EU CAP NETWORK

EU CAP NETWORK REPORT

Rough estimate of the soil protection potential of the CAP Strategic Plans over the 2023-2027 period

Report

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List of acronyms

C	Carbon
CAP	Common Agricultural Policy
CIS	Coupled income support
CSP	CAP Strategic Plan
DG	Directorate-General
Eco-schemes	Schemes for the climate, the environment and animal welfare
ENVCLIM	Environmental, climate-related and other management commitments
ESDAC	European Soil Data Centre
EU	European Union
GAEC	Good agricultural and environmental condition
GNB	Gross nutrient balance
INVEST	CAP investments support
JRC	European Commission's Joint Research Centre
N	Nitrogen
NE	Significant negative effect
NS	Non-significant effect
PMEF	Performance monitoring and evaluation framework
SO	Specific Objective
SOC	Soil organic carbon
UAA	Utilised agriculture area
WEI+	Water Exploitation Index Plus

Units of measurement

cm	Centimetre
ha	Hectare
m	Metre
M	Mega/Million
Mt	Megatonne
kg	Kilogramme
kt	Kilotonne
t	Tonne
yr	Year

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The work was coordinated by Adrien de Pierrepont and co-authored by Laura Nocentini. Representatives from DG AGRI contributed to the coherence and consistency of the report. Maria Martinos and 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.

1. Introduction

Soil health plays a vital role in the long-term viability of agricultural systems. Healthy soil represents a complex living ecosystem, essential for sustainable agricultural production. It promotes optimal plant growth by enhancing nutrient availability, improving water retention and protecting against pathogens. It also plays an active role in regulating biogeochemical cycles and carbon sequestration. However, soil health across the EU is facing several challenges, including erosion, degradation and desertification, as well as a decline in organic matter and loss of biodiversity. Many of these issues are directly related to agriculture and the pressure to meet rising food requirements [1]. According to the Soil Degradation Dashboard of the EU Soil Observatory, 62% of EU soils are not in a healthy condition [2]. The situation is even worse for agricultural soils [3].

To address these challenges, the Commission adopted, in 2021, the EU Soil Strategy for 2030 [4], which aims to establish the protection of soils, sustainable management practices and restoration of degraded soils. This strategy led to a Commission proposal for a directive on soil monitoring and resilience, which aims at establishing a harmonised soil health monitoring framework in the EU, among other objectives [5]. The ultimate goal is to ensure that EU soil ecosystems are healthy by 2050. The EU has also launched the Horizon 'EU Mission: 'A Soil Deal for Europe', which aims to establish 100 living labs and lighthouses to lead the transition to healthy soils by 2030 [6].

The 2023-2027 Common Agricultural Policy (CAP) is a key instrument for achieving these goals. In particular, it includes the Specific Objective 5 (SO5), which aims "to foster sustainable development and efficient management of natural resources such as water, soil and air, including by reducing chemical dependency" [7]. In line with SO5, the CAP Strategic Plan Regulation [8] directly addresses soil protection, both through mandatory requirements of the good agricultural and environmental conditions **(GAECs)** and through various **types of interventions** (voluntary commitments).

In this context, this study contributes to the methodologies needed to further analyse and better quantify the potential contribution of CAP Strategic Plans (CSPs) to sustainable soil management, and proposes a quantification tool to Managing Authorities and other interested parties, which could be updated and adapted to support their operational objectives.

2. Methodology

2.1. Understanding the approach

The aim of this study is to provide and **assess a rough estimate of the potential of CSPs to protect and/or improve the status of agricultural soils in the CAP programming period of 2023-2027,** based on the programming information they contain and the potential effects on soil health of farm practices they support and promote.

To carry out this study, the European Evaluation Helpdesk for the CAP (hereinafter the Evaluation Helpdesk) developed a methodology which was applied to 13 Member States [9] corresponding to 13 CSPs. This report provides an overview of the methodological approach, results, main difficulties and recommendations for improvement.

[1] https://agriculture.ec.europa.eu/sustainability/environmental-sustainability/natural-resources/soil_en.
[2] https://esdac.jrc.ec.europa.eu/esdacviewer/euso-dashboard/.
[3] Panagos et al., 2024 https://bsssjournals.onlinelibrary.wiley.com/doi/full/10.1111/ejss.13507.
[4] COM/2021/699 final.
[5] Soil health – European Commission.
[6] What is the Mission Soil? | Mission Soil Platform.
[7] Article 6(e) of Regulation (EU) 2021/2115.
[8] Regulation (EU) 2021/2115.
[9] Czechia, Germany, Denmark, Greece, Spain, Italy, Latvia, Luxembourg, Hungary, the Netherlands, Poland, Romania and Finland.

2.1.1. Building blocks

The methodology developed builds upon the following documents and studies carried out by the Commission.

- **Rough estimate of the climate change mitigation potential of the CAP Strategic Plans (EU-27) over the 2023-2027 period** [10]. This study provides methodological support to quantify the overall CSPs' potential contribution to climate change mitigation and the protection of carbon sinks. The present study adopts the approach proposed in that study to quantify the potential contribution of the selected CSPs to soil health.
- **Farm practice classification scheme** [11]. This three-tier classification scheme was **developed by the European Commission's Joint Research Centre (JRC)** [12] and is used to identify farm practices.
- **Labelling of CSPs interventions and GAECs**. This refers to the identification of farm practices linked to CSPs interventions and GAECs, using the JRC classification scheme introduced in the previous bullet point. The Evaluation Helpdesk and the JRC developed this database for the study 'Mapping of CAP Strategic Plans' [13]. The labelling is publicly available in the European Commission's online Catalogue of CAP Interventions [14].
- **CAP Strategic Plans.** There are 28 national CSPs that have been developed by national authorities in accordance with Regulation (EU) 2021/2115 [15], which governs the implementation of the CAP for the programming period 2023-2027. Each Member State has developed its own CSP, except for Belgium, which has separate plans for Flanders and Wallonia, for a total of 28 CSPs. These plans outline intervention strategies and specify the CAP instruments to be implemented from 2023 to 2027. These documents are essential for the study as they provide insights into the strategies to address soil-related issues, relevant interventions and expected outputs. CSPs can be amended during the implementation period. The versions used for the study are those in effect as of 1 January 2025.
- **JRC – Farming Practices Evidence Library.** The JRC farm practices data collection [16] is a comprehensive library on the effects of an extensive range of farm practices based on the scientific evidence available in meta-analyses published worldwide [17]. The quantified information on the impact of farm practices synthesised by the JRC is the primary source of information to establish coefficient values per farm practice.

2.1.2. Main steps

The present section briefly summarises the main methodological steps pursued, which are as follows:

1. To select and define the set of characteristics and related indicators used in this study to quantify soil health.
2. To assign coefficients to the farm practices assessing their potential effect on the different characteristics of soil health, using the farm practices classification developed by the JRC [18].
3. At CSP level, to identify the CAP interventions and GAECs that have the potential to contribute to soil health.
4. To allocate relevant farm practices to each CAP intervention and GAEC hereinafter 'labelling' interventions or GAECs.
5. To estimate the area (in terms of hectares) covered by the farm practices supported by the CSPs.
6. To estimate the potential contribution or added value of CAP interventions and the added value of GAECs, by multiplying the estimated area of each farm practice by its coefficient values and summing up to the CSP level.

A more comprehensive outline of the general approach and underlying assumptions is provided in a separate 'general methodology' [19] document.

2.1.3. Key assumptions

The adopted methodology is based on a **series of assumptions and simplifications necessary at various stages of the analysis**. It is crucial to consider these assumptions when interpreting the final estimates. This section outlines the study's main assumptions and clarifies how its outputs should be understood and interpreted.

Focusing on the CSPs' positive potential contribution

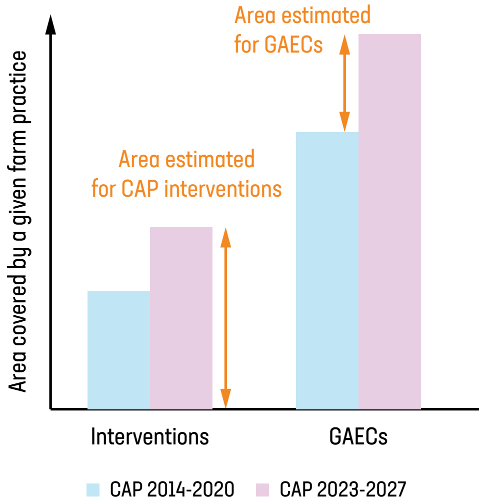
The approach focuses on the potential positive effects of the farm practices supported through CAP interventions and GAECs on soil health. Farm practices supported by CAP instruments can also have negative effects on one or several soil characteristics, but these are not assessed in this study. This is because the screening of the meta-analysis performed by the JRC when developing the Farming Practices Evidence Library focused on agroecological farm practices expected to contribute positively to soil health, animal welfare, climate change mitigation, etc. Therefore, considering the potential negative effects of farm practices supported by the CAP would require more quantified scientific evidence on the negative effects of farm practices on soil.

[10] https://eu-cap-network.ec.europa.eu/publications/rough-estimates-climate-change-mitigation-potential-cap-strategic-plans-eu-27-over_en.
[11] Angileri, V., Guerrero, I. and Weiss, F., *A classification scheme based on farming practices*, Publications Office of the European Union, Luxembourg, 2024, https://publications.jrc.ec.europa.eu/repository/handle/JRC133862.
[12] See note 11.
[13] European Commission, Directorate-General for Agriculture and Rural Development, Chartier, O., Krüger, T., Folkeson Lillo, C. et al., *Mapping and analysis of CAP strategic plans – Assessment of joint efforts for 2023-2027*, Chartier, O.(editor), Folkeson Lillo, C.(editor), Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2762/71556.
[14] https://agridata.ec.europa.eu/extensions/DashboardCapPlan/catalogue_interventions.html?page=FarmPractices#.
[15] Regulation (EU) 2021/2115 of the European Parliament and of the Council of 2 December 2021 establishing rules on support for strategic plans to be drawn up by Member States under the common agricultural policy (CAP Strategic Plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulations (EU) No 1305/2013 and (EU) N° 1307/2013.
[16] The online public database is available here: JRC – Farming Practices Evidence library.
[17] Joint Research Centre Data Catalogue – JRC-Farming-Practices data collection – An evidence library of the effects of Farming Practices on the environment and the climate – European Commission.
[18] See note 11, page 2.
[19] The detailed 'general methodology' underlying this study is described in a separate report. This report is available upon request and can be obtained by sending an email to evaluation@eucapnetwork.eu.

Using different approaches for GAECs and interventions

The areas for CAP interventions and GAECs are estimated using different approaches, as illustrated in Figure 1, estimating the added value of the new CAP for GAECs versus the total potential contribution for interventions. Thus, the study treats and presents results for GAECs and interventions separately.

Figure 1. Areas estimated for CAP interventions and GAECs



Source: JRC and EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

For interventions, **the estimated areas are based on the areas where farm practice(s) are targeted through the different types of interventions covered**. In other words, the study quantifies the total potential contribution of farm practices supported through CSP interventions, comparing the effects of these practices with those of conventional farm practices. The underlying hypothesis adopted here is that without the CSPs, conventional farm practices would cover all agricultural areas. Therefore, results represent the maximum potential contribution of all the areas receiving support from the CSP.

For GAECs, **the study focuses on estimating the added value of 2023-2027 GAECs, compared to the previous programming period.** The approach intends to calculate the additional areas covered by the current GAEC requirements compared to the ones covered by the GAEC requirements during the previous programming period, as well as areas where the practices are already adopted by farmers, even without the GAECs of the 2023-2027 programming period. Therefore, results for GAECs intend to quantify the added value of the new CAP.

For instance, regarding GAEC 1 (maintenance of permanent grasslands), the estimated potential is based on an estimation of the areas of permanent grassland that would be converted into cropland over the period 2023-2027, should the GAEC not have been introduced, based on trends observed in the past. For GAEC 6 (minimum soil cover), the estimation involves quantifying the increase in area with cover crops compared to the area covered by the equivalent GAEC in the previous programming period. The detailed approach adopted for each GAEC is provided in the methodological report [20].

This difference in approach for GAECs and interventions is considered necessary. As compliance with GAEC standards is mandatory in all the areas receiving CAP support (although they are applicable only in the areas where the requirements are relevant), including all the areas covered by CAP support would result in very high estimates for GAECs potential contribution to soil health. This will almost certainly create a significant overestimation since some of the farm practices required as part of the GAECs are considered widely adopted by farmers (greater deadweight effect than for CSP interventions). However, assessing the changes in practices resulting from the interventions, as compared to the previous CAP period, falls outside the scope of this study. The data on the interventions in place in the previous CAP and the areas covered by the farm practices are not available to make these estimations.

As a result, estimates for the potential contribution of CSP interventions and for the added value of GAECs are not comparable. This explains why there is no assessment of potential overlap between the contribution of interventions and those from GAEC when the same farm practice is concerned e.g. crop rotation as defined by GAEC and crop rotation prescribed by intervention at the same time.

Estimating the effects of adopting new farm practices or maintaining existing ones

The JRC classification of farm practices [21] distinguishes between the introduction of new agricultural practices (e.g. L111 (creation of new hedges/wooded strips) or O12 (conversion to organic farming practices)) and the maintenance of existing practices (e.g. L112 (maintenance and conservation of hedges/wooded strips) or O11 (maintenance of organic farming practices)), although the majority of the practices refer to new implementations.

For practices categorised as new implementations, the associated coefficient values reflect the difference, for a given soil characteristic, between the new practice and a 'standard/conventional' practice, which is the control test of the coefficient in the JRC Farming Practices Evidence Library.

For farm practices related to maintenance, the coefficients account for the difference observed from one year to the next after an extended period of implementation (typically 10-20 years). The coefficient can be null if maintaining a practice does not yield additional benefits over time, and in most cases, the coefficient for maintenance is lower than that of a newly implemented practice (e.g. G26 (conservation/maintenance of grassland) is lower than G27 (conversion of arable land to grassland)).

[20] See note 11, page 2.
[21] Angileri, V., Guerrero, I. and Weiss, F., *A classification scheme based on farming practices*, Publications Office of the European Union, Luxembourg, 2024, doi:10.2760/33560, JRC133862 https://publications.jrc.ec.europa.eu/repository/handle/JRC133862.

2.2. Scope of the study

2.2.1. Soil characteristics covered

In the context of this study, soil characteristics refer to key physical, chemical and biological properties that influence soil health and its ability to support sustainable agricultural production. These characteristics are critical in assessing how different farm practices affect soil quality, resilience and long-term productivity [22]. Six soil characteristics are covered in this study, selected based on available data in the JRC Farming Practices Evidence Library [23] (see Table 1), while the remainder were excluded from the analysis.

The exclusion of certain soil characteristics from this quantification exercise does not imply that they are less important. Rather, their omission is due to the limitations of the approach chosen and the data available at the time of undertaking the study. For instance, soil biodiversity could not be considered in this study because of the variety of metrics used to measure this soil characteristic in the literature and due to the difficulty of quantifying biodiversity.

Table 1. Soil characteristics studied, indicator and definition

Soil characteristic	Indicator (unit of measurement)	Definition
Soil organic carbon content	Increase in organic C stock at the top 30 cm (t of C/ha/year)	For the current work, soil organic carbon (SOC) is the main component of organic matter in the top 30 cm of soil, derived from decomposed plants, animals and microorganisms, playing a vital role in soil fertility, structure and carbon cycling [24]. The unit proposed is aligned with the performance monitoring and evaluation framework (PMEF) Impact Indicator I.11 (enhancing carbon sequestration), associated with context indicator C.40.1 (estimate of the total organic carbon content in soils on agricultural land).
Soil nitrogen	Increase in nitrogen stock at the top 20 cm (t of N/ha/year)	Soil nitrogen content is a key element for plant growth and a key driver of soil biological and chemical processes [25]. Excess nitrogen can lead to surface and groundwater pollution through runoff and leaching, but insufficient stocks can be a limiting factor to plant growth. The effects of practices on nitrogen are well documented in the evidence library of the JRC. The nitrogen stock should not be confused with the gross nutrient balance (GNB)-nitrogen (PMEF Impact Indicator I.15 and context indicator C.39). Soil nitrogen content is the nitrogen stock in soils in a certain year, while GNB is an indicator of the potential surplus or deficit in nitrogen fluxes.
Soil water retention	Increase in water stock at field capacity at the top 20 cm (t of water/ha/year)	Soil water retention capacity (or soil water holding capacity) is the soil's ability to hold water within its pores, making it available for plant uptake and sustaining microbial and chemical processes. It reduces the risk of drought stress, supports microbial and nutrient cycling, prevents water and nutrient loss through leaching, and enhances soil structure [26]. Enhancing soil water retention capacity reduces the need for irrigation and improves the Water Exploitation Index Plus (WEI+)-PMEF Impact Indicator I.17. The study focuses on an increase in water stock capacity at the top 20 cm. Other indicators available in the literature, specific to some farm practices such as the water available to plants only or the wilting point are not considered because they are hard to quantify.

[22] Definition based on the terminology used by the Food and Agriculture Organisation: https://www.fao.org/soils-portal/data-hub/soil-maps-and-databases/harmonized-world-soil-database-v12/soil-qualities-description/en/#:~:text=Important%20soil%20characteristics%20of%20the,%2FStructure%2C%20pH%20and%20TEB.

[23] See note 16, page 2.

[24] JRC European Soil Data Centre: https://esdac.jrc.ec.europa.eu/themes/soil-organic-carbon-content.

[25] JRC European Soil Data Centre: https://esdac.jrc.ec.europa.eu/themes/soil-nutrients.

[26] JRC European Soil Data Centre: https://esdac.jrc.ec.europa.eu/resource-type/glossary#W.

Soil characteristic	Indicator (unit of measurement)	Definition
Soil packing density	Reduction in packing density at the top 20 cm (t of soil loss at constant soil volume/ha/year-top 20 cm)	Soil compaction is the process by which soil particles are compressed together, reducing pore space and permeability. It limits water infiltration, air exchange, root growth and overall soil health. The mass of soil particles packed into a given volume is an indicator of soil compaction. In the study, the change in soil packing density within the top 20 cm is used to address this characteristic. Coefficients listed in the JRC-Farming Practices Evidence Library under the category 'bulk density' are used as proxies to assess changes in packing density [27].
Nutrients leaching and runoff	Reduction in mass of nitrogen loss from leaching and runoff per hectare (t of N/ha/year)	The study focuses exclusively on the loss of soil nitrogen. Leaching involves the downward movement of nutrients through the soil profile into groundwater, while runoff is the surface transport of nutrients into water bodies. The unit proposed is aligned with the PMEF Impact Indicator I.15 (improving water quality) and Context Indicator C.39.1 (gross nutrient balance-nitrogen), illustrating the potential threats to water quality in the presence of a nutrient surplus from agricultural soils.
Soil erosion by water	Reduction in mass of eroded soil through runoff per hectare (t of soil/ha/year)	Soil erosion is a natural process, occurring over geological time and indeed it is a process that is essential for soil formation in the first place. Most concerns are related to accelerated erosion, where the natural rate has been significantly increased mostly by human activity. Soil erosion by water, the detachment, transport and deposition of soil caused by direct rainfall and surface runoff, is a widespread problem throughout Europe [28]. It leads to the loss of fertile topsoil and degradation of land. The study focuses on this type of erosion, that can be directly linked to PMEF Impact Indicator I.13 (soil erosion by water).

Source: JRC/ESDAC and European Commission, gathered by the EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

2.2.2. Types of interventions and GAECs covered

The types of interventions included in the scope of the study are those that can be linked with CAP SO5 "to foster sustainable development and efficient management of natural resources such as water, soil and air, including by reducing chemical dependency", and those for which there is sufficient information in the CSP to estimate the area covered and the farm practices supported. Based on these criteria, the types of interventions covered are:

- **Schemes aimed at promoting climate, environmental and animal welfare objectives** (hereinafter referred to as eco-schemes), covered under Article 31 of the CAP Strategic Plan Regulation (EU) 2021/2115.
- **Coupled Income Support (CIS) targeting protein crops,** including legumes and mixtures thereof with legumes being predominant in the mixture, as specified in Article 33(c) of CAP Strategic Plan Regulation (EU) 2021/2115.
- **Environmental, Climate-related, and Other Management Commitments** (hereinafter referred to as ENVCLIM), detailed in Article 70 of CAP Strategic Plan Regulation (EU) 2021/2115.
- **Investments** (hereinafter referred to as INVEST), delineated in Article 73 of CAP Strategic Plan Regulation (EU) 2021/2115.

For the selection of GAECs covered, similar criteria are used, i.e. expected contributions of the GAEC to the soil characteristics covered and possibility to assess these contributions. This selection resulted in the following GAECs:

- **GAEC 1** – Maintenance of permanent grassland based on a ratio of permanent grassland in relation to agricultural area at national, regional, subregional, group-of-holdings or holding level in comparison to the reference year 2018
- **GAEC 2** – Protection of wetland and peatland
- **GAEC 4** – Establishment of buffer strips along water courses
- **GAEC 5** – Tillage management, reducing the risk of soil degradation and erosion, including consideration of the slope gradient
- **GAEC 6** – Minimum soil cover to avoid bare soil in periods that are most sensitive
- **GAEC 7** – Crop rotation in arable land, except for crops growing under water

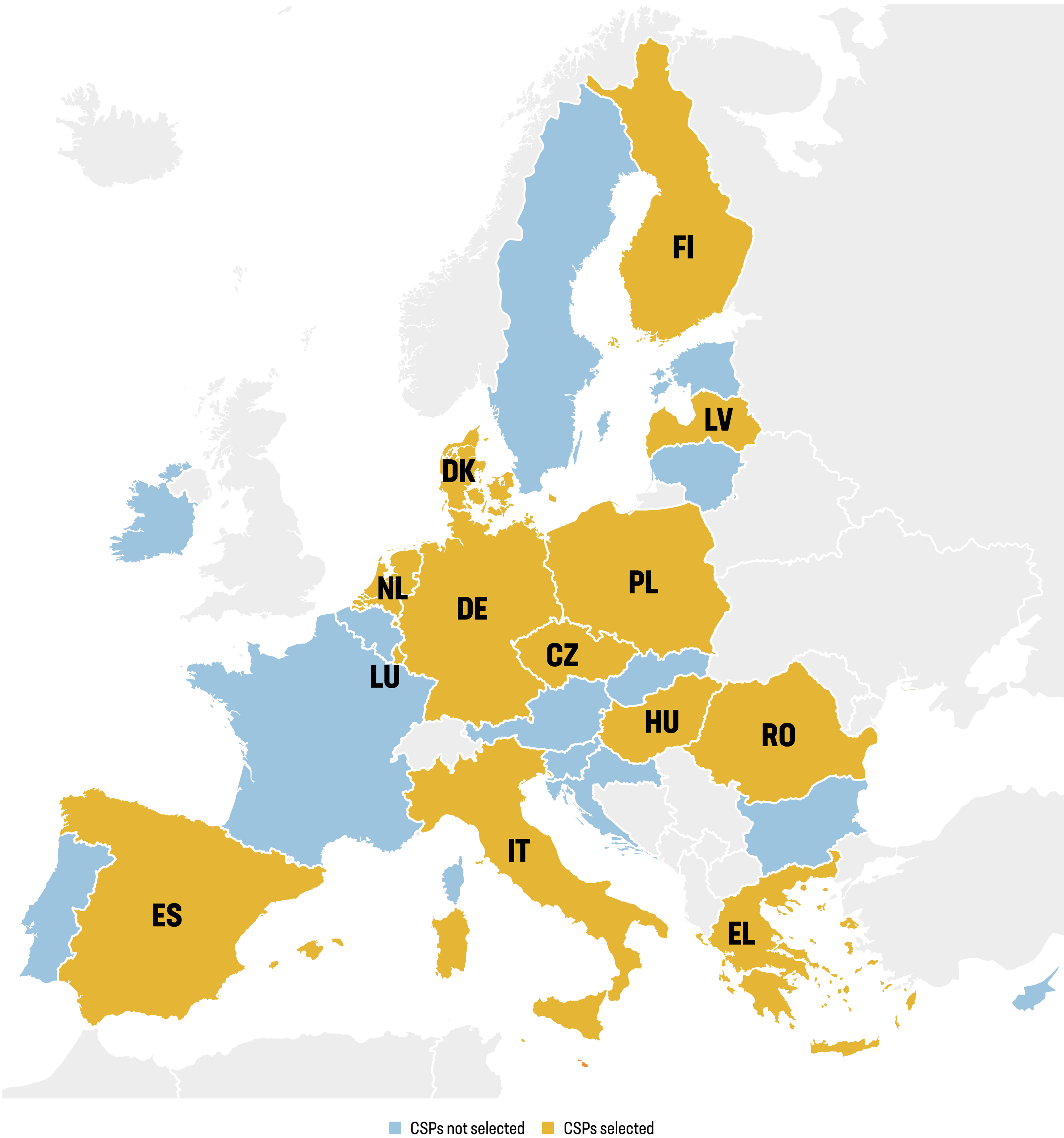
[27] The Packing Density (PD) is a measure of compactness that can be used as a proxy indicator for soil compaction. Packing density = Bulk density + 0.009 x Caly content (%). It is usually measured in g cm^{-3}. Panos Panagos, Daniele De Rosa, Leonidas Liakos, Maeva Labouyrie, Pasquale Borrelli, Cristiano Ballabio, Soil bulk density assessment in Europe, Agriculture, Ecosystems & Environment, Volume 364, 2024, 108907, ISSN 0167-8809, https://doi.org/10.1016/j.agee.2024.108907.

[28] Panagos, P., Ballabio, C., Poesen, J., Lugato, E., Scarpa, S., Montanarella, L. and Borrelli, P., 2020. *A soil erosion indicator for supporting agricultural, environmental and climate policies in the European Union*, Remote Sensing, 12(9), p.1365, https://www.mdpi.com/2072-4292/12/9/1365.

2.2.3. CAP strategic plans covered

This study covers 13 of the 28 CSPs. These CSPs are selected based on the ambitions they display regarding the protection of soil health, and also to ensure a good representation of the different EU climatic zones and soil types. The selection also takes into account the agricultural area covered by the CSPs [29]. The CSPs selected are displayed in Figure 2 and these are: Czechia, Germany, Denmark, Greece, Spain, Italy, Latvia, Luxembourg, Hungary, the Netherlands, Poland, Romania and Finland.

Figure 2. CSPs selected for the study



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

[29] See note 19, page 2.

3. The coefficients database created to estimate the potential contribution of CSPs to soil health

3.1. Step 1 – The coefficients database is populated with data from the JRC Farming Practices Evidence Library

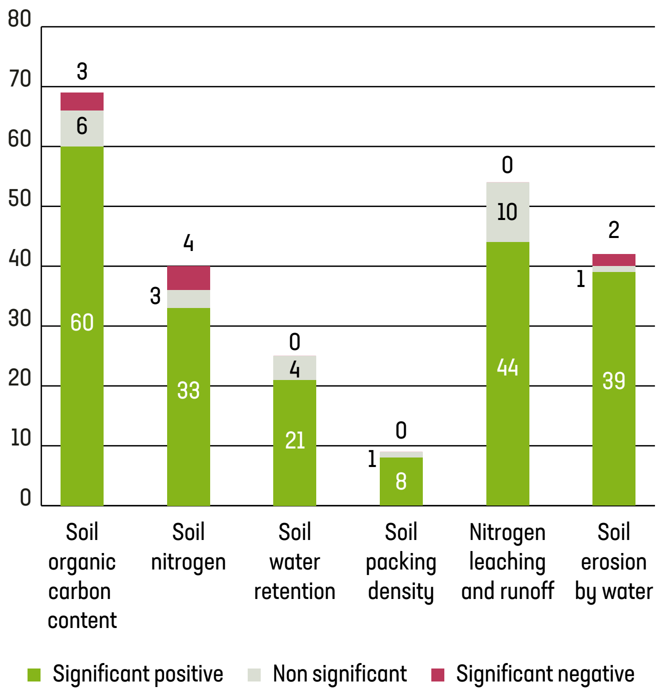
The coefficients database covers a fraction of all the farm practices covered in the CSPs

The coefficients database was created based on the data in the JRC Farming Practices Evidence Library [30]. This database is at the basis of the estimates, as it provides for a given farm practice and soil characteristic an annual effect expressed as a percentage change [31] of the soil characteristics compared to what would happen with a conventional farm practice. For instance, it shows that the farm practice S231 (summer cover crop) is expected to reduce soil erosion by water by 49.8%, compared to a situation where no summer cover crop is present. In this database, all coefficients are expressed as relative changes (percentages) common to all Member States.

The list of farm practices used for the estimates and their coefficient values is available in Annex 1 -Coefficients database. Among the 384 farm practices in the classification scheme used, 102 are associated with at least one coefficient or acknowledged to have non-significant/negative effects, including 91 farm practices with at least one significant positive effect. Among the other farm practices, some are not expected to have any significant effect on soils (e.g. most of the farm practices of the category AX (animals)), or the expected effect is difficult to quantify because they are too generic or too specific (e.g. S1X (tillage), or W126 (ban on slurry along water courses). The study also has some gaps. An obvious example is the lack of a coefficient on soil packing density for the farm practice S31 (restricted machinery usage (including timing) to avoid soil compaction). This is because the coefficients database created is limited by the evidence gathered in the JRC Farming Practices Evidence Library at the time of the study.

Figure 3 provides an overview of the number of farm practices linked to each soil characteristic. Although only positive effects are considered in the study, this figure also highlights the negative effects that are assessed, allowing an understanding of where the main data gaps are. It highlights that soil organic carbon content and nitrogen leaching and runoff are relatively well covered in the coefficients database, and water retention and soil packing density are linked to fewer farm practices. The difference in the number of farm practices covered for each soil characteristic reflects the level of available publications and possibly the efforts invested in research.

Figure 3. Number of farm practices in the study database with an effect, by soil characteristic



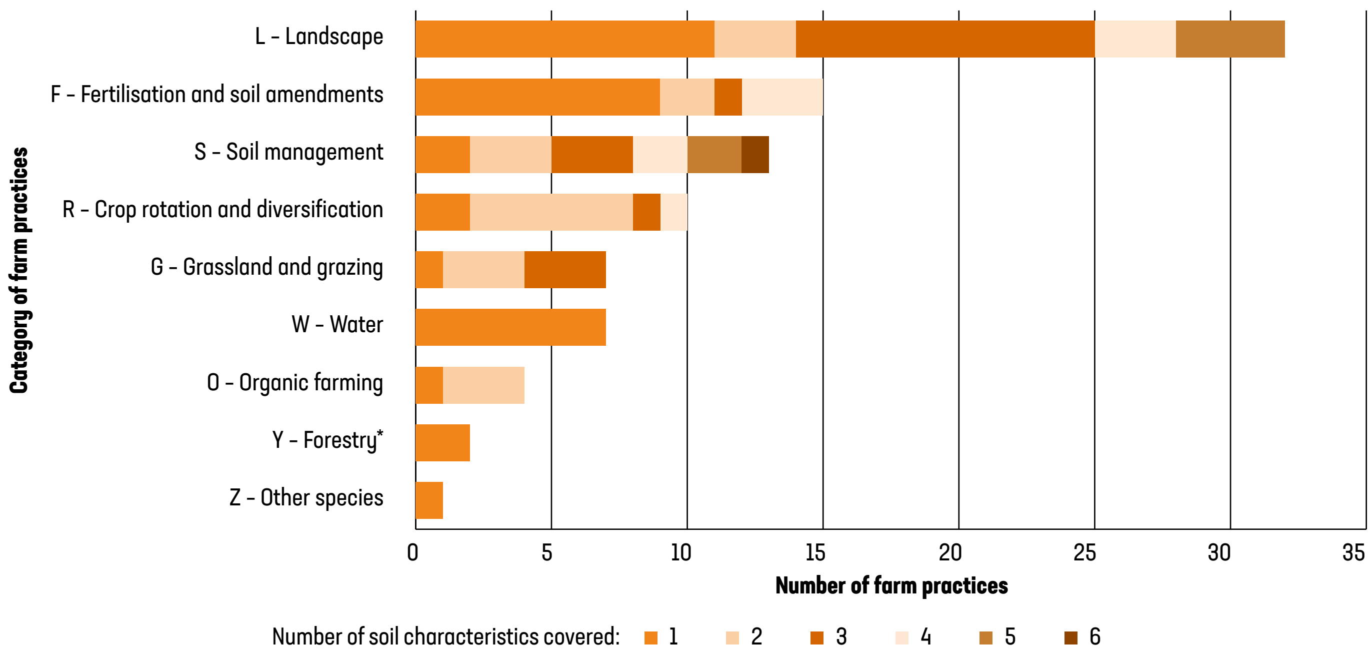
Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

Most farm practices only cover one soil characteristic

Most soil characteristics are interrelated. For instance, soil organic carbon content is expected to influence soil packing density [32], soil water retention [33] and soil erosion [34] through the improvement of soil structure. However, in the study database, many farm practices (36 farm practices out of the 91 with a significant positive effect) have a coefficient for one characteristic only (see Figure 4). This highlights probable data gaps in the coefficients database and consequently an underestimate of the soil characteristics concerned (soil packing density in particular).

[30] See note 16, page 2.
[31] In few exceptions the soil organic carbon content is expressed in absolute values.
[32] Ramírez, P. B., Machado, S., Singh, S., Plunkett, R., & Calderón, F. J., 2023, *Addressing the effects of soil organic carbon on water retention in US Pacific Northwest wheat-soil systems*, Frontiers in Soil Science, *3*, 1233886. https://doi.org/10.3389/fsoil.2023.1233886.
[33] Rattan L., 2020, Soil organic matter and water retention. *Agronomy Journal, 112, 5* pp. 3265-3277. https://doi.org/10.1002/agj2.20282.
[34] Kadlec, V., Procházková, E., Urbanová, J., Tippl, M., & Holubík, O, 2012, *Soil Organic Carbon Dynamics and its Influence on the Soil Erodibility Factor*, Soil & Water Research, *7*(3), DOI: 10.17221/3/2012-SWR, https://swr.agriculturejournals.cz/artkey/swr-201203-0002_soil-organic-carbon-dynamics-and-its-influence-on-the-soil-erodibility-factor.php.

Figure 4. Number of soil characteristics covered for each farm practice by category of farm practice



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

Only farm practices with significant positive effects.
* In the study, farm practices in the category Y-Forestry relate to the afforestation of agricultural land and the maintenance of this afforested area.

Nevertheless, one farm practice, S22 (crop residues left on soil, leaving stubble on the field), is expected to contribute to all the studied soil characteristics. In the farm practices category S-Soil management, two other farm practices have a significant positive effect on all characteristics, with the exception of soil packing density S25 (green cover on permanent crops) and S2X (soil cover). The four other farm practices with a significant positive effect on five soil characteristics are found in the category L-Landscape. These farm practices are all linked to agroforestry and sylvicultural systems.

Some farm practices have more important effects than others

Depending on the soil characteristics, the order of magnitude of the coefficients varies a lot:

- Coefficients related to a change in stocks (e.g. the stock of organic carbon or nitrogen in the soil) are, for most farm practices, inferior to 2%. The change in such stocks is a slow process (hence low annual variation values), but these changes cumulate over the years to build up the stock.
- Coefficients for soil water retention and soil packing density also reflect changes in stocks and rarely exceed 20%. Hence, these changes cumulate over time (soil packing density keeps decreasing year after year and the same goes for soil water retention capacity that keeps increasing).
- Coefficients referring to changes in fluxes (nitrogen leaching and runoff, and soil erosion by water) are much higher, and range for most of the farm practices between 20% and 75%. These values describe changes in annual losses (e.g. erosion can be reduced by half with the relevant farm practices from one year to the other), but their effects cannot be cumulated over time.

In addition, some farm practices have relatively high coefficients within a given soil characteristic:

- For **soil organic carbon content**, the farm practice R15 (mixed cropping/intercropping) stands out with a coefficient of 14.90% increase in soil organic carbon content per year, the other coefficients rarely exceeding 5%. It is also worth noting that R14 (crop diversification) has a relatively high coefficient (3.46%) compared to the average (1.58%).
- For **soil nitrogen**, a few farm practices have coefficients reaching 12%, such as S231 (summer cover crop) (12.38%) or F4X (use of specific fertiliser types or manure) (12.98%). S22 (crop residues left on soil, leaving stubble on the field) also has a relatively high coefficient (10.85%). The average effect of all farm practices covered is 4.19%.
- For **soil water retention**, the farm practices with the highest coefficients are the ones linked to F31X (amendment with biochar), with an increase of 33.54% of soil water retention capacity [35], compared to the average 9.69% effect for the farm practices covered.
- For **soil packing density**, the coefficients cluster around an average reduction in soil packing density of 5.64%, the farm practice with the highest coefficient is also related to biochar: F311 (application of raw biochar) (11.84%). S22 (crop residues left on soil, leaving stubble on the field) also has a relatively average coefficient, considering the median (6.00%).

[35] This high value highlights one of the main limitations of the coefficient database which do not reflect the fact that coefficients change with the change in stock -considering that stocks (soil organic carbon content, nitrogen, water retention capacity, packing density) stop increasing after reaching a plateau – providing only one coefficient for each of the farm practices. This is one of the primary limitations of the study's results.

- For **nitrogen leaching and runoff**, the coefficients range from an annual reduction of 1.86% for the farm practice F211 (deep placement (mineral fertilisers) or deep injection (slurry)) to 100% for banning all types of fertilisers (F11X (ban on the use of fertilisers other than along water courses)). Most of the coefficients are, however, above 20% and the average effect of all farm practices covered is 47.63%.
- For **soil erosion by water**, coefficients range from 31.02% for S22 (crop residues left on soil, leaving stubbles on the field) to 72.82% for several farm practices related to landscape features such as L121 (creation of field margins). The average effect of all farm practices covered is 52.80%.

3.2. Step 2 – National baselines are used to turn coefficients into absolute values

In the study, the term 'baseline' refers to the contextual data that quantifies the state of the soil characteristics studied in each Member State. The baselines in this study serve two main purposes:

- Turning the coefficients expressed as percentages into absolute values (for instance, from a percentage to tonnes of carbon stored per hectare in the top 30 cm), in order to accumulate the potential contributions of different farm practices at the level of CSP interventions or GAECs.
- Adapting the effect of the farm practices to the national context. For instance, if soil erosion is very high in a given Member State, a farm practice allowing for a reduction of erosion by 50% is expected to have more effect there than in a Member State where soil erosion is less significant.

Table 2 presents all the baselines used in the study, to which the coefficients from the database were applied. These baselines are expressed per hectare of agricultural land. There is significant variability across Member States, which can lead to markedly different potential effects for the same farm practice depending on where it is implemented. For example, in the Netherlands, average annual soil erosion by water is estimated at 0.3 tonnes per hectare of agricultural land, whereas in Italy it reaches 10.8 tonnes. When applying farm practice S231 (summer cover crop), which has a coefficient indicating a 49.80% reduction in soil erosion by water, this results in an annual soil saving of 149 kg per hectare in the Netherlands. In contrast, the same practice in Italy would yield a much greater benefit, reducing soil loss by 5.38 tonnes per hectare per year.

Table 2. National baselines per hectare used to convert coefficients expressed as percentages into absolute values

	Soil organic carbon content: t of carbon/ha-top 30 cm	Soil Nitrogen: t of nitrogen/ ha-top 20 cm	Soil water content: t of water/ha-top 20 cm	Soil packing density: t of soil/ha-top 20 cm	Nitrogen leaching and runoff: kg of nitrogen/ha/yr	Soil erosion by water: t of soil/ha/yr
CZ	59.5	4.6	190.2	2 877	43.0	2.6
DE	83.6	5.5	175.4	2 774	9.4	1.7
DK	55.4	4.1	144.0	2 877	53.4	0.5
EL	50.6	4.1	207.8	3 115	48.1	4.7
ES	56.1	4.1	183.0	2 475	23.0	4.6
FI	148.8	4.1	188.0	2 235	27.7	0.9
IT	45.0	4.2	227.0	2 775	41.4	10.8
LV	114.3	4.7	160.4	2 571	7.0	0.6
LU	114.0	6.3	231.4	2 613	87.7	3.2
HU	64.5	4.3	197.4	3 060	40.5	2.1
NL	138.8	5.6	70.8	2 623	110.0	0.3
PL	65.7	3.9	132.4	2 496	26.9	1.4
RO	62.2	4.7	198.6	2 875	0.0	3.9

Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025) based on different data.

- For SOC content: European Soil Data Centre (ESDAC) Pan-European SOC stock of agricultural soils: Metadata for 'Erosion integration in the European Carbone balance' – 2015
- For soil nitrogen: ESDAC Maps of Soil Chemical properties at European scale based on LUCAS 2009/2012 topsoil data
- For soil water content: ESDAC Topsoil physical properties for Europe (based on LUCAS topsoil data) – 200For soil packing density: ESDAC Soil Bulk Density in Europe (based on LUCAS 2018 topsoil data)*
- For nitrogen leaching and runoff: Eurostat [aei_pr_gnb__custom_16391433] Net nutrient balance per hectare of utilised agriculture area (UAA) (kg of nutrient per ha) – most recent value available except for RO
- For soil erosion by water: ESDAC Soil erosion by water (RUSLE2015) NEW_RUSLE2016

Colour scale highlighting the distribution of the values per soil characteristic:

Highest value	Lowest value

4. Estimated potential contributions of the CSP interventions to improving soil health

4.1. Number of interventions studied

The study quantifies the potential contribution to the improvement of soil health of 56 eco-scheme interventions and 98 ENVCLIM interventions. The number of interventions studied varies between CSPs. At the same time, the number of interventions planned to address soil health does not necessarily reflect the efforts made by a CSP in this regard, as some interventions are more complex and ambitious than others. For instance, in the Netherlands, only one eco-scheme intervention and one ENVCLIM intervention are studied, but these ambitious interventions target many different farm practices and large areas. On the other hand, CSPs that cover numerous interventions generally present the advantage of being more targeted, which makes it easier to identify the farm practices concerned and to link them to a specific area. Thus, the number of interventions covered by a CSP cannot be interpreted as an indicator of the ambition of the CSP regarding soil protection, but can sometimes provide an indication of the robustness of the assessments made, as more targeted interventions entail a more robust assessment of the farm practices and the area they cover.

Regarding CIS and INVEST, the CIS on protein crops is implemented in all 13 CSPs except Germany, Denmark, Finland and the Netherlands, while some INVEST interventions are also associated with potential contributions to the soil characteristics in all CSPs studied except in Luxembourg.

The details of the number of interventions covered in each CSP by type of intervention are available in Annex 2 – Number of interventions covered by CSP.

4.2. Results per soil characteristic

This section provides an overview of the potential contribution of CSP interventions on the six soil characteristics studied at CSP level.

The figures below show the overall estimated potential contribution of the CSP interventions to the soil characteristic concerned, in absolute and relative value (left-hand side graphs). The relative value is calculated by dividing the estimates in absolute value by the baseline expressed in total utilised agriculture area (UAA) of the CSP e.g. the total quantity of soil organic carbon in the 30 cm topsoil of national UAA. In these graphs, the upper and lower bounds (min and max estimated) represent the 95% confidence interval of the estimates in absolute value, based on the confidence interval associated with the effect of each farm practice [36].

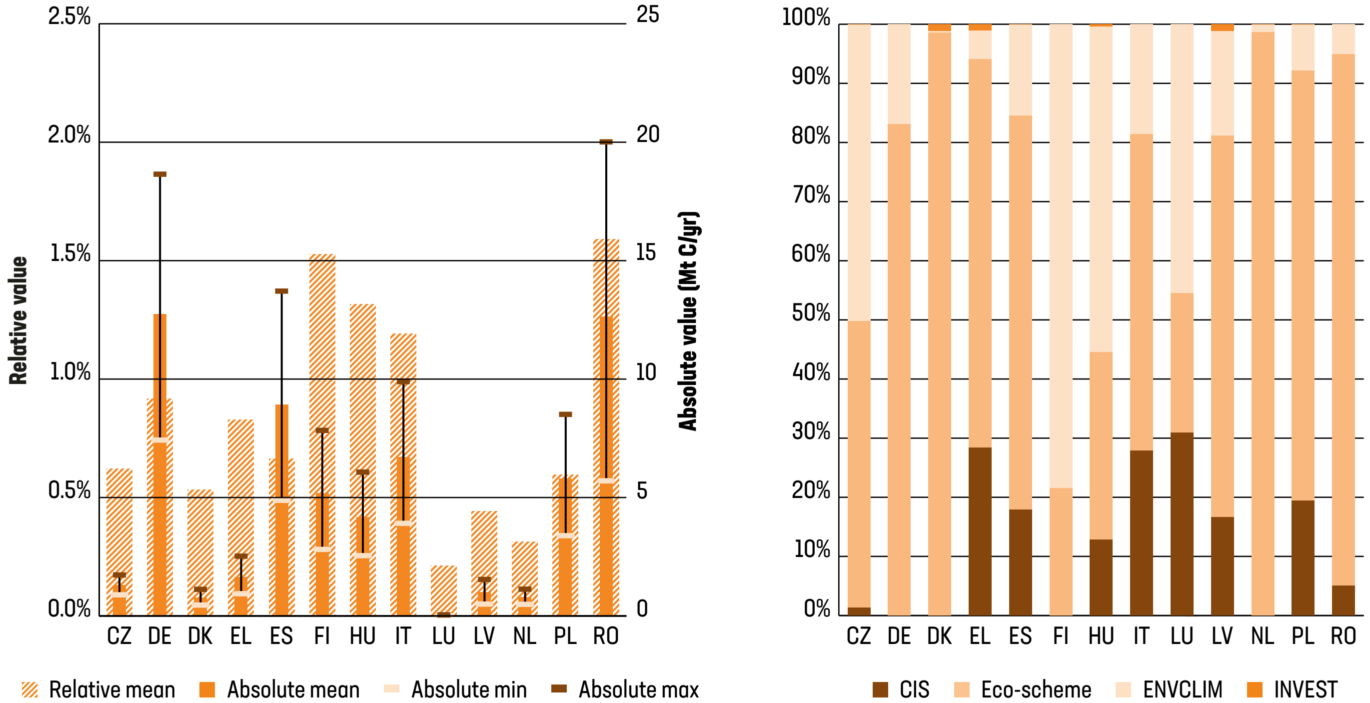
The figures also provide the breakdown of these estimates per type of intervention (right-hand side graphs).

[36] These intervals only represent the uncertainty linked to the effect of the farm practice, but they do not represent other uncertainties, such as those linked to the assessment of the baseline or of the area covered by the farm practices. See the general methodology for more information.

4.2.1. Soil organic carbon content

The analysis of the 13 CSPs covered an estimated potential increase in agricultural soil organic carbon content in the 30 cm topsoil of 0.92% per year.

Figure 5. Estimated potential of increase in soil organic carbon content through CSP interventions



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

Among these results, the following is worth noting:

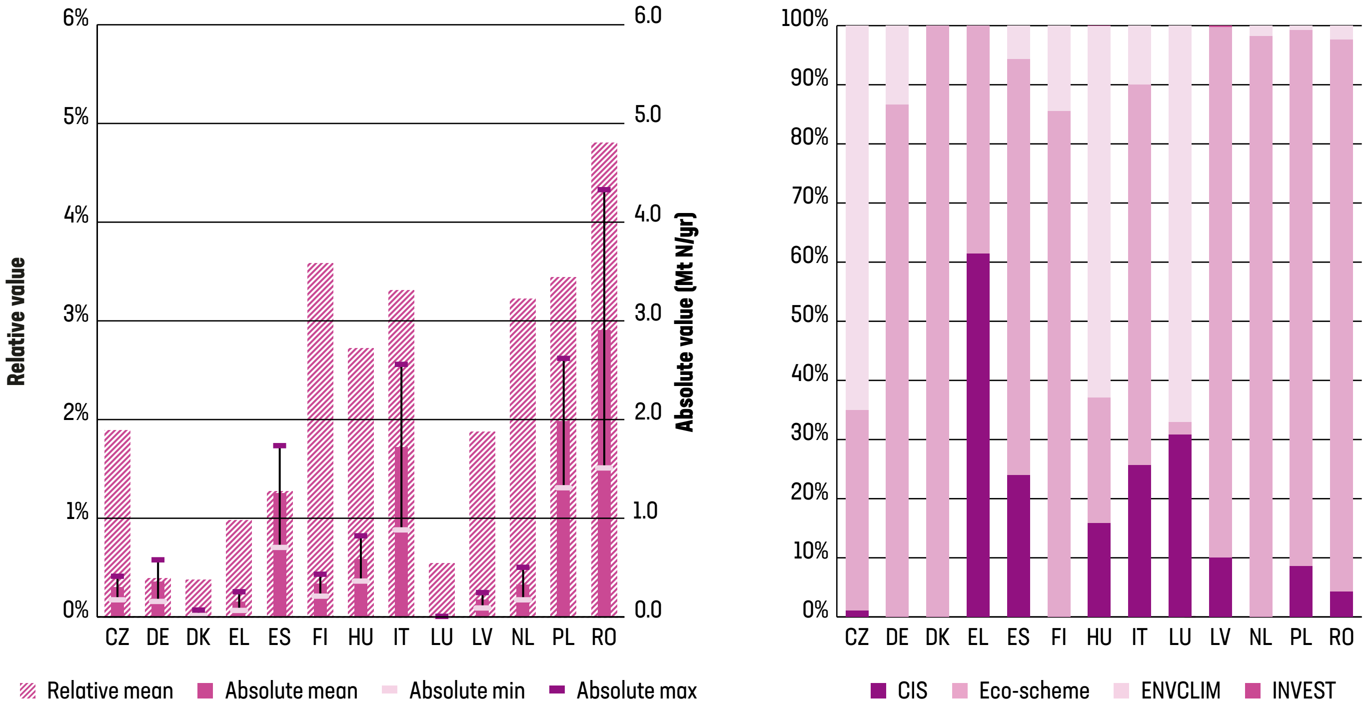
- The estimated potential annual increase in soil organic carbon content ranges from 0.21% in Luxembourg to 1.59% in Romania. Considering the agricultural area in the two Member States and the baselines (Table 2), the absolute organic carbon content translates to around 39 000 tonnes of additional organic carbon stored in the soil in Luxembourg (or 0.24 tC/ha of UAA) and 12.6 million tonnes in Romania (0.99 tC/ha).
- Germany's CSP interventions are also estimated to contribute substantially, with an estimated 12.7 million tonnes of carbon increase that translates to an additional 0.77 tC/ha of UAA. However, this increase represents a smaller relative gain (0.92%) compared to Romania (1.59%). Germany's higher SOC baseline (83.6 tC/ha compared to 62.2 tC/ha for Romania, as shown in Table 2, above), along with its larger UAA compared to Romania, helps explain the significant total contribution in absolute value despite a lower result in relative value than Romania.
- Considering the 95% confidence interval of the coefficients, the estimated potential increase in soil organic carbon shows significant variability. This variability depends on the individual farm practice. For example, in the case of soil organic carbon content, farm practice R14 (crop diversification) presents a wide confidence interval [37] linked to the variability of the results reported in the meta-analysis for this farm practice.
- In terms of interventions:
  - Eco-schemes are contributing the most to the estimated potential in most CSPs.
  - ENVCLIM play a major role in Czechia, Finland, Hungary and Luxembourg.
  - The CIS is estimated to contribute significantly to the potential increase in soil organic carbon content in Greece, Spain, Italy, Luxembourg, Latvia and Poland.
  - INVEST interventions contribute to the estimated increase in soil organic carbon in all CSPs except Germany and Luxembourg, but to a very small extent [38].

[37] See footnote 36, page 10.
[38] These estimates are so low that they are not visible in the graph for most CSPs.

4.2.2. Soil nitrogen

The analysis of the 13 CSPs indicates an estimated potential increase in agricultural soil nitrogen in the 20 cm topsoil of 2.29% per year.

Figure 6. Estimated potential of increase in soil nitrogen stocks through CSP interventions



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

Among these results, the following is worth noting:

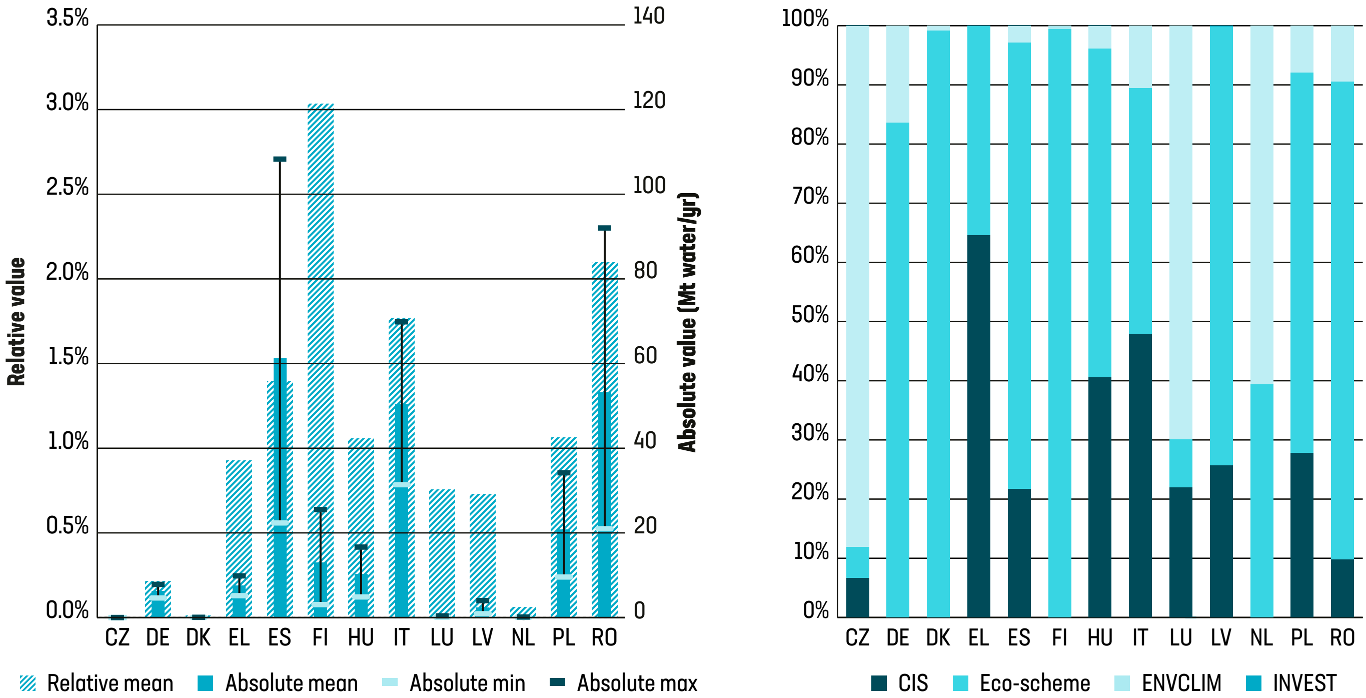
- The annual estimates range from 0.38% in Denmark to 4.81% in Romania. Considering the agricultural area in the two Member States and the baselines, this translates to 40 500 tonnes of nitrogen stored in the soil in Denmark (or 0.02 t of N/ha of UAA) and 2.9 million tonnes in Romania (0.23 t of N/ha).
- The Finish CSP is the second highest in terms of estimated potential increase in soil nitrogen compared to the national baseline (value in %), but this CSP is among the lowest when considering the results in absolute value. This can be explained by the relatively low baseline and the total UAA in this Member State.
- The 95% confidence intervals show that the mean values presented are relatively more precise than the ones presented for soil organic carbon content, as the maximum estimates represent an increase of about 50% of the mean estimates in most CSPs. In terms of interventions, there is a certain variability across the Member States. Eco-scheme interventions are the major contributor to the estimated potential increase in soil nitrogen in Germany, Denmark, Spain, Finland, Italy, Latvia, the Netherlands, Poland and Romania. ENVCLIM interventions significantly contribute to the results in Czechia, Hungary and Luxembourg. The CIS for protein crops plays a significant role in the estimated increase in soil nitrogen in the CSPs where it is programmed, particularly in Greece (although the overall estimated increase in soil nitrogen is relatively low at 0.98%). The CIS also plays an important role in Italy, where the estimated increase in soil nitrogen is among the highest estimated in absolute and relative terms (3.31%). INVEST interventions contribute to the estimated increase in soil nitrogen in half of the CSPs studied [39], but to a very small extent.

[39] Czechia, Spain, Hungary, Italy, Latvia, the Netherlands, Poland and Romania.

4.2.3. Soil water retention

The analysis of the 13 CSPs indicates an estimated potential increase in agricultural soil water retention capacity in the 20 cm topsoil of 1.17% per year.

Figure 7. Estimated potential of increase in water retention capacity through CSP interventions



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

Among these results, the following is worth noting:

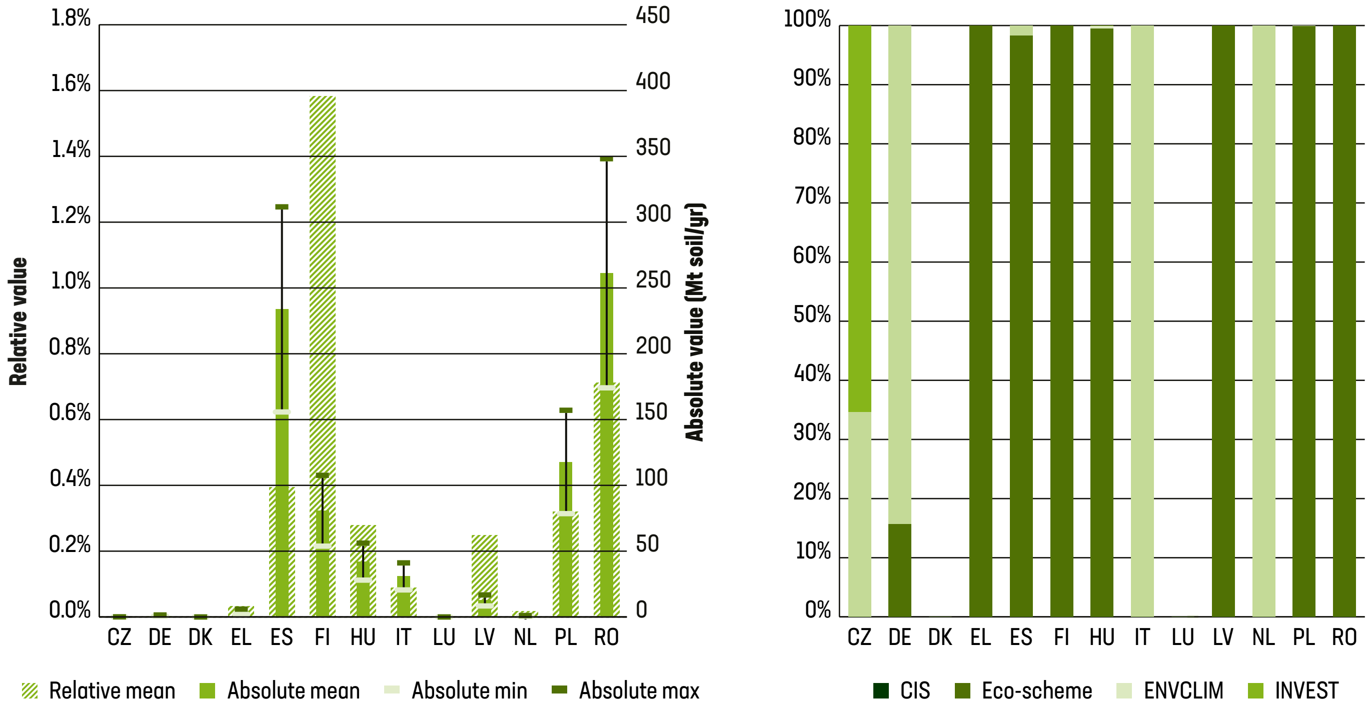
- The estimated annual increase in water retention capacity in agricultural soils (top 20 cm) at Member State level for the CSPs studied ranges from nearly no effect in Czechia to 3.04% in Finland. Considering the agricultural area in the two Member States and the baselines, this translates to approximately 2 000 tonnes of water retention capacity in Czechia (or 0.62 kg of water/ha of UAA) and 13.0 million tonnes in Finland (5.07 t/ha). The highest increase is estimated in Spain, with an additional 61.2 million tonnes of water (2.56 t/ha) that soils have the capacity to store annually.
- For Spain and Finland, the difference between results expressed as absolute and relative values is mainly explained here by the difference in UAA between these two Member States, as they have similar baselines for soil water retention capacity (183 t of water/ha in Spain and 188 in Finland).
- The 95% confidence interval associated with the coefficients shows that when considering the maximum value of this interval, results nearly double in Finland (+95.8%) and in Spain (+77.0%). It indicates that the estimates for soil water retention capacity are not precise.
- The high variability in the order of magnitude of the estimates between Member States (expressed in percentages) can be explained by the fact that only a few farm practices are given an effect on soil water retention in the coefficients database. As previously mentioned, soil water retention capacity is influenced by various soil characteristics, including soil organic carbon content. Therefore, it is likely that more farm practices than those explicitly found to have an effect in this study can, in reality, contribute positively to soil water retention capacity (there are more coefficients for soil organic carbon content than for soil water retention capacity in the study). As a result, CSPs with low estimates, because they do not include the few practices identified as effective, might in practice achieve greater improvements through other beneficial farm practices whose effects are not captured by the study.
- In terms of interventions, there is a certain variability across the Member States:
  - Eco-schemes' role in the estimated increase in soil water retention capacity remains predominant in many CSPs: Germany, Denmark, Spain Hungary, Latvia, Poland and Romania. In Denmark and Finland, this type of intervention accounts for nearly 100% of the estimated potential effect.
  - ENVCLIM interventions have a significant relative influence on the results in Czechia, Luxembourg and the Netherlands. In the case of Luxembourg and the Netherlands, the estimated increase in soil water retention capacity is very low (less than 0.01% and 0.06%, respectively) so the final impact is potentially very limited.
  - The CIS on protein crops represents 40% to 65% of the estimated potential contribution of CSP interventions to increase soil water retention capacity in Greece, Hungary and Italy.
  - INVEST interventions contribute to the estimated increase in soil water retention capacity in half of the CSPs studied [40], but to a very small extent.

[40] Czechia, Greece, Spain, Hungary, Italy, Latvia, Poland and Romania.

4.2.4. Soil packing density

The analysis of the 13 CSPs indicates an estimated potential decrease in agricultural soil packing density in the 20 cm topsoil of 0.30% per year.

Figure 8. Estimated potential of decrease in soil packing density through CSP interventions



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

Among these results, the following is worth noting:

- The annual estimates range from no effect (Denmark and Luxembourg [41]) to 1.58% decrease in soil packing density in Finland. This 1.58% decrease in packing density most likely indicates soil loosening or the addition of organic matter, resulting from the beneficial effects of the interventions. Romania, Spain, Poland, Hungary and Latvia follow, in descending order of soil packing density decreases, reflecting the positive effects of their CSPs on soil properties.
- Although the 95% confidence interval associated with the coefficients shows that results do not vary much (generally more or less 33% considering the range's min and max values), the results' precision is affected by the lack of coefficients available for this soil characteristic. Even though there are many farm practices affecting bulk density, the coefficient database contains very few coefficients (see Figure 3, where eight farm practices are associated with a positive effect on soil packing density versus 60 for soil organic carbon content). Therefore, the quantification of the potential contribution of CSPs to soil density is limited by these data gaps.
- In terms of interventions, there is a certain variability across the Member States:
  - Eco-schemes represent 100% (or almost) of the estimates in seven of the eleven CSPs where a potential contribution to the reduction of soil packing density is estimated (Greece, Spain, Finland, Hungary, Latvia, Poland, Romania).
  - At the same time, in Germany, Italy and the Netherlands, ENVCLIM interventions represent 80-100% of the estimated potential contribution.
  - The CIS on protein crops is not linked to any potential contribution to reducing soil packing density.

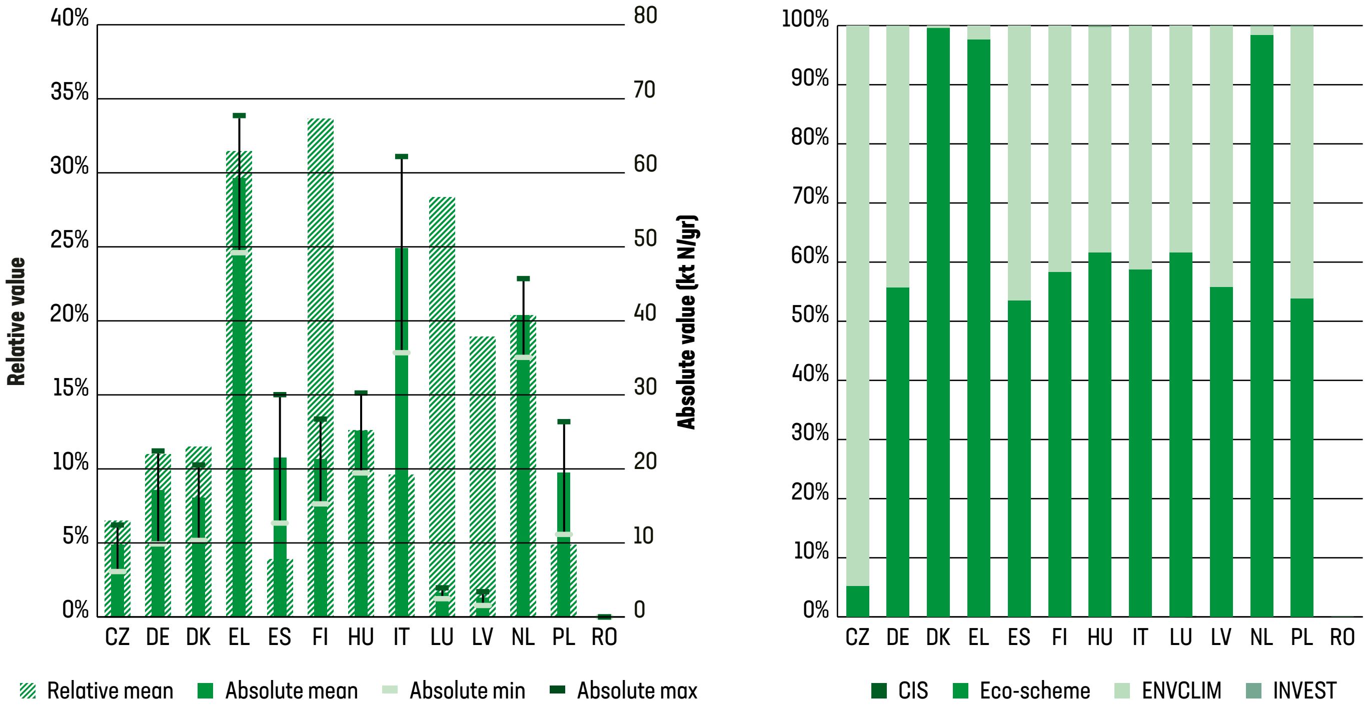
In Czechia, results highlight the predominant role of INVEST interventions. In this CSP, the INVEST intervention supporting the farm practice L322 (Creation of silvicultural system) is responsible for 65% of the estimated contribution of all CSP interventions to reduce soil packing density.

[41] In these CSPs, the few farm practices associated with a coefficient for soil packing density are not supported through the interventions studied.

4.2.5. Nitrogen leaching and runoff

The analysis of the 13 CSPs indicates an estimated potential decrease in nitrogen leaching and runoff of 9.68% per year.

Figure 9. Estimated potential of decrease in nitrogen leaching and runoff through CSP interventions



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

Among these results, the following is worth noting:

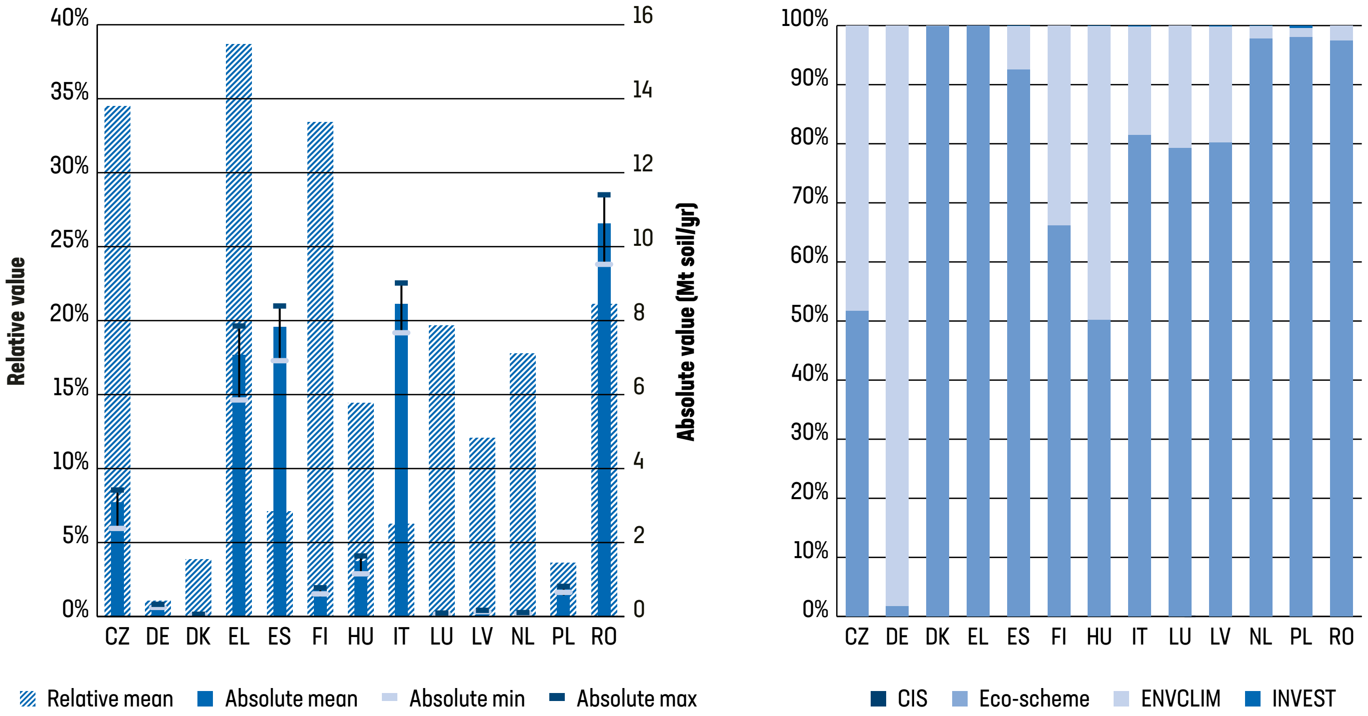
- No potential contribution is estimated for Romania as the baseline for net nitrogen balance shows that, on average, at national level, there are more nitrogen outputs than inputs in Romanian agricultural soils, suggesting that nitrogen leaching and runoff are not an issue at the national level [42].
- For the other CSPs, the estimated annual decrease in nitrogen leaching and runoff ranges from 3.91% in Spain to 33.67% in Finland. Considering the agricultural area in the two Member States and the baselines (see Table 2), this translates to approximately 21.5 thousand tonnes of nitrogen leaching and runoff annually in Spain (or 0.90 kg N/ha of UAA) and 26.7 thousand tonnes in Finland (or 9.03 kg N/ha).
- In absolute values, the highest estimate is reached in Greece (59.2 thousand tonnes of nitrogen per year or 15.13 kg N/ha) because the baseline (48.1 kg of nitrogen/ha/yr) is almost twice as high as in Spain (23.0 kg/ha/yr) and Finland (27.7 kg/ha/yr) (see Table 2).
- The 95% confidence interval is relatively tight (25% variation of the mean estimated on average), compared to other soil characteristics. This leads to the estimated potential contribution of the CSP interventions to the reduction of nitrogen leaching and runoff being more robust than most of the other soil characteristics covered.
- In terms of interventions, there are contrasting results:
  - Across most Member States analysed, namely Germany, Spain, Finland, Hungary, Italy, Luxembourg, Latvia and Poland, there is a relatively balanced distribution of contributions, with eco-schemes accounting for approximately 60% and ENVCLIM interventions for around 40% of the estimated potential effects. In contrast, in Denmark, Greece and the Netherlands, the estimated potential effect is attributed almost entirely to Eco-schemes, and in Czechia to ENVCLIM interventions.
  - The CIS on protein crops is not linked to any potential contribution to reducing nitrogen leaching and runoff.
  - INVEST interventions contribute to the estimated reduction of nitrogen leaching and runoff in all CSPs except Denmark and Luxembourg, to a very small extent.

[42] Although it could be an issue at local level, but the information provided in the CSP as well as the baseline cannot be assessed at sub-national level.

4.2.6. Soil erosion by water

The analysis of the 13 CSPs indicates an estimated potential decrease in agricultural soil erosion by water of 10.59% per year.

Figure 10. Estimated potential of decrease in soil erosion by water through CSP interventions



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

Among these results, the following is worth noting:

- The estimates range from 1.07% in Germany to 38.69% in Greece decrease in soil erosion by water in agricultural soils. Considering the agricultural area and the baselines in these two Member States, this translates to approximately 296.0 thousand tonnes of soil not lost to water erosion in Germany (or 0.02 t/ha of UAA) and 7.1 million tonnes in Greece (1.81 t/ha).
- In absolute value, the highest estimated potential is reached in Romania with 10.6 million tonnes of soil saved from runoff annually (0.83 t/ha). This value results from the potential decrease related to the CSPs intervention estimated at 21.12%, applied to an average national baseline of 3.94 tonnes per hectare, and a UAA of 12.8 million hectares [43]. High estimates are also reached in Italy and Spain in absolute terms, 8.7 million tonnes of soil saved from runoff annually (0.67 t/ha) and 7.8 million tonnes (0.33 t/ha) respectively. The estimated decrease is only 6.27% for Italy and 7.10% for Spain, but in these Member States, the baseline is relatively high, 10.77 t/ha annually for Italy and 4.61 t/ha in Spain, with the UAA 12.5 million hectares in Italy and 23.9 million in Spain.
- As with the results on nitrogen leaching and runoff, the 95% confidence interval is relatively narrow (less than 10% of the mean estimated). This suggests that the mean estimate is more reliable compared to those other soil characteristics (based on the effects of farm practices).
- In terms of interventions:
  - Eco-scheme interventions represent 50% to 100% of the CSPs' estimated potential to reduce soil erosion by water in all Member States but Germany, where ENVCLIM interventions are prevalent in the estimate.
  - ENVCLIM interventions account for a significant share of the estimated reduction in soil erosion by water. This trend is comparable to the results for nitrogen leaching and runoff, partly due to the fact that many farm practices aimed at reducing nitrogen leaching and surface runoff also have a direct impact on mitigating soil erosion in the coefficient database.
  - The CIS on protein crops is not linked to any potential contribution to the reduction of soil erosion by water.
  - INVEST interventions bring a very marginal contribution to the estimated reduction of soil erosion by water because very small areas can be associated with the farm practices supported by these interventions.

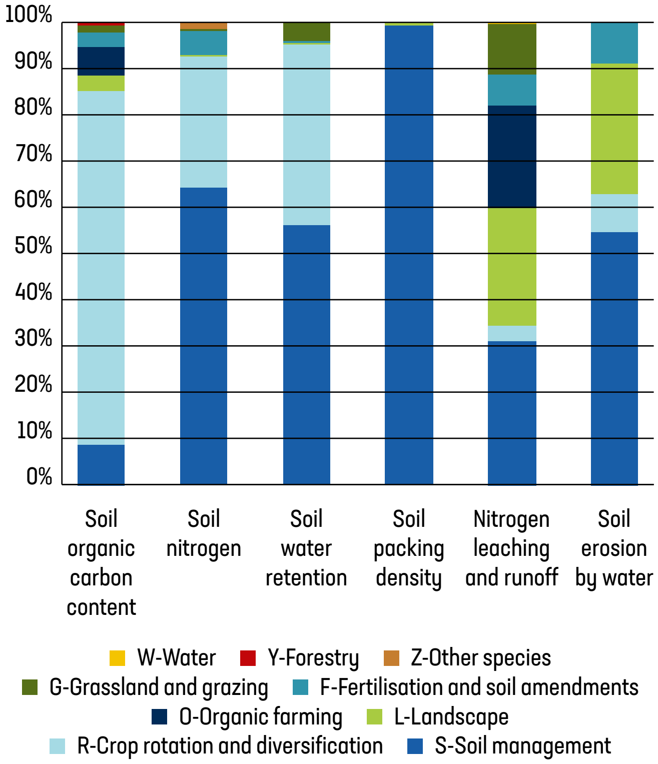
[43] Eurostat, 2020, [ef_lus_main], UAA.

4.3. Farm practices

This section provides insights into the farm practices that contribute the most to the estimated potential of the CSP interventions to improve the soil characteristics studied. Figure 11 illustrates the relative contributions of the various categories of farm practice (see Annex 1 – Coefficients database, for clarification on the farm practices categories).

4.3.1. Overall contribution of the different categories of farm practices

Figure 11. Distribution of the CSP interventions' estimates by category of farm practices



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

- Soil management farm practices (**category S**) account for most of the estimated potential contribution of the CSPs' interventions. This category includes practices that limit tillage or ensure soil cover, such as crop cover or mulching with pruning residues.

  This category of farm practices accounts for between 30-65% of the estimated potential contribution to increasing soil nitrogen, increasing soil water retention capacity, reducing nitrogen leaching and runoff and decreasing soil erosion by water. This category of practices also accounts for 99% of the estimated reduction in soil packing density.

- Farm practices related to crop rotation and diversification (**category R**) account for the vast majority (77%) of the estimated increase in soil organic carbon, and contribute significantly to increases in soil nitrogen (28%) and soil water retention capacity (39%).

- Farm practices related to landscape (**category L**), such as the creation of hedgerows or different types of field margins or patches, account for a significant part of the estimated reductions in nitrogen leaching and runoff (25%) and soil erosion by water (28%).

- Organic farming (**category O**) contributes to the estimated reduction of nitrogen leaching and runoff (22%) and, to a lesser extent, to the estimated increase in soil organic carbon content (6%). These are the only two soil characteristics for which coefficients are available for organic farming in the database.

- Maintaining grassland (**category G**) contributes 11% to the estimated reduction in nitrogen leaching and runoff.

- Farm practices related to fertilisation and soil amendments (**category F**) contribute 9% of the estimated reduction in soil erosion by water. These farm practices also notably add to the estimated reduction of nitrogen leaching and runoff (7%), the estimated increase in soil nitrogen (5%) and the estimated increase in soil organic carbon content (3%).

- Farm practices in the categories **W-Water**, **Y-Forestry** [44] and **Z-Other species**, contribute only marginally, primarily due to the limited number of coefficients available and/or their infrequent support in the CSPs examined. When supported, these practices tend to be implemented over relatively small areas.

4.3.2. Focus on the farm practices contributing the most to the estimates

The following graphs display the farm practices associated with the highest estimated potential contributions. Each graph illustrates two elements:

- the estimated potential contribution of each farm practice (expressed as a percentage); and
- the estimated area where each farm practice is expected to be implemented.

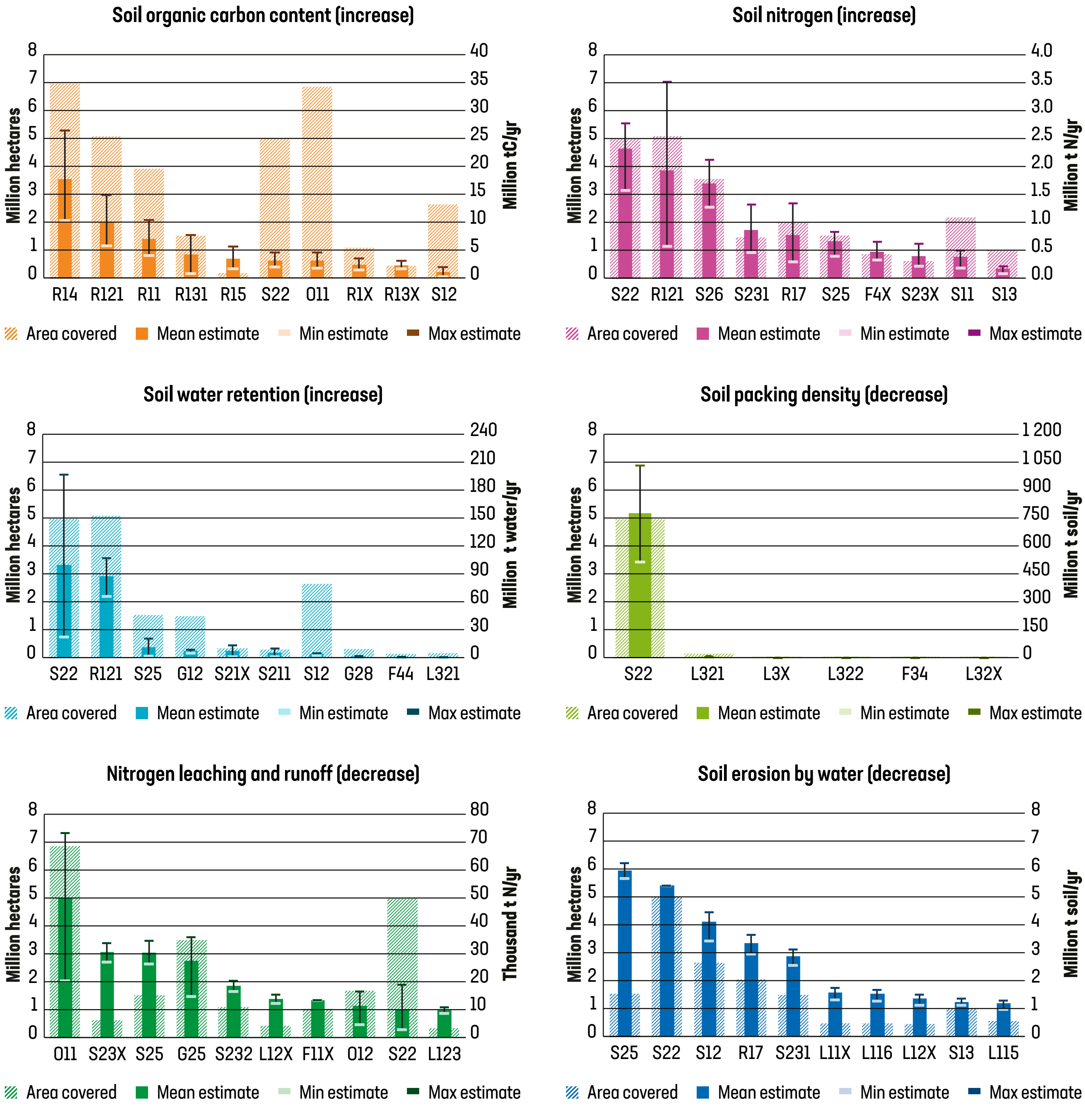
By presenting both elements together, the graphs help to identify whether a farm practice's estimated contribution is primarily driven by the extent of its implementation (area covered) or by the magnitude of its effect (as indicated by its coefficient).

The estimates presented are aggregated data from the 13 CSPs. However, it is important to note that the effects of farm practices vary across CSPs, as different baseline values are used to convert percentage-based coefficients into absolute values. For instance, the baseline soil organic carbon content in Italy is relatively low (45.0 t C/ha) compared to Germany (83.6 t C/ha). As a result, a farm practice like R14 (crop diversification), which increases soil organic carbon by 3.46% per year (see Annex 1 – Coefficients database), will yield a higher absolute gain (in t C/ha) in Germany than in Italy, even if applied to the same area.

This illustrates that for each soil component, the aggregated estimated contribution of a farm practice across Member States is more heavily influenced by those implemented in countries with higher baseline values, assuming equal areas of implementation.

[44] In the study, farm practices in the category Y-Forestry relate to the afforestation of agricultural land and the maintenance of this afforested area.

Figure 12. Estimated potential contribution of the top ten farm practices per soil characteristic and their estimated area covered (13 CSPs)



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

All the values displayed are positive; depending on what is indicated in brackets, it corresponds either to an increase (as in the case of soil nitrogen) or a decrease (as in the case of soil packing density).

Farm practice labels:

F-Fertilisation and soil amendments: F11X (ban on the use of fertilisers other than along water courses), F34 (amendment with Gypsum), F44 (use of green manure), F4X (use of specific fertiliser types or manure)

G-Grassland and grazing: G12 (none or restricted grazing (timing, animal species, etc.)), G25 (ban of ploughing of grassland), G28 (bans or restrictions on grazing, mowing or ploughing of grassland on limited areas of the field other than along watercourses)

L-Landscape: L115 (creation of group of trees/field copses), L116 (maintenance and conservation of group of trees/field copses), L11X (hedgerows/individual or group of trees/ trees in line), L123 (Creation of patches), L12X (field margins, patches and unproductive buffer strips along water courses), L321 (maintenance of silvicultural systems), L322 (Creation of silvicultural systems), L32X (silvicultural systems), L3X (agroforestry)

O-Organic farming: O11 (maintenance of organic farming practices), O12 (conversion to organic farming practices)

R-Crop rotation and diversification: R11 (crop rotation), R121 (cultivation of nitrogen fixing/protein crops), R131 (short-term fallow), R13X (land laying fallow), R14 (crop diversification), R15 (mixed cropping/intercropping), R17 (catch crops), R1X (crop rotation or crop diversification)

S-Soil management: S11 (low tillage), S12 (no tillage), S13 (restriction on tillage (timing, direction in slopes)), S211-(mulching with pruning residues), S21X (mulching), S22 (crop residues left on soil, leaving stubble on the field), S23X (cover crops), S231 (summer cover crop), S232 (winter cover crop), S23X (cover crops), S25 (green cover on permanent crops), S26 (crop residue incorporated into the soil)

Few farm practices are estimated to cover the most significant areas

These farm practices are the following:

- R14 (crop diversification) and O11 (maintenance of organic farming practices), for a total of around 6.9 M ha each.
- R121 (cultivation of nitrogen fixing/protein crops) and S22 (crop residues left on soil, leaving stubbles on the field) around 5.0 M ha.
- R11 (crop rotation) with around 3.9 M ha.
- S26 (crop residue incorporated into the soil) and G25 (ban of ploughing of grassland) with around 3.5 M ha.

At farm practice level, the estimated contribution effect of CSP intervention is mainly driven by the following farm practices:

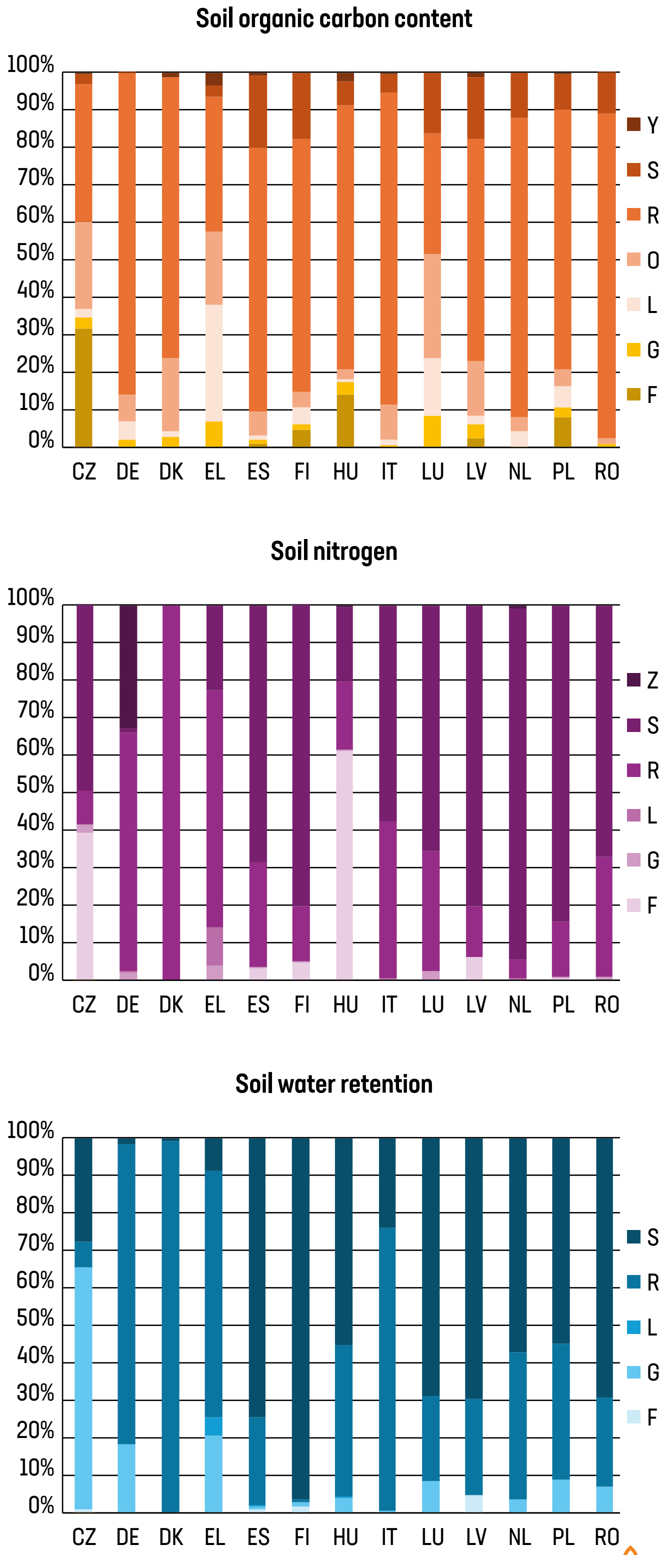
- S22 (crop residues left on soil; leaving stubble on the fields) is a key farm practice as it contributes to soil health in all its components. Supported by CAP interventions on large areas, it stands out in the results, particularly in soil nitrogen, water retention, packing density and erosion by water.
- R121 (cultivation of nitrogen fixing/protein crops) also contributes significantly to the estimated increase in soil organic carbon content, soil nitrogen and soil water retention.
- R14 (crop diversification) and R11 (crop rotation (both farm practices have the same coefficient) significantly contribute to the estimated increase in soil organic carbon content. They are estimated to be applied on large areas, accounting for a large part of the estimated potential contribution of the CSP interventions to the increase in soil organic carbon content.
- On nitrogen leaching and runoff, farm practices contributing the most are O11 (maintenance of organic farming practices), followed by S23X (cover crops), S25 (green cover on permanent crops) and G25 (ban of ploughing of grassland). S23X and S25 are much more efficient than the other two farm practices in avoiding leaching (higher coefficients).
- In terms of soil erosion, in addition to S22 (crop residues left on soil; leaving stubbles on the field), other type of covers S25 (green cover on permanent crops), R17 (catch crops), S231 (summer cover crop) as well as the restriction on tillage (S12 (no tillage)) contribute to the estimated potential reduction.

Finally, the graphs outline the high variability in the magnitude of the confidence intervals from one farm practice to another. For instance, the main contribution of organic farming lies in the reduction of nitrogen leaching and runoff. However, the confidence interval linked to this coefficient is very large (around 50% above and below the estimate). The confidence interval of the farm practice S22 (crop residues left on soil, leaving stubble on the field) is also particularly large, showing that the results achieved can double or become very low depending on whether the maximum or minimum value of the confidence interval is considered. On the other hand, other coefficients, such as the one allocated to S23X (cover crops) for nitrogen leaching and runoff, come with a relatively tight confidence interval. This is linked to the variability of the results gathered under the meta-analyses from which the coefficients stem, and it affects the reliability of the estimates.

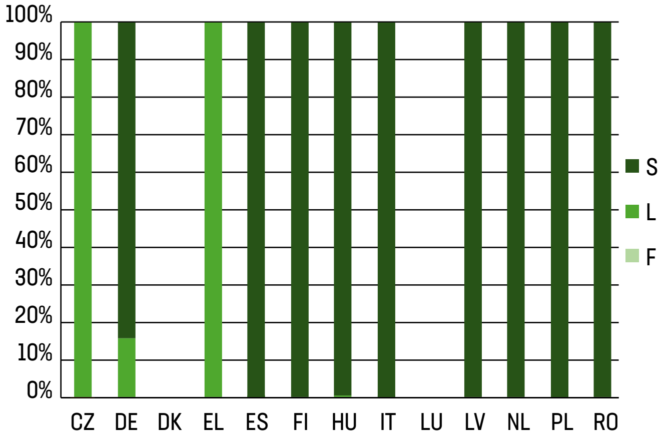
4.3.3. In the CSPs, similar results can be achieved with different sets of farm practices

The following figure shows the relative contribution of each category of farm practices in the estimates assessed for the CSP interventions, for each of the 13 CSPs covered, soil characteristic by soil characteristic.

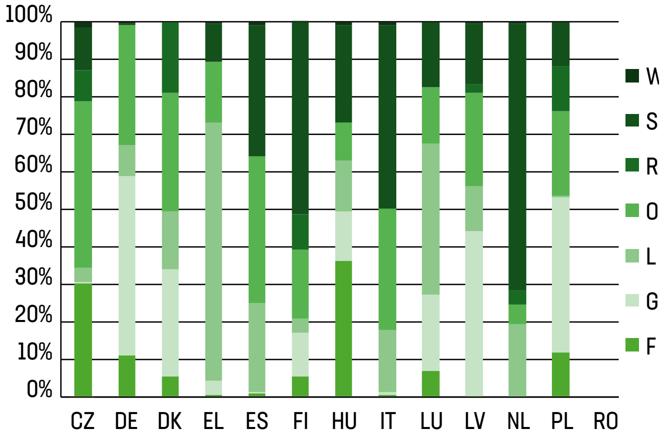
Figure 13. Distribution of the CSP interventions' estimates by category of farm practices in each CSP for each soil characteristic



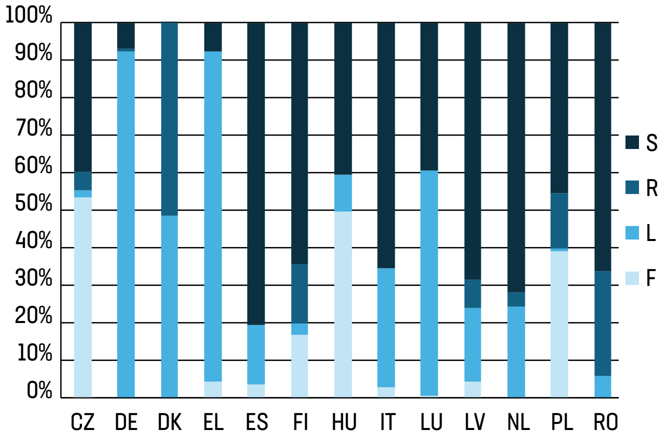
Soil packing density



Nitrogen leaching and runoff



Soil erosion by water



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

F = Fertilisation and soil amendments; **G** = Grassland and grazing; **L** = Landscape; **O** = Organic farming; **R** = Crop rotation and diversification; **S** = Soil management; **W** = Water; **Y** = Forestry; **Z** = Other species.

Different farm practices are central to the estimates provided, depending on the strategies of the CSPs, for all the soil characteristics covered. For instance:

- Although farm practices related to crop rotation and diversification (category R) are key in the estimated potential of the CSP intervention to increase soil organic carbon content, in Czechia, farm practices related to fertilisation (category F) are also important, combined with organic farming (category O). Still, CSPs among the ones with the highest estimates for this soil characteristic (in relative value) mainly achieve these results through the implementation of farm practices from category R (namely Finland, Romania and Hungary).
- For soil nitrogen, the estimates made in the CSP heavily rely on farm practices related to soil management (category S). To a lesser extent, farm practices related to crop rotation and diversification (category R) also usually contribute to the estimated increase in soil nitrogen (although the estimates are relatively low in these Member States for this soil characteristic).
- For soil water retention, in Spain, Finland and Romania, where the estimates are among the highest (in relative value), the farm practices impacting the most are related to soil management. However, similar estimates can be achieved with a more significant contribution of farm practices related to crop rotation and diversification (category R), as the example of Italy shows, as its CSP is the third highest in terms of estimated increase in soil water retention (both in relative and absolute values – see Figure 7).
- For soil packing density, in all CSPs where the estimated decrease in soil packing density is significant (Spain, Finland, Hungary, Italy, Latvia, Poland and Romania), it is linked to the farm practices category S (soil management), and more precisely to the farm practice S22 (crop residues left on soil, leaving stubbles on the field).
- Compared to the other soil characteristics, the estimated reduction in nitrogen leaching and runoff is generally achieved through a balanced diversity of types of farm practices. Different sets of farm practices allow for the achievement of comparable results. For instance, Greece relies more on landscape-related farm practices (category L) than the Netherlands, where soil management farm practices (category S) influence the estimates. Both Member States have among the highest estimates for this soil characteristic (see Figure 9). In Finland, where the estimated reduction in nitrogen leaching and runoff is the highest in relative value, the results rely on a relatively balanced set of farm practices from all categories, excluding water-related farm practices (category W).
- Similar to nitrogen leaching and runoff, results achieved in reducing soil erosion by water rely on a balanced set of farm practices. Although soil management farm practices generally dominate in the share of the estimated decrease in soil erosion by water, including in some of the Member States with the highest estimates in relative value (Spain, Finland, Romania and Italy), Greek estimates (highest estimates in relative value compared to other CSPs, see Figure 10) reach a high value relying more on a diversified set of farm practices.

5. Estimated potential added value of GAECs

5.1. GAECs with potential added values for the soil characteristics studied

As introduced in Section 2.1.3, depending on the CSP, not all the GAECs covered in the study are associated with a potential improvement of the soil characteristic studied. The approach to estimate the potential added value of GAECs depends on whether or not the GAEC was already part of the conditionality in the previous CAP programming period, 2014-2020 CAP. The two main approaches are the following:

- **GAECs that were already part of the conditionality in the 2014-2020 CAP.** For GAECs 4, 5 and 6, the requirements of the 2023-2027 CAP programming period are compared to the requirements of the previous programming period. The potential added value of the GAECs is estimated to be the difference between these two requirements, when the 2023-2027 GAECs set more stringent rules than their 2014-2020 equivalent. For instance, if GAEC 4 used to impose a buffer strip without fertilisation of 2 m and this width is now set at 3 m, only the added value of adding one extra metre is assessed (Denmark).
- **GAECs that were not part of the conditionality in the 2014-2020 CAP.** For GAECs 1, 2 and 7, the added value of GAECs is estimated by comparing GAEC requirements with farm practices already implemented by farmers. For instance, for GAEC 1, in CSPs where the historical trends in the conversion of permanent grassland areas showed that the threshold for this change imposed by the GAEC is not likely to be reached, it is considered that the GAEC does not contribute to the increase of soil condition (Germany, Greece, Finland, Hungary, Italy, Luxembourg and Romania, see Table 3).

The following table (Table 3) provides an overview of the GAECs for which a potential added value is estimated.

Table 3. GAECs associated with a potential improvement of the soil characteristics studied

	GAEC					
CSP	**1**	**2**	**4**	**5**	**6**	**7**
CZ	YES	YES	NO	NO	YES	YES
DE	NO	YES	NO	NO	YES	YES
DK	YES	NO	YES	YES	YES	YES
EL	NO	NO	YES	YES	NO	YES
ES	YES	YES	YES	YES	YES	YES
FI	NO	YES	NO	NO	YES	YES
HU	NO	NO	NO	NO	NO	YES
IT	NO	NO	NO	YES	YES	YES
LU	NO	NO	NO	NO	YES	YES
LV	YES	YES	NO	NO	NO	YES
NL	YES	YES	NO	NO	NO	YES
PL	YES	NO	NO	YES	NO	YES
RO	NO	YES	YES	YES	YES	YES
Total by GAEC	**6**	**7**	**4**	**6**	**8**	**13**

Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

- GAEC 1 – Maintenance of permanent grassland based on a ratio of permanent grassland in relation to agricultural area at national, regional, subregional, group-of-holdings or holding level in comparison to the reference year 2018
- GAEC 2 – Protection of wetland and peatland
- GAEC 4 – Establishment of buffer strips along water courses
- GAEC 5 – Tillage management, reducing the risk of soil degradation and erosion, including consideration of the slope gradient
- GAEC 6 – Minimum soil cover to avoid bare soil in periods that are most sensitive
- GAEC 7 – Crop rotation in arable land, except for crops growing under water

It shows that for most GAECs, a potential added value for soil improvement is estimated in only half of the studied CSPs. There is, however, an exception for GAEC 7, which is considered to bring additional value in all 13 CSPs studied, and another for GAEC 4, which is considered to bring additional value in only four CSPs.

Therefore, as in many cases, it is considered that the GAECs' added value is null [45], as the results presented in the next section vary substantially between CSPs.

[45] When GAECs bring no additional value compared to their equivalent in the previous programming period or when the farm practices they target are already implemented by farmers.

5.2. Results per soil characteristic/GAEC

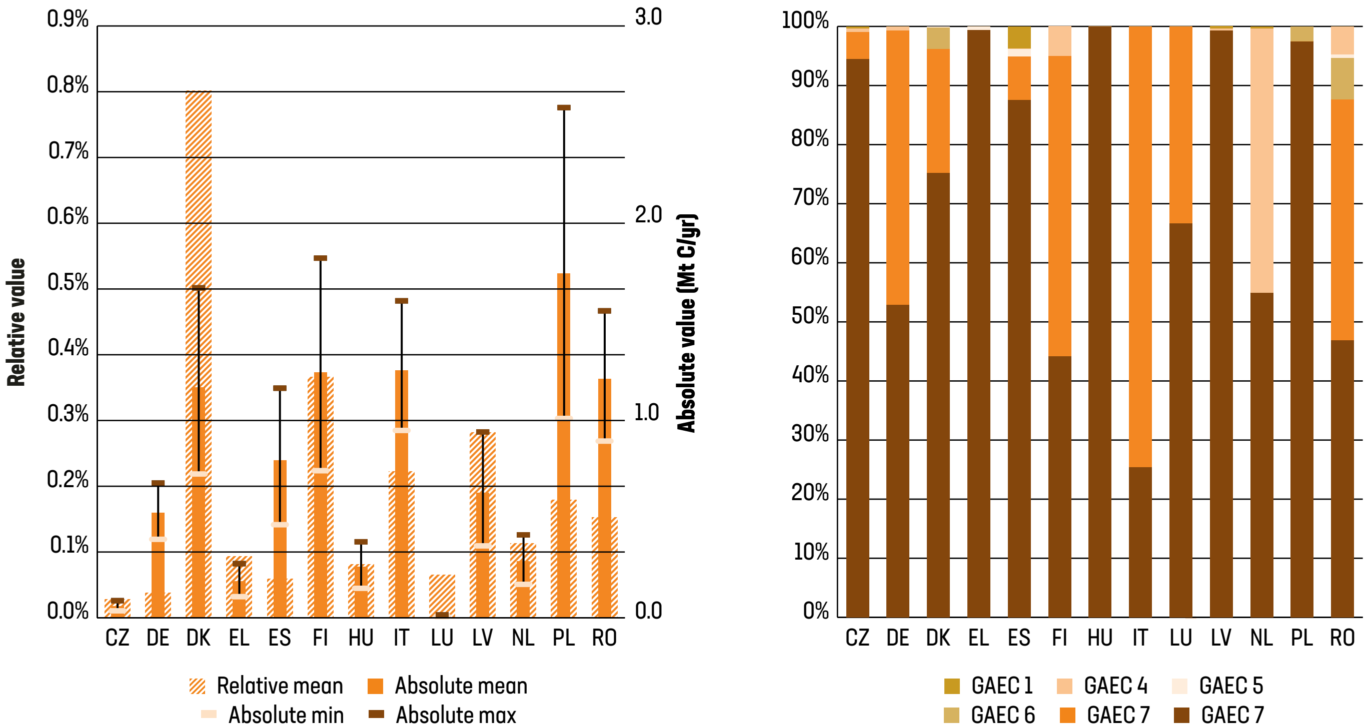
This section focuses on the estimated added value of GAECs to the soil characteristics as assessed for each CSP. Figure 14 to Figure 19 show the overall estimated added value of GAECs to improve the soil characteristics concerned, in absolute value and as a share of the national baseline (left-hand side graphs). In these graphs, the upper and lower bounds (min and max estimated) represent the 95% confidence interval of the estimates in absolute value, based on the confidence interval associated with each farm practice's effect [46].

The figures also provide the breakdown of these estimates per GAEC (right-hand side graphs).

5.2.1. Soil organic carbon content

Analysis of the 13 CSPs indicates an estimated added value of the GAEC standards to the increase of agricultural soil organic carbon content in the 30 cm topsoil of 0.14% per year.

Figure 14. Estimated potential of increase in soil organic carbon content through GAECs in the 2023-2027 period compared to the 2014-2020 period



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

Among these results, the following is worth noting:

- The estimates range from 0.03% (Czechia) to 0.80% (Denmark) of an increase in soil organic carbon content on the topsoil (30 cm) at national level. This represents 59 000 tonnes of carbon in Czechia (this translates to 0.02 t/ha of UAA) versus 1.2 million tonnes of carbon in Denmark (0.44 t/ha).
- In all 13 Member States, GAEC 6 and/or GAEC 7 constitute most of the estimated increase in soil organic carbon.
- One of the reasons Denmark stands out is because GAEC 7 is considered to bring significant added value, fostering changes in farm practices toward the use of R11 (crop rotation) [47].
- In Czechia, Greece, Hungary, Latvia and Poland, GAEC 7 contributes to 95% or more of the estimated added value of GAECs for increasing soil organic carbon content.
- Notably, the highest estimates are reached in absolute value in Poland, with an estimated increase of 1.7 million tonnes of soil organic carbon content through the implementation of GAECs, which can be explained by the fact that Poland has a relatively large UAA compared to the other Member States.

[46] These intervals only represent the uncertainty linked to the effect of the farm practice, but they do not represent other uncertainties, such as those linked to the assessment of the baseline or of the area covered by the farm practices. See the general methodology for more information.

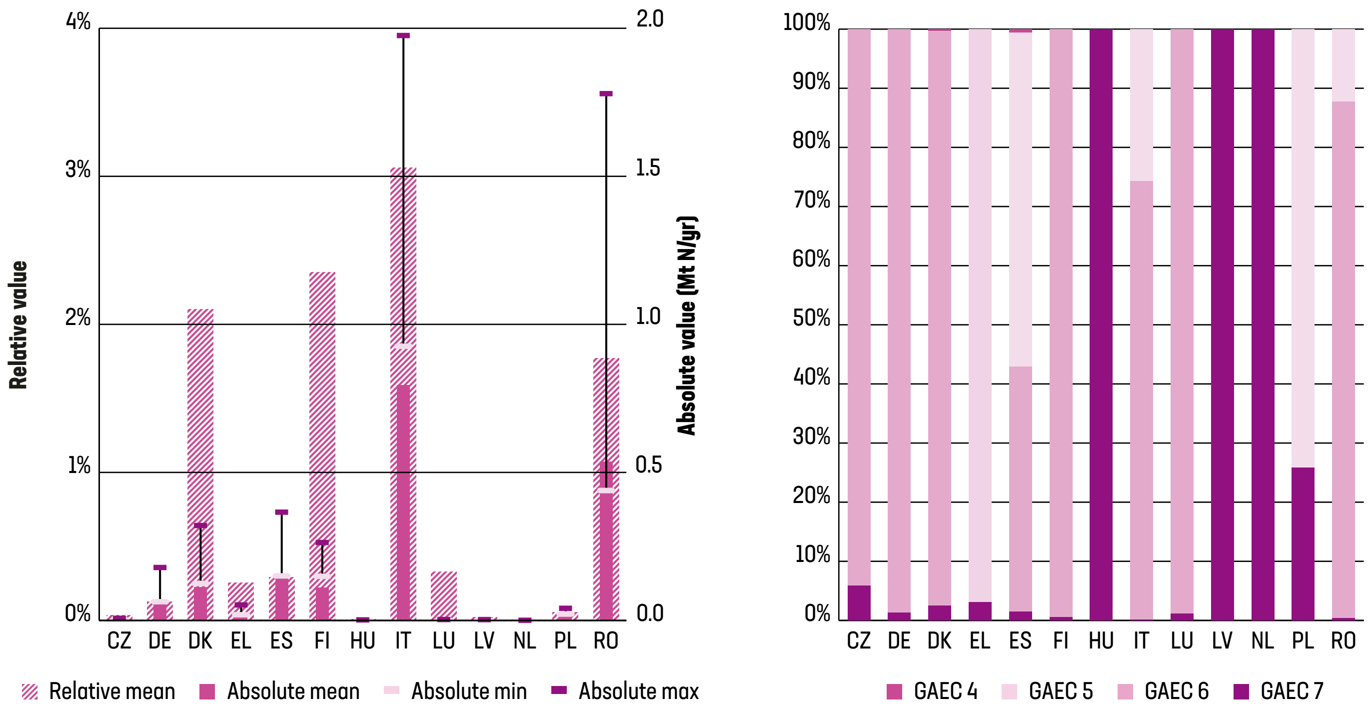
[47] As explained in the methodological report, it is considered that crop rotation and crop diversification have the same effects on soil since diversification is only beneficial to the soil at plot level if it involves rotation.

- In Italy and Finland, GAEC 6 is the first contributor due to the large area covered associated with GAEC 6 compared to the other GAECs. In Germany, GAEC 6 also has a relatively important influence on the estimates, but it is mainly because the added value of the German GAEC 7 is limited compared to other CSPs.
- The Netherlands can be seen as an exception as GAEC 2 (protection of wetland and peatland) accounts for more than 40% of the estimated potential for the soil characteristic (mainly through the farm practice L511 (wetland maintenance and conservation) associated with a large area). The estimated added value of GAEC 2 in other CSPs is more limited.

5.2.2. Soil nitrogen

Analysis of the 13 CSPs indicates an estimated added value of the GAEC standards to the increase of agricultural soil nitrogen in the 20 cm topsoil of 0.82% per year.

Figure 15. Estimated potential of increase in soil nitrogen stocks through GAECs in the 2023-2027 period compared to the 2014-2020 period



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

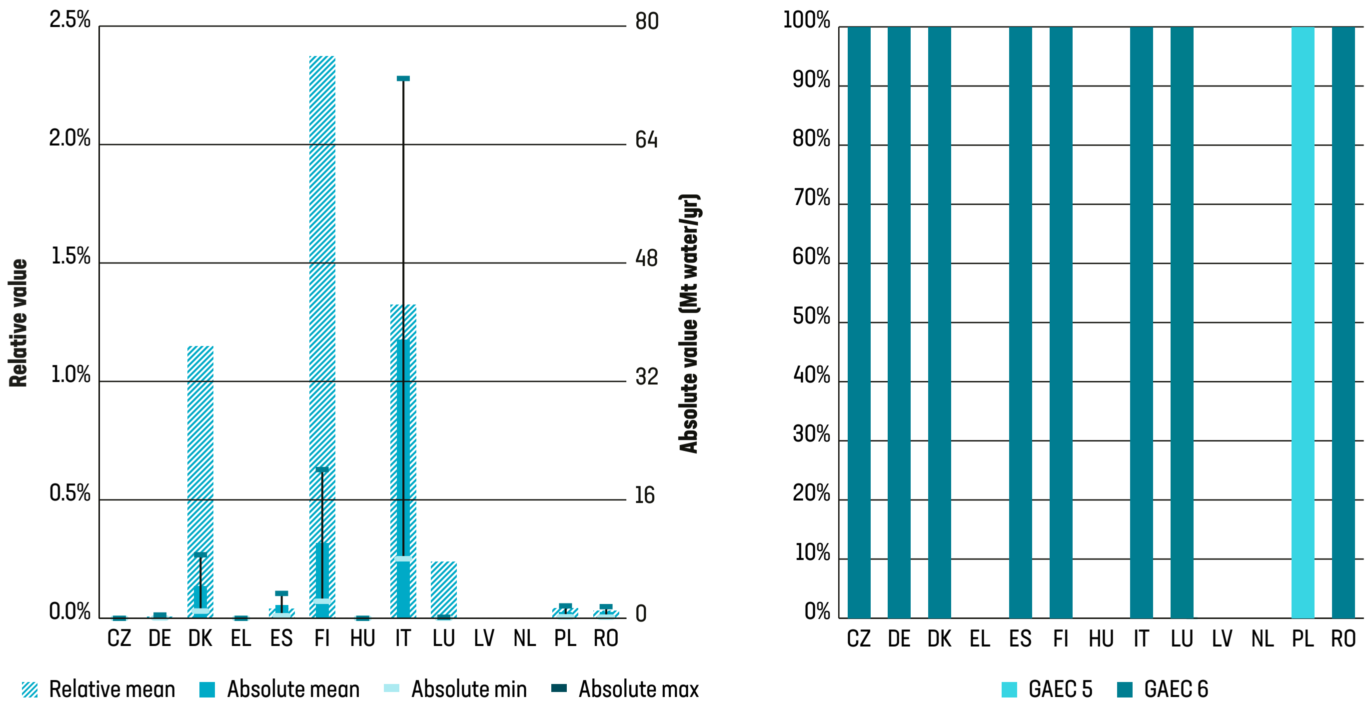
Among these results, the following is worth noting:

- The estimates range from 0.01% (the Netherlands) to 3.06% (Italy) increase in nitrogen stocks in the top 20 cm of agricultural soils at Member States level for the CSPs studied. This represents 532 tonnes of carbon in the Netherlands (or 0.3 kg/ha of UAA) versus 1.6 million tonnes of nitrogen in Italy (0.13 t/ha).
- In the CSPs with the highest estimates in relative value (Italy, Finland, Denmark and Romania notably), GAEC 6 plays a dominant role in the results.
- Nevertheless, GAEC 5 and 7 also significantly contribute to the estimated increase in soil nitrogen:
  - GAEC 5 brings the highest contribution for three CSPs (Greece, Spain and Poland); and
  - GAEC 7 is the first contributor for three CSPs (Hungary, Latvia and the Netherlands).
- This distribution depends on:
  - The relatively low effect of the farm practice R11 (crop rotation) is associated with GAEC 7 (see Section 5.3 for details on the roles of farm practices).
  - The CSPs with no stricter requirement identified for the GAECs between the CAP programming 2014-2020 and 2023-2027 (Greece, Hungary, Latvia, the Netherlands, Poland for GAEC 6 and Czechia, Germany, Hungary, Luxembourg, Latvia, the Netherlands for GAEC 5). Therefore, Hungary, Latvia, and the Netherlands (having no areas allocated to either GAEC 5 or GAEC 6) are the only Member States where GAEC 7 is the leading contributor, despite their estimated value being similar to that in other CSPs.
- It should be noted that there is no potential estimated added value of GAECs 1, 2 and 4 to the increase in soil nitrogen because the farm practices associated with these GAECs do not have a coefficient linked to soil nitrogen.

5.2.3. Soil water retention

Analysis of the 13 CSPs indicates an estimated added value of the GAEC standards to the increase of agricultural soil water retention capacity in the 20 cm topsoil of 0.27% per year.

Figure 16. Estimated potential of increase in water retention capacity through GAECs in the 2023-2027 period compared to the 2014-2020 period



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

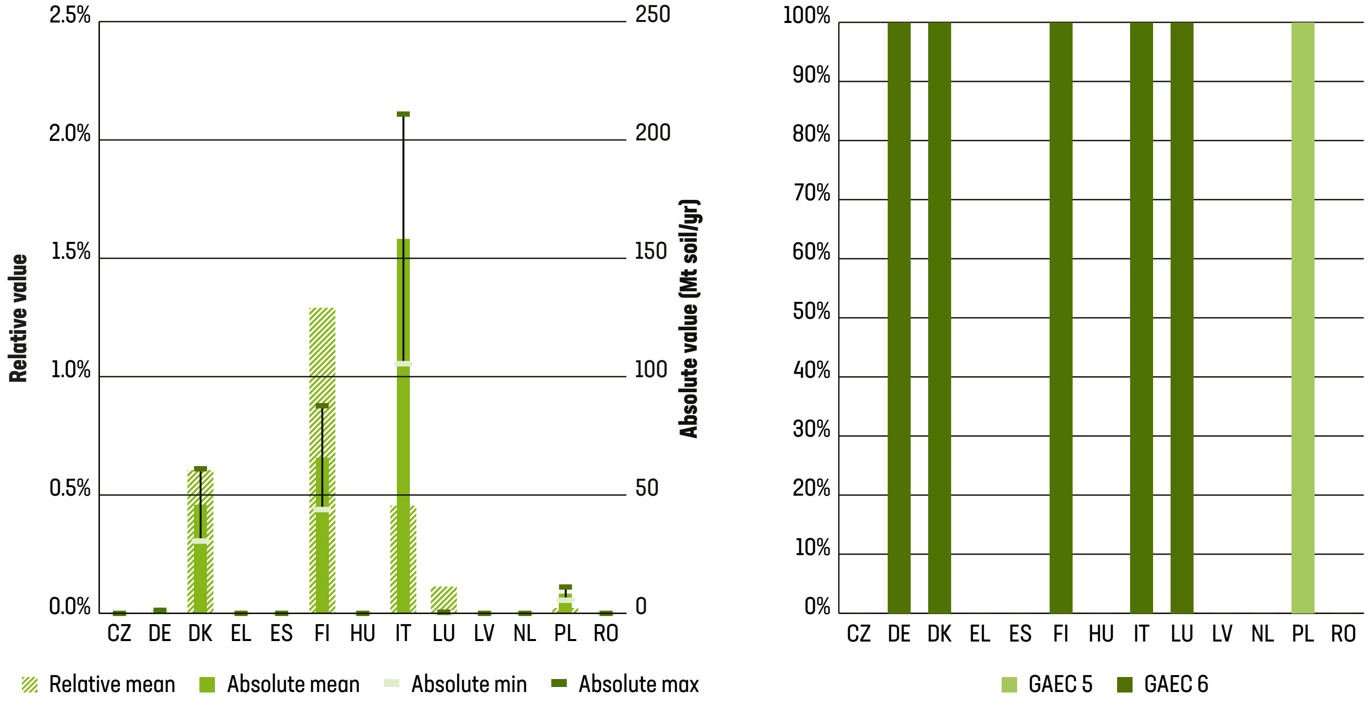
Among these results, the following is worth noting:

- Only nine CSPs have an estimated potential increase in soil water retention capacity through GAECs (no estimate in Greece, Hungary, Latvia and the Netherlands as GAECs 5 and 6 are considered to bring no additional value in these CSPs).
- Where a potential added value is estimated, the estimates range from less than 0.01% (Czechia) to 2.37% (Finland) increase in water retention capacity in agricultural soils (top 20 cm) at Member State level for the CSPs studied. This represents approximately 80 tonnes of water in Czechia (less than 1 kg/ha of UAA) versus 10.2 million tonnes in Finland (4.46 t/ha). In absolute value, the Italian CSP is the one associated with the highest estimated increase in soil water retention, with an increase of the capacity of soil to store water of 37.7 million tonnes (3.01 t/ha).
- The 95% confidence interval shows that the estimates in Italy vary greatly depending on whether the maximum or minimum values are considered. Considering the range's maximal value, the estimate's value can nearly double in this CSP. This is also the case in other CSPs, and it can be explained by the fact that GAEC 6 mainly contributes to the increase of soil water retention capacity through the implementation of the farm practice S22 (crop residues left on soil, leaving stubbles on the field), for which the confidence interval for soil water retention is very large.
- The difference between results expressed as absolute and relative values is mainly explained here by the difference in the baseline for soil water retention (227 t of water/ha for Italy versus 188 t of water/ha for Finland) and of UAA between Italy and Finland.
- GAEC 6 is the only GAEC contributing to the estimates for the soil characteristic, except for Poland, where the only contribution is associated with GAEC 5. This exception can be explained as Poland has no hectare associated with GAEC 6 (as there is no stricter requirement between the CAP programming periods 2014-2020 and 2023-2027) while in Poland, GAEC 5 supports farm practices related to cover crops (usually supported in GAEC 6).
- It should be noted that there is no potential estimated added value of GAECs 1, 2 and 4 to the increase in soil water retention because the farm practices associated with these GAECs do not have a coefficient linked to soil water retention.

5.2.4. Soil packing density

Analysis of the 13 CSPs indicates an estimated added value of the GAEC standards to the decrease of agricultural soil packing density in the 20 cm topsoil of 0.10% per year.

Figure 17. Estimated potential of decrease in soil packing density through GAECs in the 2023-2027 period compared to the 2014-2020 period



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

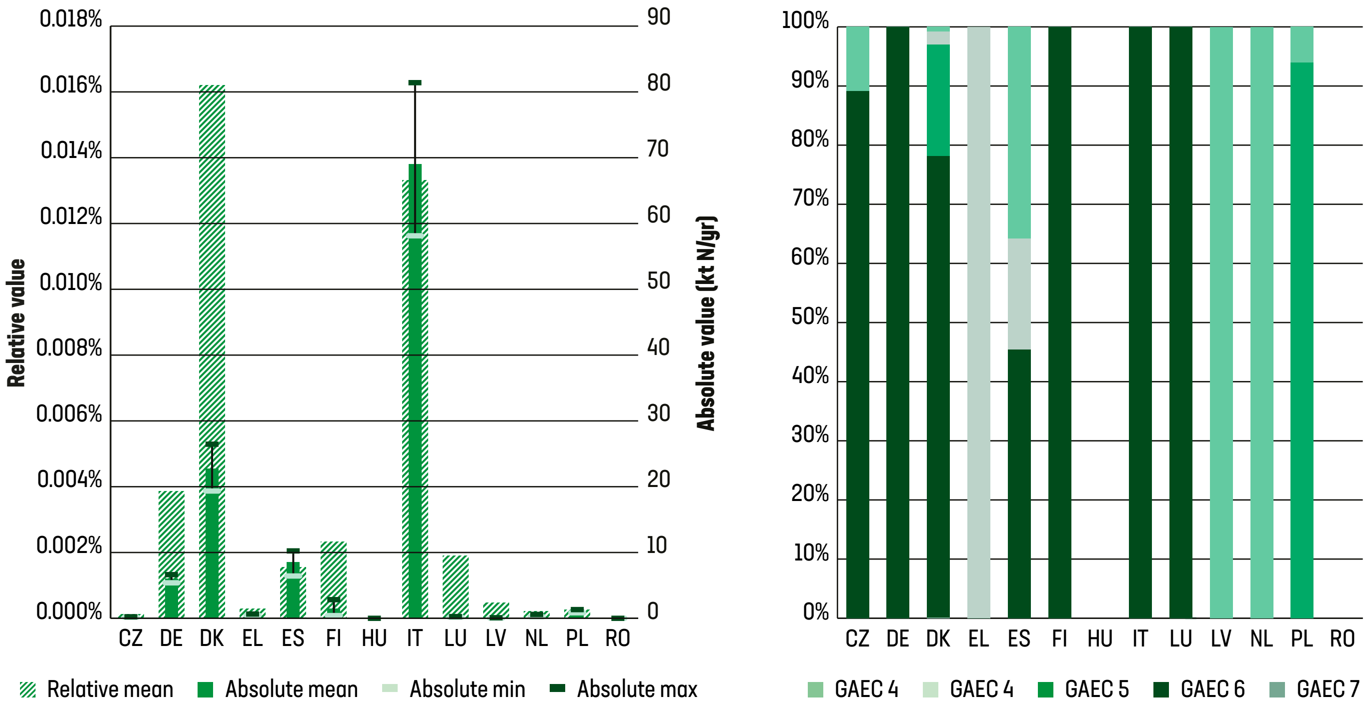
Among these results, the following is worth noting:

- Only six CSPs have an estimated potential decrease in soil packing density, as only the farm practice S22 (crop residues left on soil, leaving stubbles on the field), supported through GAECs 5 and 6, has a positive effect on this soil characteristic. S22 is not associated with GAEC 5 and 6 in Czechia, Greece, Spain, Hungary, Latvia, the Netherlands and Romania; this is why the GAECs are not estimated to bring additional value to the reduction of soil compaction in these Member States.
- In the CSPs where a potential added value of the GAECs is estimated, there are variations ranging from less than 0.01% (Germany) to 1.29% (Finland). This represents a decrease in soil packing density of agricultural soils at Member State level.
- The difference between results expressed as absolute values and relative values is mainly explained by the difference in UAA, notably when comparing Italy to Finland.
- The distribution of the contribution between the GAECs is identical to the previous section (soil water retention), as the estimates are mainly linked to the same farm practice (S22) for both soil characteristics.

5.2.5. Nitrogen leaching and runoff

Analysis of the 13 CSPs indicates an estimated added value of the GAEC standards to decrease nitrogen leaching and runoff in agricultural soils of less than 0.01% per year.

Figure 18. Estimated potential of decrease in nitrogen leaching and runoff through GAECs in the 2023-2027 period compared to the 2014-2020 period



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

Among these results, the following is worth noting:

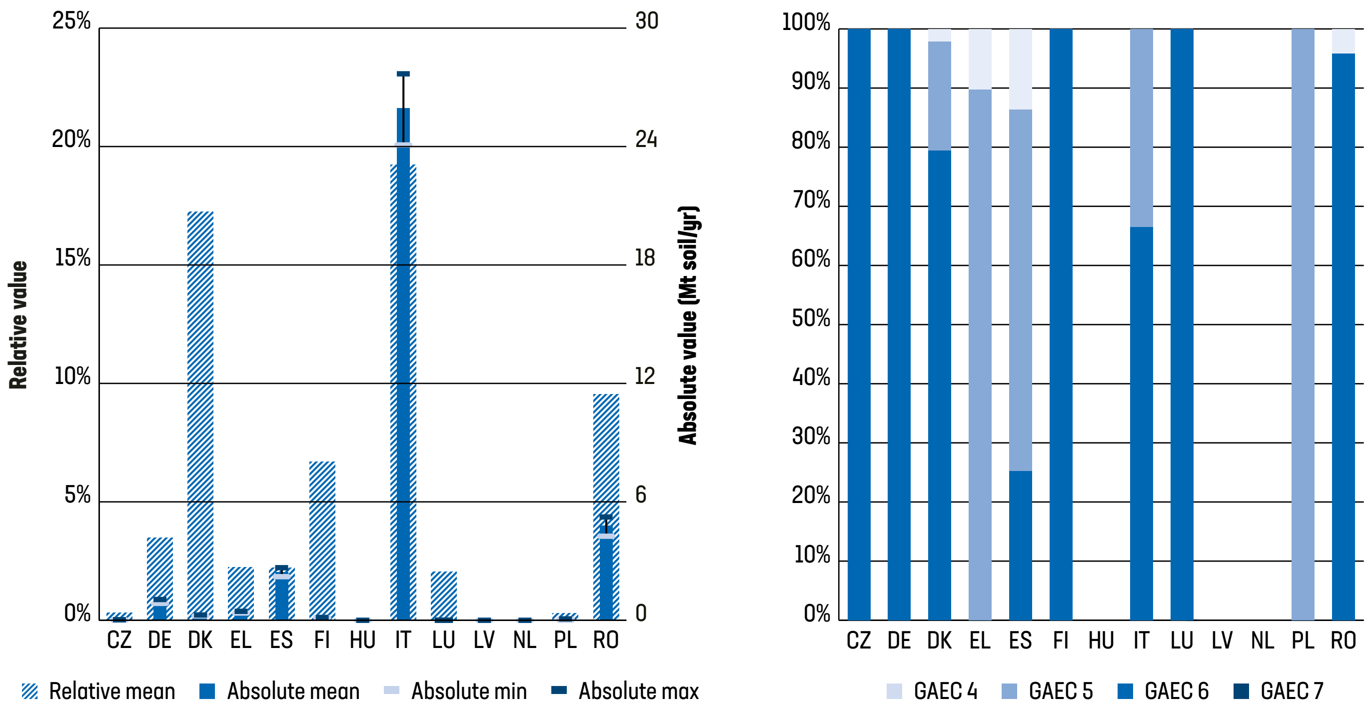
- As mentioned in Section 4, no estimate is provided in Romania as the baseline used for this soil characteristic (net nitrogen balance) shows that, on average, there are more nitrogen outputs than inputs in Romanian agricultural soils, suggesting that nitrogen leaching and runoff are not an issue at national level [48].
- No potential added value of the GAECs to the reduction of nitrogen leaching and runoff is estimated in Hungary.
- For the other CSPs, the estimates range from non-significant figures (less than 0.001% in Czechia, Greece, Latvia and Poland) to 0.016% (Denmark) decrease in nitrogen leaching and runoff from agricultural soils at Member State level for the CSPs studied. This represents approximately 22.8 thousand tonnes of nitrogen saved from leaching or runoff in Denmark (or 8.66 kg/ha of UAA). In absolute value, the highest estimate is reached in Italy (69.1 thousand tonnes of nitrogen saved from leaching and runoff annually or 5.52 kg/ha), where the UAA is almost five times higher than in Denmark.
- The distribution of these estimates by GAEC varies according to the CSP:
  - GAEC 6 is the first contributor for seven CSPs (Czechia, Germany, Denmark, Spain, Finland, Italy, Luxembourg) as the GAEC supports farm practices associated with large areas.
  - Although GAEC 5 brings a notable contribution to the estimates in Denmark, the expected added value of GAECs 1, 4 and 5 is very limited.
  - GAEC 7 has only a very marginal contribution to the estimates in Denmark.
- All GAECs except GAEC 2 are associated with an estimated potential added value for the reduction of leaching and runoff, in at least one of the CSPs studied.

[48] Nitrogen leaching and runoff in Romania could be an issue at local level, but the information provided in the CSP as well as the baseline cannot be assessed at sub-national level.

5.2.6. Soil erosion by water

Analysis of the 13 CSPs indicates an estimated added value of the GAEC standards to the decrease of agricultural soil erosion by water of 5.40%.

Figure 19. Estimated potential of decrease in soil erosion by water through GAECs in the 2023-2027 period compared to the 2014-2020 period



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

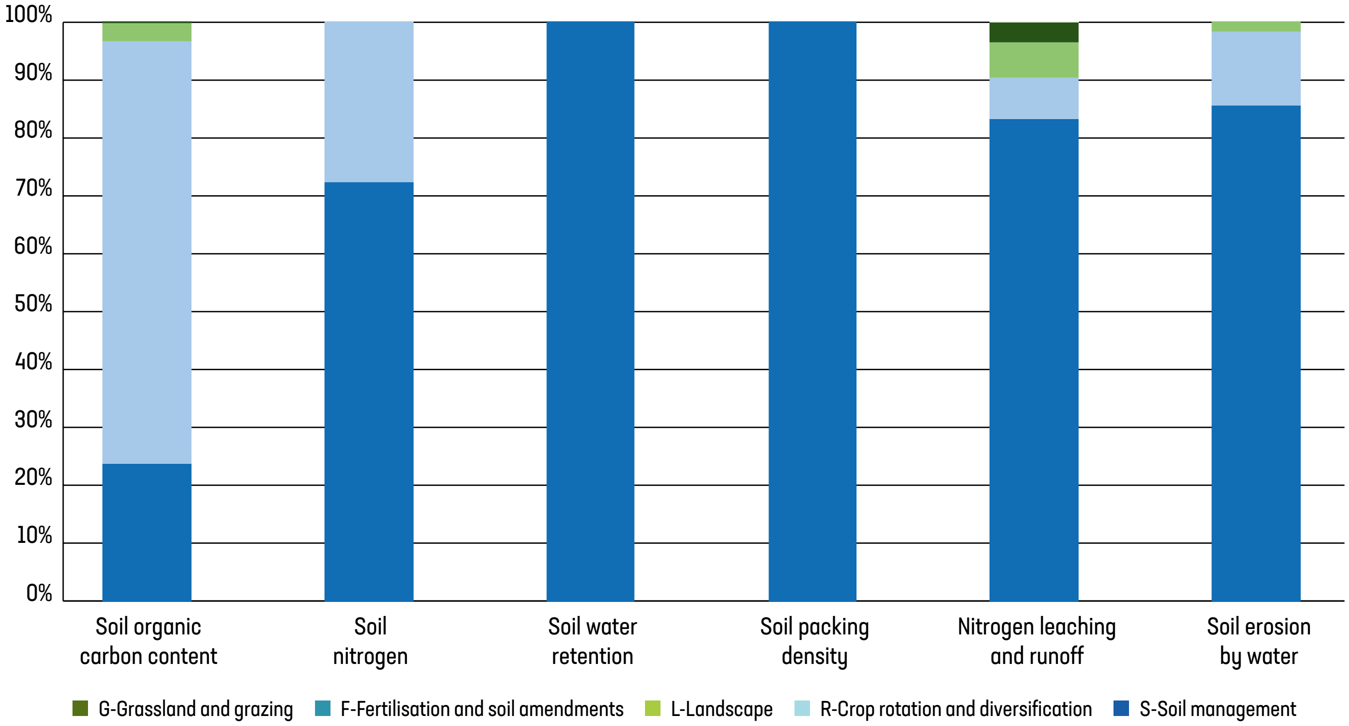
Among these results, the following is worth noting:

- It is estimated that in Hungary, Latvia and the Netherlands, GAECs do not bring additional value to the reduction of soil erosion by water.
- In the other CSPs, only GAECs 4, 5, 6 and 7 are linked to a decrease in soil erosion by water (with a very marginal contribution of GAEC 7 in Denmark).
- For these CSPs, the estimates range from an average 0.32% (Czechia and Poland) to 19.24% (Italy) decrease in soil erosion by water at Member State level. This represents approximately 26.0 million tonnes of soil saved from runoff in Italy (or 2.07 t/ha of UAA), where the estimate is therefore also the highest in absolute value by far.
- GAEC 6 is once again the first contributor to estimates in almost all CSPs, although GAEC 5 also significantly impacts the results, notably in Italy. The contribution of GAEC 4 to the results is also not negligible, especially in Spain and Greece.
- All GAECs except GAECs 1 and 2 are associated with an estimated potential added value for reducing soil erosion by water, in at least one of the studied CSPs.

5.3. Farm practices

This section provides insights into the farm practices that contribute the most to the estimates presented above. Figure 20 illustrates the relative contributions of the various categories of farm practice. These are shown prior to presenting results at the farm practice level, broken down by soil characteristics.

Figure 20. Distribution of the GAECs' estimates by category of farm practices



Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

The above figure shows that the categories of farm practices contributing the most to the estimates for each soil characteristic are mainly the same for GAECs as for CSP interventions (Figure 11). Farm practices related to soil management (category S) generally dominate the estimates for all soil characteristics, except for soil organic carbon content, where farm practices from category R (crop rotation and diversification) play a major role. It should also be noted that, for GAECs, the unique farm practice targeted under category F (fertilisation and soil amendments) [49] only contributes very marginally to the reduction of nitrogen leaching and runoff.

Unlike results from the CSP interventions, outcomes from GAECs show a smaller diversity in the groups of farm practices involved in the estimates, and a less balanced contribution of these groups of farm practices, notably for the reduction of nitrogen leaching and runoff and of soil erosion by water. This can be explained by the fact that a given GAEC is generally linked to the same farm practices in all CSPs. Considering that only six GAECs are assessed compared to the significant number of interventions in CSPs, this leads to a much lower diversity of farm practices covered by GAECs in the study.

The limited diversity of farm practices covered by GAECs can be highlighted in the following table (Table 4) which maps all the farm practices covered by GAECs and their link to each soil characteristic. This table shows that only 16 farm practices drive all the contributions estimated for GAECs.

The table also shows why GAEC 2 is only estimated to affect soil organic carbon content (because L512 and L511 only have a coefficient for this soil characteristic), and GAEC 1 only affects soil organic carbon content and nitrogen leaching and runoff (because G26 only has coefficients for both farm characteristics).

It also shows that GAEC 5 and GAEC 6 are generally associated with a wider range of farm practices, covering all soil characteristics studied. Notably, depending on the CSP, both GAECs can be linked to the farm practice S22 (crop residues left on soil, leaving stubbles on the field), which has a coefficient for all soil characteristics studied.

[49] F113 (ban on manure application) supported under GAEC 4.

Table 4. Distribution of the farm practices by GAEC for each soil characteristic

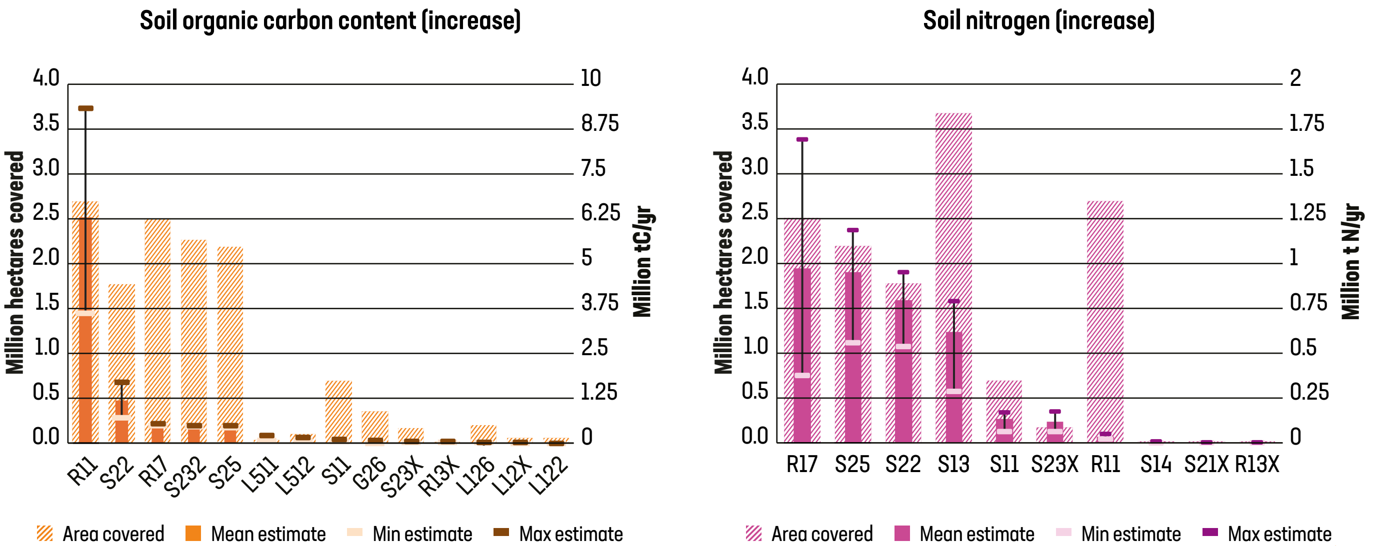
	GAEC 1	GAEC 2	GAEC 4	GAEC 5	GAEC 6	GAEC 7
Soil organic carbon content	G26	L512, L511	L126	R13X, L122, L12X, S232, S22, S25, S11	S25, S232, S23X, S22, R17	R11, R17
Soil nitrogen			S14	R13X, S13, S22, S25, S21X, S11	S25, S23X, S21X, S22, R17	R11, R17
Soil water retention				S22, S25, S21X	S25, S21X, S22,	
Soil packing density				S22	S22	
Nitrogen leaching and runoff	G26		L126, F113	L122, L12X, S232, S22, S25	S25, S232, S23X, R17, S22	R17
Soil erosion by water			L126	L122, L12X, S13, S232, S22, S25, S21X	S25, S232, S23X, S21X, S22, R17	R17

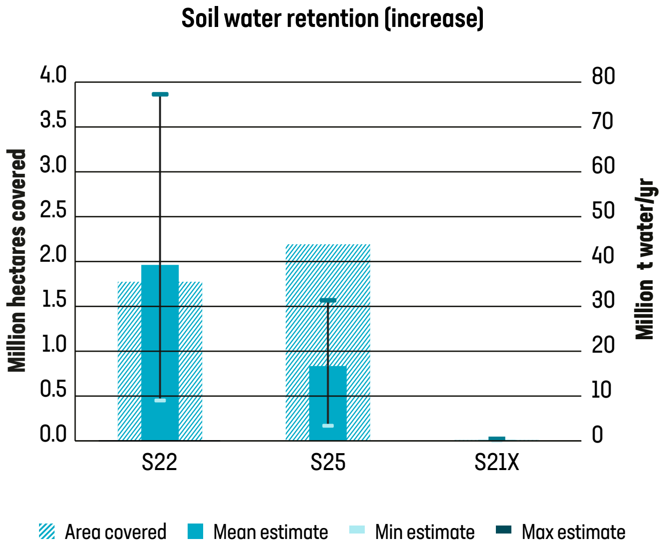
Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

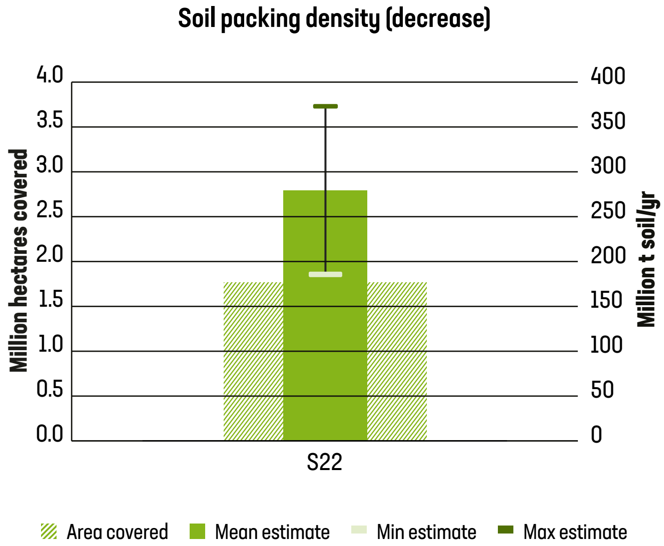
Grey cells: No farm practice identified with a contribution to the estimate. Other colours correspond to the colour code used to easily differentiate all the soil characteristics covered in the study.
F - Fertilisation and soil amendments: F113 (ban on manure application)
G - Grassland and grazing: G26 (no conversion of grassland into other uses)
L - Landscape: L122 (maintenance and conservation of field margins), L126 (maintenance and conservation of unproductive buffer strips along water courses), L12X (field margins, patches and unproductive buffer strips along water courses), L511 (wetland maintenance and conservation), L512 (peatland maintenance and conservation)
R - Crop rotation and diversification: R11 (crop rotation), R13X (land laying fallow), R17 (catch crops), S11 (low tillage)
S - Soil management: S13 (restriction on tillage (timing, direction in slopes)), S14 (bans or restrictions of ploughing on limited areas of the arable field), S21X (mulching), S22 (crop residues left on soil, leaving stubbles on the field), S232 (winter cover crop), S23X (cover crops), S25 (green cover on permanent crops)

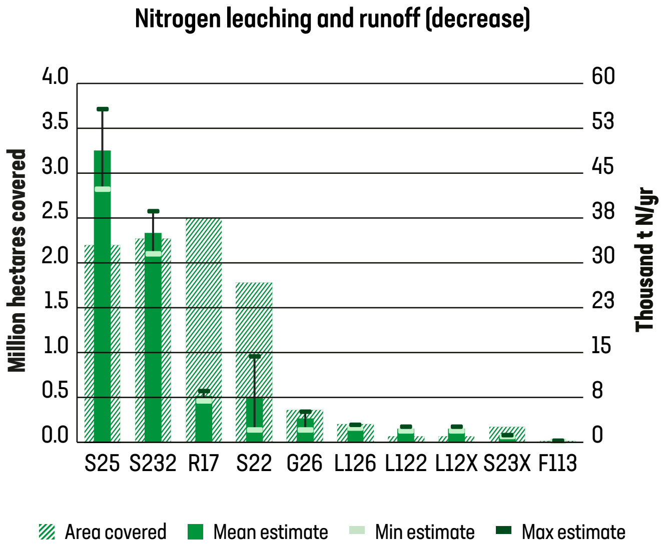
The following figure (Figure 21) provides more insights into the relative contribution of all farm practices to the overall estimated added value of GAECs to the six soil characteristics.

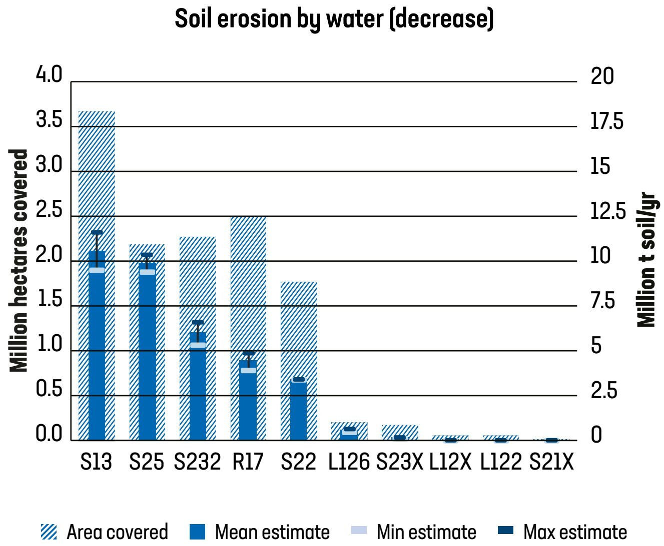
Figure 21. Farm practices contributing to the overall (13 CSPs) estimated potential added value of GAECs for each soil characteristic











Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

All the values displayed are positive; depending on what is indicated in brackets, it corresponds either to an increase (as in the case of soil nitrogen) or a decrease (as in the case of soil packing density).

Farm practice labels:

F - Fertilisation and soil amendments: F113 (ban on manure application)

G - Grassland and grazing: G26 (no conversion of grassland into other uses)

L - Landscape: L122 (maintenance and conservation of field margins), L126 (maintenance and conservation of unproductive buffer strips along water courses), L12X (field margins, patches and unproductive buffer strips along water courses), L511 (wetland maintenance and conservation), L512 (peatland maintenance and conservation)

R - Crop rotation and diversification: R11 (crop rotation), R13X (land laying fallow), R17 (catch crops), S11 (low tillage)

S - Soil management: S13 (restriction on tillage (timing, direction in slopes)), S14 (bans or restrictions of ploughing on limited areas of the arable field), S21X (mulching), S22 (crop residues left on soil, leaving stubbles on the field), S232 (winter cover crop), S23X (cover crops), S25 (green cover on permanent crops)

Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

Figure 21 shows that for the GAECs, the farm practice R11 (crop rotation) supported by GAEC 7 is by far contributing the most to the estimated increase in soil organic carbon content, despite the fact that the next four farm practices (that are implemented mainly through GAECs 5 and 6) are also implemented on very large areas.

As previously mentioned, and similarly to what is assessed for CSP interventions, the farm practice S22 (crop residues left on soil, leaving stubbles on the field) impacts the results for all soil characteristics and especially soil nitrogen, soil water retention capacity and soil packing density.

The graphs also show how the implementation of the farm practice R17 (catch crops), notably through GAEC 6, significantly contributes to the estimated increase of soil nitrogen. Although this farm practice is supported in large areas, it only has a relatively low contribution to the estimated decrease in nitrogen leaching and runoff, as well as soil erosion by water, due to its low coefficient for these components compared to the other top farm practices.

6. Limits and recommendations

The method used delivers rough estimates of the maximum potential contribution of CAP interventions and the added value of GAECs to the health of agricultural soils. These estimates come with levels of uncertainty contingent on the information available in the CSPs, the coefficients applied and the assumptions made regarding the area where specific farming practices are implemented. Therefore, these figures should be interpreted with caution.

General limitation

The first and more general limitation is **the difference in the approach for GAECs and CSP interventions** that makes direct comparisons between the two unfeasible.

The estimated potential contribution of CSP interventions represents the maximum theoretical contribution of the interventions without consideration of the degree to which such practices might occur independently of CAP support. Instead, it assumes that, in the absence of support, land would be managed using conventional practices, effectively overlooking any deadweight effects.

At the same time, measuring the added value of GAECs by accounting for what was implemented during the previous CAP programming period also comes with limitations. Notably, the approach chosen for the 'new' GAECs [50] (GAEC 1, GAEC 2 and GAEC 7) is not the same as the approach for the 'old' GAECs (GAEC 4, GAEC 5 and GAEC 6), and the approach for old GAECs does not estimate to what extent farmers would revert to conventional farm practices in the absence of the former GAEC requirements (2014-2020).

Limitations related to the assessment of farm practices effects

Non-coverage of certain key specific soil characteristics. Key aspects of soil health, such as soil biodiversity and heavy metal pollution, are not covered due to insufficient data in the JRC Farming Practices Evidence Library. As a result, only a subset of soil characteristics is included in the analysis.

Transformation of the coefficients. To build the coefficient database used in this study, data were extracted from the JRC Farming Practices Evidence Library, which compiles the 'effect sizes' of farm practices based on published meta-analyses. However, since these effect sizes are not standardised and often do not align with the specific needs of this study, a series of assumptions were made to convert them into usable coefficients. These assumptions, such as estimating effects over a one-year period or converting measurement units, were not scientifically validated. As a result, they introduce an additional layer of uncertainty into the estimates. A detailed list of these assumptions is provided in the coefficients database.

Assessing the effect of the maintenance of farm practices. Strong assumptions were used to estimate the annual effect of each farm practice over the first years of implementation, and for the soil characteristics related to a change of stock, after a certain period of being implemented (for farm practices explicitly referring to maintenance of an activity, for instance, L122 (maintenance and conservation of field margins)). For the latter, in reality, the annual effect of farm practices changes through time until it reaches a plateau. Thus, the coefficients allocated to the maintenance of farm practices only capture what the annual effect of the farm practice might be after around ten years of implementation, although the farm practice might have been implemented for a longer or shorter period.

General coefficients. The coefficients database provides effect sizes calculated at EU or world level without adjustment for regional variations in soil type, climate or farming intensity. For example, the effect of crop rotation is treated uniformly regardless of the rotation duration. Although the 95% confidence intervals are provided, they do not reflect the relevance of the underlying trials to specific local conditions. In addition, all supported farm practices are assumed to produce positive outcomes, while potential adverse effects are not considered. Context specific coefficients and baselines would allow for improving the robustness of the estimates.

Data gaps. Some relevant practices are not covered by meta-analyses covered by the JRC Farming Practices Evidence Library. For instance, the farm practice S31 (restricted machinery usage (including timing) to avoid soil compaction) is not linked to an effect on soil packing density in the study due to lack of evidence in the JRC database. These gaps may lead to underestimating potential contributions.

Variability in confidence intervals. The confidence intervals of the farm practices coefficients vary significantly depending on the practice and soil characteristic. Furthermore, there is no lower and upper bounds for certain farm practices, such as S22 (crop residues left on soil, leaving stubbles on the field).

Limitations related to area coverage estimations

Quantifying the area per farm practice. A major uncertainty stems from the assumptions made to link planned outputs of CSPs interventions to farm practices in order to estimate the area for each farm practice. While the information in the CSPs allows for robust estimations in some cases, many others require theoretical assumptions and approximations. This issue also applies to GAECs.

Non-coverage of certain types of interventions. The study covers GAECs, CIS, eco-schemes, ENVCLIM and INVEST interventions. Other types of interventions, such as sectoral supports, cooperation, or knowledge exchange and dissemination of information, are excluded due to lack of quantifiable data, although it can be expected that they may contribute to changes in agricultural practices.

[50] New in the cross compliance although the farm practices targeted by GAECs 1 and 7 were supported by the greening measures in the previous programming period.

7. Conclusions

This study provides a quantified rough estimation of the potential contribution of GAECs and CSP interventions to soil health, assessed across six characteristics: increase in soil organic carbon content, increase in soil nitrogen content, increase in soil water retention capacity, decrease in soil packing density, decrease in nitrogen leaching and runoff, and decrease in soil erosion by water.

The exercise illustrates how quantified rough estimates can support both the evaluation of the CAP's contribution to environmental and soil health objectives and assist in designing the future green architecture of the CAP. By identifying which GAECs and CSP interventions are most likely to deliver beneficial outcomes based on data from the JRC Farming Practices Evidence Library, it becomes possible to make more targeted and effective policy decisions. It also contributes to maintaining robust databases, such as the JRC's, to underpin policy design and evaluation with sound scientific evidence. This aligns with broader strategic initiatives, such as the EU's Soil Health Mission, aimed at better quantifying and improving the impact of agricultural policy on soil conditions.

This analysis should be considered a first step toward more refined and comprehensive assessments. Future improvements should include:

- Data on the actual uptake of CAP interventions.
- Distinction between newly covered areas and those where practices were implemented in the past and/or would be implemented regardless of CAP interventions.
- Coefficients tailored to specific pedoclimatic conditions, especially those with lower accuracy and contributing most to the total estimate.

As a policy evaluation tool, this methodology offers a way to link output indicators to soil health outcomes. However, for a complete CAP evaluation, a counterfactual approach is necessary to estimate the net effect of CSP interventions and GAECs.

8. Annexes

8.1. Annex 1 - Coefficients database

Table 5. Coefficients used for the study - mean value

Category	Farm practice	Soil organic carbon content increase (% or t of C ha^{-1})		Soil nitrogen % increase	Soil water content % increase	Soil packing density % decrease	Nitrogen leaching and runoff % decrease	Soil erosion by water % decrease
A-Animals	A12X-Feed from farm		-				NS	
F-Fertilisation and soil amendments	F111-Ban on organic fertiliser	NE	-	NE			73.77	NE
	F112-Ban on mineral fertilisers		-	NE	NS			
	F113-Ban on manure application		-				73.77	
	F11X-Ban on the use of fertilisers other than along water courses		-	NE			100.00	
	F211-Deep placement (mineral fertilisers) or deep injection (slurry)		-				1.86	
	F212-Split application (mineral fertilisers or manure)		-				26.12	
	F232-Use of nitrification/urease inhibitors		-				35.79	
	F311-Application of raw biochar	1.95	%		33.54	11.84	22.88	
	F312-Application of nutrients-enriched biochar		-		33.54			
	F31X-Amendment with Biochar	1.95	%		33.54	11.84	22.88	

F-Fertilisation and soil amendments	F34-Amendment with Gypsum	0.90	%	NS		7.30		
	F41X-Use of specific mineral fertiliser types		-				NS	
	F42X-Application of manure	1.95	%				NS	55.65
	F437-Application of manure/digestate mineral concentrates		-				NS	
	F43X-Application of digestates or nutrients-rich fractions recovered from manure		-				NS	55.65
	F44-Use of green manure	1.15	%	12.38	3.51		NS	55.65
	F45-Application of sewage sludge and other sludge		-				NS	
	F46-Use of compost		-				NS	55.65
	F4X-Use of specific fertiliser types or manure	1.45	%	12.98			NS	55.65
G-Grassland and grazing	G12-None or restricted grazing (timing; animal species, etc.)	0.28	%	0.61	3.13			
	G16-Rotational grazing	2.84	%	NS				
	G23-Idling/resting of grassland	0.28	%	0.61	3.13			
	G25-Ban on ploughing of grassland	0.10	t of C ha^{-1}				43.69	
	G26-No conversion of grassland into other uses	0.10	t of C ha^{-1}				43.69	
	G27-Conversion of arable land to grassland	0.41	t of C ha^{-1}				43.69	
	G28-Bans or restrictions on grazing; mowing or ploughing of grassland on limited areas of the field other than along watercourses	0.28	%	0.61	3.13			

L-Landscape	L111-Creation of new hedges/wooded strips	0.52	t of C ha^{-1}	0.23			38.20	51.97
	L112-Maintenance and conservation of hedges/wooded strips	0.21	t of C ha^{-1}	0.23			38.20	51.97
	L115-Creation of group of trees/field copses		-	0.23			38.20	51.97
	L116-Maintenance and conservation of group of trees/field copses		-	0.23			38.20	51.97
	L117-Creation of trees in line		-					51.97
	L118-Maintenance and conservation of trees in line		-					51.97
	L11X-Hedgerows/individual or group of trees/ trees in line	0.21	t of C ha^{-1}	0.23			38.20	51.97
	L121-Creation of field margins	0.28	%				70.00	72.82
	L122-Maintenance and conservation of field margins	0.19	%				70.00	72.82
	L123-Creation of patches	0.28	%				70.00	72.82
	L124-Maintenance and conservation of patches	0.19	%				70.00	72.82
	L125-Creation of unproductive buffer strips along water courses	0.28	%				70.00	72.82
	L126-Maintenance and conservation of unproductive buffer strips along water courses	0.19	%				70.00	72.82
	L12X-Field margins; patches and unproductive buffer strips along water courses	0.19	%				70.00	72.82
	L17X-Stone walls	NS	-					
	L191-Creation of new terraces	1.21	%		14.01			46.30
	L192-Maintenance and conservation of terraces		-		0			46.30

L-Landscape	L19X-Terraces		-		14.01			46.30
	L211-Seeded flower areas/strips	1.89	%					
	L21X-Seeded areas/strips	1.89	%					
	L222-Buffer strips against soil erosion	1.89	%				70.00	72.82
	L223-Strips for other aims	0.19	%				36.20	
	L22X-Other unproductive areas and strips (excluding fallows)		-				36.20	
	L2X-Presence of other unproductive areas and strips		-				36.20	
	L311-Maintenance of silvopastoral systems	NS	-					
	L312-Creation of silvopastoral systems	NS	-					
	L31X-Silvopastoral systems	NS	-					
	L321-Maintenance of silvicultural systems	0.94	%	1.20	1.33	0.96		46.20
	L322-Creation of silvicultural systems	1.88	%	1.20	1.33	2.40		46.20
	L32X-Silvicultural systems	1.88	%	1.20	0.67	2.40		46.20
	L3X-Agroforestry	3.25	%	1.81	1.33	2.40		33.00
	L511-Wetland maintenance and conservation	3.67	%					
	L512-Peatland maintenance and conservation	1.39	%					
	L521-Wetland restoration	1.38	%					
	L522-Peatland restoration	1.38	%					
	L52X-Wetland and peatland restoration	1.38	%					
	L53-Paludiculture	NS	%					

O-Organic farming	O11-Maintenance of organic farming practices	0.45	t of C ha^{-1}				28.25	
	O12-Conversion to organic farming practices	0.45	t of C ha^{-1}				28.25	
	O1X-Organic farming	0.45	t of C ha^{-1}				28.25	
	OX-Organic farming		-				28.25	
R-Crop rotation and diversification	R11-Crop rotation	3.46	%	0.29				
	R121-Cultivation of nitrogen fixing/protein crops	3.46	%	8.85	8.80		NS	NE
	R131-Short-term fallow	2.80	t of C ha^{-1}					
	R132-Long-term fallow	0.41	t of C ha^{-1}					
	R13X-Land laying fallow	5.36	t of C ha^{-1}	1.33				
	R14-Crop diversification	3.46	%	0.29				
	R15-Mixed cropping/intercropping	14.90	%					40.48
	R17-Catch crops	0.21	t of C ha^{-1}	8.29	NS		54.17	49.80
	R1X-Crop rotation or crop diversification	3.46	%	0.29				
	RX-Crop rotation and diversification	3.46	%	0.29				
S-Soil management	S11-Low tillage	0.12	t of C ha^{-1}	4.03				NS
	S12-No tillage	0.39	t of C ha^{-1}	NS	0.78	NS		39.60
	S13-Restriction on tillage (timing; direction in slopes)		-	4.03				33.00

S-Soil management	S14-Bans or restrictions on ploughing on limited areas of the arable field		-	4.03				
	S211-Mulching with pruning residues	2.63	%	1.27	11.03			44.30
	S21X-Mulching		-	1.27	11.03			44.30
	S22-Crop residues left on soil; leaving stubble on the field	0.87	%	10.85	11.03	6.00	10.73	31.02
	S231-Summer cover crop		-	12.38				49.80
	S232-Winter cover crop	0.21	t of C ha^{-1}	NE	NS		54.17	49.80
	S23X-Cover crops	0.21	t of C ha^{-1}	12.38	NS		63.09	49.80
	S25-Green cover on permanent crops	0.21	t of C ha^{-1}	10.38	3.51		60.40	47.87
	S26-Crop residue incorporated into the soil		-	12.00				
	S2X-Soil cover	0.21	t of C ha^{-1}	9.38	11.03		3.73	44.30
W-Water	W121-Ban on organic fertilisers along water courses		-				73.77	
	W123-Ban on manure application along water courses		-				73.77	
	W12X-Ban on fertilisation along water courses		-				100.00	
	W141-No irrigation		-				52.11	
	W142-Irrigation limitations in quantity and rates (% area irrigated and/or amount of water/ha/year)		-				52.11	
	W143-Improve water efficiency measures		-				20.54	
	W16-Sustainable water management on paddy rice fields (e.g. late drying up of paddy rice fields)	NE	-				16.58	
	W174-Drainage installation	NE	-					

Y-Forestry	Y11-Afforestation of agricultural land	5.20	t of C ha^{-1}					
	Y12-Maintenance of afforested land	2.10	t of C ha^{-1}					
Z-Other species	Z23-Conservation of valuable grassland species	NS	-	3.05				

Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025) based on the JRC farming practices evidence library (https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/farming-practices-evidence-library-tool-agricultural-sustainability-2025-02-21_en)

Only the farm practices with an effect assessed are displayed.
Colour code:

NS (non-significant effect)
NE (significant negative effect)
Minimum coefficient for the soil characteristic
Maximum coefficient for the soil characteristic

8.2. Annex 2 – Number of interventions covered by CSP

Table 6. Number of interventions with estimated positive contribution to the improvement of at least one soil characteristic

CSP	CIS	Eco-scheme	ENVCLIM	INVEST	Total CSP
CZ	1	3	9	3	**16**
DE	0	5	6	2	**13**
DK	0	6	1	3	**10**
EL	1	9	2	6	**18**
ES	1	9	10	5	**25**
FI	0	4	14	3	**21**
HU	2	1	5	4	**12**
IT	2	3	26	2	**33**
LU	1	3	5	0	**9**
LV	1	5	3	2	**11**
NL	0	1	1	2	**4**
PL	2	4	10	3	**19**
RO	3	3	6	10	**22**
Total	**14**	**56**	**98**	**45**	**213**

Source: EU CAP Network supported by the European Evaluation Helpdesk for the CAP (2025)

Colour scale: Highest value | Lowest value

EU CAP Network *supported by*
European Evaluation Helpdesk for the CAP
Avenue des Arts, 46
1000 Brussels, Belgium
+32 2 808 10 24
evaluation@eucapnetwork.eu

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