Assessing the biodiversity-agriculture nexus

An overview of international and European Union methods

Ana Prieto López, Facundo Odriozola, Barbara Pia Oberč,
Tommaso Demozzi, Diarmaid Ó Cuanacháin, Ophélie Cuvillard

Alberto Arroyo Schnell, editor

COMMON GROUND ON FOOD AND AGRICULTURAL SYSTEMS SERIES NO. 2

Common Ground on Food and Agricultural Systems

Ministry of Agriculture, Fisheries, Food Security and Nature

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The *IUCN Common Ground on Food and Agricultural Systems* series documents the importance of sustainable agriculture and food systems, feed the dialogue between agriculture and conservation actors, and help them balance human well-being, natural resources and life on Earth.

This report highlights the importance of common metrics for assessing the biodiversity-agriculture nexus, offering insights into 12 key tools to enhance monitoring and evidence-based decision-making. By addressing gaps in policy frameworks, it supports sustainable agriculture that balances food production with biodiversity conservation.

The *Common Ground on Food and Agricultural Systems* series ambitions to explore the complex relationships between nature, agriculture and agri-food systems to inform policies and better address food security, climate change and Nature conservation challenges.

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IUCN is pleased to acknowledge the support of its Framework Partners who provide core funding: Ministry of Foreign Affairs, Denmark; Ministry for Foreign Affairs, Finland; Government of France and the French Development Agency (AFD); Ministry of Environment, Republic of Korea; Ministry of the Environment, Climate and Sustainable Development, Grand Duchy of Luxembourg; the Norwegian Agency for Development Cooperation (Norad); the Swedish International Development Cooperation Agency (Sida); the Swiss Agency for Development and Cooperation (SDC) and the United States Department of State.

This publication has been made possible in part by funding from the Ministry of Agriculture, Fisheries, Food Security, and Nature of the Netherlands.

Published by: IUCN, Gland, Switzerland

Produced by: IUCN European Regional Office, Brussels, Belgium

Recommended citation: Prieto López, A., Odriozola, F., Oberč, B.P., Demozzi, T., Ó Cuanacháin,, D., Cuvillard, O., (2024). *Assessing the biodiversity-agriculture nexus. An overview of international and European Union methods*. Arroyo Schnell, A. (ed.). IUCN Common Ground on Food and Agricultural Systems Series No. 2 Gland, Switzerland: IUCN.

ISBN: 978-2-8317-2310-5 (PDF)
978-2-8317-2311-2 (print)

DOI: https://doi.org/10.2305/KZMX9763

Cover photo: © Dorné Marting / Unsplash.com

Layout by: Imre Sebestyén, jr. / Unit Graphics

Copy-edited by: Anne Godlewski – Terrific Text

Printed by: Media Process (SA)

The text of this book is printed on FSC mix coated silk paper, 135 gr.

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Contents

Foreword

With almost half of the world's habitable land used for agriculture and the impact this has on land systems, agriculture continues to stand at the crossroads of one of the major challenges of our time: ensuring food security for a growing global population while safeguarding the biodiversity that sustains the very ecosystems on which life depends. As one of the largest users of land and a primary driver of biodiversity loss, agriculture requires urgent transformation if we are to halt and reverse the trends of habitat degradation, species decline, and ecosystem breakdown. The challenge we face is not just about producing more food but doing so in a way that is compatible with the preservation of biodiversity and healthy ecosystems.

Biodiversity and agriculture are deeply interconnected. Biodiversity supports agricultural systems by providing essential services such as pollination, nutrient cycling, pest control, and water filtration. In return, sustainable agricultural practices can nurture and protect biodiversity. However, the reality is that conventional agriculture has too often contributed to biodiversity loss through practices such as deforestation, land conversion, and the excessive use of fertilisers and pesticides. These pressures have left ecosystems depleted and vulnerable, threatening land productivity and food security in the long run. It is now our task to rethink agriculture and align it with the needs of nature.

This publication builds on IUCN's landmark 2020 report *Approaches to Sustainable Agriculture* by offering an expanded view of how the relationship between agriculture and biodiversity can be measured and understood. One of the key issues highlighted is the lack of common metrics for assessing the benefits of sustainable agriculture. By addressing this gap in standardised measurement tools, we take an important step toward ensuring that agricultural practices enable both food production and the protection of ecosystems.

The tools and approaches presented in this publication provide crucial insights for policymakers, farmers, companies, and researchers by offering pathways for assessing the links between biodiversity and agriculture, measuring impacts, monitoring progress, and enabling informed decisions that align with global and EU biodiversity targets, such as those set forth by the Kunming-Montreal Global Biodiversity Framework, the European Green Deal, the Common Agricultural Policy, and the recently passed Nature Restoration Regulation.

At IUCN, we are committed to supporting this transformative journey toward a nature-positive future. Through our Global Initiative on Agriculture and Land Health, and our work on sustainable food systems within the EU, we promote agricultural frameworks that benefit both people and nature. Together with the European Commission, Member States, and other stakeholders, we strive to inform policies that integrate Nature-based Solutions into agriculture, ensuring that sustainable land use and food production become the norm across Europe and beyond.

The next few years will be crucial for EU agricultural policy as discussions on the CAP post-2027 commence. IUCN will continue to convene stakeholders, including land users, farmers, and consumer organisations, to foster a holistic dialogue on transitioning to sustainable agriculture. We recognise that rethinking food systems requires tailored solutions and consideration of the entire food value chain — from food waste to food production's health impacts — emphasising a systems approach as proposed in the EU's Farm to Fork Strategy and in the recently published report of the Strategic Dialogue on the Future of EU Agriculture.

This publication is not only a tool for understanding the current challenges we face but also a call to action. It underscores the importance of collaboration at all levels, stressing that achieving a balance between agriculture and biodiversity will depend on shared knowledge, common goals, and joint efforts across sectors. The transition to sustainable agriculture requires the active participation of all actors within the food system — from international organisations and national governments to farmers, businesses, and consumers.

In closing, this publication represents a vision where farming is in harmony with nature, fostering healthy ecosystems and resilient communities. Our task is ambitious, but it is achievable with commitment, collaboration, and joint action.

Boris Erg, Director
IUCN European Regional Office

Executive summary

Food is one of the basic needs for human life. At the same time, agriculture is a leading cause of biodiversity loss, driving 80% of deforestation and consuming 70% of freshwater resources globally. Furthermore, conventional farming practices and the extensive use of pesticides and fertilisers have led to habitat degradation, soil depletion and the loss of species.

The 2020 IUCN report *Approaches to sustainable agriculture* highlighted the many sustainable approaches and associated practices that exist. It also identified the lack of common metrics for assessing the benefits of sustainable agricultural practices as a significant challenge for mainstreaming sustainable agriculture.

Policy-makers and farmers need accurate information to design and implement practices that promote biodiversity. Common metrics would enable better monitoring of biodiversity changes, facilitate comparison across different regions and farming systems, and support evidence-based decision making. Addressing the lack of common metrics is essential for achieving sustainable agriculture, which balances food production with the preservation of biodiversity and ecosystem health.

This challenge has led to the development of various methods to measure biodiversity, focusing on different aspects such as species composition, ecosystem structure and functionality. Across the world, experts have developed various tools to study how agriculture impacts biodiversity. Some tools focus on agricultural impacts, such as the Agrobiodiversity Index and the Farmland Biodiversity Score, and some tools are more general, such as the Biodiversity Impact Metric, which looks at the effects of human activity on nature. Despite their differences, these methods all point to a common need for reliable, consistent data to base their findings on.

This report aims to provide a general overview of how the relationship between biodiversity and agriculture is assessed. It identifies common themes and differences among the methods analysed, as well as common challenges. The insights that are provided aim to help various stakeholders, including policy-makers in their role of creating effective policies, farmers in making informed decisions, companies in aligning with sustainability goals, and academics in conducting further research.

A non-exhaustive review of biodiversity assessment methods was conducted in developing this report. The review identified over 30 sustainability assessment tools that could be relevant to assessing biodiversity in agriculture. Following many discussions with environmental, agricultural and academic stakeholders, 12 methods were selected for their relevance to biodiversity, agriculture and policy; for their applicability to farmers, businesses and policy-makers; and for the uptake of each method.

Firstly, the methods that specifically focus on agriculture are described (Agrobiodiversity Index, Cool Farm Tool – Biodiversity Metric, Farmland Biodiversity Score, Global Farm Metric, Original Agroecological Survey Indicator System), and later the scope is broadened to more general biodiversity assessment tools that can also assess biodiversity in agricultural contexts (GLOBIO, Biodiversity Intactness Index, Global Biodiversity Score, Natural Capital Protocol, Biodiversity Impact Metric, Biodiversity Footprint and the Species Threat Abatement and Restoration metric). Some of the methods have similarities, mainly in their purpose and target users, but also differences, mainly in their methodology: some are based on a bottom-up approach, such as STAR, while others are based on a top-down approach, such as the Biodiversity Footprint, Global Biodiversity Score and Biodiversity Intactness Index.

The report also includes an analysis of how some key international and European policies assess the links between biodiversity and agriculture. In the EU, steps have been taken to integrate biodiversity concerns into agricultural policy through frameworks, such as the Common Agricultural Policy, EU Biodiversity Strategy for 2030 or the Nature Restoration Regulation. These initiatives use various indicators to help integrate biodiversity goals into farming policies. Still, there is room for improvement in these indicators: they should be more detailed and comprehensive to truly capture the complex interactions between farming and nature.

One major challenge identified is the need for further integration among global and EU methods, which would help to compare results. A joint approach to monitoring, reporting and using all the data and indicators from the different policy processes analysed would help enhance efficiency and provide the most comprehensive overview of the links between agricultural activity and biodiversity in the EU.

The report also highlights the need for better data collection methods, suggesting that advancements in technology, citizen science projects and integrated data platforms could provide more accurate and timely information. These improvements would make it easier for farmers and policy-makers to make informed decisions that benefit both agriculture and biodiversity.

Finally, integration among global and EU methods – mostly by sharing data – and standardising data collection methods and processing to allow comparability might help build a more detailed and complete picture of the impacts of biodiversity policies and actions in the field.

Acknowledgements

We would like to thank our IUCN colleagues for the support, input and collaboration for the preparation of this report, including Ludovic Larbodière, Mercedes Muñoz Cañas, Thomas Brooks, Frank Hawkins, Nicholas MacFarlane, Zoë Zürn and Margaux Ysebaert.

We are thankful to Agroecology Europe, Bioversity International, BirdLife Europe, Cambridge Institute for Sustainability Leadership, the Sustainable Food Trust, Capitals Coalition, CDC Biodiversité, Cool Farm Alliance, Copa-Cogeca, the European Council of Young Farmers, European Landowners' Organization, Foundation Earth, the Institute for European Environmental Policy, PBL Netherlands Environmental Assessment Agency, Plansup, UK Natural History Museum, UN Environment Programme Statistics Division, Wageningen University, World Agroforestry, the World Conservation Monitoring Centre, the WWF European Policy Office and the Zoological Society of London for their cooperation in the preparation of this report.

We would like to extend our gratitude to our peer reviewers, Jabier Ruiz Mirazo and Niall Curley, whose valuable expertise and guidance have been instrumental in shaping our work and supporting us throughout this endeavor.

Acronyms

BII	Biodiversity Intactness Index
CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
CEJA	*Conseil européen des jeunes agriculteurs* (European Council of Young Farmers)
CGIAR	Consultative Group on International Agricultural Research
CORINE	Coordination of information on the environment
DEFRA	Department for Environment, Food and Rural Affairs
EC	European Commission
EIONET	European Environment Information and Observation Network
ELO	European Landowners' Organization
EU	European Union
FADN	Farm Accountancy Data Network
FAO	Food and Agriculture Organization of the United Nations
FAO	Food and Agriculture Organization of the United Nations
FSDN	Farm Sustainability Data Network
GBF	Global Biodiversity Framework
GBS	Global Biodiversity Score
GEO BON	Group on Earth Observations Biodiversity Observation Network
GHG	Greenhouse Gas
GLOBIO	Global Biodiversity model for policy support
IACS	Integrated Administration and Control System
IBAT	Integrated Biodiversity Assessment Tool
IEEP	The Institute for European Environmental Policy
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IUCN	International Union for Conservation of Nature
JRC	Joint Research Centre of the European Commission
LCA	Life Cycle Assessment
LUCAS	Land Use and Coverage Area frame Survey
MAES	Mapping and Assessment of Ecosystems and their Services
MSA	Mean Species Abundance
NGO	Non-governmental organization
OASIS	Original Agroecological Survey Indicator System
PBL	Netherlands Environmental Assessment Agency
PMEF	Performance Monitoring and Evaluation Framework
SDGs	Sustainable Development Goals
SEEA	System of Environmental-Economic Accounting
STAR	Species Threat Abatement and Restoration
TNFD	Taskforce on Nature-related Financial Disclosures
UAA	Utilised Agricultural Area
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme

1. Introduction

Food is one of the basic needs for human life. Access to food is recognised as a human right (UN, 1948), and ending hunger and ensuring food security is one of the Sustainable Development Goals (SDGs) for 2030 (UN, 2016). However, our current global food systems, and especially agriculture, are the main single cause of biodiversity loss in terrestrial ecosystems and the driver of 80% of deforestation and 70% of freshwater use (UNCCD, 2022; Dudley & Alexander, 2017). In the past decades, the use of land and resources for agricultural activity has had a severe impact on ecosystems (IPBES, 2019), causing habitat and biodiversity loss, especially due to intensive agricultural practices, such as using pesticides and fertilisers, and the homogenisation of crops (Benton et al., 2021).

At the same time, biodiversity is the base of agricultural systems, ensuring nutrient recycling and crop pollination, helping soils to filter and store water, improving the resistance of agroecosystems to pests, and helping to adapt to climate change. In the EU, almost 40% of land is farmed (Eurostat, 2022a), mostly under conventional farming practices that threaten habitats and species (EEA, 2020a), including the ones agriculture relies on. For example, almost 1 out of 10 bees are threatened with extinction in Europe, mainly due to intensive agriculture (Nieto et al., 2014). The transition to sustainable agriculture is therefore imperative to ensure food security for future generations and certainly also to protect biodiversity.

Efforts to reconcile biodiversity conservation and food production are ongoing at the international and EU levels, with targets to manage agricultural areas sustainably, halt nutrient loss, or reduce the use of pesticides (CBD, 2022a; EC, 2020a; EC, 2020b). The last UN Food Systems Summit, in 2021, highlighted the link between environment and agriculture, and established "boost Nature-based Solutions of production" as one of its key commitment actions (UNFSS, 2021). Furthermore, the recently adopted Kunming-Montreal Global Biodiversity Framework (GBF) includes targets on the sustainable management of agricultural areas, and on the reduction of nutrient loss and pesticide use. In the EU, the European Green Deal, adopted in 2019, sets an objective to transform agriculture, and the EU food system more generally, through the Farm to Fork Strategy and the Common Agricultural Policy (CAP) (EC, 2019).

These policy efforts to halt biodiversity loss caused by agriculture and to boost biodiversity in agricultural land need suitable monitoring frameworks to assess progress towards their targets. To respond to this need, several methods have been developed, some of which are described in this report. Information on the status of biodiversity in relation to agriculture can help policy-makers with policy design, and even more, they can help reach those targets by supporting farmers to make decisions on their practices.

Knowledge on the status of biodiversity and its links thereof to human activities – namely, the impacts and dependencies between agricultural practices and biodiversity – is key to understanding how these policies are implemented and to building a biodiversity-friendly future. However, assessing biodiversity in relation to agriculture is not a simple task.

Biodiversity is a complex concept that encompasses multiple layers and elements. The Convention on Biological Diversity (CBD) defined biodiversity in 1992 as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (CBD, 2022a). According to this definition, it would seem logical that assessing biodiversity entails understanding the status of all its components: diversity within species, between species and between ecosystems.

To assess species diversity at a spatial scale, the 'alpha-beta-gamma' components framework (Whittaker, 1972) suggests a description at three scales: within locations (i.e. alpha diversity), between locations (i.e. beta diversity) and over the entire extent (i.e. gamma diversity) (Gavish et al., 2019).

Beyond this, to fully understand the health of an ecosystem, other factors can be considered, such as functional diversity (biodiversity elements that influence the functioning of ecosystems) (Tilman, 2001), endemic species (species native and restricted to a specific geographical area) (EEA, 2020b) or invasive species (species introduced by humans into areas outside their natural range, causing negative effects on the environment, the economy and human well-being) (IUCN, n.d.-a). Understanding the status of biodiversity in addition to the links to human activities requires an even more complex analysis.

This complexity in biodiversity assessment might be the reason why multiple methods (sets of indicators, metrics, frameworks, etc.) have been developed that focus on different aspects of biodiversity (such as composition, structure or functionality) (OECD, 2021) and on different levels (such as genes, species or ecosystems) (Walters & Scholes, 2017). The International Union for Conservation of Nature (IUCN) report *Approaches to sustainable agriculture* (Oberč & Arroyo Schnell, 2020), which highlights the many sustainable approaches and associated practices that exist, identified that one of the challenges for the mainstreaming of sustainable agriculture was the lack of common metrics to assess the benefits of such approaches or practices. Similarly, a recent report from the RISE Foundation pointed to the lack of agreed-on metrics as a key challenge to promoting sustainable agricultural soil management in the EU (Buckwell et al., 2022). Recent research by Vanham et al. (2023) also highlighted the need for a consistent methodology to monitor the land and water footprint goals of the EU Farm to Fork Strategy.

This report aims to provide an overview of different ways in which the links between biodiversity and agriculture are being assessed, highlighting commonalities and differences, and proposing some ideas on how the assessment of the progress towards biodiversity policy targets at the international and EU levels can be further improved. The target audience for this report encompasses a diverse range of stakeholders, including the agricultural sector, environmental organisations and decision makers. The data presented in the report are expected to be used by such actors to help in defining effective policies, by farmers and land managers in making informed decisions about their agricultural practices, by companies in optimising their operations in line with sustainability goals and by academics in conducting further research and analysis.

For the development of this report, a non-exhaustive review of biodiversity assessment methods was carried out. Twelve international assessment methods were selected, based on their relevance for assessing biodiversity, agriculture and policy, their potential users (mainly farmers, businesses and policy-makers) and the uptake of each method.

The selected list of methods was created with the aim of showing a diverse range of approaches, purposes and users. At the EU level, the monitoring and evaluation systems of four key EU policies, namely the CAP, the Biodiversity Strategy for 2030, the EU Nature Restoration Regulation, and the Birds and Habitats Directives, were analysed. The following environmental and agricultural stakeholders and researchers were consulted in this process: BirdLife Europe, the European Council of Young Farmers, Copa-Cogeca, European Landowners' Organization, Foundation Earth, the Institute for European

Environmental Policy, Wageningen University and Research and the WWF European Policy Office. These discussions have been useful for gathering information on the various methods and on the needs, possibilities and challenges of assessing biodiversity in relation to agriculture in the EU.

The report is structured into four chapters. Following the introduction, the second chapter provides an overview of 12 methods for assessing the biodiversity-agriculture nexus. The third chapter briefly discusses international policies that support biodiversity, as a prelude to zooming in on the EU and exploring how some key EU policies assess the links between biodiversity and agriculture. Finally, the fourth chapter provides some general conclusions about the issue of biodiversity assessment in the context of agricultural activity and makes specific conclusions with particular relevance to the EU.

2. Key methods for analysing the biodiversity-agriculture nexus

Globally, multiple methods are used to assess biodiversity, many of them also relevant for assessing the condition of biodiversity in relation to agricultural activity. These methods may have different characteristics; for example, in relation to their focus, methodology or implementation.

This chapter shows the variety and characteristics of different assessment methods by focusing on a few chosen examples. For this purpose, a literature review of the existing biodiversity assessment methods was conducted. Also importantly, many discussions were held with environmental, agricultural and academic stakeholders (as mentioned in Chapter 1) while this report was developed, which helped enormously to further identify and better understand the selected assessment methods.

The literature review was non-exhaustive, focusing on existing expertise on the topic of international organisations active in the fields of environmental assessment and agriculture. Through this initial review, over 30 sustainability assessment tools were identified, with different characteristics that can be useful for assessing biodiversity in agricultural land. From this long list, the detailed analysis was narrowed to 12 methods, selected for their specific focus on both agriculture and biodiversity, and for their more prominent presence in some key biodiversity policy debates.

This chapter describes the 12 biodiversity assessment methods that were selected. These methods are quite different regarding their scope, target user groups and other criteria (see Figure 1). Some methods have been developed specifically for agriculture and others more generally for biodiversity; some of them aim to reach businesses, investors and/or farmers; others have been developed specifically to assess progress towards global biodiversity targets. Firstly, the methods that specifically focus on agriculture are described, and later the scope is broadened to more general biodiversity assessment tools, which also can assess these tools' links to agriculture. While the methods in Subsection 2.1 are very appropriate for assessing the sustainability of agriculture, not all are designed to assess biodiversity specifically. On the other hand, the methods in Subsection 2.2 focus on the assessment of biodiversity but do not have a specific focus on agriculture; rather, their focus is on human activity, which includes agriculture.

For each assessment method, a description of its origin and purpose, its potential or target users, its methodology and some basic characteristics of its implementation are provided.

As mentioned in Chapter 1, many other methods exist that might have some potential to assess the links between biodiversity and agriculture – to a certain extent, at different levels and in some cases. For example, this is the case for the Living Planet Index developed by WWF, which assesses the status of species (Westveer et al., 2022; WWF & ZSL, n.d.), and for the Species Habitats Index, which assesses the status of habitats (GEO BON, n.d.-a). Both methods are included as indicators in the GBF. Another example is the UN System of Environmental-Economic Accounting central framework, adopted by the United Nations Statistical Commission (UN et al., 2017), which aims to standardise international environmental-economic accounting (UN, n.d.).

Several methods presented in Subsection 2.2 calculate the impact on biodiversity using mean species abundance (MSA). MSA provides information about the average population decline compared to a bioregion-based reference level. This allows for rapid assessment that can suit companies aiming to assess the impact of their activities throughout their value chain. However, as highlighted in the recent publication *Bottom-up global biodiversity metrics needed for businesses to assess and manage their impact* (Hawkins et al., 2023), the scoring system of MSA does not reflect the bioregion's global biodiversity significance or the spatial distribution of the species population decline. It is also important to consider that models based on MSA face a representation challenge due to the use of extrapolated data.

Figure 1 shows an attempt to organise the relationship between the methods analysed.

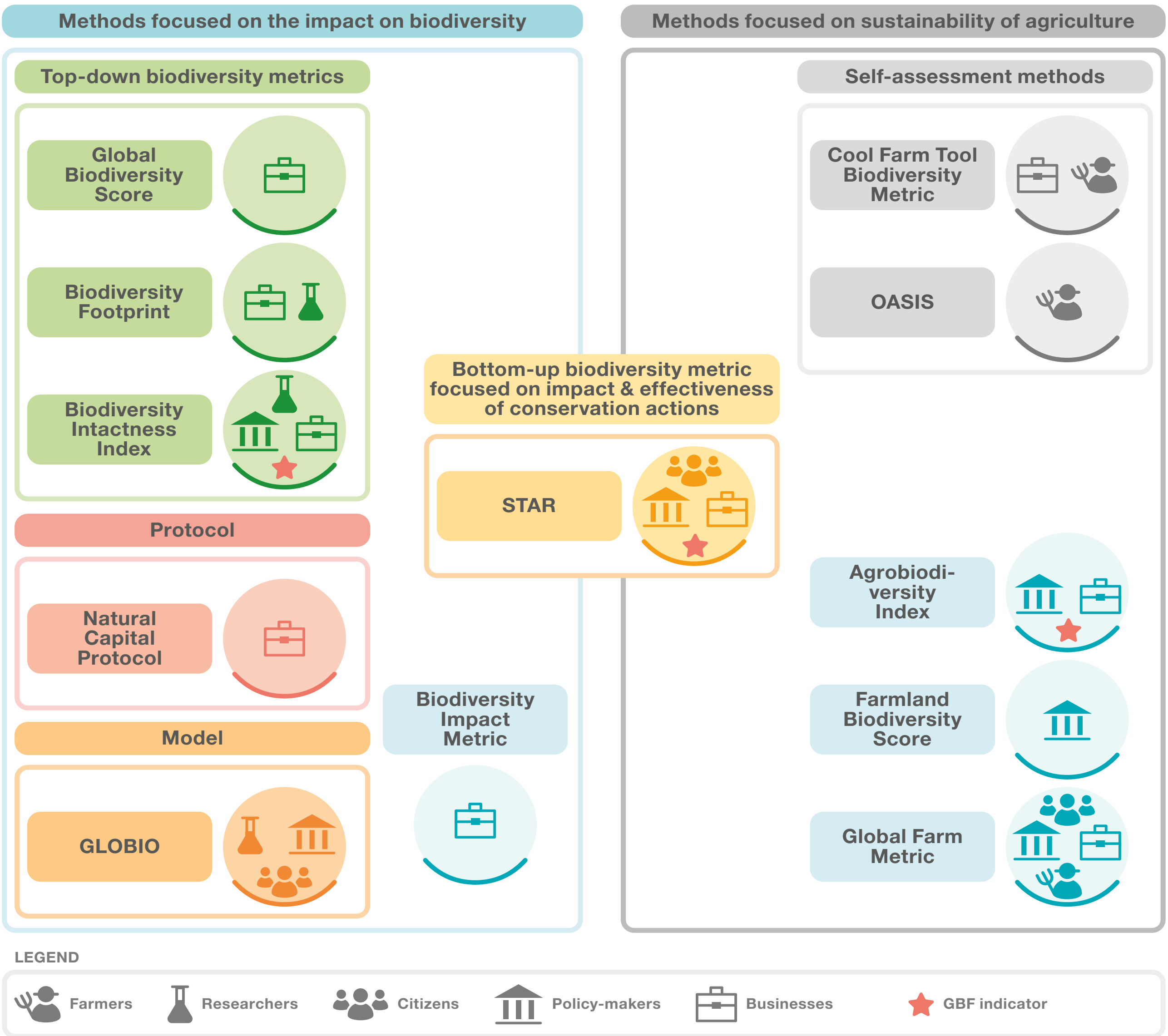

Figure 1. Overview of the methods described in this section. (Prepared by the report authors)

2.1. Methods that focus on the agriculture-biodiversity nexus

The methods described below have been designed to assess the links between agriculture and the environment, including biodiversity, to different extents. The first three methods, Agrobiodiversity Index, Cool Farm Tool – Biodiversity Metric and Farmland Biodiversity Score, focus more specifically on biodiversity. The last two methods, the Global Farm Metric and the Original Agroecological Survey Indicator System (OASIS), are designed to assess various environmental aspects related to agricultural activity more generally.

Agrobiodiversity Index

Origin and purpose

The Agrobiodiversity Index is a framework and methodology for monitoring the conservation and use of agrobiodiversity[1] in food systems. It was developed by Bioversity International with the aim of contributing to the transition to sustainable food systems by filling the knowledge gap in relation to agrobiodiversity and encouraging stakeholders (mainly governments, companies and international initiatives) to improve the management of agrobiodiversity (Bioversity International & CIAT, n.d.-a).

The European Commission, the Consultative Group on International Agricultural Research and the Italian Agency for Development Cooperation support the Agrobiodiversity Index through funding. Furthermore, the index has several partners, including corporations (Syngenta, Nestlé and Sainsbury's), governments (Ethiopia, India, Italy and Peru) and investors (Clarmondial AG) (Bioversity International & CIAT, n.d.-b).

Target users

The Agrobiodiversity Index has been designed to help governments (countries), businesses (companies) and projects with risk and resilience assessment, intervention planning, global policy alignment, ranking and benchmarking, and leveraging investment in sustainable food systems (Bioversity International & CIAT, n.d.-a).

Methodology

The Agrobiodiversity Index measures agrobiodiversity according to three pillars: consumption and markets, sustainable production and genetic resource conservation. It establishes a monitoring framework with 22 indicators which seek to assess the state of agrobiodiversity, but also includes actions and commitments (for example, the contributions of strategies, policies and codes of conduct) towards increasing agrobiodiversity. Examples of the indicators under the three categories are (Bioversity International, 2018):

- Status indicators, such as 'species diversity' or 'pollinator diversity';
- Action indicators, such as 'production management practices supporting the use and conservation of agrobiodiversity' or 'genetic resource management practices supporting the use and conservation of agrobiodiversity';
- Commitment indicators, such as 'level of commitment to enhancing production and maintenance of agrobiodiversity for sustainable agriculture'.

Data from the status indicators can be aggregated to create scores for agrobiodiversity according to user-defined thresholds. Thresholds have been set according to scientific or physical

1 Bioversity International defines agrobiodiversity as "the diversity of plants, animals and micro-organisms that support our food and agricultural systems. It includes crops, livestock, fish, and fungi, as well as organisms that provide pollination, nutrient cycling, pest control and other agroecological functions. It is a component of biodiversity that plays a central role in providing humans with adequate nutrition. Agrobiodiversity can be measured in terms of varietal, species, functional and ecosystem diversity and field, farm, landscape and whole food system levels. Enhancing the diversity of plants, animals and micro-organisms across these levels helps create productive and resilient agricultural systems that support biodiversity conservation and healthy human diets, now and in the future."

limits when identified, or by the limits of the best-performing country.

Implementation

The Agrobiodiversity Index is listed as one of the indicators of the Kunming-Montreal GBF. It is suggested as a complementary indicator to assess the progress towards Target 10 of the GBF, which aims to ensure the sustainable management of agricultural areas, among other objectives (CBD, 2022a; CBD, 2022b).

Moreover, about 20 countries worldwide have used the Agrobiodiversity Index methodology. In the EU, it has been tested in France, Italy and Spain (Jones et al., 2022).

Cool Farm Tool – Biodiversity Metric

Origin and purpose

The Cool Farm Tool is a sustainability self-assessment tool for farmers. It was originally developed in 2008 with the aim of calculating carbon footprint by the University of Aberdeen, Unilever and the Sustainable Food Lab (Cool Farm, n.d.-a), in collaboration with several stakeholders, such as the University of Edinburgh, the Consultative Group on International Agricultural Research, the London School of Hygiene and Tropical Medicine, Forest Research, the James Hutton Institute, the Sustainable Food Lab, Cool Farm Alliance, and Yara (University of Aberdeen, n.d.). Since 2014, the Cool Farm Tool has been owned and managed by the Cool Farm Alliance (University of Aberdeen, n.d.) and is being used to help members of the alliance to frame and implement their sustainability programmes (Cool Farm, 2020). The Cool Farm Alliance currently has 150 members, including companies (e.g. Bayer, Nestlé, Danone, Syngenta, MacDonalds, PepsiCo, Kellogg's, Heineken), non-governmental organisations (NGOs) (e.g. Rainforest Alliance and Fairtrade) and consultancies (e.g. Sustainable Food Lab) (Cool Farm, n.d.-a). The Cool Farm Tool allows for measuring not only greenhouse gases, but also water and biodiversity (Cool Farm, n.d.-b).

The Cool Farm Biodiversity Metric is a specific part of the Cool Farm Tool, which focuses specifically on biodiversity and enables farmers to score their on-farm practices based on impact (Cool Farm, n.d.-c).

Target users

The Cool Farm Tool has been developed to help farmers and businesses assess their impact.

Methodology

The Cool Farm Tool - Biodiversity Metric calculates scores based on the number of positive actions for biodiversity on farms. Farmers answer a questionnaire about their management practices using their own data, and questions are adapted to different biomes: there are 30 questions for Mediterranean/semi-arid biomes and 29 for temperate biomes.

This self-assessment exercise aims to help farmers understand their performance and share their results with others (Cool Farm, 2016). Verification by a third party can be requested (Cool Farm Alliance, 2021a).

Implementation

The Cool Farm Tool is being applied worldwide; so far, it has been used in 150 countries, mainly to assess greenhouse gas emissions. For example, Heineken has used it to visualise farmer and/or supplier farming and harvesting data and to measure its impact by comparing the carbon emission to conventional crops (Cool Farm Alliance, 2022), Kellogg's UK has used it to estimate the impact that potential farm management practices would have on emissions and performance (Cool Farm Alliance, 2021b), and Costco Wholesale has used it to assess the emissions of its organic egg suppliers (Vetter et al., 2018).

Farmland Biodiversity Score

Origin and purpose

The Farmland Biodiversity Score is a farm biodiversity assessment method developed by World Agroforestry to respond to the lack of systematic data on biodiversity on agricultural land. It aims to help planners and decision makers monitor agricultural land, report on biodiversity and plan conservation strategies, and ultimately contribute to the monitoring of global targets (Harrison et al., 2021), such as Target 10 of the Kunming-Montreal GBF (CBD, 2022a).

Target users

The Farmland Biodiversity Score targets policy-makers (planners and decision makers).

Methodology

The Farmland Biodiversity Score is an indicator of the biodiversity value of agricultural landscapes based on the presence of trees on farms. It is based on remote sensing: satellite data are used to estimate the quantity, diversity and spectral diversity (variability of electromagnetic radiation reflected from plants (Rossi et al., 2021)) of woody vegetation on farms. The final results of this estimation are qualitatively validated and translated into scores for each landscape. The outputs can be mapped at a national scale (Harrison et al., 2021).

Implementation

This assessment method has been tested in Uganda, Rwanda, Honduras and West Kalimantan (Indonesia). All the case studies had a high proportion of agricultural land with a high number of trees. The case studies were helpful in proving the suitability of this method for estimating farm biodiversity and in identifying the remaining challenges, mainly the need for validation through other datasets at the national and sub-national levels (Harrison et al., 2021).

Global Farm Metric

Origin and purpose

The Global Farm Metric was developed by the Sustainable Food Trust, with the purpose of homogenising the field of farm sustainability assessment (Sustainable Food Trust, 2021). It aims to facilitate the creation of and access to knowledge about the environmental performance of farms (Global Farm Metric, 2022).

Target users

The Global Farm Metric aims to help farmers, governments, companies and citizens understand the environmental performance of farms.

Methodology

The Global Farm Metric proposes a framework to be used as a common baseline for sustainability assessment at the farm level. It has been designed to assess the environmental, social and economic aspects of farming through 12 relevant categories and corresponding sub-categories and outcomes-based indicators (Global Farm Metric, 2023).

The categories that focus on the environment are nature, climate, water, soil and nutrients. The nature category specifically looks at biodiversity. Its three sub-categories are farm biodiversity; farm habitats; and air, soil and water quality. Some indicators specifically assess biodiversity; for example, the indicators for farm biodiversity, which include ‘indicator species for habitat quality’ and ‘species richness’, or the indicators for farm habitats, such as ‘area of habitats (including productive habitats)’ (Global Farm Metric, 2023).

To avoid overburdening farmers, the Global Farm Metric aims to use already available farm data and to collect additional data only when needed. Data can be aggregated to track change at a local, national or international scale. To ensure that the data collected are useful, the framework is regularly verified by researchers and farmers (Global Farm Metric, 2022). The framework was most recently updated in 2022 through a collaboration with farmers and as informed by farm-level trials, research and expert consultation (Global Farm Metric, 2023).

Implementation

The Global Farm Metric has been tested on farms in the UK and internationally – in the United States of America (USA), Malawi and Australia. Several companies, governments and research institutions have been involved in the tests, such as the supermarket chain Morrisons, the food chain assurance scheme Red Tractor, the banking and insurance holding company NatWest Group, the UK's Department for Environment, Food and Rural Affairs (DEFRA) and the Welsh and Scottish governments (Global Farm Metric, 2022).

The Global Farm Metric has been tested as a potential assessment framework for agri-environmental policies in the UK, specifically for DEFRA's environmental land management scheme. The test allowed farmers to provide feedback to refine the categories of sustainability that are included in the metric (Global Farm Metric, n.d.).

The Sustainable Food Trust and Global Farm Metric teams are partners of Regen10, a multi-stakeholder platform co-founded by IUCN that aims to help to transition to a sustainable food system globally during the next decade. The Regen10 action areas include establishing harmonised definitions, outcomes and metrics (WBCSD, 2021). Insights from the Global Farm Metric have been used to create a global framework that is currently being tested in the USA and Malawi (Global Farm Metric, 2023).

Original Agroecological Survey Indicator System

Origin and purpose

The OASIS framework was developed by Agroecology Europe to help assess the agroecological transition by farmers or land managers at the farm level. The framework was created with the aim of upscaling agroecology by identifying a common definition for agroecology, farm assessment and agroecological transition (Peeters et al., 2021).

Target users

OASIS aims to help farmers and land managers assess their progress to transition towards agroecology.

Methodology

The framework is structured according to different dimensions, themes, criteria and indicators. The dimensions, such as 'farming practices' or 'environment and biodiversity', have corresponding criteria which follow agroecological principles, such as 'maximisation of soil cover'. Some criteria have related indicators to measure the level of implementation of practices or techniques on the farm. For the final assessment result, criteria are evaluated in a semi-quantitative way. Data are collected via interviews and transect walks ('method for describing and showing the location and distribution of resources, features, landscape, main land uses along a given transect') (Fauna & Flora 2013). The framework considers different classifications of biodiversity: agrobiodiversity, functional biodiversity and heritage biodiversity (Peeters et al., 2021).

Implementation

An example of the implementation of the OASIS framework is the assessment of a farm's transition to agroecology in the region of Wallonia, in Belgium, by the association Terres Vivantes. The progress of the transition from running a conventional farm to implementing agroecological practices, such as reducing synthetic pesticides or establishing soil cover and herbaceous strips, was assessed through OASIS (Agroecology Europe, 2022).

Box 1. The land health monitoring framework

IUCN recently developed a monitoring framework to assess biodiversity on agricultural land called the land health monitoring framework. The framework (as shown in Figure 2) indicates that measuring biodiversity should be performed at four levels: soil, farm, landscape and national/global. Each level includes biodiversity indicators that cover three dimensions: genetic, species (with a focus on functional agrobiodiversity) and ecosystem (Dussán, 2023).

The framework suggests combining direct indicators, such as species diversity and abundance of species, with indirect indicators, such as land cover. This would allow assessing the links between land management practice and policies, and biodiversity. Data availability is highlighted as a key factor in the selection of indicators, which results in trade-offs between data coverage and quality, an important issue to consider when assessing agrobiodiversity (Dussán, 2023).

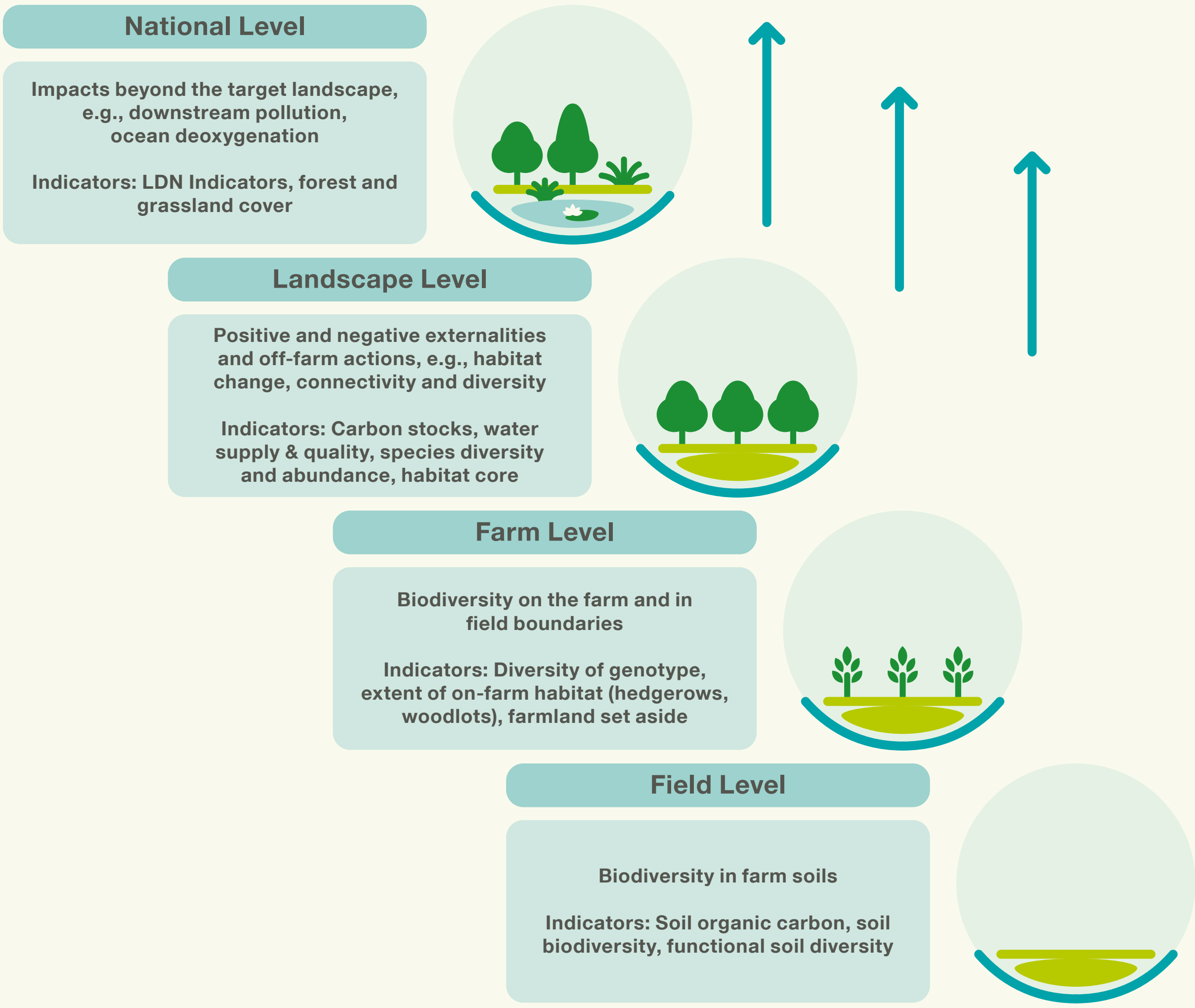

Figure 2. IUCN land health monitoring framework (Dussán, 2023)

2.2. Methods that focus on biodiversity

The methods included in this section focus on assessing the impacts of human activity, including agriculture, on biodiversity. Firstly, this section describes two methods that aim to generally assess the impact of human activity on biodiversity and target several stakeholders: (i) global biodiversity model for policy support (GLOBIO) and (ii) the Biodiversity Intactness Index. Afterwards, methods to specifically assess the impact of businesses are listed: the Global Biodiversity Score (GBS), the Natural Capital Protocol, the Biodiversity Impact Metric and the Biodiversity Footprint. Finally, a more comprehensive metric that assesses not only the impact of human activity on biodiversity, but also the potential of restoration measures, is described: the Species Threat Abatement and Restoration (STAR) metric.

Global biodiversity model for policy support – GLOBIO

Origin and purpose

GLOBIO is a global biodiversity model initially developed by the UN Environment Programme, World Conservation Monitoring Centre, United Nations Environment Programme GRID-Arendal and PBL Netherlands Environmental Assessment Agency. Currently it is maintained and being further developed by PBL Netherlands Environmental Assessment Agency. The model's objective is to support broad-scale, biodiversity-relevant policy by assessing the past, current and future impacts of human activity on biodiversity and ecosystem services; production- and consumption-based biodiversity impacts (footprints); and the effectiveness of possible biodiversity conservation strategies (GloBio, n.d.-a).

The first version of GLOBIO assessed the potential impact of infrastructure, as a proxy of human environmental pressure overall, on terrestrial biodiversity. Later, GLOBIO was further developed to include additional human pressures and to be a quantitative indicator of biodiversity intactness: the MSA indicator[2] (Alkemade et al., 2009). Further versions of the model have been developed since (Schipper et al., 2019), as well as extensions that focus on other dimensions of biodiversity or nature, such as ecosystem services, freshwater ecosystems or species distributions (GloBio, n.d.-b).

Target users

Potential users of GLOBIO are researchers, general public and policy-makers. The direct users of GLOBIO are mainly researchers, but the results and insights derived from the use of the model are also used by the general public and policy-makers. Furthermore, the assessment methodologies based on GLOBIO are also used by researchers and consultants.

Methodology

GLOBIO calculates terrestrial biodiversity intactness related to several human pressures: land use, road disturbance, habitat fragmentation (due to both land use and roads), hunting in tropical regions, atmospheric nitrogen deposition and climate change. The biodiversity impacts – expressed in MSA indicator values – and the contributions of the different pressures to these impacts are quantified as maps and as regional, national or global averages (GloBio, n.d.-a; GloBio, 2016).

Implementation

This assessment method has been used in several global environmental reports, such as the *Global Biodiversity Outlook of the Convention on Biological Diversity*, the *Global Environmental Outlook of UNEP* and the Global Assessment Report of the Intergovernmental Science-Policy

2 MSA is a metric that indicates local biodiversity intactness on a range from 1, or 100% (fully intact), to 0, or 0% (locally extinct), considering the influence of pressures compared to the undisturbed situation. It looks at the pressure–impact relationships that are relevant to agriculture, forestry and other land use activities (FAO, 2021; GloBio, n.d.-a).

Platform on Biodiversity and Ecosystem Services (IPBES) (GloBio, n.d.-b).

Biodiversity Intactness Index

Origin and purpose

The Biodiversity Intactness Index (BII), originally proposed in 2005 (Scholes & Biggs, 2005) and included as one of two biodiversity metrics in the planetary boundaries framework (Steffen et al., 2015), is produced by the PREDICTS (Projecting Responses of Ecological Diversity In Changing Terrestrial Systems) project, a collaboration led by the Natural History Museum, London, UK (Hudson et al., 2014). In 2012, the PREDICTS project started collecting data on local biodiversity, with the aim of contributing to assessing biodiversity status and, specifically, the progress towards global biodiversity targets such as the CBD's 2010 target or the Aichi biodiversity targets (Hudson et al., 2016). These data were used as a baseline to calculate the BII (Natural History Museum, 2021), which estimates how local terrestrial biodiversity responds to human pressures, such as land use change and intensification, and is meaningful at any scale, from local to global (Natural History Museum, 2021).

Target users

The BII can be useful for scientists, policy-makers, businesses (commercial enterprise, financial institutions) and NGOs.

Methodology

The index is calculated using two statistical models that estimate species abundance (number of individuals) and compositional integrity (similar to the species abundance distribution of a minimally impacted site). Published papers using the BII have analysed the impacts of land use, land use intensity, human population density and road density (Newbold et al., 2016; De Palma et al., 2021). Manuscripts in progress are also considering the landscape-scale context, landscape history and quantitative measures of other drivers, including climate change (Outhwaite et al., 2022) and pollutants. These mixed-effects models are fitted to a published database of peer-reviewed primary biodiversity data (available in two datasets) (Natural History Museum, n.d.). At the time of publication of this report, the database covered a taxonomically representative set of nearly 58,000 invertebrate, vertebrate, plant, and fungal species from over 48,000 sites representing all major terrestrial ecosystems, across 102 countries. The statistical models are then combined with geospatial data on these same pressures to make spatial projections across the region of interest (or the whole world); if the pressure data are available as either historical or projected future time series, the BII can also be projected through time. The temporal and spatial resolution of the projections is set by the resolution of the pressure data.

Implementation

The BII is listed as a core indicator by IPBES. The index provided evidence that was used in four chapters of the 2019 IPBES global assessment (IPBES, n.d.), it was endorsed by the Group on Earth Observations Biodiversity Observation Network (GEO BON, n.d.-b), and it is listed as a complementary indicator to assess Goal A[3] of the GBF (CBD, 2022b). The BII can also be used to model outcomes given a set of inputs, or to optimise inputs for the best biodiversity outcomes. This characteristic meant that the BII played a key role in the influential 'bending the curve' paper (Leclère et al., 2020) by preventing integrated assessment models from projecting land use changes that damaged biodiversity. More recently, in June 2022, McKinsey and the UK Natural History Museum used the BII in the first published application of the 'locate,

3 Goal A of the Kunming-Montreal GBF: "The integrity, connectivity and resilience of all ecosystems are maintained, enhanced, or restored, substantially increasing the area of natural ecosystems by 2050; Human induced extinction of known threatened species is halted, and, by 2050, the extinction rate and risk of all species are reduced tenfold and the abundance of native wild species is increased to healthy and resilient levels; The genetic diversity within populations of wild and domesticated species, is maintained, safeguarding their adaptive potential."

evaluate, assess, prepare' approach developed by the Taskforce on Nature-related Financial Disclosures[4] (McKinsey & FSD Africa, 2022). The approach evaluates the nature-related risks and opportunities of investment in African countries and companies. In a second pilot study by the taskforce, Ernst and Young, global investment company 'abrdn' (abrdn, n.d.) and the UK Natural History Museum combined the BII with Ernst and Young's insights on the data and reporting required to align those insights to the taskforce's beta framework (TNFD, 2023). The intention of this was to measure the potential biodiversity gain for one or more of abrdn's real asset investments. This second pilot study showed that interventions planned by abrdn for land in the Cairngorms National Park (Scotland, UK) could return biodiversity to 94% over 75 years from its current state of 52% (abrdn, 2022).

Using the BII data and working closely with the UK National History Museum scientists, ecological artist Thijs Biersteker created a 5-metre-tall robotic plant, a moving monument to the importance of the choices we are making now for the future of our planet. 'Econario' took up residence in the main conference centre of COP 15 of the Convention on Biological Diversity in Montreal, Canada, providing a powerful representation of how decisions made at the conference each day would impact nature for future generations (Natural History Museum, 2022).

Global Biodiversity Score

Origin and purpose

The Global Biodiversity Score (GBS) was developed by the private environmental organisation CDC Biodiversité in response to the need for a tool for businesses to combine qualitative and quantitative assessment, one that focuses on biodiversity conservation in addition to ecosystem services. It was developed in collaboration with businesses and financial institutions, academics, NGOs and other corporate biodiversity footprint initiatives. The GBS aims to provide an aggregate indicator of the biodiversity footprint of a business at a global scale (CDC Biodiversité, 2021a).

Target users

The GBS aims to help businesses.

Methodology

The GBS links data on economic activities to terrestrial and aquatic biodiversity pressures, including land use, fragmentation of natural ecosystems, human encroachment, infrastructure, atmospheric nitrogen deposition, climate change, hydrological disturbance due to direct water use and due to climate change, wetland conversion, freshwater eutrophication, land use in catchment of rivers and wetlands, and ecotoxicity. These pressures are translated into direct operations and upstream (and when data are available, downstream) impacts. Results are expressed in MSA·km^2 (MSA multiplied by km^2). The GBS uses tools such as EXIOBASE (Exiobase, n.d.) and GLOBIO, as well as in-house tools developed by CDC Biodiversité (CDC Biodiversité, 2021a).

Implementation

This method has been applied to assess the biodiversity footprint of more than 40 companies in the following range of industries (CDC Biodiversité, 2022):

- non-financial services and other activities
- energy (production and supply of electricity)
- agriculture and agri-food
- distribution
- construction
- electrical and electronic equipment
- manufacturing
- transportation
- raw materials extraction
- chemicals
- processing.

4 The Taskforce on Nature-related Financial Disclosures is composed of financial institutions, corporations and market service providers that aim to improve the knowledge about dependencies between economic activity and nature.

Regarding agriculture and food, a benchmark fact sheet was developed for the GBS, that informs companies or investors of the sector's impact average. This can be useful for companies to compare their own results to the sector context and to estimate their own impact (CDC Biodiversité, 2021b). The fact sheet might also be useful in providing potential future criteria for agriculture under the EU taxonomy for sustainable activities (EC, n.d.-a). Specifically, it could provide information about thresholds (based on MSA) and 'do no significant harm' criteria (CDC Biodiversité, 2021a).

Natural Capital Protocol

Origin and purpose

The Natural Capital Protocol was developed by the Capitals Coalition to standardise the assessment of business impacts and dependencies on natural capital. It aims to help businesses identify, measure and value their impacts and dependencies on natural capital (Natural Capital Coalition, 2016a) to inform decision making and the management of business risks and opportunities.

Target users

The Natural Capital Protocol targets businesses and finance[5] (Natural Capital Coalition, 2018).

Methodology

The Natural Capital Protocol is a decision-making framework that guides companies in planning and assessing their impact and dependencies on nature. The framework indicates the stages, steps, questions and actions for companies, focusing on (i) why natural capital should be assessed, (ii) what should be assessed, (iii) how to measure and value and (iv) what actions to take next based on the assessment (Natural Capital Coalition, 2016a). The Natural Capital Protocol has been accompanied by several supplements and sectoral guides (Natural Capital Coalition, n.d.-a) (for forest products, food and beverage, finance, apparel and biodiversity), a user template (Natural Capital Coalition, 2016b), a toolkit (Natural Capital Coalition, n.d.-b), a self-assessment tool for practitioners (Natural Capital Coalition, n.d.-c) and training materials (Natural Capital Coalition, n.d.-d).

Implementation

The Natural Capital Protocol is being applied by an increasing number of businesses and financial organisations across the world. The Capitals Coalition hosts a database with case studies (Natural Capital Coalition, n.d.-e). For example, in Brazil, different organisations have benefited from this assessment framework. Amaggi, a company producing soybeans, used the Natural Capital Protocol to understand their dependencies and impacts on ecosystem services and define a strategy and common commitments with other stakeholders. In the Netherlands, Rabobank used it to implement its deforestation-free policy by selecting companies eligible for credit. Imaflora, an organisation that provides forest and agricultural certification, was able to determine the impacts of farms in ecosystem services by applying the Natural Capital Protocol (Natural Capital Coalition, 2020).

Biodiversity Impact Metric

Origin and purpose

The Biodiversity Impact Metric was developed by the Natural Capital Impact Group of the University of Cambridge Institute for Sustainability Leadership with help from academia and NGOs. It was designed to help businesses determine the potential threats to nature throughout their value chain due to their operations and to help them make informed decisions. Depending on the availability of data, the metric is applicable at the global scale, but also at the farm, sub-regional or country level (CISL, 2020).

5 For a similar framework as the Natural Capital Protocol, see the "Finance Sector Supplement", which aims to inform financial institutions.

Target users

The Biodiversity Impact Metric targets businesses.

Methodology

The metric is calculated by multiplying three variables: land area, proportion of biodiversity lost (using MSA) and biodiversity importance (CISL, 2020)[6]. The result can be expressed as the number of hectares in which there is an impact on biodiversity. It can also be used to calculate the impact per unit of product. The values used to calculate the Biodiversity Impact Metric are based on the MSA indicator (which is calculated by GLOBIO), on the PREDICTS database and on the IUCN habitat-use classification scheme (CISL, 2020).

Implementation

The Biodiversity Impact Metric can be used to develop a strategy to address the environmental impacts of supply chains. It has been tested by Kering, a global luxury group (Biodiversify & CISL, 2020), to assess the impact of their cotton supply chain on biodiversity (CISL, 2020).

Biodiversity Footprint

Origin and purpose

The Biodiversity Footprint was developed by Plansup, in collaboration with Wageningen Environmental Research, with the aim of calculating the actual or potential biodiversity footprint of a company, sector or product. It allows for calculating the impact and effectiveness of biodiversity conservation actions (Plansup, n.d.-a). The methodology differs from life cycle assessment (LCA) methods, with one of the key differences being that the Biodiversity Footprint is site specific, while LCA methods are more regional and do not take into account the actual impacted sites.

Target users

The Biodiversity Footprint aims to help companies and research institutes.

Methodology

This method is based on GLOBIO (Van Rooij & Arets, 2017) and calculates the effects of four pressure factors: land use, greenhouse gas emissions, water use, and nitrogen and phosphorus emissions to water. The Biodiversity Footprint is expressed as MSA of the original species per hectare (MSA/ha) (Plansup, n.d.-b).

Implementation

The Biodiversity Footprint has been tested through several case studies, one of which was the assessment of the Dutch dairy sector. From this case study, it was concluded that the methodology allows the provision of estimation about the potential biodiversity impact (Van Rooij & Arets, 2017). It allows for differentiating between the impacts of intensive and extensive farming types and takes multiple land uses into consideration by economic allocation rules.

Species Threat Abatement and Restoration metric

Origin and purpose

The STAR metric was developed by IUCN in 2021 to help assess the Kunming-Montreal GBF, and specifically to help establish targets for threat reduction (Mair et al., 2021). It allows for calculating the impact and effectiveness of biodiversity conservation actions (Plansup, n.d.-a). It is a standardised and scalable spatial metric for estimating the impact of threats to biodiversity and is based on information from the IUCN Red List of Threatened Species (IUCN Red List, n.d.-a). It measures the potential of a given action to reduce the risk of species extinction at a specific site, of a company footprint, or of

6 based on range rarity, i.e. the size of a species' range – the area in which a species is found during its lifetime. Range rarity combines species richness and range size.

a country. Collaborators from more than 50 organisations contributed to developing this metric, with IUCN in the lead.

STAR can be useful for setting and measuring progress towards achieving local and global targets to reduce global species extinction risk (IUCN, n.d-b). Therefore, STAR helps identify actions – threat abatement and restoration activities – that have the potential to contribute to the conservation of threatened species and supports the establishment of science-based targets for species biodiversity.

Target users

Potential users are national and sub-national governments, cities, civil society, the finance industry, investors and companies. The STAR metric aims to help these stakeholders contribute to conservation and global goals by better planning projects that would bring benefits for threatened species, assess biodiversity risk and align contributions to achieve global targets (IUCN, n.d-b).

Box 2. Life cycle assessment

The European Environment Agency defines LCA as "a process of evaluating the effects that a product has on the environment over the entire period of its life thereby increasing resource-use efficiency and decreasing liabilities." It describes the key elements of LCA as those that "(1) identify and quantify the environmental loads involved; e.g. the energy and raw materials consumed, the emissions and wastes generated; (2) evaluate the potential environmental impacts of these loads; and (3) assess the options available for reducing these environmental impacts."

LCA is an important assessment framework at the international and European levels. The European Commission stated in 2003 that it is the "best framework for assessing the potential environmental impacts of products."

This assessment method is being widely used, both globally and in the EU, to assess a range of environmental issues. However, there has been a low application of LCA to assess biodiversity loss because of methodological limitations. Specifically regarding food systems, it is challenging to use LCA methods to factor in ecosystem services, such as the provision of soil health or pollination. It is therefore important that the green claims substantiation mechanisms take these limitations into account.

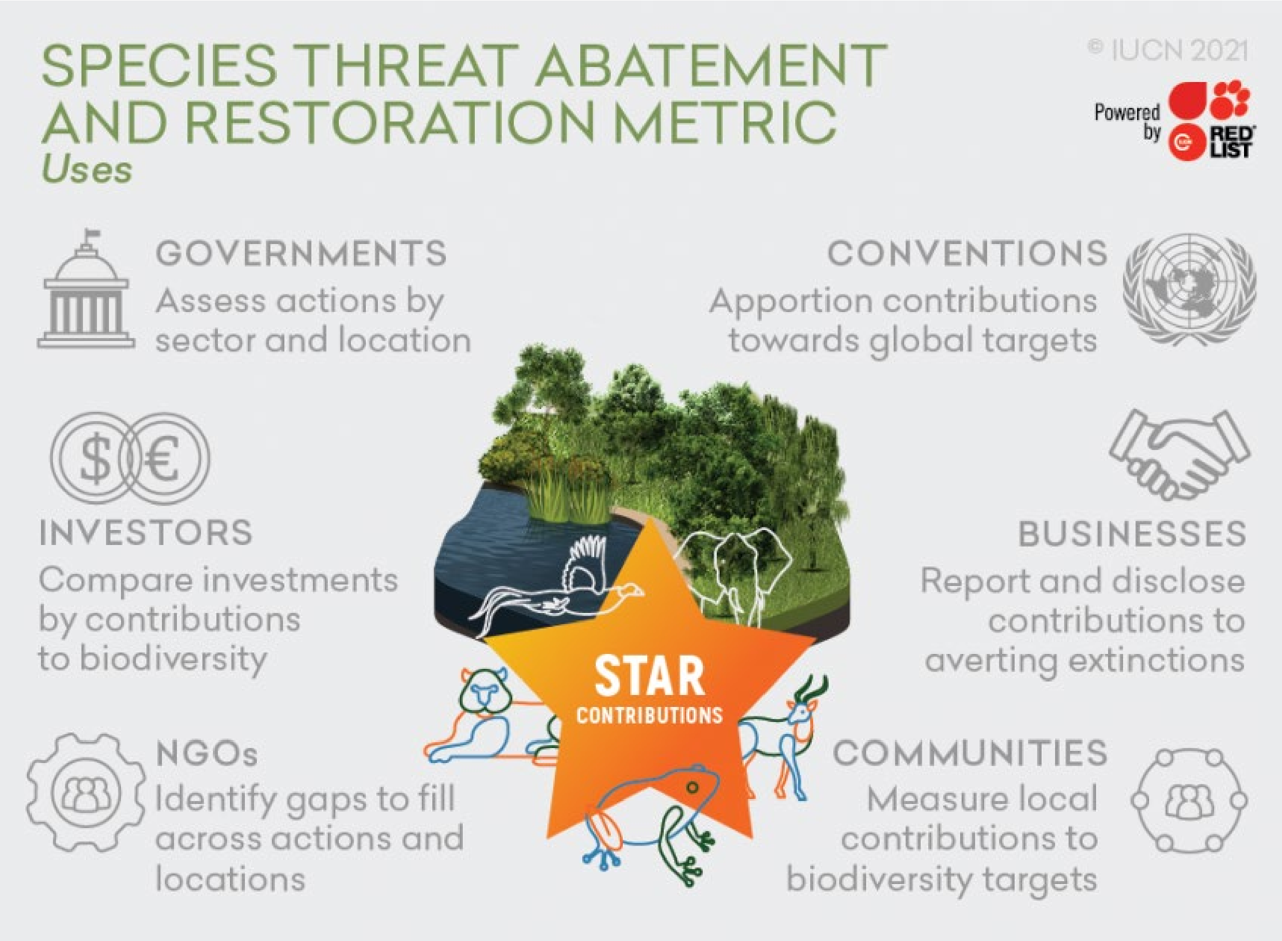

Figure 3. Uses for STAR (© IUCN 2021)

Methodology

The STAR metric calculates the potential contribution of two kinds of actions to reduce species extinction risk: threat abatement (STAR-t) and habitat restoration (STAR-r). The STAR scores determine the potential of an area to contribute to the conservation of threatened species by mitigating threats to species in their current habitat (STAR-t) and restoring habitat they have lost (STAR-r). STAR scores are calculated by using data related to the area of habitat and distribution, threats, and extinction risk of threatened species as derived from the IUCN Red List (Mair et al., 2021; IUCN, n.d.-a). Calculating STAR-r is similar to calculating STAR-t; the difference is that the value for each species is based on species whose habitat must be restored in the locality (restorable habitat), and it incorporates an adjustment factor. The resulting STAR scores, for STAR-r and STAR-t, can be filtered by threat type to show how different threats contribute to the total STAR score.

Implementation

The STAR metric is currently available in the IUCN's Contributions for Nature platform and the Integrated Biodiversity Assessment Tool. More than 2000 STAR reports have been generated and downloaded by the tool's users. STAR is listed as a complementary indicator for Target 4 (actions to halt species extinction and for the recovery and conservation of species) in the monitoring framework of the GBF.

Box 3. The IUCN Red List: The base of STAR

The IUCN Red List provides information on the extinction risk of species. Species are categorised as extinct, extinct in the wild, critically endangered, endangered, vulnerable, near threatened, of least concern, data deficient, or not evaluated. The categorisation is based on the knowledge of population trends, range and habitat availability, population size and structure, and threats.

The IUCN Red List criteria (IUCN, 2001), such as the reduction of the population size, the geographic range, or quantitative evidence of risk of extinction, determine the categorisation of a species. Since high-quality, direct data are not always available, the evidence used to categorise species is classified as observed, estimated, projected, inferred and suspected.

The IUCN Red List establishes different types of threat classification, including for agricultural practices (IUCN Red List, n.d.-b). For example, regarding annual and perennial non-timber crops, several categories are identified with different associated threats: shifting agriculture, small-holder farming and agro-industry farming. It is possible to record data when the threat scale is unknown or unrecorded. For agricultural and forestry effluents, the following categories are considered: nutrient loads, soil erosion, sedimentation, herbicides and pesticides (IUCN Red List, n.d.-b).

The IUCN Red List itself is used as an indicator for the UN's Sustainable Development Goals, particularly for Goal 15: 'life on land', and by the CBD to monitor progress towards achieving targets of the Kunming-Montreal GBF.

The IUCN Red List of Ecosystems is a standardised framework for assessing the status of ecosystems from local to global levels (IUCN Red List of Ecosystems, n.d.). It is an indicator of the GBF. The European Red List of Habitats specifically assesses the status of species in the EU (IUCN Red List, n.d.-c).

3. EU policy monitoring and evaluation frameworks

In the EU, several policies include targets and measures to promote biodiversity conservation in the context of agriculture. Especially relevant in this context is obviously the EU CAP. Also in recent years, there have been important policy developments to address the biodiversity crisis in the EU, such as the European Green Deal and its Biodiversity Strategy for 2030 (EC, 2020a) and Farm to Fork Strategy (EC, 2020b), as well as the Nature Restoration Regulation.

The Biodiversity Strategy for 2030 aims to put Europe's biodiversity on a path to recovery by 2030, and the Farm to Fork Strategy aims to make Europe's food systems more sustainable, healthy and fair. Both strategies share the objective of promoting the transition to sustainable agriculture and have common targets, such as reducing pesticides by 50%, reducing fertilisers by 20% and increasing organic farmland to a share of 25%.

The Biodiversity Strategy for 2030 has the additional target of ensuring that "at least 10% of agricultural area is under high-diversity landscape features." Following these strategies, legislative proposals have been developed by the Commission, such as the Nature Restoration Regulation.

This section analyses the key mechanisms that different EU biodiversity and agricultural policies have to assess the contribution of these policies to biodiversity conservation in relation to agriculture.

Given the links between EU and international biodiversity targets, a brief international overview is provided in Box 4; in particular, the Kunming-Montreal GBF and its monitoring framework are discussed, which are also crucial in the EU context.

Box 4. The international policy background

At the international level, the Kunming-Montreal GBF was adopted during the 15th meeting of the Conference of the Parties (COP 15) to the CBD that took place in December 2022 in Montreal, Canada. The framework has long-term goals for 2050 and action-oriented targets for urgent action until 2030. Many targets are related to agriculture, but some also specifically mention agricultural aspects, especially Targets 4, 7, 10 and 16. Target 4 aims to effectively manage human–wildlife interactions, Target 7 aims to reduce nutrient loss and pesticide use, Target 10 aims to increase sustainable agriculture and biodiversity-friendly practices and Target 16 aims to halve global food waste by 2030 (CBD, 2022a).

The CBD COP 15 also adopted a monitoring framework for the Kunming-Montreal GBF. The monitoring framework provides a list of proposed indicators, categorised into different groups. *Headline indicators* are high-level and aim to capture the overall scope of the targets and goals of the framework. *Global-level indicators* reflect 'yes/no' answers from national reports on activities undertaken by countries. *Component indicators* are optional indicators that, together with the headline indicators, cover all the aspects of the framework and can be applied at the global, regional, national and sub-national levels. Optional *complementary indicators* are highlighted, enabling in-depth analysis of specific goals or targets, and can be applied at the global, regional, national and sub-national levels (CBD, 2022b). The IUCN Red List Index and IUCN Red List of Ecosystems are headline indicators for Goal A (targeting ecosystems and threatened species conservation, and genetic diversity maintenance) and are headline, component or complementary indicators for various targets, including Target 10 (on sustainable agriculture). Any remaining issues in the monitoring framework will be addressed by an ad hoc technical expert group (CBD, 2022b).

3.1. Agricultural policies

Common Agricultural Policy

The CAP is the main policy shaping agriculture in the EU. Since it was launched in 1962, its original objectives – ensuring a stable production of food and affordability for consumers, and safeguarding farmers' livelihoods – have been complemented by further objectives, including tackling environmental challenges and maintaining rural areas (EU Council, n.d.). To date, the CAP has undergone several reforms, the most recent of which came into effect in January 2023.

The current CAP, which covers the period 2023–2027, emphasises fairness, the environment and performance. It is based on 10 objectives, three of which are environmental: climate change action, environmental care, and landscape and biodiversity preservation (EC, n.d.-b).

Figure 4. The 10 CAP objectives (© European Commission)

The objective to preserve landscapes and biodiversity – or as per the full title, "to contribute to halting and reversing biodiversity loss, enhance ecosystem services and preserve habitats and landscapes" – is key to ensuring that agriculture contributes to biodiversity conservation. Elements of the CAP 2023–2027 are intended to help shape how this objective is met.[7]

The CAP has a monitoring and evaluation system that facilitates monitoring of the progress member states make towards their targets. Environmental aspects are included in the system through specific environmental indicators. The implementation of the current CAP had not yet been analysed at the time of publication of this report, as the national strategic plans began to be implemented in January 2023. For the previous CAP, assessing the impact of agriculture on the environment was challenging, mainly due to the lack of data (DG AGRI, 2019a), the absence of baseline data to assess progress and the lack of agreed-on metrics for specific environmental aspects (Buckwell et al., 2022).

The monitoring and evaluation system of the CAP 2023–2027 has been altered from a compliance-based system to one based on performance, and it includes more environmental indicators. These indicators are useful for tracking progress towards the European Green Deal targets (DG AGRI, 2020). A more detailed description of the CAP 2023–2027 monitoring and evaluation system is provided below.

Performance Monitoring and Evaluation Framework

The performance monitoring and evaluation framework (PMEF) aims to monitor progress made towards achieving the targets of the CAP strategic plans and to assess the impact, effectiveness, efficiency, relevance, coherence and EU-added value of the CAP (EP and Council, 2021). The PMEF establishes the way forward for

7 The current CAP has various mechanisms to channel funding towards biodiversity and climate measures. First, the enhanced conditionality mentions stronger environmental mandatory requirements. Second, eco-schemes, which should receive at least 25% of the direct payments budget, aim to support climate- and environment-friendly farming practices and approaches. Third, at least 35% of the rural development funds should be allocated to measures to support climate, biodiversity, environment and animal welfare.

reporting, monitoring and evaluating processes by member states, and specifically sets the common impact, result, output and context indicators. The output indicators aim to monitor the implementation of the CAP, the result indicators aim to monitor EU member states' progress towards targets, and the context and impact indicators aim to assess the overall policy performance against the CAP objectives (EU CAP Network, 2023).

This section provides an overview of the indicators that are directly linked to species or habitats. They are linked to the biodiversity objective "to contribute to halting and reversing biodiversity loss, enhance ecosystem services and preserve habitats and landscapes."

Impact indicators

Four impact indicators aim to assess biodiversity, either directly or indirectly. They assess farmland bird populations, the percentage of species and habitats of community interest with stable or increasing trends, and the presence of landscape features and crop diversity (see table below). Most of the impact indicators are collected through other channels (European statistics, Joint Research Centre, European Environment Agency, etc.) and are not exclusively used for the CAP; they are also used for other EU legislation and for monitoring the Sustainable Development Goals.

Table 1. Impact indicators of the CAP relevant for biodiversity

I.19	Increasing farmland bird populations: Farmland Birds Index
I.20	Enhancing biodiversity protection: Percentage of species and habitats of community interest related to agriculture with stable or increasing trends, with a breakdown of the percentage for wild pollinators species
I.21	Enhancing provision of ecosystem services: Share of agricultural land covered with landscape features
I.22	Increasing agro-biodiversity in farming system: Crop diversity

(EP and Council, 2021)

Farmland Birds Index

The Farmland Birds Index was a key biodiversity-related indicator in the CAP 2014–2020 and is still key in the CAP 2023–2027, being both an impact (I.19) and a context (C.36) indicator. It shows the rate of change in the relative abundance of 39 common bird species in the EU. Member states provide data on the species relevant to their territory, and that information is aggregated first at the national level and afterwards at the EU level. Data on species population are collected by local volunteers and managed by national coordinators (DG AGRI, 2023).

The Farmland Birds Index is considered a proxy indicator to assessing biodiversity status because of the high position of birds on the food chain and the evidence of the link between agricultural practices and bird population trends. However, that link is not always straightforward, and multiple factors can affect bird populations (DG AGRI, 2023). For example, climate change might affect migration and therefore influence the presence of specific species in certain areas.

Landscape features

In the CAP 2023–2027, the presence of landscape features on a farm is a newly introduced indicator for assessing biodiversity (EC, n.d.-c). According to the Joint Research Centre of the European Commission, agricultural landscape features are "small fragments of non-productive natural or semi-natural vegetation in agricultural landscapes which provide ecosystem services and support for biodiversity" (JRC, 2022a). Examples of landscape features include hedges, trees, flower strips, ponds, etc. These elements provide habitats for farmland species and are therefore considered key to preserving and enhancing biodiversity on agricultural land.

Indicator I.21, 'enhancing provision of ecosystem services', estimates the area covered by landscape features on agricultural land. It does this by calculating the share (percentage) of agricultural land that is covered with landscape features, and by using an elaborate index of landscape element structure, which is still under development (DG AGRI, 2023).

The European Commission uses two main sources for monitoring landscape features: mapping them using remote sensing data from Copernicus, and collecting field observations using the Land Use and Coverage Area frame Survey (LUCAS) transect data. The Copernicus remote sensing data provide information specifically for small woody features and small landscape features. LUCAS provides data on land cover and land use collected through field observation. However, these data sources could not provide comprehensive information on all of the main landscape feature types. In response to this data gap, LUCAS has been redesigned and now includes a specific module on landscape features, which involves photointerpretation and field surveys (JRC, 2022a; JRC, 2022b). The monitoring systems for assessing landscape features in the EU are still under development. Some member states have developed monitoring methods at the national or regional level, but they are not homogeneous and, therefore, the information is difficult to compare and aggregate.

Percentage of species and habitats of community interest related to agriculture, with a breakdown of wild pollinators

This indicator shows the conservation status of species and habitats of community interest (listed in the Birds and Habitats Directives) related to agriculture (DG AGRI, 2023). The indicator is based on the reporting of the Birds and Habitats Directives, called the *State of Nature* report. The results of that evaluation for species that depend on agroecosystems, which are presented in the *State of Nature* report, are used to calculate this indicator. A detailed description of the Birds and Habitats Directives reporting is described in upcoming section 'Birds and Habitats Directives'.

The inclusion of the wild pollinators breakdown is new for the CAP 2023–2027. The monitoring of pollinators will be based on the Biodiversity Strategy for 2030 monitoring systems, specifically on the EU Pollinators Initiative. The monitoring scheme under this initiative is described below.

Crop diversity

This indicator assesses crop diversity and comprises two sub-indicators: crop diversity on farm (number of farms by number of crops and size) and crop diversity in a region (average number of crops grown on a holding at Nomenclature of Territorial Units for Statistics -NUTS- 2 level as one, and broken down by arable land size class) (DG AGRI, 2023). The data source for this indicator is the farm structure survey (DG AGRI, 2023), which collects information from agricultural holdings on land use, livestock numbers, rural development, management and farm labour input (Eurostat, 2022b). Data are collected by member states and sent to Eurostat every 3–4 years (Eurostat, 2022b).

Result indicators

The result indicators associated to the impact indicators measure the share of area under environmental commitments, specifically under organic farming, sustainable forest management, general biodiversity conservation or restoration, landscape feature preservation, commitments under Natura 2000 areas or number of beehives.

The CAP strategic plan objectives are linked to the PMEF result indicators, which are associated with target values set by member states. However, in the summary of the observation letters sent by the European Commission to the member states in 2020, it was mentioned that the links between the result indicators, interventions and objectives are not clearly identified (DG AGRI, 2022).

Several result indicators for biodiversity are labelled 'PR' (performance review). These indicators are mandatory for monitoring the progress towards the CAP strategic plan targets and therefore need to be notified annually by member states.[8] The mandatory result indicators are related to:

- forest land protection and management commitments
- biodiversity conservation or restoration commitments
- landscape features management commitments.

Other indicators

Output indicators measure the number of hectares under environmental commitments; for example, under organic agriculture, environmental or climate-related commitments, afforestation or agroforestry.

Context indicators measure the factors influencing impact. The PMEF context indicators include two indicators on biodiversity: the Farmland Birds Index and the percentage of species and habitats of community interest related to agriculture with stable or increasing trends. It also includes indicators on farming practices, such as 'farming intensity' or 'production under organic farming'.

Besides the mandatory indicators described above, complementary indicators can be developed by member states. These indicators can provide useful information and are already shaped to fit the national, regional or local context, data availability, etc. since they are directly developed by the member states.

Additionally, the CAP contains indicators that are categorised as environmental indicators but that do not specifically refer to biodiversity. However, they are very relevant for biodiversity; for example, I.15 'improving water quality: gross nutrient balance on agricultural land', I.16 'reducing nutrient leakage' or I.18 'sustainable and reduced use of pesticides'. The results and outputs indicators of the CAP can help monitor progress towards the European Green Deal targets, as indicated in the table below (DG AGRI, 2020).

8 More information on the performance framework can be found in Title VII, Chapter 1 of the CAP Strategic Plans Regulation: https://eur-lex.europa.eu/eli/reg/2021/2115/oj

Table 2. Green Deal targets vs. CAP indicators

Green Deal targets related to the agricultural sector	CAP impact indicators or context indicators	CAP output and result indicators
Reducing by 50% the use and risk of chemical pesticides by 2030 Reducing by 50% the use of high-risk pesticides	I.27 Sustainable use of pesticides: Reduce risks and impacts of pesticides	R.37 Sustainable pesticide use: Share of agricultural land concerned by supported specific actions which lead to a sustainable use of pesticides
Reducing by 50% the sales of antimicrobials for farmed animals and in aquaculture by 2030	I.26 Limiting antibiotic use in agriculture: Sales/use in food producing animals	R.36 Limiting antibiotic use: Share of livestock units concerned by supported actions to limit use of antibiotics
Reducing nutrient losses by at least 50% in 2030	I.15 Improving water quality: Gross nutrient balance on agricultural land	R.21 Sustainable nutrient management: Share of agricultural land under commitments related to improved nutrient management
Achieve 25% agricultural area under organic farming by 2030	C.32 Agricultural area under organic farming	O.15 Number of ha with support for organic farming
Increasing land for biodiversity, including agricultural area under high-diversity landscape features	I.20 Enhanced provision of ecosystem services: Share of utilised agricultural area covered with landscape features	R.29 Preserving landscape features: Share of agriculture land under commitments for managing landscape features, including hedgerows

Modified from DG AGRI, 2020

The indicators of the CAP assess the status of biodiversity, such as through the impact indicators Farmland Birds Index or crop diversity, as well as the enabling conditions, such as through impact indicator landscape features.

The biodiversity status assessment of the new CAP focuses on species and habitats, specifically on birds (the Farmland Birds Index), pollinators, species and habitats of community interest, crop diversity and landscape features. Assessing genetic diversity and ecosystems is not foreseen.

Evaluating activities and practices that impact biodiversity, either positively or negatively, can help identify indicators that contribute to the goal of enhancing biodiversity. For example, practices like reducing pesticide use can serve as enabling conditions. These indicators should be considered contributors to biodiversity assessment, not just categorised under 'natural resources use'.

The CAP also measures the level of commitment to the preservation and enhancement of biodiversity through result indicators, such as the 'area of agricultural land supported for organic farming', context indicators, such as 'Farmland Birds Index' or 'landscape features', and output indicators, such as 'number of hectares under organic farming support'.

Regarding assessing the context, the CAP considers only the Farmland Birds Index or landscape features. Further indicators of the context could provide a more integrated understanding of biodiversity status; for example, it should be considered if the Farmland Birds Index is affected by changes in migration of birds due to climate change.

Scoring systems in the EU: Results-based agri-environmental payment schemes

Although currently hardly in use in the context of the CAP, results-based agri-environmental payment schemes to promote sustainable agriculture have been tested in the EU during recent years. These are schemes whereby the payment to farmers relates to the achievement of a defined environmental result (ENRD, n.d.). The European Commission has been exploring how these schemes could work at the national level. Pilot tests have been conducted on 148 farms in Ireland, Romania, Spain and the UK (IEEP, 2019). Compliance and subsequent payments associated with these schemes rely on the existence of quantifiable signs of environmental outcomes. Each scheme is equipped with specific goals, indicators and methodologies tailored to measure these outcomes (ENRD, n.d.).

In these schemes, the quality of the result indicators is key. Since the indicators operate at the farm level, they should be designed taking into consideration the local characteristics (fauna, flora, natural resources, etc.). The Institute for European Environmental Policy's guidance handbook suggests some criteria for these indicators to be effective (Keenleyside et al., 2014). The handbook states that the criteria must:

- be representative of the target habitat or species;
- occur consistently in target farmland habitats in the area;
- be easily identified by farmers and paying agency representatives;
- be measurable using a simple methodology;
- be sensitive to changes in agricultural management but otherwise stable;
- be unlikely to be influenced by external factors beyond the control of the land manager; and
- not be achieved easily by means other than agricultural management.

The pilots conducted in Ireland and Spain from 2015 to 2018, one of which is presented in Box 5, showed that such an assessment method would be effective and fair for paying farmers through locally adapted scoring payment systems. This scheme, however, requires resources for its success – mainly, expertise to set the biodiversity objectives and result indicators, as well as farm advisory services to farmers with expertise in agri-environmental measures (Byrne et al., 2018).

Box 5. An example from Ireland's results-based payments

The Wild Atlantic Nature LIFE Integrated Project is developing a voluntary, results-based payment scheme linked to the quality of the habitat. The scheme design comprises two types of assessment (Wild Atlantic Nature Life, n.d.):

- **Result indicators** related to three key farm habitats: peatlands, woodlands and grasslands. These indicators are key in the evaluation process to determine a score for habitat quality assessment at the farm level.
- A **whole-farm assessment** to have a better understanding of the performance of the farmer, which includes other relevant features for the quality of habitat: farmyard management, nutrient balance and condition, and management of watercourses.

The final habitat quality score is multiplied by the whole-farm assessment result to determine the results-based payment a farmer receives.

Other relevant agricultural policies

Besides the CAP, there are other existing and proposed EU agricultural policies that have potential to reinforce the status and assessment of biodiversity on agricultural land, such as the EU Soil Strategy for 2030 or the Integrated Nutrient Management Action Plan, but also legal texts, such as the EU Deforestation Regulation and the proposed Soil Monitoring and Resilience Directive.

Furthermore, the proposed Green Claims Directive points at the Product Environmental Footprint and the Organisation Environmental Footprint as methods that businesses can use to substantiate their claims (EC, 2023a). These are LCA methods, which were developed by the Joint Research Centre of the European Commission and recommended by the Commission in 2021 (EC, 2021b) as a common environmental performance assessment method (EC, n.d.-d). Given the limitations of LCA methods for assessing biodiversity, as explained in the previous chapter, it is important that the green claims substantiation mechanisms take these limitations into account. Combining LCA methods with other methods that provide more comprehensive information on biodiversity impact could be a way of ensuring a more complete understanding of the footprint of products on the environment.

3.2. Biodiversity policies

The European Commission launched the European Green Deal in 2019, with the aim of tackling the current climate and environmental emergencies, and one of its key priorities is the preservation and restoration of ecosystems and biodiversity.

Food systems, particularly agriculture, were highlighted as key areas to address for halting biodiversity loss and tackling climate change.

The Biodiversity Strategy for 2030 was presented as a key policy development to protect and restore biodiversity and was foreseen to play a key role at the CBD COP 15. The Farm to Fork Strategy was specifically prepared to drive the transition to more sustainable, healthier and fairer food systems in Europe. Both strategies, which were launched together, set goals and paths towards reconciling agriculture and biodiversity, paving the way for the transition to sustainable agriculture. The Farm to Fork Strategy sets targets such as those related to reducing pesticides and fertilisers and increasing organic farming.

Biodiversity Strategy for 2030

The Biodiversity Strategy for 2030 aims to protect nature and recover biodiversity throughout the EU. It includes the targets 'to reduce by 50% the overall use of – and risk from – chemical pesticides by 2030 and reduce by 50% the use of more hazardous pesticides by 2030', 'at least 25% of the EU's agricultural land must be organically farmed by 2030', and 'to bring back at least 10% of agricultural area under high-diversity landscape features' (EC, 2020a).

The strategy foresees a new governance framework to ensure co-ownership and co-responsibility by all actors in achieving the strategy's objectives. The strategy announced that the framework will include a monitoring and review mechanism with specific indicators.

The indicators set to assess the progress towards achieving the targets of the Biodiversity Strategy for 2030, which are developed by the European Environmental Agency, are compiled in the EU Biodiversity Strategy Dashboard (EC, n.d.-e). The dashboard shows that 10 indicators have already been developed to track progress towards achieving specific targets, but that 11 indicators are still under development for other targets. Some of the indicators in the dashboard are related to agriculture. Of the five indicators, only two have been developed and three are still under development, as shown in the table below. The available indicators so far are the grassland butterfly index and 'area under organic farming'.

Table 3. Biodiversity Strategy for 2030 indicators relevant for agriculture

Target 5 - The decline of pollinators is reversed.	**Indicator: 5.0.1 Grassland butterfly index**
Target 6 - The risk and use of chemical pesticides is reduced by 50%, and the use of more hazardous pesticides is reduced by 50%.	Indicator under development.
Target 7 - At least 10% of agricultural area is under high-diversity landscape features.	Indicator under development.
Target 8 - At least 25% of agricultural land is under organic farming management, and the uptake of agroecological practices is significantly increased. Sub-target: 8.1 - At least 25% of agricultural land is under organic farming management.	**Indicator: 8.1.1 Area under organic farming**
Target 13 - The loss of nutrients from fertilisers is reduced by 50%, resulting in the reduction of the use of fertilisers by at least 20%.	Indicator under development.

(Modified from EC, n.d.-e)

Box 6. A complementary assessment method for the Biodiversity Strategy: Mapping and assessment of ecosystems and their services

The report *Mapping and Assessment of Ecosystems and their Services: An EU ecosystem assessment* (JRC, 2020a), published in 2020, presented the ecosystem assessment carried out by the Joint Research Centre, European Environment Agency, Directorate-General for the Environment of the European Commission, and the European Topic Centre on Biological Diversity and on Urban, Land and Soil Systems. This assessment aimed to provide useful knowledge for evaluating the Biodiversity Strategy for 2020 and developing the Biodiversity Strategy for 2030 and the Nature Restoration Regulation.

The Mapping and Assessment of Ecosystems and their Services (MAES) methodology comprises four elements: thematic ecosystem assessment, cross-cutting assessment, an integrated assessment and integrated narratives addressing key policy issues. One of the thematic ecosystem assessments is agroecosystems, including cropland and grassland.

MAES uses a vast number of indicators (JRC, 2020b), several of which are relevant to agriculture, such as the EU grassland butterfly index, nitrate concentration in groundwater, high nature value farmland, pesticide sales and spatial assessment of trends in arable crop diversity.

Data on ecosystem condition and biodiversity are provided by member states (through the Birds and Habitats Directives reporting, Article 17). Moreover, the land cover data from Coordination of Information on the Environment (Copernicus & Land Monitoring Service, n.d.) were used to delineate and analyse trends of ecosystems in the EU.

Another methodology for mapping and assessing ecosystems in the EU has been developed by the Joint Research Centre: the EU-wide methodology to map and assess ecosystem condition (JRC, 2022c). Following MAES, this methodology aims to create a common EU methodology that is aligned with global standards, specifically the UN System of Environmental-Economic Accounting central framework.

The EU-wide methodology is intended to support the implementation of the Biodiversity Strategy more generally. It might also be helpful in including ecosystem accounts in the EU Regulation on European environmental-economic accounts, proposed by the European Commission in 2022 (EC, n.d.-f) and amended by the European Parliament in November 2023. It can also provide useful information for the revised Regulation on Land Use, Land-Use Change and Forestry, the reporting under the 8th Environmental Action Programme and the Sustainable Development Goals. The report by the Joint Research Centre recognises the need to integrate different data flows, including data from CAP indicators and the Birds and Habitats Directives.

The methodology considers different ecosystems, including agroecosystems. To assess the condition of agroecosystems, it establishes some variables based on MAES, Nature Restoration Regulation indicators and impact indicators of the CAP PMEF. Some examples of the variables considered for agroecosystems are crop genetic diversity, the grassland butterfly index, common farmland bird index and the percentage of farmland species with good population status.

The grassland butterfly index is an indicator that shows the status of butterflies in the EU and was developed by the European Environmental Agency. It aggregates information of the status of 17 butterfly species in 19 EU member states. The grassland butterfly index is also relevant for other EU and international policies. In the EU, it provides information for the Birds and Habitats Directives and the EU Pollinators Initiative. At the international level, it is used for monitoring Sustainable Development Goal 15, on protecting, restoring and promoting sustainable use of land (Eurostat, n.d.-b).

The indicator 'area under organic farming' relates to the CAP PMEF indicators C.32 'agricultural area under organic farming', O.15 'number of ha with support for organic farming' and R.29 'development of organic agriculture: share of utilised agricultural area supported by the CAP for organic farming', with a split between maintenance and conversion.

The Biodiversity Strategy for 2020 already included a target to "increase the contribution of agriculture and forestry to maintaining and enhancing biodiversity." Specifically, it aimed to maximise agricultural areas covered by biodiversity-related measures under the CAP until 2020 (Target 3) (EC, 2011). The Biodiversity Strategy for 2020 has been assessed through a mid-term evaluation, and a final evaluation, which analysed the effectiveness, efficiency, relevance, coherence and EU added value of the strategy (EC, 2022a).

The EU Nature Restoration Regulation

The European Commission published a proposal for the EU Nature Restoration Regulation (EC, 2022b) in June 2022, as part of the Nature Restoration Plan of the Biodiversity Strategy for 2030. After extensive negotiations between the EU Parliament, Commission, and Council, a trilogue agreement was reached, which was approved by the Council of the EU in June 2024.[9]

With the aim of contributing to recovering biodiversity across the EU and achieving the EU's climate mitigation and climate adaptation objectives, the Regulation sets to restore at least 20% of the EU's land and sea areas by 2030 and all ecosystems in need of restoration by 2050.

To meet the EU targets, member states must restore at least 30% of habitats covered under the legislation (forests, grasslands, wetlands, rivers, lakes and coral beds) from poor to good condition by 2030, increasing to 60% by 2040, and 90% by 2050. Member states must also adopt national restoration plans outlining their strategies for accomplishing these targets. Targets for agricultural ecosystems are related to the recovery of farmland birds, ensuring an increasing trend for the share of agricultural land with high-diversity landscape features, increasing trends for the grassland butterfly index and the stock of organic carbon in cropland mineral soils, restoring and rewetting of organic soils in agricultural use, and restoring targets and obligations for habitats and species protected under the Birds and Habitats Directives and for pollinators.

The Nature Restoration Regulation sets a monitoring system to assess the implementation of restoration measures established in the national restoration plans, and trends in restored areas. Member states must achieve an increasing trend in the following agricultural ecosystem indicators:

- Grassland butterfly index: An indicator composed of species considered to be characteristic of European grasslands and which occur in a large part of Europe, covered by most of the butterfly monitoring schemes.
- Stock of organic carbon in cropland mineral soils: An indicator that describes the stock of organic carbon in cropland mineral soils at a depth of 0 to 30 cm.

9 Regulation of the European Parliament and of the Council on Nature Restoration and amending Regulation (EU) 2022/869. Available at: https://data.consilium.europa.eu/doc/document/PE-74-2023-REV-1/en/pdf

- Share of agricultural land with high-diversity landscape features: An indicator based on the percentage of different high-diversity landscape features in the utilised agricultural area.
- Common Farmland Birds Index: An indicator that summarises population trends of common and widespread farmland birds.

Furthermore, member states must report at least every 6 years on the progress in implementing the national restoration plan and measures and in achieving the targets. Data would be provided by both the member states and the European Commission. The revision of the regulation implementation would be performed in 2035.

However, there are further targets that do not have specified indicators, mainly to restore 50% of drained peatlands under agricultural use, of which 30% need to be rewetted, to implement measures to continuously improve the quality and quantity of habitats and species listed in Annex II, IV and V of the Habitats Directive (which would include agricultural habitats), to reverse the decline of and increase pollinator populations by 2030, and to remove barriers to connectivity of surface waters and improve natural functions of floodplains.

Besides these indicators, further aspects might be relevant when assessing the impact of restoration activities. For instance, the Food and Agriculture Organization of the United Nations and the World Resources Institute's *Guide for forest and landscape restoration monitoring* (FAO & WRI, 2019) highlights some key criteria for monitoring restoration activities: have a landscape-level focus, have an integrative and participatory approach (including biophysical, social, economic and governance aspects), balance trade-offs (take into account the context) and integrate data. Regarding biodiversity specifically, the guide suggests focusing on monitoring natural habitat protection, habitat connectivity and biodiversity quality through abundance of flora and fauna.

Existing methods, such as STAR or IUCN's Restoration Barometer, could be useful to further develop the Nature Restoration Regulation monitoring system.

EU Pollinators Initiative

The EU Pollinators Initiative was adopted in 2018 by the European Commission, with the aim of tackling the decline of pollinators in the EU. Despite the relevance of its objectives for pollinator conservation for 2030, this initiative faced a number of obstacles, as shown in the review of the progress of the initiative (EC, 2021c). The European Commission revised the initiative, with the goal of improving progress towards the 2030 objective. A revised initiative was adopted in 2023, which included objectives and actions regarding three priorities: knowledge on pollinator decline, pollinator conservation and tackling the causes of pollinator decline, and awareness raising.

As part of the first priority to improve the knowledge on pollinators, one of the objectives of the initiative is to establish a monitoring system for pollinators. Several actions are envisioned to achieve this objective. First, to develop a finalised methodology for an EU pollinator monitoring scheme by 2026. Second, to develop a driver-pressure-state-impact-response framework[10] to monitor decline of pollinators and its causes and consequences, and to support the systematic collection of data (through the European Monitoring of Biodiversity in Agricultural Landscapes initiative (EC, n.d.-g) and the pesticide monitoring imitative insignia (EC, n.d.-h) by 2026). Third, to develop indicators on pollinator state and pressures, and potentially on the impacts of pollinators on ecosystem health, the economy and human well-being. These indicators would help evaluate relevant policies, such as the CAP (EC, 2023b).

10 The driver-pressure-state-impact-response framework assesses the impact of policies on the environment through a cause–effect approach. The assessment comprises several elements: the driving forces (human activities), pressures, the state of the environment, the impacts on the environment and finally the responses (changes in policy, for example).

Birds and Habitats Directives

The EU Birds and Habitats Directives are key policies for the conservation of biodiversity in the EU. The Birds Directive was adopted in the 1970s and protects 500 wild bird species. The Habitats Directive was adopted later, extending the protection measures to another 1000 species and 200 habitats in the EU. Following the two directives' species and habitats conservation goals, the Natura 2000 network of protected areas was designated. The Birds and Habitats Directives establish different levels of protection for birds and habitats and for species of community interest. The main protection figures established are the special protection areas and sites of community importance, which together form the Natura 2000 network.

Agriculture strongly influences the state of the Natura 2000 areas, since nearly 40% of those areas is used for that purpose (EC, 2018). There are therefore direct links between the CAP and the Natura 2000 areas. Most importantly, the CAP is a key source of funding for Natura 2000 areas; therefore, how the CAP is designed and implemented will have a great influence on the species and habitats protected under the Birds and Habitats Directives (EC, 2018). Furthermore, specific agricultural habitats and species are protected by the Habitats Directive; for example, grasslands, pollinators and farmland birds (EEA, 2020a; EEA, 2020b).

The Birds and Habitats Directives both foresee mandatory reporting by member states – the Birds Directive through Article 12, and the Habitats Directive through Article 17. Since 2015, the reporting is conducted jointly. Every 6 years, member states provide data to the Commission on the progress of the directives that is reflected in the *State of Nature in the EU* report. The assessment is based on information on the status and trends of species populations or habitats, and on main pressures and threats. Agriculture is the most commonly reported pressure for biodiversity in the assessment. Conservation status is assessed as being 'favourable', 'unfavourable – inadequate' or 'unfavourable – bad', based on defined parameters for habitats (range, area, structure and function, and future prospects) and for species (range, population, habitat of species and future prospects).

The concept of 'favourable conditions' is defined in Article 1 of the Habitats Directive as "a situation where a habitat type or species is prospering (in both quality and extent/population) and with good prospects of continuing to do so into the future" (EEA & ETC/BD, n.d.).

The *State of Nature in the EU* 2020 report (EEA, 2020a) specifically assessed the progress towards the achievement of two targets of the EU Biodiversity Strategy for 2020 that refer to the status of species and habitats: Target 1, on the implementation of the Birds and Habitats Directives, and Target 3, on agriculture and forestry. The assessment of Target 3a on agriculture includes assessing agricultural species and habitats included in the Birds and Habitats Directives. The main agricultural habitats assessed are grasslands. Regarding species status, species linked to agricultural habitats were assessed, such as farmland birds, pollinators, butterflies, bats and amphibians (EEA & ETC/BD, 2020). The *State of Nature* report also assessed the restoration need for habitats under Annex I of the Habitats Directive.

The latest *State of Nature* report (EEA, 2020a), covering the implementation of the Birds and Habitats Directives from 2013 to 2019, pointed at the need to improve monitoring at member state level, and specifically to fill data gaps and set new indicators to evaluate the impact of Natura 2000 networks on the objectives of the Birds and Habitats Directives and the Biodiversity Strategy.

The EU's 8th Environmental Action Programme

The EU's 8th Environmental Action Plan sets the environmental agenda of the EU for 2030 (EC, n.d.-i). It includes a monitoring framework to measure the progress towards achieving the plan's goals. Although it is broader in scope, it also includes indicators relevant for biodiversity and agriculture. Some of these indicators are 'average nitrate levels in groundwater, and the percentage of monitoring stations recording values of more than 50 mg per litre – with a goal to halve nutrient losses, as set in the Farm to Fork Strategy', 'the common farmland birds index, as compiled by bird conservation groups, including BirdLife Europe – with a goal to "reverse the decline" in populations by 2030', 'area of organic farmland – with a goal to reach 25% of the EU total by 2030' and 'land take per year – with a goal to reach no net land take by 2050'.

The Environmental Action Plan recognises the importance of monitoring for the achievement of the EU environmental goals. The plan asks the European Commission, member states and sub-national authorities and stakeholders "to develop a report which identifies the interlinkages between existing indicator sets, monitoring frameworks and processes at Union level measuring social, economic and environmental progress and which proposes action on how existing dashboards and indicator sets can be streamlined."

Integrating the data and information from all the different policies' monitoring systems described in this chapter would be helpful to achieve a good understanding of how the agricultural and biodiversity measures in the EU are influencing the biodiversity status and trends in the EU in relation to agriculture.

4. Assessing biodiversity in the agricultural context: Discussion

This chapter tries to capture the many interesting discussion points that can be extracted from previous sections in relation to the assessment methods for biodiversity in the context of agricultural activity, together with the analysis of the related policy context.

In the EU, several frameworks are used to assess the progress towards policy targets related to agriculture and biodiversity. These frameworks include the PMEF of the CAP, the indicators established to assess the progress towards the Biodiversity Strategy targets, the *State of Nature* report, the Nature Restoration Regulation indicators and the EU pollinators monitoring scheme.

Of these assessment frameworks, **the *State of Nature* report under the Birds and Habitats Directives is the most comprehensive monitoring framework that assesses the status of biodiversity in the EU**, while the **PMEF of the CAP is the most complete monitoring framework that assesses biodiversity specifically in the agricultural context,** covering the status of certain farmland species and the uptake or impacts of certain agricultural practices.

The PMEF of the CAP establishes several impact and context indicators to directly or indirectly assess the status of biodiversity on agricultural land, as well as several result and output indicators to monitor the uptake of biodiversity-friendly farming practices. However, due to the nature of this policy, the assessment exclusively focuses on agricultural land and does not assess the impact of agricultural activity on biodiversity in other areas.

For example, indicator I.15 assesses the nutrient balance on agricultural land, but not the impact of the excess of nutrients on biodiversity in areas that are connected. It is worth emphasising that the CAP PMEF is linked to the *State of Nature* report through indicator I.20 'enhancing biodiversity protection: percentage of species and habitats of community interest related to agriculture with stable or increasing trends, with a breakdown of the percentage for wild pollinators species'.

Indeed, while these frameworks operate mostly independently, there are commonalities between the assessment methods for EU policies. The grassland butterfly index is an indicator for the Biodiversity Strategy, and it feeds into the *State of Nature* report. 'Area under organic farming' is also an indicator of both the Biodiversity Strategy and of the CAP PMEF. The Nature Restoration Regulation establishes four indicators for agricultural land. Three of the four indicators are already being used in the CAP PMEF or the Biodiversity Strategy. **It might be possible to establish further links between the data and assessments from the Biodiversity Strategy, the CAP, the *State of Nature* report derived from the Bird and Habitats Directives monitoring, the EU Nature Restoration Law,** the EU's 8th Environmental Action Programme, the revised EU Pollinators Initiative **and EU legislation such as the Nature Restoration Regulation and the proposed Soil Monitoring and Resilience Directive.**

Globally, many methods have been designed to help policy-makers, farmers and businesses make better decisions and assess their contribution to international biodiversity targets that apply to agriculture. The purpose, target users, methodology and implementation are unique to each method. However, they share common features, especially those with a similar focus (agriculture-focused methods and biodiversity-focused methods).

Generally, the purpose of the agriculture-focused methods is to respond to an identified methodological or data gap or to improve the assessment landscape (for example, by setting a common standard). On the other hand, the biodiversity-focused methods aim mainly to contribute to assessing the progress of international biodiversity targets.

While most of the farmland assessment methods focus on agriculture as a whole, some are specific to certain agricultural approaches or practices. Among the global methods described in this report, this is the case for OASIS, which is designed to assess agroecology, and for the Farmland Biodiversity Score, which can be useful to assess agroforestry. **In the EU, the CAP PMEF has specific indicators to monitor the uptake of organic farming and agroforestry**, but other sustainable farming approaches, such as agroecology or permaculture, which can benefit biodiversity, are not considered separately. **Exploring how to include other approaches in assessment methods would enrich the information on sustainable agriculture in the EU.**

Developing further methods targeted at specific approaches might be challenging currently, since the knowledge about the relationship between farming approaches and biodiversity is still low. Further research into the links between agricultural approaches and biodiversity might allow for the development of assessment methods based on approaches to farming in the future, which can be useful for policy-makers to plan interventions. Although all sustainable approaches benefit the environment, certain sustainable approaches might be helpful for specific challenges or may suit certain geographical conditions better. For example, if the main challenge of an area is chemical pollution, organic farming could be further promoted, while if the main challenge is the lack of habitats for pollinators, agroforestry may be a better-suited intervention.

All of the methods described in Chapter 2 that focus on biodiversity have been designed with the aim of helping businesses assess impact: GLOBIO, the BII, the GBS, the Natural Capital Protocol, the Biodiversity Impact Metric, the Biodiversity Footprint and STAR. The Natural Capital Protocol also aims to assess dependencies of businesses on nature. The STAR metric assesses not only the impact of activities, but also the potential impact of conservation actions. On the contrary, the methods in this report that focus on agriculture do not specifically mention impact in the description of their purpose, except for the Cool Farm Tool. The rest aim to improve the assessment of sustainability in agriculture more broadly.

Many of the biodiversity-focused methods calculate impact of human activities on biodiversity through the MSA indicator: GLOBIO, the GBS, the Biodiversity Impact Metric and the Biodiversity Footprint. The STAR metric has a different approach and calculates impact through the MSA indicator, but it calculates the area of habitat/distribution, threats, and extinction risk of threatened species. It is based on a bottom-up approach and brings a conservation perspective, allowing for assessment of the likelihood of persistence or extinction risk of species based on their global distribution and threats.

Regarding the territorial scale, the biodiversity-focused methods, such as the GBS, **function mainly on a regional/national or global territorial scale**. These methods could be more useful for national governments and international institutions to assess the impacts of agricultural activity on biodiversity. **On the other hand, the agriculture-focused methods**, such as the Global Farm Metric, OASIS and Cool Farm Tool, **function more on the farm or landscape level**. These metrics could be more useful for farmers, local project managers and local authorities. Some methods allow assessment from a local to a global level, such as the STAR metric or the BII.

Concerning the ecological scale, many of the global biodiversity-focused methods described in Chapter 2 focus on the status of species (their result unit is the MSA), while the agriculture-focused methods mainly assess the uptake of certain agricultural practices alongside the status of biodiversity. The same applies to the EU assessment frameworks, whereby **the CAP PMEF assesses the uptake of practices while remaining connected to the *State of Nature* report, which bases its assessment on the status of species and habitats.**

The methodology of the agriculture-focused methods is similar not only among the global methods but also within the EU. The common methodology is to establish a set of indicators, such as in OASIS or the CAP PMEF. The biodiversity-focused methods, however, use models to assess impact or formulas, as in the Biodiversity Impact Metric, or simply set standards, allowing users to define the specificities of the methodology, as in the Natural Capital Protocol.

The methods described also focus on different ecological scales, such as species, habitat or ecosystem. The EU assessment methods focus more on species diversity, although the assessment of genetic resources is included only in the Agrobiodiversity Index and the Monitoring Framework of the Kunming-Montreal GBF.

The common qualities become even more evident between biodiversity-focused methods, since those are based on other methods' results, mainly on GLOBIO. That is the case for the GBS, the Biodiversity Impact Metric and the Biodiversity Footprint. The database of PREDICTS, which is the base for the BII, is also used in the Biodiversity Impact Metric.

Most of the methods described have been tested in several countries. They are used mainly to directly assess progress towards global biodiversity targets, for example, as indicators in the GBF ; to indirectly assess progress towards global biodiversity targets; or to calculate the impact of human activity on biodiversity. Some methods have been implemented at the national level, such as the Global Farm Metric, which has been tested on farms and as a potential framework to assess national agri-environmental policy in the UK. Another example is the Biodiversity Footprint, which has been tested in assessing the biodiversity impact of the Dutch dairy sector. This may be an example of how national governments can use developed methods to assess progress towards policy goals.

Most methods in this report provide information on the status of biodiversity (trends in species populations or habitats) and on the activities or actions that affect biodiversity. Combining these two assessments is useful to gain a better understanding of the impact of human activities, including agriculture, on biodiversity. Assessing the status of biodiversity in relation to agriculture gives information on the conditions of certain species or habitats, but it does not explain the interrelation between natural and human factors. To understand biodiversity in relation to agriculture, it is important to understand the context (e.g. the location, the use of land close to the farm or the effects from climate change) and the agricultural practices.

As it has been described in Section 2, **plenty of methods have been developed, each with its unique characteristics, but they share many common features. The diversity of methods is valuable, since each method can fill a specific data gap and provide a methodology tailored to specific needs** (e.g. the type of data available, the type of agricultural activities in place, the sectoral policies or other human activity in the area). **However, this diversity can also bring challenges. First, there is a risk that the knowledge created is isolated and not used to its full potential due to comparability issues between methodologies. Second, this diverse and complex landscape** of methodologies/data **might be difficult for potential users – farmers, policy-makers, businesses or citizens – to navigate, and to**

know which is more suitable to apply, how and when (Oberč & Arroyo Schnell, 2020; Global Farm Metric, 2022)**, which leads to a risk of misuse or misinterpretation of results.**

To tackle the first challenge, it would be useful to focus on the common characteristics of the existing methods and improve their comparability, and to build on these existing methods to establish future assessment frameworks. To tackle the second challenge, related to the overwhelming variety of methodologies, more efforts are needed to identify and classify the existing methods, with a focus on how users can benefit from them. Furthermore, standards for biodiversity assessment methods, including the ones applicable to agriculture, might help to guide the development and implementation of assessment methods, and to validate the existing methods. This would help farmers, policy-makers, businesses, citizens and researchers make the best use of the methods, individually or by combining several methods. It is important that these efforts seek consensus among environmental and agricultural stakeholders.

The number of metrics that have been developed to assess impacts of human activity on biodiversity is high. Fewer metrics exist that specifically assess the biodiversity-agriculture nexus. Further analysis of the potential to assess the links between biodiversity and agriculture would help to understand whether the existing methods (and their integration) would be sufficient to adequately assess the links between biodiversity and agriculture, or whether further methods (for example, ones linked to specific agricultural approaches or practices) are needed.

Some of the global methods described in this report can be useful to help EU policy implementation to achieve global and EU biodiversity targets. At the same time, the EU assessment framework could also provide insight to global policy assessment. Policy-makers could benefit from the methods already available to improve policy monitoring, design and implementation. As much as possible, the integration between policy monitoring frameworks (e.g. GBF, the CAP, the Birds and Habitats Directives) and the broadly used assessment methods (e.g. GLOBIO, STAR, the Global Farm Metric) would help comparability and therefore improve knowledge about the links between biodiversity and agriculture.

4.1. About indicators

Many of the methods described establish indicators to inform about biodiversity status, commitments, actions, impacts, or results and outputs of policy measures. The indicators provide diverse information and have different advantages and disadvantages. For instance, impact indicators give information about progress towards an objective, but it can be difficult to measure change in short-term time frames and scales. Aggregate indicators are useful for large-scale assessment, but they might not be able to show relevant local information. Again, combining several indicators provides the most complete overview of the progress towards biodiversity targets.

The EU has systems in place to assess the links between agricultural activity and biodiversity in various ways that are strongly based on sets of indicators.

Because halting and reversing biodiversity loss is one of the objectives of CAP, **it is key that its indicators provide a good overview of the status of biodiversity and the progress towards enabling good conditions for biodiversity – in other words, sustainable agricultural practices.** It is also important that the links between result indicators, interventions and objectives are clear in the CAP strategic plans.

The Biodiversity Strategy for 2030 has few indicators on agricultural issues. The only indicators in the EU Biodiversity Strategy Dashboard that show progress on the strategy related to agriculture so far are the grassland butterfly index and 'area under organic farming'. Similarly, the Nature Restoration Regulation includes several indicators on agriculture: grassland butterfly index, 'stock of organic carbon in cropland mineral soils', 'share of agricultural land with high-diversity landscape features' and the Common Farmland Birds Index. **Adding further indicators on the links between agriculture and biodiversity would contribute to the better monitoring of progress towards the agricultural targets included in biodiversity policies.** Alternatively, the already developed CAP indicators could bring relevant information for assessing these policies. **In any case, a joint approach to monitoring, reporting and using all the data and indicators from these different processes would certainly help enhance efficiency.**

The EU's 8th Environmental Action Programme also sets indicators to monitor the progress towards environmental objectives related to agriculture. Most of the indicators measure the same issues as the previous policies, such as organic farming or birds, except for one indicator: land take per year – with a goal to reach no net land take by 2050. This indicator can provide very relevant information for future agricultural and biodiversity policy design.

The indicators included in the current EU policy assessment framework provide important information about biodiversity on farmland. However, additional information on the status of habitats, ecosystems or genetic diversity, or on the context and actions taken to increase biodiversity would help to achieve a more complete assessment of the impact of EU agricultural measures or targets on biodiversity.

Other assessment methods at the international level can guide the kinds of indicators that could be added. For example, the Kunming-Montreal GBF includes several indicators on:

- Genetic resources (complementary indicator for Goal A on conservation and biodiversity 'number of plant and animal genetic resources for food and agriculture secured in either medium- or long-term conservation facilities')
- Connectivity (component indicator 'maintenance and restoration of connectivity of natural ecosystems')
- Ecosystems (headline indicator for Goal A on conservation and biodiversity, 'IUCN Red List of Ecosystems')

At the same time, the EU framework to assess the biodiversity-agriculture nexus has some elements that could be helpful in the context of the global policy assessment methods, such as the GBF. For example, the CAP establishes several indicators on the uptake of specific agricultural practices that benefit biodiversity, such as the creation or maintenance of landscape features.

Integrating the information collected through the indicators from all the existing EU monitoring frameworks can be helpful for a more complete overview of the links between agricultural practices and biodiversity. For example, the land take indicator from the EU's 8th Environmental Action Programme, the grassland butterfly index or indicators from the EU Pollinators Initiative monitoring scheme can complement the existing indicators in the CAP PMEF.

4.2. The need for data

A common, transversal element of all the methods in this report is the need for robust data. The availability and accessibility of data are crucial in order to have comprehensive understanding of the current situation. The methods described use various data, collection methods and providers. Some methods use data from available databases or models at the global, national and regional levels, while others use data collected through the methodology prescribed by the assessment method. Many data collection methods exist; for example, satellite images and remote sensing, data collected from precision farming systems and other machinery, surveys at the farm level, and field assessments. The harmonisation of data collection approaches and methodologies is key for the comparability and integration of different assessment methods (UNEP, 2012). Despite the diversity of collection methods and sources, data are not always easily available. Often, biodiversity must be assessed indirectly through extrapolation or prediction models.

The methods analysed in this report show that data can be provided by different users: citizens, government, farm businesses or other companies. In the EU, for example, farmers provide data on the CAP, such as through the Farm Accountancy Data Network survey, and citizens collect data that contribute to assess the progress of the Farmland Birds Index, which is a CAP indicator.

Exploring further opportunities on how citizens, farmers and other economic actors can contribute to the collection of data might help to fill data gaps where governments do not reach, create ownership and awareness, and encourage users to apply the methods. **Combining the efforts of different actors would be positive for gathering the best knowledge possible on biodiversity in farmland.** For example, the IUCN Red List provides information on data availability for different species, and the category 'Data Deficient' can help identify gaps. This information could be useful to target funds in the EU and globally to improve data collection on the habitats of these species.

4.3. Linking assessment methods with funding support

Some examples in this report illustrate how biodiversity assessment methods could help to better target funding; for example, the results-based agri-environmental payment schemes in the CAP, or the use of the Global Farm Metric in relation to agricultural subsidies in the UK. Lessons learned from this analysis can be of use for EU policies. Directly linking results to funding could help encourage farmers to implement biodiversity-related measures and provide data on the progress towards the achievement of biodiversity objectives. However, achieving results often requires time and effort from the land managers or farmers. Furthermore, it would be important to also consider the progress towards creating the right conditions for biodiversity – in this case, farm practices. Therefore, **combining results and practices might be the most comprehensive way to link biodiversity assessment and public funding**.

Improving sustainability labelling in the EU is an important step in transitioning to sustainable food systems, as it would provide better guidance for buyers. However, it is challenging to develop a European label that applies across the EU, since it might not be able to reflect the specific geographical and ecological conditions of different countries and regions. **Establishing common EU criteria for regional or local labels might be a good way forward**, as the European Commission suggests in its recently published proposal for the Green Claims Directive (EC, 2023a). These standards would be useful in guiding food businesses in the transition to sustainability. They would allow national and sub-national labels to be adjusted to local contexts, while ensuring that they all follow a set of common, agreed-on standards.

Linking such labelling standards to sustainable agricultural practices, such as crop rotation, cover and companion cropping, mixed and intercropping, reducing synthetic pesticide and mineral fertiliser use, implementing no or minimal tillage, maintaining a lower livestock density, or applying managed and free-range grazing (Oberč & Arroyo Schnell, 2020), **could provide clear sustainability guidance to farm businesses. It would help farmers who use these practices to have a better position in the market**.

Recently, a study was presented to the European Parliament which explored the possibilities regarding certification linked to CAP greening measures. The study argues that certification schemes might be useful for promoting sustainable agricultural practices in the EU, using policies such as the good agricultural and environmental conditions or eco-schemes (Chever et al., 2022). **The links between the Green Claims Directive and the CAP could therefore be further explored**. Lessons from the biodiversity assessment methods criteria could also be applied to labelling, regarding the use of indicators, scale, etc. Moreover, linking specific assessment methods to labels might be a convenient solution, since they already provide a methodology and often have already been tested by farmers.

5. Conclusions

This report shows the diversity of assessment frameworks that are used to inform international and EU policy on the links between agriculture and biodiversity. It shows that a number of methods have been developed globally to improve knowledge about the links between agriculture and biodiversity, and ultimately to better design and implement policies that support biodiversity-friendly agricultural practices. The description of a selection of methods reveals that they have different purposes, target users, methodologies and applications, but also that they share many common characteristics.

Several of the international methods described have been designed to assess the impact of human activities, including agriculture, on biodiversity. Some of the methods show similarities, mainly in their purpose and target users, but also differences, mainly in their methodology: some are based on a bottom-up approach, such as the STAR metric, while others are based on a top-down approach, such as the Biodiversity Footprint, the GBS and the BII.

A different category of methods has also been described, with a focus on assessing the sustainability of agriculture. These methods generally share a common purpose – to help in the transition to sustainable agriculture by improving the assessment of progress – and target farmers as the main users. Some are self-assessment methods, and others are indicator frameworks, such as the Global Farm Metric and the Agrobiodiversity Index.

At the EU level, similarities can be quickly appreciated, as many frameworks for assessing the progress of different policies towards biodiversity conservation in relation to agriculture have common indicators and methodologies. However, the number of indicators on the biodiversity-agriculture nexus varies between frameworks. The *State of Nature* report under the Birds and Habitats Directives is the most comprehensive monitoring framework that assesses the status of biodiversity in the EU, and it includes the assessment of agricultural species and habitats. The CAP's assessment framework sets a list of indicators that focus on progress towards certain biodiversity-related targets in agriculture, such as the presence of landscape features or the status of farmland birds. The Biodiversity Strategy and the Nature Restoration Regulation have only a few indicators for assessing biodiversity in relation to agriculture. Several of these assessment frameworks use common indicators, mainly the Farmland Birds Index and the grasslands butterfly index. The EU's 8th Environmental Action Programme includes indicators on nitrate levels in groundwater and on land take, in addition to the already mentioned indicators.

A joint approach to monitoring, reporting and using all the data and indicators from these methods would help enhance efficiency and having the most comprehensive overview of the links between agricultural activity and biodiversity in the EU. In alignment with international indicators, such as the ones included in the GBF, it would be worth considering adding further indicators on the links between agriculture and biodiversity, such as on genetic resources, connectivity and ecosystems.

Finally, integration among global methods and the EU – mostly by sharing data – and standardising data collection methods and processing to allow comparability might help build a more detailed and complete picture of the impacts of biodiversity policies and actions in the field.

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