Innovation in the Irish Agrifood Sector

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Executive Summary

The purpose of this study was to investigate the performance of the Agrifood Innovation System (AIS) [1] within Ireland. This was achieved through a combination of qualitative and quantitative analyses that highlighted the strengths and weaknesses of the overall innovation system as well as its various components.

Specifically, the analysis involved three stages. First, interviews with a range of stakeholders from across the agrifood sector were undertaken. Second, available data on innovation input, output and outcome measures (from sources such as Eurostat and the OECD) were utilized to construct an overall agrifood innovation index – allowing Ireland to be compared internationally. Finally, Teagasc National Farm Survey data[2] were used to analyze farm level innovation in more detail. Based on the findings from the various analyses, recommendations for actions to further strengthen the Irish AIS were derived.

Index of Innovation for the Overall Agrifood Sector

A series of indicators were used to highlight how the Irish agrifood sector is performing in terms of innovation in an international context. The indicators were drawn from available data and can be categorized into:

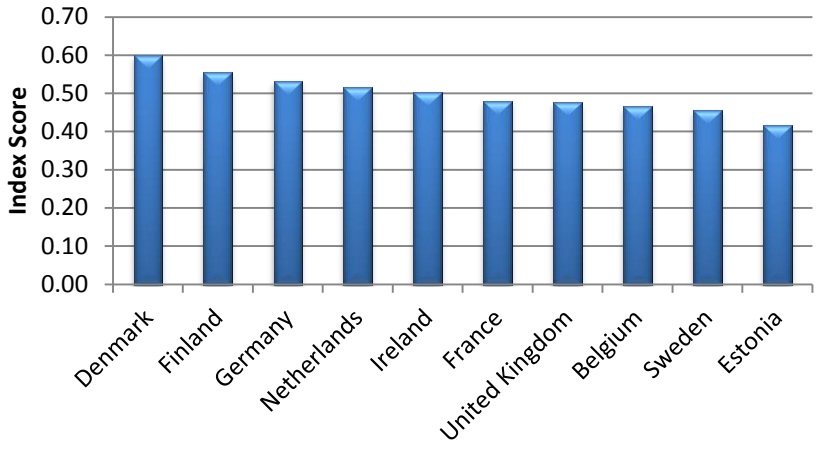
- Innovation inputs (e.g. private and public investment in R&D)
- Innovation outputs (e.g. patents, publications)
- Innovation outcomes (firm and farm performance)

Based on these indicators, an index of innovation is calculated in order to compare Ireland's performance internationally. As Figure E1 highlights, Ireland has the 5th most innovative agrifood sector in the EU according to this index, lying behind Denmark, Finland, Germany and the Netherlands. Though it should be noted that the overall score for the Netherlands and Ireland were very similar indicating that, to all intents and purposes, they were equal in terms of this index.

[1] The AIS can be seen to comprise: those that create knowledge (e.g. universities) those that facilitate its use (e.g. education, advisory services) and those that use the information, either directly (e.g. farms, businesses) or indirectly (e.g. consumers, policy makers).

[2] Hennessy, T., Moran, B. Kinsella, A. and Quinlan, G. 2013. National Farm Survey Results 2012. Teagasc Publications Office, Oak Park, Carlow, Ireland.

Figure E1: Top 10 EU Countries based on Index of Innovation



Innovation at the Farm Level

Innovation at the farm level is assessed through the creation of an innovation index based on Teagasc National Farm Survey data. In order to reflect the complexity of innovation, farm level innovation is measured through a weighted combination of adopted innovations, investments in new knowledge and renewal of machinery. The index highlighted that dairy and cattle rearing farms were at opposite ends of the innovation spectrum (Table E1). In terms of regions, the Southeast region rated the highest whilst the West came out the lowest.

Table E1: Rating of Farm Systems and Regions by Level of Innovativeness

Farm System	Innovation index score	Region	Innovation index score
1. Dairy	0.62	1. Southeast	0.55
2. Mixed Livestock	0.55	2. East	0.45
3. Tillage	0.42	3. Border	0.41
All Farms	0.40	4. Midlands	0.39
4. Sheep	0.37	5. Southwest	0.36
5. Cattle Finishing	0.34	6. South[3]	0.32
6. Cattle Rearing	0.29	7. West	0.31

Note: the index ranges from 0 to 1 with 1 being most innovative

Much of the regional variation is due to the distribution of farm systems across Ireland, however there is also considerable variation within farm systems in innovative performance. The findings also reveal that farmers with high innovative performance in general have higher farm incomes, are less dependent on subsidies, invest more, have larger farms and are younger than less innovative

[3] The relatively low score for the South may seem surprising given the large number of dairy herds in the region. It may be due to the fact that it is composed of Co Kerry and Co Cork which may have different levels of performance. In addition further examination highlights that uptake of the chosen technologies is low in this region. This may though reflect the appropriateness of the chosen technologies as much as the innovativeness of the region.

farmers. In addition, farm size and intensity, access to credit and agricultural education appear to have a positive impact on innovative performance, while age and off-farm work are negatively correlated with innovative performance.

Barriers to and Facilitators of Innovation

There was nearly unanimous agreement among the interviewed stakeholders that the strongest barriers to innovation were at the farm level and related to the structure of farm businesses, the age structure and the related issue of lack of land mobility (Table E2).

On the more positive side there was equal agreement that Ireland was very strong in terms of research capacity, overall education levels, physical infrastructure and that it had favourable tax regimes to encourage business innovation.

As Table E2 highlights a range of factors fall between these two extremes and in general there was more disagreement over the impact of many of these factors on innovation in Ireland.

Table E2: Rating of Potential Barriers to and Facilitators of Innovation in Ireland

Score	Category	Factors
< -2	Strong barrier	Land mobility, age structure, farm business structure
-1 to -2	Medium barrier	Power of supermarkets, availability of finance, CAP support, chain co-ordination
0 to -1	Weak barrier	Structure of supply chain, attitude to risk, level of leadership within sector
0 to +1	Weak facilitator	Finance skills, ICT (rural broadband), university engagement with industry, employment Legislation, private consultants
+ 1 to + 2	Medium facilitator	Government support, regulation, advisory services, training in agrifood skills
>+2	Strong Facilitator	Research capacity, education levels, physical infrastructure, tax regimes

Interviewees were asked to score each factor on a scale of -5 to +5. If the factor was seen as a potential barrier it was scored on a scale of -1 to -5 with -5 being a very strong barrier. Likewise if it was seen as being a facilitator then it was scored on a scale of +1 to +5 with +5 being very strong.

Conclusions

From the analysis undertaken a series of conclusions can be drawn concerning the state of the Irish AIS.

Ireland has a number of truly world class innovative companies, however the problem is there are simply not enough of them and there are too few new innovative companies emerging from which world leading companies could emerge.

Within Ireland there is a high level of government support for the agrifood sector and for science and technology within agriculture and food sectors in particular. However, much of the science and

the efforts at encouraging innovation are *supply pushed* rather than *demand pulled*. In addition, Ireland lags behind other countries in terms of business investment in research and development.

Even when companies are looking to engage with universities, and despite the considerable activity that is going on at high level activity within the university sector (Technology Transfer Officers, etc.), they are finding it difficult to access the knowledge they require. Much of the engagement that occurs is *ad hoc* in nature.

Ireland is relatively strong at innovation that removes cost from the supply chain (lean principles), however it is weaker in terms of the development of new products and it is argued by some that there is insufficient focus on the consumer needs as the end user.

Evidence from the interviews, the Community Innovation Survey and from start-up businesses all point to access to finance being a key constraint in the innovation process.

One of the benefits of Ireland as a small country is that it is able to co-ordinate activity more easily than other larger countries. However, more generally there is a lack of a culture of collaboration across and between all components of the AIS.

The structural issues in agriculture that are well known as more general challenges (age profile, farm size and fragmentation, etc.) are also a significant barrier to innovation at the farm level. Advisory services and agricultural education were identified as potential facilitators of innovation.

Through the discussions undertaken for the study, there is a perception that a conservative mindset dominates organisations with power and influence and that leaders in the agrifood sector need to be more open to the benefits of co-operation, collaboration and partnerships for innovation.

Due to time and resource constraints it should be noted that there are a number of limitations within this study in terms of the overall analysis, but also the data used to calculate the indices at both the overall sector and farm level. The report and indices therefore should be viewed as an initial attempt to assess the situation within Ireland and as a useful prompt for discussion.

Recommendations

Drawing on these conclusions a series of recommendations are made to *drive innovation* within the sector:

1. Whilst recognizing that tax incentives already exist for all businesses, there is a need to consider greater incentives for (medium to large-sized) agrifood companies to engage more with R&D activity and in particular activities with a longer term horizon. This can be justified on the basis that agrifood businesses have been shown to contribute more to net export earnings than many other types of businesses.
2. In terms of driving innovation, universities need to further strengthen engagement with industry. This could involve the wider adoption of advisory boards comprising (but not exclusively) business representatives at the relevant levels within universities. There is also a need for a more strategic approach to engagement. In addition reward structures (pay and promotion criteria, etc.) within the university sector need to reviewed so as to put a greater weight on successful engagement with industry. This coupled with 1) above would mean that

not only are companies incentivised to take a longer term view to R&D (fitting more with the timeframes of university research), but that academics are encouraged to look out to industry more which could improve accessibility for companies.

3. The connections between industry-academia should also be focused on development of new products that add value to the existing commodities produced in Ireland. It also needs to be in a form that is accessible to new and emerging small scale enterprises

4. Alternative funding arrangements (such as the establishment of agrifood venture capital funds[4]) are needed to overcome the identified financial constraints through the agrifood chain. Due to risk and return issues this may need to involve the development of novel public/private funding partnerships. These alternatives may be attractive to those that are averse to debt but require access to funding for expansion

5. There is a need to rethink our education and advisory structures to ensure they are fit for purpose in driving innovation through the agrifood chain.
    a. In terms of education this could involve initiatives such as promoting greater cross fertilisation between courses. For example, combining business and enterprise with science skills or a realigning of the agricultural colleges to create centres of excellence in particular aspects of agriculture (dairy, beef, tillage, horticulture).
    b. In terms of advisory services this requires a move away from a system driven by the bureaucratic requirements of the Common Agricultural Policy (CAP) to one driving innovation. Further development of the models being discussed for public/private collaboration in service delivery will benefit this.

6. Industry forums, facilitated by the government, in which all players in the supply chain can undertake full and frank discussions in the spirit of openness, can begin to create transparency which in turn can lead to trust and a stronger incentive for collaboration. In the beef sector for example, this could build on the forum that has been established as a result of the current difficulties in the sector.

7. Continued effort needs to be made to encourage structural change within the agricultural sector to facilitate innovation and profitability. Further consideration needs to be given as to how CAP support funding can be used to drive innovation. Whilst recognising the constraints of the current system, in the future there should be a greater linkage between payments and uptake of new technologies or practices (such as improved genetics, animal health planning, etc.). More widely, it will be important to ensure that there is effective implementation of European Innovation Partnerships within Ireland.

8. Overall, there is a need for key sections within the AIS to engage in full and frank internal debate as to whether their structures are fit for purpose for an Irish agrifood sector that wants to be world leading in terms of innovation and performance. Leadership is needed in this area to ensure that innovation is facilitated and not hindered within Ireland.

[4] For clarification it should be noted that this does not necessarily mean a call for more venture capitalists in the agrifood sector.

Acknowledgements

The authors would like to thank the Bank of Ireland for their sponsorship of this research. We would also like to thank all those who agreed to be interviewed for the study for giving us so much of their valuable time and for their invaluable insights into the Irish agrifood sector. We would also like to thank Teagasc for access to the National Farm Survey data without which the farm level analysis would not have been possible and Brian Moran in particular for his valuable insights. Many thanks to Karen Keaveney for undertaking the mapping work for the report.

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Foreword

Innovation is at the core of successful industry, none more so than in the agrifood sector. Given Bank of Ireland's very significant and market leading position within the agriculture industry in Ireland and its appetite to support such innovation, we were delighted to have the opportunity to partner with UCD's School of Agriculture and Food Science in this study and the production of this insightful report on the innovation system in Irish agriculture.

Bank of Ireland is proud of its position as the leading bank to this sector, which straddles the entire value chain from farmer to processer including Ireland's largest agri food corporate companies.

The opportunity innovation provides to and its criticality for the Irish agrifood sector is well captured in one of this reports' many important observations on the dairy industry "In the dairy system, our ability to grow grass gives us a *comparative* advantage, but innovation can give us a *competitive* advantage", and underpins the strong commitment at Bank of Ireland to continue to support innovation across this Sector.

Continued innovation in the sector will influence the future shape and focus of all the key industry stakeholders and participants, with a key driver of future success being identified as the ability to harness value from volume growth, which can be achieved through innovation.

Whilst Ireland compares favourably to a number of European Countries (currently ranked 5th) this study indicates that the Irish Agri Food Sector has the capability to further improve its innovation index through leveraging Ireland's strong technological capability. The focus in more recent times has been predominantly on 'lean techniques' with this study highlighting the opportunity to focus future investment in R&D to identify longer term solutions which drive sustainable growth. The positive correlation between high innovative performance and increased income supports these findings at both farm and industry level.

The real value of this report however, will of course be measured by and delivered through the discussion and implementation of its recommendations. Collaboration, co-operation and partnership across academia, advisory and industry are identified as the key drivers of innovation and value creation and must form the basis of future policy derived solutions to address the challenges of increasing land mobility and improving farm structures.

In Bank of Ireland we see exciting investment opportunities for this sector and have the capital, capability and commitment to support this investment. Our corporate banking division have been leaders in funding the additional processing capability of the dairy sector and helping our larger food companies expand internationally. We continue to invest and expand our capabilities in the general Agri Sector with a team of dedicated specialist advisors available to our customers, to support and advise them in planning their financial needs as they themselves plan and prepare for the future development of their businesses in this exciting and very valuable sector.

This report has been delivered under the excellent stewardship of Professor Alan Renwick whom I thank, along with his team members for their efforts and expertise. I would also like to thank the numerous other industry stakeholders whose contribution was also crucial, and provided depth and understanding on current innovation challenges and potential opportunities in the sector.

Mark Cunningham, Director Bank of Ireland Business Banking.

1. Introduction, Definitions and Approach

Summary

Within this section the importance of the agriculture and food sector to the Irish economy is highlighted as is the need for a focus on innovation.

Innovation is defined as *renewing, changing or creating more effective processes, products or ways of doing things*

The Irish Agrifood Innovation System is shown to comprise: those that create the knowledge (UCD, Teagasc research, etc.); those that facilitate its use (Teagasc advisory services, Enterprise Ireland, etc.) and those who actually use the knowledge either directly (agribusinesses, farms, etc.) or indirectly (government, consumers, etc.)

Extensive activity is occurring within Ireland in terms of initiatives that support innovation or are innovative in themselves.

'In the dairy system, our ability to grow grass gives us a *comparative* advantage, but innovation can give us a *competitive* advantage'

Agriculture and food and drink are vital sectors of the Irish economy, accounting for 7.1 per cent of Ireland's economy-wide Gross Value Added (GVA), 11 per cent of exports and 8.6 per cent of total employment (DAFM, 2014).

In 2013, Irish agrifood and drink exports increased by an estimated 9 per cent to approximately €9.9 billion (Bord Bia, 2013). Dairy products and ingredients (30 per cent), prepared consumer foods (17 per cent), beef (21 per cent) and beverages (13 per cent) were the main components of these exports.

The economic crisis has put a greater emphasis on the largest indigenous industry to help drive growth. This is highlighted in a range of government documents and strategies including Food Harvest 2020.

The Irish agrifood sector has come a long way over the last 20 years from one which was almost totally disconnected from the 'real' market, producing commodity products that were exported with the help of generous EU subsidies on to world markets, to one where businesses are outward facing, more closely connected to the customer and looking to find ways to add value to the product and reduce costs.

On the eve of the next big policy change within the EU and Ireland, the abolition of milk quotas, it is timely to investigate the health of the agrifood sector in Ireland. In particular this study focusses on what can be described as the Agrifood Innovation System (AIS). As the name implies AIS incorporates all of the players involved in innovation in the agrifood sector, from research and

advisory, through to businesses at all stages of the supply chain, to government and its agencies and to those that provide ancillary services. The basic premise is that for Ireland to have a successful agrifood sector in the future, all parts of this system have not only to work well individually but also function collectively as well. For example, there is no point having world class food manufacturers and processors if we have no raw material supply from Ireland.

Whilst the term innovation, like sustainability, has been overused and its impact has been diluted, it is clear that innovation in its many guises will be fundamental to the future success of the Irish agrifood sector. In addition to being able to take advantage of the well-rehearsed opportunities emerging from a growing global population and increasing numbers of middle class consumers, innovation is crucial for the Irish agrifood sector because:

- A small domestic market means that Ireland has to look abroad for markets and growth, particularly with the removal of dairy quotas
- Increasing trade and agricultural policy liberalisation mean less support and more competition for Irish agrifood products on international markets
- The domination of the sector globally by a few large corporations means that firms need to innovate to maintain and grow their position
- The need to move away from commodity markets and the associated issues of volatility and price pressure
- The need to increase production but maintain the 'green' image that is seen by many as a key competitive advantage for Ireland

It is clear that the question of innovation within the agrifood sector is a huge issue and that in a short report such as this is not possible to cover all of these issues in depth. However, the purpose is to produce a snapshot of the situation in Ireland to promote discussion and debate as to the way forward and to help identify areas that require further investigation.

Approach

This analysis of the Irish AIS system is based upon three strands of work:

- Face to face interviews were held with experts from across the agrifood sector
- Indicators of the state of the Irish AIS were constructed using available data and comparative analysis was undertaken with other countries
- Farm level data were used to analyse agricultural innovation and how this varies between farm systems and regionally across Ireland

Twenty-six individuals from across the AIS (including researchers, government bodies, consultants, input suppliers, producers, industry organisations and industry commentators) were interviewed for this study. Interviewees were selected both on the basis of their knowledge of a particular aspect of the system, but also on their ability to comment on the system more generally.

The interviews were structured around the following general questions:

- How well is the whole innovation system performing?

- How well are the various parts of the innovation system performing? (research, advisory services, private businesses, government funding and support, etc.)
- How well are the various components of the value chain performing and are there differences between sectors (dairy, beef, tillage, etc.)?
- What are the key barriers to/facilitators of innovation within Ireland?
- What could or should be done to improve performance within the agri-food industry and who has responsibility for this?

To help quantify the level of innovativeness within the Irish agrifood sector, two innovation indices are calculated, one at the sector level and the other at the individual farm level.

At the sector level, innovation is assessed by an overall index based on a range of indicators that broadly assess:

- The level of investment in research and development in the private and public sectors
- The outputs from this investment (patents, publications, etc.)
- The outcomes in terms of firm and farm performance

At the farm level, an innovation index is developed that aims to account for adopted innovations as well as innovation behaviour. The innovation index tries to take into account the fact that innovation is more than just the adoption of new technologies. Hence, innovation is assessed through a combination of three sub-measures:

- New technologies/farm practices
- Investment in new knowledge
- Renewal of machinery

In addition, the input of six farm knowledge transfer and innovation experts was used to finalise the index.[5]

What do we mean by innovation?

The term innovation, as well as being overused, also encompasses a vast array of activities. Simple evidence of this is highlighted in Figure 1.1 which reproduces a word cloud of the terms used by those interviewed for this study when asked to describe what innovation means to them.

It is therefore important at the outset to define innovation as used in this study. In its most general form innovation generally refers to *renewing, changing or creating more effective processes, products or ways of doing things.*[6]

[5] A more detailed description of the development of the farm innovation index is given in the Appendix.

[6] Australian Government.

Figure 1.1. Word Cloud of Meaning of Innovation

Often when innovation is mentioned the first thing that emerges is the idea of *technological* innovation (i.e. a new product or process applied in production, logistics or novel research method). However, innovation can also be *non-technological* and can relate to:

- Changes in thinking and behaviour (e.g. inclusion of animal welfare or environmental issues)
- Novel collaboration agreements between, for example:
    - Different sectors of the food chain
    - Private and public sectors
    - Farm and non-farm businesses
    - Business and local community (i.e. social enterprises, care farming)
- Novel organisational models, for example:
    - Establishment of a collective brand for one common food product
    - Territorial Brand: network of independent actors (e.g. farmers and service providers) who establish a collective brand within a territory (e.g. A Taste of Galway, Connemara Lamb, Ring of Kerry Lamb)
    - Brand based on the marketing channel that is collectively used by a network of independent farmers e.g. farmers' markets

    - Private marketing or processing firm that engages/organises their suppliers in areas such as experimentation/trials, performance monitoring and knowledge/information exchange (e.g. McCains organising their suppliers into growers groups)
- Novel marketing strategies:
    - Packaging
    - Novel promotion strategies
    - Foods that their production method is oriented to public goods/social values (e.g. carbon foot-print label; ethical-labels; fair-trade label)

It is often the case that the terms revolutionary or radical are used in the context of innovation, however it can equally apply to smaller more incremental changes or mimicking - where a successful technology or approach from outside food production is transferred or applied in the agrifood sector.

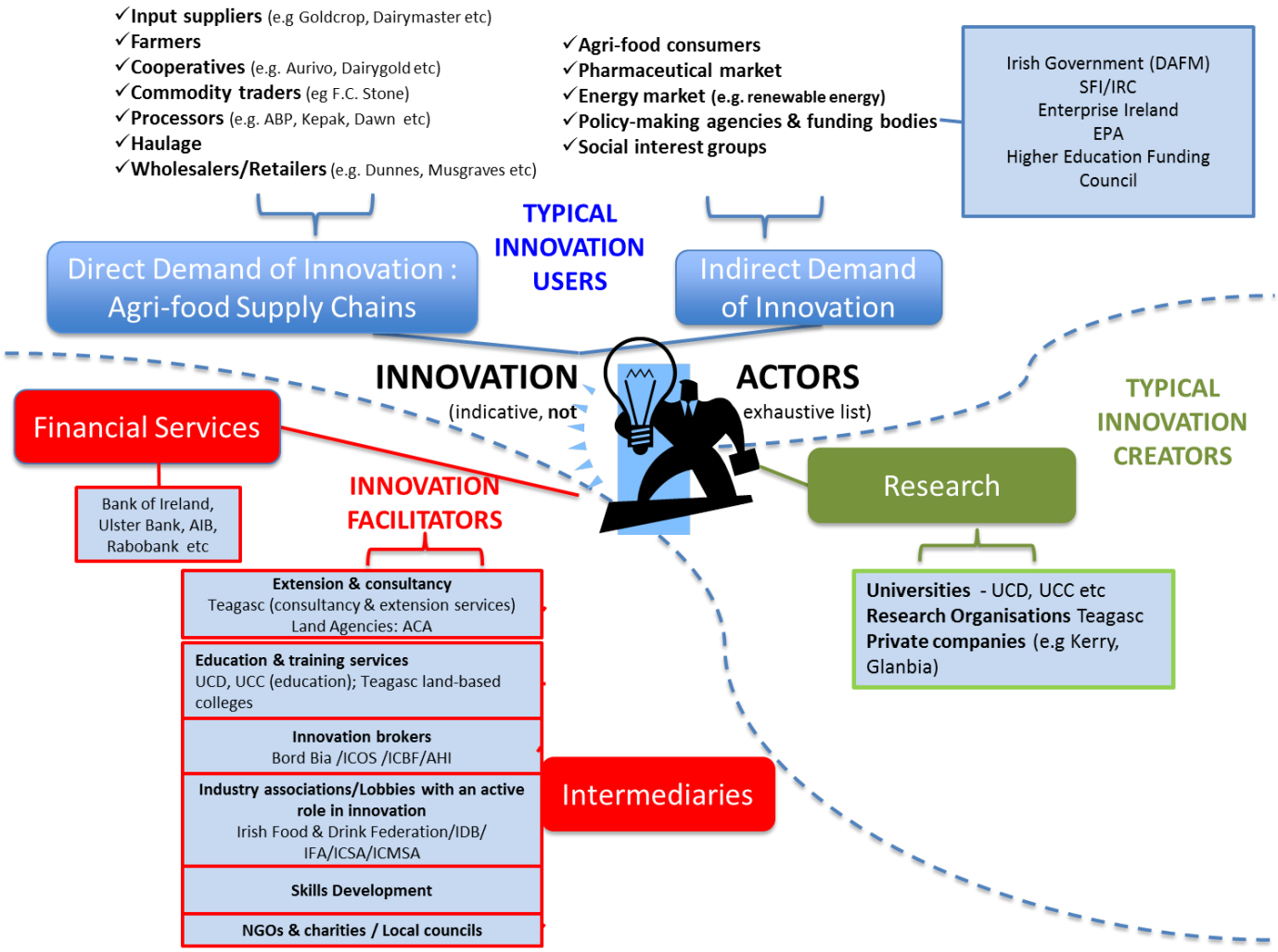
What is an Innovation System?

The World Bank (2006) states 'The Innovation Systems (IS) concept embraces not only the science suppliers but the totality and interaction of actors involved in innovation. It extends beyond the creation of knowledge to encompass the factors affecting demand for and use of knowledge in novel and useful ways.' Taking agriculture as an example an IS approach means moving away from the idea of the development and diffusion of technologies being a linear process involving public sector research and extension organisations (i.e., innovation simply being a product of science), to one with a wider focus on all the organisations responsible for innovation, including for example, the role of supply chain actors. In this study the IS we are interested is the wider agrifood sector but the principle is the same as for agriculture.

The Irish Agrifood Innovation System

There are a number of possible ways that we can picture the AIS; one way is to think of three (often interrelated) groups. 1) Those that create the knowledge, 2) those that facilitate its use and 3) those who actually use the knowledge. This final group can be further split into those who use it directly (food businesses, farmers, input suppliers, etc.) and those that use it indirectly (consumers, policy makers, social interest groups, etc.). Figure 1.2 highlights the key player in the Irish system.

Figure 1.2. Actors in the Irish Agrifood Innovation System



What is happening in Ireland at the moment?

It is clear that extensive activity is occurring through the Irish AIS and there are a wide range of programmes/initiatives that either support innovation or are innovative in themselves. Table 1.1 briefly summarises a *selection* of these initiatives in terms of their key purpose and the partners involved, whilst Figure 1.3 highlights the networks that have emerged through these activities.

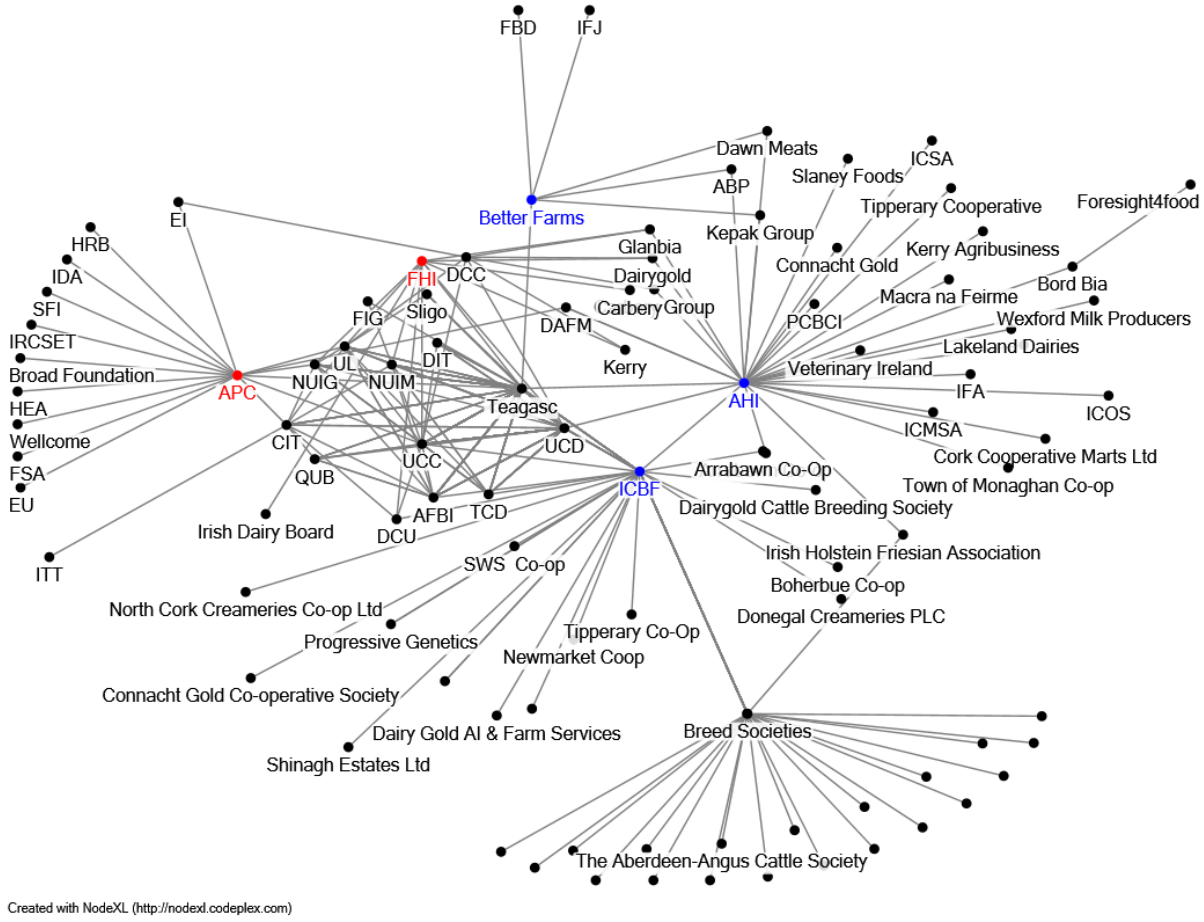
Table 1.1. Selected Initiatives within Ireland that Support Innovation or are seen as Innovative

Initiative Name	Partners	Key Purpose
Food for Health Ireland	University College Cork , University College Dublin, NUI Galway, NUI Maynooth, DCU, Teagasc, Moorepark Food Research Centre, and University of Limerick Irish Dairy Board, Carbery Group, Dairygold Food Ingredients Ltd, Glanbia plc and Kerry Group plc.	Supported by Enterprise Ireland, FHI links the expertise of researchers at to develop new functional food ingredients and products. A 'functional food' is one that serves a purpose beyond basic nutrition, promoting health or reducing the risk of certain diseases.
Dairy Processing Technology Centre	UL, UCD, UCC, Teagasc, NUIM, NUIG, TCD, DCU, DIT, ITT & CIT Glanbia, Kerry ingredients, Carbery, Aurivo, Dairygold, Lakeland Dairies, Tipperary Co-op and Arrabawn	Enterprise Ireland plans to build a strategic research and innovation base in dairy processing that will enable the Irish dairy sector to optimally exploit projected long term growth opportunities, in the post-quota era.
APC	UCC, Teagasc, CIT,UL,NUIM,NUIG	This centre is an SFI initiative that links Irish science with industry and society through research, education and outreach in gastrointestinal health.
foresight4food Innovation Programme	Bord Bia	Bord Bia's foresight4food programme aims to support Irish food and drink manufacturers and offers services in core consumer focused innovation areas. The programme aims to drive growth and innovation in the industry by organising these services, recognising that many companies have limited experience accessing them and need an incentive to incorporate them in their process
Food Innovation Gateways	UCC, Teagasc	Food innovation gateways offers opportunities for SMEs to develop food innovations in conjunction with UCC's Food Innovation Alliance Ireland Programme and offers tax incentives for R&D activities. Gateways offers supports for food entrepreneurs that hope to grow through innovation.
Foodworks	Teagasc, Bord Bia, EI	Foodworks is an acceleration programme designed to speed up the time needed to bring a novel food/drinks idea to market using Enterprise Ireland's expertise in Business Development, Bord Bia's expertise in understanding consumer needs and market demand, and Teagasc's expertise in production technologies and research.
AHI	ABP, Arrabawn Co-op, Bord Bia Carbery Group Connacht Gold Cork Cooperative Marts Ltd DAFM Dairygold, Dawn Meats, Glanbia, ICMSA ICSA, IFA, Irish Cattle Breeders' Federation (ICBF), Irish Charolais Cattle Society, Irish Co-operative Organisation Society (ICOS), Irish Holstein Friesian Association, Kepak Group, Kerry Agribusiness, Lakeland Dairies, Macra na Feirme, Pedigree Cattle Breeders Council of Ireland, Slaney Foods, Teagasc, Tipperary Cooperative, Town of Monaghan Co-op, University College Dublin, Veterinary Ireland	AHI is an industry-led, not-for-profit partnership between livestock producers, processors, animal health advisers and government. Its remit includes diseases and conditions of livestock which are endemic in Ireland, but which are not currently subject to regulation and coordinated programmes of control.
ICBF	AI companies, Milk recording companies, Cattle breed societies	The Irish Cattle Breeding Federation (ICBF) was formally set up in 1998, and is a non-profit organisation charged with providing cattle breeding information services to the Irish dairy and beef industries. ICBF exists to benefit Irish farmers and the agri-food industry through genetic gain. They apply science and technology to ensure that farmers and industry make the most profitable and sustainable decisions, through the use of the services provided from the ICBF cattle breeding database.
Better Farms	Dawn Meats, Kepak, IFJ, FBD, Teagasc	The BETTER Farm Beef programme is designed specifically to help farmers use available and new technologies to improve profits and ultimately incomes from beef farming. It is built around maximizing the growth and utilization of grazed grass in producing high quality beef from better bred animals with superior genetics

Table 1.1. continued

Teagasc Initiatives	Teagasc with a range of collaborators	Dairy Efficiency Programme, Beef Technology Adoption Programme, Succession Planning , Collaborative Farming
UCD Lyons Initiative	Dairymaster, Devenish Nutrition, Glanbia, Munster Cattle Breeding Group, Progressive Genetics and the Irish Holstein Friesian Breeders Association, UCD	UCD is constructing a new Dairy Research and Education Facility at Lyons Research Farm to support research programmes in dairy production including genetics, nutrition and herd health management

Figure 1.3. Selected Connections across the AIS



Just from the selected examples it is clear that on the surface there are extensive connections across the AIS. The real questions are though how well these connections are working and how they are leading to improvements in performance of the Irish agrifood sector. The analysis in the following sections attempts to answer these questions.

2. The Agrifood Innovation System: Stakeholder Perceptions

Summary

The overall performance of the innovation system was seen as generally good if not outstanding. This was due to the fact that there were areas where Ireland could be seen as world class but others where it was seen to be underperforming.

Ireland was viewed as being better at innovation that involved marketing or driving out cost rather than new product development.

Existing businesses were seen to be performing reasonably well, but Ireland was currently lacking a pool of new and innovative businesses pushing to grow and succeed.

Research was seen as strong in Ireland (but not necessarily in terms of linking with industry) as was the public sector in terms of government and its agencies. The food and farming organisations were rated lower in terms of supporting innovation. The existence of a publically funded advisory service was seen as a real strength within Ireland, but there was a view that much more could be made of this in promoting innovation.

There was a perception that innovation levels also varied across the different parts of the value chain, with the farm sector being generally less innovative, but within this the dairy sector was seen as a strong performer.

As part of the interview process, respondents were asked to score aspects of the Irish agrifood sector in terms of performance and these scores are highlighted within this section. However, given the number of stakeholders it was possible to interview within the scope of this study, these scores are presented more as being indicative of the strength of feeling, rather than a definitive statement of stakeholder opinion. They are also useful to highlight areas of consensus and disagreement across stakeholders. The discussion generated through the scoring process can be seen as informative as the scores themselves.

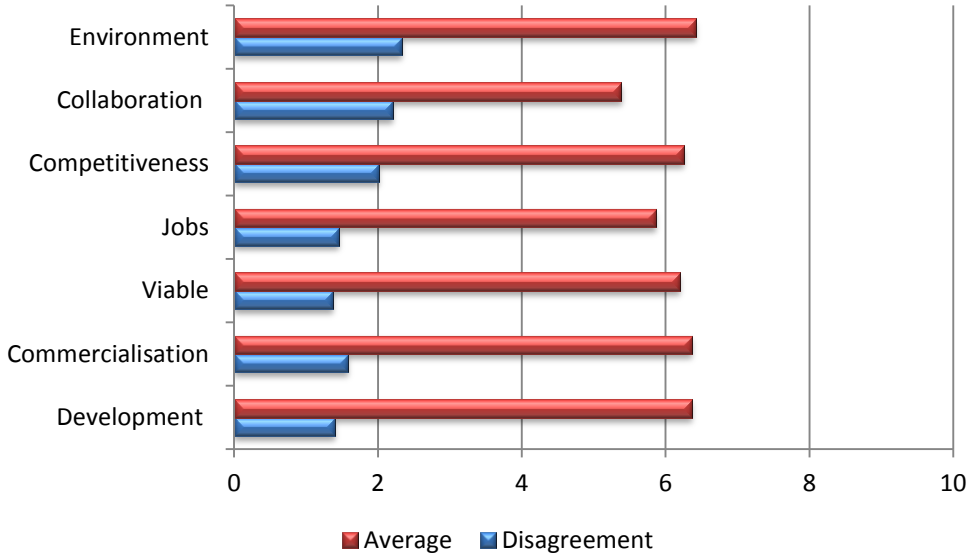
Overall innovation

The analysis begins by considering the system as a whole and then proceeds to break it down into its various components. In general, whilst the scores varied there was a consensus that the Irish agrifood system overall was reasonably strong in innovation terms leading to an average score of 6.5 out of 10. Some interviewees found it hard to score the overall system as they felt that there was such an uneven level of innovation through the system; either in terms of the nature of innovation or across different parts of the system. For example, as one respondent stated “We are strong on innovation that reduces costs but less strong on new product development or adding value.”

Interviewees were questioned as to the strength of the Irish agrifood sector in terms of: development of new products/processes; successful commercialisation of these products (market

capture); creation of new viable businesses and; increasing employment. Slightly less tangible outcomes of innovation were also included. These included the impact on international competitiveness, ability to collaborate and innovation that improved environmental performance.

Figure 2.1. Strength of Innovative Performance for Ireland



Note: 10 indicates very strong innovative performance.

The consensus from the interviews was that Ireland was performing reasonably well if not outstandingly in terms of the areas covered. Whilst Figure 2.1 shows the average scores were generally similar (clustering around the 6 mark), the graph does highlight that there was more disagreement[7] about the less tangible areas of collaboration, environment and competitiveness as opposed to the more traditional measures of performance. Another issue that arose during the discussions surrounding these indicators of performance was that while the companies that do exist were performing relatively well, there were not enough new and innovative 'start-up' companies coming through the system. Therefore whilst existing companies were maintaining (and in some cases creating) jobs through the recession period there has not been many jobs created by new companies. A number of interviewees stated that this was in contrast to periods in the past (such as the 1980s) when there were strong surges in new businesses being formed. However, it should be noted that one informed source highlighted that there has been a recent upsurge in interest in new food and drink businesses within Ireland.

Discussion around the relative position of the Irish agrifood sector in relation to a number of European and international countries,[8] highlighted that within Europe, there was general consensus that *overall* the sector was behind that of Denmark and Netherlands. There was more discussion in relation to its position in relation to Germany and the UK, whilst it was seen to be ahead of France,

[7] We use the standard deviation around the mean to highlight the extent of disagreement

[8] The countries included for this comparison were Denmark, Netherlands, Germany, UK, Poland, France, Italy and Spain.

Italy, Spain and Poland.[9] In terms of wider international comparison, whilst New Zealand was seen as a leading dairy producer, it was not seen as particularly innovative in this area. Other examples were given of highly innovative sectors within countries, for instance the dairy sector in Finland and Valio in particular. Whilst overall the AIS was seen as behind some countries, in certain areas and with certain companies, Ireland was seen as world class if not world leading. For example, the collaborative work involved in the uptake of genetic improvement was cited as an area where Ireland could be seen to be leading in the world (see Box below). However, world class performance was not seen as the norm for the Irish agrifood sector.

Innovation in Practice: Irish Cattle Breeding Federation

The ICBF is widely cited as a success story within the agrifood sector. It was formally set up in 1998, and is a non-profit organisation charged with providing cattle breeding information services to the Irish dairy and beef industries. ICBF exists to benefit Irish farmers and the agrifood industry through genetic gain. They apply science and technology to ensure that farmers and industry make the most profitable and sustainable decisions, through the use of the services provided from the ICBF cattle breeding database.

By identifying ancestry and providing quantitative data on traits of importance for large numbers of animals in each generation, the ICBF has been building a national cattle breeding database for more than a decade and continues to add to this through its innovative approach to genomics. A key measure of the success of the ICBF is that *"Irish bred bulls now dominate the ICBF Active bull list compared to ten years ago when there were mostly foreign bred bulls."*

Trust and collaboration with key stakeholders is the essence of how the ICBF operates. They do not have extensive funding, but leverage what they do have effectively through developing links to and working with a wide range of stakeholders. For example, the ICBF collates information from a wide spectrum of sources: livestock marts and auctions, animal health laboratories and abattoirs, putting Ireland in an excellent position globally as far as breeding is concerned.

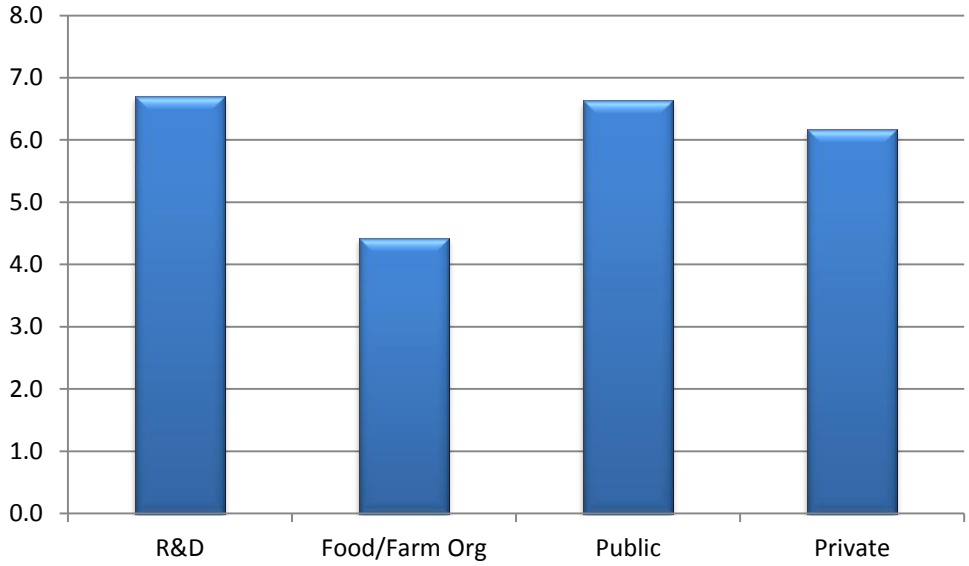
Punching well above its weight, the ICBF is at the cutting edge when it comes to genetics and the Irish cattle herd. Multi-breed genomic selection in beef cattle in Ireland was launched in 2014 based on a population of more than 3,000 high reliability purebred AI beef sires, and approximately 30,000 natural mating beef sires and 100,000 commercial crossbred beef cows. The use of genomically selected bulls is consistently increasing year-on-year. For example, 60 per cent of the semen used in Irish dairy herds in 2013 was from genomically selected young bulls. And this is trending upward for 2014 and beyond.

[9] In the next section, indicators are used to assess whether the evidence supports this view.

Performance of components of the system

Figure 2.2 highlights the perceptions of the interviewees of how strong the various components of the innovation system (research, intermediaries, public sector, private sector) were performing in Ireland, whilst Table 2.1 provides a greatly distilled summary of the discussion around the components of the innovation system. In interpreting the figure, it is important to note that the issue discussed was how well the components are supporting innovation and not how well they are operating more generally. For example, the food and farming organisations score lowly in terms of innovation, but, as the table summarises, this was partly due to the fact that a number of stakeholders did not see innovation as one of their key functions. In general, it was felt that the research capacity was strong in Ireland and that the government and its agencies were providing the right environment and support for innovation to occur. In the private sector it was felt that the 'absorptive capacity' of companies (their ability to take on board the knowledge that was being generated from research organisations) was generally poor (although again with notable exceptions from across the supply chain).

Figure 2.2. Strength of Innovative Performance for Components of AIS



Note: 10 indicates very strong innovative performance

Table 2.1. Simplified Summary of Perceptions of Innovation Actors

System Component	Strengths in supporting innovation	Challenges	Overall
Universities	Overall quality of Science. Interaction with industry strong on Food	Reduced capacity in Agriculture. There is a Lack of visibility within agricultural sector. Weakness in driving innovation *"Doing the research is only one part of it, getting it implemented is the more important. Universities are doing the research, but is it getting out into the market?"*	Personalities/Competition prevents stronger relationships being developed which could improve the science base further within Ireland.

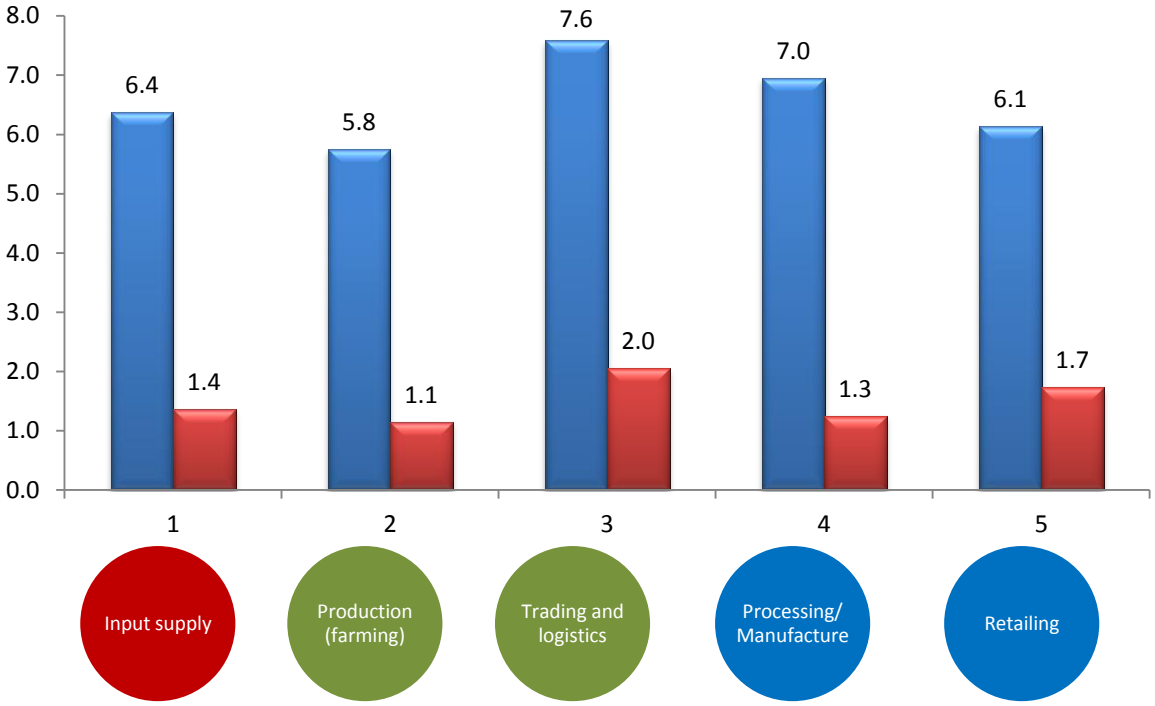
Table 2.1. continued

Teagasc Research	Moorepark Dairy – model of good science and knowledge transfer. Research collaboration strong in places. *'In food research Teagasc has done well'*	Beef research less successful. '*Teagasc need to re-affirm their credentials on the beef side'* Relatively little capacity in horticulture.	
Teagasc Advisory	Ireland fortunate to have public funded system. Discussion groups, Better Farms seen as very strong initiatives. Large amount of activity supporting the sector	Too much form filling and lack of technical expertise. Restructuring has led to loss of capacity in some areas. *'They are not evolved organizationally or behaviourally to meet the needs of the modern day farmer.'*	With reduction in Teagasc resources there is discussion about relative roles for public and private consultants in ensuring an effective service to farmers in Ireland
Private Consultants	Can provide useful alternative specialist advice to farm and other businesses	Mainly dealing with compliance, regulatory tasks and not innovation *'their need for a point of differentiation can lead to confusion of the message'*	
Government Agencies	Strong leadership in DAFM – eg FH2020. Considerable support/funding for start-ups and innovation from wide range of bodies (EI, Local Enterprise, Intertrade etc). Origin Green has the potential to be strong initiative for the sector	Lack of co-ordination between various funding streams and levels (ie local enterprise boards, national bodies etc) can lead to confusion as to roles and responsibilities	
Meat Processors	Considerable development over the last 20 years move from frozen commodity to chilled product	Lack of absorptive capacity in industry to engage with science. Competition hinders collaboration '*We all talk of "Brand Ireland", but it's all around price, cost and commodity, not a premium brand. Race to the bottom on price, especially in beef.*	Collaboration and co-ordination across chain not strong. Gains in terms of efficiencies and innovation could be great.
Dairy Processors (Co-operatives)	Co-operative structure gives farmers more power	Co-operative structures tend to ensure conservative approach, lack of consolidation (e.g. Finland). Quotas have stifled innovation. Too much focus on milk price and commodity base.	Great agglomeration opportunities for livestock markets, co-operatives etc
Other Agribusiness	Pockets of world class (McHale, Dairymaster, Kerry, Glanbia, Countrycrest etc)	Lack of investment in R&D, lack of engagement with customer driven innovation, lack of groundswell of new innovative companies. Lack of absorptive capacity,	*"We are very good at talking about collaboration, not good at doing it well"*
Farmers	Best farmers viewed as 'world class'	Long tail, lack of mobility, age structures, lack of partnerships.	*"[There is a] weakness in the Irish psyche with leadership, too much short term-ism"*
Farmer Organisations	Strong advocates for farm sector	Generally not viewed as promoting innovation. Questions as to whether this is their role; reluctance of farm organizations to force any change or collaboration.	*"[Getting] the highest milk price not a long term aim"*
Financial	Finance sector promoting stronger financial skills training through the sector.	Access to finance/ more outside 'venture capital' needed.	*"Banks are not in the innovation game. [They're in the] lending money game and getting **that** money back game."*

Performance of components of the system: Value chain

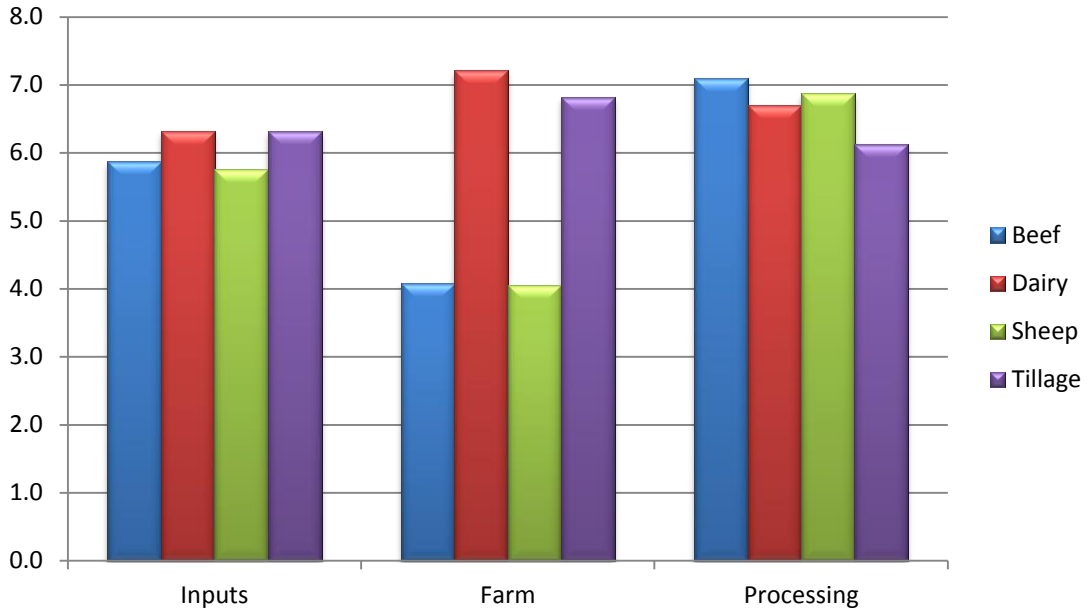
To gain further insight into the agrifood sector, the innovativeness of the components of the value chain was also considered (Figure 2.3) and this was further broken down (Figure 2.4) into the key commodity chains (dairy, beef, sheep, tillage). There are clear differences in terms of the perception of innovativeness across the chain and between the different sectors. Overall, farming was seen as less innovative than the other parts of the supply chain. However, this masks significant differences across chains, with dairy farmers for example being seen as the most innovative overall. It is interesting that whilst dairy farms were seen as significantly more innovative than beef or sheep farms, the beef processors were seen as marginally more innovative than dairy processors. As Table 2.1 highlights the stakeholders felt that the processing sector had made great strides moving from export subsidy led commodity production to a consumer facing sector.

Figure 2.3. Strength of Innovative Performance across the Value Chain



Note: 10 indicates very strong innovative performance. Figures in blue highlight the average score whilst those in red highlight the standard deviation around the mean and are an indication of the strength of disagreement over the performance of each part of the chain.

Figure 2.4. Strength of Innovative Performance by Commodity Sector



Note: 10 indicates very strong innovative performance

In conclusion, although there were areas of clear disagreement across the stakeholders interviewed there was a general perception that Ireland was performing relatively well against other countries but that there were a range of areas in which performance could be improved. In a later section the views of those interviewed as to the possible barriers to and facilitators of innovation in Ireland are discussed in more detail. First, available data is used to try and quantify more formally the position of Ireland in terms of innovativeness in the agrifood sector.

Innovation in Practice: SAMCO

The Samco company was established in Ireland in 1997 by Samuel Shine (the original inventor and patent holder of the Samco 3-in-1 machine). As is often the case, Samco emerged out of the attempt to solve a particular problem - the fact that whilst maize with its high yields had the potential to be an important forage crop in livestock production in Ireland, there were often problems with growing it effectively in the cool and less favourable climate. Samuel developed the machine to guarantee local farmers a crop of quality forage maize in these conditions.

The Samco System involves the use of a 3-in-1 machine that sows Maize Corn Seed, sprays a pre-emergence herbicide on the soil and lays a thin layer of degradable mulch film over the soil, increasing air and ground temperature and protecting the young seedling from adverse weather and late frosts.

Samco is not only a machine manufacturer, they also manufacture the degradable film for their system. Samco are actively involved with other companies and UCD in the research and development of mulch film types, maize corn varieties, and weed control formulations with many trials carried out each year to ensure customer satisfaction. The mulch film innovation is formulated with the latest ingredients in Polymer Degradation and degradability. Degradation of the mulch films depend on many factors, UV, soil temperature, air temperature, moisture, altitude and organic matter in the soil. Samco produces various degradable mulch films to suit many climatic conditions around the world.

Samco employs 35 people in Ireland and a further 25 in China, they have produced over 500 machines which are in operation around the world. In 2012, Limerick Chamber of Commerce awarded Samco with “Best Exporter of the Mid-West Region” and in 2013 they became finalists in the “Ernst & Young” Entrepreneur of the Year competition. Also in 2013 Limerick Chamber of Commerce awarded Samco with the “Overall Business of the year Award in the Mid-West Region”

Samco's focus on markets outside Ireland have led the company to export 80 per cent of what it produces. Machines leave Adare, County Limerick for mainland Europe, Russia, Japan, China, New Zealand, Chile, Canada and the US, with recent annual growth of the business of between 15 to 20 per cent.

3. The Agrifood Innovation System: An International Comparison

Summary

This section uses a range of indicators to assess the performance of the Irish AIS.

It was found that Ireland was strong in terms of: the level of investment in research in the agricultural sector; the proportion of businesses that were innovative and; the economic performance of Food and Drinks manufacturers. Ireland also rated highly for its general business environment and its investment in research in the agricultural sectors.

Ireland performed less well in terms of the level of collaboration between businesses, the contribution of new products to business turnover, the growth in productivity within agriculture and the value added from agriculture.

An overall 'index of innovativeness' for the Irish agrifood sector is derived and Ireland has the 5th most innovative agrifood sector in the EU, lying behind Denmark, Finland and the Netherlands.

This section begins to place the interview findings into context by examining the performance of the Irish agrifood system in a European context.[10] Whilst the comparison is generally made at the EU level, results are presented with just a subsample of countries (Denmark, Netherlands, Spain, Germany, France, Poland, UK and Italy). These are chosen as they represent important food producing countries within the EU.

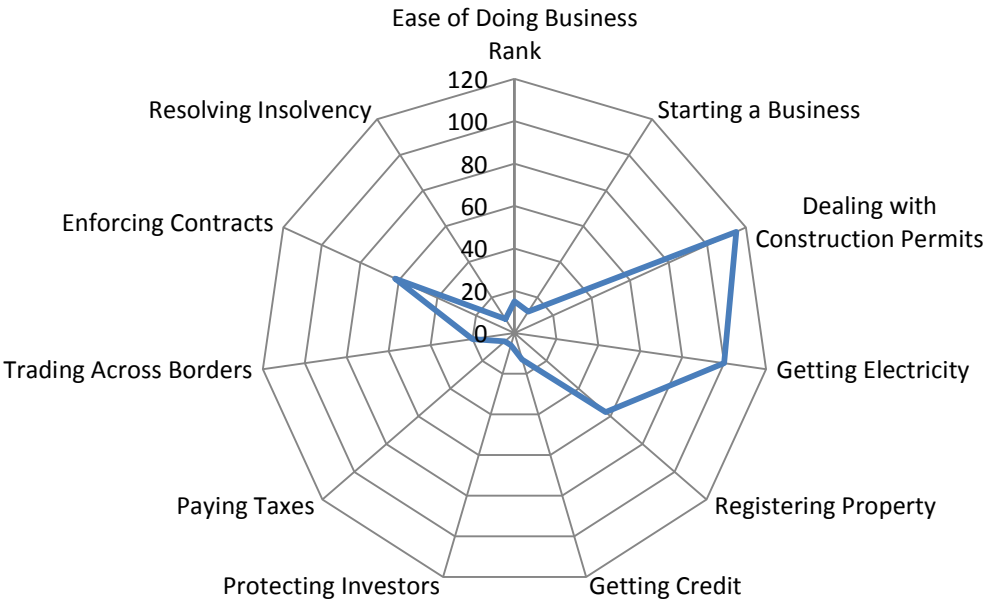
The Innovation Environment

Of course, any one sector of the economy does not work in isolation, but operates under the general business and regulatory environment of the country. Therefore, at the outset it is useful to consider this overall environment in Ireland and how it compares internationally. A commonly cited index is the World Bank Ease of Doing Business Index.[11] This comprises a range of indicators and Ireland's overall global position and ranking for each of these indicators is highlighted in Figure 3.1. Within the figure the higher ranked Ireland is for a particular indicator the closer to the centre the line is.

[10] The approach adopted broadly follows that adopted by Wageningen University in a recent study on the innovation in the food and drink sector. See http://www.wageningenur.nl/upload_mm/c/4/b/a26ddb4a-de59-49ef-94a8-2adaffc1f69b_Rapport%202013-036%20vGalen_DEF_WEB.pdf

[11] See http://www.doingbusiness.org/rankings for details of the Ease of Doing Business index

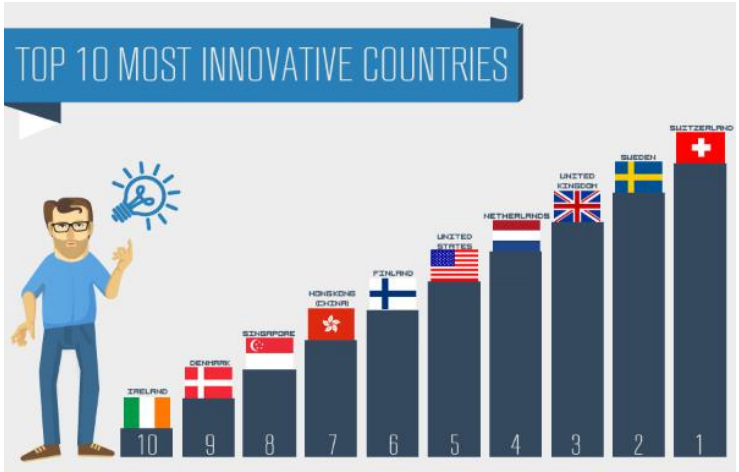
Figure 3.1. Spider Diagram of Ease of Doing Business



Source: World Bank Ease of Doing Business Rankings

It is clear that Ireland scores relatively well on this basis being ranked 15th in the world. Though Ireland scores relatively badly in terms of individual components such as dealing with construction permits and, rather surprisingly, getting electricity. In terms of the focus of this study another useful indicator is the Global Innovation Index (GII).[12] This index comprises a wide range of indicators (of which Ease of Doing Business is one aspect) and Ireland emerges a very respectable 10th in the world (Figure 3.2)

Figure 3.2. Top Ten Countries



Source: Cornell University: Global Innovation Index

[12] See www.globalinnovationindex.org for details of the GII Index

Ireland's position in these two rankings relative to a number of other countries that are active in global markets is highlighted in Table 3.1. It is apparent from the table that a number of international competitors (New Zealand, United States and Australia) are higher ranked in terms of Ease of Doing Business. However, in terms of overall innovation, with the exception of the US, the top 6 ranked countries are European.

Table 3.1 Global Rankings of Selected Countries

Top Ranked Ease of Doing Business		Top Ranked Global Innovation Index	
New Zealand	3	3	United Kingdom
United States	4	4	Netherlands
Denmark	5	5	United States
United Kingdom	10	9	Denmark
Australia	11	**10**	**Ireland**
Ireland	**15**	15	Germany
Germany	21	17	New Zealand
Netherlands	28	19	Australia
France	38	20	France
Poland	45	26	Spain
Spain	52	29	Italy
Italy	65	49	Poland
Brazil	116	64	Brazil

Innovation in the Agrifood Sector

The GII and Ease of Doing Business are useful indicators of the overall environment within which the agrifood sector operates, but of specific interest to this study is how Ireland performs in the agrifood sector and in this section a range of commonly used indicators are used to assess where Ireland sits in an international context.

Innovation in the Food and Beverage Sector

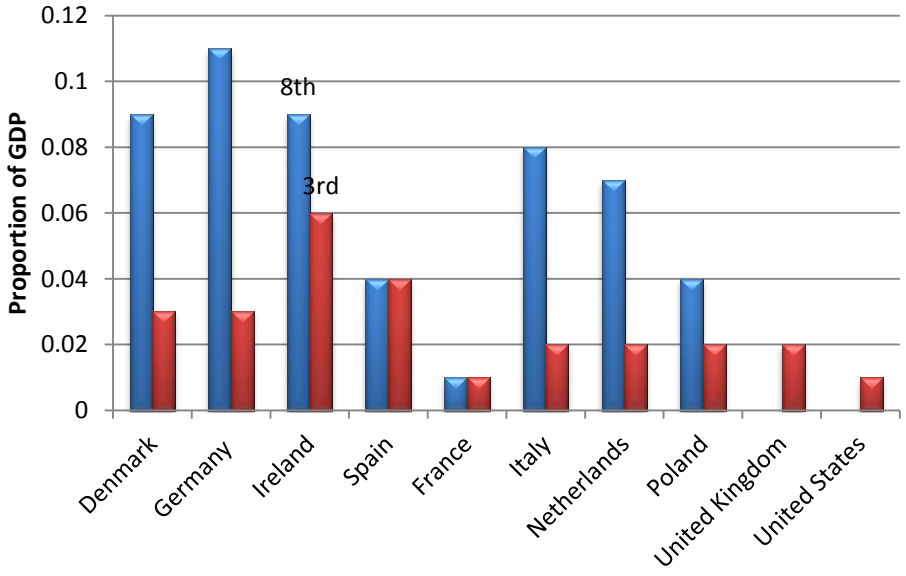
In order to build a picture of the level of innovation within the agrifood sector, we consider first the evidence surrounding expenditure on R&D by both the private and public sectors. Indicators such as expenditure on R&D and numbers of research staff employed are used to highlight the level of *input* into innovation (following common practice). We then consider indicators of the *outputs* from this activity (for example patents, publications, adoption of innovations) and finally the *outcomes* (how well firms and farms are performing).

Research Investment

There are a number of ways that we can examine investment in the agrifood sector. An indicator that is commonly used is the level of public funding of R&D. For agriculture itself in Ireland this has been steady at around €100 million per year over the last few years (according to Eurostat). This places Ireland 9th within the EU. However if we place this as a percentage of GDP we see that Ireland

moves up into 3rd place in Europe with significantly greater level of investment in relation to GDP (Figure 3.3). Whilst specific figures are not available for manufacturing within the agrifood sector, it is possible to use the figures for industry and production as an indicator and here Ireland ranks 8th in Europe in terms of percentage of GDP spent.

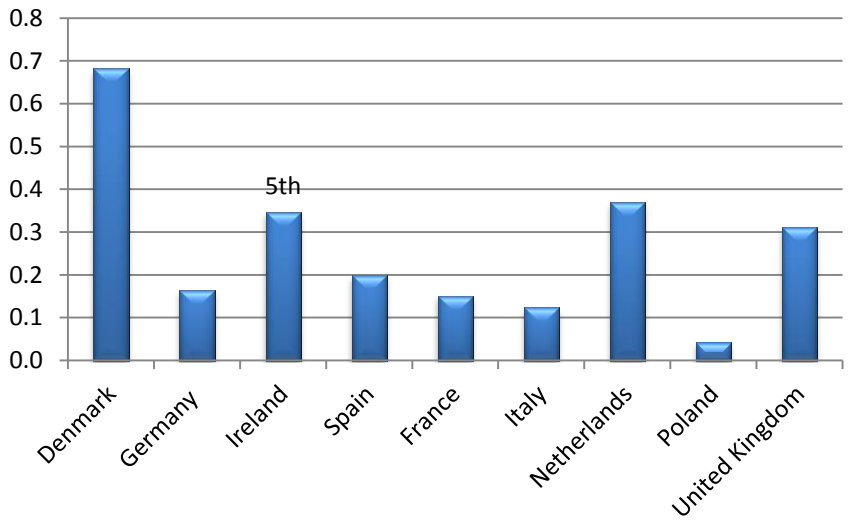
Figure 3.3. Public Investment in Research as a Proportion of GDP



Note: blue is Industry, red is agriculture. Source: Eurostat

In terms of private sector expenditure on research, the concept of research intensity relates the expenditure by businesses on R&D to their overall turnover and is a useful indicator of the importance of R&D to businesses (Figure 3.4). Ireland is ranked 5th in Europe in terms of this measure but it must be noted that the figures across Europe are relatively low (highlighting a general issue in EU food and drink manufacturing). Denmark has a significantly higher level of business investment in relation to turnover in food and drink businesses.

Figure 3.4: Research Intensity of Food and Drink Industry



Source: Authors' calculations from Eurostat data

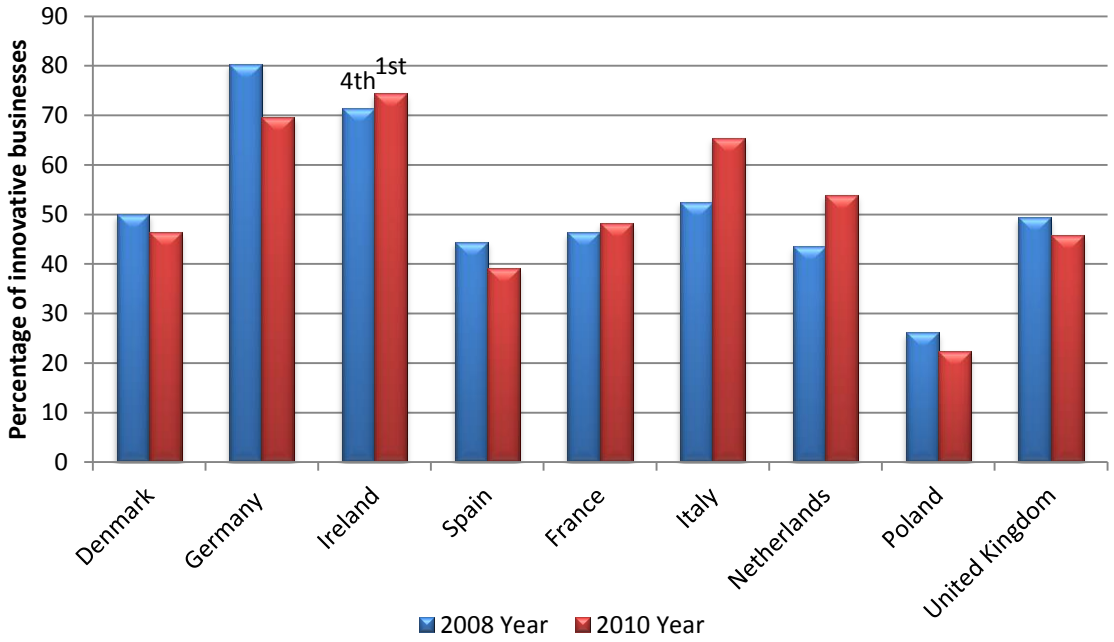
Whilst in investment terms, Ireland seems to be in the top 20 per cent in relation to other European countries, it does rank only 12th in the EU in terms of the proportion of the labour force in employment in research and development, with a figure of just under 10 per 1000. This supports the view that emerged from the interviews concerning the lack of absorptive capacity in private companies in Ireland. 'There are companies with a turnover of €150 million that have no-one employed in R&D'.

Outputs

In this sector a range of indicators that can be considered the *outputs* from the investment in R&D are presented. These include: the extent that innovation occurs within businesses; the level and quality of publications emerging from research organisations and; the development of patents.

Figure 3.5, highlighting findings from the 2008 and 2010 Community Innovation Surveys, indicates that a large proportion of Irish food businesses have undertaken innovative activities and that in 2010 this was the highest proportion within the EU.

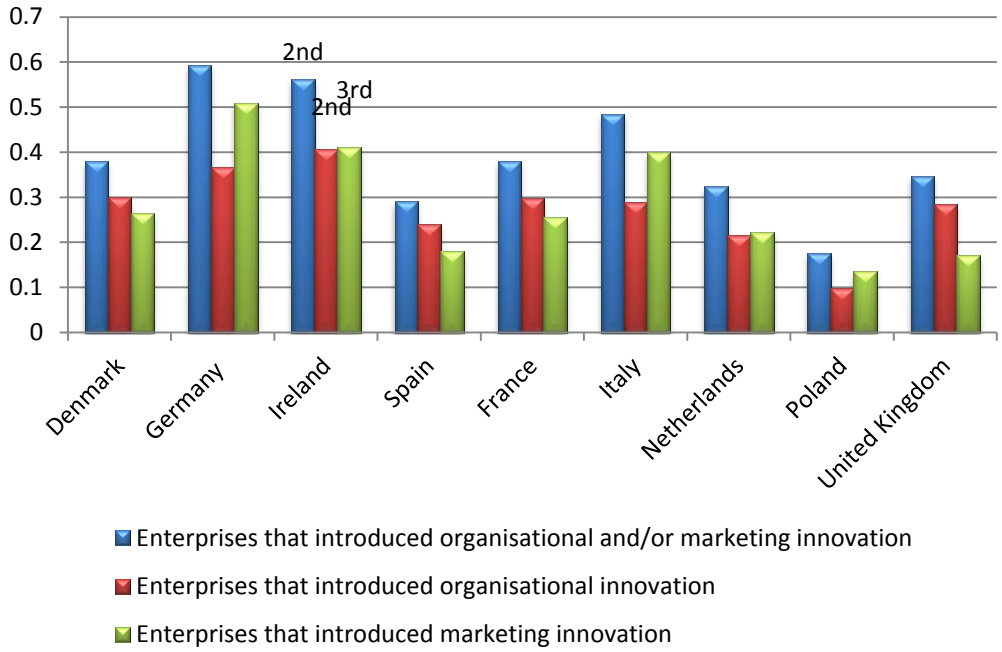
Figure 3.5. Percentage of Innovative Food Businesses 2008 and 2010 and Ireland's Rank in Europe



Source: Eurostat, Community Innovation Survey

Figure 3.6 breaks this down into types of innovation (organizational and marketing) and again Ireland scores highly in comparison with other countries

Figure 3.6: Proportion of Enterprises that have undertaken Organisational or Marketing Innovation



Source: Eurostat, Community Innovation Survey

A relatively high proportion of Irish firms that have been innovative have undertaken organizational or marketing innovation rather than technological innovation. In terms of marketing, Ireland ranks relatively highly for introducing new design but relatively lower in terms of innovation in product promotion, placement and pricing (Table 3.2).

Table 3.2: Ranking of Irish Food Businesses within EU by Type of Innovation in Marketing

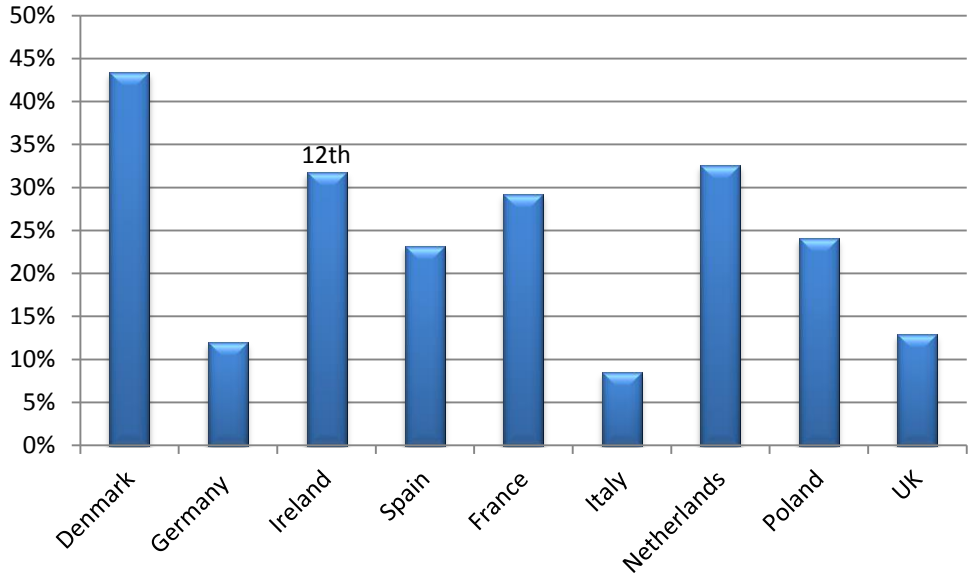
Country	New Design	New techniques for promotion	New methods for product placement	New methods of pricing goods or services
Denmark	n.a.	n.a.	n.a.	n.a.
Germany	20	8	18	13
Ireland	4	19	16	16
Spain	15	17	17	14
France	13	15	26	23
Italy	3	12	15	9
Netherlands	19	6	14	18
Poland	24	21	20	5
United Kingdom	n.a.	n.a.	n.a.	n.a.

Source: Authors' calculations based on Eurostat, Community Innovation Survey

The ability to cooperate and collaborate is often seen as important for innovation and around 30 per cent of innovative businesses are involved in co-operation for innovation in Ireland (Figure 3.7). This

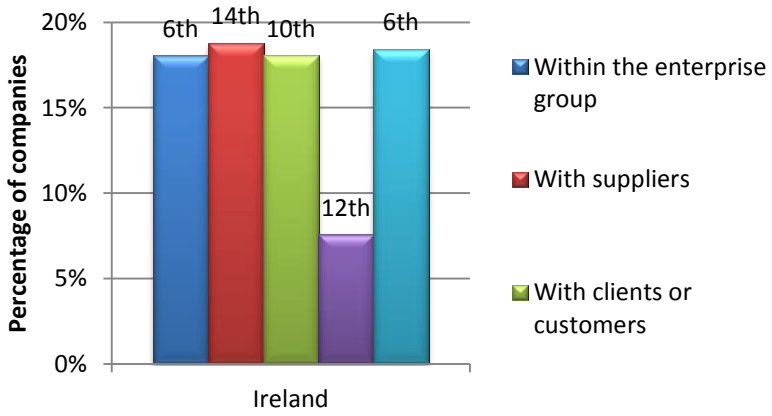
is broken down further in Figure 3.8. Both in absolute and relative terms, collaboration does not seem a strong feature of Irish food companies. The low score for collaboration with competitors is of particular relevance given that many perceive that Ireland could gain from greater levels of collaboration between potential competitors (the idea of co-opetition).

Figure 3.7: Percentage of Food Enterprises engaged in any Type of Co-operation for Innovation



Source: Eurostat, Community Innovation Survey

Figure 3.8: Percentage and Rank of Irish Food Enterprises Engaged in Different Types of Co-operation

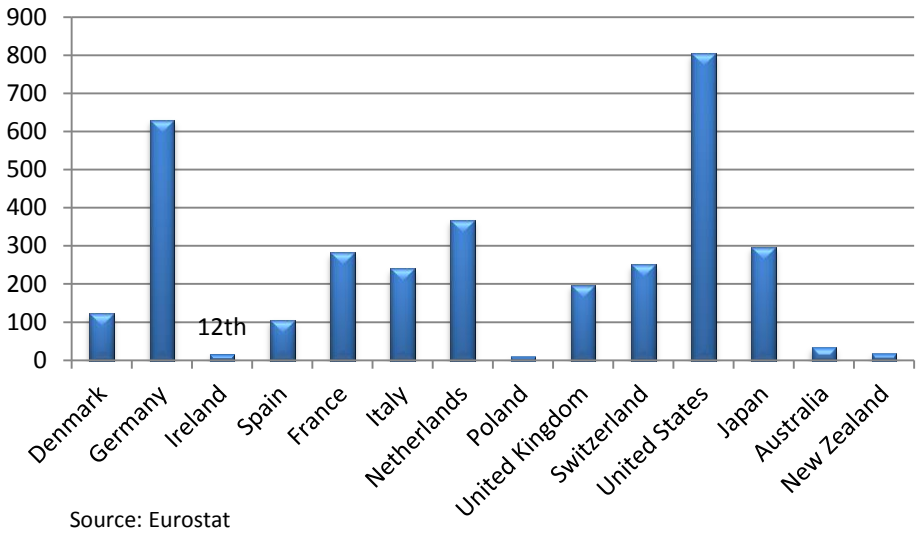


Source: Eurostat, Community Innovation Survey

Patents

Patents are often used as a measure of output of the scientific process and can equally be regarded as an indicator of the level of innovativeness.[13] Whilst internationally the US is strongest in this indicator by some way, in European terms, Germany dominates followed by the Netherlands and France (Figure 3.9).[14] Ireland appears to develop relatively few patents and is ranked 12th in Europe in this regard. This reflects the opinion expressed by a number of those interviewed that Ireland is not strong on developing *new* products.

Figure 3.9 Patent Applications between 2008 and 2010[15]



Source: Eurostat

Publications

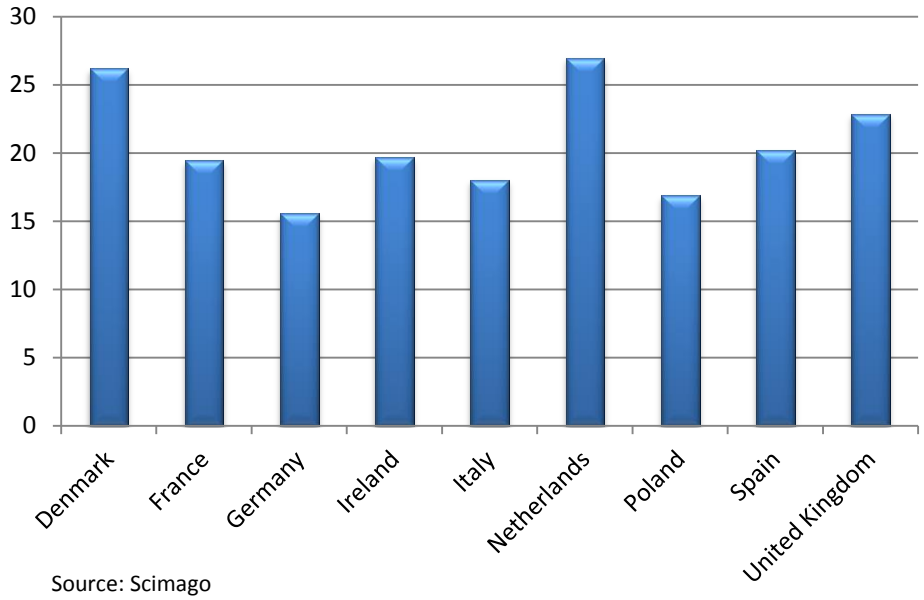
Research output is often measured in terms of publications from research organisations. Whilst the number of publications has been a key metric in the past, more emphasis is now placed on the quality of publications. An indication of quality that is often used is the number of times the paper has been cited in other publications. Following the approach of Wageningen (2013), we therefore compare the extent that research publications have been cited. Given the inevitable lag associated with the process the total citations per document published between 2003 and 2005 are compared. As argued by Wageningen (2013), this lag allows a better view of the impact of the paper on the scientific community. For Ireland, on average, each document published during this period has been cited around 20 times (Figure 3.10). Whilst significant it does put Ireland behind Denmark the Netherlands, the UK and Spain. Globally, Ireland ranked between 40th and 50th between 2003 and 2005 in this regard. Though in terms of volume of publications it ranked much higher at around 23rd place. It should be noted that if we take just food science, Ireland is placed significantly higher,

[13] There is some debate as to their appropriateness as an indicator but as it is widely used it is adopted here.

[14] Following Wageningen (2013) the patent classes chosen are Butchery, Bakery and Other Foodstuffs

reflecting the perceptions of the stakeholders concerning the performance of universities across the two disciplines of agriculture and food as highlighted in Table 2.1.

Figure 3.10 Average Citations per Document Published between 2003 and 2005 in Agriculture and Food Science



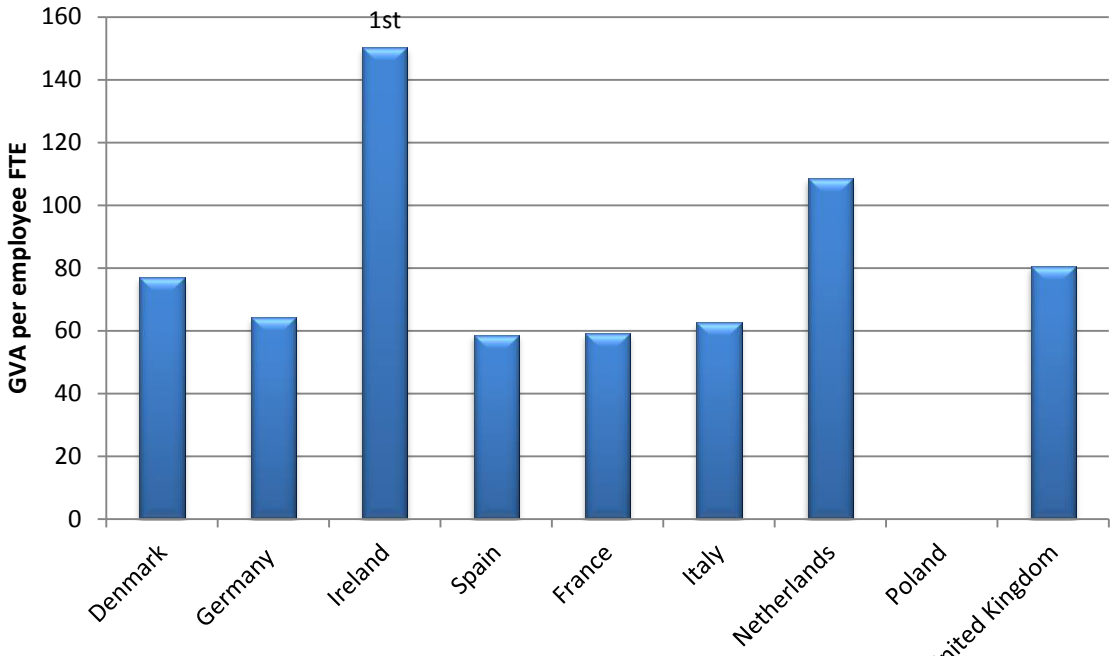
Source: Scimago

Outcomes

Whilst the level of input into innovation and the outputs discussed are useful indicators it may be argued that the acid test is how well businesses (farms and firms) within the agrifood sector are performing and how this has been changing over time.

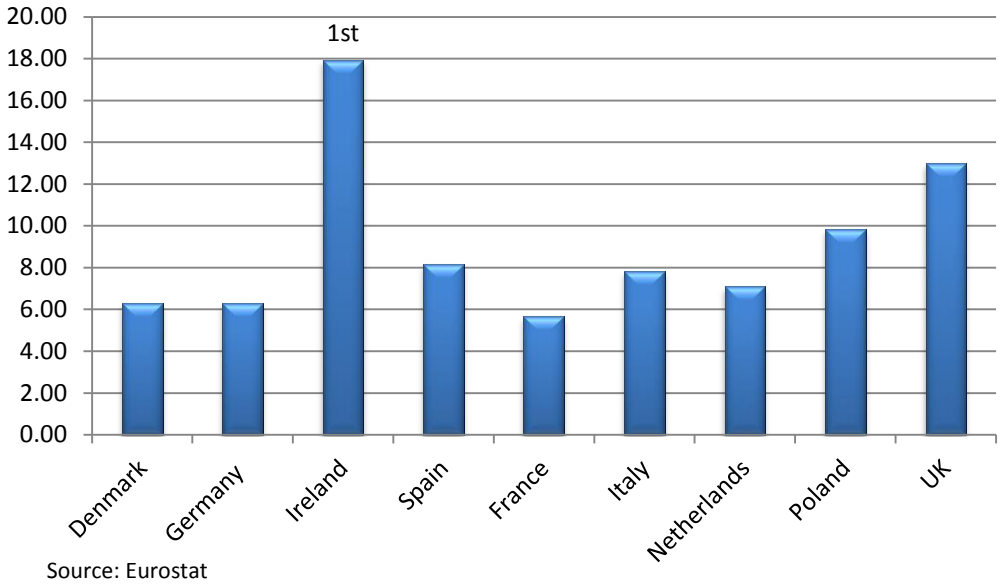
Taking food and drink manufacturing as a starting point we see that in terms of Gross Value Added (GVA) per employee, Irish food and drink firms are performing very strongly. They were ranked 1st across the EU in 2011 (Figure 3.11) and have held this position for some time. In part this may be a result of the relative importance of the drinks industry to Ireland as this this tends to have a much higher GVA per employee than the food industry. In terms of a dynamic view of the situation the growth in GVA over the period 2001 to 2008 (the last date that time series data was available) was higher in Germany than in Ireland. Whilst individual firm profitability is not available, a possible indicator is Gross Operating Surplus as a percentage of turnover. Again on this basis we see that Irish food and drink manufacturers are performing well (Figure 3.12) although this is also likely to represent the importance of the drinks industry in the overall makeup of the sector.

Figure 3.11: GVA per Employee Food and Drink Manufacture 2011



Source: Author's estimates based on European Food and Drink Federation (2014)

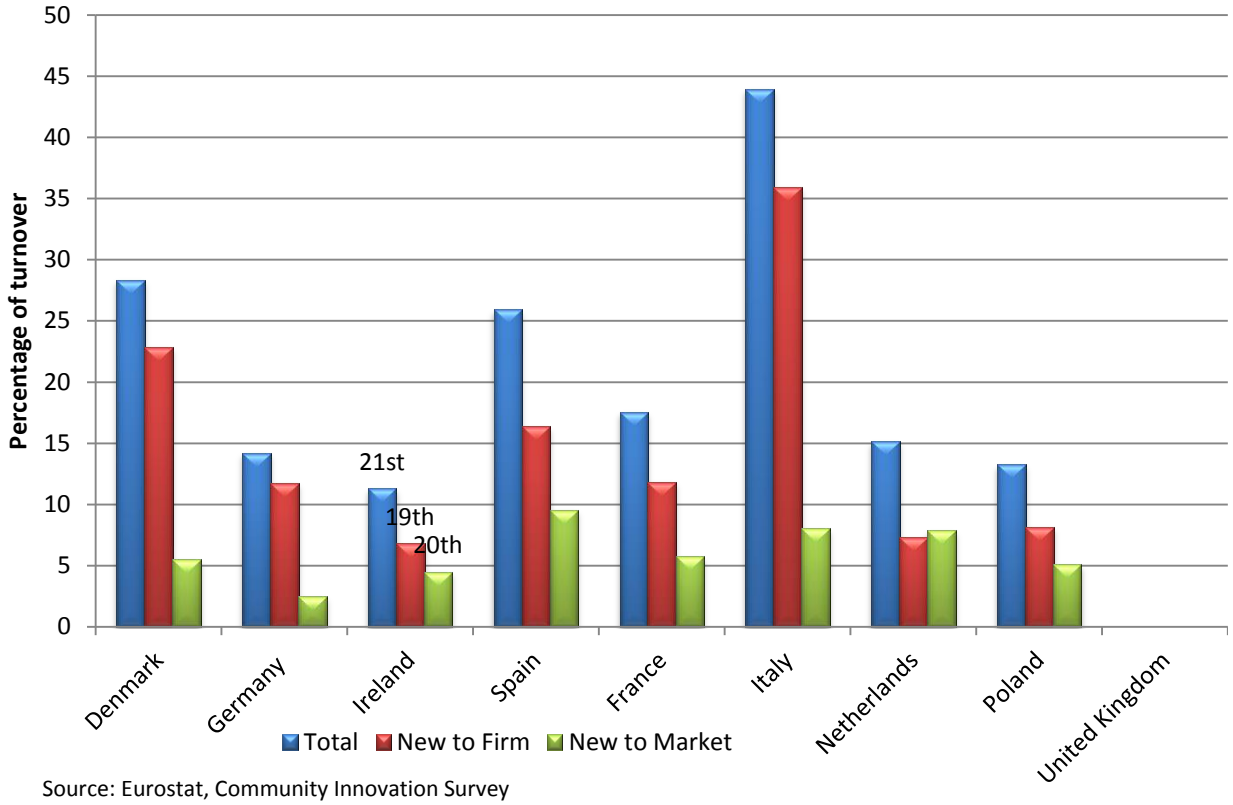
Figure 3.12. Gross Operating Surplus as Percentage of Turnover



Source: Eurostat

Whilst the indicators of innovation activity for Irish firms seems high, one issue that emerged from the stakeholder interviews was that Ireland was weak at bringing new products into play. If we consider the contribution to the turnover of firms through new products as reported in the CIS, the evidence seems to support this view. Only 11 per cent of turnover of firms is accounted for by products that are either new to the market or new to the firm (Figure 3.13), meaning that Ireland ranks 21st in the EU.

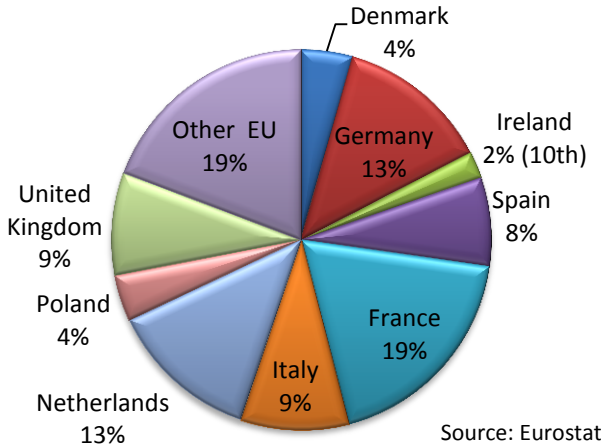
Figure 3.13. Percentage of Overall Turnover arising from Products New to the Firm or New to the Market



Source: Eurostat, Community Innovation Survey

Given the importance of exports for the food and drink industry, a final indicator may be the international competitiveness of food and drink products (Figure 3.14). In the past the widespread use of export subsidies would have meant that extra-EU trade reflected the level of support rather than the performance of the industry. However, given that export subsidies have all but disappeared in recent years, levels of extra-EU trade may be considered a valid indicator. Whilst Ireland clearly has strong exports within the EU, it ranks only 10th in terms of extra-EU exports.

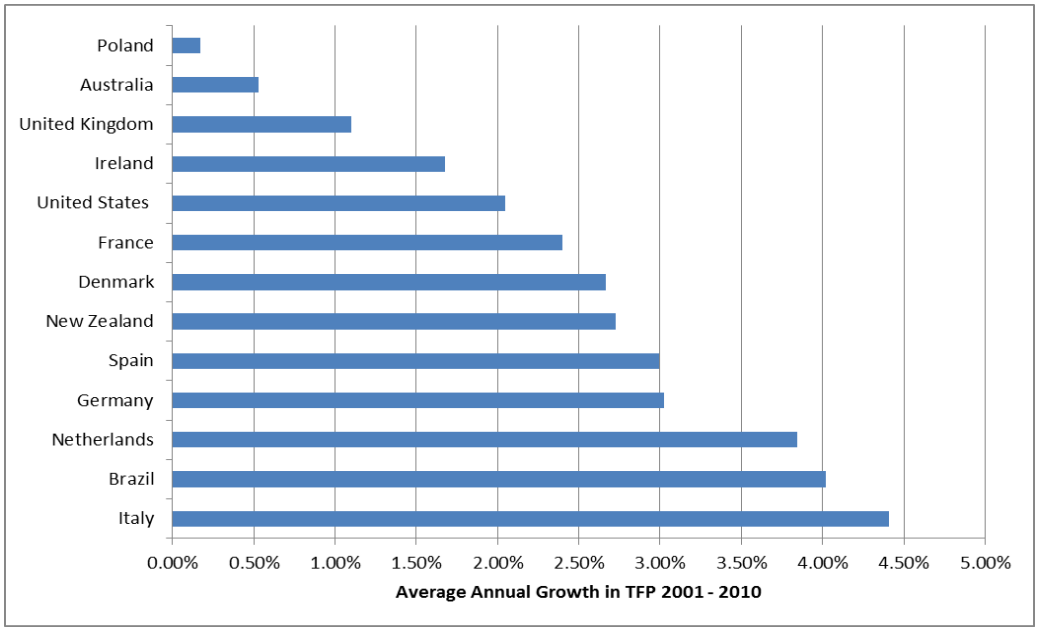
Figure 3.14. Share of Food and Drink Exports to Non EU Countries



Source: Eurostat

Whilst in many of the selected indices, the food and drink manufacturing sector seems to be performing well, it is also important to consider the performance at the farm level. A commonly used measure of the performance of agriculture is Total Factor Productivity (TFP) [15] and in particular growth in TFP. Generally, it is expected that this should increase by over 2 per cent per year on average. Recent work by the USDA compares the growth rate within the agricultural sector across the world and selected countries are highlighted in Figure 3.15. According to this measure Ireland achieved an annual growth rate of only just over 1.5 per cent between 2001 and 2010. This means it ranks only 10th in the EU and has lagged behind nearly all the countries that may be seen as competitors on the global market. [16]

Figure 3.15. Average Annual Growth in TFP 2001-2010



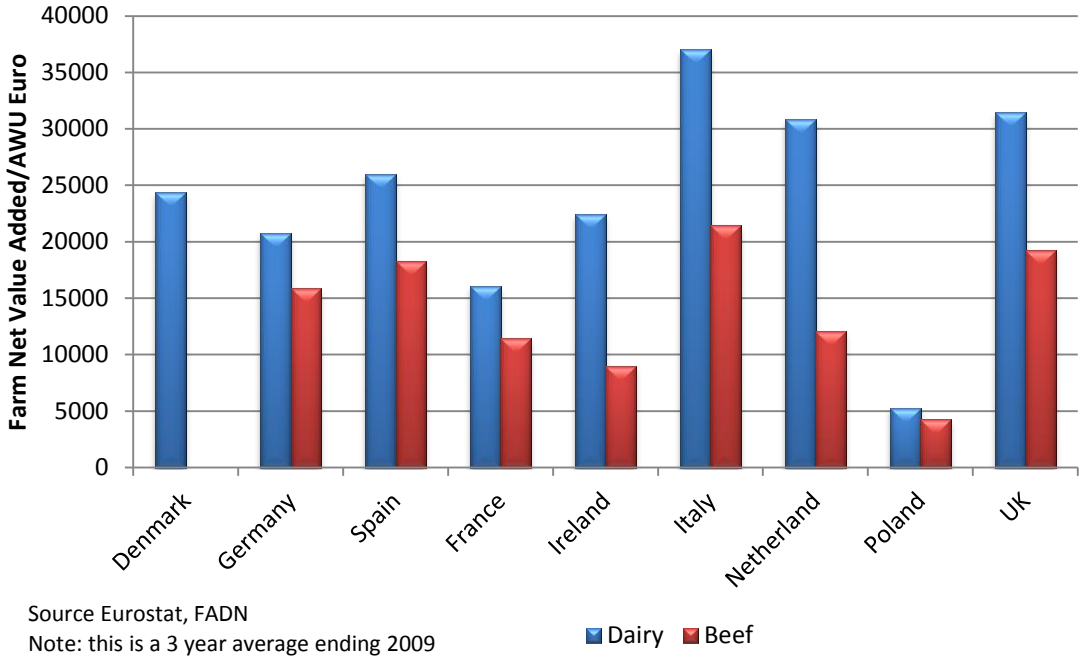
Source: USDA

Using Eurostat data it is possible to analyse the relative performance of different farming sectors across the EU. Taking the two main sectors in Ireland, Dairy and Grazing Livestock we see that value added per annual work unit (AWU) is lower than a number of other countries (Figure 3.16). The beef sector is particularly lowly ranked in this regard. For agriculture overall, Ireland was ranked 10th in terms of value added per work unit during this period.

[15] TFP is simply the ratio of the total level of output produced to the total amount of inputs used to produce that output.

[16] It should be noted that a measure of TFP undertaken with EU data actually indicates that Ireland had negative growth in TFP over a similar time period and was 24th of the 25 countries analysed.

Figure 3.16. Average GVA per AWU for selected EU Countries on Dairy and Grazing Livestock



Source Eurostat, FADN
Note: this is a 3 year average ending 2009

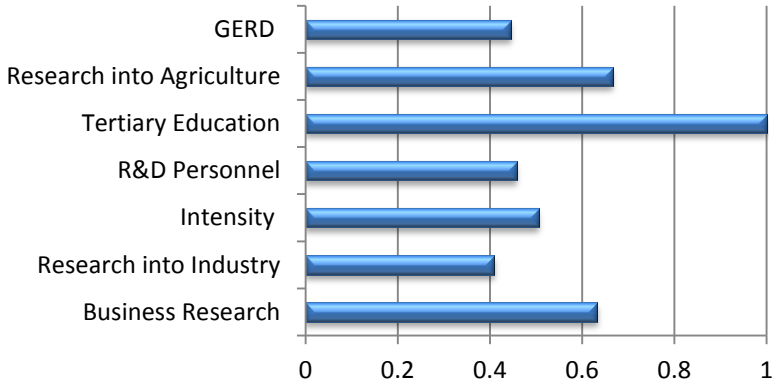
Of course these are just two relatively simple measures (indicators) of the performance of the Irish agricultural sector, and more detailed work has highlighted the relative international competitive advantage of the dairy sector. However, they are indicative of the overall position of Ireland.

Developing an Index

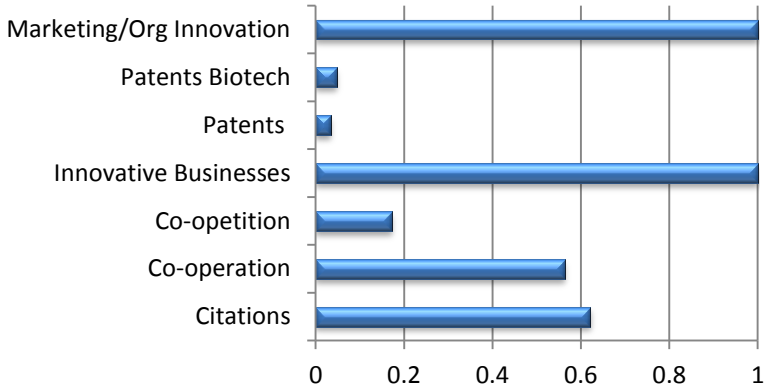
Having analysed the relative position of Ireland for a range of indicators, it is possible to proceed to developing an index that represents the overall performance of the agrifood sector. This is achieved by first 'normalising' each of the indicators. Effectively this sets the performance of Ireland (or any EU country) against the best performing EU country in that category. Therefore if Ireland is the best performing country the indicator will have the value of 1 (as in the proportion of the population in tertiary education). The closer to zero the indicator is the poorer the performance of Ireland relative to the best performer. Figure 3.17 highlights the normalized scores for the indicators selected for inclusion in the overall index.

Figure 3.17. Normalised Index Scores for Input, Output and Outcome Indicators

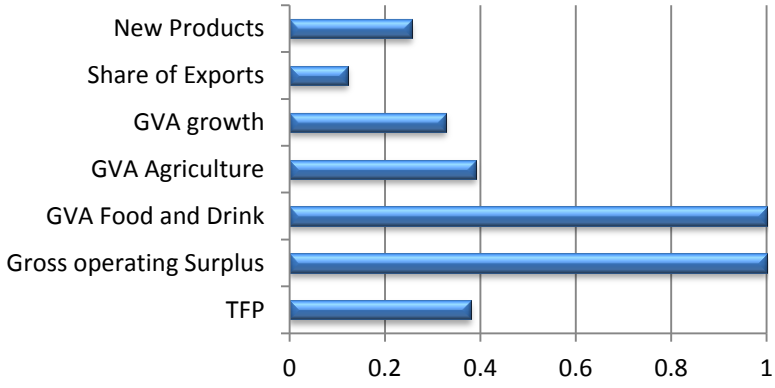
a) Innovation Inputs[17]



b) Innovation Outputs



c) Innovation Outcomes

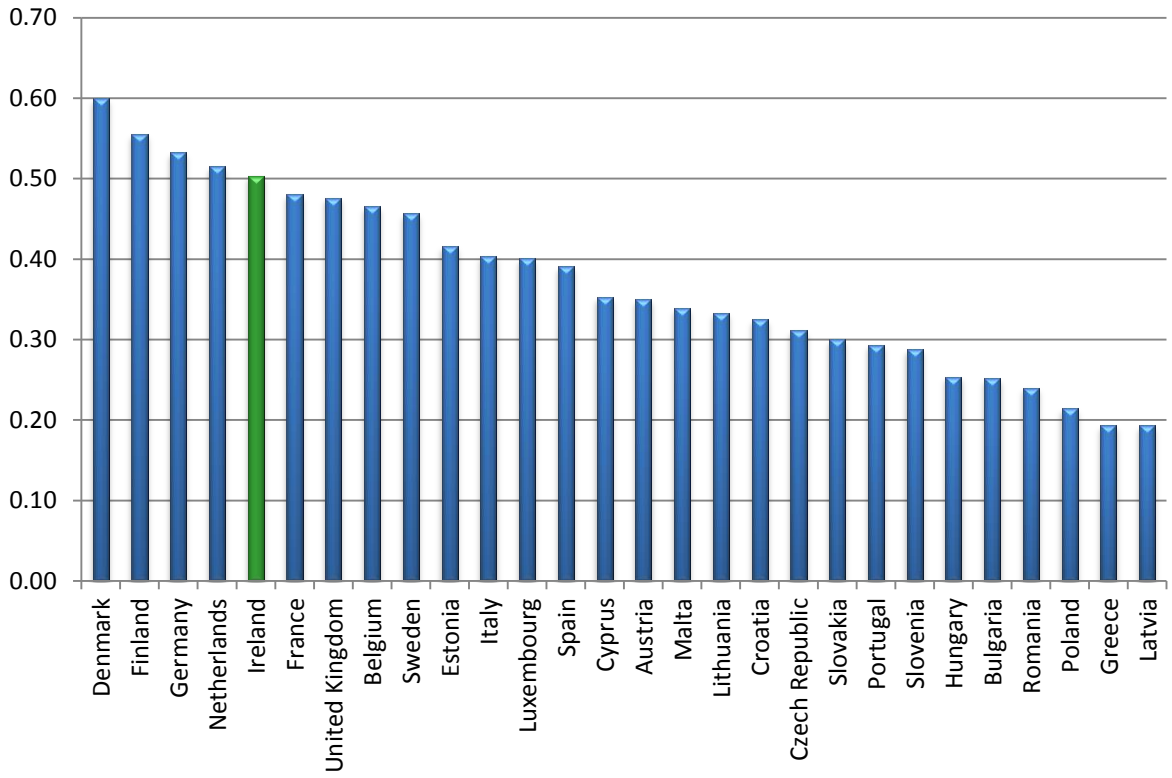


[17]Within the diagram GERD stands for Gross Expenditure of Research and Development and comprises overall public and private investment in research. Intensity is measured as the proportion of overall turnover of businesses spent on R&D.

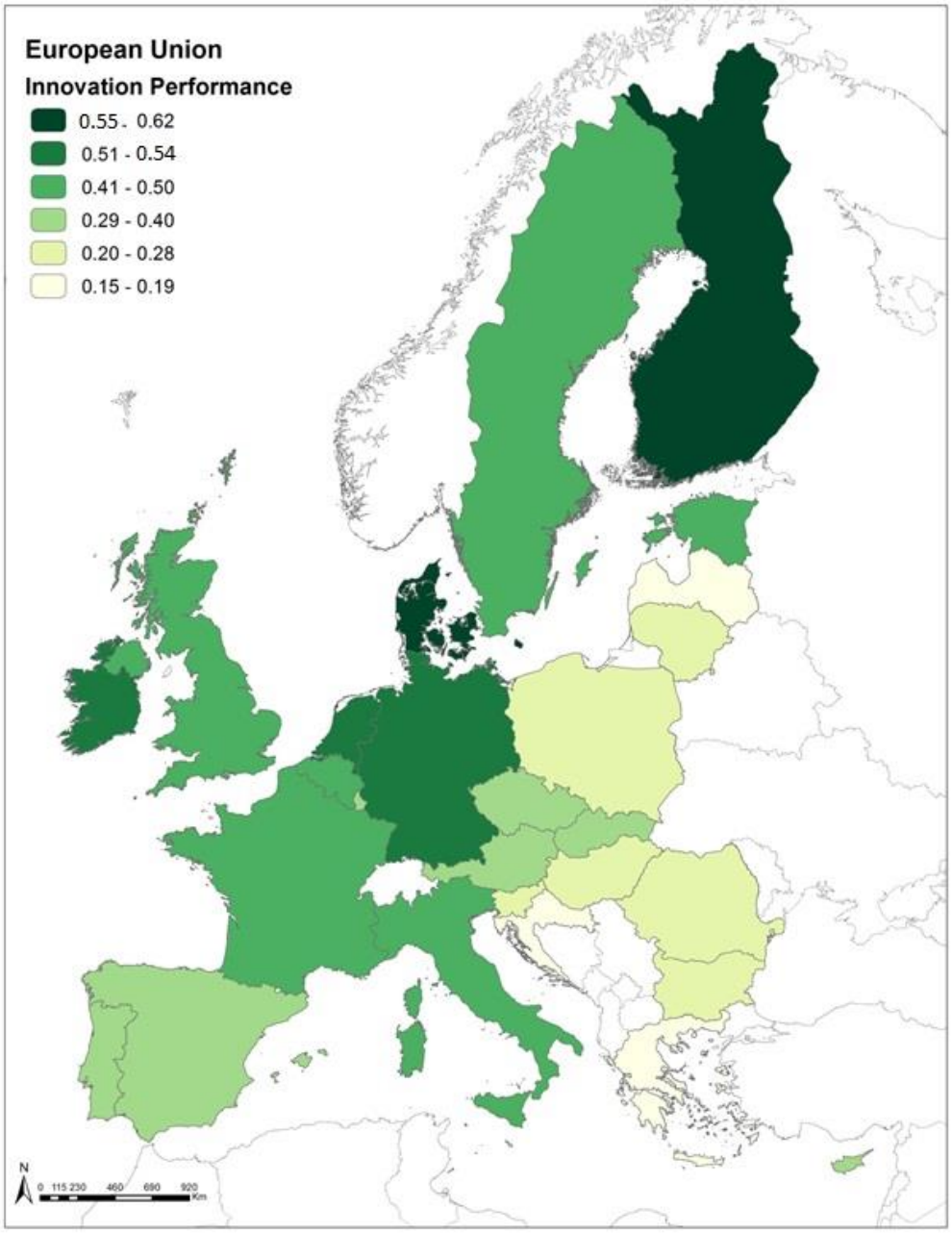
Combining the input, output and outcome scores, these values can therefore be used to provide an overall score for Ireland which can be compared with the other EU countries and this is presented in Figure 3.18 and Map 3.1. This places Ireland as the 5th most innovative country in Europe, behind Denmark, Finland, Germany and the Netherlands. However the differences between the Netherlands and Ireland are relatively small and to all intents and purposes their overall score is the same.

Of course, the validity of the use of indicators in this way in general, and the inclusion of any one of the indicators in particular, may be discussed at length. However, whilst recognizing the limitations of the approach, the results of the analysis seem plausible in terms of categorising EU countries.

Figure 3.18. Ranking of EU Countries by Index of Innovation

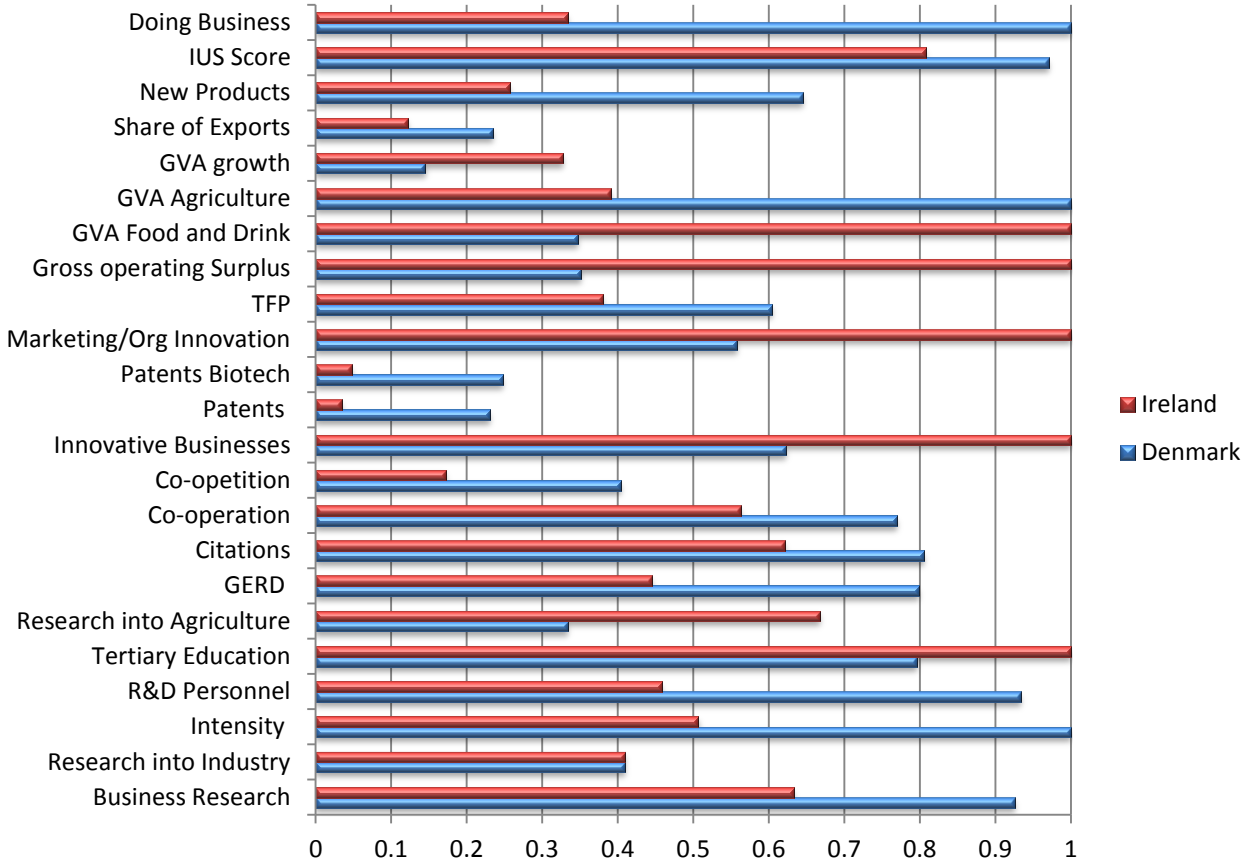


Map 3.1: Innovation Performance across the EU Agrifood Sector



Whilst Figure 3.17 effectively compares Ireland against the best performer in each indicator category, it is perhaps more informative to compare with the best performing country, Denmark and this is undertaken in Figure 3.19.

Figure 3.19. Comparison Between Denmark and Ireland



The comparison appears to show a relatively clear picture - Denmark is investing more in business research (both by the government and by industry), this is leading to more patents and new products being introduced. In general firms appear more collaborative, agriculture is more productive and the overall environment is more conducive to innovation. Ireland does have a greater proportion of innovative businesses, but this seems to be more around marketing/organisational innovation than new product development. In addition Ireland does have a higher level of value added and operating surplus in the food and drink industry, but again this is likely to be skewed by the relative importance of the alcoholic drinks industry in Ireland.

Finally in this section whilst the innovation index presents a snapshot of the situation in Ireland, it is of interest to highlight the trajectory of some indicators of performance (see next page). This is not presented for all indicators as a number are not collected every year. It does highlight for example the upward trajectory in the number of publications emerging from Irish research institutions and a growth in R&D staff. On the other hand it shows a much flatter picture for TFP and public R&D funding for agriculture, and a volatile pattern for trade.

At a glance: Trends in selected Innovation Indicators for Ireland

Inputs

- Ag Research  2012
- Total Research  2012
- Business Research  2009
- R&D Staff  2012
- Graduates  2008

Outputs and Outcomes

- Patents  2012
- Trade  2012
- Publications  2013
- TFP  2011
- GVA/FTE  2008

Note: Year refers to latest data available for trend analysis not necessarily that used for index calculation

Both the stakeholder and indicator analysis highlights particular challenges at the farm level within the Irish AIS. Whilst not the only area of concern, it is useful to analyse the farm sector in more detail. The next section therefore provides a disaggregated (by farming system and region) picture of the level of innovation within Irish agriculture and gives further insight into the opportunities and challenges for this sector.

4. Focus on Innovation at the Farm Level

Summary

This section provides an overview of innovative performance of the Irish agricultural sector. The findings reveal that:

The dairy sector is the most innovative farm sector, followed by mixed livestock and tillage, while the cattle sector is the least innovative farm sector.

The Southeast region emerges as the most innovative region, followed by the East region, while the West region is the least innovative region.

Much of the regional variation is due to the distribution of farm systems across Ireland, however there is also considerable variation within farm systems in innovative performance – suggesting that other regional specific factors are at play that influence innovation efforts.

Farmers with high innovative performance have higher farm incomes, invest more, have larger farms and are younger than less innovative farmers.

Within this section an overview of innovative performance of the Irish agricultural sector is provided. To this end, an innovation index is developed based on Teagasc National Farm Survey data from 2012.[18] In order to reflect the complexity of innovation, innovation is assessed through a combination of adopted innovations as well as innovation behaviour of the farmer which is measured through investments in new knowledge and renewal of machinery. Knowledge transfer and innovation experts have been consulted in order to assess the relative importance of each of these innovation sub-measures (i.e. new technologies, new knowledge and renewal of machinery) for each of the main farming systems considered. Effectively each farm receives a final innovation score between zero and one that allows comparison of farm systems and regions based on innovative performance as well as identifying associated characteristics.

Innovative Performance by Farm System

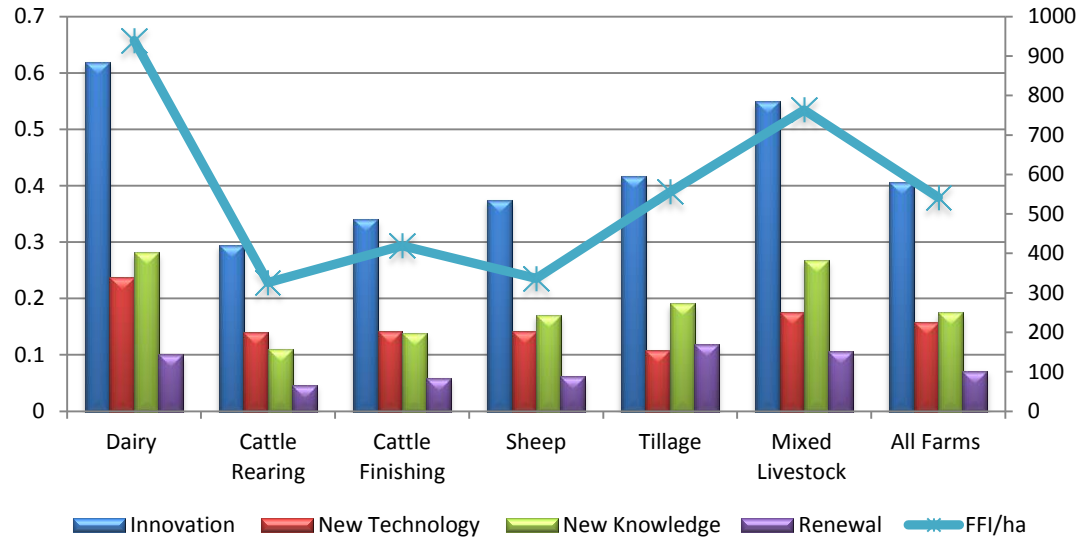
The innovative performance and family farm income per hectare classified by farm system is shown in Figure 4.1. Dairy and mixed livestock sectors are the most innovative sectors, with innovation index values of 0.62 and 0.55, respectively compared to an average score of 0.40 for all farms. This indicates that innovative performance is considerably higher than average on these farms. The tillage sector is the next most innovative sector with an innovation value of 0.42, similar to the average innovative performance of all farms. The sheep and cattle finishing sectors have lower than

[18] The creation of the innovation index was informed by NFS supplementary survey questions for the year 2012, hence cross validation of innovative performance over previous years was not possible. Please also note that the construction of the innovation index was constrained by data availability. This may especially have an impact on the innovative performance of the tillage sector as only few tillage specific technologies are recorded in the data set.

average (but similar) scores of 0.37 and 0.34, respectively. The cattle rearing sector emerges as the least innovative sector in Irish agriculture with a value of 0.29.

One sector missing from the analysis is the horticultural sector and this is due to data availability. However, as the case study on Clarke's Fruits at the end of the chapter highlights, innovation is a key feature of this sector which is often attributed to the fact that it receives very little support.

Figure 4.1. Innovative Performance by Farm System



Source: Teagasc, National Farm Survey (2012) and authors' own analysis.

When considering the individual innovation sub-measures, a number of observations can be made:

- The measure for new technologies is much higher for the dairy sector than the cattle, sheep and tillage sectors.[19]
- The new knowledge sub-measure takes on the largest proportion of the overall innovation index for all sectors except cattle.[20]
- Renewal of machinery has the greatest impact on the overall innovation index for tillage farmers relative to the remaining sectors.

Figure 4.1 also highlights that in line with innovative performance, average family farm income varies considerably by farm system. It suggests that innovative performance is reflected in farm

[19] It should be noted that this does not just reflect the uptake of technologies on farms but also the importance given to new technologies as an indicator of innovation in that sector by experts. For example for cattle systems the low score on the new technology sub-measure is generally because of lower uptake whilst for tillage the lower value may be explained by a lower expert weighting of the new technology sub-measure and few available tillage specific technologies in the data.

[20] This is driven in part by the large participation rate of dairy farmers in advisory services (which in turn can partly be attributed to the Dairy Efficiency Programme) and also in part by the weighting given to knowledge. In contrast, a low participation rate in extension programmes by cattle farmers in combination with a lower expert rating of this sub-measure explains the low value for the cattle sectors.

income for all farm systems, except for sheep farms which show higher innovative performance but lower farm incomes than cattle finishing farms.[21]

Regional Innovative Performance

Map 4.1 below shows agricultural innovative performance for all farms across Ireland. In terms of interpretation, a darker colour indicates higher innovative performance. As can be seen, innovative performance varies considerably across Ireland.

The Southeast region[22] emerges as the most innovative region, with an innovation index value of 0.55 which is markedly higher that the next highest region, the East (which has a value of 0.45). The Border and Midlands regions follow with values of 0.41 and 0.39, respectively. The Southwest (0.36) and South (0.32) regions belong to the less innovative regions, whilst the West region emerges as the least innovative region with a value of 0.31.

A large proportion of innovative performance by regions can be attributed to the distribution of farm systems across Ireland, a point that was emphasised during the stakeholder interviews. The low innovative performance of the West region, for example, can be explained by the fact that over 90 per cent of farms in this region are cattle or sheep farmers, while the Southeast region has the lowest proportion of drystock farms and consequently shows the highest innovative performance. However, there are other factors at play, because within sectors regional variation occurs. For example:

- Within the cattle sector the farms in the Southeast region are more innovative than the farms in the remaining regions (an index of 0.52 compared to the average of 0.31).
- Dairy farmers in the Southeast region also show above average innovative performance with an innovation index value of 0.72.
- While only 13.5 per cent of farms in the East region are dairy farms, these farmers achieve the highest innovative performance within the dairy sector with an innovation index value of 0.76.

[21] When interpreting family farm incomes on a per hectare basis for sheep farms, it is important to consider that sheep farms are on average larger and more extensive than cattle farms. In addition, most sheep farms have a significant proportion of cattle. In addition, a more detailed analysis reveals that there is no statistically significant difference in innovative performance and farm income between cattle rearing and sheep farms.

[22] *Border*: Louth, Leitrim, Sligo, Cavan, Donegal and Monaghan; *East:* Kildare, Meath, Wicklow and Dublin. *Midlands:* Laois, Longford, Offaly and Westmeath; *Southwest:* Clare, Limerick and Tipperary N.R.; *Southeast:* Carlow, Kilkenny, Wexford, Tipperary S.R. and Waterford; *South:* Cork and Kerry; *West:* Galway, Mayo and Roscommon.

Map 4.1: Regional Distribution of Agricultural Innovative Performance

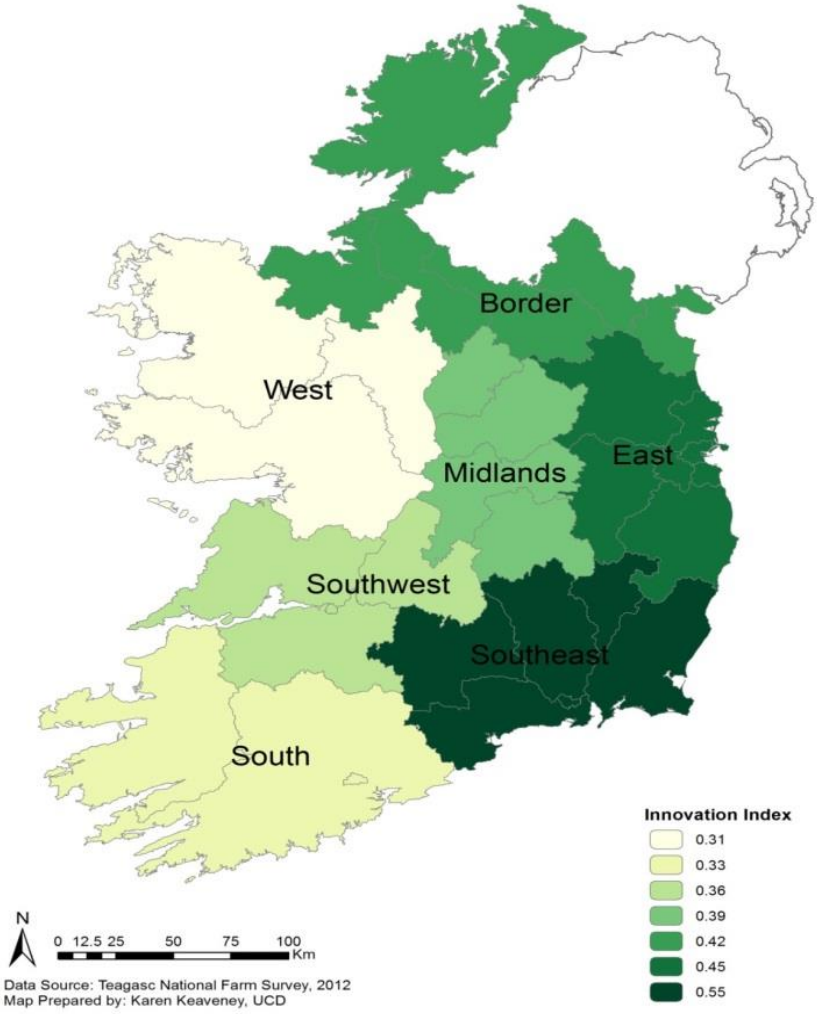
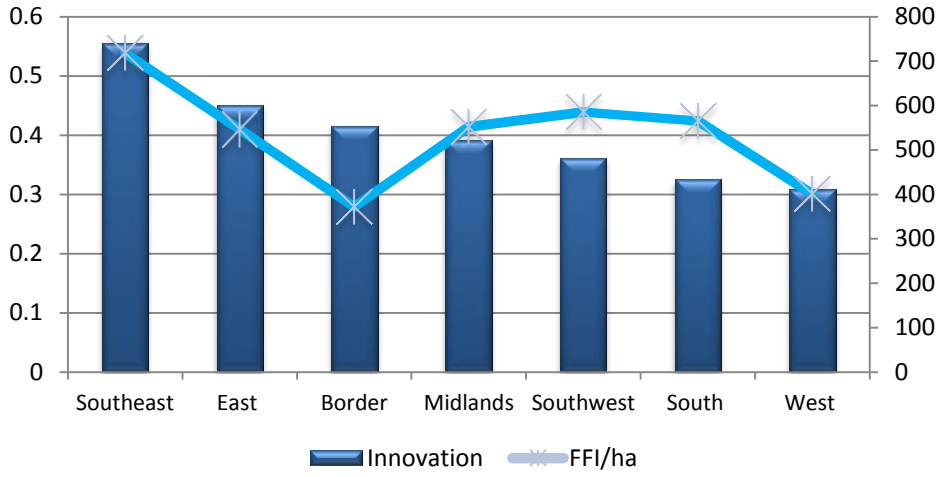


Figure 4.3 shows the relationship between innovative performance and family farm income per hectare for each region. As can be seen, regions with high innovative performance generally have high farm incomes. One exception to this trend is the Border region, which shows relatively low average farm income in contrast to relatively high innovative performance. It is important to bear in mind that due to generally poorer soil quality, it is more difficult to achieve high farm incomes in this region. However, almost a quarter of farms in the Border region are sheep farmers, who show above average innovative performance and farm incomes. Despite having a high proportion of dairy farms, farm incomes in the South region are considerably lower than in the Southeast region, which is in line with its innovative performance. When interpreting the innovative performance of the South region, it is important to note that the South region comprises Co Cork and Co Kerry which may have varying levels of performance. In addition, more detailed analysis reveals that this relatively low innovative performance is driven by lower technology adoption by dairy and especially cattle farmers in this region. However, it is important to remember that this might be because

available technologies in the data set are not as relevant in this region or farmers were just not using them in the year of the analysis.

Figure 4.2: Innovative Performance by Region



Source: Teagasc, National Farm Survey (2012) and authors' own analysis.

Characteristics of Innovative Performance

Selected farm performance indicators and farm characteristics grouped by innovative performance are reported in Table 4.1.

Table 4.1. Comparison of High and Low Innovative Performance

	Low innovative performance* *'Laggards'*	Average innovative performance+ *'Majority'*	High innovative performance~ *'Innovators'*
Family farm income (€)	11,553	23,202	45,649
Market income (€)	-2,233.95	2,517.10	16,997
Share of SFP to FFI (%)	70	70	46
Net new investments (€)	1,506	6,610	16,620
Borrowings (€)	5,197	17,692	56,274
Solvency (%)	0.7	2.2	5.5
Farm size (ha)	38.9	43.2	63.7
Livestock units/hectare	1.11	1.36	1.59
Age (years)	59	57	52

*=bottom 25 per cent, + = middle 50 per cent,~= top 25 per cent

Source: Teagasc, National Farm Survey (2012) and authors' own analysis.

As can be seen in Table 4.1, there are considerable differences between laggards and innovators in relation to all reported characteristics. In relation to farm income, the group of innovators has a significantly higher family farm income, with an average value of €45,650 than laggards who have an average income of less than €12,000. The same can also be observed in relation to market income, where laggards have a negative market income, in contrast to a market income of almost €17,000

for innovators. Overall, this supports the previous findings that high innovative performance is generally associated with high farm income. It is also worth noting that the share of single farm payment on family farm income (share of SFP to FFI) is less than 50 per cent for innovators, while this figure is 70 per cent for the other groups.

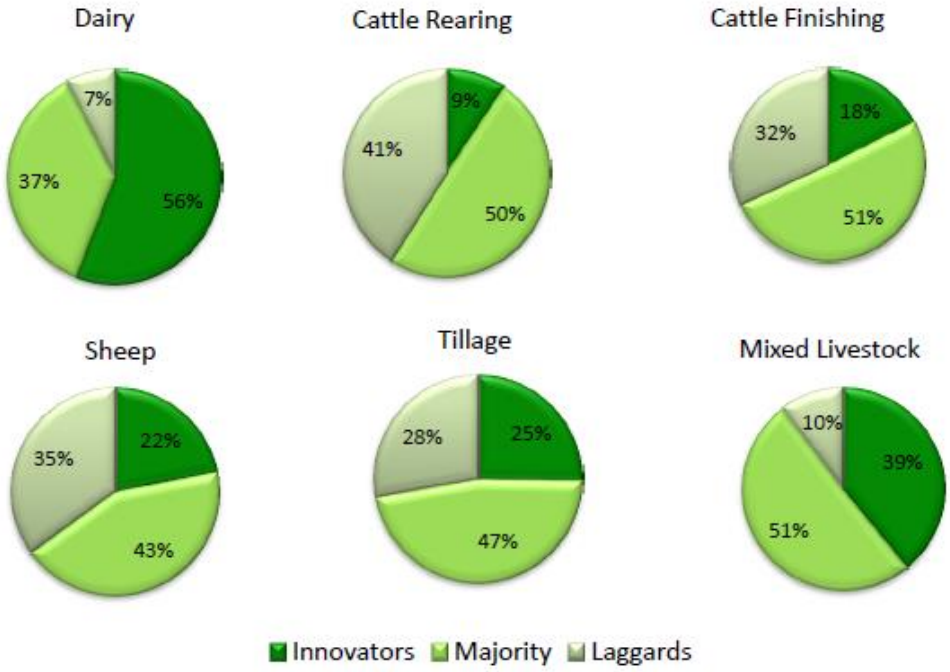
In relation to financial indicators, innovators spent almost ten times more in value on net new investments than laggards, which is also reflected in their level of borrowings and solvency rate.[23] It appears that high innovative performance requires high capital investment. Finally, innovators are found to be younger, manage larger (measured in utilisable agricultural area) more intensively stocked farms (measured in livestock units per hectare) than their less innovative counterparts.

By analysing the innovation groups in more detail, it emerges that:

- 65 per cent of laggards are cattle farmers, while only 5 per cent of this group are dairy farmers (the vast majority of these are located in the South region)
- In contrast, almost 45 per cent of the innovators are dairy farmers and just under 30 per cent of this group are cattle farmers.

The fact that 30 per cent of the innovators are cattle farmers supports the view that whilst on average the sector may not be seen as innovative, there is a cohort of progressive business focused farmers within this sector of agriculture. Figure 4.4 shows the proportion of farms in each innovation category for each farm system. It highlights that just over half of all dairy farmers, a quarter of all tillage farmers as well as almost 40 per cent of mixed livestock farmers are classified as innovators, while less than 10 per cent of cattle rearing farmers are in this group.

Figure 4.4: Innovation Performance by Farm System



Source: Teagasc, National Farm Survey (2012) and authors' own analysis.

[23] Debt to asset ratio is used as a measure for solvency rate.

Factors that Impact on Innovative Performance

Given the highlighted differences, it is useful to further examine the factors that affect innovative performance. To this end, a model is estimated and the results are summarized in Table 4.2.[24]

As expected, cattle and sheep farming has a significant negative effect on innovative performance in comparison to dairy farming, while there is no significant difference in relation to innovative performance among the remaining farm systems. In other words, dairy, mixed livestock and tillage farms are similar in innovative performance, while the cattle and sheep sector lags behind. Farm size and intensity (measured in livestock units per hectare) has a positive effect on innovation, thus confirming previous results that innovators have larger and more intensively stocked farms. While solvency has no significant impact on innovative performance, whether or not the farmer has access to credit (expressed by the variable loan) positively affects innovation. The latter result corroborates previous findings, as innovators were found to have larger net new investments and borrowings. In relation to farmer characteristics, age and being engaged in off-farm work has a negative effect on innovation, while being married and agricultural education is positively correlated with innovation.

Table 4.2: Summary of Factors Affecting Innovation

Impact on innovation	Variable
Positive	Size (UAA), access to loans, farm intensity (LU/ha), marital status, agricultural education
Negative	Cattle rearing, cattle finishing, sheep (in comparison to dairy), off-farm job, age
No significant impact	Tillage, mixed livestock (in comparison to dairy) solvency, size of household,

[24] The modelling involved the development of a Tobit model.

Innovation in Practice: Clarke's Fruits - Mayo to Meath to Royal Purveyor

Pat Clarke's strawberries are so good, they were chosen for Queen Elizabeth II while on her May 2011 visit to Ireland.

Originally from Mayo, Pat moved to Meath in the mid-fifties and by the early sixties he was growing strawberries in Stamullen, County Meath. Since this time innovation has been a constant feature of his business. For example, he was the first grower to introduce the Elsanta strawberry variety into Ireland.

In recent years, the adoption of polytunnels has revolutionised his business with a covered acre of land now yielding 10 times that of one exposed to the elements. He now grows 22 acres of fruit under protection. Polytunnels not only provide the ideal environment for strawberries to thrive but they have helped extend the season.

Highlighting how one innovation leads to others, once polytunnels were introduced the next innovation was to grow the strawberries on 'table tops' effectively raising the growing platform to table height. This has helped in all aspects of crop maintenance but in particular in makes picking easier and has had a dramatic impact on labour productivity. This is important as at the peak picking season Clarke employs up to 111 staff and so labour is a huge cost to the business.

In addition the adoption of computerized micro dosing of the plants has yielded a much better product and the recent introduction of a biomass boiler and has been part of the development of a system to extend the season further.

Highlighting the problem solving approach of Clarke's, they have also collaborated with a jam manufacture to make their own branded jam, turning a potential problem, dealing with excess fruit at certain times, into an income source. In addition challenges with pesticide availability due to legislative changes and the demands of their customers have led to the development of sophisticated Integrated Pest Management (IPM) techniques on the farm.

In 2000 Clarke's farm won family farm of the millennium, an accolade Pat Clarke is proud to have accomplished and in 2010 it won the Bórd Bia Fruit Grower of the Year award.

5. Barriers to and Facilitators of Innovation in the Agrifood Sector

Summary

The strongest barriers to innovation in Ireland are identified as being at the farm level and relate to farm business structures, the lack of land mobility and the age structure of farmers.

In contrast factors that related to the more general environment within which the sector operates – education, infrastructure, tax regimes - were seen as strong facilitators of innovation.

Opinions were strongly divided as to whether factors such as the structure of the supply chain, finance skills, level of leadership were actually barriers or facilitators in Ireland.

Wider evidence suggest that access to credit is a key issue for both established and new firms.

Having assessed the performance of the AIS within Ireland and the farm sector in more detail, this section considers the factors that may facilitate or hinder innovation within the system.

From available literature and previous work undertaken, a number of factors were identified as being important to innovation and these were discussed with the interviewees. In Table 5.1 the various factors are grouped according to their average score whilst Figure 5.1 graphically represents the strongest barriers and facilitators as identified in the study.

Table 5.1 Rating of Possible Factors Influencing Innovation

Score	Category	Factors
< -2	Strong barrier	Land mobility, age structure, farm business structure
-1 to -2	Medium barrier	Power of supermarkets, availability of finance, CAP support, chain co-ordination
0 to -1	Weak barrier	Structure of supply chain, attitude to risk, level of leadership within sector
0 to +1	Weak facilitator	Finance skills, ICT (rural broadband), university engagement with industry, employment Legislation, private consultants
+ 1 to + 2	Medium facilitator	Government support, regulation, advisory services, training in agrifood skills
>+2	Strong Facilitator	Research capacity, education levels, physical infrastructure, tax regimes

Interviewees were asked to score each factor on a scale of -5 to +5. If the factor was seen as a potential barrier it was scored on a scale of -1 to -5 with -5 being a very strong barrier. Likewise if it was seen as being a facilitator then it was scored on a scale of +1 to +5 with +5 being very strong.

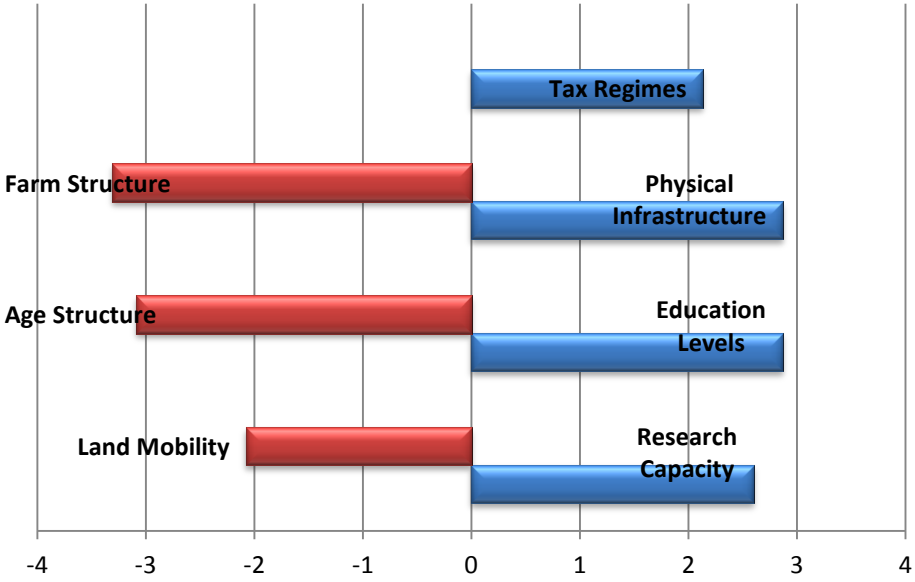
It is clear that issues surrounding the structures of farm businesses were seen as consistently the strongest barrier to innovation across the agrifood system. On the other hand factors that related to the more general environment within which the sector operates – education, infrastructure, tax regimes - were seen as strong facilitators of innovation. It is interesting that research capacity was seen as a particular strength whilst university engagement with industry was seen as much weaker

(although still positive). This relates to an earlier study that highlighted that in comparison with Scotland, a key strength of the Netherlands was that university researchers saw this form of engagement as a much greater part of their role (in fact it was an expected part of their job).

Whilst rated less strongly than the farm structural issues, a number of other factors were on average rated as barriers by stakeholders. In general there was a feeling that a number of issues within the supply chain such as the power of supermarkets, the level of co-ordination across the chain and the structure (with relatively few large companies dominating) were barriers to innovation.

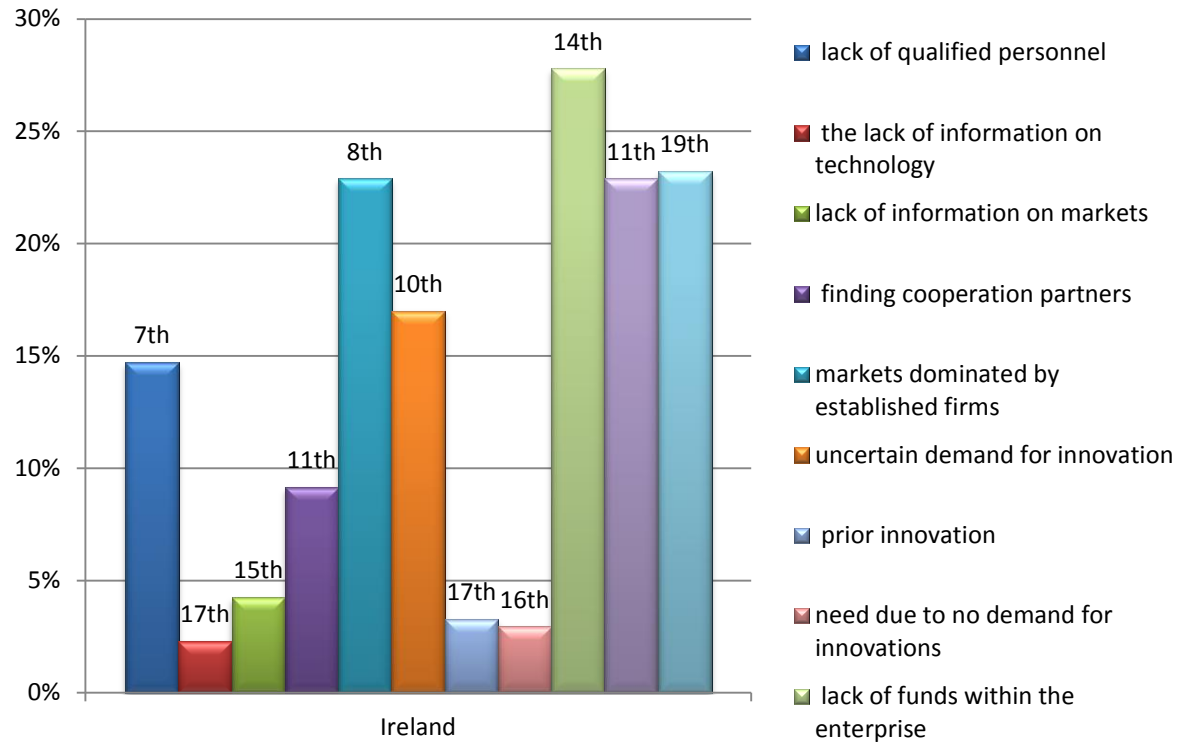
Given its importance to the agriculture sector the role of the CAP in fostering or hindering innovation was much discussed. On the one hand the support it provided into the agriculture sector was often seen as vital to maintaining the rural infrastructure in Ireland and maintaining the agri-environment. On the other hand there was a feeling that it maintained the status quo and did not encourage the change that would lead to a more innovative agriculture developing. In support of this view, the detailed farm level analysis revealed that farms with high innovative performance have a lower share of single farm payments to farm income than less innovative farms. In particular this related to its interactions with the structural barriers highlighted as major barriers to innovation.

Figure 5.1. Strong Barriers to/Facilitators of Innovation within Ireland



Access to finance was cited by stakeholders as a potential barrier and it can be seen that this is also an issue raised by firms that took part in the Community Innovation Survey (CIS). From Figure 5.2, derived from the CIS, we see that lack of internal and external funds and costs of innovation are seen as significant barriers to innovation. In addition market dominance by other firms is seen as a significant barrier and again this links in with the views of interviewees. However, it is clear that Ireland is not alone in this and really only in the area of lack of qualified personnel does it rank in the top 10 of countries that see it as a barrier. This in itself is an interesting finding given that education levels are seen as strong in Ireland. It perhaps suggests a possible mismatch between the supply and demand of particular skills within Ireland. This may relate to the perception of those interviewed that the level of training in agrifood skills was rated lower than education overall.

Figure 5.2 Barriers to Innovation in Food and Drink Businesses



Source: Eurostat, Community Innovation Survey

The findings from the CIS and interviews are generally supported by the experience of Enterprise Ireland with dealing with High Potential Start Ups (HPSU) in Food and Drink.[25] They identify that the key challenges for HPSUs in Food and Drink at the early stage include:

- High up front capital costs coupled to difficulties in raising finance
- The need to validate the product in an approved facility
- A lack of experience in scaling food production
- Getting the logistics right
- Long timelines in closing a listing with retailers particularly overseas retailers

On the other hand successful food HPSUs, that have managed to scale and export quickly, display common characteristics such as:

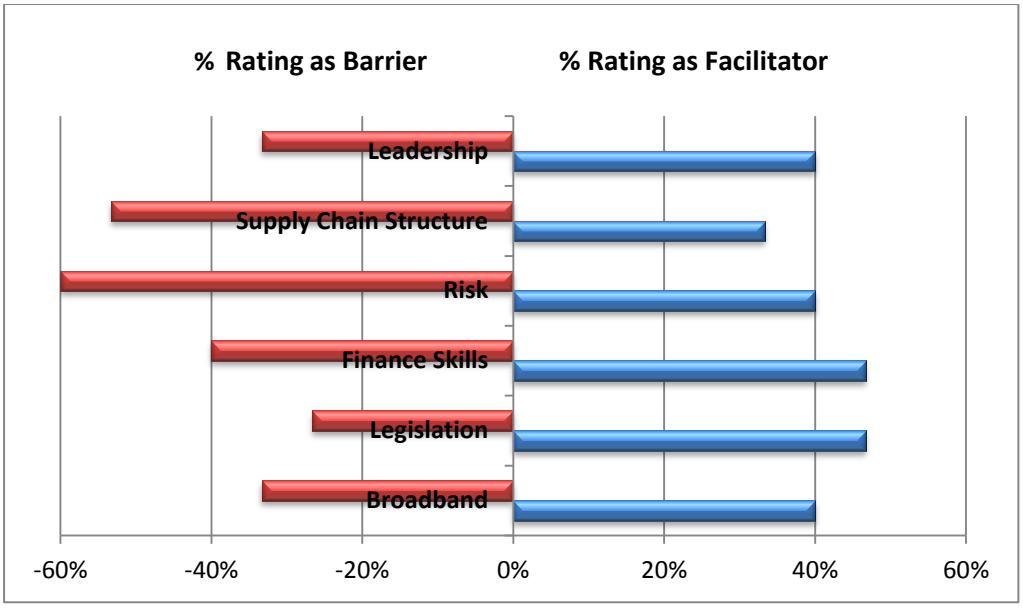
- A promoter/team with expert technical knowledge in the product sector.
- There is an innovative business model, innovative product or Intellectual Property (IP) that provides a competitive advantage in the market place.
- Expert market knowledge, ideally with access to key customers and distribution and an understanding of the real costs in the market place.
- Adequate finance and margins to fund and sustain an export dimension.

[25] Source: personal communication with Enterprise Ireland

Following on from this, whilst the focus of attention tends to be on the barriers, it is clear also that within the Irish system factors such as government support, the advisory system and general agrifood training are seen as relatively strong facilitators of innovation. In addition a range of factors were scored positively by stakeholders.

It should be noted that whilst in the case of strong barriers and facilitators there was a very high level of consensus across those interviewed, for other factors the average figures hide a much greater level of disagreement. In particular opinions were strongly divided as to whether factors such as the structure of the supply chain, finance skills, level of leadership were barriers or facilitators in Ireland (Figure 5.3).

Figure 5.3 Split of Views on Influence of Factors on Innovation



6. Discussion and Conclusion

This short study has attempted to provide an overview of the Irish Agrifood Innovation System (AIS) through a process of interviews with those involved in the sector and analysis of available data. This twin approach produces a clearer picture in that the interview process added context to the indicator data, whilst the data helped quantify the perceptions of those interviewed. This said it is important to emphasise that due to constraints on time and resources it has only been possible to provide a stylised overview of the sector.

From the analysis a picture emerges of an innovation system and related agrifood sector that is performing very well in pockets, but the level of performance is uneven. This leads to an overall consensus across the interviewed stakeholder group that the AIS was performing 'reasonably' well. However, what seems to emerge is that Ireland has all the components in place to have a consistently world class agrifood sector.

These components include a recognition of the importance of the sector by government reflected in strong support for the agrifood sector and for science and technology more generally. The necessary resources appear to be in place to support both the sector and innovation within the sector through government and its agencies operating at various levels across Ireland. In addition Ireland is seen as having good physical infrastructure, strong research capacity and a highly educated population.

However, a range of barriers need to be overcome in order for Ireland to build upon these solid foundations and realise this potential.

Within business there is a need for a greater recognition of the importance of innovation to achieving and maintain a competitive advantage. This involves:

- A stronger commitment to investing in research and development within Irish companies (particularly new product development)
- Thereby improving the absorptive capacity of industry in terms of taking advantage of the research capacity that exists within Ireland

Whilst recognising that considerable high level activity is going on within the University sector, there is a need for a greater focus on knowledge and technology transfer to industry. It may be argued, that as with the situation in the Netherlands, engagement should be the norm and not the exception.

Following on from this, the study has identified that successful innovation almost always involves collaboration and the development of partnerships. These can be:

a. Between agrifood businesses
b. Between research organisations
c. Between public and private sector
d. Across all of these

Therefore a simple conclusion of the study is that greater collaboration and stronger partnerships should be encouraged. However, a range of potential barriers stand in the way of this. For example,

one key barrier to innovation is conflict and mistrust in supply chains brought about in part by a lack of communication and transparency.

Following on from this, it became clear from the discussions that innovation comes through people and not institutions or businesses and that it is driven by leaders with a more open mindset to change. A perception emerged from the interviews that a conservative mindset tended to dominate organisations with power and influence.

To some extent linked to this, institutional structures were seen as important. For example, it was highlighted that some of the most innovative businesses are in private hands. This was seen to allow them to be more flexible and to try out new ideas and ways of working. In contrast the co-operative structure was seen as mitigating against innovation due to the need to reach consensus. Public companies were seen as somewhere between the two in that the need to satisfy shareholders drives the organisation but at the same time could lead to companies being risk adverse to some extent.

At the farm level, as in the wider agrifood sector we see an uneven performance in terms of innovation. With some farm systems and businesses appearing highly innovative and others do not. One of the findings from the farm level analysis is that there is a positive relationship between innovation and profitability. However, it must be remembered that this does not necessarily imply causation. Both within this study and earlier work in Scotland, there was much debate as to whether lack of profitability hindered innovation or whether lack of innovation hindered profitability (particularly in the cattle and sheep sectors). The truth is probably somewhere between the two. Whilst this relates to the farm level it may also be expanded to consider as a possible reason why the dairy research into practice model is seen as successful whilst the beef model is viewed as less so.

In both the stakeholder interviews and from the data analysis structural issues were seen as a strong hindrance to innovative performance. Linked to this is the issue of support and the CAP in particular. The question is the extent to which the support should be fostering innovation and driving change within the sector. This brings us back to the question of what the objectives of policy are. For example is the aim to maximize profitability in the agricultural sector or as one interviewee put it ‘maximize the number of people in the sector?’ At the moment policy may be successful at the latter rather than the former and whilst switching may indeed improve innovative performance, the move from over 100,000 farmers to say the 18,000 they have in New Zealand would have far reaching consequences for rural Ireland.

To conclude, this study highlights that Ireland has the potential to have a world leading agrifood sector. However, it may be argued that to achieve this the sector needs to operate more like a well-structured and successful business. The business is structured so that there is healthy competition between the different business units, but at the same time the units are working together for the overall greater good of the business.

Drawing on these conclusions a series of **recommendations** are made to drive innovation within the sector:

1. Whilst recognizing that tax incentives already exist for all businesses, there is a need to consider greater incentives for (medium to large-sized) agrifood companies to engage more with R&D activity and in particular activities with a longer term horizon. This can be justified on the basis that agrifood businesses have been shown to contribute more to net export earnings than many other types of businesses
2. In terms of driving innovation, universities need to further strengthen engagement with industry. This could involve the wider adoption of advisory boards comprising (but not exclusively) business representatives at the relevant levels within universities. There is also a need for a more strategic approach to engagement. In addition reward structures (pay and promotion criteria etc.) within the university sector need to reviewed so as to put a greater weight on successful engagement with industry. This coupled with 1) above would mean that not only are companies incentivised to take a longer term view to R&D (fitting more with the timeframes of university research), but that academics are encouraged to look out to industry more which could improve accessibility for companies.
3. The connections between industry-academia should also be focused on development of new products that add value to the existing commodities produced in Ireland. It also needs to be in a form that is accessible to new and emerging small scale enterprises
4. Alternative funding arrangements (such as the establishment of agrifood venture capital funds)[26] are needed to overcome the identified financial constraints through the agrifood chain. Due to risk and return issues this may need to involve the development of novel public/private funding partnerships. These alternatives may be attractive to those that are averse to debt but require access to funding for expansion
5. There is a need to rethink our education and advisory structures to ensure they are fit for purpose in driving innovation through the agrifood chain.
    a. In terms of education this could involve initiatives such as promoting greater cross fertilization between courses. For example, combining business and enterprise with science skills or a realigning of the agricultural colleges to create centres of excellence in particular aspects of agriculture (dairy, beef, tillage, horticulture).
    b. In terms of advisory services this requires a move away from a system driven by the bureaucratic requirements of the CAP to one driving innovation. More widely, it will be important to ensure that there is effective implementation of European Innovation Partnerships within Ireland.
6. Industry forums, facilitated by the government, in which all players in the supply chain can undertake full and frank discussions in the spirit of openness, can begin to create transparency which in turn can lead to trust and a stronger incentive for collaboration. In the beef sector for example, this could build on the forum that has been established as a result of the current difficulties in the sector.

[26] For clarification it should be noted that this does not necessarily mean a call for more venture capitalists in the agrifood sector.

7. Every effort needs to be continued to be made to encourage structural change within the agricultural sector to facilitate innovation and profitability. Further consideration needs to be given as to how CAP support funding can be used to drive innovation. Whilst recognizing the constraints of the current system, in the future there should be a greater linkage between payments and uptake of new technologies or practices (such as improved genetics, animal health planning, etc.).
8. Overall, there is a need for key sections within the AIS to engage in full and frank internal debate as to whether their structures are fit for purpose for an Irish agrifood sector that wants to be world leading in terms of innovation and performance. Leadership is needed in this area to ensure that innovation is facilitated and not hindered within Ireland.

Appendix: Farm Level Innovation Measurement

Agricultural innovation is a complex process that is generally difficult to measure[27]. Especially at the farm level, there is a huge variety of new technologies and farm practices as well as organisational and management practices that can be classified as innovations. In this context, any technology or practice that is new to the farm is regarded as an agricultural innovation. This can be, for example, the adoption of ICT usage or forward contracting. In addition, actions by the farmer to innovate the farm business, such as advisory contact or new investments, are also seen to play an important role in agricultural innovation.

Therefore, an innovation index is developed that aims to reflect the multidimensional nature of innovation by accounting for adopted innovations as well as innovation behaviour[28]. Hence, innovation is assessed through a combination of three sub-measures:

- New technologies/farm practices;
- Investment in new knowledge;
- Renewal of machinery.

In addition, the input of six knowledge transfer and innovation experts was used to finalise the index. The selection of variables to measure each innovation component was confined to data availability of the Teagasc National Farm Survey on the adoption of new technologies, knowledge transfer as well as investments. For each of the main farm systems (i.e. dairy, cattle, sheep, tillage and mixed livestock) five technologies and farm practices were selected, which are shown in Table A1. Four technologies are common to all systems, while one technology is specific to each sector.

Table A1: Selected Innovation Technologies

Dairy/Mixed Livestock	Cattle/Sheep	Tillage
E-profit monitor	E-profit monitor	E-profit monitor
ICT usage	ICT usage	ICT usage
Soil testing	Soil testing	Soil testing
Reseeding	Reseeding	Reseeding
Milk recording	Quality assurance member	Forward contracting

The authors acknowledge that reseeding is not a typical tillage practice. However, there is a limited amount of tillage practices available in the NFS data set. The inclusion of the measure is considered justified given that a number of farmers that are classified as tillage farms practice reseeding due to the presence of non-tillage enterprises on the farm.

In relation to the new technologies sub-measure, all technologies and farm practices have been rated by experts in relation to level of innovativeness and implementation effort. By combining the expert information with the farm system specific diffusion stage of each technology, a weight was derived for each technology which reflects the system specific innovativeness of this technology.

[27] VanGalen and Poppe (2013).

[28] The selection of indicators was informed by the literature, see for example Spielman and Birner (2008), VanGalen (2009) and Knickel et al. (2009).

In relation to the new knowledge sub-measure, whether or not the farmer consulted advisory services for non-scheme related matters was selected from the available data in order to reflect investment in new knowledge. In relation to the renewal of machinery sub-measure, whether or not the farmer invested in new machinery was used as a proxy.

In addition to the weights assigned for each technology, each of the three innovation sub-measures was also given a weight reflecting their relative importance to innovation (see Table A2). Again, this was based on the opinions of the consulted knowledge transfer and innovation experts.

Table A2: Relative Importance of Innovation Sub-measures

Innovation sub-measure	Dairy/Mixed Livestock	Cattle/Sheep	Tillage
New technologies/farm practices	0.45	0.50	0.38
Investment in new knowledge	0.40	0.36	0.33
Renewal of machinery	0.15	0.14	0.29

As can be seen in Table A2, the adoption of new technologies and farm practices is regarded by experts as the most important component of innovation, with values ranging from 0.38 for the tillage sector to 0.50 for the dairy sector. This is followed by investment in new knowledge ranging from 0.33 for the tillage sector to 0.40 for the dairy sector. Renewal of machinery is given a low weight for the dairy and drystock sector, 0.15 and 0.14 respectively, while this is seen as more important in the tillage sector, with a value of 0.29.

The final innovation index is derived by adding the weighted sub-measures. The distribution of innovation index values is depicted in Table A3 and the index can take values between zero and one, with one being the highest innovative performance.

Table A3: Innovation Index

	Mean	St. Dev	Min	Max
Innovation Index	0.40	0.30	0	1

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