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Options for Implementing the Polluter Pays Principle in Agriculture

A New Approach for the EU's Common Agricultural Policy

Elisabeth Christen, Gabriel Felbermayr, Hans Pitlik, Franz Sinabell (WIFO)

Research assistance:
Dietmar Weinberger (WIFO)

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Agriculture provides the raw materials needed to feed and clothe a global population of 8.3 billion, as well as the basic materials required for many other purposes. However, this comes at the cost of polluting the air, soil, water and natural habitats, and damaging biodiversity. The costs of this damage are not adequately reflected in the price of agricultural goods. As these negative externalities are invisible to market participants, too many agricultural goods are produced using harmful technologies. This general finding also applies to agriculture in the EU. To mitigate the negative effects of agriculture, the EU is currently focusing primarily on regulatory intervention and the promotion of environmentally friendly behaviour within the framework of the Common Agricultural Policy (CAP). However, this approach is insufficient, as it does not sufficiently curb the impact on the climate, the environment, and natural habitats. Furthermore, administrative hurdles cause many efforts to be ineffective and distort competition between countries. This report therefore proposes a fundamental change to the EU's agricultural and environmental policy to eliminate these problems. To this end, agriculture should be included in the European greenhouse gas emissions trading system. The same instrument should also be extended to cover other pollutants, such as nitrogen fertilisers and plant protection products. To prevent environmentally harmful production methods from increasing elsewhere in the world, a border adjustment mechanism is proposed. This combination will stimulate innovation in more environmentally friendly production methods, reduce the administrative burden, keep food price increases to a minimum, and reduce environmentally harmful pollutants in a predictable manner.

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Abstract

Agriculture provides the raw materials needed to feed and clothe a global population of 8.3 billion, as well as the basic materials required for many other purposes. However, this comes at the cost of polluting the air, soil, water and natural habitats, and damaging biodiversity. The costs of this damage are not adequately reflected in the prices of agricultural goods. As these negative externalities are invisible to market participants, too many agricultural goods are produced using harmful technologies. This general finding also applies to agriculture in the EU. To mitigate the negative effects of agriculture, the EU is currently focusing primarily on regulatory intervention and the promotion of environmentally friendly behaviour within the framework of the Common Agricultural Policy (CAP). However, this approach is insufficient, as it does not sufficiently curb the impact on the climate, the environment, and natural habitats. Furthermore, administrative hurdles cause many efforts to be ineffective and distort competition between countries. This report therefore proposes a fundamental change to the EU's agricultural and environmental policy to eliminate these problems. To this end, agriculture should be included in the European greenhouse gas emissions trading system. The same instrument should also be extended to cover other pollutants, such as nitrogen fertilisers and plant protection products. To prevent environmentally harmful production methods from increasing elsewhere in the world, a border adjustment mechanism is proposed. This combination will stimulate innovation in more environmentally friendly production methods, reduce the administrative burden, keep food price increases to a minimum, and reduce environmentally harmful pollutants in a predictable manner.

JEL: Q18, Q58, F13, F18.

Keywords: Common Agricultural Policy, environmental policy, trade policy, European Union

Executive Summary

This study identifies ways to reduce the external costs of agriculture in the EU and outlines what a fundamentally market-oriented reorientation of agricultural and environmental policy might look like. It takes up new approaches in trade policy to develop an innovative approach to solving global agricultural problems.

Agriculture, negative externalities and ineffective approaches in the EU

Agriculture is a key source of raw materials used to feed and clothe the world's population of 8.3 billion, as well as for many other purposes. However, it has a significant impact on the air, soil, water and natural habitats. Globally, it is responsible for around 20% of greenhouse gas emissions. On average, 50 kg more nitrogen is applied to arable land per hectare than is removed by plants. Pesticides contribute significantly to species extinction. The consumption of natural resources associated with agricultural production is often not considered at all, or is considered only insufficiently, in market prices ('costs are not internalised'). These unaccounted-for costs, i.e. the external costs, are not borne by those who produce or purchase the goods. This encourages the use of production methods that negatively impact the environment. Security of supply and natural resources, especially for future generations, is increasingly being compromised by environmental damage caused by agricultural production.

This finding is relevant to European agriculture, the world's largest importer and exporter of food and agricultural goods. A key reason for this is that the EU's Common Agricultural Policy (CAP), environmental policy and trade policy interact poorly and are not well coordinated. The combination of expensive, complex bureaucratic regulations and subsidies for environmentally friendly agriculture incurs high costs for producers and taxpayers, yet it is not very effective in reducing the social damage caused by greenhouse gas emissions (GHG emissions), fertilisers and plant protection substances. New geopolitical challenges and increased budgetary constraints within the EU make fundamental changes to agricultural and environmental policy even more urgent.

Damage to the atmosphere, loss of biodiversity, and pollution of transboundary waters caused by agricultural production are international problems that transcend national borders and often have global implications. Given the supranational dimension of the negative environmental effects of European agricultural production, their 'internalisation' must also be addressed at EU level. However, as not all environmental damage caused by agricultural production has a continental or global reach, national and local policy approaches remain necessary.

Market-based approaches to reducing external costs and why they have failed so far

The polluter pays principle (PPP), a key tenet of European environmental policy, requires polluters to pay for the external costs of environmental damage, thereby incentivising the adoption of environmentally friendly production methods. Despite numerous reforms, EU environmental policy has so far lacked a coherent pricing system for environmentally harmful agricultural production activities based on this principle. Since its inception, EU agricultural policy has favoured subsidies and regulation, primarily supporting agricultural incomes and supplying affordable goods. Environmental damage is primarily prevented through regulatory requirements that producers must meet to receive direct payments. Although environmentally friendly production methods are subsidised, they are often not linked to climate and environmental policy outcomes. This has resulted in a considerable administrative burden, especially for small farms, as well as excessive agricultural bureaucracy. Furthermore, the Common Agricultural Policy (CAP) will continue to account for approximately 31% of the EU budget until 2027. At the same time, ambitious global environmental targets are being missed. Coalitions of agricultural interest groups and agricultural bureaucracy favour ineffective regulatory measures and subsidies because they secure income for members and high agricultural budgets. Environmental organisations also find that regulations and requirements are usually easier to sell politically due to their high visibility.

Proposed actions and the advantages of market-based solutions

In economics, implementing the 'polluter pays' principle through a price mechanism is usually associated with the concept of 'Pigou taxes', which impose a cost on the use of environmental resources. Compared to subsidies and regulatory intervention, this market-based solution has the advantage that it does not prescribe technologies, while encouraging profit-oriented agricultural companies to seek innovative solutions to reduce damage. Additionally, the public sector generates tax revenue.

Since tax sovereignty lies with the Member States in principle, and achieving European unanimity on tax issues is difficult, implementing EU environmental taxes is politically challenging. At a national level, however, environmental taxes on agriculture are generally not applied, with a few exceptions in individual Member States, in order to avoid impairing the competitiveness of the agricultural sector and its supply chain. Strict production regulation or the taxation of environmental damage increases the risk of production being relocated to regions and countries with less stringent requirements and lower taxes ('leakage').

At EU level, an alternative market-based instrument is a system of tradable certificates. In this system, the political process limits the quantity of environmentally harmful agricultural inputs (e.g. nitrogen fertilisers and plant protection products) or pollutants (e.g. greenhouse gases) emitted, and issues certificates relating to the specified total quantity. These can then be gradually reduced to effectively achieve the necessary environmental targets. A market price for these certificates, which certify the purchaser's right to emissions or means of production, is formed. The certificate price signals scarcity. Thus, a certificate system acts like pricing environmental damage through taxation. Producers are strongly incentivised to invest in innovation. However, there is no need for costly documentation and monitoring of compliance with regulatory requirements. Additionally, the overall cap on production inputs and emissions can be set in advance, enabling better control of the environmental impact. Agriculture should become an integral part of the EU's established emissions trading system for greenhouse gases. The same instrument could also be applied to production inputs, such as nitrogen fertilisers or plant protection products. This would create a level playing field within the EU, which has been lacking until now, and would be in line with market and legal requirements.

The integration of reformed agri-environmental policy and trade policy

A significant counterargument is that, while this would reduce leakage within the EU, it would have a greater environmental impact globally. This could occur if more agricultural products were imported from countries where the environmental damage per unit produced is higher due to cost advantages. The global environment would not benefit if environmentally friendly production methods in the EU were forced out of the market.

This problem affects not only the agricultural sector, but also all other sectors that must comply with EU environmental regulations and trade goods internationally. In order to prevent these regulations from distorting competition, the EU has implemented a carbon border adjustment mechanism (CBAM) to offset the cost disadvantages associated with pricing external global climate costs. To integrate agricultural goods more effectively into global environmental and climate protection efforts, an expanded border adjustment is necessary. This would prevent the relocation of production of harmful emissions to countries without environmental regulations and create an international level playing field. An expanded border adjustment system adapted to the specific characteristics of agricultural goods can achieve this. It would eliminate any environmental policy-related competitive disadvantages for European producers in global trade when using fertilisers and plant protection products.

Assessment and summary

At least temporarily, curbing environmentally harmful production methods may lead to agricultural goods becoming more expensive. This will lead to an increase in food prices, even though agricultural products usually account for only a small proportion of the total value. For households that spend a large proportion of their income on food, therefore, accompanying compensation measures must be taken to ensure affordability.

The proposed mechanisms for internalising the external costs of EU agriculture are particularly suitable for goods whose environmental impact and pollutant content can be easily measured. Regulations already exist for fertilisers and plant protection products, and these can be modified to establish a trading system for certificates. For greenhouse gas emissions from agriculture, this is possible if specific production conditions are taken into account, and a simplified approach is adopted.

This new concept in the agricultural sector allows the negative external effects of agriculture to be internalised more effectively by incorporating them into market prices. At the same time, the EU's agricultural, environmental and trade policies could be coordinated more effectively, while reducing the administrative burden on the sector.

1. Introduction and problem definition

Natural resources such as soil, water and biodiversity are the fundamental capital of human existence, but they are only available in limited quantities. Their economic use not only serves to feed and clothe 8.3 billion people worldwide but also has numerous other uses. The value of agricultural production in the European Union reached a total volume of €532 billion in 2024 (European Parliament, 2025).

Agriculture is undoubtedly a sector of vital importance. However, agricultural production also has a significant impact on the air, soil, water and natural habitats. These significant negative external effects range from globally significant greenhouse gas (GHG) emissions such as methane (CH_4) and nitrous oxide (N_2O) to regionally critical nutrient inputs (nitrogen and phosphorus, which lead to water eutrophication and nitrate pollution) to direct damage to biodiversity using pesticides and herbicides and the cultivation systems based on and dependent on them (slimmed-down crop rotations, monocultures). Globally, agriculture is responsible for a good 20 % of greenhouse gas emissions. Per hectare, 50 kg more nitrogen is applied to arable land than is removed by plants, and the use of pesticides contributes to species extinction (Wan, et al., 2025).

The consumption of natural environmental resources associated with farming is often not considered, or only insufficiently so, in the market prices of agricultural products ("non-internalised external costs"). From an economic perspective, environmental damage is the consequence of a classic market failure: the social costs of these activities are not borne by the producer or consumer but are passed on to the public (externalised). This leads to economically inefficient incentives, the use of environmentally harmful production methods in agriculture, overproduction of environmentally harmful goods and insufficient provision of collective environmental services such as clean water or intact biodiversity.[1] The natural foundations of life, especially for future generations, are increasingly being compromised by the environmental damage caused by agricultural production, which ultimately even jeopardises the security of supply of agricultural products themselves.

These findings apply particularly to European agriculture, as the EU is the world's largest importer and exporter of agricultural goods and food. Despite significant public resources, the internalisation of environmental damage caused by agriculture has so far fallen far short of what is needed.

The original main objective of the Common Agricultural Policy (CAP), which was to provide sufficient affordable food, can be considered to have been achieved. However, in view of accelerated climate change and external geopolitical shocks, the future challenge lies less in quantity than in ensuring the sustainability and resilience of food production. However, the intensive production methods co-financed by the CAP have contributed to environmental and climate problems. The CAP stabilises farmers' incomes but often fails to achieve economic

[1] In this respect, agriculture also has positive external effects. These include, for example, extensively used agricultural land where grazing contributes to the preservation of specific habitats (e.g. Alpine pastures or extensive pastures). Such areas are beneficial to biodiversity goals and are often also used for recreational purposes.

parity with other economic sectors. Agricultural producers are highly dependent on direct payments; without subsidies, many farms would make losses. Despite the reforms introduced in recent years, agricultural subsidy policy still mainly favours large agricultural enterprises.

The results are particularly sobering when it comes to climate protection and biodiversity. Analyses of environmental damage caused by agricultural production suggest that the internalisation of the negative external effects of agriculture and the food system has so far fallen short and failed to meet expectations. Despite the considerable financial resources invested, climate-relevant greenhouse gas emissions from agriculture have not fallen significantly but are stagnating or in some cases even increasing. Agricultural policy has been unable to halt the decline in biodiversity on agricultural land, and the loss of habitats and species is continuing in many regions. The overall effectiveness of environmental policy under the CAP is considered to be low.

Essentially, effective agri-environmental policy is about eliminating identified market failures through appropriate policy measures and internalising the external costs of environmental damage. European agricultural policy has so far been based primarily on a combination of regulatory law (regulations, bans, limits) and subsidies for environmental measures. The combination of rigid regulatory law and area-based direct payments and agri-environmental subsidies has not solved the core ecological problems. While environmental targets are largely being missed, the density of regulations has led to a massive bureaucratic burden on farmers. Complex documentation and control requirements tie up producers' resources without having a measurable ecological steering effect, which also undermines the acceptance of agricultural policy.

In this context, economists are increasingly discussing market-based agri-environmental policies based on the polluter pays principle. The polluter pays principle is considered a central guideline for the internalisation of negative externalities and forms the basis of EU environmental policy (Art. 191(2) TFEU). It requires that (OECD, 2008: 12f)

> *... the polluter should bear the costs of implementing the [...] measures decided by the authorities to ensure an acceptable environmental status ... [T]he costs of these measures should be reflected in the costs of goods and services that cause environmental pollution during production and/or consumption.*

The aim is therefore to ensure that the prices of goods traded on the markets reflect the economic scarcity of intact environmental resources. The internalisation of costs by the polluters serves as an incentive to implement innovative, more environmentally friendly production methods in the agricultural sector as well.

The debate on a more efficient agricultural policy is being exacerbated by the fundamental shortage of public funds. Crises, and particularly Russia's war of aggression against Ukraine, have caused a massive shift in priorities. The EU is faced with the need to reorient its budget: growing expenditure on defence and internal security, demographic developments such as population ageing and international migration, but also the digital transformation and the uncertain effects of artificial intelligence are putting enormous pressure on the EU's financial framework, in addition to the challenges posed by climate policy. At Member State level, too, the scope for continuing subsidy policies is shrinking and there is little willingness to further increase the EU budget. As the EU budget is limited to only around 1% of gross national income and new tasks are being added, a nominal or at least real reduction in agricultural funding is likely in the next medium-term financial framework from 2028 onwards. A growing proportion of the agricultural budget will also have to be set aside for crisis reserves (droughts, floods, animal diseases), as climate change also increases agricultural production risks. As funds become scarcer, priority must be given to instruments that consistently implement the polluter pays principle and achieve environmental goals in a cost-effective manner, rather than merely supporting agricultural incomes. Budget constraints act as a driver for reform.

Policymakers have various options and instruments at their disposal to internalise the external environmental costs of agricultural production in accordance with the polluter pays principle and to improve resource allocation. Against this backdrop, this study examines the potential of a market-based reform of the CAP. Instead of relying on detailed behavioural regulations and complex subsidy rules, the focus is shifting to market-based instruments such as agri-environmental levies or certificate trading systems for emissions and environmentally harmful inputs in agriculture.

This study proposes a reorientation of agri-environmental policy away from innovation-inhibiting and administratively burdensome regulations and ineffective subsidisation of eco-services provided by agricultural producers towards a market-based policy. Such a policy places a greater burden on polluters, internalises external costs and has an impact on the competitive position of European agriculture. Furthermore, an increase in costs will not only burden domestic producers, but also consumers, due to potentially rising consumer prices.

The following chapters analyse the theoretical and empirical basis for the choice of economic and political instruments in agri-environmental policy and outline a roadmap for a market-oriented reform of the CAP. The study aims to identify feasible options and welfare-economic foundations for an alternative CAP model that

- increases the efficiency of agricultural policy by conserving the European and national agricultural budget and directing the economic burden of preventive costs for negative externalities to where it is lowest for a given environmental impact;
- creates dynamic incentives for innovation to transform European agriculture into an active and responsible player in climate protection;
- reduces bureaucratic burdens on agricultural producers by focusing on market price signals rather than controlling the behaviour of individual farms;
- identifies options for the interaction of agricultural policy, environmental policy and trade policy in the implementation of a border adjustment mechanism for agricultural imports to create a level international playing field;
- highlights the political and economic necessity of (transitional) compensation for consumers and certain agricultural producers in the process of implementing the reform.

Against this background, this study first presents empirical findings on the extent of external costs in agriculture, which result in particular from greenhouse gas emissions and the use of environmentally harmful inputs in the agricultural sector (e.g. nitrogen fertilisers and plant protection products) (Chapter 2). In addition, the spatial dimension of external effects – for example, with regard to global, international or regional impacts – is analysed and the possible consequences for the allocation of regulatory powers are discussed.

Building on this, Chapter 3 outlines the economic policy options for internalising the external costs of agriculture. It examines the extent to which market-based instruments for implementing the polluter pays principle can help to reduce existing inefficiencies in current agri-environmental policy.

Chapter 4 discusses political and economic factors that contribute to the persistence of current policies despite proven inefficiencies, as well as the prerequisites and opportunities for a fundamental reform of agri-environmental policy.

Chapter 5 deals with the possibilities of supporting the internalisation of external costs in the agricultural sector through market-based instruments at European Union level. The focus is on the extent to which trade policy measures can help to avoid or limit misallocations.

Chapter 6 derives recommendations for action and policy options for a market-oriented reform of agri-environmental policy based on the principles of the polluter pays principle, drawing on the considerations in the previous chapters.

Chapter 7 concludes the study with a summary of the most important findings and a brief outlook.

2. External costs of agricultural production and their spatial dimension

Agricultural production[2] causes environmental damage and social costs that affect livelihoods at the global, supranational and regional levels, but are not reflected, or only partially reflected, in the prices of agricultural goods. This chapter deals with the external costs caused by (1) greenhouse gas emissions, (2) the release of nitrogen compounds and (3) the pollution of ecosystems with plant protection substances, which play a major role in agricultural production.

2.1 External costs of agricultural production

2.1.1 External costs of greenhouse gas emissions

The agricultural sector is a significant source of greenhouse gas emissions worldwide[3] (GHG) and, at the same time, a sector that is itself severely affected by the impacts of climate change.[4] A distinction is made between two categories of GHG emissions from agricultural activities (Umweltbundesamt, 2025), which are recorded and reported separately:

A) Agriculture (excluding LULUCF): GHG emissions from agricultural production, which contribute to global warming to varying degrees. Within the European Union, approximately 11% of total emissions of climate-damaging gases are directly attributable to the agricultural sector.[5]

B) LULUCF (Land Use, Land-Use Change and Forestry) refers to the sector of greenhouse gas accounting that records CO_2 emissions and sinks from land use, land-use change and forestry. It is a sector that is closely linked to agriculture but is not identical to its emissions in the narrower sense. The use of peatlands and their conversion to arable land are particularly relevant to agriculture (Weingarten, et al., 2016).

Agriculture (excluding LULUCF) primarily involves emissions from enteric fermentation (metabolism of farm animals), storage and application of manure and other fertilisers, and emissions related to energy crops. In contrast to other industries, where CO_2emissions dominate, the emissions profile of agriculture is significantly influenced by methane from livestock farming and nitrous oxide from soil management:

[2] Our focus is on the production of agricultural products. External effects associated with the production of fertilisers are not considered, only those associated with their use in plant production. Emissions associated with the use of fossil fuels in agricultural production are listed under the "transport" sector according to the UN classification. They are also excluded here, as the external costs of fossil fuels (including agricultural diesel) will be internalised in future through their inclusion in the European emissions trading system.

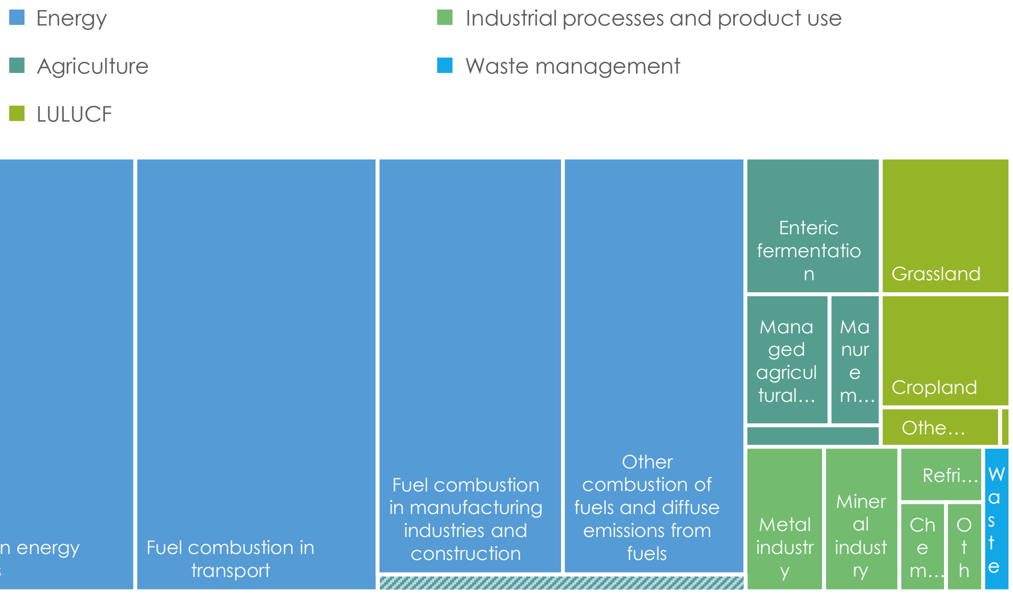
[3] These are carbon compounds (CO_2 carbon dioxide, methane CH_4) and nitrogen compounds (NH_3 ammonia, N_2O nitrous oxide, N_2 nitrogen, NO nitrogen monoxide).

[4] A study by Ray et al. (2019) shows, for example, that climate change has already caused yields of all major crops in Western and Southern Europe to decline by up to 21.2%.

[5] Emissions associated with the use of fossil fuels in agricultural production are classified under the "transport" sector according to the UN classification.

- **Livestock farming** is the main source of greenhouse gases in the agricultural sector. Animal digestion produces metabolic products that are excreted directly as gas (e.g. methane) or with excrement (including nitrogen compounds).
- In the category **of agricultural soils and plants,** greenhouse gases are produced from the application of mineral fertilisers, manure, sewage sludge and other organic fertilisers and lime fertilisers, as well as emissions from crop residues.

Figure 2-1 : **Sources of greenhouse gas emissions in Germany in 2024**



Source: WIFO calculations based on Umweltbundesamt, 2025.

Figure 2-1 illustrates the sources of greenhouse gases in Germany in 2024. The upper right section shows "Agriculture" and "LULUCF", and "Combustion of fuels in agriculture and forestry" is part of the emissions from "Combustion of fuels", the main source of emissions in Germany. The diagram shows the composition of total emissions in greenhouse gas equivalents (CO_2eq). Different gases are standardised to an equivalent amount of CO_2 according to their global warming potential.

The main share of greenhouse gas emissions within the agricultural sector is accounted for by methane emissions from fermentation and emissions from manure management (Germany: 64% in 2024).[6] This is important from an economic and ecological perspective, as these gases have a higher global warming potential than CO_2 and reducing them would require direct

[6] The figures given refer to Germany and the year 2024 (greenhouse gas emissions according to UNFCCC; https://datacube.uba.de/).

changes in production practices. A further 28% comes from agricultural soils, 4% from lime and urea fertilisers (see Table 9-1 in the appendix).

Almost all (specifically 97%) of the emissions from the "agriculture sector" in emission source A are related to livestock farming, the use of nitrogen- and carbon-containing commercial fertilisers and the mineralisation of organic fertilisers (especially farm manure). If we limit ourselves to easily observable emission sources (livestock and farm manure, commercial fertilisers, cultivation of organic soils), 83% of emissions from the "agricultural sector" can be explained.

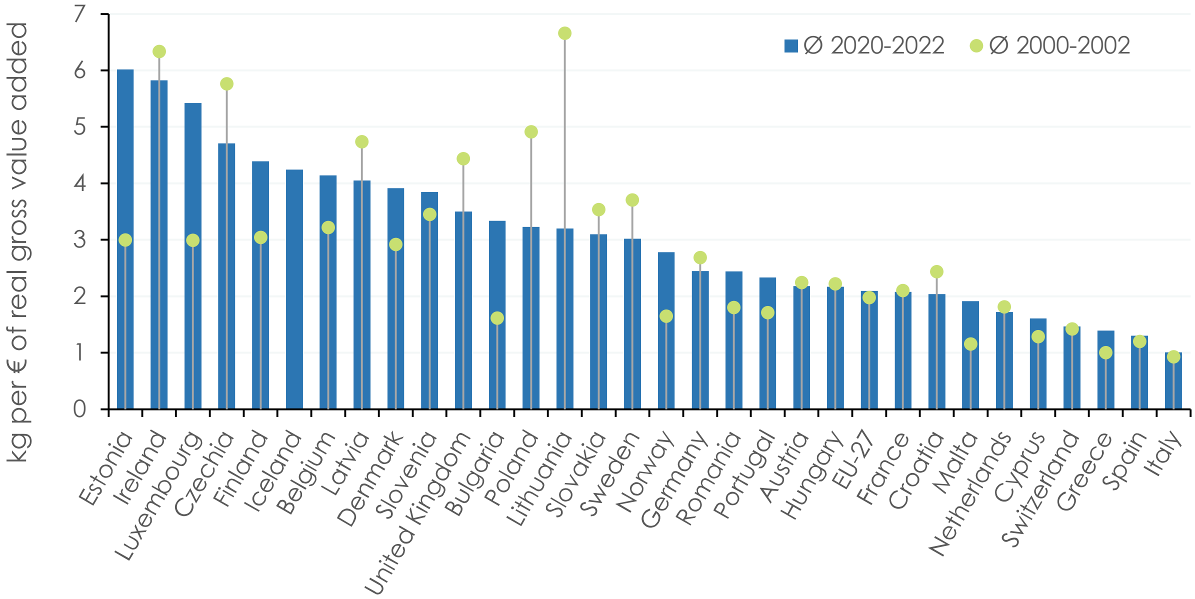
While industrial processes usually have point sources of emissions, GHG emissions in the agricultural sector almost always arise as diffuse sources within complex ecosystems and cannot be determined precisely, even with a high level of technical effort. "Emission measurements" in the greenhouse gas inventory are based on technical coefficients that are related to agricultural activities. What is measured is the input (e.g. number of animals in different categories, area of arable land and grassland with a certain organic matter content, the amount of nitrogen fertiliser by type). In agriculture, the variation in emissions from individual units (e.g. dairy cow, slaughter bull, tonne of nitrogen fertiliser, hectare of arable land) is also relatively large (Leip et al., 2015; Jacobs et al., 2018, Zentraf et al., 2025). Natural conditions such as groundwater levels or weather conditions, in conjunction with management practices, have a significant influence on actual emission levels.

Emissions of various GHGs are converted into CO_2 e (CO_2 equivalents) and thus standardised.[7] The conversion of various GHGs into CO_2e serves to enable comparison and aggregation of their climatic impact. According to the IPCC (2022), the agricultural sector accounts for around 23 % of global GHG emissions because of livestock farming, fertiliser use, energy consumption and land use changes. In 2023, the EU agricultural sector was responsible for around 365 million tonnes of CO_2 e, meaning that around 11.8 % of the EU's total greenhouse gas emissions can be attributed to direct agricultural emissions (EEA, 2023). More than half of these emissions are attributable to methane from livestock farming. In Germany, agriculture accounted for 8.2 % of total greenhouse gas emissions in 2023 (Umweltbundesamt, 2025).

Figure 2-2 shows GHG emissions (in kg CO_2e) in relation to value added (in €) in the agricultural sector (excluding LULUCF) in an international comparison. In most countries, both the intensity and the absolute burden have been reduced. Despite a reduction in EU agricultural emissions since 1990, the trend has been virtually stagnant over the last ten years. Emissions have fallen much more slowly than in other sectors, resulting in a reduction of only 7 % since 2005 (EEA, 2025). Forecasts by the European Environment Agency emphasise that the European climate targets for 2030 will be difficult to achieve without a radical reorientation of instruments.

[7] Germany's agricultural sector (excluding LULUCF) emitted just under 54 million tonnes of CO2e in 2024. Germany's net LULUCF emissions (releases minus removals) amounted to 51 million tonnes of CO2e in 2024. Arable land and grassland accounted for 77% of this total.

Figure 2-2 : **Greenhouse gas emissions from agriculture in kg per euro of real gross value added in an EU comparison (Ø 2020-2022 and Ø 2000-2002)**



Source: WIFO calculations based on EUROSTAT, greenhouse gas emissions by source sector [online data code: env_air_gge] and EUROSTAT, Economic accounts for agriculture - values at real prices [online data code: aact_eaa04]. Note: Emissions associated with land use changes are not included in this calculation.

2.1.2 External costs of fertiliser use

Plants can synthesise protein from mineral nitrogen compounds, especially nitrate. Most plants can only thrive if nitrogen and other nutrients are available in the soil. Fertilisation (farmyard manure from livestock, fermentation residues, compost and commercial fertilisers) can increase plant yields.[8] Environmental pollution caused by nitrogen[9] occurs via two channels:

- Emissions into the air (especially nitrous oxide) occur when nitrogen-containing fertilisers are applied, before water-soluble compounds seep into the soil and become available to plants. Air emissions contribute significantly to global warming and are attributed to the agricultural sector as GHG emissions. Nitrogen compounds transported through the air also introduce the nutrient into ecosystems where species thrive on low nitrogen levels. This input exposes them to competition from nutrient-loving plants.

[8] Erisman et al. (2008) argue that without the cost-effective production of nitrogen, the world's population would have grown only half as much in the 20th century.

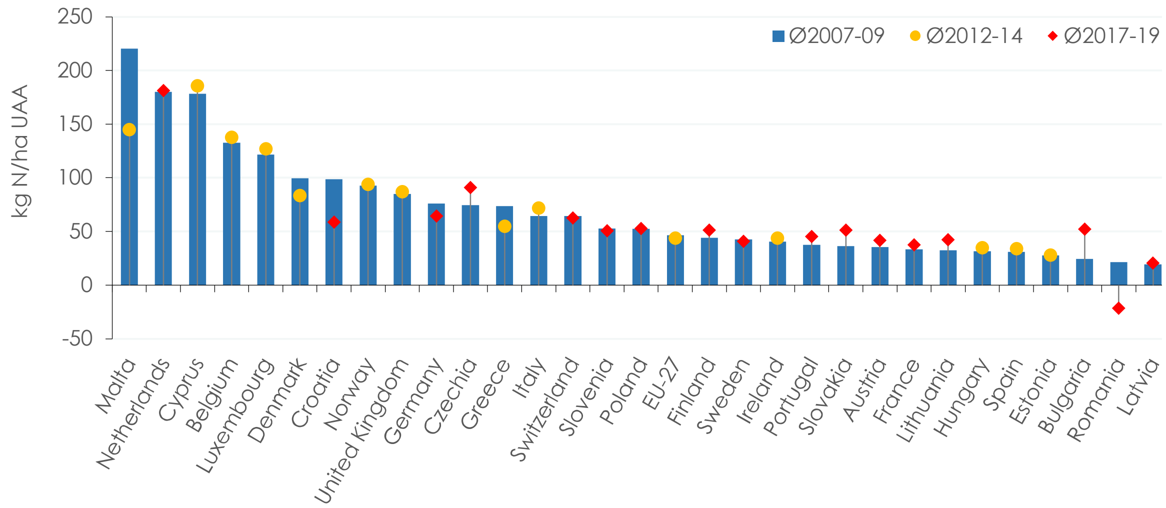
[9] The production of mineral nitrogen fertilisers is energy-intensive and requires large amounts of natural gas. Globally, approximately 2% of total greenhouse gas emissions can be attributed to the production of nitrogen fertilisers. In the greenhouse gas inventory, these emissions are recorded in the chemical industry sector.

- Water-soluble nitrogen compounds enter surface waters, and those that are not absorbed by plants can be transferred to groundwater. Accumulations in lakes and coastal waters contribute to nutrient enrichment and alter species composition.

Nitrate pollution of groundwater is also a potential hazard to human health. Drinking water with a nitrate content of more than 50 mg nitrate/litre may not be placed on the market. After the quality of groundwater declined in many regions of Europe in the 1980s, uniform EU standards for drinking water quality were introduced. The 1991 Nitrates Directive was intended to help reduce nitrogen inputs and nitrate formation. Monitoring results show that in some EU countries, a high proportion of groundwater resources are still significantly contaminated with nitrate. Although agriculture is not the only source of pollution, it is the main contributor.

The nitrogen balance is a measure of environmental pollution and measures how much of the nitrogen (N) applied is not absorbed by crops and is removed with the harvest. This amount therefore remains in the environment. Figure 2-3 shows that nitrogen pollution per hectare of agricultural land has improved only marginally in many EU Member States and has even deteriorated noticeably in some countries in recent years.

Figure 2-3 : **Nitrogen balance per hectare of agricultural land in an EU comparison for the periods 2007-2009 and 2012-2014 and 2017-2019 (3-year average)**



Source: WIFO calculations based on EUROSTAT, gross nutrient balance [online data code: aei_pr_gnb]. Balance of the total agricultural nitrogen balance in relation to the area used for agriculture (UAA).

2.1.3 External costs of pesticide use

Plant protection products are intended to secure crop yields. They are used in conventional and organic farming.[10] Pesticides reduce the population density of harmful organisms (fungi, bacteria, insects). Herbicides are used to prevent competing plants from thriving. The use of pesticides is considered a major factor in the loss of biodiversity and the alteration of natural habitats (ipbes, 2025; Wirth, et al., 2024; Rani et al, 2021; Zhang, et al., 2018). The external costs of pesticides include:

- Damage to organisms that do not harm crops, altering species composition and threatening biodiversity.
- Pollution of environmental media (water, air, soil) by persistent degradation substances.
- Harm to humans through the transport of active substances and their degradation products via the air or water.

Before plant protection products are placed on the market, they must undergo testing procedures in which their beneficial and harmful effects are thoroughly examined.[11] Approved products may only be used for defined areas of application. The use of plant protection products is measured by the quantities of active substances sold.[12] Figure 2-4 shows the quantities of plant protection products sold in EU countries (see columns, left scale). Large countries also sell the most active substances. The right-hand scale shows the amount sold in relation to the value of plant production in each country. There are significant differences between countries, which can be explained by the production structure and the value of the products produced. These differences indicate that there is also considerable heterogeneity in the costs of reducing plant protection products.

When using plant protection products, it is not only the quantity and type of substances used that play a role, but also their specific toxicity. The environmental risk can be quantified independently of the amount of active ingredient using the TAT (Total Applied Toxicity) indicator (Schulz et al. 2021; Bub et al. 2023). TAT makes it possible to comprehensively assess the potential effects of plant protection products on the environment (Wirth, et al., 2024). While application takes place at the local level, the cumulative effects on European biodiversity are critical. This is due to the mostly non-specific mode of action of many substances, which drift or wash into adjacent biotopes and disrupt the natural food chains there.

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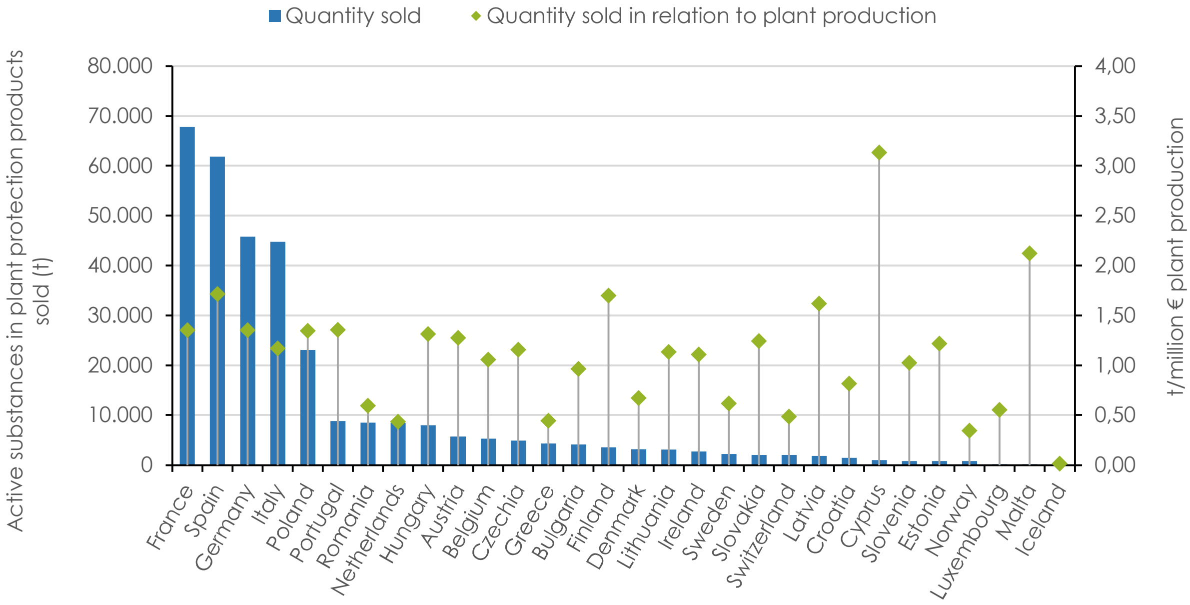
[10] In organic farming, for example, copper-based preparations are used as fungicides or mineral oils. See the overview of different approaches in EU Member States: https://www.forschungsring.de/de/projekte/projekt/organic-plus

[11] See https://www.efsa.europa.eu/de/topics/topic/pesticides. Neumeister (2022) provides a critical assessment of approval practices in various countries and approaches to reducing application rates.

[12] The annual "quantity placed on the market" may differ from the quantities actually used in agriculture. In addition, the statistics also include substances used in commercial and private applications.

Figure 2-4: **Sales volumes of active ingredients in plant protection products (in tonnes, left axis) and in relation to plant production (in tonnes per million euros, right axis) in an EU comparison, Ø 2021-2023**



Source: WIFO calculations based on EUROSTAT, sales of plant protection products [online data code: aei_fm_salpest09] and EUROSTAT, agricultural accounts – values at current prices [online data code: aact_eaa01]. Data retrieved on 16 September 2015, data status August 2025.

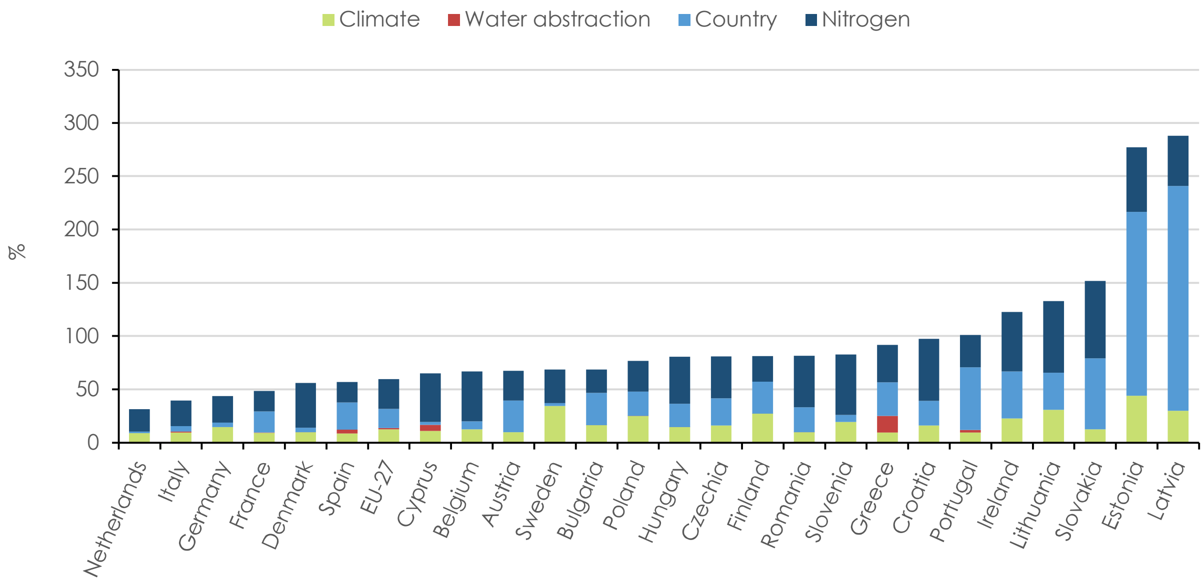
2.2 The FAO's "true cost" approach as an attempt at global accounting

In a highly acclaimed study, the FAO (2023) attempts to use true cost accounting (TCA) to estimate the hidden (external) costs and benefits of agricultural and food systems that are not included in the market price of food. The FAO emphasises that although agriculture secures the basis of global food supply, the ecological follow-up costs actually exceed the economic value added by the sector in many regions. In addition to environmental costs from GHG emissions, land use change, water abstraction and the loss of ecosystem services, TCA also takes into account health costs (e.g. productivity losses and disease burden from unhealthy diets) and costs related to poverty and malnutrition, which reduce productivity. Data from various global datasets is used at national level to model the impacts and combined with monetary estimates to assess the external costs in monetary terms. In many countries, the environmental "hidden" costs exceed the production value of the agricultural sector (Figure 2-5).

The FAO estimates that the global quantified external costs of agricultural and food systems in 2020 amount to at least $10 trillion per year, which is almost 10 % of global gross domestic product. Some estimates even put them at $12.7 trillion at purchasing power parities. For Germany, the external costs due to greenhouse gases are estimated at $10 billion and those due to nitrogen emissions at $17 billion (FAO, 2023, Table A2.1, p. 100). About one-fifth of the external costs are directly attributable to environmental impacts, which are often not reflected in the price of agricultural products (see Table 9-2 in the appendix).

The FAO report shows that current agricultural and food systems are significantly more expensive for society than market prices suggest, because many follow-up costs are not internalised. Despite considerable margins of uncertainty, the results emphasise that the market price-based costs of food only reflect part of the actual social burden.

Figure 2-5: **Ratio of the environmental "hidden" costs of agriculture compared to the production value of agriculture**



Source: WIFO calculations based on FAO. 2023. The State of Food and Agriculture 2023 – Revealing the true cost of food to transform agrifood systems. Rome. https://doi.org/10.4060/cc7724en and EUROSTAT, Agricultural accounts – Values at current prices [aact_eaa01].

2.3 Spatial dimension of external costs and political regulatory responsibilities

The damage to the atmosphere caused by GHG emissions, the loss of biodiversity, soil degradation and the pollution of transboundary waters due to fertilisers and plant protection substances in agricultural production has a spatial dimension.

While the need to internalise external costs in agriculture is undisputed, the question of the optimal political level of regulation (governance) remains the subject of intense debate. The theory of public goods (Samuelson, 1954, Musgrave, 1959) and the economic theory of federalism (Olson, 1969; Oates, 1972) provide a theoretical basis for the normative question of the appropriate political level that should be responsible for regulating the internalisation of the external costs of agricultural production. These approaches provide two key criteria for the allocation of competences.

The **decentralisation theorem** (Oates, 1972) states that decentralised regulation has the advantage of being better able to reflect local preferences and specific ecological damage costs. The **principle of fiscal equivalence** (Olson, 1969) requires that the spatial extent of the political decision-making area should correspond to the circle of beneficiaries or victims. **The**

more global the damage, the more centralised the regulation must be. The more local the damage, the more efficient decentralised control is. The spatial extent of negative externalities is important when it comes to determining which level of government should be responsible for limiting their extent.

Greenhouse gases such as CO_2, CH_4 and N_2O are mixed globally within a short period of time after they are emitted. The location of the emission is practically irrelevant for the climate impact. A reduction in emissions in one country also changes the global greenhouse gas concentration, regardless of where it takes place. The climate effect does not depend on local emission flows, but on the global atmospheric concentration of the gases. Emissions have a global impact, regardless of country or sector boundaries (e.g. agriculture vs. industry).

Limiting agricultural greenhouse gas emissions is therefore a **global public good**, as the benefits of emission reduction are non-rivalrous, non-excludable and distributed globally (Samuelson, 1954). This characteristic is particularly pronounced in the case of agricultural emissions, because not only are CH_4 and N_2O in particular very effective in terms of climate impact, their agricultural sources are diffuse and cannot be controlled at specific points, technical measurement is difficult, and local emission reduction does not generate any exclusive local climate benefits. This structure explains the high need for coordination of national and international climate policy regarding the reduction of greenhouse gas emissions. The marginal benefits of central coordination far outweigh the advantages of local flexibility in this case. According to the principle of fiscal equivalence, action is required at EU level:

- National regulation would lead to carbon leakage: companies would relocate to countries with lower standards without reducing global damage.
- An EU-wide regulation ensures a level playing field in the internal market.

The use of **fertilisers** is a precondition for high yields, but inefficient application leads to massive pollution of the biosphere. Nitrate pollutes groundwater and surface water when it cannot be absorbed by plants. Nitrogen and phosphorus inputs cause externalities with varying spatial radii. On the one hand, they pollute local groundwater bodies (regional dimension), and on the other hand, they lead to eutrophication of transboundary waters such as the North Sea and Baltic Sea (supranational dimension) via river systems. A **multi-level governance system** is optimal in such a situation. However, the specific design and pricing should be determined at national or regional level:

- Cross-border pollution of surface, coastal and marine waters falls primarily within the competence of the countries concerned. Since nitrogen is transported in practically all waters, it stands to reason that the EU should be given the authority to limit the damage. This situation has been addressed since 1991 by the Directive on the protection of waters against pollution caused by nitrates from agricultural sources, which sets out regulatory provisions. In the current nitrate report of the German Federal Ministry of Food and Agriculture (BMEL) and the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV): 'Despite slight improvements in individual parameters, coastal and marine waters remain in poor condition.' (BMEL and BMUV, 2024).

- Mineral components of nitrogen fertilisers that pollute groundwater cause regional negative external effects. If permissible groundwater thresholds are exceeded, this should be regulated at regional level. Decentralised regulation allows regional ecological scarcities and damage costs to be reflected in the price system.

Chemical **plant protection substances** have toxic effects on non-target organisms due to the often non-specific mode of action of many substances. The damage (loss of biodiversity, toxicity to soil organisms) occurs primarily locally on the land or in adjacent habitats. The decentralisation theorem therefore initially argues in favour of local or national responsibility. However, plant protection products can drift or wash into adjacent biotopes and disrupt food chains there. Conversely, several authors consider **biodiversity** to be a global public good with special characteristics (e.g. Anderson et al., 2021). Following this line of argument, the responsibility for regulation should ideally be centralised at the supranational level in this case as well. The EU Rregulation on nature restoration has only recently taken this fact into account. However, the choice of instruments to achieve the objectives set out in the Regulation is left to the Member States. One consequence of this is that plant protection products with the same active substance are authorised in some EU Member States but not in others.

3. Regulatory vs. market-based instruments of agri-environmental policy

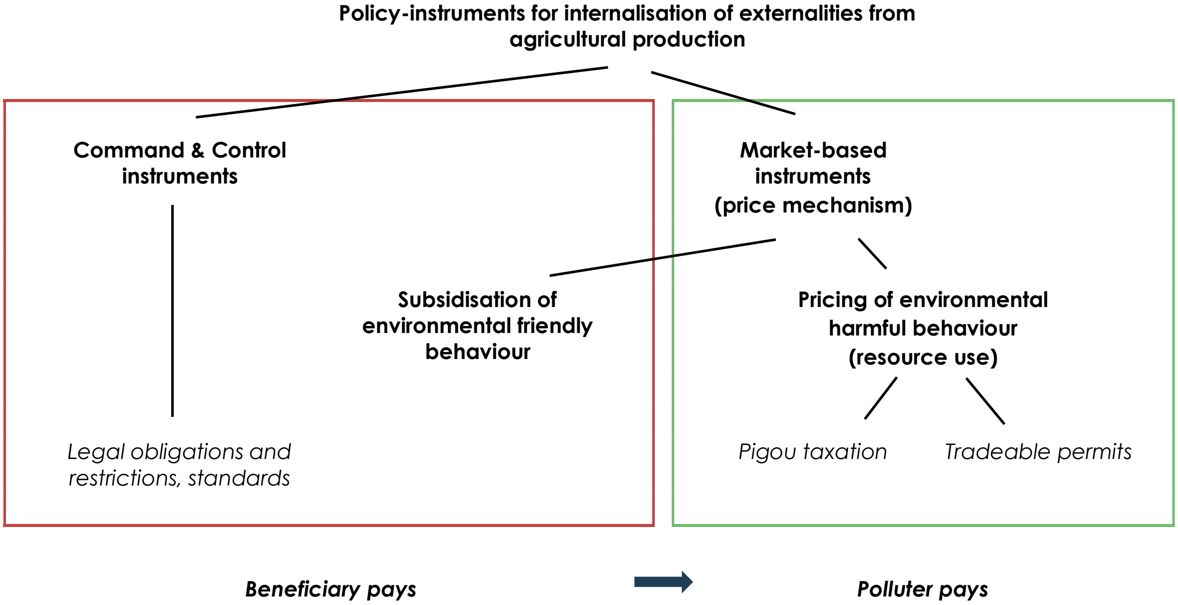
3.1 Theoretical basis for the choice of instruments

The internalisation of the social costs of agricultural production is the central objective of agri-environmental policy (e.g. Cooper et al., 2009; McCann, 2013; Deryugina et al., 2021). From an economic perspective, the choice of appropriate instruments for internalising externalities is primarily a question of efficiency (e.g. Stavins, 2007; Goulder & Parry, 2008). Theoretical environmental economics distinguishes between

- static allocation efficiency, which requires that an environmental policy outcome target, e.g. the quantitative reduction of pollutant emissions, should be achieved at the lowest possible economic cost.
- dynamic efficiency, which exists when there are permanent incentives for technological and organisational innovations to reduce the costs of preventing environmental damage in the future.

There is a broad portfolio of regulatory or market-based policy instruments for reducing environmental pollution or damage. Figure 3-1 schematically illustrates the classification of these instruments.

Figure 3-1: **Policy instruments for internalising external costs**



Source: WIFO.

Regulatory instruments are requirements in the form of documentation and reporting obligations[13], emission limits and regulatory thresholds, prescribed technology standards and technical process regulations, area-based constraints and land-use regulations, as well as restrictions on the use of production inputs. Compliance with the regulations is monitored by government agencies ("command and control", CC).

In the context of agri-environmental policy, CC refers to the direct control of environmental pollution through standards that prescribe how production must be carried out or emissions must be controlled. In theory, differentiated performance or production standards in the CC approach could be designed in such a way that the reduction of external environmental damage can be achieved at minimal cost (static allocation efficiency); In practice, however, the state or the regulatory authorities generally lack the necessary information about the individual damage prevention costs of individual producers. Particularly in cases of pronounced heterogeneity of technological possibilities and specific framework conditions, CC instruments prove to be cost-inefficient in the internalisation of externalities (Newell & Stavins, 2003). They apply a "one-size-fits-all" approach that ignores heterogeneous framework conditions, technological possibilities and cost structures. A uniform limit value, for example, forces companies with low damage prevention costs to make less effort, while it can be very expensive for companies with high prevention costs. In this respect, regulations generally also lack dynamic efficiency. Once a prescribed limit is met or a technology standard is complied with, there is no further incentive to invest in more environmentally friendly or efficient technologies.

Regulatory instruments entail complex information requirements, approval and licensing procedures as well as bureaucratic monitoring and sanction mechanisms. Compliance and implementation cause administrative burdens or lost income opportunities for agricultural suppliers and bureaucratic costs for the public sector.

Market-based instruments (MBIs) put a price on environmentally harmful activities. They are policy tools that use price signals in markets to reduce or eliminate negative externalities. MBIs aim to encourage environmentally friendly behaviour through financial incentives rather than administrative requirements, thereby ideally also helping to reduce bureaucracy. The decisive factor for the incentive effects of MBIs is the change in relative prices between environmentally harmful production and refraining from it. MBIs price externalities, environmental resource consumption, and make the use of environmentally harmful production methods more expensive. They create a cost incentive to avoid emissions, reduce the use of environmentally harmful inputs and/or use more environmentally friendly production methods.

The **distinction between the polluter pays principle and the beneficiary principle** is central to this. Market-based instruments (MBIs) can be based on both principles. In both cases, they aim to internalise external costs into private decision-making processes by making environmentally harmful activities relatively more expensive. However, the two principles differ in their legal,

[13] Initiatives to promote environmental awareness or the obligation to make product characteristics and environmental impacts transparent (e.g. EU directives on sustainability reporting) serve to influence behaviour in the long term. The aim is to provide information that enables consumers to make more informed purchasing decisions and encourages companies to take greater environmental responsibility ('moral suasion').

distributional and political-economic implications and thus also in their effects on allocative and dynamic efficiency.

The **beneficiary pays principle** requires that those who benefit from an improvement in the environment should also bear the costs of preventing damage, regardless of who caused the damage. The instrument is not the pricing of pollution, but the **subsidisation of environmentally friendly behaviour.** This increases the opportunity costs of environmentally harmful behaviour if the producer does not receive any support without changing their behaviour.[14] The financial burden of reducing environmental pollution by reducing the amount of (agricultural) goods produced or by changing production methods is distributed among the general public and taxpayers, rather than being borne by those responsible for the environmental pollution. One variant is direct payments for clearly defined ecosystem services (payments for ecosystem services), which, however, only come into question for purely positive external effects.

While in theoretical discussions subsidies are seen as a suitable instrument for internalising negative external effects by subsidising the costs (reducing the price) of more environmentally friendly production methods, in practice several problems arise that make the use of this instrument inefficient and, in some cases, questionable.

On the one hand, subsidies incur high fiscal costs and can place a significant burden on the national budget. There is a risk of windfall gains when subsidies are paid to companies that would have implemented the measures, anyway, thereby imposing budgetary costs without generating additional environmental benefits.

On the other hand, subsidies are often not targeted precisely enough to directly and effectively address critical environmental problems. This is also due to the fact that, due to a lack of information, subsidies are often designed in such a way that they are not linked to climate and environmental policy outcomes (e.g. emission reduction), but to the use of certain technologies.

In addition, subsidies often pursue additional political goals (e.g. income security or cushioning structural change) alongside the internalisation of external effects. In this respect, they tend to be viewed critically in the economic literature on environmental agriculture (Arguedas & van Soest, 2009; Amaglobeli et al., 2024; Bernini & Galli, 2024; Matthews & O'Neill, 2025).

The **polluter pays principle** states that the party responsible for a negative external effect should also bear the costs of preventing or reducing it. The polluter pays principle is the basis of **EU environmental policy** (Art. 191(2) TFEU) and, in this context, also serves as a guideline for the internalisation of negative external effects. **Taxes on environmentally harmful production inputs, emission taxes (CO_2 levies or eco-taxes) and emissions trading are market-based mechanisms for internalising the external costs of agriculture in accordance with the polluter pays principle.** Emitters are encouraged to reduce environmentally harmful emissions because the use of pollutants or pollutant emissions is priced.

[14] Technically speaking, "refraining from emitting a negative external effect" creates a (supportable) positive external effect.

Taxes and levies set a price for the use of scarce environmental resources, or for each emission unit or pollutant used, but do not set a quantitative upper limit for pollution. The total reduction in damage achieved depends on the tax rate and the options for adjustment. Polluters can decide flexibly whether to avoid emissions (investment in technology/other cultivation methods) or pay the tax. External damage is automatically avoided where the (marginal) avoidance costs are lowest.

The idea of taxing negative externalities goes back to Pigou (1920). For efficient allocation, the causation ("emission") of negative externalities should affect the polluter in such a way that marginal charges reflect the external damage caused by the activity (e.g. de Mooij et al., 2012).[15]

Proponents of Pigou taxes emphasise their advantages in terms of administrative simplicity (reduction of bureaucracy) and cost predictability. The fixed price per unit of emission or pollutant provides farmers with stable incentives and investment signals for the use of emission reduction technologies or for diversifying their product portfolio. Pigou taxes also generate revenue for the state, which can be used, for example, to compensate consumers (social compensation) or to reduce growth-inhibiting taxes (the "double dividend" thesis).

The disadvantage is that the extent of the environmental damage caused cannot be directly controlled by taxes based on the amount of emissions or pollutant inputs. In agriculture in particular, the weakness of damage-based taxes lies in their practical implementation, as agriculture is characterised by many diffuse emission sources (non-point pollution). This forces a switch to input-based taxes, which ignore different emission potentials (e.g. for different soils).

The polluter pays principle also corresponds to the idea of a **certificate trading system (cap-and-trade)**. Individual permits ("pollution rights") for the emission of pollutants (e.g. greenhouse gases) or the use of production resources (e.g. fertiliser use) are created and traded. The quantity of certificates issued sets an upper limit ('cap') for permissible emissions (environmental damage). This regulatory requirement is combined with the possibility of trading ('trade') the rights. Cap-and-trade creates market incentives by requiring rights to cause negative external effects in the production process to be purchased or, once allocated, traded on a market. A price is formed on the market for the securitised right to emit or use means of production. Unused rights can be sold by their owners, and producers who need additional permits can purchase them on the market. The higher the demand for certificates, the more the price rises when the total supply is limited (e.g. Meckling & Jenner; 2016; Stavins, 2022).

A cap-and-trade system works in principle like pricing environmental damage through taxation, but in contrast, the permissible amount of pollutant emissions or environmentally harmful inputs used is fixed, and the price of pollution rights is determined by the supply and demand for certificates. Producers have incentives to generate fewer external costs and/or invest in environmentally friendly innovations in order to keep the costs of purchasing certificates low,

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[15] If there are unavoidable distortions in third-party markets, the polluter pays principle in Pigou's sense implies the implementation of 'second-best solutions', but not a fundamental departure from the principle of offsetting marginal social costs.

or even to generate their own revenues from the sale of rights. This system thus promotes both static and dynamic efficiency. As a result, rational profit-maximising producers will demand as many permits as necessary until the certificate price corresponds to their (marginal) damage avoidance costs.

As with the tax solution, rights trading leads to an equalisation of marginal abatement costs across all producers, which minimises overall costs. This approach is therefore also associated with more or less severe price fluctuations. This can reduce planning security for all market participants. However, it offers the **advantage that the fixed cap ensures that the targeted emission or pollution levels are adhered to**. Cap and trade is therefore considered the preferred instrument in economics when compliance with an environmental target is the primary concern, as the cap ensures that the ecological target (the reduction amount) is achieved.

Depending on the institutional structure of the certificate issuance, the state either receives no revenue or proceeds from the sale of emission or purchase rights. The measurability and verification problems that are already central to Pigou tax solutions also arise in certificate trading. Tradable emission rights cannot be precisely defined, which makes it difficult to establish a strict output-based definition of tradable rights, particularly in agriculture. Without precise measurement of emissions at farm level, compliance with the cap cannot be verified or sanctioned. **Input-based certificate trading therefore appears to be the more economically and politically realistic MBI solution for quantity control in connection with the negative external effects of agriculture.**

However, the theoretical dichotomy between MBI and CC approaches is highly simplistic. The implementation of MBI usually requires complementary regulation. Cap-and-trade systems require a regulatory cap on emissions or pollutant use, and Pigou taxes not only require a legal framework for their levying and collection, but the setting of the tax rate is also based on an implicit idea of the quantity of pollutants to be limited, which must be determined in the political-regulatory process.

Overall, **market-based instruments (MBIs**) do not prescribe any specific technology and do not impose emission reduction targets for individual producers. This facilitates the search for cost-effective methods of reducing external effects. Accordingly, economists generally favour polluter-based pricing through Pigouvian taxes or the establishment of permit markets over subsidies and command-and-control regulation (e.g. Krupnick and Parry, 2012; Berendse, 2017; Finger et al., 2017; Arvanitopoulos et al., 2021).

An overview of the advantages and disadvantages of the various approaches to internalising external effects is provided by Table 3-1. It shows that the measurement of harmful effects or emissions and the administrative burden are not negligible in any of the options considered, but that there is little difference between the instruments (regulatory measures, subsidies, taxes and cap and trade).

Table 3-1: **Overview of the assessment of environmental policy instruments**

Criterion	Regulatory law	Subsidies	Taxes, cap and trade
Basic logic	Mandates, prohibitions, limits, standards	Rewarding desired practices	Relative prices influence behaviour
Achievement of environmental targets	High (if complied with)	Uncertain	High (especially cap and trade)
Static efficiency	Low: same requirements for all	Low to medium: windfall gains	High: reduction where it is most cost-effective
Innovation incentives	Weak	Weak to moderate	Strong
Measurement and bureaucratic costs			
Non-point source emissions	high	high	high
Point source emissions	limited	limited	limited
Bureaucratic costs	high	medium-high	limited
Distribution effects	unclear	income support for farmers	Potentially regressive
Political acceptance			
Agricultural associations	Medium	High	low-medium
Agricultural bureaucracy	high	high	low-medium
Consumers	unclear	low	Depends on design
EU compatibility	high	High (CAP)	limited / in need of reform

Source: WIFO compilation.

3.2 Approaches in the CAP to internalising external costs of agriculture

3.2.1 Evolution of agri-environmental policy

The Common Agricultural Policy (CAP) was established in 1957 with the primary aim of ensuring food security for the population and stabilising farmers' incomes. According to these ideas, agriculture is characterised by very long production cycles and short-term weather conditions, which makes it more vulnerable to economic fluctuations and would justify special political intervention to secure food supplies. Specific characteristics thus justify the "exceptionalism" of agricultural policy (e.g. Greer, 2017). When it effectively entered into force in 1962, the CAP aimed to maintain agricultural prices above world market levels through quasi-planned instruments such as supply quotas, intervention purchases, tariff barriers and export subsidies. [16]

In the decades since its inception, the CAP has undergone repeated reform processes. In the process, environmental regulations have gradually evolved and gained in importance (European Court of Auditors, 2024). The MacSharry reforms (1992) marked the first steps towards market liberalisation and the integration of climate and environmental objectives (Henke et al., 2011; Lakner & Röder, 2024). Prices were lowered and market support expenditure significantly reduced in order to limit agricultural overproduction. Instead, subsidies (direct

[16] An overview of the development of the CAP can be found at https://www.bmleh.de/DE/themen/landwirtschaft/eu-agrarpolitik-und-foerderung/gap/gap-geschichte.html

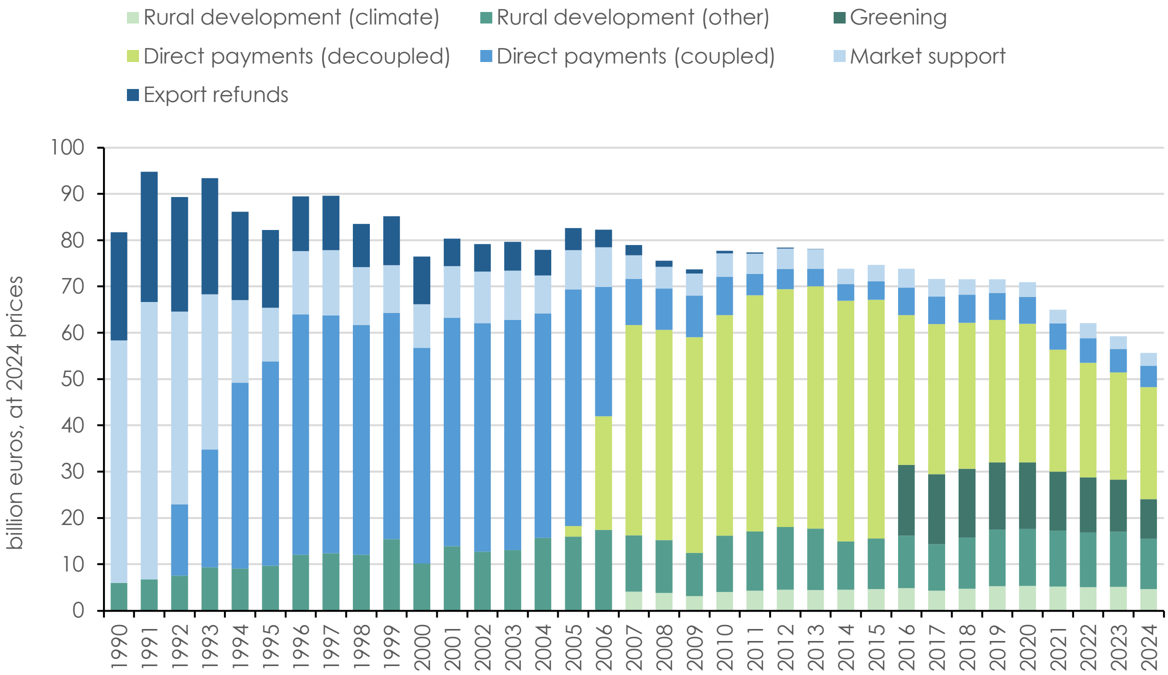
payments) linked to agricultural land and livestock numbers were introduced to compensate farmers for income losses.

The Fischler reform (2003) and Health Check (2008) further decoupled agricultural subsidies from production. On the one hand, further steps towards market liberalisation were taken, including the abolition of milk and sugar beet quotas. On the other hand, regulatory environmental conditions ("cross compliance") were implemented. Direct payments to farmers were linked to compliance with certain environmental, animal welfare and plant protection requirements, such as basic environmental requirements for farm management (GAB/SMR) or standards for good agricultural and environmental condition (GLÖZ/GAEC).

From 2015 onwards, environmental regulatory provisions were expanded, and a growing proportion of the agricultural budget was used for direct payments to compensate for ecosystem services ("greening", from 2023 onwards eco-schemes) that go beyond compliance with specified minimum standards (Pufahl, et al., 2025). Agri-environment-climate measures (AECM) were restructured in the 2023–2027 CAP period, while agri-environment programmes (e.g. Natura 2000 payments) were already established in the course of the CAP reforms of the 1990s and have been continued since then. Although environmental and climate protection is thus an integral part of the current CAP Strategic Plan, it is still not one of the explicit core objectives of agricultural policy.

Figure 3-2 illustrates CAP expenditure since 1980 and the importance of environment and climate-related expenditure compared to other CAP objectives. Traditionally, the CAP is by far the largest expenditure-related policy area of the EU. According to the original financial planning, the CAP was to spend a total of €386.6 billion over the period 2021-2027 (Becker et al., 2022). Between 2021 and 2024, actual payments amounted to €224.2 billion. The CAP's share of total EU expenditure, which was still 73.2% in 1980, has fallen to 23.3% by 2024, but this is primarily due to a substantial increase in other EU expenditure, including crisis-related increases in spending under the Recovery and Resilience Facility (RRF).

Figure 3-2: **Expenditure under the CAP 1990-2024 (at 2024 prices)**



Source: WIFO calculation based on European Commission. CAP expenditure and CAP reform path post-2013. https://agriculture.ec.europa.eu/data-and-analysis/financing/cap-expenditure_en. Note: Nominal values have been deflated using the World Bank's GDP deflator for the European Union (Worldbank, World Development Indicators. https://data.worldbank.org).

In 2024, €55.6 billion was paid out from the EU agricultural budget. Of this, around €13.3 billion (23.8%) was accounted for by greening direct payments and climate-related payments under rural development. Direct payments decoupled from production accounted for around €24.2 billion, or 43.5% of the EU agricultural budget. Market support, production-linked direct payments and export refunds totalled €7.4 billion (13.3% of CAP expenditure). EUR 10.8 billion (19.5% of the CAP budget) was paid out for rural development without explicit climate policy focus.

Overall, the transformation from a planned economy to a more liberalised and market-based agricultural policy has progressed[17], **but the CAP still remains interventionist and regulation-intensive** in **its overall approach**. Since the introduction of green direct payments, the explicitly 'green' share of expenditure has been around a quarter of the CAP budget.

In terms of environmental and climate protection, the CAP primarily combines environmental regulatory requirements and the systematic remuneration of environmental services. Nevertheless, climate protection successes, environmental and animal welfare, and the preservation of biodiversity fall well short of stated objectives and expectations (Pe'Er et al., 2019; Leahy et al.,

[17] Politically, liberalisation was achieved primarily through the introduction of direct payments, but this contributed little to the internalisation of negative externalities in the agricultural sector. However, studies by the OECD (Henderson & Lankoski, 2019; De Boe, 2020; OECD, 2023) show that policies with strong market distortions (e.g. administratively guaranteed agricultural prices) often also have negative environmental effects.

2020; Acampora et al., 2023; Lakner & Röder, 2024; Marelli et al., 2025). This finding is particularly true for biodiversity protection targets (Marelli, et al., 2025).

Agri-policy measures aimed at promoting sustainable agriculture, reducing greenhouse gas emissions and pesticide use, and protecting biodiversity appear to have only negligible effects (European Court of Auditors, 2021; 2024). Agricultural subsidy policy also plays a key role in the failure to achieve environmental and climate targets, as government support measures run counter to the effects sought by emissions pricing policies and can lead to an increase in emissions (Henderson & Lankoski, 2019).

3.2.2 The special position of agriculture in environmental and climate policy

To date, the CAP does not incorporate market-based instruments such as environmental taxation or emissions trading schemes that are already applied in other (European) industries and sectors.

The European Emissions Trading System (EU ETS) is the European Union's main market-based climate protection tool and has covered the energy sector and energy-intensive industries since 2005. Since 2012, intra-European air traffic has been included in the EU ETS, and since 2024, maritime transport has been included too. The EU ETS thus covers key industries and sectors that are responsible for a significant proportion of greenhouse gas emissions. However, the agricultural sector is still not covered by the EU ETS. Direct emissions such as methane (CH_4) and nitrous oxide (N_2O), which are produced in the agricultural sector through processes in animal husbandry, fertilisation and soil management, are not subject to EU ETS regulation (EU Regulation 2003/87/EC). Indirect emissions, such as those from energy consumption in agriculture through diesel consumption for agricultural machinery, are included in the ETS, but only account for around 4% of the sector's total emissions. The production of fertilisers (especially ammonia) is covered by the ETS as an energy-intensive industry. This means that at least the emissions from the production of intermediate inputs such as mineral fertilisers are priced. In this respect, certain parts of agriculture are indirectly covered by carbon pricing.

The Effort Sharing Regulation (ESR) sets greenhouse gas reduction targets and applies to sectors not covered by the EU ETS. It is a key instrument of the European climate architecture and complements the EU ETS. The target is an EU-wide emission reduction of 40% by 2030 (compared to 2005) for the ESR sectors, with the burden being distributed among Member States according to their economic capacity (GDP per capita). The ESR is designed as a national total emissions budget to give Member States leeway in deciding in which sectors it is most cost-effective for them to achieve their emission reduction targets. Agriculture is covered by non-CO_2 emissions (methane from livestock farming and nitrous oxide from fertilisation). There are no sector-specific reduction targets for agriculture (unless EU Member States have set them). In terms of emissions policy, agriculture therefore competes with other non-ETS sectors (primarily transport and buildings). In addition, the LULUCF Regulation (2018/841/EU) separately accounts for and regulates emissions and carbon sinks from land use, land use change and forestry. According to this, emissions and removals in the combined land use and forestry sectors, including agricultural use of arable land and grassland, must be balanced or even generate surpluses. Carbon farming initiatives, voluntary programmes for carbon sequestration in soil and the promotion of regenerative agriculture, are being developed but are not yet linked to the ETS. The fragmentation of climate policy due to the separation of ETS and non-ETS sectors causes higher economic mitigation costs, particularly when it comes to achieving climate policy goals (Böhringer et al., 2017).

The future ETS2 fundamentally changes climate policy in non-ETS sectors, as transport and buildings are included, but agriculture, with its climate-relevant emissions, remains explicitly excluded.[18] With the introduction of ETS2, ESR will remain in place, but with a reduced scope that will be limited to the agriculture, waste management and smaller non-ETS industries sectors. The introduction of ETS2 exacerbates the asymmetrical treatment of agriculture within European climate policy. While other non-ETS sectors, in particular transport and buildings, will be subject to a uniform EU-wide CO_2 price and binding quantitative limits on their emissions in future, agriculture will continue to be exempt from MBI. Instead, climate policy control of agricultural emissions will continue to be governed by national reduction commitments under the ESR burden-sharing regulation.

This institutional separation is associated with different governance logics: in the ETS2 sectors, the polluter pays principle dominates in the form of a market-based price signal, while agriculture continues to be addressed through compensation and incentive-based instruments. The resulting sectoral inequality reinforces the special position of agriculture as a largely unpriced emission sector and raises questions from an economic perspective regarding the efficiency, cost distribution and target achievement of EU climate policy. The systemic weaknesses underscore the need for integrated policy instruments that combine ecological effectiveness with economic efficiency.

3.2.3 Member State level

Agri-environmental policy also enjoys a special status at Member State level. Although environmental taxes are being applied in an increasing number of countries and economic sectors, the agricultural sector is mostly exempt from market-based approaches and is rarely subject to specific environmental levies. Although many European countries have CO_2 taxes, these do not typically cover diffuse agricultural emissions from livestock farming or soil management directly. Overall, only a few EU countries have made attempts to explicitly tax the environmental impact of agricultural activities. As discussed above, monitoring, reporting and verification (MRV) of diffuse agricultural cost externalities remains a significant technical and practical hurdle for output-oriented taxation of emissions and pollutant inputs. Conversely, many countries have reduced sales tax rates on pesticides or agricultural diesel which undermines environmental policy objectives as an indirect subsidy.

In 2030, **Denmark** will be the first country to introduce **direct taxes on CO_2 emissions in the agricultural sector** (Searchinger & Waite, 2024; Matthews & O'Neill, 2025). The levy obliges producers to pay a tax on emissions from major agricultural sources (primarily livestock and fertiliser

[18] ETS2 was originally scheduled to be fully launched on 1 January 2027. However, in the course of European negotiations on the revised climate law, this timetable was postponed by one year to January 2028 due to political and economic concerns on the part of member states.

use). The taxes are to be introduced gradually and increased step by step. A **cornerstone of the plan is the obligation to return the revenue generated by the tax to the agricultural sector**.

Taxes on pesticide use in agriculture are known in Sweden, Denmark, Italy and France (Björnavold et al., 2023).[19] The development of the few existing pesticide taxes shows a gradual shift from volume-based taxation to risk-differentiated taxation. In 1984, Sweden was the first country in the world to introduce a special flat-rate tax on pesticides. Until 1995, the revenue generated by this tax was used specifically for agri-environmental programmes. In Denmark, a pesticide tax has been in place since the 1990s with the aim of reducing the use of chemical pesticides. The previous value-based system was replaced in 2013 by a tax differentiated according to the product's health and ecological impacts.

4. Political-economic aspects of implementing a market-based agri-environmental policy

4.1 Political attractiveness of subsidies and regulatory measures

Traditional climate and environmental policy instruments such as subsidies and detailed regulations are reaching their limits due to their associated inefficiencies, tight budgets at EU and national level, and high bureaucratic burdens. Recent initiatives underscore the interest in shifting to a more market-based agri-environmental policy and making the polluter pays principle the basis for policy (e.g. van Dijk et al., 2023; Bognar et al., 2024; Cammeo et al., 2024). Despite the broad consensus in economics[20] on the desirability of polluter-oriented pricing of external costs, the importance of MBIs remains limited compared to CC regulations and subsidies in the agricultural sector. The persistence of a regulatory regime that is associated with high social costs and reduced flexibility and efficiency suggests that efficiency considerations do not play a decisive role in the choice of policy instruments.

Climate and agricultural policies are not only shaped by the structural characteristics of the primary sector. They are an expression of successful political rent-seeking[21] by interest groups representing agriculture and upstream and downstream industries, in conjunction with electoral considerations and bureaucratic regulatory interests.

Political economy analyses demonstrate that instrument choice and reform feasibility depend less on theoretical efficiency gains than on the government's ability to manage distributional conflicts. Trends toward particularistic interventionism and overregulation can be explained by the interplay of voter and politician interests, association influence, and agricultural

[19] See also the Pesticide Action Network PAN https://www.pan-europe.info/issues/pesticide-taxation

[20] Drews et al (2024) show in a survey study that scientific representatives from disciplines other than economics tend to support direct regulations over market-based instruments to combat the causes of anthropogenic climate change. Confidence in market mechanisms is essentially only pronounced among economists.

[21] This behaviour, referred to in the literature as "rent seeking", describes the processes by which producers primarily use their energy to gain advantages rather than to implement innovative changes.

bureaucracy (e.g. Daugbjerg & Swinbank, 2011; Cullenward & Victor, 2021; Swinnen, 2018; Anderson et al., 2013; Resnick & Swinnen, 2013; Lovec et al., 2024).

Farmers' associations, consumers, taxpayers and environmental organisations are among the key stakeholder groups in the network of interests surrounding agricultural policy. Politicians act as "brokers" of group interests in competition for votes. The literature explains the strong influence of agricultural interest groups with the logic of collective action (Olson 1965, 1982). According to this theory, small, homogeneous producer groups can organise their interests with lower coordination costs and a higher probability of success than large, heterogeneous social groups. Agricultural associations are well-organised groups with effective lobbying capabilities.[22] As a potential counterweight to agricultural industry interests (Dür et al., 2015; Orach et al., 2017; van Hoof, 2023), consumer or taxpayer interests and environmental protection associations are poorly organised (Nedergaard, 2006; Mennig, 2024) and their influence is rather limited (Gawel, Strunz, & Lehmann, 2014).[23]

An agricultural policy that burdens those responsible for environmental damage is unattractive to governments seeking re-election because the benefits of limiting environmental damage are diffuse and, in some cases, only materialise in the (distant) future (e.g. Oates & Portney, 2003), **while the costs are concentrated among agricultural businesses.**

In the competition for political support, it is rational to provide subsidies to a coherent voter group such as farmers and to avoid imposing costs on these groups, as the burden of tax increases or government debt is spread across all (future) taxpayers. Subsidies or market support measures (price guarantees), which have historically characterised the CAP, generate income for farmers and shield the agricultural sector from international competition. Ecologically desirable behavioural changes are therefore implemented mainly through cross-compliance or eco-schemes that remunerate environmental services (Sinabell et al., 2012).

Environmental protection requirements based on the polluter pays principle reduce profits (e.g. van Hoof, 2023; Matthews & O'Neill, 2025). Agricultural associations also secure special advantages for their members by delaying, watering down or preventing more ambitious climate projects (Keeler, 1996; Gawel et al., 2014; Swinnen, 2015; Baranzani et al, 2017; Meng & Rode, 2019; Grant, 2024). Strict CC regulation and pricing of external costs reduce the profits of agricultural businesses that are unable to pass on these costs, especially small businesses. However, interests within the agricultural sector are not equally represented. Larger, capital- and land-intensive producers usually have more influence than small businesses or new entrants.

While financial aid to agriculture is limited by the need for counter-financing, environmental CC regulations are seen by politicians as budget-friendly instruments. However, regulatory requirements place a burden on agricultural producers and are therefore not an attractive

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[22] As the most influential European lobby organisation in the agricultural sector, COPA-COGECA primarily represents the interests of industrially organised agriculture. Salhofer et al. (2000) use Austria as an example to illustrate the high political influence of the agricultural lobby compared to less well-organised groups of food consumers and taxpayers.

[23] The structural asymmetry is reinforced when agricultural associations are embedded in corporatist advisory and decision-making structures and receive public funds for services.

instrument at first glance. Political-economic regulation theory (Stigler, 1971; Buchanan & Tullock, 1975; Peltzman, 1976) provides explanations that are counterintuitive at first glance but robust as to why regulatory requirements and standards are frequently used despite their inefficiency and the burden they place on producers.

Direct CC regulations enable politicians to generate support by granting specific advantages to certain providers or interest groups, for example through different technological standards for established and new market entrants or different transition periods for adapting to new regulatory requirements. Existing businesses are particularly protected when newcomers are subject to stricter requirements than established providers. Compliance with administrative rules imposes substantial burdens on smaller farms, whereas larger farms face relatively lower administrative costs in proportion to revenue (Espinoza Diaz et al, 2023).

From a political perspective, CC regulations are easier to sell than MBIs due to their visibility. This is partly because politicians operate in short election cycles and prefer measures that show quick results. **Regulation allows for symbolic climate policy with limited real impact.** Politicians can use limit values to demonstrate that concrete steps are being taken to protect the climate or the environment. Physical emission reduction targets are easy to communicate to the public, even if they ignore the aspect of weighing up the marginal costs and marginal benefits of damage reduction (Edenhofer et al., 2021). **Accordingly, it is apparent that environmental measures are politically watered down and often only implemented symbolically ("greenwashing")** (Alons, 2017). Seemingly strict regulations are enacted that require little adjustment to production methods. **Environmental requirements for cross-compliance, greening payments or eco-schemes are often unambitious, difficult to monitor and therefore ineffective** (European Court of Auditors, 2021). Member States can use national leeway for implementation to effectively water down requirements.

In addition, environmental organisations and climate protection NGOs are reluctant to support MBIs, partly due to the concern – which is theoretically and empirically unfounded – that the focus on market-based incentive systems would lower the overall level of climate protection or even establish an immoral "right to pollute". Successful NGO engagement can thus contribute to the prevalence of regulatory approaches that are de facto less effective.

In this context, the Europe-wide farmers' protests in 2023/24 reflected not only resistance to falling revenues for agricultural products, coupled with rising production costs for energy, diesel, fertiliser and transport. Farmers criticised the fact that the conditions for EU direct payments were now associated with a multitude of requirements, controls and administrative barriers. Farmers expressed deep dissatisfaction with environmental regulations, which they perceive as a threat to their income and competitiveness (Matthews, 2024; Finger et al., 2024; Carbon Brief, 2024; Mayol & Porcher, 2025).[24]

[24] The protests were not only a reaction to specific environmental ambitions of the EU, but also reflected fundamental problems in agriculture in individual countries. In many cases, the protests were directed against decisions in the Member States, such as the elimination of tax advantages for agricultural businesses. See https://www.swissinfo.ch/eng/explainer-why-farmers-are-protesting-in-europe/

From a political economy perspective, the **bureaucracy** is **not seen as a neutral enforcement body, but as an independent actor with specific interests and discretion** (Niskanen, 1975; Majone, 1994). Agricultural bureaucracy plays an important role in policy design and implementation at national and EU level. The administration, allocation and control of subsidies, quota regulations and regulatory requirements tie up personnel and resources.

Self-interest in expanding agricultural budgets and securing one's own livelihood through regulatory complexity reinforce the political tendency towards interventionism and the rejection of market mechanisms. The legitimacy of bureaucracy is not ensured by economic efficiency, but rather by rule-based control, legal compliance and verifiability. Area-based direct payments, standard requirements (greening, eco-schemes) or prescribed farming practices are preferred by the administration because they are integrated into existing control infrastructures and institutionalise routines.

As a result, specific knowledge and expertise tailored to existing subsidy and regulatory policies have developed within administrations. A transition to market-based solutions would devalue the specific skills and expertise of the administration and create new requirements.

4.2 Environmental taxes vs. certificate trading from a political-economic perspective

The (theoretical) choice between an environmental tax and certificate trading is not a purely technical one, but a strategic political decision. There is also a difference in terms of whether pricing external costs through taxes or emissions trading systems is more attractive from a political perspective. Tax solutions that are not diluted by exemptions could be simple and transparent, which reduces the scope for lobbying. Their greatest weakness is the resistance of voters and interest groups to new taxes.

Although most of the population considers climate change to be a serious problem and there is generally high public support for climate protection (OECD, 2022: 123), this does not automatically mean acceptance of specific climate policy measures. Support is significantly influenced by the public perception of the burdens or relief provided by policy measures.

The political sensitivity of eco-tax increases is particularly evident in the "yellow vest" movement in France, which emerged in 2018 in response to a planned increase in fuel tax and led to weeks of political deadlock (Douenne & Fabre, 2022).

Survey studies (e.g. Dresner et al., 2006; Kallbekken & Sælen, 2011; Drews & van den Bergh 2016; Carattini et al., 2017; Baranzini & Carattini, 2017; Sommer et al., 2022) and experimental evidence (Gampfer, 2014; Diederich & Göschl, 2014; Muhammad et al., 2021; Bergquist et al., 2022) find that public understanding of climate targets is important for the acceptance of eco-taxes. Environmental taxes are more likely to be supported if revenues are transparent and earmarked for environmental projects or for reducing the burden on citizens.

Certificate trading, on the other hand, enables the creation of economic rents for producer groups simply by setting the total allowable emissions. For tradable emission rights derived from the cap, the allocation method is of central importance to companies. If certificates are allocated selectively or free of charge, for example based on historical emissions data ("grandfathering"), this acts as a barrier to market entry for new providers and can even generate additional income for existing companies if they sell certificates (Keohane et al., 2019). By allocating certificates free of charge, politicians serve the interests of organised producers and can thus secure their support (Mathys & de Melo, 2011). This method can even enable more ambitious climate targets than would be politically feasible under a pure tax solution (Goulder & Parry 2008; Gawel, et al., 2014). However, the level of the emissions cap may also be the result of a political negotiation process. This carries the risk of a loose cap, leading to low prices and a low steering effect.

Measures to compensate low-income households can increase political support among the population (Brännlund & Persson, 2012; Dreyer & Walker, 2013; Baranzini & Carattini, 2017), although the effects are influenced by the design (flat-rate climate bonus or social grading) and environmental awareness (Sommer et al., 2022).

Political economy of the EU ETS introduction

A political economy analysis by Skjærseth and Wettestad (2009) provides insights into the emergence and success of EU emissions trading (EU ETS) compared to environmental taxes. For the EU Commission, the EU ETS was politically more attractive than a CO_2-tax, as environmental taxes require unanimity at EU level, while the ETS could be adopted by a qualified majority. To persuade national governments to agree, the Commission proposed National Allocation Plans, which give Member States autonomy in setting their national caps and allocating allowances to industry. Industry was more willing to accept emissions trading than taxes, as it was perceived to be more cost-effective and even offered economic opportunities for shrinking emitters through trading. **A key factor in its appeal was grandfathering based on historical emissions, which neutralised opposition from industry lobbies.** Free allocation largely avoided direct price shocks for consumers in the initial phase, and environmental organisations were won over by the promise of ecological effectiveness through the cap.

4.3 Institutional decision-making processes and restrictions at EU level

CAP budget formation is characterised by a lack of transparency and structural predetermination, favouring incrementalism and hindering fundamental reforms (Pe'Er et al., 2019). **Past entitlements continue to reward states with historically large agricultural sectors. Transitioning from subsidies to market mechanisms would fundamentally alter this distribution and disrupt the “deal” established over decades.**

CAP decisions result from complex co-decision procedures in the Council and European Parliament, aiming for consensus that often dilutes ambitious environmental, animal welfare, or climate reforms (Swinnen, 2015). While EU governance structures could theoretically undermine market-based reform, fiscal constraints may eventually open a window for reform.

CAP budgets are the result of complex negotiations in which Member States compete to obtain the largest possible share. Net contributor countries often view the CAP as a costly transfer regime with limited European added value. They are pushing for a "lean and efficient" budget.

Negotiations on the Multiannual Financial Framework (MFF) and the CAP run in parallel, leading to political-economic dependencies. To relieve the national contributions of net contributors, there are also calls for new own resources. **Revenue from emissions trading (ETS) or own EU levies would ease the pressure for CAP cuts.**

However, the net contributor debate does not automatically lead to an ecological reorientation of the CAP. **Each Member State pursues its own interests in maximising the benefits of the CAP for its own farmers and passing on costs to others.** The economic and social significance of agriculture varies greatly from one Member State to another. Net recipients of CAP subsidies defend direct payments to farmers, as they guarantee income stability in the agricultural sector. The result is incremental reforms that largely preserve the expenditure structure but give it new political legitimacy (e.g. greening, eco-schemes). However, strong climate conditionalities are seen as a threat to the transfer flow (Garzon 2006).

Market-based mechanisms for internalising external effects in line with the polluter pays principle would mean that costs are incurred where external effects are caused. This would lead to a significant shift in the distribution of burdens and potential disadvantages. Heterogeneous emission profiles and asymmetric burdens between Member States are an obstacle to the adoption of a market-based agricultural climate policy. As the share of agricultural emissions in total greenhouse gas emissions varies greatly, strict caps would hit individual countries hard.

Feindt et al. (2022) and Rac et al. (2024) see the multitude of seemingly equal targets for European agricultural policy as a cause for the dilution of environmental and climate policy ambitions in the Member States, which would be exacerbated by the decentralisation of agricultural policy implementation responsibilities to the Member States.

From an economic perspective, EU taxation powers for agriculture-specific GHG emissions would make sense, as they cause globally homogeneous damage. National solo efforts with different tax rates carry the risk of fiscally induced distortions of competition and an intra-European tax reduction race in eco-taxes.

The situation is different for pollutant inputs from fertilisers and plant protection products. Damage caused by nitrogen/nitrates and pesticides/fungicides is highly regional and location-dependent. A uniform EU-wide tax would ignore regional differences in marginal damage costs between countries, but a harmonised EU-wide levy would be the same everywhere. This is undesirable from the perspective of allocation efficiency because it is statically inefficient. A harmonised framework directive that prescribes minimum tax rates for Member States and leaves them the competence for regional differentiation (e.g. in water catchment areas) would be preferable here.

Institutional and legal restrictions limit the possible implementation of environmental taxes. The EU has no original competence to levy taxes or duties. It can only impose taxes indirectly through directives to harmonise the internal market or achieve environmental objectives. The biggest legal hurdle is the unanimity principle in taxation. According to Article 113 TFEU, all Member States must agree to the adoption of a directive harmonising indirect taxes. This gives each Member State a right of veto. Countries with strong agricultural lobbies can block an EU agricultural environmental tax.

Environmental policy is a shared competence between the EU and Member States. This allows Member States to levy national environmental taxes even if the EU does not adopt a harmonised tax. In contrast to the area of taxation, environmental protection allows for qualified majority voting instead of unanimity under certain circumstances – this is regularly controversial in the tax context but opens up the option of a certificate trading-based agri-environmental policy.

4.4 Agri-environmental policy, food prices and social compensation mechanisms

The pricing of external costs of agricultural production would also affect consumers. Political resistance to market-based reform of agri-environmental policy centres on the fear that internalising the external costs of agricultural production through higher levies or certificate trading, while at the same time eliminating agricultural subsidies, would not only put pressure on the market income of agricultural producers, but also lead to higher end consumer prices for agricultural products as costs rise.

Empirical studies have found a significant correlation between food prices and political unrest in developing countries (Arezki & Bruckner, 2011; Hendrix & Haggard, 2015; Weinberg & Bakker, 2015; Rudolfsen, 2021). Survey evidence also suggests that the rise in food prices was a driving force behind Donald Trump's re-election as US president (Kalaitzandonakes et al., 2024).

In principle, the economic burden (incidence) of eco-taxes or costs should not fall entirely on agricultural producers. It is to be expected that consumers will bear part of the burden in the form of food price increases. Both price-based instruments (e.g. taxes) and quantity-based instruments (e.g. cap-and-trade systems) increase the relative prices of environmentally harmful inputs, thereby creating incentives to reduce their use or to substitute them with alternative production methods and technologies. In the short term, both types of instruments require adjustments that involve investment and conversion costs. Price-based instruments are generally considered to have a regressive effect (at the expense of poorer households), especially in the case of staple foods, while quantity-based instruments can cause additional market distortions through rationing effects. For example, both taxes on animal emissions and quantity-based limits on livestock numbers lead to higher prices for meat and dairy products in the short term. In the long term, technological and breeding advances should mitigate these effects, but the speed of dynamic adjustment processes is difficult to predict.

Specific incidence analyses mostly imply that CO_2 taxes on agricultural goods tend to have a regressive effect, i.e. they particularly affect low-income households (Burke et al., 2020; Schaffer, 2021), although the evidence is by no means robust (Köppl & Schratzenstaller, 2023).

Model calculations by Kornher et al. (2024) show that food prices in Europe respond to changes in production costs and only secondarily to world market prices. However, simulation calculations (Chen et al., 2025) suggest that long value chains in developed economies absorb a large part of the effects of raw material costs on consumer prices. The production costs of agricultural goods account for an increasingly smaller share of food prices (Sinabell, 2025). This means that a more ambitious agri-environmental policy would only cause food prices in rich EU countries to rise slightly, especially since existing regulations that would become obsolete are already partially reflected in prices. Calculations by Oebel et al. (2024) provide evidence to the contrary, suggesting that internalising external costs would roughly double the prices of animal agricultural products.

Table 4-1: **Share of food expenditure by income quintile, 2020**

Country		First (lowest) quintile	Second quintile	Third quintile	Fourth quintile	Fifth (highest) quintile	Ratio between the highest and lowest income quintiles
		Percentage					
EU-27	EU-27	.	.	.	.	.	.
BE	Belgium	13.3	14.2	14.4	14.3	14.9	1.12
BG	Bulgaria	31.2	27.1	25.3	22.9	18.9	0.61
CZ	Czechia	.	.	.	.	.	.
DK	Denmark	11.2	11.9	11.8	11.4	10.5	0.94
DE	Germany	12.7	11.4	10.6	10.2	8.9	0.70
EE	Estonia	25.5	19.8	18.8	17.6	13.2	0.52
IE	Ireland	12.1	12.0	11.6	10.9	10.0	0.83
EL	Greece	21.0	21.5	19.9	18.6	16.6	0.79
ES	Spain	18.3	17.5	16.5	15.8	13.8	0.75
FR	France	13.4	13.8	14.3	13.8	11.9	0.89
HR	Croatia	25.5	21.8	20.4	18.3	16.7	0.65
IT	Italy	.	.	.	.	.	.
CY	Cyprus	20.4	17.7	15.2	13.1	10.4	0.51
LV	Latvia	25.0	22.3	20.3	20	15.5	0.62
LT	Lithuania	26.6	22.6	22.2	22.5	19.8	0.74
LU	Luxembourg	11.0	8.9	8.9	8.4	7.5	0.68
HU	Hungary	16.0	15.5	15.6	14.7	13.8	0.86
MT	Malta	22.7	22.6	18.5	16.7	14.6	0.64
NL	Netherlands	10.6	10.5	10.7	10.6	10.4	0.98
AT	Austria	12.5	11.3	11.4	10.5	9.5	0.76
PL	Poland	22.5	23.8	24.0	23.2	20.4	0.91
PT	Portugal	.	.	.	.	.	.
RO	Romania	.	.	.	.	.	.
SI	Slovenia	16.7	14.4	12.9	11.9	10.7	0.64
SK	Slovakia	20.5	19.6	18.9	18.2	16.9	0.82
FI	Finland	14.3	12.8	14.2	13.2	11.9	0.83
SE	Sweden	.	.	.	.	.	.

Source: EUROSTAT, Structure of consumption expenditure by quintile of household income and COICOP purpose of use [online data code: hbs_str_t223]. Data status: 15 October 2025.

If food accounts for a disproportionately high share of consumption in poorer households, the incidence of agri-environmental policy could be regressive, at least in the short term (e.g. Grainger & Kolstad, 2010; Klenert & Mattauch, 2016; Sager, 2023).Table 4-1 shows that the share of food expenditure in total household income varies greatly across the EU and is generally lower in countries with higher per capita income. Within countries, expenditure patterns also differ: in most cases, the share of income spent on food declines with higher household income, but in some Member States (e.g., the Netherlands or Denmark), differences between income quintiles are negligible.

From a political-economy perspective, these observations **support combining market-based reforms with transitional measures and social compensation mechanisms. Such approaches can maintain public acceptance of market-oriented agri-environmental transformations and mitigate regressive effects on vulnerable households.**

4.5 Conclusion

In the context of the European Union's agricultural policy, several political and economic factors interact to inhibit reform. Electoral incentives, the high organisational capacity and lobbying power of agricultural interests, and bureaucratic tendencies toward budget maximisation and the preservation of existing structures all interact within complex national and European governance systems. This constellation favours an agricultural policy that is sceptical of reforms, especially those based on market-based price mechanisms. Price-based instruments generate transparent cost effects and redistribution effects that are politically visible and therefore tend to meet with more resistance than less explicit, regulatory measures. Embedded in the complex multi-level governance structures of the EU, in particular the Common Agricultural Policy (CAP), this constellation encourages incremental adjustments rather than fundamental reforms. Approaches based on price mechanisms, such as taxes or tradable emission rights, face particular. Reform approaches that rely on price mechanisms such as taxes or tradable emission rights meet with particular resistance because they reveal costs and redistribution effects and are therefore more difficult to communicate politically than regulatory or subsidy-based instruments.

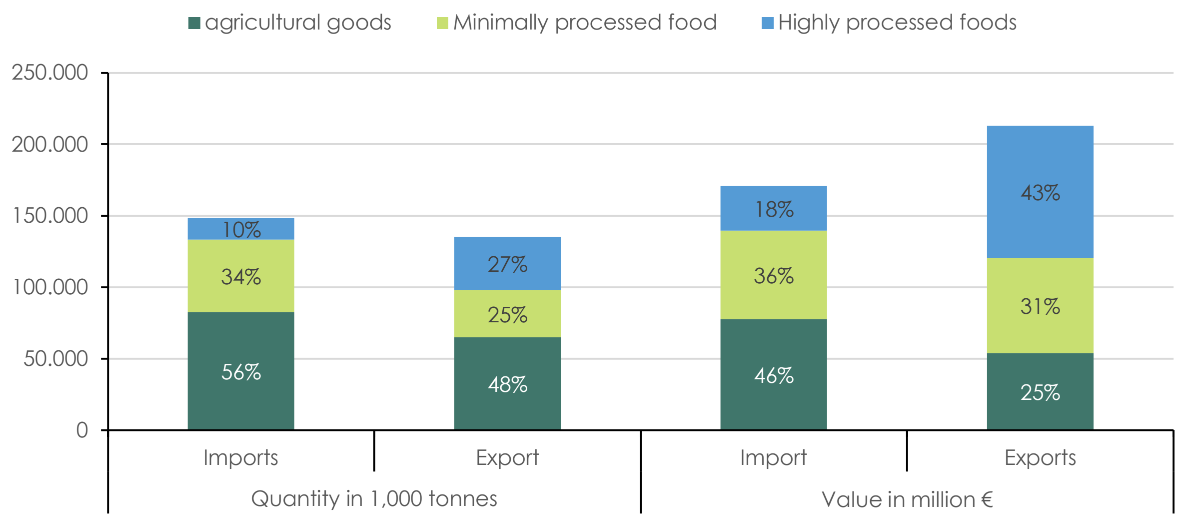
Nevertheless, examples such as Denmark show that MBIs are also politically feasible in the agricultural sector if they are embedded in a broad social consensus ("eco partnership") and the revenues are returned in full to the sector to support the green transition. The choice of instrument therefore depends less on its theoretical superiority than on the ability of policymakers to defuse distribution conflicts through compensation and skilful communication.

5. Foreign trade policy safeguards for market-based agri-environmental policy

5.1 The importance of international trade in agricultural goods and foodstuffs from the EU

The importance of agriculture in the economy, measured in terms of gross domestic product, is very low in highly developed countries such as Germany. However, when agriculture is considered in conjunction with the food industry, the proportions change. The added value of agriculture (sector A01) and the food industry, beverage production and tobacco processing (sectors C10-C12) together account for 3.5 % of gross domestic product in the EU, 2.5 % in Germany and 2.8 % in Austria.

Figure 5-1: **International trade in agricultural goods and low- and high-processed foodstuffs between the EU and non-EU countries (Ø 2020-2024)**



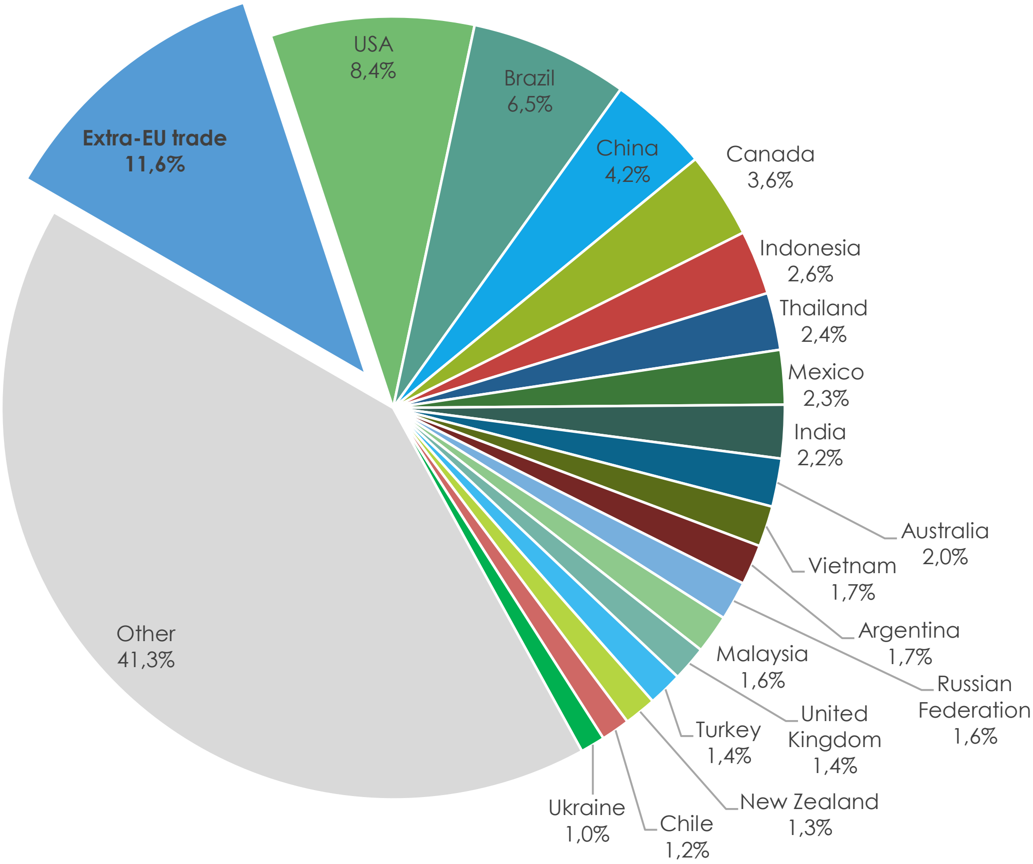
Source: EUROSTAT, International trade in goods between EU and non-EU countries since 2002, according to SITC [ds-059331], average 2020-2024.

These relationships are reflected in international trade in goods. The share of imports of agricultural goods and foodstuffs in monetary terms from other EU countries corresponds to 7.3 % of total imports of goods into the EU, 4.8 % in Germany and 4.5 % in Austria. The share of exports of agricultural goods and foodstuffs in monetary terms to countries outside the EU corresponds to 9 % of total EU exports of goods to these countries, or 3.5 % of Germany's exports and 6.3 % of Austria's exports of goods.

Agricultural goods and foodstuffs are statistically recorded in the international goods classification system according to SITC[25] , and foreign trade statistics provide a detailed picture of the development of goods flows. All internationally traded goods are classified according to this system, allowing goods flows to be monitored accurately.

[25] SITC is the abbreviation for Standard International Trade Classification.

Figure 5-2: **Share of global exports of agricultural goods and foodstuffs in 2024**



Source: World Trade Organisation (WTO), Merchandise Trade Statistics, Merchandise exports by product group – annual, https://stats.wto.org/.

Classes can be formed based on individual goods, allowing unprocessed foodstuffs (= agricultural commodities such as cereals) to be distinguished separately from foodstuffs with a low degree of processing (e.g. flour) and foodstuffs with a high degree of processing (e.g. biscuits). If we follow this classification into three groups, we see that the EU as a whole imports significantly more agricultural commodities (unprocessed foodstuffs) than it exports, both in terms of volume and value. The EU's importance in the global market for agricultural goods and foodstuffs lies precisely in its ability to produce high-quality foodstuffs from agricultural goods and foodstuffs with a low degree of processing, which sell well on international markets. The EU is by far the largest exporter of agricultural goods and foodstuffs (Figure 5-2).

This brief statistical overview shows that foreign trade is significant for agricultural goods and foodstuffs and should therefore be taken into account when designing a new instrument for internalising external effects in agriculture. The options for taking this fact into account are presented in detail in the following sections.

5.2 Leakage in international agricultural trade using the example of climate protection

In recent years, European climate and environmental policy outside the agricultural sector has increasingly relied on unilateral emissions pricing instruments, while important trading partners outside Europe have so far implemented inadequate or no pricing mechanisms at all.[26] This asymmetric situation creates increasing competitive disadvantages for EU producers in emission-intensive sectors and incentives to relocate production to jurisdictions with lower or no emissions pricing requirements. This phenomenon is known as (carbon) leakage.

If greenhouse gas emissions and the use of pesticides and fertilisers could be shifted from countries or regions with stricter climate protection requirements to those with less restrictive regulations, the effectiveness of climate protection strategies would be significantly reduced due to global effects (Böhringer et al., 2022; Jakob, 2021). Furthermore, the risk of production and GHG emissions shifting poses a significant challenge, as it reduces the acceptance of climate protection measures within the agricultural sector (Grosjean et al., 2018; Wreford et al., 2017) and causes economic losses (Martin et al., 2014). Carbon leakage due to unilateral climate policies in the agricultural sector manifests itself through several interdependent channels.

When climate policies (e.g. CO_2 pricing or fertiliser regulation) increase production costs in regulated economies, this leads to competitive disadvantages compared to producers in regions with weaker regulations. As a result, emission-intensive production will shift to third countries. This effect affects not only the agricultural sector, but also upstream sectors such as energy or fertiliser production, whose cost increases are passed on to agriculture in a cascade effect (Arvanitopoulos et al., 2021).

If climate policy reduces the consumption of certain agricultural products in the regulated country without initially affecting production, world market prices will fall. This in turn stimulates consumption in countries without comparable regulations, leading to an expansion of emission-intensive production in third countries (Matthews, 2022; Jansson et al., 2024). Known as the "fossil fuel channel" in the energy sector, this mechanism is particularly evident in the agricultural sector for tradable goods such as soy or palm oil, which are also essential for biofuel production. Shifts in demand lead not only to emissions, but also to deforestation and land-use change.

Ambitious climate targets in leading economies can trigger both negative and positive incentives in third countries. One negative effect is the free rider effect, whereby countries reduce their own climate efforts because they rely on the emission reductions of other countries (Copeland & Taylor, 2005). On the other hand, environmental provisions in trade agreements could enforce binding minimum standards or establish technological cooperation, thereby inducing positive effects themselves (Arvanitopoulos et al., 2021). Dynamic and efficient climate policies in pioneering regions can accelerate the development of low-emission technologies

[26] The World Bank's Carbon Pricing Dashboard provides a detailed overview: https://carbonpricingdashboard.worldbank.org/.

(e.g. precision farming or green fertilisers), which are later adopted globally (technology spillover channel).

Studies simulating the introduction of carbon pricing in agriculture using general equilibrium models show that leakage in the agricultural sector could be substantial, even exceeding displacement effects in energy-intensive industries (Arvanitopoulos et al., 2021; Fournier Gabela & Freund, 2023). Displacement rates in the agricultural sector range from -5% to 111% (e.g. Pérez-Domínguez et al., 2012; Frank et al., 2021; Himics et al., 2018; van Doorslaer et al., 2015; Nordin et al, 2019), although the range can vary considerably in individual subsectors. In contrast, the meta-analysis by Branger & Quirion (2014) shows that in energy-intensive sectors, the range of carbon leakage rates without policy measures is between 5% and 25% (mean 14%) and with border adjustment schemes between −5% and 15% (mean 6%).

A recent study by Fournier Gabela & Freund (2023), which examines the potential risk of carbon leakage between different sectors, shows that in the agricultural sector, the risk of carbon leakage due to indirect carbon costs - such as rising input prices for fertilisers - could be higher than the risk arising from the direct internalisation of external costs. It should also be borne in mind that mitigation policies that do not rely on price mechanisms may also encourage emissions leakage. Model calculations by Zech and Schneider (2019) show that the effectiveness of an EU greenhouse gas tax on food is significantly limited by trade reactions. If the tax is introduced without further trade policy measures, additional net exports of greenhouse gas-intensive meat products will offset around 70% of the demand-induced emission reductions. Although adjustments on the production side partially mitigate this effect, a significant emissions shift of around 43% remains.

With the expansion of the EU ETS, the share of EU emissions covered by an EU-wide CO_2 price will increase from around 40% at present to around three quarters (ESABCC, 2024). The remaining gap is mainly due to the lack of inclusion of the **agriculture** and **LULUCF** (land use, land use change and forestry) sectors and the partial exclusion of international aviation.

EU-wide GHG pricing for agriculture and LULUCF would provide financial incentives for emission-reducing farming methods, reduce the shift of emissions within the EU through national pricing mechanisms ("intra-EU leakage") (Stepanyan et al., 2023) and steer consumers towards more climate-friendly agricultural products. However, the specific challenges of these sectors – such as the fragmentation of farms and the complex measurability of nitrous oxide and methane emissions – require sector-specific solutions.

5.3 The concept of the EU border adjustment mechanism currently being implemented

5.3.1 Basic idea and functioning

To address the risk of carbon leakage and maintain the effectiveness of unilateral climate and environmental policies, the EU developed the Carbon Border Adjustment Mechanism (CBAM) as a complementary instrument and foreign trade compensation measure to the EU ETS. From January 2026, importers from non-EU countries will be obliged to purchase CBAM CO2 certificates for emissions that were emitted during production but not priced. Their price will be based on the average weekly ETS certificate price. This will ensure that EU imports have the same environmental cost as domestically produced goods subject to the EU ETS.

A key element of the system is the possibility to credit external costs already paid in third countries. This is intended to create a level playing field in the European market for producers in the EU and third countries in terms of pricing environmental targets, preventing carbon leakage and incentivising higher climate ambitions (Wolfmayr et al., 2024). However, there are two points of criticism. First, the current crediting mechanism requires sufficient comparability between schemes. Second, export-oriented EU producers face competitive disadvantages on the world market (Marcu et al., 2022). The implementation of a functioning border adjustment mechanism is crucial for the EU. Without such a measure, the EU's ambitious emissions pricing policy risks being discredited and replaced by inefficient regulation.

The **conceptual ideal** of such a mechanism follows the well-established model of VAT treatment in international trade: consumption-based, non-discriminatory pricing would be achieved through import duties corresponding to the external costs of emissions on the one hand, and export rebates for EU producers on the other.

However, the **practical implementation** of this approach faces two major obstacles: First, the system requires an objective and legally secure quantification of the emissions content of imported goods along the value chain as a basis for pricing. This has so far failed due to its complexity. Secondly, compatibility with international trade law (GATT) forces the EU to justify border adjustment under Article XX, which allows for a derogation from national treatment (Article III), which excludes a refund system for exports by EU producers. While EU exporters export their goods without paying VAT, the additional cost of compulsory participation in the ETS1 cannot be deducted on export.

The **operational design** of the CBAM therefore deviates from the ideal border adjustment system: the mechanism is currently limited to a small group of CO2-intensive commodities (steel, aluminium, cement, fertilisers, hydrogen, electricity). The latest simplifications in the Omnibus Package I also introduced a volume threshold, so that only large companies importing more than 50 tonnes of these raw materials per year will have to provide evidence of emission allowances, thereby reducing the administrative burden for SMEs (COM(2025) 87). At the beginning of 2026, the transitional period of pure reporting obligations will end and imported emissions will gradually be covered by CBAM certificates, with the volume of emissions covered increasing gradually from 2.5% to 100% by 2034 - in line with the gradual phasing out of free allocation in the EU ETS.

5.3.2 Structural deficits of the current EU border adjustment system

In addition to the considerable administrative and measurement requirements for determining emissions along complex value chains, the implemented concept of the EU border adjustment system has **four specific problem areas** that could also have a broadly similar impact on the possible inclusion of agricultural goods.

- **Distortion of competition due to lack of compensation for exports:** The border adjustment system currently does not provide for the reimbursement of emission prices for exports of goods to third countries. This creates a competitive distortion in favour of non-European manufacturers, who become more competitive in foreign markets without equivalent emissions pricing, while the market position of European manufacturers is weakened, and they are likely to lose market share abroad.

- **Cascading effects due to selective coverage**: By limiting the EU CBAM to a selected group of emission-intensive commodities, these imports become more expensive for European companies and are passed on in downstream value chains. Companies that process these intermediate products (e.g. farmers) will have to absorb these higher input prices and accept a loss of international competitiveness. Non-European competitors do not face this cost disadvantage, as lower or non-existent emissions pricing systems in these countries place less or no burden on intermediate products. These indirect distortions of competition may lead to a relocation of downstream production processes to countries outside Europe. It is particularly critical that technologically sophisticated and high value-added manufacturing stages are affected.
- **Resource shuffling** in importing countries, i.e. strategic differentiation of export destinations according to emission intensity. The EU border adjustment mechanism gives importing countries an incentive direct climate- and environment-friendly products (e.g. steel made from scrap and hydropower) mainly to the EU market, while placing more emission-intensive products (steel made with coke from coal) on third markets with lower regulatory requirements. This targeted redirection of trade flows significantly reduces the effectiveness of the border adjustment mechanism.
- **Geopolitical retaliation by trading partners:** Extending the pricing system to extra-territorial emissions carries the risk of protectionist counter-measures by affected trading partners. They may perceive CBAM as a trade protection measure by the EU. In view of increasing geo-economic trade tensions, tariff disputes and export restrictions, e.g. in trade with the US or China, the risk of trade conflicts and retaliatory measures should not be underestimated, as they could make the application of CBAM massively more expensive for the EU. In addition, the EU's need for regulatory simplification - some of which is difficult to reconcile with international trade agreements (in particular GATT Article XX) - increases the likelihood of conflicts in WTO arbitration, giving trading partners legitimate grounds for retaliation.

5.4 Implementation problems of the CBAM in the agricultural sector

The inclusion of nitrogen fertilisers is particularly important for the agricultural sector, as they account for a significant proportion of agricultural inputs and emit both CO_2 and nitrous oxide (N_2O) throughout their life cycle. In its current form, the CBAM covers five categories of fertilisers: nitric acid, ammonia, potassium nitrate, mineral or chemical nitrogen fertilisers, and blended fertilisers. In 2022, the EU imported around 30 per cent of its nitrogen needs, mainly from Russia, Algeria and Egypt (Christen, 2024). The inclusion of fertilisers in the CBAM therefore only affects the agricultural sector indirectly for the time being.

In recent years, the discussion about a more comprehensive integration of the agricultural sector into the CBAM has gained momentum. Extending the CBAM to agricultural products is conceptually much more challenging than including industrial commodities.

One possible scenario for gradual expansion could focus on livestock production, which has relatively high and easily quantifiable emissions. A second, more ambitious scenario would involve the full integration of the agricultural sector into the CBAM. The international dimension must be taken into account in all expansion scenarios. A unilateral extension of the CBAM to agricultural products by the EU could lead to significant trade tensions, especially with major agricultural exporters such as Brazil, Argentina and the US. The risk of trade conflicts and WTO complaints is real and could negate the economic benefits of an extended CBAM.

6. Implementation of the polluter pays principle in EU agriculture

Agriculture causes a variety of negative externalities, including greenhouse gas emissions, biodiversity loss and the chemical pollution of soil and water. The absence of corrective price signals can lead to the misallocation of resources and the overproduction of emission-intensive goods. According to the polluter pays principle, there are two basic market-oriented approaches to correcting such market failures: price-based instruments, such as taxes and levies; and quantity-based instruments, such as tradable emission rights. This chapter presents the theoretical and practical options for implementing the 'polluter pays' principle within the framework of European agricultural and environmental policy.

6.1 Implementation level

The normative determination of the (political) implementation level largely depends on the spatial characteristics of the respective pollutants and the associated negative externalities.

The spatial dynamics of greenhouse gases, nutrients and pesticides are central to choosing appropriate regulatory instruments and determining their level of implementation. Greenhouse gases (GHGs) mix globally in the atmosphere, so every emission causes the same amount of climate damage, regardless of its origin (IPCC 2022). Conversely, this mixing also means that reductions in emissions have the same impact on climate change, regardless of where they occur. The technical and economic benefits of the measures are therefore clearly global.

From an economic perspective, this justifies the adoption of supranational regulatory frameworks, as well as the anchoring of future agricultural greenhouse gas (GHG) policies at the EU level. This would help to avoid distortions in competition between agricultural producers in the Member States, while also realising efficiency gains through larger markets.

On the other hand, nutrient and pesticide pollution are often spatially concentrated environmental problems. Nitrogen and phosphorus inputs lead to the eutrophication of inland waters and marine areas such as the Baltic and North Seas, which experience significant differences in ecological stress (Sutton et al., 2011). There is high spatial heterogeneity: soil textures, precipitation patterns, and hydrological flow characteristics influence how strongly an area reacts to nutrient surpluses (Carpenter et al., 1998). Plant protection products also have limited spatial effects in terms of residues and degradation products, but they can have transboundary effects via long-range atmospheric transport or watercourses (Stehle & Schulz, 2015). The impact of nutrients and degradation products on water quality in transboundary waters clearly has a European and international dimension. In the context of plant protection products, the knock-on effects on biodiversity, which also have a global dimension, should be noted.

Therefore, a combination of regionally differentiated regulation under the responsibility of Member States (or subordinate political units) and EU-wide coordinated minimum standards makes sense. The following picture emerges:

- the EU level appears particularly well-suited to for regulating greenhouse gases.
- for fertilisers and plant protection products, a multi-level approach is necessary due to the spatial dynamics of their effects, allowing for regionally differentiated solutions but including EU-wide minimum standards to avoid distortions of competition and regulatory arbitrage.

6.2 Agri-environmental taxes

The CAP is based on expensive subsidies and rigid regulations. It is economically inefficient and fails to achieve its long-term goals. In terms of environmental objectives, it violates the 'polluter pays' principle, encourages free riding, and provides little incentive for innovation in agricultural production methods that would reduce the sector's external costs. Market-based instruments under the 'polluter pays' principle, such as environmental taxes and tradable certificates, are superior from an economic perspective and would be better suited to improving static allocation efficiency (i.e. the internalisation of external environmental costs) and incentivising dynamic innovation in the agricultural sector to make production methods more environmentally friendly. However, their implementation is hindered by the central problem of diffuse emissions that are difficult to measure.

6.2.1 Fundamentals

In light of the implementation of the polluter pays principle for agriculture-specific cost externalities, it would make sense for the EU to have taxing powers, especially for climate emissions. Greenhouse gas emissions cause globally homogeneous damage. Harmonised European pricing through GHG taxes ensures the most cost-effective reduction across all Member States and creates a level playing field for agricultural production throughout the economic area.

Damage caused by nitrogen/nitrate and pesticides, on the other hand, varies greatly from region to region and depends on location. A uniform EU-wide tax on fertilisers would ignore the regional differences in damage costs. A harmonised framework directive would make more sense, prescribing minimum tax rates (for intensive inputs) to Member States while also allowing them the option of regional differentiation (e.g. in water catchment areas). This combines internal market neutrality with ecological precision.

Environmental taxes are often considered to be an effective instrument for internalising external costs in accordance with the polluter pays principle due to their potential administrative simplicity, revenue generation and existing national taxing powers. In theory, an efficient Pigou tax should be set at the level of marginal damage costs to internalise the external costs caused in the price. However, the design of the tax must overcome the various measurability and regionality problems associated with the external costs of the agricultural sector.

Since marginal environmental damage in agriculture is usually not directly measurable due to the countless diffuse sources and differences in the vulnerability of environmental media, an efficient tax design should be based on input proxies (substitute means of production). The central objective here is not to generate revenue, but to create a steering effect through taxation.

Taxing emissions (harmful outputs) or inputs that are closely linked to the harmful effects is a market-based and efficient solution for reducing the damage caused by negative externalities.

The CO_2 tax on fossil fuels, which promotes the reduction of greenhouse gas emissions, is a current example. In agriculture, the cost of inputs has increased in various countries to reduce their use. For example, Austria imposed a tax on mineral fertilisers and maize seeds prior to 1995. Since 2013, Denmark has taxed plant protection products depending on their environmental impact, and has taxed fertilisers since 2002 (Möckel, et al., 2021).

A major disadvantage of taxing emissions or inputs with harmful effects is that changes in pollution cannot be easily controlled. Although the tax has a steering effect (reducing pollution), the extent of this effect cannot be accurately predicted.

6.2.2 Taxation of agricultural greenhouse gas emissions

Since all types of greenhouse gas (GHG) emissions (CO_2, N_2O, CH_4) have a homogeneous global effect, regardless of the emitter and regardless of the geographical location of the emission source, EU-wide harmonisation of the tax rate is optimal for efficiency reasons to avoid possible distortions of competition between agricultural producers (level playing field). In agriculture, methane and nitrous oxide from livestock farming and fertiliser use play a primary role.

- For methane emissions (CH_4), a proxy tax per livestock unit would be appropriate, with weighting according to animal species necessary to reflect their different emission intensities. In this context, tax rebates for farms that can demonstrate the use of emission-reducing technologies (e.g. feed additives, fermentation residue treatment) could also be considered. Since animal manure contains nitrogen, limiting livestock numbers, depending on the design, also leads to a reduction in N_2O emissions.
- For nitrous oxide emissions (N_2O), a supplementary input tax per unit of mineral nitrogen is conceivable. At first glance, the nitrogen levy only covers the quantity of input, but not the efficiency of nitrogen use. Since nitrous oxide emissions reduce the fertilising effect, the levy increases the incentive to keep these losses as low as possible.
- Taxation or pricing of greenhouse gases is rather rare in agriculture. Denmark is currently discussing a tax on methane-intensive livestock farming.

6.2.3 Taxation of fertilisers

Nutrient inputs mainly cause regional or local environmental damage. Therefore, taxation of fertiliser use should be differentiated according to location. To keep the administrative costs of taxation low, the tax on fertilisers can be levied on the manufacturer or distributor ('upstream').

At the EU level, the tax rate should be based on the level of damage caused by cross-border pollution. It is not practicable to levy a higher tax rate in nitrate hotspots and water protection areas than in regions with low pollution, so remaining regional and local problems must be solved by complementary regulations (a multi-level approach).

6.2.4 Taxation of pesticide use

The pricing of plant protection products must reflect the toxicity/risk, as well as the quantity used. A levy based solely on quantity would be inefficient, as it would incentivise users to switch to lower quantities of highly toxic substances. Therefore, the levy should be based on environmental toxicity to ensure that the polluter pays principle prices the actual risk, not just the quantity. Higher taxation on more environmentally hazardous pesticides would incentivise innovation to replace them with less toxic alternatives. In this case, too, the tax could be levied on the manufacturer or distributor ('upstream') to keep administrative costs low.

Denmark, Sweden and France already have or have had tax systems based on toxicity or risk.

6.2.5 European and jurisdictional obstacles

The legal feasibility and advisability of EU-wide environmental taxes in agriculture is of central importance, as it affects Member States' sovereignty and political acceptance directly. While the introduction of harmonised environmental taxes at EU level is legally possible, it faces procedural obstacles and hurdles in the distribution of competences.

The biggest legal hurdle is the unanimity principle in the area of taxation. According to Article 113 of the Treaty on the Functioning of the European Union (TFEU), all EU Member States must agree to the adoption of a directive on the harmonisation of indirect taxes. This gives each Member State a right of veto. Experience shows that tax harmonisation in the EU is generally extremely slow. Countries with a particularly strong agricultural lobby could block an agricultural environmental tax, for example.

The EU also has no general, original competence to levy taxes or duties (no "EU tax law"). The EU is primarily financed through its own resources, so environmental taxes can only be introduced indirectly via directives on the harmonisation of the internal market as a steering instrument. Environmental policy is a shared competence between the EU and the Member States. This enables Member States to levy national environmental taxes even if the EU does not introduce a harmonised tax.

However, the EU could theoretically act under Article 192 TFEU (environmental protection). Unlike taxation, environmental protection allows for a qualified majority instead of unanimity in certain circumstances, but this is regularly controversial in the context of taxation.

6.3 Cap-and-trade in agriculture

This subchapter explores the theoretical and practical potential of a cap-and-trade system (certificate trading) within the context of European agriculture. It analyses the opportunities and challenges for three key areas of application: greenhouse gases, nutrient inputs (fertilisers) and plant protection products. Based on political-economic and socio-political considerations, it discusses whether implementation at EU, national or regional level is more appropriate. The analysis shows that, in principle, cap-and-trade systems in agriculture can combine high ecological effectiveness and economic efficiency, but their technical and political feasibility depends heavily on the specific problem category.

The role and significance of property rights

Although identifying the sources of pollutants and the polluters is important, it is only one aspect among many. It may be the case that the emitter has the right to release emissions without restriction, or to a certain extent. This perspective ties in with the concept of property rights developed by Coase (1960) in connection with resource use, which plays a major role in environmental economics. Coase explicitly treats resources as a bundle of rights, analysing how the allocation and exchange of property rights under different conditions affects the resolution of externalities and the efficiency of resource use.

Some property rights are explicit (e.g. permissible noise pollution, specified in an operating licence), while others are implicit (e.g. the right to emit nitrous oxide as a fertilisation by-product). The allocation of property rights can change over time (e.g. regulations requiring uncovered slurry storage tanks to be covered retrospectively), and implicit rights can be converted into explicit rights. Environmental policy explicitly or implicitly intervenes in the distribution of property rights between polluters, their immediate neighbours, and society.

Any instrument designed to internalise external effects, whether an environmental tax or a cap-and-trade scheme, should be structured in such a way that the underlying property rights remain intact. When doing so, changes in the allocation of these rights must be taken into account. Therefore, when introducing or modifying instruments for internalising external effects, the initial situation must be considered. The instruments should be chosen in such a way that they can be adapted to different property rights configurations to achieve the desired outcome of internalising external effects. Tradable certificates have particular advantages in this respect. The effectiveness of this instrument can be assessed regardless of how property rights are distributed in a given context.

6.3.1 Basic idea

In addition to the option of internalising external effects in accordance with the polluter pays principle through Pigou taxes, a system of tradable certificates represents an alternative market-based instrument at EU level. To this end, the political process limits the quantity of an environmentally harmful input in the agricultural sector (e.g. quantity of nitrogen fertilisers and/or plant protection products) or the emission of pollutants (greenhouse gases) ("cap"). Tradable certificates are issued in relation to the total quantity specified ("trade"). The upper limit for the use of environmentally harmful production inputs and emissions is set in advance as a regulatory requirement, allowing the desired environmental impact to be controlled very precisely.

Cap-and-trade systems have already proven their worth in the European energy and industrial sectors. Many farmers are very familiar with this system, as the supply of milk and sugar beet was limited by quotas until 2015 and 2017 respectively and, depending on the country, it was possible to trade supply rights. Tradable payment entitlements were also introduced in EU Member States following the Luxembourg agricultural market reform in 2004. The question is whether such systems can be applied to agriculture in the context of negative externalities. The particularities of negative externalities in agriculture — high heterogeneity, diffuse pollutant input, and limited measurability — present unique challenges to implementation.

6.3.2 Cap-and-trade for greenhouse gas emissions from livestock in the agricultural sector

Cap-and-trade sets an upper limit on emissions and leaves pricing to the market. In economics, certificate trading is considered the preferred instrument when the focus is on achieving an environmental goal and thus on "quantity security". Greenhouse gas emissions from agriculture, in particular methane from livestock farming and nitrous oxide in connection with fertiliser application, can generally be modelled using standardised emission factors (Pérez Domínguez et al., 2009). A cap-based quantity regime generally offers a clear ecological control effect (static efficiency) and can trigger cost-efficient emission reductions (dynamic efficiency) through tradable certificates.

Starting points for emissions trading systems in agriculture (AgETS)

At European level, the European Commission is currently examining options for pricing emissions and rewarding emission reductions in the agricultural sector. As part of these efforts, Trinomics (2023) is evaluating five different design options for the introduction of an emissions trading system in agriculture (AgETS). In line with the EU ETS, such an AgETS system would put a price on emissions from the agricultural and food sector and introduce an emissions cap that would decrease each year:

- **On-farm ETS for all greenhouse gas emissions:** This option covers all greenhouse gas emissions from agriculture, including net LULUCF emissions from arable land and grassland. All agricultural holdings (arable farming, livestock farming and mixed farming) would be covered.
- **On-farm ETS for emissions from livestock farming:** This option focuses on emissions related to livestock farming, in particular from enteric fermentation and manure management. Livestock and mixed farms would be subject to the scheme.
- **On-farm ETS for peat soils:** This option applies to emissions from drained peat soils used for agricultural production.
- **Upstream ETS:** This option focuses on emissions from enteric fermentation (feed production and imports), nitrous oxide emissions from soils (use of fertilisers) and the use of fertilisers. Fertiliser and feed manufacturers and importers would be subject to the obligation.

- **Downstream ETS:** This option focuses on emissions from enteric fermentation and manure management. The obligation would lie with meat and milk processors.

Tiered or de minimis thresholds, as used in the EU Emissions Trading System, would reduce the number of farms potentially subject to regulation. Upstream and downstream options affect a comparatively smaller number of farms and could reduce the administrative burden of an emissions trading system.

In on-farm ETS models, a price signal could create incentives for cost-effective measures in different types of agriculture by introducing lower-emission farming methods and production processes. Taking into account all GHG emissions from a large number of different farms is very complex in terms of administrative effort. To limit the administrative burden, CO_2-pricing at farm level could be simplified by using the amount of nitrogen fertilisers purchased or livestock numbers by category.

In value chain-based ETS models (upstream and downstream approaches), a key trade-off is that their effectiveness depends largely on the passing on of incentives to agricultural businesses. The strength of implementation in upstream and downstream sectors lies in the potentially positive social acceptance of these two options compared to on-farm ETS options (Trinomics, 2023).

Depending on the design of the system, farmers could even generate and sell new tradable credits through emission-reducing measures in feeding, manure treatment or peat soils. Innovation is rewarded when farmers reduce emissions below their allocated certificate level and sell their rights. In this respect, an agricultural cap-and-trade system for greenhouse gas emissions offers considerable opportunities through innovation incentives and the achievement of environmental targets. In certain cases, they can be a potential additional source of income for farmers, for example when farms are allocated rights free of charge on the basis of historical production and want to convert their operations. They can use the proceeds from the sale of the certificates to finance the conversion.

Such a system should be integrated into the European Emissions Trading System (ETS) in the future. However, the ETS1 for industry and the energy sector is based on the output principle, in which large, stationary emitters measure and verify CO_2 emissions precisely. The main difficulties in agriculture lie in measurability and verification (Schulte, Lanigan & Donnellan 2021). A functioning market requires that tradable property rights are precisely defined. However, agricultural emissions vary depending on weather conditions, soil structure and type of cultivation: methane (CH_4) is produced during enteric fermentation (digestion by ruminants), nitrous oxide (N_2O) during manure storage and the application of nitrogen fertilisers to the soil. These emissions are diffuse and variable and originate from a large number of small farms.

Direct measurement and allocation of actual emissions at farm level (as required in the ETS1) would entail considerable monitoring and administrative costs. Economists have so far rejected the inclusion of agricultural holdings in the existing ETS1 due to the measurement problems mentioned above. It would overload the ETS administratively and disrupt market transparency due to the high number of small emitters.

In ETS2, which will price fuel consumption in buildings and transport from 2028, pricing will take place upstream at the wholesaler/importer of the fuel, not at the end consumer. Diesel consumption in agriculture will be integrated into ETS2, as it is an easily measurable input source. However, the two other sources of greenhouse gas emissions in agriculture, methane and nitrous oxide, will not be covered by ETS2.

A separate agricultural ETS would have to set a specific cap for agriculture in order to control emissions. The design of the cap-and-trade system must take into account the challenges of diffuse sources (non-point pollution) and the measurability of environmental damage at the downstream level of agricultural producers. One possible solution is to move away from output pricing towards a trading system that targets inputs, i.e. the resources in the production process that potentially cause environmental damage. The object of trade is the certificate for the use/purchase of this input and thus the right to use the potential pollutant carrier.

The concept of choosing livestock numbers as a proxy variable in an input-oriented trading system can largely circumvent the administrative problem of measurement. It is primarily an approach to controlling methane emissions from enteric fermentation and emissions associated with manure. Since methane and nitrous oxide emissions are largely determined by livestock numbers at farm level as an input variable in the production process, livestock numbers can serve as such a proxy control variable. Livestock numbers (number of animals and their categorisation) are easily measurable and can already be easily verified today using animal databases.

Methane emissions are closely correlated with the number and type of ruminants. Farms would have to purchase certificates for each livestock unit. The system controls only the amount of input (the animal that provides the meat or milk – the outputs), but not the environmental compatibility of the production method (emission intensity), as the theoretical measurement of emissions must refer to standardised average values. It should therefore be supplemented by differentiated emission factors, possibly with a credit system. One such approach could be to take into account the lifespan of cows. Considerable emissions are generated before a cow produces its first litre of milk. If these are spread over many years of use, there is an incentive to keep animals healthy and fit for as long as possible. This example shows that it is possible to modify the certificate system to better achieve the desired goals.

6.3.3 Cap-and-trade for mineral nitrogen fertilisers

The use of agricultural fertilisers (especially nitrogen and phosphorus) causes considerable pollution of groundwater, lakes and coastal waters. A certain proportion of nitrogen also escapes immediately after application as nitrous oxide (N_2O), thus contributing to climate change.

While there is considerable measurement uncertainty in quantifying the environmental damage caused (outcome-based approach), nutrient inputs are an easily measurable input variable in the agricultural production process. The amount of nitrogen and phosphorus can be easily quantified on the basis of purchase, storage and application data. This makes fertilisers suitable for a quantity-based (input-oriented) trading instrument. This avoids the direct measurement of the environmental damage caused. Certificate trading for nutrient inputs could financially reward low-emission farms with lower input use, thereby also triggering an incentive for innovation and increasing dynamic efficiency.

A key problem is the spatial heterogeneity of nutrient inputs (Horan & Shortle 2011). The harmfulness of nitrogen depends heavily on the area where it is applied. Since nutrient inputs cause considerable regional damage (reduction in water quality), the cap should also be tailored regionally to critical catchment areas. The aim would be to set and adhere to a spatially limited reduction target for nutrient inputs in critical water catchment areas. The cap then describes the maximum permissible total amount of nitrogen and phosphorus use from mineral and, where applicable, organic commercial fertilisers in the region in a year. The certificate prices thus reflect regional scarcity and marginal abatement costs. A certificate from a region with low pollution levels is not tradable with a certificate from a pollution hotspot.

Nutrient trading in America's Chesapeake Bay shows that model-based nutrient trading can work, with farmers also generating tradable credits by demonstrably implementing measures (e.g. buffer strips or adapted fertilisation strategies) whose reduction performance is calculated using standardised models. Properly designed fertiliser cap-and-trade systems offer considerable potential: targeted regional control, economic efficiency and noticeable improvements in water quality. They also enable farmers to benefit financially from environmentally beneficial farming practices.

As these explanations show, a cap-and-trade system is not effective for all negative external effects of fertilisers, as the main advantage – ease of administration – would be lost. However, a cap-and-trade system for mineral nitrogen fertilisers is well suited to limiting the damage associated with the associated emissions into the atmosphere (nitrous oxide) and coastal waters (via nitrate leaching). Reactive nitrogen compounds that are transported through the air and reach the soil via rain also contribute significantly to nutrient enrichment in near-natural locations (such as high altitudes in the Alps or heathland sites), thereby altering the natural species composition (nutrient-loving organisms displace species typical of the habitat).

Nitrogen compounds are an essential component of farm manure, the excrement of farm animals. Limiting methane emissions goes hand in hand with limiting farm manure and thus also reduces the problem of nitrogen pollution. Therefore, there is no need for further measures if a system of tradable certificates for methane is implemented (see above).

Reducing the amount of mineral nitrogen fertiliser used in the EU can be implemented relatively easily by requiring producers and distributors to purchase the specified number of certificates. For certain catchment areas or hot spots in groundwater regions, supplementary national or local regulations are necessary (multi-level approach).

Nitrogen fertilisers produced in nitrogen plants in the EU are already more expensive than on the world market. EU producers are part of the ETS1 and must therefore purchase certificates for the GHG emissions associated with the *production* of N fertilisers. With ETS2, emissions associated with *distribution* will also become more expensive from 2028 onwards. The proposed system of tradable certificates for nitrogen fertiliser quantities is therefore intended to reduce emissions associated with its *use*. The *triple* market-based cap could price the external effects of agriculture in the EU through mineral nitrogen pollution and thus significantly reduce them.

6.3.4 Cap-and-trade for the ecotoxicity of plant protection products

In principle, the use of plant protection products can also be controlled by means of cap-and-trade. The aim here is to reduce the ecological risk of plant protection products and not just the amount used. The steering effect should therefore shift from toxic to less toxic products. A certificate market for plant protection products is therefore ideally based on a toxicity-weighted risk measure (Shortle 2013), which takes into account both active ingredient content and ecological damage potential. This aspect is already considered today, albeit in a very crude manner. The EU Member States are divided into a northern zone (e.g. Denmark, Finland, Sweden), a central zone (e.g. Germany, Austria, Netherlands, Poland) and a southern zone (e.g. Spain, Italy, France), based on similar agroclimatic conditions.

The decisive step in this context is the mathematical conversion of the amount of a plant protection product used into a tradable risk measure that reflects its toxicity. From the perspective of a cap-and-trade system, the design of such a system is not particularly complex. Each approved active substance must be assigned a toxicity factor that reflects the potential risk to biodiversity (insects, birds), water bodies and soil. However, there is a risk that the miscalibration of weighting factors could lead to unforeseeable and undesirable substitution effects.

One possibility is for agricultural producers to receive risk certificates and trade them. A farmer who wants to use a highly toxic agent must purchase more certificates than a farmer who uses a low-toxicity agent. This mechanism automatically steers the market towards more efficient agents, as these cost fewer certificates per application. Since the total amount of less toxic substances is also limited, overuse should be prevented. A cap-and-trade system could thus be a flexible tool that gives farmers the choice of either reducing the amount of plant protection products they use or purchasing additional usage rights.

Another option is to require distributors of plant protection products to purchase a corresponding number of certificates for their products. This would significantly reduce transaction costs and have a similar steering effect. With this approach, complementary national or regional regulations would have to be established to avoid hot spots of pollution. In this case, a multi-level approach would also be necessary. This is already structurally in place today in the form of the plant protection services of the federal states. These services carry out inspections, monitor compliance with requirements (e.g. application, trade), advise farmers and thus implement the Plant Protection Act with a focus on the status quo.

Plant protection product-related cap-and-trade systems thus also promote innovation in the field of biological plant protection and create economic incentives to reduce risks.

How a cap-and-trade system can be implemented in EU agriculture

The CAP is a differentiated sectoral policy, but it is only one of many policies that regulate agriculture. Environmental policy is one of them, but food policy[27] and health policy also plays an important role. Since many agricultural goods are processed into food, there are a wealth of rules that are motivated by health policy considerations. There is therefore a close-knit network of controls and reporting requirements covering all stages of the value chain. The purpose of these control systems is to ensure that the origin of food (for example, if it is contaminated with EHEC) can be traced back to its source. This creates a dense network of complementary control points that can be used to develop a CAP-and-trade system without having to develop completely new approaches.

- **Livestock and manure:** Depending on the species and use, livestock of various types (ruminants, pigs, poultry and others) emit greenhouse gases during metabolism, and their excrements also release greenhouse gases. Since the number and type of animals are already recorded in registers and can be assigned to individual livestock farmers, these registers can be used to establish a trading system for animal units (differentiated by species and use, e.g. beef cattle and dairy cows). The type and lifespan of the animals can be used to estimate emissions by applying standard coefficients. At an aggregate level, the total emissions associated with animal husbandry and manure management can thus be attributed to individual animals and their owners. The number of certificates corresponds to the number of differently weighted animals.
- **Mineral nitrogen fertilisers and other commercial fertilisers:** The air emissions associated with different types of fertilisers are known. They are derived from standard coefficients. The expected emission quantity can thus be calculated from the amount of fertiliser. From this, the number of certificates in the initial situation can be derived. Those who place commercial fertilisers on the market must have an adequate number of certificates.
- **Plant protection products:** This system can be implemented in a similar way to that for mineral commercial fertilisers. However, the certificates do not refer to the quantity of active substances, but to an ecotoxicity index assigned to each individual product unit.
- **Soils:** Agricultural soils can be included in a cap-and-trade system. This is particularly relevant for soils that can build up or break down significant amounts of humus when their type of use is changed. If the initial humus content is known, the change in use can be used to infer the emissions or absorption of carbon dioxide from the atmosphere. Knowledge of the area covered by such soils – in conjunction with knowledge of how they are managed – can be integrated into a system of tradable greenhouse gas certificates.

[27] See Principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety (https://eur-lex.europa.eu/legal-content/DE/TXT/HTML/?uri=CELEX:32002R0178).

Such a system can include either individual environmental media (e.g. air only) or several (e.g. air and coastal waters), depending on which emissions are being considered. The basic elements of the approach can be differentiated in a variety of ways to take account of different constellations of property rights or alternative technologies. Per kg of milk, a cow that produces 6,000 kg per year emits significantly more greenhouse gases than one that produces 12,000 kg of milk. It also makes a difference whether farm manure is incorporated into the soil immediately after application or not. When looking at the situation in detail, these and many other factors are important. When implementing a specific system, it is important to bear in mind that greater accuracy comes at the cost of the effort required to obtain this information. The costs of obtaining information and monitoring must be taken into account in a systemic analysis. Therefore, simpler but slightly less accurate systems can be more efficient than more accurate ones which are more complicated.

6.4 Accompanying measures to ensure social compatibility

One of the political and economic prerequisites for the successful implementation of a reversal of agri-environmental policy towards a pricing system for environmental damage based on the polluter pays principle is social compensation that is preventive in nature, in order to gain the approval and support of citizens for a reversal of environmental and agricultural policy and to avoid political blockades (Blattner, 2020). To ensure that the desired transformation remains politically stable and socially acceptable, a preventive compensation concept is necessary to cushion the burden of adjustment. The aim is not to dilute the economic steering effect (the price signal), but to cushion the resulting hardship for particularly affected groups through accompanying measures. Three social groups will be particularly affected by the market-oriented reforms if they are implemented at EU level:

- Farmers face the challenge of changing their production methods. Compensation should not take the form of permanent income support, but rather targeted transformation support. Possible measures could include co-financing investments in emission-reducing technologies (precision farming, barn conversion, manure management). Compensation should only be in the form of start-up financing.
- Downstream companies such as slaughterhouses and dairies, as well as their employees, are affected by structural changes when livestock numbers decline, or raw material flows change. The EU's "just transition" approach could be applied to the agri-food sector, with a focus on state-co-financed retraining and qualification programmes. The aim would be to prevent regional unemployment in rural areas that are particularly affected.
- The share of agricultural raw material costs in food prices is low and declining. Increases in the price of agricultural goods therefore have only a small effect on food prices. Nevertheless, consumers will have to pay higher food prices, at least temporarily, during the transition. Higher prices for meat or dairy products have a relatively greater impact on low-income households (regressive effect).

Since social policy is not a primary EU mandate, compensation must be provided at Member State level. A "climate allowance" or "eco-dividend", whereby potential revenues from agricultural eco-taxes or agricultural environmental certificates are returned to citizens on a per capita or socially graded basis, could help as an accompanying measure during a transition period. Schaper et al. (2025) use Germany as an example to show that the revenue generated by a climate levy can be returned to consumers in the form of climate money. This would provide relief to poorer households, while wealthier households would tend to bear higher costs. This would provide disproportionate relief to low-income earners, while fully maintaining the price incentive to refrain from consuming environmentally harmful products.

Overall, it is the task of the general social policy of the Member States to enable low-income households to obtain a balanced and sufficient supply of food.

Depending on how the system for pricing external costs of agriculture through agricultural eco-taxes or tradable certificates is designed, it may or may not generate revenue for the EU or Member States. If revenue is generated, it can be used to cover or co-finance earmarked expenditure for the three groups mentioned above. However, such earmarking has the disadvantage that more efficient solutions may be introduced later. Since the planned changes should also lead to a reduction in expensive agricultural subsidies, at least in the medium term, this could also open up a source of financing for the EU – provided that the funds do not have to be reallocated to other future areas of EU policy (defence, migration, industrial transformation).

Income support (such as direct payments in agriculture, but also other forms of social assistance) tends to be permanent, as it is framed as a "social necessity". To ensure that compensation measures merely serve as a bridge to a new system and do not become a permanent burden on the budget, they must be subject to strict institutional and temporal constraints. Several strategies are conceivable to this end:

- Instead of fixed annual amounts, the compensation design must provide for systematic degression. The legislator stipulates at the time of introduction that payments will decrease annually by a fixed percentage.
- Sunset clauses: The legal basis for compensation payments is given an automatic expiry date. Any extension requires a new scientific evaluation of the necessity.

6.5 Options for action to secure the implementation of a unilateral polluter pays principle in EU agriculture in terms of foreign trade

6.5.1 The option of extending CBAM to agricultural goods

The introduction of emissions pricing in agriculture also raises issues of international trade and emissions leakage (Henderson and Verma, 2021; Zech and Schneider, 2019). The proposed options for unilateral EU action could trigger production relocation to regions without climate regulations in all model options except for peatlands) and require possible countermeasures, such as a sector-specific agricultural border adjustment mechanism (agricultural CBAM) for agricultural imports, in order to create a level playing field.[28] Border adjustment mechanisms are trade policy measures that aim to create a level playing field between domestic and foreign producers when environmental or carbon taxes are levied domestically.

Agricultural goods are the raw materials for food and many other products. Many of the agricultural commodities produced in the EU (wheat, milk powder, soybeans, butter, sugar, rapeseed oil, etc.) are well defined and traded on international exchanges, meaning they are fungible products.

A CBAM-based model for agricultural products would have to be implemented differently than the current CBAM for steel or fertiliser, which takes into account the emissions from both the production facility and the country. As agricultural products are produced by a large number of producers, it is administratively impossible to include producer-specific emissions. Therefore, country- and product-specific emission factors would have to be determined for agricultural goods. The FAO already publishes corresponding emission factors for the most important agricultural goods in most countries (see https://www.fao.org/faostat/en/#data/EI).

By extending the current calculations to a larger number of agricultural goods, CBAM for agricultural goods could be implemented somewhat more easily than for industrial products (it would only be necessary to differentiate between products and countries).

However, as food products (e.g. chocolate) are derived from crop production (e.g. cocoa), but do not originate directly from the place where the agricultural products are processed (e.g. Ghana) but only become food products at the place of processing (e.g. the UK), the problems mentioned above remain.

One option for action to **offset** higher production costs for agricultural goods through tradable **greenhouse gas certificates at the border** is therefore **to introduce an agricultural CBAM approach.** The levy can be based on calculations that take into account country-specific coefficients for agricultural goods. **Analogous data for compensating higher production costs due to restrictions on mineral fertilisers and pesticides are not currently available.**

6.5.2 Trade neutralisation instruments

An alternative approach to addressing the competitive distortions caused by unilateral emissions pricing is to interpret the unilateral increase in production costs resulting from market-based emissions pricing not primarily as an environmental measure, but as an unintended intervention in competition policy that effectively gives foreign producers a competitive advantage (Mehling & Jakob, 2024). According to this logic, the resulting distortion of competition can be compensated for by targeted trade instruments without the need for detailed information on the actual emission intensity of foreign production. This approach significantly reduces the information requirements compared to an ideal CBAM design and allows its extension to a broader range of imported goods.

[28] The renegotiation of trade agreements with environmental provisions could also be considered (see Felbermayr et al., 2022).

The **core principle** of this alternative approach is based on compensatory tariffs and subsidies that neutralise the potential effects of unilateral internalisation on imports (increase) and exports (decrease) (Staiger, 2022).

The **application** leads to the so-called **Leakage Border Adjustment Mechanism (LBAM)** (Campolmi et al. 2025), which is compatible with key GATT principles and aims **to neutralise the relocation of production abroad** and stabilise trade flows. This does not discriminate against foreign producers; it merely compensates for the cost disadvantage of European producers, regardless of the emission intensity abroad.

First, the extent to which the production costs of all goods within the EU increase as a result of the internalisation of external costs is determined. On this basis, the border adjustment mechanism is calibrated so that the imposition of non-discriminatory, product-specific import tariffs increases import prices to the extent that import volumes remain constant despite the changed domestic cost structure. At the same time, export subsidies can be provided to ensure that the export volumes of European producers remain unchanged despite increased domestic production costs (Campolmi et al., 2025). Effectively, this means that the effects of domestic emissions pricing on imports and exports are precisely neutralised. By adjusting trade volumes in this way, LBAM achieves leakage avoidance more directly than CBAM, but does not provide any incentives to reduce or price emissions abroad.

The main advantage of this alternative compensation measure is that it requires less information and involves less bureaucracy. This is because the necessary parameters – price elasticities of domestic import demand and foreign demand for EU exports – are more robust than the emission intensities of products from different production processes and jurisdictions. While respecting key principles of WTO law, this proposal for a possible border adjustment system could raise WTO law issues regarding its acceptance by trading partners. In principle, a LBAM can be applied in the same way to all internationally traded goods. Although **agricultural goods** have specific price elasticities, meaning that im-port duties (and possibly export subsidies) would differ from those of other goods, access would not differ. Consequently, a LBAM as outlined here is another option for offsetting higher production costs due to environmental regulations at EU level in foreign trade. An increase in production costs in the EU due to the limitation of greenhouse gases in agriculture and the re-duction of mineral nitrogen and plant protection products can be considered in such a system by offsetting these price increases with an adequate import duty. However, this approach is currently being discussed primarily at the scientific level and not at the political level. Despite the theoretical claim of minimal information requirements, several hurdles are emerging in the practical implementation of the LBAM approach. A key obstacle concerns the parametric calibration of the approach. LBAM requires precise econometric estimates of im-port demand and export supply elasticities, which exhibit high sectoral variability. In addition, this approach requires continuous recalibration and sector-specific adjustment of import du-ties, which means that the administrative complexity cannot be ignored. Furthermore, to prevent leakage entirely, the LBAM requires export subsidies, which are sensitive from a WTO legal perspective and thus pose a legal friction problem that jeopardises political implement-ability and exposes the EU to dispute settlement proceedings.

6.5.3 Burden on domestic consumption

A third design option could be a hybrid system that maintains the free allocation of emission allowances under the ETS but imposes a non-discriminatory excise tax on domestic consumption of certain emission-intensive products to achieve the desired behavioural change. This specific design option has already been considered in the feasibility study commissioned by the European Commission (2021). This approach was rated highly in terms of leakage protection, incentives for decarbonisation investments and administrative feasibility, but has not yet been prioritised.

The **core principle** is to continue allocating free emissions trading allowances to EU producers of emission-intensive goods, thereby preventing their competitiveness on domestic and foreign markets from being eroded by progressive price increases. This arrangement also preserves the economic steering instruments of the ETS, as unused allowances can be sold on the market and additional requirements must be covered by purchases, thereby maintaining the incentive structure for emission reductions.

In order to reflect these price signals in domestic consumption and thus induce a change in behaviour towards a lower demand for emission-intensive products, domestic consumption of certain goods is subject to a product-specific environmental tax with standardised rates (per unit of quantity based on the ETS), which can be offset at the border (Neuhoff et al., 2025a, Neuhoff et al. 2025b).

In **practice**, the tax would have to be calibrated to neutralise the allocation of free allowances. As the **excise tax** is levied at the same rate regardless of the origin of the goods, there is no discrimination between domestic and imported products and therefore no WTO compatibility issues.

However, practical implementation requires a careful legal construction that classifies the instrument as a *regulatory levy* rather than a traditional *consumption tax*. This avoids questions of competence within the European governance system.

The advantage of this approach lies in the low level of bureaucracy involved in designing the border adjustment. By basing pricing on emissions consumed domestically, it primarily burdens consumers and does not create any incentives for decarbonisation abroad. Such a system also enables market players to gradually adapt to changing price signals. Abrupt competitive discontinuities and the risk of trade retaliation could thus be avoided.

As explained in the context of CBAM, emission coefficients are already available for the main agricultural commodities. The EU's Joint Research Centre (JRC) also publishes data on the greenhouse gas intensity of the food value chain (https://edgar.jrc.ec.europa.eu/). Using standard recipes, it is therefore possible to estimate the greenhouse gas emissions of food products with a high degree of accuracy.

The system presented here can therefore be considered as a further option for offsetting the impact of introducing the polluter pays principle in the EU's agricultural and food sector on international trade. No calculations are currently available on the possible increase in production costs in the EU as a result of restrictions on mineral nitrogen and plant protection products. Studies should therefore be carried out to quantify the impact. This approach is also currently being discussed mainly at a scientific rather than a political level, although this option has already been discussed at EU level. Such a system could serve as an **interim solution** while free allowances are phased out, eventually leading to a comprehensive, adapted border adjustment system.

7. Discussion and conclusions

The study analyses ways of reducing the external costs of agriculture in the EU through a market-oriented reform of agricultural and environmental policy. To avoid production being relocated to regions outside the EU with potentially even greater external effects of global relevance, options for border adjustment are also presented.

Agriculture causes considerable environmental pollution globally: approximately 20% of greenhouse gas emissions worldwide, over 50 kg of nitrogen surplus per hectare of arable land globally, and a significant contribution to species extinction through the use of plant protection substances and the cultivation methods they enable. Agriculture in the EU also contributes to global environmental pollution. These external costs, which are not internalised in the price of agricultural goods, lead to widely used environmentally harmful production methods. In the long term, this also jeopardises security of supply due to the degradation of natural resources.

The EU's approaches to date to reduce the negative consequences of agricultural production have not been very effective. In the EU, a lack of coordination between the CAP, environmental and trade policies exacerbate inefficient subsidies and regulations. This leads to high costs (31% of the EU budget until 2027), bureaucratic burdens and the failure to meet environmental targets. The prevailing approach of regulatory requirements and direct payments granted under environmental conditions is not very effective. From a political economy perspective, this is the result of powerful interest groups that are reluctant to accept effective measures that would curb agricultural production.

Market-based solutions such as environmental taxes or tradable certificates are the instruments with which effective change can be brought about. They are the most effective way of taking account of the polluter pays principle, which applies in the EU. However, taxes on environmentally harmful activities at EU level have so far failed due to insurmountable barriers such as the requirement for unanimity in the Council. EU-wide tradable certificates for emissions are easier to implement politically, as demonstrated by the EU Emissions Trading System (ETS).

Economists favour market-based instruments based on the polluter pays principle because they put a price on environmental damage and tackle it at source. At the same time, they are giving companies the freedom to reduce environmental costs in the way that is most favourable to them.

Agriculture is not yet part of the ETS, but is primarily subject to national regulations, which vary greatly between Member States. This causes significant distortions of competition within the EU. As a result, the reduction of greenhouse gases in agriculture has slowed down in recent years.

The study proposes a new solution for integrating agriculture into the ETS, the details of which still need to be worked out. The mechanism does not focus on emissions, which are practically impossible to measure in the agricultural sector, but on important inputs to produce agricultural goods. Concrete models are being developed for mineral nitrogen fertilisers, live-stock and plant protection products.

The advantages of a system of tradable certificates are the effective limitation of inputs associated with negative external effects, incentives for innovation and the possibility of adapting technologies to specific circumstances. Depending on the design of the system, this can generate revenue for the state or allow provisions to be made to cushion the cost burden of adapting to the new regime at the outset.

At least temporarily, it is to be expected that agricultural goods will become more expensive, and incomes will fall if important inputs for production are effectively restricted. For the farmers and employees in the food industry who are affected, there are already instruments at EU level to mitigate the costs of adjustment. As higher production costs in agriculture will make agricultural goods and thus also food more expensive, low-income households will also be affected by a more effective agri-environmental policy. Support measures should be developed for them as part of social policy.

If the external effects of EU agriculture are internalised, there is a risk of leakage, i.e. production may shift to regions outside the EU. Currently, the Carbon Border Adjustment Mechanism (CBAM) provides a European compensation mechanism for certain industrial goods and electricity. In principle, it is possible to include agricultural goods in this system. However, as the CBAM has several shortcomings, two further options are presented to enable effective border compensation. In one of these systems, the cost burdens on producers within the EU are neutralised by changes in import duties and export subsidies. Concepts developed for industrial goods can also be applied to agricultural goods. The second alternative involves increasing the price of consumer goods whose production incurs high external costs. This option was already considered in the feasibility study for a border adjustment system commissioned by the EU in 2021. This approach was rated highly in terms of leakage protection, incentives for decarbonisation investments and administrative feasibility, but has not been prioritised to date. However, it could serve as a transitional solution, ultimately leading to a comprehensive, adapted border adjustment regime.

This combination of market-based instruments within the EU with safeguards in international trade shows a way to stimulate innovation towards more environmentally friendly production methods, reduce the administrative burden, keep food price increases low and achieve a predictable reduction in environmentally harmful pollutants.

However, the European Commission's current proposals for a reformed CAP (Common Agricultural Policy) focus primarily on the existing mix of instruments, which has so far had little effect in reducing environmental pollution. Effective measures to curb emissions from the agricultural sector are not being pursued because market-based instruments for reducing emissions are not provided for in the CAP. Instead, considerable funds are earmarked to compensate for climate-related production losses. The proposals developed here show how a combination of measures in agricultural, environmental and trade policy can effectively reduce the negative externalities of agriculture while keeping the agricultural sector competitive and innovative.

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9. Appendix

Table 9-1: **Development of greenhouse gas emissions in Germany**

Source group	1990	2000	2010	2020	2024
	Millions of tonnes of CO2 equivalents				
Total emissions with LULUCF[1])	**1,288.42**	**1,047.04**	**935.55**	**809.65**	**700.35**
Total emissions excluding LULUCF[1])	1,252.40	1,042.35	930.25	732.99	649.06
1, Energy	1,044.28	872.68	795.99	613.28	542.94
2, Industry	93.28	76.70	61.88	55.35	47.09
3, Agriculture	**73.29**	**63.40**	**60.19**	**58.25**	**53.68**
3 A 1, cows and cattle	35.12	28.97	26.60	25.21	23.62
3 A 2, sheep	0.65	0.55	0.45	0.36	0.36
3 A 3, pigs	0.78	0.68	0.70	0.71	0.59
3 A 4, Other farm animals	0.76	0.83	0.79	0.79	0.85
3 A, Fermentation	37.30	31.03	28.53	27.06	25.42
3 B 1 a, dairy cows	3.60	3.49	3.25	3.36	3.11
3 B 1 b, cattle	3.75	3.04	2.55	2.35	2.18
3 B 1, cows and cattle	7.35	6.53	5.81	5.71	5.29
3 B 2, sheep	0.08	0.06	0.05	0.04	0.04
3 B 3, pigs	3.55	3.28	2.89	2.87	2.30
3 B 4 c, game	0	0	0	0	0
3 B 4 d, goats	0.00	0.01	0.01	0.01	0.01
3 B 4 e, horses	0.41	0.42	0.39	0.38	0.42
3 B 4 g i, laying hens	0.06	0.06	0.06	0.07	0.07
3 B 4 g ii, broiler chickens	0.02	0.03	0.06	0.07	0.07
3 B 4 g iii, turkeys	0.02	0.03	0.05	0.05	0.04
3 B 4 g iv, other poultry	0.01	0.01	0.01	0.01	0.01
3 B 4 g, poultry	0.12	0.14	0.18	0.2	0.18
3 B 4 h, Other farm animals	0.02	0.01	0.01	0.00	0
3 B 4, Other farm animals	0.55	0.58	0.58	0.59	0.61
3 B 5, Indirect emissions	1.45	1.20	1.17	1.04	0.94
3 B, Manure management	12.98	11.65	10.50	10.25	9.18
3 D 1 a, Inorganic N fertilisers (including urea application)	5.56	4.86	4.14	3.36	2.6
3 D 1 b i, animal manure	3.20	2.82	2.73	2.71	2.54
3 D 1 b ii, sewage sludge	0.07	0.08	0.06	0.03	0.03
3 D 1 b iii, Other organic N fertilisers (including compost)	0.03	0.16	0.62	0.97	1.01
3 D 1 b, Organic N fertilisers	3.30	3.07	3.42	3.71	3.57
3 D 1 c, urine and dung from grazing animals	0.52	0.38	0.33	0.3	0.29
3 D 1 d, crop residues	1.74	1.85	1.94	2.13	2.15
3 D 1 e, mineralisation/immobilisation[2])	0.37	0.37	0.34	0.32	0.32
3 D 1 f, cultivation of organic soils (i.e. histosols)	3.40	3.47	3.45	3.52	3.34
3 D 1, Direct emissions from managed soils	14.89	14.01	13.62	13.33	12.28
3 D 2 a, Atmospheric deposition	2.60	2.22	2.25	1.87	1.72
3 D 2 b, nitrogen leaching and runoff	2.33	1.79	1.62	1.51	1.13
3 D 2, Indirect emissions from managed soils	4.93	4.02	3.88	3.38	2.85
3 D, Agricultural soils	19.82	18.02	17.50	16.71	15.12

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Source group	1990	2000	2010	2020	2024
	Millions of tonnes of CO2 equivalents				
3 G, liming	2.20	1.7	1.55	2.01	1.83
3 H, urea application	0.48	0.59	0.71	0.43	0.33
3 I, Other carbonaceous fertilisers	0.51	0.37	0.26	0.19	0.14
3 J, Other agriculture	0	0.04	1.14	1.59	1.64
4, Land use, land use change and forestry	36.03	4.69	5.30	76.66	51.29
4 A 1, Forest stock	-25.57	-51.96	-39.34	24.46	1.13
4 A 2 a, farmland converted to forest			-0.02	-0.09	-0.08
4 A 2 b, grassland converted to forest	0.45	0.39	-0.36	0.01	-0.37
4 A 2 c, wetlands converted to forest			0.05	0.07	0.05
4 A 2 d, settlements converted to forest	-0.13	-0.14	-0.38	-0.16	-0.15
4 A 2 e, Other land converted to forest	-0.11	-0.11	-0.13	-0.08	-0.05
4 A 2, Land converted to forest	0.21	0.13	-0.84	-0.25	-0.59
4 A, forests	-25.36	-51.82	-40.18	24.20	0.54
4 B 1, Arable land	16.56	16.13	14.19	13.33	12.45
4 B 2 b, grassland converted to arable land	4.06	4.01	5.72	8.77	7.43
4 B 2 c, wetlands converted to farmland			0.02	0.1	0.09
4 B 2 d, Settlements converted to farmland	0.25	0.26	0.37	0.27	0.1
4 B 2 e, Other land converted to arable land	-0.02	-0.02	-0.01	-0.01	0
4 B 2, Land converted to arable land	4.29	4.24	6.10	9.13	7.63
4 B, farmland	20.86	20.38	20.29	22.46	20.08
4 C 1, grassland stock	32.05	32.92	26.68	30.26	26.79
4 C 2 a, forest converted to grassland					0
4 C 2 b, arable land converted to grassland	0.45	0.41	-2.58	-1.69	-1.88
4 C 2 c, wetlands converted to grassland			0.04	0.22	0
4 C 2 d, Settlements converted to grassland	-0.08	-0.07	-0.62	-	-0.7
4 C 2 e, Other land converted to grassland	-0.15	-0.14	-0.21	-0.21	-0.09
4 C 2, Land converted to grassland	0.22	0.21	-3.38	-2.15	-2.52
4 C, grassland	32.27	33.13	23.29	28.12	24.27
4 D 1, Wetland population	9.15	9.66	9.19	9.91	8.29
4 D 2 a, forest converted to wetland			0.03	0.10	0.16
4 D 2 b, farmland converted to wetland			0	0	0
4 D 2 c, grassland converted to wetland			0.05	0.22	0.33
4 D 2 d, Settlements converted to wetlands			0	0.01	0
4 D 2 e, Other land converted to wetland			0	0	
4 D 2, Land converted to wetlands			0.08	0.33	0.5
4 D, Wetlands	9.15	9.66	9.28	10.24	8.79
4 E 1, Settlement area stock	1.11	1.07	0.98	1.02	1.02
4 E 2 a, forest converted to settlement	0.01	0.01	0.12	0.67	0.57
4 E 2 b, farmland converted to residential use	-0.55	-0.54	-3.31	-2.39	-1.39
4 E 2 c, grassland converted to settlement	-0.10	-0.10	-1.12	-0.26	-0.38
4 E 2 d, wetlands converted to settlement			0	0	0
4 E 2 e, Other land converted to settlement use	-0.01	-0.01	-0.03	0	0
4 E 2, Land converted to settlements	-0.65	-0.65	-4.34	-1.92	-1.19
4 E, Settlements	0.46	0.42	-3.35	-0.90	-0.17
4 G, wood products	-1.34	-7.07	-4.02	-7.46	-2.23
5 Waste	41.55	29.57	12.19	6.12	5.36

Source: German Umweltbundesamt (UBA), Central Emissions System (ZSE), greenhouse gas emissions according to UNFCCC (Paris Agreement). Data as of 12 December 2025. –[1]) Excluding land use, land use change and forestry; –[2]) In connection with loss/gain of organic matter in the soil.

Table 9-2: **Environmental hidden (external) costs of agricultural and food systems in the European Union, 2020**

		Environmental hidden costs				
		Total	Climate	Water abstraction	Land	Nitrogen
Land		US$ million 2020				
EU-27	**EU-27**	**291,429**	**61,376**	**5,218**	**88,481**	**136,354**
BE	Belgium	7,089	1,311	0	796	4,982
BG	Bulgaria	3,589	849	3	1,592	1,145
CZ	Czechia	5,427	1,082	0	1,701	2,644
DK	Denmark	7,374	1,273	6	567	5,528
DE	Germany	30,085	10,027	0	2,813	17,245
EE	Estonia	3,293	522	0	2,050	721
IE	Ireland	12,856	2,369	0	4,647	5,840
EL	Greece	12,409	1,282	2,108	4,241	4,778
ES	Spain	34,809	5,147	2,217	15,654	11,791
FR	France	43,203	8,226	20	17,791	17,166
HR	Croatia	2,814	462	0	666	1,686
IT	Italy	24,965	5,908	567	3,313	15,177
CY	Cyprus	564	95	50	23	396
LV	Latvia	5,617	581	0	4,118	918
LT	Lithuania	5,274	1,225	0	1,378	2,671
LU	Luxembourg	0	–	–	–	–
HU	Hungary	8,153	1,464	1	2,212	4,476
MT	Malta	0	–	–	–	–
NL	Netherlands	11,762	3,346	0	556	7,860
AT	Austria	6,146	883	0	2,703	2,560
PL	Poland	23,460	7,626	1	6,986	8,847
PT	Portugal	10,016	935	239	5,823	3,019
RO	Romania	17,611	2,105	1	5,083	10,422
SI	Slovenia	1,263	294	0	104	865
SK	Slovakia	4,099	336	0	1,796	1,967
FI	Finland	4,505	1,509	5	1,668	1,323
SE	Sweden	5,046	2,519	0	200	2,327

Source: FAO. 2023. The State of Food and Agriculture 2023 – Revealing the true cost of food to transform agrifood systems. Data from Table A2.1. Rome. https://doi.org/10.4060/cc7724en.