







Opportunities and challenges for Common Agricultural Policy reform to support the European Green Deal

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Abstract

The Common Agricultural Policy (CAP) is the European Union's main instrument for agricultural planning, with a new reform approved for 2023–2027. The CAP intends to align with the European Green Deal (EGD), a set of policy initiatives underpinning sustainable development and climate neutrality in the European Union (EU), but several flaws cast doubts about the compatibility of the objectives of these 2 policies. We reviewed recent literature on the potential of CAP environmental objectives for integration with the EGD: protection of biodiversity, climate change mitigation and adaptation, and sustainable management of natural resources. The CAP lacks appropriate planning measures, furthering instead risks to biodiversity and ecosystem services driven by landscape and biotic homogenization. Funding allocation mechanisms are not tailored to mitigate agricultural emissions, decreasing the efficiency of climate mitigation actions. The legislation subsidies farmers making extensive use of synthetic inputs without adequately supporting organic production, hindering the transition toward sustainable practices. We recommend proper control mechanisms be introduced in CAP Strategic Plans from each member state to ensure the EU is set on a sustainable production and consumption path. These include proportional assignment of funds to each CAP objective, quantitative targets to set goals and evidence-based interventions, and relevant indicators to facilitate effective monitoring of environmental performance. Both the CAP and the EGD should maintain ambitious environmental commitments in the face of crisis to avoid further degradation of the natural resources on which production systems stand.

KEYWORDS

biodiversity conservation, climate change, Common Agricultural Policy, environmental policy, European Green Deal, farm to fork strategy, food production, sustainable agriculture

Oportunidades y retos para la reforma a la Política Agrícola Común que respalden el Pacto Verde Europeo

Resumen: La Política Agrícola Común (PAC) es el principal instrumento de planificación agraria de la Unión Europea, con una nueva reforma aprobada para 2023–2027. La PAC pretende alinearse con el Pacto Verde Europeo (PVE), un conjunto de iniciativas políticas que apuntan al desarrollo sostenible y la neutralidad climática en la UE, aunque varias fallas han arrojado dudas sobre la compatibilidad de los objetivos de estas dos políticas. Revisamos la bibliografía reciente sobre el potencial de integración de los objetivos

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medioambientales de la PAC con el PVE en tres categorías: protección de la biodiversidad; mitigación del cambio climático y adaptación al mismo y, gestión sostenible de los recursos naturales. Encontramos que la PAC carece de medidas de planificación adecuadas, lo que agrava los riesgos para la biodiversidad y los servicios ambientales derivados de la homogeneización biótica y paisajística. Los mecanismos de asignación de fondos no están adaptados para mitigar las emisiones agrícolas, lo que disminuye la eficiencia de las acciones de mitigación del cambio climático. La legislación subsidia a los agricultores que hacen un uso extensivo de insumos sintéticos sin apoyar adecuadamente la producción ecológica, obstaculizando la transición hacia prácticas sostenibles. Recomendamos que se introduzcan mecanismos de control adecuados en los Planes Estratégicos de la PAC de cada Estado miembro para garantizar que la UE se encamina hacia una producción y un consumo sostenibles. Estos mecanismos incluyen la asignación proporcional de fondos a cada objetivo de la PAC, objetivos cuantitativos para fijar metas e intervenciones basadas en pruebas, e indicadores pertinentes para facilitar un seguimiento eficaz de los resultados medioambientales. Tanto la PAC como el PVE deben mantener compromisos medioambientales ambiciosos frente a la crisis para evitar una mayor degradación de los recursos naturales sobre los que se asientan los sistemas de producción.

PALABRAS CLAVE

agricultura sustentable, cambio climático, conservación de la biodiversidad, estrategia de la granja a la mesa, Pacto Verde Europeo, política ambiental, producción alimentaria

【摘要】

共同农业政策(Common Agricultural Policy, CAP)是欧盟农业规划的主要工具,目前2023-2027年的新改革方案已获批准。CAP计划与《欧洲绿色协议(European Green Deal, EGD)》保持一致,EGD是一系列支持欧盟可持续发展和气候中立的政策倡议,但存在的一些不足导致人们质疑这两项政策目标的兼容性。本研究回顾了最近关于CAP环境目标与EGD整合的潜力的文献,聚焦在保护生物多样性,减缓和适应气候变化,以及自然资源的可持续管理。我们发现,CAP缺乏适当的规划措施,反而进一步增加了景观和生物同质化对生物多样性和生态系统服务的风险。资金分配机制不是专门为减缓农业排放而设计的,因此降低了减缓气候变化行动的效率。法案补贴了大量使用合成投入物的农民,但却没有充分支持有机生产,阻碍了向可持续生产实践的转变。我们建议在每个成员国的CAP战略计划中引入适当的控制机制,以确保欧盟走上可持续生产和消费的道路。这些机制包括按比例给CAP的每个目标分配资金,制定目标的量化指标和基于证据的干预措施,以及采用促进有效环境成效监测的相关指标。CAP和EGD都应该在危机面前保持有雄心壮志的环境承诺,以避免生产系统所依赖的自然资源进一步退化。

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适应性管理

生物多样性保护,气候变化,共同农业政策,环境政策,《欧洲绿色协议》,《农场到餐桌战略》,粮食生产,可持续农业

INTRODUCTION

In 2019, the European Commission reaffirmed its commitments to tackle sustainability challenges by adopting the European Green Deal (EGD), a set of policy initiatives aimed at reducing the environmental footprint of the European Union (EU). Under this overarching goal, the EGD aims to introduce new legislations in the energy and transport sectors, on research and innovation, climate neutrality, and industrial and agricultural sustainable development. To enhance implementation of the EGD environmental commitments, the EU Biodiversity and Farm to Fork Strategies were adopted, and a proposal for

climate action (European Commission, 2019a) was later ratified as a binding Climate Law to achieve climate neutrality by 2050 (Official Journal of the European Union, 2021). The specific objectives of these strategies include restoring degraded ecosystems, establishing biodiversity-rich landscape features on farmlands, halting and reversing species declines, increasing targets for the reduction of greenhouse gas (GHG) emissions, restoring and maintaining carbon sinks, managing agricultural land under organic farming, reducing the use and risk of pesticides and fertilizers, and reducing soil degradation. These strategies are especially relevant for the conservation of natural assets in agricultural landscapes, but a significant challenge for

their successful implementation is to have direct alignment with other major European policies that could support similar environmental objectives, such as the Common Agricultural Policy (CAP) (European Commission, 2020a; Pe'er et al., 2022).

Established in 1957, the CAP is one of the world's largest and oldest agricultural policies in force. It is the most expensive policy in the EU (34.5% of the total EU annual budget in 2020) intended for planning and regulating support programs for farms and rural areas. The policy has undergone reforms since its establishment and is currently expected to be the main EU instrument to address the challenges of sustainable development (European Parliament, 2020). Recognizing the role of agriculture as a primary producer of public goods and responding to social demands to protect them, a new focus on innovation, climate change, and the environment has been pursued since the 2013 CAP reform (2014–2020 financial period), when green direct payments including economic incentives for crop diversification or the maintenance of permanent grasslands for environmental goods were agreed. In the 2018 reform (2021–2027 financial period), the European Commission drafted the first proposal with 3 specific objectives that were subsequently incorporated, confirming new overall performance goals: contribute to the protection of biodiversity, enhance ecosystem services, and preserve habitats and landscapes; contribute to climate change mitigation and adaptation and sustainable energy; and foster sustainable development and efficient management of natural resources, such as water, soil, and air.

These objectives acknowledge the role of the CAP in preventing further environmental degradation that past reforms failed to address, hindering the transition to agricultural sustainability (Pe'er et al., 2019). For example, over 70% of the CAP budget goes to direct payments under Pillar I, which grant farmers income support based on the number of hectares farmed. However, it has been demonstrated that past payments favored mostly input-intensive systems responsible for high GHG emissions and were disproportionately concentrated in regions where income was already above the EU median, aggravating income inequality and providing only marginal support to biodiversity, climate, and environmentally friendly practices (Scown et al., 2020). A smaller share of the CAP budget (about 23%) goes to the Rural Development Program under Pillar II. It contains measures for rural development and voluntary actions for climate and environment, including compensation for income foregone associated with environmentally friendly practices in a scheme known as Agri-Environment-Climate Measures (AECM). These measures can vary significantly among member states, as can the criteria for fund allocation, creating substantial discrepancies in how states use their funds (Alliance Environment, 2019). The AECM also provided monetary benefits to farmers engaging in agricultural practices without explicit environmental protection goals, which reduced the effectiveness of the scheme in improving environmental performance (Simoncini et al., 2019).

With recently signed commitments on the EGD, in 2020 the European Parliament agreed on a general CAP reform, and in July 2021 it ratified the new CAP for 2023–2027 (with a

2-year delay due to COVID-19). As a result of the reform, the new environmental architecture of CAP replaced the former Cross Compliance scheme, under which farmers had to respect a basic set of rules to be eligible for receiving EU income support, with a new payment approach based on a system of enhanced conditionality requirements. These include 2 mechanisms, the Statutory Management Requirements (SMR), comprising national and EU regulations, and a set of land maintenance conditions known as the Good Agricultural and Environmental Conditions (GAEC). Farmers are eligible to receive payments according to their performance, which is measured based on a set of indicators in accordance with strategic plans defined by member states. In an attempt to raise environmental ambition beyond conditionality requirements, voluntary measures in the form of AECMs were confirmed in Pillar II, whereas the previous greening instrument was replaced by ecoschemes under Pillar I (Council of the European Union, 2021). Within those 2 instruments, member states will decide how to allocate funding for voluntary measures tailored to meet their own specific needs (European Commission, 2020a).

The approved CAP reform aims to reflect the EGD objectives, but substantial flaws in the design of its mechanisms raise doubts about the effectiveness of resource allocation to achieve the environmental commitments (Pe'er et al., 2021). We considered the challenges of fulfilling the sustainability ambitions of CAP and the opportunities CAP provides to member states to improve their environmental performance, with the aim of successfully integrating the CAP with the EGD mandate. Based on the framework of the EU Biodiversity Strategy, the European Climate Law, and the Farm to Fork Strategy, we provide recommendations for the implementation of CAP national strategic plans that can support achievement of the EGD's objectives for the protection of biodiversity, climate change mitigation and adaptation, and the sustainable management of natural resources.

PROTECTION OF BIODIVERSITY

The protection and restoration of biodiversity in agricultural landscapes is a priority action to ensure sustainable food systems in the EU. Accordingly, the EGD contains provisions in its biodiversity strategy for 2030, with objectives and commitments to enable transformative changes to benefit both nature and people (Table 1). In accordance with those provisions, CAP objective 6 aims to protect biodiversity and its derived ecosystem services. Yet, several concerns exist about how the CAP mechanisms can support achievement of the EGD objectives of protecting natural landscapes and species, envisioned under the EU Biodiversity Strategy.

In contrast with the EGD commitment to restore degraded ecosystems and farmland biodiversity, previous CAP regulations that contributed to the intensification of European agriculture through production-oriented mechanisms, such as payments per hectare and number of livestock heads (Emmerson et al., 2016; Pe'er et al., 2017), remain unchanged in the current reform. Although economically beneficial for some, the

TABLE 1 Comparison of European Union Green Deal Biodiversity Strategy and the corresponding Common Agricultural Policy (CAP) objectives regarding protection of biodiversity and habitats.^a

| EU Green Deal objectives | CAP objectives and measures | CAP provisions and mismatches with the EU Green Deal | References |
|---|---|---|--|
| Halting and reversing the decline of pollinators | Contribute to the protection of biodiversity, enhance ecosystem services, and preserve habitats and landscapes (CAP specific objective 6) | No targets or interventions to maintain or enhance wild pollinators diversity at local or landscape level. Species monitoring is restricted to threatened species, according to the species of community interest in the Natura 2000 framework. Early detection of threats or decreasing population trends requires comprehensive monitoring programs of species, areas, and environmental practices for which there are no clear financing mechanisms. Species trends are assessed using multiannual output indicators, which can potentially hinder timely actions to deter threats occurring within shorter time frames. Member states can include advisory services, technical assistance, training, information, and exchange of best practices to beekeepers' organizations. However, there are no indicators to measure the effectiveness of these tools. | Council of the European Union, 2021; European Court of Auditors, 2020b |
| Manage established invasive alien species and decrease by 50% the number of International Union for Conservation of Nature Red List species they threaten by 2050 | Maintenance of nonproductive features and areas to improve on-farm biodiversity (GAEC 8) | There are no landscape planning strategies dedicated to maintaining biodiversity for farmers willing to increase productivity by the intensification of agricultural activities. As a result, agricultural expansion and intensification might further homogenize landscapes and biological communities, reducing their resistance to threats such as biological invasions and pest outbreaks. Introduction and management of invasive animal species are not addressed in the CAP. Only optional measures for avoiding invasive plant species are mentioned. Management of invasive animal species should also be addressed. | Gamez-Virués et al., 2015; Thomson et al., 2019 |
| Increasing land for biodiversity and bringing at least 10% of agricultural area under high-diversity landscape features | Protection of habitat and species (GAEC 9) | "Minimum share of agricultural area devoted to nonproductive areas or features. Minimum share of at least 4% of arable land at farm level devoted to nonproductive areas and features, including land lying fallow. Where a farmer commits to devote at least 7% of his/her arable land to nonproductive areas and features [...]. Minimum share of at least 7% of arable land at farm level if this includes also catch crops or nitrogen fixing crops, cultivated without the use of plant protection products [...], of which 3% shall be lying fallow or nonproductive feature [...]. Ban on cutting hedges and trees during the bird breeding and rearing season. As an option, measures for avoiding invasive plant species" (GAEC 8). ^b Thresholds are too low to be effective compared to successful intervention programs. Fast-growing crops are unlikely to deliver significant results for native or endangered biodiversity. Hedges and trees can be cut out during the breeding season. Member states can exempt holdings from the obligation under several conditions, greatly decreasing the extent and the effectiveness of GAEC 8. In 2018, only 0.5% of agricultural area was covered by landscape features, and 4.1% was fallow. The new optional measure does not raise environmental ambition to match the EU Green Deal commitment, despite declining on-farm biodiversity trends. Following the introduction of greening measures in CAP 2014–2020, holdings where the ecological focus areas (now GAEC 8) resulted in a positive change in farming practices are estimated to be 1% of total EU arable land. Forty-eight percent of farmed areas were exempt due to small farm size. Seminatural habitats declined, and the new conditionality system is not halting the trend. | European Commission, 2020b; European Court of Auditors, 2017; Pe'er et al., 2019; Scown et al., 2020, 2021 |
| | | "Ban on converting or ploughing permanent grassland designated as environmentally-sensitive permanent grasslands in Natura 2000 sites" (GAEC 9). ^b In 2018, there were 16.6 million ha of permanent grasslands in Natura 2000 areas. Of this, 9.54 million ha (57.6%) was designated as environmentally sensitive permanent grasslands, but only 4.9 million ha (29.6%) were declared by farmers as such. Natura 2000 areas not designated as sensitive sites are excluded; hence, subsidies for converting species-rich natural land might persist in protected areas. The CAP has a limited effect because environmentally sensitive permanent grasslands cover approximately 16% of all permanent grassland in the EU. About 38% of all Natura 2000 habitat types are linked to agriculture, and only 7% show a favorable conservation status compared with 21% for nonagricultural habitats. High-nature-value farmlands were used to identify agricultural areas with the highest environmental and biodiversity value, but their preservation was poorly operationalized, resulting in no targeted funding. Fifty-eight percent of direct payments under Pillar 1 went to 40% of regions maintaining the lowest fraction of high-nature-value farmland. The new result indicator on high-nature-value farming assesses the area covered with this measure, rather than the actual contribution to biodiversity. Without proper assessments tailored to biodiversity improvement, the effectiveness of interventions will be unknown. | Alliance Environment, 2019; European Court of Auditors, 2017; Simoncini et al., 2019 |

^a Highlighted are contradictions between Common Agricultural Policy (CAP) measures and the achievement of environmental objectives set under the EU Green Deal Biodiversity Strategy. ^b Policies under the Good Agricultural and Environmental Conditions of land (GAECs) approved on 28 July 2021 by member states' (MS) delegations and the council presidency, constituting a general approach to the CAP proposal for 2023–2027.

widespread adoption of such policies had detrimental unintended effects on farmland biodiversity. The continuation of these practices may hinder the environmental ambitions of both the CAP and the EGD (Scown et al., 2020). For example, payments based on farmland size resulted in major economic revenues to bigger farms, incentivizing increased field size, whereas incentives to grow mainly crops that are eligible for economic support increased production of a few selected varieties. These approaches resulted in the homogenization of large areas of cropland that negatively affected biodiversity through different mechanisms, both directly and indirectly.

The reduction of landscape features, such as hedges, trees, and wetland areas, led to a decrease in permanent refuges for species that rely on these features, thereby depleting reservoirs of biodiversity in farm landscapes. The larger the fields, the fewer the number of different crop types subsisting in the landscape, which further aggravated landscape homogenization and biodiversity loss (Lefebvre et al., 2012). Landscape homogenization acts as a facilitator of invasive species due to simplified ecological communities (Gamez-Virués et al., 2015) and leads to the loss of beneficial species, such as wild pollinators and natural pest control organisms, which has significant negative effects on crop productivity (Potts et al., 2016). Agricultural intensification remains one of the main causes of biodiversity loss and ecosystem degradation in Europe (EEA, 2019), and it has severe consequences for farmland species, including widespread insect and bird populations declines (European Court of Auditors, 2020a). Preventing such effects would be cheaper than correcting them after an impact has occurred (Hanley & Roberts, 2019), making the protection of species in agricultural landscapes ecologically and economically advantageous.

Failure of intensively managed landscapes to deliver ecosystem services calls for the protection and restoration of native species within these landscapes (Garibaldi et al., 2019). Accordingly, the EGD proposes a return of at least 10% of Europe's agricultural area to lands with high-diversity landscape features, and CAP recognized the ecological relevance of certain agricultural systems to maintain biodiversity and deliver ecosystem services beyond food production. With the goal of improving on-farm biodiversity, GAEC 8 of CAP requires that at least 4% of arable land be set aside for nonproductive features; this amount is notably short of the relevant EGD goals (Table 1). The CAP also integrated an indicator to measure the area under commitments that support conservation and restoration, including high-nature-value (HNV) farmlands (result indicator R.31^{PR}). The HNV farmlands consist of production systems characterized by low-intensity agricultural practices, remarkably high biodiversity values, and large ecosystem services provision, including water and soil protection, carbon storage, and fire and climate change mitigation. Despite their ecological value, HNV farmlands are threatened by agricultural intensification (Keenleyside et al., 2014), and their delineation remains unclear; thus, their practical prioritization remains a problem that is unaddressed by the CAP (Navarro & López-Bao, 2018). The latest reform did not allocate specific targets to define and increase HNV farmlands or provide specific income support to make them economically viable (Alliance Environment, 2019).

Biodiversity and ecosystem service provision of HNV farmlands helps meet growing demands for multifunctional agricultural landscapes; thus, clear criteria to identify them should be devised and member states should prioritize their maintenance and expansion and monitoring of their biodiversity state.

Because both the EGD and the CAP aim to protect biodiversity-rich landscapes, appropriate indicators are crucial to establishing effective monitoring programs that identify and measure the state of farmland biodiversity and address biodiversity threats. Indicators should thus provide the baseline to quantify progress toward achievement of CAP and EGD biodiversity objectives. Yet, CAP indicators fail to address the complexity of farmland biodiversity and how it is affected by agricultural activities.

Two context indicators were adopted to measure trends in species populations: the farmland bird index (I.19), which measures changes in the relative abundance of common bird species, and enhancing biodiversity protection (I.20), which measures the percentage of species and habitats of community interest related to agricultural landscapes with stable or increasing trends. Other indicators refer to general habitat state. The optional Natura 2000 areas indicator delineates the area protected that is used for agriculture and forestry. Two mandatory indicators are share of agricultural land covered with landscape features (I.20) and share of utilized agricultural area under supported commitments for managing landscape features (R.29^{PR}). These indicators do not comprehensively assess the status of farmland biodiversity or the impacts of agriculture. For example, insects and freshwater species that declined due to agricultural practices are not specifically considered (European Court of Auditors, 2020a). The implementation of additional indicators, such as the European Grassland Butterfly Indicator, has been repeatedly suggested due to its well-established monitoring program, but was never considered (Pe'er et al., 2020). Because data collection depends mostly on different programs unrelated to the CAP, associating biodiversity trends with specific agricultural practices remains challenging. The CAP biodiversity assessments should aim to evaluate species' population trends, measure the impact of specific interventions, and identify threats in a timely manner. A monitoring framework tailored to measure the effects of agriculture and food production systems on biodiversity would enable faster decision-making to further timely actions and reverse negative trends (Table 2).

CLIMATE CHANGE MITIGATION AND ADAPTATION

To tackle the pressing challenge of climate change, the European Commission enacted the Climate Law and the 2030 Climate Target Plan as part of the EGD strategies. Their main objective is to incentivize the reduction of industrial, agricultural, and civil GHG emissions by 2030, with the ultimate aim to reach climate neutrality by 2050. Agriculture is deeply interconnected with climate change, being one of the drivers of GHG emissions and highly sensitive to its effects. Extreme weather

TABLE 2 Recommendations for European Union Member States for implementing strategic plans to facilitate the compatibility between The EU Green Deal and the achievement of Common Agricultural Policy (CAP) specific objectives.*

| | Protection of biodiversity (Biodiversity Strategy, CAP specific objective 6) |
|------------|--|
| AECMs | <p>Set a target to maintain or recover 10% of native habitats with nonproductive areas as proposed by The EU Green Deal. All landscape feature areas should be eligible for support.</p> <p>Set a target of 20% native habitat protected across all agricultural landscapes, to maintain ecosystem services at large (not just food production).</p> <p>Define clear regional criteria to identify and register high-nature-value farmlands. Set short-term steppingstone targets within annual performance reviews to spatially document them.</p> |
| Ecoschemes | <p>Prioritize improvement and restoration of landscape heterogeneity by providing economic incentives to increase the amount of in-farm habitats (e.g., margins and buffer strips, pollen providing crops) from 4% (GAEC 8) to 10% (as proposed by the EU Green Deal) through stepping stone targets.</p> <p>Support biodiversity monitoring schemes to assess population trends and to measure threats to biodiversity in agricultural landscapes, according to the sites' ecological features, as part of the strategic plans' performance reviews.</p> <p>Prioritize interventions to address threats driving species population declines.</p> <p>Establish cooperative support programs to reward and promote the maintenance of functional connectivity between patches of ecological importance (e.g., reed beds, shrublands, grassland) across farmland areas hosting species or habitats of high conservation relevance.</p> <p>Achieve a 50% expansion and, where needed, restoration of environmentally sensitive permanent grasslands in regions well below the EU average.</p> <p>Climate change mitigation and adaptation (Climate Law, CAP specific objective 4)</p> |
| AECMs | <p>Set quantitative progressive targets for the reduction of GHG emissions, verifiable during each Annual Performance Review, toward the final commitment of reducing emissions of 55% by 2030.</p> <p>Differentiate emission reduction targets for livestock, fuel, and food crops according to their impact and extent.</p> |
| Ecoschemes | <p>Discontinue ecoschemes support if short-term goals are not achieved during 2 following years. Extra funds should be used to increase the ceiling of support to compliant farmers.</p> <p>Establish incentives for farmers who avoid ploughing grassland plots, and expand the proportion of on-farm permanent grassland beyond the requirements of GAEC 1 (i.e., 10% following the EU Green Deal).</p> <p>Promote and incentivize the maintenance and restoration of natural habitats with high capacity of carbon retention (e.g., saltmarshes, native forests, wetlands, peatlands), and make paludiculture set of practices eligible for support payments.</p> <p>Provide financial incentives to agroforestry schemes in abandoned agricultural areas for their potential to restore carbon retention and biodiversity values.</p> <p>Provide compensation to support farmers switching their current agricultural systems toward carbon sustainable practices (e.g., agroforestry, silvopasture, organic composting, guiding and monitoring the process with progressive targets following a long-term strategy complemented by AECMs).</p> <p>Set targets and actions to reduce consumption of red meat products to favor both greenhouse gases emission reduction and health indicators, according to the European Commission recommendations and projection (current consumption: 1.5 kg/week; projected in 2030: 1.3 kg/week; recommended: 0.3 kg/week per person).</p> <p>Sustainable management of natural resources (Farm to Fork Strategy, CAP specific objective 5)</p> |
| AECMs | <p>Set yearly targets of organic farming expansion according to countries' 2023-year baseline, and in accordance with the EU overall goal set by the Farm to Fork strategy of 25% by 2030.</p> <p>Provide incentives to farmers who use a significant portion (e.g., 50%) of low-impact alternative livestock feed, with the aim of reducing habitat loss in feed producing areas.</p> |
| Ecoschemes | <p>Establish advisory services to provide farmers with continuous access to updated information regarding the implementation of sustainable practices and measure the percentage of farmers trained per administrative area (e.g., integrated pest management).</p> <p>Define integrated pest management principles into practical and assessable criteria and incentivize their implementation in strategic plans.</p> <p>Promote use of secure information tools to record the amount, extent, and frequency of application of pesticides along with their toxicity level for humans and wild plants and animals.</p> |

*The Common Agricultural Policy (CAP) Environmental Infrastructure of Agri-Environment-Climate Measures (AECMs), Ecoschemes, and Good Agricultural and Environmental Conditions of land (GAECs) refer to provisions approved on 28 July 2021 by member states' delegations and the Council Presidency, constituting a general approach on the CAP proposal for 2023–2027.

events affect agricultural production, causing reduced yields and economic losses, which are expected to increase in the future, warranting the need for mitigation policies. Because agriculture is responsible for 12.7% of the EU's GHG emissions, there is the potential to mitigate around 90 million t CO₂eq per year by 2050 (Alliance Environment, 2018). Cutting emissions from agriculture is subsequently one of the overarching principles of the CAP (objective 4) (Table 3).

Within the CAP, several farming practices have been listed as potential strategies to reduce emissions, including the conversion of arable land to grassland (when soil is not managed for intensive livestock), tillage reduction, agroforestry practices, and wetlands conservation and restoration (Martineau et al., 2016). However, the feasibility of these practices is not addressed by the CAP reform, which lacks specific targets and pathways for GHG reduction. Animal production systems and synthetic agricultural inputs are the major causes of agricultural emissions, but clear mechanisms to reduce or mitigate their impacts are missing from the reform. As such, there is no baseline for member states to plan the transition to sustainable production systems for livestock and crops. The CAP instituted GAECs to safeguard permanent grasslands, carbon rich soils, and soil organic matter, but decreases in the grassland to cropland ratios are still allowed, effectively depleting carbon stocks, despite the EGD commitments. The lack of guidelines for the protection of soils and organic matter also raises concerns regarding consistency of the measures farmers could adopt across regional contexts (Table 3).

The mismatch between climate mitigation requirements and the expected outcomes derives in part from the funding allocation mechanisms. According to the EGD, funds allocated for climate action should be at least 40% of the CAP overall budget. Yet member states are only required to assign 25% of their Pillar I budget (approximately 19% of the total CAP resources) to ecoschemes targeting climate and environmental action. Additionally, only 30% of the European Agricultural Fund for Rural Development in Pillar II (around 7% of the total CAP budget) is bound to finance environment and climate investments, and funding allocation is not systematically linked to any effective climate mitigation or adaptation strategy. In delineating the requirements for GAECs, ecoschemes, and AECMs, member states can adopt measures with only marginal effects on climate mitigation and adaptation, such as mechanical weed control or cultivation of leguminous plants for crop rotation. Therefore, there is a risk that funds may not be assigned properly, leading to farmers with disproportionately higher emissions receiving more money than those who comply with more restrictive practices. This unresolved drawback evidenced in the past CAP formulation is caused by funding not being allocated based on the effective implementation of sustainable measures, but on farm size (Pe'er et al., 2020). If large, intensively managed farms continue to receive the majority of income support without conforming to clear environmental targets, the policy will not achieve a substantial reduction of GHG emissions (Scown et al., 2020). Without a solid strategic framework for national plan delineation and international coordination and with no measures to monitor the efficiency of the CAP in reducing

emissions, the pledge to contribute to the EU reduction of GHG emissions by 2030 seems unlikely to be achieved.

Member states are allowed to dispose of funding to select greening-equivalent practices tailored to their national contexts, but this flexibility has been used as a shortcut to facilitate the implementation of greening measures without substantial changes in farming practices (Simoncini et al., 2019). Member states should implement climatic measures to attain the goal set in the EGD to reduce emissions by 55% by 2030. Ecoschemes represent a powerful tool to achieve meaningful mitigation objectives, consequently assigning fixed portions of the budget for specific climate-friendly measures would ensure that the CAP will finance climate action in farmlands (Guyomard et al., 2020). Ecoschemes could also act as support and compensation tools for farmers who are willing to downsize livestock production systems in favor of other less intensive practices. Livestock production systems, which encompass meat and dairy production as well as pasture and animal waste management (Robinson et al., 2011), account for two thirds of the EU agricultural GHG emission, and a reduction in such systems would greatly decrease the environmental footprint of EU agriculture. Finally, ecoschemes could also bolster the creation of national programs to protect peatlands and marshlands from drainage and degradation, which are currently responsible for a significant portion of agricultural emissions. Measures funded by AECMs could incentivize the implementation of long-term mitigation targets and compensate for market-based inequalities to facilitate the transition to sustainable agriculture.

SUSTAINABLE MANAGEMENT OF NATURAL RESOURCES

Within the EGD, the Farm to Fork Strategy is the main tool to address sustainability challenges in agriculture. The overarching goal of the strategy is to reduce the environmental impact of agriculture while ensuring access to fair, healthy, and environmentally friendly food systems; the same commitments are addressed by CAP specific objective 5 (Table 4). Pesticide reduction is key to halt environmental degradation. The unregulated use of synthetic farm inputs negatively affects wild communities, reducing ecosystem functions and services. Up to 50% of fruits, vegetables, and cereals grown in the EU contain pesticide residues, raising concern about their possible negative effects on human health (Bjørning-Poulsen et al., 2008). Since 1997, the European Commission recognized the relevance of setting limits on synthetic inputs as an effective strategy to promote their reduction and avoid undesired effects of long-term exposure on human health and the environment. More than 2 decades later, limits are not yet enforced, pesticides sales have not decreased, and the level of human exposure remains largely unknown (Eurostat, 2021).

To address these concerns, the Farm to Fork Strategy set objectives to reduce the use and risk of pesticides, and the CAP conditionality scheme included 2 old directives, SMR 12 and 13, on plant protection products. However, their unsuccessful application in the past (European Commission, 2020b)

TABLE 3 Comparison of European Green Deal Climate Law and the corresponding Common Agricultural Policy (CAP) objectives regarding climate mitigation and adaptation.^a

| EU Green Deal objectives | CAP objectives and measures | CAP provisions and mismatches with the EU Green Deal | References |
|--|---|---|---|
| Increase the EU greenhouse gas emission reductions target for 2030 to at least 55% compared to 1990 (from 1990 levels) | Contribute to climate change mitigation and adaptation and sustainable energy (CAP specific objective 4) | Agriculture's share in total net emission increased from 11.8% to 12.6% between 1995 and 2017. Sixty-eight percent of total agricultural land is used for animal production, which accounts for nearly 70% of emissions. Within the CAP, there are no specific targets for greenhouse gases mitigation with regard to agriculture production. The policy does not address differences in emissions coming from agricultural land or pastures. Between 2013 and 2020, 70% of direct payments were paid to the highest 50% of greenhouse gases emitting regions. Payments were 1.5 higher in more polluting regions than in the lowest polluting regions. The reform does not address this standing issue. | European Commission, 2020b; Scown et al., 2020 |
| Grow carbon sink to reach 300 million tons CO ₂ equivalent by 2030 | General safeguard against conversion to other agricultural uses to preserve carbon stock (GAEC 1) | “Maintenance of permanent grassland based on a ratio of permanent grassland in relation to agricultural area at national, regional, subregional, group-of-holdings, or holding level in comparison to the reference year 2018. Maximum decrease of 5% compared to the reference year” (GAEC 1). ^b Rather than promoting grassland conservation, this measure allows further declines with subsequent losses of carbon stocks. Afforestation and reforestation will be implemented by member states via the Rural Development Fund; however, no comprehensive strategic plan has been delineated, ignoring that positive outcomes are context dependent. Poorly planned conversion of grassland to forest can be detrimental for grassland biodiversity. | Pe'er et al., 2019, 2020 |
| | Protection of carbon rich soils (GAEC 2) | “Protection of wetland and peatland” (GAEC 2). ^b There are no clear guidelines on the minimum degree of protection required. Member states can delay the application of GAEC 2 for up to 2 years, further hindering climate mitigation progress. | Scown et al., 2020; Tanneberger et al., 2020 |
| | maintenance of soil organic matter (GAEC 3) | “Ban on burning arable stubble, except for plant health reasons” (GAEC 3). ^b GAECs are not mandatory for all farmlands. Agriculture on drained peat soils constitutes only 2.5% of the EU agricultural area but generates approximately 25% of the total agricultural greenhouse gas emissions. CAP payments between 2014 and 2020 heavily supported the drainage of peatlands, depleting existing carbon stocks. The CAP reform does not address this mismatch with the EU Green Deal commitment. | |
| At least 40% of CAP budget (2023–2027) would contribute to climate action | At least 30% of European Agricultural Fund for Rural Development (EAFRD) allocated to investment in the environment and climate, development of woodland, and improving viability of forests, agri-environment, and climate measures, organic farming, and Natura 2000 payments | EAFRD budgets were reduced in the post-2020 proposal from €99 to €77 billion, accounting for 22% of CAP expenditure. Climate and environment investments correspond to <7% of the total CAP budget. Only 13% of the physical EU area is under agri-environment and climate measures that can mitigate CO ₂ emissions. Strong differences still persist between member states, compromising the overall efforts. Average farm incomes in regions with highest agricultural greenhouse gases emission are almost 60% higher than those with lower emissions. CAP payments are not properly incentivizing climatic measures. Member states shall provide support for voluntary ecoschemes for climate and environment; however, member states can allocate funding to measures that are not related to climate action regardless of the thresholds envisioned by both the EU Green Deal and the CAP itself. | European Parliament, 2020; Pe'er et al., 2019; Scown et al., 2020 |

^a Highlighted are contradictions between Common Agricultural Policy (CAP) measures and the achievement of environmental objectives set under the EU Green Deal Climate Law.

^b Policies under the Good Agricultural and Environmental Conditions of land (GAECs) approved on 28 July 2021 by member states' (MS) delegations and the Council Presidency, constituting a general approach to the CAP proposal for 2023–2027.

TABLE 4 Comparison of EU Green Deal Farm to Fork strategy and the corresponding Common Agricultural Policy (CAP) objectives regarding sustainable management of natural resources.^a

| EU Green Deal objectives | CAP objectives and measures | CAP provisions and mismatches with the EU Green Deal | References |
|---|--|---|--|
| Achieve 25% EU agricultural farmland to be put under organic production by 2030 | Foster sustainable development and efficient management of natural resources such as water, soil, and air (CAP specific objective 5) | Total utilized agricultural area for organic farming only increased from 2% in 2000 to 8% in 2018. Mechanisms regulating the distribution of CAP direct payments do not encourage the transition toward organic production and can instead reward environmentally harmful agricultural practices. There are no incentives for maintaining measures in the long term, nor mandatory targets in the CAP to follow the EU Green Deal commitment. | European Commission, 2020b; Scown et al., 2020; Simoncini et al., 2019 |
| 50% reduction in antibiotics sale for farmed animals and aquaculture by 2030 | | The overall sales of veterinary antimicrobials across EU-27 decreased by one third between 2010 and 2017, but only for MS that provided yearly data. There are large differences between member states. Member states shall include in their strategic plans a system providing farm advisory services to support land and farm management, aiming to prevent antimicrobial resistance, following A European One Health Action Plan against Antimicrobial Resistance. However, member states are not obliged to do so, and can rely on already existing systems, hindering the consistency of measures across EU states. | Corporate Europe Observatory, 2020; European Commission, 2020b |
| Reducing by 50% the use and the risk of chemical pesticides by 2030 | | In the past, the European Crop Protection Association has not been able to provide data on pesticide use and supplies, hindering the reduction. The CAP reform does not enforce compliance. No appropriate measures and targets to monitor or reduce use, risk, and impacts of pesticides by 2030. Poor enforcement has slowed down achievement of goals proposed in old directives. | Corporate Europe Observatory, 2020 |
| 20% reduction in fertilizer use by 2030 | | Nitrogen surplus in EU-27 has not decreased between 2005 and 2015, remaining at 50 kg/ha per year. There are no measures in the CAP concerning the sustainable use of fertilizers and nutrients. The Farm Sustainability Tool for nutrients to monitor and optimize usage of nutrients across farmlands was proposed, but later cancelled. | Corporate Europe Observatory, 2020; European Commission, 2020b |
| Reduce nutrient losses by at least 50%, while ensuring no deterioration on soil fertility | Minimum land management reflecting site-specific conditions to limit erosion (GAEC 5) protection of soils in periods that are most sensitive (GAEC 6) Preserve soil potential (GAEC 7) | “Tillage management, reducing the risk of soil degradation and erosion, including consideration of the slope gradient” (GAEC 5). ^b The measures are not mandatory and they do not address nutrient loss due to soil degradation. “Minimum soil cover to avoid bare soil in periods that are most sensitive” (GAEC 6). ^b There is no minimum threshold specified and no clear criteria to identify sensitive areas and/or periods. In 2016, 23% of EU arable land was left as bare soil with no vegetation cover during winter, with negative effects on soil erosion and runoff of both pesticides and nutrients. “Crop rotation in arable land, except for crops growing under water” (GAEC 7). ^b Less than 10 ha holdings are exempted from the requirement, and member states can exempt from the standard holdings where 75% of the land is permanent grassland or used for the production of grasses or other herbaceous forage. The inefficiency of this practice to enhance soil conditions is not addressed by the new regulation. Under the current legislation, a single crop could cover up to 75% and 2 crops up to 95% of a farm area. Farms with <10 ha of arable area were exempt, accounting for 92% of arable holdings in new member states and 13% of arable area across the EU. The most constraining component among diversification measures was the 75% threshold for the main cultivated crop; however, the proportion of reallocated area due to the diversification measure represents <1% of total agricultural area. | European Court of Auditors, 2017; Pèr et al., 2019; Scown et al., 2020; Simoncini et al., 2019 |

^a Highlighted are contradictions between Common Agricultural Policy (CAP) measures and the achievement of environmental objective set under the EU Green Deal Farm to Fork Strategy.

^b Policies under the Good Agricultural and Environmental Conditions of land (GAECs) approved on 28 July 2021 by member states' (MS) delegations and the Council Presidency, constituting a general approach to the CAP proposal for 2023–2027.

raises doubts as to effects they could have in future reforms if the same mechanisms persist. Besides these directives, no strategies were included to encourage pesticide reduction, and the lack of targets and standardized monitoring is likely to limit CAP achievements. Organic farming aims to produce food using natural substances and processes; therefore, it has great potential to reduce synthetic input and prevent the pollution of soils, water, and air. It is one of the few environmental practices with a specific support mechanism in AECMs payments for converting to or maintaining it. However, the policy lacks specific targets to incentivize the shift to organic practices, which remain marginal in extent (European Commission, 2020c). Moreover, organic farmers are still unprotected against supply-and-demand imbalances that put them at a disadvantage over conventional market competitors and hinder consumer accessibility to organic products (Naspetti & Zanoli, 2012).

The protection of soil and water resources is a priority of the EGD. Still, the CAP conditionality measures do not provide adequate thresholds and criteria to enforce it or efficient strategies to mitigate nutrient losses as a consequence of intensive agricultural practices. The GAEC 7 concerning crop rotation fails to address the problems highlighted in the previous CAP reforms because exemptions greatly diminish its efficacy and measures for water protection rely on articles of old European directives that are inadequate to respond to current environmental challenges. Specifically, the directives in SMR 1 and 2 concerning protection of waters against nitrate and phosphate pollution ignore negative environmental and health effects of other pollutants, such as copper and cadmium, associated with unsustainable agricultural practices. Adequate pesticide and nitrates use reporting should complement the obligatory requirements aimed at preserving soil potential (Guyomard et al., 2020).

The EGD also acknowledges unsustainable food production as an important driver of natural resources degradation and GHG emissions globally, and the Farm to Fork Strategy seeks to reduce such impacts of food supply chains by ensuring sustainable production and facilitating the shift to healthy diets (European Commission, 2019a). The CAP subsidies can influence production patterns and lead the EU toward sustainable food systems, but direct payments excessively subsidize the production of dairy and meat products, which are associated with high levels of resource consumption and environmental impacts. Incentives to increase meat and dairy production indirectly promote higher demand for livestock feeds, such as soy. About 97% of the total soy products required by the EU in 2020 were imported, and 72% of the imports came from biodiversity-rich countries in South America, bringing about deforestation with all its associated environmental impacts (Boshnakova et al., 2021; Kuepper & Stravens, 2022). Direct payments also continue to offer income security for crops used as substitutes for fossil fuels, which, although necessary to reduce fossil fuels demand, promoted native habitat loss in overseas territories (Muller & Bautze, 2017). Approved subsidies to oilseed plantations in pristine areas of French Guiana's Amazon forest were based on the premises that jobs would be created and

biofuels produced; instead, there is the risk of promoting large-scale deforestation in previously unaffected areas (Catanoso, 2020). The approved legislation lacks clear mechanisms or sanctions to prevent detrimental practices, and it is up to member states to properly address CAP resources for environmentally sustainable production.

The EGD also recognizes food waste and unsustainable consumption as key drivers of biodiversity loss, contamination of soil and water resources, excessive carbon footprint, use of pesticides, and human health problems (European Commission, 2020d). Consumption of meat and dairy above recommended levels and their unsustainable production should be specifically addressed in the CAP. Yet the legislation actively subsidizes their production and overlooks practices to reduce unhealthy intake of such products. Discouraging unhealthy consumption of livestock products could benefit the environment and public health, and the CAP should not disregard its potential key role in preventing unsustainable practices (Table 2).

OPPORTUNITIES FOR CROSS-CUTTING INTEGRATIONS

Despite the commitments of the policy, the set of CAP conditionality requirements and voluntary schemes are functionally disconnected from the objectives set under the EGD, weakening the CAP's ability to achieve pressing environmental objectives. The majority of monetary resources is still pooled into payments that encourage input-intensive and high-emission systems, whereas the economic and environmental added value from ecosystem services provided by low-input agricultural areas has been largely overlooked. The new measures added by the enhanced conditionality scheme establish lower levels of environmental protection compared with the previous obligatory greening requirements under cross-compliance. The criteria to assess the efficiency of environmental practices and to reject those that are ineffective remain unclear, and administrative penalties for beneficiaries who do not comply appear to be less dissuasive than those previously enforced. Also, some of the measures previously implemented as compulsory will now only be addressed in the voluntary ecoschemes, delegating responsibility to individual member states (Appendix S1).

Due to the flexibility granted to member states to promote interventions according to their assessed priorities, environmental funds can be reallocated for purposes that do not necessarily prioritize environmental measures. To avoid this, member states should allocate fixed portions of ecoschemes and AECM budgets to each environmental objective. Evidence-based interventions should be defined to pursue specific targets that go beyond basic conditionality requirements and are consistent with the overall goals of the EGD (Table 2). Their evaluation should be based on quantitative assessments done on a regular basis and specifically designed to measure the impact of interventions. Embedding assessments in long-term monitoring programs will allow for early identification of trends and correction actions, especially if payments are based on performance. Regionally predefined interventions could

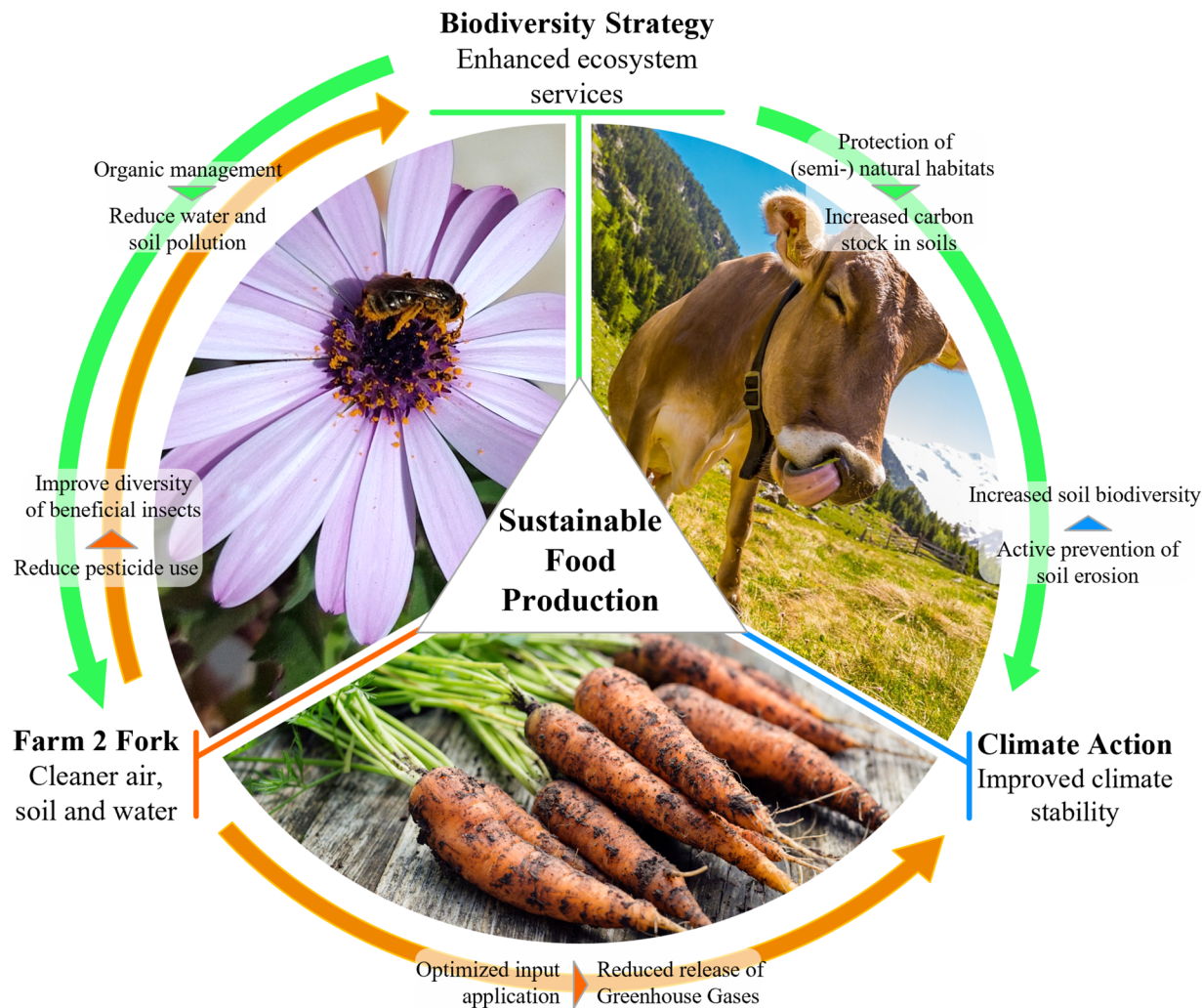


FIGURE 1 Synergies among measures to pursue sustainable food production in the EU Common Agricultural Policy (CAP) reform and the proposed strategies of the EU Green Deal (3 main axes, green deal strategies that support the environmental objectives of the CAP; boxes, practices that can enhance achievement of simultaneous CAP and EU Green Deal objectives; arrows, direction of practices; lines converging at the center, measures, objectives, and strategies that if implemented correctly could contribute to the achievement of sustainable food production [underlying objective of the EU Green Deal and the CAP]). Image by Hagen Meischner from www.flickr.com/photos/hagens_world/14407622114 licensed under CC-BY-NC-ND 2.0.

provide farmers with guidelines on how to implement ecoschemes and AECMs with proven positive environmental effects. Practices potentially benefiting multiple CAP objectives should be strongly encouraged, such as reducing synthetic input to benefit biodiversity, climate change mitigation, and water and soil quality (Figure 1).

The unprecedented degradation of nature and its negative effects on human well-being demand bold policy measures to put producers on the path to sustainable use of natural resources. Although the CAP offers a variety of tools for the EU agricultural sector to do so, it fails to provide mechanisms of adherence to such schemes. Procedures introduced by the European Commission to analyze strategic plan outcomes before their adoption (ex ante impact assessments), during implementation, and at the end of the fiscal period (ex post evaluations) remain important mechanisms to monitor and strengthen the contribution of environmental interventions to the CAP and

EGD objectives. The European Commission and independent evaluators will need to ensure that the allocation and use of funds is consistent with the expected results and the urgency to enhance the applicability of effective environmental measures (European Commission, 2019b; 2022). Ambitious implementation by member states will determine whether environmental and climate commitments proposed under the EGD will be achieved.

ENVIRONMENTAL COMMITMENTS AMIDST GLOBAL CRISES

The Russian invasion of Ukraine exposed the fragility of unsustainable food systems reliant on intensive inputs, such as agrochemicals and fossil fuel (Hanson et al., 2022). The market crisis followed by the war put food security at risk in the EU

and worldwide, pushing legislators for rapid rollbacks of elusive environmental progress made over recent years. For example, the temporal derogation of the ecological focus areas, one of the few greening measures set in CAP 2014–2020 with the objective to increase the area for crop production, may have disproportionately negative effects on biodiversity and ecosystem services in comparison with the expected increase in food production. Because ecological focus areas can increase the capacity of landscapes to supply important ecosystem services, their suspension will likely worsen the negative effects of climate change and environmental degradation on crop and dairy production in the long term. The abolition of these areas to increase cereal production in 2007 has already shown the irreversible effects of similar measures on European diversity (Herzon et al., 2011). The EGD strategies and the CAP have the potential to change production and consumption patterns in the EU to rightfully respond to the current biodiversity and climate emergencies by maintaining the EU's environmental ambition to make its food system sustainable, resilient, and climate neutral. Consequently, the environmental components of these policies should not be watered down or counteracted in times of crisis and shifting political priorities (Strange et al., 2022). The consequences of doing so threaten the natural resources and biodiversity on which the foundation of food systems stands. Food insecurity and the social and economic impacts of it will only increase if unsustainable production and consumption practices continue defining food systems, as demonstrated by the food and energy crisis resulting from Russia's war on Ukraine.

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REFERENCES

- Alliance Environment. (2018). *Evaluation study of the impact of the CAP on climate change and greenhouse gas emissions* (Final Report). European Commission.
- Alliance Environment. (2019). Evaluation of the impact of the CAP on habitats, landscapes, biodiversity (Final Report). European Commission.
- Björling-Poulsen, M., Andersen, H. R., & Grandjean, P. (2008). Potential developmental neurotoxicity of pesticides used in Europe. *Environmental Health*, 7(1), 1–22.
- Boshnakova, M., Fischer, J., Krautgartner, R., & Omnes, M. (2021). *EU 28: Oilseeds and products semi-annual* (GAIN Report Number: AU1501). USDA Foreign Agricultural Service.
- Catanoso, J. (2020). French Guiana soy biofuel power plants risk massive Amazon deforestation. Mongabay. <https://news.mongabay.com/2020/12/french-guiana-soy-biofuel-power-plants-risk-massive-amazon-deforestation/>
- Corporate Europe Observatory. (2020). CAP vs Farm to Fork. Will we pay billions to destroy, or to support biodiversity, climate, and farmers? Author.
- Council of the European Union. (2021). *Proposal for a Regulation of the European Parliament and of the Council establishing rules on support for strategic plans to be drawn up by Member States under the Common agricultural policy and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulation (EU) No 1305/2013 of the European Parliament and of the Council and Regulation (EU) No 1307/2013 of the European Parliament and of the Council*. Author.
- Emmerson, M., Morales, M. B., Oñate, J. J., Batary, P., Berendse, F., Liira, J., Aavik, T., Guerrero, I., Bommarco, R., Eggers, S., Pärt, T., Tscharrntke, T., Weisser, W., Clement, L., & Bengtsson, J. (2016). How agricultural intensification affects biodiversity and ecosystem services. *Advances in Ecological Research*, 55, 43–97.
- European Commission. (2019a). *The European Green Deal* (COM/2019/640 final). Author.
- European Commission. (2019b). *Indicative outline of terms of reference for the ex-ante evaluation of the CAP strategic plan* (TWG-7/Tool 1.2). Author.
- European Commission. (2020a). *Analysis of links between CAP Reform and Green Deal* (SWD(2020) 93 final). Author.
- European Commission. (2020b). *Report from the commission to the European parliament and the council on the experience gained by Member States on the implementation of national targets established in their National Action Plans and on progress in the implementation of Directive 2009/128/EC on the sustainable use of pesticides*. Author.
- European Commission. (2020c). *EU agriculture in numbers – Performance on the nine specific objectives of the CAP. EU country factsheets*. Agriculture and Rural Development. https://agriculture.ec.europa.eu/cap-my-country/performance-agricultural-policy/agriculture-country/cap-specific-objectives-country_en
- European Commission. (2020d). *Farm to fork strategy: For a fair, healthy and environmentally-friendly food system. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*. Author.
- European Commission. (2022). *Commission Implementing Regulation (EU) 2022/1475 of 6 September 2022 laying down detailed rules for implementation of Regulation (EU) 2021/2115 of the European Parliament and of the Council as regards the evaluation of the CAP Strategic Plans and the provision of information for monitoring and evaluation*. Author.
- European Court of Auditors. (2017). *Greening: A more complex income support scheme, not yet environmentally effective* (Special Report 21/2017). Publications Office of the European Union.
- European Court of Auditors. (2020a). *Biodiversity on farmland: CAP contribution has not halted the decline* (Special Report). Publications Office of the European Union.
- European Court of Auditors. (2020b). *Protection of wild pollinators in the EU - Commission initiatives have not borne fruit* (Special Report). Publications Office of the European Union.
- European Environment Agency. (2019). *The European Environment—State and outlook 2020: Knowledge for transition to a sustainable Europe*. Author.
- European Parliament. (2020). *Towards a post-2020 common agricultural policy. Fact sheets on the European Union*. <https://www.europarl.europa.eu/factsheets/en/sheet/113/towards-a-post-2020-common-agricultural-policy>
- Eurostat. (2021). *Agri-environmental indicator - consumption of pesticides*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Agri-environmental_indicator_-_consumption_of_pesticides
- Gamez-Virués, S., Perovic, D. J., Gossner, M. M., Börschig, C., Blüthgen, N., de Jong, H., Simons, N. K., Klein, A.-M., Krauss, J., Maier, G., Scherber, C., Steckel, J., Rothenwöhler, C., Steffan-Dewenter, I., Weiner, C. N., Weisser, W., Werner, M., Tscharrntke, T., & Westphal, C. (2015). Landscape simplification filters species traits and drives biotic homogenization. *Nature Communications*, 6(1), 1–8.
- Garibaldi, L. A., Pérez-Méndez, N., Garratt, M. P., Gemmill-Herren, B., Miguez, F. E., & Dicks, L. V. (2019). Policies for ecological intensification of crop production. *Trends in Ecology & Evolution*, 34(4), 282–286.

- Guyomard, H., Bureau, J., Chatellier, V., Détang-Dessendre, C., Dupraz, P., Jacquet, F., Reboud, X., Requillart, V., Soler, L., & Tysebaert, M. (2020). *The Green Deal and the CAP: Policy implications to adapt farming practices and to preserve the EU's natural resources*. Policy Department for Structural and Cohesion Policies, European Parliament.
- Hanley, N., & Roberts, M. (2019). The economic benefits of invasive species management. *People and Nature*, 1(2), 124–137.
- Hanson, C., Ranganathan, J., Davey, E., Searchinger, T., & Holzer, J. (2022). *The Ukraine crisis threatens a sustainable food future*. World Resources Institute. https://www.wri.org/insights/ukraine-food-security-climate-change?utm_medium=email&utm_source=rasa_io
- Herzon, I., Ekroos, J., Rintala, J., Tiainen, J., Seimola, T., & Vepsäläinen, V. (2011). Importance of set-aside for breeding birds of open farmland in Finland. *Agriculture, Ecosystems & Environment*, 143(1), 3–7.
- Keenleyside, C., Beaufoy, G., Tucker, G., & Jones, G. (2014). *High nature value farming throughout EU-27 and its financial support under the CAP* (Vol. 10, p. 91086). Institute for European Environmental Policy.
- Kuepper, B., & Stravens, M. (2022). *Mapping the European soy supply chain – Embedded soy in animal products consumed in the EU27+UK*. Profundo.
- Lefebvre, M., Espinosa, M., & Gomez y Paloma, S. (2012). *The influence of the Common Agricultural Policy on agricultural landscapes* (Report EUR 25459 EN). European Commission.
- Martineau, H., Wiltshire, J., Webb, J., Hart, K., Keenleyside, C., Baldock, D., Bell, H., & Watterson, J. (2016). *Effective performance of tools for climate action policy-meta-review of Common Agricultural Policy mainstreaming*. Institute for European Environmental Policy.
- Muller, A., & Bautze, L. (2017). *Agriculture and deforestation: The EU Common Agricultural Policy, soy, and forest destruction*. FERN.
- Naspetti, S., & Zanolì, R. (2012). Organic meat production in Europe: Market and regulation. In R. Van Loo & J. O'Bryan (Eds), *Organic meat production and processing* (pp. 53–66). John Wiley & Sons.
- Navarro, A., & López-Bao, J. V. (2018). Towards a greener common agricultural policy. *Nature Ecology & Evolution*, 2(12), 1830–1833.
- Official Journal of the European Union. (2021). *Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law')*. Author.
- Pe'er, G., Birkenstock, M., Lakner, S., & Röder, N. (2021). *The Common Agricultural Policy post-2020. Views and recommendations from scientists to improve performance for biodiversity: Volume 1 - Synthesis Report (No. 311098)*. Johann Heinrich von Thünen-Institut (vTI).
- Pe'er, G., Bonn, A., Bruelheide, H., Dieker, P., Eisenhauer, N., Feindt, P. H., Hagedorn, G., Hansjürgens, B., Herzog, I., Lomba, Á., Marquard, E., Moreira, F., Nitsch, H., Oppermann, R., Perino, A., Röder, N., Schleyer, C., Schindler, S., Wolf, C., ... Lakner, S. (2020). Action needed for the EU Common Agricultural Policy to address sustainability challenges. *People and Nature*, 2(2), 305–316.
- Pe'er, G., Finn, J. A., Díaz, M., Birkenstock, M., Lakner, S., Röder, N., Kazakova, Y., Šumrada, T., Bezák, P., Concepción, E. D., Dänhardt, J., Morales, M. B., Rac, I., Špulerová, J., Schindler, S., Stavrinides, M., Targetti, S., Viaggi, D., Vogiatzakis, I. N., & Guyomard, H. (2022). How can the European Common Agricultural Policy help halt biodiversity loss? Recommendations by over 300 experts. *Conservation Letters*, 15(6), e12901.
- Pe'er, G., Lakner, S., Müller, R., Passoni, G., Bontzorlos, V., Clough, D., & Sutherland, W. (2017). *Is the CAP Fit for purpose. An evidence-based, rapid fitness-check assessment*. German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig.
- Pe'er, G., Zinngrebe, Y., Moreira, F., Sirarmi, C., Schindler, S., Müller, R., Bontzorlos, V., Clough, D., Bezák, P., Bonn, A., Hansjürgens, B., Lomba, A., Möckel, S., Passoni, G., Schleyer, C., Schmidt, J., & Lakner, S. (2019). A greener path for the EU Common Agricultural Policy. *Science*, 365(6452), 449–451.
- Potts, S. G., Ngo, H. T., Biesmeijer, J. C., Breeze, T. D., Dicks, L. V., Garibaldi, L. A., Hill, R., Settel, J., & Vanbergen, A. (2016). *The assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on pollinators, pollination and food production*. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.
- Robinson, T. P., Thornton, P. K., Francesconi, G. N., Kruska, R. L., Chiozza, F., Notenbaert, A. M. O., Cecchi, G., Herrero, M., Epprecht, M., Fritz, S., You, L., Conchedda, G., & See, L. (2011). Global livestock production systems. FAO and ILRI.
- Scown, M. W., Brady, M. V., & Nicholas, K. A. (2020). Billions in misspent EU agricultural subsidies could support the sustainable development goals. *One Earth*, 3(2), 237–250.
- Simoncini, R., Ring, I., Sandström, C., Albert, C., Kasymov, U., & Arlettaz, R. (2019). Constraints and opportunities for mainstreaming biodiversity and ecosystem services in the EU's Common Agricultural Policy: Insights from the IPBES assessment for Europe and Central Asia. *Land Use Policy*, 88, 104099.
- Strange, N., Geldmann, J., Burgess, N. D., & Bull, J. W. (2022). Policy responses to the Ukraine crisis threaten European biodiversity. *Nature Ecology & Evolution*, 6(8), 1048–1049.
- Tanneberger, F., Appulo, L., Ewert, S., Lakner, S., Ó Brocháin, N., Peters, J., & Wichmann, W. (2020). The power of nature-based solutions: How peatlands can help us to achieve key EU sustainability objectives. *Advanced Sustainable Systems*, 5(1), 2000146.
- Thomson, A. M., Ellis, E. C., Grau, H. R., Kuemmerle, T., Meyfroidt, P., Ramankutty, N., & Zeleke, G. (2019). Sustainable intensification in land systems: Trade-offs, scales, and contexts. *Current Opinion in Environmental Sustainability*, 38, 37–43.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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