# Are there any guarantees for carbon farming in Portugal?

**Martinho, VJPD[1]; Ferreira, AJD[2]; Cunha, C[1]; Pereira, JIS[1]; Sánchez-Carreira, MC[3]; Castanheira, NL[4]; Ramos, TCB[5]; Leite, CB[1]; Santos, RGFA[1]; Barreto, AKB[1]; Amorim, EF[1]**

[1]Polytechnic Institute of Viseu, Portugal; [2]Polytechnic Institute of Coimbra, Portugal; [3]University of Santiago de Compostela, Spain; [4]National Institute of Agricultural and Veterinary Research, Portugal; [5]University of Lisbon, Portugal
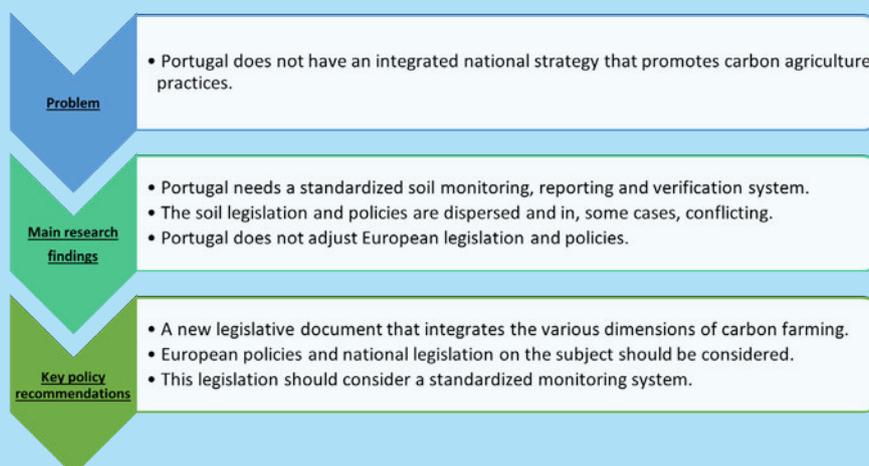
## Executive Summary

Portugal is far from having an integrated national strategy that effectively promotes carbon farming practices.

Portugal needs an adjusted and integrated system to standard monitoring, reporting and verifying the soil characteristics. The Portuguese soil legislation and policies are dispersed, in some cases conflicting and vague about concrete problems related to the dimensions of carbon farming. In many cases, Portugal does not adjust European legislation and policies to the specificities of the national situation.

It is suggested that a legislative document be created for soils that integrates the various dimensions of carbon farming, taking into account European strategies and policies and national legislation on the subject. This new legislation should provide for a standardised monitoring system that allows for the collection of information on soil characteristics (as well as other variables with an impact on soil dynamics) in accordance with European and international rules.

The recipients of this policy brief may be the Assembleia da República, Governo, Direção-Geral do Território and Agência Portuguesa do Ambiente.

The executive summary can be summarized in the Figure.



**Problem**
- Portugal does not have an integrated national strategy that promotes carbon agriculture practices.

**Main research findings**
- Portugal needs a standardized soil monitoring, reporting and verification system.
- The soil legislation and policies are dispersed and in, some cases, conflicting.
- Portugal does not adjust European legislation and policies.

**Key policy recommendations**
- A new legislative document that integrates the various dimensions of carbon farming.
- European policies and national legislation on the subject should be considered.
- This legislation should consider a standardized monitoring system.

## Setting the scene / Introduction and problem statement

Following the concerns related to climate change and the consequent global warming, the European and international institutions have defined strategies and designed policy measures to deal with carbon emissions. In these contexts, the carbon farming practices may contribute significantly to removing the carbon from the atmosphere and storing it in the soils. To comply with these frameworks, the European Union countries should have standard methodologies to collect and analyse information associated with the soil's capacity to sequester carbon. In the Portuguese-specific context, there is a lack of a standard system, following, for example, the European Joint Programme on Agricultural Soil Management (EJP SOIL, 2025) survey, to collect information associated with soil dynamics. This is a problem, because the statistical information available for the Portuguese context, in the national databases, was collected in a random way and without continuity over time. The data available in the international databases also have limitations. For example, the LUCAS (LUCAS, 2025) platform considers, namely, the information in the topsoil until 20 cm, but the depth influences the soil characteristics. The FAO Soils Portal (FAO, 2025) is based on national/regional databases, some of them needing updates. This problem is even greater when Portugal also needs a legislative document that integrates the several soil dimensions and considers the national, European and International strategies, policies and legislation related to soil dynamics. Considering the implications of the soil management and the diversity of stakeholders involved, the requirements for the implementation of an integrated soil policy are not consensual in the national, European and international scenarios (Martinho et al., 2024). In any case, even in the context of dispersed soil legislative documents and policy measures, the European Union countries must comply with targets defined by the European Union institutions for carbon emissions mitigation and control.

## Analysis / Key findings and their implications in terms of policy

There is a concern from the stakeholders with the soil quality and the implications of farming activities and practices on soil health. It is understood that the soil legislation and policies may contribute significantly to better soil management. The recent strategies and legislative initiatives of the European Union show the increased interest of the European institutions in the soil conditions. Soil management is interrelated with other dimensions, such as ecosystem services, and this should be considered in the soil strategies. The scientific literature highlights that soil management is not unanimous among the different stakeholders and this is an explanation why in the last decades the air and water conditions have deserved more attention than the soil quality. The literature survey also shows that soil security is central to the policy definition and carbon is an important indicator. Some topics still need attention from the national and European institutions (Figure 2), namely those related to salinisation, smart methodologies and transdisciplinary approaches (Martinho et al., 2024).

**Figure 2.** Word cloud considering the Soil Monitoring Law proposal (Martinho et al., 2024)



Carbon farming practices are fundamental to promoting soil carbon sequestration. Generally, pastures and grasslands, arable crops, horticulture and forest land use categories present the highest percentage of soil organic carbon (SOC). Between the soil groups with relevant levels of SOC appear the Leptosols and Umbrisols and among the most important indicators to predict the organic carbon are the nitrogen

and the elevation (Cunha et al., 2025). Other indicators were identified to predict the SOC, such as the depth, pH, farming practices, soil type, temperature, precipitation and vegetation indexes. In any case, the soil sequestration capacity depends on the specific conditions of each location. The Portuguese soils have low percentages of SOC and nitrogen appears as the most important predictor of organic carbon in the Portuguese context (Martinho et al., 2025). The economic dimension in farm management is an important issue for effective sustainable development. In these contexts, the cost assessment and control play a fundamental role. Additionally, the methodologies associated with artificial intelligence may bring relevant contributions to these analyses. In these scenarios, it is important to be aware of the impacts of the production processes, farm size and structure and Common Agricultural Policy (CAP) instruments (Martinho, 2025). The Portuguese legislation is vague relative to some soil issues, such as soil monitoring, soil restoration, soil conservation and SOC loss. Soil pollution, for example, appears among the subjects more directly addressed by national legislation. On the other hand, soil salinisation is an increased problem that needs special attention from policymakers and decision-makers (Leite, 2025a). The policy framework, a more effective carbon credit market and an adjusted standard soil monitoring, reporting and verifying methodology are needed for the Portuguese context (Leite, 2025b, 2025c). Beyond the nitrogen, the SOC storage in the Portuguese soils is explained by the carbon/nitrogen ratio, drainage conditions, bulk density (mass per unit volume) and cation exchange capacity (soil's capacity to maintain positively charged nutrients such as calcium, magnesium, and potassium). The relative importance of these indicators depends on the depth considered. In turn, climate and socioeconomic indicators have lower relevance in predicting the SOC (Almeida Santos, 2025a). It is important to create living laboratories in locations with the highest SOC levels in Portugal to better understand the conditions involved in these enhanced carbon storage capacities. It is also important to create a policy that interlinks agricultural, environmental and climate dimensions (Almeida Santos, 2025b). The European Union recently created two legislative documents associated with the targets to be achieved to comply with climate change and voluntary carbon certification. Namely, these two documents identify goals for the carbon removal, emissions and storage that must reserve the attention of the national institutions (Amorim & Almeida Santos, 2025).

## Policy alternatives

Portugal has several legislative documents related to soil dimensions, however, they are dispersed, in some cases conflicting and in other cases do not adjust the European and international strategies, policies and legislation to the national specific contexts. Including in the European Union legislation some soil issues are addressed from a residual perspective, namely the salinisation topic, despite its increased impacts on the worldwide soils. This is visible in the European Union Soil Monitoring Law documents. Despite the recent European legislative documents with targets to mitigate carbon emissions, the approaches and methodologies to collect and assess the information in each member state still need clarification and adjustments. In these frameworks, Portugal needs to create and implement a standard system of soil monitoring, reporting and verifying. This system should identify strategic national points to collect information and adopt the methodologies of assessment available by the scientific community. These points to collect soil information should take into account the diversity of land use categories and soil groups. This standard system must allow the creation of time-series data, considering that the conditions of each year influence the soil's capacity to store carbon. Other variables with impact on the soils (such as those related to climate and socioeconomic

conditions) should be considered by this monitoring system. On the other hand, it would be pertinent that Portugal create a soil legislative document that predicts this standard monitoring system and integrates the several dimensions with impact on the soil conditions in compliance with the European strategies, policies and legislation.

## Conclusions

Carbon farming practices are fundamental to deal with the new challenges created by global warming, namely to remove carbon from the atmosphere and store it in the soils and biomass. This is assumed by the different stakeholders. However, considering the diversity of dimensions that soil management involves has not been easy to find consensus, including at the European Union level, to design and implement soil legislative documents. In any case, relevant steps have been given, namely because of the European and international targets for carbon removals and carbon emissions mitigation. Nonetheless, some questions and doubts remain, particularly how these conditions to reduce the carbon in the atmosphere can be assessed and quantified in an effective way by the member-states. In the Portuguese context, it would be pertinent to create a standard system for monitoring the soil conditions that support the collection and analysis of information in compliance with international requirements. The design and implementation of a national legislative document that integrates several soil dimensions and defines the conditions of a soil monitoring system would bring benefits for adjusted land management in compliance with European policy and legislation. Boosting the carbon market in Portugal, adjusting what has already been done and taking advantage of new technologies for this purpose, is another important dimension for improving carbon sequestration and should be considered in future legislation with a more integrated perspective. This can be achieved, namely through Web3 (new approach to the internet), Blockchain (records transactions through a transparent digital network) and Cryptosphere (cryptocurrencies, blockchain and related contexts) approaches. The consideration of carbon balance analysis methodologies in agroforestry activities and projects (specifically life cycle sustainability assessments) is another aspect to be contemplated. The conditions to conceive this legislative and monitoring system are well emphasised in the scientific literature and highlighted in this study.

To summarise (Figure 3), Portugal has the conditions to promote and preserve carbon farming practices, but it needs to consider the following:

- Integrate soil legislation;

- Create a standardised soil organic carbon monitoring system;

- Put carbon farming on the agricultural policy agenda;

- Promoting the carbon market;

- Encourage the use of life cycle sustainability assessment to analyse the carbon balance;

- Create living laboratories in places with high levels of SOC;

- Set up an independent technical-scientific commission to reflect on soil issues in Portugal.

**Figure 3.** Dimensions to consider to improve carbon farming
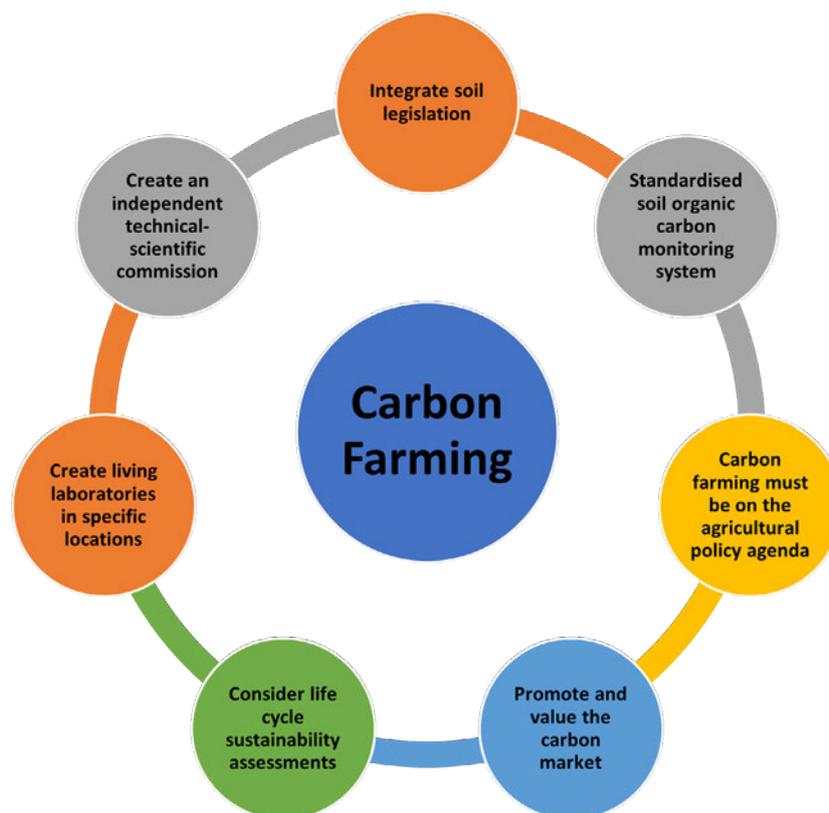


## References

1. Almeida Santos, R. G. F. (2025a). *Influencing factors of soil organic carbon in mainland Portugal: Geospatial, Socioeconomic, and Machine Learning Approaches.* Zenodo. https://doi.org/10.5281/zenodo.15149923

2. Almeida Santos, R. G. F. (2025b). *Spatial Modelling of Soil Organic Carbon in Portuguese Winegrowing Regions: Insights from Machine Learning for Sustainable Land Management.* Zenodo. https://doi.org/10.5281/zenodo.15275969

3. Amorim, E. F., & Almeida Santos, R. G. F. (2025). *Projected Net Carbon Emission Limit (PNCEL): A Dynamic Model for Carbon Management in Agroforestry Systems.* Zenodo. https://doi.org/10.5281/zenodo.15579185

4. Cunha, C., Castanheira, N. L., Ramos, T. B., Martinho, V. J. P. D., Ferreira, A. J. D., Pereira, J. L. da S., & Sánchez-Carreira, M. del C. (2025). Suggestions for promoting SOC storage within the carbon farming framework: Analyzing the INFOSOLO database. *Open Agriculture, 10*(1). https://doi.org/10.1515/opag-2025-0433

5. EJP SOIL. (2025). *European Joint Programme on Agricultural Soil Management.* https://ejpsoil.eu/

6. FAO. (2025). *FAO Soils Portal | Food and Agriculture Organization of the United Nations.* https://www.fao.org/soils-portal/en/

7. Leite, C. B. (2025a). *Critical analysis of Portuguese and European Union soil legislation based on information available in the SoiLEX database* (2025020168). Preprints. https://doi.org/10.20944/preprints202502.0168.v1

8. Leite, C. B. (2025b). *Promotion of Green Bussiness for Climate Neutrality: New Proposals for Carbon Farming* (2025050263). Preprints. https://doi.org/10.20944/preprints202505.0263.v1

9. Leite, C. B. (2025c). *Prospects for an Effective Voluntary Carbon Market to Reduce Environmental Impacts and Support Sustainable Agroforestry Practices* (2025070179). Preprints. https://doi.org/10.20944/preprints202507.0179.v2

10. LUCAS. (2025). LUCAS - *Land use and land cover survey.* https://ec.europa.eu/eurostat/statistics-explained/index.php?title=LUCAS_-_Land_use_and_land_cover_survey

11. Martinho, V. J. P. D. (2025). Five models and ten predictors for energy costs on farms in the European Union. *Open Agriculture, 10*(1). https://doi.org/10.1515/opag-2025-0441

12. Martinho, V. J. P. D., Ferreira, A. J. D., Cunha, C., Pereira, J. L. da S., Sánchez-Carreira, M. del C., Castanheira, N. L., & Ramos, T. B. (2024). Soil legislation and policies: Bibliometric analysis, systematic review and quantitative approaches with an emphasis on the specific cases of the European Union and Portugal. *Heliyon, 10*(14), e34307. https://doi.org/10.1016/j.heliyon.2024.e34307

13. Martinho, V. J. P. D., Ramos, T. C. B., Castanheira, N. L., Cunha, C., Ferreira, A. J. D., Pereira, J. L. da S., & Carreira, M. del C. S. (2025). Analysing the different interrelationships of soil organic carbon using machine learning approaches: The specific case of Portuguese land. *Revista de Ciências Agrárias, 48*(1), Article 1. https://doi.org/10.19084/rca.40281.

**HOW TO CITE THIS DOCUMENT**

Martinho, V. J. P. D., Ferreira, A. J. D., Cunha, C., Pereira, J. I. S.; Sánchez-Carreira, M. C.; Castanheira, N. L.; Ramos, T. C. B.; Leite, C.B.; Santos, R. G. F. A.; Barreto, A. K. B.; & Amorim, E. F. (2026). *Are there any guarantees for carbon farming in Portugal?*. S4P-23 Policy Brief 5385/2023. PLANAPP - Centro de Planeamento e de Avaliação de Políticas Públicas.

**CONTACT**

science4policy@planapp.gov.pt

| | | | |
|---|---|---|---|
| 🌐 Ciência para as Políticas Públicas | | 🌐 PLANAPP | |
| 💼 PLANAPP | | ▶️ @planapp_ | |
| ✉️ Newsletter | | 🎵 PLANAPP podcasts | |