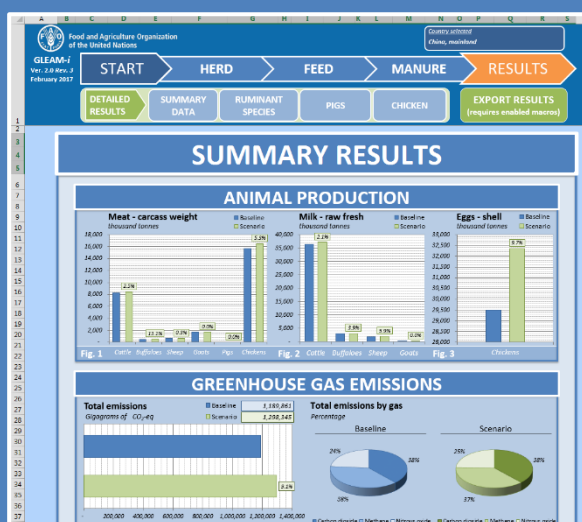




A tool for estimating livestock production, greenhouse gas emissions and assessing intervention scenarios

VERSION 2.0



USER GUIDE

Revision 3
March 2017

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO.

© FAO, 2017

FAO encourages the use, reproduction and dissemination of material in this information product. Except where otherwise indicated, material may be copied, downloaded and printed for private study, research and teaching purposes, or for use in non-commercial products or services, provided that appropriate acknowledgement of FAO as the source and copyright holder is given and that FAO's endorsement of users' views, products or services is not implied in any way.

All requests for translation and adaptation rights, and for resale and other commercial use rights should be made via www.fao.org/contact-us/licence-request or addressed to copyright@fao.org.

FAO information products are available on the FAO website (www.fao.org/publications) and can be purchased through publications-sales@fao.org.

Table of Contents

1. INTRODUCTION	1
1.1. USER'S GUIDE CONTENT	1
1.2. KEY CONCEPTS AND TERMINOLOGY	1
1.3. GLEAM- <i>i</i> STRUCTURE OVERVIEW	2
1.4. SOURCES OF EMISSIONS	3
1.5. TARGETED USERS	4
2. GLEAM- <i>i</i> IN DETAIL	5
2.1. GENERAL ASPECTS	5
2.2. START PAGE	8
2.3. MODULES DESCRIPTION: HERD MODULE	9
2.4. MODULES DESCRIPTION: FEED MODULE	10
2.5. MODULES DESCRIPTION: MANURE MODULE	13
2.6. RESULTS PAGES	14
3. STEP-BY-STEP EXAMPLE	19
3.1. SETTING THE BASELINE	19
3.2. SCENARIO DESCRIPTION	19
3.3. IMPLEMENTING THE SCENARIO: HERD MODULE	21
3.4. IMPLEMENTING THE SCENARIO: FEED MODULE	23
3.5. IMPLEMENTING THE SCENARIO: MANURE MODULE	25
3.6. BASELINE AND SCENARIO COMPARISON	26
3.7. SAVING THE RESULTS	27
4. ANNEX	28

1. INTRODUCTION

1.1. USER'S GUIDE CONTENT

This user guide describes how to use the Global Environmental Assessment Model-interactive tool (GLEAM-*i*) to estimate production, greenhouse gas (GHG) emissions and mitigation potential in livestock supply chains. GLEAM-*i* is intended to support policy-makers, private sector, NGOs, scientists and civil society in understanding emissions from livestock production and designing interventions to reduce their contribution to climate change.

This user guide is divided into three chapters and one annex:

- **Introduction:** provides a brief introduction to key concepts and terminology, describes the general structure of the model and discusses the targeted public of the tool.
- **GLEAM-*i* in detail:** describes the livestock production systems covered by GLEAM-*i* and explains the different modules of the tool.
- **Step-by-step example:** provides a detailed example on how to implement a scenario.
- **Annex:** detailed lists of variables in GLEAM-*i*.

1.2. KEY CONCEPTS AND TERMINOLOGY

GREENHOUSE GAS EMISSIONS AND GLOBAL WARMING POTENTIAL

GLEAM-*i* covers the emissions of the three main GHG related to agricultural activities: carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). The Global Warming Potential (GWP) is the measure of the ability of a certain gas to trap heat in the atmosphere for a given period of time relative to a CO₂ molecule. GLEAM-*i* uses the 100 years AR5 IPCC report¹ GWP values: 34 for CH₄ and 298 for N₂O. That is to say that molecules of methane and nitrous oxide trap respectively 34 and 298 times more heat than carbon dioxide over a period of 100 years.

USE OF IPCC TIER 2 METHODOLOGIES

A given IPCC Tier refers to a set of methodological rules used to estimate GHG emissions with an increasing level of complexity². GLEAM-*i* uses Tier 2 methodologies to perform most of its calculations. In contrast with the simpler Tier 1 approach, Tier 2 methods rely on enhanced characterization of animal populations. This translates into a more accurate estimation of feed intake and quality for the calculation of emissions from enteric fermentation and manure management. Also, the use of Tier 2 methodologies better reflects changes in emissions due to intervention scenarios such as feed or manure management.

LIFE CYCLE ASSESSMENT

The general principle of a life cycle assessment (LCA) is to account for all the inputs and outputs associated with a specific product within a defined boundary system. The application of LCA allows the detection of negative environmental burdens along the main stages of livestock production. It also allows to identify when interventions would result in shifting the negative effects from one stage to another.

DEFAULT, BASELINE AND SCENARIO CONDITIONS

Default conditions are those included in the tool database and are calculated as country averages of the values used in the main GLEAM model. *Baseline* conditions represent the “initial” system state, that is, the situation to which the *Scenario* conditions will be compared to. *Scenario* conditions refers to the situation where changes to the *Baseline* conditions have been made (to simulate a mitigation package, for instance). Before any modifications, all three sets of values are identical.

¹ IPCC, 2014. *Climate change 2014: Synthesis report*. IPCC, Geneva.

² IPCC, 2006. *Guidelines for National Greenhouse Gas Inventories*. IPCC, Geneva

1.3. GLEAM-*i* STRUCTURE OVERVIEW

GLEAM-*i* is based on the Global Livestock Environmental Assessment Model (GLEAM), a spatially explicit modelling framework that simulates the biophysical processes of livestock production and its environmental impacts using a LCA approach. GLEAM differentiates key stages along livestock supply chains such as feed production, processing and transport, herd dynamics, animal feeding and manure management.

GLEAM-*i* retains most of the key characteristics of GLEAM:

- Coverage of six livestock species and their edible products: meat and milk from cattle, buffalo, sheep and goats; meat from pigs and meat and eggs from chicken.
- Estimation of CO₂, CH₄ and N₂O emissions arising from each stage of production.
- Use of Tier 2 methodology in animal herd dynamics, enteric fermentation and manure management emissions, providing accurate information on how animal husbandry, feeding and manure management options affect environmental performance.
- Use of 2010 data in GLEAM-*i* 2.0 and a number of new features also added in GLEAM 2.0 such as CO₂ emissions due to land-use change for production of palm kernel cakes and addition of a new production system: feedlot operations for beef cattle.

Users can find detailed description of GLEAM, including variables and equations, in the [GLEAM model description](#) on line.

GLEAM-*i* consists of three modules for data input, representing the main livestock production stages and one calculation module (Figure 1). The purpose of each module is summarized below:

- The herd module simulates the herd dynamics and the average animal characteristics for each cohort.
- The feed module determines the nutritional characteristics of diets and estimates the associated emissions.
- The manure module calculates the rate at which nitrogen from manure is deposited and applied in the fields. This is necessary to calculate emissions associated with feed production.
- Total herd emissions and production are calculated in the system module using Tier 2 methods.

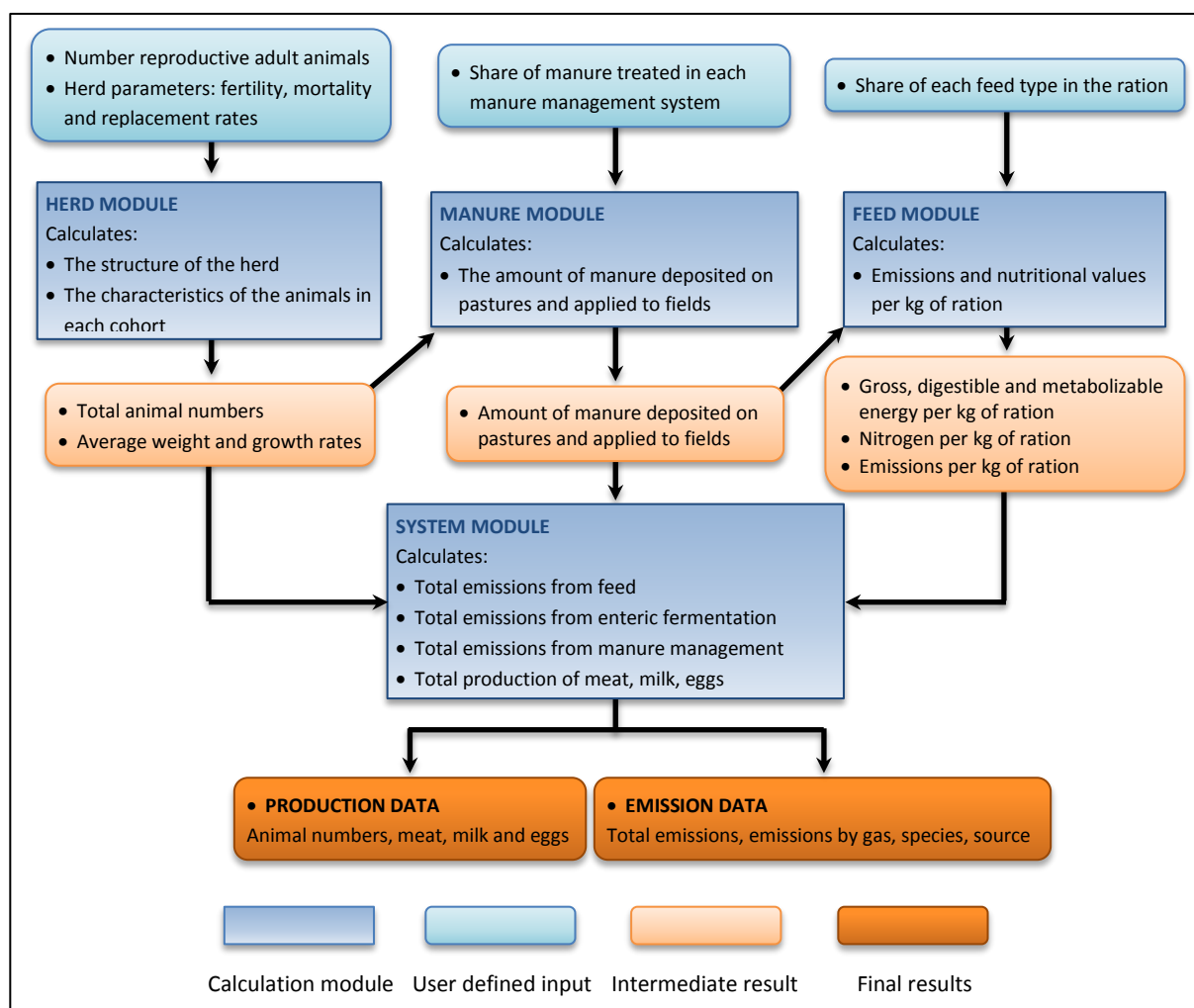


Figure 1. Schematic representation of GLEAM-i, showing the main modules, input data and calculation flows.

1.4. SOURCES OF EMISSIONS

GLEAM-i covers the emissions from the three major GHGs associated with animal food chains: methane (CH₄), nitrous oxide (N₂O) and carbon dioxide (CO₂). Table 1 presents the emissions sources included in GLEAM-i.

Note that, in contrast with GLEAM, 'Postfarm' emissions (that is, CO₂ emissions from the postfarm processing and transport of livestock products) is not included in GLEAM-i. The reason to exclude them is that data needed to estimate those emissions is rarely available at country level, making the estimation highly uncertain below a regional or sub-continental scope.

TABLE 1. Emission sources covered in GLEAM-*i*

Source of emissions		Description
FEED: production (N₂O)	applied and deposited manure	N ₂ O emissions from the conversion of nitrogenous compounds present in animal excreta: manure can be deposited in the fields by grazing and scavenging animals or applied to feed crop fields as organic fertilizer. It includes direct emissions (conversions of nitrogen into N ₂ O through a combination of nitrification and denitrification processes) and indirect emissions (nitrogen is lost in forms of ammonia and NO _x).
	fertilizer and crop residues	N ₂ O emissions from the conversion of nitrogenous compounds present in synthetic nitrogenous fertilizers applied to feed crops and from the decomposition of crop residues. It includes direct emissions (conversions of nitrogen into N ₂ O through a combination of nitrification and denitrification processes) and indirect emissions (nitrogen is lost in forms of ammonia and NO _x).
FEED: production (CO₂)	production	CO ₂ emissions arising from the production, transport and processing of feed. This includes emissions from fossil fuels use in fertilizer and pesticides manufacture, field operations and feed manufacture in feed mills.
FEED: land-use change (CO₂)	soybean cultivation	CO ₂ emissions due to the expansion of soybean cultivation into natural areas. Emissions are related to changes in carbon stored in biomass, dead organic matter and soils.
	palm kernel cake	CO ₂ emissions due to the expansion of palm oil plantations into natural areas. Emissions are related to changes in carbon stored in biomass, dead organic matter and soils.
	pasture expansion	CO ₂ emissions due to the expansion of pastures into natural areas. Emissions are related to changes in carbon stored in biomass, dead organic matter and soils.
FEED: methane (CH₄)		CH ₄ emissions from the cultivation of rice used as feed. Emissions are related to anaerobic decomposition of organic matter in flooded rice fields.
ENTERIC (CH₄)		CH ₄ emissions from enteric fermentation of ruminant species and pigs. During the digestive process, microbial fermentation breaks down part of the carbohydrates in the diet, generating methane as a by-product. In general, fibrous materials cause higher enteric emissions.
MANURE MANAGEMENT (CH₄)		CH ₄ emissions from the anaerobic decomposition of organic material present in animal excreta. This is most common when urine and dung are stored and treated in liquid-based systems.
MANURE MANAGEMENT (N₂O)		N ₂ O emissions from the conversion of nitrogenous compounds present in animal excreta. It includes direct emissions (conversions of nitrogen into N ₂ O through a combination of nitrification and denitrification processes) and indirect emissions (nitrogen is lost in forms of ammonia and NO _x).
ENERGY USE: direct (CO₂)		CO ₂ emissions from the on-site use of energy for animal production. This includes heating, ventilation, refrigerations, machinery, etc.
ENERGY USE: indirect (CO₂)		CO ₂ emissions from the energy used on the construction of facilities (animal housing) and equipment.

Source: Authors.

1.5. TARGETED USERS

GLEAM-*i* users are national and international project planners in governments, producers and civil society organizations with the aim of understanding GHG emissions from the sector and reducing its contribution to climate change. Users of GLEAM-*i* should be those involved in GHG inventories and in the design, discussion or implementation of mitigation projects at national or subnational scale.

2. GLEAM-i IN DETAIL

2.1. GENERAL ASPECTS

2.2.1 Navigating through GLEAM-i

At the top of each page, users will find the navigation bar, shown in Figure 2. It facilitates the navigation between the different pages either using the *Previous* and *Next* arrows or by clicking directly on the desired module. Also, a reminder of the selected country is present at the top right corner.

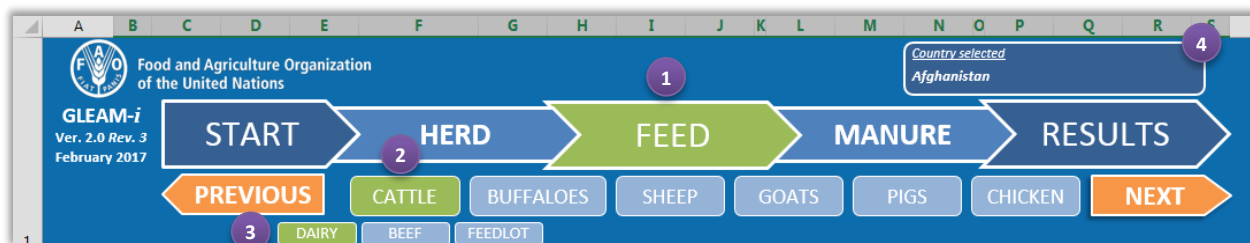


Figure 2. GLEAM-i navigation bar. Current module (1), species (2) and herd (3) are highlighted in green. Selected country is shown in the top corner (4).

2.2.2 GLEAM-i pages structure and color code

Throughout the tool, **Default**, **Baseline** and **Scenario** cells are color coded to facilitate their identification (Figure 3-1). **Default** values (light blue) are based on the selected country and are average country data from the GLEAM database. Those values cannot be modified. **Baseline** (dark blue) and **Scenario** (green) cells indicate where the user can introduce, delete or modify data. If no changes are made, both **Baseline** and **Scenario** conditions are simulated using the aforementioned **Default** values.

A short explanation on each page and a reminder on how to fill in the data are located below the navigation bar (Figure 3-2). Cells to insert values and/or parameters, are always identified (Figure 3-3, **Animal numbers** section in this case). Depending on the module, there are some special cells for clarification. For instance, changes of animal numbers due to modified starting animals or parameters are shown in the special cells shown in Figure 3-4.

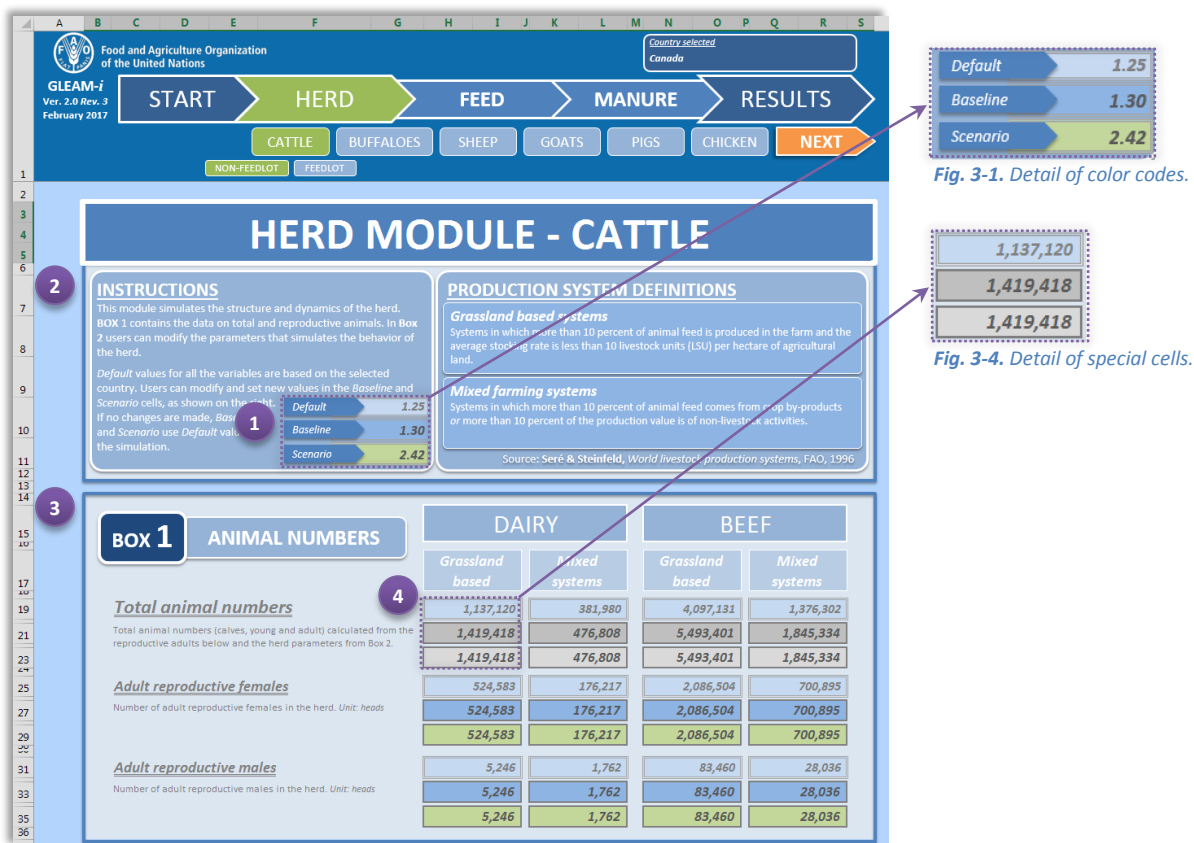


Figure 3. Page structure and color code example. Color code (1), instructions (2) and area for data insertion (3) are shown. In some pages, special cells are also used (4).

2.2.3 Livestock production systems and herd types

GLEAM-i distinguishes between three production systems for cattle (grassland based, mixed farming systems and feedlots), two for buffaloes, sheep and goats (grassland based and mixed farming systems), three for pigs (backyard, intermediate and industrial) and three for chicken (backyard, layers and broilers). In addition, ruminant species are split into dairy and non-dairy herds. Tables 2 to 4 summarize the characteristics of each production system.

TABLE 2. Summary of ruminant production systems

System	Characteristics
Grassland based systems	Livestock production systems in which more than 10 percent of the dry matter fed to animals is farm-produced and in which annual average stocking rates are less than ten livestock units per hectare of agricultural land.
Mixed systems	Livestock production systems in which more than 10 percent of the dry matter fed to animals comes from crop by-products and/or stubble or more than 10 percent of the value of production comes from non-livestock farming activities.
Feedlots	Specialized, fully market-oriented operations where animals are fed with a specialized diet that is intended to stimulate weight gain. This period typically lasts for six to nine months, depending on the starting and targeted live weight. Diets are generally composed of highly energetic and protein-rich feedstuffs, such as corn and cakes, respectively.

Source: Authors.

TABLE 3. Summary of pig production systems

System	Housing	Characteristics
Backyard	Partially enclosed: no concrete floor, or if any pavement is present, made with local material. Roof and support made of local materials (e.g. mud bricks, thatch or timber).	Mainly subsistence driven or for local markets; level of capital inputs reduced to the minimum; herd performance lower than commercial systems; feed contains maximum 20 percent of purchased non-local feed; high shares of swill, scavenging and locally-sourced feeds.
Intermediate	Partially enclosed: no walls (or made of a local material if present), solid concrete floor, steel roof and support.	Fully market-oriented; medium capital input requirements; reduced level of overall herd performance (compared with industrial); locally-sourced feed materials constitute 30 to 50 percent of the ration.
Industrial	Fully enclosed: slatted concrete floor, steel roof and support, brick, concrete, steel or wood walls.	Fully market-oriented; high capital input requirements (including infrastructure, buildings, equipment); high level of overall herd performance; purchased non-local feed in diet or on-farm intensively produced feed.

Source: Authors.

TABLE 4. Summary of chicken production systems

System	Housing	Characteristics
Backyard	Simple housing using local wood, bamboo, clay, leaf material and handmade construction resources for supports plus scarp wire netting walls and scrap iron for roof.	Animals producing meat and eggs for the owner and local market, living freely. A significant part of the diet consists of swill and scavenging, while locally-produced feed constitutes the rest.
Layers	Layers housed in a variety of cage, barn and free-range systems, with automatic feed and water provision.	Fully market-oriented; high capital input requirements; high level of overall flock productivity; purchased non-local feed or on-farm intensively produced feed.
Broilers	Broilers assumed to be primarily loosely housed on litter, with automatic feed and water provision.	Fully market-oriented; high capital input requirements; high level of overall flock productivity; purchased non-local feed or on-farm intensively produced feed.

Source: Authors.

2.2. START PAGE

After downloading GLEAM-i from the website, users will first encounter the **Start** page:

- 1 Welcome to GLEAM-i message from the team.
- 2 GLEAM-i basics, essential information on GLEAM-i structure and navigation.
- 3 Name for the simulation. Note that it cannot contain any of the following characters: \ / : * ? < > |
- 4 Selection of region and country. It will load **Default** values for all variables involved in the model once the country is selected.
- 5 Begin the simulation by clicking the Start the simulation button.
- 6 Users can find guidance on how to provide feedback about the tool in the Providing feedback box.
- 7 Disclaimer regarding the use of GLEAM-i.

The screenshot shows the GLEAM-i Start page interface. At the top, there is a navigation bar with tabs: START (highlighted in green), HERD, FEED, MANURE, and RESULTS. Below this, the main heading reads 'GLEAM-i GLOBAL LIVESTOCK ENVIRONMENTAL ASSESSMENT MODEL - i interactive'. The page is divided into several sections:

- 1 WELCOME TO GLEAM-i**: A text box on the left side of the main content area.
- 2 GLEAM-i BASICS**: A text box on the right side of the main content area.
- 3 STEP 1**: A text input field labeled 'Type a name for your simulation' with a placeholder '[Type the simulation name]'.
- 4 STEP 2**: A text input field labeled 'Select your target region' with a placeholder '[select a region]'.
- 5 STEP 3**: A text input field labeled 'Select your target country'.
- 6 STEP 4**: A large green button labeled 'START THE SIMULATION'.
- 7 PROVIDING FEEDBACK**: A text box at the bottom left.
- DISCLAIMER**: A text box at the bottom right.

At the top of the main content area, there are also buttons for 'HERD' and 'FEED', and a sub-section for 'CATTLE' and 'BUFFALOES'.

Figure 4. Screen capture of the **Start** page with all of its parts highlighted.

2.3. MODULES DESCRIPTION: HERD MODULE

The **Herd** module simulates the size and dynamics of the herd based on animal numbers and several parameters, such as fertility or mortality rates. This module impacts directly production and emissions, as it constitutes the basis for the simulation.

Summarized instructions for the page and a description of the production systems are found at the top section of the page (Figure 5-1). The second section, **Animal numbers**, (Figure 5-2) contains the cells to insert or modify numbers of reproductive animal, differentiated by production system and herd type. The third section, **Herd parameters** (Figure 5-3), contains the list and a brief description of the variables determining the dynamics of the herd. For a full description of the parameters, please refer to tables A1 to A5 in the annex. Any changes either in animal numbers or herd parameters are immediately reflected in the **Total animal numbers** cells (Figure 5-4).

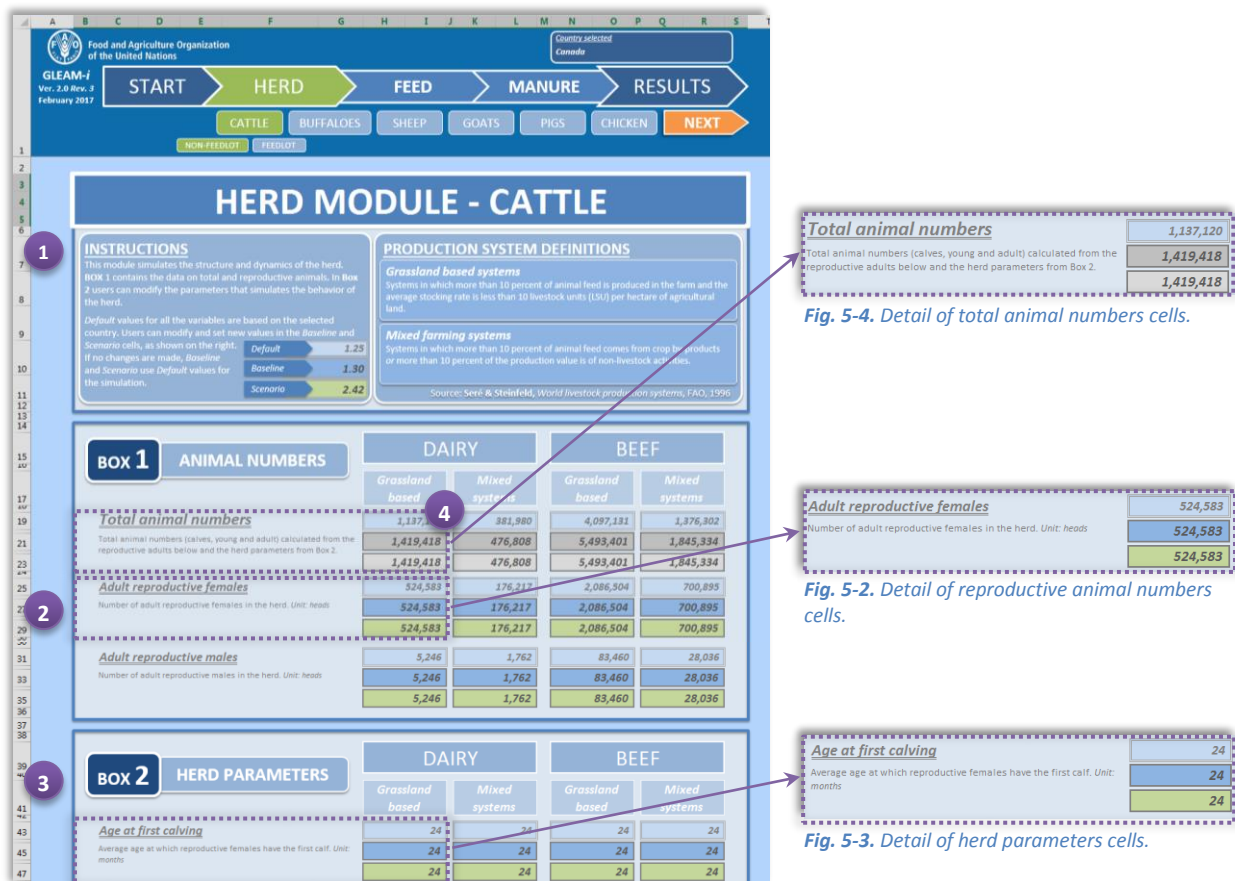


Figure 5. Herd module page example.

2.4. MODULES DESCRIPTION: FEED MODULE

Animal diets can be modified in the **Feed** module, directly impacting the emissions related to feed production and enteric fermentation. N₂O emissions from manure are also affected through the nitrogen content of the ration.

RUMINANT SPECIES PAGES

Ruminant diets are defined for each combination of species, production systems, herd and feeding groups (Figure 6a and Figure 6b). Summarized instructions for the page are found under the main label (Figure 6-1). A second section provides a **Summary ration** by main feed category (Figure 6-2). The share of each feedstuff can be modified in the **Detailed ration** section (Figure 6-3). For a full description of feed materials for ruminant species, please refer to Table A5. When modifying the ration, users can easily check that the new shares add up to 100% within the **Ration percentages overview** section (Figure 6-4).

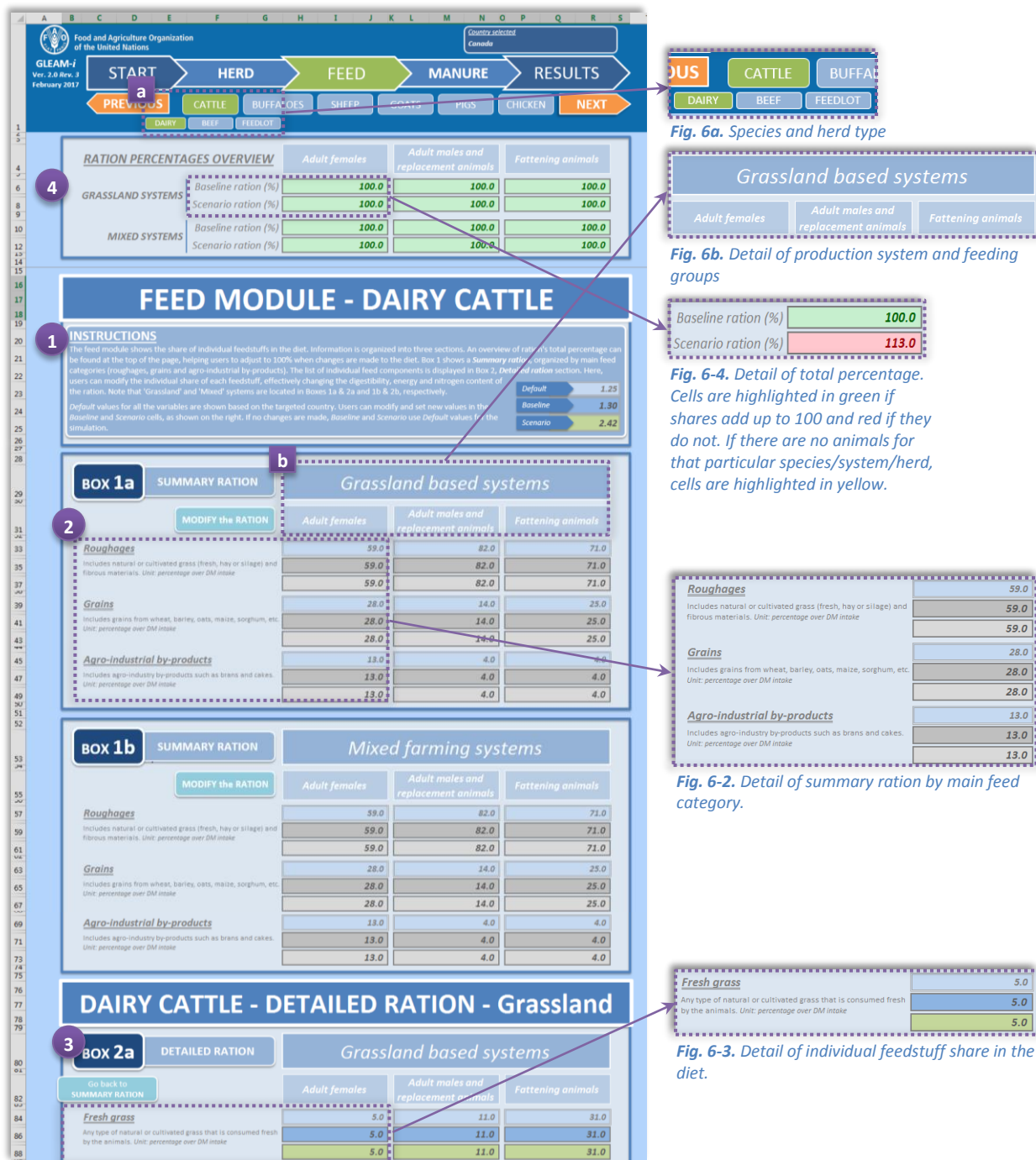


Figure 6. Feed module example page for ruminant species.

EMISSIONS FROM PASTURE EXPANSION

This page presents the data on emissions arising from the expansion of pastures used for grazing into natural areas. Following GLEAM, this calculation applies exclusively to specialized beef cattle in grazing systems in the following countries of Latin America and the Caribbean: Brazil, Chile, Nicaragua, Honduras, Ecuador, Panama, El Salvador and Belize. For further details on background data and the methodology, please refer to GLEAM model description.

Users can access the page through a dedicated button in the 'Beef cattle – Grazing systems' (Figure 7).

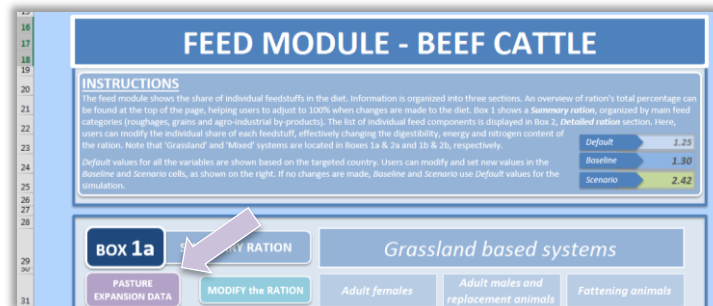


Figure 7. Dedicated button in the Beef cattle Feed page to open the Pasture expansion page.

Summarized instructions can be found at the top of the page (Figure 8-1), alongside the result of the calculation (Figure 8-2). Emissions are calculated using the IPCC *Stock-Difference method*, which measures carbon stocks at two points in time to assess carbon changes. Users can modify the length of the period (Figure 8-3) and the area of expansion (Figure 8-4). Biomass figures depending on the country selection are given for reference (Figure 8-5).

Modifications of **Default** conditions regarding pasture expansion should be done with additional care, and it is not recommended to change the given values unless users have a high degree of confidence in the new data.

EMISSIONS FROM PASTURE EXPANSION

1 INSTRUCTIONS

This page shows the data needed to estimate emissions from land-use change due to pasture expansion into natural areas. Those emissions are allocated to beef cattle from grassland systems, assuming that the new pasture areas are devoted to grazing.

Default values presented here correspond to GLEAM values using 2010 data. Users can modify those values for both baseline and Scenario conditions by adjusting the time period or the expanded pasture area. The estimation of emissions is based on IPCC guidelines and uses IPCC Tier 1 default carbon stock values for biomass. Note: LUC pasture expansion is not applicable or available for all countries (Default data is shown as 0 in those cases).

2 TOTAL EMISSIONS

LUC - PASTURE EXPANSION

295,346,920,000 kg CO₂

295,346,920,000 kg CO₂

295,346,920,000 kg CO₂

3 Step 1 - PERIOD considered

	Initial year	Final year	Period length
Period of expansion	1990	2010	20
	1990	2010	20
	1990	2010	20

4 Step 2 - Pasture expansion AREA

	Pasture area at INITIAL stage	Pasture area at FINAL stage	TOTAL pasture expansion
Pasture expansion area	184,200,000	196,000,000	11,800,000
	184,200,000	196,000,000	11,800,000
	184,200,000	196,000,000	11,800,000

5 Data on carbon in BIOMASS

	Above-ground biomass	Below-ground biomass	Total biomass
Carbon in biomass pool	220	52.8	272.8

Figure 8. Pasture expansion page.

MONOGASTRIC SPECIES PAGES

Feed rations for monogastric species are defined for each combination of species and production system (Figure 9a and Figure 9b). Similarly to ruminant pages, summarized instructions for the page are found under the main label (Figure 9-1). Summary ration section provides the aggregated share of each main feed category (Figure 9-2). The share of each feedstuff can be modified in the Detailed ration section (Figure 9-3). Table A6 provides the full description of feed materials for monogastric species. Ration percentages overview section allows for an easy check that new shares add up to 100% when modifying the ration (Figure 9-4).

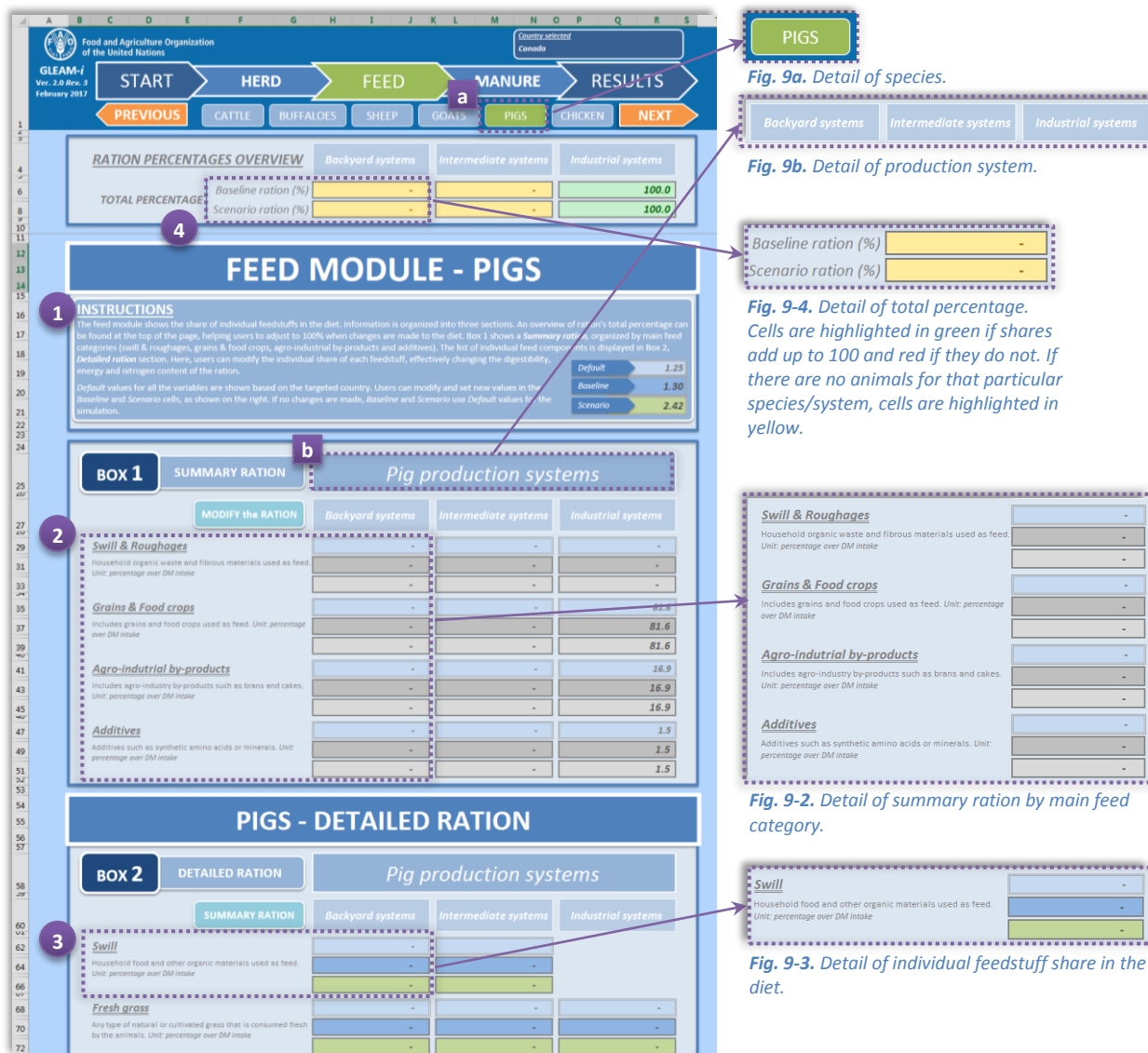


Figure 9. Feed module example page for monogastric species.

2.5. MODULES DESCRIPTION: MANURE MODULE

The **Manure** module contains the information on the storage and handling of urine and dung (collectively referred to as manure). This module impacts directly the CH₄ and N₂O emissions from manure and, indirectly, the emissions related to feed through the use of manure as fertilizer. The manure management systems (MMS) used in this module are taken from the 2006 IPCC guidelines. The full description of all MMS used in GLEAM-i can be found in Table A7.

The page displays the share of each MMS for each species, production system and, in the case of ruminants, for each type of herd (Figure 10a and Figure 10b). Summarized instructions about the page can be found under the main title (Figure 10-1). The share of each MMS can be modified in the **MMS percentages** section (Figure 10-2). To keep track of total percentages when modifying any value, the **Manure systems overview** section provides a quick way to ensure new values add up to 100% (Figure 10-3).

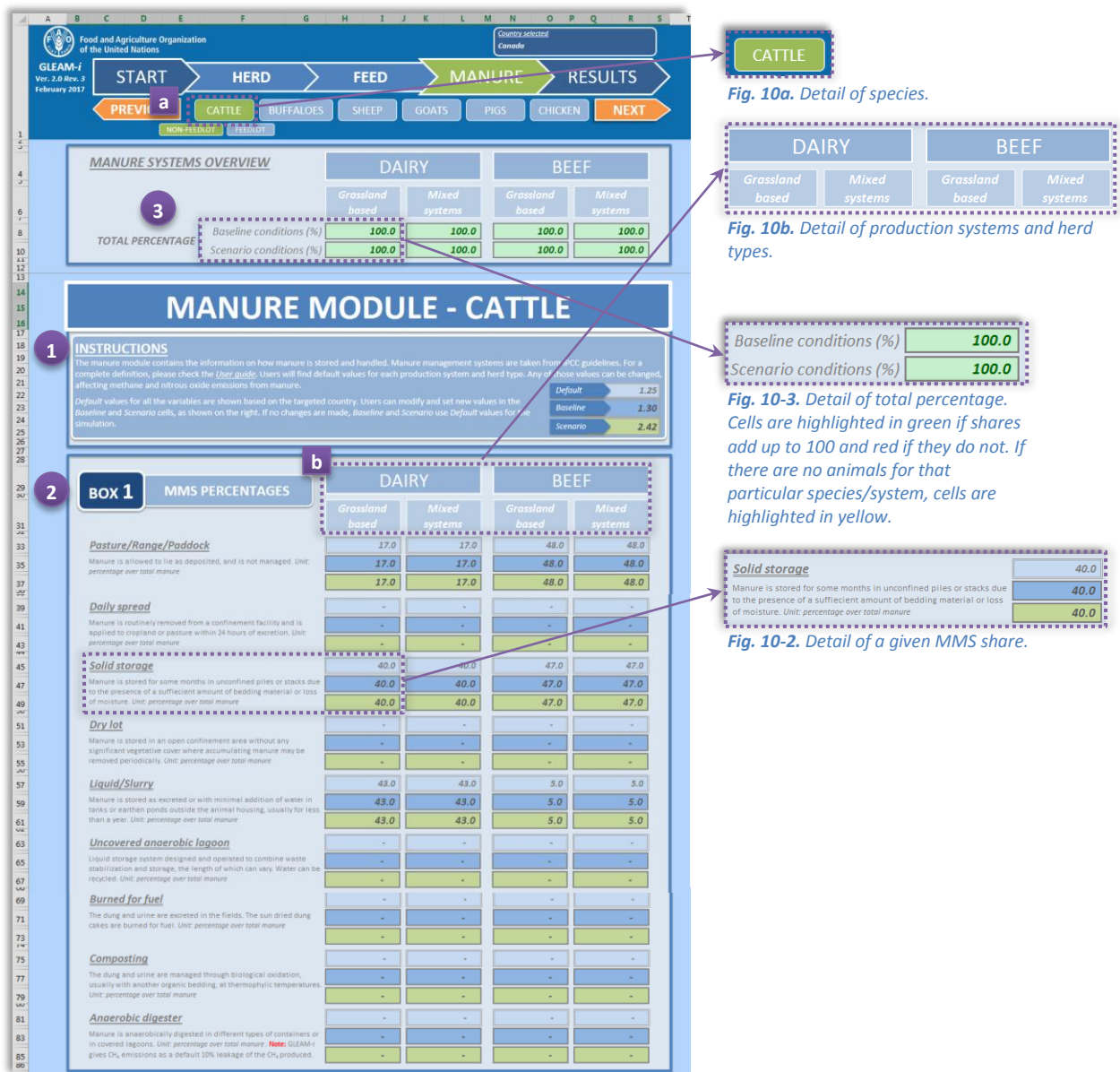


Figure 10. **Manure** module page example.

2.6. RESULTS PAGES

GLEAM-i provides the results of the simulation in two complementary formats. First, a dedicated **Results** page contains a series of graphs and figures where **Baseline** and **Scenario** conditions are displayed side by side to facilitate a visual and fast comparison between them. Second, a series of tables with more detailed results by species and production systems are available for easy numeric comparisons.

At the top of the **Results** page, users will find the usual navigation bar with a direct access to every module (Figure 11-1). In addition, summary results and detailed tables for each species can be accessed by clicking in their corresponding buttons (Figure 11-2). Additionally, users can save a copy of all the numeric tables in a separate file using the **Export results button** (Figure 11-3). Macros must be enabled to use this feature.

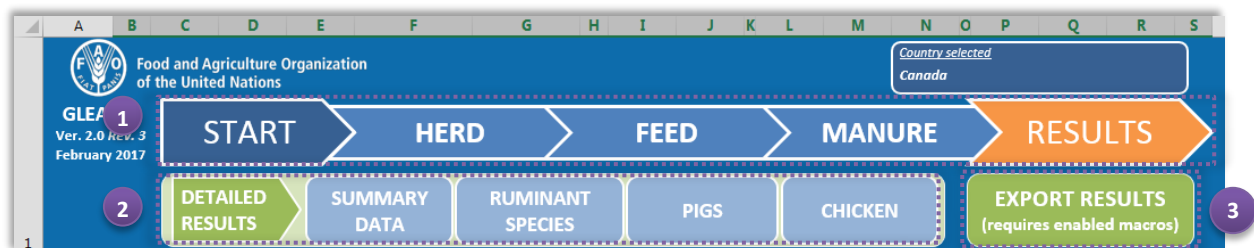


Figure 11. Navigation bar in the **Results** page.

2.7.1 Graphs – Animal production

Estimates on animal production are shown in this section. Graphs include meat production in carcass weight (Figure 12-1), milk production as fresh, raw milk (Figure 12-2) and egg production in shell weight (Figure 12-3). **Baseline** and **Scenario** conditions are represented by blue and green bars, respectively. For **Scenario** conditions, a label with the percentage of change respect to the **Baseline** is also shown to facilitate the comparison (Figure 12-4).

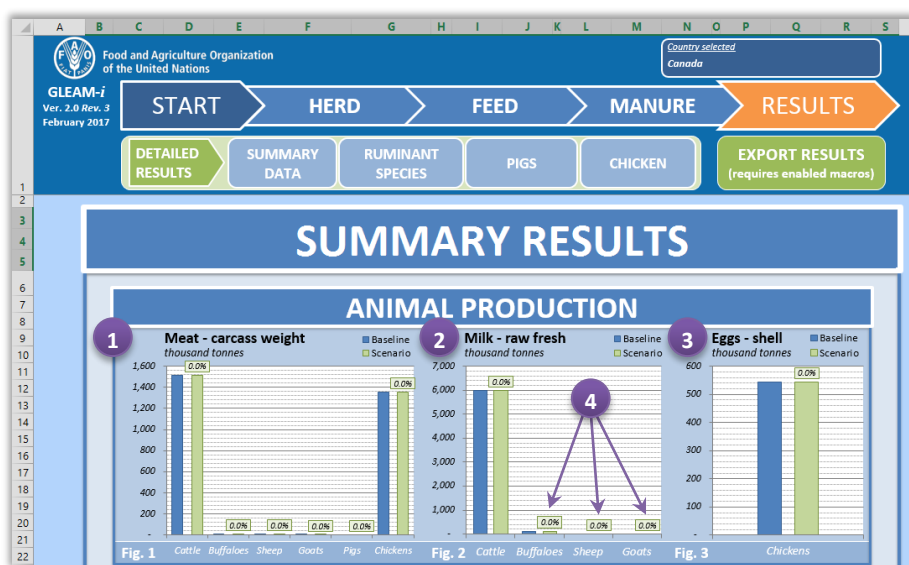


Figure 12. 'Animal production' graphs, including meat, milk and eggs production.

2.7.2 Graphs – Total GHG emissions

This section contains the estimates on GHG emissions. First, sector's total emissions are shown, both numerically and graphically (Figure 13-1). A second graph shows the share of each gas (CO₂, CH₄ and N₂O) in the aggregated emissions' tally (Figure 13-2). The third graphs shows, for each species, the contribution of each emission source aggregated into four main categories: feed, enteric, manure and energy use. (Figure 13-3). The labels in **Scenario** conditions (Figure 13-4) refer to the change of each species' total emissions.

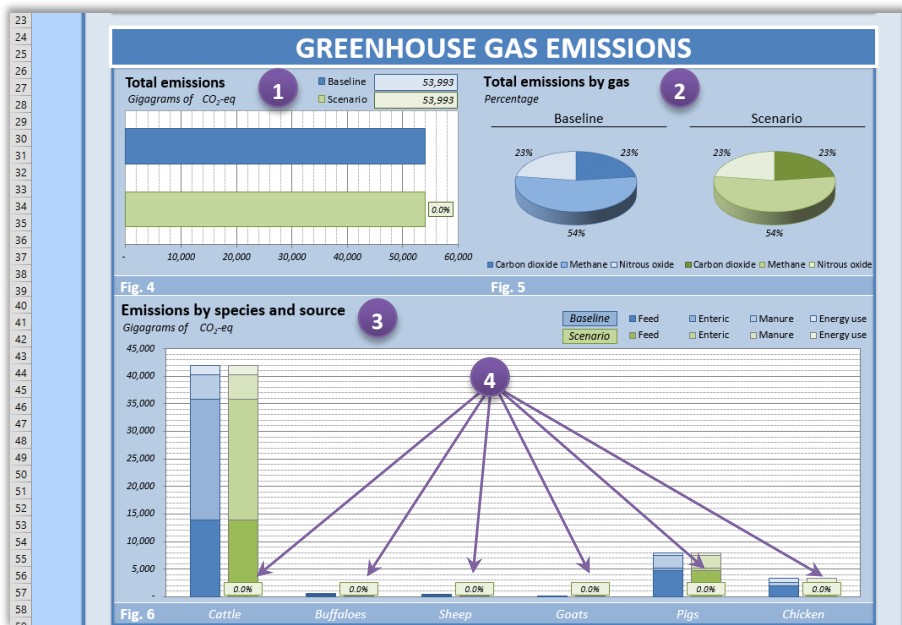


Figure 13. 'Greenhouse gas emissions' graphs, including sector's total emissions, share by gas and total emissions and main sources by species.

2.7.3 Graphs – Source of emissions

The shares and a brief description of all twelve sources included in GLEAM-i are given here, both in the form a stacked bar graph (Figure 14-1) as well as numeric percentages (Figure 14-2).

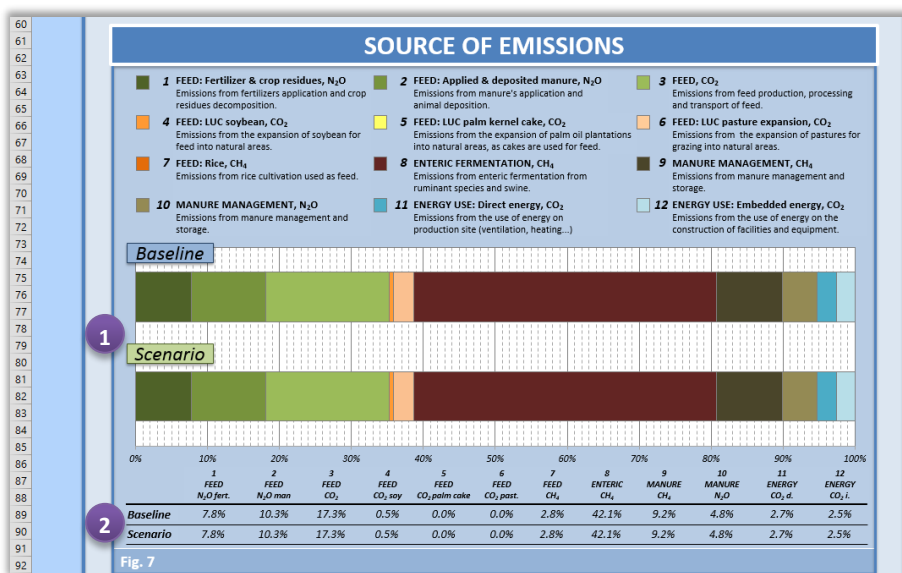


Figure 14. 'Source of emissions' graphs, where detailed sources for total emissions are shown.

2.7.4 Graphs results – GLEAM-i and IPCC Tier 1

The graphs in this section compare the estimated emissions arising from GLEAM-i (Tier 2), and those arising from IPCC Tier 1 approach. The comparison includes the three sources of emissions from livestock covered in the IPCC Guidelines (Volume 4, Chapter 10): enteric fermentation and methane and nitrous oxide from manure management. The graph includes the total of the three for additional reference. Users can find one graph for **Baseline** (Figure 15-1) and **Scenario** conditions (Figure 15-2).

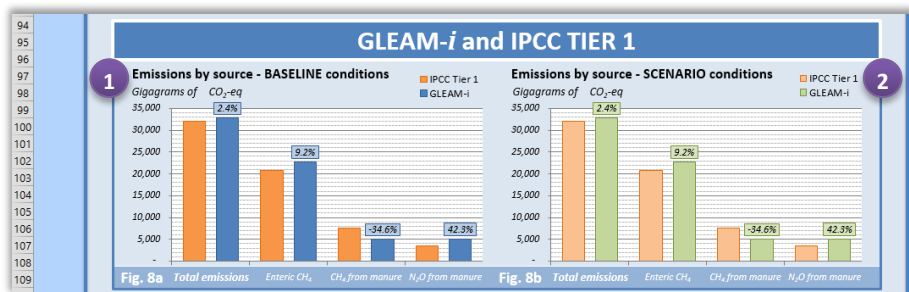


Figure 15. 'GLEAM-i and IPCC TIER 1' graphs, showing the comparison between Tier 1 and GLEAM-i estimations of enteric fermentation and manure related emissions.

2.7.5 Graphs results – Emission intensities

Emissions related to the production of a given commodity are shown here (Figure 16-1). In order to compare the environmental performance among different products, meat milk and eggs quantities are converted into edible protein and production is divided by the emissions associated with their production. Regional average values from GLEAM are also provided for reference purposes (Figure 16-2).

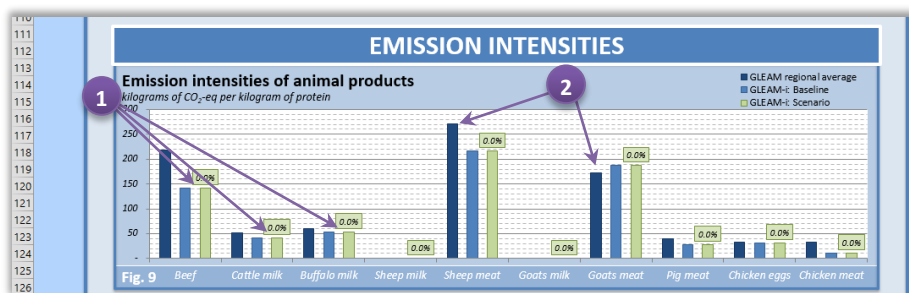


Figure 16. 'Emission intensities' graph, where **Baseline** and **Scenario** emission intensities are compared. Regional average values from GLEAM are also provided for reference.

2.7.6 Detailed results – Summary data

The spreadsheet below summarizes the numeric results for **Baseline** and **Scenario** conditions, alongside the percentage of change for each variable. Aggregated values are found at the top of the page (Figure 17), while species specific data on emissions, production, feed intake and emission intensities are found at the second part of the page (Figure 18).

Aggregated emissions are organized into four blocks: total emissions by gas (Figure 17-1), total emissions by species (Figure 17-2), total emissions by source (Figure 17-3) and GLEAM-i vs IPCC Tier 1 emissions (Figure 17-4).

A		C		D	E	F	G	H	I	J	K
1	REGION	North America									
2	COUNTRY	Canada									
3	SIMULATION NAME	(Type the simulation name)									
TOTAL EMISSIONS BY GAS											
4	Variable	Unit	Baseline value	Scenario value	Percentage of change	Variable	Unit	Baseline value	Scenario value	Percentage of change	
5	Total GHG emissions	kg CO2-eq/year	53,993,024,018	53,993,024,018	0.0%	Feed: N2O from fertilization and crop residues	kg CO2-eq/year	4,189,236,403	4,189,236,403	0.0%	
6	Total CO2 emissions	kg CO2-eq/year	12,414,280,808	12,414,280,808	0.0%	Feed: N2O from manure application and deposition	kg CO2-eq/year	5,560,938,406	5,560,938,406	0.0%	
7	Total CH4 emissions	kg CO2-eq/year	29,231,604,140	29,231,604,140	0.0%	Feed: CO2 from feed production, transport and processing	kg CO2-eq/year	9,317,080,143	9,317,080,143	0.0%	
8	Total N2O emissions	kg CO2-eq/year	10,324,139,027	10,324,139,027	0.0%	Feed: CO2 from land use change related to soy cultivation	kg CO2-eq/year	274,639,706	274,639,706	0.0%	
9	Feed: N2O from fertilization and crop residues	kg CO2-eq/year	4,189,236,403	4,189,236,403	0.0%	Feed: CO2 from land use change related to palm oil plantations	kg CO2-eq/year	-	-	0.0%	
10	Feed: N2O from manure application and deposition	kg CO2-eq/year	5,560,938,406	5,560,938,406	0.0%	Feed: CO2 from land use change related to pasture expansion	kg CO2-eq/year	-	-	0.0%	
11	Feed: CO2 from feed production, transport and processing	kg CO2-eq/year	9,317,080,143	9,317,080,143	0.0%	Feed: CH4 from rice cultivation	kg CO2-eq/year	1,530,034,000	1,530,034,000	0.0%	
12	Feed: CO2 from land use change related to soy cultivation	kg CO2-eq/year	274,639,706	274,639,706	0.0%	Enteric: CH4 from enteric fermentation	kg CO2-eq/year	22,714,360,733	22,714,360,733	0.0%	
13	Feed: CO2 from land use change related to pasture expansion	kg CO2-eq/year	-	-	0.0%	Manure: CH4 from manure management	kg CO2-eq/year	4,987,209,407	4,987,209,407	0.0%	
14	Feed: CH4 from rice cultivation	kg CO2-eq/year	1,530,034,000	1,530,034,000	0.0%	Manure: N2O from manure management	kg CO2-eq/year	2,596,974,256	2,596,974,256	0.0%	
15	Enteric: CH4 from enteric fermentation	kg CO2-eq/year	22,714,360,733	22,714,360,733	0.0%	Energy: CO2 from direct energy use	kg CO2-eq/year	1,457,255,353	1,457,255,353	0.0%	
16	Manure: CH4 from manure management	kg CO2-eq/year	4,987,209,407	4,987,209,407	0.0%	Energy: CO2 from indirect energy use	kg CO2-eq/year	1,365,305,607	1,365,305,607	0.0%	
17	Manure: N2O from manure management	kg CO2-eq/year	2,596,974,256	2,596,974,256	0.0%						
18	Energy: CO2 from direct energy use	kg CO2-eq/year	1,457,255,353	1,457,255,353	0.0%						
19	Energy: CO2 from indirect energy use	kg CO2-eq/year	1,365,305,607	1,365,305,607	0.0%						
20	Meat production in carcass weight	kg protein/year	543,814,655	543,814,655	0.0%						
21	Meat production in fresh, whole weight	kg protein/year	124,213,867	124,213,867	0.0%						
22	Milk production in protein amount	kg CO2-eq/kg protein	53.5	53.5	0.0%						
23	Milk production in fresh, whole weight	kg CO2-eq/kg protein	54.1	54.1	0.0%						
24	Emission intensity of milk	kg CO2-eq/kg protein	54.1	54.1	0.0%						
25	Emission intensity of meat	kg CO2-eq/kg protein	187.0	187.0	0.0%						
26	Total feed intake - Roughages	kg DM/year	9,915,118	9,915,118	0.0%						
27	Total feed intake - Grains	kg DM/year	1,540,532	1,540,532	0.0%						
28	Total feed intake - Additives	kg DM/year	207,576,293	207,576,293	0.0%						
ENTERIC AND MANURE - SIMULATION											
29	Variable	Unit	Baseline value	Scenario value	Percentage of change	Variable	Unit	Baseline value	Scenario value	Percentage of change	
30	Enteric fermentation	kg CO2-eq/year	22,714,360,733	22,714,360,733	0.0%	Enteric fermentation	kg CO2-eq/year	22,714,360,733	22,714,360,733	0.0%	
31	Manure (methane)	kg CO2-eq/year	4,987,209,407	4,987,209,407	0.0%	Manure (methane)	kg CO2-eq/year	7,629,725,211	7,629,725,211	0.0%	
32	Manure (nitrous oxide)	kg CO2-eq/year	5,043,182,412	5,043,182,412	0.0%	Manure (nitrous oxide)	kg CO2-eq/year	3,544,541,968	3,544,541,968	0.0%	

Figure 17. Aggregated summary data.

Summary data for each species is organized into six blocks, one for each animal category: cattle (Figure 18-1), buffaloes (Figure 18-2), sheep (Figure 18-3), goats (Figure 18-4), pigs (Figure 18-5) and chickens (Figure 18-6). The results include total emissions, emissions by source, animal commodities production, feed intake and emission intensities. For a complete list and description of the variables, please refer to Table A9 in the Annex.

CATTLE					BUFFALOES				
Variable	Unit	Baseline value	Scenario value	Percentage of change	Variable	Unit	Baseline value	Scenario value	Percentage of change
1 GHG emissions	kg CO ₂ -eq/year	41,979,279,235	41,979,279,235	0.0%	1 GHG emissions	kg CO ₂ -eq/year	376,450,980	376,450,980	0.0%
2 Total CO ₂ emissions	kg CO ₂ -eq/year	6,996,263,357	6,996,263,357	0.0%	2 Total CO ₂ emissions	kg CO ₂ -eq/year	61,399,162	61,399,162	0.0%
3 Total CH ₄ emissions	kg CO ₂ -eq/year	24,793,923,268	24,793,923,268	0.0%	3 Total CH ₄ emissions	kg CO ₂ -eq/year	261,405,487	261,405,487	0.0%
4 Total N ₂ O emissions	kg CO ₂ -eq/year	10,190,092,711	10,190,092,711	0.0%	4 Total N ₂ O emissions	kg CO ₂ -eq/year	56,846,331	56,846,331	0.0%
5 Feed: N2O from fertilization and crop residues	kg CO ₂ -eq/year	3,140,842,446	3,140,842,446	0.0%	5 Feed: N2O from fertilization and crop residues	kg CO ₂ -eq/year	2,800,584	2,800,584	0.0%
6 Feed: N2O from manure application and deposition	kg CO ₂ -eq/year	5,427,023,183	5,427,023,183	0.0%	6 Feed: N2O from manure application and deposition	kg CO ₂ -eq/year	4,071,130	4,071,130	0.0%
7 Feed: CO ₂ from feed production, transport and processing	kg CO ₂ -eq/year	5,241,033,187	5,241,033,187	0.0%	7 Feed: CO ₂ from feed production, transport and processing	kg CO ₂ -eq/year	51,831,621	51,831,621	0.0%
8 Feed: CO ₂ from land use change related to soy cultivation	kg CO ₂ -eq/year	89,209,348	89,209,348	0.0%	8 Feed: CO ₂ from land use change related to soy cultivation	kg CO ₂ -eq/year	754,763	754,763	0.0%
9 Feed: CO ₂ from land use change related to palm oil plantations	kg CO ₂ -eq/year	-	-	0.0%	9 Feed: CO ₂ from land use change related to palm oil plantations	kg CO ₂ -eq/year	-	-	0.0%
10 Feed: CH ₄ from rice cultivation	kg CO ₂ -eq/year	-	-	0.0%	10 Feed: CH ₄ from rice cultivation	kg CO ₂ -eq/year	-	-	0.0%
11 Enteric CH ₄ from enteric fermentation	kg CO ₂ -eq/year	21,857,366,402	21,857,366,402	0.0%	11 Enteric CH ₄ from enteric fermentation	kg CO ₂ -eq/year	243,351,115	243,351,115	0.0%
12 Manure: CH ₄ from manure management	kg CO ₂ -eq/year	2,935,556,068	2,935,556,068	0.0%	12 Manure: CH ₄ from manure management	kg CO ₂ -eq/year	18,092,182	18,092,182	0.0%
13 Manure: N2O from manure management	kg CO ₂ -eq/year	1,622,127,078	1,622,127,078	0.0%	13 Manure: N2O from manure management	kg CO ₂ -eq/year	22,703,811	22,703,811	0.0%
14 Energy: CO ₂ from direct energy use	kg CO ₂ -eq/year	606,480,634	606,480,634	0.0%	14 Energy: CO ₂ from direct energy use	kg CO ₂ -eq/year	6,210,693	6,210,693	0.0%
15 Energy: CO ₂ from indirect energy use	kg CO ₂ -eq/year	1,059,479,418	1,059,479,418	0.0%	15 Energy: CO ₂ from indirect energy use	kg CO ₂ -eq/year	2,800,584	2,800,584	0.0%
16 Meat production in carcass weight	kgCWT/year	1,513,105,608	1,513,105,608	0.0%	16 Meat production in carcass weight	kgCWT/year	7,802,235	7,802,235	0.0%
17 Meat production in protein amount	kg protein/year	239,789,411	239,789,411	0.0%	17 Meat production in protein amount	kg protein/year	1,236,462	1,236,462	0.0%
18 Milk production in fresh, whole weight	kg milk/year	5,886,070,080	5,886,070,080	0.0%	18 Milk production in fresh, whole weight	kg milk/year	124,213,867	124,213,867	0.0%
19 Milk production in protein amount	kg protein/year	197,540,313	197,540,313	0.0%	19 Milk production in protein amount	kg protein/year	5,786,366	5,786,366	0.0%
20 Emission intensity of milk	kg CO ₂ -eq/kg protein	41.3	41.3	0.0%	20 Emission intensity of milk	kg CO ₂ -eq/kg protein	53.5	53.5	0.0%
21 Emission intensity of meat	kg CO ₂ -eq/kg protein	141.1	141.1	0.0%	21 Emission intensity of meat	kg CO ₂ -eq/kg protein	54.1	54.1	0.0%
22 Total feed intake - Roughages	kg DM/year	31,842,293,893	31,842,293,893	0.0%	22 Total feed intake - Roughages	kg DM/year	338,156,793	338,156,793	0.0%
23 Total feed intake - Grains	kg DM/year	24,282,145,711	24,282,145,711	0.0%	23 Total feed intake - Grains	kg DM/year	187,381,614	187,381,614	0.0%
24 Total feed intake - Additives	kg DM/year	5,840,894,101	5,840,894,101	0.0%	24 Total feed intake - Additives	kg DM/year	52,420,661	52,420,661	0.0%
25 Total feed intake - Animal by-products	kg DM/year	1,219,283,293	1,219,283,293	0.0%	25 Total feed intake - Animal by-products	kg DM/year	87,445,417	87,445,417	0.0%
SHEEP					GOATS				
Variable	Unit	Baseline value	Scenario value	Percentage of change	Variable	Unit	Baseline value	Scenario value	Percentage of change
1 GHG emissions	kg CO ₂ -eq/year	343,564,843	343,564,843	0.0%	1 GHG emissions	kg CO ₂ -eq/year	10,377,476	10,377,476	0.0%
2 Total CO ₂ emissions	kg CO ₂ -eq/year	60,223,996	60,223,996	0.0%	2 Total CO ₂ emissions	kg CO ₂ -eq/year	2,002,400	2,002,400	0.0%
3 Total CH ₄ emissions	kg CO ₂ -eq/year	183,366,262	183,366,262	0.0%	3 Total CH ₄ emissions	kg CO ₂ -eq/year	6,628,763	6,628,763	0.0%
4 Total N ₂ O emissions	kg CO ₂ -eq/year	100,374,584	100,374,584	0.0%	4 Total N ₂ O emissions	kg CO ₂ -eq/year	3,746,333	3,746,333	0.0%
5 Feed: N2O from fertilization and crop residues	kg CO ₂ -eq/year	35,728,743	35,728,743	0.0%	5 Feed: N2O from fertilization and crop residues	kg CO ₂ -eq/year	1,158,408	1,158,408	0.0%
6 Feed: N2O from manure application and deposition	kg CO ₂ -eq/year	57,500,750	57,500,750	0.0%	6 Feed: N2O from manure application and deposition	kg CO ₂ -eq/year	1,886,816	1,886,816	0.0%
7 Feed: CO ₂ from feed production, transport and processing	kg CO ₂ -eq/year	51,058,605	51,058,605	0.0%	7 Feed: CO ₂ from feed production, transport and processing	kg CO ₂ -eq/year	1,654,657	1,654,657	0.0%
8 Feed: CO ₂ from land use change related to soy cultivation	kg CO ₂ -eq/year	182,116	182,116	0.0%	8 Feed: CO ₂ from land use change related to soy cultivation	kg CO ₂ -eq/year	5,905	5,905	0.0%
9 Feed: CO ₂ from land use change related to palm oil plantations	kg CO ₂ -eq/year	-	-	0.0%	9 Feed: CO ₂ from land use change related to palm oil plantations	kg CO ₂ -eq/year	-	-	0.0%
10 Feed: CH ₄ from rice cultivation	kg CO ₂ -eq/year	-	-	0.0%	10 Feed: CH ₄ from rice cultivation	kg CO ₂ -eq/year	-	-	0.0%
11 Enteric CH ₄ from enteric fermentation	kg CO ₂ -eq/year	177,391,996	177,391,996	0.0%	11 Enteric CH ₄ from enteric fermentation	kg CO ₂ -eq/year	5,445,244	5,445,244	0.0%
12 Manure: CH ₄ from manure management	kg CO ₂ -eq/year	5,979,466	5,979,466	0.0%	12 Manure: CH ₄ from manure management	kg CO ₂ -eq/year	189,537	189,537	0.0%
13 Manure: N2O from manure management	kg CO ₂ -eq/year	7,137,092	7,137,092	0.0%	13 Manure: N2O from manure management	kg CO ₂ -eq/year	225,910	225,910	0.0%
14 Energy: CO ₂ from direct energy use	kg CO ₂ -eq/year	6,308,920	6,308,920	0.0%	14 Energy: CO ₂ from direct energy use	kg CO ₂ -eq/year	258,862	258,862	0.0%
15 Energy: CO ₂ from indirect energy use	kg CO ₂ -eq/year	2,675,012	2,675,012	0.0%	15 Energy: CO ₂ from indirect energy use	kg CO ₂ -eq/year	18,376	18,376	0.0%
16 Meat production in carcass weight	kgCWT/year	10,581,603	10,581,603	0.0%	16 Meat production in carcass weight	kgCWT/year	432,543	432,543	0.0%
17 Meat production in protein amount	kg protein/year	1,492,054	1,492,054	0.0%	17 Meat production in protein amount	kg protein/year	50,134	50,134	0.0%
18 Milk production in fresh, whole weight	kg milk/year	-	-	0.0%	18 Milk production in fresh, whole weight	kg milk/year	-	-	0.0%
19 Milk production in protein amount	kg protein/year	-	-	0.0%	19 Milk production in protein amount	kg protein/year	-	-	0.0%
20 Emission intensity of milk	kg CO ₂ -eq/kg protein	-	-	0.0%	20 Emission intensity of milk	kg CO ₂ -eq/kg protein	-	-	0.0%
21 Emission intensity of meat	kg CO ₂ -eq/kg protein	215.8	215.8	0.0%	21 Emission intensity of meat	kg CO ₂ -eq/kg protein	187.0	187.0	0.0%
22 Total feed intake - Roughages	kg DM/year	274,968,695	274,968,695	0.0%	22 Total feed intake - Roughages	kg DM/year	8,915,118	8,915,118	0.0%
23 Total feed intake - Grains	kg DM/year	224,524,393	224,524,393	0.0%	23 Total feed intake - Grains	kg DM/year	2,292,867	2,292,867	0.0%
24 Total feed intake - Additives	kg DM/year	47,514,590	47,514,590	0.0%	24 Total feed intake - Additives	kg DM/year	1,540,532	1,540,532	0.0%
25 Total feed intake - Animal by-products	kg DM/year	2,879,213	2,879,213	0.0%	25 Total feed intake - Animal by-products	kg DM/year	47,445,417	47,445,417	0.0%
PIGS					CHICKEN				
Variable	Unit	Baseline value	Scenario value	Percentage of change	Variable	Unit	Baseline value	Scenario value	Percentage of change
1 GHG emissions	kg CO ₂ -eq/year	7,994,190	7,994,190	0.0%	1 GHG emissions	kg CO ₂ -eq/year	1,238,667	1,238,667	0.0%
2 Total CO ₂ emissions	kg CO ₂ -eq/year	183,059,036	183,059,036	0.0%	2 Total CO ₂ emissions	kg CO ₂ -eq/year	2,111,332,878	2,111,332,878	0.0%
3 Total CH ₄ emissions	kg CO ₂ -eq/year	3,776,427,999	3,776,427,999	0.0%	3 Total CH ₄ emissions	kg CO ₂ -eq/year	209,852,367	209,852,367	0.0%
4 Total N ₂ O emissions	kg CO ₂ -eq/year	1,039,203,889	1,039,203,889	0.0%	4 Total N ₂ O emissions	kg CO ₂ -eq/year	96,631,422	96,631,422	0.0%
5 Feed: N2O from fertilization and crop residues	kg CO ₂ -eq/year	444,254,118	444,254,118	0.0%	5 Feed: N2O from fertilization and crop residues	kg CO ₂ -eq/year	540,217,300	540,217,300	0.0%
6 Feed: N2O from manure application and deposition	kg CO ₂ -eq/year	35,540,800	35,540,800	0.0%	6 Feed: N2O from manure application and deposition	kg CO ₂ -eq/year	31,998,748	31,998,748	0.0%
7 Feed: CO ₂ from feed production, transport and processing	kg CO ₂ -eq/year	2,633,018,948	2,633,018,948	0.0%	7 Feed: CO ₂ from feed production, transport and processing	kg CO ₂ -eq/year	1,818,150,311	1,818,150,311	0.0%
8 Feed: CO ₂ from land use change related to soy cultivation	kg CO ₂ -eq/year	50,106,620	50,106,620	0.0%	8 Feed: CO ₂ from land use change related to soy cultivation	kg CO ₂ -eq/year	134,298,953	134,298,953	0.0%
9 Feed: CO ₂ from land use change related to palm oil plantations	kg CO ₂ -eq/year	-	-	0.0%	9 Feed: CO ₂ from land use change related to palm oil plantations	kg CO ₂ -eq/year	-	-	0.0%
10 Feed: CH ₄ from rice cultivation	kg CO ₂ -eq/year	-	-	0.0%	10 Feed: CH ₄ from rice cultivation	kg CO ₂ -eq/year	-	-	0.0%
11 Enteric CH ₄ from enteric fermentation	kg CO ₂ -eq/year	1,530,034,000	1,530,034,000	0.0%	11 Enteric CH ₄ from enteric fermentation	kg CO ₂ -eq/year	-	-	0.0%
12 Manure: CH ₄ from manure management	kg CO ₂ -eq/year	431,804,397	431,804,397	0.0%	12 Manure: CH ₄ from manure management	kg CO ₂ -eq/year	-	-	0.0%
13 Manure: N2O from manure management	kg CO ₂ -eq/year	1,816,589,619	1,816,589,619	0.0%	13 Manure: N2O from manure management	kg CO ₂ -eq/year	209,852,367	209,852,367	0.0%
14 Energy: CO ₂ from direct energy use	kg CO ₂ -eq/year	505,408,971	505,408,971	0.0%	14 Energy: CO ₂ from direct energy use	kg CO ₂ -eq/year	394,371,974	394,371,974	0.0%
15 Energy: CO ₂ from indirect energy use	kg CO ₂ -eq/year	312,386,589	312,386,589	0.0%	15 Energy: CO ₂ from indirect energy use	kg CO ₂ -eq/year	510,603,311	510,603,311	0.0%
16 Meat production in carcass weight	kgCWT/year	166,609,477	166,609,477	0.0%	16 Meat production in carcass weight	kgCWT/year	133,657,841	133,657,841	0.0%
17 Meat production in protein amount	kg protein/year	284,844,945	284,844,945	0.0%	17 Meat production in protein amount	kg protein/year	94,341,655	94,341,655	0.0%
18 Milk production in fresh, whole weight	kg milk/year	-	-	0.0%	18 Milk production in fresh, whole weight	kg milk/year	67,445,417	67,445,417	0.0%
19 Milk production in protein amount	kg protein/year	-	-	0.0%	19 Milk production in protein amount	kg protein/year	-	-	0.0%
20 Emission intensity of milk	kg CO ₂ -eq/kg protein	28.1	28.1	0.0%	20 Emission intensity of milk	kg CO ₂ -eq/kg protein	1,353,574,484	1,353,574,484	0.0%
21 Total feed intake - Roughages	kg DM/year	930,737,599	930,737,599	0.0%	21 Total feed intake - Roughages	kg DM/year	192,884,364	192,884,364	0.0%
22 Total feed intake - Grains & Food crops	kg DM/year	759,116,305	759,116,305	0.0%	22 Total feed intake - Grains & Food crops	kg DM/year	31.2	31.2	0.0%
23 Total feed intake - Additives	kg DM/year	157,660,584	157,660,584	0.0%	23 Total feed intake - Additives	kg DM/year	10.9	10.9	0.0%
24 Total feed intake - Animal by-products	kg DM/year	1,386,089	1,386,089	0.0%	24 Total feed intake - Animal by-products	kg DM/year	6,330,089	6,330,089	0.0%
25 Total feed intake - Grains & Food crops	kg DM/year	4,424,962,968	4,424,962,968	0.0%	25 Total feed intake - Grains & Food crops	kg DM/year	4,424,962,968	4,424,962,968	0.0%
26 Total feed intake - Additives	kg DM/year	1,097,156,424	1,097,156,424	0.0%	26 Total feed intake - Additives	kg DM/year	1,097,156,424	1,097,156,424	0.0%
27 Total feed intake - Animal by-products	kg DM/year	207,576,293	207,576,293	0.0%	27 Total feed intake - Animal by-products	kg DM/year	207,576,293	207,576,293	0.0%

Figure 18. Summary data by species.

2.7.7 Detailed results – Ruminant species

Detailed, disaggregated data for ruminant species are displayed in this page (Figure 19). Users can filter the results by species, production system, herd type and variable (Figure 19-1). The page presents results on total emissions, emission sources, production, animal numbers, feed intake and emission intensities. Table A9 contains the full list and description of all the variables.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
REGION	COUNTRY	SIMULATION NAME	Species	Production system	Variable	Unit	Baseline value	Scenario value	Percentage of change																																																																																										
North America	Canada		Cattle	All systems	EMSS: Total GHG emissions	kg CO ₂ -eq/year	36,855,233,157	36,855,233,157	0.0%																																																																																										
			Cattle	All systems	EMSS: Total CO ₂	kg CO ₂ -eq/year	6,223,621,718	6,223,621,718	0.0%																																																																																										
			Cattle	All systems	EMSS: Total CH ₄	kg CO ₂ -eq/year	23,558,726,477	23,558,726,477	0.0%																																																																																										
			Cattle	All systems	EMSS: Total N ₂ O	kg CO ₂ -eq/year	7,072,884,963	7,072,884,963	0.0%																																																																																										
			Cattle	All systems	EMSS: Feed - N ₂ O fertilizer and crop residues	kg CO ₂ -eq/year	2,974,899,127	2,974,899,127	0.0%																																																																																										
			Cattle	All systems	EMSS: Feed - N ₂ O manure applied and deposited	kg CO ₂ -eq/year	2,786,022,246	2,786,022,246	0.0%																																																																																										
			Cattle	All systems	EMSS: Feed - CO ₂ feed production	kg CO ₂ -eq/year	4,870,117,305	4,870,117,305	0.0%																																																																																										
			Cattle	All systems	EMSS: Feed - CO ₂ LUC soy	kg CO ₂ -eq/year	84,134,428	84,134,428	0.0%																																																																																										
			Cattle	All systems	EMSS: Feed - CO ₂ LUC palm kernel cake	kg CO ₂ -eq/year	-	-	0.0%																																																																																										
			Cattle	All systems	EMSS: Feed - CO ₂ LUC pasture expansion	kg CO ₂ -eq/year	-	-	0.0%																																																																																										
			Cattle	All systems	EMSS: Feed - CH ₄ rice	kg CO ₂ -eq/year	-	-	0.0%																																																																																										
			Cattle	All systems	EMSS: Enteric - CH ₄ from enteric fermentation	kg CO ₂ -eq/year	20,702,660,235	20,702,660,235	0.0%																																																																																										
			Cattle	All systems	EMSS: Manure - CH ₄ from manure management	kg CO ₂ -eq/year	2,856,066,242	2,856,066,242	0.0%																																																																																										
			Cattle	All systems	EMSS: Manure - N ₂ O from manure management	kg CO ₂ -eq/year	1,302,163,590	1,302,163,590	0.0%																																																																																										
			Cattle	All systems	EMSS: Energy - CO ₂ direct energy use	kg CO ₂ -eq/year	504,218,084	504,218,084	0.0%																																																																																										
			Cattle	All systems	EMSS: Energy - CO ₂ indirect energy use	kg CO ₂ -eq/year	765,153,901	765,153,901	0.0%																																																																																										
			Cattle	All systems	PROD: Meat - carcass weight	kg CW/year	1,163,683,163	1,163,683,163	0.0%																																																																																										
			Cattle	All systems	PROD: Meat - protein amount	kg protein/year	184,414,689	184,414,689	0.0%																																																																																										
			Cattle	All systems	PROD: Milk - fresh weight	kg milk/year	5,986,070,080	5,986,070,080	0.0%																																																																																										
			Cattle	All systems	PROD: Milk - protein amount	kg protein/year	197,540,313	197,540,313	0.0%																																																																																										
			Cattle	All systems	HERD: total number of animals	heads/year	6,392,910	6,392,910	0.0%																																																																																										
			Cattle	All systems	HERD: adult females	heads/year	2,611,087	2,611,087	0.0%																																																																																										
			Cattle	All systems	HERD: adult males	heads/year	88,706	88,706	0.0%																																																																																										
			Cattle	All systems	HERD: replacement females	heads/year	984,920	984,920	0.0%																																																																																										
			Cattle	All systems	HERD: replacement males	heads/year	90,535	90,535	0.0%																																																																																										
			Cattle	All systems	HERD: fattening females	heads/year	1,276,603	1,276,603	0.0%																																																																																										
			Cattle	All systems	HERD: fattening males	heads/year	1,341,059	1,341,059	0.0%																																																																																										
			Cattle	All systems	INTAKE: Total intake	kg DM/year	5,745,380,182	5,745,380,182	0.0%																																																																																										
			Cattle	All systems	INTAKE: Total intake - Roughages	kg DM/year	3,778,308,027	3,778,308,027	0.0%																																																																																										
			Cattle	All systems	INTAKE: Total intake - Grains	kg DM/year	4,425,172,476	4,425,172,476	0.0%																																																																																										
			Cattle	All systems	INTAKE: Total intake - Agro-industrial by-products	kg DM/year	541,899,680	541,899,680	0.0%																																																																																										
			Cattle	All systems	EMSS: Emission intensity of milk	kg CO ₂ -eq/kg protein	41.1	41.1	0.0%																																																																																										
			Cattle	All systems	EMSS: Emission intensity of meat	kg CO ₂ -eq/kg protein	141.2	141.2	0.0%																																																																																										
			Cattle	All systems	EMSS: Total GHG emissions	kg CO ₂ -eq/year	10,815,934,434	10,815,934,434	0.0%																																																																																										
			Cattle	All systems	EMSS: Total CO ₂	kg CO ₂ -eq/year	1,842,509,251	1,842,509,251	0.0%																																																																																										

Fig. 19-1. Detail of available filters in detailed results pages.

Figure 19. Detailed data spreadsheet for ruminant species.

2.7.8 Detailed results – Monogastric species

Detailed, disaggregated data on monogastrics can be found in the dedicated spreadsheets for pigs and chickens. Similarly to ruminants, data can be filtered by species, production systems and variable (Figure 20-1). The page presents results on total emissions, emission sources, production, animal numbers, feed intake and emission intensities. Table A9 contains the full list and description of all the variables.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	ЕК	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD	FE	FF	FG	FH	FI	FJ	FK	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY	FZ	GA	GB	GC	GD	GE	GF	GG	GH	GI	GJ	GK	GL	GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX	GY	GZ	HA	HB	HC	HD	HE	HF	HG	HH	HI	HJ	HK	HL	HM	HN	HO	HP	HQ	HR	HS	HT	HU	HV	HW	HX	HY	HZ	IA	IB	IC	ID	IE	IF	IG	IH	II	IJ	IK	IL	IM	IN	IO	IP	IQ	IR	IS	IT	IU	IV	IW	IX	IY	IZ	JA	JB	JC	JD	JE	JF	JG	JH	JI	IJ	JK	KL	KM	KN	KO	KP	KQ	KR	KS	KT	KU	KV	KW	KX	KY	KZ	LA	LB	LC	LD	LE	LF	LG	LH	LI	LJ	LK	LM	LN	LO	LP	LQ	LR	LS	LT	LU	LV	LW	LX	LY	LZ	MA	MB	MC	MD	ME	MF	MG	MH	MI	MJ	MK	ML	MM	MN	MO	MP	MQ	MR	MS	MT	MU	MV	MW	MX	MY	MZ	NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NM	NN	NO	NP	NQ	NR	NS	NT	NU	NV	NW	NX	NY	NZ	OA	OB	OC	OD	OE	OF	OG	OH	OI	OJ	OK	OL	OM	ON	OO	OP	OQ	OR	OS	OT	OU	OV	OW	OX	OY	OZ	PA	PB	PC	PD	PE	PF	PG	PH	PI	PJ	PK	PL	PM	PN	PO	PP	PQ	PR	PS	PT	PU	PV	PW	PX	PY	PZ	QA	QB	QC	QD	QE	QF	QG	QH	QI	QJ	QK	QL	QM	QN	QO	QP	QQ	QR	QS	QT	QU	QV	QW	QX	QY	QZ	RA	RB	RC	RD	RE	RF	RG	RH	RI	RJ	RK	RL	RM	RN	RO	RP	RQ	RR	RS	RT	RU	RV	RW	RX	RY	RZ	SA	SB	SC	SD	SE	SF	SG	SH	SI	SJ	SK	SL	SM	SN	SO	SP	SQ	SR	SS	ST	SU	SV	SW	SX	SY	SZ	TA	TB	TC	TD	TE	TF	TG	TH	TI	TJ	TK	TL	TM	TN	TO	TP	TQ	TR	TS	TU	TV	TW	TX	TY	TZ	UA	UB	UC	UD	UE	UF	UG	UH	UI	UJ	UK	UL	UM	UN	UO	UP	UQ	UR	US	UT	UU	UV	UW	UX	UY	UZ	VA	VB	VC	VD	VE	VF	VG	VH	VI	VJ	VK	VL	VM	VN	VO	VP	VQ	VR	VS	VT	VU	VV	VW	VX	VY	VZ	WA	WB	WC	WD	WE	WF	WG	WH	WI	WJ	WK	WL	WM	WN	WO	WP	WQ	WR	WS	WT	WU	WV	WW	WX	WY	WZ	XA	XB	XC	XD	XE	XF	YG	YH	YI	YJ	YK	YL	YM	YN	YO	YP	YQ	YR	YS	YT	YU	YV	YW	YX	YY	YZ	ZA	ZB	ZC	ZD	ZE	ZF	ZG	ZH	ZI	ZJ	ZK	ZL	ZM	ZN	ZO	ZP	ZQ	ZR	ZS	ZT	ZU	ZV	ZW	ZX	ZY	ZZ	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD	FE	FF	FG	FH	FI	FJ	FK	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY	FZ	GA	GB	GC	GD	GE	GF	GG	GH	GI	GJ	GK	GL	GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX	GY	GZ	HA	HB	HC	HD	HE	HF	HG	HH	HI	HJ	HK	HL	HM	HN	HO	HP	HQ	HR	HS	HT	HU	HV	HW	HX	HY	HZ	IA	IB	IC	ID	IE	IF	IG	IH	II	IJ	IK	IL	IM	IN	IO	IP	IQ	IR	IS	IT	IU	IV	IW	IX	IY	IZ	JA	JB	JC	JD	JE	JF	JG	JH	JI	IJ	JK	KL	KM	KN	KO	KP	KQ	KR	KS	KT	KU	KV	KW	KX	KY	KZ	LA	LB	LC	LD	LE	LF	LG	LH	LI	LJ	LK	LM	LN	LO	LP	LQ	LR	LS	LT	LU	LV	LW	LX	LY	LZ	MA	MB	MC	MD	ME	MF	MG	MH	MI	MJ	MK	ML	MM	MN	MO	MP	MQ	MR	MS	MT	MU	MV	MW	MX	MY	MZ	NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NM	NN	NO	NP	NQ	NR	NS	NT	NU	NV	NW	NX	NY	NZ	OA	OB	OC	OD	OE	OF	OG	OH	OI	OJ	OK	OL	OM	ON	OO	OP	OQ	OR	OS	OT	OU	OV	OW	OX	OY	OZ	PA	PB	PC	PD	PE	PF	PG	PH	PI	PJ	PK	PL	PM	PN	PO	PP	PQ	PR	PS	PT	PU	PV	PW	PX	PY	PZ	QA	QB	QC	QD	QE	QF	QG	QH	QI	QJ	QK	QL	QM	QN	QO	QP	QQ	QR	QS	QT	QU	QV	QW	QX	QY	QZ	RA	RB	RC	RD	RE	RF	RG	RH	RI	RJ	RK	RL	RM	RN	RO	RP	RQ	RR	RS	RT	RU	RV	RW	RX	RY	RZ	SA	SB	SC	SD	SE	SF	SG	SH	SI	SJ	SK	SL	SM	SN	SO	SP	SQ	SR	SS	ST	SU	SV	SW	SX	SY	SZ	TA	TB	TC	TD	TE	TF	TG	TH	TI	TJ	TK	TL	TM	TN	TO	TP	TQ	TR	TS	TU	TV	TW	TX	TY	TZ	UA	UB	UC	UD	UE	UF	UG	UH	UI	UJ	UK	UL	UM	UN	UO	UP	UQ	UR	US	UT	UU	UV	UW	UX	UY	UZ	VA	VB	VC	VD	VE	VF	VG	VH	VI	VJ	VK	VL	VM	VN	VO	VP	VQ	VR	VS	VT	VU	VV	VW	VX	VY	VZ	WA	WB	WC	WD	WE	WF	WG	WH	WI	WJ	WK	WL	WM	WN	WO	WP	WQ	WR	WS	WT	WU	WV	WW	WX	WY	WZ	XA	XB	XC	XD	XE	XF	YG	YH	YI	YJ	YK	YL	YM	YN	YO	YP	YQ	YR	YS	YT	YU	YV	YW	YX	YY	YZ	ZA	ZB	ZC	ZD	ZE	ZF	ZG	ZH	ZI	ZJ	ZK	ZL	ZM	ZN	ZO	ZP	ZQ	ZR	ZS	ZT	ZU	ZV	ZW	ZX	ZY	ZZ	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD	FE	FF	FG	FH	FI	FJ	FK	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY	FZ	GA	GB	GC	GD	GE	GF	GG	GH	GI	GJ	GK	GL	GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX	GY	GZ	HA	HB	HC	HD	HE	HF	HG	HH	HI	HJ	HK	HL	HM	HN	HO	HP	HQ	HR	HS	HT	HU	HV	HW	HX	HY	HZ	IA	IB	IC	ID	IE	IF	IG	IH	II	IJ	IK	IL	IM	IN	IO	IP	IQ	IR	IS	IT	IU	IV	IW	IX	IY	IZ	JA	JB	JC	JD	JE	JF	JG	JH	JI	IJ	JK	KL	KM	KN	KO	KP	KQ	KR	KS	KT	KU	KV	KW	KX	KY	KZ	LA	LB	LC	LD	LE	LF	LG	LH	LI	LJ	LK	LM	LN	LO	LP	LQ	LR	LS	LT	LU	LV	LW	LX	LY	LZ	MA	MB	MC	MD	ME	MF	MG	MH	MI	MJ	MK	ML	MM	MN	MO	MP	MQ	MR	MS	MT	MU	MV	MW	MX	MY	MZ	NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NM	NN	NO	NP	NQ	NR	NS	NT	NU	NV	NW	NX	NY	NZ	OA	OB	OC	OD	OE	OF	OG	OH	OI	OJ	OK	OL	OM	ON	OO	OP	OQ	OR	OS	OT	OU	OV	OW	OX	OY	OZ	PA	PB	PC	PD	PE	PF	PG	PH	PI	PJ	PK	PL	PM	PN	PO	PP	PQ	PR	PS	PT	PU	PV	PW	PX	PY	PZ	QA	QB	QC	QD	QE	QF	QG	QH	QI	QJ	QK	QL	QM	QN	QO	QP	QQ	QR	QS	QT	QU	QV	QW	QX	QY	QZ	RA	RB	RC	RD	RE	RF	RG	RH	RI	RJ	RK	RL	RM	RN	RO	RP	RQ	RR	RS	RT	RU	RV	RW	RX	RY	RZ	SA	SB	SC	SD	SE	SF	SG	SH	SI	SJ	SK	SL	SM	SN	SO	SP	SQ	SR	SS	ST	SU	SV	SW	SX	SY	SZ	TA	TB	TC	TD	TE	TF	TG	TH	TI	TJ	TK	TL	TM	TN	TO	TP	TQ	TR	TS	TU	TV	TW	TX	TY	TZ	UA	UB	UC	UD	UE	UF	UG	UH	UI	UJ	UK	UL	UM	UN	UO	UP	UQ	UR	US	UT	UU	UV	UW	UX	UY	UZ	VA	VB	VC	VD	VE	VF	VG	VH	VI	VJ	VK	VL	VM	VN	VO	VP	VQ	VR	VS	VT	VU	VV	VW	VX	VY	VZ	WA	WB	WC	WD	WE	WF	WG	WH	WI	WJ	WK	WL	WM	WN	WO	WP	WQ	WR	WS	WT	WU	WV	WW	WX	WY	WZ	XA	XB	XC	XD	XE	XF	YG	YH	YI	YJ	YK	YL	YM	YN	YO	YP	YQ	YR	YS	YT	YU	YV	YW	YX	YY	YZ	ZA	ZB	ZC	ZD	ZE	ZF	ZG	ZH	ZI	ZJ	ZK	ZL	ZM	ZN	ZO	ZP	ZQ	ZR	ZS	ZT	ZU	ZV	ZW	ZX	ZY	ZZ	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD	FE	FF	FG	FH	FI	FJ	FK	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY	FZ
--	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

Figure 20. Example of detailed data spreadsheet for monogastric species.

3. STEP-BY-STEP EXAMPLE

This chapter provides a practical example on how to run a simulation that involves setting a **Baseline** and implementing a **Scenario** that consists of several intervention measures in all modules.

3.1. SETTING THE BASELINE

The first step to assess the impact of any intervention measures is to establish and characterize the starting conditions. When defining the **Baseline**, users should consider two possibilities:

- **Case 1.** If users do not have complete and/or reliable information regarding any of the parameters and values required to run the simulation, **Baseline** conditions should make use of the **Default** values provided by the tool.
- **Case 2.** Otherwise, users should modify any value or parameter for which sufficient and reliable information is available, setting more realistic **Baseline** conditions.

3.2. SCENARIO DESCRIPTION

The **Scenario** described here simulates the implementation of measures aimed at reducing the emissions from livestock production. Although the example focuses on cattle, similar scenarios can be applied to the other species. The details on the scenario are shown in Tables 5 to 7. The **Scenario** is only applied here to grassland systems, but changes can be simultaneously applied to any combination of species and production systems.

TABLE 5. Example scenario description

HERD TYPE	HERD MODULE	FEED MODULE	MANURE MODULE
Dairy	- Sector growth: increase of reproductive animals by 10% - Animal health improvements: reduction of 30% in mortality of calves.	Increase in feed quality for adult dairy animals by increasing the share of energy rich feed items (see Table 5) for grassland animals.	50% reduction of deposited manure in the fields and reallocation under dry lot.
Beef	Breeding program resulting in heavier animals at slaughter (+1.5% live weight).	Increase in feed quality for adult dairy animals by increasing the share of energy rich feed items (see Table 6) for grassland animals.	Higher adoption (+20%) of dry lot system to the detriment of liquid/slurry.
Feedlots	Expand feedlot systems: increase of 10% in animals finished in feedlot operations.	No further changes, Default values are used.	No further changes, Default values are used.

TABLE 7. Feed ration example for adult dairy females

Feed item	Baseline	Scenario
Roughages		
Fresh grass	5.0	5.0
Hay or silage from grass	34.0	14.0
Silage from whole grain plants	5.0	-
Silage from whole maize plant	15.0	15.0
Grains		
Maize	16.2	25.0
Grains	11.8	20.0
Agro-industrial by-products		
By-products from soy	4.3	11.0
By-products from rape (canola)	1.9	-
Maize gluten meal	0.3	-
Dry by-products from grain industries	4.5	5.0
Wet by-products from grain industries	2.0	5.0

TABLE 8. Feed ration example for fattening beef animals

Feed item	Baseline	Scenario
Roughages		
Fresh grass	46.0	20.0
Hay or silage from grass	24.0	15.0
Silage from whole grain plants	8.0	5.0
Silage from whole maize plant	8.0	-
Grains		
Maize	5.0	20.0
Grains	5.0	15.0
Agro-industrial by-products		
By-products from soy	1.0	10.0
By-products from rape (canola)	1.0	5.0
Dry by-products from grain industries	1.0	5.0
Wet by-products from grain industries	1.0	5.0

3.3. IMPLEMENTING THE SCENARIO: HERD MODULE

To implement the **Scenario** conditions, overwrite the values in the appropriate cells for changes in animal numbers (Figure 21-1), mortality of calves (Figure 21-2) and slaughter live weight (Figure 21-3).

HERD MODULE - CATTLE

INSTRUCTIONS
This module simulates the structure and dynamics of the herd. BOX 1 contains the data on total and reproductive animals. In BOX 2 users can modify the parameters that simulates the behavior of the herd.

Default values for all the variables are based on the selected country. Users can modify and set new values in the *Baseline* and *Scenario* cells, as shown on the right. If no changes are made, *Baseline* and *Scenario* use Default values for the simulation.

Default: 1.23
Baseline: 1.30
Scenario: 2.42

PRODUCTION SYSTEM DEFINITIONS

Grassland based systems
Systems in which more than 10 percent of animal feed is produced in the farm and the average stocking rate is less than 10 livestock units (LSU) per hectare of agricultural land.

Mixed farming systems
Systems in which more than 10 percent of animal feed comes from crop by-products or more than 10 percent of the production value is of non-livestock activities.

Source: Seel & Steinfeld, World livestock production systems, FAO, 1996

BOX 1 ANIMAL NUMBERS

	DAIRY		BEEF	
	Grassland based	Mixed systems	Grassland based	Mixed systems
Total animal numbers Total animal numbers (calves, young and adult) calculated as reproductive adults below and the herd parameters from Box 2.	1,137,120	381,980	4,097,131	1,376,302
	1,419,418	476,808	5,493,401	1,845,334
	1,586,457	476,808	6,087,633	1,845,334
Adult reproductive females Number of adult reproductive females in the herd. Unit: heads	524,583	176,217	2,086,504	700,895
	524,583	176,217	2,086,504	700,895
	577,000	176,217	2,295,000	700,895
Adult reproductive males Number of adult reproductive males in the herd. Unit: heads	5,246	1,762	83,460	28,036
	5,246	1,762	83,460	28,036
	5,770	1,762	91,800	28,036

BOX 2 HERD PARAMETERS

	DAIRY		BEEF	
	Grassland based	Mixed systems	Grassland based	Mixed systems
Age at first calving Average age at which reproductive females have the first calf. Unit: months	24	24	24	24
	24	24	24	24
	24	24	24	24
Fertility of adult females Average percentage of successful adult female parturitions. This includes young that die before reaching maturity. Unit: percentage	80.0	80.0	93.0	93.0
	80.0	80.0	93.0	93.0
	80.0	80.0	93.0	93.0
Mortality of young females Annual average rate of non-intended young female deaths before reaching maturity. Unit: percentage	8.0	8.0	6.0	6.0
	8.0	8.0	6.0	6.0
	5.6	8.0	6.0	6.0
Mortality of young males Annual average rate of non-intended young male deaths before reaching maturity. Unit: percentage	8.0	8.0	6.0	6.0
	8.0	8.0	6.0	6.0
	5.6	8.0	6.0	6.0
Weight of fattening females Average slaughter live weight of fattening females. Unit: kilograms	609	609	609	609
	609	609	609	609
	609	609	618	609
Weight of fattening males Average slaughter live weight of fattening males. Unit: kilograms	609	609	609	609
	609	609	609	609
	609	609	618	609

Figure 21. Implementing the example scenario. Note the change in the total number of animals due to the new values (thick arrow). Some parts of the page are not shown for clarity purposes (dotted line).

Similarly, introduce the new values for feedlot animals (Figure 22-1).

HERD MODULE - CATTLE - Feedlot

INSTRUCTIONS
This module simulates the dynamics inside the feedlot operation. Animal numbers and feedlot parameters are shown in Box 1 and Box 2, respectively. Animals are transferred to feedlots from the available fattening (or surplus) numbers from 'Grassland' and 'Mixed' systems.

Default values for all the variables are shown based on the selected country. Users can modify and set new values in the Baseline and Scenario calls. NOTE: for countries where GLEAM has no Default feedlot data, average regional parameters will be used if feedlots are activated by the user (parameters will be highlighted in blue).

PRODUCTION SYSTEM DEFINITION
Feedlots
Type of animal feeding operation that is used for finishing livestock – specifically here, beef cattle. Before entering the feedlot operation, animals spend their first months, usually about a year, feeding on pastures or rangelands. This period is often referred to as the rearing phase. When animals reach a certain live weight, they are transferred to feedlots for the finishing phase.

Once inside the feedlot operation, animals are fed with a specialized diet that is intended to stimulate weight gain. This period typically lasts for six to nine months, depending on the starting and targeted live weight. Diets are generally composed of highly energetic and protein-rich feedstuffs, such as corn and cakes, respectively.

Source: Authors

BOX 1 ANIMAL NUMBERS

	Animals from grassland based systems	Animals from mixed farming systems
Total fattening numbers		
Annual number of fattening (or surplus) animals calculated from the parameters in the previous page. This is the maximum number of animals that can be sent to feedlots. Unit: heads	3,137,572	1,053,968
	3,521,601	1,053,968
Animals transferred to feedlots		
Annual number of animals that enter the feedlot system. It cannot exceed the total number of surplus animals (shown above for reference, both for baseline and scenario conditions). Unit: heads	519,908	1,053,968
	519,908	1,053,968
	572,000	1,053,968

Figure 22. Implementing the example scenario for feedlot animals. Some parts of the page are not shown for clarity purposes (dotted line).

3.4. IMPLEMENTING THE SCENARIO: FEED MODULE

3.4.1 Implementing the scenario – Feed module for dairy animals

Introduce the new values in the **Scenario** cells according to the diet defined in Table 6 (Figure 23-1). Check that the total percentage adds up to 100% for the new conditions (Figure 23-2).

GLEAM-i Ver. 2.0 Rev. 3 February 2017

Country selected: Canada

START **HERD** **FEED** **MANURE** **RESULTS**

PREVIOUS **CATTLE** **BUFFALOES** **SHEEP** **GOATS** **PIGS** **CHICKEN** **NEXT**

DAIRY **BEF** **FEEDLOT**

RATION PERCENTAGES OVERVIEW

	Baseline ration (%)	Scenario ration (%)	Adult females	Adult males and replacement animals	Fattening animals
Grassland SYSTEMS	100.0	100.0	100.0	100.0	100.0
MIXED SYSTEMS	100.0	100.0	100.0	100.0	100.0

FEED MODULE - DAIRY CATTLE

INSTRUCTIONS

The feed module shows the share of individual feedstuffs in the diet. Information is organized into three sections. An overview of ration's total percentage can be found at the top of the page, helping users to adjust to 100% when changes are made to the diet. Box 1 shows a **Summary ration**, organized by main feed categories (roughages, grains and agro-industrial by-products). The list of individual feed components is displayed in Box 2. **Detailed ration** section. Here, users can modify the individual share of each feedstuff, effectively changing the digestibility, energy and nitrogen content of the ration. Note that 'Grassland' and 'Mixed' systems are located in Boxes 1a & 2a and 1b & 2b, respectively.

Default values for the variables are shown based on the targeted country. Users can modify and set new values in the **Baseline** and **Scenario** cells, as shown on the right. If no changes are made, **Baseline** and **Scenario** use Default values for the simulation.

Default: 1.25
Baseline: 1.30
Scenario: 2.42

BOX 1a SUMMARY RATION

Grassland based systems

	Adult females	Adult males and replacement animals	Fattening animals
Roughages Includes natural or cultivated grass (fresh, hay or silage) and fibrous materials. Unit: percentage over DM intake	59.0	82.0	71.0
Grains Includes grains from wheat, barley, oats, maize, sorghum, etc. Unit: percentage over DM intake	28.0	14.0	25.0
Agro-industrial by-products Includes agro-industry by-products such as beans and cakes. Unit: percentage over DM intake	13.0	4.0	4.0

DAIRY CATTLE - DETAILED RATION - Grassland

BOX 2a DETAILED RATION

Grassland based systems

	Adult females	Adult males and replacement animals	Fattening animals
Fresh grass Any type of natural or cultivated grass that is consumed fresh by the animals. Unit: percentage over DM intake	5.0	11.0	31.0
Hay or silage from grass Hay or silage from any type of natural or cultivated grass. Unit: percentage over DM intake	34.0	43.0	24.0
Silage from whole grain plants Silage from wheat, barley, sorghum, rye or oats plants. Unit: percentage over DM intake	5.0	14.0	8.0
Silage from whole maize plant Silage from entire plants of maize (Zea mays). Unit: percentage over DM intake	15.0	14.0	8.0
Maize Grains from maize (Zea mays). Unit: percentage over DM intake	16.2	7.0	5.0
Grains Grain from wheat (Triticum), barley (Hordeum), oat (Avena), rye (Secale) or sorghum (Sorghum). Unit: percentage over DM intake	11.8	7.0	20.0
By-products from soy By-products from soy oil production, commonly referred to as 'soy cakes'. Unit: percentage over DM intake	4.3	2.0	1.0
By-products from rape (canola) By-products from canola oil production, commonly referred to as 'canola cakes'. Unit: percentage over DM intake	1.9	-	1.0
Maize gluten meal By-product from maize processing. It is a protein-rich feed without 65% crude protein. Unit: percentage over DM intake	0.3	-	-
Dry by-product from grain industries By-products from dry grain industries such as beans, middlings, etc. Unit: percentage over DM intake	4.5	1.0	1.0
Wet by-product from grain industries By-products from wet grain industries such as bioethanol, distilleries, breweries, etc. Unit: percentage over DM intake	2.0	1.0	1.0

Figure 23. Implementing the example scenario. Some parts of the page are not shown for clarity purposes (dotted line).

3.4.2 Implementing the scenario – Feed module for beef animals

Introduce the new values in the **Scenario** cells according to the diet defined in Table 7 (Figure 24-1). Note that the total percentage should add up to 100% for the new conditions (Figure 24-2).

GLEAM-i
Ver. 2.0 Rev. 3
February 2017

Country selected: **Canada**

START **HERD** **FEED** **MANURE** **RESULTS**

PREVIOUS **CATTLE** **BUFFALOES** **SHEEP** **GOATS** **PIGS** **CHICKEN** **NEXT**

EMERY **BEEF** **FEEDLOT**

RATION PERCENTAGES OVERVIEW

	Adult females	Adult males and replacement animals	Fattening animals
GRASSLAND SYSTEMS			
Baseline ration (%)	100.0	100.0	100.0
Scenario ration (%)	100.0	100.0	100.0
MIXED SYSTEMS			
Baseline ration (%)	100.0	100.0	100.0
Scenario ration (%)	100.0	100.0	100.0

FEED MODULE - BEEF CATTLE

INSTRUCTIONS

The feed module shows the share of individual feedstuffs in the diet. Information is organized into three sections. An overview of ration's total percentage can be found at the top of the page, helping users to adjust to 100% when changes are made to the diet. Box 1 shows a **Summary ration**, organized by main feed categories (roughages, grains and agro-industrial by-products). The list of individual feed components is displayed in Box 2, **Detailed ration** section. Here, users can modify the individual share of each feedstuff, effectively changing the digestibility, energy and nitrogen content of the ration. Note that 'Grassland' and 'Mixed' systems are located in boxes 1a & 2a and 1b & 2b, respectively.

Default values for all the variables are shown based on the targeted country. Users can modify and set new values in the **Baseline** and **Scenario** cells, as shown on the right. If no changes are made, **Baseline** and **Scenario** use Default values for the simulation.

Default: 1.23
Baseline: 1.30
Scenario: 2.42

BOX 1a SUMMARY RATION

Grassland based systems

MODIFY THE RATION

	Adult females	Adult males and replacement animals	Fattening animals
Roughages			
Includes natural or cultivated grass (fresh, hay or silage) and fibrous materials. Unit: percentage over DM intake	82.0	82.0	86.0
	82.0	82.0	40.0
Grains			
Includes grains from wheat, barley, oats, maize, sorghum, etc. Unit: percentage over DM intake	14.0	14.0	10.0
	14.0	14.0	35.0
Agro-industrial by-products			
Includes agro-industry by-products such as beans and cakes. Unit: percentage over DM intake	4.0	4.0	4.0
	4.0	4.0	25.0

BOX 2a DETAILED RATION

Grassland based systems

SUMMARY RATION

	Adult females	Adult males and replacement animals	Fattening animals
Fresh grass			
Any type of natural or cultivated grass that is consumed fresh by the animals. Unit: percentage over DM intake	11.0	11.0	46.0
	11.0	11.0	20.0
Hay or silage from grass			
Hay or silage from any type of natural or cultivated grass. Unit: percentage over DM intake	43.0	43.0	24.0
	43.0	43.0	15.0
Silage from whole grain plants			
Silage from wheat, barley, sorghum, rye or oats plants. Unit: percentage over DM intake	14.0	14.0	8.0
	14.0	14.0	5.0
Silage from whole maize plant			
Silage from entire plants of maize (Zea mays). Unit: percentage over DM intake	14.0	14.0	8.0
	14.0	14.0	-
Maize			
Grains from maize (Zea mays). Unit: percentage over DM intake	7.0	7.0	5.0
	7.0	7.0	20.0
Grains			
Grain from wheat (Triticum), barley (Hordeum), oat (Avena), rye (Secale) or sorghum (Sorghum). Unit: percentage over DM intake	7.0	7.0	5.0
	7.0	7.0	15.0
By-products from soy			
By-products from soy oil production, commonly referred to as 'soy cakes'. Unit: percentage over DM intake	2.0	2.0	1.0
	2.0	2.0	10.0
By-products from rape (canola)			
By-products from canola oil production, commonly referred to as 'canola cakes'. Unit: percentage over DM intake	-	-	1.0
	-	-	5.0
Dry by-product from grain industries			
By-products from dry grain industries such as bran, middlings, etc. Unit: percentage over DM intake	1.0	1.0	1.0
	1.0	1.0	5.0
Wet by-product from grain industries			
By-products from wet grain industries such as brewer's, distiller's, etc. Unit: percentage over DM intake	1.0	1.0	1.0
	1.0	1.0	5.0

Figure 24. Implementing the example scenario. Some parts of the page are not shown for clarity purposes (dotted line).

3.5. IMPLEMENTING THE SCENARIO: MANURE MODULE

To implement the **Scenario** conditions, overwrite the values in the appropriate cells for each manure management system for both dairy animals (Figure 25-1) and beef animals (Figure 25-2).

MANURE SYSTEMS OVERVIEW

TOTAL PERCENTAGE	Baseline conditions (%)	DAIRY		BEEF	
		Grassland based	Mixed systems	Grassland based	Mixed systems
Baseline conditions (%)	100.0	100.0	100.0	100.0	100.0
Scenario conditions (%)	100.0	100.0	100.0	100.0	100.0

MANURE MODULE - CATTLE

INSTRUCTIONS

The manure module contains the information on how manure is stored and handled. Manure management systems are taken from IPCC guidelines. For a complete definition, please check the User guide. Users will find default values for each production system and herd type. Any of those values can be changed, affecting methane and nitrous oxide emissions from manure.

Default values for all the variables are shown based on the targeted country. Users can modify and set new values in the Baseline and Scenario cells, as shown on the right. If no changes are made, Baseline and Scenario use Default values for the simulation.

	Default	Baseline	Scenario
	1.25	1.30	2.42

BOX 1 MMS PERCENTAGES

	DAIRY		BEEF	
	Grassland based	Mixed systems	Grassland based	Mixed systems
Pasture/Range/Paddock	17.0	17.0	48.0	48.0
Manure is allowed to lie as deposited, and is not managed. Unit: percentage over total manure.	17.0	17.0	48.0	48.0
	8.5	17.0	24.0	48.0
Daily spread	-	-	-	-
Manure is routinely removed from a confinement facility and is applied to cropland or pasture within 34 hours of excretion. Unit: percentage over total manure.	-	-	-	-
	-	-	-	-
Solid storage	40.0	40.0	47.0	47.0
Manure is stored for some months in unconfined piles or stacks due to the presence of a sufficient amount of bedding material or loss of moisture. Unit: percentage over total manure.	40.0	40.0	47.0	47.0
	40.0	40.0	47.0	47.0
Dry lot	-	-	-	-
Manure is stored in an open confinement area without any significant vegetative cover where accumulating manure may be removed periodically. Unit: percentage over total manure.	-	-	-	-
	8.5	-	24.0	-
Liquid/Slurry	43.0	43.0	5.0	5.0
Manure is stored as excreted or with minimal addition of water in tanks or earthen ponds outside the animal housing, usually for less than a year. Unit: percentage over total manure.	43.0	43.0	5.0	5.0
	43.0	43.0	5.0	5.0
Uncovered anaerobic lagoon	-	-	-	-
Liquid storage system designed and operated to combine waste stabilization and storage, the length of which can vary. Water can be recycled. Unit: percentage over total manure.	-	-	-	-
	-	-	-	-
Burned for fuel	-	-	-	-
The dung and urine are excreted in the fields. The sun dried dung cakes are burned for fuel. Unit: percentage over total manure.	-	-	-	-
	-	-	-	-
Composting	-	-	-	-
The dung and urine are managed through biological oxidation, usually with another organic bedding, at thermophilic temperatures. Unit: percentage over total manure.	-	-	-	-
	-	-	-	-
Anaerobic digester	-	-	-	-
Manure is anaerobically digested in different types of containers or in covered lagoons. Unit: percentage over total manure. Note: GLEAM-i gives CH ₄ emissions as a default 10% leakage of the CH ₄ produced.	-	-	-	-
	-	-	-	-

Figure 25. Implementing the example scenario. When modifying the share of manure management systems, make sure they add up to 100%, as shown in the Manure systems overview box.

3.6. BASELINE AND SCENARIO COMPARISON

GLEAM-i allows for a quick and easy comparison between **Baseline** and **Scenario** conditions, both graphically (Figure 26) and numerically (Figure 27). In that particular case, note that both meat and milk production from cattle increase around 7.5% (Figure 26-1), while total emissions only do by 0.5% (Figure 26-2).

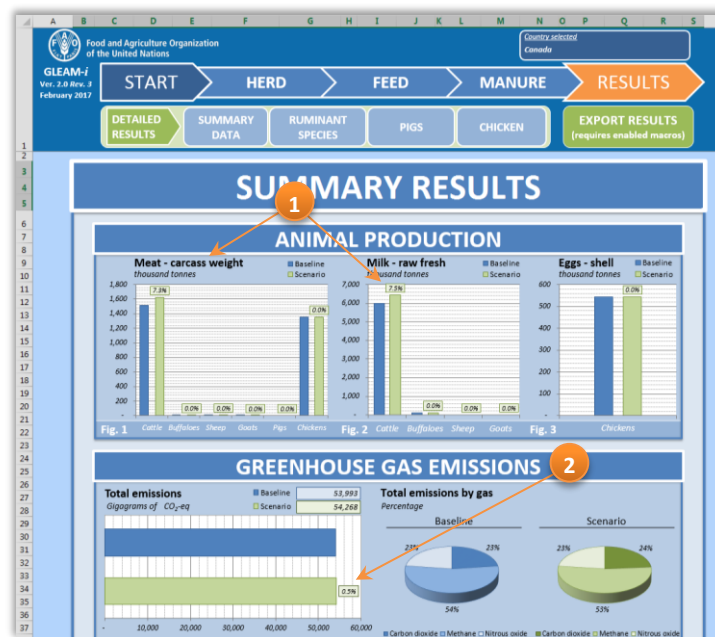


Figure 26. Screenshot of the graphic results based on the example scenario.

Detailed results page displays total and disaggregated data on emissions, emission sources, production, animal numbers, feed intake and emission intensities (Figure 27). The example intervention fosters meat and milk production by 7.3% and 7.5%, respectively (Figure 27-1), while total emissions remains almost unchanged (Figure 27-2). This is reflected in lower emission intensities for both commodities (Figure 27-3). Data on total feed intake and by main feed type is also available (Figure 27-4).

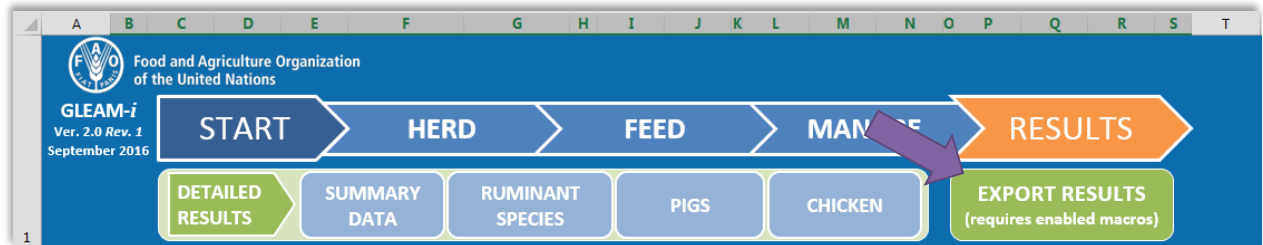
1	A	B	C	D	E	F	G
2	REGION	North America					
3	COUNTRY	Canada					
4	SIMULATION NAME	[Type the simulation name]					
5	Species	Production system	Variable	Unit	Baseline value	Scenario value	Percentage of change
6	Cattle	All systems	EMSS: Total GHG emissions	kg CO ₂ -eq/year	41,979,279,235	42,236,731,743	0.6%
7	Cattle	All systems	EMSS: Total CO ₂	kg CO ₂ -eq/year	6,996,263,257	7,460,612,449	6.6%
8	Cattle	All systems	EMSS: Total CH ₄	kg CO ₂ -eq/year	24,792,923,268	24,423,814,841	-1.5%
9	Cattle	All systems	EMSS: Total N ₂ O	kg CO ₂ -eq/year	10,190,092,711	10,352,304,453	1.6%
10	Cattle	All systems	EMSS: Feed - N ₂ O fertilizer and crop residues	kg CO ₂ -eq/year	3,140,942,449	3,099,776,058	-1.3%
11	Cattle	All systems	EMSS: Feed - N ₂ O manure applied and deposited	kg CO ₂ -eq/year	5,427,023,183	4,502,285,859	-17.0%
12	Cattle	All systems	EMSS: Feed - CO ₂ feed production	kg CO ₂ -eq/year	5,241,013,857	5,467,838,234	4.3%
13	Cattle	All systems	EMSS: Feed - CO ₂ LUC soy	kg CO ₂ -eq/year	89,289,348	208,775,083	133.8%
14	Cattle	All systems	EMSS: Feed - CO ₂ LUC palm kernel cake	kg CO ₂ -eq/year	-	-	0.0%
15	Cattle	All systems	EMSS: Feed - CO ₂ LUC pasture expansion	kg CO ₂ -eq/year	-	-	0.0%
16	Cattle	All systems	EMSS: Feed - CH ₄ rice	kg CO ₂ -eq/year	-	-	0.0%
17	Cattle	All systems	EMSS: Enteric - CH ₄ from enteric fermentation	kg CO ₂ -eq/year	21,857,366,402	21,694,786,206	-0.7%
18	Cattle	All systems	EMSS: Manure - CH ₄ from manure management	kg CO ₂ -eq/year	2,935,556,866	2,729,028,635	-7.0%
19	Cattle	All systems	EMSS: Manure - N ₂ O from manure management	kg CO ₂ -eq/year	1,622,127,078	2,750,242,535	69.5%
20	Cattle	All systems	EMSS: Energy - CO ₂ direct energy use	kg CO ₂ -eq/year	606,480,634	648,370,504	6.9%
21	Cattle	All systems	EMSS: Energy - CO ₂ indirect energy use	kg CO ₂ -eq/year	1,059,479,418	1,135,628,628	7.2%
22	Cattle	All systems	PROD: Meat - carcass weight	kg CW/year	1,513,105,608	1,624,136,149	7.3%
23	Cattle	All systems	PROD: Meat - protein amount	kg protein/year	239,789,411	257,384,976	7.3%
24	Cattle	All systems	PROD: Milk - fresh weight	kg milk/year	5,986,070,080	6,433,803,864	7.5%
25	Cattle	All systems	PROD: Milk - protein amount	kg protein/year	197,540,313	212,315,527	7.5%
26	Cattle	All systems	HERD: total number of animals	heads/year	9,234,961	9,996,232	8.2%
27	Cattle	All systems	HERD: adult females	heads/year	3,488,199	3,749,112	7.5%
28	Cattle	All systems	HERD: adult males	heads/year	118,504	127,368	7.5%
29	Cattle	All systems	HERD: replacement females	heads/year	1,315,773	1,414,190	7.5%
30	Cattle	All systems	HERD: replacement males	heads/year	120,947	129,994	7.5%
31	Cattle	All systems	HERD: fattening females	heads/year	2,044,164	2,235,187	9.3%
32	Cattle	All systems	HERD: fattening males	heads/year	2,147,374	2,340,381	9.0%
33	Cattle	All systems	INTAKE: Total intake	kg DM/year	31,842,292,893	31,979,135,978	0.4%
34	Cattle	All systems	INTAKE: Total intake - Roughages	kg DM/year	24,282,145,711	20,438,186,496	-15.8%
35	Cattle	All systems	INTAKE: Total intake - Grains	kg DM/year	5,840,894,101	8,154,977,809	39.6%
36	Cattle	All systems	INTAKE: Total intake - Agro-industrial by-products	kg DM/year	1,719,253,081	3,385,971,674	96.9%
37	Cattle	All systems	EI: Emission intensity of milk	kg CO ₂ -eq/kg protein	41.1	37.7	-8.4%
38	Cattle	All systems	EI: Emission intensity of meat	kg CO ₂ -eq/kg protein	141.2	133.0	-5.8%

Figure 27. Screenshot of the numeric results based on the example scenario. Results for each variable can be filtered by species and production system.

3.7. SAVING THE RESULTS

To save the results of the simulation, please follow one of the two options below:

- **Macros are enabled.** Go to the **Results** page and click on the **Export results** button. This will create a new file with a copy of all detailed spreadsheets which can be saved into any folder. It will suggest the name of the simulation as the name for the saved file.



- **Macros are not enabled.** Save the file using the *Save as* instruction from Excel. This will create an entire copy of the current simulation.

4. ANNEX

This Annex presents the list and description of all parameters used in GLEAM-*i*.

TABLE A1. HERD module – Herd parameters: cattle and buffaloes

Parameter	Description	Unit
Age at first calving	Average age at which cows have their first parturition, either it is a successful one or not.	Months
Fertility of adult females	Average fertility rate, expressed as the percentage of calving adult cows over the total amount of adult cows. This includes born calves that die before reaching maturity.	Percentage
Mortality of young females	Annual average percentage of non-intended deaths of female animals before reaching maturity.	Percentage
Mortality of young males	Annual average percentage of non-intended deaths of male animals before reaching maturity.	Percentage
Mortality of adult animals	Annual average percentage of non-intended deaths of animals (males and females), after reaching maturity.	Percentage
Adult females replacement	Annual average percentage of adult females' replacement.	Percentage
Weight at birth	Average live weight of calves at birth.	Kilograms/animal
Weight of adult females	Average live weight of cows once they reach maturity.	Kilograms/animal
Weight of adult males	Average live weight of bulls once they reach maturity.	Kilograms/animal
Weight of fattening females	Average live weight at slaughter of adult females culled for meat.	Kilograms/animal
Weight of fattening males	Average live weight at slaughter of adult males culled for meat.	Kilograms/animal
Milk yield	Annual average milk yield per milking cow.	Kilograms/animal
Milk fat	Average milk total fat content.	Percentage
Milk protein	Average milk total protein content.	Percentage

TABLE A2. HERD module – Herd parameters: feedlot operations

Parameter	Description	Unit
Initial weight – Female animals	Average live weight of female animals when are transferred to feedlot operations	Kilograms/animal
Weight at slaughter – Female animals	Average live weight at which feedlot female animals are slaughtered	Kilograms/animal
Initial weight – Male animals	Average live weight of male animals when are transferred to feedlot operations	Kilograms/animal
Weight at slaughter – Male animals	Average live weight at which feedlot male animals are slaughtered	Kilograms/animal
Finishing period	Average duration of the finishing period	Days

TABLE A3. HERD module – Herd parameters: sheep and goats

Parameter	Description	Unit
Age at first calving	Average age at which does/ewes have their first parturition, either it is a successful one or not.	Months
Fertility of adult females	Average fertility rate, expressed as the percentage of lambing (or kidding) adult ewes (or does) over the total amount of adult ewes (or does). This includes born lambs/kids that die before reaching maturity.	Percentage
Parturition interval	Average interval between two consecutive parturitions.	Days
Litter size	Average number of lambs/kids born in each parturition, including those that die before reaching maturity.	Number
Mortality of young animals	Annual average percentage of non-intended deaths of animals before they reach maturity.	Percentage
Mortality of adult animals	Annual average percentage of non-intended deaths of adult animals after reaching maturity.	Percentage
Adult females replacement	Annual average percentage of adult females' replacement.	Percentage
Weight at birth	Average live weight of lambs/kids at birth.	Kilograms/animal
Weight of adult females	Average live weight of does/ewes once they reach maturity.	Kilograms/animal
Weight of adult males	Average live weight of rams/bucks once they reach maturity.	Kilograms/animal
Weight of fattening females	Average live weight at slaughter of adult females culled for meat.	Kilograms/animal
Weight of fattening males	Average live weight at slaughter of adult males culled for meat.	Kilograms/animal
Milk yield	Annual average milk yield per milking doe/ewe.	Kilograms/animal
Milk fat	Average milk total fat content.	Percentage
Milk protein	Average milk total protein content.	Percentage

TABLE A4. HERD module – Herd parameters: pigs

Parameter	Description	Unit
Age at first parturition	Average age at which sows have their first parturition, either it is a successful one or not.	Weeks
Fertility of adult females	Annual average of parturitions per sows, including all the sows in the herd.	Number/animal
Gestation period	Average duration of the gestation period.	Days
Litter size	Average number of piglets born in each parturition, including those that die before reaching maturity.	Number
Lactation period	Average amount of time that piglets are lactated.	Days
Idle period	Average amount of time between one parturition and the consecutive pregnancy.	Days
Mortality of piglets before weaning	Annual average mortality of non-intended piglets' deaths before weaning.	Percentage
Weaning age	Average age at which piglets are weaned.	Days
Mortality of juvenile replacement animals	Annual average mortality of replacement animals with ages comprised between weaning and maturity.	Percentage
Mortality of adult replacement animals	Annual average mortality of replacement animals after reaching maturity.	Percentage
Mortality of fattening animals	Annual average mortality of adult fattening animals.	Percentage
Replacement of adult females	Rate of reproductive adult females' replacement.	Percentage
Replacement of adult males	Rate of reproductive adult males' replacement.	Percentage
Weight of piglets at birth	Average live weight of piglets at birth.	Kilograms/animal
Weight of weaned piglets	Average live weight of piglets at weaning age	Kilograms/animal
Weight of adult females	Average live weight of sows once they reach maturity.	Kilograms/animal
Weight of adult males	Average live weight of boars once they reach maturity.	Kilograms/animal
Weight of fattening animals	Average live weight at slaughter of fattening animals culled for meat.	Kilograms/animal
Average daily weight gain	Average daily weight gain of fattening animals.	Kilograms/animal/day

Source: Authors

TABLE A5. HERD module – Herd parameters: chicken

Parameter	Description	Unit
Laying age	Average age at which hens starts laying eggs.	Weeks
Annual laid eggs	Annual average number of eggs laid per hen.	Eggs/animal
Hatchability	Average percentage of successfully hatched eggs.	Percentage
Mortality of pullets	Annual average percentage of non-intended deaths of pullets under 16 weeks old.	Percentage
Mortality of adult animals	Annual average percentage of non-intended deaths of pullets after their first 16 weeks	Percentage
Egg weight	Average weight of eggs	Grams/egg
Weight of pullets at birth	Average live weight of pullets at hatching	Grams/animal
Slaughter weight of backyard hens	Average live weight of hens when slaughter for meat in backyard production system	Kilograms/animal
Slaughter weight of backyard roosters	Average live weight of roosters when slaughter for meat in backyard production system	Kilograms/animal
Molting	Is molting done in laying systems?	Boolean
Initial weight of laying hens	Average live weight of laying hens at the beginning of the first laying period	Kilograms/animal
Final weight of laying hens	Average live weight of laying hens at the end of the first laying period	Kilograms/animal
Laying period	Average length of the laying period for hens in layer and broiler systems	Days
Mortality of adult broilers	Average percentage of non-intended deaths of broiler animals after their first 16 weeks	Percentage
Slaughter weight of broilers	Average live weight at slaughter of broiler animals	Kilograms/animal

Source: Authors

TABLE A6. FEED module – List of feed items for ruminant species

Feed item	Description
Roughages	
Fresh grass	Any type of natural or cultivated fresh grass grazed or fed to the animals.
Hay or silage from grass	Hay (grass is cut, dried and stored) or silage (grass is cut and fermented) from any natural or cultivated grass.
Fresh mixture of grass and legumes	Fresh mixture of any type of grass and leguminous plants that is fed to the animals.
Hay or silage from grass and legumes	Hay or silage produced from a mixture of any type of grass and leguminous plants.
Hay or silage from alfalfa (Lucerne)	Hay or silage from alfalfa (<i>Medicago sativa</i>)
Silage from whole grain plants	Silage from whole barley (<i>Hordeum vulgare</i>), oat (<i>Avena sativa</i>), buckwheat (<i>Fagopyrum esculentum</i>) and fonio (<i>Digitaria spp.</i>) plants.
Silage from whole maize plant	Silage from whole maize (<i>Zea mays</i>) plants.
Crop residues from wheat	Residual plant material such as straw, brans, leaves, etc. from wheat (<i>Triticum spp.</i>) cultivation.
Crop residues from maize	Residual plant material such as straw, brans, leaves, etc. from maize (<i>Zea mays</i>) cultivation.
Crop residues from millet	Residual plant material such as straw, brans, leaves, etc. from millet (<i>Pennisetum glaucum</i> , <i>Eleusine coracana</i> , <i>Panicum miliaceum</i> , etc) cultivation.
Crop residues from sorghum	Residual plant material such as straw, brans, leaves, etc. from sorghum (<i>Sorghum spp.</i>) cultivation.
Crop residues from rice	Residual plant material such as straw, brans, leaves, etc. from rice (<i>Oryza spp.</i>) cultivation.
Crop residues from other grains	Residual plant material such as straw, brans, leaves, etc. from barley (<i>Hordeum vulgare</i>), rye (<i>Secale cereale</i>) or oat (<i>Avena sativa</i>) cultivation.
Crop residues from sugarcane	Residual plant material such as straw, brans, leaves, etc. from sugarcane (<i>Saccharum spp.</i>) cultivation.
Fodder beet	Fodder beet (<i>Beta vulgaris</i>), also known as mangel beet or field beet, used as animal feed.
Grains	
Maize	Grains from maize (<i>Zea mays</i>) plant.
Grains	Grains from wheat (<i>Triticum spp.</i>), barley (<i>Hordeum vulgare</i>), sorghum (<i>Sorghum spp.</i>), rye (<i>Secale cereale</i>) or oat (<i>Avena sativa</i>) plants.
Agro-industrial by-products	
By-products from soy	By-product from soy (<i>Glycine max</i>) oil production, commonly referred to as 'soy cakes' or 'soybean meal'.
By-products from rape (canola)	By-product from rape (<i>Brassica napus</i>) oil production, commonly referred to as 'rape cakes' or 'rapeseed meal'.
By-products from cottonseed	By-product from cottonseed (<i>Gossypium spp.</i>) oil production, commonly referred to as 'cottonseed meal'.
By-products from sugar beet	Also known as 'beet pulp', is the remaining material after the juice extraction for sugar production from the sugar beet (<i>Beta vulgaris</i>).
Oil palm kernel cake	By-product from the extraction of palm (<i>Elaeis guineensis</i>) kernel oil production, commonly referred to as 'kernel cake'.
Molasses	By-product from the sugarcane sugar extraction. It is a viscous, dark and sugar-rich material.
Maize gluten meal	By-product from maize processing. It is a protein-rich feed, with about 65% crude protein content.
Maize gluten feed	By-product from maize processing. Unlike the gluten meal, its protein content is lower, of about 25% crude protein content.
Dry by-products from grain industries	'Dry' by-products of grain industries such as brans, middlings, etc.
Wet by-products from grain industries	'Wet' by-products of grain industries such as biofuels, distilleries, breweries, etc.

Source: Authors

TABLE A7. FEED module – List of feed items for monogastrics

Feed item	Description
Swill & roughages	
Swill	Household organic waste used as feed that would otherwise been disposed.
Fresh grass	Any type of natural or cultivated fresh grass grazed or fed to the animals.
Grains & Food crops	
Pulses	Beans from leguminous species, such as <i>Phaseolus spp.</i> , <i>Vicia faba</i> , <i>Pisum sativum</i> , etc.
Cassava	Pellets from cassava (<i>Manihot esculenta</i>) roots.
Wheat	Grains from wheat (<i>Triticum spp.</i>)
Maize	Grains from maize (<i>Zea mays</i>).
Barley	Grains from barley (<i>Hordeum vulgare</i>).
Millet	Grains from millet (<i>Pennisetum glaucum</i> , <i>Eleusine coracana</i> , <i>Panicum miliaceum</i> , etc.)
Sorghum	Grains from sorghum (<i>Sorghum spp.</i>)
Rice	Grains from rice (<i>Oryza spp.</i>)
Soybeans	Beans from soy (<i>Glycine max</i>).
Rapeseed	Seeds from rapeseed (<i>Brassica napus</i>).
Banana fruit	Fruits from banana trees (<i>Musa spp.</i>)
Agro-industrial by-products	
Crop residues from banana	Crop residues such as steams, peels, etc. from banana (<i>Musa spp.</i>) cultivation.
Crop residues from pulses	Residual plant material such as straw, brans, leaves, etc. from pulses cultivation.
Crop residues from sugarcane	Residual plant material such as straw, brans, leaves, etc. from sugarcane (<i>Saccharum spp.</i>) cultivation.
Soybean oil	Vegetal oil extracted from soybeans (<i>Glycine max</i>).
By-products from soy	By-product from soy (<i>Glycine max</i>) oil production, commonly referred to as 'soy cakes' or 'soybean meal'.
By-products from cottonseed	By-product from cottonseed (<i>Gossypium spp.</i>) oil production, commonly referred to as 'cottonseed meal'.
By-products from oilseeds	By-product from seed oil production other than soy, cottonseed or palm oil.
Oil palm kernel cake	By-product from the extraction of palm (<i>Elaeis guineensis</i>) kernel oil production, commonly referred to as 'kernel cake'.
Dry by-products from grain industries	'Dry' by-products of grain industries such as brans, middlings, etc.
Wet by-products from grain industries	'Wet' by-products of grain industries such as biofuels, distilleries, breweries, etc.
Molasses	By-product from the sugarcane sugar extraction. It is a viscous, dark and sugar-rich material.
Fishmeal	Meal obtained by cooking, drying and milling of raw fish, by-captures or fish trimmings.
Additives	
Additives	Synthetic additives such as amino acids or minerals.
Limestone	Sedimentary stone composed mainly of calcium carbonate (CaCO ₃). Used as a source of calcium, is commonly given to laying hens to favor the formation of the egg shell.

Source: Authors

TABLE A8. MANURE module – Description of manure management systems

Manure system	Description
Pasture/Range/Paddock	The manure from pasture and range animals is allowed to lie as deposited, and is not managed.
Daily spread	Manure is routinely removed from a confinement facility and is applied to cropland or pasture within 24 hours of excretion.
Solid storage	The storage of manure, typically for a period of several months, in unconfined piles or stacks. Manure is able to be stacked due to the presence of sufficient amount of bedding material or loss of moisture by evaporation.
Dry lot	A paved or unpaved open confinement area without any significant vegetative cover where accumulating manure may be removed periodically.
Liquid/Slurry	Manure is stored as excreted or with some minimal addition of water in either tanks or earthen ponds outside the animal housing, usually for periods less than one year.
Uncovered anaerobic lagoon	A type of liquid storage system designed and operated to combine waste stabilization and storage. Lagoon supernatant is usually used to remove manure from the associated confinement facilities to the lagoon. Anaerobic lagoons are designed with varying lengths of storage (up to a year or greater), depending on the climate region, the volatile solids loading rate, and other operational factors. The water from the lagoon may be recycled as flush water or used to irrigate and fertilize fields.
Burned for fuel	The dung and urine are excreted on the fields. The sun dried dung cakes are burned for fuel.
Pit storage	Collection and storage of manure usually with little or no added water typically below a slatted floor in an enclosed animal confinement facility, usually for periods less than one year.
Anaerobic digester	Animal excreta with or without straw are collected and anaerobically digested in a containment vessel or covered lagoon. Digesters are designed and operated for waste stabilization by microbial reduction of complex organic compounds into CO ₂ and CH ₄ , which is captured and flared or used as fuel.
Poultry manure with litter	May be similar to open pits in enclosed animal confinement facilities or may be designed and operated to dry the manure as it accumulates. The latter is known as high-rise manure management system and is a passive windrow composting when designed and operated properly.

Source: IPCC, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, 2006.

TABLE A9. DETAILED RESULTS page – Description of variables

Variable	Description
EMSS: Total GHG emissions	Total GHG emissions.
EMSS: Total CO ₂	Total carbon dioxide emissions.
EMSS: Total CH ₄	Total methane emissions.
EMSS: Total N ₂ O	Total nitrous oxide emissions.
EMSS: Feed - N ₂ O fertilizer and crop residues	N ₂ O emissions from the conversion of nitrogenous compounds present in synthetic nitrogenous fertilizers applied to feed crops and from the decomposition of crop residues. It includes direct emissions (conversions of nitrogen into N ₂ O through a combination of nitrification and denitrification processes) and indirect emissions (nitrogen is lost in forms of ammonia and NO _x).
EMSS: Feed - N ₂ O manure applied and deposited	N ₂ O emissions from the conversion of nitrogenous compounds present in animal excreta: manure can be deposited in the fields by grazing and scavenging animals or applied to feed crop fields as organic fertilizer. It includes direct emissions (conversions of nitrogen into N ₂ O through a combination of nitrification and denitrification processes) and indirect emissions (nitrogen is lost in forms of ammonia and NO _x).
EMSS: Feed - CO ₂ feed production	CO ₂ emissions arising from the production, transport and processing of feed. This includes emissions from fossil fuels use in fertilizer and pesticides manufacture, field operations and feed manufacture in feed mills.
EMSS: Feed - CO ₂ LUC soy	CO ₂ emissions due to the expansion of soybean cultivation into natural areas. Emissions are related to changes in carbon stored in biomass, dead organic matter and soils.
EMSS: Feed - CO ₂ LUC palm kernel cake	CO ₂ emissions due to the expansion of palm oil plantations into natural areas. Emissions are related to changes in carbon stored in biomass, dead organic matter and soils.
EMSS: Feed - CO ₂ LUC pasture expansion	CO ₂ emissions due to the expansion of pastures into natural areas. Emissions are related to changes in carbon stored in biomass, dead organic matter and soils.
EMSS: Feed - CH ₄ rice	CH ₄ emissions from the cultivation of rice used as feed. Emissions are related to anaerobic decomposition of organic matter in flooded rice fields.
EMSS: Enteric - CH ₄ from enteric fermentation	CH ₄ emissions from enteric fermentation of ruminant species and pigs. During the digestive process, microbial fermentation breaks down part of the carbohydrates in the diet, generating methane as a by-product. In general, fibrous materials cause higher enteric emissions.
EMSS: Manure - CH ₄ from manure management	CH ₄ emissions from the anaerobic decomposition of organic material present in animal excreta. This is most common when urine and dung are stored and treated in liquid-based systems.
EMSS: Manure - N ₂ O from manure management	N ₂ O emissions from the conversion of nitrogenous compounds present in animal excreta. It includes direct emissions (conversions of nitrogen into N ₂ O through a combination of nitrification and denitrification processes) and indirect emissions (nitrogen is lost in forms of ammonia and NO _x).
EMSS: Energy - CO ₂ direct energy use	CO ₂ emissions from the use of energy in the animal production site for heating, ventilation, refrigeration, machinery, etc.
EMSS: Energy - CO ₂ indirect energy use	CO ₂ emissions from the use of energy on the construction of facilities (animal housing) and equipment.
PROD: Meat - carcass weight	Total production of meat expressed in carcass weight
PROD: Meat - protein amount	Total production of meat expressed in protein amount
PROD: Milk - fresh weight	Total production of milk expressed in whole, fresh weight
PROD: Milk - protein amount	Total production of milk expressed in protein amount
PROD: Eggs - shell weight	Total production of eggs expressed in whole, shell weight
PROD: Eggs - protein amount	Total production of eggs expressed in protein amount
HERD: total number of animals	Total number of animal heads. It includes all cohorts for a given species. Applies to all species.
HERD: adult females	Total number of adult female animals for a given species. Applies to all species.
HERD: adult males	Total number of adult male animals for a given species. Applies to all species.
HERD: replacement females	Total number of replacement female animals for a given species. Applies to all species.
HERD: replacement males	Total number of replacement male animals for a given species. Applies to all species.
HERD: fattening females	Total number of surplus female animals for a given species. Applies to ruminant species and chicken.
HERD: fattening males	Total number of surplus male animals for a given species. Applies to ruminant species and chicken.
HERD: fattening animals	Total number of surplus animals. Applies to pigs and chicken only.
INTAKE: Total intake	Total annual dry matter intake by the herd (or flock) of a given species. Applies to all species.
INTAKE: Total intake - Roughages	Total annual dry matter intake of roughages for ruminant species.
INTAKE: Total intake - Grains	Total annual dry matter intake of grains for ruminant species.
INTAKE: Total intake - Agro-industrial by-products	Total annual dry matter intake of agro-industrial by-products. Applies to all species.
INTAKE: Total intake - Swill & Roughages	Total annual dry matter intake of swill and roughages. Applies to pigs and chicken.
INTAKE: Total intake - Grains & Food crops	Total annual dry matter intake of grains and food crops. Applies to pigs and chicken.
INTAKE: Total intake – Additives	Total annual dry matter intake of additives. Applies to pigs and chicken.
EI: Emission intensity of milk	Emission intensity of milk, expressed as emissions per unit of edible protein. Applies to ruminant species.
EI: Emission intensity of meat	Emission intensity of meat, expressed as emissions per unit of edible protein. Applies to all species.
EI: Emission intensity of eggs	Emission intensity of eggs, expressed as emissions per unit of edible protein. Applies to chickens.

Source: Authors and Gerber, P. *et al.*, *Tackling climate change through livestock. A global assessment of emissions and mitigation opportunities*. FAO, 2013.