D5.1 - Digital repository for carbon & environmental models, methods and tools

Deliverable 5.1

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Disclaimer

List of Abbreviations

CFD	Climate Farm Demo
NC	National Coordinator
WP	Work Package
KO	Knowledge Object
UI	User Interface
SLR	Systematic Literature Review
AUA	Agricultural University of Athens
BIOS	Biosense
CSA	Climate Smart Advisors

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Abstract

The Climate Farm Demo (CFD) project's WP5 aims to develop a digital repository for carbon and environmental models, methods and tools that have been widely used and implemented across the EU for climate change mitigation and adaptation. The repository's ambition is to span across the entire agricultural sector, covering all crop, livestock and mixed production systems while also accounting for inherent differences between the highly variable pedoclimatic zones of Europe. Following the first task of WP5, namely Task 5.1 "Inventory/mapping of the existing carbon and climate methodologies/tools used in the EU" that launched an online survey for National Coordinators (NCs) in February (M5) and successfully collected 51 replies from NCs across the EU (Milestone 5.1[1]), the first Deliverable of the WP "Digital repository for carbon & environmental models, methods and tools" essentially presents the methodology used to collect, analyse, categorise, deploy and ultimately materialise the first version of the open-to-all repository of the CFD project. This online repository has already been launched by the writing of this Document (Month 18), hosted on the project website[2] in a dedicated space under the "Resources" section[3]. The repository constitutes a "living" entity, as it will implement extensive bi-annual updates adding new models, methods and tools developed to the repository from both within and outside the project's activities throughout the project's duration, available to all users. The ultimate objective of the CFD Repository is to constantly provide an accurate and scientific overview of "current state" information, curate and compile them, thus enabling a benchmark analysis of all tools/methods used across the continent and throughout various agricultural systems within the sector.

This Deliverable is divided into three (3) main sections. It starts with an introductory chapter, explaining the methodology followed to gather all Knowledge Objects (KOs) entries from within the project's activities, as well as the international scientific and grey literature, alongside their curation process. The second chapter presents a general characterisation of the KOs and their distribution, providing general information as an overview of the entire repository's contents. A third and final Section explains various basic functionalities developed as part of the User Interface (UI) of the online repository on the project's website. Finally, a Conclusions section gathers all the important ideas discussed throughout the document and outlines insights, future steps and ambitions.

The most recent version (as of writing this deliverable, exported on March 20th 2024) of the CFD repository in tabular form, is also accompanying this Deliverable as an Appendix, which alongside its online counterpart is available to all CFD partners on the project's Sharepoint (titled '*CFD Repository Task 5.1.xlsx*').

[1] https://actaassofr.sharepoint.com/:b:/r/sites/h-eu/Documents%20partages/General/Deliverables%20%26%20Milestones/WP5%20-%20Carbon%20%26%20Climate%20Tool%20Box/WP5%20Milestones/MS.41%20First%20benchmark%20of%20the%20EU%20carbon%20and%20climate%20methodologies%20tools/CFD_WP5_Milestone1_V1.1.pdf?csf=1&web=1&e=VWcRq4

[2] https://climatefarmdemo.eu/

[3] https://climatefarmdemo.eu/cfd/en/#/resources

Chapter 1

Repository Collection

An overview of the data acquisition strategies used to collect, filter and analyse the KOs that populate the online CFD repository.

1. Repository Collection

1.1. NC Survey

The first entries of the Repository were collected through an extensive survey conducted under Task 5.1, which was circulated in the form of an online questionnaire to all CFD NCs during the early stages of the project. This step collected a total of 34 individual tools from the NCs that completed the survey, which served as a foundation to initially populate the repository. An overview of the recorded tools collected through this process, alongside their frequency (times mentioned in separate surveys) are presented in the following indicative chart selected from the submitted Milestone Report (Figure 1). An extensive analysis and breakdown of the results were documented in the first Milestone report of WP5, namely "***First benchmark of the EU carbon and climate methodologies/tools***".

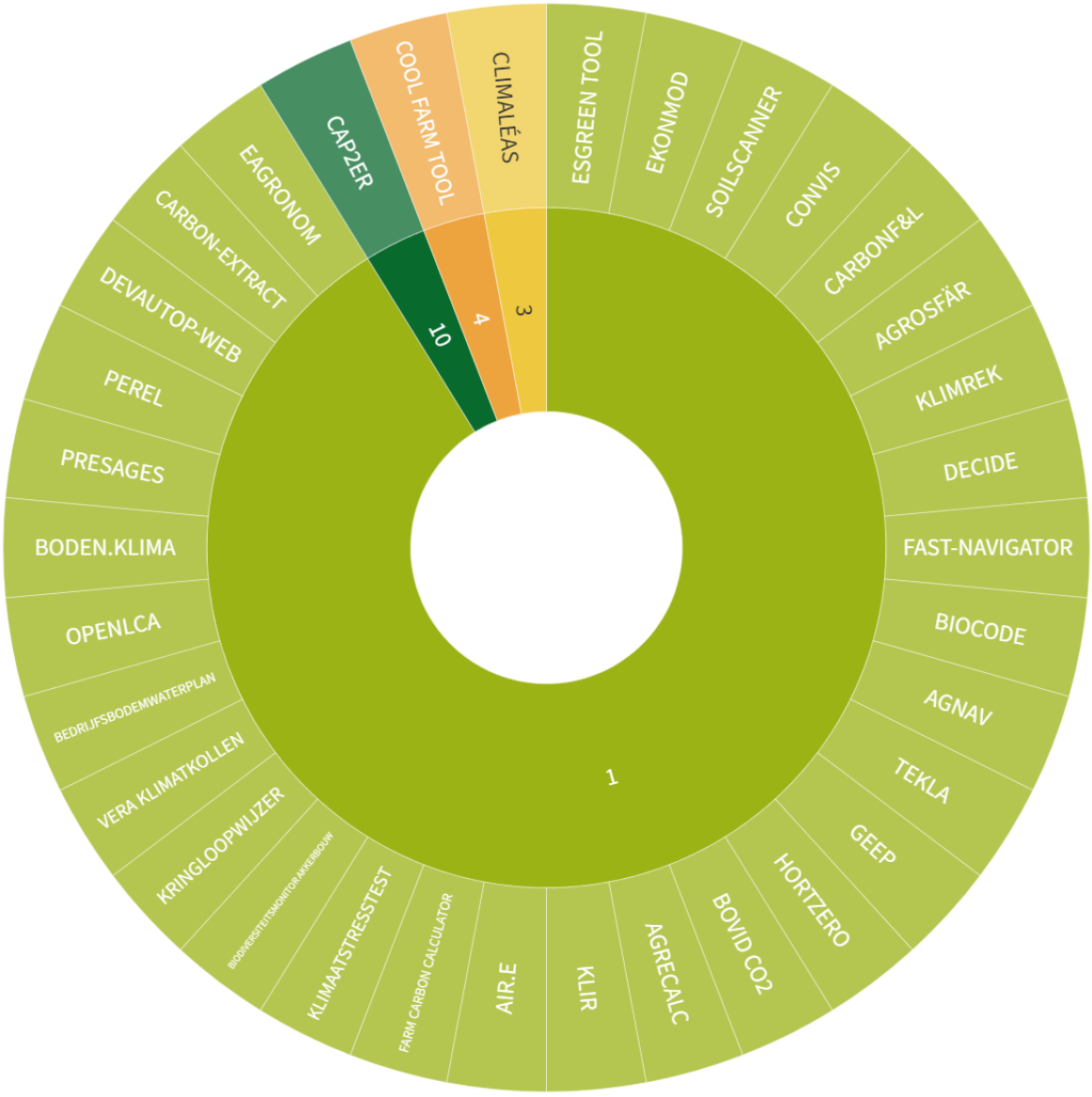

Figure 1. An overview of the tools collected through the NC survey and their respective survey.

1.2. Systematic Literature Review

The following step for the gathering of KOs was the implementation of a Systematic Literature Review (SLR) focusing on existing carbon tools and methods from international sources. The review aimed to identify and record the wide array of available climate tools, methods and models, as well as assessment and management strategies. The SLR methodology used to map existing carbon and climate methodologies/tools utilised in the European Union (EU) involved utilising the extensive online bibliographic database Scopus[4]. The primary aim was to gather pertinent scientific literature focused on subjects such as carbon footprint, carbon accounting, carbon assessment, carbon measurement, carbon calculation, carbon management, carbon sequestration, climate change mitigation, climate change adaptation, greenhouse gas (GHG) emissions, carbon storage, nitrogen balance, air quality, eutrophication, and non-GHG emissions.

The derived results were limited by the following criteria:

- Document type, year, subject area, language
- Articles discussing carbon and climate methodologies/tools in the context of the European Union
- Articles written in English
- Articles published up to the date of the search

The language filter, despite the fact that the repository contains KOs that exist exclusively in local languages with no English versions / translations was necessary to facilitate an effective search. Considering that most widely used tools either contain documentation in English, and if not, the most noticeable ones were already assumed to have been collected from the NC survey, each KO entry was classified using an [Yes/No] filter for the availability of the KO in the English language.

The search query for the systematic review was as follows:

(TITLE-ABS-KEY ("carbon footprint" OR "carbon accounting" OR "carbon assessment" OR "carbon measurement" OR "carbon calculation" OR "carbon management" OR "carbon sequestration" OR "climate change mitigation" OR "climate change adaptation" OR "GHG" OR "greenhouse gas emission" OR "carbon storage" OR "nitrogen balance" OR "air-quality" OR "eutrophication" OR "non-GHG emission*")) AND (TITLE-ABS-KEY ("tool*" OR "model*")) TITLE-ABS-KEY ("farm*" OR "agriculture*" OR "agri*") AND (TITLE-ABS-KEY ("European Union" OR "EU")) AND (LIMIT-TO (OA, "all"))*

The subsequent step involved a comprehensive analysis of these articles to manually extract information concerning the methodologies and tools employed in carbon and climate-related assessments and management.

The initial query yielded a total of 1440 articles (n = 1440), and the systematic review adhered to the PRISMA framework (Moher et al., 2009[5]). Subsequently, full-text articles were reviewed to confirm eligibility. Criteria for exclusion were based on subject areas, including Environmental Science,

[4] https://www.scopus.com/
[5] Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & PRISMA Group*. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Annals of internal medicine, 151(4), 264-269.

Agricultural and Biological Sciences, Earth and Planetary Sciences, Energy, and Engineering. Additional filters encompassed country territory (European Union), document type (Article, Review, Conference Paper), and publication year (2003-2023). Of the initially identified papers, 928 were removed for not meeting the specified criteria, or not providing sufficient details about the various tools or models utilised within their context.

With 512 scientifically relevant papers remaining, a further manual selection process ensued. This involved eliminating papers inaccessible for full review, as well as those not aligned with the study's objectives, as determined by relevance of titles, abstracts (n = 376). Ultimately, 136 research studies met the inclusion criteria and were subjected to detailed analysis in this research study as they were identified as relevant for the Eligibility step. Finally, after careful consideration, the Qualitative Synthesis step would conclude the SLR process and the Prisma Methodology, yielding a total of 107 publications that contained carbon tools and methods relevant to the scope of CFD. A PRISMA flow diagram (Figure 2) illustrates the selection process of articles from the initial search to the final inclusion, providing a transparent representation of the article selection procedure. Ultimately, the number of unique, new (not previously recorded during the NC survey) KOs identified across the SLR was 91, thus increasing the final number of repository entries to 125.

Each individual entry and their respective extracted data were organised and summarised to identify the distinct tools/models (KOs), which were then categorised and described in terms of their applications and relevance to carbon and climate assessments in the EU agricultural sector. The identified KOs cover various areas such as carbon footprint measurement and modelling, accounting frameworks, emission assessment methods and measurement techniques, calculation models (both process-based and empirical), management strategies, sequestration practices, climate change mitigation endeavours, adaptation strategies, estimation of GHG emissions, mechanisms for carbon storage, assessment of nitrogen balance, monitoring of air quality, analysis of eutrophication, and evaluation of non-GHG emissions.

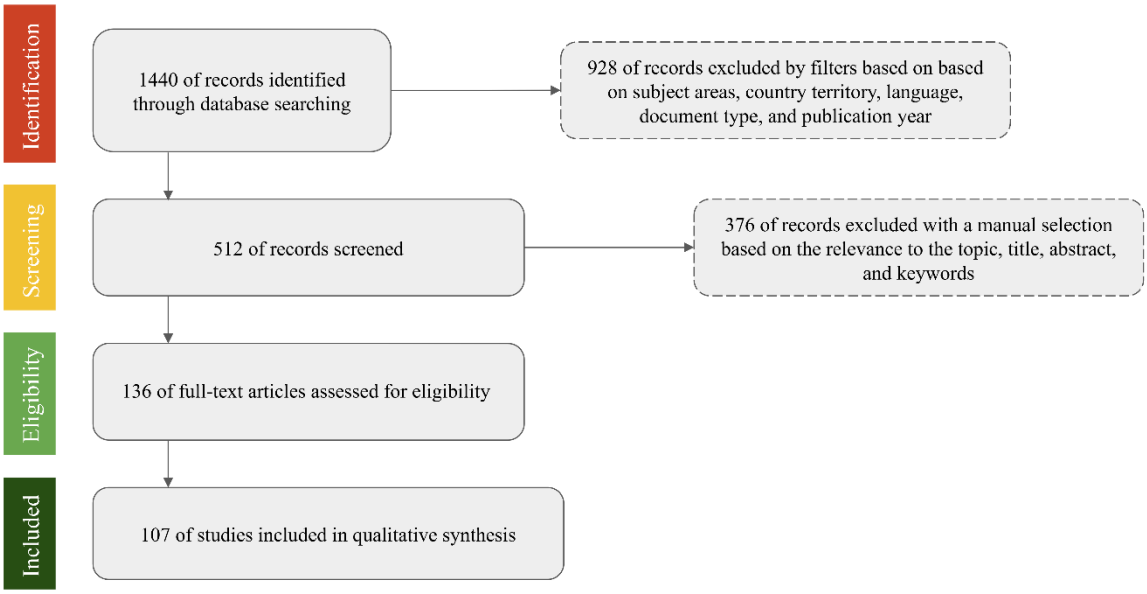

Figure 2. The PRISMA flow chart used for the SLR.

1.3. Object Characterisation

The KOs that were registered as entries to the repository are essentially accompanied by metadata that describe their use, scope, capabilities and overall characteristics. These metadata can both provide information about the described model, tool or method in an accessible way, but can also help users search the repository more efficiently by filtering the various fields (metadata) they are interested in. To this end, the parameters that should be used to effectively convey the most important aspects of each KO were selected within WP5, and can be divided into four (4) main categories (Figure 3). The first one provides basic information about each KO and its source, such as link to the original entity where the users can access the actual model, tool or method, a [Yes/No] field indicating the accessibility of each KO by stating whether it is Open Access, and finally another [Yes/No] field indicating whether documentation and/or the KO itself have an English version available.

The second category provides general information relevant to the usage of each KO. To this end, the main scope of each model, tool and method are described, alongside the data the KO requires to operate, and finally the spatial level that it covers, recorded as a [Yes/No] field for Farm Level implementation. The third category focuses on the Modelling process, describing the parameter(s) that the KO can predict or simulate, followed by an open-text field that elaborates on the modelling process and provides insights for its use. Finally, a fourth category was added, providing miscellaneous information about each KO. This information currently covers an estimated ease of use for each tool, model or method (expressed in a numeric 1-5 scale), and whether each KO has been used within the CFD project activities.

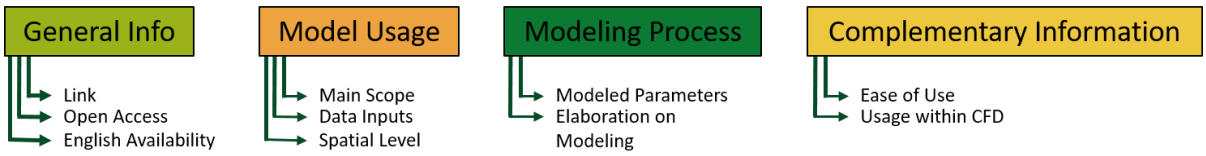

Figure 3. A schematic representation of the KO categorisation and description.

Chapter 2

Repository Overview

An overview of the 1st version of the CFD online repository, its contents and KO categorisation.

2. Repository Overview

2.1 KO Representation

In this chapter the curated categorised and analysed results derived from the compilation of KOs within the online CFD repository are presented. The main objective of this chapter is to illuminate key trends, patterns, and insights embedded within the data collected under Task 5.1. By utilising schematic visual representations, this section provides a clear and structured overview of the landscape of carbon tools, their distribution, functionalities, and implications for climate change mitigation and adaptation efforts across the EU.

The first qualitative parameter that was documented was the availability (for both the KO itself as well as its documentation / user guidelines) in the English language. This is arguably a pivotal parameter for the widespread adoption of each KO, but at the same time it can potentially indicate an association with various inherent limitations, such as spatial restrictions (namely the model, tool or method are designed for a certain region under its specific pedoclimatic zones and can only be applied within these areas). Out of the 125 KOs of the repository, 83 % of them provided access to English documentation and an English version of the model, tool or method (Figure 4).

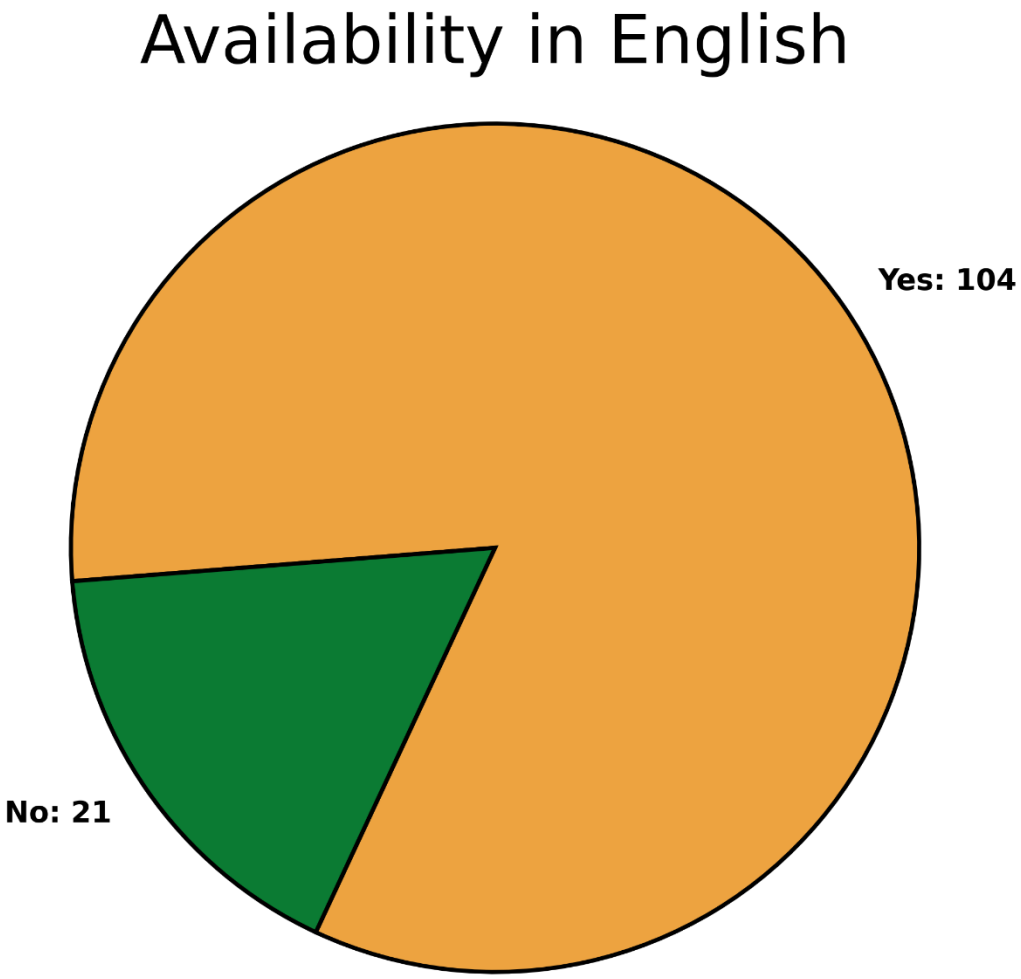

Figure 4 The analysis of English Language Availability for the KOs.

The second qualitative parameter that was recorded was the accessibility of each KO, namely whether all of its required components are provided in a “free-of-charge” way to all users. Several options were encountered in describing the registers to this parameter, e.g. some tools would charge a specific amount per usage, or a monthly / yearly subscription, instead of a one-time purchase. At the same time, several tools offer a limited free trial (either based on a number of assessments or for a predetermined period of time per user). These tools were categorised as Open in this 1st version of the repository, but in future updates, this specific parameter can be further elaborated to include more detailed information for each specific KO. Out of the 125 tools of the repository, 62 % offer a free version of their materials, while the authors/owners of two (2) KOs suggested that a free-trial version of the tool, method or model was currently under development (Figure 5).

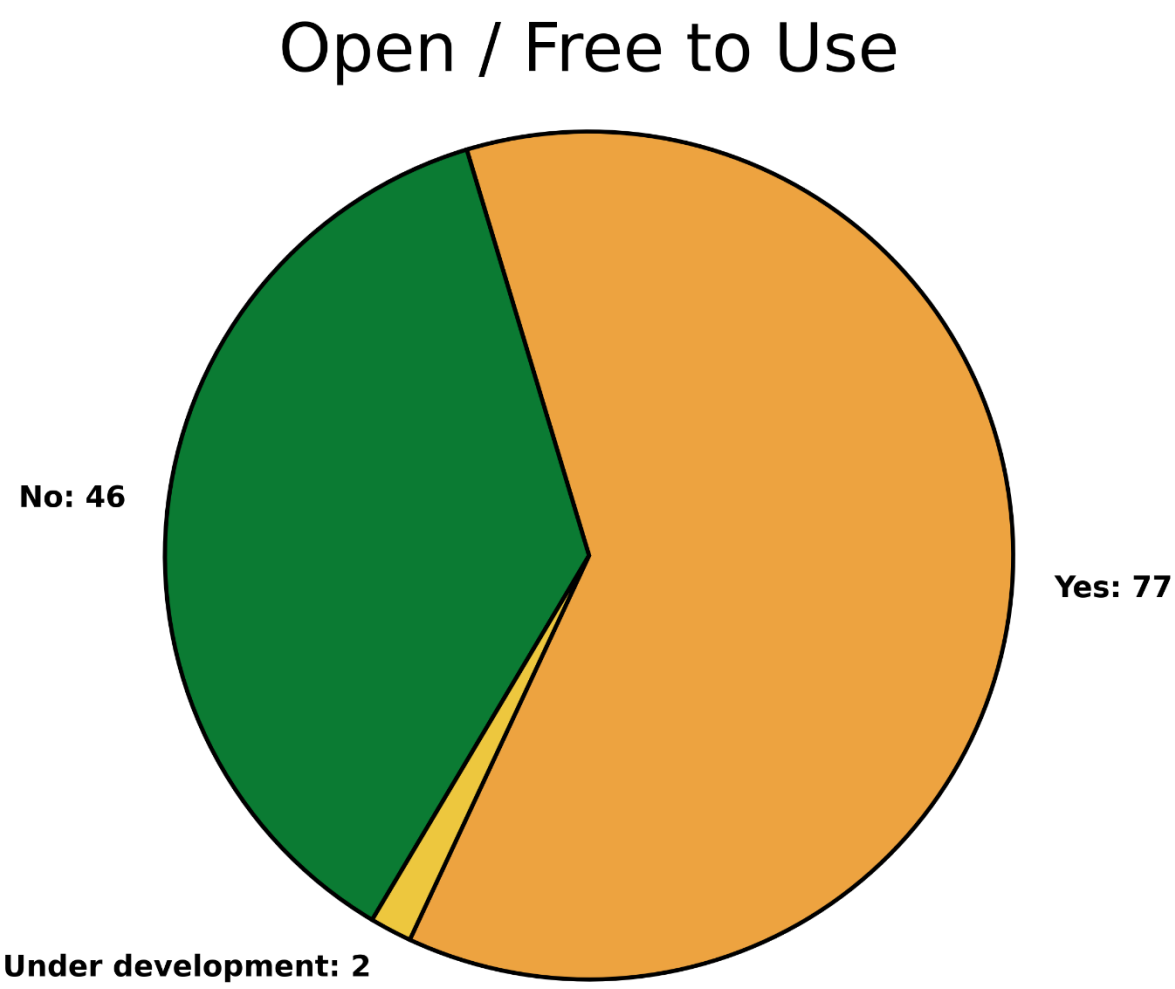

Figure 5. The accessibility of KOs, namely whether a "free-of-charge" option is provided.

The final qualitative parameter that was documented with this type of categorisation was the spatial resolution on which the KOs could operate. To this end, their ability to conduct assessments, simulations or prediction on a farm-level was evaluated. (Figure 6). A total of 55 % of the repository’s KOs offer the option to perform on a farm-level, while a single KO owner indicated that a smaller scale version of their model was currently developed, and would soon offer farm-level assessments.

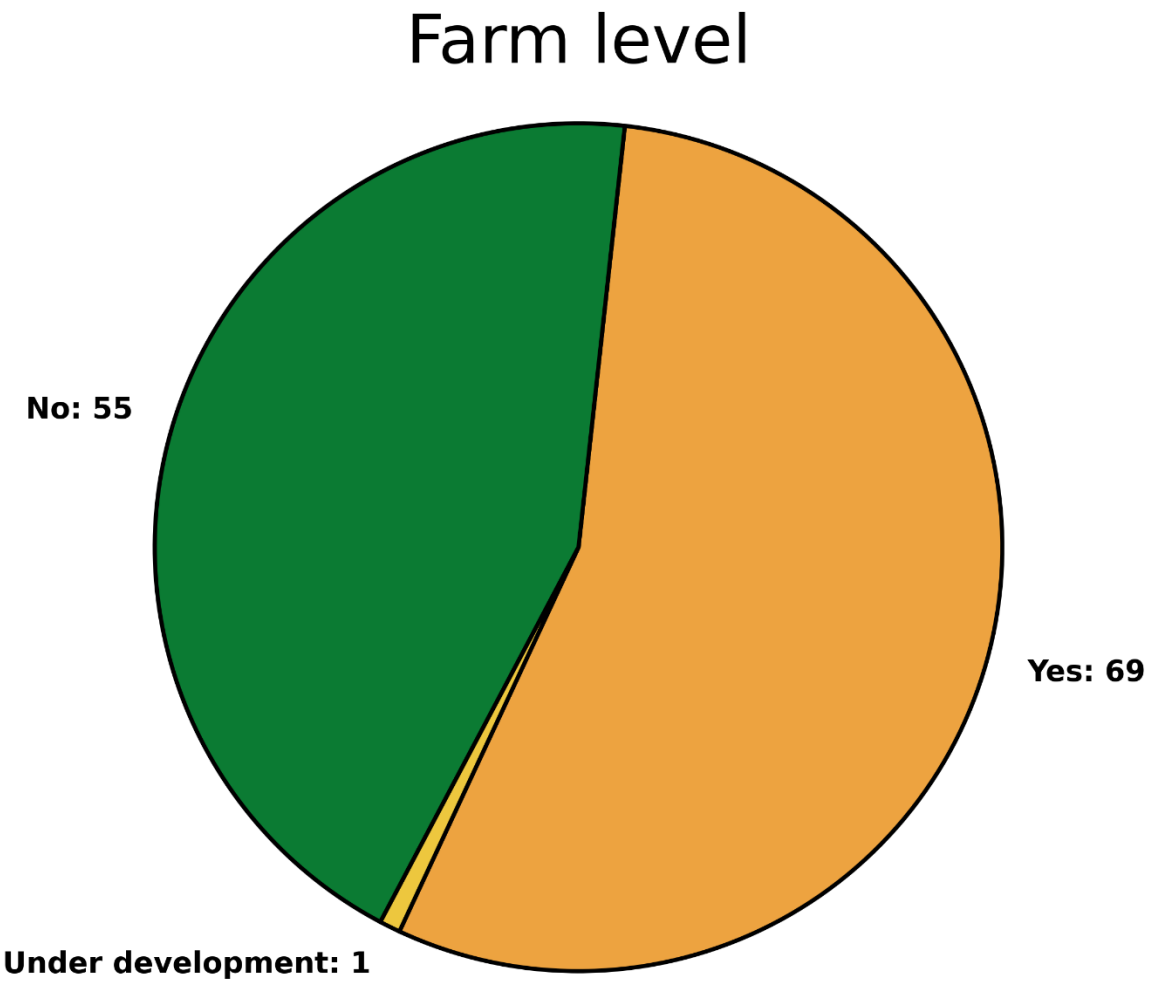

Figure 6. The ability of KOs to perform on a farm-level.

For the visualisation of the open-text characterisation of the repository entries, a series of Word cloud diagrams using the Python 3 Wordcloud library[6] (Figures 7, 9 and 11 respectively) and Frequency charts (Figures 10, 12 and 14 respectively) are provided below, illustrating what are the most commonly used words and/or terms in the description of the repository's KOs. Preliminary in this step, an effort to filter the text fields and omit non-keyword terms such as prepositions and conjunctions was first conducted. For the Frequency charts, an additional separation within each text field was conducted, using a dedicated (secondary) delimiter to distinguish different terms that represent a single data point. Similarly, "umbrella terms" such as 'Livestock" were handled as unique entries if they were encountered in the description of a KO, and were not linked to their respective subclasses (e.g. specific livestock systems such as "dairy").

[6] https://pypi.org/project/wordcloud/

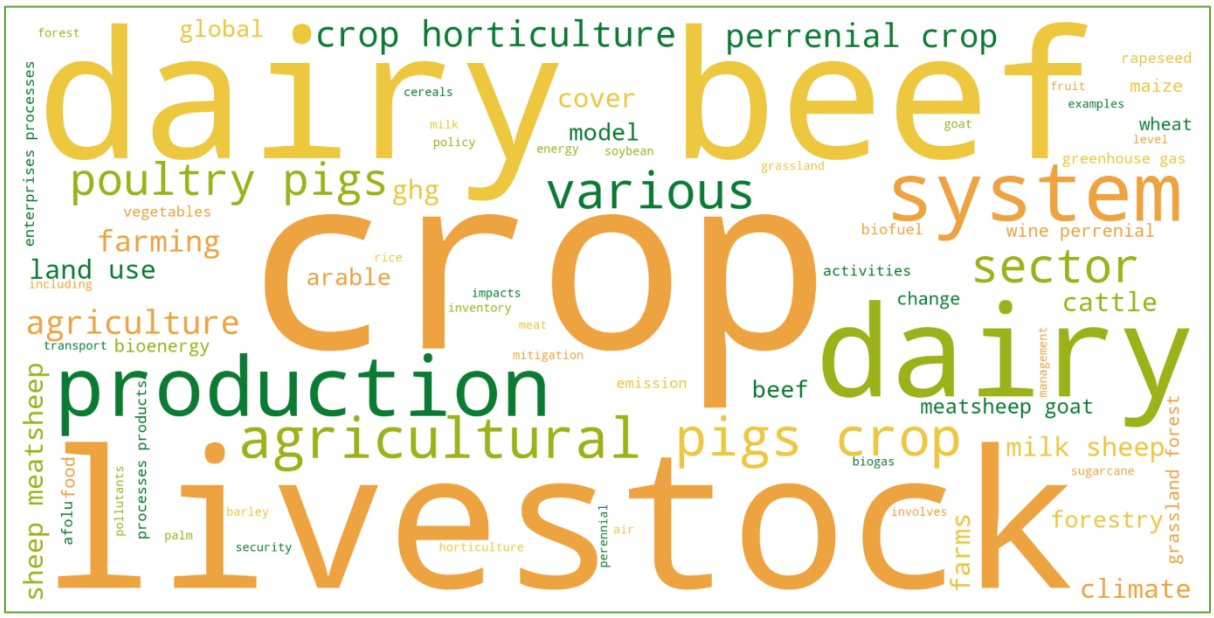

Figure 7. The Word cloud diagram for the KO's "Main Objectives" characterisation.

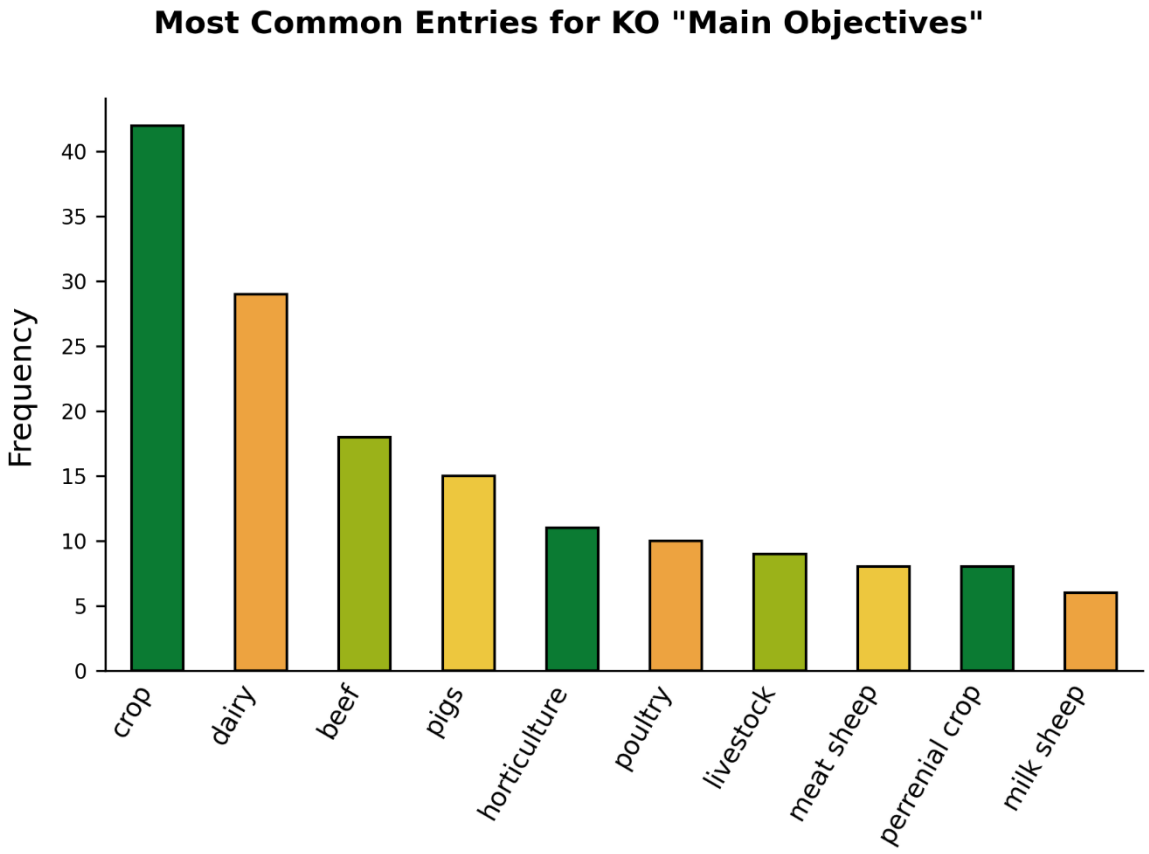

Figure 8. The frequency chart for the term characterising the KOs' "Main Objectives".

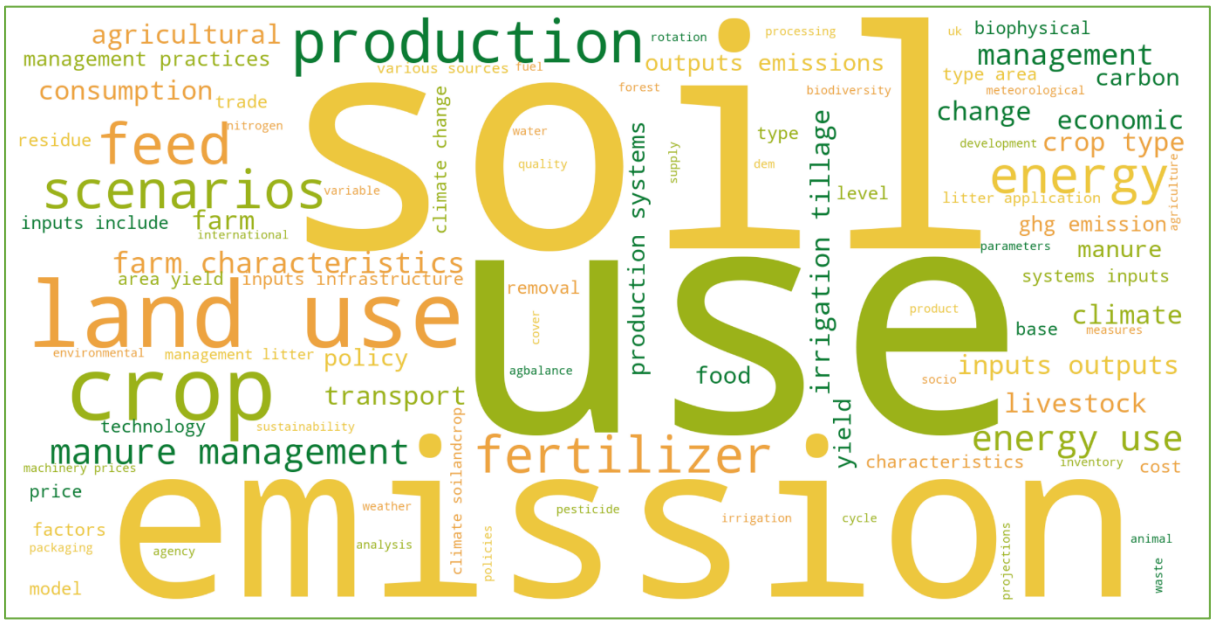

Figure 9. The Word cloud diagram for the KO's "Data Inputs" characterisation.

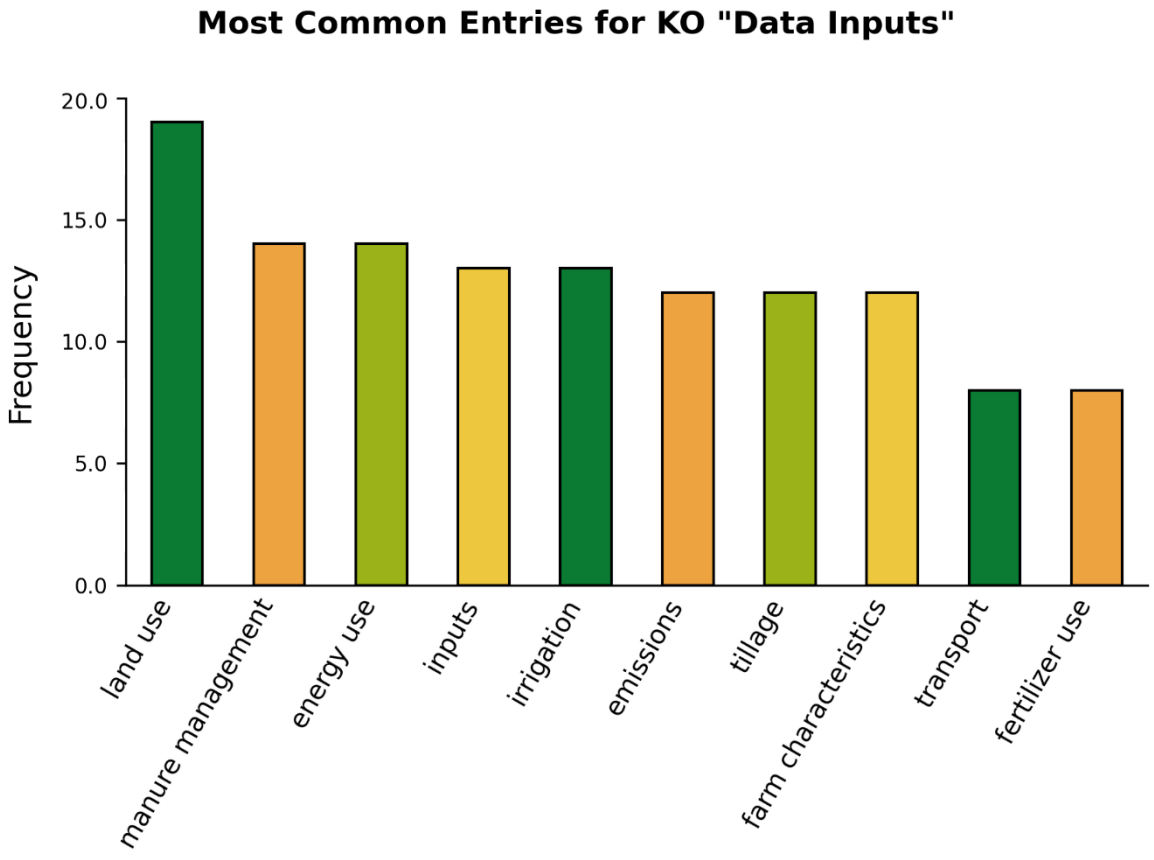

Figure 10. The frequency chart for the term characterising the KOs' "Data Inputs".

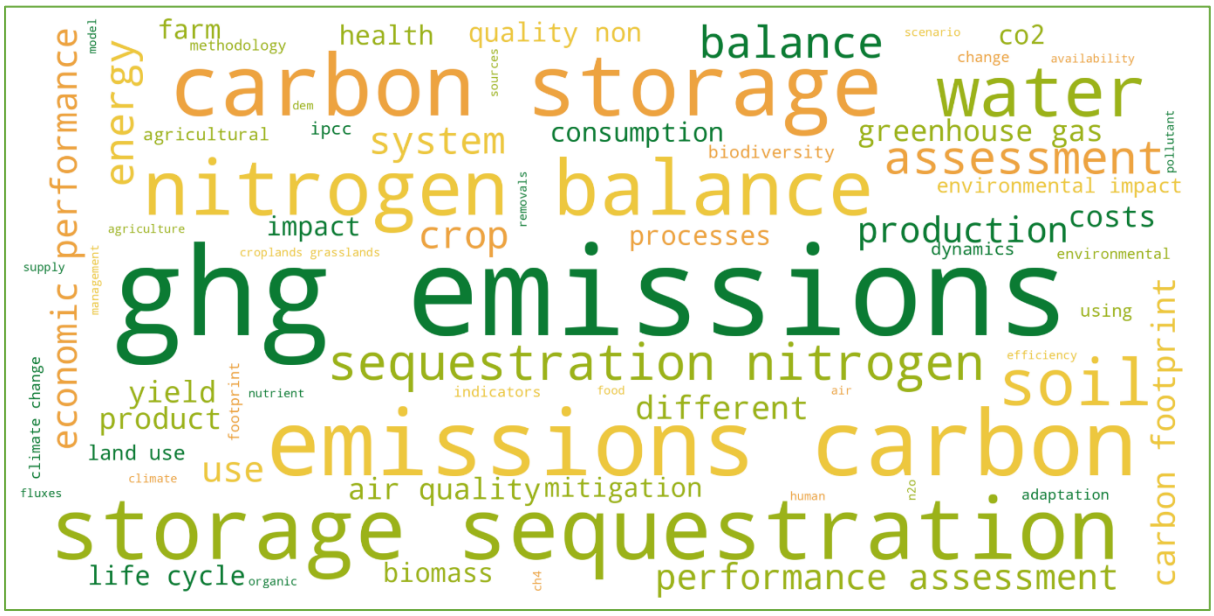

Figure 11. The Word cloud diagram for the KO's "Modelling Parameter" characterisation.

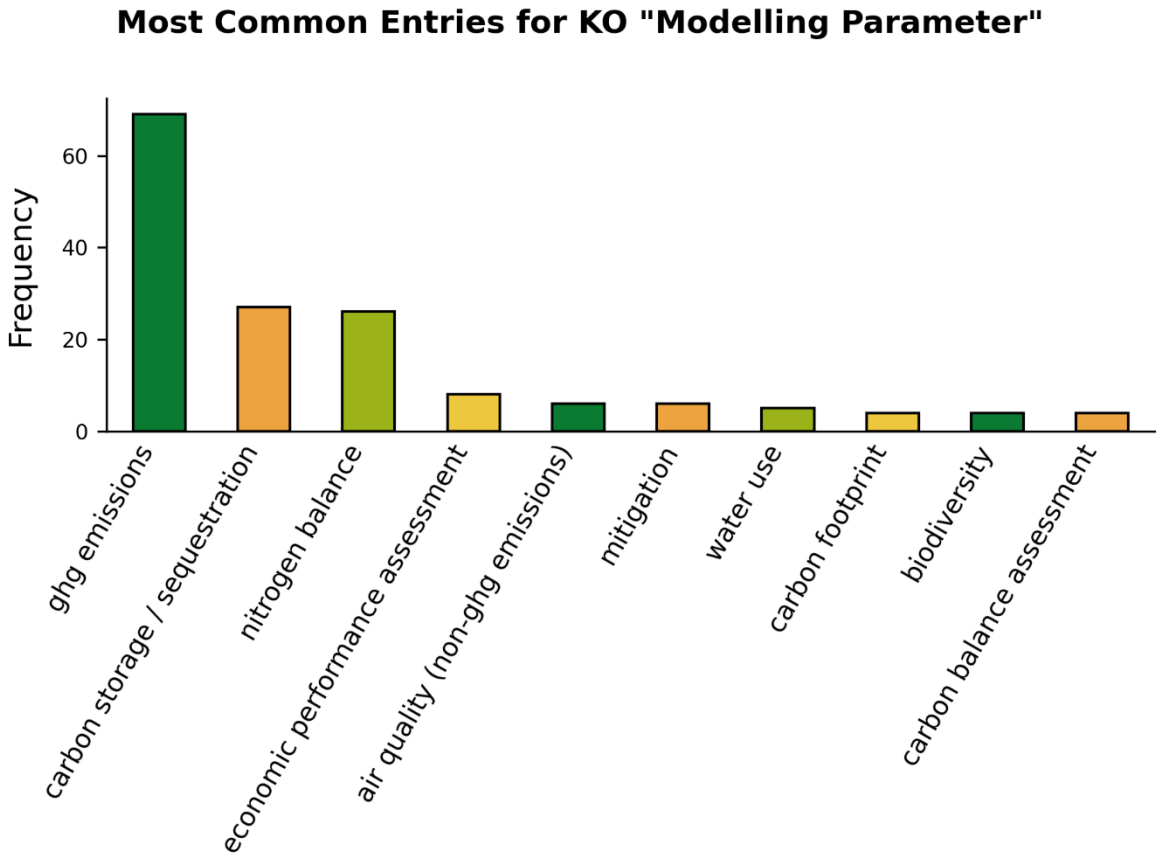

Figure 12. The frequency chart for the term characterising the KOs' "Modelling Parameters".

Chapter 3

Platform Integration

An overview of the most important functionalities integrated to the repository on the CFD project's website.

3. Platform Integration

3.1 Online Interface

In order to develop an online knowledge reservoir, all Task 5.1 partners, in collaboration with BIOS (who are leading all development tasks under WP8), meticulously followed a systematic approach to outline the core functions and user requirements essential for its efficient deployment and operation. Upon identifying various functionality requirements, BIOS designed the layout of the repository, ensuring an intuitive and accessible user interface (UI), while also considering parameters such as the repository's scalability and modularity (which are pivotal for the upcoming update operations that will follow on a bi-annual basis throughout the project's duration), and naturally, performance. Upon successful completion of development and testing, the repository was deployed, integrated to the CFD project's website under the "Resources" section (Figure 13), facilitating effective utilisation of the repository's documented knowledge, including a simplistic filtering system, which empowers users to refine their KO searches based on various metadata (KO characterisation data) criteria.

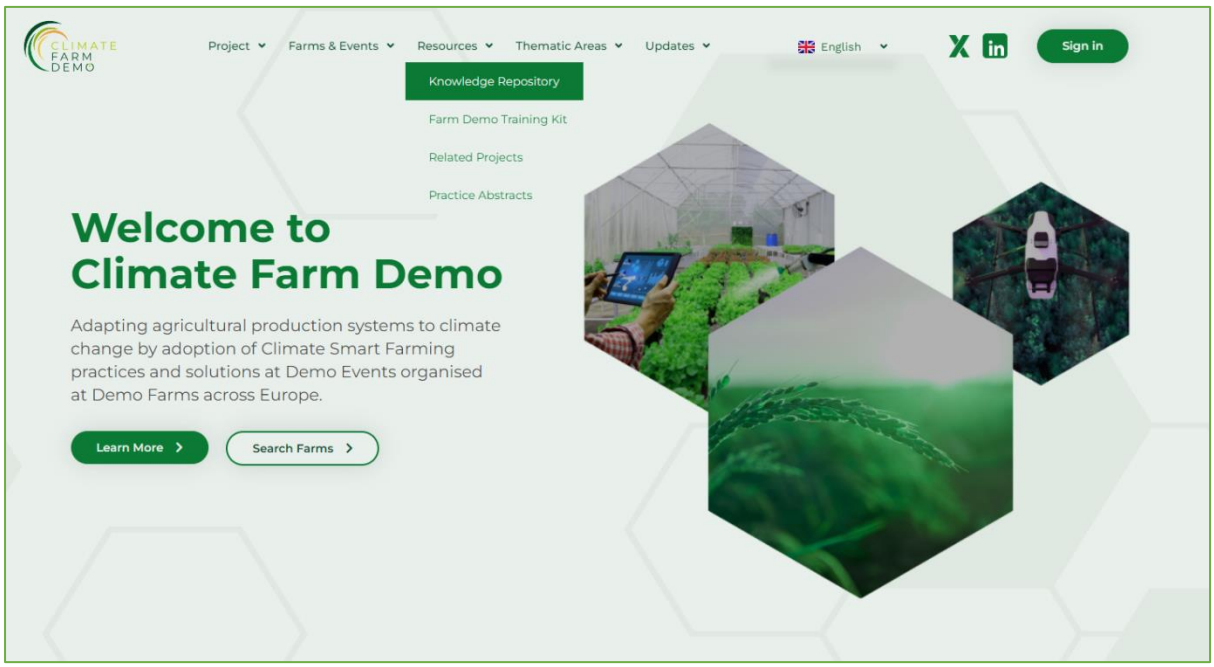

Figure 13. The CFD website platform and path to the online Repository, developed by BIOS.

3.2 Filtering Fields

An effective filtering system for each specific data structure enhances the usability and accessibility of an online repository, enabling users to efficiently discover and retrieve the information they need from a large and diverse collection of data. To this end, the filtering system for an online repository's entries typically involves categorising and organising the available data based on various attributes or metadata. In our case, the metadata were the categorisation parameters identified within WP5 to describe KOs, which BIOS used to develop a discreet interface that allows users to utilise these metadata tags as filters to refine their search results and narrow down the repository entries to suit their specific needs or interests. The filtering system includes various commonly used, widely recognised elements such as checkboxes, dropdown menus, sliders, and search boxes, which allow users to easily

select and apply the desired filters (Figure 14). As users apply their selected filters, the repository dynamically updates the displayed results to reflect the selected criteria, enabling users to quickly locate the most relevant KOs for their purposes. A snapshot of the finalised UI with a few KO displayed are presented in Figure 15.

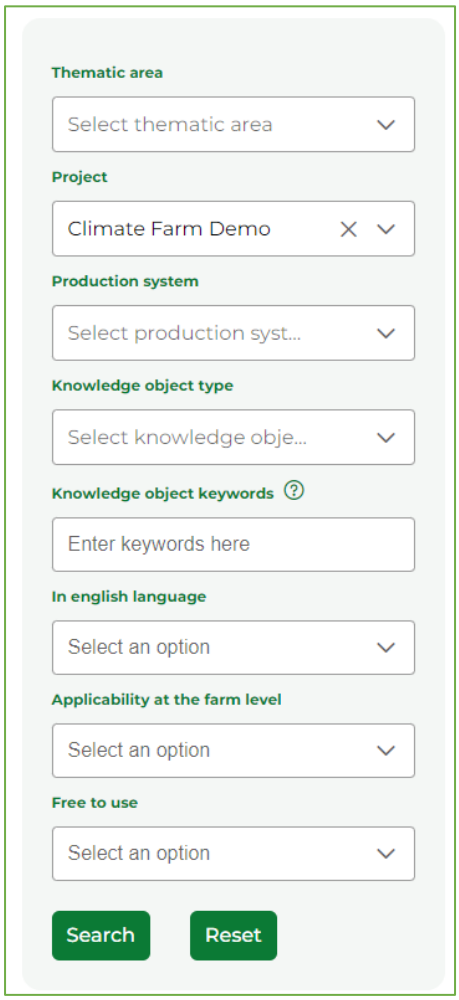

Figure 14. An indicative UI for a set of filters for the CFD online repository.

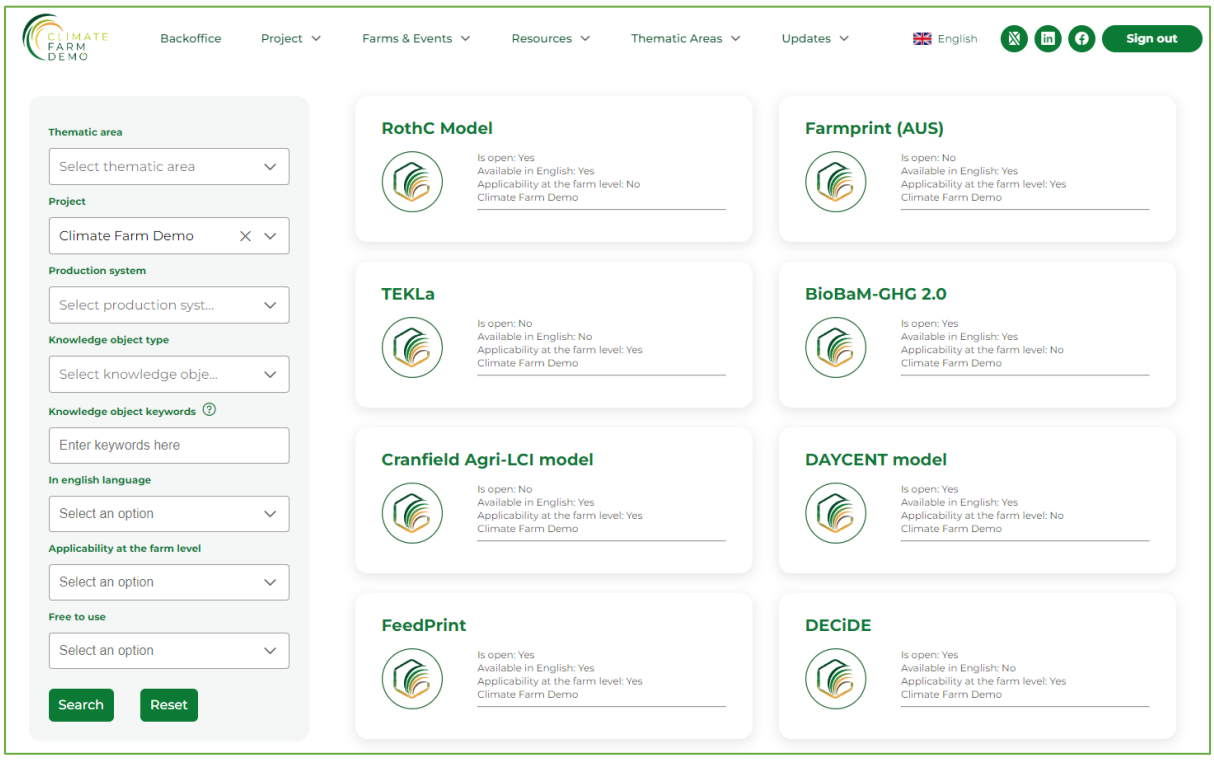

Figure 15. The finalised UI of the online repository.

3.3 Common Online Repository

During the development phase of the CFD repository, which was aligned with the preliminary stages of the Climate Smart Advisors (CSA)[7] "sister project", we undertook an ambitious endeavour to create a shared repository for climate-related EU projects. This repository aimed to accumulate knowledge from both projects, as well as other climate-focused initiatives such as the Horizon2020 project ClieNFarms[8] (Figure 16). Extensive discussions between the management teams of these projects have been ongoing since late 2023, in order to realise this goal and implement the shared repository in the following months.

[7] https://climatesmartadvisors.eu/
[8] https://clienfarms.eu/

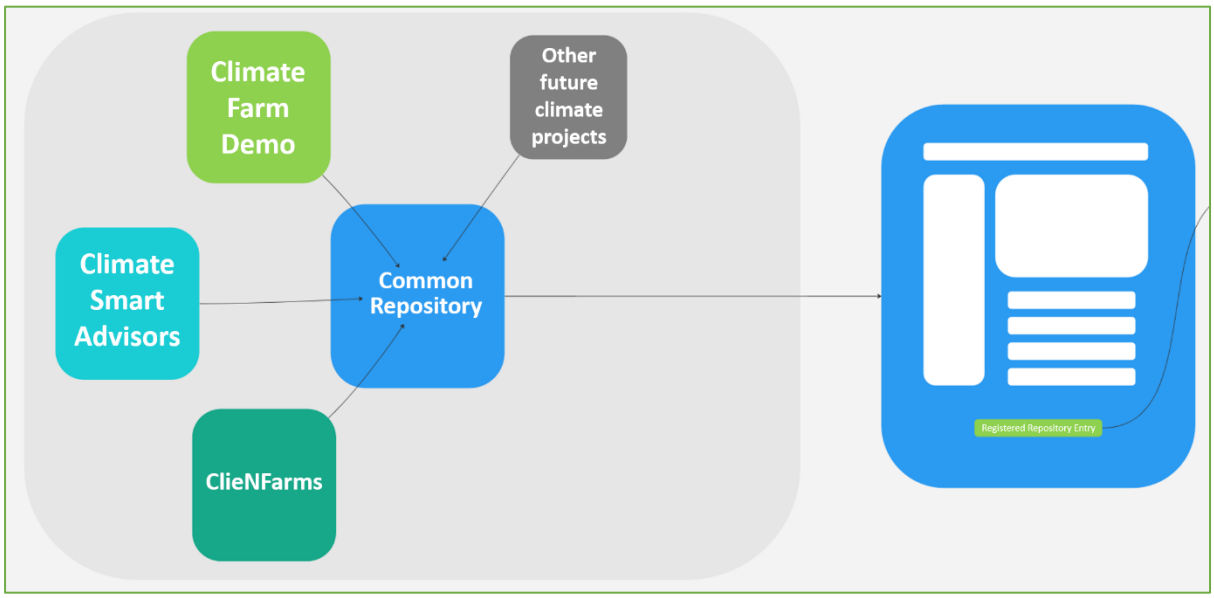

Figure 16. A schematic draft of the common repository, serving as a cumulative knowledge reservoir for all involved projects.

Currently, several internal documents have been developed to identify user requirements, optimise role allocations, and ensure an overall alignment and harmonisation among stakeholders (entities and end-users) from both projects. The repository is aspired to be a dynamic library, encompassing both knowledge generated within the involved projects, but also giving the option to various users to submit their own KO entries, which could be published (upon moderation checks). A key development step for this dynamic process involves the identification of the various users/entities and their roles across each participating project, namely which users will have the option to view, submit/upload and moderate (accept or reject) submitted KOs (Figure 17). The development tasks for the common repository is a collaboration between AUA (also responsible for developing the CSA repository), and BIOS. The first version is anticipated to be completed by March 2025, aligning with CSA's initial repository deliverable.

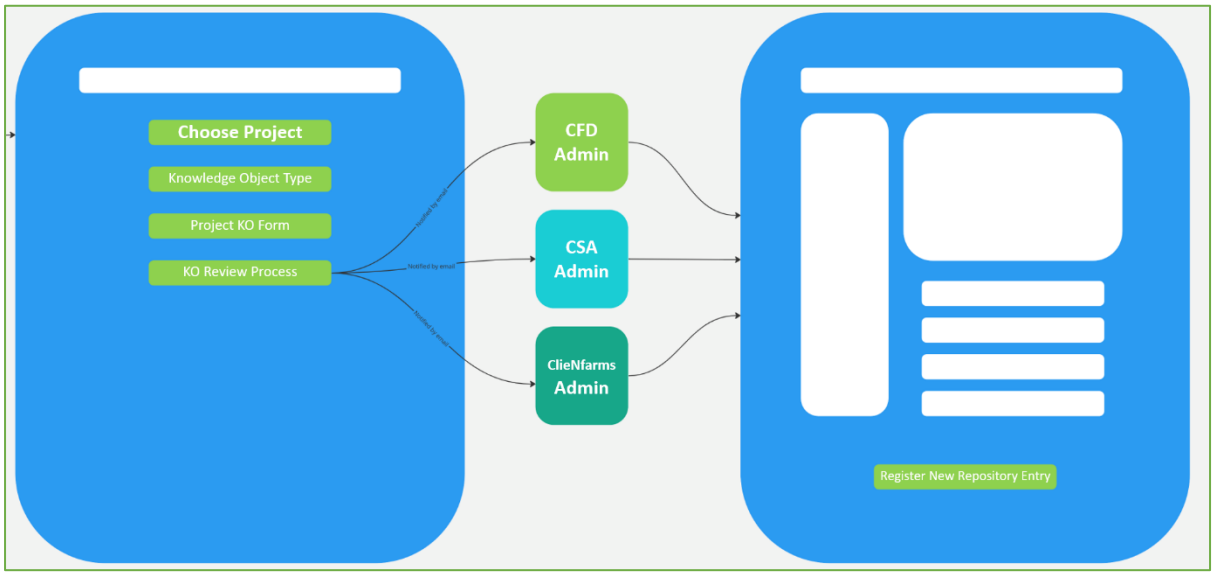

Figure 17. A schematic draft demonstrating potential steps for a KO submission to the Common Repository.

Chapter 4

Conclusions

4. Conclusions

To conclude, the development of the repository marks a significant milestone and achievement in our project, providing a centralised platform for accessing and sharing valuable climate-related knowledge and resources. Through meticulous planning, collaboration, and dedication, the WP5 and WP8 teams have successfully created an efficient and user-centric repository that will serve as a vital tool for European farmers, advisors, researchers, practitioners, and stakeholders in the agri-food sector. Moving forward, we are committed to continuously improve and expand the repository, ensuring the enduring relevance, comprehensiveness, and accessibility of its contents, facilitating and assisting in the advancement of knowledge and innovation across the agricultural domain.

The repository is forecasted to implement 2 (two) updates throughout the project's duration, namely in Month 48 (September 2026) and Month 78 (March 2029). These updates will not only expand the repository's entries, including new models, tools and methods that might have been introduced during this period, but will also enhance already existing KOs and their characterisation, by integrating new knowledge generated within the CFD project, but also covering externally obtained knowledge, implementation cases and potential added functionalities to the KOs themselves.

Finally, a pivotal aspect for the widespread knowledge exchange within the EU agricultural sector is expected to be the common repository that will host selected entries from all involved projects (including but not limited to CFD, CSA and ClieNFarms - as of the writing of the document). The ambition behind this common repository is to provide a "one-stop" library for all agricultural actors across the European agrifood value chain, essentially gathering potentially fragmented knowledge from major climate-related projects into a single online, accessible and fully open entity.

Appendix

1. The most recent version of the repository

Model	Link	Open / Free to Use	Available in Engish	Main Objective	Data inputs	Farm level	Modelling Parameter	Elaboration in Modelling	Ease of Use	Used within CFD
ACCT Tool	https://www.bodensee-stiftung.org/agroco2ncept/	Yes	No	Crops and livestock systems in Germany, France, Italy and Spain	Energy consumption, fertilizer use, manure management, crop residues, etc.	Yes	GHG emissions, carbon storage / sequestration.	Uses IPCC methodology and national emission factors to estimate GHG emissions and carbon sequestration per hectare.	3	No
ADAPT2CLIMA	https://tool.adapt2clima.eu/en/home/ -------- https://climate-adapt.eea.europa.eu/en/metadata/tools/adapt2clima-decision-support-tool	Yes	Yes	Wheat, barley, maize, potato, tomato,grapevine	Information on the climate scenarios, crop parameters, irrigation parameters, soil parameters, adaptation measures	No	GHG emissions, water use, crop yield	The tool uses a crop simulation model (AquaCrop) to estimate the impacts of climate change and adaptation measures on crop performance and water use. The tool also uses an emission factor approach to estimate the GHG emissions from crop production	4	No
Adaptation Support Tool	https://climate-adapt.eea.europa.eu/en/knowledge/tools/adaptation-support-tool	Yes	Yes	All sectors affected by climate change impacts	Climate change scenarios and projections, vulnerability assessments, adaptation options and measures	Under development	Climate change impacts and adaptation strategies and plans	Web-based tool that provides guidance and resources for developing adaptation strategies and plans at national level	4	No
AFOLU Carbon Calculator	http://afolucarbon.org/ ------- http://clh-ckan.apps.fao.org/dataset/tools-for-greenhouse-gas-assessments/resource/e2d11b93-a6f8-40f5-8934-712a6909547a?inner_span=True	Yes	Yes	Agriculture, forestry and other land use (AFOLU)	Land use, livestock, energy use, inputs and infrastructure, emission and removals	No	Carbon balance assessment for the life cycle of the AFOLU system	The model uses the IPCC methodology and other peer-reviewed literature to calculate the carbon balance of the AFOLU system based on land use, land use change and management practices.	1	No
AgBalance	https://agriculture.basf.com/global/en/sustainable-agriculture/climate-smart-farming/sustainability-assessments.html	No	Yes	Various farming systems, agricultural enterprises, processes and products	Data on 69 indicators of sustainability across 16 categories of interest such as working conditions, human toxicity, fair trade, variable costs, farm profits, water use,, emissions, soil health and biodiversity https://www.agricentre.basf.co.uk/en/Sustainability/AgBalance/ https://www.agricentre.basf.co.uk/en/Sustainability/AgBalance/AgBalance.html	Yes	Sustainability performance of different farming systems, agricultural enterprises, processes and products across three dimensions: economy, environment and society https://agriculture.basf.com/global/en/sustainable-agriculture/climate-smart-farming/sustainability-assessments.html https://www.agricentre.basf.co.uk/en/Sustainability/AgBalance/ https://www.agricentre.basf.co.uk/en/Sustainability/AgBalance/AgBalance.html	A comprehensive life cycle assessment method based on over 20 years' data from more than 600 studies https://www.agricentre.basf.co.uk/en/Sustainability/AgBalance/ https://www.agricentre.basf.co.uk/en/Sustainability/AgBalance/AgBalance.html . Evaluates the trade-offs within and across the three dimensions of sustainability and helps drive innovative and sustainable solutions https://agriculture.basf.com/global/en/sustainable-agriculture/climate-smart-farming/sustainability-assessments.html https://www.agricentre.basf.co.uk/en/Sustainability/AgBalance/ . Provides a virtual farming game to simulate different scenarios and compare results https://www.agricentre.basf.co.uk/en/Sustainability/AgBalance/	5	No
AgNav	https://www.teagasc.ie/news--events/daily/environment/introducing-agnav---putting-climate-action-planning-back-in-farmers-hands.php	Yes	Yes	Dairy;Beef;Tillage and Meat Sheep will be added	Farm characteristics , production systems, inputs, outputs, emissions	Yes	GHG emissions;Air quality (non-GHG emissions);Further to be added	Comparing two scenarios (current and planned); using a cutting edge big data solution for fast data analysis; providing accurate and verificable data to support decision making on farm to help meet agriculture's climate action	4	Yes
Agrecalc	https://www.agrecalc.com/	Yes	Yes	Dairy;Beef;Milk sheep;Meat sheep;Goat;Poultry;Pigs;Crops	Land use, livestock, energy use, inputs and infrastructure, emission and removals	Yes	GHG emissions, carbon balance assessment	The model uses the Intergovernmental Panel on Climate Change (IPCC) methodology and other peer-reviewed literature to calculate GHG emissions and carbon sequestration at farm level. It compares a baseline scenario (without project) and an alternative scenario (with project)	2	Yes
Agri-footprint	https://blonksustainability.nl/tools-and-databases/agri-footprint	No	Yes	Crops	Life cycle inventory data for agricultural production , processing , transport and packaging	No	Environmental impact of agricultural products	The model uses the Life Cycle Assessment technique and the IPCC methodology to calculate the environmental impacts of agricultural products. It covers a wide range of impact categories including those related to water, land use, land use change, fertilizers, and pesticides.	5	No
AGRI-I (Ireland)	https://agri-i.ie/	Yes	Yes	Agricultural greenhouse gas (GHG) monitoring and mitigation in Ireland	GHG measurement and modelling, spatial analysis, policy development and economics	No	Greenhouse gas monitoring and mitigation	Uses a consortium of researchers, students and professionals to develop verified strategies to decrease greenhouse gas emissions from Irish agriculture	4	No

AGRICARBON-EO	https://www.cesbio.cnrs.fr/agricarboneo/agricarbon-eo/	No	No	Crops and cover crops	Crop and soil maps, climate and remoting sensing data, biophysical variables, emission factors, carbon cycle feedbacks	Yes	Biomass ,yields, CO2 fluxes and C-budgets of crops and cover crops	AGRICARBON-EO is a tool that uses the PROSAIL radiative transfer model and the SAFYE-CO2 agronomic model to simulate the carbon budget components of crops and cover crops. It assimilates remote sensing data from Sentinel 2 satellites into the models and computes the uncertainties of the estimates. It allows for comparing the carbon balance of different scenarios (without and with project) and evaluating the additionality of the intervention	1	No
Agriculture and Land Use national Greenhouse Gas Inventory software (ALU)	https://www.nrel.colostate.edu/projects/alusoftware/home ------ http://clh-ckan.apps.fao.org/dataset/tools-for-greenhouse-gas-assessments/resource/0f1fbd73-9a48-49aa-934f-931239972dc3?inner_span=True	Yes	Yes	Agriculture, forestry and other land use (AFOLU)	Land use, livestock, energy use, inputs and infrastructure, emission and removals	No	GHG emissions and removals assessment for the AFOLU system	The model uses the IPCC methodology and other peer-reviewed literature to calculate greenhouse gas emissions and removals of the AFOLU system based on land use, land use change and management practices. It also provides a toolkit for building national GHG inventory systems	5	No
Agro-Chain Greenhouse Gas Emissions (ACE) calculator	https://ccafs.cgiar.org/resources/tools/acge-calculator	Yes	Yes	All agricultural products : feed, food, biomass	Life cycle inventory data for agricultural production , processing , transport and packaging	No	Life cycle assessment for the environmental impact of agricultural products	The model uses the Life Cycle Assessment technique and the IPCC methodology to calculate the environmental impacts of agricultural products. It covers a wide range of impact categories including those related to water, land use, land use change, fertilizers, and pesticides	5	No
Agrosfär	https://www.agronod.com/om-agrosfar	No	No	Dairy;Beef;Crops;Perrenial crops	User-defined data on farm characteristics, production systems , inputs, outputs, emissions	Yes	GHG emissions;Both per product and also total farm CO2 foodprint (for diary, beef, crop farms)	Agrosfar is a tool that uses a life cycle assessment (LCA) approach to estimate the carbon footprint of farming practices. It allows for comparing the performance of different scenarios (e.g. current vs improved) and identifying the key drivers of GHG emissions and carbon balance. It also provides guidance on how to implement best practices to reduce emissions and increase sequestration	1	Yes
AHDB Carbon footprinting decision support tool	https://ahdb.org.uk/carbon-footprint-decision-tool	Yes	Yes	Cereals and oilseeds	Crop type,area,yield,tillage,irrigation,fertiliser use,pesticide use,residue management, transport	Yes	GHG emissions (CO2,CH4,N2O)	The tool uses emission factors from the IPCC and other sources to estimate the GHG emissions from different sources on the farm and along the supply chain. The tool also provides a comparison with a benchmark farm and a breakdown of emissions by source and gas	4	No
Air.e	https://www.solidforest.com/en/index.html	No	Yes	Crops, Perennial crops, Horticulture, Livestock	Land use, soil type, crop type, management practices, carbon stocks, GHG emissions, etc.	Yes	GHG emissions;Carbon storage / sequestration;Product carbon footprint, Life Cycle Assessment	Air.e is a tool that allows farmers to measure and monitor their carbon footprint and carbon sequestration potential. It uses satellite imagery, machine learning, and agronomic models to estimate the carbon balance of different land uses and management practices. It also helps farmers to access carbon markets and generate income from their carbon credits.	4	No
Alltech Dairy 'What If?' Tool	https://www.alltech-e-co2.com/e-co2-alltech-launch-dairy-tool-london/	Yes	Yes	Dairy	Feed use,manure management, soil management,crop production and transport	Yes	GHG emissions	The tool uses emission factors from the IPCC and other sources to estimate the GHG emissions from different sources on the farm and at the farm gate. The tool also provides suggestions for reducing emissions and improving efficiency	4	No
Annual Nutrient Cycle Assessment (ANCA)	https://edepot.wur.nl/533905	Yes	Yes	Dairy farms with or without arable production or livestock	Feed use,manure management, soil management,crop production and transport	Yes	Nitrogen balance, Phosphorous balance , Carbon balance	The tool uses a mass balance approach to estimate the inputs, outputs and losses of nitrogen, phosphorus and carbon on the farm. The tool also provides indicators for nutrient use efficiency, nutrient surplus and emissions	4	No

APEX: A WATERSHED & LAND MANAGEMENT SIMULATION MODEL	https://epicapex.tamu.edu/	Yes	Yes	Crops, Perennial crops, Horticulture, Livestock	Weather, soil, land use, management practices, hydrology, water quality, crop growth, nutrient cycling, etc.	Yes	GHG emissions, Carbon storage / sequestration, Nitrogen balance, Water balance, Sediment yield, Crop yield, Economic performance assessment	APEX is a comprehensive model that can simulate land management impacts for small-medium watersheds and heterogeneous farms. It can be configured for various land management strategies and can route water, sediment, nutrient, and pesticide between subareas and channel systems. It can also be integrated with other models such as EPIC and SWAT.	3	No
AROPAj	https://www6.inrae.fr/basc/Recherche/Modeles/AROPAJ	No	No	crop production, livestock production, bioenergy production (Some examples of crops are wheat, maize, rapeseed, sunflower, etc. Some examples of livestock are dairy cattle, beef cattle, sheep, goats, poultry, pigs)	The data inputs include biophysical characteristics of land and soil, technological change, climate change scenarios, policy scenarios, market prices, production costs, GHG emissions	No	GHG emissions from agriculture sources, carbon storage and sequestration in biomass and soils, nitrogen balance in croplands and grasslands, water use and availability	The model allows for a full account of all agriculture GHG sources based on advanced IPCC methods	2	No
B-INTACT: The Biodiversity Integrated Assessment and Computation Tool	https://www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/b-intact/en/	Yes	Yes	dairy, beef, milk sheep, meat sheep, goat, poultry, pigs, crops, wine, perrenial crops and horticulture.	It requires data inputs on land use changes, habitat fragmentation, infrastructure and human encroachment that affect biodiversity.	No	GHG emissions, carbon storage/sequestration, biodiversity loss	Global Biodiversity (GLOBIO) Model Version 3.6 developed by the Netherlands Environmental Assessment Agency (PBL).	3	No
BedrijfsBodemWaterPlan	www.bedrijfsbodemwaterplan.nl	Yes	No	Dairy;Beef;Milk sheep;Meat sheep;Goat;Crops;Horticulture	Soil characteristics , inputs,outputs, emissions.	Yes	Soil health	Comparing two scenarios (current and planned); using a cutting edge big data solution for fast data analysis; providing accurate and verifiable data to support decision making on farm to help meet agriculture's climate action	4	No
BioBaM-GHG 2.0	https://www.sciencedirect.com/science/article/pii/S0304380021002817	Yes	Yes	Crops, Livestock	Food system scenarios, crop yields, land use data, GHG emission factors	No	Biomass supply and demand, GHG emissions, land use changehttps://www.sciencedirect.com/science/article/pii/S0304380021002817https://www.sciencedirect.com/science/article/pii/S0959378021000923	BioBaM-GHG 2.0 is a biophysical model that calculates the balance between the supply and demand of biomass on a global scale, differentiating 11 regions and allowing for trade between regions. A scenario is feasible when global biomass demand is matched by supply by at least 95% (considering a 5% uncertainty range; cropland constraints). The model also calculates GHG emissions from agriculture and land use change based on emission factors and land use data. https://www.sciencedirect.com/science/article/pii/S0304380021002817 https://www.sciencedirect.com/science/article/pii/S0959378021000923	3	No
Biocode	https://biocode.io	No	Yes	Crops;Perrenial crops;Horticulture	Farming and production methods, crop rotations , soil carbon sequestration	Yes	GHG emissions;Carbon storage / sequestration	Biocode is a cloud-based tool that uses life cycle assessment and international standards to calculate the carbon footprint of food products. It is based on the guidelines of the national greenhouse gas inventories of the international climate panel IPCC	4	Yes
Biodiversiteitsmonitor akkerbouw	Biodiversiteitsmonitor Akkerbouw: in theorie en praktijk - WUR	Under development	No	Arable crops	Biodiversity indicators such as soil quality, water quality, landscape diversity , functional agrobiodiversity, pollinators and natural enemies	Yes	Biodiversity, Environmental indicators, Economic performance assessment	Biodiversiteitsmonitor akkerbouw is a tool that helps arable farmers to measure and improve their biodiversity and environmental performance. It uses a set of Critical Performance Indicators (KPIs) that reflect the impact of different land uses and management practices on biodiversity. It also provides benchmarking and improvement options for farmers to enhance their environmental performance. It also serves as a basis for rewarding farmers for their biodiversity achievements by various stakeholders.	3	No

BioGrace	https://www.biograce.net/home	Yes	Yes	Biofuels	Biomass type, conversion technology, transport mode and distance, energy use, emissions	No	Greenhouse gas emissions from biofuel production and use	BioGrace is a spreadsheet-based tool that calculates the greenhouse gas emissions from biofuel production and use in line with the sustainability criteria of the Renewable Energy Directive (2009/28/EC, RED) and the Fuel Quality Directive (2009/30/EC, FQD). It uses standard values, calculation rules and a user manual that are harmonized across the EU. It can be used to demonstrate compliance with the minimum greenhouse gas emission saving required by the directives.	4	No
Boden.Klima	https://bioland-stiftung.org/was-wir-tun/#bodenklima https://www.klim.eco/	No	No	Dairy;Beef;Pigs;Crops	Land use,soil structure, climate data, fertilization,irrigation,tillage,crop rotation,cover cropping	Yes	GHG emissions;Carbon storage / sequestration;Soil health	Boden.Klima is a tool that aims to drive the regenerative transformation and connect farmers, food producers and consumers. It is based on a digital platform that allows farmers to document their regenerative practices and receive financial rewards from different parties (such as food companies, banks, governments) for their climate and environmental benefits. It also enables food producers to measure and reduce their scope 3 emissions along their supply chains by sourcing from regenerative farmers. It also offers climate credits for other industries that want to offset their emissions and support regenerative agriculture		No
BOVID CO2	https://hub.bovine-eu.net/tools-for-calculating-and-improving-environmental-sustainability-on-beef-cattle-farms/bovidco2-a-tool-for-environmental-assessment-specialized-in-spanish-beef-cattle-farms	No	No	Beef Cattle	Farm characteristics, animal inventory, feed consumption, manure management, energy use, fertilizer use, etc.	Yes	GHG emissions, Carbon footprint, Environmental indicators	BOVID CO2 is a tool that allows beef cattle farmers to calculate and reduce their carbon footprint and environmental impact. It uses the Life Cycle Assessment (LCA) methodology and follows the IPCC guidelines and recommendations. It also provides benchmarking and improvement options for farmers to enhance their environmental performance.	3	Yes
BovIS carbon footprint calculator	https://www.afbini.gov.uk/news/afbi-develops-carbon-calculator-northern-ireland-dairy-farms	Yes	Yes	Dairy	farm characteristics, energy use, feed use, manure management, litter application	Yes	GHG emissions	The tool uses emission factors from the IPCC and other sources to estimate the GHG emissions from different sources on the farm and along the supply chain. The tool also provides a comparison with a benchmark farm and a breakdown of emissions by source and gas	4	No
C-ROADS	https://www.climateinteractive.org/c-roads/ ---------- https://c-roads.climateinteractive.org/scenario.html?v=23.6.1	Yes	Yes	Model covers the global climate system and regional GHG emission reduction	Emissions reduction targets, population and economic growth, CO2 removal, emissions intensity	No	System dynamics model for the long-term climate outcomes of policy scenarios	The model simulates the interactions between the economy, the energy systems and the environment, taking into account the effects of the policies on energy mix, emissions, temperature, sea level rise.	1	No
CAP2ER	https://cap2er.eu/	No	No	Dairy;Beef;Milk sheep;Meat sheep;Goat;Crops	Farm characteristics , production systems, inputs, outputs, emissions	Yes	GHG emissions;Carbon storage / sequestration;Nitrogen balance;Biodiversity;Air quality (non-GHG emissions)	Comparing two scenarios (current and planned) ; Tier 1 and Tier 2 approaches; IPCC methodology and peer-reviewed literature,FAO LEAP guidelines	3	Yes
CAPRI	https://capri-model.org/	Yes	Yes	Crops	Economic, agricultural and environmental data at regional, national and global levels	Yes	GHG emissions, nitrogen balance , economic performance assessment	Comparing two scenarios (current and planned); using a recursive-dynamic global partial equilibrium model; using a biophysical model for GHG emissions and nitrogen balance ; using a spatial downscaling module for high-resolution results	3	No
Carbon Calculator	https://setac.onlinelibrary.wiley.com/doi/pdfdirect/10.1002/ieam.1629	No	Yes	Farming	Farm characteristics, management practices, inputs outputs	Yes	GHG emissions, Carbon storage / sequestration, Economic Performance Assessment	Uses a farm-level C footprint calculator that quantifies GHG emissions based on international standards and technical specifications on Life Cycle Assessment (LCA) and C footprinting	No information available	No

Carbon Footprint Calculator	http://agroclimate.org/tools/carbon-footprint-calculator/ ----- https://www.carbonfootprint.com/calculator.aspx	Yes	Yes	Model covers the household carbon footprint for all activities	Household location, energy consumption , transportation, waste generation	No	carbon footprint assessment and mitigation for different household activities	The model uses the IPCC methodology and other peer-reviewed literature to calculate carbon footprint of different household activities based on energy consumption, transportation, waste generation and lifestyle choices. It also provides recommendations for reducing emissions and offsetting options	1	No
Carbon footprint of a farm. Scope 1 + 2	https://www.miteco.gob.es/es/cambio-climatico/temas/organismos-e-instituciones-implicados-en-la-lucha-contra-el-cambio-climatico-a-nivel-nacional/oficina-espanola-en-cambio-climatico/default.aspx	Yes	No	Crops;Wine;Perrenial crops;Horticulture	User-defined data on farm characteristics, production systems , inputs, outputs, emissions	Yes	GHG emissions	Measurin direct emissions from sources that are owned or controlled by the farm (scope 1) and indirect emissions from purchased electricity, steam, heat or cooling (scope 2); using IPCC methodology and peer-reviewed literature	3	No
Carbon Footprint Tool for Milk	https://www.arla.dk// https://lca-net.com/projects/show/carbon-footprint-milk//.	No	Yes	Milk production	farm characteristics, energy use, feed use, manure management, litter application	Yes	GHG emissions	The tool uses emission factors from the IPCC and other sources to estimate the GHG emissions from different sources on the farm and along the supply chain. The tool also provides a comparison with a benchmark farm and a breakdown of emissions by source and gas	4	No
Carbon Navigator	https://www.teagasc.ie/about/our-organisation/connected/online-tools/carbon-navigator/ https://www.ocae.ie/agricultural-consultancy/schemes-and-grants/caron-navigator-bdgf-scheme/	No	Yes	Beef cattle	Farm management data such as herd size, calving rate, weaning weight, slaughter age	Yes	GHG emissions, carbon efficiency (Kg CO2 per Kg beef)	The Carbon Navigator is a tool that uses data from the Irish Cattle Breeding Federation (ICBF) and Teagasc National Farm Survey (NFS) to calculate the carbon footprint of beef farms. It allows for comparing the performance of different scenarios (e.g. current vs target) and identifying the key drivers of carbon efficiency. It also provides guidance on how to implement best practices to reduce emissions and improve profitability	3	No
CarbonID™ Calculator Tool	https://agriculture.newholland.com/en-us/nar/our-vision/sustainable-farming/carbonid-calculator	Yes	Yes	Tractor fleet	tractor model, fuel type , annual working hours, annual fuel consumption	Yes	Carbon footprint assessment for the tractor fleet	The model uses the IPCC methodology and other peer-reviewed literature to calculate the carbon footprint of the tractor fleet based on fuel type and consumption	1	No
CCalC	http://www.ccalc.org.uk/	Yes	Yes	Biofuels, industrial activities	Product system, raw materials, energy use, waste management and transport	No	GHG emissions, water footprint, acidification, eutrophication, human toxicity	The tool uses emission factors from the IPCC and other sources to estimate the GHG emissions and other environmental impacts from different sources along the supply chain. The tool also provides a comparison with a benchmark system and a breakdown of emissions by source and gas	4	No
CERES-EGC	https://www6.versailles-grignon.inrae.fr/ecosys_eng/Productions/Softwares-Models/CERES-EGChttps://www6.versailles-grignon.inrae.fr/ecosys_eng/Productions/Softwares-Models/CERES-EGC	Yes	Yes	Crops	Meteorological and management data as forcing variables and soil and vegetation data as input factors https://www.sciencedirect.com/science/article/pii/S0269749111000418	No	GHG emissions, Carbon storage / sequestration, Nitrogen balance https://www6.versailles-grignon.inrae.fr/ecosys_eng/Productions/Softwares-Models/CERES-EGC	CERES-EGC is a process-based model describing soil–crop atmosphere processes in daily time steps with a focus on the simulation of environmental outputs such as N2O emissions. It comprises sub-models accounting for different types of processes.	3	No
Climate Change, Agriculture and Food Security (CCAFS) Mitigation Option Tool	https://globalclimateactionpartnership.org/resource/climate-change-agriculture-food-security-mitigation-option-tool/?loclang=en_gb ------ http://clh-ckan.apps.fao.org/dataset/tools-for-greenhouse-gas-assessments/resource/5408923d-cb7f-40c0-a8c4-d7917f0faf4c?inner_span=True#	Yes	Yes	Barley, maize, sugar cane, vegetables, legumes and livestock	Crop type, yield , area, management practices, livestock type, feed intake, manure management	No	GHG emissions assessment and mitigation for different agricultural systems	The model uses the IPCC methodology and other peer-reviewed literature to calculate greenhouse gas emissions from different agricultural systems based on crop type, yield, area, management practices, livestock type, number, feed intake, manure management. It also ranks the most effective mitigation options for different crops and livestock according to mitigation potential and in relation to current management practices and spatially-linked climate and soil characteristic	3	No
CONVIS Sustainability Assessment Tool	https://www.convis.lu/home.html	No	Yes	Dairy;Beef;Pigs;Crops;Biogas-Farms		Yes	GHG emissions;Carbon storage / sequestration;Nitrogen balance;Soil health;Air quality (non-GHG emissions);Feedstuff autonomy (dry matter, energy, protein)			Yes

CoolFarmTool	https://coolfarmtool.org/coolfarmtool/	Yes	Yes	Crops	Crop type, area, yield, fertilizer use, irrigation, tillage, manure management	Yes	GHG emissions;Carbon storage / sequestration;Biodiversity;Water	CoolFarmTool is a tool that uses a life cycle assessment (LCA) approach to estimate the environmental impacts of farming practices. It allows for comparing the performance of different scenarios (e.g. current vs improved) and identifying the key drivers of environmental efficiency. It also provides guidance on how to implement best practices to reduce emissions and improve water and biodiversity management	4	Yes
Cranfield Agri-LCI model	https://www.cranfield.ac.uk/courses/short/agrifood/agricultural-life-cycle-assessment-more-than-just-the-carbon-footprint	No	Yes	Various farming systems, agricultural enterprises, processes and products	Data on climate, soil, crop, feed, manure, fertilizer, irrigation, tillage, machinery, prices, etc. https://www.cranfield.ac.uk/courses/short/agrifood/agricultural-life-cycle-assessment-more-than-just-the-carbon-footprint https://sphera.com/wp-content/uploads/2022/02/Documentation-for-the-Agricultural-LCI-model-2022.pdf	Yes	Environmental impacts of different farming systems, agricultural enterprises, processes and products using different life cycle assessment methods and categories https://www.cranfield.ac.uk/courses/short/agrifood/agricultural-life-cycle-assessment-more-than-just-the-carbon-footprint https://sphera.com/wp-content/uploads/2022/02/Documentation-for-the-Agricultural-LCI-model-2022.pdf	A process-based simulation of dairy, beef, and crop farming systems https://www.cranfield.ac.uk/courses/short/agrifood/agricultural-life-cycle-assessment-more-than-just-the-carbon-footprint https://sphera.com/wp-content/uploads/2022/02/Documentation-for-the-Agricultural-LCI-model-2022.pdf . Integrates the many physical and biological processes on a farm over many years of weather. Considers primary and secondary sources of emissionst	3	No
DairyGEM	https://data.nal.usda.gov/dataset/dairy-gas-emissions-model-dairygem	Yes	Yes	Dairy	Climate, soil, crop, feed manure, fertilizer, irrigation, tillage, residue management, etc.	Yes	GHG emissions, ammonia emissions, hydrogen sulfide emissions, VOC emissions, carbon footprint, energy footprint, water footprint https://data.nal.usda.gov/dataset/dairy-gas-emissions-model-dairygem https://www.ars.usda.gov/northeast-area/up-pa/pswmru/docs/dairy-gas-emissions-model/	Process level simulation and process related emission factors to predict gas emissions from dairy production systems https://data.nal.usda.gov/dataset/dairy-gas-emissions-model-dairygem https://www.ars.usda.gov/northeast-area/up-pa/pswmru/docs/dairy-gas-emissions-model/ . Uses a daily simulation of feed use and manure handling. Considers primary and secondary sources of emissions.	4	No
DairyWise	https://www.sciencedirect.com/science/article/pii/S0022030207720039	No	Yes	Dairy	Farm type data, crop and animal yields, prices, costs, subsidies, uncertainty parameters	Yes	Technical, environmental and financial processes on a dairy farm	DairyWise is an empirical model that simulates technical, environmental and financial processes on a dairy farm. The central component is the FeedSupply model that balances the herd requirements, as generated by the DairyHerd model, and the supply of homegrown feeds, as generated by the crop models for grassland and corn silage. The output of the FeedSupply model is used as input for several technical, environmental and economic submodels. The submodels simulate a range of farm aspects such as nitrogen and phosphorus cycling, nitrate leaching, ammonia emissions, greenhouse gas emissions, energy use and a financial farm budget. The final output is a farm plan describing all material and nutrient flows and the consequences on the environment and economy.	4	No
DAYCENT model	https://www.sciencedirect.com/science/article/pii/S1364815214003685	Yes	Yes	Crops, Grassland, Forest	Daily maximum/minimum air temperature and precipitation, surface soil texture class, and land cover/use datahttps://www.sciencedirect.com/science/article/pii/S1364815214003685https://www.nrel.colostate.edu/projects/century/index.php	No	Fluxes of C and N among the atmosphere, vegetation, and soil, soil water content and temperature by layer, plant production and allocation of net primary production (NPP), decomposition of litter and soil organic matter, mineralization of nutrients, N gas emissions from nitrification and denitrification, and CH4 oxidation in non-saturated soils	DAYCENT is a daily time-step version of the CENTURY biogeochemical model. It simulates the biogeochemical cycles of carbon, nitrogen, phosphorus, and sulfur in agroecosystems. It also accounts for plant growth, water balance, erosion, and nutrient leaching. It can be used to assess the impacts of management practices on crop productivity, soil organic matter, greenhouse gas emissions, and water quality. https://www.sciencedirect.com/science/article/pii/S1364815214003685 https://www.nrel.colostate.edu/projects/century/index.php https://en.wikipedia.org/wiki/DAYCENT	3	No

DECiDE	https://www.decide.cra.wallonie.be/fr	Yes	No	Dairy;Beef;Crops		Yes	GHG emissions;Carbon storage / sequestration;Nitrogen balance;Air quality (non-GHG emissions)			Yes
DNDC calculator	https://www.dndc.sr.unh.edu/	Yes	Yes	Crops	Climate, soil, crop, fertilizer, irrigation, tillage, residue management, etc.	Yes	GHG emissions, carbon storage/sequestration, nitrogen balance, crop yield	Elaboration in Modelling: Process-oriented simulation model of soil carbon and nitrogen biogeochemistry https://link.springer.com/chapter/10.1007/978-3-642-61094-3_20 https://www.sciencedirect.com/science/article/pii/S0304380014004190 . Consists of three main sub models: soil-climate/thermal-hydraulic flux sub-model, decomposition sub-model, and denitrification sub-model https://www.sciencedirect.com/science/article/pii/S0304380014004190	4	No
Dutch Annual Nutrient Cycling Assessment (ANCA) tool	https://research.wur.nl/en/publications/calculation-rules-of-the-annual-nutrient-cycling-assessment-anca	Yes	Yes	Dairy farms, arable farms, and farms with livestock other than dairy cows and young stock in the Netherlands.	Farm characteristics, management practices, inputs and outputs, nutrient flows and losses	Yes	Nitrogen, phosphorus, carbon and greenhouse gas cycles and losses.	Uses farm-specific excretion parameters, emission factors and coefficients to calculate nutrient flows and balances per hectare and per kilogram of milk.	4	No
eAgronom Farm Management Software; Carbon Program	https://www.eagronom.com/fms	No	Yes	Crops	Regenerative practices such as crop rotation, soil coverage, no-till, precision fertilization	Yes	GHG emissions;Carbon storage / sequestration	eAgronom is a digital platform that helps farmers monitor and report their emissions and implement sustainable practices that reduce GHG emissions and increase carbon sequestration. It also enables farmers to receive financial rewards from different parties (such as banks, governments, corporations) for their climate and environmental benefits. eAgronom applies the Verra Verified Carbon Standard methodology for calculating carbon credits	4	No
ECOSSE model	https://soil-modeling.org/resources-links/model-portal/ecosse	Yes	Yes	Crops, Grassland, Forest	Meteorological, land use, land management and soil data	No	Soil carbon and nitrogen dynamics, greenhouse gas emissions from mineral and organic soils	ECOSSE is a process-based model that simulates soil carbon and nitrogen turnover and greenhouse gas emissions using a pool-type approach. It comprises five soil organic matter pools: inert organic matter, humus, biomass, resistant plant material and decomposable plant material. The decomposition rate of each pool is modified by temperature, water content, plant cover and pH. The decomposition process results in gaseous losses of CO2 and CH4, with CO2 losses dominating under aerobic conditions and CH4 losses under anaerobic conditions. The nitrogen content of the soil follows the decomposition of the soil organic matter, with a stable C:N ratio defined for each soil organic matter pool at a given pH.	3	No
eFoodPrint ENV	https://efoodprint.com/	No	Yes	Fruit, vegetables,cereals,wine	Feed use,manure management, soil management,crop production and transport	Yes	Water footprint, carbon footprint	The tool uses emission factors from the IPCC and other sources to estimate the water use and GHG emissions from different sources on the farm and along the supply chain. The tool also provides a comparison with a benchmark farm and a breakdown of emissions by source and gas	4	No
EkonMOD	http://madobis-sk.cvzv.sk/hd/index.php?menu=o_video#uvod	Yes	Yes	Dairy;Milk sheep;Meat sheep;Pigs	Farm characteristics , production systems, inputs, outputs, emissions	Yes	GHG emissions;Nitrogen balance;economic aspects	Comparing two scenarios (current and planned) ; Tier 1 and Tier 2 approaches; IPCC methodology and peer-reviewed literature,FAO LEAP guidelines	3	No

Emissions Database for Global Atmospheric Research (EDGAR)	https://edgar.jrc.ec.europa.eu/	Yes	Yes	The database covers various emission sources from agriculture and farming such as enteric fermentation, manure management, rice cultivation, agricultural soils, field burning of agricultural residues	The database uses various data sources such as FAO (Food and Agriculture Organization), IEA (International Energy Agency), IPCC (Intergovernmental Panel on Climate Change), etc. The data inputs include activity data, emission factors, emission inventories,	No	The database estimates emissions of all greenhouse gases, air pollutants and aerosols from human activities on Earth using a consistent methodology based on the latest IPCC guidelines	The database also provides emission scenarios for future projections based on different assumptions and policies		No
En-ROADS	https://www.climateinteractive.org/en-roads/ ---------- https://en-roads.climateinteractive.org/scenario.html?v=23.6.1	Yes	Yes	Global climate system and cross-sector climate solutions	Energy supply and demand trade, prices,technologies,policies and emissions	No	System dynamics model for the long-term climate outcomes of policy scenarios	The model simulates the interactions between the economy, the energy systems and the environment, taking into account the effects of the policies on energy mix, emissions, temperature, sea level rise.	1	No
Environmental Policy Integrated Climate Model (EPIC)	https://data.nal.usda.gov/dataset/environmental-policy-integrated-climate-epic-model	No	Yes	Crops	Soil, weather, crop, management, and erosion data	Yes	GHG emissions, Carbon storage / sequestration, Nitrogen balance, Economic Performance Assessment	Uses a process-based simulation model that estimates soil productivity as affected by erosion and other factors	2	No
EPA. 2020. U.S. EPA Toolkit for Building National GHG Inventory Systems	http://clh-ckan.apps.fao.org/dataset/tools-for-greenhouse-gas-assessments/resource/8a588049-615a-4287-baf0-26241c28a07c?inner_span=True#	Yes	Yes	GHG inventory system for all sectors	not specified, depends on national circumstances and data availability	No	GHG emissions and removals assessment for all sectors using the IPCC methodology	The model provides a toolkit for building national GHG inventory systems that consists of seven templates that can be adapted to reflect national circumstances and compiled into a National GHG Inventory System Manual. The toolkit covers inventory planning, institutional arrangements, data collection and management, quality assurance and quality control, uncertainty analysis, reporting and archiving	5	No
ESGreen Tool	www.seges.dk/esgreentool	No	No	Dairy;Beef;Poultry;Pigs;Crops;Perrenial crops	Farm characteristics , production systems, inputs, outputs, emissions	Yes	GHG emissions;Soil carbon balance	Comparing two scenarios (current and planned) ; Tier 1 and Tier 2 approaches; IPCC methodology and peer-reviewed literature,FAO LEAP guidelines	3	Yes
EU Land Use Futures (EULUF)	https://www.europarl.europa.eu/thinktank/en/document/EPRS_ATA%282022%29729453	Yes	Yes	Crops and livestock systems in the EU	Land use, food consumption, food waste, bioenergy, forestry, etc.	No	Land use change, greenhouse gas emissions, carbon storage / sequestration	Uses a system dynamics model to simulate a range of European land use scenarios and their impacts on climate mitigation by 2050	3	No
EUCalc (European Calculator Model)	https://www.european-calculator.eu/model/	No	Yes	Various (crops, livestock, dairy, etc.)	energy, resources, production and food systems at the EU level + UK and Switzerland	No	GHG emissions, carbon sequestration, nitrogen balance, water consumption, land use, etc.	A model that simulates the effects of different scenarios of technological deployment and consumption behaviour on energy, resources, production and food systems at the EU level + UK and Switzerland	4	No
European national greenhouse gas inventories (NGHGIs)	https://www.eea.europa.eu/publications/annual-european-union-greenhouse-gas-inventory-2021	Yes	Yes	All sectors, including agriculture, land use, land use change and forestry (LULUCF)	Emissions of seven greenhouse gases (the greenhouse gas inventory) from all sectors	No	GHG emissions	The EU inventory is a compilation of national inventories, based on the emissions reported under the EU Climate Monitoring Mechanism. UNFCCC regularly reviews the submitted EU inventory. EU inventory system & quality assurance programme	3	No
EX-ACT VC: The EX-Ante Carbon-balance Tool for value chains	https://www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en/	Yes	Yes	Any agri-food value chain	Production level emissions, processing, storage, packaging, transportation, food loss, income levels	No	GHG emissions, socio-economic performance assessment for the life cycle of the agri-food value chain	The model uses the Intergovernmental Panel on Climate Change (IPCC) methodology and other peer-reviewed literature to calculate GHG emissions at each stage of the value chain. It compares a baseline scenario (without project) and an alternative scenario (with project). It also evaluates the economic, social and environmental impacts of the interventions along the value chain, such as value added, income levels, employment, food loss, gender and youth participation and SDG alignment.	2	No

EX-ACT: The EX-Ante Carbon-balance Tool	https://www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act/en/	Yes	Yes	Agriculture, forestry and other land use (AFOLU)	Land use, livestock, energy use, inputs and infrastructure, emission and removals	Yes	Carbon balance assessment	The model uses the Intergovernmental Panel on Climate Change (IPCC) methodology for greenhouse gas (GHG) emissions inventories. It provides estimates of the impact of interventions on the carbon balance by comparing a baseline scenario (without project) and an alternative scenario (with project). It covers both GHG emissions and carbon sequestration	3	No
EXIOBASE3	https://www.exiobase.eu/	Yes	Yes	Crop production, livestock production, bioenergy production, water use, nutrient cycles	The database uses various data sources such as FAO (Food and Agriculture Organization), IEA (International Energy Agency), IPCC (Intergovernmental Panel on Climate Change), etc. The data inputs include socio-economic scenarios, climate scenarios, biophysical data, emission factors	No	GHG emissions, air pollutants using methodology based on IPCC	The database provides emission maps at different spatial and temporal resolutions, as well as different sectorial and substance breakdowns.The database also provides emission scenarios for future projections based on different assumptions and policies		No
Farm Carbon Calculator	https://calculator.farmcarbontoolkit.org.uk/	Yes	Yes	Dairy;Beef;Meat sheep;Poultry;Pigs;Crops;Wine;Perrenial crops;Horticulture	Crop type , area, yield, fertilizer use, irrigation, tillage, manure management	Yes	GHG emissions;Carbon storage / sequestration	Farm Carbon Calculator is a tool that uses a life cycle assessment (LCA) approach to estimate the carbon footprint of farming practices. It allows for comparing the performance of different scenarios (e.g. current vs improved) and identifying the key drivers of GHG emissions and carbon offsets. It also provides guidance on how to implement best practices to reduce emissions and increase sequestration	4	Yes
Farm Carbon Calculator	https://calculator.farmcarbontoolkit.org.uk/	Yes	Yes	All farming systems that produce agricultural products	Land use,livestock , energy use, inputs and infrastructure ,emissions and removals	Yes	GHG emissions, carbon balance assessment	The model uses the Intergovernmental Panel on Climate Change (IPCC) methodology and other peer-reviewed literature to calculate GHG emissions and carbon sequestration at farm level. It compares a baseline scenario (without project) and an alternative scenario (with project)	2	Yes
Farm Energy Analysis Tool (FEAT)	https://www.ecologicalmodels.psu.edu/agroecology/feat/about.htm	Yes	Yes	Crops	crop type, area,yield,tillage,irrigation,fertilizer use,pesticide use,residue management and transport	Yes	GHG emissions and energy consumption	The tool uses emission factors from the IPCC and other sources to estimate the energy use and GHG emissions from different sources on the farm and along the supply chain. The tool also provides a comparison with a benchmark farm and a breakdown of emissions by source and gas	4	No
FarmAC	https://www.farmac.dk/	Yes	Yes	arable and livestock farms	Farm-scale information, cropping sequences, crop production potential, ruminant livestock production, livestock manure management, manure and fertiliser applications	Yes	GHG emissions, carbon storage / sequestration, nitrogen balance	Uses Tier 2 methodologies for livestock and manure management and Tier 3 methodologies for crops and soil. Simulates crop and livestock production, C and N mass flows, mineral N supply and losses, crop dry matter yield. Depends on agro-ecological zone parameters.	3	No
FARMDYN	https://www.ilr1.uni-bonn.de/en/research/research-groups/economic-modeling-of-agricultural-systems/farmdyn	Yes	Yes	The model covers various agricultural activities such as crop production, livestock production, bioenergy production	The model uses various data sources such as KTBL (German Association for Technology and Structures in Agriculture), EUROSTAT (European Statistical Office), CAPRI (Common Agricultural Policy Regionalised Impact), etc. The data inputs include biophysical characteristics of land and soil, technological change, climate change scenarios, policy scenarios, market prices, production costs, GHG emissions, nitrogen fate	Yes	GHG emissions from agriculture sources, carbon storage and sequestration in biomass and soils, nitrogen balance in croplands and grasslands, water use and availability	The model allows for a full account of all agriculture GHG sources based on advanced IPCC methods		No

Farmprint (AUS)	https://www.csiro.au/en/research/environmental-impacts/sustainability/FarmPrint	No	Yes	Dryland broadacre cropping	Farm management data, such as crop type, area, yield, fertilizer use, irrigation, tillage	Yes	GHG emissions, carbon storage / sequestration, water use efficiency	FARMPRINT is a tool that uses life cycle assessment (LCA) methodology to calculate the environmental impacts of farming practices. It allows for comparing the performance of different scenarios (e.g. baseline vs improved) and identifying the hotspots and improvement opportunities. It also enables farmers to communicate their environmental credentials to different stakeholders (e.g. consumers, investors, regulators)	1	No
FaST-Navigator	https://tool.fastnavigator.eu/index.html	Yes	Yes	Dairy;Beef;Milk sheep;Meat sheep;Goat;Poultry;Pigs;Crops;Wine;Perrenial crops;Horticulture		Yes	GHG emissions;Carbon storage / sequestration;Nitrogen balance;Economic Performance Assessment			No
FeedPrint	http://webapplicaties.wur.nl/software/feedprintNL/index.asp	Yes	Yes	Livestock (meat, milk and eggs)	Data on feed raw materials, crop production, processing of crop and animal products, compound feed production, utilization by the animal, transport and storage http://webapplicaties.wur.nl/software/feedprintNL/index.asp https://www.wur.nl/en/show/FeedPrint-Calculate-CO2-per-kilogram-meat-milk-or-eggs.html https://research.wur.nl/en/publications/methodology-used-in-feedprint-a-tool-quantifying-greenhouse-gas-ee	Yes	Carbon footprint of feed raw materials during their complete life cycle http://webapplicaties.wur.nl/software/feedprintNL/index.asp https://www.wur.nl/en/show/FeedPrint-Calculate-CO2-per-kilogram-meat-milk-or-eggs.htm https://research.wur.nl/en/publications/methodology-used-in-feedprint-a-tool-quantifying-greenhouse-gas-e	A calculation tool and database that calculates the greenhouse gas emissions during the production and utilization chain of feed and identifies mitigation options http://webapplicaties.wur.nl/software/feedprintNL/index.asphttps://www.wur.nl/en/show/FeedPrint-Calculate-CO2-per-kilogram-meat-milk-or-eggs.htm https://research.wur.nl/en/publications/methodology-used-in-feedprint-a-tool-quantifying-greenhouse-gas-e . Covers the complete Dutch Feed list, over 300 feed materials, sourced from countries all over the globe https://research.wur.nl/en/publications/methodology-used-in-feedprint-a-tool-quantifying-greenhouse-gas-e . Incorporates animal nutrition to evaluate the ultimate effect of changing rations https://research.wur.nl/en/publications/methodology-used-in-feedprint-a-tool-quantifying-greenhouse-gas-e .	4	No
Footprint Category Rules for Red Meat	http://www.uecbv.eu/UECBV/documents/FootprintCategoryRulesRedMeat16661.pdf ---------- https://ec.europa.eu/enrd/sites/default/files/enrd_publications/bioeconomy_factsheet-decision-support.pdf	Yes	Yes	Beef, pork, lamb	Feed, energy consumption, water management, waste, emissions	No	GHG emissions, carbon storage / sequestration, nitrogen balance, energy use, water use, land use	The tool uses a life cycle assessment approach based on ISO standards and the Product Environmental Footprint Category Rules guidance document. The tool uses different allocation methods for different stages of the supply chain and different environmental impacts. The tool also provides guidance on uncertainty analysis and sensitivity analysis	3	No
GAINS	https://gains.iiasa.ac.at/models/	Yes	Yes	All sectors that emit GHG and air pollutants	Economic,energy and agricultural development, emission control potentials and cost.	No	GHG emissions, carbon storage / sequestration , air pollutant, health and ecosystem impacts	Integrated assessment model of air pollutant and greenhouse gas emissions and their interactions	3	No
GEM-E3	https://e3modelling.com/modelling-tools/gem-e3/ https://joint-research-centre.ec.europa.eu/gem-e3_en	No	Yes	(cover all sectors of economy)	Economic data, Energy data, Environmental data, Policy scenarios, etc.	No	Economy, Energy system, Environment, Climate change impacts, GHG emissions, Adaptation, Mitigation, etc.	GEM-E3 is a multi-regional, multi-sectoral, recursive dynamic computable general equilibrium (CGE) model that covers the interactions between the economy, the energy system and the environment. It is especially designed to evaluate energy, climate and environmental policies. It simulates the economic behaviour of various agents (households, firms, governments, etc.) and the market equilibrium conditions for all goods and services. It also accounts for the feedbacks between the economic system and the environment through energy use and GHG emissions. It can analyse various policy scenarios such as carbon taxes, emission trading schemes, renewable energy subsidies, energy efficiency standards, etc.	2	No

GHGFarm	https://www.researchgate.net/figure/Overview-of-the-GHGFarm-emission-model-and-software-tool-addressing-multi-user_fig1_234789193	Yes	Yes	Various farming systems, agricultural enterprises, processes and products	Data on climate, soil, crop, feed, manure, fertilizer, irrigation, tillage, machinery, prices, etc. https://www.semanticscholar.org/paper/GHGFarm%3A-a-software-tool-to-estimate-and-reduce-gas-Newlands/e8723810d669e07e8b6bcf91e7f8d63c5ce497cc https://www.researchgate.net/profile/Nathaniel-Newlands/publication/234789193_GHGFarm_a_software_tool_to_estimate_and_reduce_net-greenhouse_gas_emission_from_farms_in_Canada/links/54f0a4e90cf2b36214aac37d/GHGFarm-a-software-tool-to-estimate-and-reduce-net-greenhouse-gas-emission-from-farms-in-Canada.pdf?origin=publication_detail	Yes	Net-greenhouse gas emission (carbon dioxide - CO2, nitrous oxide - N2O and methane CH4) from farms as a function of climate and management practices https://www.semanticscholar.org/paper/GHGFarm%3A-a-software-tool-to-estimate-and-reduce-gas-Newlands/e8723810d669e07e8b6bcf91e7f8d63c5ce497cc https://www.researchgate.net/profile/Nathaniel-Newlands/publication/234789193_GHGFarm_a_software_tool_to_estimate_and_reduce_net-greenhouse_gas_emission_from_farms_in_Canada/links/54f0a4e90cf2b36214aac37d/GHGFarm-a-software-tool-to-estimate-and-reduce-net-greenhouse-gas-emission-from-farms-in-Canada.pdf?origin=publication_detail	A software tool and a set of algorithms that simulate whole farm greenhouse/trace gas emissions consistent with the International Panel on Climate Change (IPCC) emissions quantification methodology modified to Canadian conditions and farming. Allows users to quantify, interpret and compare alternative farm management scenarios and identify mitigation strategies. https://www.semanticscholar.org/paper/GHGFarm%3A-a-software-tool-to-estimate-and-reduce-gas-Newlands/e8723810d669e07e8b6bcf91e7f8d63c5ce497cc https://www.researchgate.net/profile/Nathaniel-Newlands/publication/234789193_GHGFarm_a_software_tool_to_estimate_and_reduce_net-greenhouse_gas_emission_from_farms_in_Canada/links/54f0a4e90cf2b36214aac37d/GHGFarm-a-software-tool-to-estimate-and-reduce-net-greenhouse-gas-emission-from-farms-in-Canada.pdf?origin=publication_detail .	4	No
GLEAM v 3.0 Dashboard	https://foodandagriculture organization.shinyapps.io/GLEAMV3_Public/ -------- http://clh-ckan.apps.fao.org/dataset/tools-for-greenhouse-gas-assessments/resource/eea21911-f7ae-449c-b8c5-65ff796850e7?inner_span=True ---------- https://www.fao.org/fileadmin/user_upload/gleam/docs/GLEAM_3.0_Model_description.pdf _	Yes	Yes	Livestock	Livestock numbers, animal production, GHG emissions and emissions intensities by region, production systems and source of emissions	No	GHG emissions assessment and mitigation for different livestock systems	The model uses the IPCC methodology and other peer-reviewed literature to calculate greenhouse gas emissions from different livestock systems based on livestock numbers, animal production, feed intake, manure management and land use change. It also provides an interactive web application for data aggregation and visualization	1	No
Global Biosphere Management Model GLOBIOM	https://iiasa.ac.at/models-tools-data/globiom	Yes	No	wheat, rice, maize, soybean, rapeseed, sugarcane, dairy cattle, beef cattle, sheep, goats, poultry, pigs,	The data inputs include population dynamics, income levels, food preferences, technological change, land use and cover change, biophysical characteristics of land and soil, climate change scenarios, etc	No	Some of the modelling parameters are demand and supply quantities, bilateral trade flows, prices for commodities and natural resources, GHG emissions from agriculture and forestry sources, carbon storage and sequestration in biomass and soils, nitrogen balance in croplands and grasslands, water use and availability	The model allows for a full account of all agriculture and forestry GHG sources based on advanced IPCC methods. The model accounts for various land use activities such as crop production (rainfed or irrigated), livestock production (grazing or mixed), forest management (plantation or natural), bioenergy production (first or second generation), etc. The model also accounts for various processing activities such as crop processing (food or feed), livestock processing (meat or dairy), forest processing (sawlogs or pulpwood), bioenergy processing (ethanol or biodiesel)	2	No
GLOBIOM-G4M	https://iiasa.ac.at/models-tools-data/globiom	No	Yes	Crops, Bioenergy, Forestry	land use, crop yields, livestock production, forest management, trade consumption, GHG emissions	Yes	GHG emissions	Partial equilibrium model that covers the competition for land use between agriculture, forestry and bioenergy sectors	3	No
GNOC- Global Nitrous Oxide Calculator	https://gnoc.jrc.ec.europa.eu/	Yes	Yes	Biofuel crops	Crop type , soil type, irrigation, fresh yield, mineral fertilizer , manure	No	Nitrous oxide (N2O) emissions from soil associated with biofuel crop production	The model uses the IPCC methodology and other peer-reviewed literature to calculate nitrous oxide emissions from soil based on crop type, soil type, irrigation and nitrogen inputs	1	No
HolosNor	https://www.sciencedirect.com/science/article/pii/S0022030207720039	No	Yes	Dairy and beef production systems in Norway	Farm-scale data of soil physical characteristics, weather, and farm operations	Yes	GHG emissions, soil C changes, N losses, crop and livestock production	Uses a mixture of Tier 2 and Tier 3 methodologies, considers direct and indirect emissions of CH4, N2O and CO2, estimates soil C emissions using the Introductory Carbon Balance Model (ICBM)	No information available	No
HortZero	In pilot testing phase so doesn't have one yet	Under development	Yes	Horticulture		Yes	GHG emissions			No

IMPRESSION Integrated Assessment Platform (IAP2)	http://www.highendsolutions.eu/page/IAP2	Yes	Yes	Agriculture, Forests, Biodiversity	Climate scenarios, Socio-economic scenarios, Land use, Management practices, etc.	No	Climate change impacts, Vulnerability, Adaptation, Ecosystem services	IMPRESSION IAP2 is a web-based modelling platform that allows users to assess climate change impacts and vulnerabilities for a range of sectors, including agriculture, forests, biodiversity, coasts, water resources and urban development. It is a further development of the CLIMSAVE Integrated Assessment Platform (IAP). It integrates a suite of ten sectoral models that simulate the effects of different climate and socio-economic scenarios on various indicators of human well-being. It also provides options for adaptation and mitigation measures and evaluates their costs and benefits.	3	No
INCA-N	https://catalogue.ceh.ac.uk/documents/imp-model-b88b-960d0c2b6b14	No	Yes	River systems	land use, climate, hydrology, nitrogen sources and sinks	No	Nitrogen dynamics	The model simulates the sources, transport and fate of nitrogen in catchments and rivers. It accounts for the effects of land use, climate and management practices on nitrogen fluxes	3	No
Integrated Farm System Model (IFSM)	https://www.ars.usda.gov/northeast-area/up-pa/pswmru/docs/integrated-farm-system-model/	Yes	Yes	Dairy and Beef	Climate, soil, crop, feed, manure, fertilizer, irrigation, tillage, machinery, prices, etc. https://www.ars.usda.gov/northeast-area/up-pa/pswmru/docs/integrated-farm-system-model/ https://data.nal.usda.gov/dataset/integrated-farm-system-model-ifsm	Yes	GHG emissions, nutrient flows, crop yields, feed production and use, manure production and handling, production costs and returns https://www.ars.usda.gov/northeast-area/up-pa/pswmru/docs/integrated-farm-system-model/ https://data.nal.usda.gov/dataset/integrated-farm-system-model-ifsm https://www.agmrv.org/knowledge-portal/resources/the-integrated-farm-system-model/	Process-based simulation of dairy, beef, and crop farming systems https://www.ars.usda.gov/northeast-area/up-pa/pswmru/docs/integrated-farm-system-model/ https://data.nal.usda.gov/dataset/integrated-farm-system-model-ifsm https://www.ars.usda.gov/research/software/download/?softwareid=5 Integrates the many physical and biological processes on a farm over many years of weather https://www.ars.usda.gov/northeast-area/up-pa/pswmru/docs/integrated-farm-system-model/ https://data.nal.usda.gov/dataset/integrated-farm-system-model-ifsm . Considers primary and secondary sources of emissions https://www.ars.usda.gov/northeast-area/up-pa/pswmru/docs/integrated-farm-system-model/ .	4	No
Integrated model to Assess the Global Environmental (IMAGE)	https://www.pbl.nl/en/image/about-image	Yes	Yes	Crops and livestock systems at the global level	Land use, energy use, climate change, socio-economic scenarios, policies, etc.	No	Environmental impacts, human well-being, sustainability issues, etc.	The model consists of 13 submodels that cover different aspects of the human-environment system such as energy supply and demand, land and water use, climate policy, terrestrial and aquatic ecosystems. he model can be used to explore different scenarios and pathways for sustainable development as well as possible response strategies	3	No
INTEGRATOR	https://edepot.wur.nl/192673	No	Yes	Various (crops, livestock, dairy, etc.)	Various data sources, such as farm records, sensors, satellites, drones, etc.	Yes	Yield, quality, costs, revenues, profitability, environmental impact, etc.	A software platform that integrates data from different sources and provides decision support tools for farmers and advisors	4	No
IPCC 2020. IPCC Inventory Software	https://www.ipcc-nggip.iges.or.jp/software/index.html ----- http://clh-ckan.apps.fao.org/dataset/tools-for-greenhouse-gas-assessments/resource/2fd3ab39-dfdd-4325-9045-96cc3378e631?inner_span=True	Yes	Yes	GHG inventory system for all sectors	not specified, depends on national circumstances and data availability	No	GHG emissions and removals assessment for all sectors using the IPCC methodology	The model provides a software for developing and reporting national GHG inventories using the 2006 IPCC Guidelines. The software consists of worksheets for data entry and calculation, quality control checks, uncertainty analysis, key category analysis and reporting tables	5	No
JRC Carbon Calculator	https://forobs.jrc.ec.europa.eu/iforce/carbon_emissions.php	Yes	Yes	Any sector that involves deforestation and forest degradation	Pixel-based maps of forest area change and forest degradation, biomass or carbon values	No	Emissions in forest area or in area of degraded forest (in ha) and Emission Factors are the emissions expressed in tC/ha	Two modules, CarbEF and ForestER, to link pixel-based maps of forest area change and forest degradation to biomass or carbon values	No information available	No
JRC-EU-TIMES	https://data.jrc.ec.europa.eu/collection/id-00287	Yes	Yes	Transport, industry, agriculture	Energy technologies, building stock	No	GHG emissions, carbon storage/ sequestration, energy demand and supply	The tool uses a linear programming optimization algorithm that simultaneously solves for the optimum investment portfolio of energy technologies and their operation under different sets of assumptions	3	No

Klimaatstresstest	https://edepot.wur.nl/517290	Yes	No	Crops;Aniek de Jong		Yes	Climate change adaptation crop impact and measures		1	No
Klimrek	www.klimrekproject.be	No	No	Dairy;Pigs;Horticulture		Yes	GHG emissions	and		Yes
KLIR = Klimaschonende und Ressourceneffiziente Milchproduktion	pas de site pour l'outil KLIR (en tout cas pas en libre accès)	No	No	Dairy		Yes	GHG emissions			Yes
Kringloopwijzer	www.mijnkringloopwijzer.nl	No	No	Dairy	Soil analysis, feed analysis, manure	Yes	GHG emissions;Nitrogen balance	The tool uses a life cycle assessment approach that simulates the nutrient flows and GHG emissions from different sources and sinks on the farm.	No information available	Yes
LandscapeDNDC	https://ldndc.imk-ifu.kit.edu/	No	Yes	Crops, Grassland, Forest	Meteorological data, soil data, land use data, management data	No	GHG emissions, Carbon storage / sequestration, Nitrogen balance, Water balance	LandscapeDNDC is a simulation framework for terrestrial ecosystem models on site and regional scales. LandscapeDNDC emerged from the site scale model MoBiLE, which was based on the Arable-DNDC and Forest-DNDC models. The modular design of LandscapeDNDC allows plugging in any choice of process descriptions for various parts of different natural ecosystems.	3	No
LandscapeDNDC-MeTrx	https://ldndc.imk-ifu.kit.edu/doxy/ldndc/doc/html/metrx.html	No	Yes	Main agricultural and farming target: Crops, Grassland, Forest	Meteorological data, soil data, land use data, management data	No	GHG emissions, Carbon storage / sequestration, Nitrogen balance, Water balance	LandscapeDNDC-MeTrx is a sub-model of LandscapeDNDC that simulates carbon and nitrogen cycle of soils. Focus lies on the production and consumption of the greenhouse gases CO2, CH4 and N2O. Therewith related outputs include leaching of NO3 and emissions of NH3.https://ldndc.imk-ifu.kit.edu/doxy/ldndc/doc/html/metrx.html	3	No
Latvian Agricultural Sector Analysis Model (LASAM)	https://lasam.llu.lv/	Yes	Yes	Agricultural production, greenhouse gas emissions, food security, policy analysis	Historical data on agricultural sectors, medium-term price projections for agricultural products in the EU, changes in support policy, resource use	No	Econometric, recursive, multi-period scenario model	The model covers all agricultural sectors and considers the special features and trends of each sector. The model can also assess the impacts of changes in climate, markets, and policy on agricultural production, greenhouse gas emissions, food security, and rural development		No
MAGICC	https://magicc.org/	Yes	Yes	Global model that simulates climate system and its interactions with GHG and other pollutants	Emissions scenarios, climate sensitivity, radiative forcing, carbon cycle feedbacks	No	GHG emissions, carbon storage / sequestration, global mean temperature, sea level rise.	MAGICC is a reduced complexity model that approximates the behaviour of more complex Earth system models. It consists of a set of coupled differential equations that describe the carbon cycle, atmospheric chemistry, climate and sea level. It allows for exploring the implications of different emissions pathways and policy scenarios for future climate change and its uncertainty	3	No
MIRAGE-BIOF	https://www.worldscientific.com/doi/abs/10.1142/S2010007812500170	No	Yes	Crops (such as corn, sugarcane, wheat, soybean, rapeseed, palm oil, etc.)	Global Trade Analysis Project (GTAP) database, FAOSTAT database, International Energy Agency (IEA) database, etc.	No	GHG emissions, carbon storage/sequestration, nitrogen balance, economic performance assessment	Dynamic recursive model with 13 regions and 28 sectors; land use change module based on biophysical and economic drivers; GHG emissions module based on IPCC guidelines; economic performance module based on welfare indicators	3	No
MITERRAEUROPE	https://edepot.wur.nl/192673	No	Yes	Various (crops, livestock, dairy, etc.)	Various data sources, such as CAPRI model outputs, GAINS model outputs, soil type, climate, land use, etc.	No	Nitrogen losses, phosphorus balances, ammonia emissions, nitrous oxide emissions, nitrate leaching, etc.	A model that integrates the effects of policies and measures on nitrogen and phosphorus flows in agriculture at a regional level in EU-27	3	No

Model of Agricultural Production and its Impact on the Environment (MAgPIE)	https://www.pik-potsdam.de/en/institute/departments/activities/land-use-modelling/magpie	No	Yes	Land-use change, food security, climate change impacts, greenhouse gas mitigation, land-related policies	Regional demand for agricultural commodities, technological development, production costs, potential crop yields, land and water constraints	No	Land use change, food security, greenhouse gas emissions, water scarcity, etc.	The model is a modular open source framework for modeling global land-systems, which is coupled to the grid-based dynamic vegetation model LPJmL. The model minimizes total cost of production for a given amount of regional food and bioenergy demand, taking into account spatially explicit data on potential crop yields, land and water constraints. The model can also assess the competition for land and water and the associated consequences for sustainable development under future scenarios of rising food, energy and material demand as well as production, climate change impacts and greenhouse gas mitigation and different land related policies	3	No
Modular Applied GeNeral Equilibrium Tool (MAGNET)	https://www.magnet-model.eu/	Yes	Yes	Crops and livestock systems at the global level	Agricultural production, trade, consumption, prices, policies, etc.	No	Economic impacts, environmental impacts, food security, nutrition, etc.	Uses a global computable general equilibrium model based on the GTAP database to simulate the impacts of agricultural, trade, land, and bioenergy policies on the global economy with a particular focus on the impacts on land use, agricultural prices, nutrition, and household food security	3	No
OpenLCA 1.10.3	https://www.openlca.org/openlca/	Yes	Yes	Dairy;Beef;Pigs;Crops;Horticulture		Yes	GHG emissions;Nitrogen balance;Air quality (non-GHG emissions)			No
ORCHIDEE-GM	https://wiki.lsce.ipsl.fr/pku/lib/exe/fetch.php?media=blog:abstract_presentation_j_chang.pdf	No	Yes	Grassland	Climate, soil, vegetation, management data	No	Carbon, water and energy fluxes in grassland ecosystems under different management practices	ORCHIDEE-GM is a version of ORCHIDEE, a process-based ecosystem model, that integrates the management of grassland, including mowing, grazing and fertilizer application. It uses the equations from PaSim, a grassland model developed for site applications, to simulate the dynamics of leaf area index, biomass and carbon fluxes of managed grasslands. It can operate in deterministic or stochastic programming mode, allowing for scenario tree reduction and different risk measures. It also includes detailed modules for nitrogen fate, machinery use, grassland management and environmental indicators	3	No
Outil de gestion de trésorerie fourragère (OGF)	https://www.perel.autonomie-fourragere-des-elevages.fr/tresorerie/	No	No	Dairy;Beef		Yes	fodder stock			No
PalmGHG Calculator	https://rspo.org/as-an-organisation/tools/ghg/	Yes	Yes	palm oil production only	Land use change, soil type, fertilizer use, mill effluent, methane capture, palm oil production, etc.	Yes	GHG emissions, Carbon storage / sequestration, Carbon footprint	PalmGHG Calculator is a tool that enables oil palm growers to estimate and monitor their net GHG emissions and identify and reduce troublesome areas in their production chain. It uses the approach of Life Cycle Assessment (LCA) and follows the IPCC guidelines and recommendations. It can also be integrated with other tools such as RSPO Credits and GeoRSPO.	4	No
Pig Production Environmental Footprint Calculator (PPFEC)	https://blog-swine.extension.umn.edu/2018/06/pig-production-environmental-footprint.html	Yes	Yes	Pigs	farm characteristics, energy use, feed use, manure management, litter application	Yes	GHG emissions	The tool uses emission factors from the Intergovernmental Panel on Climate Change (IPCC) and other sources to estimate the GHG emissions from different sources on the farm. The tool also provides suggestions for reducing emissions and improving efficiency	4	No
PigGas (AUS)	https://australianpork.com.au/environmental-practices/greenhouse-gases/piggas-studies	Yes	Yes	Swine	farm characteristics, energy use, feed use, manure management, litter application	Yes	GHG emissions	The tool uses emission factors from the IPCC and other sources to estimate the GHG emissions from different sources on the farm and at the farm gate	4	No

POLES-JRC	https://joint-research-centre.ec.europa.eu/poles/model_en	No	Yes	Can be used for any sector that involves energy supply and demand, including agriculture	historical statistics, projections, technology characteristics, policies and scenarios	No	Energy prices, demand elasticities, technology costs, potentials and learning rates, emission factors and abatement costs	A dynamic partial equilibrium framework that simulates year-by-year recursive modelling, with endogenous international energy prices and lagged adjustments of supply and demand by world region. The tool also follows the discrete choice modelling paradigm in the decision-making process	No information available	No
Poultry Carbon Footprint Calculation Tool (PCFCT)	https://extension.uga.edu/publications/detail.html?number=B1443	Yes	Yes	Poultry	farm characteristics, energy use, feed use, manure management, litter application	Yes	GHG emissions	The tool uses emission factors from the Intergovernmental Panel on Climate Change (IPCC) and other sources to estimate the GHG emissions from different sources on the farm. The tool also provides suggestions for reducing emissions and improving efficiency	4	No
PRIMES	https://climate.ec.europa.eu/eu-action/climate-strategies-targets/economic-analysis/modelling-tools-eu-analysis_en	No	Yes	Energy	Energy demand and supply data, technology data, policy data, economic data, environmental data	No	CO2 emissions from energy and industrial processes	PRIMES is a partial equilibrium model that simulates an energy market equilibrium by finding the prices for each energy source that clear the market. It also represents energy demand, supply and emission abatement technologies in a detailed and dynamic way. It uses a bottom-up approach with a rich technological representation and a top-down approach with macroeconomic feedbacks	2	No
PRIMES-TREMOVE	https://climate.ec.europa.eu/eu-action/climate-strategies-targets/economic-analysis/modelling-tools-eu-analysis_en	No	Yes	Transport	Transport demand and supply data, technology data, policy data, economic data, environmental data	No	CO2 emissions from transport activity and vehicle stock	PRIMES-TREMOVE is a partial equilibrium model that simulates an transport market equilibrium by finding the prices for each transport mode and vehicle type that clear the market. It also represents transport demand, supply and emission abatement technologies in a detailed and dynamic way. It uses a bottom-up approach with a rich technological representation and a top-down approach with macroeconomic feedbacks	2	No
RothC Model	https://www.rothamsted.ac.uk/sites/default/files/RothC_guide_WIN.pdf	Yes	Yes	Various (arable, grassland and woodland)	Soil type, temperature, soil moisture, plant cover, soil organic carbon inputs and initial soil organic carbon content	No	Soil organic carbon, microbial biomass carbon, radiocarbon age	A model for the turnover of organic carbon in non-waterlogged topsoils that divides the total organic carbon into four active pools and one inert pool	3	No
Scientific Integrated Modelling Platform for Agro-Ecological Crop and Environmental Simulation (SIMPLACE)	http://www.simplace.net/	No	Yes	Crop and ecosystem management, model development, decision and policy support	Crop models, soil models, weather data, management data, etc.	No	Crop growth, soil processes, water balance, nutrient dynamics, etc.	Uses a modular software framework to integrate different crop and soil models and run simulations at different spatial and temporal scales	3	No
SHERPA-city	https://www.terraria.com/sherpa-city/	Yes	Yes	Urban air quality and traffic measures	Traffic data, emission factors, NO2 concentrations, traffic measures	No	NO2 and PM concentration	SHERPA-city is a tool that allows users to assess the impact of traffic measures on NO2 pollution in cities. It uses a simplified source-receptor relationship to estimate the changes in NO2 concentrations due to changes in traffic emissions. It also evaluates the co-benefits of traffic measures for other pollutants (e.g. PM) and impacts (e.g. health and ecosystems). It allows for comparing different scenarios and identifying the most effective measures	4	No
Sima-pro	https://www.sciencedirect.com/science/article/pii/S0959652622046121?pes=vor	No	Yes	Various	Various LCI databases, such as ecoinvent v3 and Agri-footprint	Yes	GHG emissions, Carbon storage / sequestration, Nitrogen balance, Economic Performance Assessment, Water consumption, Land use, etc.	A software tool for conducting LCA studies and creating reports in a transparent and user-friendly way	4	No
Soilscanner	https://www.agrocares.com/	No	Yes	Crops		Yes	Carbon storage / sequestration;Nitrogen balance;Soil health			No
Solagro Carbon Calculator	https://solagro.org/carbon-calculator - https://solagro.com/images/imagesCK/files/publications/2016/Farm_Tool_Calculator_Carbon.pdf	Yes	No	All agricultural production	Energy consumption, GHG emissions, farm activities, mitigation actions	Yes	Energy consumption and GHG emissions assessment and mitigation for the farm system	The model uses the IPCC methodology and other peer-reviewed literature to calculate energy consumption and greenhouse gas emissions at farm level. It also provides a distribution of emissions per workshop and calculates the potential mitigation actions for the farm	1	No

SustainFARM Public Goods Tool	http://www.sustainfarm.eu/en/decision-support-tool	Yes	Yes	Crops, livestock, vegetables, fruit, olives	yields, fuel consumption	Yes	Soil management, landscape, NPK balance, energy and carbon, animal health	Answers are scored on a scale between 1 (poor) and 5 (excellent) and an overall score given for each spur. Results are captured on a radar diagram to give an instant visual overview of the sustainability of the farm1 (poor) and 5 (excellent)	4	No
SYSTERRE	https://www.systerre.fr/systerre/home/description/home	Yes	Yes	Crops	Crop production systems and farming practices such as crop type, area, yield, fertilizer use, irrigation, tillage, manure management, etc	No	Environmental indicators (GHG emissions, energy consumption); Economical indocators (Raw product, Total production costs, Gross margin, Operational costs, Mechanization costs, Wages, Input efficiency); Technical indocators (Labor time, Fuel consumption, NPK balances, Amounts of active ingredients, Irrigation volumes)	SYSTERRE assesses performances, through the calculation of 20 main indicators with 190 subindicators The GHG emissions modelling is based on the IPCC methodology with parameters defined at the French level	2	No
TEKLa	https://www.lwk-niedersachsen.de/lwk/news/35108_Rechentool_TEKLa_fuer_Deutschen_Innovationspreis_fuer_Klima_und_Umwelt_nominiert	No	No	Dairy;Beef;Poultry;Pigs;Crops;Biogas		Yes	GHG emissions;Nitrogen balance;Air quality (non-GHG emissions);water, energy consommations			Yes
Trinity AgTech's Sandy	https://www.trinityagtech.com/	No	Yes	Grasslands, uplands, peatlands	Farm location, land use, soil type, livestock type and number, management practices, carbon sequestration projects	Yes	Carbon balance, biodiversity, water quality and other natural capital indicators for different farm systems	The model uses the IPCC methodology and other peer-reviewed literature to calculate carbon balance, biodiversity, water quality and other natural capital indicators for different farm systems based on farm location, land use, soil type, livestock type and number, management practices and carbon sequestration projects. It also provides recommendations for optimizing natural capital outcomes and accessing carbon markets	1	No
Vera klimatkollen	https://adm.greppa.nu/vera.html https://adm.greppa.nu/vera/kurs-vera-klimatkollen.html https://verra.org/programs/verified-carbon-standard/	No	No	Dairy;Beef;Poultry;Pigs;Crops;Perrenial crops		Yes	GHG emissions		No information available	No
WineGB Carbon Calculator	https://calculator.farmcarbontoolkit.org.uk/winegb	Yes	Yes	Vineyards and wineries	Vineyard records, energy bills, fuel receipts, fertilizer and pesticide use	Yes	Carbon sequestration following the IPCC guidelines and methods for estimating emissions	I found some information on how the WineGB Farm Carbon Calculator elaborates its modelling. It seems to be a tool that uses two modules, Vineyard and Winery, to calculate emissions from different sources and sinks. The tool also provides reports and graphs that show the carbon footprint per hectare of vineyard or per bottle of wine	No information available	No
WRF-Chem	https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019JD030248	Yes	Yes	Crops	Various meteorological, chemical and land use data sets at different spatial and temporal resolutions	No	GHG emissions, Carbon storage / sequestration, Nitrogen balance, Air quality	A regional atmospheric model coupled with chemistry that simulates dust emission, transport and deposition at high resolution	2	No
AMG	Modeling soil organic carbon evolution in long-term arable experiments with AMG model - ScienceDirect	No	Yes	Crops and vineyards	Meteorological data, soil data, land use data, management data	No	Carbon storage / sequestration.	Mechanistic model that model soil compartment to asses soil organic carbon evolution whithin a 100 years time period	2	No

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