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Title: **Qualitative assessment of manure management in main livestock production systems and a review of gaseous emissions factors of manure throughout EU27**

"Studies in support of the European project GGELS"

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Final report

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Summary

In response to an invitation to tender, Cemagref-Rennes offered to fulfil the two specific tasks set out: the preparation, distribution and subsequent analysis of a questionnaire to establish the current manure management practice of livestock farms across the EU 27 and supporting the project management of GGELS in the compilation of the best and most appropriate emission factors in this context.

Context of proposed study

Since 1850, the concentration of carbon dioxide (CO_2) in the atmosphere has increased by 31%, that of methane (CH_4) by 151% and that of nitrous oxide (N_2O) by 17% (GIEC, 2001). The global warming potential (GWP) set over a period of 100 years for the latter two greenhouse gases are respectively 25 and 298 times the CO_2 equivalent (GIEC, 2005), thus giving them the highest priority in the search for mitigation options. It is noted that agriculture contributes substantially to the anthropogenic emissions of both N_2O and CH_4 as well as ammonia (NH_3) which is implicated in other negative environmental impacts as well as public and animal health. The FAO publication: "Livestock's Long Shadow" set out that livestock production is a major contributor to the world's environmental problems, including climate change. At a global level, the report estimates that livestock accounts for a significant share of anthropogenic greenhouse gas emissions representing 18 % of total estimate. The intensification of livestock production has led to the storage of large volumes of slurry within and outside the farm buildings mostly in open tanks. These now contribute to the emission of CH_4 by the natural process of fermentation in anaerobic conditions. Furthermore, quantities of N_2O are emitted following the process of nitrification and denitrification after land application of the effluents. The volatilization of NH_3 is directly related to the pH of livestock slurries and local air movements: it occurs mostly within the livestock buildings and following landspreading.

As signatories to international conventions, EU Member States are obliged to reduce their emissions regarding:

- the United Nations Framework Convention on Climate Change (UNFCCC) for greenhouse gas,
- the Geneva Convention on Long Range Trans-boundary Air Pollution (LRTAP), and
- the European Directive on the National Emission Ceilings (NEC) with respect to NH_3.

Within this framework, the IPCC methodologies are important for achieving national inventories that are comparable between the Members States of these conventions. These methodologies enable aggregated results. The default emission factors for agricultural sources characterise broadly similar conditions, and the default data for the characteristics of animal husbandry systems may impose considerable bias on national inventories (Freibauer, 2003). It still has to be confirmed that the emission factors adequately apply to agricultural practice and conditions in EU Member States (Freibauer, 2003). One important pre-requisite is to improve our knowledge on manure management practices across the EU27. New methods, (especially applying to the nitrogen-based emissions) are currently under development. Such developments seek both a more accurate assessment of emissions throughout the various stages of livestock manure management (livestock buildings, storage, land application, grazing, etc) and also to enable the implementation of a mass flow approach, which depicts the pathways of both N and C species strictly under the aspect of mass conservation (Webb and Misselbrook, 2004). Studies have been carried out in different countries to improve the accuracy of national inventories, using more precise livestock data, and/or more accurate emission factors (Pain et al., 1998, Chadwick al., 1999, Hyde et al., 2003, Freibauer, 2003, Gac et al., 2007).

Introduction

In order to formulate an appropriate answer to the growing political and social concern about livestock's contribution to climate change, the Directorate-General for Agriculture and Rural Development commissioned a study to the JRC to estimate livestock GHG emissions in the EU context. This became the GGELS project (Greenhouse Gas from the European Livestock Sector) which started in July 2008 (JRC contract no. 30944-2008-04 NFP ISP, AGRI-2008-0245). As a part of this project, the challenge is estimating GHG emissions during the processing and storage of manure, as well as the subsequent emissions following application: all with a suitable accuracy. It is thus crucial to improve the knowledge base on manure management throughout the EU27.

Unfortunately no official consistent reporting on manure management takes place under current EU law (neither the Nitrate Directive nor CAP cross compliance). The only existing sources of information at EU level are two surveys collecting qualitative expert knowledge: one dating from 2001, covering all EU27 except for Romania (in the context of the MATRESA FP5 project – Burton and Turner, 2003) and one dating from 2004, covering EU25 (IIASA, RAINS model), with some additional information available from national submissions of GHG inventories to the UNFCCC. These data are useful, but need to be updated and completed. Further, more important drawbacks of these approaches are their reliance on single expert estimates at national level with no confidence interval estimate.

The European Joint Research Centre (JRC) based at Ispra in Italy is coordinating the project for the Commission. They have already carried out a detailed analysis dividing Europe into 243 regions and ascribing to each to one of a list of descriptions which fits closest reflecting geographic and agronomic factors. The objective is to look more closely at a selection of representative regions for each class of livestock system. We asked selected people to give information for the country or region that they have expert knowledge for. Overall, about 400 experts were contacted across Europe.

The GGELS project characterises production and assesses emissions at the sub-national regional level. The goal of the present study is to augment these regional production descriptions with information on manure management (i.e. processing, storage and application) per farm animal species.

First, this report deals with the methodology used to build the questionnaire (chapter 1) and then the methodology used to process results is presented (chapter 2). The average results are presented (chapter 3).

1. Preparation of questionnaires and distribution

1.1 Introduction

The central challenge to any questionnaire is to get recipients to respond! In most cases, one can expect an indifferent reaction from people who are unaware of the importance of the project and who will have their own work pressures. Consequently, the proposed questionnaire had several features to encourage participation:

- Online format for ease of completion (with option to get a pdf version if preferred);
- Simplicity in layout both pleasing in appearance and easy to complete;
- Avoidance of requiring unnecessary data; focus only on what is needed;
- Avoidance of ambiguity; clear instruction;
- Use of devices to aid completion: multiple choice boxes with drop down menus, tick boxes, comment boxes, etc.

The online questionnaire is also useful to collect the results directly in the form of a data base.

1.2 Online form of the questionnaire

The online tool: http://www.surveymonkey.com was used to prepare and distribute the questionnaires. The main advantages of this tool are:

- A powerful survey designer:
  - Using just your web browser, it is possible to create your survey with an intuitive survey editor. A dozen types of questions are possible (multiple choices, rating scales, drop-down menus...). Useful options are available like the “require answers” to any question and the control of the flow with custom skip logic allowing to jump from a question to another depending of the answers.

- Address book and mail invitation
  - Once the address book is completed online including mail, it is possible to send to the whole contact list of a country an invitation link to proceed with the online questionnaire

- Download of results
  - Several formats are possible but the most interesting is to download all of the raw data collected as a spreadsheet.

The category dairy cattle for Italy are presented in Annexe 1 as an example. The questionnaires for the overall species and countries are based on the same appearance.

1.3 Address book

Initial enquiries to specify suitable experts in each country were made using European contacts known to Cemagref via previous surveys and via the RAMIRAN network. In addition, we involved the Copa-Cogeca network and the “Mission Economique, Service des Ambassades de France”. Both provided a helpful list of experts.
The address book reached about 400 experts across EU27.
In addition, a web link was added to the RAMIRAN web site to encourage or remind experts about the importance of such questionnaire.

We dispatched the questionnaires at the beginning of February and we stopped collecting completed forms at the end of May.

1.4 Sampled regions

The European Joint Research Centre (JRC) based at Ispra in Italy is coordinating the project for the Commission. They have already carried out a detailed analysis dividing Europe into 243 regions and ascribing to each to one of a list of descriptions which fits closest in terms of Livestock Production Systems (LPS) and climate.
The JRC proposed a methodology to group those European regions (titled “Climate & LPS association”) presenting similarities and then to sample a representative number of regions to survey via a statistical method. (Report n° JRC IPSC/G03/P/DG/dg D(2008)(xxxx), §.7 ranking and sorting of the regions)
The tables presenting the sampled regions are visible below in § 2.1
In the rest of this document, we propose to replace the name of “Climate & LPS association” with the term: “ClimLPS” for ease of reading.

The sampled regions identified with the statistical method were specified in the questionnaire form. However, we offered the possibility to input the code of other regions as well if the experts felt that he had information on such areas.
Indeed, sometimes, experts did reply for non-sampled regions. So, we propose to update the original “ClimLPS” to include regions completed by some experts in addition to the requested sampled regions.
These additional replies allowed us to capitalize on 176 replies instead of just the 159 that fitted with the original sampling plan.
The location of the 176 replies is presented in annexe 2.
Unfortunately, despite this concession, we still haven’t received enough replies for each “ClimLPS”.

2. Methodology for the questionnaires' analysis – ascribing results to unreported regions

2.1 Method to attribute results to unreported regions

Unfortunately, we have not received enough completed questionnaires to enable a comprehensive description of all "ClimLPS". Consequently, we saw fit to propose a method to attribute descriptive factors to regional types lacking data. Where aggregation of data is inevitable, below are the rules of attribution that we used.

We had to merge the "ClimLPS" in order to assign to unreported regions the closest ones. As for the "ClimLPS", we propose to define a term for the merging of ClimLPS: "ClimLPSmerge" and that will be useful for ease of reading in the rest of this report.
The proposed "ClimLPSmerge" are closely based on the Climate and the LPS maps made available by the JRC. Indeed the merging of "ClimLPS" must be based on similar LPS and/or Climate types.

The maps of climate types and LPS classifications are presented below and were taken from the JRC report : D. Grandgirard, report n° JRC IPSC/G03/P/DG/dg D(2008)(xxxx).

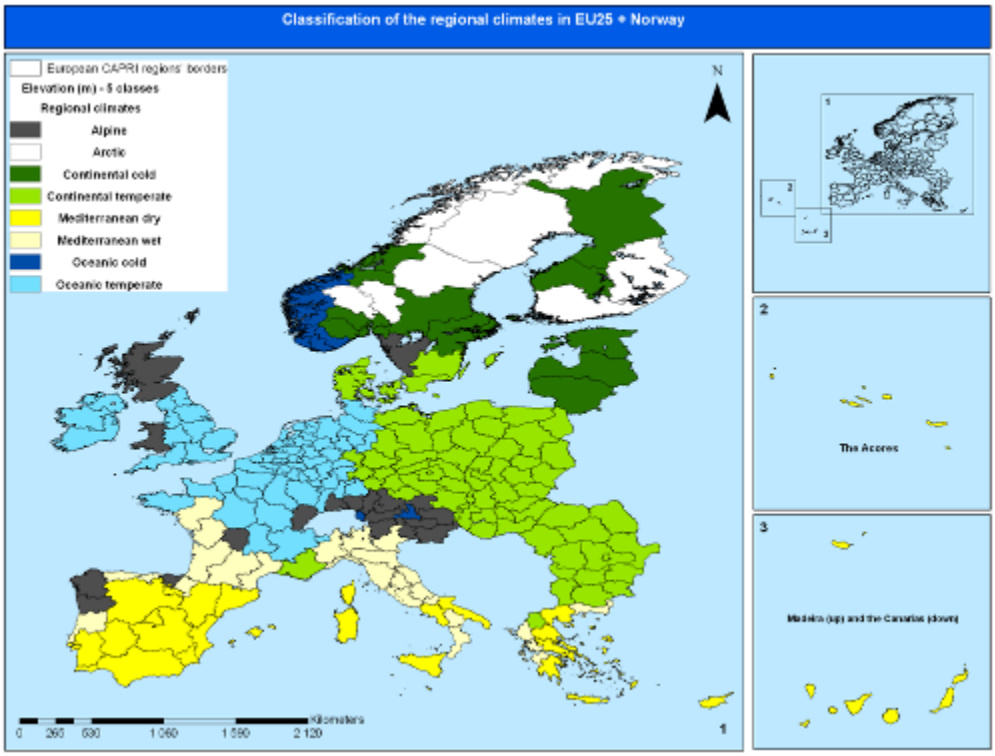


Figure 1: Climate map from the JRC report IPSC/G03/P/DG/dg D(2008)(xxxx), Figure 11

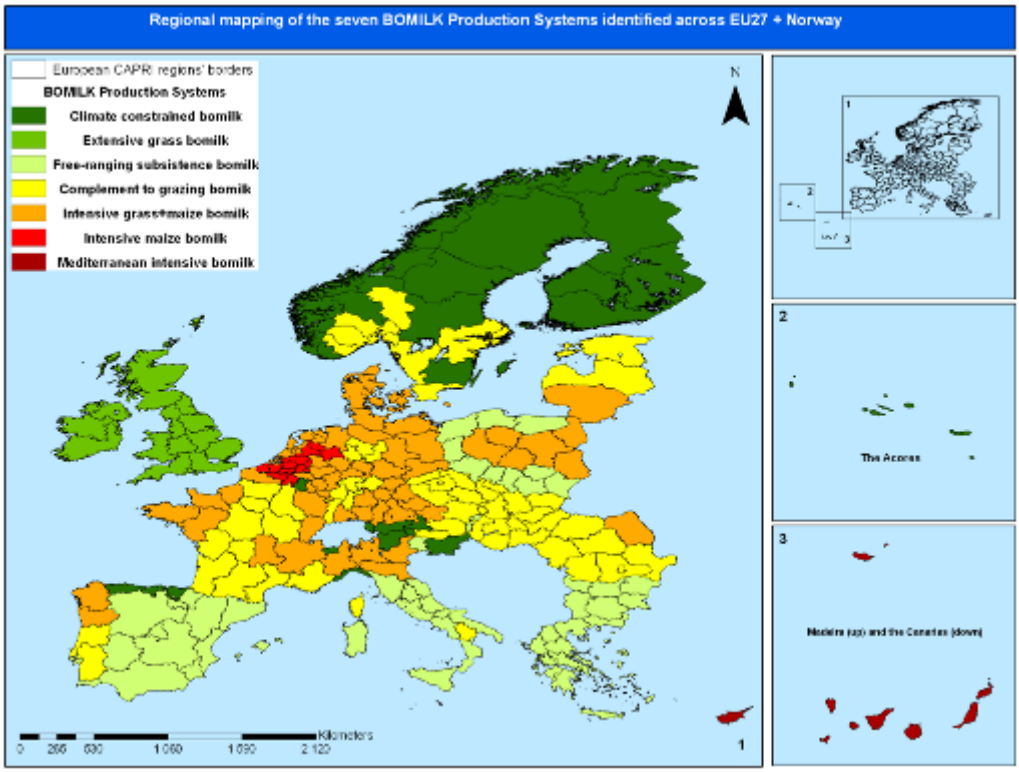


Figure 2: Example of LPS map for Dairy Cattle from the JRC report IPSC/G03/P/DG/dg D(2008)(xxxx), Figure 14

In the tables built by Joint Research Centre (D. Grandgirard, report n° JRC IPSC/G03/P/DG/dg D(2008)(xxxx)), we add 3 items:

1 - No. of replies:

This is the total number of completed questionnaires for each “ClimLPS”.

2- Kind of attribution:

With the help of a Microsoft Access® database, we compared the sums of the standard deviation values for 2 types of associations: merging the whole climates types or merging the whole LPS types. It appears that merging climate types leads to less deviation than LPS aggregation.
In addition, we tried a more accurate merging test: we compared the standard deviations of merging closest climate types or closest LPS. The same was observed, Climate merge induces less deviation.
Nevertheless, differences between the 2 merging tests were not so important so that we can assume that in case we have difficulties to merge with closest climate types, merging of closest LPS types may be useful in a second step.

This item corresponds to the level of confidence that we can have for the replies:

*: Excellent: number of responses for “ClimLPS” is >= 3
**: Good: number of responses for “ClimLPS” is < 3 but >0, merge proposition with closest climate or LPS types,
***1: Estimate: number of replies for “ClimLPS” is 0, merge proposition with closest climate types but with the same LPS,
***2: Estimate: number of replies for “ClimLPS” is 0, merge proposition with closest LPS and with the same climate types.

When we have to merge climate, we use in priority the Climate aggregation rules' as below:

1-Continental Cold, Oceanic Cold, Alpine, Artic
2-Oceanic Temperate, Continental Temperate
3- Mediterranean dry, Mediterranean wet

When we have to merge LPS categories, we use the LPS aggregation rules' as set out below:

Dairy Cattle:
1- Climate constrained, Extensive Grass
2- Intensive Grass+maize, Intensive maize, Complement to grazing,
3- Free ranging subsistence, Mediterranean intensive

Beef Cattle:
1-intensive x, intensive y
2-Complement to x…, Complement to y,
3-Subsidiary x…, Subsidiary y…
4-Secondary x…, Secondary y…

In some cases, we have judged it necessary to merge 2 with 3 or 3 with 4.

Sheep and Goats:
Because of the poor number of replies, we merged all LPS typologies, and we only used the Climate aggregation rules' described above for separating groups.

Fattening Pigs and Sows:
1-Secondary very intensive, Primary intensive with bovine, Common secondary intensive, Subsidiary intensive with crops
2-Subsidiary traditional, Secondary complement to grazing
3-Specialized PORCIN

Because of sufficient data, the type "Specialized Porcin" wasn't merged with others.

Laying Hens:
Because of the poor number of replies, we merged all LPS, and we only used the Climate aggregation rules' described above for separating groups.

All other Poultry:
With a better number of replies compared to the Laying Hens category, we merged the closest climate types' but we kept some separate headings for LPS types.

3 - Merge Proposition

This item corresponds to the aggregation choices in relation with the previous paragraph.

2.2 Tables obtained for the 6 species, merge proposition

Using the merge proposition above, we obtained 34 "ClimLPSmerge" (corresponding to "**a**" to "**ai**" categories in the tables below).

Table 1: Dairy Cattle (BOMILK), "ClimLPS", number of responses, rules of aggregation.

LPS	Climates	No regions per association	No. regions to be sampled	Leader regions	Other regions	No. of Replies	Merge proposition	Kind of attribution
Climate constrained bomilk	Alpine	4	1	AT33	ITD2 SI ES21	1	a	**
Climate constrained bomilk	Arctic	8	2	SE08 FI13	NO122 NO233 SE07 NO111 NO121 FI1A	2	a	**
Climate constrained bomilk	Continental cold	6	2	FI18 NO231	FI19 NO123 SE06 FI20	1	a	**
Climate constrained bomilk	Continental temperate	1	1	SE09			a	***1
Climate constrained bomilk	Mediterranean dry	4	1	PT20	ITC3 ES12 ES13		g	***2
Climate constrained bomilk	Oceanic cold	7	2	NO243 NO252	NO242 AT34 NO241 NO244 AT32	1	a	**
Climate constrained bomilk	Oceanic temperate	2	1	ITC2	BE34		d	***2
Extensive grass bomilk	Alpine	2	1	UKL UKM		3	c	*
Extensive grass bomilk	Oceanic temperate	11	3	UKN UKC UKE	UKH UKK IE01 UKF UKD UKJ UKG IE02	1	c	**
Free-ranging subsistence bomilk	Alpine	1	1	ITD4			a	***2
Free-ranging subsistence bomilk	Continental temperate	18	4	PL62 EL13 PL32 PL63	BG04 AT11 PL22 BG01 PL51 PL33 BG02 BG05 PL42 PL21 PL52 BG06 PL43 BG03	3	d	*
Free-ranging subsistence bomilk	Mediterranean dry	25	6	ES62 EL41 EL24 EL30 ES30 ES23	ES41 ES61 ITG2 ES24 EL42 EL25 PT17 ES43 ITF4 PT15 EL12 ES42 ITG1 ES51 EL43 EL14 ITF3 ES52 ES53		g	***2
Free-ranging subsistence bomilk	Mediterranean wet	12	3	EL11 ITE3 ES22	EL22 ITE4 ITE1 ITE2 EL23 ITF1 EL21 ITF2 ITF6		g	***2
Complement to grazing bomilk	Alpine	4	1	SE0A	FR63 AT21 AT22		f	***2
Complement to grazing bomilk	Arctic	1	1	NO232			f	***2
Complement to grazing bomilk	Continental cold	9	2	LV NO254	EE SE02 NO262 NO255 NO253 NO261 SE01		f	***2
Complement to grazing bomilk	Continental temperate	30	7	SK04 CZ03 RO08 AT12 DE26 SK01 FR82 CZ06 CZ01 SE04 CZ02	CZ05 RO03 RO04 CZ04 RO02 RO05 CZ08 HU03 HU06 RO07 HU04 SK03 HU02 RO06 HU01 SK02 CZ07 HU05 HU07	7	e	*
Complement to grazing bomilk	Mediterranean dry	2	1	PT18	FR83	1	g	**
Complement to grazing bomilk	Mediterranean wet	6	2	PT16 FR81	FR61 FR62 ITF5 FR53	1	g	**
Complement to grazing bomilk	Oceanic cold	1	1	NO251			f	***2
Complement to grazing bomilk	Oceanic temperate	12	3	FR42 FR26 DE92	DE91 FR24 DE12 DEB3 DE71 FR21 FR10 FR22 DEA4	1	e	**
Intensive grass+maize bomilk	Alpine	8	2	PT11 DE13 AT31	DE21 DE14 ES11 FR43 DE27	2	f	**
Intensive grass+maize bomilk	Continental cold	1	1	LT			f	***1
Intensive grass+maize bomilk	Continental temperate	18	4	DE40 DE23 PL11 DE25	DE73 PL31 DE24 PL34 DK PL41 DEE0 RO01 PL12 DED0 PL61 DE80 DEG0 DE22	1	h	***1
Intensive grass+maize bomilk	Mediterranean wet	5	2	ITC1 ITD5	FR51 ITC4 ITD3	3	g	*
Intensive grass+maize bomilk	Oceanic temperate	41	9	NL33 DEF0 DE93 DEA1 NL12 DE72 DEB2 DEA5 FR25 FR30 NL31 FR71	DEC0 DE94 FR52 FR23 FR72 NL34 BE33 LU00 NL13 DE11 NL11 NL32 FR41 DEA2 NL23 DEB1 BE32 BE24 BE25 BE23 NL42 NL22 NL21 BE22 BE21 BE31 DEA3 NL41 BE35	13	h	*
Mediterranean intensive bomilk	Mediterranean dry	4	1	ES70	CY MT PT30		g	***2

Description of the "ClimLPSmerge" category for Dairy Cattle:

a: This group corresponds to the combining of the cold climate (Alpine, Arctic, Continental cold, Oceanic cold) within the LPS category : "Climate Constraint bomilk. One record from a different LPS type (Free-ranging subsistence bomilk) was also attributed to this group. This group finally merged 5 records of the initial table and obtained a total of 5 replies.

c: This group merged only 2 records of the initial table and obtained a total of 4 replies. This group corresponds to the assemblage of the LPS category: "Extensive grass bomilk" without taking into account Climate types because this category is geographically limited to UK and Ireland.

d: This group merged "Climate Constraint bomilk" and "Free-ranging subsistence bomilk" LPS categories for temperate climates. This group merged 2 records of the initial table and obtained a total of 3 replies.

e: This group corresponds to the assemblage of temperate climate within the LPS category : "Complement to grazing bomilk". 2 records of the initial table were merged and obtained a total of 8 replies.

f: This group corresponds to the assemblage of cold climates within the LPS category : "Intensive grass+maize bomilk". Some other cold climate belonging to the "Complement to grazing bomilk" LPS category were attributed with the replies of the "Intensive grass+maize bomilk" category because no replies were obtained for such LPS type. 6 records of the initial table were merged and obtained a total of 2 replies.

g: This group corresponds to the assemblage of mediterranean climates within the LPS category : "Intensive grass+maize bomilk". Some other mediterranean climate belonging to the "Complement to grazing bomilk" LPS category and the "Mediterranean intensive bomilk" were attributed with the replies of the "Intensive grass+maize bomilk" category because no replies were obtained for such LPS type. 7 records of the initial table were merged and obtained a total of 5 replies.

h: This group corresponds to the assemblage of temperate climate within the LPS category : "Intensive grass+maize bomilk". 2 records of the initial table were merged and obtained a rather good rate of answered questionnaires (14 replies).

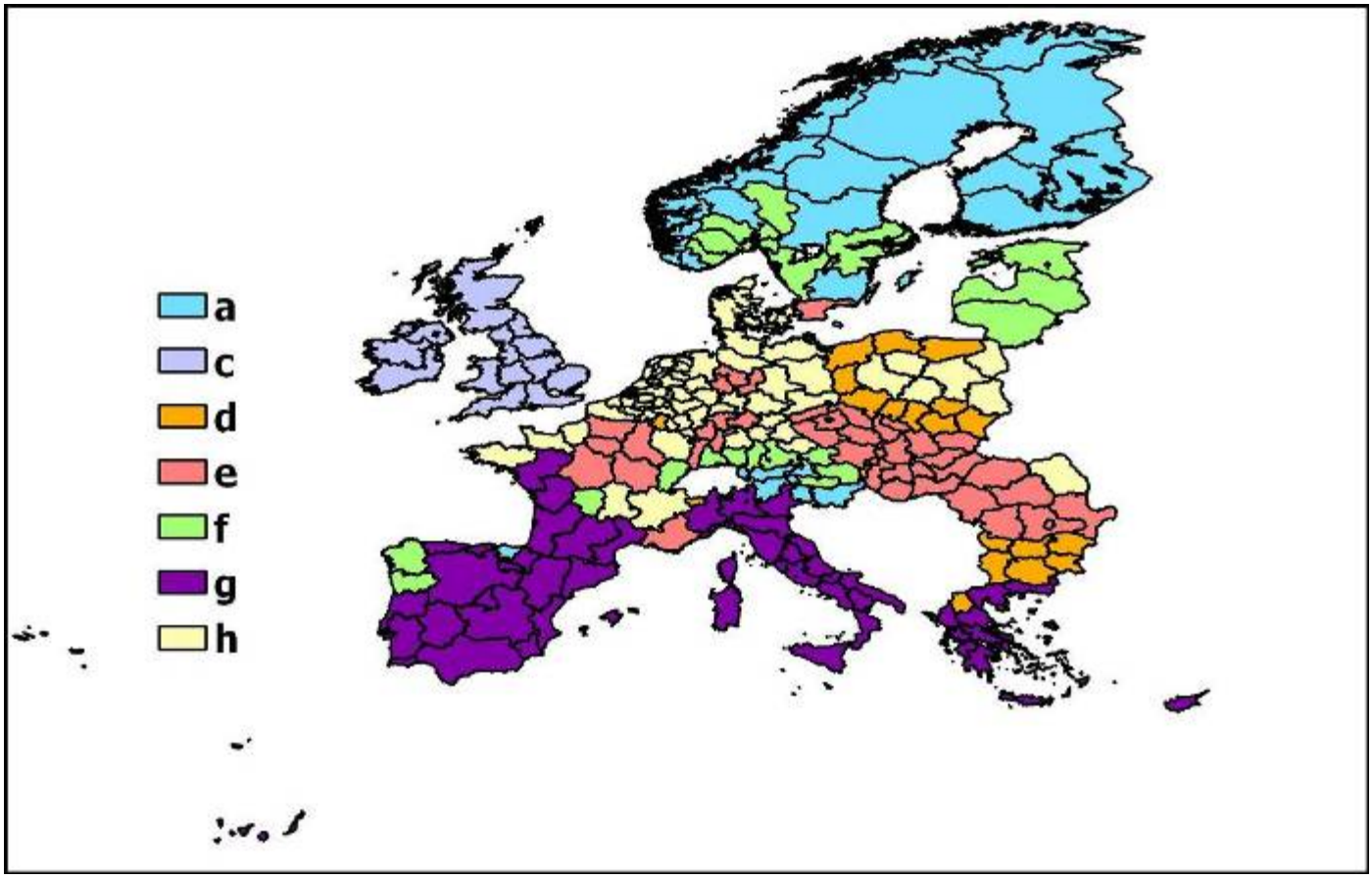


Figure 3: Map of the “ClimLPSmerge” for Dairy Cattle

Table 2: Beef Cattle (BOMEAT), "ClimLPS", number of responses, rules of aggregation.

LPS	Climates	No. regions per association	No. regions to be sampled	Leader regions	Other regions	No. of Replies	Merge proposition	Kind of attribution
Complement to ovine BOMEAT	Alpine	13	3	ITD2 FR43 AT33	ES21 DE14 ITD4 DE13 SE0A ES11 AT22 AT21 AT31 SI		j	***2
Complement to ovine BOMEAT	Arctic	3	1	NO232	FI1A NO233	1	j	***2
Complement to ovine BOMEAT	Continental cold	10	3	NO255 NO123 SE02	LT NO261 NO262 NO254 SE01 FI18 NO253		j	***2
Complement to ovine BOMEAT	Continental temperate	14	4	SK03 RO06 RO02 FR82	RO07 RO03 SE04 RO04 RO08 DE73 BG04 RO05 RO01 SK04		i	***2
Complement to ovine BOMEAT	Mediterranean dry	11	3	ITG1 PT18 PT20	FR83 PT15 ES23 ITG2 ES30 EL42 ITF4 ITF3	2	k	**
Complement to ovine BOMEAT	Mediterranean wet	15	4	ITF6 PT16 ES13 ITE1	ITC3 ITE3 ITE4 ES12 ITF5 ITF2 EL21 ITF1 FR81 ES22 ITE2	1	k	**
Complement to ovine BOMEAT	Oceanic cold	4	1	NO244	AT34 NO251 AT32		j	***2
Complement to ovine BOMEAT	Oceanic temperate	8	2	DE72 FR71	ITC2 DEB1 DEB2 BE34 DEC0 DEA5		i	***2
Complement to porcine BOMEAT	Continental temperate	15	4	CZ04 HU03 CZ05 HU02 CZ06	HU04 SK01 HU05 AT11 CZ02 SK02 HU07 HU06 CZ03 CZ07	3	i	*
Complement to porcine BOMEAT	Oceanic temperate	6	2	UKG UKC	UKH UKE UKF UKJ	2	i	**
Intensive grass maize BOMEAT	Alpine	2	1	UKL	FR63	2	j	**
Intensive grass maize BOMEAT	Mediterranean dry	3	1	ES61 ES41	ES43	2	k	**
Intensive grass maize BOMEAT	Mediterranean wet	6	2	ITC1 FR62	ITD3 FR61 ITC4 FR51	1	k	**
Intensive grass maize BOMEAT	Oceanic temperate	12	3	FR23 FR21 FR25 IE01 IE02 UKK	FR52 UKD FR41 FR24 FR26 FR72	2	l	***2
Intensive maize BOMEAT	Alpine	3	1	PT11	DE27 DE21		j	***1
Intensive maize BOMEAT	Continental temperate	11	3	DE40 DE23 DE22	DEG0 AT12 DE26 DED0 DE24 DE80 DK DE25		l	***1
Intensive maize BOMEAT	Mediterranean dry	2	1	ES70	CY		k	***2
Intensive maize BOMEAT	Mediterranean wet	1	1	FR53		1	k	***2
Intensive maize BOMEAT	Oceanic temperate	38	9	NL34 NL12 DEA3 NL22 BE32 NL13 DE11 BE21 NL21 BE33 BE31 BE35	FR42 DE94 DEA1 NL11 DEA2 FR22 DEA4 BE22 NL42 NL33 DEB3 DE71 DEF0 LU00 BE23 DE93 DE91 NL41 BE24 NL23 NL31 NL32 DE12 BE25 FR30 DE92	12	l	*
No declared activity	Alpine	1	1	UKM		1	n	**
No declared activity	Continental cold	3	1	EE	LV FI20	3	n	*
No declared activity	Continental temperate	2	1	CZ08	CZ01		n	***1
No declared activity	Mediterranean dry	2	1	MT	PT30		k	***2
No declared activity	Oceanic temperate	1	1	UKN			n	***1
Subsidiary Mediterranean BOMEAT	Continental temperate	24	6	PL32 DEE0 PL62 PL34 PL63 PL41	BG06 PL33 PL42 HU01 EL13 PL52 PL11 PL21 BG01 PL51 BG02 BG03 BG05 PL22 PL31 PL43 PL12 PL61	1	i	***2
Subsidiary Mediterranean BOMEAT	Mediterranean dry	14	4	EL14 ES42 EL12 ES62	EL43 ES24 EL25 ES51 PT17 EL30 EL41 ES53 EL24 ES52	1	k	***2

Subsidiary Mediterranean BOMEAT	Mediterranean wet	4	1	EL23	ITD5 EL11 EL22		k	***2
Subsidiary Mediterranean BOMEAT	Oceanic temperate	1	1	FR10			i	***2
Subsidiary Nordic BOMEAT	Arctic	6	2	SE08 NO122	NO111 SE07 FI13 NO121	1	j	***2
Subsidiary Nordic BOMEAT	Continental cold	3	1	NO231	FI19 SE06		j	***2
Subsidiary Nordic BOMEAT	Continental temperate	1	1	SE09			i	***2
Subsidiary Nordic BOMEAT	Oceanic cold	4	1	NO242	NO241 NO243 NO252		j	***2

Description of the "ClimLPSmerge" category for Beef Cattle:

i: This group corresponds to the assemblage of the temperate climates within the LPS categories : "Complement to ovine BOMEAT", "Complement to ovine BOMEAT", "Subsidiary Mediterranean BOMEAT" and "Subsidiary Nordic BOMEAT". This group merged 7 records of the initial table and obtained a total of 6 replies.

j: This group corresponds to the assemblage of the cold climates within the LPS categories : "Intensive grass maize BOMEAT" and "Intensive maize BOMEAT". "Complement to ovine BOMEAT" and "Subsidiary Nordic BOMEAT" for cold climates were also added in this group because of insufficient data in the initial "m" group. This group finally merged 6 records of the initial table and obtained a total of 4 replies.

k: This group correspond to the assemblage of mediterranean climates within the whole LPS categories. 2 records of the initial table were merged and obtained a total of 8 replies.

l: This group corresponds to the assemblage of the temperate climates within the LPS categories : "Intensive grass maize BOMEAT" and "Intensive maize BOMEAT". This group merged 3 records of the initial table and obtained a total of 14 replies.

n: This group corresponds to the whole merging of the LPS category : "no declared activity" except for the Mediterranean climate type. 4 records of the initial table were merged and obtained a total of 4 replies.

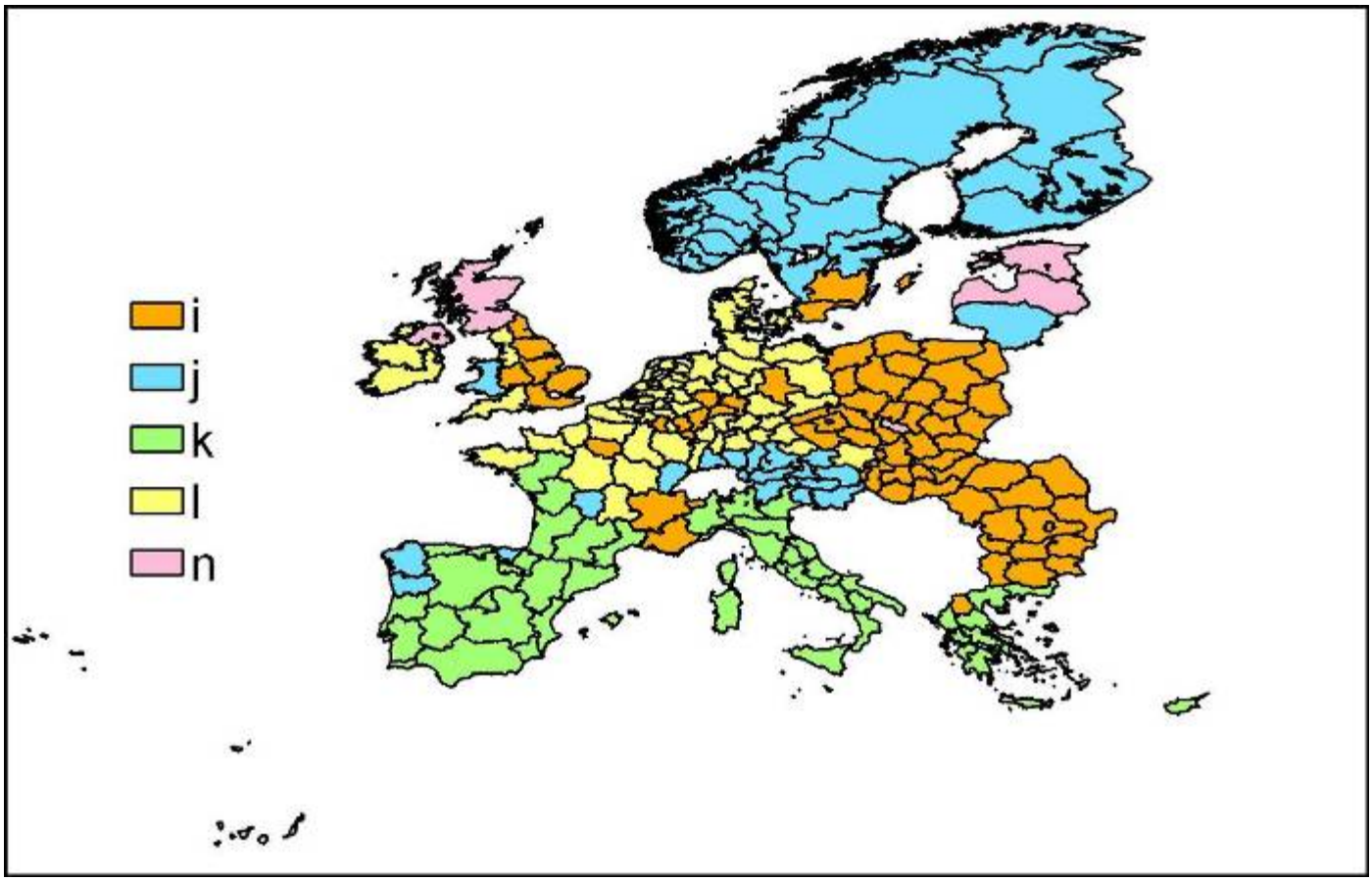


Figure 4: Map of the “ClimLPSmerge” for Beef Cattle

Table 3: Sheep and Goats (SHGOAT), "ClimLPS", number of responses, rules of aggregation.

LPS	Climates	No regions per association	No. regions to be sampled	Leader regions	Other regions	No. of Replies	Merge proposition	Kind of attribution
Complement to bovine intensive SHGOAT	Alpine	8	2	ES11 AT31	FR43 DE13 DE21 SI DE27 DE14		o	***1
Complement to bovine intensive SHGOAT	Arctic	2	1	FI13	NO233		o	***1
Complement to bovine intensive SHGOAT	Continental cold	2	1	NO123	NO254	1	o	**
Complement to bovine intensive SHGOAT	Continental temperate	13	3	DK DE25 DE80	DE23 DED0 DE73 DE24 CZ01 DE40 DEG0 DE22 DE26 RO08		q	***2
Complement to bovine intensive SHGOAT	Mediterranean dry	4	1	ES70	PT30 CY MT		p	***2
Complement to bovine intensive SHGOAT	Mediterranean wet	3	1	ITD3	ITC4 ITC1		p	***2
Complement to bovine intensive SHGOAT	Oceanic cold	1	1	NO244			o	***1
Complement to bovine intensive SHGOAT	Oceanic temperate	32	7	BE35 DEA4 DEA2 BE23 DEA5 DE11 BE21	FR23 BE24 DEB1 LU00 FR52 FR30 BE31 FR41 DEA3 FR25 DE71 BE32 BE22 DE92 BE33 DE72 DE94 DEF0 DE12 DEA1 FR22 DEC0 DE93 BE25 DE91		q	***2
Complement to bovine mountainous SHGOAT	Alpine	6	2	AT22 ITD2	ES21 FR63 AT33 AT21	1	o	***2
Complement to bovine mountainous SHGOAT	Continental temperate	2	1	SE09	BG04		q	***2
Complement to bovine mountainous SHGOAT	Mediterranean dry	1	1	PT20		1	p	**
Complement to bovine mountainous SHGOAT	Mediterranean wet	3	1	ES12	ITC3 ES13		p	***2
Complement to bovine mountainous SHGOAT	Oceanic cold	2	1	AT32	AT34		o	***2
Complement to bovine mountainous SHGOAT	Oceanic temperate	7	2	IE02 BE34	DEB2 UKN IE01 ITC2 FR72		q	***2
Complement to dairy cattle Nordic SHGOAT	Arctic	5	2	SE08 NO122	SE07 NO111 NO121		o	***2
Complement to dairy cattle Nordic SHGOAT	Continental cold	2	1	NO231	SE06		o	***2
Complement to dairy cattle Nordic SHGOAT	Oceanic cold	4	1	NO241	NO242 NO243 NO252		o	***2
Complement to granivores intensive SHGOAT	Alpine	3	1	PT11	SE0A ITD4		o	***2
Complement to granivores intensive SHGOAT	Arctic	1	1	NO232			o	***2
Complement to granivores intensive SHGOAT	Continental cold	9	2	EE NO253	SE01 LT NO262 SE02 NO261 NO255 LV	1	o	***2
Complement to granivores intensive SHGOAT	Continental temperate	51	12	BG05 RO07 AT11 BG03 PL32 HU07 CZ05 FR82 AT12 SE04 CZ07 PL34	PL21 PL11 CZ08 HU02 PL33 PL12 PL22 CZ02 RO04 CZ03 PL41 BG02 PL43 BG01 HU04 RO03 PL62 PL31 CZ04 RO06 PL51 PL63 RO01 RO02 HU06 CZ06 PL42 PL61 HU03 PL52 HU01 HU05 RO05 DEE0 BG06 SK03 SK01 SK04 SK02	4	q	*
Complement to granivores intensive SHGOAT	Mediterranean dry	14	4	ES51 FR83 ES24 PT15	ES52 ITG1 ES53 ITF4 ES23 ES30 PT18 PT17 ES62 ITF3	1	p	**
Complement to granivores intensive SHGOAT	Mediterranean wet	15	4	FR51 ITF5 ITF6 ITE2	ITD5 ITE4 FR61 ITF1 ES22 FR62 FR81 ITF2 ITE3 PT16 ITE1		p	***1

Complement to granivores intensive SHGOAT	Oceanic cold	1	1	NO251			o	***1
Complement to granivores intensive SHGOAT	Oceanic temperate	7	2	FR42 FR71	FR24 FR10 DEB3 FR21 FR26		q	***1
Mediterranean free-ranging SHGOAT	Continental temperate	1	1	EL13			q	***2
Mediterranean free-ranging SHGOAT	Mediterranean dry	13	3	ITG2 EL43 ES43	EL41 ES42 ES41 ES61 EL25 EL24 EL14 EL30 EL12 EL42		p	***2
Mediterranean free-ranging SHGOAT	Mediterranean wet	5	2	EL22 FR53	EL23 EL21 EL11		p	***2
No declared activity	Arctic	1	1	FI1A		1	o	***2
No declared activity	Continental cold	3	1	FI19 FI18	FI20	2	o	***2
Temperate intensive indoor SHGOAT	Alpine	2	1	UKM	UKL	1	o	***2
Temperate intensive indoor SHGOAT	Oceanic temperate	20	5	NL33 NL23 NL21 UKJ NL32	NL42 NL34 UKD NL13 UKH UKK UKC UKG UKF NL41NL12 NL22 NL31 NL11 UKE	2	q	**

Description of the “ClimLPSmerge” category for Sheep and Goats:

Due to a poor rate of replies for this animal category, we had to merge the whole LPS categories and we kept only the differentiation of climate types.

o: This group corresponds to the assemblage of cold climate replies for the whole Sheep and Goats category. This group merged 16 records of the initial table and obtained a total of 7 replies.

p: This group corresponds to the assemblage of Mediterranean climate replies for the whole Sheep and Goats category. This group merged 8 records of the initial table and obtained only 2 replies.

q: This group corresponds to the assemblage of temperate climate replies for the whole Sheep and Goats category. This group merged 8 records of the initial table and obtained a total of 6 replies.

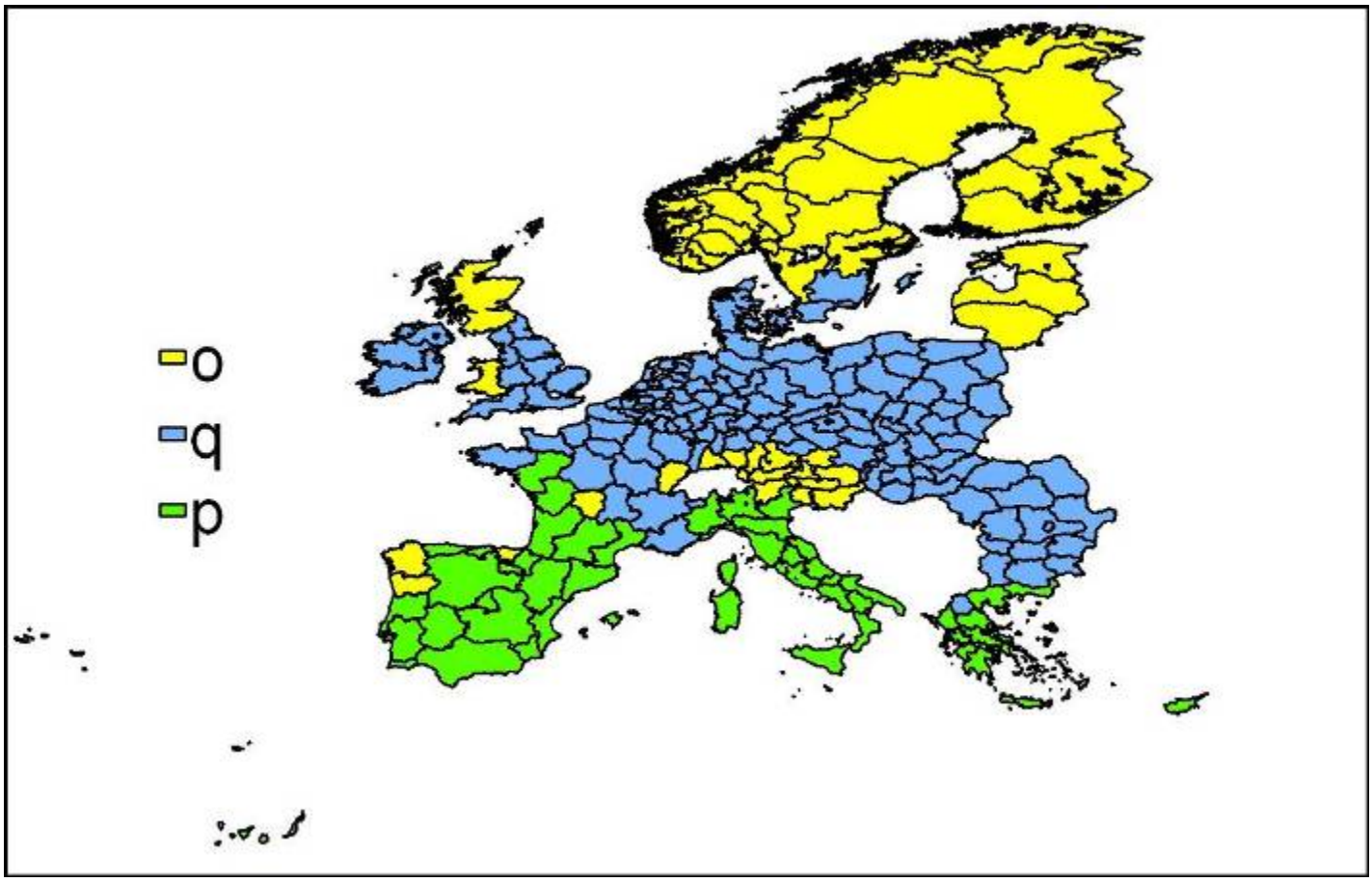


Figure 5: Map of the “ClimLPSmerge” for Sheep and Goats

Table 4: Fattening Pigs and Sows (PORCIN), "ClimLPS", number of responses, rules of aggregation.

LPS	Climates	No regions per association	No. regions to be sampled	Leader regions	Other regions	No. of Replies	Merge proposition	Kind of attribution
Common secondary intensive PORCIN	Alpine	11	3	FR43 ES21 AT33	ES11 DE21 FR63 AT21 DE27 DE14 AT31 DE13	1	r	**
Common secondary intensive PORCIN	Arctic	2	1	FI1A	FI13	1	r	**
Common secondary intensive PORCIN	Continental cold	3	1	FI20	FI19 FI18	1	r	**
Common secondary intensive PORCIN	Continental temperate	40	9	PL41 DE73 AT11 DE80 CZ06 DE24 DE26 DEG0 PL32	CZ08 DE40 PL52 PL43 PL62 CZ02 PL63 PL22 PL21 DE25 PL11 PL42 CZ01 PL34 PL33 CZ07 CZ05 PL51 PL61 CZ04 FR82 DE22 DE23 CZ03 PL31 DED0 DEE0 RO08 SK02 AT12 PL12	3	s	*
Common secondary intensive PORCIN	Mediterranean dry	16	4	ES52 PT17 PT30 PT15	ES24 ES30 ES41 ES61 ES42 FR83 ES23 MT ES70 ES53 ES43 CY	5	t	*
Common secondary intensive PORCIN	Mediterranean wet	9	2	PT16 FR51	FR81 FR53 ES22 ES12 FR61 ES13 FR62	2	t	**
Common secondary intensive PORCIN	Oceanic cold	2	1	AT34	AT32		r	***1
Common secondary intensive PORCIN	Oceanic temperate	31	7	FR30 DE12 FR42 DE91 BE35 DE92 DEF0	DE71 FR72 DEA4 BE24 FR71 DEA1 BE31 FR24 DE72 BE32 DEA2 LU00 DEB2 UKH DE11 DEA5 BE34 DEB3 FR26 FR25 DEC0 DE93 DEB1BE33	1	s	**
Primary intensive with bovine PORCIN	Alpine	1	1	AT22			r	***2
Primary intensive with bovine PORCIN	Mediterranean dry	2	1	ES51 ES62		6	u	*
Primary intensive with bovine PORCIN	Oceanic temperate	8	2	NL41 NL22	BE21 BE22 NL42 NL21 DEA3 NL31	2	v	**
Secondary complement to grazing PORCIN	Alpine	3	1	PT11	UKL UKM		aa	***2
Secondary complement to grazing PORCIN	Arctic	5	2	NO122 NO233	NO232 NO111 NO121	1	aa	***2
Secondary complement to grazing PORCIN	Continental cold	8	2	NO253 NO254	NO255 NO261 NO123 NO262 NO231 EE		aa	***2
Secondary complement to grazing PORCIN	Continental temperate	4	1	SK04	SK01 SK03 EL13		b	***2
Secondary complement to grazing PORCIN	Mediterranean dry	10	3	EL43 PT18 EL25	PT20 EL42 EL30 EL41 EL14 EL12 EL24		t	***2
Secondary complement to grazing PORCIN	Mediterranean wet	4	1	EL23	EL22 EL11 EL21		t	***2
Secondary complement to grazing PORCIN	Oceanic cold	6	2	NO242 NO241	NO243 NO252 NO244 NO251		aa	***2
Secondary complement to grazing PORCIN	Oceanic temperate	15	4	NL11 UKE NL23 NL12 IE01 IE02	UKD UKF NL32 UKK UKN NL33 NL34 UKG NL13	2	w	**
Secondary very intensive PORCIN	Alpine	2	1	ITD2	ITD4		r	***2
Secondary very intensive PORCIN	Continental temperate	7	2	HU01 HU07	HU02 HU03 HU04 HU06 HU05		s	***2
Secondary very intensive PORCIN	Mediterranean dry	4	1	ITG2	ITF3 ITF4 ITG1		x	***1
Secondary very intensive PORCIN	Mediterranean wet	13	3	ITE4 ITC1 ITD5 ITC4	ITE3 ITF5 ITE2 ITE1 ITD3 ITF1 ITF6 ITC3 ITF2	5	x	*

Secondary very intensive PORCIN	Oceanic temperate	3	1	BE25	ITC2 BE23		s	***2
Specialized PORCIN	Continental temperate	1	1	DK		5	y	*
Specialized PORCIN	Oceanic temperate	2	1	FR52	DE94	3	z	*
Subsidiary intensive with crops PORCIN	Oceanic temperate	7	2	FR10 UKC	UKJ FR23 FR21 FR41 FR22		s	***2
Subsidiary traditional PORCIN	Alpine	2	1	SI	SE0A		aa	***1
Subsidiary traditional PORCIN	Arctic	2	1	SE07	SE08		aa	***1
Subsidiary traditional PORCIN	Continental cold	5	2	LT SE02	LV SE06 SE01	2	aa	**
Subsidiary traditional PORCIN	Continental temperate	15	4	SE04 RO04 BG03 RO05 BG05	SE09 BG02 RO07 RO02 RO01 RO06 BG01 BG06 BG04RO03	5	b	*

Description of the "ClimLPSmerge" category for fattening pigs and sows:

r: This group corresponds to the assemblage of the cold climates within the LPS categories: "Common secondary intensive PORCIN", "Primary intensive with bovine PORCIN" and "Secondary very intensive PORCIN". This group merged 6 records of the initial table and obtained a total of 3 replies.

s: This group corresponds to the assemblage of the temperate climates within the LPS categories: "Common secondary intensive PORCIN", "Primary intensive with bovine PORCIN","Secondary very intensive PORCIN" and "Subsidiary intensive with crops PORCIN". This group merged 5 records of the initial table and obtained a total of 4 replies.

t: This group corresponds to the assemblage of the mediterranean climates within the LPS categories: "Common secondary intensive PORCIN" and " Secondary complement to grazing PORCIN". 4 records of the initial table were merged and obtained a total of 7 replies.

u: Due to sufficient replies, this group corresponds to the replies for the single initial record: "Primary intensive with bovine PORCIN" and "Mediterranean dry" climate. 6 replies were obtained.

v: As previous one, this group corresponds to the replies for the single initial record: "Primary intensive with bovine PORCIN" and "Oceanic temperate" climate. 2 replies were obtained.

w: As previous one, this group corresponds to the replies for the single initial record: "Secondary complement to grazing PORCIN" and "Oceanic temperate" climate. 2 replies were obtained.

x: This group corresponds to the assemblage of the Mediterranean climates within the LPS category: "Secondary very intensive PORCIN". 2 records of the initial table were merged and obtained a total of 5 replies.

y: Due to sufficient replies, this group corresponds to the replies for the single initial record: “Specialized PORCIN” and “Continental temperate” climate. 5 replies were obtained.

z: As previous one, this group corresponds to the replies for the single initial record: “Specialized PORCIN” and “Oceanic temperate” climate. 3 replies were obtained.

aa: This group corresponds to the assemblage of the cold climates within the LPS categories : “Secondary complement to grazing PORCIN” and “Subsidiary traditional PORCIN”. This group merged 7 records of the initial table and obtained a total of 3 replies.

b: This group corresponds to the assemblage of the temperate climates within the LPS categories : “Secondary complement to grazing PORCIN” and “Subsidiary traditional PORCIN”. This group merged 2 records of the initial table and obtained a total of 5 replies.

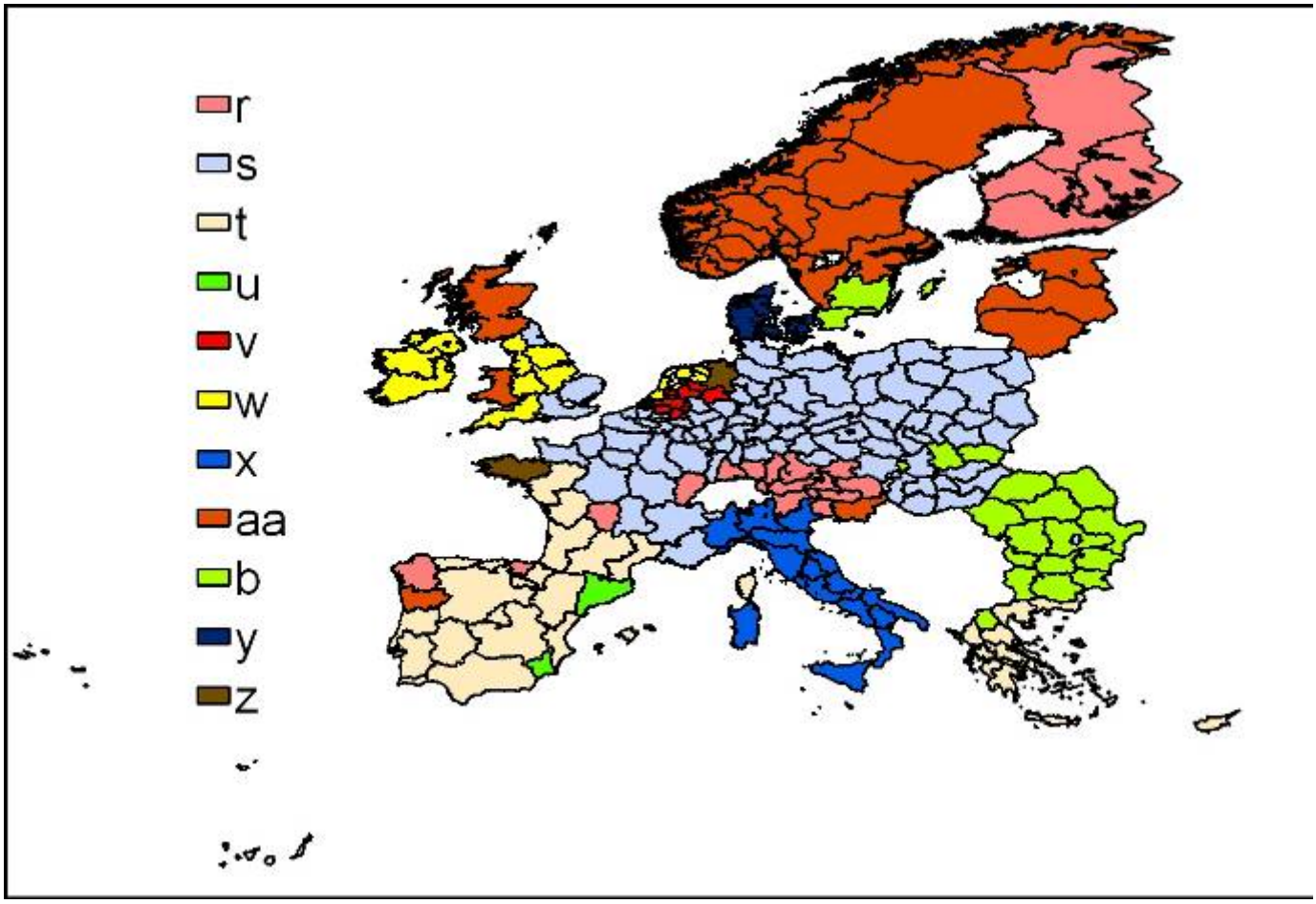


Figure 6: Map of the “ClimLPSmerge” for Pigs and Sows

Table 5: Laying Hens (LAHENS), "ClimLPS", number of responses, rules of aggregation.

LPS	Climates	No regions per association	No. regions to be sampled	Leader regions	Other regions	No. of Replies	Merge proposition	Kind of attribution
No declared activity	Alpine	1	1	ITD2			ad	***2
No declared activity	Arctic	3	1	NO122	NO121 NO111		ad	***2
No declared activity	Continental cold	1	1	NO255			ad	***2
No declared activity	Mediterranean dry	2	1	PT30	PT20		ac	***2
No declared activity	Oceanic cold	4	1	NO251	NO242 NO252 NO241		ad	***2
No declared activity	Oceanic temperate	4	1	UKD	UKC UKJ UKH		ab	***2
Primary economically constrained LAHENS	Alpine	1	1	SI			ad	***2
Primary economically constrained LAHENS	Continental cold	2	1	LV	LT		ad	***2
Primary economically constrained LAHENS	Continental temperate	31	7	RO02 PL63 RO03 PL32 RO07 BG01 RO06	RO08 PL51 PL31 RO05 PL62 BG02 BG04 PL11 RO01 BG03 BG05 PL42 PL33 EL13 RO04 PL61 BG06 PL41 PL12 PL52 PL34 PL43 PL22 PL21	2	ab	***2
Primary economically constrained LAHENS	Mediterranean dry	8	2	EL42 EL43	EL12 EL24 EL25 EL14 CY EL41		ac	***2
Primary economically constrained LAHENS	Mediterranean wet	3	1	EL11	EL23 EL22		ac	***2
Primary very dependent LAHENS	Alpine	3	1	UKL	UKM ITD4	1	ad	***2
Primary very dependent LAHENS	Arctic	1	1	NO232			ad	***2
Primary very dependent LAHENS	Continental cold	4	1	NO261	NO254 NO253 NO262		ad	***2
Primary very dependent LAHENS	Continental temperate	10	3	HU06 HU05 HU02	HU01 HU03 SK01 SK03 HU07 SK02 SK04		ab	***2
Primary very dependent LAHENS	Mediterranean dry	8	2	EL30 ES41	ES70 ES53 ES30 ES61 MT ES42	2	ac	**
Primary very dependent LAHENS	Mediterranean wet	12	3	ITC4 ITD5 FR51	ITE3 ES12 ITF1 ITC1 ITF2 EL21 ITD3 ES13 ITE2	1	ac	**
Primary very dependent LAHENS	Oceanic cold	1	1	NO244			ad	***2
Primary very dependent LAHENS	Oceanic temperate	18	4	UKE NL42 DE94 UKF FR52	BE21 NL22 NL11UKG NL12 UKN NL13 NL34 NL41 NL31 NL21 UKK NL23	4	ab	*
Subsidiary climatically contrained LAHENS	Alpine	1	1	SE0A			ad	***2
Subsidiary climatically contrained LAHENS	Arctic	2	1	SE07	SE08		ad	***2
Subsidiary climatically contrained LAHENS	Continental cold	3	1	SE02	SE01 SE06		ad	***2
Subsidiary climatically contrained LAHENS	Continental temperate	2	1	SE04	SE09		ab	***2
Subsidiary common intensive LAHENS	Alpine	12	3	ES21 ES11 AT31	AT21 DE21 DE27 AT22 FR63 PT11 DE14 DE13 AT33	1	ad	**
Subsidiary common intensive LAHENS	Arctic	3	1	NO233 FI1A	FI13	2	ad	**
Subsidiary common intensive LAHENS	Continental cold	6	2	NO231 FI19	FI20 FI18 NO123 EE		ad	***1

Subsidiary common intensive LAHENS	Continental temperate	23	6	CZ04 DED0 HU04 CZ02 AT12 DE23	DK DE26 DE80 DEE0 AT11 CZ08 DEG0 FR82 DE25 CZ03 DE22 DE24 DE40 DE73 CZ06 CZ05 CZ07	2	ab	***2
Subsidiary common intensive LAHENS	Mediterranean dry	13	3	ES52 ES43 ES23	ES24 ES51 PT17 ITG2 PT18 ITF4 ITG1 ES62 ITF3 PT15		ac	***2
Subsidiary common intensive LAHENS	Mediterranean wet	9	2	PT16 ITE1	ES22 ITF6 FR81 ITF5 FR61 ITC3 ITE4	1	ac	**
Subsidiary common intensive LAHENS	Oceanic cold	3	1	AT32	NO243 AT34		ad	***1
Subsidiary common intensive LAHENS	Oceanic temperate	37	9	NL33 FR42 DE12 BE24 ITC2 DEA3 DEA4 DE11 DE92	DE91 DE72 FR72 FR25 IE02 BE31 DEB2 BE25 FR71 DEA1 DEF0 BE22 FR30 DEB3 DE93 BE34 DEC0 LU00 NL32 BE33 IE01 DEA5 BE32 BE23 DEA2 DE71 DEB1 BE35		ab	***1
Subsidiary complement to crops LAHENS	Alpine	1	1	FR43			ad	***2
Subsidiary complement to crops LAHENS	Continental temperate	1	1	CZ01			ab	***2
Subsidiary complement to crops LAHENS	Mediterranean dry	3	1	FR83	FR53 FR62		ac	***2
Subsidiary complement to crops LAHENS	Oceanic temperate	7	2	FR22 FR26	FR10 FR23 FR21 FR24 FR41		ab	***2

Description of the “ClimLPSmerge” categories for Laying hens:

Due to a poor rate of replies for this animal category, we had to merge the whole LPS categories and we kept only the differentiation of climate types.

ab: This group corresponds to the assemblage of temperate climate replies for the whole Laying hens category. This group merged 9 records of the initial table and obtained a total of 8 replies.

ac: This group corresponds to the assemblage of mediterranean climate replies for the whole Laying hens category. This group merged 8 records of the initial table and obtained a total of 4 replies.

ad: This group corresponds to the assemblage of cold climate replies for the whole Laying hens category. This group merged 19 records of the initial table and obtained a total of 4 replies.

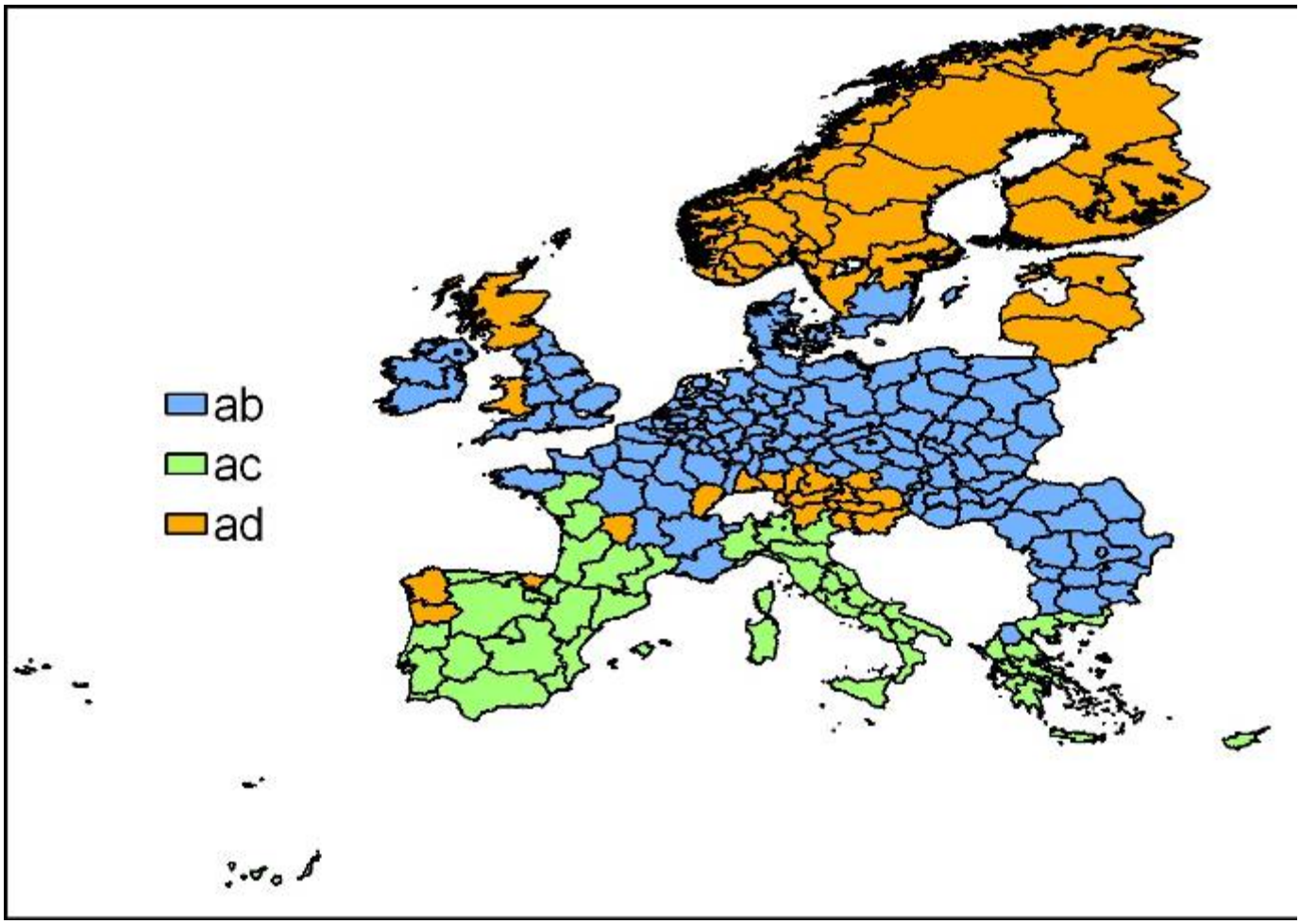


Figure 7: Map of the “ClimLPSmerge” for laying hens

Table 6: All other Poultry (POUFAT), "ClimLPS", number of responses, rules of aggregation.

LPS	Climates	No regions per association	No. regions to be sampled	Leader regions	Other regions	No. of Replies	Merge proposition	Kind of attribution
No declared activity	Alpine	1	1	ITD2			ae	***2
No declared activity	Arctic	3	1	NO122	NO111 NO121		ae	***2
No declared activity	Mediterranean dry	2	1	PT30	PT20		af	***2
No declared activity	Oceanic cold	2	1	NO241	NO252		ae	***2
No declared activity	Oceanic temperate	4	1	UKH	UKC UKD UKJ		ag	***2
Primary very intensive POUFAT	Alpine	3	1	ITD4	UKM UKL	1	ae	**
Primary very intensive POUFAT	Continental temperate	6	2	HU02 HU05	HU03 HU06 HU01 HU07		ag	***2
Primary very intensive POUFAT	Mediterranean dry	4	1	ES61	ES41 ES42 ES30		af	***1
Primary very intensive POUFAT	Mediterranean wet	9	2	FR51 ITD5 ITD3 ITC4 ITE3 ITE2	ITF2 FR61 ITC1	6	af	*
Primary very intensive POUFAT	Oceanic temperate	8	2	UKN UKK FR52	UKG UKE DE94 UKF FR71	1	ag	***2
Secondary very dependent Canarias POUFAT	Mediterranean dry	1	1	ES70			af	***2
Subsidiary constrained intensive POUFAT	Alpine	1	1	PT11		1	ae	**
Subsidiary constrained intensive POUFAT	Arctic	4	1	NO233 FI1A	FI13 NO232	1	ae	**
Subsidiary constrained intensive POUFAT	Continental cold	12	3	FI19 EE NO255	NO253 NO231 LV FI18 NO254 NO261 NO262 FI20 NO123		ae	***1
Subsidiary constrained intensive POUFAT	Continental temperate	21	5	DK RO08 CZ01 CZ03 SK01	SK04 RO03 RO01 CZ04 RO02 RO04 CZ02 CZ06 RO05 SK02 CZ05 RO06 CZ07 CZ08 SK03 RO07	3	ag	*
Subsidiary constrained intensive POUFAT	Mediterranean dry	3	1	PT18	PT15 PT17	1	af	**
Subsidiary constrained intensive POUFAT	Mediterranean wet	1	1	PT16		1	af	**
Subsidiary constrained intensive POUFAT	Oceanic cold	4	1	NO251	NO244 NO242 NO243		ae	***2
Subsidiary constrained intensive POUFAT	Oceanic temperate	2	1	IE02 IE01		2	ag	**
Subsidiary constrained natural rhythm POUFAT	Alpine	9	2	AT21 AT31	DE27 AT33 DE21 DE14 DE13 AT22 SE0A		ae	***2
Subsidiary constrained natural rhythm POUFAT	Arctic	2	1	SE08	SE07		ae	***2
Subsidiary constrained natural rhythm POUFAT	Continental cold	4	1	LT	SE02 SE01 SE06		ae	***2
Subsidiary constrained natural rhythm POUFAT	Continental temperate	37	9	DE73 AT12 DEG0 BG03 DE24 PL21 PL62 DE22 DE25 SE04	PL52 DE80 PL32 BG05 BG06 PL11 BG01 PL22 DE26 PL43 PL42 PL12 DE40 SE09 BG04 PL34 PL51 PL61 PL31 AT11 PL63 DED0 DE23 PL33 DEE0 PL41 BG02	3	ai	*
Subsidiary constrained natural rhythm POUFAT	Mediterranean dry	5	2	ITF3 ITG1	ITG2 CY ITF4		af	***2
Subsidiary constrained natural rhythm POUFAT	Mediterranean wet	6	2	ITC3 ITF1	ITF6 ITE4 ITF5 ITE1		af	***2

Subsidiary constrained natural rhythm POUFAT	Oceanic cold	2	1	AT32	AT34		ae	***
Subsidiary constrained natural rhythm POUFAT	Oceanic temperate	18	4	DEA2 DE71 DEA1 DEF0	DE93 DEB1 DEA5 DEB3 DE91 DEC0 ITC2 DEA3 DE92 DE12 DEA4 DE72 DEB2 DE11		ai	***1
Subsidiary very dependent POUFAT	Oceanic temperate	12	3	NL32 NL22 NL41	NL13 NL21 NL31 NL12 NL42 NL23 NL33 NL34 NL11	3	ah	*
Subsidiary with cattle intensive POUFAT	Alpine	4	1	SI	FR63 ES11 ES21		ae	***2
Subsidiary with cattle intensive POUFAT	Continental temperate	3	1	EL13	HU04 FR82		ai	***2
Subsidiary with cattle intensive POUFAT	Mediterranean dry	16	4	EL25 ES52 EL12 ES23	ES43 ES62 ES24 EL30 EL42 EL41 MT ES53 EL14 EL24 ES51 EL43		af	***2
Subsidiary with cattle intensive POUFAT	Mediterranean wet	8	2	ES12 FR81	EL22 EL23 ES22 EL21 EL11 ES13		af	***2
Subsidiary with cattle intensive POUFAT	Oceanic temperate	15	4	FR25 LU00 BE22 BE32	BE34 BE25 BE24 BE33 FR42 BE23 BE31 FR72 BE35 FR30 BE21		ag	***2
Subsidiary with cattle very intensive POUFAT	Alpine	1	1	FR43			ae	***2
Subsidiary with cattle very intensive POUFAT	Mediterranean dry	1	1	FR83			af	***2
Subsidiary with cattle very intensive POUFAT	Mediterranean wet	2	1	FR53	FR62		af	***2
Subsidiary with cattle very intensive POUFAT	Oceanic temperate	7	2	FR23 FR22	FR21 FR10 FR26 FR41 FR24		ag	***2

ae: This group corresponds to the assemblage of cold climate replies for the whole POUFAT category. This group merged 14 records of the initial table and obtained a total of 3 replies.

af: This group corresponds to the assemblage of Mediterranean climate replies for the whole POUFAT category. This group merged 12 records of the initial table and obtained a total of 8 replies.

ag: This group corresponds to the assemblage of the temperate climates within the LPS categories : “Subsidiary constrained intensive POUFAT”, “Subsidiary with cattle intensive POUFAT” and “Primary very intensive POUFAT”. This group merged 7 records of the initial table and obtained a total of 6 replies.

ah: Due to sufficient replies, this group corresponds to the replies for the single initial record: “Subsidiary very dependent POUFAT” and “Oceanic temperate” climate. 3 replies were obtained.

ai: Due to sufficient replies, this group corresponds to the replies for the single initial record: “Subsidiary constrained natural rhythm POUFAT” and “Continental temperate” climate. 3 replies were obtained.

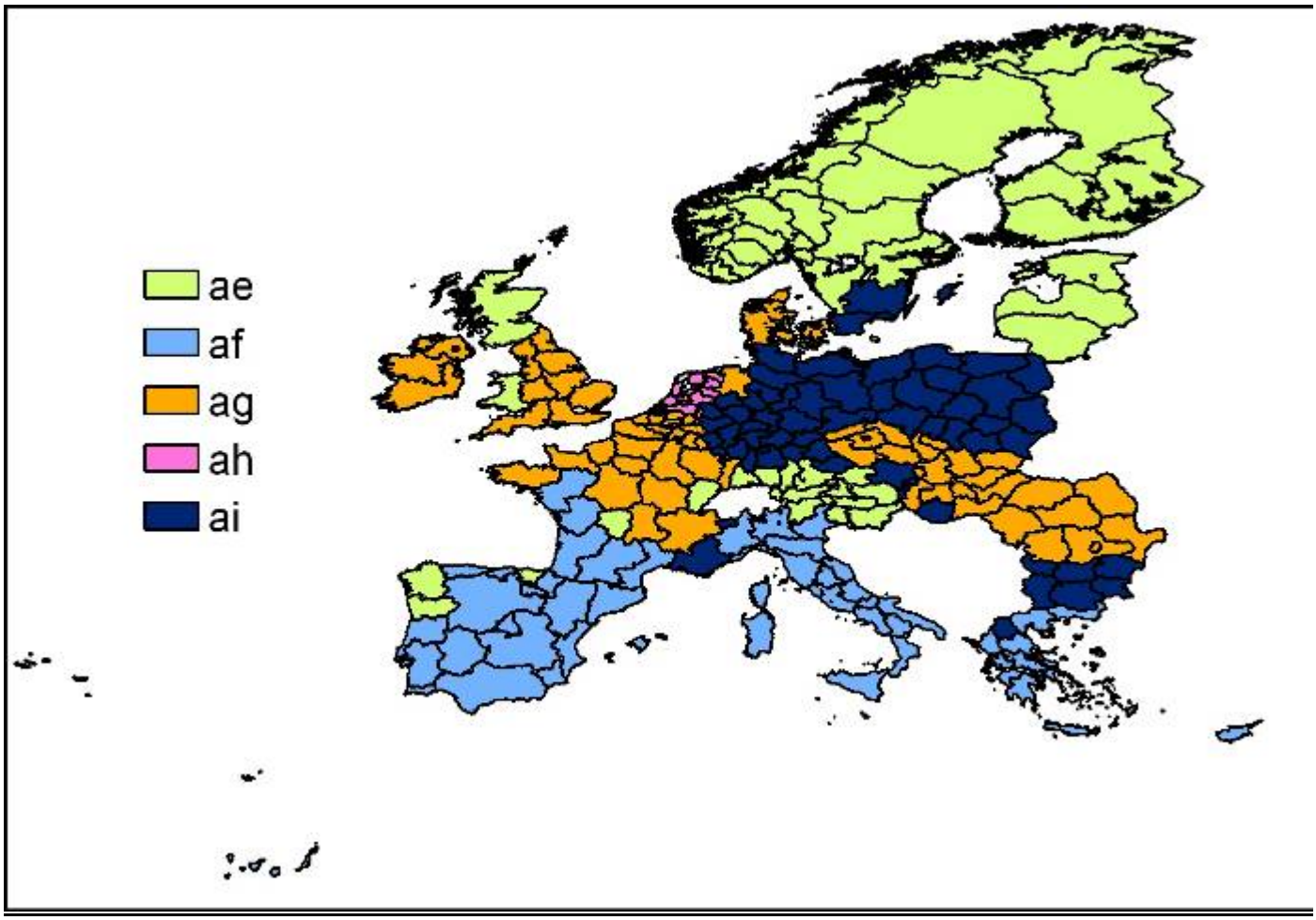


Figure 8: Map of the “ClimLPSmerge” categories for all other poultry

3- Results of the questionnaires' analysis

3.1- Pre-analysis of Raw data

The raw data were first reviewed in order to avoid some errors while averaging the data. Indeed, very often, checklists were left blank (ie "No Data") instead of 0% which was the case. Thus, we checked if the sum of fields equalled 100% and in so, we replaced "No data" with 0%. In a few cases, the sum was not equal to 100%. When it was about 90%, we decided to input the rest of the 10% in the "other" category.
If only a few fields have been completed and, with a percentage <90%, then we replaced by "No Data".
In rare cases, more accurate data in relation to steps of 10% was noted in the comments boxes, so we replaced with these more precise data supplied.

3.2- Results in support to the GGELS project

From the data gathered by the questionnaires, the main manure management practices and their prevalence can be reasonable established across the EU 27 for the groups of regions as defined previously.
In support to the GGELS project, the questionnaires provide information on management practices which will allow a support in the methodology as used by JRC to complete the GHG inventory.

The relevant data collected that present a special interest for the GGELS project are:

- **The Solid/Liquid manure fractions**
- **The Storage capacity of Solid Manure and Liquid Manure**
- **The Time spent indoors/outdoors**
- **The Characteristics of Solid and Liquid Manure storage**
- **The treatments of Solid and Liquid Systems**
- **The land application techniques for Solid and Liquid spreading**
- **Kind of incorporation**
- **The periods of land application**

3.2.1 – The Solid/Liquid manure fractions

		Solid manure system - %	Liquid manure system - %
BOMILK	a	48,0	52,0
	c	7,5	92,5
	d	80,0	20,0
	e	66,0	34,0
	f	15,0	85,0
	g	58,0	42,0
	h	20,8	79,2
BOMEAT	i	90,0	10,0
	j	53,3	46,7
	k	77,1	22,9
	l	60,7	39,3
	n	75,0	25,0
SHGOAT	o	100,0	0,0
	p	100,0	0,0
	q	84,0	16,0
PORCIN	r	16,7	83,3
	s	22,5	77,5
	t	10,0	90,0
	u	6,7	93,3
	v	5,0	95,0
	w	0,0	100,0
	x	8,0	92,0
	y	10,0	90,0
	z	10,0	90,0
	aa	10,0	90,0
	b	26,0	74,0
LAHENS	ab	98,8	1,3
	ac	95,0	5,0
	ad	95,0	5,0
POUFAT	ae	100,0	0,0
	af	100,0	0,0
	ag	96,7	3,3
	ah	90,0	10,0
	ai	100,0	0,0

Table 7: Fractions of Solid and Liquid Manure Systems (%) for each “ClimLPSmerge” category

The “ClimLPSmerge”: **x** corresponds to “Pigs and sows” is mainly represented by regions within Italy. The value obtained from the questionnaire analysis is 8.0% for Solid Manure and 92.0% for Liquid Manure. The RAINS values for Italy are close to these results with the values of 100% and 0% respectively.
Doing the same, we can compare the “ClimLPSmerge”: **y** corresponding to Pigs in Denmark. The value obtained from the questionnaire analysis is 10.0% for Solid Manure and 90.0% for Liquid Manure. The RAINS and the National inventories values for Denmark are very close to these results.
Also, we can focus on the “ClimLPSmerge” **c** that is for Dairy Cattles and exclusively represented by regions within Ireland and United Kingdom. The value obtained from the questionnaire analysis is very close to the RAINS value for Ireland.

In very general, the questionnaires' results show a certain coherence with the RAINS values. The global trends are similar, i.e.:

- Pigs and sows are mostly raised in Liquid manure management systems
- Beef Cattles are generally raised in Solid manure management systems
- Dairy Cattles are variously managed in Liquid or Solid manure management systems

In addition to the above table 7, the table 8 may complete the data and become an alternative in the framework of the GGELS project.

3.2.2 – The Storage capacity of Solid Manure and Liquid Manure

		SOLID					LIQUID		
		< 2 months	2-6 months	6-10 months	> 10 months	< 2 months	2-6 months	6-10 months	> 10 months
BOMILK	a	0,0	2,0	58,0	40,0	0,0	8,0	86,0	6,0
	c	6,7	33,3	26,7	33,3	12,5	82,5	2,5	2,5
	d	0,0	100,0	0,0	0,0	0,0	100,0	0,0	0,0
	e	0,0	6,7	43,3	50,0	0,0	60,0	23,3	16,7
	f	20,0	70,0	10,0	0,0	15,0	70,0	15,0	0,0
	g	20,0	56,7	10,0	13,3	16,7	80,0	3,3	0,0
	h	4,0	55,0	37,0	4,0	2,1	61,4	33,6	2,9
BOMEAT	i	2,5	22,5	35,0	40,0	2,5	75,0	12,5	10,0
	j	5,0	80,0	5,0	10,0	10,0	40,0	30,0	20,0
	k	32,5	58,8	5,0	3,8	62,5	25,0	7,5	5,0
	l	3,6	42,9	48,6	5,0	10,0	64,6	20,8	4,6
	n	0,0	26,7	66,7	6,7	20,0	50,0	30,0	0,0
SHGOAT	o	0,0	18,3	66,7	15,0				
	p	5,0	45,0	0,0	50,0				
	q	6,0	14,0	18,0	62,0	16,7	26,7	30,0	26,7
PORCIN	r	0,0	0,0	0,0	100,0	0,0	0,0	0,0	100,0
	s	0,0	85,0	10,0	5,0	5,0	82,5	12,5	0,0
	t	100,0	0,0	0,0	0,0	0,0	90,0	10,0	0,0
	u	30,0	60,0	10,0	0,0	20,0	65,0	15,0	0,0
	v	0,0	25,0	65,0	10,0	0,0	10,0	75,0	15,0
	w					0,0	100,0	0,0	0,0
	x	10,0	90,0	0,0	0,0	15,0	80,0	5,0	0,0
	y	2,0	10,0	42,0	46,0	2,0	4,0	60,0	34,0
	z	0,0	0,0	0,0	100,0	0,0	0,0	93,3	6,7
	aa	3,3	20,0	73,3	5,0	0,0	0,0	66,7	50,0
	b	6,7	20,0	20,0	53,3	10,0	10,0	30,0	50,0
LAHENS	ab	17,1	38,6	35,7	8,6	0,0	30,0	70,0	0,0
	ac	42,5	42,5	7,5	7,5	0,0	70,0	20,0	10,0
	ad	25,0	0,0	50,0	25,0	0,0	0,0	100,0	0,0
POUFAT	ae	30,0	33,3	3,3	33,3				
	af	37,5	55,0	7,5	0,0				
	ag	20,0	55,0	20,0	5,0	33,3	53,3	13,3	0,0
	ah	50,0	50,0	0,0	0,0				
	ai	6,7	33,3	46,7	13,3				

Table 8: Storage capacity of Solid Manure and Liquid Manure (%)

The “No data” values present in this table are in coherence with the previous table because the percentages of Solid manure systems and Liquid manure systems are equalled to 100%. Consequently, experts didn’t need to fill out the storage capacities.

3.2.3 – The Time spent indoors/outdoors

		Winter (November to February)	Spring (Mars to May)	Summer (June to August)	Autumn (September to October)	Average Time Indoors	Average Time outdoors
BOMILK	a	56,0	50,0	52,0	38,0	**49,0**	**51,0**
	c	97,5	45,0	37,5	55,0	**58,8**	**41,3**
	d	10,0	10,0	40,0	40,0	**25,0**	**75,0**
	e	50,0	52,9	68,6	65,7	**59,3**	**40,7**
	f	95,0	90,0	95,0	95,0	**93,8**	**6,3**
	g	88,0	78,0	74,0	80,0	**80,0**	**20,0**
	h	100,0	52,1	45,7	52,9	**62,7**	**37,3**
BOMEAT	i	62,5	35,0	12,5	20,0	**32,5**	**67,5**
	j	94,0	37,5	5,0	20,0	**39,1**	**60,9**
	k	47,1	28,6	20,0	27,1	**30,7**	**69,3**
	l	61,4	47,9	27,9	38,6	**43,9**	**56,1**
	n	75,0	80,0	45,0	52,5	**63,1**	**36,9**
SHGOAT	o	72,9	58,6	25,7	41,4	**49,6**	**50,4**
	p	50,0	90,0	90,0	90,0	**80,0**	**20,0**
	q	68,0	12,0	6,0	16,0	**25,5**	**74,5**
PORCIN	r	100,0	96,7	96,7	96,7	**97,5**	**2,5**
	s	75,0	57,5	67,5	55,0	**63,8**	**36,3**
	t	94,3	94,3	94,3	94,3	**94,3**	**5,7**
	u	100,0	98,0	98,0	98,0	**98,5**	**1,5**
	v	100,0	100,0	100,0	100,0	**100,0**	**0,0**
	w	100,0	100,0	100,0	100,0	**100,0**	**0,0**
	x	100,0	100,0	100,0	100,0	**100,0**	**0,0**
	y	100,0	100,0	100,0	100,0	**100,0**	**0,0**
	z	100,0	100,0	100,0	100,0	**100,0**	**0,0**
	aa	66,7	63,3	63,3	63,3	**64,2**	**35,8**
	b	50,0	50,0	60,0	46,0	**51,5**	**48,5**
LAHENS	ab	93,8	88,8	88,8	88,8	**90,0**	**10,0**
	ac	100,0	100,0	100,0	100,0	**100,0**	**0,0**
	ad	85,0	82,5	82,5	82,5	**83,1**	**16,9**
POUFAT	ae	96,7	96,7	96,7	96,7	**96,7**	**3,3**
	af	97,5	97,5	97,5	97,5	**97,5**	**2,5**
	ag	96,7	96,7	96,7	96,7	**96,7**	**3,3**
	ah	100,0	90,0	90,0	90,0	**92,5**	**7,5**
	ai	100,0	100,0	100,0	100,0	**100,0**	**0,0**

Table 9: Total percentage of time animals spends indoors (%) compared to time spend outdoors

As a support to the GGELS project, the questionnaires’ results regarding the average time animals spend outdoors can be compared to actual data.

In very general, global trends are the same between the comparable species: Sheep and goats spend more time outdoors, Beef Cattle spend more or less half time outdoors while the trend for Dairy cattle is more various.

Pigs and Sows and Poultry show trends in coherence with relatively confined livestock production systems.

In more details, Average time spent outdoors deriving from questionnaires’ results for Dairy Cattles show a strange value regarding the “ClimLPSmerge”: **f**. However, very few time spent

outdoors can be explained by the assemblage of cold climates with an intensive production system.
The same comparison can be done for the “ClimLPSmerge”: **e** representing a group of regions from Eastern Europe (Czech Republic, Romania, Hungary and Slovakia). Indeed, the value obtained from the questionnaire analysis is 40.7% whereas the average value from RAINS is 39.5% while the National inventories show trends very far from this values (between 8% and 13%).
However, one ClimLPS belonging to Sheep and Goats (“ClimLPSmerge”: **p**) looks like surprising. The result of 20% spent outdoors is based on 2 expert replies. Nevertheless, this result comes from Spain and is in coherence with the National Inventories value but very different compared to the RAINS value.

3.2.4 – The characteristics of Solid and Liquid Manure storage

		SOLID							LIQUID								
		Field storage (as heap)	% Covered	On farm storage	% Covered	Other	% Covered		On farm storage	% Covered	% Below ground	Lagooning system	% Covered	% Below ground	Other	% Covered	% Below ground
BOMILK	a	2,5	0,0	97,5	10,0	0,0			77,5	42,5	75,0	0,0	3,3	0,0	22,5	100,0	100,0
	c	27,5	3,3	72,5	10,0	0,0			80,0	20,0	75,0	20,0	0,0	33,3	0,0		0,0
	d	50,0		50,0		0,0			100,0			0,0			0,0		
	e	23,3	0,0	76,7	0,0	0,0			90,0	30,0	33,3	10,0	0,0	100,0	0,0		
	f	50,0	0,0	45,0	20,0	5,0			100,0	80,0	75,0	0,0			0,0	20,0	20,0
	g	20,0	0,0	56,0	10,0	24,0	0,0		96,0	54,0	66,0	5,0	0,0	66,7	0,0	0,0	
	h	23,8	11,4	76,3	17,1	0,0			100,0	55,7	48,5	0,0	0,0	0,0	0,0	0,0	0,0
BOMEAT	i	30,0	0,0	70,0	10,0	0,0	0,0		90,0	12,5	27,5	10,0	0,0	75,0	0,0	0,0	0,0
	j	24,0	0,0	76,0	72,5	0,0			55,0	40,0	86,7	5,0	0,0	0,0	40,0	100,0	100,0
	k	25,0	6,7	35,0	20,0	40,0			75,0	20,0		25,0	90,0		0,0		
	l	41,7	3,3	55,8	18,2	2,5	4,0		94,0	88,0	60,0	4,0	0,0	0,0	2,0	20,0	0,0
	n	60,0	0,0	40,0	10,0	0,0			80,0	35,0	20,0	20,0	0,0	25,0	0,0		
SHGOAT	o	28,6	0,0	71,4	66,7	0,0				0,0	0,0		0,0	0,0			
	p	15,0	0,0	45,0	10,0	40,0											
	q	48,0	15,0	50,0	55,0	2,0	20,0		80,0	40,0	43,3	20,0	20,0	56,7	0,0		0,0
PORCIN	r	0,0		100,0	6,7	0,0			83,3	40,0	100,0	16,7			0,0		
	s	40,0	0,0	60,0	10,0	0,0			92,5	43,3	32,5	7,5	5,0	50,0	0,0		
	t	10,0	0,0	90,0	80,0	0,0			5,7	45,7	51,4	94,3	0,0	57,1	0,0	0,0	0,0
	u	70,0	5,0	30,0	5,0	0,0			40,0	13,3	84,0	43,3	5,0	76,0	16,7		
	v	0,0	0,0	80,0	80,0	20,0	100,0		70,0	100,0	100,0	10,0	50,0	20,0	20,0	100,0	100,0
	w								100,0	90,0	100,0	0,0			0,0		
	x	0,0		100,0	10,0	0,0			75,0	17,5	32,5	25,0	0,0	100,0	0,0		
	y	22,5	52,5	77,5	35,0	0,0	0,0		95,0	44,0	0,0	5,0	80,0	0,0	0,0	0,0	50,0
	z	20,0	0,0	80,0	10,0	0,0	0,0		100,0	10,0	80,0	0,0	0,0	0,0	0,0		
	aa	33,3	0,0	66,7	50,0	0,0			100,0	90,0	60,0	0,0	20,0	20,0	0,0		
	b	48,0	0,0	48,0	80,0	4,0	20,0		22,5	70,0		75,0		40,0	2,5	30,0	60,0
LAHENS	ab	52,9	34,3	47,1	16,0	0,0	0,0		100,0			0,0			0,0		
	ac	35,0	0,0	57,5	73,3	7,5			100,0	20,0	30,0	0,0			0,0		
	ad	0,0		100,0	70,0	0,0			100,0	100,0	100,0	0,0			0,0		
POUFAT	ae	13,3	20,0	70,0	46,7	16,7	100,0										
	af	28,8	16,7	36,3	56,3	35,0	100,0										
	ag	40,0	20,0	43,3	15,0	16,7			93,3	73,3	100,0	0,0			6,7		
	ah	0,0		100,0	100,0	0,0			100,0	100,0		0,0			0,0		
	ai	70,0		30,0	100,0	0,0											

Table 10: Fractions of the different storage systems of Solid and Liquid Manure (Percentages)

In complement to the previous tables, this table describes the types of storage for Solid and Liquid Manure with or without covered systems. For the use of these values in models, these data should be applied with the values from table 7.

3.2.5 – The treatments of Solid and Liquid Systems

		SOLID							LIQUID				
		No treatment	biogas production	Composting	Drying processes	Incineration	Other		No treatment	biogas production	Aerobic processes	Solid separation	Other
BOMILK	a	70,0	0,0	25,0	0,0	5,0	0,0		72,0	2,0	26,0	0,0	0,0
	c	93,0	0,3	6,7	0,0	0,0	0,0		89,5	3,0	0,0	7,5	0,0
	d	100,0	0,0	0,0	0,0	0,0	0,0		100,0	0,0	0,0	0,0	0,0
	e	76,7	13,3	10,0	0,0	0,0	0,0		73,3	16,7	0,0	10,0	0,0
	f	100,0	0,0	0,0	0,0	0,0	0,0		98,5	0,0	0,0	1,5	0,0
	g	96,7	0,0	0,0	0,0	0,0	3,3		80,0	6,7	0,0	10,0	3,3
	h	90,0	2,0	5,0	3,0	0,0	0,0		92,1	5,7	0,0	2,1	0,0
BOMEAT	i	77,5	22,5	0,0	0,0	0,0	0,0		67,5	25,0	0,0	7,5	0,0
	j	97,5	0,0	0,0	0,0	0,0	2,5		100,0	0,0	0,0	0,0	0,0
	k	73,3	6,7	20,0	0,0	0,0	0,0		50,0	15,0	15,0	20,0	0,0
	l	92,7	0,0	6,4	0,0	0,0	0,9		76,0	9,0	15,0	0,0	0,0
	n	90,0	0,0	5,0	0,0	0,0	5,0		90,0	0,0	0,0	10,0	0,0
SHGOAT	o	76,7	0,0	23,3	0,0	0,0	0,0						
	p	90,0	0,0	10,0	0,0	0,0	0,0						
	q	38,0	4,0	52,0	6,0	0,0	0,0		40,0	13,3	23,3	13,3	10,0
PORCIN	r	100,0	0,0	0,0	0,0	0,0	0,0		83,3	0,0	16,7	0,0	0,0
	s	53,3	3,3	43,3	0,0	0,0	0,0		47,5	12,5	2,5	37,5	0,0
	t	60,0	0,0	40,0	0,0	0,0	0,0		10,0	10,0	0,0	80,0	0,0
	u	75,0	5,0	20,0	0,0	0,0	0,0		79,7	2,7	2,0	10,0	5,7
	v	80,0	5,0	0,0	10,0	0,0	5,0		90,0	5,0	0,0	0,0	5,0
	w	100,0	0,0	0,0	0,0	0,0	0,0		100,0	0,0	0,0	0,0	0,0
	x	100,0	0,0	0,0	0,0	0,0	0,0		75,0	5,0	5,0	15,0	0,0
	y	93,0	5,0	2,0	0,0	0,0	0,0		83,0	10,0	0,0	7,0	0,0
	z	10,0	0,0	90,0	0,0	0,0	0,0		80,0	0,0	10,0	10,0	0,0
	aa	100,0	0,0	0,0	0,0	0,0	0,0		85,0	10,0	0,0	0,0	5,0
	b	64,0	4,0	18,0	8,0	0,0	6,0		62,0	0,0	12,0	22,0	4,0
LAHENS	ab	51,3	5,0	8,8	30,0	0,0	5,0		100,0	0,0	0,0	0,0	0,0
	ac	80,0	0,0	15,0	5,0	0,0	0,0		90,0	5,0	0,0	5,0	0,0
	ad	96,7	0,0	3,3	0,0	0,0	0,0		100,0	0,0	0,0	0,0	0,0
POUFAT	ae	55,0	10,0	25,0	5,0	5,0	0,0						
	af	23,3	16,7	43,3	8,3	8,3	0,0						
	ag	70,0	5,0	20,0	5,0	0,0	0,0		96,7	0,0	0,0	3,3	0,0
	ah	60,0	0,0	0,0	40,0	0,0	0,0		100,0	0,0	0,0	0,0	0,0
	ai	66,7	0,0	13,3	6,7	0,0	13,3						

Table 11: Fractions of the different treatment systems of Solid and Liquid Manure (Percentages)

This table may supply additional data especially for the assessment of reduction measures due to existing treatment systems in EU.
Nevertheless, values for Biogas production, especially for ClimLPSmerge: **e, l** and **af** may be used with carefully and rather be substituted by other data, if possible. Indeed, ascribing ClimLPS to ClimLPSmerge may be inappropriate for this parameter due to particular legislations in each country. So, because the ClimLPSmerge gathered regions of different countries, we suggest not using these data. A special task is started via the RAMIRAN network to assess the Biogas production variability throughout EU 27 and will supply results in 2010.

3.2.6 – The land application techniques for Solid and Liquid spreading

		SOLID				LIQUID				
		Mechanical aerial spreading	Manual distribution	Other		Aerial spreading	surface spreading	Shallow injection	Deep injection	Other
BOMILK	a	98,0	2,0	0,0		66,0	22,0	12,0	0,0	0,0
	c	100,0	0,0	0,0		76,7	10,0	10,0	3,3	0,0
	d	90,0	10,0	0,0		100,0	0,0	0,0	0,0	0,0
	e	100,0	0,0	0,0		30,0	60,0	10,0	0,0	0,0
	f	50,0	50,0	0,0		100,0	0,0	0,0	0,0	0,0
	g	96,0	4,0	0,0		90,0	10,0	0,0	0,0	0,0
	h	100,0	0,0	0,0		34,3	37,9	21,4	5,7	0,7
BOMEAT	i	97,5	2,5	0,0		67,5	25,0	3,8	3,8	0,0
	j	100,0	0,0	0,0		82,5	12,5	5,0	0,0	0,0
	k	87,5	12,5	0,0		65,0	20,0	10,0	5,0	0,0
	l	100,0	0,0	0,0		38,0	32,0	30,0	0,0	0,0
	n	100,0	0,0	0,0		70,0	30,0	0,0	0,0	0,0
SHGOAT	o	98,6	1,4	0,0		0,0				
	p	95,0	5,0	0,0						
	q	74,0	26,0	0,0		46,7	16,7	16,7	20,0	0,0
PORCIN	r	96,7	3,3	0,0		70,0	13,3	6,7	6,7	3,3
	s	100,0	0,0	0,0		32,5	55,0	12,5	0,0	0,0
	t	94,3	5,7	0,0		94,3	5,7	0,0	0,0	0,0
	u	95,0	5,0	0,0		88,0	4,0	4,0	0,0	4,0
	v	100,0	0,0	0,0		0,0	0,0	15,0	85,0	0,0
	w					100,0	0,0	0,0	0,0	0,0
	x	100,0	0,0	0,0		87,5	5,0	5,0	0,0	2,5
	y	100,0	0,0	0,0		0,0	74,0	4,0	22,0	0,0
	z	100,0	0,0	0,0						
	aa	100,0	0,0	0,0		60,0	40,0	0,0	0,0	0,0
	b	80,0	18,0	2,0		65,0	20,0	10,0	5,0	0,0
LAHENS	ab	100,0	0,0	0,0		90,0	0,0	0,0	10,0	0,0
	ac	82,0	18,0	0,0		95,0	0,0	5,0	0,0	0,0
	ad	100,0	0,0	0,0		90,0	10,0	0,0	0,0	0,0
POUFAT	ae	93,3	6,7	0,0						
	af	91,3	8,8	0,0						
	ag	100,0	0,0	0,0		86,7	13,3	0,0	0,0	0,0
	ah	100,0	0,0	0,0		0,0	0,0	100,0	0,0	0,0
	ai	100,0	0,0	0,0						

Table 12: Fractions of the different land application techniques for Solid and Liquid Manure (Percentages)

The emission reduction measures during land application (surface spreading, shallow injection, deep injection in soil) are now taken into account in GHG inventories especially for NH_3.

In complement, the table 13 presented below bring a supplementary information with the fraction of Solid or Liquid manure applied on grasslands.

		SOLID			LIQUID			
		Mechanical aerial spreading	Manual distribution		Aerial spreading	surface spreading	Shallow injection	Deep injection
BOMILK	a	0,0			90,0	100,0		
	c	82,5			83,3	66,7	90,0	90,0
	d	10,0			40,0			
	e	20,0	0,0		70,0	70,0	70,0	
	f	0,0	10,0		0,0			
	g	20,0			26,0	27,5		
	h	31,0			30,0	74,2	81,8	58,8
BOMEAT	i	17,5	2,5		20,0	2,5	10,0	70,0
	j	53,3			90,0	20,0	10,0	
	k	45,0			30,0	40,0		
	l	63,6	0,0		30,0	91,1	68,9	
	n	50,0			80,0	80,0		
SHGOAT	o	34,3	100,0		0,0			
	p	0,0						
	q	60,0	32,5		53,3	16,7	16,7	13,3
PORCIN	r	100,0	90,0		100,0			
	s	10,0			10,0	10,0	100,0	
	t				40,0	0,0		
	u	0,0			7,5			
	v	10,0						
	w				90,0			
	x	10,0			13,3	10,0		
	y	2,5			0,0	6,7	30,0	20,0
	z	20,0						
	aa	6,7	0,0		0,0	0,0	0,0	
	b	2,5	15,0		10,0	13,3	10,0	10,0
LAHENS	ab	26,7			0,0			
	ac	10,0	20,0		50,0			
	ad	50,0						
POUFAT	ae	50,0						
	af	83,3						
	ag	32,5			66,7	100,0		
	ah	30,0					50,0	
	ai	20,0						

Table 13: Application on grasslands for Solid and Liquid Manure (Percentages applied on grasslands)

3.2.7 – Kind of incorporation

		SOLID					LIQUID			
		<6 hours	6-24 hours	>24 hours	None		< 6 hours	6-24 hours	> 24 hours	None
BOMILK	a	0	0	0	3		0	0	0	3
	c	0	3	0	0		0	3	0	0
	d	0	0	3	1		0	0	3	0
	e	0	3	0	0		0	3	0	0
	f	1	3	0	0		1	3	0	0
	g	0	2	3	0		0	1	3	0
	h	0	0	3	0		0	0	3	0
BOMEAT	i	2	3	1	0		2	3	1	1
	j	0	3	0	0		0	3	0	0
	k	0	0	0	3		0	0	0	3
	l	3	0	1	0		0	3	0	0
	n	3	0	1	0		0	3	0	0
SHGOAT	o	0	3	0	0		0	0	0	3
	p	0	1	3	0		0	0	3	0
	q	0	3	1	0		0	3	0	0
PORCIN	r	0	0	3	0		0	0	0	3
	s	0	0	3	0		0	0	0	3
	t	0	3	0	1		3	0	0	1
	u	0	3	0	0		1	3	0	0
	v	0	3	0	0		0	3	0	0
	w	0	0	3	0		0	1	1	3
	x	0	3	0	0		0	0	0	0
	y	0	3	0	0		0	1	0	3
	z	0	0	3	0		0	0	3	1
	aa	3	1	0	0		0	0	0	3
	b	0	3	0	0		0	0	0	3
LAHENS	ab	0	3	2	0		0	2	3	0
	ac	0	3	0	0		0	0	0	3
	ad	0	2	3	0		0	3	0	0
POUFAT	ae	0	3	0	0		0	3	0	0
	af	0	3	0	0		0	0	0	3
	ag	0	3	1	0		0	3	0	0
	ah	1	3	0	0		0	0	0	3
	ai	1	3	0	0		0	0	0	3

Table 14: Time spent before incorporation (3: dominant, 2: important, 1: used, 0: not used)

The incorporation in soils is described within 4 items from best efficiency to low efficiency:

- incorporation in soils < 6 hours
- incorporation in soils between 6 and 24 hours
- incorporation > 24 hours
- none incorporation

Raw data were analysed to fit with 4 modalities:

- 3=dominant
- 2=important
- 1=used
- 0=not used

In case some doubts exist between modalities, the option of assigning the worse efficiency was done. Indeed, one of the ClimLPSmerge wasn't filled and the value "None Incorporation" was assigned. The same option of assigning the worse efficiency was chosen when modalities were equally filled out.

In most cases, we can note that solid manure and liquid manure are similarly incorporated in soils.

3.2.8 – The periods of land application

		SOLID				LIQUID			
		Winter (November-February)	Spring (Mars-May)	Summer (June-August)	Autumn (September-October)	Winter (November-February)	Spring (Mars-May)	Summer (June-August)	Autumn (September-October)
BOMILK	a	0,0	85,0	7,5	7,5	0,0	76,7	23,3	0,0
	c	36,7	40,0	10,0	13,3	32,5	40,0	15,0	12,5
	d	10,0	50,0	20,0	20,0	0,0	60,0	10,0	30,0
	e	0,0	43,3	20,0	36,7	0,0	33,3	13,3	53,3
	f	15,0	60,0	0,0	25,0	5,0	60,0	0,0	35,0
	g	14,0	28,0	20,0	38,0	8,0	36,0	22,0	34,0
	h	25,6	34,4	11,1	28,9	8,5	42,3	29,2	20,0
BOMEAT	i	0,0	25,0	2,5	72,5	0,0	42,5	2,5	55,0
	j	27,5	25,0	17,5	30,0	18,0	44,0	28,0	10,0
	k	12,9	28,6	11,4	47,1	6,7	33,3	10,0	50,0
	l	7,5	43,3	17,5	31,7	9,1	44,5	17,3	29,1
	n	16,7	63,3	3,3	16,7	25,0	55,0	10,0	10,0
SHGOAT	o	1,7	71,7	10,0	16,7				
	p	0,0	30,0	25,0	45,0				
	q	24,0	18,0	16,0	42,0	6,7	46,7	13,3	33,3
PORCIN	r	0,0	80,0	20,0	0,0				
	s	0,0	50,0	0,0	50,0	0,0	60,0	15,0	25,0
	t	8,6	35,7	20,0	35,7	0,0	44,3	11,4	44,3
	u	40,0	10,0	0,0	50,0	18,0	18,0	12,0	52,0
	v	5,0	40,0	30,0	25,0	0,0	70,0	25,0	5,0
	w					0,0	40,0	30,0	30,0
	x	10,0	60,0	0,0	30,0	10,0	37,5	20,0	32,5
	y	8,0	70,0	2,0	20,0	0,0	80,0	14,0	6,0
	z	0,0	80,0	0,0	20,0	0,0	80,0	0,0	20,0
	aa	0,0	40,0	30,0	30,0	3,3	63,3	23,3	10,0
	b	8,0	36,0	8,0	48,0	11,0	35,0	17,0	37,0
LAHENS	ab	4,3	37,1	22,9	35,7	30,0	50,0	10,0	10,0
	ac	10,0	27,5	22,5	40,0	0,0	10,0	60,0	30,0
	ad	0,0	70,0	0,0	30,0				
POUFAT	ae	16,7	43,3	6,7	33,3				
	af	31,3	22,5	12,5	33,8				
	ag	22,5	12,5	0,0	65,0	30,0	0,0	0,0	70,0
	ah	0,0	60,0	20,0	20,0	0,0	60,0	20,0	20,0
	ai	0,0	60,0	20,0	20,0				

Table 15: Periodicity of the land application of solid and liquid manure (%)

Table 15 deals with main seasons when the spreading of solid and liquid manure takes place. In complement to the table 15, the fractions of land application on grasslands in function of the season is presented in table 16. Consequently, to modulate the calculation of emissions

whereas manure is applied in arable lands or grasslands is becoming possible using the questionnaires' results.

		SOLID				LIQUID			
		Winter % on grassland	Spring % on grassland	Summer % on grassland	Autumn % on grassland	Winter % on grassland	Spring % on grassland	Summer % on grassland	Autumn % on grassland
BOMILK	a	0,0	0,0	0,0	0,0	0,0	55,0	25,0	5,0
	c	35,0	55,0	15,0	15,0	75,0	80,0	63,3	63,3
	d								
	e	0,0	10,0		10,0	0,0	40,0	100,0	10,0
	f					0,0	0,0	0,0	15,0
	g	33,3	15,0	0,0	6,7	10,0	46,7	23,3	36,7
	h	35,0	33,3	46,7	55,0	55,7	64,5	78,9	54,2
BOMEAT	i	0,0	37,5	2,5	60,0	0,0	37,5	2,5	60,0
	j	42,5	35,0	52,5	55,0	52,5	75,0	82,5	52,5
	k	50,0	0,0		30,0	20,0	40,0	20,0	20,0
	l	96,7	63,0	100,0	68,0	86,7	86,7	86,7	64,4
	n	46,7	53,3	33,3	50,0	65,0	60,0	40,0	50,0
SHGOAT	o	20,0	28,0	20,0	28,0	0,0			
	p	0,0	0,0	0,0	0,0				
	q	40,0	26,7	20,0	40,0	10,0	60,0	13,3	36,7
PORCIN	r								
	s					0,0	30,0	50,0	50,0
	t	80,0	80,0	80,0	80,0	0,0	80,0	0,0	80,0
	u	0,0	0,0	0,0	0,0	5,0	0,0	0,0	0,0
	v	0,0	5,0	0,0	10,0	0,0	30,0	55,0	80,0
	w					100,0	80,0	100,0	90,0
	x					50,0	30,0	26,7	35,0
	y	0,0	7,5	25,0	0,0	0,0	5,0	56,7	26,7
	z	0,0	10,0	0,0	20,0	0,0	10,0	0,0	20,0
	aa	0,0	0,0	0,0	0,0	0,0			0,0
	b	0,0	13,3	10,0	20,0	0,0	13,3	30,0	10,0
LAHENS	ab	0,0	20,0	40,0	6,7	0,0	0,0	0,0	0,0
	ac	0,0	0,0	0,0	0,0	0,0	0,0	0,0	15,0
	ad	0,0				0,0			
POUFAT	ae	100,0	100,0		100,0				
	af	83,3	83,3	0,0	83,3				
	ag	0,0	10,0		0,0	0,0			0,0
	ah	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	ai		10,0		10,0				

Table 16: Fractions of land application on grasslands in function of the season (%)

With the help of the previously presented tables, one can make maps to present the results. An example of map regarding the percentages of manure managed in liquid form is presented in annexe 3.

Conclusions

1. The distribution and the analysis of the questionnaires allowed us to capitalize on 176 replies.
2. Unfortunately, we haven’t received enough replies for each groups of regions with similar livestock production systems and climate types (ClimLPS)
3. Consequently, we had to propose a method to ascribe descriptive factors to region types lacking data based on the LPS and Climate maps provided by the JRC. In some cases, due to the poor rate of replies, these aggregations lead to a high number of merged regions and we finally obtained 34 “ClimLPSmerge”.
4. Nevertheless, the analysed results enable possible alternatives or supplementary information in support to the GGELS project.

Glossary

ClimLPS:	Association of the Livestock Production System and the climate type
ClimLPSmerge:	Merging groups of similar ClimLPS in response to a poor rate of questionnaires' replies
EF:	Emission factors
GGELS:	Greenhouse Gas from the European Livestock Sector
GHG:	Greenhouse Gases
JRC:	European Joint Research Centre
LPS:	Livestock Production System

Annexes

Annexe 1: Example of questionnaire for Italy

Annexe 2: Location of regions which have obtained at least 1 answer whatever the species chosen by experts

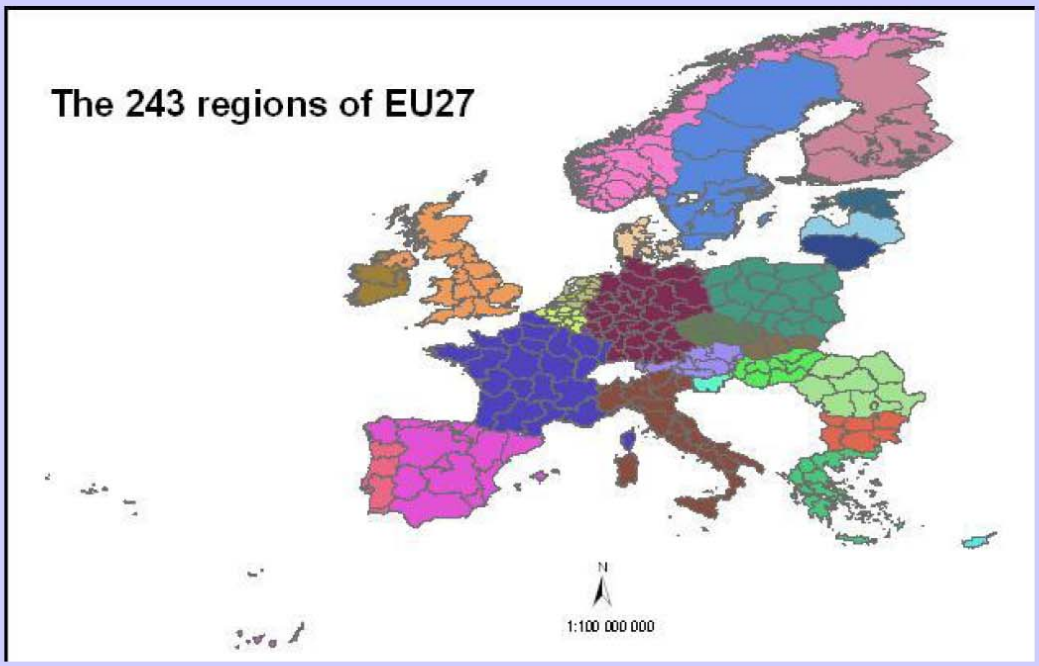
Annexe 3: Map obtained with the questionnaires' results for Dairy Cattle - % of liquid manure systems

Annexe 1: Example of questionnaire for Italy (Dairy Cattle)

General Information

We are currently reviewing the impacts of livestock agriculture across the Europe as part of an EU project GGELS (click "Next" for more information). Good information is crucial and we would be very grateful of your knowledge with respect to the sectors and regions of Europe that you know about. We would thus be grateful if you can find 20 minutes or so to complete this questionnaire for us. Thank you in advance for your kind help.

Note: If you wish, we will send you the synthesis of the questionnaires analysis.



Note:

☐ **To skip the "More Information" section, tick the box, and then click "Next", otherwise, just click "Next".**

More information

In order to formulate an appropriate answer to the growing political and social concern about livestock's contribution to climate change, the Directorate-General for Agriculture and Rural Development commissioned a study to the European Commission to estimate livestock GHG emissions in the EU context. This became the GGELS project (Greenhouse Gas from the European Livestock Sector). As a part of this project, a crucial challenge is estimating GHG emissions during the handling, processing and storage of livestock manure, as well as subsequent emissions following its application to land : and all this with a suitable accuracy. It is thus crucial to improve the knowledge base on manure management throughout the EU27.

The Joint Research Center (JRC) based at Ispra in Italy are coordinating the project for the Commission. They have already carried out a detailed analysis dividing Europe into 243 regions and ascribing to each to one of a list of descriptions which fits closest reflecting geographic and agronomic factors. The objective is now to look more closely at a selection of representative regions for each class of livestock system. We are only asking selected people to give information for the country or region that they have expert knowledge for. Overall, about 100 experts will be contacted across Europe.

The GGELS project characterises production and assesses emissions at sub-national region level. The goal of the present questionnaire is to describe these regional production descriptions with information on the related typical manure management (i.e. processing, storage and application). A separate study will be done for each farm animal species.

Contact Information

Please complete boxes marked with an ""*

* *Contact Information*

Name:

Company or organisation*:

Address:

City/Town:

Postal Code:

Professional activity:

Prefered Email Address*:

* *Please select one of the species you have been asked to provide information on (cf. invitation letter).*

- ◯ **Dairy Cattle (milk production)**
- ◯ **Beef Cattle (meat production)**
- ◯ **Fattening Pigs and Sows**
- ◯ **Sheep and Goats (both milk and meat production)**
- ◯ **Laying Hens (egg production)**
- ◯ **All other Poultry (meat production)**

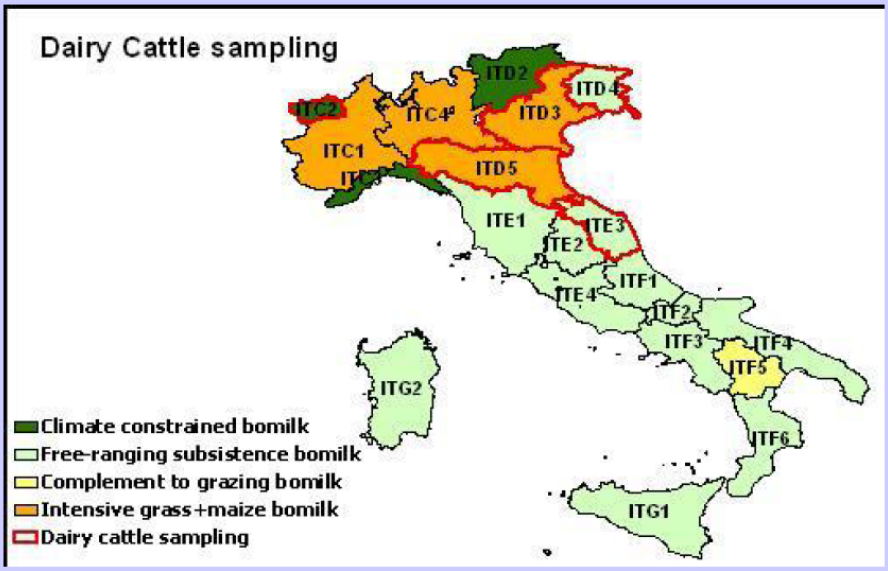
Note:
You will be asked at the end, if you wish to complete the same questionnaire for other species.

Selection of the production system

Below is a map of the country divided into regions coloured according to the dominant livestock system for the animal type chosen. Those regions of special interest to us are outlined in red. Firstly you need to select a common production system relating to one (or more) of these regions that will apply to your following answers.
Note: You will be asked at the end, if you wish to complete the same questionnaire for other production systems.

*** *Please select the production system - the corresponding definitions of main farm type are given below the map.***

- ◯ **Climate constrained bomilk**
- ◯ **Intensive grass+maize bomilk**
- ◯ **Free-ranging subsistence bomilk**



Definitions of farm types:

"Climate constrained BOMILK" corresponds to regions for which the milk production is considered of primary importance. Regions have large fodder grass areas at their disposal but producers prefer to use marketed animal feeds. It is assumed that despite large grass areas, the biomass production is low because of climatic reasons.

"Free-ranging subsistence BOMILK" corresponds to regions for which the milk production is considered as a subsistence production. Farms are smalls with a very low share of fodder areas, a medium autonomy for energy supply from fodders and a low stocking density. Although feedstuffs and veterinary products represent a very large proportion of the production costs, the amount invested remains very limited.

"Complement to grazing BOMILK" corresponds to regions for which the milk production is not considered of primary importance : other livestock activities are conducted in parallel and contribute at least the same proportion of incomes. However, because of a shorter grazing period, the feeding strategy is based on a mixed of pasture grazing and fodder maize supplies during winter period.

"Intensive grass+maize BOMILK" production : Dairy Cattle activity is of first importance and even preponderant. The utilization of grass and maize allows regions to sustain large Dairy Cattle herds at medium to high stocking density. Dairy Cattle production in these regions is very intensive based on a mixed keeping strategy.

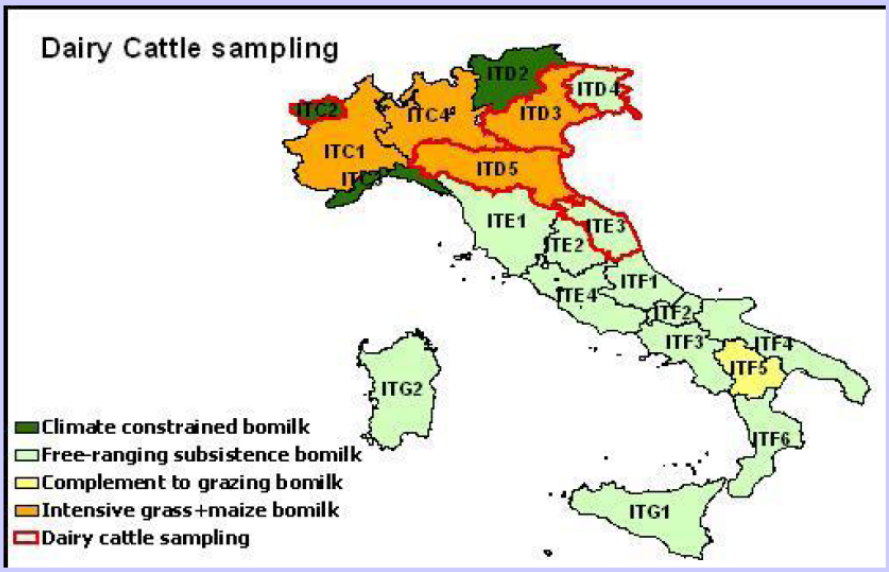
Selection of regions - Climate constrained bomilk

Now please select one (or more) regions that apply to the production system that you have selected. Your following answers will relate only to the production system and region(s) selected. Note: You will be asked at the end, if you wish to complete the same questionnaire for other regions and/or for other production systems.

* ***Please select region(s) (See the map):***

☐ **ITC2 Valle dAosta**

☐ **Input the code of another region if you feel that you have more information:**



Manure storage systems

Please remember that the questions on this page are specific to the regions and species you have selected.

Percentage of animals kept on solid/liquid manure system (%)

	Percentage (sum of column should be 100%)
Solid manure system	
Liquid manure system	

Total percentage of time animals spend indoors (%) compared to time spend outdoors

	% of time Indoors
Winter (Nov to Feb)	
Spring (Mars to May)	
Summer (June to August)	
Autumn (September to October)	

Note: % Time indoors = 100%- %Time outdoors

Storage capacity

	SOLID MANURE STORAGE (sum of column may be 100%)	LIQUID MANURE STORAGE (sum of column should be 100%)
< 2 months		
2-6 months		
6-10 months		
> 10 months		

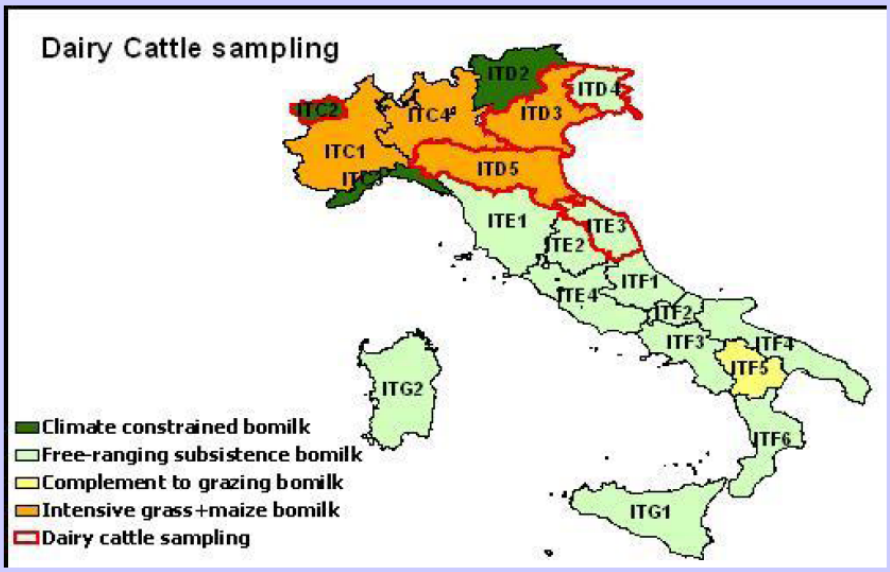
Selection of regions - Free-ranging subsistence bomilk

Now please select one (or more) regions that apply to the production system that you have selected. Your following answers will relate only to the production system and region(s) selected. Note: You will be asked at the end, if you wish to complete the same questionnaire for other regions and/or for other production systems.

* ***Please select region(s) (See the map):***

☐ **ITD4 Friuli-Venezia Giulia** ☐ **ITE3 Marche**

☐ **Input the code of another region if you feel that you have more information:**



Characteristics of manure storage systems

Please remember that the questions on this page are specific to the regions and species you have selected.
Some combinations may be unused (for instance : Field storage - Covered).

Field storage

Concrete floor

Covered concrete floor

Characteristics of Solid Manure Storage

	Percentage (sum of column should be 100%)	%Covered
Field storage (as heap)		
On farm storage (within constructed stores: concrete, wood or steel)		
Other		

Please specify below

below ground storage

above ground storage

covered above ground storage

lagooning systems

Characteristics of Liquid Manure Storage

	Percentage (sum of column should be 100%)	%Covered	%Below ground
On farm storage (within constructed stores : concrete, wood, steel)			
Lagooning system			
Other			

Please specify below

Treatment systems

Please remember that the questions on this page are specific to the regions and species you have selected.

Anaerobic digestion

Composting

Drying processes

Treatment systems - Solid Manure

	Percentage (sum of column should be 100%)
No treatment	
Anaerobic digestion (biogas production)	
Composting	
Drying processes	
Incineration	
Other	

Please specify below

Anaerobic digestion

Aerobic processes

Solid Separation

Treatment systems - Liquid Manure

	Percentage (sum of column should be 100%)
No treatment	
Anaerobic digestion (biogas production)	
Aerobic processes (Nitrogen removal)	
Solid separation	
Other	

Please specify below

Land application

Please remember that the questions on this page are specific to the regions and species you have selected.
Some combinations may be unused (for instance : Manual distribution - Incorporation).

Aerial spreading

Manual distribution

Land Application of Solid Manure

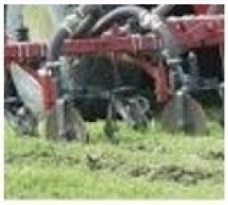
	Percentage (sum should be 100%)	Incorporation	% on grassland
Mechanical aerial spreading (all types)			
Manual distribution			
Other			

Please specify below

Aerial spreading

Surface spreading

Shallow injection


Deep injection

Land Application of Liquid Manure

	Percentage (sum should be 100%)	Incorporation	% on grassland
Aerial spreading (splash plate)			
surface spreading (band spreader, trailing hoses...)			
Shallow injection (trailing shoe...)			
Deep injection			
Other			

Please specify below

Period of Land application of manure

	SOLID MANURE	% on grassland	LIQUID MANURE	% on grassland
Winter (November-February)				
Spring (Mars-May)				
Summer (June-August)				
Autumn (September-October)				

Note: Sums of SOLID MANURE and LIQUID MANURE columns should be 100%.

To finish off

Are the data you have filled valid for ? :

- ☐ National scale
- ☐ Regional scale

What is the original source of information?
Please tick all that apply:

- ☐ Official document
- ☐ Bibliographic review
- ☐ Technical report
- ☐ Dedicated Website
- ☐ Official statistics
- ☐ Your expert knowledge
- ☐ Other

Other (please specify)

Could you suggest us someone else capable of responding to this questionnaire for other regions or animal species not covered by your answers?

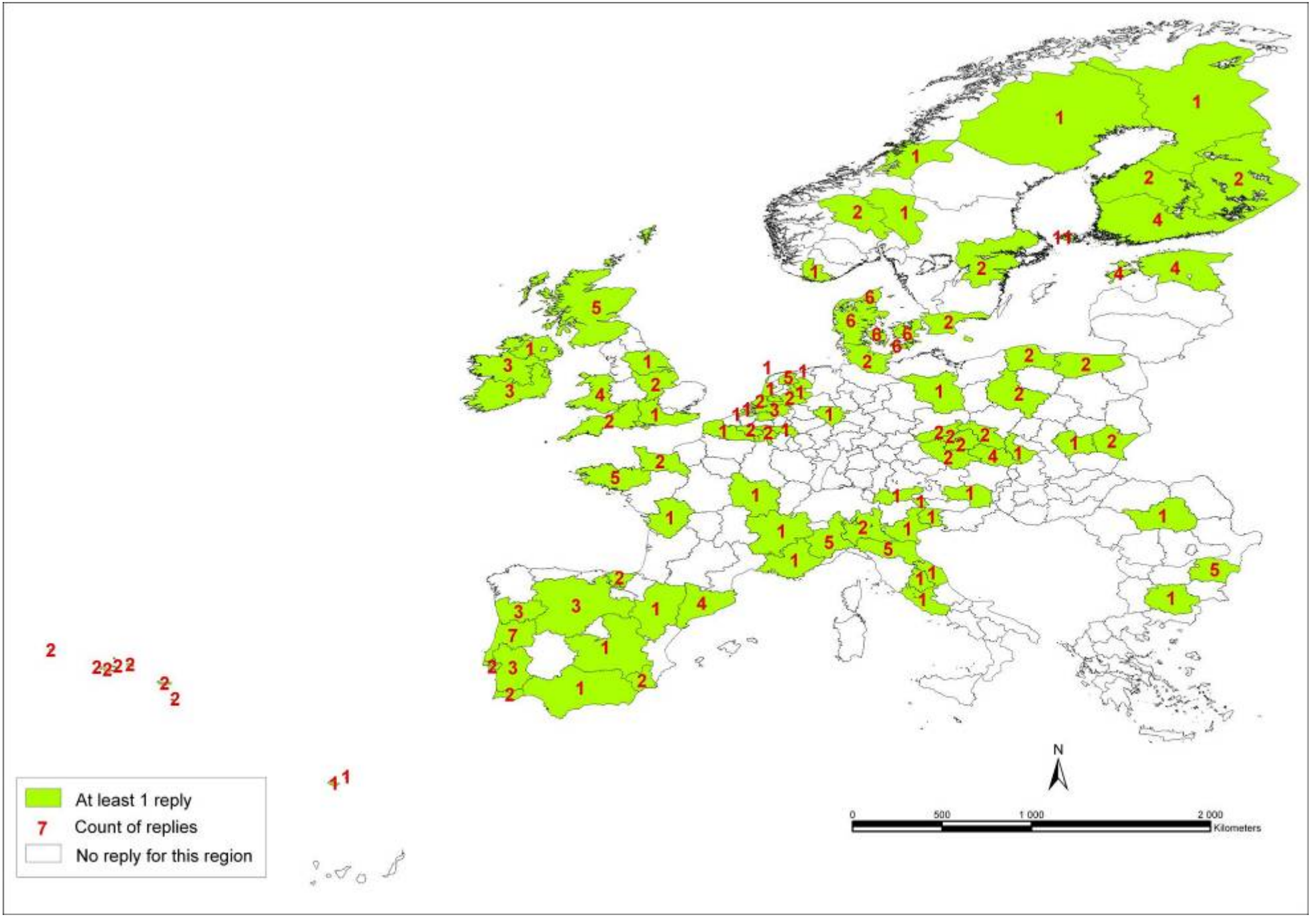
Name:	
Company:	
Address:	
City/Town:	
Postal Code:	
Country:	
Email Address:	
Phone Number:	

Would you like to recieve the synthesis of the questionnaires analysis?

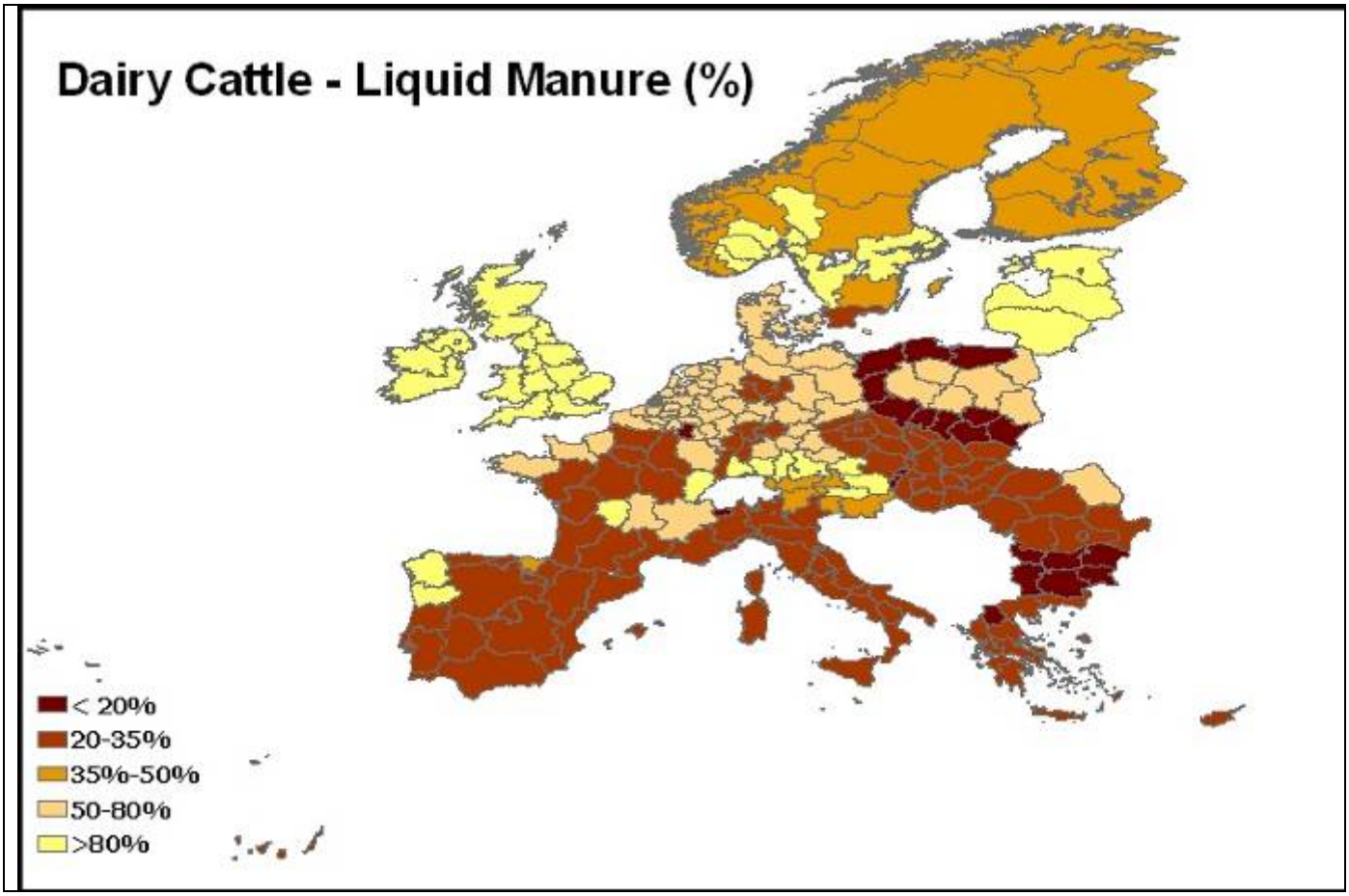
○ YES ○ NO

If you wish, you can inform us of any comments or suggestions about this questionnaire?

Annexe 2: Location of regions which have obtained at least 1 answer whatever the species chosen by experts


At least 1 reply
7 Count of replies
No reply for this region
N
0
500
1 000
2 000
Kilometers

Annexe 3: Map obtained with the questionnaires' results for Dairy Cattle - % of liquid manure systems



Map obtained with the questionnaires' results for Dairy Cattle - % of liquid manure systems