034,247
Oats Production	tonnes	143,024	136,733	131,284	128,349	126,379	125,342	124,531	124,044	123,719	123,512	123,325
Wheat Production	tonnes	600,428	609,357	639,852	658,756	674,179	688,332	699,597	709,871	718,040	724,602	729,410
Pasture	hectares	2,131,235	2,132,149	2,132,056	2,129,688	2,127,349	2,128,160	2,130,045	2,131,396	2,132,195	2,132,910	2,133,864
Hay	hectares	224,754	223,754	223,334	223,346	223,407	222,939	222,399	222,013	221,771	221,574	221,368
Silage	hectares	1,023,880	1,019,324	1,017,413	1,017,465	1,017,745	1,015,612	1,013,150	1,011,395	1,010,291	1,009,392	1,008,455
Rough Grazing	hectares	441,200	441,200	441,200	441,200	441,200	441,200	441,200	441,200	441,200	441,200	441,200
Wheat Area Harvested	000 ha	68.7	70.8	73.2	75.1	76.6	77.8	78.7	79.3	79.7	79.9	79.9
Spring Wheat Area Harvested	000 ha	15.8	16.3	16.8	17.2	17.6	17.9	18.1	18.2	18.3	18.4	18.4
Winter Wheat Area Harvested	000 ha	52.9	54.5	56.4	57.8	59.0	59.9	60.6	61.1	61.4	61.5	61.6
Barley Area	000 ha	168.6	169.3	167.4	165.7	163.9	162.3	160.5	158.7	156.9	155.2	153.6
Spring Barley Area Harvested	000 ha	150.3	150.9	149.2	147.7	146.1	144.7	143.0	141.4	139.9	138.4	136.9
Winter Barley Area Harvested	000 ha	18.3	18.4	18.2	18.0	17.8	17.6	17.4	17.2	17.1	16.9	16.7
Oats Area Harvested	000 ha	18.8	17.7	16.9	16.3	15.9	15.7	15.4	15.3	15.1	15.0	14.8
Spring Oats Area Harvested	000 ha	3.8	3.6	3.4	3.3	3.2	3.2	3.1	3.1	3.0	3.0	3.0
Winter Oats Area Harvested	000 ha	15.0	14.1	13.5	13.0	12.7	12.5	12.3	12.2	12.1	11.9	11.8
Potatoes Area Harvested	000 ha	12.7	12.8	12.5	12.2	11.8	11.4	10.9	10.4	9.9	9.4	8.9
Sugar Beet Area Harvested	000 ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fodder Beet Area Harvested	000 ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turnips Area Harvested	000 ha	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Silage Area Harvested	000 ha	1,023.9	1,019.3	1,017.4	1,017.5	1,017.7	1,015.6	1,013.1	1,011.4	1,010.3	1,009.4	1,008.5
Hay Area Harvested	000 ha	224.8	223.8	223.3	223.3	223.4	222.9	222.4	222.0	221.8	221.6	221.4
Maize Area Harvested	000 ha	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9

Source: FAPRI-Ireland (2010)

Table A7: Scenario 2 Output, Input and Income in Agriculture

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2007-2009 vs. 2020
Livestock	**2,254**	**2,316**	**2,392**	**2,531**	**2,584**	**2,617**	**2,672**	**2,711**	**2,751**	**2,794**	**2,845**	**2,885**	**20%**
of which: *cattle*	1,468	1,504	1,550	1,629	1,663	1,695	1,744	1,777	1,807	1,837	1,872	1,899	23%
pigs	307	324	342	384	388	395	406	417	428	441	455	467	50%
sheep and lambs	158	190	199	216	231	224	217	211	207	204	204	204	20%
Livestock Products	**1,142**	**1,618**	**1,669**	**1,681**	**1,737**	**1,801**	**2,037**	**2,176**	**2,288**	**2,379**	**2,449**	**2,496**	**65%**
of which: *milk*	1,100	1,576	1,628	1,640	1,695	1,759	1,995	2,134	2,247	2,337	2,407	2,454	68%
Crops	**1,372**	**1,512**	**1,461**	**1,467**	**1,489**	**1,518**	**1,535**	**1,543**	**1,549**	**1,554**	**1,559**	**1,563**	**1%**
Total Cereals	107	194	178	179	177	176	174	173	172	170	168	165	-9%
Root Crops	82	99	100	99	98	97	94	92	89	87	84	81	-8%
Forage Plants-Output	852	908	856	860	882	911	929	937	942	948	953	958	3%
Goods output producer prices	**4,768**	**5,446**	**5,522**	**5,679**	**5,810**	**5,936**	**6,245**	**6,430**	**6,589**	**6,727**	**6,853**	**6,945**	**28%**
Contract Work	269	262	258	262	269	278	286	295	302	309	316	322	15%
Subsidies less taxes on products	15	-10	-15	-15	-15	-15	-15	-15	-15	-15	-15	-15	0.0%
Ag. Output basic prices	**5,051**	**5,698**	**5,765**	**5,926**	**6,064**	**6,198**	**6,516**	**6,710**	**6,876**	**7,021**	**7,154**	**7,252**	**27%**
Intermediate consumption	**4,068**	**3,973**	**3,800**	**3,783**	**3,838**	**3,932**	**4,031**	**4,130**	**4,226**	**4,316**	**4,397**	**4,471**	**6%**
Feeding stuffs	1,079	1,013	973	928	916	929	953	988	1,026	1,063	1,097	1,129	2%
Fertilisers	416	421	347	347	354	363	376	389	400	408	413	415	-3%
Energy & Lubricants	303	335	342	354	362	368	371	374	376	378	381	384	19%
Forage Plants-Input	844	892	840	844	866	895	914	922	927	932	938	943	3%
Contract Work-Input	269	262	258	262	269	278	286	295	302	309	316	322	15%
Gross value added basic prices	**952**	**1,725**	**1,965**	**2,143**	**2,226**	**2,266**	**2,485**	**2,580**	**2,650**	**2,705**	**2,756**	**2,781**	**86%**
Fixed capital consumption	756	724	707	702	711	730	753	779	806	832	859	887	19%
Net value added basic prices	**196**	**1,001**	**1,257**	**1,441**	**1,515**	**1,537**	**1,731**	**1,801**	**1,844**	**1,872**	**1,897**	**1,894**	**152%**
Subsidies less taxes on production	1,846	1,830	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	-6%
Factor income	**2,042**	**2,831**	**3,007**	**3,191**	**3,264**	**3,287**	**3,481**	**3,551**	**3,594**	**3,622**	**3,647**	**3,644**	**39%**
Compensation of employees	427	409	400	407	421	435	449	462	474	484	493	503	15%
Operating surplus	**1,615**	**2,422**	**2,607**	**2,784**	**2,843**	**2,851**	**3,032**	**3,089**	**3,120**	**3,139**	**3,154**	**3,140**	**44%**

Source: FAPRI-Ireland GOLD Model (2010).
Historical data, CSO *Output, Input and Income in Agriculture.*

Table A8: Historical and Scenario 2 Projections of GHG emissions from Irish Agriculture

	1990	1995	2000	2005	2010	2015	2020
	Gg	*Gg*	*Gg*	*Gg*	*Gg*	*Gg*	*Gg*
Total CH4 from Fermentation(CH4 Gg/Yr)	452.07	458.71	452.52	437.48	411.85	398.49	430.30
Total CH4 from Manure (CH4 Gg/Yr)	110.69	111.84	109.90	107.07	102.43	101.46	114.29
Total CH4 from Livestock	562.76	570.55	562.42	544.55	514.28	499.95	544.59
CO2 equivalent of CH4	11,818.00	11,981.45	11,810.80	11,435.60	10,799.90	10,498.98	11,436.32
Total N2O emitted from Slurry System(Gg N2O/yr)	0.18	0.19	0.19	0.18	0.17	0.17	0.19
Total N2O from Solid System(Gg N2O/yr)	1.10	1.18	1.20	1.11	1.01	0.98	1.01
Total N2O from Pasture System(Gg N2O/yr)	9.04	9.32	9.33	9.10	8.30	7.99	8.33
Direct N2O emissions from fertiliser (N2O Gg/yr)	7.34	8.30	7.84	6.81	7.01	5.75	6.13
Direct N2O from soils - FAW (Gg N2O/yr)	1.49	1.56	1.61	1.53	1.45	1.41	1.55
Direct N2O from N-Fixing Crops N2O (Gg N2O/yr))	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Direct N2O-Crop Residue (Gg N2O/yr)	0.39	0.38	0.43	0.35	0.20	0.19	0.18
Indirect Emissions of N2O due to volatilisation of NH3 from manure and fertiliser inputs (N2O Gg/Yr)	1.42	1.48	1.55	1.39	1.31	1.25	1.32
Nitrous Oxide Emissions from Leaching (Gg of N2O/yr)	2.92	3.16	3.09	2.83	2.76	2.46	2.63
Total Nitrous Oxide	23.89	25.59	25.22	23.31	22.23	20.20	21.35
CO2 equivalent of N2O	7,404.66	7,931.89	7,819.38	7,227.54	6,891.96	6,263.21	6,618.36
Total Agriculture CO2 equivalent emissions	19,222.66	19,913.34	19,630.18	18,663.14	17,691.86	16,762.19	18,054.68
Fuel Combustion	689.16	950.92	858.14	899.52	850.00	850.00	850.00
Total CO2e Gg	19,911.82	20,864.26	20,488.32	19,562.66	18,541.86	17,612.19	18,904.68

Source: FAPRI-Ireland (2010)

Table A9: Scenario 2 Activity Levels for Irish Agriculture - Housing Period

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total Cattle	000 head	5,848.1	5,661.1	5,579.2	5,514.0	5,467.9	5,435.9	5,476.4	5,576.3	5,662.4	5,709.6	5,714.9
Dairy Cows	000 head	1,107.0	1,117.1	1,108.1	1,107.3	1,109.3	1,110.5	1,199.3	1,265.0	1,316.0	1,353.9	1,380.8
All Other Cattle (excl. Dairy Cows)	000 head	4,741.1	4,544.0	4,471.1	4,406.7	4,358.6	4,325.4	4,277.1	4,311.3	4,346.4	4,355.7	4,334.1
Other Cows	000 head	1,069.5	1,049.4	1,029.8	1,022.9	1,013.8	1,008.3	1,017.0	1,008.1	987.5	958.7	925.1
Dairy Heifers	000 head	222.5	215.9	227.2	227.5	236.8	252.6	264.6	273.7	280.3	284.9	289.5
Other Heifers	000 head	118.5	106.9	102.2	99.8	96.8	94.8	93.4	93.2	92.3	90.5	87.9
Cattle < 1 yrs	000 head	1,584.1	1,507.3	1,478.3	1,451.5	1,429.6	1,409.6	1,377.0	1,393.6	1,417.9	1,435.2	1,440.2
Cattle < 1 yrs - male	000 head	828.5	788.3	773.1	759.1	747.7	737.2	720.2	728.9	741.6	750.6	753.2
Cattle < 1 yrs - female	000 head	755.6	719.0	705.1	692.4	681.9	672.4	656.8	664.8	676.3	684.6	687.0
Cattle 1 - 2 yrs	000 head	1,180.3	1,123.1	1,101.5	1,081.5	1,065.2	1,050.3	1,026.0	1,038.4	1,056.5	1,069.4	1,073.1
Cattle 1 - 2 yrs - male	000 head	712.8	678.3	665.2	653.2	643.3	634.4	619.7	627.2	638.1	645.8	648.1
Cattle 1 - 2 yrs - female	000 head	467.5	444.8	436.2	428.3	421.9	416.0	406.4	411.3	418.4	423.5	425.0
Cattle > 2 yrs	000 head	508.4	483.8	474.5	465.9	458.9	452.5	442.0	447.3	455.1	460.7	462.3
Cattle > 2 yrs - male	000 head	291.8	277.6	272.3	267.4	263.3	259.7	253.6	256.7	261.2	264.4	265.3
Cattle > 2 yrs - female	000 head	216.7	206.2	202.2	198.5	195.5	192.8	188.3	190.6	193.9	196.3	197.0
Bulls	000 head	57.9	57.8	57.6	57.6	57.5	57.5	57.2	57.1	57.0	56.8	56.5
Total Sheep	000 head	4,694.6	4,986.0	5,364.4	5,651.5	5,399.0	5,211.9	5,122.2	5,070.4	5,037.4	5,021.7	5,020.2
Ewes Lowland	000 head	1,782.9	2,029.2	2,235.2	2,405.8	2,271.0	2,158.8	2,088.2	2,039.6	2,005.3	1,984.3	1,974.6
Ewes Upland	000 head	445.7	458.1	479.0	496.6	495.8	477.2	464.1	454.3	446.8	441.4	437.9
Rams	000 head	66.9	74.6	81.4	87.1	83.0	79.1	76.6	74.8	73.6	72.8	72.4
Other Sheep>1	000 head	98.3	121.0	135.6	148.8	141.0	131.4	124.0	118.4	114.3	111.4	109.8
Lambs	000 head	2,300.8	2,303.1	2,433.3	2,513.2	2,408.2	2,365.4	2,369.2	2,383.2	2,397.5	2,411.8	2,425.5

Source: FAPRI-Ireland (2010)

Table A10: Scenario 2 Activity Levels for Irish Agriculture - Pasture Period

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total Cattle	000 head	6,531.9	6,323.1	6,231.5	6,158.7	6,107.2	6,071.6	6,116.8	6,228.3	6,324.5	6,377.2	6,383.2
Dairy Cows	000 head	1,117.9	1,128.7	1,119.1	1,118.3	1,120.4	1,121.7	1,216.1	1,285.9	1,340.1	1,380.3	1,408.9
All Other Cattle (excl. Dairy Cows)	000 head	5,414.0	5,194.4	5,112.5	5,040.5	4,986.8	4,949.9	4,900.7	4,942.5	4,984.4	4,996.9	4,974.2
Other Cows	000 head	1,130.3	1,109.1	1,088.4	1,081.0	1,071.5	1,065.7	1,074.8	1,065.4	1,043.6	1,013.2	977.7
Dairy Heifers	000 head	215.3	208.9	219.9	220.2	229.1	244.5	256.1	264.9	271.3	275.7	280.2
Other Heifers	000 head	127.2	114.8	109.7	107.1	103.9	101.7	100.2	100.0	99.1	97.1	94.3
Cattle < 1 yrs	000 head	1,527.2	1,456.4	1,430.0	1,405.4	1,385.8	1,368.4	1,341.5	1,358.4	1,381.5	1,397.6	1,402.3
Cattle < 1 yrs - male	000 head	750.6	715.8	702.8	690.7	681.1	672.5	659.3	667.6	679.0	686.9	689.2
Cattle < 1 yrs - female	000 head	776.6	740.6	727.2	714.7	704.7	695.9	682.2	690.8	702.5	710.7	713.1
Cattle 1 - 2 yrs	000 head	1,454.7	1,387.3	1,362.1	1,338.7	1,320.1	1,303.5	1,277.9	1,294.0	1,316.0	1,331.3	1,335.8
Cattle 1 - 2 yrs - male	000 head	857.3	817.6	802.7	788.9	778.0	768.2	753.1	762.6	775.5	784.6	787.2
Cattle 1 - 2 yrs - female	000 head	597.4	569.7	559.4	549.8	542.1	535.3	524.8	531.4	540.4	546.7	548.6
Cattle > 2 yrs	000 head	890.5	849.3	833.9	819.5	808.1	798.0	782.3	792.1	805.6	815.0	817.7
Cattle > 2 yrs - male	000 head	598.9	571.1	560.8	551.1	543.5	536.6	526.1	532.7	541.8	548.1	549.9
Cattle > 2 yrs - female	000 head	291.6	278.1	273.1	268.4	264.6	261.3	256.2	259.4	263.8	266.9	267.8
Bulls	000 head	68.7	68.7	68.6	68.5	68.3	68.1	67.9	67.7	67.3	66.9	66.3
Total Sheep	000 head	4,694.6	4,986.0	5,364.4	5,651.5	5,399.0	5,211.9	5,122.2	5,070.4	5,037.4	5,021.7	5,020.2
Lowland Ewes	000 head	1,782.9	2,029.2	2,235.2	2,405.8	2,271.0	2,158.8	2,088.2	2,039.6	2,005.3	1,984.3	1,974.6
Upland Ewes	000 head	445.7	458.1	479.0	496.6	495.8	477.2	464.1	454.3	446.8	441.4	437.9
Rams	000 head	66.9	74.6	81.4	87.1	83.0	79.1	76.6	74.8	73.6	72.8	72.4
Other Sheep>1	000 head	98.3	121.0	135.6	148.8	141.0	131.4	124.0	118.4	114.3	111.4	109.8
Lambs	000 head	2,300.8	2,303.1	2,433.3	2,513.2	2,408.2	2,365.4	2,369.2	2,383.2	2,397.5	2,411.8	2,425.5

Source: FAPRI-Ireland (2010)

Table A11: Scenario 2 Activity Levels for Irish Agriculture (PART I)

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Pigs	000 head	1,504.8	1,543.5	1,602.3	1,674.2	1,747.9	1,824.1	1,903.9	1,986.9	2,072.6	2,160.8	2,251.2
Gilts in Pig	000 head	21.9	22.2	22.5	22.6	22.6	22.7	22.7	22.7	22.6	22.6	22.6
Gilts not yet Served	000 head	18.8	19.1	19.3	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5
Sows in Pig	000 head	97.3	98.9	100.0	100.6	100.8	100.9	100.9	100.9	100.8	100.8	100.7
Other Sows for Breeding	000 head	30.8	31.3	31.6	31.8	31.9	31.9	31.9	31.9	31.9	31.9	31.8
Boars	000 head	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Pigs 20 Kg +	000 head	1,010.6	936.1	962.6	1,005.0	1,057.6	1,111.8	1,167.9	1,226.8	1,288.1	1,351.5	1,416.7
Pigs Under 20 Kg	000 head	420.8	395.2	405.4	420.8	439.7	459.1	479.1	500.0	521.8	544.3	567.5
Poultry	000 head	13,814.7	13,710.5	13,882.4	14,175.2	14,582.3	15,081.4	15,614.8	16,174.1	16,761.6	17,386.5	18,022.0
Layer	000 head	1,761.9	1,748.6	1,770.5	1,807.9	1,859.8	1,923.4	1,991.5	2,062.8	2,137.7	2,217.4	2,298.5
Broiler	000 head	11,381.5	11,295.7	11,437.3	11,678.5	12,013.9	12,425.1	12,864.6	13,325.3	13,809.4	14,324.2	14,847.8
Turkey	000 head	671.3	666.2	674.6	688.8	708.6	732.8	758.8	785.9	814.5	844.9	875.7
Horses	000 head	98.1	98.1	98.1	98.1	98.1	98.1	98.1	98.1	98.1	98.1	98.1
Mules	000 head	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
Goats	000 head	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1
Fertiliser	kg of N	363,072.9	316,290.6	310,767.6	304,506.2	297,032.6	297,508.8	303,919.7	310,707.4	315,378.6	317,588.2	317,348.1

Source: FAPRI-Ireland (2010)

Table A12: Scenario 2 Activity Levels for Irish Agriculture (PART II)

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Pulses Production	tonnes	18,600	18,600	18,600	18,600	18,600	18,600	18,600	18,600	18,600	18,600	18,600
Potatoes Production	tonnes	400,572	404,053	400,685	393,991	383,579	371,080	357,017	342,135	327,004	311,977	297,184
Sugar Beet Production	tonnes	0	0	0	0	0	0	0	0	0	0	0
Barley Production	tonnes	1,183,886	1,099,852	1,101,806	1,089,301	1,075,650	1,063,626	1,049,396	1,036,552	1,023,156	1,009,757	996,002
Oats Production	tonnes	143,015	136,725	131,254	128,112	125,832	124,376	122,963	121,783	120,696	119,675	118,644
Wheat Production	tonnes	595,672	605,174	635,974	654,234	668,332	680,438	688,507	694,919	698,724	700,536	700,354
Pasture	hectares	2,131,235	2,132,159	2,132,191	2,130,342	2,128,716	2,130,473	2,133,643	2,136,196	2,137,992	2,139,661	2,141,639
Hay	hectares	224,754	223,755	223,342	223,370	223,463	223,051	222,577	222,305	222,232	222,219	222,185
Silage	hectares	1,023,880	1,019,327	1,017,448	1,017,574	1,018,000	1,016,120	1,013,962	1,012,725	1,012,390	1,012,332	1,012,176
Rough Grazing	hectares	441,200	441,200	441,200	441,200	441,200	441,200	441,200	441,200	441,200	441,200	441,200
Wheat Area Harvested	000 ha	68.1	70.3	72.7	74.6	75.9	76.9	77.4	77.6	77.5	77.2	76.7
Spring Wheat Area Harvested	000 ha	15.7	16.1	16.7	17.1	17.4	17.7	17.8	17.8	17.8	17.7	17.6
Winter Wheat Area Harvested	000 ha	52.5	54.1	56.0	57.4	58.5	59.3	59.6	59.8	59.7	59.5	59.1
Barley Area	000 ha	169.1	169.8	167.8	165.8	163.6	161.3	158.7	156.0	153.3	150.6	147.9
Spring Barley Area Harvested	000 ha	150.7	151.3	149.6	147.8	145.8	143.8	141.5	139.1	136.6	134.2	131.8
Winter Barley Area Harvested	000 ha	18.4	18.4	18.2	18.0	17.8	17.5	17.2	17.0	16.7	16.4	16.1
Oats Area Harvested	000 ha	18.8	17.7	16.9	16.3	15.9	15.5	15.2	15.0	14.7	14.5	14.3
Spring Oats Area Harvested	000 ha	3.8	3.6	3.4	3.3	3.2	3.1	3.1	3.0	3.0	2.9	2.9
Winter Oats Area Harvested	000 ha	15.0	14.1	13.5	13.0	12.7	12.4	12.2	12.0	11.8	11.6	11.4
Potatoes Area Harvested	000 ha	12.7	12.8	12.5	12.2	11.8	11.4	10.9	10.4	9.9	9.4	8.9
Sugar Beet Area Harvested	000 ha	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fodder Beet Area Harvested	000 ha	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Turnips Area Harvested	000 ha	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Silage Area Harvested	000 ha	1,023.9	1,019.3	1,017.4	1,017.6	1,018.0	1,016.1	1,014.0	1,012.7	1,012.4	1,012.3	1,012.2
Hay Area Harvested	000 ha	224.8	223.8	223.3	223.4	223.5	223.1	222.6	222.3	222.2	222.2	222.2
Maize Area Harvested	000 ha	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9

Source: FAPRI-Ireland (2010)