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Irish agri-food expansion: What is its role in feeding the world?

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List of Abbreviations

ACRES	Agri-Climate Rural Environment Scheme
BSE	Bovine spongiform encephalopathy (mad cow disease)
CBN	Central Bank of Nigeria
COC	Carbon opportunity cost
DIAAS	Digestible indispensable amino acid score
ECM	Energy corrected milk
EEA	European Environment Agency
EFRAG	European Financial Reporting Advisory Group
EPA	Environmental Protection Agency
EQS	Environmental quality standard
ESR	Effort Sharing Regulation
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FAOSTAT	Food and Agriculture Organisation Statistics database
FPCM	Fat and protein corrected milk
GBD	Global Burden of Disease
GDQS	Global Diet Quality Score
GHG	Greenhouse gas
GLAS	Green Low-Carbon Agri-Environment Scheme
GWP	Global warming potential
IGEES	Irish Government Economic and Evaluation Service
IPCC	International Panel on Climate Change
LCA	Life Cycle Analysis
N	Nitrogen
NCD	Non-communicable disease
NPWS	National Parks and Wildlife Service
OECD	Organisation for Economic Co-operation and Development
P	Phosphorus
PB	Plant-based
PM	Particulate matter
RCB	Remaining carbon budget
SSA	Sub-Saharan Africa
TASF	Terrestial animal source food
UHT	Ultra-high temperature
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change

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Executive Summary

The aim of this study is to evaluate some of the trade-offs involved if policies to reduce GHG emissions in Ireland led to reduced production of livestock and livestock products, particularly dairy production. The paper focuses on the dairy sector to illustrate the issues involved. This is both because dairy is the sector likely to lead the expansion of Irish agricultural output in this decade in the absence of policy interventions and is also the sector which is seeking growth in emerging markets. Emerging markets are defined as low- and middle-income countries, including China and mainly in the Global South – Africa, Asia and Latin America.

Several competing narratives are in play when discussing the expansion of Irish dairy output in the light of the climate imperative to reduce agricultural emissions, and which are highlighted in the terms of reference provided by the Council.

- Dairy products are an important source of nutrition and there is rapid growth in demand in emerging markets. What should be the role of dairy products and other animal source foods in ensuring that populations in these countries can achieve a healthy diet? Does greater consumption of dairy products and other animal source foods in these countries contribute to improved nutrition and is it desirable?
- Does the availability of Irish dairy exports, including promotional campaigns in emerging markets, encourage the consumption of dairy products beyond levels that ensure a healthy diet for the majority of local populations?
- If Irish dairy exports were not available, where would alternative supplies come from? Would the GHG footprint of alternative supplies be higher and thus risk increasing global emissions?
- If a sufficient reduction in national agricultural emissions is not achieved, would this put at risk business and sales to existing markets that might counterbalance any gains in export sales to emerging markets?

The objectives of the study are to collect evidence and provide insights into these four questions with a view to assisting the Council in making recommendations on reducing GHG emissions from ruminant agriculture in Ireland.

Is greater consumption of dairy products in emerging markets desirable on nutritional grounds?

Dairy products are an important source of nutrition and there is rapid growth in demand in emerging markets. What should be the role of dairy products and other animal source foods in ensuring that populations in these countries can achieve a healthy diet? Does greater consumption of dairy products and other animal source foods in these countries contribute to improved nutrition and is it desirable?

Dairy products currently make a significant contribution to global nutrition, although this role varies significantly across regions. Cow milk is energy-dense and provides high-quality protein. Dairy product consumption is twice the world average or more in the more developed regions of North America, Oceania and particularly the EU, while consumption in Central America, Asia but particularly the Caribbean and Africa is well below the global average. In absolute terms, the most dynamic regions in terms of growth in per capita milk consumption are Asia and Latin America, while little growth in per capita milk consumption has occurred in Africa over the 1990-2020 period. As most milk is consumed as fresh products and is not traded, trade is a relatively small share of global production and is confined to processed dairy products. The main feature of international trade is the high concentration among suppliers on the export side (where New Zealand, the EU and the US accounted for 77% of global exports by value in 2021). In contrast, import demand is much more diversified, with only China, Russia and Ukraine prior to the Russian invasion of Ukraine accounting for significant import shares. Africa including North Africa accounts for 10% of global dairy imports.

OECD/FAO projections foresee a continuing increase in demand over the coming decade to 2031. This will occur mainly in low-middle income countries (2.0% increase p.a.) and low-income countries (1.5% increase p.a.) in contrast to the more limited growth projected in high-income countries (0.4% increase p.a.). Despite increasing production in developing countries, some of this demand growth will be met through increased imports. The three main exporting regions, New Zealand, EU and US, are projected to remain the key exporters of processed dairy products. This growth in dairy demand will be accompanied by a growth in GHG emissions from dairying in the absence of significant innovation, contrary to the objectives of the Paris Agreement.

To date, there is only a very limited number of studies that ask what the minimum requirement for dairy product consumption would be consistent with securing good human nutrition while ensuring planetary health. These suggest dairy can contribute to a healthy, sustainable diet. However, the consumption of animal source foods in many developing countries are currently below reference levels intake for dairy products indicated in these studies. This suggests that dairy consumption would continue to grow even if the world as a whole were to adopt the healthy diets, whereas global consumption of beef may decrease.

In the longer term, these projections may be challenged by the substitution of cow's milk by plant-based alternatives. However, this is unlikely to be the case in the coming decade if only on cost grounds. Plant-based drinks will have to become cheaper than dairy products to be an attractive alternative in low and middle-income countries. There is also debate whether they can provide a complete nutritional alternative to dairy products. For these reasons, the OECD projection that emerging economies will need continued and increased imports of dairy products is assumed to form the backdrop for the discussion of Irish dairy exports in subsequent chapters.

Do Irish dairy exports and promotional activity contribute to dairy consumption beyond levels that ensure a healthy diet for the majority of local populations?

The five top emerging market destinations for Irish dairy exports are China, Nigeria, Mexico, Algeria, and Saudi Arabia. Within Sub Sahara Africa, (SSA) the main export destinations are in West Africa. Apart from Nigeria, the next most important destinations (ranked according to the value of exports in 2022) are Senegal, Mali and Ghana. Nearly all Irish dairy exports to SSA – 88% - consist of fat-filled milk powder with the remaining 12% consisting of other milk powders. This contrasts with the importance of butter and cheese exports to high-income markets.

To illustrate any potential impacts of Irish exports on the growth in demand for dairy products in emerging markets, the role of Irish dairy exports in the three main export markets China, Nigeria and Mexico were examined in detail. Although each market has its own characteristics, Ireland is not a dominant supplier in any market (although it did provide more than half of

Nigeria's imports of fat-filled milk powder in 2021). If Irish exports to these markets ceased, the strong probability is that the gap left would be filled by substitute exports by other existing suppliers to these markets, rather than leading to a reduction in domestic consumption.

Bord Bia has a marketing objective to help grow the value of Irish dairy exports through investment in market development in Africa, Asia, Europe, Middle East, North America and the UK. The big question is whether such promotional activity leads to overall market growth, or instead leads to Irish supplies being preferred to those from another competitor. There is no empirical literature that provides guidance in answering this question, so a more qualitative assessment has been undertaken. Bord Bia's activities in emerging markets are mainly business-to-business interactions (through trade fairs and targeted interactions with business customers) rather than consumer-focused promotions. This means that the activity is primarily geared to promoting Irish exports at the expense of competitors. Any impact on the overall growth of dairy consumption in these markets will be limited relative to the underlying factors (income growth, demographic changes, urbanisation) that influence demand.

Would lower Irish dairy exports lead to increased global emissions?

If Irish dairy exports were not available, where would alternative supplies come from? Would the GHG footprint of alternative supplies be higher and thus risk increasing global emissions? In the absence of findings from a quantitative economic and trade model, a more qualitative approach is adopted to answer this question.

Comparisons from several emission intensity databases and studies are presented and evaluated. International comparisons need careful interpretation because of methodological differences, differences in the way emissions from the dairy herd are allocated between milk and beef, and the scope of the emissions covered. Ireland has made progress in recent years in reducing the emissions footprint of its dairy products. Nonetheless, based on the evidence reviewed it is difficult to discern a significant difference in emission intensities among EU countries and major exporters. However, there is a clear difference between this milk and the milk produced in emerging economies which, particularly in Africa, has a much higher carbon footprint.

These differences in emission intensities are relevant when considering how global emissions might be affected if Irish dairy exports were reduced as a result of climate policies. Three impact channels are identified: the direct substitution of Irish exports in emerging country markets by exports from existing competing suppliers, additional production stimulated by higher world market prices, and lower consumer demand also due to higher world market prices.

As Irish dairy exports mainly compete with other EU Member States, New Zealand and the United States with similar emission intensities, no net increase in global emissions is expected from the substitution effect. Regarding the production effect, most of the production response will occur in low carbon footprint production locations, both because of higher supply responses to price in these locations and because of the more limited transmission of higher world market prices to domestic markets in many emerging economies. Nonetheless, there will also be a production response in current high carbon footprint dairy producers and thus an increase in global emissions from this production effect. The third effect is that higher world market prices will reduce the overall demand for dairy products, so that not all of the market gap left by lower Irish dairy exports will be replaced by additional global production. Globally, this 'saving' in emissions due to lower demand offsets the increase in global emissions from the production effect. Without quantitative modelling, it is not possible to say which effect will be greater. The net effect on global emissions is unlikely to be large in either direction.

Any leakage rate will be reduced to the extent that farmers can reduce emissions through adopting new technologies or changing management practices, and when the impact of complementary climate action commitments in third countries is factored in. Irish action is part of a broader international action mandated by legal commitments to reduce emissions in the EU and supported by non-binding commitments under the Paris Agreement. While there is understandable scepticism whether these commitments will be translated into real changes in behaviour, we already see countries as diverse as Brazil, the United States, Australia, New Zealand, China and Vietnam begin to tackle the mitigation of agricultural emissions. These commitments can lead to lower dairy emissions either because of action to reduce demand or because of lower emissions from production activity. These emission reductions arising from coordinated international action will further reduce the impact on global emissions that might arise from the substitution of Irish exports by supplies from other exporters. Ireland along with other developed countries can contribute finance and technical expertise to the various UNFCCC mechanisms to bring about emissions reductions in emerging economies. Some carbon leakage arising from Irish climate policy in agriculture is unavoidable, but the worry that it might lead to an overall increase in global emissions seems not well-founded.

Would failure to meet climate targets undermine value and returns in existing markets?

If a sufficient reduction in Irish agricultural emissions is not achieved, would this put at risk business and sales to existing markets that might counterbalance any gains in export sales to emerging markets?

Bord Bia research has emphasised the importance of being able to demonstrate and defend sustainability claims when seeking to maintain existing customers or attract new customers for Irish agri-food products. While Origin Green has been an important initiative in underpinning sustainability claims, customers and competitors have not been standing still. Many food companies, both supermarkets and processors, have announced their own ambitious targets to reduce emissions and monitor other environmental impacts. In some cases, these go beyond what Ireland has committed to. While Ireland can match its competitors on some environmental indicators (pesticide use, biodiversity), on other indicators Ireland is clearly losing ground (GHG emissions, ammonia emissions, phosphorus surplus).

This study is particularly focused on GHG emissions. New reporting standards under EU legislation will make it mandatory for large companies to report emissions across their supply chains, including Scope 3 emissions arising not from the direct activities of the companies themselves but indirectly from activities up and down their value chains. This reporting will primarily highlight the importance of emission intensity indicators as for any given throughput it is the emission intensity of its suppliers that will determine a company's Scope 3 emissions. As noted in Chapter 5, Ireland's emission intensity figures for dairy compare well with its competitors.

However, it would be unwise to ignore trends in absolute emissions, and not only because there are now legally binding targets to meet for absolute emissions. Failure to meet these targets would also undermine the credibility of Food Brand Ireland and make it more difficult to position Ireland as a leader in the sustainability space. Competitors will not be slow in highlighting any gap between rhetoric and reality with respect both to climate targets and other environmental indicators. For this reason, there is an evident risk that further expansion, if it leads to climate targets not being met, will negatively impact on Ireland's ability to hold on to existing customers in high-value markets.

1 Introduction

The world is already experiencing the impacts of climate change in terms of rising temperatures, changing precipitation patterns, and the greater frequency of extreme events such as floods and droughts. According to the IPCC, global warming is due to human activity, particularly the burning of fossil fuels, ruminant livestock (and rice) production, and land use change (where at least a part is associated with the expansion of livestock production). Globally, livestock production alone is estimated to contribute 11-17% of global greenhouse gas emissions calculated on a life-cycle basis using the standard metric of Global Warming Potential (GWP) over 100 years[1], of which cattle (raised for both milk and beef, as well as manure and draught power) account for about 65% of these emissions.[2]

In Ireland, around 38% of national territorial emissions originate from agricultural production, of which it is estimated that about 80% originate from bovine animals (O′Mara et al. 2021). Under Ireland's 2021 Climate Action and Low Carbon Development (Amendment) Act 2021, the government has adopted carbon budgets to 2030 which provide for a reduction of 51% in the total amount of GHG emissions by 2030, relative to 2018. Under the Sectoral Emissions Ceilings published by the government in July 2022, agricultural emissions should fall by 25% by 2030 relative to 2018, with cumulative emissions in the first carbon budget period, 2021-2025, limited to 106 Mt CO2eq and to 96 Mt CO2eq over the second carbon budget period, 2026-2030 (Government of Ireland 2022). However, EPA data show that agricultural emissions, which were 23.4 million tonnes CO_2e in 2018, had barely dropped to 23.3 million tonnes CO_2e in 2022 (EPA 2023). The rapid expansion in dairy cow numbers has been a major contributor to this outcome.

The industry-led strategy for the development of agriculture in the period to 2030 is set out in the Food Vision 2030 Strategy (DAFM 2021) while measures to reduce GHG emissions in the dairy and beef sectors are further elaborated in the reports of two Food Vision working groups (DAFM 2022b; 2022a). Building on this Strategy, Bord Bia, the state body charged with the marketing of Irish food, drink and horticulture, has set out specific growth targets for meat and dairy in its three year strategy 2022-2025 (Bord Bia 2022b). The strategy sets out steps to retain business in existing markets and to grow markets particularly for dairy products in Asia, West Africa and the Middle East. How these marketing and growth objectives for the sector are consistent with the need to limit and reduce agricultural emissions remains to be demonstrated.

The aim of this study is to evaluate some of the trade-offs involved if policy to reduce GHG emissions limited livestock, and particularly dairy production, in Ireland. Irish agricultural production consists of meat and dairy in roughly equal proportions together with a relatively small crops sector. The very significant 45% increase in milk prices in 2022 boosted the value of milk production to €5.0 billion compared to the value of livestock output of €4.5 billion, to which cattle contributed €3.0 billion.[3] The study focuses on the dairy sector to illustrate the issues involved. This is both because dairy is the sector likely to lead the expansion of Irish agricultural output in this decade in the absence of further policy interventions, and because it is the sector which is particularly seeking growth in emerging markets. Emerging markets are defined as low- and middle-income countries, including China and mainly in the Global South

[1] Blaustein-Rejto, D. and Gambino, C., Livestock Don't Contribute 14.5% of Global Greenhouse Gas Emissions, The Breakthrough Institute, 20 March 2023 explain the sources of uncertainty around these figures.
[2] FAO, Key facts and findings, part of a series Major cuts of greenhouse gas emissions from livestock within reach, 26 September 2013.
[3] CSO, Output, Input and Income in Agriculture - Preliminary Estimate 2022, 9 March 2023.

– Africa, Asia and Latin America. There is a broad consensus, as set out, for example, in national dietary guidelines, that dairy and beef consumption in high-income countries exceeds what is necessary for purely nutritional reasons and that a reduction in consumption of these products would help to meet both health and environmental goals. The situation in emerging markets, where many people still suffer from dietary deficiencies, is arguably more complex and is discussed in this study.

Several competing narratives are in play when discussing the expansion of Irish dairy output in the light of the climate imperative to reduce agricultural emissions, and which are highlighted in the terms of reference provided for this study.

- Dairy products are an important source of nutrition and there is rapid growth in demand in emerging markets. What should be the role of dairy products and other animal source foods in ensuring that populations in these countries can achieve a healthy diet? Does greater consumption of dairy products and other animal source foods in these countries contribute to improved nutrition and is it desirable?
- Does the availability of Irish dairy exports, including promotional campaigns in emerging markets, encourage the consumption of dairy products beyond levels that ensure a healthy diet for the majority of local populations?
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The objectives of the study are to collect evidence and provide insights into these four questions with a view to assisting the Council in making recommendations on reducing GHG emissions from ruminant agriculture in Ireland. The focus is on dairy exports although limited references are also made to beef. The study examines the nutritional impact of Irish dairy exports in emerging markets, the extent to which Irish marketing efforts might drive increases in dairy consumption beyond growth that would otherwise occur, the potential for carbon leakage if dairy and beef exports from Ireland were limited or reduced, and the risk of reputational damage in existing markets for Irish exports if further expansion implies that agricultural emissions are not reduced.

Given the urgency of reducing global greenhouse gas (GHG) emissions, it is suggested that the world should cease not only to burn fossil fuels but also to cease to manage ruminant animals for food production. Whether animal source foods have a role in play in future human nutrition is a contested topic with arguments made on both sides. This study does not examine this broader debate but addresses solely the four questions set out in the terms of reference.

2 Trends in Irish dairy and beef exports

2.1 Trends in Irish dairy exports

Irish dairy exports to all markets (intra- as well as extra-EU) increased in value terms from €3.9 billion in 2015 to €5.1 billion in 2021 and jumped further to €6.9 billion in 2022. Much of this increase in the value of exports in 2022 was due to a significant increase in dairy product prices on world markets in 2022. Table 1 shows the breakdown of these exports by dairy product and the changes in the relative importance of individual dairy products in the total over the period 2015-2022. In 2015, infant formula was the most important export product by value, followed by fat-filled milk powder,[4] butter and cheese. In 2022, butter was the most important export product (helped by very high world market prices in that year), followed by cheese and fat-filled milk powder. The collapse in the value of infant formula exports is particularly striking given the upward trend in the value of exports of all other dairy products.

Table 1. Growth and composition of Irish dairy product exports, by value, € million, 2015-2022

Year		2015	2016	2017	2018	2019	2020	2021	2022	Growth 2015-2022
SITC	Product	€m	€m	€m	€m	€m	€m	€m	€m	%
02300	Butter, dairy spreads	625	591	935	1,125	1,144	1,016	1,109	1,701	172%
02499	Cheese except for fresh cheese	562	546	667	682	888	880	862	1,032	84%
09894	Fat-filled milk powder	628	664	718	677	780	836	694	907	44%
09893	Infant formula	1,169	1,285	1,291	1,032	904	896	661	761	-35%
02221	Skim milk powder	124	123	179	201	342	362	392	615	396%
59221	Casein	267	241	249	231	283	348	424	604	127%
02241	Whey	112	92	104	114	155	155	210	266	138%
02222	Whole milk powder	81	116	191	157	157	199	171	215	164%
02491	Fresh cheese	25	38	35	23	39	50	156	200	707%
02213	Cream	13	17	29	65	46	49	89	140	941%
	Others	279	278	275	281	347	320	320	454	63%
	Grand Total	3,885	3,991	4,673	4,587	5,085	5,109	5,088	6,896	78%

Source: CSO.

Table 2 strips out the impact of changes in product prices by showing changes in the volume of exports. In tonnage terms, the growth in the combined volume of dairy product exports was 32% between 2015 and 2022 compared to value growth of 78%. In particular, the growth in butter and cheese exports is now more modest and actually below the volume growth for all dairy products. The fall in infant formula exports is confirmed, showing that lower prices were not responsible for the reduction in the value of exports. Volume growth was particularly important for skim milk powder and whey.

[4] Fat-filled milk power is obtained by removing the high-value butterfat in producing skim milk, blending the skim milk with vegetable oil (usually either palm oil or coconut oil) and then spray-drying it. Vitamins are often added. It has similar physical, organoleptic and chemical properties as the dairy product.

Table 2. Growth and composition of Irish dairy product exports, by volume, '000 tonnes, 2015-2022

		2015	2016	2017	2018	2019	2020	2021	2022	Growth 2015-2022
SITC	Product	'000 tonnes								%
02300	Butter, dairy spreads	199	197	208	227	272	301	285	233	17%
02499	Cheese except for fresh cheese	175	191	200	201	277	257	227	206	17%
09894	Fat-filled milk powder	263	291	312	316	358	350	297	286	9%
09893	Infant formula	161	156	165	152	147	134	87	98	-39%
02221	Skim milk powder	63	69	91	123	168	161	154	170	172%
59221	Casein	41	45	43	48	53	52	57	55	33%
02241	Whey	60	64	83	89	113	119	137	135	127%
02222	Whole milk powder	33	53	71	60	57	75	57	49	47%
02491	Fresh cheese	8	10	8	5	7	8	32	37	373%
02213	Cream	8	9	9	16	15	17	28	31	310%
	Others	173	132	178	195	259	241	269	264	52%
	Grand Total	1,185	1,216	1,366	1,431	1,725	1,714	1,630	1,564	32%

Source: CSO.

Table 3 completes the picture by showing the change in the unit value of exports for individual dairy products. The trends for the 2015-2022 period are very influenced by the unusually high prices in 2022. This influence has been particularly important for butter, cheese and milk powders. The unit value of infant formula exports appears relatively little affected. These high world market prices in 2022 should be kept in mind in interpreting later tables that show trends through 2022.

Table 3. Unit values of Irish dairy product exports, € per tonne, 2015-2022

		2015	2016	2017	2018	2019	2020	2021	2022	Growth 2015-2022
SITC	Product	€ per tonne								%
02300	Butter, dairy spreads	3,137	3,003	4,506	4,952	4,211	3,371	3,890	7,313	133%
02499	Cheese except for fresh cheese	3,205	2,852	3,336	3,400	3,200	3,425	3,789	5,010	56%
09894	Fat-filled milk powder	2,389	2,285	2,303	2,146	2,176	2,390	2,333	3,175	33%
09893	Infant formula	7,247	8,225	7,831	6,764	6,147	6,677	7,557	7,773	7%
02221	Skim milk powder	1,984	1,789	1,974	1,643	2,039	2,255	2,540	3,619	82%
59221	Casein	6,438	5,372	5,808	4,830	5,383	6,739	7,438	10,933	70%
02241	Whey	1,874	1,449	1,249	1,282	1,375	1,304	1,535	1,961	5%
02222	Whole milk powder	2,451	2,181	2,696	2,610	2,755	2,668	3,024	4,390	79%
02491	Fresh cheese	3,179	3,871	4,351	4,392	5,648	6,021	4,925	5,420	70%
02213	Cream	1,764	1,852	3,370	4,060	3,103	2,887	3,228	4,473	154%
	Others	1,608	2,109	1,550	1,438	1,340	1,327	1,190	1,718	7%
	Grand Total	3,280	3,281	3,421	3,205	2,947	2,981	3,121	4,408	34%

Source: CSO.

Within the EU, Ireland was the third largest extra-EU exporter after Netherlands and France in 2022 (Table 4). Ireland is the fourth largest exporter of dairy products overall, after Netherlands, Germany and France, but has a much greater dependence on extra-EU exports than other countries because of the importance of the UK market which is treated as extra-EU in these statistics. Ireland's dependence on exports outside the EU, at 63%, is higher than for any other EU member state apart from the other two island states of Malta and Cyprus.

Table 4. Irish dairy exports in an EU context, 2022, € million and percentage shares

Reporter	Total exports	Extra-EU exports	Intra-EU exports	Extra-EU share
EU27	79,936	29,073	50,864	36%
Netherlands	15,295	6,387	8,908	42%
France	9,943	4,525	5,417	46%
Ireland	6,806	4,317	2,489	63%
Germany	14,883	3,589	11,294	24%
Italy	5,564	1,875	3,688	34%
Denmark	3,674	1,814	1,861	49%
Belgium	6,109	1,807	4,302	30%
Poland	4,593	1,645	2,948	36%
Others	13,070	3,113	9,956	24%

Source: Own compilation based on Eurostat, Easy Comext.

In many extra-EU markets Irish dairy exports compete with exports from other EU countries as well as with the other global heavyweights New Zealand and the United States (see Table 17 later in the study). Table 5 shows that Ireland had the biggest increase among the larger EU exporters in the value of dairy exports between 2015 and 2022, although smaller EU exporters such as Poland, Italy and Belgium had even higher percentage increases though from a lower base. Ireland accounted for 15% of the over €10 billion increase in the value of extra-EU dairy exports over this period.

Table 5. Growth in Irish extra-EU dairy exports in an EU context, 2015-2022

	2015	2022	Change 2015-2022
	€ million	€ million	%
EU27	18,662	29,073	56%
Netherlands	4,282	6,387	49%
France	3,358	4,525	35%
Ireland	2,705	4,317	60%
Germany	2,376	3,589	51%
Italy	990	1,875	89%
Denmark	1,397	1,814	30%
Belgium	875	1,807	107%
Poland	745	1,645	121%
Others	1,933	3,113	61%

Source: Own compilation based on Eurostat, Easy Comext.

Table 6 provides a broad overview of the destinations for Irish dairy exports. Growth rates are shown for two periods, 2015-2021 and 2015-2022, to take account of the impact of the unusually high global dairy prices in 2022. Counting the UK as extra-EU trade throughout the period, exports to current EU member states were 30% of the total and increased to 37% of the total by 2022. However, this increase occurred in 2022 and taking the longer view exports to the EU have increased in line with total Irish dairy exports. Exports to developing countries accounted for 37% of the value of all exports in 2015, but this share fell to 32% in 2022. Again, this is an artefact of the changed global price regime in 2022. Until 2021, the developing country share had held fairly steady. Within the developing country category, the share of exports to Sub-Saharan Africa (SSA) countries increased from 6% of total exports in 2015 to 9-10% of total exports in 2021-2022. The shares of exports to Latin America and the Caribbean also increased but remain at a low level. On the other hand, Developing Asia and particularly China have become less important destinations over time.

Table 6. Export destinations for Irish dairy product exports, € million, 2015-2022

Destination	2015	2016	2017	2018	2019	2020	2021	2022	Growth 2015-2022	Growth 2015-2021
	€ million								%	%
EU	1,180	1,178	1,538	1,606	1,756	1,724	1,555	2,574	118%	32%
Other Developed	1,280	1,196	1,354	1,452	1,556	1,514	1,593	2,133	67%	24%
Sub-Saharan Africa	251	245	338	282	388	429	515	619	147%	106%
Near East and North Africa	390	397	426	377	430	495	445	464	19%	14%
Developing Asia	674	834	891	741	799	773	743	821	22%	10%
of which China	395	541	572	397	452	489	417	441	12%	6%
Latin America and Caribbean	102	132	119	122	148	172	206	282	175%	101%
Other	8	9	8	8	8	2	2	3	-65%	-76%
Total	3,885	3,991	4,673	4,587	5,085	5,109	5,060	6,896	78%	30%
Share extra-EU exports	70%	70%	67%	65%	65%	66%	69%	63%		
Share emerging countries	37%	41%	38%	33%	35%	37%	38%	32%		
Share Developing Asia	17%	21%	19%	16%	16%	15%	15%	12%		
Share Latin America and Caibbean	3%	3%	3%	3%	3%	3%	4%	4%		
Share Sub-Saharan Africa	6%	6%	7%	6%	8%	8%	10%	9%		

Note: Sub-Saharan Africa includes Mauritania and Sudan. The UK is included in extra-EU throughout the series.
Source: Own compilation based on CSO.

2.2 Trends in Irish beef exports

Irish dairy exports are now much more valuable than exports of beef. In 2022, dairy exports were worth €6.9 billion while beef exports were worth €3.0 billion. Furthermore, the value of dairy exports has increased more rapidly than beef in recent years. The trend and breakdown of beef exports in value terms is shown in Table 7. The bulk of Irish beef is exported as fresh or chilled beef and it is a more valuable product than frozen beef. However, the value of frozen beef exports has been growing more rapidly reflecting a rising relative price for frozen beef

(Table 9). As with dairy, 2022 was a record year for beef prices during the period. When the volume of beef exports is examined, there has been no growth in the volume of overall beef exports over the period 2015-2022 (Table 8). Closer examination shows that this reflects a steep fall in offal exports, stagnation in the volume of fresh and chilled exports, and an increase in the volume of exports of frozen beef.

Table 7. Growth and composition of Irish beef exports, by value, € million, 2015-2022

Year		2015	2016	2017	2018	2019	2020	2021	2022	Growth 2015-2022
SITC	**Product**	**€m**	**€m**	**€m**	**€m**	**€m**	**€m**	**€m**	**€m**	**%**
01111	Fresh or chilled beef, bone-in	346	195	214	196	171	152	147	186	-46%
01112	Fresh or chilled beef, boneless	1,239	1,450	1,519	1,516	1,446	1,430	1,504	1,799	45%
01121	Frozen beef, bone-in	7	8	13	18	43	29	33	40	522%
01122	Frozen beef, boneless	167	176	195	238	263	324	469	623	273%
01251	Edible offal, fresh or chilled	137	111	106	134	130	134	36	50	-64%
01252	Edible offal, frozn	82	100	126	104	72	59	80	85	4%
01681	Beef and offal, salted, in brine, dried or smoked	0	0	0	0	0	0	5	10	68187%
01760	Beef and offal preparations n.e.s.	230	228	230	228	223	207	154	226	-2%
	Total	2,209	2,268	2,403	2,435	2,349	2,335	2,428	3,019	37%

Source: CSO

Table 8. Growth and composition of Irish beef exports, by volume, '000 tonnes, 2015-2022

		2015	2016	2017	2018	2019	2020	2021	2022	Growth 2015-2022
SITC	**Product**	**'000 tonnes**								**%**
01111	Fresh or chilled beef, bone-in	76,173	48,722	54,352	48,751	43,728	39,686	25,382	34,145	-55%
01112	Fresh or chilled beef, boneless	186,612	237,637	245,763	250,808	247,775	242,704	220,370	228,340	22%
01121	Frozen beef, bone-in	2,971	4,083	5,201	6,890	13,447	10,254	11,350	11,590	290%
01122	Frozen beef, boneless	54,638	74,673	65,829	67,405	83,039	95,826	115,713	119,269	118%
01251	Edible offal, fresh or chilled	51,864	45,552	41,848	45,499	45,555	45,289	11,773	14,935	-71%
01252	Edible offal, frozen	48,874	58,224	65,100	55,112	40,565	38,922	36,122	35,462	-27%
01681	Beef and offal, salted, in brine, dried or smoked	1	67	15	25	24	26	1,592	2,083	225545%
01760	Beef and offal preparations n.e.s.	64,970	63,654	69,047	60,051	54,246	52,003	32,319	40,930	-37%
	Total	486,102	532,612	547,153	534,542	528,379	524,710	454,620	486,754	0%

Source: CSO.

Table 9. Unit values of Irish beef exports, € per tonne, 2015-2022

		2015	2016	2017	2018	2019	2020	2021	2022	Growth 2015-2022
SITC	Product	€ per tonne								%
01111	Fresh or chilled beef, bone-in	4,547	4,009	3,946	4,027	3,905	3,819	5,803	5,451	20%
01112	Fresh or chilled beef, boneless	6,642	6,101	6,179	6,046	5,836	5,892	6,825	7,877	19%
01121	Frozen beef, bone-in	2,189	1,897	2,509	2,575	3,229	2,801	2,876	3,490	59%
01122	Frozen beef, boneless	3,058	2,352	2,955	3,532	3,171	3,378	4,051	5,223	71%
01251	Edible offal, fresh or chilled	2,646	2,442	2,530	2,942	2,850	2,969	3,016	3,338	26%
01252	Edible offal, frozen	1,682	1,712	1,933	1,883	1,781	1,518	2,225	2,410	43%
01681	Beef and offal, salted, in brine, dried or smoked	15,350	2,391	3,403	855	1,529	2,831	3,035	4,645	-70%
01760	Beef and offal preparations n.e.s.	3,545	3,582	3,335	3,804	4,114	3,986	4,778	5,526	56%
	Total	4,544	4,257	4,391	4,555	4,445	4,450	5,340	6,203	36%

Source: CSO.

Ireland plays an important role in extra-EU trade in beef, accounting for just over 50% of total extra-EU exports in 2015 and just under 50% in 2022. No other EU Member State comes close in terms of its exports to extra-EU markets. Furthermore, the share of Ireland's total exports going to extra-EU markets is much greater than for any other EU Member State (Table 10). This reflects the importance of the UK as an export market for Irish beef, as the UK is treated as an extra-EU destination. However, the growth in value of Irish extra-EU exports has been slightly lower than for the EU as a whole, which results in the slight fall in its overall share of these exports during this period (Table 11).

Table 10. Irish beef exports in an EU context, 2022, € million and percentage shares

Reporter	Total exports	Extra-EU exports	Intra-EU exports	Extra-EU share
EU27	17,728	3,095	14,633	17%
Ireland	2,994	1,517	1,476	51%
Poland	2,375	354	2,021	15%
Netherlands	3,890	301	3,590	8%
Germany	1,863	189	1,674	10%
Spain	1,350	140	1,209	10%
Italy	918	126	792	14%
France	1,413	121	1,292	9%
Others	2,925	347	2,577	12%

Source: Own compilation based on Eurostat, Easy COMEXT.

Table 11. Growth in Irish extra-EU beef exports in an EU context, 2015-2022

	2015	2022	Change 2015-2022
	€ million	€ million	%
EU27	2,415.5	3,095.0	28%
Ireland	1,243.7	1,517.4	22%
Poland	227.4	353.7	56%
Netherlands	272.9	300.7	10%
Germany	184.6	189.4	3%

Spain	93.8	140.0	49%
Italy	98.6	125.9	28%
France	95.6	120.5	26%

Source: Own compilation based on Eurostat, Easy COMEXT.

The breakdown of Irish beef exports by destination is shown in Table 12. Several conclusions can be drawn. First, Irish beef exports are sold almost exclusively to high-income countries, either in the EU (where France, Italy, Netherlands and Germany are the most important markets) or other developed countries (the UK and Northern Ireland are the main export destinations in this latter group, with much smaller sales to Japan, Switzerland, Canada and the United States). The share of emerging economies has fluctuated but has never been higher than 9% of total export sales. The fluctuations partly reflect the volatility of sales to China. After several years of negotiations, Ireland secured access for the export of frozen boneless beef to China in April 2018. Export sales were on an upward trajectory in the following years, but beef shipments were suspended following the confirmation in May 2020 by the Department of Agriculture of an isolated case of atypical BSE. In January 2023 an announcement was made that beef exports to China could resume, so export sales to China are expected to increase in the coming years.

Table 12. Export destinations for Irish beef exports, € million, 2015-2022

Destination	2015	2016	2017	2018	2019	2020	2021	2022	Growth 2015-2022
	€ million								%
EU	966	1,009	1,050	1,061	1,105	1,026	1,128	1,495	55%
Other Developed	1,163	1,163	1,208	1,248	1,076	1,169	1,171	1,419	22%
Sub-Saharan Africa	20	20	21	20	17	21	19	23	19%
North Africa and Near East	0	0	1	1	1	0	0	1	275%
Asia	58	74	123	104	145	111	95	68	18%
of which China	7	0	-	2	40	24	2	0	-95%
Latin America	2	2	1	1	5	5	8	12	406%
Other	1	0	0	0	0	2	6	1	9%
Total	2,216	2,268	2,403	2,437	2,389	2,359	2,429	3,020	36%
Share emerging countries	4%	4%	6%	5%	9%	7%	5%	3%	

Source: Own compilation based on CSO data.

2.3 Conclusions

Irish dairy exports have been growing in both value and volume terms in recent years, while beef exports have stagnated in volume terms while growing in value terms due to higher prices obtained. Irish dairy exports consist primarily of butter, cheese and fat-filled milk powder. Infant formula, which was the most important single dairy product export in 2015, has declined both in relative importance and also in absolute terms since then.

Another difference lies in the importance of emerging markets among export destinations. Emerging markets account for up to one-third of Irish dairy exports, but on average only around 5% of export sales of beef in the 2015-2022 period. For both dairy and beef, there has been considerable stability in the export shares between EU and non-EU markets, and between developed (high-income) and developing (emerging) markets. For neither product is there evidence of an increasing share of emerging markets in export sales. Within the developing country category, however, the share of dairy exports to SSA countries increased from 6% of total exports in 2015 to 9-10% of total exports in 2021-2022. The share of dairy exports to Latin America and the Caribbean also increased but remain at a low level. On the other hand, Developing Asia and particularly China have become less important destinations for dairy products over time. The Chinese market for Irish beef has also been limited due to sanitary restrictions in recent years.

However, emerging markets have been targeted as a potential growth area for dairy exports in particular, while exports of beef may increase to China in particular following the re-opening of that market in January 2023. Given the rising volume of dairy exports and the greater importance of emerging markets particularly in Africa for dairy exports, this study focuses primarily on the dairy sector in examining possible trade-offs in promoting or limiting livestock product exports to emerging markets.

3 Is greater consumption of dairy products desirable in emerging economies?

Dairy products are an important source of nutrition and there is rapid growth in demand in emerging markets. This chapter assesses the evidence on the future role of dairy products in ensuring that populations in these countries can achieve a healthy diet. Does greater consumption of dairy products and other animal source foods in these countries contribute to improved nutrition and is it desirable?

The role of dairy products in providing nutrition in emerging markets is explored using FAOSTAT data. The role of international trade in dairy products in meeting this demand is investigated, including major importers and exporters. Projections of the likely increase in market demand for these products are available from international organisations such as FAO and OECD. These projections are compared with recommendations for healthy diets such as the EAT-Lancet diet (Willett et al. 2019) and other nutritional bodies. The chapter concludes by asking if plant-based alternatives with a lower environmental footprint could provide the desired nutritional outcomes in emerging economies in future.[5]

3.1 Dairy products and beef are nutritious foods

3.1.1 Nutritional context

The consumption of animal products contributes to food and nutrition security not least in developing countries and emerging economies. The precise role animal source foods could and should play in human nutrition remains the subject of debate in nutrition science.[6] The FAO undertook a comprehensive overview of the role of dairy in human nutrition in its publication *Milk and dairy products in human nutrition* published in 2013 (FAO 2013). In 2020, FAO's Committee on Agriculture established a Sub-Committee on Livestock with a mandate to discuss and build consensus on livestock issues and priorities.[7] This Sub-Committee is tasked, among other issues, with providing comprehensive and evidence-based global assessments of the contribution of livestock to nutrition and healthy diets. The first component of the assessment focused on the contribution of terrestrial animal source food (TASF) to healthy diets for improved nutrition and health (FAO 2023).[8] Links between the consumption of animal source foods and planetary health are to be addressed in later components of the assessment. This FAO assessment is the most recent and comprehensive on this topic and its conclusions are referenced later in this chapter.

Nutrients in food fall into two categories: macronutrients and micronutrients. Macronutrients refer to the three main substances required in large (macro) amounts in the human diet: protein, carbohydrates, and fats. Micronutrients are vitamins, minerals, and other compounds required by the body in small (micro) amounts for normal physiological function. A healthy diet is not just a matter of the right number of calories; growth, development and health rely on a wide range of nutrients, including vitamins, minerals, protein, fibre and essential fatty acids. The

[5] With respect to this chapter, the author underlines that he is not a nutrition expert but this chapter contains my best summary of the relevant evidence.
[6] For example, see Great debates in nutrition, Leroy and Barnard (2020).
[7] https://www.fao.org/coag/sub-committee-on-livestock/about/en/
[8] It can be downloaded from the following URL: https://sle.be/sites/default/files/FAO%20voeding%20uit%20vee%20%281%29.pdf.

debate around the desirability of animal source foods particularly in relation to plant-based sources of these nutrients revolves around concepts such as diet and particularly protein quality, nutrient density, and bioavailability.

Protein quality refers to the distribution of essential amino acids within the protein compared to the ratios needed for human consumption and to their digestibility. While quality is relevant for all nutrients, it is especially important for proteins, given the large variability in amino acid composition and digestibility between dietary proteins. Both animal and plant proteins are made up of 20 amino acids, of which nine are considered essential amino acids because they cannot be synthesised by mammals and must be provided in the foods we eat.[9] Protein-containing foods do not contain the 20 amino acids in equal proportions. Protein quality is based on an amino acid scoring method that compares the essential amino acid content of the protein with the requirement pattern for people. These scores are also adjusted for protein digestibility.

There are different methods available to measure protein quality, but the current FAO-recommended method is the Digestible Indispensable Amino Acid Score (DIAAS). The calculation of the DIAAS involves consideration of essential amino acid digestibility in different foods, as well as the ratio of these nutrients compared to the ratio they are required in the body.

Digestibility is the percentage of protein or amino acid intake that has disappeared from the digestive tract and is a standard measure to estimate bioavailability. **Bioavailability** refers to the proportion of a nutrient that is absorbed from the diet and used for normal body functions. Bioavailability is influenced by the form of the nutrients, the presence of other nutrients that may boost bioavailability (nutrient synergy) and the presence of nutrient inhibitors and anti-nutrients. Amino acids with a high bioavailability are more valuable because a greater proportion is available for nutrition.

Foods containing a similar calorie content also differ in terms of the nutrients they provide. **Nutrient density** refers to the amount of important nutrients per calorie. A staple of dietary guidelines is to eat nutrient-dense foods because this lowers the risk of eating too many calories to obtain the desired amounts of micronutrients and other health-promoting compounds. Nutrient profiling methods measure how much of specific nutrients foods contain and compare them to dietary recommendations, assigning them a score. They aim to identify foods that are more likely to be part of a healthy diet and those that may particularly contribute to the excessive consumption of energy, saturated fats, *trans* fats, sugar or salt. Nutrient density can be contrasted with energy density which refers to the number of calories contained in 100 g of food, and which is a direct measure of the energy a given food provides. Evidence that anthropogenic CO_2 emissions are reducing iron and zinc concentrations in crops highlights the increasing importance of improving dietary nutrient density.

3.1.2 How do animal source foods contribute to nutrition?

Cow milk is energy-dense and provides high-quality protein. Fat constitutes approximately 3 to 4% of the solid content of cow milk, protein about 3.5% and lactose 5%, although the gross chemical composition of cow milk varies depending on the breed of cow. The two primary

[9] Essential (sometimes referred to as indispensable) amino acids are an absolute requirement for bodily protein synthesis; once any one of the essential amino acids is depleted in the body, protein synthesis cannot continue.

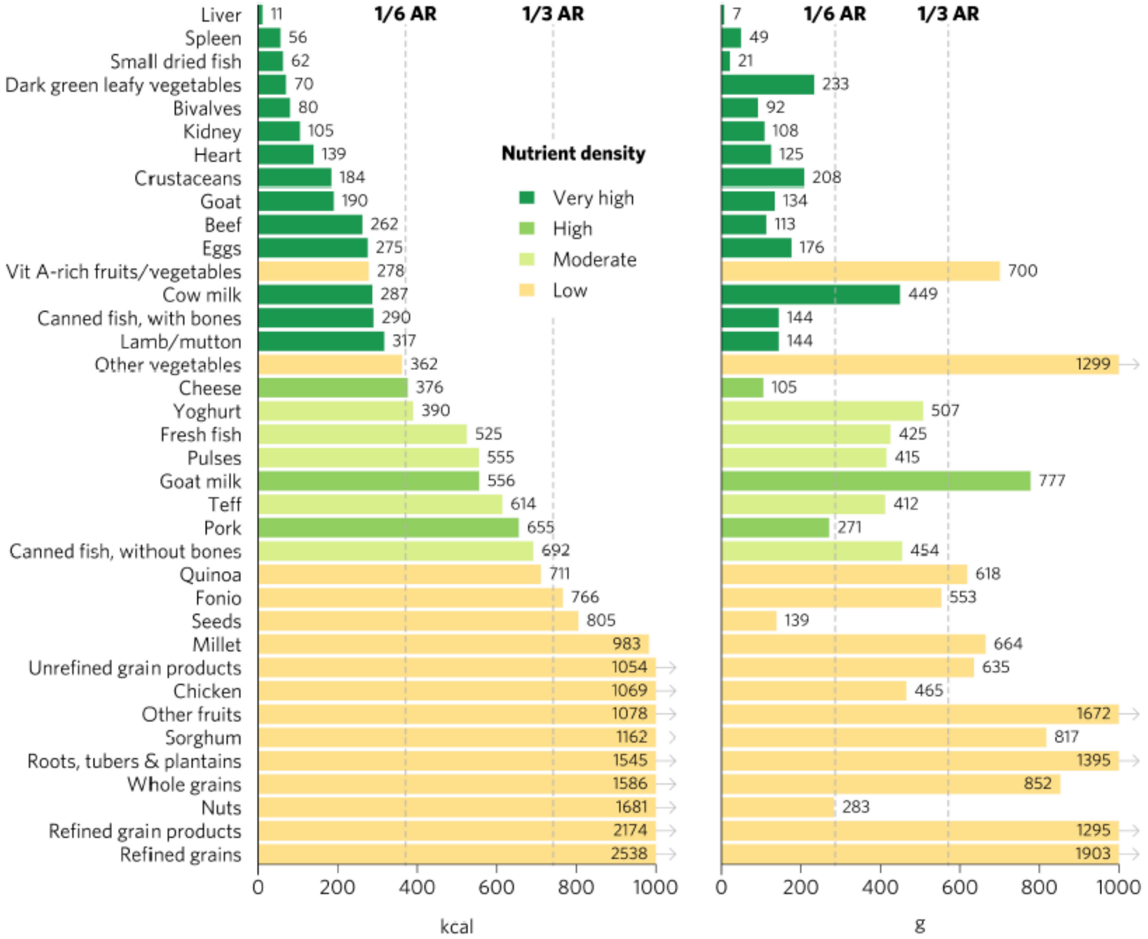
protein categories in milk are casein (insoluble) and whey (soluble). Dairy products (such as milk, cheese, yogurt, butter) are a culturally accepted source of high-quality protein and micronutrients for many people. Dairy consumption makes a significant contribution to meeting the required nutrient intakes of calcium, magnesium, selenium, riboflavin, vitamin B12 and pantothenic acid (FAO 2013). Milk has among the highest protein quality of common protein sources. Milk protein concentrate has a DIAAS of around 1.2, compared to that of beef (0.8–1.3), soy protein isolate (0.84–0.91), pea protein concentrate (0.62–0.82), rice (0.60), and peanuts (0.43) (Smith et al. 2022). These authors conclude that the high protein quality of milk, coupled with its high contribution to global essential amino acid supply, demonstrates the need for milk protein in meeting increasing global protein requirements.[10]

Meat, including beef, is also a high-quality protein food. The protein and amino acid composition of meat from muscle tissue aligns well with human nutrition requirements. Beef is also a good source of iron, zinc and B vitamins, particularly B12. There is evidence that Irish grass-fed beef has a higher concentration of several important micronutrients compared to concentrate-fed beef.[11] There has been concern that beef is a source of saturated fats, which have been associated with raised blood cholesterol levels, which raises the risk of coronary heart disease. However, the FAO study concludes that "While evidence has shown unequivocally that processed red meat consumption increases risk of mortality and chronic disease outcomes (cardiovascular disease and colorectal cancer), recent systematic reviews and meta-analysis have found unprocessed red meat intake to have non-significant effects on health outcomes and biomarkers of chronic diseases" (FAO 2023, p.111). Animal source foods also provide nutrients that are either not found in plant-based sources (such as vitamins D and B12 and long-chain omega 3 fatty acids), found in small amounts (e.g., vitamin B6 and riboflavin), or found in less bioavailable forms (e.g., iron and zinc), with the latter including unique sources of fiber, folate, vitamins E and C, and other antioxidants (Vieux et al. 2018). Ranking food sources by nutrient density for individual micronutrients commonly lacking in diets particularly in emerging economies shows that animal source foods and dark green leafy vegetables score highly as excellent sources of priority nutrients (Figure 1). Overall, the FAO study summarises the available evidence as supporting that terrestrial animal source food intakes at appropriate levels have beneficial effects on several health outcomes and do not lead to significant increases in chronic diseases among otherwise healthy individuals (FAO 2023, p. 91).

While appropriate levels of milk and beef consumption contribute to healthy outcomes, the question is whether they are *necessary* for this outcome, or whether alternative plant-based foods can provide equally satisfactory health outcomes while having a much lower planetary footprint. We take up this question in the final section of this chapter.

[10] Without questioning the integrity of this research, the conflict of interest statement notes that two of the authors are employees of Fonterra Cooperative Group Ltd, the big New Zealand dairy coop, while all authors are affiliated with the Riddet Institute which has a strategic partnership with Fonterra. It is not unusual to see nutrition research sponsored by companies that stand to benefit from this research.
[11] Teagasc, Nutritional composition and human-health implications of grass-fed beef, 10 July 2020.

Figure 1. Calories and grams needed to provide an average of one-third of recommended intakes of vitamin A, folate, vitamin B12, calcium, iron, and zinc for adults ≥ 25 years.



Note: The length of each bar shows the quantity of calories and grams required to provide an average of one-third of recommended intakes for adults 25 years of age and over of vitamin A, folate, vitamin B12, calcium, iron, and zinc which are micronutrients commonly lacking in populations in emerging economies. Each nutrient's contribution is capped at 100% of recommended intakes. Hypothetical average requirements for mass are based on an energy density of 1.3 kcal/g. AR, average requirement; Vit, vitamin.

Source: Beal and Ortenzi (2022).

3.2 Contribution of dairy products and beef to dietary intake

The contribution of dairy products to dietary patterns varies substantially across countries, with some populations showing very high intake and others very low intake (Table 13). Globally, dairy products provide around 182 kilocalories of energy per capita per day and just under 8 grams protein and 12 grams of fat per capita per day. Dairy product consumption is twice the world average or more in the more developed regions of North America, Oceania and particularly the EU, while consumption in Central America, Asia but particularly the Caribbean and Africa is well below the global average. Milk provides 3-5% of dietary energy supply in Africa and Asia compared with 11–13% in Europe and Oceania; 5–8% of dietary protein supply in Africa and Asia compared with 24% in the EU; and 7–12% of dietary fat supply in Africa and Asia, compared with 16–21% in Europe, Oceania and North America.[12] Looking at

[12] Calculated based on FAOSTAT. Milk here includes butter. When FAO made a similar calculation, it excluded butter, see FAO, 2013, p. 43.

individual countries, Ireland has a particularly high consumption of dairy products per head, while consumption in low-income countries such as Bangladesh, Senegal and Nigeria is particularly low.

Table 13. Contribution of dairy products to nutrient availability, selected regions and countries, 2020

Area	Food supply (kcal/capita /day)	Fat supply quantity (g/capita/ day)	Protein supply quantity (g/capita/ day)	Food supply (kcal/capita /day)	Fat supply quantity (g/capita/ day)	Protein supply quantity (g/capita/ day)
	DAIRY			**BEEF**		
World	182.06	11.81	8.96	38.69	2.64	3.47
Main regions						
Africa	67.90	4.04	3.45	27.56	2.06	2.11
Asia	152.03	9.79	7.02	24.79	1.8	2.01
Caribbean	127.4	6.74	6.68	33.8	2.65	2.31
Central America	167.27	9.54	9.58	44.02	2.36	5.34
South America	225.08	12.85	11.78	130.8	9.1	11.11
European Union (27)	472.94	32.51	25.63	52.12	3.25	5.33
Northern America	422.68	29.74	21.60	102.81	5.44	12.62
Oceania	329.92	24.52	14.44	79.01	4.21	9.62
Specific countries						
Ireland	605.65	40.00	30.66	113.1	8.64	8.11
Bangladesh	43.37	2.61	2.18	5.72	0.39	0.52
China	59.44	3.46	2.98	32.71	2.45	2.51
India	244.44	16.39	10.34	3.89	0.23	0.41
Kenya	153.62	9.01	6.89	23.6	1.76	1.81
Nigeria	10.04	0.48	0.56	8.27	0.62	0.64
Senegal	32.04	1.85	1.57	25.13	1.85	1.98
South Africa	90.73	5.81	4.99	107.43	8.62	6.93

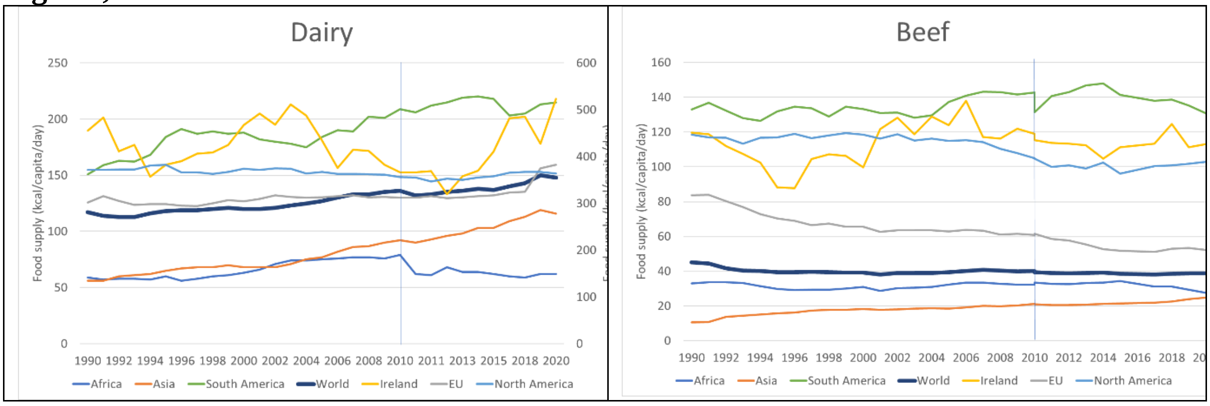
Note: Figures are the sum of the items 'Butter, ghee' and 'Milk – excluding butter'. Beef is 'bovine meat'.
Source: FAOSTAT Food Balance Sheet domain.

The long-term trend in per capita consumption of dairy products and beef by region is shown in Figure 2. Total consumption would also take population growth into account. Among the high-income regions since 1990, per capita consumption of dairy products has fallen slightly in North America. It would appear to have grown significantly (by 26%) in the EU, but this is an artefact of a puzzling jump shown in EU consumption in 2019 and 2020.[13] Taking just the trend between 1990 and 2018 shows a more modest increase of 8%. EU dairy consumption seems still to fall a little below the North American level ignoring the final two years. Irish per capita consumption of dairy products shows great fluctuation (which may be an artefact of the calculation method to derive food supply which is calculated as a residual). Still, Ireland has

[13] No such jump is apparent in the per capita consumption figures for dairy products in the EU's most recent agricultural outlook database (European Commission 2022).

one of the highest levels of dairy product consumption in the world although it is hard to discern any trend. Among the developing country regions, South America is the region with the highest per capita consumption (but still well behind the levels in high-income countries). The most rapid growth in consumption has taken place in Asia, where consumption more than doubled between 1990 and 2020 but from a very low base (very similar to Africa in 1990). Consumption increased in Africa between 1990 and 2010 but has since fallen back to the 1990 level.

Figure 2. Growth in dairy and beef consumption (kcal/capita/day) in major world regions, 1990-2020



Note: FAOSTAT changed its food balance sheet methodology in 2010. Figures prior to and after 2010 are thus not comparable. In the Dairy panel, the series for high-income countries (Ireland, EU and North America) are measured on the right hand axis. The dairy series is for 'Milk, excluding butter' while the beef series is for 'Bovine Meat'.
Source: FAOSTAT Food Balance Sheet domain.

Trends in per capita beef consumption are shown in the right-hand panel of Figure 2. Here the South American region has the highest level of consumption with the lowest levels of consumption in Asia. Per capita consumption has been rising in Asia while falling slowly in Africa, such that average per capita beef consumption in the two regions is now broadly similar. However, the main message to take from the chart is that, unlike per capita consumption of dairy products, there has been no increase in global per capita beef consumption. The increase in per capita consumption in Asia and, to a smaller extent, South America, has been offset by decreases in per capita consumption of beef in North America and, particularly, the EU.

The changes in dairy consumption over time are also illustrated using FAOSTAT data on the absolute change in per capita milk demand between 1990 and 2020 in Table 14. In absolute terms, the most dynamic regions in terms of growth in per capita milk consumption are Asia and Latin America. The figures confirm that very little growth in per capita milk consumption occurred in Africa over this period. For beef (red meat), the figures confirm that at the global level, there has been very limited change in per capita consumption, due partly to the significant fall in consumption in industrialised countries. However, the growth in consumption in East Asia stands out, as does the stagnant level of consumption in South Asia and Africa.

Table 14. Change in demand for animal source foods, 1990–2020 (kg/person/year)

Region	Fish, Seafood	Milk	Eggs	Poultry	Red Meat
Eastern Asia	21.0	21.3	12.4	11.4	28.4
Southern Asia	3.1	50.1	2.2	2.8	-1.5
Southeast Asia and Pacific	18.1	10.0	3.9	10.5	7.7
West Asia and North Africa	3.3	29.7	1.1	9.5	5.5
Sub-Saharan Africa	-0.2	4.9	0.0	3.1	-0.4
Latin America	1.0	26.7	5.8	26.0	9.5
Industrialized Countries	0.8	17.7	0.6	15.4	-10.1
World	6.1	19.7	3.6	8.5	2.9

Source: Ruel and Fanzo (2022).

3.3 International trade in dairy products

Most milk is consumed as fresh products and is not traded except for some cross-border trade between neighbouring countries. International trade is mainly confined to processed dairy products. The main exporting and importing regions (measured in value terms) are shown in Table 15.[14] Exports are very concentrated in just three regions, Oceania, the EU and North America. Imports are more diversified, although Asia accounts for more than half of global dairy imports, followed by 'Rest of Europe' (which includes Belarus, Russia and Ukraine). Africa (including North Africa) accounts for about 10% of global dairy imports. Both Oceania and North America significantly increased their exports in recent years (the extra-EU figure is not available in this database). It is also clear that most of the increase in dairy exports went to Asia in the period since 2015 though Africa (including North Africa) also increased its imports while imports into Latin America fell.

Table 15. Global exports and imports of dairy products, by region, 2015 and 2021

	Exports				Imports			
Region	**2015**	**2021**	**2021 share**	**Change**	**2015**	**2021**	**2021 share**	**Change**
	USD m.	**USD m.**	**%**	**%**	**USD m.**	**USD m.**	**%**	**%**
Africa	834	690	1%	-17%	4,848	5,722	10%	18%
Asia	4,751	5,485	9%	15%	20,864	29,489	54%	41%
Caribbean	20	15	0%	-27%	756	825	2%	9%
Central America	495	551	1%	11%	2,034	2,717	5%	34%
EU		17,434	29%			1,795	3%	
Rest of Europe	4,555	5,842	10%	28%	5,888	7,691	14%	31%
Northern America	3,987	6,099	10%	53%	2,436	3,150	6%	29%
Oceania	9,871	22,102	37%	124%	1,021	1,483	3%	45%
Latin America	2,074	1,896	3%	-9%	2,084	1,934	4%	-7%
World		60,115	100%			54,808	100%	

[14] In assessing international trade statistics, it is important to check whether intra-EU trade is included or not. FAOSTAT provides data on both extra-EU and total EU trade so it is possible to derive intra-EU trade by subtraction. However, individual country and world totals include intra-EU trade. This section mostly only includes extra-EU trade unless otherwise specified. It should also be noted that changes in the value of trade can reflect both changes in the volumes traded and changes in their respective prices.

Note: Total for Europe, EU and World exclude intra-EU trade (see footnote 14). FAOSTAT does not calculate intra-EU trade for 2015, so those cells are left empty for 2015.
Source: FAOSTAT

Table 16 describes the composition of world dairy trade and highlights the relative importance of different dairy products. Including intra-EU trade, global dairy trade (measured in export value) increased in value by nearly 50% between 2015 and 2021 (an increase that took place prior to the significant increase in dairy product prices on world markets in 2022). Cheese is by far the most important traded dairy product, with butter, fresh products, skim powder and whole milk powder of roughly equal importance. However, the growth in the value of cheese exports has been slower than for other dairy products, with faster growth in the value of butter and powders trade.

Table 16. Global exports and imports of principal dairy products, 2015 and 2021

	Export Value				Import Value	
Dairy product	**2015**	**2021**	**2021 shares**	**Change**	**2015**	**2021**
	USD m.	**USD m.**	**%**	**%**	**USD m.**	**USD.m**
Cheese and curd	26,447	37,352	38%	41%	26,607	36,324
Butter	6,334	10,887	11%	72%	6,030	9,277
Skim milk powder	7,448	11,188	11%	50%	7,723	10,379
Whole milk powder	8,801	15,202	15%	73%	9,872	13,310
Milk and fresh milk products	8,995	10,915	11%	21%	9,269	10,930
Milk and cream, concentrated or sweetened	2,344	2,683	3%	14%	2,756	3,071
Cream	1,921	3,909	4%	104%	1,765	3,478
Whey	2,989	4,134	4%	38%	3,259	4,433
Dairy products n.e.s	1,121	1,853	2%	65%	1,082	1,378
Total dairy products	66,405	98,137	100%	48%	68,431	92,693

Note: FAOSTAT statistics only cover the main dairy products, for example, excluding trade in casein and fat-filled milk powder. The value of world exports and imports in each category should be equal but differ because of different valuation principles (exports are measured f.o.b. and imports c.i.f.), goods in transit and statistical errors. The figures in this table include intra-EU trade and this explains the difference in the value of world dairy trade between this table and the previous one.
Source: FAOSTAT Trade statistics domain.

These regional trends are informative but do not reveal the specific countries that play the most important roles in international dairy trade. Table 17 shows all exporting and importing countries that account for more than 2% of their respective global totals. The leading exporters are New Zealand, the EU and the USA which together accounted for 77% of global exports in 2021. China is the largest importer, accounting for 16% of global imports, while Russia and Ukraine together accounted for a further 11% in 2021. Beyond these countries, importers are very diversified and no other country stands out as a major importer.

Table 17. Major global exporters and importers of dairy products, 2015 and 2021

Exporter	**2015**	**2021**	**2021 share**	**Importer**	**2015**	**2021**	**Share 2021**
	USD m.	**USD m.**	**%**		**USD m.**	**USD m.**	**%**
New Zealand	8,083	19,905	36%	China, mainland	3,180	9,037	16%
European Union	n.a.	17,434	31%	Ukraine	3,311	3,381	6%

USA	3,817	5,813	10%	Russian Federation	1,729	2,623	5%
Belarus	1,736	2,661	5%	USA	2,007	2,492	4%
Australia	1,782	2,193	4%	Mexico	1,447	1,843	3%
UK	1,658	1,873	3%	European Union	n.a.	1,795	3%
Saudi Arabia	1,107	1,014	2%	Saudi Arabia	1,927	1,762	3%
United Arab Emirates	628	913	2%	Algeria	1,169	1,597	3%
Switzerland	699	886	2%	Japan	1,382	1,564	3%
Argentina	862	837	1%	United Arab Emirates	1,445	1,559	3%
				Indonesia	855	1,308	2%
				Republic of Korea	729	1,229	2%
				Viet Nam	525	1,191	2%
				Malaysia	847	1,132	2%
				China, Hong Kong SAR	1,748	1,131	2%
				Philippines	655	1,059	2%
				Australia	661	1,041	2%
				Singapore	768	922	2%

Note: Includes all exporters and importers with more than 2% market share in 2021, Argentina is included as an exporter as its market share is expected to grow by 2030. The EU is only extra-EU trade.
Source: FAOSTAT Trade Statistics domain.

3.4 Global dairy demand projections

With rising incomes and increased production, milk and dairy produce have become an important part of the diet in some parts of the world where little or no milk was consumed in the 1970s. Consumption of milk and dairy products is growing fastest in Asia and the Latin America and Caribbean region. India has recently become the world's largest milk producer, yet per capita consumption levels there are still low. Globally, many poor people are still not able to afford a better diet. Historically, as incomes rise we observe an increase in the demand for dairy products. Together with increasing population these trends are likely to drive increased demand for dairy products in the coming period. This section reviews recent projections based on assumptions of future population and income growth and taking account of the historical relationship between increased incomes and increased demand.[15]

FAO undertakes foresight exercises with long-term projections of global food supply and demand. The most recent FAO exercise was undertaken in 2018 providing projections up to 2050 with a base of 2012 (FAO 2018). In the business-as-usual scenario global milk production increases by 26% between 2012 and 2030 and by 40% between 2012 and 2050. Production in developing countries (excluding China) is expected to grow by 80% in 2050 compared to 2012. In this scenario, developing countries are expected to account for 75% of global milk production in 2050, compared to 60% in 2012. In high income countries, on the contrary, milk production is projected to fall by 14% between 2012 and 2050 and, to satisfy their demand, they turn into net importers from developing countries.

The FAO also collaborates with the OECD in preparing medium-term projections for the growth in supply and demand for food commodities. They jointly publish a ten-year

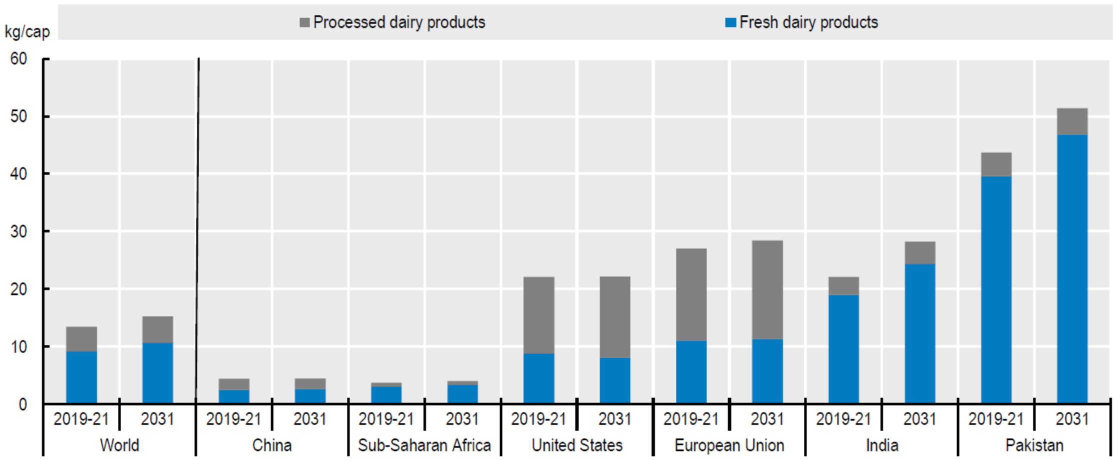
[15] Long-term projections to 2050 are also undertaken regularly by the International Food Policy Research Institute. However, the latest projections (IFPRI 2022) do not include dairy products so are not further considered here

agricultural outlook each year with the latest one published in 2022 (OECD/FAO 2022). This outlook foresees an evolution of the world dairy market much closer to existing trends than to the FAO (2018) 2030 projections and are presented here.

World milk production is projected to grow at 1.8% p.a. over the next decade to 2031, faster than most other main agricultural commodities. The projected growth in the number of milk-producing animals is expected to be strong (1.1% p.a.), especially in regions with low yields such as Sub-Saharan Africa and in major milk-producing countries such as India and Pakistan. Over the projection period, milk yields across the world are expected to grow steadily with the strongest growth expected in Southeast Asia and North Africa where average yield growth is around 2% p.a. Over half of the increase in total milk production is anticipated to come from India and Pakistan, which will jointly account for over 30% of world production in 2031. Production in the second largest global milk producer, the European Union, is expected to grow more rapidly than Oceania but more slowly than in North America as a result of EU policies targeted to sustainable production, the expansion of organic production, and pasture-based production systems.

As incomes and population increase, more dairy products are expected to be consumed over the medium term. Overall, per capita consumption is expected to increase 0.4% p.a. to 21.9 kg (milk solids equivalent) by 2031 in high-income countries compared to 2.0% p.a. (21.2 kg) and 1.5% p.a. (5.4 kg) in low-middle income and low-income countries, respectively. The key drivers for this are strong demand growth in India, Pakistan and Africa. In low and middle-income countries, fresh dairy products comprise over two-thirds of the average per capita dairy consumption (milk solids), while consumers in high income countries tend toward processed products (Figure 3).

Figure 3. Per capita consumption of processed and fresh dairy products in milk solids



Note: Milk solids are calculated by adding the amount of fat and non-fat solids for each product; Processed dairy products include butter, cheese, skim milk powder and whole milk powder.
Source: OECD/FAO (2022).

As regards global trade, China is expected to remain the most important importer of milk products despite a slight increase in domestic milk production relative to the past decade. Russia, Mexico, the Near East and North Africa will also continue to be important net importers of dairy products. Over the medium term, the European Union, New Zealand and the United States are projected to remain the key exporters of processed dairy products and are projected to jointly account for around 65% of cheese, 71% of WMP, 74% of butter, and 80% of SMP exports in 2031. The OECD/FAO projections do not foresee the massive growth in dairy production and exports in the Europe/Central Asia region projected in the FAO (2018) 2050 global perspectives study.

Table 18. Actual and projected trade in processed dairy products, 2010-2031

Region	Exports ('000 tonnes)			Imports ('000 tonnes)		
	2010	2021	2031	2010	2021	2031
Africa	267	157	165	980	1,281	1,743
Asia	1,067	1,582	1,658	3,845	6,828	7,528
European Union	2,600	3,546	4,498	336	328	356
Rest of Europe	900	1,386	1,467	1,268	1,565	1,680
Latin America	940	1,142	1,207	1,050	1,459	1,807
North America	825	1,645	2,019	187	274	269
Oceania	2,727	3,373	3,496	147	260	258
Developed countries	7,093	10,025	11,587	2,338	3,045	3,265
Developing countries	2,233	2,805	2,924	5,474	8,952	10,376
WORLD	9,326	12,831	14,511	7,812	11,997	13,640

Note: The figures are the sum in weight of the processed dairy products butter, casein, cheese, fresh dairy products, skim milk powder, whey powder, whole milk powder.
Source: OECD/FAO (2022) database.

3.5 How much dairy products consumption in future?

The projections of dairy consumption reported in the previous section are based largely on assumptions regarding population and income growth, with little regard given to their potential environmental, sustainability and health implications. Just one indicator from the OECD/FAO report, with reference to the greenhouse gas emissions (GHGs) expected under the projected scenario, illustrates the problem (Table 19). Emissions from dairying would increase by a further 9% over the coming decade. This would be driven largely by emissions from dairying in developing countries, which would be expected to grow by 14% and to account for two-thirds of global dairy emissions in 2031. Emissions from dairying in developed countries are projected to stabilise and even to fall slightly in the EU and the Rest of Europe.[16]

Table 19. Direct GHG emissions from dairy production, million tonnes CO_2e

Region	2010	2021	2031	Share 2031	Change 2021-2031
Africa	214.9	239.8	278.1	21%	16%
Asia	388.3	439.3	512.9	39%	17%
European Union	173.7	160.9	151.4	12%	-6%
Rest of Europe	105.2	85.8	79.6	6%	-7%
Latin America	177.3	142.4	149.2	11%	5%
North America	85.0	85.5	87.1	7%	2%
Oceania	41.9	42.8	41.2	3%	-4%
Developed countries	459.9	439.3	433.0	33%	-1%

[16] The FAO Emissions Agriculture database uses Tier I emissions factors following the 2006 IPCC Guidelines for National GHG Inventories and thus differs from emissions reported by countries to the UNFCCC. They may not capture the impact of abatement measures and improved efficiency which could lead to an over-estimation of future emissions.

Developing countries	726.3	757.1	866.6	67%	14%
WORLD	1,186.3	1,196.4	1,299.5	100%	9%

Source: Source: OECD/FAO (2022) (database).
Note: Estimates are based on historical time series from the FAOSTAT Emissions Agriculture databases which are extended with the Outlook *database.*

Instead of asking how dairy consumption might evolve in an unconstrained world, from a climate perspective the more relevant question is what level of dairy consumption in both developed and developing countries is consistent both with human health and nutrition requirements and with the requirements to stay within the carbon budget necessary to achieve the Paris Agreement target to hold “the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels” (Article 2). This question is explored in the remainder of this section.

3.5.1 EU countries food based dietary guidelines

Governments have increasingly moved away from recommending specific nutrient intakes to proposing food-based dietary guidelines. Food-based dietary guidelines express the principles of nutrition in terms of the food and food choices available to the population rather than in terms of specific nutrients or food components. These guidelines are based on the association between dietary patterns and the risk of diet-related diseases and incorporate recommendations that address major diet-related public health issues. There are also a few countries where these dietary recommendations take account of sustainability objectives. A generally applicable “ideal” level of calorie intake and mix of food items does not exist as such, since diets depend on lifestyles, culture, tradition, climate, local food availability, and other elements. FAO has a website where national food-based dietary recommendations can be accessed.[17]

Table 20 provides information on the recommended intake of dairy products (in terms of whole milk equivalent) in the food-based dietary guidelines of EU Member States plus the UK. These are mainly based on health considerations only. The range is quite striking, varying from Spain at the top to Bulgaria at the bottom. Only a few EU member states have begun to incorporate sustainability objectives in their dietary guidelines. Those that have (e.g. Denmark, Sweden) have noticeably lower recommended intakes than other Member States. High intake of dairy products, at least three servings per day, has been widely promoted in western counties for bone health and fracture prevention, primarily because of their high calcium content. However, the optimum calcium intake remains uncertain (Willett et al. 2019).[18]

Table 20. EU Member State + UK dairy recommendations (g/milk/per day)

Spain	699	Slovenia	621	UK	414
Netherlands	678	Germany	610	Italy	388
Latvia	647	Finland	569	Belgium	375
Portugal	647	Estonia	518	Sweden	362

[17] FAO, Food-based dietary guidelines, https://www.fao.org/nutrition/education/food-dietary-guidelines/background/en/.
[18] Although the EU Member State dietary recommendations for dairy intake are much higher, actual intakes in many EU countries are often below these recommendations. The European Dairy Association notes that in 18 out of 23 EU countries for which consumption data were available, consumption was below the dietary recommendation for that country. That report also notes the shortcomings in available consumption data at national level and calls on the European Commission to support Member States in their efforts to provide recent and accurate data on actual consumption of dairy products (EDA 2021).

Romania	647	Croatia	517	Denmark	359
Austria	621	Greece	517	Lithuania	324
Cyprus	621	Hungary	517	France	310
Ireland	621	Malta	517	Poland	259
Luxembourg	621	Slovakia	517	Bulgaria	207

Source: EDA, 2021.
Notes: The figures represent the amount of milk contained in dairy products expressed in grams of whole milk per capita per day. Recommendations based on the number of servings have been converted into milk equivalent using fixed conversion factors. Where a range is indicated in the original source, for example, differing by age groups, the figure represents the median.

3.5.2 The EAT-Lancet reference diet

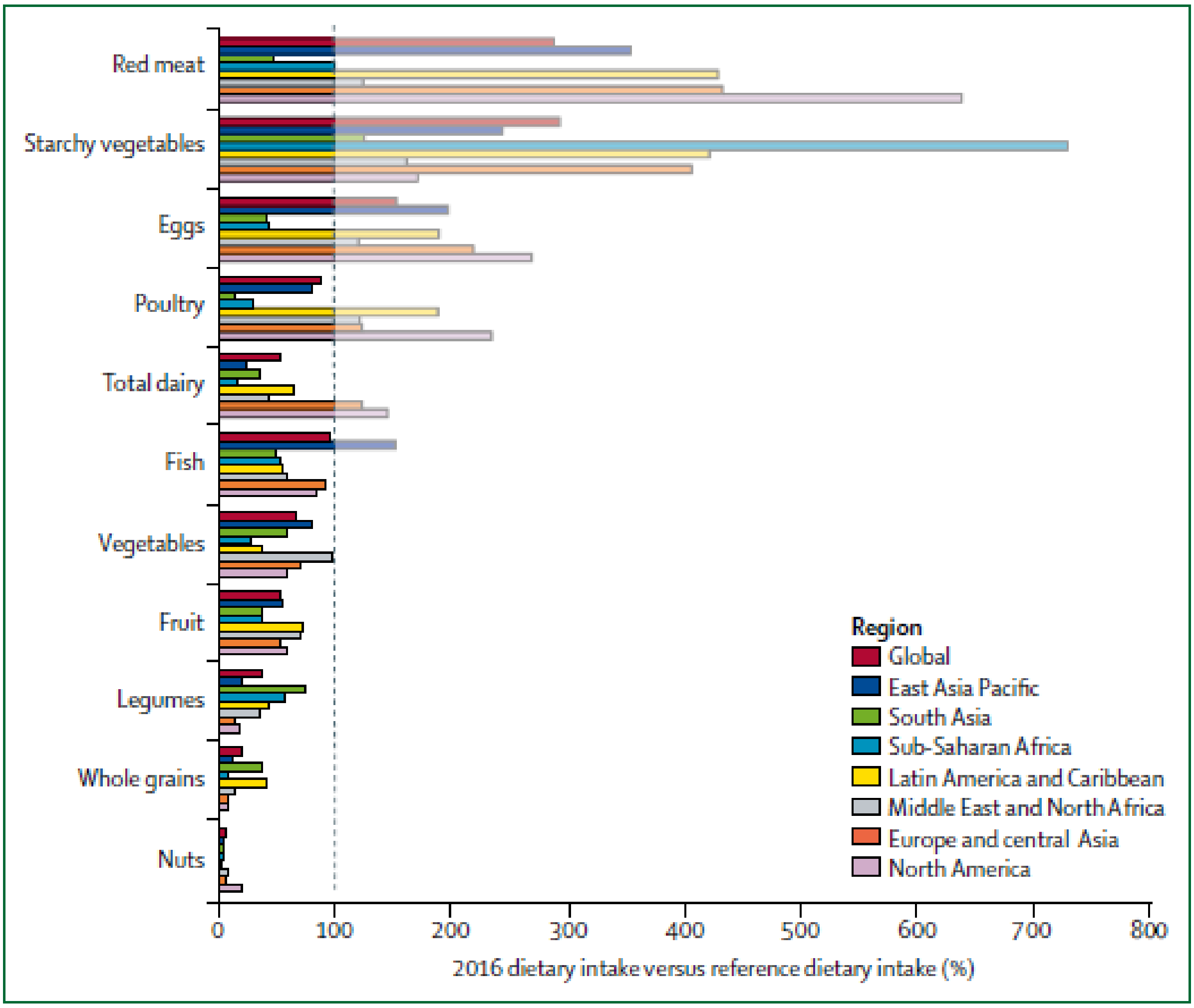
The EAT-Lancet study (Willett et al. 2019) was the first to lay out how to achieve healthy diets for all within planetary boundaries. It includes a range of possible intakes by food group and substantially restricts the intake of highly processed foods and animal source foods globally. Its reference diet is intended to provide adequate nutrients for the average adult aged 30 years. The diet was not recommended for children aged 0–2 years due to their unique requirements, nor did it recognise women of reproductive age separately as a population with increased needs. Concern has also been expressed about the extent to which the diet provides adequate essential micronutrients, particularly those that are generally found in higher quantities and in more bioavailable forms in animal source foods (Beal, Ortenzi, and Fanzo 2023).

With respect to the consumption of dairy products, the EAT-Lancet study noted that prospective studies do not show a significant increase or decrease in risk of overall mortality or cardiovascular disease with increasing consumption of dairy foods, although overall and cardiovascular mortality is likely to decrease if dairy foods are replaced with nuts and other plant sources of protein. High milk consumption, probably because of its calcium content, is associated with reduced risk of colorectal cancer, but also increased risk of prostate cancer in men, especially advanced cases. Some evidence suggests that yoghurt might reduce risk of diabetes and weight gain. Although low-fat dairy foods might be preferable to high-fat dairy foods for health, nearly all the fat in milk that is produced remains in the human food supply, often as butter or cream. Thus, low-fat dairy products will have little overall effect on population health because fat is consumed in other forms. These findings relate to adults and there is a clearer positive link between dairy and nutritional health among children. School age children and adolescents undergo critical growth, reproductive, endocrinal, and neurodevelopmental changes that require energy and nutrient dense foods. Findings from systematic reviews on milk and dairy for this age group are associated with increased height, bone health and lower risks for overweight and obesity (FAO 2023).

The EAT-Lancet study argued that, because a clear association does not exist between intake of milk or its derivatives greater than 0–500 g/day and major health outcomes, and competing risks for some types of cancer, a wide range of intakes is compatible with good health. Because consumption of unsaturated plant oils conveys lower risks of cardiovascular disease than does dairy fat, optimal intake will usually be at the lower end of this range. It used 250 g/whole milk equivalent/day for the reference diet. This is well below the recommended daily intake in most EU member state dietary guidelines (Table 20).

Some regions over-consume dairy products, while other regions have not yet reached the recommended dietary intake. Figure 4 taken from the EAT-Lancet report shows that, based on 2016 data, sub-Saharan Africa is on average consuming just about 30% of the recommended reference daily intake for dairy, while consumption in Europe and Central Asia and North America exceeds the reference intake.

Figure 4. Diet gap between dietary patterns in 2016 and reference diet intakes of food



Note: Data on 2016 intakes are from the Global Burden of Disease database. The dotted line represents intakes in the EAT-Lancet reference diet.
Source: Willett et al. 2019.

3.5.3 FAO Assessment

The FAO Assessment being undertaken by the Subcommittee for Livestock of the Committee on Agriculture is the most recent review of recommended dietary intakes also taking sustainability considerations into account. Table 21 presents an extract from its literature review of studies that recommend a healthy reference intake. In addition to the EAT-Lancet study, it includes a study that linked dietary adequacy and diet related noncommunicable disease (NCD) risk in diverse settings (Bromage et al. 2021). In that study, foods are divided into healthy and unhealthy foods. Healthy food groups are assigned higher points for greater consumption, and more points are also given for lower consumption of unhealthy foods, allowing the construction of a Global Diet Quality Score (GDQS). Low fat dairy is assigned to the healthy food group, while for high fat dairy higher points are given until specific consumed amounts, after which no points are given, to recognise that modest consumption of these products is an important source of nutrients and higher consumption is an NCD risk factor.

These scores were then assessed against NCD outcomes to arrive at recommended intake levels. The approach used also allowed the GDQS score to be subdivided to give more detailed information about the contribution of smaller sets of food groups or individual food groups to diet quality in populations. Again, the range of consumption intakes considered healthy for dairy products varies very considerably. No account is taken of sustainability considerations.

Table 21. Healthy reference intake and risk thresholds for dairy products for adults

Food	Study	Mean (range in g/day)	Method for calculating range	Analysis or data source	Reference
Low fat dairy	Global Dietary Quality Score	33-132g/day	Categories of consumed amounts: Low: <33g/day Middle: 33-132g/day High: > 132g/day Healthy	Based on ability to produce a reasonably even distribution of categories of consumed amounts of each food group using analyses of Food frequency questionnaire and 24-h dietary recall data from cross-sectional and cohort studies of non-pregnant and non-lactating women in diverse settings.	Bromage *et al.*, 2021
High fat dairy[c] (in milk equivalents)	Global Dietary Quality Score	35-734g/day	Categories of consumed amounts: Low: <35g/day Middle: 35-142g/day High: 142-734g/day Very High: >734g/day Unhealthy in excessive amounts	Based on ability to produce a reasonably even distribution of categories of consumed amounts of each food group using analyses of Food frequency questionnaire and 24-h dietary recall data from cross-sectional and cohort studies of non-pregnant and non-lactating women in diverse settings.	Bromage *et al.*, 2021
Whole milk or derivative equivalents (e.g. cheese)	EAT-Lancet Commission	250g/day (0-500g/day)	Because a clear association does not exist between intake of milk or its derivatives greater than 0–500g/day and major health outcomes and competing risks for some types of cancer, a wide range of intakes are compatible with good health. Because consumption of unsaturated plant oils conveys lower risks of cardiovascular disease than dairy fat, optimal intake will usually be at the lower end of this range and 250g/day were used for the reference diet.	Derived using calculations of nutrient intake adequacy relative to WHO recommendations. Systematic review of evidence-based.	Willett *et al.*, 2019

Source: FAO, 2023

3.5.4 What about alternatives to dairy products in nutrition?

An important issue is the extent to which plant-based milk substitutes can and will replace cow’s milk in human consumption. Plant-based (PB) milk substitutes formulated and reassembled from legumes (soy), nuts, grains, and seeds have a much lower GHG footprint than cow’s milk (Poore and Nemecek 2018; Coluccia et al. 2022). Almond and soy milks are the most common, but PB milk alternatives derived from cashews, hazelnuts, walnuts, pistachios, and macadamia nuts are also found, as are PB products formulated from oats, rice, quinoa, amaranth, and flax or hemp seeds. In the case of beef, there is also the potential of cell-cultured meat. The debate around the potential for substitution revolves around nutritional quality, cost, and the fact that PB alternatives fall into the category of ultra-processed products with a very different route to market than traditional milk.

One view is that these products are not a substitute for animal source foods in terms of nutritional composition (for milk, for example, see Walther et al. 2022). Smith et al. (2022) quoted previously argue that, were milk removed from the global food system, a suitable nutritional replacement would be challenging to find. They argue PB milk alternatives generally have lower protein content, amino acid bioavailability and, even when calcium-fortified to comparable levels with bovine milk, have low calcium delivery due to solubility and digestibility issues. Considering other milk nutrients in addition to protein and calcium increases the challenge of finding a suitable replacement. They also note that replacing the nutritional content of milk with other foods would also likely require greater concomitant energy intakes, resulting in health consequences. In their view, replacements would also be unlikely to replicate other beneficial properties of milk, such as in hydration and exercise recovery, and influencing the intestinal microbiome.

Other authors argue that the amounts and proportions of amino acids consumed by vegetarians and vegans are typically more than sufficient to meet and exceed individual daily requirements, provided a reasonable variety of foods are consumed and energy intake needs are being met (Mariotti and Gardner 2019). All plant foods contain all 20 amino acids, including the 9 essential amino acids, even if the amino acid distribution profile is less optimal in plant foods than in animal foods. Thus, a person who eats a variety of foods and has an adequate total intake of protein will have an intake of all 20 amino acids that is more than sufficient to cover requirements. These authors also argue that there is very little evidence at present regarding a marked difference in protein digestibility in humans. A criticism of DIAAS scores used to rank protein quality is that the plant proteins studied come from raw, unheated, or minimally heated sources, whereas plant proteins like beans are usually consumed after cooking which breaks down the anti-nutrients and as well are usually eaten combined with other foods.

Even if it is accepted that milk is nutritionally superior to PB alternatives, given the high climate footprint of animal source foods the policy question is whether the PB alternatives can be a nutritionally acceptable alternative (also taking account of the potential for fortification) in the context of a varied and complete diet. For emerging markets, a follow-on question is whether this substitution can take place at an acceptable cost. At the present time, the cost of PB drinks greatly exceeds the cost of cow milk. Coluccia et al (2022) calculated that soy drink consumption implies paying 66% more than for cow milk, when considering the same protein content. However, there is the potential for the price of PB drinks to fall as production is scaled up and the technology matures. In addition, it can be argued that the price of milk is too cheap because it does not factor in the cost of negative externalities. There is also some evidence that liquid milk is sold as a loss leader by supermarkets while the price of PB drinks is maintained at a high level by retailers to maintain a bigger profit margin.

Finally, the switch to PB drinks replacing milk in the global food system is criticised for its likely socio-economic consequences. Partly, this criticism relates to the impact on livelihoods of dairy farmers if consumer choice switches from a farm-based product to a product produced by an industrial process in an industry which is likely to be dominated by large multinational corporates. Others react against the idea of an ultra-processed food compared to what is perceived as the more natural alternative (but see Messina et al. 2022 for a contrary view). How this clash in worldviews will be resolved will play a significant role in determining the future of PB drinks and cell-based meat.

3.6 Conclusions

Dairy products currently make a significant contribution to global nutrition, although this role varies significantly across regions. Cow milk is energy-dense and provides high-quality protein. Dairy product consumption is twice the world average or more in the more developed regions of North America, Oceania and particularly the EU, while consumption in Central America, Asia but particularly the Caribbean and Africa is well below the global average. In absolute terms, the most dynamic regions in terms of growth in per capita milk consumption are Asia and Latin America, while little growth in per capita milk consumption has occurred in Africa over the 1990-2020 period. As most milk is consumed as fresh products and is not traded, trade is a relatively small share of global production and is confined to processed dairy products. The main feature of international trade is the high concentration among suppliers on the export side (where New Zealand, the EU and the US accounted for 77% of global exports by value in 2021). In contrast, import demand is much more diversified, with only China, Russia and Ukraine prior to the Russian invasion of Ukraine accounting for significant import shares. Africa including North Africa accounts for 10% of global dairy imports.

OECD/FAO projections foresee a continuing increase in demand over the coming decade to 2031. This will occur mainly in low-middle income countries (2.0% increase p.a.) and low-income countries (1.5% increase p.a.) in contrast to the more limited growth projected in high-income countries (0.4% increase p.a.). Despite increasing production in developing countries, some of this demand growth will be met through increased imports. The three main exporting countries, New Zealand, EU and US, are projected to remain the key exporters of processed dairy products. However, this growth in dairy demand will be accompanied by a growth in GHG emissions from dairying, contrary to the objectives of the Paris Agreement.

To date, there are only a very limited number of studies that ask what the minimum requirement for dairy product consumption would be consistent with securing good human nutrition while ensuring planetary health. The best known of these reference diets is the EAT-Lancet diet. Although seen as a diet that minimises the consumption of animal source foods, no developing country region has yet achieved its reference level intake for dairy products. This suggests that dairy consumption would continue to grow even if the world as a whole were to adopt the EAT-Lancet diet.

In the longer term, these projections may be challenged by the growing substitution of cow's milk by plant-based alternatives. However, this is unlikely to be the case in the coming decade alone on cost grounds. Plant-based drinks will have to become cheaper than dairy products to be an attractive alternative in low and middle-income countries, and there is still debate whether they can provide a complete nutritional alternative to dairy products. For these reasons, the OECD projection that emerging economies will need continued and increased imports of dairy products is assumed to form the backdrop for the discussion of Irish dairy exports in subsequent chapters.

4 Do Irish dairy exports stimulate consumption in emerging markets?

This chapter discusses the role of Irish dairy exports in emerging markets. The question addressed is whether the availability of Irish dairy exports, including promotional campaigns to encourage consumption of dairy products, encourages the consumption of dairy products beyond levels that ensure a healthy diet for the local populations. To answer this question requires establishing the counterfactual, how would demand in these markets evolve in the absence of Irish exports? This counterfactual, by definition, cannot be observed, but various indicators are used to assess the role that Irish exports play relative to competing exports from other suppliers. The potential impact of Bord Bia's marketing spend on overall dairy consumption in these markets is also evaluated.

4.1 Irish dairy exports to emerging markets

Table 22 breaks down exports to emerging markets both by value and volume on an individual country basis, ranked by the value of exports in 2022. The wide distribution of dairy exports is striking. According to Bord Bia, Ireland exported dairy products to 147 markets in 2021 (Bord Bia 2022a). In 2015, the top 27 destinations shown in the table still accounted for only 70% of exports to emerging markets, though this share had increased to 81% in 2022. The five top emerging market destinations for Irish dairy exports are China, Nigeria, Mexico, Algeria, and Saudi Arabia. Leaving China to one side as the world's largest importer of dairy products, all the other four destinations are major oil producers and exporters. The table highlights in green all markets where Irish exports have increased in both value and volume terms over the period. In only a few cases have exports reduced (Nigeria, Saudi Arabia, Egypt, Turkey and Vietnam).

Table 22. Value and volume of Irish dairy exports to emerging markets 2015-2016 to 2021-2022, ranked by value of exports in 2022, € million and '000 tonnes

	2015	2016	2021	2022	2015	2016	2021	2022
Country	€m	€m	€m	€m	'000 tonnes	'000 tonnes	'000 tonnes	'000 tonnes
China	395	541	417	441	50	61	97	79
Nigeria	95	69	163	161	48	37	69	48
Mexico	28	53	87	133	5	15	11	12
Algeria	41	42	58	112	15	16	18	23
Saudi Arabia	155	131	102	88	22	24	22	17
Senegal	40	47	67	88	20	26	29	28
United Arab Emirates	35	42	51	83	10	16	19	21
Mali	22	24	49	72	12	14	22	25
Philippines	8	13	34	72	2	4	12	17
Malaysia	41	39	65	63	<11	14	29	20
Iran, Islamic Republic of	1	6	-	52	0	2	-	14
Thailand	30	9	48	48	10	5	18	16
India	0	0	3	47	0	0	1	14
Morocco	13	15	40	45	4	5	9	8
Egypt	31	37	56	36	10	15	17	8

Niger	0	3	15	36	0	2	6	10
Ghana	15	16	30	34	9	10	13	11
Congo, D.R.	14	12	23	31	7	7	11	11
South Africa	14	19	28	30	5	8	8	8
Taiwan	16	20	24	26	2	2	4	3
Togo	12	11	18	25	7	7	7	7
Cote d'Ivoire	3	6	25	23	1	3	10	7
Turkey	25	23	23	23	7	6	4	5
Peru	9	12	27	22	1	2	8	5
Yemen	3	5	9	21	1	3	3	5
Viet Nam	30	41	26	21	3	5	4	4
Colombia	11	17	15	20	2	2	2	3
Others	445	496	534	430	115	134	169	103
Grand Total	**1,531**	**1,750**	**2,037**	**2,278**	**379**	**444**	**624**	**532**

Note: All countries with export values greater than €2 million in 2022 are individually shown. The green shading denotes markets where exports have grown in both value and volume terms. Recall that the value of exports could have risen in 2022 because of very high world market prices even though the volume of exports may have fallen.
Source: Own compilation based on CSO.

Given the growth in Irish dairy exports to SSA, Table 23 shows the main SSA export destinations for Irish dairy exports and the trend over time. Export destinations are mainly in West Africa. Apart from Nigeria, the next most important destinations (ranked according to the value of exports in 2022) are Senegal, Mali and Ghana. The growth rates for the two periods 2015-2021 and 2015-2022 are also shown. Many of these are very high because they start from a very small base. However, they illustrate the diversification of Irish export markets given that for four of the top six export destinations (including Congo D.R. and South Africa) the growth in exports has been slower than for SSA as a whole.

Table 23. Main Sub-Saharan African export destinations for Irish dairy product exports, € million, 2015-2022

Destination	2015	2016	2017	2018	2019	2020	2021	2022	Growth 2015-2022	Growth 2015-2021
	€million								%	%
Nigeria	95	69	95	77	127	124	163	161	70%	72%
Senegal	40	47	52	43	50	51	67	88	119%	67%
Mali	22	24	29	29	38	45	49	72	234%	128%
Ghana	15	16	19	16	28	29	30	34	118%	94%
Congo, D.R.	14	12	14	16	16	24	23	31	131%	73%
Niger	0	3	10	4	2	7	15	36	76569%	32517%
South Africa	14	19	31	23	25	25	28	30	109%	95%
Togo	12	11	12	11	16	20	18	25	99%	46%
Cote d'Ivoire	3	6	11	10	14	15	25	23	739%	801%
Angola	6	6	7	6	10	20	17	20	242%	188%
Other SSA	30	32	57	45	61	68	81	100	232%	168%
Total SSA	251	245	338	282	388	429	515	619	147%	106%

Note: Sub-Saharan Africa includes Mauritania and Sudan.

Source: Own compilation based on CSO.

The composition of Irish dairy exports to SSA and how this compares to the overall profile of Irish dairy exports is shown in Table 24 for the latest year 2022. The conclusion is striking. Nearly all Irish dairy exports to SSA – 88% - consist of fat-filled milk powder with the remaining 12% consisting of other milk powders. This contrasts with the importance of butter and cheese exports to high-income markets.

Table 24. Value and volume of exports by product, all Irish exports and exports to SSA, 2022

		Total Irish dairy exports				Total exports to SSA			
SITC	Product	€m	'000 Tonnes	Per cent value	Per cent volume	€000	'000 Tonnes	Per cent value	Per cent volume
02211	Skim milk	26.5	57.2	0.4%	3.7%	0.0	0.0	0.0%	0.0%
02212	Whole milk	91.7	148.7	1.3%	9.5%	0.1	0.2	0.0%	0.1%
02221	Skim milk powder	615.4	170.0	8.9%	10.9%	58.7	15.0	9.5%	7.8%
02222	Whole milk powder	214.9	49.0	3.1%	3.1%	13.8	3.4	2.2%	1.8%
02241	Whey	265.7	135.5	3.9%	8.7%	2.4	1.7	0.4%	0.9%
02300	Butter	1,701.3	232.6	24.7%	14.9%	6.1	1.1	1.0%	0.6%
02499	Cheese	1,032.0	206.0	15.0%	13.2%	1.2	0.2	0.2%	0.1%
09893	Infant formula	761.5	98.0	11.0%	6.3%	3.9	0.7	0.6%	0.4%
09894	Fat-filled milk powder	906.9	285.7	13.2%	18.3%	523.8	168.3	84.6%	87.8%
59221	Casein	604.4	55.3	8.8%	3.5%	7.3	0.8	1.2%	0.4%
	Total selected products	6,220.3	1,437.9	90.2%	91.9%	617.5	191.4	99.7%	99.9%
	Grand Total	6,896.4	1,564.4	100.0%	100.0%	619.5	191.6	100.0%	100.0%

Source: Own compilation based on CSO.

4.2 Role of Irish dairy exports in selected markets

Irish dairy products are exported to very different markets. Even focusing on emerging markets alone, some destinations are wealthy oil exporters in the Near East, others are middle-income countries in Asia and Latin America where consumer tastes and preferences are moving in the direction of more processed dairy products, while others are very poor low-income economies in West Africa with very low per capita intake of dairy products and where exports are almost entirely in the form of milk powders. The impacts of those exports on the growth in demand in those markets are likely to be very different. To assess the potential impacts, the role of Irish dairy exports in the three main export markets China, Nigeria and Mexico is examined in this section.

4.2.1 Irish dairy export performance in China

China is the world's largest import market for dairy products. By 2020, imports as a share of domestic consumption exceeded 90% for skimmed milk powder, 50% for butter, and 30% for cheese and dry whole milk powder.[19] China is also one of the world's largest importers of liquid milk which is not normally a highly traded product. While a much smaller share, imports of liquid milk (mainly UHT milk) grew from essentially 0% to 2.6% of China's consumption in the previous decade, mainly supplied from New Zealand but also EU suppliers such as Germany and France.[13] The value of Chinese dairy imports increased from $6.1 billion to $14.0 billion between 2015 and 2022. The decline in overall Chinese imports in 2022 reflected the slowdown in the Chinese economy in that year, as historically there is a close relationship between China's economic growth and its level of dairy imports. Chinese imports are concentrated in two product categories, infant formula and milk powders. The growth in infant formula imports reflects continuing Chinese consumer lack of trust in local brands following the melamine contamination scandal in 2008.

The Chinese market is mainly supplied from Oceania and to a lesser extent the United States. Ireland had a market share of around 8% of Chinese imports by value composed mainly of infant formula (where its share reached 18% in 2016) and fat-filled milk powder exports (with a share of 14% in 2019). Since the high points in 2019 the value (and share) of Chinese imports of Irish dairy products has fallen by 45%. Because of Ireland's small and declining share of China's imports, it is unlikely that Irish dairy exports have had any significant influence on the growth of China's consumption of dairy products. If Irish dairy exports ceased, exports would likely be replaced by China's dominant suppliers New Zealand and the United States, or by the Netherlands in the case of infant formula.

Table 25. Irish share of China imports of dairy products, 2015-2022, euro million and per cent

HS code	2015	2016	2017	2018	2019	2020	2021	2022
0401 Milk and cream	**437**	**578**	**778**	**773**	**984**	**1,147**	**1,532**	**1,555**
New Zealand	23.8%	29.5%	42.9%	41.0%	41.7%	40.9%	40.7%	47.0%
Ireland	0.3%	0.9%	0.8%	1.6%	1.6%	1.7%	2.0%	2.5%
0402 Powders, evaporated and condensed milk	**1,378**	**1,369**	**1,959**	**2,098**	**2,840**	**2,918**	**3,944**	**4,278**
New Zealand	78.3%	76.8%	74.6%	72.0%	71.2%	67.7%	66.9%	68.4%
Ireland	0.9%	0.6%	0.6%	0.8%	1.3%	1.4%	1.3%	1.2%
0403 Fresh milk products	**25**	**38**	**59**	**51**	**53**	**51**	**47**	**46**
Germany	16.2%	41.9%	61.8%	64.0%	62.9%	51.6%	53.3%	53.4%
Ireland	0.0%	0.1%	0.2%	0.3%	0.4%	0.2%	0.7%	0.8%
0404 Whey products	**473**	**409**	**590**	**536**	**541**	**717**	**864**	**922**
United States of America	34.5%	41.2%	42.1%	32.5%	19.3%	25.9%	28.2%	31.2%
Ireland	6.5%	5.9%	4.8%	6.2%	7.6%	5.6%	5.6%	5.7%
0405 Butter	**239**	**273**	**443**	**590**	**417**	**479**	**564**	**888**
New Zealand	80.1%	82.0%	83.4%	86.6%	79.8%	79.9%	77.1%	86.2%
Ireland	0.3%	0.2%	0.2%	0.2%	0.6%	0.6%	1.4%	0.4%
0406 Cheese	**313**	**379**	**440**	**435**	**466**	**517**	**687**	**735**
New Zealand	46.5%	51.6%	49.1%	48.3%	54.5%	53.1%	50.3%	55.5%

[19] Zulauf, C., D. Orden, A. Lines and B. Brown. "China's Imports of Meat and Dairy during the 21st Century." *farmdoc daily* (10):210, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, December 14, 2020.

Ireland	0.4%	0.3%	0.3%	0.5%	2.0%	2.1%	1.5%	1.3%
190110 Infant formula	**2,268**	**2,775**	**3,604**	**4,139**	**4,762**	**4,572**	**3,764**	**4,342**
Netherlands	32.2%	33.3%	28.7%	33.7%	30.6%	34.1%	35.0%	45.5%
Ireland	16.3%	18.4%	16.0%	14.9%	14.5%	12.0%	9.2%	7.6%
190190 Fat-filled milk powder	**322**	**332**	**339**	**397**	**424**	**557**	**575**	**609**
New Zealand	16.2%	16.6%	18.7%	19.7%	28.7%	22.4%	24.7%	31.5%
Ireland	5.2%	3.9%	8.9%	12.3%	13.7%	10.6%	7.7%	3.8%
Total	**5,456**	**6,153**	**8,213**	**9,019**	**10,487**	**10,957**	**11,978**	**13,374**
Ireland (€ million)	433	563	655	732	856	724	539	506
Ireland (%)	7.9%	9.2%	8.0%	8.1%	8.2%	6.6%	4.5%	3.8%

Note: For each product group imports from the country with the largest import share in 2022 and imports from Ireland are shown.
Source: Own calculations based on International Trade Centre database based on UN COMTRADE.

4.2.2 Irish dairy export performance in Nigeria

Even more than in China, the majority of Nigeria's dairy consumption is met from imports though the precise share is disputed, with shares quoted between 60%[20] and 87%.[21] Nigeria has the fourth largest cattle population in Africa, estimated at 20 million cattle, including 2.35 million cows used for dairy production. Despite its size, the Nigerian dairy sector is largely fragmented, unproductive, and inefficient. Smallholder dairy households (i.e., pastoralists) produce most of the raw milk in Nigeria but it is totally insufficient to meet demand, and the end market is controlled by multinational companies that use imported milk in most of products consumed. Local dairy processors rely on combining and reconstituting milk powder imported mostly from the European Union. The reconstituted milk is mostly sold as powdered, evaporated, and condensed milk and packaged in metal cans and sachets of different weights. Ice cream, chocolate milk, yogurt, and shelf-stable milk production is from reconstituted imported milk powder. Infant formula, cheese, butter, as well as some ice cream, are mostly imported. Demand for these products continues to grow, but average per capita consumption remains very low (Table 13).

Beginning February 2020, the Central Bank of Nigeria (CBN) launched a program to conserve foreign exchange and encourage local production of milk and dairy products. The program introduced foreign exchange restrictions on the import of milk and milk products, while the then Minister for Agriculture stated that the Federal Government intended to ban milk importation from 2022. Following the introduction of this policy, the CBN exempted and approved six Nigerian companies to import milk and dairy products that provided support for Nigeria's backward integration program as the solution to increase dairy productivity. These companies are: FrieslandCampina WAMCO Nigeria, Chi Limited, TG Arla Dairy Products Limited, Promasidor Nigeria Limited, Nestle Nigeria Plc, and Integrated Dairies Limited. While dairy imports fell in 2021 compared to 2020 (Table 26) imports in 2020 were at abnormally high levels and imports have returned to a more 'normal' level.

[20] https://www.premiumtimesng.com/news/more-news/452244-60-of-dairy-products-consumed-in-nigeria-imported-minister.html?tztc=1.
[21] https://www.trade.gov/country-commercial-guides/nigeria-agriculture-sector. This and the next paragraph in this section are largely based on this report by the US International Trade Administration of the US Department of Commerce.

In value terms, milk powders, fat-filled milk powder and infant formula are the most important dairy imports. Ireland had a significant import share in all three in 2021 (9% of milk powder imports, though down from 14% some years before, 53% of fat-filled milk powder, and 19% of infant formula imports (down from 32% some years previously).

Even before the drop in imports in 2021, whether due to the foreign exchange restrictions or representing a return to more normal import levels, Nigeria was not a growth market for dairy imports but experienced considerable volatility from year to year. Nigeria is hugely keen to develop its domestic dairy industry. The foreign exchange restrictions introduced by the Central Bank are designed to favour domestic production over imports rather than to curtail consumption per se; in fact, given the low absolute level of consumption, government policy is to increase milk intake per capita. It is likely that, in the absence of imported products including Irish products, overall milk consumption in Nigeria would be lower. The ready availability of milk in sachet or tinned form, suitable for distribution in a hot climate, and sold at prices well below the cost of domestic milk, is likely to stimulate consumption beyond what would be feasible based on domestic production alone, given the weaknesses in the domestic production base.

There is a considerable literature that blames the failure to develop a successful dairy industry in Nigeria and elsewhere in West Africa on competition from subsidised low-cost milk powders particularly from the EU (Choplin 2016; Matthews and Soldi 2019). This criticism was well-founded when the EU used export subsidies that enabled the dumping of EU milk surpluses on developing country markets. The EU eliminated its use of export subsidies in 2015 and after that date it is harder to argue that EU dairy exports can be sold more cheaply abroad because they benefit from subsidy, although it is probably the case that EU dairy export surpluses are slightly larger given the existence of direct payment support to EU dairy farmers under the EU's Common Agricultural Policy. But the main reason why the Nigerian and other West African dairy industries face competition from low-cost dairy imports is the innovation that allows the extraction of the high-value butterfat from milk and its substitution by low-cost vegetable fat, usually palm oil (Matthews and Soldi 2019). This results in a dairy product that can be sold much more cheaply than raw milk purchased from traditional pastoralists and makes the development of a domestic dairy industry more difficult.

Although Ireland is a significant player in the Nigerian import market, it is the dominant player only for fat-filled milk powder. The import market is highly competitive, and Nigeria imports from other EU exporters as well as New Zealand, the US and the UK. It is thus very likely that, subject to foreign exchange availability, imports would continue by substituting alternative sources of supply rather than that consumption would be limited were Irish dairy exports to Nigeria to cease.

Table 26. Irish share of Nigerian imports of dairy products, 2015-2021, euro million and per cent

HS code	2015	2016	2017	2018	2019	2020	2021
0401 Milk and cream	**3**	**20**	**4**	**2**	**2**	**2**	**3**
India	0.5%	0.0%	0.1%	0.1%	0.1%	0.9%	91.9%
France	1.3%	0.7%	0.0%	4.9%	21.5%	14.3%	3.6%
0402 Powders, evaporated and condensed milk	**389**	**320**	**348**	**237**	**307**	**675**	**391**
New Zealand	30.3%	33.8%	28.4%	36.4%	23.2%	39.5%	49.5%
Ireland	6.0%	7.0%	8.8%	10.4%	14.2%	9.4%	8.7%

0403 Fresh milk products	**13**	**14**	**18**	**8**	**13**	**29**	**15**
New Zealand	4.8%	25.0%	8.0%	21.5%	17.6%	56.5%	54.4%
Ireland	12.1%	15.8%	8.7%	13.1%	5.6%	1.1%	0.5%
0404 Whey products	**11**	**8**	**7**	**4**	**5**	**6**	**6**
France	17.2%	15.2%	26.6%	14.4%	19.8%	17.5%	22.2%
Ireland	0.2%	1.5%	0.0%	0.9%	0.0%	3.9%	3.4%
0405 Butter	**15**	**15**	**16**	**14**	**7**	**13**	**7**
New Zealand	82.9%	58.9%	45.7%	43.2%	38.2%	55.7%	37.5%
Ireland	1.6%	0.5%	0.7%	0.0%	0.0%	0.0%	0.0%
0406 Cheese	**3**	**5**	**3**	**3**	**4**	**6**	**3**
Denmark	9.6%	30.0%	31.8%	45.8%	42.4%	72.0%	50.2%
Ireland	1.1%	0.5%	0.0%	1.2%	0.0%	0.0%	0.0%
190110 Infant formula	**46**	**51**	**64**	**114**	**223**	**194**	**69**
United Kingdom	3.0%	10.5%	15.6%	32.4%	32.0%	28.6%	19.3%
Ireland	0.0%	0.0%	0.4%	0.0%	0.6%	0.3%	5.7%
191090 Fat-filled milk powder	**205**	**165**	**147**	**107**	**161**	**246**	**214**
Ireland	26.9%	40.8%	44.0%	40.8%	49.8%	44.4%	53.1%
Ireland	26.9%	40.8%	44.0%	40.8%	49.8%	44.4%	53.1%
Total	**686**	**597**	**608**	**488**	**721**	**1,170**	**708**
Ireland (€ million)	80	92	97	69	126	173	152
Ireland (%)	11.7%	15.4%	16.0%	14.2%	17.4%	14.8%	21.4%

Note: For each product group imports from the country with the largest import share in 2021 and imports from Ireland are shown.
Source: Own calculations based on International Trade Centre database based on UN COMTRADE.

4.2.3 Irish dairy export performance in Mexico

Mexico has a significant dairy industry and milk is the third most important livestock product behind beef and poultry.[22] Liquid milk remains the most important product (including for factory use) where it is processed into pasteurised milk, ultra-high temperature pasteurised, and milk powder. Dairy products derived from liquid milk for factory use are yogurt, cheese, cream and butter (consumed in that order). Mexico's demand for milk and dairy continues to grow, especially in the processing sector, as novel products such as fortified drinks, and comfort foods such as pastries and bakery items, continue to trend upward in Mexico's consumer preferences. The trend in consumption is shifting from liquid milk to other dairy products, as shelf life has noticeably improved through processing. Cheese, for example, is consumed in different ways in Mexico, whether alone or as an essential part in the preparation of a wide variety of dishes. Mexico's production of liquid milk satisfies most domestic demand but there is still a demand for imports. According to the USDA report, national milk consumption has been satisfied by a steady 75% share domestic production and a 25% share of imports over the past twenty years. About 60% of imports go to the Hotel, Restaurant, and Institution (HRI) sector, and 40% is destined for retail.

The main dairy products imported into Mexico are shown in Table 27. Milk powders, mainly skimmed milk powder, and cheese are the two big import items. Mexico's proximity to the

[22] This paragraph summarises information in the USDA FAS GAIN report Dairy and Products Annual: Mexico, Report Number: MX2022-0056, 2022, Washington, D.C.

United States which is a major exporter of dairy products means that its imports are mainly supplied from there; the exception is butter where New Zealand is the main supplier. According to Mexican trade statistics Ireland is a very marginal supplier with some exports of infant formula in the past and more recently some exports of fat-filled milk powder. The Mexican import statistics show a very different value of trade to the Irish export statistics (Table 22). Whereas the Irish trade statistics show the value of exports growing to reach €87 million in 2021, the Mexican trade statistics show imports from Ireland almost disappearing. The explanation for this discrepancy is not clear, but in any event Ireland plays a minor role as a dairy supplier in comparison to the United States and, for butter, New Zealand. If Irish dairy exports were to case, it is highly probable that these exporters would be able to satisfy the outstanding demand.

Table 27. Irish share of Mexican imports of dairy products, 2015-2021, euro million and per cent

HS code	2015	2016	2017	2018	2019	2020	2021
0401 Milk and cream	**25**	**38**	**37**	**23**	**22**	**17**	**8**
United States of America	84.6%	98.4%	96.9%	99.3%	98.9%	100.0%	100.0%
Ireland	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
0402 Powders, evaporated and condensed milk	**585**	**558**	**642**	**616**	**776**	**693**	**863**
United States of America	82.6%	88.5%	82.5%	93.7%	90.8%	98.5%	100.0%
Ireland	0.3%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%
0403 Fresh milk products	**24**	**33**	**40**	**32**	**31**	**27**	**18**
United States of America	66.5%	63.6%	81.9%	93.3%	96.1%	100.0%	100.0%
Ireland	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
0404 Whey products	**91**	**73**	**96**	**99**	**111**	**81**	**124**
United States of America	93.8%	90.5%	92.8%	93.6%	97.9%	99.2%	99.7%
Ireland	0.1%	0.1%	0.1%	0.2%	0.4%	0.0%	0.0%
0405 Butter	**120**	**179**	**191**	**148**	**242**	**146**	**83**
New Zealand	84.5%	87.7%	79.0%	72.5%	90.8%	90.3%	82.4%
Ireland	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
0406 Cheese	**453**	**448**	**459**	**436**	**485**	**467**	**462**
United States of America	75.7%	74.9%	74.6%	76.9%	77.0%	81.0%	85.9%
Ireland	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
190110 Infant formula	**88**	**79**	**70**	**75**	**68**	**52**	**26**
Netherlands	40.1%	41.1%	41.9%	44.2%	45.1%	69.7%	77.9%
Ireland	11.4%	9.9%	8.6%	5.2%	0.0%	0.0%	0.0%
19109005 Fat-filled milk powder	**41**	**38**	**72**	**30**	**28**	**5**	**11**
Ireland	22.1%	33.3%	51.8%	2.6%	64.4%	0.0%	48.3%
Poland	4.3%	6.6%	2.2%	4.9%	4.6%	14.5%	17.5%
Total	**1,427**	**1,446**	**1,607**	**1,460**	**1,761**	**1,488**	**1,594**
Ireland (€ million)	21	21	44	6	18	0	5
Ireland (%)	1.5%	1.4%	2.7%	0.4%	1.0%	0.0%	0.3%

Note: For each product group imports from the country with the largest import share in 2021 and imports from Ireland are shown.

Source: Own calculations based on International Trade Centre database based on UN COMTRADE.

4.3 The impact of Bord Bia promotional spending

Launched in 2022, the Bord Bia Statement of Strategy *Nurturing a Thriving Future* operates over two timelines: (a) a 10-year horizon, aligned to *Food Vision 2030*, and ensuring the actions assigned to Bord Bia, as part of the four missions of *Food Vision 2030*, receive the necessary strategic resources; and (b) a three-year strategic cycle, encompassing the years 2022 to 2025. Five strategic priorities drive Bord Bia actions over this three-year period:

- Build Food Brand Ireland and further develop its proof points.
- Develop better ways for our clients and customers to connect and build partnerships.
- Nurture and attract industry talents and drive client capability.
- Champion insight-led innovation and brand development.
- Support and enable the organisation and stakeholders to execute strategy.

Bord Bia's business objectives for the three-year period 2022-2025 include the following objectives for meat and dairy products:

- To help defend and grow the value of the meat and livestock sector on the domestic and UK markets by €375 million or 11% by 2025.
- To help grow Irish dairy's value share of the Irish market by 2025 and help grow the value of Irish dairy exports by 10.5% or €508 million to a value of €5.6 billion through investment in market development in Africa, Asia, Europe, Middle East, North America and the UK.

To help achieve these objectives (and others for the horticultural, seafood, drinks, and prepared consumer goods sectors), Bord Bia disposes over a marketing and promotion budget (Table 28). Total marketing and promotion spending has increased from €32.8 million in 2015 to €44.3 million in 2021. Marketing spending is reported under the several pillars of the Statement of Strategy but for the earlier year there is a more meaningful breakdown by type of expenditure. This indicates that spending is used (in decreasing order of importance) for trade fairs, marketing development, promotions, trade development, information and other services. No breakdown of marketing expenditure by destination market is provided. In addition to spending reported under this heading, Bord Bia receives funding under the Food Promotions Special Funding scheme and funding for a marketing finance scheme. Additional funding from the Department of Agriculture, Food and the Marine Quality Assurance Scheme Special Fund covers the costs of independent on-farm inspections and associated certification processes under the Bord Bia Quality Assurance Scheme. Most of its income comes from an Oireachtas grant-in-aid and other Oireachtas funding, but Bord Bia also receives funding from a statutory levy on producers and from successful applications to the EU agri-food promotional fund.

Table 28. Bord Bia marketing and promotional expenditure, €'000

Statement of Strategy Strategic Pillars	2015 spending	Statement of Strategy Strategic Pillars	2021 spending
Consumer Insight	4,033	Insights to Power Growth	7,178
People Talent Infrastructure	2,563	Leading through People	4,252
Origin Green	3,098	Building Reputation for Growth – Providing Proof	3,174
Routes to Market	9,221	Driving Success and Growth in the Market	9,759

Brand Communication	12,270	Building Reputation for Growth – Marketing	18,112
Support Services	1,624	Support Services	1,861
TOTAL	32,809	TOTAL	44,336
Analysis of expenditure type			
Promotions	5,080		
Marketing development	5,832		
Trade fairs and exhibitions	8,131		
Information services – research	569		
Information – other services	4,044		
Quality assurance	2,684		
Trade development	4,139		
Technical support – pigmeat sector	368		
Other client services	172		
Talent development programmes	1,790		

Sources: Bord Bia Annual Reports, 2016 and 2021.

As noted, there is no breakdown of the spending specifically in emerging markets in the Bord Bia annual reports. Examples of activities undertaken by Bord Bia in emerging markets in its 2021 Annual Report included (Bord Bia 2022a):

- A virtual seminar organised by Bord Bia Africa for Irish seafood, drink and dairy clients that included presentations by Minister Heydon and the Bord Bia CEO Tara McCarthy.
- An Irish grass-fed dairy standard media and trade event hosted by Bord Bia Shanghai in the Embassy of Ireland, Beijing, highlighting the key principles of Bord Bia's grass-fed standard.
- Communications activity in China to raise awareness of Irish dairy and build its reputation among B2B customers. Key events included the launch of the Dairy Grass Fed Standard in Beijing.
- Webinars to give North African livestock importers the opportunity to learn more about Irish farming practices and import opportunities.
- Three virtual trade missions targeted South-East Asia over a four-week period, including Vietnam, Malaysia and Thailand. Over 400 meetings were hosted across the three missions.
- A social media campaign coordinated by Bord Bia Africa for World Milk Day to build awareness of Irish dairy powders and premium Irish butter.

Whether Bord Bia's marketing spend in emerging markets increases overall demand or simply shifts existing demand in favour of Irish exports goes to the heart of an age-old debate in advertising generally: does advertising grow markets? Because most advertising is undertaken at the brand level (e.g., Irish dairy rather than dairy products in general), it might be assumed that it leads primarily to brand switching rather than to an increase in total dairy product consumption.

Advertising can affect behaviour through different channels. These include objective information, image creation, and cues that stimulate consumption. Objective information informs that the brand exists and explains attributes such as its constituents, how much it costs, and innate characteristics such as its environmental footprint. Image creation and consumption cues are designed to be much more persuasive, often playing on feelings and emotions to create the desire to purchase that particular product.

The impact of Bord Bia spending on the growth of demand for dairy products in target markets will depend on the nature of its promotional activity and on the specific actors in the food chain who are targeted by this promotional spending. Promotional spending directed at consumers (e.g. TV or billboard advertising, in store promotions, or social media activity) will have a persuasive character and may have a potential impact in increasing overall demand for the advertised products. However, it may also simply shift an existing demand in favour of Irish products relative to competitors.

Spending targeted at business customers (e.g. importers or wholesalers, or hotel and catering organisations) through participation in trade fairs or Ministerial visits is more likely to have an objective character. The emphasis is on promoting the desirable attributes of Irish dairy products relative to competitors. Such promotional activity is more likely to have a ‘switching’ effect rather than a ‘growth’ effect as these customers already have markets and are looking for a reliable partner to supply them. Bord Bia’s promotional activities in emerging markets tend to be of this nature, interacting with customers rather than specifically with consumers, though there are also examples of the latter.[23]

There is very limited literature focusing on the impact of dairy export promotion programmes in particular. Various studies have been undertaken of the impact of general agricultural trade promotion expenditure. Despite methodological problems, the studies give some support to the effectiveness of these activities in increasing exports (Ribera and Fischer 2022). Song and Kaiser (2016) examined the effectiveness of US dairy export promotion programmes on increasing foreign demand and enhancing producers’ revenues. This seems to be the only empirical study to look specifically at dairy promotion programmes. They examined two agricultural market development programmes partially funded by the US Department of Agriculture that aimed to assist US agricultural and food organisations in expanding the demand for dairy products in international markets. The Market Access Programme primarily promotes high-value consumer-oriented goods with either brand promotion or generic promotion. Through the programme, industry associations can submit proposals to apply for government assistance in marketing activities. These include trade servicing (the dissemination of information about availability, utility and reliability of US suppliers), technical assistance with the use of US products in manufacturing processes in importing countries, and consumer promotions such as store demonstrations, media advertising, recipes and nutrition information, and event sponsorship. The Foreign Market Development Programme mainly applies to promotion of bulk commodities and emphasizes long-term market development. The study focused on total expenditure on dairy export promotion in countries and regions where activities had taken place.

The study concluded the combined effort of public and private dairy export promotion expenditures had a positive and statistically significant impact on demand for US dairy products in the world market. Their findings indicated that export promotion stimulated total US dairy exports by 4.14 billion pounds, on average, per year, which represented 55.8% of

[23] This is illustrated by the programme for Minister Martin Heydon leading an agri-food trade visit to China in April 2023. The activities include Irish participation in the 2023 Hainan Expo, followed by a visit to Shanghai to Shanghai for a series high level engagements with Irish agri-food companies and their Chinese customers, facilitated by Bord Bia. https://www.gov.ie/en/press-release/15ab3-minister-heydon-to-lead-agri-food-trade-visit-to-china/.n

total exports. However, the nature of the econometric model that they used for their analysis means that they cannot distinguish between the impact of market growth and market switching as they focus only on the impact on US exports. Thus, the impact of promotional activity on the overall growth of demand for dairy products remains untested in the literature.

4.4 Conclusions

The five top emerging market destinations for Irish dairy exports are China, Nigeria, Mexico, Algeria, and Saudi Arabia. Within SSA, the main export destinations are in West Africa. Apart from Nigeria, the next most important destinations (ranked according to the value of exports in 2022) are Senegal, Mali and Ghana. Nearly all Irish dairy exports to SSA – 88% - consist of fat-filled milk powder with the remaining 12% consisting of other milk powders. This contrasts with the importance of butter and cheese exports to high-income markets.

To illustrate any potential impacts of Irish exports on the growth in demand for dairy products in emerging markets, the role of Irish dairy exports in the three main export markets China, Nigeria and Mexico was examined in detail. Although each market has its own characteristics, Ireland is not a dominant supplier in any market (although it did provide more than half of Nigeria’s imports of fat-filled milk powder in 2021). If Irish exports to these markets ceased, the strong probability is that the gap left would be filled by substitute exports by other existing suppliers to these markets, rather than that domestic consumption would be reduced.

Bord Bia has a marketing objective to help grow the value of Irish dairy exports through investment in market development in Africa, Asia, Europe, Middle East, North America, and the UK. The big question is whether such promotional activity leads to overall market growth, or instead leads to Irish supplies being preferred to those from another competitor. There is no empirical literature that provides guidance in answering this question, so a more qualitative assessment has been undertaken. Because Bord Bia’s activities in emerging markets are mainly business-to-business interactions (through trade fairs and targeted interactions with business customers) rather than consumer-focused promotions, the activity is primarily geared to promoting Irish exports at the expense of competitors. Any impact on the overall growth of dairy consumption in these markets will be limited relative to the underlying factors (income growth, demographic changes, urbanisation) that influence demand.

5 Would limiting Irish dairy exports lead to increased global emissions?

If demand growth in emerging markets is taken as exogenous or given, then in the absence of Irish supplies this demand would be met by alternative suppliers. Whether this would lead to increased global emissions (due to carbon leakage) is an empirical issue. Carbon leakage can be defined as the additional amount of GHG emissions generated in third countries caused by the implementation of stricter climate policies to reduce GHG emissions in the implementing country or countries. Leakage expressed as a percentage is calculated as the emissions increase outside the implementing country divided by the emissions decrease in the implementing country. For example, if because of climate policy emissions in Irish agriculture fall by 1 Mt CO_2e but emissions in other countries increase by 0.5 Mt CO_2e, then the leakage rate would be 50%. 50% of the reduction in the Ireland would be offset by increases in countries outside Ireland. If production is reduced in Ireland because of climate policy, then because of the role of international trade leakage will occur as Irish supplies are substituted by increased production elsewhere. What is important is whether the leakage rate exceeds 100% or not. When the leakage rate exceeds 100%, then Irish climate policy leads to an increase in global emissions, which is clearly contrary to the climate policy objective. Because some leakage is inevitably associated with unilateral climate policy, the focus in this chapter is on the likelihood that the leakage rate exceeds 100%.

There is a growing literature attempting to estimate carbon leakage rates following implementation of climate policy in agriculture (Arvanitopoulos, Garsous, and Agnolucci 2021; Henderson and Verma 2021; Matthews 2022). The leakage rate is not a fixed number. It depends on many factors, including the availability of technological and management options for farmers to reduce the emission intensity of production, the level of climate policy ambition, the scope of included emissions, the climate policy instruments used, the size of the implementing coalition, and the existence of accompanying demand measures (Matthews, 2022).

Ideally, one would like to be able to model how production and trade flows might react to lower Irish dairy product exports by using a global model of agricultural production and trade. Several global models of this type exist, but none have been used to simulate specific scenarios regarding Irish exports of dairy products to emerging markets. Instead, a more qualitative approach is adopted here. First, it is important to establish how the GHG intensities of production in Ireland compare with other potential suppliers. Ireland is seen as a relatively low-emissions producer of dairy products and, on a global scale, also of beef, although precise figures differ due to differences in the scope of emissions measured, the methodology and data used, and the time period covered. Second, these figures are combined with estimates of where production is likely to increase if Irish dairy exports were curtailed to assess the potential impact on global emissions. Third, taking account of the fact that Ireland is not taking action alone but in conjunction with other countries that also face emission reduction targets is explored.

5.1 The value of dairying to the Irish economy

The Irish dairy industry makes a significant contribution to the Irish economy, which has recently been summarised in a report by Ernst & Young for Dairy Industry Ireland (Ernst & Young 2023). Direct output of the dairy industry in 2022 was €7.0 billion, of which payments to farmers accounted for €5.2 billion reflecting the high milk price in that year. Around 16,700 dairy farmers produce the raw milk, while 5,651 persons were directly employed in the processing sector. Dairying is the most profitable farm enterprise. The average dairy farm output per hectare was €6,005 in 2002, compared to €2,812 for tillage, €1,740 for cattle farms, and €1,475 for sheep production. Average income per labour unit (unpaid family labour) for dairy farms in 2022, when prices were particularly high, was €109,003. Again, this was above the comparable figures for tillage (€97,910) and well above income on cattle farms (€7,154) and from sheep production (€14,890). Furthermore, dairy farmers relied on market returns for 94% of their income in 2022 and the remaining 6% came from direct payments, while the comparable dependence on direct payments in 2022 was 18% for tillage farms, 30% for cattle farms, and 36% on sheep farms. Dairy is thus not only more profitable but also less dependent on farm supports (Buckley and Donnellan 2023).

Activity in the dairy industry has ramifications for other sectors of the economy through purchases along the supply chain and through the economic activity supported by the spending of incomes and profits earned in the industry. Using an input-output model, Ernst & Young estimated that the dairy industry is associated with total output of €17.6 billion (implying an output multiplier effect of 2.5 (17.6/7.0 = 2.5), GVA of €4.5 billion, and total employment of 53,930 jobs in Full Time Equivalents. This multiplier effect measures the impact of an exogenous change in final demand in the economy on overall output or employment. We should be cautious about drawing the conclusion that a €1 increase in dairy exports contributes to a €2.5 increase in total output. Multipliers in an input-output model assume the existence of unemployed resources. In an economy close to full employment like the Irish economy at the present time, expansion of the dairy industry will be at the expense of contraction (or foregone expansion) in other sectors, meaning a much smaller multiplier. Multipliers also assume that input relationships (for example, the relationship between employment and output) remain unchanged when industry direct output increases or decreases. The impact of marginal changes in industry output for different inputs may well be different than embodied in the average coefficients in the input-output model. For example, an increase in dairy industry output of 20% may not necessarily translate into an employment increase of 20%.

Limiting the growth of Irish dairy output means foregoing the associated economic gains. What is missing from the Ernst & Young analysis is an assessment of size of the unpriced and hidden costs of dairying. Dairying contributes €4.3 billion to the economy in economic terms, but there are external costs arising from emissions of greenhouse gases and ammonia to the air, as well as the release of nitrogen and phosphorous to waterways (see Chapter 6 for trends in these indicators). Furthermore, dairying depending on the management regime may be associated with the loss of habitat and biodiversity, but may also be responsible for sequestering additional carbon in the soil. Given the purpose of this study, we focus on the potential cost of greenhouse gas emissions.

There are different ways one could cost greenhouse gas emissions from dairying. One could use the price of CO_2 allowances in the Emissions Trading Scheme, or the level of the Irish carbon tax, or the likely cost to Ireland of failing to comply with EU targets by 2030. Total GHG emissions from dairying can be calculating by applying the Teagasc estimate of agricultural GHG emissions from milk in 2022 using the IPCC activity approach of 0.84 kg CO_2e/kg milk (see Table 31 below)[24] and multiplying this by the total volume of milk produced

[24] Note that emissions from energy use on farms is not included in this estimate.

in 2022 of 8,582 million kg giving total dairy emissions of 7.2 Mt CO_2e.[25] This compares to total agricultural emissions of 23.3 Mt CO2e in 2022 (EPA 2023).

If these emissions were priced at the ETS allowance price of €80/t CO_2 at end October 2023,[26] they would represent a charge of €577 million on the dairy sector at farm level. The carbon tax was raised from €33.50 to €41 per tonne CO2 on 1 May 2022 which is just half the ETS allowance price. Applying a levy similar to the carbon tax to Irish dairy emissions would imply a charge of €296 million. If milk producers were required to pay these social costs, the incentive for further expansion would be reduced.

A cost of compliance with EU targets would arise if Ireland fails to meet its annual targets for reductions up to 2030 under the EU Effort Sharing Regulation. Unlike the two other estimates, this would be a real cost to the Irish Exchequer were it to materialise. The cost would arise if Ireland is required to purchase carbon credits from other EU Member States that have exceeded their reduction targets. Alternatively, if sufficient carbon credits are not available, Ireland would face infringement proceedings and possible daily fines for each day it was not in compliance.

The Irish Government Economic and Evaluation Service (IGESS) has made an effort to estimate what the potential cost of compliance might be (Walker et al. 2023). Conceptually, the cost will be the emissions gap in any year (the difference between actual Irish emissions under the Effort Sharing Regulation and allowed emissions, subject to any flexibilities that are allowed) and the potential cost of available carbon credits from other member states. Both these variables are currently very uncertain, but the IGEES paper provides some extremely tentative estimates assuming that the price of purchasing carbon credits would be similar to the average futures price of ETS allowances as available Sept-Dec 2022. If this price were to hold, and if Ireland were to breach its total allowed emissions under the Effort Sharing Regulation in the period up to 2030, this would require the Irish Exchequer to pay between €80 and €120 per tonne of excess CO_2e emitted. If part of the reason for the failure to meet the ESR reduction targets was because agricultural emissions exceeded the limits established in the Sectoral Emissions Ceilings under the Climate Act (Government of Ireland 2022), the total cost to the Exchequer of purchasing compliance would be attributable to the agricultural sector in proportion to its contribution to the overall overshoot.

Because of all these uncertainties, the size of this potential cost cannot be estimated at this time, and in any case would only arise if agricultural emissions exceeded the limits set in its Sectoral Emissions Ceilings up to 2030. The message to take from this discussion is that the dairy sector makes an important and valuable economic contribution to the Irish economy, and further increases in output volumes would add to this contribution. But there is also a social cost to its greenhouse gas emissions and potentially also an economic cost if EU reduction targets and its Sectoral Emissions Ceiling are not met. Similar arguments can be made for other environmental impacts of the industry. These costs need to be included and should not be ignored in any assessment of continued expansion of the Irish dairy industry.

5.2 International comparisons of emission intensities in dairy

[25] The total volume of milk produced in 2022 is given as 8,840 million litres in CSO Quantity of Agricultural Output series https://data.cso.ie/table/AEA02 and this has been converted to kg by dividing by 1.03.

[26] Source: EMBER Carbon price tracker https://ember-climate.org/data/data-tools/carbon-price-viewer/.

The comparison of emission intensities (also called carbon or emission footprints) across different countries is greatly complicated by differences in the methodologies used to calculate these estimates in different studies (Baldini, Gardoni, and Guarino 2017). Recognising these difficulties, the International Dairy Federation published "*A common carbon footprint approach for the dairy sector – the IDF guide to standard life cycle assessment methodology*" (IDF 2015). However, studies continue to use different methodologies that make comparisons difficult. Among the key methodological choices that can influence the outcome are the following:

The functional unit used. Often studies quote emissions per unit of product either in mass (weight) or volume (litres). Other studies emphasise the nutritional function of milk and quote results in terms of the energy or protein supplied using units such as Fat and Protein Corrected Milk (FPCM).

The scope of included emissions. This refers to where the boundaries for the activities whose emissions are being measured are set. The narrowest definition is to look at direct on-farm emissions only. A more common scope used is the 'cradle to farmgate' approach which also counts upstream emissions, such as emissions from the manufacture of fertiliser or the production of purchased feed, referred to as Life Cycle Analysis (LCA). A twist on this approach is whether only production-related emissions of these upstream activities are counted or whether any induced changes in land use are also included. This is the difference between counting the direct production emissions from the production of soy used in dairy feeds and also including emissions from deforestation for which soy production may have been responsible. There is no agreed method how to account for indirect land use but it can obviously be important. As an example, if a farm producing wheat reduces fertiliser use and therefore emissions per hectare, ignoring any changes in land use would treat that change as beneficial even if it resulted in a decline in yields and would require an increase in the wheat area to maintain the same volume of production. Even if that additional land does not directly lead to deforestation or the conversion of land from natural ecosystems, the use of that land ultimately has an opportunity cost. For example, if it were to revert to its native ecosystem state, it would probably act as a significant carbon sink. For this reason, Wirsenius et al. (2020) include the concept of Carbon Opportunity Cost (COC) in their LCA study. Finally, in making comparisons with other food products, it could also be important to include downstream emissions in the assembly, processing, retail and waste sectors.

The method used to allocate emissions between milk and meat. Dairy systems produce a mix of goods (mainly milk and meat) that cannot be easily disaggregated. Some decision rule is required to allocate the environmental burdens among the different products. The method used to partition the inputs and/or outputs between the main product, i.e. milk, and co-product, i.e. liveweight sold for meat), for example, either using feed energy requirements or economic values, has an obvious influence on the estimated emission intensity.

Metrics. Dairy farming produces a variety of greenhouse gases, mainly methane and nitrous oxide, but also carbon dioxide from energy use. The Global Warming Potential (GWP) is a standard metric for comparing emissions of different greenhouse gases but it has been evolving (and in consequence changing values) over the last 20 years in successive assessment reports of the IPCC. As the ratio produced of these different GHGs differs between different management systems (e.g. intensive systems heavily reliant on purchased feed, compared to pasture-based grazing systems), the ranking by emission intensity will be affected by the particular GWP metric used. Other metrics such as the Global Temperature Potential and GWP* (GWPstar) have also been proposed which can result in different rankings.

The methodology used. Another important factor is the methodology used to calculate emissions. LCA studies have different levels of sophistication (or "Tiers"), depending on the emission factors available for each country/region. More developed countries like Ireland use a national inventory approach and (mostly) regional/national specific emission factors (referred to as Tier 2 or even Tier 3 where modelling approaches are used). Other countries may have to use a Tier I approach which means the default factors for particular activities recommended by the IPCC methodology. Country-specific emission factors can be either higher or lower than the default factors recommended by the IPCC, which again will influence the ranking of countries when emission intensities are calculated using different Tiers.

Representivity of the estimates. In some cases, studies set out to derive estimates of the emissions footprint of the entire national milk production, but other studies may have a narrower focus. For example, they may focus on farms in a particular region of a country, or high-yielding farms, or milk produced using a specific production system (e.g., pasture-based vs. confined, organic vs. conventional). When making international comparisons, it is important to compare like with like and not to compare studies measuring different things.

These measurement uncertainties need to be borne in mind when evaluating the findings from different sources on the relative size of dairy carbon footprints in different countries. Several international comparative databases and studies are examined here. FAOSTAT data are unique in that they are calculated by a single source using a uniform methodology for all countries. This enhances their comparability, but the cost is that the scope of the emissions included is very narrow, only covering direct on-farm emissions. Three studies (Leip et al. 2010; Lesschen et al. 2011; Wirsenius et al. 2020) were undertaken by research teams that apply a common methodology to national data, where the results obtained are influenced by the methodologies used. A final study (Mazzetto et al. 2022) is a systemic literature review of national studies. It attempted to standardise the results to a common methodology but not all such differences could be eliminated, and the representivity of the estimates can be questioned.

5.2.1 The FAOSTAT emissions data domain

FAOSTAT data on emissions are widely used because they are available for all countries, over a lengthy period, and calculated on a comparable basis. However, they do not pretend to provide a life cycle assessment and the coverage of emission sources is severely limited to only some emissions sources inside the farm. They thus give a very biased comparison of relative emission intensities across countries. However, as they provide broad coverage, uniquely provide data on the changes in emission intensities over time, and are easily accessed, this section describes the FAOSTAT data in greater detail.

FAOSTAT computes emission intensities by country as the ratio between FAOSTAT GHG emissions data associated to a given commodity and the underlying national production data. The GHG emissions used to calculate the intensities indicator are limited to emissions generated within the farm gate. Additional emissions from upstream and downstream production and consumption processes are excluded. The emissions included are those of methane and nitrous oxide from manure management systems; nitrous oxide from the application of manure to soils and manure left on pastures; and methane from enteric fermentation, for applicable animal categories. Emissions from the application of chemical fertiliser to grazing pastures as well as from the production of feed are excluded.

Emissions are calculated by multiplying activity data by IPCC Tier I emission factors for the different sources of emissions, where activity data are the number of animals. These are the default emission factors set out in the 2006 IPCC *Guidelines for National GHG Inventories*. Emissions from the cattle sector are divided between milk and beef in the FAOSTAT dataset as follows. Cattle numbers are divided between dairy cattle, which are the number of heads of cows producing milk, and non-dairy cattle, which are defined as all cattle minus dairy cattle. Emissions from dairy cattle are associated with the commodity milk and emissions from non-dairy cattle are allocated to the commodity beef. Milk production is expressed in FAOSTAT as quantities of raw milk, not standardised for fat and protein content. The FAOSTAT emission factors for milk and beef for EU countries, selected major exporters and several developing country regions are set out in Table 29.

Table 29. Emission intensities for milk and beef production, FAOSTAT, 2010 and 2020

	Raw milk of cattle		Meat of cattle with the bone, fresh or chilled	
Area	**2010**	**2020**	**2010**	**2020**
	kg CO_2e/kg product			
EU Member States				
Austria	0.8	0.6	14.4	13.3
Belgium	0.8	0.6	16.3	15.5
Bulgaria	1.0	1.0	27.2	45.7
Croatia	1.1	0.9	15.4	16.0
Cyprus	0.3	0.3	10.8	11.9
Czechia	0.5	0.4	28.8	29.1
Denmark	0.5	0.5	16.6	16.7
Estonia	0.7	0.5	23.4	38.6
Finland	0.6	0.5	16.8	14.6
France	0.8	0.6	22.8	22.0
Germany	0.7	0.6	15.7	14.8
Greece	1.4	0.6	12.4	29.3
Hungary	0.7	0.4	30.9	53.3
Ireland	0.9	0.8	21.7	17.5
Italy	0.9	0.7	8.8	13.8
Latvia	0.9	0.6	25.3	35.9
Lithuania	1.0	0.7	20.3	20.0
Luxembourg	0.7	0.6	35.9	28.9
Malta	0.8	0.8	14.5	16.7
Netherlands	0.6	0.5	13.6	10.7
Poland	0.8	0.5	17.6	16.3
Portugal	0.6	0.6	29.8	34.4
Romania	1.3	1.1	15.3	19.4
Slovakia	0.6	0.5	43.6	64.5
Slovenia	0.8	0.7	22.0	23.2

Spain	0.6	0.5	19.4	19.3
Sweden	0.6	0.5	18.9	16.7
Major exporters				
Argentina	0.5	0.4	35.6	33.3
Brazil	1.8	1.1	40.9	40.0
Australia	0.7	0.6	27.9	22.0
New Zealand	1.1	0.9	19.0	17.4
UK	0.6	0.6	19.9	18.2
USA	0.6	0.5	14.2	13.5
Emerging regions				
Africa	3.5	3.2	57.1	65.9
Asia	1.4	1.1	32.4	29.0
Central America	1.0	0.9	36.7	33.9
South America	1.5	1.0	42.3	41.4

Source: FAOSTAT, Emissions domain.

Within the EU, the emission intensity for milk production in 2020 in the FAOSTAT dataset varied from 0.3 – 1.1 kg CO_2e/kg milk though most EU countries are in the range 0.5 – 0.7 kg CO_2e/kg milk. Ireland's emission intensity is 0.8, only exceeded by Croatia, Bulgaria and Romania, in that order. However, all EU countries and major exporters have a lower emission intensity compared to the four emerging regions identified, with Africa's emission intensity being particularly high (four times higher than Ireland in the FAOSTAT dataset).

In terms of the emission intensity of beef production, Ireland is in the middle of the EU ranking. The emission intensity varies from 10.7 kg CO_2e/kg beef in the Netherlands to 64.5 kg CO_2e/kg beef in Slovakia, with Ireland's figure estimated as 17.5 kg CO_2e/kg beef. Comparing with the major exporters, the Irish figure is somewhat higher than the US figure (13.5 kg CO_2e/kg beef) and equivalent to the emission intensity of New Zealand and the UK. The emission intensity of other exporters (Australia, Argentina and particularly Brazil) is significantly higher.

To reiterate, these figures do not represent life cycle assessments. They do not include emissions from fertiliser use on grassland or emissions from cropland used for livestock feed, nor do they take account of net emissions from land use or land use change. They are particularly useful in identifying trends over time in the specific emission sources covered by the dataset, but they should not be used to rank countries by the emission intensity of their production.

5.2.2 Joint Research Centre (2010) and Lesschen et al. (2011)

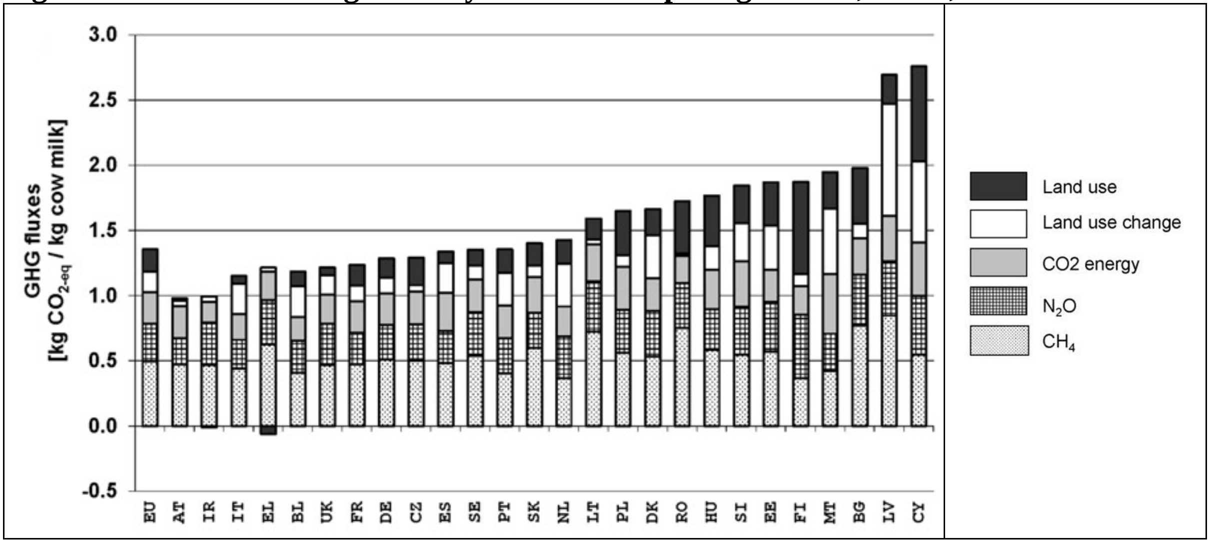
In 2010 the EU Joint Research Centre undertook a study (called the GGELS study referring to Greenhouse Gas Emissions Livestock) to provide an estimate of the net emissions of GHGs from the livestock sector in the EU-27 (Leip et al. 2010). This was subsequently published as a peer-reviewed paper (Weiss and Leip 2012). Following the publication of the FAO's *Livestock's Long Shadow* report in 2006 (Steinfeld et al. 2006), the JRC study followed a food chain approach and thus included a much broader set of emissions than does FAOSTAT. It covered all on-farm emissions related to livestock rearing and the production of feed, as well as emissions caused by providing input of mineral fertilisers, pesticides, energy, and land for the production of feed – also referred to as cradle-to-farmgate analysis. Emissions were calculated for all biogenic greenhouse gases carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

Specifically, the emission sources considered included (i) on-farm livestock rearing including enteric fermentation, manure deposition by grazing animals, manure management and application of manure to agricultural land; (ii) fodder and feed production including application of mineral fertiliser, the cultivation of organic soils, crop residues and related upstream industrial processes (fertiliser production); (iii) on-farm energy consumption related to livestock and feed production and energy consumption for the transport and processing of feed; (iv) land use changes induced by the production of feed (excluding grassland and grazing); and (v) emissions (or removals) from land use through changes in carbon sequestration rates related to feed production (including grassland and grazing).

Allocation of emissions between multiple products throughout the supply chain was done on the basis of the nitrogen content of the products with the exception of the allocation of CH_4 emissions from enteric fermentation and manure management of dairy cattle, which was allocated to milk and beef on the basis of the energy requirement for lactation and pregnancy, respectively. The functional unit of milk is given at a fat content of 4% for cow milk and the carcase of the animal for beef. Unlike FAOSTAT which calculates emissions as the product of activity x a Tier 1 emissions factor, the JRC study uses a more flexible approach. For some emissions (e.g. methane from cattle) it uses a Tier 2 approach (where emission factors are derived from the gross energy intake of animals rather than applying a default factor to the whole population as with Tier 1). For other emissions (e.g. nitrogen) it used estimates derived from a purpose-built model developed in a separate research project. Land use emissions/removals from carbon sequestration were calculated as the difference from the emissions on three types of managed agricultural land (managed permanent grassland, temporary grassland (arable land sown with grass or legumes), and other arable land) and natural grassland. For land use change, a Tier 1 methodology was used.

The variability of cow milk emissions among EU member states in 2004 is presented in Figure 5. The total GHG emissions per kg of milk ranged from 1 kg CO_2e per kg of milk in Austria and Ireland to 2.7 kg in Cyprus. Most older member states were in between the range of 1kg and 1.4 kg, while new member states showed generally values above 1.5 kg. Ireland and Austria both have grass-based production systems, and this is reflected in the absence of any penalty due to land use and land use change, which even shows a slight removal for Ireland.

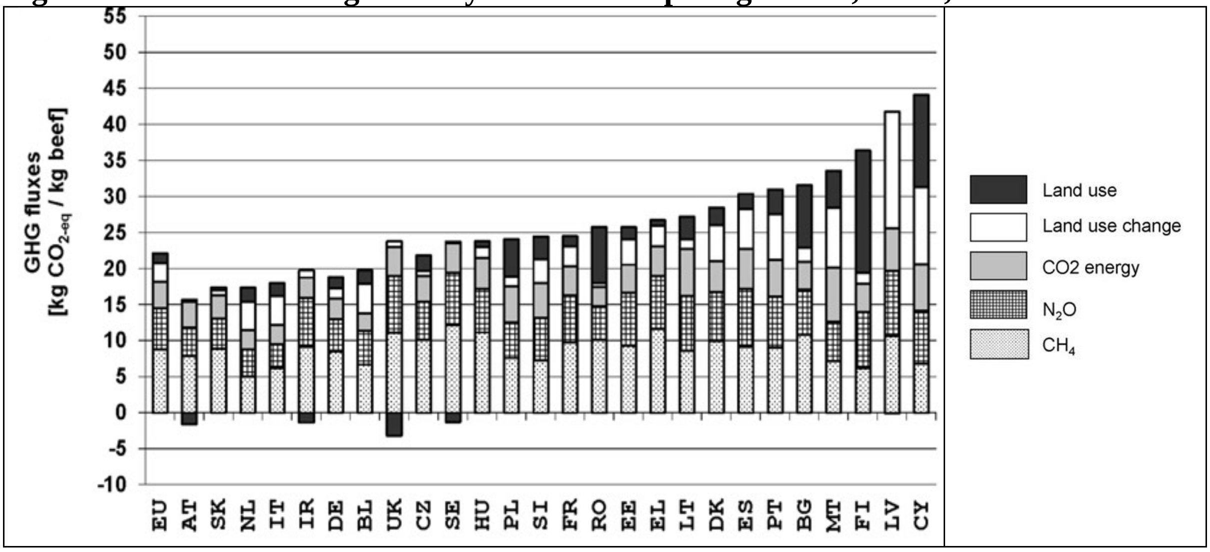
Figure 5. Cradle-to-farmgate lifecycle emissions per kg of milk, EU27, 2004



Source: Weiss and Leip (2012).

For completeness, Figure 6 shows the differences in emission intensities for beef between EU member states in 2004. The total GHG emissions per kg of beef ranged from 14.2 kg CO_2e per kg of beef in Austria to 44.1 kg in Cyprus. Ireland also ranks well in this figure, with the fifth lowest emission intensity among the countries shown.

Figure 6. Cradle-to-farmgate lifecycle emissions per kg of beef, EU27, 2004

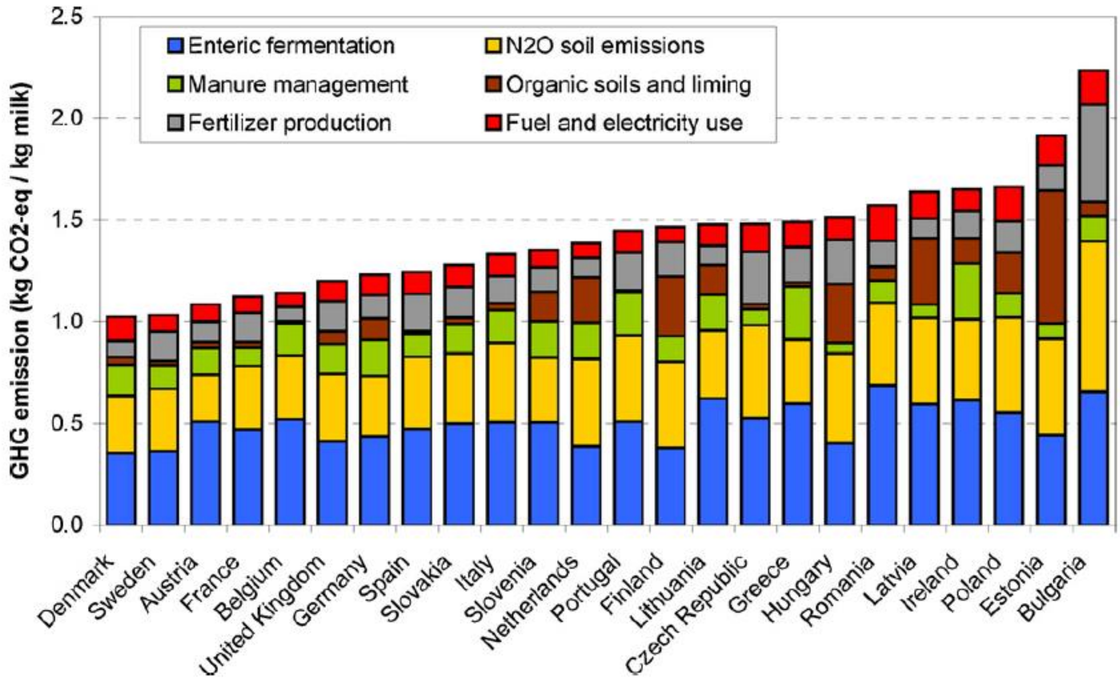


Source: Weiss and Leip (2012).

This GGELS project was a pioneering study as it calculated, for the first time, detailed product-based emissions of the main livestock products according to a cradle-to-gate life-cycle assessment on a comparable basis across EU member states. The study noted that good data for several emissions sources were lacking, notably for land use and land use change emissions, and that there was high uncertainty around emission factors and farm production methods such as the share of manure management systems. The main caveat in relying on this study is that it is based on 2004 data. Since then, there has been significant change in the structure of dairy holdings across the EU, productivity has advanced in all countries, the policy environment has changed with the removal of dairy quotas, and the GHG module in CAPRI used to derive the estimates has itself been updated. Thus, the relevance of this study for comparing milk (and beef) emission intensities today may be limited. Also (apart from an estimate for Brazilian beef derived from literature), the study does not include comparisons with non-EU countries, such as New Zealand and the US.

It should also be highlighted that a group of Wageningen University researchers used the same CAPRI model and nitrogen model to calculate milk and beef emissions per kg of product for the same year (actually the average of 2003-2005) yet came to very different results (Lesschen et al. 2011). One difference with the JRC study was they excluded land use change on the grounds that its quantification is difficult and hard to allocate to individual products. They also used a different mechanism to allocate emissions between milk and beef in the dairy sector and made different assumptions regarding emission factors for specific production processes. Their results for milk are shown in Figure 7. What is most striking is that the emission intensities and subsequent ranking these researchers found are so different to the JRC study. Ireland is shown among the countries with the highest emission intensity for milk production. It is not my purpose here to argue that one study is 'better' or more accurate than the other, but to emphasise the importance of the many assumptions that must be made in life cycle assessments and the large uncertainty associated with the subsequent estimates.

Figure 7. Cradle-to-farmgate lifecycle emissions per kg of milk, EU27, 2003-05



Source: Lesschen et al. (2011).

5.2.3 The Mazzetto et al. (2022) review

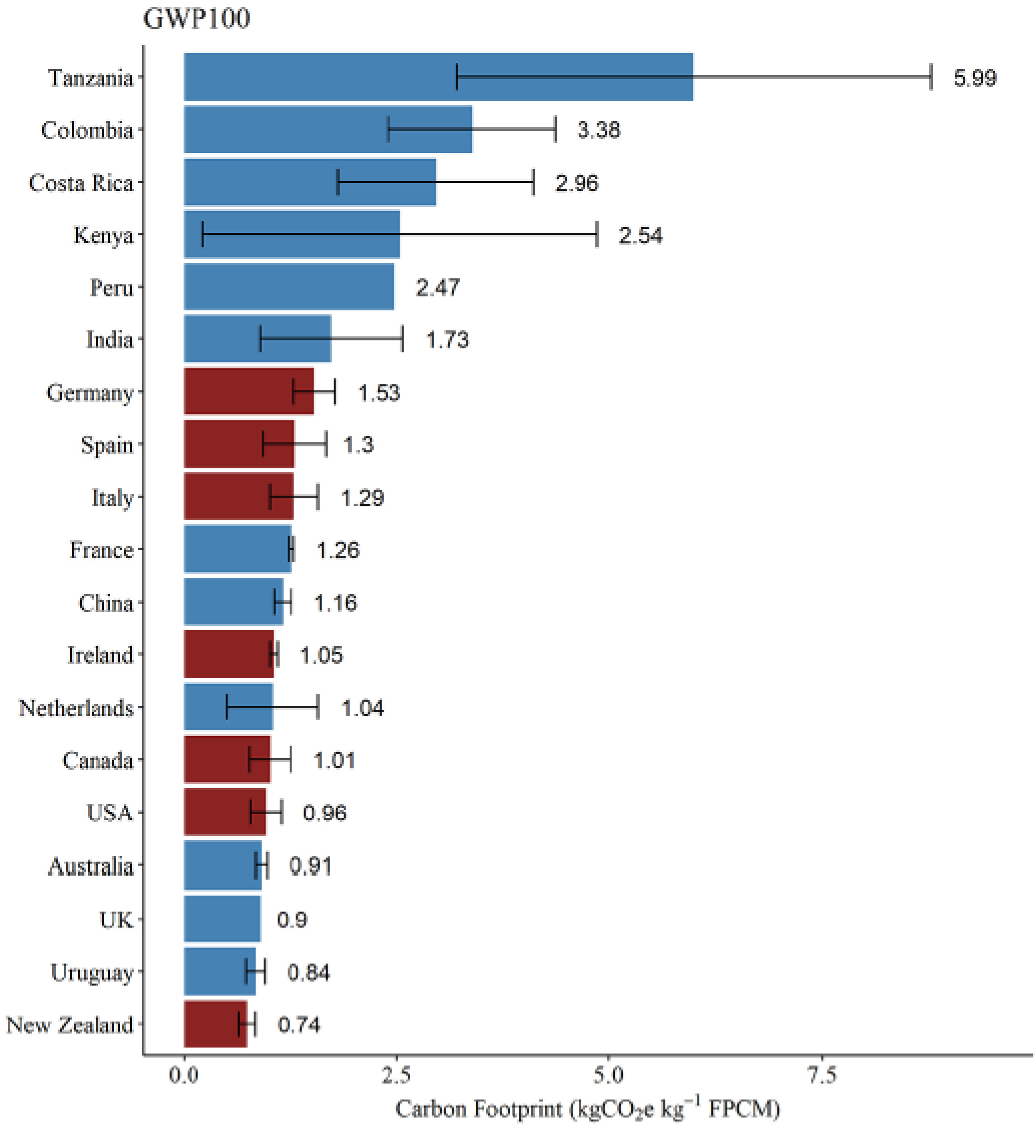
Mazzetto et al. (2022) conducted a structured review focusing on the carbon footprint of cow's milk from different countries. Their review covered 19 countries for which they could find papers that reported sufficient data to allow international comparisons to be made based on 'cradle to farmgate' LCA calculations. While more recent than the JRC and Lesschen et al. studies and focused on global rather than just EU comparisons, the paper illustrates further difficulties in making international comparisons.

First, the papers they review may have used different methodologies to calculate their emission intensity figures. To ensure comparability of the results, the authors recalculated the results in individual papers to a common methodology (for example, converting the GWP100 values used to those in the IPCC 4th Assessment Report, applying the biological allocation method between milk and liveweight sold for meat, and correcting for FPCM as the functional unit). One issue that could not be properly addressed, due to the absence of specific information in the published papers, was the use of a common Tier methodology across the papers. Some used IPCC Tier 1 default emission factors, while other countries used country/national specific Tier 2 emission factors. As noted previously, the use of different Tier emission intensity factors is likely to influence the ranking of the different studies.

A second issue is that many of the cited studies use relatively small samples of farms that are not necessarily representative of national production. For example, the research may have been carried out with animals from research farms, or in a particular region. The Irish paper used in the structured review uses data from the dairy farms in the National Farm Survey and thus may be considered representative (but note that the data are from 2012 so not necessarily reflecting current conditions). The data for Australia are drawn from 41 farms, for Italy from 75 farms, and for China from 189 farms (Table 1 in Mazzetto et al., 2022). Even if the methods used to measure emissions are fully comparable, the value of comparisons across samples of farms that are not necessarily nationally representative and where the data is collected at different points in time is questionable.

Keeping these caveats in mind, the results of their comparative review are shown in Figure 8. New Zealand appears as the most carbon-efficient dairy producer among the countries reviewed, followed by Uruguay, UK and Australia. Irish milk production is shown to have a relatively low carbon footprint, on a par with the Netherlands and lower than for other EU countries such as France, Italy, Spain or Germany. As with the FAOSTAT data, milk production in emerging economies (here represented by Tanzania, Columbia, Costa Rica, Kenya, Peru and India) had a much larger carbon footprint than for the developed economies. However, China's milk emissions footprint is only slightly higher than Ireland.

Figure 8. Carbon footprint of milk production in different countries according to Mazzetto et al. (2022)



Notes: Carbon footprint of milk [kg of CO_2 equivalents (CO_2e) per kg of fat- and protein-corrected milk (FPCM)] in different countries [after correction to common global warming potential (GWP), functional unit, and allocation methodology]. Red bars represent studies that used the International Dairy Federation (biophysical) allocation of emissions between milk and meat. Blue bars represent studies that used a different type of allocation than recommended by the International Dairy Federation. Error bars denote the standard deviation, calculated as a weighted standard deviation when more than one study was selected per country or extracted from the study when only one study was considered.
Source: Mazzetto et al. (2022)

5.2.4 The World Resources Institute study

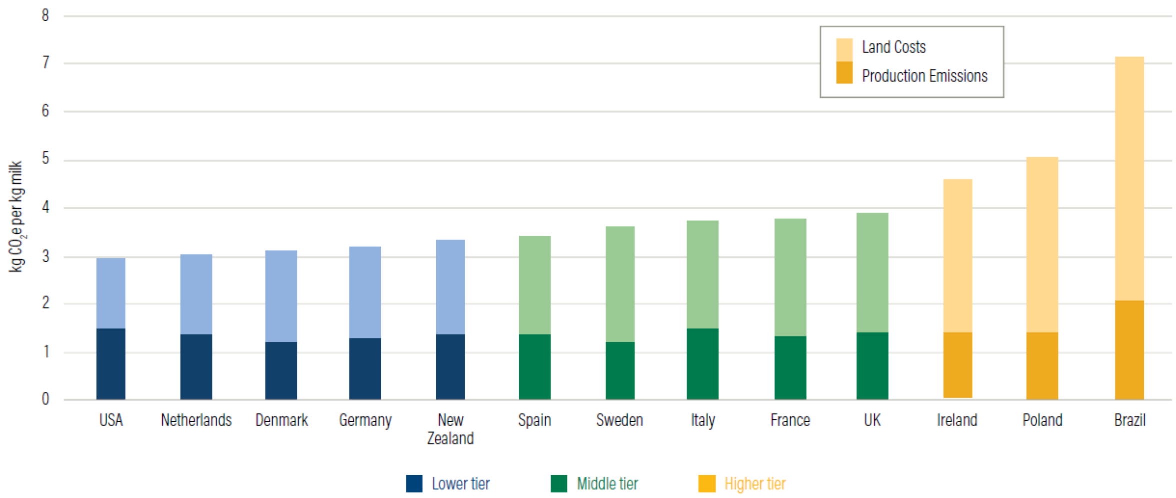
Wirsenius et al. (2020) also provide a comparative review of the life cycle greenhouse gas emissions of average dairy production from 13 countries. Their study is also a ‘cradle to farmgate’ LCA including emissions upstream of the farm arising from the production of inputs as well as animal feed regardless of its origin. Their sample of countries includes mainly EU countries but also Brazil, New Zealand and the United States.

Unlike the Mazzetto et al. (2022) review, they use their own common methodology to calculate the emissions in each country based on their ClimAg model and more up to date estimates of emissions factors. They note that the feed used on dairy farms with confined feeding systems is most often produced off the farm rather on the farm itself. They therefore use a global/regional mixed average of emissions from producing concentrate feed which puts the focus on the emissions attributable to the livestock operation. All European countries are assigned one regional average meaning that emissions per kg of animal feed (apart from forage) including land use are assumed the same for every country in Europe. Regarding national representivity, the authors note that very different production systems can coexist within a country (in the United States, for example, dairy production in California is entirely confined but other states such as New York and Wisconsin can use significant grazing). They use the average of key parameters and put them together to create the average dairy farm. However, for Ireland they note that their calculations are based primarily on small-scale farms as they claimed they could not find data showing the percentage of larger farms that could be incorporated into the overall balance.

The most significant innovation in their study is that their estimates incorporate a carbon opportunity cost (COC) for land used for grazing livestock or to produce feed produced by livestock. This method assumes that most land devoted to food production has an opportunity cost in the form of less carbon storage in vegetation and soils compared to forests and other native vegetation.[27] For feed, the COC is the same for all European countries, as noted previously, but national averages are used for grazing and fodder crops. Factoring in these COC estimates increases the carbon footprint of dairy production significantly (Figure 9). Land use carbon costs, with some exceptions, tend to range roughly from one and a half to two times the production emissions for dairy. Indeed, production emissions are broadly similar across countries, and the differences in ranking are largely due to the different estimates of COC in each country. The assumed carbon opportunity cost of using land for dairying in Ireland is particularly high, and results in Ireland being placed in the tier of countries with the highest emission intensity.

[27] See Ritchie, H., 'What are the carbon opportunity costs of our food?', Our World in Data, accessed 21 October 2023, for an accessible explanation of the carbon opportunity cost concept, https://ourworldindata.org/carbon-opportunity-costs-food.

Figure 9. Dairy production and land use emissions by country by tier due to Wirsenius et al. (2020)



Note: The data are presented in coloured tiers to reflect the fact that because of data uncertainties in the calculations, countries within each tier should be considered equal (with the possible exception of Brazil)
Source: Wirsenius et al., 2020

The concept of COC assumes that, if dairy production ceased, the land used to support that production (including indirect land use for feed) would revert to native ecosystems (Hayek et al. 2021). Or, alternatively, that if dairy production increases, the land frontier must expand and native ecosystems are lost. Production and COC emissions footprints are presented separately in Table 30, ranked by the level of production emission intensity. In general, the differences in production emission intensities between EU member states are small, and intensities are somewhat lower than direct production emission intensities in the US and Brazil.

Production emission intensities include the production emissions of feed use but make no allowance for emissions from indirect land use change. Instead, the WRI replaces this by its estimate of the COC of grazing land. There is greater variation in the carbon opportunity costs between countries, as these reflect the assumed alternative ecosystems if grazing were to cease. On this metric, Ireland is estimated to have one of the highest carbon opportunity costs which raises the total emission intensity of Irish dairy production to well above the other major dairy exporters New Zealand and the United States. This arises because, in the vegetation model used by the authors to estimate the carbon that would be stored in above-ground biomass in the absence of human management, small changes in climate can cause the models to project different types of dominant vegetation, which lead to quite different carbon stocks. It seems Ireland's wet climate leads to estimates of COC that are much higher than for other European countries.[28]

[28] The WRI model assumes that carbon stocks (tonnes C/ha) in the above-ground component of potential native vegetation derived from the LPJmL vegetation model would be 160 tonnes more than current grassland use, whereas the figure is 125 (average) in the UK, 115 in Denmark and 88 in Spain. In fact, the vegetation model shows even higher values for Ireland but the authors use a 'smoothing' technique for northern European countries where they derive the national COC value as the average of the value for the national carbon stock and the value for the average of northern European countries as a whole. If the Irish value for the potential carbon stock in native vegetation was used alone, the COC value for Ireland would be 22% higher (Wirsenius et al, 2020 and pers. comm. with S. Wirsenius).

Table 30. Greenhouse gas emission intensities for dairy by country (Wirsenius et al, 2020), kg CO_2e/kg milk

Country	Production emission intensity	Land cost (COC) intensity	Total emission intensity
Sweden	1.21	2.39	3.61
Denmark	1.22	1.89	3.11
Germany	1.30	1.88	3.17
France	1.34	2.43	3.77
Netherlands	1.37	1.65	3.02
Spain	1.37	2.06	3.44
New Zealand	1.40	1.95	3.35
UK	1.40	2.48	3.88
Ireland	1.44	3.14	4.58
Poland	1.44	3.64	5.08
USA	1.49	1.47	2.96
Italy	1.50	2.22	3.72
Brazil	2.08	5.05	7.13

Source: Wirsenius et al., 2020.

The concept of "carbon opportunity cost" is a relatively new idea in the field of life cycle analysis of agricultural systems. Its value is that it forces researchers to reflect not just on the emissions they observe from the use of land today but also to take account of emissions or sequestration that might occur if the land were left unused. The difficulty in applying the concept is that we do not have good empirical measurements of what emissions from non-use of land might be in different parts of the world. It thus introduces a further element of subjectivity into the analysis of lifecycle emissions depending on the assumed alternative land use cover in the non-use state. It might also be argued that for many practical applications we are interested in comparisons of emissions between alternative enterprises on agricultural land where emissions or sequestration from non-use is not relevant. The Wirsenius et al. (2020) study is to my knowledge the only one that has so far used the COC concept in livestock product emission intensity comparisons.

5.2.5 Comparisons with Irish LCA studies of dairy emissions

The literature just cited reveals a wide range of estimates for the emissions footprint of Irish dairy products. They range from 0.8 kg CO_2e/kg milk in the (very limited coverage of emission sources) FAOSTAT database, 1.0 kg CO_2e/kg milk in the JRC study, about 1.3 kg CO_2e/kg milk in the Lesschen et al. (2011) study, 1.05 CO_2e/kg milk in the Mazzetto et al. (2022) paper, and 1.44 CO_2e/kg milk for production emissions alone in the WRI study. These figures are not comparable as they refer to different system boundaries and use different methodologies. In this section, we compare these figures to estimates from stand-alone Irish studies.

Teagasc in Ireland has pioneered the development of sustainability indicators on a national scale through the National Farm Survey. These are published regularly in its National Farm Survey Sustainability Reports (see Buckley and Donnellan (2023) for the most recent report). For milk production, emission intensities are calculated both using the IPCC activities approach and also using a lifecycle approach based on the Teagasc Dairy LCA model (O'Brien et al. 2014). Emission intensities using the IPCC approach are expressed either per kg milk or corrected for milk solids (per kg Fat and Protein Corrected Milk (FPCM) which is standardised to 4% fat and 3.3% true protein per kg milk). The IPCC approach does not include emissions from the production of cereals and concentrate animal feeds fed to livestock, emissions from energy use (though these are reported separately), nor emissions from the upstream production of inputs such as fertiliser, whereas these emission sources are included in the LCA figures.

Emission intensities derived from the Teagasc Sustainability Report are reproduced in Table 31. They are representative of the national herd and show a steadily improving emission efficiency. The 2022 LCA figure for emissions intensity of milk is 1.06 kg CO_2e/kg FPCM. The emissions intensity of beef production has also fallen, with a noticeable decline in 2022 when high fertiliser prices curtailed use.

Table 31. GHG emission intensity of Irish milk and beef production using different indicators

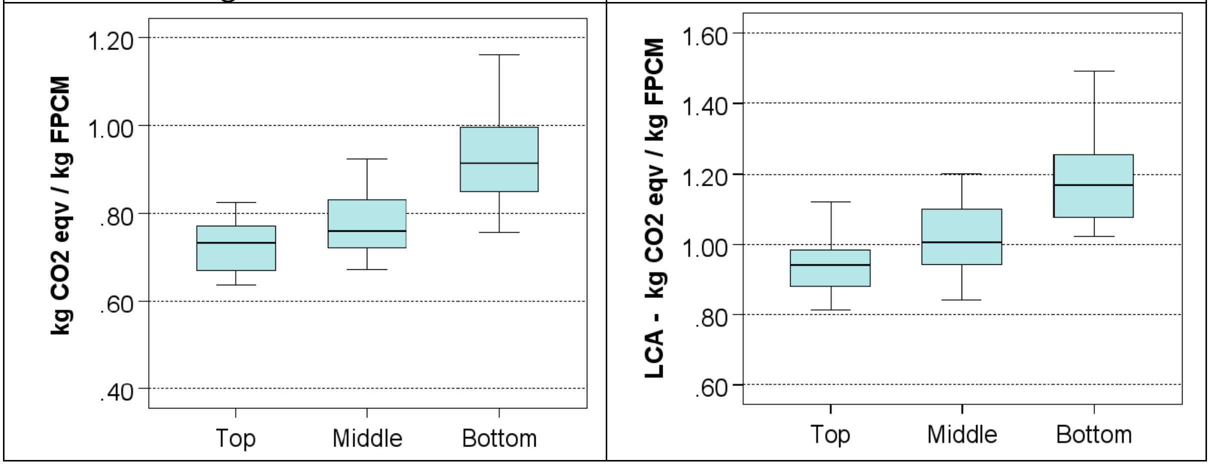
	2017	2018	2019	2020	2021	2022
Dairy						
Agricultural GHG emissions per kg milk	0.89	0.90	0.88	0.87	0.85	0.84
Agricultural GHG emissions per kg FPCM	0.95	0.91	0.88	0.85	0.84	0.82
Agricultural GHG emissions per € output	2.9	3.1	2.8	2.9	2.5	1.7
GHG emissions per kg FPCM (LCA)	1.12	1.12	1.07	1.07	1.05	1.06
Beef						
Agricultural GHG emissions per liveweight beef	12.1	12.7	11.8	11.8	12.1	9.4
Agricultural GHG emissions per € output	6.5	5.9	5.4	5.1	4.5	3.6

Note: Agricultural emissions Global warming potentials (GWP) for CH_4 and N_2O which are respectively 28 and 265 times greater than the GWP of CO_2 from the IPCC 5th Assessment Report are used to aggregate gases to CO_2e. This gives an increase in estimated emissions produced by Irish farm systems compared to previous calculations.
Source: Buckley and Donnellan (2023).

One of the key insights from the Teagasc Sustainability Reports is that there is a wide variation in emission footprints within the Irish dairy herd. In general, lower footprints were found among the group of top economically-performing dairy farms. This will be true in any national sample and has relevance when estimating potential leakage from substituting production abroad for Irish production at home. For example, if climate policy raised the costs of producing milk in Ireland, it is likely that cows in the poorest economically-performing herds would with high emission footprints would be the first to leave the industry. Similarly, in competitor countries that might increase production to replace Irish production, the additional milk is likely to come from high economically-performing herds with a lower emission footprint compared to their national average. Using national averages to estimate the leakage effect of substituting production in one country with production in another will significantly overestimate the size of leakage that might occur.

Figure 10. Emissions from Irish dairy farms distinguishing farms by economic performance, 2022

IPCC agricultural emissions	LCA Greenhouse Gases



Source: Buckley and Donnelly, 2023.

O'Brien et al. (2014) compared the carbon footprints of high-performance confinement and grass-based dairy farms in Ireland, the UK and the US using data from research herds in Ireland and the UK. They showed that when GHG emissions were only attributed to milk, the carbon footprint of milk from the Irish grass-based system (0.837 kg CO_2e/kg energy-corrected milk, ECM) was 5% lower than the UK confinement system (0.884 kg of CO_2e/kg ECM) and 7% lower than the US confinement system (0.898 kg of CO_2e/kg ECM). However, without grassland carbon sequestration, the grass-based and confinement dairy systems had similar carbon footprints per kg ECM. Further, they noted that the carbon footprints estimated for these top performing herds were 27 to 32% lower than average dairy systems in the respective countries, confirming the point just made that a clear association exists between economic performance and emission footprints within these conventional dairy systems.

Herron, O'Brien, and Shalloo (2022) estimated an LCA emission footprint for the Irish national herd to establish as baseline as part of a larger project to investigate the impact of reaching higher performance targets. Of interest for this study is the impact on the emission footprint figure of their work in updating the Teagasc Dairy LCA model. In this update they took account of the latest science (e.g., using emission factors taken from the updated 2019 IPCC guidelines compared to the previous 2006 guidelines), changes in technology (e.g., in the production of fertiliser where significant improvements in both energy and GHG emission intensities have been achieved), and other changes in parameters.

Their main finding following this updating of the LCA model was that it led to a reduction in the estimated emission footprint of milk production in Ireland from 1.08 kg CO_2e/kg FPCM to 0.97 kg CO_2e/kg FPCM based on 2017-2019 data. Furthermore, the paper notes that ongoing Irish research finds that using even the updated IPPC enteric methane emission factor may overestimate methane emissions in Irish circumstances given a pronounced seasonal effect. It is intended to develop a Tier 3 methodology for CH_4 emissions from dairy cattle using this novel research which would further reduce the emission footprint for milk from 0.97 kg to 0.91 kg CO_2e/kg FPCM. The paper emphasises that these changes in emission footprint estimates are the result of improvements in understanding and not improvements in the production systems. Improvements in understanding do not help to meet GHG reduction targets, as any changes are applied throughout the data series. However, they are relevant in determining the emissions efficiency of Irish milk production relative to other countries. These changes in our scientific understanding of emissions are another reason for not over-emphasising relatively small differences in emission intensities across countries given the uncertainties involved.

5.2.6 Summarising Ireland's dairy emission footprint relative to other producers

We have summarised published datasets and studies that have ranked countries by their emission intensity of milk production.[29] At first sight, it seems difficult to draw strong generalisations from the often conflicting results. It is also the case that some studies rely either on small and not necessarily representative samples, omit important emission sources, or do their calculations with less accurate input data.

Nonetheless, the following conclusions seem warranted. Ireland is a highly competitive dairy producer when measured by emission intensity. Emissions per kg of milk produced are relatively low in a global context. Whether Ireland is *the* most carbon efficient milk producer globally remains an open question. The major dairy exporters in Europe, together with New Zealand and the United States, are all relatively carbon efficient milk producers, and their relative ranking seems to depend as much on methodological choices in the calculation methods as on real differences. The differences between countries at the top of the leader board are certainly much less than the differences between dairy farms within each of these countries. We conclude that there is little difference in emission intensities among EU countries and major exporters. However, there is a clear difference between this milk and the milk produced in emerging economies which, particularly in Africa, has a much higher carbon footprint.

5.3 Implications of differing carbon footprints of dairy products for global emissions if Irish dairy exports are limited

If Irish dairy exports were not available, where would alternative supplies come from? Would the GHG footprint of alternative supplies be higher and thus risk increasing global emissions? To answer this question, information on the sources of alternative supplies must be combined with the information on carbon footprints discussed in the previous section. It is also important to clearly define the scenario considered and the counterfactual situation.

5.3.1 The emission intensity of alternative sources of supply

The impact on global emissions of limiting Irish dairy exports will result from the combination of three effects:

- **Substitution effect.** The direct effect will be that Irish dairy exports to emerging markets will be substituted by increased export volumes from existing suppliers to these markets. Existing suppliers will benefit because they already have the established market contacts and have demonstrated that they can meet the food safety and technical

[29] There are also proprietary databases such as the AgriFootprint 6.0 database https://blonksustainability.nl/news/update-of-agri-footprint) which shows Ireland again at the low end of the range comparable with Belgium, Denmark, Netherlands and New Zealand but with 'America' much higher according to this press release from the Flanders Research Institute for Agriculture, Fisheries and Food https://ilvo.vlaanderen.be/en/news/most-climate-friendly-milk-comes-from-flanders. FAO has also worked on measuring emission intensities in livestock production in its Global Livestock Environmental Assessment Model (GLEAM) which is now in Version 3 https://www.fao.org/gleam/en/. This data would in principle allow national comparisons and this was possible in GLEAM Version 2, but this is no longer possible at the country level in Version 3.

standards required to gain access to those markets. From the analysis in the previous chapter, the main competitors for Irish dairy exports in emerging markets are other EU countries, New Zealand and the United States. The previous discussion on emission intensities has shown that the emission intensities of milk production across these exporters are broadly comparable to the emission intensity of milk production in Ireland, keeping in mind the uncertainties that arise in making international comparisons. The carbon footprint of Irish dairy products is not significantly superior to these other exporters such as to fear an increase in global emissions if their production and exports substitute for Irish products. This is even more the case if we take account of the fact that additional exports from competitors will come from high-performing farms (with a lower-than-average emission footprint) while the reduction in production in Ireland would come from the economically-lower performing farms (with a higher-than-average emission intensity).

- **Production effect.** In the absence of any change in consumer preferences in emerging markets, this reshuffling of import suppliers will induce a small increase in world market prices. While this will support an increased level of domestic production in the main exporters, it can also result in increased production even in countries that have no relationship to the import market. The previous discussion on emission intensities has shown that the carbon footprint of milk production in these countries, many in Asia and Africa, is much higher than in Ireland. Thus, the impact on emissions of this increase in global production will depend on where the increase in production takes place. This, in turn, will depend on the relative supply responsiveness of milk production in different regions of the world to changes in the world market price. Recall that India and Pakistan between them are expected to account for 30% of global milk production in 2031 (OECD/FAO 2022). Key here is the extent to which price changes on world markets are transmitted to domestic market prices in countries that are not well integrated into the world market. Much of the production response will occur in low carbon footprint production locations, both because of higher supply responses to price in these locations and because of the more limited transmission of higher world market prices to domestic markets in many emerging economies. However, even if we assume that supply responsiveness in low emission intensity countries (i.e., countries with a similar emission intensity of milk production to Ireland) will be higher than in high emission intensity producers, there will still be some incentive effect leading to increased production in these countries. We can thus expect a small increase in global emissions from this production effect.

- **Demand effect.** The third effect is that the increase in world market prices if it feeds through to domestic prices in all countries will reduce consumer demand and thus the volume of dairy products demanded, particularly in import markets where domestic prices are already closely linked to world market prices. Globally, this ‘saving’ in emissions due to reduced consumer demand can be offset against the small increase in global emissions arising from the production effect. The overall impact will depend on the relative size of the responsiveness of demand and supply (in technical terms, the relative size of demand and supply elasticities taking account of the ease of price transmission between world and domestic markets) in the different markets and producing regions. Without quantitative modelling, it is not possible to say which effect will be greater. The net effect on global emissions is not likely to be large in either direction.

5.3.2 Additional considerations on emissions leakage

This conclusion that any carbon leakage effect from limits on Irish milk production due to climate action is unlikely to raise the level of global emissions (i.e., implying a leakage rate over 100%) may still be seen as a disappointing outcome. After all, the goal of climate policy is to reduce Irish *and* global emissions. But there are several reasons why the analysis so far results in an overly pessimistic conclusion on the likely extent of emissions leakage.

In the analysis so far, we have assumed that the only way to reduce emissions from dairy production in Ireland is by reducing production. This would be the case if, for example, a herd reduction scheme were implemented. In practice, farmers have a range of technological options as well as management practices available that can help to reduce emissions while also maintaining production. Research and investment to enlarge the range of these possibilities is obviously essential and is taking place. Climate policy should focus on the need to reduce emissions rather than targeting production per se. To the extent that farmers make use of technical and management abatement options, the leakage rate from climate policy in Ireland will be reduced.

Climate policy can also bring important co-benefits for other environmental objectives, such as maintaining and restoring biodiversity, reducing water pollution, or reducing ammonia emissions to air (see discussion in Chapter 6 for Ireland's performance on these indicators). It does not make sense to maintain or increase production where this implies damage to Ireland's environment or the health of the Irish population. The social costs of that production are greater than its social benefits, and to achieve the optimal level of production from society's point of view production should be reduced (Matthews, 2022). If a more stringent climate policy is introduced that, as well as reducing emissions, results in a reduction in production towards that optimal level, one can question whether any offsetting emission increases outside Ireland are relevant when evaluating the merits of the policy.

Furthermore, the discussion so far has assumed the absence of climate policies in other countries. That is, other countries are assumed not to adopt climate targets or measures to reduce emissions. It has been assumed that there are no constraints in other countries on increasing production to meet the market gap left by reduced Irish supplies. But the rationale for Irish action is in part that it is part of a global collective action where individual national initiatives are self-reinforcing. No one country on its own can mitigate the threat of climate change but conversely no country can opt out of climate action on the basis that its actions only make a marginal contribution to addressing the threat.

Climate action in Ireland is partly synchronised with climate action in the EU through the EU's Climate Law and the national emission reduction targets set in the Effort Sharing Regulation (ESR), and with non-EU countries through the commitments in Nationally Determined Contributions mandated under the Paris Agreement rulebook. Some might argue that whether Ireland takes action or not to limit emissions from dairying will have no influence on the behaviour of other countries and thus it is not relevant to take account of their climate actions. The counterargument is that these institutional mechanisms have been put in place precisely to address this free-rider problem and it is thus appropriate to include these institutional mechanisms when estimating the likely extent of carbon leakage.

To be sure, the implications of these commitments for reductions in agricultural emissions specifically are unclear as these commitments are not necessarily binding. In the case of the

EU, where reduction commitments are legally binding, they do not refer to agriculture alone. In many countries, agricultural emissions are a smaller share of emissions covered by the ESR than in Ireland. There is thus a smaller imperative to reduce these emissions if reductions can be achieved more easily in the other ESR sectors. Despite this, an increasing number of EU Member States are setting unilateral targets for reductions in agricultural emissions. The stringency of these emission reduction targets can be expected to increase over time. These emission reduction targets will limit the extent to which EU countries can expand production to substitute for Irish dairy supplies, and thus reduce the extent of carbon leakage from climate action in Ireland alone.

Commitments under the Paris Agreement are much looser than those facing EU countries because of the non-binding nature of these commitments, they are essentially best-endeavour declarations. One-quarter of the Nationally Determined Contributions submitted to the UNFCCC make no mention of agricultural mitigation and very few have set quantitative targets (UNFCCC 2022). Almost no countries have taken a food systems approach that also covers initiatives to influence demand such as food loss and waste reduction, sustainable diets or food consumption (WWF 2020). Under the Paris Agreement, there is a process intended to encourage parties to ratchet up their level of ambition through the mechanism of a Global Stocktake every five years. The first stocktake got underway at the UN Climate Change Conference in Glasgow in November 2021 and will conclude at COP28 in 2023. Despite scepticism about the degree of implementation of commitments, the level of commitments by countries over time has been increasing, even if the UNFCCC shows they are still not sufficient to ensure that the Paris Agreement targets can be met.

Commitments by countries to limit emissions from dairy production can include measures to limit consumption (e.g., through revision of dietary guidelines, or encouraging the consumption of plant-based drinks) or to limit production. Both types of commitments would influence the leakage rate associated with limiting Irish dairy exports on global emissions. If commitments refer to limiting consumption of high-emission foods such as dairy products, then any market gap due to limits on Irish exports will be offset by reduced consumption in these markets. This would avoid any increase in world market prices, so avoiding carbon leakage due to additional production that would counterbalance the reduction in emissions in Ireland. If the commitments refer to limiting production emissions, this could also reduce any offsetting increase in emissions outside Ireland either directly by limiting the production response in third countries or indirectly by encouraging the adoption of technical and management practices that would reduce the emission intensity of production in third countries. These examples show that taking account of the responses of third countries that are complementary to Irish action to reduce dairy emissions will further reduce the impact on global emissions that might arise from the substitution of Irish exports by supplies from other exporters. Ireland and other developed countries can assist this process by ensuring that technical expertise on mitigation options gained in Ireland is shared with emerging economies where production is expected to increase. Support and funding for the UNFCCC Technology Mechanism and Financial Mechanism for this purpose should be encouraged.

A final consideration to keep in mind when considering carbon leakage follows from the concept of a global carbon budget. The remaining carbon budget (RCB) defines the net amount of CO_2 that humans can still emit without exceeding a chosen global warming limit. Although the concept has been around for some time, it really gained traction following the publication of the 5th and 6th IPCC Assessment Reports and the Special Report on *Global Warming of 1.5°*. Although conceptually clear, there are multiple definitions of the global carbon budget and fixing the size of the RCB is not an exact science, including the allowance that needs to be made for non-CO_2 emissions, the accepted chance of staying within the temperature limits, as well as whether overshoot and subsequent negative emissions are allowed or not (Peters 2023; Lamboll et al. 2023). For our purposes, it is not important to know the exact size of the RCB (although it is small for targets to keep temperature increases below 1.5° or 2°). What is important is the concept that there is a fixed limit to the emissions the world can release if we are to achieve the Paris Agreement targets.

In a second step, it is possible to allocate this RCB to countries, sectors and individuals based on some distribution or fairness principle. How this might be done is considered in the advice given by the European Scientific Advisory Board on Climate Change to the Commission on setting appropriate reduction targets for net emissions for 2035 and 2050 (ESABCC 2023). They consider different ethical and fairness principles in attempting to estimate what the EU's fair share of the RCB might be. Not surprisingly, the size of the EU's fair share varies greatly depending on the fairness principle used. Deciding which principle to use requires a political decision that is fraught with difficulty.

The Irish Climate Action and Low Carbon Development Act 2015 requires the government, in preparing its low carbon transition plan, to have regard for the principle of climate justice. The CCAC, in preparing its recommendations for carbon budgets to the government for the periods 2021-2025 and 2026-2030, considered the question what Ireland's appropriate contribution to the reduction in global emissions should be, recognising that this raised questions of climate justice, historical responsibility, equity and equality (CCAC 2021). It developed a 'Paris test' to evaluate whether its proposed carbon budgets were consistent with the temperature goals of the Paris Agreement.

Again, for our purposes we do not need to know the exact figure for Ireland's share but rather to accept the principle that Ireland can only use a finite share of the remaining global carbon budget to leave sufficient space for the legitimate claims of other countries. If carbon leakage occurs because of climate action in Ireland, this is undesirable and should be minimised where possible, but carbon leakage cannot be used to justify or rationalise that Ireland uses more of the RCB than its fair share justifies. In an efficient world, one might envisage Ireland being able to acquire a larger share of the RCB by purchasing the emission rights of other countries. Some countries might agree to import Irish dairy produce in return for payment if they were able to invest these resources in other activities that better suited their comparative advantage. But this thought experiment is far from reality today. The message to take is that Ireland's finite share of the remaining global carbon budget sets an absolute limit on Irish territorial emissions which should be observed even if carbon leakage occurs as a result.

5.4 Conclusions

If Irish dairy exports were not available, where would alternative supplies come from? Would the GHG footprint of alternative supplies be higher and thus risk increasing global emissions? In the absence of a findings from a quantitative economic and trade model, this chapter has adopted a more qualitative approach to answer this question.

Findings from the FAOSTAT emission intensity database and several studies that have estimated national dairy emission intensities were presented. International comparisons need careful interpretation because of methodological differences, differences in the way emissions from the dairy herd are allocated between milk and beef, and the scope of the emissions covered. Specific limitations of the studies reviewed were highlighted. Nonetheless, the evidence suggests that there is little difference in emission intensities among EU countries and other major exporters. However, there is a clear difference between this milk and the milk produced in emerging economies which, particularly in Africa, have a much higher carbon footprint.

These differences in emission intensities are relevant when considering how global emissions might be affected by limits on Irish dairy exports. Three impact channels are identified: the direct substitution of Irish exports in emerging country markets by exports from existing competing suppliers, additional production stimulated by higher world market prices, and lower demand equally due to higher world market prices.

As Irish exports mainly compete with other EU Member States, New Zealand or the United States with similar emission intensities, no net increase in global emissions is expected from the substitution effect. Regarding the production effect, most of the production response will occur in low carbon footprint production locations, both because of higher supply responses to price in these locations and because of the more limited transmission of higher world market prices to domestic markets in many emerging economies. Nonetheless, there will be an increase in global emissions from this production effect. The third effect is that higher world market prices will reduce the overall demand for dairy products, so that not all of the market gap left by limiting Irish dairy exports will be replaced by increased supplies in other producing countries. Globally, this ‘saving’ in emissions can be offset against the increase in global emissions from the production effect. Without quantitative modelling, it is not possible to say which effect will be greater. The net effect on global emissions will not likely be large in either direction.

This might imply that leakage rates could be close to 100% or even slightly above, but several factors suggest this would be an unduly pessimistic conclusion. It assumes that the only way to reduce emissions from dairy production in Ireland is by reducing production. Farmers also have access to technological options as well as management practices that can help to mitigate emissions while maintaining production, and their adoption will reduce the leakage rate from climate policy in Ireland. Climate policy can also have important co-benefits for other environmental objectives that can justify limits on production and make the notion of leakage a questionable one.

The leakage rate will be further reduced if the impact of complementary climate action commitments in third countries is factored in. Irish action is part of a broader international action mandated by legal commitments to reduce emissions in the EU and supported by non-binding commitments under the Paris Agreement. While there is understandable scepticism whether these commitments will be translated into real changes in behaviour, we already see countries as diverse as Brazil, the United States, Australia, New Zealand, China and Vietnam begin to tackle the mitigation of agricultural emissions. These commitments can lead to lower dairy emissions either because of action to reduce demand or, more likely, to lower emissions from production. These emission reductions arising from coordinated international action emissions will further reduce the impact on global emissions that might arise from the substitution of Irish exports by supplies from other exporters. Ireland along with other developed countries can contribute finance and technical expertise to the various UNFCCC mechanisms to bring about emissions reductions in emerging economies. Some carbon leakage arising from Irish climate policy in agriculture is unavoidable, but the worry that it might lead to an overall increase in global emissions seems not well founded.

6 Reputational risk if emissions reductions are not achieved

6.1 Marketplace and legislative pressures for sustainability reporting

Bord Bia, in its latest strategy document (Bord Bia 2022), emphasises the growing importance of sustainability criteria in the purchasing decisions of its business customers. These criteria include GHG emissions reduction targets but also extend to the management of other environmental (water, biodiversity, soil, air) pressures as well as to the social dimension of sustainability. There is growing pressure on both retailers and processors to reduce emissions not only in their own facilities (Scope 1 and 2 emissions) but along their supply chains (Scope 3 emissions).[30] This comes both from legislative initiatives – for example, the recently-adopted EU Corporate Sustainability Reporting Directive– but also from voluntary commitments being made by firms to reduce their emissions and environmental footprint more generally. There is huge effort being put into the development of international standards to measure, report and disclose these sustainability metrics (OECD 2023).

In this regard, progress in reducing emissions per unit of output will be an important metric. But there will also be a reputational cost in terms of Ireland's 'green' image if the country is seen as a laggard in reducing absolute emissions and fails to meet its EU and national targets. If a sufficient reduction in agricultural emissions is not achieved, would this put at risk business and sales to existing markets that might counterbalance any gains in export sales to emerging markets? Such a reputational cost is hard to quantify and is largely subjective, but it is an important risk factor which competitors will not be slow to highlight. The risks involved are examined in this chapter by comparing Ireland's progress with major competitors in terms of reducing emissions but also on other metrics such as water quality, ammonia emissions and biodiversity loss.

In the first half of 2021, Bord Bia conducted global research to better understand global sustainability demands around food and drink.[31] The organisation interviewed agenda setters including sustainability thought leaders from NGOs as well as purchasing and operations leaders with some of the biggest global food and drink companies; customers including those responsible for purchasing food and beverage and/or responsible for sustainability policies in relation to food and beverage; and consumers, which included a survey of more than 11,000 grocery shoppers aged 18-65 in 13 markets globally.

This Global Sustainability Survey noted how the sustainability agenda had accelerated over the previous five years and predicted increased regulation and consumer focus in the coming period. 75% of trade customers said it was important for their business. It observed different sustainability emphases among thought leaders and consumers. The agenda setters (which include large food and foodservice businesses) are focused on key environmental issues such as emissions, biodiversity, water quality and regenerative agriculture. These businesses are

[30] The different scopes of a company's emissions have been defined by the widely-used GHG corporate standard. Scope 1 emissions are direct emissions from company-owned and controlled resources and include emissions from fuel used including from company-owned transport as well as process emissions. Scope 2 are indirect emissions from all energy purchased from a utility provider, including electricity, heat and cooling. Scope 3 emissions are all indirect emissions - not included in Scope 2 - that occur in the value chain of the reporting company, including both upstream and downstream emissions. For companies in the food value chain, significant upstream emissions are those linked to primary production on farms, while significant downstream emissions include waste.

[31] Bord Bia, Global Sustainability Insights, accessed 17 May 2023.

setting science-based or net-zero targets and putting intense pressure on the food industry to reduce emissions. The research found two thirds of trade buyers globally now say ‘having the lowest possible greenhouse gas emissions/carbon footprint is important when choosing a supplier’. Consumers, on the other hand, had less focus on emissions and biodiversity and tended to view sustainability through the lens of daily living, with issues such as food waste and packaging seen as the most important. The study saw embracing sustainability as opening the door to long-term customer partnerships, but it noted that this would require demonstrable evidence of commitment, an openness to sharing data (simply have a certificate will no longer be sufficient) and being able to credibly support sustainability claims.

A key driver of these market pressures is that increasingly actors in the food chains, including processors, supermarkets, and financial institutions, are setting voluntary reduction targets and demanding sustainability information including on emissions from their suppliers. To give credibility to these pledges and to avoid criticisms of ‘greenwashing’, companies are looking to use internationally recognised standards when setting these targets and to use independent certification organisations to monitor their performance. An example is the Science Based Targets initiative (SBTi) which is a standards-based validation service provider.[32] It sets climate standards for corporates and financial institutions, and provides guidance, tools and criteria which companies then use, voluntarily, to set targets and time frames for emission reduction, including providing documentation to indicate how these were calculated and estimated. Its validation team then assesses these to determine conformance with SBTi standards and renders a judgment, ranging from Agree to Approve to Agree to Reject, which is communicated to the company. Several Irish dairy companies have either agreed to set SBTi targets or are planning to do so.

Even more important is that their customers and competitors have already started down this path. Among competitors:

- Arla Foods launched its climate target to be carbon net neutral by 2050 in 2019. It has committed to reduce its absolute Scope 1 and 2 greenhouse gas emissions by 63% by 2030 from a 2015 base year, and to reduce Scope 3 GHG emissions by 30% per tonne of standardised raw milk and whey intake by 2030 from a 2015 base year.
- FrieslandCampina aims to produce climate-neutral dairy by 2050, reducing emissions as much as possible while compensating for what it cannot reduce. It has specific 2030 targets to reduce its Scope 1 and 2 emissions by 63%, its Scope 3 absolute emissions from supplier dairy farms by 33%, and other Scope 3 emissions from sourced products such as raw materials and packaging by 43% compared to a 2015 baseline.
- The Australian red meat and livestock industry has announced an ambition to be carbon neutral by 2030 while doubling the value of red meat sales.

[32] The Science Based Targets initiative (SBTi) is a partnership between CDP (formerly the Carbon Disclosure Project), the United Nations Global Compact, World Resources Institute (WRI) and the World Wide Fund for Nature (WWF). Targets are considered ‘science-based’ if they are in line with what the latest climate science deems necessary to meet the goals of the Paris Agreement – limiting global warming to well-below 2°C above pre-industrial levels and pursuing efforts to limit warming to 1.5°C. The SBTi differentiates targets for i) scope 1 and 2 emissions and ii) scope 3 emissions. Scope 1 and 2 targets must follow a 1.5 degree C trajectory, which requires 4.2% year-on-year reductions. Near-term Scope 3 targets must, at a minimum, be aligned with the level of decarbonization required to keep global temperature increase well-below 2 degree C compared to pre-industrial temperatures. However, the long-term Scope 3 targets must align with a net-zero no later than the 2050 pathway. If a company’s relevant Scope 3 emissions are 40% or more of total Scope 1, 2, and 3 emissions, a Scope 3 target is required.

Examples of retailers and processors that purchase Irish products that have made emissions reduction commitments include:

- Tesco made a commitment in 2021 to be carbon neutral in its own operations by 2035 and net zero across its whole footprint by 2050.
- Sainsbury's (UK) has also committed to being net zero in its own operations by 2035, five years ahead of its previously announced target, and has committed to reduce its Scope 3 emissions by 30% by 2030, with a long-term commitment to be net zero by 2050 across its value chain.
- Danone as part of its Renew strategy has set the objective of a 30% absolute reduction in methane emissions from fresh milk by 2030 compared to a 2020 baseline aligning its efforts with the Global Methane Pledge, and plans to source 30% of its key ingredients that it sources directly from farms that have begun to transition to regenerative agriculture by 2025 (see also here).
- Walmart - the largest grocer in the world - has set the ambition as part of its Project Gigaton to remove 1 billion tons of CO_2e annually out of its supply chain by 2030 compared to a baseline of 2017. More than 3,000 suppliers accounting for more than 75% of US product net sales are now reporting their emissions to the company.
- Nestlé has committed to reducing its absolute value chain GHG emissions against a 2018 baseline by 50% by 2030 and to be net zero by 2050, even while planning to grow its business. It recognises that dairy and livestock ingredients are the largest single source of its emissions and plans both to reduce these emissions using technology and to offset remaining emissions through projects within its value chain. It plans to acquire 20% of its key ingredients through regenerative agricultural methods by 2025.

Other retailers are focused on increasing sales of plant-based proteins which will also drive competition with Irish dairy and beef production.

- Albert Heijn, the Netherlands' largest supermarket chain, aims to ensure 60% of consumed proteins are plant-based by 2030, and is doubling the number of alt-meat products with a price equal to or cheaper than conventional counterparts.
- By 2025, Delhaize wants to double its offering of plant-based meat and dairy substitutes, from about 400 to 800 products. It notes that the Flemish Government wants consumers to obtain 60% of their proteins from vegetable products by 2030 and intends to contribute to meeting this goal.

Financial institutions are also demanding to see sustainability action plans as part of their lending decisions, with marginally lower financial rates offered by banks to companies with ambitious plans. Pension funds and asset management funds are increasingly making investment allocation decisions in the light of sustainability principles. Advocacy groups, such as Ceres in the US, are working with the most influential capital market leaders, to encourage businesses to sign up to SBTi targets.

There is a degree of scepticism around claims for carbon neutrality by dairy and beef companies because of the reliance of these claims on carbon offsets.[33] Also the implementation of science-

[33] A Swedish court in February 2023 upheld a complaint by the country's consumer ombudsman that claims made by Arla Foods that its dairy products were carbon-neutral were misleading and banned it from using the term "net-zero climate footprint" in the marketing of its products sold in the country. See JustFood, Swedish court bans Arla's net-zero advertising claim, 6 February 2023.

based targets lags behind. Ceres assessed the performance of 50 focus companies in the food and agriculture sector in the United States chosen because of their high emissions against key indicators focused on Scope 3 emissions disclosures and emissions reduction targets. It found that most of the 50 food sector companies are lagging in key areas that are necessary to increase the ambition of their climate transition action plans. It found 70% of the 50 companies do not disclose emissions from agriculture, and more than 80% do not disclose emissions from land use change. More than 60% do not include any Scope 3 emissions in their emission reduction targets.

But this is likely to change as purely voluntary initiatives are supplemented by legislative requirements. For instance, in the United States, the Securities and Exchange Commission (SEC) proposed a rule in 2023 which would require (among other things) the disclosure of Scope 1, 2, and 3 greenhouse gas emission data. The U.S. Government has also released a proposal that would require major government suppliers and contractors to set science-based emissions reduction targets aligned with the Paris Agreement, as well as to disclose their GHG emissions and climate risks. In the EU, the Corporate Sustainability Reporting Directive entered into force on 5 January 2023. It obliges large companies to report on what they see as the risks and opportunities arising from social and environmental issues, and on the impact of their activities on people and the environment. Companies will report based on European Sustainability Reporting Standards. Draft standards were prepared by the European Financial Reporting Advisory Group (EFRAG), and the final standards were adopted by the Commission in July 2023. These developments on company disclosure and reporting will be complemented by the proposal for a Green Claims directive intended to create standardised rules on the substantiation and communications of green claims. This is part of a greater push to introduce carbon or sustainability labelling such as eco-scores at consumer level, likely to be part of the Commission's proposal for a framework law on sustainable food system expected in the second half of 2023, and already being trialled by individual supermarket groups.

6.2 Environmental performance comparison

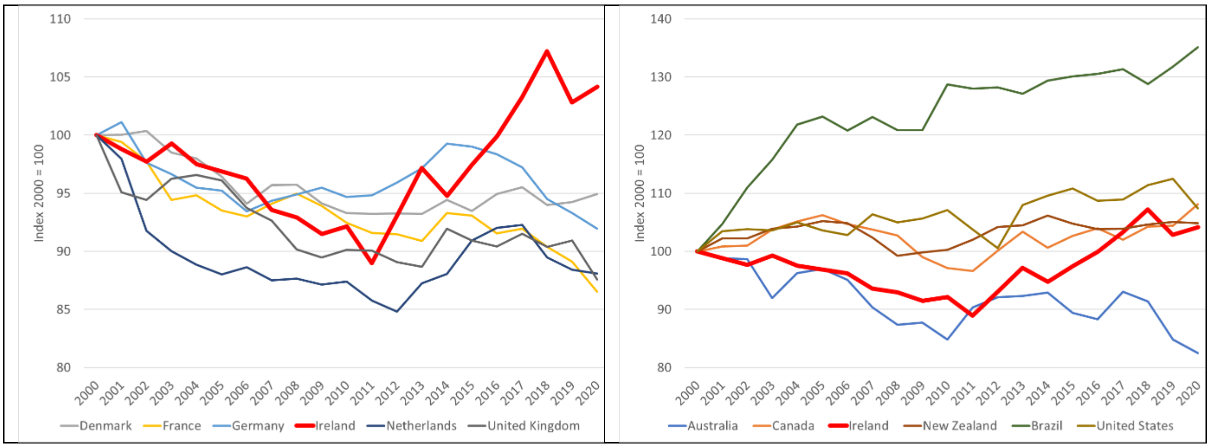
Having established that sustainability claims are increasingly an important element of competitive advantage, how does Ireland stack up against its competitors? This section reviews Ireland's progress in terms of reducing GHG emissions but also on other metrics such as water quality, ammonia emissions and biodiversity loss relative to major competitors.

6.2.1.1 *GHG emissions*

Purchasers of Irish dairy products will primarily be interested in the climate footprint of those products themselves. However, if Ireland wishes to promote itself as a sustainable food producer, and as being ahead of its competitors, it is also important to pay attention to the overall trend in absolute agricultural emissions. Ireland's performance in comparison to some major competitors is shown in Figure 11. The left-hand panel shows the trend in comparison to other European producers, while the right-hand panel shows the trend in comparison to non-EU competitors. All EU countries as well as the UK have legally binding emissions reduction targets, and in some cases also have reduction targets for the agricultural sector. The general trend in the left-hand panel is for a slow reduction in agricultural emissions in the period 2000-2010. In the UK, this trend continued during the decade 2011-2020 but in most other EU countries agricultural emissions have stabilised. In both Ireland and the Netherlands, there has been a sharp increase in agricultural emissions starting in 2011 following the phase out of milk quotas. While this increase has been partially reversed in the Netherlands since 2017, emissions have continued to increase in Ireland. Emissions in the Netherlands in 2020 were 12% lower than in 2000, whereas they were 4% higher in Ireland.

A more mixed picture is shown in the right-hand panel. Australia is the only country in the sample that has succeeded in reducing agricultural emissions since 2000. Agricultural emissions in other countries have increased roughly in line with Ireland, except for Brazil where emissions in 2020 were 135% higher than in 2000. Thus, in comparison with non-EU competitors, Ireland's GHG emissions may not look out of line, but the selected European countries have all performed better. It would not be possible to argue that Ireland is leading the climate transition in agriculture on these figures.

Figure 11. Comparative trends in agricultural GHG emissions, million tonnes CO_2e, converted to base 2000 = 100



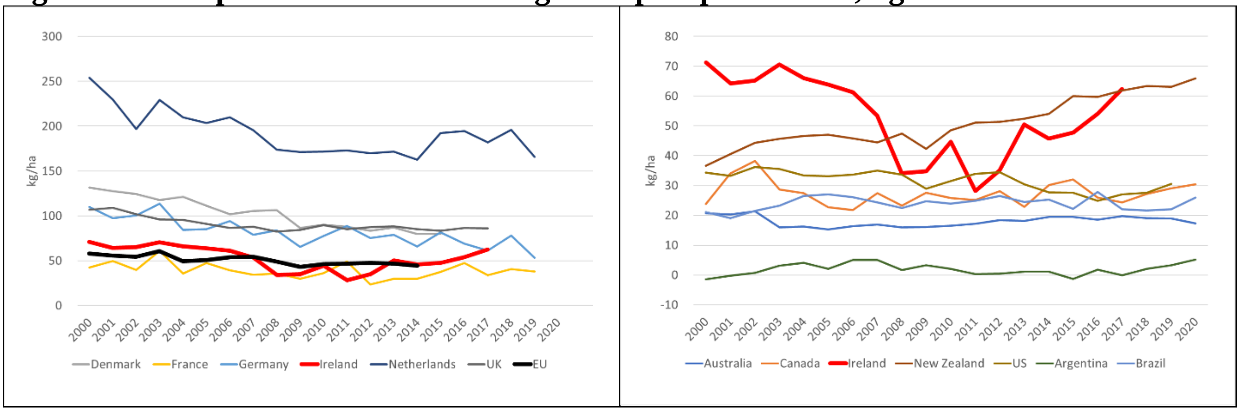
Source: Own compilation based on OECD Agri-environment indicators database

6.2.1.2 *Nitrogen balance*

The gross nitrogen balance or gross nitrogen surplus indicator provides an indication of the potential surplus of nitrogen (N) on agricultural land (kg N/ha/year). The indicator is calculated from the total inputs minus total outputs to and from the soil. Inputs include inorganic and organic fertiliser, manure, biological nitrogen fixation by leguminous crops, and atmospheric nitrogen deposition. The outputs are the amounts of nitrogen contained in harvest of crops and fodder, as well as crop residues removed from the field. The gross nitrogen balance per ha is derived by dividing the total gross nitrogen balance by the reference area, where the reference area is the sum of arable land, permanent grassland, and land under permanent crops. The indicator is closely related to nitrogen use efficiency, which is the ratio of total nitrogen outputs divided by total nitrogen inputs. A decreasing gross nitrogen balance over time in principle means that nitrogen use efficiency increases. The significance of the indicator is that a high gross nitrogen balance implies the risk of significant losses with potential pollution of the environment.

Trends in the gross nitrogen balance in Ireland and some major dairy competitors are shown in Figure 12. The left-hand panel shows the situation in selected European countries (EU plus UK). The Netherlands has by far the highest potential losses to the environment, a situation reflected in the nitrate and ammonia problems the Dutch government is grappling with at present and which has led to proposals for the buy-out and closure of dairy farms to reduce livestock numbers by around 30%. The general picture shows a reduction across countries in the gross nitrogen surplus in the first decade of this century but a stalling of further reductions since then. The Irish case is rather unique. Relative to the selected EU competitors in the figure Ireland has a low gross nitrogen balance/high nitrogen use efficiency. Over the period 2000-2014 this closely tracked the EU average. But since 2011 the Irish gross balance has started to increase although the data only go as far as 2017. This reflects the dairy intensification that has taken place prior to and after the removal of the EU milk quota in 2015.

Figure 12. Comparative trends in nitrogen surplus per hectare, kg/ha

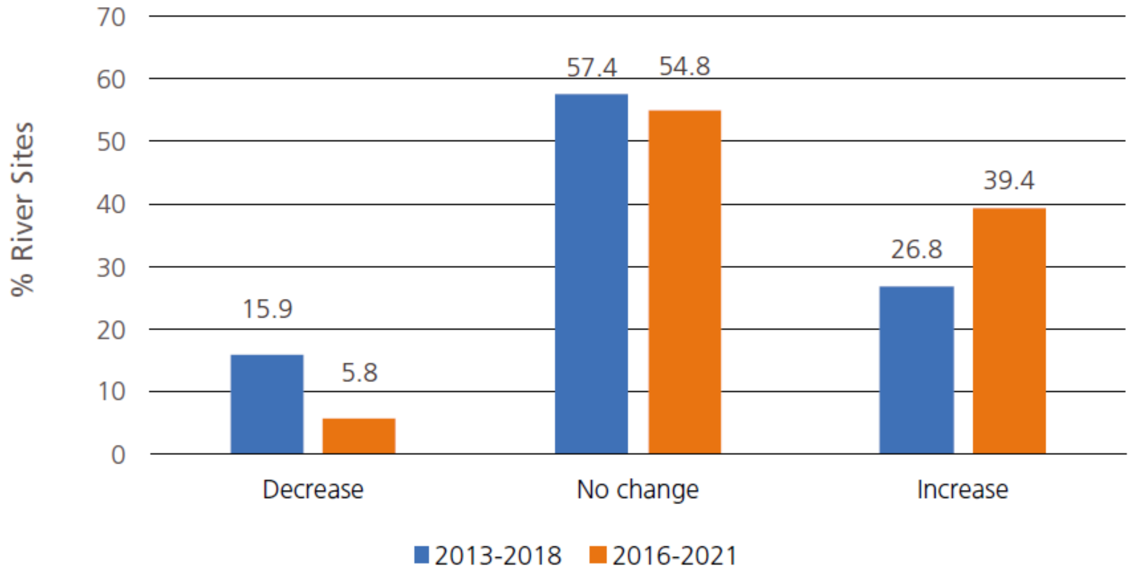


Source: Own compilation based on OECD Agri-environment indicators database

The Irish case emerges even more clearly in the right-hand panel where Ireland is compared to its non-EU competitors. Here Ireland together with New Zealand have considerably higher nitrogen losses compared to the other exporters in the figure (note that the vertical scale in the right hand panel is very different to the vertical scale in the left hand panel). The gross nitrogen surplus per ha in New Zealand has steadily increased over time as dairying has also intensified in that country. The improvement in Ireland's performance over the period 2000-2011 also emerges clearly, as does the reversal of that trend after 2011. The US has also improved its performance over the full period while, for the other selected exporters, there appears to be little trend. Indeed, in the case of Argentina, the nitrogen surplus is close to zero and turns negative in some years. This indicates that more nitrogen is being exported in the form of crops and fodder than is being returned to the soil, a form of soil mining which is also unsustainable in the longer run. While a high nitrogen use efficiency is desirable, this should not be at the cost of damaging soil health in the longer term.

These aggregate trends in nitrogen surplus are reflected in the EPA's water quality report published in 2022 (EPA, 2022). There has been an increase in the proportion of river sites with increasing nitrate concentrations in the most recent period compared to 2013-2018. Up to 2018, 26.8% of sites had an increasing trend compared to 39.4% of sites in the more recent period (Figure 13).

Figure 13. Change in river nitrogen concentration between 2013-2018 and 2016-2021.



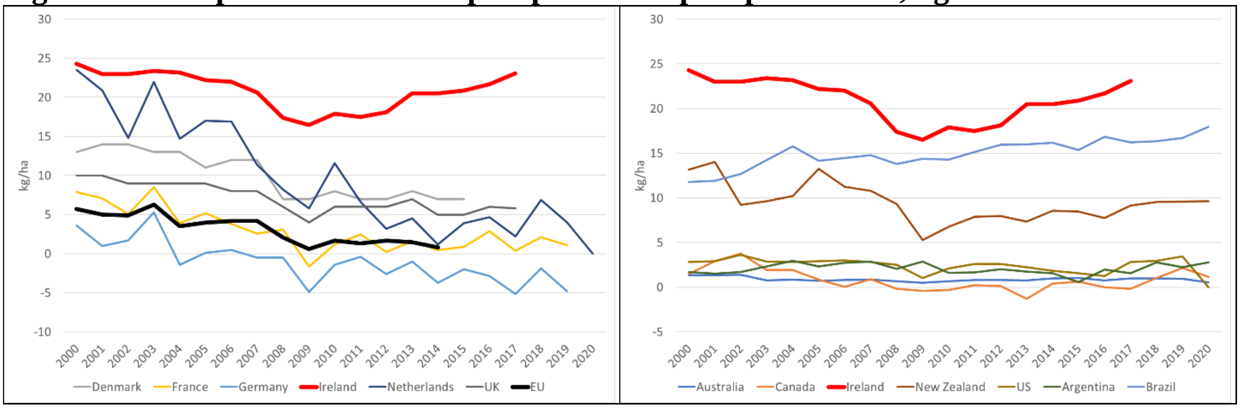
Note: Nitrogen measured as total oxidised nitrogen.
Source: EPA (2022).

6.2.1.3 Phosphorus surplus

The gross phosphorus balance or surplus per ha is calculated analogously to the gross nitrogen balance as the difference between total inputs and total outputs to and from the soil divided by the reference area. While nitrogen surpluses contribute both to pollution of waterways and lakes through nitrate leaching, air pollution through ammonia and climate pollution through the emission of nitrous oxide, phosphorus surpluses are primarily a problem for water quality. Excessive inputs of phosphorus can contribute to eutrophication of freshwater and the development of algal blooms, which can lead to the deterioration of water quality and to restrictions on the use of water bodies for drinking water and recreational activities.

Trends in the phosphorus surplus in Ireland, other EU and selected non-EU exporting countries are shown in Figure 14. In this figure, the vertical axis scales are the same in both panels. The left-hand panel shows Ireland in a European context. There appears to be a very similar narrative to the evolution of nitrogen surpluses. There was some improvement in this indicator across countries in the first decade of this century and some evidence that surplus levels have stabilised more recently (except in Germany where the gross phosphorus balance is already low and where a slow improvement is evident throughout the period). Ireland not only has the highest level of phosphorus surplus in absolute terms, but this surplus began to increase steadily already since 2009. There is also a similar story in the right-hand panel. Ireland also has the highest absolute surplus relative to these non-EU exporters. The surplus fell in both Ireland and New Zealand until 2009 after which it has increased in both countries, though somewhat faster in Ireland. The gross phosphorus surplus has also been increasing in Brazil, while there is little trend in other exporters.

Figure 14. Comparative trends in phosphorus surplus per hectare, kg/ha

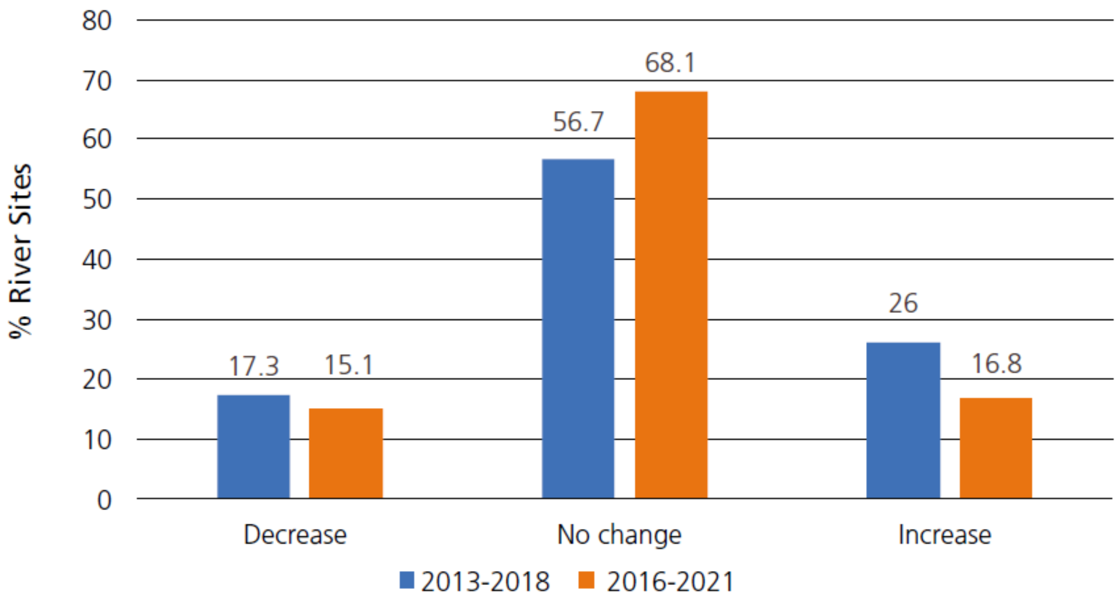


Source: Own compilation based on OECD Agri-environment indicators database

The concentration of total phosphorus (mg/l P) in lakes is a key quality indicator because of its impact on biological quality in freshwater. Average total phosphorus concentrations in lakes of less than 0.01 mg/l P and less than 0.025 mg/l P have been established in Ireland as legally binding environmental quality standards (EQS) to support the achievement of high and good ecological status. Concentrations of total phosphorus consistently greater than 0.025 mg/l P are likely to result in the lake not achieving good ecological status. Two-thirds (67%) of monitored lakes are classed as either high or good quality for total phosphorus in 2019-2021. The remaining one third (33%) have unsatisfactory phosphorus concentrations. A trend assessment showed that most lakes had a stable trend where total phosphorus was relatively unchanged (EPA, 2022). Thus, unlike for nitrogen, the increasing phosphorus surplus does not appear to be showing up in river concentrations. The proportion of river sites with increasing phosphate concentrations has decreased, from 26% to 16.8% (Figure 15). Nonetheless, almost a third of rivers are still classified as unsatisfactory with respect to phosphate quality.

The EPA report notes that the monitoring of nutrient inputs from 19 major Irish rivers to estuarine and coastal waters shows a decrease until 2013 but after 2014 this trend was reversed and nutrient inputs to the marine environment have increased. This increase is having a significant negative impact on the ecological status of transitional and coastal waters, and excessive nutrients are seen as the primary cause.

Figure 15. Change in river phosphorus concentration between 2013-2018 and 2016-2021.



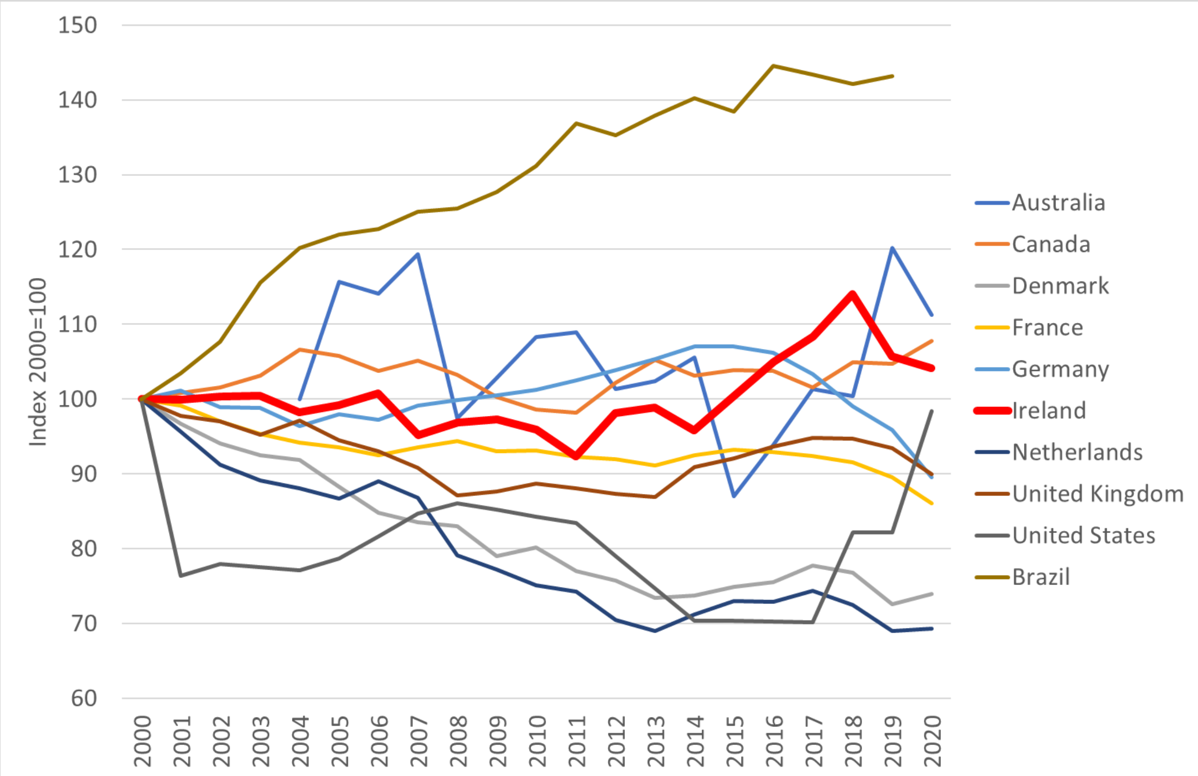
Note: Phosphorus measured as molybdate reactive phosphorus.
Source: EPA, 2022.

6.2.1.4 Ammonia emissions

Ammonia is an air pollutant that is produced mainly from agricultural sources such as manures, slurries and fertiliser application (these account for 93% of ammonia emissions across the EU). Ammonia emissions can lead to increased acid depositions and excessive levels of nutrients in soil, rivers or lakes, which can have negative impacts on aquatic ecosystems and cause damage to forests, crops and other vegetation. Eutrophication can lead to reductions in water quality with subsequent impacts including decreased biodiversity, and toxicity effects. Ammonia emissions also contribute to the formation of $PM_{2.5}$, the main air pollutant driving premature death in EU Member States. Reducing ammonia emissions is thus critical to achieving the EU's zero pollution targets of reducing the number of premature deaths caused by air pollution by 55% and reducing by 25% the EU ecosystems where air pollution threatens biodiversity by 2030.

Ammonia emissions are controlled under the EU's National Emissions Reduction Commitments Directive (2016/2284/EU) which sets national emission reduction targets for 2020 and 2030 for five main air pollutants including ammonia. Under the Directive, Ireland has an ammonia reduction target of -1% in 2020, and -5% in 2030, relative to 2005 emissions levels. Ireland failed to meet its 2020 target. In fact, ammonia emissions increased by 3.1% compared to the required 1% emission reduction commitment (EPA 2022a) and by 14% between 1990 and 2019 according to EEA (2021). These trends in ammonia emissions are compared to selected other exporters in Figure 16. Brazil is an outlier with a strong increase in ammonia emissions. In EU countries such as France, Germany, Denmark and Netherlands absolute emissions are declining. Within the EU, 16 Member States met their 2020 commitments while 11 including Ireland did not. Ireland's performance is on a par with Australia and Canada. Ammonia emissions in Ireland come mainly from livestock farming (principally the management of animal manures) and from the application of nitrogen-containing mineral fertilisers.

Figure 16. Trends in agricultural ammonia emissions, thousand tonnes, converted to index base 2000 = 100



Source: Own compilation based on OECD Agri-environment indicators database. The series for Australia is to base 2004 = 100.

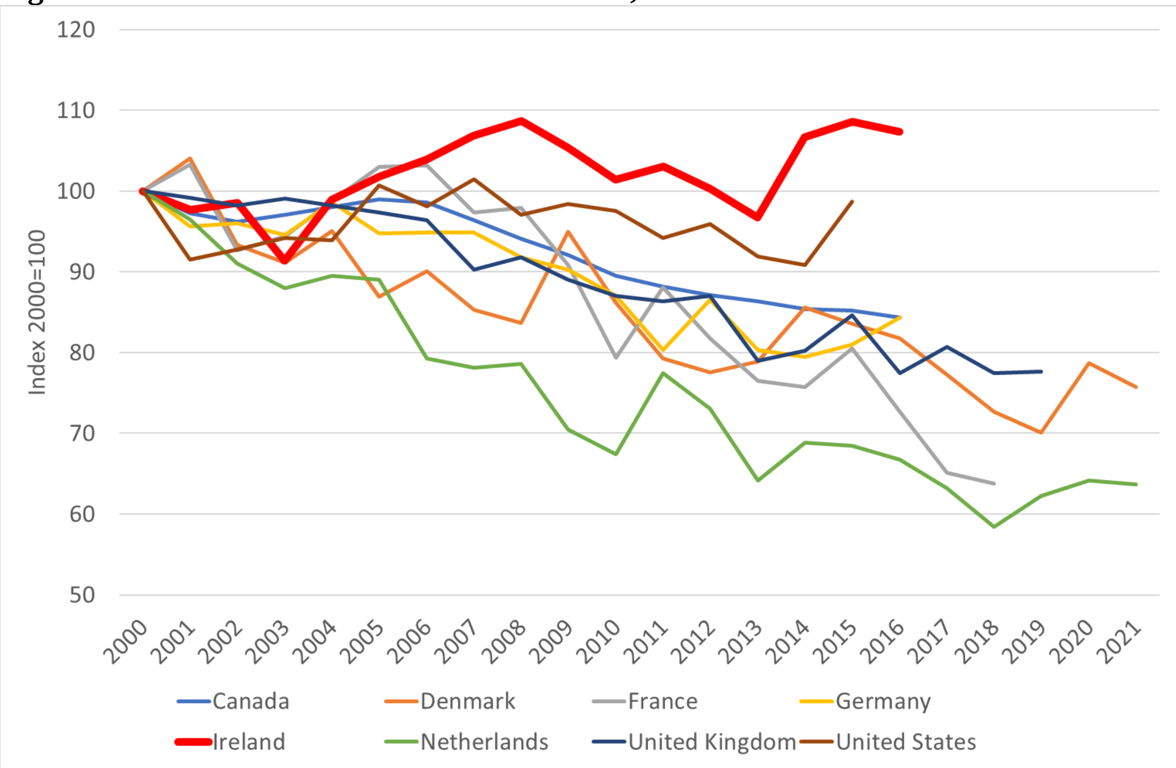
6.2.1.5 Biodiversity

Biodiversity, apart from its intrinsic value, has a key role to play in strengthening the resilience of ecosystems. Ecosystems with a lot of biodiversity are generally stronger and more resistant to adverse shocks than those with fewer species. In the past hundred years, biodiversity around the world has decreased dramatically. Many species have gone extinct. The reasons for this decline are many and include the loss of habitats, the impact of pollution, the introduction of invasive species, overfishing, and climate change (IPBES 2019).

Agricultural practices have mixed impacts on biodiversity. There are agricultural land use practices that are beneficial to biodiversity, but in many cases agricultural intensification can be a threat to biodiversity. The NPWS has listed the pressures negatively impacting on Article 17 Habitats (these are habitats listed in the annexes to the EU Habitats Directive which are considered threatened in the EU territory and where the state has an obligation to maintain or restore favourable conservation status). The most frequent pressures recorded in habitats relate to the agriculture category. Over 70% of habitats are impacted by pressures relating to agricultural practices, and the pressure is ranked as High importance in more than 50% of habitats (Lynn and O.Neill 2019).

Trying to find a single indicator to summarise biodiversity status is not easy. The EU uses the Farmland Bird Index which is based on bird population counts carried out by a network of volunteer ornithologists coordinated within national schemes. The farmland bird indicator is intended as a proxy to assess the biodiversity status of agricultural landscapes in Europe. Birds are high in the food chain and therefore are considered good indicators for the overall state of biodiversity. The indicator is a composite index that measures the rate of change in the relative abundance of common bird species at selected sites. Trends in this index for those countries that collect this information are summarised in Figure 17. Ireland stands out on this index as the only country in the sample where the index has increased over time. Irish national data which extend to 2021 support this trend, although there has been a worrying fall in the index over the three years since 2018.[34]

Figure 17. Trends in the Farmland Bird Index, 2000 = 100



Source: Own compilation based on OECD Agri-environment indicators database

6.2.1.6 Pesticide use

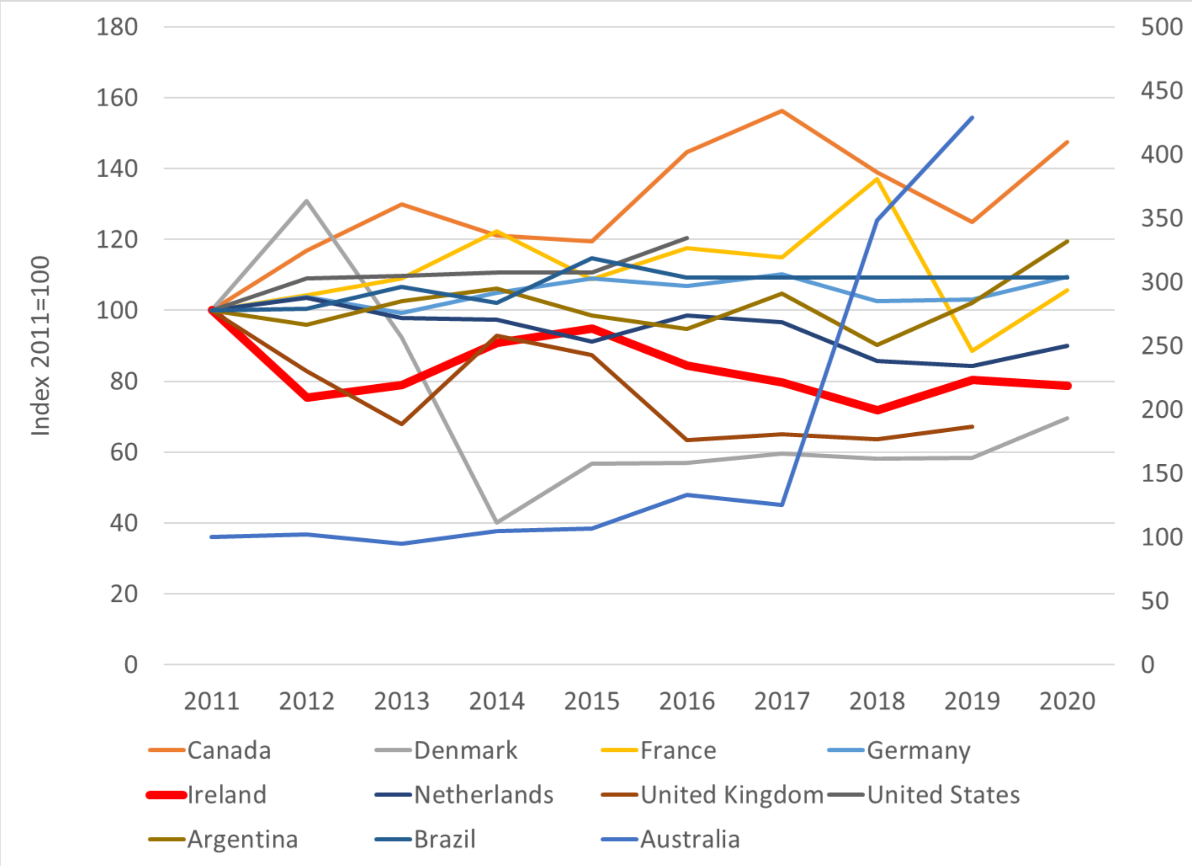
Pesticide use is a major contributory factor to biodiversity loss, as well as posing health hazards for consumers and operators (the term 'pesticides' here covers all plant protection products, including fungicides, herbicides, insecticides and plant growth regulators). Pesticides are regulated in all countries, but data on pesticide use is missing in many cases. The EU's Farm to Fork Strategy has the objective to reduce the use and risk of pesticides in the EU by 50% in 2030 relative to 2015-2017. Within the EU, the preferred indicator (the Harmonised Risk Indicator 1) is calculated by multiplying the quantities of active substances placed on the market by a weighting factor reflecting the toxicity of the pesticide. The OECD indicator shown in Figure 18 does not reflect toxicity and is based solely on the weight of sales of the active ingredients in agricultural pesticides. Because the absolute amounts of pesticides used in a country reflect in part the size of its agricultural sector, the trends shown in the figure are indexed to 2011.[35]

[34] Birdlife Ireland, Countryside Bird Population Indicators.

[35] The Irish data in the OECD database are consistent with those published by the CSO in its release Plant Protection Products 2020.

Ireland performs relatively well on this indicator. The most common pesticide sold in Ireland is herbicide (78% of the total in 2020) which is widely used to kill off the old sward prior to reseeding grassland. There has been significant growth in sales in Canada and Argentina, while sales have been stable or declining in other countries, including in Ireland. Only Denmark and the UK have a better performance in reducing use of pesticides than Ireland over the period shown. This result is because of the large drop in sales of pesticides between 2011 and 2012, with little evidence of further reduction since then. Ireland will have to make significant efforts to achieve the Farm to Fork target reduction by 2030. Under the Commission's proposal for a revised Sustainable Use of Pesticides Regulation, which at the time of writing is still under discussion in the EU co-legislature, it will be up to countries to adopt binding targets towards the overall EU 50% reduction target within specified parameters, but in no case can the target reduction be less than 35%.

Figure 18. Sales of agricultural pesticides, 2011-2020, index 2011=100



Source: Own compilation based on OECD Agri-environment indicators database. Australia shown on the right-hand axis. The Irish figures (and possibly in other countries) include sales to non-professional users.

6.3 Reputational risk

Bord Bia is very aware of the importance of improving Ireland's agri-environmental performance to underpin its sustainability claims in the marketing of Irish agri-food products. It has identified sustainability as a core theme in its recently published ten year and three year strategies (Bord Bia 2022b). It intends to strengthen its supports and standards to reflect the high level of ambition required to meet both environmental challenges and market demands. Bord Bia's Origin Green initiative is its main programme to monitor and drive improvements in environmental sustainability and to demonstrate this to trade customers and consumers, both at home and abroad.

Origin Green was launched in 2011 and now covers 55,000 farms and over 300 company members (Bord Bia 2021b).[36] It is a voluntary programme that measures sustainability improvements across the entire food and drink supply chain at a national level. The current membership coverage accounts for 92% of beef produced, 95% of milk produced, 70% of horticulture produced and 95% of eggs produced. At farm level, this is done through Bord Bia's Sustainable Quality Assurance schemes, which assess farming practices and record data to demonstrate the sustainability of Irish farming in a systematic way at an individual farm level. On-farm audits are conducted by an independent auditor on every scheme member's farm at 18-month intervals. The producer receives the results in a dedicated Farmer Feedback Report, which allows them to make informed decisions on improving the sustainability of their farms as well as improving economic viability. The 2021 update on Origin Green notes that 290,000 carbon footprints have been calculated to date.

Since the introduction of Origin Green farm members of the Sustainable Assurance Schemes have achieved a 6.3% average reduction in CO_2 per unit of beef since 2012 and a 6% average reduction in CO_2 per unit of milk since 2013. Bord Bia reports that Origin Green is an important selling point with trade buyers; in its Global Sustainability Survey, 48% of dairy buyers and 47% of meat buyers said it would encourage them to do business with Irish suppliers (Bord Bia 2021a).

Bord Bia published its updated Origin Green 2022-2025 strategy in October 2022 which puts a greater emphasis on science-based targets, nature-based solutions and integrating circular approaches (Bord Bia 2022c). The Strategy acknowledges the targets set by government across a range of agri-environment indicators: a 25% reduction in absolute emissions by 2030 compared to 2018; a 5% reduction in ammonia emissions below 2005 levels by 2030; a 10% reduction in biogenic methane emissions by 2030 compared to a 2018 baseline; a more than 50% reduction in the use of chemical fertiliser by 2030; an ambition to have 10% of the farmed area prioritised for biodiversity by 2030; a 50% reduction in food waste by 2030; the goal to have all packaging reusable or recyclable by 2030; a target for 50,000 ha cultivated organically in 2022; and a commitment to reduce nutrient losses to water by 50% by 2030. To achieve these targets, Bord Bia proposes to update its Producer Standards in 2023 and 2024 to include strengthened water quality, biodiversity and soil health measures, to promote the implementation of the measures in the Teagasc Marginal Abatement Cost Curve to reduce emissions, and to develop training and guidance programmes that will be offered to farmers.

The Food Vision Dairy Group on measures to mitigate GHG emissions from the dairy sector has also recommended reduced chemical nitrogen use in the dairy sector by 27-30% by end of 2030, with an interim target of 22-25% reduction by 2025.[37]

These voluntary measures will be supported by financial support under Ireland's national CAP Strategic Plan as well as company-led sustainability incentive schemes. Funding under the new ACRES agri-environment-climate scheme amounts to €1.5 billion over five years 2023-2027 while a further €1.5 billion has been allocated to eco-schemes designed to promote practices beneficial to the environment, climate and animal welfare over the same period. Also, many

[36] Elsewhere this Bord Bia document states that 71,000+ producers are part of Bord Bia's Sustainable Assurance Schemes for beef, dairy, eggs, horticulture, lamb, pig and poultry.
[37] The farm organization stakeholders either rejected or reserved their positions on this recommendation.

dairy co-ops now offer a sustainability bonus to their milk suppliers. Dairygold, which introduced a sustainability bonus of 0.25c/l in 2019, has increased this to 0.75c/l in 2023 as part of a new "Grassroots Milk Supplier Sustainability Bonus". Carbery will pay a 1c/l bonus for sustainability measures in 2023, while Tirlán (formerly Glanbia co-op) will pay its suppliers a 0.5c/l Sustainability Action Payment in 2023. The co-ops are also part of the Teagasc/Dairy Sustainability Ireland Agricultural Sustainability Support and Advisory Programme which has a focus on water quality improvement. The programme funds 30 sustainability advisors who work in close cooperation with the Local Authorities Water Programme.

These voluntary incentive schemes will be complemented by stricter regulatory requirements, of which the most important are the changes to the Nitrates Directive. The Nitrates Directive is EU legislation introduced in 1991 designed to protect waters against pollution caused by nitrates from agricultural sources. As the application of nitrogen-based fertiliser and animal manure to agricultural soils also gives rise to the GHG nitrous oxide, limitations under the Nitrates Directive also contribute to emissions abatement. The Directive has been implemented in Ireland since 2006 and regulates agricultural practices related to the Water Framework Directive, such as stocking rate, fertiliser use, organic manure storage requirement, and timing of manure and fertiliser application.

Its primary lever is a limit on the amount of organic nitrogen that can be deposited on agricultural land of 170 kg N/hectare annually. For grassland-based ruminant production, the organic N limit translates into a maximum stocking rate of 2 dairy cows or equivalent per hectare in areas that are designated as nitrate vulnerable zones. In Ireland, the government has designated the entire territory as a nitrate vulnerable zone, so these limits apply across the state. While there is no limit in the directive on the additional amount of chemical nitrogen that can be applied, farmers in Ireland are required to keep within the overall maximum fertilisation rates for nitrogen and phosphorus (i.e., organic and chemical fertiliser combined), the basic rule being that a farmer should only apply as much nitrogen and phosphorus as the crops, including grass, need. Maximum chemical fertilisation rates for grassland depending on the grassland stocking rate apply.

The directive permits a country to apply for a derogation that allows producers to exceed these maximum limits subject to stricter conditions. In Ireland, the derogation limit has been 250 kg organic N/hectare. Farmers can therefore have stock to a higher intensity level than stated in the directive. Around 6,500 dairy farmers availed of the derogation in 2021, while a further number maintain higher stocking rates by exporting slurry to neighbouring farms to meet the directive's requirements.

The State must seek to have the derogation renewed on a regular basis. This has become increasingly problematic given the evidence of water quality problems in areas with intensive dairying. Following the querying of the use of a single figure for the amount of organic N per dairy cow by the European Commission the conditions for the nitrates derogation granted in 2022 included a banded approach in which excretion factors are related to milk yield. Three excretion rate bands were introduced which are calculated as 80kg/ha, 92 kg/ha and 106 kg/ha depending on the milk yield of the cow. This means that for higher yielding cows to remain below the maximum permitted organic nitrogen loads of 250 kg/ha in derogation, there will have to be less cows per ha. The 2022 derogation also introduced several additional actions designed to reduce nutrient loss in order to improve water quality.

Although the current derogation runs to the end of 2025, given the adverse trends in water quality in particular catchments, the 2022 derogation included a requirement for an interim review of water quality to be undertaken in 2023 by the EPA. If this water quality assessment indicated average water quality above a threshold of 50 mg/l NO_3, or increasing trends, or eutrophic water bodies or water bodies that could become eutrophic, the derogation application limit of 250kg/ha would be reduced to 220kg/ha in farms in these catchment areas from 2024. The EPA published its interim water quality monitoring report in June 2023 and, based on the criteria established by the Commission for this review, it identified over 44,000 km2 of land as requiring additional measures to protect water quality. By 1 January 2024, derogation farms located within this area must reduce their application rate of manure from a maximum of 250 kg nitrogen/ha per year to 220 kg nitrogen/ha per year. If improvements in water quality are not seen in the coming years, this remaining derogation from the Nitrates Directive rules will also be at risk of being removed.

6.4 Conclusions

Bord Bia research has emphasised the importance of being able to demonstrate and defend sustainability claims when seeking to maintain existing customers or attract new customers for Irish agri-food products. While Origin Green has been an important initiative in starting on the sustainability journey, customers and competitors have not been standing still. Many food companies, both supermarkets and processors, have announced their own ambitious targets to reduce emissions and monitor other environmental impacts. In some cases, these go beyond what Ireland has committed to. While Ireland can match its competitors on some environmental indicators (pesticide use, biodiversity), on other indicators Ireland is clearly losing ground (GHG emissions, ammonia emissions, phosphorus surplus).

This study is particularly focused on GHG emissions where new reporting standards are being introduced and where new EU legislation will make it mandatory for large companies to report emissions across their supply chains, including Scope 3 emissions. This will primarily highlight the importance of emission intensity indicators as it is only direct purchases of primary produce in its supply chain that will count towards a company's Scope 3 emissions. As noted in Chapter 5, Ireland's emission intensity figures for dairy compare well with its competitors.

However, it would be unwise to ignore trends in absolute emissions, not least because there are now legally binding targets to meet for absolute emissions. Failure to meet these targets may not directly affect a customer's willingness to purchase Irish products in terms of making it more difficult to meet its own reporting obligations, but it will certainly undermine the credibility of Food Brand Ireland and make it more difficult to position Ireland as a leader in the sustainability space. For this reason, there is an evident risk that further expansion, if it leads to climate targets not being met, will negatively impact on Ireland's ability to hold on to existing customers in high-value markets.

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