DECARB TRACK

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EU Agri-Food Carbon Footprint Certification and Public Procurement

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Contents

1 Carbon footprint in agrifood sector, scope and purpose

The European Union (EU) agri-food sector is a significant contributor to greenhouse gas (GHG) emissions, accounting for a notable share of the EU's environmental impact. The measurement, reporting, and certification of the carbon footprint (CF) across the food supply chain—from farms to food processing companies—has become a critical tool in driving sustainability.

The European Union (EU) has positioned itself as a global leader in climate and sustainability policy, with agriculture and food processing among the sectors targeted for decarbonization under the **European Green Deal** and **Farm to Fork Strategy**. These sectors are responsible for a substantial share of greenhouse gas (GHG) emissions, making **carbon footprint (CF)** assessment and reduction vital for achieving EU climate neutrality by 2050. As both **farms and food processors** seek to meet regulatory requirements and market expectations, CF quantification has emerged as an indispensable tool for ensuring transparency, compliance, and sustainability.

Considering food's estimated 26% share of global anthropogenic GHG emissions (Figure 1) (Our World in Data, 2025), Figure 2 (Rosa & Gabrielli, 2023), these actions are vital. Holistic mitigation approaches—ranging from soil and crop management to animal husbandry—are essential for aligning agricultural practices with global climate objectives and increasing resilience (Hasukawa et al., 2021; Hristov et al., 2013; Mendenhall & Singer, 2019).

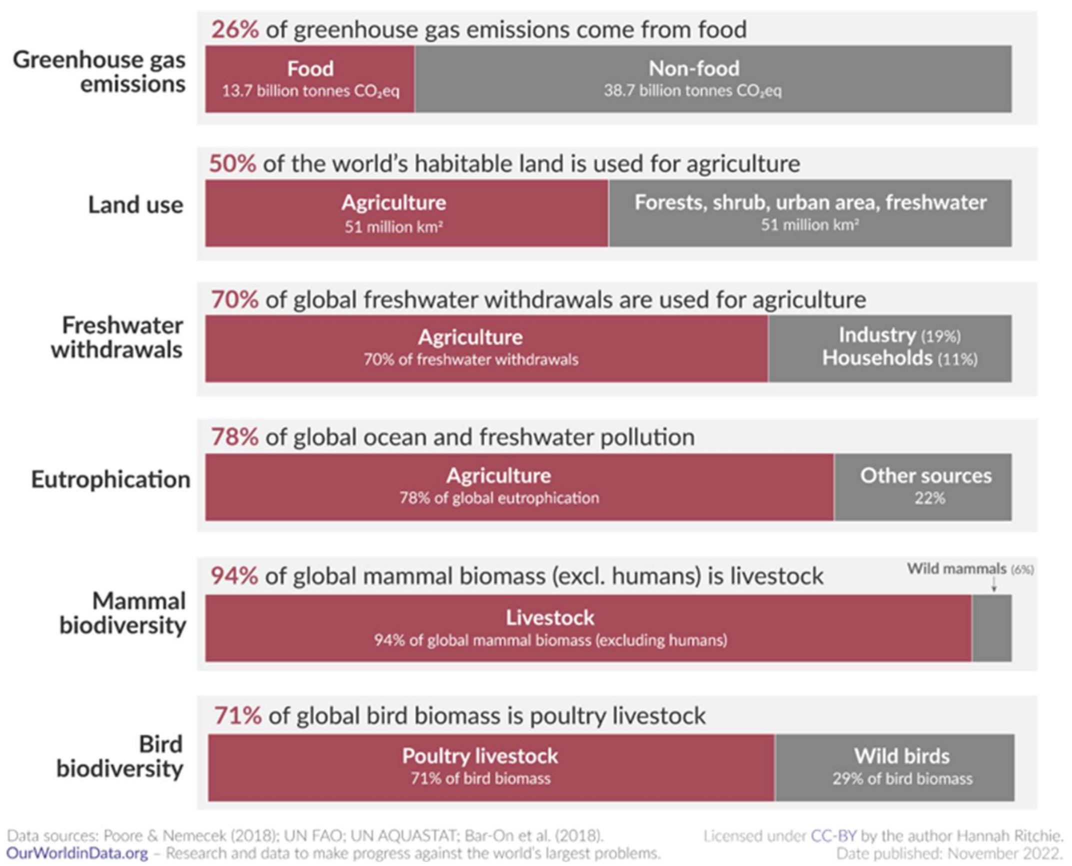

Figure. 1 Environmental impact of the food industry and agriculture, Source: Our World in Data (2025)

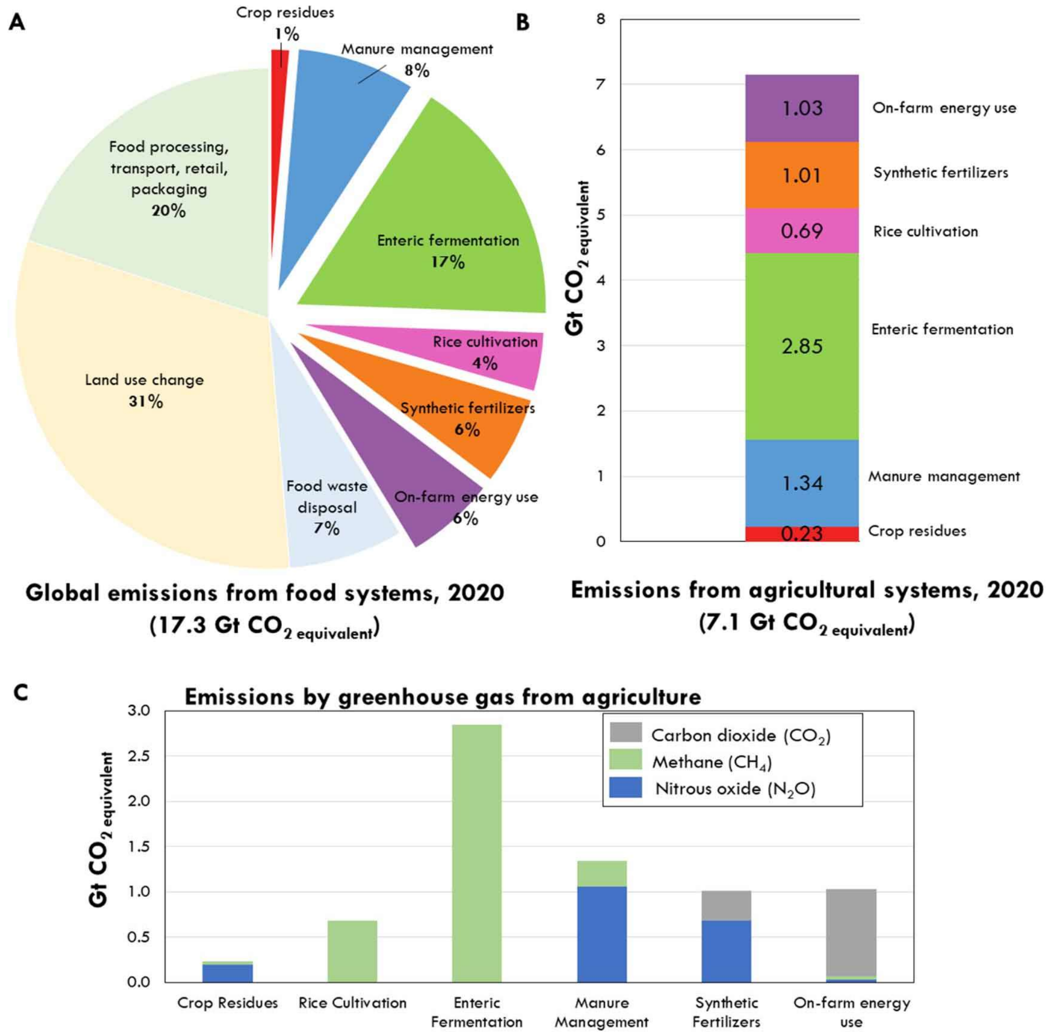

Figure 2. Greenhouse gas emissions from agriculture in 2020. (A) Shares of GHG emissions related to food systems by sector. (B) Estimates of GHG emissions related to agriculture by sector. (C) Breakdowns of estimates of GHG emissions from agriculture by sector and GHG (carbon dioxide, methane, nitrous oxide). Totals and breakdowns are based on data from FAO
Source: Rosa & Gabrielli (2023)

Overall, the global food system contributes 21–37% of total annual GHG emissions when evaluated using the 100-year global warming potential metric (Lynch et al., 2021). The agricultural sector alone emits 24%, with carbon dioxide, methane, and nitrous oxide contributing 76%, 16%, and 6%, respectively (Assumpção, 2021). With growing global meat consumption driving higher emissions from livestock and land-use change, it is essential that certification standards incorporate strategies to achieve net-zero emissions from the sector (Mendenhall & Singer, 2019).

This paper examines the role of CF accounting in the EU agri-food sector, its application in certification schemes, and its integration into public procurement strategies.

Carbon footprinting in agriculture and food processing quantifies the GHG emissions associated with production, transport, and consumption stages. It offers both diagnostic and strategic value—enabling stakeholders to identify emission hotspots and improve supply chain sustainability (Popova et al., 2022).

At the farm level, CF assessments can reflect practices such as fertilizer use, livestock emissions, and energy consumption. At the food processing level, emissions stem from energy inputs, packaging, logistics, and waste management. The widespread implementation of CF calculations is increasingly facilitated by frameworks like Life Cycle Assessment (LCA), which help standardize these efforts (Notarnicola et al., 2015).

Poore and Nemecek (2018) analyze data from 38,000 farms to assess the environmental impacts of 40 major food products. They find that most environmental harm—especially greenhouse gas emissions, land use, and water pollution—occurs at the farm stage and varies widely between producers. A small fraction of high-impact producers causes a disproportionate share of total damage. Moreover, even the most efficient animal products tend to have higher environmental costs than plant-based foods. The authors conclude that combining improved production practices with shifts toward plant-based diets offers the most effective path to reducing food-related environmental impacts. According to this study, while changing production methods is critical, dietary shifts—especially reducing meat and dairy consumption—can be even more effective. If everyone moved toward **plant-based diets, food's environmental footprint could drop by more than 70%.**

1.1 Frameworks and Methodologies for Carbon Footprinting

The **Life Cycle Assessment (LCA)** methodology is the backbone of carbon footprint accounting in the agri-food sector. According to the ISO 14040 and ISO 14044 standards, LCA enables the systematic quantification of environmental impacts, including CF, across the entire product life cycle—from raw material extraction to end-of-life disposal (Notarnicola et al., 2015). Standards and methodologies such as **ISO 14067** (International Organization for Standardization [ISO], 2018), **PAS 2050** (British Standards Institution, 2011), and the **European Commission's Product Environmental Footprint (PEF)** (Damiani et al., 2022) provide widely recognized frameworks for assessing the environmental impacts of products, focusing on greenhouse gas emissions and PEF extending to multiple environmental impact categories.

LCA databases like Ecoinvent and Agri-footprint supply background data critical for reliable assessments. However, challenges such as data variability, particularly in organic and small-scale farming systems, continue to limit consistency. To support practical implementation, databases like **Ecoinvent**, **Agri-footprint**, and national tools (e.g., **CAP'2ER** in France) provide emission factors that help stakeholders calculate CF with reasonable accuracy. Still, data availability and heterogeneity remain challenges, particularly in Mediterranean and organic farming systems (Sanye et al., 2021).

1.2 Certification Systems for Carbon Footprint

Certification schemes serve as market-based tools to validate, standardize, and communicate carbon performance across the agri-food value chain. In the EU, carbon certification can be implemented at multiple levels—farm, product, or supply chain—and is increasingly recognized in both public procurement and sustainability reporting.

Carbon footprint certification transforms emissions data into verified environmental claims. These are validated through third-party audits and may be displayed through labels such as "CO_2 evaluated," "CO_2 reduced," or "climate neutral." Certification provides transparency, enhances market access, and supports alignment with broader EU climate objectives including the Green Deal and the Farm to Fork Strategy.

Notable European certification systems include France's **Label Bas Carbone**, the **Carbon+ Program**, and frameworks developed by **ADEME** and **Solagro**, which use farm-level data and modeling to certify emission reductions. **ISCC (International Sustainability and Carbon Certification)** is another widely adopted system. Originally designed for biofuels and circular products, **ISCC PLUS** and **ISCC Agri** now extend to food and feed products, offering modular carbon footprint certification for farms, processors, and traders. These certifications are compliant with ISO 14064, use Life Cycle Assessment (LCA), and include Scope 1, 2, and increasingly Scope 3 emissions, aligning with corporate ESG frameworks and the Science Based Targets initiative (SBTi, 2023; ISCC, 2024).

Pilot initiatives also exist under the EU Organic Certification, where carbon performance add-ons are being tested. These schemes allow certified organic farms to integrate climate metrics—such as GHG emissions per hectare or mitigation plans—into their certification portfolios. This hybrid approach is being explored in several member states as a way to consolidate sustainability credentials and reduce administrative duplication (Bartzas et al., 2025).

Certification schemes vary in methodological rigor, recognition, and incentives. Some apply **dual-level certification models**, which combine baseline performance assessments with commitments to future improvements. These models are increasingly popular as they encourage both transparency and continuous decarbonization.

Carbon labelling further extends the impact of certification. Labels—such as "low carbon," "carbon neutral," or digital carbon tags—are used to signal environmental performance to consumers and institutional buyers. Although voluntary, these labels have become de facto policy instruments in markets where buyers, retailers, or municipalities reward low-carbon products (Trebbin & Geburt, 2024; Röös, 2013).

Despite their promise, carbon certification schemes face several challenges. Label proliferation, inconsistent methodologies, and consumer confusion can undermine trust. Harmonization of standards and alignment with EU-level frameworks such as the **Product Environmental Footprint (PEF)** and **ISO 14067** is necessary to ensure comparability (Bolwig & Gibbon, 2009).

Nonetheless, certified food products tend to demonstrate better environmental and economic performance. A study of 52 products across various stages of the agri-food supply chain found that carbon-certified goods had lower GHG emissions and greater access to green markets (Bellassen et al., 2022). For farms and firms alike, carbon certification is not just a compliance tool but a strategic pathway to resilience, transparency, and competitive advantage in an increasingly climate-conscious economy.

1.3 Integration into Public Procurement

Carbon footprinting is embedded in broader EU climate policy. The **EU Climate Law**, **Farm to Fork Strategy**, and **Circular Economy Action Plan** call for emissions reductions across value chains, explicitly targeting food production.

Carbon footprint certification has increasingly found its place in **Green Public Procurement (GPP)** policies. The EU Procurement Directive 2014/24/EU allows environmental considerations, including carbon certifications, to be integrated into procurement decisions. Municipalities and institutions can use these certifications to select suppliers with demonstrably lower environmental impacts (Alberdi & Begiristain-Zubillaga, 2021).

For instance, the City of Turin implemented a carbon-based food policy in public catering, leading to demonstrable environmental savings and influencing procurement patterns (Cerutti et al., 2016). Similar outcomes have been observed in Romania and Italy, where certified organic or low-carbon products were favored in public tenders, enabling sustainable local production and supporting smaller farms (Dobrota et al., 2023; Tricase et al., 2024).

JRC's assessment of GPP in the EU highlights its contribution to climate targets, especially when combined with other social and economic sustainability criteria (Sanye et al., 2021).

A 2024 policy framework developed for Mediterranean countries proposed standardized low-carbon certification integrated with procurement eligibility, boosting participation of smaller producers (Bartzas et al., 2024).

Public buyers increasingly require proof of sustainability through environmental labels or carbon disclosure. However, without broader harmonization across EU states, discrepancies in recognition and enforcement remain a barrier to wider uptake (Tricase et al., 2024).

1.4 Challenges and Future Directions

Despite its utility, CF accounting and certification face challenges. These include data variability, lack of harmonization across sectors, and high administrative costs for smallholders. Moreover, while certification facilitates access to public contracts, its voluntary nature and complexity can discourage widespread adoption.

Efforts are ongoing to simplify and harmonize certification protocols, especially for Mediterranean and small-scale producers, using real-time GHG field measurements and integrated frameworks (Bartzas et al., 2024).

2 Carbon Certification Standards and Methodologies

Carbon certification programs are grounded in clearly defined standards and methodologies that provide the technical basis for calculating, verifying, and reporting greenhouse gas emissions and removals. These methodologies ensure that emission reductions are measurable, reportable, and verifiable (MRV), forming the cornerstone of credible certification systems. Internationally recognized standards—such as the Greenhouse Gas Protocol, ISO 14064, and PAS 2050—serve as foundational frameworks for many agri-food carbon footprint certification schemes (Ranganathan et al., 2004; ISO, 2018). These standards offer detailed guidance on emissions accounting, system boundaries, allocation methods, and the treatment of land-use change, enabling consistent and comparable results across farms and geographies (Schulte et al., 2021).

Each certification system adopts or adapts methodologies based on its scope, focus, and regional context. For example, some standards may emphasize soil carbon sequestration and regenerative practices, while others prioritize livestock emissions or energy-related inputs (Tubiello et al., 2021; Haya et al., 2020). The methodologies used must strike a balance between scientific robustness and practical feasibility for farmers. This includes accounting for data availability, administrative burden, and technical capacity on the ground. Many certification schemes now integrate user-friendly digital tools that automate calculations and reduce errors, enabling small and medium-scale farmers to participate more easily in carbon certification programs (Ghosh et al., 2024).

Beyond carbon dioxide (CO_2), comprehensive methodologies increasingly incorporate methane (CH_4) and nitrous oxide (N_2O), which are significant in agriculture due to their higher global warming potentials. These methodologies outline emission factors, baseline definitions, leakage risks, and permanence criteria, ensuring that emission reductions are genuine and long-lasting (Rosa & Gabrielli, 2023). They also specify protocols for the quantification of co-benefits, such as improvements in biodiversity, soil health, and water use efficiency, aligning carbon certification with broader sustainability objectives (Hasukawa et al., 2021).

A growing number of standards also accommodate nature-based solutions (NbS) and carbon farming approaches, where climate mitigation is integrated with ecosystem restoration and rural development (Tubiello et al., 2021; Dinesh et al., 2023). These standards often rely on regionally calibrated models and Tier 2 or Tier 3 IPCC methodologies to ensure accuracy. Lifecycle assessment (LCA) is another common component, particularly in product-level certification, enabling full traceability of emissions from farm to fork (Schau & Fet, 2008; Canfora, 2016). These LCAs help quantify embedded emissions and identify leverage points for decarbonization across the value chain.

To ensure integrity and comparability, many certification bodies maintain **public registries of approved methodologies,** which undergo regular review by expert panels. This process allows standards to evolve in response to scientific advances, stakeholder feedback, and policy developments. **Transparent methodology** updates help prevent greenwashing and enhance stakeholder trust in certification outcomes (González-García et al., 2013). Ultimately, **robust** methodologies are central to establishing credibility, unlocking carbon finance, and supporting the integration of certified emissions reductions into carbon markets and procurement systems.

3 Prospects for Mandatory Carbon Footprint Certification of Farm Products in the EU

As of 2025, **carbon footprint certification of farm products is not mandatory in the European Union**. Current EU legislation, particularly the **Carbon Removal Certification Framework (CRCF)** under Regulation (EU) 2024/3012, introduces a **voluntary** scheme for certifying carbon removals through activities like carbon farming, agroforestry, and biochar deployment. While the CRCF lays out a harmonized methodology for quality certification based on criteria such as additionality, long-term storage, and monitoring, it does not impose any legal obligation on farms or agribusinesses to participate (European Commission, 2024a). Similarly, the EU Deforestation Regulation (EUDR) (Regulation (EU) 2023/1115) enforces mandatory due diligence for commodities such as soy, palm oil, and cocoa, but stops short of requiring carbon certification, instead relying on traceability and geolocation data to ensure compliance (European Commission, 2023).

Despite this voluntary status, several regulatory initiatives and policy discussions suggest that a **transition toward mandatory climate-related certification or accounting in agriculture may be forthcoming**. Notably, policy tools (Table 1) such as Mandatory Climate Standards (MCS) and an Agricultural Emissions Trading System (AgETS) have been proposed, potentially requiring large agri-food companies to reduce Scope 3 emissions annually, with farms participating indirectly via supply chain obligations (Carbon Market Watch, 2025). Additionally, the EU Farm to Fork Strategy had originally proposed a Sustainable Food Labelling Framework, which could include carbon footprint indicators on food packaging; however, this remains in development and has not been adopted as binding legislation (Profeta et al., 2022).

P**ublic procurement schemes** and **voluntary carbon markets** may create increasing demand for certified carbon removals. However, the adoption of carbon certification for farm products remains **voluntary** under current EU law (Table 1). Nevertheless, the **combined pressure** from **supply chain ESG obligations**, **CAP eco-schemes**, and **investor transparency requirements** is gradually making **certification an economic necessity**, even without legal mandates. Thus, while **carbon footprint certification is not obligatory today**, the regulatory trajectory indicates a shift toward **greater standardization, accountability, and potential future obligation**, particularly for actors integrated into broader food value chains.

Table 1 Overview of EU Legal and Policy Instruments Related to Carbon Certification in Agriculture and Food Systems

Legal Framework / Policy Option	Mandatory?	Scope / Impact
CRCF Regulation (EU) 2024/3012	Voluntary	Carbon removals & carbon farming certification
Mandatory Climate Standards (MCS) proposal	Under consideration	Could obligate large firms to reduce Scope 3 emissions
Agriculture Emissions Trading System (AgETS) proposal	Proposed	Price-based cap on emissions for agriculture
Sustainable Food Labelling Framework	Proposed, not adopted	Could include carbon labels, but still voluntary

Table 2 provides a side-by-side comparison of how farms and firms (e.g., food processors, manufacturers) are evaluated under various carbon footprint certification schemes, with focus on baseline methodology, data reporting, monitoring practices, and alignment with EU policy instruments.

Table 2 Comparison of farm and firm certification schemes

Criteria	Farms	Firms (Processors, Manufacturers)
Initial Baseline Establishment	Established during first certification audit using field-level data (Carbon Standards International, n.d.).	Established using energy, process, and logistics data from the last operating year (Carbon Trust, 2023).
Typical Certification Schemes	Label Bas Carbone (FR), Carbon+ Program, EU CRCF, ISCC-Agri (Basheer et al., 2024; ISCC, 2024).	ISCC PLUS, Carbon Trust Standard, ISO 14064, SBTi, CDP (ISCC, 2024; SBTi, 2023).
Emissions Scope	Primarily Scope 1 (on-farm emissions) and some Scope 2 (energy use) (ISCC, 2024).	Scope 1, Scope 2, and increasingly Scope 3 (supply chain) (SBTi, 2023).
Multi-Year Certification	Yes (e.g., 3–5 years) with annual updates or site checks (IATP, 2024).	Yes, typically 2–3 years with annual GHG inventory updates (Carbon Trust, 2023).
Annual Data Reporting	Required for updates on practices, seasonal changes, new inputs (Carbon Standards International, n.d.).	Standardized reports aligned with financial or ESG reporting cycles (SBTi, 2023).
Performance Benchmarks	Benchmarked against regional farming averages or modeled scenarios (Basheer et al., 2024).	Benchmarked against industry or sectoral emission intensity (Carbon Trust, 2023).
Monitoring Methods	Remote sensing, satellite data, field audits, GHG calculators (Carbon Standards International, n.d.).	Metered energy data, software-based LCA, digital emissions logs (ISCC, 2024).
Use of Sectoral Averages	Yes, often due to limited historical farm-specific data (ISCC, 2024).	Yes, especially for SMEs or new entrants without legacy data (SBTi, 2023).
Verification Type	Third-party audits, remote verifications, public databases (ISCC, 2024).	External verification bodies, ISO-compliant audits (ISCC, 2024).
Integration with EU Policy	Directly linked to CAP, Farm to Fork Strategy, Green Deal (IATP, 2024).	Used in ESG reporting, procurement eligibility, taxonomies (SBTi, 2023).

4 EU Certification Procedure for farm

4.1 Data Collection and Baseline Assessment

Farms must meticulously collect detailed data on greenhouse gas (GHG) emissions, encompassing direct emissions from on-farm activities such as machinery operation and livestock, indirect energy-related emissions from purchased electricity or heating, and other indirect emissions associated with the supply chain, such as fertilizer production and transportation of goods (Karwacka et al., 2020). This comprehensive data collection is crucial for establishing a baseline carbon footprint, which is typically calculated using standardized tools or templates provided by the certification body (Ozlu et al., 2022).

The resulting **baseline** enables a quantitative assessment of the farm's environmental impact and serves as a reference point against which future emission reductions can be measured, while also highlighting areas for improvement. Furthermore, this assessment identifies significant emission sources and informs the development of targeted mitigation strategies (Ozlu et al., 2022).

Evidence Requirements: In addition to baseline data, farms must typically submit data from the most recent operational year to establish the baseline and demonstrate progress.

The carbon calculator includes documentation of sustainable practices, such as conservation agriculture, that enhance carbon sequestration (Cariappa et al., 2024). Standards like the World-Climate Farm Standard require annual data collection and meticulous record-keeping of all inputs, outputs, and management practices (Zhang et al., 2018). Such data supports continuous monitoring and adaptive management strategies, enabling consistent reductions in GHG emissions and alignment with long-term sustainability goals. **Annual and historical data** allow for robust year-on-year comparisons and incremental assessments of performance. Accurate data also strengthens the scientific basis of the certification and facilitates data-driven improvements in farm operations (Janssens-Maenhout et al., 2011; Sarwar et al., 2023).

Subsequent steps involve the implementation of reduction measures and their validation through accredited bodies. This structured approach to data management and verification ensures transparency and accountability, reinforcing the credibility of the carbon footprint assessment.

4.2 Implementation of Reduction Measures

Based on the baseline assessment, farms must develop and implement strategic mitigation measures aimed at reducing their carbon footprint (Narh et al., 2020). These may include transitioning to no-till or reduced tillage practices, optimizing fertilizer application, improving manure management, and enhancing overall energy efficiency (Mazengo et al., 2024).

Farms often adopt renewable energy sources, upgrade irrigation systems, and select crop varieties with lower environmental impacts, contributing to the overall sustainability of agricultural systems (Sanz-Cobeña et al., 2016; Mendenhall & Singer, 2019). Specific interventions are typically guided by emissions inventories and include the adoption of precision agriculture technologies and advanced livestock management systems that improve efficiency while reducing emissions (Waddell et al., 2011; McNicol et al., 2024). These strategies lower the environmental cost of production and reduce emissions typically associated with traditional methods (Sanz-Cobeña et al., 2017).

4.3 Validation and Verification

An accredited Validation and Verification Body (VVB) rigorously reviews the submitted data and verifies the implementation of emission reduction measures (Basheer et al., 2024). This process may include on-site inspections, especially during the first year of certification and periodically thereafter, to ensure data accuracy and compliance with established methodological standards. This level of scrutiny upholds the integrity of the carbon footprint assessment and provides assurance to both certifiers and consumers (Carbon Standards International AG. (n.d.)).

4.4 Certification Decision

Following successful verification, the certification body issues a certificate classifying the farm's carbon footprint status using labels such as "**CO_2 evaluated," "CO_2 reduced," or "climate neutral**," based on the level of reductions achieved and the use of offsetting mechanisms (Carbon Standards International AG. (n.d.)).

5 Duration of Evidence, Data Collection Periods and Certification Timing

Farms are typically required to provide data covering at least the most recent full year of operations to establish a reliable baseline and to demonstrate improvements over time. This dataset must include detailed records of all farm activities—such as energy consumption, fertilizer use, livestock numbers, and crop yields—necessary for accurately quantifying both greenhouse gas emissions and carbon sequestration efforts (Koneswaran & Nierenberg, 2008). Whether data is collected using traditional or digital methods, complete and precise on-farm record-keeping is essential for certification and for verifying tangible progress in emissions reductions (Basir et al., 2024). These datasets also support adaptive management strategies, enabling farms to track environmental performance over time and to identify new opportunities for mitigation.

While certification schemes typically require one year of data, **longer historical datasets are often encouraged or required to capture seasonal variations and assess long-term trends** (Narh et al., 2020; Tubiello et al., 2013). Data types may include biophysical, environmental, and operational attributes collected via conventional monitoring, remote sensing, proximal sensors, or in-field observations (Bayih et al., 2022). Collected datasets are analyzed using standardized methodologies to quantify carbon stocks, assess sequestration potential, and identify emissions hotspots.

While annual data collection is typically required to establish carbon footprint baselines and monitor year-on-year progress, some certification schemes mandate multi-year datasets to **evaluate long-term environmental trends and verify sustained improvements.** This extended time frame is especially important when assessing gradual changes such as increases in soil carbon sequestration or enhancements in water-use efficiency over multiple growing seasons (Parra-López et al., 2025; Getahun et al., 2024).

Long-term data **distinguishes between temporary fluctuations and systemic environmental gains**, thereby strengthening the credibility and robustness of certification claims. It helps demonstrate that farms are implementing enduring operational changes rather than merely short-term adjustments. This type of robust data record enables a more accurate evaluation of sustainability outcomes and contributes to an evidence-based understanding of agricultural impacts (Triviño-Tarradas et al., 2020). Multi-year datasets also support the assessment of agricultural resilience to environmental variability, offering insights into how consistently farms deliver ecological benefits despite changing climatic conditions (Wartenberg et al., 2021). Such historical data contributes to an improved understanding of a farm's capacity for adaptation and mitigation, which is essential for building climate-smart agricultural systems (Mendenhall & Singer, 2019). These comprehensive records also serve as a valuable resource for researchers and policymakers, helping to shape more effective agricultural and climate policy (Reytar et al., 2014;).

Certification bodies often specify **the minimum duration and the type of evidence required**, depending on the environmental parameters being assessed. For example, certifying an *apple value chain* may necessitate specific types of data covering particular crop cycles, farm inputs, and regional ecological factors (Féon et al., 2023). These requirements generally involve tracking inputs, outputs, and farm management practices across multiple production seasons to confirm sustained environmental performance and ensure compliance with evolving certification standards. These detailed, multi-seasonal records also help refine the standards themselves, ensuring their continued relevance and effectiveness in driving meaningful ecological outcomes. By generating long-term evidence of environmental performance, farms contribute to the global understanding of sustainable agriculture and support the development of best practices applicable across diverse agroecosystems.

Rigorous process ensures that certifications are based on verifiable evidence and informs both farm-level and policy-level decisions for sustainable agriculture (Basir et al., 2024). Some data, such as yield monitor data, may be collected over multiple years to better support decision-making and improve predictive accuracy (Thompson et al., 2021).

Livestock operations, which have traditionally lagged in data collection, now benefit from emerging technologies such as ventilated head hood systems that offer cost-effective and precise measurement of emissions like methane from enteric fermentation (Place et al., 2011). Monitoring of methane (CH_4) and nitrous oxide (N_2O) is particularly crucial given their high global warming potential. These gases require accurate measurement to inform effective mitigation strategies (Ma et al., 2024; Li et al., 2024). Modern systems often employ advanced instrumentation and analytical tools to ensure reliability in emissions tracking (McGinn et al., 2021).

Due to the complex nature of agricultural systems, data integration and modeling are essential for accurately attributing emissions to specific activities and evaluating mitigation outcomes (Jalota et al., 2018). Emerging sensor technologies and refined data-processing algorithms are significantly improving the precision and scope of greenhouse gas accounting from diverse sources (André et al., 2025). Methane and nitrous oxide remain particularly significant, as agriculture accounts for 43% of global methane emissions and contributes to 24% of overall anthropogenic GHG emissions (Gunter et al., 2017). Despite carbon dioxide comprising 81% of total GHGs, methane's warming potential is far greater per unit, emphasizing the need for targeted mitigation strategies within agriculture (Musa, 2020; Sejian et al., 2016). Precise quantification of these gases allows for more informed intervention design and supports improved sustainability outcomes (Rosa & Gabrielli, 2023; Kazimierczuk et al., 2023).

Certification frameworks must incentivize the **adoption of mitigation technologies and practices** while incorporating life cycle assessments that account for **emissions across the entire value chain**—from farm to fork (Rosa & Gabrielli, 2023; Lynch et al., 2021). The tiered nature of many certification systems allows farms to start with baseline assessments and progress toward more stringent targets as sustainability practices become embedded across operations.

Integration of digital tools and remote sensing technologies further enhances data accuracy and supports continuous improvement. These systems enable real-time monitoring and responsive farm management, which are vital for long-term emissions reductions and climate adaptation. The iterative process of collecting, analyzing, and acting on data supports ongoing improvement, ensuring that certified farms remain aligned with evolving sustainability benchmarks (Yang et al., 2024; Zhu & Piao, 2025).

As certification standards evolve to reflect scientific advancements and climate policy changes, data-driven farm operations will be better positioned to lead the transformation toward low-carbon agriculture. Increasing global demand for environmental transparency further underscores the need for robust, verifiable performance indicators in certification systems (Inwood et al., 2018). Digital agricultural tools, such as drones, smart sensors, and AI analytics, are increasingly used to optimize input efficiency, monitor crops, and reduce emissions (Papadopoulos et al., 2024; Ogwu & Kosoe, 2025; Balyan et al., 2024). These technologies not only streamline certification processes by offering quantifiable performance metrics but also empower farmers to continuously improve their environmental performance (Makapela et al., 2025). Such innovations support sustainable intensification, precision agriculture, and climate-smart practices that enhance both productivity and ecological integrity (Veres et al., 2020; Poli & Fontefrancesco, 2024). Ultimately, these advancements contribute directly to the UN 2030 Agenda's goals for sustainable agriculture by promoting food security, environmental stewardship, and efficient use of natural resources.

6 Certificate Validity and Renewal

Certified farms are typically required to renew their carbon footprint certification annually, ensuring ongoing alignment with evolving sustainability standards and reinforcing the credibility of the certification system (Carbon Standards International, n.d.). Annual renewal serves as a mechanism for verifying that farms continue to meet or exceed the original environmental benchmarks and are making demonstrable progress in reducing emissions.

This process involves the submission of updated farm data, documentation of mitigation measures undertaken, and evidence of continuous improvement in environmental performance. Depending on the certification scheme, renewal may also include periodic on-site inspections or third-party audits to ensure consistency, prevent data manipulation, and strengthen public confidence in the label (Basheer et al., 2024).

Some certification schemes allow for **multi-year certification periods**—commonly three to five years—on the condition that **interim monitoring and annual reporting** confirm ongoing compliance and gradual performance improvement. For example, the **Carbon Removals and Carbon Farming (CRCF)** framework mandates that carbon farming activities be monitored for at least five years, with periodic (often annual) updates required to uphold certification integrity (IATP, 2024). Similarly, under the **ISCC Carbon Footprint Certification**, dairy operations may hold multi-year certifications but remain subject to **annual third-party audits** to confirm alignment with evolving carbon standards (ISCC, 2024).

Even in these cases, routine annual updates remain essential to ensure that reported data reflect current farm conditions, seasonal variations, and the implementation of new climate-smart practices. These updates allow certifiers to track longitudinal performance and evaluate how farms are adapting to climatic shifts, regulatory changes, and technological developments over time. This dynamic tracking framework helps ensure that certification systems not only validate static compliance but also foster continuous environmental improvement.

Beyond operational oversight, certification renewal contributes to broader policy integration. It supports alignment with the European Green Deal, Farm to Fork Strategy, and Common Agricultural Policy (CAP) objectives. Regular data reporting enables harmonized monitoring across public databases, allowing policymakers to track sector-wide progress toward climate targets. By embedding renewal into the agricultural calendar, carbon certification becomes a strategic governance tool—ensuring that decision-makers, farmers, and markets operate based on consistent, up-to-date, and credible data.

In cases where certified firms/farms lack historical environmental performance data, certification systems typically establish a **baseline year** during the first audit cycle. This baseline serves as a **reference point for evaluating future improvements**. Rather than assessing performance retrospectively, certifiers monitor **progress prospectively**, comparing new annual data to the initial benchmark. Additionally, farms may be assessed relative to regional averages, modelled emission profiles, or **similar farm types**. Certification schemes often require the submission of action plans or climate-smart interventions to demonstrate commitment to continuous improvement. This approach allows certifiers to begin tracking longitudinal performance from the point of certification, ensuring that even newly participating farms are held to progressive, evidence-based standards (ISCC, 2024; IATP, 2024).

These performance tracking principles apply **firms across the agri-food supply chain**—including processors, manufacturers, and distributors. For companies without existing emissions data, the first certification cycle establishes a baseline for GHG performance, typically covering direct and indirect emissions (Scope 1 and 2). From this baseline, certifiers monitor progress through **annual or periodic data submissions**, enabling the assessment of improvement trajectories. Even in multi-year certification frameworks, firms are generally required to submit **annual updates** to reflect changes in production volumes, energy sourcing, and mitigation actions. This approach ensures that **performance tracking is dynamic**, evidence-based, and aligned with best practices in corporate sustainability governance (Carbon Trust, 2023; ISCC, 2024).

7 Carbon Footprint Labelling for Public Procurement

Carbon footprint labelling is emerging as a strategic instrument for integrating sustainability into public procurement across the European Union. These labels communicate the environmental performance of agri-food products by quantifying greenhouse gas emissions associated with their life cycle—from production to distribution and consumption (Finkbeiner, 2009). Public institutions, including schools, hospitals, and government agencies, are increasingly using carbon labels to guide sustainable purchasing decisions, thereby leveraging procurement budgets to accelerate climate goals (Sonnemann et al., 2018). Labelling supports the EU's Green Public Procurement (GPP) objectives by providing a transparent, verifiable basis for evaluating suppliers and food service providers, incentivizing climate-smart production practices throughout the supply chain (Wognum et al., 2011).

Carbon labels typically categorize products using standardized metrics such as kilograms of CO_2-equivalent per kilogram of food. Some systems offer multi-tiered indicators—ranging from **basic carbon footprint** disclosure to "**CO_2 reduced**" and "**climate neutral**" certifications—based on the level of emissions mitigation or offsetting achieved (Canfora, 2016). By making emissions visible to buyers and consumers, carbon labels help shift market demand toward lower-impact products and create reputational **incentives for suppliers to decarbonize**. This market signal is particularly powerful in institutional settings, where high-volume procurement can reshape supply chains at scale (Testa et al., 2016).

Several certification programs also integrate carbon labelling with broader sustainability criteria, such as biodiversity protection, animal welfare, and fair trade, to reflect the interconnected nature of environmental and social objectives (Järviö et al., 2020). The integration of carbon footprint labels into procurement practices aligns with key EU policy frameworks—including the Farm to Fork Strategy, the EU Taxonomy, and the Sustainable Food Systems initiative—by promoting life cycle thinking and evidence-based sourcing. This alignment ensures that procurement systems are not only cost-efficient but also environmentally accountable.

Challenges persist in **harmonizing carbon labels across member states** due to methodological differences, varying levels of data granularity, and the need for reliable third-party verification. The lack of uniform standards can undermine trust and create market confusion, especially when different labels report emissions using incompatible metrics or boundaries (Finkbeiner, 2009; Jørgensen et al., 2021). Addressing these challenges requires stronger coordination at the EU level to establish **common labelling frameworks**, facilitate mutual recognition of certification schemes, and support small-scale producers in accessing carbon labelling programs (van der Werf et al., 2020).

Ultimately, carbon footprint labelling empowers public authorities to act as sustainability champions, aligning public food purchases with climate targets while fostering demand for transparent and verifiable environmental performance across the food system. As public procurement represents nearly 14% of EU GDP, mainstreaming carbon labelling in institutional purchasing could drive substantial emissions reductions and accelerate the agri-food sector's transition to net-zero (European Commission, 2020).

8 Public Procurement as a Driver for Decarbonisation:

Public procurement represents a powerful tool for promoting the decarbonisation of the agri-food sector. As governments and public institutions are major purchasers of food—through schools, hospitals, canteens, and other facilities—their procurement choices can significantly influence supply chains and market behaviour (Wognum et al., 2011). By incorporating carbon footprint criteria into tendering processes, **public authorities can create demand for low-emission agricultural products and services**, thereby incentivizing farmers, food processors, and distributors to adopt sustainable practices (Testa et al., 2016).

The European Union's Green Public Procurement (GPP) policy provides a framework for embedding environmental considerations, including carbon metrics, into public contracts. This policy aims to use public sector purchasing power to stimulate innovation, reduce greenhouse gas emissions, and support the transition to a sustainable economy (European Commission, 2020). Integrating carbon footprint certification into procurement criteria allows buyers to assess and reward suppliers based on measurable climate performance, shifting the focus from price alone to long-term sustainability and value-for-money outcomes (Sonnemann et al., 2018).

By favouring suppliers who have undergone third-party verified carbon certification, procurement agencies send a clear market signal that climate accountability is not optional but essential. This drives private sector actors to measure, reduce, and report their emissions, and it creates a competitive advantage for farms and firms that invest in decarbonisation. Over time, this can stimulate systemic change, as entire supply chains work toward meeting the climate criteria embedded in procurement frameworks (Canfora, 2016).

Moreover, carbon-based procurement can help local governments meet their own climate commitments under national or EU-level targets, including those related to the European Green Deal and the Fit for 55 package. It ensures that public spending aligns with environmental goals, providing co-benefits such as improved air quality, reduced resource use, and the promotion of regenerative agricultural models (Durrant et al., 2021). This is particularly relevant in food systems, where emissions are often embedded in complex global supply chains and require upstream interventions to achieve meaningful reductions (Schulte et al., 2021).

The strategic use of procurement also enables public institutions to support local economies by prioritizing certified farms within their regions, thereby linking decarbonisation to rural development and food system resilience. Coupled with transparent monitoring systems, carbon-inclusive procurement policies can build public trust and create replicable models for climate-conscious purchasing across Europe (Reytar et al., 2014; Mendenhall & Singer, 2019).

While some challenges remain—such as harmonizing carbon metrics across certification bodies and reducing administrative burdens for small producers—the alignment of public procurement with verified carbon certification represents a high-impact, scalable solution for reducing agricultural emissions and accelerating the transition to net-zero food systems.

9 Empirical Examples Across the EU

EU Member States have begun integrating carbon footprint considerations into **public procurement**, particularly in catering, school meals, hospitals, and municipal supply chains. Below are documented cases of implementation:

Italy – City of Turin's Carbon-Based Food Policy

The **City of Turin** piloted one of the earliest implementations of CF metrics in procurement. By integrating carbon footprint analysis into the tendering process for public school catering, the city achieved a **20% reduction in total GHG emissions** over three procurement cycles (Cerutti et al., 2016). The procurement criteria awarded points to suppliers based on product-level carbon certification and the presence of low-emission supply chains.

France – Label Bas Carbone for Agricultural Producers

France's **Label Bas Carbone** was adopted in several local procurement contracts, especially in **short food supply chains**. Certified farms received preferential treatment in municipal contracts, particularly in Occitanie and Nouvelle-Aquitaine, where **carbon scoring** influenced supplier selection. Regional governments also offered financial incentives to producers with certified emission reductions (Bartzas et al., 2025).

Romania – GPP Strategy for Sustainable Agriculture

A national case study in Romania highlighted the integration of environmental footprint indicators in **healthcare and education sector procurement**. Contracts required carbon disclosure or certified environmental performance for staple goods like bread, dairy, and meat. Authorities used tools like environmental product declarations (EPDs) to assess supplier eligibility (Dobrota et al., 2023).

Netherlands – Carbon Footprint Standards in Hospital Procurement

In the **Netherlands**, several hospitals have adopted **carbon-based procurement criteria** in collaboration with regional sustainability platforms. One prominent example is the **Amsterdam UMC**, which implemented procurement guidelines based on the carbon footprint of food products served in canteens and patient meals. Suppliers were evaluated on life cycle emissions and environmental certifications, including alignment with ISO 14067 and EPDs. The initiative aimed not only to reduce emissions but also to **stimulate innovation in low-carbon food processing** and packaging. Preliminary evaluations showed a **15–25% reduction in food-related emissions** after two procurement cycles and improved traceability of climate impacts. This example showcases how **healthcare institutions in Western Europe** are using procurement power to drive climate accountability in supply chains (JRC, 2021; Dutch Ministry of Health, 2024).

EU-Wide Tools and Recommendations

The **Joint Research Centre (JRC)** has issued harmonized templates for evaluating environmental impacts—including CF—in public tenders. The **2021 JRC report** identified best practices, such as assigning up to 30% of evaluation weight to verified sustainability indicators in food supply contracts (Sanye et al., 2021).

Despite these advances, challenges persist. These include varying methodologies across regions, low adoption in Eastern Europe, and limited capacity among smallholders to obtain certification.

Still, the growing alignment between **CF standards and procurement policy** signals a positive trajectory toward climate-smart public spending.

The performance of certified food products across 52 case studies in Europe indicates better environmental metrics than non-certified counterparts. For example, average CF savings ranged from 15–35% depending on production system and geography (Bellassen et al., 2022). These findings support the dual value of certification: improving climate outcomes and enhancing competitiveness in sustainable markets.

10 Agrofood Environmental indicators in EU Data Systems

The integration of farm-level environmental data into broader European Union data systems is increasingly critical for aligning agricultural policies, enabling cross-country comparisons, and supporting evidence-based decision-making. Synergies between individual farm data and EU-level platforms enable more efficient compliance monitoring and facilitate the identification of regional sustainability trends, allowing the EU to develop targeted interventions for climate and biodiversity goals (Mathenge et al., 2022; Mendenhall & Singer, 2019).

Beyond enhancing transparency and accountability, this integration also supports the enforcement of environmental regulations and accelerates the adoption of sustainable farming practices (Agarwala et al., 2022). A key challenge lies in the development of coherent data governance frameworks and standardized reporting protocols to manage the vast influx of agricultural data and reduce fragmentation within the current system (Weersink et al., 2018). EU initiatives such as the digitalization strategy for agriculture and the development of a unified European agricultural data space aim to address these gaps by fostering interoperability, innovation, and AI-powered insights across agri-food chains (Garske et al., 2021).

To maximize the potential of digital integration, these efforts also involve the establishment of data trusts and common data environments, which enable the secure and efficient sharing, validation, and analysis of sensitive environmental and performance data (Durrant et al., 2021). A unified and standardized data ecosystem is vital for generating actionable insights that can accelerate the transition to sustainable agricultural practices and help meet EU climate and biodiversity targets (Garske et al., 2021; Štreimikis & Baležentis, 2020). This approach not only enables consistency in reporting across borders but also reinforces the EU's broader policy objectives under the Green Deal and Farm to Fork strategies.

Ultimately, the alignment of farm-level certification data with EU-wide data systems enhances the effectiveness of environmental policy implementation, improves public trust through verifiable sustainability metrics, and supports the integration of carbon footprint performance into public procurement systems. This harmonization is essential for scaling sustainable food production across Europe in a way that is transparent, efficient, and policy driven.

Starting in **2025**, the **Farm Sustainability Data Network (FSDN)**—formerly the Farm Accountancy Data Network (FADN)—will begin to collect environmental and social indicators in addition to its long-established economic data, although participation remains voluntary for Member States (European Commission, n.d.; OECD, 2023). This reform supports the environmental objectives of the Common Agricultural Policy (CAP) 2023–2027 and the European Green Deal, particularly regarding climate neutrality, biodiversity protection, and sustainable natural resource use. Among the new indicators is the carbon footprint index, derived using harmonized methods based on Life Cycle Assessment (LCA) principles and activity data such as energy use, fertilizer application, and livestock management. These environmental metrics are designed to inform CAP policy evaluations, support the implementation of eco-schemes, and guide tools like carbon certification and green public procurement (European Commission, 2022; Bartzas et al., 2024). The first data sets reflecting these additional indicators are expected to cover 2025 and will likely be made publicly available in 2026 or 2027 (OECD, 2023). Despite this expansion the inclusion of environmental indicators in the FSDN is voluntary for EU Member States, and participation varies across countries. Notably, Slovakia has opted not to collect these environmental data from 2025 onward, citing administrative and technical constraints. This divergence raises concerns about data comparability, coherence in CAP implementation, and equitable access to sustainability-driven incentives across the Union.

11 Summary and Policy Recommendations

Carbon footprint certification is emerging as a pivotal tool for decarbonizing the EU agri-food sector. By enabling farms and firms to quantify and reduce greenhouse gas (GHG) emissions, certification supports core EU policies, including the Green Deal, Farm to Fork Strategy, and the Common Agricultural Policy (CAP). When integrated with digital infrastructure and green public procurement (GPP), certification systems become powerful levers for aligning agricultural production with climate goals.

A variety of certification approaches are currently in place, including national schemes (e.g. Label Bas Carbone), international frameworks (e.g. ISCC Carbon Certification), and pilot carbon add-ons to EU Organic Certification. These systems differ in methodology, scope, and market recognition, but increasingly converge around standardized metrics such as Life Cycle Assessment (LCA), ISO 14067, and the Product Environmental Footprint (PEF) (ISO, 2018; European Commission, 2022). Dual-level certification models that combine baseline assessment with reduction plans are gaining traction, offering both benchmarking and incentives for continual improvement.

Public procurement is proving to be a critical pathway for scaling low-carbon agri-food systems. Municipalities and institutions in Italy, France, Romania, and the Netherlands have adopted carbon-based procurement criteria with measurable success—demonstrating emission reductions, innovation incentives, and improved traceability (Cerutti et al., 2016; JRC, 2021; Dutch Ministry of Health, 2024). Yet, harmonization challenges, capacity gaps for smallholders, and data fragmentation still limit broader adoption.

Policy Recommendations

1. **Standardize Certification Frameworks across the EU**
   Promote interoperability between schemes by aligning with international standards (ISO 14067, PEF, PAS 2050) and encouraging mutual recognition. This enhances consistency and facilitates market access across Member States.
2. **Integrate Certification with EU Data Systems**
   Ensure compatibility with platforms such as the Farm Sustainability Data Network (FSDN), supporting unified monitoring and policy coherence under the CAP and CRCF Regulation (European Commission, 2024a; OECD, 2023).
3. **Support Small and Medium-Sized Farms**
   Offer financial incentives, digital tools, and technical assistance to lower entry barriers to certification for smaller producers, ensuring equitable participation in carbon markets and public tenders.
4. **Embed Carbon Criteria in Public Procurement**
   Encourage Member States to incorporate carbon footprint certification into national GPP frameworks, enabling institutions to prioritize verified low-emission products and foster sustainable demand (European Commission, 2020).
5. **Ensure Transparency of Methodologies and Verification**
   Require certification bodies to publish clear protocols and maintain public registries of approved methodologies. Transparent MRV (monitoring, reporting, verification) builds trust and prevents greenwashing (Rosa & Gabrielli, 2023).
6. **Promote Lifecycle Thinking and Co-Benefits**

Encourage certification systems to reflect the full environmental performance of agri-food products, including biodiversity, soil health, and water efficiency, not just GHGs. This supports holistic sustainability transitions (Hasukawa et al., 2021).

By integrating certification into agricultural, environmental, and procurement policy, the EU can advance climate-smart food systems. Well-designed certification schemes—linked to data infrastructure, market incentives, and public spending—offer scalable pathways toward net-zero agriculture while enhancing transparency, competitiveness, and rural resilience.

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