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The reshaping of European food systems through plant-rich diets

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Chapter 2. Over 80% of the European Union's Common Agricultural Policy supports emissions-intensive animal products

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This chapter is based on the published article (<https://doi.org/10.1038/s43016-024-00949-4>). To improve consistency across the thesis, the article has been reformatted into the common structure. The scientific content, analyses, and conclusions remain unchanged, apart from minor editorial revisions.

Abstract

The EU's CAP strongly influences the EU's food system via agricultural subsidies. Linking global physical input–output datasets with public subsidy data reveals that current allocation favours animal-based foods, which use 82% of the EU's agricultural subsidies (38% directly and 44% for animal feed). Subsidy intensity (€ kg⁻¹) for animal-based foods approximately doubles after feed inclusion. The same animal-based foods are associated with 84% of embodied GHG emissions of EU food production while supplying 35% of EU calories and 65% of protein.

Keywords

Common agricultural policy; CAP; agricultural subsidies; animal-sourced food

2.1 Introduction

The global food system is responsible for approximately one-third of GHG emissions (Crippa et al., 2021), occupies half of global habitable land (Ellis et al., 2010), and accounts for more than four-fifths of all water consumption (Wu et al., 2022). Current global food emissions alone will probably preclude the 1.5 °C Paris Agreement target (Clark et al., 2020). The food system is also vulnerable to the impacts of environmental and climate change, which include increasing temperatures and shifting precipitation patterns. More frequent and severe extreme weather events are already affecting food security (Ray et al., 2019), and additional EU funds are already supporting farmers experiencing climate damages (European Commission, 2023a).

As a result, several studies have pointed out that a low-emission food-system transition towards more plant-rich diets is urgently needed and may even result in greater food security (Mora et al., 2020; Springmann et al., 2018; Sun, Scherer, Tukker, et al., 2022). Such a transition requires supportive market and policy instruments (Linares Quero et al., 2022). The EU's CAP could potentially be reconfigured as such. Currently, the CAP is composed of two pillars: Pillar I, which comprises market management and income support (that is, direct payments), and Pillar II, which targets more diverse rural development. Direct payments constitute most of the CAP budget and are allocated based on utilised agricultural area, whereas other measures or schemes are earmarked for specific objectives and projects and are more diversified.

CAP payments represent the largest expense (~30%) of the total EU budget (Supplementary Information Fig. 2.6 includes a timeline; European Commission, 2022). However, the CAP lacks long-term strategic planning for transforming agricultural systems and reducing emissions (Heyl et al., 2022; Langlais, 2023; Pe'er et al., 2020). This policy gap is concerning in the face of global environmental targets required to keep within the 1.5 °C target, which requires achieving net-zero emissions, eliminating reliance on fossil fuels, and substantially reducing animal farming within 20 years (Ekardt et al., 2018).

In contrast, the CAP supports high-emissions livestock farming through various mechanisms, including direct payments, commodity support for livestock products (for example, border tariffs), or explicit support linked to the production or consumption of livestock products (for example, coupled support, subsidies for investments, and improvements on farms, EU School Milk Scheme; Baldock & Mottershead, 2017). Whereas some investments are geared towards improving feed quality and traceability, the de facto subsidising of livestock production may lead to animal-rich diets becoming artificially cheap, both monetarily and through unaccounted externalities, supporting unsustainable patterns of production and consumption (Gautam et al., 2022; Springmann & Freund, 2022).

Here we investigate how public funds support and promote animal agriculture by tracking how EU+UK CAP subsidies flow across the global food supply chain. We use the physical-flow FABIO database (Bruckner et al., 2019) coupled with EU CAP subsidies using the FADN Public Database (European Commission, 2024; Methods). We trace upstream subsidies embodied in products sold domestically, imported by other EU countries, or exported to non-EU countries. For example, we account for subsidies allocated to animal feed production in France and then fed to cattle in the Netherlands, which is either consumed as beef domestically or exported. As such, we trace the CAP subsidy regime from producer to consumer for different products.

2.2 Methods

We used the FABIO database, which contains a global set of physical IO tables covering agriculture, food, and forestry activities (Bruckner et al., 2019). The global multi-regional input-output (MRIO) model allows for the tracking of socio-economic and environmental metrics throughout the entire supply chain, while keeping a high level of product detail. FABIO covers 191 countries (n^i), 125 food commodities (n^s), and six final demand categories (n^y) for the years 1986–2013.

Subsidy data for 2013 were available for 14 farm types (n^i) (concordance table in Supplementary Information Table 2.1) for each EU Member State (European Commission, 2024). We did not account for other international subsidies. Animal-agriculture subsidies also include those in the Common Fisheries Policy, but we only included land-based subsidies here. The overall negative picture in terms of animal-based subsidies would intensify if these were included given the high environmental impacts of fisheries, for example in terms of GHG emissions and eutrophication (Poore & Nemecek, 2018). The n^i subsidy flows are proportionally allocated to the n^s commodities of FABIO using the total output of each commodity-region combination. We assume that all food items receive subsidies (about 90% of the agricultural land in the EU receives subsidies) and overall, 99% of the subsidies are allocated. This 1% difference is likely due to the imperfect concordance between the farm and food classification systems of the different data sources. The subsidy data consist of annual surveys conducted by each EU Member State, which in principle represent the 4.9 million farms in the EU-27+UK in 2013.

We conducted a contribution analysis to assess the embodied impacts (in other words, the impacts associated with all emissions and resources throughout the entire supply chain) across the global food supply chain: $R^C = \widehat{b'}LY$, where $b'L$ is diagonalised and b' is a row vector. R^C yields the matrix ($n^*n^s \times n^r$) of the embodied impacts of each commodity-region combination, b the vector of the direct subsidy intensities (€/t) which is derived by dividing the vector e of subsidy flows by the total output x ($b' = e'x^{-1}$), L the Leontief inverse is $(I - A)^{-1}$ where I is the identity matrix (diagonalised matrix of ones (n^*n^s)), A the matrix of technical coefficients ($n^*n^s \times n^*n^s$), and Y the final demand matrix ($n^*n^s \times n^*n^y$). Full contribution analysis results are provided in Supplementary Information Table 2.2.

To analyse the impacts embodied in trade (that is, the impacts associated with all emissions and resources involved in international trade), domestic consumption was isolated from the Z ($A = Zx^{-1}$) and Y matrices (that is, the off-diagonals were set to zero), after which the R^C_{dom} was calculated as $R^C_{dom} = b'LY^{dom}$. The difference between R^C and R^C_{dom} represents the impacts embodied in trade, where the row sum yields the impacts embodied in imports and the column sum the impacts embodied in exports.

To analyse the environmental impacts, the land use and the GHG emissions extensions of FABIO were used. The GHG emission extension (in GWP100) includes direct and indirect GHG emissions by commodity as well as the emissions associated with land use change (Sun, Scherer, Tukker, et al., 2022). Conversion factors to translate the EU diets from weight to calories or protein were derived from FAO Food Balance Sheets (FAOSTAT, 2020). Data processing was carried out using Python version 3.8.8 and RStudio version 2022.07.2.

2.3 Distribution of CAP subsidies

In 2013, the total CAP budget was €57 billion, of which 84% supported food for consumption by households, 1.5% was lost through agricultural losses and 14.5% supported other uses such as biofuels or fibres. We find that 63% of CAP subsidies were domestically consumed, 23% were traded within the EU and 12%, or €6.8 billion, was exported to non-EU countries (Fig. 2.1.a). The large majority, 75%, of these non-EU exports were destined for upper-middle and high-income countries, including China, Russia, and the United States. As such, 12% of CAP subsidies do not support food security within the EU, a key goal of the CAP (Fig. 2.1.b), leading to distorted situations where China consumes more embodied CAP subsidy than the Netherlands (17% of total embodied subsidies in non-EU exports) or the United States more than Denmark (9%; Supplementary Information Fig. 2.5). Furthermore, subsidies embodied in domestic plant-based product consumption and those in exported animal-based products are similar, illustrating another example of distorted priorities (Fig. 2.1.a).

Animal products supplied only 35% of calories and 65% of proteins consumed in the EU. Yet the large majority, 82% of the CAP budget for food production, was spent on animal products, of which more than half (44%) was allocated to animal feed production (Fig. 2.1.a). Our finding is higher than other estimates using OECD (Organisation for Economic Co-operation and Development) data, probably because OECD data omit some grazing and fodder crops (Springmann & Freund, 2022; Vanham et al., 2023). Embodied subsidy amounts are highest for beef and milk, although there is variation among countries (Fig. 2.2). The proportion of subsidies for livestock production doubles for milk, beef, mutton, and goat meat once subsidies in embodied animal feed are included. For example, subsidies embodied in beef increase from €0.71 kg⁻¹ to €1.42 kg⁻¹ once feed is included, and in poultry they

increase from €0.06 kg⁻¹ to €0.15 kg⁻¹. They triple for pig meat (€0.07 kg⁻¹ to €0.28 kg⁻¹; Fig. 2.1.d provides subsidy per retail weight of different products).

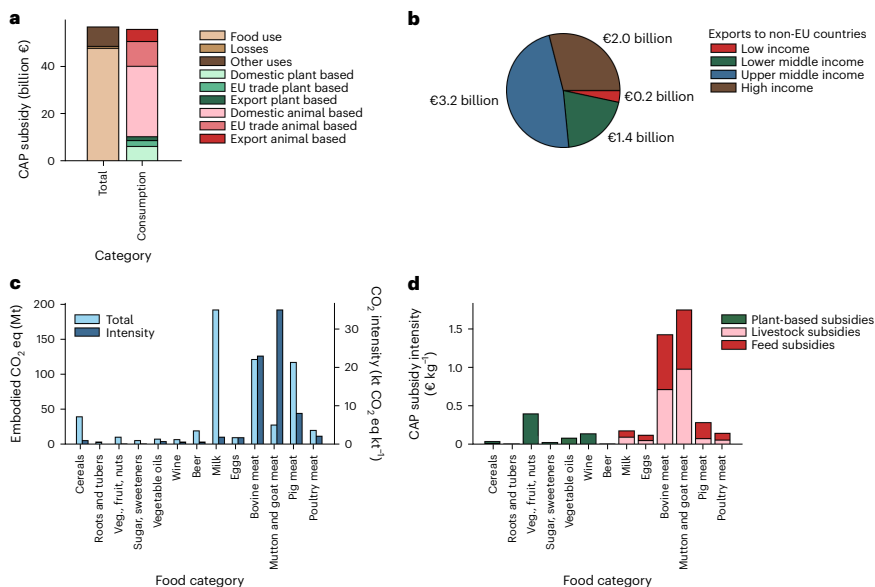


Fig. 2.1 Overview of CAP subsidies in the EU in relation to food types, international exports, emissions, and subsidy intensities. Panel a: Total CAP budget (left bar) and total EU+UK domestic food consumption and trade by animal- and plant-based foods (right bar). Panel b: Exports to non-EU countries by income level of the importing country. Panel c: Embodied CO₂ equivalent (CO₂ eq.) (in global warming potential over 100 years (GWP100)) by food category in total (light blue, left axis) and per mass (dark blue, right axis). Veg., vegetables. Panel d: Subsidy intensity of food categories in euro per kilogram of retail weight in 2013.

Nearly all European countries use notably more arable land than that available at the national level (that is, total land area required to produce food for national consumption is larger than the land area allocated for food production within the same country; Fig. 2.2). Whereas food trade remains indispensable for many of these countries in safeguarding food security (Bureau & Swinnen, 2018; Navarre et al., 2023), questions arise concerning the appropriateness of exporting agricultural subsidies, which have been specifically targeted to improve food security within the EU, to non-EU countries. It could be argued that food security here simply implies farmer support, which would mean the indirect subsidising of exports and circumventing the World Trade Organization's agreement for explicit export subsidies (WTO, 2015). EU trade in embodied subsidies is more than twice as large as non-EU trade, with substantial variation among countries. Most EU countries with large agricultural outputs export more subsidies than they import (Fig. 2.2). For instance, Denmark, Finland, and France are relatively large exporters to non-EU countries, primarily for high value-added food commodities such as milk products, pig meat, and wine (Fig. 2.2 shows the largest countries and Supplementary Information Figs. 2.1–2.4 show all other countries and per-capita results). These trade patterns of subsidised EU products can have a distorting influence on world agricultural markets as the EU's

exports may lower world food prices in some cases, weakening domestic agricultural markets (Borrell & Hubbard, 2000).

Previous research has shown that global agricultural support is channelled heavily towards emissions-intensive food commodities, which harms planetary health and hinders the production and consumption of lower-impact foods such as fruit, vegetables, and nuts (FAO et al., 2021; Stanaway et al., 2018). In the EU, products with the highest environmental impacts are heavily supported via CAP subsidies (Fig. 2.1). Although not a policy intent, animal-based commodities represent 84% of the embodied GHG emissions from EU agriculture (Fig. 2.1.c; all commodities, including non-foods, are included in Supplementary Information Table 2.3). Because CAP is based primarily on land use, and animal products require large amounts of land both directly and indirectly via feed, it results in perverse outcomes for a food transition. Although the CAP does not designate animal-based commodities as desirable, by disproportionately supporting livestock farming, especially when accounting for animal feed subsidies, the CAP presents an economic disincentive for transitions towards more sustainable plant-based foods.

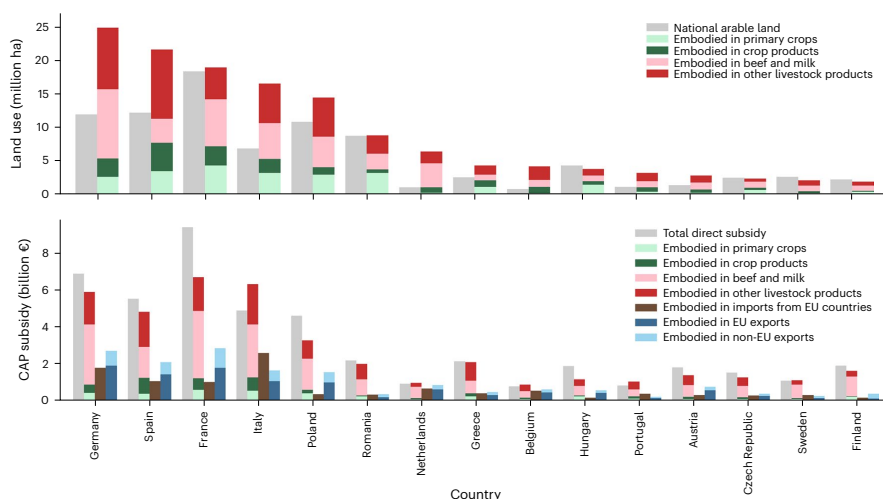


Fig. 2.2 Arable land, embodied land use, and subsidies for the top 15 land-consuming EU countries. Upper: land used for arable purposes (World Bank, 2013; cropland, meadows, pastures, gardens, and fallow) within the country and embodied land use in country-level consumption of different agricultural products based on land-use extension of FABIO (Bruckner et al., 2019). Embodied land use represents the total land area used to supply current food consumption. Where embodied land use exceeds arable land, a country is relying on land in other countries to supply a portion of its total food consumed nationally. Lower: each bar shows (from left to right): (1) total direct CAP subsidies received, (2) embodied CAP subsidy in consumption of primary crops (for example, rice, wheat, fruit, and vegetables), crop products (for example, sugar, vegetable oils, and alcoholic beverages), beef and milk products and other livestock products, (3) CAP subsidies imported from other EU countries and (4) CAP subsidies exported to EU and non-EU countries in 2013. For example, Germany directly receives (bar 1) more subsidy than it consumes (bar 2), which is due to exports to other EU and non-EU countries (bar 4). Imports from other EU countries (bar 3) are part of Germany's subsidy consumption (bar 2).

Despite some recent reductions in the total CAP budget, there are many opportunities for subsidy reform (Supplementary Information Fig. 2.6). The CAP holds the potential to steer the food system towards addressing environmental issues including climate change, biodiversity loss, disturbed nitrogen and phosphorus cycles, and water and land degradation (Baldock & Mottershead, 2017;

Gautam et al., 2022; Springmann & Freund, 2022). Understanding how subsidies can be redirected for beneficial outcomes starts with mapping how subsidies flow through production to consumption (FAO et al., 2021). We provide such a mapping for CAP subsidies, revealing several counterintuitive outcomes of the current regime and laying the foundation for future research into redesigning the CAP for environmental outcomes and food security.

Redesigning CAP policies to help support sustainable diets is urgent, as current subsidies incentivise the acquisition of physical assets related to animal agriculture (for example, automatic milking machines), resulting in a physical and social lock-in. These assets may well be stranded and represent wasted capital investment (Caldecott et al., 2013). Moreover, delaying action maintains current negative environmental impacts and can lead to decreased land-based response options due to climate change and other pressures, including the altered sink capacity for soil and vegetation carbon sequestration, reducing the potential of increased soil organic carbon storage (IPCC, 2019).

