Exploring the Effect of Policy Reform on the Economic, Social and Environmental Sustainability of Irish Farms

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Please tick below the appropriate area on the research continuum where you feel this project fits

BASIC/FUNDAMENTAL ————> APPLIED/PRE COMMERCIAL

X

Key words: economic research, policy analysis, sustainability indicators, farm-level modelling, micro-simulation
1. **Rationale for Undertaking the Research**

The principle of sustainability is firmly enshrined in the objectives of the Common Agricultural Policy and is one of the forefront issues in European agriculture. Much policy reform states sustainability as its goal. The Irish government are also committed to fostering a sustainable agriculture, as echoed in the Agri-Vision 2015 report which stated that policy that supports a sustainable agriculture and rural community should remain at the core of Irish economic policy (Department of Agriculture, 2005). Indeed, one of the main objectives of the Research Stimulus Fund is to facilitate research that supports sustainable and competitive agricultural production practices.

Prior to this research, little work had been undertaken in an Irish context in the area of sustainability and agricultural sustainability in particular. Most existing research focused environmental sustainability alone. The Economic and Social Research Institute (ESRI) study *Formulating Environmental and Social Indicators for Sustainable Development* (Scott, Nolan and Fahey, 1996) contained separate essays on social and economic indicators but prior to this work an integrated approach, encompassing the three dimension of sustainability (economic, environmental and social) had not been developed at the farm level or indeed at the national level.

Measurement of sustainability can prove difficult in practice at the farm level. Nonetheless, a meaningful measure is required if it is to guide policy. Prior to this, ex-ante agricultural policy analysis in Ireland has tended to focus on the economic effects of policy in isolation, for example the FAPRI-Ireland model (Binfield et al 2006), or the environmental effects alone, for example (Hennessy and Shalloo 2005) or the social implications. This project builds upon research previously funded through the RSFP and Teagasc core funding to adapt pre-existing modelling tools and databases to explore agricultural sustainability at the farm level. The project aimed to provide quality scientific based policy advice and recommendations on (i) the current state of farm sustainability in Ireland and (ii) the effect of hypothetical policy scenarios on the economic, social, quality of life and environmental sustainability of farming practices. The overall objective to develop an all-encompassing modelling system that can show the effect of policy on all three dimensions of sustainability simultaneously has been met.

2. **Research Approach**

The overall objective of the research was to assess the effect of policy on the sustainability of Irish farming with a view to providing policymakers with scientific based policy advice. The specific objectives and the approach taken are outlined below:

1) **To develop indicators of economic, social and environmental farm sustainability**

A literature review of international sustainability indicators was firstly undertaken. This proved useful in designing indicators for the Irish case. Indicators encompassing the multi-dimensional nature of sustainability (economic, environmental and social) were then developed using Teagasc National Farm Survey (NFS) data over an eleven year period (1996-2006) to assess the overall sustainability of Irish agriculture. This is the first such study undertaken for Ireland and the results show significant change over the decade, in all three areas examined. The main indicators chosen are listed below:
Economic - Viability, Direct Payments as a percentage of gross output, Market return

Environmental - Methane emissions, Organic nitrogen (kg/ha), Organic phosphorus (kg/ha)

Social - Demographic Viability, One person farm households

The RERC SMILE model is then used to demonstrate how these indicators can be derived at a spatial level below the national scale. Some additional work has also been undertaken in the area of composite indicators; these are a mathematical aggregation of individual indicators compiled into a single index and are becoming increasingly popular for sustainability assessments. There is some debate in the literature as to the usefulness of this methodology; they are useful in that they can summarise complex or multi-dimensional issues and are easy to interpret, however, they may lack accuracy if poorly constructed. Their overall usefulness in assessing agricultural sustainability, particularly in an Irish context is an area we would like to examine further at a future date.

2) To develop a tool to generate these indicators on an annual basis
An indicator tool (a user friendly spreadsheet model) capable of generating sustainability indicators annually using national farm survey data was designed.

3) To model farmers’ participation in the Rural Environmental Protection Scheme (REPS)
This is the first such study to model the participation decision of farmers in agri-environmental schemes over time. Previous studies that have attempted to model the participation decision of farmers in agri-environmental schemes have used a static framework where it was not possible to examine changes in the participation decision of farmers over time. This is rectified here by utilising an 11 year panel that contains information on approximately 1,100 farmers for each year. Linking of the REPS participation model to SMILE and the FAPRI farm-level model, spatially mapping the participation of farmers in the REPS scheme has also been completed. The statistically matched information was then used to produce small area farm population microdata estimates of the probability of participation by Irish farmers in the Rural Environmental Protection Scheme (REPS) for the year 2005. Previous studies that have examined the participation of farmers in agri-environmental schemes across Europe have been unable to quantify the type of habitats being protected under the programmes. This is rectified in this work by combining the simulated farm population microdata with habitat land cover data within a GIS framework to examine what types of habitats are actually being protected under the agri-environmental programme. The results indicate that bogland, rocky complexes, forestry and shallow water are habitats that are more likely to be given protection under the REPS programme while heath, dry grassland, built land and cut fen are habitat types that are unlikely to be protected under REPS. Further analysis (using NFS data) shows that participation in REPS has had a substantial impact on farming practises i.e. the use of chemical nitrogen, phosphorous and potassium and a potentially more significant reduction in the production of organic nitrogen, organic phosphorous and methane emissions that would have been the case if the REPS farmers in the NFS had not joined the scheme.
To link the FAPRI-Ireland and SMILE models

The FAPRI-Ireland and SMILE models were linked and adapted to generate indicators of future sustainability under a number of policy scenarios. The impact on the economic viability of farm businesses, the implications for the environment and the social status of farm households was then assessed. The linked models have also been used to map important sustainability indicators highlighting some interesting regional differences across the country, in particular with regard to economic and environmental sustainability. Using NFS data it was possible to estimate the average flat rate payment by aggregating the SFP paid per farm and allocating it across land area farmed. Using 2006 data, the flat rate payment was estimated to be €314 per hectare. At this rate of payment, almost one-third of farmers would experience a change of 20 percent or less to their SFP. A small proportion of farmers, less than 3 percent, would experience very large losses, with reductions in their SFP of 50 percent or more. While about 15 percent of farmers would stand to double their SFP if a flat rate payment model was adopted. “Cattle Rearing” and “Mainly Sheep” farms gain from the flat rate payment model, by an average of 19 and 15 percent respectively. These farm systems tend to be very reliant on the SFP. In 2006 approximately 88 and 77 percent of income on “Cattle Rearing” and “Mainly Sheep” was derived from the SFP. Hence increases in the SFP on these farms will have more considerable implications for income than for dairy farms for example.

The data shows that very large sheep farmers, farming 100 hectares or more, are the main beneficiaries of the flat area payment model. This group, representing less than 1 percent of the total farm population, would on average increase their SFP by 95 percent from an average of €42,000 to €82,000. On the other hand, “Cattle Other” and “Tillage” farms stand to lose most under a flat rate payment model (by 10 and 15 percent on average respectively). For example, the “Cattle Other” farms with 100 hectares or more stand to lose almost 20 percent of their SFP, which translates to a 21 percent loss in farm income, declining from €44,600 to €35,234. The very large “Tillage” group (100 hectares or more) would lose 10 percent causing farm income to decline by 7 percent from €81,322 to €75,600. The changes on the two dairy farm groups are relatively small, although small “Dairy” farms do experience more considerable increases. Given that the SFP comprises a much smaller proportion of income on dairy farms the changes do not have a significant impact on farm income.

Taking regional implications into account, using the SMILE model (Spatial Microsimulation Model of the Irish Local Economy developed in the Rural Economy Research Centre, GIS tools were then used to map variables from the NFS. Results show that decoupled payments would move from the south-eastern half of the country to the north-west if the flat rate payment model was adopted; extensively farmed holdings located along the western seaboard and border regions would gain significantly at the expense of the southeast.
5) To adapt the linked models to generate the sustainability indicators
On linking the two models the effect of a number of policy scenarios on the economic viability of farm businesses, the sustainability of farm households, the implications for the environment and the social status of farm households in the rural economy under different policy scenarios can be assessed.

6) To simulate the effect of a number of policy scenarios on the indicators
The policy scenarios undertaken are outlined below:

Milk Quota Reform - under this task the FAPRI farm-level model was utilised to examine a baseline and milk quota expansion scenario of +3% from 2008 to 2014. The farm level modelling system is comprised of a number of representative farms that are modelled using multi-period profit maximising linear programming (LP) models. The methodology involves integrating econometric and optimisation models. The economic, environmental and social impact on dairy farms was then assessed.

The effect of a carbon equivalent tax to reduce methane emissions was also examined. The economic impact was assessed by analysing family farm income at a regional level using a micro-simulation modelling technique called simulated annealing to match the Irish Census of Agriculture data to the NFS. The main advantage of the spatial micro-simulation approach is the fact that it allows one to account for the heterogeneity in the farm population across space.

A third scenario was undertaken to estimate farmers’ willingness to pay (WTP) to conserve the Corncrake (Crex crex) an endangered Irish farmland bird. NFS data is used to produce individual farm-level WTP estimates for the year 2006 and figures are then aggregated to obtain a total value figure for the farming community of Corncrake conservation in Ireland.

3. Research Achievements
The main results from each task are detailed below:

Calculation of Indicators
Indicators encompassing the multi-dimensional nature of sustainability (economic, environmental and social) are developed here using Irish NFS data over an eleven year period (1996-2006). The RERC SMILE model is then used to demonstrate how these indicators can be derived at a spatial level below the national scale and results mapped. The main indicators are reported upon below:

- Economic Sustainability

Economic Viability - based on the work of Hennessy (2004) and Frawley and Commins (1996), an economically viable farm is defined as having (a) the capacity to remunerate family labour at the average agricultural wage and (b) the capacity to provide an additional 5 per cent return on non-land assets. A poor degree of viability is reported upon on average across farms over the period with between 29 and 41 percent of farms only, being classified as ‘economically viable’. However, when individual farming systems were taken into account, some were found to perform better than others.
Direct Payments as a percentage of Gross Output - direct payments as a percentage of gross output were found to be greater in 2006 than in 1996 for all systems (with the cattle rearing system showing the least amount of change). Such payments are evidently of huge significance to Irish farmers and therefore any future reform should prove important for the sustainability of Irish farming.

Market Return per farm is calculated here by subtracting direct payments from family farm income. Worryingly, only the dairying and tillage systems are seen to show a significantly positive market return in both years. All other systems provided some degree of market return in 1996; however, this is seen to diminish over the period, resulting in negative market return in the cattle and sheep sectors in 2006.

- Environmental Sustainability

Methane emissions - the more intensive farming systems (primarily dairy) were found to pollute more on average while in more general terms the levels of methane emissions produced per hectare has been falling over the reference period. In calculating market return in terms of methane emissions (€ per kg) only the dairying systems are seen to be making a positive return per kg of methane produced. All other systems are polluting at a loss.

Total nitrogen polluting pressure - an examination of the NFS dataset indicates that purchased fertiliser usage was on average increasing in Ireland up to 2001 but from that point on it is seen to fall, probably due to increased costs. Organic nitrogen produced on-farm was seen to change little from 1996 to 2006. Levels of total nitrogen are generally higher for the dairying systems and have increased relatively more dramatically for these systems over the ten year period.

- Social Sustainability

Demographic viability - taking into account the percentage of farm households which have at least one household member below 45 years of age (i.e., those defined as demographically viable), a slight decline is found over the eleven year period examined across all systems. This indicator can be thought of as an indicator of succession with the likelihood of someone taking over the farm being worse when no member of the farm household is below the age of 45. An outstanding issue which may be of importance in this case is that although the potential successor may currently live away from home (e.g., attending college) they could well intend to return to the farm at some future point. Since these individuals are not included in the data the true presence of a successor may be underestimated here.

Isolation - results from EU-SILC 2003, indicate that persons living alone (i.e. in single adult households) were most at risk of poverty with almost 45% below the 60% threshold. Those living alone in Irish farm households are also thought to be in danger of isolation, with many such people being elderly. Once again using the NFS, it was found that there was relatively little change in this indicator over the period 1996-2006; however it was seen to fall slightly for dairy and sheep farms and to rise significantly for cattle and tillage farms. Interestingly, the number of dairy farmers living alone tended to be smaller than for other systems. There were a
number of other peer reviewed articles assessing the sustainability of Irish agriculture using farm-level indicators over the period 1996-2006. A general conclusion of which is that Irish agriculture is experiencing a period of fundamental change, not least in terms of the ever-changing rural demographic; the challenge therefore lies in ensuring that farms remain economically, environmentally and socially sustainable in the long-term.

The fact remains that sustainability is a subjective notion with many different measurement approaches. Multidimensional aspects - economic, environmental and social - must be taken into account but this can prove difficult in practice at the farm level. This research gives a snapshot of the current sustainability of Irish farming and should provide policymakers with some interesting insights. The characteristics and complexity of sustainability (multidimensional, global, dynamic), make it a concept, which gives a certain direction for policy making rather than serving as a precisely defined benchmark. Sustainability indicators should allow one to judge whether a certain development contributes to movement in ‘the right direction’. In reality the interpretation of a set of multidimensional indicators can prove difficult and it can therefore sometimes be useful to aggregate a multidimensional set of indicators into a single index or composite indicator. These are becoming increasingly popular for sustainability assessments and can be more straightforward when interpreting data than trying to find a common trend in separate indicators. However, there is some debate as to their usefulness; they are helpful in that they can summarise complex or multi-dimensional issues and are easy to interpret, but, they may lack accuracy if poorly constructed. Furthermore, the choice of indicators is subjective and the weighting process by which the variables are combined is arbitrary. In our analysis the amalgamation of indicators into one composite indicator proved not very useful. The economic and environmental results were highly negatively correlated and in effect cancelled each other out; meaning that the social indicators were the main drivers of the composite indicator. Results highlight the complexity of the concept of farm sustainability and the difficulty of providing a comprehensive measure; the debate continues.

**Modelling Participation in REPS**

The structure of the NFS data set allows us to employ pooled, fixed and random effects panel data logit models that take into account changes in the participation decision of farmers over time rather than simply examining the participation decision at just one point in time. An eleven year panel containing information on approximately 1,100 farmers for each year is used. The results point to the fact that systems of farming that are more extensive and less environmentally degrading (i.e., extensive drystock) remain those most likely to participate in the REPS. This is a classic case of an adverse selection problem, whereby the undesirable members of a population are more likely to participate in a voluntary exchange.

**The Impact of REPS Participation on Farm Chemical Input Usage and the Production of Negative Externalities.**

REPS was introduced under Council Regulation 2078/92 in order to encourage farmers to carry out their activities in a more extensive and environmentally friendly manner. Using NFS data we examine the extent to which farming practices have changed due to farmer participation in the REPS scheme. The analysis shows that REPS has had a substantial impact on the use of chemical nitrogen, phosphorous and potassium. Also, participation in REPS may have resulted in a more significant reduction in the production of organic nitrogen, organic phosphorous and
methylene emissions than would have been the case if the REPS farmers in the NFS had not joined the scheme.

**Policy Scenarios – Future Trends in Sustainability**

**Milk Quota Expansion**

Analysis has also been completed on the impact on sustainability of a milk quota expansion scenario (assuming milk quota expansion of 3% per annum 2008-2014). Using an integrated modelling approach, with entry and exit and quota trade modelled exogenously using econometric models the policy effect on farm income, farm numbers, off-farm labour supply and trade of quota as well as indicators were then assessed. Key findings included an improvement in economic sustainability with average family farm income improving under quota expansion from 2009. Quota expansion would result in a decline in the active population of farmers but with those remaining performing better on average i.e. the proportion of economically viable farms improves under quota expansion. However, environmental sustainability worsens under quota expansion with an increase in average methane emissions and organic nitrogen. The latter having questionable implications for the nitrates directive going forward. In terms of social sustainability, demographic viability improves (i.e. the proportion of households with at least one member under 45 increases) and the number of one person farm households decreases. To summarise then quota expansion improves economic and social sustainability on average at the expense of environmental sustainability (based on our chosen indicators).

A baseline analysis for the future trends in non-dairy livestock systems was also conducted. The baseline projections for prices and costs were taken from the FAPRI-Ireland model (2008 analysis) and the baseline scenario assume no change to current policies. The impact of the projected price and cost changes on farm level sustainability was examined. The outlook for beef and sheep prices is poor relative to the costs of production. The results show that this results in a decline in the average gross margin on non-dairy livestock farms, assuming no change in current production systems and no change in agricultural policy, of 21 percent between 2008 and 2018. This decline in gross margin has implications for the economic viability of production. The number of cattle farms estimated as being economically viable is projected to decline to less than 10% in 2018. In relation to tillage farmers it was estimated that 27% of farmers are unable to return a positive gross margin in 2018 hence economic viability declines and reliance on subsidies increases. A large majority of livestock and tillage farmers would increase their economic and environmental sustainability by reducing production. A scenario where farmers optimise their production systems by reducing production was examined the implications for the various indicators was assessed, however this analysis has not been fully written up to date.

The effect of a **carbon equivalent tax to reduce methane emissions** was also examined. The economic impact was assess by analysing family farm income at a regional level using a micro-simulation modelling technique called simulated annealing to match the Irish Census of Agriculture data to the NFS. The main advantage of the spatial micro-simulation approach is the fact that it allows one to account for the heterogeneity in the farm population across space. The results of the modelling process are presented using GIS mapping techniques and highlight
the fact that there would be significant regional variation in the burden of an agricultural tax that was based on a rate per unit of methane emissions. The results also demonstrate that if the methane tax revenue raised was redistributed in the form of an environmental subsidy to farmers participating in an agri-environmental scheme it would encourage farmers to participate in the scheme and could also have the effect of moving low income farms up the earnings distribution ladder. A ring–fenced agri-environmental programme is proposed that on the one hand places a methane emissions tax on farmers but on the other redistributed the revenue to farmers who opt to participate in an agri-environmental program has the double advantage of reducing greenhouse gas emissions from Irish agriculture (assuming farmers implement abatement technologies or reduce the livestock stocking densities on the farm to reduce their tax bill) while at the same time encouraging farmers to participate in the REPS scheme which should lead to further improvements in the state of the rural environment. This demonstrates a balanced policy that combines an element of both an environmental tax and environmental subsidy giving the necessary incentive to Irish farmers to consider not only the level of emissions on their farms (environmental sustainability) but also to consider the economic benefit (sustainability) of joining such a scheme.

A final policy simulation considers farmers willingness to pay (WTP) to conserve an endangered Irish farmland bird, the Corncrake (Crex crex). The National Farm Survey is used to produce individual farm-level WTP estimates. These figures are then aggregated to obtain a total value figure for the farming community of Corncrake conservation in Ireland. It is very evident from our model results that farmers willingness to pay for the restoration of the corncrake is positively correlated with participation in existing agri-environment schemes. The second main finding of the study in terms of corncrake conservation was the fact that the yearly total non-market value of corncrake conservation to the farming community in Ireland, estimated using our valuation function approach, of €1,541,819 was 6 times the cost of corncrake conservation programs (€264,530) in operation in Ireland for the reference year 2006.

4. Impact of the Research

Future sustainability of Irish farming

A worrying trend coming from the research is that economic viability was in decline across the time period examined, particularly for the cattle and sheep systems. Given the current downturn the availability of off-farm employment for such farmers is questionable. The increasing importance of direct payments cannot be ignored either. Diversification could certainly be justified in some cases. Taking the milk quota expansion scenario into account, future trends in sustainability were more positive with less viable farms exiting to be replaced with more efficient ones.

Trade-off between economic efficiency and environmental efficiency

Another finding of the research was the correlation between market return and environmental pollution. It was found in general that more profitable farmers tended to pollute more on average. In addition it was found that the least environmentally damaging farmers were actually those participating in REPS. This should be factored into the design of a replacement agri-environmental scheme. There should not be a trade-off between economic and environmental sustainability.
**Measurement difficulties**

The principle of sustainability is firmly enshrined in the objectives of the Common Agricultural Policy and is one of the forefront issues in European agriculture. The concept, however, is difficult to define and there is much debate over its precise meaning. Multidimensional aspects – economic, environmental and social – must be taken into account but this can prove difficult in practice at the farm level. Nonetheless, a meaningful measure is required if it is to guide policy. Perhaps a debate at EU level could help eliminate ambiguity about how best to combine or co-ordinate multidimensional aspects and to potentially generate an agreed uniform approach. With regard to this project specifically the National Farm Survey was a worthy source allowing us to track sustainability indicators over time; however the lack of social indicators therein would have to be acknowledged. Future work utilising a number of other datasets to primarily examine the issue of social sustainability would be beneficial.

5. **Exploitation of the Research**

The objective of this project was to conduct research on a number of issues pertaining to the current sustainability of farming and the subsequent impact of potential policy reform providing evidence based policy advice to government. As such, the objectives of the project were not to generate any technology or intellectual property that could be adopted by industry. A set of recommendations have been drawn up and a number of articles published. It is hoped that these will feed through to the relevant policymakers.

6. **Summary of Research Outputs**

(a) Intellectual Property applications/licences/patents  
N/A

(b) Innovations adopted by industry  
N/A

(c) Number of companies in receipt of information  
N/A

(d) Outcomes with economic potential  
N/A

(e) Outcomes with national/ policy/social/environmental potential  
N/A

(f) Peer-reviewed publications, International Journal/Book chapters.


(g) Scientific abstracts or articles including those presented at conferences


(h) National Report
   N/A

(i) Popular non-scientific publications


(j) Workshops/seminars/ open days at which results were presented (excluding those in (g)) N/A
### 7. Permanent Researchers

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### 9. Postgraduate Research

Total Number of PhD theses: N/A

Total Number of Masters theses: 1.

10. **Project Expenditure**

Total expenditure of the project: **€251,474.39**

Total Award by RSF: **€272,758**

Other sources of funding (specify) **€0**

Breakdown of Total Expenditure

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11. **Future Strategies**

Work is still ongoing on the preparation of a number of papers for submission to peer reviewed journals.

12. **Industry Collaboration**

N/A
References


