

**Carbon Toolkit** Section 4.2 Pages 36-45 Viresco Report 6.20.2019

## 4.2 Application of Methodology to Calculators and Tools

4.2.1 Bord Bia PAS2050 Carbon Footprinting Model

The Bord Bia PAS2050 Carbon Footprinting Model is a carbon footprint tool developed to explore the effect of varying management practices on GHG emissions from pastoral beef production systems (Crosson et al., n.d.; Foley, et al., 2011). Further information on the PAS2050 Carbon Footprinting Model is provided in Table 3 below.

Table 3 <sup>.</sup> Bord B	ia PAS2050 Carbon Footprinting Model Assessment Summary
Bord Bia PAS	2050 Carbon Footprinting Model Assessment Summary
Developer	Teagasc and Bord Bia
Format	Excel based model
Geographic Focus	Specific to Ireland and based on average farm conditions.
Larget Audience	Researchers
Cost	Unknown
Current Users	
Indicators/met rics	GHG emissions
GWP's	IPCC (2013) 100 year: Biogenic Methane-27.75; Fossil Methane-30.5;
	Nitrous Oxide-265
	<ul> <li>Munoz (2016) Methane oxidation, biogenic carbon, and the IPCC's emission metrics. Proposal for a consistent greenhouse-gas accounting</li> </ul>
Scope and	Farm Gate - Direct GHG emissions associated with farm activities and indirect
System	GHG emissions associated with inputs brought onto the farm, nitrate leaching
Boundary	GHG emissions associated with inputs brought onto the farm, nitrate leaching and ammonia (NH3) volatilization are simulated.
Notable	• GHG emissions generated after cattle have left the farm for slaughter are not
Omissions in	included (e.g. meat processing and transport).
Scope	• GHG emissions associated with buildings and machinery are also excluded as
Coope	it assumed that they do not differ between the various farming systems
	<ul><li>examined.</li><li>GHG sinks associated with and use are not considered.</li></ul>
LCA Approach	
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Guidance on or Threshold for Emissions Use       Not addressed in documentation         Primary       Farm size         Primary       Farm size         Input Data       Fertilizer application         Requirements       Finishing age         Manure management       Carcass output         - Concentrate consumed       IPCC Tier 2 for N20 emissions from grazing and fertilizer application         Factor       IPCC Tier 2 for NH3 volatilisation from manure management, concentrate consumed         Sources       IPCC Tier 2 for NH3 volatilisation from manure management, grazing and fertilizer application         Sources       IPCC Tier 1 for Nitrate leaching         PCC Tier 1 for Nitrate leaching       IPCC Tier 1 for N20 emissions from manure management         - IPCC Tier 1 for Nitrate leaching       IPCC Tier 1 for N20 emissions from manure management         - Publicly available data including:       EPA (2018) Ireland's Informative Inventory Report 2017         Sources       EPA (2018) Ireland's Informative Inventory Report 2017         Used for       Bertrup (2016) Carbon footprint analysis of mineral fertilizer production in Europe and other world regions         - Krol (2016) Improving and disaggregating N20 emission factors for ruminant excreta on temperate pasture soils         - Harty (2016) Reducing nitroux soide emissions by changing N fertiliser use from calcium ammonium nitrate (CAN) to urea-based formulations <tr< th=""><th></th><th></th></tr<>		
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calcium ammonium nitrate (CAN) to urea-based formulations• IPCC (2006)• EcoinventEmission Factor TierIPCC Tier 1 and 2 (Nitrogen) and 2 (Farm Emissions)Co-Product Allocation MethodNot addressed in documentationSoil Carbon Sequestr ation ApproachLand UseNot addressed in documentation		
<ul> <li>IPCC (2006)</li> <li>Ecoinvent</li> <li>Enission Factor Tier</li> <li>IPCC Tier 1 and 2 (Nitrogen) and 2 (Farm Emissions)</li> <li>Co-Product Allocation Method</li> <li>Not addressed in documentation</li> <li>Soil</li> <li>Facility built into model to include soil carbon sequestration (Soussanna et al., 2010).</li> <li>Sequestr ation Approach</li> <li>Not addressed in documentation</li> </ul>		
Ecoinvent     Emission     Factor Tier     IPCC Tier 1 and 2 (Nitrogen) and 2 (Farm Emissions)     IPCC Tier 1 and 2 (Nitrogen) and 2 (Farm Emissions)     IPCC Tier 1 and 2 (Nitrogen) and 2 (Farm Emissions)     Co-Product     Allocation     Method     Soil     Facility built into model to include soil carbon sequestration (Soussanna et al.,     Carbon     Sequestr     ation     Approach     Land Use     Not addressed in documentation		
Emission Factor TierIPCC Tier 1 and 2 (Nitrogen) and 2 (Farm Emissions)Co-Product Allocation MethodNot addressed in documentationSoilFacility built into model to include soil carbon sequestration (Soussanna et al., 2010).Sequestr ation Approach2010).Land UseNot addressed in documentation		
Factor TierNot addressed in documentationCo-Product Allocation MethodNot addressed in documentationSoilFacility built into model to include soil carbon sequestration (Soussanna et al., 2010).Carbon Sequestr ation Approach2010).Land UseNot addressed in documentation	<b>F</b> ueineine	
Co-Product Allocation MethodNot addressed in documentationSoilFacility built into model to include soil carbon sequestration (Soussanna et al., 2010).Carbon Sequestr ation Approach2010).Land UseNot addressed in documentation	Emission Factor Tier	IPCC Tier 1 and 2 (Nitrogen) and 2 (Farm Emissions)
Allocation MethodFacility built into model to include soil carbon sequestration (Soussanna et al., 2010).Carbon Sequestr ation Approach2010).Land UseNot addressed in documentation		Not addressed in documentation
SoilFacility built into model to include soil carbon sequestration (Soussanna et al., 2010).Carbon Sequestr ation Approach2010).Land UseNot addressed in documentation		
Carbon 2010). Sequestr ation Approach Land Use Not addressed in documentation		
Sequestr     ´       ation		•
ation Approach Land Use Not addressed in documentation	Carbon	2010).
Approach           Land Use         Not addressed in documentation	Sequestr	
Land Use Not addressed in documentation		
	Approach	
Change 2	Land Use	Not addressed in documentation
2	Change	
	-	2

Approach (Direct and Indirect)	
Output	Kg CO2e/kg live weight gain
Unit (i.e.	
Functional	
Unit)	
Uncerta	Stochastic budgeting was used to model the effect of uncertainty around key
inty	input variables on production system GHG emissions. The model was first run
Assess	deterministically to identify the GHG emission sources of most importance.
ment	

#### Cool Farm Tool v2.0

4.2.2 The Cool Farm Tool (CFT) v2.0 - Beef Module and Crop Module can be used to model onfarm Best Management Practice (BMP) impacts and model baselines. The tool is intended to be used by both producers and supply-chain actors. Application Programming Interfaces (APIs) enable assessment of large datasets for agri-businesses to assess supply-shed emissions and opportunities. Further information on the CFT is provided in Table 4 below.

Table 4: Cool Farm Tool v2.0 – Beef Module and Crop Module Assessment Summary

Cool Farm Tool v2.0 – Beef Module and Crop Module Assessment Summary	
Developer	Cool Farm Alliance
Format	Online and off-line (Excel) versions
Geographic Focus	<ul> <li>Global application, though some datasets and assumptions are European- centric.</li> </ul>

Cool Farm To	ol v2.0 – Beef Module and Crop Module Assessment Summary
	<ul> <li>Beginning to develop 'versioning' to allow better specificity to smaller regions – underlying methodology is globally applicable, but emission factors and coefficients will be altered where more refined data are available.</li> </ul>
Target	<ul> <li>Corporations and agri-businesses sourcing agricultural products.</li> </ul>
Audience	<ul> <li>Individual producers who are motivated to improve environmental and</li> </ul>
	<ul><li>economic attributes.</li><li>Consultants wanting to model on-farm emissions and BMP impacts.</li></ul>
Cost	Free – but there are membership fees for corporate members of the Cool Farm Alliance.
Current Users	Many major agri-businesses worldwide, but a stronger representation of European
	and North American users. Some individual producers as well.
Indicators/met rics	GHGs, biodiversity, water, economics
GWP's	IPCC (2007) 100-year: Methane – 25; Nitrous Oxide - 298

Scope and	Overview: Cradle to Farm Gate (with transport to next stage of animal's life
System	included)
Boundary	Start Point: Various depending on process mapping.
Doundary	<ul> <li>On-farm feed production starts with LCA-based embedded fertilizer and</li> </ul>
	pesticide production emissions pre-farm gate, as well as transport to the farm.
	However, energy emissions are from on-farm combustion of fuel only.
	<ul> <li>Off-farm feed production draws from the LCA-based FeedPrint (2013) LCI</li> </ul>
	emission factors - see 'Feedprint' below
	End Point: Farm gate
	<ul> <li>Transportation emissions from farm gate to next stage/processing is optional</li> </ul>
	but encouraged.
Notable	Carbon sequestration in grasslands is not considered – this is a deviation from
Omissions in	the Feedprint LCI
Scope	
LCA Approach	
Guidance	Not addressed in documentation
on or	
Threshold	
for	
Excluding Emissions	
Limitations to	Some limitations when considering different beef production systems
Use	Some limitations when considering different beef production systems globally. Can be used as a partial LCA tool.
Primary	Herd data
Input Data	Fertilizer inputs
Requiremen	Grazing and feed data
ts	<ul> <li>Manure management (including bedding)</li> </ul>
	On-farm energy use – fossil fuels, biofuels, electricity imports and on-farm
	electricity production.
	<ul> <li>Transportation – inbound farm inputs and transport of product to next stage/processing.</li> </ul>
Emission	<ul> <li>IPCC Tier 1 and 2 for on-farm (non-LCA based)</li> </ul>
Factor	<ul> <li>FeedPrint – LCA embedded emissions for off-farm feed production</li> </ul>
Sources	GHG Protocol Compilation of emission factors for cross-sector tools (2003)

Cool Farm Tool v2.0 – Beef Module and Crop Module Assessment Summary		
	DEFRA – Transportation (tonne-km basis) (IPCC-based)	
Dataset	Centraal Veevoeder Bureau – Feed nutrition values	
Sources	<ul> <li>Feedipedia – Feed nutrition values</li> </ul>	
Used for	ASAE Agricultural machinery management data (2006) – default fuel use	
Modeling	for on-farm machinery where primary data is unavailable for on-farm feed	
Ū	production.	
Emission Factor	On Farm is a mix of Tier 1 and Tier 2	

Co-Product	N/A - Emissions are to the farm gate at which point emissions from all co-
Allocation Method	products are still collectively accounted together (i.e. the functional unit is a live animal).
Soil Carbon	<ul> <li>Included in direct LUC for on-farm feed production for conversion to/from grassland and forest. Also assesses green manure.</li> </ul>
Sequestra	Uses IPCC methods with two deviations:
tion	<ul> <li>Conversion to/from grassland uses IPCC factors for set-aside not forest</li> </ul>
Approach	<ul> <li>Organic amendments (compost, manure, residue) are modelled using</li> </ul>
	<ul> <li>the methodology from Smith et al. (1997) and IPCC factors.</li> <li>Off-farm feed production – see FeedPrint LCA database below</li> </ul>
Land Use	Direct (on-farm feed production only) - Biomass changes from loss of gain of
Change	forest use IPCC Tier 1 methodology and account SOC (see above).
Approach	<ul> <li>LUC directly from beef production is not considered, nor are biomass</li> </ul>
(Direct and	changes directly as a result of beef production (such as silviculture
Indirect)	<ul><li>systems).</li><li>Off-farm feed production – see FeedPrint below</li></ul>
Output Unit (i.e. Functional Unit)	Emissions (CO2e) per unit live weight (at farm gate)
Uncertainty Assessment	Not addressed in documentation

# 4.2.3 CAP 2'ER

CAP 2'ER is a tool for quantifying the impacts of milk and beef production in France and assessing actions that may reduce these impacts. Further information on CAP 2'ER is provided in Table 5 below.

# Table 5: CAP 2'ER Assessment Summary

CAP 2'ER Ass	essment Summary
Developer	Institute of Livestock, France
Format	Online
Geographic Focus	France
Target Audience	Farmers, farm consultants, supply chain actors
Cost	Not specified
Current Users	
Indicators/met rics	(# of people fed), economics, and work conditions
GWP's	IPCC (2007) 100-year: Methane – 25; Nitrous Oxide - 298
Scope and System Boundary	Cradle to gate

CAP 2'ER Ass	essment Summary
Notable	Land use change
Omissions in	5
Scope	Attributional
LCA Approach	Not addressed in documentation
Guidance	not addressed in documentation
on or Threshold	
for	
Excluding Emissions	
Limitations to Use	Specific to France and based on data for France
Emission	<ul> <li>Uses LCI data from Ecoinvent and Agribalyse for bought feeds</li> </ul>
Factor Sources	
Dataset	Ecoinvent and Agribalyse - purchased feed inputs
Sources	Dia'Terre - purchased energy inputs
Used for	
Modeling	Mixtures Tier 1 for NOO from fortilizer Tier 2 for monute CU14 and NOO (Erones
Emission Factor Tier	Mixture: Tier 1 for N2O from fertilizer, Tier 2 for manure CH4 and N2O (France-
	specific), Tier 2 (France-specific) for soil carbon and Tier 3 (France-specific) for enteric fermentation.
Co-Product	None for beef, milk allocation is based on lifetime energy intake for milk and
Allocation Method	meat (74% mílk, 26% meat)
Soil	For land use only. Has emission factors for France based on type of cover –
Carbon	permanent pasture, range, hedges, non-permanent pastures, annual crop in rotation with pasture and annual crop alone.
Sequestr	rotation with pasture and annual crop alone.
ation	
Approach	
Land Use	Not included in scope
Change	
Approach	
(Direct and Indirect)	
Output	GHG emissions / Kg of live weight
Unit (i.e.	
Functional	
Unit)	
Uncertainty Assessment	Not addressed in documentation
Other	Level 1 contains many simplifying assumptions (one housing type, one diet). Level
Comments	2 allows using more detailed data and whole farm including cattle and feed
on	production. A major difference between Cap'2er and other LCA methods
Quantificatio	is that Cap'2er includes automatic carbon sequestration for grassland.
n Approach	

## 4.2.4 FAO Global Livestock Environmental Assessment Model (GLEAM)

GLEAM is a spatially explicit modelling framework that simulates the environmental impacts of the livestock sector using an LCA Approach. GLEAM differentiates key stages across livestock supply chains such as feed production, processing and transport; herd dynamics, animal feed and manure management. LCA benchmarking is completed relative to a baseline situation where no program or intervention is carried out. GLEAM-i can be also used in the preparation of national inventories and in ex-ante project evaluations assessing technical improvements in animal husbandry, feed and manure management. GLEAM is designed to analyze multiple environmental dimensions, such as feed use, GHG emissions and land use and land degradation. The current version of GLEAM (2.0) focuses on the quantification of GHG emissions related to livestock sector supply chains. Future versions of GLEAM, which are under development, will also include other environmental impacts such as nutrient and water use or interactions with biodiversity. Further information on GLEAM is provided in Table 6 below.

	Livestock Environmental Assessment Model (GLEAM) Assessment Summary
Developer	Food and Agriculture Organization of the United Nations
Format	The model runs in a Geographic Information System (GIS) and provides spatially disaggregated estimates of GHG emissions and commodity production by production system, thereby enabling the calculation of an emissions intensity for any combination of commodity and farming systems at different spatial scales.
	GLEAM-interactive (GLEAM-i) brings the core functionalities of the FAO Global
	Livestock Environmental Assessment Model to the public in a web application.
	The current version of GLEAM-i allows the direct comparison
	between Baseline and Scenario conditions, includes feedlot systems for cattle and
	incorporates the 2010 background data from GLEAM. GLEAM-i is available online.
Geographic Focus	Global by coarse geographic regions
Target Audience	Producers, policymakers, private sector organizations, academia, standard setting bodies and non-governmental organizations.
Cost	Free - GLEAM-i is the first open, user-friendly and livestock specific tool designed
	to support governments, project planners, producers, industry and civil society organizations to calculate emissions using Tier 2 methods.
Current	Used in multiple case studies including regional case studies on climate change
Users	mitigation and productivity gains in livestock supply chains; addressing enteric
	methane for food security and livelihoods cost benefit analysis of greenhouse gas
	mitigation in the livestock sector amongst many others. See the following site for
	additional information: <u>http://www.fao.org/gleam/in-</u> practice/en/

 Table 6: FAO Global Livestock Environmental Assessment Model (GLEAM) Assessment

 Summary

Indicators/m	Outputs include:
etrics	<ul> <li>Livestock animal numbers, production systems and their spatial</li> </ul>
	distribution;
	<ul> <li>Production of manure and its management;</li> </ul>
	<ul> <li>Feed intake and animal feed rations composition and quality;</li> </ul>
	<ul> <li>Land use associated with feed intake;</li> </ul>
	<ul> <li>Production of livestock commodities;</li> </ul>
	<ul> <li>GHG emissions arising from each stage of production;</li> <li>Nitrogen used at each stage of production</li> <li>IPCC (2014) 100-year: Methane – 34; Nitrous Oxide - 298</li> </ul>
GWP's	Nitrogen used at each stage of production     IPCC (2014) 100-year: Methane – 34: Nitrous Oxide - 298
Scope	Cradle-to-Retail - GLEAM covers the entire livestock production chain, from feed
and	production to the retail point. The system boundary is defined from "Cradle-to-
System	retail of processed animal products." All emissions occurring at final
Boundary	
	consumption are outside the defined system boundary and are thus excluded from this assessment.
Notable	<ul> <li>Beef processing – hides, tallow, blood, renderables;</li> </ul>
Omissions	<ul> <li>Land use change emissions are limited to soy cultivation and pasture</li> </ul>
in Scope	expansion
	Carbon stored in products
LCA Approach	Attributional

FAO Global	Livestock Environmental Assessment Model (GLEAM) Assessment Summary
Guidance on	Not addressed in documentation
or	
Threshold	
for	
Excluding	
Emissions	
Limitations to Use	Global by coarse geographic regions
Primary Input Data Requirem ents	<ul> <li>User input data include: herd structure, herd size, weight, age, animal transfers, gestation period, lactation, mineral fertilizer application rates and crop yields (among others).</li> <li>If user input data is unavailable for variables such as fertilizer application rates, crop yield and herd parameters, these factors are taken from literature, databases, aurusus or through expert application.</li> </ul>
Emission Factor Sources	<ul> <li>databases, surveys or through expert consultation.</li> <li>IPCC Tier 2 for most calculations</li> </ul>

Dataset	• FAOSTAT (2011)
Sources	Swiss Centre for Life Cycle Inventories database (EcoInvent) – Embodied
Used for	energy
Modeling	Feedipedia, NRC Guidelines for Pigs and Poultry and CVB Tables from the
	Dutch Feed Board Database – Feed nutrition values
	• Literature, databases, surveys and expert consultation for data such as crop
	yield and fertilizer application rates that the user is unable to enter.
	• LEAP database of GHG emissions related to feed crops – emission factors for
	feed production, processing and transportation
	Regional emission factors for emissions from nitrogen, phosphorus and
	potassium used for feed production
	<ul> <li>National inventory reports, expert knowledge and literature reviews – manure management system (MMS) emissions</li> </ul>
Emission	Gleam uses IPCC Tier 2 methodology - animals are broken into cohorts (adult
Factor Tier	females, adult males, replacement females, replacement males and male and
	female fattening animals). GHG emission estimates are completed for each
	stage of production. The model covers emissions of methane (CH4), carbon
	dioxide (CO2) and nitrous oxide (N2O).
Co-Product Allocation	The allocation of total impact between different commodities, products and services is based on both biophysical and economic approaches.
Method	services is based on both biophysical and economic approaches.
Soil Carbon	Not addressed in documentation
Seques	
tration	
Approa	
ch	
Land Use	Land use change emissions from soybean, palm oil plantations and pasture
Change	expansion are included. It is unclear in the documentation if both direct and
Approach	indirect LUC are included.
(Direct	
and	
Indirect)	
Output	Emissions (CO2e) per kg of edible protein for different livestock
Unit (i.e.	commodities.
Function	Average energy requirement of each animal cohort and the necessary feed
al Unit)	intake.
L	Total production of meat, milk and eggs.
FAO Global	Livestock Environmental Assessment Model (GLEAM) Assessment Summary
	Modules develop different outputs – including herd module, manure module,
	feed module, system module, allocation module and energy and post farm emissions module.

<ul> <li>Modules develop different outputs – including herd module, manufer module, feed module, system module, allocation module and energy and post farm emissions module.</li> </ul>
Not addressed in documentation

Uncertainty Assessment

## 4.2.5 Carbon Neutral Brazilian Beef

The Carbon Neutral Brazilian Beef tool quantifies CH4 emissions and woody biomass carbon gains. The purpose of the tool is to identify beef farms using integrated crop forest systems or integrate livestock forest systems that are carbon neutral (i.e. carbon gains balance CH4 emissions) for labeling purposes. Further information is presented in Table 7 below.

Developer         EMBRAPA, Government of Brazil           Format         Methodology with online software for estimating tree carbon           Geographic         Brazil           Focus         Iarget           Farmers, supply chain actors         Audience           Cost         Not specified           Current Users         Beef farmers in Brazil, the beef supply chain           Indicators/met         GHGs           GWP's         IPCC (2007) 100-year: Methane – 25; Nitrous Oxide - 298           Scope and         Cradle to beef processor gate (consequential LCA - so all emissions other           than stocking rate, enteric fermentation and tree carbon gain are assumed         to be           Boundary         to be         the same).           Notable         Some of the harvested wood needs to be used for wood products           Omissions in         (lumber, veneers, laminates). However, there appears to be no provision           Scope         for tracking the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.           LCA Approach         Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.           Not addressed in documentation         Not		al Brazilian Beef Assessment Summary
Format       Methodology with online software for estimating tree carbon         Geographic Focus       Brazil         Farget Audience       Farmers, supply chain actors         Cost       Not specified         Current Users       Beef farmers in Brazil, the beef supply chain         Indicators/met its       GFIGs         GWP's       IPCC (2007) 100-year: Methane – 25; Nitrous Oxide - 298         Scope and       Cradle to beef processor gate (consequential LCA - so all emissions other than stocking rate, enteric fermentation and tree carbon gain are assumed to be the same).         Notable       Some of the harvested wood needs to be used for wood products (lumber, veneers, laminates). However, there appears to be no provision for tracking the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.         LCA Approach       Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.         Guidance on or       Not addressed in documentation         Threshold for Excluding Emissions       IPCC Factor Sources         Dataset Sources       Brazil specific (Brazilian emission factors)         Used for Modeling       Brazilian tree growth data         Sources       Brazilian tree for the factor for enteric fermentation. The ca		
Geographic Focus       Brazil Farzil         Focus       Farmers, supply chain actors         Audience       Cost         Cost       Not specified         Current Users       Beef farmers in Brazil, the beef supply chain         Indicators/met ics       GHGs         GWP's       IPCC (2007) 100-year: Methane – 25; Nitrous Oxide - 298         Scope and       Cradle to beef processor gate (consequential LCA - so all emissions other than stocking rate, enteric fermentation and tree carbon gain are assumed to be         Boundary       to be         Motable       Some of the harvested wood needs to be used for wood products         Omissions in (lumber, veneers, laminates). However, there appears to be no provision for tracking the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.         LCA Approach       Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.         Guidance       Not addressed in documentation         on or       Interstons         Threshold for       Brazil specific (Brazilian emission factors)         Use       Brazil specific (Brazilian emission factors)         Use       Brazilian tree growth data         Sou		
Target Audience       Farmers, supply chain actors         Audience       Not specified         Cost       Not specified         Current Users       Beef farmers in Brazil, the beef supply chain Indicators/met         GWP's       IPCC (2007) 100-year: Methane – 25; Nitrous Oxide - 298         Scope and       Cradle to beef processor gate (consequential LCA - so all emissions other than stocking rate, enteric fermentation and tree carbon gain are assumed to be         Boundary       Some of the harvested wood needs to be used for wood products         Omissions in       Some of the harvested wood needs to be used for wood products         Curality to be       Some of the harvested wood needs to be used for wood products         Omissions in       (lumber, veneers, laminates). However, there appears to be no provision for tracking the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.         LCA Approach       Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.         Guidance       Not addressed in documentation         on or       Threshold for         Excluding       Brazil specific (Brazilian emission factors)         Use       Brazilian tree growth data         Sources		
Audience       In the section         Cost       Not specified         Current Users       Beef farmers in Brazil, the beef supply chain         Indicators/met       GHGs         rics       GWP's         GWP's       IPCC (2007) 100-year: Methane – 25; Nitrous Oxide - 298         Scope and       Cradle to beef processor gate (consequential LCA - so all emissions other than stocking rate, enteric fermentation and tree carbon gain are assumed to be         Boundary       to be         Notable       Some of the harvested wood needs to be used for wood products         Omissions in       (lumber, veneers, laminates). However, there appears to be no provision for tracking the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.         LCA Approach       Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.         Mot addressed in documentation       Not addressed in documentation         on or       IPCC         Factor       Sources         Dataset       Brazil specific (Brazilian emission factors)         Use       Brazilian tree growth data         Sources       Used for         Modeling       Mixture – Tier 1 or		
Current Users       Beef farmers in Brazil, the beef supply chain         Indicators/met       GHGs         GWP's       IPCC (2007) 100-year: Methane – 25; Nitrous Oxide - 298         Scope and       Cradle to beef processor gate (consequential LCA - so all emissions other than stocking rate, enteric fermentation and tree carbon gain are assumed to be the same).         Notable       Some of the harvested wood needs to be used for wood products         Omissions in       Some of the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.         LCA Approach       Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.         Guidance       Not addressed in documentation         on or       Threshold for         Excluding       Brazil specific (Brazilian emission factors)         Use       Brazilian tree growth data         Sources       Brazilian tree from the fate of tree cacepted for enteric fermentation. The carbon	Target Audience	
Indicators/met GHGs GWP's IPCC (2007) 100-year: Methane – 25; Nitrous Oxide - 298 Scope and Cradle to beef processor gate (consequential LCA - so all emissions other than stocking rate, enteric fermentation and tree carbon gain are assumed to be the same). Notable Some of the harvested wood needs to be used for wood products (lumber, veneers, laminates). However, there appears to be no provision for tracking the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting. LCA Approach Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys. Guidance Not addressed in documentation Threshold for Excluding Emissions LIMEATION BERICE (Brazilian emission factors) Use Brazil specific (Brazilian emission factors) Use Brazil specific (Brazilian tree growth data Sources Used for Modeling Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	Cost	
rics GWP's IPCC (2007) 100-year: Methane – 25; Nitrous Oxide - 298 Scope and Cradle to beef processor gate (consequential LCA - so all emissions other than stocking rate, enteric fermentation and tree carbon gain are assumed to be the same). Notable Some of the harvested wood needs to be used for wood products (lumber, veneers, laminates). However, there appears to be no provision for tracking the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting. LCA Approach Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys. Guidance on or Threshold for Excluding Emission IPCC Factor Sources Dataset Brazilian tree growth data Sources Used for Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon		
Scope and System       Cradle to beef processor gate (consequential LCA - so all emissions other than stocking rate, enteric fermentation and tree carbon gain are assumed to be the same).         Notable       Some of the harvested wood needs to be used for wood products         Omissions in Scope       Iumber, veneers, laminates). However, there appears to be no provision for tracking the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.         LCA Approach       Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.         Guidance on or       Not addressed in documentation         Threshold for       Brazil specific (Brazilian emission factors)         Emission Sources       Brazil specific (Brazilian emission factors)         Dataset       Brazilian tree growth data         Sources       Brazilian tree growth data         Sources       Brazilian tree of the factor         Used for Modeling       Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	rics	
System       than stocking rate, enteric fermentation and tree carbon gain are assumed to be the same).         Notable       Some of the harvested wood needs to be used for wood products (lumber, veneers, laminates). However, there appears to be no provision for tracking the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.         LCA Approach       Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.         Guidance       Not addressed in documentation         on or       Threshold         for       Erazil specific (Brazilian emission factors)         use       Brazil specific (Brazilian emission factors)         Use       Brazilian tree growth data         Sources       Brazilian tree growth data         Sources       Brazilian tree growth data         Sources       Brazilian tree of the grae accepted for enteric fermentation. The carbon	GWP's	
Boundary       to be the same).         Notable       Some of the harvested wood needs to be used for wood products (lumber, veneers, laminates). However, there appears to be no provision for tracking the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.         LCA Approach       Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.         Guidance       Not addressed in documentation         on or       Threshold         for       Brazil specific (Brazilian emission factors)         Use       Brazil specific (Brazilian emission factors)         Used for Modeling       Brazilian tree growth data         Sources       Brazilian tree growth data         Sources       Brazilian tree growth data	Scope and	
the same).         Notable       Some of the harvested wood needs to be used for wood products         Omissions in       Some of the harvested wood needs to be used for wood products         Scope       for tracking the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.         LCA Approach       Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.         Guidance       Not addressed in documentation         on or       Brazil specific (Brazilian emission factors)         Use       Brazil specific (Brazilian emission factors)         Used for       Brazilian tree growth data         Sources       Brazilian tree growth data         Outside for       Brazilian tree growth data         Sources       Brazilian tree of the grawth data         Outside for       Brazilian tree of the production of the production of the production for the production of the production for the production the production of the production for the productin the production for the production for the p	System	than stocking rate, enteric fermentation and tree carbon gain are assumed
Notable Omissions in Scope         Some of the harvested wood needs to be used for wood products (lumber, veneers, laminates). However, there appears to be no provision for tracking the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.           LCA Approach         Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.           Guidance on or Threshold for Excluding Emissions         Not addressed in documentation           IPCC Factor Sources         Brazil specific (Brazilian emission factors)           Dataset Used for Modeling         Brazilian tree growth data           Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	Boundary	
Omissions in Scope       (lumber, veneers, laminates). However, there appears to be no provision for tracking the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.         LCA Approach       Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.         Guidance       Not addressed in documentation         on or       Threshold for         Excluding       Brazil specific (Brazilian emission factors)         Use       Brazil specific (Brazilian emission factors)         Dataset       Brazilian tree growth data         Sources       Brazilian tree growth data         Modeling       Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	Notable	
Scope       for tracking the fate of tree carbon after harvest. As a consequential LCA, the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.         LCA Approach       Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.         Guidance       Not addressed in documentation         on or       Threshold         for       Excluding         Emissions       Brazil specific (Brazilian emission factors)         Use       IPCC         Factor       Sources         Dataset       Brazilian tree growth data         Sources       Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	Omissions in	•
the emissions from harvesting, transporting, processing, and final product manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.         LCA Approach       Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.         Guidance       Not addressed in documentation         on or       Threshold         for       Excluding         Emissions       Brazil specific (Brazilian emission factors)         Use       IPCC         Factor       Sources         Dataset       Brazilian tree growth data         Sources       Used for         Modeling       Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon		· · · · · · · · · · · · · · · · · · ·
manufacture should be included but are not. It is also missing emissions for tree seedlings and planting.         LCA Approach       Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.         Guidance       Not addressed in documentation         on or       Threshold for         Emissions       Brazil specific (Brazilian emission factors)         Use       IPCC         Factor       Sources         Dataset       Brazilian tree growth data         Sources       Used for         Modeling       Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	00000	•
and planting.         LCA Approach       Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.         Guidance       Not addressed in documentation         on or       Threshold         for       Excluding         Emissions       Brazil specific (Brazilian emission factors)         Use       IPCC         Factor       Sources         Dataset       Brazilian tree growth data         Sources       Used for         Used for       Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon		
open pasture to integrated production with pasture between treed alleys.         Guidance       Not addressed in documentation         on or       Threshold         for       Excluding         Emissions       Brazil specific (Brazilian emission factors)         Use       IPCC         Factor       Sources         Dataset       Brazilian tree growth data         Sources       Used for         Modeling       Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon		
on or Threshold for Excluding Emissions Limitations to Use Emission IPCC Factor Sources Dataset Brazilian tree growth data Sources Used for Modeling Emission Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	LCA Approach	Consequential - basically, consequential in that it quantifies changes from open pasture to integrated production with pasture between treed alleys.
Threshold         for         Excluding         Emissions         Limitations to         Use         Emission         IPCC         Factor         Sources         Dataset         Sources         Used for         Modeling         Emission         IPCC         Factor         Sources         Dataset         Brazilian tree growth data         Sources         Used for         Modeling         Emission         Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	Guidance	Not addressed in documentation
for Excluding Emissions Limitations to Use Emission IPCC Factor Sources Dataset Brazilian tree growth data Sources Used for Modeling Emission Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	on or	
Excluding         Emissions         Limitations to         Use         Emission         IPCC         Factor         Sources         Dataset         Brazilian tree growth data         Sources         Used for         Modeling         Emission         Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	Threshold	
Excluding         Emissions         Limitations to         Use         Emission         IPCC         Factor         Sources         Dataset         Brazilian tree growth data         Sources         Used for         Modeling         Emission         Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	for	
Use       IPCC         Emission       IPCC         Factor       Sources         Dataset       Brazilian tree growth data         Sources       Used for         Used for       Modeling         Emission       Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	Excluding Emissions	
Factor         Sources         Dataset         Brazilian tree growth data         Sources         Used for         Modeling         Emission         Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	Limitations to Use	Brazil specific (Brazilian emission factors)
Sources       Brazilian tree growth data         Dataset       Brazilian tree growth data         Sources       Used for         Modeling       Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	Emission	IPCC
Sources Used for Modeling Emission Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	Factor Sources	
Sources Used for Modeling Emission Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon	Dataset	Brazilian tree growth data
	Sources Used for Modeling	
	Emission	Mixture – Tier 1 or Tier 2 are accepted for enteric fermentation. The carbon
$1 a \cup 0 + 1 = 1 + 1 = 0$ a $0 \cup 0 + 1 = 0$ a	Factor Tier	in trees is a country specific Brazilian model (Tier 3).

Table 7: Carbon Neutral Brazilian Beef Assessment Summary

Co-Product Allocation Method	Trees are a new co-product and land area is allocated between pasture
	and
	trees.

Carbon Noutr	al Provision Poof Accommon Summary
	al Brazilian Beef Assessment Summary
Soil Carbon	Not included, but farms need to have initial SOC tested to ensure that
Sequestr	SOC does not decrease over time.
ation	
Approac	
h	
Land Use	Not considered
Change	
Approach	
(Direct	
and Indirect)	
Output Unit	Kg of meat
(i.e.	
Functional	
Uncertainty	Not addressed in documentation
Assessment	
Other	The method appears to be based on using tree carbon to balance CH4
Comments	emissions. It is easy for the farmers to make the calculations. However,
on	the fate of tree carbon from standing tree to finished products and the
Quantificatio	fate of those finished products is not considered. This is a fundamental
n Approach	weakness. It
	also neglects emissions associated with providing and planting tree seedlings.

## 4.2.6 **Bovid CO2**

The BOVID CO2 tool has been developed for use by Spanish beef farmers and other participants in the beef supply chain downstream of the farm gate. The tool quantifies on-farm emissions with some emissions from upstream sources for farm inputs, notably including onfarm infrastructure and building construction. There is a particular focus on manure, slurry and fertiliser emissions and nitrogen balance, although the scope and boundaries are broader than these sources/sinks. The tools include conversion factors to allow the user to choose the functional unit.

Bovid CO2 Assessment Summary		
Developer	Neiker and Asoprovac	
Format	Excel	
Geographic Focus	Spain (plus Italy, Ireland and France)	
Target	Farmers and consultants	

Audience	
Cost	
Current Users	
Indicators/met rics	Carbon, protein, nitrogen balance, (biodiversity under development)
GWP's	Choice of IPCC (2007) 100-year: Methane – 25; Nitrous Oxide – 298
	Or IPCC (2013) 100-year: Biogenic Methane-27.75; Fossil Methane-30.5;
	Nitrous Oxide-265
Scope and	Overview: Cradle to farm gate (livestock products)
System	
Boundary	Starting points: Origin of raw materials:
	Does not appear to include the production of equipment/machinery.
	Does include construction of farm infrastructure and buildings.
	Manufacture and transport of feed concentrates and forages.
	Manufacture and transport of synthetic fertilisers Manufacture
	and transport of seeds
	Manufacture and transport of plastics, oils and other inputs

Bovid CO2 As	sessment Summary
	End points:
NI-4-61-	Treatment of livestock by-products
Notable	Soil carbon sequestration, Losses of feed and
Omissions in Scope	product waste, Land use change.
LCA Approach	Attributional
Guidance on	Not included
or	
Threshold	
for Excluding	
Emissions	
Limitations to	The tool uses average values by type of animal for
Use	factors such a dry matter
	intake and feed digestibility. This may change in subsequent versions.
Emission	National Inventories of Atmosphere Emissions
Factor	1990-2012. Volume 2: Analysis by SNAP Activities.
Sources	IPCC 2006 – manure and slurry.
	MAGRAMA-OECC Carbon Footprint Calculator
	Scope 1 and 2 for organisations (2007-2013) – fuel
	consumption and electricity consumption (Spanish
	grid)
Dataset	Embedded emissions for feed and forages are from
Sources	different sources: Diaterre
Used for	1.11 Table 6.1 (2011), COOP France/SNIA (2010),
Modeling	Grignon Energies Positive, and Feedprint.
	MAGRAMA-OECC Carbon Footprint Calculator Scope 1 and 2 for organisations
	(2007-2013) – fuel consumption Manure and slurry emissions – Tier 2 from National
Emission Factor Tier	Manure and slurry emissions – Tier 2 from National Inventory.
Co-Product	Allows for four different allocation systems:
Allocation	1. Economic 3. Protein
Method	2. Mass 4. Energy
Soil	Not included.
Carbon	
Sequestr	
ation	
Approach	

Land Use	Not included
Change	
Approach	
(Direct and Indirect)	
Output	Three options for kg of meat by:
Unit (i.e.	1. Live weight
Functional	2. Live weight gain
Unit)	3. Carcass weight
Uncerta	Not included
inty	
Assess	
ment	
Other	Exact method used to calculate emissions from
Comments on	applied N-P-K is not detailed in the methodology
Quantific	document but is mentioned.
ation	Strong focus on farm economics also.
Approac	-
h	