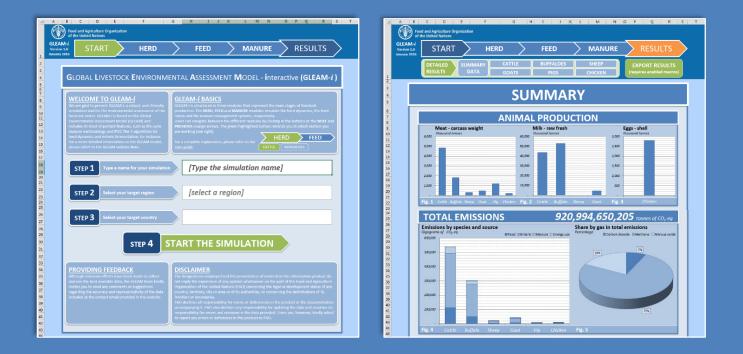


GLOBAL LIVESTOCK ENVIRONMENTAL ASSESSMENT MODEL - *interactive*

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



USER GUIDE

Revision 1 February 2016

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1. INTRODUCTION

1.1. Guide content

This user guide describes how to use the Global Environmental Assessment Model-interactive tool (GLEAM-*i*) to estimate 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 its contribution to climate change.

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

- **Introduction.** This chapter 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. The second chapter describes the livestock production systems covered by GLEAM-*i* and explains the different modules of the tool.
- **Step-by-step example.** This chapter provides a detailed example on how to implement a scenario.
- **Annex.** Users can find detailed lists of all the variables involved in GLEAM-*i* in the Annex.

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. The enhanced characterisation of animal populations translates into a better and more accurate estimation of feed intake and quality for the calculation of enteric fermentation, emissions from manure managent and the impact of intervention measures.

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 and detects measures that would only shift the negative effects from one stage to another.

BASELINE SCENARIO

The baseline refers to the situation where no program or intervention is carried in the livestock sector. It comprises the circumstances to which any other scenario and its beneficial and detrimental effects is to be compared to.

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 environmental impacts of the livestock sector 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. Further details on GLEAM can be found at the dedicated website (<u>http://www.fao.org/gleam/en/</u>).

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

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

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 carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) emissions 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.

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 determines the proportion of animals in each cohort, the rate at which animals move between cohorts and the average animal characteristics of for each cohort.
- 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.
- The feed module determines the nutritional characteristics of the feed rations and estimates the associated emissions.
- Total herd emissions and production are calculated in the system module using Tier 2 methods.

Users are able to modify any data from the herd, feed and manure modules, effectively impacting both animal production and GHG emissions.

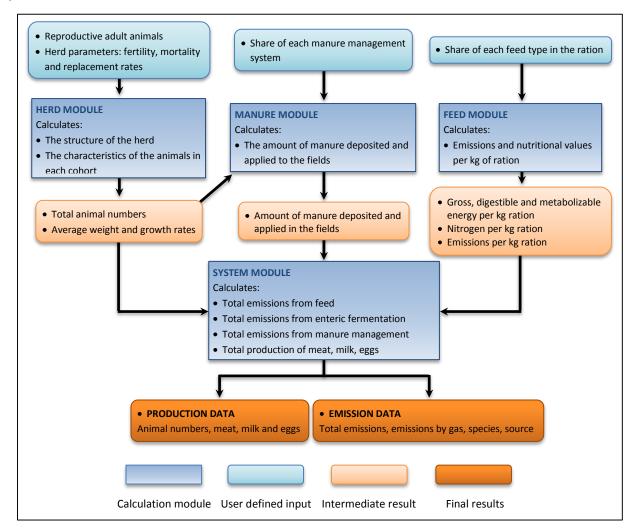


Figure 1. Schematic representation of GLEAM-i, showing the main modules, input data and calculation flows.

1.4. 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. <u>GLEAM-*i* IN DETAIL</u>

2.1. GENERAL ASPECTS

2.1.1 Navigating through GLEAM-i

The navigation bar (Figure 2) located at the top of each page allows the users to move between the different pages within modules and between modules either using the *Previous* and *Next* arrows or by clicking directly on the desired module.



Figure 2. GLEAM-i navigation bar. Current module (1), species (2) and herd (3) are highlighted in green.

2.1.2 GLEAM-i pages structure and color code

Every page in GLEAM-*i* follows a clear structure and color code. A short explanation on the page and a reminder on how to fill in the data are located below the navigation bar.

Light blue cells show default values based on the selected country and cannot be modified. White cells indicate where the users can introduce, delete and modify data. Grey cells found on **Herd** and **Feed** modules reflect the changes on the total animal numbers and the feed ration, respectively.

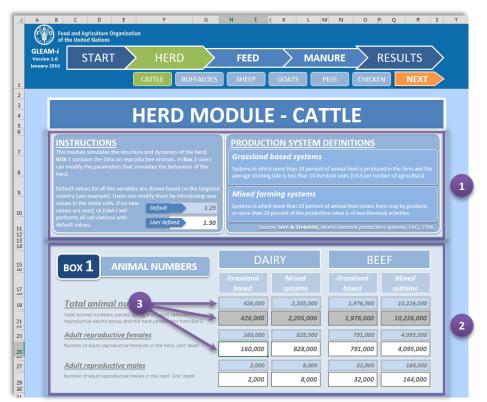


Figure 3. Page structure and color code example, where heading section (1), area for data insertion (2) and color codes (3) are shown.

2.1.3 Livestock production systems and herd types

GLEAM-*i* distinguishes between two production systems for cattle, 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 meat herds (Figure 4). Tables 1 to 3 summarize the characteristics of each production system.

RUMINAN Cattle, buffaloes,		MON	NOGASTRIC SP Pigs	PECIES	MONO	GASTRIC S Chicken	SPECIES
GRASSLAND BASED SYSTEMS Dairy Meat	MIXED FARMING SYSTEMS Dairy Meat	BACKYARD SYSTEMS	INTERMEDIATE SYSTEMS	INDUSTRIAL SYSTEMS	BACKYARD SYSTEMS	LAYERS SYSTEMS	BROILERS SYSTEMS

Figure 4. Schematic view on livestock production systems (green boxes) and herds (blue boxes) considered in GLEAM-i.

TABLE 1. Summary of ruminant production systems

System	Characteristics
Grassland based (or grazing) 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.

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

TABLE 2.	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: Gerber, P. et. al., Tackling climate change through livestock. A global assessment of emissions and mitigation opportunities. FAO, 2013.

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. Diet consists of swill and scavenging (20 to 40 percent) 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 intensivesly produced feed.
Broilersl	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 intensivesly produced feed.

TABLE 3. Summary of chicken production systems

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

1

2

3

2.2. START PAGE

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

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

	d and Agriculture Organization he United Nations							
.EAM- <i>i</i> rsion 1.0 uary 2016	START 🔰	HERD	>	FEED	\geq	MANUR		RESULTS
We sim live Env	OBAL LIVESTOCK ELCOME TO GLEAN are glad to present GLEAM-1, a ulation tool for the environmen stock sector. GLEAM-1 is based ironmental Assessment Model udges its most important feature	<u>M-i</u> robust, user-friendly ntal assessment of the on the Global (GLEAM) and	GLEAM product ration Users	AM- <i>i</i> BASICS I- <i>i</i> is structured in th tion. The HERD, FEE and the manure mai can navigate betwee	iree module D and MAN nagement s in the differ	s that represent t URE modules sim ystems, respectiv ent modules by cl	the main stay nulate the he ely. icking in the	2
ana her For	hysis methodology and IPCC Tie d dynamics and enteric fermen a more detailed information or ase refert to the GLEAM website		are wo	rking (see right). omplete explanation <u>uide</u> .	n, please ref	er to the CAT	HERD	FEED
		e for your simulatio target region		[Type the [select a			me]	3
	STEP 3 Select your t	target country						4
			STAF	RT THE S	IMU	LATION	N S	
Alth and invi reg	ROVIDING FEEDBACC nough intensive efforts have bee I use the best available data, the tes you to send any comments arding the accuracy and represe uded at the contact email provi	en made to collect e GLEAM team kindly or suggestions entativity of the data	The de not im Organi countr frontie FAO de accom	ply the expression o zation of the United y, territory, city or a rs or boundaries. clines all responsab panying it. FAO also	f any opinio Nations (F4 rea or of its ility for erro declines an	n whatsoever on O) concerning th authorities, or co rs or deficiencies y responsability fo	the part of t e legal or de ncerning the in the produ or updating t	information product do he Food and Agriculture velopment status of any e delimitations of its uct or the documentatio the data and assumes n re, however, kindly aske

Figure 5. Screen capture of the Start page.

2.3. MODULES DESCRIPTION: HERD MODULE

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

Adult females. Annual average number of adult reproductive females in the herd (cows, ewes, goats, sows and laying hens). Setting the adult females number to 0 deactivates the emissions coming from that specific species, production system or herd. This feature can be used to focus the simulation on a particular species or production system.



1

Adult males. Annual average number of adult reproductive males in the herd (bulls, rams, bucks, boars and roosters).

Herd parameters that determine the dynamic of the herd such as age at first calving, fertility of adult females, weight at birth or hatchability. The complete set can be found in Tables A1 to A4.

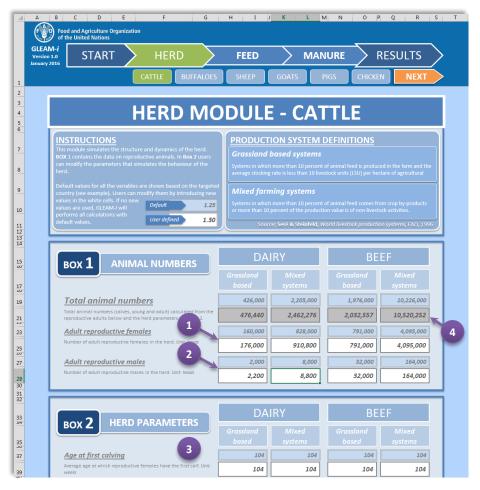


Figure 6. Herd module page example. Users can modify reproductive animal numbers (1 and 2), herd parameters (3) or both. The complete set of herd parameters for all species can be found in Tables A1 to A4. The effect of changes is immediately displayed in the Total animal numbers cells (4).

GLEAM-i

2.4. MODULES DESCRIPTION: FEED MODULE

Data on feed rations 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.

For ruminant species, rations are defined for each unique combination of species, production systems, herd and feeding groups. For monogastrics, rations are defined at species and production system level. Users will find a *Summary ration* by main feed category and the total percentage (Box 1) and a list with individual feed components (Box 2). Navigation buttons are provided to quickly switch between the two (see Figure 7). Users can modify the default ration percentages for each item in the *Detailed ration* section in terms of percentage over the total dry matter intake. A detailed description of each feed item is provided in Tables A5 and A6.

EAM- <i>i</i> sion 1.0 ary 2016	START HERD	FEED	MANURE	RESULTS
2016	PREVIOUS CATTLE BUE	FFALOES SHEEP	GOATS PIGS	CHICKEN NEXT
	DAIRY BEEF			
	FEED MO	DULE - DA	AIRY CAT	TLE
The	ISTRUCTIONS efeed module contains the information on the animal	feed ration. Box 1 shows the Summ		
agr ing Gra	o-industrial by-products. The list of of individual feed redients, effectively changing the average digestibility sssland and mixed systems are denoted with a and b in	and energy content on the ration. I and energy content on the ration. I	Please check that the total perce	sers can modify any of the ntage is 100 before proceeding.
				Default 1.25
				User defined 1.30
l	BOX 1a SUMMARY RATION	Grassi	and based sys	stems
	4 MODIFY the RATION	Adult females		
	Roughages	59.0	82.0	71.0
	Includes natural or cultivated grass (fresh, hay or silage) a fibrous materials. Unit: percentage over DM intake	and 59.0	82.0	71.0
	Grains	31.0	14.0	25.0
	Includes grains from wheat, barley, oats, maize, sorghum, Unit: percentage over DM intake	etc. 31.0	14.0	25.0
	Agro-industrial by-products	10.0	4.0	4.0
	Includes agro-industry by-products such as brans and cake Unit: percentage over DM intake	10.0	4.0	4.0
	TOTAL RATION PERCENTAGE	100.0	100.0	100.0
	BOX 1b SUMMARY RATION	Mixe	d farming sys	tems
			Adult males and	
	5 MODIFY the RATION	Adult females	replacement animals	
	<u>Roughages</u> Includes natural or cultivated grass (fresh, hay or silage) a	59.0	82.0	71.0
	fibrous materials. Unit: percentage over DM intake	59.0	82.0	71.0
	<u>Grains</u> Includes grains from wheat, barley, oats, maize, sorghum,	31.0 etc. 31.0	14.0	25.0
	Unit: percentage over DM intake Agro-industrial by-products	10.0	4.0	4.0
	Includes agro-industry by-products such as brans and cake Unit: percentage over DM intake		4.0	4.0
	TOTAL RATION PERCENTAGE	100.0	100.0	100.0
	DAIRY CATTLE -			Grassland
				Jrassianu
	BOX 2a DETAILED RATION	Grass	and based sys	stoms
		J		
	5 SUMMARY RATION			
	5 SUMMARY RATION	Adult females	replacement animals 11.0	31.0

Figure 7. Feed module example page. Summary rations for grassland (1) and mixed systems (2), as well as total percentages (3) are shown. Users can modify the individual share of each feed component in the Detailed raiont box (4). The complete list of feed items can be found in Tables A5 and A6. Navigation buttons are also shown (5).

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 methane and nitrous oxide 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. For a detailed description of each system, please refer to Table A7 in the Annex. The module shows the share under each MMS with respect to the total amount generated within each production system (and herd in the case of ruminants). The total percentage for each production systems is also provided to minimize errors when modifying the default values.

Food and Agriculture Organization of the United Nations									
AM- <i>i</i> on 1.0 ry 2016	START	HERD	> FEED			ESULTS			
	PREVIOUS	CATTLE BUFFALO	ES SHEEP	GOATS	PIGS CHICKEI	NEXT			
_									
	R.4.4	ANURE							
	IVIA	ANURE			ATTLE				
	nanure module contains the in lines. For a complete definitio re changed, affecting methane		stored and handled. Ma						
can b	e changed, affecting methane	n, please check the <u>User guid</u> and nitrous oxide emissions	from manure.	t values for each produc	tion system and nerd ty	pe. Any of those value			
Defa					em by				
	ducing new values in the white lard ones.		sed, the model will perfo		h the User d	efined 1.30			
			DA	IRY	BE	EE			
E	BOX 1 MMS P	PERCENTAGES							
	Pasture/Range/Paddocl	k	17.0	17.0	48.0	48.0			
N	lanure is allowed to lie as depos		17.0	17.0	48.0	48.0			
	ercentage over total manure								
	Daily spread	a confinement facility and is	-	-	-	-			
a	pplied within 24 hours of excretio	n. Unit: percentage over total man	ure	-	-	-			
	olid storage		40.0	40.0	47.0	47.0			
	lanure is stored for some months ufficient bedding material. Unit: p		40.0	40.0	47.0	47.0			
Ē	Dry lot		-	-	-	-			
	lanure is stored within an open o cant vegetative cover. Unit: percent				-				
L	iquid/Slurry		43.0	43.0	5.0	5.0			
	lanure is stored as excreted in tar nimal housing for less than a yea			43.0	5.0	5.0			
	Incovered anaerobic la		-	-	-	-			
u	quid system that combines waste an be recycled for irrigation. Unit:	e stabilization and storage. Wat	ter _	-	-	-			
	an be recycled for imigation. Unit:	percentage over total mailure	-	-		-			
Т	he dung and urine are excreted in	the fields. The sun dried dung	-	-	-				
	akes are burned for fuel. Unit: per	centage over total manure				-			
	Anaerobic digester lanure is anaerobically digested i	in a containment vessel or cove	red	-		-			
	agoon. Unit: percentage over total m		· ·	· ·		· .			

Figure 8. Manure module page example. Relative shares (1) and total percentage (2) for different production systems.

2.6. Results page

GLEAM-*i* provides two set of results. First, a series of figures allows for a fast and visual overview. Second, further results are found in seven spreadsheets.

2.6.1 Navigation bar

1
2
3

Modules bar. Users can quickly return to any of the modules by using this bar.

Detailed numeric results for all species and data used to generate the summary graphs can be found here.

With macros enabled, the *Export results* button generates a separate copy of detailed numeric results.

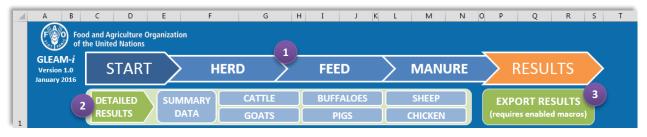


Figure 9. Use the Module tabs to quickly return to any of them (1). Spreadsheets with detailed results for each species can be found in the Explore the detailed results bar (2). Use the Export results button (3) to generate a separated file containing all the detailed spreadsheets.

2.6.2 Graphic results – Animal production

Estimates on animal production are shown in Figure 10:

1

3

Meat. Meat production by species, expressed in carcass weight.

Milk. Milk production by species, expressed in raw fresh weight.

Eggs. Eggs production, expressed in shell weight.

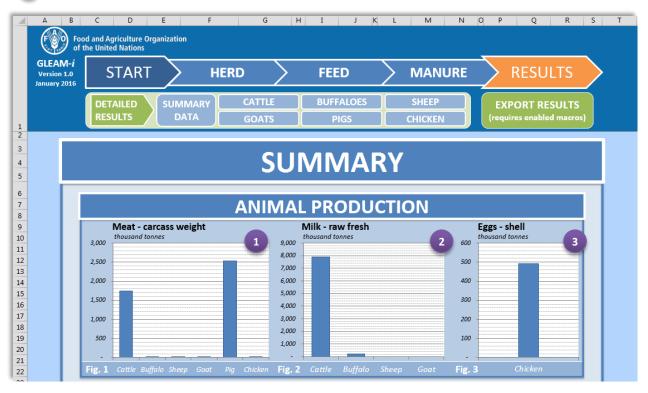


Figure 10. Animal production with graphs for meat (1), milk (2) and eggs (3).

2.6.3 Graphic results – Total GHG emissions

Estimates on GHG emissions are shown in Figure 11:



2

Total emissions. Total emissions from all species and sources, expressed in CO₂-eq. It represents the total estimated impact of the livestock sector in terms of GHG emissions.

Emissions by species and source. The chart shows the total emissions associated with each animal species and the relative share of each major source, namely feed related, enteric fermentation, manure management and energy use. Further details on emission sources can be found in the next section. For a complete definition of sources, please refer to Table A8 in the Annex.



Share by gas. Share of each gas (CO₂, CH₄ and N₂O) in the total emissions.

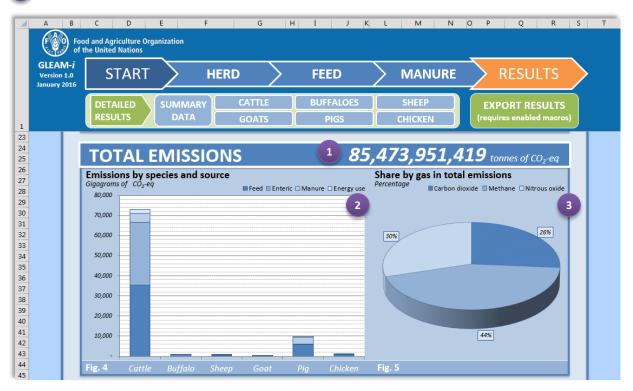


Figure 11. Total emissions block, with total emissions (1), by species and source (2) and total share by gas (3).

2.6.4 Graphic results – Emission sources

Estimates on GHG emissions split by source are shown in Figure 12:



2

Source of emissions. A more detailed look at the main sources of emissions along the livestock supply chain. For a full definition of emission sources, please refer to Table A8.

GLEAM-*i* **vs IPCC Tier I**. Comparison between GLEAM-*i* emission estimates (Tier 2) and IPCC Tier I methods. The comparison covers emissions from enteric fermentation and manure management. IPCC emissions are calculated using the total animal numbers from the herd module and 2006 IPCC Tier I default emission factors, parameters and equations.

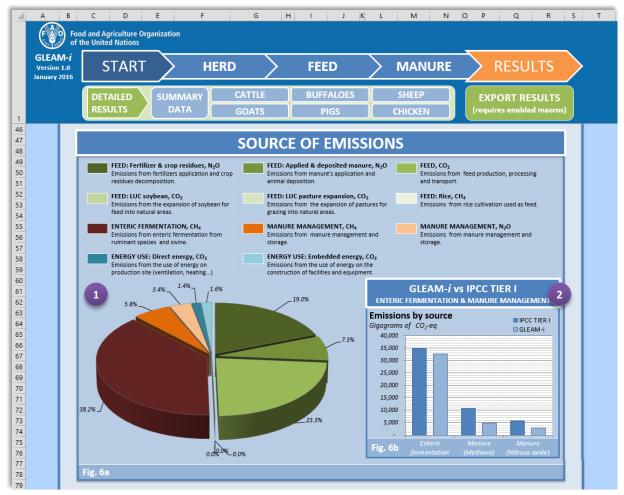


Figure 12. Emissions sources block, where sources for the total emissions (1) and the comparison between the tool and IPCC Tier I methods (2) are shown.

1

2.6.5 Graphic results – Emission intensities

Emissions related to the production of a given commodity are shown in Figure 13. In order to compare the environmental performance among different products, meat milk and eggs quantities are converted into edible protein.

Emission intensities. Amount of emissions, expressed in CO₂ equivalents, per kilogram of edible protein for different livestock commodities are shown. Regional values from GLEAM are also displayed for reference.

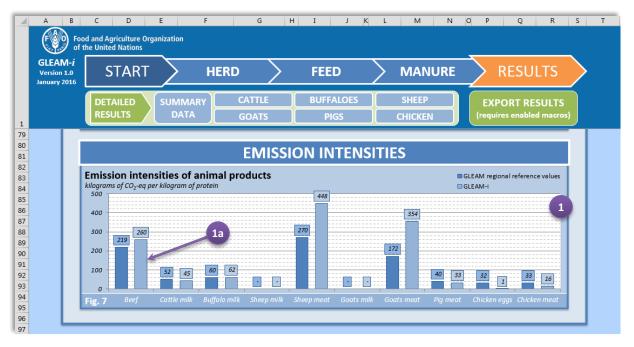


Figure 13. Graph showing the simulation emission intensities for livestock commodities (1). Regional average values from GLEAM are also shown for reference purposes (1a).

2.6.6 Detailed results – Summary data

The spreadsheet below contains the numeric data that constitutes the summarized results.

		r		
It type the simulation r	anej			
			c	=(
	Matura			Malin
				Value
kg CO2-eq/year		Feed: CO2 from land use change related to soy cultivation	kg CO2-eq/year	
		Feed: CO2 from land use change related to pasture expansion	kg CO2-eq/year	
S		Feed: CH4 from rice cultivation		
Unit	Value			
			kg CO2-eq/year	
			kg CO2-eq/year	
kg CO2-eq/year		Energy: CO2 from direct energy use	kg CO2-eq/year	
kg CO2-eq/year	-	Energy: CO2 from indirect energy use	kg CO2-eq/year	-
kg CO2-eq/year	-			
				_
				Value
	-			
	-			
kg CO2-eq/year	•	Manure (nitrous oxide)	kg CO2-eq/year	-
		BUEFALOES		
Unit	Value		Unit	Valu
				-
		Total CH4 emissions		
		Total N2O emissions		
kg CO2-eq/year		Feed: N2O from fertilization and crop residues	kg CO2-eq/year	
kg CO2-eq/year	-	Feed: N2O from manure application and deposition	kg CO2-eq/year	-
kg CO2-eq/year		Feed: CO2 from feed production, transport and processing	kg CO2-eq/year	•
kg CO2-eq/year		Feed: CO2 from land use change related to soy cultivation	kg CO2-eq/year	
kg CO2-eq/year		Feed: CO2 from land use change related to pasture expansion	kg CO2-eq/year	
kg CO2-eq/year		Energy: CO2 from indirect energy use	kg CO2-eq/year	
kgCW/year	-	Meat production in carcass weight	kgCW/year	
kg protein/year		Meat production in protein amount	kg protein/year	
kg milk/year		Milk production in fresh, whole weight	kg milk/year	
	-			
	-			
	-			
	-			
kg CO2-eq/kg protein	-	Emission intensity of milk	kg CO2-eq/kg protein	
		GOATS		
	Value	Variable	Unit	Value
kg CO2-eq/year		Total CO2 emissions	kg CO2-eq/year	
kg CO2-eq/year		Total CH4 emissions	kg CO2-eq/year	
kg CO2-eq/year		Total N2O emissions	kg CO2-eq/year	
		Feed: CO2 from land use change related to solv curtivation	kg CO2-eq/year	
		Feed: CH4 from rice cultivation	kg CO2-eq/year	
kg CO2-eq/year	-	Enteric: CH4 from enteric fermantation	kg CO2-eq/year	
kg CO2-eq/year	-	Manure: CH4 from manure management	kg CO2-eq/year	
kg CO2-eq/year	-	Manure: N2O from manure management	kg CO2-eq/year	
	-			
	-	Management of the second s		
		Milk production in fresh, whole weight		
		Milk production in protein amount		
kg CO2-eq/kg protein	-	Emission intensity of meat	kg CO2-eq/kg protein	
		Emission intensity of milk	kg CO2-eq/kg protein	•
kg CO2-eq/kg protein				
kg CO2-eq/kg protein				
		CHICKEN		
Unit	Value	Variable	Unit	Value
Unit kg CO2-eq/year	-	Variable Total CO2 emissions	kg CO2-eq/year	•
Unit kg CO2-eq/year kg CO2-eq/year	-	Variable Total CO2 emissions Total CH4 emissions	kg CO2-eq/year kg CO2-eq/year	•
Unit kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	- - -	Variable Total CO2 emissions Total CH4 emissions Total N20 emissions	kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	• • •
Unit kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	- - -	Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Feed: N20 from fertilization and crop residues	kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	• • •
Unit kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	- - - -	Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition	kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	• • • •
Unit kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year	• • • •	Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from feed production, transport and processing	kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	· · · ·
Unit kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	• • • • •	Variable Total CO2 emissions Total CH4 emissions Total X20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from feed production, transport and processing Feed: CO2 from land use change related to soy cultivation	kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	• • • •
Unit kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year	- - - - - - - - - - - -	Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from feed production, transport and processing	kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	· · · ·
Unit kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	- - - - - - - - - - - -	Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from feed production, transport and processing Feed: CO2 from land use change related to soy cultivation Feed: CO2 from land use change related to pasture expansion	kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	· · · · ·
Unit kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	- - - - - - - - - - - - - - - - -	Variable Total CO2 emissions Total CO2 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from lead use change related to soy cultivation Feed: CO2 from land use change related to pasture expansion Feed: CO2 from land use change related to pasture expansion Feed: CO2 from ice cultivation	kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	- - - - - - - - - - - - -
Unit kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	- - - - - - - - - - - - - - - - - -	Variable Total CO2 emissions Total CH4 emissions Total CH4 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from land use change related to soy cultivation Feed: CO2 from land use change related to pasture expansion Feed: CO2 from rice cultivation Enteric: CH4 from enteric fermantation Manure: CH4 from manure management Manure: N20 from manure management	kg CO2-eq/year kg CO2-eq/year	· · · · · · · · · · · · · · · · · · ·
Unit kg CO2-eq/year kg CO2-eq/year	- - - - - - - - - - - - - - - - - -	Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from land use change related to posture expansion Feed: CO2 from induce change related to pasture expansion Feed: CH4 from enteric fermantation Manure: CH4 from manure management Manure: N20 from direct energy use	kg CO2-eq/year kg CO2-eq/year	· · · · · · · · · · · · · · · · · · ·
Unit kg CO2-eq/year kg CO2-eq/year	- - - - - - - - - - - - - - - - - - -	Variable Total CO2 emissions Total CO2 emissions Total AC2 emissions Total N20 emissions Feed: N20 from feruilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from land use change related to soy cultivation Feed: CO2 from land use change related to pasture expansion Feed: CH4 from rice cultivation Enteric: CH4 from enteric fermantation Manure: N44 from manure management Manure: N20 from manure management Energy: CO2 from lindicet energy use	kg CO2-eq/year kg CO2-eq/year	· · · · · · · · · · · · · · · · · · ·
Unit kg CO2-eq/year kg CO2-eq/year	- - - - - - - - - - - - - - - - - - -	Variable Total CO2 emissions Total CH4 emissions Total CH4 emissions Total CH4 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from land use change related to soy cultivation Feed: CO2 from land use change related to pasture expansion Feed: CO4 from enteric fermantation Manure: CH4 from enteric fermantation Manure: CH4 from manure management Energy: CO2 from indicet energy use Energy: CO2 from indicet energy use Energy: CO2 from indicet solution	kg CO2-eq/year kg CO2-eq/year	· · · · · · · · · · · · · · · · · · ·
Unit kg CO2-eq/year kg CO2-eq/year	- - - - - - - - - - - - - - - - - - -	Variable Total CO2 emissions Total CP2 emissions Total AP2 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from land use change related to pasture expansion Feed: CO2 from land use change related to pasture expansion Feed: CO2 from andure emangement Manure: CP4 from manure management Manure: N20 from direct energy use Energy: CO2 from direct energy use Meat production in protein amount	kg CO2-eq/year kg CO2-eq/year	· · · · · · · · · · · · · · · · · · ·
Unit kg CO2-eq/year kg CO2-eq/year	- - - - - - - - - - - - - - - - - - -	Variable Total CO2 emissions Total CH4 emissions Total CH4 emissions Total CH4 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from land use change related to soy cultivation Feed: CO2 from inard use change related to soy cultivation Feed: CO2 from rice cultivation Enteric: CH4 from enteric fermantation Manure: CH4 from enteric fermantation Manure: CH4 from enteric fermantation Enteric: CH4 from enteric fermantation Enteric: CD7 from indirect energy use Energy: CO2 from indirect energy use Meat production in carcass weight Meat production in protein amount Eggs production in weight	kg CO2-eq/year kg CO2-eq/year	· · · · · · · · · · · · · · · · · · ·
Unit kg CO2-eq/year kg CO2-eq/year	- - - - - - - - - - - - - - - - - - -	Variable Total CO2 emissions Total CP2 emissions Total AP2 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from land use change related to pasture expansion Feed: CO2 from land use change related to pasture expansion Feed: CO2 from andure emangement Manure: CP4 from manure management Manure: N20 from direct energy use Energy: CO2 from direct energy use Meat production in protein amount	kg CO2-eq/year kg CO2-eq/year	· · · · · · · · · · · · · · · · · · ·
	Unit kg CO2-eq/year kg CO2-e	Iselect a country] [Type the simulation name] Unit Value kg CO2-eq/year - kg CO2-eq/year	TOTAL EMISSIONS BY SOURC Unit Value Rec: R20 from fertilization and drop residues Feed: R20 from manure application and drop residues Feed: R20 from manure application and drop residues Rec: C2-eq/year Feed: R20 from manure application and drop residues Rec: C2-eq/year Feed: R20 from manure application and drop residues Rec: C2-eq/year Feed: R20 from manure application and drop residues Rec: C2-eq/year Feed: R20 from manure application and drop residues Rec: C2-eq/year Feed: R20 from manure application and drop residues Rec: C2-eq/year Rec: R20 from manure application and drop residues Rec: C2-eq/year Energy: C22 from indirect energy use Rec: C2-eq/year Manure (introus oxide) Unit Value Rec: C2-eq/year Total C22 emissions Rec: C2-eq/year Total R20 emissions Rec: C2-eq/year Total R20 emissions Rec: C2-eq/year Feed: C22 from land use change related to pasture expansion Rec: C2-eq/year Feed: C22 from manure application and drop residues Rec: C2-eq/year Feed: C22 from manure application and drop residues <tr< td=""><td>TOTAL EMISSIONS BY SOURCE Unit Value TOTAL EMISSIONS BY SOURCE Unit Value Feed N20 from feer ilitation and cop residues kg C02-eq/year kg C02-eq/year Feed N20 from feer ilitation and cop residues kg C02-eq/year kg C02-eq/year Feed N20 from feer ilitation and cop residues kg C02-eq/year kg C02-eq/year Feed N20 from feer instance application and deposition kg C02-eq/year kg C02-eq/year Feed N20 from feer instance kg C02-eq/year kg C02-eq/year Manure: N4 form ensure management kg C02-eq/year kg C02-eq/year Manure: N4 form instruce management kg C02-eq/year kg C02-eq/year Manure: N4 form instruce management kg C02-eq/year kg C02-eq/year Manure (intraus oxide) kg C02-eq/year kg C02-eq/year Manure (intraus oxide) kg C02-eq/year kg C02-eq/year Manure (intraus oxide) kg C02-eq/year kg C02-eq/year Total C02 emissions kg C02-eq/year kg C02-eq/year Total C02 emissions kg C02-eq/year kg C02-eq/year Total C02 emissions kg C02-eq/year</td></tr<>	TOTAL EMISSIONS BY SOURCE Unit Value TOTAL EMISSIONS BY SOURCE Unit Value Feed N20 from feer ilitation and cop residues kg C02-eq/year kg C02-eq/year Feed N20 from feer ilitation and cop residues kg C02-eq/year kg C02-eq/year Feed N20 from feer ilitation and cop residues kg C02-eq/year kg C02-eq/year Feed N20 from feer instance application and deposition kg C02-eq/year kg C02-eq/year Feed N20 from feer instance kg C02-eq/year kg C02-eq/year Manure: N4 form ensure management kg C02-eq/year kg C02-eq/year Manure: N4 form instruce management kg C02-eq/year kg C02-eq/year Manure: N4 form instruce management kg C02-eq/year kg C02-eq/year Manure (intraus oxide) kg C02-eq/year kg C02-eq/year Manure (intraus oxide) kg C02-eq/year kg C02-eq/year Manure (intraus oxide) kg C02-eq/year kg C02-eq/year Total C02 emissions kg C02-eq/year kg C02-eq/year Total C02 emissions kg C02-eq/year kg C02-eq/year Total C02 emissions kg C02-eq/year

Figure 14. Export spreadsheet summary page. Region, country and simulation name are shown in (1). Aggregated values are found at the top of the page (2), while species data can be found below (3).

2.6.7 Detailed results – Ruminant species

Export spreadsheets for cattle, buffalo, sheep and goats have the same structure. They all contain detailed data on total emissions by gas, emission sources and animal production as shown below.

SPECIES	CATTLE				
REGION	[select a region]		1		
COUNTRY	[select a country				
SIMULATION NAME	[Type the simula	ation na	-		
	CVCT		GGREGATED		2
	5151	EIVIS A	GGREGATED		
DAIRY HERD			BEEF HERD		
Variable	Unit	Value	Variable	Unit	Value
fotal CO2 emissions	kg CO2-eq/year		Total CO2 emissions	kg CO2-eq/year	· 1
fotal CH4 emissions	kg CO2-eq/year	-	Total CH4 emissions	kg CO2-eq/year	
Total N2O emissions	kg CO2-eq/year	-	Total N20 emissions	kg CO2-eq/year	
eed: N2O from fertilization and crop residues	kg CO2-eq/year	-	Feed: N2O from fertilization and crop residues	kg CO2-eq/year	- E
eed: N2O from manure application and deposition	kg CO2-eq/year	-	Feed: N2O from manure application and deposition	kg CO2-eq/year	- 1 I
Feed: CO2 from feed production, transport and processing	kg CO2-eq/year		Feed: CO2 from feed production, transport and processing	kg CO2-eq/year	
Feed: CO2 from land use change related to soy cultivation	kg CO2-eq/year		Feed: CO2 from land use change related to soy cultivation	kg CO2-eq/year	
eed: CO2 from land use change related to pasture expansion	kg CO2-eq/year		Feed: CO2 from land use change related to pasture expansion	kg CO2-eq/year	
Feed: CH4 from rice cultivation	kg CO2-eq/year		Feed: CH4 from rice cultivation	kg CO2-eq/year	- 1
Enteric: CH4 from enteric fermantation	kg CO2-eq/year		Enteric: CH4 from enteric fermantation	kg CO2-eq/year	- 1
Manure: CH4 from manure management	kg CO2-eq/year		Manure: CH4 from manure management	kg CO2-eq/year	-
Manure: N2O from manure management	kg CO2-eq/year		Manure: N2O from manure management	kg CO2-eq/year	- 1
Energy: CO2 from direct energy use	kg CO2-eq/year		Energy: CO2 from direct energy use	kg CO2-eq/year	I
energy: CO2 from indirect energy use	kg CO2-eq/year		Energy: CO2 from indirect energy use	kg CO2-eq/year	- II
Meat production in carcass weight	kgCW/year		Meat production in carcass weight	kgCW/year	- 1
Meat production in protein amount	kg protein/year		Meat production in protein amount	kg protein/year	- 1
Milk production in fresh, whole weight	kg milk/year		Milk production in fresh, whole weight	kg milk/year	- 1 I
Ailk production in protein amount	kg protein/year	-	Milk production in protein amount	kg protein/year	· .
			D SYSTEMS		3
	GRA				
DAIRY HERD		4	BEEF HERD		
Variable	Unit	Value	Variable	Unit	Value
otal CO2 emissions	kg CO2-eq/year		T 2 emissions	kg CO2-eq/year	•
otal CH4 emissions	kg CO2-eq/year		4a 4 emissions	kg CO2-eq/year	
fotal N2O emissions	kg CO2-eq/year		Total N20 emissions	kg CO2-eq/year	- II
eed: N2O from fertilization and crop residues	kg CO2-eq/year		Feed: N2O from fertilization and crop residues	kg CO2-eq/year	- II
eed: N2O from manure application and deposition	kg CO2-eq/year		Feed: N2O from manure application and deposition	kg CO2-eq/year	- II
eed: CO2 from feed production, transport and processing	kg CO2-eq/year		Feed: CO2 from feed production, transport and processing	kg CO2-eq/year	- II
eed: CO2 from land use change related to soy cultivation	kg CO2-eq/year		Feed: CO2 from land use change related to soy cultivation	kg CO2-eq/year	- II
Feed: CO2 from land use change related to pasture expansion	kg CO2-eq/year		E 2 from land use change related to pasture expansion	kg CO2-eq/year	- II
Feed: CH4 from rice cultivation	kg CO2-eq/year		4b 4 from rice cultivation	kg CO2-eq/year	
Enteric: CH4 from enteric fermantation	kg CO2-eq/year		Enteric: CH4 from enteric fermantation	kg CO2-eq/year	
Manure: CH4 from manure management	kg CO2-eq/year		Manure: CH4 from manure management	kg CO2-eq/year	
Manure: N2O from manure management	kg CO2-eq/year	-	Manure: N2O from manure management	kg CO2-eq/year	
Energy: CO2 from direct energy use	kg CO2-eq/year	-	Energy: CO2 from direct energy use	kg CO2-eq/year	•
Energy: CO2 from indirect energy use	kg CO2-eq/year	-	Energy: CO2 from indirect energy use	kg CO2-eq/year	
Meat production in carcass weight	kgCW/year		Memoryoduction in carcass weight	kgCW/year	•
Meat production in protein amount	kg protein/year	-	4 4c duction in protein amount	kg protein/year	
Milk production in fresh, whole weight	kg milk/year		M duction in fresh, whole weight	kg milk/year	•
Milk production in protein amount	kg protein/year		Milk production in protein amount	kg protein/year	
					_
	N	IIXED S	SYSTEMS		
DAIRY HERD	N	1IXED S	SYSTEMS BEEF HERD		
Variable	V Unit	Value	BEEF HERD Variable	Unit	Value
Variable		Value	BEEF HERD	Unit kg CO2-eq/year	Value
Variable Total CO2 emissions	Unit	Value -	BEEF HERD Variable		Value -
Variable fotal CO2 emissions fotal CH4 emissions	Unit kg CO2-eq/year	Value -	BEEF HERD Variable Total CO2 emissions	kg CO2-eq/year	Value - -
Variable fotal CO2 emissions fotal CH4 emissions fotal N20 emissions	Unit kg CO2-eq/year kg CO2-eq/year	Value - -	BEEF HERD Variable Total CO2 emissions Total CH4 emissions	kg CO2-eq/year kg CO2-eq/year	Value - - -
Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Total N20 from fertilization and crop residues	Unit kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	Value - - -	BEEF HERD Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Feed: N20 from fertilization and crop residues	kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	Value - - - -
Variable otal CO2 emissions otal CH4 emissions otal N20 emissions eed: N20 from fertilization and crop residues eed: N20 from manure application and deposition	Unit kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	Value - - - -	BEEF HERD Variable Total CO2 emissions Total CH4 emissions Total N2O emissions	kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	Value - - - -
Variable fotal CO2 emissions fotal CH4 emissions fotal N20 emissions reed: N20 from fertilization and crop residues reed: N20 from manure application and deposition reed: CO2 from feed production, transport and processing	Unit kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	Value - - - - -	BEEF HERD Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from feed production, transport and processing	kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	Value - - - - -
Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Teed: N20 from fertilization and crop residues Teed: N20 from manure application and deposition Teed: CO2 from feed production, transport and processing Teed: CO2 from land use change related to soy cultivation	Unit kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year	Value - - - - - - - - -	BEEF HERD Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition	kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	Value - - - - - -
Variable Total CO2 emissions Total CO2 emissions Total N20 emissions rede: N20 from fertilization and crop residues rede: N20 from manure application and deposition rede: CO2 from feed production, transport and processing rede: CO2 from land use change related to soy cultivation rede: CO2 from land use change related to pasture expansion	Unit kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year	Value - - - - - - -	BEEF HERD Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: C02 from feed production, transport and processing Feed: C02 from land use change related to soy cultivation	kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	Value - - - - - - - - -
Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from land use change related to soy cultivation Feed: CO2 from land use change related to pasture expansion Feed: CO2 from land use change related to pasture expansion Feed: CH4 from rice cultivation	Unit kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year	Value - - - - - - - - - - - -	BEEF HERD Variable Total CO2 emissions Total CH4 emissions Total X20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from feed production, transport and processing Feed: CO2 from land use change related to soy cultivation Feed: CO2 from land use change related to pasture expansion	kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year	Value - - - - - - - - - - - -
Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from feed production, transport and processing Feed: CO2 from land use change related to soy cultivation Feed: CO2 from land use change related to pasture expansion Feed: CH4 from rice cultivation Eretric: CH4 from enteric fermantation	Unit kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	Value - - - - - - - - - - - - - -	BEEF HERD Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: N20 from fertilization and rop residues Feed: CO2 from fertilization and reparation and processing Feed: CO2 from land use change related to soy cultivation Feed: CO2 from inard use change related to pasture expansion Feed: CO2 from ince cultivation Enteric: CH4 from enteric fermantation	kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year kg C02-eq/year	Value - - - - - - - - - - - - - - - - - - -
Variable Total CO2 emissions Total CO2 emissions Total CO2 emissions Total N20 from fertilization and crop residues reed: N20 from manure application and deposition Feed: CO2 from feed production, transport and processing Feed: CO2 from land use change related to soy cultivation Feed: CO2 from land use change related to pasture expansion Feed: CO2 from rice cultivation Feed: CO4 from manure management	Unit kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year kg CO2-eq/year	Value - - - - - - - - - - - - - - - - - - -	BEEF HERD Variable Total CO2 emissions Total XO4 emissions Total XO2 emissions Feed: N20 from fertilization and crop residues Feed: N20 from feet induction, transport and processing Feed: CO2 from feet production, transport and processing Feed: CO2 from land use change related to say cultivation Feed: CO2 from land use change related to pasture expansion Feed: CO2 from land use thange related to pasture expansion	kg C02-eq/year kg C02-eq/year	Value - - - - - - - - - - - - - - - - - - -
Variable Total CO2 emissions Total CO2 emissions Total N20 emissions Total N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from land use change related to soy cultivation Feed: CO2 from land use change related to pasture expansion Feed: CO4 from recultivation Thereic: CH4 from manure management Wanure: N20 from manure management	Unit kg CO2-eq/year kg CO2-eq/year	Value - - - - - - - - - - - - - - - - - - -	BEEF HERD Variable Total CO2 emissions Total CH4 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from fertilization and crop residues Feed: N20 from fertilization and properties Feed: CO2 from lead production, transport and processing Feed: CO2 from land use change related to soy cultivation Feed: CO2 from rice cultivation Enteric: CH4 from enteric fermantation Manure: N20 from manure management Manure: N20 from manure management	kg C02-eq/year kg C02-eq/year	• • • • • • • • • • • • • •
Variable Total CO2 emissions Total CH4 emissions Total ACD emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from feed production, transport and processing Feed: CO2 from lead use change related to pasture expansion Feed: CO2 from lined use change related to pasture expansion Feed: CH4 from enteric fermantation Manure: CH4 from manure management Manure: N20 from mire cultivation Enteric: CH4 from manure management Manure: N20 from direct energy use	Unit kg CO2-eq/year kg CO2-eq/year	Value - - - - - - - - - - - - - - - - - - -	BEEF HERD Variable Total CO2 emissions Total CO2 emissions Total CH4 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from fertilization and crop residues Feed: N20 from famarure application and deposition Feed: CO2 from land use change related to pasture expansion Feed: CO2 from inard use change related to pasture expansion Feed: CO2 from inard use change related to pasture expansion Feed: CO2 from inard use change related to pasture expansion Feed: CO2 from enteric fermantation Manure: CH4 from manure management Manure: N20 from direct energy use	kg C02-eq/year kg C02-eq/year	· · · · ·
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Variable Total CO2 emissions Total CH4 emissions Total XD2 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: CO2 from land use change related to soy cultivation Feed: CO2 from land use change related to pasture expansion Feed: CO2 from land use change related to pasture expansion Feed: CO4 from recultivation Interic: CH4 from exercic fermantation Wanure: N20 from manure management Manure: N20 from manure management Energy: CO2 from lind tet energy use Energy: CO2 from lind rect energy use	Unit kg CO2-eq/year kg CO2-eq/year	Value	BEEF HERD Variable Total CO2 emissions Total CO2 emissions Total N20 emissions Feed: N20 from fertilization and crop residues Feed: N20 from manure application and deposition Feed: N20 from fertilization and rop residues Feed: N20 from fertilization and provide the state of the state o	kg CO2-eq/year kg CO2-eq/year	· · · · ·
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Figure 15. Export spreadsheet example for ruminant species. Species, region, country and simulation name are shown in (1). Data on emissions and animal production, aggregated over production systems, can be found at the top of the page (2). The same data split by grassland and mixed systems is found below (3). Each 'block' of data (4) contains numbers on total emissions by gas (4a), emission sources (4b) and animal production (4c).

2.6.8 Detailed results - Monogastric species: pigs

Data on emissions and production from pigs can be found in this spreadsheet. Similarly to ruminants, data are shown aggregated and disaggregated by production systems.

SPECIES	PIGS				
REGION	[select a region]]			
COUNTRY	[select a country	/]			
SIMULATION NAME	[Type the simula	ation name]			
		AGGREGATED	BACKYARD	INTERMEDIATE	INDUSTRIAL
Variable	Unit		Value	Value	Value
Total CO2 emissions	kg CO2-eq/year	•	-		
Total CH4 emissions	kg CO2-eq/year	-	-	-	-
Total N2O emissions	kg CO2-eq/year				
Feed: N2O from fertilization and crop residues	kg CO2-eq/year		-		
Feed: N2O from manure application and deposition	kg CO2-eq/year	-	-	-	-
Feed: CO2 from feed production, transport and processing	kg CO2-eq/year	-	-	-	-
Feed: CO2 from land use change related to soy cultivation	kg CO2-eq/year	-	-	-	-
Feed: CO2 from land use change related to pasture expansion	kg CO2-eq/year	-	-	-	-
Feed: CH4 from rice cultivation	kg CO2-eq/year	-	-	-	-
Enteric: CH4 from enteric fermantation	kg CO2-eq/year	-	-		-
Manure: CH4 from manure management	kg CO2-eq/year	-	-	-	-
Manure: N2O from manure management	kg CO2-eq/year	-	-	-	-
Energy: CO2 from direct energy use	kg CO2-eq/year	-	-	-	-
Energy: CO2 from indirect energy use Meat production in carcass weight	kg CO2-eq/year				
Meat production in protein amount	kg protein/year	-	-	-	-

Figure 16. Export spreadsheet for pigs. Species, region, country and simulation name are shown in (1). Data on total emissions by gas (2), emission sources (3) and animal production (4) can be found for both aggregated and disaggregated fields.

2.6.9 Detailed results – Monogastric species: chicken

Data on emissions and production from chicken are located in this spreadsheet. Data are shown aggregated and disaggregated by production systems.

SPECIES	CHICKEN		1		
REGION	[select a region]				
COUNTRY	[select a country	1			
SIMULATION NAME	[Type the simula	ation name]			
		AGGREGATED	BACKYARD	LAYERS	BROILERS
Variable	Unit	Value	Value	Value	Value
Total CO2 emissions	kg CO2-eq/year	-	-	-	-
Total CH4 emissions	kg CO2-eq/year	-	-	-	-
Total N2O emissions	kg CO2-eq/year				
Feed: N2O from fertilization and crop residues	kg CO2-eq/year			-	
Feed: N2O from manure application and deposition	kg CO2-eq/year	-	-	-	-
Feed: CO2 from feed production, transport and processing	kg CO2-eq/year	-	-	-	-
Feed: CO2 from land use change related to soy cultivation	kg CO2-eq/year	-	-	-	-
Feed: CO2 from land use change related to pasture expansion	kg CO2-eq/year	-	-	-	-
Feed: CH4 from rice cultivation	kg CO2-eq/year	-	-	-	-
Enteric: CH4 from enteric fermantation	kg CO2-eq/year	-	-	-	-
Manure: CH4 from manure management	kg CO2-eq/year	-	-	-	-
Manure: N2O from manure management	kg CO2-eq/year	-	-	-	-
Energy: CO2 from direct energy use	kg CO2-eq/year	-	-	-	-
Energy: CO2 from indirect energy use	kg CO2-eq/year kgCW/year				i-
Meat production in protein amount	kg protein/year		-	-	-
Eggs production in weight	kg eggs/year	-	-	-	-
Eggs production in protein amount	kg protein/year	-	-	-	-

Figure 17. Export spreadsheet for chicken. Species, region, country and simulation name are shown in (1). Data on total emissions by gas (2), emission sources (3) and animal production (4) can be found for both aggregated and disaggregated fields.

3. <u>STEP-BY-STEP EXAMPLE</u>

This section provides a full example on how to set the baseline and how to implement a scenario.

3.1. SAVING THE RESULTS

To save the results of either the baseline or a scenario, 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 GLEAM-*i*.

3.2. Setting the baseline

The baseline scenario represents the situation where no intervention or project is taking place, and sets the reference level to which any other scenario has to be compared against. When defining the baseline, users should consider two possibilities:

- **Case 1.** Sufficient and reliable data is scarce or non-existing. The baseline should be set using the default values from GLEAM-*i*.
- Case 2. Sufficient and reliable information on a given aspect of the model is available. Users should define
 the baseline by introducing the known data on the model. For instance, if herd parameters for cattle are
 known and data is considered reliable, users should overwrite the GLEAM-*i* default values on that particular
 aspect.

Once the baseline is set, save it following the steps described in the previous section.

3.3. Scenario description

The details on the scenario are shown in Tables 4 to 6. The example assumes that changes are equally applied to both grassland based and mixed farm systems. However, any scenario can be applied to a specific production system.

HERD TYPE	HERD MODULE	FEED MODULE	MANURE MODULE
Dairy	 Sector growth: increase of reproductive animals by 10% Vaccination campaign: reduction of 30% in mortality of calves. 	 Increase in feed quality for adult dairy animals: 15% increase of energy rich feed items. 	 50% reduction of deposited manure in the fields and reallocation under anaerobic lagoon.
Beef	 Breeding program resulting in heavier animals at slaughter (+1.5% live weight). Vaccination campaign: reduction of 30% in mortality of calves. 	 Increase in feed quality for adult fattening animals: increase of 25% of energy rich feed items. 	 Higher adoption (+20%) of dry lot system to the detriment of liquid/slurry.

TABLE 4. Example scenario description

¹ The scenario includes cattle only, illustrating the possibility of focusing on a particular species. Similar scenarios can be implemented for all species.

TABLE 5. Feed ration example for lactating adult females in dairy cattle

Feed item	Default value	Scenario
Roughages		
Fresh grass	5.0	5.0
Hay or silage from grass	14.0	14.0
Silage from whole grain plants	20.0	17.0
Silage from whole maize plant	20.0	17.0
Grains		
Maize	19.0	20.0
Grains	12.0	13.0
Agro-industrial by-products		
By-products from soy	4.0	5.0
By-products from rape (canola)	1.0	-
Maize gluten meal		5.0
Dry by-products from grain industries	3.0	2.0
Wet by-products from grain industries	2.0	2.0

TABLE 6. Feed ration example for fattening animals in beef herd

Feed item	Default value	Scenario
Roughages		
Fresh grass	31.0	26.0
Hay or silage from grass	24.0	20.0
Silage from whole grain plants	8.0	5.0
Silage from whole maize plant	8.0	5.0
Grains		
Maize	5.0	20.0
Grains	20.0	20.0
Agro-industrial by-products		
By-products from soy	1.0	1.0
By-products from rape (canola)	1.0	1.0
Dry by-products from grain industries	1.0	1.0
Wet by-products from grain industries	1.0	1.0

3.4. IMPLEMENTING THE SCENARIO: HERD MODULE

Introduce the new values in the white cells according to the scenario:

- **DAIRY.** Increase of 10% in the number of reproductive animals.
- **DAIRY and BEEF.** Reduction of 30% in mortality rate of calves, both male and female.
- **BEEF.** Increase of 1.5% in the live weight of both male and female fattening animals at slaughter.

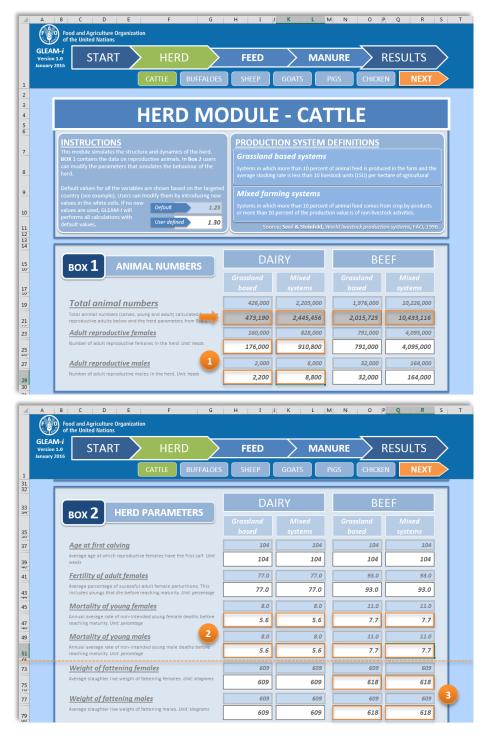


Figure 18. Implementing the scenario example. New values for adult reproductive animals (1), mortality of calves (2) and live weight at slaughter (3) are shown. Notice the change in the total number of animals due to the new values (arrow). Some parts of the page are not shown for clarity purposes (dotted line).

3.5. Implementing the scenario: Feed module

Introduce the new values in the white cells according to the scenario:

DAIRY. Increase of 15% in energy rich ingredients for lactating animals.

GLEAM-i Version 1.0	START	\geq	HERD	\rightarrow	FEED	\sum	MANURE	RES	ULTS
January 2016	PREVIOUS			BUFFALOES	SHEEP	GOATS	PIGS	CHICKEN	NEXT
		DAIRY	BEEF						
	вох 1а 💽		RY RATIO	N	Gras	sland	based s	vstems	
					orus.			y sterns	
	Roughages				59.(82.0	2	71.0
	Includes natural or cultiv fibrous materials. Unit: p			age) and	53.0	,	82.0	2	71.0
	Grains	creeninge ore	LOW MILLING		31.(14,1	0	25.0
	Includes grains from whe Unit: percentage over DM in	at, barley, or	ats, maize, sorg	hum, etc.	33.0	,	14.0	7	25.0
	Agro-industrial b		ts		10.0	2	4.1	2	4.0
	Includes agro-Industry by Unit: percentage over DM in	-products su		d cakes.	14.0		4.0		4.0
	TOTAL RATION PL	ERCENTA	GE		100.0		100.0		100.0
Version 1.0 anuary 2016	START PREVIOUS	CA	HERD	BUFFALOES	FEED SHEEP	GOATS	PIGS		NEXT
		DAIRY	BEEF						
							ON - (Eracola	
	DAIRY (ILE -			NAT		319221C	ina
						\ATI		31 8 5 1 6	anu
			RATION				ased sys		and
		DETAILED	D RATION		Grassi	land k	pased sys	stems	
		DETAILED				and k			
	BOX 2a		D RATION		Grassi	and k	ased sys	stems	
	вох 2а	DETAILED SUMI	D RATION		Grassi Iult females	and k	males and ment animals	stems	imals
	BOX 2a	SUMI vated grass t ntage over DM	NATION	DN Ac d fresh	Grassi iult females 5.0	and k	Dased sys males and nent animals 11.0	stems	imals 31.0
	BOX 2a	SUMI vated grass t ntage over DM	NATION	DN Ac d fresh	Grassi luit females 5.0 5.0	and k	males and ment animals 11.0 11.0	stems	imals 31.0 31.0
	Box 2a Fresh grass Any type of natural or culti by the animals. <i>Unit:</i> perce Hay or silage from any type percentage over DM intake Silage from whole	DETAILED SUMI vated grass t ntrage over DM <u>o grass</u> e of natural o c grain plo	D RATION MARY RATIO hat is consumed intake or cultivated gras	DN Ac 1 ss. Unit:	Grassi luit females 5.0 5.0 14.0	and k	males and ment animals 11.0 11.0 43.0	stems	imals 31.0 31.0 24.0
	Box 2a Fresh grass Any type of natural or cutit by the animals. <i>Unit</i> : percer Hay or silage from Hay or silage from any typ percentage over DM intake	DETAILED SUMI vated grass t ntrage over DM <u>n grass</u> e of natural o c grain plo	D RATION MARY RATIO hat is consumed intake or cultivated gras	DN Ac 1 ss. Unit:	Grassi tult females 5.0 5.0 14.0 14.0	and k	males and nent animals 11.0 11.0 43.0 43.0	stems	imals 31.0 31.0 24.0 24.0
	BOX 2a Fresh grass Any type of natural or culiti bythe animals. Unit: percen- Hay or silage from any typ- percentage over DM intake Silage from wheat, barley, percentage over DM intake Silage from whole	DETAILEE SUMI vated grass t ntoge over 0M D grass e of natural o grain plo sorghum, rye maize pl	D RATION MARY RATIO hat is consumed intake or cultivated gran or cultivated gran traines or coats plants.	N Ac	Grassi iuit females 5.0 14.0 14.0 20.0 17.0 20.0	and k	males and nent animals 11.0 11.0 43.0 43.0 14.0 14.0 14.0	stems	imals 31.0 31.0 24.0 24.0 8.0 8.0 8.0
	BOX 2a Fresh grass Any type of natural or culiti by the animals. Unit: perce Hay or silage from any typ- percentage over DM intake Silage from wholes Silage from wholes Silage from wholes	DETAILEE SUMI vated grass t ntoge over 0M D grass e of natural o grain plo sorghum, rye maize pl	D RATION MARY RATIO hat is consumed intake or cultivated gran or cultivated gran traines or coats plants.	N Ac	Grassi iuit females 5.0 5.0 14.0 20.0 17.0	and k	males and nent animals 11.0 11.0 43.0 43.0 14.0 14.0	stems	imais 31.0 31.0 24.0 24.0 8.0 8.0 8.0
	Box 2a Fresh grass Any type of natural or culit by the animals. Unit: perce Hay or silage from White Silage from wheat, barley, percentage over DM intake Silage from wheat, barley, Silage from w	SUMI SUMI vated grass t ntage over DM <u>o grass</u> e of natural o sorghum, nye maize <u>pl</u> of maize (Zeo	D RATION MARY RATIC MARY RATIC hat is consumed intise or cultivated gras or cultivated gras or or oats plants. <u>Cant</u> mays). Unit: perc	Action of the second se	Grassi iuit females 5.0 14.0 14.0 20.0 17.0 20.0	and k	males and nent animals 11.0 11.0 43.0 43.0 14.0 14.0 14.0	stems	imals 31.0 31.0 24.0 24.0 8.0 8.0 8.0
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	Box 2a Fresh arass Any type of natural or culit by the animals. Unit: perce- Hay or silage from any typ- percentage over DM intake Silage from wheat, barley, percentage over DM intake Silage from wheat Silage from wheat Silage from wheat Silage from wheat Silage from maile Silage from silage Silage from silage Silage	DETAILED SUMI vated grass t intage over DM D grass e of natural o grain plo sorghum, rye maize plo of maize (Zeo	D RATION WARY RATIC Intake arc cultivated gram arcs or or ats plants. ant mays). Unit: percenter rentage over DM /	N Ac 1 ss. Unit: centope centope	Grassi iult females 5.0 5.0 14.0 14.0 20.0 17.0 20.0 17.0 19.0	and k	Dased sys males and nent animals 11.0 11.0 43.0 43.0 14.0 14.0 14.0 14.0 14.0 7.0	stems	mais 31.0 31.0 24.0 24.0 8.0 8.0 8.0 8.0 5.0
	BOX 2a Fresh grass Any type of natural or cult by the animals. <i>Unit: perce</i> Hay or silage from any typ- percentage over DM intake Silage from wheet, barley, Silage from wheet, barley, Silage from wheet, barley, Silage from wheet, barley, Silage from wheet, barley, Grains from maize (Zee mo	DETAILED SUMI vated grass ti <i>ntage over DM</i> <i>p grass</i> e of natural o <i>g grain plo</i> sorghum, rye <i>maize pl</i> of maize (<i>Zeo</i> <i>sorghum</i> , rye <i>maize pl</i> of maize (<i>Zeo</i> <i>sorghum</i> , rye	D RATION WARY RATIC Intake intake in cultivated gras ants or or oats plants. (ant mays). Unit: perc mays). Unit: perc intake additional context and co	DN Acc 1 1 1 1 1 1 1 1 1 1 1 1 1	Grassi luit females 5.0 5.0 14.0 14.0 20.0 17.0 20.0 17.0 19.0 20.0	and k	Dased sys males and nent animals 11.0 11.0 43.0 43.0 14.0 14.0 14.0 14.0 7.0 7.0 7.0	stems	mais 31.0 31.0 24.0 24.0 8.0 8.0 8.0 8.0 8.0 5.0 5.0
	Box 2a Fresh grass Any type of natural or culti by the animals. <i>Unit:</i> perce Hay or silage from any type percentage over DM intake Silage from whest, barley, Silage from whest, barley, Silage from whest, barley, Grain from maize (Zee me Grains from maize (Zee me Grain from whest (<i>Triticum</i> (Scrie) or sorghum (Sorgh	DETAILED SUMI vated grass t a grass e of natural o gracin pic sorghum, rye maize pic of maize (Zeo maize (Hor mi), Unit: perc soy	D RATION WARY RATIC Intoke intoke in cultivated gras ants is or oats plants. Cants mays). Unit: pere ientage over DM i ideum), oat (Avee entage over DM i	DN Ac 1 1 1 1 1 1 1 1 1 1 1 1 1	Grassi luit females 5.0 5.0 14.0 14.0 20.0 17.0 20.0 17.0 19.0 20.0 12.0	and k	Dased sys males and nent animals 11.0 11.0 43.0 43.0 14.0 14.0 14.0 14.0 14.0 7.0 7.0 7.0	stems	mais 31.0 31.0 24.0 24.0 8.0 8.0 8.0 8.0 5.0 5.0 20.0
	BOX 2a Fresh arass Any type of natural or cult by the animals. <i>Unit:</i> perce Hay or silage from any type percentage over DM inside Silage from wheat. Darley percentage over DM inside Silage from wheat. Darley Bilage from entire plants co over DM inside Calins from maize (Zeo mo Crains Grains from wheat (Triticum (Secole) or sorghum (Sorgh	DETAILED SUMI vated grass t antage over DM 2 grass e of natural o corrain pilo sorghum, rye maize pilo of maize (Zeo ys). Unit: perc), bartey (Hor ys). Unit: perc soy), bartey (Hor ys). Unit: perc Soy	D RATION MARY RATIC MARY RATIC intoke ants or cultivated gras or cultivated gras ants or construction ants ants ants ants ants ants ants ant	DN Ac 1 1 1 1 1 1 1 1 1 1 1 1 1	Grassi luit females 5.0 5.0 14.0 14.0 20.0 17.0 20.0 17.0 20.0 19.0 20.0 12.0 13.0	and k	and a system of the system of	stems	mais 31.0 24.0 24.0 8.0 8.0 8.0 8.0 8.0 5.0 5.0 20.0 20.0
	Box 2a Fresh arass Any type of natural or cult by the animals. <i>Unit: perce</i> Hay or silage from any type recentage over 0M intele Silage from wheat, barley Silage from wheat, barley Silage from wheat, barley Silage from entire plants of over 0M intele Silage from maize (Zeo me Crains from maize (Zeo me Grains from maize (Zeo me Sicain from wheat (Triticum (secole) or sorghum (Sorgh By-products from any oil pp By-products from any oil pp	DETAILED SUMI vated grass t argan of the second or grass e of natural of argan plo sorghum, rye maize pl of maize (Zeo natural of the second of maize (Zeo natural of the second of maize (Zeo natural of the second of the second	D RATION WARY RATIC Intake intake in cultivated gras contast contast contast mays). Unit: perc intage over OM i deum), oot (Aver eventage over OM i deum), oot (Aver eventage over OM i monoly reference and anonly reference anonly reference and anonly reference anonly refe	N Acc 1 S. Unit Unit: Unit	Grassi luit females 5.0 5.0 14.0 14.0 14.0 20.0 17.0 20.0 17.0 20.0 12.0 13.0 13.0 4.0	and k	Dased sys males and nent animals 11.0 11.0 43.0 43.0 14.0 14.0 14.0 14.0 14.0 14.0 7.0 7.0 7.0 7.0 7.0 2.0	stems	mais 31.0 24.0 24.0 8.0 8.0 8.0 8.0 8.0 5.0 20.0 20.0 20.0 1.0
	Box 2a Fresh arass Any type of natural or cuilti by the animals. <i>Unit percent</i> Hay or silage from wheat, barley, percentage over DM intake Silage from wheat, Darley, percentage over DM intake Silage from maize (Zeo me Grains from maize (Zeo me Grains from maize (Zeo me Sprachusts from south (Sorght By-products from south (Sorght) By-products from south (D) Singe products from south	DETAILED SUMI vated grass t intage over DM D grass e of natural o grain plo grain plo grass t in barley (Por majze (Por majze (Car in production, cor e over DM into rape (Car in production, cor e over DM into	D RATION MARY RATIC MARY RATIC Intoke ar cultivated gran ar cultivated gran intoke ar cultivated gran arc	N Acc 1 S. Unit Unit: Unit	Grassi luit females 5.0 5.0 14.0 14.0 14.0 20.0 17.0 20.0 17.0 20.0 17.0 19.0 20.0 17.0 19.0 20.0 13.0 4.0 5.0	and k	males and nent animals 11.0 11.0 43.0 43.0 14.0 14.0 14.0 14.0 14.0 7.0 7.0 7.0 7.0 7.0 7.0 2.0 2.0	stems	mals 31.0 31.0 24.0 24.0 8.0 8.0 8.0 5.0 5.0 5.0 20.0 20.0 1.0 1.0
	Box 2a Fresh arass Any type of natural or cultil by the animals. <i>Unit percent</i> Hay or silage from wheat, barley, percentage over DM intake Silage from wheat, Darley, Silage from wheat, Silage from wheat, Silage from wheat, Silage, Silage from wheat, Silage from wheat, Silage from wheat,	DETAILED SUMI vated grass ti argan plo grans be grain plo gran plo	D RATION MARY RATIC MARY RATIC hat is consumer intoke ants or cultivated gras ants or cultivated gras	N 1 Ac Ac Ac Ac Ac Ac Ac Ac Ac Ac	Grassi luit females 5.0 5.0 14.0 14.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 19.0 20.0 17.0 17.0 20.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 1	and k	males and nent animals 11.0 11.0 43.0 43.0 14.0 14.0 14.0 14.0 14.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7	stems	mals 31.0 31.0 24.0 24.0 8.0 8.0 8.0 5.0 5.0 5.0 20.0 20.0 1.0 1.0 1.0
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	Box 2a Fresh grass Any type of natural or culit by the animals. Unit: perce Hay or silage from any type percentage over DM intelse Silage from wheat, barley, percentage over DM intelse Grains from maize (Zee mo Scale) or sorghum (Sorgh By-products from any over I) products from any over I) Payroaducts from By-products from any over I) By-product By-produ	DETAILED SUMI vated grass t ntage over DM D grass e of natural o grann plo sorghum, rye maize pl of maize (Zeo maize pl) of maize (Zeo maize pl) of maize (Zeo maize pl) of maize (Zeo maize pl) for maize (Zeo maize pl) of maize (Zeo maize pl) for	D RATION MARY RATIC MARY RATIC Intake in cultivated gran recultivated gran recultiva	N 1 Carlor Carlo	Grassi tult females 5.0 14.0 14.0 14.0 20.0 17.0 20.0 17.0 19.0 20.0 17.0 19.0 20.0 17.0 19.0 20.0 17.0 19.0 20.0 17.0 19.0 20.0 17.0 19.0 20.0 17.0 19.0 20.0 17.0 19.0 20.0 17.0 19.0 20.0 17.0 19.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 17.0 20.0 19.0 20.0 17.0 20.0 19.0 20.0 19.0 20.0 19.0 20.0 10.0 10.0 20.0 10.0 10.0 20.0 10.	and k	Dased sys males and nent animals 11.0 11.0 43.0 43.0 14.0 14.0 14.0 14.0 14.0 7.0 7.0 7.0 7.0 7.0 7.0 2.0 2.0 2.0 2.0	stems	mais 31.0 31.0 24.0 24.0 8.0 8.0 8.0 5.0 5.0 20.0 20.0 20.0 1.0 1.0 1.0 1.0
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	BOX 2a Fresh arass Any type of natural or cult by the animals. <i>Unit: percentage</i> any or silage from wheels. Silage from wheels. barley, Silage from wheels. barley, Silage from wheels. Silage	DETAILED SUMI vated grass t arge over DM D grass e of natural o grafin plo sorghum, rye maize pl of maize (Zeo maize (Zeo maize (Zeo maiz	D RATION WARY RATIC Intake Int	N Acc 1 Acc Acc	Grassi tult females 5.0 14.0 14.0 14.0 20.0 17.0 20.0 17.0 19.0 20.0 17.0 19.0 20.0 17.0 19.0 20.0 17.0 19.0 20.0 10.0 20.0 10.0 20.0 10.0 20.0 10.0 20.0 10.0 20.0 10.0 20.	and k	Dased sys males and nent animals 11.0 11.0 43.0 43.0 14.0 14.0 14.0 14.0 14.0 7.0 7.0 7.0 7.0 7.0 7.0 2.0 2.0 2.0 2.0	stems	mais 31.0 31.0 24.0 24.0 8.0 8.0 8.0 8.0 8.0 5.0 20.0 20.0 20.0 1.0 1.0 1.0 1.0 1.0
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	BOX 2a Fresh arass Fresh arass Any type of natural or cult by the animals. <i>Unit: perce</i> Hay or silage from any type percentage over DM induse Silage from wheat, Darley, percentage over DM induse Silage from wheat, Darley, Grains from maize (Zea mo Carains Grains from any area) By-products from ary on point Sycakes'. Unit: percentage By-products from araise (Seate) or sorghum (Borph By-products from araise pro Sycakes'. Unit: percentage By-product from maize pro Sycakes'. Unit percentage By-product from maize pro Sycakes'. Unit percentage By-product from maize pro Sycakes'. Unit percentage By-product from maize pro Sycakes'. Grains pro By-product from maize pro Synthese from the sy conde prote Dyrb by-product from dyrgain B	DETAILED SUMI vated grass t nange over DM D grass e of natural o gradin plo sorghum, rye maize pl of maize (Zeo of maize (Zeo nange), Unit: perc soy nange), Unit: perc soy nange), Unit: perc soy nange), Unit: perc soy roduction, coo over DM into rape (Can rape (Can)	D RATION WARY RATIC hat is consumed intake in cultivated gras arts contas plants. Cant moys). Unit: perc deum), oat (Aver mentage over DM i monoly referred ter to commonly referred ter ter to commonly referred ter to commonly referred to commonl	N Accorded and a second and a s	Grassi luit females 5.0 5.0 1440 1440 1440 2000 17.0 2000 17.0 2000 17.0 2000 17.0 19.0 20.0 12.0 13.0 40 5.0 10 - - 5.0 - 5.0 3.0	and k	Dased sys males and nent animals 111.0 11.0 43.0 43.0 14.0 14.0 14.0 14.0 14.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7	stems	mais 31.0 31.0 24.0 24.0 8.0 8.0 8.0 8.0 8.0 8.0 5.0 20.0 20.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0

Figure 19. Implementing the scenario example. Cells with new values for lactating animals are depicted (1). When modifying the feed ratio, make sure that it adds to 100%, as shown in the Summary ration (arrow). Some parts of the page are not shown for clarity purposes (dotted line).

A B	C D E		Н	I J	K L	M N	0 P	Q	R
GLEAM-i Version 1.0	START	HERD	<u> </u>	FEED	~	MANURE	7	RESU	ITS
January 2016									
1	PREVIOUS	CATTLE BUFF4	ALOES	SHEEP	GOATS	PIGS	СНІС	KEN	NEXT
14									_
	BOX 1a SU	IMMARY RATION		Grass	lanc	l based sy	vstei	ns	
16						ult males and			
18		MODIFY the RATION				cement animals			
20	Roughages			82.0		82.0			71.0
22	fibrous materials. Unit: perc	ed grass (fresh, hay or silage) and centage over DM intake		82.0		82.0			71.0
24	Grains Includes grains from wheat	t, barley, oats, maize, sorghum, etc.		14.0		14.0			25.0
26	Unit: percentage over DM into	ike		14.0		14.0			25.0
28	Agro-industrial by Includes agro-industry by-p	roducts such as brans and cakes.		4.0		4.0			4.0
30 51	Unit: percentage over DM inta					4.0			
32	TOTAL RATION PER	RCENTAGE		100.0					100.0
A B	C D I	E F G	н	I J	ΚL	M N	0 P	Q	R
	Food and Agriculture Organ			1 5	K L		0F	¥.	K
	of the United Nations								
GLEAM-i Version 1.0 January 2016	START	HERD	\geq	FEED	\geq	MANURE	\geq	RESU	LTS
Junuary 2010	PREVIOUS	CATTLE BUFFA		SHEEP	GOATS	PIGS	Сніс	KEN	NEXT
1		DAIRY BEEF							NEA
54		DAIRY BEEF			_				
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54					RAT				
54 55 56 57 58	BEEF C	DAIRY BEEF		ILED F		'ION - (Gra	ssla	
54 55 56 57 58 59	BEEF C	DARY BEEF	ETA	ILED F	lanc	T ION - (I based sy	Gra	ssla	
54 55 56 57 58 59	BEEF C	ATTLE - DI	ETA	ILED F	lanc Aa	'ION - (Gra	ssla	nd
54 55 56 57 78 59 89	BEEF CA	DARY BEEF ATTLE - DI ETAILED RATION SUMMARY RATION	ETA	ILED F	lanc Aa	' ION - (I based sy ^{Iult males and}	Gra	ssla	nd
54 55 56 57 77 88 88 88 99 97 77 11 11 13 33	BEEF CA	DAIRY BEEF ATTLE - DI ETAILED RATION SUMMARY RATION	ETA	ILED F Grass	lanc Aa	ION - (I based sy lult males and Icement animals	Gra	ssla	nd imals 31.0
54 55 56 57 77 58 88 88 88 58 57 57	BEEF CA BOX 2a D Fresh grass Any type of natural or cultivit by the animals. Unit: percent Hay or silage from	DAIRY BEEF ATTLE - DI ETAILED RATION SUMMARY RATION Area grass that is consumed fresh toge over <i>DM intake</i> grass	ETA	ILED R Grass ult females 11.0	lanc Aa	' ION - (I based sy lult males and cement animals 11.0	Gra	ssla	nd imals 31.0 26.0
54 55 56 57 77 53 54 55 55 55 55 55 55 57 57 59	BEEF CA BOX 2a D Fresh grass Any type of natural or cultivit by the animals. Unit: percent Hay or silage from	DAIRY BEEF ATTLE - DI ETAILED RATION SUMMARY RATION Vated grass that is consumed fresh tage over DM intoke	ETA	ILED R Grass ult females 11.0	lanc Aa	ION - (based sy lult males and ccement animals 31.0 11.0	Gra	ssla	nd imals 31.0 26.0 24.0
54 55 56 77 58 59 99 99 99 99 99 99 99 99 99 97 77	BEEFF CA BOX 2a D Fresh grass Any type of natural or cultive by the animals. Unit: percent Hay or silage from any type percentage over DM image Silage from whole	DAIRY BEEF ATTLE - DI ETAILED RATION SUMMARY RATION Arted grass that is consumed fresh tage der DM Intake Grass of natural or cultivated grass. Unit grain plants	ETA	ILED R Grass ult females 11.0 43.0	lanc Aa	ION - (based sy lult males and ccement animals 11.0 43.0	Gra	ssla	nd imals 31.0 26.0 24.0 20.0
54 55 56 57 77 77 59 99 77 77 199 99	BEEFF CA BOX 2a D Fresh grass Any type of natural or cultive by the animals. Unit: percent Hay or silage from any type percentage over DM image Silage from whole	DAIRY BEEF ATTLE - DI ETAILED RATION SUMMARY RATION ANTED grass that is consumed fresh toge over DM intake GTOSS of natural or cultivated grass. Unit	ETA	ILED R Grass ult females 11.0 43.0	lanc Aa	ION - C based sy lult males and cement animals 11.0 43.0 43.0	Gra	ssla	nd imals 31.0 26.0 24.0 20.0
54 55 56 57 57 57 57 57 57 57 57 77 77 77 77 77	BEEFF CA BOX 2a D Encircle of natural or cultifue by the animals. <i>Unit: percent</i> Hay or silage from any type percentage over DM intale Silage from wheat, barley, percentage over DM intale	DAIRY BEEF ATTLE - DI ETAILED RATION SUMMARY RATION Area grass that is consumed fresh agrass of natural or cultivated grass. <i>Unit</i> area grass of natural or cultivated grass. <i>Unit</i> mained plants sorghum, ne or cats plants. <i>Unit</i> : maize plant		ILED R Grass ult females 11.0 11.0 43.0 43.0 14.0 14.0 14.0	lanc Aa	Lion - C Libased sy luit males and icement animals 11.0 11.0 43.0 43.0 14.0 14.0 14.0	Gra	ssla	nd imals 26.0 20.0 5.0 5.0 5.0 8.0 8.0 8.0
54 55 56 57 57 58 59 59 50 57 55 55 55 57 77 59 99 55 55 55 57 77 59 99	BEEFF CA BOX 2a D Encircle of natural or cultifue by the animals. <i>Unit: percent</i> Hay or silage from any type percentage over DM intale Silage from wheat, barley, percentage over DM intale	DAIRY BEEP ATTLE - DI ETAILED RATION SUMMARY RATION Mated grass that is consumed fresh tage over DM intole Grass of natural or cultivated grass. Unit areain plants sorghum, ne or cats plants. Unit		ILED R Grass ult females 11.0 11.0 43.0 43.0 14.0 14.0	lanc Aa	I based sy luit males and icement animals 11.0 43.0 43.0 14.0 14.0	Gra	ssla	nd imals 26.0 20.0 5.0 5.0 5.0 8.0 8.0 8.0
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54 56 57 57 59 59 50 55 55 55 57 57 55 55 57 77 59 59 55 57 77 77 59 59 50 57 77 77 59 59 50 50 50 50 50 50 50 50 50 50 50 50 50	BEEEF CA BOX 2a D Encode A Contract of Contract Any type of natural or cultify by the animals. White performant have they or silage from any type reservence over OM inside Silage from wheat, barley, percentage over OM inside Silage from wheat, barley, percentage over OM inside Silage from entire plants of over OM inside	DAIRY BEEF ATTLE - DI ETAILED RATION SUMMARY RATION Area grass that is consumed fresh agrass of natural or cultivated grass. <i>Unit</i> area grass of natural or cultivated grass. <i>Unit</i> mained plants sorghum, ne or cats plants. <i>Unit</i> : maize plant	ETA Adu	ILED R Grass ult females 11.0 11.0 43.0 43.0 14.0 14.0 14.0 14.0 7.0 7.0	lanc Aa	100N - 0 based sy lult males and ceement animals 11.0 11.0 43.0 43.0 14.0 14.0 14.0 14.0 7.0 7.0		ssla	nd imals 31.0 26.0. 24.0 24.0 5.0 5.0 5.0 5.0 5.0 20.0
54 55 56 57 77 59 59 59 50 57 77 55 55 57 77 19 99 52 52 52 52 52 52 52 52 52 52 52 52 53 55 55 55 55 55 55 55 55 55 56 56 56 56	BEEEF CA BOX 2a D BOX 2a D CALL CALL CALL CALL Any type of natural or cultifu by the animals. Unit: percent Any or silage from whose. Silage from whose. Dailey. I percentage over OM inside Silage from whose. Dailey. I Silage from whose. Dailey. Silage from whose. Dailey. Call for the main of the operation of the operation over DM inside Call for the main of the operation.	ATTLE - DI ATTLE - DI ETAILED RATION SUMMARY RATION ISUMMARY RATION IN THE STATE OF A STATE IN THE STATE OF A STATE IN THE STATE OF A STATE OF A STATE IN THE STATE OF A STATE OF A STATE OF A STATE IN THE STATE OF A STATE		ILED R Grass ult females 11.0 11.0 43.0 43.0 14.0 14.0 14.0 14.0 7.0 7.0 7.0	lanc Aa	ION - C based sy lult males and cement animals 11.0 11.0 43.0 43.0 14.0 14.0 14.0 14.0 7.0 7.0 7.0		ssla	nd imals 31.0 26.0. 20.0 5.0 5.0 5.0 5.0 5.0 20.0 20.0
54 55 55 57 59 59 59 50 50 50 55 55 55 55 57 77 77 55 55 55 57 77 77	BEEEF C. BOX 2a D	DAIRY BEEF ATTILE - DI ETAILED RATION ETAILED RATION SUMMARY RATION arted grass that is consumed fresh type over <i>DM</i> intake grass of natural or cultivated grass. <i>Unit</i> grain plants grain plants maize plant (maize plant) (maize grasma). <i>Unit: percentage</i> (a). <i>Unit: percentage over DM</i> intake (b). barley (<i>Hordeum</i>), oat (<i>Aleno</i>), rye (m). <i>Unit: percentage over DM</i> intake		ILED R Grass ult females 11.0 13.0 14.0 14.0 14.0 14.0 14.0 7.0 7.0 7.0 7.0 7.0	Adress Constraints of the second seco	ION - C based sy lult males and cement animals 11.0 11.0 43.0 43.0 14.0 14.0 14.0 14.0 7.0 7.0 7.0 7.0 7.0 7.0	Gra	ssla	nd imals 31.0 26.0 5.0 5.0 5.0 5.0 5.0 20.0 20.0 20.0 20
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BEEF.

Figure 20. Implementing the scenario example. Cells with new values for fattening animals are depicted (1). When modifying the feed ratio, make sure that it adds to 100%, as shown in the Summary ration (arrow). Some parts of the page are not shown for clarity purposes (dotted line).

3.6. IMPLEMENTING THE SCENARIO: MANURE MODULE

Introduce the new values in the white cells according to the scenario:

DAIRY. Increase of 50% in uncovered anaerobic lagoon system and same magnitude reduction in pasture.

BEEF. Reduction of 20% in liquid/slurry system and same magnitude increase in drylot system.

		_		
A-i 1.0 START HERD	FEED		IURE F	RESULTS
	SHEEP	GOATS P		N NEXT
MANURE M	ODU	LE - C	ATTLE	
INSTRUCTIONS				
The manure module contains the information on how manure is stored guidelines. For a complete definition, please check the <u>User guide</u> . Use				
can be changed, affecting methane and nitrous oxide emissions from n			Defau	
Default values for all the variables are shown based on the targeted co introducing new values in the white cells. If no new values are used, th				defined 1.
standard ones.				
BOX 1 MMS PERCENTAGES	DAI	IRY	BE	EF
		Mixed		Mixed
	based	systems	based	
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	8.5	8.5	48.0	48.0
Daily spread	-	-	-	-
Manure is routinely removed from a confinement facility and is applied within 24 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 with sufficient bedding material. Unit: percentage over total manure	40.0	40.0	47.0	47.0
Dry lot	-	-	-	-
Manure is stored within an open confinement area without signi- ficant vegetative cover. Unit: percentage over total manure	-	-	1.0	1.0
Liquid/Slurry	43.0	43.0	5.0	5.0
Manure is stored as excreted in tanks or earthen ponds outside the	43.0	43.0	4.0	4.0
animal housing for less than a year. Unit: percentage over total manure Uncovered anaerobic lagoon				
Liquid system that combines waste stabilization and storage. Water	8.5	8.5		_
can be recycled for irrigation. Unit: percentage over total manure				1
Burned for fuel The dung and urine are excreted in the fields. The sun dried dung	-	-	-	-
	-	-	<u> </u>	-
cakes are burned for fuel. Unit: percentage over total manure				
	-	-	-	-

Figure 21. Implementing the scenario example. Cells with new values for manure management systems for dairy (1) and beef herds (2) are depicted. When modifying the share of any system, make sure that it adds to 100%, as shown in the Total percentage (arrow).

3.7. BASELINE AND SCENARIO COMPARISON

It is highly recommended to save each simulation into separate files as described in section 3.1. Comparing any scenario against the baseline can be easily done given the identical layout of the data between files.

4. ANNEX

This Annex presents the list of parameters used in the various modules.

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

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

Source: Authors

TABLE A2. 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.	Weeks
Fertility of adult females	Average percentage of successful parturitions, including 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	Annual average percentage of non-intended deaths of adult animals after reaching	Percentage
animals	maturity.	
Adult females replacement	Annual average percentage of adult females' replacement.	Percentage
Weight at birth	Average live weight of lambs/kids at birth.	Kilograms
Weight of adult females	Average live weight of does/ewes once they reach maturity.	Kilograms
Weight of adult males	Average live weight of rams/bucks once they reach maturity.	Kilograms
Weight of fattening females	Average live weight at slaughter of adult females culled for meat.	Kilograms
Weight of fattening	Average live weight at slaughter of adult males culled for meat.	Kilograms
males		
Milk yield	Annual average milk yield per milking doe/ewe.	Kilograms/head
Milk fat	Average milk total fat content.	Percentage
Milk protein	Average milk total protein content.	Percentage

Source: Authors

TABLE A3. 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/head
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
Weight of weaned piglets	Average live weight of piglets at weaning age	Kilograms
Weight of adult females	Average live weight of sows once they reach maturity.	Kilograms
Weight of adult males	Average live weight of boars once they reach maturity.	Kilograms
Weight of fattening animals	Average live weight at slaughter of fattening animals culled for meat.	Kilograms
Average daily weight gain	Average daily weight gain of fattening animals.	Kilograms/head/day

Source: Authors

TABLE A4. HERD module – Herd parameters: chicken

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/head
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	Annual average mortality of non-intended piglets' deaths before weaning.	Percentage
weaning		
Weaning age	Average age at which piglets are weaned.	Days
Mortality of juvenile replacement	Annual average mortality of replacement animals with ages comprised	Percentage
animals	between weaning and maturity.	
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
Weight of weaned piglets	Average live weight of piglets at weaning age	Kilograms
Weight of adult females	Average live weight of sows once they reach maturity.	Kilograms
Weight of adult males	Average live weight of boars once they reach maturity.	Kilograms
Weight of fattening animals	Average live weight at slaughter of fattening animals culled for meat.	Kilograms
Average daily weight gain	Average daily weight gain of fattening animals.	Kilograms/head/day

Source: Authors

TABLE A5. 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 (Medicago sativa)
Silage from whole grain plants	Silage from whole 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.
Silage from whole maize plant	Silage from whole maize (Zea mays) plants.
Crop residues from wheat	Residual plant material such as straw, brans, leaves, etc. from wheat (Triticum spp.) cultivation.
Crop residues from maize	Residual plant material such as straw, brans, leaves, etc. from maize (Zea mays) cultivation.
Crop residues from millet	Residual plant material such as straw, brans, leaves, etc. from millet (<i>Pennisetum glaucum, Eleusine coracana, Panicum miliaceum, etc</i>) cultivation.
Crop residues from sorghum	Residual plant material such as straw, brans, leaves, etc. from sorghum (Sorghum spp.) cultivation.
Crop residues from rice	Residual plant material such as straw, brans, leaves, etc. from rice (Oryza spp.) 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 (Saccharum spp.) cultivation.
Fodder beet	Fodder beet (Beta vulgaris), also known as mangel beet or field beet, used as animal feed.
Grains	
Maize	Grains from maize (Zea mays) 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 (Gossypium spp.) 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 expeller	By-product from the extraction of palm oil (<i>Elaeis guineensis</i>) kernel oil production, commonly referred to as 'kernel expeller'.
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

Feed item	Description		
Swill & roughages	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 Phaseolus spp., Vicia faba, Pisum sativum, etc.		
Cassava	Pellets from cassava (Manihot esculenta) roots.		
Wheat	Grains from wheat (Triticum spp.)		
Maize	Grains from maize (Zea mays).		
Barley	Grains from barley (Hordeum vulgare).		
Millet	Grains from millet (Pennisetum glaucum, Eleusine coracana, Panicum miliaceum, etc.)		
Sorghum	Grains from sorghum (Sorghum spp.)		
Rice	Grains from rice (Oryza spp.)		
Soybeans	Beans from soy (Glicyne max).		
Rapeseed	Seeds from rapeseed (Brassica napus).		
Banana fruit	Fruits from banana trees (Musa spp.)		
Agro-industrial by-produc	ts		
Crop residues from banana	Crop residues such as steams, peels, etc. from banana (Musa spp.) cultivation.		
Crop residues from pulses	Residual plant material such as straw, brans, leaves, etc. from pulses cultivation.		
Crop residues from	Residual plant material such as straw, brans, leaves, etc. from sugarcane (Saccharum spp.) cultivation.		
sugarcane			
Soybean oil	Vegetal oil extracted from soybeans (Glicyne max).		
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 expeller	By-product from the extraction of palm oil (<i>Elaeis guineensis</i>) kernel oil production, commonly referred to as 'kernel expeller'.		
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.		
Fish meal	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 A7. 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 A8. RESULTS page – Description of emission sources

Source	Description
FEED	Emissions caused by the production, processing and transport of feed
FEED: Fertilizer & crop	N ₂ O emissions caused by fertilizers applied to the feed crops and by the decomposition of crop residues.
residues, N ₂ O	
FEED: Applied &	N ₂ O emissions from the manure deposited in the fields by grazing or scavenging animals or from manure applied
deposited manure, N ₂ O	to crop fields or pastures.
FEED, CO ₂	CO ₂ emissions arising from the production, transport and processing of feed. This includes emissions from fossil
	fuels use in fertilizer manufacture, field operations and feed manufacture in feed mills.
FEED: LUC soybean, CO ₂	CO ₂ emissions from the expansion of soybean used for feed into natural areas.
FEED: LUC pasture, CO ₂	CO ₂ emissions from the expansion of pastures into natural areas.
FEED: Rice, CH ₄	CH₄ emissions from rice cultivation for feed purposes.
ENTERIC	CH₄ emissions from enteric fermentation of ruminant species and pigs. During the digestive process, microbial
FERMENTATION	fermentation breaks down part of the carbohydrates in the diet, generating methane as a by-product. In
	general, fibrous materials cause higher methane emissions.
MANURE	Emissions caused by the management of dung and urine (application and deposition are excluded)
MANAGEMENT	
MANURE, CH ₄	CH₄ emissions from the anaerobic decomposition of organic material. This occurs mostly when manure is managed in liquid form.
MANURE, N ₂ O	N ₂ O emissions from the conversion of nitrogen compounds. It includes direct emissions (conversion of N into
	N ₂ O via combined nitrification and denitrification) and indirect emissions (nitrogen is lost in forms of ammonia
	and NO _x).
ENERGY USE	Emissions caused by energy consumption from fossil fuels
ENERGY USE: Direct	CO_2 emissions from the use of energy in the animal production site for heating, ventilation, refrigeration,
energy, CO ₂	machinery, etc.
ENERGY USE:	CO ₂ emissions from the use of energy on the construction of facilities (animal housing) and equipment.
Embedded energy, CO ₂	

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