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Climate Change Mitigation in Agriculture: Barriers to the Adoption of Carbon Farming Policies in the EU

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Abstract: Climate change mitigation in the agricultural sector is essential to keep the goal of limiting global warming to 1.5 °C within reach. This article explores why there has been a limited adoption of carbon farming policies in the EU, despite the potential for emissions reductions and carbon sequestration at the farm level. Desk research revealed that EU Member States are increasingly setting sectoral climate targets for agriculture, but there is a lack of policies addressing carbon farming. Governments have largely refrained from using laws and regulatory instruments, with strategies and plans representing the large majority of carbon farming policies in the EU. Moreover, interviews with policymakers and other stakeholders revealed that the main barriers to the adoption of carbon farming policies are concerns over carbon leakage and competitive advantage, the need for a just transition, and structural issues in the food value chain. Despite being regarded by researchers as a main barrier to carbon farming, the agricultural lobby is not perceived as a barrier by policymakers, who emphasise the importance of involving farmers in the policy process. A key implication of these findings is that carbon farming policies need to form part of a wider food system transformation in order to successfully contribute to climate change mitigation.

Keywords: agriculture; carbon farming; climate change mitigation; food system; sustainability



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1. Introduction

The food system is responsible for 21–37% of global greenhouse gas (GHG) emissions, according to the Intergovernmental Panel on Climate Change (IPCC) [1]. Mitigation in the agricultural sector will be essential to keep the goal of limiting global warming to 1.5 °C within reach [2,3]. The IPCC's model pathways that limit global warming to 1.5 °C with no or limited overshoot include substantial reductions in agricultural GHG emissions, a reduction from 11% to 30% in CH₄ emissions, and –3% to 21% reduction in N₂O emissions by 2030 (interquartile range, relative to 2010 levels) [4]. In the EU, agriculture accounted for 11.8% of total GHG emissions in 2020 [5]. The mitigation of these emissions will be important for Europe to become climate neutral by 2050, as set out in the European Climate Law. However, agricultural emissions have remained relatively stable in the EU between 2005 and 2019, and are expected to decline by only 2% by 2030 compared with 2005 levels under the existing measures [6].

Agricultural emissions can be mitigated from both the supply and demand sides [7]. This article focuses on the supply side of agricultural mitigation, in particular through carbon farming. For the purpose of this article, carbon farming will be referred to as measures at the farm level to reduce emissions, avoid emissions, or increase carbon sequestration. The research focuses on the mitigation of farm-level emissions from agriculture and land use, land-use changes, and forestry (LULUCF). Others define carbon farming as focused solely on carbon sequestration, yet this can create an artificial separation between farm-level mitigation measures [8]. Examples of carbon farming practices include the enhancement of soil organic carbon (e.g., through crop rotation or reduced tillage), livestock management (e.g., optimised feeding), manure management, peatland restoration, or agroforestry [8,9].

While this article focuses on the climate mitigation aspects of carbon farming, the measures can have other benefits, for example, in terms of climate adaptation, biodiversity, or the quality of soil, water, and air [10].

McDonald et al. [8] estimated a mitigation potential of carbon farming in the EU of 101–444 Mt CO₂-eq yr⁻¹, equivalent to 3–12% of the EU's total annual GHG emissions. More specifically, Roe et al. [11] considered there is a large mitigation potential in the EU for reduced emissions from enteric fermentation, synthetic fertiliser, and manure. However, there is considerable uncertainty over the mitigation potential of carbon farming [8], and some are critical of the mitigation potential of certain carbon farming practices [12,13].

Despite the importance of agricultural mitigation to reach the goals of the Paris agreement, the IPCC has reported that policy coverage remains limited for agricultural emissions [14]. Indeed, scholars have argued that there has been limited attention to agriculture in climate change mitigation policy [15–18], especially compared to other sectors such as energy [3,17]. This lack of attention to agriculture has also been reported for European climate policy more specifically [19–22]. Verschuuren [19] has argued that the EU needs to step up regulatory intervention for agricultural emissions in order to reach the goals of the Paris agreement and the European Green Deal.

Different policy instruments can be used to address GHG emissions in the agricultural sector. In the context of livestock emissions abatement, Cooper et al. [23] noted that the most common policy approaches are subsidies, grants and tax incentives, and voluntary offset programmes. Most countries have been opposed to pricing agricultural emissions through a carbon tax or emissions trading scheme (ETS) [3,23,24]. New Zealand has attempted to integrate agriculture into its national ETS, yet ultimately reversed this decision [20]. However, some countries do allow the use of offsets from agriculture in an ETS [15,20]. In the EU, command-and-control regulation [19] as well as carbon pricing schemes [9,20] have been missing for agricultural emissions.

Quantified national targets are important to increase the credibility of climate change policies [25]. Nachmany and Setzer [26] have found that most sectoral climate targets relate to emissions from energy, transport, and LULUCF, while agriculture is significantly less targeted. In a review of agricultural policies, the Organisation for Economic Co-operation and Development (OECD) [27] indicated that only 16 out of the 54 countries analysed had set emissions reduction targets for agriculture. However, Henderson et al. [28] observed a slow but growing trend in the number of countries establishing mitigation targets for Agriculture, Forestry, and Other Land Use (AFOLU).

The literature assessing climate policy for the agricultural sector is generally rather limited [29]. In particular, Hönle et al. [29] have argued that the drivers of, and barriers to, a progressive agricultural mitigation policy require further elaboration. In terms of barriers, Wreford et al. [18] have observed that the volume of literature on policy-related barriers is rather low, while there is more literature on farm-level barriers. In other words, the carbon farming literature has largely focused on the implementation stage, rather than the policy adoption stages.

This article researches why there has been a limited adoption of carbon farming policies in the EU. The research aims are two-fold: Firstly, the article assesses what carbon farming policies and targets have been adopted by the EU and its Member States. This allows us to gain a better understanding of the current carbon farming landscape in the EU. Secondly, the research aims to identify the barriers for policymakers to adopt carbon farming policies. The existing literature on such barriers will be discussed in the next section.

2. Barriers to the Adoption of Carbon Farming Policies

Barriers can be defined as 'obstacles that can be overcome with concerted effort, creative management, change of thinking, prioritisation, and related shifts in resources, land uses, institutions, etc.' [30] (p. 22027). This article focuses on the barriers that occur at the policy stages of agenda setting, policy formulation, and decision-making [31], referring to these more generally as barriers to policy adoption.

Through a review of the literature, 12 studies were identified that discuss barriers to the adoption of carbon farming policies. Some of these sources look at challenges for mitigation policy in agriculture generally [3,10,21,32], while others focus on more specific aspects, such as reducing livestock emissions [23,33] or the use of market-based instruments [9,20]. Other studies discuss climate or environmental policy for agriculture more generally, but were deemed relevant to mitigation [18,34–36]. Studies focused on adaptation policies were not included in this review, nor was research focusing solely on farm-level barriers.

The selected studies were analysed to identify relevant barriers to the adoption of carbon farming policies, an overview of which can be found in Table 1. Barriers were grouped into three categories: sector complexity, mitigation effects, and institutional barriers. Each of these categories will be further described below.

Table 1. Overview of the barriers to the adoption of carbon farming policies identified through the literature review.

Category	Barrier	Sources
Sector complexity	Fragmented nature of the sector	[33–36]
	MRV at the farm level	[9,18,20,21,23,33]
	MRV in national GHG inventories	[10,18]
Mitigation effects	Impact on food production/security	[3,18,36]
	Carbon leakage and loss of competitive advantage	[3,18,20,23,32,33]
	Impact on farmers' livelihoods	[3,20]
Institutional barriers	Lack of political support	[21,34,36]
	Agricultural lobby	[3,20,21]
	Policy coordination	[3,18,34,36]
	Lack of institutional capacity	[9,34]

2.1. Sector Complexity

Due to the large number of farmers and the variety of production systems, agriculture is a complex sector with multiple interests and stakeholders [36], often requiring adapted technical packages and policy instruments [33]. This fragmented nature of the agricultural sector is one of the barriers to the adoption of the carbon farming policies mentioned in the literature. Scholars also mention issues of knowledge brokerage between farmers and regulators, with millions of farmers using and providing data [34,35].

A further element of complexity are the difficulties involved in the measurement, reporting, and verification (MRV) of emissions at the farm level, one of the most mentioned barriers. Authors mention large uncertainties over the measurement of agricultural emissions, in particular for livestock emissions and soil carbon flows [20,23,33]. Agricultural emissions can be highly variable and depend on local soil, management, and climate conditions [20,33]. Scholars also mention the diffuse nature of agricultural emissions, which make the sector harder to address than point-source emissions [20,35]. However, Schäfer [21] argued that it is possible to at least adopt some policy despite MRV difficulties.

MRV difficulties and the large number of farmers are considered a particular challenge for adopting market-based instruments due to the high transactions costs [9,20,33]. The literature is largely inconclusive as to how high the transaction costs of climate policies are for the European agricultural sector [20]. While MRV may present a barrier to market-based instruments for agricultural mitigation, this barrier may not be insurmountable. Grosjean et al. argued that transaction costs could be reduced over time and a 'significant proportion of agricultural emissions and mitigation potential could be covered by a policy targeting large farms and few emissions sources' [20] (p. 1).

In addition to the difficulties of MRV at the farm level, authors also indicate barriers related to the reporting of agricultural emissions in national GHG inventories. Smith et al. [10] raised concerns that the reduction in emissions resulting from carbon farming practices may not be represented in national GHG inventories under IPCC guidelines due to the use of fixed emissions factors. In terms of carbon sequestration, Bellassen et al. [12] also point out that current GHG inventories would not capture the mitigation benefits of soil carbon storage policies, as most soil carbon stock changes are currently not being monitored in Europe. This reduces the incentive to adopt carbon farming policies or practices, as they may not have an effect on nationally reported emissions [18].

Under IPCC guidelines [37], farms' emissions are reported under several categories in national GHG inventories: some emissions are reported as agricultural emissions, while others are reported under LULUCF or energy. Mitigation efforts at the farm level may thus be reported as reduced emissions under LULUCF or energy, rather than agriculture. This attribution of emissions to different sectors can also present a barrier: Wreford et al. [18] argued that this reduces incentives to act, as a sector or government ministry not properly acknowledged for reducing emissions may be discouraged from engaging in mitigation. Furthermore, Lynch et al. [38] mentioned that the conventional reporting of aggregated CO₂-equivalent emissions does not reflect the different impacts of stock pollutants (such as CO₂) and flow pollutants (CH₄ and N₂O). This distinction could be of particular importance for agriculture, as non-CO₂ GHG represent a significant share of agricultural emissions.

2.2. Mitigation Effects

The agricultural sector faces several challenges at the same time, including the increase in food production in the context of a growing population, while also reducing GHG emissions and adapting to climate change [36,39]. Wreford et al. [18] argued that the perceived effects of mitigation on food production present a barrier, especially in countries where agriculture represents an important share of the economy and provides a significant source of emissions. In this context, countries tend to focus on the efficiency gains of reducing agricultural emissions [18].

Mitigation consistent with a 1.5 °C target could raise food prices globally and increase the risk of food insecurity [40,41]. Concerns over the negative impacts of mitigation on food security are particularly high in developing countries, where food security problems are already acute [3,40]. Developed countries, such as EU Member States, might compensate for the loss of food production by increasing food imports from third countries, which raises the issue of carbon leakage [32,42].

Due to the large international trade in agricultural commodities, the risk of carbon leakage is often mentioned as a barrier to (unilateral) mitigation efforts in agriculture [20,23,33]. Other authors emphasise countries' concerns over a loss of competitive advantage in the absence of multilateral action [3,18]. The literature indicates carbon leakage resulting from European agricultural emission reductions could be substantial, yet the magnitude remains unclear [18,20,43].

Another barrier mentioned in the literature is the potential negative impacts of mitigation policies on farmers' livelihoods [3,20]. The distributional impacts of agricultural mitigation are uncertain and will be heterogeneous across different regions and agricultural activities [20]. While some mitigation measures might increase farmers' income due to efficiency gains [18], Fellmann et al. [32] estimated it is likely that some farmers in the EU would have to leave the sector when faced with more stringent agricultural mitigation policies.

2.3. Institutional Barriers

In terms of institutional barriers, some authors mention a lack of political support for mitigation in agriculture. In order to explain the absence of EU climate policy for agriculture, Schäfer claimed 'there is basically no strong constituency in member states that favours reductions in agricultural GHG emissions' [21] (p. 319). Writing about a decade

ago, Schäfer argued that the decline in agricultural emission in the EU since 1990 made it easy for governments to argue no mitigation measures were needed in the past, while a more restrictive climate policy environment started to place pressure on policymakers to address agricultural emissions. Soto Golcher et al. [36] also mentioned limited political support for the inclusion of agriculture in climate negotiations in the context of the United Nations Framework Convention on Climate Change (UNFCCC).

Further developing this aspect of political support, Schäfer [21] argued that Member States can be expected to oppose policies that jeopardise large domestic interest groups, such as farmers. Even though the number of farmers varies among Member States, there is a significant group of farmers in each country that can be expected to resist ambitious climate policies, leading to governments' opposition to reduce agricultural emissions [21]. On a similar note, Grosjean et al. mentioned that European agricultural lobbies are perceived as particularly strong, 'thereby potentially reducing the scope for ambitious climate policies in the sector' [20] (p. 14).

Another institutional barrier mentioned in the literature is policy coordination. Soto Golcher et al. [36] argued environmental and agricultural policies are in conflict with one another in many countries, which is echoed by Verschuuren for the EU specifically [19]. In particular, the original purpose of the EU's Common Agricultural Policy (CAP) of providing income support to farmers might be in conflict with the objective of reducing emissions, as it distorts signals to farmers [18,35]. Agricultural mitigation policies require coordination across government ministries, such as agriculture, health, and rural development [3]. Several authors mention the particular importance of a crosscutting approach to transform food systems [15,34,44].

Lastly, some authors mention institutional capacity as a barrier to agricultural mitigation policies. COWI et al. [9] mentioned institutional capacity as a barrier to result-based carbon farming schemes in the EU, as these are complex to set up, implement, and monitor. On a similar note, Giles et al. [34] pointed out that a lack of expertise and awareness of climate issues can lead to the poor strategic planning of agricultural policies. Moreover, they raised the issue of financial capacity, although this is likely to be a larger barrier for developing countries [34].

3. Materials and Methods

3.1. Desk Research

Desk research was conducted throughout June and July 2022 to identify what carbon farming policies and targets the EU and its Member States have adopted. Data were primarily collected from the Climate Change Laws of the World (CCLW) database [45], as well as the Climate Policy Radar (CPR) search tool [46]. In addition, the National Energy and Climate Plans (NECPs) of EU Member States were reviewed to identify carbon farming policies and targets. Member States' long-term strategies submitted to the UNFCCC were also included in the dataset, insofar they addressed carbon farming. Lastly, the OECD's Agricultural Policy Monitoring and Evaluation [27] was consulted to identify additional policies and targets. The dataset of carbon farming policies does not include the CAP strategic plans, as they had not been adopted at the time of conducting the desk research.

The datasets of carbon farming policies and targets can be found in Tables S1 and S2 (see Supplementary Materials), respectively. The following information was collected for policies: year, document type, and instrument type. This information was drawn from the CCLW database or identified through our own analysis. For the instrument type, the methodology of the CCLW database was used, which is based on Hood & Margetts' NATO typology [47]. The dataset was then analysed to identify emerging patterns.

While CCLW is arguably the most comprehensive database of its kind [48], it does not claim to have identified every relevant policy. Additional sources were used for the data collection to address this limitation. While the research cannot claim to have identified all carbon farming policies in the EU, the dataset does allow us to obtain a general sense of the prevalence of carbon farming policies and to identify overarching patterns. A further

limitation of the desk research is the focus on policies adopted at the EU and national level, excluding subnational policies or voluntary initiatives. In particular in federal countries, subnational entities can be an important source of agricultural and climate policies, which could be an area for future research.

3.2. Interviews

Interviews were conducted to research the barriers for policymakers to adopt carbon farming policies in the EU. This research method was particularly useful to gather perspectives from policymakers and other stakeholders on how they experience barriers [49,50], and to gain more in-depth information from experts [49,51].

A total of 12 interviews were conducted with 14 participants; an overview of the interviewees can be found in Table S3 (see Supplementary Materials). The participants included eight policymakers, of which three were EU policymakers, four Irish policymakers, and one French policymaker. Four interviewees represented research, one a farmers' association, and one media. Interviewees were selected using purposive sampling [52] based on their expertise on carbon farming and/or the role they held in an organisation of particular interest to the research. Interviews were conducted via Zoom in July and August 2022 and lasted around 30 min on average. Interviews were semi-structured [53]; the interview protocol can be found in Table S4 (see Supplementary Materials).

The research was designed to include a majority of policymakers, as this contributes to the current gap in the literature on policy barriers. Both European and national policymakers were included to reflect the barriers that exist at both policy levels. France was chosen as a case study as it is the Member State with the highest agricultural emissions [54]. The country has set a target to reduce these emissions by 24% by 2030 compared to 1990 levels and has adopted a national certification scheme for emissions reductions in agriculture ('Label Bas Carbone'). The desk research also revealed that France is the Member State with the highest number of carbon farming policies. Secondly, Ireland is the EU Member State with the highest share of agricultural emissions in its total GHG emissions [54]. The Irish government aims to reduce agricultural emissions by 25% by 2030, compared to 2018 emissions. Ireland has adopted an average number of carbon farming policies (4), yet both the Irish NECP and the strategy for mitigation in agriculture (Ag Climatise) mention the challenge of balancing the multiple objectives of the agricultural sector.

A thematic analysis was used to detect patterns between interviewees' responses [55] and to construct thematic networks [56]. Interview transcripts were coded manually using a spreadsheet [57]. A combination of a priori coding and grounded coding was used: the barriers identified in the literature review were used as themes, while additional themes were added during the coding process based on grounded theory [58]. In some cases, sub-themes were developed to provide more granular data. In line with the literature review, themes were grouped into the categories of sector complexity, mitigation effects, and institutional barriers, with an additional category for policy coverage. A thematic map can be found in Figure S1 (see Supplementary Materials).

A limitation of this research design is that, due to the diversity of the stakeholders interviewed, the number of participants from each stakeholder group was limited. However, responses between interviewees showed patterns and similarities, indicating that a certain degree of saturation was reached [50]. Gaining access to policymakers proved challenging in some cases, a common issue when interviewing elites [59]. This was particularly challenging for a research project during Summer, when many policymakers are out of office, which explains why only one French policymaker was interviewed. A further limitation of the research is the variety of definitions of the term carbon farming. While participants were informed of the researcher's understanding of carbon farming and the scope of the research, it is possible that interviewees' answers were informed by a different conception of the term, for example, focusing on carbon sequestration rather than reducing emissions.

4. Results

4.1. Carbon Farming Policies in the EU

Data from the CCLW database reveal that the number of climate change mitigation policies in the EU is limited for agriculture compared to other sectors, in line with the IPCC's finding of a limited policy coverage for agricultural emissions [14]. In particular, there is a significantly lower number of mitigation policies for agriculture than for the energy, transport, and buildings sectors (see Figure 1).

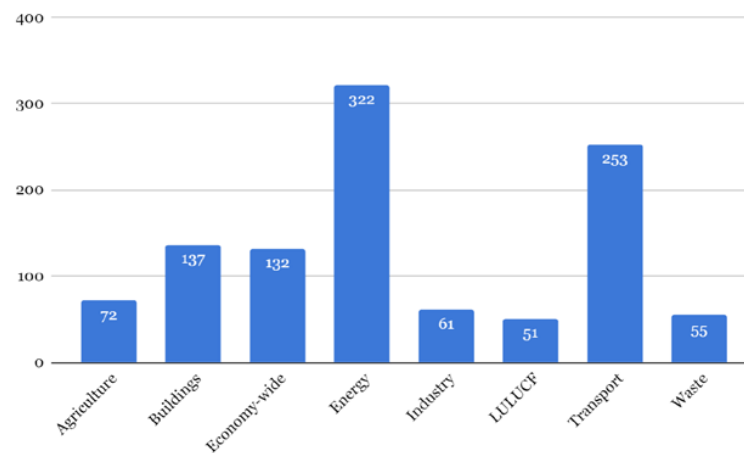


Figure 1. Number of climate change mitigation policies in the EU for selected sectors. Data retrieved from the 'Climate Change Laws of the World database' by Grantham Research Institute on Climate Change and the Environment & Sabin Center for Climate Change Law (<https://climate-laws.org>, accessed on 20 June 2022).

This section presents the results of the desk research conducted to identify what carbon farming policies the EU and its Member States have adopted. In total, 91 carbon farming policies were identified. It must be noted that Member States' NECPs and the long-term strategies submitted to the UNFCCC constitute a significant part of the dataset, accounting for 27 and 17 policies, respectively. Interestingly, most policies do not mention carbon farming explicitly, but contain measures that implicitly target carbon farming.

Each EU Member State has adopted at least one carbon farming policy (see Figure 2). With 11 policies, France stands out as the Member State with the highest number of carbon farming policies. In five Member States (Croatia, Cyprus, Greece, Romania, and Sweden), the NECP is the only carbon farming policy identified through the desk research. Moreover, in five Member States (Belgium, Latvia, Lithuania, Luxembourg, and Portugal), the only carbon farming policies identified are the NECP and UNFCCC long-term strategy.

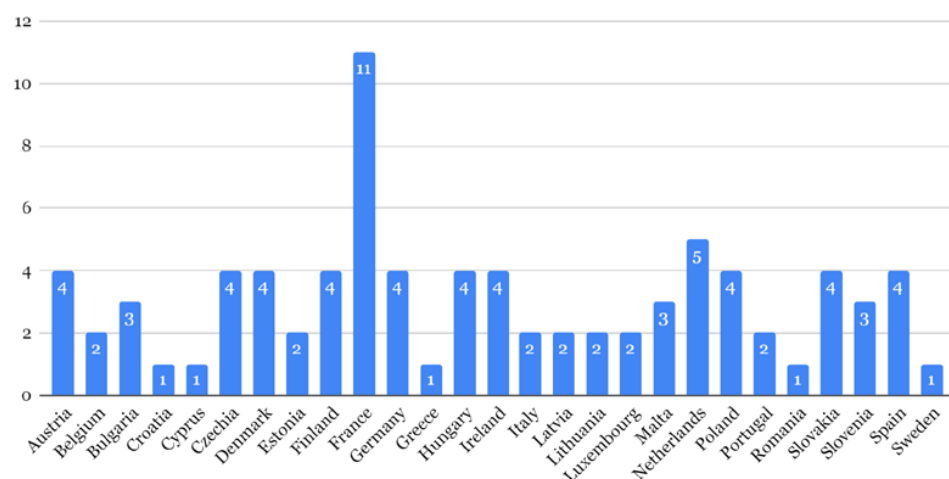


Figure 2. Number of carbon farming policies per Member State.

The majority of policies in the dataset were adopted between 2019 and 2021 (see Figure 3a). However, this figure is heavily affected by the large number of NECPs and UNFCCC long-term strategies adopted within this period. When analysing the dataset without the NECPs and UNFCCC long-term strategies, the increase in the adoption of carbon farming policies in recent years becomes rather insignificant (see Figure 3b). As the dataset only includes policies that are still in force, the figure might be biased towards more recent years. Taking into account these considerations, we cannot conclude from the dataset that there has been a substantial increase in the adoption of carbon farming policies in recent years.

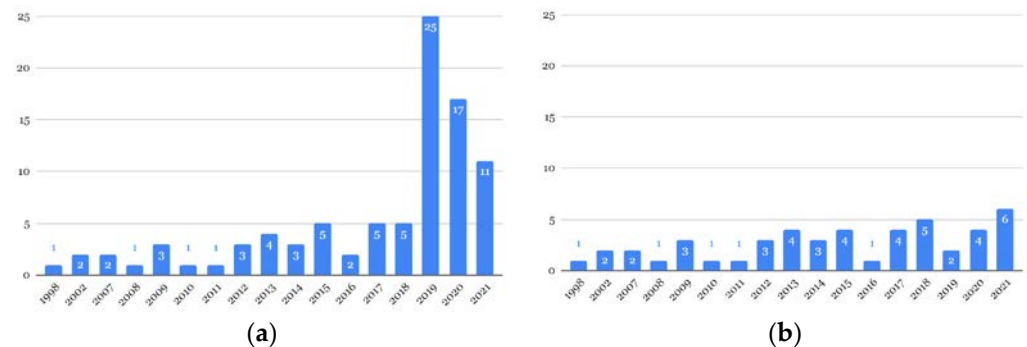


Figure 3. Number of carbon farming policies per year of adoption: (a) full dataset; (b) dataset excluding NECPs and UNFCCC long-term strategies.

While the dataset does not reveal a substantial increase in policy adoption, Member States have increasingly adopted emission targets for the agricultural sector in recent years (cfr. Table S2 (see Supplementary Materials)). A total of 13 targets relevant to carbon farming were identified through the desk research, of which 11 at the Member State level and 2 at the EU level. With one exception, all of these targets were adopted in 2019–2022. However, in the majority (19/27) of EU Member States, no sectoral target for agricultural emissions was identified. This finding is in line with the slow but growing trend of AFOLU targets reported by Henderson et al. [28].

When looking at the types of carbon farming policies adopted, the vast majority (89%) of policies in the dataset are of an executive nature, such as plans (41.8%), strategies (33%), programmes (6.6%), decrees (5.5%), and agreements (2.2%). Laws addressing carbon farming were only found in four Member States and the EU, representing 11% of the dataset (see Figure 4).

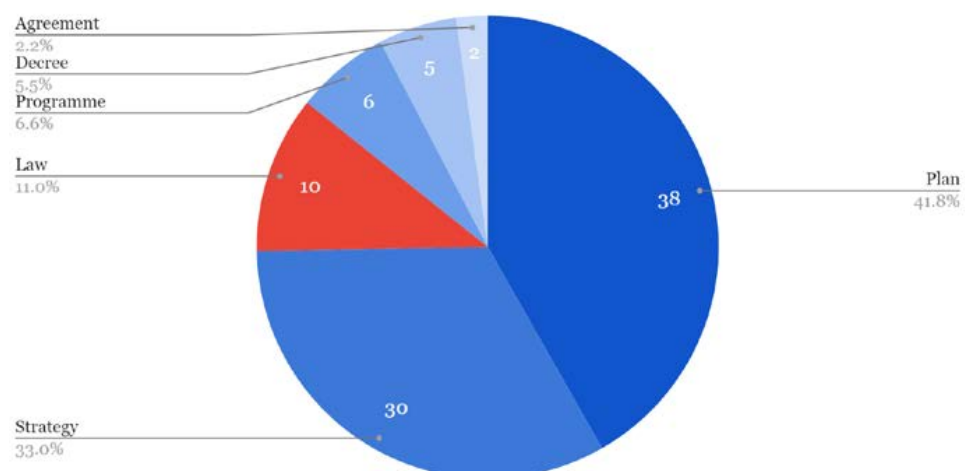


Figure 4. Types of carbon farming policies adopted.

In line with the high number of plans and strategies, Figure 5 shows that the large majority (89%) of policies in the dataset use governance instruments to address carbon

farming. Other instruments are used to a lesser extent. In particular, there is a low number of policies using instruments of regulation and direct investment. This supports Verschuuren’s argument that regulatory intervention for agricultural mitigation needs to be stepped up in the EU [19].

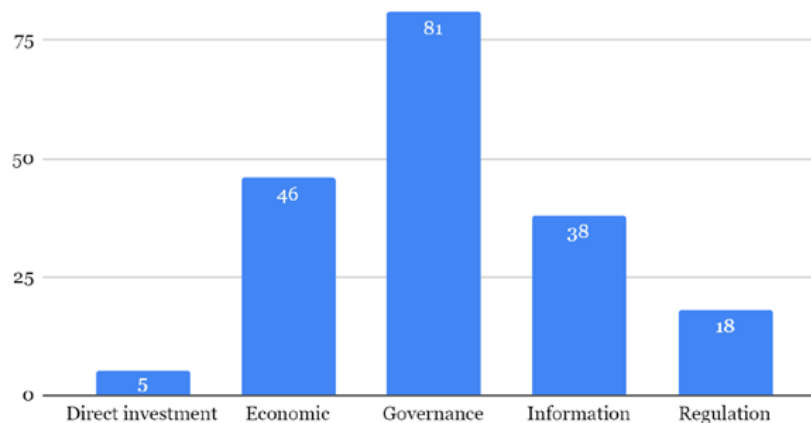


Figure 5. Types of instruments used in carbon farming policies.

4.2. Barriers to the Adoption of Carbon Farming Policies

The lack of attention to agriculture in climate mitigation policy was echoed by nearly all participants in the interviews. Only two interviewees from the Irish Department of Agriculture (IE3 and IE4) argued there has been enough policy attention to the sector, while also recognising that more policies need to be adopted to reach Ireland’s mitigation targets for agriculture by 2030. Other interviewees mentioned that targets have been set for the sector (RE3) and strategies have been developed (FR1), but there is a lack of policies to deliver them. This is in line with the findings of the desk research.

Several interviewees perceived an increase in attention to agricultural mitigation in recent years (EU1, IE1, IE3, RE1, RE3, and ME1). This supports Schäfer’s argument that a more stringent climate policy has placed pressure on policymakers to address agricultural emissions [21]. In particular, interviewees report increased attention to carbon sequestration driven by significant interest from industry (IE3, RE1, and ME1).

The next sections discuss the findings from the interviews on the barriers for policymakers to adopt carbon farming policies. Barriers were grouped across the categories identified through the literature review: sector complexity, mitigation effects, and institutional barriers. An overview of the main findings per barrier can be found in Table 2 below.

Table 2. Main findings on the barriers to the adoption of carbon farming policies.

Category	Barrier	Findings
Sector complexity	Fragmented nature	Mentioned by four interviewees.
	MRV at the farm level	Differing views: MRV is a particular issue for LULUCF and market-based instruments, but not necessarily for policy overall.
	MRV in national GHG inventories	Raised by five interviewees, in particular the distinction between agriculture, energy, and LULUCF emissions.
	Structural issues in the food system	Mentioned by the majority of policymakers and researchers, in particular consumption patterns and concentration of power in the food value chain.

Table 2. Cont.

Category	Barrier	Findings
Mitigation effects	Impact on food production/security	Acknowledged as an argument by most interviewees, but there are differing views on whether it represents a barrier.
	Carbon leakage and competitive advantage	Mentioned by seven interviewees, mostly policymakers.
	Impact on farmers' livelihoods	Addressed by six interviewees, in particular the need for a just (rural) transition.
Institutional barriers	Lack of political support	Mentioned by few interviewees.
	Agricultural lobby	Main barrier for researchers; not perceived as a barrier by policymakers.
	Policy coordination	Most interviewees do not see inter-ministry cooperation as a barrier, but competing objectives of the CAP is a particular issue.
	Lack of institutional capacity	Not mentioned as a barrier by most interviewees.

4.2.1. Sector Complexity

The fragmented nature of the agricultural sector was only mentioned by a minority of interviewees as a barrier. A number of policymakers (FR1, IE1, and IE2) considered the wide variety of farms and the differences in mitigation potential between farms as a barrier. One researcher (RE1) mentioned a knowledge gap from the bottom up and the importance of setting up pilot schemes, reflecting the issue of knowledge brokerage raised by Giles et al. [34].

Interviewees had different perceptions as to whether MRV issues at the farm level present a barrier to policymaking. Six interviewees considered MRV issues a barrier to carbon farming policies (EU3, FR1, IE1, IE2, RE4, and ME1). In particular, interviewees mentioned MRV as a challenge for the LULUCF aspects of carbon farming (IE1, IE2, and ME1). Other interviewees did not consider MRV to be a barrier and mentioned that the data around agricultural emissions have improved (EU1, IE4, RE1, and RE2). Two researchers (RE1 and RE2) argued that MRV is a barrier for market-based instruments specifically, but not for mitigation policy overall. This reflects the MRV issues raised by the scholarship on market-based instruments in agriculture [9,20,33] and supports Schäfer's argument that it is possible to adopt some mitigation policies despite the difficulties of measurement [21].

In terms of reporting in national GHG inventories, four interviewees (IE2, IE3, IE4, and RE3) expressed that the distinction between agricultural, energy, and LULUCF emissions is indeed a barrier. Interestingly, policymakers from both the Irish Department of Agriculture as the Department of the Environment considered combined AFOLU emissions reporting as the direction of travel, but raised concerns that LULUCF sinks would be used to reduce ambition for emissions reductions in agriculture. One policymaker (IE1) raised the idea of treating methane emissions differently to other GHG in inventories, as discussed by Lynch et al. [38], but argued it would take too long to reach a political agreement on this.

Throughout the interviews, it became clear that structural issues in the food system present an additional barrier for policymakers to adopt carbon farming policies. The majority of policymakers interviewed (EU2, EU3, FR1, IE1, and IE2) expressed challenges related to the need for structural changes, and the need for a food system transformation was mentioned by most researchers (RE1, RE2, and RE4). As one policymaker articulated, 'we basically are facing what looks like an existential question: do we continue our current economic agricultural model or do we transform it completely over the next years' (IE1). In particular, many interviewees argued that the whole value chain needs to be addressed, including food consumption, rather than only taking farm level measures (EU2, EU3, FR1, RE1, RE2, and RE4). 'There is no useful change at the agricultural level without changes at the food consumption level', as one policymaker stated (FR1). A further issue

mentioned by researchers is the economic structure of the food system and the concentration of power, in particular, in the hands of retailers and agrochemical input suppliers (RE1 and RE4). A researcher (RE1) stated that ‘the retailers still have enormous power, in terms of how they define the prices, they want economies of scale. So if you want to transition, there are structural problems in there that are not being talked about and are not being addressed sufficiently.’ While there is literature on the need for a food system transformation (e.g., see [44]), this aspect did not come up as a barrier to policymaking in the literature review.

4.2.2. Mitigation Effects

Many interviewees acknowledged that the potential negative impacts on food production or security is an argument used against more ambitious mitigation policies, especially in light of the war in Ukraine (EU2, EU3, RE1, RE4, and ME1). National policymakers indeed mentioned food production, and the close link between production and emissions, as a barrier to reducing agricultural emissions (FR1, IE1, and IE3). Some interviewees mentioned that emissions can be reduced by increasing efficiency (e.g., through reduced fertiliser use), yet further emissions reductions are harder to achieve (IE1, IE3, and RE3). This supports the argument made by Hönle et al. that mitigation policies are easier to implement for countries if they are accompanied by modernization, efficiency gains, and other co-benefits [29]. EU policymakers did not see food security as a genuine barrier to mitigation, as the two can be married (EU1, EU2, and EU3). One researcher mentioned that ‘for food security reasons, it’s actually necessary to move to a plant based diet’ (RE2).

In line with the literature, several interviewees mentioned concerns over carbon leakage (FR1, IE1, IE3, RE4, and FA1) and the loss of competitive advantage (EU1, FR1, IE1, IE3, FA1, and ME1). In this context, two interviewees (FR1 and RE4) emphasised the importance of addressing diet change to prevent carbon leakage. FR1 also emphasised the need for a coordinated EU approach to address concerns over the loss of competitiveness advantage among Member States. This supports the argument made by Fellmann et al. that multilateral action is necessary to prevent carbon leakage and to minimise distortions to competitiveness [32]. Interviewees raised concerns that the increased freedom of Member States under the reformed CAP (ME1) and the delegation of CAP implementation to subnational authorities (EU1) could lead to a race to the bottom on the basis of competitiveness concerns.

In terms of the impact on farmers’ livelihoods, several interviewees mentioned the challenge of a just transition (EU3, RE1, and RE4) or the economic difficulty of carbon farming policies (IE1). Interviewees also mentioned the need for a just rural transition, because of the importance of agriculture to rural economies (EU3, IE1, and RE4). In particular, two policymakers (EU2 and FR1) raised the issue of farmers’ dependence on CAP subsidies, which is a challenge for policymakers as CAP reforms can have a disproportionate impact on farmers’ income. This links back to the need for a food system transformation to increase farmers’ resilience and the sustainability of their business. Two interviewees mentioned that carbon farming can also present a new source of income for farmers (EU1 and FA1).

4.2.3. Institutional Barriers

In terms of institutional barriers, two researchers identified a lack of political will as the main barrier to the adoption of carbon farming policies (RE1 and RE2). This lack of political will can be seen as an emanation of other factors. In line with Schäfer [21] and Grosjean et al. [20], RE2 referred to resistance from the agricultural lobby as the reason for a lack of political support. Other interviewees mentioned a wider lack of societal support or demand for mitigation in agriculture (EU1, FR1, and RE4), which could explain the lack of political will.

The interviews showed the stark contrast between researchers and policymakers’ perceptions of agricultural lobbying as a barrier. All researchers considered agricultural lobbying to be a main barrier to the adoption of carbon farming policies. National policy-

makers, on the other hand, acknowledged that farmer organisations have a large influence over policymaking, but did not perceive agricultural lobbying as a barrier to policy adoption. Policymakers perceived farmer organisations to be constructive and emphasised the importance of engaging them early in the policy process (FR1, IE3, and IE4). Policymakers also mentioned that support from farmer organisations is important to obtain buy-in for the implementation of policies (FR1, IE3, and IE4). Some interviewees further mentioned that there is demand from the agricultural sector to adopt more sustainable practices (EU2, IE3, and RE4).

Policymakers recognised that policy coordination can be a challenge for mitigation policies, but considered this part of the nature of policymaking (EU1, EU2, and IE1). Both French and Irish policymakers mentioned good working relations between the ministries of agriculture and environment (FR1 and IE4). However, FR1 mentioned coordination issues with the Ministry of Finance, resulting in a lack of financial commitments to implement the agricultural strategies. Interestingly, all Irish policymakers emphasised that the adoption of the Irish Climate Act has reduced barriers for policy coordination. National policymakers also mentioned coordination by the prime minister's office or a senior officials group to improve policy coherence (IE4 and FR1). An independent review body, such as France's High Council on Climate, is also helpful in the improvement of climate policy (FR1).

A particular issue of policy coordination is the competing objectives of the CAP between income support and environmental objectives. This issue was raised by six interviewees (EU1, EU2, EU3, IE1, RE2, and ME1), echoing points made in the literature [18,35]. Another issue is the coordination between policies at the EU and Member State levels: several national policymakers expressed frustration that policy is moving too slowly at the EU level (IE1, IE3, and IE4). This lack of EU policy coordination can be a barrier for Member States to adopt more ambitious carbon farming policies. However, interviewees also mentioned that Member States do have agency to adopt more ambitious policies if they wanted to (IE1, RE4, and ME1).

Most interviewees did not mention institutional capacity as a barrier. IE3 mentioned concerns over institutional capacity for environmental policy overall, and considered working in partnership with industry as a way forward. RE1 mentioned a lack of human resources at the European Commission to deliver the European Green Deal as an institutional barrier. Two researchers (RE1 and RE4) also mentioned a lack of integrated modelling for agricultural mitigation as a barrier for policy decisions. Some policymakers mentioned concerns over financial capacity to implement mitigation policies (EU2, EU3, and FR1), which underlines the importance of coordinating with the Ministry of Finance.

5. Discussion

5.1. Limited Carbon Farming Policies in the EU and Main Barriers

The findings of the desk research confirm that there has been a limited policy coverage of agricultural emissions in the EU, compared to other sectors. With 75% of carbon farming policies being strategies and plans, the desk research revealed that strategies have been adopted, but there is a lack of policies to implement them. This was echoed by interviewees and reflects the implementation gap reported in the literature [14–17]. In particular, there is a lack of laws and regulatory instruments addressing carbon farming.

Several interviewees mentioned a recent increase in policy attention to carbon farming, yet the desk research indicates this has not yet translated in a substantial increase in policy adoption. There has, however, been an increase in the adoption of mitigation targets for agriculture, and interviewees indicated the importance of such targets to hold governments accountable (FR1 and IE2), echoing a key argument of Nachmany and Mangan [26]. However, the majority of EU Member States has not defined a mitigation target for agriculture.

Interviews confirmed that among the main barriers for policymakers to adopt carbon farming policies are concerns over carbon leakage and the loss of competitive advantage, as well as the challenge of ensuring a just transition for farmers and rural economies.

Moreover, one of the main barriers that emerged from the interviews are structural issues in the food system, in particular, the need for changes to consumption patterns and the concentration of power in the food value chain.

Other barriers mentioned in the literature were met with differing views by interviewees, such as MRV issues at the farm level, the impact of mitigation on food security, and the role of agricultural lobbying. The fragmented nature of the sector and MRV issues in the national GHG emissions inventories were not considered as the main barriers by interviewees, despite being reported as barriers to carbon farming policies in the literature [10,18,33–36]. While previous studies identified a lack of institutional capacity as a barrier to carbon farming policies [9,34], this also did not emerge as a major barrier from the interviews in this research. Political will was mentioned by some interviewees, but was mostly perceived as an emanation of a lack of societal support or resistance from agricultural lobbies. Lastly, most interviewees did not see inter-ministry cooperation as a barrier, but mentioned some issues of policy coordination, such as a lack of EU coordination and the competing objectives of the CAP.

5.2. Policy Implications

The first implication of these findings is that EU Member States should adopt more policies to deliver the carbon farming targets and strategies they have set. In particular, the study points to a need for more laws and regulatory instruments to address agricultural mitigation. This supports the call by Verschuuren [19] for the EU to step up regulatory intervention to address mitigation in agriculture.

Secondly, carbon farming policies should be accompanied by a wider food system transformation. Mitigation measures at the farm level are unlikely to be successfully implemented if they are not accompanied by structural changes, in particular, consumption shifts, a just transition for farmers and rural economies, and changes to the economic model of the food value chain. This requires strategic coordination across the government, including with the ministries of agriculture, health, and finance. The food system transformation also presents an opportunity: several interviewees mentioned co-benefits for biodiversity, nature conservation, water quality, and health. A food system transformation can also increase buy-in from farmers for mitigation measures.

In terms of institutional arrangements, the research highlights the importance of adopting a climate change framework law and setting sectoral targets for agriculture. Interviewees' responses indicated this helps to improve policy coordination and to hold governments accountable. Other best practices that emerged from the interviews include the coordination of climate policy by the prime minister's office and the establishment of an independent climate change review body.

This study further points to the importance of multilateral action to address mitigation in agriculture, echoing the findings of Fellmann et al. [32]. In particular, a multilateral approach is required to address the issues of carbon leakage and the loss of competitive advantage. Interviewees also mentioned the importance of a coordinated EU approach for certification standards and accounting methodologies.

Lastly, it is important that policymakers involve farmers in the design of carbon farming policies from the early stages. This can improve the design of policies and increase buy-in from farmers for the implementation of carbon farming.

5.3. Limitations and Future Research

A limitation of this study is the focus on climate mitigation at the farm level. The research findings show that the barriers to carbon farming policies are inherently connected to the demand side and other parts of the food value chain. This could explain why some of the structural issues to the food system raised by interviewees did not come up in the literature review. Future research could further investigate the connection between mitigation at the farm level and mitigation in other parts of the value chain, considering the food system transformation in a holistic way.

A further limitation of this research is that the methodology does not allow to assess the quality of the carbon farming policies in the dataset. Therefore, the research cannot draw conclusions on the design of policies, the effectiveness of mitigation measures or the implementation level. This presents avenues for further research on carbon farming.

6. Conclusions

While mitigation in the agriculture sector is essential to keep the goals of the Paris agreement within reach [2,3,60], the IPCC has reported a limited policy coverage of agricultural emissions [14]. This article aimed to understand why there has been a limited adoption of carbon farming policies in the EU.

Through the analysis of the CCLW database, this study confirmed that there has been a more limited adoption of mitigation policies for agriculture in the EU compared to other sectors, such as energy, transport, and buildings. While EU Member States are increasingly adopting targets for agricultural mitigation, the desk research revealed that there is a lack of policies to deliver them. 75% of carbon farming policies in the EU are strategies and plans, indicating governments have largely refrained from using laws and regulatory instruments to address carbon farming.

Interviews with policymakers and other stakeholders indicated that the main barriers to the adoption of carbon farming policies include concerns over carbon leakage and competitive advantage, and the need for a just transition. Moreover, structural issues in the food system form a major barrier to carbon farming policies, in particular, the need for changes to consumption patterns and the economic model of the food value chain.

Whereas researchers perceived agricultural lobbying as one of the main barriers to carbon farming, policymakers did not experience this as a barrier and emphasised the importance of involving farmers in the policy process. Interviewees also expressed differing views on whether MRV issues and the impact of mitigation on food production are barriers to carbon farming policies. Lastly, some of the barriers mentioned in the literature do not seem to play a major role, such as the fragmented nature of the sector, issues of inter-ministry cooperation, and a lack of institutional capacity.

These findings contribute to the rather limited literature assessing climate policy for the agricultural sector. While past scholarship has largely focused on farm-level barriers to carbon farming, this study is one of few to have researched the barriers for policymakers to adopt carbon farming policies.

As countries continue to address global warming, this article provides insights into the specific challenges of adopting policies to address mitigation at the farm level. In particular, the study highlights the importance of setting sectoral targets for agricultural emissions and the need to implement policies that deliver on them. In order to address the barriers identified throughout the research, carbon farming policies will need to be accompanied by structural changes, including consumption shifts, a just transition, and changes to the economic model of the food system. This will require strategic coordination by governments, multilateral efforts, and the involvement of farmers in the policy process. Only by undertaking this food system transformation, countries can increase the sustainability of the agricultural sector and keep the goal of limiting global warming to 1.5 °C within reach.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su151310452/s1>, Figure S1: interviews thematic map; Table S1: carbon farming policies; Table S2: carbon farming targets; Table S3: list of interviewees; Table S4: interviews protocol.

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List of Abbreviations

AFOLU	Agriculture, forestry, and other land use
CAP	Common Agricultural Policy
CCLW	Climate Change Laws of the World
CPR	Climate Policy Radar
ETS	Emissions trading scheme
EU	European Union
GHG	Greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land use, land-use change, and forestry
MRV	Measurement, reporting, and verification
NECP	National Energy and Climate Plan
OECD	Organisation for Economic Co-operation and Development
UNFCCC	United Nations Framework Convention on Climate Change

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