Study on Livestock scenarios for Belgium in 2050

Executive summary

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This study was conducted independently by UCLouvain (team of Professor Philippe Baret) in 2017 and 2018. The terms of reference were written by Greenpeace Belgium. The criteria for ecological agriculture and livestock developed by Greenpeace were taken into account in the selection of environmental impacts to be assessed as well as in the determination of the entry parameters of transition scenarios. The study was entirely financed by Greenpeace Belgium. The study went through a peer-review process involving experts from scientific institutions and the sector.

1. Approach & methodology of the study

1.1. Context and objectives

This study has been commissioned by Greenpeace Belgium in 2017 with the aim to open a public debate on the environmental consequences (especially GHG emissions) of current livestock practices and food consumption patterns in Belgium, and on existing alternative production systems.

The objectives of this study are:

- **to provide information about the current livestock sector, and to highlight the diversity of production systems in terms of practices, productivity and environmental consequences;**
- **to assess several scenarios for the development of the livestock sector and the consumption of animal-based products towards 2050. A business as usual scenario and two scenarios that pursue a reduction of GHG emissions and a shift to organic and extensive systems are analysed.**

1.2. Methodological principles

The methodology is based on the following principles:

- **Participative and inclusive research:** Actors from the livestock sector were involved in the research process through individual interviews and collective focus groups. This way, they contributed to data collection and validation as well as to the discussion and interpretation of the scenarios.
- **Holistic and multi-scale approach:** As the study aims to obtain a holistic view of the livestock sector, it works at different scales: the individual one (both from the producers and the consumers' perspective), the territorial and regional one, and the sectoral one (with all its stakeholders, from pre-production activities to the retail of products).
- **Prospective approach:** As opposed to a predictive approach aimed at describing the most likely scenario, the interest of such a work is to provide diverse possible horizons which can contribute to the elaboration of a shared strategic framework for actors and help them prioritising relevant actions.

1.3. Scope and scale of the study

The study focuses on the five main livestock productions in Belgium (dairy, bovine meat, pork, poultry meat and eggs production). Analyses are provided at the national and regional level (Flanders, Wallonia) as well as for each sector. For each livestock sector, a typology of *production systems* is proposed. A livestock production system comes with a set of technical choices that determine elements such as the choice of the animal breeds, the quantities of inputs used, the level of productivity and, to a certain extent, the marketing channel.

Four environmental impact categories are considered: climate change, eutrophication potential, biodiversity and animal welfare. Social and economic aspects, which influence the trajectories of agricultural and food systems, are not modelled because these parameters are strongly linked to the current situation and susceptible to complex evolutions. These elements were nevertheless discussed during the focus groups.

1.4. Methodology for the assessment of environmental impacts

The production systems differ in terms of practices and production levels but also in terms of environmental impacts.

Feeding practices

Given the importance of feeding practices in the assessment of N and GHG emissions, a typical feed (with the shares of each ingredient) was proposed for every production system within each sector, based on the existing literature and the actors' interviews. Specific feed conversion ratios (FCR) to each system then allowed to quantify how much of each ingredient is consumed in each system.

GHG emissions

GHG emissions were calculated for each livestock sector and each production system within each sector. Several processes involved in livestock rearing result in GHG emissions and were considered in this study:

- Feed production and consumption: Feed-related GHG emissions are estimated by multiplying the share of each ingredient in the animal diet by its emission factor. Transportation emissions are included.
- Enteric fermentation of animals[1] can be estimated through IPCC[2] empirical relations which are used in national GHG inventories.
- Manure management related emissions, estimated through empirical relations from IPCC.
- The sequestration of carbon by pastures and grasslands is estimated but not included in the calculations.

Assessment of N emissions

N emissions were calculated based on feed composition and consumption. The N content in the feed and the Nitrogen Use Efficiency (NUE)[3] of a particular species allow calculating how much N is emitted.

Assessment of PPP use

The use of livestock-related phytopharmaceutical products (PPP) was estimated in the context of this study but at a different precision level than other impact categories. Indeed, this assessment was carried out a sectoral level and not for each production system (because of lacking data).

Assessment of animal welfare considerations

In order to assess how each system performs regarding animal welfare, a series of criteria established by the animal welfare charity Compassion In World Farming (CIWF), which specifically focuses on farm animals, were used. For each livestock species, CIWF has defined *bad*, *better* and *best* practices[4]. Per species, two or three welfare categories and corresponding CIWF criteria were identified.

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1 Enteric fermentation emissions are negligible for poultry but are relevant for pigs and bovines.

2 IPCC: Intergovernmental Panel on Climate Change.

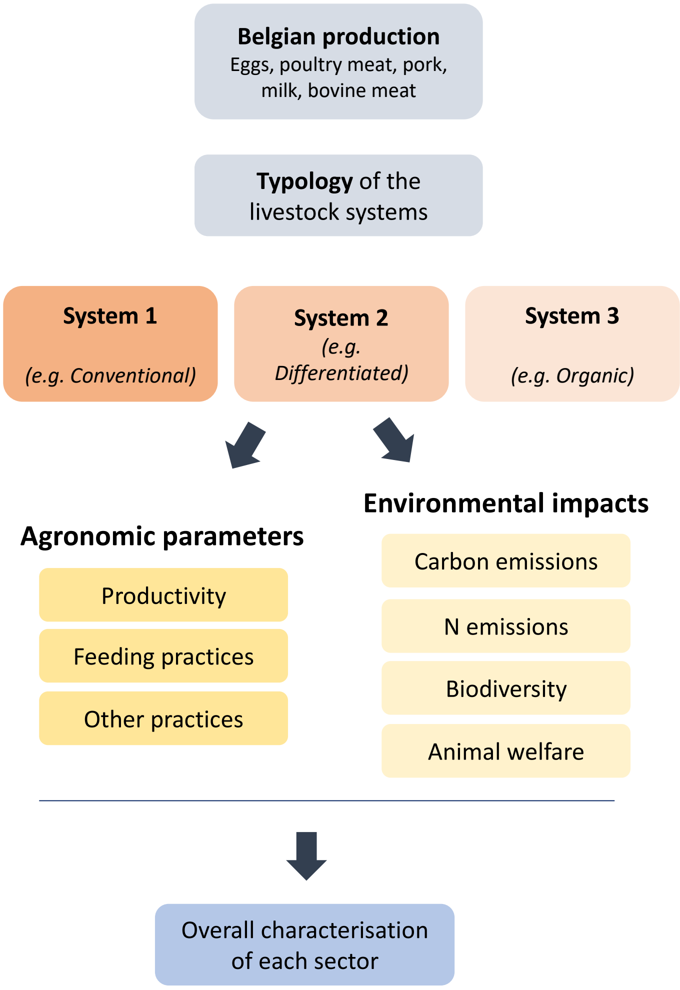
3 Indeed, the NUE indicates the amount of nitrogen retained in animal products as a percentage of total feed nitrogen intake. Hence, 1-NUE indicates the proportion of N emitted.

4 (CIWF, 2014).

Biodiversity impact

In order to characterise the biodiversity impacts of each system, the methodology developed by De Schryver et al. (2010) was used[5]. The method is based on the impact that a particular feed has on biodiversity: a characterisation factor (CF) which expresses the ecosystem damages of certain land-uses and agricultural areas (arable land vs. grassland), was attributed to each feed ingredient. This indicator varies with the duration of the crop and the occupied area. The impact of each feed ingredient is then aggregated to determine the overall Damage Score (DS) associated to a certain production system. The higher the Damage Score, the higher the impact in terms of Biodiversity (lower scores are thus preferable).

• Characterisation of livestock systems and their environmental impacts



[5] This methodology has for example been applied in Guerci et al. (2013).

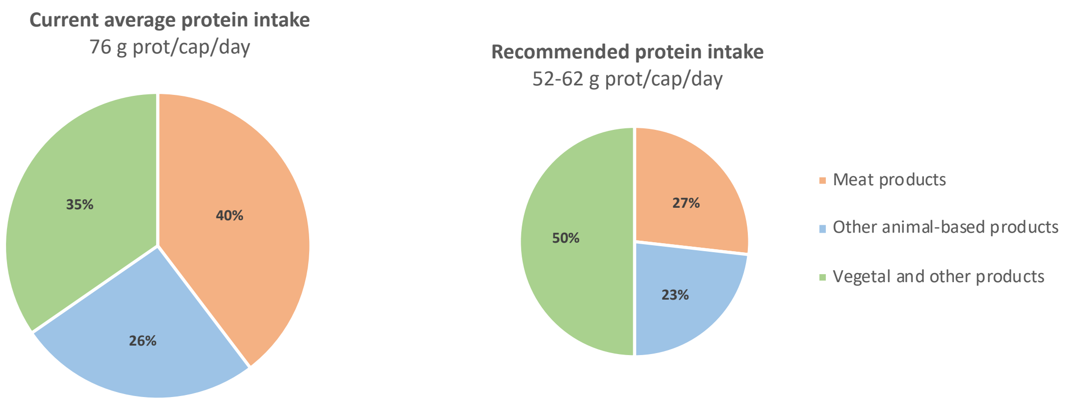
2. Key facts about the current livestock sectors in Belgium

2.1. Consumption of animal-based products

The average consumption of meat products in Belgium for the 15-64 years old category is 114 g/capita/day[6] of which it is estimated that 43% is pork meat, 28% is poultry meat and 19% is bovine meat[7]. This is twice the recommended consumption level which is of 57 g/capita/day[6].

In terms of protein consumption there is a situation of overconsumption as the total protein intake in Belgium averages 76 g protein/cap/day whereas the recommendations for the 18-59 years old category range between 52-62 g protein/cap/day. Furthermore, it is recommended to observe a balance between animal and vegetal sources of protein, which is not the case as animal sources of protein represent 65% of total protein intake, of which 40% are meat products only [8].

• Comparison of protein sources in recommended and average diets in Belgium[9]



2.2. Evolution and distribution of the livestock populations in Belgium

The five main livestock productions in Belgium are bovine meat, pork, poultry meat, eggs, and milk. Over the last ten years (from 2005 to 2015), the pig population was maintained whereas the laying hens, dairy cows and other bovine populations tended to decrease (respectively -5%, -3% and -8%) and the poultry population increased (13%).

An important specificity of the Belgian livestock sector resides in the regional distribution of animal productions. Indeed, whereas the monogastric populations (pigs and poultry) are importantly concentrated in Flanders (94% of all pigs and 85% of all broilers and laying hens), the bovine herds are better distributed. Nevertheless, a certain degree of specialisation has occurred for these sectors too as 60% of dairy cows are in Flanders and 60% of suckler cows are in Wallonia. The bovine meat fattening sector is more concentrated in Flanders.

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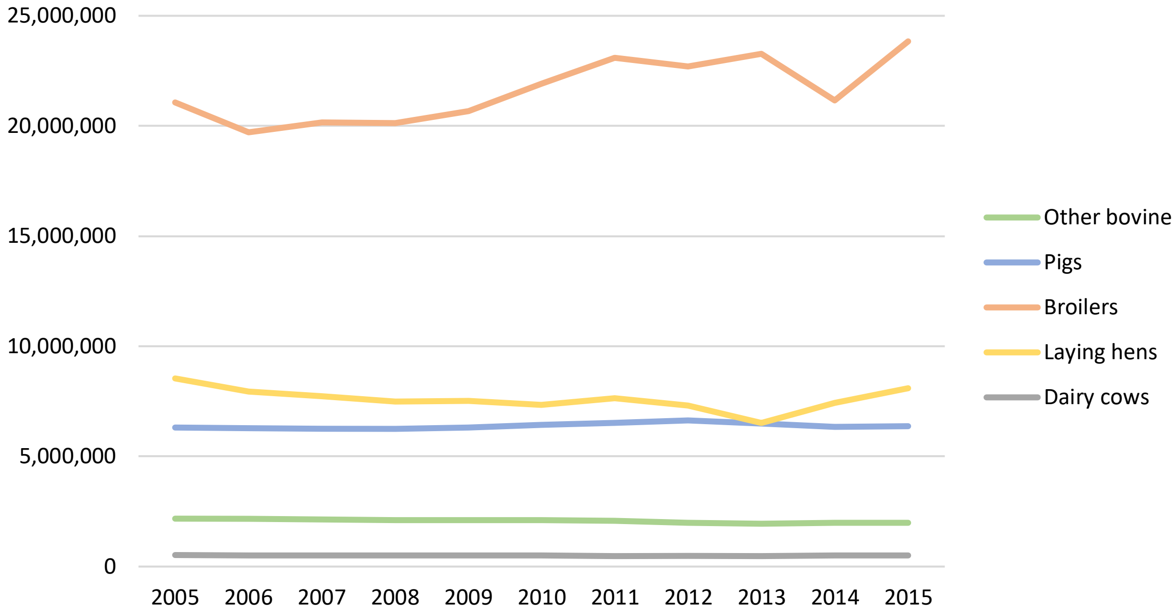
[6] Values from the last survey on food consumption, carried out in 2014 (De Ridder et al., 2016).
[7] (Statistics Belgium 2017).
[8] (Conseil Supérieur de la Santé 2016).
[9] Based on (ANSES 2016; De Ridder et al. 2016; Conseil Supérieur de la Santé 2016; Statistics Belgium 2017).

• **Evolution of the livestock population in Belgium from 2005 to 2015**[10]



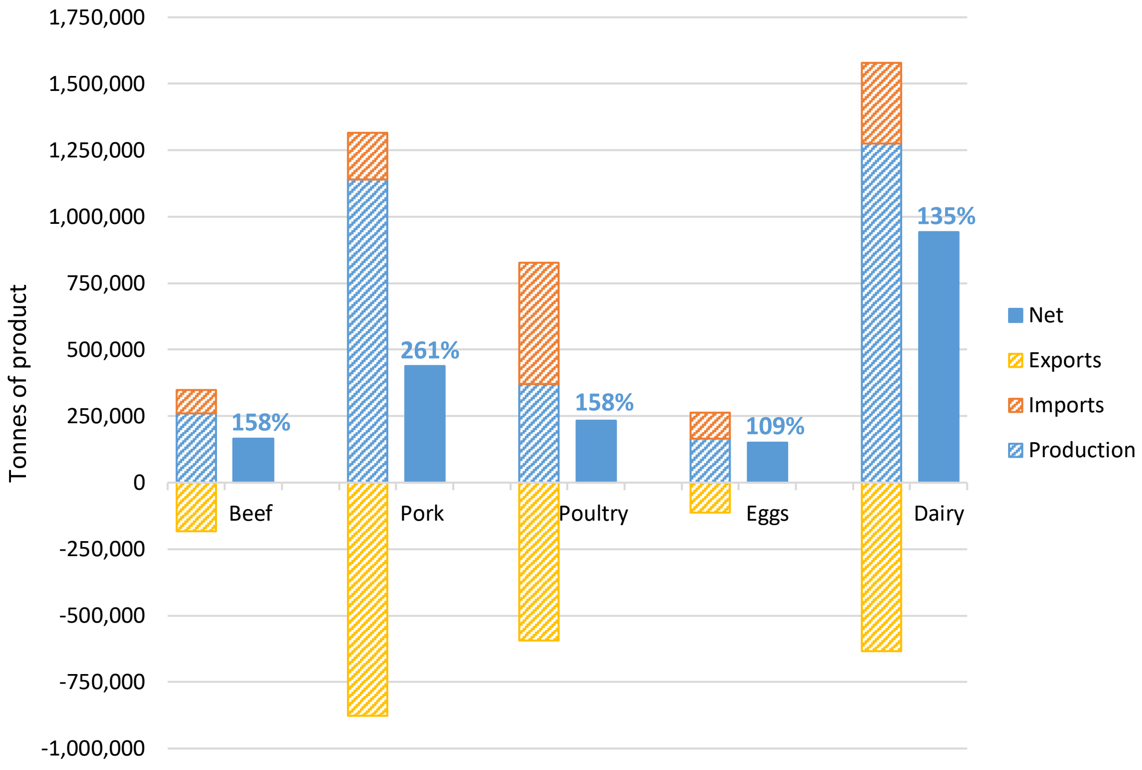
• **Regional distribution of the livestock population in Belgium in 2015, expressed in Livestock units**[11]

[10] Statistics Belgium (2016, 2014b). Note: the category 'other bovine' represents the difference between the total bovine herd and dairy cows.
[11] Statistics Belgium (2016, 2014b). Note: the category 'other bovine' represents the difference between the total bovine herd and dairy cows. Boxes and values refer to animal numbers expressed in livestock units.

2.3. Production, import and export of livestock products in Belgium

A significant share of the national production is exported. Indeed, Belgium has self-sufficiency ratios[12] higher than 100% for all animal products. This indicates that domestic supply (production) exceeds domestic demand (consumption), in particular for pork (261%), followed by bovine meat (158%), poultry meat (158%), dairy products (135%) and finally eggs which are closer to 100%.

• Food balance of animal products in Belgium in 2015 and associated self-sufficiency ratios (Production/Net)[13]



[12] Self-sufficiency ratio: production volume on the net volume (where net volume = Production + Imports – Exports). This net value can be associated with consumption. The values are presented here for 2015.
[13] (Statistics Belgium 2017, 2014a, 2013).

2.4. Contribution of agriculture and livestock to GHG emissions in Belgium

Considering the three sources of emissions which were assessed in the study (feed-related emissions, enteric fermentation and manure management emissions)[14], the Belgian livestock sector emitted **13.920 kt CO_2e** in 2015. The biggest contributors are the dairy and pork sectors (34% and 33% of total GHG emissions each), followed by the bovine meat sector (23%), and by both poultry sectors to a lesser extent (10% of emissions for the two sectors together). Feed is the biggest contributor (55% of total emissions assessed in this study) followed by enteric fermentation (32%) and manure emissions (13%).

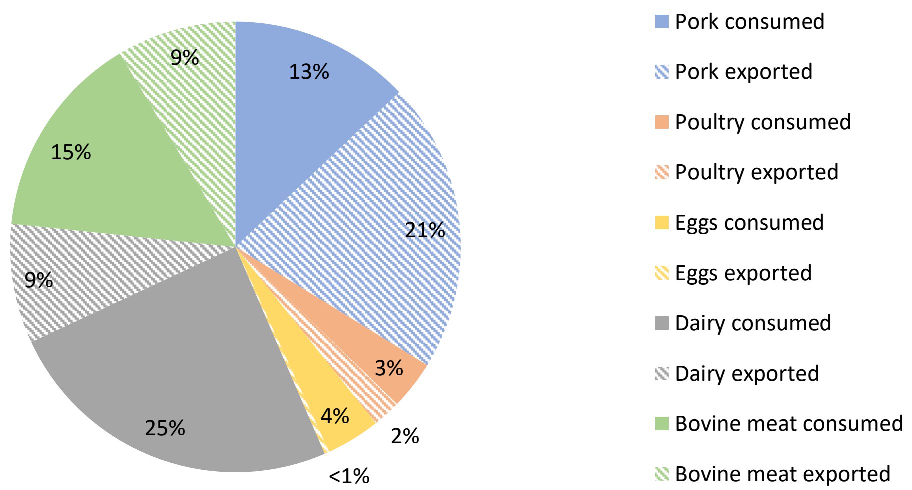
According to Belgium's GHG inventory, direct emissions from livestock (related to enteric fermentation and manure management) are responsible for 7% of the total annual GHG emissions in Belgium[15]. Indirect emissions (feed-related emissions) occur partly in Belgium and abroad, depending on the origin of the feed.

In total, 60% of the emissions (8.300 kt CO_2e/year) can be attributed to livestock products that match the current consumption in Belgium whereas 40% of the emissions (5.620 kt CO_2e/year) can be attributed to livestock products which are exported.

• GHG emissions by livestock sector and by emission source in Belgium in 2015

Sector	Feed	Enteric fermentation	Manure	TOTAL	Share
		kt CO_2e/year			%
Pork	3.634	250	820	**4.705**	*34%*
Broiler	745	0	21	**766**	*6%*
Laying hen	569	0	18	**587**	*4%*
Dairy	1.745	2.358	508	**4.611**	*33%*
Bovine meat	991	1.782	479	**3.252**	*23%*
Total	**7.683**	**4.390**	**1.847**	**13.920**	*100%*
Share (%)	*55%*	*32%*	*13%*	*100%*	

• Contribution of each livestock sector to total GHG emissions from the Belgian livestock sector in 2015 and distinction between "consumed" and "exported" emissions



[14] Other emissions sources such as on-farm energy emissions were not included in the assessment, because of lacking data.
[15] (VMM et al. 2017). The national inventory does not include indirect emissions such as feed-related emissions.

3. Livestock production systems in Belgium

3.1. The pork sector

Flanders hosts 94% of the national pig population. National production amounted 1.312 kt of live weight in 2015 obtained through more than 11,8 million slaughters[16].

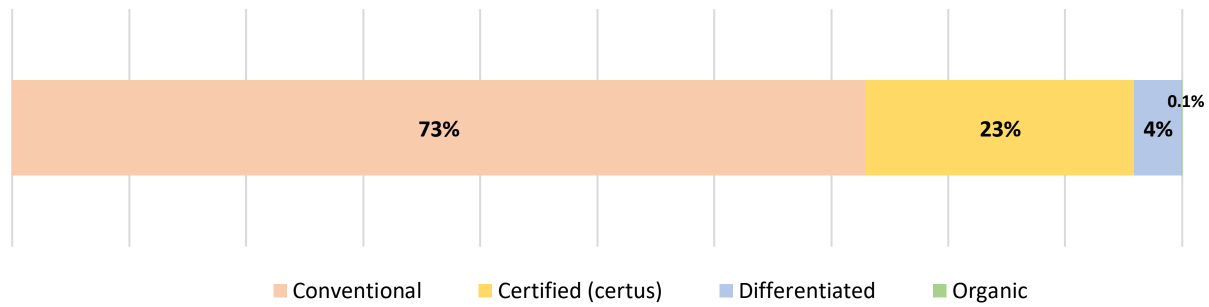
Five distinct production systems were identified, which differ in terms of practices (feed use, access to outdoor area, etc.) as well as production and environmental outcomes. Conventional systems, which can be Certus-certified or not, concentrate the vast majority of the production (96% of slaughters). Alternative production systems (Differentiated[17] and Organic), which are characterised by longer fattening periods and slightly higher feed conversion ratios represent less than 5% of slaughters.

In terms of environmental impacts, more intensive systems tend to have lower relative GHG and N impacts (per unit of product), but contribute much more to the total impact given their larger share. The biodiversity impact (both total and relative) is lowest for organic systems.

• Characteristics of pork production systems in Belgium [18]

	Conventional	Certified (Certus)	Differentiated	Differentiated +	Organic
Outdoor area (m^2/pig)	-	-	*varies*	*varies*	1,2
Fattening period (days)	120	120	135	135	135
Production cycles per year	2,6	2,6	2,5	2,5	2,5
Final live weight (kg)	110	110	120	120	120
Feed (kg feed/kg live weight)[19]	2,7	2,7	2,7	3,3	3,3
Use of phytopharmaceuticals[20]	Yes	Yes	Yes	Yes	No

• Shares of production systems in the pork sector in Belgium in 2015[21, 22]



[16] (Statistics Belgium 2016).

[17] Within differentiated systems, there is a wide diversity of practices, ranging from the use of specific breeds, particular feed, outdoor housing, etc. This is why, a distinction was made between Differentiated and Differentiated+ systems, the latter being more extensive and closer to organic systems.

[18] Figures were collected in the literature and through expert interviews.

[19] The feed consumption factor or ''feed conversion ratio'' of an animal can be estimated by examining feed consumed against weight gained. Feed conversion ratios were obtained from literature and then adjusted according to local sector's experts' knowledge. According to current data, pigs have a conversion ratio of 2.6–3.3 kg feed to 1 kg pigs weight gain (Nguyen, Hermansen, and Mogensen 2010; Weidema et al. 2008).

[20] Chemical phytopharmaceuticals. Organic systems may use only non-synthetic phytopharmaceuticals.

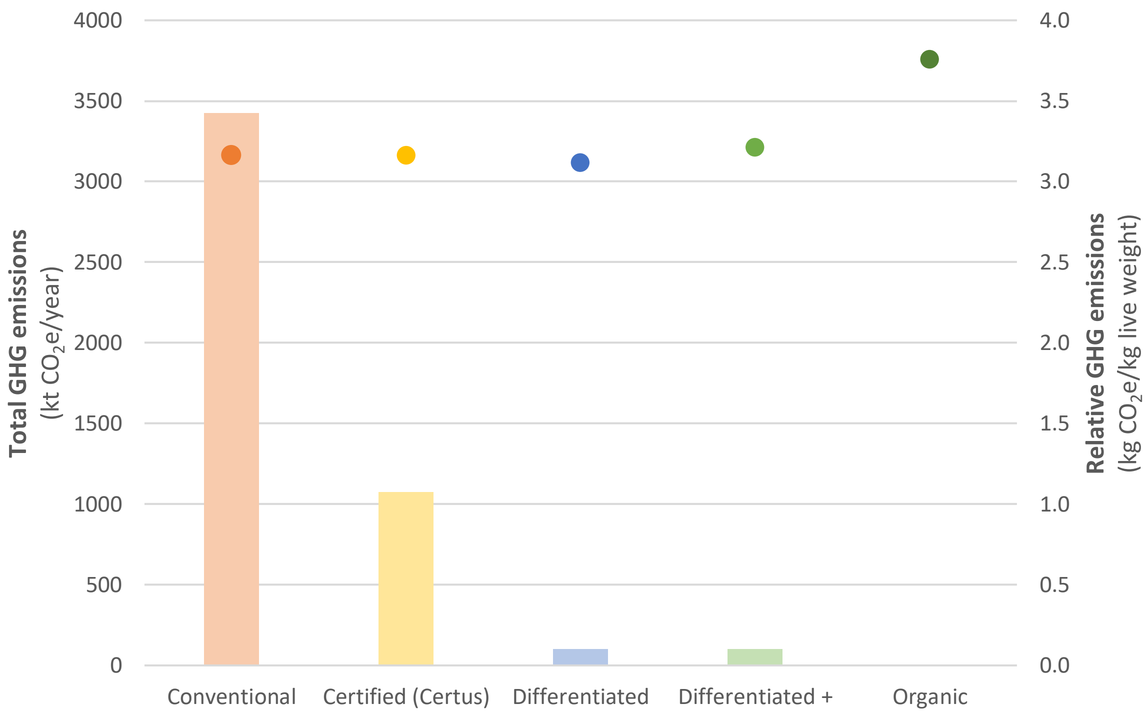
[21] Percentage of total slaughters in 2015. Based on (Van Buggenhout and Vuylsteke 2016).

[22] 'Differentiated' and 'Differentiated+' systems are considered together here.

• Production and environmental consequences of the Belgian pork sector in 2015

		Conv	Cert	Diff	Diff +	Org	TOTAL
Production							
Share	% of slaughters	73%	23%	2%	2%	<1%	100%
Production	kt live meat	955	299	29	29	1	1.312
Relative impact							
GHG emissions	kg CO_2e/kg live weight	3,16	3,16	3,11	3,21	3,76	
N emissions	kg N/kg live weight	0,046	0,046	0,048	0,055	0,058	
Biodiversity	DS/kg live weight	0,0073	0,0073	0,0076	0,0089	0,0036	
Total impact							
GHG emissions	kt CO_2e/year	3.424	1.074	100	101	6	4.705
N emissions	kt N/year	51	16	2	2	<1	70
Biodiversity	10^3 DS/year	6.992	2.193	217	254	5	9.661

• Total and relative GHG emissions of the Belgian pork sector in 2015



3.2. The laying hen sector

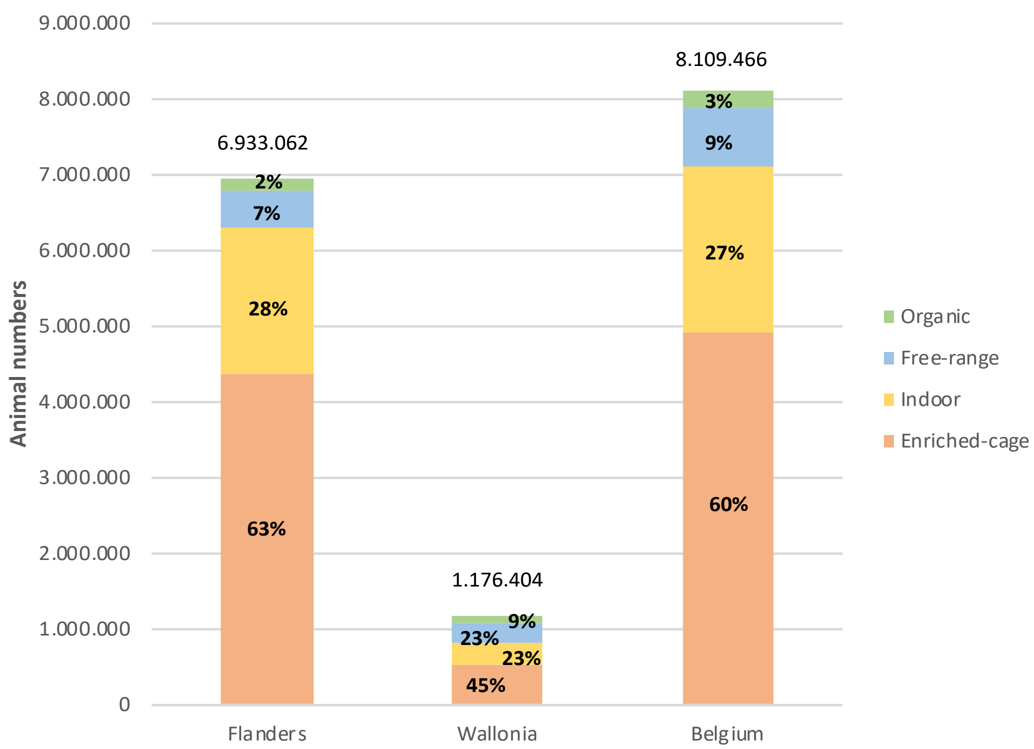
National production of eggs is largely located in Flanders (85% of the animals) and amounts 164 kt of eggs per year. Egg production in Belgium mainly occurs in conventional systems either in enriched cages or just indoor (87% of laying hens). Free-range and organic systems, that are characterised by a minimum outdoor area and lower productivity levels represent 9% and 3% of the laying hen population respectively. They are more frequent in Wallonia than in Flanders.

In terms of environmental impact, extensive systems tend to have higher relative GHG and N emissions but contribute very little to total emissions. Biodiversity impact is lowest for the organic system.

• Characteristics of egg production systems in Belgium[23]

Production and inputs	Enriched cage	Indoor	Free-range	Organic
Maximum farm size (animals)	-	-	-	3.000
Indoor area (cm^2/animal)	750	1.110	1.110	1.667
Outdoor area (m^2/animal)	-	-	4	4
Production period (days)	392	381	363	362
Productivity (eggs/laying hen/year)	327	321	321	210
Feed consumption (kg feed/kg egg)	2,01	2,2	2,33	2,41
Use of phytopharmaceuticals [24]	Yes	Yes	Yes	No

• Shares of egg production systems in Flanders, Wallonia and Belgium in 2015[25]

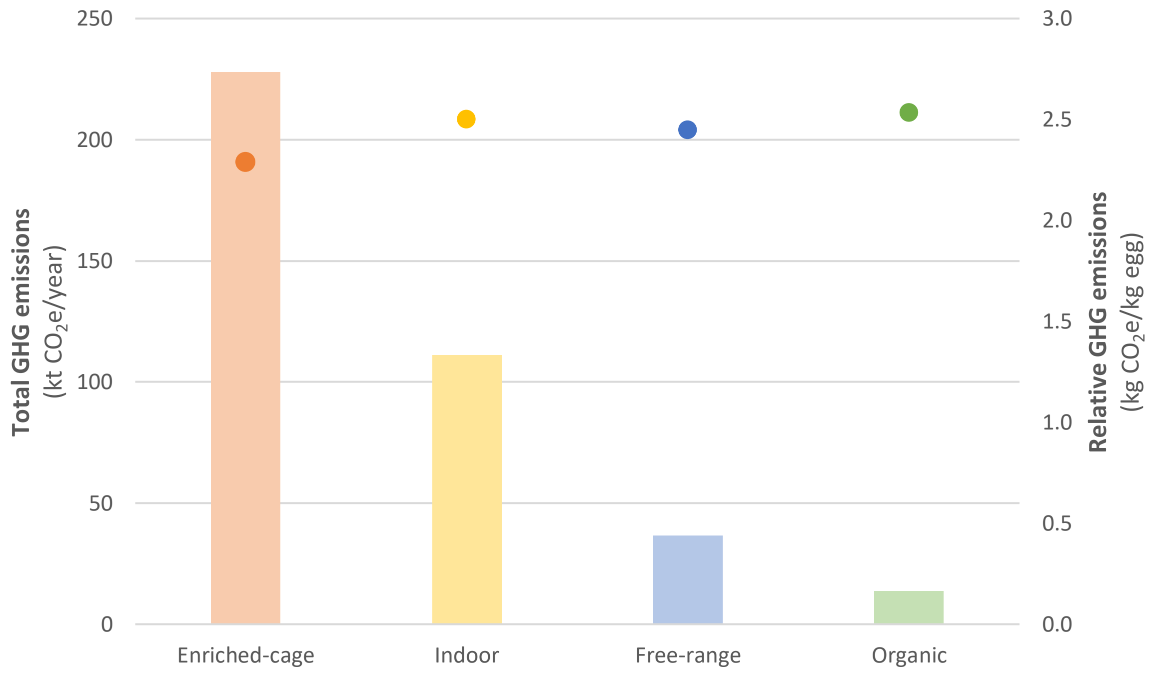


[23] Sources: (VILT 2015); Averages for Belgium in 2010 (Viaene 2012); Values from the Netherlands (Wageningen UR, 2013); (ITAVI 2014); (ITAVI 2014).
[24] Chemical phytopharmaceuticals. Organic systems may use only non-synthetic phytopharmaceuticals.
[25] Share in animal numbers.

• Production and environmental consequences of the Belgian laying hen sector in 2015

		Enriched-cage	Indoor	Free-range	Organic	TOTAL
Production						
Share	% of laying hens	60%	27%	9%	3%	100%
Production	kt eggs	100	44	15	5	164
Relative impact						
GHG emissions	kg CO_2e/kg egg	2,29	2,50	2,45	2,53	
N emissions	kg N/kg egg	0,038	0,042	0,046	0,047	
Biodiversity	DS/kg egg	0,0024	0,0026	0,0028	0,0013	
Total impact						
GHG emissions	kt CO_2e/year	228	111	37	14	389 [26]
N emissions	t N/year	3.799	1.853	682	256	6.591 [27]
Biodiversity	10^3 DS/year	236	115	42	7	399

• Total and relative GHG emissions of the Belgian laying hen sector in 2015



[26] This number does not include emissions related to young hens and reproductive animals which amount 198 kt CO_2e/year.
[27] This number does not include emissions related to young hens and reproductive animals which amount 3,3 kt N/year.

3.3. The broiler sector

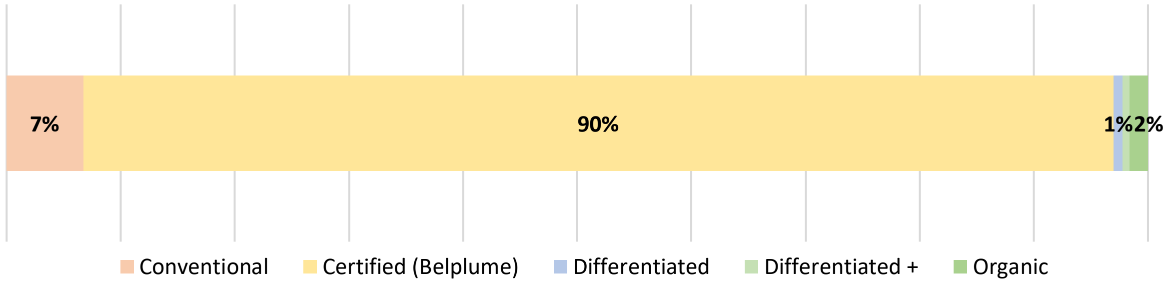
Flanders hosts 84% of the broiler population. National production of broiler meat amounts to 363 kt live weight in 2015. The production of poultry meat from broilers mainly occurs in conventional systems (97% of slaughters), which are Belplume-certified in the vast majority of cases (equivalent of the Certus label in the pork sector). Differentiated[28] and organic systems, which are based on slower growing breeds, only represent 2% each of broiler slaughters.

In terms of environmental impacts, the same trend is observed, i.e. more intensive systems have lower relative GHG and N emissions but are responsible for the vast majority of total emissions. Biodiversity impact is lowest for the organic system.

• Characteristics of poultry meat production systems

Production system	Conventional	Certified (Belplume)	Differentiated	Differentiated +	Organic
Indoor density (kg/m³)	Up to 42	Up to 42	Varies	Varies	21
Outdoor area (m²/animal)	0	0	0-2	0-2	4
Production period (Days)	38	38	56	70	70
Production cycles	7	7	5,5	4,5	4,5
Final weight (kg)	2,2	2,2	2,3	2,4	2,4
Feed (kg feed/kg live weight)	1,7	1,7	2,4	2,6	2,6
Use of phytopharmaceuticals	Yes	Yes	Yes	Yes	No

• Shares of broiler production systems in Belgium in 2015[29]

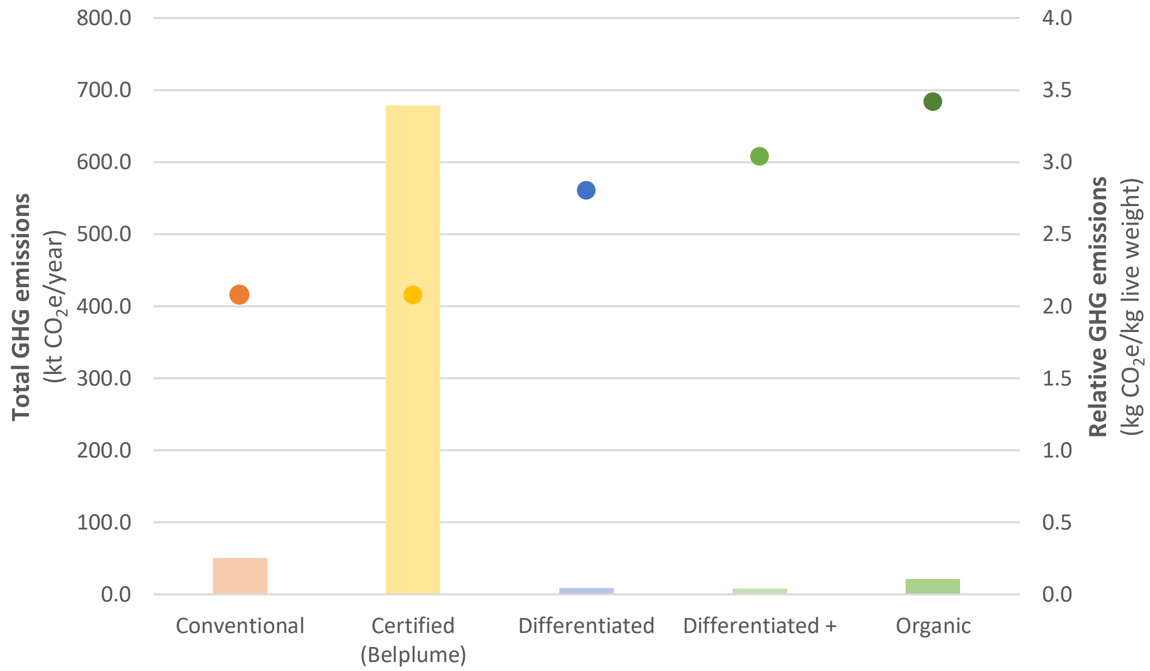


[28] Here too a distinction is made between Differentiated and Differentiated+ systems, which are more extensive and closer to organic systems.
[29] Percentage of Belgian broiler slaughters in 2015. Estimated from (Bergen 2015) and expert interviews.

• **Production and environmental consequences of the Belgian broiler sector in 2015**

		Conv	Cert	Diff	Diff +	Org	TOTAL
Production							
Share	% of slaughters	7%	89%	1%	1%	2%	100%
Production	kt live meat	24	327	3	3	6	363
Relative impact							
GHG emissions	kg CO_2e/kg live weight	2,1	2,1	2,8	3,0	3,4	
N emissions	kg N/kg live weight	0,029	0,029	0,040	0,043	0,047	
Biodiversity	DS/kg live weight	0,0025	0,0025	0,0033	0,0036	0,0018	
Total impact							
GHG emissions	kt CO_2e/year	50	678	8	8	21	766
N emissions	t N/year	708	9.551	120	111	292	10.782
Biodiversity	10^3 DS/year	61	822	10	9	11	913

• **Total and relative GHG emissions of the Belgian broiler sector in 2015**



3.4. The dairy sector

The dairy herd is located in Flanders and Wallonia (respectively 40% and 60% of dairy cows). The national production of milk amounted to 3.527 million litres in 2015.

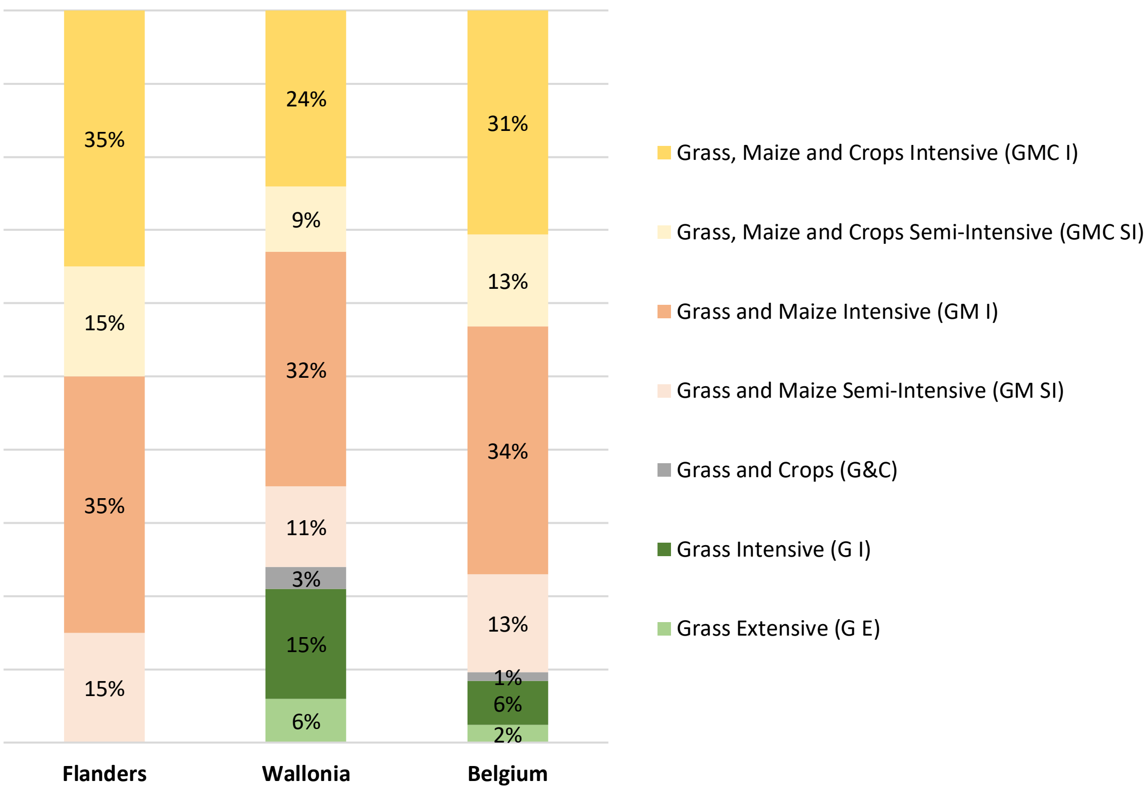
Dairy systems can be characterised based on their feeding strategies (e.g. use of maize silage or not) and productivity. Milk production in Belgium mainly occurs in intensive systems based on maize (65% of dairy cows), semi-intensive systems based on maize (26%) and extensive systems based on grass (9%). Systems based exclusively on grass and which do not use maize silage only exist in Wallonia and were estimated inexistent in Flanders, where intensive systems are more common.

In terms of environmental impacts, more intensive systems have lower relative GHG and N emissions. The Grass Extensive system, which is most often associated with organic systems, has the lowest biodiversity impact.

• Structural characteristics of dairy production systems in Belgium[30]

	GE	GI	G&C	G&M SI	G&M I	GMC SI	GMC I
Milk yield (L/dairy cow/year)	5.197	7.486	6.256	4.939	7.677	4.413	8.150
% of permanent pasture	99%	100%	70%	79%	76%	62%	44%
% of temporary pasture	1%	0%	14%	2%	4%	8%	11%
% of maize silage	0%	0%	0%	18%	19%	19%	37%
Use of concentrates (kg/cow/year)	179	220	191	154	209	133	211

• Shares of dairy production systems in Belgium in 2015[29]

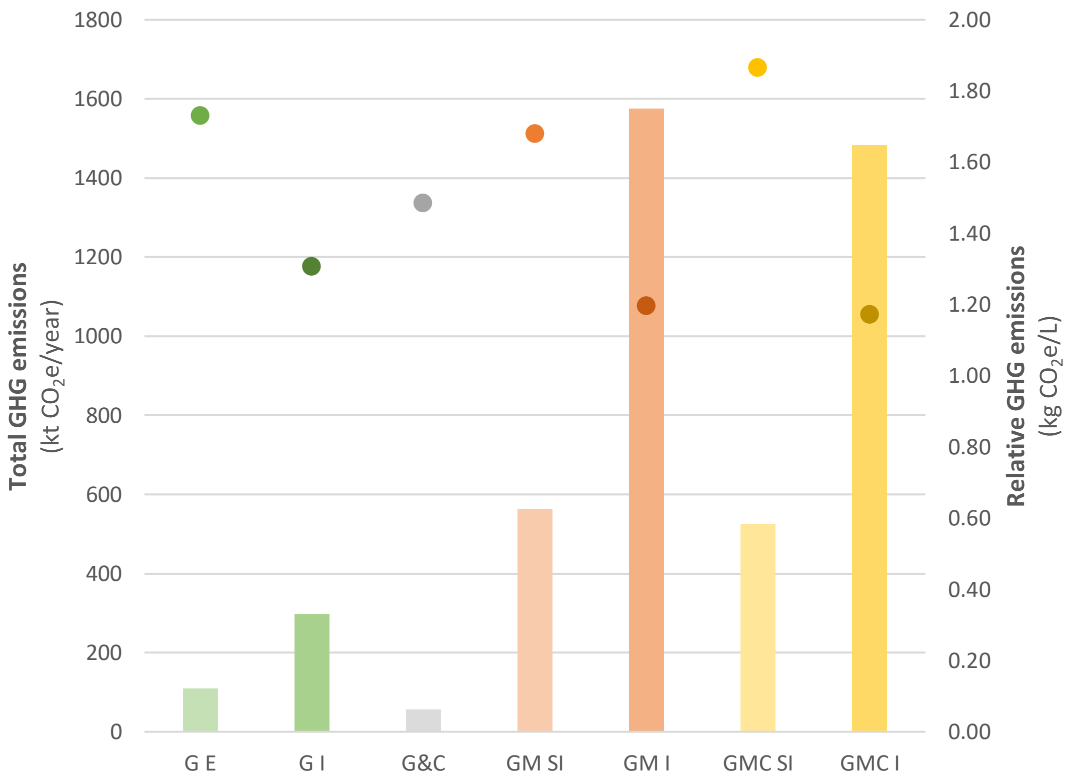


[30] Based on a typology elaborated by (Petel, Antier, and Baret 2018a) for Wallonia. It was extrapolated to whole Belgium by validating and estimating the shares of systems in Flanders through expert interviews.

• Production and environmental consequences of the Belgian dairy sector in 2015

		G E	G I	G&C	GM SI	GM I	GMC SI	GMC I	TOTAL
Production									
Share	% dairy cows	2%	6%	1%	13%	34%	13%	31%	100%
Production	10^6 L milk/year	63	228	38	336	1.316	282	1.265	3.527
Relative impact									
GHG	kg CO_2e/L	1,73	1,31	1,48	1,68	1,20	1,87	1,17	
N	kg N/L	0,033	0,023	0,030	0,036	0,026	0,046	0,028	
Biodiversity	DS/L	0,0004	0,0014	0,0012	0,0011	0,0011	0,0013	0,0011	
Total impacts									
GHG	kt CO_2e/year	109	297	57	564	1.575	526	1.483	4.611
N	kt N/year	2	5	1	12	34	13	36	103
Biodiversity	10^3 DS/year	28	329	47	374	1.507	368	1.378	4.030

• Total and relative GHG emissions of the Belgian broiler sector in 2015



3.5. The bovine meat sector

The national production of bovine meat amounted 268 kt carcass weight in 2015. The bovine meat sector is characterised by a regional specialisation: the breeding activities are more present in Wallonia whereas the majority of bull fattening happens in Flanders.

Breeding

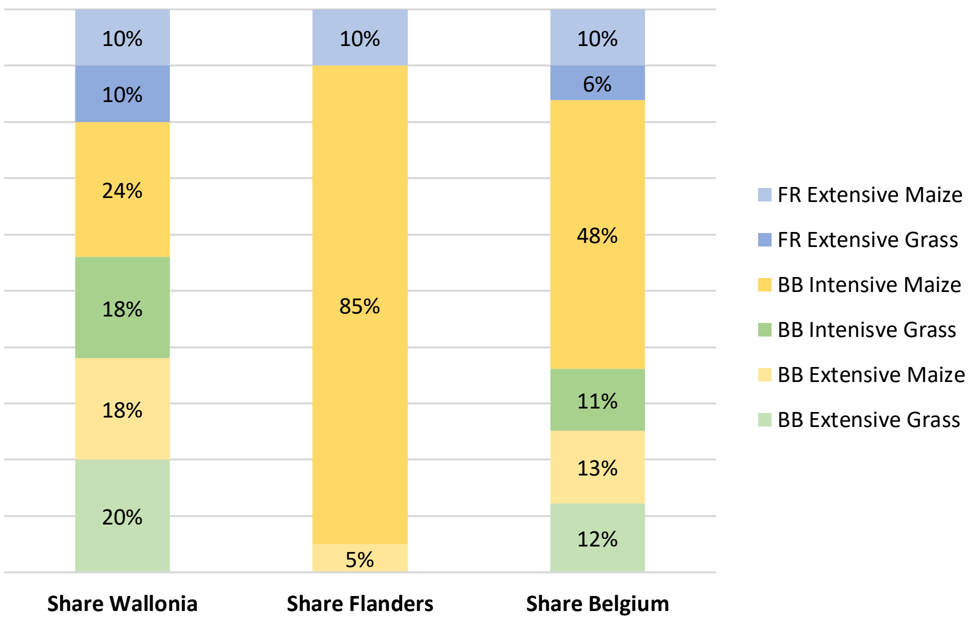
The predominance of the Belgian Blue breed is quite evident as 84% of suckler cows are of that breed. The most common system combines that breed with maize (61% of suckler cows). Alternatively, extensive systems with French breeds represent 16% of suckler cows. As a result of the choice of breed and feeding practices (using more grass and less concentrates), extensive systems have lower productivity levels (expressed in kg of weight gain per suckler cow and progeny per year). Extensive systems are much more present in Wallonia than in Flanders.

In terms of environmental impacts, the extensive French systems have higher relative GHG and N emissions. Nevertheless, the French system based on grass, which can be associated with organic systems, has the lowest biodiversity impact.

• Productivity and use of concentrates of breeding systems in Belgium [31]

	FR Ext Grass	FR Ext Maize	BB Ext Grass	BB Ext Maize	BB Int Grass	BB Int Maize
Productivity (kg weight gain/SC/yr)	373	363	357	430	431	438
Total Concentrates (kg/SC)	392	421	693	861	1151	1095

• Shares of breeding systems in Wallonia, Flanders and Belgium (in number of suckler cows) in 2015[30]

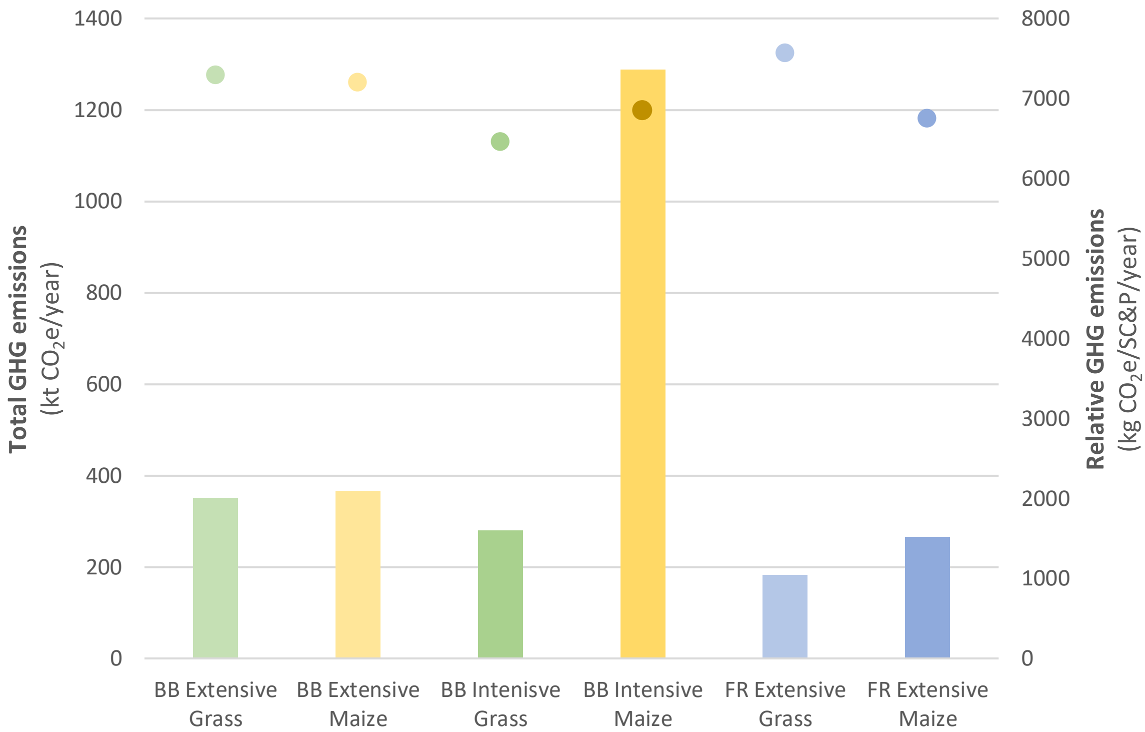


[31] Based on a typology elaborated by (Petel, Antier, and Baret 2018b) for Wallonia. It was extrapolated to whole Belgium by validating and estimating the shares of systems in Flanders through expert interviews.

• Production and environmental consequences of Belgian suckler cow systems (breeding sector) in 2015

		BB Ext Grass	BB Ext Maize	BB Int Grass	BB Int Maize	FR Ext Grass	FR Ext Maize	TOTAL
Production								
Share	% suckler cows	12%	13%	11%	48%	6%	10%	100%
Relative impact								
GHG	kg CO_2e/SC&P/year	7.292	7.200	6.456	6.851	7.564	6.748	
N	kg N/SC&P/year	241	221	149	183	262	195	
Biodiversity	DS/SC&P/year	7,3	6,3	8,4	7,8	1,1	5,4	
Total impacts								
GHG	kt CO_2e/year	350	366	279	1.288	182	266	2.731
N	kt N/year	12	11	6	34	6	8	78
Biodiversity	10^3 DS/year	352	319	364	1.467	26	198	2.727

• Total and relative GHG emissions of the Belgian breeding sector in 2015



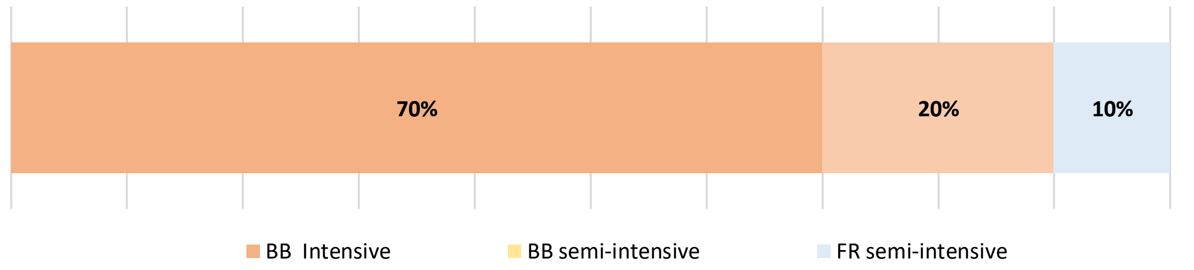
Fattening

The fattening of young bulls in Belgium most often happens intensively with Belgian Blue animals (70% of total bull slaughters). Semi-intensive strategies are applied with Belgian Blue or French breeds (respectively 20% and 10% of bull slaughters). The shares of system were estimated in Flanders as the majority of bull fattening happens in this region. The results were then extrapolated to whole Belgium based on the shares of bull slaughters in each region.

• System specifications of fattening systems in Flanders[32]

Parameter	BB Intensive	BB semi-intensive	FR semi-intensive
Share in Flanders (%)1	70%	20%	10%
Fattening duration (days)	240	360	360
Final weight (kg)	665	725	750
Total gain (kg)	365	425	450
Daily gain (kg/day)	1,4	1,2	1,2
Feed (kg feed/kg gain)	6,2	7,8	8,4

• Shares of bull fattening systems in Belgium in 2015[31]

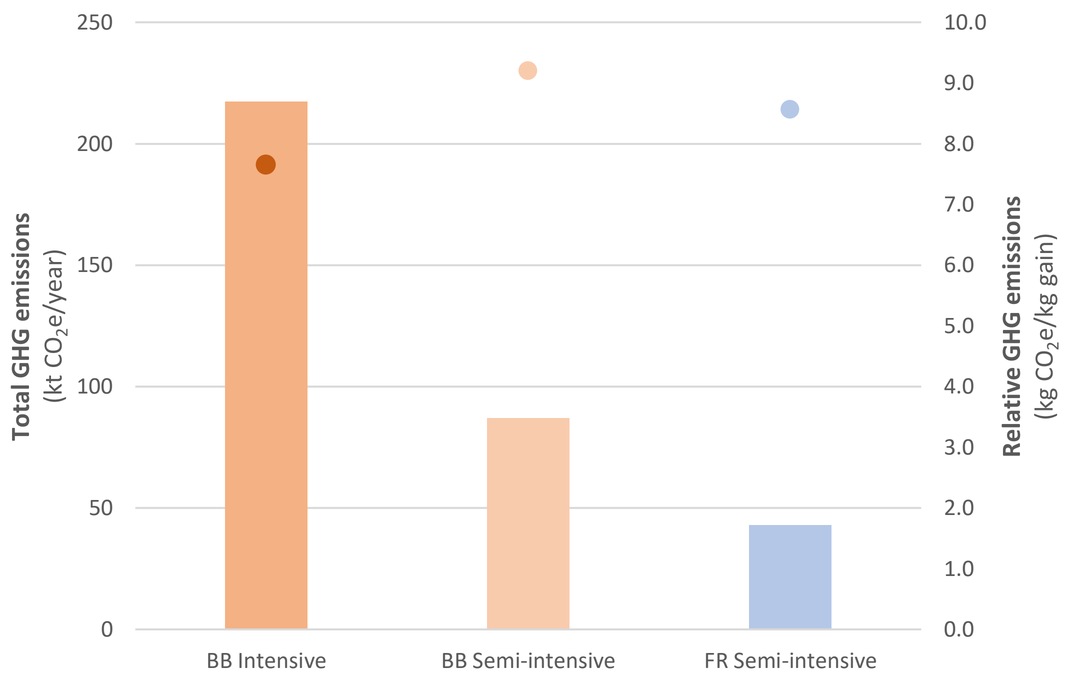


[32] (Experts interviews (2018)).

• Production and environmental consequences of bull fattening systems in Flanders in 2015

		BB Int	BB Semi-int	FR Semi-Int	TOTAL
Production					
Share	% slaughtered bulls	70%	20%	10%	100%
Production	kt live weight	52	16	8	76
Relative impact					
GHG emissions	kg CO_2e/kg gain	7,6	9,2	8,6	
N emissions	kg N/kg gain	0,17	0,20	0,17	
Total impacts					
GHG emissions	kt CO_2e/year	217	87	43	347 [33]
N emissions	kt N/year	4,8	1,9	0,8	7,6 [34]

• Total and relative GHG emissions of the bull fattening sector in Flanders in 2015



[33] This assessment is only for Flanders, extrapolating it to Belgium, the emissions amount 521 kt CO_2e.
[34] This assessment is only for Flanders, extrapolating it to Belgium, the emissions amount 11,3 kt N.

4. Challenging the trends with a diversity of scenarios

4.1. Introduction – Conception of the scenarios

Three prospective scenarios towards 2050 were designed:

- the **Business-as-usual (BAU)** scenario is based on trends from the past ten years;
- the **Transition 1 (T1)** scenario seeks to significantly reduce livestock GHG emissions while maintaining pastures, shifting towards extensive systems (organic or not), and using cereal feed only from national origin;
- the **Transition 2 (T2)** scenario seeks to significantly reduce livestock GHG emissions while maintaining pastures, shifting towards only organic systems by 2050, and using only pastures and co-products from EU origin for feeding the livestock.

Other scenarios for pursuing a reduction in GHG emissions and based on different strategies (such as focusing on intensive systems with lower emissions per unit of product) were not developed in this study, given the focus on extensive and organic systems requested to fit with Greenpeace criteria in terms of animal welfare, low biodiversity impact, non-GMO and pesticides-free feed.

• Main hypotheses used for the modelling of scenarios

	BAU scenario	Transition 1	Transition 2
Livestock populations	Vary according to trends until 2030 and remain stable after that.	Vary according to available resources.	Vary according to available resources.
Feed sources	National production & world-wide import.	- No import of cereals; based on available national cereal resources for animal feed. - No soybean meal.	- National and regional (EU) sources of coproducts. - No soybean meal.
Shares of production systems	Vary according to trends until 2050.	70% extensive and 30% organic systems in 2050	100% of organic systems in 2050.
Consumption patterns	Vary according to trends until 2050 OR follow the recommendations.	Changes in food patterns are proposed in order to fit with the production potential. The nutritional recommendations pattern was also considered for T1.	
Optimisation of technical parameters[35]	From 0% to 15% between 2015 and 2050 depending on livestock sectors and measures[36].		

[35] Gains in efficiencies or productivities and implementation of GHG emissions reduction measures (e.g. reductions in enteric fermentation through dietary additives, reduction of manure management emissions through the implementation of biogas installations, etc). Reduction in emissions can also result indirectly from gains in efficiencies or productivities.
[36] See full report.

4.2. Evolution of consumption patterns

In order to account for possible changes in consumption patterns along time, the evolution in the consumption of meat and other animal products in the scenarios was analysed according to different patterns. Four dietary patterns were considered for 2050:

1. The **'Trends 2050'** ('TR') pattern follows the trends from the last ten years in terms of animal products consumption and extends them to 2050. It reduces the consumption of pork, poultry and bovine meat in 2050 by 19% compared to 2015. This is the smallest change among patterns compared to 2015.
2. The **'Intermediate 2050'** ('Int') pattern aligns the consumption of meat with the production potential of the Transition 1 scenario. It reduces meat consumption in 2050 by 25% compared to 2015 - and is therefore quite close to the trends pattern.
3. The **'Nutritional Recommendations'** ('NR') pattern aligns the consumption of meat with the nutritional recommendations, i.e. 50 g meat/cap/day for pork, poultry and bovine meat. It reduces consumption by 43% compared to 2015.
4. The **'Low-meat 2050'** ('LM') pattern aligns the consumption of meat with the production potential of the Transition 2 scenario. It is the most restrictive consumption pattern as it reduces meat consumption in 2050 by 69% compared to 2015.

Each scenario was assessed under different consumption situations, which fitted the best the hypotheses of each scenario. The Transition 2 scenario was assessed exclusively under the 'low-meat' pattern.

• Pork, poultry and bovine meat consumption under different consumption patterns in 2015 and 2050[37]

Dietary pattern	Amount g meat/cap/day	Delta vs. 2015 %
Present 2015	87	na
'Trends 2050'	70	-19%
'Intermediate 2050' (Int)	65	-25%
'Nutritional recommendations' (NR)	50	-43%
'Low-meat 2050' (LM)	27	-69%

• Considered consumption patterns in each scenario

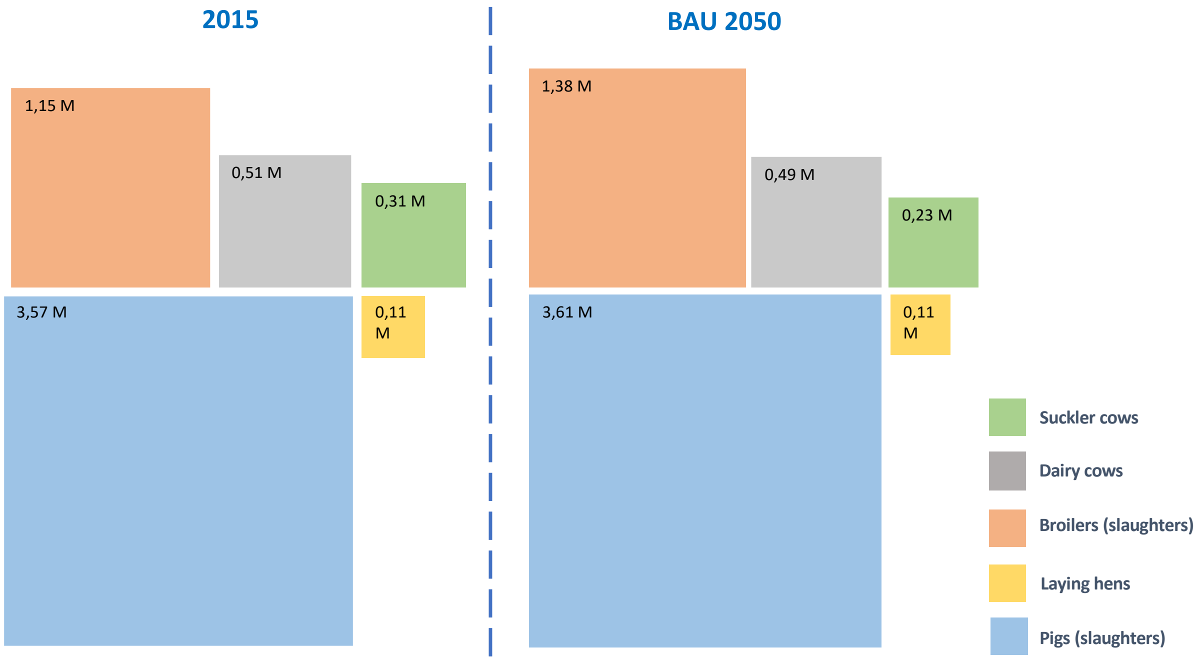
Scenario	Assessed consumption pattern 1	Assessed consumption pattern 2
BAU	'Trends'	'Nutritional recommendations'
T1	'Intermediate'	'Nutritional recommendations'
T2	'Low-meat'	-

[37] The values presented in this table are specific to the consumption of pork, poultry and bovine meat, which is why the amounts for the present situation and the nutritional recommendations pattern do not correspond to the values of 114 and 57 g/cap/day mentioned in Section 2.1. (which consider all types of meat).

4.3. Evolution of livestock populations

The different scenarios lead to evolutions in terms of livestock populations as well as production systems. The following figures illustrate these evolutions. Their implications are discussed in the following sections.

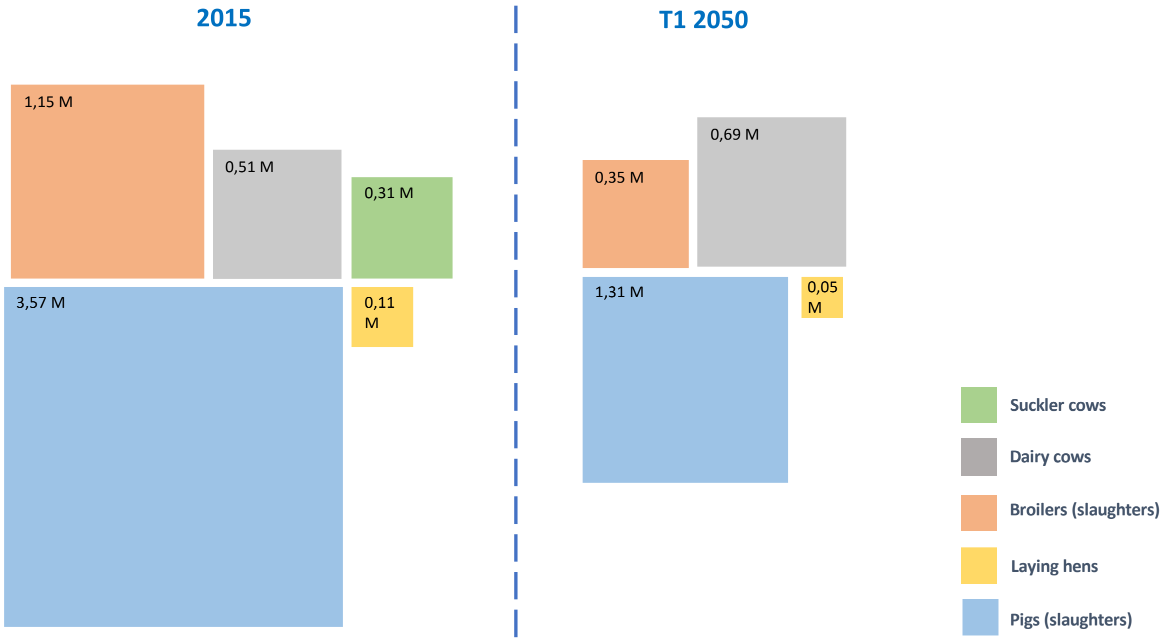
• Evolution of the pigs, broilers, laying hens, dairy cows and suckler cows populations between 2015 and 2050 according to the BAU scenario, in Livestock units (LSU)[38]



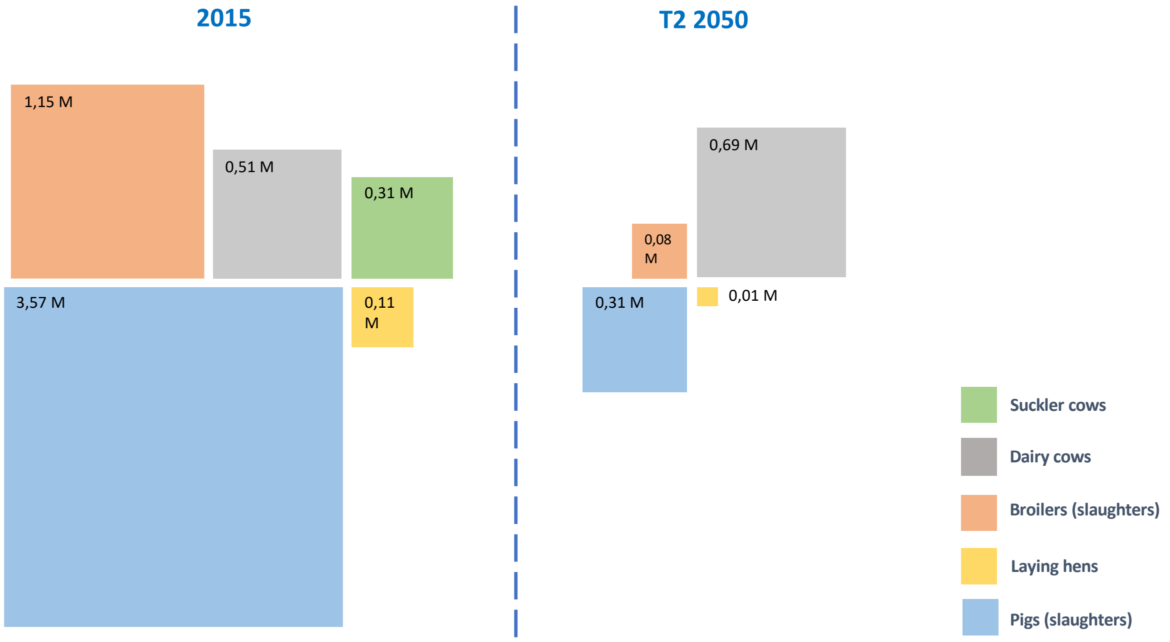
[38] Boxes and values refer to animal numbers expressed in livestock units (LSU). The pigs and broilers populations are expressed in terms of annual slaughters.
The shares of production systems in 2050 in the BAU scenario are the following:

- **Pigs** (in percentage of slaughters): 42% Conventional / 50% Certified (Certus) / 4% Differentiated / 4% Differentiated + / <1% Organic.
- **Broilers** (in percentage of slaughters): 0% Conventional / 96% Certified (Belplume) / 1% Differentiated / 1% Differentiated+ / 2% Organic.
- **Laying hens** (in percentage animals): 35% Cage / 45% Indoor / 15% Free-range / 6% Organic.
- **Dairy cows** (in percentage animals): 2% GE / 0% GI / 4% G&C / 3% GM SI / 45% GM I / 6% GMC SI / 40% GMC I.
- **Suckler cows** (in percentage animals): 2% BB Ext Grass / 6% BB Ext Maize / 9% BB Int Grass/ 59% BB int Maize / 11% FR Ext Grass / 13% FR Ext Maize.

• Evolution of the pigs, broilers, laying hens, dairy cows and suckler cows populations between 2015 and 2050 according to the T1 scenario, in Livestock units (LSU)[39]



• Evolution of the pigs, broilers, laying hens, dairy cows and suckler cows populations between 2015 and 2050 according to the T2 scenario, in Livestock units (LSU)[36]



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[39] Boxes and values refer to animal numbers expressed in livestock units (LSU). The pigs and broilers populations are expressed in terms of annual slaughters.
The shares of production systems in 2050 in T1 and T2 are the following:

- **Pigs** (in percentage slaughters): 70% Differentiated+ / 30% Organic in **T1**; 100% Organic in **T2**.
- **Broilers** (in percentage slaughters): 70% Differentiated + / 30% Organic in **T1**; 100% Organic in **T2**.
- **Laying hens** (in percentage animals): 70% Free-range / 30% Organic in **T1; 100%** Organic in **T2.**
- **Dairy cows** (in percentage animals): 50% GE / 50% G&C in **Wallonia**; 100% GM SI in **Flanders** (idem for T1 and T2). In the transition scenarios (T1 and T2), only a mixed dairy herd is considered. The suckler cow herd has disappeared.

4.4. Consequences of the business as usual scenario

The Business-as-usual scenario extends the trends observed in the Belgian livestock sector during the past 10 years until 2050. While the dairy cow, laying hen and suckler cow populations are all expected to decrease (respectively -5%, -7% and -26%), the pig population is likely to remain stable (+1%) and the broiler population would increase significantly (+20%).

Overall, according to the trends, conventional intensive systems would remain predominant, with a slight decrease due to the growth of alternative systems. In the pork, laying hen, and broiler sectors, certified systems (and the indoor system for laying hens) are expected to grow, resulting in smaller shares for the conventional, not-certified systems (enriched cage system for laying hens). The organic and differentiated systems grow too but remain very small. In the dairy sector, the most intensive systems are expected to become even more important. In the bovine meat sector, extensive breeding systems based on French breeds and intensive systems based on Belgian Blue breeds gain shares. Regarding the fattening sector (in Flanders), it is assumed that French breeds will become more common, although Belgian Blue systems will nevertheless remain predominant.

Production

Production levels of animal products in the BAU scenario evolve similarly to livestock populations, except for the dairy sector, in which the decrease in the dairy cow population is compensated by an increase in productivity levels.

Consumption

Considering a 'trends' consumption pattern, all productions still exceed national demand in 2050, except for the laying hen sector where the production of eggs is not sufficient to meet the expected increase in demand (the production could cover 88% of the demand).

If nutritional recommendations are followed ('NR' pattern), consumption of animal products is lower (50g meat/cap/day) and the self-sufficiency ratios are thus higher than in the previous situation (>100% for all five considered animal productions).

GHG emissions

In terms of livestock-related GHG emissions which were assessed in the context of this study (see Section 1.4), this scenario results in a reduction of 13% in 2050 compared to 2015 (12.066 kt CO_2e in 2050 vs. 13.920 kt CO_2e in 2015). This is mainly the result of technological and productivity improvements.

• Livestock production levels in 2050 in a BAU scenario and comparison with 2015

Sector	Unit	Production 2015	Production 2050	Delta 2050-2015	Self-sufficiency 'Trends'	Self-sufficiency 'NR'
Pork	kt carcass/year	1.037	1.052	+1%	287%	357%
Broilers	kt carcass/year	261	313	+20%	205%	255%
Laying hens	kt eggs/year	164	151	-8%	88%	110%
Dairy	mo L milk/year	3.527	4.026	+14%	137%	170%
Bovine meat	kt carcass/year	268	208	-22%	133%	165%

Note: The self-sufficiency indicator is the result of the ratio Production/Consumption.

4.5. Consequences of the Transition 1 scenario

In the first transition scenario, the sizes of the livestock populations are established on the basis of national resources available for animal feed (grassland and national production of cereals). Furthermore, only organic and extensive systems are considered (30% of organic systems and 70% of extensive systems).

The specialised dairy herd and the specialised bovine meat herd are replaced by a single mixed dairy herd, which is assumed to occupy all available grassland resources and ensures the production of both milk and bovine meat. As a result, the total number of cows in 2050 decreases by 24% compared to 2015 (688.286 cows in 2050 vs. 900.895 cows in 2015). Indeed, although the number of milk-producing cows increases by 34%, the number of suckler cows decreases by 100%.

The sizes of the pig and poultry populations are based on the national cereal resources. This means that only cereals produced in Belgium and available for animal feed are used [40]. In such a scenario, the pig population decreases by 63%, the broiler population by 70% and the laying hen population by 56%.

Production

All productions are more than halved compared to 2015 levels, except for the production of milk (+15%). In particular, the production of poultry meat through broilers is greatly reduced (-67%), followed by the production of pork (-60%), eggs (-57%) and bovine meat (-50%).

Consumption

The 'intermediate' consumption pattern under which this scenario is assessed assumes that 100% of the production is consumed. This results in a daily meat intake of 65 g meat/capita, which comes closer to the recommendations (50 g/cap/day) but still exceeds them by 28%.

The 'NR' pattern results in lower animal product consumption (50 g meat/cap/day) and hence implies that a share of the production is available for export (self-sufficiency ratios of 130%).

GHG emissions

This scenario results in the emissions of 7.231 kt CO_2e in 2050, i.e. a reduction of 48% of GHG emissions compared to 2015 emission levels.

• Production of animal products in the Transition 1 scenario, and comparison with 2015.

Sector	Unit	Production 2015	Production 2050	Delta 2050-2015	Self-sufficiency 'Int	Self-sufficiency 'NR'
Pork	kt carcass/year	1.037	415	-60%	100%	130%
Broilers	kt carcass/year	261	86	-67%	100%	130%
Laying hens	kt eggs/year	164	71	-57%	100%	130%
Dairy	mo L milk/year	3.527	4.044	+15%	100%	130%
Bovine meat	kt carcass/year	268	134	-50%	100%	130%

Note: The self-sufficiency indicator is the result of the ratio Production/Consumption.

[40] It is estimated that currently, about 62% of the Belgian cereal production is used as animal feed. In 2015, this represented 2.048 kt cereals, i.e. 55% of the total cereal consumption by the Belgian livestock sector.

4.6. Consequences of the Transition 2 scenario

The Transition 2 scenario was designed in order to follow as closely as possible Greenpeace's criteria for ecological livestock. As a consequence, only organic systems were considered in the scenario[41] and the size of the herds were established on the basis of available national and regional resources which do not result in a food-feed competition.

In this context, the same assumptions as in Transition 1 were made regarding the bovine herd, i.e. only a mixed dairy herd which occupies all the available grassland resources was considered.

Regarding the pig and poultry populations, only regional sources of coproducts (national and/or EU-origin) were considered as animal feed. Two types of coproducts were considered: protein-rich coproducts and cereal-equivalent coproducts, which appear to be more limiting than protein-rich coproducts. Hence, in order to ensure that no food-feed competition occurs, the animal populations were estimated based on the available cereal-equivalent coproducts. Based on these considerations, the sizes of the pig and poultry herds would be reduced drastically (-91% for the pig population, -93% for the broilers population, and -90% for the laying hen population)[42].

Production

Accordingly, the production of pork, poultry meat and eggs are drastically reduced compared to 2015 (-91%, -92%, -90% respectively). The milk and bovine meat productions are similar to Transition 1 (+15% and -50% respectively).

Consumption

The 'low-meat' consumption pattern considered in this scenario results in a consumption level of 27 g meat/cap/day (-69% compared to 2015). Self-sufficiency is 100% as the entire production is consumed.

GHG emissions

As a result of the important decrease in the animal populations and the fact that local coproducts are used as feed (i.e. no soybean meal), Transition 2 leads to a significant reduction of 59% of the livestock sector's GHG emissions in 2050 compared with 2015 emissions levels.

• Production of animal products in the transition 2 scenario, and comparison with 2015.

Sector	Unit	Production 2015	Production 2050	Delta 2050-2015	Self-sufficiency 'Low-meat'
Pork	kt carcass/year	1.037	98	-91%	100%
Broilers	kt carcass/year	261	21	-92%	100%
Laying hens	kt eggs/year	164	16	-90%	100%
Dairy	mo L milk/year	3.527	4.044	+15%	100%
Bovine meat	kt carcass/year	268	134	-50%	100%

Note: The self-sufficiency indicator is the result of the ratio Production/Consumption.

[41] Organic systems ensure that there is no use of pesticides, the use of GMO-free feed and high animal welfare standards.

[42] Estimating the pig and poultry populations based on the available protein-rich coproducts, the reductions in animal populations would be smaller (-66% for the pig population, -72% for the broiler population, and -58% for the laying hen populations). Nevertheless, as the cereal-equivalent coproducts sources would not be sufficient in this case, these would need to be complemented by a share of the cereal production, hence resulting in food-feed competition.

5. Compared results of the scenarios

5.1. General overview

The main results of the scenarios are presented in the table below which provides an overview and a comparison of the three scenarios in terms of production and consumption levels, export capacity, feed autonomy (for cereals) and environmental impacts.

• Overview of the consequences of each scenario and comparison with the present situation

Indicator	Unit	Present 2015	BAU 2050	T1 2050	T2 2050
Production [a]					
Meat - Total	kt meat	740	743	300	125
Meat - Per capita	g meat/cap/day	181	160	65	27
Delta Total vs. 2015	%	Na	<1%	-59%	-83%
Protein - Total	kt protein	303	315	188	136
Protein - Per capita	g protein/cap/day	74	68	40	29
Delta Total vs. 2015	%	Na	4%	-38%	-55%
Consumption					
Meat	g meat/capita/day	87	70 [b]	65 [b]	27
Delta vs. 2015	%	Na	-19%	-25%	-69%
Protein	g protein/cap/day	43	38 [b]	40 [b]	29
Delta vs. 2015	%	Na	-11%	-7%	-32%
Export capacity					
Self-sufficiency of meat	%	209%	228%	100%	100%
Feed (cereals)					
Feed autonomy (cereals)	%	55%	55%	100%	Na [c]
Share of cereals for feed	%	62%	62%	62%	0%
Environmental impacts					
GHG emissions - Total	kt CO_2e	13.920	12.066	7.231	5.747
GHG emissions - Relative	kg CO_2e/kg prot	46,0	38,3	38,5	42,4
Delta Total vs. 2015	%	Na	-13%	-48%	-59%
N emissions - Total	Kt N	283	253	171	145
N emissions - Relative	kg N/kg prot	0,93	0,80	0,91	1,07
Delta Total vs. 2015	%	Na	-10%	-40%	-49%
Biodiversity – Total [d]	DS	18.207.628	16.619.789	7.827.840	4.400.502
Biodiversity - Relative	DS/kg prot	0,060	0,053	0,042	0,032
Delta Total vs. 2015	%	Na	-9%	-57%	-76%
PPP use – Total [e]	t a.s.	810	765	254	0
PPP use - Relative	g a.s./kg prot	2,7	2,4	1,4	0
Delta Total vs. 2015	%	Na	-6%	-69%	-100%

Notes:

[a] The production levels are expressed after slaughter and carcass yields, as well as a waste factor are taken into account.

[b] BAU and T1 were assessed under several consumption patterns. The results presented here are for the 'Trends' pattern for BAU and the 'Intermediate' pattern for T1. Additionally, both scenarios were assessed under a 'Nutritional recommendations' pattern which presents a consumption level of 50g meat/cap/day and 31 g animal prot/cap/day.

[c] Feed autonomy in Transition 2 was not assessed in terms of cereals strictly. Nevertheless, this scenario relies exclusively on the use of regional coproducts (from Belgian and EU origin).

[d] The damage score (DS) gives an indication of the Biodiversity impact of crops which are involved in the livestock production.

[e] The PPP use was estimated for the Belgian crops destined for livestock feed.

5.2. Production, consumption and export potential

Meat (pork, poultry and bovine meat)

Analysing a specific scenario under one or another consumption pattern does not affect its production potential or environmental impacts (GHG emissions, etc.) but it affects the share of the production which is consumed nationally and hence it influences the export capacity of the scenario.

As an illustration, considering the BAU scenario under the 'trends' pattern results in a self-sufficiency ratio of 228% (in terms of pork, poultry and bovine meat), which is quite similar to the situation in 2015 (209%). Analysing the same scenario under the 'Nutritional recommendations' pattern increases the export capacity of the scenario and its self-sufficiency ratio to 322%, meaning that less than a third of the produced meat is consumed nationally in this situation.

Similarly, the 'intermediate' pattern considered in Transition 1 results in a meat consumption level which comes close to the 'Trends' pattern in BAU (65 g meat/cap/day vs. 70 g meat/cap/day respectively). Analysing Transition 1 under the 'nutritional recommendations pattern' results in a lower consumption level (50 g meat/cap/day) and hence in a share of the production which could potentially be exported. This highlights that it is possible to move towards a production system based on organic and extensive systems in which nutritional recommendations are met and a certain export capacity is maintained.

Transition 2 corresponds to a 'low-meat' situation in which the consumption of meat has decreased substantially compared to 2015 (-69%) and there is no export capacity left.

Animal protein

Expressing the results in terms of protein, it is possible to consider the consumption of all five animal products (not only pork, poultry and bovine meat but also milk and eggs).

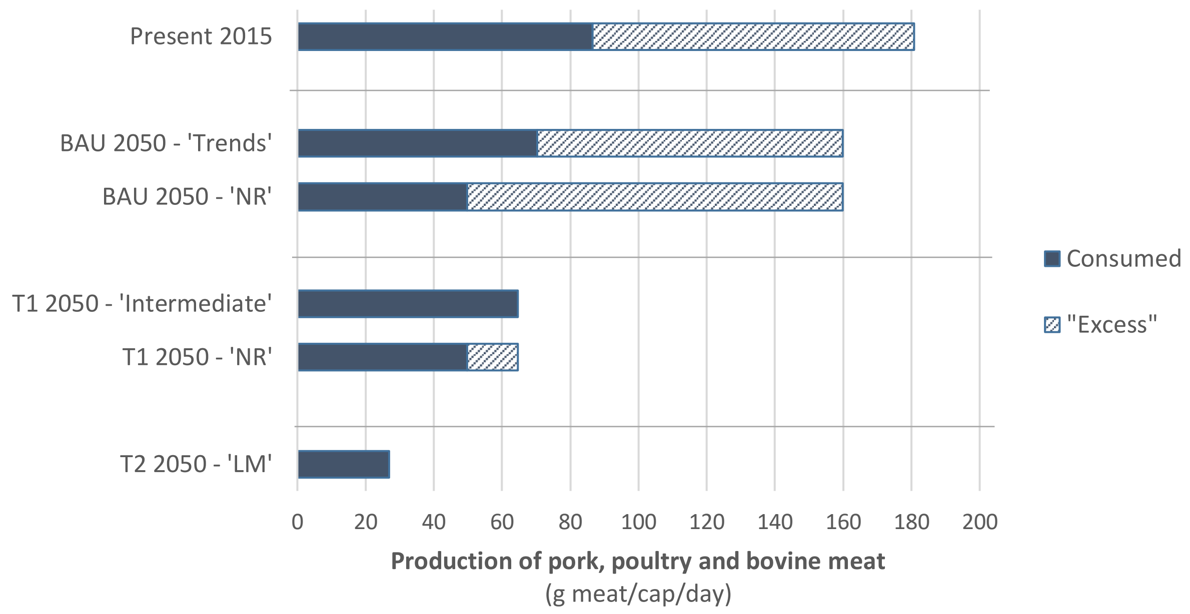
The highest animal protein intake is obtained under the 'intermediate' pattern in Transition 1 (40 g of animal protein/cap/day). This 'intermediate' pattern actually results in a higher total protein intake than the 'Trends' pattern (BAU scenario), which presented a higher meat consumption level. This is due to the importance of dairy products in the 'Intermediate' pattern and highlights the shift implied by the Transition scenarios regarding the consumption of animal protein towards lower meat consumption levels but higher consumption levels of other animal products, in particular dairy products.

Interestingly, the Transition 2 scenario and its 'Low-meat' pattern, which in terms of meat intake involved an important reduction compared to 2015 and other scenarios, shows results which come very close to the 'Nutritional recommendations' patterns when expressed in terms of protein intake. Compared to the nutritional recommendations, the 'low-meat' pattern compensates its low meat consumption level with a higher intake of other animal products, in particular milk and dairy products. Furthermore, this scenario could contribute to balancing out the shares of animal and vegetal sources of protein. This situation would also be favoured in the 'Nutritional recommendations' pattern[43].

[43] As mentioned in Section 2.1, the recommended protein intake ranges between 52-62 g protein/cap/day and it is recommended to observe a balance between animal and vegetal sources of protein. The situations resulting from the 'LM' and the 'NR' pattern are in line with this (about 30 g animal protein/cap/day).

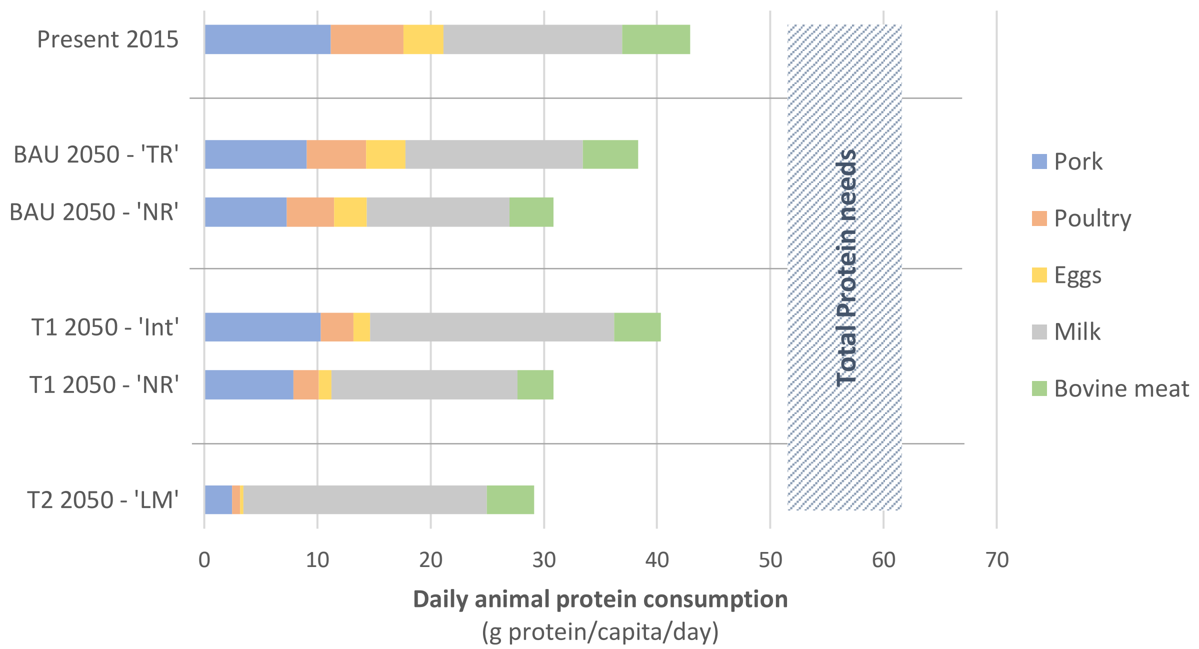
• Production, consumption and excess of pork, poultry and bovine meat in 2015 and 2050 according to each scenario and under different consumption patterns

('NR' stands for 'Nutritional recommendations; 'LM' stands for 'Low-meat')



• Consumption of animal sources of protein in 2015 and 2050 according to each scenario and under different consumption patterns

('TR' stands for 'Trends'; 'NR' stands for 'Nutritional recommendations; 'Int' stands for 'Intermediate' and 'LM' stands for 'Low-meat')



5.3. Environmental impacts

GHG Emissions

In terms of total emissions, all scenarios result in lower GHG emissions compared to 2015. Transition 2 presents the greatest reduction potential compared with 2015, followed by Transition 1 and BAU (-59%, -48% and -13% respectively). These reductions are the combined result of changes in the livestock populations, changes in the shares of production systems and technological improvements.

The contributions of each sector to the total livestock GHG emissions vary from one scenario to another. In general, the same trend can be observed as for the protein levels, i.e. the bovine sector contributes the most to the total emissions and its share increases in the transition scenarios.

When expressed per unit of meat (kg CO_2e/kg meat), BAU is the scenario with the lowest relative emissions whereas Transition 2 has the highest (16,2 vs. 46,0 kg CO_2e/kg meat). However, differences between scenarios are much smaller when results are expressed per unit of protein. Transition 2 still has the highest emission level (42,4 kg CO_2e/kg protein) but these are lower than in 2015 (46,0 kg CO_2e/kg protein) and much closer to the lowest emission level, which is observed in BAU (38,3 kg CO_2e/kg protein). This contrasting situation is due to the low meat production potential resulting from Transition 2 which is compensated by its important dairy production levels. Transition 1 comes very close to the results from BAU (38,5 kg CO_2e/kg protein).

N emissions

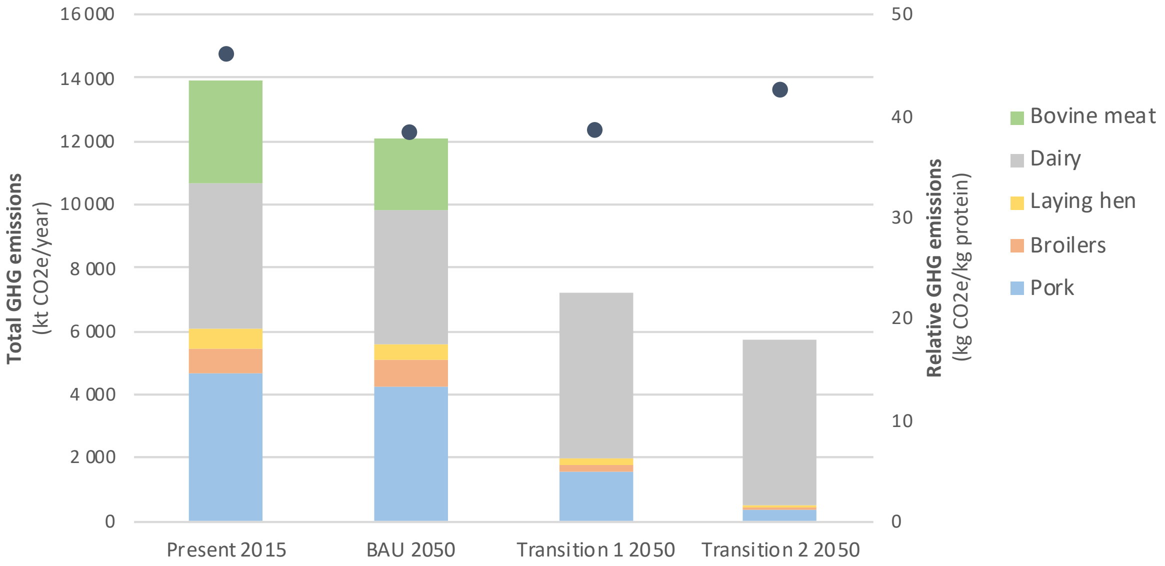
Compared to 2015, BAU reduces N emissions by 10%, Transition 1 by 40% and Transition 2 by 49%. All scenarios thus succeed in reducing N emissions from the livestock sector in 2050. Here too the reductions are the combined result of changes in the livestock populations, changes in the shares of production systems and technological improvements.

In all scenarios, the dairy sector is the biggest contributor to total N emissions, and all the more so in the transition scenarios. The pork sector is the second biggest contributor, especially in 2015 and in BAU.

In terms of relative emissions, the same trend as for GHG emissions can be observed, i.e. the important gap in emission levels between BAU and Transition 2 expressed per unit of meat (0,34 kg N/kg meat vs. 1,16 kg N/kg meat respectively) is partially closed when expressed per unit of protein (0,80 kg N/kg protein for BAU vs. 1,07 kg N/kg protein in Transition 2). Transition 1 presents an intermediate situation which comes closer to BAU.

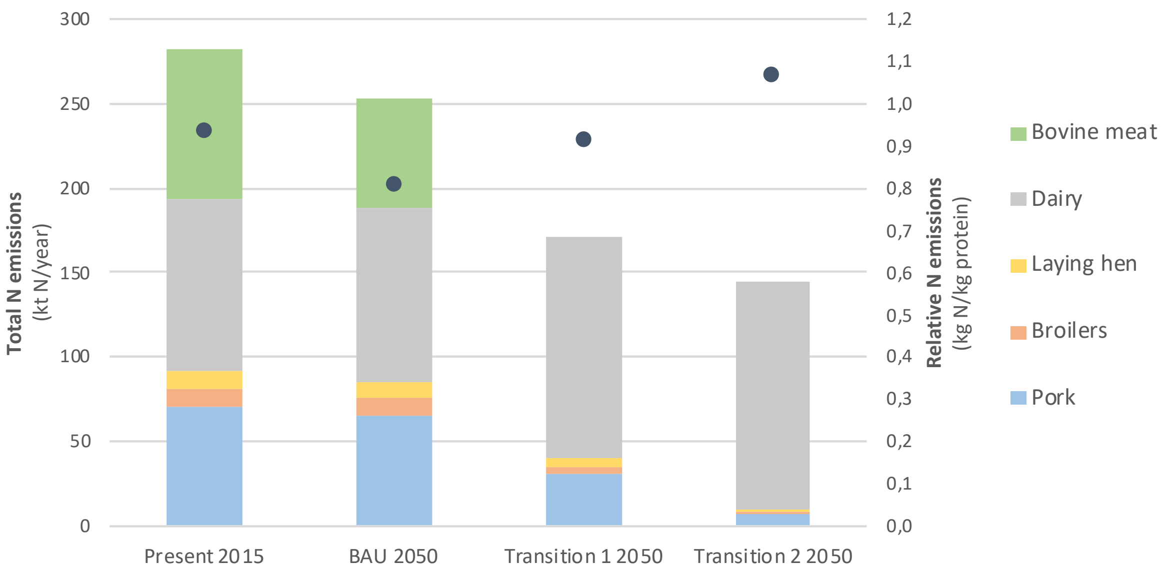
• Total and relative (per kg of protein) GHG emissions of the Belgian livestock sector in 2015 and 2050 according to different scenarios

In the transition scenarios, only a mixed 'dairy' herd is considered (which explains the absence of 'bovine meat' category for Transition 1 and Transition 2)



• Total and relative (per kg of protein) N emissions of the Belgian livestock sector in 2015 and 2050 according to different scenarios

In the transition scenarios, only a mixed 'dairy' herd is considered (which explains the absence of 'bovine meat' category for Transition 1 and Transition 2)



Biodiversity impact

Compared to 2015, the total Damage Score (DS) decreases by 9% in BAU, by 57% in Transition 1 and by 76% in Transition 2. All scenarios thus succeed in lowering the Biodiversity impact of the livestock sector in 2050 in comparison with 2015.

In this case, the biggest contributor is the pork sector. This can be explained by the methodology which attributes a damage score (DS) to the used feed. Because arable land has a higher damage score than grassland, the bovine sector is favoured compared to the pork sector which cannot benefit from the use of grassland but relies on arable land for its feed.

In terms of relative impact (per unit of protein), Transition 2 leads to the lowest impacts, followed by Transition 1 and BAU. This situation is explained by the higher shares of organic productions in these scenarios, which have lower biodiversity impacts.

Use of phytopharmaceutical products

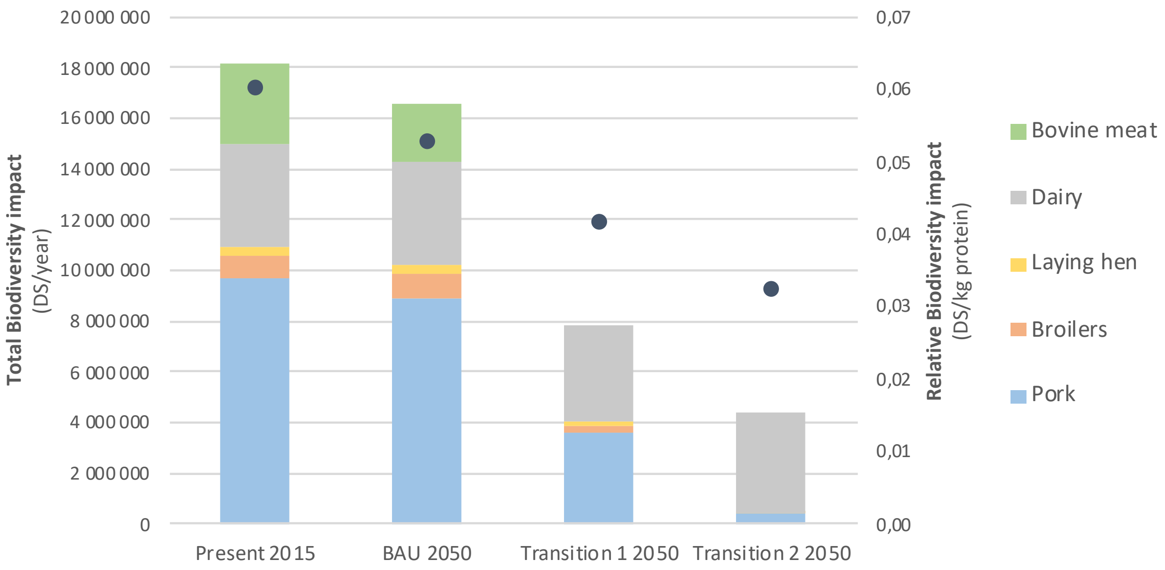
Based on the available data, the level of PPP use could not be characterised directly for each production system. Hence, the evolution of this indicator in the different scenarios was estimated based on the evolution of feed intake in each scenario, and in particular of the most PPP-intensive crops, i.e. cereals and forage maize. The share of organic systems was also taken into account (30% of the livestock population in T1 and 100% in T2) as the use of PPP is forbidden in such systems.

It appears that the use of PPP decreases in all three scenarios. BAU results in a 6% reduction compared to 2015; Transition 1 does so by 69% and finally, in Transition 2, the reduction is of 100% only organic systems are considered in this scenario.

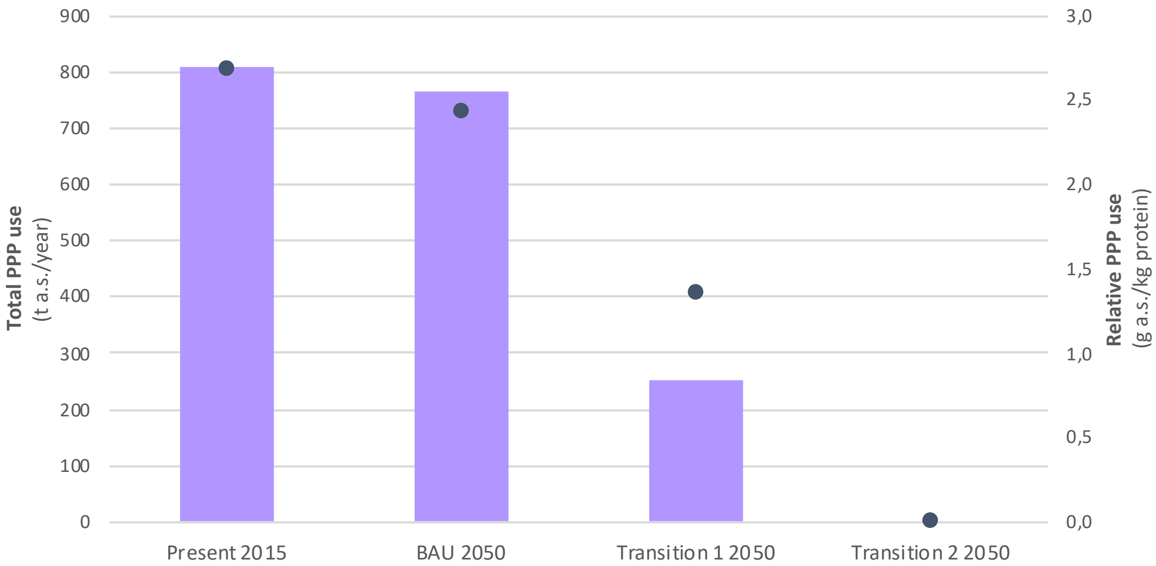
The same trend is observed when results are expressed in relative terms: Transition 2 results in the lowest emissions level (0 g a.s./kg protein), followed by Transition 1 (1,4 g a.s./kg protein) and finally by BAU which results in the highest relative emissions of all three scenarios (2,4 g a.s./kg protein) but remains lower than the emissions level in 2015 (2,7 g a.s./kg protein).

• **Total and relative (per kg of protein) Biodiversity impact of the Belgian livestock sector in 2015 and 2050 according to different scenarios**

In the transition scenarios, only a mixed 'dairy' herd is considered (which explains the absence of 'bovine meat' category for Transition 1 and Transition 2)



• **Total and relative (per kg of protein) livestock-related PPP use in Belgium in 2015 and 2050 according to different scenarios**



5.4. Combined results: consumption of animal protein and GHG emissions

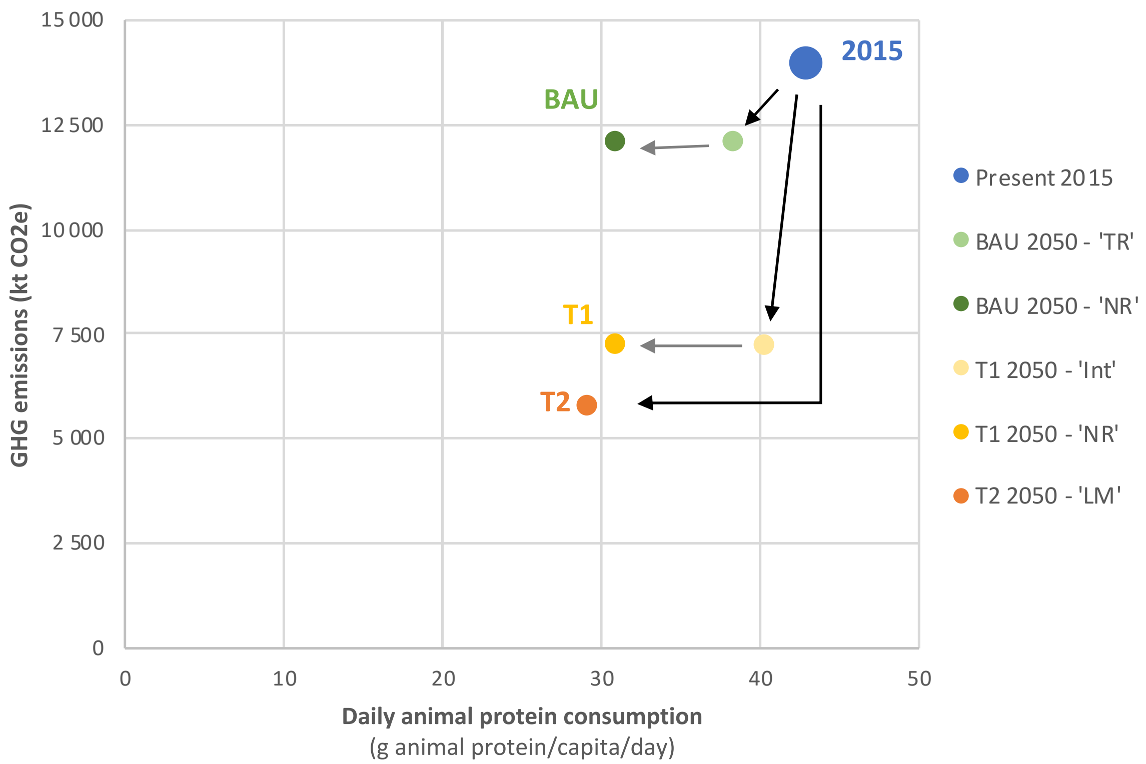
The highest animal protein consumption level is that of the present situation (2015). Nevertheless, the current consumption level exceeds the nutritional recommendations (see Section 2.1). Furthermore, this situation also comes with the highest GHG emissions.

In the BAU scenario, the GHG emissions decrease slightly compared to 2015 (-13%). In terms of protein intake, two consumption patterns were assessed. The ‘Nutritional recommendations’ pattern implies lower animal protein consumption than the ‘Trends’ pattern but implies a greater ‘excess’ production, which could potentially be exported.

Transition 1 results in greater GHG emissions reductions (-48% compared to 2015). The potential animal protein consumption level resulting from this scenario (‘Intermediate’ pattern) is very close to protein intake in 2015 but this situation comes with no excess production and hence no export potential. Analysing this scenario under the ‘Nutritional recommendations’ pattern does not modify its GHG emissions but lowers the consumption of animal products. As a result, a small share of the production exceeds the population needs and could thus potentially be exported.

Finally, Transition 2 results in the lowest GHG emission (-59% compared to 2015) and the lowest animal protein intake (‘Low-meat’ diet). In this situation, the entirety of the production must be consumed by the national population and there is no export potential. This situation would require an increased intake of vegetal-based protein sources, and could contribute to a better balance between animal and vegetal sources of protein. This could also be the case in the nutritional recommendations pattern.

• Potential animal protein consumption and total GHG emissions from the Belgian livestock sector in 2015 and 2050 according to different scenarios



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All details about the hypothesis and scenarios modelling are provided in the full report.

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