LIFE – DairyClim - September 2017
LIFE14 CCM/BE/001187

Survey on grasslands loss and proportion of grazed areas

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1 Introduction

The DairyCLIM Life Project is a European Life project started on 1.10.2015 for 48 months. The general aim of the project is the development of feeding strategies to decrease greenhouse gases emissions and the estimation of the carbon footprint of dairy farming in Belgium, Luxembourg and Denmark. In fact, agriculture is usually considered responsible for 14% of the production of greenhouse gases (GHG) as described in the report from FAO by Tubiello et al. (2014). Out of these, methane mainly produced by dairy cows represents 76% of total emissions. However, the particular digestive tract with the presence of the rumen allows the ruminants to convert forage even of poor quality into milk and meat. For that reason, cattle are important for the global production of protein and fat, especially in countries where climate is fit for a high proportion of grasslands. Thus, the objective of the Life Dairyclim project is to highlight the importance of grasslands in dairy farming as potential carbon sink contributing to the mitigation of GHG emissions from the agricultural sector. It aims also to increase grazing practice.

The role of grassland in climate change is important as they are generally considered contributing to GHG mitigation by playing a role of carbon sink (Soussana et al., 2010). The mitigation potential of grassland could be influenced by type of grassland, utilization including grazing intensity and rotational use of pastures. Furthermore, grazing has demonstrated several advantages as improving animal welfare (Burow et al., 2011), decreasing production costs (Dillon et al., 2005), preserving the landscape and the biodiversity (EAA, 2016) or having a good image on the consumer (De Olde et al., 2016).

It seemed thus useful as part of the project to survey the dairy sector of the three countries to get an overview of the dairy farms, the role of grassland and grazing practices, of the perceptions and of the expectations of the farmers about grazing. Before presenting the results of this survey, a short introduction based on statistic information will present data about grassland – and development in the areas in the three countries.

Grazing is decreasing in most of European countries. A survey about grazing practices was published during the Grass day about the "Future of Grazing" on 7/9/2014. The Table 1 shows the figures provided by the participating countries.

Table 1. Grazing practices in European countries (Grass day, EGF 2014, Aberyshtmith)

Country	Year reference	% of cattle grazing	Trend	Comments
Norway	2016	90 %	Slightly decreasing	n.a.
Sweden	2016	100 %	n.a.[1]	Welfare legislation – 6 weeks to 4 months outside
Finland	2016	70 %	n.a.	Cows in tie stalls have to be outdoors for 60 days between 1/5 till 30/9
Ireland	2016	95-100 %	Stable	n.a.
United Kingdom	2016	80-90 %	n.a.	95 % in Nothern Ireland 70% in Wales
The Netherlands	2014	70 %	n.a.	Premium to support grazing
Belgium	2016	60-85%; 90% in Wallonia	Decreasing in Flanders	n.a.
Luxembourg	2016	75%	Slightly decreasing	73% in 2014 – 75-85 % Free access in 2010
France	2016	75-95 %	90 % in 2014 – 90-95 % in 2011	n.a.
Switzerland	2016	80-97 %	75-90% in 2014 85-100 % in 2011	n.a.
Denmark	2016	25 %	Decreasing	25-30% in 2014 30-35 % in 2011
Germany	2016	10-50 %	Decreasing	42 % of dairy cows grazing in 2009
Austria	2016	40 %	Stable	25 % in 2011
Poland	2016	20 %	Quickly decreasing	n.a.
Estonia	2011	35 %	n.a.	n.a.
Lithuania	2014	50-70 %	n.a.	n.a.
Czech Republic	2016	3%	Deep decrease	20 % in 2010
Bosnia and Herzegovina	2011	5%	n.a.	n.a.
Slovenia	2016	20 %	Slightly decreasing	25 % in 2010
Hungary	2016	2-3 %	n.a.	Grazing dairy cows
Bulgaria	2016	50 % dairy cows	n.a.	Only in small farms

[1]n.a. : not applicable

2 Grassland development in the three countries

Belgium

As demonstrated on Figure 1, permanent grassland decreased by 16,5% in 2015. This decrease is compensated by an increase in temporary grassland. This shift in the recording of grassland is due to the reform of the common agricultural policy of 2014. This policy lead to 2 consequences: the registering of areas of grassland never registered before, to get access to financial help and the registering of permanent grasslands to temporary ones. This allows the farmers to get the opportunity to land them for a 5-years period. Actually, due to the "Greening policy" dated from 2014, it will be no longer allowed to crop pastures considered as permanent and after a delay of 5 years a percentage of temporary grasslands would be automatically assigned as permanent depending on the total declared pasture area. As a consequence, this decrease in permanent grasslands is expected to get regulated in the next years.

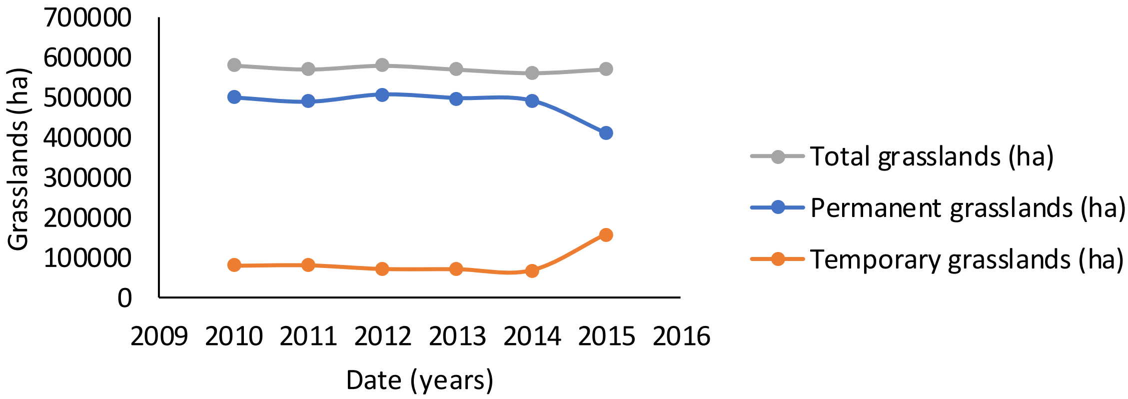

Figure 1. Evolution of surfaces devoted to grassland in Belgium

Denmark

The land use in Denmark is very different with a larger proportion of grassland areas registered as temporary grasslands. Figure 2 gives areas of permanent and temporary grassland since 1980. The comparison between the long and short development gives very different situations, with slow decrease in permanent grassland at the long perspective, but a large increase looking only on the data from 2011 to 2016. The change in proportion between the two types of grassland in the statistical data is not in line with the actual status of the grassland, but rather a matter of how data are treated and how the relation is between type of crop and environmental restrictions and/or possibilities for economic subsidies. Therefore, a more realistic figure for grassland development is the total area with grassland, which in Denmark since 1980 has been around 500,000 ha or 20% of the total farm area.

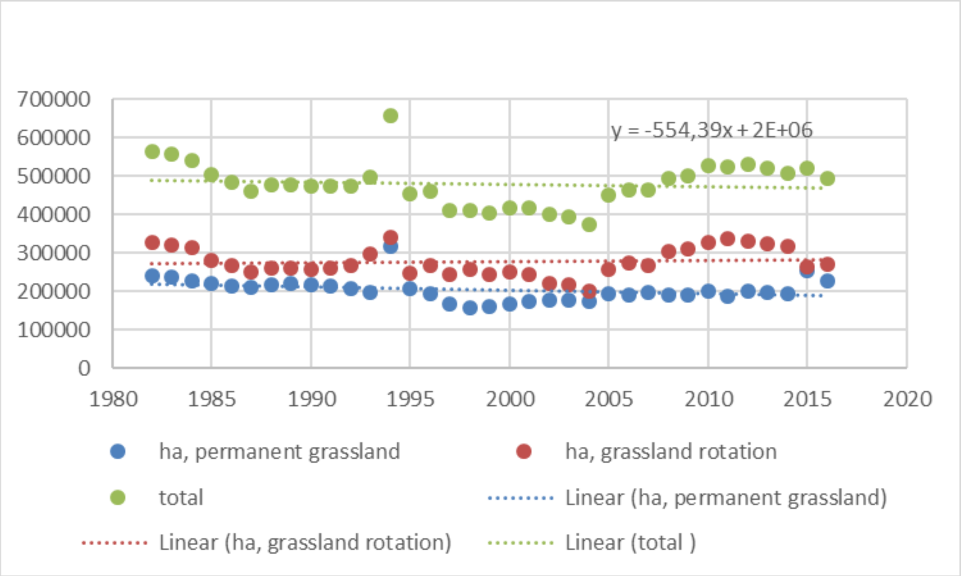

Figure 2. Evolution of surfaces devoted to grassland in Denmark.

Luxembourg

In Luxembourg, few changes in permanent and temporary grassland areas are noticed. The decrease in temporary grassland areas corresponds to an increase in permanent grassland (Figure 3). It highlights the efficiency of Luxembourg policies for grassland conservation.

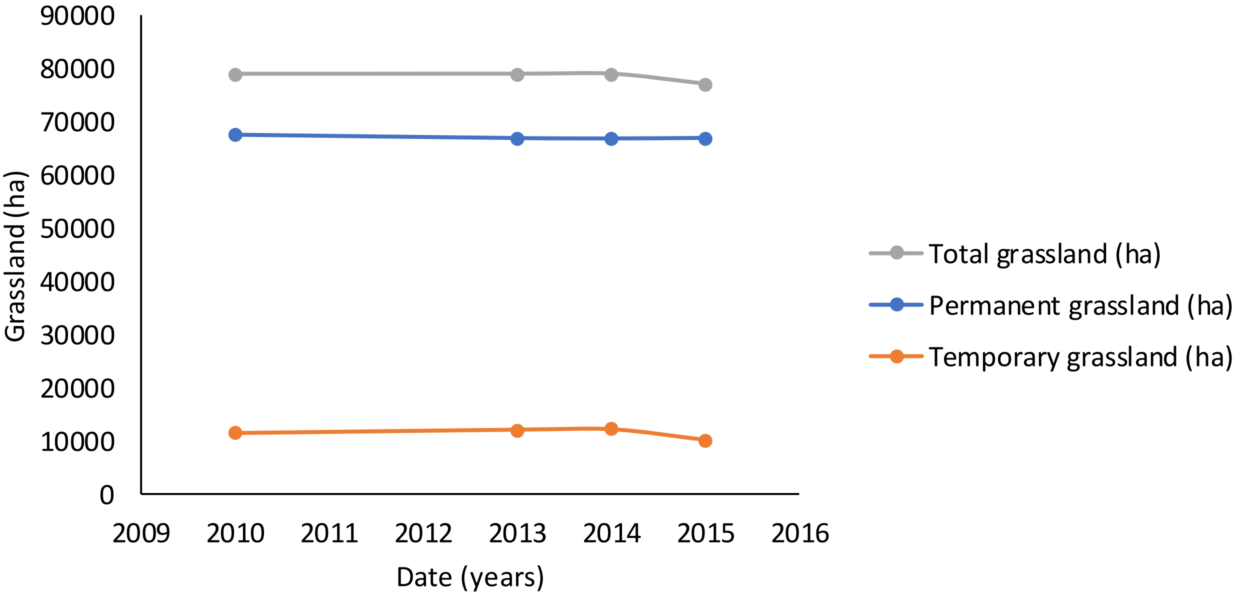

Figure 3. Evolution of surfaces devoted to grassland in Luxembourg

3 Grassland practices

3.1 Materials & Methods

Eighteen questions about grazing were formulated focusing on the description of the farm, of grazing practices and of perceptions and expectations of farmers. In Belgium, hard copies of questionnaires were sent to the Walloon dairy producers by the "Comité du Lait" on 10 December 2015. Questionnaires and information about the survey and the project were also disseminated in conferences for dairy farmers and by the internet. The questionnaires received after 31 March 2016 were not taken into consideration.

In parallel, the survey was available on the website of the project. The Luxembourg team expected the farmers to fill in the form through this way. However, many farmers from Luxembourg expressed the desire to be accompanied by an advisor. Thus, the decision was taken at the end of January 2016 to provide the CONVIS advisors from the milk control service with hard copies during a 6 weeks period so that they could ask the farmers personally to participate at the survey. Finally, 62 completed forms were received at the end of March 2016.

In Denmark, a mail with a short introduction and a link to questionnaire was sent – by ARLA coop Denmark - to 2550 dairy farmers delivering milk to ARLA Denmark, representing 80% of all the dairy farmers in Denmark.

3.1.1 Statistical analysis

The statistical analyses were performed using SAS (SAS Institute, 2002). Descriptive procedures were used (proc univariate – proc means) for the analysis of numeric values. The proc freq statement was used for the analysis of the categorical variables. Chi-square test and Fisher- test were used to test equality of proportions. Cell chi-square allowed to determine the importance of the participation of each cell to the global F-value. On data about permanent and temporary grasslands, after descriptive analysis by proc univariate and proc means, further analysis was performed using a GLM procedure, for surface, production, use of organic and mineral fertilizer, testing differences between countries, lands, systems and interactions between these factors.

3.2 Results

The number of received filled forms per country is presented in Table 1. The mean response rate has reached 23.9%. From this total, some questionnaires presenting obvious mistakes or an insufficient rate of answers were not considered.

A total of 1439 filled forms was thus analysed. A global analysis was firstly undertaken then each country presented a more specific report.

Table 2. Number of questionnaires sent, collected and estimation of answer rates per country and in total.

Country	Sent forms	Filled forms	Used forms	Answer rate
Wallonia	3152	1016	1004	32,2 %
Denmark	2550	386	375	15,1 %
Luxembourg	430	62	60	14,4 %
Total	6132	1464	1439	23,9 %

3.2.1 Overview of the farms from the three countries

The first question of the questionnaire required the farmers to specify their system of exploitation. Out of the 1439 collected forms, 16 did not mention the exploitation type (1%).

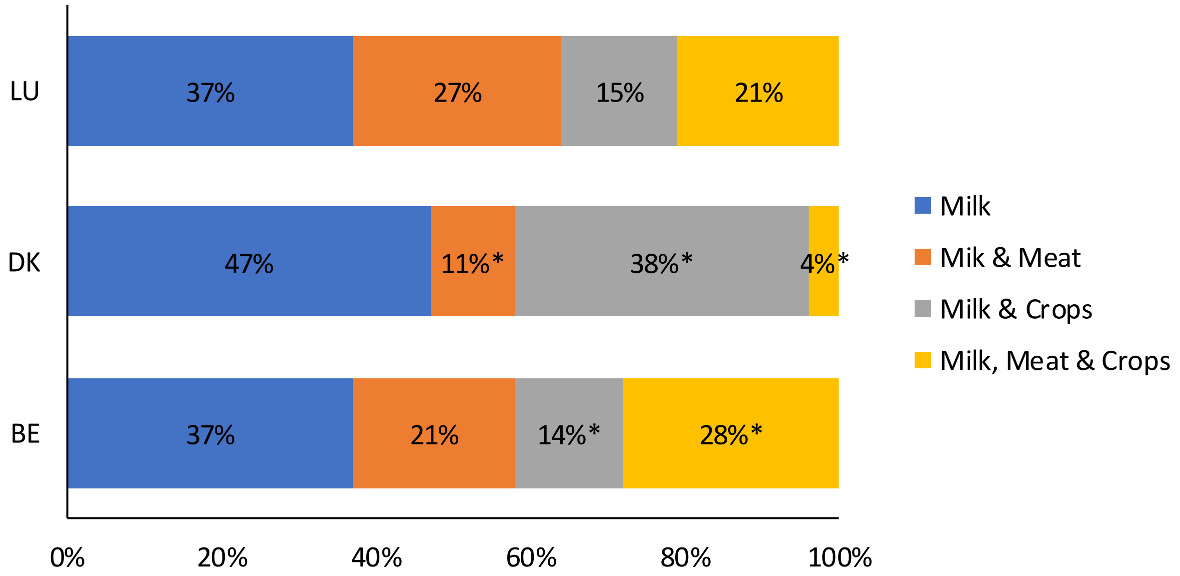

Figure 4. Activities in the dairy farms from each country. Statistical differences (p<0,05) are highlighted by "*". *BE is Belgium. DK is Denmark. LU is Luxembourg*

Not surprisingly, the more represented was the conventional system (1287 forms – 89%) while 136 organic farms were recorded (9,6%). Belgium and Denmark presented a similar proportion of organic farming reaching around 10% (BE: 9,2% - DK: 11%). In Luxembourg, only 3 farms were included in organic system (3%) but it must be assumed that 2 other farms did not answer the question. Thirty – nine % of farms were specialized in milk production (Figure 4). Belgian farms had more diversified activities (milk, meat &crops; p<0,05) (Figure 4).

In only 17% of the forms, the presence of 2 or more people on the farm was indicated. The most frequently the second worker was between 30-40 years old (42%), 33% of the answers indicated a second worker aged of less than 30 years.

The majority of surveyed people (42%) was 50-60 years old, confirming the aging of the farmer community. Young people (<30 y) were less than 12% while people over 60 years represented still 15%. The distribution of the age of farmers did not differ between the countries (Figure 5).

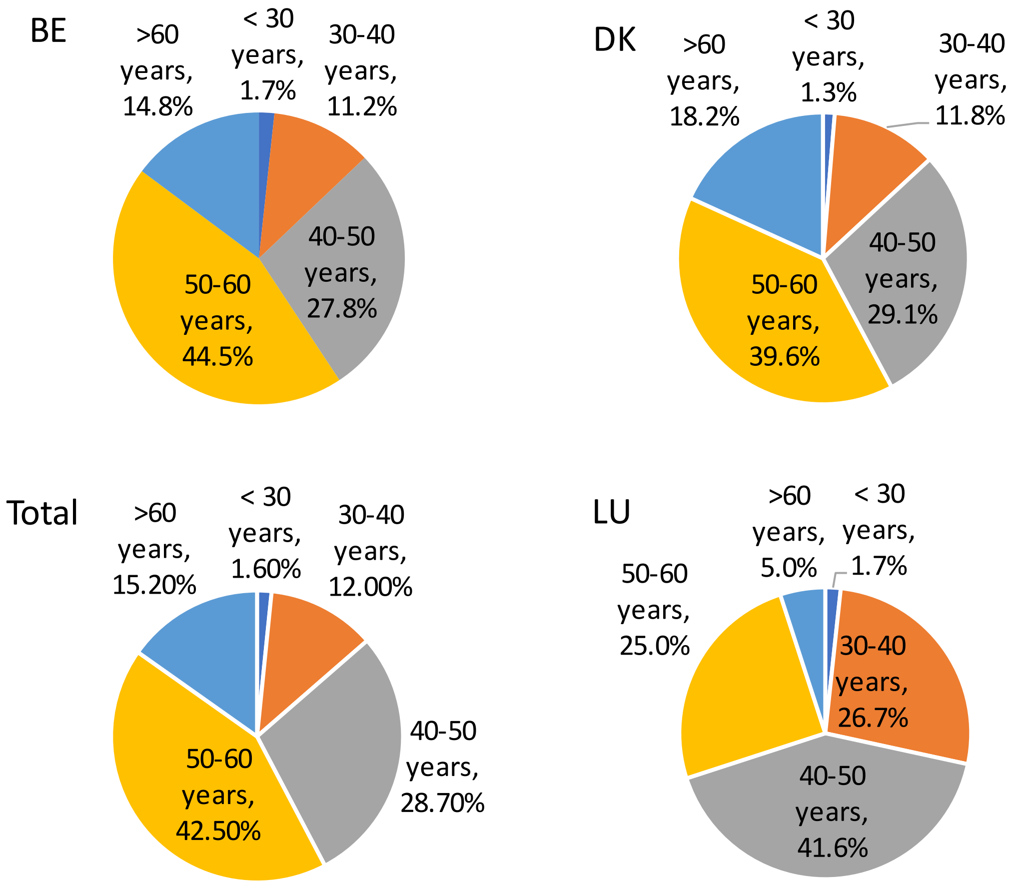

Figure 5. Age of the main manager of the farm: figures from the compiled dataset and from each country. BE is Belgium. DK is Denmark. LU is Luxembourg.

The figures of the compiled dataset described the standard farm from the 3 countries as exploiting agricultural area less than 100 ha (61%), with less than 100 cows (71%) producing less than 8000 L/y (53%) (Figures 6 and 7). For 83 % of the farms the annual milk yield could be estimated between less than 6000 L and <10000 L/y (Figure 8). Highest performance remained exceptional (5,6% of farmers with more than 250 ha, 5% with more than 250 cows and 2% with an annual milk yield over 12000 L/y).

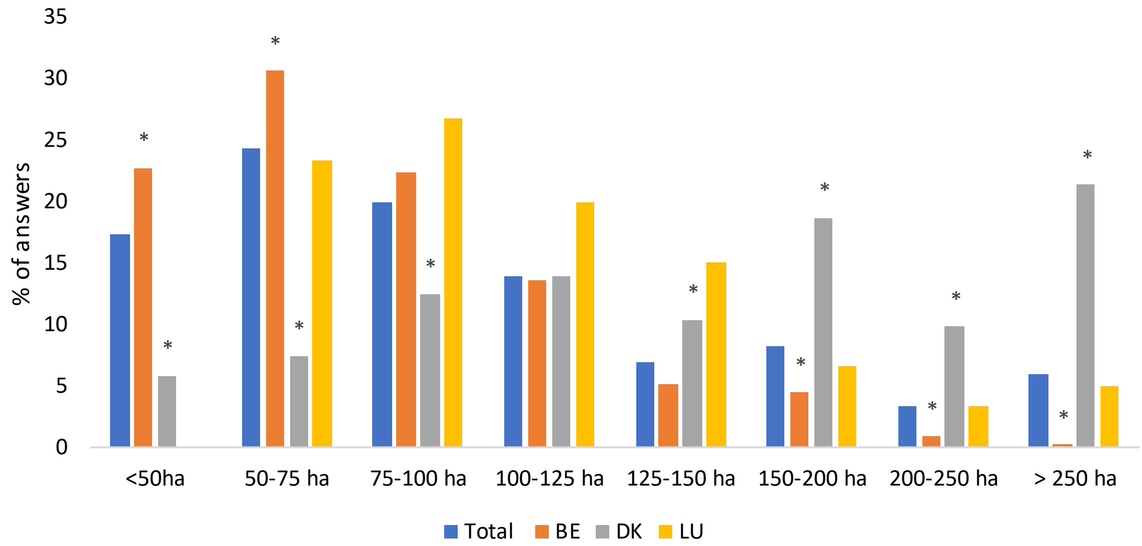

Figure 6. Surfaces of the dairy farms from each country and comparison with the compiled dataset. Statistical differences (p<0,05) are highlighted by "". BE is Belgium. DK is Denmark. LU is Luxembourg.*

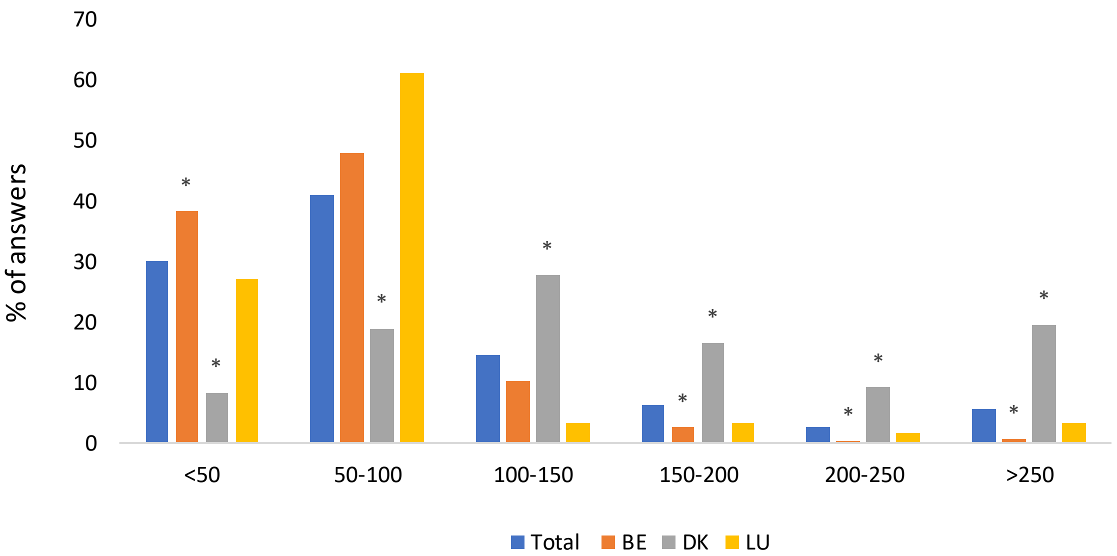

Figure 7. Number of dairy cows per farm in each country and comparison with the compiled dataset. Statistical differences (p<0,05) are highlighted by "". BE is Belgium. DK is Denmark. LU is Luxembourg.*

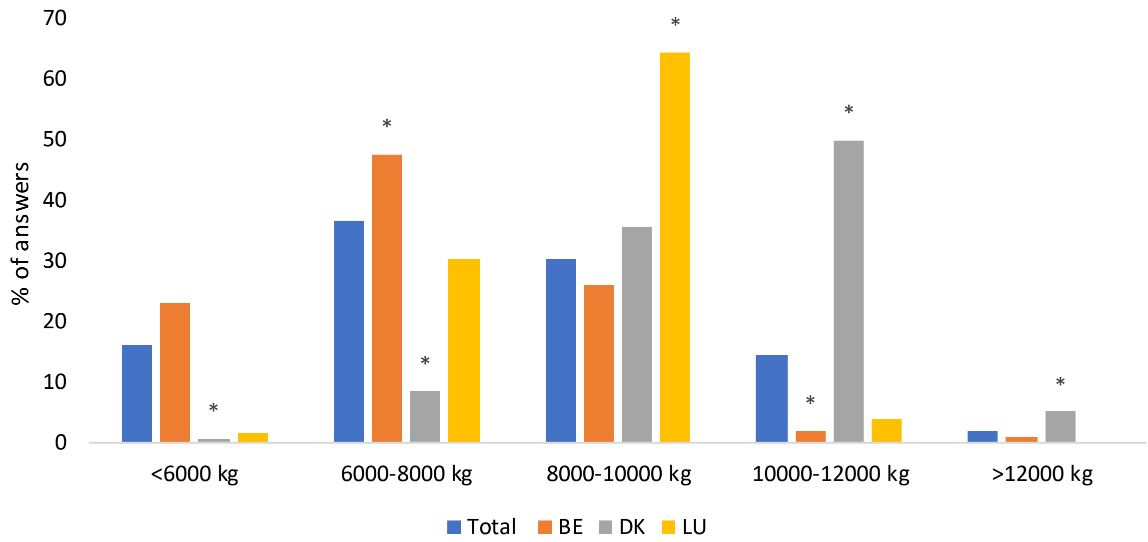

Figure 8. Average annual milk yield per cow and per farm in each country and comparison with the compiled dataset. Statistical differences (p<0,05) are highlighted with an "". BE is Belgium. DK is Denmark. LU is Luxembourg.*

From more specific analysis of the data, it appears that Denmark and Belgium farms differed from each other in farm size regarding the surface and the number of lactating cows. Due to the low number of answers Luxembourg data did not reach often the significant level of statistics (Figure 6-7).

The Danish average milk yield was superior to these from the 2 other countries. It must be noticed the high percentage of Luxembourg farms recording an average milk yield ranging between 8000 -10000 kg superior to the percentage demonstrated in Belgium and Denmark (Figure 8).

Description of grazing practices for lactating cows

Access to pastures was provided to young stock (63%), heifers (89%), lactating cows (80%) and dried cows (77%).

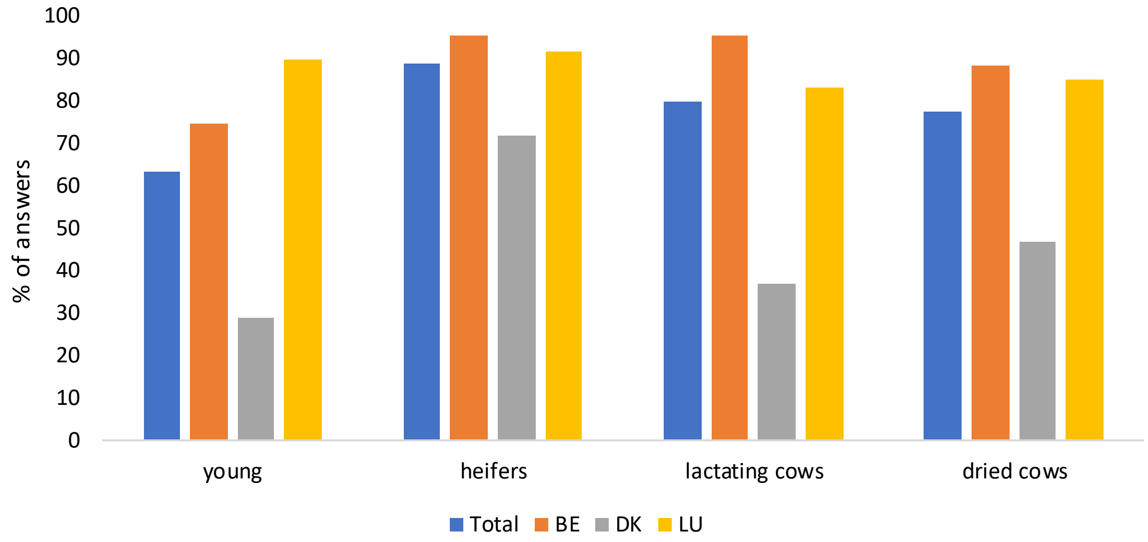

Figure 9. Dairy cattle having access to pastures: percentage of each category in the compiled dataset and in each country. BE is Belgium. DK is Denmark. LU is Luxembourg.

From all the received filled forms, 1147 declared to let lactating cows grazing (80%). These forms were further analysed to give a description of grazing practices. The proportion of grazing cows was significant lower in Denmark compared with the other countries.

Information from grazing farms

Results from farms that actually used grazing showed that the grazing period lasted for 4 months or more in 95% of forms. No major difference appeared between countries but more Danish farms grazed for 2-4 months (11%; p<0,05).

Dairy cows grazed day/night for 66%, during the day for 29% and only a few hours per day for 5%. Danish farms showed lower proportion of day/night grazing: only 29% kept cows outside during the night (p<0,05). Grazing during only the daytime was reported in 63% of Danish farms (p<0,05) and 52% of Luxembourg farms (p<0,1). Proportion of Luxembourg farms grazing only a few hours a day tended to be more important (14%; p<0,1). The area available for grazing was 21,2 ± 18,5 ha (n=1086; median =16 ha, min: 0,6 ha, max: 200 ha). In organic farms, the surface allocated for grazing was larger: 18,8 ± 14,0 ha (n=127; median =15 ha, min: 0,9 ha, max: 95 ha) while in conventional farms the grazed surface was 21,2 ± 18,5 ha (n=1086; median =16 ha, min: 0,6 ha, max: 200 ha). The grazeable area for lactating cows was in Belgium 19,8 ± 14,3 ha (n = 902; min = 0,9; max= 77 ha), in Denmark 32,9 ± 34,0 ha (n = 136; min = 2; max = 200 ha) and in Luxembourg 14,2 ± 8,5 ha (n = 48; min = 1; max = 33 ha).

Complementation was supplied in permanence to the cows for 74% of farmers, most of the time for 12%, sometimes for 11% and never for 2%. The complementing feed was concentrates (64%), grass silage (61%), maize silage (31%), cereals (28%), hay (25%) and other (19%). More than one component was reported frequently: 2 components (26%), 3 components (28%), 4 components (17%), more than 4 (7%).

However, 40% of the farmers estimated that grazed grass represented more than 50% of the diet during the summer. No significant difference appeared following the countries. However, Danish farmers were more numerous to give to the dairy cows a diet including less than 25% of grazed grass in summer (31% vs 15% following the compiled dataset; p<0, 1). During the winter, 49% considered that grass reached more than 50% of the ration (for 30%, percentage of grass = 50-75% - for 19% grass was more than 75%).

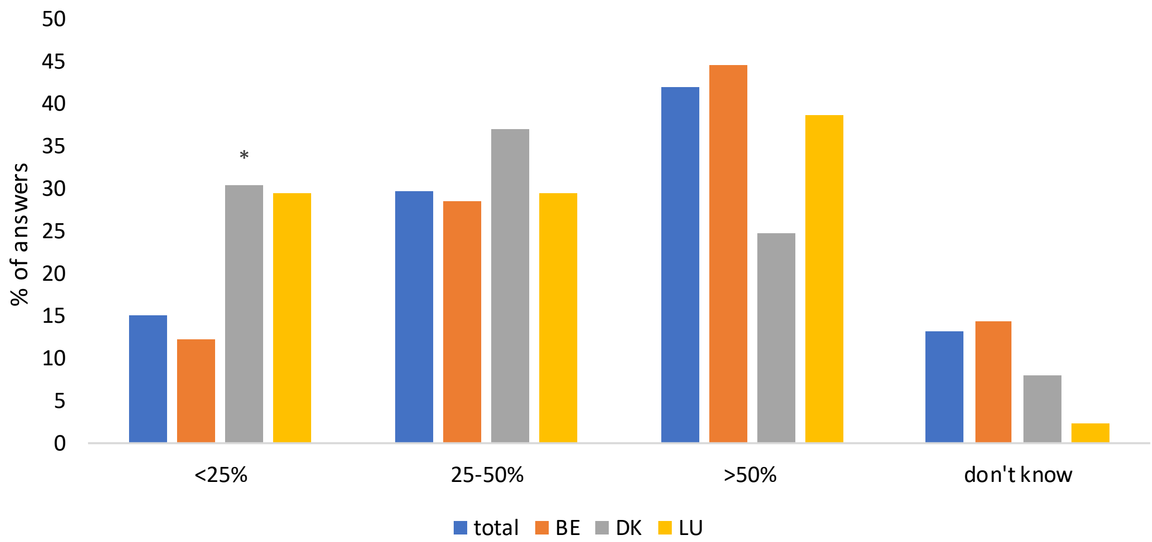

Figure 10. Proportion of grazed grass in cows' diet during the summer: differences between the countries and comparison with the compiled dataset. Statistical differences (p<0,05) are highlighted by „". BE is Belgium. DK is Denmark. LU is Luxembourg.*

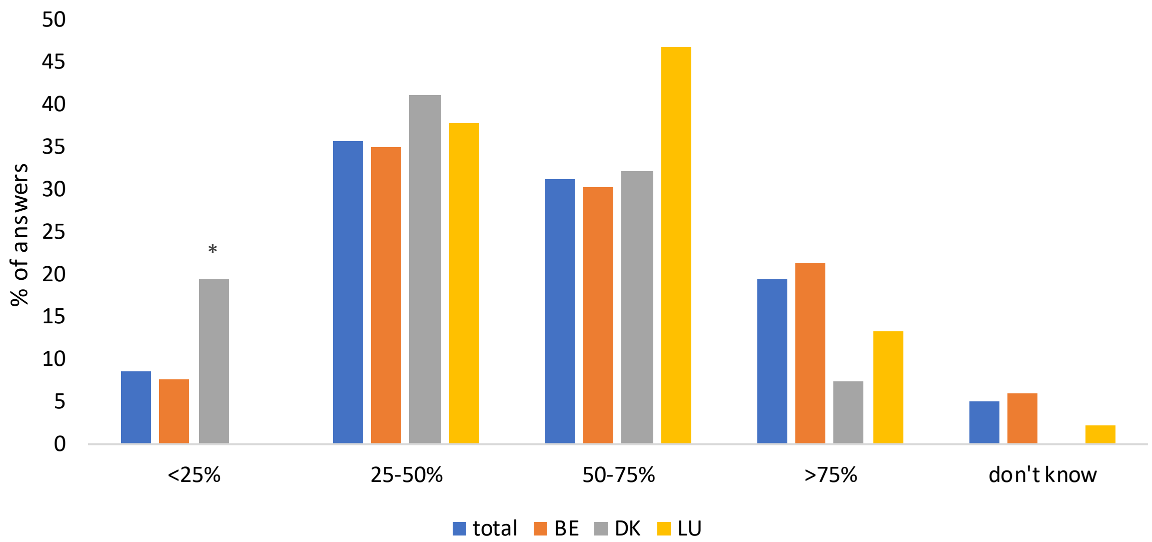

Figure 11. Proportion of grazed grass in cows' diet during the winter: differences between the countries and comparison with the compiled dataset. Statistical differences (p<0,05) are highlighted by „“. BE is Belgium. DK is Denmark. LU is Luxembourg.*

3.2.2 Permanent and temporary grasslands

The questionnaire aimed, also, to collect figures about permanent and temporary grasslands to estimate the relative importance of surfaces and to get information about their use and management. A sort was made to take into account only the forms including figures about surface different from nihil.

Temporary grassland

The Table 2 gives an overview of the figures describing the management of temporary grasslands in the 3 countries (compiled dataset) and for each country respectively. Figure 12 provides information about the use of the temporary grasslands (silage, hay, grazing for dairy cows and heifers). No used areas had to be mentioned too. It has to be noted that some figures about mineral fertilizer used on temporary grassland (e.g the maximum value of 1300) reflected some misunderstanding of the question. These weird values were very limited.

Table 3. Temporary grassland; overview of figures from the compiled dataset and from each country.

	Mean ±SD[1] (n[6])			
	All countries	BE[3]	DK[4]	LU[5]
Surface (ha)	35,6 ± 46,3 (831)	16,6 ± 21,3 (427)	58,3 ± 57,5 ha (371)	26,0 ± 22,0 (33)
Estimated production (t DM[2]/ha)	10,4 ± 5,6 (447)	11,3 ± 3,6 (81)	9,9 ± 2,9 (355)	9,1 ± 2,4 (11)
Cuts (/grazing. season)	3,4 ± 1,3 (635)	3,1 ± 1,3 (402)	3,9 ± 1,2 (201)	3,6 ± 0,8 (32)
Organic fertilizer (t/ha)	35,2 ± 22,9 (684)	29,0 ± 17,6 (324)	41,7 ± 26,0 (335)	28,4 ± 11,9 (25)
Mineral fertilizer (kg N/ha)	150,0 ± 161 (660)	172,0 ± 196 (323)	124,9 ± 116 (312)	178,0 ± 101 (25)

[1]SD: standard deviation; [2]DM: dry matter; [3]BE: Belgium; [4]DK: Denmark; [5]LU: Luxembourg; [6]n: number of samples

The use of the temporary grasslands in the compiled data set and for each country is presented in Figure 12. From those figures, it seems that arable grasslands were mainly valued as silage.

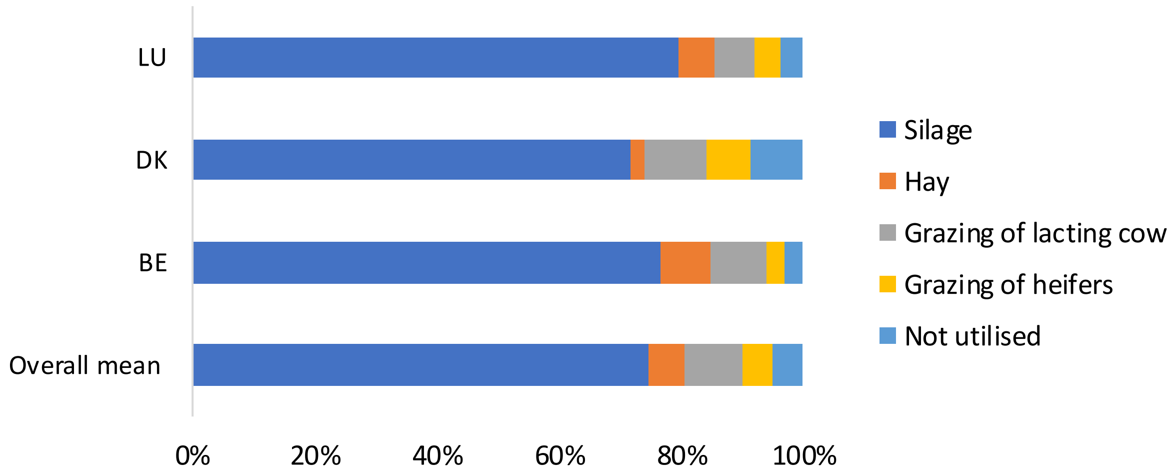

Figure 12. Use of temporary grasslands: values from the compiled dataset and of each country. BE is Belgium. DK is Denmark. LU is Luxembourg.

Permanent grassland

General overview on the main characteristics of permanent grasslands is given in Table 3. The use of these surfaces is described in Figure 13. From these figures, it seems that these were mainly allocated to grazing of dairy cows and heifers.

Table 4. Permanent grass; overview of figures from the compiled dataset and from each country.

	Mean ±SD[1] (n[6])			
	All countries	BE[3]	DK[4]	LU[5]
Surface (ha)	38,4 ± 32,6 (1242)	45,3 ± 28,8 (883)	14,7 ± 17,1 (308)	61,2 ± 71,0 (51)
Estimated production (t DM[2]/ha)	5,7 ± 4,7 (395)	10,2 ± 5,7 (105)	3,9 ± 2,7 (278)	7,7 ± 2,4 (12)
Cuts (/grazing season)	1,9 ± 1,7 (1124)	2,3 ± 1,6 (829)	0,4 ± 1,0 (252)	3,3 ± 1,1 (43)
Organic fertilizer (t/ha)	22,7 ± 30,4 (825)	27,3 ± 33,1 (599)	6,5 ± 14,3 (184)	28,5 ± 10,1 (42)
Mineral fertilizer (kg N/ha)	126 ± 160 (889)	149,2 ± 175,1 (626)	56,2 ± 84,5 (254)	164,0 ± 114 (38)

[1]SD: standard deviation; [2]DM: dry matter; [3]BE: Belgium; [4]DK: Denmark; [5]LU: Luxembourg; [6]n: number of samples

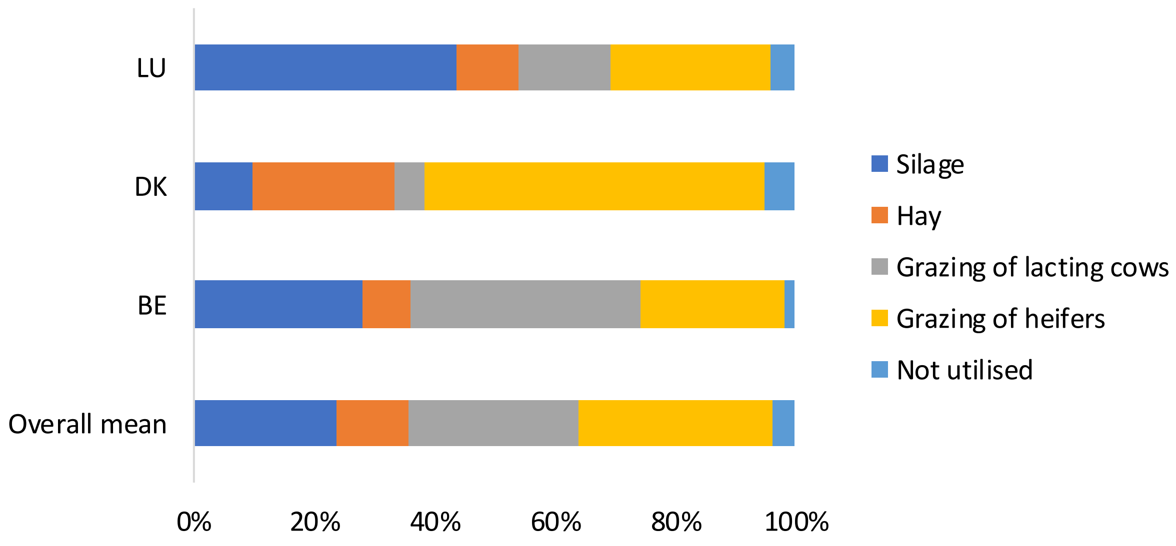

Figure 13. Use of permanent grasslands: values from the compiled dataset and of each country. BE is Belgium. DK is Denmark. LU is Luxembourg.

Comparison of temporary and permanent grasslands

Considering the compiled dataset, the areas of permanent (PG) and temporary grasslands (TG) are similar (PT: 35,6 ± 46,3 ha; PG: 38,4 ± 32,2 ha). However, Danish farmers registered a higher surface of temporary grasslands (58,3 ± 57,5 ha) even greater when organic farms were distinguished (130,6 ± 83,9 ha). In Luxembourg and in Belgium, mean surface of permanent grasslands was higher than 45 ha while Danish figures mentioned mean PG area of 14,7 ± 17,1 ha.

Provided data on production were statistically lower in permanent grasslands compared with temporary ones. This difference was particularly apparent in Danish data (PG:3,68 t DM/ha vs TG: 8,58 t DM/ha; p<0,001). The difference was observed whatever the studied system (conventional farms:4 t DM/ha vs 3,37 t DM/ha in organic; ns).

Regarding fertilization, the use of organic fertilizer was the same in Luxembourg and Belgium whatever the type of grasslands. No significant difference between these 2 countries could be observed. On the contrary, the use of organic and mineral fertilizers was less intense in Denmark on permanent grasslands while organic fertilizer on temporary grassland of Denmark was higher compared with the 2 other countries.

Comparison of grazing farms with no-grazing ones

The comparison was made on 1421 filled questionnaires (1141 from conventional farms – 280 from organic ones). No organic farm was no grazing. The same proportion between grazing and no grazing of farms specialized in dairy production was determined in grazing and no grazing farms. However, the agricultural surface and the number of cows were larger in no grazing farms with higher proportion of farms of more than 150 ha and of more than 100 dairy cows. The percentage of milk yield over 10000 kg per cow per year was also increased in no grazing farms. On the other hand, zero grazing farms were more interested in crops + dairy production (36% of the no grazing vs 16% of grazing farms; p<0,05).

Figure 14. Activities developed on farms following the grazing practices. Statistical differences (p<0,05) are highlighted by "".*

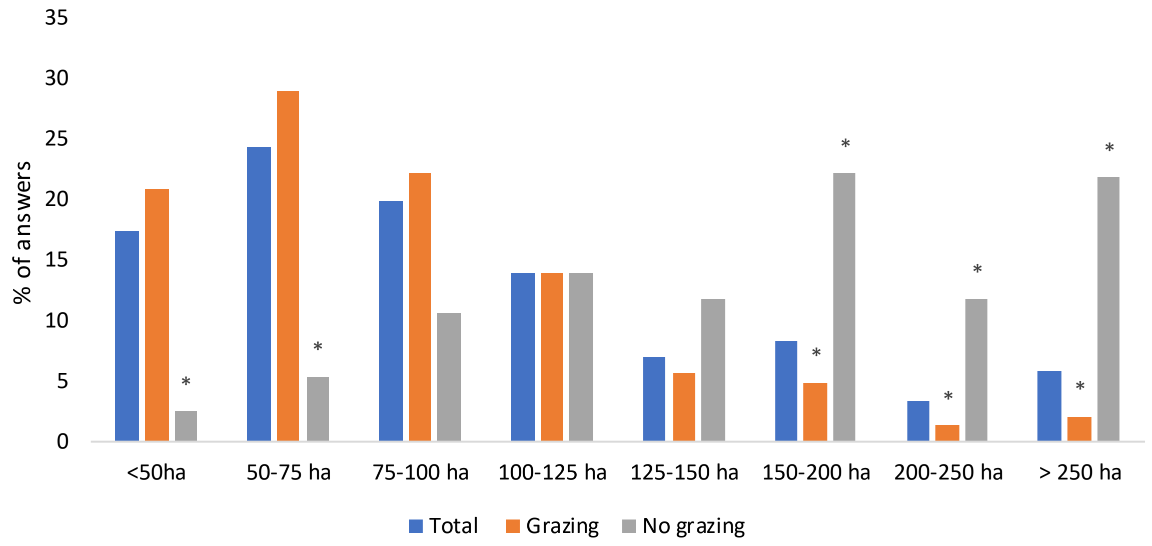

Figure 15. Effect of surface of farms on grazing practice. Statistical differences (p<0,05) are highlighted by "".*

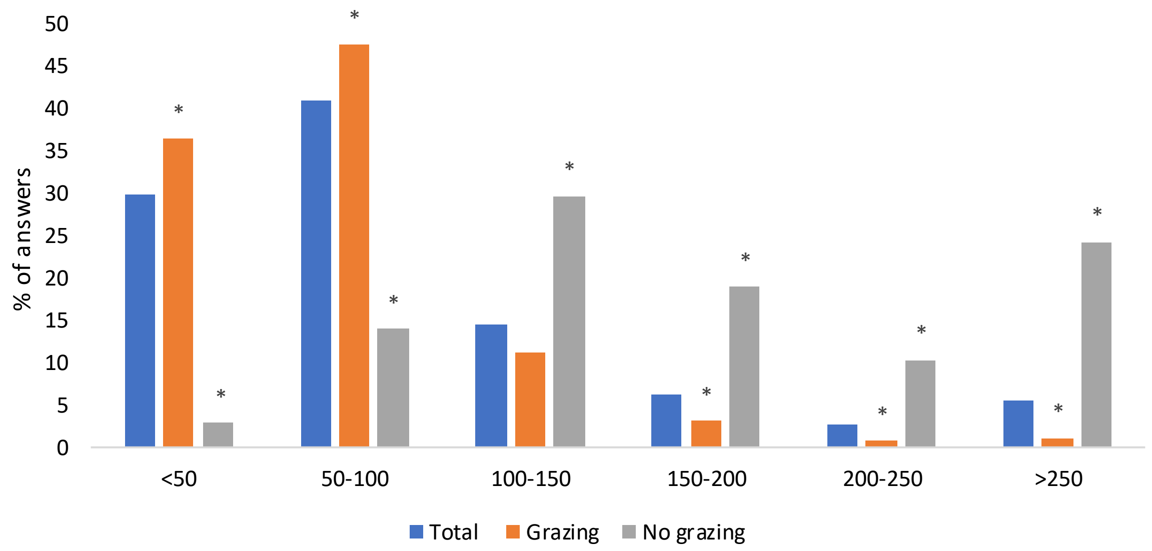

Figure 16. Effect of the number of dairy cows on grazing practices. Statistical differences (p<0,05) are highlighted by ""*

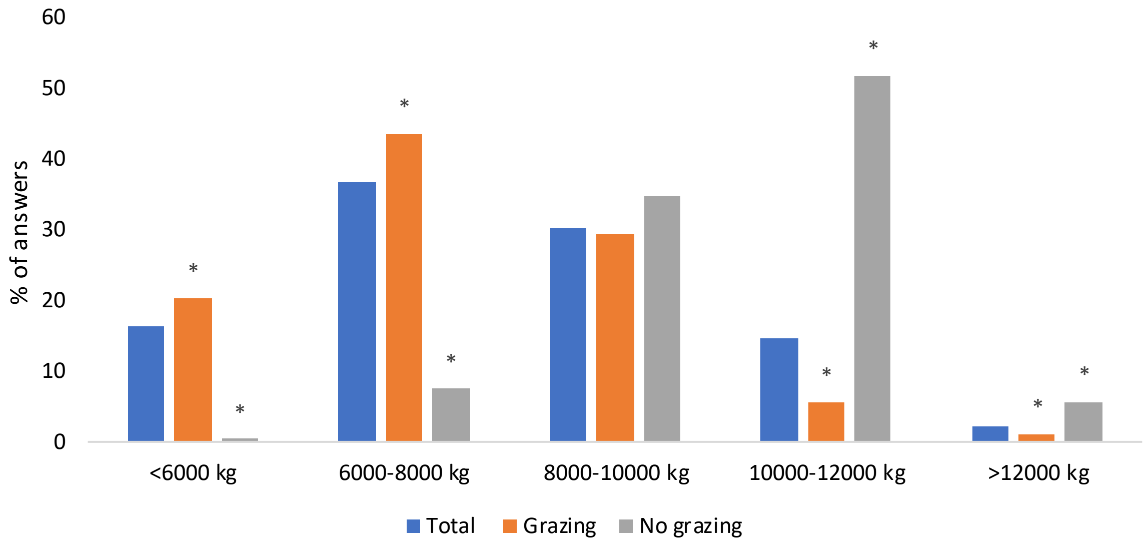

Figure 17. Average annual milk yield following grazing practices. Statistical differences (p<0,05) are highlighted by ""*

3.2.3 Opinions about grazing

In the questionnaire, a first set of questions addressed all the surveyed people while the second one was more specific for grazing exploitations.

Despite no question in relationship with their well-being was present in the questionnaire, the feeling of malaise of dairy farmers was perceptible as some Luxembourg and Walloon farmers used this means to talk about their worries and difficulties.

Opinions about the potential benefits of grazing were asked regarding production costs (Figure 18), animal welfare (Figure 19), landscape preservation (Figure 20) and environment (Figure 21). Farmers had to indicate whether they find the assertion correct, false or had no opinion about it. Results from the combined dataset and country by country are presented. Statistical differences are highlighted. Danish farmers were the more critical about grazing. Only landscape preservation was recognized as a benefit of grazing.

Positive effect on environment was the less cited one (61,3%). Moreover, grazing was considered as negative for environment in 16,6%. This high percentage is due to the very negative opinion of Danish farmers. 42,2% of Danish farmers considered that grazing had a negative effect on environment.

The opinion about benefits of grazing was largely dependent on the grazing practices of the farms. Grazing farmers were very convinced about beneficial effects of grazing on animal welfare (95,4%) and on landscape preservation (86,1%). Around 80% estimated that grazing decreased production costs. Effect on environment was less cited: only 72% of grazing farmers thought that grazing could preserve or improve environment and 20% had no opinion on this topic. Around 70% of no grazing farmers thought that grazing could affect production costs and preserve landscape. For them the effect on animal welfare was not positive or dubious (no opinion) (67% of answers). Regarding impact on environment, only 16,5% thought it could be beneficial. Moreover, more than 50% considered that the influence of grazing was negative on the environment.

- **Does grazing decrease production costs?**

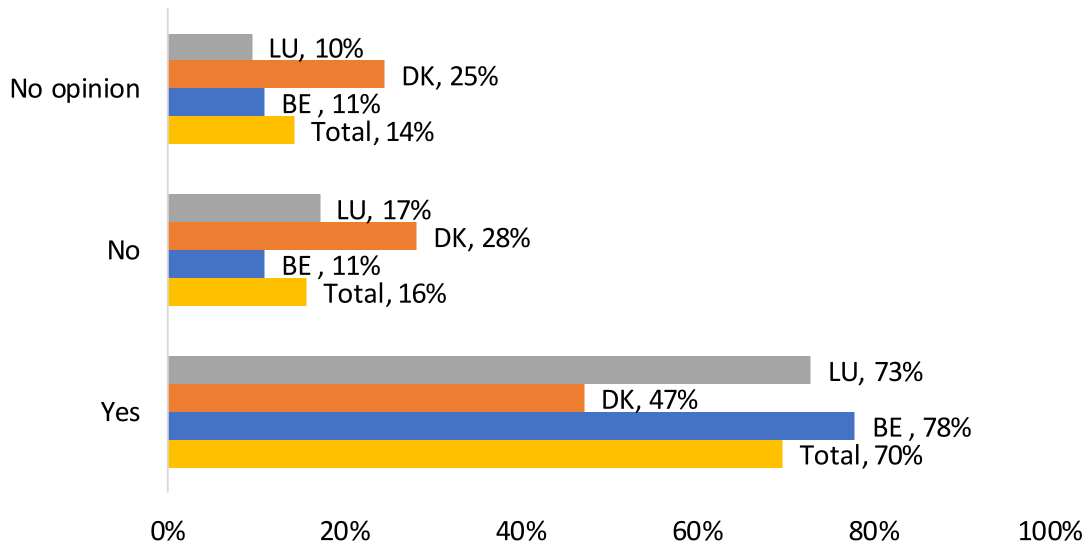

Figure 18. Opinion about influence of grazing on production costs. BE: Belgium; DK: Denmark; LU: Luxembourg.

- **Does grazing favour animal welfare?**

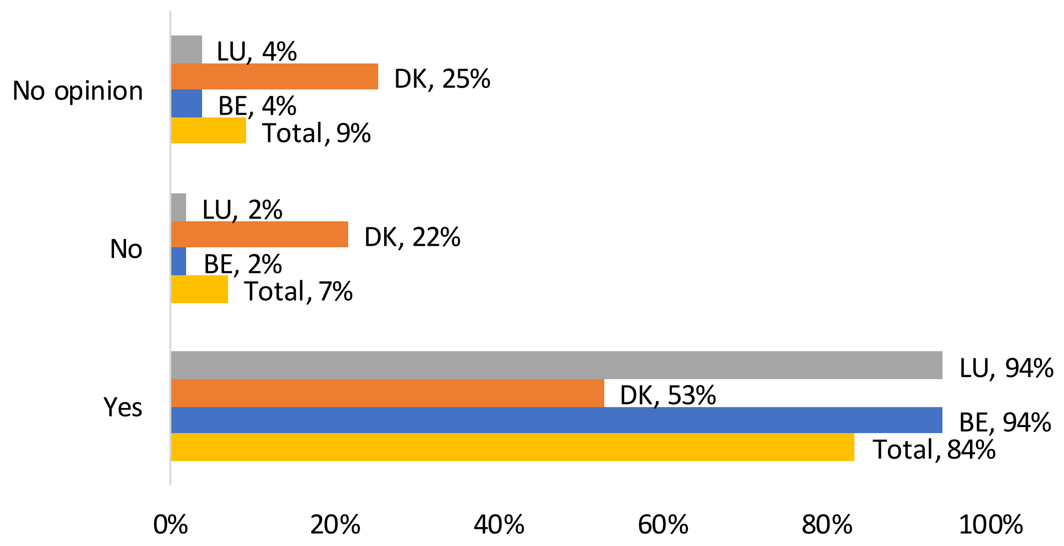

Figure 19. Opinion about influence of grazing on animal welfare. BE: Belgium; DK: Denmark; LU: Luxembourg.

- **Is grazing positive for the landscape?**

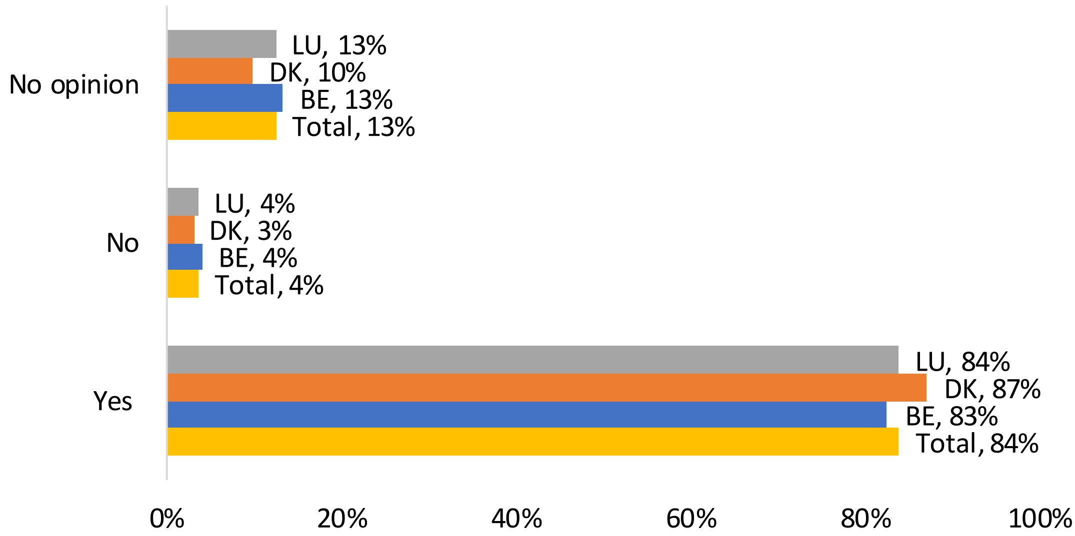

Figure 20. Opinion about influence of grazing on landscape. BE: Belgium; DK: Denmark; LU: Luxembourg.

- **Is grazing positive for the environment?**

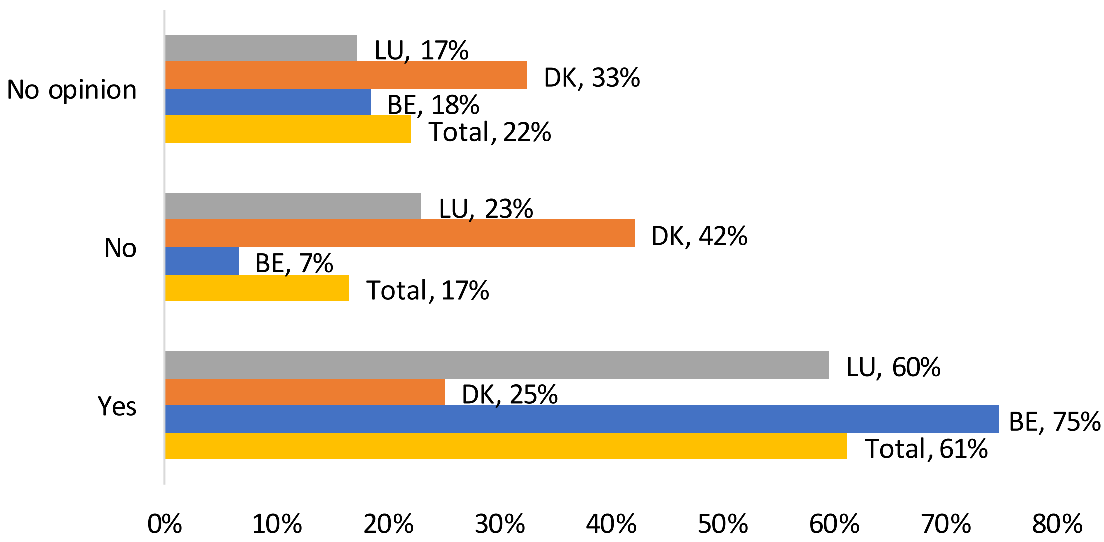

Figure 21. Opinion about influence of grazing on environment. BE: Belgium; DK: Denmark; LU: Luxembourg.

Reasons for stopping grazing

This set of questions addressed farmers with no-grazing dairy cows for a total of 280 questionnaires. It represented 35 forms from Belgium (12,5%), 236 from Denmark (84,3%) and 9 forms from Luxembourg (3,2%).

Seven choices were proposed (Figure 22). Answers were given by conventional farms (n =279) and one exploitation undetermined. Only 7,4% of addressed farmers did not provide at least one answer.

Only 20% of farmers gave only one factor explaining their choice so that the proposed factors were combined. Factors linked to environment (climate and/or soil) represented 20%, those in relationship with the management (management and/or pastures far and/or limited pastures available) 70% and those in relation with the economic factors (decrease in milk yield) 70%. The importance of the related factors differed between the countries: Belgian farmers highlighted the difficulties in management (27/35) and economic factors (26/35), climatic reasons were given in 9/35 of answers. For Danish farmers, climatic reasons were more represented (98/236). In Luxembourg, difficulties in management were reported in 8/9 questionnaires. No relation with climate conditions appeared.

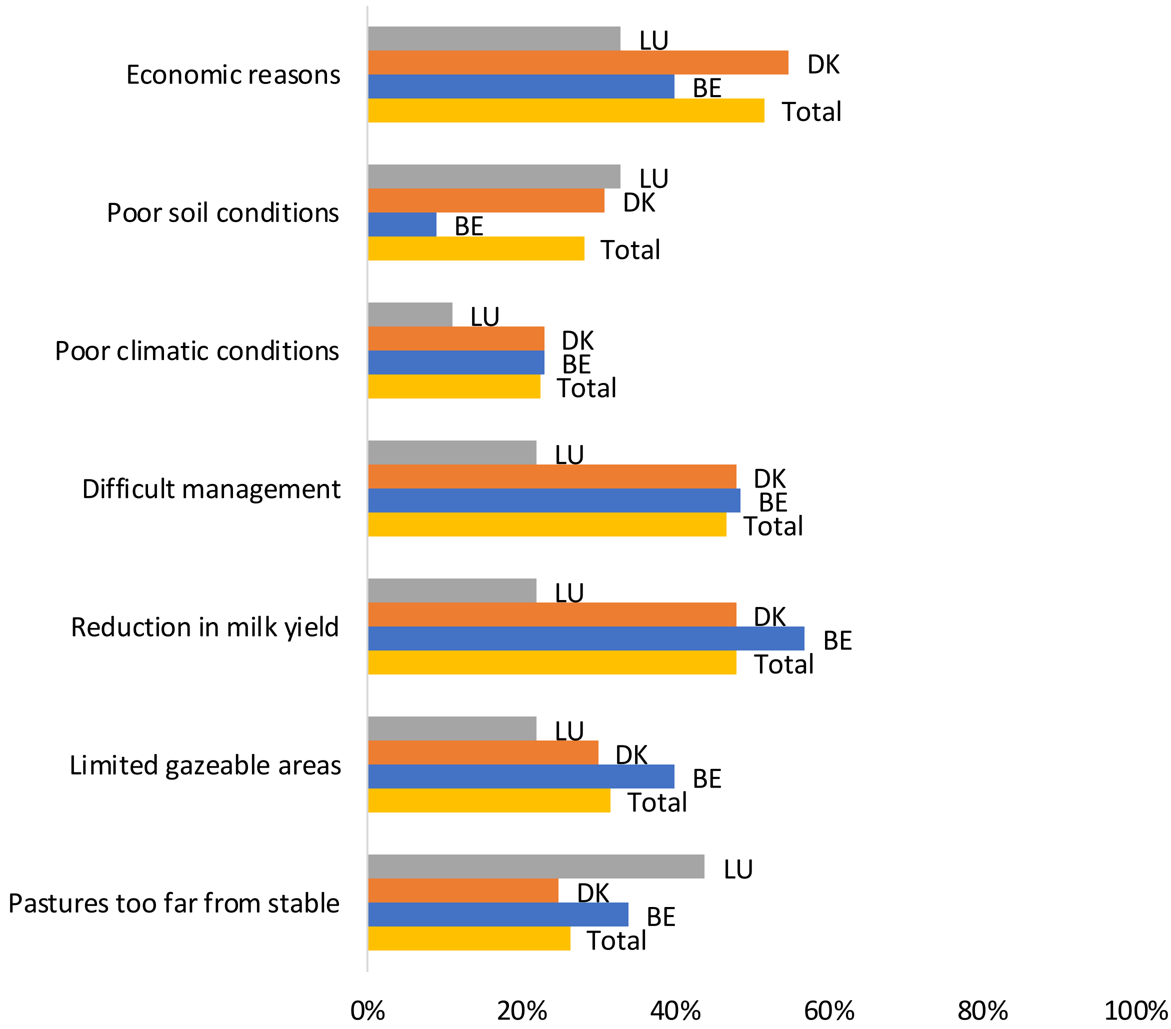

Figure 22. Reason for no grazing in the global dataset (Total) and in each country. BE: Belgium; DK: Denmark; LU: Luxembourg.

Reasons for keeping grazing

Only farmers with cows grazing received these questions. It represented 96,5% of the farms in Belgium, 37% in Denmark, and 84,8% in Luxembourg.

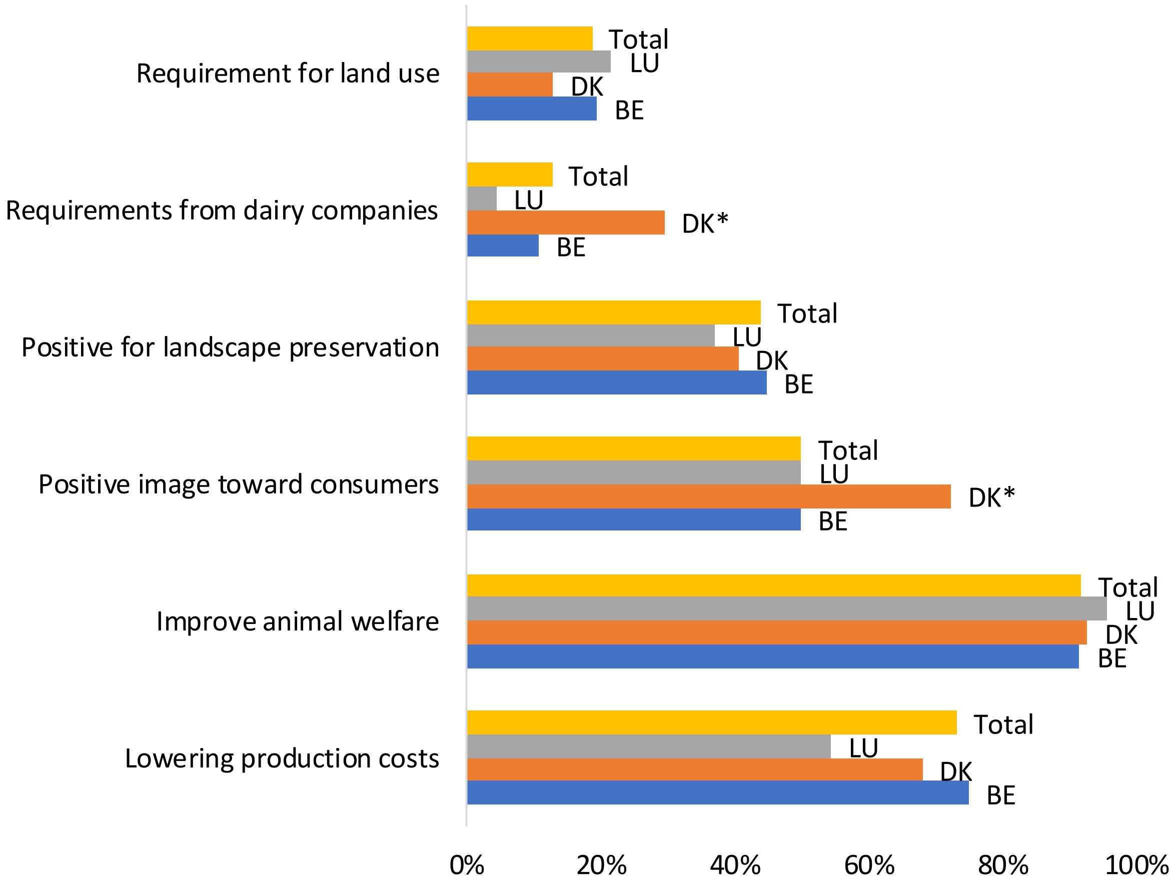

Figure 22. Reason for grazing in the global dataset and grazing in each country. Statistical differences (p<0,05) are highlighted by "*". BE: Belgium; DK: Denmark; LU: Luxembourg.

Future of grazing

Farmers were asked about their perspectives regarding grazing:

- Eighty-six % expected keeping or increasing grazing practices.
- Ten percent considered they would decrease grazing and 4% thought they would stop it.
- No opinion was recorded in 13%. No difference appeared between countries.

3.2.4 Life Cycle Assessment (LCA) - grassland

Dairy farming across the world relay on various degrees of utilization of grass as either pasture, hay or silage. Several studies have shown that proportion of grassland has an impact on the environmental performance. Guerci et al. (2013) comparing twelve different farming systems observed that proportion of grassland of the farmed area was negatively correlated to the emission of GHG per kg milk, and that the three farms with the lowest emission also were the farms with the highest proportion of grazing. This could indicate that not only the proportion of grassland, but also the way of using the grass growth has an impact on the emission. These inconsistencies in effect on GHG of different systems may partly be due to differences in the models used for calculation as well as the type of farms chosen as representative for the systems. Permanent grassland compared to temporary grassland, being part of an arable crop rotation system, is one factor. Several studies have shown that soil carbon sequestration is different from these types of grassland systems, with an expected higher annual sequestration in temporary grassland compared to permanent pasture, but also a high release of carbon when temporary grassland is turned into annual crops like maize or grain (Soussana et al., 2010). These effects might have an importance even at the emission at farm level. In general, higher milk yield is associated with lower emission per kg of milk, which is an obstacle for pasture based system which have a lower yield than confinement system. Some emission might be reduced though, like methane emission from storage of slurry compared to methane emission from deposition during grazing, while on the other hand, emission of N_2O from manure deposited is much higher than from manure applied to land after storage. Even the enteric methane emission might be different as content of starch and fat in the feed is related to a reduced methane production, and in pasture based diet the level of these two nutrients is often lower than in economical optimal ration fed indoor.

All together it is not obvious to understand how system differing in proportion, type and utilization of grassland affects the environmental impact of dairy farming. The aim with this action is therefore to add additional knowledge to understand how farming differing in these aspects performs in relation to the release of greenhouse gasses, land use and biodiversity.

This action used a combination of farm data and modelling of the farm production to estimate the environmental impact of dairy production at farm and product scale.

Information from the questionnaire sent to dairy farmers together with additional national statistical information and other literature sources was used to define two systems, both with conventional farming, typical for Luxembourg (LUX) and Belgium (BEL) and two systems, either conventional (DK-con) or organic (DK-org) typically for Denmark. These systems represent a large variation in grassland utilization (silage vs grazing), proportion of grass in the feeding regime and the type of grassland (temporary vs permanent) and grassland management. All farm data were based on dataset from year 2015.

Table 5. Basic information

	Luxembourg	Belgium	Denmark	
	Conventional	Conventional	Organic	Conventional
General data				
Soil, clay %	19	19	5	5
Rainfall (mm annually)	865	821	842	842
Precipitation (mm annully)	653	530	547	535
Specific data				
Herd (dairy cows)	74	70	169	168
Milk (kg/cow.year)	8 389	8 254	9 199	9 980
Stocking rate (LU[1]/ha)	1,99	1,73	1,26	1,95
Milk (kg ECM[2]/ ha farm land)	9 519	8 102	6 641	11 103
Crop type (% of land size)				
Permanent grassland	57%	55%	9%	7%
Temporary grassland	11%	11%	48%	32%
Maize	18%	5%	3%	31%
Feed intake (kg DM/year. cow)				
Pasture	2 355	2 956	2 161	550
Grass silage/hay	1 898	2 838	3 358	2 792
Maize silage	2 225	693	925	3 525

[1]DM: dry matter; [2]ECM: Energy Corrected Milk

The actual area at farm level was estimated with focus on balance between roughage net production and herd demand (DMI, net energy and protein) as well as between manure excretion and use of fertilizer – which has to be evaluated and corrected as part of initiation of the model. If necessary in order to established realistic crop rotation some minor areas with grain as cash crops was included. This was an important part of the work going from farm data to model as some of the farms (LU and BE 49% and DK 15%) from the questioner had beef and crop production together with dairy.

Simulation of each scenario was done by running the model for a period of 10 years with average annually climate data for each location. In order to have possibilities for comparing different types of dairy systems and products directly, the model farm area represent only the area needed for producing the home-grown feed for the dairy herd (cows and young stock). To include a product approach, life cycle assessment (LCA) was the system boundary extended in order to include also the emissions related to the imported resources such as feed and fertilizer. The functional unit in the study was one kg energy corrected milk (ECM) from kg milk sold at the farm gate and one kg of live weight gain, including both cows and heifers, but not bulls and calves.

Table 6. Product environmental impact for milk and meat – after allocation

	Luxemburg	Belgium	Denmark	
	Conventional	Conventional	Organic	Conventional
Allocation to milk (%)	85%	83%	87%	88%
Per kg milk				
GHG[1] (g CO_2 eq.)	1 010	999	933	949
Soil carbon sequestration, (g CO_2 eq.)	44	82	38	37
Land use (m^2)	1.12	0.94	1.47	1.00
Biodiversity damage index	0.36	0.26	0.12	0.52
Per kg live weight gain				
GHG (g CO_2 eq.)	6 850	6 976	6 174	6 223
Soil carbon sequestration (g CO_2 eq.)	301	569	252	240
Land use (m^2)	7,59	6,58	9,75	6,58
Biodiversity damage index	2,41	1,79	0,81	3,39

[1]GHG: greenhouse gases

3.3 Discussion

3.3.1 Comparison with official figures

Updated official figures about the dairy sector were difficult to find. For example, the report published in 2017 by the Walloon government takes into account figures from 2015 and discrimination between dairy and other sectors is not systematic. Official data from Denmark and Luxembourg are from 2015 too. Data provided by the governments of each country partner of the survey are often not comparable as they consider different aspects of agriculture, e.g not discriminate dairy from other activities, use range of data different from those from the study.

Wallonia

In Wallonia, comparison with official sources (L'agriculture Wallone en chiffres, 2017) showed the same key of repartition between conventional and organic farms as this observed in the survey. The number of dairy farms was estimated at 3569 units following figures of 2015. However, the survey was delivered to 3152 dairy producers by the mean of the Comité du Lait responsible for milk quality analysis for all dairy exploitations. This difference between figures could be due to the fact that the survey took place at the end of 2015. Yet the number of dairy farms decreases steadily. On the other hand, the official figure could be enhanced by some farms detaining a very small number of dairy cows and not delivering to the dairy plants. This hypothesis could be confirmed by the difference between the number of cows estimated at 53 animals per farm, lower than the figure from the survey.

The mean agricultural surface was estimated at 58 ha without discrimination between dairy and meat farms (L'agriculture Wallone en chiffres, 2017). This is coherent with the results of our survey.

Denmark

Comparison of official figures with results from the survey demonstrated a similar percentage of organic farms vs conventional ones (Table 7). The difference between both systems regarding agricultural areas is also marked in the survey (Figure 24). The average surface of organic farms seems even more important than from the official figures.

Table 7. Danish average figures from 2015

	Conventional	Organic
No of dairy farms	2860 (90%)	326 (10%)
Ha	154	198
Number of cows	173	157
Average annual milk yield per cow (kg)	10436	9356
Grassland surfaces (ha) (temporary + permanent)	56	119

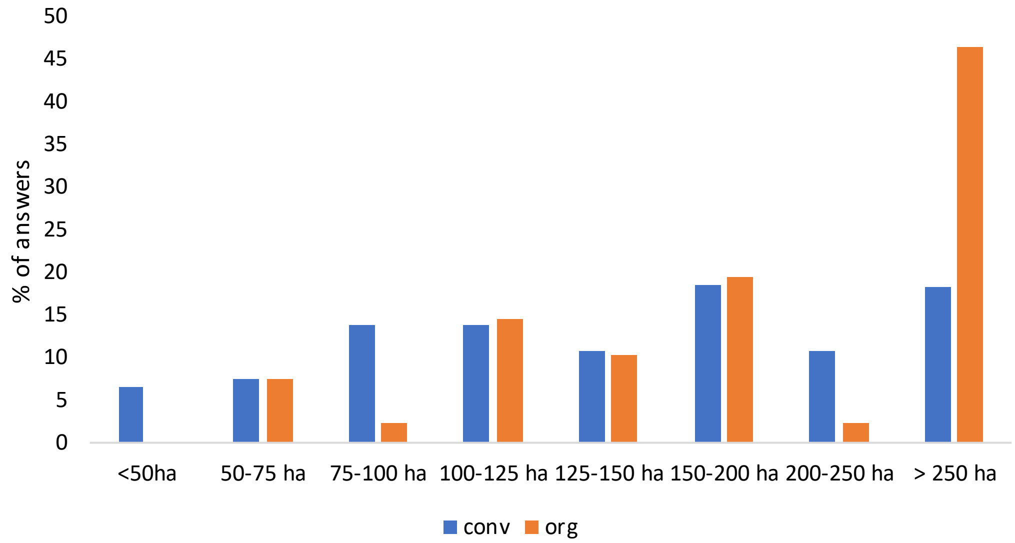

Figure 24. Surface of dairy farms in Denmark following the system. Data from the survey. Conv: conventional, org: organic

In the survey, no difference between the systems appeared in the number of cows. The figures of the survey indicated 39% of organic dairy farms with 100 to 150 cows vs 45% in conventional ones. This is in accordance with the official figures.

The milk yield is slightly lower in organic farms with 49% of the farmers indicating that their average milk yield per cow per year was comprised between 8000 and 10000 kg. On the other hand, 52% of the conventional system estimated its annual milk production at between 10000 to 12000 kg. These figures are slightly above the official ones. Grassland surfaces reported in the survey were above official estimations.

Luxembourg

In Luxembourg, 2022 agricultural exploitations were active following the report "L'agriculture Luxembourgeoise en chiffres" (2016). Out of them, 515 were specialized in dairy production (25% vs 35% in the survey) and 8% in meat, milk and crop (vs 21% in the survey). Only 83 farms were organic (4%) which corresponds to the percentage reached in the survey. The mean agricultural surface was estimated at 65 ha while farms declaring surface between 70 and 100 ha reached 17,3% and those of more than 100 ha, 23%. Figures from the survey showed more bigger entities with 26,7% of farms claiming between 75 and 100 ha and 50% above 100 ha.

In 2015, 46903 dairy cows were present in Luxembourg. If only the farms specialized in milk are taking into account, a mean of 91 cows per farm on average could be considered. This figure is in accordance with results of the survey. Milk yield reported from official figures was lower than estimated from the survey: the average annual milk production per cow was estimated at between 7000 and 8000 kg compared with 30% of the farmers producing from 6000 to 8000 kg and 64,4% from 8000 to 10000 kg in the survey. It is noteworthy that these official figures took into consideration the deliveries to the dairy plants. Thus, an amount of the total milk yield of exploitations could be used by other means, for example to feed calves or by direct trade. On the other hand, the questionnaires were sent only to dairy farmers explaining discrepancies between official figures and those from the survey.

In each country, some little discrepancies between official data and results were noticed probably due to the more restricted target than official sources addressing all agricultural exploitations.More generally, the panel of farmers who have answered is representative of the farmers of each country.

Comparison between the three countries

The three surveyed countries are very different. The farm size is far greater in Denmark whatever the criteria: surface, number of cows or milk yield. Even organic farms had more surface than conventional ones. Grazing practice, accordingly with this increased size, grazing was less practiced in Denmark. The proportion of no grazing affected the answers of Danish farmers and their perception about grazing. This point was already highlighted by Kristensen et al., 2010. In Luxembourg, intensification of dairy farms is increasing with a negative impact on grazing. In Wallonia, intensification process is less pronounced and grazing practices still play a key role.

3.4 Conclusion and summary for policy makers

In Europe, dairy farmers feel disappointed by the milk crisis. In our survey, the feeling of malaise of dairy farmers was perceptible. One of the chosen strategy is the intensification of farm management. Anyway, the number of farmers is decreasing in the European Union. Less young people are motivated for this profession so that ageing of farmers is very pronounced. These features were also demonstrated in our study. Thus, the agricultural sector is crucial for the preservation of grassland that otherwise got abandoned or became shrubs. While the intensive use of grasslands might cause damage for the environment, the LCA analysis performed in our study showed that intensive Danish systems gave the highest GHG emission per area of farm land, but also the lowest emission per kg of product. The impact of intensive management has thus to be considered at both levels: in relationship with the farm area and per kg of milk produced. A dynamic point of view is also necessary as carbon sequestration is fluctuating with land use change and ploughing of permanent and temporary grasslands.

Results of this survey showed huge variation between Denmark and Belgium/Luxembourg in the role of grassland. Some general conclusion can be made.

- Intensification of dairy sector hinders grazing for different reasons:
  - Not enough surfaces in the surroundings of the farm to let cows grazing
  - Not enough grasslands to feed the animals
  - Increased labour and difficult management of pastures
  - Competition between resources provided by grasslands e.g. silage production and grazing
- Although cows are grazing, large amount of supplement feed is allocated
- At the moment, most dairy farmers grazing wish keeping grazing, even increasing it.

Preservation of grassland is a huge society concern. It is thus necessary to intensify the education of the farmers about impact of their sector on the environment. Our survey shows that they are not very aware of that issue. Moreover, landscape and environment preservation by the farmers could be highlighted as environmental services and valued. Effect of national policies on grassland preservation is still limited but could be an incentive for grazing as showed by the recent measures decided by the Luxembourg government. An increase in organic sector can help preserving grassland surfaces.

3.5 References

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