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### **Measuring the sustainability of agriculture**

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## **Measuring the sustainability of agriculture**

### **Abstract**

This policy paper reviews the sustainability literature, with a view to furthering research in the area of the sustainability of Irish agriculture. This is the first component of a larger project currently being undertaken by the authors to assess the effect of policy reform on the economic, social and environmental sustainability of farms in Ireland using Irish National Farm survey data. One of the main objectives of the project is to develop indicators including all three dimensions of sustainability. The literature reviewed here should prove useful in designing a template for suitable Irish farm level indicators. In the paper the issue of sustainability is examined, and how it is defined and measured outlined. Sustainability indicators are explained, as is the framework on which these are generally based – using the ‘*Driving-Force-Pressure-State-Impact-Response*’ (DPSIR) framework. Finally, a review of the general literature in both the European and Irish contexts is given, with a view to using a number of indicators as a blueprint for the Irish case. It is evident from the main literature that research in the area builds upon previous studies and the original work of the OECD and the EU Commission in particular. Country specific studies continue to use the established DPSIR framework for the design of indicator sets and indeed similar indicators are chosen in most cases subject to data availability.

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## 1. Introduction

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. There is no consensus on its precise or operational meaning, with it differing across space and time and between individuals. Sustainability means different things to different people and hence Jacobs (1995), noted that there are at least 386 definitions of sustainable development (Rigby et al., 2001:464).

The definition most widely adopted is included in the 1987 report “Our Common Future” of the “World Commission on Environment and Development” (the Brundtland report) which defined sustainability 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). This report triggered wide scientific and policy interest in sustainable development as it brought the three dimensions of development: economic, environmental and social, into an integrated framework (Rao and Rogers, 2006:439).

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).

This paper will outline the general approach of the main sustainability literature, with a view to furthering the research in an Irish context. Section 2 looks at the issue of sustainability and how it is defined and measured. Section 3 introduces the concept of sustainability indicators and section 4 further describes the framework on which these are generally based – the ‘*Driving-Force-Pressure-State-Impact-Response*’ (DPSIR) framework. Sections 5 and 6 look at sustainability in the European and Irish contexts respectively, and finally section 7 summarises and surmises how the international research reviewed could be used as a template for an Irish study.

## **2. Background**

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). 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). Thus, many governments and agencies have devoted substantial resources to indicator development and testing (Simon, 1992:1). 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, 2003).

According to Agenda 21, the concept of sustainability is *multidimensional*. It includes ecological, social and economic objectives. Between these different elements, there is interdependency. Research results indeed confirm that the relationships are strong, numerous and complex, e.g., strengthening the economic viability of rural areas is the basis for providing the means of preserving their social and environmental functions. Social implications result from the provision of rural employment opportunities, the diversification of economic activities and the promotion of local products, services, craft activities and agri-tourism. Preserving environmental quality is also a precondition for developing lasting economic potential in rural areas. The ecological integrity and the scenic value of rural landscapes are key ingredients for making rural areas attractive for enterprise settlements, as a place to live, and for the tourist and recreation business. Economic, social and environmental objectives can to a

certain degree develop synergies. However, they are not always mutually supportive; they can even compete with each other. Where this is the case, the concept of sustainability refers to the need to strike the right *balance* between its three elements. Political choices concerning one out of these three elements must at least ensure that certain minimum standards with respect to the other two are observed (EU Commission, 2001:3). Despite the contested nature of sustainability, there is agreement that it is multi-faceted, and therefore the sustainability of systems must be assessed over several dimensions (Woodhouse et al, 2000).

### **3. Indicators of sustainability**

*‘Indicators provide the basis for assessing progress towards the long-term objective of sustainable development. Long-term targets only have meanings as policy goals if progress towards them can be assessed objectively’ (European Commission, 2001).*

The information generated by the study of sustainability, alongside the creation and implementation of sustainability policies and practices, has taken many forms including policy initiatives that utilize quantitative indicators to track trends associated with sustainability (Schlossberg and Zimmerman, 2003:641). Sustainability indicators are quantifiable and measurable attributes of a system that are judged to be related to its sustainability. They have multidimensional attributes (economic, environmental and social) and can be meaningfully integrated into an aggregated index. Such an index allows integrated assessments about the sustainability of a system, after taking into account all information provided by indicators (Rao and Rogers, 2006). Rigby et al. (2001) point out that there are many definitions of what an indicator is and indeed different understandings of their primary role. Gallopín (1997:14) surveys a

wide range of literature and reports that in different sources an environmental indicator has been identified as “*a variable...a parameter...a measure...a statistical measure...a proxy...a value...a meter or measuring instrument...a fraction...an index...something...a piece of information...a single quantity...an empirical model...a sign.*” Moxey argues that there is no widespread agreement on design and use of what he calls Agri-Environmental Indicators (AEIs) because “*AEIs have to address interactions of both socio-economic and environmental factors. Consequently, the debate is inevitably complicated*” (Moxey, 1998:4).

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. Successful indicators are usually readily understandable, representative of key environmental policies and concerns, and capable of illustrating trends over time. In addition, indicators provide an early warning of potential economic, social or environmental damage. They must be scientifically valid, analytically sound, measurable and verifiable. They depend significantly, therefore, on the availability of adequate, good quality data, which is updated at regular intervals (FAO, 2003:4).

Indicators can take account of the various components (economic, social and environmental) separately, in numerous ‘partial indicators’ or they can encapsulate all these components in indexes, or ‘frameworks of indicators.’ The multidimensionality of sustainability would suggest the use of such frameworks. Rigby et al. (2001) argue that their design and use can be extremely useful in that they force

those involved in the discussion of sustainability to identify the key aspects of sustainable agriculture and to assign weights to them. They note too that there is some subjectivity in the defining and selection of indicators, which is evident in decisions about the relative weighting given to the different dimensions of sustainability (Rigby et al., 2001:464).<sup>1</sup>

Unlike environmental assessments, where there have been significant international and national initiatives, most initiatives on agricultural sustainability have been at individual scientist and group levels. As a result, there are differing approaches, guided by local priorities and practises, and only limited attempts at developing systematic frameworks. The different approaches can be broadly classified into three groups: those based on agro-ecosystems, total factor productivity, and farm-level assessment frameworks (Rao and Rogers, 2006:440). However, new systems of sustainability indicators are appearing that stretch beyond the discrete measurement of environmental and economic conditions (Rigby et al. 2001).

The problems of incommensurability, as well as data requirements, become stronger as the analysis moves to the system beyond the farm boundaries: part of the difficulty in assessing the sustainability of agricultural systems is the fact that both the units of measurement and the appropriate scales for measurement differ both within and across the commonly identified economic, biophysical and social dimensions of sustainability. For example, consideration of the effects of organic production on farm margins, soil fertility and rural employment are difficult to combine in an overall measure. This is an issue, which will not be solved simply by greater knowledge of the impacts of different production systems; even with complete

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<sup>1</sup> The 'weighting' issue is not dealt with in this paper but is an issue the authors are currently examining in an Irish context.

information regarding impacts one will still have to consider trade-offs with movement towards targets in some respects accompanied by reverses in others (Rigby and Caceres, 2001:30).

There is some disagreement amongst countries about appropriate indicators (Woodhouse et al., 2000: 13). The uses and desirable properties of indicators are given in Tunstall (1992, 1994) and Gallopín (1997) who identify the major functions of indicators as:

- to assess conditions and changes;
- to compare across place and situations;
- to assess conditions and trends in relation to goals and targets;
- to provide early warning information; and,
- to anticipate future conditions and trends.

According to the European Commission sustainability indicators should help to assess the extent to which sustainability concerns have been integrated into the Common Agricultural Policy. Indicators should therefore meet the following criteria:

- Policy-relevance
- Conceptual soundness
- Definition at an appropriate level of aggregation
- Effectiveness
- Statistical validity
- Analytical soundness
- Technical feasibility
- Cost-efficiency.

Furthermore, indicators should be limited in number, be simple and easy to interpret in order to make them useful for policy-decisions (EU Commission, 2001:10). They should be developed in the context of

overall frameworks, which are capable of providing information in a comprehensive and consistent way (OECD 1999a).

A developing issue in the literature, highlighted by several authors including Syers *et al.* (1995) and Coughlan (1996) is the importance of defining thresholds for indicators. A threshold is a boundary level of a variable, which is regarded on the basis of expertise to represent the point at which significant changes occur. *“Thresholds are particularly important in an agri-environmental context given the propensity of ecological systems to ‘flip’ from one state to another”* (Moxey, 1998: 14). When an indicator passes this level then the system is considered to be unsustainable or on the road to unsustainability. Issues arise as to the identification of a threshold level (be it qualitative or quantitative), whether passing a threshold level for one indicator is sufficient to signify unsustainability, or whether several indicators need to have passed their threshold levels before the system is unsustainable (Woodhouse et al., 2000: 13).

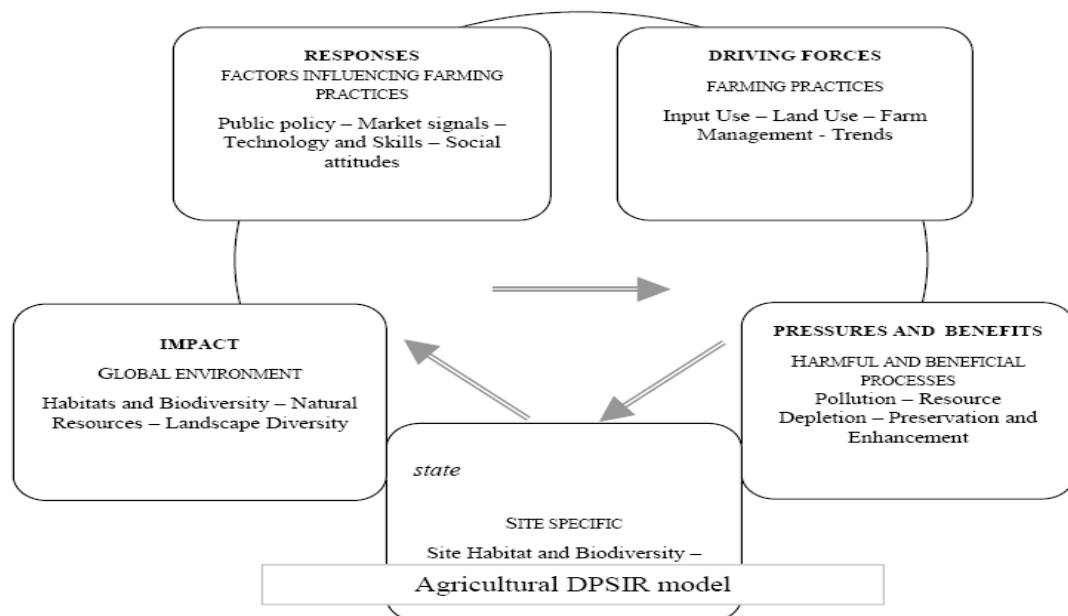
#### **4. Driving-Force-Pressure-State-Impact-Response framework**

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 1 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. 1: 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.

## 5. The European Context

In '*A Framework for Indicators for the Economic and Social Dimensions of Sustainable Agriculture and Rural Development*' the sustainability of rural areas as a whole and not only agriculture is analysed. In this document the EU Commission suggests that the core issues of sustainability are:

- Maintenance (protection, renewal) of a combination of stocks with a view to sustaining wellbeing
- Efficiency of the transformation process (avoiding inefficiency, promoting efficiency)
- Intra- and intergenerational equity.

Sustainable development in these areas represent, as already stated, a main objective of the European Union, as can be derived from the most recent documents on rural development. Taking into account these new directions, the meaning attributed to agri-environmental sustainability is deeper. It demands not only enhanced environment-respectful agriculture but also an agriculture that ensures the continued presence of farmers in rural areas through the maintenance of the production function of agriculture (European Commission 2000). Consequently, in order to allow sustainable development, it is

necessary to maintain a certain amount of capital (natural, human, and human produced), agriculture production efficiency and equity. Within this vision it is possible to identify not only general concerns regarding the conservation of environmental resources, but also society concerns about the social function of agriculture, the preservation of rural communities, and an equilibrated development model (European Parliament, 2001).

In terms of the three pillars of sustainability, the *economic* dimension relates to the efficient use of resources, the competitiveness and the viability of the sector as well as its contributions to the viability of rural areas. Efficient agricultural structures, appropriate technologies as well as the diversification of income sources for farm households are important elements of this dimension. Efficiency of resource use is an important basis for the viability of rural areas (EU Commission, 2001:8). The *ecological* dimension refers above all to the management of natural resources with a view to ensure that they are available in the future. However, it also includes issues such as the protection of landscapes, habitats, biodiversity, as well as the quality of drinking water and air. The *social* dimension relates to questions of labour opportunities and access to resources and services of agricultural households compared to other economic agents in rural areas (EU Commission, 2001:9).

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).

In the European '*Framework for Indicators for the Economic and Social Dimensions of Sustainable Agriculture and Rural Development*' it is stated that since maintaining stocks is at the core of the concept of sustainability (Rechatin et al., 1997, Legg 1999), *state indicators* relating to capital stocks should be at the centre of a set of sustainability indicators. Indicators of capital stocks are of particular interest, because capital stocks have to be used in a prudent manner given the uncertainty relating to the substitutability between different types of capital, the option values of certain natural resources, the scope for efficiency gains in the transformation process, and future demand (EU Commission, 2001:13). In addition, indicators must cover not only quantitative and but also qualitative aspects. State indicators should be supplemented by *flow* indicators, which explain the changes in the stocks of various types of capital. The combination of the various types of capital leads to market and non-market outputs. *Efficiency indicators* provide the link between capital input and output. As the result of the transformation process as regards market outputs should be an output that together with imports can meet demand, indicators for physical outputs has also to be included (EU Commission, 2001:13).

A more comprehensive picture is given through combining efficiency indicators with *competitiveness* and *viability indicators*. Only if the

sector is competitive and production factors are sufficiently remunerated, the production potential of the sector can be sustained in the long run. As efficiency is an important condition for maintaining and creating employment opportunities, employment indicators complement the context. Also, indicators on institutional efficiency have to be incorporated. (EU Commission, 2001:13).

Equity indicators (across sectors and territories) address different issues. Territorial indicators allow a judgement as to whether or not economic and social development between rural and other areas is balanced. *Sectoral indicators* allow a judgement as to whether or not development between sectors is balanced. *Social group indicators* cover the topic of equal opportunities. Finally, indicators have to be included which monitor issues linked to the agricultural transformation process such as ethical concerns of society with respect to production methods. This includes different issues such as labour conditions and animal welfare (EU Commission, 2001:13).

Taking all the above considerations into account, the report proposed two types of indicators: *descriptive indicators* relating to the state of sustainable agriculture and rural development and *policy indicators* showing how policy measures respond to sustainability concerns.

The report concluded that the identification of such descriptive indicators as key-indicators for sustainable agriculture re-values them and gives them a new weight in the agricultural policy debate. This was particularly found to be the case for stock indicators. The sufficient renewal of human and man-made capital, together with safeguarding natural capital were seen as essential pre-conditions for agriculture to be able to satisfy human needs now and for future generations (EU Commission, 2001:14).

This EU framework document dealing with the socio-economic dimension of sustainable agriculture in conjunction with another entitled '*Indicators for the Integration of Environmental Concerns in the Common Agricultural Policy*' together with international experience within OECD, EEA and ECNC (European Centre for Nature Conservation) formed the blueprint for further country specific studies. One such study for **Italy**, was undertaken by the INEA (National Institute of Agricultural Economics) where the evolving sustainability of Italian agriculture is summarised using a set of indicators. Thirty-five indicators are calculated, of which the first 10 are of a socio-economic nature and aim at analysing production efficiency of the agricultural sector, its capacity to create employment and to contribute to the maintenance of rural areas. The remaining 25 indicators inform on the impact of agriculture over different components of the environment. The DPSIR framework is again used and indicators are classified in table 1 below:

**Table 1: Classification of indicators in the Italian study**

<b>Social dimension</b>		<b>DPSIR</b>
Human capital	Agricultural employment	D
	Ageing index	D
Equal opportunities	Educational level of farmers	D
	Differences among female and male employment shares	D
	Rural population	D
<b>Economic dimension</b>		
Efficiency	Labour profitability	D
	Land profitability	D
	Labour productivity	D
	Land productivity	
Vitality	Marginalisation	D
	Diversification of farmer labour	D
	Incidence of agricultural value added on total value added	D
Competitiveness	Fixed investment in agriculture	D
<b>Environmental dimension</b>		
Soil	Livestock units per hectare	P
	Stock per breed	P
	Phosphorous balance	P
	Pesticide use	P

Air	Emissions of methane	P
	Emissions of ammonia	P
	Emissions of carbon dioxide	P
	Direct use of energy	P
Water quality	Nitrogen balance	P
	Potential nitrate leaching	P
	Nutrient use	P
	Use of fertiliser schemes	P
Water quantity	Irrigation systems	P
	Irrigated area	D
	Source of water supply	P
Biodiversity	Protected area	R
	Species at risk or extinct	I
	Fired walls area	P
	Organic farming	R
	Agri-environmental schemes	R
Landscape	Agricultural Utilised Area	S
	Forest cover index	S
	Agricultural intensity	P
	Concentration	P
	Man made and natural elements	P

**Source: INEA (2002)**

The **IRENA** operation (*Indicator Reporting on the Integration of Environmental Concerns into Agriculture Policy*) has also added to this knowledge base. This is a joint exercise between several Commission Directorates-General (DG Agriculture and Rural Development, DG Environment, DG Eurostat and DG Joint Research Centre) and the European Environment Agency (EEA) with the main purpose of developing agri-environmental indicators for monitoring the integration of environmental concerns into agriculture policy in the European Union (EU-15). IRENA also follows the two Commission communications mentioned above.

Different driving forces on agri-environmental dynamics were seen as important in integrating environmental concerns into CAP. External (e.g., changing trade patterns and consumer trends and market forces) and internal (economic trends in farming, intensification versus extensification and social trends (attitudes)) driving forces

impact on agriculture. Some of these are captured by the indicators outlined in the IRENA report, while for others no indicator is available.

The report provides a broad overview of environmental issues in agriculture on the basis of 42 agri-environmental (sub) indicators produced. These are set out in table 2 below. The relationship between agriculture and environment is described by indicator groups that relate to driving forces, pressures, state, impact and responses (the DPSIR framework) (European Environment Agency, 2006:8).

**Table 2: List of IRENA Indicators**

<b>DPSIR</b>	<b>IRENA indicator</b>
Driving forces	Fertiliser consumption
	Consumption of pesticides
	Water use (intensity)
	Energy use
	Land use change
	Cropping/livestock patterns
	Farm management practices- tillage
	Farm management practices- soil cover
	Farm management practices- manure
	Intensification/extensification
	Specialisation/diversification
	Marginalisation
Pressures	Gross nitrogen balance
	Ammonia emissions
	Emissions of methane (CH <sub>4</sub> ) and nitrous oxide (N <sub>2</sub> O)
	Pesticide soil contamination
	Use of sewage sludge
	Water abstraction
	Soil erosion
	Land cover change
	Genetic diversity
	High nature value farmland
	Production of renewable energy (by source)
State	Population of farmland birds
	Soil quality
	Nitrates in water
	Pesticides in water
	Ground water levels
	Landscape state

Impact	Impact on habitats and biodiversity Share of agriculture in GHG emissions Share of agriculture in nitrate contamination Share of agriculture in water use Impact on landscape diversity
Responses	Area under agri-environment support Regional levels of good farming practice Regional levels of environmental targets Area under nature protection Organic producer prices Agricultural income of organic farmers Farmers' training levels Area under organic farming

**Source: European Environment Agency (2006)**

A study was also undertaken in the **United Kingdom** in 2000. A pilot set of indicators was drawn up by the Ministry of Agriculture, Fisheries and Food (MAFF) to provide a means of measuring the economic, social and environmental impacts of agriculture and to help assess the effectiveness of policies and the sustainability of the sector in the U.K. The 35 indicators focus on the key issues for sustainable agriculture and take account of data availability. They are generally grouped under the following headings:

- 1) Agriculture within the rural economy and society
- 2) Farm management systems
- 3) Input use
- 4) Resource use
- 5) Conservation value of agricultural land

Again, the indicators were classified during their development according to 'driving force, state and response' model (DSR model) and a summary list is contained in table 3.

**Table 3: Summary list of indicators for sustainable agriculture in the UK**

<i>Issue</i>	<i>Area</i>	<i>Indicator</i>
<b>Agriculture within the rural economy and society</b>	<i>Structure of the agriculture industry</i>	Agricultural assets and liabilities
		Age of farmers
		Percentage of holdings that are tenanted
	<i>Farm financial resources</i>	EU Producer Support Estimate (PSE)
		Payments to farmers for agri-environment purposes
		Total income from farming
	<i>Agricultural productivity</i>	Average earnings of agricultural workers
		Agricultural productivity
	<i>Agricultural employment</i>	Agricultural employment
<b>Farm management systems</b>	<i>Management</i>	Adoption of farm management systems
	<i>Organic farming</i>	Area converted to organic farming
	<i>Codes of Practice</i>	Knowledge of Codes of Good Agricultural Practice
Input use	<i>Pesticide use</i>	Pesticides in rivers
		Pesticides in groundwater
		Quantity of pesticide active ingredients used
		Spray area treated with pesticides
		Pesticide residues in food
		Nitrate and phosphorus losses from agriculture
		Phosphorus levels of agricultural topsoils
	<i>Nutrients</i>	Manure management
		Ammonia emissions from agriculture
		Emissions of methane and nitrous oxide from agriculture
		Direct energy consumption by farms
		Trends in indirect energy inputs to agriculture

<b>Resource use</b>	<i>Water</i>	Use of water for irrigation
	<i>Soil</i>	Organic matter content of agricultural topsoils
		Accumulation of heavy metals in agricultural topsoils
	<i>Agricultural land</i>	Area of agricultural land
		Change in land use from agriculture to hard development
<b>Conservation value of agricultural land</b>	<i>Non-food crops</i>	Planting of non-food crops
	<i>Environmental conservation</i>	Area of agricultural land under commitment to environmental conservation
	<i>Landscape</i>	Characteristic features of farmland
	<i>Habitats</i>	Area of cereal field margins under environmental management
		Area of semi-natural grassland
	<i>Biodiversity</i>	Populations of key farmland birds

**Source: MAFF (2000)**

Most of the literature to date attempts to evaluate the sustainability of agriculture at a national level only, with ecological and economic issues mainly addressed. A paper by Mathijs and Wauters (2004), reports on an effort to develop a consistent and comprehensive framework for analysing the sustainability of farming systems. The authors maintain that many evaluation methods to date define their goal to be ‘sustainable agriculture’, but their implementation is limited in reporting scores of indicators and how these scores relate to certain references or threshold values (whether these reference values represent a sustainable farming system is often not clear). They also point to a further flaw of many methods in that indicators and themes at a global scale are transposed to a local scale.

They propose using a hierarchical framework based on principles, criteria and indicators (developed by Van Cauwenbergh et al., (2004)) to assess the sustainability of farming systems. The paper further explores different accounting frameworks aimed at integrating the results from the hierarchical framework. It focuses on a recently introduced measure to assess contributions of firms to sustainability: sustainable value added, that integrates considerations of efficiency and effectiveness, by considering economic (and social) efficiencies as opportunity costs of environmental (and social impact).

## **6. The situation in Ireland**

As already stated, 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 the three components of sustainability in an Irish context; with some work done in particular in the area of the environment. As already outlined however, environmental indicators alone do not adequately measure progress towards or away from sustainability. Interrelations between environment, economic activity and society are important in discussing overall farm level sustainability (CASS Environmental Services Ltd., 2000:5). The National Sustainable Development

Strategy also established a clear role for the regional authorities in terms of the processes involved in moving towards a situation of sustainability and some regional development indicators have subsequently been developed.

Traditional literature therefore has focused mainly on the environmental dimension which unaccompanied is not an adequate measure of sustainability. Interrelationships between environment, economy and society are more complex than the linear Pressure-State-Response framework allows; this is now being further amplified by a closer focus on economic driving forces as the anterior cause of environmental pressures (Department of the Environment, Heritage and Local Government, 1997:180). More recent literature is taking economic and social components into account (this can perhaps be correlated with an improvement in data availability). The principle Irish study on sustainability is one undertaken by the ESRI '*Formulating Environmental and Social Indicators for Sustainable Development*' (Scott, Nolan and Fahey, 1996).<sup>2</sup> This contains separate essays on social and economic indicators, proposing a set of indicators of sustainable economic development taking into account both environmental and social factors. However, to date an integrated approach to these areas has not yet been developed at the farm level or indeed at the national level but work now being undertaken by the authors' aims to fill the gap in this regard.

Three main types of *environmental indicators* are discussed in the ESRI study:

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<sup>2</sup>This does not however examine sustainable agriculture in particular but looks at sustainable development more generally. Nevertheless, it is of use in determining the appropriateness of indicators choices for a more agri-focused study.

- *Environmental indicators for individual themes*

Indicators can be expressed in physical terms and the choice of themes may reflect environmental aims and priorities at national, regional or local levels.

- *Environmentally-adjusted (or green) national income*

As national income is a measure of economic activity rather than well-being, it ignores the depletion of natural assets and the negative impact on welfare of environmental damage which has not been remedied. This measure extends the measurement of national income to take account of important environmental considerations and also reflects '*defensive expenditure*', i.e., expenditure to prevent or correct pollution – and maintain the status quo environmentally – as output rather than costs. Such adjustment is difficult however.

- *National sustainability indicators*

These are related to green national income and share similar data requirements. Nonetheless, they go further in terms of estimating national change in assets over time. Again, measurement difficulties arise; measurements, which rely on monetary valuation, cannot easily include aspects of environmental sustainability, which have no price.

The potential Irish environmental '*state*' indicators as outlined in the ESRI study are given in table 4:

**Table 4: Potential Environmental 'State' Indicators for Ireland**

<b>Themes</b>	<b>Aspects of concern</b>	<b>Indicator (Time series)</b>	<b>Data availability</b>
<b>Eutrophication</b> (from agriculture, sewage etc.)	Water quality, Health, Fish, Visual quality, Amenity, Marine waters.	<b>Concentrations of DO, N and P in inland waters. Quality of water at bathing areas. Fish populations.</b>	All quite good
<b>Acidification</b> (from SO <sub>x</sub> and NO <sub>x</sub> emissions, mainly energy use).	Air, Water, Soil, Health (respiratory), Building damage.	<b>Acidity of rain. Ph in soil and water.</b>	Recent data good
<b>Toxic contamination</b> (e.g., from pesticides and hazardous waste)	Contamination of food chain, Health, damage to eco-systems (also radiation).	<b>Quality and composition of solid waste. Hazardous waste. Contamination from pesticides, etc. Soil contamination.</b>	Patchy
<b>Urban quality</b>	Health: air. Quality of life: noise, congestion.	<b>SO<sub>2</sub>, nitrogen compounds, particularly NO<sub>2</sub>, lead, tropospheric ozone, VOCs, PM<sub>10</sub> in air. Water quality. Urban noise index. Traffic density or travel times. Dereliction.</b>	Quite good Quite good Poor Poor Poor
<b>Built heritage</b>	Survival history	<b>Disappearance of built heritage. Loss of historic sites. Damage to monuments.</b>	Patchy: audit required.
<b>Species/Biodiversity</b>	Threatened birds, mammals, amphibians, plants etc.	<b>Population trends. % threatened. Habitats, eco-systems (as landscape).</b>	Birds, fish, amphibians: good. Mammals: patchy. Insects, fungi: poor.

<b>Landscapes</b>	Visual quality, habitats. Coastal zones.	<b>Views.</b>	Difficult
		<b>Wetlands, peatlands.</b> <b>Semi-wilderness areas.</b>	Not good Quite good
<b>Resources</b>	Water, forest, soil (incl. overgrazing).	<b>Sufficiency/shortage of water. Afforestation. Soil erosion.</b>	Patchy
<b>Finite resources</b>	Depletion of minerals	<b>Extraction. New economic discoveries.</b>	Patchy
<b>Waste</b>	Hazardous waste. Landfill area and quality	<b>Hazardous waste. Solid waste.</b>	Fair/improving.
<b>Global warming</b>	Weather extremes, lowland flooding, and international social disruption.	<b>Emissions of GHG per head (over time v OECD or EU average).</b>	Good in some respects.
<b>Ozone depletion</b>	Health. Effects on natural environment.	<b>Release of ozone depleting substances per head (over time v OECD or EU average).</b>	Poor

Note: DO = dissolved oxygen, N = Nitrates, P = Phosphorous, GHG = greenhouse gases.

**Source: ESRI (1996)**

The ESRI study also addressed the issues associated with the selection and quantification of *social indictors*, the purpose of which they saw as to focus on the distribution of economic resources, and to extend traditional economic measurements to include non-economic aspects of social life such as health, literacy, social integration and crime. Various approaches to social indicators have emerged within the social sciences, some concerned with fundamental questions about the nature of progress and development; others focused more on technical issues of conceptualisation and measures (ESRI, 1996:181). The quality and availability of data was found to be an immediate constraint in the ESRI

study. This issue was also raised in the National Strategy for Sustainable Development published the following year (1997).

The OECD list of 33 Social Indicators was seen as a starting point in the drawing up of indicators in the Irish context in the ESRI study. The criteria, which the OECD adopted in developing this list, were that the indicators should:

- a) be output-oriented or designed to describe a final social outcome, rather than inputs, throughputs or intermediate outputs;
- b) be relevant to policy, in describing social conditions which are potentially amenable to improvement through collective action or public policy;
- c) be applicable over a long period of time in a substantial number of countries;
- d) apply to conditions of individual well-being, thus excluding 'indivisible public goods' such as national defence or wild-life species protection;
- e) be independent of particular institutional arrangements, so as to be reasonably comparable between countries and over time;
- f) form part of a comprehensive grid portraying all areas of social concern;
- g) correspond closely to the social concern to which they relate, yet be more than a narrow description of social phenomena;
- h) form an integrated framework of definitions, specifications, statistical guidelines and desegregation which should be compatible with other important sets of social and demographic statistics.

The list of social indicators developed on the basis of these criteria is shown in table 5 below. These were held by the ESRI to provide a

useful starting point for the development of social indicators for Ireland.

**Table 5: Potential Social Indicators for Ireland**

<i>Social Concern</i>	<i>Social Indicator</i>	<i>Availability of Data</i>	
<b>Health</b>			
Length of Life	<b>Life Expectancy</b>	Good	
Healthfulness of Life	<b>Perinatal Mortality Rate</b>	Good	
	<b>Short-term Disability</b>	Poor	
	<b>Long-term Disability</b>	Poor	
<b>Education and Learning</b>			
Use of Educational Facilities	<b>Regular Education Experience</b>	Good	
Learning	<b>Adult Education</b>	Poor	
	<b>Adult Literacy</b>	Poor	
<b>Employment and Quality of Working life</b>			
Availability of Employment	<b>Unemployment Rate</b>	Good	
Quality of Working Life	<b>Involuntary Part-time Work</b>	Fair	
	<b>Discouraged Workers</b>	Fair	
	<b>Average Working Hours</b>	Good	
	<b>Travel time to work</b>	Poor	
	<b>Paid annual leave</b>	Good	
	<b>Atypical Work Schedule</b>	Poor	
	<b>Distribution of Earnings</b>	Good (some sectors)	
	<b>Fatal Occupational Injuries</b>	Good	
	<b>Work Environment</b>	Poor	
	<b>Nuisances</b>		
<b>Time and Leisure</b>			
Use of time	<b>Free time</b>	Poor	
<b>Command over goods and services</b>	<b>Free time activities</b>	Poor	
	<b>Distribution of Income</b>	Fair	
		<b>Low Income</b>	Fair
		<b>Material Deprivation</b>	Fair
	Wealth	<b>Distribution of wealth</b>	Poor
<b>Physical Environment</b>			
Housing Conditions	<b>Indoor Dwelling Space</b>	Poor	
Accessibility to Services	<b>Access to Outdoor Space</b>	Poor	
	<b>Basic Amenities</b>	Good	
	<b>Proximity to services</b>	Fair	
Environmental Nuisances	<b>Exposure to Air Pollutants</b>	Good	
	<b>Exposure to noise</b>	Poor	

**Social Environment**

Social Attachment	<b>Suicide rate</b>	Good
<i>Personal Safety</i>	<b>Fatal injuries</b>	Fair
Exposure to Risk	<b>Serious Injuries</b>	Poor
Perceived Threat	<b>Fear for Personal Safety</b>	Poor

**Source: ESRI (1996)**

The issue of data availability is an important one in developing a comprehensive set of indicators for Ireland, as can be seen from the ESRI study. Further work has been undertaken by Scott (1999) and Curtis and Eakins (2003). *The EPA report 'Environment in Focus' – A Discussion Document on Key National Environmental Indicators* (EPA, 1999) also identified fifty environmental and social indicators under the internationally recognised DPSIR framework in an Irish context. This has been done at a national and not a regional level. Regional development indicators (at the county level) have been drawn up by Walsh (1995). The Central Statistics Office (CSO) also publishes “*Pilot Environmental Accounts*” within a national accounting framework; with the most recent version (1997-2004) being published by the ESRI and the CSO in 2006 but more work needs to be done however.

The overall objective of the work currently being undertaken by the authors is to assess the effect of policy reform on the economic, social and environmental sustainability of farms in Ireland using Irish National Farm survey data to develop indicators including all three dimensions of sustainability. Such indicators will present a benchmark measure of current sustainability and a tool will then be developed to generate these indicators annually for policy analysis.

## **7. Conclusion**

This paper outlined the general approach of the main sustainability literature, with a view to furthering research in the area, in an Irish context, to assess the sustainability of Irish agriculture. Such an evaluation should prove useful in designing a template for suitable Irish sustainability indicators. It is evident from the main literature that research in the area builds upon previous study and the original work of the OECD and the EU Commission in particular. Country specific studies continue to use the established DPSIR framework for the design of indicator sets and indeed similar indicators are chosen in most cases subject to data availability. Research itself is augmented by improvements in the availability of data. In the Irish case it is envisaged that a similar approach to that of the literature will be undertaken using Irish National Farm Survey data where possible (and other sources when needed). Future work will include some discussion on the weighting of indicators and the relative ‘importance’ attached to the three dimensions of sustainability; the economic, environmental and social.

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## **Annex 1 Examples of existing indicator sets**

	<b>Indicator</b>	<b>Spatial level</b>
<b>UK</b>	UK Agricultural assets and liabilities	Country
	Age of farmers	Country
	Percentage of holdings that are tenanted	Country
	PSE	EU
	Agri-environment payments	Country
	Total income from farming	Country
	Agricultural workers' earnings / manual workers' earnings	Country
	Agricultural productivity (labour and total)	Country
	Agricultural employment	Country
	Direct energy consumption	Country
	Indirect energy inputs	Country
	Area of agricultural land	Country
<b>Finland</b>	Rural socio-economic resources:	Region
	Share of labour force in primary production	
	Population of age group 0-4 and share in total population	
	Pensioners and share in total population	
	Higher educated inhabitants and share in total population	
	Population density (various indicators)	
	Unemployment	
	Quality of housing	
	Socio-cultural indicators:	Region
	Number of active farmers	
	Co-operation between farms	
	Environmentally conscious behaviour	

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<b>France</b>	Socio-territorial indicators:	Farm level
	Product quality	
	Quality of buildings and landscapes	
	Access to land	
	Social structures	
	Value of sales through Direct Marketing	
	Social services and services related to farming (agro-tourism)	
	Contribution to employment	
	Joint use of resources	
	Perdurability of farm	
	Imported feedstuffs from developing countries	
	Training	
	Number of weeks with heavy work-load	
	Subjective quality of life	
	Subjective feeling of isolation	
	Economic indicators:	Farm level
	Viability	
	Specialisation	
	Financial autonomy	
	Dependency on direct payments	
	Invested capital	
	Efficiency	
<b>OECD</b>	Farm income	Country
	Related:	
	Share agricultural income / total income	Country
	Income parity	Country
	Farm real estate values	Country
	Educational level of farmers	Country
	Agri-environment payments	Country

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<b>Australia, NZ</b>	Long-term real net farm income	Country, region
	Real net farm income	Country, farm type
	Total Factor Productivity	As above
	Farmers' Terms of Trade	Country, region
	Average Real Net Farm Income	Country, region
	Debt Servicing Ratio	Country, region
	Managerial Skills	
	Level of Farmer Education	Country, region
	Participation in training and landcare	Country, region
	Implementation of Sustainable practises	Country, region
	Off-site socio-economic impacts	
	Age-structure of agricultural workforce	Country, region
	Access to Key Services	Region
<b>Shadbolt</b>	Farm financial equilibrium	Farm
<b>Canada</b>	Agricultural Production efficiency	Region
	Manitoba Sustainability indicators initiative	
	Net farm income	Region
	Number, size and type of farms	Region
	Food meeting quality standards	Region
<b>Switzerland</b>	Change in net worth combined with liabilities/assets	Farm, region, country
	Cash flow (1) / net investments	As above.
	Sustainability index	Country

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