



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

# 14S875 - Total Factor Productivity of Irish Agriculture: Measurement, Sources and Comparisons

## Final Report

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

## **SUMMARY**

The objectives of the research project were a) the development, using Teagasc NFS and CSO data, of Total Factor Productivity (TFP) indicators for the Irish farming systems covered by the NFS, b) the empirical investigation of links between innovation and productivity and c) the investigation of the source of TFP growth in Irish agriculture and d) the conduct of a cross-country comparison of the TFP performance of dairy farms in Ireland and a selection of other countries.

The principal result of the project has been the development of the research infrastructure with which to generate, on an annual basis, TFP indicators for Irish farm systems. This TFP indicator set will be added to the expanding set of indicators already reported on by Teagasc Rural Economy Development Programme.

The research undertaken highlights the strong growth in the TFP of Irish dairy farmers, particularly following the removal of quota. The TFP performance of other farms was more volatile and less than half of that achieved by Irish dairy farms during the period studied (2006-2016).

Research on the links between innovation on dairy farms and TFP confirmed that higher TFP is associated with higher innovation levels. Research on the drivers of TFP growth on Irish beef farmers showed that technical change was the main driver of TFP growth followed by technical efficiency. Cross-country comparisons of TFP performance on dairy farms in Ireland, Northern Ireland and New Zealand (NZ) found that TFP performance during the period 2010-2016 was similar in Ireland and Northern Ireland with both regions outperforming NZ.

The main impact of the research will be to allow the regular (annual) reporting of the TFP performance of Irish agriculture, deeper understanding of TFP will facilitate the formulation of policies designed to augment this performance and ultimately facilitate sustainable growth in farm incomes.

## **KEYWORDS**

Productivity, sustainability, policy analysis

## **ACRONYM**

TFP IrishAg

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12/08/2020

# Section 1 - Research Approach & Results

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## Start Date

01 January 2016

## End Date

31 August 2018

## Research Programme

Research Stimulus Fund

## TRL Scale

TRL 4: Technology validated in lab

## NRPE Priority area

Sustainable Food Production and Processing

## Total DAFM Award

€191,577.81

## Total Project Expenditure

€157,891.76

## Rationale for undertaking the Research

The challenge for Irish agriculture is how to maintain and increase incomes arising in agriculture, while minimizing the environmental impact of agricultural production. Productivity based growth, getting more output for a given volume of inputs, will be the key to sustainable growth in agricultural incomes and be the basis for the environmental sustainability of Irish agriculture.

A total factor productivity (TFP) index compares total outputs relative to the total inputs used in production of the output (with both the output and the inputs expressed in term of volumes). Thus, a TFP index reflects output per unit of some combined set of inputs, so that an increase in TFP reflects a gain in output quantity, which is not originating in an increase of input use.

This research will

- (1) Facilitate the regular monitoring of the TFP of the main sectors of Irish agriculture. The regular (annual) publication of this new indicator will enable policy makers to monitor progress in the achievement of policy objectives relating to agricultural productivity. The new productivity indicator set together with the annual Teagasc NFS report, Teagasc Enterprise Fact Sheets and the Teagasc NFS Sustainability Report will greatly enrich the information available to the Irish agricultural policy community and agricultural sector stakeholders;
- (2) Facilitate informed policy making by better understanding the sources of TFP growth within Irish agriculture
- (3) Help by understanding TFP change in Ireland and competitor countries elucidate the fundamental sources of on-going competitive and comparative advantage.

## Methodology

The research reviewed the Irish and international literature on TFP measurement in an agricultural context. This review guided the development of the approach used to calculate TFP growth measures for the Irish agricultural sector using Teagasc Farm Survey (NFS) data and data from the CSO. The approach adopted largely mirrors that used by the OECD and ABARES.

The construction of TFP indicators for Irish agriculture, at a system level, was based on data from the Teagasc, National Farm Survey and the CSO. The historic time series used was from 2006 to 2016. The methodological approach used was the Fischer Index approach.

Computer programming code (STATA) was developed and now provide a routine process through which the index of TFP performance for Irish farms be updated on an annual basis on the release of the required Teagasc and CSO data.

Two main pieces of analysis were carried out pertaining to the sources of TFP. The first investigated the link between innovation and productivity. The results suggest that higher TFP is associated with higher innovation levels on Irish dairy farms.

The second piece of research on the sources of TFP growth examined the link between sources of TFP (technical change, technical efficiency and scale efficiency) and TFP growth on Irish beef farms.

A comparative analysis of the TFP performance of Irish dairy farming and dairy farming on other competitor countries over the period 2010 to 2016 was undertaken. In this analysis micro-economic data from the EU Farm Accountancy Data Network (FADN) was used for Ireland and Northern Ireland and micro data from Dairy NZ data was used for New Zealand.

## Project Results

The most significant finding from the research conducted relating to the TFP performance of Irish agriculture over the period 2006 – 2016 relates to the performance of Irish dairy farms. The removal of milk quotas in 2015 has led to an increase of over 30% in dairy cow numbers since 2010, and although suckler cow numbers have dropped slightly, the total number of cows in Ireland has reached an alltime high of over 2.5 million head.

The TFP index developed during this research project shows that relative to 2010 the TFP of Irish dairy farms increased by 14% by 2016, however in one production year, 2014-2015, the year when milk quota was removed, the TFP measure increased by 10%. The TFP index for dairy farms then grew by 3% in the production year 2015-2016. It is apparent that the removal of the European dairy quota system has resulted in a windfall gain for Irish dairy farmers and that these productivity gains are continuing to be realised and will be important contributors to ongoing income growth in Irish dairy farming.

The TFP performance of the other livestock farms (cattle and sheep) and crop farms was not as positive as that achieved by the dairy sector. Weather driven volatility was the main feature of the crops sector TFP performance. In later part of the 2002-2016 period some TFP growth on Irish beef farms was found but it was less than half the annualised TFP growth on dairy farms.

In terms of the analysis relating to the sources of productivity performance in Irish agriculture, two specific pieces of analysis were conducted. The impact of innovation on the Irish dairy farm level productivity and its components was examined. The results suggest that higher TFP is associated with higher innovation levels on Irish dairy farms.

The second piece of analysis which was carried out was an in-depth econometric approach which focused on the drivers of productivity in the Irish beef sector. Divergent sources of TFP growth among the beef farming population were identified. Technical change appeared as the main driver of TFP change, followed by technical efficiency.

The inter-country performance of TFP indicated that TFP growth levels in Ireland and Northern Ireland were similar in the period 2010 to 2016, and that these were greater than the growth of TFP in New Zealand dairying in recent years. FADN data from the European Commission, based on micro data from specialist dairy farms in Ireland and Northern Ireland, for the period 2012 to 2016, using a Fisher Index approach, indicated that average annual growth rates were just over 3 per cent in both regions. Dairy NZ micro data for the period 2012 to 2016, has indicated that average annual growth rates in TFP on New Zealand dairy farms were far lower than that experienced in either Ireland or Northern Ireland.

## Section 2 - Research Outputs

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### Summary of Benefits / Improvements of Project Findings

The relevance of this research to the end user include:

- (1) Facilitation of the regular monitoring of the TFP performance of the main sectors of Irish agriculture. The publication of this new indicator set will enable policy makers to monitor progress in the achievement of policy objectives relating to agricultural productivity. The new productivity indicator, together with the annual Teagasc NFS report, Teagasc Enterprise Fact Sheets and Teagasc NFS Sustainability report will collectively enrich the information available to the Irish agricultural policy community and agricultural sector stakeholders;
- (2) To facilitate informed policy making by better understanding the sources of TFP growth within Irish agriculture;
- (3) To better understand TFP changes in other countries, so as to gain insights on the role and influence of policy on agricultural sector productivity and agricultural competitiveness performance.

### Summary of Staff Outputs

Research Output	Male	Female	Total Number
PhD Students	1	0	1
Post Doctorates	0	2	2

### Summary of Academic Outputs

Research Outputs	Total Number	Details
Publications in Peer Reviewed Scientific Journals	2	1) A paper currently under review at the Irish Journal of Agricultural and Food Research on the development of the TFP indicators set for Irish agriculture using Teagasc NFS data and 2) a paper published (2019) in the journal Applied Economics ( <a href="https://www.tandfonline.com/doi/full/10.1080/00036846.2019.1588944">https://www.tandfonline.com/doi/full/10.1080/00036846.2019.1588944</a> ) on a Färe-Primont decomposition of the sources of productivity growth on Irish beef farms.

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Peer Reviewed Conference Papers 3

- 1) Measuring Total Factor Productivity on Irish Dairy Farms: A Fisher Index Approach using Farm Level Data (<https://ageconsearch.umn.edu/record/273479>)
- 2) The effect of the implementation of the 2003 Mid-Term Review of the CAP on technical efficiency of beef production. A comparative analysis <https://ageconsearch.umn.edu/record/258617>
- 3) Competitiveness, Efficiency and Productivity Measurement in Agriculture paper at the Workshop "Competitiveness, Efficiency and Productivity Measurement in Agriculture" co-organised by Teagasc and the AES, April 2017 Dublin

Other 8

- 1) McCormack, M., Hanrahan, K., Thorne, F. (2017) Update on productivity in Irish Agriculture Outlook Conference, December 2017, RDS Dublin
- 2) Cillero, M. and Thorne, F. (2017) 20th Session of the OECD Farm Level Analysis Network. Presentation "Sources of productivity growth using the Färe-Primont decomposition. An empirical application to the Irish beef sector"
- 3) Cillero, M. and Thorne, F. (2017) 19th OECD Farm Level Analysis Network meeting, Paris, ~May 2017 to present work from Project tasks 4 and 5. 4) Cillero, M. and Thorne, F. (2017) Presentation at IFCN dairy conference, on productivity in Irish dairying based on Project task 5. 06/06/17
- 5) Thorne, F., McCormack, M, Hanrahan, K., Cillero, M., (2017) Productivity and Competitiveness of Irish Agriculture, Presentation to FoodWise 2025 HLIC Based on Project tasks 3, 4 and 5 (20/07/17)
- 6) Thorne, F., McCormack, M, Hanrahan, K., Cillero, M., (2018) Global trends in Agriculture, presented at Alltech One Ideas Forum, October 2018 Presentation based on this research project Tasks 2-5 (16/10/18)
- 7) Thorne, F., McCormack, M, Hanrahan, K., Cillero, M., (2018) TFP in Irish dairying, IFCN conference, June 2018 (10/06/18)
- 8) Thorne, F., McCormack, M, Hanrahan, K., Cillero, M., (2018) Productivity in Irish Agriculture, Joint Teagasc/SRUC conference, Edinburgh, Feb 2018 (01/02/18)

#### Intellectual Property

N/A

#### Summary of other Project Outputs

Project Outputs	Details	Total No.
New Processes	1) Stata code written and Teagasc NFS datasets constructed so as to allow ongoing generation of Fischer index TFP indicators for Irish farms systems 2) Färe-Primont TFP index for Irish agriculture	2
New Industry Collaborations Developed	New research collaborations with peers at a) the University of Dundee b) the University of Wisconsin-Madison c) UCC d) Lincoln University, NZ	

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

Impact Details

The project outcome that allows for the assessment of the TFP performance of the main components of Irish agriculture will allow for on-going assessment of the improvement in fundamental underpinning of income growth in Irish agriculture - i.e. productivity growth. It will with the tool developed in this project be possible to parse improvements in economic performance into those that may be transitory, e.g. higher output prices, and those that fundamentally shift incomes upward e.g. productivity growth.

The economic analysis relating to the sources of productivity performance in Irish agriculture, found that the innovation performance was related to productivity growth on Irish dairy farms. Analysis relating to the drivers of productivity growth on Irish beef farms found that technical change was the main driver of productivity change rather than increases in technical efficiency.

### Dissemination Activities

Activity	Details
Workshops at which results were presented	Results from the project have been presented at successive sessions of the OECD Farm Level Analysis Network, and at Academic Conferences organised by the Agricultural Economics Society (UK).
Seminars at which results were presented	Research findings from this project have been presented to the HLIC of Food Wise 2025 (July 2017).

### Knowledge Transfer Activities

N/A

## Section 3 - Leveraging, Future Strategies & Reference

### Leveraging Metrics

Type of Funding Resource	Funding €	Summary
Other	€176,000.00	Two Teagasc Walsh Fellowship Awards 1) Innovation and Productivity in Irish Dairy farming (with UCD) 2) International comparison in productivity and competitiveness in the dairy sector (with UCC and Lincoln University, New Zealand)

### Future Strategies

Our intention is that the TFP index set constructed as part of this project will be updated on an annual basis following the finalisation in July each year of the annual Teagasc NFS. This indicator set will be released as an annual national publication by the Teagasc Agricultural Economics and Farm Survey Department. The first of these reports will be forthcoming in 2020.

The extension of TFP measures to include the environmental outputs of agricultural production activities is an active area of research internationally. Teagasc plans to explore how the research undertaken in this project can be extended through the inclusion of environmental outputs (and inputs) in future TFP indicators.

Future research will also explore the links between productivity growth as measured by TFP and existing and future indicators of environmental and social sustainability.

### Project Publications

- 1) McCormack, M., Hanrahana, K., Thorne, F Measuring Total Factor Productivity on Irish Dairy Farms: A Fisher Index Approach using Farm Level Data Currently under review at the Irish Journal of Agricultural and Food Research
- 2) Cillero, M. and Thorne, F. (2019) Sources of productivity growth using the Färe-Primont decomposition. An empirical application to the Irish beef sector, Applied Economics, 51:36, 3982-3994, DOI: 10.1080/00036846.2019.1588944

- 3) McCormack, M., Thorne, F. and Hanrahan K. Measuring Total Factor Productivity on Irish Dairy Farms: A Fisher Index Approach using Farm Level Data. AES Annual Conference 2018. (<https://ageconsearch.umn.edu/record/273479>)
- 4) Cillero, Maria Martinez ; Breen, James ; Thorne, Fiona ; Wallace, Michael (2017) The effect of the implementation of the 2003 Mid-Term Review of the CAP on technical efficiency of beef production. A comparative analysis <https://ageconsearch.umn.edu/record/258617>
- 5) Michele McCormack (2017) Competitiveness, Efficiency and Productivity Measurement in Agriculture - paper presented at the Workshop "Competitiveness, Efficiency and Productivity Measurement in Agriculture" co-organised by Teagasc and the AES, April 2017 Dublin.
- 5) Cillero, M and Thorne F. (2017) "Sources of productivity growth using the Färe-Primont decomposition. An empirical application to the Irish beef sector" Presentation to the 20th session of the OECD Farm Level Analysis Network, Paris. November 2017.
- 6) McCormack, M., Hanrahan, K., Thorne, F (2017) Update on productivity in Irish Agriculture Outlook Conference, December 2017, RDS Dublin
- 9) Cillero, M. and Thorne, F. (2017) 19th OECD Farm Level Analysis Network meeting, Paris, ~May 2017 presentation of work from Project tasks 4 and 5.
- 10) Cillero, M. and Thorne, F. (2017) Presentation at IFCN dairy conference, on productivity in Irish dairying based on Project task 5. 06/06/17
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- 13) Thorne, F., McCormack, M, Hanrahan, K., Cillero, M., (2018) TFP in Irish dairying, IFCN conference, June 2018 (10/06/18)
- 14) Thorne, F., McCormack, M, Hanrahan, K., Cillero, M., (2018) Productivity in Irish Agriculture, Joint Teagasc/SRUC conference, Edinburgh, Feb 2018 (01/02/18)