



An Roinn Talmhaíochta,  
Bia agus Mara  
Department of Agriculture,  
Food and the Marine

# 14S889 - Proofing Relevant Indicator Data to Evaluate the Sustainability of Irish Food Final Report

This project was funded under the Department of Agriculture,  
Food and the Marine Competitive Funding Programme.

## **SUMMARY**

The project undertook to assess the current/future demand for sustainability metrics from the perspective of agricultural, rural development and environmental policy and also in the context of the international promotion of Irish food.

In order to do this the project undertook a review of available data and identified the additional data required in order to generate new and improved sustainability metrics for Irish agriculture.

The project developed a longer time series of sustainability metrics to assess the progress that has been made in improving sustainability.

The project also developed new and improved socio- economic and environmental metrics.

Life cycle assessment (LCA) based metrics for milk and beef were developed, using nationally representative data drawn from the Teagasc National Farm Survey.

The methodologies used for developing Irish sustainability indicators are consistent with Farm Accountancy Data Network (FADN) methodologies.

The project produced a sustainability report, covering the three pillars of sustainability, economic, social and environmental. This report allows for comparisons through time and across systems. It will be produced annually.

The project also scoped out of the potential of extending the LCA methodology beyond the farm gate, using an Input-Output methodology.

## **KEYWORDS**

Sustainability, Economic, Environmental

## **ACRONYM**

PRIDES Irish Food

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24/08/2020

# Section 1 - Research Approach & Results

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## Start Date

01 January 2016

## End Date

31 December 2017

## Research Programme

Research Stimulus Fund

## TRL Scale

TRL 5: Technology validated in relevant environment

## NRPE Priority area

Sustainable Food Production and Processing

## Total DAFM Award

€199,607.88

## Total Project Expenditure

€184,044.12

## Rationale for undertaking the Research

Increasing global food demand, driven by population growth and rising incomes have important implications for food security and sustainability. More food needs to be produced with fewer emissions. Furthermore, food production must be a profitable and attractive career if generational renewal is to occur.

Sustainable intensification refers to the increase in desired outputs with the same or fewer inputs, but with significantly reduced or eliminated environmental degradation.

Sustainability indicators are quantifiable and measurable attributes of a system that are related to its sustainability. They are statistical constructs which support decision making by revealing trends in data that can then be used to analyse the results of policy actions.

Indicator design is dependent on the availability of good quality data, updated at regular intervals. Indicator development is an iterative process as, particularly in the area of environmental sustainability, the development of novel scientific methodologies will necessitate further data collection.

From an Irish perspective, the sustainable intensification of agriculture is of particular relevance, given the ambitious targets for increased economic activity in the agri-food sector, particularly in the case of dairy.

However, environmental constraints are likely to pose significant challenges for sustainable expansion. The development of such metrics for farm, food product and sector level sustainability are of much relevance to stakeholders within the agri-food sector and are of particular importance with regard to the successful marketing of Irish food in a global marketplace.

## Methodology

In conjunction with stakeholders, an assessment was undertaken of future data needs in regard to sustainability metrics.

A review of the international literature on available metrics was undertaken to guide metric design and to allow data overlaps and data gaps in existing data sources to be detailed.

This allowed for the creation of a prioritised list of new data which could be collected to measure sustainability.

A historical dataset of Irish sustainability metrics was developed using a backcasting approach. This demonstrated the evolution of sustainability of agriculture in Ireland.

The collated data were used to build new and improved metrics where appropriate, using internationally recognised methodologies.

The strategies required to collect these new metrics were described and resource requirements associated with this data collection was determined.

An input-output methodology was adapted to measure environmental sustainability using a life cycle approach.

## Project Results

There are an extensive range of sustainability indicators in use, but coverage varies according to farm type, and the different means by which indicators are generated. Producing a standardised set of measures using official data through an independent source should be seen as best practice.

Accordingly, the project developed a range of new metrics for the measurement of the various dimensions of economic, social and environmental sustainability. These metrics are too numerous to present in this summary, but they are described and presented in detail in the Teagasc Sustainability Report, which has become an annual publication, which can be easily accessed online.

From an environmental perspective, metrics were produced covering among other things GHG emissions, ammonia emissions and nitrogen balances. This was done for different farm types and also for different region as well as at national scale. A particular advantage of the approach used is that it allows for the exploration of the

relationship between economic or social metrics with environmental metrics. This demonstrates whether more profitable farms operate in a manner that is more or less environmentally friendly. The approach also provides a high level of detail for the farm population showing the spread in the level of performance across the farm population, making it a much richer data source than one that merely reports an average figure for the population. Measures of spread provide a basis for the assessment of the improvement that can be achieved in particular areas.

The detailed data collected to fulfil the various indicator needs can be linked with, and feed back into, national level statistics. This may be done either to provide an additional level of validation, and/or to increase the accuracy of the national statistics. For example, synthetic fertiliser use statistics at farm level can be compared with national level data that is based on records of imports (given that no fertiliser elements are currently manufactured in Ireland).

For GHG emissions, detailed farm management and livestock inventory data can be incorporated in the National Inventory Report emissions factors to improve the accuracy of national GHG reporting and show progress over time. Where data and scientific understanding can be shown to reach the required standards, this can redefine some emissions estimates from IPCC Tier 1 methodologies based on standard generic approaches to nationally specific Tier 2 emissions factors, or even the most detailed category of Tier 3 locally-specific emissions estimation.

Comparing with other national indicator programmes, the scope and detail of Ireland's agricultural sustainability assessments are internationally leading. Despite these strengths, areas were identified where indicators are currently not in place, not covering all relevant systems, or could benefit from further detail and/or methodological development.

The project also suggested areas in which new sustainability metrics could be developed in the future.

Finally, the project explored how a Live Cycle Analysis could be implemented within a bio-economic input output model.

## Section 2 - Research Outputs

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### Summary of Benefits / Improvements of Project Findings

In the case of environmental indicators, the developments of new indicators reflects emerging policy objectives, on-going policy developments and the volume of recent scientific research published on the topics in question.

As our scientific understanding of the environmental impacts of agriculture matures, the complexity and level of detail desirable for generating sustainability indicators has also increased. While this presents some challenges in data collection and metric development, many data needs can be met through emerging technologies (e.g. remote sensing) and continued integration of agricultural databases, and additional data requirements frequently overlap for multiple indicators.

For economic and social sustainability, the current indicators are able to explore many relevant policy issues, and potential developments are driven by emerging topics. Some of the indicator developments can be readily integrated into existing national data collection and indicator schemes, while others may reflect one-off or occasional studies required to evaluate specific policy needs.

There is a need to consider the trade-off between the benefits of greater data collection and coverage on the one hand versus on the other hand the risk that surveys become too invasive or time-consuming.

Ultimately, we should strive to develop our agricultural indicators to gain a more reliable measure of the wider impacts of agricultural systems. Interrogation and continued development of agricultural indicators, can contribute to better alignment of agricultural activity with a wide range of policy objectives to ensure agriculture operates in a sustainable manner.

### Summary of Staff Outputs

Research Output	Male	Female	Total Number
Post Doctorates	1	1	2

### Summary of Academic Outputs

Research Outputs	Total Number	Details
Publications in Peer Scientific Journals	1	Lynch, J.; Donnellan, T.; Finn, J.A.; Dillon, E.; Ryan, M. (2019) Potential development of Reviewed Irish agriculture sustainability indicators for current and future policy evaluation needs. <i>Journal of Environmental. Management.</i> , 230, pp. 434–445.

There is a significant and detailed range of sustainability indicators for Irish agrifood production, but there remain areas where further indicator development or new indicators could prove valuable.

This review provides an outline of potential developments in Irish assessment of agricultural sustainability following the latest research and in order to meet policy demands. Recent research findings have suggested means of improved quantitative modelling of greenhouse gas emissions, but additional dietary and soil data may be important for this, especially for the potential inclusion of any soil sequestration. This information could also benefit more detailed modelling of nutrient

losses to water. Specific concerns over pesticide and antibiotic use may require additional survey work on the particular locations or types of farms of interest.

Biodiversity monitoring could be improved by expanding the range of results-oriented agri-environment schemes or employing remote-sensing habitat monitoring, likely supplemented with targeted field surveys for specific objectives.

Farm-level economic sustainability is largely well-covered, but additional data collection may be of benefit to address specific issues such as labour costs. Recent additional surveys on farm-level social sustainability have addressed important social indicators of isolation and access to local services, and could be rolled out on a larger number of farms in the future.

Wider societal concerns such as animal welfare, genetically modified materials in foodstuffs and antibiotic resistance have limited indicators currently available, and could also benefit from additional surveys.

The breadth and detail required in agri-food sustainability indicators present a significant challenge to survey design and implementation, but many developments can be achieved without additional surveys through the use of remote sensing and geospatial technologies and integration of existing datasets.

Despite the important benefits of further developments in Irish sustainability indicators, consideration must also be given to farmer confidentiality and survey fatigue.

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Publications in Peer  
Reviewed Scientific Journals

1

O'Donoghue C., Chyzheuskaya A., Grealis E., Kilcline K., Finnegan W., Goggins J., Hynes S. and Ryan M. (2019) Measuring GHG emissions across the agri-food sector value chain: the development of a bioeconomy input-output model. *International Journal of Food System Dynamics* 10 (1), pp. 55-85

Increasing food production to meet rising global demand while minimising negative environmental impacts such as agricultural greenhouse gas (GHG) emissions is one of the greatest challenges facing the agri-food sector.

Sustainable food production relates not only to primary production, but also has wider value chain implications. An input-output (IO) model is a modelling framework which contains information on the flow of goods and services across a value chain at a regional or national economy level.

This paper provides a detailed description of the development of a Bioeconomy IO (BIO) model which is disaggregated across the sub-sectors of the agri-food value chain and environmentally extended (EE) to examine environmental outputs, including GHG emissions. We focus on Ireland, where emissions from agriculture comprise 33% of national GHG emissions and where there has been a major expansion and transformation in agriculture supported by national and EU policy.

In a substantial Annex to this paper, we describe the modelling assumptions made in developing the BIO model. Breaking up the value chain into components, we find that most value is generated at the processing stage of the value chain, with greater processing value in more sophisticated value chains such as dairy processing.

On the other hand, emissions are in general highest in primary production, albeit emissions from purchased animal feed are higher for poultry than for other value chains, given the lower animal based emissions from poultry than from cows or sheep.

The level of disaggregation also shows that the sub-sectors are themselves discrete value chains. The analysis highlights that emissions per unit of output are much higher for beef and sheep meat value chains than for pig and poultry.

The analysis facilitated by the BIO model also allows for the mapping of emissions along the agri-food value chain using the adapted IO EE approach. Such analysis is valuable in identifying emissions 'hot-spots' along the value chains and analysing potential avenues for emission efficiencies.

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Peer Reviewed Conference  
Papers

1

Lynch, J., Donnellan, T., Hanrahan, K., (2016). Exploring the Implications of GHG Reduction Targets for Agriculture in the United Kingdom and Ireland. *Agricultural Economics Society 90th Annual Conference*, University of Warwick, England.  
<https://ideas.repec.org/p/ags/aesc16/236370.html>

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Other	1	Lynch, J., Hennessy, T., Buckley, C., Dillon, E., Donnellan, T., Hanrahan, K., Moran, B., Ryan, M., (2016) Teagasc National Farm Survey 2015 Sustainability Report. Teagasc National Farm Survey. Agricultural Economics & Farm Surveys Department, REDP, Teagasc, Athenry, Co. Galway. ISBN 978-1-84170-631-3. <a href="https://www.teagasc.ie/media/website/publications/2017/2015-sustainabilityreport.pdf">https://www.teagasc.ie/media/website/publications/2017/2015-sustainabilityreport.pdf</a>
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Other	1	Buckley, C., Donnellan, T., Dillon, E., Hanrahan, K., Moran, B. and Ryan, M. (2019). 'Teagasc National Farm Survey 2017 Sustainability Report'. ISBN: 978-1-84170-650-4 Available at: <a href="https://www.teagasc.ie/media/website/publications/2019/2017sustainability-report-250319.pdf">https://www.teagasc.ie/media/website/publications/2019/2017sustainability-report-250319.pdf</a>
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### Intellectual Property

Not Applicable. This was desk based research with the objective of better measuring the sustainability of the agri-food sector, principally to inform public policy.

### Summary of other Project Outputs

Project Outputs	Details	Total No.
New Industry Collaborations Developed	In order to create some of the environmental sustainability metrics, ICBF agreed to share data with Teagasc, so that a Beef Life Cycle Analysis could be produced as part of the National Farm Survey	1

### Potential Impact related to Policy, Practice and Other Impacts

Impact	Details
Environmental Sustainability	The project has given the Teagasc National Farm Survey the capacity to measure the environmental impact of agriculture (including for example metrics for greenhouse gases, ammonia, N balances and N use efficiency) and changes in such metrics over time. Such metrics show the environmental impact of each farm type. Within farm type, it is also possible to see the spread of such metrics, showing farms that have a higher and lower environmental impact. All of this information is very valuable in terms of understanding the scale of the impact that is achievable from measures designed to reduce emissions. Therefore this information can inform scheme design.
Socio-Economic	The environmental metrics can be paired with socio-economic metrics so that the interaction between socioeconomic metrics and environmental metrics can be observed. This allow one to examine whether for example more/less profitable farms have more/less environmental impact.

### Dissemination Activities

Activity	Details
Workshops at which results were presented	Environmental Farm Performance Tools in Ireland. EIP- AGRI Workshop Tools for environmental farm performance - Zagreb, Croatia.
Seminars at which results were presented	Sustainability measurement in Irish Agriculture. Presentation of Project to National Dairy Council, Board Dublin, 26 January 2017

Seminars at which results were presented [https://www.teagasc.ie/media/website/publications/2017/Developments\\_in\\_monitoring\\_and\\_Improving\\_Agricultural\\_Sustainability.pdf](https://www.teagasc.ie/media/website/publications/2017/Developments_in_monitoring_and_Improving_Agricultural_Sustainability.pdf)

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### Knowledge Transfer Activities

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<b>Identify knowledge outputs generated during this project.</b>	The project has led to the production of an annual report on the sustainability of the sector. In particular the environmental metrics now available by farm type demonstrate where progress that is being made a farm level and where greater effort is required. This is of use in the formulation and targeting of policy. It is also of use as an official independent reference source to demonstrate the sustainability of agricultural production in Ireland. The success of the project has attracted international interest from other member states interested in emulating what has been achieved in Ireland.
<b>Identify any knowledge transfer activities executed within the project.</b>	There have been several presentations of results of the project to industry stakeholders. There has also been a presentation of the project's outputs at an international workshop organised by the European Commission in Zagreb.
<b>List any impacts resulting from the knowledge transferred during the project.</b>	There is now much greater awareness amongst farmers of the environmental impact of agricultural activity. Environmental concerns have become much more central to the debate about the future strategy for the sector. Having concrete data available to demonstrate how sustainability has changed in recent years, particularly since the removal of the milk quota system has been central to creating this increased awareness of the importance of reducing agriculture's environmental impact. Dairy farmers in particular are now much more disposed towards making improvements at farm level to address the environmental impact of their activities.

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## Section 3 - Leveraging, Future Strategies & Reference

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### Leveraging Metrics

Not applicable. The subject of the study should be considered as public good research.

### Future Strategies

There is significant scope to continue developing existing Irish agri-food sustainability and further expand the range of indicators, across a number of important areas. Developing an integrated set of metrics linking environmental, economic and social sustainability might appear onerous for those focused only on one strand of sustainability. However, a holistic, multi-disciplinary collaboration allows integrated data collection and identifies synergies or trade-offs in the provision of desirable outcomes, reflecting the multidimensional impacts and outputs of agricultural activity.

A comprehensive national indicator set could potentially combine indicators into a composite sustainability indicator. At present there are practical challenges in designing such an indicator, but even if there was complete national and sectoral coverage for all topics, further work would be required to design a composite indicator.

This is because different indicator weightings or priorities can influence the overall ranking of a composite sustainability index. Defining these is challenging due to the varied stakeholders perspectives in the agri-food industry. A composite indicator may also be of little additional value where there is already demand for individual indicator reporting, such as for greenhouse gas emissions.

### Project Publications

Buckley, C., Donnellan, T., Dillon, E., Hanrahan, K., Moran, B. and Ryan, M. (2019). 'Teagasc National Farm Survey 2017 Sustainability Report'. ISBN: 978-1-84170-650-4

Available at: <https://www.teagasc.ie/media/website/publications/2019/2017-sustainability-report-250319.pdf>

Lynch, J., Donnellan, T., Hanrahan, K., (2016). Exploring the Implications of GHG Reduction Targets for Agriculture in the United Kingdom and Ireland. Agricultural Economics Society 90th Annual Conference, University of Warwick, England. <https://ideas.repec.org/p/ags/aesc16/236370.html>

Lynch, J., Hennessy, T., Buckley, C., Dillon, E., Donnellan, T., Hanrahan, K., Moran, B., Ryan, M., (2016) Teagasc National Farm Survey 2015 Sustainability Report. Teagasc National Farm Survey. Agricultural Economics & Farm Surveys Department, REDP, Teagasc, Athenry, Co. Galway.

Lynch, J.; Donnellan, T.; Finn, J.A.; Dillon, E.; Ryan, M. (2019) Potential development of Irish agriculture sustainability indicators for current and future policy evaluation needs. *Journal of Environmental. Management.*, 230, pp. 434–445.

O'Donoghue C., Chyzheuskaya A., Grealis E., Kilcline K., Finnegan W., Goggins J., Hynes S. and Ryan M. (2019) Measuring GHG emissions across the agri-food sector value chain: the development of a bioeconomy input-output model. *International. Journal of Food System Dynamics* 10 (1), pp. 55-85