D 5.2: Farm GHG accounting methodology guidelines

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Abbreviations

ANCA	Annual Nutrient Cycling Assessment
ANOVA	Analysis of Variance
CFD	Climate Farm Demo
CFT	Cool Farm Tool
CH_4	Methane
CO_2	Carbon dioxide
FCC	Farm Carbon Calculator
FPCM	Fat-Protein Corrected Milk
GHG	Greenhouse Gas
GWP	Global Warming Potential
IDF	International Dairy Federation
LCA	Life Cycle Assessment
LW	Live Weight
NIR	National Inventory Report
N_2O	Nitrous oxide
SOC	Soil Organic Carbon

Summary

The report presents guidelines and comparative analysis of farm-level greenhouse gas (GHG) accounting tools within the Climate Farm Demo (CFD) project (EU Horizon Europe, Grant 101060212). From the 42 tools that were identified across 16 countries, 23 tools were selected for qualitative assessment of which 19 were recommended for use within the CFD project. Tools were evaluated against methodological rigor, user-friendliness, data requirements, and ability to support mitigation planning.

A quantitative comparison of nine tools on 40 farms (arable, dairy, beef) in four countries revealed substantial variability in Greenhouse Gas (GHG) outputs despite standardized input data. Discrepancies arise from differing emission factors, assumptions, and treatment of processes (e.g., enteric fermentation, N_2O emissions, feed-related emissions). Therefore, benchmarking and comparisons of farm GHG performance, based on assessments with multiple tools should be treated very carefully.

The report concludes that harmonisation is needed in emission factor databases, Global Warming Potential (GWP) values, and output categories, while maintaining flexibility for regional adaptation. Recommendations stress the importance of aligning methodologies, developing sector-specific international standards, and improving transparency of intermediate indicators to enhance comparability and robustness of farm-level GHG assessments.

1 Introduction

1.1 Background

The Climate Farm Demo (CFD) aims to create a unique pan-European network of Pilot Demo Farmers covering 27 countries and all pedo-climatic areas. Its overall objective is to accelerate the adoption of Climate Smart Farming practices and solutions by farmers with a view to adapting agricultural production systems to climate change and to achieving a carbon neutral agricultural sector by 2050. To support farmers in this transition, they first need insight in the current GHG emissions and carbon removals on their farms in order to create climate change Adaptation and Mitigation Plans.

Over the last decade, a range of farm level GHG assessment tools have been developed for different farming systems. Most tools were developed to calculate the carbon footprint of crops or livestock products, which is increasingly being demanded by the food industry. Other tools were developed as farm level tools to provide insights in nutrient flows and emissions on the farm. Some tools are more appropriate as monitoring tools, whereas others also enable to perform simulations with alternative management, which can be used for creating action plans. There is also a large geographical variation, where countries in Western Europe have multiple tools available, while in Central-eastern European countries often no tools are yet developed.

WP5 ‘Carbon and Climate Toolbox’ of the Climate Farm Demo project aims to provide the tools and methodologies to support the development of the action plans that have to be made for each of the pilot demo farms in WP2. In Task 5.2, a common methodology for the use of carbon and climate tools is being developed, which can be used to monitor and advice the pilot farms in WP2. This task builds on Task 5.1 in which a digital repository is being created of carbon and environmental models, methods and tools that are widely used and implemented across the EU for climate change mitigation and adaptation.

The main objective for the use of these tools is to help farmers and advisors to determine their baseline GHG emissions and to assist them in the development of the action plans. A comparison of the GHG performance of farms among countries is not the focus of the project. Therefore, the project decided not to restrict the use to a single tool for all farms, but instead allow farmers and advisors to work with the tools they already might use in their country. However, the selected tools should be of sufficient quality and comply with to a certain scientific standard.

1.2 Objective

The aim of this report is twofold: 1) to present the results of the assessment of the selected farm-level GHG tools and to provide recommendations on the use of these tools in the Climate Farm Demo project and 2) to perform a quantitative comparison of selected GHG tools, based on data of 40 representative farms, and to provide recommendations for future harmonisation of tools.

The report is divided in two main parts: the qualitative comparison and the quantitative comparison. Chapter 2 describes the selection of the farm-level GHG tools, the assessment of these tools and the recommendations on their use in Climate Farm Demo. Chapter 3 presents the quantitative comparison, with the farm data collection, the data analysis and results and discussion of the comparison. Finally in Chapter 4 some general conclusions and recommendations for harmonisation of the tools are provided.

2 Qualitative comparison

2.1 Selection of tools

The first selection of farm-level GHG tools was based on the survey amongst the National Coordinators of the project, which was performed in Task 5.1 “Inventory/mapping of the existing carbon and climate methodologies/tools used in the EU”. This survey was launched online in February 2023, with the objective to obtain information on the current state of climate tools that are used on farms by farm advisors across the EU and across various agricultural production systems.

The online survey contained questions on the tool and its usage: tool name, owner and contact information, website address, tool format, target user, accessibility and cost, data storage and export, available languages and available documentation. Furthermore, there was the possibility to upload documentation of the tools.

The survey resulted in 51 replies from NCs across the EU and 42 individual tools were identified. These tools originated from 16 different countries, of which most tools were developed in France (12) and United Kingdom (5). All farm typologies that are distinguished in Climate Farm Demo are potentially covered by the tools (Figure 2.1), with dairy, arable crops and beef being the farming systems for which most tools are available. Further details on the survey can be found in Deliverable 5.1 (Psiroukis et al., 2024)[1].

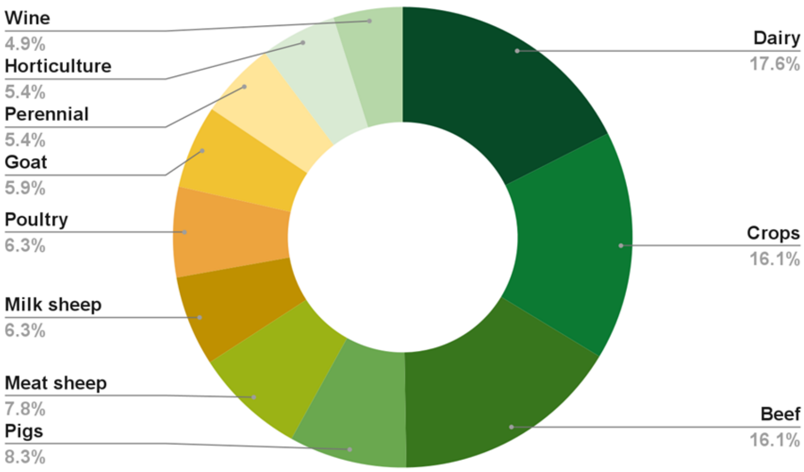

Figure 2.1 Overview of share of tools that can assess specific farm typologies

Next, we performed a first screening of the full list of tools, to select the ones that could be included in the qualitative comparison. For this, only tools that complied with the following criteria were selected: i) perform GHG emission calculations, ii) sufficiently advanced in their development so that the tool can be used directly by farmers/advisors for the development of the action plans and iii) sufficient

[1] Psiroukis, Vasilis, Uyar Havva, Fountas Spyros, Brocas Catherine, Remi Vial, Nenad Lukic. 2024. Digital repository for carbon & environmental models, methods & tools. Climate Farm Demo Deliverable 5.1.

documentation material available to perform the evaluation. This resulted in a list of 23 tools that were included in the qualitative comparison (Table 2.1). Climate adaptation tools were not included in this evaluation, as these have a different objective and the work on adaptation tools will be part of Task 5.4 in Climate Farm Demo.

Table 2.1. Selected tools for the qualitative comparison

Model	Country of origin	Farm typologies
AGNAV	Ireland	Dairy, Beef
Agrecalc	UK	Dairy, Beef, Sheep, Goat, Poultry, Pigs, Crops
Agrosfär	Sweden	Dairy, Beef, Arable crops, Perennial crops
Biocode	Finland	Dairy, Beef, Poultry, Pigs, Crops, Perennial crops, Horticulture
BOVID CO_2	Spain	Beef
CAP2'ER PE (mixed farming)	France	Dairy, Beef, Goat/sheep milk and meat
CAP2'ER GC	France	Arable crops
Carbon footprint	Spain	Arable crops, Wine, Perennial crops, Horticulture
Carbon F&L	France	Fruits and vegetables
CONVIS	Luxemburg	Dairy, Beef, Pigs, Crops, *Biogas*
Cool Farm Tool	Global	Dairy, Beef, Sheep, Goat, Poultry, Pigs, Arable crops, Wine, Perennial crops, Horticulture
DECiDE	Belgium (Wallonia)	Dairy, Beef, Arable crops, Sheep milk and meat
ESGreen Tool	Denmark	Dairy, Beef, Pigs, Poultry, Arable crops
EkonMod	Slovakia	Dairy, Sheep, Pigs
Farm Carbon Calculator	UK	Dairy, Beef, Sheep meat, Poultry, Pigs, Arable crops, Wine, Perennial crops, Horticulture
FaST-Navigator	EU	Dairy, Beef, Sheep, Goat, Poultry, Pigs, Arable crops, Wine, Perennial crops, Horticulture
GEEP	France	Pigs
GES&VIT	France	Wine
Klimrek	Belgium (Flanders)	Dairy, Pigs, Horticulture
KLIR	Switzerland	Dairy
Kringloopwijzer (ANCA)	Netherlands	Dairy
SANDY	UK	Dairy, Beef, Pigs, Sheep and goat meat, Arable crops, Perennial crops, Horticulture
TEKLa	Germany	Dairy, Beef, Poultry, Pigs, Arable crops, Biogas

2.2 Approach

For the selected tools, we performed a qualitative assessment based on a range of criteria. These criteria were grouped in 5 categories:

- Methodology climate indicators (GHG sources)
- User friendliness
- Presentation of results
- Data collection (level of detail)
- Other environmental impacts

The full list of criteria is provided in Annex A. Each criteria was scored on a scale from 0 to 3, where 3 represents the best/most detailed score on that criteria. For the criteria regarding the methodology for each GHG source, the scoring can be interpreted as:

- 0 = not present
- 1 = tier 1 methodology (fixed emission factors)
- 2 = tier 2 (national derived emission factors)
- 3 = tier 3 detailed methodology (e.g. detailed measurements or process based model)

For each criteria, the definition of the scoring was agreed before the actual assessment was done, to ensure that different people conducting the assessment would use the same objective way of scoring. An example of the scoring for two of the criteria is provided in Figure 2.2. The full list of scoring criteria and the results of the actual assessment are provided in an Excel file on the internal CFD SharePoint. This assessment is for now only available for internal use in the project, as not all scores have been verified with the tool owners.

We did not provide an overall score per tool. First of all, because the objective is not to select the best tool, but rather provide the information on the tools that can be used in the project for the GHG performance assessment of farms. Second, the scope of the tools is not always the same and differs among production systems, which makes a direct comparison of all tools not straightforward.

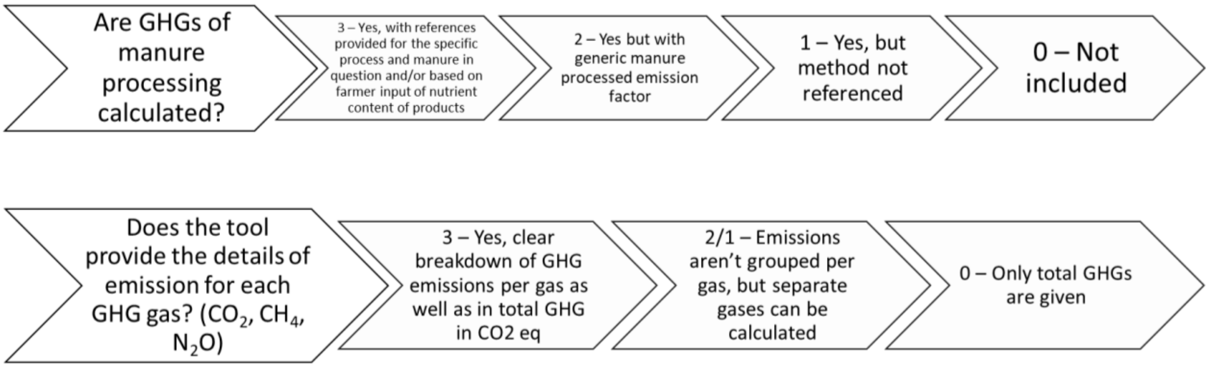

Figure 2.2. Example of scoring for two criteria.

To assist the National Coordinators and Climate Farm Advisors in their choice of GHG tools for performing the carbon audits in the Pilot Demo Farms, we elaborated factsheets for each of the selected and approved tools. These factsheets provided a summary of the qualitative assessment, but also provided information on features that were relevant for the development of an action plan for the farms. An important aspect is to what extent the tools are sensitive to certain mitigation practices, as the practices that will be implemented on those farms should ideally be reflected in the following GHG assessment. Below the full list of topics addressed in each factsheet is presented:

- General information
  - Covered production systems
  - Available languages
  - Scope of the tool
  - Cost of the tool
- Features for development of an action plan
  - Description of farm
  - Type of GHG emissions and carbon storage included
  - Benchmark possibility
  - Other environmental impacts
  - List of mitigation options
  - Economic impact results
  - Action plan simulation possibility
- Support for advisors
  - Training possibilities (cost, format, support)

- Documentation (user guide, methodology documentation)
  - Data handling
- Sensitivity to mitigation practices
  - Enteric fermentation
  - Manure management
  - Nitrogen management in the field
  - Energy consumption
  - Fertilizer emission factors (related to production emission)
  - Feed emission factors
  - Carbon storage

2.3 Tool assessment

From the assessed tools, most were from Western European countries (13 tools), whereas 3 tools from northern Europe were available, 3 tools from Central/Eastern European countries and 2 tools from Southern Europe. Furthermore 2 tools were international tools not linked to a specific country. The tools that were assessed covered all farm typologies that are distinguished in the Climate Farm Demo project. Most tools are available for dairy, beef and arable production systems (Figure 2.3)

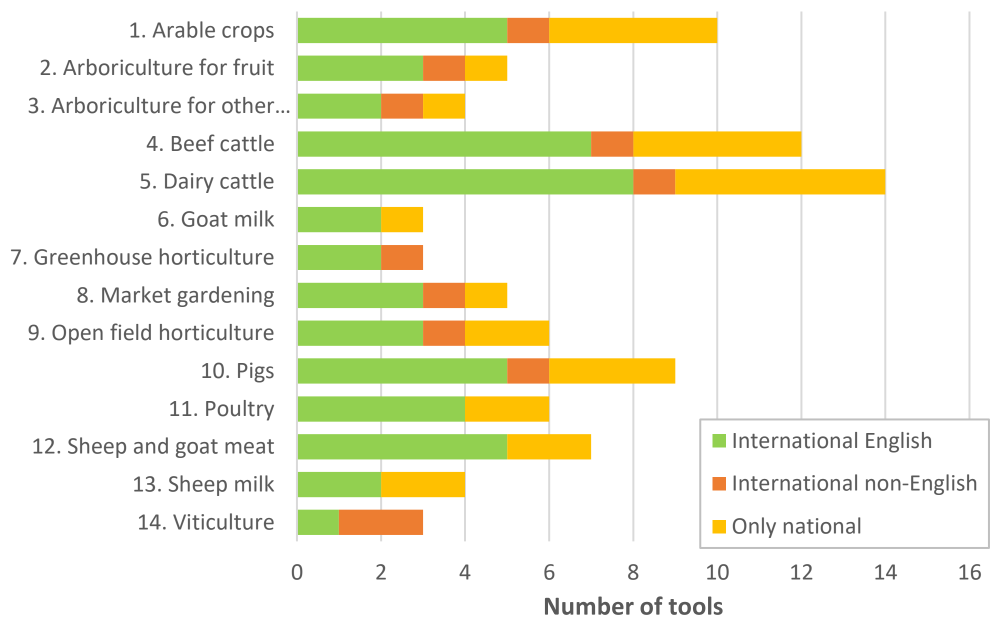

Figure 2.3. Number of tools that can assess the farm typologies that are included in the Climate Farm Demo project

The qualitative assessment enabled to draw some preliminary conclusions and discussion points:

- Many countries have not farm GHG tools yet and needed to choose one or more of the international or national tools available.
- Only a limited set of GHG tools could be widely used for a range of production systems and countries.
- Only few tools included the calculation of carbon removals in soil or biomass. As many farmers consider to implement soil carbon sequestration practices, this might become a problem for the evaluation of the action plans. It may be necessary to apply certain specific soil carbon models in addition to the farm-level GHG tools.

- Several tools were developed to assess the GHG footprint of a single agricultural product ("product-based tool"), rather than enabling an assessment at farm level. Using these tools for full farm assessments requires additional guidance, e.g. correct allocation of inputs and prevent double counting in the aggregation to farm level.
- Many tools are still in development, e.g. extension to more production systems or lacking good methodology description. Their further development might raise issues for the evaluation of the farm performance at the end of the Climate Farm Demo project, as results from year 2 are most likely not comparable with the version of the tools that will be used in 2029 for the final evaluation. This might imply that the baseline will have to be reassessed as well.
- Most tools have been developed as monitoring tools. These tools should be treated carefully when using them for simulation of new practices, e.g. calculating effect of the action plans. For some practices this can be done without problems, but for others there can be interactions that are not included in the model. Most important ones are practices that might affect the productivity, which is normally not simulated in these farm level GHG tools

2.4 Recommendations for selecting tools

Following the results of the qualitative assessment, we selected 19 farm-level GHG tools that can potentially be used in the project. Although the quality of tools differs in terms of level of detail of the methodology (tier level), these tools were considered to comply with the minimum quality standard. If the objective had been to compare results across the 1,500 farms participating in the project, it would have been essential to use the same tools for all of them. However, the primary objective of the CFD project is to improve and increase the dissemination of climate-smart practices and to be able to monitor changes in GHG emissions and carbon storage for each participating farm. Therefore was decided to prioritise existing working practices and concluded that it would be preferable (and more effective in terms of implementing the system) to work with tools that the advisors and farmers were already familiar with, rather than forcing them to use a different tool. Table 2.2 shows the tools that can be used in the project and provide a recommendation for which country / farming system they are most suitable. Some of the tools can only be used in the country where they were developed, as they are linked to specific databases. Other tools can be used in other countries, but language might be a barrier. The tools with a green evaluation score are mostly recommended for countries where no tools are available. Further details on these tools can be found in the factsheets in Annex B.

Table 2.2. Recommendations for use of selected farm-level GHG tools for use in WP2.

The colours for the evaluation have the following meaning: Green = tool is recommended for other countries; yellow = tool can be used in other countries but language of data might be a complication; orange = tool cannot be used in other countries as data or use is restricted to the country where the tool was developed.

Model	Evaluation	Recommendation
AGNAV		Currently only for dairy and beef farms in Ireland as part of the Signpost programme
Agrecalc		Can be used in many countries and many production systems, only in English, product-based approach, mainly Tier 1-2 methods, one free assessment per year
Agrosfär		Can only be used for Swedish dairy, beef, arable and perennial farms
Biocode		Can be used outside Finland, only recommended for arable and poultry farms, product-based approach (strong LCA focus), not very sensitive to practices
BOVID CO_2		Can only be used for Spanish beef sector (suckling cows and feedlots)
CAP2'ER PE		Can be used outside France for livestock farms, multiple languages
CAP2'ER GC		Only for arable farms in France, not yet widely used
Carbon F&L		Specialised tool for fruits and vegetables, only in French, paid tool
CONVIS		Can be used outside Luxembourg, for dairy, beef and arable farms, mainly Tier 1-2 methods, available in English and German, paid tool (small fee)
Cool Farm Tool		Can be used in many countries and for many production systems, product-based approach
DECiDE		Can be used outside Belgium, for dairy, beef, sheep and arable farms, only in French
ESGreen Tool		Can only be used for Danish livestock and arable farms, paid tool
Farm Carbon Calculator		Can be used in many countries and many production systems, only in English, product-based approach
GEEP		Specialised tool for pig farms, only in French
GES&VIT		Specialised tool for vineyards, only in French, paid tool
Klimrek		For dairy and pig farms in Flanders, only in Dutch, only recently published
KLIR		Only for Swiss dairy farms, only in German, not very sensitive to fertilization practices
Kringloopwijzer (ANCA)		Specialised tool for dairy farms, focussed on Netherlands, but can be applied in other countries
TEKLa / Bioland		Can only be used for German farms, for multiple production systems, new tool not widely used yet

Four tools were not included in the final list for the following reasons:

- Carbon Footprint: Scope 2 only, the carbon footprint of inputs is not taken into account
- EkonMod: Not complete, only direct emissions from animals are taken into account
- FaST-Navigator: Only available in specific regions, no training and support available
- Sandy: No public methodology document available at the time the selection was made.

But, for the Sandy tool, we had some discussion after the 2023 annual meeting, and received some further information. Based on this we decided that the Sandy tool could be used, but this was limited to some specific UK farms that already make use of the tool.

3 Quantitative comparison

3.1 Introduction

As shown in the previous chapter, already many different farm-level GHG calculators exist, which differ in scope (e.g. farming system, monitoring versus decisions support tool), applicability in different countries and stage of development. In Climate Farm Demo, different GHG calculators will be used, and although it is not the direct objective to compare GHG emission profiles of the different farms, a degree of comparability is useful to ensure that recommendations on mitigation practices are based on sound GHG emission profiles of the farms. Furthermore, benchmarking and scope 3 reporting, especially relevant for international companies, require greater harmonisation, to allow multiple tools to be used for reporting.

Several studies already started conducting qualitative tool comparisons. ADAS performed a comparison of six GHG tools that are used in the UK, including Agrecalc, Cool Farm Tool, carbon footprint tool from Eggbase, Farm Carbon Calculator, Sandy, and the Farm Carbon Calculator (Solagro) for 20 model farms in the UK[2]. The carbon calculators allowed users to input farm-level data to generate results that could aid in reducing on-farm GHG emissions, but they varied significantly in methodology, coverage, and functionality. This led to large differences in emissions outputs between calculators. 7 out of 20 model farms showed emissions estimates more than double the lowest, with the biggest divergences seen in farms with organic soils, high share of soya in the feed basket, or lowland livestock systems. There was no consistent ranking of the emissions between the calculators across all the farms. Some trends were seen within a farm type (e.g. one calculator gave much higher emissions than the other calculators for both poultry farms), but due to the multiple sources of divergence between the calculators there was not a calculator that consistently gave the highest or lowest emissions when looking across different production systems.

In another study by de Vries et al. (2023)[3] three GHG tools for dairy farms were compared, including CAP'2ER, AgreCalc and ANCA. GHG and ammonia (NH_3) emissions were simulated by all three tools for 36 farms from 7 countries in total. However, their focus was not specifically on comparing tools, but rather on estimating the baseline emissions for those farms and explaining differences among farms. They concluded that data collection was a main challenge with different levels of input data required by the tools and the quality of the input data was sometimes not sufficient as it was based on self-reported data by farmers. Most differences in outcomes could be explained by the use of different (country specific) emission factors.

The objective of this quantitative tool comparison undertaken in CFD is to compare different farm assessment tools with each other in order to identify where and why the outcomes are different. This should result in recommendations for harmonisation of tools to ensure that outcomes of farm-level assessments are comparable and not depending on the selected tool. This assessment is the first one

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[2] https://sciencesearch.defra.gov.uk/ProjectDetails?ProjectId=20967

[3] de Vries, M., M. de Haan, P. Hargreaves, X. Vergé, D. Ruska, G. Kadžienė, D. Stankevičienė, A. Cieslak, V. Becciolini, J. de Boer, P. Galama. 2023. Estimating greenhouse gas and ammonia emissions of dairy farms participating in the CCCfarming project. CCCfarming Deliverable Work package 1.4.

that will compare a range of farm level GHG tools, which are already applied in practice, for multiple farming systems in multiple countries of the EU.

Most of these tools focus on GHG emissions. However, some also include other factors such as biodiversity or water quality. For this project, only the GHG emission modules of the tools were used. Furthermore, the comparison was done at farm level and not at product level. This means that only emissions till the farm gate are included; emissions occurring downstream (such as transport or waste management) are not considered.

3.2 Selected tools

The tools used for the quantitative comparison were selected based on i) the number of farms assessed with the tool within the project and ii) accessibility to the tool for the partners involved in this task. This resulted in a list of 9 tools (Table 3.1). Originally, the German Tekla tool was also included since it is used for many German farms in Climate Farm Demo. However, this tool is not supported anymore since June 2025. A new tool is being developed based on a new harmonized methodology for Germany, but not yet available. Therefore, Tekla has not been included in the comparison.

Table 3.1: Tools by farming system and tool origin.

Tools	Arable	Dairy	Beef	Tool origin
CAP’2ER PE		x	x	France
Farm Carbon Calculator	x	x	x	UK
Cool Farm Tool	x	x	x	UK
Agrecalc	x	x	x	UK
CONVIS	x	x	x	Luxembourg
CAP’2ER GC	x			France
BOVID CO_2			x	Spain
DECiDE	x	x	x	Belgium
Kringloopwijzer (ANCA)		x		Netherlands

Some of the tools are developed for specific farming systems, e.g. ANCA tool for dairy and BOVID CO_2 for beef, while others cover multiple farming systems. All three farming systems are covered by at least 7 of the tools. A short description for each of the tools is provided below and more details about the tools can be found in the factsheets in Annex B.

CAP’2ER (PE & GC)

CAP’2ER (Automated Calculation of Environmental Performance for Responsible Agricultural Holdings) is a multi-criteria environmental assessment tool developed by IDELE (the French Livestock Institute) to help farmers and their advisors evaluate the overall environmental performance of agricultural holdings. It is available in two versions: one for mixed crop–livestock systems (CAP’2ER PE: beef cattle, dairy and meat sheep, goats, poultry, horses) which is widely used in France and one version for arable systems (CAP’2ER GC). The scale of analysis provided by CAP’2ER can be at the farm, production unit and product level. Proposed in French, German, Italian, English, Spanish, and Romanian, CAP’2ER has been adapted for use in several European countries and can be customised to local conditions by adjusting parameters such as emission factors, animal weights, and farming practices. As of 2024, 2,016 advisors have been trained in France and 100 across Europe, with 45,103 diagnostics carried out in France since 2015.

CAP'2ER provides a detailed and refined assessment that directly links farming practices to environmental outcomes. It supports the identification of improvement opportunities, the development of action plans, and targeted advisory services for farmers. For mixed crop–livestock farms, the tool requires around 250 data points covering herd management, housing, cropping systems, feed, and energy use. For arable farms, the number of inputs varies depending on the number of plots. Each evaluation typically takes a full day, is conducted by a trained agricultural advisor. Beyond carbon accounting, CAP'2ER also delivers economic, social and other environmental (biodiversity, ammonia emissions, eutrophication) indicators. It is already used in France for Low Carbon Label (Label Bas Carbone) certification in both mixed and arable systems.

The methodology behind both versions is based on Life Cycle Assessment (LCA; ISO 14040). Indicators are defined at the farm system level, including the farm and upstream inputs, and end when products such as milk or meat leave the farm, excluding downstream processes like transport or processing (Scope 2). The LCA framework uses four categories of indicators: practice indicators based on technical data collected from the farm, state indicators derived from practice data, flow indicators representing emissions and resource use calculated with emission and characterisation factors, and impact indicators that present the final environmental outcomes. This structure enables users to trace environmental results back to specific practices, making it easier to identify improvement opportunities and support sustainable transitions. More information can be found at: https://cap2er.eu/

Farm Carbon Calculator (FCC)

The Farm Carbon Calculator was developed by the Farm Carbon Toolkit, a UK-based Community Interest Company providing practical support for farmers to reduce their environmental impact. The calculator is free for non-commercial use by farmers, but a subscription fee applies for consultants. The Farm Carbon Calculator also offer 'white label' versions of the calculator to other organisations (e.g. there is a version for use in GB Wine). Development of the calculator was partly funded by a grant from the Agritech Cornwall Innovation Scheme, part of the ERDF's European Structural and Investment Funds Growth Programme 2014-2020.

The Farm Carbon Calculator was designed for UK agricultural systems and all major crops and livestock types are included. Users can define the scope of the carbon assessment they wish to calculate, covering Scopes 1, 2 and or 3. It has the capability to include emissions from capital items, consumables and infrastructure and in its carbon removals module has the functionality to capture actual soil carbon data.

Accessed online by creating an account, the calculator interface is user-friendly and straight forward to follow. The Farm Carbon Calculator provide an Excel spreadsheet separate to the calculator which allows users to assess and collect the necessary data prior to using the calculator itself. The outputs are displayed in visual graphs and charts, showing the total carbon emissions and offsets in CO_2 equivalent. Key performance indicators show the farm carbon balance per hectare and per tonne of product. Emissions and sequestration are displayed by sector (e.g., fuel, woodland) and emissions are separated by Scope and GHG type. Live results are shown as data is inputted. Documentation detailing the methodology behind the calculator is available to download from the Farm Carbon Calculator website. The calculator is typically updated annually. More information can be found at: https://calculator.farmcarbontoolkit.org.uk/

Cool Farm Tool (CFT)

The Cool Farm Tool (CFT) is a farm-level greenhouse gas calculator for estimating GHG emissions from agriculture. It has been in existence since 2010, with an online version since 2014. The tool was originally developed by the University of Aberdeen, Sustainable Food Lab and Unilever, with support and contributions from many stakeholders and partners. Nowadays it is being maintained and further developed by the Cool Farm Alliance, which is a science-led, not-for-profit membership organisation (community interest company) dedicated to advancing regenerative agriculture on a global scale. The

Cool Farm Alliance has now more than 160 members from the food and beverage industry, but also NGOs, academics and farmer organisations. The tool is free for use by farmers, while companies have to pay a membership fee.

The Cool Farm Tool is a globally widely used, science-based on-farm greenhouse gas calculator that helps farmers identify opportunities to reduce emissions and sequester carbon while enhancing soil health, water quality and biodiversity. The Cool Farm Tool offers quantified, credible, and standardised metrics based on empirical research and a broad range of published data sets and IPCC methodologies. Personalised results allow users to create "what-if" scenarios and gap analysis to develop tailored reduction strategies.

The methodology for the GHG calculations is mostly based on IPCC Tier 2 approaches, following the recent IPCC 2019 guidelines. The tool has been developed as a product based tool, which calculated the carbon footprint of a product. For specialised dairy and beef farms, the tool provides also farm level results. For mixed or arable farms, farm level assessments can be created manually by filling in multiple assessments. More information can be found at: https://coolfarm.org/.

Agrecalc

Agrecalc, the Agricultural Resource Efficiency Calculator, has been developed by SAC Consulting, the commercial holding company of the Scottish Rural College (SRUC). The basic calculator is freely available for non-commercial use; however, charges apply for commercial use and to access more in-depth analysis. Agrecalc is applicable to UK farming systems and covers all major production systems, including over 40 crop and grassland systems (cereals, potatoes, vegetables, forage and soft fruit) and all the main livestock species (beef, sheep, dairy, pigs and laying hens).

The calculator provides the carbon assessment for the whole farm at an enterprise and per unit output level. Users are also able to benchmark their carbon assessment against other users who have completed the calculator. The outputs of Agrecalc are provided in the form of charts, broken down into GHG type and per output unit (e.g., hectare). Agrecalc is designed for repeat use and can show results from three years simultaneously to allow for direct comparisons.

The online calculator is certified under the PAS2050 specification for GHG life cycle assessments, an independent standard that provides internationally applicable methods for quantifying the carbon assessment of products. It combines Tier 1, 2 and 3 calculations. More information can be found at https://www.agrecalc.com/

CONVIS

The CONVIS tool for calculating greenhouse gas emissions in agricultural farms is an internet application. Consultants collect data from farmers and, once the data has been entered, the application calculates emissions and generates a report with the results and the share of emissions from the different farm compartments.

The application follows a cradle-to-gate approach, which not only takes into account the emissions generated on the farm from crop and animal production, but also calculates the emissions generated during the production and transport of the inputs used. The application is designed to calculate emissions for milk, beef meat, cash crops, pig meat and biogas from crop production.

The calculation of emissions from plant and animal production is essentially based on the IPCC guidelines (2006 and refinements from 2019) and is mostly carried out at Tier 2 level, while established databases such as Ecoinvent are used for emissions from im-ported production means.

Since June 2021, the CONVIS tool for calculating GHG emissions in agriculture has been certified according to ISO 14064-3:2019 by the Société Générale de Surveillance (SGS). More information can be achieved on demand by rocco.lioy@convis.lu.

BOVID CO_2

BOVIDCO_2 is a Spanish tool for environmental assessment specialized in beef cattle farms. By analysing several indicators, it provides valuable information to the farmer about the status of its farm and, it is the basis for stablishing a future improvement plan. BOVIDCO_2 does not only consider environmental indicators, but also considers economic and social sustainability aspects. The tool was developed and used in the framework of the LIFE Beef Carbon project, and both the methodology and the calculations were harmonized with the other tools used in the study, CAP2ER and Carbon Navigator.

Basically, BOVIDCO_2 performs a multicriteria analysis for evaluating all the components of sustainability: environmental, social, and economic. It allows to determine:

- Positive contributions of the farm including i) carbon sequestration, ii) biodiversity maintenance and iii) food productivity.
- Environmental impacts: i) climate change, ii) water quality (eutrophication), iii) air quality (acidification) and iv) depletion of fossil sources.
- Economic and labour productivity: i) economic performance (production cost/gross production) and ii) labour conditions (quantity and quality of work).

Based on the analysis and action plan is elaborated by experts for each case based on the type of farm (suckler to weaning farm, fattening farm, or mixed farm) and promote good practices for improving the indicators. More information can be found at: https://www.asoprovac.com/huella-de-carbono

DECiDE

Based on LCA methodology, DECiDE is a tool developed by the Walloon Agricultural Research Centre in Belgium. It enables the evaluation of the environmental, economic and social impacts of farms. DECiDE takes into account both direct emissions (produced on the farm itself) and indirect emissions (associated with the transportation and production of inputs). Therefore, the tool includes all emissions associated with the energy and material flows from the extraction of raw materials to the farm gate.

The data required for conducting the assessments is based on farm-available data without extra measurements. Generic databases are also used (soil, climatic, zootechnical, phytotechnical data, etc.). For these types of data, specific data on Walloon agricultural practices have been collected.

To encompass three pillars of sustainability, GHG balance assessments are complemented by other environmental indicators (e.g. nitrogen balance, agroecological measures), economic indicators (e.g. gross margin, EBITDA, agricultural labour income, etc.), technical indicators (e.g. feed autonomy) and social indicators. Results are then presented in a "flower of sustainability", which each petal representing an indicator.

To understand and interpretate the results, it is possible to compare the outcomes of one farm with the average results of similar farms or to choose to be compared to another farm typology. To reduce the encoding time, a module is available for importing agricultural accounting data directly into the tool. Users can also run simulations and export their data in CSV format. The DECiDE tool is operational for arable farms, dairy and/or beef cattle, sheep and mixed farms in Wallonia. Assessments are available at the farm level (per hectare of utilized agricultural area) and for products (per liter of standardized milk or per kg of live weight sold or per hectare of commercialized crops). The tool is publicly available and it provides encoding assistance (www.decide.cra.wallonie.be).

Kringloopwijzer (ANCA)

The KringloopWijzer, in English Annual Nutrient Cycling Assessment (ANCA), is a Dutch management tool for dairy farmers to monitor their environmental footprint and reduce it through improved farming practices. Its main goal is to ensure a more sustainable dairy production, in terms of nutrient cycles and emissions. It was developed by Wageningen University & Research in collaboration with several consultancies and groups of interest, commissioned by the dairy industry and Ministry of Agriculture.

The tool is mandatory for nearly all dairy farmers in the Netherlands, as required by Dutch dairy processors.. Dairy companies like FrieslandCampina make use of the tool for reporting their Scope 3 emissions.

The GHG module in ANCA uses advanced methods (such as IPCC Tier 3 for enteric methane emissions) to ensure accurate calculation of the carbon footprints of raw milk from individual dairy farms, and is transparent and near-compliant with international LCA standards (PEFCR and IDF guidelines) and the IPCC guidelines. It is also aligned with the methodologies used in the Dutch national GHG inventory. ANCA provides both the carbon footprint of raw milk (gram CO_2-eq./kg FPCM), but also the full farm GHG emissions.

The calculation rules and methodology are maintained by Wageningen Research. Recently also CO2 emissions from organic soils were added to the calculations and SOC changes on mineral soils. These emissions/removals are currently not included yet in the carbon footprint, but separately reported. A detailed methodology report of ANCA and the calculation of the carbon footprint is available and updated each year (latest version: Van Dijk et al., 2024)[4]. More information can be found at: https://mijnkringloopwijzer.nl/

3.3 Farm data collection

For the quantitative comparison of the tools, the main farming systems in the project were chosen. These were arable (28% of all demo farms), dairy (18% of all demo farms) and beef farms (15% of all demo farms). Data was collected in four countries throughout Europe to represent different climatic zones and management (Figure 3.1). Climate Farm Demo partners from those countries, being Teagasc (Ireland), IDELE (France), Agricultural University of Athens (Greece) and CDR (Poland) contributed to the data collection. Farms were selected by these Climate Farm Demo partners from their network, and they provided data for farm types that are typical for their country. Each partner provided 5 farms per farming system. In Ireland 5 dairy and 5 beef farms, in Greece 5 dairy farms, in France 5 arable, 5 dairy and 5 beef farms and in Poland 5 arable and 5 beef farms, which resulted in a total of 40 farms. To allow for a “clean” comparison, only specialized farms were chosen and no mixed farms.

[4] https://edepot.wur.nl/678185 (Dutch) and https://edepot.wur.nl/563400 (English)

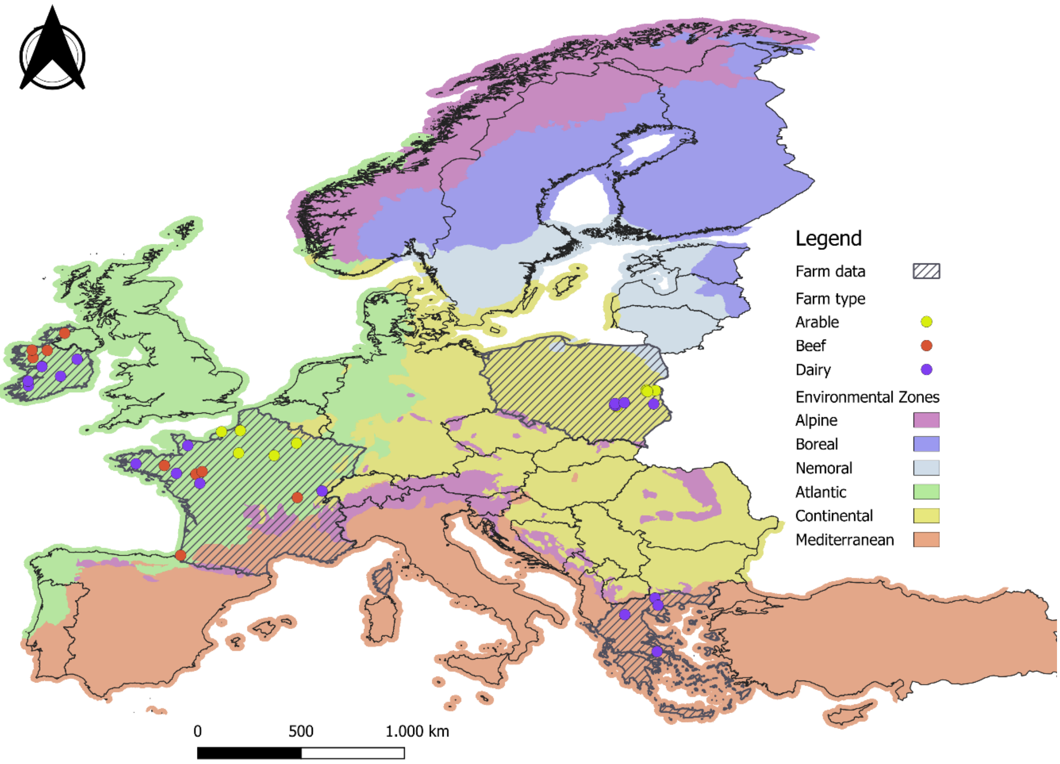

Figure 3.1. Origin of farm data and environmental zones in Europe.

For the data collection, a common data sheet was created which was based on the tool requirements. When creating the data collection sheet, the challenge was to gather all information needed to fill in the tools while at the same time keeping the data requirements as low as possible so that the information could be gathered by the partners. Therefore, some parameters that do not contribute much to the overall GHG balance were left out of the data collection (e.g. pesticide use or refrigerants). An assumption sheet was created to keep the differences in assumptions that the people running the tools had to make to a minimum between the tools. In case farmers could not provide all required information, the partners made assumptions based on their knowledge to complete the data collection sheet. Since the objective of this research was to compare the tools and not the farms, it was more important to have a consistent data set with plausible numbers, rather than obtaining a fully accurate data set of the farm.

The common dataset included information on beef and dairy cattle numbers and categories, the number and weight of purchased and sold animals, milk production, housing periods, manure management system, feed use, crop area and yields, crop residue management, amount and types of mineral fertilizer applied, amount of manure application, energy consumption and soil data. The complete input data collection sheet is provided in Annex C. An anonymised version of the input data from all 40 farms will be made available through a Zenodo repository.

3.4 Data analysis

The GHG simulations for the farms were done by the partners that were involved in the modelling part, where ADAS did the simulations with AgreCalc and Farm Carbon Calculator (FCC), IDELE performed simulations with both CAP2'ER tools, WR for Cool Farm Tool and ANCA, Convis for their own CONVIS tool, CRAW for DECIDE and Neiker for BOVIDCO$_2$. In total 258 simulations were performed. These results were collected in one Excel file for the total GHG emissions per farm and the main GHG emission sources.

Tools were compared based on the total emissions per farm and the contribution of the main emissions sources to the overall average GHG emissions. These emission sources were selected based on the common output categories produced by the tools and their scope (Table 3.2). In this context, Scope 1 includes direct on-farm emissions, Scope 2 covers indirect emissions associated with electricity use, and Scope 3 refers to upstream emissions related to the production of external inputs (e.g. feed and fertilizer). Originally it was planned to distinguish between scope 1 and scope 2 energy. However, since the Cool Farm Tool does not provide this difference in their output, these two sources were summed up. Similarly, the Farm Carbon Calculator does not differentiate CH_4 emissions from enteric fermentation and manure management in its output files. As enteric fermentation is one of the main emission sources from cattle farms, it was important to have this as a separate category. Based on some assumptions and the input data it was possible to split these CH_4 emissions into both categories.

Table 2.2: Output GHG emission categories and scope.

Emission source	Scope	Comment
Enteric fermentation	Scope 1	
Manure management	Scope 1	Comprises both CH_4 and N_2O emissions
N_2O grazing emissions	Scope 1	
N_2O soil emissions	Scope 1	Comprises direct and indirect (related to N leaching and runoff and N volatilization) N_2O soil emissions
(N_2O crop residues)	Scope 1	This was only separated for the arable farms
Energy consumption	Scope 1 and 2	Comprises on farm fuel, gas and electricity use
Purchased feed	Scope 3	Emissions related to feed production (concentrates and off farm forages) including possible land use change and energy related emissions
Fertilizer and other inputs production	Scope 3	GHG emissions related to production of other inputs (e.g. fertilizer and pesticides)
SOC stock changes	Scope 1	Was only available for some tools and was not included in the comparison

To see whether tools give significantly different outputs, an ANOVA was used, including country of the farm data as an extra factor to explain the variance. A Tukey test was performed as a posthoc in case significant differences between tools were detected in the ANOVA. If emissions only differed significantly among countries but not among tools, no further analysis was performed. The analysis was done for the three farming systems separately.

An ANOVA was performed on the total farm emissions calculated by the different tools. For visualization purposes and to get a better understanding of differences between tools regardless of farm size, the arable farm emissions per source were divided by the crop area, the beef emissions were divided by the total live weight (LW, kg) of the herd and the dairy emissions divided by the fat-protein corrected milk (FPCM). FPCM was calculated following the formula recommended by FAO[5]. To ensure comparability, the same milk production value was applied across all tools, since allocation factors between milk and beef, as the corrections for milk fat and protein content, may differ among tools.

3.5 Results

[5] https://www.fao.org/4/k7930e/k7930e00.pdf

3.4.1 Overall emissions

Arable

Figure 3.2 shows the box-plots of the total farm GHG emissions per tool and per country. The GHG emissions on the Polish farms are lower compared to the French farms, as the Polish farms are and more extensive farms with lower fertilizer inputs. The ANOVA showed a significant effect of tool ($p<0.001$) and country ($p<0.001$) on the emissions, as well as a significant interaction between the two ($p=0.002$).

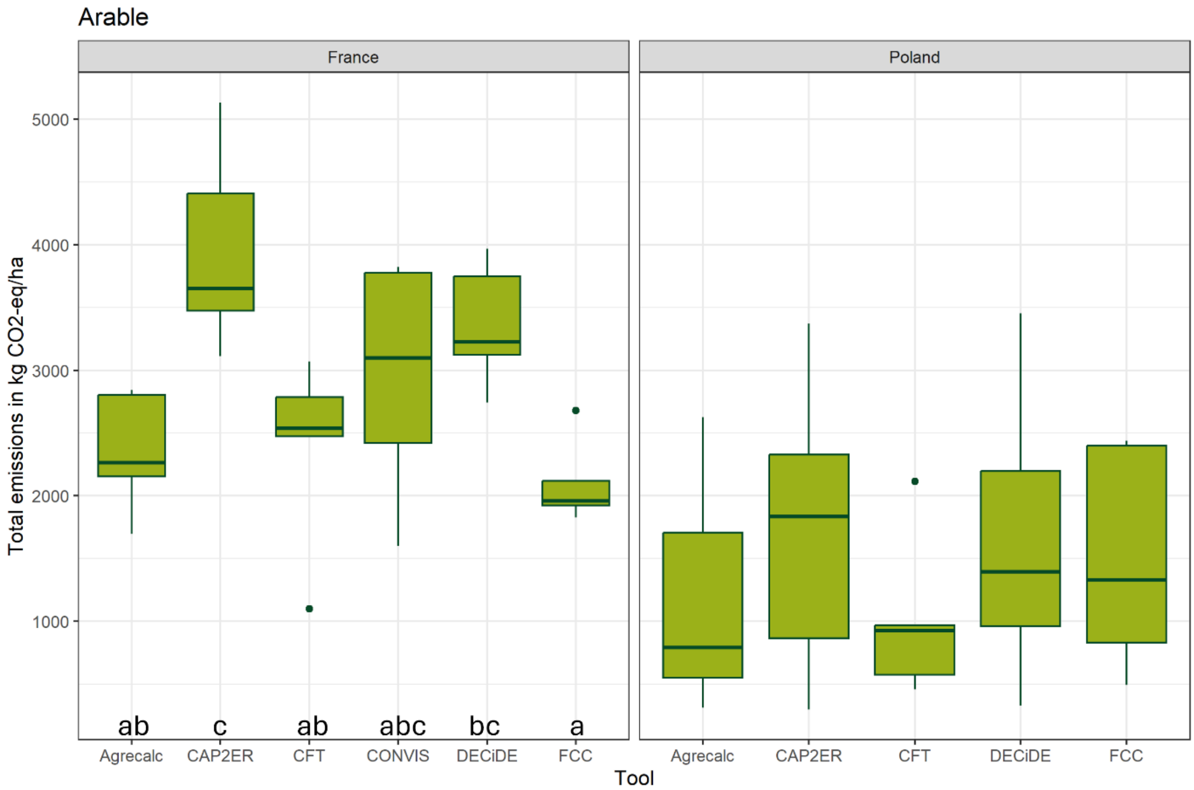

Figure 2.2: Total GHG emissions for the arable farms. Letters indicate significant differences between tools. Since only the emissions in France were significantly different, the boxplots for Poland do not have letters.

The posthoc test showed that only GHG emissions in France are significantly different among the tools. CAP2ER has significantly higher emissions than Agrecalc, CFT, and FCC. The emissions from these three tools are lower than for DECiDE, however, only the difference with FCC is significant. Convis does not show significant differences between the tools, however, the tool shows a trend towards higher emissions compared to Agrecalc, CFT, and FCC. It should be noted that due to capacity constraints, Convis was only run for the French data. For the Polish farms the total GHG emissions are more or less in the same range for all tools and no significant difference is observed.

Beef

Figure 3.3 shows the box-plots of the total farm GHG emissions per tool for beef farms. The Irish beef farms were not simulated by CONVIS due to capacity constraints. Also for beef, country has a significant influence on the total emissions ($p<0.01$), but the interaction effect was not significant ($p=0.95$). The results are not significantly different, but median emission values still differ from kg CO_2-eq per kg live weight. Agrecalc, CFT, and FCC, on average, do seem to have lower emissions than the other tools. For Ireland, the variation in calculated GHG emissions in higher among the tools, but no significant difference can be found.

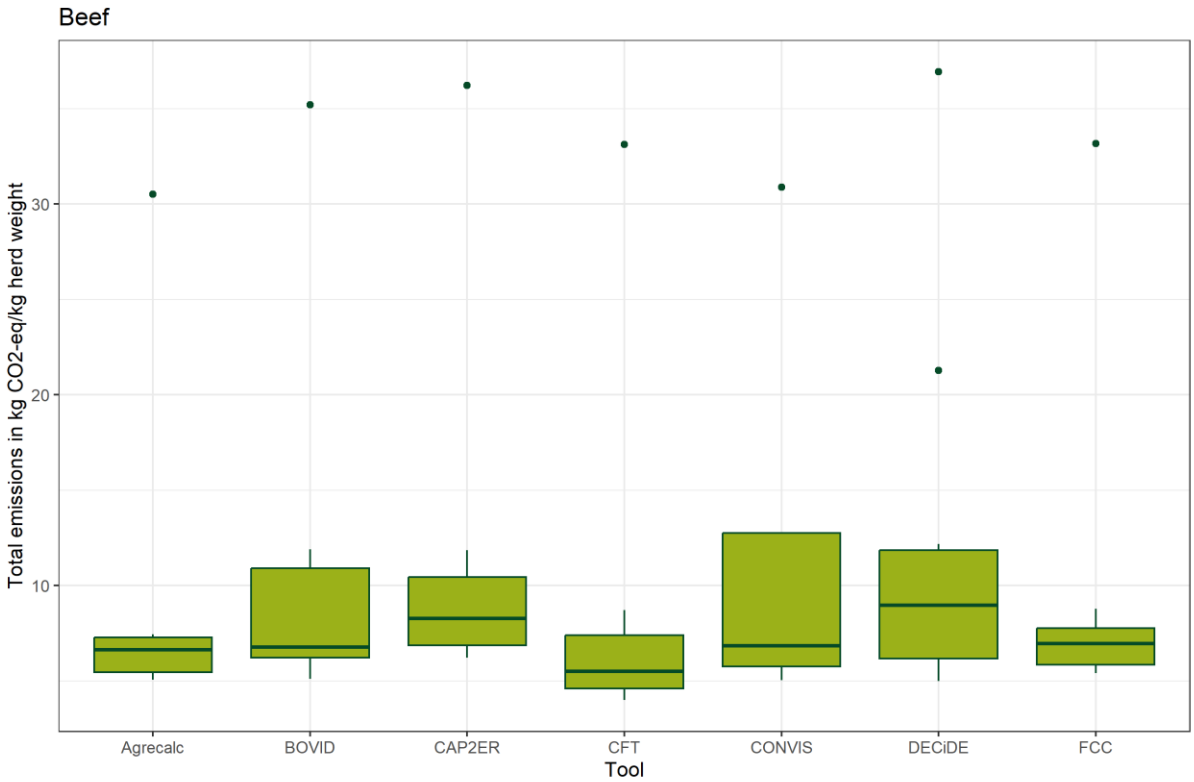

Figure 3.3: Total GHG emissions for the beef farms. Letters indicate significant differences between tools.

Dairy

For dairy farms the tools show lower variation for the total GHG emissions of dairy farms and no significant differences among tools ($p=0.9$) are observed, but only between the four countries ($p<0.001$). There is also no interaction between country and tool ($p=0.98$).

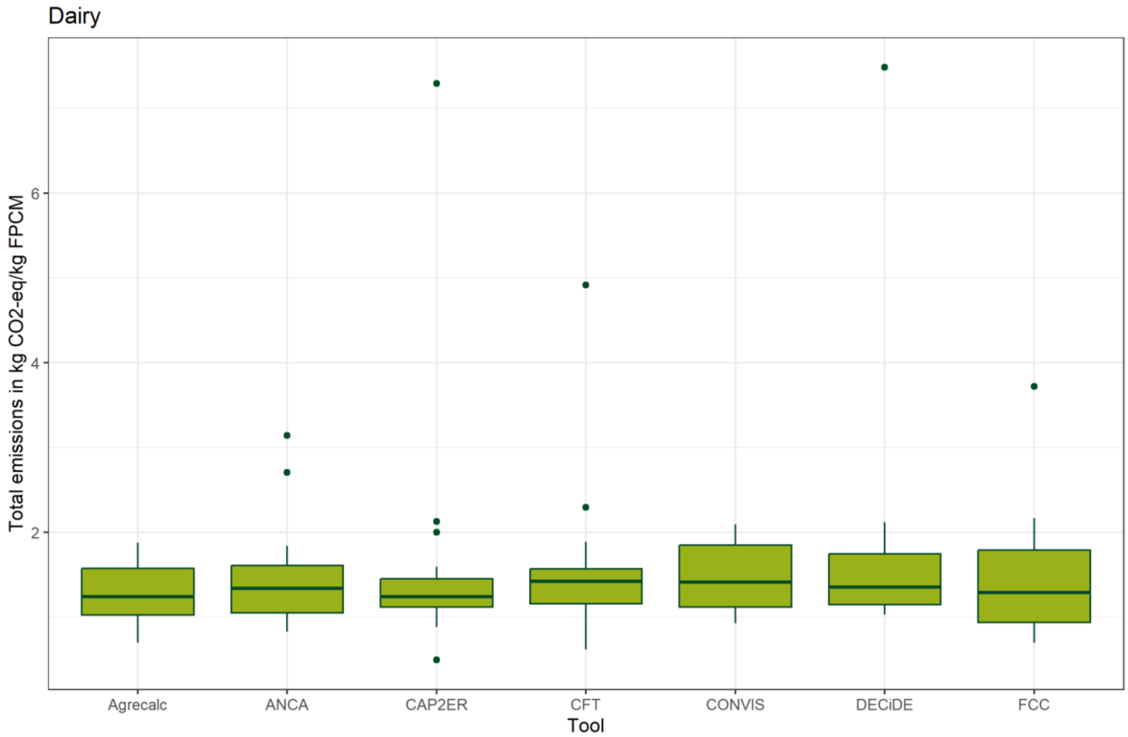

Figure 3.4: Total GHG emissions for the dairy farms.

3.4.2 Emissions per source

Arable

For a better understanding of the differences in calculated GHG emissions among the tools, we also compared the calculated GHG emissions per emission source. For arable farms the main emission sources are N_2O soil emissions, N_2O from crop residues, GHG from energy use and GHG emissions from input production (mainly mineral fertilizers). The results are shown in Figure 3.5 as normalised averaged emissions per ha of all 5 farms for both countries. In addition, a posthoc test was performed to check whether differences among the tools were significantly different.

For some of the emissions sources large differences were observed among the tools, but these differences were not always consistent for the two countries and still some missing data might affect these results. For arable farms, Agrecalc failed to calculate two Polish farms and fertilizers production impacts are missing for another one. N_2O emissions from crop residues are missing for the French farms in CAP2ER as these are not reported separately, but included under N_2O soil emissions.

Table 3.3: Results of the posthoc test. Different letters indicate a significant difference.

Arable emission sources	FCC	CFT	Agrecalc	Convis	DECiDE	CAP2'ER	Country
N_2O soil emissions	a	b	b	b	c	c	Only France
N_2O crop residues	a	a	a	a	a	a	Both countries
Energy	a	a	a	a	a	a	Both countries
Input production	a	a	a	a	a	b	Only France

Table 3.3 indicates whether differences in GHG emission sources are significantly different among the tools. For N_2O soil emissions the differences are significant for the French farms, where FCC has much lower emissions, while DECiDE and CAP2'ER GC have significantly higher emissions. FCC reports higher crop residues emissions than the other tools, however, this difference is not significant. The emissions related to energy consumption are relatively low for the French farms, but high for the Polish farms, which can be explained by the more extensive arable systems in Poland that have lower fertilizer

inputs, while fuel use is relatively high. For emissions related to input production, CAP2ER has significantly higher emissions than the other tools for the French farms.

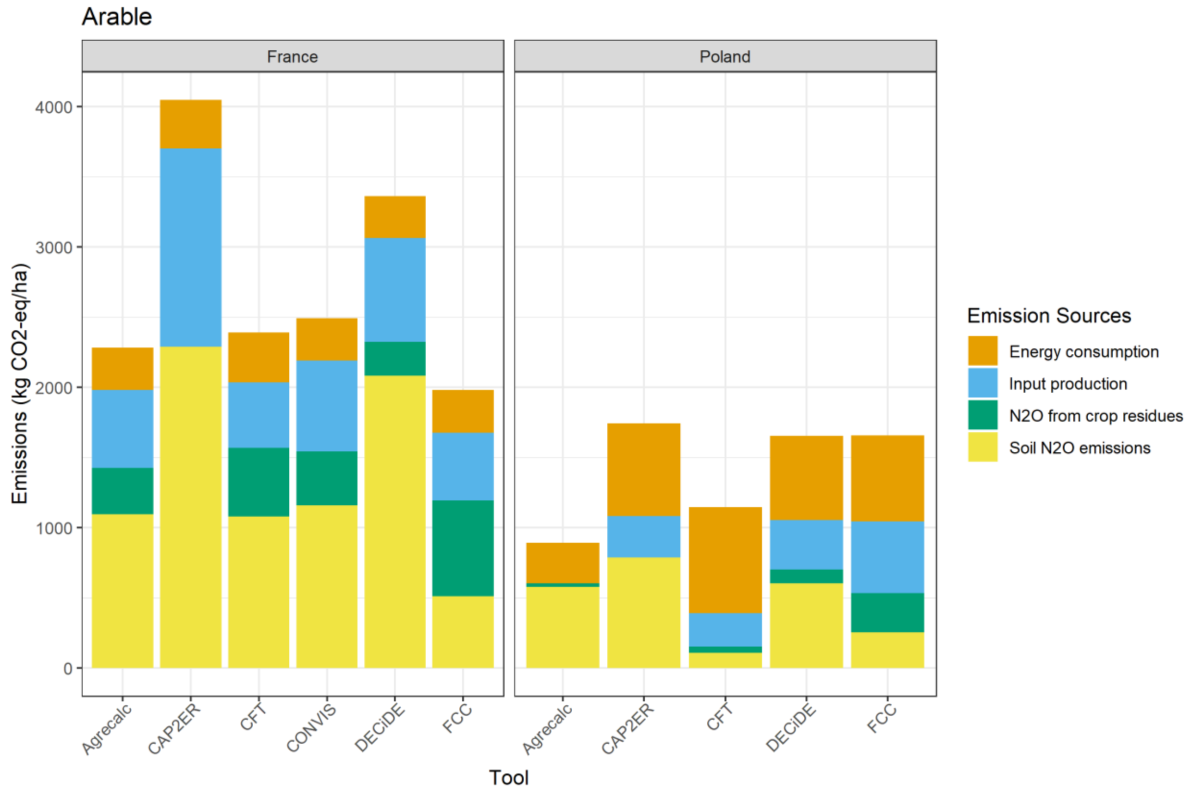

Figure 3.5: GHG emissions by source for arable farms. Note: N_2O crop residue emissions are for CAP2'ER included under soil N_2O emissions and AgreCalc results are not fully reliable for Polish farms, as the fertilizer application rates were below the range that could be provided as input.

Beef

For beef farms the main emission sources are enteric fermentation, manure management, grazing, N_2O soil emissions (here combined with N_2O from crop residues), GHG from energy use, GHG emissions from input production (mainly mineral fertilizers), and GHG related to purchased feed. The results are shown in Figure 3.6 as normalised averaged emissions per kg herd weight of all 5 farms for both countries. In addition, a posthoc test was performed to check whether differences among the tools were significantly different.

The total emission analysis did not show significant differences between the tools. Also for the emissions per source, several emission sources did not show a significant difference between the tools. For this comparison, some data are missing regarding the emissions by source. Specifically, no emissions are reported for grazing in the FCC tool, as these are included under N_2O soil emissions. In the case of the French farms calculated by CFT, soil emissions are lower than for the other sources because no separate crop footprint was calculated for them. Finally, for the Agrecalc and FCC tools, soil emissions data are missing for one French farm in each case.

Table 3.4: Results of the posthoc test. Different letters indicate a significant difference.

Emission sources	Agrecalc	BOVID	CAP2ER	CFT	Convis	DECiDE	FCC	Country
Enteric fermentation	a	a	a	a	a	a	a	Both countries
Manure management	a	bc	b	bc	c	bc	c	Only France
Grazing	b	a	b	a	ab	a	-	Only France
N_2O soil emissions	ab/ab	bc/ab	ab/b	a/ab	ab	c/ab	a/a	France / Ireland

Energy	a	ab	b	ab	a	a	a	Only France
Purchased feed	a	a	a	a	a	a	a	Both countries
Input production	a	a	a	a	a	a	a	Both countries

No significant difference was found between tools for enteric fermentation, purchased feed, and input production. For grazing emissions from French farms, BOVID, CFT, and DECiDE report significantly lower emissions than the other tools. This difference is not observed for Irish farms. The DECiDE tool reports significantly higher emissions for soil N_2O emissions than Agrecalc, CAP2ER, CFT, FCC, and Convis in France. For Irish farms, soil emissions estimated by CAP2ER are significantly higher than those from FCC. Energy consumption-related emissions show significant differences only for French farms. For these farms, CAP2ER reports significantly higher results than Agrecalc, Convis, DECiDE, and FCC.

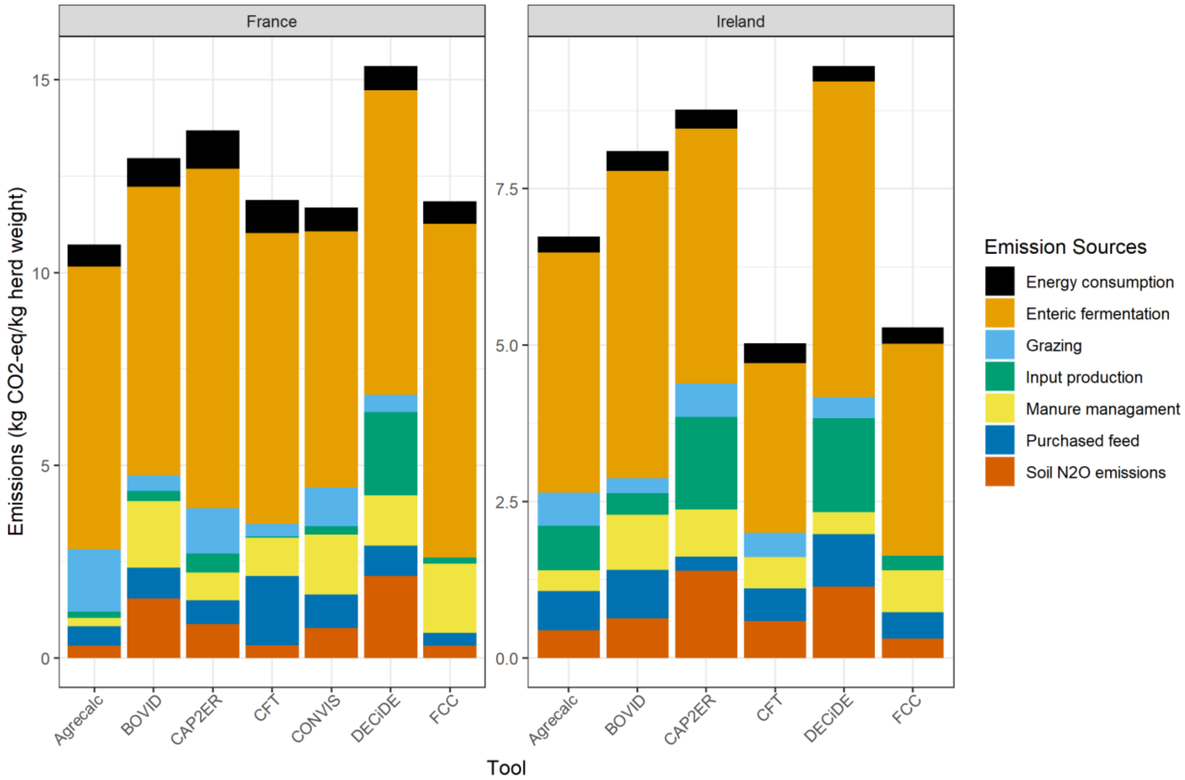

Figure 3.6: GHG emissions by source for beef farms.

Dairy

For dairy farms the same emission sources as for beef farms are included (enteric fermentation, manure management, grazing, N_2O soil emissions (combined with N_2O from crop residues), energy use, input production and purchased feed). The results are shown in Figure 3.7 as normalised averaged emissions per kg of fat and protein corrected milk (FPCM) of the 5 farms for each of the four countries. In addition, a posthoc test was performed to check whether differences among the tools were significantly different (Table 3.5).

In the assessment of emissions from dairy farms, several tools show missing data across different emission categories, as these emission categories are not reported separately, but included within another emission category. For dairy farms, two Polish farms are missing for Agrecalc due to constraints in the input data. Furthermore, some of the Greek dairy farms are landless farms, which means that all feed is imported. N_2O soil emissions are therefore in some of the tools included under purchased feed, but others might have included part of these emissions still under N_2O soil emissions.

For dairy, there are no significant differences in total emissions between the tools. Enteric fermentation, and manure management do not show significant differences either and there are also no consistent trends when looking at the emissions per country. The same is the case for purchased feed and production of inputs (**Erreur ! Source du renvoi introuvable.**).

Table 3.5: Results of the posthoc test. Different letters indicate a significant difference.

Emission sources	Agrecalc	Anca	CAP2ER	CFT	CONVIS	DECiDE	FCC	Country
Enteric fermentation	a	a	a	a	a	a	a	All countries
Manure management	a	a	a	a	a	a	a	All countries
Grazing	ab/b	b/ab	ab/ab	b/a	ab/ab	a/a	-	Ireland/France
N_2O soil emissions	a	ab	ab	ab	ab	b	ab	All countries
Energy	a/a	c/bc	a/abc	b/abc	b/ab	a/abc	a/c	Greece/Poland
Purchased feed	a	a	a	a	a	a	a	All countries
Input production	a	a	a	a	a	a	a	All countries

DECiDE has significantly lower grazing emissions compared to CFT in Ireland, and Agrecalc in France. It should be noted that Agrecalc does assign emissions for manure management to grazing even if no grazing takes place as is the case for Greece. To still make a comparison possible with the other tools, these emissions were combined with the manure management emissions in Greece.

Also soil emissions and energy emissions differ significantly between tools, especially the outputs from DECiDE differ from the other tool outputs. DECiDE has significantly higher emissions for soil than FCC in all countries. For energy production, the emissions from Decide are significantly lower than Anca, CFT, and Convis in Greece, however. In this country, the emissions calculated by Anca are significantly higher than for the other tools. In Poland, emissions calculated by Agrecalc are significantly lower than Anca, and FCC. FCC also has significantly higher emissions than Convis in Poland.

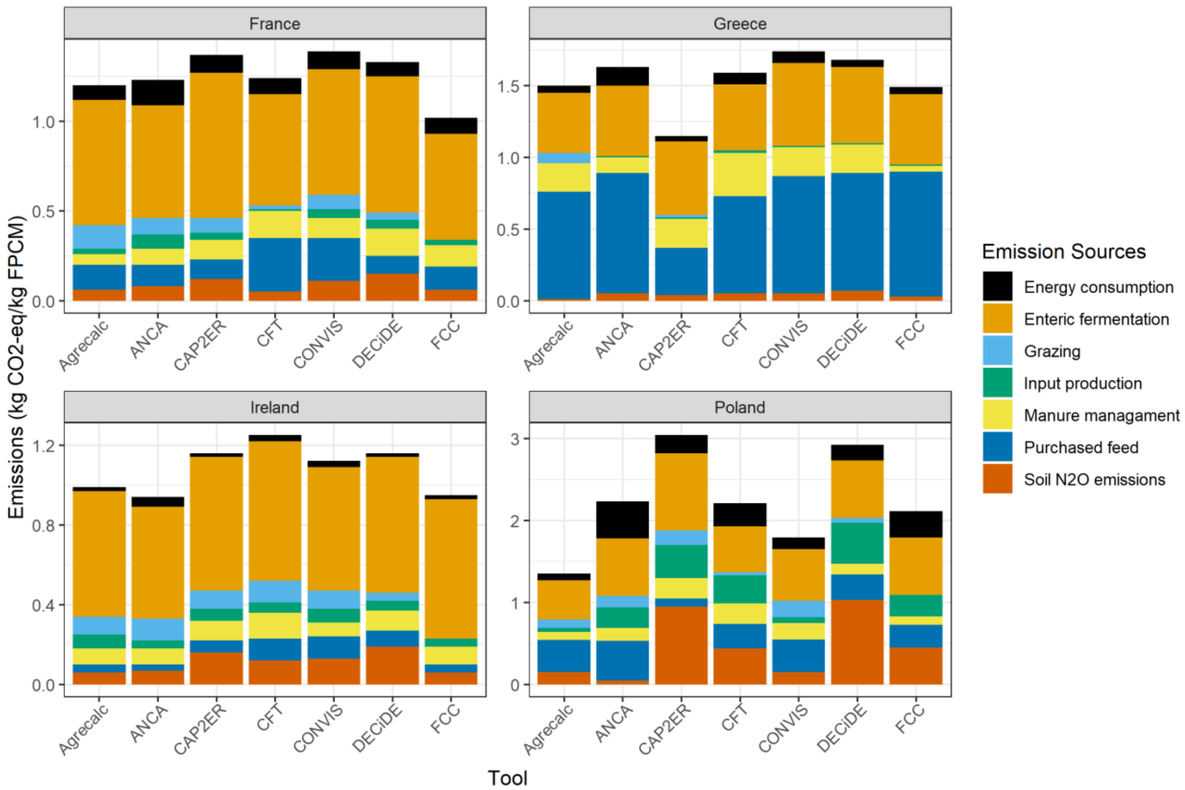

Figure 3.7: GHG emissions by source for dairy farms.

3.6 Discussion

In this study 9 farm-level GHG tools were compared for 10 arable farms, 10 beef farms and 20 dairy farms. As shown in the previous chapter, there can be large and sometimes even significant differences in calculated GHG emissions among the tools. Figure 3.8 provides a summary of the calculated relative differences compared to the average of all tools for those specific farming systems. Agrecalc, FCC and CFT have mostly calculated lower GHG emissions, while CAP'2ER and DECiDE have in general calculated higher GHG emissions. Differences are larger for arable (-20% to +25%) and beef farms (-20% to +20%) compared to dairy farms (-5% to +9%).

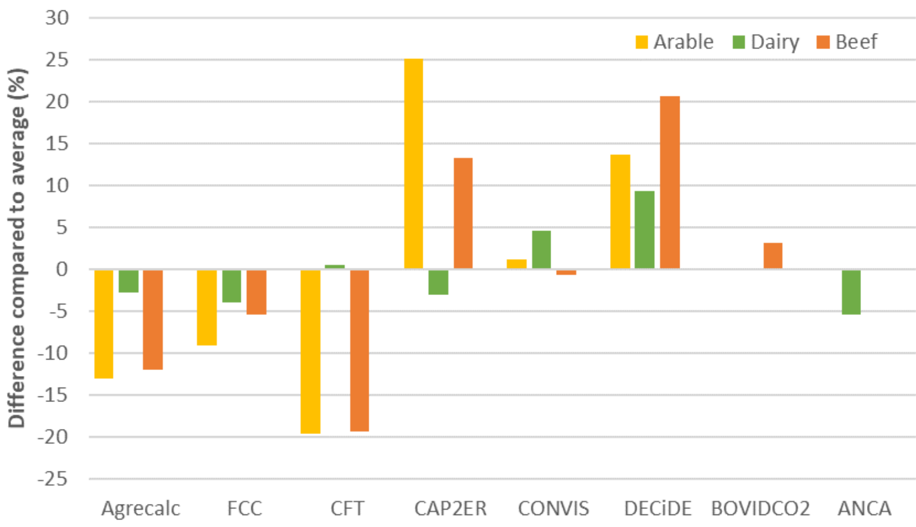

Figure 3.8: Relative differences compared to the calculated average GHG emissions of all tools for the arable, dairy and beef farming systems.

The analysis showed that tools differ, in some cases significantly, from each other in the emissions they calculate. However, from the results, we cannot conclude which tool is performing best, as there is no comparison to actual measured data. These differences originate from the different assumptions made in the tools based on the inputs and the emission factors and calculations used. Furthermore, they can also differ in how the emissions are transformed to CO_2-eq.

The last point has to do with the global warming potential (GWP) used by the tools. This potential is reported by the IPCC and is updated based on the latest insights. Therefore, the number differs depending on which assessment report is used. FCC and Agrecalc use the numbers from the 5th assessment report, which are 265 for N_2O and 28 for CH_4, while the other tools use the values from the latest IPCC report (AR6), which is 273 for N_2O and 27 for CH_4. Although it seems counterintuitive that tools do not use the latest GWP value, many of the national GHG inventories still use the AR5 GWP values. For alignment with the National Inventory Reports (NIR), it does make sense to use the AR5 values. These differences in GWP are however not directly visible in the differences among the tools.

A few significant differences in the way the tools calculate emissions can nevertheless be detected in the total emissions. In arable farming systems in France, CAP'2ER displays significantly higher emissions than the other tools, and DECiDE significantly higher emissions than FCC. For all other compared farms, there is no significant differences among the tools in the total emissions. Emissions calculated by CFT and Agrecalc are relatively low compared to the other tools in beef and arable systems, however, not for dairy farms.

When looking at how the detailed emissions are calculated, the origin of the tool has an influence on how these are assessed for some tools. FCC uses for enteric fermentation the tier 2 UK approach, and for electricity and fuels the DESNZ UK GHG inventory conversion factors. Agrecalc on the other hand only uses the UK energy figures for data from the UK, for other countries the figures from the GHG Protocol (2012) are used. For enteric fermentation, the tool uses IPCC 2019 Tier 2 approach, as does CFT. DECiDE, on the other hand, uses Tier 2 IPCC 2019 improved with specific regional data.

The origin of the emission factors used can especially have an influence on the N_2O emissions. CFT makes a distinction between wet and dry climates based on the IPCC 2019 emission factors to calculate emissions for soil N_2O emissions, while FCC and Agrecalc have aligned their calculation of N_2O emissions to the approach used for the UK National GHG Inventory. DECiDE uses mainly values from IPCC 2019 (adapted to the wet and cold Walloon weather) and EMEP/EEA 2019 to calculate direct

N_2O emissions, while indirect N2O emissions are derived from the N balance calculated by the tool. The use of UK values rather than IPCC emission factors might partly explain why N_2O emissions from Agrecalc and FCC are lower than for the other tools in some cases.

In the case of crop residues, default values assumed by the tool also play a role. Most tools only ask for the amount of harvested crop product, and then assume a residue amount based on this. Another confounding factor here is that not all tools contain all crops: therefore, assumptions sometimes need to be made, leading to additional differences between the tools. Assumptions by the tools are also necessary for the manure and feed composition. Some tools require the urea content of the milk to assess the N excretion, however, most tools use general values. The composition of the feed can differ too but such information is often not available to farmers. This can lead to differences in enteric fermentation and also manure management calculations.

Enteric fermentation is a major emission source in cattle farming systems. Besides different assumptions in input data, the tools do use different equations to assess the enteric fermentation emissions. Some tools take the different feed into account while others only calculate a generic number based on animal properties. This is for example the case for Convis where the approach from Kichgessner et al. (1991) is used which does not take feed into account. CFT and Agrecalc both use the IPCC 2019 Tier 2 approach while FCC uses tier 2 UK values, CAP'2ER a French based Tier 3 approach, and Decide GIEC 2006. The different approaches do lead to differences in emissions, however, no consistent trends and not significant differences.

The manure management calculations are based on a set of assumptions too, which are needed to make tool usage accessible to farmers and advisors. Next to differences in calculated excretion rates, also the different manure storage types taken into account can play a role. For instance, CFT allows for a wide range in storage options, which is not the case for all tools. FCC does not report manure management and enteric fermentation CH_4 emissions separately, which might explain differences between the tools. However, differences are not consistent when looking at dairy and beef emissions.

Less assumptions are required for the calculation of fertilizer production emissions when fertilizer types are known. Fertilizer production calculations are relatively similar between the tools, also because these emissions are relatively easy to quantify. Nevertheless, there are significant differences between the tools for the arable production where CAP2'ER has significantly higher emissions. CAP2'ER uses average data for French context from WFLDB 3.3 database. Convis uses data from the Ecoinvent database. CFT, FCC, and Agrecalc all use data from Fertilizer Europe, explaining their relatively similar results. The emissions in Decide are calculated based on the Diaterre database.

For purchased feed, there can be large differences in calculated GHG emissions depending on the LCI databases used and assumptions made regarding deforestation. Emissions from soybean products, in particular, can be high due to allocated deforestation emissions. CFT makes use of the Global Feed LCA Institute (GFLI) database, which accounts for the origin of the feed. In contrast, other tools often make use of national databases, which may apply different assumptions and emission factors.

Furthermore, it should be noted that the way tools allocate emissions can differ. For example, purchased straw might be connected to the manure management in some tools while it is related to the production of inputs in others. Also the allocation of indirect emissions can differ. Indirect N_2O emissions can originate from fertilizer application, manure storage, or stables via N leaching and NH_3 volatilization. Depending on the tools, these might be related to the N_2O soil emissions, or to the respective sources, such as manure management.

4 Conclusions and Recommendations

In this study, a range of farm-level GHG tools, which are already used for GHG assessments of European farms, were analysed and both qualitative and quantitative comparisons were performed. Based on the first analysis 19 tools were recommended for use in the Climate Farm Demo project. A quantitative comparison was performed for a selection of 9 tools, which are most frequently used within the CFD project. For the comparison, data from arable, dairy and beef farms in four countries were collected, with a total of 40 farms were assessed by 6 or 7 tool each, depending on the production systems.

The results of the quantitative comparison showed sometimes large differences among tools, despite using the same input data by means of a common data sheet, and despite a certain level of harmonization of models based on international standards for GHG accounting (e.g. IPCC). Therefore, benchmarking and comparisons of farm GHG performance, based on assessments with multiple tools should be treated very carefully.

One reason for this is that although there are standards available that set out how to undertake an emission assessment, detailed guidance is not provided for all areas of agriculture. For example, the dairy sector has a standard set by the IDF[6] but other sectors lack similar guidelines. Even where there are detailed standards, these do not prevent calculator providers to tailor their approach (e.g., deciding on the balance between the level of detail that the user has to provide and the level of precision of the calculator output). Being prescriptive on the methodology would enable consistent results between calculators, but it would also prevent calculator providers in innovating their own approaches.

The main recommendations of this study for tool developers and related stakeholders are:

- Align output GHG categories of the tools, in order to make comparisons and benchmarking among tools easier. A clear description of the emissions covered by each of the output category is required.
- Harmonisation of emission factor databases is needed, especially for feed, but also for production of inputs and energy consumption. Most of these LCI databases are not publicly available and it is difficult to check which emission factors have been used.
- International guidelines, like the one from the International Dairy Federation, can help to harmonize GHG calculations. Such guidelines should also be developed for other farming sectors.
- Tools could offer the possibility to choose which GWP value should be used, depending whether the results should align with the national GHG inventory or for scope 3 reporting.
- Tools could also provide information on intermediate indicators, such as feed intake per animal and N excretion per animal, for a better understanding of the results of the GHG tools. These data are required for the GHG emissions calculations, but are often not provided in the output results.

[6] https://shop.fil-idf.org/products/the-idf-global-carbon-footprint-standard-for-the-dairy-sector

Acknowledgments

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Annexes

Annex A. List of criteria used for qualitative assessment of tools

Methodology of Climate Indicators

- Methodology available?
- Upfront level of transparency of emission factor data
- Does the tool include CH_4 emissions from enteric fermentation?
- Does the tool include CH_4 emissions from other sources (manure management, rice)?
- Does the tool include N_2O emissions from effluent management?
- Does the tool include N_2O emissions from soil?
- Does the tool include indirect N_2O emissions?
- Does the tool include direct CO_2 emissions - electricity
- Does the tool include direct CO_2 emissions - fuel consumption
- Does the tool include indirect(external) CO_2 emissions
- Are GHGs of external manure processing calculated?
- Are GHGs of external fertiliser production calculated?
- Are GHGs of food/feed exported calculated?
- Are GHGs of imported feed & bedding material calculated?
- Is uncertainty addressed? Is there a publication in which uncertainty of the tool is studied?
- Does the tool include land use change? For loss of carbon storage Tier from IPCC?
- Does the tool include carbon sequestration in soils?
- Does the tool include carbon sequestration in biomass? (Production with trees)
- Does the tool include an organic matter balance? (like Nitrogen Balance not only the sequestration).
- Does the tool include land use change? For N_2O emissions after destroying grassland/perennial crop
- Is fuel consumption calculated based on farm activities?
- Does the tool take refrigerant losses into account?
- GWP (Global Warming Potential) (how they count $N_2O/CH_4/CO_2$ as CO_2 eq)
- Tool Scope

User friendliness

- Is the tool readily available?
- Is the tool free to use?
- Is support available?
- Are manuals provided?
- Target User
- Time needed to make an assessment
- Is it possible to enter data with multiple units of measure (e.g. kg v lbs)
- What languages is the tool available in?
- Are farmer's data kept secure & private?

Presentation of results

- In what format are results provided?
- Is it possible to export the results?
- Does the tool provide a breakdown of where emissions occur within the farm?
- Are results provided in multiple units (e.g. GHG/kg or GHG/ha or GHG/cow etc.)?

- Does the tool provide the details of emission for each GHG gas (CO_2,CH_4,N_2O)?
- Does the tool provide results about energy consumption?
- Results scope (farm versus product)
- Benchmarking - Can the farmer compare his farm to other farms?
- Are technical indicators to link environmental results to agricultural practices available?
- Action plan simulation

Data collection

- Herds data
- N fertilisation
- Organic fertiliser
- Fuel consumption
- Pedoclimatic context
- Nutrients fertilised
- Organic matter input (including fertilizer, manure, compost, crop residues, biochar, etc)
- Manure production
- Feed
- Grazing
- Manure processing and export
- Manure storage system
- Crop rotation/fields
- Techniques used for crops (tillage etc)
- Animal housing system
- Calving pattern
- Crop yields DM
- Crop yields N
- Crop protection products (pesticides/herbicides)
- Water practices/irrigation
- Green manure/crop residue management
- Crop product processing/storage
- Soil type
- Flooding patterns for rice paddies
- Perennial systems
- management of perennial system
- Shade trees/other trees - i.e. trees in a pasture
- Seed import
- Export of crop products as food/feed
- Buildings/tractors/other capital assets
- Refrigerant looses

Other environmental impacts

- Does the tool include the full nitrogen cycle/balance?
- Are NH_3 emissions given specifically?
- Are NO_3 emissions given specifically?
- Does the tool include the full phosphorus cycle/balance?
- Does the tool include cycles/balances for other nutrients? (list)
- Is biodiversity included?

Annex B. Tool factsheets

AGNAV

Country of origin	**Ireland**
Tool owner	Teagasc/Bord Bia/ICBF
Available language	English
Production system covered by the tool	Beef cattle; Dairy cattle; Sheep and goat meat
Scope of tool (Farm level / Production unit level)	Farm level
Cost of the tool (in the project)	Free, in Ireland
Website	https://www.agnav.ie/landing
Website for the cost of the tool:	/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	Not in results
GHG emissions from the farm (/ha)	Yes
Carbon storage on the farm (/ha)	No
GHG emission by product	Yes
Carbon storage by product	No
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	No
Technical indicators to evaluate performance of the production unit	Yes
Benchmark on the technical indicators	No
Environmental impacts other than GHG	Yes
List of mitigation levers	Yes
Links with economic results	Not fully developed
Action plan simulation	Yes
2° Support for advisers	
Training in the use of the tool	Available
Training in understanding the results	Available
User guide	Available
Methodological guide	Under construction
Support	Available
Cost of training (in the project)	Free
Training format	Face to face
Data export and aggregation	To confirm
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	
Level 2: Sensitive to animal weight and production level (and DMI)	
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	Yes
Level 4: Sensitive to added fats and other additives	No
3.2: Level of precision of methodology on manure management (CH_4 / N_2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes

Level 3: Sensitive to manure storage and treatment	Yes
Level 4: Sensitive to additives	
Level 5: Sensitive to the animal feed (digestibility, protein)	Yes
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	Yes
Level 4: Sensitive to crop residue management (export, burial, etc.)	No
Level 5: Leaching is sensitive to practices	No
Level 6: Sensitive to additive and nitrification inhibitor	Yes (mineral)
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	Yes
Level 3: Several emission factor by type of energy sources	
Level 4: Sensitive to energy production on farm and self-consumption	
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	Yes
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	

General comment on the tool:
Developed by Teagasc/Bord Bia/ICBF, some functions are still under construction. Used in Ireland by Teagasc advisors, it is an advisory tool, with a link to agricultural practices and environmental results. Mitigation levers are easy to test in the tool. Well adapted to be used in Ireland, connection with Irish database for data collection.

AGRECALC

Country of origin	**United Kingdom**
Tool owner	SRUC
Available language	English
Production system covered by the tool	Arable crops; Arboriculture; Beef cattle; Dairy cattle; Market gardening; Open field horticulture; Pigs; Poultry; Sheep and goat meat; Viticulture
Scope of tool (Farm level / Production unit level)	Farm level
Cost of the tool (in the project)	Free for farmer and non-commercial use (One assessment per year). Cost for companies: (From 85£ to 105£ / farm)
Website	https://www.agrecalc.com/
Website for the cost of the tool:	https://www.agrecalc.com/home/pricing/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	Yes
GHG emissions from the farm (/ha)	Yes
Carbon storage on the farm (/ha)	Yes
GHG emission by product	Yes
Carbon storage by product	Yes
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	Yes
Technical indicators to evaluate performance of the production unit	Yes
Benchmark on the technical indicators	Yes
Environmental impacts other than GHG	No
List of mitigation levers	Not really
Links with economic results	Not fully developed
Action plan simulation	Simulation available
2° Support for advisers	
Training in the use of the tool	Available
Training in understanding the results	Available
User guide	Available
Methodological guide	Not fully
Support	Available
Cost of training (in the project)	Depending on the group size around 2 000£
Training format	In video and face to face possible
Data export and aggregation	Available
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	
Level 2: Sensitive to animal weight and production level (and DMI)	Yes
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	Yes
Level 4: Sensitive to added fats and other additives	Yes 3NOP (Bovaer)

3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes
Level 3: Sensitive to manure storage and treatment	Yes
Level 4: Sensitive to additives	No
Level 5: Sensitive to the animal feed (digestibility, protein)	Yes
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	No
Level 4: Sensitive to crop residue management (export, burial, etc.)	Yes
Level 5: Leaching is sensitive to practices	**O** Take in account but fixed value
Level 6: Sensitive to additive and nitrification inhibitor	Yes (mineral)
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	Yes
Level 3: Several emission factor by type of energy sources	Yes
Level 4: Sensitive to energy production on farm and self-consumption	Yes
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	Yes
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	

General comment on the tool:
Tool used at a large scale in UK, (700 adviser, 12,000 assessments). Cover wide type of production with a farm level approach. Assessments available for farms with several production. Good methodology precision and sensitivity to practices. Data collection requires pre-treatment of data when several production units are involved. The connection between each production unit seems to be not well developed. User guide and training available, but for the methodology only simplified elements were available on the website. The evaluation was completed with an exchange with the tool owner.

Agrosfär

Country of origin	**Sweden**
Tool owner	Agronod AB owned by Lantmännen, LRF, Hushållningssällskapet, Växa, Arla, HK Scan
Available language	Swedish
Production system covered by the tool	Arable crops; Arboriculture for fruit ; Arboriculture for other purpose ; Beef cattle ; Dairy cattle; Market gardening; Open field horticulture ;
Scope of tool (Farm level / Production unit level)	Production unit level
Cost of the tool (in the project)	?
Website	https://www.agronod.com/om-agrosfar
Website for the cost of the tool:	
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	No
GHG emissions from the farm (/ha)	No
Carbon storage on the farm (/ha)	No
GHG emission by product	Yes
Carbon storage by product	No
Breakdown of GHG emissions sources	?
Benchmark of the breakdown of GHG emission	?
Technical indicators to evaluate performance of the production unit	?
Benchmark on the technical indicators	?
Environmental impacts other than GHG	No
List of mitigation levers	?
Links with economic results	?
Action plan simulation	?
2° Support for advisers	
Training in the use of the tool	?
Training in understanding the results	?
User guide	?
Methodological guide	Yes
Support	?
Cost of training (in the project)	?
Training format	?
Data export and aggregation	?
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	
Level 2: Sensitive to animal weight and production level (and DMI)	Yes
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	Yes
Level 4: Sensitive to added fats and other additives	Dairy cows
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	

Level 2: Sensitive to type of manure and time spend housed	Yes
Level 3: Sensitive to manure storage and treatment	Yes
Level 4: Sensitive to additives	
Level 5: Sensitive to the animal feed (digestibility, protein)	Yes
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	Yes
Level 4: Sensitive to crop residue management (export, burial, etc.)	Yes
Level 5: Leaching is sensitive to practices	Yes
Level 6: Sensitive to additive and nitrification inhibitor	
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	
Level 3: Several emission factor by type of energy sources	Yes
Level 4: Sensitive to energy production on farm and self-consumption	
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes
3.7: Level of precision for carbon storage	
Level 1: Not available	Yes
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	

General comment on the tool:

Agrosfär is a climate calculation tool developed for the Swedish agriculture environment and market and is therefore not the best fit for other countries. The evaluation of the tool is only based on methodology guide available in English. This evaluation showed a good level of precision of the methodology. Many practical information are missing in the use of the tool in farm.

BIOCODE

Country of origin	**Finland**
Tool owner	Biocode
Available language	English, Swedish, Finnish
Production system covered by the tool	Arable Crops; Beef cattle; Dairy cattle; Pigs; Poultry
Scope of tool (Farm level / Production unit level)	Production unit
Cost of the tool (in the project)	Free for farmers From 170€ to 340€ / month
Website	https://biocode.io/
Website for the cost of the tool:	https://biocode.io/pricing/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	No
GHG emissions from the farm (/ha)	Yes, for specialized
Carbon storage on the farm (/ha)	Yes, for specialized
GHG emission by product	Yes
Carbon storage by product	Yes
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	No
Technical indicators to evaluate performance of the production unit	No
Benchmark on the technical indicators	No
Environmental impacts other than GHG	No
List of mitigation levers	No
Links with economic results	No
Action plan simulation	No
2° Support for advisers	
Training in the use of the tool	Yes
Training in understanding the results	Yes
User guide	No
Methodological guide	No
Support	For paying customers
Cost of training (in the project)	From 2 000 to 9 000 € content-dependent
Training format	?
Data export and aggregation	No
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	Yes
Level 2: Sensitive to animal weight and production level (and DMI)	No
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	No
Level 4: Sensitive to added fats and other additives	No
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes

Level 3: Sensitive to manure storage and treatment	No
Level 4: Sensitive to additives	No
Level 5: Sensitive to the animal feed (digestibility, protein)	No
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	No
Level 4: Sensitive to crop residue management (export, burial, etc.)	No
Level 5: Leaching is sensitive to practices	No
Level 6: Sensitive to additive and nitrification inhibitor	No
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	Yes
Level 3: Several emission factor by type of energy sources	
Level 4: Sensitive to energy production on farm and self-consumption	
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	Yes
Level 3: Specific emission factor by type of fertilizer	
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	Yes
Level 3: Specific emission factor by type of feed	
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	Yes
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	

General comment on the tool:
There are two versions of the tool, one specifically for LCA (carbon footprint) assessments for the food industry, and a more simple version for producers and farmers. Biocode propose several life cycles models for their clients (Pork, Beef, Milk and Egg production). Arable crops and broilers life cycle models can be used widely and are available freely for farmers. The methodology and the data collection are the same as the paid version but with less services. Methodological guidance is not fully available. The evaluation was made with exchange with the tool owner and according to information available on website, with the possibility to use the tool for arable crops and broilers. According to these elements the level of precision of the data collected seems to be low and in consequence the model is not very sensitive to agriculture practices. The tool seems to be more adapted to provide carbon footprint calculations for an agricultural product than to make an action plan to mitigate GHG emissions on a farm.

BOVID CO2 / ARDICARBON

Country of origin	**Spain**
Tool owner	NEIKER - ASOPROVAC
Available language	Spanish
Production system covered by the tool	Beef cattle; Sheep and goat meat ; Sheep milk
Scope of tool (Farm level / Production unit level)	Farm level
Cost of the tool (in the project)	
Website	/
Website for the cost of the tool:	/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	Yes
GHG emissions from the farm (/ha)	Yes
Carbon storage on the farm (/ha)	Yes
GHG emission by product	Yes
Carbon storage by product	?
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	Yes
Technical indicators to evaluate performance of the production unit	Yes
Benchmark on the technical indicators	?
Environmental impacts other than GHG	Yes
List of mitigation levers	?
Links with economic results	Yes
Action plan simulation	Yes
2° Support for advisers	
Training in the use of the tool	?
Training in understanding the results	?
User guide	Yes
Methodological guide	Will be available soon
Support	?
Cost of training (in the project)	?
Training format	?
Data export and aggregation	?
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	Yes
Level 2: Sensitive to animal weight and production level (and DMI)	In progress
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	
Level 4: Sensitive to added fats and other additives	
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes
Level 3: Sensitive to manure storage and treatment	Yes
Level 4: Sensitive to additives	Yes
Level 5: Sensitive to the animal feed (digestibility, protein)	No

3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	Yes
Level 4: Sensitive to crop residue management (export, burial, etc.)	No, only fixed value
Level 5: Leaching is sensitive to practices	No, only fixed value
Level 6: Sensitive to additive and nitrification inhibitor	No
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	
Level 3: Several emission factor by type of energy sources	Yes
Level 4: Sensitive to energy production on farm and self-consumption	
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	Yes
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	

General comment on the tool:

The Bovid CO2 tool is developed for beef cattle and Ardicarbon for is for sheep. The tool is used in Spain by Asoprovac and it is developed by Neiker University. The tool is a spreadsheet. It is still under construction but is already available. Thanks to its format, the tool can be updated quickly. (especially the enteric methane part). In the tool several methodologies are available. Need to have rules for advisor to compare results.

CAP'2ER Grandes cultures

Country of origin	**France**
Tool owner	IDELE
Available language	French
Production system covered by the tool	Arable crops
Scope of tool (Farm level / Production unit level)	Farm level
Cost of the tool (in the project)	Free in the project
Website	https://cap2er.eu/
Website for the cost of the tool:	/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	Yes
GHG emissions from the farm (/ha)	Yes
Carbon storage on the farm (/ha)	Yes
GHG emission by product	Yes and by type of crops
Carbon storage by product	At farm and eSDC level
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	No
Technical indicators to evaluate performance of the production unit	Yes
Benchmark on the technical indicators	Yes only partially
Environmental impacts other than GHG	Yes
List of mitigation levers	Yes
Links with economic results	No
Action plan simulation	Yes and comparison synthesis
2° Support for advisers	
Training in the use of the tool	Yes
Training in understanding the results	Yes
User guide	Under construction
Methodological guide	Yes
Support	Available
Cost of training (in the project)	Free in the project
Training format	Face to face
Data export and aggregation	Available
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	/
Level 2: Sensitive to animal weight and production level (and DMI)	/
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	/
Level 4: Sensitive to added fats and other additives	/
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	/
Level 2: Sensitive to type of manure and time spend housed	/
Level 3: Sensitive to manure storage and treatment	/
Level 4: Sensitive to additives	/
Level 5: Sensitive to the animal feed (digestibility, protein)	/

3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	Yes
Level 4: Sensitive to crop residue management (export, burial, etc.)	Yes
Level 5: Leaching is sensitive to practices	No, Take in account but fixed value
Level 6: Sensitive to additive and nitrification inhibitor	Yes (mineral and organic)
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	Yes
Level 3: Several emission factor by type of energy sources	Yes
Level 4: Sensitive to energy production on farm and self-consumption	No
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	No
Level 2: One emission factor, national reference	No
Level 3: Specific emission factor by type of feed	No
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	
Level 4: Modeling taking into account (Soil type, Climate, Organic matter, yield, intercrop, management of crop residues, …)	Yes

General comment on the tool:
CAP’2ER Grandes cultures is a French tool specialized in the evaluation of arable crops, it is not suitable for mixed production systems with livestock. The tool is new (2023) and is not widely used yet. For now, it is used is more adapted to France, with specific setting for carbon storage link to the soil type and climatic condition of the country.
The tool evaluates environmental impact (GHG emissions, Nitrogen losses, ammonia emissions, energy consumption, …) and positive contribution (Biodiversity, Carbon storage, people fed).
It is an advisory tool, which can be used to build action plan and to give technical advice. There is a functionality which allows comparison of results (simulation or real diagnosis) and a calculation of the carbon credits on the bases of the French low carbon certification process.

CAP'2ER

Country of origin	**France**
Tool owner	IDELE
Available language	French, Italian, Romanian, English, German, Spanish
Production system covered by the tool	Beef cattle; Dairy cattle; Goat milk; Sheep and goat meat ; Sheep milk and crops
Scope of tool (Farm level / Production unit level)	Farm level
Cost of the tool (in the project)	Free in the project
Website	https://cap2er.eu/
Website for the cost of the tool:	/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	Yes
GHG emissions from the farm (/ha)	Yes
Carbon storage on the farm (/ha)	Yes
GHG emission by product	Yes
Carbon storage by product	Yes
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	Yes
Technical indicators to evaluate performance of the production unit	Yes
Benchmark on the technical indicators	Yes
Environmental impacts other than GHG	Yes
List of mitigation levers	Yes
Links with economic results	Not fully developed
Action plan simulation	Yes
2° Support for advisers	
Training in the use of the tool	Available
Training in understanding the results	Available
User guide	Available
Methodological guide	Available
Support	Available
Cost of training (in the project)	Free
Training format	Face to face or remote
Data export and aggregation	Available
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	
Level 2: Sensitive to animal weight and production level (and DMI)	Yes

Level 3: Sensitive to feed composition (concentrate, protein, etc.)	Yes
Level 4: Sensitive to added fats and other additives	Dairy cows
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes
Level 3: Sensitive to manure storage and treatment	Yes
Level 4: Sensitive to additives	No
Level 5: Sensitive to the animal feed (digestibility, protein)	Yes
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	Yes
Level 4: Sensitive to crop residue management (export, burial, etc.)	**O** Take in account but fixed value
Level 5: Leaching is sensitive to practices	Yes
Level 6: Sensitive to additive and nitrification inhibitor	Yes (mineral)
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	Yes
Level 3: Several emission factor by type of energy sources	No
Level 4: Sensitive to energy production on farm and self-consumption	Yes
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	Yes
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	

General comment on the tool:
CAP'2ER is a farm-level tool that covers mixed farming crops and ruminant breeding (Dairy, Beef, Milk and Meat Sheep, Goat). It is widely used in France (about 30,000 assessment and 1500 users).
It is also used in other countries (Switzerland, Italia, Germany, Spain, Romania).
The tool evaluates environmental impact (GHG emissions, Nitrogen losses, energy consumption, …) and positive contribution (Biodiversity, Carbon storage, people fed). It is an advisory tool that is suitable to build and action plan and to provide technical advice. You can make simulations to test implementation of practices.

CARBON F&L

Country of origin	**France**
Tool owner	CTIFL
Available language	French
Production system covered by the tool	Arboriculture for fruit; Arboriculture for other purpose; Greenhouse horticulture; Market gardening ; Open field horticulture ; Viticulture
Scope of tool (Farm level / Production unit level)	Farm level
Cost of the tool (in the project)	300€ / assessment
Website	https://www.ctifl.fr/realiser-le-bilan-carbone-de-son-exploitation-grace-a-l-outil-carbone-f-l-infos-ctifl-392
Website for the cost of the tool:	/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	Yes
GHG emissions from the farm (/ha)	Yes
Carbon storage on the farm (/ha)	Yes
GHG emission by product	No
Carbon storage by product	No
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	No
Technical indicators to evaluate performance of the production unit	Yes
Benchmark on the technical indicators	Yes
Environmental impacts other than GHG	No
List of mitigation levers	Yes
Links with economic results	No
Action plan simulation	Yes
2° Support for advisers	
Training in the use of the tool	Yes
Training in understanding the results	Yes
User guide	Yes
Methodological guide	No
Support	Yes
Cost of training (in the project)	Around 1 800€
Training format	Face to face
Data export and aggregation	Available
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	/
Level 2: Sensitive to animal weight and production level (and DMI)	/
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	/
Level 4: Sensitive to added fats and other additives	/
3.2: Level of precision of methodology on manure management (CH_4 / N_2O)	
Level 1: Fixed values / head	/

Level 2: Sensitive to type of manure and time spend housed	/
Level 3: Sensitive to manure storage and treatment	/
Level 4: Sensitive to additives	/
Level 5: Sensitive to the animal feed (digestibility, protein)	/
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	Yes
Level 4: Sensitive to crop residue management (export, burial, etc.)	
Level 5: Leaching is sensitive to practices	
Level 6: Sensitive to additive and nitrification inhibitor	
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	
Level 3: Several emission factor by type of energy sources	Yes
Level 4: Sensitive to energy production on farm and self-consumption	Yes
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	/
Level 2: One emission factor, national reference	/
Level 3: Specific emission factor by type of feed	/
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	Yes
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	

General comment on the tool:
Carbon F&L is a specialized tool for vegetable and fruits production, it is used in France with about 10 advisors using the tool. The data collection is done in calculation spreadsheet. The use of the tool is made by the tool owner itself. It guarantees a good quality in data collection and results but does not allow the use of the tool in a large scale for the moment. It is an advisory tool make to build action plan and to give technical advice. The evaluation format is not necessarily well suited to this type of specialized production, as it doesn't do justice to the precision of the data collected on very specific elements linked to vegetable and fruit production.

CONVIS

Country of origin	**Luxembourg**
Tool owner	CONVIS Société coopérative
Available language	English, German
Production system covered by the tool	Arable crops; Beef cattle; Dairy cattle; Pigs
Scope of tool (Farm level / Production unit level)	Farm level
Cost of the tool (in the project)	From 20 to 50 euros / farm
Website	No website
Website for the cost of the tool:	/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	Yes
GHG emissions from the farm (/ha)	Yes
Carbon storage on the farm (/ha)	Yes
GHG emission by product	Yes
Carbon storage by product	Yes
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	Yes
Technical indicators to evaluate performance of the production unit	Yes
Benchmark on the technical indicators	Yes
Environmental impacts other than GHG	Yes
List of mitigation levers	?
Links with economic results	Yes
Action plan simulation	No
2° Support for advisers	
Training in the use of the tool	Available
Training in understanding the results	Available
User guide	Available
Methodological guide	On request
Support	Available
Cost of training (in the project)	Free in the project
Training format	In video
Data export and aggregation	Available
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	Other livestock
Level 2: Sensitive to animal weight and production level (and DMI)	Dairy
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	No
Level 4: Sensitive to added fats and other additives	No
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes
Level 3: Sensitive to manure storage and treatment	Yes
Level 4: Sensitive to additives	No
Level 5: Sensitive to the animal feed (digestibility, protein)	No

3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	No
Level 4: Sensitive to crop residue management (export, burial, etc.)	No, take in account but fixed value
Level 5: Leaching is sensitive to practices	No, take in account but fixed value
Level 6: Sensitive to additive and nitrification inhibitor	No
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	Yes
Level 2: National emission factor	
Level 3: Several emission factor by type of energy sources	
Level 4: Sensitive to energy production on farm and self-consumption	
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	Yes
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	

General comment on the tool:

Convis is a tool focused on Luxembourg in terms of data collection, but the tool can be used in other countries as well. It is available in English and German. Benchmarking is available against all farms assessed in the country. The tool is an internet application and is quite clear to use for a trained advisor. It is not intended for direct farmer use. A PDF report is generated at the end with emissions and economic assessment. Economic assessment is optional and requires more time to fill in. N farm gate balance is also given, as are P & K. Sectors included are beef, dairy, crops. They also have a pig tool, but this is not recommended for use because Luxembourg has a very small pig sector and so this part is not sufficiently developed. The tool also includes biogas production (and attached to that digestion of slurry). Training available for in the project, 1 day training. Free for the project. Training includes data collection, particularities of the tool, results interpretation.

COOL FARM TOOL

Country of origin	**United Kingdom**
Tool owner	COOL FARM ALLIANCE
Available language	German, English *Beta languages: Czech, Greek, Spanish, Finnish, French, Hungarian, Lithuanian, Latvian, Dutch, Romanian, Bulgarian, Swedish, Italian, Portuguese, Polish*
Production system covered by the tool	Arable crops, Dairy, Beef, Meat sheep, Milk sheep, Goat, Pigs, Poultry, Crops, Arboriculture (Fruit), Arboriculture (other), Market gardening, Field Horticulture
Scope of tool (Farm level / Production unit level)	Production unit level
Cost of the tool (in the project)	Free for farmer, From 2 200 to 40 000£ / year for company
Website	https://app.coolfarmtool.org/
Website for the cost of the tool:	https://coolfarm1.wpengine.com/join-us/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	No
GHG emissions from the farm (/ha)	No
Carbon storage on the farm (/ha)	No
GHG emission by product	Yes
Carbon storage by product	Yes
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	No
Technical indicators to evaluate performance of the production unit	Some
Benchmark on the technical indicators	No
Environmental impacts other than GHG	Yes
List of mitigation levers	No
Links with economic results	No
Action plan simulation	No
2° Support for advisers	
Training in the use of the tool	Available
Training in understanding the results	Available
User guide	?
Methodological guide	Available
Support	Available
Cost of training (in the project)	At least 1 000£
Training format	Both possible
Data export and aggregation	Available
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	Other livestock
Level 2: Sensitive to animal weight and production level (and DMI)	Yes, Bovine No, Other livestock
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	Yes, Bovine No, Other livestock

Level 4: Sensitive to added fats and other additives	Yes, Bovine No, Other livestock
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes
Level 3: Sensitive to manure storage and treatment	Yes
Level 4: Sensitive to additives	No
Level 5: Sensitive to the animal feed (digestibility, protein)	No
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	Partly
Level 4: Sensitive to crop residue management (export, etc.)	Yes
Level 5: Leaching is sensitive to practices	No
Level 6: Sensitive to additive and nitrification inhibitor	Yes (mineral)
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	Yes
Level 3: Several emission factor by type of energy sources	Yes
Level 4: Sensitive to energy production on farm and self-consumption	No
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	Yes
Level 4: Modeling taking in account (Soil type, Climate, OM))	

General comment on the tool:
Cool Farm Tool is used at a large scale at European and global level, it is available in several languages (English and German and 15 beta languages). The tool covers many productions system.
There is a good transparency in the methodology used in the tool and a good precision for dairy, beef and crop production systems, but more focused on product level. The tool is more adapted to evaluate carbon footprint than make technical advice at farm level, there are few features to build an action plan. The tool is not well adapted to mixed farm, it is more a production aggregation (one assessments per production and crop). There are a few consistencies check on data entry and the data has to be pre-processed by the advisers in order to allocate the use of inputs to different crops/ production units. There is no help in the tool to assist in this allocation.

DECiDE

Country of origin	**Belgium**
Tool owner	**Walloon Agricultural Research Centre**
Available language	**French**
Production system covered by the tool	Arable crops; Beef cattle; Dairy cattle; Sheep cattle
Scope of tool (Farm level / Production unit level)	Farm level
Cost of the tool (in the project)	Free
Website	**https://www.decide.cra.wallonie.be/fr**
Website for the cost of the tool:	/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	Yes
GHG emissions from the farm (/ha)	Yes
Carbon storage on the farm (/ha)	Yes
GHG emission by product	Yes
Carbon storage by product	Yes
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	Yes
Technical indicators to evaluate performance of the production unit	Yes
Benchmark on the technical indicators	Yes
Environmental impacts other than GHG	Yes
List of mitigation levers	No
Links with economic results	Yes
Action plan simulation	Yes
2° Support for advisers	
Training in the use of the tool	Available
Training in understanding the results	Available
User guide	Available
Methodological guide	Available
Support	Available
Cost of training (in the project)	Free
Training format	Face to face
Data export and aggregation	Available
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	
Level 2: Sensitive to animal weight and production level (and DMI)	Yes
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	Yes
Level 4: Sensitive to added fats and other additives	Soon
3.2: Level of precision of methodology on manure management (CH4 / N2O)	

Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes
Level 3: Sensitive to manure storage and treatment	Yes
Level 4: Sensitive to additives	No
Level 5: Sensitive to the animal feed (digestibility, protein)	Yes
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	Yes
Level 4: Sensitive to crop residue management (export, burial, etc.)	Yes
Level 5: Leaching is sensitive to practices	No
Level 6: Sensitive to additive and nitrification inhibitor	No
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	
Level 3: Several emission factor by type of energy sources	Yes
Level 4: Sensitive to energy production on farm and self-consumption	Yes
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	Permanent Grassland
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	Arable crops

General comment on the tool:
DECiDE is a tool from Belgium used in Wallonia. DECiDE has a good precision of methodology and it is made to provide technical advice and to build an action plan. It is possible to use DECiDE in another country, but the tool is only available in French.

ESGREEN TOOL

Country of origin	**Denmark**
Tool owner	SEGES Innovation P/S
Available language	Danish
Production system covered by the tool	Arable crops; Beef cattle; Dairy cattle ; Pigs ; Poultry
Scope of tool (Farm level / Production unit level)	
Cost of the tool (in the project)	Paid assessments (From 60 to 500 €)
Website	https://segesinnovation.dk/produkter-og-ydelser/digitale-loesninger/
Website for the cost of the tool:	/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	No
GHG emissions from the farm (/ha)	Yes
Carbon storage on the farm (/ha)	Yes
GHG emission by product	Yes
Carbon storage by product	Yes
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	No
Technical indicators to evaluate performance of the production unit	No
Benchmark on the technical indicators	No
Environmental impacts other than GHG	No
List of mitigation levers	Yes
Links with economic results	No
Action plan simulation	Yes
2° Support for advisers	
Training in the use of the tool	Online training modules for farmers
Training in understanding the results	Online training modules for farmers
User guide	Yes
Methodological guide	Yes
Support	Yes
Cost of training (in the project)	/
Training format	/
Data export and aggregation	No
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	Yes
Level 2: Sensitive to animal weight and production level (and DMI)	Yes
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	Dairy cows
Level 4: Sensitive to added fats and other additives	Dairy cows
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes

Level 3: Sensitive to manure storage and treatment	Yes
Level 4: Sensitive to additives	No
Level 5: Sensitive to the animal feed (digestibility, protein)	No
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	No
Level 4: Sensitive to crop residue management (export, burial, etc.)	Yes
Level 5: Leaching is sensitive to practices	Yes
Level 6: Sensitive to additive and nitrification inhibitor	Yes
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	
Level 3: Several emission factor by type of energy sources	Yes
Level 4: Sensitive to energy production on farm and self-consumption	Yes
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	Yes
Level 3: Specific emission factor by type of fertilizer	
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	Yes

General comment on the tool:
Danish tool, only available in Denmark. Part of the data collection is taken directly from mandatory farm registration data to the Danish Government. The tool is sensitive to many agricultural practices. The tool is used to make calculation of mitigation scenarios.

FARM CARBON CALCULATOR

Country of origin	**United Kingdom**
Tool owner	Farm Carbon Toolkit
Available language	English, *Italian*
Production system covered by the tool	Arable crops; Beef cattle; Dairy cattle; Greenhouse horticulture; Market gardening; Open field horticulture; Pigs; Poultry; Sheep and goat meat
Scope of tool (Farm level / Production unit level)	Farm level
Cost of the tool (in the project)	Free for farmer, Cost for companies: (From 120£ to 42£ / report + annual fee from 0 to 5 000£)
Website	https://calculator.farmcarbontoolkit.org.uk/
Website for the cost of the tool:	https://farmcarbontoolkit.org.uk/commercial-services/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	Quick presentation
GHG emissions from the farm (/ha)	Yes
Carbon storage on the farm (/ha)	Yes
GHG emission by product	Yes
Carbon storage by product	No
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	Yes
Technical indicators to evaluate performance of the production unit	No
Benchmark on the technical indicators	No
Environmental impacts other than GHG	No
List of mitigation levers	No
Links with economic results	No
Action plan simulation	Simulation available
2° Support for advisers	
Training in the use of the tool	Available
Training in understanding the results	?
User guide	Available
Methodological guide	Available
Support	Available
Cost of training (in the project)	paid training
Training format	Both possible
Data export and aggregation	Yes, aggregation?
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	
Level 2: Sensitive to animal weight and production level (and DMI)	Yes for bovine No for other livestock
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	No
Level 4: Sensitive to added fats and other additives	No

3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes
Level 3: Sensitive to manure storage and treatment	No
Level 4: Sensitive to additives	No
Level 5: Sensitive to the animal feed (digestibility, protein)	No
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	Yes
Level 2: Differentiation between organic and mineral fertilization	No
Level 3: Sensitive to the spreading and burial practices	No
Level 4: Sensitive to crop residue management (export, burial, etc.)	No
Level 5: Leaching is sensitive to practices	No
Level 6: Sensitive to additive and nitrification inhibitor	No
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	Yes
Level 3: Several emission factor by type of energy sources	Yes
Level 4: Sensitive to energy production on farm and self-consumption	
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	Yes
Level 3: Fixed values national reference	
Level 4: Modeling taking in account (Soil type, Climate)	Yes

General comment on the tool:

Farm Carbon Calculator is an English tool used in UK and several other countries (South Africa, South America, Spain, Ireland…). There are about 150 people trained to the use of the tool. It covers many productions system and it seems to be user friendly. The level of precision of the methodology is low on some points (Nitrogen and effluent management in field). The data collection is made at the scope of the production unit. For mixed farming systems, the user needs to pre-process the data to allocate the use of inputs, surfaces for each production. There is no help and control for this allocation, and no control in data collection. The tool is more adapted to evaluate carbon footprint than make technical advice at farm level, there are few features to build an action plan.

FAST NAVIGATOR

Country of origin	**EU**
Tool owner	EU, Agrisat, ITAP, UCLM, INTIA, CREA, IFEU, INRAE, IUNG and Ariespace.
Available language	English, Italian, Estonian, Spanish
Production system covered by the tool	Arable crops; Arboriculture for fruit and other purpose; Beef cattle; Dairy cattle; Goat; Greenhouse horticulture; Market gardening; Open field horticulture; Pigs; Poultry; Sheep; Viticulture
Scope of tool (Farm level / Production unit level)	Farm level
Cost of the tool (in the project)	Free
Website	https://tool.fastnavigator.eu/index.html
Website for the cost of the tool:	/

1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	No
GHG emissions from the farm (/ha)	Yes
Carbon storage on the farm (/ha)	Yes
GHG emission by product	Yes
Carbon storage by product	Yes
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	No ?
Technical indicators to evaluate performance of the production unit	No ?
Benchmark on the technical indicators	No ?
Environmental impacts other than GHG	No ?
List of mitigation levers	No ?
Links with economic results	Yes ?
Action plan simulation	No ?
2° Support for advisers	
Training in the use of the tool	Yes
Training in understanding the results	Yes ?
User guide	No ?
Methodological guide	Yes
Support	Yes
Cost of training (in the project)	Paid
Training format	?
Data export and aggregation	?
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	
Level 2: Sensitive to animal weight and production level (and DMI)	Yes

Level 3: Sensitive to feed composition (concentrate, protein, etc.)	Yes
Level 4: Sensitive to added fats and other additives	Yes
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes
Level 3: Sensitive to manure storage and treatment	Yes, Storage only
Level 4: Sensitive to additives	No
Level 5: Sensitive to the animal feed (digestibility, protein)	No
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	No
Level 4: Sensitive to crop residue management (export, burial, etc.)	Yes
Level 5: Leaching is sensitive to practices	No
Level 6: Sensitive to additive and nitrification inhibitor	Yes (mineral)
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	Yes
Level 3: Several emission factor by type of energy sources	Yes
Level 4: Sensitive to energy production on farm and self-consumption	Yes
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes (few emissions factor)
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	
Level 4: Modeling taking in account (Soil type, Climate, OM)	Yes

General comment on the tool:
The Fast navigator was first of all developed to provide farmers advice and fertilization, but was later extended to calculate GHG emissions as well. The tool can be used for both livestock and crop production systems. The tool uses many Tier 2/3 methods, and the methodology is clearly published online. The tool offers possibilities for benchmarking for participating regions. The tool has been implemented in several countries, however, there seems to be a lack of central guidance and the tool still only available as beta version.

GEEP

Country of origin	**France**
Tool owner	IFIP
Available language	French
Production system covered by the tool	Pigs
Scope of tool (Farm level / Production unit level)	Farm / Production unit level
Cost of the tool (in the project)	Free in France
Website	https://geep.ifip.asso.fr/
Website for the cost of the tool:	/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	No
GHG emissions from the farm (/ha)	No
Carbon storage on the farm (/ha)	No
GHG emission by product	Yes
Carbon storage by product	No
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	Yes
Technical indicators to evaluate performance of the production unit	Yes, with the GTE
Benchmark on the technical indicators	Yes, with the GTE
Environmental impacts other than GHG	Yes
List of mitigation levers	Yes
Links with economic results	Yes, with the GTE
Action plan simulation	Yes
2° Support for advisers	
Training in the use of the tool	Yes
Training in understanding the results	Yes
User guide	Yes
Methodological guide	Available
Support	Free
Cost of training (in the project)	Face to face
Training format	Available
Data export and aggregation	Yes
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	Yes
Level 2: Sensitive to animal weight and production level (and DMI)	
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	
Level 4: Sensitive to added fats and other additives	
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes
Level 3: Sensitive to manure storage and treatment	Yes
Level 4: Sensitive to additives	Yes, to confirm
Level 5: Sensitive to the animal feed (digestibility, protein)	Yes
3.3: Level of precision of methodology for nitrogen management in the field	

Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	/
Level 2: Differentiation between organic and mineral fertilization	/
Level 3: Sensitive to the spreading and burial practices	/
Level 4: Sensitive to crop residue management (export, burial, etc.)	/
Level 5: Leaching is sensitive to practices	/
Level 6: Sensitive to additive and nitrification inhibitor	/
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	Yes
Level 3: Several emission factor by type of energy sources	
Level 4: Sensitive to energy production on farm and self-consumption	
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	/
Level 2: One emission factor, national reference	/
Level 3: Specific emission factor by type of fertilizer	/
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes
3.7: Level of precision for carbon storage	
Level 1: Not available	/
Level 2: Fixed values international reference	/
Level 3: Fixed values national reference	/
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	/

General comment on the tool:
GEEP is a tool specialized in pig production. It is widely used for French pig farms. It is very sensitive to feed on farms. It is possible to use the tool in other countries, but it is only available in French for now. If needed, the tool owner can consider a translation. There is a strong link with technical and economic indicators. It is well adapted for action plan simulation and advisory services.

GES&VIT

Country of origin	**France**
Tool owner	IFV
Available language	French
Production system covered by the tool	Viticulture
Scope of tool (Farm level / Production unit level)	Farm / Production unit level
Cost of the tool (in the project)	Paid licence
Website	https://www.vignevin.com/article/outil-devaluation-de-lempreinte-carbone-des-exploitations/
Website for the cost of the tool:	/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	Yes
GHG emissions from the farm (/ha)	Yes
Carbon storage on the farm (/ha)	Yes
GHG emission by product	No
Carbon storage by product	No
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	No
Technical indicators to evaluate performance of the production unit	Yes
Benchmark on the technical indicators	No
Environmental impacts other than GHG	No
List of mitigation levers	No
Links with economic results	No
Action plan simulation	Yes
2° Support for advisers	
Training in the use of the tool	Yes
Training in understanding the results	Yes
User guide	Yes
Methodological guide	Will be available soon
Support	Yes
Cost of training (in the project)	450 € / trainee
Training format	Face to face
Data export and aggregation	Available
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	/
Level 2: Sensitive to animal weight and production level (and DMI)	/
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	/
Level 4: Sensitive to added fats and other additives	/
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	/

Level 2: Sensitive to type of manure and time spend housed	/
Level 3: Sensitive to manure storage and treatment	/
Level 4: Sensitive to additives	/
Level 5: Sensitive to the animal feed (digestibility, protein)	/
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	
Level 4: Sensitive to crop residue management (export, burial, etc.)	
Level 5: Leaching is sensitive to practices	
Level 6: Sensitive to additive and nitrification inhibitor	
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	Yes
Level 3: Several emission factor by type of energy sources	
Level 4: Sensitive to energy production on farm and self-consumption	
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	/
Level 2: One emission factor, national reference	/
Level 3: Specific emission factor by type of feed	/
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	Yes

General comment on the tool:
Specialized tool for viticulture used in France by around 50 advisors. A translation in German and Italian is under consideration. The evaluation form is not very well suited to this type of production and therefore the assessment does not do justice to the precision of the data collected on very specific elements linked to viticulture.

KLIMREK

Country of origin	**Belgium**
Tool owner	ILVO and Boerenbond
Available language	Dutch
Production system covered by the tool	Dairy cattle; Pigs
Scope of tool (Farm level / Production unit level)	Farm level
Cost of the tool (in the project)	Price to be determined according to demand
Website	https://scan.klimrekproject.be/Login
Website for the cost of the tool:	/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	Yes, to confirm
GHG emissions from the farm (/ha)	Yes
Carbon storage on the farm (/ha)	No
GHG emission by product	Yes
Carbon storage by product	No
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	Yes
Technical indicators to evaluate performance of the production unit	No
Benchmark on the technical indicators	No
Environmental impacts other than GHG	Yes
List of mitigation levers	No
Links with economic results	No
Action plan simulation	Yes
2° Support for advisers	
Training in the use of the tool	Yes
Training in understanding the results	Yes
User guide	Yes, for dairy
Methodological guide	Will be published soon
Support	Under construction
Cost of training (in the project)	Not determined yet
Training format	Face to face
Data export and aggregation	?
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	
Level 2: Sensitive to animal weight and production level (and DMI)	Yes
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	Yes
Level 4: Sensitive to added fats and other additives	
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes
Level 3: Sensitive to manure storage and treatment	Yes

Level 4: Sensitive to additives	No
Level 5: Sensitive to the animal feed (digestibility, protein)	Yes
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	No
Level 4: Sensitive to crop residue management (export, burial, etc.)	No, take in account but fixed value
Level 5: Leaching is sensitive to practices	No, take in account but fixed value
Level 6: Sensitive to additive and nitrification inhibitor	No
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	Yes
Level 3: Several emission factor by type of energy sources	
Level 4: Sensitive to energy production on farm and self-consumption	
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes
3.7: Level of precision for carbon storage	
Level 1: Not available	Yes
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	

General comment on the tool:
Tool used in Flanders. Its use is rather reserved for Belgium, as specific parameters for Belgium are used. The tool is used for dairy cattle and pig production systems, the crop part is only for the fodder production. The tool for dairy cattle is available online, the tool for pigs is still in development but available as an Excel file. Some services for users (support, training) are still under construction.

KLIR

Country of origin	**Switzerland**
Tool owner	Haute école des sciences agronomiques, forestières et alimentaires HAFL, Zollikofen (Suisse)
Available language	German
Production system covered by the tool	Dairy cattle
Scope of tool (Farm level / Production unit level)	Production unit
Cost of the tool (in the project)	Free, in a Swiss project
Website	/
Website for the cost of the tool:	/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	No
GHG emissions from the farm (/ha)	No
Carbon storage on the farm (/ha)	No
GHG emission by product	Yes
Carbon storage by product	No
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	Yes
Technical indicators to evaluate performance of the production unit	For some
Benchmark on the technical indicators	Yes
Environmental impacts other than GHG	No
List of mitigation levers	No
Links with economic results	No
Action plan simulation	Yes
2° Support for advisers	
Training in the use of the tool	No training outside the Swiss project
Training in understanding the results	/
User guide	Yes
Methodological guide	No
Support	/
Cost of training (in the project)	/
Training format	/
Data export and aggregation	/
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	Other animal categories
Level 2: Sensitive to animal weight and production level (and DMI)	
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	Dairy cows only
Level 4: Sensitive to added fats and other additives	
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes
Level 3: Sensitive to manure storage and treatment	Yes
Level 4: Sensitive to additives	No

Level 5: Sensitive to the animal feed (digestibility, protein)	No
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	Included in emission factor
Level 2: Differentiation between organic and mineral fertilization	No
Level 3: Sensitive to the spreading and burial practices	No
Level 4: Sensitive to crop residue management (export, burial, etc.)	No
Level 5: Leaching is sensitive to practices	No
Level 6: Sensitive to additive and nitrification inhibitor	No
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	Electricity, only
Level 3: Several emission factor by type of energy sources	No
Level 4: Sensitive to energy production on farm and self-consumption	No
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	No
Level 2: One emission factor, national reference	No
Level 3: Specific emission factor by type of fertilizer	No
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes
3.7: Level of precision for carbon storage	
Level 1: Not available	Yes
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	

General comment on the tool:
Tool used as part of a Swiss project. It is used at about 250 farms. The tool is sspecialized for dairy production. Sensitive to the feeding of dairy cows but less sensitive for other animals. Several emission items (Nitrogen management and fuel used in field) are included in the fodder emission factors. This makes the tool less sensitive to forage area management.

Kringloopwijzer (ANCA)

Country of origin	**Netherlands**
Tool owner	ZuivelNL
Available language	Dutch, English
Production system covered by the tool	Dairy cattle
Scope of tool (Farm level / Production unit level)	Farm / Production unit level
Cost of the tool (in the project)	Free
Website	https://mijnkringloopwijzer.nl/
Website for the cost of the tool:	/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	Yes
GHG emissions from the farm (/ha)	Yes
Carbon storage on the farm (/ha)	Yes
GHG emission by product	Yes
Carbon storage by product	Yes
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	Yes
Technical indicators to evaluate performance of the production unit	Yes
Benchmark on the technical indicators	Yes
Environmental impacts other than GHG	Yes
List of mitigation levers	No
Links with economic results	No
Action plan simulation	Yes
2° Support for advisers	
Training in the use of the tool	Available
Training in understanding the results	Available
User guide	Available
Methodological guide	Available
Support	Available
Cost of training (in the project)	Free in the project (limited outside NL)
Training format	Outside NL online
Data export and aggregation	Available
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	
Level 2: Sensitive to animal weight and production level (and DMI)	Yes
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	Yes
Level 4: Sensitive to added fats and other additives	Yes
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes
Level 3: Sensitive to manure storage and treatment	Yes
Level 4: Sensitive to additives	No

Level 5: Sensitive to the animal feed (digestibility, protein)	Yes
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	Yes
Level 4: Sensitive to crop residue management (export, burial, etc.)	Yes
Level 5: Leaching is sensitive to practices	No
Level 6: Sensitive to additive and nitrification inhibitor	Yes (manure)
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	
Level 3: Several emission factor by type of energy sources	Yes
Level 4: Sensitive to energy production on farm and self-consumption	
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of feed	Yes
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	Yes

General comment on the tool:
ANCA is a Dutch tool specialized in Dairy cattle, it is widely used in Netherland. ANCA has a good precision of methodology and it is made to deliver technical advice and build action plan. The tool is available in English, but the tool requires quite some data collection, which in quite focussed on the Dutch conditions. Part of the data collection is made by API linked to central databases from the government as well as from the feed and dairy industry.

TEKLa

Country of origin	**Germany**
Tool owner	LWK Niedersachsen
Available language	German
Production system covered by the tool	Arable crops; Beef cattle; Dairy cattle; Open field horticulture; Pigs ; Poultry ; Sheep and goat meat
Scope of tool (Farm level / Production unit level)	Production unit
Cost of the tool (in the project)	To check for the project
Website	/
Website for the cost of the tool:	/
1° Features to help build an action plan:	
Description of the farm (Surfaces, production system...)	No
GHG emissions from the farm (/ha)	No
Carbon storage on the farm (/ha)	No
GHG emission by product	Yes
Carbon storage by product	Yes
Breakdown of GHG emissions sources	Yes
Benchmark of the breakdown of GHG emission	Yes, with standard values
Technical indicators to evaluate performance of the production unit	Yes
Benchmark on the technical indicators	Yes, in Germany
Environmental impacts other than GHG	No
List of mitigation levers	No
Links with economic results	No
Action plan simulation	Yes
2° Support for advisers	
Training in the use of the tool	Yes, in Germany
Training in understanding the results	Yes
User guide	No
Methodological guide	Yes
Support	Yes
Cost of training (in the project)	To defined
Training format	Face to face
Data export and aggregation	Yes
3° Level of precision of the methodology and sensitivity to practices	
3.1: Level of precision of methodology for enteric methane	
Level 1: Fixed values per animal category (independent of weight and production)	
Level 2: Sensitive to animal weight and production level (and DMI)	Yes
Level 3: Sensitive to feed composition (concentrate, protein, etc.)	Yes
Level 4: Sensitive to added fats and other additives	No
3.2: Level of precision of methodology on manure management (CH4 / N2O)	
Level 1: Fixed values / head	
Level 2: Sensitive to type of manure and time spend housed	Yes
Level 3: Sensitive to manure storage and treatment	Yes
Level 4: Sensitive to additives	No

Level 5: Sensitive to the animal feed (digestibility, protein)	No
3.3: Level of precision of methodology for nitrogen management in the field	
Level 1: Overall quantity of nitrogen per ha (1 Emission factor)	
Level 2: Differentiation between organic and mineral fertilization	Yes
Level 3: Sensitive to the spreading and burial practices	Yes
Level 4: Sensitive to crop residue management (export, burial, etc.)	Yes
Level 5: Leaching is sensitive to practices	No
Level 6: Sensitive to additive and nitrification inhibitor	No
3.4: Level of precision of energy consumption emission factors	
Level 1: International emission factor	
Level 2: National emission factor	Yes
Level 3: Several emission factor by type of energy sources	Yes
Level 4: Sensitive to energy production on farm and self-consumption	
3.5: Level of precision of fertilizer emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	
Level 3: Specific emission factor by type of fertilizer	Yes
3.6: Level of precision of feed emission factors	
Level 1: One emission factor, international reference	
Level 2: One emission factor, national reference	Few categories
Level 3: Specific emission factor by type of feed	
3.7: Level of precision for carbon storage	
Level 1: Not available	
Level 2: Fixed values international reference	
Level 3: Fixed values national reference	Yes
Level 4: Modeling taking in account (Soil type, Climate, Organic matter)	

General comment on the tool:

German tool only available in Germany for now. (About 20 users in Nordrhein-Westfalen). There are several other tools in Germany, e.g. Bioland tool, that are all based on the same methodology. These tools are based on the German BEK standard (https://www.ktbl.de/themen/bek), which is the base for several tools in Germany.

Annex C. Example data collection sheet dairy

LIVESTOCK

Breed name	Share in the herd (%)
Holstein Friesian	
Jersey x Friesian	

	Average number livestock on farm in the assessment year (number)	Start livestock (number)	End livestock (number)	Live weight (kg)
Lactating dairy cows				
Non-lactating dairy cows/cull dairy cows				
Heifers 0-1 year/Calves				
Heifers 1-2 years				
Heifers 2-3 years				
Heifers >3 years				
Dairy bulls				
Meat calves				

	Livestock purchased (number)	Live weight at purchase (kg)	Livestock sales (number)	Live weight at sale (kg)	Livestock deaths (number)	Weight at death (kg)
Lactating dairy cows						
Non-lactating dairy cows/cull dairy cows						
Heifers 0-1 year/Calves						
Heifers 1-2 years						
Heifers 2-3 years						
Heifers >3 years						
Dairy bulls						
Male calves						

Total milk produced (gross litres/year)	
Milk given to young animals/self-consumed/discarded (excluding colostrum) (gross liters/year)	
Milk sold	
Fat rate (%)	
Protein content (%)	
Phosphorus content (mg/100 g)	
Urea content (mg/100 g)	
Type of milking system	
Milkings per day	
Number of milking clusters	
Average age at first calving (months)	
Replacement rate (%)	
Interval between calvings (days)	

Housing	Proportion of time spent in the barn during the year	Proportion of time spent in the pasture during the year	Type of barn
Lactating dairy cows			
Non-lactating dairy cows/cull dairy cows			
Heifers 0-1 year/Calves			
Heifers 1-2 years			
Heifers 2-3 years			
Heifers >3 years			
Dairy bulls			
Male calves			

Manure	Slurry (% of total manure)	Farm yard manure (%)	Grazing manure (%)	Daily spread (fresh manure) (%)
Lactating dairy cows				
Non-lactating dairy cows/cull dairy cows				
Heifers 0-1 year				
Heifers 1-2 years				
Heifers 2-3 years				
Heifers >3 years				
Dairy bulls				
Male calves				

Bedding	Type	Quantity (t)

Effluent management

Do you use a digester ?	
Majority type of slurry pit	Pit with natural crust
Majority type of solid manure storage	
% of slurry to digester	
% of manure to digester	

Effluent imports

Type				
Quantity (T/year or m3/year)				

Effluent exports

Type				
Quantity (T/year or m3/year)				

Spreading

Manure incorporation time	
Type of slurry spreader used	
Slurry incorporation time	

AREAS

				Harvest				**Residue management**	
Crops type	% of leguminous crops	Number of years crop is in the ground	Area (ha)	Storage yield (t/ha)	Fresh or dry weight?	Sold (t)	Fresh or dry weight?	Type of residue management	Amount (t DM/ha) (only if known, otherwise there are default values in cft)
Grassland grazed				-	-	-	-	-	-
Grassland cut									
Grassland cut and grazed									
Maize silage	-								
Barley	-								
Grain corn	-								
Wheat	-								

Mineral fertilisation									Organic fertilisation				Fertilization event
Ammonuim nitrate (kg N / ha / year)	Nitrogen solution (kg N / ha / year)	Urea (kg N / ha / year)	Mineral phosphorus (kg P2O5 / ha / year)	Potash (kg potash/ha/year)	Blended fertilizer (kg fertilizer/ha)	Lime (t/ha)			Farmyard Cattle manure (T/ha)	Cattle slurry (T/ha)			Fertilization event (dd/mm/yy) (add a row if there are multiple events per crop. If the exact date is not know, give an estimation of the month)

Fertilizers	Application method	N (%) (optional)	P(%) (optional)	K(%) (optional)	N from nitrate (%)	N from ammonia (%)	N from urea (%)	Nitrification inhibitors used?
Ammonium nitrate					-	-	-	
Nitrogen solution								
Urea					-	-	-	
Mineral phosphorus					-	-	-	
Potash					-	-	-	
Blended fertilizer								
Solid / farmyard cattle manure					-	-	-	
Cattle slurry					-	-	-	

Straw		Fresh or dry weight?
Amount of straw harvested (t /year)		
Quantity of straw purchased (t /year)		
Quantity of straw sold (t /year)		

Feeding	Total feed consumed (t/year)	Dry or fresh matter

	Quantity for dairy cows (kg FM/day)	Quantity for non-lactating dairy cows (kg FM/day)	Quantity for calves/dairy heifers 0-1 years (kg FM/day)	Quantity for dairy heifers 1-2 years (kg FM/day)	Quantity for dairy heifers 2-3 years (kg FM/day)	Quantity for Heifers >3 years (kg FM/day)	Quantity for Dairy bulls (kg FM/day)	Quantity for Meat calves (kg FM/day)	Total	Average share in feed used (%, in case the detailed info is not available)	DM content feedstock (%, if available)
er and crops produced											
Fodder or concentrate purchased (specify country of origin)											
Other food purchased (feed additives, vitamin, milk powder...)											
Total (should be 100%)										0.0	

Energies	Energy source 1	Energy source 2 (optional)	Energy source 3 (optional)
Origin of electricity			
Total electricity consumption (kWh/year)			
Type of fuel			
Total fuel consumption on the farm (liters/year)			
Total gas consumption (m3)			

Installations producing renewable energy			
Annual production (kWh/year)			

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