TRUE COST ACCOUNTING FOR
FOOD SYSTEMS TRANSFORMATION

Report

Interim Report II

SWOT Analysis of True Cost Accounting in the German Agrifood Sector

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Executive Summary

The German Ministry of Agriculture, Food and Regional Identity (BMLEH) aims to strengthen sustainability in the agri-food sector by making sustainability performance visible along the entire value chain. Current market prices often fail to capture externalized costs and benefits, limiting consumer awareness of and incentives for sustainable agricultural practices. To address this gap, TMG is conducting a study, commissioned by BMLEH, to explore the potential and feasibility of a science-based True Cost Accounting (TCA) system that reveals the hidden environmental, social, and health costs and benefits of business activities and products in the German agri-food sector. Such a system has the potential to support more sustainable policy, business practices, and consumer choices by fostering greater transparency in the sector, but its implementation would be complex and faces challenges related to methodological approaches, data availability, and stakeholder willingness.

The report analyzes the potential strengths and weaknesses of the TCA approach, as well as external opportunities and risks that influence its implementation in the German agri-food sector. It then derives strategies for the development of a TCA system. Table 1 summarizes the results of the SWOT analysis.

Table 1. Overview of SWOT Results

Internal assessment	
Strengths	**Weaknesses**
• Broad applicability of TCA frameworks and guidelines • Increasing harmonization across TCA approaches • Feasibility of TCA implementation with existing data and tools • Flexible use of monetization for impact translation • Strong methodological development and solid data coverage for natural capital	• Sector-specific limitations of methodologies • Methodological and data fragmentation • Practical and technical barriers to implementation • Challenges of translating complex issues into monetary terms • Inadequacies of Life Cycle Assessment (LCA) in capturing realities of agri-food systems • Incomplete methodological and data coverage of the various impact categories • Data gaps and regional limitations
External assessment	
Opportunities	**Threats**
• Alignment with international, EU, and German sustainability goals • Growing international and civil society momentum for TCA • EU policy framework can support data collection and communication of TCA results	• Political deprioritization of sustainability and obstructive influence from interest groups (lobbying) • Barriers to implementation in an open and globalized market

• Financial incentives supporting the uptake of sustainable practices • Strong consumer awareness on sustainability issues and moderate trust in labels • Digitalization and data sharing innovations in the agri-food chain	• Resistance from key actors in the agri-food sector • Limited consumer willingness to pay for sustainability • Public misunderstanding and mistrust toward TCA • Inadequate data infrastructure and legal limitations

The analysis of strengths and weaknesses (internal assessment) of existing TCA methodologies and databases shows that current TCA frameworks and guidelines provide a solid foundation for application in Germany's agri-food sector, though notable methodological and data gaps remain. At the national and product levels, TCA frameworks are already broadly applicable, supporting policy development, labelling initiatives, and consumer education. However, business-level TCA frameworks designed for sustainability reporting and corporate decision-making are less developed. While agri-food-specific TCA frameworks on the business level lack methodological depth, more general ones fail to capture the sector's complex realities. Product-level assessments are comparatively more advanced, enabling comprehensive evaluations based on generic datasets. However, these databases often rely on global or national averages, which may overlook regional and production-specific characteristics. Leveraging farm- or business-specific data requires standardized sustainability data collection approaches, which are not yet widely applied in the German agri-food sector. Methodological maturity and database coverage are strongest for natural capital, where well-established models allow for robust assessments. In contrast, coverage of social and human capital in TCA frameworks remains limited, and positive externalities are frequently neglected. Despite these challenges and the absence of best-practice examples, early application is both feasible and valuable, as it provides early experience, involves stakeholders, and specifically supports the development of practical methods and the expansion of relevant databases. A stepwise implementation, drawing on existing tools and generic databases, can provide practical insights to guide the prioritization of further methodological and data-related measures.

The analysis of opportunities and threats (external assessment) related to external factors influencing the implementation of a TCA system in the German agri-food sector highlights both strong opportunities and significant challenges across political, economic, consumer, and data-related dimensions. Politically, there are international, EU, and national sustainability strategies that provide a supportive framework, while emerging support for TCA and recent regulatory frameworks offer momentum for TCA adoption. The recent political shift towards competitiveness and reduction of bureaucracy, which deprioritizes long-term sustainability, may hamper the uptake of TCA, as it is often perceived as a regulatory rather than a market-based instrument supporting efficiency and transparency. Economically, trade considerations, competitive pressures, and stakeholder resistance may slow uptake, though financial incentives and

alignment with sustainable finance initiatives could facilitate participation. Consumer attitudes are generally favourable toward sustainability, yet price sensitivity and limited understanding of complex TCA information pose challenges for public acceptance. Finally, gaps in data infrastructure, the often-inadequate farm-level data management, and legal constraints complicate implementation, although emerging digital tools and technological innovations for data collection, analysis, and sharing offer promising solutions. Overall, the external assessment suggests that while TCA has strong potential to enhance transparency and sustainability, careful policy design and targeted support will be crucial for successful adoption.

Based on the SWOT analysis results, the report provides strategies for the development of a TCA system. A summary of these strategies can be found in Table 2. The strategies outline ways in which BMLEH may build on existing expertise in methodology and data collection, drawing on researchers, private sustainability tool providers, and Life Cycle Assessment (LCA) database providers, while actively involving stakeholders in policy design, data infrastructure development, and the creation of (financial) incentives. To secure public acceptance, TCA must be communicated through clear, benefit-oriented messaging and supported by targeted education efforts.

Table 2. Overview of strategies towards developing a TCA system

Thematic area	Strategy
Design of a TCA system	Initiate national stakeholder dialogue for participatory policy design
	Consider and plan a stepwise implementation process
	Advocate for EU-wide collaboration on the topic of TCA
Methodological requirements	Co-develop a methodology tailored to the TCA system that is transparent and scalable
	Pilot the co-developed methodology with a representative sample of farms and food businesses to evaluate its feasibility, accuracy, and user-friendliness before national rollout
Data requirements	Secure funding to expand national LCA databases for TCA, especially for underdeveloped impact categories, positive externalities, and non-conventional production practices
	Advocate for a standardized sustainability data collection scheme within the EU Benchmarking System that supports TCA assessment
Data infrastructure and governance	Develop a unified data entry platform for farms that integrates data collection for multiple purposes
	Collaborate with private sustainability reporting tool providers to co-develop a TCA database that builds on existing expertise in business-level data management and digital infrastructure
	Develop a national data governance framework that defines responsibilities, access rights, quality standards, validation, and secure sharing procedures
	Create targeted incentives for stakeholders who voluntarily implement TCA

Willingness and capacity of stakeholders	Engage with farmers and agri-food business representatives in the development of the TCA methodology, digital data solutions, and overall system design to ensure feasibility and acceptance
	Use positive and benefit-oriented communication to engage adopters, emphasizing bureaucratic efficiency and financial advantages
	Establish training and extension programs to support farmers and agri-businesses in adopting TCA-related digital tools
	Educate staff in the public administration to be able to assist adopters and assign one or more local TCA system experts
Public awareness	Launch a national TCA awareness campaign
	Integrate TCA into education
	Highlight health aspects in the communication of TCA

This report is the second interim report of the project. Interim report I examined the availability and applicability of existing TCA frameworks, guidelines, and data sources relevant to the agri-food sector. The third and final report will assess the feasibility and effectiveness of TCA-informed policy instruments and outline a practical roadmap for implementing TCA in Germany's agri-food system.

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List of Abbreviations

AI	Artificial Intelligence
ASAN	From Field to School (Vom Acker in die Schule)
ACM	Netherlands Authority for Consumers and Markets
BfDI	German Federal Commissioner for Data Protection and Freedom of Information (Bundesbeauftragte für den Datenschutz und die Informationsfreiheit)
BLE	German Federal Office of Agriculture and Food (Bundesanstalt für Landwirtschaft und Ernährung)
BMAS	German Federal Ministry of Labour and Social Affairs (Bundesministerium für Arbeit und Soziales)
BMBFSFJ	German Federal Ministry for Education, Family Affairs, Senior Citizens, Women and Youth (Bundesministerium für Bildung, Familie, Senioren, Frauen und Jugend)
BMDS	German Federal Ministry for Digital Transformation and Government Modernisation (Bundesministerium für Digitales und Staatsmodernisierung)
BMLEH	German Federal Ministry for Agriculture, Food and Regional Identity (Bundesministerium für Landwirtschaft, Ernährung und Heimat)
BMEL	German Federal Ministry for Food and Agriculture (Bundesministerium für Ernährung und Landwirtschaft, now BMLEH)
BMF	German Federal Ministry of Finance (Bundesministerium der Finanzen)
BMG	German Federal Ministry of Health (Bundesministerium für Gesundheit)
BMUV	German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit)
BMUKN	Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Klimaschutz, Naturschutz und nukleare Sicherheit)
BVE	Federal Association of the German Food Industry (Bundesvereinigung der Deutschen Ernährungsindustrie)
CAP	Common Agricultural Policy
CDU	Christian Democratic Union of Germany (Christlich Demokratische Union Deutschlands)
CSDDD	Corporate Sustainability Due Diligence Directive
CSU	Christian Social Union in Bavaria (Christlich-Soziale Union in Bayern)
CSRD	Corporate Sustainability Reporting Directive
DARP	German Recovery and Resilience Plan (Deutsche Aufbau- und Resilienzplan)
DBV	German Farmers' Association (Deutscher Bauernverband)
DG AGRI	Directorate-General for Agriculture and Rural Development
DLG	German Agricultural Society (Deutsche Landwirtschafts-Gesellschaft)
DNS	German Sustainability Strategy (Deutsche Nachhaltigkeitsstrategie)

EBIT	Earnings Before Interest and Taxes
EU	European Union
EUFIC	European Food Information Council
ESG	Environmental, Social, and Governance
FAO	Food and Agricultural Organization of the United Nations
FADN	Farm Accountancy Data Network
FDP	Free Democratic Party (Freie Demokratische Partei)
FSDN	Farm Sustainability Data Network
FTA	Free Trade Agreements
GAR	Green Asset Ratio
GATT	General Agreement on Tariffs and Trade
GCD	Green Claims Directive
GeschGehG	German Trade Secrets Act (Geschäftsgeheimnisgesetz)
GDPR	General Data Protection Regulation
GHG	Greenhouse gas
GRI	Global Reporting Initiative
iaw	Institute Labour and Economy (Institut Arbeit und Wirtschaft)
IFH Köln	Center for Research in Retailing Cologne (Institut für Handelsforschung Köln)
IFOAM	International Federation of Organic Agriculture Movements
IFVI	International Foundation for Valuing Impacts
KMK	Conference of Ministers of Education (Kultusministerkonferenz)
KTBL	Kuratorium für Technik und Bauwesen in der Landwirtschaft e. V.
KPI	Key Performance Indicators
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
NABU	Nature and Biodiversity Conservation Union (Naturschutzbund Deutschland e.V.)
NFP	Netherlands Food Partnership
NGO	Non-Governmental Organization
OEF	Organization Environmental Footprint
PEF	Product Environmental Footprint
PD	PD – Berater der öffentlichen Hand GmbH
S-EBIT	Sustainable Earnings Before Interest and Taxes
SDG	Sustainable Development Goal
SFDR	Sustainable Finance Disclosure Regulation
sLCA	Social Life Cycle Assessment
SMEs	Small and medium-sized enterprises
SOFA	State of Agriculture and Food
SPD	Social Democratic Party of Germany (Sozialdemokratische Partei Deutschlands)
SWOT	Strength, weaknesses, opportunities, and threats
TBT	Technical Barriers to Trade
TCA	True Cost Accounting
TMG	Töpfer, Müller, Gaßner GmbH
TEEB	The Economics of Ecosystems and Biodiversity
UBA	German Environment Agency (Umweltbundesamt)

UN	United Nations
UNEP	United Nations Environmental Programme
UNFSS	United Nations Food Systems Summit
VBA	Value Balancing Alliance
VSME	Voluntary Small and Medium-sized Enterprises Reporting Standard
WTO	World Trade Organization

1. Introduction

1.1. The project's rationale

True Cost Accounting (TCA) is a method for making the positive and negative impacts and associated costs and benefits of food systems visible. By looking beyond market prices, it can be used to reveal the hidden costs and benefits (economic, social, environmental, and human) of food production and consumption. The information obtained through TCA assessments can be used in various ways. A common misunderstanding about TCA is that it will lead to higher prices for food products. While TCA does uncover hidden costs that are not reflected in current market prices, "true pricing" is only one way to utilize TCA information. TCA can also inform the design of policy instruments such as subsidies, tax adjustments, or tradeable permits (e.g. carbon or nature credits) that can directly or indirectly influence prices. Alternatively, businesses may use TCA for internal and external reporting (e.g. Sustainability Performance Accounting), dual pricing (e.g. second price tag), TCA-based labels and awareness campaigns—which are all approaches that inform rather than directly change consumer prices.

The Federal Ministry for Agriculture, Food and Regional Identity (BMLEH) is currently investigating TCA as a possible approach to making sustainability performance visible along the value chain. The overarching goal is to foster greater sustainability in the agri-food sector. On the supply side, TCA is intended to empower farmers to actively shape the transformation process by creating incentives to adopt more sustainable management practices and to strengthen appreciation for the natural and human resources on which their work depends. On the demand side, TCA aims to raise consumer awareness of the true value of food and the sustainability efforts undertaken by farmers.

Against this backdrop, BMLEH commissioned TMG Think Tank for Sustainability (TMG) to identify the relevant methods and data sources for TCA at the company and product levels in the agri-food sector (Interim Report I) and to analyse their strengths, weaknesses, opportunities, and risks for potential implementation (Interim Report II). Based on these findings, recommendations for action will be derived for politics, science, and industry and presented in the form of a roadmap for the development of a scientifically sound TCA system for assessing and communicating true costs and benefits in the German agri-food sector (final report). The process is informed by expert workshops and consultations with a broad range of stakeholders.

1.2. About this report

Building on the findings of Interim Report I—which reviewed existing TCA frameworks, guidelines, and data sources relevant to the agri-food sector—this Interim Report II conducts a strengths, weaknesses, opportunities, and threats (SWOT) analysis of current TCA methods and databases, assessing their suitability for the implementation of a TCA system for agri-food products and

businesses in Germany. The analysis is carried out in two steps. First, we evaluated the strengths and weaknesses of existing methods and databases (internal assessment) and identified opportunities and threats related to the implementation of TCA (external assessment). Second, we developed strategic recommendations for the development of a TCA system tailored to the German agri-food sector.

The report is organized into six chapters. Chapter 2 outlines the methodological approach of the SWOT analysis and strategy development. Chapter 3 discusses the internal and external factors influencing TCA implementation in the German agri-food sector (a more detailed analysis and background information on the internal and external assessment is provided in Appendices 2 and 3). Chapter 4 proposes strategies for building a TCA system in Germany. Finally, Chapter 5 provides an outlook on the third and final report, which will present a detailed roadmap for TCA implementation.

2. Method description

A SWOT analysis is a method of assessing the status quo of an organization or another unit of analysis by identifying its strengths, weaknesses, opportunities, and threats to create a basis for strategy development and action recommendations (Bundesministerium des Innern, n.d.). In this report, we conduct a SWOT analysis to assess the status quo of TCA methods and databases and the societal framework conditions for the implementation of a TCA system in the German agri-food sector. The SWOT analysis comprises two steps:

1. Identification of strengths and weaknesses (internal factors) and opportunities and threats (external factors)
2. Strategy development through pairwise combination of internal and external factors

The first step can be divided into two parts, internal and external assessments (see Figure 1**Error! Reference source not found.**). The internal assessment i dentifies strengths and weaknesses of methods and databases that can be used for TCA. This assessment shows what current TCA methods and databases can deliver, as well as highlighting any methodological or data gaps. The external assessment focuses on external factors that may impact the implementation of a TCA system in the German agri-food sector. This assessment draws a picture of the current political, economic, societal, and technological situation in which the implementation of a TCA system would be taking place.

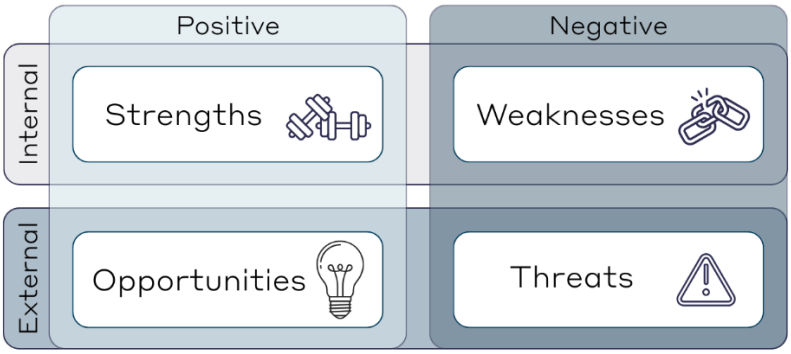

Figure 1. First step of the SWOT analysis

The second step of the SWOT methodology allows us to develop concrete strategies towards the implementation of a science-based TCA system. The combination of internal and external factors facilitates the identification of strategies towards the development of a TCA system for the German agri-food sector. These strategies show which actions are needed to build a functioning TCA system. Figure 2 summarizes the guiding questions of the second step of the SWOT analysis.

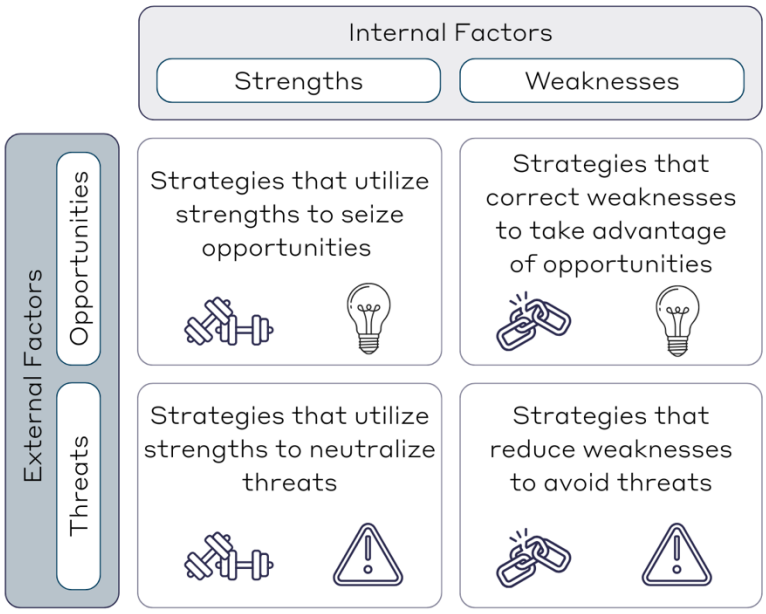

Figure 2. Second step of the SWOT analysis

The results from Interim Report I are used to identify the strengths and weaknesses of TCA methods and databases. The identification of opportunities and threats was informed by literature review, expert interviews, and internal brainstorming sessions. In the first expert workshop of the project, stakeholders verified the preliminary results of the SWOT analysis and developed strategies. For this purpose, an online workshop was held in June 2025. The participants were members of the European TCA community of practice as well as representatives from BMLEH and the Federal Office for Agriculture and Food (BLE). A participants list can be found in Appendix 1: Participants list of expert workshop.

The SWOT results were verified as part of a virtual gallery walk. The participants had access to an online whiteboard presenting the preliminary results of the internal and external assessment. They had 20 minutes to write comments and add to the findings, followed by a verbal discussion of the results. In the second part of the workshop, participants were divided into four groups. Each group developed strategies through pairwise combinations of internal and external factors, following the guiding questions presented in Figure 2. After 30 minutes, the results were presented in the plenary and the groups had the opportunity to comment on others' results. The strategies suggested in the workshop were used by TMG as a starting point to formulate concrete strategies towards the development a TCA system for the German agri-food sector.

3. Results of the SWOT analysis

Table 3 summarizes the results of the SWOT analysis. The first section of the table outlines the strengths and weaknesses of TCA methods and databases identified through the internal assessment, structured around five thematic areas: applicability, operational maturity, harmonization and standardization of methods, monetization, and practicability of TCA implementation. The second section presents the external assessment results, highlighting external factors influencing the implementation of TCA in the German agri-food sector. These are categorized into political environment, economic conditions, consumer attitudes, and data infrastructure. Detailed information on each of the points in Table 3 can be found in Appendix 2: Internal assessment and Appendix 3: External assessment, which provide the detailed results of the SWOT analysis. Sections 3.1 and 3.1.3 summarize the findings from the internal and external assessment.

Table 3. Summary of results of the SWOT analysis

Strengths	Weaknesses
Applicability of TCA frameworks and guidelines	
Broad applicability of TCA frameworks and guidelines • Available TCA frameworks and guidelines support more holistic sustainability assessments by taking into account and monetizing economic, environmental, social, and health externalities. • At the business level, frameworks and guidelines allow for broad application of TCA across key areas of corporate decision-making and reporting. • At the product level, TCA allows for applications such as true pricing,	**Sector-specific limitations of methodologies** • Most frameworks are not tailored to the specific characteristics and complexities of the agri-food sector, restricting application.

consumer education, and sustainability labelling. • TCA has strong potential to drive sustainable consumer behaviour change.	
Harmonization and standardization of TCA methodology and data	
Increasing harmonization across TCA approaches • Conceptual alignment across existing frameworks supports a certain level of harmonization and TCA can provide practical information without methodological perfection across different analytical levels.	**Methodological and data fragmentation** • In the agri-food sector, there is no standardized best practice or gold standard methodology for TCA, and existing approaches vary widely in scope, data requirements, and impact measurement methods (e.g. due to different goals and objectives), which limits comparability. • There is a lack of a comprehensive database that covers all essential input/output, management, impact, and model data on environmental, social, and human capital; relevant information is fragmented across multiple sources and formats. • There is neither a standardized approach for collecting specific TCA data nor established data pools including specific data within the agri-food sector. • The absence of universally accepted definitions for indicators and measurements across databases undermines data consistency and comparability.
Practicality of TCA implementation	
Feasibility of TCA implementation with existing data and tools • TCA can be implemented incrementally by building on existing data and focusing on practical progress.	**Practical and technical barriers to implementation** • High data collection requirements and the need for interdisciplinary expertise make TCA resource- and expertise-intensive and time-consuming. • Generic datasets are not well integrated into TCA methodologies, and methodological guidance for their use in the context of TCA is lacking. • Lack of best-case examples that can clearly demonstrate the business case to those still skeptical about TCA.
Use of monetization	

Flexible use of monetization for impact translation • TCA can guide holistic decision-making, even without monetization. • Monetization makes impacts comparable and understandable and allows for the creation of market incentives.	**Challenges of translating complex issues into monetary terms** • Reduction of complex realities into economic terms and limitations in capturing long-term and cultural values through monetization.
Operational maturity of methodology and data	
Strong methodological development and solid data coverage for natural capital • TCA for natural capital is relatively advanced, providing a strong foundation for assessment with robust life cycle inventory (LCI) databases and evolving monetization factors.	**Inadequacies of LCA in capturing realities of agrifood systems** • Current LCA impact models often fail to reflect agri-food-specific externalities and interdependencies. **Incomplete methodological and data coverage of the various impact categories** • Social and human capital categories are underrepresented in terms of indicators, monetization, and data. • No single comprehensive framework provides a structured and consistent approach covering all capital categories and equally prioritizing negative and positive externalities. **Data gaps and regional limitations** • Existing generic databases providing input/output, model, and impact data rely on broad global or country averages, failing to reflect the diversity of production practices, regional variations, and specific industry branches, while the limited availability of country-specific data results from a lack of systematic sustainability data collection.
Opportunities	**Threats**
Political environment	
Alignment with international, EU, and German sustainability goals • International agreements underline the need for a more sustainable economic system. • The EU Green Deal and Farm-to-Fork Strategy could offer long-term policy certainty and a comprehensive framework to support the transition towards more sustainability. • The German Sustainability Strategy provides a policy framework that	**Political deprioritization of sustainability and obstructive influence from interest groups (lobbying)** • The EU Commission's efforts to increase business competitiveness and reduce bureaucracy may diminish opportunities for TCA implementation. • The strong German agricultural lobby prioritizes reducing bureaucratic burdens for farms and may oppose TCA initiatives.

aims to achieve a sustainable agri-food system. **Growing international and civil society momentum for TCA** • There is international interest and support for the national-level development and implementation of TCA. • Dialogue platforms in the agri-food sector underline the importance of assessing true costs and compensating farmers for providing public services. **EU policy framework can support data collection and communication of TCA results** • The EU Vision for Agriculture and Food calls for the development of a benchmarking system that sets sustainability standards and allows for sustainability data collection at the farm level. • The EU Corporate Sustainability Reporting Directive (CSRD) supports standardized business reporting on sustainability impacts and could serve as an opportunity for standardized data collection (though this potential may be curtailed by the EU Omnibus Directive). • The EU's Environmental Footprint Methods provide a standardized methodology for measuring environmental impacts at product and business levels, offering a solid methodological foundation for TCA assessments. • The European Commission's planned nature credits scheme can serve as a starting point for the implementation of TCA methodology at EU level.	• The German government prioritizes economic growth, which might lead to neglect or discontinuation of sustainability efforts. • Opponents may try to frame TCA as 'left-wing' politics.
Economic conditions	
Financial incentives supporting the uptake of sustainable practices • Farmers are willing to engage in more sustainable practices, especially if they are being reimbursed for their efforts. • The EU Sustainable Finance Disclosure Regulation (SFDR) will increasingly demand sustainability reporting in the financial sector and	**Barriers to implementation in an open and globalized market** • International and EU trade legislation may limit the use of TCA policy instruments that are considered trade-distorting. • Agri-food businesses are embedded in global value chains, which poses significant challenges for implementing a consistent TCA system.

incentivize investment in sustainable business models.	• German farms and agribusinesses face competition from within and outside the EU single market. **Resistance from key actors in the agri-food sector** • Businesses in the processing and retail sector currently make little effort to integrate TCA into their strategies • German farms face significant economic and political pressure that discourages engagement and investment in sustainability initiatives. • Farms and agri-food businesses perceive a high bureaucratic burden that may restrict their willingness and/or capacity to participate in a TCA system. • Potential unwillingness of farms and agri-food businesses to collect and share sensitive data, because they expect insufficient financial benefits and competitive disadvantages. • Scepticism of value chain actors towards the completeness of TCA calculations and the communication of results. • Given the strong market influence of the food retail sector in Germany, voluntary TCA initiatives depend heavily on their willingness to engage.
Consumer attitude	
Strong consumer awareness on sustainability issues and moderate trust in labels • High consumer awareness of environmental sustainability can support acceptance of TCA implementation. • High consumer interest in health factors related to diets can support acceptance of TCA implementation. • Consumer trust in sustainability labels and demand for holistic sustainability information can support TCA implementation.	**Limited consumer willingness to pay for sustainability** • Rising food prices for consumers lower the acceptance of TCA implementation. • Price sensitivity and consumers' persisting attitude–behaviour gap results in low willingness to pay for sustainability efforts. **Public misunderstanding and mistrust toward TCA** • Consumers' perception and understanding of TCA-related sustainability information can hamper the effectiveness of TCA communication. • Greenwashing or social washing practices undermine the credibility of TCA efforts and create public mistrust.
Data infrastructure	

Digitalization and data sharing innovations in the agri-food chain	Inadequate data infrastructure and legal limitations
• Farm Sustainability Data Network (FSDN) could serve as a starting point for TCA data collection at the farm level. • Existing private sector digital tools can be a starting point for the development of a TCA data infrastructure. • Recent technological developments (such as Artificial intelligence (AI) and Blockchain) have the potential to facilitate TCA assessments by making them faster, less resource- and knowledge-intensive, and more accessible. • Ongoing research on data sharing and usage in the agri-food sector could be leveraged for TCA.	• No existing public data infrastructure or systematic collection of sustainability data in the German agri-food sector. • Farm-level data management in Germany is inadequate for comprehensive sustainability assessments, as data is collected for diverse purposes and key figures must be extracted from multiple primary sources. • There are legal restrictions in the collection, storage, sharing, and use of personal or commercially sensitive data.

3.1. Results of the internal assessment

The internal assessment of TCA implementation in the German agri-food sector evaluates the strengths and weaknesses of currently available methodologies and databases. It highlights what the methodologies and databases can deliver at the business and product level, as well as where gaps remain. Strengths and weaknesses are structured into five categories: applicability of TCA frameworks and guidelines; harmonization and standardization of methodology and data; practicality of implementation; use of monetization; and operational maturity. Appendix 2: Internal assessment provides detailed descriptions and background information on the results of the internal assessment presented in

Table 3. The following sections discuss the general methodological considerations as well as the status quo of business- and product-level assessments based on the internal assessment.

3.1.1. General methodological considerations

TCA offers a holistic framework and increasingly actionable approach for addressing the often-overlooked externalities of the German agri-food system. By accounting for hidden costs and benefits, TCA can support policy development on a national level, sustainability management and reporting at the business level, and consumer communication at the product level, informing sustainable decision-making of different food systems actors. While TCA offers a lot of potential, the methodology and data are still under development, and practical, real-world applications remain at an early stage. There is a lack of best-case examples that clearly demonstrate the business case for applying TCA across various farm types, resulting in hesitancy among stakeholders.

Practical examples can help shift TCA from a theoretical concept to a tangible, actionable approach.

TCA assessments at national, business, and product levels require different methods and data; current TCA methodologies vary widely in scope, data requirements, and impact measurement methods (e.g. due to different goals and objectives). This variability can limit the comparability of results. While standardization of methodologies would be beneficial insofar as it promotes scientific consensus, comparability, and public acceptance, complete standardization would also be challenging as different assessment levels require tailored approaches.

Another challenge of comprehensive TCA application lies in indicator and data coverage across capital categories. Natural capital is relatively well developed, with available impact indicators and generic databases providing a strong foundation for assessment. In contrast, social and human capital categories are underrepresented, with limited indicators, monetization methods, and available data, which can constrain the scope of TCA results. Furthermore, current methodologies often overlook positive externalities, leading to assessments that underestimate the full benefits of sustainable practices.

Nevertheless, as highlighted in the expert workshop, scholars agree that meaningful TCA application is already possible and should not be delayed by the pursuit of perfection, which may never be attainable. A consensus on a 'good enough' methodology can enable implementation without waiting for a single gold standard. At its current stage, TCA can be applied incrementally using existing methodologies, data, and knowledge. Organizations can begin with areas where data is already available, gain practical experience, identify knowledge gaps, and iteratively expand their assessment scope over time. This approach allows early adoption to provide actionable insights, even while methodological and data development continues, and helps build a foundation for a more comprehensive TCA framework in the future.

At national level, a prominent example of large-scale TCA application with currently available methodologies comes from the Food and Agriculture Organization of the United Nations (FAO). In its 2023 *State of Food and Agriculture* (SOFA) report, the FAO presented the first global assessment of the hidden costs of agri-food systems, using national-level data from 154 countries, including Germany (FAO, 2023c). This analysis highlighted key policy interventions needed to transform these systems. Building on this work, the subsequent SOFA report (FAO, 2024) engaged stakeholders at the national level to validate the quantified hidden costs, identify data gaps, and contextualize challenges and potential solutions based on each country's priorities and commitments. This example shows how national-level TCA can guide concrete political action and define desired outcomes for a more sustainable agri-food system.

Conducting a full TCA assessment can require substantial resources, and its scope should be carefully weighed against the intended objectives and expected benefits. However, even partial application of TCA can provide meaningful

insights and inform decision-making. Each step of the TCA process can generate value:

- **Step 1. Identification of impacts**

Applying a systems thinking approach across the four capitals—natural, human, social, and produced—can highlight key impacts, reveal priority areas for intervention, and support more holistic decision-making, even without complete quantification or monetization.

- **Step 2. Impact assessment** (quantification of impacts)

Impact assessment alone can already be useful when monetization factors for relevant capitals and impacts are not yet available. Assessing impacts provides valuable insights for holistic decision-making, for example, helping policymakers identify commodities and production practices with the highest negative impacts. These insights can inform a wide range of policies, such as introducing taxes on products with high negative impacts, restricting their advertising, and producing public awareness campaigns that promote sustainable consumption.

- **Step 3. (E)Valuation** (monetizing impacts)

Translating impacts into monetary terms enhances the comparability of results across impact categories. At the business level, monetization helps to compare the financial implications of different practices and prioritize actions that mitigate financial risks. Monetized data can also be included in sustainability reports and financial reporting to improve transparency. At the product level, monetization helps businesses to communicate their sustainability efforts to consumers by integrating monetized TCA results into prices (true pricing) and sustainability labelling. However, monetization comes with limitations, where translating complex environmental and social issues into economic terms risks oversimplification and may fail to capture long-term consequences, cultural significance, or ethical values.

- **Step 4. Reporting and action**

The outputs of TCA—whether from impact identification, quantification, or monetization—become actionable when systematically reported and integrated into decision-making processes. At the policy level, TCA results inform regulatory decisions, incentive programs, and system-level interventions to promote sustainable consumption and production. Policymakers can use TCA insights to inform the public about the true costs of products and production systems. Transparent communication of these costs can increase public awareness and acceptance of sustainability policies, making voters more likely to support measures such as taxes on products with high negative impacts, subsidies for sustainable practices, or stricter environmental regulations. At the business level, TCA supports corporate decision-making and reporting. It helps companies measure and monitor their sustainability performance, showing impact on natural, social, and human capitals, as well as related financial risks. In line with this approach, according to the German Accounting Standard, if TCA indicators are used for business steering, they must be

included in company management reports (True Cost Initiative, 2022). Assessment results can be reported as quantitative non-financial Key Performance Indicators (KPIs) or as financial KPIs if they directly affect accounting data or the company's value. Including TCA results in annual reports (e.g. in the management report) improves transparency for external stakeholders such as investors, civil society, and regulators, helping organizations communicate their sustainability performance, resilience, and strategic priorities.

3.1.2. Business-level assessment

At the business level, existing TCA frameworks and guidelines provide a solid conceptual basis, but practical implementation in the agri-food sector remains challenging. In theory, these frameworks support the four-step TCA process (impact identification, impact assessment, valuation, and reporting/action), yet detailed, sector-specific guidance at the business level is limited.

For example, the TEEB Agrifood Evaluation Framework (Eigenraam et al., 2020) is specific to the agri-food sector and outlines the general steps of TCA and underlying principles, but it does not offer detailed, business-level instructions on the design and format of indicators, the exact data to collect, or practical reporting procedures.

The Conceptual Framework for Impact Accounting (IFVI and VBA, 2024) provides a general approach for business-level TCA, addressing major natural capital impacts (e.g. greenhouse gas (GHG) emissions, air pollution, land use, water pollution) and some social impacts (e.g. fair wages, occupational health and safety), providing a foundation for broad application at the business level. However, it is not tailored to the agri-food sector and therefore omits important impacts such as soil degradation, scarce water use, soil organic carbon, human toxicity, forced labour, child labour, and animal welfare.

Conceptual frameworks for reporting TCA results at the business level exist. One example is Sustainable Performance Accounting (Henkel et al., 2024), which conceptualizes the creation of shadow balance sheets and the calculation of Sustainable Earnings Before Interest and Taxes (S-EBIT). Another example is provided by the TCA AgriFood Handbook (True Cost Initiative, 2022), which outlines how to present TCA results in the management section of a company's annual report. However, practical guidance on detailed implementation and design remains incomplete. Detailed guidance on indicators, data collection, reporting formats, and best-practice examples remains incomplete, limiting the practical application of TCA for agri-food businesses.

Existing frameworks do not adequately reflect agri-food specific impacts and do not cover all relevant capitals (natural, social, human, and produced). There is no detailed, sector-specific guideline that covers natural, social, and human capital categories, reflects the complexity of agri-food value chains, and defines the required methodology and data to achieve more accurate and comprehensive TCA assessments. Existing frameworks and guidelines can serve as a starting point for further development. Guidelines such as the TCA

AgriFood Handbook could be adapted and operationalized for business-level application. Frameworks such as Sustainable Performance Accounting need additional guidance on reporting formats, indicators, and practical examples.

When it comes to data requirements for business-level assessments, conducting a comprehensive TCA assessment requires the collection of specific data[i] across the supply chain. Availability of such data is currently limited due to the lack of standardized data pools and systematic collection processes. Establishing dedicated data resources and introducing systematic collection methods could accelerate progress. The farm management data collected by the Kuratorium für Technik und Bauwesen in der Landwirtschaft e. V. (KTBL) already provides a foundation for standardized data collection, even though the indicators are not yet sufficient for a full TCA implementation. At the European level, the new (as of 2025) Farm Sustainability Data Network (FSDN) will allow for voluntary collection of farm-level sustainability data across economic, environmental, and social dimensions, creating an important reference framework. Another promising initiative is the MinKriSet project, led by the Thünen Institute and the German Agricultural Society (DLG), which is developing a minimum criteria set for on-farm sustainability assessment through a multi-stakeholder process. By prioritizing farmers' needs, MinKriSet could serve as a practical starting point for scaling up sustainability data collection.

3.1.3. Product-level assessment

At the product level, TCA focuses on quantifying and monetizing the environmental, social, and human capital impacts associated with specific food products. This level of analysis enables businesses to communicate product-specific sustainability performance, supports consumer-facing instruments such as sustainability labels or true pricing, and can inform policy measures targeting specific commodities or production practices. Product-level TCA typically draws on established assessment methodologies that combine specific product data with generic databases, translating impacts into monetary terms to facilitate comparison and decision-making.

For product-level assessment, there are three methodologies that can support the implementation of TCA. Firstly, the TCA AgriFood Handbook (True Cost Initiative, 2022) focuses on plant-based products and helps estimate and monetize natural, social, and human capital impacts including climate change, pollution, resource use, labour rights, and human rights. Impact estimations mainly depend on collection of specific data and the handbook recommends that, when specific data is not available, generic data[ii] such as ecoinvent or Agribalyse can be used as a substitute for environmental impact assessment.

[i] Data that is directly linked to a specific product, company or process, often based on primary data collection or direct measurements. Specific data provides more accurate and context-relevant insights compared to generic data.

[ii] Generic data refers to data that is not specific to a particular product, company or region but represents industry averages, estimates or model-based assumptions. Generic data is often used when specific data is unavailable and can be sourced from databases, literature or statistical reports.

However, for accuracy, they recommend prioritizing the collection of specific data. Relevant monetization factors for each impact indicator are provided in the handbook.

Secondly, the True Price Assessment Method for Agri-food Products (Galgani et al., 2023) provides methodologies for calculating and monetizing a wide range of environmental (e.g. climate change, air and water pollution, land use, acidification, eutrophication, scarce water use) and social impacts (e.g. living income, occupational health and safety, child labour). It can be used for different branches of the agri-food sector, plant production, livestock production, aquaculture, and fishing. Environmental impact assessment requires a combination of specific data collection and the use of life cycle inventories (LCIs) such as ecoinvent. It is recommended that assessments of social impacts rely on specific data, although in cases where specific data is unavailable, generic databases such as Global Living Wage datasets can support the application. The methodology provides monetization factors for assessed environmental and social impacts.

Lastly, environmental Life Cycle Assessment (LCA) can be used as a product-level analysis tool combined with monetization factors to assess the environmental costs of food products. This approach can draw on available generic data such as agricultural statistics (e.g. FAO, national statistics), life cycle inventories (e.g. Agribalyse, ecoinvent), impact data (e.g. Agribalyse, Poore and Nemecek, 2019), LCA models and environmental monetization factors (e.g. CE Delft monetization factors, True Price monetization factors). Analysis can be made more precise through product-specific data collection. It is possible to apply LCA to all branches of the agri-food sector.

However, current LCA models have limitations in fully capturing agri-food-specific issues such as biodiversity loss, animal welfare, and the benefits of agroecological production systems that strengthen resilience and sustainability. Because they measure impacts per unit of output, LCA models tend to favour high-yield intensive farming systems and can misrepresent less intensive agroecological systems like organic farming. While organic farming generally produces fewer pollutants, its typically lower yields can lead to higher impacts per unit of product. Focusing only on product-based impacts can therefore bias decisions toward conventional farming (Van Der Werf et al., 2020). Improving LCA models would enable more accurate comparison across farming systems and avoid bias.

From a data perspective, existing generic databases providing input/output, model, and impact data rely on broad global or national averages, failing to reflect the diversity of production practices, regional variations, and specific industry branches. For example, the LCI database ecoinvent provides a useful start but often reflects average conventional farms and may not capture the diversity of agri-food systems or regional specificities in Germany. Building databases tailored to Germany, like Agribalyse is to France, would enable more representative and precise impact estimations. The Life Eco Food Choice

project, which aims to replicate Agribalyse for selected European countries including Germany, is a promising step in this direction.

While existing TCA frameworks, guidelines, and databases for natural capital are comparatively well-developed and provide a strong basis for application, coverage of social and human capital impacts remains limited. Methodologies for these capital categories are less mature, and available data is sparse, reducing the ability to capture the full scope of impacts within TCA assessments. Relevant input/output, model, and impact data relevant to TCA are highly fragmented, with no structured, centralized, or easily accessible repositories. In addition, existing generic databases are not well-integrated into TCA methodologies and clear guidance on their effective use is lacking. This fragmentation creates barriers to efficient and consistent TCA implementation. The absence of a comprehensive, publicly accessible platform in Germany that integrates environmental, social, and human capital data further constrains the application of TCA across sectors.

Moreover, the restricted accessibility of LCI datasets like ecoinvent and Agri-footprint can pose a challenge, especially for smaller businesses, researchers, or practitioners without technical expertise. These datasets often require paid licenses and can be complex to navigate. This highlights a need to increase accessibility through capacity-building and training for farmers and non-experts, developing intuitive software tools, and enabling specialized experts (similar to tax advisors) to support stakeholders in using the datasets effectively.

Finally, specific data availability remains limited and, as with business-level application, product-level assessments would benefit from standardized data pools and systematic processes for the collection of specific data .

3.2. Results of external assessment

The external assessment of TCA implementation in the German agri-food sector identifies both opportunities and potential threats. While there is broad recognition of the need for sustainability, implementation challenges and resistance to TCA may arise. The assessment organizes opportunities and threats into four categories: political environment, economic conditions, consumer attitudes, and data infrastructure. The subsequent sections summarize the key results of this assessment. Appendix 3: External assessment provides detailed descriptions and background information on the external assessment results presented in

Table 3.

3.2.1. Political environment

International, EU, and German political initiatives aim to accelerate the transition towards sustainability in the agri-food sector. International agreements and high-level frameworks such as the UN Agenda 2030, the EU Green Deal with the Farm-to-Fork Strategy, and the German Sustainability Strategy align with the goal for more sustainability in agri-food systems. The

application of TCA can support the implementation of these strategies by helping to internalize environmental, social, and human costs and benefits, thereby contributing to the systemic change these strategies envision.

At the same time, TCA is gaining momentum among international and civil society actors. The United Nations Environmental Programme (UNEP) initiative *The Economics of Ecosystems and Biodiversity for Agriculture and Food* (TEEBAgriFood) published a prominent framework for TCA assessments in 2018. In 2021, the topic was prominently discussed as a key enabler for food system transformation during the UN Food Systems Summit (UNFSS). The FAO has elevated the concept on the global policy agenda via its 2023 and 2024 SOFA reports assessing the true costs of the global agri-food system. Belgium, the Netherlands, and Switzerland are actively supporting TCA through research funding and integration into national or regional strategies. In parallel, national and international groups such as the True Cost Alliance, the Global Partnership on the True Price of Food, and the TCA Accelerator are working to build momentum, coordinate action, and advocate for greater uptake of TCA in policy and practice. This growing interest is further echoed in multi-stakeholder dialogues at both EU and national levels. Processes such as the Strategic Dialogue on the Future of EU Agriculture, the German Commission for the Future of Agriculture, and the Youth Policy Forum have all highlighted the need for policy instruments that can make sustainability visible and measurable. Specifically, there is increasing demand for benchmarking systems that create economic incentives for ecosystem service provision (Strategic Dialogue on the Future of EU Agriculture, 2024; Zukunftskommission Landwirtschaft, 2024) and for tools that internalize hidden costs and benefits (Deutsche Bundesregierung, 2024; Strohschneider, 2024), both being core principles of TCA.

Complementing this international and civil society momentum, regulatory developments in the EU create a timely opportunity to advance TCA implementation. Emerging frameworks such as the On-farm Sustainability Compass, the Corporate Sustainability Reporting Directive (CSRD), and the planned nature credits scheme offer a potential backbone for the data infrastructure that TCA requires. TCA could serve as a method to implement these policies by calculating monetary values for benchmarking, reporting, and the pricing of nature credits. To fully capitalize on these developments, TCA requirements should be integrated into regulatory design early on, in order to ensure the generation of consistent, comprehensive, and high-quality data necessary for meaningful TCA assessments.

However, TCA implementation still faces significant political challenges. A growing trend toward sustainability deregulation in the name of competitiveness—seen in the positions of the European Commission, the current German government, and the agricultural lobby—may conflict with the governance needs of TCA. The EU Vision for Agriculture and Food marks a shift from the sustainability-centred approach of the Farm-to-Fork Strategy toward prioritizing the competitiveness and attractiveness of the agri-food sector. Although TCA is fundamentally a market-based tool aimed at correcting pricing failures related to natural, human, and social capitals, it is sometimes

mischaracterized as a left-leaning agenda. This misperception could slow political support from politicians, institutions, and voters who usually lobby for market-based over regulatory approaches.

3.2.2. Economic conditions

As part of the EU Single Market, Germany would implement a TCA system within the framework of an open market economy, in compliance with both EU internal-market rules and international trade law. A TCA system could be considered protectionist or trade-distorting if it favoured domestic over imported goods, discriminated between trading partners (e.g. favouring those able to provide TCA data), or created technical barriers that disproportionately increase costs for foreign producers, particularly in developing countries. While environmental or societal objectives can justify certain measures under legal exceptions, these measures must prove to be necessary, proportionate, and non-discriminatory. The TCA system must further account for the competitive pressures faced by private actors, both from within the EU and globally. The fact that many agri-food businesses are embedded in international value means that implementing TCA in Germany would require data collection and assessment that may extend to actors and activities outside national borders. A TCA system in Germany must be carefully designed to avoid placing German farms and downstream actors at a competitive disadvantage while also ensuring it is not perceived as protectionist or trade-distorting.

Despite its potential benefits, the implementation of TCA may encounter resistance from key stakeholders such as farmers, processors, and retailers. To date, there has been limited uptake of TCA practices in the private sector, and previous initiatives have often been short-lived. Farms are under both economic and political pressure, and many businesses in the agri-food sector express concern that TCA might further increase an already high administrative burden. Moreover, value chain actors may be reluctant to collect and share sensitive data, particularly in the absence of clear financial incentives or regulatory obligations. Value chain actors also express scepticism regarding the methodological robustness of TCA and concerns about how the results will be communicated and interpreted. In Germany, where the retail sector wields significant market power, the success of any voluntary TCA initiative will largely depend on the willingness of retailers to actively participate and lead by example.

Financial incentives could play a crucial role in building private sector support for TCA. The findings of the external analysis show that farmers are generally open to adopting more sustainable practices, provided they receive adequate compensation for the additional effort. Furthermore, opportunities may arise from the EU's Sustainable Finance Disclosure Regulation (SFDR), which could steer investments toward more sustainable business models. Agri-food companies that measure and communicate their impacts through TCA could position themselves as attractive investment targets, offering a potential win-win scenario for both business and sustainability.

3.2.3. Consumer attitudes

The current societal landscape in Germany offers favourable conditions for implementing TCA. Many consumers are aware of the negative environmental impacts of agri-food systems and supportive of concrete measures to make the German economy more sustainable. However, information on the health impacts of food seems to influence purchasing decisions more than environmental factors (Robert Bosch Stiftung & More in Common, 2025; van Bussel et al., 2022), suggesting that health-related data should be a key component of any TCA-based labelling scheme. German consumers appear open to comprehensive sustainability assessments and the introduction of a new label that integrates environmental, social, and health dimensions. Existing food labels already enjoy a moderate level of trust (Profeta & Cicek, 2021; Sonntag et al., 2023), which can be leveraged in the development of a TCA label. However, to secure lasting public confidence and acceptance, it will be critical to ensure institutional credibility and establish robust verification mechanisms.

However, sustainability awareness does not always translate into changes in consumer behaviour. Despite a high level of concern about sustainability issues, many consumers remain price sensitive. While TCA does not inherently lead to increased consumer costs, public willingness to pay for internalized externalities must still be carefully considered. Surveys from Germany suggest that, in theory, consumers support paying for the true cost of food (Michalke et al., 2022; Stein et al., 2024). However, there seems to be an attitude–behaviour gap, meaning that sustainability and health concerns do not necessarily influence actual food purchasing decisions as much as prices and taste preferences do (Robert Bosch Stiftung & More in Common, 2025; Seubelt et al., 2022; van Bussel et al., 2022). Adverse socio-economic trends such as rising food prices and widening social inequalities further underscore the need for a socially just and transparent TCA implementation. These conditions could otherwise undermine public acceptance, particularly if TCA leads to noticeable changes in food prices. Overcoming the attitude–behaviour gap will be a critical challenge for any effective and equitable rollout of a TCA system.

Although the use of monetary values is one of TCA's key strengths, it also presents communication challenges. The complexity of TCA calculations can easily lead to misinterpretation (e.g. Carlsson et al., 2025; Michalke et al., 2022), especially if not communicated in a transparent and accessible way. To ensure the effectiveness of a TCA system, public misunderstandings and mistrust must be proactively addressed. Consumers' perception and comprehension of sustainability information significantly influence how they respond to such information. Overly technical or unclear messaging may lead to confusion, scepticism, or disengagement. Years of greenwashing and social washing have further eroded public trust, making credibility and clarity critical for any TCA initiative. To overcome these barriers, the methodology behind TCA must be communicated in a way that is both comprehensible and verifiable. Only then can TCA serve as a meaningful tool to guide consumer behaviour and build support for more sustainable food systems.

3.2.4. Data infrastructure

The implementation of a TCA system faces several barriers related to data infrastructure, gaps in on-farm data collection, and restrictions on data sharing. At present, there is no public data infrastructure or systematic approach to data collection that can adequately support TCA assessments. Farm-level data management remains fragmented and often insufficient for comprehensive sustainability evaluations. Although farms already collect sustainability data for various purposes, many struggle to provide it in a timely manner (Grün et al., 2023), which could result in a significant administrative burden under a TCA system. German and EU data protection regulations protect personal data and sensitive business information from unauthorized use or disclosure. These rights impose legal restrictions on the collection, storage, and sharing of data within a TCA system. Therefore, the design of data governance must account for the protection of both personal and confidential business information, which may result in limiting data collection and sharing to the necessary minimum.

At the same time, digital innovation and emerging data-sharing initiatives in the agri-food sector offer potential pathways to address these challenges. Starting in 2025, the Farm Sustainability Data Network (FSDN) will replace the Farm Accountancy Data Network (FADN). The FSDN expands the voluntary data repository to include farm-level sustainability data across economic, environmental, and social dimensions, laying the groundwork for more standardized data collection at the farm level. Private sector actors (e.g. Ecovadis, Planted, and Sunhat) offer digital tools that help companies assess, manage, and report their sustainability performance. These solutions can serve as a foundation for developing a TCA-compatible data infrastructure by enabling integrated reporting and reducing duplication of data efforts across regulatory and voluntary frameworks. In addition, technologies such as Artificial Intelligence (AI) and Blockchain can further facilitate data collection, analysis, and sharing. AI can facilitate data collection on the business level and processing of large volumes of data, while Blockchain can facilitate secure, transparent data-sharing along the supply chain. Ongoing research by the DATA4FOOD cluster explores how data is generated, used, and shared across the agri-food sector. These insights may offer valuable contributions to future data governance and infrastructure design, helping to overcome current limitations and support the implementation of a robust TCA system.

4. Strategies towards a TCA system

The following chapter presents strategies towards the development of a TCA system. These strategic steps lay the foundation for any further actions towards the implementation of TCA in the German agri-food sector. The strategies combine insights from the internal and external assessments by showing how to advance the technical prerequisites (such as methodological standards, data infrastructure, and governance) and create favourable

conditions for implementation, considering the wider political, economic, and societal context.

4.1. Design of a TCA system

One of the initial steps in the implementation of TCA is the design of TCA system that attains political and societal consensus. Therefore, it must be tailored to the needs of implementing value chain actors, particularly farmers. The design of a TCA system must answer the following questions:

1. Purpose and communication of the TCA system: Who should benefit from the TCA system and how? Which policy instruments will the TCA system inform? How is the TCA information used and communicated? Who is the target audience for the TCA information?
2. Scope of the TCA system: Will the TCA assessment take place at business or product level? Which value chain stages will be considered in the assessment? Which industry branches will be the subject of the assessment? Will it consider negative and/or positive externalities? Which products or businesses will be included in the TCA assessment (e.g. German, EU, or global)?
3. Responsibilities: Who will collect the data and conduct the TCA assessments? Who will validate the data, review the results, and ensure quality control? Who owns which rights to the data?

These decisions heavily influence the methodological, data, and legal requirements of a TCA system and should therefore be taken early in the policy-making process to allow for more targeted research and implementation efforts. The following presents some strategies to inform the TCA system design to ensure feasibility and acceptability.

Initiate national stakeholder dialogue for participatory policy design
Addressees: BMLEH in cooperation with other relevant ministries (e.g. Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety (BMUKN), German Federal Ministry of Health (BMG), German Federal Ministry of Labour and Social Affairs (BMAS)); a scientific advisory board

To achieve policy acceptance, stakeholders should be included in the design of the TCA system. This could be achieved through a national-level dialogue with policymakers, public administration from relevant ministries, scientists, representatives from the agri-food sector, and farmers. The dialogue could help identify the purpose of the TCA system and align objectives with stakeholders' needs. For further planning and coordination, task forces could be created to bring together relevant stakeholders for co-design and consultation to support the implementation on different levels; i.e. farms, downstream value chain actors, researchers, data infrastructure and protection specialists, and legal scholars. This process will also facilitate the definition and division of responsibilities among implementing stakeholders. This process should help to simplify and ease data-collection processes to avoid increasing the reporting burden on farmers and other value chain actors.

Consider and plan a stepwise implementation process

Addressee: BMLEH

The internal assessment shows that TCA methodologies and databases are at different stages of their development. To address methodological and data shortcomings, the ministry should consider a stepwise implementation of a TCA system that builds on existing knowledge and invests in developing methodologies and the collection of specific data in order to enable more comprehensive and complex TCA assessments. The implementation of a TCA system should begin with an assessment of impact categories (e.g. climate change, water use, air pollution, land use, fair/living wages) that are well developed using existing generic databases. This initial assessment can be improved through a stepwise inclusion of other currently less developed impact categories and specific data to more thoroughly capture the complexity of food production.

The initial scope of products or businesses covered under the TCA system can also be widened in a stepwise process. Starting off with products produced in Germany, the TCA system could be extended to EU and global products and businesses, considering existing trade agreements and obligations. A well-established and functioning voluntary system could eventually be transformed into a mandatory system that creates full transparency of externalities in the agri-food sector.

Advocate for EU-wide collaboration on the topic of TCA

Addressees: Agricultural Attachés at the Permanent Representation of Germany to the EU; German Members of European Parliament; BMLEH and other relevant ministries (e.g. BMUKN, BMG, BMAS)

The external assessment shows that the international community and a few other European countries expressed general interest in the topic of TCA. Spreading awareness for the concept of TCA on the European level will enable the creation of partnerships and learning about the attitude of other member states towards the implementation of TCA. An EU-wide implementation of TCA would have regulatory and bureaucratic advantages compared to a German implementation. A national implementation is less favourable as it can create competitive disadvantages for German producers and tensions with trading partners. Creating a level playing field for private businesses is in line with the spirit of the EU.

The German representatives in the EU should use their voice to create synergies and momentum for this topic. Therefore, the TCA approach should be more prominently positioned in political discussions at EU level. The integration of TCA assessments should be advocated for or opportunities for implementation into existing and upcoming policy schemes should be considered; e.g. the simplifications of CSRD under the Omnibus directive, the EU Benchmarking System, and the Nature Credits scheme. It is particularly important to allow for synergies between different forms of data collection and to be aware of considerable overlaps between different data collection purposes. The German government should consider collaboration with countries that have expressed

early interest in implementing TCA, namely Switzerland, Belgium, and the Netherlands, in order to create synergies in research efforts and advance methodological approaches.

4.2. Methodological requirements

To implement a TCA system in Germany, the methodology needs to be tailored to the TCA system envisioned. The results from Interim Report I and the internal assessment show that there is a need to advance the methodology further to cover positive externalities and underdeveloped impact categories, especially for social and human capital. In the expert workshop, members of the TCA community of practice agreed that the existing TCA methodology needs to be implemented and tested rather than aiming for methodological perfection. They advocated developing a 'good enough' methodology, referring to a methodology that provides meaningful, comparable, and policy-relevant results without demanding data or technical capacity beyond what is feasible for most stakeholders, particularly farmers and small and medium enterprises (SMEs).

Co-develop a methodology tailored to the TCA system that is transparent and scalable
Addressee: BMLEH; TCA research community; value chain representatives

In the development of TCA methodology there is a considerable trade-off between comprehensiveness and practicability. TCA assessments should reflect all sustainability dimensions sufficiently and reflect positive and negative external effects. The completeness of results is a matter of fairness from a value chain actor perspective and a matter of transparency from a consumer perspective. That said, reflecting complex realities in comprehensive assessments can be time and resource-intensive for implementing stakeholders. To balance these two aspects, an acceptable TCA methodology should build on existing and frequently used methodological approaches and aim to be data-light by leveraging data already documented by value chain actors and minimizing the need for additional primary data collection. The methodology and corresponding data sources need to be comprehensive and transparent enough to represent the complex realities of the food sector, but pragmatic enough to be feasible.

A co-design process should be implemented for the development of the TCA methodology that involves relevant stakeholder groups (e.g. interdisciplinary researchers, value chain representatives, and public administrators) to share their perspectives on the trade-offs involved. While researchers should lead this process in alignment with overarching political objectives, it should be closely accompanied by practitioners to ensure feasibility and relevance in real-world application. The insights of implementing actors are especially essential, as they are most familiar with the complex realities of food production. To develop a holistic assessment, implementing actors should be consulted on which impact categories are indispensable for a TCA assessment.

Pilot the co-developed methodology with a representative sample of farms and food businesses to evaluate its feasibility, accuracy, and user-

friendliness before national rollout
Addressees: TCA research community; BMLEH; value chain representatives

Before the national rollout of a TCA system, the co-developed methodology and associated data collection processes should be tested with representative farms and agri-food businesses. The time and resources required for the administrative efforts should be evaluated and communicated to implementing actors to ensure transparency. The resulting methodology should be revised based on the implementing actors' feedback to ensure a smooth rollout. National communication campaigns on TCA should be in line with the developed methodology and results should underline the necessity of a TCA system.

4.3. Data requirements

The internal assessment indicates that generic data, particularly for environmental assessments, is already available and can serve as a foundation for TCA. However, this data is fragmented across various databases and no existing system is fully suited to meet the specific requirements of a comprehensive TCA assessment. The external assessment further highlights that any additional data collection must be designed to avoid increasing the bureaucratic burden on agri-food businesses. A well-designed TCA system should therefore leverage existing generic databases where possible, while also enabling more coordinated and efficient collection of specific data where needed.

Secure funding to expand national LCA databases for TCA, especially for underdeveloped impact categories, positive externalities, and non-conventional production practices
Addressee: BMLEH

In a stepwise implementation of a TCA system, generic data plays a foundational role. Existing national LCA data should be consolidated and expanded through the development of a dedicated TCA module. Public authorities should secure dedicated funding (e.g. through Common Agricultural Policy (CAP), Horizon Europe, and national agri-environmental budgets) to support TCA research to support open access database initiatives and targeted research. A current example for such a project is the Life Eco Food Choice project, which is planning to replicate the approach of the French LCA database Agribalyse for Germany, Spain, and the Netherlands. However, here the focus is solely on the negative environmental impacts of conventional production.

Germany should build on this momentum by developing complementary projects that capture the full sustainability spectrum, allowing the TCA system to differentiate costs and benefits across diverse production practices. The extended LCA database should include monetization factors aligned with the assessed impacts, forming the basis of a robust TCA module. In parallel, existing farm-level data collection efforts (e.g. by KTBL) should be adapted to support generic sustainability assessments by including relevant management and performance indicators.

Advocate for a standardized sustainability data collection scheme within the EU Benchmarking System that supports TCA assessment
Addressees: BMLEH; Agricultural Attachés at the Permanent Representation of Germany to the EU

As outlined in the EU's Vision for Agriculture and Food, a sustainability benchmarking system is supposed to be developed to harmonize measurement methods and indicator frameworks for assessing the sustainability performance of farms. If shaped early in its design, this system could serve as a foundation for data collection tailored to TCA assessments. To enable this, the benchmarking scheme should include measurable and monetizable impacts at the farm level.

Germany should proactively contribute a TCA-oriented proposal to the EU discussion, highlighting how TCA can complement the benchmarking system by enabling more comprehensive policy evaluation and value chain transparency. Existing frameworks such as the minimum sustainability criteria developed by the Thünen Institute and DLG in the MinKriSet project should be reviewed for their suitability as a basis for monetizable TCA indicators. Alternatively, the potential of expanding the FSDN to accommodate TCA-relevant data should be assessed. Aligning the EU benchmarking initiative with TCA data requirements would streamline data collection efforts and pave the way for assessments of products and businesses from other EU countries.

4.4. Data infrastructure and governance

Reliable data availability is essential for implementing TCA methodologies, yet current documentation requirements are often perceived as burdensome by value chain actors. To ensure acceptance and feasibility, TCA implementation must be accompanied by a streamlined, efficient documentation and reporting system. A robust TCA data infrastructure will require a formal data governance framework that clearly defines legal responsibilities, data access, and protection measures in line with EU and German regulations. Importantly, farms and agri-food businesses should derive tangible benefits from data collection and retain control over their data. They must be able to decide which information is anonymized and what can be shared publicly, thereby fostering trust, transparency, and stakeholder ownership.

Develop a unified data entry platform for farms that integrates data collection for multiple purposes
Addressee: BMLEH and/or Directorate-General for Agriculture and Rural Development (DG AGRI); Federal Ministry for Digital Transformation and Government Modernisation (BMDS); software developers

Farms already generate much of the data needed for sustainability assessments, yet limited data management capacities and overlapping reporting requirements often make documentation burdensome. A key recommendation from the Future Commission for Agriculture (Zukunftskommission Landwirtschaft, 2024) is the development of a unified documentation solution that reduces redundancy across reporting obligations

at state, national, and EU levels. A central platform should streamline existing and new data systems and enable secure data exchange between them. Ideally, the system should support communication not only with public authorities but also with downstream value chain actors. To ensure adoption, the platform must be user-friendly, support internal farm management, and be accompanied by targeted training and advisory services.

Collaborate with private sustainability reporting tool providers to co-develop a TCA database that builds on existing expertise in business-level data management and digital infrastructure
Addressees: BMLEH; BMDS; private sustainability tool developers

As noted in the external assessment, a growing number of private providers have built digital systems for collecting, managing, and safeguarding sustainability-related data from businesses. These tools are often aligned with international frameworks such as GRI, CSRD, and ESG benchmarks, and are tailored to the operational realities of the sector and to streamline administrative workflows. To leverage this expertise, a consortium of experienced developers should be engaged in the design of the TCA data infrastructure. Their involvement can enhance technical viability, ensure user-friendly design, strengthen data security, and enable interoperability with existing farm management and reporting systems, reducing duplication and increasing acceptance.

Develop a national data governance framework that defines responsibilities, access rights, quality standards, validation, and secure sharing procedures
Addressees: BMLEH; BMDS; Federal Commissioner for Data Protection and Freedom of Information (BfDI); data protection and cybersecurity experts

Before the implementation of a TCA system, a national data governance framework must be developed to ensure legal compliance, data security, and trust among stakeholders. This framework should define the specific purpose of data collection, assign responsibilities for data provision and management, and establish clear rules on data access, sharing, and protection in accordance with national and EU data protection laws. A central coordination body should be established to oversee the development, continuous improvement, and safeguarding of the TCA data infrastructure. It should allow for user feedback to support research, policy evaluation, and continuous methodological and technical improvement. To ensure consistency, the framework must also set clear standards for data quality and validation processes. Technical interoperability with existing reporting obligations (e.g. for CAP compliance, sustainability reporting, or organic certification) should be prioritized to reduce administrative burden, but data exchange must be carefully regulated to maintain data integrity and cybersecurity. To encourage participation, the governance framework should clarify data ownership and communicate it transparently to all users.

4.5. Willingness and capacity of stakeholders

The acceptance of the TCA system is essential for its successful implementation. Broad stakeholder participation can be fostered by actively involving implementing actors in the system's design, offering practical implementation support, setting incentives, and clearly communicating the benefits of participation. Targeted financial incentives include improved market positioning and reduced bureaucratic burden through streamlined documentation. Lowering entry barriers and aligning the TCA system with existing practices will further increase its attractiveness and usability for value chain actors.

Create targeted incentives for stakeholders who voluntarily implement TCA
Addressees: BMLEH and other relevant ministries (e.g. BMUKN, BMAS, BMG, BMF); state-level governments

In the case of a voluntary TCA system, effective incentives are essential to encourage uptake. Farmers and agri-food businesses should be encouraged to collect and report sustainability data by clearly communicating the non-monetary as well as the direct and indirect monetary benefits of participation. Non-monetary benefits can be improved information and insights for farm management and advisory services. Direct monetary incentives could involve financial instruments such as grants, increased CAP payments (e.g. through eco-schemes), tax reliefs, or payments for ecosystem services like carbon or nature credits. Indirect, market-based incentives for participation are price premiums for TCA-labelled products, preferential credit conditions, priority in public procurement, and access to niche markets (e.g. true price supermarkets). Evidence from the FSDN implementation process shows that direct financial compensation is perceived as the most effective motivator for farmer participation (European Commission, 2022). Other attractive incentives include priority access to CAP rural development funds and tailored advisory services based on the data provided.

Engage with farmers and agri-food business representatives in the development of the TCA methodology, digital data solutions, and overall system design to ensure feasibility and acceptance
Addressees: BMLEH; value chain representatives

Actively involving farmers' unions, industry associations, and other agri-food sector representatives in the design and implementation of the TCA system is essential to build trust, ensure practicality, and address concerns early. Their participation in the development of the methodology and digital data entry tools can help ensure that the system reflects on-the-ground realities and minimizes bureaucratic burden. Early and continuous engagement allows for more realistic planning of data collection processes, ensures technical solutions are user-friendly, and increases the likelihood of long-term acceptance and adoption by those responsible for implementation.

Use positive and benefit-oriented communication to engage adopters, emphasizing bureaucratic efficiency and financial advantages
Addressee: BMLEH

Effective communication is essential to increase stakeholder acceptance of the TCA system. Messages should focus on concrete benefits such as simplified documentation processes, targeted financial incentives, and reduced operational risks. Financial advantages may include access to subsidies, tax relief, improved contractual terms with downstream value chain actors, and enhanced access to credit. In the long term, TCA can support more sustainable business practices, helping to reduce operational risk resulting from depleting natural, human, and social resources. To appeal to stakeholders' intrinsic motivation, communication should also emphasize the societal value of TCA, such as fairer wages, environmental protection, and more transparent value chains, reinforcing a sense of purpose and alignment with sustainability goals.

A powerful way to build trust and engagement is through concrete examples of successful implementation. Regional pilot projects should be used to generate real-world case studies that highlight how TCA can be effectively integrated into business operations. These case studies can demonstrate tangible benefits such as cost savings, improved market positioning, or access to financial incentives. Honest, first-hand accounts from farmers and agri-businesses can make the value of TCA more relatable and credible. Sharing these stories through targeted communication channels, such as regional networks, industry associations, or agricultural advisory services, can help reduce uncertainty, encourage peer learning, and show that TCA is not only feasible but advantageous in practice.

Establish training and extension programs to support farmers and agri-businesses in adopting TCA-related digital tools
Addressees: BMLEH; BLE; State Ministries of Agriculture; TCA research community; digital tool developers

In line with the Strategic Dialogue on the Future of EU Agriculture (2024), which emphasizes the need for lifelong learning in digital skills in the agricultural sector, the implementation of the TCA system should include tailored training and extension services for farmers and agri-food businesses. These programs should address technical onboarding, interpretation of TCA data for internal decision-making, and understanding the broader digital infrastructure and governance model behind the system. Training should not only reduce user frustration but also build trust by addressing concerns related to data privacy, competitiveness, and the handling of sensitive business information. A regional pilot program combining hands-on learning, peer exchange, and real-world implementation should be funded to support practical uptake and ensure relevance across diverse agricultural contexts.

Educate staff in the public administration to be able to assist adopters and assign one or more local TCA system experts
Addressees: BMLEH; BLE; State Ministries of Agriculture; local agricultural offices

In addition to training implementers, public administration staff may need to be trained for several purposes. At local and regional levels, staff should be trained to assist implementing actors, respond to inquiries, and provide guidance on the TCA system. They should be familiar with the data collection process, data governance, and the legal framework related to the data infrastructure. On the local level, the responsibility should be clearly assigned to one or more persons who can be directly approached by implementing actors. Having one designated point of contact helps to address concerns, resolve uncertainty, and ease the implementation process. Depending on the institutional setup and division of responsibilities, public administration staff may also be involved in monitoring activities, including verifying data accuracy and translating assessment results into subsidy allocations or other policy instruments.

4.6. Public awareness

TCA systems will gain broader legitimacy and momentum if consumers know, understand, and support the accounting of externalities (e.g. through pricing, taxation, and subsidies). Public awareness campaigns are essential to help consumers recognize the hidden costs of food production, including environmental degradation, health impacts, and social inequalities. Raising public awareness can help build societal support for policy changes and foster demand for more sustainable and fair food systems.

Launch a national TCA awareness campaign

Addressee: Public relations and communication of BMLEH and other relevant ministries (e.g. BMUKN, BMAS, BMG); BLE; consumer protection organizations

A national campaign should inform the public about the environmental, social, and human costs and benefits of food production and consumption, highlighting the systemic impacts of failing to account for these externalities in the current economic system. The communication campaigns on TCA should be in line with the co-developed TCA methodology and demonstrate clearly which impact categories will be covered by the TCA system to avoid misunderstandings. Messaging should be evidence-based and tested for effectiveness, exploring how TCA-related information can meaningfully influence consumer behaviour and increase willingness to pay for sustainable products. If the TCA system is used to inform a national label, the campaign could also serve to build public understanding and trust in this label, helping consumers interpret its meaning and laying the groundwork for future regulatory tools.

Integrate TCA into education

Addressee: BMLEH; Federal Ministry for Education Family Affairs, Senior Citizens, Women and Youth (BMBFSFJ); Conference of Ministers of Education (KMK)

To influence long-term attitudes and reach younger generations, awareness of the positive and negative externalities of production and consumption (not necessarily limited exclusively to the agri-food sector) should be integrated into school curricula, university programs, and public education. Topics such as sustainable consumption and healthy diets can be included in health, economics,

and environmental education. Teachers and educators should be equipped with up-to-date knowledge and materials to convey these concepts effectively. Initiatives could build on the results of the From Field to School (vom Acker in die Schule, ASAN) project. From December 2024 to September 2025, TH Nürnberg is working with local elementary and secondary schools to develop interdisciplinary teaching materials, including a comic, game, group discussion, excursion, and future lab on the subject of TCA. The material will be tested in approximately ten schools, accompanied by a scientific evaluation and public presentation of the results (TH Nürnberg, n.d.).

Highlight health aspects in the communication of TCA
Addressees: BMLEH; BMG

While sustainability concerns may be declining, personal health remains a strong motivator for consumers. The ministries for agriculture and health should collaborate on a joint communication strategy that promotes sustainable and healthy diets, based on TCA findings. One concrete step could be to incorporate TCA-based insights into national dietary guidelines, supported by research that highlights more and less favourable food groups in terms of external costs.

5. Outlook

The third and final report will examine the feasibility and effectiveness of TCA-informed policy instruments and outline steps for the implementation of TCA in the German agri-food system. The report will build on the findings of Interim Reports I and II, summarizing the status quo and drawing on the internal and external assessment presented in this report. It will describe how TCA-informed policy instruments could be used in the German agri-food system, outlining several use options of TCA and assessing their effectiveness and feasibility from different stakeholder perspectives. This analysis will be informed by the project's second stakeholder workshop, involving stakeholders from politics, public administration, the private sector, developers, and researchers. Based on this assessment, we will create a roadmap for the development of a TCA method and a TCA system for the German agri-food sector. The roadmap will build on the strategies described in this report, presenting concrete implementation steps for building a TCA system.

6. Appendix

6.1. Appendix 1: Participants list of expert workshop

Table 4. Participants list of the expert workshop

Country	Institution	Name
Netherlands	Wagenigen University & Research	Michiel van Galen
Switzerland	École polytechnique fédérale de Lausanne (EPFL)	Agathe Crosnier
Switzerland	University of Lausanne	Laurence Jeangros
Switzerland	University of Bern	Rolf Arnold
Belgium	Katholieke Universiteit (KU) Leuven	Henri Contor
Germany	Technische Hochschule Nürnberg / Universität Greifswald	Lennart Stein
Germany	Research Consultant Wurzer-Mulders	Dr. Maartje Wurzer-Mulders
Germany	Regionalwert Leistung	Erik Borner
Germany	Oeko-Institut	Dr. Florian Antony
Netherlands	Impact Institute	Dr. Reinier de Adelhart Toorop
Switzerland	FiBL Switzerland	Dr. Adrian Müller
Switzerland	FiBL Switzerland	Kevin de Luca
Italy	EcorNaturaSì	Gianluca de Nardi
France	Danone	Fabien Delaere
UK	University College London	Sebastiano Caleffi
Germany	BLE	Jenny Eichelhard
Germany	BMLEH	Judith Arndt

6.2. Appendix 2: Internal assessment

This appendix provides a comprehensive internal assessment of TCA methodologies and data, highlighting their strengths and weaknesses for

business and product level TCA assessment. It offers insights into the capacities of currently available methodologies and data for conducting TCA in the agri-food sector in Germany, as well as explaining what is not yet possible and requires future improvement.

6.2.1. Applicability of TCA frameworks and guidelines

Strength: Broad applicability of TCA frameworks and guidelines

Available TCA frameworks and guidelines support more holistic sustainability assessments by identifying and monetizing economic, environmental, social, and health externalities.

Available TCA frameworks and guidelines enable more holistic sustainability assessments by assessing and assigning monetary values to economic, environmental, social, and health externalities—such as GHG emissions, soil degradation, labour rights violations, and diet-related health impacts. These costs are often not reflected in market prices and are therefore typically overlooked in conventional business accounting, policy design, and consumer decision-making. By looking at the interlinkages and economic, environmental, social, and health outcomes, TCA supports systems thinking and encourages more integrated evaluations of agricultural and food system decisions. For example, TCA can support farmers and businesses in identifying trade-offs and synergies between production practices, environmental impacts, and social outcomes.

Many European countries—including Germany—already have sufficient methodology and data to conduct a national-level assessment to understand common trends and major food system externalities, without going into specific details. On the public-policy level, such assessment can be particularly useful as it highlights hotspots and areas in need of action, providing governments with guidance to redirect public funding and encourage private investment towards more sustainable practices.

At the business level, frameworks and guidelines allow for broad application of TCA across key areas of corporate decision-making and reporting.

Of the 23 identified frameworks and guidelines (see Interim Report I for more details), 21 are suitable for the application of TCA at a whole-of-business level, including for farms, offering varying levels of methodological detail. Some provide principles of TCA, helping organizations to understand the core concepts of TCA application (e.g. *TEEB for Agriculture and Food: Operational Guidelines for Business*; *Natural Capital Protocol*; *Social and Human Capital Protocol*). Others offer a step-by-step approach to support practical implementation, providing concrete indicators and metrics (e.g. *The Conceptual Framework for Impact Accounting*)

Frameworks and guidelines with a high level of methodological detail focus on natural capital impacts such as contributions to climate change, environmental pollution, resource depletion, and land use. Social and human capital impacts are

less frequently covered, but commonly include occupational health and safety, income and wages, training, and human rights issues. For example, the *Conceptual Framework for Impact Accounting* by the International Foundation for Valuing Impacts (IFVI) and the Value Balancing Alliance (VBA) provides detailed, implementable methodologies for assessing and monetizing natural capital impacts (GHG emissions, water use, air pollution, land use) and social capital impacts (occupational health and safety, adequate wages). However, it is not tailored to agri-food sector and does not represent sector-specific impacts (e.g. biodiversity loss or soil degradation).

By identifying inefficiencies and unsustainable practices in the value chain, TCA serves as an informative tool that can be adapted to various business functions, such as sustainability strategy development, investment planning, and corporate reporting with Sustainable Performance Accounting, which allows for the integration of environmental, social, and governance aspects into reporting practices. In addition to the traditional Earnings Before Interest and Taxes (EBIT), which measures a company's financial performance, a sustainability-adjusted EBIT (S-EBIT) can also be calculated. It also highlights opportunities to reduce costs through more sustainable production methods.

At the product level, TCA allows for applications such as true pricing, consumer education, and sustainability labelling.

TCA can be used to assess and communicate environmental, social, and health externalities of food products. By revealing hidden costs such as GHG emissions or forced labour, TCA enables transparent pricing and helps inform and educate consumers about the impacts of the products they purchase. Depending on the use, these insights may be used to adjust actual product prices to reflect hidden costs (true pricing) or to display a second price tag that highlights the environmental, social, and health costs without changing the market price. TCA also provides information for sustainability labelling, enabling different dimensions of a product's sustainability to be communicated under a unified label.

At the product level, three guidelines are particularly relevant for applying TCA in the agri-food sector, providing high methodological detail. The first is the *TCA AgriFood Handbook* (True Cost Initiative, 2022), which focuses on product-level assessment and offers practical guidance. It defines key impact indicators for the agri-food sector, provides monetization factors, and explains how to calculate, aggregate, and report true costs. The handbook addresses natural, human, and social capitals, covering issues such as contributions to climate change, environmental pollution, depletion of scarce resources, occupational health and safety, income and labour rights, and human rights. However, it is only applicable to plant-based agri-food products and lacks important agri-food specific topics (e.g. animal welfare indicator, GHGs from livestock production). The second is the *True Price Assessment Method for Agri-Food Products* (Galgani et al., 2023), which outlines the calculation and monetization of an extensive set of impact categories across environmental, social, and human capitals for true pricing. These include environmental impacts such as

climate change, air pollution, water pollution, soil pollution, land use, and water use, as well as social and human impacts such as forced labour, child labour, gender discrimination, living wage, and occupational health and safety. The third option is environmental LCA (e.g. EU Product Environmental Footprint (PEF), ReCiPe (Huijbregts et al., 2016)) that can serve as a product-level assessment tool for estimating environmental impacts. These results can then be monetized using appropriate monetization factors (e.g. CE Delft's *Environmental Prices Handbook* (de Vries, 2024)).

TCA has strong potential to drive sustainable consumer behavioural change.

By assessing hidden costs, TCA can influence consumer choices and encourage sustainable behaviour. A recent TCA campaign by the University of Greifswald and German retailer Penny demonstrates TCA's effectiveness as a sustainability communication and awareness-raising tool (Stein et al., 2024). The study, which involved a survey of 120 consumers, found that more than 50% of the participants were aware of the TCA initiative, indicating increasing recognition in public. Although the willingness to pay the true price decreased when it affected personal spending, a significant number of consumers expressed a willingness to reduce their consumption of animal products if true pricing were implemented (Stein et al., 2024). Moreover, research shows that when consumers perceive personal value from true pricing, in terms of social status or green value, they are more likely to trust the concept and be willing to purchase true price products (Taufik et al., 2023). These findings show that TCA can contribute to behavioural change and lay the groundwork for long-term shifts in consumer choices toward more sustainable diets.

Weakness: Sector-specific limitations of methodologies

Most frameworks are not tailored to the specific characteristics and complexities of the agri-food sector, restricting application.

Many frameworks are designed for broad sectoral application, with only 6 out of 23 tailored specifically to the agri-food sector (see Interim Report I for details). As a result, most do not account for the sector's unique characteristics, such as regional environmental dependencies, complex supply chains, precarious labour conditions, and human health and nutrition impacts. This lack of sector-specific focus limits the accuracy of TCA in the agri-food context. However, meaningful application is still possible, as existing methodologies provide a foundation for broader application. TCA can be applied using current methodologies, data, and knowledge, with the scope gradually expanded over time.

6.2.2. Harmonization and standardization

Strength: Increasing harmonization across TCA approaches

Conceptual alignment across existing frameworks supports a certain level of harmonization and TCA can provide practical information without methodological perfection across different analytical levels..

There are growing efforts to harmonize TCA frameworks and guidelines, with many methodologies building on shared conceptual foundations and promoting methodological alignment based on the Applying The TEEB Agrifood Evaluation Framework (Eigenraam et al., 2020). Although full harmonization has not yet been achieved, most TCA methodologies follow a similar structured process of identifying, quantifying, and monetizing externalities. This common structure creates a degree of coherence across applications. However, with multiple actors and initiatives attempting to shape the harmonization process, there is a risk of increased fragmentation in the short term.

Standardizing TCA methodologies across product, business, and national levels is a complex and resource-intensive process, especially given the diversity of actors within the agri-food sector. Each level of assessment requires tailored approaches, making it unrealistic to expect a single, universally applicable methodology. Additionally, public authorities and businesses often have different goals and capacities, further complicating the design of a one-size-fits-all solution. However, this issue should not delay implementation. TCA can already be applied using existing methodologies; e.g. impact assessment with LCA can be combined with monetization factors to assess food products at the national level. This could be useful at the food system or policy levels, where broader strategies can be drawn using available data and methods. Pushing for practical application, even without complete standardization, allows for learning and progress toward more sustainable agri-food systems.

Weakness: Methodological and data fragmentation

In the agri-food sector, there is no standardized best practice or gold standard methodology for TCA and existing approaches vary widely in scope, data requirements, and impact measurement methods (e.g. due to different goals and objectives), which limits comparability.

A weakness of TCA is the absence of a standardized best practice or gold standard methodology. The lack of standardization makes it difficult to ensure comparability and consistency across assessments. The challenge is further complicated by the fact that TCA can be applied at different levels (i.e. product, business, and national levels), with each requiring different scopes, granularity, and data inputs. Because different levels of assessments serve different purposes, they require different methodological approaches, meaning that developing a unified standard for all levels is likely not practical. Moreover, without a recognized authority to define what a robust or gold standard in TCA is, methodological uncertainty remains.

There is no comprehensive database that covers all essential environmental, social, and human capital data; relevant information is fragmented across multiple sources and formats.

TCA requires integrating a wide range of data from environmental, social, and human capitals to provide a holistic assessment. However, no single, unified database currently brings together all the necessary information across these capitals. As shown in Interim Report I, relevant data is dispersed across multiple

sources, often varying in structure, scope, and accessibility. This fragmentation makes TCA resource-intensive and technically complex, often requiring the compilation of diverse data sources. This poses a barrier to scaling TCA in the agri-food sector.

There is neither a standardized approach for collecting specific TCA data nor established data pools that include specific data within the agri-food sector.

One of the key barriers to implementing TCA in the agri-food sector is the lack of a standardized approach to data collection. In Germany, there are no coordinated efforts to systematically gather and centralize the diverse data required for TCA. While some relevant data is collected for other purposes, it is fragmented and not compiled in a structured or accessible way that supports TCA implementation.

The absence of universally accepted definitions for indicators and measurements across databases undermines data consistency and comparability.

Without standard definitions, the same indicator may be interpreted and measured differently depending on the data source. This reduces the comparability of the data and creates challenges when aggregating data from different resources to implement a meaningful TCA assessment. Standardized definitions and methods are essential to ensuring the methodological transparency, comparability, and scalability of TCA.

6.2.3. Practicality of TCA implementation

Strength: Feasibility of TCA implementation with existing data and tools

TCA can be implemented incrementally by building on existing data and focusing on practical progress.

As highlighted in Interim Report I, a range of generic data is available to support TCA, though it remains fragmented. Specific data tailored to TCA is not available, especially at the farm level, where data collection often lacks standardization and sustainability information. In Germany, datasets from KTBL, which collect farm management data, can offer a starting point for TCA implementation. While the lack of both perfect data and complete methodological standardization is often seen as a major barrier, meaningful application is still possible without them. Available data and methodologies can already support better-informed decisions. Aiming for methodological perfection of TCA can become a barrier to implementation, delaying progress. Instead, TCA system can be approached as an iterative process, which is introduced step by step, starting with existing tools and knowledge. Such applications can demonstrate value, build momentum, and help refine methodologies over time.

Weakness: Practical and technical barriers to implementation

High data collection requirements and the need for interdisciplinary expertise make TCA resource- and expertise-intensive and time-consuming.

Implementing TCA is a resource-intensive process, due to the requirement of the collection of a wide range of data and the need for interdisciplinary expertise. This makes TCA implementation challenging for businesses or public actors with limited internal capacity or funds. The most advanced methodologies that follow best practices require significant time, expertise, and financial resources, highlighting the resource intensiveness of TCA. While newly developed software tools such as Impact Suite by Impatec or WISIT by WifOR can ease this burden by simplifying data collection and supporting users with TCA application, they are still in early stages and require a paid license.

Additionally, many existing databases relevant to TCA (e.g. LCI dataset ecoinvent) have paid licensing requirements and are not user-friendly, particularly for smaller businesses, researchers with limited fundings, or practitioners without technical expertise. Complex interfaces and a lack of intuitive tools can create barriers to using the underlying data, limiting the application of such databases in TCA.

Generic datasets are not well integrated into TCA methodologies, and methodological guidance for their use in the context of TCA is lacking.

Although a range of generic-model and impact datasets exist, particularly for natural capital (e.g. Agribalyse, ecoinvent), these are not systematically integrated into TCA methodologies. The absence of structured guidance on how to use existing databases within the TCA methodologies described in the frameworks and guidelines creates a barrier for implementation. Practitioners usually do not have clear instructions on how to align existing data sources with TCA methodologies.

Lack of best-case examples that can clearly demonstrate the business case to those still skeptical about TCA.

One barrier to the broader adoption of TCA in the agri-food sector is the absence of successful case studies that demonstrate its practical business value. Many businesses remain sceptical about investing in TCA because they have not seen real-world examples where its application has led to tangible financial and strategic benefits. Without case studies of success stories across different farm types or value chains, adoption is likely to remain slow and limited.

6.2.4. Use of Monetization

Strength: Flexible use of monetization for impact translation

TCA can guide holistic decision-making, even without monetization.

Monetization in TCA comes with methodological challenges, but monetizing impacts is not always essential once a strategy for conducting TCA is established. The necessity of monetization largely depends on the objective of

the TCA exercise and the target audience. In many cases, TCA's systems-thinking approach and the identification of environmental, social, and health impacts already provide substantial value. These steps can overcome siloed thinking, inform decision-making, highlight sustainability issues, and support transparency, even without translating impacts into monetary terms.

Monetization makes impacts comparable and understandable and allows for the creation of market incentives.

Monetization, where needed, can help translate complex sustainability impacts into easily understandable and comparable economic terms. By assigning monetary values to environmental, social, and health impacts, stakeholders can more easily assess and compare different externalities. It allows for the aggregation of various impacts into a single monetary value, making communication more straightforward. This supports the development of effective market incentives that encourage sustainable behaviour through rewards and penalties. For example, public disclosure of sustainability performance based on TCA certification can boost or decrease consumer interest, while procurement policies can prioritize suppliers with sustainable practices.

Weakness: Challenges of translating complex issues into monetary terms

Reduction of complex realities into economic terms and limitations in capturing long-term and cultural values through monetization

A fundamental concern about monetization in TCA, where environmental, social, and human impacts are translated into monetary terms, is the risk of oversimplifying their true value. Valuing environmental impacts at market prices can ignore their intrinsic, cultural, or spiritual value, e.g. for local and Indigenous communities. Social factors such as the worth of human life are difficult to monetize without reducing them to numbers that fail to capture ethical importance. Doing so may also marginalize Indigenous perspectives that view nature not as a resource to be priced but rather as something sacred or as part of communal identity. Another criticism is that hidden cost assessments often emphasize negative impacts while overlooking social and economic benefits, resulting in an incomplete picture for policymakers (Brooks & Diaz-Bonilla, 2025). Meanwhile, adding up costs from different impact categories (e.g. climate damage and health costs) reduces impacts into a single number, even though they are fundamentally different and may require distinct policy approaches (Brooks & Diaz-Bonilla, 2025). Additionally, even when the monetization of externalities accurately reflects harm, assigning a monetary value can lead decision-makers to treat the damage as an acceptable cost, as long as it can be paid for (Patel, 2021). Finally, although TCA aims to measure long-term impacts that will occur over decades, monetization factors are usually based on current market prices and economic assumptions shaped by Western economic thinking. As a result, TCA may undervalue the needs and rights of future generations.

6.2.5. Operational maturity of methodology and data

Strength: Strong methodological development and solid data coverage for natural capital

TCA for natural capital is relatively advanced, providing a strong foundation for assessment with robust life cycle inventory (LCI) databases and evolving monetization factors.

All frameworks and guidelines include the natural capital category and offer strong coverage of key environmental impacts, such as GHG emissions, land use, and ecotoxicity. Natural capital is well supported by existing impact models, as established LCA methodologies provide a solid foundation and offer robust coverage of impacts within this capital category. As presented in Interim Report I, these LCA methodologies are supported by generic databases (e.g. LCI databases like Agribalyse), enabling the assessment of environmental impacts and their monetization using monetization factors from e.g. the German Environment Agency (UBA), CE Delft, and True Price. While monetization factors for natural capital are relatively well-developed, coverage and methodological robustness vary across impact categories. Overall, natural capital is currently the most mature and technically supported dimension of TCA, offering an entry point for implementation efforts.

Weakness: Inadequacies of LCA in capturing realities of agrifood systems

Current LCA impact models often fail to reflect agri-food-specific externalities and interdependencies.

LCA models are typically designed for industrial production systems and often fail to capture the complexity of agricultural systems with seasonal, location-specific, or non-conventional practices. They lack sufficient detail on critical factors such as soil health, biodiversity, and ecosystem services. According to a study by (Van Der Werf et al., 2020), LCA inadequately assesses agricultural systems due to the absence of indicators for key issues like land degradation, biodiversity loss, and animal welfare, along with a narrow, product-focused perspective on the functions of agriculture systems. Current LCA models often favour intensive farming and overlook the benefits of agroecological systems such as organic farming. Although organic farming produces fewer pollutants, its lower yields can increase impacts per unit of product, biasing results toward conventional products. As a result, these models risk misrepresenting the overall societal impacts of sustainable practices, because they do not take into account the resilience and sustainability benefits of agroecological approaches. The limited approach of LCA, therefore, does not fulfil the conceptual framework of TCA, which seeks to recognize the multifaceted functionality of agriculture and its role in delivering diverse ecosystem services.

Weakness: Incomplete methodological and data coverage of the various impact categories

Social and human capital categories are underrepresented in terms of indicators, monetization, and data.

While natural capital is well-represented across TCA frameworks, guidelines, and databases, social and human capitals remain significantly underrepresented in terms of methodologies, indicators, and data availability. As outlined in Interim Report I, indicators for social and human capitals are far less developed compared to those for natural capital. Most generic databases include environmental impacts, while data on labour conditions, human rights violations, gender equality, food security, and human health are scarce. Existing social life cycle assessment (sLCA) databases offer limited sector-specific insights for agri-food systems and focus on identifying risks rather than modelling and estimating impacts. Specific data on social and human capital in the agri-food chain is also currently lacking. KTBL's collection of farm management data in Germany includes wage information, but this remains the only social aspect covered. Developing robust methodologies for social and human capital is challenging due to the complexity of quantifying human well-being.

No single comprehensive framework provides a structured and consistent approach covering all capital categories and equally prioritizing negative and positive externalities.

Ideally, a comprehensive TCA assessment should account for both positive and negative impacts to accurately reflect all externalities of a product or business. As noted in Interim Report I, conceptual frameworks often support the inclusion of both positive and negative impacts, but detailed methodologies and databases often focus on negative impacts, rarely capturing positive ones. This risks undervaluing responsible practices and can lead to an incomplete assessment of sustainability performance.

Weakness: Data gaps and regional limitations

Existing generic databases providing input/output, model, and impact data rely on broad global or country averages, failing to reflect the diversity of production practices, regional variations, and specific industry branches, while the limited availability of country-specific data results from a lack of systematic sustainability data collection.

Although generic data for natural capital is increasingly available, it usually lacks the granularity required for context-specific TCA assessments. Many existing databases (e.g. ecoinvent, Agri-footprint) rely on global or national averages, which fail to capture the diversity of production practices, regional conditions, and specific industry branches, and often lack detailed country-specific data for Germany. While the LCI database Agribalyse (developed for France) tries to reflect regional production differences and offers a relatively detailed national overview, no comparable resource currently exists for

Germany or any other country. As a result, assessments often rely on broad averages that reduce precision and detail. Additionally, there is no coordinated effort in Germany to systematically gather, standardize, and centralize the range of input/output, management, model, and impact data (on environmental, social, and human capitals) required for TCA, which makes data-collection efforts resource-intensive.

6.3. Appendix 3: External assessment

This appendix provides a comprehensive external assessment of the future implementation of a TCA system in the German agri-food system, highlighting the opportunities and threats associated with business- and product-level TCA systems. It offers insights into the economic, political, and societal context and identifies the external factors that could influence the implementation of a TCA system via different policy instruments (i.e. true pricing, product labels, business reporting, subsidies, taxation). Together, these elements outline the current framework conditions for implementing a TCA system in Germany.

6.3.1. Political environment

Opportunity: Alignment with international, EU, and German sustainability goals

International agreements underline the need for a more sustainable economic system.

The concept of TCA aligns with the international community's goals and agreements towards more sustainability. The Agenda 2030 defines 17 Sustainable Development Goals (SDGs). Although these goals will presumably not be reached by 2030, they outline a common vision for the future for the international community. TCA in the agri-food sector supports many of the SDGs through its holistic assessment of environmental and social costs and benefits and by promoting the effective transformation of food systems toward sustainability. It is particularly relevant for SDG 12, Responsible Consumption and Production. Target 12.6 specifically aims to 'encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.' Other relevant SDGs are SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Health and Well-being), SDG 6 (Clean Water and Sanitation), SDG 8 (Decent Work and Economic Growth), SDG 13 (Climate Action), SDG 14 (Life under Water), and SDG 15 (Life on Land) (United Nations, 2015b).

Furthermore, the internalization of external costs through TCA aligns with several legally binding international treaties that aim to safeguard nature and humankind. These include: the Paris Agreement as a legally binding international treaty to limit global warming (United Nations, 2015a); the Convention on Biological Diversity, with Article 14 calling for environmental impact assessment and the minimizing of adverse effects (United Nations, 1992); and the International Covenant on Economic, Social and Cultural Rights, which protects

fundamental human rights related to social and economic well-being (United Nations General Assembly, 1966).

The EU Green Deal and Farm-to-Fork Strategy could offer long-term policy certainty and a comprehensive framework to support the transition towards more sustainability..

The Green Deal sets out the EU's strategy to achieve climate neutrality by 2050 through transformative policies across energy, transport, agriculture, and biodiversity (European Commission, 2019). It provides an overarching framework to make the EU's economy sustainable, climate-neutral, and resource-efficient, while emphasizing the need for better measurement and disclosure of environmental, social, and economic impacts. Crucially, it creates a political and legal mandate to internalize external costs in economic decision-making, a core principle of TCA. Opportunities arising from the Corporate Sustainability Reporting Directive (CSRD) are discussed below.

As part of the European Green Deal, the Farm-to-Fork Strategy outlines the aspirations for the agri-food sector until 2030. It aims to make agri-food systems fair, healthy, and environmentally friendly. The strategy outlines efforts to combine certification and labelling on the nutritional, climate, environmental, and social performance of food products, with targeted incentives for more sustainable practices, thereby effectively describing a practical application of TCA for the European agri-food sector. Further, the strategy intends to reflect real environmental costs (in terms of finite natural resources, pollution, GHG emissions, and other environmental externalities) in the EU tax systems, creating financial incentives to encourage improved consumer decision-making (European Commission, 2020).

In February 2025, the EU released its 'Vision for Agriculture and Food', aiming to shape the future of farming through generational renewal until 2040 (European Commission, 2025b). Although the vision does not formally replace the Farm-to-Fork strategy, it shifts from a clear focus on environmental, social, and health-related sustainability to the economic attractiveness and competitiveness of the sector. The priority area 'future-proofing' includes the need for environmental sustainability and innovation for long-term economic resilience, while 'connection' includes social sustainability, such as fair living and working conditions. This political shift—from a sustainability focus to a competitiveness focus—is in line with the general political shift in the EU and Germany and will be further discussed under threats. That said, the vision does outline the idea of a sustainability benchmarking system for farms, which will be further discussed as an opportunity in the following section.

The German Sustainability Strategy provides a policy framework that aims to achieve a sustainable agri-food system.

The German Sustainability Strategy (DNS) provides a policy framework to align national policies with the SDGs (Deutsche Bundesregierung, 2025). In line with SDG 12, it promotes more sustainable production and consumption patterns. The Transformation Report for the agri-food sector explicitly calls for the

internalization of hidden environmental, health, and social costs into market prices to incentivize sustainable practices (Deutsche Bundesregierung, 2024). This ambition aligns closely with TCA, which can help to operationalize these goals by making external costs and benefits visible and measurable. The Strategy's emphasis on measurable indicators and regular reporting further supports the development of robust TCA approaches. However, turning these ambitions into actionable change remains a challenge, making TCA an important tool to help close the implementation gap.

Opportunity: Growing international and civil society momentum for

There is international interest and support for the national-level development and implementation of TCA.

The Economics of Ecosystems and Biodiversity (TEEB) is an initiative hosted by the UN Environment Programme (UNEP) and was launched in 2007 with the aim of evaluating the economic significance of biodiversity, assessing the cost of biodiversity losses and the failure to engage in conservation measures. The TEEBAgriFood framework was published in 2018, providing a comprehensive framework for TCA assessments in the eco-agri-food sector (TEEB, 2018). Thereafter, TCA was prominently discussed as a key enabler for food system transformation during the 2021 UN Food Systems Summit (UNFSS). The UNFSS scientific group recognized the role of TCA in supporting policy shifts by revealing hidden costs in food production and consumption (Hendriks et al., 2021). In 2023 *State of Agriculture and Food* (SOFA) report, the FAO presented a global assessment of the true cost of the agri-food sector, based on national-level assessments for 154 countries (FAO, 2023c). The 2024 SOFA report provided updated data sets, especially regarding consumption-related health costs, and identified policy interventions aiming at sustainable transformation (FAO, 2024). In April 2025, the FAO hosted a TCA Global Summit to bring together relevant stakeholders to discuss scaling the implementation of TCA to transform food systems. Most recently, the FAO report *Transforming Food and Agriculture Through a Systems Approach* highlights that implementing TCA can generate systems knowledge to inform agri-food transformation (FAO, 2025).

Following the FAO's call to implement TCA on a national level, various European countries have expressed interest in the concept of TCA. The Swiss government has funded the TRUE-COST-CH research project (2024–2027) to explore options for the implementation of TCA in the agri-food sector (TRUE-COST-CH, n.d.). The food strategy of the Belgian region Flanders states an intention to 'charge the true price of food', taking into account the 'social, environmental and economic long-term consequences of production and/or consumption' (Flemish Government, 2023, p. 14). To this end, the REFORM project (2025–2028), funded by the Research Foundation Flanders, aims to support the implementation of the Flemish Food Strategy by advancing a TCA approach for the agri-food sector. TCA has also been salient in Dutch politics in recent years. Since 2021, the Netherlands Enterprise Agency has been funding a project on the TCA assessment of organic bananas from the Dominican Republic and Peru

(Netherlands Enterprise Agency, 2024). In response to a parliamentarian's request in 2023 (Tweede Kamer, 2023), the Dutch government commissioned a report on the true cost and pricing of consumer items, later published by CE Delft (de Vries et al., 2024). A more recent parliamentarian's request to create a level playing field for companies that cause few negative externalities was granted (Tweede Kamer, 2025). Finally, in their guidelines regarding sustainability claims, the Netherlands Authority for Consumers and Markets (ACM) refers to true prices as an important tool for fact-based claims (ACM, 2023).

Civil society actors also express interest in TCA. The International Federation of Organic Agriculture Movements (IFOAM) is a global non-governmental organization (NGO) that highlights the need for TCA to support organic production (e.g. IFOAM, 2019; Sachse & Bandel, 2018). In Germany, Misereor is interested in the advancement of TCA and is funding the True Cost Alliance (Misereor, n.d.), an action alliance for institutions interested in the development and implementation of TCA. Currently, the True Cost Alliance consists of Misereor, Nuremberg Institute of Technology, and TMG - Think Tank for Sustainability (True Cost Alliance, n.d.). The Global Partnership on True Price of Food is a collaboration between governments, businesses, and civil society, launched at the UNFSS+2 and aiming to enable private actors to implement true pricing on a large scale. This body was implemented in a collaboration between the True Price Foundation and the Netherlands Food Partnership (NFP, n.d.; True Price Foundation, n.d.). The TCA Accelerator (which organized the FAO's TCA Global Summit) is a global network aiming to advocate for a widespread adoption of TCA (TCA Accelerator, n.d.).

Dialogue platforms in the agri-food sector underline the importance of assessing true costs and compensating farmers for providing public services.

The Strategic Dialogue on the Future of EU Agriculture clearly expresses the necessity to engage in TCA to address market failure. It underlines the importance of markets driving sustainability and value creation in order to internalize externalities in the agri-food sector. A central aspect of the recommendations includes establishing a benchmarking system that will harmonize methodologies for on-farm sustainability assessments, which could then be extended to the entire food value chain. The benchmarking could be used to reward farmers for their sustainability efforts and their provision of ecosystem services based on quantifiable outcomes (Strohschneider, 2024). Picking up the suggestion from the EU level, the German dialogue platform Zukunftskommission Landwirtschaft (Commission for the Future of Agriculture) reiterates the necessity of developing both a benchmarking system to create economic incentives and a compensation system to reward the provision of ecosystem services (Zukunftskommission Landwirtschaft, 2024). As part of the Youth Policy Forum hosted by the German Ministry of Food and Agriculture (BMEL, now BMLEH) in September 2023, youth representatives from agricultural and environmental organizations, universities, and farms were supportive of internalizing true costs in food prices, renumerating ecosystem service provision along the entire value chain, and creating incentives

for sustainable products such as tax adjustments for organic products (Deutsche Bundesregierung, 2024).

The current German government has underlined in its coalition contract that it wants to build on past and ongoing dialogues to spur sustainability in the agri-food sector (CDU, CSU, & SPD, 2025). This could engender more dialogue and communication around the potential of TCA in the future. Engaging stakeholders from the agricultural sector and highlighting TCA's relevance as a market-based approach with possible economic advantages could support its wider acceptance.

Opportunity: EU policy framework can support data collection and communication of TCA results

The EU Vision for Agriculture and Food calls for the development of a benchmarking system that sets sustainability standards and allows for sustainability data collection at the farm level.

In recent years, European farmers have faced a growing number of sustainability standards, certification schemes, and reporting requirements. While all aim to assess and monitor farm-level sustainability, their development in isolation has led to poor comparability, inconsistent metrics, and unnecessary duplications of effort. As part of the EU Vision for Agriculture and Food, first presented by the European Commission in February 2025, the European Union aims to simplify and streamline EU requirements and wants to establish a voluntary benchmarking system for farms. The On-farm Sustainability Compass should support farmers in monitoring, recording, and benchmarking their sustainability performance. By acting as a one-stop shop, it aims to streamline reporting and reduce farmers' administrative burden. The system will be developed in a bottom-up and participatory approach to enable adjustments to farmers' needs (European Commission, 2025a).

The EU Corporate Sustainability Reporting Directive (CSRD) supports standardized business reporting on sustainability impacts and could serve as an opportunity for standardized data collection (though this potential may be curtailed by the EU Omnibus Directive).

As part of the European Green Deal, the CSRD requires companies in the EU to disclose detailed and standardized information about their environmental, social, and governance (ESG) impacts. It applies the principle of double materiality, assessing both how ESG issues affect a company's financial performance (internal risks) and how the company's activities impact the environment and society (external impacts). Both factors conceptually align with the idea of a TCA system: TCA can be used to monetize the internal corporate risks resulting from social, human, and natural capital depletion, though most TCA assessments focus on external impacts, encouraging companies to collect data on externalities resulting from their economic activities. Although the CSRD does not yet require monetization of these impacts, it establishes an important regulatory and conceptual foundation for TCA in Germany (European Union, 2022).

Initially, the CSRD, which came into force in December 2022, was expected to apply to approximately 50,000 companies in the EU (European Parliament, 2022). However, the scope was significantly narrowed with the announcement of the Omnibus Directive in February 2025. The Omnibus Directive limits the reporting obligations to large undertakings, defined as companies with more than 1,000 employees and either an annual turnover above €50 million or a balance sheet total exceeding €25 million, reducing the number of affected companies by an estimated 80%. This adjustment aims to protect small and medium-sized enterprises (SMEs) from excessive reporting burdens and to mitigate regulatory trickle-down effects. Nevertheless, SMEs may adopt the Voluntary SME Reporting Standard (VSME), which provides simplified guidelines for reporting sustainability impacts (European Commission, 2025g). The reduced scope of the CSRD limits its immediate impact to very large firms; however, trickle-down demands from larger buyers and financial institutions could still encourage voluntary reporting by small or medium businesses in the agri-food sector, thereby supporting TCA-related data collection. The Omnibus packages will be discussed below.

The EU's Environmental Footprint Methods provide a standardized methodology for measuring environmental impacts at product and business levels, offering a solid methodological foundation for TCA assessments.

The EU's Environmental Footprint methods comprise the Product Environmental Footprint (PEF) and the Organisation Environmental Footprint (OEF), instruments developed by the European Commission to establish a harmonized methodology for measuring environmental impacts across products and organizations (European Commission, n.d.-b). Both are based on LCA principles but go further by providing standardized rules for modelling, calculating, and reporting environmental footprints across sectors, ensuring consistency and credibility. They provide a legally recognized basis for assessing and disclosing environmental externalities (considering 16 environmental impact categories) in the agri-food sector that can be used for TCA at product and business levels. By linking TCA approaches to the LCA-based PEF and OEF frameworks, there is a strong opportunity to ensure methodological consistency, enhance legitimacy, and pave the way for embedding TCA within future EU regulatory frameworks. A shortcoming of the methodology is the disregard of social and health-related sustainability aspects.

The development and testing of the standardized methodology is taking longer than initially expected, however. The pilot phase was planned for 2013 to 2015, but was later extended for two more years. The transition phase, intended to be completed by 2021, is still ongoing. This current phase, initiated in 2019 and expected to end in 2025, aims to monitor the implementation of the standardized methodology and integrate recent scientific advances. This will result in new recommendations for the environmental footprint methods (Antony et al., 2024; European Commission, n.d.-a).

The European Commission's planned nature credits scheme can serve as a starting point for the implementation of TCA methodology at the EU level.

In July 2025, the European Commission published a *Roadmap towards Nature Credits*, outlining how a nature credit scheme could be developed and implemented in the EU (European Commission, 2025d). Building on lessons learned and experiences from carbon markets, the roadmap envisions a participatory process in close collaboration with stakeholders to establish a functioning voluntary nature credits market. The proposed system would reward farmers, foresters, fishers, landowners, and local communities for sustainable practices, conservation, and restoration efforts. On the demand side, private investors could purchase nature credits to mitigate reputational and operational risks while complementing public nature financing. The Commission acknowledges the challenges of monetizing ecosystem services and embedding their value into market prices. Here, TCA can play a key role by quantifying the impacts of sustainable practices and informing impact-based pricing of nature credits. To support this, TCA experts should be included in the planned expert group on criteria and methodologies for nature credit markets, raising awareness of the TCA approach and enabling its integration into the scheme.

Threat: Political deprioritization of sustainability and obstructive influence from interest groups (lobbying)

The strong German agricultural lobby prioritizes reducing bureaucratic burdens for farms and may oppose TCA initiatives.

There is a strong political lobby for economic interests in the agri-food sector in Germany and the EU. The biggest lobby organization representing farms in Germany is the Deutscher Bauernverband (DBV), an association that represents the interests of farmers in Germany.[iii] In the preamble of its mission statement, DBV emphasizes its entrepreneurial mindset and commitment to sustainability by combining 'freedom with responsibility in the market, the environment and society' (DBV, 2011). The association clearly demands the reduction of bureaucratic and regulatory burdens on farmers (DBV, 2025). A study by the German Nature and Biodiversity Conservation Union (NABU) and the Institute Labour and Economy (iaw) published a study showing the interconnectedness of the DBV's network and its possible influence on politics (iaw, 2019). Other economic interests that might hinder sustainability efforts are producers of agro-chemicals, food corporations, and the retail industry (iaw, 2019). Alongside the DBV, other lobby organizations representing livestock farming, meat, and milk producers may oppose the implementation of TCA due to the high environmental impacts and costs associated with animal-based products compared to plant-based products and the associated reputational damages towards animal products.

[iii] Despite its high level of political influence, a representative farmer survey shows that only around 42% of farmers feel well represented by the DBV, while 37% feel rather poorly, and 19% feel very poorly represented (forsa Politik- und Sozialforschung GmbH, 2019).

The German government prioritizes economic growth, which might lead to neglect or discontinuation of sustainability efforts.

New elections in Germany were held in February 2025 after the previous government, consisting of the Social Democratic Party of Germany (SPD), Alliance 90/The Greens, and the Free Democratic Party (FDP) collapsed. The election resulted in a new coalition between the Christian Democratic Union of Germany (CDU), Christian Social Union in Bavaria (CSU), and the SPD. The new coalition understands itself as parties of the democratic centre and wants to clearly set itself apart from the goals of the previous left-leaning government. The preamble of the coalition contract clearly states that the government understands the election results 'as a mandate for a comprehensive renewal of our country' (CDU, CSU & SPD, 2025, p. 1). One of the central goals of the coalition is the renewal of the 'promise of a social market economy—opportunities and welfare for all' (CDU, CSU & SPD, 2025, p. 2). This promise includes increasing competitiveness and growth in the German economy, improving conditions for businesses, supporting innovation, and reducing bureaucracy. The preamble and, therefore, the central goals do not mention sustainability aspects explicitly.

The first speech of Federal Minister for Agriculture, Food and Regional Identity, Alois Rainer, took place in the German Bundestag on the 15 May 2025. Rainer stated BMLEH's aim to reduce bureaucracy, create planning security, and to increase public appreciation for the agricultural sector. He underlines that there will be a 'real change of course', highlighting an increase of freedom and targeted support for farmers. The speech made it clear that the focus is on the market economy—increasing competitiveness, corporate freedom, and trust in farmers to make sustainable decisions with fewer regulations, documentation, and reporting obligations. Although sustainability aspects were mentioned, they were given less emphasis compared to other policy areas in the current administration's agenda. Sustainability goals are to be achieved through (financial) incentives, contractual nature protection, and remuneration of nature and environmental protection (Rainer, 2025). This political change may discourage the implementation of a TCA system that requires the willingness to invest in data infrastructure for sustainability targets and create additional documentation efforts on the farm and value chain levels. However, there are also opportunities to align the development of a TCA system with new goals by creating economic incentives and public appreciation for the sustainability efforts of farms by allowing consumers to make more informed decisions.

The EU Commission's efforts to increase business competitiveness and reduce bureaucracy may diminish opportunities for TCA implementation.

In response to the Draghi report on EU competitiveness, the European Commission presented the Competitiveness Compass in January 2025. The Compass identifies simplification as one of five key horizontal enablers of competitiveness, calling for a drastic reduction in regulatory and administrative burdens on businesses (European Commission, 2025e). Building on this agenda, the Commission announced in February 2025 a series of Omnibus packages

aimed at simplifying EU rules, enhancing competitiveness, and improving the business environment. The first package proposes revisions to major sustainability-related legislation, including the CSRD and Corporate Sustainability Due Diligence Directive (CSDDD), scaling back reporting obligations to reduce costs and complexity for businesses (European Commission, 2025c).

In response to widespread protests from farmers, the CAP has been undergoing simplifications. In March 2024, the Commission put forward proposals to simplify environmental conditionality and improve farmers' remuneration by protecting them from unfair trading practices in the food supply chain (European Commission, 2024c). In May 2025, the Commission further announced an Omnibus package to simplify the CAP to increase competitiveness in the agricultural sector. The proposal includes actions to simplify payments for small farms, simplify environmental regulations and controls, improve crisis response, and increase competitiveness through financial tools and digitalization. This package is currently under review by the European Parliament and Council, with additional simplification measures expected later in 2025 (European Commission, 2025h).

While these efforts aim to strengthen the competitiveness of EU businesses and farms in the global market, they may undermine opportunities for implementing TCA in the agri-food sector. Reductions in sustainability reporting and environmental compliance obligations risk weakening the regulatory and informational infrastructure on which TCA depends. By prioritizing administrative simplification over transparency and accountability, these measures could limit data availability, reduce incentives for internalizing externalities, and slow progress toward true-cost-based decision-making. However, the more efficient and streamlined reporting measures could also benefit data collection for TCA applications (see previous section on the EU benchmarking system).

Opponents may try to frame TCA as 'left-wing' politics.

TCA may be criticized or politically framed as a left-wing policy, which risks alienating certain political actors, lobbyists, and voters. This framing arises because TCA highlights issues—such as environmental degradation, climate change, and social injustice—that are often associated with parties left of centre. However, such a characterization is misleading. In economic theory, externalities are widely recognized as a form of market failure (Coase, 1960; Pigou, 2002). TCA as a concept is in line with prevailing neoliberal worldviews that understand that failures in the current economic system are leading to climate change, environmental degradation, and social injustice (de Adelhart Toorop et al., 2021; Michalke et al., 2022; Patel, 2021b). TCA can be considered as a neoclassical approach that aims to solve market failures through pricing and creation of new markets for natural, social, and human capital. Nevertheless, the perception of TCA as ideologically partisan remains a challenge for its broader acceptance.

6.3.2. Economic conditions

Threat: Barries to implementation in an open and globalized market

International and EU trade legislation may limit the use of TCA policy instruments that are considered trade-distorting.

International trade legislation, EU trade laws, and EU Free Trade Agreements (FTAs) could present barriers to the implementation of TCA in Germany, particularly if TCA affects how products are priced, labelled, or traded across borders. TCA-based policy instruments or disclosure rules can trigger legal and political challenges under international trade law if perceived as discriminatory or restrictive. Major agricultural exporters may view TCA implementation as a form of 'green protectionism' or 'green imperialism', especially if it affects market access and impacts trade volumes.

As part of the EU, Germany cannot impose measures that distort competition or impede the free movement of goods in the EU single market. Depending on the design of the TCA system, other member states may view it as a trade barrier or as undermining the level playing field. Furthermore, Germany is bound by more than 40 FTAs with third parties such as Canada, Japan, Vietnam, and Chile (European Commission, 2025i). These agreements typically aim to reduce tariffs, harmonize standards, and eliminate non-tariff barriers to trade. Germany cannot unilaterally renegotiate these trade agreements to request the inclusion of TCA requirements. Efforts to extend TCA requirements to imported goods could conflict with these agreements and lead to friction with both trade partners and EU institutions.

From a World Trade Organization (WTO) perspective, TCA-based measures must respect principles like National Treatment (equal treatment for imported and domestic goods) and Most Favoured Nation (non-discrimination among trade partners) under the General Agreement on Tariffs and Trade (GATT) (WTO, 2025b). Labelling schemes or the internalization of externalities that place imported products at a disadvantage could be challenged as trade-restrictive, unless implemented in a non-discriminatory manner. Environmental or societal objectives can justify certain measures under legal exemptions of the GATT Article XX, if they are non-discriminatory, necessary, and proportionate (WTO, n.d.). The WTO's Agreement on Technical Barriers to Trade (TBT) may also apply, particularly if TCA compliance imposes significant costs or lacks flexibility for producers in developing countries (WTO, 2025a).

In short, the successful implementation of TCA in Germany will require careful coordination at the EU level to avoid intra-European disputes and to ensure compatibility with existing international trade obligations. Any unilateral move risks legal challenges and political backlash, both from EU partners and global trade allies.

Agri-food businesses are embedded in global value chains, which poses significant challenges for implementing a consistent TCA system.

In 2023, Germany was the world's third biggest importer and fourth largest exporter of agricultural commodities (BMLEH, n.d.). German agri-food businesses are deeply embedded in global value chains, exporting processed food products such as cheese, chocolate, pastries, and coffee, while importing key agricultural commodities like rapeseed, wheat, soybeans, maize, bananas, cocoa, and green coffee (FAO, 2023a, 2023b). Many agri-food companies depend on raw materials that are not, or cannot be, produced domestically, such as soybeans and maize for animal feed, bananas for retail, and cocoa and coffee for confectionery and beverage industries.

This global integration poses challenges for implementing a TCA system, particularly regarding its scope: should TCA only account for externalities of products fully produced in Germany (e.g. apples, meat, bread with local ingredients) or also include externalities from the production of imported raw materials and processed goods? While assessing the true cost of domestic products may be feasible, tracing and monetizing externalities in global supply chains is much more difficult due to limited influence over suppliers, poor data availability, and resulting implementation costs. Moreover, if TCA obligations apply only to domestically produced goods and not to imports, the implementation risks creating price distortions and undermining the competitiveness of German agri-food businesses.

German farms and agribusinesses face competition from within and outside the EU single market.

As part of the EU's internal market, German agricultural producers compete with producers across Europe and beyond, many of whom operate under lower production costs and weaker environmental or labour standards. While the CAP and EU-wide trade rules provide some regulatory framework, the introduction of TCA in Germany could increase operational costs due to data collection and reporting obligations, potentially leading to competitive disadvantages. If external costs are disclosed only for German products, while imports remain unassessed, this asymmetric transparency could mislead consumers and hurt domestic sales. Moreover, producers outside the EU may be unwilling or unable to provide TCA-relevant data, especially in complex global supply chains (e.g. of cocoa, spices, or bananas). This could complicate sourcing and trade, potentially triggering political friction.

Although Germany ranked among the world's top agricultural exporters in 2023 (BMLEH, n.d.) and its agricultural sector is one of the most competitive in the EU (Nowak & Różańska-Boczula, 2022), actors in the sector perceive their position as increasingly fragile. The 2024 farmer protests against the planned elimination of agricultural diesel subsidies highlighted the sector's sensitivity to rising operational costs. Farmers argued that higher fuel taxes would make them less competitive compared to peers in other EU countries with lower energy taxes. The DBV echoed these concerns in its 2025 situation report (*Situationsbericht 2024/25*, 2024). Other factors that are often seen to reduce the competitiveness of the German agri-food sector are the uneven regulatory restrictions in the EU, high labour costs due to the increasing minimum wage,

rising energy costs through CO_2 pricing, a shortage of seasonal and skilled workers, and slow and excessive administrative processes.

Threat: Resistance from key actors in the agri-food sector

Businesses in the processing and retail sector currently make little effort to integrate TCA into their strategies.

There is currently limited effort from private companies to engage in TCA initiatives. In the past, there have been private sector initiatives that were mostly short-lived. The German retailer Penny, part of the larger Rewe Group, participated in two TCA experiments in collaboration with Nuremberg Institute of Technology and Greifswald University. In 2022, a supermarket in Berlin displayed a second price tag with the true price of eight selected products (Penny, n.d.-a). In 2023, a six-day true pricing experiment was conducted in all branches of Penny in Germany, where consumers had to pay the true price of nine selected products (Penny, n.d.-b). From April to June 2023, a similar campaign was hosted by the large Dutch retailer Albert Heijn in collaboration with True Price, which charged the true price of coffee in three selected branches in the Netherlands (True Price & Albert Heijn To Go, n.d.). In 2019, the temporary 'True Cost—From Costs to Benefits in Food and Farming' initiative was established, consisting of NGOs, research institutions, and private companies. The aim of the initiative was the development of a handbook to allow transparent and systematic reporting of the environmental, social, and health-related impacts of businesses (Soil & More GmbH, 2021). In 2023, Biofach, the world's leading private-sector trade fair for organic food, made TCA one of the core subjects of their convention in Nuremberg with the theme 'Organic. Food Sovereignty. True Prices' (BIOFACH, 2023a). The trade fair also positioned the subject prominently in 2024 (BIOFACH, 2023b).

German farms face significant economic and political pressure that discourages engagement and investment in sustainability initiatives.

The situation of the agricultural sector is very dynamic. Farms are subject to price fluctuations of inputs, outputs, and land, as well as changes in climate and environmental conditions, political requirements, and terms of trade. In the short term, market prices have become relatively stable, while climatic and trade conditions continue to be challenging (European Commission, 2024b). Medium-term uncertainties in prices are driven by an unstable geopolitical situation, while climate change and natural resource depletion are impacting yields (European Commission, 2024a). The dynamic situation creates uncertainty that disincentivizes investment and affects farmers' motivation to engage in the long-term transformation of business activity. For the implementation of TCA, this presents a challenging situation. In times of high input and labour costs with low producer prices, farms may not be open to diverting labour towards on-farm data collection. Small farms in particular could be driven out of the market by increased sustainability reporting requirements, which are to be expected through the implementation of TCA.

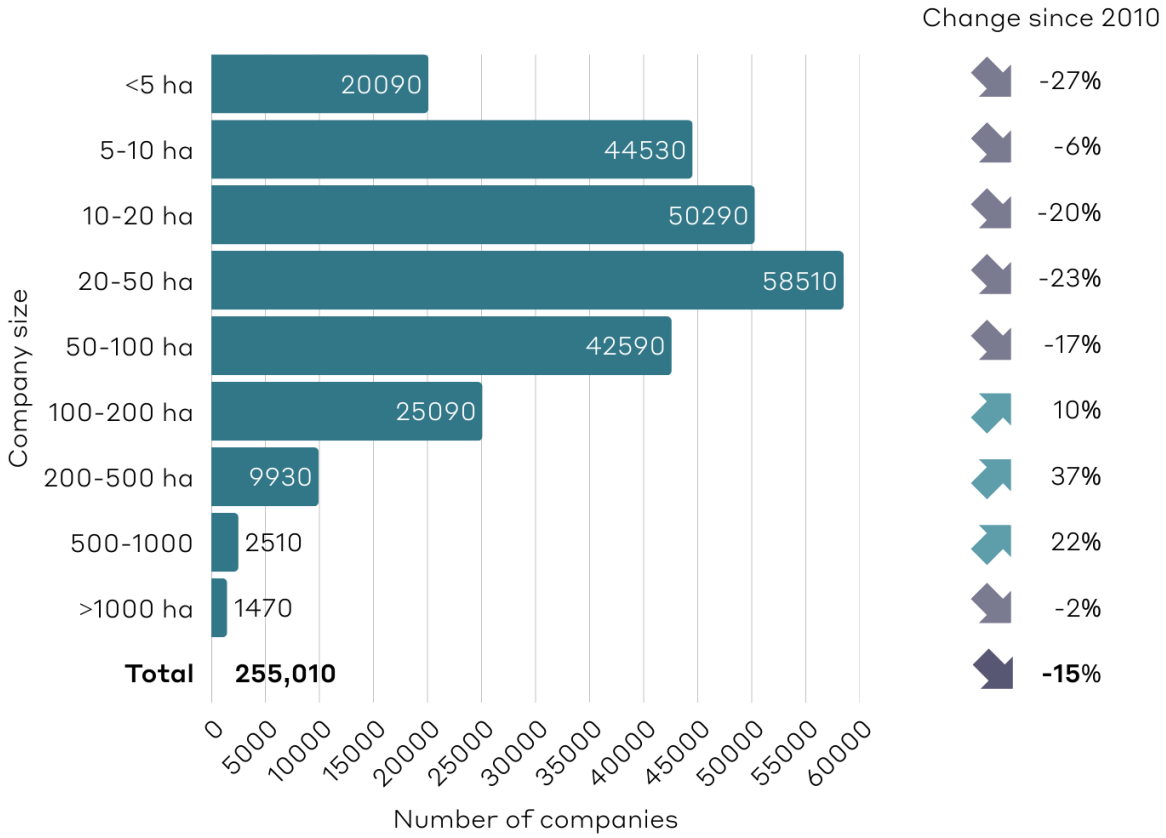

Figure 3. Number and size of farms in Germany (2010–2023); adapted from BLE (2024)

The current system drives farms to industrialize and increase productivity to remain profitable. Figure 33 shows that between 2010 and 2023, the number of farms in Germany has decreased by 15%. Farms below 100 hectares seem to drop out of the market, while the number of large farms tends to increase (BLE, 2024). Small-scale farms are pushed out of business due to competitiveness struggles, financial sector preferences, and unequal distribution of EU subsidies based on farm size (Greenpeace, 2024). Although larger and specialized farms are more profitable, smaller and diversified farms are perceived to be more resilient, having flexibility to adjust to changing conditions (Zukunftskommission Landwirtschaft, 2021).

Farms and agri-food businesses perceive a high bureaucratic burden that may restrict their willingness and/or capacity to participate in a TCA system.

As previously mentioned, there is a large political movement towards the reduction of bureaucracy in Germany that reflects the sentiment in the agri-food sector. Farms are subject to a high level of verification and documentation obligations. A statement from the German Farmers' Association (DBV) suggests that each renewal of the CAP comes with promises of a reduction in bureaucracy, but results in even more (Krüsken, 2023). The association lobbies for more pragmatic solutions and surveys suggest that a large share of farmers agree with these demands. A survey from April 2019 found that 26% considered 'too much bureaucracy' to be one of the most important problems of agriculture in Germany. A more recent survey by the industry magazine *top agrar*, published

in April 2025, shows that 71% of farmers perceive bureaucracy to be their biggest burden, followed by economic pressure (12%), and high labour demands (9%) (Meusener, 2025). A study conducted by a private sector actor confirms that complex bureaucracy, agricultural policies, and guidelines are stress factors that affect farmers (Wörner, 2025). These concerns are also acknowledged in the results from national and EU dialogue platforms, the Commission for the Future of Agriculture and the Strategic Dialogue on the Future of EU Agriculture. A report from Switzerland suggests that training and advisory services regarding the use of digital tools and data exchange between data entry platforms may help to reduce the perception of bureaucratic burden (Mack et al., 2019).

Downstream value chain actors are also subject to these types of obligations. In 2025, the Federal Association of the German Food Industry (BVE) launched a survey of 160 businesses. A large majority perceived the current bureaucratic requirements to be overly burdensome, with 18.3% of medium and 22% of small enterprises considering the bureaucratic load to be threatening their company's existence. Of the businesses surveyed, 96.2% agreed that the newly elected German government needs to reduce the bureaucratic burden (BVE, 2025b). Prior to the elections in February 2025, BVE demanded the establishment of a central data reporting platform to avoid the double assessment of data points (BVE, 2025a).

Potential unwillingness of farms and agri-food businesses to collect and share sensitive data, because they expect insufficient financial benefits and competitive disadvantages.

A major barrier to TCA is the high demand for specific data from farms and agri-food businesses. At the same time, the unwillingness of key actors to collect and share data needed for the TCA calculation could pose a major threat to its implementation. Reasons for the resistance to collecting and sharing data include the high burden of bureaucracy, the lack of financial incentives, and potential competitive disadvantages, especially for voluntary initiatives. A project funded under the German Recovery and Resilience Plan (DARP) that aimed to create a transparency system for the German agri-food sector found that (bar a few exceptions) most businesses refused to share data (PD, 2024). This was mostly due to scepticism towards a public transparency system, low expectations regarding the financial advantages of such a system, and the fear of being one of few companies to share such data.

Scepticism of value chain actors towards the completeness of TCA calculations and the communication of results.

A recent study investigated the attitude of nine value chain stakeholders across the EU towards TCA (Carlsson et al., 2025). The focus was on stakeholders' perception around supporting, adopting, or suggesting improvements for true price labels. The sampled stakeholders generally had a positive attitude toward sustainability initiatives and TCA aspirations. However, there was scepticism regarding the balancing of negative and positive externalities in the calculations, the inclusion of all relevant impact categories, and the fairness of

the results. Participants further raised concerns regarding true price labelling in general and questioned the effectiveness of communicating negative externalities to consumers as an instrument to achieve behavioural change or to internalize externalities at the farm level. Since the active participation of such stakeholders will be necessary for the successful implementation of TCA, this scepticism must be addressed or accommodated.

Given the strong market influence of the food retail sector in Germany, voluntary TCA initiatives depend heavily on stakeholders' willingness to engage.

The food trade sector in Germany can be broadly divided into wholesale and retail. The wholesale sector supplies food to businesses, while the retail sector sells directly to consumers. A survey by the Center for Research in Retailing Cologne (IFH Köln) on German consumers found that more than 80% of respondents regularly buy food at the supermarket or discounter (IFH Köln, 2024). As of 2023, the four largest food retailers in Germany—EDEKA, REWE, the Schwarz Group (Lidl and Kaufland), and the Aldi Group—collectively control approximately 76% of food retail revenues, indicating a significant level of market concentration (BVE, 2024; Tradedimensions, 2024). This market power allows retailers to exert significant pressure on suppliers, potentially limiting fair pricing, innovation, and the adoption of sustainability measures among upstream actors. In 2023, 94% of the domestic supply of fresh produce was produced in Germany, 44% was demanded by households, and 40% was distributed by food retailers (IFH Köln, 2024). Although farmers have other trade partners, the food retail sector plays a major role in the distribution of domestic products to domestic consumers. In the transformation of the agri-food sector, food retailers play a pivotal role as gatekeepers between producers and consumers (Keller et al., 2022). Their stance on TCA therefore carries considerable weight, which necessitates their active involvement.

Retailers' procurement policies, product pricing strategies, and consumer communication channels can significantly influence the adoption and scalability of TCA-based practices across the supply chain. A recent study shows that the retail sector is engaging with sustainability issues; however, efforts remain insufficient and fall short of fully leveraging potential influence (Sander et al., 2025). The TCA policy framework should accommodate increased regulations and financial incentives to allow the retail sector to increase its sustainability performance without being subject to competitive disadvantages (Keller et al., 2022). The current level of engagement suggests that the food retail sector is unlikely to play a leading role in the large-scale implementation of TCA under present conditions.

Opportunity: Financial incentives supporting the uptake of sustainable practice

Farmers are willing to engage in more sustainable practices, especially if they are being reimbursed for their efforts.

For the implementation of TCA in Germany, it is crucial that farmers are in favour of such initiatives, as a large share of external cost and benefits are produced during and affect agricultural production. A 2019 farmer survey in Germany found that 87% of respondents were willing to engage in more environmental protection, but most of them (68%) were only willing to do so if they are being financially compensated for their efforts (forsa Politik- und Sozialforschung GmbH, 2019). Another survey confirms these results, finding that 60% of responding farmers would like to work in a more climate-friendly manner and are motivated by the public appreciation for and competitive advantage of climate-friendly products. Almost 80% said they would reduce GHG emissions if related costs were compensated (Schulze Stumpenhorst, 2020).

A positive example is the Initiative Tierwohl (English: Animal Welfare Initiative), an industry-led program to improve animal welfare in conventional poultry and pork production in Germany. Downstream value chain actors purchasing from participating farms pay a premium into a fund, which is then distributed to the farms to support investments in animal welfare practices that exceed national standards. The initiative also uses product labels to inform consumers about producers' participation and compliance with animal welfare standards, helping to justify higher retail prices. As of February 2024, 13,200 farms have joined the initiative since 2015, which represents 90% of poultry and 40% of pork production in Germany (Initiative Tierwohl, 2024). Farmers' willingness to participate is influenced by factors such as the perceived cost–benefit balance (Wellner et al., 2019). Although economic assessments show limited profitability for farms through the initiative (Heise & Schwarze, 2019; Schukat, Ottmann, et al., 2020), the initiative successfully motivates and incentivizes farmers to participate in the initiative.

However, while many German farmers express a general willingness to adopt more sustainable practices, their actual engagement in climate mitigation, environmental protection, and animal welfare initiatives depends on more than financial incentives alone. Studies show that farmers are motivated by public recognition and product labelling, but often lack accessible, practical information to guide implementation (Jantke et al., 2020). Factors such as perceived effort, implementation risks, increased bureaucratic burden, unannounced inspections, and overall doubts about effectiveness may outweigh mere cost considerations (Sattler & Nagel, 2010; Schukat, von Plettenberg, et al., 2020). A study on the implementation of agri-environmental measures shows that farms with different farming styles name different reasons for not engaging in these measures (Hammes et al., 2016). For TCA to gain traction, it must address such barriers through tailored communication, reduced bureaucracy, and alignment with farmers' motivations and operational realities.

The EU Sustainable Finance Disclosure Regulation (SFDR) will increasingly demand sustainability reporting in the financial sector and incentivize investment in sustainable business models.

The financial sector is undergoing a structural shift towards sustainability, creating new incentives for businesses to disclose their environmental and social performance. The EU defines sustainable finance as the integration of environmental, social, and governance considerations into investment decision-making, with the aim of directing capital towards sustainable economic activities (EU, 2025). Central to this transformation is the Sustainable Finance Disclosure Regulation (SFDR), which requires financial market participants and advisers to report sustainability risks and impacts to enhance transparency and accountability. The aim is to allow informed decision-making with respect to environmental, social and governance standards of financial products (EU, 2019). One key instrument is the Green Asset Ratio (GAR), which measures the share of a financial institution's assets aligned with the EU Taxonomy for Sustainable Activities. This metric creates a direct incentive for banks and investors to favour businesses that meet stringent environmental standards (EU, 2024). As a result, companies that can demonstrate sustainable practices stand to benefit from improved access to financing.

This regulatory pressure will increasingly extend to the agrifood sector. The DBV has warned that banks and insurers will pass sustainability reporting obligations on to their clients, including farms and agribusinesses (Krüsken, 2023). In this context, the implementation of TCA can provide a structured framework for quantifying environmental and social externalities, helping agri-food businesses align with evolving financial disclosure requirements and become more attractive to sustainability-focused investors. Experts highlight that, through monetization, TCA could play an important role as it speaks 'the language of the financial sector' and has the potential to create a fair playing field (Michalke et al., 2022). However, the Omnibus process is aiming to introduce simplifications to EU legislation that may reduce the trickle-down effects to agriculture. The Commission will publish the proposed changes to the SFDR in the fourth quarter of 2025.

6.3.3. Consumer attitude

Opportunity: Strong consumer awareness on sustainability issues and moderate trust in labels

High consumer awareness of environmental sustainability can support acceptance of TCA implementation.

Since 1996, the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV, now BMUKN) and the German Environment Agency (UBA) have conducted a biannual study tracking trends in environmental awareness. The preliminary results of the most recent representative survey from 2024 reveal that 88% of the population consider environmental and climate protection to be important or rather important (Frick et al., 2025). Nearly three-quarters of respondents believe that national and EU-level politics are not doing enough to address these issues. The 2022 survey even found that approximately 91% of respondents favoured a shift towards a more sustainable economic system (UBA & BMUV, 2023). This strong

public support for environmental protection and the associated demand for action can enhance social acceptance for the implementation of TCA. A survey conducted as part of an information campaign in 2021 found that over 90% of respondents perceived the implementation of TCA as rather important (Michalke et al., 2022). In 2023, a survey found that, after being confronted with increased prices, 47.5% of respondents still had a positive attitude towards the implementation of true costs, mostly motivated by an understanding of the reasons for the price increase (Stein et al., 2024).

Nonetheless, there are concerns about the potential social consequences of such a transition towards a more sustainable economic system. Many respondents of the UBA and BMUV survey worried that sustainability reforms could exacerbate social injustice, inequality, and conflict. Despite an overall high level of environmental awareness, there appears to be a slight downward trend since 2018 (Frick et al., 2025). Increasingly, the public perceives issues in the health, education, and economic sectors as more urgent priorities. Other reasons that might threaten the implementation of TCA, such as consumer finances, rising prices, and misunderstandings, will be presented below.

High consumer interest in health factors related to diets can support acceptance of TCA implementation.

Given that health impacts account for the largest proportion of hidden costs in Germany (FAO, 2024), a focus on health data may be a socially accepted measure. A study found that 79% of survey respondents agreed that social costs should be included in TCA initiatives, concluding that future research should further investigate specific aspects of TCA, including health costs and animal welfare (Stein et al., 2024). Academic research shows that consumers perceive price, taste, and health to be more influential than sustainability (van Bussel et al., 2022). A representative consumer survey from Germany confirms these results, showing that, following taste preferences and prices, health aspects play an important role in nutrition and purchasing decisions (Robert Bosch Stiftung & More in Common, 2025). The survey further found that 47% of respondents would be willing to accept higher prices if governments set higher standards regarding the impact of food on human health. A total of 87% saw steering attention to healthy nutrition as an important ambition for the future, compared to 72% for mitigating climate and environmental impacts of diets. Throughout the study, human health appears to be more important than environmental and climate aspects in German society. These findings suggest that health costs and benefits should be a crucial element in the implementation of TCA initiatives such as TCA labels, since this strongly resonates with consumer concerns. However, empirical evidence from Germany also shows that health-related factors have a limited impact on purchasing decisions, as price is the most influential factor (Seubelt et al., 2022).

Consumer trust in sustainability labels and demand for holistic sustainability information can support TCA implementation.

Widespread consumer awareness and use of sustainability labels present a valuable opportunity for advancing TCA. Compared to other European

countries, i.e. Sweden, Poland, France, and Spain, consumers in Germany show relatively high levels of sustainability concerns, alongside a consistent understanding and self-reported use of sustainability labels (Grunert et al., 2014). A representative study from 2022 found that approximately 46% of German consumers said they frequently choose products based on environmental labels such as Blauer Engel, EU Organic, or EU Ecolabel, while another 31% said they do so occasionally (UBA & BMUV, 2023). Additionally, 82% reported at least occasionally purchasing goods from certified organic production, demonstrating openness to sustainability-oriented consumption, even if regular purchasing remains below 25%.

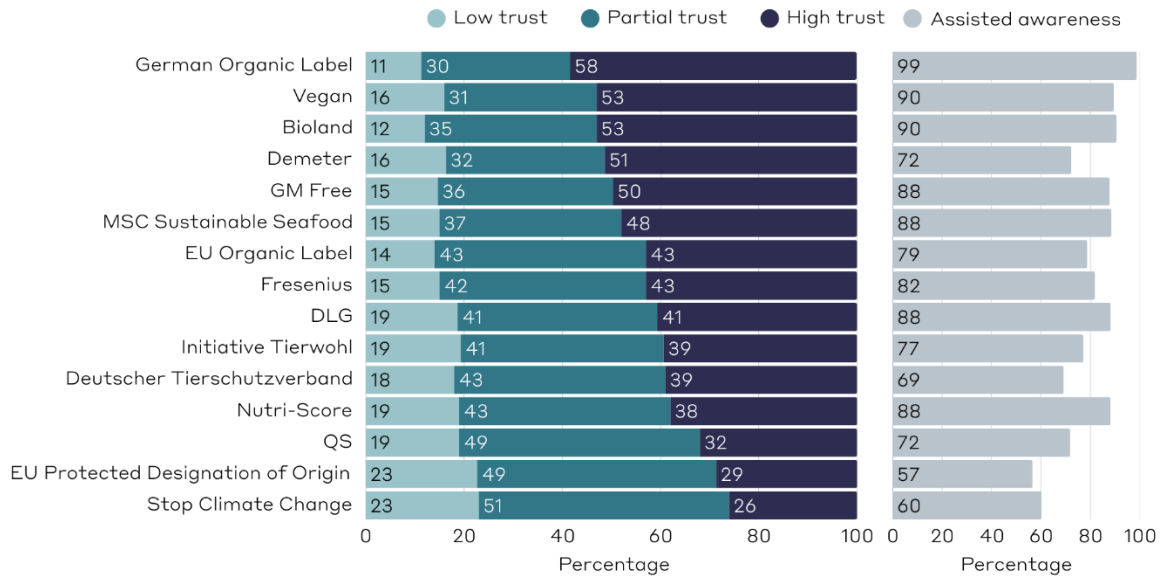

Figure 4. Consumer trust in selected sustainability labels; adapted from Profeta & Cicek (2021)

Trust seems to play an important role in the influence of sustainability labels on consumer behaviour (Cook et al., 2023; Gorton et al., 2021). Many consumers are familiar with and place confidence in established labels, particularly in the food sector. However, level of trust seems to depend on the type of label. Figure 4 shows that labels such as the German Bio label, the Vegan label, Bioland, Demeter, and Ohne Gentechnik (GM free) are widely known and trusted by at least half of the respondents of a consumer survey (Profeta & Cicek, 2021). Another scientific study investigated German consumers' level of awareness of three common labels. A share of 87.8% recognized the German organic label, 56.4% the industry-driven animal welfare label, and 43.2% the EU nutri-score. Trust in these three labels was reported by 39–47% of consumers, with 46% and 42.2% saying they often considered the organic and the animal welfare labels in their grocery shopping, respectively, while only 21.5% considered the nutri-score in their decision process (Sonntag et al., 2023).

This moderate level of trust offers a foundation upon which more comprehensive approaches such as TCA can build. A comparative study on consumer trust in organic food certification in four European countries puts these findings into perspective: despite a generally high level of trust in all countries, German and British consumers report relatively lower trust

compared to those in Italy and Poland. The results suggest a preference for national over EU-level certification bodies (Murphy et al., 2022). These results are supported by further research indicating that trust in eco-labels are strongly influenced by institutional trust and third-party certification (Gorton et al., 2021). This suggests that aligning TCA with established national labelling schemes and/or trusted third-party certification could significantly increase its acceptance and effectiveness. Importantly, there is already strong consumer support for more holistic sustainability information. A recent representative survey found that around 70% of respondents in Germany were in favour of introducing a mandatory label covering climate, animal welfare, and health impacts—highlighting a clear demand for a more comprehensive transparency label that a TCA label could fulfil (Robert Bosch Stiftung & More in Common, 2025).

Threat: Limited consumer willingness to pay for sustainability

Rising food prices for consumers lower the acceptance of TCA implementation.

Between April 2020 and April 2025, the German consumer price index for food increased by approximately 34% (Statistisches Bundesamt, 2025). This development is due to multiple factors, including the COVID-19 pandemic, increased energy prices, labour shortages, the war in Ukraine, and crop failures as a result of climate change (Verbraucherzentrale, 2025). A recent survey in Germany shows that, for consumers, food prices are one of the most influential factors in daily food choices and their increase is perceived as one of the biggest challenges in the agri-food sector (Robert Bosch Stiftung & More in Common, 2025). Rising food prices serve as a possible explanation for the decline in the demand for climate and environmental action in the agricultural sector (UBA & BMUV, 2023). Consumers may worry that more environmentally- and climate-friendly production may translate into higher prices. A study in Bavaria found that, between 2020 and 2022, the importance of environmental impact, origin and fairness of food products reduced, while the importance of prices increased (Hempel & Roosen, 2024). Although this development coincides with ongoing inflation, other factors may have also influenced this development. A continuing rise in food prices could potentially hamper the implementation of a TCA system in Germany as some policy instruments aiming to internalize external costs may increase the prices of selected food items.

A related study found that more than a quarter of respondents fall into the consumer segment that is most affected by rising food prices (Hempel, 2024). The study implies that consumers with lower incomes and lower likelihood to be fully employed are most impacted by rising food prices. A report by foodwatch suggests that particularly the price of off-brand products increased from January 2022 to January 2023, which disproportionately affects consumer segments with lower incomes (foodwatch, 2023). A survey on true prices also highlights consumers' concerns for rising prices and their impact on increasing social inequalities (Michalke et al., 2022). These results suggest that any form of

TCA system must consider its impact in aggravating social inequalities and implement measures to counteract such adverse effects.

Price sensitivity and consumers' persisting attitude–behaviour gap results in low willingness to pay for sustainability efforts.

Even though TCA implementation does not necessarily result in increased consumer expenses, it is important to assess the willingness-to-pay of consumers and anticipate reactions to absolute and relative price changes in the design of a TCA system. A representative survey shows that, although food prices are increasing, approximately half of the participants were willing to accept higher food prices if governments ensure higher standards in terms of animal welfare, fair income for farmers, and the maintenance of food quality (Robert Bosch Stiftung & More in Common, 2025). Around 40% of respondents said they would accept higher prices in return for reduced negative impacts on the climate and the environment. Two surveys conducted in 2021 and 2023 in Germany found that consumers are willing to pay true prices to a certain extent (Michalke et al., 2022; Stein et al., 2024). The willingness to pay for selected food items (apple, cheese, and meat) was correlated with the amount of external cost, with less acceptance for drastic price changes (Michalke et al., 2022). Compared to a purely informational campaign in 2021, consumers expressed a lower willingness to pay the external costs for cheese when they were asked to actually pay them at the checkout in 2023 —even though they were told that the excess revenue generated from the true pricing approach would be donated (Stein et al., 2024).

Although consumers report willingness to accept higher prices in return for social and environmental sustainability, there seems to be an attitude–behaviour gap in (food) consumption. The term describes a phenomenon according to which a positive attitude towards sustainable consumption does not translate into actual consumption behaviour. This inconsistency might be down in part to a social desirability bias, where survey responses are given in a way that will be viewed favourably by others, rather than reflecting real behaviour. Although a positive attitude does act as a predictor for sustainable consumption behaviour, the attitude–behaviour gap remains (Schäufele-Elbers & Janssen, 2023). On a positive note, another study found that, despite the limited change in purchasing behaviour, a positive consumer/voter attitude

towards climate protection exerts pressure on political decision-makers (Venghaus et al., 2022).

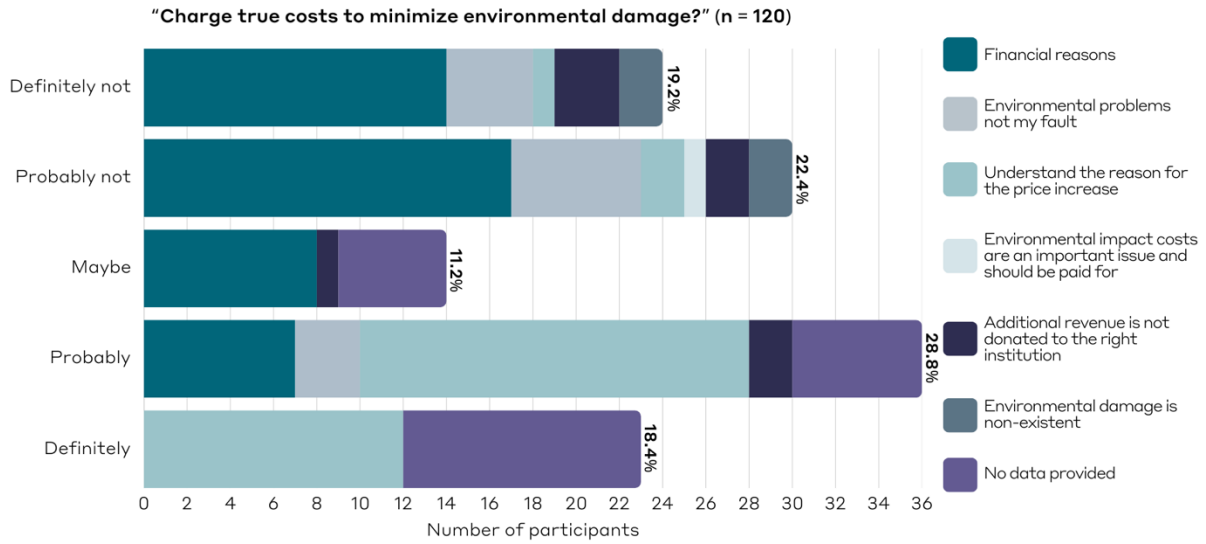

Figure 5. Perceptions of True Prices; adapted from Stein et al. (2024)

Results from the true price survey in 2023 show that 39.9% of consumers opposed the implementation of true pricing. The main reasons for opposition were financial and, to a lesser extent, not feeling responsible for environmental damages (see **Error! Reference source not found.**). Other reasons mentioned i n the survey include the view that 'additional revenue is not donated to the right institution' and the belief that 'environmental damage is non-existent'. The attitude–behaviour gap in Germany further seems to be driven by factors such as convenience, price differences, socio-economic status of consumers, product assortment, and communication (Leibmann et al., 2024).

Threat: Public misunderstanding and mistrust toward TCA

Consumers' perception and understanding of TCA-related sustainability information can hamper the effectiveness of TCA communication.

A major threat to the effectiveness of TCA lies in the way consumers perceive and interact with sustainability information. Evidence from a comparative study across four European countries, including Germany, shows that consumer understanding of sustainability information is often limited, reducing its potential to influence behavioural change (Cook et al., 2023). Overly detailed or technical information can overwhelm rather than empower consumers. Many sustainability indicators, especially those collected at the farm level, require expert interpretation, making them difficult for the public to understand or meaningfully apply to purchasing decisions. A report on the development of a transparency system for the German agri-food sector suggests that consumers struggle to interpret complex variables and their relevance to sustainability (PD, 2024), potentially leading to confusion and even disengagement.

Although the communication of monetary values is considered a strength of TCA assessment, the communication of its complex calculations can be subject

to misinterpretation (Carlsson et al., 2025). A consumer survey conducted as part of an informational campaign on the true environmental cost of food items using second price tags showed that many people did not remember which impact categories had been included and some people did not understand the colour coding system used. The results imply a need to improve communication for future campaigns, via e.g. improved presentation, explanation, and structuring (Michalke et al., 2022). Calculations of true costs or prices need to be communicated in a clear, comprehensive, and transparent way to address the desired target group (Gemmill-Herren et al., 2021; Michalke et al., 2022).

When asked what hinders the purchase of sustainable products, over a quarter of consumers interviewed in a private sector study reveal that they find it difficult to assess whether a product is truly sustainable (EY Global & Huber, 2022). Interestingly, this sentiment is even stronger among sustainability-conscious consumers, likely because they are more critical of existing labels and more aware of the complexity and inconsistency of sustainability claims. If TCA is perceived as adding yet another layer of complexity, there is a risk that it may be met with resistance or indifference, rather than facilitating more sustainable choices. To mitigate this, sustainability information should be simplified and communicated through intuitive, user-friendly formats.

Greenwashing or social washing practices undermine the credibility of TCA efforts and create public mistrust.

Due to a high consumer demand for sustainable products, private companies have been using green and social claims regarding their products, services, or business as a marketing strategy. Whether or not a company's sustainability efforts are genuine and impactful, such messaging can serve as a competitive advantage—despite the fact that it may involve oversimplification, opaque, vague, or unverifiable claims, or simply false advertising (Deutsche Umwelthilfe, 2024). These practices are often referred to as green- or social-washing, with the latter term being less common and attracting less research and media attention. Social aspects are however often covered under the term greenwashing and the respective legislation.

These practices pose a significant threat to the successful implementation of frameworks like TCA. The deception of consumers not only misleads consumption behaviour but also generates mistrust in corporate sustainability communication, thereby negatively impacting actual sustainability efforts (Furlow, 2010) and undermining the entire market-based approach to sustainability . Greenwashing creates a competitive disadvantage for companies that genuinely invest in sustainability and internalize social and environmental costs, as called for by TCA. Value chain stakeholders raised concerns that TCA claims may be subject to greenwashing accusations, if calculations are not presented in a transparent manner (Carlsson et al., 2025). A large-scale survey in Germany shows that these concerns are valid. Following a food retailer's national campaign on TCA, 46% of respondents perceived the campaign as greenwashing (Stein et al., 2024; Universität Greifswald, 2024). In order to ensure the credibility and effectiveness of sustainability claims

(including those related to TCA), messaging should focus on transparent communication, clarity of statements, the absence of sustainability trade-offs, the co-development of standards, the obligation to provide evidence, and third-party verification (Antony et al., 2025). Research also suggests that it is important that consumers trust the TCA-implementing organization in terms of transparency and honesty and the methodology used to calculate true prices (Taufik et al., 2023).

Consumers demand more regulation and independent verification of environmental claims (Antony et al., 2025). The EU Green Claims Directive (GCD) aims to limit greenwashing and improve the credibility of sustainability claims by setting minimum requirements for how companies substantiate and communicate environmental claims. The directive has the potential to retain consumers' trust in private companies by strengthening regulations on green claims. The extent to which the GCD can support the implementation of TCA depends on the intended use of the disclosed information, whether solely for transparency and internal decision-making, or as a basis for policy measures such as taxation or product differentiation. However, it remains to be seen whether the GCD will ultimately be adopted, as its political future in the EU is currently uncertain (European Parliament, 2025).

6.3.4. Data infrastructure

Threat: Inadequate data infrastructure and legal limitations

No existing public data infrastructure or systematic collection of sustainability data in the German agri-food sector.

A threat to implementing TCA in the German agrifood sector is the absence of a public, standardized data infrastructure tailored to TCA needs. Currently, there is no single comprehensive database in Germany that collects and publishes sustainability data from farmers or businesses, which could be used for TCA. Ongoing national efforts toward data collection at farm level include the annual update of the KTBL database and the Thünen Institute's MiniKriSet project to create a minimum criteria set for on-farm sustainability assessments. Currently, the data required for TCA assessment (e.g. impact and monetization data) is fragmented over several sources (e.g. Agribalyse and True Price's *Monetisation Factors for True Pricing* (2021)), some of which are not specific to TCA assessments or are not publicly available (see Interim Report I).

Farm-level data management in Germany is inadequate for comprehensive sustainability assessments, as data is collected for diverse purposes and key figures must be extracted from multiple primary sources.

Although many key figures to calculate sustainability indicators are already collected on farms, the accessibility of the data remains a problem. A study investigated the documentation and availability of data on three farms in Germany (Grün et al., 2023). It found that the data is collected for different purposes such as accounting, management activities, funding applications, and certifications. The data sources include plot records, financial documentation,

funding applications, livestock records, certifications, personnel documentation, resource planning, geographic information systems, administrative documents, contracts, and laboratory or research data. The sheer variety of data sources already suggests that sharing this data in an aggregated format could be time-intensive and add to the bureaucratic burden of farms. When the farms were asked about the extraction time for data from their primary source, it was found that 42% of key figures were extractable in less than five minutes, while 32% needed up to 30 minutes. Only 7% had an extraction time of above 30 minutes. Without further investment in digitalization at the farm level, the accessibility of data might act as a restricting factor in the implementation of a TCA system. The aggregation of all types of farm or value chain data in a shared digital platform could solve the problem of accessibility and simplify bureaucratic processes for farmers. Digitalization and capacity-building of farm staff could make on-farm data collection more efficient and reduce the bureaucratic burden in the long term (Mack et al., 2019; Snoek et al., 2024).

There are legal restrictions in the collection, storage, sharing, and use of personal or commercially sensitive data.

Commercially sensitive data is protected by a combination of EU regulations, national laws, and contractual arrangements. The EU Trade Secrets Directive aims to protect undisclosed know-how and business information from unlawful acquisition, use, and disclosure. In Germany, the directive was translated into the German Trade Secrets Act (Geschäftsgeheimnisgesetz, GeschGehG). It protects data such as information from manufacturing processes, supply chain data, cost structures, and non-public environmental or sustainability metrics. The General Data Protection Regulation (GDPR) protects personal data in the EU. Personal data, meaning data that can be linked to individuals, such farm owners or workers. The storage of personal data requires explicit consent, secure storage, and the right to access, correct, or delete personal data. The data must be collected for a specific purpose and should be limited in scope. According to data protection law, farms and agribusinesses may resist sharing personal information and information that is considered a trade secret. Data collection efforts for TCA must therefore uphold confidentiality protections and legal agreements, such as non-disclosure agreements. It requires contracts and data-sharing agreements that define ownership and use rights, set confidentiality obligations, and clarify how results are published and monetized.

Opportunity: Digitalization and data sharing innovations in the agri-food chain

Farm Sustainability Data Network (FSDN) could serve as a starting point for TCA data collection at the farm level.

Efforts to collect farm-level specific data in the EU and Germany remain limited. At the EU level, the European Commission launched the Farm Accountancy Data Network (FADN), a voluntary data repository where farmers can report their economic data. From 2025 onwards, the Farm Sustainability

Data Network (FSDN) replaces the FADN, additionally collecting sustainability data on economic, environmental, and social factors. While the FADN has long served as the EU's source of harmonized microeconomic farm data, supporting policy evaluation under the common agricultural policy, the FSDN introduces a more holistic approach (European Commission, 2025f). By integrating farm data on fertilizers, pesticides, feed, water use, and sustainable farming practices, the FSDN is intended to enable benchmarking of farm performance. The voluntary platform has the potential to support the implementation of TCA (Snoek et al., 2024). The FSDN could represent a major step toward accelerating and standardizing data collection at the farm level, helping to overcome fragmentation and inconsistencies in current farm data systems across the EU.

Existing private sector digital tools can be a starting point for the development of a TCA data infrastructure.

Several companies, such as EcoVadis, Planted, and Sunhat, offer digital solutions that help private sector actors manage, internally assess, and report sustainability performance, particularly in the context of increasing regulatory requirements such as the CSRD and CSDDD.

EcoVadis is a leading sustainability rating provider that evaluates companies based on international standards across key areas such as environment, labour and human rights, ethics, and sustainable procurement. It offers digital tools that support supply chain transparency and help businesses measure and improve their sustainability performance. Planted is an all-in-one ESG software platform designed to support companies throughout the sustainability reporting process. Its features include double materiality analysis, carbon footprint measurement, and the ability to set science-based targets. Planted enables businesses to generate audit-proof, CSRD-compliant reports, streamlining ESG management from data collection to disclosure. Sunhat focuses on automating ESG data workflows for companies and suppliers. It consolidates various reporting frameworks, including EcoVadis, CDP (formerly: Carbon Disclosure Project), and CSRD, into a single, intuitive platform. By providing standardized templates, integrated data management, and AI-supported automation, Sunhat reduces the administrative burden associated with ESG reporting and enhances data reliability.

All three platforms collect and manage essential sustainability data such as carbon emissions, resource use, and supply chain practices, which are also key components for implementing TCA. Their existing infrastructure could serve as a valuable foundation for adapting or expanding data systems to support TCA methodologies in the agri-food sector, enabling transparent and evidence-based sustainability assessments.

Recent technological developments (such as AI and Blockchain) have the potential to facilitate TCA assessments by making them faster, less resource- and knowledge-intensive, and more accessible.

Recent developments in AI and blockchain technology offer the potential to enhance the accuracy, transparency, and scalability of TCA in the agri-food

sector. AI can support data entry at the business level or data processing. As an example, the reporting tool Sunhat uses AI for customer support in answering reporting questions about different reporting standards and for building comprehensive databases and reports. AI-powered tools can process large volumes of data, enabling more efficient and precise impact modelling. For example, Impatec's Impact Suite integrates AI technology to help users evaluate, monitor, and optimize their impacts by offering pre-built calculations, customizable models, and an AI model generator. These solutions create an opportunity for the implementation of TCA within a reasonable timeframe, while potentially even alleviating the bureaucratic burden. However, we do not have full access to the tools and therefore cannot verify the extent or effectiveness of their AI integration.

Blockchain, on the other hand, can facilitate secure and transparent data sharing along the supply chain. It allows multiple actors to input and access standardized data along the supply chain. Platforms like OpenSC already apply blockchain technology to trace food products, verifying sustainability claims at each stage of the supply chain (OpenSC, n.d.). By integrating AI for data analysis with blockchain for traceability and verification, stakeholders can build a powerful infrastructure for TCA.

However, there are also concerns that integrating these new technologies alongside older technologies such as remote sensing, use of satellite data, and machine learning in TCA assessment will lead to untransparent calculations and opaque business models that are detached from the reality of the agri-food sector.

Ongoing research on data sharing and usage in the agri-food sector could be leveraged for TCA.

Recent EU-supported initiatives are working to improve how data is generated, shared, and used across the agri-food sector. The European Food Information Council (EUFIC) has launched the DATA4FOOD cluster, which brings together four Horizon Europe research projects: Foodity, SOSFood, FoodDataQuest, and DRG4FOOD. These projects aim to create a data-driven transformation that covers the entire food chain. They focus on responsible data governance, digital trust, food transparency, and citizen empowerment. Their shared goal is to create reliable, interoperable, and privacy-aware data systems that can more holistically capture food system impacts (DRG4FOOD, n.d.). SOSFood is an initiative relevant to advancing TCA from a value chain perspective. By leveraging AI-driven technologies, the project aims to accelerate the green transition by enabling stakeholders across the food value chain to make informed, data-driven, and sustainable decisions. Some of the expected results include tailored decision-making tools for all stakeholders and consistent sustainability recommendations for primary producers, industries, consumers, and policymakers (SOSFood Project, n.d.). Outcomes of these projects can support implementation of TCA in the agri-food sector by providing insights into responsible data storage, governance, and use along the value chain.

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