

Economic Impact Assessment of the Tillage Sector in Ireland



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Foreword

The tillage sector in this country has never been fully evaluated in terms of its contribution to Irish agriculture, national economic output, or its importance in helping maintain the fabric of rural Ireland. It is a high cost sector with significant local turnover in terms of the input trade, machinery requirements, electrical services etc, and its requirement for labour.

While the sector is now mainly a supplier of feed grains to the livestock sector, it also produces a range of raw materials for the drinks industry, is a producer of high quality oats that are used in food and feed markets and exported around the world, and it has many favourable environmental credentials when compared to other enterprises. It also supplies a large quantity of straw to the livestock sector and has been an increasing supplier of protein sources for animal feeds.

The presence of a vibrant tillage sector on this island is important to help validate the authenticity of the livestock products we export. But as Irish cereals slide down the self-sufficiency scale for animal feeds, and we witness an increasing swing to imported feeds, we risk a backlash from an increasingly discerning marketplace.

For these reasons it was important that the contribution of the tillage sector to Irish agriculture and the rural economy be assessed and enumerated. In this regard Tillage Industry Ireland is very thankful to Professor Michael Wallace from University College Dublin for his tremendous work in the production of this very comprehensive and timely report. Prof. Wallace is a very respected agricultural economist with a great knowledge of the agricultural industry, and the organisation is privileged that he was willing to take on the production of this report.

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Andy Doyle
Irish Farmers Journal

Contents

Foreword.....	ii
Acknowledgments.....	4
Disclaimer.....	4
Infographic.....	5
Executive Summary.....	6
Extended Summary.....	7
1. Introduction.....	12
1.1 Study objectives.....	13
1.2 Scope of the report.....	13
1.3 Data sources and use of multi-year averaging.....	14
1.4 Report structure.....	15
2. Structure of the Tillage Sector.....	17
2.1 Holdings.....	17
2.2 Farm and farm household characteristics.....	18
2.3 Tillage crop areas.....	19
2.4 National cropping mix.....	22
2.5 Volumes of native crop production.....	25
2.6 Farm economics.....	28
3. Trade.....	33
3.1 Cereals.....	33
3.2 Flour and malt.....	35
3.3 Livestock feed ingredients.....	37
3.4 Potatoes.....	39
4. Tillage Supply Chain.....	40
4.1 Cereals.....	40
4.1.1 Milling.....	42
4.1.2 Livestock feed.....	43
4.1.3 Brewing and distilling.....	44
4.1.4 Straw.....	47
4.2 Oilseed rape and pulses.....	48
4.3 Potatoes.....	50

4.4	Tillage fodder crops.....	52
4.5	Market price premiums	53
4.6	Input supply chain and tillage-supported expenditure.....	54
5.	Economic Impact.....	58
5.1	Introduction	58
5.2	Tillage farm output	58
5.3	Multiplier analysis	59
5.4	Impact on gross output in the economy.....	61
5.5	Employment effects	61
5.6	Regional significance of tillage.....	63
5.7	Downstream impacts	65
6.	Tillage and the environment.....	67
6.1	Carbon footprint	67
6.2	Plant protection products	72
6.3	Advanced crop breeding	72
6.4	Biodiversity.....	73
	References	75
	Appendix 1: Crop areas by region.....	79
	Appendix 2: Map of soil suitability for tillage in Ireland	83

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Disclaimer

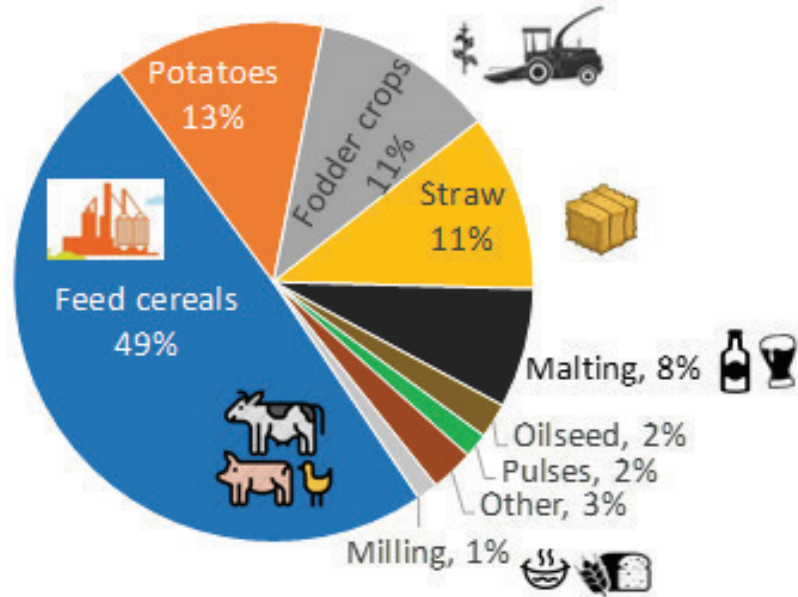
The views expressed in this report are those of the author and do not necessarily represent opinions of University College Dublin or Tillage Industry Ireland. Some industry data were provided to the author subject to confidentiality conditions. The author has adhered to these terms by preserving the anonymity of sources and amalgamating data-categories in selected areas where more granular reporting would breach confidentiality. Figures provided in this report are estimates based on available data sources; accordingly, they should be interpreted as approximate rather than exact magnitudes. Any remaining errors or omissions are the responsibility of the author.



Irish Tillage Impact



Direct Farm Output
€640m
per annum



Expenditure in the Rural Economy



Farm inputs
€423m



Investment
€54m



Household
€200m



Output
in the Economy

€1.3bn per annum
€4m per 1,000 hectares



Employment

11,000 FTE jobs
32 jobs per 1,000 hectares
17 jobs per €1m tillage output

Carbon Efficiency



Executive Summary

- The current and potential contribution of the Irish tillage sector, environmentally and economically, should be recognised in a balanced agri-food strategy for Ireland.
- The Irish tillage sector is estimated to contribute over €1.3bn per annum to Irish economic output. It supports 11,000 full-time equivalent jobs or 32 jobs per 1,000 hectares of tillage. It spends an estimated €423m per annum on inputs and invested about €54m per annum in machinery, buildings, and land improvements. The estimated average net cash flow from tillage production was €200m per annum during 2014-2018.
- The sector comprises almost 10,000 farms, almost half of which are 'specialist' tillage farms. However, numbers have decreased considerably in recent years and the area under tillage crops has declined by 15% (57,400 hectares) from 382,700ha over the last decade and by 42% since 1980. It is likely that much of this 'formerly tillage land' is now used for milk production.
- Despite the fall in area, cereals output has remained relatively stable at around 2.3m tonnes per annum during 2014-2018. The sector has been highly responsive to policy initiatives, doubling oilseed rape production after 2005 and trebling the area sown to pulses since the introduction of the Protein Aid Scheme in 2015.
- The area of potatoes grown has declined by 37% since 2008, reflecting changing consumer habits and increased substitution by alternative carbohydrate sources in the daily diet. Imports now account for almost 20% of the potatoes consumed in Ireland.
- The income performance from tillage has been strong compared to the other main sectors of Irish agriculture and is second only to dairying and more than double the average income for drystock systems. Only tillage and dairy returned, on average, a positive market income (excluding direct payments) during 2014-2018.
- However, Ireland's import dependence has been increasing across all the main tillage outputs, reflecting that increasing demand has outpaced native supplies. These trends indicate significant opportunities for expansion in tillage for import substitution. Imports of cereals increased at a rate of 64,000 tonnes per annum between 2000 and 2018 and reached 1.6m tonnes in 2017, valued €257m. Maize alone accounted for 1.1m tonnes of imports in 2017. Wheat flour imports increased at 7,000 tonnes per annum between 2000 and 2018, to reach 210,000 tonnes (€80m) in 2018. Livestock feed ingredient imports increased at 113,000 tonnes per annum between 2000 and 2018 to reach almost 4m tonnes in 2017, valued c. 800m. Potato imports hit 80,000 tonnes in 2018, valued c.€42m.
- About 250,000 tonnes of Irish barley is used in the brewing and distilling industries, supplying virtually all the requirements for brewing but only two in five tonnes used in distilling. Porridge production used about 25% of the native supply of oats, with an estimated retail value of 40m in 2018.
- Tillage is regarded as having a good environmental footprint with low emissions, is important for biodiversity and is essential for some bird species.
- The tillage sector in Ireland contributes significantly to agricultural output and rural well-being and deserves to be part of the greater plan for agricultural development.

See main points on following pages.

Extended Summary

Scope of report

- The analysis of Irish tillage in this report encompasses the following crops: cereals (wheat, barley, oats, other cereals), oilseed rape, pulses (peas, beans), potatoes, and arable fodder crops (maize silage, whole crop cereals, fodder beet).
- The tillage industry comprises the primary farm sector that cultivates these crops, the upstream input-supply sectors, and the downstream sectors that process crops for use in other areas such as livestock feed production, food and drink manufacturing.
- The economic impact analysis comprises estimates based on average values for the five years 2014-2018. This approach controls for inter-year variability so that assessments are representative of a medium-term horizon.

Structure of the tillage sector

- Approximately 10,000 Irish farms grow tillage crops, representing 7.5% of all farm holdings in Ireland.
- Among the 10,000 holdings, almost 5,000 are 'specialist' tillage farms whose crop sales account for more than two-thirds of their output. The remaining holdings are mixed enterprise farms that grow crops, sometimes on a limited scale, alongside livestock enterprises.
- The number of 'specialist' tillage farms declined by 2% between 2005 and 2016 compared to a reduction of 3% in all farm holdings over the same period.
- In contrast, the number of 'non-specialist' tillage holdings declined by around 40% between 2005 and 2016.
- The area under tillage crops, nationally, has declined by 15% (57,400 hectares) over the last decade and some 42% since 1980, reaching 321,000 hectares in 2018. Nationally, the area under tillage crops during the five years, 2014-2018, averaged 338,000 hectares.
- The most substantial reductions in tillage *acreage* have been in the south-east and south-west regions where crop area fell by almost 35,000 hectares between 2008 and 2018, accounting for 60% of the national decline in tillage in that period. It is likely that much of this former tillage land is now used in milk production.
- Over the last decade, the largest *percentage* reductions in tillage areas have been in the border and western counties, where tillage has retrenched by around 30%, although from a small base.
- The volume of cereals output averaged 2.3m tonnes per annum during 2014-2018. Production volume has remained stable, despite the reduction in cereal area, because of yield improvements and a shift from spring-sown towards higher output winter-sown cereals.
- The national crop mix is heavily weighted towards barley, which accounted for 57% of tillage area in 2014-2018, while wheat and oats comprised 19% and 7%, respectively.
- The mix of break crops has evolved with a doubling of oilseed rape to c.10,000 hectares after 2005. The area of pulses has trebled to c.10,000 hectares since the introduction of the Protein Aid Scheme in 2015.

- The area of potatoes has fallen by 37% since 2008 to reach 7,100 hectares in 2018. Potato cultivation has declined by two-thirds since the early 1990s, while the number of growers has declined by over 90% in that timeframe.
- During 2014-2018, the average annual production of potatoes was c.350,000 tonnes compared to c.600,000 tonnes per annum in the 1990s.

Farm economics

- Tillage is a commercially focussed sector with strong farm income performance compared to the other main sectors of Irish agriculture.
- The average income of 'mainly tillage' farms was c.€34,000 over the last five years, second only to the average income for dairy farms and more than double the average incomes for drystock systems.
- Direct payments are a critical part of tillage farm output and income, representing 22% of Gross Output and 71% of Family Farm Income.
- Among the main farming systems, only tillage and dairy returned, on average, a positive market income (excluding direct payments) during 2014-2018.
- Tillage farms compare very favourably with other systems in terms of economic viability. Some 63% of 'mainly tillage' farms were classified as economically viable in 2018, with a further 19% deemed financially sustainable due to the presence of off-farm income.
- Irish tillage farms are competitive with those in other EU member states based on costs of production. However, Ireland has specific competitive disadvantages from high land and labour costs compared to other EU states.
- Average land rental costs in Ireland are fourth highest in the EU after the Netherlands, Denmark, and Austria. High land costs inhibit farm expansion and reduce the scope for tillage farmers to spread increasing machinery and labour overheads over larger acreages.

Trade balances

- Ireland's tillage sector principally serves the domestic market and is less reliant on exports compared to the other main agricultural enterprises. For this reason, tillage is considered to face lower risks from Brexit than other sectors in Irish agriculture.
- Ireland's import dependence has been increasing across all main outputs of the tillage sector, reflecting increases in demand that have outpaced native supplies. These trends indicate significant opportunities for the Irish tillage sector to expand through import replacement.
- Imports of cereals increased at a linear rate of 64,000 tonnes per annum between 2000 and 2018. In 2017, cereal imports were 1.6m tonnes to a value of €257m.
- Maize is the largest and fastest increasing component of Ireland's cereal imports, reaching 1.1m tonnes in 2017.
- Net imports of wheat flour increased at a linear rate of 7,000 tonnes per annum between 2000 and 2018, reaching 210,000 tonnes (€80m) in 2018. This level of imports is equivalent to 31,000 hectares at average Irish wheat yield.
- Ireland's net imports of livestock feed materials increased at a linear rate of 113,000 tonnes per annum between 2000 and 2018. Net imports of key concentrate feed ingredients amounted to almost 4m tonnes in 2017 with a trade value of c.€800m.

- Ireland imported 80,000 tonnes of potatoes in 2018 with a trade value of c.€42m.

Supply chain

- The average annual ex-farm output of cereals was €386m during 2014-2018, of which €355m was commercially traded through grain merchants, and €31m was retained on-farm for feed.
- The livestock feed sector comprised 93%, 83%, and 65% of the domestic uses of wheat, barley, and oats, respectively.
- Ireland's overall self-sufficiency in the domestically produced cereal crops was 88%, but this figure fell to 60% when imported maize is included.
- The brewing and distilling industries utilised c.17% (250,000 tonnes) of Irish barley, generating an average ex-farm output value of €48m per annum during 2014-2018.
- Native sources accounted for nearly all barley used in Irish brewing and about two in every five tonnes of grain used in Irish distilling. An estimated 115,000 tonnes of imported maize were used annually in Irish distilling during 2014-2018.
- Strong export-led growth in beer and whiskey sales has created an increase in the demand for barley from the brewing and distilling industries. This trend will provide valuable opportunities for further expansion of native malting barley production.
- The porridge oats milling industry utilised c.25% of the native supply of oats providing ex-farm output of almost €7m per annum in 2014-2018.
- The retail value (including exports) of Irish oat products was an estimated €40m in 2018.
- Ireland's overall self-sufficiency in compound feed ingredients was less than 40% and this figure has been deteriorating with increasing demand especially from the dairy sector. Specifically, native supplies accounted for c.62% of cereals and c.7% of primary protein sources used by the Irish animal feed industry.
- The value of compound feeds used by Irish agriculture averaged nearly €1.4bn per annum during 2014-2018.
- Straw is an essential output of the Irish tillage sector, with c.1m tonnes baled annually with an estimated ex-farm output value of around €70m. The livestock sectors utilise the majority of Irish straw for bedding and feed, but c.100,000 tonnes annually is required by the mushroom composting industry.
- The areas of oilseed rape and pulses have each been c.10,000 hectares annually, producing an ex-farm output value of c.€24m.
- Potato output averaged nearly 360,000 tonnes per annum with an ex-farm value of c.€83m. The sector has remained heavily focussed on the ware market (88%). Lack of processing capacity and variety specialisation (Rooster) has restricted the scope for added value and increased reliance on imports of salad potatoes, chipping varieties, and frozen potato products.
- The average area of tillage fodder crops (maize silage, whole crop cereals, and fodder beet) was 27,000 hectares during 2014-2018, with an estimated output value of €72m.
- The share of Irish tillage output that has access to a premium end use (i.e. priced above feed grade) is much lower than in the UK, and this factor disadvantages tillage margins in Ireland.

Inputs and tillage-supported expenditures

- During 2014-2018, Irish tillage farmers spent an estimated €423m per annum on inputs and invested c.€54m per annum in machinery, buildings, and land improvements. Previous research has suggested that most farmers' input expenditures occur within a 35-kilometre radius of their farms, thereby supporting their local economies.
- The input supply sectors comprise numerous, often small businesses, that are geographically dispersed through rural parishes providing essential jobs and incomes in those communities.
- The estimated average net cash flow from tillage production was c.€200m per annum during 2014-2018. Much of this cash flow is used for household expenditures, further supporting incomes, jobs, and social activities in rural towns and villages.

Economic impact

- Overall direct (farm) output from tillage production averaged c.€640m per annum during 2014-2018.
- For each €1 of output produced by tillage farms, due to the multiplier effect, an additional €1.05 of output is generated in the Irish economy. Consequently, the farm-level output from tillage (c.€640m) generated a further €670m per annum of indirect and induced output within the tillage supply chain.
- Overall, the tillage sector is estimated to contribute over €1.3bn per annum to output in the Irish economy. This impact equals almost €4m per 1,000 hectares of crop production.
- The tillage sector supports c.11,000 full-time equivalent (FTE) jobs, equating to 17 jobs per €1m in farm-level tillage output or 32 jobs per 1,000 hectares of tillage.
- Tillage output and employment are most concentrated in the prime cropping areas of the southern and eastern counties. Tillage production accounts for 28%, and 26% of the Gross Valued Added from agriculture in the 'Dublin & Mid-East' and 'South-East' regions, respectively.
- The five counties estimated to have the highest tillage output are Cork, Wexford, Meath, Kildare, and Louth. In each of these counties, tillage contributes between €100m and €180m to economic output per annum.
- For counties, Tipperary, Carlow, Kilkenny Dublin, and Laois, the contribution of tillage to economic output, is between €60 and €90m per annum, while the economic impact of tillage in counties Wicklow, Waterford, Offaly, and Donegal is each around €40m per annum.

Tillage and the environment

- The carbon footprint of tillage, calculated using IPCC methodology, is c.1.2 tonnes of CO₂ equivalent per hectare. This footprint is only 14% of the estimated carbon emissions per hectare for an 'average' dairy system, and about 30% of the emissions per hectare for a 'typical' beef enterprise.
- Based on the calculated carbon footprints, every 100 hectares of land switched from tillage into an 'average' dairy system increases greenhouse gas emissions by c.740 tonnes of CO₂e.
- Based on system averages of Family Farm Income (FFI) per hectare for 2014-2018, carbon emissions of the tillage system were only 2.4 tonnes per €1,000 of FFI compared to 7.5 tonnes per €1,000 of FFI for the 'average' dairy system.

- Tillage land is essential for biodiversity, especially farmland birds. UK research has shown that loss of arable cultivation, especially in pastoral landscapes, can negatively impact populations of threatened farmland bird species.
- The contribution of the tillage sector to the provision of ecosystem services is being further enhanced through a range of current management practices, including maintenance of field and riparian margins, min-till cultivations, cover cropping, crop diversity, integrated pest management, and nutrient planning.
- The current and potential contribution of the tillage sector, environmentally and economically, should be more explicitly recognised in a balanced agri-food strategy for Ireland.

1. Introduction

The Irish tillage sector is compact, comprising approximately 10,000 holdings or almost 8% of farms nationally. About half of these holdings are classified as specialist tillage units, and the balance are mixed farms that grow tillage crops, often on a small scale, as a complementary activity to livestock enterprises. The total area of the principal tillage crops (cereals, oilseeds, pulses, potatoes, fodder beet, arable silages) is c.340,000 hectares or 7.6% of national Utilised Agricultural Area. Cereals comprise the largest component of the tillage sector, with approximately 280,000 hectares and an annual output of around 2.3 million tonnes.

Irish tillage farmers are commercially focussed, and, among the main farm systems, their income performance is second only to dairying. The sector sustains high output performance with average cereal yields that are among the highest in the world. The average area of specialist tillage farms is c.60 hectares, almost double the average for all farms in Ireland. However, the Irish tillage sector is at a critical juncture. While tillage operates on the most productive and versatile agricultural lands in the country, this also means the sector faces high opportunity costs from competing land uses such as dairying.

Nationally, the area under cultivation has been declining alongside a more rapid fall in the number of grower units. Tillage area has declined by 15% over the last decade and by over 40% since the early 1980s. Since the early 1990s, the number of growers has declined by almost 60%, with much of the reduction due to cessation of tillage on previously mixed-enterprise farms. Consequently, the sector has been losing critical mass, and in percentage terms, the retreat has been most severe in areas outside the traditional tillage heartlands of the east and south-east counties.

Loss of critical mass in affected areas means that essential tillage support services (e.g. tillage contracting, agronomy, storage, etc.) become less economic to sustain perpetuating further decline. Even in traditionally strong tillage areas of the south and south-east, substantial reductions in cultivated area have occurred with cropland shifting into milk production. Conacre rents for cropable land have risen sharply due to competition from the dairy sector, curtailing profitable business expansion in tillage production.

The tillage sector also faces challenges in the policy and regulatory arena. Tillage farmers have incurred proportionately higher reductions in Basic Payment Scheme (BPS) through the convergence process which commenced in 2015. Moreover, the extreme precautionary principle applied in EU decision-making for approvals of crop protection products and other technologies may be stifling innovation and productivity growth in the sector. Meanwhile, Irish and EU tillage farmers must compete in marketplaces with global products that are often produced in countries with less onerous regulatory regimes. Consequently, there are valid concerns about the levelness of the competitive playing field.

Notwithstanding these challenges, there are significant market opportunities for Irish tillage. Ireland has an increasing deficit in cereals and protein crops, particularly due to rising feed demand from expansion of the dairy sector. Accordingly, net imports of cereals and proteins have risen sharply, with

imports of the main concentrate feed ingredients reaching €1.2bn in 2018. Moreover, Ireland imports almost all its flour and more than 100,000 tonnes of maize annually for distilling. Meanwhile, net imports of potatoes and potato products have also been increasing. These trends mean that there are opportunities for Irish tillage to address market gaps that are currently being met by imports. There are excellent examples where these market opportunities are being captured through entrepreneurial approaches within the industry.

The sector's net trade position means that it may be less exposed to adverse impacts from Brexit than other sectors of Irish agriculture. Analysis by Teagasc suggests that net margins of Irish tillage crops may increase under scenarios where Brexit creates increased trade barriers for UK exports to the Irish market¹. However, down-stream processing constraints, investment needs, and minimum efficient scales remain challenges to profitably addressing market gaps that are subject to formidable international competition.

1.1 Study objectives

Against this background, the current report was commissioned by Tillage Industry Ireland to:

- Establish longitudinal developments with the tillage sector in terms of farm structure and performance.
- Quantify the evolution of native crop production and trade balances.
- Evaluate the tillage supply chain both downstream and upstream of the primary sector.
- Assess the direct and indirect economic impacts of the tillage sector on output and employment in the economy.
- Highlight the potential role of the tillage sector in addressing environmental challenges such as mitigating carbon emissions and biodiversity loss.

It is anticipated that the outputs of this research will provide an evidence base to support the formulation of strategies to enhance the economic contribution of the Irish tillage to the agri-food sector and wider economy.

1.2 Scope of the report

The tillage industry supply chain comprises the primary farm sector that cultivates crops, the upstream input-supply sectors, and the downstream sectors that process crops for use in other industries such as livestock production, food and drink manufacturing.

The upstream impacts of tillage can be measured in terms of the supply of goods and services to tillage farmers. However, disaggregating downstream impacts are more challenging due to the complexities of sophisticated supply chains that involve multiple products and multiple intermediate inputs with varying degrees of imported content. Cereals, for example, are used in a range of downstream industries including, brewing and distilling, flour milling, food processing, and animal feed

¹ Thorne, F., Donnellan, T., and Hanrahan, K. (2019).

manufacturing. Native grains are supplemented to varying degrees in product manufacturing by imported alternatives. Downstream processes rely on multiple intermediate inputs, and the end products often represent major ‘transformations’ of the tillage raw material.

Additionally, the scope of analysis is constrained by data availability and the commercially sensitive nature of the information required. Moreover, the extent of the value-chain boundaries, and shares of final economic value attributable to different sub-processes/inputs are often ill-defined. For example, the tillage sector provides feed grains as an intermediate input to the livestock sectors, thereby contributing indirectly to outputs generated in those sectors (e.g. a burger sold in a fast-food restaurant produced by cattle fed with barley).

For pragmatic reasons, the boundary of the downstream supply chain is defined in this study to encompass the first stage processes involving acquisition of ‘raw’ crop outputs. Assessment of value generated through secondary processes (e.g. flour used in baked goods) was outside the scope of the project.

The crops included in the study comprise the main outputs of the tillage sector, namely:

- Cereals (wheat, barley, oats, other cereals)
- Oilseed rape
- Pulses (peas and beans)
- Potatoes
- Arable fodder crops (whole crop cereals, maize silage, fodder beet)

Horticulture, biomass crops, and forage crops (e.g. stubble turnips, forage rape, kale) have not been included in the current analysis.

1.3 Data sources and use of multi-year averaging

Key information used in this report was obtained from several sources:

- Central Statistics Office (CSO)
 - Data on crop areas, yields, and tonnages harvested for the main crops.
 - Data on farm structure (numbers of holdings) from the Agricultural Census and Farm Structure Survey.
 - Supply, Use and Input-Output Tables – sectoral output multipliers.
 - Census of Industrial Production – employment data.
 - Annual Services Enquiry – employment data.
- Department of Agriculture, Food and the Marine
 - Crop area statistics from Basic Payment Scheme administrative data (provided via CSO)
 - Livestock feed-use statistics
 - Organic crop production statistics
 - Annual Review and Outlook (years 2014 – 2019) – Cereals and Cereal Preparations
- Eurostat Comext
 - Data on trade flows – imports, exports by volume, and value.
- Market research data and reports
 - Euromonitor, Mintel

- AHDB
- Teagasc National Farm Survey (NFS)
 - Family Farm Income
 - Labour input
 - Input expenditures
- Teagasc Crop Costs and Returns
 - Crop enterprise budgets – verification of crop output and input data.
- Miller, A.C., Matthews, A., Donnellan, T., and O’Donoghue, C. (2011).
 - Agriculture-Food SAM (AgriFood SAM) for Ireland – output multipliers.
- Environmental Protection Agency
 - Ireland’s National Inventory Report, 2019.

Furthermore, selected information was obtained from individual industry contacts, mainly to cross-check figures and to establish crop usage estimates.

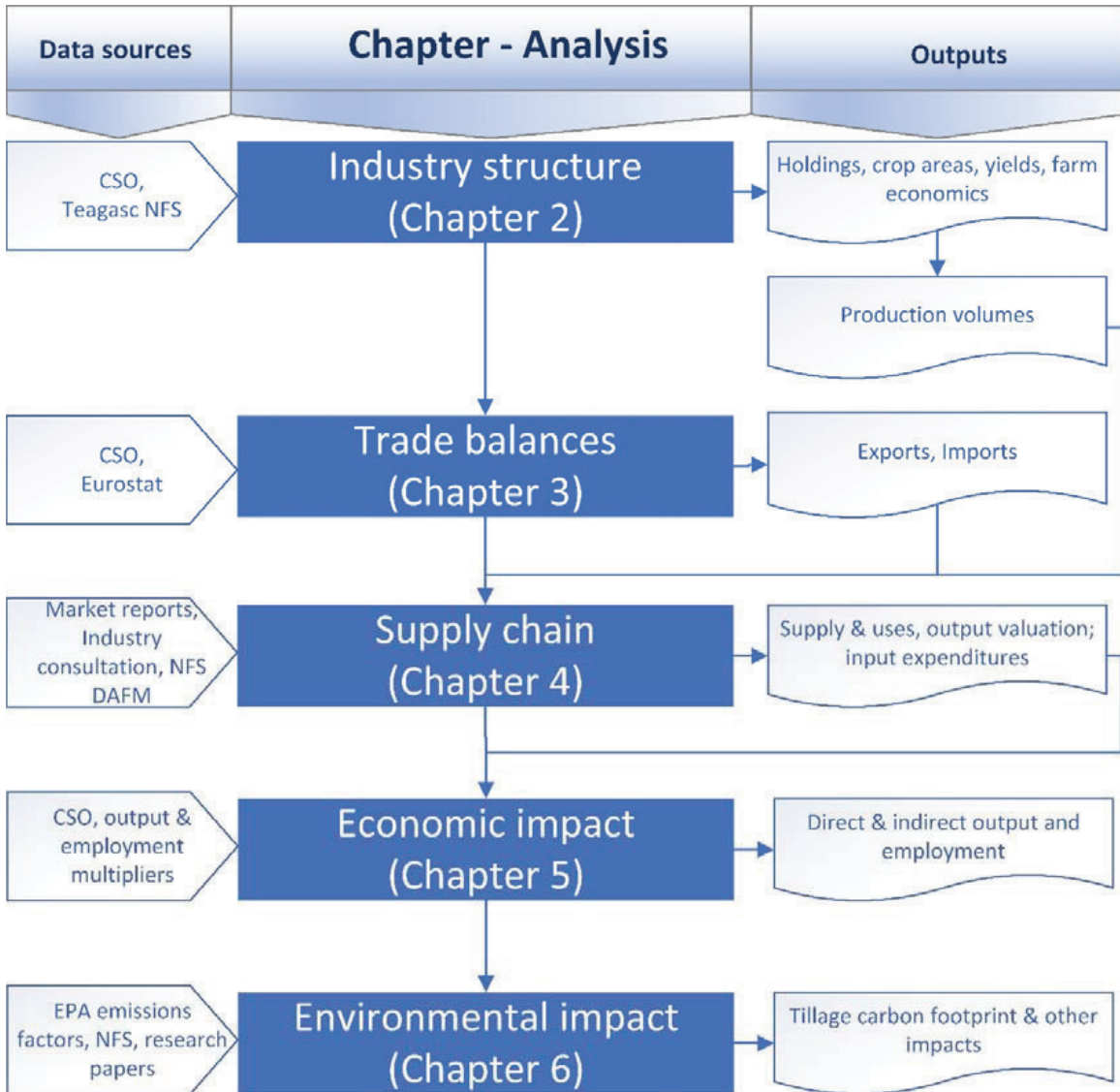
The economic impact analysis uses ‘normalised’ variables by obtaining their five-year averages for the period 2014-2018. This approach allows inferences to be drawn from representative figures for a medium-term horizon, mitigating anomalies that might occur from reporting possibly uncharacteristic figures for a single year. Of course, this concern is especially relevant in an analysis of the tillage sector because of year-to-year variability associated with weather dependence.

1.4 Report structure

Figure 1.1 provides a flow chart of the analytical process used in the report, including the main data sources and outputs of each section and the linkages between the components of the study.

The report is organised as follows: Chapter 2 outlines the longitudinal trends in tillage holdings, cultivated areas, production volumes, and farm financial performance. Chapter 3 assesses the developments in Ireland’s trade balances for the main tillage crops. Chapter 4 quantifies the principal volume and value flows in the tillage supply chain. Chapter 5 draws together information from the preceding chapters to derive overall estimates of the economic impact of the tillage sector on output and employment. Finally, chapter 6 considers some of the wider environmental implications that support the role of the tillage sector in a balanced land use strategy.

Figure 1.1 Structure of the analysis



2. Structure of the Tillage Sector

This chapter provides a descriptive analysis of the structure and performance of the Irish tillage sector. It begins by exploring the number and characteristics of the farm holdings that grow tillage crops. Next, longitudinal changes in tillage areas both nationally and regionally are evaluated, and the national cropping mix is described. This leads to the quantification of trends in the overall volume of native production for cereals, potatoes, pulses, and oilseeds. Finally, the chapter concludes with an analysis of the economics of tillage at the farm-level, including profitability comparisons with other farming systems.

2.1 Holdings

There are approximately 10,000 farm holdings in Ireland that grow tillage crops, and these comprise 7.5% of farms nationally (see Table 2.1). Almost half of these business units are classified as ‘specialist tillage,’ defined as generating more than two-thirds of their farm revenue from crop production. Additionally, some 5,000 ‘non-specialist’ holdings grow tillage crops as a complementary or subsidiary activity alongside livestock enterprises. Within these ‘non-specialist’ holdings, the level of tillage activity varies considerably. For about 60% of ‘non-specialist’ holdings, tillage may be classified as a ‘minor’ activity, comprising less than one-third of farm output, and in many cases, extending to only to a few acres of barley or whole-crop for on-farm use. The other 40% of ‘non-specialist’ holdings are ‘mixed’ enterprise farms where tillage accounts for between one-third and two-thirds of farm output.

Table 2.1 Number of farms with tillage crops

	2005	2016	% Change 2005 - 2016
Specialist Tillage ¹	4,800	4,700	-2%
Mixed Crops and Livestock ²	3,500	2,100	-40%
Tillage as Minor Enterprise ³	4,900	2,900	-41%
Total Farms with Tillage	13,200	9,700	-27%
All Holdings	132,700	129,300	-3%
<i>% of Farms with Tillage</i>	<i>9.9%</i>	<i>7.5%</i>	

Notes:

¹ Field crops >2/3 of Standard Output (SO); ² Field Crops >1/3 and Livestock >1/3 of SO; ³ Tillage > 0 but <1/3 of SO

Source: CSO Farm Structure Survey, except (³), which is own estimate extrapolated from CSO Agricultural Census and crop area data.

Between 2005 and 2016, the number of holdings with tillage crops declined by almost 30% (Table 2.1). Most of the reduction occurred among ‘non-specialist’ growers, with similar rates of decline (c.40%) among the ‘mixed’ and ‘minor’ categories. In contrast, the population of specialist tillage farms remained more stable, experiencing a 2% decline between 2005 and 2016. These trends suggest a

clear exodus from mixed cropping and livestock systems. This pattern is not unique to Ireland, and according to Ryschawy et al. (2013) has been a consistent trend across Europe.

2.2 Farm and farm household characteristics

Table 2.2 summarises key socio-economic indicators for tillage farms relative to the farm population as a whole. The average land area of tillage farms is c.59 hectares, approaching double the average for all farm types. However, specialist tillage farmers are more reliant on rented land, which comprises, on average, almost 30% of their farmed acreage. Moreover, 20% of specialist tillage farmers rent more than half of their farmed area.

Table 2.2 Socio-economics of tillage farms versus national average for all farms

	Farm Type		
	Specialist Tillage	Mixed crops and livestock	All Types
Area farmed (ha)	58.6	58.7	32.4
Share of holdings > 100 ha	14.9%	14.3%	3.6%
Rented land as % of farmed area	29.4%	19.6%	18.6%
Proportion of farm area rented in			
Nil	55.3%	57.1%	65.8%
> 0% - 25%	17.0%	19.0%	10.3%
> 25% - 50%	8.5%	9.5%	9.5%
> 50% - 75%	6.4%	9.5%	8.4%
> 75%	12.8%	4.8%	6.1%
Age of holder			
< 35	8.5%	4.8%	5.4%
35 - 44	19.1%	19.0%	15.6%
45 - 54	21.3%	23.8%	23.7%
55 - 64	23.4%	23.8%	25.3%
>= 65	27.7%	28.6%	30.0%
Annual work units per farm ¹			
0 -< 0.25	10.6%	4.8%	7.5%
0.25 -< 0.50	12.8%	4.8%	14.2%
0.50 -< 0.75	25.5%	9.5%	20.3%
0.75 -< 1.00	17.0%	19.0%	21.1%
>= 1.00	31.9%	57.1%	36.8%
Share of family labour in workforce (%)	84.0%	93.0%	94.0%
Significance of farm work (Holder):			
Sole Occupation	51.1%	66.7%	52.8%
Major Occupation	21.3%	19.0%	23.7%
Subsidiary Occupation	27.7%	14.3%	23.5%

¹ One annual work unit = 1,800 hours or more of labour input per person per annum

Source: CSO Farm Structure Survey, 2016.

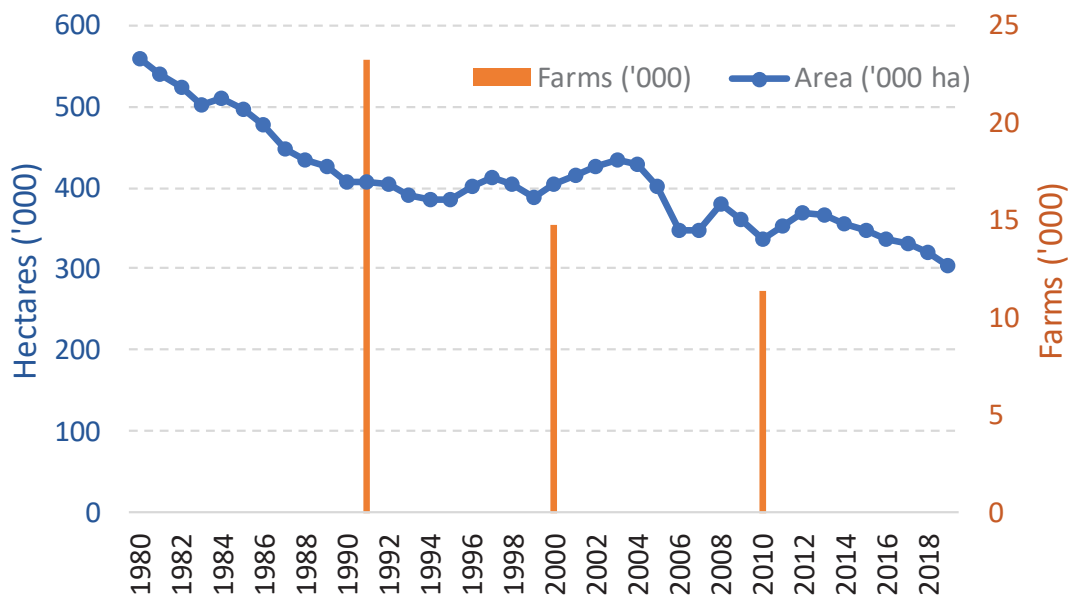
The age profile of tillage farmers comprise a slightly younger demographic compared to the average for the overall farmer population. The average number of labour units employed per farm in tillage are similar to the average for all farm types, but there is a higher proportion of hired (relative to family

labour) on tillage farms. According to the CSO Farm Structure Survey, the levels of off-farm employment among specialist tillage farmers are broadly similar to the average for the overall population of farmers. Over 72% of specialist tillage farmers and 86% of mixed crops and livestock farmers identified farming as their sole or major occupation. According to the National Farm Survey, one-third of farm operators of ‘Mainly Tillage’ farms had off-farm employment in 2018.

2.3 Tillage crop areas

The trend in the area of tillage crops cultivated nationally over the period 1980-2018 is presented in Figure 2.1. The chart also shows the number of farms with tillage obtained from the agricultural censuses conducted in 1991, 2000 and 2010. The area of tillage declined sharply in the 1980s before stabilising in the 1990s followed by a further period of decline since the mid-2000s. Between 1980 and 2018, the area of tillage crops nationally declined by over 230,000 hectares (42%), dropping from 9.8% to 7.1% of overall utilised agricultural area.

Figure 2.1 Total area of tillage and number of farms with tillage crops



Source: CSO.

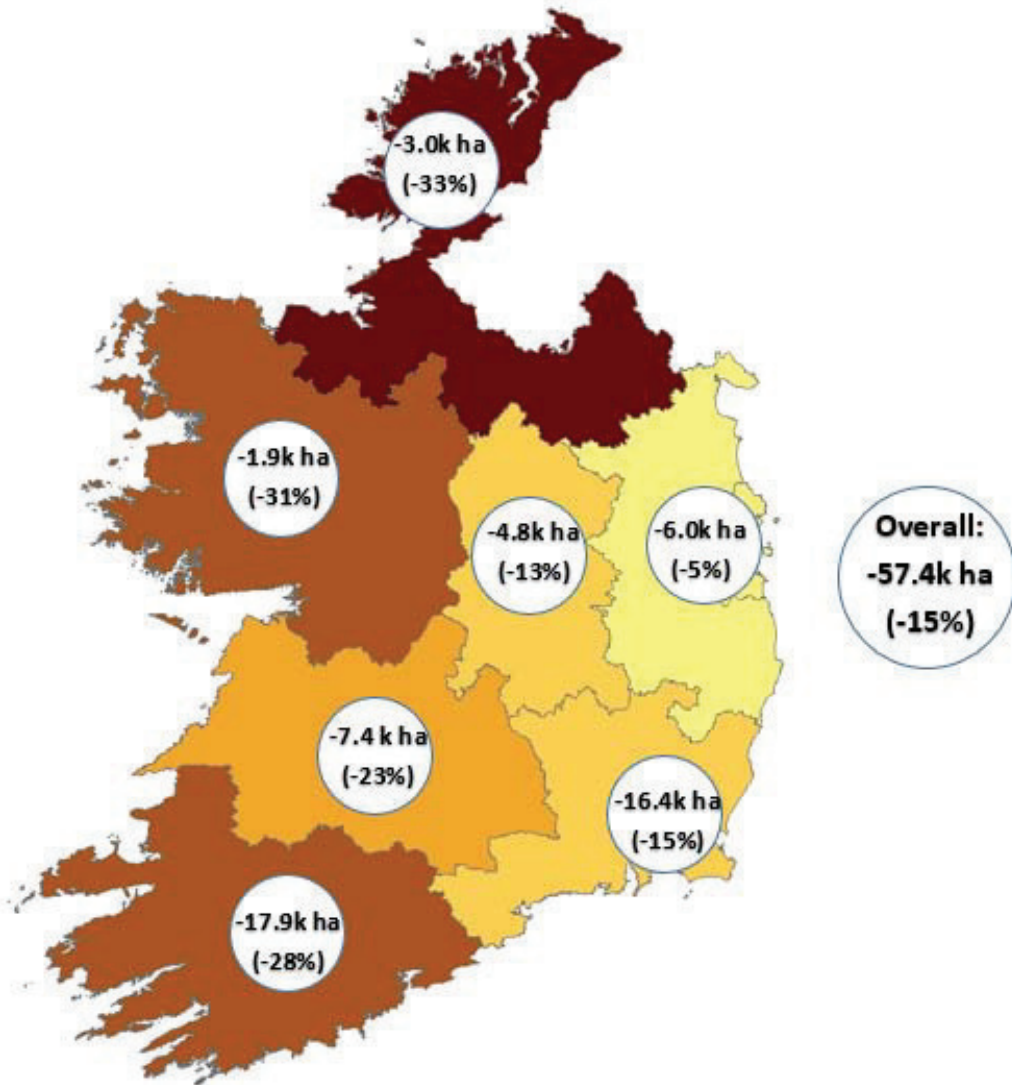
Note: Tillage defined as described in Chapter 1: cereals, oilseed rape, pulses, potatoes, maize, beet and arable silage². There is a ‘structural break’ in 2005 due to closure of sugar processing. Prior to this event c.32,000 hectares of sugar beet were grown annually.

² Chart excludes horticulture, fruit, forage crops (i.e. forage rape, kale, stubble turnips) and ‘other crops’ (incl. willow, miscanthus, wild-bird cover (Glas scheme option), fallow) which in total comprised 35,700 hectares in 2018. Within this total, wild bird cover accounted for almost 14,000 ha, biomass crops c.1,000 ha and horticulture and fruit crops were c.5,000 ha.

Data on the number of farms growing tillage crops is less detailed but suggests a more marked reduction of over 50% in the number of growing units between 1991 and 2010 compared to a 10.5% reduction in the area of tillage crops over the same period.

Figure 2.2 shows the regional variation in the percentage change in tillage area between 2008 and 2018. Nationally, tillage area fell by 57,000 hectares (15%) over the 10 years, with reductions evident in all NUTS3 regions.

Figure 2.2 Change in tillage area by region between 2008 and 2018



Source: own map derived from CSO data

In percentage terms, the Border and West regions experienced the most pronounced reductions in tillage, but in the context of an already small tillage acreage. In these regions, cropping is usually a non-specialist activity that is maintained alongside livestock enterprises. As noted in the previous

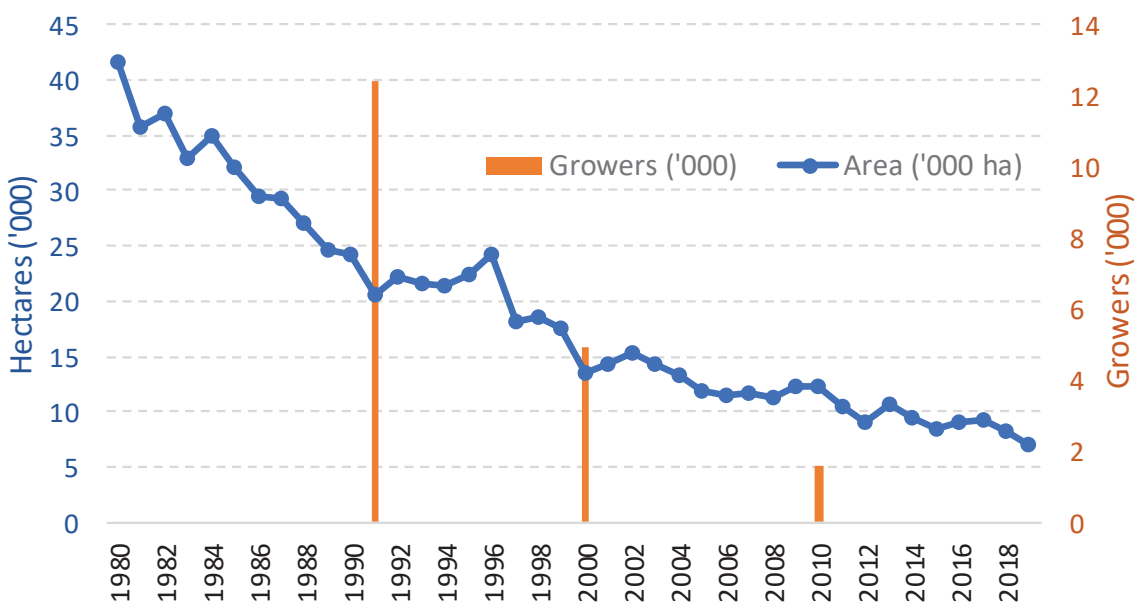
section, the attrition rate in non-specialist tillage has been particularly high, and this is reflected in the observed reductions in crop acreages outside the dominant tillage areas of the eastern counties.

Nonetheless, in absolute terms, the largest reductions have been in traditional ‘specialist’ tillage heartlands of the South-East and South-West, which together accounted for 60% of the national reduction in tillage acreage. These areas have experienced strong dairy expansion since the abolition of milk quotas, and it can be inferred that the decrease in crop production here reflects a shift in land-use from tillage to dairy.

Tillage production has remained more stable in the Mid-East region (Louth, Meath, Dublin, Kildare, Wicklow), which experienced a more modest reduction of 5% between 2008 and 2018. In 2018, the Mid-East and South-East regions accounted for 35% and 29% of the national tillage acreage, respectively.

The level of structural change in the potato sector has been especially dramatic (see Figure 2.3), evidenced by a decline of almost 90% in the number of growers between 1991 and 2010. The area of potatoes halved during the 1980s to around 20,000 hectares in the early 1990s. Over the last two decades, the area of potatoes declined by a further two-thirds reaching 7,100 hectares in 2018.

Figure 2.3 Total area of potatoes and number of farms growing potatoes



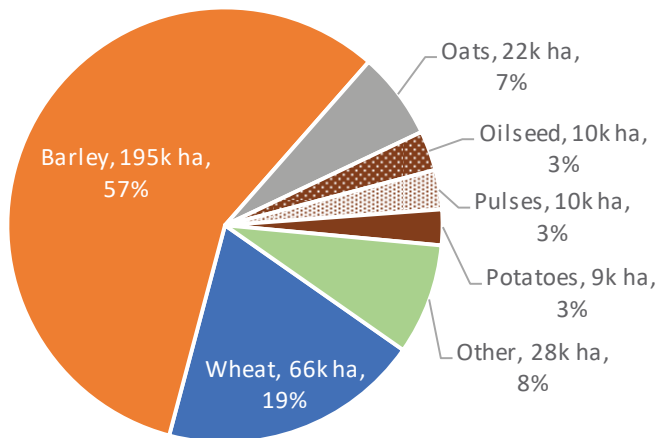
Source: CSO

Additional information on crop areas broken down by region is provided in Appendix 1.

2.4 National cropping mix

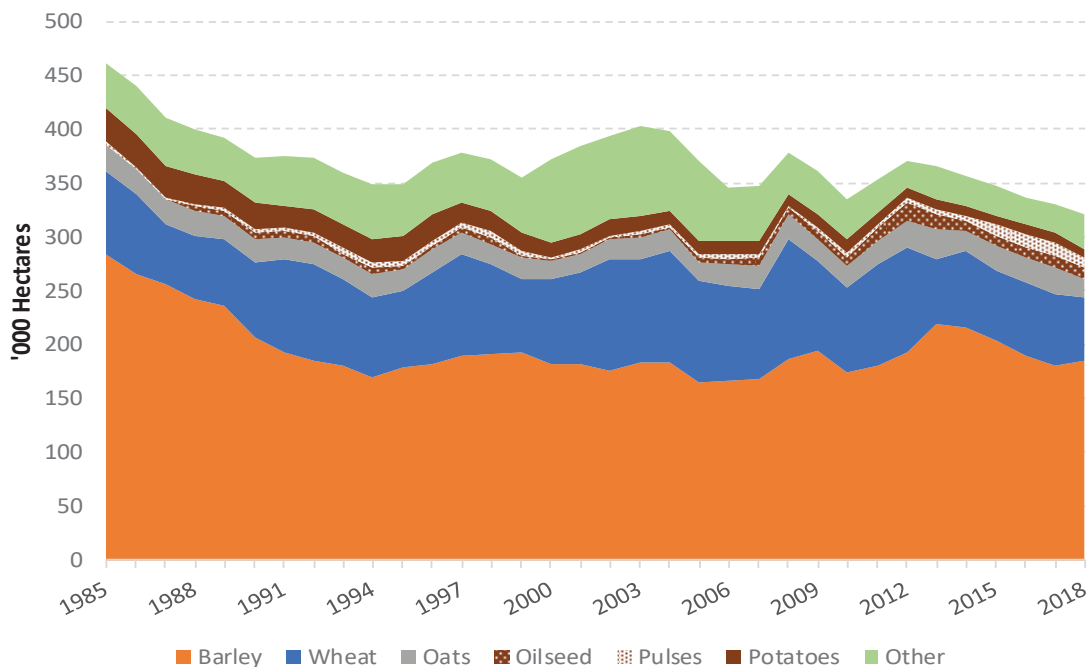
Figure 2.4 shows the composition of the domestic crop mix by average areas cultivated over the five years 2014-2018, while Figure 2.5 shows the longitudinal trend in the crop mix.

Figure 2.4 National tillage crop mix (2014-2018 Average)



Source: CSO Crop Production Statistics

Figure 2.5 Trend in tillage crops areas, 1985-2018



Source: CSO Crop production statistics.

Note: 'Other' comprises maize, arable silage, fodder beet and minor cereals (triticale & rye).

Chart does not include sugar beet of which c.32,000 hectares was also grown annually until closure of the sugar processing industry in 2005.

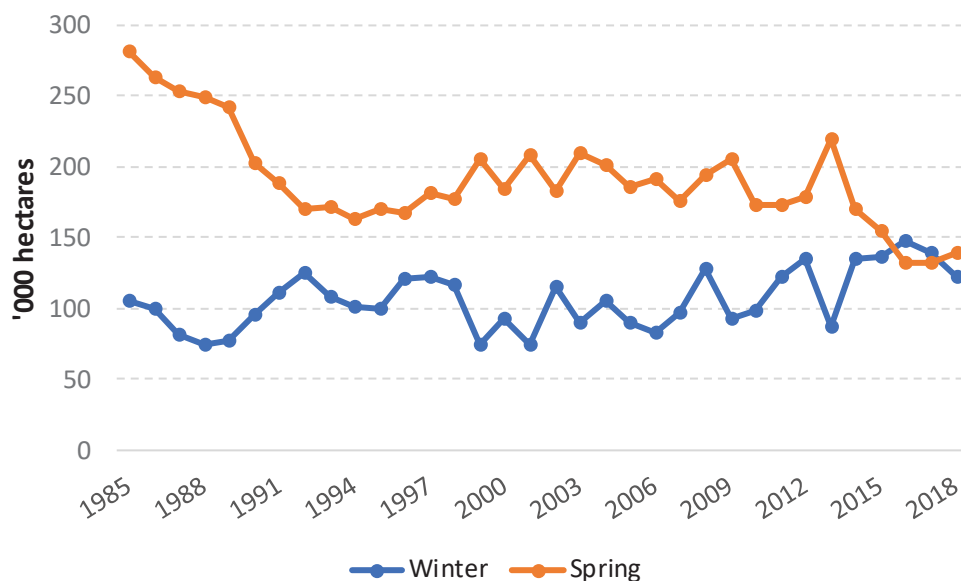
During 2014-2018, barley accounted for 57% of the tillage area, followed by wheat (19%) and oats (7%). The main break crops of oilseeds, pulses, and potatoes each comprised c.3% of tillage area, while fodder crops (maize, arable silage, and beet) accounted for c.8% of tillage area.

Changes in the national crop mix between 1985 and 2018 are highlighted in Figure 2.5. The relative shares of barley, wheat, and oats have remained broadly consistent over this period. The areas of oilseed and pulses have increased while the share of potatoes declined. There has also been a notable reduction in the area of tillage fodder crops in the last decade.

Further information on crop mix by region is provided in Appendix 1.

Figure 2.6 compares the trends in the areas of spring-sown versus winter-sown cereal crops over the period 1985 to 2018. The area of spring cereals declined sharply in the 1980s stabilised over the 1990s and early 2000s, dipping again in the mid-2010s. In contrast, the area of winter cereals has remained more stable over the period. The shift favouring winter wheat and winter barley reflects their superior gross margin performance, particularly compared to spring barley, and NFS figures suggest that this gross margin advantage has increased in the last decade or so³. Accordingly, the traditional dominance of spring cereals in the national crop mix has diminished, and the areas of winter and spring cereals have equalized.

Figure 2.6 Trend in areas of spring-sown and winter-sown cereals

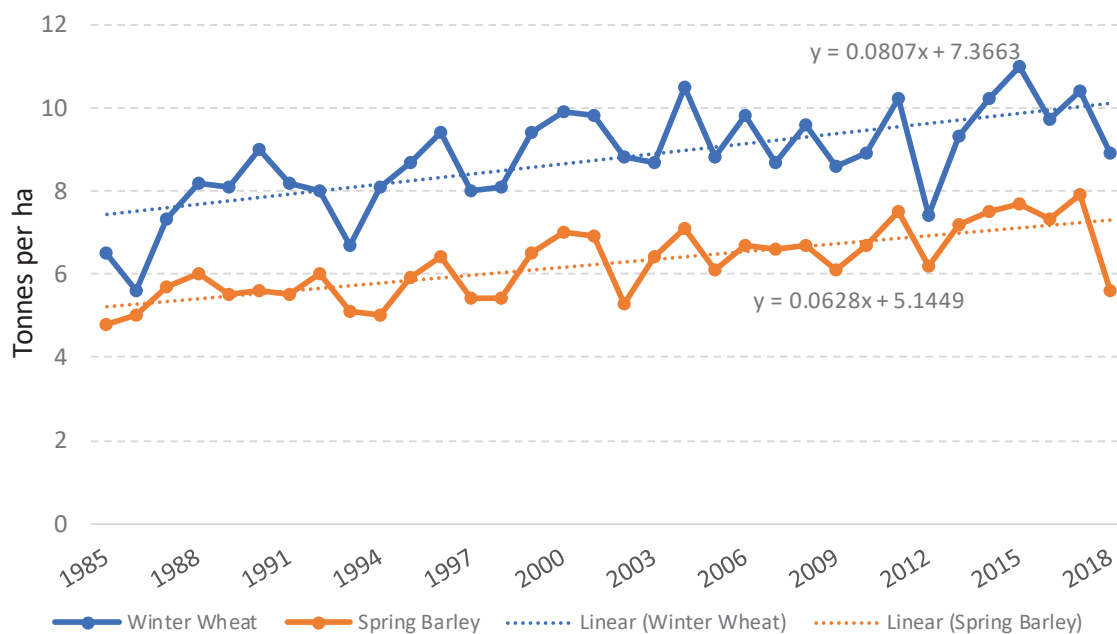


Source: CSO: Crop production statistics. Cereals: wheat, barley and oats.

³ Teagasc Tillage Crop Stakeholder Consultative Group (2012) and Teagasc (2019)

The trend in national average yields for winter wheat and spring barley are shown in Figure 2.7. The data highlight the large year-to-year yield fluctuations associated with variability in weather conditions. However, within this variation, the fitted trend lines show that the industry has consistently improved average yields. Over the period 1985 to 2018, linear growth in average yield for winter wheat and spring barley was 81 kg/ha/year and 63 kg/ha/year, respectively. However, the rate of yield improvement has plateaued over the last decade or so. Taking the period 2000-2018, yield improvement for winter wheat averaged only 20 kg/ha/year while the average improvement in spring barley yields was 40 kg/ha/year.

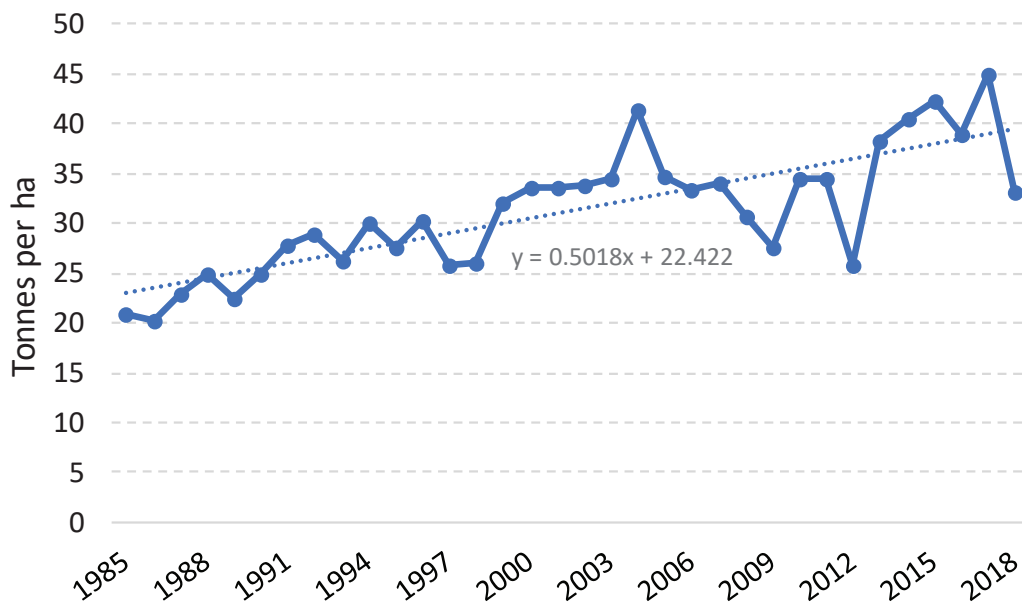
Figure 2.7 Average yields for winter wheat and spring barley, 1985-2018



Source: CSO crop production statistics (annual yield survey conducted jointly by CSO and Teagasc)

The trend in average annual yield for potatoes is shown in Figure 2.8. Over the period 1985-2018, average yields almost doubled, reflecting a linear rate of improvement of about 0.5 tonnes per annum. During the last decade or so, there has been a notable increase in year-to-year variability in the average yield while, similar to cereals, there is evidence of a plateauing in the rate of yield improvement.

Figure 2.8 Average potato yields, 1985-2018



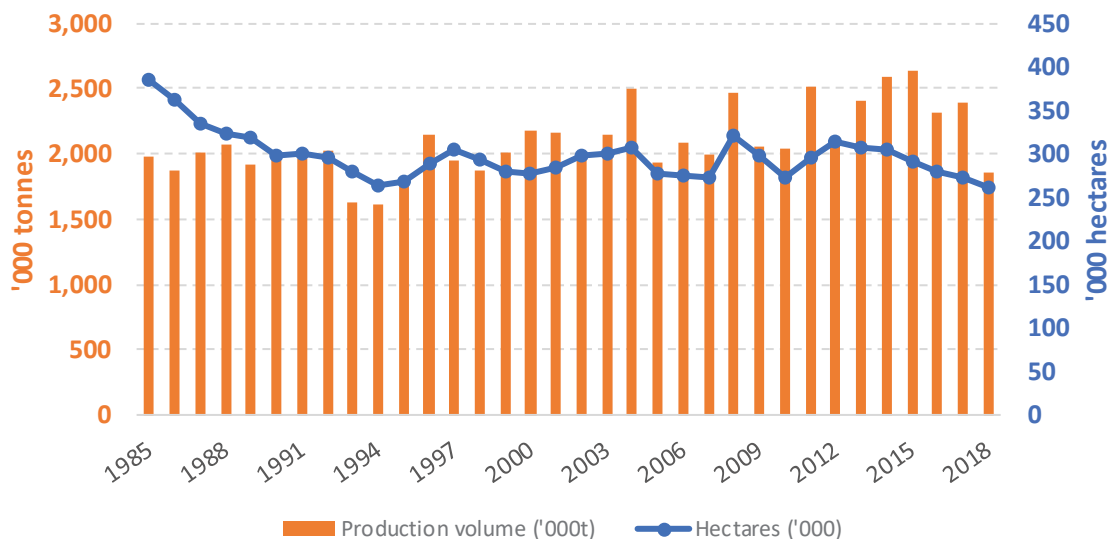
Source: CSO crop production statistics (annual yield survey conducted jointly by CSO and Teagasc)

2.5 Volumes of native crop production

This section presents the longer-term trends in the tonnages of domestic production of cereals (Figure 2.9), potatoes (Figure 2.10), oilseed rape (Figure 2.11) and pulses (Figure 2.12).

In the case of cereals, while the area has declined by c.100,000 hectares since the mid-1980s, the total volume of production has been maintained in most years above 2m tonnes. As noted in the previous section, cereal output per hectare has increased through yield improvements and the increasing proportion of higher-output winter-sown crops. This productivity growth has offset the output effects of reductions in cereal acreages.

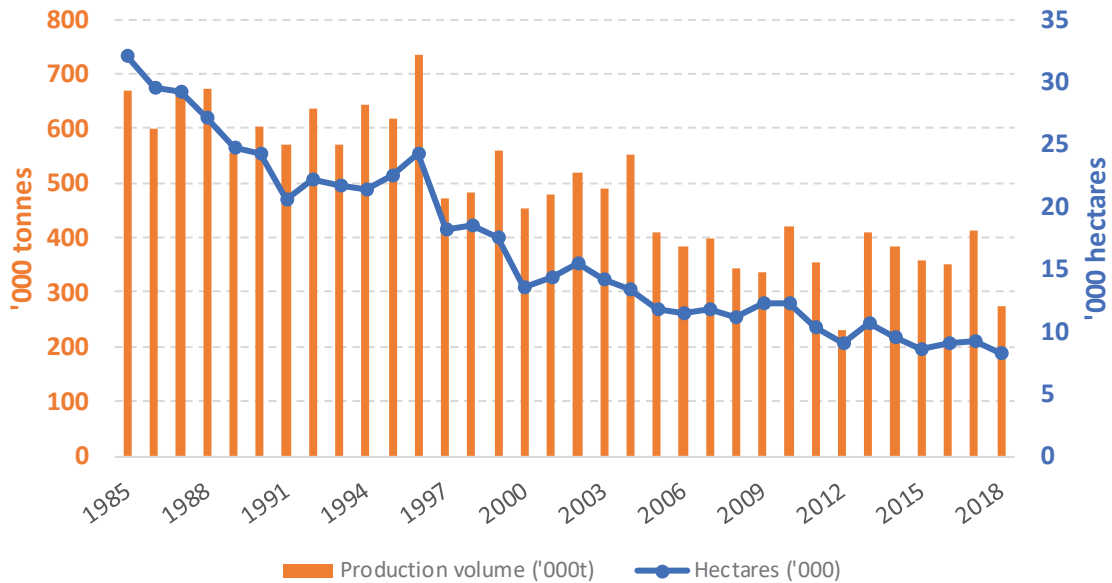
Figure 2.9 Trend in total domestic production and area of cereals



Source: CSO: Crop production statistics. Cereals: wheat, barley and oats.

The situation in potatoes has seen production decline by (c.46%) from c.650m tonnes per annum in the mid-1980s to around 350m tonnes in recent years (Figure 2.10). Over the same period the area of potatoes declined by c.70% and the smaller reduction in output reflects the considerable productivity improvements that have been delivered in the sector, characterised by an almost doubling of yields since the mid-1980s. Consequently, the structural changes within the potato sector and have been immense. The industry in the 1980s was fragmented with many small scale producers characterised by low levels of mechanisation. Concentration in the retail sector has intensified competitive pressures that have driven greater specialisation, and a focus on the necessary scale to support the large capital investments in modern potato production. Meanwhile, changes in consumer preferences have resulted in lower consumption of potatoes in favour of other sources of carbohydrates in daily diets.

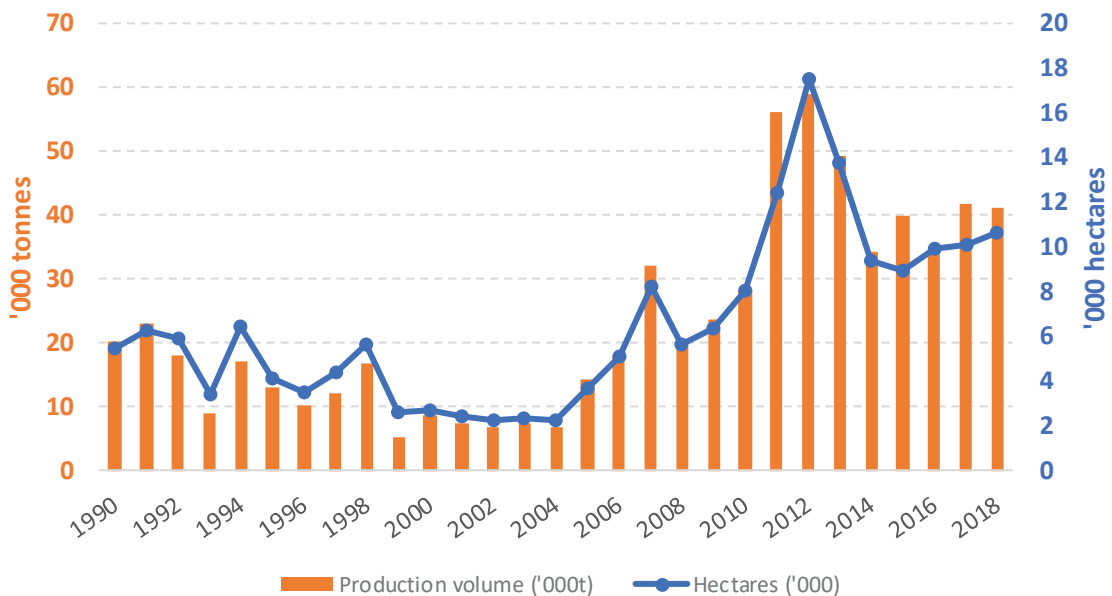
Figure 2.10 Trend in total domestic production and area of potatoes



Source: CSO: Crop production statistics

Oilseed rape production increased in the mid-2000s, becoming the primary break crop after the closure of the sugar beet industry. Acreage and production peaked at almost 18,000 hectares and nearly 60,000 tonnes in 2012 before falling back to c.10,000 hectares and c.40,000 tonnes in more recent years (Figure 2.11).

Figure 2.11 Trend in total production and area of oilseed rape

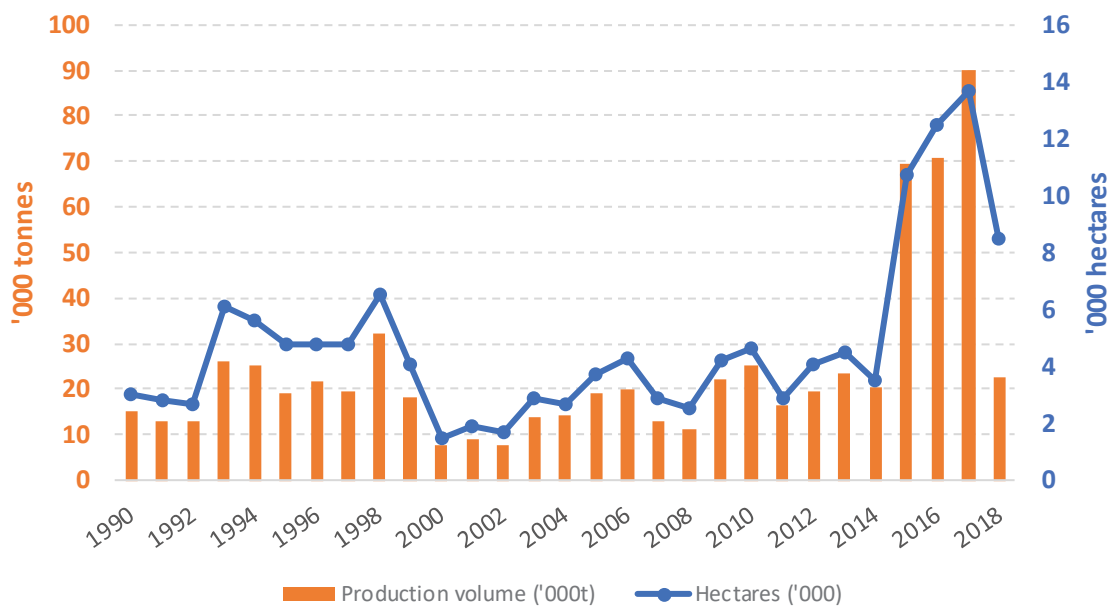


Source: CSO: Crop production statistics

The production situation for pulses has varied considerably (Figure 2.12). During the 1990s and early 2000s, the combined area of peas and beans fluctuated between 2,000 and 6,000 hectares, with output ranging from 10,000 to 30,000 tonnes.

A noticeable jump in the area of pulses occurred from 2015 following the introduction of the EU Protein Aid Scheme and Greening requirements under CAP reform.⁴ The Protein Aid Scheme in Ireland has provided a support payment of up to €250 per hectare for nitrogen-fixing protein crops under the CAP’s Voluntary Coupled Support arrangements. Subsequently, the area of pulses tripled to over 13,000 hectares in 2017, with the output of peas and beans reaching 90,000 tonnes. Weather conditions in 2018 saw the production of pulses drop back due to challenging establishment and growing conditions. Average yields of peas and beans in 2018 were less than 50% of their 5-year average due to the drought conditions.

Figure 2.12 Trend in total production and area of pulses



Source: CSO: Crop production statistics

2.6 Farm economics

According to the Teagasc National Farm Survey (NFS), Family Farm Income (FFI) of ‘mainly tillage’ farms averaged €34,400 per annum over the 5 years, 2014-2018 (Table 2.3), compared to an average FFI for all farms of €26,300 over the same period. As has been well documented, dairy farm incomes

⁴ The tillage greening measures included the three-crop rule and Ecological Focus Areas (EFA). Legume crops such as beans are an eligible ‘in-field’ option that contributes to the required 5% of tillage area under EFA. Since 2017 the EU Commission has applied a ban on use of Plant Protection Products on EFAs, forcing many tillage farmers to reevaluate how best to meet their EFA requirement.

continue to outpace those of other enterprises. Still, tillage has consistently remained the second most profitable farming system within the NFS classification (Table 2.3).

During 2014-2018, direct payments, on average, accounted for 22% of gross output of ‘mainly tillage’ farms compared to 10% of gross output for dairy farms and over one-third of gross output of cattle and sheep systems. Only the Dairy and Tillage systems returned a positive market income, on average, when direct payments were not included. The average Basic Payment Scheme (BPS) entitlement values per hectare are higher for tillage farms than other systems reflecting the previous structure of tillage area payments that applied during the historical reference period (2000-2002)⁵. Consequently, the ongoing convergence in BPS payment rates under CAP reform has, on average, resulted in tillage farmers experiencing larger BPS income reductions than other systems.

Given the differences in average farm size and labour input between systems, it is useful to compare performance according to income per labour unit employed. As shown in Table 2.3, the average annual FFI per labour unit for the period 2014-2018 was still highest on dairy farms, but tillage followed more closely due to the lower labour intensity of tillage systems. A longer-term comparison, according to real (inflation-adjusted) FFI per labour unit between 1993 and 2018, is shown in Figure 2.13. The average labour income of tillage farms during the 1990s and early 2000s was at least on par with that of dairy farms. In more recent years, the income differential favouring dairy over other systems has widened. This trend in some measure reflects faster productivity growth on dairy farms through improvements in technical and scale efficiencies unleashed by milk quota abolition.

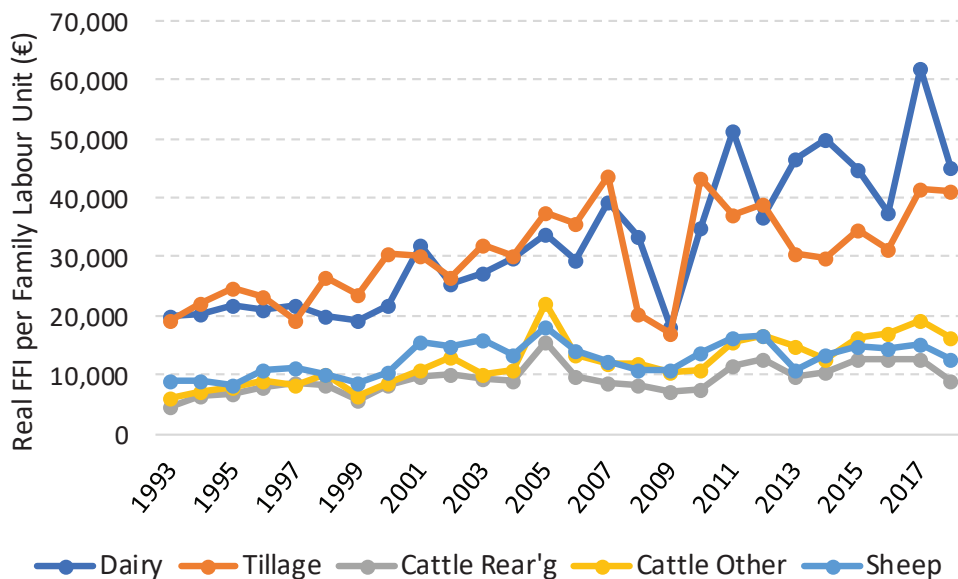
Table 2.3 Output, direct payments, and income by farm type (2014-2018 average)

	TILLAGE	DAIRY	CATTLE REARING	CATTLE OTHER	SHEEP
Gross Output (€/farm)	111,632	192,916	39,428	51,657	49,779
<i>of which:</i> Direct Payments (€)	24,507	20,178	14,060	16,594	18,438
Family Farm Income:					
€ per farm	34,363	65,882	11,277	15,650	15,359
€ per family labour unit	35,280	47,602	11,414	16,134	13,988
€ per hectare	566	1,195	344	434	341
Cash Income (€/farm)	45,550	77,673	15,569	20,724	19,487

Source: Teagasc National Farm Survey (2014-2018)

⁵ According to National Farm Survey average entitlements per hectare in 2014 (before start of convergence), by system were: €236, €267, €309, €351 and €381 for Sheep, Cattle-Rearing, Dairy, Cattle-Other and Tillage, respectively.

Figure 2.13 Trend in real farm income per family labour unit by farm type, 1993-2018

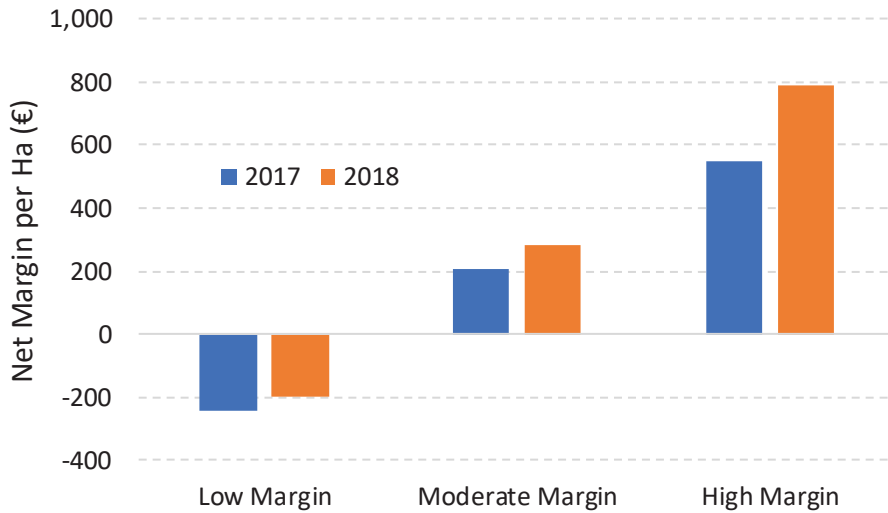


Source: Teagasc National Farm Survey (annual averages by system), deflated by Consumer Price Index (2018 = base)

Clearly, averages mask the range in performance, and as in other farming systems, there is wide variation in financial performance across tillage farms (see Figure 2.14). The management factors and resource constraints that influence such variability are complex. Extension and research services continue to target performance gaps and support overall efficiency improvement through benchmarking, discussion groups, knowledge-transfer events, and one-to-one advice. However, as noted by Irish (2013), the level of uptake by Tillage farmers of financial tools provided by Teagasc (such as eProfit Monitor and Crop Costs) has been relatively low⁶.

⁶ Results from Irish’s survey of Tillage farmers in the South-East in 2013 indicated that only 7% of respondents were using Teagasc eProfit monitor

Figure 2.14 Cereal enterprise net margin on specialist tillage farms



Source: Teagasc (2018, 2019). Low margin, moderate margin and high margin comprise bottom third, middle third and top third of net margin per hectare, respectively.

While there is recognised scope for improvements in financial performance, analysis from the Teagasc National Farm Survey shows that tillage farms compare favourably to other systems in terms of economic viability (see Figure 2.15)⁷. In 2018, 63% of tillage farms were classified as economically viable, with a further 19% deemed economically sustainable due to the presence of off-farm income. Across all farm types represented in the NFS, some 32% of farms were economically viable, and a further 34% were economically sustainable (Dillon et al., 2019). Figure 2.15 clearly highlights the higher viability levels associated with tillage and dairy compared to the drystock systems.

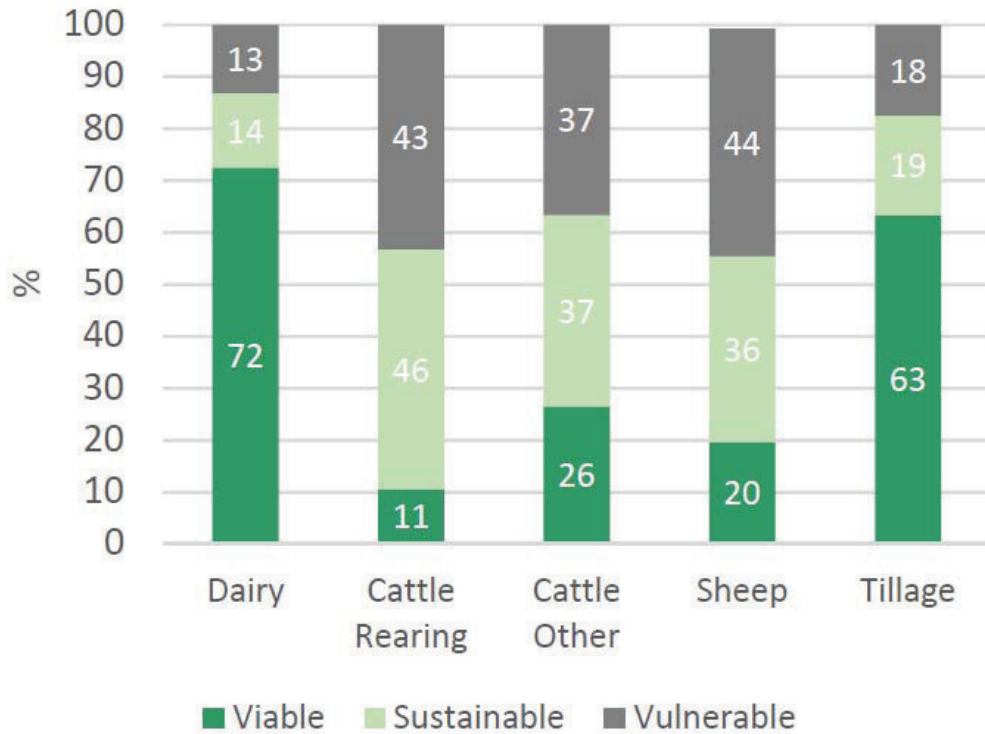
⁷ The National Farm Survey analysis classifies each farm into one of three viability groups as follows:

Viable - A farm is defined as economically viable if the farm income can remunerate family labour at the minimum agricultural wage, and provide a 5% return on the capital invested in nonland assets.

Sustainable - If the farm business is not viable, the household is still considered sustainable if the farmer or spouse has an off-farm income.

Vulnerable - A farm is considered to be economically vulnerable if the farm business is not viable and if neither the farmer nor spouse works off the farm.

Figure 2.15 Viability of farming by system, 2018



Source: Teagasc, National Farm Survey 2018 (Dillon et al., 2019)

Research by Thorne⁸ compared the competitiveness of Irish cereal production with 18 other EU countries using data from the Farm Accountancy Data Network. This analysis showed that Irish cereal production ranking in 8th and 10th positions based on cash costs and economic costs, respectively. However, among the longer-term member states of the EU, Ireland’s competitive position ranked third behind Germany and France based on economic costs of production. Thorne noted that competitive challenges to Irish tillage arise from high opportunity costs of land and labour. This is supported by Eurostat (2018), indicating that arable land purchase prices in Ireland were fifth highest in the EU after the Netherlands, Italy, Luxemburg, and the UK, while average land rents in Ireland were fourth-highest after the Netherlands, Denmark, and Austria.

⁸ Reported by Teagasc Tillage Crop Stakeholder Consultative Group (2012).

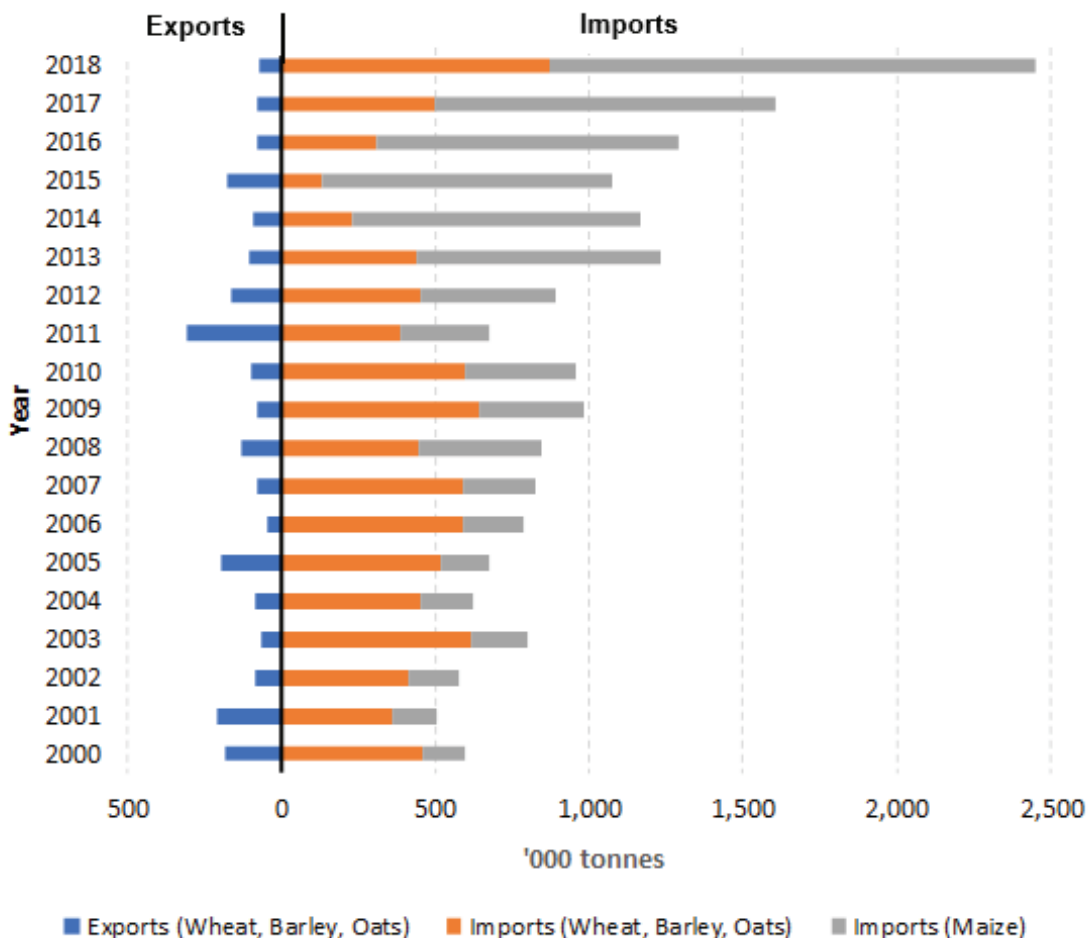
3. Trade

This chapter examines the pattern of Ireland’s external trade flows for cereals, flour, malt, livestock feed ingredients, protein crops, and potatoes. It appraises the longitudinal trends in Ireland’s tillage trade balances, focusing on net imports. This analysis, along with the trends in native production described in the previous chapter, provides a picture of the supply-side of the sector. It will then be further elaborated and combined with an analysis of the demand-side in Chapter 4.

3.1 Cereals

Ireland’s trade balance in the main domestically produced cereals (wheat, barley, oats) and imported maize is shown in Figure 3.1 for the period 2000-2018.

Figure 3.1 Ireland’s trade balance in cereal grains, 2000 - 2018



Data source: Eurostat Comext Database.

These data show a very marked increase in Ireland's dependence on imported cereals. The exceptionally high import figures for 2018 reflected extreme weather conditions that led to a fodder shortage in the ruminant livestock sectors. However, even discounting 2018 as being atypical, there has been a clear upward trend in cereal net imports, driven by the expansion of the national dairy herd, which increased by 30% between 2012 and 2018. The average net imports of cereals for 2015-2017 were 1.44m tonnes per annum, almost 40% above the average annual level of net imports in 2009-2011. Over the reported period (2000-2018), net imports increased at a linear rate of 64,000 tonnes per annum.⁹ In monetary terms, net imports of cereals were €257m and €425m in 2017 and 2018, respectively.

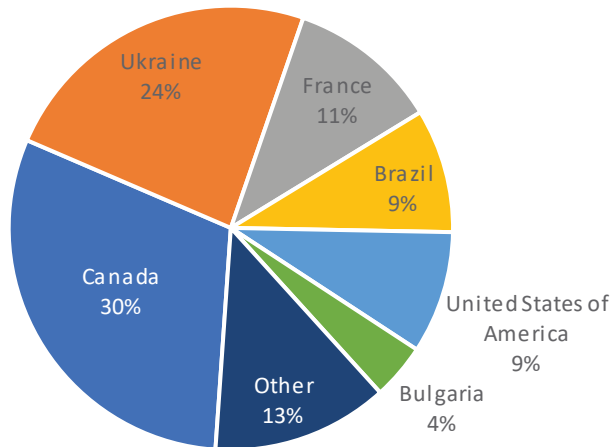
The increased reliance on imported maize is especially noteworthy. Maize imports grew at a linear rate of 67,000 tonnes per annum, exceeding 1.1m tonnes in 2017 and reaching almost 1.6m tonnes in 2018. The global nature of the origin of these imports is highlighted in Figure 3.2, with North America accounting for nearly 40% of the supply in the 2014-2018 period.

For the domestically grown cereals, Ireland maintains a limited export trade, which has averaged c.100m tonnes per annum but fluctuates with year-to-year variations in the domestic harvest (Figure 3.1). The breakdown of Ireland's cereal exports by tonnage for 2014-2018 comprised 40% barley, 40% oats, and 20% wheat with almost all exported grain going to the UK.

Combined imports of barley, wheat, and oats have not shown any significant trend but have fluctuated around an average of c.500,000 tonnes per annum. This import trade is comprised principally of wheat and barley, which accounted for 62% and almost 38% of the imported tonnage, respectively. The main trading partners for these imports are shown in Figure 3.3, with the UK supplying just over half of the imported volume over the period 2014-2018.

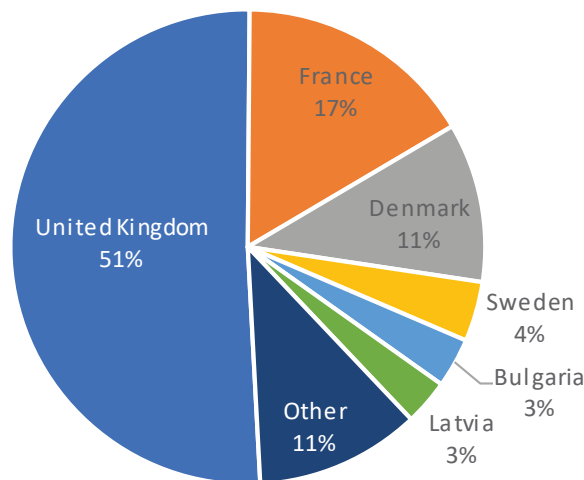
⁹ Calculated as the slope of a linear trend line fitted to the data shown in Figure 3.1.

Figure 3.2 Main trading partners for imported maize (2014-2018)



Data Source: ITC Trademap. Average share (2014-2018) of Ireland's tonnage imports of maize by exporting country.

Figure 3.3 Main trading partners for imported wheat, barley, and oats (2014-2018)



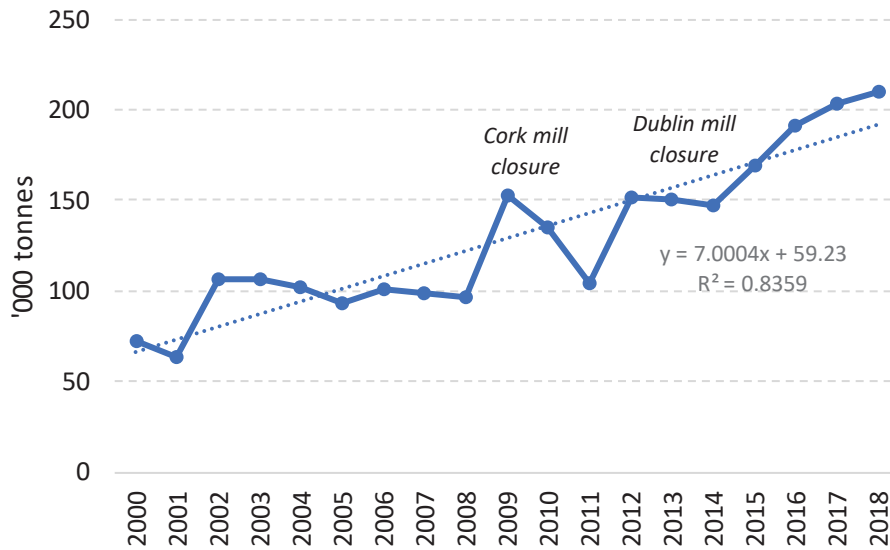
Data Source: ITC Trademap. Average share (2014-2018) of Ireland's tonnage imports of wheat, barley and oats by exporting country.

3.2 Flour and malt

The previous section has explored Ireland's trade balance in unprocessed cereal grains. However, it is instructive to also quantify trends in key processed cereal products with flour and malt as indicative examples. Net imports of flour over the period 2000-2018 are shown in Figure 3.4. Ireland's leading commercial flour miller (Odlums) closed its Cork mill in 2009, and its Dublin mill, which had been

producing 17,000 tonnes of flour annually, in 2012¹⁰. The company cited low-cost imports of flour as the reason for the closure decisions. Over the period 2000-2018, net imports of flour increased at a linear rate of 7,000 tonnes per annum, reaching 210,000 tonnes in 2018 with a value of almost €80m. Ireland’s flour imports correspond to c.263,000 tonnes (or c. 31,000 hectares) of wheat production.

Figure 3.4 Trend in net imports of flour (2000-2018)

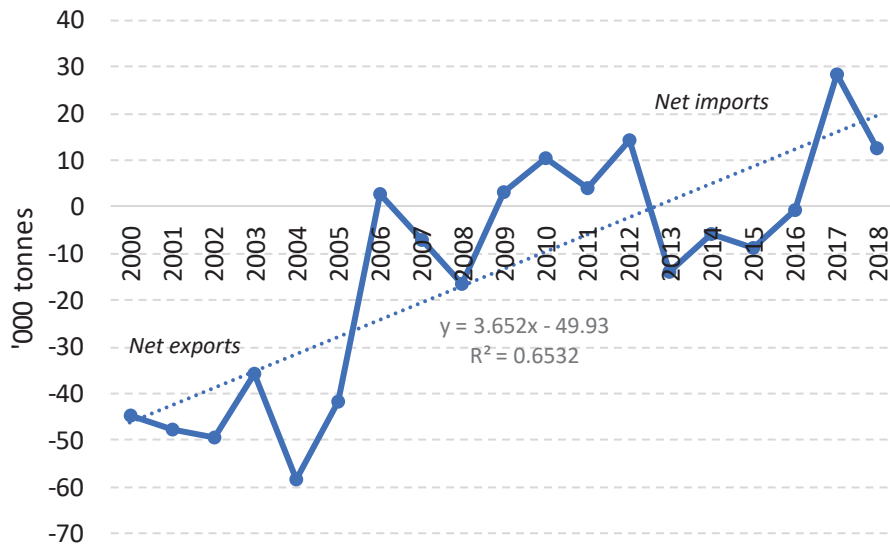


Data source: Eurostat Comext Database. The dotted line is a linear trend fitted to the data.

In the case of malt (see Figure 3.5), Ireland’s net export position (c.40,000 tonnes per annum) in the early 2000s has narrowed, and the country has intermittently been a net importer over the last decade. This trend suggests that increases in demand for malt for the Irish drinks industry have been outpacing growth in domestic supply.

¹⁰ Irish Examiner (2012).

Figure 3.5 Trend in net imports of malt (2000-2018)



Data source: Eurostat Comext Database. The dotted line is a linear trend fitted to the data.

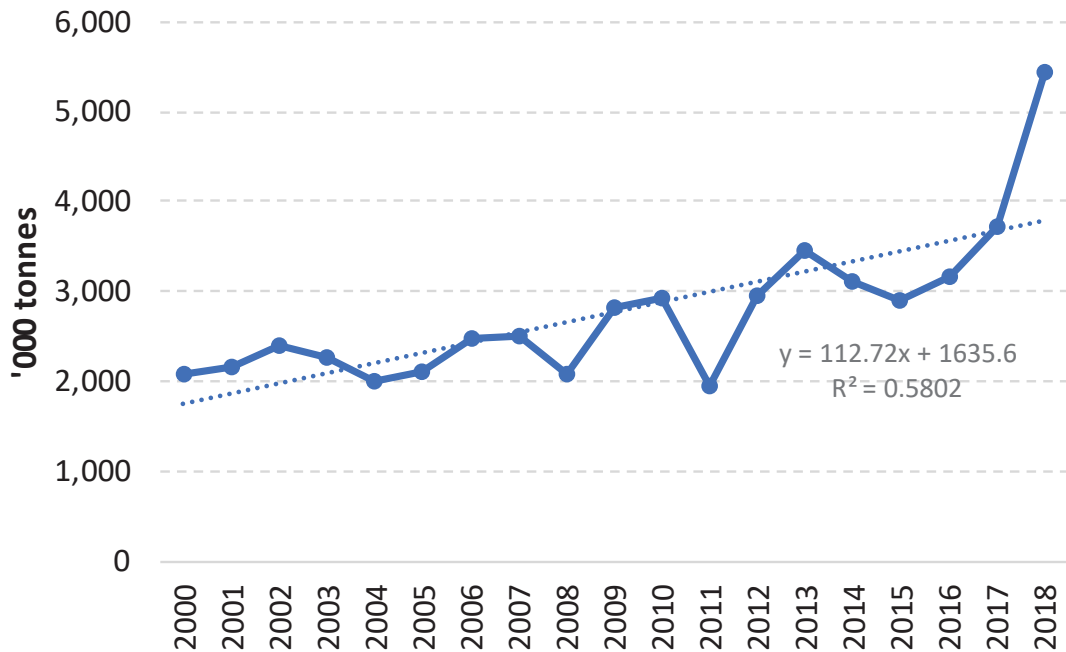
3.3 Livestock feed ingredients

The evolution of net imports for the aggregate volume of the main ingredients used in concentrate feed manufacture is shown in Figure 3.6. In addition, the trend for just the principal protein feed sources (e.g., soya, oilseed meals, etc.) is shown in Figure 3.7.

In common with the profile shown for cereals, there has been an upward trend in net imports of overall feed ingredients, with a spike in 2018 arising from a weather-related fodder crisis. Based on the linear trend-line (Figure 3.6), net imports of all feed ingredients increased at a rate of c.113,000 tonnes per annum over the period 2000 – 2018. In the case of protein feed sources, the upward trend was flatter rising at a linear rate of about 11,000 tonnes per annum over the same period (Figure 3.7).

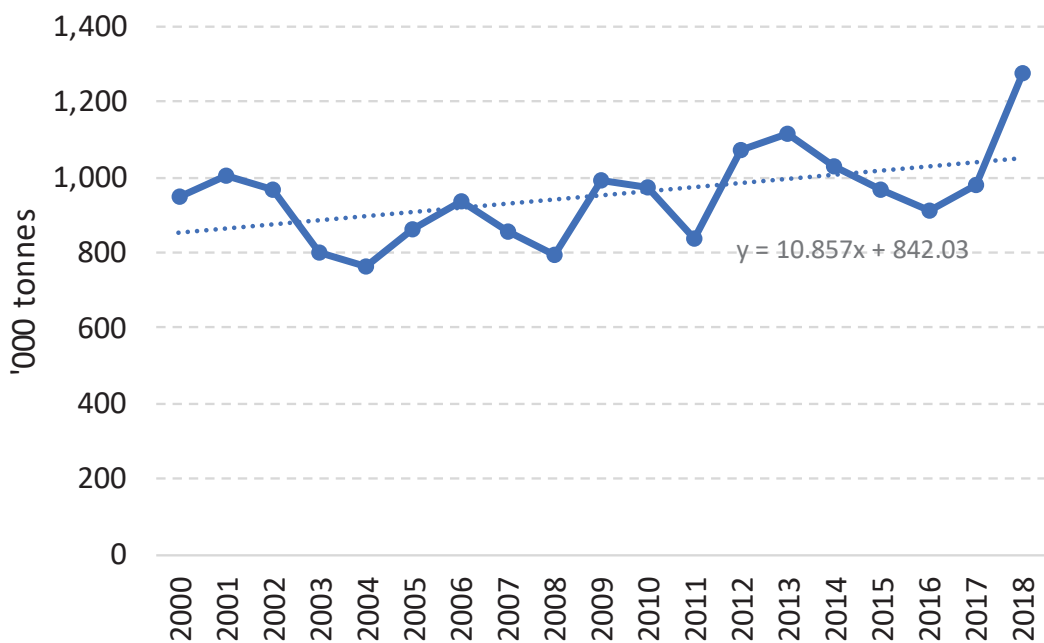
In 2017, Ireland’s net imports of all main feed ingredients were almost 4m tonnes, including c.1m tonnes of protein ingredients. According to Eurostat, the trade value of Ireland’s imports of the primary concentrate feed ingredients (included in Figure 3.6) was c.€800m and c.€1.2bn in 2017 and 2018, respectively.

Figure 3.6 Trend in net imports of livestock feed ingredients (2000-2018)



Data source: Eurostat Comext Database. Aggregate data for main feed ingredients comprising: cereals (wheat, barley, oats, maize, sorghum), proteins (see footnote to Figure 3.7), and other materials (distillers and brewers grains, mill screenings, wheat bran, molasses, citrus pulp, beet pulp, bagasse, alfalfa, soya hulls). The dotted line is a linear trend fitted to the data.

Figure 3.7 Trend in net imports of protein for livestock feed (2000-2018)

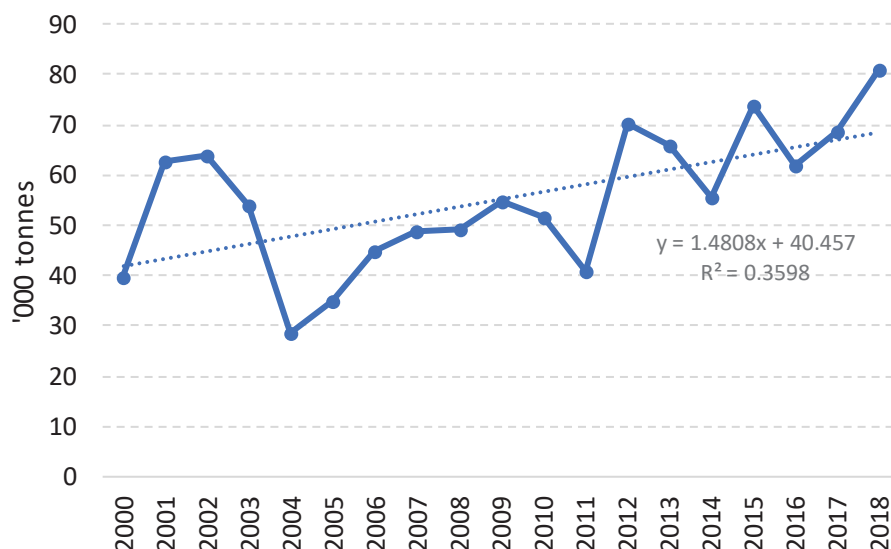


Data source: Eurostat Comext Database. Aggregated data for main protein sources: soya beans, soya bean meal, linseed, rapeseed, oilseed meals, palm kernel, corn gluten, copra, peas, beans. The dotted line is a linear trend fitted to the data.

3.4 Potatoes

A chart of net imports of potatoes over the period 2000-2018 is shown in Figure 3.8. Net imports have fluctuated widely from year-to-year according to the volume of the Irish harvest and other market factors. Figure 3.8 indicates a moderate upward trend in net imports, which reached c.80,000 tonnes in 2018 with a value of almost €42m (Eurostat). The volume of potato imports equates to c.2,000 hectares of production at average Irish yield. The majority of these imports were sourced from the UK, which accounted for nearly 80% by volume between 2014 and 2018. Moreover, the dominant share of this trade comprised chipping varieties destined for the Irish foodservice sector. Ireland has a small export trade in potatoes, mainly to the UK. The level of potato exports has varied widely from year to year (from 2,000 to 20,000 tonnes) with an average of 8,000 tonnes per annum during the five years, 2014-2018.

Figure 3.8 Trend in net imports of potatoes (2000-2018)



Data source: Eurostat Comext database. The dotted line is a linear trend fitted to the data.

4. Tillage Supply Chain

This chapter describes and quantifies the supply chain of the Irish tillage industry. It begins with the output side presenting ‘supply and use’ tables for each of the main tillage crops. These tables detail estimates of native production, exports, imports, and the breakdown of domestic uses. The value of domestic production is quantified, and key metrics concerning the end-use markets are evaluated. In the final part of the chapter the upstream supply chain is quantified in terms of the input sectors that are supported by expenditure of tillage farmers.

To provide representative figures of the medium-term performance of the sector, variables are normalised by obtaining their five-year averages for the period 2014-2018. This approach mitigates the risk of reporting atypical values that might arise from reporting data for a single year.

4.1 Cereals

A supply-demand balance sheet showing estimates of Ireland’s production, net trade balance, and domestic uses of wheat, barley, and oats is provided in Table 4.1. Over the period 2014-2018, Ireland’s average annual production of cereals comprised c.2.3m tonnes with an estimated annual ex-farm value of c.€385m. Organic cereals accounted for less than 0.5% of the total production by volume¹¹.

Barley, wheat, and oats comprised 65%, 28%, and 7% of cereals output, respectively. Teagasc National Farm Survey data indicated that 11%, 2%, and 6% of the outputs of barley, wheat, and oats, respectively, were retained on-farm for feed use¹². Consequently, the overall value of cereals retained on-farm was c.€31m at average ex-farm market prices. Over 90% of cereal output, with an average annual ex-farm value of c.€355m, was traded commercially through grain merchants.

During 2014-2018, aggregate net imports of wheat, barley, and oats averaged over 300,000 tonnes per annum with wheat accounting for the largest share of this trade at some 230,000 tonnes. The total net supply (native production + net imports) for domestic uses of wheat, barley, and oats was almost 2.5m tonnes¹³ per annum.

During the years 2014-2018, on average, c.2.1m tonnes per annum (i.e., 85%) of cereal supply was used for livestock feed. Human consumption uses accounted for 11% of the aggregate supply of cereals but varied by crop. Specifically, 15% of barley (malting/distilling), 32% of oats (milling), and less than 1% of wheat supply were used in human food and drink products. These figures are

¹¹ According to Department of Agriculture, Food and the Marine (2019) organic cereals in 2017 accounted for less 1% of the total area of cereals and production of c.7,500 tonnes.

¹² The author is grateful to Fiona Thorne and Brian Moran of Teagasc Agricultural Economics and Farm Surveys Department for supplying these figures.

¹³ Standardised to 13% moisture content.

noteworthy because price premiums that apply for specific uses (milling and malting) have an important impact on farmer incomes, and this aspect is explored further in Section 4.5.

Table 4.1 Estimated production, supply and use of cereals (annual average 2014-2018)

	Wheat	Barley	Oats	Total
Native production				
Area (hectares)	66,000	194,700	21,500	282,200
Yield (green tonnes per hectare)	9.8	7.8	7.9	8.3
Volume of harvested production (green '000 t)	648	1,526	169	2,343
Value of production (€ million)	110	249	28	386
<i>of which: sales to grain merchants</i>	108	221	26	355
<i>on-farm use¹</i>	2	27	2	31
Average price per tonne incl. premiums (€)	170	163	163	165
Supply and use ('000 tonnes)				
Native production @13% moisture	609	1,437	159	2,206
+ Imports from: UK	151	124	2	277
EU	93	26	0	119
Rest of the world	-	-	-	-
- Exports to: UK	14	33	12	58
EU	1	3	23	27
Rest of the world	-	-	3	3
= Total net supply for domestic uses	839	1,551	124	2,514
<i>of which: milling</i>	5	-	40	45
<i>brewing</i>	-	150	-	150
<i>distilling</i>	-	75	-	75
<i>livestock feed</i>	784	1,283	80	2,146
<i>seed</i>	10	33	3	47
<i>other uses² and waste</i>	40	10	1	51
Native production as % of use in Ireland	73%	93%	128%	88%

Sources: production data from CSO, trade data from Eurostat, use data from industry consultation. Figures are estimates and should be interpreted as approximate magnitudes only.

Note: Figures are author's estimates from available data sources and should be interpreted as approximate magnitudes only. Some minor discrepancies in totals due to rounding. ¹Estimate from Teagasc National Farm Survey. ²Estimate includes the production of pet food, wild bird seed, etc.

Ireland's aggregate self-sufficiency¹⁴ for the three domestically produced cereal crops was 88%. Individually, self-sufficiencies were 73%, 93%, and 128% for wheat, barley, and oats, respectively. This supply position is reflective of the Irish tillage sector's favourable international cost competitiveness in the primary domestic cereal crops (see Section 2.6). However, as shown in Chapter 3, imports of maize have increased dramatically and form a major component of Ireland's overall supply of

¹⁴ Native production expressed as a percentage of total net supply for domestic uses.

cereals¹⁵. When we include maize imports in the calculation, Ireland's overall self-sufficiency in cereals falls to c.60%. Consequently, the continuing price competitiveness of imported maize represents a prominent competitive threat to native cereal production.

It should also be noted that the figures in Table 4.1 refer to 'raw' cereal grains and do not take account of imported processed cereal products such as flour. For example, Ireland's flour imports are equivalent to c.263,000 tonnes of 'raw' wheat (see Section 3.2) and including these imports Ireland's wheat self-sufficiency falls to 55%.

4.1.1 Milling

Traditionally, the quantity of domestic wheat production used for flour milling has been c.5,000 tonnes annually, comprising a small share (c.6%) of Ireland's spring wheat output. Ireland's climatic conditions hinder the consistent production of milling specification wheat with gluten strength for pan-loaf breads. However, a higher proportion of Irish wheat is suitable for traditional farmhouse wholemeal and soda breads that require medium-extensible gluten. A small number of artisan mills operate in this niche producing stoneground wholemeal flour.

In recent years, the loss of commercial flour milling capacity has almost entirely curtailed the Irish milling wheat sector¹⁶. Since the closure of Odlum's flour mills in Cork and Dublin, Ireland has imported almost all its flour requirements, and in 2018 Irish imports of flour exceeded 200,000 tonnes with a value of c.€80m¹⁷. Further along the value chain, wheat flour comprised the primary ingredient in bread and bread products with an Irish retail market value of over €400m in 2018^{18,19}.

Oats are the principal cereal crop that is milled in Ireland for human consumption. Some 40,000 tonnes (c.€6.8m ex-farm) were milled annually, producing c.27,000 tonnes of oatlets for breakfast cereal, cereal bars and other food products. According to Kantar, the retail value of the Irish market for porridge oats was over €25m in 2018. More than half of oatlets milled in Ireland are exported with the USA and the UK being the key export markets for Irish porridge oats. According to Eurostat, this export trade averaged 14,500 tonnes per annum in 2014-2018 with an export value of c.€15m per annum.

The organic porridge oats market has been an important growth area, particularly in an export context. In 2017, the area of organic oats reached 1,181 hectares, amounting to almost 50% of the overall organic cereal acreage. Nonetheless, growth in demand for organic oats has outpaced increases in native supply. According to DAFM (2019), the supply of organic oats produced nationally

¹⁵ Imports of maize averaged more than 1.1 tonnes per annum in the 2014-2018 reference period.

¹⁶ It is estimated that quantities of Irish wheat used for milling have now fallen to almost negligible levels due to the loss of commercial milling capacity. Only a couple of small-scale mills continue to produce flour from Irish wheat for the artisan bakery sector.

¹⁷ Eurostat data.

¹⁸ Mintel (2019)

¹⁹ Also Wheat flour is utilised in a multitude of products including numerous prepared foods, cooking sauces and many food ingredients.

fulfilled only 40% of the demand in the breakfast cereal market in 2017. During 2014-2018, Irish oat millers imported c.1,600 tonnes of organic oats per annum from the UK to fill a deficit in native organic supply.

4.1.2 Livestock feed

Livestock feed milling used over 2.3m tonnes of native tillage crops (cereals, oilseeds, pulses, co-products) per annum during 2014-2018 (Table 4.2). Cereal grains represented the vast majority of this tonnage, with approximately 85% of native cereal production used in the animal feed industry.

Table 4.2 Estimated supply and Use of animal feed ingredients (annual average 2014-2018)

	Feed (‘000 t)
Native production for feed	2,332
<i>of which: cereals</i>	2,116
<i>pulses</i>	46
<i>rapeseed</i>	18
<i>other materials (co-products)</i> ³	152
+ Net imports of feed ingredients	3,707
<i>of which: cereals</i> ¹	1,289
<i>protein</i> ²	896
<i>other materials</i> ³	1,437
<i>compound</i>	84
= Total net supply of feed ingredients	6,039
Use of purchased compound, coarse and straights	5,856
<i>of which: cattle</i>	3,300
<i>sheep</i>	200
<i>pig</i>	1,276
<i>poultry</i>	589
<i>other</i>	492
+ On-farm use of home-produced cereals	183
= Total use of feed ingredients	6,039
Native tillage as % of all feed ingredients by tonnage	39%
Native cereals as % of cereal feed use by tonnage	62%
Native protein as % of protein feed use by tonnage ⁴	7%

Sources: Feed use data from DAFM; Trade data from Eurostat Comext. Figures are estimates and should be interpreted as approximate magnitudes only.

Notes: Some minor discrepancies in totals due to rounding. ¹Cereals - wheat, barley, oats, maize, sorghum. ²Proteins - soya beans, soya bean meal, sunflower meal, rapeseed, rapeseed meal, linseed, copra, fishmeal, maize gluten meal, peas, beans.

³Other materials - brewers/distillers grains, wheat bran, mill screenings, molasses, soya hulls, citrus pulp, beet pulp, alfalfa.

⁴Calculated based on the definition of protein in note 2 and may omit ingredients, including some in ‘other materials’ that may enhance protein content in feed rations.

Table 4.2 provides a summary of the estimated supply and use of livestock feed ingredients, including net-import data collated for 25 primary feed ingredients across the categories of cereals, proteins,

other materials (mainly by-products), and compound. Estimates of feed use are broken down by sector using data from DAFM. According to CSO²⁰, concentrate feed expenditure in agriculture was c.€1.35bn per annum, on average, over the period 2014-2018. Table 4.2 highlights the import dependence of Irish animal feed production. In volume terms, native cereals, oilseed, and pulses accounted for almost 40% of all ingredients utilised by the feed industry in Ireland. For the cereal component alone, native supply accounted for 62% of the volume of all cereals used in Irish animal feed. In contrast, native supply of protein crops (defined as pulses and rapeseed) met only 7% of the primary requirement of the domestic feed industry over the period 2014-2018.

4.1.3 Brewing and distilling

The drinks industry provides a critical market for Irish barley, and Table 4.3 shows the estimated average annual supply and use of malting barley during 2014-2018. The average area of malting barley was c.40,000 hectares with a production volume of c.287,000 tonnes per annum. Each year a proportion of the available malting barley will not be accepted because it fails to meet the required specification. Our inquiries indicated that a representative rejection rate was c.7% of total malting barley production with rejected barley obtaining feed-grade price. The average price premiums were €23 per tonne of barley accepted for malting and €10 per tonne for roasting.

During 2014-2018, the estimated volume of native barley supplied for the Irish brewing and distilling industries averaged c.250,000 tonnes per annum with an ex-farm value of c.€48m per annum. During the reference period, imports of barley for malting were confined to 2018 only when c.65,000 tonnes were imported due to a deficit of native barley caused by drought conditions²¹. The total net supply (including imports) of barley to the drinks industry was c.265,000 per annum. This figure included c.180,000 tonnes used for malt production for brewing and distilling and c.45,000 tonnes in roasting for stout production. A further c.40,000 tonnes per annum of unmalted (raw) barley was used in distilling.

Ireland's domestic malt production was c.137,000 tonnes per annum over the 2014-2018 period, and net imports of malt comprised a further 5,000 tonnes per annum. It is estimated that the average gross output value of Irish malt production exceeded €110m per annum during 2014-2018.

Overall, native produced barley accounted for about 93% of all barley used by the combined brewing and distilling industries.

²⁰ CSO estimates of Output, Input and Income in Agriculture. The average annual expenditure on purchased feed was almost €1.5bn during 2017-2019.

²¹ This was equal to 13,000 tonnes averaged over the five year reference period. However apart from 2018, imports of malting barley in other years of the data period (i.e. 2014-2017) were negligible, comprising minor quantities of speciality varieties only.

Table 4.3 Estimated supply and use of malting barley (annual average 2014-2018)

Malting Barley	
Production	
Area (hectares)	40,200
Yield (green tonnes per hectare)	7.2
Volume of harvested production (green '000t)	287
Value of production (€ million)	51
<i>of which: Malting specification</i>	48
<i>Feed-grade (not malting spec)</i>	3
Grain supply to brewing/distilling ('000 tonnes)	
Native production (@13% moisture) - Net ¹	252
+ Imports of barley for brewing/distilling ²	13
= Total net supply of barley for brewing/distilling	265
<i>of which: barley for roasting</i>	45
<i>'raw' barley for distilling</i>	40
<i>barley for malting</i>	180
Malt supply ('000 tonnes)	
Malt produced in Ireland ³	137
+ Imports:	
UK	16
EU	7
Rest of the world	-
- Exports to:	
UK	16
EU	2
Rest of the world	1
= Total net supply of malt for domestic use	142
Native % of barley used by Irish Brewing and Distilling	93%

Sources: production data from CSO, trade data from Eurostat, use data from industry consultation. Figures are estimates and should be interpreted as approximate magnitudes only.

Note: ¹ Dry weight after allowing for an estimated average rejection rate of 7% due to missing malting specification or over contracted tonnage. Rejected tonnage assumed feed grade and price. ² Value is subject to year-to-year variability based on harvested volume and quality of domestic malting barley. Industry sources estimated imports of over 65,000 tonnes for 2018 but negligible import quantities in the other years (i.e. 2014-2017). ³ Calculated at 0.76 tonnes of malt per tonne of malting barley.

Table 4.4 summarises the aggregate supply of all grain to the Irish brewing and distilling industries according to native and imported sources. Maize is a significant raw material in Irish distilling, and it was estimated that net imports of this crop for distilling were c.115,000 tonnes per annum during 2014-2018. Overall, native grain as a percentage of all grain used by the combined brewing and distilling industries averaged c.65% during the reference period (2014-2018). More specifically, native supply accounted for more than nine in every ten tonnes of grain used for Irish brewing and four in ten tonnes of grain used in Irish whiskey distilling.

Table 4.4 Estimated supply of grain and malt to Irish brewing and distilling (annual average 2014-2018)

Brewing & Distilling Grains	
Native Supply ('000 tonnes)	252
<i>of which:</i> <i>barley for malting</i>	167
<i>barley for roasting</i>	45
<i>'raw' barley for distilling</i>	40
+ Net Imports ('000 tonnes)	136
<i>of which:</i> <i>barley for malting</i>	13
<i>malt (grain equiv.)¹</i>	7
<i>maize for distilling</i>	115
<i>other (e.g. rye)</i>	1
= Total net supply of grains to brewing & distilling	387
Native barley as % of grain to Irish brewing and distilling	65%

Note: Figures are approximate, based on information from industry consultation. ¹ Malt converted to grain equivalent assuming 1 tonne of barley (@13% mc) = 0.76 tonne of malt.

Fitzgerald (2015) calculated that Ireland's alcohol industry generates over €1 billion in exports, supports over 92,000 jobs (directly and indirectly), and contributes over €2 billion to the economy.

The Irish brewing and distilling sectors have continued to exhibit robust growth in sales. Between 2014 and 2018, beer production increased at a compound annual rate of 4% to reach 8.3m hectolitres²². Production of microbreweries (craft beers) increased by 22% compound annual rate between 2014 and 2017 to reach 157,000 hectolitres²³. In 2018, the value of beer output was c.€600m (excl. taxes), including €268m in exports and supporting direct employment of over 1,100 people²⁴.

The number of Irish whiskey distilleries increased from 4 to 32 between 2010 and 2019, while global sales increased from c.6m cases (72m bottles) in 2010 to 10.7m cases (130m bottles) in 2018. Ireland's exports of whiskey were €647m in 2018, and Irish whiskey is projected to be the fastest-growing whiskey category over the coming years²⁵.

The continuing expansion in brewing and distilling is indicative of further growth in the demand for malting barley. Irish maltsters have responded with new investment, including an extra 30,000 tonnes of malting capacity at Boortmalt, Athy²⁶.

The production responses at the farm level are expected to mirror the underpinning market signals that determine the financial merits of malting barley versus competing crops. The financial advantage for growers is primarily reflected in the price premium for malting over feed grade barley, which

²² Irish Brewers Association (2018b).

²³ Feeney, B. (2018).

²⁴ Irish Brewers Association (2018b).

²⁵ Drinks Ireland (2019).

²⁶ Boortmalt (2018)

averaged €23/tonne during the reference period. However, producers note that this premium is partially offset by the opportunity costs (potential margins from higher-yielding competing crops) and additional management risks such as rejection rates for grain that does not meet the tight malting specifications. Nonetheless, the continuing growth in demand for malt from the Irish drinks industry, coupled with the already committed investment in additional capacity by maltsters, means that the fundamentals of the Irish malting barley sector remain strong. These fundamentals, matched by suitable price premiums, should support a positive production response by growers. However, malting premiums will also depend on external competition from imports and the importance placed by brewers and distillers on 'Irish origin' malting barley.

4.1.4 Straw

Straw sales are an essential component of the revenue of Irish tillage farmers. The estimated ex-farm value of this output was c.€70m per annum during 2014-2018 (Table 4.5). According to industry sources, c.93% of cereal straw and c.25% of oilseed rape straw are baled rather than chopped.

Table 4.5 Estimated supply and use of baled straw (annual average 2014-2018)

		Straw
Production		
Total straw baled ('000 tonnes)		1,115
<i>of which:</i>		
<i>wheat straw</i>		270
<i>barley straw</i>		740
<i>oat straw</i>		95
<i>rape straw</i>		10
Value of straw baled (€ million)		70
<i>of which:</i>		
<i>wheat straw</i>		16
<i>barley straw</i>		48
<i>oat straw</i>		6
Weighted average price per tonne (€)		63
Supply and use ('000 tonnes)		
Native production		<u>1,115</u>
+ Imports to: UK		11
- Exports to: UK		<u>3</u>
= Total net supply for domestic uses		<u>1,123</u>
<i>of which:</i>		
<i>mushroom composting</i>		100
<i>on-farm bedding & feed</i>		1,013
<i>other uses (incl. biomass)</i>		<u>10</u>
Native production as % of use in Ireland		99%

Sources: production data from CSO and Teagasc (2016b), trade data from Eurostat, use data from industry consultation. Figures are estimates and should be interpreted as approximate magnitudes only.

Livestock farms requiring straw for bedding (barley, wheat, oat straw) and feed (esp. spring barley straw) represented the most significant market at c.1m tonnes annually.

Approximately 100,000 tonnes of wheat and rape straw were purchased annually by the mushroom compost sector. The composting industry, with an estimated output of €50m of compost per annum, has provided a valuable source of demand, especially for wheat and rape straw.

Other uses of straw such as biomass for energy (e.g. in grain drying) appeared limited, but figures could not be ascertained with precision.

4.2 Oilseed rape and pulses

Estimates of production, supply, and use for oilseed rape and pulses are shown in Table 4.6. Oilseed rape and pulses each comprised similar average acreages of c.10,000 hectares during 2014-2018.

Rapeseed production was c.36,000 tonnes per annum with an estimated ex-farm value of c.€14m per annum. Based on Eurostat trade statistics, over 40% (16,000 tonnes per annum) of Irish oilseed production was exported to the UK for processing during 2014-2018. The lack of commercially viable crushing capacity within Ireland has been noted by Zahoor and Forristal (2016) as a barrier to the development of the Irish oilseed sector, limiting the scope to add-value to rapeseed output, domestically²⁷. During 2014-2018, Ireland imported c.200,000 tonnes per annum of rapemeal to a value of €47m per annum for use in the animal feed industry. This volume included around 36,000 tonnes of expeller cake (rapemeal) from oilseed rape processed in the UK.

However, c.24,000 tonnes per annum of whole rapeseed was used by Irish compound feed manufacturers, substituting for imported protein meals. Its small seed and high oil content make oilseed rape an awkward ingredient to process with standard feed mill equipment. However, a limited number of Irish compounders have adapted their plants to crack the oilseed before incorporating it in compound feed. One feed mill contacted by the author used c.9,000 tonnes per annum of whole rapeseed, processing it through a fine mesh. Their poultry feed included 3% whole rapeseed in place of a similar quantity of imported protein.

²⁷ Between 2005 and 2008, eight oilseed crushing plants were constructed to produce biodiesel from rapeseed. These plants were supported by the Mineral Oil Tax Relief Scheme (MOTRS) aimed at fostering the biofuel sector. The MOTRS was replaced on 1 January 2011 by the Biofuel Obligation Scheme (BOS). Following the government policy switch to BOS, the production of biofuel from rapeseed was no longer financially viable and the crushing plants shut down.

Table 4.6 Estimated supply and use of oilseed rape and pulses (annual average 2014-2018)

	Oilseed	Pulses
Production		
Area (hectares)	9,700	9,700
Yield (green tonnes per hectare)	3.9	5.4
Volume of harvested production (green '000 t)	38	53
Value of production (€ million)	14	10
Average price per tonne incl. premiums (€)	365	182
Supply and use ('000 tonnes)		
Native production (dry)	36	50
+ Imports from: UK	5	2
EU	0	3
- Exports to: UK	16	0
EU	1	0
= Total net supply for domestic uses	25	54
of which: <i>commercial crushing</i>	-	n/a
<i>cold pressing (on-farm)</i>	1	n/a
<i>human consumption/processing</i>	n/a	1
<i>livestock Feed</i>	24	51
<i>seed</i>	0.1	2
Native production as % of use in Ireland	145%	91%

Sources: production data from CSO, trade data from Eurostat, use data from industry consultation. Figures are estimates and should be interpreted as approximate magnitudes only.

Approximately 1,000 tonnes of Irish rapeseed are cold-pressed annually to produce premium cooking oil, often through small scale, on-farm processing facilities. Cold-pressing creates important value-added from local oilseed, generating a retail value of €5-€7 per 500mls of processed oil. In 2019, Irish retail volume sales of edible oils were 8m litres with a retail value of €32m. Native rapeseed oil had c.5% share of that market. It achieved the highest retail value growth within the category at 6% in 2019, reflecting consumer demand for healthier alternatives and their preference for 'Irish origin' products.

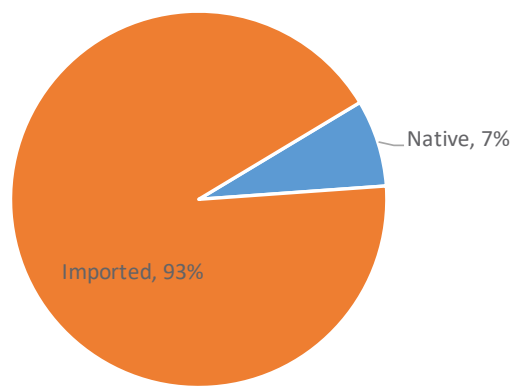
Pulses represent a critical source of domestically produced protein that can be readily incorporated into ruminant feed rations in place of imported protein. Increasing the production of pulses is a national policy priority, demonstrated by the introduction of the Protein Aid Scheme in 2015. This scheme has provided an annual coupled support payment of up to €250/ha for pulses (beans, peas, lupins), subject to an overall expenditure limit of €3m. As noted in chapter 2, the scheme has been instrumental in a more than doubling of the area of pulses since 2015. This has been important for increasing domestically produced protein while yielding environmental benefits through greater crop diversity and harnessing the nitrogen-fixing characteristics of legumes to reduce inputs.

During 2014-2018, the average annual area of pulses was 9,700 hectares comprising c.8,800 hectares of spring beans and c.900 hectares of peas. Total production of pulses averaged 50,000 tonnes per annum with an estimated ex-farm value of c.€10m per annum, not including Protein Aid.

There is a small premium market for c.1,000 tonnes of peas grown under contract and processed annually for human consumption. However, the vast majority of Irish output of pulses is used in the animal feed industry.

As shown in Figure 4.1, Irish livestock feed manufacturing remains heavily dependent on imported protein. Considering the estimated use of native rapeseed and pulses about 7% of primary feed protein requirement in Ireland is met from domestic protein production²⁸. However, it is noted that this native share is difficult to estimate with precision because of the diversity of imported ingredients, including co-products used in feed manufacturing. The suggested figure is based on a narrow definition of standard protein feed sources (as described in section 4.2.2). Calculation based on a wider definition to include imported co-products (e.g. maize distillers) that are moderately high in protein would suggest an even lower share of native protein.

Figure 4.1 Estimated share of native vs. imported protein in Irish livestock feed



Source: author's calculation

4.3 Potatoes

Estimates of supply and use of potatoes are shown in Table 4.7. The average annual domestic production over the reference period (2014-2018) was c.350,000 tonnes, with an estimated ex-farm output value of over €80m. Native production accounted for c.84% of the supply of potatoes with net imports, mainly for the foodservice sector (chipping potatoes), of c.70,000 tonnes (c.€35m) per annum.

Maincrop production accounted for the majority (87.5%) of potato output, principally destined for the ware market. The Rooster variety has predominated this segment with as much as 70% of the maincrop potato area in recent years. Early potato varieties and seed production comprised 9% and

²⁸ This figure comprises c.5% from native pulses and 2% from native rapeseed.

3.5%, respectively²⁹. Until the mid-2000s, Ireland exported c.2,000 tonnes per annum of seed potatoes, but Eurostat statistics indicate that this trade has significantly diminished in recent years.

Table 4.7 Estimated supply and use of potatoes (annual average 2014-2018)

Potatoes	
Production	
Area (hectares)	8,900
Yield (tonnes per hectare)	40.0
Volume of harvested production ('000 tonnes)	356
Value of production (€ million)	83
<i>of which: commercial sales</i>	82
<i>stock feed</i> ¹	1
Average price per tonne (€) ²	234
Supply and use ('000 tonnes)	
Native production	356
+ Imports from: UK	60
EU	14
Rest of the world	2
- Exports to: UK	6
EU	2
Rest of the world	0
= Total net supply for domestic uses	424
<i>of which: ware and processing</i>	372
<i>stock feed</i>	25
<i>seed</i>	27
Native production as % of use in Ireland	84%

Sources: production data from CSO, trade data from Eurostat, use data from industry consultation. Figures are estimates and should be interpreted as approximate magnitudes only.

Note: ¹Share of crop not meeting market specification based on Redman (2019) and assumed sold as stock feed.

²Weighted average based on estimated shares of maincrop and early varieties, and allowance for proportion sold as stock feed.

Ireland imports sizeable quantities of prepared potato products. In the period 2014-2018, average imports of frozen potato products, according to Eurostat were c.90,000 tonnes per annum with a value of c.€80m per annum³⁰. Over the same period, imports of other processed potato products (including crisps) were over 25,000 tonnes with a value above €50m per annum³¹.

²⁹ Teagasc Tillage Crop Stakeholder Consultative Group (2012).

³⁰ There are no frozen chip factories in Ireland and frozen chip imports are mainly from the UK but also Belgium and the Netherlands. These frozen chip products are principally for the retail market but a proportion are also destined for the quick service restaurant sector.

³¹ Eurostat (2019)

The retail volume and value of the savoury snacks market in 2019 was 54,000 tonnes and €580m, respectively³². Analysis by Euromonitor International indicated that premiumisation and provenance have become more prominent in the potato crisps market, and they noted that consumers are keen to purchase brands that are produced locally with locally sourced ingredients. Accordingly, Irish brands such as Tayto, Keogh's, and O'Donnells have performed strongly, especially in the premium, hand-cooked crisps segment.

Notwithstanding consumer preferences for local products, the share of imports within the Irish market for processed potato products has been increasing. For example, AHDB (2018) highlighted the growing importance of Ireland for UK processed potato trade, commenting that:

“Exports of crisps increased by 12% between July and January this year compared to the same period last season. This was largely driven by increased demand from Ireland, who imported 9.3Kt in the first seven months of the 2017/18 season, an increase of 23% on the year. Crisps exported to Ireland have seen strong growth over the past five years, increasing by 70% since the 2013/14 season.

The UK exported 34.4Kt of frozen chips between July and January (2017/18), with Ireland remaining the primary destination receiving 17.9Kt and having steadily increased its demand by 28% since 2013/14. This reflects a growing market for UK exporters driven by limited processing capacity in Ireland.”

The Teagasc Tillage Crop Stakeholder Consultative Group (2012) identified opportunities for import replacement in the potato sector. The group suggested diversification of current potato output to include increased emphasis on value-added segments such as seed potatoes for export, and salad potatoes and chipping for the local market.

4.4 Tillage fodder crops

Between 2014 and 2018, the area of fodder crops, comprising maize silage, whole crop cereals, and fodder beet, was c.27,000 hectares per annum (see Table 4.8). Conservatively, fodder crop output was valued at c.€72m annually over the period 2014-2018. These tillage crops often feature as a subsidiary feed production enterprise on livestock farms, but transport costs and machinery availability can be barriers to their uptake.

Contractual growing agreements for fodder crops are an opportunity for livestock farmers to outsource production to tillage farmers who already maintain the necessary expertise and machinery. Such contracts can be a win-win for both parties: livestock farmers can access specialist management expertise and machinery while tillage farms benefit from an additional market and potential scale economies. Teagasc is fostering the development of collaborative farming agreements through advice and specimen contacts. In the tillage sector, most of this work has focussed on share farming

³² Euromonitor International (2019).

agreements. However, more recently, there is a developing interest in the potential of fodder crop contract agreements as a feed-supply management strategy, especially for dairy farms.

Table 4.8 Estimated production and output value of tillage fodder crops (2014-2018 average)

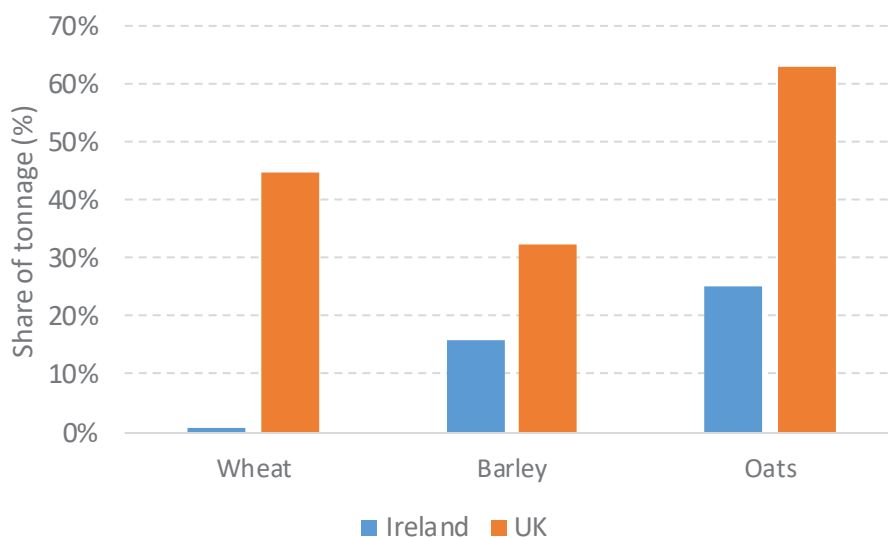
	Maize	Wholecrop cereals	Fodder Beet
Production			
Area (hectares)	13,500	3,300	10,100
Yield (green tonnes per hectare)	51	30	92
Volume of harvested production (FW '000t)	693	99	926
Volume of harvested production (DM '000t)	189	41	167
Value of production (€ million) - feed	34	6	32
Average value per tonne DM (€)	182	134	192

Sources: production data from CSO and Finneran et al. (2010), trade data from Eurostat, use data from industry consultation. Figures are estimates and should be interpreted as approximate magnitudes only.

4.5 Market price premiums

The availability and magnitude of price premiums associated with specific product markets are vital for crop margins and tillage farmer incomes. Not surprisingly, this can be an emotive subject for farmers. Figure 4.2 contrasts Ireland and the UK in terms of the estimated percentages of cereal outputs grown for a premium end-use (milling or malting) and for which a price advantage above standard feed grade may apply. The comparatively lower shares of Irish cereals achieving market premiums (above feed standard) represents a financial disadvantage faced by Irish tillage farmers because of greater reliance on the competitive feed segment that establishes the base market prices.

Figure 4.2 Estimated share of output targeting a price premium market above feed grade (2017): Ireland and UK

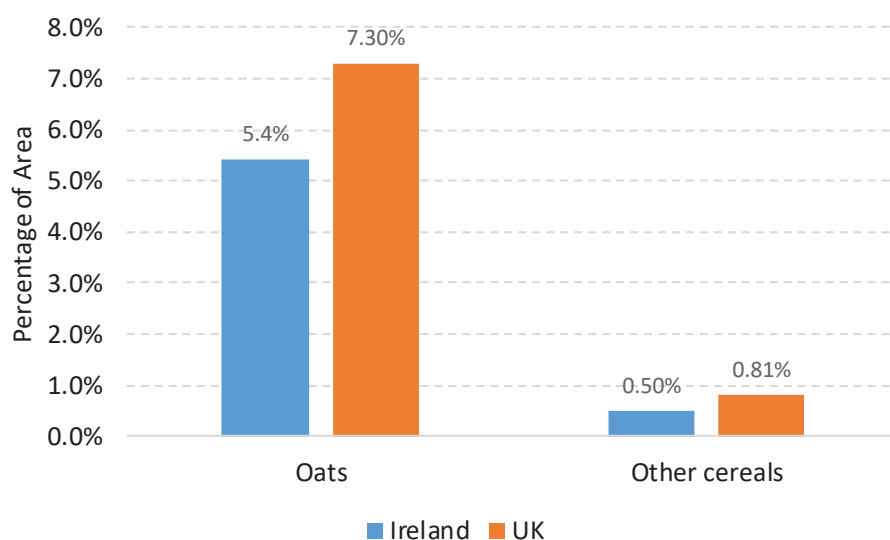


Source: Own calculation using CSO and DEFRA (UK) data

Indicatively, the magnitude of price premiums for milling oats in Ireland and the UK have been similar at c.€10 and £10 per tonne, respectively. Over 40% of UK wheat production targets the milling market with an average farm-level price premium of c.£10 per tonne above feed price. Irish barley for malting has been achieving a price premium of c.€23/tonne while the premium for roasting has been c.£10 per tonne above feed price. The price premium for malting barley in the UK has been ranged between £18 to £28 per tonne above feed price³³.

Production of organic certified cereals offers a further source of price premiums for the tillage sector. While organic cereal prices are often double their conventional equivalents, this advantage is set against yields that are lower and more variable. The organic proportion of the areas of oats and other cereals in 2017 for Ireland and the UK are shown in Figure 4.3. In both Ireland and the UK, organic production is more common for oats than other cereals. About 7% of the area of oats in the UK was organic compared to c.5% in Ireland.

Figure 4.3 Share of cereal area in organic production (2017): Ireland and UK



Source: DAFM (2019) and DEFRA (2018)

4.6 Input supply chain and tillage-supported expenditure

In addition to the economic value of crop output, the tillage industry’s contribution to the wider economy embraces a variety of related sectors³⁴ that are supported by tillage production and expenditures. Disaggregated figures for input expenditures from the tillage sectors are difficult to

³³ In the UK, the higher malting premiums are used to incentivise the growing of lower-yielding heritage varieties that are required for specialty malts.

³⁴ These are numerous including sectors that supply goods and services to the tillage industry as well as retail and other sectors supported by farm household spending in the economy.

obtain since official estimates of intermediate demand are provided only for the overall agricultural sector. However, it is possible to derive approximate magnitudes using data for ‘mainly tillage’ farms in the Teagasc National Farm Survey (NFS).

Table 4.9 details estimates of input expenditures derived from the NFS, using average expenditure levels per hectare for mainly tillage farms over the five years 2014-2018, then aggregated to national tillage area. One limitation of this approach is the relatively small NFS sample of tillage farms (c.70 per annum) used in the calculations. Secondly, the NFS sample principally comprises combinable crops and provides more limited coverage of crops such as potatoes, maize, and fodder beet, which have higher input costs. Accordingly, the figures in Table 4.9 may be an underestimate of actual tillage expenditures.

Table 4.9 Estimated average annual expenditures on tillage inputs, 2014-2018

	€ m
Direct costs	228
<i>of which:</i>	
<i>fertiliser & lime</i>	71
<i>crop protection products</i>	75
<i>purchased seed</i>	30
<i>contractors and transport</i>	47
<i>other direct costs</i>	6
Cash overhead costs	195
<i>of which:</i>	
<i>machinery operation</i>	65
<i>hired labour</i>	16
<i>land rent</i>	46
<i>car, electric, phone</i>	13
<i>farm maintenance</i>	11
<i>interest</i>	8
<i>other overhead costs</i>	36
Total operating expenditure	423
Net investment (machinery, buildings, land improv)	54

Source: own calculation from Teagasc National Farm Survey data for years 2014-2018

Conservatively, it is estimated that tillage enterprises generated over €420m per annum of input expenditures, of which c.€230m was direct input costs, including over €175m on seed, fertilisers and crop protection. Tillage farmers spent c.€47m on contractors and transport services while a further c.€65m was spent on own-machinery operation (fuel, lubricants, servicing). The tillage sector supported wages to hired farm workforce of c.€16m (excluding unpaid family labour), and conacre rents of c.€46m.

It is estimated that net investments on machinery, buildings, and land improvements by the tillage sector averaged c.€54m per annum over the 2014-2018 period.

Renwick (2013) and O’Connell and Phelan (2011) have highlighted evidence that farm households spend locally within their rural communities. Based on an analysis of survey data, O’Connell & Phelan noted that:

“The vast bulk of all input purchases by all farmers were made locally, i.e. within a 35-kilometre radius of the farm. This behaviour has a relatively huge impact on local economies throughout the country and is a major reason why agriculture has the highest direct and indirect [economic] multiplier.”

Illustrating this point, a map of the spatial distribution of DAFM-registered grain intakes is shown in Figure 4.4. The map highlights the network of merchants who supply key direct inputs as well as grain drying, storage, and marketing services to tillage farmers. Many of these sites comprise small businesses that provide vital economic activity within rural areas where other opportunities may be scarce. The dispersed nature of this economic activity within the principal cropping regions (Figure 4.4) is noteworthy, especially in terms of employment provided by these businesses that operate within the tillage supply chain.

In addition to input purchases, tillage farm families spend their incomes within the economy. Such expenditures contribute further to overall economic activity as an ‘induced’ impact of tillage production. Quantifying the level of tillage farm household expenditure is difficult. However, again using NFS data, the aggregate average net cash flow³⁵ from tillage over the period 2014-2108 was estimated at c.€200m per annum. This figure represents an approximate gross disposable income, which after netting off income taxes and savings, yields a proximate measure of tillage household expenditures within the economy on goods and services. However, in the absence of necessary data on savings and income tax, it is not possible to provide a more precise estimate of tillage-household expenditure. Nonetheless, it is reasonable to infer that such expenditures are very significant and play a pivotal role in supporting incomes and jobs in rural areas.

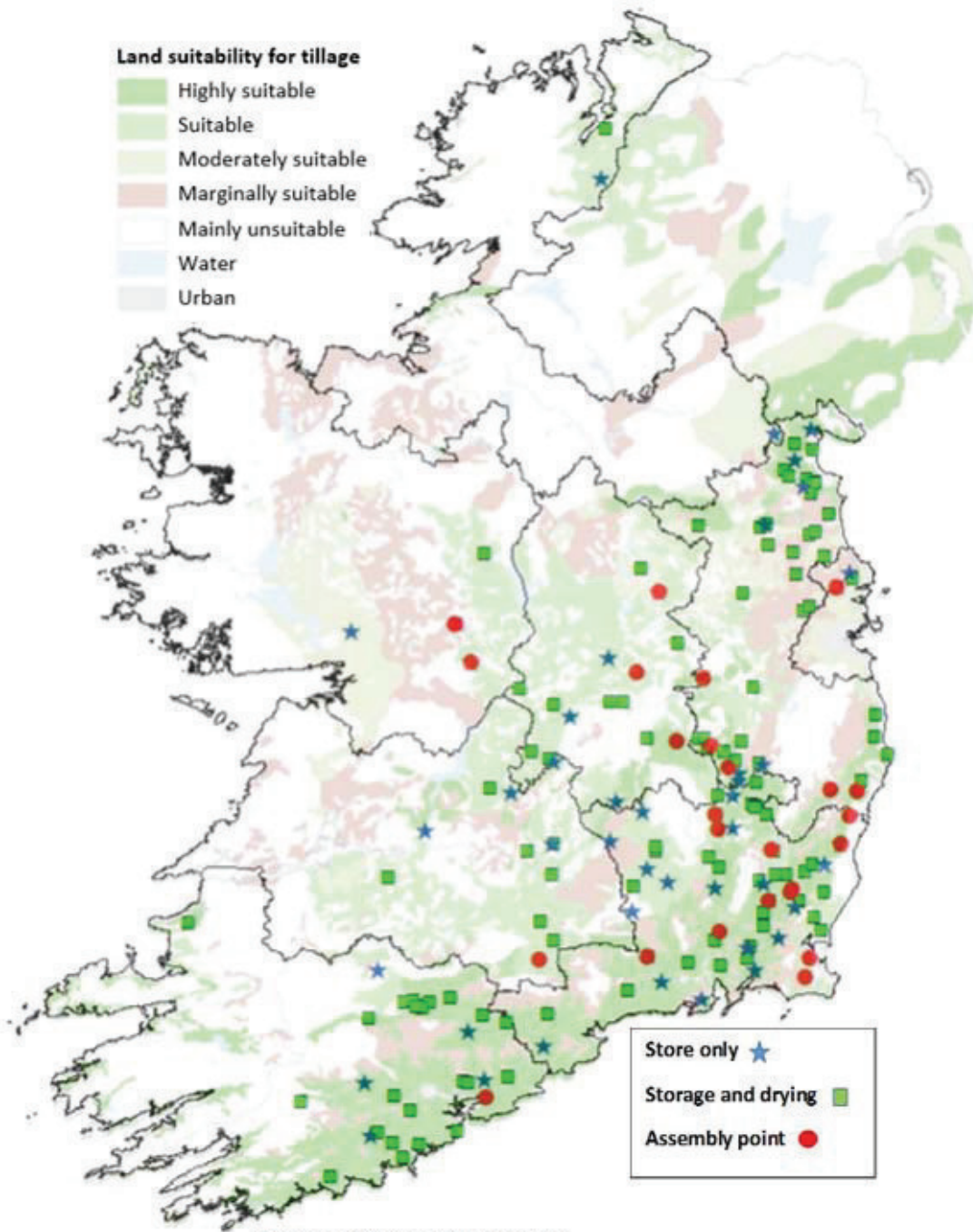
On this point, O’Connell and Phelan (2011) commented that:

“... the great bulk of farm household expenditure is made within 35 kilometres of the farm. Given the geographical spread of farming, this major level of expenditure contributes to the maintenance of economic and social life in towns and townlands in Ireland.”

This chapter has highlighted the breadth and depth of the Irish tillage industry in terms of its outputs and the upstream and downstream linkages within the sector’s supply chain. This analysis is further elaborated in the next chapter with an assessment of the tillage industry’s overall economic impact on output and employment within the economy.

³⁵Calculated by deducting cash expenditures and net investment from the value gross output (including direct payments).

Figure 4.4 Map of registered grain intakes and land suitability for tillage



Sources: (1) Boundary data: OSI;
(2) Soil map from Spatial Analysis Unit, Teagasc, 2012 (see Appendix 2);
(3) Registered grain intakes – own mapping using data from DAFM (2020).

5. Economic Impact

5.1 Introduction

This section assembles the data presented in the preceding chapters to estimate the overall economic impact of tillage production in Ireland. The economic contribution of the tillage sector to gross output and employment in the economy is calculated using multiplier analysis. This analysis considers the direct, indirect, and induced economic impacts of tillage production:

- **Direct** The output of the tillage industry arising from final demand for its products.
 - **Indirect** The additional inter-industry output within the supply chain arising from the direct output of tillage.
 - **Induced** The impact of additional household expenditure resulting from the direct and indirect effects of the tillage sector on incomes and employment in the wider economy.
-
- The diagram uses blue brackets on the right side of the list. A bracket groups the 'Direct' and 'Indirect' items under the label 'Within tillage farming'. A second bracket groups the 'Indirect' and 'Induced' items under the label 'Wider economy'.

The chapter begins by summarising the direct economic effect of the tillage sector in terms of the farm-level output. Next, the output impacts on the broader economy are quantified based on the estimated multiplier effects. These calculations consider the indirect and induced impacts of tillage output through the tillage supply chain and household expenditures. The chapter then explores the direct and indirect impacts of the tillage sector on employment. It concludes by considering the regional significance of tillage and comments on some of the vital ‘downstream’ effects through the beverage and animal feed sectors that source their essential raw materials from the tillage industry.

5.2 Tillage farm output

A detailed breakdown of the outputs of the Irish tillage sector was provided in Chapter 4 and Table 5.1 provides a summary of these farm output estimates by crop type and region. Nationally, tillage farm output averaged c.€640m per annum over the period 2014-2018. Over 70% of this output was from cereals with potatoes and tillage forage crops accounting for c.13% and 11%, respectively. Some

65% of national tillage output was concentrated in the tillage heartlands of Mid-East (Louth, Meath, Kildare, Dublin, Wicklow) and South-East (Wexford, Carlow, Kilkenny, Waterford)³⁶.

Table 5.1 Estimated direct output from tillage at producer prices (2014-2018 average)

	Farm Output (€ million per annum)				Total
	Cereals ¹	Oilseeds &	Potatoes	Tillage Fodder	
		Pulses		Crops ²	
Dublin & Mid-East	167.0	11.3	44.8	14.9	238.0
South-East	127.0	7.4	17.7	21.5	173.5
South-West	62.8	2.0	7.3	19.7	91.9
Midland	47.9	1.8	1.7	7.9	59.2
Mid-West	37.1	1.4	2.3	5.3	46.0
Border	8.7	0.0	8.8	1.4	18.9
West	6.8	0.0	0.8	1.4	8.9
State	457.3	23.9	83.3	72.1	636.6

Note: ¹Cereal output includes straw. ²Maize silage, whole crop cereals, and fodder beet.

NUTS3 (2016) Regions: Dublin & Mid-East: Dublin, Louth, Meath, Kildare, Wicklow; South-East: Wexford, Carlow, Kilkenny, Waterford; South-West: Cork, Kerry; Midland: Laois, Offaly, Westmeath, Longford; Mid-West: Clare, Tipperary, Limerick; Border: Donegal, Monaghan, Cavan, Leitrim, Sligo; West: Galway, Mayo, Roscommon.

The figures in Table 5.1 represent the direct farm output from the tillage sector. The broader economic impacts of the industry on the economy are considered in the following sections.

5.3 Multiplier analysis

Our evaluation of the wider economic effects of the tillage sector applies the established approach of multiplier analysis. Multipliers are derived from national input-output (I-O) tables that quantify the interdependencies between sectors of the economy and enable impacts of changes in the final demand for given sectors to be assessed. The output multiplier captures the impact upstream through the economy, of the output produced by a given sector. Specifically, it identifies how much additional output is initiated in other sectors to produce €1 of output in the chosen sector.

Two types of output multipliers, based on their scope, are distinguished in economic research. Type I multipliers capture the direct and indirect effects, while Type II multipliers also include the induced impact of a change in final demand. The Supply, Use and Input-Output Tables for Ireland, published by the CSO provide Type I output multipliers for the 'Agriculture, Forestry and Fishing' sector. For 2015 (the most recent available), the estimated output multiplier for the overall sector was 1.49 based on domestic product flows and 2.08 based on total product flows (i.e. including imports). While these estimated multipliers are insightful, they are much too general for quantifying the specific impact of the tillage industry.

³⁶ This pattern corresponds to the areas with soils that are most suitable for tillage as shown in Appendix 2.

Fortunately, Miller et al. (2011b) estimated a sectorally disaggregated I-O matrix for the Irish Agri-Food sector. Their analysis included Type II output multipliers for cereals, potatoes, fodder crops, and other crops. However, their estimates, based on 2005 data, are now quite dated, given structural changes in the economy over the elapsed timeframe. Consequently, it was necessary to calculate updated multipliers using data from the most recently available Input-Output tables for 2015 supplemented by information from Output, Input and Income in Agriculture and National Farm Survey. Following the procedure outlined by Parikh (1979), relative changes between 2005 and 2015 in the mix of intermediate inputs, as well as the ratio of intermediate expenditures to total outputs, were evaluated. The technical coefficients in the I-O matrix reported by Miller were then updated using these proportionate adjustment factors, and the multipliers were recalculated. Due to time constraints, the revisions were confined only to the I-O coefficients for the tillage sector. While this procedure was not ideal, it was considered pragmatic for determining more current multipliers required for this study.

Table 5.2 shows the original output multipliers from Miller *et al.* (2011b) for the main tillage sub-sectors and the revised estimates based on the recalculation procedure described in the previous paragraph. An average output multiplier for the overall tillage sector is shown on the right-hand side of the table, calculated by weighting the individual multipliers by the relative output shares of each crop type in national tillage output (2014-2018).

Table 5.2 Tillage output multipliers

	Cereals	Potatoes	Fodder crops	Other crops	Tillage - Average ¹
Miller et al. (2011b)	2.545	1.849	1.775	1.856	2.343
Updated estimate	2.198	1.678	1.622	1.674	2.047

Note: ¹Own calculation of weighted average according to output shares (2014-2018) by crop type and assuming the multiplier for 'other crops' applicable to 'oilseeds and pulses.'

The updated multipliers were moderately lower than the original figures published by Miller et al. (2011b). However, the direction and magnitude of the changes were consistent with the c.14% reduction in the Type I output multiplier for Agriculture, Forestry, and Fishing over the same period, from 1.734 in 2005 to 1.495 in 2015³⁷.

According to the updated estimates (Table 5.2), a €1 increase in the final demand for Cereals generates an overall output increase in the economy of almost €2.20. In other words, for each €1 of cereal output produced on tillage farms, due to the multiplier effect, an additional €1.20 of output is generated in the Irish economy. For potatoes and other crops, the estimated output multipliers are lower than for cereals but still indicate strong economic linkages supporting additional output through their supply chains. The estimated multiplier for the overall tillage sector is 2.05, implying that each €1 of output

³⁷ CSO (2009). Supply, Use and Input-Output Tables for Ireland, 2005; CSO (2018a). Supply, Use and Input-Output Tables for Ireland, 2015

from the tillage sector (based on 2014-2108 output composition) generates a further €1.05 in output in the Irish economy.

Miller et al. (2011a) reported a Type II multiplier for the overall agriculture sector in 2005 of 2.086, and their estimated multiplier for cereals (see Table 5.2) was 22% higher than the average for agriculture as a whole. However, their estimated multipliers for potatoes and other tillage crops were somewhat lower than the agriculture average. As noted by Miller et al. (2011b), higher multipliers are associated with sectors that are more embedded in the national economy with stronger inter-sectoral linkages.

5.4 Impact on gross output in the economy

Applying the updated output multipliers (Table 5.2) to the direct output figures (Table 5.1), we calculate that the tillage sector contributes c.€1.3bn to aggregate output in the Irish economy (Table 5.3). This impact equals almost €4m of output in the economy per 1,000 hectares of tillage, comprised almost equally of the direct (farm-level) output and the more extensive indirect/induced output from the sector.

Table 5.3 Tillage contribution to gross output in the economy

	Direct output (€m)	Indirect output ¹ (€m)	Total output (€m)
Cereals	457	548	1,005
Oilseeds & pulses	24	16	40
Potatoes	83	56	140
Tillage fodder crops	72	45	117
Tillage sector (total)	637	665	1,302
Per 1000 ha of tillage	1.88	1.97	3.85

Note: ¹ includes induced effects

5.5 Employment effects

Direct farm employment was calculated using National Farm Survey data on actual labour units per hectare for the sample of specialist tillage farms aggregated to the national crop area³⁸. The average direct farm employment for tillage crops is estimated to be almost 7,500 FTE or 22 FTE per 1,000

³⁸ An exception was necessary for potatoes because of the absence of the crop in the NFS sample of 'mainly tillage' farms. To account for the higher labour input requirements of potatoes, standard man day coefficients estimated by Teagasc were applied in the labour calculation for this crop. The author is grateful to Dr Emma Dillon for sharing this data.

hectares of crop production (Table 5.4). The estimated direct employment multiplier is 11.7 full-time equivalent FTE per €1m of primary output.

Broader employment in the provision of tillage inputs and associated services were estimated using data from the Census of Industrial Production (CIP) and Annual Services Inquiry (ASI). In the absence of more granular data on employment within the tillage supply chain, average FTEs per €1m of turnover were calculated using CIP (food products manufacturing) and ASI (retail trade; wholesale machinery, equipment, supplies; maintenance & repair). These estimates were applied to the I-O coefficients (used to derive the output multipliers) to quantify employment in the wider economy arising from the tillage industry.

The employment estimates, provided in Table 5.4, indicate that total employment for the tillage sector is almost 11,000 full-time equivalents (FTE). Overall, tillage employment comprises direct on-farm employment of c.7,450 FTE with a further c.3,400 FTE ‘indirectly’ employed in the supply chain and associated activities supported by the tillage sector. The estimated total employment multipliers are 17 FTE jobs per €1m of primary output from tillage farming or 32.1 jobs per 1,000 hectares of crop production. The estimated tillage employment multiplier is comparable to an employment multiplier of 16.2 per €1m increase in primary output for the overall Agriculture, Fisheries, and Food sector reported by Hennessy et al. (2018).

Table 5.4 Estimates of FTE employment within the tillage sector

	Direct Employment (FTE)	Indirect Employment (FTE)	Total Employment (FTE)
Tillage sector	7,450	3,400	10,850
Per €1m of tillage output	11.7	5.3	17.0
Per 1000 ha of tillage	22.0	10.1	32.1

To validate the indirect employment estimates that were derived from the multiplier analysis, an additional verification check was performed. Tillage industry leaders were consulted to obtain their assessments of employment levels in the tillage supply chain. These estimates, reported in Table 5.5, suggest a higher level of employment of c.4,700. However, the figures obtained from industry consultees were mainly employment headcounts rather than FTEs. Consequently, if we make allowance for the seasonal nature of work and the fact that some of the listed roles may include activities outside the tillage sector, the employment level suggested by the industry experts seems broadly supportive of the earlier estimate (Table 5.4) of around 3,400 FTEs³⁹.

³⁹ Also, since some contractors are also tillage farmers there is potential double counting because FTEs for Tillage farmer-contractors are already included in direct (farm) employment. Accordingly, the ‘additional’ employment associated with tillage contracting will be lower than the total ‘contractors’ figure shown in Table 5.5.

Table 5.5 Industry estimates of employment associated with the tillage industry (excl. on-farm)

	Employees (est. no.)	Notes:
Contractors	2,000	Industry estimate based on 20% of 10,000 contractors nationally
Machinery trade & servicing	1,100	Industry estimate based on 10% of the national total but may be higher
Registered agronomists, soil analysts	135	Agronomists: 530 approved in IASIS but estimated 125 practicing; Soil lab work: 10% of national total
Fertiliser & pesticides	253	Industry estimate
Seed industry	50	Industry figure
Merchants/distributors	120	Industry estimate based on 10% of PD staff nationally
Grain intake/drying/storage	160	Industry figure
Haulage	300	Industry estimate: calculation for grain x2 for fertiliser, straw, seed, pesticides
Maintenance of facilities, diesel, sheds, electricians, plumbers, etc	60	Industry consensus estimate
Primary producer maintenance inputs, diesel, sheds, electricians, plumbers, etc	120	Industry consensus estimate
Media, representative bodies, advisory, research, legislative bodies, legal services, Admin	420	Industry consensus estimate
Total	4,718	

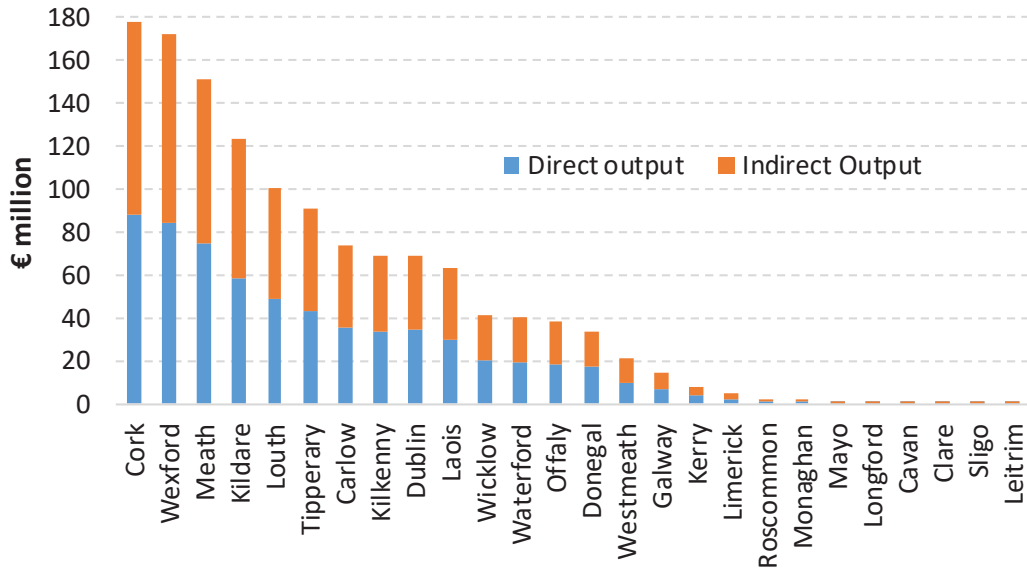
Source: employment estimates from tillage industry consultees.

5.6 Regional significance of tillage

The preceding sections have highlighted the national contribution of the tillage sector. However, reflecting spatial variations in soil characteristics and topography, the economic contribution of tillage activity is regionally concentrated. This geographic distribution of crop production means that the relative importance of tillage to local rural economies in the main tillage regions is underestimated by reference to national averages. This factor is highlighted in Figures 5.1 and 5.2, which show the estimated breakdown by county for output and employment, respectively. The five counties with the highest tillage output and jobs are Cork, Wexford, Meath and Kildare and Louth. A second block

comprising East and Midland counties plus Tipperary and Donegal account for most of the remaining tillage output and employment.

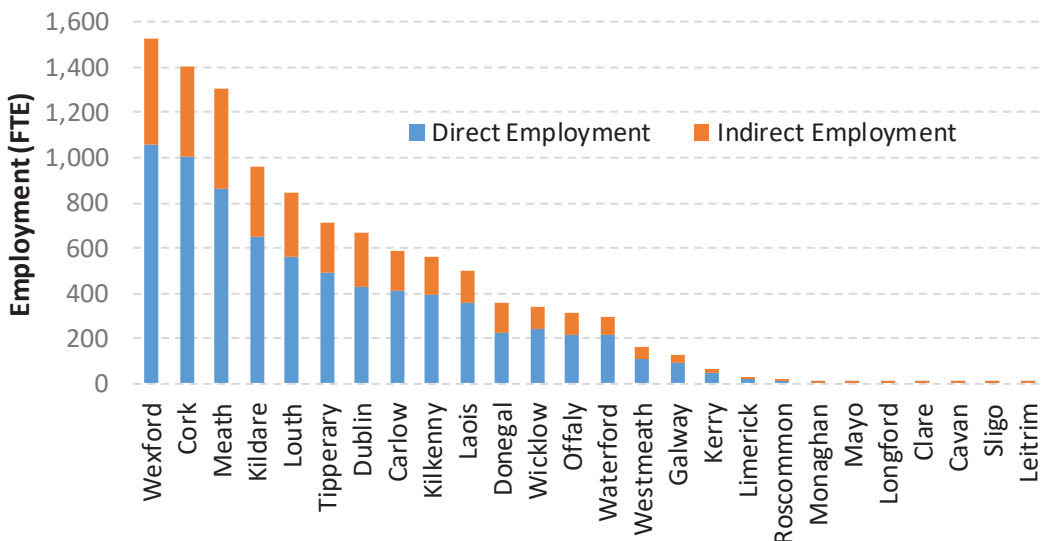
Figure 5.1 Estimates of direct and indirect output from tillage by county



Source: author’s estimates using CSO county-level crop area statistics.

Note: Output estimates use average national crop yields. Regional variation in yields (and output per hectare) has not been considered due to insufficient data. Indirect output apportioned to counties based on their shares of farm-level tillage outputs. The estimates are approximate as indirect output may occur outside the county where the primary tillage output originated reflecting the spatial concentrations of businesses in the supply chain. Capturing such effects was outside the scope of the present study.

Figure 5.2 Estimates of direct and indirect employment from tillage by county



Source: author’s estimates using CSO county-level crop area statistics.

Note: Indirect employment apportioned to counties based on their shares of national tillage output. The estimates are approximate as indirect employment may occur outside the county where the tillage output originated, reflecting the spatial concentrations of businesses in the supply chain. Capturing such effects was outside the scope of the present study.

The contribution of tillage production to regional Gross Value Added (GVA)⁴⁰ provides further evidence of this geographic profile. Table 5.6 shows regional GVA estimates for the primary tillage and the primary⁴¹ agriculture sectors using data provided by the CSO for 2014 (the most recent available). Nationally, primary agriculture (overall) and tillage accounted for 1.4% and 0.2% of GVA, respectively. Consequently, tillage accounted for almost 13% of agricultural GVA, nationwide.

It is useful to highlight the regional variations in the economic importance of agriculture and specifically the tillage sector. For the traditional cropping areas of the South-East and Dublin & Mid-East, tillage contributed more than 25% of their regional GVA from primary agriculture. Moreover, tillage accounted for c.20% of agriculture GVA in the Midland region.

Table 5.6 Primary agriculture and tillage share of Gross Value Added (GVA) by region, 2014

	Agriculture share of regional GVA (%)	Tillage share of regional GVA (%)	Tillage share of agriculture GVA (%)
Border	4.4	0.1	2.2
Dublin and Mid-East	0.4	0.1	27.7
Midland	2.9	0.6	20.2
Mid-West	2.7	0.2	6.9
South-East	3.2	0.8	26.0
South-West	2.0	0.1	7.1
West	1.9	0.0	2.1
State	1.4	0.2	12.9

Source: CSO Table RAA06 Gross Value Added by Region plus own estimates of GVA for Tillage.

Note: Primary (i.e. farming) sector GVA at basic prices and does not include indirect or induced effects. **NUTS3 (2016) Regions:** Border: Donegal, Monaghan, Cavan, Leitrim, Sligo; Dublin & Mid-East: Dublin, Louth, Meath, Kildare, Wicklow; Midland: Laois, Offaly, Westmeath, Longford; Mid-West: Clare, Tipperary, Limerick; South-East: Wexford, Carlow, Kilkenny, Waterford; South-West: Cork, Kerry; West: Galway, Mayo, Roscommon.

5.7 Downstream impacts

The impacts described in this chapter have focussed on the economic contribution of tillage at the farm-level and upstream through the tillage supply chain. However, as noted in Chapter 4, downstream industries, such as brewing/distilling and animal feed production, rely on Irish tillage production for significant shares of their inputs. These downstream sectors are substantial in terms of output and employment. The drinks sector was estimated to contribute over €2bn to the economy

⁴⁰ Gross Value Added (GVA) is a measure of the value of the goods and services produced in a region minus the cost of all inputs and raw materials that are directly attributable to that production. GVA includes all subsidies but excludes product taxes. It is conceptually similar to Gross Domestic Product (GDP) with the difference being that GDP is calculated including product taxes but excluding subsidies.

⁴¹ 'Primary' comprises the farm-level GVA only and therefore excludes the GVA contribution of the broader agri-food industry outside the 'farm gate.'

(Fitzgerald, 2015), while direct output from the livestock feed industry was c.€1.4bn per annum during 2014-2018. The brewing sector directly employs c.1,100 FTE while the Irish animal feed sector, comprising 82 registered manufacturing sites, employs c.2,000 people.

However, it is recognised that the contribution of Irish tillage to its downstream industries cannot be readily quantified because the output of those sectors depends on a mix of inputs (including imported ingredients). Increases in final demand for productions of the downstream industries may, in some cases, be met from increased imports rather than an enhanced native supply of raw materials. Also, the value creation in the drinks sector, for example, includes dimensions such as brand equity, which are not correctly attributable to the tillage industry⁴². Consequently, it is difficult to assign the specific contribution of Irish tillage to the broader value creation in the downstream industries that use its outputs. Notwithstanding this measurement problem, it is vital to acknowledge at least qualitatively these broader economic impacts. These benefits include the provenance, traceability, and lower food miles of locally sourced raw materials, and their value to 'Irish-origin' branding of the end-products. Furthermore, the commitment of down-stream industries to local sourcing is instrumental in providing the confidence and foundation for strategies to enhance the output and value-added from native tillage production.

⁴² A representative from the drinks industry emphasised that the 'Irishness' of Irish whiskey was not just about the origin of the raw materials but embodied the traditional processes (e.g distillation methods, cask maturing, etc) used in its production.

6. Tillage and the environment

This chapter considers opportunities and challenges in the interface between tillage production and the natural environment. It begins by quantifying the carbon footprint of tillage relative to other conventional land-based farming enterprises in Ireland. The chapter then briefly explores other environmental considerations, such as regulation of plant protection products and the role of tillage in supporting biodiversity.

6.1 Carbon footprint

Binding commitments to reduce Greenhouse Gas (GHG) emissions represent a critical challenge for Irish agriculture. Under the European Union Climate and Energy Framework and subsequent Effort Sharing Proposals (COM/2016/482), Ireland has committed to a 30% reduction in its non-ETS greenhouse gas emissions by 2030, relative to the baseline year of 2005. Agriculture accounts for one-third of Ireland's non-ETS emissions, and consequently, the sector's role is pivotal in meeting the national abatement targets. In its 2019 report, the Climate Change Advisory Council (CCAC) highlighted the risks of Ireland missing its 2030 emissions reduction target and the consequences in additional exchequer costs through applicable penalties (e.g. purchase of emissions allowances with public funds).

The Climate Change Advisory Council (CCAC) noted that annual agriculture emissions increased by 6.9% between 2014 and 2017 and were projected to increase further because of the continuing expansion of the national dairy herd. They acknowledged the potential for a variety of mitigation options⁴³ to reduce agriculture emissions but suggested that:

“Many of the actions undertaken to mitigate emissions and improve efficiency cannot be readily reflected in national estimates of emissions and removals”
(p.42)

“The collective impact of existing mitigation measures is likely to be insufficient in achieving reductions in agricultural emission” (p.116)

Consequently, achieving reductions in emissions from agriculture could involve unpalatable choices such as direct curbs on bovine numbers. The CCAC suggested that reduction of the national suckler cow herd could be a *‘cost-effective contribution to mitigation in the [agriculture] sector.’* (p.iv)

Surprisingly, CCAC (2019) did not refer to the potential role of tillage production as part of Ireland's climate actions. The remainder of this section quantifies the lower carbon-footprint of tillage

⁴³ Based on the Teagasc Marginal Abatement Cost Curve (MACC) - Schulte, R.P.O. and Donnellan, T. (2012).

compared to bovine enterprises. It suggests that maintenance of a vibrant cropping sector has a key role to play in cost-effective emissions reduction in agriculture.

Our analysis uses the standard IPCC methodology⁴⁴ used for the preparation of national GHG inventories under UNFCCC and EU regulation 525/2013. The Environmental Protection Agency (EPA) is the responsible authority for preparing Ireland's submissions to UNFCCC (see EPA, 2019). This national emissions inventory submission contains activity statistics (e.g. fuel consumption, production, livestock numbers, and land areas), emission factors, and the associated emission estimates for a specified list of source categories. The emissions are calculated by applying agreed emission factors for each source (gas) to appropriate activity data for the activity concerned (EPA, 2019). Accordingly, it is possible to apply the same calculation equations and emissions factors to quantify GHG emissions for specific farming systems.

Specifically, we use this framework to calculate GHG inventories for tillage and comparator farming enterprises, including 'specialist dairy,' 'cattle rearing' and 'cattle other.'⁴⁵ A summary of the results of this evaluation is shown in Table 6.1, with all figures shown per hectare utilised to aid comparison.

The simulated tillage system comprised the national average crop mix (as shown in Figure 2.4) with conventional plough-based cultivations. Nitrogen usage (per hectare) for each crop was derived from Teagasc Crop Costs and Returns 2019. It was assumed that 20% of the available N requirement was obtained from organic manures. Emissions from crop residues were derived from figures reported in EPA (2019).

For the comparator systems (Dairy, Cattle Rearing, Cattle Other), activity data comprising livestock numbers were taken from the National Farm Survey (2018) as the reported 'averages'⁴⁶ for each system. Chemical nitrogen application rates were taken from Teagasc (2016b), corresponding to the average farm stocking rate for each livestock system.

Lime application rates for all systems were derived from NFS data. The shares of chemical N applied as urea, and calcium ammonium nitrate were 86.6% and 13.4%, respectively, from EPA (2019)⁴⁷. Emissions from fuel were calculated using estimated fuel consumption in litres times the emission factor per litre for green diesel⁴⁸.

⁴⁴ International Panel on Climate Change (IPCC): 2006 IPCC Guidelines for National Greenhouse Gas Inventories and 2019 refinement to the 2006 guidelines.

⁴⁵ The systems here correspond to the Teagasc NFS classification. 'Cattle rearing' comprises suckler cow systems while 'cattle-other' are mainly cattle finishing systems.

⁴⁶ For each system this comprised the average stocking rate and 'activity' data used in the IPCC inventory calculation including the details of livestock numbers by type. Emissions from enteric fermentation and manure management were calculated by applying the emissions factors (per head) reported in EPA (2019) to the relevant livestock numbers.

⁴⁷ These were the national proportions calculated from EPA (2019). Due to the absence of more granular information these rates were applied across all systems.

⁴⁸ Fuel consumption for each system was calculated using NFS data on their average fuel expenditure plus 25% of contractor costs, assumed to represent the average proportion of fuel cost in contractor charges. Fuel

Emissions of Carbon Dioxide (CO₂), Methane (CH₄), and Nitrous Oxide (N₂O) were converted to CO₂ equivalents (CO₂e) using their 100-yr global warming potentials which, on a weight basis relative to CO₂, were set to a factor of 28 for 1 kg of CH₄ and 265 for 1 kg of N₂O (IPCC, 2014).

Table 6.1 shows the estimates of GHG emissions per hectare, broken down by source, for each of the modelled farm systems. Estimated emissions from fuel are shown separately since these emissions are reported under the ‘energy’ sector rather than ‘agriculture’ within the IPCC reporting framework.

GHG emissions from tillage comprise direct and indirect N₂O from soils through fertiliser application and crop residues, and CO₂ from the application of lime and urea. Direct emissions from applications of synthetic nitrogen and lime accounted for 73% of CO₂e from tillage. The remaining emissions comprised N₂O from crop residues (20.5%) and indirect N₂O emissions (6.5%) from atmospheric deposition and leaching/run-off.

In the case of the bovine systems, emissions of methane (CH₄) from enteric fermentation and manure management were the dominant GHG sources accounting for around three-quarters of their CO₂e.

Excluding fuel consumption, emissions for the tillage system were approximately 1.2 tonnes of CO₂e per hectare. This was 14% of the emissions per hectare from the average dairy system and about 30% of the emissions per hectare from the beef systems.

Table 6.1 Comparison of estimated greenhouse gas emissions per hectare by system

Emissions (kg per hectare)	Tillage (specialist)	Dairy (2.1 LU/ha)	Cattle Rearing (1.2 LU/ha)	Cattle Other (1.5 LU/ha)
Enteric fermentation (CH ₄)	0.00	212.77	97.04	102.83
Manure management (CH ₄)	0.00	20.07	9.48	9.69
Manure management (N ₂ O)	0.00	0.35	0.30	0.30
Direct emissions from managed soils (N ₂ O)	3.82	5.96	2.50	3.37
Indirect emissions from managed soils (N ₂ O)	0.30	0.74	0.33	0.43
Liming (CO ₂)	123.20	220.00	92.40	96.80
Urea application (CO ₂)	13.85	15.54	5.33	8.29
Total Carbon Dioxide (CO₂)	137.05	235.54	97.73	105.09
Total Methane (CH₄)	0.00	232.84	106.52	112.52
Total Nitrous Oxide (N₂O)	4.12	7.06	3.13	4.10
Total CO₂ equivalent excl. fuel (CO₂e)¹	1,228.38	8,624.70	3,910.99	4,342.32
Emissions from fuel usage (CO ₂ e)	363.99	371.90	220.88	228.25
Total CO₂ equivalent incl. fuel (CO₂e)	1,592.37	8,996.60	4,131.87	4,570.57

Source: own estimates using NFS 2018 and EPA (2019) emissions factors

consumption in litres was approximated by dividing estimated fuel expenditure by an average price of green diesel in 2018.

Including fuel usage, emissions from the tillage system increased to almost 1.6 tonnes of CO₂e per hectare. Tillage fuel usage per hectare was similar to that of dairy, although somewhat higher than the levels estimated for the beef systems. However, the relative positions of the systems in CO₂e per hectare were broadly unaltered when we include fuel-related emissions. The tillage emissions per hectare, including fuel consumption, were 18%, 39%, and 35% of the levels for the modelled dairy, cattle rearing, and cattle other systems, respectively. Importantly, tillage compared favourably to the other systems across all the component GHG gases. Tillage has zero methane emissions per hectare, but it also has relatively low emissions per hectare of carbon dioxide and nitrous oxide.

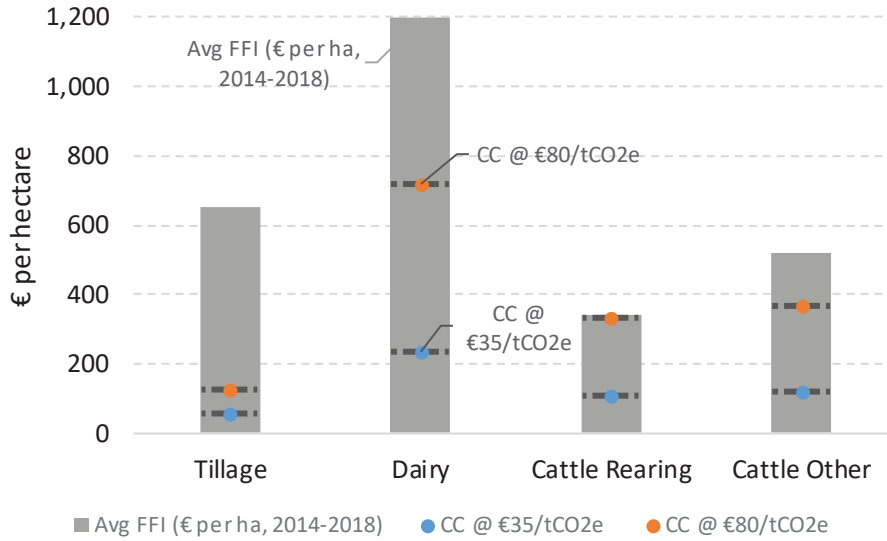
In tillage areas, there has been a notable shift in land use towards dairy production since the removal of milk quotas. Based on the estimates Table 6.1, for every 100 hectares of tillage switched to an 'average' dairy system, GHG emissions would increase by about 740 tonnes of CO₂e. This indicates a potentially significant impact on Ireland's ability to meet its climate targets from the drift of land from tillage into milk production⁴⁹. In chapter 2 it was shown that tillage area declined by 57,400 hectares with much of this area diverted to milk production. This change in land use would correspond to an increase in Greenhouse Gas Emissions of c.425,000 tonnes of CO₂e, based on the system-level estimates in Table 6.1.

The CCAC (2019) recommended an increase in carbon tax to €35 per tonne of carbon dioxide equivalent in Budget 2020 and proposed that this should be steadily increased each year to reach at least €80 per tonne by 2030. Figure 6.1 shows the implied cost of carbon emissions per hectare for each system based on the carbon pricing levels suggested by CCAC. To provide context, the average annual Family Farm Income (FFI) per hectare over the period 2014-2018 is also shown for each system.

A theoretical carbon cost of €80 per tonne would indicate an implied 'cost of emissions' equivalent to 20% of average (2014-2018) FFI for tillage compared to 60% for dairy and 100% for cattle rearing (Figure 6.1).

⁴⁹ It is noted that emissions from land use change have not been considered here and that carbon sequestration is likely to be greater for permanent grassland than tillage. However, research studies suggest high uncertainty about soil carbon stocks associated with land use change from tillage to grassland.

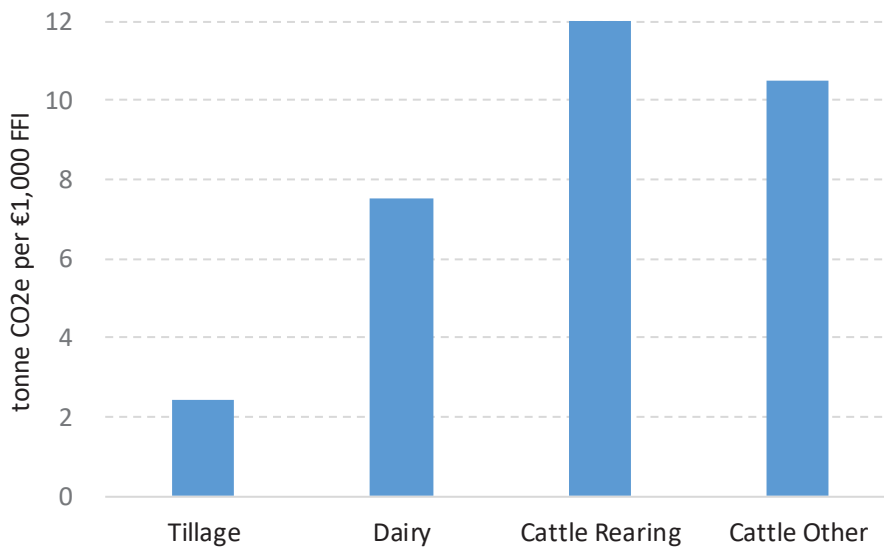
Figure 6.1 Average Family Farm Income per hectare and carbon cost (CC) per hectare



Source: Family Farm Income from Teagasc National Farm Survey 2014-2018. Own estimates of carbon cost per hectare

As shown in Figure 6.2, tillage compares favourably to the other farm systems based on GHG emissions intensity measured in tonnes of CO₂e per €1,000 of Family Farm Income.

Figure 6.2 Emissions intensity: tonnes of CO₂e per €1,000 Family Farm Income (Avg 2014-2018)



Source: own calculations using emissions estimates (Table 6.1) and Family Farm Income data from Teagasc National Farm Survey 2014-2018.

6.2 Plant protection products

In the environmental context, a pressing challenge for the tillage sector concerns increased restrictions on Plant Protection Products (PPPs). The availability and use of PPPs are being curtailed by several areas of EU policymaking, including:

- The approvals process for PPPs
- Implementation of the Water Framework Directive
- Regulations on Sustainable Use of Pesticides
- Maximum Residue Levels

Andersons (2014) suggested that the cumulative effects of these policies could threaten 87 out of 250 active substances available to tillage farmers. The intense political debate that surrounded the EU's decision to renew the licence for Glyphosate in 2017 was symbolic of the challenges in the decision-making processes for approvals of PPPs in Europe.

From the perspective of farmers, further PPP restrictions make control of weeds, diseases, and pests in tillage crops more problematic, and they place greater reliance on a narrower set of products, increasing the risks of resistance build-up. As noted by Kildea (2016), resistance to fungicide sprays in wheat crops is already a significant problem in Ireland. Andersons (2014) concluded that loss of critical PPPs would substantially reduce tillage yields with predicted reductions of up to 50% in some crops based on the effect of losing PPPs they classified as 'high' likelihood of being restricted or not gaining reauthorisation.

6.3 Advanced crop breeding

Advanced crop breeding technologies can support some of the adaptations necessitated by tighter regulation of PPPs. For example, gene-editing tools provide plant breeders with the potential to develop crops that are more resistant to diseases, pests, and extreme environments, thereby reducing reliance on PPPs. This technology can also be used to enhance the nutritional value of crops through biofortification. Unlike Genetically Modified Organisms (GMOs), gene-edited plants do not incorporate foreign DNA from other plant species. Consequently, the risks of gene-editing technology are lower than with GM crops because most edits alter only limited nucleotides, producing changes, not unlike those found in the naturally occurring plant populations (Voytas & Gao, 2014).

The crop breeding process seeks to improve beneficial traits within the plant and to minimise undesirable characteristics. Genome editing can speed-up the natural breeding process allowing precise changes to the expression of specific genes for traits of interest, and more rapid progress in genetic improvement can be achieved. In a review paper, Zhang, et al. (2018) listed a range of crop traits that have been improved by genome editing techniques, including disease resistance, grain weight, and protein content. Accordingly, gene-editing technology offers the potential to solve real challenges for farmers and the planet, like reducing the need for pesticides and energy, enhancing quality characteristics, and overall productivity. Advances in plant breeding that deliver greater crop resilience and resource efficiencies can realise benefits for growers, consumers, and the environment (Voytas & Gao, 2014).

The regulatory frameworks created to address public safety and environmental concerns will determine the extent to which new technologies such as gene editing are deployed. In the European Union, the Precautionary Principle is applied in such decisions. The EU Court of Justice, in 2018, ruled that gene-edited plants and crops will be subject to the same onerous regulations as GMOs. However,

Christensen et al. (2018) argue that novel gene-editing technologies, such as CRISPR/Cas9, are much more precise and cause fewer alterations in plants even than traditional breeding methods. They suggest that the Court's ruling puts the EU out of step with its international competitors, making it practically impossible for EU scientists to commercialise crops produced through gene editing. Consequently, the EU's regulatory environment may be inhibiting critical aspects of crop science innovation in Europe. Irish and European tillage farmers are thereby disadvantaged in global markets where they compete with international producers that are already harnessing the potential of these new technologies⁵⁰.

6.4 Biodiversity

Tillage farmland, which accounts for 8% of Ireland's agricultural area, is a crucial habitat for biodiversity. Changes in agricultural land use, including intensification and the decline in mixed (livestock and crop) farming, are factors that threaten biodiversity through habitat loss. Concerning farmland birds, for example, Robinson et al. (2001) noted that in Britain:

'Local extinctions have occurred in grassland-dominated areas in western Britain, which may be influenced by loss in habitat diversity and a decline in the amount of arable cultivation.' P.1059

'Increasing arable cultivation in pastoral landscapes is likely to be beneficial to granivorous species, particularly those that have experienced severe population declines.' P.1066

The reduction in tillage as a subsidiary enterprise on Irish livestock farms was highlighted in Chapter 2, and this decline may be negatively impacting on farmland bird populations. Consequently, sustaining mixed agricultural land use that includes 'pockets' of tillage within Ireland's grassland landscapes may be of particular value in agri-environmental planning.

The environmental contribution of tillage is further enhanced through a variety of current management practices, supported through agri-environmental policy (CAP, Glás), including:

- Minimum tillage cultivation to reduce energy consumption, reduce erosion, and enhance soil health.
- Integrated Pest Management strategies to reduce reliance on PPPs.
- Management of arable margins along field and riparian boundaries.
- Environmental management of fallow land including wild bird mixtures.
- Sowing of winter cover crops to mitigate nutrient loss and sequester carbon.
- Increased crop diversity in tillage rotations with break crops such as pulses.
- Low emission slurry spreading on tillage land.

⁵⁰ Including in the EU market where imports of certain approved GM crops is permissible.

The 2020 CAP reform has signalled a greater environmental ambition across a range of performance metrics, including climate action, water quality, and biodiversity. Through a clear focus on sustainable management practices, the tillage sector has a pivotal role in preserving habitats and landscapes, protecting biodiversity, mitigating GHG emissions, and enhancing ecosystems services. Consequently, the sector's potential contribution across these domains should be more explicitly recognised in a balanced land use strategy for Ireland.

References

- AHDB (2018). Growing Importance of Ireland for UK processed potato trade.
<https://potatoes.ahdb.org.uk/publications/growing-importance-ireland-uk-processed-potato-trade>
- Andersons (2014). The Effect of the Loss of Plant Protection Products on UK Agriculture and Horticulture and the Wider Economy. Report prepared for the Agricultural Industries Confederation (AIC), the Crop Protection Association (CPA) and the National Farmers Union (NFU). Melton Mowbray: The Andersons Centre.
- Boortmalt (2018). Boortmalt Ireland has decided to extend its malting capacity in Athy by 30k MT. <https://www.boortmalt.com/en/boortmalt-ireland-has-decided-extend-its-malting-capacity-athy-30k-mt>
- Connolly, L., Kinsella, A, Quinlan, G., and Moran, B. (2006). National Farm Survey Results 2005. Agricultural Economics and Farm Surveys Department, Rural Economy and Development Programme: Teagasc.
- CSO (2019a). AQA04 Crop yield and production by year, type of crop and statistic.
<https://statbank.cso.ie/>
- CSO (2019b). AQA06 Area framed in June by Type of Land Use, Region and Year.
<https://statbank.cso.ie/>
- CSO (2018a). Supply, Use and Input-Output Tables for Ireland, 2015.
<https://www.cso.ie/en/releasesandpublications/ep/p-sauio/supplyanduseandinput-outputtablesforireland2015/>
- CSO (2018b). Output, Input and Income in Agriculture.
<https://www.cso.ie/en/statistics/agriculture/outputinputandincomeinagriculture/>
- CSO (2017a). Census of Industrial Production.
<https://www.cso.ie/en/statistics/multisectoral/structuralbusinessstatistics/>
- CSO (2017b). Annual Services Inquiry. <https://www.cso.ie/en/statistics/services/>
- CSO (2009). Supply, Use and Input-Output Tables for Ireland, 2005.
- Department of Agriculture, Food and the Marine (2020). Registered Grain Intake.
<https://www.agriculture.gov.ie/agri-foodindustry/feedingstuffs/listsoffbos-registeredandapproved/>
- Department of Agriculture, Food and the Marine (2019). Review of Organic Food Sector and Strategy for its Development 2019-2025.
<https://www.agriculture.gov.ie/media/migration/farmingsectors/organicfarming/organicscheme/ReviewofOrganicFoodSector290119.pdf>
- Department of Agriculture, Food and the Marine (2019). Annual Review and Outlook for Agriculture, Food and the Marine 2019. Dublin: Economics and Planning Division, DAFM
- Department of Agriculture, Food and the Marine (2018). Annual Review and Outlook for Agriculture, Food and the Marine 2018. Dublin: Economics and Planning Division, DAFM

- Department of Agriculture, Food and the Marine (2017). Annual Review and Outlook for Agriculture, Food and the Marine 2016-2017. Dublin: Economics and Planning Division, DAFM
- Department of Agriculture, Food and the Marine (2016). Annual Review and Outlook for Agriculture, Food and the Marine 2015-2016. Dublin: Economics and Planning Division, DAFM
- Department of Agriculture, Food and the Marine (2015). Annual Review and Outlook for Agriculture, Food and the Marine 2014-2015. Dublin: Economics and Planning Division, DAFM
- Department of Agriculture, Food and the Marine (2014). Annual Review and Outlook for Agriculture, Food and the Marine 2013-2014. Dublin: Economics and Planning Division, DAFM
- DEFRA (2018). Organic Farming Statistics 2017. London: HMSO
- DEFRA (2019). Agriculture in the United Kingdom, 2018. London: HMSO.
- Dillon, E., Moran, B., and Donnellan, T. (2017). Teagasc National Farm Survey Results 2016. Agricultural Economics and Farm Surveys Department, Rural Economy and Development Programme: Teagasc.
- Dillon, E., Moran, B. Lennon, J. and Donnellan, T. (2018). Teagasc National Farm Survey Results 2017. Agricultural Economics and Farm Surveys Department, Rural Economy and Development Programme: Teagasc.
- Dillon, E., Moran, B. Lennon, J. and Donnellan, T. (2019). Teagasc National Farm Survey Results 2018. Agricultural Economics and Farm Surveys Department, Rural Economy and Development Programme: Teagasc.
- Drinks Ireland (2019). Whiskey Industry in Ireland.
https://www.drinksireland.ie/Sectors/DI/DI.nsf/vPagesWhiskey/Industry_in_Ireland~whiskey-industry-in-ireland!OpenDocument
- EPA (2019). Ireland's National Inventory Report, 2019. Greenhouse Gas Emissions 1990 – 2017 reported to the United Nations Framework Convention on Climate Change. Environmental Protection Agency: Johnstown Castle, Co. Wexford.
- Eurostat (2018). Land prices and rents.
<https://ec.europa.eu/eurostat/documents/2995521/8756523/5-21032018-AP-EN.pdf/b1d0ffd3-f75b-40cc-b53f-f22f68d541df>
- Eurostat (2019). Comext International Trade data. Available at:
<http://epp.eurostat.ec.europa.eu/newxtweb/>
- Euromonitor International (2019). Savoury Snacks in Ireland.
- Feeney, B. (2018). Craft and Microbreweries in Ireland, 2018. A report for the Independent Craft Brewers of Ireland and Bord Bia. <http://icbi.ie/wp-content/uploads/2018/11/Craft-Beer-Report-2018.pdf>

- Finneran, E., Crosson, P., O'Kiely, P., Shalloo, L., Forristal, D. and Wallace, M. (2010). Simulation Modelling of the Cost of Producing and Utilising Feeds for Ruminants on Irish Farms. *Journal of Farm Management*, 14 (2), 95-116.
- Fitzgerald, C. (2015). Sustainable Growth of the Drinks Industry. Report to Alcohol Beverage Federation of Ireland.
[https://www.drinksireland.ie/Sectors/DI/DI.nsf/vPagesDI/Publications~sustainable-growth-of-the-drinks-industry-by-ciaran-fitzgerald/\\$File/Drinks+Industry+Report+by+Ciaran+Fitzgerald+26.11.15.pdf](https://www.drinksireland.ie/Sectors/DI/DI.nsf/vPagesDI/Publications~sustainable-growth-of-the-drinks-industry-by-ciaran-fitzgerald/$File/Drinks+Industry+Report+by+Ciaran+Fitzgerald+26.11.15.pdf)
- Hennessy, T. and Moran, B. (2015). Teagasc National Farm Survey Results 2014. Agricultural Economics and Farm Surveys Department, Rural Economy and Development Programme: Teagasc.
- Hennessy, T. and Moran, B. (2016). Teagasc National Farm Survey Results 2015. Agricultural Economics and Farm Surveys Department, Rural Economy and Development Programme: Teagasc.
- Hennessy, T., Doran, J., Bogue, P., and Repar, L. (2018). The Economic and Societal Importance of The Irish Suckler Beef Sector. Report prepared for the Irish Farmers' Association. University College Cork
- International Panel on Climate Change (2006). 2006 IPCC Guidelines on National Greenhouse Gas Inventories. <https://www.ipcc-nggip.iges.or.jp/public/2006gl/>
- International Panel on Climate Change (2014). Climate Change 2014: Synthesis Report. Inventories. https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf
- Irish Brewers Association (2018a). Annual Beer Report.
[https://www.abfi.ie/Sectors/DI/DI.nsf/vPagesBeer/Publications~abfi-2018-year-in-review/\\$File/ABFI+2018+Year+in+Review.pdf](https://www.abfi.ie/Sectors/DI/DI.nsf/vPagesBeer/Publications~abfi-2018-year-in-review/$File/ABFI+2018+Year+in+Review.pdf)
- Irish Brewers Association (2018b). The Irish Beer Market in 2018.
[https://www.drinksireland.ie/Sectors/DI/DI.nsf/vPagesBeer/Publications~the-irish-beer-market-report-2018/\\$File/ABFI+Beer+Report+WEB.pdf](https://www.drinksireland.ie/Sectors/DI/DI.nsf/vPagesBeer/Publications~the-irish-beer-market-report-2018/$File/ABFI+Beer+Report+WEB.pdf)
- Irish Examiner (2012, February 9th). Odlums Mill Closure will Increase Bread Flour Imports. <https://www.irishexaminer.com/farming/odlums-mill-closure-will-increase-bread-flour-imports-183124.html>
- Irish, J. (2013). An Analysis of the Use of Profit Monitor and Other Financial Management Tools by Tillage Farmers and Advisors. Unpublished MAgrSc Thesis: University College Dublin.
- ITC (2019). TradeMap. Trade statistics for international business development.
<https://www.trademap.org/Index.aspx>
- Kildea, S. (2016). Wheat Disease Control and Resistance Issues. National Tillage Conference, 28 January 2016. <https://www.teagasc.ie/media/website/publications/2016/Tillage-Conference-Proceedings-2016.pdf>
- Miller, A.C., Matthews, A., Donnellan, T., and O'Donoghue, C. (2011a). A 2005 Social Accounting Matrix (SAM) for Ireland. IIS Discussion Paper No. 365. Trinity College Dublin.

- Miller, A.C., Matthews, A., Donnellan, T., and O'Donoghue, C. (2011b). A 2005 Agriculture-Food SAM (AgriFood SAM) for Ireland. IIS Discussion Paper No. 372. Trinity College Dublin.
- Mintel (2019). Bread and Baked Good – Ireland – April 2019.
- O'Connell, J. and Phelan, J. (2011). The Importance of Agriculture and the Food Industry to the Irish Economy. Report commissioned by the Irish Farmers Association, June 2011.
- Parikh, A. (1979). Forecasts of Input-Output Matrices Using the R.A.S. Method. *The Review of Economics and Statistics* 61(3): 477-481.
- Robinson, R.A., Wilson, J.D., and Crick, H.Q.P. (2001). The importance of arable habitat for farmland birds in grassland landscapes. *Journal of Applied Ecology*, 38, 1059-1069.
- Ryschawy, J., Choisis, N., Choisis, J., P., and Gibon, A., (2013). 'Paths to last in mixed crop-livestock farming: Lessons from an assessment of farm trajectories of change', *Animal*, 7(4), 1-9.
- Schulte, R.P.O., Donnellan, T. (Eds.) (2012). A Marginal Abatement Cost Curve for Irish Agriculture. Teagasc submission to the National Climate Policy Development Consultation, Teagasc, Carlow.
- Teagasc (2019). Annual Review and Outlook 2020. Rural Economy and Development Programme: Athenry.
- Teagasc (2018). Annual Review and Outlook 2019. Rural Economy and Development Programme: Athenry.
- Teagasc (2016a). Straw for Energy. Tillage Factsheet No. 12.
<https://www.teagasc.ie/media/website/publications/2016/12.-Straw-for-Energy.pdf>
- Teagasc (2016b). Major and Micro Nutrient Advice for Productive Agricultural Crops. 4th Edition. Teagasc: Johnstown Castle, Co. Wexford
- Teagasc Tillage Crop Stakeholder Consultative Group (2012). Tillage Sector Development Plan.
https://www.teagasc.ie/media/website/publications/2012/Tillage_Sector_Plan_2012_FINALLowres.pdf
- Thorne, F., Donnellan, T., and Hanrahan, K. (2019). Economics of the tillage sector: possible Brexit implications. Presentation to the National Tillage Conference, 30th January 2019.
https://www.teagasc.ie/media/website/rural-economy/rural-economy/Tillage-Conf-2019_fiona-thorne_29-Jan_to-EM-.pdf
- Voytas D.F. and Gao C. (2014). Precision genome engineering and agriculture: opportunities and regulatory challenges. *PLoS Biol.* 2014;12: e1001877.
- Zahoor, F. and Forristal, D. (2016). Oilseed Rape: Crop Report. CROPQUEST Project Report. Oakpark: Teagasc. <https://www.teagasc.ie/media/website/crops/crops/OSR-Full-report.pdf>
- Zhang, Y., Massel, K., Godwin, I.D., and Gao, C. (2018) Applications and Potential of Genome Editing in Crop Improvement. *Genome Biology*, 19:210

Appendix 1: Crop areas by region

Table A1.1 Areas by crop type and NUTS3 region ('000 hectares)

2013	Barley	Wheat	Oats	Oilseed	Pulses	Potatoes	Other	Total
Dublin and Mid-East	60.9	30.4	9.6	6.2	1.9	5.9	6.5	121.4
South-East	69.7	13.4	8.1	4.8	1.1	2.0	7.6	106.7
South-West	35.2	7.2	3.1	0.8	0.8	1.0	8.7	56.7
Midland	26.3	4.4	1.8	0.9	0.4	0.3	3.2	37.3
Mid-West	17.6	4.4	2.1	0.9	0.3	0.3	2.0	27.6
Border	5.4	0.6	1.0	*	*	1.1	1.0	9.2
West	4.3	0.2	0.9	*	*	*	0.8	6.4
State	219.4	60.6	26.7	13.7	4.5	10.7	29.6	365.2
2014	Barley	Wheat	Oats	Oilseed	Pulses	Potatoes	Other	Total
Dublin and Mid-East	56.4	41.6	5.8	4.3	1.7	5.2	5.9	121.0
South-East	71.2	13.0	5.8	3.4	0.8	1.9	7.7	103.8
South-West	35.2	6.5	2.0	0.6	0.5	0.9	8.0	53.7
Midland	25.6	5.5	1.6	0.6	0.2	0.2	3.3	36.9
Mid-West	17.9	4.2	1.6	0.6	0.2	0.2	1.9	26.6
Border	5.1	0.6	0.9	*	*	1.0	0.9	8.7
West	4.2	0.3	0.9	*	*	*	0.7	6.2
State	215.7	71.6	18.6	9.4	3.5	9.5	28.5	356.8
2015	Barley	Wheat	Oats	Oilseed	Pulses	Potatoes	Other	Total
Dublin and Mid-East	54.7	36.8	7.4	4.8	4.4	4.5	5.7	118.3
South-East	66.2	11.7	7.1	2.6	3.2	1.7	7.4	100.0
South-West	32.3	6.5	2.9	0.5	1.6	0.7	7.2	51.6
Midland	24.2	4.8	2.3	0.4	0.7	0.2	3.0	35.5
Mid-West	17.0	4.6	1.9	0.5	0.6	0.3	2.2	27.2
Border	4.7	0.6	0.8	*	*	1.0	0.8	7.9
West	3.7	0.3	1.0	*	*	*	0.5	5.6
State	202.8	65.3	23.4	8.9	10.7	8.5	26.9	346.5
2016	Barley	Wheat	Oats	Oilseed	Pulses	Potatoes	Other	Total
Dublin and Mid-East	51.1	38.7	7.5	4.9	4.8	4.8	4.9	116.8
South-East	61.1	12.1	7.2	3.1	4.2	1.9	7.2	96.8
South-West	31.4	6.4	2.6	0.5	1.6	0.8	6.4	49.7
Midland	22.6	4.9	2.2	0.7	1.0	0.2	2.9	34.6
Mid-West	15.9	4.9	2.1	0.6	0.7	0.3	2.0	26.5
Border	3.9	0.6	0.8	*	*	1.0	0.7	7.1
West	3.2	0.3	0.8	*	*	*	0.5	4.9
State	189.2	67.9	23.2	9.9	12.5	9.0	24.7	336.4

2017	Barley	Wheat	Oats	Oilseed	Pulses	Potatoes	Other	Total
Dublin and Mid-East	48.4	38.0	8.1	5.1	5.5	5.0	5.5	115.7
South-East	58.1	12.2	7.3	2.8	4.8	2.0	7.6	94.8
South-West	29.4	6.1	3.1	0.5	1.7	0.8	6.5	48.1
Midland	22.1	5.1	2.3	0.9	1.0	0.2	2.9	34.5
Mid-West	15.4	4.6	2.2	0.6	0.7	0.2	1.8	25.6
Border	3.6	0.7	0.7	*	*	0.9	0.7	6.6
West	3.1	0.3	0.7	*	*	*	0.5	4.8
State	180.2	67.0	24.4	10.1	13.7	9.2	25.6	330.2

2018	Barley	Wheat	Oats	Oilseed	Pulses	Potatoes	Other	Total
Dublin and Mid-East	52.3	34.5	5.8	5.8	3.7	4.3	7.6	114.0
South-East	59.9	10.1	5.5	2.5	2.9	1.9	9.7	92.6
South-West	29.3	4.7	1.9	0.4	0.9	0.7	8.5	46.5
Midland	22.2	4.0	1.7	1.1	0.6	0.1	3.4	33.1
Mid-West	15.3	3.9	1.6	0.7	0.4	0.2	2.3	24.5
Border	3.4	0.6	0.5	*	*	0.8	0.7	6.1
West	2.8	0.1	0.7	*	*	*	0.6	4.2
State	185.2	58.0	17.8	10.6	8.5	8.2	33.0	321.3

Source: CSO

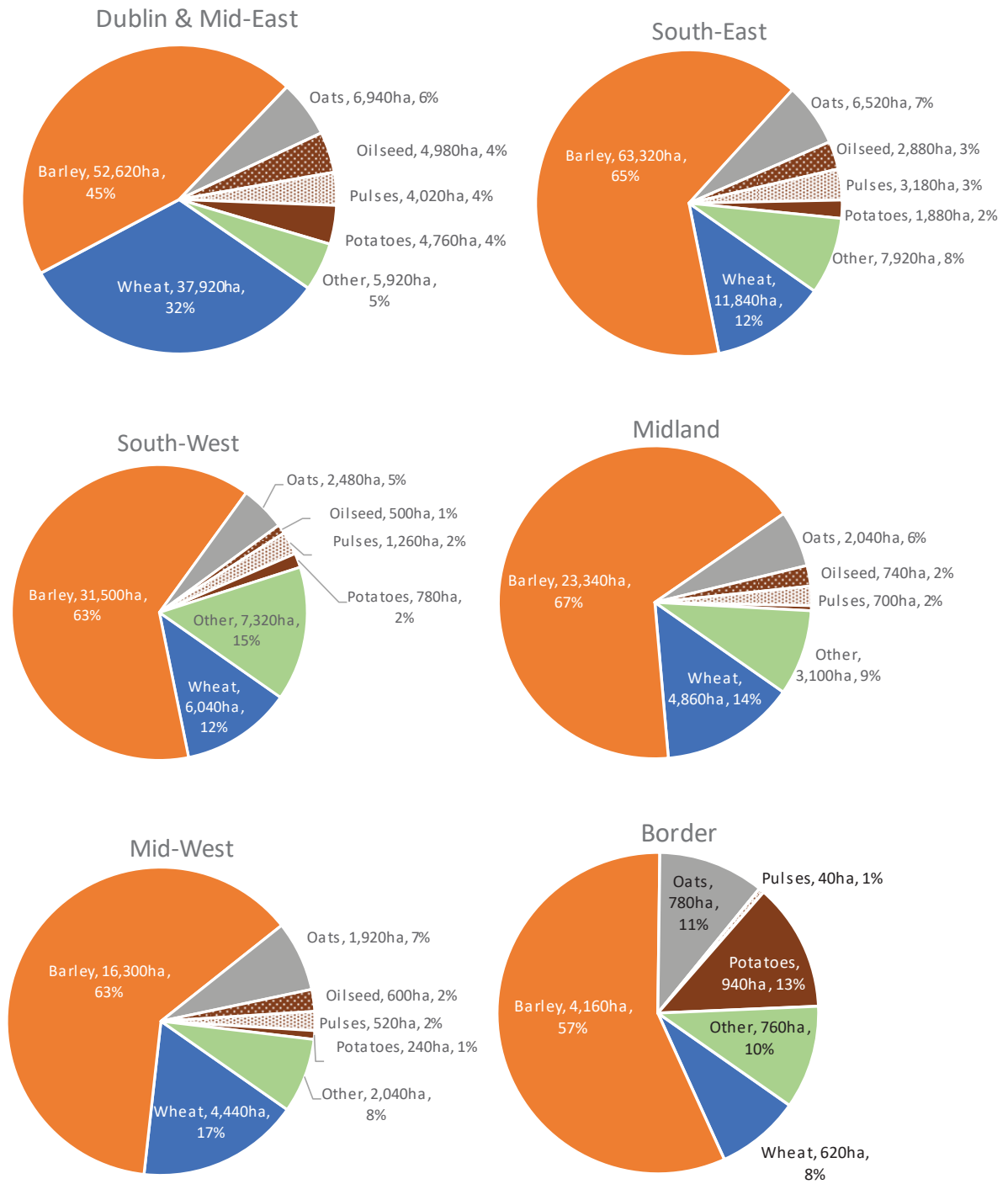
Note: * indicates less than 100 hectares. 'Other' comprises tillage fodder crops (maize, arable silage, beet) and minor cereals (e.g. triticale and rye).

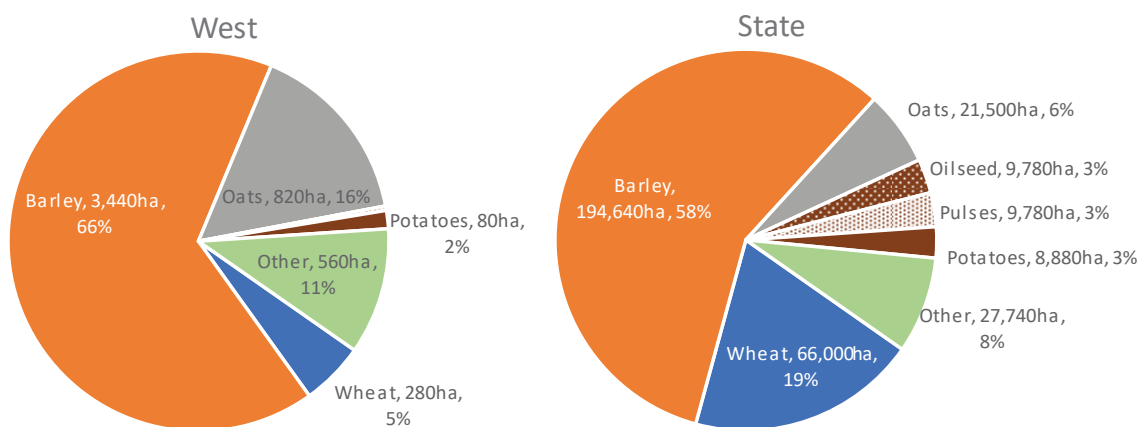
NUTS3 (2016) Regions: Dublin & Mid-East: Dublin, Louth, Meath, Kildare, Wicklow; South-East: Wexford, Carlow, Kilkenny, Waterford; South-West: Cork, Kerry; Midland: Laois, Offaly, Westmeath, Longford; Mid-West: Clare, Tipperary, Limerick; Border: Donegal, Monaghan, Cavan, Leitrim, Sligo; West: Galway, Mayo, Roscommon.

Table A1.2. Percentage changes in crop areas, 2017-18 vs 2013-14 by NUTS3 region

	Barley	Wheat	Oats	Oilseed	Pulses	Potatoes	Other	Total
Dublin and Mid-East	-14%	+1%	-10%	+4%	+156%	-16%	+6%	-5%
South-East	-16%	-16%	-8%	-35%	+305%	0%	+13%	-11%
South-West	-17%	-21%	-2%	-36%	+100%	-21%	-10%	-14%
Midland	-15%	-8%	+18%	+33%	+167%	-40%	-3%	-9%
Mid-West	-14%	-1%	+3%	-13%	+120%	-20%	+5%	-8%
Border	-33%	+8%	-37%	*	*	-19%	-26%	-29%
West	-31%	-20%	-22%	*	*	*	-27%	-29%
State	-16%	-5%	-7%	-10%	+178%	-14%	+1%	-10%

Figure A1.1 Cropping profiles by region (2014-2018 average)





Source: CSO Crop Statistics, average areas per annum over the period 2014-2018

Note: 'Other' comprises tillage fodder crops (maize, arable silage and beet) and minor cereals (e.g. triticale, rye)

NUTS3 (2016) Regions: Dublin & Mid-East: Dublin, Louth, Meath, Kildare, Wicklow; South-East: Wexford, Carlow, Kilkenny, Waterford; South-West: Cork, Kerry; Midland: Laois, Offaly, Westmeath, Longford; Mid-West: Clare, Tipperary, Limerick; Border: Donegal, Monaghan, Cavan, Leitrim, Sligo; West: Galway, Mayo, Roscommon.

Table A1.3 Detailed crop areas by NUTS3 region used in model estimates (average for 2014-2018 '000 hectares)

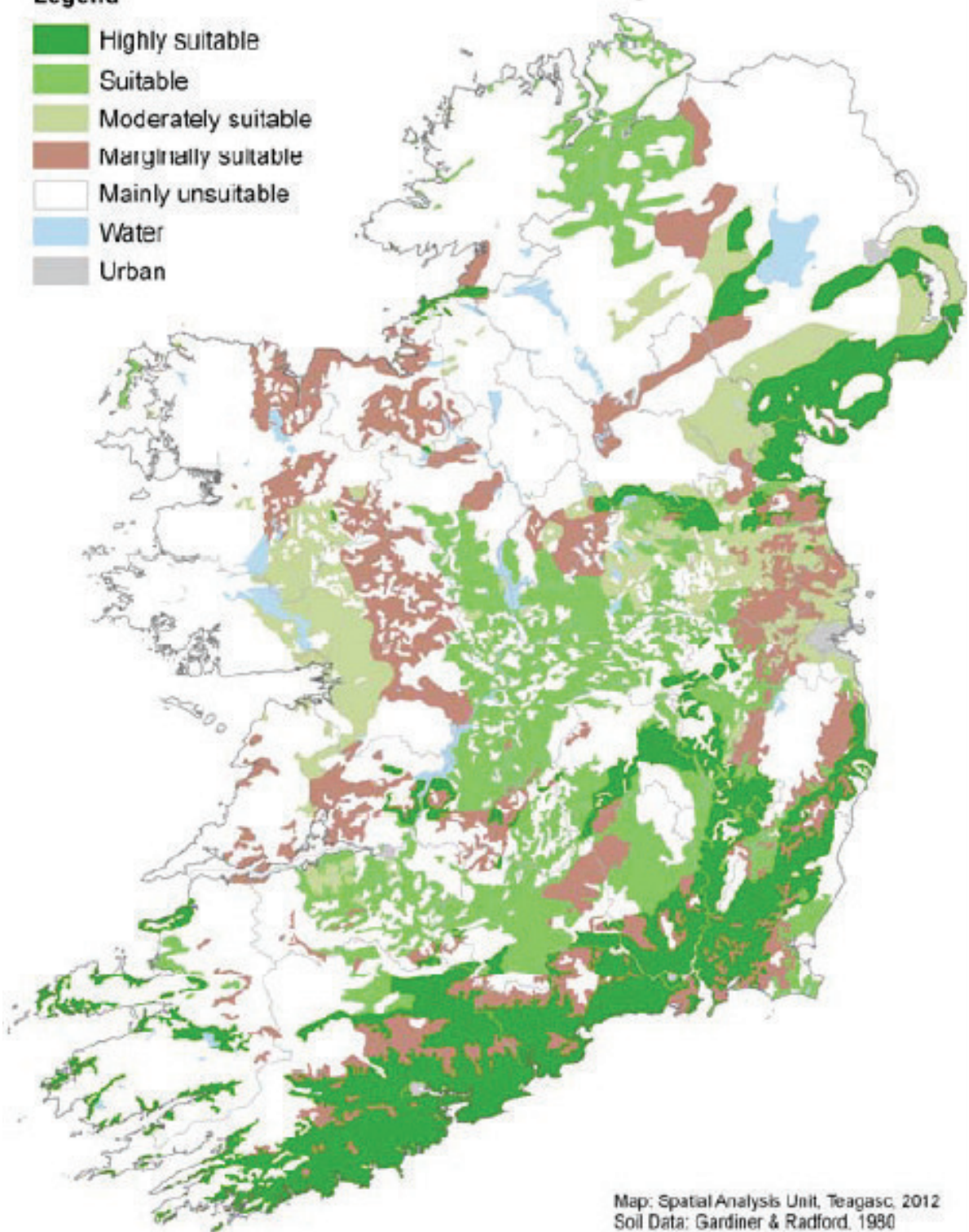
	Dublin and Mid-East	South-East	South-West	Midland	Mid-West	Border	West	State
Winter wheat	35,820	10,200	4,180	4,300	3,920	480	180	59,080
Spring wheat	2,100	1,640	1,860	560	520	140	100	6,920
Winter barley	24,200	14,160	10,780	6,420	7,740	1,500	680	65,480
Spring barley	28,420	49,160	20,720	16,920	8,560	2,660	2,760	129,200
Winter oats	4,820	3,660	940	1,060	1,140	180	100	11,900
Spring oats	2,120	2,860	1,540	980	780	600	720	9,600
Other cereals	260	140	20	200	40	20	0	680
Oilseed rape	4,980	2,880	500	740	600	0	0	9,700
Beans and peas	4,020	3,180	1,260	700	520	40	20	9,740
Potatoes	4,760	1,880	780	180	240	940	80	8,860
Maize silage	3,860	3,640	3,780	820	1,140	160	120	13,520
Arable silage	420	620	700	520	240	580	220	3,300
Fodder beet	1,380	3,520	2,820	1,560	620	0	220	10,120
Total	117,160	97,540	49,880	34,960	26,060	7,300	5,200	338,100

Source: CSO Crop Statistics, average areas per annum over the period 2014-2018

Appendix 2: Map of soil suitability for tillage in Ireland

Legend

- Highly suitable
- Suitable
- Moderately suitable
- Marginally suitable
- Mainly unsuitable
- Water
- Urban



Map: Spatial Analysis Unit, Teagasc, 2012
Soil Data: Gardiner & Radford, 1990
Boundary Data: OGI

