HOLOSIE SOFTWARE

A Model for Decision-making in Agri-environmental Systems (MODASYS)

A Quick User Guide

CONTENT

For further information and collaboration, please contact Dr. Ibrahim Khalil, School of Agriculture and Food Science, University College Dublin, Dublin 04, Ireland. Email: ibrahim.khalil1@ucd.ie

1 INTRODUCTION

HOLOS-IE (V4.5) is a systems-based digital platform designed to support agricultural land use planning, decision-making for climate change mitigation and adaptation, as well as national inventory reporting. Developed through Research Ireland (Formerly Science Foundation Ireland)'s National Challenge Fund (Future Digital Challenge) in collaboration with ReLive project funded by Transnational ERA-NET (EU) through the Department of Agriculture, Food and the Marine, Ireland, HOLOS-IE addresses a critical gap as a sustainability tool for Irish agricultural system by providing an integrated approach at land parcel through farm to national scale carbon accounting and environmental impact assessment.

The model enables farmers, advisors, policymakers, and researchers to evaluate existing agricultural practices and explore alternative management strategies that sustain productivity while reducing agri-environmental footprint, leading to achieving net-zero emissions. By integrating multiple farm components (e.g., crops, grasses, livestock, agroforestry, and farm infrastructure) and their subcomponents/types, the model provides comprehensive assessments of greenhouse gas (GHG) emissions, carbon sequestration potential, changes in soil organic carbon density, soil health indices, and the overall total and net carbon balance.

The HOLOS-IE model is evolving into HOLOSEU, a European Union version of the digital platform. This development is supported through the ICT-AGRI-FOOD initiative, with national co-funding commencing on January 1, 2025. The HOLOSEU initiative aims to extend the capabilities of the Irish HOLOS-IE model to a broader European context, enabling harmonised assessment and comparison of agricultural GHG emissions and mitigation strategies across EU member states and beyond. In addition, the project will include modules on agrobiodiversity and the bioeconomy, integrating circularity concepts at a limited scale to explore resource efficiency, nutrient cycling, and sustainable production systems within European agriculture. The modelling work will continue, with sustained efforts dedicated to refinement and validation, until a fully functional software system integrating all essential components of an agricultural systems model is achieved.

N.B.: The HOLOS-IE platform is currently in its development phase, i.e. mainly considered as a research and educational tool. The estimates and projections provided by the platform are approximate and subject to refinement as new scientific findings emerge and the platform undergoes continued calibration and validation. At this stage, University College Dublin (UCD) and collaborating institutions make no warranty regarding the platform's reliability for operational farm management or policy compliance purposes beyond research exploration and educational applications. Users should consult with qualified agricultural advisors for farm-level decision-making.

2 GETTING STARTED

2.1 Software

HOLOS-IE Software can be downloaded from www.ucd.ie/holos-ie and the HOLOSEU project website (www.holoseu.net), or receive the link by contacting the Team Lead and using it for free.

2.2 Installation

- Run the **setup** installer (Figure 1.1)
- Launch **HOLOSIE** from the Windows start menu (search "HOLOSIE")

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- Once the installation is complete, HOLOSIE should begin immediately, greeting you with a disclaimer shown below.

  Installer (Note: Temporarily turn off Anti-Virus before installation):

  https://drive.google.com/file/d/11ysrVtnC3etat1M4jkeEYOL9wCjemG5V/view?usp=drive_lin

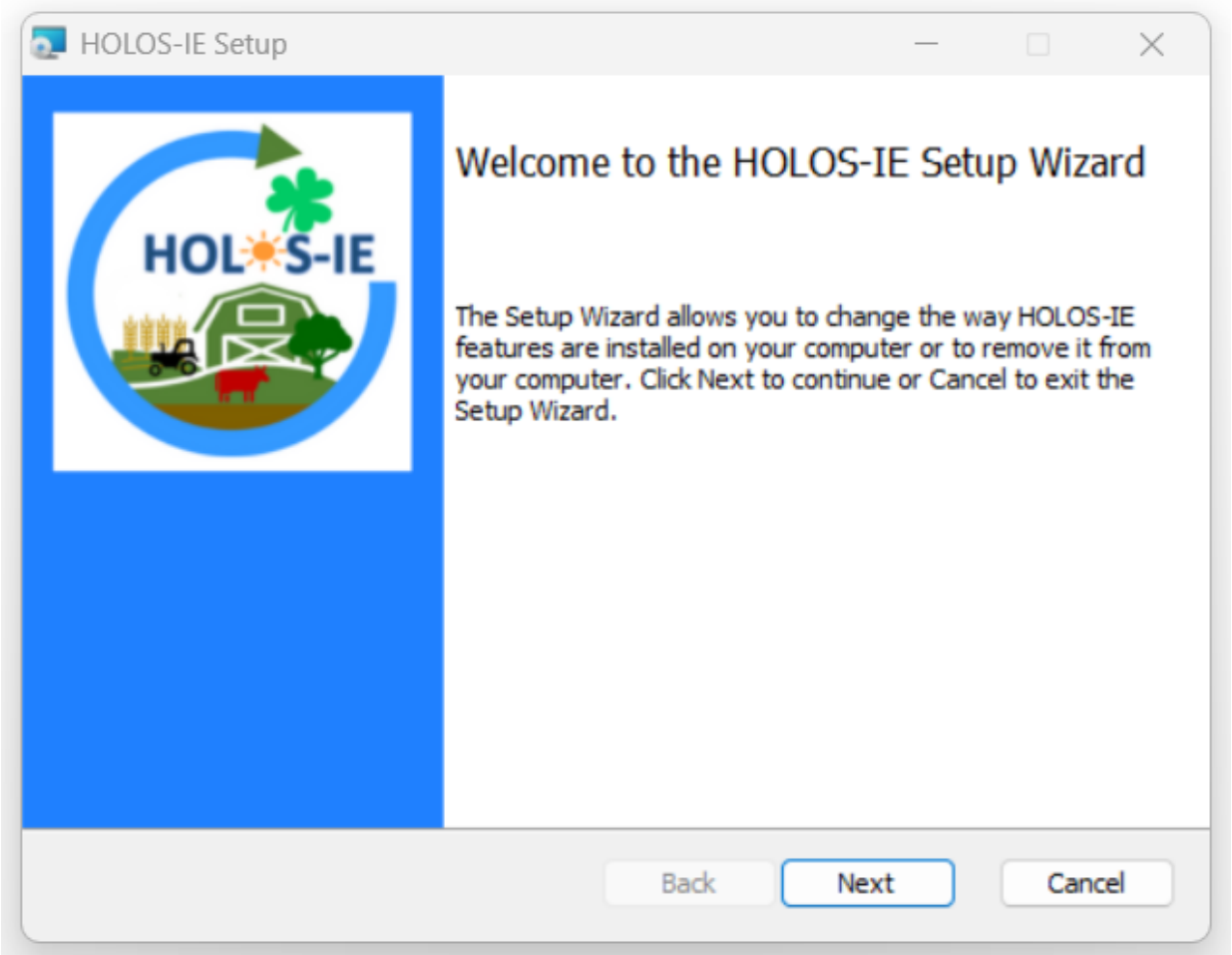

***Figure 1.1**: The install screen for HOLOSIE 4.5*

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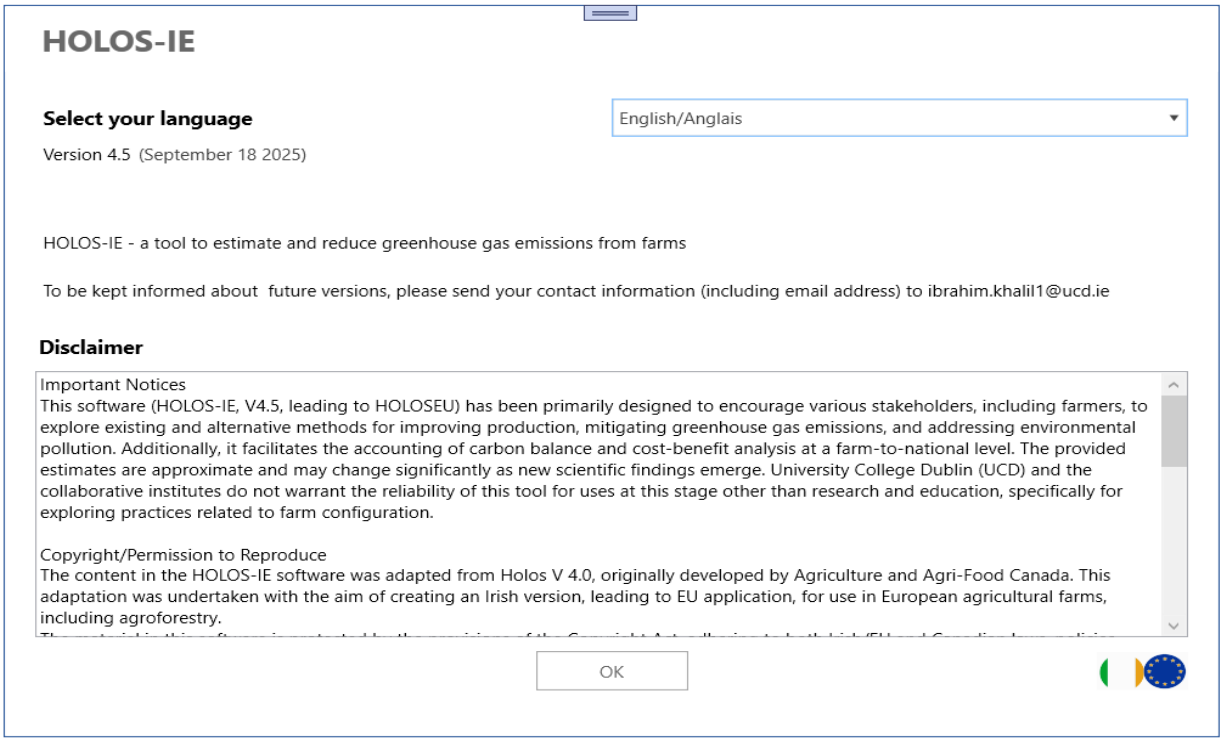

Figure 1.2: *HOLOSIE 4.5*

3 CREATING YOUR FIRST FARM

3.1 Create a new farm or open or import an existing farm from the selection screen.

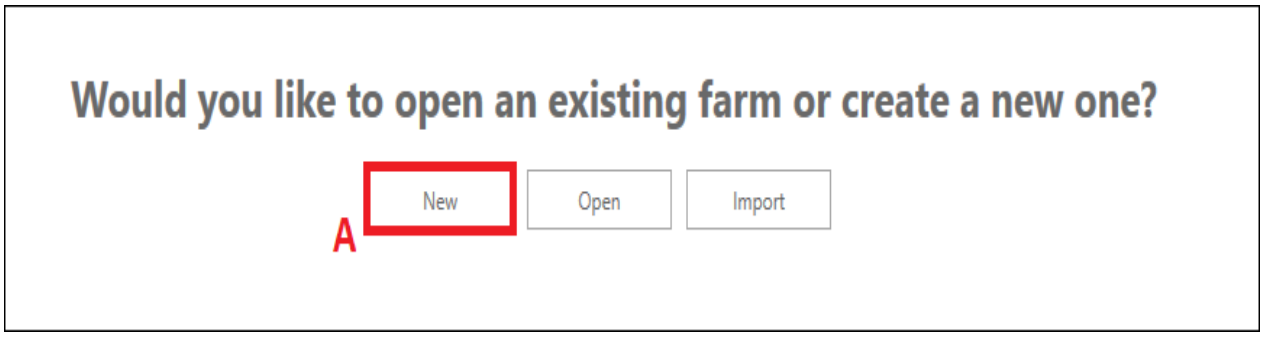

Figure 1.2*: Create a new farm or open an existing farm selection screen or import from a file. A: Click "New" to create a new farm.*

3.2 Please enter a name for the farm you would like to create and add any additional comments in the "Comments" section and click "OK" button to proceed.

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Figure 1.3: *Enter a name for your farm and any comments.*

3.3 Currently, we have only one Unit option to select i.e. “Metric” from the drop-down list in the next screen, and we have a plan to add "Imperial" measurement in the future. After choosing the unit of measurement, click “Next” button to proceed (Figure 2.3).

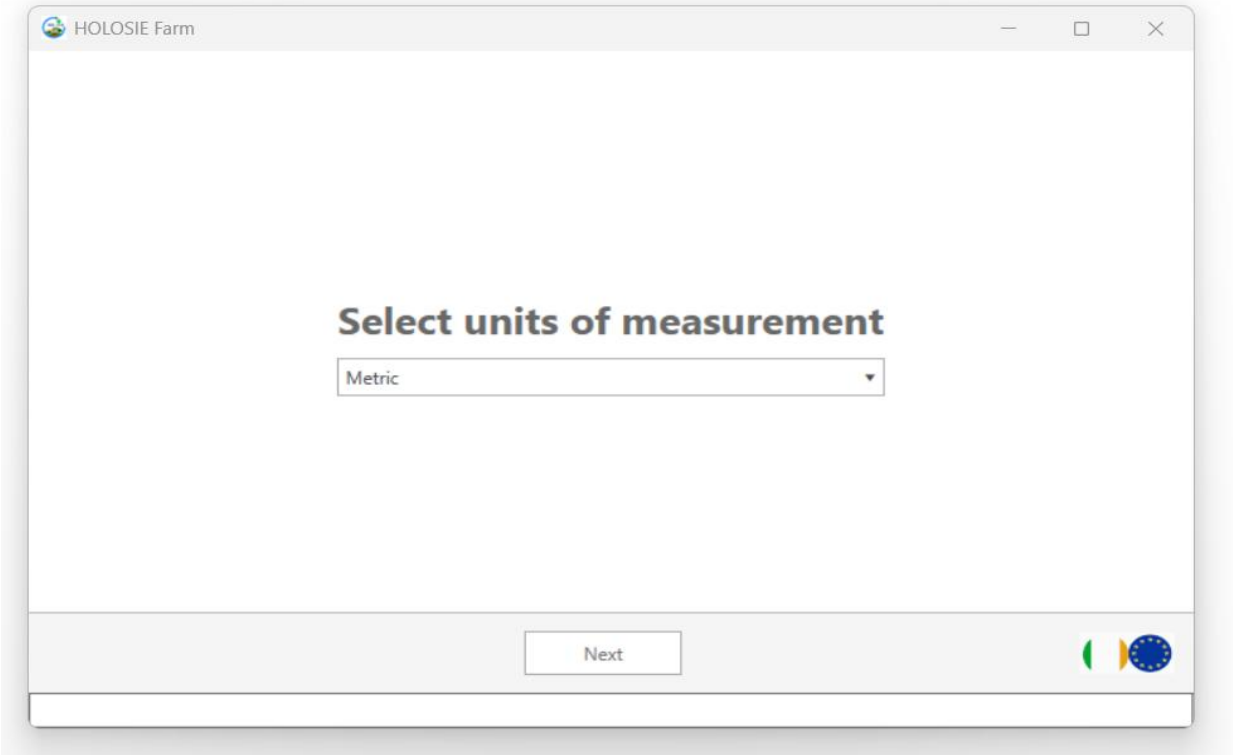

Figure 1.4: *Unit of Measurement Selection Screen.*

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3.4 Select your county (mainly applicable for Irish users but not restricted to others) from the drop-down list and click "Next" on the bottom of the screen.

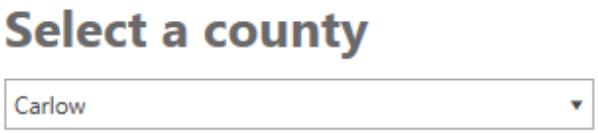

Figure 1.5: *County Selection Screen.*

4. SELECTING FARM LOCATION FOR SOIL AND CLIMATE DATA

4.1. Use of Default Soil and Climate Data:

On your screen, you will now see many polygon-shaped regions on the map for the County you selected. Each specific region is shaded in red. You can adjust the magnification (i.e. zoom in/out) of the map by using your mouse wheel or by selecting the magnifying sign near the bottom of the screen. Please select the location of your land parcel/farm by right-clicking on one of the regions (see Figure 2.1). The model framework will automatically download the soil data integrated with the map and climate data directly from NASA for your selected location/area. A progress bar will display the progress in downloading the data, and after a few seconds, the location, soil, and climate details will appear on the right, and this data will be auto-transferred (API) to the main platform for use and running the model. However, the platform has a provision to use its own soil and climate data, illustrated below. In addition to the Irish users, this approach should commonly be used by users outside of Ireland.

4.2 Using Your Own Soil and Climate Data

If you intend to run the model using inputs and activity data outside of Ireland, you are advised to use your own soil and climate data to better represent your site characteristics. To begin with, simply select any county in Ireland and let the system load the default data. Once this is done, go to the farm location page where you can upload or enter your own climate data (see Figure 2.1). How to prepare the soil and climate data is stated below:

- After completing that step, proceed to the component page and replace the default soil data with your own (see **Figure 3.7.1**).

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- Users from any country can fully customize their farm setup using their local soil and climate information.

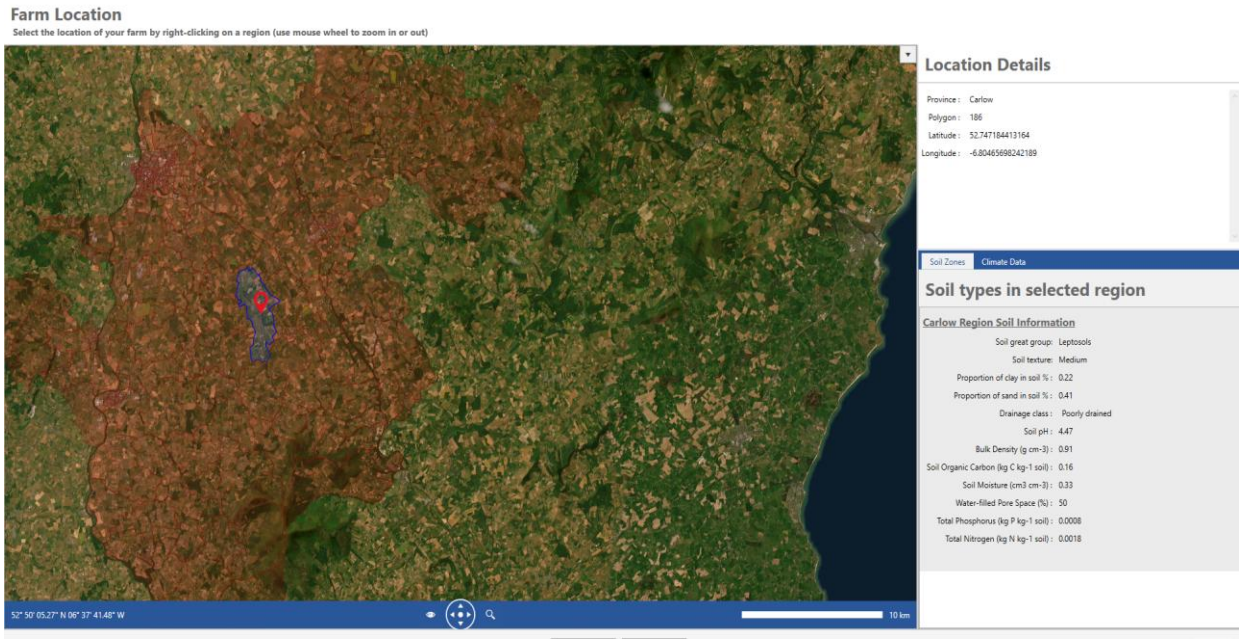

Figure 2.1: *Hovering the mouse cursor over the regions on the map will display a tool tip near your mouse pointer. The details of the soil and climate details for your chosen location will be shown on the right.*

The polygon shape region you selected has access to climate data. HOLOSIE will load the location-specific climate data by default should you choose to ignore this tab. If you would like to load custom data, you can load your own data from a file with ".csv" extension. The platform will confirm your custom data is loaded.

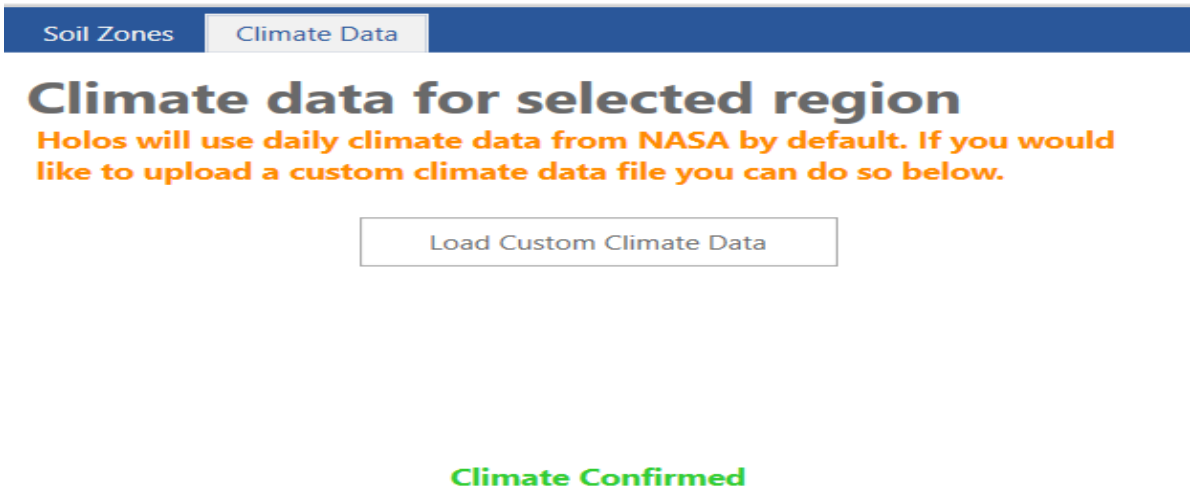

Figure 2.2*: Climate Data Tab. (A) Load your custom climate data file by clicking the button. (B) A loading bar will show up while the data is being loaded, and (C) If successful, you'll see a confirmation message.*

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When you are finished selecting your desired location, click “Next”.

4.3 Formatting the Custom Climate Data File

To import your own climate data into HOLOSIE, the file must be a Comma Separated Values (CSV) and have the “.csv” file extension. The file must also contain the following columns:

- Year – The year the climate data is from.
- Julian day – The day based on the Julian Calendar.
- Mean daily air temperature – The mean temperature of that day.
- Mean daily precipitation – The mean precipitation of that day.
- Mean daily potential evapotranspiration (PET) – The mean PET of that day.

	A	B	C	D	E
1	Year	Julian day	Mean Daily Air Temperature	Mean Daily Precipitation	Mean Daily PET
2	1912	1	-15.6	0	0
3	1912	2	-17.5	2	0
4	1912	3	-17.2	0	0

Figure 2.3: *custom climate data file format.*

5. Component Selection Procedures

5.1 Component Selection

With HOLOSIE, you can accommodate mono to mixed farming systems, from land parcel to landscape (and even national) scale through the selection of each component separately that is available under the “All Components” section. Each component is categorized by its type and includes the following: site characteristics, land use and management (crops, grasses, livestock, agroforestry, and infrastructure, which is under further improvement).

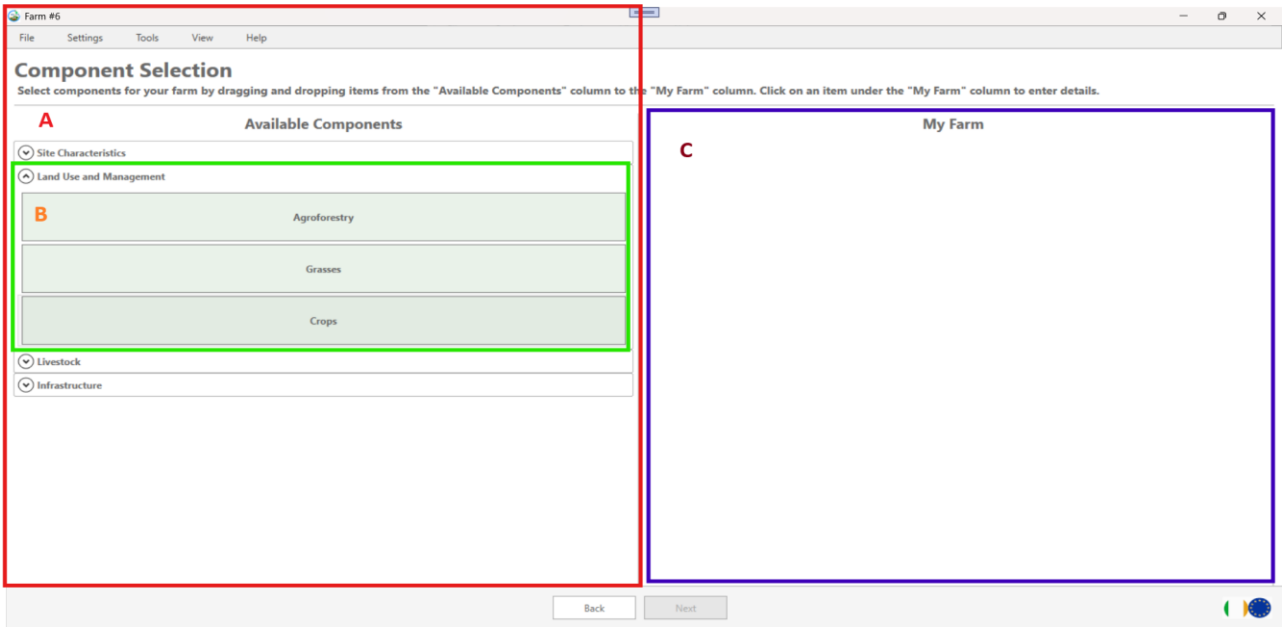

Figure 3.1 *- Component Selection, (A) All the possible Components, separated by component categories, that can be added to the Farm; (B) A single component category and (C) All the components that have been added to the Farm.*

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5.2 Adding a Component to Your Farm

a. To add a component to your farm, you must double-click or drag a component from the **"Available Components"** list into **"My Farm."**

b. As a result, the component will appear under the **"My Farm"** tab, and the inputs required for the selected component/subcomponent will be displayed in the section to the right of **"My Components."** The components are grouped into four main categories: **Site Characteristics** (e.g. Farm component), **Land Use and Management** (e.g. Crops, and Grass components), **Livestock** (e.g., Dairy, Beef, Sheep, and other animal components), **Agroforestry** (trees within a farm) and **Infrastructure** (e.g. Anaerobic Digestion).

c. To switch between selected farm components, simply click on the component you want to view, and the programme will automatically display that component's information.

d. For a farm moving from **mono-systems to mixed systems,** inputs can be added across multiple categories and subcomponents, allowing flexibility to represent more complex farm structures and run the model once to get results for both individual and mixed systems. See **Figure 3.2** below for a visual representation.

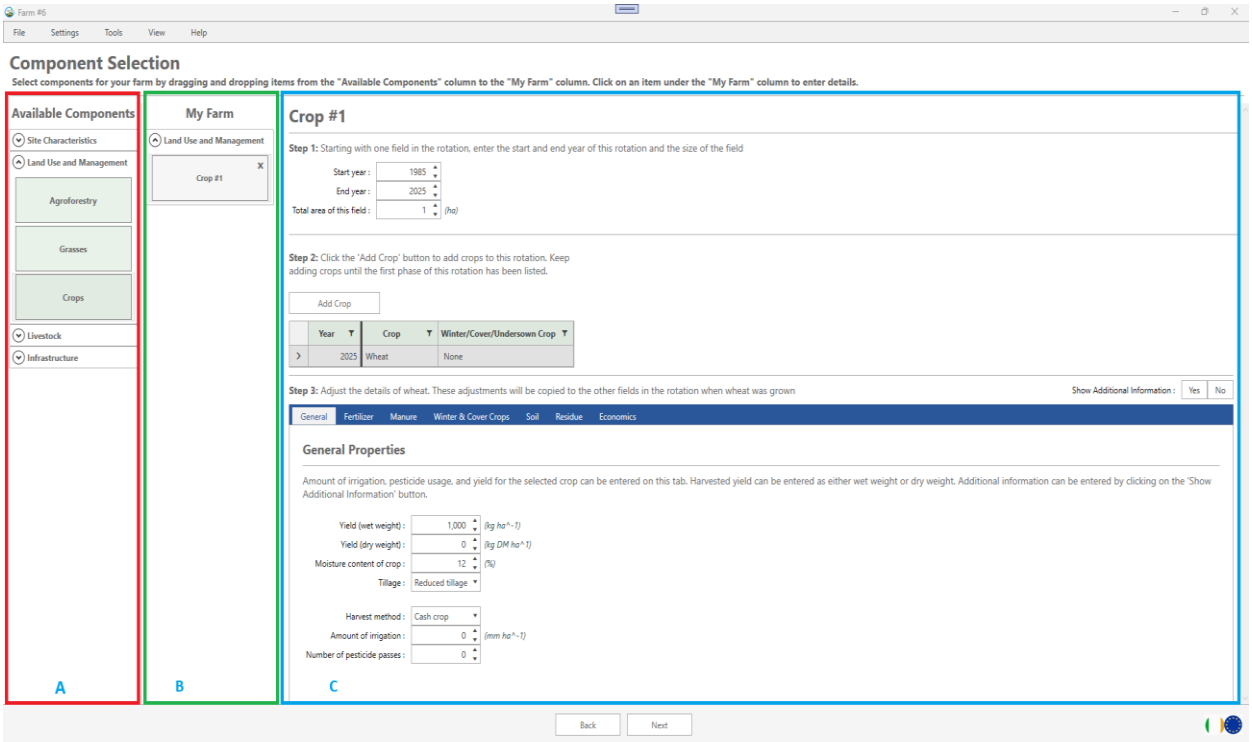

Figure 3.2: *Adding a Component; (A) A list of all available components that can be added to the farm, separated by component category. (B) A list of components that have been added to the farm, and (C) the data associated with the selected component.*

5.3 Crops/Grasses Component

- A crops component contains details like the crop sown, land area, and tillage regime (see figure 6.4). Crops are categorized by their growth type (i.e. Annual, Perennial, etc.)
- To enter specific details about the field, you need to access the Tab View containing: General, Manure, and Residue properties for the field/farm.
- To view additional information, Tab View, click "Yes" beside "Show Additional Information".

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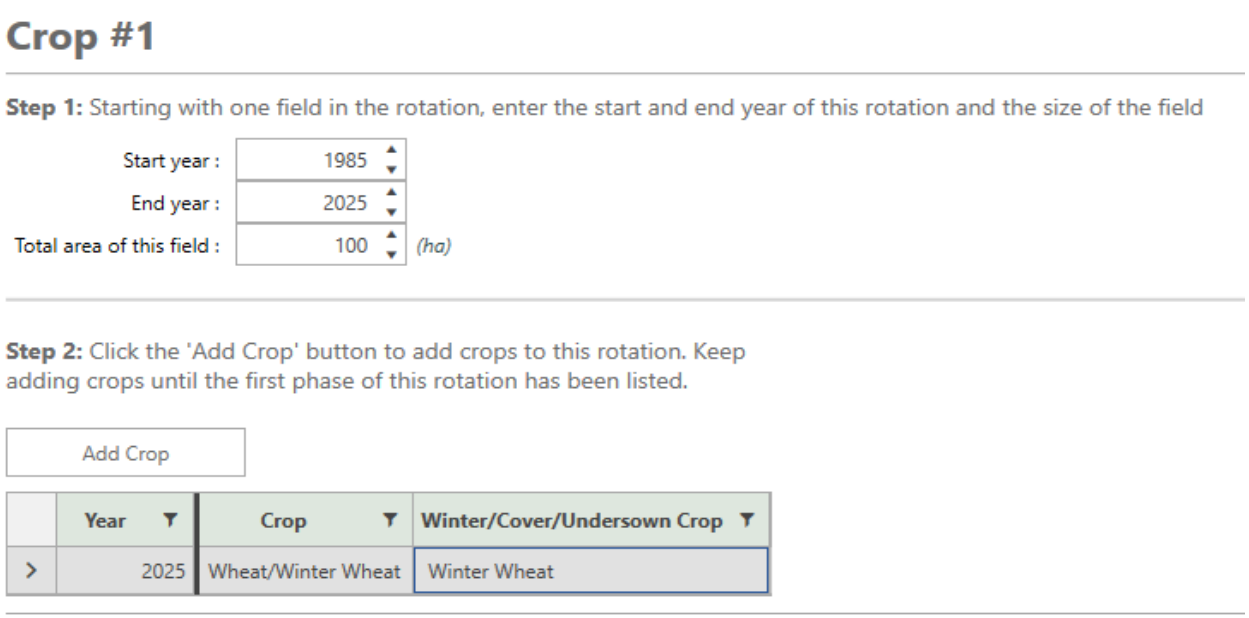

Figure 3.3: *Crop Step 1. Define name, area, crop, and tillage type for your field component.*

The crop component contains different tabs for each aspect of the component.

Tab View

General Properties

Contains information like yield, harvest method, fertilizer application rate etc.

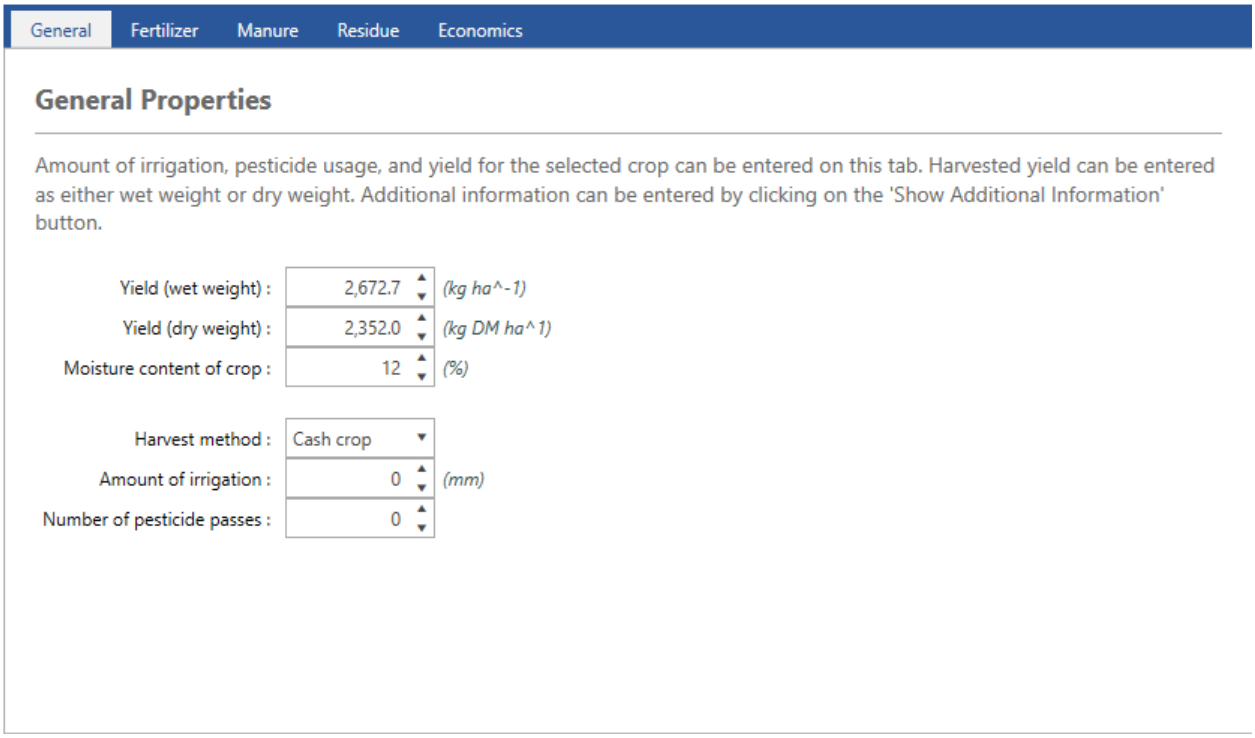

Figure 3.4*: General tab for a field component.*

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Fertilizer

Allows the user to enter fertilizer applications including information like Season of Application, Blend Type and Application Rate to the field.

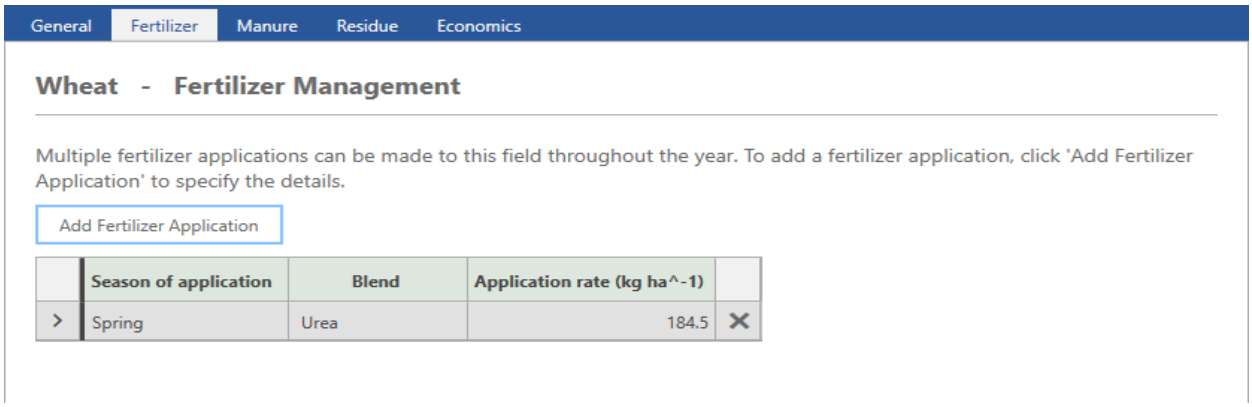

***Figure 3.5**: Fertilizer tab for a field component. This shows the fertilizer application table for a field*

Manure

Allows the user to add a manure application to the field. This application includes information like Date of Application, Manure Type used, Origin of Manure and Amount of Manure applied.

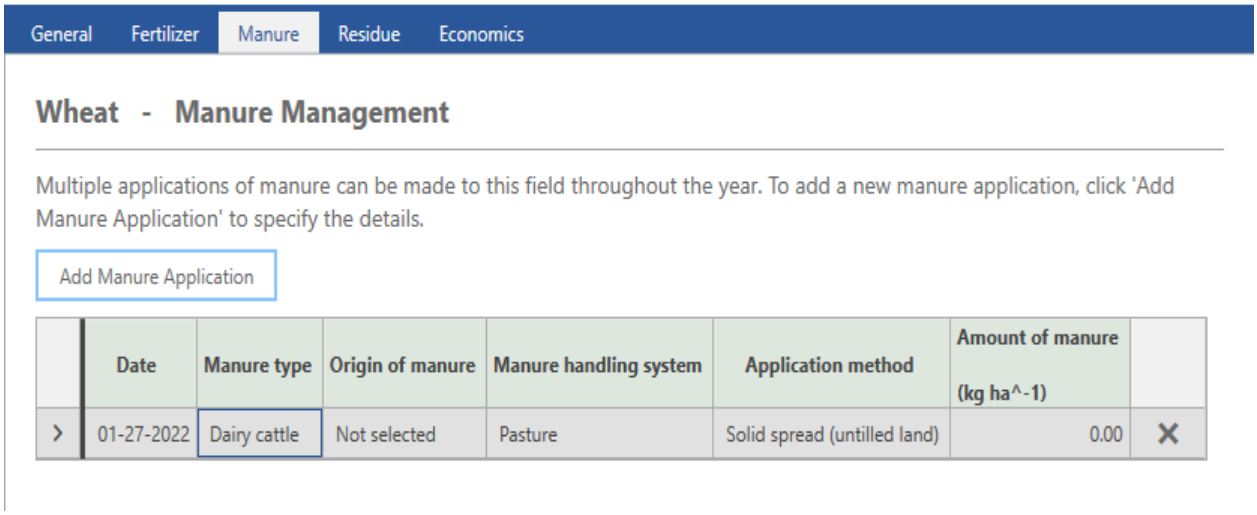

***Figure 3.6**: Manure tab for a field component. This shows the manure application table for a field.*

Soil

The soil tab allows the user to change the soil type for the specific field. The table shows the list of all soil types available for the selected polygon. If a soil type is to be set on the specific field, select one from the list. To customize the soil, click "Custom Mode" and edit the individual soil properties for the field only.

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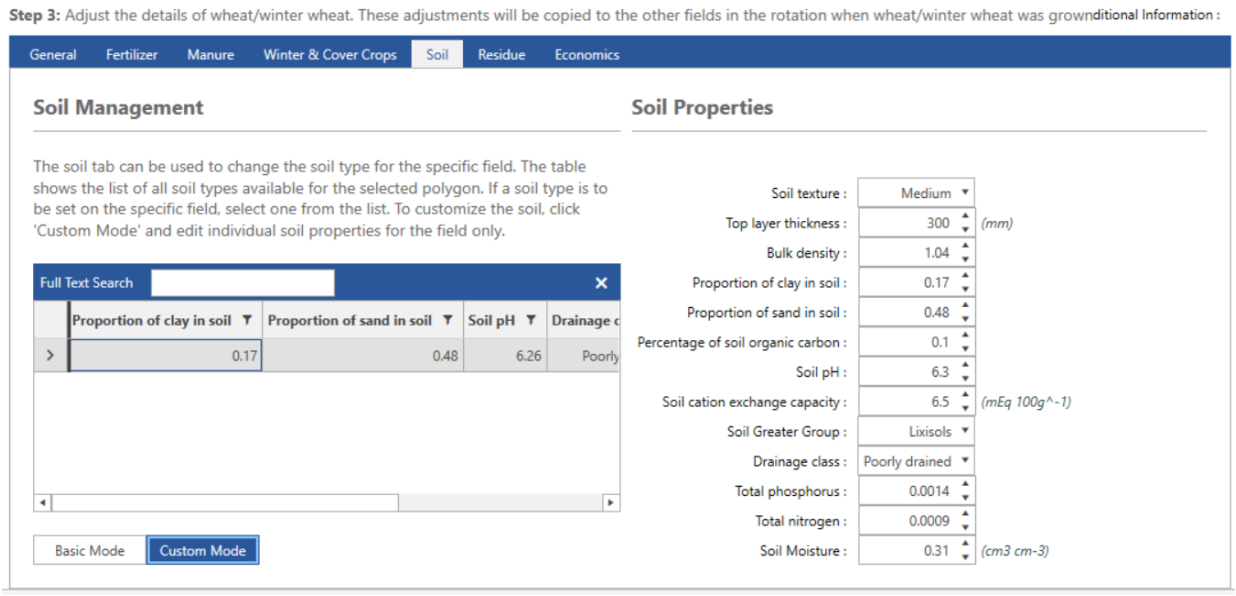

***Figure 3.7.1**: Soil tab for a crops component.*

Residue

This section lets the user specify how much carbon and nitrogen are in your crops. They can also specify how much of the crop remains above or below the ground after harvest.

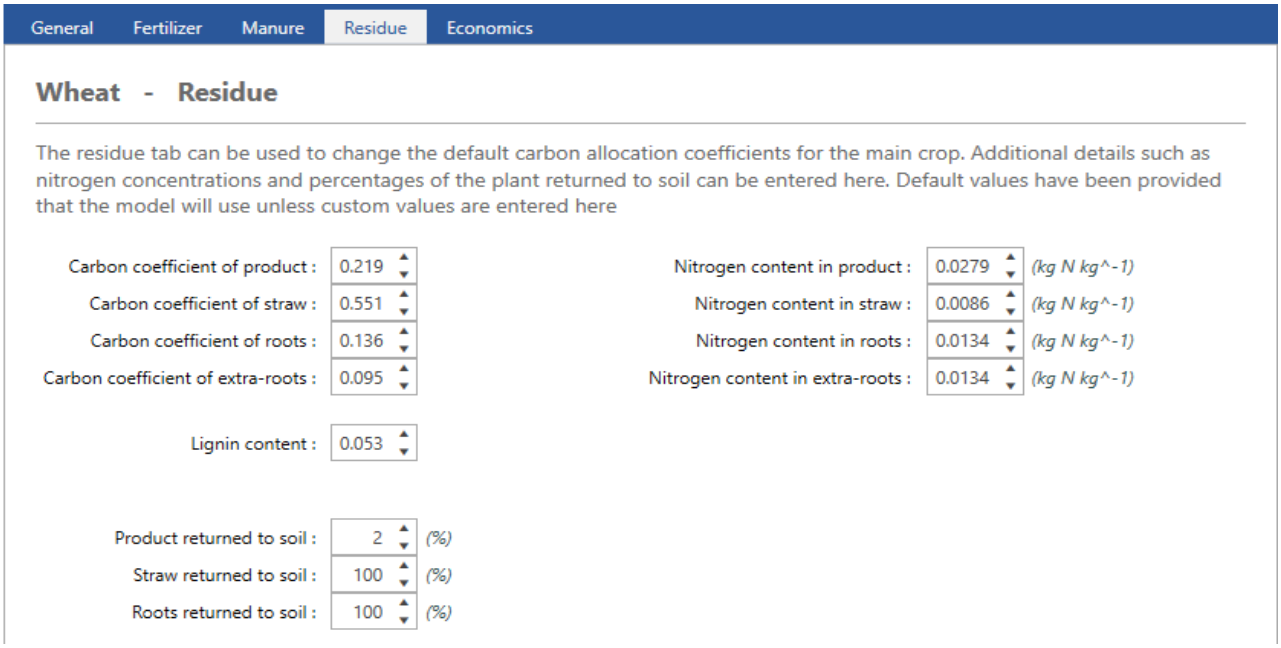

Figure 3.8: Residue tab for a field component.

Economics

The economics section shows various economic data related to the component including crop price, direct costs and total fixed and variable costs.

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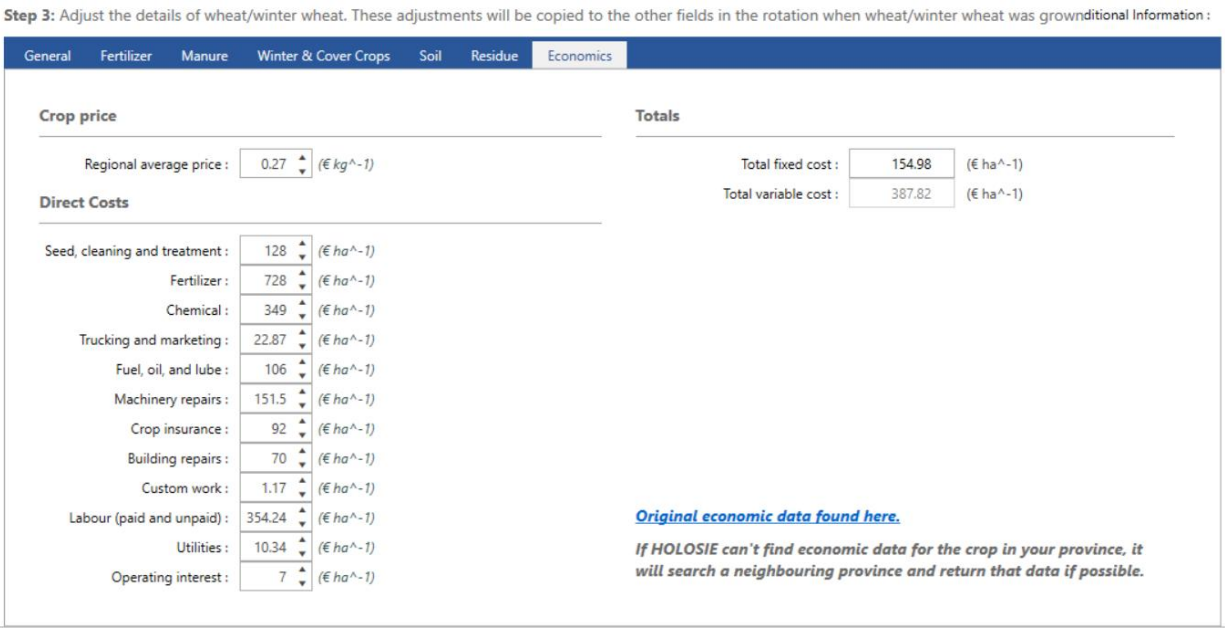

Figure 3.9: Economic tab for a field component showing various costs related to the field.

6. Detailed Results

6.1 Soil Organic Carbon

The submodule of the HOMOSIE simulates SOC density changes (kg/ha) during a specified time, allowing users to compare how different management practices affect SOC density. Users can toggle between graph and grid views, and when analyzing farms with multiple fields or crop types, separate trend lines appear color-coded by component (e.g. wheat crops vs. mixed grass/legume pastures). The interface includes an option to compare multiple farm scenarios simultaneously, enabling side-by-side analysis of alternative management strategies.

***Figure 4.1**: SOC Results Tab*

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6.2 Estimates of Production

The source model has limitations in simulating farm production, which is based on the national average derived from .CSV file (monthly or yearly format). If the component has multiple products like beef cattle (manure and beef), there will be buttons that appear above the graph portion of the report to display the appropriate graph. However, the team has been progressing with dynamic growth modules to be integrated by 2026.

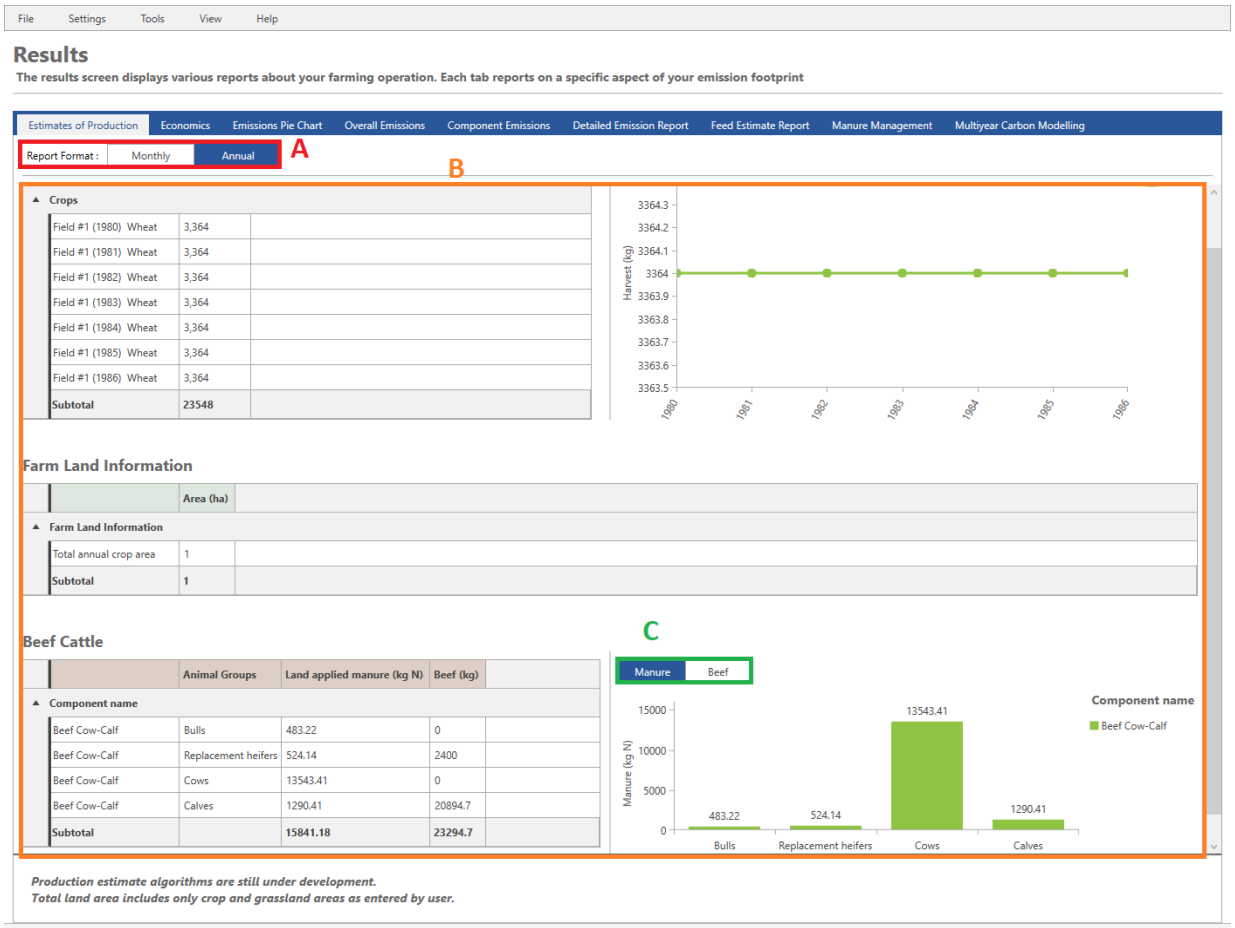

Figure 4.2: Estimates of Production Results Tab: (A) Toggle that helps switch the reporting format to Monthly or Annual, (B) Production Estimates, and (C) Toggle that helps switch between different component items.

Emissions Pie Chart

A proportional representation of all farm emissions. You can view how each farm component contributes by clicking “Yes” beside “Show Details”. You can also change the units of measurement; click on the drop-down box beside “Units of Measurement”. The chart will highlight whichever slice your mouse over for easy identification.

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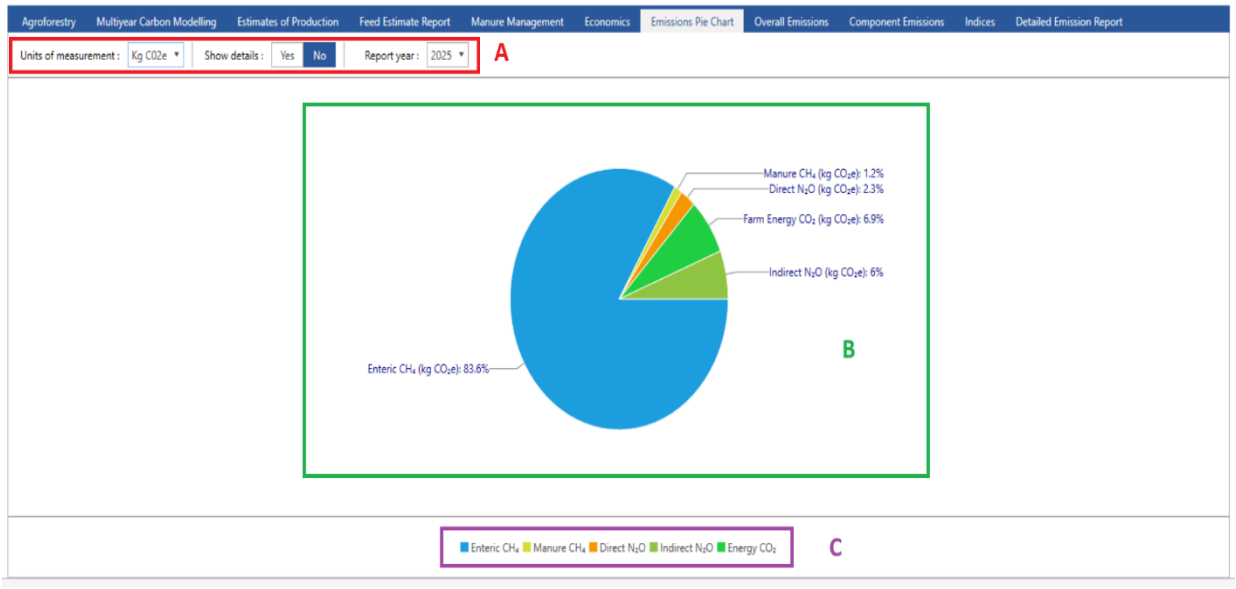

Figure 4.3: Emission Pie Chart Results Tab: (A) Various options related to display of chart. (B) The pie chart and data, and (C): The various emissions from the farm.

Component Emissions

Shows a breakdown of all emissions from a farm on a monthly basis.

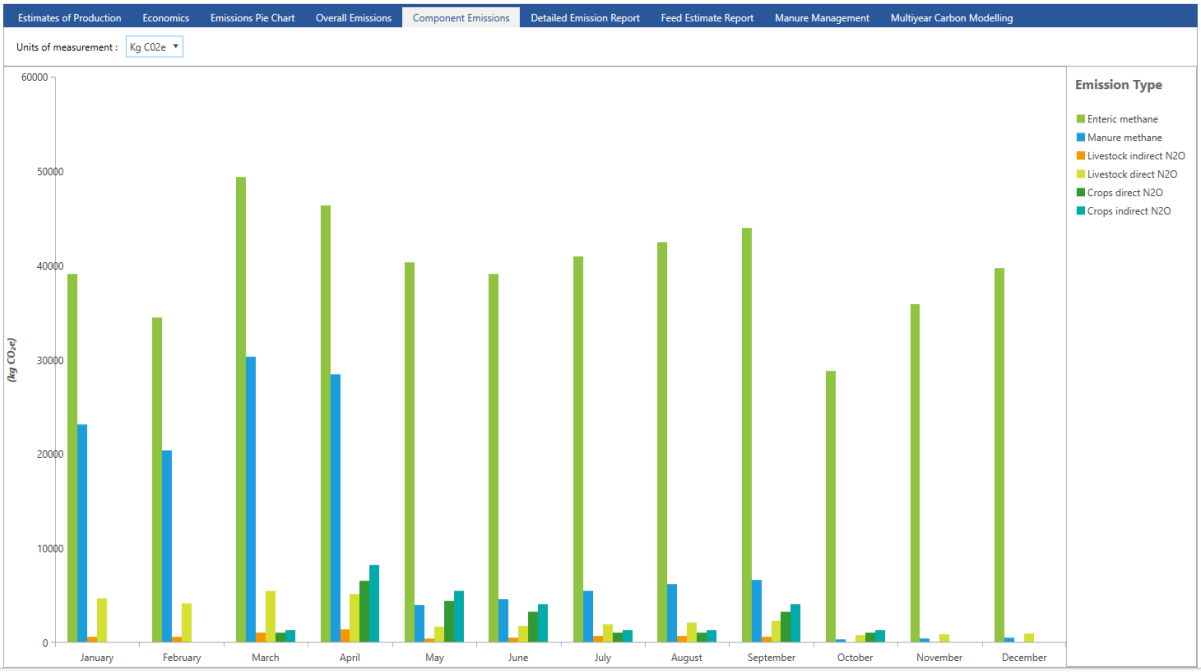

Figure 4.4: Component Emissions Results Tab.

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Overall Emissions

Display the overall amount of each greenhouse gas produced by the farm.

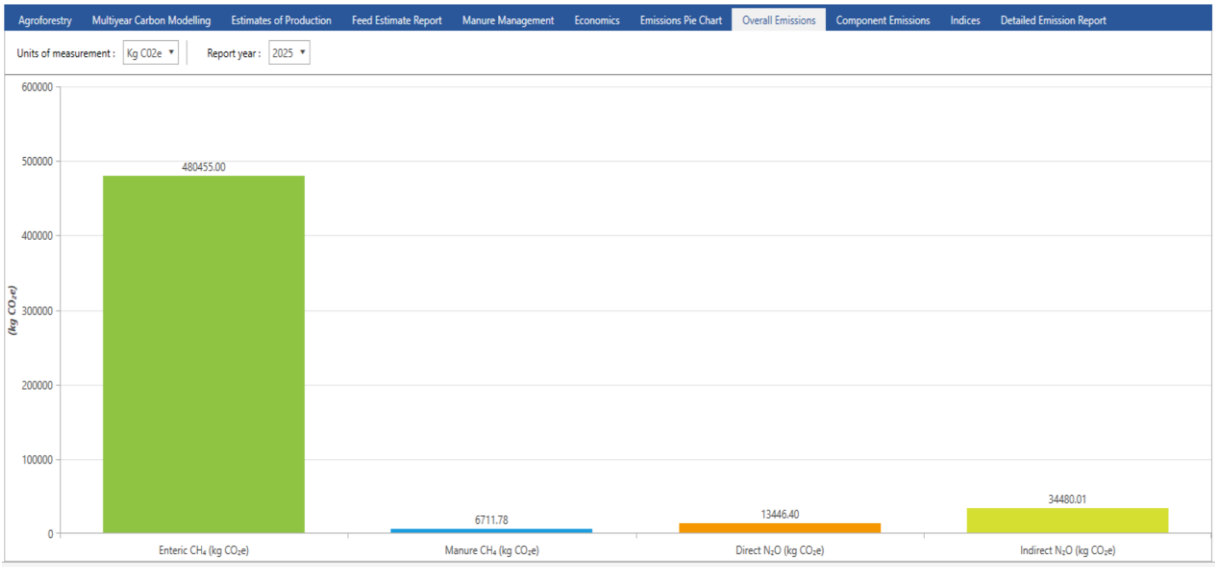

Figure 4.5: Overall Emissions Results Tab.

Detailed Emissions Report

A detailed summary of each component in the farm, showing emission breakdown for each component in the farm (i.e. total Direct/Indirect N2O, Enteric CH4, and Manure CH4 produced by the given component). You can export this data to a CSV file of your choosing. You can also compare multiple farms and see the comparison in the table.

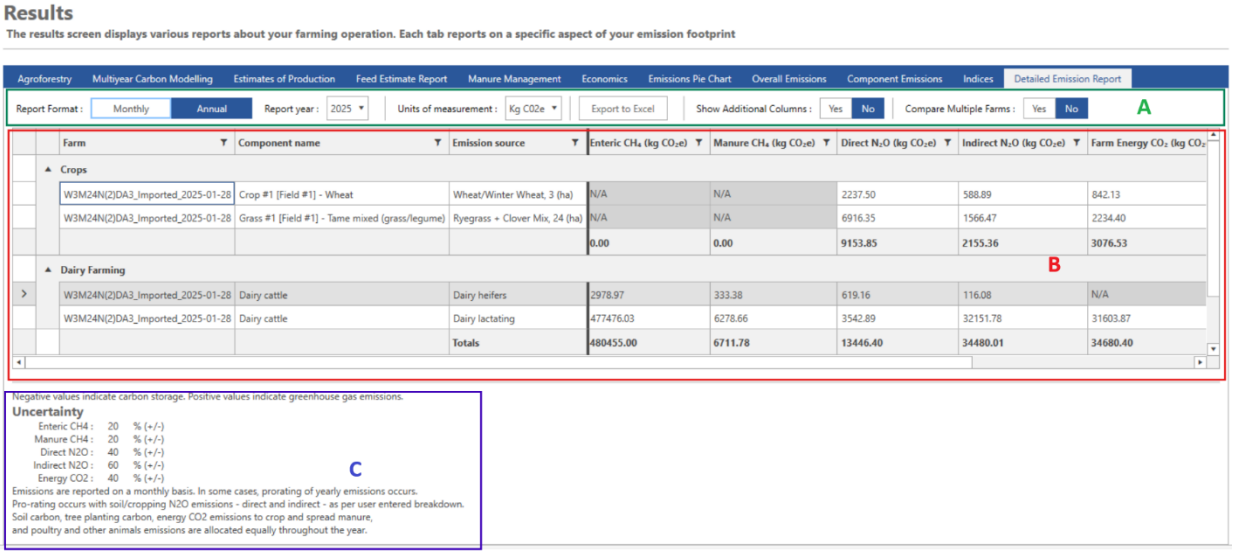

Figure 4.6: Detailed Emissions Results Tab: (A) Command bar capable of exporting the chart data, comparing multiple farms, along with other options previously mentioned. (B) Legend depicting each type of emission, and (C) Uncertainty associated with each type of emission

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Agroforestry

The platform specifically models agroforestry (trees within a farm) as a carbon offsetting strategy. By predicting the atmospheric carbon sequestered by trees (biomass-C, like Silvopastoral, hedgerows) alongside emissions from crops and livestock, the model can assess the total and net carbon balance of a land parcel/farm.

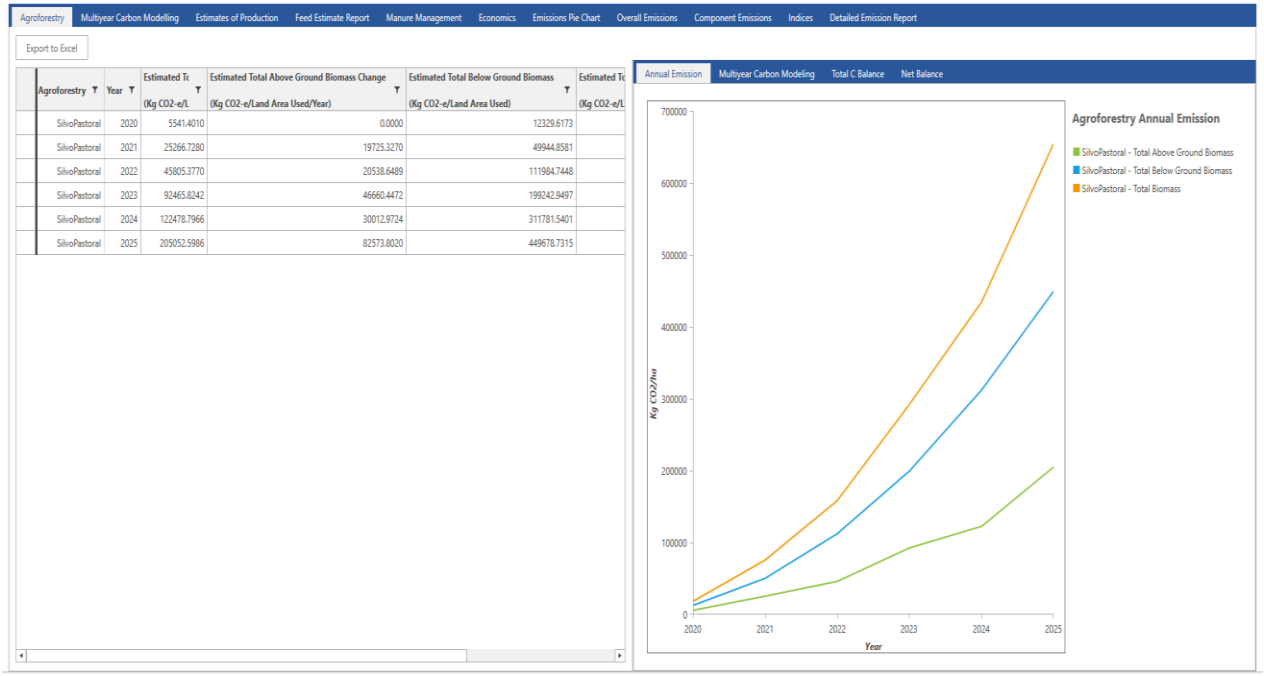

Figure 4.7: Agroforestry Annual Emission, Results Tab.

Soil Organic Carbon (SOC) trends for Silvo-Pastoral system.

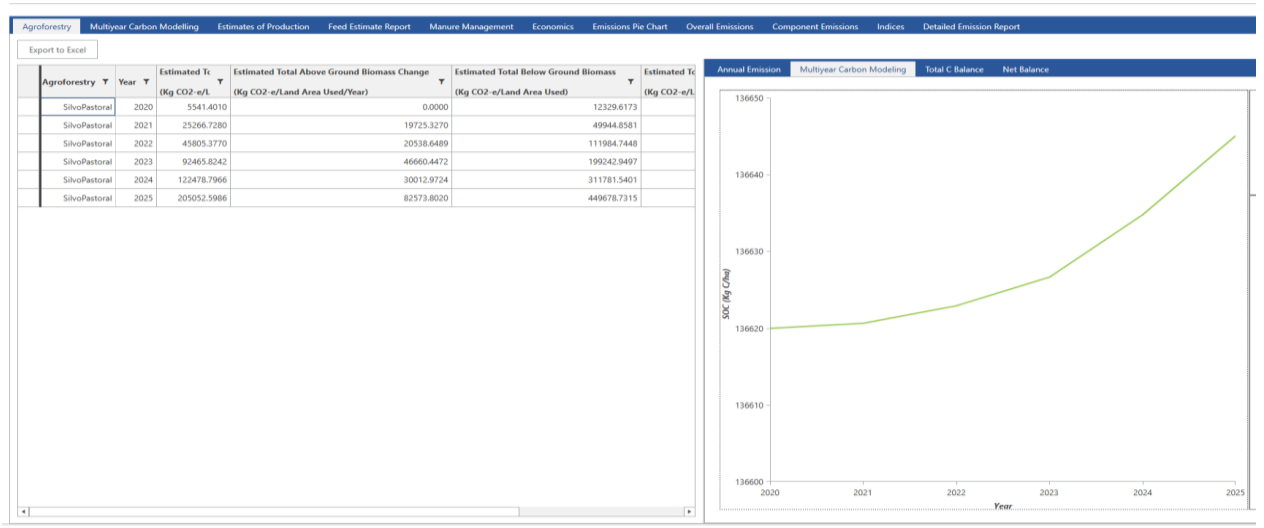

Figure 4.7: Agroforestry Soil Organic carbon (SOC), Results Tab

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Total carbon balance for the selected farm, including the Agroforestry system, and Farm energy.

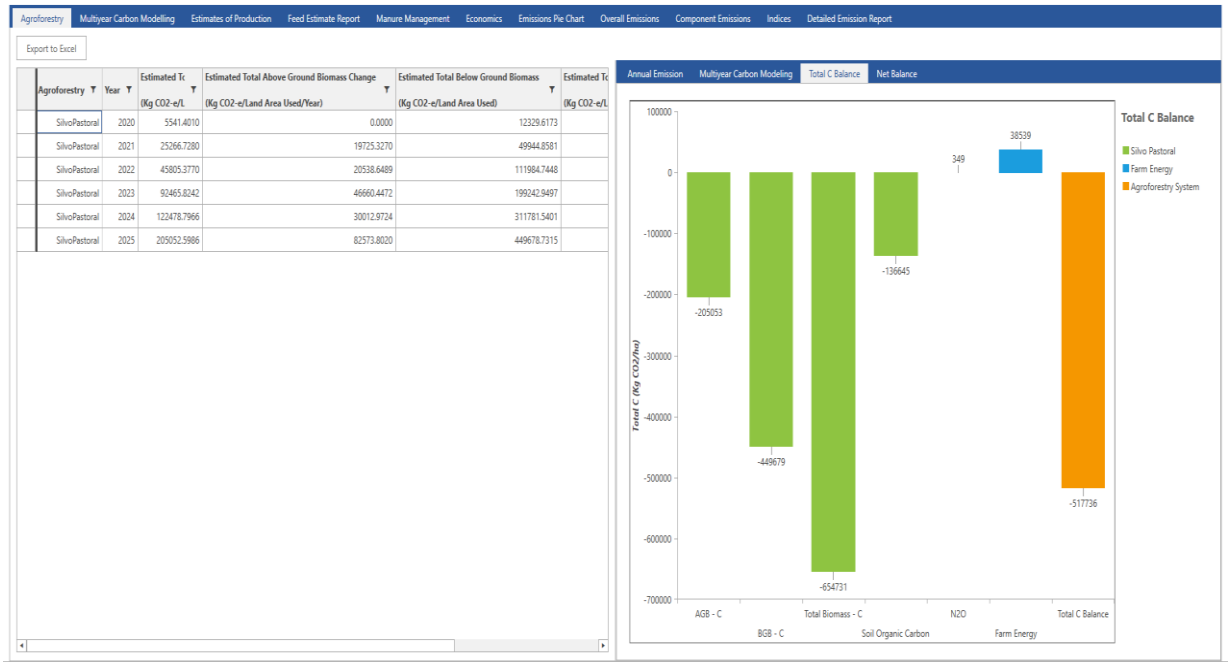

Figure 4.7: Agroforestry Total Carbon Balance, Results Tab

Net balance for the selected farm, Crops/grasses, livestock, agroforestry emissions and net balance.

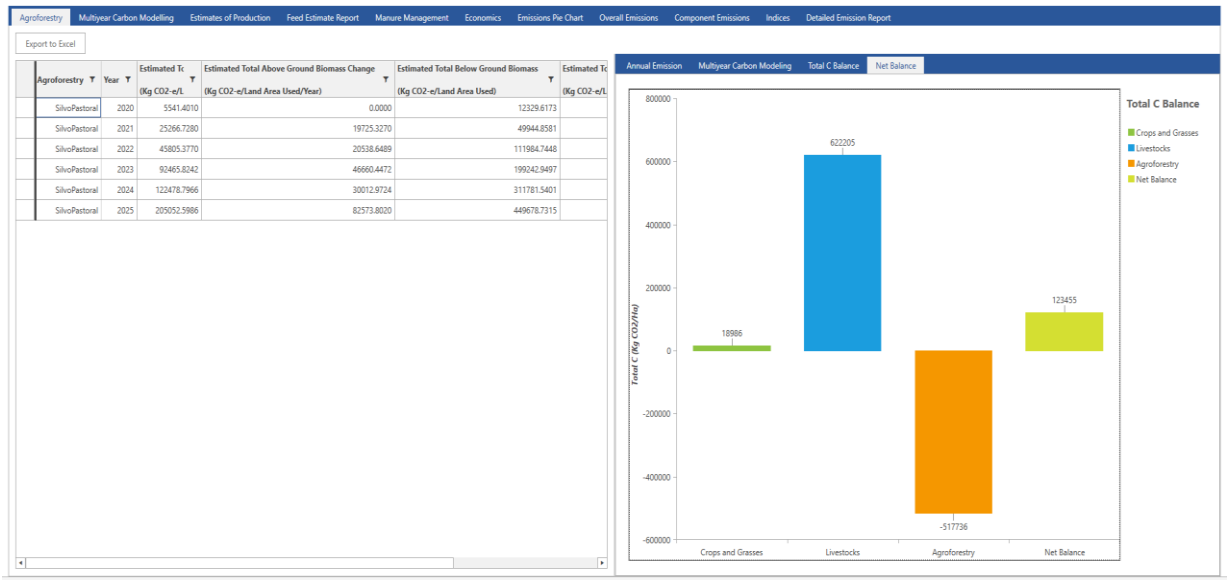

Figure 4.7: Net Balance for Selected Farm, Results Tab

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Economics

Shows the market price and total revenue for crops on your farm. Economic data is provided by various data sources and might be incorrect. This tab offers a rough estimate of the revenue of crops, grassland, livestock, and agroforestry.

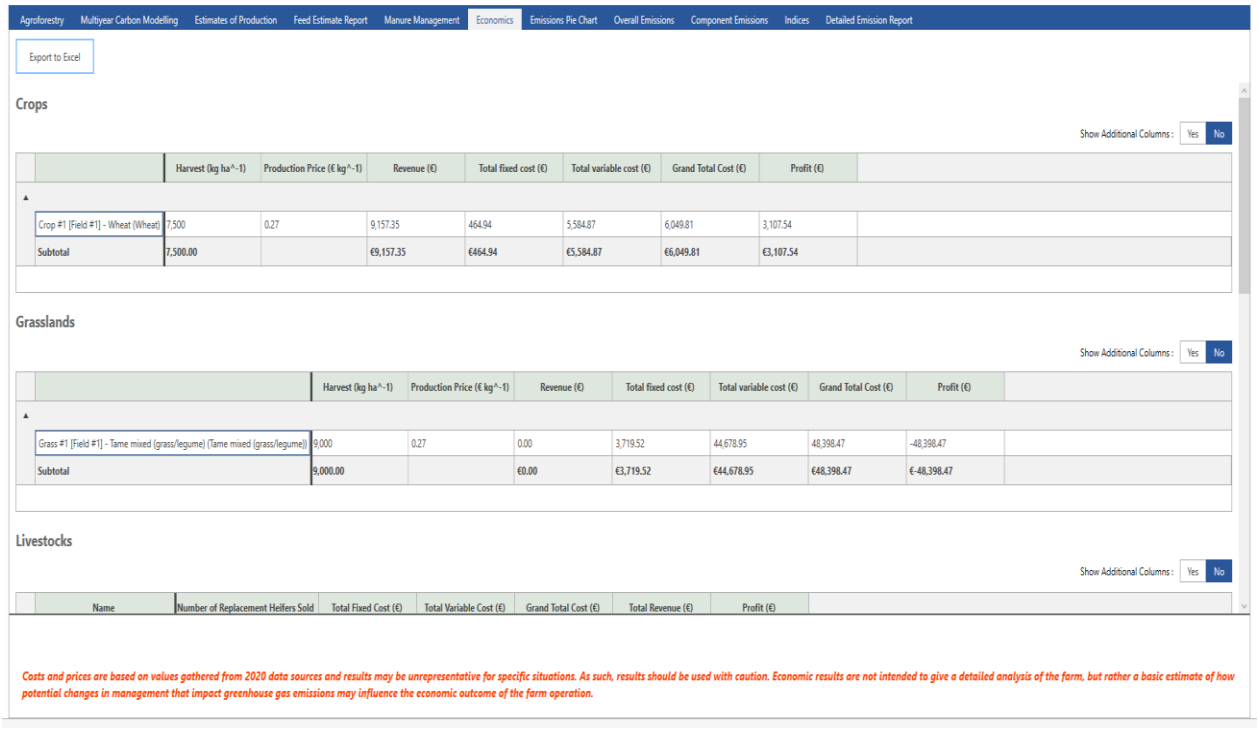

Figure 4.8: Economics Results Tab

7 CONCLUSIONS

Version 4.5 of HOLOS-IE represents a mature and promising iteration of the platform, now poised to expand beyond its Irish roots toward a more pan-European ambition. With the HOLOSEU initiative under development (open-source initiative), backed by 8 European partners with funding from ERA-NET Co-Fund ICT-AGRI-FOOD, the foundation is being laid for a broader application across EU nations and beyond. However, the true unlocking of that potential will depend on rigorous user feedback and comprehensive, country-level validation and recalibration, tasks that the UCD team is already preparing for. In effect, HOLOS-IE v4.5 acts as a springboard: robust enough now for national-scale deployment yet architected to adapt and evolve into HOLOS-EU, once localised calibration, stakeholder consultation, and model refinement have been systematically applied. To achieve improved vision and wider use, active national and international collaboration will be vital in ensuring the model's accuracy, credibility, and relevance across diverse agricultural contexts.

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