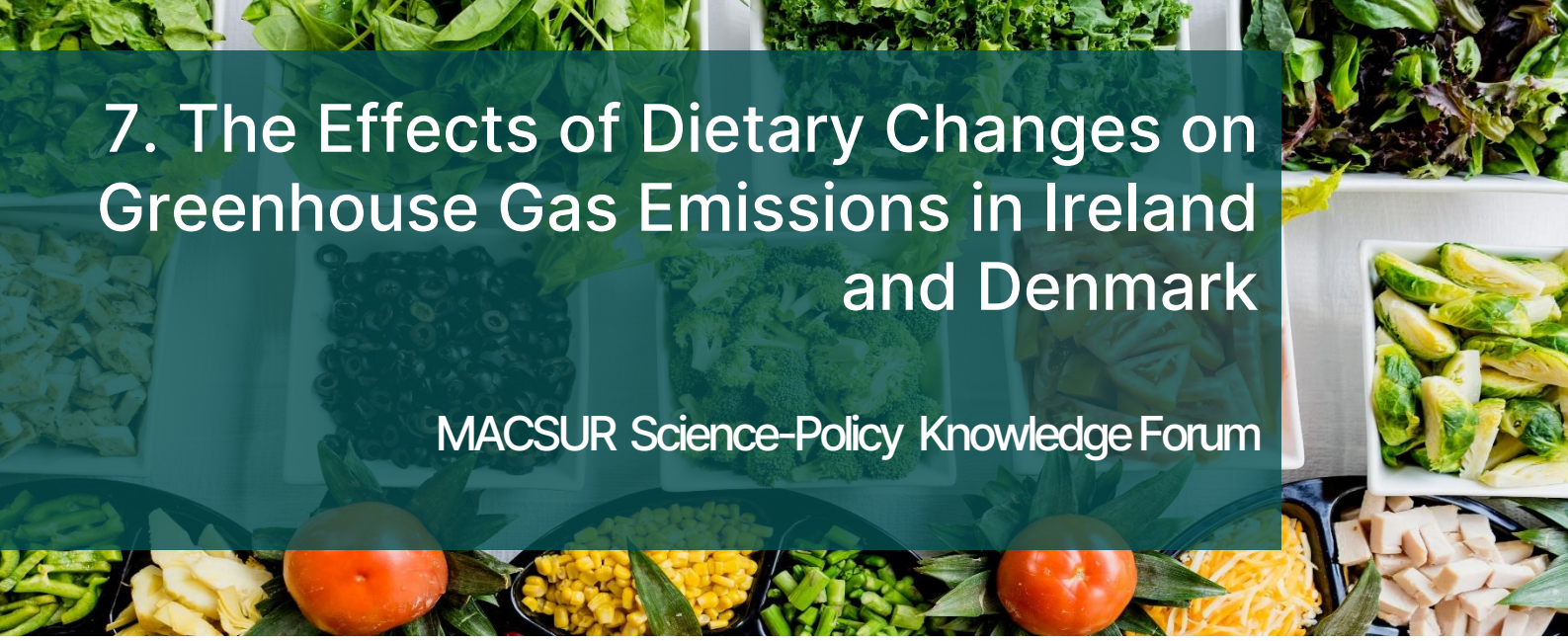

7. The Effects of Dietary Changes on Greenhouse Gas Emissions in Ireland and Denmark

MACSUR Science-Policy Knowledge Forum

The policy brief provides a model-based analysis of the effects of dietary change on agricultural greenhouse gas emissions in Ireland and Denmark showing that reduced consumption of animal-source foods can contribute to meeting climate targets.

Key Messages

- Dietary changes can potentially reduce agricultural emissions in all EU countries, while the particularities of the agricultural system in each country affect the magnitude of savings.
- In Ireland, where beef and dairy production dominate the agricultural sector, greenhouse gas emissions could be reduced by up to 36%.
- In Denmark, where pork and piglets play a crucial role, agricultural greenhouse gas emissions could be reduced by up to 10%.

Background

Global livestock production is increasingly associated with negative environmental, climatic and resource impacts. While animal foods provide 18 % of the daily calories available for human consumption, livestock production occupies two-thirds of agricultural land (FAOSTAT,2022) and is responsible for 57% of GHG from food production.

European citizens consume 79 kg of meat and 187 kg of dairy products per capita per year, excluding household waste; at least twice the global average (FAOSTAT 2022). Consumption at this level is not only problematic for the environment but also poses increasing health risks.

Against this background, the EAT-Lancet Commission on Food, Planet and Health derived a diet that is consistent with public health and environmental objectives. Adopting this diet would imply a major change in the current diets of European citizens. In particular, the consumption of red meat and dairy products would have to be reduced, while the consumption of fruits, vegetables, legumes, whole grains and nuts would have to be increased. The EAT-Lancet Commission estimates that such a dietary shift could reduce global agricultural GHG by up to 80% while reducing premature mortality by 19%. Combined with improved agricultural production practices and a reduction in food waste and loss, the commission estimates that this diet would allow 10 billion people to be fed within planetary boundaries by 2050 (Willett et al. 2019).

Relevance

Livestock production is an important pillar of the European agricultural sector. In the production of dairy products, beef and pork, the EU is one of the top three producing regions and maintains positive trade balances for this commodity group. In total, livestock generates 36% of the total agricultural production value.

In some countries, the shares are even higher, with the agricultural sectors of Ireland (74.2%) and Denmark (56.7%) being the most dominated by livestock production in the EU (Eurostat, 2022). With respect to emissions, the agricultural sector accounts for 37.5% and 27% of total GHG in Ireland (EPA, 2022) and Denmark (Nielsen et al. 2022), respectively. Therefore, the potential for emissions savings due to dietary changes could be particularly high in these two countries where the agricultural sector is dominated by animal husbandry and contributes a considerable share to the country's GHGs.

Based on a scenario analysis with the general equilibrium model MAGNET (Woltjer and Kuiper, 2014), we estimate how the adoption of the dietary recommendations of the EAT-Lancet Commission in the EU27 will affect the GHG in Ireland and Denmark. To derive the scenarios, the average difference in the EU27 between the product-specific consumption values in kcal per capita and the EAT-Lancet diet was calculated. In the simulated scenarios, this difference was reduced by 10% or 30% for each food group in 2030. In addition, we implemented a scenario that assumes full adoption of the EAT-Lancet diet. The required percentage changes in demand for each food group can be found in Table 1.

The dietary changes are implemented as exogenous changes in consumer preferences. This means it is assumed that consumer behaviour will change by itself without any external intervention and, thus, no costs will be incurred to bring about this change. The Thuenen Baseline, which represents the average medium-term development of the economy taking into account the general economic development (GDP, population growth, etc.), serves as a basis for comparison for the year 2030 (Haß et al. 2020).

Table 1: Consumption changes compared to Baseline in 2030 [%]

		Reference Scenario 2030	Lancet_low: 10% shift of EU diets to EAT-Lancet diet	Lancet_high: 30% shift of EU diets to EAT-Lancet diet	Lancet_full: Full shift to EAT-Lancet diet
Cereals	kcal/day	525	553.9	611	811
	%-change		5.4	16.3	76.3
Fruits & vegetables[2]	kcal/day	153	219.5	352.5	818
	%-change		43.6	130.3	521.6
Beef	kcal/day	51	46.4	37.6	7.5
	%-change		-8.7	-26	-85.3
Pork	kcal/day	203	187.8	157.4	51
	%-change		-7.5	-22.5	-74
Poultry	kcal/day	78	76	72.2	62
	%-change		-2.4	-7.3	-27.9
Eggs	kcal/day	39	37	33	19
	%-change		-5.1	-15.4	-52.9
Dairy	kcal/day	352	332	291.2	153
	%-change		-5.8	-17.4	-57.7
Sugar	kcal/day	298	280	244.4	120
	%-change		-6	-17.9	-56.3

Source: Rieger et al. (2022); Note: positive/negative sign: increase/decrease of food item consumption required; Example: 43.6% increases in consumption of fruits & vegetables are needed to achieve a 10% step towards the EAT-Lancet diet recommendation

Results and Discussion

The following section presents changes in GHG from the primary agricultural sector in Ireland and Denmark as a result of the adoption of the EAT-Lancet diet in the EU27. In this context, the changes in emissions are mainly due to the changes in production that follow from changes in consumption.

In Ireland, a 10% change in diet towards the EAT-Lancet recommendations could reduce GHG from the primary agricultural sector by 29.5% (Table 2). Full implementation of the EAT-Lancet recommendations could reduce emissions by 36.2%. Most of the emissions savings are due to reductions in nitrous oxide and methane emissions from cattle and dairy farming, primarily from ruminant digestion, manure storage and application, and feed production. At the same time, as diets become closer to the EAT-Lancet Diet, demand for fruits and vegetables increases, causing production to rise. If the EAT-Lancet diet is fully implemented, CO_2 emissions, which come from the energy use in the production of fruits and vegetables, can increase by 8% and offset part of the CO_2 emission reductions from animal husbandry.

The emission reductions in Denmark are comparatively lower than in Ireland. On the one hand, this is related to the production focus on pig farming, which is comparatively less emission-intensive than ruminants, and on the other hand to a greater expansion of fruit and vegetable production. In particular, increased use of fertilisers causes more nitrous oxide emissions in fruit and vegetable cultivation and leads to nitrous oxide emissions in Denmark falling by only 2.0% in the Lancet_full scenario. With regard to methane emissions, the savings potential in Denmark is also lower than in Ireland, at -22.2% in the Lancet_full scenario. In terms of CO_2 emissions, higher fruit and vegetable production can even lead to increases by 26.9% in the Lancet_low and by 37.1% in the Lancet_full scenario. In absolute terms, however, CO_2 emissions only account for 2% of total emissions in the Danish agricultural sector (Nielsen et al. 2022).

Therefore, these increases in CO_2 emissions can slightly reduce, but not offset the emission savings from reduced livestock production. Overall, emissions from the Danish agricultural sector decreased by 10.3% in the Lancet_Full scenario.

The agricultural sectors of Ireland and Denmark are both heavily dominated by livestock. However, the Irish agricultural sector is more specialized in ruminant farming, while Danish agriculture is dominated by pig farming. This difference in production focus explains the different impacts of following the EAT-Lancet recommendations on GHG emissions in these two countries. In general, beef and dairy farming are more emissions-intensive compared to other animal species. Globally, ruminants account for three-quarters of global emissions from livestock (Gerber et al. 2013), making the potential for emissions savings in agriculture particularly high in countries that specialize in beef and dairy farming.

Table 2: Changes in Greenhouse Gas Emissions from the Primary Agricultural Sector compared to the Baseline 2030 [%]

	Ireland			Denmark		
	Lancet_low	Lancet_high	Lancet_full	Lancet_low	Lancet_high	Lancet_full
CO_2	-1.7	0.6	8.0	26.9	28.3	37.1
N_2O	-23.8	-24.5	-26.5	-3.4	-3.5	-2.0
CH_4	-33.1	-35.1	-42.3	-6.6	-10.1	-22.2
Total in CO_2-equivalent	-29.5	-31.0	-36.2	-3.4	-5.1	-10.3

Source: Simulations with the MAGNET model

An important driver of the results is also international trade effects; both in Ireland and Denmark, animal food production is very export-oriented. Overall, approximately 90% of beef and dairy products produced in Ireland are exported. The main export regions are the UK and the EU27 (Department of Agriculture, Food and the Marine,2022). The situation is very similar in Denmark, where also about 90% of the production of pigs and pork is exported, mainly to other EU countries and China (Danish Agriculture and Food Council, 2023). This focus on international trade leads to production changes in cattle and pig farming being smaller than demand changes, as the effects of reduced domestic demand can be partly offset by an increase in exports to other non-EU countries, particularly China. These international trade effects offset some of the positive impacts that dietary change could have on GHG emissions through production changes. Overall, the potential for emission reductions may be greater as more countries shift their diets towards more plant-based foods and less animal-based foods.

Further Reading:

Gerber, P. J.; Steinfeld, H.; Henderson, B.; Mottet, A.; Opio, C.; Dijkman, J. et al. (2013): Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities. Food and Agriculture Organization of the United Nations. Rome. http://www.fao.org/docrep/018/i3437e/i3437e00.htm

Rieger, J.; Freund, F.; Offermann, F.; Geibel, I. (2022): From Fork to Farm: Impacts of more sustainable diets in the EU-27 on the agricultural sector. Journal of Agricultural Economics. https://doi.org/10.1111/1477-9552.12530

Willett, Walter; Rockström, Johan; Loken, Brent; Springmann, Marco; Lang, Tim; Vermeulen, Sonja et al. (2019): Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems (10170). https://doi.org/10.1016/S0140-6736(18)31788-4

The MACSUR SciPol knowledge forum is a pilot exercise initiated by the Joint Programming Initiative for Agriculture, Food Security and Climate Change (FACCE-JPI) to bring science and policy actors together for the strategic design of climate change adaptation and mitigation solutions in the agri-food sector in Europe. This policy brief contributes to this mission by providing evidence-based information to policy for achieving carbon neutrality by 2050, adapting to climate change and understanding synergies and trade-offs in achieving these targets.

Writing and research: Inna Geibel [1], Dr. Florian Freund [1], PD Dr. Martin Banse [1],
Editing and Design: Abigail Muscat[3,4] Heather McKhann[4]
[1]Thünen Institute for Market Analysis, [3]Wageningen University and Research, [4]FACCE-JPI secretariat