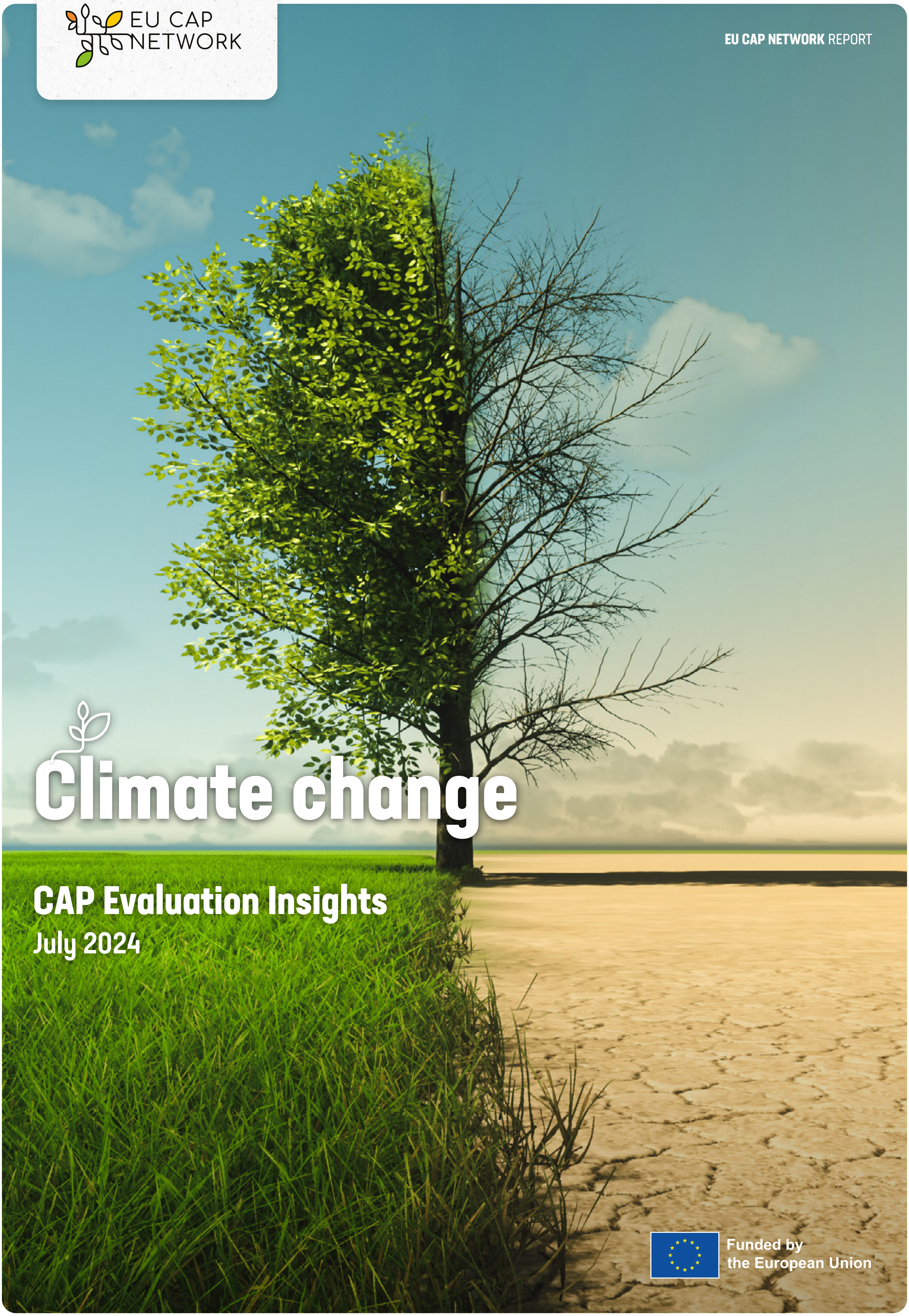

EU CAP NETWORK

EU CAP NETWORK REPORT

Climate change

CAP Evaluation Insights

July 2024

Funded by the European Union

Recommended citation:

EUROPEAN COMMISSION – Directorate-General for Agriculture and Rural Development – Unit A.3 (2024): CAP Evaluation Insights: Climate Change.

EU CAP NETWORK

The European Evaluation Helpdesk for the CAP is responsible for providing support for monitoring and evaluation activities at the EU and Member State level. It works under the guidance of DG AGRI's Unit A.3 (Policy Performance Unit) of the European Commission. The European Evaluation Helpdesk for the CAP supports all evaluation stakeholders, in particular DG AGRI, national authorities, Managing Authorities and evaluators, through the development and dissemination of appropriate methodologies and tools; the collection and exchange of good practices; capacity building and communicating with network members on evaluation-related topics.

Additional information about the activities of the European Evaluation Helpdesk for the CAP is available on the Internet through the Europa server [https://eu-cap-network.ec.europa.eu/support/evaluation].

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List of acronyms

CMEF	Common Monitoring and Evaluation Framework
DiD	difference in differences
ECA	European Court of Auditors
EEA	European Environment Agency
ERDF	European Regional Development Fund
EAFRD	European Agricultural Fund for Rural Development
FoS	Factors of Success
GHG	greenhouse gas
GVA	gross value added
IACS	Integrated Administration and Control System
JC	judgment criteria
LCA	Life cycle assessment
LPIS	Land Parcel Identification System
NAP	National Adaptation Plans
NIR	National Inventory Report
PMEF	Performance Monitoring and Evaluation Framework
RD	Rural Development
RDP	Rural Development Programme
SOC	soil organic carbon
TOE	Tonne of oil equivalent
UAA	Utilised agricultural area

Acknowledgements

'CAP Evaluation Insights: Climate Change' has been developed in the framework of the EU CAP Network supported by the European Evaluation Helpdesk for the CAP.

The work was coordinated by Carina Folkeson Lillo and has been co-authored by Dimitris Skuras, Carina Folkeson Lillo, Valdis Kudins, Anna Gregis and Kaley Hart. Representatives from DG AGRI contributed to the coherence and consistency of the report. Margherita Sforza supported the editorial quality and visual appearance of the final report.

Questions and suggestions regarding the content of the publication can be addressed to the European Evaluation Helpdesk for the CAP at evaluation@eucapnetwork.eu.

European Union country codes sorted by official protocol order

Member State	Country codes
Belgium	(BE)
Bulgaria	(BG)
Czechia	(CZ)
Denmark	(DK)
Germany	(DE)
Estonia	(EE)
Ireland	(IE)
Greece	(EL)
Spain	(ES)
France	(FR)
Croatia	(HR)
Italy	(IT)
Cyprus	(CY)
Latvia	(LV)

Member State	Country codes
Lithuania	(LT)
Luxembourg	(LU)
Hungary	(HU)
Malta	(MT)
Netherlands	(NL)
Austria	(AT)
Poland	(PL)
Portugal	(PT)
Romania	(RO)
Slovenia	(SI)
Slovakia	(SK)
Finland	(FI)
Sweden	(SE)

Introduction

This publication presents findings identified from Member States' CAP evaluations in relation to climate change mitigation and adaptation. Over the last two programming periods, the climate transition, e.g. both improving farmers' resilience and adaptation to climate change and reducing agriculture's impact on climate, has become a key priority of the CAP and other strategic EU policies [1], such as the European Green Deal, the Farm to Fork strategy, the EU Biodiversity strategy for 2030, the EU Climate Risk Assessment and the European Climate Law.

In support of the EU CAP Network, the European Evaluation Helpdesk for the CAP (Evaluation Helpdesk) ongoingly identifies and collects evaluations undertaken by Member States in relation to the CAP to build the CAP evaluation database. The database serves multiple purposes, including allowing the identification of common findings on related topics and the identification of good and recommendable evaluation practices. Some relevant evaluations from this database are published on the EU CAP Network website.

This publication contains a review of the evaluations in the CAP evaluation database related to climate change mitigation and adaptation, thus gathering the available empirical research on the topic, grouping findings with a similar focus and drawing first conclusions on the trends observed. Also, it contains ideas on how to overcome common challenges confronted while undertaking these evaluations, based on a sample of evaluations that have undergone in-depth appraisals by experts in the field. Hence, the publication is not an attempt at undertaking a meta-analysis, which would imply a statistical process of analysing and combining results from several similar studies in order to produce new findings.

As such, the aim of this publication is to inspire the reader to go deeper into the evaluations reviewed. It should serve both as a reference for the reader looking for examples of findings from the evaluations undertaken by the Member States in relation to the CAP and climate change, and to inspire future evaluators of the topic by sharing good evaluation practices identified in some of these reports.

First, an overview is provided regarding the frequency with which these evaluations have been undertaken in individual Member States as well as an explanation of the type of evaluations done. The second chapter provides examples of the findings from these evaluations, together with a brief analysis of these. Finally, the third chapter looks at some of the challenges commonly confronted while undertaking evaluations on the topic, including suggestions for how these can be overcome to inspire future evaluators.

[1] https://www.consilium.europa.eu/en/policies/climate-change/eu-climate-action/

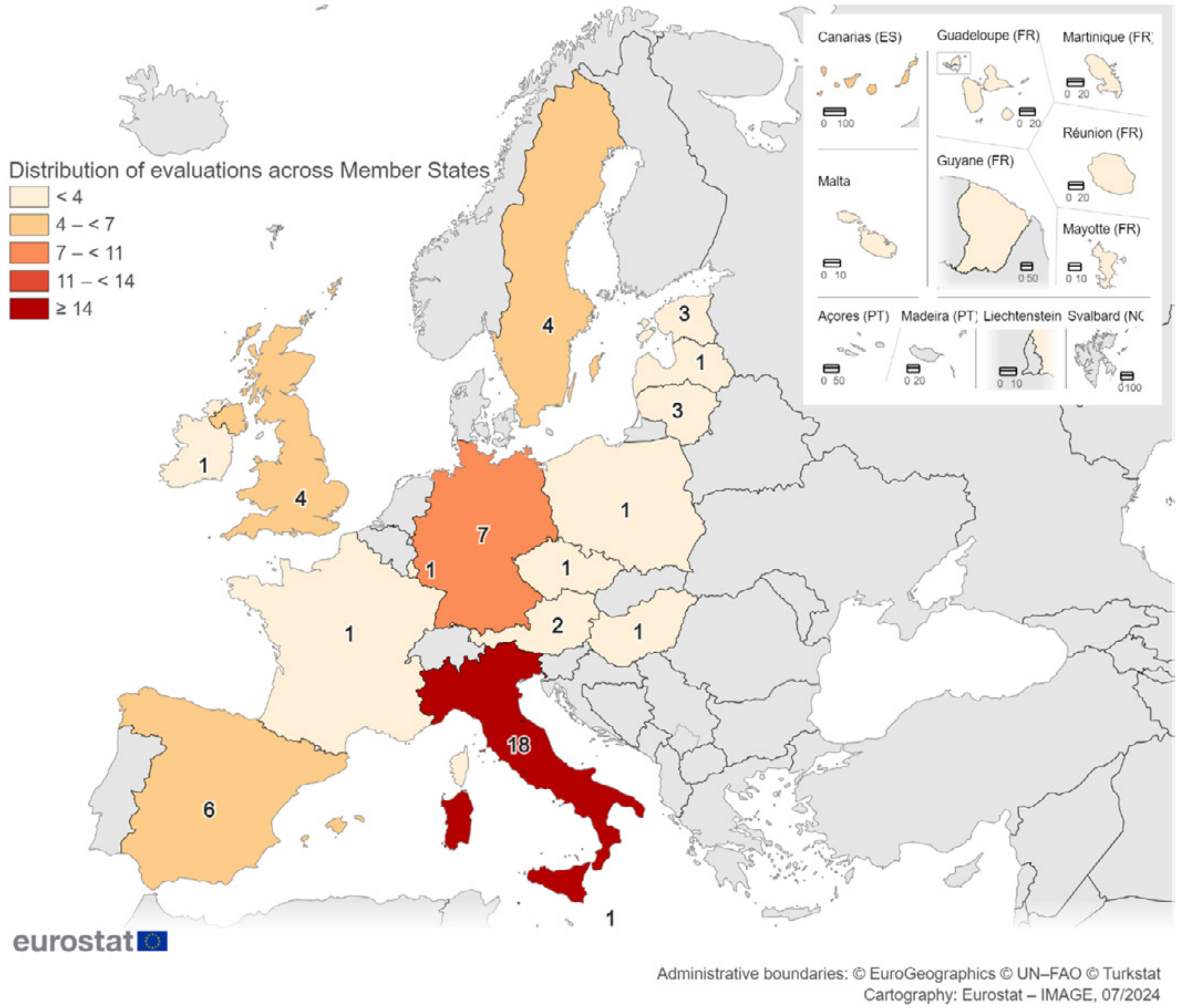
1. Where do we stand?

At the time of writing, 55 evaluations undertaken by Member States between 2018 and 2024 (April) have been identified to be of relevance in relation to the CAP and climate change (Annex I). From here on, these are referred to as CAP climate change evaluations. These evaluations have been identified from over 500 evaluations stored in the CAP evaluation database of the Evaluation Helpdesk [2]. Note that additional Member State evaluations of relevance may be available, however those have not yet come to the knowledge of the Evaluation Helpdesk.

The identification of CAP climate change evaluations was done both on the basis of the expressed objectives of the evaluations, as well as from the identification of findings related to climate change (including for those where climate change was not directly expressed as the focus of the evaluation). This chapter outlines the main characteristics of these evaluations.

CAP climate change evaluations have been identified from 15 Member States and the UK. Among the 55 CAP climate change evaluations identified, the highest number of evaluation stem from Member States with regional Rural Development Programmes (RDP), namely Italy (18 evaluations), Germany (7) and Spain (6). For the remaining Member States (Austria, Czechia, Estonia, France, Hungary, Ireland, Lithuania, Luxemburg, Latvia, Malta, Poland, Sweden and the United Kingdom). There are currently between 1-4 evaluations for each of these countries in the database (Figure 1) [3].

Figure 1. Climate change-related evaluations undertaken by Member States (15 Member States and the United Kingdom) between 2018 and April 2024



Source: CAP evaluation database (2024), EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2024)

[2] The CAP evaluation database of the Evaluation Helpdesk consists of the CAP-related evaluations undertaken by Member States since the previous CAP programming period (2014-2020).
[3] Among the sources available in the CAP evaluation database, no climate change-related evaluations were identified in the following Member States: Belgium, Greece, Portugal, Bulgaria, Romania, Slovenia, Denmark, Croatia, Slovakia, Finland and Cyprus. However, such evaluations may exist, although not identified by the Evaluation Helpdesk.

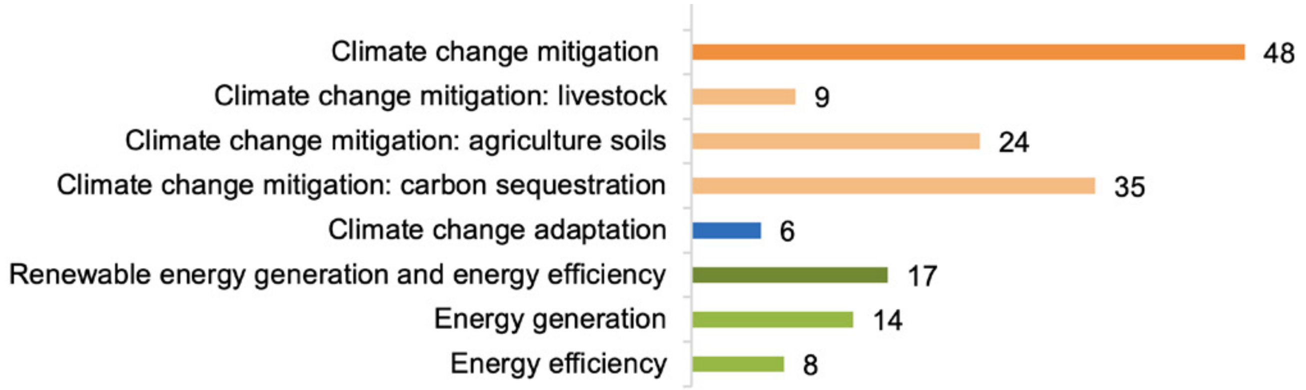
Concerning the year of publication, most of the climate change-related evaluations (46) available in the CAP evaluation database were published by the Member States in 2021 and 2022, while four were published in 2023, one in 2024 and the remaining five between 2018 and 2020.

At this stage, there are still no relevant evaluations related to the 2023-2027 programming period available in the CAP evaluation database. Therefore, the scrutiny of the publications selected follows the rural development (RD) policy framework for the 2014-2020 programming period based on six RD policy priorities [4]. During this period, the RDPs were designed to respond to these priorities, taking into account national and regional circumstances. Evaluations were also designed to follow this logic. Thus, the 55 evaluations in the database with relevant findings about CAP and climate change can be grouped into four categories depending on their scope:

1. Evaluations with a specific focus on 'RD Priority 5 – Resource efficiency, low carbon and climate-resilient economy' (13 evaluations) [5].
2. Evaluations with a specific focus on 'RD Priority 4 – Ecosystems related to agriculture and forestry' (12 evaluations) [6].
3. Evaluations that more globally address the CAP environmental impacts (Sustainable management of natural resources and climate action) (11 evaluations) [7].
4. Evaluations that address multiple RD priorities, including evaluations that address 'RD Priority 3 – Food chain organisation, animal welfare, and risk management', 'RD Priority 2 – Farm viability' and competitiveness priorities 2 and 3 (19 evaluations) [8].

Furthermore, the 55 evaluations have also been grouped according to the types of climate change findings identified (as further discussed in Chapter 2). Forty-eight of the relevant evaluations contain findings related to climate change mitigation, of which 35 contain findings related to carbon sequestration, 24 relate specifically to agriculture soils and nine to livestock. Seventeen of the 55 evaluations contain findings related to energy topics, of which 14 treat renewable energy generation and eight energy efficiency. Finally, only six of the evaluations have findings related to climate change adaptation. It should be noted that the same evaluation can have findings related to several topics, whereby the total number does not add up to 55 (Figure 2).

Figure 2. Classification of 55 evaluations grouped according to the types of climate change findings identified in Chapter 2.



Source: CAP evaluation database (2024), EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2024)

The evaluations are also classified according to the type of evaluation. For this purpose, four categories are used as described below (Table 1).

[4] The rural development policy priorities for the CAP 2014-2020 policy framework are: 1) Fostering knowledge transfer and innovation in agriculture, forestry, and rural areas; 2) Enhancing farm viability and competitiveness of all types of agriculture in all regions and promoting innovative farm technologies and sustainable management of forests; 3) Promoting food chain organisation, including processing and marketing of agricultural products, animal welfare and risk management in agriculture; 4) Restoring, preserving and enhancing ecosystems related to agriculture and forestry; 5) Promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors; and 6) Promoting social inclusion, poverty reduction and economic development in rural areas. Source: Article 5 of the Regulation (EU) 1305/2013 http://data.europa.eu/eli/reg/2013/1305/oj

[5] An example of this category is the 'Study on the volume of renewable energy produced in agriculture and the food industry with the help of Estonian RDP 2014-2020 subsidies', undertaken by Estonia (Ref. 11).

[6] An example of this category is the 'Adaptation to climate change in EU programmes 2014-2020', undertaken by Sweden (Ref. 48).

[7] An example of these evaluations is the 'Effects on water and climate protection: An analysis of operational nutrient comparisons of the Lower Saxony-Bremen RDP 2014-2020 selected land measures', undertaken by Germany (Ref. 7).

[8] An example of this category is the study undertaken by Hennen, Germany, 'Evaluation of the promotion of investments in the processing and marketing of agricultural products' (Ref. 8).

Table 1. Climate change-related evaluations across evaluation types

Type of evaluation	Definition	Numbers of Evaluations
Impact-oriented evaluation	Evaluation that captures the higher-level effect (impacts) of a programme/intervention against a baseline situation (with or without a counterfactual approach).	26
Result-oriented evaluation	Evaluation that captures achievements of results by beneficiaries in relation to targets planned but does not necessarily capture effects against a baseline situation.	23
Process-oriented evaluation	Evaluation that assesses how a programme/intervention is implemented (e.g. governance, delivery system, communication, technical assistance and networks).	1
Research study supporting evaluation	Analytical work that supports evaluation without assessing the effect of the programme/intervention (e.g. context analysis, environmental monitoring study, study to develop evaluation methods and identification of data gaps).	5

Source: CAP evaluation database (2024), EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2024)

Thus, the CAP evaluation database contains CAP climate change evaluations from all four categories. However, for this report, the Evaluation Helpdesk focuses on impact-oriented (26) and result-oriented (23) evaluations [9]. In addition, the CAP evaluation database contains five climate change-related research studies [10].

[9] For the reader that wants to look at examples of these types of evaluations, an example of an impact evaluation is the study undertaken by Pays de la Loire, France, on "Evaluation of the impact of the ERDF and EAFRD programmes on climate change adaptation and mitigation (Priority 5 and LEADER)" (Ref. 19) , while for result evaluation, Lithuania undertook the study on "Evaluation of the effectiveness of Measure 10 'Agri-environment and climate of the Lithuanian Rural Development Programme for 2014-2020" (Ref. 39).

[10] An example of climate change related research includes "Reduction of greenhouse gases in agriculture" undertaken by Austria (Ref. 46), and one relevant process evaluation (Analysis of the typologies of investment supported through measure 4.1 of the Murcia RDP, Spain, Ref. 14).

2. What has been found?

Before presenting the evaluation findings, the wider policy context has to be considered. Non-CO_2 emissions from agriculture account for 11% of the EU's total net greenhouse gas (GHG) emissions and have remained largely unchanged since 2005 [11]. Agriculture directly generated 366 Mt CO_2-eq of GHG in 2022. Enteric fermentation in livestock accounts for 49.4% of total agricultural emissions, agricultural soils for 29.6% and livestock manure management for 17% [12]. A European Court of Auditors (ECA) report [13] attributed the inability to reduce emissions to several factors, including the absence of specific measures in the CAP to reduce livestock numbers or effectively incentivise emission reductions, the stable emissions from cultivated drained organic soils, the increase in emissions from chemical fertilisers and manure, and the stable emissions from livestock [14]. In its response, the Commission acknowledged the lack of national mitigation targets, although there are national commitments for CO_2 net removals under the land use, land use change, and forestry (LULUCF) regulation [15]. The Commission also accepted ECA's recommendation "to ensure that the CAP provides effective incentives to reduce greenhouse gas emissions from livestock and fertilisers that contribute to achieving EU climate goals" [16]. Encouraging renewable energy generation and use and promoting energy efficiency in agriculture is part of the Member States' response to support agricultural decarbonisation in line with the EU and National Energy and Climate Plans (NECPs). Since 2013, the inclusion of adaptation as an objective within the CAP was a response to the need to address the impacts of climate change on the agriculture sector. A 2019 European Environment Agency's (EEA) report expressed fears concerning the prioritisation of mitigation over adaptation, the lack of diversity in adaptation measures and possible maladaptation efforts [17].

In this context, understanding what has been found in the evaluations undertaken by Member States related to the CAP and climate change is of significant value. The Evaluation Helpdesk has reviewed and extracted findings from the 55 CAP climate change evaluations stored in the CAP evaluation database (as described under Chapter 1), allowing for common findings to be extracted. Thus, this is not an exhaustive synthesis of all findings related to climate change and the CAP from Member State evaluations, but rather represents important snapshots of findings from those evaluations identified and stored in this database.

As described in Chapter 1, the 55 evaluations from which relevant findings have been extracted all had different scopes, objectives, assumptions and limitations. Also, they all focused on different geographical areas and evaluation periods and reflected very different study contexts. When summarising findings, this information is not reflected. Hence, while this chapter aims to provide a sense of the types of findings identified, they are presented without acknowledging most of the assumptions underlying the studies at hand, or taking into account the context in which these findings were identified. Nonetheless, the presentation of findings from the evaluations shows the variety of topics addressed, including the variety of findings, and aims to inspire the reader to further explore the reviewed evaluations.

The findings identified are presented below in relation to the main agricultural policy themes of climate change mitigation, including carbon sequestration, climate change adaptation and energy, which includes the production of renewable energy and efficient use of energy.

2.1. Climate change mitigation Livestock (enteric fermentation and manure management)

2.1.1. Livestock (enteric fermentation and manure management)

The livestock sector emits 66.5% of the agriculture sector's total emissions [18]. The CAP targets emissions from the livestock sector and supports the EU's methane strategy and the EU's combat against ammonia. The measures that particularly target this include investments for manure treatment and storage, promotion of methane-low diets and support for selective breeding, animal health and welfare.

Nine evaluations present findings related to the mitigation of GHG from the livestock sector by considering measures designed to manage enteric fermentation or manure or the reduction in livestock numbers [19]. A majority of the eight evaluations that deal with manure management show the significant mitigation opportunities from investments in manure treatment, storage, transportation and land application. For example, the Italian evaluation from Emilia-Romagna (Ref. 20 [20]), showed how an investment measure supporting manure management that affected 4% of the regional livestock numbers resulted in a 5.7% and 20.6% reduction of the 'pre' intervention GHG emission and ammonia levels respectively. In Ireland, the review of the Beef Data and Genomics Programme (Ref. 12) forecasts that, by improving the quality and efficiency of the beef herd through genomic selection, the sector could emit 67.8 Kilotonnes (kt) (2%) less CO_2-eq in 2030 compared to 2020 for a constant population level versus the counterfactual of no scheme in place. In Austria, the evaluation (Ref. 45) shows that measures in the livestock sector can reduce ammonia emissions by 2.6%

[11] European Scientific Advisory Board on Climate Change, 2024, *Towards EU climate neutrality: progress, policy gaps and opportunities* (p.153).
[12] Eurostat. Greenhouse gas emissions by source sector. Online data code:env_air_gge. DOI:10.2908/env_air_gge, last update:18/04/2024
[13] European Court of Auditors, 2021, *Special report 16/2021: Common Agricultural Policy and climate: Half of EU climate spending but farm emissions are not decreasing*.
[14] See note 13
[15] Regulation (EU) 2018/841 on land use, land use change, and forestry https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02018R0841-20230511
[16] *Replies of the European Commission to the European Court of Auditors special report: "Common Agricultural Policy and climate: half of EU climate spending but farm emissions are not decreasing"*
[17] European Environment Agency (EEA), 2019, *Report No 4/2019: Climate change adaptation in the agriculture sector in Europe*.
[18] Eurostat. Greenhouse gas emissions by source sector. Online data code:env_air_gge. DOI:10.2908/env_air_gge, last update:18/04/2024
[19] Nine evaluations in AT, DE, IE, IT. The Irish study (Ref. 12) deals exclusively with a measure concerning the genetic improvement of livestock for reducing GHG emissions through improved fermentation. The Austrian (Ref. 46) and German (Ref. 2) studies include, among others, scenarios of GHG emissions after reduction in livestock numbers.
[20] Reference numbers refer to Annex I, where there is an overview of the whole set of Member State evaluations analysed for this publication.

despite the higher livestock numbers and larger quantities of mineral fertiliser. The measures included interventions in animal welfare that can reduce ammonia emissions by 1 842 tonnes annually in 2017, followed by 1 273 tonnes using drag hose land application of manure and 184 tonnes from investments in solid manure storage.

Greater reductions in GHG emissions can be easily attained by reducing livestock numbers, as demonstrated by two macro simulations. In Baden-Wurttemberg (Ref. 2) it was found that a 38% reduction in GHGs can be achieved by a scenario that simultaneously decreases livestock numbers by 30%, increases the area covered by legumes to 15% and supports rewetting of agricultural peatlands. In Austria (Ref. 46), a simulated 40% reduction in overall GHG emissions by 2040 was estimated by a drop in the cattle population by 28.1%. This scenario assumes, among others, the restoration of all organic soils under agricultural management, the transition to a climate-friendly diet, a 33% reduction in the price of milk, taxes on methane emissions from enteric fermentation and from manure, premiums for reducing the number of ruminants and the stable space capacity, considerable reductions in mineral nitrogen fertilisers and others. These scenarios were found to have "unreasonable income losses" in Germany (Ref. 2) and serious economy-wide gross value added and job losses in Austria (Ref. 46). In certain variants of these scenarios the evaluators observe the emergence of significant knock-on effects. For instance, the reduction in livestock numbers in the simple scenario with additional measures in Austria causes a rise in the need for inorganic fertilisers, which increases greenhouse gas and ammonia emissions and erodes the net effects of livestock reduction (Ref. 46).

2.1.2. Agricultural Soils

The CAP pursues multiple objectives related to agricultural soils which can be obtained from undertaking a wide range of farming practices. These practices reduce the use of nitrogen fertilisation directly or indirectly. For example, organic agriculture prohibits the use of synthetic nitrogen fertilisers, while other land uses, such as set-aside land, like buffer strips, do not need any fertilisation. The reduction of nitrogen fertilisers and reduced cultivation of organic soils [21] also supports improved water quality, improved air quality due to lower ammonia emissions, increased organic matter and soil water retention capacity, protection against soil erosion, improved soil biodiversity and the ability of areas to support wildlife, as well as other essential services which directly or indirectly contribute to climate change mitigation by reducing greenhouse gas emissions. Many of these practices also support increases in soil carbon content.

A substantial amount of agricultural land was under area-based mitigation commitments. The effect of these commitments depends on the type of farm practices supported within the commitments. According to the 25 evaluations that present findings related to the mitigation of GHG from farm practices on agricultural soils, the types of measures that have been found to achieve measurable GHG reduction effects include, among others, organic farming and integrated production methods, low emission application of farm manure (Ref. 7), set-aside land (Ref. 20), strips or plots of melliferous plants and stubble fields during winter (Ref. 39), no-till after cultivation with maise and cultivation of hardy catch crops (Ref. 7).

Many of these evaluations found that the RDPs had significant uptake rates for these measures i.e. the percentage of utilised agricultural area (UAA) committed to GHG emission reduction is significant. However, at the same time, the evaluations found that for almost all farming practices except for organic agriculture, the effects in terms of reduced CO_2-eq emissions were not always very satisfactory. For example, the RDP in Puglia (Ref. 30) supported 275 229 hectares, or 18.5% of the regional agricultural area for GHG reduction. However, the evaluated nitrogen fertiliser reducing measures had no discernible effect with GHG reduction accounting for only 1.61% of the annual total agricultural emissions in Puglia, or 7% of the emissions from the mineral fertiliser sector. In accordance with this, the Marche region (Ref. 32) found that the commitment of 18% of its total UAA to reducing GHG emissions led to an annual 1.9% decrease in emissions from agriculture or a 5.3% reduction in emissions from mineral fertilisers. In Umbria (Ref. 33), the simultaneous action of all measures dedicated to reducing GHG emissions attained an annual reduction of 1.9%.

Organic agriculture and integrated production are found to be the most important farm practices for the reduction of GHG emissions from agricultural soils, reduction of ammonia and increase in carbon sequestration (Ref. 24). At least 18 of the 25 evaluations present findings confirming the importance of organic agriculture among all other farm practices in mitigating GHG emissions from agricultural soils. In the Italian region of Marche (Ref. 32), GHG reductions from agricultural soils were overall found to be low, but 99% of them were due to organic agriculture, while in the region of Umbria (Ref. 31) the corresponding contribution is also very high at 54% with the remaining 46% attributed to integrated cultivation methods.

Other farm practices also contribute to the reduction of GHG emissions from agricultural soils. However, due to their low uptake, their small impact, or the more important soil carbon sequestration service they offer, the quantification of their effect is neglected by evaluations. Such farming practices included, for example, protection strips along watercourses and the maintenance of landscape elements, for instance hedgerows or individual trees in fields.

In a notable exemption, the evaluation in Lithuania (Ref. 39) calculated that the measure "Strips or plots of melliferous plants or fields in arable land", intended for improving biodiversity and the landscape and supporting pollinators, reduced GHG emissions by 0.6 kilotonnes (kt) of CO_2-eq and ammonia emissions by 5.5 tonnes due to no fertilisation and highlighted the multidimensional effects of farm practices.

The effect of no cultivation of organic soils (such as peatlands) on GHG mitigation is also important and has a significant emission reduction capacity. In at least four out of the 25 evaluations that provide information on how agricultural soil management affects greenhouse gas mitigation, organic soil management is included in GHG reduction scenarios (Ref. 2, 46), and is considered a significant option (Ref. 50) or has already been implemented (Ref. 55). In Sweden it was found that organic soils play a crucial role in reducing GHG emissions (Ref. 50). The Swedish Board of Agriculture calculated that a rewetting of all organic agricultural soils would entail a reduction in GHG emissions of 2.2 million tonnes CO_2-eq which in 2022 accounted for 89% of all GHG emissions from agricultural soils and 33.8% from the whole agricultural sector in Sweden.

[21] Rich in organic matter and undigested plant material are soils known as histosols, or organic soils. These can be found in places where persistent moisture (in the Wet Tropics) or frigid temperatures (in Boreal climates) hinder the breakdown of organic matter. Histosols typically have low fertility (FAO Soils Portal).

2.1.3. Carbon sequestration

On several different types of land, various approaches and farm practices can support effective carbon sequestration above and below ground. Among them, the maintenance or conversion to temporary grasslands, management of permanent grasslands, measures protecting and expanding forest areas, rewetting of wetlands and peatlands, and various carbon enhancing or carbon conserving farm practices contribute to increased soil and biomass carbon storage, such as the cultivation of catch and cover crops, no or low tillage agriculture, residue management and many others. In total, 35 evaluations present findings related to these carbon sequestration practices.

Temporary and permanent grasslands are an effective farming practice for improving soil organic carbon. Of the 35 evaluations that examine carbon storage, at least 20 explore the implications of managing both temporary and permanent grasslands. In Luxembourg, the introduction of temporary grassland in the crop rotation seems the most effective practice for improving soil organic carbon (SOC) content in croplands (Ref. 42). In Sweden, temporary grass is supported through environmental compensation in southern and central Sweden, which was shown to have a higher effect on carbon sequestration than farm practices like the cultivation of catch crops or maintaining buffer zones. In Lithuania (Ref. 39), maintenance and non-drainage of permanent grasslands prevented the loss of 86.2 kt CO_2-eq and absorbed 2 kt CO_2-eq of GHG emissions. However, findings from a German evaluation (Ref. 2) warn that declining profitability of permanent grassland use can reduce both the willingness to maintain permanent grassland and the propensity to convert arable land into permanent grassland.

Eighteen evaluations highlight the potential of RDPs to contribute to an increase in organic carbon storage in forest biomass. The measures assessed include agroforestry and the afforestation of agricultural land, silvicultural practices for improving and maintaining woodlands, restoration and maintenance of wood pastures by planting tree saplings on semi-natural grassland, protecting forests from wildfires or other extreme phenomena, and other practices that maintain carbon storage or promote carbon sequestration. As an example, the investments supported in Emilia-Romagna (Ref. 24) were estimated to have led to an increase of 26.213 tonnes of CO_2-eq per year, approximately 47% of its target value (as set by the region's steering group). In the Balearic Islands, Spain (Ref. 16), 55.45% of the total forested area was supported through the RDP forestry measure (M8.1) and wooded forest area grew by 8% and dispersed woodland by 4.4%, due to support for afforestation of agricultural land. In Lithuania, an area of 133,251 hectares (ha), or 2.67% of all land (Ref. 40) registered for agriculture and forestry, was supported in 2020 and contributed to sequestering and retaining carbon dioxide.

At least seven evaluations identify soil carbon sequestration opportunities related to peatlands, moorlands and wetlands. Such measures include fully or partly rewetting wetlands and peatlands, conservation and avoidance of drainage, and continuous maintenance of green cover over peatlands. It is important to underline that most measures addressing wetlands and moorlands have important impacts on farm biodiversity and the rural landscape. In Lithuania, it was found that the measure "Conservation of aquatic warbler habitats in natural and semi-natural grasslands" prevented drainage of carbon rich grasslands and supported the sequestration of 1.4 kt of CO_2-eq.

Evaluations also estimate the impact of other farm practices on soil organic carbon content. For example, organic farming in Sardegna (Ref. 35) or maintenance of buffer strips along watercourses in Sweden (Ref. 49) show good results. The cultivation of cover and catch crops was beneficial for soil carbon enhancement in Sweden (Ref. 49), but of questionable value in Luxemburg (Ref. 42) since it was selected by silage maise cultivators to confront excess humus consumption by maize.

2.1.4. Challenges for the CAP in reducing GHG emissions and supporting carbon sequestration

Some concerns about organic agriculture's effectiveness in GHG emission reduction and carbon sequestration are raised in several studies. A general concern is related to the lower yields of organic cultivation, which may be offset by increased imports and the consequent emission leakage i.e. a shift of emissions to the exporting country without reducing global emissions. None of the evaluations measured the impact of emission leakage. A German study (Ref. 2) argued that the quantification of the GHG reduction due to organic farming is not easy because the yield is usually lower and more extensive farms tend to convert (self-select) to organic production. The Polish study (Ref. 47) indirectly confirms this perspective by finding that organic farming was located, relative to average soils, on soils with lower acidity, levels of assimilable nutrients [22] and erosion. In fact, a counterfactual analysis undertaken by this study indicated possible negative effects of organic agriculture consisting of (a) reducing soil total organic carbon (TOC) and (b) increasing erosion. The Swedish study (Ref. 49) highlights research suggesting that organic farming has negative direct and indirect effects on soil carbon storage and underlines the need "to interpret the results of organic farming with caution as it is very difficult to carry out appropriate and fair assessments of the effect of organic farming systems, as these systems involve many factors that operate simultaneously".

The potential of restoring and protecting organic soils, which, is a potential option with significant emission reduction capacity, may be confronted by high costs, as well as legal, institutional and feasibility constraints. In Sweden, where organic soils play a crucial role in reducing GHG emissions, the evaluation calculated the private costs of rewetting per kilogramme. The evaluators concluded that the costs are 'almost disproportionate' if only the climate mitigation effect is taken into account (Ref. 50). In Baden-Wurttemberg, Germany (Ref. 2), the evaluation warned that it is generally not possible to raise water levels in individual areas or at the farm level. It concluded that rewetting may be a lengthy, conflictual and complex project requiring a broad mix of instruments and measures to overcome institutional, legal and technical barriers. An evaluation undertaken by the Lower Saxony-Bremen, Germany (Ref. 4), confirms these findings and argues that for a successful rewetting of peatlands, land should first be made available through acquisition, followed by land consolidation and the technical implementation of irrigation. This land readjustment ideally requires a lead time of several years.

In addition, and besides institutional, legal and technical barriers, some studies argue that the net effects of rewetting are considerably lower because rewetting causes methane emissions which should be taken into account for the complete picture (Ref. 46, 52). In addition, experts in Sweden (Ref. 49) believe that aid for conversion to temporary grassland has very low additionality i.e. conversion would have been largely implemented even without support from the RDP.

[22] Phosphorus pentoxide, potassium oxide, magnesium (P205, K20 and Mg).

2.2. Climate change adaptation

Although climate change adaptation is commonly supported through RDPs, only six evaluations have been identified to explicitly address the topic. All RDPs for the past programming period included elements of climate change adaptation, whether through actions meant to protect output from extreme weather events, foster immediate recovery and resilience, or provide a more comprehensive, long-term overhaul of the agricultural system. For example, the evaluations of Emilia Romagna, Italy (Ref. 24), and La Rioja, Spain (Ref. 18), focus on climate change's effects on certain regions and suggest various adaptation strategies. The UK (Ref. 52) study proposes an integrated methodology to determine the contribution of agri-environment agreements to climate change adaptation for biodiversity at a landscape and catchment scale.

Various RDP investment measures for water and soil resources and farm practices can contribute towards adaptation, such as crop rotation. The Emilia-Romagna evaluation (Ref. 24) examines how RDP actions can benefit the eight risk areas identified by the Emilia-Romagna Climate Change Adaptation Strategy. The study concluded that many of the RDP's investment strategies generally contributed towards adaptation. For instance, water-saving investments in irrigation infrastructure protect water tables from over-abstraction in periods of high temperatures and mitigate the risk of production loss due to heat stress. Another example considers investments that control the temperature in stables, improving both the welfare of the animals and their ability to produce.

Climate change adaptation activities for important crops in La Rioja (Ref. 18) were investigated by an evaluation assessing the potential contribution from several different agri-environment measures of the RDP. For instance, measures to improve the soil structure and enhance water retention rate in anticipation of prolonged periods with higher temperatures. The preservation of terraces in specific sensitive and vulnerable woody species systems, particularly in almond and olive groves, in preparation for the increase in the frequency of intense precipitation phenomena. Furthermore, the study recommended actions related to taking up crop insurance, changing harvesting techniques, increasing pest control, adopting climate-friendly farming methods and increasing irrigation requirements to better adapt to the impacts of climate change.

When simulating future GHG emissions, consideration is given by the Austrian study (Ref. 45) to the adaptation activities that farmers and the local government will undertake as a response to climate change, even without planned policy support. Among other things, the study investigates whether Austrian agriculture can achieve zero net emission levels by 2040 with the CAP Strategic Plan's (CSP) current measures. The study is distinctive in that it makes the assumption that, over time, there will be some adaptation in response to climate change while modelling the effects of current and new policies. Consequently, it incorporates climate change adaptation into its macroeconomic model by permitting price fluctuations as a mechanism for adaptation, anticipating irrigation investments to guarantee water supply and achieving higher yields through innovative farming practices.

Lastly, it should be mentioned that National Adaptation Plans (NAPs), identify the vulnerabilities to climate change and establish strategies to become more resilient in the face of those vulnerabilities. NAPs integrate climate change adaptation into existing policies and programmes across different sectors, including agriculture. They recommend the majority of the adaptation measures found in the RDPs from the previous programming period as well as the CSPs for the 2023-2027 period. Thus, if evaluators are uncertain of what adaptation means in their region and whether the RDP has taken adaptation strategies into consideration, the NAP is very illuminating. The reviewed evaluation studies, however, hardly ever mention NAPs or examine whether the recommended courses of action were taken into account.

2.3. Renewable energy generation and energy efficiency

Despite supporting many rural projects, the CAP is a limited driving force behind the transition to renewable energy in agriculture or rural areas as identified in Member State evaluations. Seven-teen evaluations out of the 55 deal with energy issues, out of which 14 with renewable energy generation and eight with energy efficiency (some evaluations treat both topics).

For example, in Czechia (Ref. 1), the RDP contribution to the total annual renewable energy was found to be 0.29%. In Pays de la Loire (France), the overall effect of the RDP was 1% of the total capacity for renewable energy production (Ref. 19). Five Italian studies show that the effect of the RDP support for renewable energy is limited. In Marche (Ref. 32) investments generated only 91 tonnes of oil equivalent (TOE) annually. In Aosta Valley (Ref. 27), evaluators observe that administrative challenges and town planning or landscape-related restrictions significantly impede good intentions and the growing interest in energy production from renewable sources. In Emilia-Romagna, by the end of 2020, the RDP (Ref. 24) had directly and indirectly contributed to the construction of a capacity of 1 153 TOE which is 0.63% of the annual regional electricity consumption in agriculture.

In Veneto (Ref. 21), supported investments produced 7 180 TOE per year in 2020 (both thermal and electrical energy), which corresponded to 0.8% of the thermal energy used regionally and 4.2% of the total electrical energy produced from biomass in the region. In Sicily (Ref. 36), the RDP supported 1% of the region's total photovoltaic capacity. Furthermore, although the RDP in Hungary (Ref. 43) supported 4 723 projects with an estimated annual energy production of 627.07 gigawatt-hours (GWh), this accounts for only 0.27% of the total energy available for final consumption in Hungary and for 2.59% of the energy available for final consumption from renewable and biofuels.

Targeting specific forms of renewable energy and concentrating financial resources can make specific renewable energy projects appealing. According to the Pays de la Loire assessment (Ref. 19), the CAP effect can be significant for supporting and focusing on particular types of renewable energy to help achieve other CAP objectives rather than producing renewable energy in general. For instance, methanisation, i.e. turning organic waste into renewable gas, fits the CAP's goals for a circular economy and helps waste management. Five projects (Ref. 19) would boost regional biogas capacity to about 15% of the total biogas production capacity. However, the assessment lists a number of reasons why farms are unwilling to make investments in the production of biogas. Support is insufficient to maintain a financially feasible investment when its scope or size does not meet the needs of the farms.

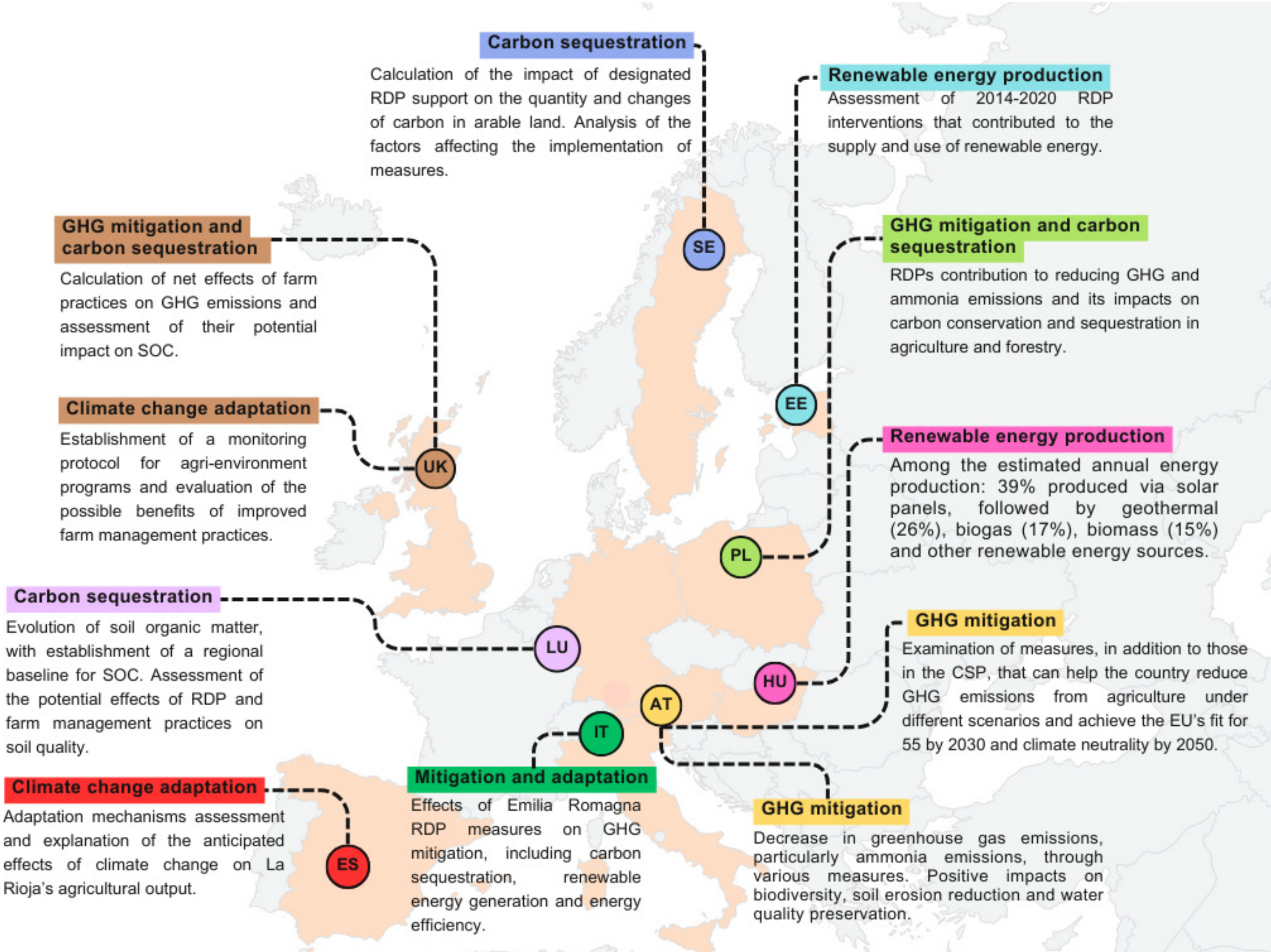
Eight evaluations highlight the potential contributions of RDPs to improving energy efficiency. Given the energy cost and its share in overall production costs, investments in energy efficiency and savings can be a crucial component of policies promoting farm competitiveness. An interesting example is found in Hungary, where the RDP adopted a mandatory target for a minimum 10% energy efficiency improvement (Ref. 43). The evaluation calculated a total of 16.43 GWh of energy savings in the period 2014-2020 which accounts for 2.62% of the annual renewable energy generated by RDP supported projects. Equipment purchases for energy savings supported by the RDP included high-energy class machinery and equipment in packing, ripening, processing and the cooling and heating of farm operations, field machinery and equipment for the food industry. Furthermore, in the evaluation undertaken in the Balearic Islands, Spain (Ref. 17), it was found that 60% of the supported companies could make changes because of investment support to their energy sources, including adjustments to their machinery and changes to renewable energies. In Pays de la Loire, France (Ref. 19), the RDP supported energy savings in 6 979 renovated social housing units (or 7.3% of the social housing stock), 14 secondary schools (or 2% of the regional secondary schools) and 22 renovated tertiary sector buildings. Evaluators noted that, in light of the significance of enhancing energy efficiency in social buildings, it is imperative to investigate potential developments in energy efficiency financing mechanisms for the upcoming programming period.

3. How were the evaluations done and what can be learnt?

From the 55 evaluation studies on the CAP response to climate change available in the CAP evaluation database, 11 have been quality appraised by experts in the field [23] (Figure 3), focusing on the evaluation framework, data and methods. These appraisals have identified common evaluation challenges to determine the CAP's effects on climate change and highlighted best practices for addressing them. This chapter aims to provide Managing Authorities and evaluators practical guidance when tackling evaluations related to climate change by outlining challenges and best practices. The overall lesson from the appraisal of these 11 evaluations demonstrates that undertaking high-quality assessment is feasible and possible even when evaluators are confronted with significant challenges.

The evaluations appraised stem from eight Member States (two evaluations from Austria) and the UK (two evaluations), and they addressed different aspects of climate change as discussed in the previous chapter. They mostly aimed to provide insights into the effectiveness of measures implemented, identify adaptation mechanisms and make recommendations for future programming. Figure 3 provides an overview of the evaluations appraised.

Figure 3. Distribution across different countries of the 11 climate change-related evaluations that were appraised and the specific topics treated in the evaluations



Source: CAP evaluation database (2024), EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2024)

[23] Every year the Evaluation Helpdesk and DG AGRI select up to 30 evaluations to undergo an in-depth appraisal. Each year, a number of priority topics/themes are identified, and evaluations for these topics are prioritised. Also, appraisals are normally prioritised for impact evaluations undertaken over a recent time period. Geographical balance among Member States is sought among the appraisals carried out. The appraisals identify challenges confronted by evaluators, as well as good practices on how these challenges have been overcome.

Challenges related to establishing an appropriate evaluation framework. The most critical challenges in designing evaluation frameworks are related to:

- the formulation of the **judgment criteria** (JC) [24] or factors of success (FoS) or equivalent criteria; and
- the identification and presentation of the **intervention logic**.

JCs are imperative but, unfortunately, the most neglected evaluation tool since they rarely quantify the objectives and thus fail to provide a yardstick for measuring progress. One of the rare exceptions is the Emilia-Romagna study (Ref. 22), which establishes a quantitative goal and determines the effectiveness of individual interventions [25]. In the Austrian study (Ref. 46), reaching zero emissions is the benchmark set by the evaluation mandate against which the effectiveness of additional measures was evaluated, and thus provides another interesting example.

Evaluations rarely examine and challenge the intervention logic and seldom depict it visually. The intervention logic illustrates the underlying assumption of how the designed measures aim to influence the behaviour of actors and change characteristics or traits by taking account of the context, eligibility requirements, operation of other measures, ex-ante conditionalities in place and any other action or condition that might affect the effectiveness, efficiency, relevance and coherence of the policy. With this said, the Estonian (Ref. 11), Polish (Ref. 47) and Swedish (Ref. 49) evaluations contain particularly interesting examples which may inspire future evaluators [26].

Recommendations to evaluators for establishing an appropriate evaluation framework:

- Quantify, if possible, the JCs by linking them to existing targets and then use them to assess effectiveness and other evaluation criteria.
- Examine the intervention logic and, if needed, challenge it, propose amendments, corrections and additions.
- Use visualisations (tables, diagrams, flow charts, etc.) to depict the intervention logic and support the evaluation.

3.1. Climate change and challenges related to evaluation data

The absence of an appropriate evaluation data framework is the most severe barrier to applying sophisticated evaluation methodologies and achieving credible, robust and reliable results.

Data availability can be a significant constraint, sometimes dictating the evaluation approach, the formulation of the judgment criteria, and the choice of indicators and evaluation methods. Data are typically used in climate change evaluations to set a baseline, calculate impact indicators, and evaluate the direct and indirect, gross or net effects of a single measure, a set of measures or the entire programme. The most frequently cited difficulty refers to extensive data gaps in existing evaluation databases due to the complete lack of essential indicators, partial temporal or spatial coverage, absence of data on beneficiaries due to low uptake or on non-beneficiaries, absence of a baseline (data before the intervention) and the lack of other data helpful in supporting the application of more advanced and complex evaluation methods. In addition, existing databases may also suffer from 'dirty' and 'messy' data structures. 'Dirty' data may be due to errors and mistakes during data collection, coding and entry. 'Messy' data sometimes emerge after migrating data from an old system to a new database, mixing laboratory values from different instruments or when integrating data from multiple sources of different formats, etc.

Successful evaluations presume the establishment and maintenance of dedicated databases for evaluation complemented by external sources of data and information.

Some Member States, such as Luxembourg, maintain permanent databases while others collect ad hoc data and create temporary evaluation databases. Databases for evaluation that are organised and maintained are essential for conducting assessments of climate change, constructed around the IACS/LPIS [27] and link data on GHG emissions from National Inventory Reports (NIR), data on soil properties for carbon sequestration and data on renewable energy sources from national statistics or Eurostat. A good example is Luxembourg's Ministry of Agriculture, which maintains a soil database assembled from all georeferenced findings of soil analyses regularly conducted by farmers. Other critical external data are sourced from previous evaluations, academic literature, stakeholders and local experts. The Swedish evaluation (Ref. 49) examined the carbon sequestration measures applied by the RDP and alternative measures searched among Swedish studies or studies in countries with similar agricultural conditions. Stakeholders in the Spanish region of La Rioja, Spain (Ref. 18), developed a list of practices farmers currently employ to adjust to climate change, which was the guiding list of the evaluation.

Maintaining a database requires filling data gaps as they emerge and cleaning the data under transparent rules. In Estonia's (Ref. 11) evaluation of renewable energy, the generated renewable energy data gap was estimated through a questionnaire survey among beneficiaries. In Hungary (Ref. 43), the evaluators took account of available data, industry standards and expert estimates to use installed capacity, efficiency, daily output, peak hours of use and conversion factors to estimate the missing data on annual energy produced in kilowatt-hours (kWh) or TOE. In Luxemburg (Ref. 42), the evaluators carried out more than 300 additional SOC analyses, aiming to improve the spatial coverage of the database and increase the number of paired (before-after and with-without) observations in the database. Establishing and maintaining databases also implies data harmonisation and standardisation efforts i.e. making data uniform, consistent, and comparable across sources and formats.

[24] The judgment criterion is a benchmark providing a structured framework for making informed judgments about a measure, an intervention or a programme.

[25] The study adopts the regional partnership agreement's targets of reducing emissions by 19.21 Gt of CO_2-eq as the JC, compares them to the achieved reductions of 16.65 Gt of CO_2-eq to conclude that GHG emissions were successfully decreased (to 86.7% of the target) and the JC was also met.

[26] The Estonian evaluation challenged the intervention logic that linked, among others, measure M8.6 (support for investments in forestry technologies and in processing, mobilising and marketing of forest products) to Focus Area 5C on renewable energy generation. The Polish evaluation presented the intervention logic in a tabular format. The Swedish study provided a useful visual representation of the critical components of the intervention logic and how they relate to one another.

[27] Integrated Administration and Control System (IACS)/Land Parcel Identification System (LPIS).

The most common harmonisation activities include changing the resolution of raster data sources, converting data units, and aggregating spatial or temporal data.

The main reason why evaluations of climate change adaptation lag behind evaluations of mitigation is the lack of a clear monitoring framework and, consequently, coherent evaluation data.

The Spanish study in La Rioja (Ref. 18) starts the evaluation by identifying farmers' adaptation activities and highlighting the inappropriateness and lack of readiness to account for adaptation from the current monitoring and data frameworks. The UK study (Ref. 52) on climate change adaptation addressed this question to conclude that there is an important "difficulty (and complexity) of translating high-level adaptation principles into indicators that can be monitored at different spatial scales". This study identifies issues with efficiency in data richness i.e. data detail, such as insufficient specificity and infrequently insufficient data granularity, and suggests developing a monitoring framework for adaptation.

Recommendations for Member States and evaluators related to evaluation data:

- Establish and maintain dedicated long-term evaluation databases linked to IACS/LPIS.
- Maintain the databases by filling in data gaps and cleaning the database.
- Harmonise and standardise the data to be able to enrich the database.
- Connect to external sources of data and information, including credible data providers (e.g. NIRs, IPCCC, Eurostat, FAOStat and OECDData), desk research including previous evaluation reports and academic literature review, stakeholders and local experts.
- Establish a monitoring framework for adaptation, including farm-level, landscape and national scale data elements.

3.2. Challenges related to the evaluation methodological framework

The evaluation methodological framework is the landscape of interconnected quantitative and qualitative techniques used in an evaluation to estimate the impacts of policies on pre-defined indicators using evaluation criteria. It is also the techniques used to prepare specific data, estimate the impacts of policies on indicators or themes beyond those under evaluation, triangulate the derived results and examine their rigorousness and robustness. The choice of evaluation methodology mainly depends on evaluation questions and the availability of evaluation data and resources to produce new data or fill in existing data gaps.

The methodological frameworks of the appraised evaluations include a very simple but credible calculation of CMEF Complementary Result Indicator 15 on 'Renewable energy production from supported projects' (CRI.15). This is done through a supplementary questionnaire survey and scaling up of the results for all supported projects in Estonia (Ref. 11), advanced statistical difference in differences (DiD) techniques in Poland (Ref. 47), machine learning techniques for data preparation in Luxembourg (Ref. 42). In other cases, this is done through life cycle assessment (LCA) to quantify the effects of countryside options on soil carbon and climate change mitigation in the UK (Ref. 55), data mining to analyse the characteristics of activities undertaken by beneficiary farms in Hungary (Ref. 43), an input-output methodology to examine the impacts of GHG mitigation measures on the Austrian economy (Ref. 46) and a sensitivity analysis of the additionality of SOC enhancing measures in Sweden (Ref. 49).

The identification of suitable and appropriate counterfactuals is a significant challenge.

Identifying counterfactuals is not always easy and, sometimes, not apparent. One of the Austrian (Ref. 46) evaluation questions aimed to determine the additional measures and actions needed to restrict GHG emissions to pre-established targets in 2030 and 2040. The challenge was addressed by simulating the activity rates to 2030 and 2040 without (current CSP) and with varying intensity of additional measures and converting them to GHG emissions using emission coefficients, a methodology of the Austrian NIR and other credible emission factors.

The Luxembourg evaluators examined the policy's effects on SOC and constructed two types of counterfactuals. They utilised data in their complete database to create a SOC map before the start of the programming period and another one at the end, which were then compared as a counterfactual. Second, they examined paired observations from soil sampling points before and after the RDP's operation and completed the sampling after the RDP with additional samples and the size of matched pairs. In this case, the presence of an observation before does not make it automatically a counterfactual unless there is a matching observation after, which was made possible because the evaluators issued additional soil samples.

In Poland (Ref. 47), the evaluation of actions supporting carbon conservation and carbon removals through afforestation considered that the best counterfactual was arable land located in NATURA 2000 areas where it was difficult to access afforestation support under the RDP, or where support could not be found. Thus, the evaluation estimated a DiD model between areas where the RDP supported afforestation of arable land and Natura 2000 areas as counterfactual.

Testing for bias is a significant challenge. The use of counterfactual analysis does not always ensure unbiased results.

The correct use of matching techniques is a strategy ensuring that the counterfactual analysis is unbiased. The fact that none of the reviewed evaluation studies of climate change mitigation employed any matching techniques may be by chance, but it may also indicate the difficulties associated with such techniques.

Selectivity, and especially self-selection i.e. the specific type of selectivity where farmers choose to participate in a measure, is a major source of bias. According to the evaluation conducted in Luxembourg, plots with cover crops hardly maintained SOC content compared to control plots in a before-after comparison (Ref. 42). Thus, the result would be that cover crops are not an effective farm practice because SOC levels have not improved over the time period studied. However, the evaluators noted, that cover crops – which are excellent for humus – are sown in Luxembourg immediately before the cultivation of silage maize, which is a humus consumer. Thus, farmers who plan to grow silage maize self-select to cultivate cover crops and provide the excess humus demand. Thus, self-selection is frequently the cause of low additionality of the measures because, in the absence of policy, farmers would have carried out the practice, at least to some extent. Low additionality is also an issue when considering the efficiency of measures. Diagnosing and addressing severe selectivity is an evaluation priority.

Unobserved heterogeneity, i.e. underlying factors that can influence the outcome of a study but which are not considered or are not known to evaluators, can create bias and make it difficult to assess the true impact of a project accurately. For instance, the carbon mineralisation rate is affected by the weather conditions of the year in which cover crops are cultivated. The study in Luxembourg (Ref. 42) addressed this unobserved heterogeneity challenge by including a variable depicting the year of soil sampling. Evaluators of climate change and environmental policies in agriculture should also consider whether their estimated impacts capture knock-on, indirect or unintended, effects caused by the same or other policy measures. Failing to account for knock-on effects overestimates results.

Early and continuous involvement of national experts and stakeholders can address many methodological challenges.

Evaluation studies used a panel of experts and stakeholders to address methodological challenges at the start, during and end of applied methodologies. The Austrian evaluation (Ref. 46) used stakeholders to co-formulate future scenarios of additional GHG mitigation measures to feed into the simulation exercise. Scenarios were the starting point of the methodology, and the challenge was to draw them as accurately and realistically as possible. The Swedish evaluation (Ref. 49) used a qualitative approach with a panel of experts to measure the additionality of the proposed interventions. The study in Poland (Ref. 47) used a panel of experts to triangulate the results of the analysis and then to recommend, if needed, changes and improvements in policy design and implementation.

The dominance of the design of evaluations to assess the effectiveness of the policy, while ignoring other evaluation criteria, produces single-focused evaluations which may mask substantial evidence for understanding the complete effects of the policy.

The primary criterion for evaluating CAP impacts in relation to climate change is effectiveness. Relevance and EU value added were not considered in any of the evaluations appraised, whereas efficiency and coherence are seldom considered. Very frequently, evaluators mistakenly associate effectiveness – progress toward goals rather than merely an estimate of impacts – with the identification and quantitative estimation of impacts. From the studies appraised, only the study from Emilia-Romagna in Italy (Ref. 22) and the Austrian study (Ref. 46) clearly used the effectiveness criterion. Efficiency and coherence were only addressed in the Italian study.

However, a careful examination reveals that considerations about effectiveness may sometimes also include considerations related to other evaluation criteria. For example, in Poland (Ref. 47), the low effectiveness and low additionality of afforestation measures are found to be due to the non-relevance of the measure to farmers' needs. The Austrian study (Ref. 46) revealed a possible internal incoherence of the measures analysed, where reducing the stock numbers may cause an increase in inorganic fertilisers and thereby reduce effectiveness. However, the issue at stake is not effectiveness but lack of coherence. The Swedish study (Ref. 49) warns of low additionality for specific measures supporting carbon sequestration. However, this issue is more a matter of efficiency than effectiveness.

Furthermore, several evaluations expanded the scope of their analyses of the effects of climate change-related policies to cover topics, such as uptake rates (adoption rates) in Sweden (Ref. 49), the spatial targeting of measures in Poland (Ref. 47), the long-term trends of GHG indicators in Poland and several others. In addition, some evaluation mandates extended the evaluation towards an impact analysis of policies on the economy (Austria, Ref. 46), innovation, human capital development and environmental concerns over natural resources and biodiversity (Emilia Romagna, Italy, Ref. 22).

Frequently, in their efforts to assess and determine impacts and effectiveness, evaluators tend to rely on one-dimensional, shallow and superficial evaluations that prevent a holistic view of policy outcomes. Therefore, the chance for a well-rounded view, a comprehensive analysis of the effects and cumulative measurement of the outcomes is forfeited on the altar of effectiveness, and relinquishing or neglecting a more in-depth analysis of the other evaluation criteria.

For example, the catch crops farming practice is effective for carbon sequestration, although it increases methane emissions, as does the rewetting of peatlands. However, it has undisputably positive effects on nutrient leaching, soil erosion, soil biodiversity, soil nutrients and fertility, as the rewetting of peatlands has on biodiversity. The same holds for manure management and the prevention of ammonia emissions. The ability of the evaluation to determine how a farm practice influences GHG emissions along with its overall environmental and climate effects is a very serious challenge.

Recommendations for Member States and evaluators related to the methodology for evaluating CAP impacts in relation to climate change:

- If the evaluation study is based on a counterfactual analysis, identifying an appropriate counterfactual very early is essential because the evaluator may even have the time to construct it.
- Identifying an appropriate counterfactual assumes an excellent knowledge of the programme/measures since counterfactuals can be identified with ingenious approaches.
- Testing the results of the analysis for bias is important. Depending on prior knowledge, test for selectivity bias and unobserved heterogeneity.
- Evaluate knock-on effects. If they are substantial, the evaluator may consider including them in the evaluation analysis to avoid over- or under-evaluation of impacts. Flag secondary positive effects of farm practices on the climate and the environment.
- National experts can support the solution to various methodological issues from the very beginning to the end of the evaluation.
- Effectiveness dominates evaluations. MAs should extend the scope of evaluation and include other criteria illuminating the evaluation results.

Conclusions

Chapter 1 showed us that, from the over 500 evaluations stored in the CAP evaluation database of the Evaluation Helpdesk [28], 55 evaluations undertaken by Member States between 2018 and 2024 (April) have been identified as relevant to the CAP and climate change, hence either stating to have a specific objective to assess the RDP contribution towards climate change, or containing findings related to climate change. These evaluations have been identified from 15 Member States and the UK, and some of the Member States with regional RDPs (Italy, Germany, Spain) have a higher number of evaluations related to the topic.

The 55 CAP climate change evaluations in the CAP evaluation database have different evaluation scopes. Some focused specifically on the RDP contribution towards RD priorities 4 or 5, others assessed the RD impact in relation to several RD priorities in parallel or had a wider scope that addressed more globally the CAP environmental impacts (e.g. 'Sustainable management of natural resources and climate action'). Some focused on specific measures, others on the impact of the full RDP.

The findings from the evaluations presented in Chapter 2, although highly contextual and stemming from evaluations with different scopes, provide a shared understanding concerning CAP's efforts and results in dealing with climate change.

First, despite the fact that the evaluated RDPs were designed in 2014 (implemented in 2014-2020) – long before the adoption of EU's flagship environmental, climate and energy policies – they were designed to address all areas of climate change, including GHG mitigation, carbon sequestration, adaptation and decarbonisation of energy demands. The narrative from the evaluations presented in Chapter 2 recounts many successes, some loss in effectiveness and careful forays into uncharted scientific territories. In general, a considerable amount of agricultural land has successfully adopted GHG mitigation and carbon sequestration activities supported by RDPs, irrespective of the size of the effect of these interventions. In certain regions, RDP measures also addressed considerable livestock numbers with manure management investments. Considering budgetary constraints, many RDPs made efforts to decarbonise the sector's energy needs and gained experience and knowledge irrespective of achievements.

Second, the evaluations presented in Chapter 2 make up a rich repository that is abundant in evaluation ideas, recommendations and solutions, as well as concerns and warnings. What is the GHG mitigation effect of a strip of melliferous plants? What to do with the low uptake of afforestation measures? How do evaluators take knock-on effects into account? Do the measures that decrease agricultural production increase emissions elsewhere in the world? Can the scale of mitigation measures increase, and if yes, will the effects continue to be the same? Can more focused interventions and more targeting of beneficiaries increase the effectiveness of measures? Is large-scale rewetting of peatlands feasible? How do evaluators monetise the multiple environmental and climate benefits of GHG mitigation or carbon sequestration interventions? What is an adaptation monitoring framework?

Despite the many challenges associated with evaluating climate change, the evaluations appraised are of high quality. Chapter 3 highlighted that the appraised evaluations have produced genuinely innovative and intelligent approaches addressing the challenges and assessing the impacts and effectiveness of measures. The reviewed evaluations are invaluable decision-making tools because they illuminate the process, shed light on impacts, and offer precious policy design and implementation recommendations. Many evaluations are based on well-established and data-rich evaluation frameworks, especially those related to carbon sequestration, linked to soil databases and IACS/LPIS. The evaluations have overcome many data and methodological constraints to produce robust and credible results, questioned their calculations, accumulated evaluation lessons and experience, and advocated innovative policy design and implementation solutions.

However, evaluations are highly constrained by the dominance of the effectiveness criterion, which frequently leads to one-dimensional assessment quests. Evaluations also suffer from the absence of a coherent evaluation framework for climate change adaptation. Some evaluations raise the issue of the diversity of positive impacts of farm practices and how they are treated unfairly when only assessed for their climate change mitigation or adaptation impact. Other evaluations warn of the adverse knock-on effects of certain farm practices, as found in their evaluation results or the academic literature. This discussion calls for more integrated and holistic evaluation approaches which can embrace the negative and positive side effects of climate change measures on the environment and climate.

[28] The CAP evaluation database of the Evaluation Helpdesk consists of the CAP-related evaluations undertaken by Member States since the previous CAP programming period (2014-2020).

Annex I: List of Member State evaluations related to climate change analyse in this paper and available in the CAP evaluation database

The below listed Member State evaluations are the ones identified from the CAP evaluation database relevant to climate change and thus analysed in this paper. Across this publication, the reference number, rather than the full study reference, is included for ease of reading.

Reference number	Member State	Year	Title (English version)	Author	Publisher
1	CZ	2022	Interim spring evaluation report 2021	Naviga Advisory and Evaluation s.r.o.	Ministry of Agriculture
2	DE	2021	Strengthening climate protection in agricultural support programmes	Angenendt Elisabeth, Nitsch Heike, Sponagel Christian (IfLS und Universität Hohenheim)	Ministry of Food, Rural Affairs and Consumer Protection Baden-Wurttemberg
3	DE	2022	Evaluation report on the RDP measure for landscape and territorial management	Bathke, M.	Thünen Institute for Living Conditions in Rural Areas
4	DE	2022	Evaluation report on the support measure 'Land Management for Climate and Environment'	Bathke, M.	Thünen Institute for Living Conditions in Rural Areas
5	DE	2021	2020 ongoing evaluation of Saarland RDP	Doluschitz Reiner, Kühne Olaf	EAFRD Managing Authority
6	DE	2022	Evaluation of the Natural Heritage measure of the Brandenburg-Berlin RDP	Pawletko Karoline (with the contribution of Jungmann Susanne)	Ministry of Agriculture, Environment and Climate Protection
7	DE	2021	Effects on water and climate protection: An analysis of operational nutrient comparisons of the Lower Saxony-Bremen 2014-2020 RDP selected land measures	Roggendorf, W.	Thünen Institute for Living Conditions in Rural Areas
8	DE	2023	Evaluation of the promotion of investments in the processing and marketing of agricultural products	Schwarz	Thünen Institute for Living Conditions in Rural Areas

Reference number	Member State	Year	Title (English version)	Author	Publisher
9	EE	2022	2021 evaluation report: Priorities 4 and 5, and Priority 3 on animal welfare	Põllumajandusuuringute Keskus	Agricultural Research Centre
10	EE	2022	2021 report on studies examining Priorities 4 and 5	Põllumajandusuuringute Keskus	Agricultural Research Centre
11	EE	2022	Study on the volume of renewable energy produced in agriculture and the food industry	Põllumajandusuuringute Keskus	Agricultural Research Centre
12	IE	2022	Review of Ireland's 2015-2021 Beef Data Genomics Programme	Cawley Anthony and Banks Charlie (DAFM)	DAFM and the Irish Government Economic and Evaluation Service (IGEES)
13	ES	2022	Environmental monitoring plan report	Gestión Ambiental de Navarra, S.A. (GAN)	Department of Rural Development and Environment, Navarra Government
14	ES	2021	Analysis of investment types supported by Measure 4.1 of Murcia's RDP	Red2Red	Managing Authority
15	ES	2021	Castilla y Leon 2021 interim evaluation report	Red2Red	Managing Authority
16	ES	2021	Thematic assessment on the climate change impact of RDP forestry measures	Red2Red	Managing Authority
17	ES	2021	Thematic evaluation: impact of the RDP of the Balearic Islands on energy use	Red2Red	Ministry of Agriculture, Fisheries and the Natural Environment, Govern de les Illes Balears
18	ES	2022	Assessment of the impact of climate change on agricultural production in La Rioja	Tragsatec S.A.	Ministry of Agriculture, Livestock, Rural World, Territory and Population of the Government of La Rioja
19	FR	2021	ERDF and EAFRD impact assessment on resource efficiency, low-carbon economy and climate change resilience	Teritéo	Teritéo
20	IT	2021	Annual evaluation report 2020	Agriconsulting SpA	Agriconsulting SpA

Reference number	Member State	Year	Title (English version)	Author	Publisher
21	IT	2021	2020 annual evaluation report of the Veneto region	Agriconsulting SpA	Veneto region
22	IT	2022	Cross-cutting assessment of the effects of regional programmes in reducing greenhouse gas emissions	Agriconsulting SpA	Agriconsulting SpA
23	IT	2022	Synthesis of the 2020 intermediate evaluation report for the Emilia Romagna region	Agriconsulting SpA	Agriconsulting SpA
24	IT	2022	Updated interim report for the 2014-2020 period	Agriconsulting SpA	Agriconsulting SpA
25	IT	2021	2021 interim evaluation report of the Lazio region	Cogea	Cogea
26	IT	2021	Thematic report: effects of the Lazio RDP on climate change and the environment	Cogea	Cogea
27	IT	2022	2021 annual evaluation report of the Aosta Valley region	Lattanzio KIBS	Lattanzio KIBS
28	IT	2023	Annual evaluation report of Aosta Valley's Rural Development Programme	Lattanzio KIBS	Lattanzio KIBS
29	IT	2021	2021 annual evaluation report of the Campania region	Lattanzio KIBS	Lattanzio KIBS
30	IT	2021	2021 annual assessment report of the Puglia region	Lattanzio KIBS	Lattanzio KIBS
31	IT	2022	The effects of Umbria's RDP amendment related to Measures 10 and 11	Lattanzio KIBS	Lattanzio KIBS

Reference number	Member State	Year	Title (English version)	Author	Publisher
32	IT	2021	Interim assessment report: update 2021 of Marche region	Lattanzio KIBS	Lattanzio KIBS
33	IT	2021	2021 interim evaluation report update for the Umbria region	Lattanzio KIBS	Lattanzio KIBS
34	IT	2022	2022 annual evaluation report of the Abruzzo region	ISRI	ISRI
35	IT	2021	2021 annual evaluation report of the Sardegna region	RTI ISRI-Intellera-Interforum-Primaidea	RTI ISRI-Intellera-Interforum-Primaidea
36	IT	2022	2021 annual evaluation report of the Sicily region	RTI ISRI -AGT	RTI ISRI -AGT
37	IT	2022	Opportunities for the development of organic farming in Sardinia	RTI ISRI-Intellera-Interforum-Primaidea	RTI ISRI-Intellera-Interforum-Primaidea
38	LV	2022	Report on water quality from agricultural land impact measures	Lakovskis P., Benga E., Ieviņa L.	AREI (Institute of Agricultural Resources and Economics)
39	LT	2022	Evaluation of the agri-environment and climate measures of the Lithuanian Rural Development Programme	Lithuanian Centre for Social Sciences Institute of Economics and Rural Development	Ministry of Agriculture
40	LT	2021	Report on the implementation of the 2014-2020 Lithuanian RDP	UAB, ESTEP Vilnius	Ministry of Agriculture
41	LT	2021	The impact of Lithuania's Rural Development Programme on organic farming	UAB, Smart Continent LT	Ministry of Agriculture
42	LU	2020	Evolution of soil organic carbon in the Grand-Duchy of Luxembourg	Ministry of Agriculture, Viticulture and Rural Development (MAVDR) and UCLouvain	Ministry of Agriculture, Viticulture and Rural Development (MAVDR)

Reference number	Member State	Year	Title (English version)	Author	Publisher
43	HU	2024	Final report: improving energy efficiency in agriculture and the food processing industry	Tamás Saád, Balázs Mezősi, Péter Kádár, Kata Radó ,József Fogarasi, Enikő Vígh, Katalin Vágó, Andrea Kiss, Katalin Lőrincz, Gyene Gyöngyvér	Ministry of Agriculture
44	MT	2022	Thematic evaluation on soil	Adi Associates, E-Cubed Consultants and EMCS Ltd	Managing Authority
45	AT	2019	Summary assessment of the effects of the Austrian 2014-2020 RDP on the cross-cutting issues of environment and climate	Schwaiger Elisabeth, Anderl Michael, Michael Gössl, Storch Alexander, Huber Sigbert, Lindinger Helga, Loishandl-Weiß Harald, Nemetz Stephan, Gabriel Oliver, Offenzeller Martina, Ortner Roman, Schwaiger Elisabeth, Schwarzl Bettina, Sedy Katrin	Federal Environment Agency
46	AT	2023	Reduction of greenhouse gases in agriculture to achieve the goals of the Climate Protection Act	Umweltbundesamt	Michael Anderl, Manuela Bürgler, Simone Mayer, Erwin Moldaschl, Elisabeth Schwaiger, Bettina Schwarzl, Peter Weiss
47	PL	2022	Evaluation on the environmental impacts of RDP 2014-2020	Institute of Soil Science and Plant Cultivation (IUNG), Institute of Technology and Life Sciences	Ministry of Agriculture and Rural Development
48	SE	2021	Adaptation to climate change in EU programmes 2014-2020 in Sweden	Göran Hallin, Sirje Pädam, Jenny Wallström, WSP	Swedish Board of Agriculture
49	SE	2023	Evaluation of the effect on carbon storage in arable land	Noring, M., Jörnling, A., Dahlöf, C-A., Zehaie, F., Halvars Klintäng, A. & Kätterer, T	Swedish Board of Agriculture
50	SE	2021	Possible climate measures and policy instruments in a future RDP	Rabinowicz Ewa (Sveriges lantbruksuniversitet), Jörgensen Christian (AgriFood Economics Centre)	Swedish Board of Agriculture
51	SE	2023	Compensations for catch cropping, intermediate cropping and spring processing	Swedish Board of Agriculture	Swedish Board of Agriculture

Reference number	Member State	Year	Title (English version)	Author	Publisher
52	UK	2018	Assessing the contribution of agri-environment schemes to climate change adaptation	Atkins Ltd.	DEFRA
53	UK	2020	Assessment of arable reversion retention	LUC in association with CCRI and ESL	DEFRA
54	UK	2021	Assessment of the adaptive capacity of Agri-Environment Schemes to respond to the impacts of climate change	Short Chris, Urquhart Julie, Lenormand Theo, Hickman Megan, Staddon Phil (CCRI) James Nick, Roberts Verity (LUC), Breyer Johanna (Environment Systems Ltd)	Natural England
55	UK	2020	Field-based evidence for the agri-environment impact on soil carbon and climate change mitigation in England	Warner, D.J., Tzilivakis, J., Green, A. and Lewis, K.A. (Agriculture and Environment Research Unit)	DEFRA

Annex II: Additional references

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European Court of Auditors, 2021, *Special report 16/2021: Common Agricultural Policy and climate: Half of EU climate spending but farm emissions are not decreasing*.

European Environment Agency (EEA), 2019, *Report No 4/2019: Climate change adaptation in the agriculture sector in Europe*.

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