Crops
Environment
& Land Use
Programme

Athenry

Agri Environment Conference 2012

'Sustainable Pathways to Food Harvest 2020'

Farmleigh, Dublin | Wednesday, 5 December 2012

Agriculture and Food Development Authority

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Teagasc
Agriculture and Food Development Authority

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Padraig Brennan, Senior Analyst, Bord Bia

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EUROPEAN COMMISSION
DIRECTORATE-GENERAL
ENVIRONMENT
Directorate B - Nature, Biodiversity & Land Use
ENV.B.1 - Agriculture, Forests and Soil

Challenges in the agri-environment relationship in the period to 2030

Michael Hamell, DG Environment

Introduction

Agriculture is not just an industry important to all Member States (MS) and our major land user. It is also the subject of a common European policy and, historically, the sector financially most supported by European taxpayers. The CAP is 50 years old and the situation in which it was established much changed. Farming now accounts for only a few percent of Europe's workforce and issues of adequate food supply in Europe haven't made headlines for decades although food security is a growing global concern. Environment is also subject to a common European policy. But it differs greatly from the CAP in that it concerns all facets of life and land use, that it is not directly attached to a major European funding source and, perhaps more subtly, that its execution is largely through directives which give much more latitude to MS than the regulations of the CAP.

This paper examines the next 20 years in a relationship between two major European policy areas. Are they moving to better toleration of each other? The environmental issues related to agriculture will come as no surprise. Water and biodiversity, soil and landscape, air and climate. They are valid now and will be in 20 years.

Water

Water is perhaps easiest; the building blocks of the **nitrates** (ND) and water framework directives (WFD) are in place for 21 and 12 years respectively. Implementation of the nitrates directive was initially slow but, during the past decade, it has improved greatly across most of the EU although a few hotspots remain such as in Greece and France but there is still much to be done. Implementation itself involves great attention to detail and the EU is unique in having legislation dealing with diffuse agricultural pollution. Today, we notice a huge interest in improved manure management be it in the form of processing, biogas production and new spreading techniques as intensive farming grapples with the sustainability agenda. We are now at the third and even fourth round of action programmes and have long experience of derogations to the amount of livestock manure that can be applied to land. Progress in water quality is being achieved and the continuation of that progress will determine the Commission's views as to the quality of Member States' action programmes and derogation requests. This will also apply to Ireland so the Commission report on implementation 2008-11 due for publication in 2013 will be an important document. The nitrates directive is at the heart of the cross-compliance mechanism of CAP support and remains so in the current reform proposals for 2014-20.

The long preparatory period for the implementation of the **WFD** is now over. From 2009, MS should have completed the first round of river basin management plans and programmes of measures should apply in full no later than the beginning of 2013. The Commission has proposed that the WFD become part of cross-compliance as soon as implemented by all MS and obligations on farmers are identified. **The sustainable use of pesticides directive** (also for inclusion in cross-compliance) has great significance for both water and biodiversity and the national management plans now in finalisation as well as the obligations with respect to integrated pesticide management should play an important role in further improving water quality. Water use is a huge issue of concern in Europe as climate change begins to bite.

Within **current and future rural development programmes**, the Commission is encouraging much more efficient water use notably though much improved irrigation systems. So, broadly, water legislation, relevant to agriculture is in place, but it is very clear that, particularly on the WFD and on the very difficult quantity issue, the plans of the next two 6 year periods will be crucial. Agriculture needs clean water in sufficient quantity so there is a great interest in ensuring the plans support delivery. Otherwise, by 2030, we will see a very different shape to EU agricultural production. The Commission has, in recent weeks, set out further thinking in its Water blueprint.

Biodiversity

At the international and EU level, the issue of biodiversity and ecosystem services is of significant concern and is subject of a UN Convention on Biological Diversity (CBD). Biodiversity decline has continued apace over the last few decades and has led to global and EU targets being established for 2010 which were not achieved and new targets for 2020 which will need real commitment including from agriculture if they are not to suffer the same fate. The EU biodiversity strategy to 2020 will be heavily dependent on agriculture and forestry to achieve the aims set by the heads of government.

EU legislation on biodiversity, namely the **birds and habitats directives dating from 1979 and 1992** respectively, is not yet fully implemented and funding is a factor. While agri-environment schemes across the EU have been commonplace for 20 years at a total cost of about €100 billion, we still see important declines in species such as farmland birds, bees and butterflies. Farmers claim, with some justification, to be guardians of the land and the environment, but it is sobering to reflect on the extent of the changes in farm practice over the past 50 years and their largely unintended negative effects on the environment. For example, the increase of the productivity of the dairy sector has come partly from a system change from traditional production to one mainly based on silage (including maize in many regions) and greater use of concentrates, with a resultant decline of highly ecological grassland. Likewise, the change from spring to winter cereals has removed feed sources for birds and increased soil run off and water pollution.

Today's intensive farming systems leave little room for biodiversity so new solutions must be found. This is very much behind the Commission's thinking in greening the CAP and the proposals on ecological focus areas, permanent pasture and crop diversification reflect this. Greening the first pillar of the CAP will present a real challenge but there is no public appetite for having parts of Europe which do not deliver environmental services while benefitting from CAP support. Much of the thinking on greening has been shaped by the concept of public goods and the inclusion of greening in pillar 1 reflects that. Farmers are supported in their activities but, as part return, they deliver public goods. As a complement, the new proposed approach for Rural Development will be more strategic and will enable better targeting of environmental issues by the application of more ambitious environmental measures. So, on biodiversity, we need, within both direct payments and rural development to respond to commitments made and the shape and execution of the CAP reform is the delivery mechanism. If we fail on biodiversity again, it is difficult not to imagine that questions will be posed as to the suitability of current approaches in 2020 for the next financial period.

Soil and land

In Ireland, it is sometimes hard to imagine issues related to landscape and soil. Yet, we face across Europe some frightening realities. Half our European soils have low organic matter and well over 10 million hectares are subject to high and unsustainable levels of erosion. As a consequence, yields are lower than they could be and the effects of erosion are seen in greater clean-up frequency and cost even in northern European countries such as Belgium. Land take from agriculture for infrastructure and urbanisation is an issue of common concern. We now estimate this to be the equivalent of the land area of Berlin each year, Cyprus every 10 years and the equivalent in wheat production of the bread consumption of Germany. We are increasingly dependent on "imported land" from the rest of the world to produce our food. **The soil framework directive proposal** addresses land take as it does the urgency of beginning to address the legacy of up to 5 million potentially contaminated sites in Europe but it remains blocked at Council.

In 2014, the Commission intends to bring forward **a communication on land as a resource** as demands on land spiral whether to feed the world's growing and more affluent population, provide biofuels or raw materials for the emerging bio-economy. Mark Twain was right and Malthus is at least back in fashion. Neither might like our rather increasingly bleak landscapes, devoid of features and unwelcoming to wildlife.

Climate change and air

It is difficult not to be concerned by **current trends in GHG emissions** and the difficulty in reaching durable global agreements which would them now and lead the way to the much sought but as yet rather intangible low carbon economy. Agriculture is essential to our human well-being but so, today, are energy and transport. At a conservative estimate, we probably transport more than 2 million tonnes of food and packaging around Europe each day to feed our cities. Agriculture, transport and energy are fully inter-linked.

Europe's 2020 commitments and strategic long term approach in moving to a low carbon economy by 2050 has been spelt out and indeed the EU wants to go from 20% to 30% reduction in emissions subject to global climate agreements and some MS want to get there regardless. Agriculture will have to play its part and that presents a real challenge here as you gear up dairying for the post quota era. When quotas are gone in 2015, they will have been in existence for over 30 years which is pretty close to the timescale after which we aim to reduce GHG emissions by 80%. That ambition will certainly involve changes not yet imagined and agricultural research and practice will need to be in high gear.

But there is another immediate problem looming. How do we address the ongoing **emissions of ammonia** from agriculture and their important contribution to eutrophication, acidification and biodiversity decline as well as to human health problems? 2013 is the year of environmental focus on air. On most other gases covered by the Goteborg protocol on long range transboundary air pollution and the **EU national emission ceilings directive**, solid progress has been made. We now need to consider how to up the pace of reducing agricultural emissions. Large pigs and poultry installations have addressed this and we are slowly improving the situation of manure management including spreading techniques but we will need to go further if we are to reduce eutrophication. So issues such as cover of manure stores, spreading techniques and ammonia capture will remain on the agenda for the next decade. Upcoming regulatory reviews will provide the opportunity to reflect further on air quality issues.

Closing comments

On a wider note, **resource efficiency** is very much in focus. In late 2011, the Commission launched a roadmap to resource efficiency against the background of rapid increases in global uses and depleting resources. The recent **Rio +20 Conference** raised many concerns including on land and these will feed into the agricultural agenda rapidly this decade. The Commission will bring forward its vision in the **7th Environmental Action Programme** due for adoption by the end of 2012. The issue of **phosphorus** is being looked at in detail with a view to change from a situation in which this most vital of minerals would run out in the medium term to one where it is sustainably used and available for the longterm. A green paper is at an advanced stage of preparation and we look forward to the reaction not least of the agricultural sector. And yet wider, the issues of sustainable consumption and food waste. We will come forward with ideas in these areas which, while not chiefly related to the farm, concern the food industry where estimates suggest losses of 30%. Eliminating half of this waste would ease greatly pressure on resources.

Actually, society needs to completely reorganise its views on resources. We have to become, globally, more efficient at resource use and more committed to recycling. Simply reflecting on the food chain, its sobering and challenging that probably 95% of our production needs to be recycled if we are to achieve a sustainable society. We are a long way from this today.

The EU farm sector today is largely unrecognisable from 40 years ago when Ireland joined the EU. The changes in the next 20 years will be as dramatic. To some extent, the environmental underpinning is in place but it will have to adapt to take account of ever larger farms, more concentrated areas of production and potentially more imbalances between production and the absorptive capacity of land. Can the relationship between farming and the environment improve? This is really no longer the question; they are two sides of the same earthly coin so a positive cooperative relationship is in both their interests but it takes and will take very considerable and detailed work at every level.

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Mitigating greenhouse gas emissions from Irish beef cattle systems – the Carbon Navigator

Paul Crosson, Animal & Grassland Research and Innovation Centre, Teagasc, Dunsany, Co. Meath.

Introduction

In Ireland, agriculturally derived greenhouse (GHG) emissions have shown steady reductions in recent years with emissions in 2010 8.3% lower than 1990 levels (EPA, 2011). Furthermore, analysis by Leip et al. (2010) has shown that Ireland is among the most efficient food producers in Europe with regard to carbon footprint (the quantity of GHG emissions generated per kg of food produced). The analysis showed that Ireland had the fifth lowest and lowest carbon footprint for beef and milk, respectively. However, it is necessary to take steps aimed at further reducing the carbon footprint of Irish agricultural products given the contribution of Irish agriculture to total national GHG emissions (over 30% in 2010; EPA, 2011) and the increasing importance of continuing to demonstrate sustainable farm management practices for international markets.

The Carbon Navigator

Teagasc and Bord Bia are currently developing a software program to assist farmers to identify measures to reduce GHG emissions and to achieve these reductions by setting targets for key aspects of their production system. This software program is called the Carbon Navigator and focuses on "distance to target" – in other words the focus of the program will be to provide farmers with an indication of how current and target levels of GHG emissions relate to poor, average and high performing farms operating comparable farming systems. It will not be necessary to estimate total beef farm system GHG emissions to use this program; it aims to "cut" emissions rather than "count" emissions. The program focuses on mitigation options that are cost effective and in most cases improve farm profitability.

The mitigation options available in the Carbon Navigator are outlined below:

1. *Extending the grazing season*

Extending the grazing season provides opportunities to reduce greenhouse gas emissions in two ways. Firstly, the shorter indoor period results in lower quantities of slurry stored. Since stored slurry is a source of methane, this would lead to a direct reduction in methane emissions (Husted, 1994). Grass-based diets are also associated with lower enteric fermentation emissions relative to grass silage-based diets (IPCC, 2006). Although pasture, paddock and range emissions from direct deposition during grazing are greater the overall effect is normally to reduce total systems GHG emissions.

2. *Improving the calving rate of suckler beef cows.*

The calving rate on Irish farms is low at 0.8 calves per cow annually (ICBF, 2012). Thus, 20% of suckler beef cows fail to produce a calf every year. Regardless of production levels, suckler cows are a significant contributor of GHG (O'Mara, 2011). Higher calving rates reduce carbon footprint by increasing output per cow unit, thus "diluting" the GHG footprint over a greater quantity of beef.

3. *Reducing age at first calving for replacement heifers.*

Age at first calving is the age at which replacement breeding heifers calve for the first time. ICBF (2012) indicate that average age at first calving for suckler cows in Ireland is 32 months of age. Reducing age at first calving is associated with lower feed, enteric fermentation and manure management emissions for first calving heifers.

4. *Increased animal performance.*

Improvements in live weight gain for Irish beef production systems was found by Foley et al. (2011) to be an important mitigation strategy. The impact of improved average lifetime daily gain for beef production systems is to "dilute" the GHG emission association with production. No changes in feed efficiency are assumed in this measure.

5. *Nitrogen efficiency*

Improving the efficiency of nitrogen utilization, for example by applying the most appropriate compound at the optimum time and at the optimum rate, can reduce nitrogen fertiliser use (Humphreys et al., 2008) and, therefore, nitrous oxide emissions, significantly. The reduction in fertiliser use would also reduce indirect emissions for the farming system by reducing the greenhouse gas emissions associated with the production, marketing and distribution of the fertiliser. In addition to reducing fertilizer nitrogen requirements, the incorporation of legumes such as white clover into grassland swards can also reduce emissions by improving animal productivity and reducing enteric fermentation emissions (van Dorland et al., 2005).

6. *Improved manure management*

There are a number of management tools available which reduce nitrogenous losses from slurry application. Increasing the quantity of slurry spread in spring rather than summer reduces ammonia emissions as spring weather conditions are normally associated with lower ammonia losses. Lower ammonia losses also increase the fertilizer replacement value of slurry, and therefore reduce the total fertilizer N inputs. Adopting low emission application methods such as trailing shoes or bandspreading also reduces ammonia losses. Again, the fertilizer replacement value of slurry is increased, and therefore total fertilizer N inputs are lowered.

Impacts of mitigation on farm profitability

The acceptability of options to mitigate GHG emissions from beef cattle systems to farmers is predicated on the impact of these options on farm profitability. Mitigation options that reduce profitability are unlikely to be widely adopted in the absence of regulation or incentivisation. The options presented above however, are cost-beneficial in that the adoption of these options will improve farm productivity and thus, profitability.

Application

The Carbon Navigator assesses each option using a common approach and presents the user with an output sheet outlining; current and target levels of production, impact on GHG emissions versus comparable production systems, a “score” (from 1 to 10) for each measure, an indication of financial impacts and, an outline of how the measure impacts on GHG emissions. The scores achieved for each measure is also presented graphically to provide a simple comparison of current and target levels of performance for each mitigation measure.

Summary

Cattle and beef production is the largest agricultural sector in the Republic if Ireland. The value of output in 2011 was €1.8 billion, 29% of total agricultural output. However, at farm level the sector is facing considerable challenges. Clearly demonstrating sustainable production practices and the development of management systems that further enhance sustainability is a key requirement of export markets; in particular there is a significant focus on GHG emissions at the present time. At the same time, farm level incomes will be refocused on market based returns as changes to EU farm support mechanisms are proposed following the ending of the current regime in 2013. The Carbon Navigator seeks to address both of these challenges; primarily the objective is to assist farmer and advisors to identify management practices that have the greatest potential to reduce the carbon footprint of beef produced on individual farms. The software program will also provide an indication of the impact that the selected changes have on farm profitability.

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Where is the Sustainable Road Leading to?

Audrey O'Shea, Carbon & Sustainability Manager, Glanbia

Glanbia Ingredients Ireland

Based in Ireland the Glanbia Co-operative society up owns 51.6% of Glanbia plc and since November 2012 owns Glanbia Ingredients Ireland in a joint venture with Glanbia PLC (60%:40%). The 4,300 dairy member of the Co-op are also the 4,300 farmers that supply milk to Glanbia Ingredients Ireland.

Glanbia Ingredients Ireland (**GII)** employs approximately 470 people at two large-scale processing facilities and processes approximately one third of the Irish milk pool (1.4bn litres) and 25% of the Irish whey pool (over 1bn litres). Ballyragget is the largest integrated dairy site in Europe, with seven individual dairy ingredients plants operating – Butter, Cheese, Attrition casein, Acid casein, Milk Protein Concentrate (MPC) Whey protein Isolate (WPI) and Whey.

The plant at Virginia produces cream for "Baileys" cream liquor and also "NuNu" an Enriched Milk Powder that is produced for export.

A third production site is planned for 2016. This plant will be built in Belview, Co. Kilkenny in the heartland of expected milk growth and will convert the additional milk post quota into dairy ingredients.

GII also incorporates Glanbia Milk, the business unit responsible for milk collection and quality.

Glanbia Ingredients Irelands Sustainable practices to date.

IPPC licensed since 1998

ISO 14001 Energy management system since 1999

De-lactose Permeate was disposed of and injected into land using until the late '90s when the innovation team formulated De-lactose concentrate that replaces molasses in animal feed made by agribusiness.

In 1999 GII was the first company in the world to apply the Japanese technology "Kubota membranes" as a waste water treatment application. This application is now viewed as B.A.T. and replicated globally.

The solid fraction collected by the membranes is recognised as a valuable nutrient source (phosphate, nitrogen and potash). GII was the first company to have the Organic Trust certify dairy sludge as an organic fertiliser. This is now offered free of charge and displaces the requirement for synthetic or mined phosphates to over 150 farmers on an annual basis

CHP Plant installed in 1999

In 2007 the first Irish owned Company to get an accreditation for energy management system

Carbon Trust Certification November 2011 (Virginia) and May 2012 (Ballyragget)

Carbon Trust Award October 2012

Glanbia Ingredients Irelands Carbon Footprint

The three sectors contributing most to Greenhouse gas emissions (GHG) in Ireland are Agriculture, Transport and energy generation (Figure1). Ireland's EU carbon emission reduction target is 20% by 2020. While the Government has not penalised Agriculture directly it has imposed a carbon-tax on fossil fuels in an effort to achieve these targets.

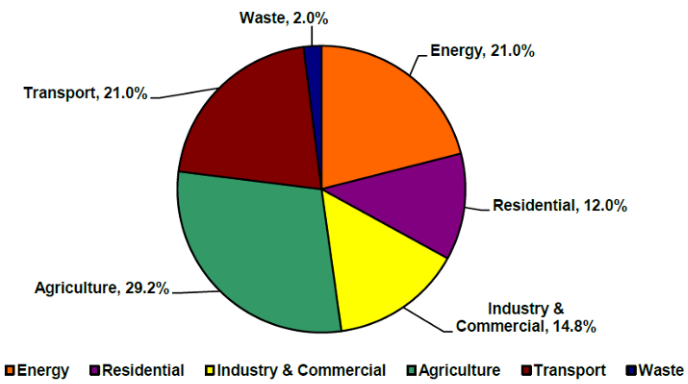

Figure 1: Ireland's 2009 GHG Sector Profile. Source EPA 2011[1]

As an organisation, GII reflects the Irish GHG emissions scenario with the greatest proportion derived on farm (Cradle to farm-gate). GII has recently launched a Sustainable Dairy Strategy to encourage greater efficiencies and to reduce greenhouse gases on farm.

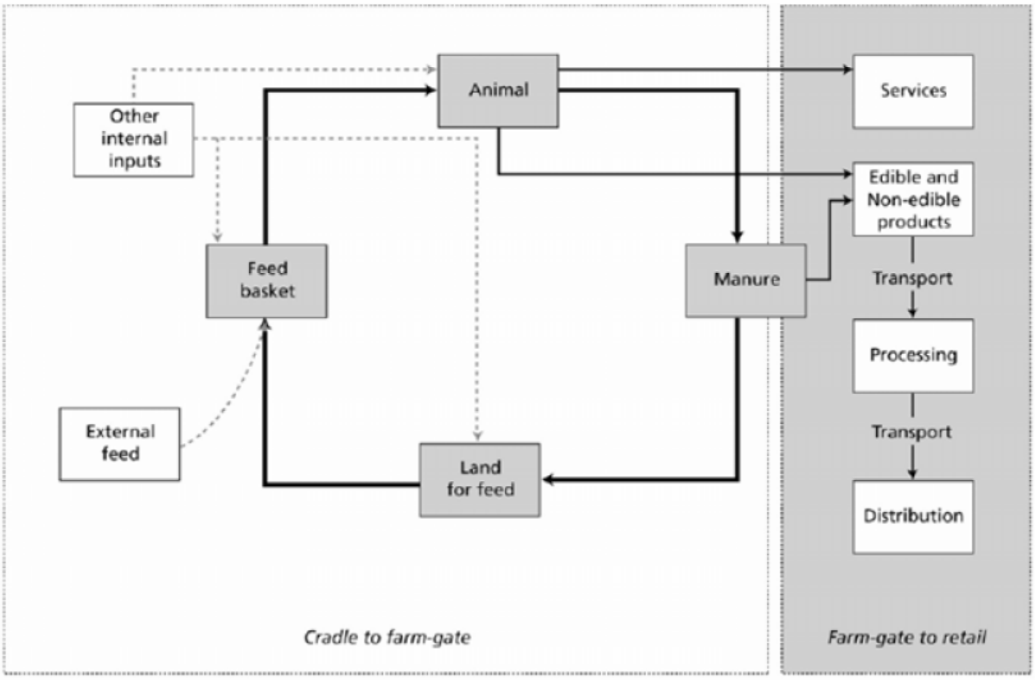

Figure 2: GHG Sources from Cradle to Retail. Source FAO 2011

Today's presentation from a GII perspective will cover

- Factors driving demand for sustainability
- Industry response
- What is sustainability?
- Sustainability at processing level
- Sustainability on farm

In order to exceed our customers' requirements and to document and put structure on our own sustainable practices Glanbia Ingredients Ireland have launched a sustainability programme that will build on existing best practices and quality assurance schemes. Today's paper will discuss the elements of the GII Sustainability programme.

The GII sustainability programme will focus on farm and include areas such as health and safety on farm, carbon emissions, energy efficiency, water efficiency and biodiversity. As part of this programme an advisory group which includes Bord Bia and Teagasc has been established.

Glanbia Ingredients Irelands Ambition is to:

- Be the global point of reference for best practice in the area of sustainability
- Establish an internationally recognised sustainability standard.
- To make 'sustainability' synonymous with good commercial farming practice

European Farmers responding to the Sustainability Challenge

James Humphreys, Andy Boland and John Upton, Teagasc

Introduction

Dairy production is an important economic activity in North West Europe (NWE). Climate and soils are suitable and there is a large affluent local market for dairy products. In the past two decades there is increasing pressure stemming from various EU Directives to lower emissions from dairy farms to water and to the atmosphere and to improve other aspects of environmental performance. In addition to these environmental pressures dairy farmers are coping with increasingly volatile milk prices and input costs, high investment costs (in slurry storage, for example) and narrow profit margins. The sustainability of dairy farming in NWE is under threat from both environmental and economic perspectives.

DAIRYMAN (www.interregdairyman.eu) is a project part-funded by INTTERREG aimed at improving resource use efficiency on dairy farms in NWE. The objective is to improve the sustainability of these farms primarily in terms of economic performance, N and P use efficiency and greenhouse gas emissions. Stakeholder cooperation is an important part of the project with the ultimate goal of strengthening rural communities. The project involves 14 partner organisations, a network of 127 pilot dairy farms and nine Knowledge Transfer Centres in 10 regions: Ireland, Northern Ireland, Brittany, Pays de la Loire, Nord Pas de Calais, Flanders, Wallonia, Baden Württemberg, Luxembourg and The Netherlands. The project started in 2009 and will finish in August 2013. The focus of this paper is to compare the performances of the pilot farms in the 10 regions (Table 1) with particular emphasis on the performance of the Irish farms.

Table 1. Pilot farms involved in the Dairyman Project

Code	Country	Region	Number of pilot farms	Annual milk output (L per farm)
BF	Belgium	Flanders	13	778,464
BW	Belgium	Wallonia	20	520,553
FB	France	Brittany	11	469,338
FL	France	Pays De La Loire	10	584,018
FN	France	Nord Pas de Calais	7	556,635
GE	Germany	Baden-Württemberg	14	887,616
LU	Luxembourg		6	453,948
IN	United Kingdom	Northern Ireland	9	806,849
IR	Ireland		21	512,815
NL	The Netherlands		16	1,094,714

Details of the study

Data was collected for three years (2009, 2010, 2011) and the sustainability of the farms in each region was assessed using standard methodologies; economic performance, farm gate N and P balances and greenhouse (GHG) emissions. GHG emissions were quantified using the Wageningen University C Calculator modified for this purpose and now called the Dairyman C Calculator. Results for 2010 are presented unless indicated otherwise. Farms with the lowest milk output per farm were in Luxembourg and Brittany with on average between 450,000 and 500,000 L. Farms in Ireland, Wallonia and the two other regions of France averaged between 500,000 and 600,000 L. Farms in Flanders, Northern Ireland and Germany averaged between 750,000 and 900,000 L. Farms in the Netherlands averaged just over 1,000,000 L.

Milk output per cow

The Irish pilot farms differed from the other pilot farms in a number of respects. One was the relatively low milk yield per cow, which averaged 5128 L per cow (range: 3986 to 5915) compared with an average of 8147 L per cow for the other pilot farms (range: 4415 to 10500). Lower milk yield per cow on Irish farms is attributable to the grass-based system and relatively low level of concentrates fed per cow in Ireland, which averaged 780 kg cow^{-1}. The overlap in milk yield per cow at the lower end of the range between the Irish and other pilot farms was typically with similar grass-based farms in Brittany, in particular, and Northern Ireland.

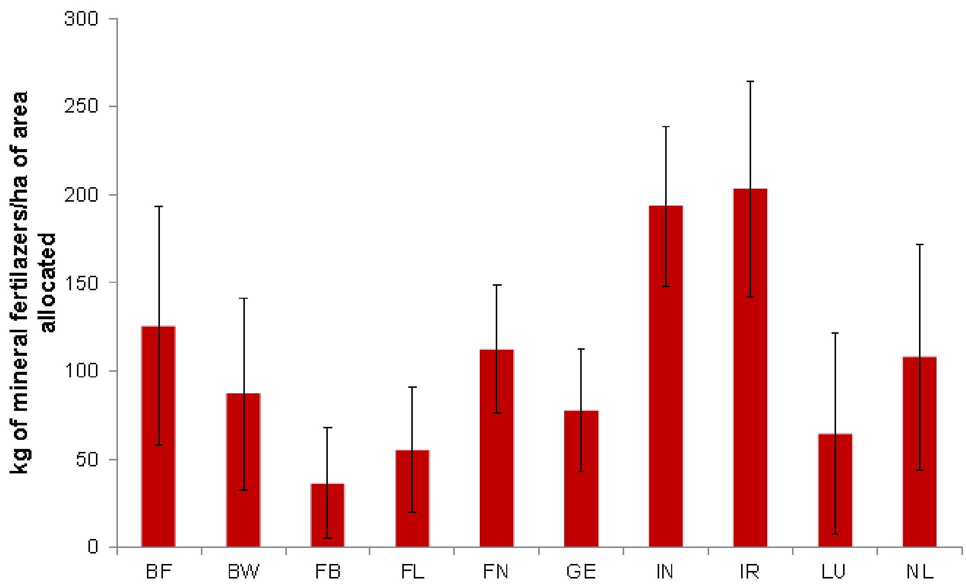

Figure 1a. Fertilizer N use on pilot farms in the Dairyman project

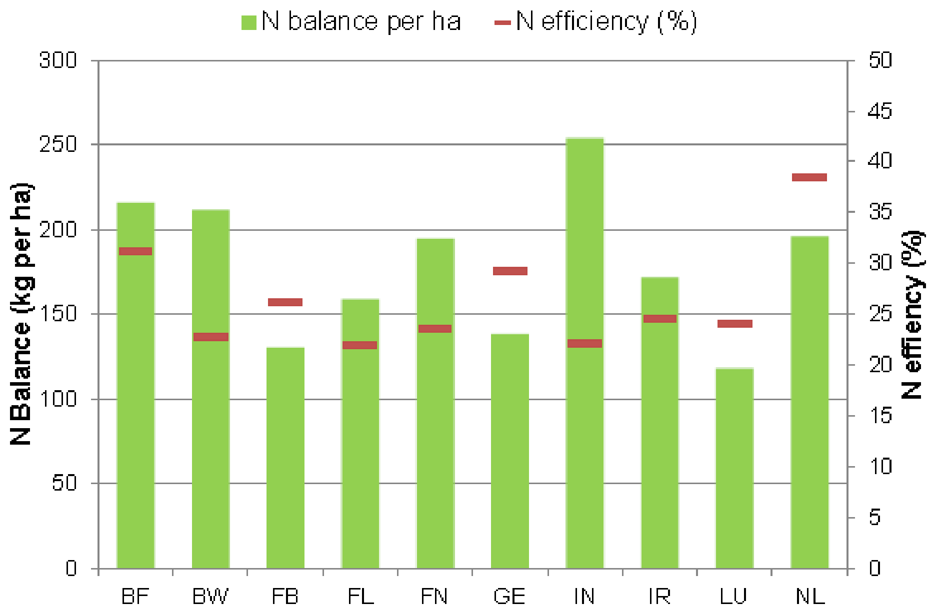

Figure 1b. N balances and N use efficiency on pilot farms in the Dairyman project

Fertilizer N input

Another difference was in the use of fertilizer N, which averaged approximately 200 kg ha^{-1} in Ireland and Northern Ireland, which was far higher than the other regions (Fig 1a). This reflects the high reliance on grassland as feed for cows in Ireland compared with the other regions. In the other regions there was higher reliance on maize silage, which has a lower requirement for N than grassland, and higher input of concentrate feed. Therefore, although fertilizer N input was relatively high on Irish farms relatively low imports of concentrate and other feeds resulted in surplus N on Irish farms (170 kg ha^{-1}) being close to the average of the regions in the study (Figure 1b). Likewise N use efficiency on Irish farms (25%) was close to the average of the regions in the study.

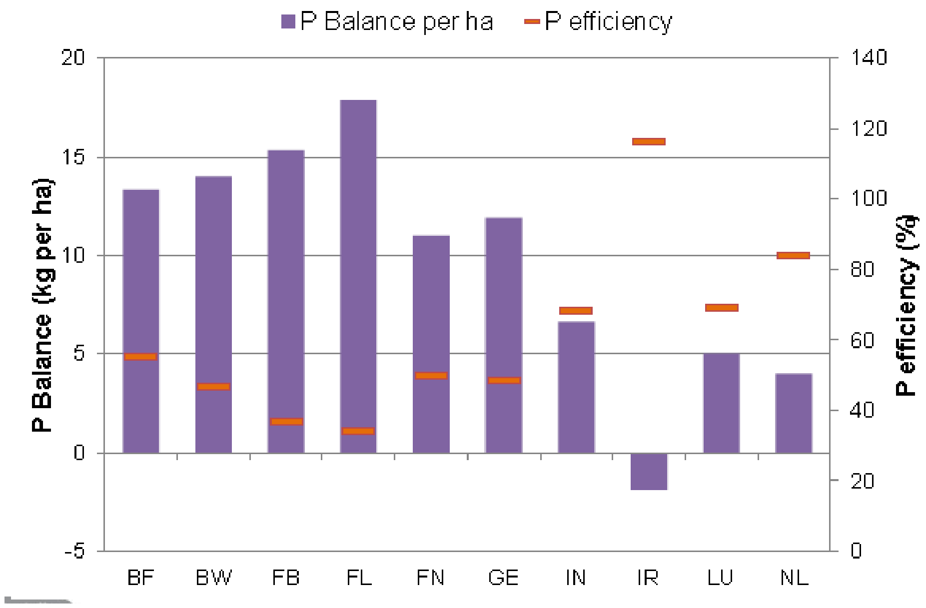

Figure 2. P balances and P use efficiency on pilot farms in the Dairyman project

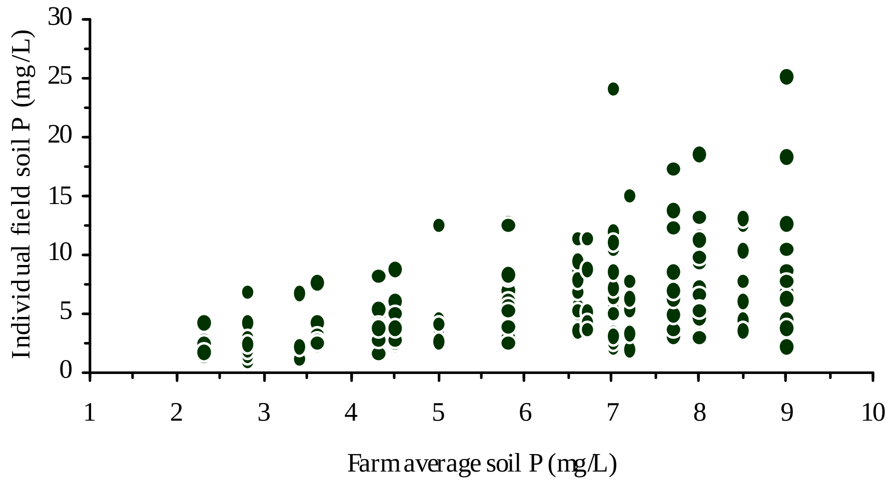

Figure 3. Distribution of soil P concentrations on Irish pilot farms in the Dairyman project

P balances on farms

The Irish farms stood out very clearly in terms of P balance and P use efficiency (Fig. 2). Whereas average P surplus on farms typically ranged between 4 and 17 kg ha^{-1} in the other regions, there was a deficit of P on the Irish farms; more P was being exported from than imported onto farms. The reason for the relatively higher surpluses in the other regions can be largely attributed to the import of concentrate and other feeds and absence of export of manure; (for example, export of manure accounts for the relatively low surplus on Dutch pilot farms). The deficit of P on Irish farms can be attributed to the relatively low levels of concentrates fed per cow and low P fertilization of grassland. Low P fertilization of grassland during this study is attributable to the stringent regulations governing P fertilization of grassland in Ireland and the sharp increase in the cost of artificial fertilizer P in recent years. Nutrient management, particularly management of P, was identified as an important weakness on Irish pilot farms. Random sampling found that 48% of fields were deficient in P (18.5% in index 1 and 29.5% in index 2; Fig 3). On one farm with 8 out of 9 fields sampled were in index 1. However, even on farms with average soil P concentrations within the recommended range of 5 to 8 mg L^{-1}, 29% of fields were deficient in P (6.5% index 1 and 22.5% in index 2). When examined in terms of soil pH, P and K only 5% of fields fell within the recommended ranges for all three.

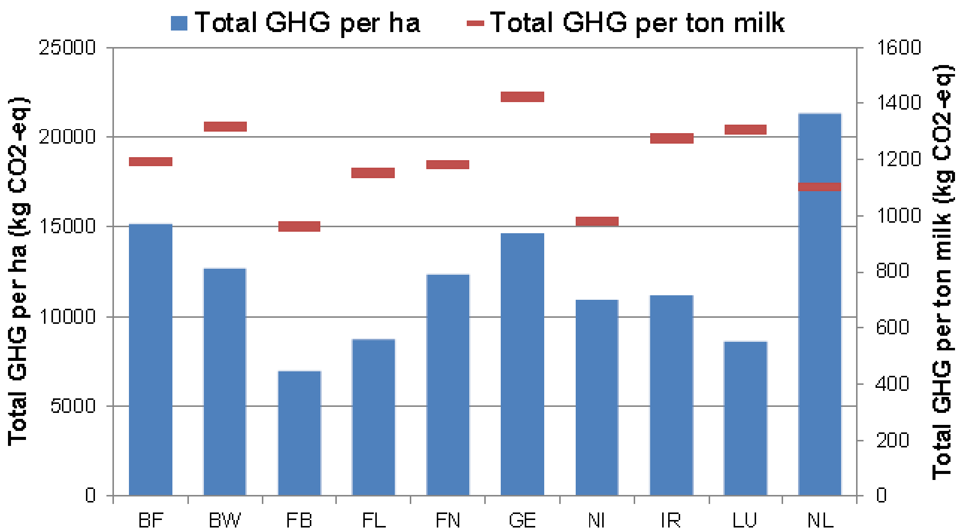

Figure 4. Greenhouse gas emissions per ha and per tonne of milk on pilot farms in the Dairyman project

Greenhouse gas emissions

Total GHG emissions per t milk on Irish farms (1.25 t CO_2 eq. per t milk) was slightly above average for the group which ranged between 1.0 and 1.4 t CO_2 eq. The average emissions for the Irish farms using the Dairyman C calculator are similar to the average emissions for the Irish farms determined in a study using Life Cycle Assessment by Yan *et al*., (2013). Lower emissions per t milk were associated with higher milk output per cow. Intensive specialised dairy farms feeding high levels of concentrate per cow in the Northern Ireland, The Netherlands and Flanders tended to have low emissions per t milk. Low emissions per t milk on farms in France, and Brittany in particular, were associated with low stocking densities and a high proportion of home-grown feed. Relatively high emissions on Irish farms were attributed to relatively high methane emissions per t milk associated with the high proportion of grass in the diet and relatively high nitrous oxide emissions associated with the high fertilizer N use on grassland.

Economic performance

The economic performance of the Irish pilot farms was also exceptional (Figure 5). Milk price in Ireland and Northern Ireland was clearly lower than in the other regions, and across regions, milk price in 2009 was substantially lower than 2010. The lowest costs of production per 100 kg of milk were recorded in Ireland followed by Northern Ireland. Low costs of production in Ireland were due to low expenditure on concentrate feed and on contractor charges, fuel, oil and machinery maintenance and other overhead costs such as electricity and maintenance of buildings. Costs associated with breeding and fertilizer use on Irish farms were similar to the other regions. Low costs gave higher income per labour unit on Irish farms than on farms in any other region. Low costs also helped to sustain incomes on Irish farms in 2009 despite the low milk price. In contrast the low milk price received by Dutch farmers, for example, resulted in very low income per family labour unit in 2009.

Conclusions

Farms in this study were pilot farms selected to inspire other farmers. Hence, the level of technical performance in terms of resource use efficiency on these farms at the commencement of the study was well above the average of farms in each region. Nevertheless it is clear that farms in this study were very vulnerable to fluctuating milk price with very tight or negative net margins on many farms in 2009. Low costs on Irish farms tended to protect farm income in 2009 compared with European counterparts. The farm-gate N balances recorded in this study are far lower than similar studies that were first conducted in the 1980s. N use efficiency on farms was far higher than the average of 16% recorded by Van der Meer and van Uum-van Lohuyzen (1986). N use efficiency of 25% on Irish farms was higher than that reported in similar studies in the past: 19.5% between 2003 and 2006 (Treacy *et al*., 2008) and 17% in 1997 (Mounsey *et al*., 1998). Improving N use efficiency will lower risks of losses to water and will also lower GHG emissions; nitrous oxide was an important source of GHG emissions from Irish farms. Greenhouse gas emissions in this study were similar to that recorded in other studies. Assessment of GHG emissions on farms are a recent phenomenon. Studies such as this one set a benchmark against which improvements on GHG emissions can be measured in the future. The P deficit on Irish farms can be, in part, attributed to the stringent regulations governing P fertilization of grassland in Ireland. Nutrient management and particularly management of P, was identified as an important weakness on Irish pilot farms in this study.

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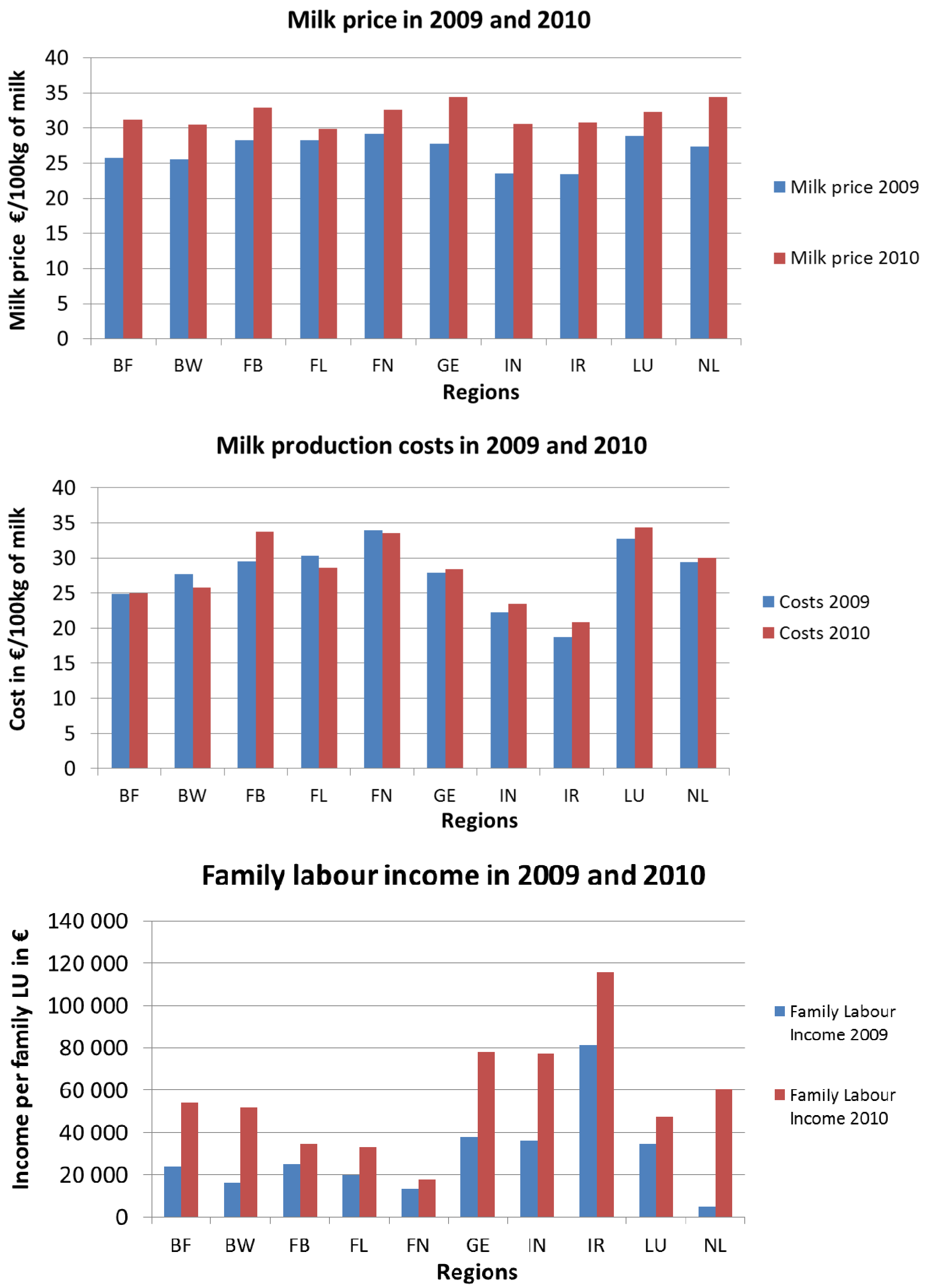

Figure 5. Milk price, costs of production and income per family labour unit on pilot farms in the Dairyman project

Farm Advisory System in the context of CAP2020

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The introduction of cross compliance in 2005 under the Single Payment Scheme was accompanied by an obligation on Member States to set up a **Farm Advisory System (FAS)** the objective of which was to help farmers to better understand and meet the EU rules in respect of the environment, public and animal health, animal welfare and the GAEC. The CAP now fifty years old continues to retain its original objectives which are to increase agricultural productivity, ensure a fair standard of living for the agricultural community, stabilise markets, guarantee the availability of food and ensure that this food reaches consumers at reasonable prices. While productivity may have been the focus in the early years, competitiveness and sustainability have gained an increasing focus following on from the McSharry reform in 1992 through Agenda 2000 and on to the Fishler reform of 2003. The quality of the Irish advisory service is reflected in the increase in farm productivity over the years achieved under the CAP.

Agenda 2000 created the Rural Development Pillar which presented new challenges for the advisory service from an environmental perspective. This was strengthened in the 2008 health check. The CAP2020 proposals now move the emphasis placed on the environment and sustainability to a higher level and this presents further challenges to the advisory service in meeting the needs of farmers. This evolving trend is also reflected in the ever changing relative distribution of the CAP budget. Export refunds, coupled payments and market supports are diminishing and are being replaced by decoupled support and rural development payments. It is likely that an increasing proportion of the CAP support will be directed towards Rural Development in CAP2020.

Member States are required to establish a FAS and have the flexibility to designate public and private bodies to achieve it. Under CAP2020 there is the possibility of financial support to be provided under Pillar II. The FAS is not intended to replace the existing advisory systems in Member States but to ensure the presence of an approved advisory system with a clear goal of advising in the first instance on cross compliance but also on the wider CAP2020 requirements. A separation of advice and controls is essential as the trust of the farmer must be maintained if he is to use the service.

Under the proposals for the new CAP, the scope of the FAS will be significantly enhanced. FAS is proposed to be a stand alone CAP instrument, the objectives of which are to make farmers more aware of the relationship between agricultural practices and the management of their farms on the one hand, and standards relating to the environment, climate change, good agricultural condition of land, food safety, public health, animal health, plant health and animal welfare on the other.

The designated advising bodies can be public or private and their advisors must be ***qualified*** and ***trained***. Farmers must have access to advice, targeted to the actual situation on the holding but the provision of advice must remain voluntary in respect of farmer participation. A significant change under the CAP2020 proposals is the separation of the advice into mandatory and optional elements.

In respect of the **mandatory** elements advice must be provided on:

- The SMR and GAEC rules under cross compliance;
- Agricultural practices beneficial for climate and environment;

- The maintenance of agricultural area;
- Requirements related to climate, biodiversity, protection of water, notifiable diseases, and promoting innovation
- Sustainable development of the economic activities of small farms

In respect of the **optional** elements advice may be provided on:

- Sustainable development of the economic activities of holdings other than small farms;
- The relevant minimum requirements for fertiliser and plant protection products use and other relevant mandatory requirements established by national legislation.

The cross compliance objectives under CAP2020 are now proposing to address the areas of water, soil and carbon stock, landscape, minimum level of maintenance, climate change mitigation and adaptation, biodiversity, protection of water, animal and plant disease notification and innovation.

While we are familiar with the existing cross compliance measures, however in the area of ***climate change mitigation and adaptation*** it will be necessary to provide advice on:

- Information on prospective impacts of climate change;
- Investments in physical assets ;
- Restoration of agricultural production potential and introduction of appropriate preventative action;
- Afforestation and creation of woodland;
- Establishment of agro-forestry systems;
- Prevention of damage to and restoration of damaged forest;
- Investments improving the resilience and environmental value of forest ecosystems;
- Investments in new forestry technologies and in processing and marketing of forest products;
- Agri-environment operations addressing climate change mitigation and adaptation
- Organic farming addressing climate change mitigation and adaptation;
- Environmental services from forests and forest conservation addressing climate change mitigation and adaptation.

In the area of ***Biodiversity*** it will be necessary to provide advice on:

- Establishment of agro-forestry systems
- Directive 2009/147/EC (Birds)
- Council Directive 92/43/EEC (Habitats)
- Investments in physical assets
- Investments improving the resilience and environmental value of forest ecosystems
- Agri-environment operations addressing biodiversity
- Organic farming addressing biodiversity
- Environmental services from forests and forest conservation addressing biodiversity

And in the area of ***the protection of water*** it will be necessary to provide advice on:

- Article 11 (3) of Directive 2000/60/EC in respect of the Water Framework Directive;
- Proper use of plant protection products in particular Integrated Pest Management (Directive 2009/128/EC);
- Investments in physical assets for water management;
- Agri-environment operations addressing water management;
- Organic farming addressing water management.

Under this latest proposed reform, CAP2020 will now be composed of two very complementary pillars. While some coupled support may be considered, most support will be decoupled and farmers will be subject to a more targeted cross-compliance regime and will be required to deliver on a greening requirement. Rural development is being strengthened. However success in meeting the various objectives will only be achieved if competitiveness and productivity are improved through enhanced efficiency which in the main will be attained by better use of knowledge and technology. This again reiterates the need for an effective FAS. The challenge will be to evolve and adapt the current FAS model to provide the necessary support to the farming industry.

Rural Development funds could provide for financing of the FAS if it is part of the National Rural Development Plan. The proposed provisions allow for support for the provision of advice to farmers, for the setting up of advisory bodies and for training advisors. In view of the expanded scope of the FAS under CAP2020, consideration must be given to the skill set and ongoing training which FAS approved advisors will require.

A more enhanced monitoring and evaluation process is proposed for all schemes or actions under CAP2020. The monitoring process will acquire quantitative data on the implementation while evaluation will judge schemes according to their results culminating in an assessment of each scheme or action. In the context of FAS, this could in the first instance be judged on the number of one-to-one or one-to-many interactions between advisor and farmer. However the indicator variables used to judge the outcome could be more wide-ranging such as determining in some way the beneficial effects of advice given to farmers.

The "Budget for Europe 2020" includes a major investment in the CAP section with 4.5 billion euros targeted for research and innovation in the field of food security, bio-economy and sustainable agriculture. FAS advisors can play a major role in enhancing innovation by ensuring its effective application at farm level. Moreover, advisors may identify and remove impediments in the implementation of existing innovations and help to identify areas for further research related to productivity and sustainability.

In view of the scope of knowledge now required, how can FAS be effectively and efficiently provided? It is apparent from the CAP2020 proposals that a significantly expanded knowledge base will be an essential requisite within an advisory service. Its organization and delivery is a challenge we must all now address.

Accounting for N losses in dairy production at Solohead Research Farm

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Irish grass-based systems of dairy production are highly reliant on input of fertilizer N and tend to have relatively high farm-gate N surpluses (N inputs – N outputs) (Treacy et al., 2008). Nevertheless despite high N surpluses on farms research indicates that losses of nitrate N to water is not particularly high especially on heavier textured soils with high soil organic matter content, which is typical of many farms in Ireland. Where substantial N surpluses do not lead to high nitrate-N losses to water, it raises the question: what happens to the 'missing' surplus N? This topic has been a subject for research at Solohead Research Farm for more than 10 years (Humphreys et al., 2008; Li et al., 2011; Necpalova et al., 2012; Yan et al., 2013). Accumulated results indicate that losses as N_2 gas is the most likely explanation. This gas is environmentally benign; accounting for around 79 percent of the earth's atmosphere. In 2010 a study was commenced to test this hypothesis. The objective of the study was to quantify the annual production of N_2 and to evaluate its contribution to accounting for the 'missing' N in the farm N balance at Solohead Research Farm.

Nitrogen flows were measured on a white clover based system of dairy production from January 2011 to December 2012. The system was rotationally grazed by Holstein-Friesian cows at stocking density of 2.35 cows ha^{-1} and received annual fertilizer N input of 112 kg ha^{-1}. The main products of denitrification N_2 and N_2O were quantified using a ^{15}N gas flux and static chamber method, respectively.

Inputs and outputs of N (kg/ha) to and from the system were 548 and 80 respectively, with surplus N of 468 kg/ha in 2011 (Table 1). Of this surplus losses to groundwater accounted for 4.1%, losses of NH_3 9.2% and losses of N_2O 6.0%. Losses of N_2 gas accounted for 79%, which more-or-less accounted for all of the remaining surplus N or the 'missing N' described above.

Table 1. Nitrogen inputs, outputs and losses on a dairy production system at Solohead Research Farm in 2011

Inputs		Outputs		Losses	
		(kg N/ha)			
Rain deposition	10	Milk	79	N losses to water*	19
N fertilizer	112	Cull cow & calves	1	Soil N accumulation	0
Feed	35			NH_3	43
Biological N fixation	85			N_2O	28
Net soil N Mineralization	306			N_2	371
Total	**548**		**80**		**461**

* N losses to ground water consisted of (kg N/ha) 2, 7 and 10 in the form of ammonium, dissolved organic nitrogen and nitrate, respectively.

Emission of environmentally benign N_2 was the major N loss pathway. The clay loam soil with high organic matter at Solohead Research Farm is representative of around one quarter of the soils of Ireland. Although there are high N surpluses associated with Irish dairy farms, the results of the current study indicate that a large proportion of these surpluses are returned to the atmosphere as environmentally benign N_2 gas.

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Nutrient management: 'Getting the Balance Right'

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Aggregate results of over 100,000 agronomic soil-tests by Teagasc show that soil P and K fertility status has been declining during the period 2008-2012, indicating that current nutrient management practices on farms require investigation and improvement. A survey of farmers was conducted to develop an understanding of awareness and practices in Nutrient Management (NM) on farms. A total of 375 responses were collected from 22 counties.

Results showed that 25% of farmers don't have a NM plan, and those that do saying the main reason for it is to calculate a whole-farm fertilizer allowance for cross-compliance rather than for agronomic benefits. Teagasc advisors were also surveyed for their attitudes and experience to NM activities. Results from 145 responses, from every county, indicate that the majority of soil samples are taken for compliance rather than agronomic reasons. The advisors requested simpler user-friendly NM tools to facilitate more adoption of NM for agronomic purposes. A comprehensive case study survey of 50-farms is in progress to determine the NM practice on a subset of intensive farms. To maintain high quality produce and high levels of production; as well as collaborating good environmental practice, nutrient management will be the key to unlocking the issues and improving the level of the soil nutrient status.

The surveys showed that there was a great difference with regard to attitude between age, location and enterprise. The more intensive farming enterprises had higher regard for the benefits of NM. Bridging the gap between advice given to the farmer and NM practice on Irish farms through improved knowledge transfer is where the improvements can be made. Improved NM delivery methods and tools along with training sessions and discussion group meetings will be the main drivers of improved NM efficiency and fulfil the objectives of Food Harvest 2020.

Irish Soils Information System

Dr. Brian Reidy, ISIS Project, Teagasc Johnstown Castle.

Farming activities have long been heralded as being a critical developer and shaper of the rural landscape and environment which we enjoy in Ireland today. Historically, farmers engaged in resource protection solely out of necessity to sustain their production capacity through generations. However, what has changed in recent times is the way in which environmental protection must be implemented at farm level: we have now entered a new era of legislation driven by environmental protection and legislation at a global and European scale.

Comparison of soil information at a European scale has led to the requirement for the harmonisation and coordination of soil data across Europe, and, in light of the demands for soil protection on a regional basis within member states there is a growing need to support policy with harmonised soil information.

Critical to the successful development of such strategies is the knowledge on the location of our soils, and their associated properties. To date, Ireland has a national soil map at a scale of 1:575,000, with only half the country mapped in significant detail. Over 450 soil series have been identified in Ireland, each of them different in properties, with different environmental and agronomic responses.

The project will develop a national soil map of 1:250,000 and an associated digital soil information system, providing both spatial and quantitative information on soil types and properties across Ireland. Both the map and the information system will be freely available to the public through a designated website. This project began in 2008 and will continue for a period of 5 years.

The Irish Soil Information System (ISIS) project will uniquely combine the latest spatial mapping technologies with tried-and-tested ground-truthing: soil pits, at a national scale. Using existing historical data from the An Foras Talúntais soil survey from the 1960s, 70s and 80s, which surveyed 44% of the country. This project will seek to map the remaining half of the country by generating predictive soil maps based on satellite imagery, digital terrain mapping, and other geo-environmental GIS layers. It will then proceed to calibrate and verify these models through an intensive 2.5 year traditional field sampling campaign from 2010 to 2012; this campaign will provide hard soils data on 300 new reference profiles.

It is hoped that this project will form the basis for more accurate soil data in Ireland at a national scale and will provide to the public, data which to date has not been accessible. This will provide the opportunity for soil specific nutrient advice and better research opportunities in spatial soil mapping and modelling in the future.

Greenhouse Gas Emissions Associated With Establishing Energy Crops

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Climate change policy demands that environmental sustainability underpins future growth in the agricultural sector. Concerns about the impact of global climate change have led to the adoption of challenging emission reduction strategies at an EU level, aimed at decarbonising the energy and industrial sectors and reducing emissions in the non-ETS sector which includes agriculture. In addition to this, EU member states have committed to a 20% share of renewable energy in the total energy mix by 2020. Future agricultural expansion and intensification must therefore be accompanied by a reduction in the greenhouse gas (GHG) intensity of agricultural activities, an enhancement of natural carbon sinks and the advancement of low carbon/carbon neutral technologies.

Land-use change to biomass crop production can contribute towards meeting both national and international renewable energy and emissions targets. As a carbon-neutral fuel stock, these crops have the capacity to mitigate GHG emissions through the substitution of fossil fuels. However, studies have also provided evidence of carbon sequestration in vegetative and soil reservoirs in these ecosystems. Realisation of this mitigation potential is, however, dependent on suitable crop selection and thorough assessment of the emissions and sinks associated with biomass crop cultivation.

The aim of this research was to assess the GHG implications of land-use change to biomass crops by quantifying carbon dioxide (CO_2) and nitrous oxide (N_2O) emissions both during the initial land conversion phase and in the newly-established plantations. Field-scale stands of *Miscanthus* × *giganteus* and Reed Canary Grass (RCG; *Phalaris arundinacea*) were established on land previously under permanent pasture in 2009 and 2010 respectively in the south-east of Ireland. CO_2 uptake and release was measured at the ecosystem scale by two open path eddy covariance systems, while N_2O fluxes before and after cultivation were sampled using the static chamber technique.

Short-term tillage-induced carbon emissions were found to be high immediately after ploughing but transient in nature, reducing to background levels within a matter of hours. Results suggest that longer term losses could be limited to approximately 2 t CO_2 ha^{-1} provided the fallow period is minimised. A more sustained release of N_2O was observed after soil cultivation, resulting from increased availability of organic N for mineralisation by soil microbes. Development was initially slow in the *Miscanthus* stand, however by the third year, the crop had begun to mature and had switched from a net GHG source in the first year of establishment to a net sink of over 10 t CO_2 ha^{-1} yr^{-1}. More rapid establishment of RCG facilitated the development of a dense canopy in its first year and correspondingly high net CO_2 uptake, which increased further in the second year to a value close to that of year-3 *Miscanthus*. However, continued development of the *Miscanthus* crop to full maturity and maximum biomass yields is expected to enhance further the superior GHG sink strength of *Miscanthus* relative to RCG. This research highlights the high GHG efficiency of perennial biomass crops, which, combined with fossil fuel displacement during combustion, may present opportunities in the future for offsetting emissions in the agricultural sector.

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