Abstract title:

A Deep-Dive of the EAT-Lancet 2 Global Diet into European Food Systems

Background:

In 2019, the EAT–Lancet Commission on Food, Planet and Health set the first global scientific benchmarks for healthy diets, highlighting the outsized pressure that current food systems place on planetary boundaries[1]. At the same time, key trade-offs also emerged, showing that dietary changes alone, without concurrent improvements in the efficiency of food production systems, may increase food prices and exacerbate inequalities in access to healthy foods[2]. Since then, geopolitical instability, the COVID-19 pandemic, and sharp increases in food and energy prices have exposed and amplified structural weaknesses in global food systems. Currently, more than half of the world's population cannot afford a healthy diet, while climate risks to food production continue to intensify[3], underscoring the urgency of food-system transformations.

Building on these foundations, the second EAT–Lancet Commission released an updated assessment[3] that advances both the scientific basis of healthy diets and the understanding of their environmental and social implications. In addition to refining dietary recommendations, it strengthens the quantitative assessment of food-system transitions by using an economic multi-model ensemble that captures economic feedback and system-wide interactions across the food–environment nexus, integrating both demand-side and supply-side measures. Alongside dietary changes, these measures include carbon pricing, productivity improvements, and reductions in food losses and waste[4].

Outcomes remain, however, highly context dependent[3,4]. In regions with high consumption of animal-source foods, dietary shifts may reduce overall food prices and improve affordability, whereas in lower-income regions they can trigger more complex adjustments, including increases in the overall cost of producing a healthy diet. More broadly, outcomes depend on existing production systems, consumption patterns, and regional capacity to reallocate resources. This heterogeneity underscores the need for policy-relevant analyses that explicitly account for synergies among measures and regional differences when designing food-system transformation pathways.

In settings where dietary change simultaneously lowers prices and emissions, such as in the European Union, prioritising healthier diets may deliver environmental gains without undermining economic stability. To assess these challenges, we simulate four food-system transformation measures both jointly and under EU-only implementation using the CAPRI model, one of the agroeconomic models employed in the second EAT–Lancet Commission's multi-model assessment. By comparing regional and global outcomes under worldwide versus EU-only implementation, we isolate the role of EU action within an increasingly interconnected global food system.

Methods and scenario specification:

CAPRI is a global agroeconomic model designed to assess the effects of changes in EU and international agricultural policies on European agriculture and global commodity markets[5,6]. Its economic core is a static, partial equilibrium framework composed of two main interconnected modules: 280 regional supply models covering the EU, Norway, Turkey, and the Western Balkans, and a global multi-commodity market model covering the world in 43 regional country blocks. CAPRI is solved through sequential iteration across its modules. Each regional supply model maximises agricultural income given prices and policy settings, subject to land, feed, and nutrient constraints, and represents 59 crop and livestock activities. Production choices are guided by a quadratic cost function, with parameters estimated from time-series analysis or calibrated to exogenous elasticities. Environmental indicators, including nitrogen balances and greenhouse gas (GHG) emissions, are derived from the supply-side results. The market module represents both individual countries and regional aggregates, covering 56 primary agricultural products and key processed commodities (such as dairy, oilseed cakes, and oils). Trade is modelled under the Armington assumption and incorporates bilateral tariffs, tariff-rate quotas, and export subsidies, using flexible functional forms calibrated to elasticities from the literature.

Using this model, we simulated four core food-system transformation measures in 2050: i) productivity improvements (PROD), aligned with the "taking the greener road" pathway (SSP1); ii) reductions in food losses and waste (WAST), consistent with Sustainable Development Goal 12.3, which aims to halve per-capita food waste and reduce losses along the supply chain; iii) dietary shifts (DIET) toward healthier consumption patterns, in line with the EAT–Lancet 2.0 healthy reference diet; and iv) GHG emission mitigation policies (MITI), represented by a carbon pricing mechanism that imposes a cost on emissions and increases over time. Scenarios are run both as a combined package including all measures (ELM) and with each component implemented individually to quantify their individual environmental and economic impacts. In addition, each scenario is applied at both the global and EU-only levels to isolate the direct contribution of EU action to overall outcomes. Results are compared with a business-as-usual (BAU), based on the latest "middle-of-the-road" Shared Socioeconomic Pathway (SSP2).

Preliminary results:

We isolated the consequences of applying demand- and supply-side interventions unilaterally in the EU and assess how production, prices and GHG emissions could change at EU and global scales in 2050 compared to a BAU situation. Across the unilateral scenarios considered, the EU experiences markedly different production, emissions, and price responses (Table 1).

Table 1: Relative changes between scenarios and BAU in 2050 per indicator and regional blocks.

Scenario	Variable	EU	NONEU	World
DIET	GWPA	-9.6	-1.3	-1.9
MITI	GWPA	-43.1	0.6	-2.3
PROD	GWPA	0.1	0.0	0.0
WASTE	GWPA	-3.6	-0.5	-0.7
ELM	GWPA	-52.2	-1.0	-4.3
DIET	PRI	-7.7	-0.8	-2.8
MITI	PRI	7.5	1.5	3.2
PROD	PRI	-0.4	0.0	-0.1
WASTE	PRI	-7.1	-1.8	-3.4
ELM	PRI	-9.4	-2.4	-4.5
DIET	PROD	-4.2	-0.3	-0.6
MITI	PROD	-9.1	0.3	-0.5
PROD	PROD	0.3	0.0	0.0
WASTE	PROD	-6.6	-0.6	-1.0
ELM	PROD	-21.0	-1.0	-2.6

An EU-only dietary change (DIET) primarily reallocates agricultural production rather than inducing a global contraction, reducing global output by 0.6% by 2050, with most of the adjustment concentrated within the EU (−4.2%) and only marginal spillovers outside the EU (−0.3%). This leads to a sharp decline in EU agricultural GHG emissions (−9.6%), but only a modest global reduction (−1.9%), while exerting strong downward pressure on prices, which fall by 7.7% in the EU and 2.8% globally, the largest price effect among unilateral measures.

In contrast, EU-only carbon pricing (MITI) delivers the largest GHG emissions reductions, cutting EU agricultural emissions by 43% and lowering global GHG-warming pressure by 2.25%, although slight emissions increase outside the EU (+0.6%), reflecting limited carbon leakage and production relocation. Indeed, only a small production expansion outside the EU (+0.6%) accompanies this mitigation scenario, which produces the largest EU agricultural production decline (−9.1%) among the simulated measures. Furthermore, it is the only one that raises prices due to higher production costs, with average agricultural prices increasing by 7.5% in the EU and 3.2% globally.

Reducing food losses and waste in the EU (WAST) leads also to a sizeable contraction in EU output (−6.6%) driven by lower effective demand, with limited spillovers outside the EU (−0.5%) and a 1% decline in global production. With this measure, emissions reductions are moderate (−3.6% in the EU and −0.7% globally), while price effects resemble those of dietary change, generating downward pressure and a 3.3% fall in average global agricultural prices. Finally, productivity improvements through higher EU yields (PROD) have the smallest overall impacts among interventions, slightly increasing EU output (+0.3%), leaving global production and emissions virtually unchanged, and inducing only marginal price declines (−0.3% in the EU and −0.1% globally).

Integrating all food system transformation measures (ELM) delivers the strongest environmental outcomes, confirming what the literature suggests even when the policy package is implemented unilaterally by the EU. Under the EU-only integrated ELM scenario, agricultural GHG-warming pressure in the EU declines by more than 52%, translating into a global reduction of 4.3%, with emissions outside the EU falling by less than 1%. Decomposition results indicate that these emission reductions are driven primarily by MITI, with DIET playing a complementary role and the remaining measures contributing only marginally. Compared with global implementation of the integrated transformation, EU-level outcomes remain remarkably similar under unilateral EU adoption, with EU emissions falling by around 52% and agricultural production declining by about 21% in both cases. Global effects are those that differ substantially, with EU-only implementation corresponding to roughly one quarter of the reduction observed under global implementation (−16.9%). The decline in emissions is largely explained by a substantial contraction in EU agricultural production, which falls by about 21%. Spillover effects abroad are limited, with production outside the EU decreasing by around 1%, resulting in a 2.6% reduction in global agricultural output. Within the EU, production declines are mainly driven by MITI and DIET, while outside the EU DIET and WAST offset the production expansion induced by carbon pricing. Despite the inclusion of carbon pricing, the integrated approach leads to a net decline in agricultural prices, in contrast to the price increases observed under mitigation policies alone. This outcome is driven by strong demand-side effects from DIET and WAST, with a minor contribution from PROD, leading to average price declines of 9.4% in the EU, 2.4% outside the EU, and 4.5% globally.

Discussion and Conclusion:

Across the food system transformations considered, carbon pricing emerges as the most effective single intervention for reducing agricultural GHG emissions when applied only in the EU. However, its strong domestic mitigation effect is accompanied by higher agricultural prices and potential carbon leakage, limiting its global effectiveness under a unilateral EU implementation. Demand-side measures, such as dietary change and food waste and losses reduction, achieve more moderate GHG emission reductions but exert downward pressure on agricultural prices, improving average food affordability and exhibiting comparatively better international price transmission. Integrating these measures into a comprehensive food system transformation will amplify EU-level environmental benefits, halving EU agricultural emissions, while reversing the price-increasing effect of carbon pricing through dominant demand adjustments. At the same time, the integrated scenario entails a substantial contraction of EU agricultural production, highlighting potential adjustment challenges for producers.

Across all policy instruments, a unilateral EU implementation achieves only a fraction of the global effect reported in the literature, translating into about one quarter of the emission reduction achieved under global implementation. While EU-only action is effective and meaningful for reducing domestic environmental pressures, it delivers limited benefits from a global perspective and cannot substitute a fully coordinated international implementation. These results are preliminary and reflect an ongoing analysis. The full paper and presentation will extend the assessment by incorporating additional environmental indicators, including land use, livestock numbers, and nitrogen surplus, and by exploring heterogeneous impacts across countries and income groups as well as across crop- and animal-based production systems, fully exploiting the granularity of the modelling framework.

References:

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