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Adopting carbon farming certification framework: Lessons from the EU's initiative and potential for Türkiye

Yusuf Serengil[a,*]

Abstract: One of the essential components of carbon markets is certification. In December 2024, the European Parliament reached a political agreement to establish the first EU-level certification framework for permanent carbon removals, carbon farming, and carbon storage in products. The voluntary framework aims to reduce carbon emissions in the EU by implementing activities that promote carbon removal and emission reduction. The regulation covers four types of units: permanent storage, temporary storage of wood products, temporary storage, and emission reductions through carbon farming. The initiative has the potential to serve as a model for Türkiye, where the recent land sector mitigation targets provide a foundation for developing a national carbon farming regulation. Since Türkiye lacks a national carbon certification regulation for carbon farming, the EU's framework can provide valuable guidance and inspiration for Türkiye to develop its tailored approach. However, several country-specific challenges must be addressed, including land ownership complexities and the issue of additionality in forestlands. It must also be designed to be both simplistic and robust, ensuring transparency and integrity to attract investment. While initially voluntary, the regulation should consider transitioning toward a compliance-based market in the future. Additionally, we suggest that a well-defined land sector-wide mitigation target for 2030 and beyond may serve as an incentive for effective implementation.
Keywords: Carbon farming, EU Carbon border adjustment mechanism, Green taxonomy, Land sector, Net zero

Karbon tarımı sertifikasyon çerçevesinin içselleştirilmesi: AB girişiminden çıkarılan dersler ve Türkiye için potansiyel

Öz: Karbon piyasalarının temel bileşenlerinden biri sertifikalandırmadır. Aralık 2024'te Avrupa Parlamentosu, kalıcı karbon giderimi, karbon tarımı ve odun ürünlerinde karbon depolaması için AB düzeyinde ilk sertifikasyon çerçevesini oluşturmak üzere siyasi bir anlaşmaya vardı. Gönüllü nitelikteki bu çerçeve, karbon giderimi ve emisyon azaltım faaliyetlerini uygulayarak AB'deki karbon emisyonlarını azaltmayı amaçlamaktadır. Yönetmelik dört tür birimi kapsamaktadır: kalıcı karbon depolama, ahşap ürünlerinde geçici depolanması, geçici karbon depolama ve karbon tarımı yoluyla sağlanan emisyon azaltımları. Bu girişim, yakın zamanda arazi kullanma sektörü için belirlenen azaltım hedeflerinin ulusal bir karbon tarımı yönetmeliğinin geliştirilmesi için temel oluşturduğu Türkiye açısından da örnek teşkil etme potansiyeline sahiptir. Halihazırda Türkiye'de karbon tarımı için ulusal düzeyde bir karbon sertifikasyonu yönetmeliği bulunmamaktadır. AB'nin bu çerçevesi, Türkiye'nin kendi koşullarına uygun bir yaklaşım geliştirmesi için değerli bir rehber ve tetikleyici etken olabilir. Ancak, arazi mülkiyetiyle ilgili sorunlar ve ormanlık alanlarda özgün katkı gibi ülkeye özgü zorlukların giderilmesi gerekmektedir. Geliştirilecek sistem hem sade hem de sağlam yapıda olmalı; güvenilirlik sağlamalı ve yatırım çekebilmelidir. Başlangıçta gönüllü olacak şekilde tasarlansa da yönetmelik ileride bir düzenlenmiş piyasaya geçişi de göz önünde bulundurmalıdır. Ayrıca, arazi kullanma sektörüne özel, 2030 ve sonrasına yönelik, iyi tanımlanmış bir azaltım hedefi belirlenmesi, etkin uygulamayı teşvik edecek önemli bir unsur olabilir.
Anahtar kelimeler: Karbon tarımı, AB sınırda karbon düzenlemesi, Yeşil taksonomi, Arazi kullanma sektörü, Net sıfır

1. Introduction

The urgent need to limit or reduce GHG emissions, often emphasized by the IPCC reports, is prompting governments to create new regulations. The Green Deal (GD), launched in September 2020 (Ruiz et al., 2023), has been a comprehensive response by the EU to the climate crisis. The 55% reduction target for 2030 compared with 1990 levels (Rivas et al., 2021), also called the "Fit for 55 package (FF55)", is expected to enable the EU to reach climate neutrality by 2050 (Pisoni et al., 2023). As part of the GD and to indicate its intentions on the land sector, the EU adopted its third Forest Strategy in 2021 (Aggestam and Giurca, 2021). This forest strategy underlines the roles of biogenic removals, biodiversity protection, and forest restoration. Since then, the EU has incorporated forestry into its plans to achieve the targets of its environmental policies (Bottaro et.al., 2024). In 2023, with Regulation (EU) 2023/839, the EU set a target of 310 million tons of CO2 equivalent of net Land sector removals for 2030.

Based on the aforementioned policy framework, the EU aims to utilize land sector credits to achieve its climate targets. However, considering that 60% of Europe's forest area is owned and managed by small-scale owners with an average land size of 13 hectares (Westin et al., 2023), the key to success lies in influencing their management approaches with incentives. The new EU Carbon Removals Certification Framework aims to promote the wider adoption of climate-

[a] İstanbul University-Cerrahpasa, Faculty of Forest, Department of Forestry Engineering, İstanbul, Türkiye
[*] **Corresponding author** (İletişim yazarı): serengil@iuc.edu.tr
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smart forest management practices and other land-based practices that can generate carbon credits in a sustainable and additional manner. Land sector mitigation actions can also enhance adaptation if the results of both sides are incentivized (Buck et al., 2020).

The EU 2030 Strategy outlines a plan to plant 3 billion trees in the European Union by 2030. This initiative aims to help Europe's forests adapt to the new conditions and weather extremes brought about by climate change, which involves significant uncertainty (Fleckenstein, 2024). However, some critics raise concerns about the potential consequences of afforestation efforts (Pérez-Gómez et al., 2024).

Furthermore, with the CBAM, the EU will start applying carbon taxes in 2026 on energy-intensive sectors of Türkiye, such as steel, aluminum, and cement production. The regulation is estimated to have significant impacts on these industries (Amendola, 2025). While coverage may widen and diversify in the coming years, this is likely to build further stress and uncertainties for Türkiye's economy (Celik et al., 2025).

Türkiye has embraced several climate change mitigation strategies over the past decade and is now in the phase of initiation and implementation. Key developments include the setting of the 2030 emission reduction target, the Long-Term Strategy (LTS), the Nationally Determined Contribution (NDC), and the net-zero target for 2053. A net-zero emission target is achieved when the amount of greenhouse gas (GHG) released into the atmosphere is neutralized by carbon sequestration, i.e., by removing carbon from the atmosphere, or through offsetting measures, which typically involve supporting biogenic GHG mitigation projects (Yang et al., 2025). In addition to these efforts, framework legislation for a National Emissions Trading System (ETS) and a Carbon Border Adjustment Mechanism (CBAM) have recently been adopted as part of the National Climate Law.

In its NDC, Türkiye noted that it will consider trading carbon credits under the Article 6[1] framework but has not yet developed a strategy for which sectors to engage. Land sector[2] projects may offer potential for selling or buying credits in international markets under Article 6.

Türkiye has started developing its national legislation on carbon pricing; however, it has limited experience, constrained financial resources, and a reliance on energy-intensive industries for economic growth (Ranja, 2024). With the aforementioned upcoming regulations, a rapidly growing demand for carbon credits may emerge among private sector companies. The companies may undertake all carbon abatement measures that can be costly, or they can purchase emission permits from the EU or the upcoming national ETS. A third option is the use of land sector voluntary carbon credits as green bonds (Lee et al., 2023). A land-sector based GHG mitigation mechanism may be well-positioned to respond to the upcoming demand. The sequestration projects are typically grouped under carbon farming (Hackfort and Haas, 2025).

Türkiye recently launched its 2030 Climate Action Plan (CCAP), which prioritizes the restoration and balanced utilization of forest resources. There is no sectoral target for the land sectors, but there are ambitious mitigation targets such as:

Achieving negative net emissions in cropland and grassland categories – The cropland and grasslands are net emissions according to the most recent GHG inventory (NID Türkiye, 2025). The objective is to convert these two large land categories into net removals (negative emissions).

Increasing the annual net sequestration (gains-losses) in the forest category (forest management) each year in the period 2025-2030 compared to the previous year. This action ensures that removals in the 2025-2030 period will continuously increase.

The Long-Term Strategy (LTS) of Türkiye also aims to increase removals by investing in restoration. The ultimate objective of CCAP and LTS is to increase carbon removals required for climate neutrality within the next three decades. A national carbon farming regulation may help financially support the restoration of non-productive ecosystems.

Land practices are diverse due to socio-economic and cultural attributes worldwide, particularly in the Middle East and the Mediterranean region, where Türkiye is located. Therefore, the carbon farming framework must be tailored for the country or region to be appropriately implemented. In an analysis by Gonzales-Gemio and Sanz-Martín (2025), farmers were found to be resistant to carbon farming practices due to both technical complexities and social and economic reasons. The authors suggested demonstration sites and training to overcome the challenges. The concerns over carbon leakage and competitive advantage are also mentioned by Van Hoof (2023) as barriers, suggesting that carbon farming policies be embedded into the broader food system transformation.

In this paper, we tried to identify, put forward, and discuss EU-based and national initiatives related to Land sector to draw conclusions on the policy board. We prioritized CRCF and its applicability to Türkiye's conditions. To provide a meaningful picture of land sector activities we also performed some draft calculations for selected land sector mitigation activities.

2. Material and Methods

To discuss the EU CRCF regulation from Türkiye's perspective and the potential for adoption, we first briefly explained the general approach of the CRCF regulation, then the differences between the EU and Türkiye in the sector, and finally, focused on Türkiye's land sector. The methodology followed a reductive approach, moving from a general view to specific land sector activities.

We benefited from the latest scientific and political papers to explain EU CRCF regulation, the Land sectors of the EU and Türkiye, and Türkiye's strategies. To analyze the entire

[1] Article 6 of the Paris Agreement establishes the foundation for international carbon markets by allowing Parties to cooperate to achieve their nationally determined contributions (NDCs) [Cook et al., 2024].

[2] In this paper, the term *"land sector"* is used for simplicity and broadly refers to agriculture, forestry, and other types of land use. However, in official UNFCCC reporting, *Agriculture* and *LULUCF* (Land Use, Land-Use Change, and Forestry) are reported as separate sectors. LULUCF greenhouse gas (GHG) accounting includes all land use types—such as forest land, cropland, grassland, wetlands, settlements, and other lands—while *Agriculture* covers non-CO_2 emissions from agricultural practices (e.g., methane and nitrous oxide from livestock and fertilization). In contrast, the IPCC Guidelines combine these two categories under a single term: *AFOLU* (Agriculture, Forestry, and Other Land Use), to better reflect the interconnections and interactions among them.

sector and individual activities, we utilized Türkiye's national GHG calculations and scientific analyses.

In this study, we also conducted an indicative comparison of some common land-based mitigation activities in terms of their carbon benefits. To do that, we;

i. Identified the activities with potential for Türkiye,
ii. Estimated the potential area for each activity,
iii. Calculated baseline carbon stocks for each activity type,
iv. Calculated a carbon stock for each activity for three-time intervals: 0-1 year representing the first-year emissions and removals due to conversion; 2-18 year representing the early ages of the new ecosystem; 21-100 years to represent the whole period of activity implementation and capitalization.
v. Calculated the net carbon benefit as the difference of project implementation and reference scenario.

To calculate the carbon stock changes, we used the IPCC (2006) and IPCC (2019) AFOLU Guidance as well as the National GHG Report coefficients from NID Türkiye (NID, 2025)[3].

3. Results and discussions

3.1. EU CRCF (Carbon Removals Certification Framework) regulation

Since 2019, the EU has materialized its Green Deal[4] objectives with solid sector-specific steps. The Union adopted Soil Strategy 2030[5] in 2021 to achieve land-based climate neutrality until 2035 by enhancing soil organic carbon (SOC) stocks. The Strategy included plans for a legislative proposal on carbon removal certification (Paul et al., 2023). The EU Forest[6] and Biodiversity[7] Strategies 2030 aimed to reverse degradation and protect and restore ecosystems.

The EU established the CRCF to support its goal of climate neutrality by 2050 by ensuring that carbon removals are high-quality, verifiable, and sustainable. With the adoption of the Carbon Removal Certification Framework (CRCF) in 2024, the EU established a voluntary framework for carbon removal certification, which includes criteria for certifying removals, rules governing the certification process, and recognition of certification schemes.

The CRCF Regulation covers the following sets of activities:

- Carbon removals – Capturing CO2 from the atmosphere and storing it in reservoirs such as forests, soil, or other products for the long term or even underground geological formations.
- Carbon farming - Practices implemented by landowners (farmers and foresters) to enhance carbon sequestration and storage in forests and soils.

The CRCF enhances the EU's efforts in the agricultural sector. The framework will, of course, influence the neighboring countries like Türkiye.

The European Parliament adopted the provisional CRCF regulation on April 10, 2024. The regulation may further evolve in the coming years due to concerns about comparability, transparency, and investability (Štrubelj et al.,2023). The general concerns are listed below (Scherger, 2024; Scherger and Sharma, 2024).

i. Risk of undermining efforts to cut emissions - The framework will allow polluters to use certificates as carbon credits to offset emissions, potentially delaying necessary emissions cuts. Thus, the markets or industries that can utilize these credits must be identified so that the CRCF supplements, rather than replaces, existing mitigation efforts.
ii. A wide range of activities – A large set of activities may lead to an ample supply of carbon credits that might drive down the price of credits and further delay climate action.
iii. Greenwashing risk – Although regulations exist for this issue in the EU, there is still a risk that climate claims may be based on offsetting.
iv. Uncertainty on safeguards – The sector-specific issues include permanence, additionality (i.e., an activity would not have occurred otherwise), co-benefits such as biodiversity, soil, and water protection, and double counting, among others.

3.2. Major differences between the EU and Türkiye in the land sector

Land use in Türkiye and the EU differs significantly due to variations in legal frameworks, historical land management practices, and institutional structures. In Türkiye, forests are predominantly state-owned, with strict regulations governing their use and conservation under the authority of the General Directorate of Forestry (Başkent, 2021; Baskent, 2023). Private forest ownership is limited, unlike in many EU countries, where private ownership is more common, and sustainable forest management is often incentivized through subsidies and certification schemes (Lier et al. 2021). Agricultural land use in Türkiye is shaped by a mix of smallholder farming and large-scale commercial agriculture, with government support programs focusing on productivity and rural development (Demirdöğen et al., 2016). In contrast, EU agricultural policies are heavily influenced by the Common Agricultural Policy (CAP), which provides subsidies, promotes sustainable farming practices, and enforces strict environmental regulations (Röder et al., 2024). Additionally, land consolidation efforts in Türkiye continue to address issues of fragmented agricultural plots, whereas many EU countries have long-established policies for land consolidation and rural development (Pace et al., 2025). Urban land use also varies, with Türkiye experiencing rapid urbanization and infrastructure expansion, often leading to conflicts between agricultural, forest, and urban areas (Çeler et al., 2023), whereas EU urban planning is generally

[3] https://unfccc.int/documents/646494
[4] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52019DC0640
[5] https://environment.ec.europa.eu/publications/eu-soil-strategy-2030_en
[6] https://commission.europa.eu/document/cf3294e1-8358-4c93-8de4-3e1503b95201_en
[7] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52020DC0380

more regulated, with stronger zoning laws and environmental considerations (Peters and Reisch, 2025).

Türkiye and the EU have distinct positions within the UN Framework Convention on Climate Change (UNFCCC), shaped by their economic status, historical emissions, and policy commitments (Ari, 2013; Wang et al., 2024). The EU is a leading actor in global climate policy, committed to ambitious mitigation and adaptation targets. As a bloc, it has pledged to achieve net-zero greenhouse gas (GHG) emissions by 2050 and has set binding targets under the European Green Deal, including a 55% reduction in emissions by 2030 compared to 1990 levels (Olczyk and Kuc-Czarnecka, 2025).

Türkiye, on the other hand, has a unique position within the UNFCCC. Initially classified as an Annex I (developed) country without access to climate finance mechanisms for developing nations, Türkiye has long sought special treatment due to its developing economy (Ari, 2013). In 2021, after years of negotiations, Türkiye ratified the Paris Agreement and was reclassified as eligible for specific climate finance opportunities. However, it still does not benefit from the full range of financial and technical support available to developing countries. Türkiye has committed to achieving net zero by 2053 and has updated its Nationally Determined Contributions (NDCs), aiming to reduce emissions by 41% by 2030 compared to a business-as-usual scenario[8]. While the EU's climate policies are deeply integrated into its governance and economic strategies, Türkiye's approach remains more flexible, balancing economic growth with climate commitments while seeking greater financial and technological support for its transition.

Türkiye is a developing country with a high population and economic growth rate. The country's development policies focus on increasing per capita income and reducing poverty. Climate mitigation is a significant target in the paper but has not yet been included in the development plans and projections. For example, it is unclear how much emission reduction is targeted for a net-zero. There are a limited number of scientific (Serengil and Papageorgiou, 2023) and technical assessments; however, no government policy has been established yet.

The mitigation objectives of Türkiye have not been established well technically and scientifically. The background modeling results for the net-zero target by 2030 are not transparent. The 2030 target of a 41 percent reduction compared to BAU is not in line with a 2053 net-zero target. There will be mitigation efforts to limit emissions, but the emissions are projected to increase by 2030, peak in 2038, and start reducing to net zero in 15 years. The technical background of this down curb is not transparent. Türkiye's long-term plans, such as the 12th National Development Plan 2024 2028, lack any projection or estimation. On the other hand, EU climate policy documents outline the land-based (Land Use, Land Use Change, and Forestry) GHG reduction targets, which are regularly updated with new policies based on technical data and projections. Consequently, in the case of Türkiye, there is an ambitious net-zero target; however, the road to achieving this objective is neither outlined in the national policy documents nor technically documented.

Finally, Türkiye does not have an Emission Trading System yet and thus lacks experience in GHG management and trade. In contrast, the EU has an emission trading system and experience in carbon offsetting.

3.3. Land sector mitigation strategy of Türkiye

Türkiye recently developed and submitted its climate change policy documents to the UNFCCC. The NDC[9] was submitted in 2023, and the CCAP and LTS were submitted in 2024. In its NDC, Türkiye mentioned that it will invest in afforestation, forest management, and restoration to increase its removals in the forest category. However, these activities have always been a part of Türkiye's climate efforts and have frequently been mentioned in the UNFCCC process. The NDC or LTS did not contain much on the additionality side. However, the CCAP provided a precise mechanism for land sector mitigation strategies. As explained further below, the land sector mitigation strategy prioritizes circularity and high added value for a more balanced land and forest management. The R&D will enhance circularity and high-value production to reduce harvests in forests. The restoration and protection efforts will further increase biomass, allowing for more carbon storage in forest products and on the land. Consequently, higher biomass carbon stocks will result in greater carbon removals.

In their 2030 action plans, the EU and Türkiye prioritized restoration as the main mitigation policy item. In CCAP[10], the mitigation framework is established on a strategy that will reduce production in forests by improving the efficiency of forest products industries (Figure 1).

The central Strategy in Türkiye's CCAP[11] is "Strategy S1: Increasing GHG sequestration annually by protecting and sustainably managing ecosystems and increasing sink areas and reducing ecosystem-based emissions" complemented by circularity (S2) and Research and Development (S3).

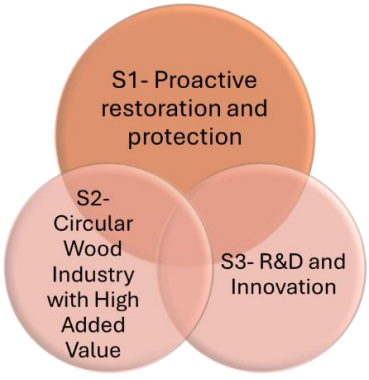

Figure 1. The LULUCF Sector Backbone Components in 2030 CCAP of Türkiye

[8]https://unfccc.int/sites/default/files/NDC/2023-04/TÜRKİYE_UPDATED%201st%20NDC_EN.pdf
[9]https://unfccc.int/sites/default/files/NDC/2023-04/TÜRKİYE_UPDATED%201st%20NDC_EN.pdf
[10]https://iklim.gov.tr/db/english/icerikler/files/CLIMATE%20CHANGE%20MITIGATION%20STRATEGY%20AND%20ACTION%20PLAN%20_EN.pdf
[11] https://iklim.gov.tr/eylem-planlari-i-19

The restoration of any ecosystem can be passive, active, costly, or inexpensive, depending on factors such as ecosystem type, level of degradation, and the planned intensity of intervention(McBride et al., 2010). According to the Land Gap Report (2023), countries have committed 1 billion hectares of land for carbon removal, with 50% focused on restoration, as part of their climate mitigation pledges (Dooley et al.,2022).

The World Bank Climate Change and Development Report (CCDR)[12] suggested a pathway for Türkiye to achieve its 2053 carbon neutrality target, which included an extensive restoration plan (Serengil and Papageorgiou, 2023). The authors provided long-term restoration targets that can significantly enhance the current 10-12 percent offset percentage of forests.

The below-restoration-focused carbon farming actions have been included in the 2030 Action Plan and Long-Term Strategy of Türkiye:

- A basin-scale, proactive, result-based afforestation/ reforestation roadmap to be prepared and implemented,
- Potential afforestation/reforestation lands are determined by using state-of-the-art remote sensing technologies,
- Mechanisms to incentivize the restoration of riparian ecosystems in croplands, grasslands, and wetlands are established.
- Climate-friendly agricultural practices, such as olive plantations, poplars, and orchards, are incentivized both technically and financially.
- Afforestation of abandoned croplands with fast-growing tree species,
- Application and scaling up of the nature-based solutions (NBSs) at headwaters of the watersheds,
- An action plan to be developed for grassland restoration for 2025-38,
- The climate-friendly agricultural practices are incentivized for 2025-38 to increase soil C stocks,
- Good practices to improve soil C stocks are supported and scaled up in all land classes,
- Restoration of wetlands,
- Support blue carbon projects in sea and coastal areas.

The Action Plan supports all ecosystem-based C farming practices in all land use types and suggests establishing new mechanisms to incentivize them.

3.4. GHG Mitigation Potential of Türkiye

In Türkiye's GHG inventory, forestland is the primary category of carbon removal in the LULUCF sector. Other land uses (cropland, grassland, wetland, settlement, otherland) have limited removal rates and net emissions (Figure 2). Considering that forests are publicly owned in Türkiye, there is a limited amount of land available for the private sector to establish a land-based GHG reduction project.

A carbon certification system may incentivize especially small-sized farms and enhance the quality of products. Grasslands cover a wide area in Türkiye, but their potential for removing GHGs is relatively low. In grasslands, the only carbon pool that can be enhanced is the soil, and this is a slow process for building carbon stocks. Other environmental benefits can also be considered, such as water conservation and soil protection. The details of potential activities are discussed below.

Harvested wood products (HWP) constitute a significant portion of the Land sector of Türkiye. Therefore, long-term storage of carbon in wood products should be emphasized either as an activity or a component in accounting.

The Land sector removals accounted for -69.24 Mt CO2eq, dominated by forestlands with 55.28 Mt CO2eq, according to the most recent GHG inventory. The amount offsets only 12.5 percent of the national emissions. Based on this gap for net zero, we anticipate that Türkiye might want to use the land sector removals primarily for its own NDC targets. On the other hand, the importation of timber may help enhance its land sector removals, considering that the "production approach" is used in HWP (Harvested Wood Products) calculations.

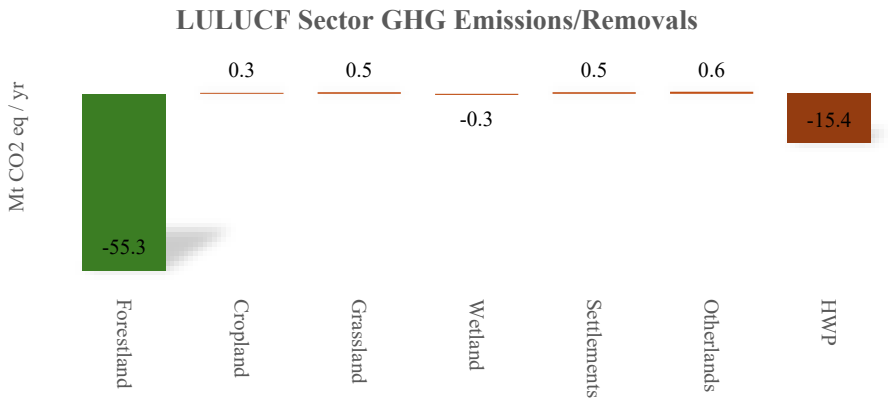

Figure 2. The share of LULUCF sector categories in the 2025 GHG inventory of Türkiye for the year 2023 (NID Türkiye, 2025)

[12] https://openknowledge.worldbank.org/entities/publication/01826a0c-059f-5a0c-91b7-2a6b8ec5de2f

3.5. Potential carbon removal activities in Türkiye

Land sector mitigation activities play a vital role in reducing GHG emissions while providing benefits across other sectors. Afforestation and reforestation enhance carbon sequestration by converting non-forest lands into forests, while reducing deforestation prevents emissions from land-use change and maintains ecosystem services. Range restoration enhances soil health and vegetation cover in degraded grasslands, thereby increasing carbon storage and reducing soil erosion. These mitigation actions also create important connections with other sectors. Sustainable forest management supports harvested wood products (HWP), which store carbon over extended periods and serve as substitutes for emissions-intensive materials like steel and concrete in construction. Additionally, bioenergy from sustainably managed forests can replace fossil fuels in the energy sector, reducing overall emissions. By integrating land-based mitigation with cross-sectoral strategies, such as promoting wood-based alternatives and enhancing soil carbon storage, these efforts contribute to long-term climate resilience and sustainable resource use (Figure 3).

Land Use, Land-Use Change, and Forestry (LULUCF) and the agriculture sector are closely linked under the UNFCCC framework, as both play a critical role in climate change mitigation and adaptation. The carbon stock changes in agricultural land are reported under LULUCF, while non-CO2 emissions are reported under the Agriculture sector. The Koronivia Joint Work on Agriculture (KJWA)[13] under the UNFCCC highlights the need for integrated approaches that address both sectors, emphasizing sustainable land use, soil carbon sequestration, and climate-resilient agricultural practices.

Below, we discussed the eligibility and potential of some activities that can be considered for C farming in Türkiye.

3.5.1. Afforestation of abandoned croplands

In Türkiye and other Mediterranean countries, rural population decline and shrinking cropland areas are critical issues that intersect with land-sector mitigation and broader sustainability challenges. Over the past decades, migration from rural to urban areas has accelerated due to economic shifts, mechanization in agriculture, limited employment opportunities, and the impacts of climate change, such as prolonged droughts and soil degradation. As a result, many agricultural lands, particularly in marginal or semi-arid regions, are abandoned or converted to other uses, leading to a decrease in cropland areas (Dincer, 2023). This trend poses risks to food security, traditional farming practices, and rural economies while also creating both challenges and opportunities for land-based mitigation. The amount of cropland moved out of production has reached 1 Mha in the country (Özkan, 2019).

On the one hand, abandoned croplands may undergo natural regeneration or be repurposed for afforestation and range restoration, contributing to increased carbon sequestration and ecosystem recovery. At the same time, reduced agricultural activity can lead to land degradation if soil is left unmanaged, making it vulnerable to erosion, desertification, and wildfires. Furthermore, the decline in rural populations reduces the local workforce available for sustainable land management, including wildfire prevention, sustainable grazing, and reforestation efforts.

Reforestation or afforestation of former croplands can substantially increase biomass and soil carbon stocks because forests take up and store more carbon per unit of land area than non-forested ecosystems (Yang et al., 2020). The restoration of degraded or abandoned croplands to mitigate climate change has been a well-established approach with a high potential even in middle-income countries. The CCAP of Türkiye has several actions related to afforestation of croplands with specific emphasis on the basin scale. The riparian restoration in croplands and plantations of woody croplands with orchards or fast-growing species has also been emphasized in the CCAP. Afforestation of cropland replenishes the existing soil and biomass carbon pools and creates litter and deadwood pools with a later HWP pool. According to the GHG inventory of Türkiye, a forestland can accumulate more than 50 tC/ha, while an annual cropland accumulates around 5 tC/ha. The amounts vary according to the ecozone, and the biomass produced. With added litter, deadwood, and enlarged belowground C pools, the total accumulation may rise up to or over 100 tC/ha in a forest area, while carbon stocks in a cropland are assumed to stabilize around 5 tC/ha. With the afforestation of croplands, there is a potential carbon stock increase of up to 100 tC/ha in productive sites during a project lifetime of 50-100 years based on the species used and management. The potential for this activity is vast; however, the government prefers to keep these lands under agricultural use rather than forest.

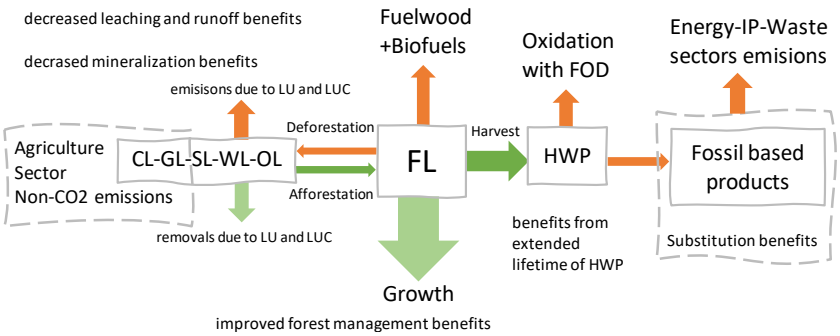

Figure 3. Mitigation actions in the land use sector and their connections

[13] https://openknowledge.fao.org/server/api/core/bitstreams/4d2b392d-1c13-4d19-b134-29b931243afa/content

3.5.2. Improved forest management (IFM)

Improved Forest Management (IFM) refers to a set of forestry practices designed to increase carbon sequestration, reduce emissions, and enhance the overall resilience of forest ecosystems (Ezquerro et al., 2024). It is widely recognized as a significant carbon mitigation activity because it optimizes forest growth, carbon storage, and ecosystem functions while maintaining or even increasing the economic value of forests (Sevillano et al., 2025). IFM can be implemented in both natural forests and plantation forests, and it plays a critical role in climate change mitigation under various carbon accounting frameworks, including voluntary and compliance carbon markets.

By increasing carbon sequestration and reducing emissions from forest degradation, IFM aligns with global climate targets under the Paris Agreement and is an essential strategy in Nature-based Solutions (NbS) for climate change mitigation. However, effective implementation requires strong governance, robust monitoring systems, and incentives to strike a balance between carbon benefits and economic and ecological sustainability.

IFM projects are eligible for carbon offset programs, where landowners can generate carbon credits by demonstrating measurable carbon sequestration benefits. Additionally, forests managed under IFM provide long-lived harvested wood products (HWP) that store carbon and serve as substitutes for emissions-intensive materials like steel and concrete in the construction sector. Sustainably sourced biomass from IFM can also replace fossil fuels in the energy sector, further contributing to emissions reductions. IFM uses strategies such as:

- Extending Rotation Lengths
- Selective Logging & Reduced Impact Logging (RIL)
- Enhanced Forest Productivity
- Fire Management & Prevention
- Conserving High Carbon Stock Areas
- Improving Soil Carbon Sequestration

3.5.3. Climate-friendly agricultural practices

Agriculture sector emissions in Türkiye have increased by around 36 percent over the last decade, with the ratio of total emissions rising from 11 to 14 percent (Yalcinkaya, 2024). The author estimates the manure management GHG mitigation potential to be around 6 percent. Bioenergy offers a mitigation potential of up to 96.6 Mt CO2e by 2050 according to Ersoy and Ugurlu (2024). The potential of climate-friendly agricultural practices has not been thoroughly scientifically analyzed on a national scale; however, they may also play a crucial role in mitigating greenhouse gas emissions and enhancing soil carbon sequestration (Savari et al., 2025; Kumar et al., 2025), making them highly relevant for carbon certification programs. These practices include conservation agriculture, which minimizes soil disturbance through the use of no-till or reduced-tillage systems, thereby preserving soil organic carbon and improving soil structure (Xiao et al., 2025). Cover cropping and crop rotation enhance soil fertility, increase carbon sequestration, and reduce the need for synthetic fertilizers, thereby lowering greenhouse gas emissions. Agroforestry, which integrates trees into agricultural landscapes, sequesters carbon while providing additional ecosystem benefits such as erosion control and biodiversity conservation. Regenerative grazing and silva-pasture optimize livestock management by preventing overgrazing, enhancing plant biomass, and improving soil carbon retention (Morales-Ruiz et al., 2025).

Additionally, biochar application enhances soil carbon stability, locking carbon in a solid form for extended periods (He et al., 2025). Many of these practices are eligible for carbon certification programs, allowing farmers to generate carbon credits that can be sold in voluntary or compliance carbon markets. By aligning agricultural activities with carbon certification frameworks, such as the Verra (VCS), Gold Standard, or Climate Action Reserve, these practices contribute to global climate goals while creating financial incentives for sustainable land management practices.

Long-term data are required for analyzing GHG emissions and removals in agricultural practices (Moreno-Ramón et al., 2024). The volume and quality of research in the field have increased drastically in recent years; however, Türkiye still needs to improve its data and technical background to develop and sustain a robust assessment methodology.

There is good potential for these practices. The per-hectare mitigation potential is not as high as that of IFM or AR, but the potential area for these activities is larger.

Projects Involving Substitution Benefits

The construction sector is a significant part of the Turkish economy, and it has a considerable GHG mitigation potential, as the sector is growing at a rapid pace. According to Sarıca et al. (2023), the building sector's CO2 emissions are expected to double by 2050 compared to 2015 levels. Projects that provide emission reductions in the construction sector can be certified with a certification framework like VCS Methodologies for "Use of Hempcrete as a Replacement for Carbon-Positive Building Materials[14]" or "Methodology for Mass Timber Constructions[15]", The methodology provides a framework for quantifying the carbon benefits of using wood-based products as substitutes for carbon-intensive materials (e.g., concrete, steel, and plastics) in construction and other applications. It is not possible to estimate the mitigation potential for this activity, but it must be substantial, considering the high emission intensity of substituted materials (such as iron, steel, and plastic) and the sector's extensive reach.

3.5.4. Mitigation Potentials of the Selected Activities

Three main parameters can evaluate the mitigation potential of a Land sector activity (intervention):

i. The per area removal or emission reduction rate,
ii. The potentially eligible area for intervention
iii. The cost of the intervention.

[14] https://verra.org/methodologies/methodology-for-the-reduction-of-ghg-emissions-in-building-material-production-through-the-use-of-carbon-negative-hempcrete-as-a-replacement-for-carbon-positive-building-materials/

[15] https://verra.org/methodologies/methodology-for-mass-timber-constructions/

In this paper, we provide a general potential eligible area based on current forestry figures and per-area removal rates. The harvest and other emissions have not been taken into account. The activities in the sector must undergo a thorough cost-benefit analysis, and the potential eligible area must be determined through GIS-based regional assessments.

In this evaluation, we considered:

Cropland afforestation is a potential activity, given that approximately 1 Million Hectares of cropland are currently abandoned or unused in production. Despite some recent government policies and measures, we anticipate that agricultural land use will continue to shrink in the coming decades (Figure 4). Thus, we consider the potential for this mitigation activity to be realistic and potentially increase in the coming decades.

The conversion from cropland to forestland (afforestation) results in net emissions in the year of conversion, as existing biomass is removed and seedlings are planted. The IPCC default for biomass in croplands is 5 tC/ha. On the other hand, the biomass growth for new afforestation sites is assumed to be 0.34 tC/ha, according to Türkiye's national GHG inventory (NID Türkiye, 2025). Therefore, the conversion yields a net emission of 4.66 tC/ha (= 5 - 0.34) for the year of conversion, followed by net removals of 0.34 tC/ha during the first 20 years. The biomass growth is approximately 4 tC/ha on average for forests over 20 years of age, according to Türkiye's national GHG inventory. The growth rate changes annually based on the age class of the national forests. The most recent figures can be found in the GDF annual activity reports[16].

The Improved Forest Management (IFM) has been evaluated under two sub-activities: Improved carbon sequestration through management practices and conversion to fast-growing species. In the first case, the enhanced growth and carbon stock will remain low because the effect of silvicultural practices on growth is limited (Walter et al., 2025).

IFM is one of the major activities for land sector removals because it can be implemented in both public and private lands. The additionality and sustainability can be ensured and documented with ease. On public forests, this can be achieved by shifting the management objective from wood production to carbon sequestration. This may require the reallocation of managed and protected forest lands and an intensification of management. Nevertheless, thanks to new advancements in remote sensing, AI, and digitalization, we may already anticipate improvements in production (Bastos et al., 2024). The additional carbon sequestered can be used to reach the national targets. In private lands, the major issue is the size of the project area.

For the first type of IFM, the difference between baseline and improved conditions can be calculated and given as the net carbon benefit. The average growth rate of the forests ranges between 3.55 m^3/ha/yr for productive forests (GDF Activity Report, 2024), corresponding to a carbon stock increase of 3-4 tCO_2eq/ha/yr based on productivity, species type, and coefficients used. Consequently, whether private or public, an increased growth rate of 1 m^3/ha/year may yield an additional 15-20 Mt CO_2e of negative emissions per year in Türkiye, which has a forest area of over 23 Mha.

In the case of agroforestry, we established a baseline scenario involving an annual cropland where carbon stock change is zero, meaning that there is no woody biomass growth. The cropland in the project scenario is not abandoned but complemented with trees, with 202 stems per hectare, and a 30-year rotation period. We used the IPCC default emission factor of 0.91 tC/ha in this scenario. The carbon accumulation reaches 91 tC/ha by the end of the 100 years.

The grassland restoration is calculated based on the assumption that a degraded grassland has been restored. In the baseline scenario, there is no increase in carbon stocks. In the restored grassland scenario, the grassland reaches a maximum of 6.1 tC/ha and then reaches an equilibrium.

It should be noted that these calculations are indicative, covering just the removals, not the emissions. The emission calculations are complicated (i.e., harvest products can be reused, stored long-term, or burned) and variable according to site properties.

When the activities are assessed as a group, it can be seen that IFM with fast-growing species may potentially provide the highest rate of carbon removal, followed by afforestation of croplands. However, the species conversion generally comes with an increased risk of disturbances (Özkan and Serengil, 2025), and the highly productive sites eligible for this activity are limited. Agroforestry and grassland restoration need to be implemented on a large scale to achieve a high rate of carbon sequestration.

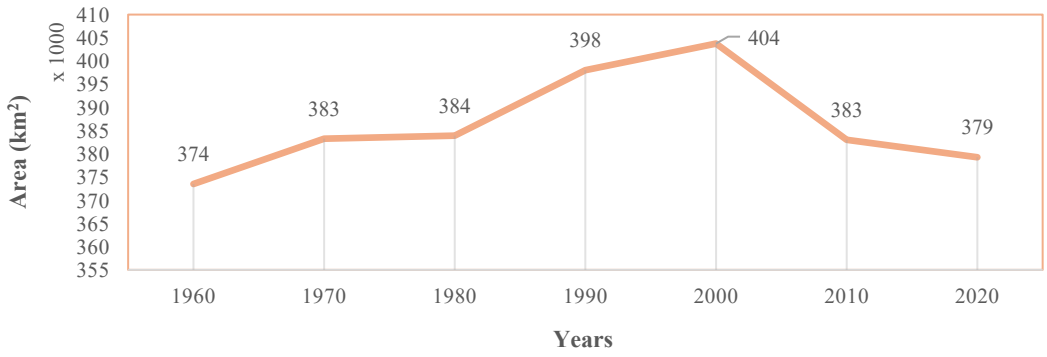

Figure 4. The agricultural land use of Türkiye (Worldbank Data Portal, www.data.worldbank.org)

[16] https://www.ogm.gov.tr/tr/faaliyet-raporu

Mitigation Activities	Area Potential	Period			100yrs Cumulative	Annual Average
	ha	0-1 yrs (tC/ha yr)	2-20 yrs (tC/ha yr)	21-100 yrs (tC/ha yr)	tC/ha	tC/ha yr
Cropland Afforestation	1M+					
Baseline		0	0	0	0	0
Project		-4.661	0.34	4	331.121	3.31
Net C benefit					331.121	3.31
Improved Forest Management						
Baseline		4	4	4	400	4
Project 1 (ImprovedPractices)	1M+	4	5	5	499	4.99
Net C benefit-Project1					99	0.99
Project 2 (FastGrowth)	0.3M+	-50	4	10	826	8.26
Net C benefit-Project2					426	4.26
Agroforestry	1M+					
Baseline		0	0	0	0	0
Project		0.91	0.91	0.91	91	0.91
Net C benefit					91	0.91
Grassland Restoration	1M+					
Baseline		0	0	0	0	0
Project		1.6	0.24	0	6.1	0.061
Net C benefit					6.1	0.061

Figure 5. Potential applicable area and approximate net carbon benefits (as the difference between the scenarios) of selected C farming practices. Agroforestry gain of 0.91 tC/ha taken from IPCC 2019 Table 5.1 (202 stems per hectare, harvest cycle 30 years). Grassland cumulative C stock of 6.1 tC/ha taken from IPCC 2006 Table 6.4 Temperate Dry Ecozone.

3.6. Institutional and technical aspects

3.6.1. Legal Background

The background legislation to develop a land-based offsetting system is already in place. In July 2025, Türkiye adopted its framework climate law that will guide the follow up technical legislation. In Article 5 of Section 2 of the law, institutions have been assigned responsibilities to enhance and protect biogenic sinks such as:

Article 5: "In order to balance emissions towards achieving the net-zero emission target, measures are taken by relevant institutions and organizations to prevent carbon sink losses in forests, agricultural lands, pastures, and wetlands, and to ensure the protection and enhancement of sink areas and protected areas."

In Article 6: "The sustainable management of sink areas established in non-forest lands within the scope of combating desertification and erosion, as well as afforestation and soil conservation, is ensured in line with the net-zero emission target."

In Article 11: "(1) Offsetting may be permitted in order to meet a portion of the allocation obligations under the ETS (Emissions Trading System) with an equivalent amount of carbon credits. (2) The principles of a national carbon crediting and offsetting system, which generates carbon credits through greenhouse gas emission reduction or removal activities and activities aimed at increasing sink areas, to be used in offsetting processes under the ETS and voluntary commitments, shall be determined by the Presidency. (5) Project owners of domestic projects that have started or will start generating carbon credits under any voluntary carbon market within the country, using national or international standards, are required to register their projects in the carbon credit registry system within the period specified by the Presidency. The Presidency may cooperate with organizations that develop international standards within the scope of this article.

The above-mentioned articles of the law inform us that the Climate Presidency is considering an offsetting system that involves land-based removals.

3.6.2. Institutional arrangements and public support

The EU will establish a centralized registry by December 2028 to publish all certification-related information, including certificates and audit reports. This registry will also track certified carbon removal units to ensure transparency and prevent double-counting.

Under the EU system, to obtain certification, an operator must submit an application to a recognized certification scheme. This application must include an activity plan outlining how the proposed activity complies with the relevant CRCF (Carbon Removal Certification Framework) methodology, as well as a monitoring plan detailing how compliance will be tracked over time. The activity must then be implemented in full accordance with CRCF methodologies.

The project will be subject to independent audits conducted by an accredited certification body, which will verify compliance with the applicable CRCF methodology before certification is granted[17].

Therefore, in addition to the centralized registry, the key actors in the system will include accredited independent certification bodies responsible for verification, transparent certification schemes, and the project developers implementing the carbon removal activities.

[17] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=legissum:4797298

Carbon markets that cover land-based removals enable the financing of climate change mitigation by recognizing ecosystems as natural carbon sinks, capable of removing and storing atmospheric carbon dioxide (Budiharta and Holl, 2025). Carbon credits are generated through a variety of land-based activities, including afforestation/reforestation, improved forest management (IFM), climate-smart agricultural practices, wetland restoration, and the avoidance of deforestation or forest degradation (Roy and Bhan, 2024).

Based on an extensive review, Roy and Bhan (2024) emphasize that the effectiveness and credibility of land-based carbon markets rely on four essential design principles. First, there must be comprehensive governance regimes in place to ensure accountability, transparency, and coordination across institutions. In Türkiye, this calls for enhanced coordination between national ministries, local governments, and regulatory bodies, as well as clear legal frameworks to support carbon market activities.

Second, the system should strengthen oversight in forest carbon accounting, with robust mechanisms to manage risks such as leakage, double-counting, and over-crediting. For Türkiye, improving technical capacity in monitoring and reporting is crucial, alongside developing localized methodologies that reflect the country's diverse forest types and land-use practices.

Third, it is crucial to reduce transaction costs and adapt engagement terms to encourage meaningful participation of local communities, who often face financial and administrative barriers to entry. In Türkiye, many smallholder farmers and forest owners can be hesitant to participate due to the complexity of certification processes and the uncertainty of short-term benefits. Simplifying procedures, providing financial incentives, and delivering targeted capacity-building programs can help overcome these barriers.

Finally, the framework should allow for context-specific flexibility in both temporal and spatial commitments, recognizing the diverse ecological conditions and socio-economic realities that shape land management decisions on the ground. Given Türkiye's varied climate zones and land tenure systems, such flexibility is essential to design carbon farming projects that are locally relevant, socially acceptable, and environmentally sustainable.

By addressing these principles with attention to Türkiye's specific social, institutional, and ecological contexts, land-based carbon markets can become a viable tool to support the country's 2053 net-zero target and align with evolving European policies such as the Carbon Border Adjustment Mechanism (CBAM).

The principle on lowering of transaction costs and public involvement is probably the most important one for Türkiye since the major challenge in voluntary market projects have been the transaction costs and public involvement yet. The authors also mentioned the importance of temporal and spatial flexibilities in the local context. The project developers hesitate especially in case of forestry that requires very long project periods. There are other social issues such as low short-term benefits for farmers and technical complexity. Besides, the carbon farming practices do not fully align with the traditional practices (Gonzales-Gemio and Sanz-Martin, 2025). A strong capacity building, public demonstration and awareness campaign are needed. Living labs and demonstrative farms can be good options for these. According to Gao et al. (2025) co-benefits such as biodiversity is crucial in carbon farming projects and can be enhanced by partnering with conservation organizations to provide technical assistance while Strauss et al. (2024) suggests additional payments for co-benefits created.

Consequently, land-based carbon markets hold significant potential to support climate change mitigation by leveraging ecosystems as natural carbon sinks. However, their success depends on well-designed institutional arrangements that ensure accountability, transparency, and effective engagement with local stakeholders.

In the case of Türkiye, several social and institutional challenges must be addressed. Farmers and landowners may show low levels of social acceptance due to uncertainty around long-term commitments, limited awareness of benefits, or incompatibility with traditional agricultural practices. At the same time, institutional readiness remains uneven—particularly in terms of local governance capacity, monitoring infrastructure, and inter-agency coordination. A lack of clear mandates or streamlined procedures between national and local authorities may further complicate implementation. Overcoming these challenges will require capacity building, incentivized pilot programs, and greater efforts to integrate carbon farming within existing agricultural and land-use frameworks.

To ensure broader success, the perspective on stakeholder involvement must also expand. While national-level policy is key, local governments can play a critical role in land-use planning and community mobilization. The private sector, especially industries with voluntary climate commitments or exposure to EU climate regulations, can contribute by investing in carbon removal projects or purchasing certified credits. In addition, NGOs and civil society organizations can support outreach, training, and third-party verification, thereby helping to improve both credibility and inclusiveness of carbon farming initiatives.

Crucially, the proposed certification framework and land-based strategies offer practical tools to align with Türkiye's 2053 net-zero target and prepare for interaction with the EU's Carbon Border Adjustment Mechanism (CBAM). Developing a transparent and trusted system for quantifying, certifying, and trading carbon removals will be increasingly important as climate-related trade and finance frameworks evolve. Initiatives such as living labs, demonstrative farms, and public-private partnerships can serve as platforms to test, adapt, and scale solutions in a locally relevant way.

4. Conclusions

Carbon markets are useful mechanisms to enhance land sector GHG removals. Furthermore, they are necessary to provide the funds needed to transform land-based mitigation actions. Türkiye should develop a well-tailored market mechanism in the coming years to support its restoration efforts to reach its NDC targets.

Türkiye has set a net-zero emissions target for 2053, which will require both a significant reduction in greenhouse gas emissions and an increase in carbon removals. To achieve this goal, the country is seeking strategies to enhance its biogenic carbon stocks. The new Climate Law (Law No. 7552) introduced offsetting possibilities for corporates through land sector biogenic removals within the framework of the national ETS. One promising approach is carbon farming, which offers a practical pathway to support Türkiye's green transition. Furthermore, the land sector may

provide GHG mitigation opportunities for corporates that will encounter new regulations, such as CBAM and national ETS.

The EU's CRCF, a voluntary certification system, introduces a structured approach to quantifying, verifying, and incentivizing carbon removals and emission reductions in the land sector. Türkiye, with its diverse ecosystems and significant potential for land-based carbon sequestration, stands to benefit from adopting a similar certification framework. However, key differences in land ownership, policy integration, and institutional capacity present challenges. Unlike the EU, Türkiye lacks a national carbon certification system, an emissions trading scheme, and a fully transparent roadmap for achieving its 2053 net-zero target. Nevertheless, its 2030 Climate Action Plan includes promising measures such as afforestation, grassland restoration, and climate-friendly agricultural practices that could form the basis of a domestic carbon farming certification system.

Türkiye may develop its Land sector removals under two main pillars: forest and non-forest. The non-forest component can be subject to carbon farming regulations. This has already been mentioned in Climate Law, Paragraph 11.2.

To effectively implement a carbon certification framework, Türkiye must address several key aspects:

- Policy Alignment – Integrating carbon farming into national climate and development strategies with clear, science-based targets.
- Incentive Mechanisms – Developing financial and technical support systems for farmers and forest owners to adopt carbon-sequestering practices.
- Monitoring & Transparency – Establishing robust MRV (Measurement, Reporting, and Verification) systems to ensure credibility and prevent double-counting.
- Cross-Sectoral Synergies – Linking carbon farming with sustainable forestry, agriculture, and bioeconomy strategies to maximize co-benefits such as biodiversity conservation and rural development.
- To benefit from Article 6 mechanisms, Türkiye must determine the eligible sectors. Based on its strategy for development, Türkiye may consider permitting the trade of Land sector removals. For example, Türkiye may sell energy sector credits and buy Land sector credits from other countries to use in its NDC. These require sectoral and cross-sectoral analyses.

The EU's CRCF serves as a guidance reference, but Türkiye must tailor its approach to local ecological, economic, and governance contexts. Future research should focus on refining carbon accounting methodologies, assessing the economic feasibility of different carbon farming activities, and evaluating the social acceptance of such schemes among stakeholders. By adopting a well-designed certification framework, Türkiye can enhance its climate mitigation efforts while supporting sustainable land management and rural livelihoods.

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