Assessing the Sustainability of Irish Farming

Emma Dillon, Thia Hennessy, Stephen Hynes & Verena Commins

Rural Economy Research Centre, Teagasc, Athenry, Co. Galway, Ireland.

Emma.Dillon@teagasc.ie

Paper prepared for presentation at the 107th EAAE Seminar *"Modelling of Agricultural and Rural Development Policies"*. Sevilla, Spain, January 29th - February 1st, 2008

1. Introduction

1.1 Background

Agriculture is an indigenous sector that has strong linkages within the Irish economy and a geographic spread throughout the country. Irish agriculture is primarily a grass-based industry. Of the total land area (6.9 million hectares), 64% (4.3 million hectares) is used for agriculture with a further 11% used for forestry (710,000 hectares). 80% (3.4 million hectares) of this agricultural area is devoted to grass (silage, hay and pasture), 11% (0.5 million hectares) to rough grazing and 9% (0.4 million hectares) to crop production. The country is home to almost 6.2m cattle, 4.3m sheep and 1.7m pigs (Department of Agriculture and Food, 2007b). Beef and milk production account for 55.4% of total agricultural output at producer prices (Department of Agriculture and Food (c), 2006:1).

There exist distinctive farming regions within the country, whose boundaries span unevenly across county limits. These are undergoing different processes of change depending on their resource base, their responses to economic imperatives, and the policy environment. Land type (and thus usage) varies considerably across the state; generally, the west and north have the more difficult land (i.e., stony and infertile soils, steep slopes, and rock outcrops). Mountain and coastal areas in the west are subject to high rainfall, lower temperatures and a shorter growing season. Another significant aspect of the resource base is that the inferior tracts are mainly those on which small farms predominate. The largest concentration of small farms occurs in the Border and Western regions with the largest farms in Dublin, Mid-East and South-East (Lafferty et al., 1999:13).

The importance of primary agriculture to the economy has certainly reduced in recent years, in line with the trend in all industrialised countries. Nonetheless, it remains important, accounting for 2.3% of GDP at factor cost, in 2006. Furthermore, the Agri-Food industry is one of the country's largest home-grown industries accounting for an 8.1% share of GDP. Employment in the sector accounts for 8.1% of total employment or 163,400 jobs (Department of Agriculture and Food, 2007a). The regional distribution of the Agri-Food processing sector is crucial for maintaining employment and growth in rural areas. The country is traded the world over as *"The Food Island"* and competes successfully in over 130 markets worldwide. Agri-Food exports in 2006 were valued at €8.1 billion or 9% of total exports. Almost 74% of these exports went to the high-value EU-15 markets in 2005 (Department of Agriculture 2006:1). Due to its very strong export orientation and low import content, the agri-food sector is responsible for a much higher proportion of the country's net foreign earnings. Although its relative importance in the economy has diminished somewhat, due to the very rapid expansion of some other sectors in recent years, it remains vital to national prosperity (Department of Agriculture and Food, 2004:3).

Livestock and livestock products accounted for over 73% of the value of gross agricultural output in Ireland in 2004, a figure which has fluctuated little over time (CSO, 2005). Commodities as a percentage of Goods output in 2005 are given in fig. 1 below. The traditional orientation of Irish farming towards livestock enterprises can be explained by a number of factors, including climate, soil, topography, history, and by economic conditions, which have ensured a market for livestock and livestock products in the UK and mainland Europe (Lafferty et al, 1999:82).

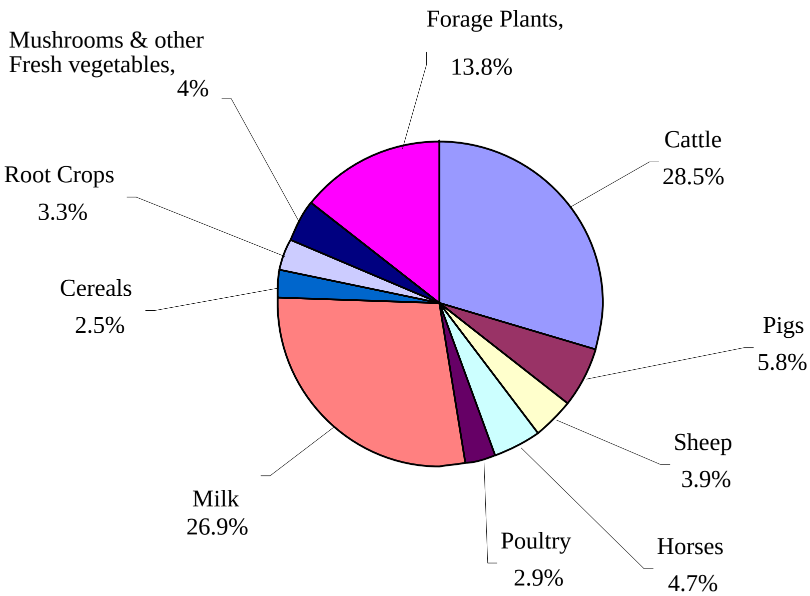


Fig. 1: Commodities as a % of output 2005

Source: CSO data

The overall objective of this research is to examine the sustainability of farming in Ireland using FADN data (Farm Accountancy Data Network of the EU) to develop a number of indicators of sustainability (economic, environmental and social); presenting a benchmark measure of the current sustainability of farming in the country. A general overview of results is given in section 3.

1.2 Sustainability

The concept of sustainability has emerged in the past thirty years as a leading framework for understanding economic development, community development, and natural resource management around the world (Schlossberg and Zimmerman, 2003:641). There is much debate as to an appropriate definition of sustainability. The notion has many dimensions, and indeed deliberation on such has further highlighted its complexity. A widely adopted definition is that included in the 1987 report "Our Common Future" of the "World Commission on Environment and Development" (the Brundtland report) which defined it as *"development which meets the needs of the present without compromising the ability of future generations to meet their own needs"* (World Commission on Environment and Development, 1987).

Sustainability is the main principle of the declaration of the Rio Earth Summit and Agenda 21, established in 1992 at the United Nations Conference for Environment and Development (UNCED). The widespread 'adoption' or pursuit of sustainable development, and indicators of sustainability, took off following the summit (Woodhouse et al., 2000:12); triggering wide scientific and policy interest as it brought the three dimensions of development: economic, environmental and social, into an integrated framework (Rao and Rogers, 2006:439). It established a mandate for the UN to formulate a set of indicators that would help gauge progress towards sustainability and there has been a concerted effort since then to construct indicators to monitor progress towards sustainable development. This has included indicators of sustainable land management, land quality indicators and indicators of sustainable agriculture (Rigby et al, 2001:463). Sustainable development at sectoral (i.e., agriculture) and territorial (i.e., rural area) level represent a priority objective of European Union strategy, as can be derived from many of the most recent documents where one finds that *"all policies…must have sustainable development as their core concern" (*Commission of the European communities, 2001), and that *"sustainable development is a priority at all levels of public governance, and increasing awareness in the private sector"* (Commission of the European Communities, 2002).

Sustainable agriculture is defined as a practise that meets current and long-term needs for food, fibre, and other related needs of society while maximizing net benefits through the conservation of resources to maintain other ecosystem services and functions, and long-term human development. This definition again emphasizes the multidimensional (economic, environmental and social) goals of sustainable development in agricultural terms (Rao and Rogers, 2006). With regard to the achievement of sustainable agriculture, the basic long-term challenge as seen by the OECD is to produce sufficient food and industrial crops efficiently, profitably and safely, to meet a growing world demand without degrading natural resources and the environment (OECD, 2000). Within the OECD approach, financial resources, farm management and the vitality of rural areas are considered as essential socio-economic indicators for the sustainability of agriculture; consequently, adequate indicators are identified to represent these variables (OECD, 2002:2). Indicators can be thought of as statistical constructs which support decision-making by revealing trends in data and subsequently, they can be used to analyse the results of policy actions. Indicators of sustainability seek to describe and measure key relationships between economic, social and environmental factors with sustainable development being seen as a better balance between all three dimensions (FAO, 2003:4).

Sustainable agriculture indicators are important in improving transparency, accountability and ensuring the success of monitoring, control and evaluation of sustainable agriculture measures (Matthews, 2003:10). Indicators tend to be based on a *Driving-Force-Pressure-State-Impact-Response (DPSIR)* framework, a widely accepted model. This approach was first pursued by the European Environment Agency and applied to agriculture in the EU Commission Communication on Indicators for the Integration of Environmental Concerns into the Common Agricultural Policy, COM (2000) 20 (European Commission 2000a) Ag Policy 2006. It is a refinement of the original *Driving Force-State-Response (DSR)* model of the 1970s by the Canadian statistician Anthony Friend, which was subsequently adopted by the OECD's State of the Environment (SOE) group.

This framework, as seen in figure 2 below, recognises cause and effect relationships; human activities exert pressure on the environment, and change its state in terms of the quality and quantity of natural resources. Society then responds to these changes through environmental, economic and sectoral policies (Department of the Environment, Heritage and Local Government, 1997:180).

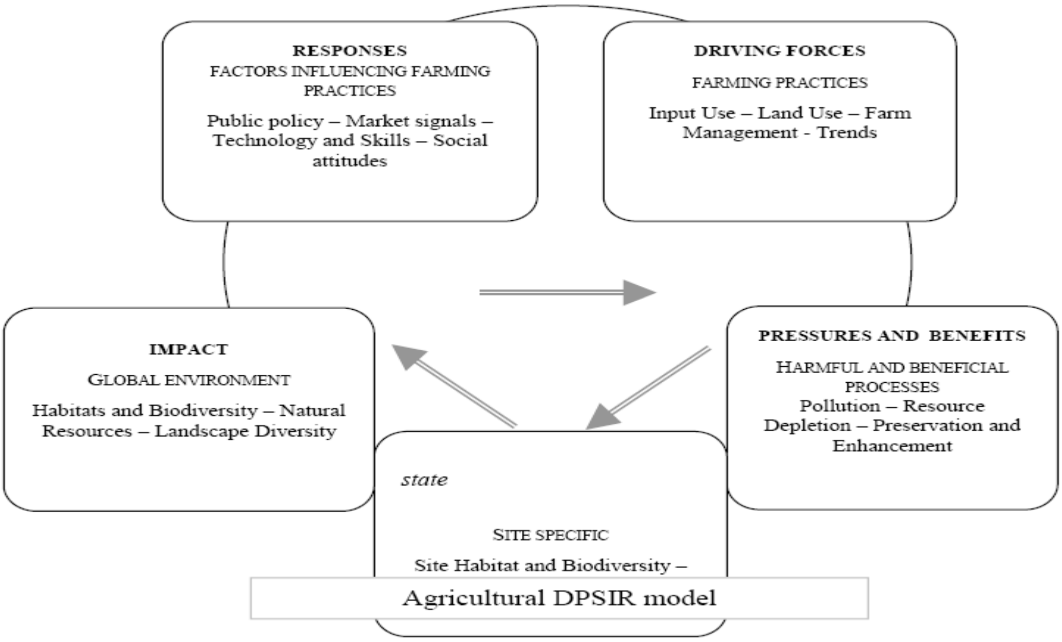


Fig. 2: Agricultural 'Driving-Force-Pressure-State-Impact-Response' Model

Source: European Commission (2002)

At the centre of the framework is the current *state* of a variable e.g., the agricultural environment and how this has changed over time. State indicators might highlight undesirable changes, which need to be combated, as well as provide information on desirable states, which should be preserved. The second step is to identify the *pressures* (controls), which influence an indicator (e.g., both desirable and undesirable change resulting from farming). Thirdly these pressures are linked to the *driving forces* in the economy. Driving forces might include input use, land use, trends in farm management etc. that are directly influenced by agricultural policy. Finally, it is desirable to monitor how society's *response* to these issues is working (Matthews, 2003). In policy terms, response indicators can gauge required progress in the responses of governments.

The characteristics and the complexity of the concept of sustainability (multidimensional, global, dynamic) as well as the fact that it reaches out into the future, make sustainability a concept, which gives a certain direction for policy making rather than serving as a benchmark that could be precisely defined. Whereas it seems difficult to identify a quantifiable distance of a certain state to quantified sustainability targets, sustainability indicators should allow one to judge whether a certain development contributes to movement in 'the right direction'. It may be that individual indicators point in two different directions. While it would seem desirable to construct composite indicators for the different dimensions (environmental, economic and social) caution should be exercised as regards the development of an overall composite indicator. Indeed, it is the very purpose of sustainability indicators to show that there are trade-offs between the three dimensions, which require appropriate policy choices (EU Commission, 2001:12).

2. The situation in Ireland

The principle of ensuring the sustainability of agriculture is firmly enshrined in the objectives of the EU Common Agricultural Policy and is a key objective of the Irish government. The National Strategy for Sustainable Development (1997) describes sustainable development indicators as a means of measuring progress over time towards, or away from, sustainability and states the Government's commitment to work towards a new set of indicators of sustainable economic development outside the conventional measures of economic activity, considering the environmental and other impacts (Department of the Environment, Heritage and Local Government, 1997:186). To date there has been relatively little research on all three components of sustainability in an Irish context; with some work being done in the area of the environment in particular. This research aims to fill the gap in this regard; developing indicators of economic, environmental and social farm sustainability.

2.1 Data Description

Data used is that of the Irish National Farm Survey (1996 - 2005), which is collected as part of the FADN. It is a random sample of 1,200 farms representing approximately 115,000 farms.[1] The method of classifying farms into farming systems used in the NFS is based on the EU FADN typology set out in the Commission Decision 78/463. The system titles refer to the dominant enterprise in each group based on Standard Gross Margins (SGMs). Within the NFS, the farm system variable is broken down into six different categories as follows: Dairying, Dairying and Other, Cattle rearing, Cattle Other, Mainly Sheep and Tillage Systems (Hynes et al., 2005).

3. Indicators of Sustainability

Economic, Environmental and Social indicators of sustainability are developed here to present a benchmark measure of the current sustainability of Irish farming. A short overview of findings to date is given here.

3.1 Economic Indicators

Economic measures of importance calculated here broadly relate to farm viability, the importance of direct payments and market return from farming. These are dealt with in turn below:

3.1.1 Viability

The reliance of farm households on non-farm income seems to be a growing phenomenon in Irish farming with the Agri-Vision 2015 report concluding that the number of economically viable farm

[1] The weights used to make the NFS representative of the Irish farming population are based on the sample number of farms and the population number of farms (from the Census of Agriculture) in each farm system and farm size category. The sample number of observations by size/system is simply divided by the population number of observations by size/system to get the weights that make the sample representative of the actual farming population.

businesses is in decline and that a large number of farm households are sustainable only because of the presence of off-farm income (Hennessy, 2004). It is clear that the future viability and sustainability of a large number of farm households is dependent on farmers and their spouses' ability to secure employment off the farm (O'Brien and Hennessy, 2006:3). 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. The number of viable farms (on average), across all systems between 1996 and 2005 are shown in fig. 3 below. A poor degree of viability is reported upon with between 29% and 40% of farms only, being classified as 'economically viable' over the ten-year period.

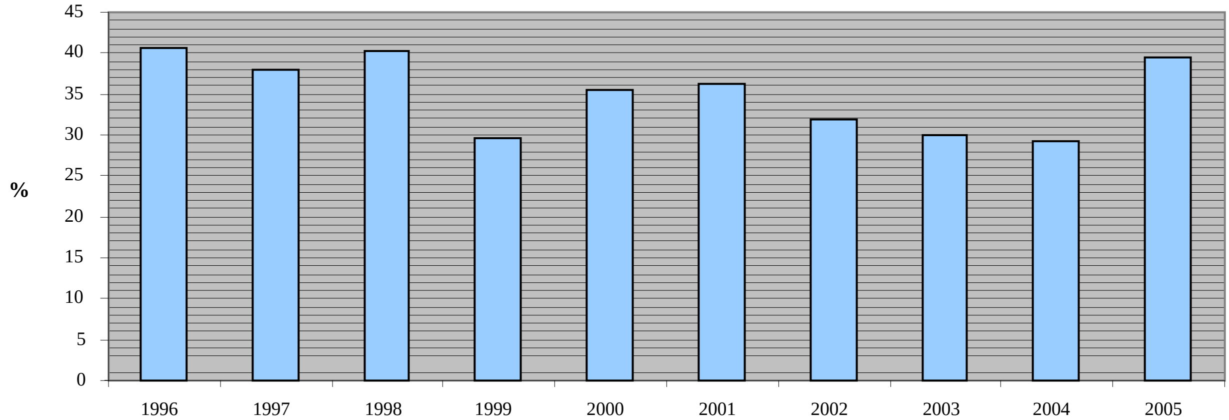
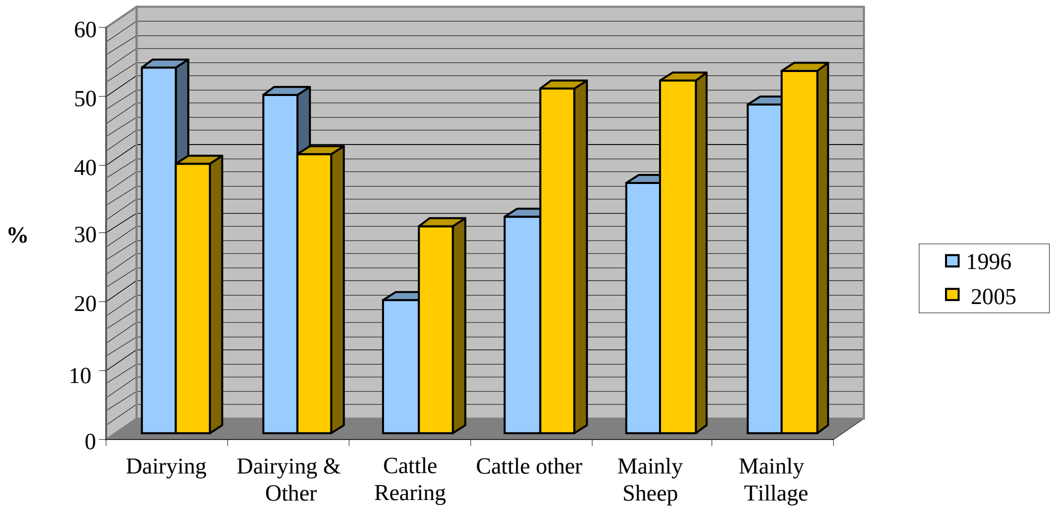


Fig. 3: Percentage of viable farms (on average) across systems 1996-2005

Source: National Farm Survey data

Taking each system into account individually proves more interesting. Looking then at the opening and closing years of this period (1996 and 2005 respectively, see fig. 4 below); it would appear that dairy farms have become less viable over the period whereas both sheep and cattle farms have become more so with the single farm payment assumedly having some impact in 2005 (this will be discussed in more detail in the following section).



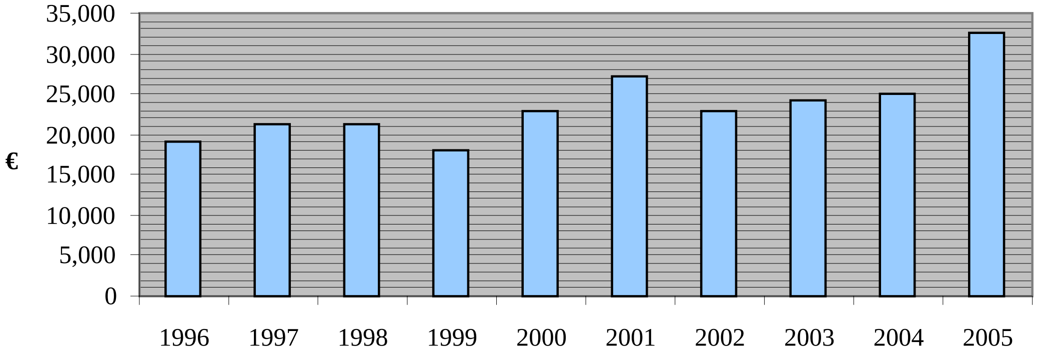
Source: National Farm Survey data

Fig. 4: Average farm viability by system 1996 and 2005

It should be noted here that 1996 was a difficult year for the cattle sector, given the BSE crisis and the subsequent impact on cattle prices, which fell by on average 12% (National Farm Survey 1996:1.03).

3.1.2 Importance of Direct Payments

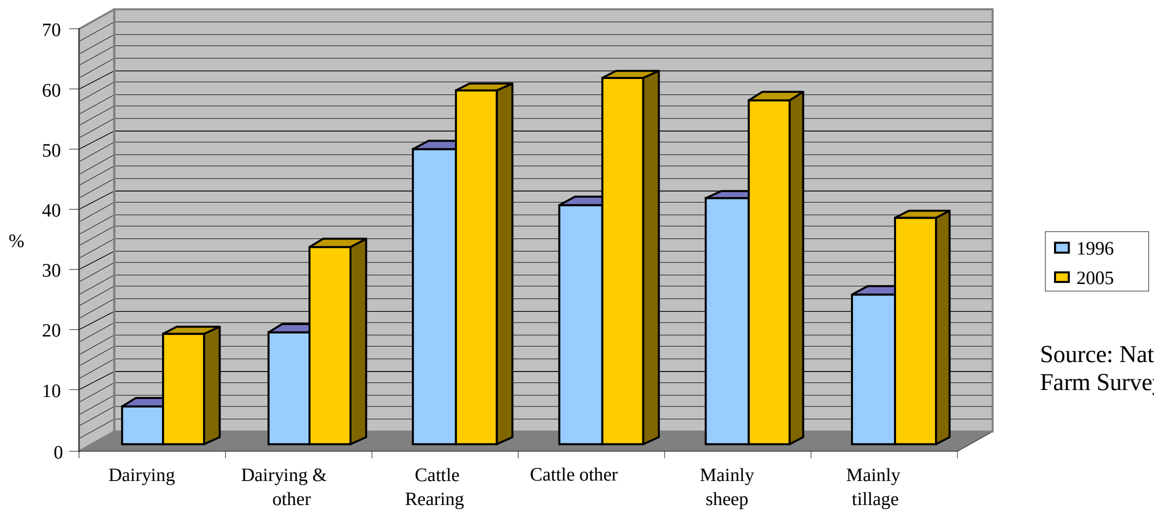
Average Family Farm Income in general, grew fairly steadily over the period 1996-2005 (see fig. 5 below) to a high of €32,573 in 2005; an increase of over 30% on the previous year: this large increase mainly due to the change in EU policy, implemented in 2005 when the coupled payment system was replaced with a decoupled one. Farmers received on average a one-off payment of €5,266 per farm due to a carry-over of arrears from 2004 coupled payments (National Farm Survey 2005:3).



Source: National Farm Survey data

Fig 5: Average Family Farm Income 1996-2005

The influence of direct payments is interesting and is illustrated in figure 6 below. Direct payments as a percentage of gross output are seen to be greater in 2005 than in 1996 for all systems (with all showing a similar rise over the period), however the impact of the once-off payment as detailed above is obviously important here too. Such payments are evidently of huge significance to Irish farmers and therefore any future reform of such in the coming years should prove important for Irish farming.

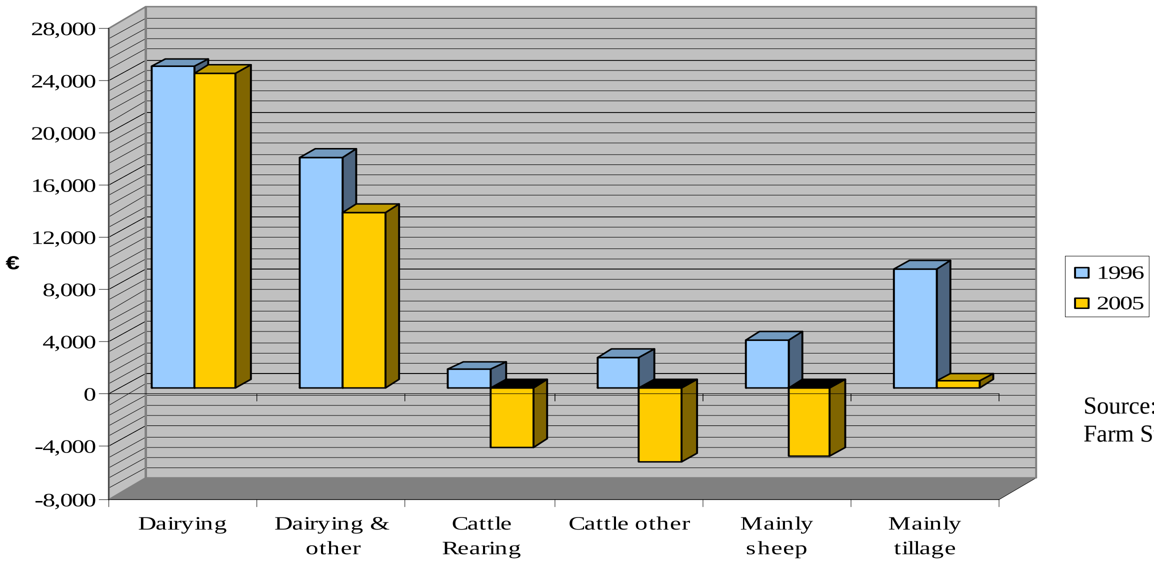


Source: National Farm Survey data

Fig.6: Direct Payments by system as a % of Gross Output 1996 and 2005

3.1.3 Market Return

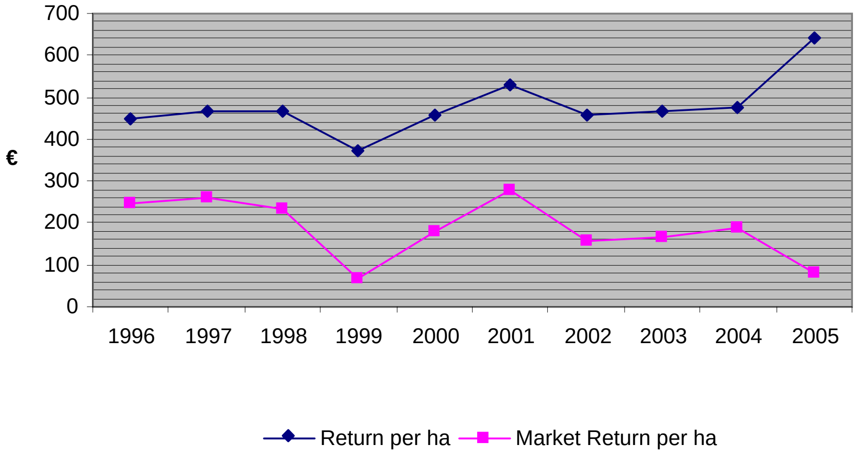
The impact of direct payments can be further seen when looking at market return (i.e., family farm income minus direct payments) over the decade. Worryingly, only the dairying systems are seen to show a significantly positive market return in both 1996 and 2005 (see fig. 7 below). All other systems provided 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 2005. Again, any further trade reform (and subsequent phasing out of payments will impact severely on such farms).



Source: National Farm Survey data

Fig. 7: Market Return, by system 1996 and 2005

Comparing then both market return and return more generally (i.e., family farm income) per hectare, it can be clearly seen in fig. 8 below that the latter is significantly higher over the period with a marked divergence in 2005 when the single farm payment was paid. A similar pattern for returns per labour unit is also found. This is surely a worrying trend questions must be posed for the long term viability of some operators.



Source: National Farm Survey data

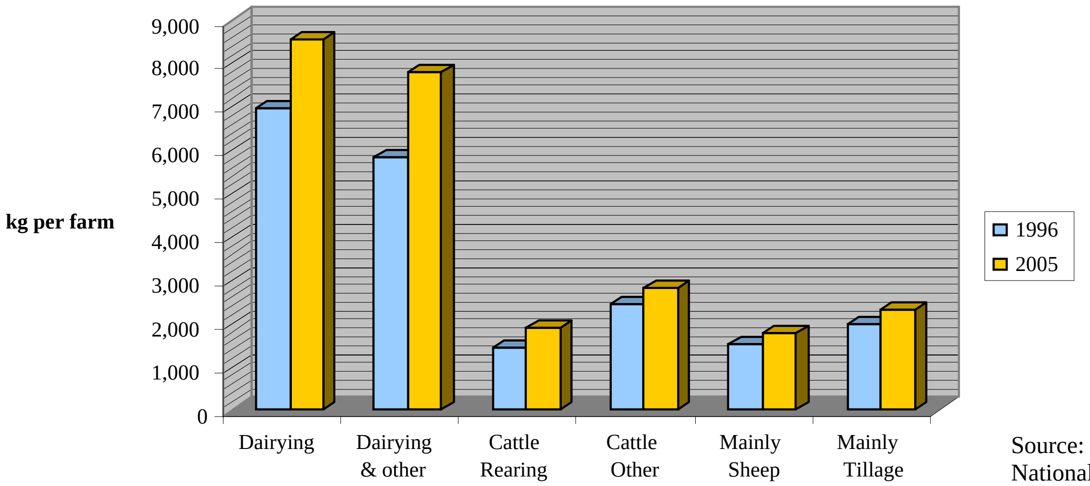
Fig. 8 Return and Market Return, per hectare 1996 and 2005

4. Environmental Indicators

Headline or benchmark environmental indicators can be seen to deal with several different aspects of the environment (soil quality and quantity, water quality, air, habitat diversity and biodiversity). For the purposes of this paper however, it was decided to concentrate on the calculation of indicators concerning air and water quality; computing simple indicators based on the variables available in the National Farm Survey. These are outlined in the following section.

4.1 Air quality

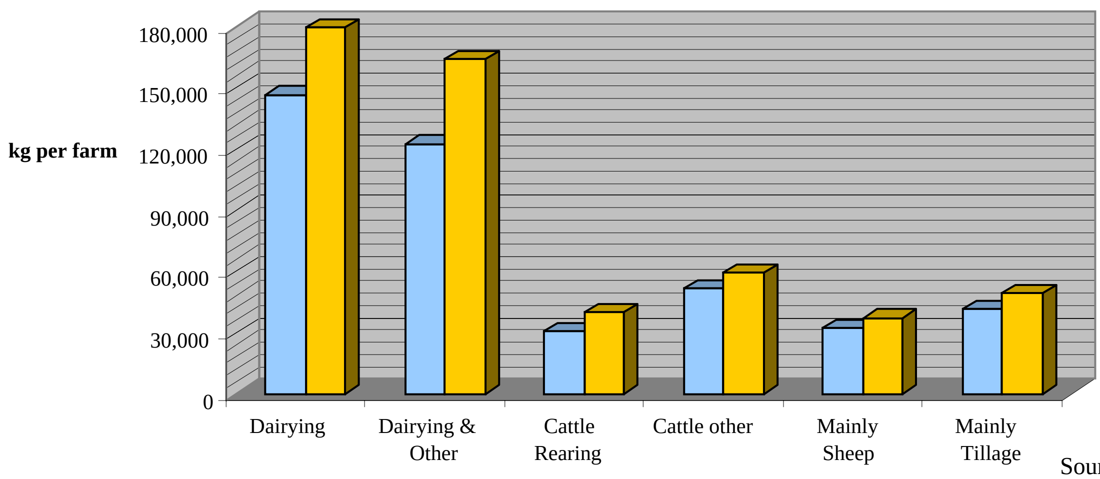
In terms of air quality, methane emissions and CO_2 equivalents were measured. Methane emissions (kg per farm) were found to be as expected, much higher for dairying than for other systems (fig. 9).



Source: National Farm Survey data

Fig.9: Methane emissions (kg per farm) 1996 and 2005

Similarly, CO_2 equivalents were found to be higher for dairying systems. Overall, these were found to increase over the period for all systems (fig. 10 below).



Source: National Farm Survey data

Fig 10: CO_2 equivalents (kg per farm) 1996 and 2005

1996 2005

Interestingly, upon further investigation it can be seen that higher market return may also be associated with higher methane emissions; with both dairying systems displaying a much higher degree of the two (see fig. 11 below).

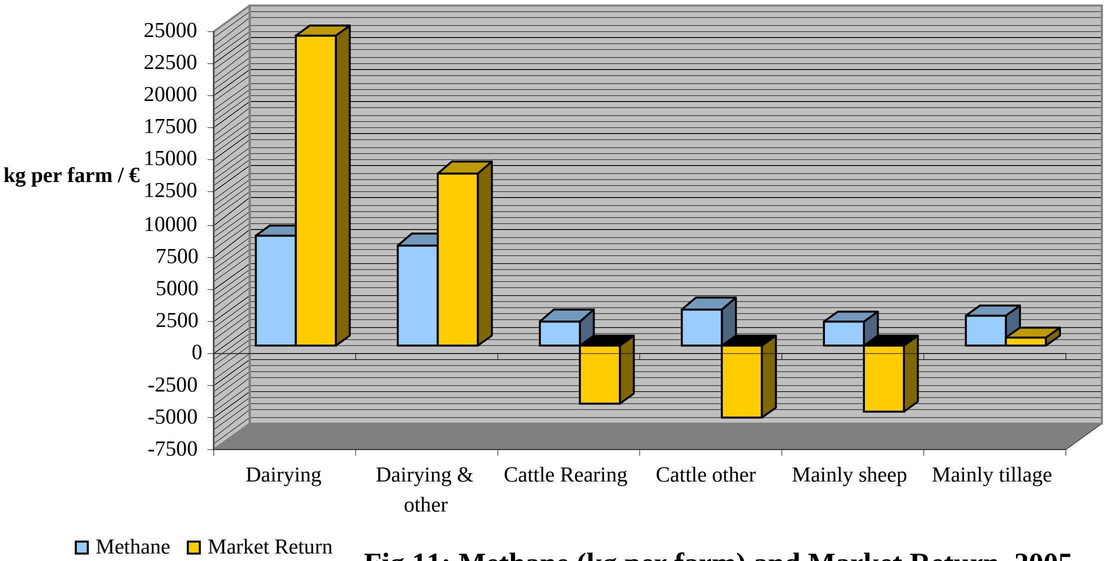


Fig 11: Methane (kg per farm) and Market Return, 2005

Source: National Farm Survey data

4.2 Water quality

In terms of water quality, nitrogen pollution poses a major environmental threat. Organic nitrogen produced on-farm (by livestock) only is evaluated here. In order to assess overall nitrogen polluting pressure, purchased nitrogen mineral fertilisers should also be taken into account.[2]

For the purposes of this analysis organic nitrogen produced on-farm was seen to change little from 1996 to 2005. Dairying systems again showed higher levels than all others.

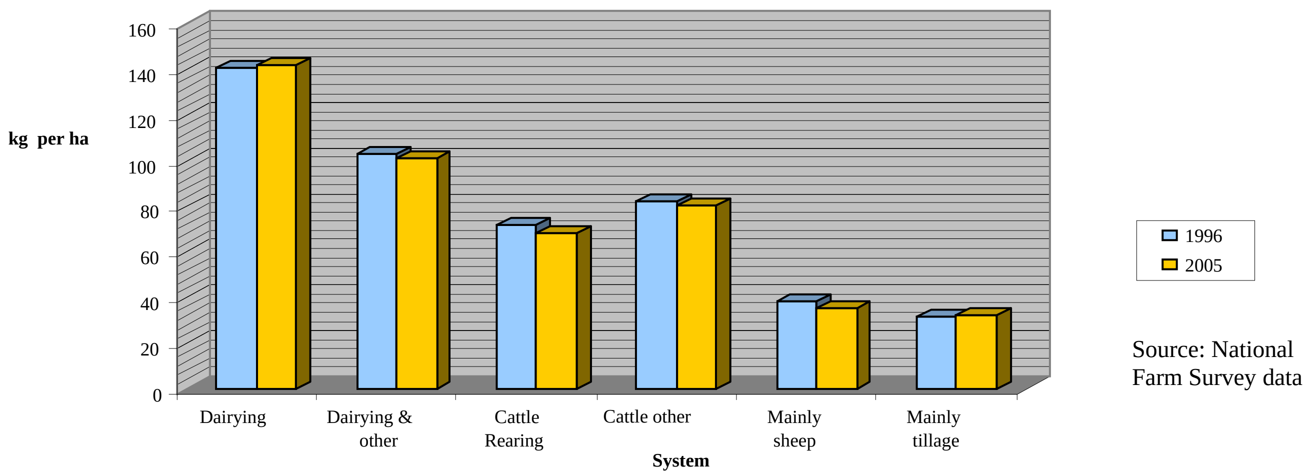


Fig 12: Organic Nitrogen produced (per hectare), 1996 and 2005

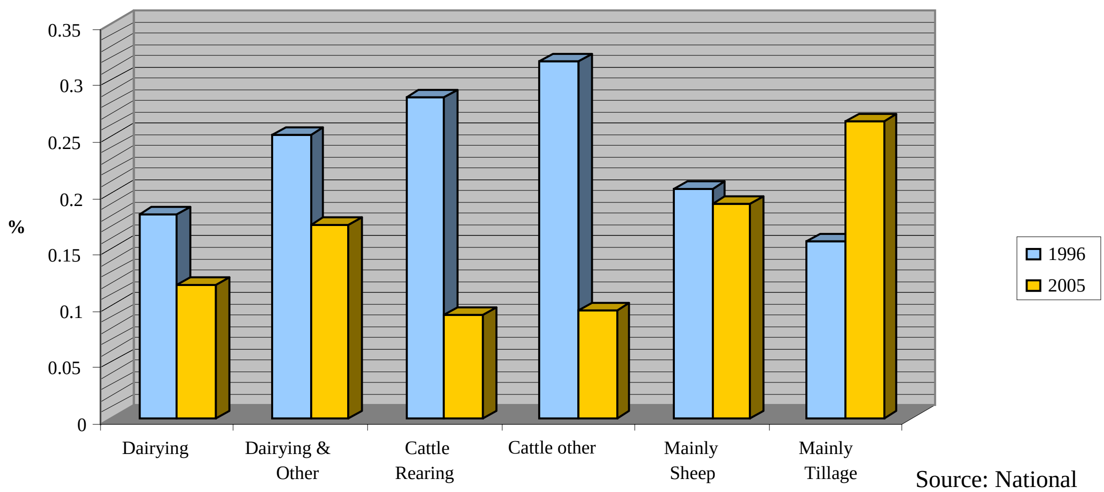
[2] Work is ongoing by the authors in this regard.

5. Social Indicators

Social indicators are statistics which aim to provide empirical, valid measurements of different dimensions of human well-being (Nolan 2003). In the pursuit of agricultural sustainability, economic and environmental factors often take precedent over human well-being, and fail to benefit the social quality of life. Even when taken into account, income was commonly used as an indicator of social welfare, however, there is a growing awareness that concentrating solely on income levels fails to capture the multidimensionality of social welfare and a more broadly based approach that encompasses a whole range of living conditions is necessary. As a result there has been a considerable amount of work in the development of social indicators that measure ‘social cohesion’ as opposed to just drawing a poverty line and examining those who fall below it (Layte et al. 2001, Scott et al. 1996, Whelan et al. 2007). A number of relevant indicators are dealt with below.

5.1 Demographic indicators

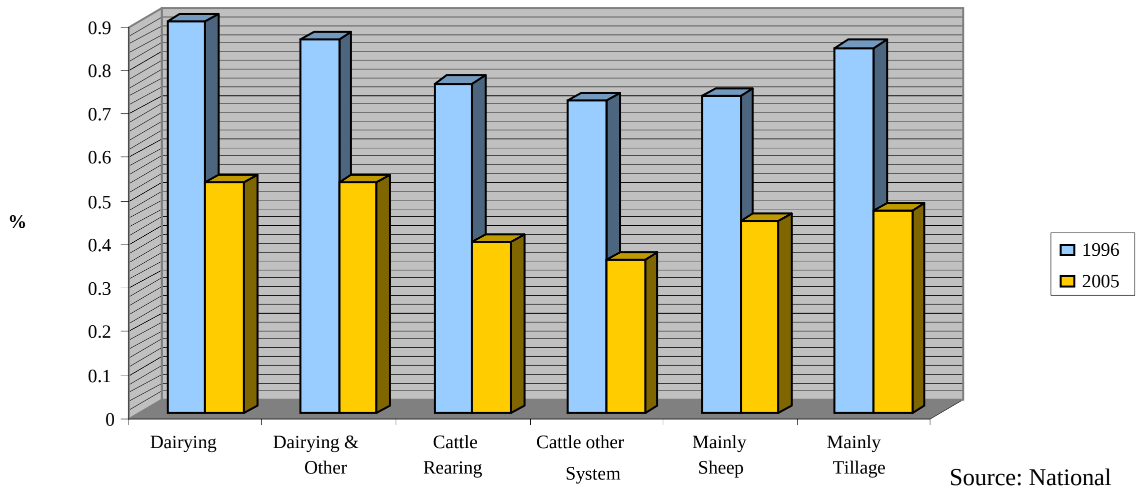
There has been some concern in recent years regarding the aging of the Irish farming population. Indeed there is reason for such. The changing face of the age structure can clearly be seen when examining the old-age dependency ratio over the period 1996-2005. This ratio calculates those aged 15-64 compared to those over 65 and was found to be far lower in all cases in 2005 except for tillage farms. This therefore indicates that Irish farmers are generally older than they were ten years ago (with younger people choosing not to join the industry).



Source: National Farm Survey data

Fig 13: Old Age Dependency Ratio, 1996 and 2005

This is also reflected when looking at the demographic viability of Irish farms. 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 vast decline is found over the ten-year period examined here (see fig. 14 below).

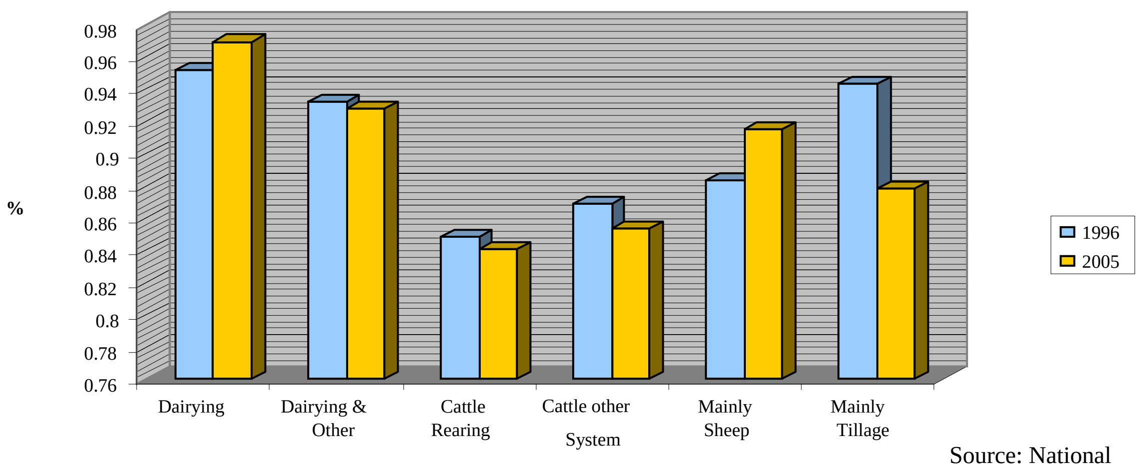


Source: National Farm Survey data

Fig. 14: Demographic viability by system, 1996 and 2005

5.2 Poverty risk

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. Fig. 15 below shows that there was relatively little change in this indicator over the period 1996-2005; however it was seen to rise slightly for dairy and sheep farms and to fall for tillage farms.



Source: National Farm Survey data

Fig. 15: Isolation (poverty risk) by system 1996 and 2005

6. Conclusion

This paper attempts to assess the overall sustainability of Irish farming using National Farm Survey data from 1996 to 2005. As in all European Member states the significance of primary agriculture in the country is waning; however, the sector remains important, with the Agri-Food industry accounting for an 8.1% share of GDP in 2006 and playing an important role in an ever-changing rural Ireland

(Department of Agriculture and Food, 2007a). The sustainability of Irish farming is an emerging area of great importance, with a new focus being put on evaluating environmental and social sustainability as well as the economic. This research is part of a larger project in which a comprehensive set of indicators are being calculated in an Irish context. Clearly, initial results show great change over the ten-year period examined here, in all three areas of sustainability. In an attempt to summarise the current situation, one could say in terms of economic sustainability that the growing importance of direct payments is worrying, particularly if farm families are seen to be reliant on such. The economic viability of such farms is something that is to be examined in more detail by the authors, with the presence of off-farm income, an interesting dimension. In terms of the environment, it is interesting but hardly surprising that the more intensive farming systems (primarily dairy) are the biggest polluters with a definite correlation between polluting pressure and market return. As EU policy looks towards more environmentally friendly methods (with financial incentives therein) it should prove interesting to see how farming practises will change into the future, with farms hopefully becoming more environmentally sustainable. The challenge therefore lies in ensuring that such farms remain economically viable. Of the three dimensions of sustainability, social sustainability is where least work has been done. As the face of rural Ireland continues to change, such indicators are bound to prove insightful. As it is, initial calculation of such indicators confirm the aging of the Irish farming population. This is something that will require attention by the government almost immediately with large numbers of farmers (across all systems) over the age of 45 (with many living alone as initial results here have shown). The sustainability (economic, environmental and social) of Irish agriculture is without doubt and emerging area, and one of great interest going forward. This research attempts to give a snapshot of the current sustainability of Irish farming. Future work will include some discussion on the weighting of indicators and the relative 'importance' attached to all three dimensions.

References

Atkinson, A.B., E. Marlier and B. Nolan. (2004). Indicators and Targets for Social Inclusion in the European Union. *Journal of Common Market Studies*, 42 (1): 47-75.
Atkinson, A.B. (2005) EUROMOD and the Development of EU Social Policy. German Institute for Economic Research, Discussion Paper 467.
CSO. (2003). Measuring Ireland's Progress (Volume 1). Stationery Office, Dublin.
CSO. (2005). EU Survey on Income and Living Conditions (EU-SILC) 2004. Stationery Office, Dublin.
CSO (2006). Measuring Ireland's Progress 2006. Stationery Office, Dublin
Frawley, J., Commins P., Scott, S. and Fergal Trace. (2000). Low income farm households: Incidence, Characteristics and Options for Improving Policy Measures. Proceedings of the Agricultural Society of Ireland 1999/2000, Department of Economics, Trinity College Dublin.
Department of Agriculture, Fisheries and Food. (2006). Compendium of Irish Agricultural Statistics, 2006, downloaded from the Dept of Agriculture, Fisheries and Food website, www.agriculture.gov.ie.
Department of Agriculture, Fisheries and Food (2007)a: Annual Review and Outlook, April 2007.
Department of Agriculture, Fisheries and Food (2007)b: Fact sheet on Irish Agriculture, May 2007.
Department of the Environment, Heritage and Local Government (1997). National Strategy for Sustainable Development, Dublin, 1997.
European Commission (2000). EU Commission Communication on Indicators for the Integration of Environmental Concerns into the Common Agricultural Policy, COM (2000) 20.
European Commission. (2001). A Framework for Indicators for the Economic and Social Dimensions of Sustainable Agriculture and Rural Development. European Commission, Agriculture Directorate-General.

European Commission. (2002). The Development of Agri-Environmental Indicators in the EU: The IRENA project. Paper prepared by Giovanna Pisano, for the 8th IWG. AGRI Seminar, Paris, November 2002.
FAO. (2003). Compendium of Agricultural – Environmental Indicators 1989-91 to 2000. Statistics Analysis Service, Statistics Division, Food and Agriculture Organisation of the United Nations, Rome (November, 2003).
Hanan. (2004). Measuring 'global poverty' – the Irish experience. European Anti Poverty Network (EAPN) Ireland.
Hynes, S., Morrissey, K., O'Donoghue, C. (2005). Building a Static Farm Level Spatial Microsimulation Model: Statistically Matching the Irish National Farm Survey to the Irish Census of Agriculture. Rural Economy Research Centre Working Paper Series, Teagasc.
Keeney, M (1999). Viability of Rural Areas.
Lafferty, S., Commins P., and Walsh, J.A. (1999). Irish Agriculture in Transition - A Census Atlas of Agriculture in the Republic of Ireland. Teagasc, Dublin.
Layte, Richard, Maître B., Nolan, B, Watson, D. Whelan, C.T., Williams, J. and Casey B. (2001). Monitoring Poverty Trends and Exploring Poverty Dynamics in Ireland. ESRI Policy Research Series No. 41 June 2001.
Matthews, A. (2003). Sustainable Development Research in Agriculture: Gaps and Opportunities in Ireland. Trinity Economic Paper No. 13. TCD, Dublin.
Mathijs, E. and Wauters E. (2004). Assessing the sustainability of farming systems: Back to basics. Paper presented at the Agricultural Economics Society 78th Annual Conference, London, England, 2-4 April 2004.
NAPS 2001, Report of the National Anti-Poverty Strategy (NAPS) Working Group on Rural Poverty. Downloaded from the Irish Department of Agriculture, Fisheries and Food website: http://www.agriculture.gov.ie/index.jsp?file=publicat/naps_report_2001/toc.xmlon
National Farm Surveys (1996-2005). Teagasc Farm Surveys Department, RERC, Athenry.
Nolan, B. (2003). Social Indicators in the European Union. Paper presented at the Statistics Users' conference "Measuring Government Performance" London, 13th November 2003.
OECD. (2000). Frameworks to Measure Sustainable Development. OECD, Paris.
OECD. (2002). The Sustainability of Italian Agriculture: A set of Indicators. Paper prepared by Ms. Velazquez, INEA, for the 8th IWG. AGRI Seminar, Paris, November 2002.
Rao, N., H., and Rogers, P. P. (2006). Assessment of agricultural sustainability in Current Science, vol. 91, No. 4, August, 2006.
Scott, S. Nolan, B. and Fahey, T. (1996). Formulating environmental and social indicators. ESRI Policy Research Series Paper No. 27.
Whelan, CT, Nolan, B and Maitre, B. (2006). Measuring Consistent Poverty in Ireland with EU SILC Data, ESRI Working Paper No. 165.
Whelan, CT, Maitre, B. and Nolan, B. (2007). Multiple deprivation and multiple disadvantage in Ireland: An analysis of EU-SILC. ESRI Policy Research Series Number 61, April 2007.
Woodhouse, P., Howlett, D., Rigby, D. (2000). A Framework for Research on Sustainability Indicators for Agriculture and Rural Livelihoods. Sustainability Indicators for Natural Resource Management and Policy Working Paper 2. UK.
World Commission on Environment and Development. (1987). Our Common Future. Oxford University Press.