Sustainability assessment of livestock farms with the CONVIS tool

presented by Rocco Lioy

The CONVIS-Sustanability Assessment Tool (SAT): General information

- Tool to assess environmental and economic* sustainability of livestock farms
- Inside the environmental assessment: calculation of GHG emissions and carbon credits
- Separate GHG calculation for dairy cattle, beef cattle, pigs, cash crops
  N.B: no GHG calculation for small ruminats, poultry and permanent crops
- Applicable in specialized and in mixt farms, in conventional and organic farming
- In the case of mixt farms, automatic allocations allow to separate production branches

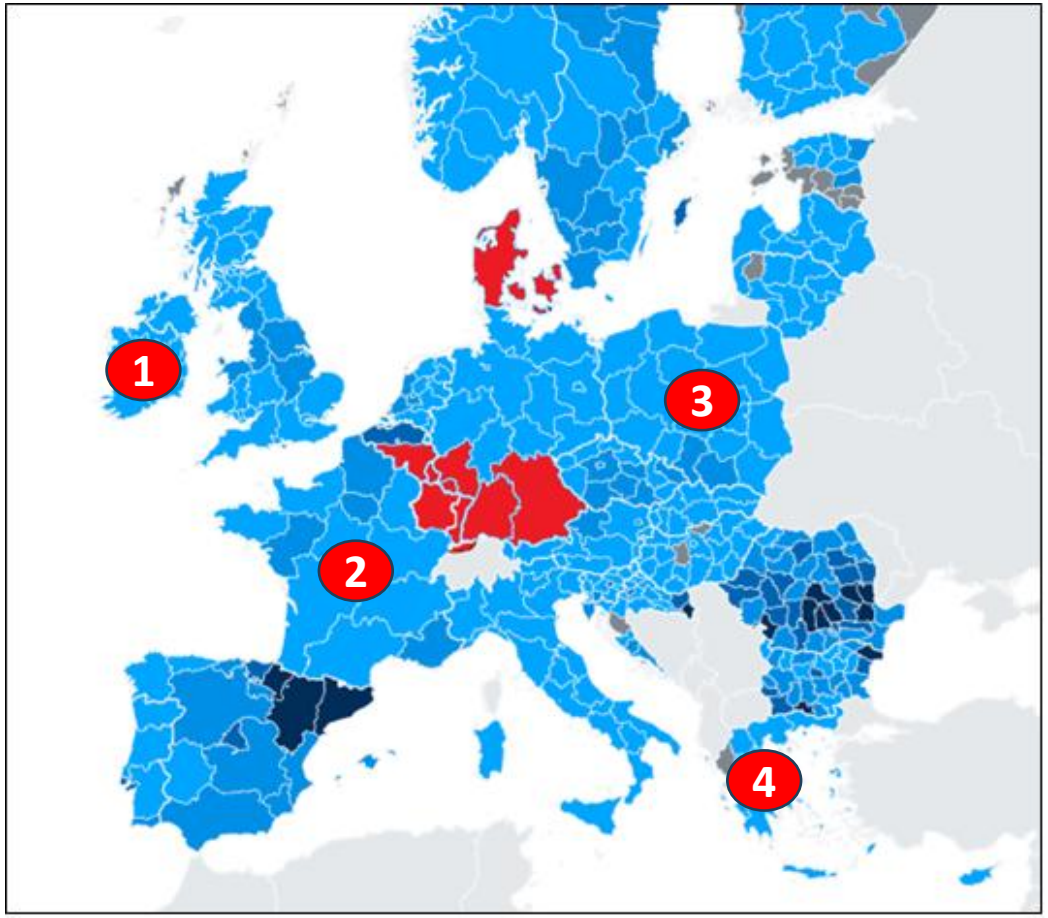
**Only for Dairy and Beef cattle. Not relevant in the frame of Climate Farm Demo*

Lands or regions (in red) where the sustainibility tool of CONVIS was or is applied

National references

- **Yearly sustainability assessment of Luxembourgish cattle and pig farms** (2012-2021), corresponding in average **to 22%** of the whole **agricultural area in Luxembourg**

- **Study to mitigate the climate impact** of Luxembourgish agriculture, carried out on behalf of the **Luxembourgish Environmental Ministery** (2018)



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1 2 3 4 → **Lands where the CONVIS is applied in the frame of Climate Farm Demo**

International references

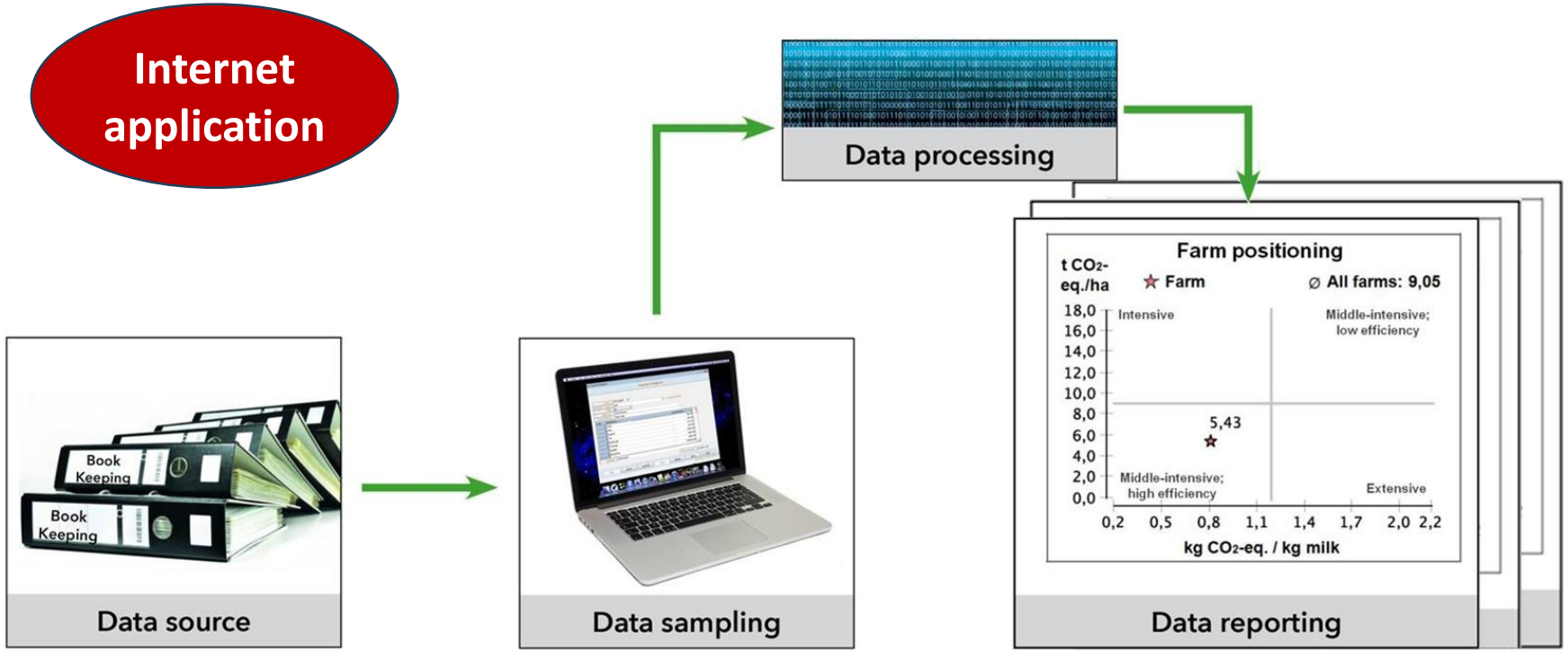
- **Interreg-project IV A „OPTENERGES“** (LU-FR-BE, 2009-2012)

- **Life-project „DAIRYCLIM“** (LU-BE-DK, 2016-2019)

- **Interreg project V A „AUTOPROT“** (LU-DE-FR-BE, 2018-2022)

- **Interreg-pr.** Upper Rhine **„KLIMAKO“** (DE-FR-CH 2021-2023)

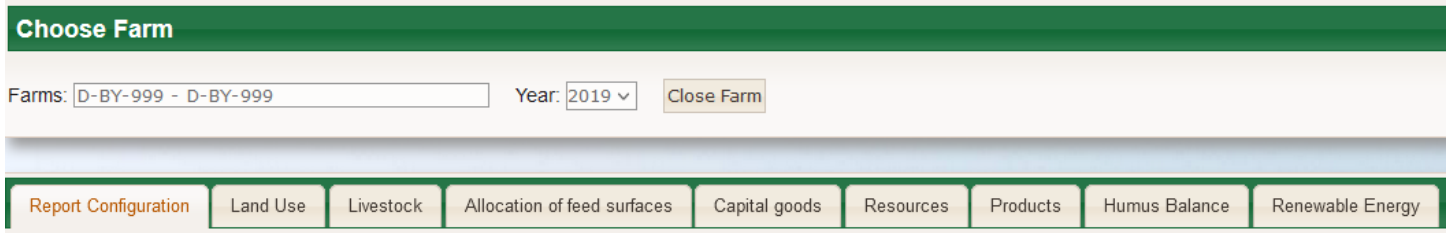
The CONVIS sustainability assessment tool (SAT): In 1,5 hours from row data to farm evaluation



Data sampling

(Languages of the application: German and English, switchable)

The data entry forms



1. **Land use**	Info about the agricultural areas
2. **Livestock**	Livestock, stable and storage facilities
3. **Allocation of feed surfaces**	Allocation of the forage and forage areas
4. **Capital goods [facultative!]**	Data entry of capital goods (buildings, machines,...)
5. **Inputs**	Purchased or imported production means
6. **Products**	All outputs of the farm
7. **Humus balance**	Info regarding organic fertilization and catch crops
8. **Renewable energy**	Information about biogas and photovoltaic plants

Form „Land use“

Crop type	Details	Total surface (ha)	Feed crops (ha)	Biogas crops (ha)	Cach crops - ha	Yield - (dt/ha)
Oat						50
S-Wheat						
W-Wheat		15.97	12.09		3.88	51.35
Spelt						
Corn						
Barley for brewery						
S-Barley						
W-Barley		6.1	6.1			50
Rye						
Triticale						
Rape						
Sunflowers						
Faba beans						
Peas						
Potatoes						
Sugar beets						
Forage beets						
Silage Maize		24.04	14	10.04		
Alfa alfa, clover, gras-clover						
Permanent grassland		30	30			
Temporary grassland		14.31	14.31			
Gras for seed production						
Others (to specify)						
Fallow land / Set a side						
Grasland for horses and/or sheeps		10				

Form „Livestock“

Animal category	Code	Number	Months in stable	% on slurry-systems*	% on FYM-systems**	*Loose housing	*Fully slatted floor	**Sloped floor	**Deep bedding
BC-Female calfs 0 - 6 months	820001	3.7	0.5		100	☐	☐	☑	☐
BC-Female calfs > 6 months; <1 year	820002	3.8	0.5		100	☐	☐	☑	☐
BC-Female calfs 1-2 years	820003	5.4	0.5		100	☐	☐	☑	☐
BC-Female calfs > 2 year (heifers)	820004	2.6	0.5		100	☐	☐	☑	☐
BC-Fattenig heifers	820005					☐	☐	☐	☐
BC-Sucker cows	820006	15.6	0.5		100	☐	☐	☑	☐
BC-Male calfs 0 - 6 months	820010	3.3	0.5		100	☐	☐	☑	☐
BC-Young bull > 6 months; <1 year	820007	5	0.5		100	☐	☐	☑	☐
BC-Fattening bulls	820008	10.7	0.5		100	☐	☐	☑	☐
BC-Breeding bulls	820009	13.3	0.5		100	☐	☐	☑	☐
DC-Female calfs 0 - 6 months	821001	29.2	12		100	☐	☐	☑	☐
DC-Female calfs > 6 months; <1 year	821002	25.8	10	100		☑	☐	☐	☐
DC-Female calfs 1-2 years	821003	46.7	6	100		☑	☐	☐	☐
DC-Female calfs > 2 year (heifers)	821004	15.3	6	100		☑	☐	☐	☐
DC-Fattenig heifers	821005					☐	☐	☐	☐
DC-Dairy cows	821006	126.5	12	95	5	☑	☐	☑	☐
DC-Slaughter cows	821007					☐	☐	☐	☐
DC-Breeding bulls	821010	2.6	7.5	100		☑	☐	☐	☐
DC-Male calfs 0 - 6 months	821011	2.6	12		100	☐	☐	☑	☐

- Form „Inputs“ (1) -

(1)
Farm inputs to be allocated directly to the crops

- 30 :: Seed and planting material (quantity values in dt)
- 31 :: Fertilisers (quantity values in dt)
- 32 :: Plant protection products (quantity values in l (kg))
- 33 :: Other expenses for crop production
- 34 :: Animal purchase (quantity values in dt)
- 35 :: Feedstuffs (quantity values in dt)
- 35.1 :: Pig feed (quantity values in dt)
- 35.2 :: Feedstuffs other animals
- 36 :: Other expenses for Animal Husbandry
- 41 :: Machine work costs (quantity values in ha)
- 42 :: Fuel and lubricants
- 48 :: Electricity, heating fuel, water

31 :: Fertilisers (quantity values in dt)

Mineral Fertilisers

N	P	K	BD
			☐

Create Edit

Organic Fertiliser: Slurry (pigs)

Description	Code	Euro	W-Wheat	Triticale	Maize	Permanent grassland
Triple superphosphate	313000					
Kainite	315000					9.5
Potassium chloride 40%	316000					
Potassium chloride 60%	317000					
NP 18/46	322002					
Lime ferzilizer	334000					

- Form „Inputs“ (2) -

(2)
Farm inputs without allocation to crops

- *30 :: Seed and planting material (quantity values in dt)*
- *31 :: Fertilisers (quantity values in dt)*
- *32 :: Plant protection products (quantity values in l (kg))*
- *33 :: Other expenses for crop production*
- *34 :: Animal purchase (quantity values in dt)*
- *35 :: Feedstuffs (quantity values in dt)*
- *35.1 :: Pig feed (quantity values in dt)*
- *35.2 :: Feedstuffs other animals*
- *36 :: Other expenses for Animal Husbandry*
- *41 :: Machine work costs (quantity values in ha)*
- *42 :: Fuel and lubricants*
- *48 :: Electricity, heating fuel, water*

Description	Code	% - Young Dairy Cattle	Dairy cattle	Euro	Meat (beef cattle)	Euro
Potatoes	350001					
Corn meal	350010					
Corn gluten feed (23-30% CP)	350011					
Corn gluten feed (<23% CP)	350012					
Soybean oil	350016		0.2	27		
Feed cereals (11% CP)	351000					
Wheat bran	352000					
Sugar beet pulp (dry)	356000					
Sugar beet pulp (wet)	357000					
Molasses sugar beet	359003					
Soybean meal 44%	361001					
Soybean meal 48%	361002					
Rapeseed extraction meal	362002	56.3	225.2	4504		
Fresh brewer's grains (26% DM)	366002					
Alfalfa pellets	367002					
Lime meal	369001					
Calf feed pellets	371027					
Cattle concentrate feed 12%	371069					
Cattle concentrate feed 14%	371081					
Cattle concentrate feed 16%	371093					
Cattle concentrate feed 18%	371105	15.4	4059.84	122130		
Cattle concentrate feed 20%	371117					
Cattle concentrate feed 25%	371141					
Cattle concentrate feed 30%	371147					
Cattle concentrate feed 35%	371153		254.98	8949		
Cattle protein concentrate 40%	371159					
Cattle protein concentrate 44%	371165					
Milk powder	382000	100	47.8	13273		
Salt for animals	385128					
Minerals 4%P	385304		252.6	17373		

- Form „Products“-
(All outputs of the farms)

- 60 :: Cereals, grain crops
- 61 :: Legumes, oil fruits, fibre plants
- 62 :: Potatoes
- 65 :: Other cash crops
- 69 :: Fodder crops
- 71 :: Vegetables
- 76 :: Organic fertilisers
- 80 :: Cattle
- 81 :: Milk
- 82 :: Pigs
- 83 :: Sheep/Goats
- 84 :: Poultry Eggs
- 85 :: Horses
- 87 :: Sale of field work and transport services

60 :: Cereals, grain crops

Search

Description	Code	Quantity	Euro
Wheat (13% CP)	601000	210.4	
Wheat (14% CP)	602002		
Wheat (15% CP)	602003		
Buckwheat (10% XP)	602004		
Rye (11% CP)	603000		
Barley (Winter)	604000		
Barley (Summer)	605001		
Malting barley (11% protein)	605002		
Oats (11% crude protein)	606000		
Triticale (13% crude protein)	607000	364.4	

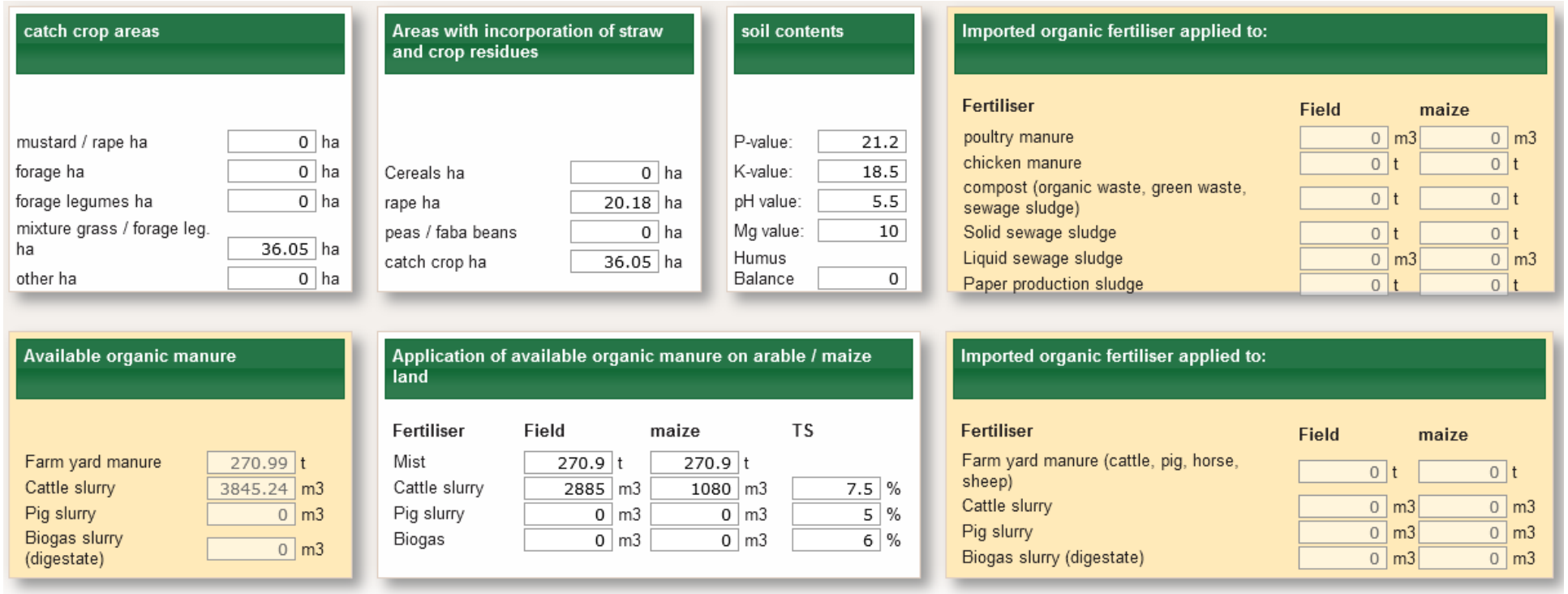
81 :: Milk

Description	Code	Quantity	Euro
Milk (4.50/3.45) (dt)	831009		
Milk, On-farm sales	831040		
Goat milk	846000		

Fat Content	Protein Content	Urea
4.00	3.45	220

Description	Quantity (dt)
Internal consumption	

- Form „Humus Balance“ -



catch crop areas

mustard / rape ha	0	ha
forage ha	0	ha
forage legumes ha	0	ha
mixture grass / forage leg. ha	36.05	ha
other ha	0	ha

Areas with incorporation of straw and crop residues

Cereals ha	0	ha
rape ha	20.18	ha
peas / faba beans	0	ha
catch crop ha	36.05	ha

soil contents

P-value:	21.2
K-value:	18.5
pH value:	5.5
Mg value:	10
Humus Balance	0

Imported organic fertiliser applied to:

Fertiliser	Field		maize	
poultry manure	0	m3	0	m3
chicken manure	0	t	0	t
compost (organic waste, green waste, sewage sludge)	0	t	0	t
Solid sewage sludge	0	t	0	t
Liquid sewage sludge	0	m3	0	m3
Paper production sludge	0	t	0	t

Available organic manure

Farm yard manure	270.99	t
Cattle slurry	3845.24	m3
Pig slurry	0	m3
Biogas slurry (digestate)	0	m3

Application of available organic manure on arable / maize land

Fertiliser	Field		maize		TS	
Mist	270.9	t	270.9	t		
Cattle slurry	2885	m3	1080	m3	7.5	%
Pig slurry	0	m3	0	m3	5	%
Biogas	0	m3	0	m3	6	%

Imported organic fertiliser applied to:

Fertiliser	Field		maize	
Farm yard manure (cattle, pig, horse, sheep)	0	t	0	t
Cattle slurry	0	m3	0	m3
Pig slurry	0	m3	0	m3
Biogas slurry (digestate)	0	m3	0	m3

- Form „Renewable energies“ -

Internal biogas plant

51 :: Biogas - Intern

Purchase of co-ferments (t)

Description	Code	Quantity	Euro subsidiary farm
Bio-waste/food waste	339050		
Tree/shrub trimmings	339051		
Grass/greenery cuttings	339052		
Leaves	339053		
Household waste (kitchen/garden waste)	339054		
Vegetable waste	339055		
Fruit pomace	339056		
Grape pomace	339057		
Paper production sludge	339058		
Old bread/bakery waste	339059		
Mais silage (27% TS)	339060		
Clean-out grain	339061		
Other subsidiary expenses	51		
		Sum	0

Fuels and lubricants

Description	Code	Quantity	Euro subsidiary farm
Fuel for combined heat and power unit (l)	402001		
Lubricants for biogas plants	404001		
Electricity (kWh) for biogas plant	555001		
Other fuel/lubricants	42		
		Sum	0

Yield Electricity

Description	Code	Quantity	Euro subsidiary farm
Electricity (kWh) [biogas]	555000		
Fuel (l) - [biogas heat]	402001		
		Sum	

Data processing

(key notes on carbon footprint calculation)

The Carbon footprint module of the CONVIS-SAT ist SGS-certified

Greenhouse Gas Verification Statement Number 5249226

Verification Statement Date: 16.06.2021

This Statement is not valid without the full verification scope, objectives, criteria and findings available on pages 2 to 3 of this Statement.

The Product Carbon Footprint Calculation Tool of
CONVIS s.c.

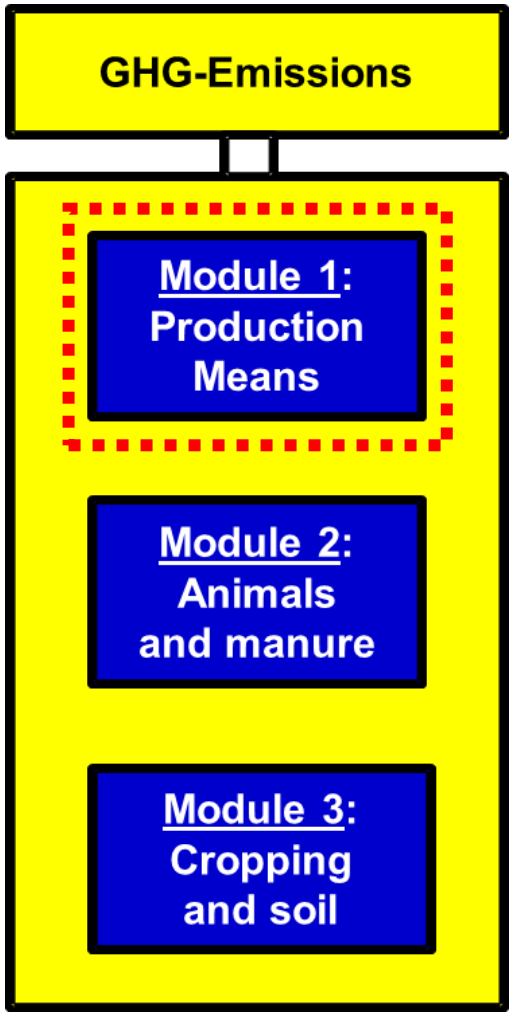
4 zone artisanale et commerciale
L-9085 ETTELBRUCK
LUXEMBURG

Authorised by:

ppa Dr. Christian Temme
Director
Industries & Environment
Environment, Health and Safety

i.A. Dina Bauer
Lead Auditor
Industries & Environment
Environment, Health and Safety
SGS Institut Fresenius GmbH
Goerzallee 305a
D – 14167 Berlin

Module production means: key methodological notes



Module production means Items
1 Fertilizers
1.1 Mineral fertilizers
1.2 Manure (import)
1.3 Co-Ferments (Biogas plant)
2 Feedstuffs
2.1 Concentrates
2.2 Raughage and straw
2.3 Mineral feeds
3 Energy
3.1 Electricity
3.2 Fuel
3.3 Machine work
4 Other production means and capital goods
4.1 Pesticides, seeds, animal imports, plastics, medicaments, lubrifiants
4.2 Machines, Devices
4.3 Buildings, facilities

Module production means: key methodological notes

For all inputs that are imported or consumed once a year, the calculation of emissions consists of the formula:

kg CO_2eq = Quantity of production mean * EF (PM)

Production means	Quantity (unit)	Source of emission factors for production means EF (PM)
Mineral fertilisers	dt	ECOINVENT 3.7 2020
Organic fertilisers and biogas co-ferments	m3; t	PLANETE 2002
Fodder and straw	dt	Feed components and straw: BLONK 2015; Concentrates: AGRIFEEDPRINT 2019
Plant protection products	kg; l	ECOINVENT 2.2 2010
Livestock purchase	dt	AGRIBALYSE v1.2; BLONK 2015
Seeds	dt	ECOINVENT 2.2 2010
Fuel (Diesel), heating oil	dt	ECOINVENT 2013
Lubricants	kg; l	ECOINVENT 2013
Silage film (plastic)	kg	ECOINVENT 2013
Medicaments (animals)	€	ECOINVENT 2013
Electricity	kWh	MORO&MONZA 2018
Water	m3	ECOINVENT 2013
Machine work (imported)	ha; h; t	ECOINVENT 2.2 2010 + ECOINVENT 2013

Module production means: key methodological notes (2)

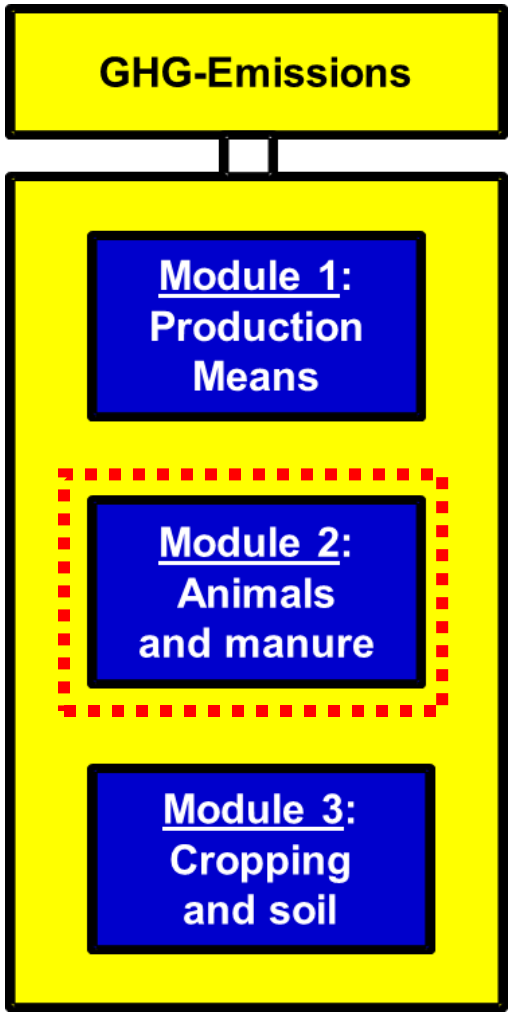
For all capital goods imported or built on the farm, the calculation of emissions consists of the formula:

kg CO_2eq = Unit of the capital good * EF (CG) / DY

Type of capital good	Unit	Source of emission factors for capital goods EF (CG)
Stables, halls, barns	m2	ECOINVENT 2.2 (2010)
Slurry pits	m3	ECOINVENT 2.2 (2010)
Concrete, steel	dt	ECOINVENT 2.2 (2010)
Polyester	t	ECOINVENT 2.2 (2010)
Machinery	t	ECOINVENT 2.2 (2010)
Equipment	t	ECOINVENT 2.2 (2010)

- Please note: **The calculation of GHG from capital goods is facultative!**

Module animals and manure: key methodological notes



Module animals and manure Items
1 Ruminal fermentation
1.1 Methane
2 Storage of slurry and farm yard manure
2.1 Methane
2.2 Dinitrogen oxyde
3 Spreading manure
3.1 Dinitrogen oxyde
4 Grazing
4.1 Methane
4.2 Dinitrogen oxyde

Module animals and manure: key methodological notes

1. Methane: Enteric fermentation

- **Dairy cows**

  [IPCC 2019, Tier 2]

TABLE 10.12 (UPDATED)[6]
CATTLE/BUFFALO METHANE CONVERSION FACTORS (Y_M)

Livestock category	Description	Feed Digestibility (DE %) and Neutral Detergent Fibre (NDF, % DMI)	MY, g CH_4 kg DMI^{-1}	Y_m[3] (%)
[1,4]Dairy cows and Buffalo	High-producing cows[5] (>8500 kg/head/yr^{-1})	DE ≥ 70 NDF ≤ 35	19.0	5.7
	High-producing cows[5] (>8500 kg/head/yr^{-1})	DE ≥ 70 NDF ≥ 35	20.0	6.0
	Medium producing cows (5000 – 8500 kg yr^{-1})	DE 63-70 NDF > 37	21.0	6.3
	Low producing cows (<5000 kg yr^{-1})	DE ≤ 62 NDF >38	21.4	6.5

- **Other cattle**

g CH_4 / animal / d = 55 + 1,2* kg Live weight^{0,75}

[Kirchgessner et al. 1991, Tier 2]

Module animals and manure: key methodological notes

2. Methane: Manure management
[IPCC 2006, Tier 2]

General formula: **CH_4 (storage) in kg/d = VS * B_0 * ρCH_4 * MCF**

VS = Volatile solids excretion (kg/d)

B0 = maximum methane formation capacity in m3 CH4 / kg DM

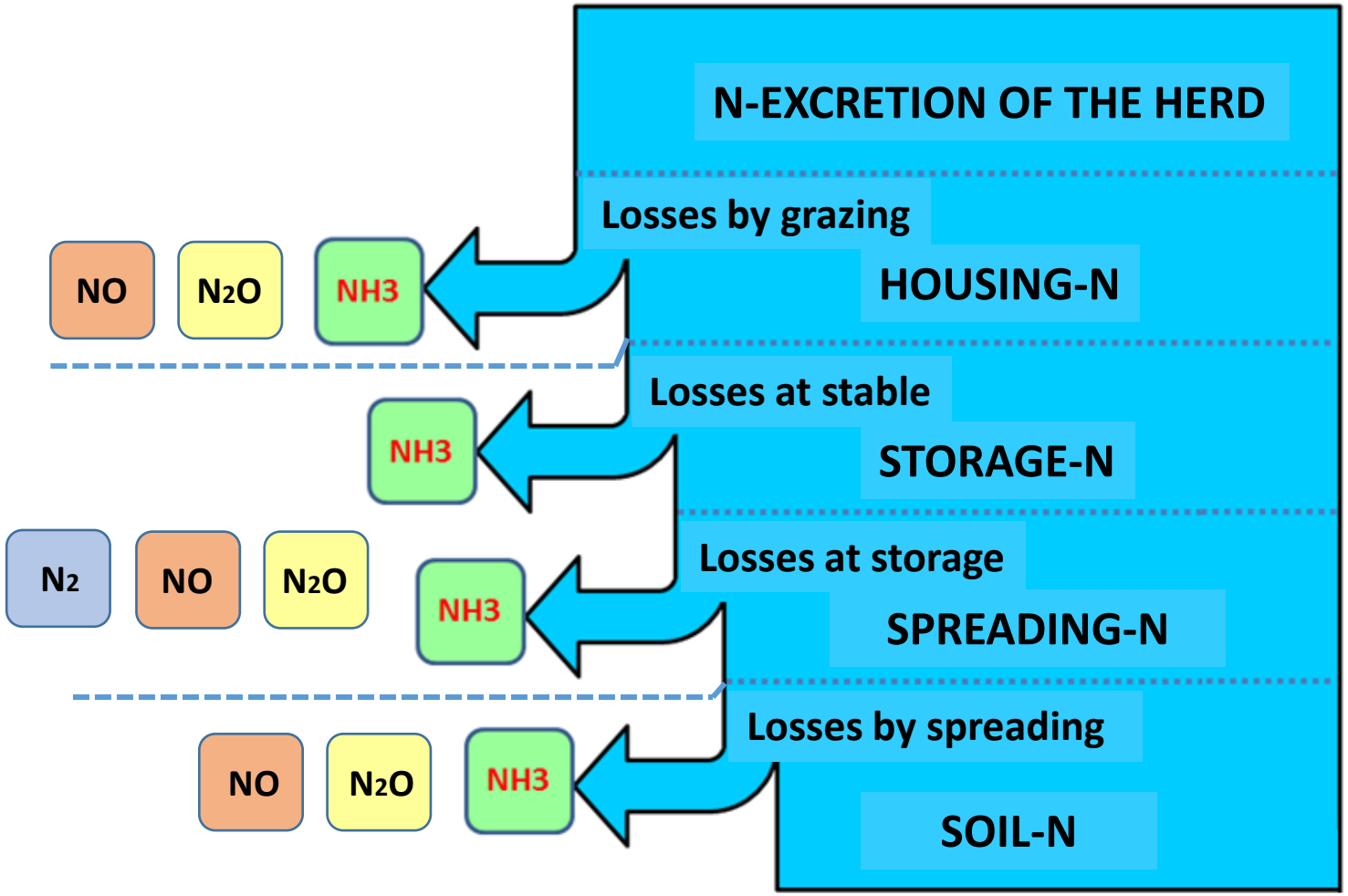
depending on animal (cattle, pig)

ρCH4 = density of methane = 0.67 kg / m3

MCF = methane conversion factor (different if manure is untreated, fermented or available as excreta on pasture)

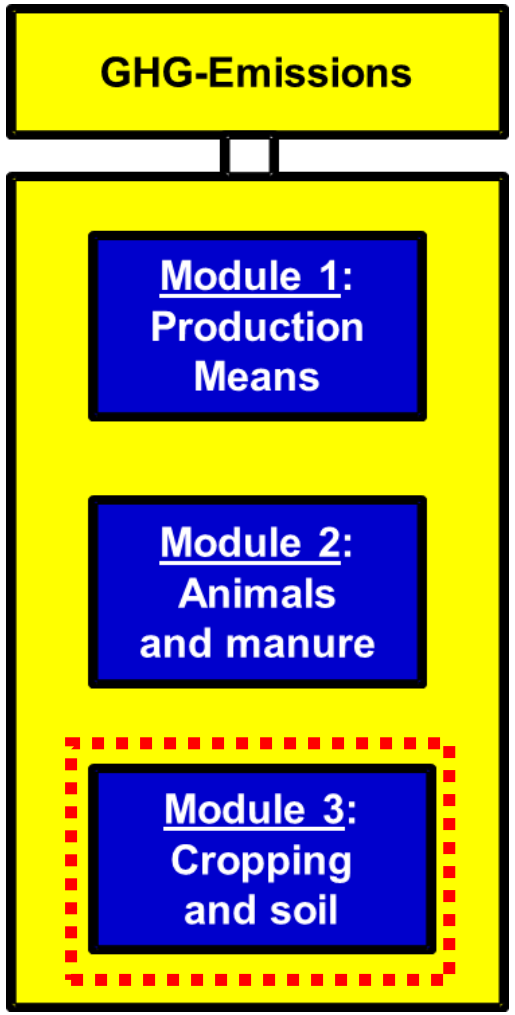
Module animals and manure: key methodological notes

3. N_2O-emissions *[IPCC 2006]:* A mass-flow concept



- N-Excretion of dairy cows etimated after Bannink and Hindle (2003) : data of milk-urea required!
- Ammonia (NH3) emissions estimated after Doehler et al. 2002
- Emission of all other nitrogen species (N2O, NO, N2) estimated after IPCC 2006

Module Cropping and soil: key methodological notes



Module cropping and soil Items
1 Indirect soil emissions
1.1 N-Deposition
1.2 N-Leaching
2 Mineral fertilization
2.1 Mineral nitrogen
2.2 Urea application
2.3 Lime application
3 Fuel combustion
4 Other emission sources
4.1 Negative Humus balance
4.2 Plowing perm. grassland
4.3 Plowing straw into soil
4.4.Plowing intercrop residues

Module Cropping and soil: key methodological notes

Items of module soil and cropping	GHG calculation after
Indirect soil emissions	IPCC 2006, Tier 2
Mineral nitrogen application	IPCC 2006, Tier 2
Urea application	IPCC 2006, Tier 2
Lime application	IPCC 2006, Tier 2
Plowing straw into soil	IPCC 2006, Tier 2
Plowing cover crops into soil	IPCC 2006, Tier 2
Negative humus balance	Leithold et al. 1997, Tier 2
Turning grassland	Guo&Gifford 2002, Tier 1

Used functional units and allocations

Production branch	Surface related emissions	Product related emissions
Dairy production	t CO_2eq/ha	kg CO_2eq/kg ECM*
Beef meat production	t CO_2eq/ha	kg CO_2eq/kg LW** (cattle)
Pig meat production	t CO_2eq/ha	kg CO_2eq/kg LW** (pig)
Cash crops	t CO_2eq/ha	kg CO_2eq/dt CU***

* Energy Corriged Milk

** Live wight

** Cereal units

- Allocation in dairy branch between milk and meat: after **protein** in milk and meat
- Allocation in cash crop branch between grain and straw: after **nitrogen** in grain and straw

Carbon credits

Carbon credits	Credit-factor after
Biogas-Electricity	Moro&Monza 2018
Biogas-Heat (as fuel-equivalent)	Eoinvent 2013
Conversion of arable land into grasland	Guo&Gifford 2002
Positive humic balance (arable land)	Leithold et al. 1997
Photovoltaic-Electricity	Moro&Monza 2018

- Please note: **ΔC of permanent grassland = 0**, i.e. no credits!

Data reporting

(on the example of a dairy farm)

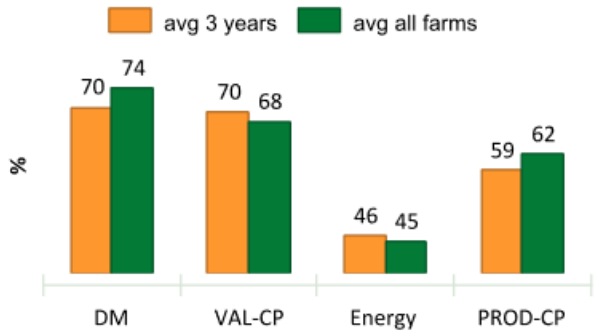
Example of presentation of results (dairy farms)

Dairy farming and milk production

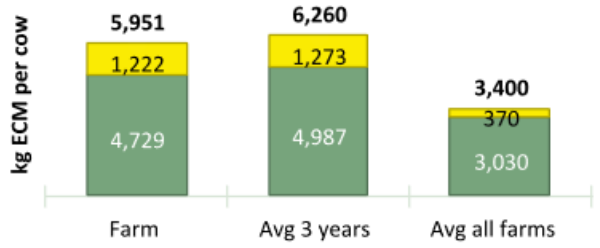
Key figures	Farm	avg all farms
Total feed area (ha)	69.5	91.4
farm concentrates (ha)	0.0	6.8
Silage maize (ha)	11.3	17.3
Other crops (ha)	0.0	0.2
Grassland (permanent and temporary, ha)	58.2	67.0
Number of dairy cows	61.9	91.2
Young stock	70.8	93.6
livestock density (LAU/ha)	1.4	1.6
kg milk/farm (sold milk)	569,839	746,187
kg milk/farm (produced milk)	574,839	754,701
kg ECM/cow (produced milk)	9,741	8,276
kg ECM/ha (produced milk)	8.675	8.289

Comparative figures for feed self-sufficiency (sold milk)

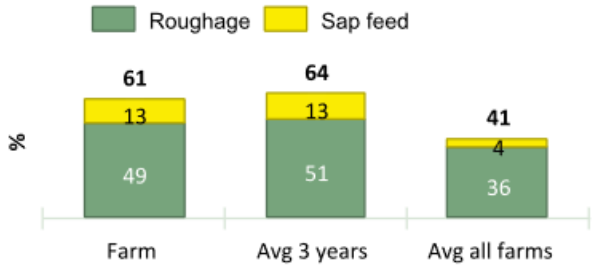
Dry matter	Energy	Valorized CP	Produced CP
45%	44%	31%	50%



Concentrate-adj. forage perform. (produced milk)



Relative forage performance (produced milk)

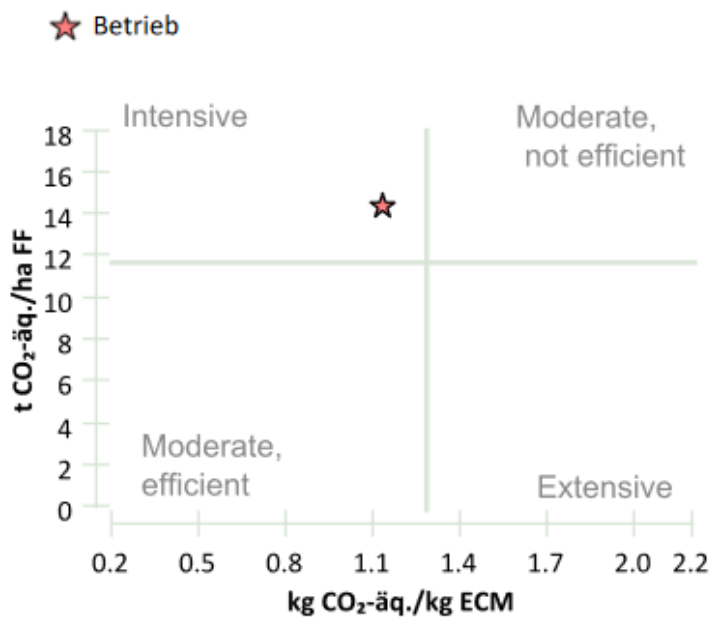


Consumption/ dt sold milk	Total conc. dt	Conc. <25% CP dt	Protein conc. dt	Electricity	Medicaments €	Water m^3	Fuel l
Farm	0.26	0.19	0.07	13.84	0.81	0.49	2.56
avg all farms	0.37	0.30	0.07	6.20	0.95	0.36	2.04

Example of presentation of results (dairy farms)

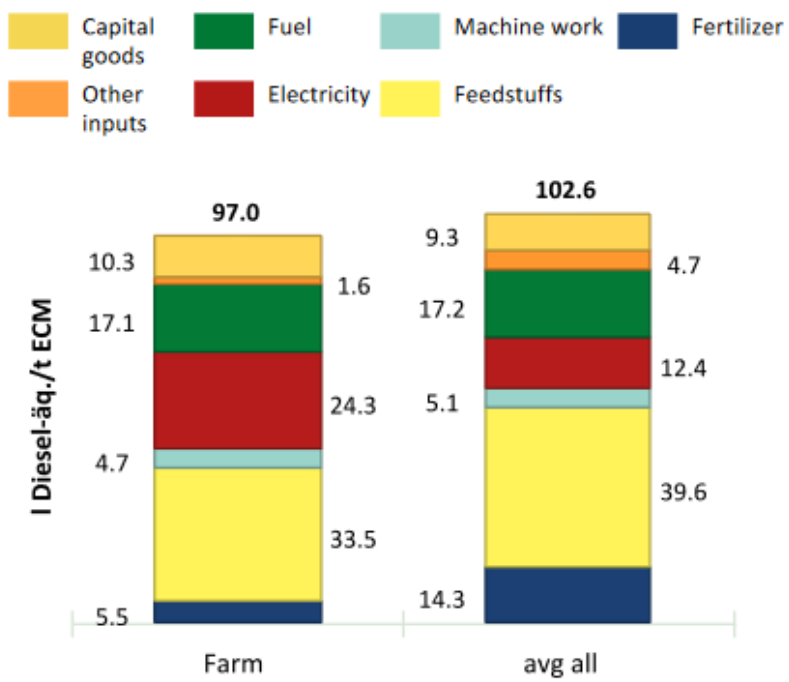
LCA data for milk production (sold milk)

Farm positioning (GHG emissions)



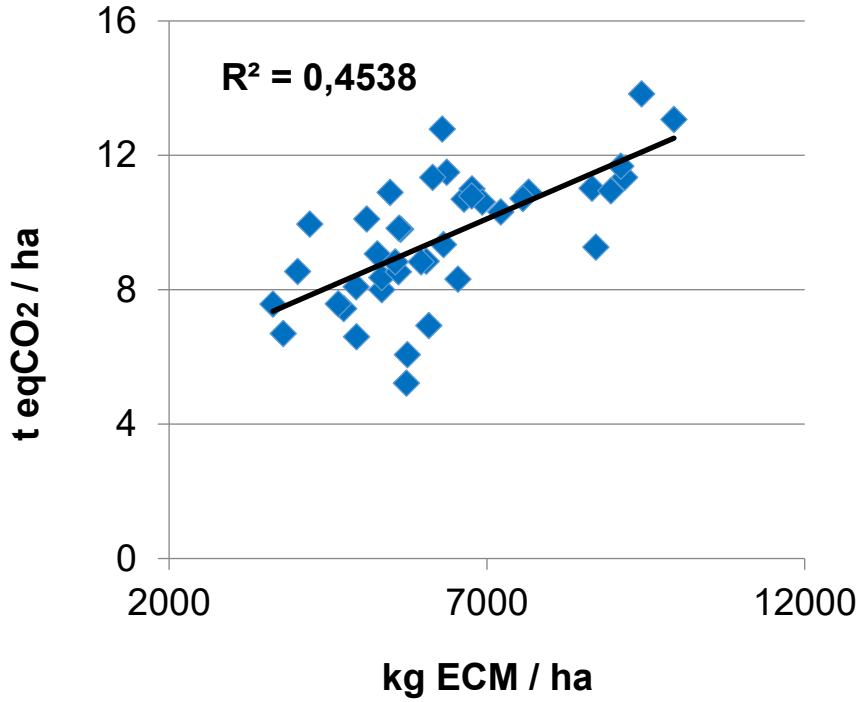
GHG emissions	Farm	avg all farms
t CO_2eq/ha	14.4	11.7
kg of eqCO_2 kg ECM	1.1	1.3
Carbon credits		
t CO_2eq/ha	1.6	0.6
kg of eqCO_2 kg ECM	0.1	0.1

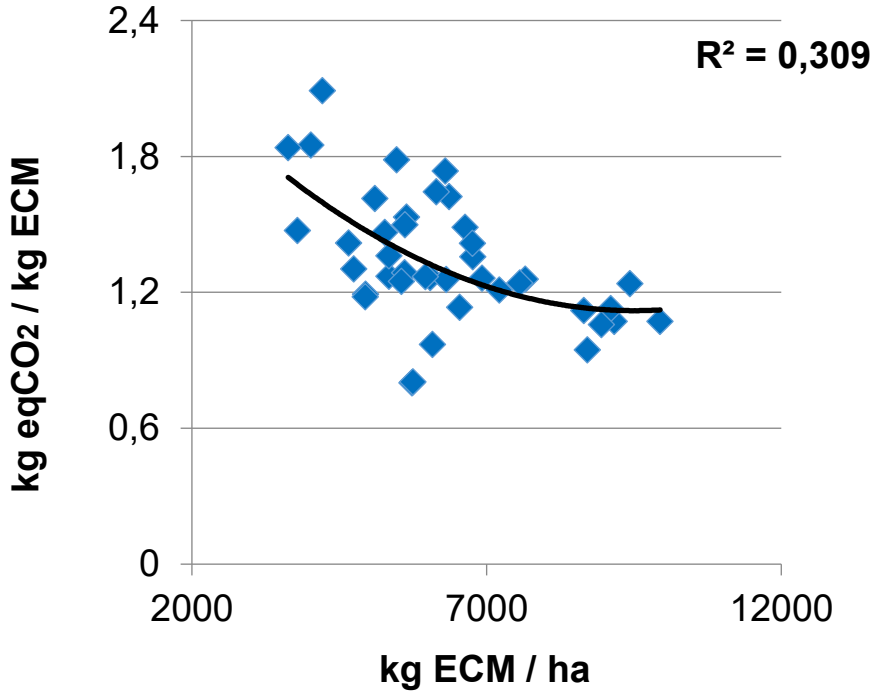
Repartition of energy consumption



	Farm	avg all farms
l Fuel-eq/ha	1,232	914
l fuel equivalent / t ECM	97	103

Behaviour of GHG emissions related to production surface and produced milk in function of production intensity





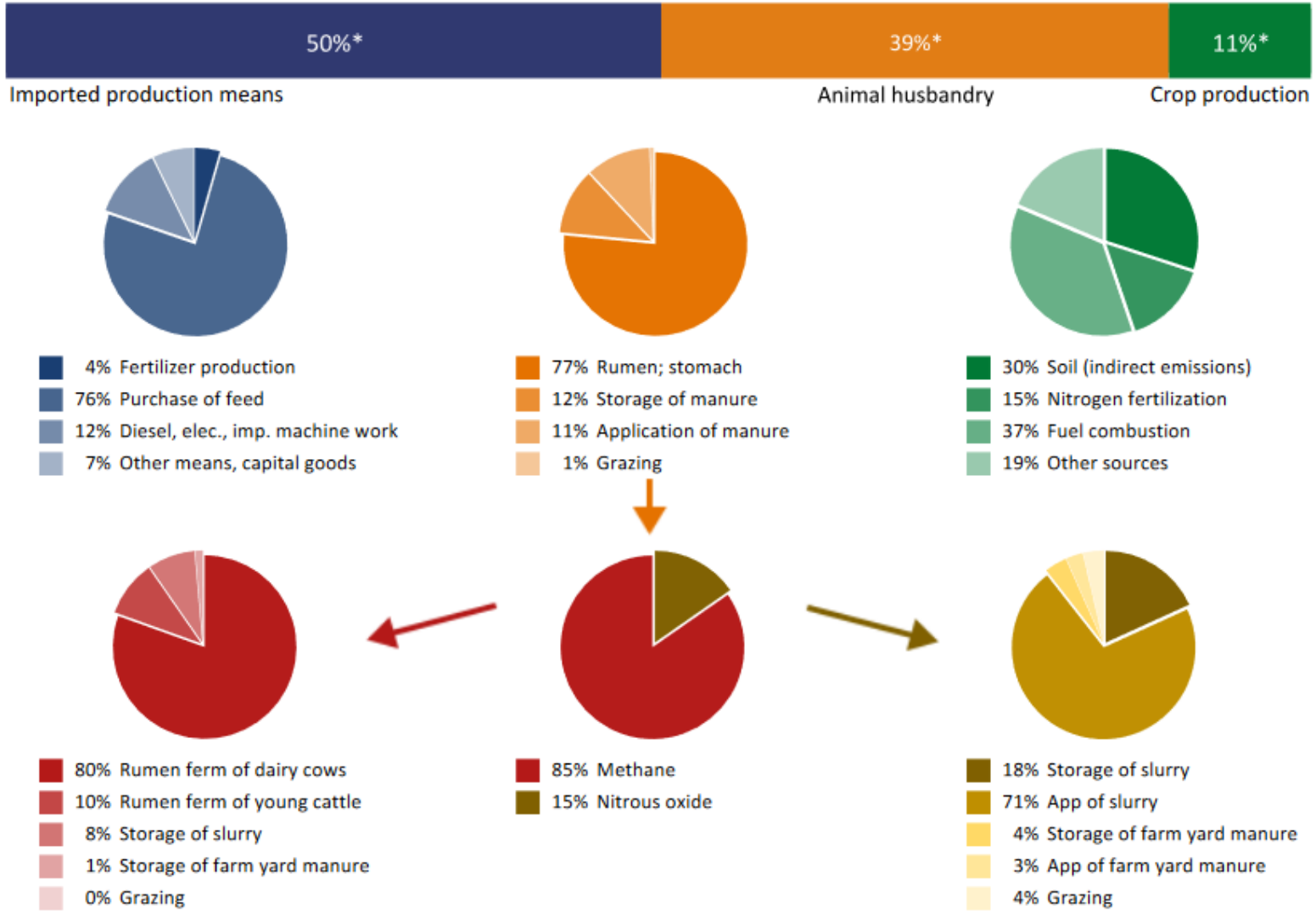
t eqCO2 / ha = pressure indicator

kg eqCO2 / kg ECM = efficiency indicator

CO_2 emissions from dairy farming

14.38 t CO_2-eq./ha | 1.13 kg CO_2-eq./kg ECM

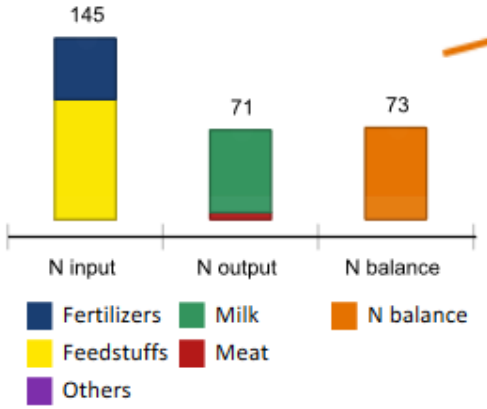
*CO_2-eq. = 1 x CO_2 + 25 x CH_4 (methane) + 298 x N_2O (nitrous oxide)



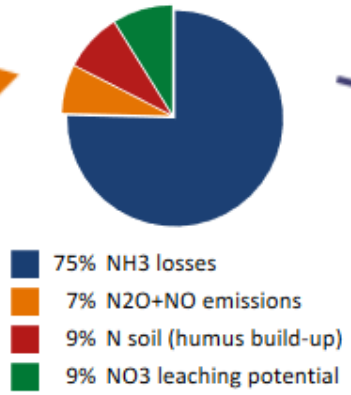
NH_3 emissions from dairy farming

55 kg NH_3_N/ha (Ø avg. all farms: 37.8 NH_3_N/ha)

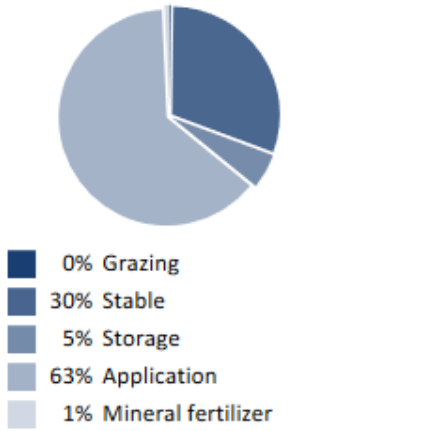
N farm gate balance milk production (kg N/ha DM)



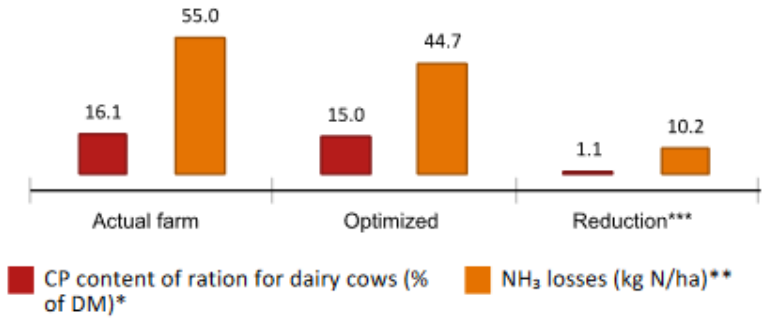
Repartition of N surplus



Repartition of NH_3 losses



NH_3 reduction potential via optimization of feed ration

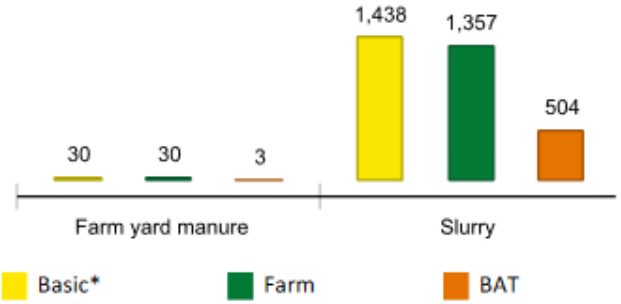


*Estimated based on not valorized protein (excess crude protein)

**17% less NH_3 with a 1% reduction in CP content

***Displayed only if CP content > 15.0%

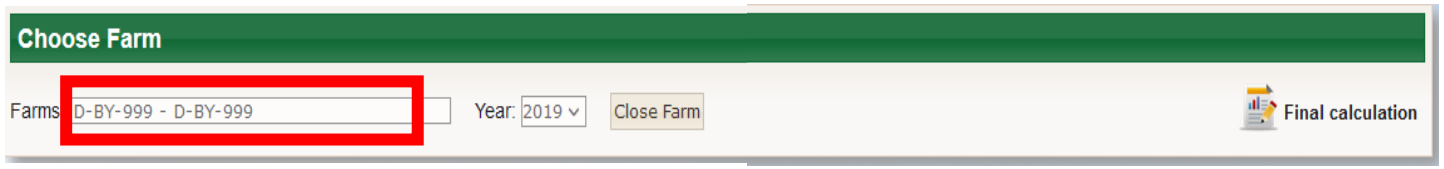
NH_3 emissions from manure application (kg NH_3_N)



*Application of farm yard manure and slurry with broadcast and without incorporation

** Best Available Technic

Data privacy and access to application



- Code of the farm in Climate Fam Demo: 8 characters (CFD001DE)
- The farm name is only known from the national organizations
- CONVIS doesn‘t know any name as well as location of farms. From CONVIS is only known the nationality of the farm
- The advisors charged with the data entry get a personalized access to the application with password

Training

- To be able to use well the application a **full day traning** is foreseen

- The trainig takes **6 hours** (3 in the morning and 3 in the afternoon)

Licence fees

- The CONVIS-Application is **NOT for free**
- The licence fees per farm and year **are not fix,** but depending on the total amount of farms
- The user have to **subscribe a convention** to use the application

THANK YOU!

For any questions:

rocco.lioy@convis.lu