Received: 20 October 2021 | Revised: 23 May 2022 | Accepted: 24 May 2022

DOI: 10.1111/conl.12901

Conservation Letters
A journal of the Society for Conservation Biology
Open Access
WILEY

PERSPECTIVE

How can the European Common Agricultural Policy help halt biodiversity loss? Recommendations by over 300 experts

Guy Pe'er[1,2] | **John A. Finn**[3] | **Mario Díaz**[4] | **Maren Birkenstock**[5] | **Sebastian Lakner**[6] | **Norbert Röder**[5] | **Yanka Kazakova**[7] | **Tanja Šumrada**[8] | **Peter Bezák**[9] | **Elena D. Concepción**[4,10] | **Juliana Dänhardt**[11] | **Manuel B. Morales**[12] | **Ilona Rac**[8] | **Jana Špulerová**[13] | **Stefan Schindler**[14,15] | **Menelaos Stavrinides**[16] | **Stefano Targetti**[17] | **Davide Viaggi**[17] | **Ioannis N. Vogiatzakis**[18,19] | **Hervé Guyomard**[20]

[1]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, Germany

[2]UFZ–Helmholtz Centre for Environmental Research, Department of Ecosystem Services, Leipzig, Germany

[3]Teagasc, Environment, Soils and Land Use Department, Johnstown Castle, Wexford, Ireland

[4]Museo Nacional de Ciencias Naturales, CSIC, Department of Biogeography and Global Change (BGC–MNCN), Madrid, Spain

[5]Thünen Institute of Rural Studies, Johann Heinrich von Thünen Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries, Braunschweig, Germany

[6]Faculty of Agricultural and Environmental Sciences, chair of Agricultural Economics, University of Rostock, Rostock, Germany

[7]Department of Economics of Natural Resources, University of National and World Economy, Sofia, Bulgaria

[8]Biotechnical Faculty, University of Ljubljana, Ljubljana, Slovenia

[9]Institute of Landscape Ecology of the Slovak Academy of Sciences (ILE SAS), Nitra, Slovakia

[10]Department of Biodiversity, Ecology and Evolution, Faculty of Biological Sciences, Complutense University of Madrid, Madrid, Spain

[11]Centre for Environmental and Climate Science, Lund University, Lund, Sweden

[12]Department of Ecology and Research Center for Biodiversity and Global Change, Universidad Autónoma de Madrid, Madrid, Spain

[13]Institute of Landscape Ecology of the Slovak Academy of Sciences (ILE SAS), Bratislava, Slovakia

[14]Environment Agency Austria, Vienna, Austria

[15]Faculty of Environmental Sciences Community Ecology and Conservation Research Group, Czech University of Life Sciences, Prague, Czech Republic

[16]Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, Limassol, Cyprus

[17]Department of Agricultural and Food Sciences, University of Bologna, Viale Fanin, Italy

[18]Faculty of Pure and Applied Sciences, Open University of Cyprus, Nicosia, Cyprus

[19]Department of Earth and Environmental Sciences, University of Milano-Bicocca, Milano, Italy

[20]INRAE, Centre de Bretagne-Normandie, SDAR, Paris, France

Correspondence
Guy Pe'er, German Centre for Integrative Biodiversity Research (iDiv)

Abstract

The European Union's Common Agricultural Policy (CAP) has not halted farmland biodiversity loss. The CAP post-2023 has a new "Green Architec-

Halle-Jena-Leipzig, Puschstraße 4, 04103 Leipzig, Germany.
Email: guy.peer@idiv.de

Funding Information
German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig of the German Research Foundation (DFG–FZT 118, 202548816), Integrated Infrastructure Operational Programme funded by the ERDF, project ITMS2014+ 313011W580 (Scientific support of climate change adaptation in agriculture and mitigation of soil degradation) and thematic collaboration initiative LU Land-Land use for a sustainable future.

ture," including the new "Eco-scheme" instrument. How can this new Green Architecture help tackle the biodiversity crisis? Through 13 workshops and an online survey, over 300 experts from 23 European Member States addressed this question.

From experts' contributions, key principles for success include preserving and restoring (semi)natural elements and extensive grasslands; improving spatial planning and landscape-scale implementation, including through collective actions; implementing result-based approaches; and improved knowledge exchange. To maximize the effectiveness of Eco-scheme for biodiversity, experts highlighted the need to prioritize evidence-based actions, allocate a sufficient budget for biodiversity, and incentivize management improvements through higher payment levels. Additionally, stronger coherence is needed among CAP instruments.

For effective CAP implementation, the European Commission and the Member States should expand investments in biodiversity monitoring, knowledge transfer, and capacity-building within relevant institutions. The remaining risks in the CAP's ability to reverse the loss of farmland biodiversity still require better design, closer monitoring, greater transparency, and better engagement with farmers. Additionally, greater involvement of scientists is needed to guide the CAP toward restoring farmland biodiversity while accounting for synergies and trade-offs with other objectives.

KEYWORDS
agri-environment-climate measures, Common Agricultural Policy, Eco-schemes, European Union, farmland biodiversity, green architecture, monitoring, science-policy, strategic plans

1 | INTRODUCTION

Agriculture is a key driver of declines in biodiversity and associated ecosystem services. In the European Union, approximately 40% of land is farmed (Eurostat, 2021). With expenditures of €55 billion annually (37% of the European Union's 2019 budget; 31% in 2027), the European Union's Common Agricultural Policy (CAP) markedly influences land-use decisions and biodiversity. The CAP introduced various instruments to reduce the negative environmental impacts of agriculture. These include compulsory conditionality criteria for all farmers receiving subsidies laid down in "Cross Compliance"; voluntary measures in Pillar 2 ("Rural Development Programmes"), in particular through agri-environment-climate-measures (AECM); and since 2014, Greening measures in Pillar 1 (see Figure 1 and Supporting Information 1 for further information). However, overall, the CAP has failed to reverse biodiversity loss or markedly reduce the environmental footprint of European agriculture. Critics propose that this is due to low requirements and broad exemptions in the compulsory instruments, unambitious design of voluntary schemes, overpayment for ineffective environmental measures, and imbalanced investment in the environment compared to other objectives (Alliance Environment, 2019; ECA, 2017; Pe'er et al., 2014, 2019).

To address these weaknesses, the CAP post-2023 proposes a new "Green Architecture" around three area-related environmental instruments: "enhanced conditionality"; AECM in Pillar 2; and new "Eco-schemes" in Pillar 1. Similar to AECM, Eco-schemes are voluntary for farmers, but Member States (MS) have much more freedom in their design. MS are required to invest at least 20% of Pillar 1 payments in Eco-schemes in 2023–2024 and at least 25% after 2025. The minimum share of Pillar 2 payments for environmental instruments increases from 30% currently to 35% after 2023. A new delivery model will also focus more on outcomes than prescriptions, granting MS more flexibility regarding how they intend to achieve the CAP's objectives.

In parallel to the CAP reform, the European Commission introduced the Green Deal, the Farm to Fork Strategy

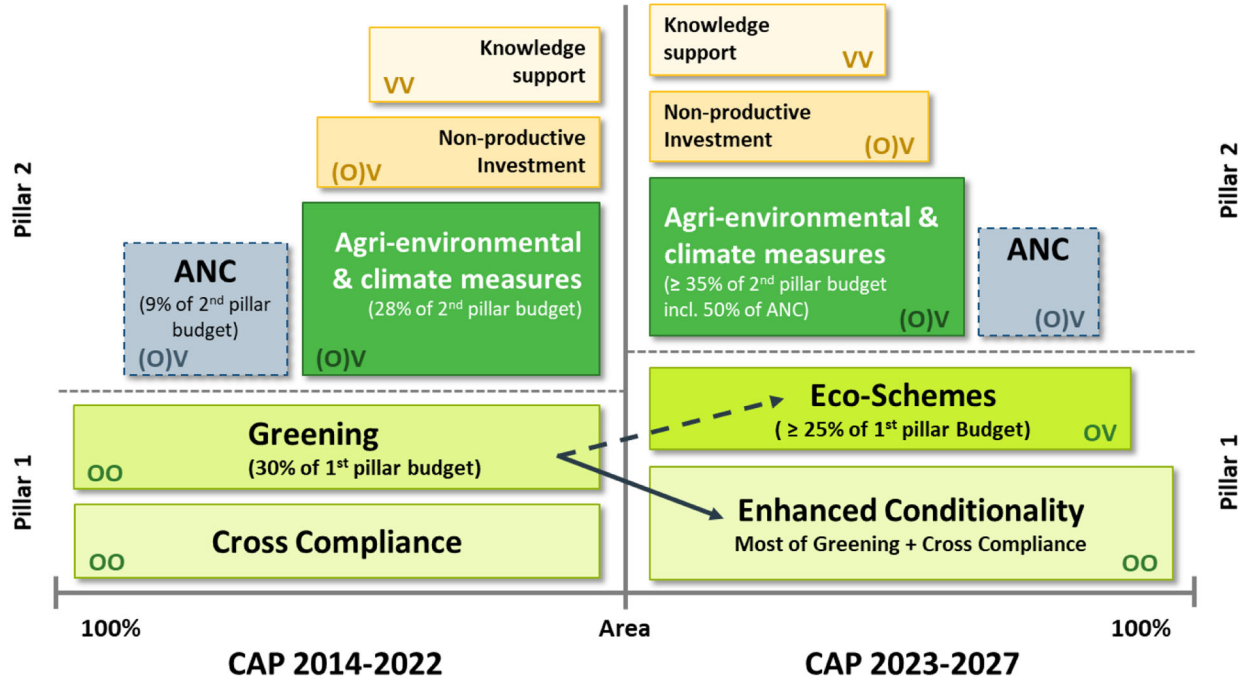

FIGURE 1 Schematic overview of the biodiversity relevant instruments of the Common Agricultural Policy (CAP) pre- and post-2020. Box width (*x*-axis) reflects the relative extent of area affected by measures (not to scale). Green color intensity reflects the potential effectiveness for biodiversity. Adopted from EC communication of the new CAP, we note that the three instruments of the "Green Architecture" (Conditionality, Eco-schemes, and agri-environment-climate-measures [AECM]) only cover the "area-related" payments of the CAP. Other CAP instruments are relevant for meeting environmental objectives as well—summarized here in the three boxes of ANC, nonproductive investments, and knowledge support instruments. For further details and an extended figure, see Supporting Information 1. ANC = Areas facing natural or other constraints. OO = implementation obligatory for Member States, obligatory for farmers; OV = implementation obligatory for Member States, voluntary for farmers; VV: implementation voluntary for Member States, voluntary for farmers; (O)V = implementation Member states must ascertain a minimum implementation over several interventions, voluntary for farmers. *Note*: under "Agri-Environmental and Climate Measures." we also include payments for organic farming and Natura 2000 support, and in the CAP post-023, nonproductive investments. The shares of spending for Agri-Environmental Climate Measures in the post-2023 CAP (30%/35%) refer to all measures

and an updated Biodiversity Strategy and adopted a Climate Law in June 2021. Major agri-environmental targets by 2030 include reduced use of chemical pesticides (−50%), antibiotics (−50%), and fertilizers (−20%); expanding the land share of organic farming to 25%; maintaining or restoring landscape features on at least 10% of farmland; and reducing net GHG emissions by 55%. These ambitious goals require improved environmental performance of European agriculture, with many implications for the CAP.

Following interactions with the European Commission (especially DG AGRI and the Vice-presidency for the European Green Deal) and drawing on inputs from over 300 experts, this study focuses on how the CAP 2023–2027 can improve its performance for biodiversity, in line with the CAP objective to preserve biodiversity and landscapes, as well as the Green Deal objective of halting and reversing farmland biodiversity loss (European Commission, 2020). To address this question, the Commission invited European scientists to collate evidence-based recommendations. In response, 13 national workshops were organized between October and December 2020 and followed up by an online survey between December 2020 and March 2021. Workshop coordinators invited scientists with CAP expertise from various disciplines (ecology, agronomy, economics, and social sciences). In some MS, experts from stakeholder groups participated as well. Workshop protocols and individual expert replies were compiled into a predetermined template, where references supporting their statements were provided. We used MAXQDA software to code and extract relevant quotes throughout the questionnaires. We then organized the experts' insights, distilled important guiding principles, and synthesized key findings for this study (for detailed methods, see Supporting Information 2). Overall, we received inputs from over 300 participants in 23 MS (Figure 2) (further details in Pe'er et al., 2021).

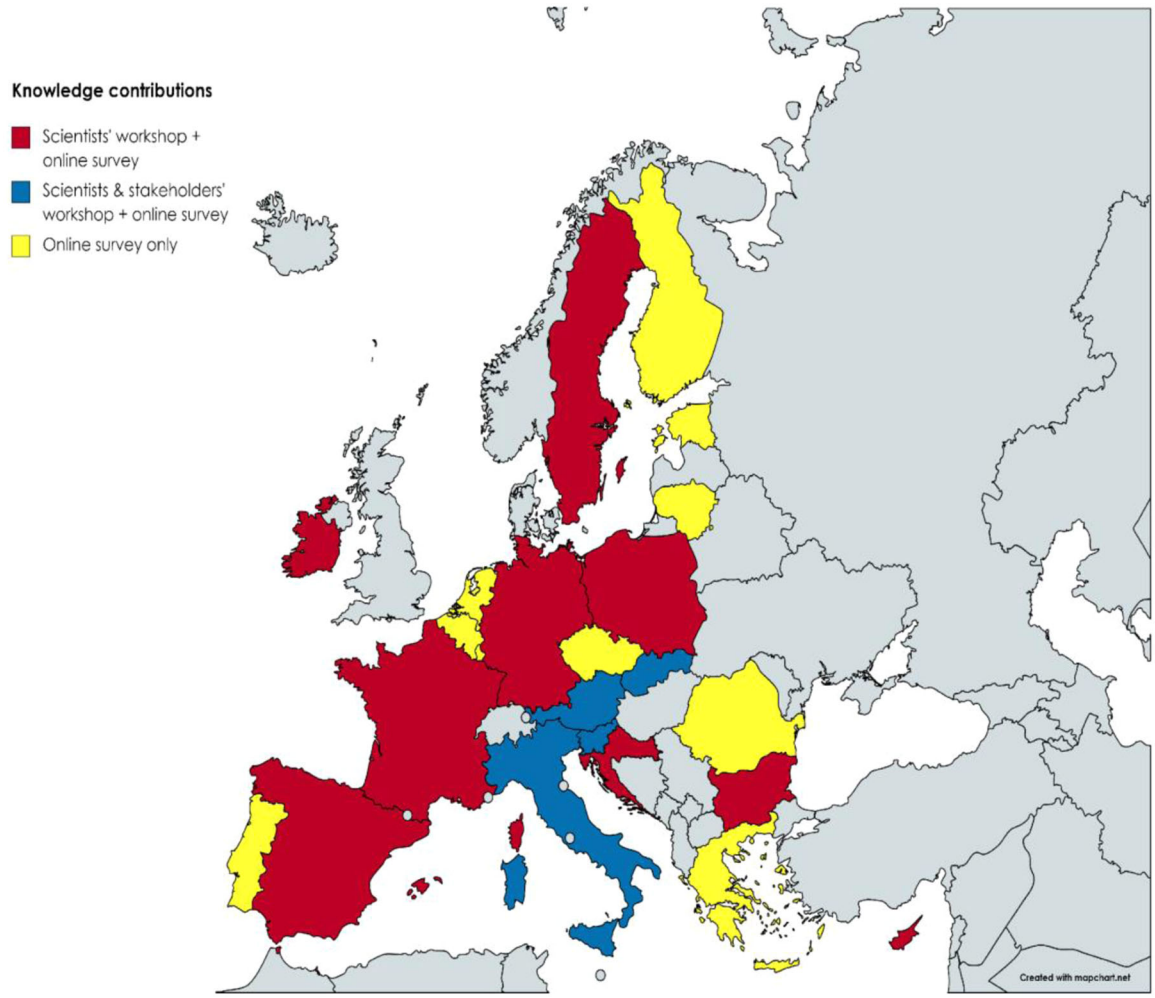

FIGURE 2 Countries where workshops took place involving scientists (red) or both scientists and stakeholders (blue). Contributions to the online survey were made by individuals in all these countries as well as those marked in yellow. Map created using MapChart (https://mapchart.net/europe.html)

2 | EXPERTS' INSIGHTS ON THE GREEN ARCHITECTURE AND BIODIVERSITY

First, we summarize six key principles that emerged from the workshops as overarching perspectives, providing recommendations for the design, implementation, evaluation, and adaptive management of the CAP's biodiversity goal. The four subsequent sections reflect prominent points with regard to Green Architecture and the CAP's implementation.

2.1 | Guiding principles for effective biodiversity protection

2.1.1 | Landscape features and seminatural areas, including grasslands, are central for biodiversity

Participants in all workshops highlighted seminatural areas, landscape features, and extensively managed, species-rich grasslands as the most critical elements for farmland biodiversity in Europe (Concepción et al., 2020; Jeanneret et al., 2021). Measures in both pillars should ensure protection of existing features, reward effective management for biodiversity, and incentivize restoration efforts. In the post-2023 CAP, the default "Good Agriculture and Environmental Condition" (GAEC) 8 requires a minimum share of nonproductive features of 4%, applied only to arable land. MS should utilize other instruments to reach the minimum 10% target for nonproductive features required by the Biodiversity Strategy and recommended by science to apply on all farmland (Kremen & Merenlender, 2018) and avoid losses of area or quality where current coverage is above 10% (Jeanneret et al., 2021). MS should use the opportunity granted by the CAP's improved definitions of grasslands and eligible areas to set land eligibility definitions that support farmers in protecting landscape features on all farmland and habitats under the Habitats Directive (e.g., scrublands, ponds, wood pastures).

2.1.2 | Diversity and multifunctionality should be prioritized and rewarded at the field, farm, and landscape levels

Diverse, multifunctional farms and landscapes support a diversity of habitats and species. They also promote farm resilience and adaptability, both environmentally (Martin et al., 2019) and economically (e.g., through income diversification). At the farm level, supporting diversity can be achieved by paying proportionally to the environmental services delivered (O'Rourke & Finn, 2020); prioritizing measures addressing multiple environmental objectives; supporting bundles of complementary measures in the same field or farm; and supporting crop diversity in both space and time.

2.1.3 | Spatial planning is needed in target setting and implementation

To survive, species require networks of functionally connected habitats of sufficient size and quality. This requires dedicated measures at the landscape level (Concepción et al., 2020), whose impact depends on various environmental conditions. Therefore, MS should ensure the spatial targeting of measures to secure habitats in terms of size, quality, and connectivity. Specific focus should also be given to maintaining key habitats, landscape complexity and heterogeneity, particularly in high nature value farmland (HNVF) regions.

2.1.4 | Collaborative and coordinated implementation enhances the achievement of biodiversity targets

As ecological responses are governed by landscape properties, current financial supports (focusing on individual farms) limit the reach and success of measures (Concepción et al., 2012; Leventon et al., 2017). By extending the spatial scale of interventions, MS can enhance ecological success and improve landscape-scale benefits from ecosystem services. This can be achieved by collaborative and coordinated implementation within target areas, with economic and social benefits for the farming community (Westerink et al., 2017). MS can do so by both AECM and Eco-schemes.

2.1.5 | Result-based approaches provide multiple advantages

In contrast to action-based (or prescription-based) approaches, result-based payments are linked to achieving specific environmental outcomes. Experts in 10 of the 13 workshops highlighted that these approaches reward farmers who maintain farmland with high biodiversity (O'Rourke & Finn, 2020), empower farmers to use their knowledge and experience, and incentivize adaptive management and innovation (De Snoo et al., 2013). However, result-based approaches require careful design to reduce unnecessary risks to farmers (Herzon et al., 2018; O'Rourke & Finn, 2020). Therefore, a combination of both result-based and action-oriented payments is likely optimal.

2.1.6 | Communication, education, and farmer engagement can improve acceptance, cooperation, and uptake of voluntary measures

Farmer involvement, extension services, and training were repeatedly highlighted as important to improve the acceptance of compulsory requirements and to maximize the uptake of effective voluntary measures (de Snoo et al., 2013; Díaz et al., 2021). Farmer engagement can improve the design and implementation of measures, facilitate communication, and enable rapid learning and adaptive management (O'Rourke & Finn, 2020). It also generates a sense of ownership and stewardship that can help expand good practices. MS should therefore improve the support of local action groups and farmer engagement programs for biodiversity, for example, through the European Innovation Partnership for Agriculture (EIP-AGRI) and the LEADER program.

2.1.7 | Setting ambitious targets

Setting S.M.A.R.T targets (Specific, Measurable, Ambitious, Reasonable, and Time-bound) is a key issue for MS in meeting objectives of the CAP and related strategies. To do so, workshop participants highlighted the need for explicit conservation and restoration priorities that should align with the Green Deal, Farm to Fork, and Biodiversity Strategies. The intervention logic must be clear, namely how the choice of instruments and the allocated budgets can achieve targets in an effective and timely manner, including explicit milestones and adaptive strategies (Concepción et al., 2020).

The "no-backsliding" principle (Article 105 of the CAP Strategic Plan Regulation) requires MS to retain at least the current level of environmental investment and calls for "greater overall contribution to the achievement of the specific environmental- and climate-related objectives" (European Commission, 2021). This principle should be reflected in instruments, budgets and management

prescriptions and should be applied to existing habitats and landscape features to avoid any losses of area or quality. The Commission should seek to ensure transparent evaluation of results and clarify what incentives are available for MS who develop ambitious programs. The Commission should also clarify what sanctions will apply to MS who are not on track to achieve the EU targets or fail to provide sufficient data for assessing progress.

2.1.8 | Setting ambitious Eco-schemes

Eco-schemes can more than double the CAP's budget for biodiversity, climate, and other environmental objectives compared to current AECM investments. To deliver substantial benefits, Eco-schemes should prioritize measures that are proven to achieve environmental objectives (Gouriveau et al., 2019) and be financially attractive and administratively simple. However, MS should address several risks:

- Inappropriate payment levels can incentivize the uptake of measures with low or no ecological benefits. Similarly, since Eco-schemes pursue several objectives simultaneously, MS choices can yield low uptake of biodiversity-relevant interventions. Thus, MS should exclude options that are damaging for biodiversity and set a low reward for ineffective options (Table 1); ring-fence sufficient budgets for biodiversity-support options; and prioritize measures that simultaneously fulfil multiple environmental objectives.
- Eco-schemes will be implemented on an annual basis. To enhance biodiversity benefits that increase over multiple years, MS should consider multiannual agreements, bonus payments, or progressive payment systems based on, that is, a points system. Short-term options (e.g., flower strips for several months) should be monitored and (re)assessed to avoid undesirable effects.
- There is a considerable risk of watering down environmental ambitions and of windfall effects if MS choose to fund primarily existing practices, some of which should have been better included under Conditionality.

Generally, MS should maximize their efforts to monitor, learn, continuously adapt and further develop Eco-schemes. In particular, MS should use the opportunity of the increased budget of Eco-schemes (from 20% to 25% from 2025) to remove ineffective options and add missing (effective) options for biodiversity, following the principles above.

2.1.9 | Enhancing coherence between CAP instruments

Coherence and complementarity among conditionality, Eco-schemes and AECM are important in terms of both content (which measures support which objectives and targets) and payment levels (to avoid light green interventions competing with more effective dark green ones).

Eco-schemes can optimally operate as an intermediate instrument between conditionality (minimum standards) and AECM (target areas with complex ecological requirements, such as Natura 2000 sites or HNVF). Eco-schemes can complement AECM, especially in simplified landscapes. For example, where landscape features are protected by Conditionality (GAEC 8), Eco-schemes could support an expansion to 10%, while AECM may reward either further improvement of habitat quality or restoration of landscape elements (Díaz et al., 2021) or an expansion beyond 10%. Additionally, nonproductive investments can be used to support habitat restoration and maintenance. Workshop participants highlighted that, especially for biodiversity-valuable AECM options, complementarity with Eco-schemes (i.e., multiple payments for different actions on the same parcels) can help enhance the uptake of more demanding measures aimed at improving habitat quality.

MS should establish effective and justifiable payment approaches and consider the pros and cons of income foregone and costs incurred (currently in AECM) compared to "top-up" options that are additional to the basic income support (Eco-schemes option; Table 2).

Beyond the Green Architecture, MS should strive for improved coherence and balance among CAP objectives, instruments, and investments to ensure that other CAP instruments do not counteract environmental measures. This applies particularly to payments coupled to production, productive investments that are harmful for biodiversity, and payments for areas facing natural or other specific constraints, which are counted toward the biodiversity objective (at 50% weight) without justification.

2.1.10 | Improved monitoring and transparent reporting to support a result-oriented policy implementation

Workshop participants highlighted that environmental monitoring and reporting of the CAP are insufficient, especially for biodiversity (ECA, 2019; Geijzendorffer et al., 2016), and need to be expanded. Public administrations in many MS have insufficient experience with result-oriented measures and inadequate resources for

TABLE 1 Examples of measures proposed by workshop participants for inclusion versus exclusion in Eco-schemes in relation to their expected impact on biodiversity protection and restoration

Item	Proposed action	Specific measure	Rationale
Nonproductive land, landscape features, catch crops, and green cover	Include	Protection and restoration of nonproductive land and landscape features	Several landscape features have high biodiversity benefits (Pe'er et al., 2019). Complement GAEC 8 by supporting a higher share of nonproductive land. Landscape features with little biodiversity benefit should, however, not be included.
		Promotion of field margins, buffer strips, and grass-covered fallow land	Strong evidence for negative impacts of fallow-land losses on biodiversity and endangered species (Traba & Morales, 2019); expert-based assessments indicating high value of fallow land and buffer strips for biodiversity (Pe'er et al., 2017) and ecosystem services (e.g., pollination or weed control; Martin et al., 2019)
	Exclude	Catch crops and green cover	Little or no demonstrated effects on biodiversity[2]; included under Enhanced Conditionality (GAECs 7, 8, 9)
Wetlands and peatlands	Include	Wetland and peatland conservation and restoration	Direct evidence for positive effects on endangered species; exceptional benefit for climate-change mitigation (Jantke et al., 2011)
Grassland management	Include	Conservation of extensive permanent grasslands	Potential concomitant benefits for biodiversity, soil, water quality, carbon sequestration, animal welfare, as well as provision, regulation and recreation services (Faria & Morales, 2021)
	Exclude	Intensive grazing on grasslands	Negative effects on biodiversity due to overgrazing; trampling and nutrient loads affecting soil and water; invasive species; chemical pollution and greenhouse gas emissions
Agroforestry Management	Exclude	Forestry & unsustainable afforestation	Negative effects demonstrated for farmland diversity (Díaz & Concepción, 2016)

(Continues)

TABLE 1 (Continued)

Item	Proposed action	Specific measure	Rationale
Precision farming approaches	Exclude	Precision farming	Geared toward increasing production efficiency, many forms of precision farming lack explicit benefits to biodiversity, and tend to favor monocultures, plot size expansion and agricultural landscape simplification. Reduction of surplus inputs or substitute inputs (fertilizers, pesticides, water) do have positive environmental effects but can be better supported by other CAP instruments such as Investment support measures. Since costs of precision farming technology do not scale with area, Eco-schemes as an area-related support is not a suitable instrument.
Exceptions can include precision farming and technology that enhances codelivery of biodiversity, ecosystems services, and market products (O'Rourke & Finn, 2020)			

TABLE 2 Main attributes of "top-up" versus 'income-foregone' payment approaches

"Top-up" payment approach	"Income-foregone" payment approach
• Simple to administer and attractive to farmers, potentially leading to high uptake, particularly for measures with a high impact on biodiversity (regardless of their relation to farm income) • Allows rewarding environmental services above the level of "income foregone" + transaction costs. • Can improve uptake in places where overall income from farming, or income foregone associated with the measure, are low and thus the payment is unattractive (e.g., for small-scale, low intensity grazing and/or for part-time farmers). • Can advance a more positive perception of nature conservation as a benefit rather than a cost. • Can support innovative practices.	• The existing system works if well designed and implemented, e.g., taking into account public and private transaction costs. • The "cost-incurred" element serves as an objective economic benchmark for the level of payment. • Allows consistency among funding modalities for agri-environment-climate-measures and Eco-schemes, thus reducing the risk of competition and the lack of comparability. • Prevents Eco-scheme payments from becoming income-support in disguise. • Limits rent-seeking by lobby groups • Avoids misspending of taxpayers' funds by providing a solid baseline for calculus.

wildlife monitoring (Šumrada et al., 2021). These require significantly increased investments in funding, human resources, scheme design, training (e.g., of farmer advisors), and in situ monitoring.

Workshop participants proposed that monitoring and evaluation efforts should be proportional to CAP investments in different instruments and to their potential impact on biodiversity. This especially applies to direct payments and payments for areas facing natural and other constraints, which remain poorly assessed despite having significant budget allocations and affecting large areas (Alliance Environment, 2019).

TABLE 3 Recommended indicators for (a) biodiversity and (b) landscape attributes

3a: Indicators for biodiversity	
Indicator	**Justification**
Birds	Established monitoring programs; indicator value of farmland ecosystem quality (e.g., Farmland Bird Index; https://ec.europa.eu/eurostat/cache/metadata/en/t2020_rn130_esmsip2.htm)
Butterflies	Established monitoring programs; indicator value of grassland quality and diversity (e.g., European Butterfly Monitoring Scheme [eBMS]; https://butterflymonitoring.net/en/ebms
Pollinators	Indicators of pollinator biodiversity and the amount and quality of pollination service provision (e.g., proposal of EU Pollinator Monitoring Scheme (EU-PoMS) (Cole et al., 2020); https://ec.europa.eu/jrc/en/science-update/proposal-eu-pollinator-monitoring-scheme-eu-poms
Plants	Indicator of basic farmland ecosystem diversity and productivity (Oppermann et al., 2021)
Species of conservation concern	Compulsory monitoring programs; potential indicator of value of ecosystem integrity (e.g., conservation status of species under the EU Habitats Directive; https://www.eea.europa.eu/data-and-maps/indicators/species-of-european-interest-3/assessment)
Invasive species	Indicator of farmland ecosystem simplification and degradation (e.g., List of Invasive Alien Species of Union concern; https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1483614313362&uri=CELEX:32014R1143
3b: Indicators for landscape structure	
Extent and spatial distribution of biodiversity relevant habitats such as high nature value farmland	Extent of habitats with tested positive effects on biodiversity (e.g., extensive grassland, fallow land or specific landscape features); established indicator of heterogeneous biodiversity rich farmland landscapes (Larkin et al., 2019; Oppermann et al., 2021)
Habitat quality	Conservation status of habitats like, e.g., according to the EU Habitats Directive (Article 17 reports)
Landscape heterogeneity	Indicators on diversity of composition and configuration in farmland landscapes (Martin et al., 2019)
Crop diversity, field size	Indicators on diversity of composition and configuration of complex/heterogeneous farmland landscapes

The European Commission should guide MS in ensuring the selection of suitable indicators for biodiversity (Table 3a), as well as for habitats and landscape structures (Table 3b). The new delivery model requires tight monitoring of these indicators to enable rapid performance evaluation, especially of HNVF, landscape features and grassland management.

MS should employ improved and harmonized standards in recording and archiving relevant biodiversity, landscapes, and socioeconomic data and improve access to databases, especially the Integrated Administration and Control System (IACS), for researchers and the public. Otherwise, existing barriers to data access will continue impeding evidence-based evaluation of the CAP's performance. Mapping efforts can be readily expanded by increasing the comprehensiveness of Land Parcel Identification Systems (LPIS) to generate a broader picture of the state of European farmlands.

2.2 | Outlook: How to still improve the CAP for biodiversity

2.2.1 | The environmental ambition of the post-2023 CAP is not yet guaranteed

With the lion's share of EU biodiversity conservation budgets (SM1 in Pe'er et al., 2014), the CAP is fundamental to achieve the EU Biodiversity Strategy. The CAP post-2023 is equipped with new opportunities to significantly address the biodiversity and climate crises. However, the Green Architecture is no guarantee of success. First, changes in the new CAP are disproportionately small compared to the challenges of halting biodiversity loss and combating climate change (Mace et al., 2018). Second, despite the forthcoming CAP offering more flexibility to implement higher environmental ambition, most MS seem unwilling to use this opportunity. Support for this assessment

includes, inter alia, the pressure exerted by the Council to minimize environmental requirements toward the Trilogue agreement achieved in June 2021, the National Strategic Plans submitted to the Commission, and the rapid decision to allow production on Focus Areas in response to the war in Ukraine (Pe'er et al., 2022). Third, many MS lack the capacity to support a transition to result-based implementation in terms of the required ambition, design, monitoring, reporting, and adaptability.

The Eco-schemes proposed by the MS within their national strategic plans show varying levels of ambition. Although some Eco-schemes include options with biodiversity benefits (e.g., expansion of landscape features), many others support existing practices with little or no added value (e.g., support for crop rotation, merely substituting a weak GAEC 7), and some may even yield negative biodiversity impacts (e.g., supporting the replacement of existing habitats, such as species-rich grasslands or longer-term fallow land). Spatial diversification, bonuses for improved spatial design, multiyear implementation of Eco-schemes, and collective options seem prominently absent. The risk therefore prevails that large proportions of Eco-scheme budgets will be spent on maintaining a status quo rather than improving farmland management for biodiversity. The Commission should ensure that strategic plans are improved either prior to implementation or after a performance review by suggesting how MS can make appropriate alterations. Such alterations may include the addition of effective Eco-scheme options (such as fallow land, Table 1), the removal of counterproductive options, and reduced remuneration for options with limited added value. Regular reviews comparing the likely impacts of CAP interventions with intended impact levels are crucial for the adaptive development of Eco-schemes as a new policy instrument. These reviews should consider criteria such as added environmental value, uptake, and adherence to the S.M.A.R.T framework as a means to achieve the nine CAP objectives.

2.2.2 | Beyond biodiversity

Meeting the nine CAP objectives requires a balance among all three sustainability dimensions (Pe'er et al., 2019). Developing the capacity to achieve this balance requires institutional support as well as a transdisciplinary approach and multiactor research and innovation networks (Šūmane et al., 2018). Participants in many workshops highlighted synergies and trade-offs between biodiversity and other CAP objectives, including climate change mitigation and the efficient use and protection of natural resources. There was a distinct concern that a strong focus on carbon farming and on water protection measures could result in a net loss of biodiversity; thus, measures that promote synergies should be identified and strongly prioritized.

2.2.3 | The role of science in the CAP reform and its long-term future

This study emerged from a unique interaction among scientists and policymakers, where scientists were invited by the Commission to deliver their recommendations on the basis of the best available evidence. During workshops, participants emphasized the need for a more structured dialog between science and policy. The European Union is placing greater responsibility on MS to adapt EU policy to local needs. Science, in return, can provide evidence-based solutions to support such needs (Díaz et al., 2021; Jeanneret et al., 2021) to identify win–win options, address trade-offs, and reach compromises among interests and objectives.

Misconceptions and misinformation abound in many contentious topics in modern society, and the CAP is not immune. Social sciences and interdisciplinary research can help address these issues. Science plays an important role by providing accurate and reliable information and alerting when policy instruments, or prevailing discourses and narratives, fail to accord with the best available evidence.

Complex challenges lie ahead for the Commission, national and regional administrations, farmers, and society. Alternative pathways to success are needed to support societal transformation and sociopolitical discourse and enhance political will. This includes communicating nature conservation as an investment and insurance and highlighting the values of biodiversity. The science-policy interface needs strengthening to improve transparency and engagement. Scientists can support policy development by evaluating outcomes, maximizing success within the realms of existing flexibility, and identifying innovative paths away from business-as-usual and toward models that reconcile food production and consumption, nature conservation, and economic and social objectives.

ACKNOWLEDGMENTS

We are grateful to all workshop coordinators, particularly Sonja Karoglan Todorovic (Croatia), Alan Matthews (Ireland), Edward Majewski (Poland), and Lovisa Nilsson (Sweden), and to all contributors for their valuable inputs. A preprint version of this paper was published in Volume 3 of "Thünen Working Paper 175" (Pe'er et al., 2021) as a summary of the full synthesis of results (Volume 1). The independent study emerged from interactions with DG AGRI and the office of European Commission Executive Vice-Presidency for the European Green Deal.

It was led and coordinated by Guy Pe'er, Maren Birkenstock, Norbert Röder and Sebastian Lakner. Guy Pe'er received funding from the German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig of the German Research Foundation (DFG–FZT 118, 202548816). Jana Špulerová and Peter Bezák received funding from the Integrated Infrastructure Operational Programme funded by the ERDF, project ITMS2014+ 313011W580 (Scientific support of climate change adaptation in agriculture and mitigation of soil degradation). Juliana Dänhardt was supported by the thematic collaboration initiative LU Land—Land use for a sustainable future.

ORCID

Guy Pe'er https://orcid.org/0000-0002-7090-0560
John A. Finn https://orcid.org/0000-0003-3616-5563
Mario Díaz https://orcid.org/0000-0002-6384-6674
Sebastian Lakner https://orcid.org/0000-0002-5122-8924
Norbert Röder https://orcid.org/0000-0002-2491-2624
Tanja Šumrada https://orcid.org/0000-0003-1297-9108
Elena D. Concepción https://orcid.org/0000-0002-6715-6902
Juliana Dänhardt https://orcid.org/0000-0003-2383-2339
Manuel B. Morales https://orcid.org/0000-0001-8534-7895
Ilona Rac https://orcid.org/0000-0003-4344-267X
Jana Špulerová https://orcid.org/0000-0002-1666-8369
Stefan Schindler https://orcid.org/0000-0002-1755-4304
Menelaos Stavrinides https://orcid.org/0000-0002-6459-1941
Stefano Targetti https://orcid.org/0000-0002-2154-546X
Davide Viaggi https://orcid.org/0000-0001-9503-2977
Ioannis N. Vogiatzakis https://orcid.org/0000-0001-7071-6950
Hervé Guyomard https://orcid.org/0000-0003-1935-2359

REFERENCES

Alliance Environment (2019). *Impacts of the CAP on habitats, landscapes, biodiversity*. Study for the EU Commission. https://bit.ly/37iBy63

Concepción, E. D., Díaz, M., Kleijn, D., Báldi, A., Batáry, P., Clough, Y., Gabriel, D., Herzog, F., Holzschuh, A., Knop, E., Marshall, E. J. P., Tscharntke, T., & Verhulst, J. (2012). Interactive effects of landscape context constrain the effectiveness of local agri-environmental management. *Journal of Applied Ecology*, *49*, 695–705.

Concepción, E. D., Aneva, I., Jay, M., Lukanov, S., Marsden, K., Moreno, G., Oppermann, R., Pardo, A., Piskol, S., Rolo, V., Schraml, A., & Díaz, M. (2020). Optimizing biodiversity gain of European agriculture through regional targeting and adaptive management of conservation tools. *Biological Conservation*, *241*, 108384

Cole, L. J., Kleijn, D., Dicks, L. V., Stout, J. C., Potts, S. G., Albrecht, M., Balzan, M. V., Bartomeus, I., Bebeli, P. J., Bevk, D., Biesmeijer, J. C., Chlebo, R., Dautartė, A., Emmanouil, N., Hartfield, C., Holland, J. M., Holzschuh, A., Knoben, N. T. J., Kovács-Hostyánszki, A., … Scheper, J. (2020). A critical analysis of the potential for EU Common Agricultural Policy measures to support wild pollinators on farmland. *Journal of Applied Ecology*, *57*, 681–694.

Díaz, M., Concepción, E. D., Morales, M. B., Alonso, J. C., Azcárate, F. M., Bartomeus, I., Bota, G., Brotons, L., García, D., Giralt, D., Gutiérrez, J. E., López-Bao, J. V., Mañosa, S., Milla, R., Miñarro, M., Navarro, A., Olea, P. P., Palacín, C., Peco, B., … Velado-Alonso, E. (2021). Environmental objectives of Spanish agriculture: Scientific guidelines for their effective implementation under the Common Agricultural Policy 2023–2030. *Ardeola*, *68*, 445–460.

Díaz, M., & Concepción, E. D. (2016). Enhancing the effectiveness of CAP greening as a conservation tool: A plea for regional targeting considering landscape constraints. *Current Landscape Ecology Reports*, *1*, 168–177.

De Snoo, G. R., Herzon, I., Staats, H., Burton, R. J., Schindler, S., van Dijk, J., Lokhorst, A. M., Bullock, J. M., Lobley, M., Wrbka, T., Schwarz, G., & Musters, C. J. M. (2013). Toward effective nature conservation on farmland: Making farmers matter. *Conservation Letters*, *6*, 66–72.

European Commission (2020). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, EU biodiversity strategy for 2030: Bringing nature back into our lives*. EU Commission.

European Commission (2021). *Proposal for a regulation of the European Parliament and the Council establishing rules on support for strategic plans to be drawn up by Member States under the Common agricultural policy (CAP Strategic Plans) (Consolidated version of 28 July 2021)*. EU Commission.

ECA (2017). More efforts are needed to implement the Natura 2000 network to its full potential (special report 01/2017), European Court of Auditors (ECA), Luxembourg. https://bit.ly/3xiHGWF

ECA (2019). Biodiversity on farmland: CAP contribution has not halted the decline; (special report 13/2020), European Court of Auditors (ECA), Luxembourg.

EUROSTAT (2021). Statistics | Eurostat: Main farm land use by NUTS 2 regions. https://ec.europa.eu/eurostat/databrowser/view/ef_lus_main/default/table?lang=en

Faria, N., & Morales, M. B. (2021). Farmland management regulates ecosystem services in Mediterranean drylands: Assessing the sustainability of agri-environmental payments for bird conservation. *Journal of Nature Conservation*, *58*, 125913.

Geijzendorffer, I. R., Targetti, S., Schneider, M. K., Brus, D. J., Jeanneret, P., Jongman, R. H., Knotters, M., Viaggi, D., Angelova, S., Arndorfer, M., Bailey, D., Balazs, K., Bogers, M. M. B., Bunce, R. G. H., Choisis, J.-P., Dennis, P., Eiter, S., Fjellstad, W., … Herzog, F. (2016). Editor's choice: How much would it cost to monitor farmland biodiversity in Europe? *Journal of Applied Ecology*, *53*, 140–149.

Gouriveau, F., Beaufoy, G., Moran, J. M., Poux, X., Herzon, I., de Oliviera, M. I. F., Gaspart, M., Genevet, E., Goussios, D., Herrera, P. M., Jitea, M. I., Johansson, L., Jones, G., Kazakova-Mateva, Y., Lyszczarz, D., McCann, K., Priac, A., Puig de Morales, M., Rodriguez, T., Roglic, M., … Roglic, M. (2019). What EU policy framework do we need to sustain High Nature Value (HNV) farming and biodiversity? Policy Paper prepared in the framework of

HNV-Link (project funded by the H2020 Research and Innovation Programme under Grant Agreement no 696391). https://doi.org/10.13140/RG.2.2.35978.62402

Herzon, I., Birge, T., Allen, B., Povellato, A., Vanni, F., Hart, K., Radley, G., Keenleyside, C., Oppermann, R., Underwood, E., Poux, X., Beaufoy, G., & Pražan, J. (2018). Time to look for evidence: Results-based approach to biodiversity conservation on farmland in Europe. *Land Use Policy*, *71*, 347–354.

Jantke, K., Schleupner, C., & Schneider, U. A. (2011). Gap analysis of European wetland species: Priority regions for expanding the Natural 2000 network. *Biodiversity and Conservation*, *20*, 581–605.

Jeanneret, P., Lüscher, G., Schneider, M. K., Pointereau, P., Arndorfer, M., Bailey, D., Balázs, K., Báldi, A., Choisis, J.-P., Dennis, P., Diaz, M., Eiter, S., Elek, Z., Fjellstad, W., Frank, T., Friedel, J.-K., Geijzendorffer, I. R., Gillingham, P., Gomiero, T., … Herzog, F. (2021). An increase in food production in Europe could dramatically affect farmland biodiversity. *Communications Earth & Environment*, *2*, 183. https://doi.org/10.1038/s43247-021-00256

Kremen, C., & Merenlender, A. M. (2018). Landscapes that work for biodiversity and people. *Science*, *362*, 6412.

Larkin, J., Sheridan, H., Finn, J. A., Denniston, H., & Ó hUallacháin, D. (2019). Semi-natural habitats and ecological focus areas on cereal, beef and dairy farms in Ireland. *Land Use Policy*, *88*, 104096.

Leventon, J., Schaal, T., Velten, S., Dänhardt, J., Fischer, J., Abson, D. J., & Newig, J. (2017). Collaboration or fragmentation? Biodiversity management through the common agricultural policy. *Land Use Policy*, *64*, 1–12.

Mace, G. M., Barrett, M., Burgess, N. D., Cornell, S. E., Freeman, R., Grooten, M., & Purvis, A. (2018). Aiming higher to bend the curve of biodiversity loss. *Nature Sustainability*, *1*, 448–451.

Martin, E. A., Dainese, M., Clough, Y., Baldi, A., Bommarco, R., Gagic, V., Garratt, M. P. D., Holzschuh, A., Kleijn, D., Kovács-Hostyánszki, A., Marini, L., Potts, S. G., Smith, H. G., Al Hassan, D., Albrecht, M., Andersson, G. K. S., Asís, J. D., Aviron, S., Balzan, M. V., … Steffan-Dewenter, I. (2019). The interplay of landscape composition and configuration: New pathways to manage functional biodiversity and agroecosystem services across Europe. *Ecology Letters*, *22*, 1083–1094.

Oppermann, R., Aguirre, E., Bleil, R., Domingo Calabuig, J., Šálek, M., Schmotzer, A., & Schraml, A. (2021). A rapid method for monitoring landscape structure and ecological value in European farmlands: The LISA approach. *Landscape Online*, *90*, 1–24. https://doi.org/10.3097/LO.202190

O'Rourke, E., & Finn, J. A. (2020). *Farming for Nature: The Role of Results-Based Payments. Teagasc and National Parks and Wildlife Service (NPWS)*. Wexford. https://bit.ly/3lstyYu

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. Braunschweig: Johann Heinrich von Thünen-Institut, Thünen Working Paper 175. Vol. 1: Main report (https://doi.org/10.3220/WP1620646984000); Vol. 2: Member State reports (https://doi.org/10.3220/WP1620647428000); Vol. 3: Policy Brief. https://doi.org/10.3220/WP1620647816000

Pe'er, G., Dicks, L. V., Visconti, P., Arlettaz, R., Báldi, A., Benton, T. G., Collins, S., Gregory, R. D., Hartig, F., Henle, K., Hobson, P. R., Kleijn, D., Neurmann, R. K., Robijns, T., Schmidt, J., Shwartz, A., Sutherland, W. J., Turbe, A., Wulf, F., & Scott, A. V. (2014). EU agricultural reform fails on biodiversity. *Science*, *344*, 1090–1092. https://doi.org/10.1126/science.1253425

Pe'er, G., Lakner, S., & Candel, J. (2022). Ukraine-Crisis impacts on food security: Tackling the short-term shock must be done with a vision in mind of the larger-scale and longer-term threats of the Climate- and Biodiversity-Crises. https://urlcc.cc/c1ao2

Pe'er, G., Zinngrebe, Y., Moreira, F., Sirami, C., Schindler, S., Müller, R., Bontzorlos, V. A., Clough, D., Bezak, P., Bonn, A., Hansjurgens, B., Lomba, A., Mockel, S., Passoni, G., Schleyer, C., Schmidt, J., & Lakner, S. (2019). A greener path for the EU Common Agricultural Policy. *Science*, *365*, 449–451.

Pe'er, G., Zinngrebe, Y., Hauck, J., Schindler, S., Dittrich, A., Zingg, S., Tscharntke, T., Oppermann, R., Sutcliffe, L. M. E., Sirami, C., Schmidt, J., Hoyer, C., Schleyer, C., & Lakner, S. (2017). Adding some green to the greening: Improving the EU's Ecological Focus Areas for biodiversity and farmers. *Conservation Letters*, *10*, 517–530. https://doi.org/10.1111/conl.12333

Šūmane, S., Kunda, I., Knickel, K., Strauss, A., Tisenkopfs, T., des Ios Rios, I., Rivera, M., Chebach, T., & Ashkenazy, A. (2018). Local and farmers' knowledge matters! How integrating informal and formal knowledge enhances sustainable and resilient agriculture. *Journal of Rural Studies*, *59*, 232–241

Šumrada, T., Vreš, B., Čelik, T., Šilc, U., Rac, I., Udovč, A., & Erjavec, E. (2021). Are result-based schemes a superior approach to the conservation of High Nature Value grasslands? Evidence from Slovenia. *Land Use Policy*, *111*, 105749.

Traba, J., & Morales, M. B. (2019). The decline of farmland birds in Spain is strongly associated to the loss of fallow land. *Scientific Reports*, *9*, 9473. https://doi.org/10.1038/s41598-019-45854-0

Westerink, J., Jongeneel, R., Polman, N., Prager, K., Franks, J., Dupraz, P., & Mettepenningen, E. (2017). Collaborative governance arrangements to deliver spatially coordinated agri-environmental management. *Land Use Policy*, *69*, 176–192.

SUPPORTING INFORMATION

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

How to cite this article: 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*, e12901. https://doi.org/10.1111/conl.12901